Commercial and Sublime: Popular Astronomy Lectures in Nineteenth Century Britain

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Thesis submitted for the degree of Doctor of Philosophy

(PhD) in History and Philosophy of Science

March 2015

I, Hsiang-Fu Huang, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

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Abstract

This thesis discusses the practitioners, sites, curriculums, apparatus and audiences of popular astronomy lecturing in nineteenth-century Britain. Lecturers who were active approximately between 1820 and 1860 are the focus. This thesis emphasises popularisers who were not scientific elites, including C. H. Adams (1803-1871), George Bartley (c. 1782-1858), and D. F. Walker (1778-1865). Activities of private popularisers are compared with those in scientific establishments, such as the Royal Institution. Private entrepreneurs were not inferior to institutional competitors and enjoyed popularity among audiences. Until the 1860s, popular astronomy lecturing was a shared arena of institutional and private popularisers.

A theatrical turn occurred in the popular astronomy lecturing trade before 1820. Popularisers moved lectures into theatres and adopted theatrical facilities in performance. They developed large onstage devices, such as the transparent orrery, for achieving scenic and dramatic effects. These onstage astronomical lectures were a phenomenon in the early nineteenth century and were usually performed during Lent.

This thesis highlights ‘commercial’ and ‘sublime’ features in popular astronomy lecturing of this period. The lecturing trade had an economic side involving paying, selling, profits and competitions in everyday practices. In addition to this material aspect, lectures also had emotional appeal. Lecturers exploited the sublime: the display of beautiful visual representations, the use of natural theology rhetoric, plus religious and moral reflections, all appealed for the sublimilty of the universe and the Creator behind it.

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Acknowledgements

PhD research is a long journey and now I come to the end. There is no curtain call in the journey's end. However, I view the acknowledgements as the curtain call for those who are 'behind the scenes'.

First and foremost, a tribute goes to my supervisors. I thank Joe Cain and Simon Werrett, who made enormous efforts to guide my research and to provide necessary supports. We have spent much wonderful time in enjoyable discussions. I especially enjoy Joe's extrovert philosophy – Joe is never an armchair investigator; he would stroll all over the streets of London and the Crystal Palace Park rather than hiding in a library.

I also wish to give a special thank to Jane Gregory, who was my supervisor in the first year of my PhD study. This research project was initially granted admission by her. Jane helped me to accommodate in the UCL and London; without her, my PhD research would not begin.

The UCL Department of Science and Technology Studies provides all important resources and supports throughout the course of my study. I have an excellent group of colleagues, whether faculty members, staff, alumni, visiting researchers, or fellow PhD students. I cannot list every name but sincerely appreciate my colleagues' company. Among them, I especially thank Jon Agar and Chiara Ambrosio, who are the graduate tutors. I also thank Alastair Tatam, whose administrative support is extremely helpful.

During the course of my study, many people contributed their professional knowledge, commented on my points, or provided useful information. I appreciate these people's advice. Among them, I especially thank these three: Geoffrey Cantor, who clarified the religious context in nineteenth-century British science and improved my discussions concerning religion in this thesis; Jonathan Topham, who provided insights and useful references on natural theology and nineteenth-century periodicals; Iwan Morus, who commented on the part of astronomical performances in theatres. I also wish to thank Richard Bellon, Tim Boon, Martin Bauer, Alison Boyle, Rita Cain, Hasok Chang, Silvia De Bianchi, Jonathan Everett, Jean-Baptiste Gouyon, Rebekah Higgitt, Frank James, Melanie Keene, Michael Kliegl, Yuto Ishibashi, Don Leggett, Bernard Lightman, Dan Lloyd, William Macauley, Felicity Mellor, Thomas Rose, Charlotte Sleigh, James Sumner, and Haiyan Yang.

Many people kindly helped proofread my final drafts. English is not my first language, so these volunteers made great efforts to correct my use of language and to sharpen my writing. I am much obliged to Joe Cain, Geoffrey Cantor, Rupert Cole, Melanie Keene, Oliver Marsh, Matthew Paskins, and Simon Werrett. This thesis would be more flawed without the above proofreaders.

The transcription of Samuel James Arnold's *Ouranologia* is a very important project in my research. It was a quite challenging task and would not be completed without the support of the UCL Department of Science and Technology Studies. The fruits of my labours are shown in Appendix B. I would like to thank Aileen Robinson, who first reminded me to notice this manuscript at the British Library. I also appreciate that Tom O'Donnell proofread my transcript.

Many archives, libraries and museums, contributed materials to my research. I got many helps from the staff of these institutions during my investigation. Unfortunately I cannot list every librarian who had given me assistances, so I only list the organisations: the UCL libraries; the Royal Institution of Great Britain; the Royal Astronomical Society; the Science Museum; the Victoria and Albert Museum; the British Library; the Manchester Archives; the Derby Museums and Art Gallery; the Bill Douglas Cinema Museum, Exeter; the Priaulx Library, Guernsey; the Jodrell Bank Discovery Centre, Manchester. I also thank the British Society for the History of Science, which awarded me travel grants to present my research in several conferences.

Finally, and literally, I owe my parents. My PhD study would not realise without their supports, whether financial or emotional. I am much obliged to my parents.

There is an old popular saying in Chinese: "So many people we have to thank, therefore we thank heavens." Indeed, I encountered many wonderful people during the course of my research. I regret that I cannot list them all in the acknowledgements. Thank heavens, I complete this thesis.

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List of Abbreviations

BAAS	British Association for the Advancement of Science
BL	British Library
MA	Manchester Archives (Manchester Libraries, Information and Archives)
ODNB	*Oxford Dictionary of National Biography*
OED	*Oxford English Dictionary*
RAS	Royal Astronomical Society
RI	Royal Institution of Great Britain
(MS) GB	Guard Book
(MS) LE	Index to lectures (Index for Friday evening meetings)
MM	Managers' Minutes
RTS	Religious Tract Society
SM	Science Museum, London
SDUK	Society for the Diffusion of Useful Knowledge
V&A	Victoria and Albert Museum, London

Notes on Currency

In the nineteenth century, Britain did not use a decimal currency. The money was divided into three units: pounds (£), shillings (s.), and pennies (d.). The guinea was a coin circulated before 1816 and its value was officially fixed at twenty-one shillings. After 1816, the term *guinea* was still common in colloquial use and charge of professional fees. The value of each unit is as follows:

1 guinea = 1 pound and 1 shilling = 21 shillings (21s.)

1 pound (£1) = 20 shillings (20s.)

1 shilling (1s.) = 12 pennies (12d.)

Chapter 1 Introduction

This introductory chapter will give an overview of my thesis. This thesis is about 'popular science', the practice which links science to audiences in public. It deals with a broader community rather than being confined to the scientific intelligentsia. To provide the big picture regarding social contexts, it is necessary to set the scene in this introduction.[1] The frame of this introduction is therefore as follows: First of all, my three central arguments will be highlighted in Section 1.1. Then I will clarify the social background of Britain in the early nineteenth century, especially focusing on the prevalence of science and its functions for society, in Section 1.2. The development of public scientific lecturing, and the culture of urban entertainments, was crucial to the shaping of nineteenth-century popular astronomy. The contexts of the above two perspectives will be explained in Sections 1.3 and 1.4. After setting the scene, Section 1.5 is the synthesis of my central arguments, in which I will explain further the theme 'commercial and sublime'. I will also show the structure of my thesis.

1.1 Main Thesis

An article in *Chambers's Edinburgh Journal*, published in 1847, commented on the phenomenon of popular astronomy in Britain.[2] The topic of this essay was the movement of the sun through space; it was a typical account

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[1] This is exactly what Morrell and Thackray did in their book on the early years of the BAAS, in which the first chapter is 'Knowledge in Context' that depicts the wider framework. See Morrell and Thackray (1981), Introduction and ch. 1, pp. 1-34.

[2] 'The Central Sun', *Chambers's Edinburgh Journal*, no. 163 (13 February 1847), pp. 99-101.

introducing recent scientific progress in an all-inclusive journal to common readers. The anonymous author started the article with a brief remark on the prevalence and popularity of astronomical lectures: "LECTURES on astronomy have for many years been highly popular with a large portion of the public". He continued: "in the smaller provincial towns, the arrival of an itinerant lecturer, and the delivery of his 'course of three,' illustrated by an orrery, was an event productive of general satisfaction, and served to enliven one or two of the dreary weeks of winter." These astronomical lectures were presumably informative and amusing, as the journalist described: "Something was generally added that largely excited the wonder of the auditors, who went away fully persuaded that they had learned the whole scheme and compass of astronomical science – for them it had no more secrets."[3]

This remark of the *Chambers's Edinburgh Journal* article was a clear observation about the prosperity of contemporary astronomical lecturing. Popular lectures on astronomy were a phenomenon in Britain throughout the nineteenth century. Different lectures were delivered in various sites, and the speakers were not necessarily working astronomers. Several celebrated astronomers, such as the Astronomer Royal George Biddell Airy (1801-1892) and Cambridge professor Robert Stawell Ball (1840-1913), undoubtedly contributed great efforts to popularisation. Nevertheless, there were far more private showmen who engaged in the business of popular astronomy lecturing. Historians pay scant attention to these private entrepreneurs, who were neither scientific elites nor practising astronomers.

The term 'private lecturer/showman/entrepreneur' defined in this thesis

[3] *Ibid.*, p. 99.

means people who did not have institutional affiliations but ran lecturing business. A broader term ‘populariser’ is also used but it covers all kinds of practitioners involving in popular science. The term ‘practising/working astronomer’ means practitioners who involved in mathematical calculations or observations of celestial objects, usually relating to original research.

My thesis explores the category of popular astronomy lecturers who were not elite institutional men of science in the nineteenth century. The period I emphasise is approximately between 1820 and 1860. Three central arguments will be developed in this thesis:

1. A trend of institutionalisation in the early nineteenth century did not overwhelm private entrepreneurs in the market. The astronomy lecturing trade remained a shared arena of private and institutional practitioners.

2. Popular astronomy lecturing had a theatrical turn before the commencement of this period, and continued through it. This development related to the use of the theatre, including physical facilities and showmanship.

3. Popular astronomy in the nineteenth century had both commercial and sublime components: ‘commercial’ means the economic aspect of popular astronomy in the market; ‘sublime’ qualities were widely exploited by contemporaries for emotional appeal.

My first argument connects with my analysis of the affiliations of lecturers in Chapter 2. Despite the fast growth of scientific institutions in this period, private lecturers continued thriving until the 1860s. Private entrepreneurs occupied a noticeable place in the popular astronomy lecturing trade. They were not inferior to institutional competitors in terms of popularity among and influence over audiences.

The second argument regards the theatrical trend in the market. Some popularisers moved astronomy lectures into theatres and adopted theatrical facilities in performance. These lecturers developed large onstage devices for achieving scenic effects, and their performance emphasised sensational amusement in addition to scientific instruction. The theatrical turn and activities of astronomical popularisers in theatres will be clarified in Chapter 3 and Chapter 4. The apparatus used on stage will be discussed in Chapter 5.

The third argument, last but not least, highlights the common strategies and practices which many lecturers employed. The display of beautiful visual representations, the use of natural theology rhetoric and connections with religious sentiment, all appealed for the sublimity of the universe and the Creator behind it. In addition to sublime features, the lecturing business involved profits, competitions, responsive lecturers and audiences. These were commercial features of the everyday practices of the trade. The theme of 'commercial and sublime' runs through my entire thesis; I will explain this theme further in Section 1.5.

The focus on private lecturers and the periodization in this thesis have ample justification. The means and localities of private lecturers' practices were often at odds with institutional scientific elites. Many astronomical lectures delivered by private entrepreneurs had links with, but were not limited to, Lent and the transparent orrery in theatres.[4] Astronomical shows had benefited from the

[4] An orrery is a mechanical model invented in the early eighteenth century to illustrate the motion of the planets around the sun. The transparent orrery is an

conventional ban on dramatic performance in theatres during Lent. These astronomical exhibitions reached their heyday by the 1820s, when some noticeable figures discussed in this thesis such as D. F. Walker and George Bartley had already commenced their businesses, as Figure 1.5 shows. However, private astronomy lecturing declined fast after the 1860s, partly due to the lift of the ban and the change of recreational fashions. Despite the widespread popularity these private entrepreneurs enjoyed at the time, their contributions to popular astronomy remain obscure and are largely neglected by modern historians. The activities of private entrepreneurs provide a comparison with those done by institutional men of science, such as the discourses delivered by Airy at the Royal Institution of Great Britain.

1.2 Science in Context

This section starts with the social context of the expansion of science in nineteenth-century Britain. The growing power and pervasiveness of science in daily life was a phenomenon the contemporaries could not overlook. "Science is no longer a lifeless abstraction floating above the heads of the multitude," a contemporary author wrote: "It has descended to earth. It mingles with men. It penetrates our mines. It enters our workshops. It speeds along with the iron courser of the rail."[5] Science was also a fashionable conversation piece, which drew the general public's attention and fascination. Science was also full of practical uses, of which Henry Brougham, the Whig politician and reformer, asserted that "there is hardly any man who may not gain some positive

enlarged version later developed for the use on stage. I will discuss further details of orreries in Section 1.3 and Chapter 5.

[5] Garvey (1852), p. 3; Secord (2000), p. 522.

advantage in his worldly wealth and comforts, by increasing his stock of information."[6] The visions of science were also reflected in two representative bodies which were established around this period: the Royal Institution of Great Britain in 1799 and the British Association for the Advancement of Science (BAAS) in 1831. The proposal of the Royal Institution sought to launch an institution "[f]or diffusing the Knowledge, and facilitating the general Introduction, of Useful Mechanical Inventions and Improvements; and for teaching, […] the application of Science to the common Purposes of Life."[7] Half a century later, Michael Faraday, the favourite son of the Royal Institution, became the embodiment of this ideal to the general public. Faraday's involvement in public affairs, such as his advice on table-turning and the pollution of the Thames, consolidated the image of a man of science as a rational and useful agent (Fig. 1.1).

Nevertheless, science itself was undergoing a tremendous transformation during this period. The younger generation of scientific intellectuals such as Charles Babbage (1791-1871) claimed that British science was declining; the BAAS was initiated to avert the decline and to reform the sluggish somnolence of the Royal Society.[8] Historians of science would concur that the long nineteenth century was a pivotal age, in which many characters of modern science were shaping.[9] William Whewell (1794-1866) coined the term

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6 Brougham (1827), p. 6.

7 RI: MM, vol. 1: 1 (9 March 1799); James (2002a), p. 1.

8 The argument of decline of British science refers to Babbage (1830). For the origins and early years of the BAAS, see Morrell and Thackray (1981; 1984).

9 Many scholarly works discuss the big picture of the transformation of science in this period; for example, see Secord (2014); Knight (2009); Bowler and Morus (2005); Russell (1983). For a general introduction on astronomical disciplines, see

‘scientist’ in the meeting of the BAAS in 1833 and later printed in a book review to describe the practitioners with reference to their pursuits. This proposal was initially not serious and slow adopted.[10] A career in science was unprecedented before, yet the trend that science transformed into a profession started during this period. Some historians use the controversial term of ‘professionalisation’ to describe this process.[11]

This period was also the time of an extensive transformation in many aspects other than science.[12] British society in the early nineteenth century was long in a state of political and religious transformation. While conservatives worried about revolutions, reformers called for political and social change. Political conflicts were also related to religion, with quarrels between and within the established church, Nonconformists, and atheists.[13] All sides in this contest, whether Anglican Tories, atheist radicals, or anyone in between, had been aware of the usefulness and the soaring authority of science. They made use of science for their own purposes. While the Church and gentry saw science as the agent of revealing God’s design and the order of the universe, radicals saw

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Herrmann (1984).

[10] Ross (1962); *Quarterly Review*, vol. 51 (1834), pp. 58-61.

[11] For example, see Morrell (1990). Further discussions on professionalisation of science are in Chapter 2.

[12] There has much literature on the social contexts of this period, covering different aspects from the Industrial Revolution to political upheaval. One most recent account is Secord (2014), in which the social background and the readership of science around the 1830s are well introduced. See also Morrell and Thackray (1981); Desmond (1989); Secord (2000); Fyfe (2012). For the discussions regarding Georgian society in the previous century, Elliott (2009) is a good example.

[13] Religious upheaval is an important issue in the nineteenth-century history of science. Secord (2000) has a comprehensive analysis of the impact of the book *Vestiges* on churches. Fyfe (2004) provides views from the evangelicals. I also refer to literatures on science and natural theology; for example, Brooke and Cantor (1998); Topham (2010a; 2010b).

science as a powerful instrument to endorse progressive ideas and to overthrow the establishment. For many nineteenth-century contemporaries, science was exploited as a tool for political, social and religious agendas.[14]

The advance of technology also had a drastic influence on the printing and publishing trades. Steam-powered printing machines made cheap and mass prints possible. A new class of readers emerged from this wave of low-priced popular literature.[15] Numerous cheap scientific publications for common readers sprouted during this period. The avid reformer of scientific education, Henry Brougham, founded the Society for the Diffusion of Useful Knowledge (SDUK) in 1826. A series of SDUK publications were launched within the next two decades under the supervision of publisher Charles Knight, including the *Penny Magazine* and the *Penny Cyclopaedia*. The periodical *Chambers's Edinburgh Journal*, mentioned at the beginning of Section 1.1, was another attempt among this army of affordable publications.[16]

This flood of cheap prints reflected not only the transformation of readership but also the creation of mass culture. The scale of audiences tremendously increased; the dissemination of scientific knowledge reached the masses rather than a limited number of elites. Robert Chambers, the publisher of *Chambers's Edinburgh Journal*, anonymously wrote a scandalous work, *Vestiges of the Natural History of Creation* (1844), which caused an immediate and lasting

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[14] Secord (2014), pp. 1-3; Morus (2006), pp. 5-8.

[15] One recent and readable scholarly work analysing the nineteenth-century printing trade is Fyfe (2012), which focuses on Scottish publisher William Chambers. See also Secord (2000), ch. 4, pp. 111-152.

[16] *Chambers's Edinburgh Journal* was created by William and Robert Chambers in 1832. It was dedicated to providing a miscellany of instructive articles at an affordable price to common readers. For the production of this journal and the comparison with the *Penny Magazine*, see Fyfe (2012), pp. 21-25.

sensation. Examples from the religious side included the *Bridgewater Treatises* (1833-1836) written by several celebrated scientific savants based on natural theology, and the *Monthly Series* (1845-1855) conducted by the evangelical Religious Tract Society (RTS). These literatures have attracted many historians' interest in recent years.[17] Aside from reading, lecturing was also an important channel of diffusing scientific knowledge. Lectures were conducted in various institutions, such as the Christmas series and the Friday evening discourse at the Royal Institution, in which Faraday had been deeply involved. Lectures were also held in Mechanics' Institutes, aimed at working-class audiences. Lectures also appeared in other venues which could be surprising to present-day readers, as I will elaborate in later chapters.

When the transformation of science caused the coining of the term 'scientist', the phrase 'popular science' also came into use. Jonathan Topham indicates that publications before 1820 seldom appeared under the designation 'popular science', yet the phrase rapidly came into regular usage after then. The new genre of popular publications was born of a social change. It appealed to a broader audience: a new class of readers covering not merely the Enlightenment bourgeois public but also the Industrial working-class people.[18] Popular science genre had multiple indications: it could be in terms of ease of understanding, or in terms of cheap price and mass production. Either indication exemplified the burgeoning mass culture in the early nineteenth

[17] For the *Penny Magazine*, see Scott Bennett (1982; 1984); Altick (1998). For *Chambers's Edinburgh Journal*, see Fyfe (2012). For *Bridgewater Treatises*, see Topham (1992; 1998); Brooke and Cantor (1998). For *Vestiges*, see Secord (2000). For the RTS publications, see Fyfe (2004). Topham (2007) has a fine introduction on popular science publishing in the early nineteenth century.

[18] Topham (2007). See also Gregory and Miller (1998), pp. 20-26, in which they describe the nineteenth century as the 'coming of age of popular science'.

century. The coining of popular science, in Topham's words, reflected a "diversification of reader audiences", a move to specialised and disciplinary science, and was "loaded with consciousness of the new social order".[19] The study of the history of popular science draws increasing attention despite the fact that popular science itself is never an easy and undisputed term.[20] Many researches in this area focus on popular scientific publishing in the nineteenth century, including the works of Jonathan Topham, James Secord, Aileen Fyfe and Bernard Lightman.[21] Another thread of scholarship is related to the scientific lecturing, spectacles and performance, such as the studies on the metropolitan spectacles of chemistry and electricity.[22]

Astronomy had been a field which held a distinct place in scientific lecturing prior to the coining of the term 'popular science'. As one of the oldest branches of science, astronomy retained strong connections with antiquity and humanity. The Enlightenment intelligentsia regarded astronomy as a traditional subject for liberal arts education and the cultivation of gentility.[23] Public lectures on natural philosophy in the eighteenth century usually contained astronomy in the curriculums. However, lecturing scenes in the eighteenth century were not similar to the experience of the nineteenth century. Some curriculums, apparatus and rhetoric in nineteenth-century astronomy lectures were

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19 Topham, *ibid.*, pp. 135-137, especially notice Topham's analysis of the multiple meanings of the word 'popular'. See also Lightman (2007b), pp. 9-13.

20 Cooter and Pumfrey (1994); Bowler and Morus (2005), ch. 16, pp. 367-390; Topham (2007); O'Connor (2009). See also the discussion about James Secord's rejection of the term 'popular science' in Section 1.5.

21 *Op. cit.* (17). See also Lightman (2007b).

22 For example, see Golinski (1992); Morus (1998; 2007); Bensaude-Vincent and Blondel, ed. (2008).

23 Walters (1997), p. 125.

inheritance from the previous century; other features of lecturing activities had large differences. To compare the continuity and differences of astronomy lecturing between the two periods, we must talk about the milieu of the lecturing trade in the eighteenth century.

1.3 Public Lecturing in the Eighteenth Century

Public lecturing on natural philosophy played a significant role in the diffusion of Newtonian science in eighteenth-century Britain. It was a new venture in association with Robert Boyle's experimental methods, Isaac Newton's mathematical principles and the flourishing scientific instrument trade in Britain. A few figures in the Royal Society, such as John Theophilus Desaguliers (1683-1744), had a profound influence on its early course of development.[24] By the mid-eighteenth century, a growing marketplace for public philosophical lectures had already formed in Britain. Many lecturers who commenced the business after Desaguliers were not necessarily members of the Royal Society at the beginning: Some were writers and teachers of natural philosophy; some were scientific instrument craftsmen. James Ferguson (1710-1776), Benjamin Martin (c. 1704-1782) and Stephen Demainbray (1710-1782), were examples of celebrated lecturers in the mid-eighteenth century.[25] Ferguson, in particular, was a key person whose works would shape

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[24] For Boyle's experimental philosophy and the Royal Society's role in public experiment demonstrations, see Shapin and Schaffer (1985), Golinski (1989) and Pumfrey (1991). The cause and the development of public lectures on Newtonian science are elaborated in Stewart (1992); Morton and Wess (1993); Elliott (2000). See also Huang (2013), a preliminary study of my current thesis, wherein the public lecturing trade in the eighteenth century is further discussed.

[25] James Ferguson and Benjamin Martin's life and works are discussed in Millburn (1973); King (1978), chs. 11 and 12, pp. 178-212. For Stephen Demainbray, see Morton and Wess (1993).

astronomical lecturing in the forthcoming decades into the nineteenth century. I will discuss Ferguson's influence on astronomical subjects further in later chapters. These itinerant lecturers were active not only in the metropolis but also in provincial towns; they often travelled between place and place, and some had affiliation with local literary and philosophical societies.[26] Pre-course subscription was a common arrangement for a lecturer to ensure the income and attendance at the discourse. Syllabus, regulation and charge were often advertised in a printed short account of the course (Fig. 1.2). These printed accounts also served as a promotion of lecturers' proficiency in this subject. Some lecturers were also respected authors, such as Ferguson and Martin, who regularly transformed their lectures into monographs.[27]

There had been a noticeable connection between natural philosophy lecturing and the instrument trade. Eighteenth-century public lecturing on natural philosophy had a strong instrument-orientated character: the core of the curriculum was usually based on the demonstration of experiments and the use of apparatus; many lecturers either had instrument-making experience or were going to engage in this trade sooner or later. Possessing a fine set of apparatus was a necessary investment and the common means to enhance a lecturer's proficiency.

Of those philosophical instruments, the major apparatus for astronomical

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[26] For example, Elliott (2000) discusses several lecturers who had been active at Derby and other towns in the Midlands in the eighteenth century.

[27] For example, Ferguson's *Astronomy explained upon Sir Isaac Newton's principles* (1756) had profound influence on astronomy education later, which I will introduce in Chapter 4. Martin's *The young gentleman and lady's philosophy* (1759) was a popular account which rendered natural philosophy lectures in the form of dialogue.

display was the orrery. An orrery is a machinery of the solar system model for demonstrating the orbital motions of the planets and satellites.[28] The design of the orrery could vary in complexity, ranging from elaborate complex clockwork to a simple manual device. With appropriate attachments or alterations, the orrery could plainly demonstrate the principles of particular phenomena, such as a solar eclipse or the change of the seasons on the Earth. Many similar devices such as the tellurian and the lunarium, which were made to illustrate the terrestrial and lunar rotation respectively, were attachments to fit particular functions (Fig. 1.3). Thus, the orrery was a useful visual aid for astronomy lecturing. It had become a symbolic apparatus of this trade; an instrument of Enlightenment polite science par excellence.[29] A well-known painting by English artist Joseph Wright (1734-1797) dramatically shows the image of a lecturer who was delivering a discourse using a grand orrery (Fig. 1.4). In the painting the lecturer stands in the central background with composure and ease. A small group of audience – men and women; children and the elders – surrounds the grand orrery with different emotions: awe, wonder or pondering. Wright's painting is a romanticised portrayal of the contemporary astronomy demonstrations. It did not accurately reflect a typical lecturing scene, yet the artist did capture a zeitgeist of the Enlightenment and the rise of Newtonian science in this representation.

The polite science culture, represented by Wright's painting, also

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[28] King (1978) is the most comprehensive volume to illustrate the history of clockwork astronomical machines, including planetariums, orreries and astronomical clocks, from the ancient Greek Antikythera mechanism to post-war Zeiss planetarium projectors. See also Millburn (1973). For a basic introduction to the orrery, see Bailey et al. (2005) and Asher et al. (2007).

[29] Walters (1992; 1997) has an explanation for the distinct role of the orrery and astronomy education in Enlightenment polite science culture.

encountered a transformation into the mass culture. The establishment of many literary and scientific institutions across Britain reflected the flourishing of the lecturing business as well as the increase of science enthusiasts. These newly-founded societies in the late eighteenth century were often located in affluent cities or growing industrial centres. For example, Bath, a fashionable spa town in Georgian England, had its own philosophical society since 1779. William Herschel, who was then a professional musician in residence at Bath, was an original member of the Bath Philosophical Society and contributed many of his earliest research papers to the society.[30] By the 1780s, literary and philosophical societies also sprouted in industrial towns in the Midlands and the North, such as Derby, Leeds and Manchester. These societies provided local science enthusiasts with a platform for meeting and studying.[31] Towards the nineteenth century, the pioneer of formalised scientific institutions was the Royal Institution founded in 1799. Many nineteenth-century institutions where scientific lectures were performed followed the success of the Royal Institution model. These formalised scientific institutions, to some extent, were the specialised version of literary and philosophical societies; they reflected the continuity of the Enlightenment polite science culture, which represented bourgeois taste and interest. However, lecturing condition in the early nineteenth century had already changed. The growth of audiences and the scale of institutions made the nineteenth-century experience very different from Wright's depiction of the previous century.

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[30] Elliott (2000), p. 91. For William Herschel's early unpublished papers to the Bath Philosophical Society, see Dreyer, ed. (1912), volume 1.

[31] For the development of public science culture in the English provinces during the Industrial Revolution, see Musson and Robinson (1969); Wach (1988); Elliott (2000; 2009); Jones (2008).

Opportunities and resources for scientific life were much more widespread in the metropolis. Jo N. Hays has a well-summarised article on the milieu of London scientific lecturing in the early nineteenth century.[32] London's dominance of the scientific life of Britain was increasing during this period. In his article Hays argues there was a significant process of the institutionalisation of lecturing in the early nineteenth century. He claims that scientific lecturing in London was decisively institutionalised by the 1820s. London lecturing scenes had changed notably in the direction of formalisation by then and institutional activities overshadowed private enterprise; this change of institutionalisation also prompted the professionalisation of the men of science.[33] Hays's argument is based on the establishment of metropolitan institutions, the increase of lecturers' affiliation with these formalised bodies and the decline of private entrepreneurs. This observation, however, is inapplicable to the astronomy lecturing trade, as I will examine and demonstrate in later chapters.

1.4 A Nation of *Show*-keepers

Aside from the institutional development, the other thread of my thesis is the connection between popular astronomy lecturing and other entertainments. London was not only the hub of science but also the centre of fashion, culture and entertainment at the turn of the nineteenth century. Various exhibitions, shows and spectacles were staged in the metropolis to appeal to spectators'

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[32] Hays (1983). This article is in Inkster and Morrell, ed. (1983), *Metropolis and Province: Science in British Culture, 1780-1850*. Other articles in this book are also good references on the issue of the comparison between the metropolis and the provinces.

[33] Hays, *ibid*.

sense and sensibility. The British were proud of their love of shows, as a letter to the newspaper *The Examiner* remarked: “Well might the great Napoleon say, we trafficked in every thing; but he was little aware that to ‘a nation of shopkeepers,’ he might have added, of show-keepers.”[34] Among those bizarre displays in the metropolis, lectures and spectacles related to scientific curiosity or mechanical ingenuity occupied a distinct part of this marketplace. This aspect regarding science in the amusement arena, however, catches relatively few scholars’ attention in studies of the history of science. Recent interest in investigating the performance and performativity in the history of science over the past decade is a welcome turn in accordance with concerns over amusement and pleasure.[35]

Richard Altick’s pioneering work, *The Shows of London* (1978), describes a wide range of entertainments and exhibitions in London during the Georgian and early Victorian periods until the Great Exhibition of 1851. The social and cultural milieu in which London’s amusement market was formed is also analysed in this book. Altick concludes that the two great streams of appeal – amusement and instruction – had been once mingled in a single channel dominated by commercial entrepreneurs.[36] Displays of the celestial world were also a significant spectacle in the array of shows. Astronomy lecturing, in Altick’s words, was one branch of the exhibition business “exploring infinite space in a little room”.[37] Popular astronomy best exemplified the attempt to blend amusement and instruction; lectures inside theatres especially took the

[34] *The Examiner* (7 March 1824); Altick (1978), p. 1.

[35] Morus (2010a; 2010b); Wintroub (2010).

[36] Altick (1978), p. 509.

[37] *Ibid.*, p. 80.

lead of this tendency.

The key figures in the transformation of astronomy lecturing into theatrical performance were Adam Walker (1730/31 - 1821) and his eldest son William Walker (c. 1766 - 1816). The father and son were both celebrated lecturers in the late eighteenth century. Adam Walker was an itinerant lecturer from a self-taught background, who began his lecturing venture in the North and established a good reputation for polymath and mechanical ingenuity. By 1782, Adam Walker had been a famous lecturer whose lecture circuit moved southwards and eventually settled in London. William Walker, who was then about 16 years old, joined his father's business. The father and son started to lecture on astronomy using Adam Walker's newly-designed transparent orrery, which they branded as 'Eidouranion'. The track of the Walkers is also illustrated in Henry King's *Geared to the Stars* (1978), an important scholarly volume in collaboration with John Millburn on the history of clockwork astronomical machines.[38] The commercial success of the Walkers drew many imitators and competitors, who also constructed their own transparent orreries.

The Walkers successfully brought celestial scenes onto the stage in theatres. This move, as I call it 'theatrical turn', created a different type of lecture from conventional natural philosophy demonstrations. It also reflected the transformation of astronomy lecturing from the polite science culture to the mass culture. This transformation could not be achieved without the invention of the transparent orrery. The transparent orrery was an enlarged orrery, insofar as a simplified but spectacular version, which was designed for the display on

[38] King (1978), ch. 19, pp. 309-321. The *Dictionary of National Biography* also has a brief entry of Adam Walker, see E. I. Carlyle, *rev.* Anita McConnell, 'Walker, Adam (1730/31-1821)', *ODNB* (2004).

stage and hence emphasised much visual effects.[39] The size of the Eidouranion already reached 15 feet across in 1781, and later improved versions continually broke the previous records.[40] Gigantic apparatus was a character of popular astronomy lecturing in the late eighteenth and the early nineteenth centuries. Lecturers would make things as big as possible if the scale of the lecturing venue allowed. Spiritual elements were also brought into theatricalised astronomy lecturing. This stress was often a didactic way of connecting astronomy with moral philosophy and Christian religion. It was accorded with, and borrowed the language from, the increasing interest in natural theology in Britain at the turn of the nineteenth century.[41] This religious connection was most obvious during Lent, a common time of year when astronomy lectures were held. The combination was an astronomical show blended with Newtonian science, religious reflections, visual effects and entertaining instruction.

1.5 Commercial and Sublime: A Contested Sphere

So far we have set the scene. Itinerant public lectures on natural philosophy, together with theatricalised displays of the heavens, formed the cornerstone of popular astronomy at the turn of the nineteenth century. The industrial boom and economic prosperity of Britain during this period prepared a growing market for readers and audiences; social and political upheavals influenced the

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[39] However, the mechanical nature and the technical details of the transparent orrery are still disputed among scholars. See further discussions in Chapter 5.

[40] King (1978), p. 311.

[41] The rise of natural theology in nineteenth-century Britain and its rhetoric, function and arguments are explored in many scholarly works. For example, see Brooke (1991a); Brooke and Cantor (1998); Topham (2004; 2010a; 2010b).

taste for and representation of popular science. The prevalence and popularity of astronomy lecturing in the nineteenth century was no isolated development nor came from nowhere. It was the extension of the previous century's legacy as well as a reflection of the noticeable social change at present. Like other contemporary spectacles of chemistry, electricity and geology, which have been explored by many historians of science, displays of astronomy demonstrate the zeitgeist and the transformation of society.

I choose the title of this thesis on purpose. 'Commercial' and 'sublime', I argue, are two adjectives best describing the character of British popular astronomy lecturing in the nineteenth century. This is not a fresh idea of adopting the word 'commercial'. James Secord uses the term 'commercial science' to designate the hotchpotch of paid pursuits of science, which were reflected in the "glittering prose of journalism, in lecture demonstrations, panoramas, museums" and so forth.[42] This term also relates to, though does not totally agree with, the ideas of 'low science' and 'popular science'. However, the three terms are all problematic. Secord does not adopt the term 'low science' since it creates a potentially misleading dichotomy or even a hierarchy. Secord also objects to the catch-all use of the term 'popular science' due to the often pejorative meaning of it stabilised by scientific professionals in the late nineteenth and the twentieth centuries. It also easily makes prejudgment about the boundaries between experts, esoteric knowledge and the exoteric knowledge found in textbooks.[43] In defence of 'popular science',

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[42] Secord (2000), pp. 437-438.

[43] Secord (2004a), p. 671. For the proposal of the use of the term 'low science', see Sheets-Pyenson (1985). For 'popular science', especially its meaning in the nineteenth century, see Topham (2007); Lightman (2007b), pp. 9-13; O'Connor

Bernard Lightman criticises Secord's use of 'commercial science', arguing it is not broad enough to cover those practitioners whose motivation was religious and did not concern money in the first instance. Despite this deficiency, Lightman agrees that the use of 'commercial science' has the virtue of reminding us the economic factor that "popularizers were involved in a form of activity involving pay".[44] Therefore, the concept 'commercial' can serve as an analogy between popular astronomy and profit-making, and to interpret the role of audiences as the consumers of science. Besides, it can also describe the competition among popular astronomical lecturers in the marketplace. The use of 'commercial' is hence a sensible choice by historians to approach the nature of popular science activities in the nineteenth century.

The adjective 'sublime', in contrast, was an original description extensively used by the nineteenth-century contemporaries rather than an invented term reconstructed by modern scholars. 'Sublime' can mean a top-flight quality that "[b]elonging to or designating the highest sphere of thought, existence, or human activity; intellectually or spiritually elevated"[45] Astronomy had been regarded as the highest achievement of humanity, for it attempts to decipher the code of the universe by human reason. "Of all the sciences cultivated by mankind," James Ferguson claimed: "Astronomy is acknowledged to be, and undoubtedly is, the most sublime".[46] William Whewell also asserted the advantage of astronomy for learning the character of the government of the

(2009).

[44] Lightman, *ibid.*, p. 10.

[45] 'sublime, adj. and n.', *OED*, 3rd edition, June 2012 (Online version, March 2014).

[46] Ferguson (1756), p. 1.

world: “[I]n considering the universe, […] as a collection of *laws*, astronomy, the science which teaches us the laws of the motions of the heavenly bodies, possesses some advantages”.[47] When reporting astronomical lectures in newspapers and magazines, Victorian journalists often designated the field of astronomy as “the sublime science”.[48] ‘Sublime’ can also mean a feature that “fills the mind with a sense of overwhelming grandeur of irresistible power; that inspires awe, great reverence, or over high emotion, by reason of its beauty, vastness, or grandeur.”[49] The immensity of the universe and the vast dimensions of celestial bodies are perfect to inspire the feeling of the sublime. Michael Faraday once commented on William Walker’s lecture that Walker “has shewn in the most splendid and sublime manner that Astronomy may be illustrated”.[50] Either usage of the adjective had emerged in English language and had been commonly applied by the eighteenth century. The concept of sublimity is highly spiritual. Since ‘sublime’ can be linked to strong emotions, reverence for magnificent power and a sense of elevation, this word is also associated with religious experience and rhetoric.[51] It can also imply the

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[47] Whewell (1839), p. 149.

[48] For example, ‘Royal Polytechnic Institution.– Lectures on Astronomy’, *The Critic* (6 March 1847), p. 193; ‘Recollections of the Rev. John Eyton, A.M., formerly Vicar Wellington, Salop’, *The Wesleyan-Methodist Magazine*, vol. 3 (June 1847), p. 557.

[49] *Op. cit*. (45).

[50] Faraday to Benjamin Abbott, 1 June 1813. James, ed. (1991), Letter 23, p. 56.

[51] Edmund Burke (1729-1797) had a famous treatise *A Philosophical Enquiry into the Origin of Our Ideas of the Sublime and Beautiful* (1757) on the concept ‘sublime’. Burke argued the source of the sublime is from the terrors of pain, danger and death. The sublime can produce the strongest emotion, hence passion. Burke regarded the emotions of astonishment, admiration and reverence as the effects of the sublime. He also linked the sublime to other visual aspects like vastness, infinity and darkness. Although Burke’s treatise does not directly involve astronomy, it is noteworthy for the connections between the sublime and passion.

richness of religious elements in nineteenth-century popular astronomy. The spiritual aspect of the adjective 'sublime' can make a good supplement to the material perspective of the term 'commercial'.

Therefore 'commercial and sublime' forms my central argument of the culture of popular astronomy lecturing during the Regency and the early Victorian periods. I *do not* claim that all nineteenth-century popular astronomy activities served this dual purpose or contained either element. However, the two components, I argue, were the most obvious features of astronomical lecturing at this time. In later chapters we will see the rivalry among metropolitan lecturers during Lent; improved apparatus, showmanship and advertisements for marketing; itinerant lecturing circuit between the metropolis and the provinces; audiences following a fashion, a cause or utility. These activities involved competition for profits and commercial practices of paying and selling.[52] Even the 'non-profit' scientific bodies, such as the Royal Institution, would be more or less involved in some commercial-oriented practices. Apart from this practical perspective, we will also see the very spiritual aspect of popular astronomy. Nineteenth-century popular science was filled with emotional appeal. Authors and lecturers loved to arouse the feelings of awe, wonder and pleasure: languages of passion were prevalent in their narratives. Scientific issues were also usually associated with other spiritual concerns in terms of morals or Christianity. Narratives of the heavens were almost narratives of earthly orders, too. Secord explores the meanings of

[52] Secord uses the phrase 'Grub Street science' to describe these commercial practices. Lightman uses another more ambitious phrase 'spatial economy of science' to encompass the economic practices occupying diverse spaces in the marketplace of science. See Secord (2000), ch. 13, pp. 437-470; Lightman (2007a).

Vestiges as sensation – to see "how reading engaged the passions and the senses" and then to examine "how these responses spread through society."[53] My study, too, demonstrates the sensational side of astronomical lecturing.

Many nineteenth-century practitioners of popular astronomy, as well as their activities, exemplified the commercial and sublime features. Historians Richard Altick and Henry King have illustrated several case studies of celestial showmen. In their articles on the milieu of popular astronomy lecturing, Ian Inkster and Allan Chapman also explore a few big names and lesser-known individuals, of whom many were working-class lecturers.[54] The above literature makes a good starting point for my research, in addition to archival mining from advertisements, playbills, reviews and reports in contemporary periodicals. Lecturers covered in this thesis, whether being discussed in detail or being mentioned in brief, are listed in Appendix A. Those individuals, who were active in London and regularly operated lecturing business (Fig. 1.5), are especially my focus. Some of the names frequently appear in previous scholarly works, such as the Walker family and their old rival R. E. Lloyd. Some have been mentioned in literature before but lack further details of their activities or biographical information, such as C. H. Adams and John Wallis. Of these two individuals I supplement my biographical findings in this thesis. Two figures are recognised for other occupations yet their involvement in popular astronomy lecturing is not widely known: George Bartley is known for his career in the theatre, and George Henry Bachhoffner is discussed by historians of science for his demonstrations of electricity at the Polytechnic

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[53] Secord (2000), p. 11.

[54] Inkster (1982); Chapman (1998), ch. 9, pp. 165-179.

Institution.[55] Several notable men of science who had delivered public lectures on astronomy, such as Airy, John Pond (1767-1836), John Pringle Nichol (1804-1859) and Baden Powell (1796-1860), are also covered in this thesis. Nevertheless, it should be understood that my thesis does not intend to make a complete survey or a biographical account of particular astronomical lecturers.

My three central arguments in this thesis stand comparison with other scholarship. In the title *Victorian Popularizers of Science* (2007), Bernard Lightman inspects those popularisers who offered ‘sensational science’ to the British public in the second half of the nineteenth century. Lightman emphasises a group of people who were not practitioners of science in particular. The figures examined in Lightman’s study include a majority of educated middle-class writers and journalists; a significant number of women were among them. Lightman’s attempt is to create a distinctive place for popularisers in the ‘topography’ of nineteenth-century British science, in which the agenda of these popularisers was at odds with scientific authorities – a class of increasingly professionalised practitioners of science.[56] My investigation of private entrepreneurs in popular astronomy agrees with Lightman’s objective; the results confirm the long-standing contributions of private popularisers, who displayed sensational astronomy.

David Livingstone and Iwan Morus summarise that nineteenth-century

[55] Both Bartley and Bachhoffner have entries in the *Dictionary of National Biography*: Joseph Knight, *rev*. Katharine Cockin, ‘Bartley, George (1782?-1858)’, *ODNB* (2004); H. T. Wood, *rev*. M. C. Curthoys, ‘Bachhoffner, George Henry (1810-1879)’, *ODNB* (2004). See also Morus (2007) and Weeden (2008) for Bachhoffner’s career at the Royal Polytechnic Institution.

[56] Lightman (2007b), p. viii. Lightman frequently uses geographical terms such as ‘topography’ and ‘remapping the terrain’ in this book to describe his concepts.

science was a contested space, where rival notions of how and by whom legitimate knowledge should be constructed were competing and were promulgating.[57] This perspective would lead to a 'decentering' in our understanding of nineteenth-century science; as Morus remarks, the locus of scientific authority was "both everywhere and nowhere."[58] My study confirms their assertion: the argument of the theatrical turn, together with the commercial and sublime features of popular astronomy, draws the heterogeneity of this trade. Popular astronomy was a contested sphere in the nineteenth century. Different sites, actors and agendas, all indicate there was a contested marketplace for popular astronomy lecturing.

Surveying the topography of nineteenth-century popular astronomy clarifies several matters. The first issue, as I have mentioned, is the argument of Jo N. Hays regarding the institutionalisation of scientific lecturing. The activities of private lecturers identified in my study would challenge Hays's opinion about the immediate and inevitable triumph of formalised institutional lecturing in the early nineteenth century. Second, the institutional issue raises the question of credibility and qualification. How did a lecturer gain his credentials if he had no affiliation with an institution or any learned coterie? Was there any consensus about the judgement of a lecturer's competence? These sorts of questions will be answered later. The third issue is in regard to the geography of scientific knowledge. Recent interest in the spatial dimensions of science in historical contexts argues that science has 'geography': Science does not merely happen in a few central places, and spatial factors can affect the

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57 Morus (2006); Livingstone (2003).

58 Morus (2006), p. 5.

practice, content, as well as propagation of science.[59] Astronomy, too, has localities. This thesis will show a variety of spaces where astronomical knowledge was constructed and circulated. Another effect of popular astronomical activities on society, last but not least, is the issue of shifting analytical focus from popularisers to the audiences. The diffusionist model of science communication, which regards knowledge as one-way diffusion from experts to 'deficient' audiences, has been criticised much in recent years.[60] The role and reactions of the audience in popular astronomy lecturing leave much uncharted space to be explored.

My thesis structure is thematic rather than biographical or chronological. Each chapter discusses one theme related to a specific aspect of astronomy lecturing. I begin with the affiliations of lecturers. By analysing the relations between lecturers and institutions, the identity of a lecturer and his place within the map of scientific practitioners can be revealed. In other words, the question being asked here is 'who'. Chapter 3 talks about geography of popular astronomy lecturing, hence the issue of 'where'. This chapter investigates different venues in metropolitan or provincial regions where popular astronomy took place in. Chapter 4 concerns the subjects which were included in the curriculums of popular astronomy. Some recurring subjects contained not only wide-accepted Newtonian science but also controversial issues like the nebular hypothesis and the plurality of the worlds. We can also find that scientific novelty and religious sentiment would be strong attractions for the contemporary audience. This and the next chapters both relate to the questions

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[59] Livingstone (2003).

[60] See, for example, Gregory and Miller (1998), pp. 89-90; Locke (1999); Broks (2006), pp. 122-123.

of ‘what’ and ‘how’. Chapter 5 deals with the apparatus of astronomical lecturing, in which I emphasise the transparent orrery and lantern transparencies. The nature of the transparent orrery is still a disputed and unclear issue. This kind of large-stage apparatus certainly had an important place in nineteenth-century popular astronomy, yet very little literature and almost no physical remnants have survived. A comparison and reference to this area would help us to shed more light on the history of astronomical visual aids. Finally, Chapter 6 discusses the audiences of popular astronomy, in which a few accounts of the contemporaries are shown as specimens to reflect the fashion of astronomy lecturing, the responses from the spectators and the conflict between different stands concerning science.

Chapter 2 Affiliation

Two parallel developments emerged in scientific communities during the nineteenth century: the rise of specialised professionals and institution-affiliated practitioners. The change of the organisation of science was significant. In the beginning of the nineteenth century, most scientific figures were 'gentlemanly specialists' who cultivated knowledge but did not depend their livelihoods on income from scientific research;[1] towards the end of the century, science had become a professional practice associated with institutions. Today, scientific communities have largely consolidated into professional facilities, so it is hard for modern readers to imagine a 'private scientist' who works without any institutional link. The roots of professional scientific institutions are often traced to the commencement of the nineteenth century, when the institutional sites of analysis and professional education started to develop.[2] Nevertheless, the change did not occur suddenly and overwhelmingly – the rise of scientific professionals was not the end of amateur practitioners.[3] In terms of the scientific lecturing trade, the rise of institution-affiliated lecturers did not lead to a decisive withdrawal of independent competitors.

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[1] The term 'gentlemanly specialists' is adopted by Rudwick (1985) to denote the geologists of early nineteenth-century Britain. Similar terms such as 'Gentlemen of Science' are also used in scholarship. See Morrell and Thackray (1981); Bowler and Morus (2005), ch. 14, pp. 319-340.

[2] John Pickstone uses this term 'institutional sites of analysis' to designate the establishments which hosted scientific analysis functions. See Pickstone (2000), pp. 130-134. See also Bowler and Morus, *ibid.*; Russell (1983); Cardwell (1972).

[3] Samuel Alberti has similar points in his case study on late Victorian amateurs and laboratory-based professionals of biology. See Alberti (2001).

This chapter deals with the affiliations of popular astronomy lecturers in nineteenth-century Britain. The popular astronomy lecturing trade, I argue, remained a shared arena of private and institutional practitioners. The rivalry between two popularisers, C. H. Adams and George Bachhoffner, in early Victorian London, best exemplifies this comparison. Furthermore, my study indicates the distinctions between institutional men of science and private entrepreneurs were not sharp in popular astronomy in the first half of the nineteenth century. Some figures, like John Wallis and other artisan lecturers, wandered around the grey area. They might be employed by institutions on a contract basis yet still kept regular activities of private lecturing; the level of their institutional affiliations is therefore disputable.

The above cases of lecturers' affiliations shed light on the unsolved issue of professionalisation of astronomy in the nineteenth century. This chapter, however, demonstrates and analyses the data of several lecturers rather than providing a solution to the professionalisation problem. During the course of this chapter, three perspectives will be covered in the discussions: institutionalisation of scientific lectures, the categories of private and institutional lecturers, and the qualifications necessary for astronomy lecturing. To start with, the lives of C. H. Adams and Bachhoffner will be brought out in Sections 2.1 and 2.2, since these two figures are obscure in the history of science. Their cases refute the assertion that decisive institutionalisation of lecturing occurred in the early nineteenth century.[4] Then Section 2.3 will explain the classification of private and institutional lecturers, and the problem

[4] This assertion is the main argument of Hays (1983). See further discussions in Section 2.3.

of this dichotomy. Finally, Section 2.4 will show that there was no firm qualification for popular astronomy lecturing. A lecturer's credentials were not necessarily based upon his educational background or involvement in astronomical research.

2.1 C. H. Adams, "The Only Orthodox Interpreter"

Competition between lecturers in the marketplace was common, especially during the high season of Lent. Astronomical exhibitions were arranged as an alternative amusement in theatres during Lent when regular plays were banned.[5] Newspapers and theatrical journals would report this year's Easter entertainments for those pleasure-seekers who did not follow the ascetic teachings of the Church. One story in the *Illustrated London News* on 11th April 1857, for example, summarised the events of that season in the metropolis. The shows were of all kinds: an exhibition of dissolving views, a comic ballet, a performance of a German wizard, a narrative of lion-hunting adventure, and many more. Among the multifarious shows, two rivals presented respective celestial exhibitions: "Mr. C. H. Adams has, as usual, presented his Orrery at the HAYMARKET during the week, accompanied with his annual lecture on astronomy. […] while Dr. Bachhoffner has delivered at the COLOSSEUM a daily lecture on astronomy, illustrated by a new and beautiful orrery".[6] The two displays of heavenly bodies were on a collision course in the arena of Lent amusements.

The two lecturers C. H. Adams and Bachhoffner were representative figures

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5 For Lenten ban on dramatic performance in the nineteenth century, see further discussions in Section 3.2.

6 'Easter Amusements, &c.', *Illustrated London News* (11 April 1857), p. 337.

who shined at popular astronomy lecturing on stage in early Victorian London. The significance of these two lecturers' cases for my research not only because of their commercial rivalry but also their different affiliations as well as business modes. C. H. Adams was a typical private showman, whilst Bachhoffner mostly affiliated his lecturing career to a particular institution. Distinctions between these two figures offer us a specific means to analyse the identity of popular astronomical lecturers: Who were the people being active in this marketplace? This question relates to the issue of affiliation and also links to the problem of credentials.

Punch magazine was famous for its satirical and humorous portrayals of current events. The popularity of *Punch* was evident from the wide adoption of its contents as extracts: small pieces from *Punch* were often used as column fillers in other newspapers or magazines. One example was a short paragraph in the 2nd January 1861 issue of the *Aberdeen Journal*, which was extracted from the latest 'Punch's Almanack'. This extract made jokes on solar eclipses and relevant business:

> ECLIPSES. – We are happy to inform our readers that the Astronomical Society of London has at length succeeded in rectifying the globe, and that in future there will be no more eclipses. The holes in the sun's path have been carefully filled up with concrete of diamonds, the Zodiac has been duly and completely oiled, and all the houses that were in opposition have been pulled down. The course of the planets will henceforth be regular. Compensation has been demanded by about eleven thousand street boys, who were in the habit of selling smoked glasses to view the old phenomena, and the claimants have been sent to the Compulsory College, and Mr. Adams, the lecturer, who on Saturday attained his six hundredth year, has put fireworks instead of eclipses into his famous Orrery, with which our young folks are much better

pleased.[7]

The original piece in *Punch* had a subtitle of "From Punch's Almanack for 2417", which gave this satire a futuristic flavour. The lecturer Mr Adams, who was mentioned in this piece, would have attained his "six hundredth year" in such an imaginary future. In fact, at the moment of this extract published, the celebrated lecturer had already achieved his 30th year of London performance last year and was going to make the 31st year soon. *Punch* poked fun at Mr Adams's long-time annual performance of his famous Orrery, which was a significant phenomenon among popular astronomical lecturers.

C. H. Adams's long-running lecture in London over thirty years was evident to its commercial success. The lecturer himself was aware of the benefit of the continuity of his annual performance, and such continuity was repeatedly used as a selling point in his promotion. Advertisements of Adams's lecture would stress how long the show had existed, and the slogans such as "TWENTY-FOURTH YEAR in LONDON." were usually printed in bold (Fig. 2.1). The long life of Adams's lecture was not only a fact but also a self-branding, which was a unique advantage to help Adams's business keep in the lead. *The Era*, one of the most influential weekly theatrical journals in Victorian London, regarded C. H. Adams as "the only orthodox interpreter" of astronomy. It commented that Adams's performance was still competitive in the marketplace when the seasoned lecturer confronted rising competitors:

Long ago, when the present middle-aged gentleman and father of a

[7] 'Eclipses', *Aberdeen Journal* (2 January 1861); 'Astronomical Information. From Punch's Almanack for 2417. Eclipses', *Punch*, vol. 40 (1861), 'Punch's Almanack for 1861'.

> family was a little boy with amplified collar and abbreviated jacket, the lecturer [Adams] commenced his illustrations of the wonders of the starry heavens; and from that time, though Panopticons and Polytechnics have arisen in the interval, and done much to elucidate the same subject, there has yet been a firm faith kept alive in the minds of the public that Mr. Adams was the only orthodox interpreter of the phenomena attendant on the revolutions of the celestial bodies.[8]

Charles Henry Adams was born at Edmonton, Middlesex (today a part of Greater London), on 22nd February 1803, and died at the same place on 15th November 1871.[9] Very little is known about Adams's early life and his educational background. Because Adams's father was a local schoolmaster, it is reasonable to suppose that he had received appropriate education. Later on Adams succeeded his father as the headmaster of the Latymer School, a grammar school at his home town;[10] this position was what he did for a living when not lecturing on astronomy. His wife Jane Adams (née Sawyer) was a teacher; the couple married in 1834, and at least four of their children – two daughters and two sons – survived to adulthood.[11]

What motivation drove a schoolmaster to perform astronomical lecture on stage is unknown. It is only certain that Adams had engaged in astronomical

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8 *The Era* (23 March 1856).

9 The baptism record at Edmonton showed Adams's birthday and he was baptized on 24 April 1803. The death announcement of Adams appeared in the *Pall Mall Gazette* (21 November 1871), which indicates he was aged 68. The burial record of Adams can be referred to London Metropolitan Archives, All Saints, Edmonton, Register of burials, DRO/040/A/01, Item 023; Call Number: dro/040/a/01/023.

10 Cockburn et al., ed. (1969), pp. 305-306. The Latymer School offered education of grammar and Latin for poor pupils aged between five and seventeen. It also had formal links with St John's College, Cambridge, which funded scholarship for graduates to the university.

11 This is according to the marriage certificate and the census record in 1871.

lecturing by 1830. A playbill in the *Theatrical Observer*, dated 6th April 1830, advertised that Mr C. H. Adams would deliver a lecture on astronomy that evening at the Royal Adelphi Theatre, the Strand. This is the earliest record of Adams's lecture.[12] Since then Adams developed a remarkable thirty-two-year lecturing career until 1861. An advertisement in the *Morning Chronicle*, dated 22 March 1861, was one of the last records showing Adams's lecture and perhaps it was the last season of his lecturing.[13] It is certain that Adams's business had already finished by 1864. A newspaper article summarised "some changes amongst the general entertainments", including Mr Adams, "with that horrible Orrery, no longer frightens 'children of tender years and women'".[14] Throughout the thirty-two years, Adams delivered astronomical lectures annually in London during Lent, and occasionally lectured outside London. The name of the lecturer Mr C. H. Adams was well known in connection with Adams's Orrery, as the very brief notice on his death in the literary magazine *The Athenaeum* indicated.[15]

Not all of Adams's performances went well in the beginning. The *Literary Gazette* reported an "extraordinary circumstance" on 17th March 1832. The story said the lecturer was forced to begin his course last Friday in a rather

[12] *Theatrical Observer* (6 April 1830).

[13] *Morning Chronicle* (22 March 1861). The year counting of Adams's lecture is inconsistent with the earliest playbill in 1830. For example, the advertisement in 1861 claimed this was the '31st year' of Adams's annual lecture, yet the debut should be 1831 if this claim was correct. It is not clear why Adams did not count his performance prior to 1831on the list.

[14] 'Public Amusements – The Christmas Holidays', *Lloyd's Weekly Newspaper* (25 December 1864).

[15] 'Science Gossip', *The Athenæum* (25 November 1871), p. 692.

difficult situation, since the theatre had been raided before the show's open.[16] "Between two o'clock in the afternoon, when all the apparatus was put in order, and seven o'clock, when Mr. Adams came to meet his expectant audience," the newspaper described, "some evil-doer had contrived to enter the concert-room, abstract the glass of the lantern, break in the face of the orrery's sun, knot up all the cords, and commit other mischief, so as to prevent the lecture from being illustrated in the magnificent manner". The *Literary Gazette* did not mention further details of the following lecture, so we do not know how Adams responded under such unexpected damage at that evening. It simply said the consequence that "By much exertion the injuries were in great measure remedied" and "the exhibition presented to a sympathising and admiring theatre." The identity and motivation of the raiders are unknown, although "a reward of fifty pounds has been offered for the perpetrator of the offence." Was this break-in conducted by a business rival to sabotage Adams's lecture? Or, was this merely a random vandalism of the theatre and Adams's apparatus? There is no clear conclusion. The incident, however, shows that the venture of popular astronomy lecturing could encounter unexpected risks.

Nevertheless, Adams's lectures gained a positive reception from the critics from his debut onwards. Most reviews acclaimed Adams's lucid style of expression and his skilful use of visual aids; these abilities made his lecture accessible for the lay people even when dealing with some specialised topics, such as the parallaxes of stars.[17] A review in the *Theatrical Observer* in 1836 clearly indicated these merits:

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16 'Varieties – Mr. Adams' Lectures', *Literary Gazette* (17 March 1832), p. 172.

17 *The Musical World*, vol. 22, no. 14 (3 April 1847), p. 224.

> […] bringing before the public a very interesting and instructive exhibition, Mr. Adams's Tellurian and Orrery, and that gentleman, assisted by some very ingenious apparatus, will in the course of one lecture render, not only the outline, but also many of the details of the science of astronomy easy of comprehension to the meanest capacity. Mr. Adams last night delivered his second lecture for this season, and we never heard a lecturer with a more pleasing and attractive manner, his voice is very distinct, and his style of explanation perspicuous, clear and unaffected.[18]

Similar approval for Adams's lectures also appeared in the *Literary Gazette*, an influential weekly literary magazine,

> *Mr. Adams's Orrery*, at the Adelphi, has been open throughout the week, and afforded delight and instruction to hundreds of young and old. It is very gratifying (as we stated in reference to another place of entertainment, last week) to observe the thirst for instruction which prevails among the multitude, and also to find such excellent means of supplying them with what they seek. Mr. Adams is among the most delightful and meritorious of their purveyors; and his orrery and lectures convey very lasting impressions of the most sublime of all sciences.[19]

And the list of approval went on; such positive reviews were common throughout Adams's lecturing career. Except for the value of lucid expression, some critics had stressed the religious merits of Adams's performance, far beyond knowledgeable instruction or pure amusement. A review in the *Metropolitan Magazine* encouraged its readers to attend the lecture. "Not only will his visitors gain a rapid notion of the motions of the heavenly bodies, in a most pleasing manner," the review claimed: "but also they will have afforded

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18 'King's Theatre', *Theatrical Observer* (25 February 1836), p. 1.

19 'Varieties – Mr. Adams's Orrery', *Literary Gazette* (26 March 1842), p. 221.

to them the very best manner of elevating their thoughts into piety, by the contemplation of the wonderful system of the universe, and which thoughts, though always laudable, are particularly appropriate during the continuation of Lent."[20] Similar moral and religious rhetoric was familiar to contemporary readers. It rendered the virtue of astronomy studying as a beneficial mean to confirm faith and to inspire devotion. The *Bridgewater Treatises* and many other contemporary popular scientific publications bore the same language and verification.[21]

The audience for Adams's lecture covered a large range of people – the working classes and the rich; juveniles and the old. This can be shown by the different tiers of admission rates. Take the season at the Adelphi Theatre in 1853, for example: the cheapest price for a lecture was 6d. in the gallery. The medium prices included 1s. for the pit, 2s. for the boxes, and 3s. for the stalls. A seat in the private boxes was much more expensive, costing 10s. 6d. or 21s.[22] This set of rates had no large variation within Adams's long-running career. The most expensive ticket, 21s., was about the average weekly wage of a general labourer in early Victorian London – apparently this was not an affordable price to the working classes.[23] The prices for the pit, the boxes, and

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20 'Fine Arts', *The Metropolitan Magazine* (March 1835), p. 85.

21 The first edition of the *Bridgewater Treatises* was published during the years 1833 to 1836, the same period when this review appeared. For further discussions on the *Bridgewater Treatises* and natural theology, see Chapter 4.

22 The rates refer to the advertisement in the *Morning Chronicle* (21 March 1853).

23 The amount of the average wage is referred to Picard (2006), Appendix I. This was also the average weekly income of many other unskilled workers, such as coffee-stall keepers or female copying-clerks. During the long Victorian era, the levels of wage and cost of living varied and might have significant difference between decades. The data used in this chapter is appropriate for the mid-nineteenth century.

the gallery, were comparable to the rate of other dramatic plays in most ‘minor’ London theatres or provincial ones.[24] Charles Dickens had described a working-class theatre at Shoreditch in 1850, where the ticket prices were 1s. for the boxes, 6d. for the pit, and 3d. for the upper gallery.[25] The admission prices of Adams’s lecture at the Adelphi, in comparison with the budget rate in a working-class theatre, were certainly much more expensive. Nevertheless, the lower tiers of ticket for Adams’s lecture were still affordable to the working class audience. Among the broad range of the audience, juveniles, along with their parents and teachers, were a prospective group Adams attempted to win to his favour. School pupils or children often had half-price admission to the pit and boxes; this offer was especially common in Adams’s later years. Other special bargains occasionally appeared; for example, in a series of touring lecture at Colchester in 1853 the advertisement remarked “FAMILY TICKETS may be had of any of the Booksellers, to ADMIT FOUR: Lower Boxes, 6s. Upper Boxes, 4s.”[26] Such offers were undoubtedly tempting to teachers and parents.

The Adelphi was not the only theatre Adams had performed in. During the thirty-two years, Adams had delivered lectures in different West End theatres, including the King’s Theatre (which renamed Her Majesty’s Theatre in 1837 under the reign of the Queen Victoria), the Haymarket, the Lyceum, and the

[24] ‘Pit, Boxes & Gallery’, written by Iain Mackintosh in Fox, ed. (1992), p. 553.

[25] The National Standard Theatre (1837-1940), which Dickens called ‘The People’s Theatre’, was the largest establishment of its kind in London. Dickens wrote a series of articles on the leisure habits of the working classes in the *Household Words* magazine, in which the one cited here was on 13th April 1850. See Jackson, ed. (1994), p. 28.

[26] The advertisement in the *Essex Standard* (12 August 1853).

Princess's. Except for the Haymarket, these theatres were 'minor' theatres in contrast to the patent 'major' theatres – namely Drury Lane and Covent Garden – which had royal patents to perform serious spoken dramas and hence held a privileged position.[27] Nevertheless, these 'minor' theatres shared comparable popularity from every stratum of Victorian society. Theatres in the early Victorian era still obeyed Lenten tradition of suspending dramatic plays. When theatres ceased dramatic performance during Lent, many substituted shows would appear on stage, including astronomical lectures with exhibition of the orrery. Adams's lecture had been "the best of the substituted exhibitions" as the *Theatrical Journal* praised.[28]

All good things come to an end – Adams's show is unexceptional. The Passion Week of 1861 was the '31st year' of Adams's lecture and perhaps his final one, since *The Era* and *The Standard* both reported the occurrence. The reports of the two newspapers seemed to be a conclusion of C. H. Adams's stage career. The *Era* extolled the "informative astronomical lecture with which he has for the last thirty years enlightened the public" was "appears to have lost nothing of its interest."[29] The *Standard* noted the curtain call in the end of the story, said "On the termination of the lecture Mr. Adams was called forward to receive the applause of his admiring audience."[30] After his retirement from the stage, Adams still held the position of the headmaster of the Latymer School until 1868. Compared to the acclaimed astronomy lecturing business, however, Adams's schoolmaster career had not been successful. During the reign of

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[27] For further discussions on Victorian theatres, see Chapter 3.

[28] 'Royal Polytechnic', *Theatrical Journal*, vol. 32 (15 March 1871).

[29] 'Amusements of Passion Week', *The Era* (31 March 1861).

[30] 'Mr. Adams's Orrery', *The Standard* (27 March 1861).

Adams in the Latymer School, its quality of education had declined. Adams failed to maintain satisfactory operations in the school, yet he still kept in charge of the school management with his son for a long time.[31] Eventually Adams agreed to retire from the headmaster position on a pension in 1868. Three years later, the former celebrated lecturer died at home in the age of 68.

Over thirty years of successful performance on the stage had undoubtedly made Adams's lecture iconic. After the close of his business, an article in the *Leeds Mercury* extracted from *The Telegraph* mentioned such a legacy, in which it referred to Adams's orrery as a comparable event to other amusement landmarks:

> To the present generation, however, Saville House had a history of its own, less classic, perhaps, but not less curious. Who amongst Londoners able to date his childhood so recently as a quarter of a century ago, but must remember the marvels of the Linwood tapestry gallery? The spectacle to which little boys and girls were taken in the humdrum days when William IV. was King was not, perhaps, one of dazzling excitement. Possibly the recollection of a morning passed at Saville House ranked with the evening at Adams's Orrery, or with the afternoon at the old Adelaide Gallery, and was not to be mentioned in the same breath with the jaunt to Vauxhall or the pantomime.[32]

This paragraph reflected a strong, though not totally positive, nostalgia to many popular amusements in London, including Adams's orrery. In a way, perhaps it is not exaggerated to interpret Adams's show as part of the collective memory

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31 Cockburn et al., ed. (1969), pp. 305-306. An inspection to the school in 1865 indicated that the teaching standards of Latin and elementary subjects were very low. Only two-third of registered students attended school in the morning and less than a half of them stayed in the afternoon. The income of the Cambridge scholarship was used for church repairs.

32 'The destruction of Saville House', *Leeds Mercury* (3 March 1865).

among Londoners in the early Victorian era. Like pantomimes in Christmas and New Year, astronomical shows with large orrery had become a conventional occurrence during Lent, in which Adams's was in the lead. Even when the *Theatrical Journal* reviewed John Henry Pepper's astronomical lecture in the Royal Polytechnic Institution in 1871, it used Adams's one as a reference. The article referred to Adams's orrery as the best Lenten exhibition, and commented "the Polytechnic Professor's Astronomical Lecture is a reproduction of this [Adams's] once popular representation of the revolutions of heavenly bodies, on a more refine and elegant scale."[33] Adams's lecture had achieved a level of quality used to judge subsequent similar spectacles.

2.2 Bachhoffner and the Royal Polytechnic

C. H. Adams was the epitome of private lecturing on astronomy in early Victorian London. Despite Adams's lecture being undoubtedly popular, it was far from a monopoly. Bachhoffner, a significant long-time rival of Adams, shared a few career similarities with the Edmonton schoolmaster. Both of them started to engage in lecturing ventures in their late twenties: Adams gave his at twenty-seven; Bachhoffner was a 28-year-old when he participated in the foundation of the Royal Polytechnic Institution. Both of them retired from lecturing by the early 1860s. Their activities of astronomy lecturing overlapped a long period in the metropolis, and both lecturers enjoyed comparable popularity from the audience. However, their business operations had a distinct difference: while Adams kept his venture independent of institutions, Bachhoffner's lecturing affiliated mostly to the Royal Polytechnic and later the

[33] 'Royal Polytechnic', *Theatrical Journal*, vol. 32 (15 March 1871).

Colosseum. It is hard to ignore the institutional influence on Bachhoffner's lecturing due to the close relationship between his career and the Royal Polytechnic, as it is impossible to discuss Michael Faraday without mentioning the Royal Institution.

Nevertheless, as with Adams's, the life of Bachhoffner has still remained unclear to historians of science. The short obituary of Bachhoffner in the *Leeds Mercury* made a rough sketch of his life:

> The death is announced of Dr. G. H. Bachhoffner, who died at his house in Hammersmith on July 22nd, aged sixty-nine. He was for upwards of thirty years a popular lecturer at the Polytechnic Institution and the Royal Colosseum, [*sic*] on natural philosophy, chemistry, and astronomy. The Royal Polytechnic, in fact, was originated by him, a meeting being held at his house at which he suggested the scheme.[34]

George Henry Bachhoffner was born in London on 13th April 1810. Little is known for Bachhoffner's early life. He studied at the University of Giessen in Germany, where he graduated MA and PhD.[35] Bachhoffner started to engage in scientific lecturing and writing very early: prior to the foundation of the Royal Polytechnic Institution, he had published two treatises – *Chemistry as Applied to the Fine Arts* (1837) and *A Popular Treatise on Voltaic Electricity and Electro-Magnetism* (1838) – in his late twenties. The former was based on the lectures he had delivered, and was suggested by "several eminent members of the profession" that "if the substance of these lectures were printed, it would

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[34] *Leeds Mercury* (6 August 1879).

[35] H. T. Wood and M. C. Curthoys, 'Bachhoffner, George Henry (1810–1879)', *ODNB* (online edition, September 2014).

form a useful book of reference for the artists."[36] A list of subscribers was put in the beginning of the book, which included Earl of Derby, Earl de Grey, landscape painter Sir Augustus Callcott, and many other patrons. The latter, designed for the use of laymen, remarked the author as "Lecturer on Chemistry to the Artists' Society" on its title page. These publications show that Bachhoffner had taught chemistry courses to artists before the foundation of the Royal Polytechnic.

The Royal Polytechnic Institution, opened to the public at 309 Regent Street on 6th August 1838, was the formidable new blood in London's competitive spectacle market.[37] Many figures had been involved in the foundation as well as early operation of the Royal Polytechnic; these members included practical men of science and politicians in the Parliament, yet little is known about most of them today.[38] Among the founding fathers, three people were most significant and recognised by the contemporaries: the first chairman Sir George Cayley (1773-1857), the former Adelaide Gallery supervisor Charles Payne, and the builder William Mountford Nurse. Being a wealthy landowner and an enthusiastic aeronautical designer, Cayley had been a keen patron of scientific and technological affairs. He was also the sponsor of the Adelaide Gallery at the Strand, which was the predecessor and model of the Royal Polytechnic in the aspect of displaying practical science and arts to the public. Payne, who later became the secretary of the Royal Polytechnic, was the major organiser of

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[36] Bachhoffner (1837), p. ix.

[37] It was founded as the Polytechnic Institution and changed the name to the Royal Polytechnic Institution in 1841, when Prince Albert became the patron.

[38] Altick (1978), p. 382. Many scholarly works have further discussions on the foundation and history of the Royal Polytechnic. For example, see Altick (1978), ch. 27, p. 375-389; Lightman (2007a); Morus (2007); Weeden (2008).

this planned new institution and had secured the sponsor of Cayley. Nurse, a speculative builder who focused more on potential profit, contributed to the building and furnished a large part of the capital.[39] The role of Bachhoffner in the foundation of the Royal Polytechnic is not clear; we do not know if the scheme exactly originated from him as his obituary suggested. Nevertheless, it would not be surprising if Bachhoffner had such an idea, since the demand and the voice urging a permanent institution where new inventions and technical knowledge can be introduced to the public never rested during the first half of the nineteenth century.[40] It is clear that Bachhoffner had been involved in day-to-day operation of the institution ever since its beginning: he was appointed as the 'principal of the department of natural and experimental philosophy' in the Royal Polytechnic, which he held until 1855.

As the principal, it is supposed that Bachhoffner delivered public lectures ever since the foundation of the Royal Polytechnic Institution, yet astronomy was not the concern in his early years. Subjects of Bachhoffner's lecture in the Royal Polytechnic at the beginning were still on chemistry and natural philosophy. For example, an advertisement in 1842 shows Bachhoffner's topic was on "Electricity, Galvanism, and other branches of Natural Philosophy," and would accompany "with the use of the Colossal Electrical Machine."[41] It is not certain when Bachhoffner commenced lecturing on astronomy; by 1845

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[39] Weeden (2008), pp. 9-14; Altick (1978), p. 382.

[40] Altick, *ibid*, pp. 375-377. Although the Royal Polytechnic Institution was originally built for this instructional aim, the struggle of its direction between scientific use and profitable entertainment had been the constant shadow upon it. Such struggle was common among many contemporary spectacles; for example, see Secord (2004b) on the Crystal Palace at Sydenham.

[41] See the advertisement in *The Examiner* (24 September 1842).

he had already delivered astronomical discourses.[42] In contrast to C. H. Adams, Bachhoffner had always been a versatile lecturer who did not confine himself to the topics of astronomy – astronomy was important in Bachhoffner's repertoire, yet he never gave up lecturing on other scientific subjects. A story in the *Illustrated London News* on 3rd May 1851 depicted a lecture delivered by Bachhoffner on the rotation of the Earth, in which he demonstrated a Foucault pendulum in front of the audience (Fig. 2.2).[43] Sometimes the topics he spoke would be very technical and utilitarian, such as 'electro-gilding and silvering',[44] and "Wilkins's New Patent Universal Electric Telegraph".[45] These practical subjects accorded with the agenda of the Royal Polytechnic Institution. Bachhoffner would also adjust his lecturing to suit particular groups of audience, such as the children. He lectured on the philosophy of scientific recreation in December 1851, and advertisements claimed that "This Lecture has been arranged expressly for the instruction and amusement of the Junior Branches visiting the Institution during the Holydays."[46]

Bachhoffner's versatile nature was not only reflected in his lecturing subjects, but also proved by his conduct of experiments. He was in charge of many instruments and experiments in the Royal Polytechnic Institution, particularly those related to electricity. This suggests Bachhoffner's role in the Royal Polytechnic was similar to the ones of Francis Hauksbee and J. T.

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42 Advertisements of the Royal Polytechnic Institution in 1845 said Bachhoffner would deliver lecture on astronomy during Lent. For example, see *The Examiner* (15 February 1845) and *The Era* (16 March 1845).

43 'Rotation of Earth', *Illustrated London News* (3 May 1851), pp. 345-346.

44 *Literary Gazette* (24 September 1853), p. 921.

45 *Literary Gazette* (11 March 1854), p. 217

46 See the advertisement in *The Era* (7 December 1851).

Desaguliers in the Royal Society during the early eighteenth century, or to Faraday in the Royal Institution. A significant example of Bachhoffner's instrument was the hydroelectric machine.[47] Invented by the Newcastle lawyer and then amateur inventor William Armstrong, the hydroelectric machine was a locomotive-like gigantic apparatus to produce static electricity by high-pressured steam from a boiler. Armstrong contacted the Royal Polytechnic to discuss the possibility of transforming this novelty apparatus into a sensational exhibition to the public. Stories of the machine appeared in the London newspapers during August 1843: for example, the *Illustrated Polytechnic Review* reported it with a diagram.[48] Under the supervision of Armstrong, the machine was constructed with the assistance of Bachhoffer. In particular, Bachhoffner spent enormous efforts to conduct a series of experiments for testing the machine before bringing it in front of the public.[49] The Royal Polytechnic Institution first presented the hydroelectric machine to the audience on 15th September 1843, in which Bachhoffner demonstrated the apparatus. The debut of the hydroelectric machine received mostly approving reviews from the press; the critics agreed its ability to produce spectacular electricity effects and predicted that the machine would become 'a great lion of this popular and well-conducted establishment'.[50]

The rivalry between Bachhoffner and C. H. Adams, although no direct evidence such as letters or diaries of the two lecturers survives to indicate it,

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47 Morus (2007), pp. 350-355; Weeden (2008), pp. 25-26.

48 'The Hydro-electric Machine', *Illustrated Polytechnic Review*, vol. 2 (1843), pp. 162-163; Morus (2007), p. 352 and Fig. 11.4.

49 Weeden (2008), p. 25.

50 *The Times* (15 September 1843), p. 7; Weeden, *ibid.*; see also Morus (2007), pp. 352-353.

could be suggested most apparently by the newspaper advertisements. As the beginning of this chapter has indicated, during the decade between 1845 and 1855, these two lecturers had occupied a great part of popular astronomical lecturing market in London during Lent. Most advertisements for astronomical lectures in the newspapers were their contributions. Frequently, their advertisements were put in the same page, even next to each other. In *The Era* on 16th March 1845, for example, Adams announced his "accustomed ANNUAL LECTURE on ASTRONOMY, for MONDAY, March 17th, and every evening during the week (Good Friday excepted)" will be at the Adelphi Theatre. Meanwhile, the Royal Polytechnic Institution notified its programme in the same column, included "A Series of Lectures on Astronomy, by Professor Bachhoffner on the Mornings and Evenings of Mondays, Wednesdays, and Fridays, during Lent".[51] Obviously, the two lecturers were confronting each other in the Lenten amusement arena. At the time Adams had already presented his show to the audience for fifteen years. In contrast, though Bachhoffner was an experienced lecturer, astronomy was the subject he had just started to engage. The established reputation, along with the audience's familiarity of the show, was Adams's advantage. Nevertheless, Bachhoffner's lecture backed by the resources of the Royal Polytechnic must have been a serious challenge which Adams could not overlook.

Although I use the word 'rivalry' to describe the relations between Adams and Bachhoffner, there is no evidence to show the two persons had any acquaintance or correspondence. The suggestion of rivalry is based on the fact that they were contemporaries and both engaged in the astronomy lecturing

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[51] See the advertisement in *The Era* (16 March 1845).

trade in London. It is unlikely they never heard of each other during their time. In later years, interestingly, Bachhoffner's Lenten astronomical lecture had moved to afternoons at one or three o'clock, while Adams kept his accustomed evening performance between eight and ten.[52] This alteration was perhaps a change in order to avoid previous clash. It might be also a move towards increasing the thirst for attendances at astronomical lectures. The arrangement of lecturing time could reflect the distinction of the target audiences between the two events. An afternoon lecture was not convenient to the working classes, but was suitable for schoolmasters with their pupils. Evening was the usual time for theatre and leisure; evening events might also draw more family audiences.

Bachhoffner left the Royal Polytechnic Institution in August 1855, when he moved his eyes onto another ambitious project. The Colosseum at Regent's Park, which had been an amusement attraction since 1827, particularly for its colossal panorama exhibition, was in financial crisis again. The auction of the property had failed early that year, and Bachhoffner became involved in a plan to salvage the once glorious spectacle.[53] The new 'Colosseum of Science and Art Company (Limited)', in which Bachhoffner played a chief role, was formed to take control of the property. The company expected to raise £10,000 funds for the leasing and future operations. To achieve this goal, it provided a broad prospect to appeal the support of the public:

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[52] For example, see the advertisements in the *Athenaeum* (31 March 1849; 23 March 1850) and *Daily News* (14 April 1854).

[53] Wood and Curthoys, *op. cit.* (35); Altick (1978), p. 161; Weeden (2008), p. 55. For the history of the Colosseum and its long-time straits, see Altick (1978), ch. 11, pp. 141-162.

> […] which, with the employment of agents of competent skill and attainment, will provide at the north of London, and within the metropolis itself, an institution which, like the Crystal Palace at Sydenham, must prove a great and valuable means of furthering our national progress, while it will be a constant source of most pleasing recreation. Each share is to be £10, on which it is expected only £2 will be called up, and this will give the holder a free admission to the whole during the season.[54]

With the reputation of the hitherto "universally-known conductor of the Polytechnic Institution"[55], Bachhoffner's fame among the public certainly made a strong promise to the shareholders. Under the management of Bachhoffner, the Colosseum eventually re-opened on 26th December 1856. The very next day, the *Standard* reported the re-opening of the Colosseum and praised its magnificent interior had no damage after months of repose. "Nothing has been taken away – nothing, that we see, added." The journalist said: "Dr. Bachhoffner proposes to add to the well-known attractions of the place lectures on various popular topics, besides a series of dissolving views, and other optical illusions."[56] Evidently, Bachhoffner planned to copy the same repertoire from the Polytechnic to the reconstructed Colosseum. To achieve this project he also proposed to spend £2,000 to purchase scientific equipments.[57] Soon after the re-opening, Bachhoffner rebuilt his regular astronomical performance in the Colosseum during the following Lenten season, as the advertisement announced: "On the evenings of Wednesday and

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54 'The Colosseum', *Morning Chronicle* (14 July 1856).

55 'The Royal Colosseum', *Morning Chronicle* (25 December 1856).

56 'Miscellaneous Exhibitions – The Colosseum', *The Standard* (27 December 1856).

57 Altick (1978), p. 161.

Friday, during Lent, Dr. Bachhoffner will deliver a lecture on Astronomy, illustrated by a new and beautiful Orrery, with selections from Haydn's oratorio of the 'Creation,' by the Crystal Palace Orchestra."[58] In the Royal Polytechnic Institution, the vacancy of astronomical lecturing was later filled by Bachhoffner's former colleague John Henry Pepper (1821-1900), another genius of scientific entertainment.[59]

The efforts of Bachhoffner to revive the Colosseum, however, did not achieve success whether in commercial aspects or in scientific ones. Despite the policy of reducing admission price to 1s. – it had been 4s. 6d. before the re-opening – which was expected to attract upwards of 12,000 visitors within one week, the actual effect on the audience was questionable.[60] One year after the re-opening, the company had already been dissolved and Bachhoffner became the sole leasee and manager. He managed the Colosseum independently for the next six years until 1863, when the licence was granted to a new leasee.[61] By the beginning of the next year, the director of the Colosseum had already changed, and its attractions had transformed into pure entertainment without any scientific elements, such as dioramas and pantomimes.[62] However, all these changes could not save the downfall of the

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58 See the advertisement in *The Era* (22 February 1857).

59 For more details on John Henry Pepper, see Lightman (2007a).

60 This optimistic estimation of the amount of visitors can be seen in the newspaper report 'Colosseum', *Morning Chronicle* (5 January 1857).

61 "Mr. John Burns Bryson applied for the renewal of a licence heretofore granted to Dr. Bachhoffner, for music and dancing, for the Royal Colosseum, Regent's-park.–The licence was immediately granted." See 'Music and Dancing Licences', *The Era* (11 Oct 1863).

62 The new arrangements of the Colosseum was reported in 'The London Exhibitions, &c. – Collosseum', *The Era* (3 January 1864).

Colosseum. The business eventually closed and the demolition of the building started in 1868.

After stepping down as the manager of the Colosseum, Bachhoffner's lecturing career seems to come to a full stop. There is no record to show any lecturing activities of Bachhoffner afterwards whether on astronomy or on other subjects. However, Bachhoffner did not totally retract his profession on scientific affairs, albeit retiring from lecturing business. As the superintendent registrar in the district of Marylebone, a job he retained from 1853 until his death,[63] also with his expertise on chemical knowledge, Bachhoffner had involved in an inquest in 1867. The general public was concerned for the safety of the atmosphere in the underground railway after a 29-year-old young woman suddenly died in the King's Cross station of Metropolitan Railway. On behalf of the railway company, Bachhoffner was among a group of specialists to investigate the accident.[64] His talent of invention also did not dry out: a patent of the improved gas-fuel lamp was granted to Bachhoffner on 11th July 1871.[65] Nevertheless, the former conductor of the Royal Polytechnic Institution and the Colosseum had faded away from the memories of audiences. While Bachhoffner retired from the stage, his former colleague Pepper enjoyed successful performances in the Royal Polytechnic during the 1860s, yet Pepper

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63 Wood and Curthoys, *op. cit.* (35).

64 Stories about the accident and subsequent inquiry appeared in many newspapers after August 1867. For example, see *Pall Mall Gazette* (6 September 1867), pp. 866-867; 'The Atmosphere of the Metropolitan Railway', *Daily News* (31 October 1867). The anxiety of the public even made the general manager of the railway company to write an open letter to the newspapers, see 'Metropolitan Railway', *Daily News* (2 September 1867).

65 'Arts and Manufactures – New Patents', *Birmingham Daily Post* (30 September 1871); 'Gas as Fuel', *Bradford Observer* (1 November 1873).

also left after 1872. Following the departure of its two important early figures, the once glorious Royal Polytechnic faced its final years and eventually ceased operation in 1881. In a way, the Royal Polytechnic Institution and the Colosseum shared the common fate among numerous scientific amusement ventures in the Victorian era, where the shadow of financial struggle had always lurked upon those bold entrepreneurs.

2.3 Affiliation or Independence

The stories of Bachhoffner and C. H. Adams remind us of how diverse Victorian popular astronomy could be. The diversity appeared in their professional backgrounds: Adams was a schoolmaster and Bachhoffner was a chemistry lecturer with a doctoral degree. The diversity also appeared in the venues where their activities took place: Adams performed on the stage of various West End theatres, while Bachhoffner delivered lectures in the Royal Polytechnic Institution and the Colosseum. Though they were both recognised by the public as legitimate interpreters of astronomy, both of whom seemingly lacked any connection with astronomical organisations. These facts raise the question of the identity of these astronomical lecturers: what place they occupied within the scientific community?

Before we go ahead with discussion of the identity of astronomical lecturers, it is necessary to understand the milieu in which British astronomy worked in the nineteenth century. Unlike the Continental European mode of a state-conducted centralised body employing university-trained professionals, astronomy in Britain had kept a strong 'Grand Amateurs' convention.[66] A

[66] Chapman (1998). Chapman compares this 'Grand Amateurs' characteristic with

profession in the early Victorian sense, according to Jack Morrell, was a "vocation in which a professed knowledge of some aspect of science or learning was applied to human affairs or in the practice of an art founded upon such knowledge." By this definition, the classic professions the Victorians recognised were of divinity, law and medicine.[67] This definition emphasises the aspect of vocational pursuit: a professional relates to a salaried person earning a living by his own esoteric skills. A common presumption is that science went through a significant process of professionalisation during the nineteenth century, in which scientific practitioners moved from gentlemen virtuosi to vocational experts.[68] However, historians are more and more circumspect about this over-generalised model. The situation of nineteenth-century science was neither consensual nor inevitable.[69] This presumption does not entirely fit Victorian British astronomy, either. Astronomers in Britain were not drastically professionalised; the process was not noticeable even though the sign of professionalisation did occur in the later years. As Allan Chapman indicates, adequately-paid astronomical positions were few and far between in Victorian Britain.[70] Those Grand Amateurs, who were on the list of leading men of astronomy, were private and independent players. These gentlemen astronomers included Francis Baily the stockbroker,

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the situations of Germany, France and Russia.

67 Morrell (1990), p. 980.

68 Professionalisation of science is a complicated issue and there remains no consensus in the studies of the history of science. Many literatures have discussions on professionlisation and nineteenth-century men of science. For example, see Cannon (1978); Russell (1983); Morrell (1990); Waller (2001); Barton (2003); Mussell (2009b).

69 For example, see Morus (2006); Endersby (2008); Mussell (2009b).

70 Chapman (1998), ch. 2, pp. 14-31.

James South the surgeon, William Lassell the brewer, James Nasmyth the iron-engineer, William Huggins the family firm owner, Lord Rosse the aristocrat, and so forth. John Herschel, the leading character of the Grand Amateurs, also benefited from the bequests of his parents. These Grand Amateurs managed their own observatories and instruments; they conducted their own researches while their livelihood did not depend on stargazing. The Royal Astronomical Society, the dominant establishment where these Grand Amateurs were active, was a clearing house of independent enthusiasts rather than a state-conducted centralised institution. George Biddell Airy, who lived solely on the incomes from the Astronomer Royal position, was a rare case among these leading men of astronomy. Other directors of public or university observatories usually had additional clerical or academic duties to provide their main income.[71]

Salaried assistants hired by individuals or observatories were another important workforce in British astronomy. Observatories, whether private or public, unavoidably needed assistants for day-to-day work. Some amateur astronomers hired aides to maintain daily operations of observatories while they were busy with earthly business – like the role of a butler in a mansion. The Greenwich Observatory was the most prestigious employer in this job market. Aside from six senior warrant assistants, Greenwich employed and trained a few middle-class lads as 'Supernumerary Computers' to do routine calculation or observation work.[72] This supernumerary system was described

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71 *Ibid*.

72 Chapman (1998), pp. 146-151. For the astronomical assistantship at Greenwich in the late eighteenth and early nineteenth centuries prior to Airy, see Crokren (2003).

as a “band of scientific clerks” by the journalist Frederick Knight Hunt in the *Household Words*.[73] Nonetheless, the positions of assistantship were few in whole country; the career prospects of these professional assistants were also limited. These assistants were usually ‘invisible’ in the Grand Amateur science and very few of them could raise to a socially-recognised executive rank.[74]

C. H. Adams and Bachhoffner were not involved in the astronomical community described above. They were neither astronomers nor astronomical professionals who worked for observatories. There is no evidence to show that they had correspondence with the coterie of Grand Amateur astronomers. Neither of the two lecturers had affiliation with astronomical learned bodies such as the Royal Astronomical Society, which had been a dominant establishment for the communication between British astronomical practitioners by the mid-nineteenth century.[75] They did not make astronomical observations or conduct original research throughout their career.[76] The activities of lecturing were almost their only involvement in this subject. Nevertheless, in terms of lecturing, their involvement was no less or more than any other practitioners’ doings. The Astronomer Royal would give lectures somewhere, yet these activities were not on a regular basis and were beyond

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[73] Hunt, ‘The Planet Watchers of Greenwich’, *Household Words*, no. 9 (25 May 1850), pp. 200-204; Chapman (1998), p. 157.

[74] Chapman (1998), ch. 8, pp. 145-157.

[75] Although Bachhoffner had no relation to astronomical institutions, he was the fellow of the Chemical Society of London, from which he often styled ‘FCS’ in his advertisements. Bachhoffner was also a member of the short-lived London Electricity Society, see Weeden (2008), pp. 24-25; Morus (1998), pp. 99-124.

[76] Though, a copy of sunspot drawings preserved in the Royal Astronomical Society (RAS: Add MS 44) is likely attributed to C. H. Adams. The author of this diary was ‘Charles H. Adams’ of Edmonton, who industriously recorded the change of sunspots between 1819 and 1823. It might show C. H. Adams’s early interest in astronomy in his youth.

his duties. Grand Amateur astronomers, too, had no necessity to lecture regularly before the general public. Lecturing was more a vocational pursuit to Bachhoffner and Adams. Bachhoffner's full-time dedication to the programmes of the Royal Polytechnic and the Colosseum lectures, and Adams's annual West End shows, all made them more 'professional' in terms of vocation.

Numerous lecturers were active in the metropolitan popular astronomy marketplace in the nineteenth century. These lecturers were not necessary associated with astronomical community or learned coteries of men of science, as we have seen from C. H. Adams's and Bachhoffner's cases. Growing literary and scientific institutions which sprouted at the turn of the nineteenth century provided a noticeable stage, yet not all lecturers had to be employed by these institutions. Some lecturers were affiliated with one particular or more than one institution; some ran their own businesses independently without any institutional resources. Bachhoffner was a representative of the former, whilst C. H. Adams was a typical example of the latter. Bachhoffner's involvement in the foundation and operation of the Royal Polytechnic was significant; his activities of lecturing took place at this very site until he left and pursued the management of the Colosseum. John Wallis was another important example of this class of institutional lecturer, who was popular among several employers including the Royal Institution and London Mechanics' Institution during the 1820s and the 1830s.[77]

Despite the increasing influence of institutions, private entrepreneurs like C. H. Adams were still a force which could not be underestimated in the

[77] Hays (1983), p. 99; Secord (2000), pp. 450-451. For further discussions of John Wallis and his lectures, see Chapter 3 and Chapter 4.

metropolitan lecturing scene. Private lecturers' activities were more diverse in place: they could be in theatres, shops, town halls, assembly rooms and public schools, rather than prescribed 'scientific sites' such as institutions or learned societies. Many figures which I will discuss further in later chapters, such as George Bartley, D. F. Walker, R. E. Lloyd, John Bird and Robert Children, were private lecturers. Errands of travelling private lecturers were important occurrence for scientific lecturing in provincial towns and the countryside, especially those places where no literary and scientific institutions existed in the neighborhood.

In his essay on metropolitan lecturing environment of early nineteenth-century London, historian Jo N. Hays argues that scientific lecturing in London was decisively institutionalised by the 1820s.[78] Hays's argument is based on the grounds of the establishment of various metropolitan institutions and learned societies, along with the direction of formalised instructions which these institutions tried to consolidate. Though there were still a large number of private instructors and entertainers, collegiate and institutional activities had already overshadowed their enterprise in popular science market.[79] On the one hand, Hays's argument of the trend of instituionalised lecturing is evident, but on the other hand he underestimates private entrepreneurs' persistence. In the realm of astronomy, the continuing flourishing of private lecturers after the 1820s was particularly obvious. C. H. Adams's success is the best example to demonstrate the significant place which private lecturers still occupied to the general public. Other private entrepreneurs before and during the early

[78] Hays (1983).

[79] Hays, *ibid.*, pp. 91-101.

Victorian era, as I will show later, enjoyed popularity in varying degrees. It would make a partial conclusion if we only emphasise institutionalised lecturing at the Royal Institution, the Royal Polytechnic and other institutions but neglect the activities of private lecturers.

We may find such a distinction between institutional and private lecturers convenient to describe the context of structural transition in scientific lecturing markets. However, this dichotomy also raises several problems. The first problem is the definition of an 'institution', which relates to demarcations. When talking about the institution boom in the early nineteenth century, historians of science often refer to the establishments which were built on the Royal Institution model. A broader definition would include those learned societies whether specialised or conventional literary and philosophical ones. In his discussion Hays also includes all kinds of collegiate or formalised bodies where different types of teachings performed, such as the radical London University and hospitals with medical schools.[80] Yet there were a number of establishments which blended scientific and technological curiosities with sheer entertainment in the nineteenth century, especially in London. These venues could contain various types of exhibitions, shows and sometimes lectures. The Adelaide Gallery, the Egyptian Hall, the Colosseum and the Diorama at Regent's Park, were all belonged to this category of spectacles. The Royal Polytechnic, too, was actually a well-developed and long-lived example among this list.[81] The sparked electricity demonstration and the illusory lantern extravaganza reflected the sensational tone and popular style of the

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[80] Hays, *ibid*. pp. 93, 95-96.

[81] For the entertainment scenes and the spectacles in nineteenth-century London, refer to Altick (1978). See also my description in Section 3.1.

Royal Polytechnic, which were distinct from those of more ‘serious’ establishment like the Royal Institution. If we count the Royal Polytechnic into the list of scientific institutions, how do we categorise other spectacles? Was the line of demarcation between these establishments really clear for contemporaries? To exclude these amusement sites from the institution list requires more circumspection.

Another problem is the definition of ‘affiliation’. The affiliation of a lecturer could be clearly recognised by the official position appointed by the institution. Bachhoffner was the principal of the department of natural and experimental philosophy at the Royal Polytechnic; Michael Faraday held the professorship of chemistry at the Royal Institution. Their long-time involvement in institutional affairs was clear and undoubted. However, full-time employees who secured a position in an institution were not common in the early nineteenth century. Most lecturers undertook the job on a contract basis. For example, the London Mechanics’ Institution paid John Wallis twenty-seven guineas for six lectures during the 1830s, and he received higher pay – forty guineas for the same six lectures – from the London Institution.[82] An acclaimed lecturer like Wallis could arrange two lectures in separate institutions within one day. Many lecturers would also pay visit to other towns for seeking lecturing opportunities, like sheep wandering on grassland to graze. Wallis, for example, regularly travelled to Northern England. Wallis’s correspondence with the secretary of the Royal Manchester Institution shows that his proposals for lecturing were not always approved.[83] All in all, these

[82] Hays (1983), pp. 98-99.

[83] MA: M6/1/49/2/p143; M6/1/49/3/p162.

traits made Wallis and his likes were much more similar to a freelancer rather than an affiliated lecturer of a particular institution. These lecturers were temporarily employed by institutions, yet they did not stay full-time and were not involved in the administrative system. In a strict point of view, if only lecturers like Bachhoffner and Faraday who had firm appointments were true institutional people, then John Wallis and his likes could be even put into the category of private lecturers. It is arguable which level of affiliation could be considered as an institutional lecturer.

The above problems remind us that using simple dichotomies between professional and amateur practitioners, and between institutional and private lecturers, is a naïve way to describe the scientific milieu in the nineteenth century. Astronomy in Britain, in particular, remained an immense space for so-called amateur practitioners in a period which is presumed to undergo decisive professionalisation. As Ruth Barton's analysis shows, the terms 'professional' and 'amateur' did not indicate the distinction between insider and outsider of science for the contemporaries, nor did the superiority in expertise or the hierarchy.[84] Recent studies, such as those by Iwan Morus and James Mussell, incline to the view that science in the nineteenth century is a contested space.[85] The contest related not only to the shaping of identity but also to the spatiality. Nothing was clearly unambiguous about what kind of person as well as place belonged in science. "The place of knowledge conferred (or withheld) authority", Morus claims: "The knowledge produced at the Adelaide Gallery or an Owenite Hall of Science was a very different beast

[84] Barton (2003). See also Mussell (2009b).

[85] Morus (2006); Mussell (2009b). For the spaciality of science, see also Livingstone (2003) and the references summarised within.

from that emanating from the London Institution or the Royal School of Mines."[86] This is a view of decentering the locus of science, as I will discuss further in the next chapter. The cases of C. H. Adams, Bachhoffner, Wallis and many other astronomical lecturers demonstrate that the conventional separation between professional and amateur practitioners is porous for analysing the context of astronomy popularisation in the nineteenth century.

2.4 The Wrangler and the Carpenter: Qualification for Lecturing

We have discussed the affiliation of astronomical lecturers, which links to the issue of professionalisation. One important feature of professionalisation, as Jack Morrell points out, is the establishment of specialist qualifications which "functioned as public certification of scientific competence".[87] Morrell claims that such qualifications "tended to displace both private patronage and market forces" and "stressed achievement as measured by examinations." This aspect also relates to a formalised training procedure, which was usually institutional, such as the state-funded university system burgeoning in Germany in the early nineteenth century for training scientific researchers with a PhD degree. However, this professionalisation model is not fully applicable to science. Science is an umbrella term to lump many disciplinary and geographical differences together and it is impossible to see science as one set of homogeneous activities. Allan Chapman shows that the Grand Amateur astronomy in Britain was distinct from the state-funded professional trend in

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86 Morus, *ibid*. p. 11.

87 Morrell (1990), p. 983. Morrell adopts the Carr-Saunders/Wilson approach as the professionalisation model, which includes six features in the process as the 'stages' of the professionalisation. The features of qualification and training are among the 'stages' as being described here.

continental Europe.[88] Morrell also acknowledges some inadequacy of this model when discussing professionalisation in Britain. For example, as the most prominent pressure group of science in Britain, the BAAS ignored many matters concerning professionalisation in its early activities, such as to promote more full-paid posts for scientific professionals supported by government. The gentlemen who managed the BAAS did not attempt to prepare the ground for the growth of scientific professionals.[89] Similarly, the notion of formalised specialist training and qualification in this professionalisation model is not applicable to British astronomy.

Concerning the question of qualification in the case of astronomy lecturing, the answer is simply negative, too. There was no authoritative system to judge a person's competence as an astronomical lecturer, nor was a formalised training procedure guaranteed to make such a professional career. Gentlemen of astronomy like John Herschel had their own family inheritance and financial resources to support astronomical work, and these Grand Amateurs did not need to do lecturing for livelihood. Many of the Grand Amateurs had received proper education from colleges whether owned degrees or not, yet their school training was not necessarily relevant to astronomy.[90] Amateur astronomers began their exploration of this field by self-taught or a sort of 'apprenticeship', as when John Herschel learned skills of instrumentation and observation from his legendary father. Astronomy was, like other branches of science, based on

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88 Chapman (1998).

89 Morrell, *op.cit*. (87), pp. 987-988.

90 For example, James South had studied at the Royal College of Surgeons as a medical student. John Herschel initially went to Lincoln's Inn to train for the Bar after his college education at Cambridge.

meritocracy and sociability. The merits of an individual's work and the networking with the peers in the specialised bodies such as the Royal Astronomical Society were critical to decide the visibility of a practitioner. Astronomy lecturing, too, had a similar work environment. Lecturers affiliated to institutions could use the association to boost their credibility as well as visibility. Private entrepreneurs without institutional connection could still promote their business by the merits of their lecturing, which might be circulated by word of mouth from the audience, or by written approval from journalists. The recurrent use of the year-counting in C. H. Adams's advertisements was also a way to promote the lecturer's credibility, since nothing can be simpler to demonstrate the continuous success of a show. Having a specialist post like the Astronomer Royal or a professorship in a university certainly endorsed an individual's competence in this subject, yet anyone could deliver public lectures on astronomy without a prestigious title. The various backgrounds of lecturers, as I have shown in the previous section, indicate that popular astronomy lecturing was a marketplace requiring no particular qualifications. Lectureships were not like instutionalised academic posts at Oxbridge. There was no formalised mechanism as well as need for certifying a lecturer's expertise outside the walls of colleges.

Thus the reason for an individual to be able to speak before the audience varied. A Cambridge graduate with the honour of the Senior Wrangler could talk about astronomy, so did a carpenter who had never received a formal education. The Senior Wrangler is the title for the highest scoring student in the undergraduate mathematics course at the University of Cambridge. This honour indicates intellectual excellence distinguished from other students and the populace. In the following part, I provide examples of a Cambridge Senior Wrangler and artisan lecturers. My comparison between the 'wrangler' and the 'carpenter' exemplifies diverse backgrounds of astronomy lecturers and lack of formalised qualification in the nineteenth-century lecturing market.

A detailed report in the newspaper *Essex Standard* in 1865 provided a story of a Cambridge Senior Wrangler's lecture.[91] "On Thursday evening a very numerous and highly influential company was attracted to the Witham Literary Institution by the announcement of a lecture by the Hon. J. W. Strutt, son of the Right Hon. Lord Rayleigh, of Terling Place, and the new Senior Wrangler of Cambridge University". The subject of this lecture was "Astronomy: the scale of the Solar System". In this lecture, Mr Strutt explained the methods used by astronomers to measure the Sun's distance from the Earth, which had primary importance to this discipline. Mr Strutt was not an ordinary lecturer aside from the honour of the Senior Wrangler he recently received: he was the eldest son of the 2nd Baron Rayleigh, from whom he succeeded the peerage later. Partly due to the lecturer's special background, the audience included two members of parliament and "most of the gentry and clergy of the neighbourhood". The president of this institution, Mr Du Cane, MP, personally chaired the session and addressed a welcoming speech of "a reception somewhat more warm than we are apt to accord to lecturers in general". This unusual reception was not only because this young man was the heir of an admirable local nobleman, who was a former president and munificent patron of this institution, also due to the victory of Mr Strutt achieved from his Alma Mater as the Senior Wrangler. The chair praised Mr Strutt as "our conquering hero", and assured: "[…] the whole

91 'Lecture by the Senior Wrangler', *Essex Standard* (17 February 1865).

county of Essex rejoices in Mr. Strutt's success, I am certain that we who live in his immediate neighborhood have gladly seized upon this the first public opportunity afforded to us of tendering to him our cordial congratulations." This lecture was like a Roman triumph dedicated to the young man by his fellow folks.

With the benefit of hindsight, we know that this young lecturer Mr Strutt would win a place in the history of science afterwards. He inherited his father's peerage as the 3rd Baron Rayleigh and chose a career as a physicist; his involvement of the discovery of argon made him the Nobel laureate for physics in 1904; his studies in acoustics, optics and fluid mechanics left ample achievements named after him.[92] The honour of the Senior Wrangler, which Strutt received in 1865, demonstrated his intellectual excellence and promised a prominent career in the future. Many renowned astronomers, including John Herschel, G. B. Airy and John Couch Adams, had won this title prior to Strutt. Therefore, it was adequate to invite the latest Senior Wrangler for commencing an astronomical lecture before his fellow country neighbours, as the chair humorously remarked "[T]o have my deep darkness illuminated by the bright and shining light".[93] Strutt was not the only case that a Cambridge graduate delivered an astronomical lecture right after the completion of college study. This task could be done without the title of the Wrangler: Charles Babbage (1791-1871), too, had lectured on astronomy fifty years ago prior to Strutt. Babbage delivered a course at the Royal Institution in 1815, one year after his

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92 For example, the effect of elastic scattering of light by small particles, which is used to explain why the sky is blue, is named Rayleigh scattering. For more biographies of Lord Rayleigh, see Kostas Gavroglu, 'Strutt, John William, third Baron Rayleigh (1842-1919)', *ODNB* (2004).

93 *Op. cit*. (91).

graduation from Cambridge.[94] Babbage did not complete the examination at Cambridge (thus he graduated without honours), yet his mathematical competence was undeniable. Babbage was then married and the couple lately moved to London. The job of lecturing at the Royal Institution would be a good stepping stone for a young scholar who was expecting to show his mettle in the metropolitan scientific circle.[95]

In contrast to those Cambridge graduates, there were lecturers at the other end of the spectrum, who lacked formal education and came from humble working-class backgrounds. Among those artisan lecturers the most prominent was John Bird, who was active in lecturing between 1814 and 1840. Bird was born in a humble family in Lincolnshire near to the end of the eighteenth century.[96] Before the year 1814, probably in his early twenties, he was a journeyman carpenter at Abingdon, Berkshire. Despite lacking astronomical education, Bird made instruments such as a tellurian (a device to demonstrate the tilted rotation of the Earth; see Figure 1.4), "simply by the help of an old print on a leaf of Ferguson's Astronomy."[97] His talent was discovered and encouraged by an unnamed patron. After a successful debut for lecturing and exhibiting his instruments at the town hall, he abandoned his carpenter trade and launched for a new vocation. A couple of periodicals reported this story of

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94 This course was also the only astronomical lecture Babbage had ever delivered in his life. An unpublished transcription of this course with an introduction by the editor is preserved in the Royal Institution. See Roberts, ed. (1989).

95 Roberts, *ibid*. For Babbage's biography, also refer to Doron Swade, 'Babbage, Charles (1791-1871)', *ODNB* (2004).

96 'A Lecturer of the Old School', *The Leisure Hour* (20 October 1853), pp. 676-678.. Not to be confused with another John Bird (1709-1776), who was also an instrument maker. There is no evidence to show the two Birds were relatives.

97 *Ibid.*, p. 676.

an genius with humble origins: “An extraordinary instance of innate scientific genius has been lately evinced in the person of a man of the name of Bird, who, less than a twelvemonth since, followed the humble occupation of a journeyman carpenter at *Abingdon*;” The journalist briefly introduced his debut and concluded: “He has since delivered lectures, with astonishing perspicuity, in the principal towns of Berkshire, Wiltshire, and Somersetshire.”[98]

By the 1820s Bird had already become a well-established private lecturer. The quality of his lectures was even recognised by the universities of Oxford and Cambridge, for “[t]he collegians attended his lectures, and the ‘heads of houses’ gave him complimentary testimonials, little short of the usual university titles.” Although the self-educated man had attained neither classics nor the mathematics, Bird secured all the possible success a working-man lecturer could expect at the universities.[99] Bird also enjoyed fame in the aristocratic circle: he was chosen as the astronomical preceptor of the Marquis of Douro, the eldest son of the Duke of Wellington, and was also honoured with the patronage of King William IV. A biography in the *Leisure Hour* remarked on Bird’s minuses and merits:

> He certainly had little learning; his qualifications consisting in reverent admiration for, and enthusiastic ardour in pursuing and illustrating, astronomical truths. Moreover, he possessed an inventive mind, a retentive memory, genuine natural humour, versatility, and readiness. There was, however, a want of refinement in his speech and manner. Still, notwithstanding these drawbacks, in those days his capacities were sufficient to insure him the reputation

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[98] ‘Country Intelligence’, *The Gentleman’s Magazine* (January 1817), p. 78; ‘Provincial Occurrences - Berkshire’, *The New Monthly Magazine*, vol. 36 (January 1817), p. 549.

[99] *Op. cit.* (96), p. 677.

> of a public favourite. His lectures were always extemporaneous; which could not be said of many other lecturers who had started up, and were obliged to acknowledge him as their Mentor. Mr. Bird, in truth, raised a host of imitators, though none of them possessed the originality of his mind.[100]

Bird was highly active in lecturing at the public schools. He was employed as a lecturer in many public schools including Charterhouse, Westminster and Eton. A handbill which informed the students of Charterhouse that Mr Bird would deliver three lectures on astronomy between 15th and 17th June 1830 is preserved in the Science Museum, London (Fig. 2.3). In the handbill the lecturer advertised that his grand transparent orrery was thirty feet in circumference, and was "[w]ith the Improvements as exhibited before His Royal Highness Prince George of Cumberland, at Kew."[101] Bird's career path followed the same traditional pattern as numerous astronomers and instrument makers raised on self-education, such as George Adams, James Ferguson, William Herschel and so on. They were all of lesser-known origins, established a good reputation by the virtues of their crafts and expertise, and eventually acquired royal patronage.[102] The title of the *Leisure Hour* article appropriately indicates this trait – John Bird was a "lecturer of the old school", who sought for aristocratic patronage and used the endorsement of his patrons very well.

John Bird's activities directly inspired a successor with a similar working-class background. Robert Children, who was originally a small-scale

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[100] *Ibid*.

[101] SM: SCM-Art: 1980-930/4.

[102] George Adams and his son George Adams junior were both the mathematical instrument maker to King George III. James Ferguson had received an annual pension of £50 from King George III since 1761. William Herschel was appointed as King's astronomer after his discovery of Uranus.

master boot maker in Bethnal Green, London, attended an astronomical lecture delivered by Bird around 1835.[103] Enthused by Bird's lecture, excited Children began to develop his own lecturing business. Like Bird in his early years, Children had to overcome many problems including illiteracy, bad pronunciations and ignorance of specialised knowledge. When the lecturer pronounced the big words poorly, catcalls and laughter broke out in the audience. Nevertheless, he persevered and survived in the market, even could make a good living from lecturing for he closed original boot-making business eventually. Several newspaper reports covered Children's lectures. The *Hampshire Advertiser* cited a paragraph from the *Oxford University Herald* of 28th November 1835 to describe Mr Children's lectures at the town hall of Oxford, which were "well attended, particularly those in the morning given at the request of several of the heads of Colleges."[104] The *Essex Standard* also reported Children's lectures at the town hall of Sudbury in 1841 with highly acclaim:

> The great fault of most lecturers on the sciences is that they take too much for granted. Having been themselves familiar perhaps for years with their subject, they are too apt to neglect the good old adage of "begin with the beginning;" and consequently the information which they unquestionably possess they fail to impart to others. This was not the case with Mr. Children. We have attended many astronomical lectures, but never heard the great principles of the science more clearly elucidated. Without any pretensions to the higher flights of oratory, Mr. Children, in easy and familiar language, explained the wonders of heavenly bodies,

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[103] Chapman (1998), pp. 172-173. According to Chapman, this lecture was delivered by a 'Dr Bird'. Although this record lacks the lecturer's full name, we can presume the lecturer was John Bird since the year coincides with his active period and no other known astronomy lecturing peers had the same surname.

[104] 'Astronomy', *Hampshire Advertiser* (23 July 1836).

> and illustrated his subject with such a variety of transparencies, and an ingeniously-contrived mechanical apparatus, constructed by himself, on a new and improved principle, that his most difficult theories must have been understood even by a mind not previously turned to the consideration of astronomy.[105]

What we can learn from John Bird's and Robert Children's stories is the ethos of self-improvement and the implication of vertical mobility in society. Self-elevation was a recurring concept being frequently addressed by the contemporaries in the nineteenth century. An individual could improve their knowledge, morals and faith by industrious self-learning and make a better useful life from it.[106] This attitude, usually associated with the practice of Bible-reading, had a strong connection with the traditions of Presbyterians, evangelicals and any other denominations of liberal dissenters.[107] From a secular perspective, the concept of self-improvement also accorded with the educational ideas of social and political reformers, such as the objectives set by Henry Brougham and the SDUK. Science was a fashionable thing that had potential for making good use of a divine gift (or in radicals' view, a powerful organ against the political and religious establishment). As the founder of the SDUK and London University, Brougham was enthusiastic about science and its function for working-class education. The reasons he listed all related to making improvements, which may 'directly benefit themselves and mankind',

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105 'Sudbury', *Essex Standard* (30 April 1841).

106 A bestseller *Self-Help*, first published in 1859 by Scottish writer and reformer Samuel Smiles (1812-1904), was a representative work on this self-improvement view. See Smiles (1897).

107 Secord (2000), ch. 10, pp. 336-363. In this chapter Secord explores a young man T. A. Hirst's reading experience and reflection in detail. Secord uses Hirst's accounts to exemplify the attitude and practice of self-development in the nineteenth century. See also Fyfe (2004) for the focus on the evangelicals and Topham (1992) for the emphasis of the *Bridgewater Treatises*.

and with the advantage of becoming 'a wiser and therefore a more exalted creature'.[108] John Pye Smith, a Congregational author, also said that the cultivation of natural history and the sciences "will be a dignified means of excluding those modes of abusing time which are the sin and disgrace of many young persons."[109] Those modes of abusing time included "amusements which bring no good to the mind or the heart". Thus we can understand why similar rhetoric that a workman who converted indolence into good use of faculties by learning science was so prevalent in the nineteenth century. As the conclusion of the *Leisure Hour* article expressed, John Bird's humble but useful career "is well calculated to teach a working man how much of self-elevation can be accomplished by the diligent use of natural abilities."[110]

Aside from internal spiritual benefit, self-elevation could also imply an external material cause. John Bird and Robert Children were successful instances of working-class philosophers, which are almost identical to Michael Faraday's career change from a bookbinder apprentice to a recognised man of science. It reflected not merely 'elevating recreation', in Allan Chapman's words, but also a climb from a lower social status to a better profession with erudition, respectability, and material prosperity. Such a story of social climbing was certainly inspirational. It is not surprising that John Bird's life would be illustrated in the *Leisure Hour*, a cheap evangelical periodical which was praised to have attractive and improving moral tones for working-class

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[108] Brougham (1827), pp. 33-40; Topham (1992), p. 405.

[109] Smith (1839), p. 327; Secord (2000), p. 345.

[110] *Op. cit.* (96), p. 678. Another example of rhetoric of self-elevation was Mr Facey's orrery in the *Juries' Report* of the Great Exhibition, of which I will discuss in Chapter 5.

Christian readers.[111] Robert Children's story, too, shows the same character. Children acquired a fortune of £6,000 from his successful lecturing, and he eventually retired as a 'great farmer' in America.[112] It was a British version of the 'American dream' in the circle of astronomy lecturing.

The comparison between the 'wrangler' and the 'carpenter' leads to a broader perspective on the role of private popularisers in the scientific lecturing market. Bernard Lightman claims that scientific naturalists such as Thomas Henry Huxley and John Tyndall cultivated the strategy of professionalisation, which included privileging select spaces where to practice legitimate science: laboratories and elite scientific institutions such as the Royal Institution and the BAAS.[113] The result was that scientific naturalists left huge cultural spaces open to lecturers who combined instruction and entertainment. These commercial lecturers, such as John Henry Pepper and the like, set out to "fill up all of the cultural nooks and crannies they could find with science and expand the extent and nature of the diverse sites of science."[114] Thus Lightman argues that these entrepreneurs altered the spatial economy of science. Lightman uses John Henry Pepper along with the Royal Polytechnic as the institutional example, and provides Frank Buckland (1826-1880) and John George Wood (1827-1889) as the specimen of private scientific lecturers. Lightman exemplifies private entrepreneurs in the post-Crystal Palace era. This

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[111] The *Leisure Hour* was published by the RTS, an evangelical counterpart of the SDUK in the promotion of cheap popular science publications. For more details of the RTS and the *Leisure Hour*, see Fyfe (2004).

[112] Chapman (1998), p. 173.

[113] For scientific naturalists' efforts to strengthen the supremacy and cultural authority of science in the late Victorian period, refer to Lightman (2004; 2014) and Turner (1993).

[114] Lightman (2007a), pp. 125-126.

observation accords with my disagreement about Jo N. Hays's argument that the institutionalisation of scientific lecturing was overwhelmed early in the 1820s.

My response to Lightman's argument, however, is both yes and no. The affirmative factor in Lightman's observation is his revisiting and valuing those popular science entrepreneurs. Lightman's work reminds us about the economic side of science. Professionalisation and institutionalisation might be strategies to secure a prestigious status and cultural authority over knowledge, yet they also served for securing profit. Economic activities were important practice in nineteenth-century science, whether for institutional or private practitioners, and to neglect this business side in the history of science would tell only a partial story. As I will show in the next chapter, the diverse sites of popular astronomy best demonstrate this economic practice.

The imprecise part in Lightman's argument is the cause of commercial lecturing: entrepreneurs neither set out to occupy the spaces where scientific professionals left behind, nor to expand the extent of science – they had already been there for long time. The cases of C. H. Adams, Bachhoffner, Bird and Children, show that institutional and private entrepreneurs from different backgrounds had been active in diverse sites in the first half of the nineteenth century. The wrangler and the carpenter had co-existed in the marketplace. Hays's argument of private lecturers' decisive decline and Lightman's description of the late boom of non-practitioner popularisers in the post-Crystal Palace era are neither precise. As Lightman indicates, the new generation of scientific elites worked hard on the professionalisation strategy to enhance the supremacy and cultural authority of science, of which John Tyndall's BAAS address at Belfast in 1874 was a representative account to reflect this attempt.[115] This process made demarcations between practitioners. Some original practitioners in the scientific lecturing market were not regarded as practitioners of science in the late nineteenth century. They became 'non-practitioner' popularisers as Lightman calls them.[116] Demarcations, which were intensified during the late nineteenth century, were closer to the situation of the scientific lecturing scene.

Chapter Conclusion

This chapter has demonstrated my central argument that private lecturers' competencies and popularity in the market during the first half of the nineteenth century. The activities of private entrepreneurs like C. H. Adams, John Bird, Robert Children, and many others, indicate that private lecturers still held a significant place in the astronomy lecturing trade after the 1820s, when scientific institutions and specialised societies commenced growing in Britain. The cases of John Wallis and George Bachhoffner indicate that there were no clear-cut boundaries between institutional affiliates and private entrepreneurs, especially in the first half of the nineteenth century. Popularisers of astronomy, with or without institutional affiliations, demonstrated their professional prowess by well-established reception from audiences rather than academic qualifications. However, institutionalised science gradually influenced the scientific lecturing trade. The decline of private astronomy lecturers in Britain became noticeable after the mid-Victorian period. Private astronomy lecturers

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[115] Lightman (2004; 2014).

[116] Lightman (2007b), p. viii, and pp. 12-13. Notice Lightman's elaboration of his choice of the terms.

either sought institutional connections or to be excluded from specialised scientific communities. The demarcations advocated by scientific naturalists in the second half of the nineteenth century probably contributed to this development. Some old-school practitioners were no longer regarded as the legitimate interpreters of science. In particular, people without appropriate institutional affiliations were losing their scientific credentials.

Chapter 3 Geography

Nineteenth-century astronomical lectures took place in a variety of sites. West End theatres, such as that used by C. H. Adams, were definitely distinct from the Polytechnic Institution preferred by Bachhoffner. These two cases were just the tip of the iceberg – in fact astronomical lectures occurred in Mechanics' Institutes, public schools, town halls, and many other different venues. It would not be an exaggeration to say astronomical lectures occurred almost everywhere. Historians such as David Livingstone and Iwan Morus point out that studies of spatiality of science demonstrate heterogeneity of locality. There is no single, unified scientific rationality in its practice.[1] My study also indicates the heterogeneous locality of nineteenth-century popular astronomy.

This chapter demonstrates a wide diversity of performance sites. This diversity supports two arguments in this chapter: First, I argue that the physical space of a site was a significant factor in shaping the format and style of lecturing. Astronomical lectures performed inside theatres best exemplified this effect. The Walkers, a celebrated lecturer family, made the crucial contribution to the early development of theatricalised astronomical shows. Second, the diversity of sites indicates very different audiences, which could consist of broad social strata ranging from the wealthiest elite to the working classes.[2] Newly-growing scientific institutions in the early nineteenth century reflected the same diversity of target groups: the best comparison is between the likes of the Royal Institution and the class of Mechanics' Institutes. Astronomy lectures

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[1] Livingstone (2003), p. 184; Morus (2006), p. 9.

[2] For further discussions on audiences, see Chapter 6.

were not only everywhere but also for everyone.

Many scholarly works have already shown the sites of scientific practice are critical. When speaking of the last days of the Colosseum, Richard Altick attributes its loss of compatibility to its location. After Bachhoffner's departure, the Colosseum was transformed into a variety house hosting common music hall programmes. Yet the audience had a larger choice of music hall shows in other more convenient places, such as Leicester Square and the Strand. The location of the Colosseum at Regent's Park did not give any advantage over other variety show competitors.[3] In contrast, Altick attributes the success of the Adelaide Gallery, located in an arcade near Trafalgar Square, to its advantageous location. The bustle of its surrounding streets helped attract a large number of curious crowds; this advantage made any new exhibition famous among the populace.[4] Location is crucial; as is architecture. James Secord compares architecture for two distinct institutions to highlight the fractured society and social tensions in mid-nineteenth century Liverpool.[5] The political, religious and cultural tensions in Liverpool were also reflected in education. The Liverpool Mechanics' Institution, founded in 1825 through a Unitarian initiative, arranged courses and lectures in 'useful knowledge' for the public. In contrast, the Collegiate Institution, supported by the Anglican Church to provide 'suitable' education in science and religion to sons of middle-class elites, was established afterwards to counterbalance the

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[3] Altick (1978), p. 162.

[4] Morus (1998), pp. 75-76. Ironically, the Adelaide Gallery's city-centre location and the busy surrounding was also a limitation to hinder its further development, see Altick (1978), pp. 377-382.

[5] Secord (2000), pp. 192-199.

Mechanics' Institution. The significant contrast between the two, in Secord's words, was "built into stone".[6] Their difference was embodied in architecture: the façade of the Mechanics' Institution was designed in classical style, which linked to rationalism since the Enlightenment; the Collegiate Institution was built in Tudor Gothic style, which was preferred by the Church and religion-rooted Oxbridge colleges. The architecture plans adopted by the founders expressed the values and ideologies they stood on. In other words, architecture was an implicit language, a "symbolic writing of space".[7]

'Sites', together with 'regions' and 'circulation', are among the major themes of what David Livingstone calls the geographies of science. Spatial approaches have increasingly drawn historians' attention.[8] Science is performed in a broad variety of localities, in which the spatial conditions mould very different outcomes.[9] Geographers of science have demonstrated that sites of science are not confined to laboratories but also include various venues such as museums, zoos, botanic gardens, field stations and even public houses.[10] Sites of scientific knowledge production are not merely a stage on

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6 Secord (2000), p. 193.

7 Livingstone (2003), pp. 37-38. Livingstone uses the Natural History Museum at South Kensington as the example of a museum building's external iconography. See also Forgan (1994; 2005) and Yanni (1999).

8 Livingstone (2003), in which the author gives an accessible survey and bibliography of this field. For further historiography and discussions of the geographies of science, see also Livingstone (1995); Smith and Agar, ed. (1998); Secord (2004a); Finnegan (2008). Livingstone and Withers, ed. (2011) is the most recent scholarship focusing on the cases in the nineteenth century.

9 The core idea of locality in the geographies of science is anchored after Steven Shapin and Simon Schaffer's influential work *Leviathan and the Air-Pump* (1985). See Secord (2004a), p.657.

10 For example, Anne Secord (1994) discusses scientific practice of artisan botanists in early nineteenth-century Lancashire, wherein their activities and meetings were often in local pubs.

which actors play. Spaces themselves also shape a large part of the network between actors, for they enable and constrain all practice within. Sites are valuable to examine because such spatial settings do influence scientific practice *in situ* as well as scientific knowledge in transit.[11]

This chapter will begin with an overview of cultural and leisured milieu of London, the British capital and the most affluent metropolis. By referring to contemporary guidebooks and a foreign visitor's account, Section 3.1 demonstrates the exciting environment of London for entertainments and scientific ventures in the early nineteenth century. Then, the focus moves from London to other places in Britain. During the course of this chapter, more lecturers who were active in particular sites will be considered. While John Wallis moved around scientific institutions, the Walkers and George Bartley enjoyed the stage of theatres. The significance of each category of lecturing sites – theatres, learned institutions and Mechanics' Institutes – will be shown in Sections 3.2 to 3.4. Furthermore, the big picture in this chapter is dynamic rather than static. Section 3.5 will show the itineraries of lecturers, which indicate knowledge and business in transit, and lecturing activities reached even the country. The circulation would suggest further topics relating to geographies which I do not actually touch in this thesis, such as regional differences and comparisons between centre and periphery.

3.1 Metropolis: A Cornucopia of Amusements

"[W]hen a man is tired of London, he is tired of life; for there is in London all that life can afford." This quotation from Dr Samuel Johnson is timeless.

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[11] Livingstone (2003), pp. 17-19; Finnegan (2008), p. 372.

Our first stop of this journey is London, the metropolis as well as the gateway to Britain for many visitors. As the capital of a wealthy and growing empire in the early nineteenth century, London was full of attractions. It is not difficult to imagine the dazzling display of the hustle and bustle to a visitor who first arrives in London. “Having known that I was approaching the biggest and the wealthiest capital city in the world, I was overcome by unusual emotion.” Krystyn Lach-Szyrma (1791-1866), a Polish intellectual who first visited London in 1820, left his thoughts in a memoir.[12] Lach-Szyrma described his first walk on the streets of London: “I did not know where to go and I did not care. I was walking in the streets and squares, over the bridges, looking at shops, vehicles, tombs, dresses, monuments and people. Whenever I wanted to stop somewhere for longer, crowds of people, going in the same direction as I was, pushed me and took me with them as though in a flood and as they wanted to tell me that what I had seen was nothing compared to what I was to see further on.”[13] The metropolis has her own glamour to make a visitor impressed.

I choose London as our starting point for several good reasons. The foremost, no doubt, is the abundant resources the metropolis could offer. The resources were not only material fortune, but also cultural and scientific activities. From the Royal Academy’s summer exhibition in Somerset House, to the Panorama in Leicester Square, the metropolis had so many things to indulge in. Such a

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[12] Lach-Szyrma (2009), pp. 17-18. The original Polish text of Lach-Szyrma’s reminiscences was published in Poland in 1828. A part of the reminiscences concerning Lach-Szyrma’s stay in London and England was translated into English by Margozata Machnice and Agnieszka Kiersztejn. This English edition was edited and annotated by Mona K. McLeod. See ‘Editor’s Introduction’ in Lach-Szyrma (2009).

[13] Lach-Szyrma, *ibid.*, p. 24.

cornucopia of amusements displayed a vibrant marketplace, of which scientific lecturing was a part and competed with other business. Recent scholarship increasingly emphasises the connections between science and the city, and hence develops what some historians call the 'urban history of science'. Cities are not merely the 'setting' for scientific sites; they are variable arenas and should be regarded as a key context in which scientific practices are embedded.[14] Urban resources of the metropolis could result some particular shows which are hardly to be produced or copied in other places. Besides, the city life in nineteenth-century London is a topic never out of date and there is so much literature on it, including scholarly works and material in the semi-popular genre.[15] The abundance of literature provides an advantage in getting familiar with the everyday environment of the metropolis. It is also convenient to make comparison between scientific lecturing and other metropolitan cultural landscapes.

So our journey begins. This section intends to set the scene – to establish the imagery of early nineteenth-century London life within which astronomy lecturing was embedded. This 'setting the scene' is an effective technique of writing in the literature on geographies of science; this writing style could guide readers to 'experience' the physical spaces and to explore the spatial context within. Many historians use this method in writing: Robert Frank elaborates the streets and sites of seventeenth-century Oxford to explore the

[14] Dierig, Lachmund and Mendelsohn (2003); Withers and Livingstone (2011), pp. 5-6.

[15] Two massive volumes best depict the panoramic view of the metropolis during this period: Altick (1978) focuses on the amusements; Fox, ed. (1992) has essays which cover different aspects of London including scientific life of this period. For the popular history genre, Picard (2006), White (2008) and Flanders (2012) are some examples.

relationship between William Harvey and Oxford physiologists; Richard Bellon describes a route through Victorian London following one suggested in a contemporary guidebook in order to simulate the experience of visiting the Crystal Palace at Hyde Park; Bernard Lightman, too, says he is “a traveler” who will be “visiting” various sites in the beginning of an essay on the scientific spaces of nineteenth-century London.[16] Here I apply this method, too.

Two kinds of primary sources are used in this thesis to sketch out metropolitan life: the reminiscences and guidebooks. The accounts I select focused on city life in the 1820s, which was the time when many Lenten astronomy lectures such as the Walkers’ Eidouranion thrived. The reminiscences, such as Lach-Szyrma’s memoir, are invaluable materials since they were made through a stranger’s eyes with fresh insights. Lach-Szyrma was more than an intelligent tourist: his observation on British society covered many different aspects ranging from legal system to popular amusements, and he faithfully recorded what he had seen and thought. Mona McLeod comments that Lach-Szyrma “was dazzled by London but never quite lost the critical eye of a European intellectual.”[17] Guidebooks to London are the other important primary sources. Many guidebooks, ranging from pocket-sized handbooks to heavy dictionaries of locations, flooded into the nineteenth-century publishing market. These publications often listed a variety of landmarks, sites and activities, with informative descriptions and sometimes included the author’s

[16] Frank (1980); Bellon (2007); Lightman (2011), p. 25.

[17] Lach-Szyrma (2009), p. xxiii. For the life of Krystyn Lach-Szyrma and the background of his visits to Britain, see ‘Editor’s Introduction’ in Lach-Szyrma (2009).

personal recollections. They provide a window on the fashionable attractions and entertainments for the contemporaries. The guidebook I discuss mainly is Horace Wellbeloved's *London Lions for Country Cousins and Friends about Town* (1826), which was a representative example within this genre in Lach-Szyrma's time.[18]

London Lions was a carefully planned guidebook in many ways. The title of this book shows a little humour, as the author indicated in the preface: "that our COUNTRY COUSINS, when they come to see the "*London* LIONS," will have only to put this Volume in their pockets, and by its direction, will be led from place to place, requiring no other guide."[19] This title might be a playful variation on the famous tale 'the town mouse and the country mouse' of Aesop's Fables; besides, the term 'lions' also had a particular meaning in nineteenth-century social culture. A 'lion' means an accomplished individual, often an influential author and a celebrity in social occasions. The opposite concept of a lion is a 'bore', which was often depicted as a boar based on its pun. A lion would be the focus of attention in a party or a conversation; on the contrary, a bore's unpleasant talk and manner would drive people away. Such an animal metaphor was an important concept in the oral culture of nineteenth-century society.[20] Therefore, the title and the preface of *London Lions* brought an obvious message: this book contained the most fashionable subjects of metropolitan attractions and novelties. Readers could use this book

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[18] Wellbeloved (1826). The full title of the book is *London Lions for Country Cousins and Friends about Town being all the new buildings, improvements and amusements in the British Metropolis*.

[19] Wellbeloved (1826), Preface.

[20] Secord (2000), pp. 178-179. For the oral culture in nineteenth-century British society, see also Secord (2007).

not only for tour information but also for conversation pieces. The subjects of *London Lions* include prominent buildings, places, and organisations in the metropolis, emphisising improvements and amusements. Some entries are even on planned constructions or potentially successful companies – they had not taken form when the book was published yet were considered to be worthy of note. Each entry contains a descriptive essay on the place and is often with historical and cultural information. In addition to usefulness, *London Lions* is also ornamental and collectable: it contains over twenty exquisite scenic engravings. The price of the book was not expensive, which cost only 5s. 6d. Overall, *London Lions* was an affordable quality guidebook which most of the middle-class readers would be interested in.

So what amusement attractions does *London Lions* recommend? We can go through a virtual tour with a companion of a contemporary London map (Fig. 3.1). Let's start at Regent's Park, which was in the northern edge of the urban area in the mid-1820s. The pastoral beauty of Regent's Park was not surprisingly praised by the author, yet there was another attraction which drew visitor's attention by its artificial beauty. The Diorama at Regent's Park was extremely sensational. It was a scenic display of flat paintings with an illusion of depth. With the help of adjustable lighting, the Diorama can make dramatic effects and let the audience feels immersed in the scenes.[21] The popularity of the Diorama can be seen from its space in *London Lions*: the author uses six pages with three illustrations to describe the scenes of the display. Lach-Szyrma had visited the Diorama in 1823 and described: "As I was looking at the two views [the interior of Canterbury Cathedral and the Swiss

[21] For the details of the Diorama, see Altick (1978), ch. 12; Wood (1993).

valley of Sarnen] it seemed to me that, as though by means of supernatural power, I had been transported into the precincts of the cathedral I had already visited and into the most beautiful valley in the world in order to feast my eyes once again upon these views."[22] However, *London Lions* doesn't mention the Colosseum – the future neighbour of the Diorama was then under construction and did not open until 1829, three years after the publication of *London Lions*. Away from Regent's Park, walk down along Regent Street towards the River Themes, tourists arrive at Mayfair and Soho – the heart of the West End, where many tourist attractions were around Leicester Square and Piccadilly. The Royal Institution had already been established in this area for decades, but *London Lions* neglects to mention it. Perhaps the Egyptian Hall in Piccadilly was more fun to tourists. Formerly being Bullock's Museum, the Egyptian Hall was Londoners' long-time favourite place for seeing exhibitions of curiosities. When *London Lions* was published, the object of public attention in the exhibition was 'ancient and modern Mexico', which was Mr Bullock's collection during his stay in Mexico in 1823. Visitors can see exotic specimens from Mexico, and stroll around altars and colossal idols of the Aztecs.[23] There were many other minor exhibitions around this area. For example, Linwood Gallery in Leicester Square, which was famous for its exhibition of tapestry; Royal Armoury and Automatons in Haymarket, where Napoleon's firearms were exhibited along with musical automatons. For those ruthless spectators "who require the most repulsive anomalies of nature to excite their palled sensations", *London Lions* considers the unsparing exhibition of the Living

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[22] Lach-Szyrma (2009), p. 234.

[23] Wellbeloved (1826), pp. 49-53; Altick (1978), pp. 246-248.

Skeleton in Pall Mall as the most complete.[24]

Along with many other entertainments in the metropolis, astronomy had its own prestigious place in the market. Mr Walker's Eidouranion and the Uranologia of Mr Bartley were listed in the very first entry of *London Lions* (Fig. 3.2). "Of those optical exhibitions of the higher class, which have had their combinations made by men of science, and which have been perfected by the aid of painting and mechanics, the Eidouranion of Walker, and the improved lecture of Bartley, well deserve to rank the foremost."[25] This compliment and the entry's first place in the book show the significance of the Eidouranion and the Uranologia. The two were predecessors of C. H. Adams's show – astronomical lectures accompanied by the transparent orrery. *London Lions* introduces:

> The Vertical Orrery, or Eidouranion of Adam Walker, is not merely in unison with the artist-like exhibitions we have already described, but in its early days formed so novel, and, really, so interesting, so dignified an amusement, that we cannot hesitate to place it amongst the most respectable efforts, to extend the beneficial uses of the stage.[26]

In addition to the Eidouranion and the Uranologia, another astronomical exhibition *London Lions* introduces is the Busby Orrery. Invented by Mr Busby, this orrery is a self-moving hydraulic machine. It has the same effect of other self-acting orreries but is driven by hydraulics rather than clockwork. "[The

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[24] The 'Living Skeleton' was an emaciated Frenchman Claude Ambroise Seurat (1798-1826), who was invited to London for the bizarre show in 1825. Sadly, he succumbed to chronic wasting in 1826. See Wellbeloved (1826), pp. 79-81; Altick (1978), pp. 261-263.

[25] Wellbeloved (1826), pp. 1-2.

[26] *Ibid*., p. 2.

Hydraulic Orrery] may be erected on the most extensive scale, on a natural or artificial basin in the open air, or would form an interesting appendage to a conservatory or aquarium", *London Lions* comments: "we venture to recommend them as suitable ornaments for all public places in which a suitable piece of water occupies a commanding site."[27]

Theatres are sites *London Lions* not cover, yet these occupy an important place in the amusement market. According to John Timbs's *Curiosities of London* (1867), a more comprehensive guidebook published decades later, there were 23 theatres in London licensed by the Lord Chamberlain for the performance of any kind of drama in 1866.[28] Most of these theatres were in the West End, including the famous Drury Lane, Covent Garden and Haymarket. However, dramatic entertainments in London were not confined to the West End; many minor theatres were distributed through the East End and the fringe of the metropolis. The *Report from the Select Committee on Theatrical Licences and Regulations* in 1866 indicates that 63.7 percent of the total capacity of London theatres was taken up by theatres outside the West End. This calculation does not include the capacities of other dramatic performance venues, such as music halls and numerous penny gaffs which appealed to the lower classes.[29] In a broader sense, the range of nineteenth-century theatres was as wide as the diversity of society. Though different theatres might have

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27 *Ibid*., pp. 5-8. See also King (1978),

28 Timbs (1867), p. 789. John Timbs's *Curiosities of London* was first published in 1855 and had an enlarged new edition in 1867. It uses the format of a dictionary and is a massive volume.

29 Booth (1991), p. 5. For general situations of theatres in the early nineteenth century and Victorian era, see Booth (1991); Mackintosh (1992); Jackson, ed. (1994); Donohue, ed. (2004), Part II.

attracted different classes of audience, it was possible to observe a miniature society in a single theatre. Most West End theatres kept the hierarchical division in the auditorium by dividing space into boxes, pit, and gallery. A comical illustration ‘Pit, Boxes and Gallery’ drawn by caricaturist George Cruickshank (1792-1878) best depicts such a social make-up in a theatre (Fig. 3.3).[30] The price for a seat in boxes was the most expensive, so boxes were usually reserved for the upper class or the rich. Boxes were also a battleground among the rich to flaunt their taste of fashion, as Lach-Szyrma described: “[the boxes] were upholstered with a crimson cloth whose colour flattered the ladies who displayed themselves superbly, especially in the first row of boxes where only formally attired persons are admitted. Men attend plays clad in black tailcoats, stockings and boots with white scarves round their necks, for colourful and motley garments are deemed vulgar in London.”[31] In contrast, the gallery had the cheapest seats and was often occupied by the lower class. Lach-Szyrma described the audience in the gallery as the ‘mob’ because of its rude behaviour: “[The mob] hovers above the entire congregation, whistles, hisses, howls and boos. Occasionally dirty jests, loud laughter and national songs can be heard. The rest of the audience can do nothing but tolerate the mob’s caprices and listen to the judgments passed.”[32] Although the chaotic situation Lach-Szyrma encountered might not have happened every day, it reflects how diverse the background of audiences could be in nineteenth-century theatres.

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[30] The Victoria and Albert Museum has a copy in the H Beard Print Collection. See also Booth (1991), p. 8, Plate 1; Fox, ed. (1992), p. 553, Entry 573: ‘Pit, Boxes and Gallery’, written by Iain Mackintosh.

[31] Lach-Szyrma (2009), p. 213.

[32] *Ibid*.

Scientific institutions and societies are another part *London Lions* doesn't talk about due to its focus on amusements. Nevertheless, the first half of the nineteenth century was a crucial period for the expansion of many institutions. Lach-Szyrma's first visit to London was between 1820 and 1824, so he witnessed the growth of scientific institutions in the British capital. As a patriotic intellectual with ideas of social reform in his home country, Lach-Szyrma certainly noticed the development of scientific institutions in Britain.[33] He mentioned several scientific institutions and societies in his reminiscences, including the Royal Society, the University of London, and the Royal Institution ("a kind of technical school"). He was especially excited about those institutes for the promotion of useful knowledge among craftsmen, which followed the Mechanics' Institution created by George Birkbeck (1776-1841). Lach-Szyrma praised with excitement:

> What a huge step towards further progress in industry and crafts, as well as in morality, when craftsmen, weary after a whole day's toil at a workshop, do not seek repose in physical rest nor intoxicate their senses with liquor but study the theory of their crafts and examine relationships between specific and general laws of nature! Just how many new modifications and improvements in workshops may this bring and how many new inventions and discoveries![34]

By the mid-nineteenth century, these institutions and societies proved to be an enormous force in the development of British science. Many of them were

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[33] Poland was ruled by Russia with limited autonomy after the Congress of Vienna in 1815. Lach-Szyrma was appointed as a professor of philosophy in the University of Warsaw after his return to Poland. He played a central role in the November Uprising against Russia in 1830. After the failure of the uprising, he was exiled for life. Lach-Szyrma then moved to England as a journalist and translator, and kept active in Polish literary community in London.

[34] Lach-Szyrma (2009), p. 98.

recognised by the public, and guidebooks such as *Curiosities of London* could not neglect them. John Timbs wrote entries for the Royal Institution and the London Institution in *Curiosities of London*. He praised the collection of books in the London Institution as "one of the most useful and accessible in Britain",[35] and claimed the Royal Institution "has been worthily designated as 'the workshop of the Royal Society;' for within its laboratory Sir Humphry Davy made those brilliant discoveries which were published through the medium of the *Transactions* of the Royal Society; and the example of Davy has been followed by Faraday."[36]

The world's largest city in the nineteenth century was fascinating through the eyes of a foreign visitor and two contemporary guidebooks. These are just a few examples among the massive literature to show modern readers a cornucopia of amusements, theatres, institutions and societies in the metropolis. The sites I describe in this section were not merely the setting of astronomy lecturing – the physical spaces and the cultural context of the sites also moulded the very different appearances of lectures which took place within them. The following sections will introduce the lectures in different sites including theatres, institutions and other miscellaneous venues. Modern readers might be surprised to the diversity of lecturing venues in the nineteenth century. The diversity reflects not only different audiences but also the distinction of production, formats and styles of lectures. During the course of our further journey, we shall visit sites in the metropolis as well as in other provincial towns.

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[35] Timbs (1867), pp. 532-533.

[36] *Ibid*., p. 719.

3.2 Astronomy inside Theatres

When Michael Faraday started his assistantship in the Royal Institution in February 1813, this enthusiastic young lad already had much experience of attending lectures. In a few letters to his friend Benjamin Abbott, Faraday, who later became the most remarkable lecturer in the Royal Institution, talked about his observation on lecturing and gave profound insights into it. His comments were not only on lecturing skills, but also on many technical aspects of a lecturing site, including lighting. Faraday noticed the difference between natural and artificial lighting in a lecture room:

> In this particular the theatres in a large way have one advantage i.e. in the site of their stage lamps which illuminate in a grand manner all before them tho at the same time they fatigue the eyes of those who are situated low in the house but tho Walker has shewn in the most splendid and sublime manner that Astronomy may be illustrated in a way the most striking by artificial light yet from what little I know of these things I conceived that for by far the greater part of Philosophy day light is the most eligible and convenient[.] [37]

As Faraday remarked, astronomical lectures were distinct from others because of its requirement for achieving a better effect in a dark environment with artificial lighting. No venues better than a theatre could fulfill this need. When concerning his favourite lecture sites, Faraday named the lecture room in the Royal Institution, the Automatical Theatre, and the Theatre Royal Haymarket, which were "[t]hose in which I have seen company and which please me

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[37] Faraday to Benjamin Abbott, 1 June 1813. James, ed. (1991), Letter 23, p. 56.

most".[38] Theatres had a place for being the site of early nineteenth-century's lectures, especially astronomical ones.

The 'Walker' mentioned in Faraday's letter was William Walker, the eldest son of Adam Walker. William Walker had already succeeded his father's philosophical lecturing venture when Faraday began assistantship. Adam Walker carefully educated and prepared his eldest son to take over the family business: William attended Eton College between 1778 and 1780, and delivered his first lecture with his father at Newbury when only sixteen.[39] William and his youngest brother Deane Franklin Walker (1778-1865) were also responsible for some later editions of their father's publications; for example, the long printed tract *An Epitome of Astronomy; including an account of Eidouranion; or, Transparent Orrery*, which was first published around 1782, went through thirty editions by 1824. As early as in the tenth edition (1793), William's name already appeared on the title page showing the course was lectured by him.[40] Although the Walkers were based in London after 1781, they still traveled frequently for lecturing like other itinerate lecturers in the late eighteenth century. The Eidouranion was the trademark repertoire in the Walkers' astronomical lectures. Faraday had attended William Walker's lecture sometime before June 1813 and was impressed by its magnificent demonstration. He praised Walker's arrangement for programme yet also

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[38] *Ibid*. Interestingly, these three venues were three distinct types of sites: an institution, a spectacle exhibition, and a playhouse. The Automatical Theatre was an automatons exhibition operated by Henri Maillardet at the Great Room, Spring Gardens, and elsewhere in London between 1798 and 1817. See Altick (1978), p. 350.

[39] E. I. Carlyle, 'Walker, Adam (1730/31-1821)', *rev*. Anita McConnell, *ODNB* (2004).

[40] Walker (1793); *ODNB, ibid*.

pointed out that the venue contributed to such a distinction:

> The only instance in which I have seen a Lecturer succeed in occupying the attention of his audience for a time eminently longer than an hour was at Walker's orrery in which the subject has occupied time to the amount of two or three hours[.] But here we have peculiar attendant circumstances from the nature of the place itself (a theatre) we expect to remain there a considerable time & tho the subject differs from such as usually draw us there yet we in part associate the ideas together – Again Mr. Walker very judiciously leaves the audience at intervals to themselves during which time they are entertained by harmony well suited to accompany such a subject by these interruptions he allows the minds of his company to return to their wonted level and they are in a short time again ready to accompany him into the celestial regions[.] [41]

Faraday's comment reminds us of two crucial differences between Walker's orrery demonstration and other lectures – the venue and the format. An astronomical lecture inside a theatre would own some special features which other scientific lectures did not have. These features included stage lighting, ample space for large apparatus, the company of music performances in intervals and, last but not least, larger audience capacity. Figure 3.4 is the ground plan of the new Lyceum Theatre (English Opera House), where Walker, Bartley and C. H. Adams had performed one after another. The huge scale of the stage and the auditorium is clearly shown by the ground plan. Even during the glorious period of the Royal Institution in the mid-nineteenth century, the average size of its discourse audience was mostly between 400 and 500;[42] in contrast, a West End theatre could host over 1,000 and even reach 2,000

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[41] Faraday to Benjamin Abbott, 11 June 1813, James, ed. (1991), Letter 25, p. 62.

[42] James (2002b), pp. 138-139, see especially Table 6.2.

people.[43] Besides, the arrangement of musical intervals between divided parts in Walker's lecture allowed the audience to unwind and enjoy artistic entertainment. All these traits certainly made Walker's lecture was very different from discourses held in other sites. Differences of interior space created a distinct performance.

Many popular astronomical lectures in the early nineteenth century, such as William Walker's one, used the physical space of theatres. Theatres were common venues to accommodate astronomical lectures. The Walkers demonstrated their Eidouranion at the Theatre Royal Haymarket and the English Opera House. R. E. Lloyd, the Walkers' major competitor, also exhibited his Dioastrodoxon in theatres around Britain. Lloyd's lecture circuit venues included the Theatre Royal Haymarket, the Music Room in Oxford, and Caledonian Theatre in Edinburgh.[44] James Howell, who worked as a City clerk during the daytime yet performed on the stage at the Strand by night, delivered astronomical lectures at the Adelphi and Her Majesty's Theatres in the 1830s.[45] Not to mention C. H. Adams's rise on the stage since 1830. The development of the transparent orrery contributed to this theatrical connection of astronomical lectures. The transparent orrery was a large and simplified version

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[43] The capacity of London theatres refers to Timbs (1867), p. 789. See also Mander and Mitchenson (1961). Unfortunately, unlike the Royal Institution has records of discourse audience size since 1832, it is more difficult to trace the actual number of the audience in a theatre. But if we assume a theatre auditorium was half full, the number of the audience was still larger than most contemporary institutional lectures.

[44] An advertisement of Lloyd's lecture at Caledonian Theatre, Edinburgh, appeared in the *Edinburgh Literary Journal*, no. 29, p. 20 (30 May 1829); For more records and introduction of Lloyd's lecture, see Altick (1978), pp. 314-317.

[45] *Theatrical Observer* (30 March 1836), p. 1; *Theatrical Observer* (27 February 1839), p. 3; Chapman (1998), p. 167.

of the orrery designed to be demonstrated in front of a large audience. Many lecturers and instrument-makers in the late eighteenth century made efforts to introduce the transparent orrery; among these pioneers, Adam Walker was the most significant inventor.[46] As early as in 1772, Walker had mentioned his transparent orrery in this year's edition of *Syllabus of a Course*, and later the device was named Eidouranion. Other early records of Adam Walker's transparent orrery demonstrations include exhibitions of a 15-feet-across Eidouranion in the New Theatre in Birmingham in 1781, and the one staged at the Theatre Royal Haymarket in London in 1782.[47] The success of Adam Walker's Eidouranion opened a lecture empire on the stage over the next four decades, which was consisted of Adam Walker and two of his sons. In every way, Adam Walker was a pivotal figure in the transition from itinerant philosophical lecture to theatrical demonstration of astronomy between the eighteenth and early-nineteenth centuries. William and Deane, the two sons who followed their father onto the path of lecturer, also participated in and witnessed this process.

During Lent in the first half of the nineteenth century, London theatres were especially competitive arenas for astronomical lectures. The Walkers, Lloyd, Bartley, Howell, and C. H. Adams, were familiar names in the market. Frequently, their lectures clashed with others in Lenten season; such rivalry can be seen from the newspaper advertisements – notices announcing different lectures at different theatres appeared in the same column and were next to one another. This 'astronomical mania' was partly due to the traditional restrictions

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[46] King (1978), pp. 309-314; Altick (1978), p. 81, 364-365. I will discuss more on the transparent orrery and other apparatus in Chapter 5.

[47] King, *ibid.*, pp. 309-311; RAS: Add MS 88: 133b.

on performances during Lent.[48] Dramatic performances were restricted as a Lenten convention: the restrictions included theatre closures on Wednesdays and Fridays during Lent and the complete ban on dramatic performances during Passion Week.[49] Like the censorship of dramas, the power to supervise Lenten restrictions was controlled by the Lord Chamberlain. Such restrictions continued to exist, although to some extent declined, in the mid-nineteenth century. Major patent theatres, such as Drury Lane and Covent Garden, particularly enforced the restrictions, while minor theatres often flouted them with impunity.[50]

The ban on dramatic performances was unfavourable for actors and theatre managers, yet it was the opportunity for other amusements. "It is an acknowledged axiom that there is no evil without some counter balancing good," a notice in the *Theatrical Observer* criticised sharply: "therefore the stupid practice of closing our Theatres for dramatic representations two nights per week during Lent (a practice which, in this enlightened age, ought certainly to be abolished,) is the means of bringing before the public a very interesting and instructive exhibition, Mr. Adam's [*sic*] Tellurian and Orrery".[51] Various substituting entertainments were flourishing during the period, of which

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[48] 'Astronomical Mania' was the title of a satirical newspaper article which reviewed the current season's crop of astronomical lectures around 1839. See Chapman (1998), p. 167.

[49] For discussions of conventional Lenten restrictions on dramatic performances, see Foulkes (1997), pp. 32-34; Altick (1978), p. 364.

[50] Foulkes (1997), p. 32. In the *Report from the Selected Committee on Dramatic Literature* (1832), John Payne Collier, the Lord Chamberlain's Examiner of Plays, gave evidence before the Parliament committee that many theatres continued playing on Wednesdays and Fridays during Lent; see also Jackson, ed. (1994), pp. 18-19.

[51] *Theatrical Observer* (25 February 1836), p. 1.

astronomical lectures were usual events in the programmes. Vacant stages of theatres were often reserved for orrery demonstrations; celestial movements temporarily replaced earthly plays in front of the audience. Moreover, in addition to the entertaining function, astronomical lectures were full of educational values – not only scientific knowledge, but also divine inspiration. The latter was especially often stressed by lecturers and reviewers, whether as a genuine motive or a justification on the occasion. In a contemporary reviewer's words, "These lectures are particularly appropriate to the season, for religious and solemn aspirations ought to be cherished, more than any other period of the year".[52] Astronomical lectures were therefore a common fixture during Lent for many decades.

With an established reputation inherited from his father, talented William Walker would have a long and celebrated career, yet an unexpected illness impeded it. In 1816, William Walker died at the age of 50, when his health condition had already deteriorated during the last three years due to a severe cold.[53] William Walker's early death must have been a great loss to the family. Deane Franklin Walker, William's 38-year-old youngest brother, continued the family business of lecturing on experimental philosophy and took over the Eidouranion. In the following year's Lent, the new Eidouranion lecture was presented at the English Opera House (Fig. 3.5), which was confronted by the

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[52] These words were from a review on C. H. Adams's lecture. *The Metropolitan Magazine*, vol. 34 (February 1834), p. 56. I will discuss more on the religious and moral-uplift aspect of astronomical lectures in Section 4.4.

[53] *The Monthly Magazine*, vol. 41, no. 282 (April 1816), pp. 273-274. Compared to the lives of his father and siblings, William Walker's death was quite early. Adam Walker died in a great age of 90 and was still alive when his eldest son died. Deane Franklin Walker also had a long 87-year life.

old rival Lloyd's lecture at the Theatre Royal Haymarket.[54] D. F. Walker was keen to promote his new Eidouranion and was not content to the Lenten stage. In the same year, he travelled to the North during winter and delivered the show in Liverpool and Lancaster. He advertised the Eidouranion that "Since the death of his late Brother, it has been greatly enlarged, embellished, and improved, by the first Artists of the Metropolis."[55] The performance was successful: a correspondent for *Liverpool Mercury*, who attended the lecture, "acknowledges that he was both instructed and amused by Mr. W.'s very ingenious and splendid illustrations." The newspaper also noted that "The house was crowded."[56] Later on, D. F. Walker presented regular Eidouranion lectures in London during Lent, and constantly travelled for lecturing outside the metropolis during summer or winter. This travelling pattern was consistent in the next two decades, and D. F. Walker's Eidouranion was exhibited in every corner of Great Britain from Aberdeen to Exeter.[57]

Like his father, D. F. Walker was a versatile lecturer and did not confine his curriculum to astronomical stage shows. A handbill of the Eidouranion in March 1819 also advertised at the bottom that Mr Walker's usual course of lectures was continuing at the Assembly Room, Cateaton Street, on every Monday and Thursday, which following with the subjects including galvanism

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[54] *Morning Chronicle* (5 April 1817).

[55] See the advertisements in *Liverpool Mercury* (24 October 1817) and *Lancaster Gazette and General Advertiser* (1 November 1817).

[56] *Liverpool Mercury* (19 December 1817).

[57] The advertisements were in *Aberdeen Journal* (4 November 1829); *Trewman's Exeter Flying Post* (13 and 20 August 1818). Between 1817 and 1831, D. F. Walker's Eidouranion lecture also travelled to Liverpool (1817 and 1823), Lancaster (1817), Bury St. Edmunds (1821), Edinburgh (1823), Portsmouth (1829), Bristol (1830), and Oxford (1831).

and fortification.[58] He also inherited his father's talent of invention and sometimes used this talent dramatically in the lectures. An intriguing story was reported in the newspapers in 1844:

> A most interesting experiment was made on Friday at Kemp Town by Mr. D. F. Walker after his Lecture on Hydrostatics. He led his audience to the beach, where Tom Dunn the bather, tying his, Mr. W.'s, Cork Belt under his arms, plunged into the sea with his clothes on. There he seemed to enjoy himself excessively, as he floated away on the waves; sometimes with his hands and arms held above his head, and sometimes rolling on his back, declaring he "could support two or three besides himself." The experiment was most satisfactory, and proved that by such a cheap and simple contrivance many a valuable life might be saved in shipwreck. […] Well done, Mr. Walker! You have laboured long in the field of science and taught in your lectures many valuable truths; but this is an application of them that must essentially serve mankind in the hour of peril. We have heard that the diver at the Polytechnic has exhibited your life belt every evening in the waters of that fine Institution; but it remained till Friday last and yesterday to test its powers over the waves.[59]

We do not know the reaction of the audience at that very moment, yet such a demonstration must have been very impressive. D. F. Walker seemed to use this dramatic skill well whether he was on the stage or in a field. Though the Eidouranion show was popular and continued until the late 1830s, it seems that D. F. Walker retired from the stage at some point and then focused on lecturing on experimental philosophy in later years.[60] His obituary in 1865 described

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[58] RAS: Add MS 88: 8.

[59] 'Life Preserver', *Lancaster Gazette and General Advertiser* (12 October 1844). The original story was extracted from *Brighton Guardian*.

[60] The latest record of D. F. Walker's Eidouranion performance I know is at the Colosseum during Lent in 1838. See the advertisements in *The Examiner* (11

him as “formerly Lecturer in Natural and Experimental Philosophy at Eton College and other Public Schools”.[61]

When D. F. Walker restored his father and late brother’s Eidouranion to its former glory, another new competitor with much stronger theatrical connections appeared. In London’s newspapers during March 1821, an advertisement repeatedly announced: “The Public are respectfully informed, that this Theatre will be OPENED on Wednesday and Friday next, when an entirely new LECTURE on the STRUCTURE of the UNIVERSE, principally selected from the works of the best writers on Astronomy, will be delivered by Mr. BARTLEY.”[62] The theatre was the English Opera House, and the machinery as well as the show was later entitled ‘Ouranologia’.[63] This new competitor, George Bartley (1782?-1858), was a genuine actor – an experienced comedian who was then engaged at Covent Garden in winter and the English Opera House in summer.[64] Though astronomy was far from his profession, Bartley delivered astronomical lecture at the English Opera House during Lent in the 1820s (Fig. 3.6). Bartley was an intriguing and significant – if not unique – figure among the early nineteenth century’s astronomical lecturers. In comparison with many other contemporary lecturers, he neither had a relevant background nor treated astronomical lecturing as a long-term

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March 1838) and *Morning Chronicle* (4 April 1838).

[61] ‘Mr. Deane Walker’, *The Gentleman’s Magazine*, vol. 2 (July 1865), p. 113.

[62] For example, see *Morning Chronicle* (9 March 1821).

[63] For example, see *Morning Chronicle* (7 April 1821). The title ‘Ouranologia’ also appeared in the script in the *Lord Chamberlain’s Plays*. It was written as ‘Uranologia’ in *London Lions*, although this might be a misspelling.

[64] ‘Death of Mr. George Bartley’, *The Era* (25 July 1858). There is also an entry for Bartley in *ODNB*, see Joseph Knight and Katharine Cockin, ‘Bartley, George (1782?-1858)’, *ODNB* (2004).

career. There is no trace that Bartley had previous involvement in astronomy or natural philosophy before he got into astronomical lecturing. He only presented astronomical lectures during Lent; in other times he was a professional actor. Astronomical lecturing seemed much more a seasonal sideline rather than a persistent vocation to Bartley. Nevertheless, Bartley's lecturing on astronomy earned great compliments from his contemporaries. Guidebooks such as *London Lions* considered Bartley's lecture an improved version of the Walkers' Eidouranion. William Kitchener (1778-1827), a writer, optical-instrument enthusiast and fellow of the Royal Society, remarked that he "recommend to pay a visit to the OURANOLOGIA, in which is shewn the most beautiful and perfect Orrery ever exhibited," and praised "Mr. BARTLEY well deserves the fame he has acquired, by the impressive manner in which he delivers his illustrations of these sublime subjects".[65]

Two aspects are worthy of attention in Bartley's lectures: the production of the show and the performing skill of the showman. Bartley did not produce his astronomical lectures on his own. Samuel James Arnold (1774-1852), a playwright and the manager of the English Opera House, was the man behind the show. Arnold wrote the script and managed the production of the lecture, although his name was never showed to the public in the advertisements and playbills. However, a manuscript of the show preserved in the *Lord Chamberlain's Plays* allows us to find out the contribution of Arnold and the details of Bartley's lecture.[66] Though Arnold was neither a working

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[65] Kitchener (1824), pp. 166-167; King (1978), p. 317.

[66] Arnold, *Ouranologia*, in *Lord Chamberlain's Plays*, vol. XI (January 1826). BL: Add MS 42875, ff. 443-493[b]. More details of this manuscript and the cooperation between Arnold and Bartley will be discussed in Section 4.3.

astronomer nor a man of science, he was certainly not an ordinary layman. Arnold was involved in the activities of several learned societies and institutions, and he used popular scientific works as references to write the script. Another advantage Bartley possessed was the showmanship cultivated from his theatrical profession. By the time he became involving in astronomical lecturing, Bartley already had substantial experience of theatre performance. His debut in London was at Drury Lane in December 1802, as Orlando in Shakespeare's play *As You Like It*. He was especially renowned for playing comic bluff roles; for example, his acting as Falstaff at Drury Lane was considered to be the best of the day.[67] Bartley's performing skill on the stage was no doubt good, and his fine oratory was acknowledged by the contemporaries. A biography of the famous actor Stephen George Kemble (1758-1822) compared Kemble to another two excellent readers at the time: one was elocutionist Benjamin Smart (1787-1872), who had instructed Faraday in elocution, and the other one was Bartley. This article claimed Bartley to be "the best prose speaker" and noted "[t]hose who question our judgment, may have their scepticism removed, by hearing this gentleman deliver his lecture on the Structure of the Earth, at the English Opera House."[68] An obituary of Bartley also attributed his success in Lenten astronomical lecture to "his fine voice and perfect elocution".[69] The lecturing of Bartley was the result of the

[67] 'Memoir of George Bartley', *Oxberry's Dramatic Biography and Histrionic Anecdotes*, vol. 5 (June 1826), p. 221. See also Knight and Cockin, *op. cit*. (64).

[68] 'Memoir of Stephen Kemble', *Oxberry's Dramatic Biography and Histrionic Anecdotes*, vol. 2 (April 1825), p. 11. Benjamin Smart was one of the most prominent authors and teachers in elocution at the time. Michael Faraday had attended Smart's private lessons. For more details of the relationship between Smart and Faraday, see Morus (1998), pp. 20-21.

[69] 'Death of Mr. George Bartley', *The Era* (25 July 1858).

co-operation between a playwright and an actor; Bartley was the ablest performer of Arnold's celestial piece.

Despite the popularity of the Lent lectures on astronomy, Bartley did not perform them for a very long time. The show was only staged between 1821 and 1828.[70] There is no evidence to directly indicate why Bartley and Arnold ceased the show; however, two accidents might explain the reason. First, the turmoil of Covent Garden management caused a financial crisis in 1829. During the crisis, Bartley headed a deputation of the actors to the proprietors, and he was appointed as the stage manager of Covent Garden after the negotiation. This was not merely a provisional position; he kept the post for many years afterwards. This crisis and the following duties of stage manager might have distracted him from astronomical lecturing. The other accident – perhaps more vital – was the fire of the English Opera House in 1830. The theatre was destroyed by this fire and the show lost its sole venue. Though the theatre was rebuilt and reopened as the Theatre Royal Lyceum in 1834, the loss had already made an irreparable blow to Arnold.[71] Both events might have caused the co-operation between Bartley and Arnold to finish suddenly.

Lenten season was not the only battleground for lecturers. Lecturers who performed on the metropolitan stage during Lent usually travelled to provincial towns in other times of the year. A celebrated show from the capital would be

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[70] This is according to the earliest and latest dates of advertisements in the newspapers. However, it could be disputable. Arnold's letter to the Lord Chamberlain on 9 January 1826 claimed the show has been delivered "afar the last seven years." If this statement was true, Bartley's lecture should be staged since 1819. See Arnold, *op. cit*. (66), f. 444.

[71] See the entries of Bartley and Arnold in *ODNB*. Jessica Hinings, 'Arnold, Samuel James (1774–1852)', *ODNB* (2004); Knight and Cockin, *op. cit*. (64). See also Mander and Mitchenson (1961), p. 274.

appealing to country audiences. For example, Deane Franklin Walker's advertisement in Exeter emphasised his Eidouranion "with all the New Scenery and Mechanism, which he used last Lent, at the Theatre Royal, English Opera House."[72] Lloyd's advertisement in Edinburgh also stressed that "With all the Splendid Scenery annually displayed in London."[73] A lecturer attached to a particular theatre and season, like George Bartley, was rare in the circle of astronomical shows. Most theatrical showmen of astronomy were independent entrepreneurs and regularly transported their apparatus to a new place to try their luck. This circuit pattern was familiar to those itinerant philosophical lecturers in the eighteenth century. Many figures engaged in theatre ventures, such as the Walkers, were also from philosophical lecturing backgrounds. Though the style was more entertainment-orientated, astronomical demonstration on stage came from a bloodline of itinerant natural philosophy lecturing.

3.3 Astronomy in Institutions

By the early nineteenth century London had already developed into the largest city in the world. Scientific institutions and specialised societies were springing up during this period. The presence of these venues provided men of science and layman enthusiasts a sanctuary to exchange their common interest. As many historians have indicated, any scientifically minded person could not resist convenient metropolitan networking and resources. Iwan Morus, Simon Schaffer and James Secord remark on the correspondence from Charles Darwin,

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72 *Trewman's Exeter Flying Post* (13 August 1818).

73 *The Edinburgh Literary Journal*, no. 29 (30 May 1829), p. 20.

who admitted that "no place is at all equal, for aiding one in Natural History pursuits, to this odious dirty smokey town";[74] Jo N. Hays takes a London solicitor Daniel Moore (1759-1828) as an example to show this convenience of the metropolis. Moore's case is a fine specimen to show the viewpoint from an amateur sponsor of science. Moore was a solicitor in Lincoln's Inn and a bachelor who "had always resided in his chambers" in Kentish Town. In addition to his profession, Moore was active in London's arts and scientific circles; he was a fellow of several societies, including the Royal, Antiquarian, Linnaean, Astronomical and Horticultural Societies. Moore also sponsored the Royal Institution and "at a time of need promptly lent the Institution the sum of ₤1000., without interest; and which he bequeathed to the Institution by his will." The enjoyment of institutional activities was the reward for such a generous patron. Moore's obituary said that "His chief amusement was among the learned societies, where his good humour and love of science always insured a hearty welcome."[75] There was no place like London where a scientific enthusiast could indulge his interests so lavishly.

The Royal Institution, which Moore generously sponsored and involved himself in, was a role model for offering institutional lectures to the public. Founded in the very end of the eighteenth century, the Royal Institution opened up a vista of diffusing useful knowledge in the new era and gained an iconic status in the history of British scientific institutions.[76] The declaration of its

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[74] Morus, Schaffer and Secord (1992), p. 129.

[75] "Obituary–Daniel Moore, Esq. F.R.S.", *The Gentleman's Magazine*, vol. 98, p. 377; Hays (1983), p. 96. Moore was also actively involved in the Royal Institution's management. He was a member in the committees of general science and of mechanics, and later became a manager. See RI: MS GB 1, p. 117 and 147.

[76] The Royal Institution and many individuals affiliated to it, such as Humphry

founders proposed to build an "Institution For diffusing the Knowledge, and facilitating the general Introduction, of Useful Mechanical Inventions and Improvements; and for teaching, by Courses of Philosophical Lectures and Experiments, the application of Science to the common Purposes of Life."[77] This visionary proposal was soon taking shape on Albemarle Street in Mayfair, where the Institution still stands in this original site today. Despite the shadow of continuous financial crisis in the early years, the Royal Institution was successful in its goal of diffusing practical knowledge. The success of the Royal Institution is evidenced by the establishment of other similar organisations following its model, such as the London Institution (founded in 1805), the Russell Institution (1808) and the Surrey Institution (1810).[78] These four major institutions occupied respective corners in central London – the London Institution in the City, the Russell in Bloomsbury and the Surrey in Southwark – and competed with each other during the early nineteenth century.[79] Backed by wealthy supporters from the City, the London Institution was especially a powerful and threatening rival to its Mayfair counterpart. The

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Davy and Michael Faraday, are long-time research interest of historians of science. About its institutional history, the most recent scholarship is *'The Common Purposes of Life': Science and society at the Royal Institution of Great Britain* (2002), edited by Frank A. J. L. James. Other significant literature includes Forgan (1977) and Berman (1978).

77 RI: MM, 9 March 1799, 1: 1. See also James (2002a), p. 1.

78 Hays (1983), p. 94. Contemporary authors often mentioned these institutions in correspondence or literature; for example, Charles Lamb's letter to Mr. Manning, dated 26th February 1808, see Talfourd, ed. (1849), p. 186; John Timbs also described library resources of the Royal, London, and Russell Institutions in the *Curiosities of London*, see Timbs (1867), pp. 516-525.

79 Though the Surrey Institution did not last long and was dissolved in 1823. However, the competition between the other three lasted much longer: the Russell Institution survived until the late nineteenth century, and the London Institution closed in 1912. For the history of the London Institution, see Hays (1974) and Kurzer (2001); for the Surrey Institution, see Kurzer (2000); Parolin (2010), pp. 190-198.

fund which the London Institution accumulated within one year of its establishment was fourfold the Royal Institution's.[80] Their staff was certainly aware of the rivalry between institutions, and sometimes such sense of competition became bitter. Faraday once responded angrily when William Upcott, the library assistant of the London Institution, suspected the preeminence of the Royal Institution: "I am amused and a little offended at Upcots hypocrisy. He knows well enough that to the world an hours existence of our Institution is worth a years of the London and that though it were destroyed still the remembrance of it would live for years to come in places where the one he lives at has never been heard off [*sic*]".[81]

What facilities might an institution have in the early nineteenth century? A notice in the *Quarterly Journal of Science, Literature and the Arts* provided an ideal plan for a scientific institution. "It is proposed to form in Bath an Institution for the cultivation of Science, Literature, and the Liberal Arts." This notice then described the prospective scientific establishment:

> The Institution to consist of a house and establishment, comprising the following accommodations: namely, a library and reading-room, from which newspapers and political pamphlets shall be excluded; a botanic garden; a museum of natural history; a cabinet of mineralogy; a cabinet of antiquities; a cabinet of coins and medals; a hall for lectures, with suitable apparatus for the courses on chemistry and the several branches of natural philosophy.
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> To these will be added an exhibition gallery, for the reception and

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[80] Hays (1974), p. 146 and n. 2. Other suggestions for comparisons between the two bodies are also made in Hays's paper.

[81] Faraday to Edward Magrath, 23 July 1826, James, ed. (1991), Letter 302, p. 417; Morus (1998), pp. 30-31.

display of paintings and other works of the fine arts.[82]

Some of these prospective establishments were essential among contemporary scientific institutions, such as a reading room and a lecture hall; some were not requirements or were often accommodated by museums, such as a gallery and a collection of curiosities. The facilities of a scientific institution varied depending on managers' emphasis, but to display knowledge and to nurture intellectual activities were the common ground. Organising public lectures and maintaining a library for members were basic tasks of an institution; furthermore, some hosted laboratories and resident professors to carry out original experiments, such as the RI and the London Institution did. A research-orientated institution was an important forum for men of science to make themselves widely known to the public; for instance, Davy, Faraday and Tyndall rose to fame through professorship in the Royal Institution. For most members or subscribers, an institution offered many requisites of a good club: a place to listen to the latest discoveries or other intellectual subjects, and opportunities of social occasions to acquaint themselves with men of status in various fields.[83] This social function was, perhaps, more important than scientific education for many attendees in institutional activities.

Astronomy was one of the lecture subjects at the Royal Institution, though it was delivered not as frequently as chemistry and mechanics. The earliest astronomical lecture was delivered by Thomas Young (1773-1829), who was

82 'New Scientific Establishment at Bath', *The Quarterly Journal of Science, Literature and the Arts*, vol. 8, no. XV (October 1819), p. 190. This proposed new institution later was founded in 1824 as the Bath Literary and Scientific Institution, and gained royal patronage in 1830. It still exists and operates today.

83 Forgan (2002), pp. 32-34.

appointed as professor of natural philosophy in July 1801. Young organised a series of natural philosophy courses including astronomy during his short stay in the professorship between 1801 and 1803. The earliest six astronomical lectures delivered by Young during January and February 1802 were recorded in the first volume of the Institution's journal.[84] The style of Young's lecturing was quite tedious and abstruse. For example, Young "read a passage from Hooke's Attempt to prove the Motion of the Earth, published in 1674, in which that great philosopher expresses his opinion very clearly upon the nature of gravitation";[85] in the next lecture, he "read an extract from the Moniteur, and an account of some letters addressed to the Royal Society, respecting the new planet Ceres, discovered by Piazzi at Palermo, […] and proceeded to enumerate the most remarkable affections of the secondary planets and comets."[86] In contrast to his colleague Davy, Young was not an effective lecturer who was willing to entertain the audience. In addition, he often misjudged a mixed audience's capability of apprehending the content. Though Young's efforts in preparing the curriculum were undoubted and his later publication of the lectures was praised by reviewers, he just failed in the dimension of oral communication.[87] By all accounts Young's natural philosophy discourses at the Royal Institution were not well received and astronomical ones were likely no exception.

After Young, few courses on astronomy were delivered. Table 3.1 lists

[84] *Journals of the Royal Institution of Great Britain*, vol. 1 (1802), pp. 86-89, 108-109.

[85] *Ibid*., p. 89.

[86] *Ibid*., p. 108.

[87] Cantor (1970), pp. 92-93; Berman (1978), pp. 23-24; James (2002a), p. 7. For more details of Young's lectures at the Royal Institution, see Cantor (1970).

courses of lectures on astronomy or relevant subjects at the Royal Institution before 1862. Compared to chemistry, astronomy was not the focus of attention in the curriculum of the Royal Institution. A course of lectures on natural philosophy often covered more content on mechanics and technical subjects such as the steam engine. A professorship of astronomy was never created until 1935; except for Young, none of professors in the Royal Institution had ever delivered an astronomical course during this period.[88] Most of the astronomical lecturers were external and did not have particular connections with the Royal Institution.

Although the Royal Institution did not pay much attention to astronomy in the curriculum, lecturers in its list were a select group. Many lecturers employed to present astronomical topics had either prestigious status in scientific circles or deep connections with academia. John Pond (1767-1836) was a fellow of the Royal Society and later became the Astronomer Royal; John Dalton (1766-1844) was then a well established natural philosopher and the vice-president of the Manchester Literary and Philosophical Society; Baden Powell (1796-1860) was Savilian Professor of Geometry at Oxford. Charles Babbage (1791-1871), however, was one of the exceptions: he was merely a 24-year-old young man who just graduated from Cambridge.[89] This selective characteristic was most obvious in Friday Evening Discourses. The Friday series was officially established in 1825 and soon proved to be an important

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[88] Faraday, however, had delivered a Friday evening discourse on solar eclipses in 1862. See Table 3.2 and Section 4.2.

[89] This course was also the only astronomical lecture Babbage had ever delivered in his life. An unpublished transcript of this course according to the manuscript at the British Library, with an introduction by the editor, is preserved in the Royal Institution. See Roberts, ed. (1989).

initiative of the Institution. Each Friday Discourse generally comprised a talk in the lecture theatre and a display of collections following on in the library, which was often not relevant to the lecture. This style of a stand-alone lecture allowed speakers to talk about a more specialised subject. Table 3.2 lists the Friday Discourses on astronomical subjects until 1862. Lecturers had been invited to this series included George Biddell Airy and Charles Piazzi Smyth (1819-1900), who were then in office as Astronomer Royal and Astronomer Royal for Scotland, respectively. This list of celebrities shows the prestige of the Royal Institution and its roots in the social and scientific elite. Members, subscribers and guests who were introduced into the auditorium by them, expected to listen to cutting-edge knowledge from the most authoritative scientific minds.

Among all astronomical lecturers at the Royal Institution in the first half of the nineteenth century, John Wallis was a significant yet obscure figure.[90] Wallis delivered juvenile lectures in Christmas season three times in 1826, 1838 and 1847; he was the only lecturer who spoke on astronomical topics in the Christmas series before the celebrated speaker Robert Stawell Ball's in the late nineteenth century. Wallis had also delivered a course to an adult audience in 1826.[91] Despite recurrent lecturing at the Royal Institution, very few are known for Wallis's life. He died aged 65 at Camberwell, London, on 12th December 1852.[92] One year prior to his death, Wallis's health already

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[90] Previous scholarly work mentioning John Wallis includes Hays (1983), p. 99, Secord (2000), pp. 450-451, and James, ed. (2008), p. xvii.

[91] *The Quarterly Journal of Science, Literature and the Arts*, vol. 21 (1826), pp. 114-116.

[92] *The Gentleman's Magazine*, vol. 193 (February 1853), p. 217.

deteriorated and he ceased lecturing. A notice in the newspaper in December 1851 mentioned the lecturer was unable to visit Oxford in Christmas as originally arranged due to "illness and domestic affliction".[93] In a letter in April 1852 from Wallis to E. W. Brayley, the librarian and lecturer of the London Institution, Wallis also admitted that his 'worn out constitution' could not allow him to continue lecturing.[94] Aside from lecturing, Wallis had engaged in astronomical observation in his spare time. A proceeding of a meeting of London Astronomical Society (later the Royal Astronomical Society) on 11th November 1825 recorded: "A letter was read from Mr. R. Comfield, a member of the society, to Dr. Gregory, describing an appearance noticed by him with a Gregorian reflector, power 350; and by Mr. J. Wallis, the lecturer on astronomy, with a Newtonian telescope, power 160, in reference to the occultation of Saturn Oct. 30th."[95] However, this record is the only known source alluding to Wallis's observational work. It seems that his involvement in astronomical research was far less than lecturing.

Wallis's lectures were evidently popular. The average attendance at his juvenile lectures in 1838 was 261 people (Fig. 3.7) – although it was outnumbered by Faraday's in the previous year, this number was higher than the next year's series delivered by William Thomas Brande, the Institution's Professor of Chemistry.[96] Wallis's course at the London Mechanics' Institution

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[93] *Jackson's Oxford Journal* (27 December 1851).

[94] Secord (2000), p. 450.

[95] 'Proceedings of learned societies', *The Monthly Magazine*, vol. 60, no. 418 (January 1826), p. 69.

[96] RI: LE 2, *Index to Lectures 1829-41 and Attendance Figures*, p. 110, 127 and 142. The average attendance for Faraday's in 1837 was 406 and for Brande's in 1839 was 245 people.

in 1826 was also expected to draw a great amount of people, so the organiser arranged that "the Lecture of each Wednesday being repeated on the succeeding Friday, in order that the Theatre may not be too much crowded, and that every Member may obtain a favourable view of the splendid machinery and transparencies".[97] Another indicator of Wallis's popularity is his frequent inter-institutional lecturing. For example, during the Christmas season in 1838, Wallis presented juvenile lectures at the Royal Institution and meanwhile he also gave a course in the London Institution. His lecturing in these two institutions even occurred on the same days – juvenile lectures at the Royal Institution were at 3 o'clock in the afternoon and the London Institution's began at 7 o'clock in the evening.[98] Such a tight schedule shows that both institutions approved of Wallis's lecturing and they were willing to employ him. In addition to these institutions, Wallis had also lectured at other sites in London during the 1820s and 1830s including the Russell Institution, Southwark Astronomical Society,[99] the Royal Kensington Literary and Scientific Institution, and the Hammersmith Institution.[100] The wide range of institutions Wallis had been employed at to give discourses implies that his lecturing was flexible and accessible to different levels of audience. Perhaps it

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97 *The Examiner* (19 March 1826).

98 Wallis's juvenile lectures at the Royal Institution were on 27, 29 December 1838 and 1, 3, 5, 8 January 1839; London Institution's course was on 17, 20, 24, 27, 31 December 1838 and 3, 7, 10 January 1839. See the advertisement in the *Morning Chronicle* (5 November 1838); RI: LE 2, *op. cit*. (96), p. 127.

99 'Literary and scientific meetings for the ensuing week', *Literary Gazette* (19 November 1836), p. 747.

100 'Literary and Scientific Intelligence', *The Gentleman's Magazine* (November 1839), p. 522.

can be also explained by his relatively modest fees.[101] Wallis was an affordable quality choice to be hired by most institutions no matter its scale and budget, including those aimed at the working classes such as the London Mechanics' Institution.

3.4 Astronomy for the People

Like many other contemporary itinerant lecturers, Wallis usually travelled across the country. Wallis made frequent lecture visit to Northern England during the 1830s and 1840s, including several major cities like Leeds, Liverpool and Manchester, though he still remained in residence at London.[102] He especially had regular engagements in the Liverpool Mechanics' Institution; from the late 1830s to the mid 1840s, Wallis delivered astronomical courses there almost every year. An article in the newspaper *Liverpool Mercury* claimed few subjects have been so often treated at the Mechanics' Institution as astronomy, and the journalist commented: "Mr. Wallis has already lectured at the institution, and we doubt not the members will be glad to hear him again."[103] With over 3,000 members and extensive facilities including a library, a gallery, a day school for members' children and an evening school, the Liverpool Mechanics' Institution was the largest of its kind in Britain outside London.[104] Numerous teachers and visiting lecturers were employed by the

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[101] Hays (1983), p. 99.

[102] Wallis's correspondence with the Royal Manchester Institution in 1843 and 1845 shows his address was 338 Albany Road, Camberwell, London. MA: M6/1/49/3/p162; M6/1/49/4/p13.

[103] 'Lectures and the lecturers at the Mechanics' Institution', *Liverpool Mercury* (14 November 1845).

[104] 'Mechanics' Institution at Liverpool', *Chambers's Edinburgh Journal* (31 December 1842), pp. 396-397; 'Lectures and the lecturers at the Mechanics'

institution. It was certainly an important site for offering job opportunities to a contract-based itinerant lecturer like Wallis.

Mechanics' Institutes, for good reasons, are a distinct category among numerous sprouting establishments bearing the name of 'institution' in the early nineteenth century.[105] Although sharing the common ground for the educational purpose of diffusing useful knowledge, Mechanics' Institutes and those similar to the Royal Institution reached very different people. Despite the famous story that young Michael Faraday attended lectures while as a humble apprentice, the Royal Institution mainly appealed to the bourgeoisie and the upper class. It reflected the taste and concerns of the educated elite – if not the landed gentry, at least the professional middle class. This was evident in the composition of its governorship: the majority was initially the landed gentry during the first decade, yet had been rapidly taken over by medical and legal professions – physicians and barristers – by the 1830s.[106] Another piece of evidence is the price to be involved in the activities: the annual subscription of lectures at the Royal Institution was five guineas and the annual membership could reach 55 guineas in combination with other fees.[107] Apparently this was

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Institution', *ibid*. See also Secord (2000), pp. 191-198.

[105] Many scholarly works discuss the history of Mechanics' Institutes in Britain. See, for example, Royle (1971); Stephens and Roderick (1972); Inkster (1975). See also the references listed in Wach (1988), n. 4.

[106] Berman (1978), ch. 4, especially see pp. 100-101, 114-116. However, Berman also argues that the category of professionals does not sociologically matter to the formation of institutional governorship. The 'type', or ideological interest, of a person is much relevant. He defines a 'Utilitarian' group and argues the Utilitarians held a commanding role in the direction of the Royal Institution.

[107] This is according to Forgan (2002), p. 32, n. 38. The price and terms could vary. For example, in 1850, seasonal subscription to the theatre-lectures was only 2 guineas, while subscription to both the theatre and laboratory lectures was 3 guineas, see RI: GB 2: p. 99D. For more general description about members and audiences of the Royal Institution, see Forgan (2002), pp. 31-40.

an expensive charge. Other similar institutions, even not in the capital, were not easy to join. For example, the Royal Manchester Institution was very particular about the regulation regarding admission. It ruled that 'Hereditary Governors' should pay 40 guineas and an annual subscription of one guinea, then they were permitted to enter all exhibitions and lectures. Anyone who met this requirement of payments could bring their families and 'Strangers' (guests visiting in their houses) to above occasions (Fig. 3.8). These terms all had specific definitions. A Stranger must be "from a distance of twelve miles and upwards" and "introduced by a Governor in person, – by an order in his own hand writing, – or by an entry by the Governor in the Strangers' Book on the hall table." The term *family* was defined as "the wife or husband, the daughters and other female relatives, and *unmarried* sons and brothers under 24 years of age, so long as such parties are permanently resident in the house of the Governor."[108] This system of admission based on household made the institution tend to be a selective club of the gentry. In contrast, the people who mechanics' institutes tried to reach were the lower middle or working classes.[109] This policy was reflected by their much more economical charge of admission. An annual subscription to the London Mechanics' Institution was 24s. (one guinea and 3s.) and a quarterly subscription of 6s. was accepted. The subscription covered the following advantages: admission to the lectures delivered every Wednesday and Friday evening; to the reading room open daily from ten till ten; to the use of circulating Library; to the classes for instruction in arithmetic, mathematics, drawing, geography, writing, and English and

108 MA: M6/1/70/64. The rules were valid in March 1841.

109 Though this seems to be a common sense in general, Royle (1971) reminds that the class composition of Mechanics' Institutes requires more careful delineation. See also Inkster (1975).

French language.[110] This charge was very cheap compared to the Royal Institution's, which was almost fivefold the London Mechanics' rate. The rate could be much cheaper in rural areas: the Mechanics' Institute in Alnwick, a small market town in Northumberland, only charged 2s. quarterly and 8s. for an annual subscription.[111]

Astronomy was a subject that still mattered in the land of workers and artisans. Although this sublime science seems not close to practical use or day-to-day life on first impressions, many Mechanics' Institutes provided relevant courses in their curriculum. Not to mention those establishments attached to or derived from Mechanics' Institutes, such as day schools for working people's children and polytechnic schools. William Cooke Taylor (1800-1849), an Irish writer who had acute observations on the industrial north English cities and factory life, had proposed a curriculum for his ideal polytechnic school education. Taylor's plan also included astronomy: "Geography and astronomy are among the most important of the mixed sciences. […] Astronomy should be made the theme of simple lectures; and a celestial globe and orrery supply all the apparatus necessary for the purpose, and are a more legible book than any yet printed."[112] John Wallis's engagement in the Liverpool Mechanics' Institution was not an isolated example; there had been numerous lecturers, resident or itinerant, delivering discourses on astronomy in front of the working-class audience. A Mr. Watson

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[110] See the advertisement in the *Examiner* (30 September 1827), p. 623.

[111] 'The Mechanics' Institutions of this District', *Newcastle Magazine* (July 1827), pp. 297-298.

[112] Taylor, 'Polytechnic Schools in Manufacturing Districts', *The North of England Magazine and Bradshaw's Journal of Politics, Literature, Science and Art* (March 1842), pp. 78-79.

delivered a lecture on the solar system in the Chelmsford Mechanics' Institution on a Wednesday evening in April 1837 through illustrations by a phantasmagoria, a type of magic lantern display.[113] Mr. Moses Holden, a prominent astronomical lecturer of Preston and a member of the BAAS, had close connection with the Institution for the Diffusion of Knowledge, the equivalent of Mechanics' Institute in Preston. In Sheffield, several lecturers had delivered astronomical courses at the local Mechanics' Institution, including Glasgow professor John Pringle Nichol.[114]

It is not surprising that cheap lectures affordable to the working classes were so common in the early nineteenth century. Of course, the movements of political as well as educational reforms and the founding of organisations such as the SDUK and Mechanics' Institutes were important forces to propel such progress. Nevertheless, the industrialisation of the mass media, namely steam-powered printing and publishing, was the most critical stimulus beneath the surface. Cheap print was a phenomenon – handbills, pamphlets, newspapers and magazines, thousands of them were printed each year and the production was increasing. During the first decade of the nineteenth century, about two thousand book titles were published in Britain per annum; the amount soared to six thousand in the 1840s, and eight thousand in the next decade.[115] The *Penny Magazine*, the most representative case of cheap periodicals aimed at the working class, was commenced in 1832. This

113 'Chelmsford Mechanics' Institute', *Essex Standard* (28 April 1837).

114 Inkster (1975).

115 Secord (2000), p. 31, fig. 1.8, and see also ch. 2, pp. 41-76. For the significance of steam-powered printing and publishing in the early nineteenth century Britain, see also Topham (2000, 2007) and Fyfe (2012).

magazine was published every Saturday, containing articles of useful knowledge with extensive illustrations. The price was as affordable as its title suggested. Except for the *Penny Magazine*, many other periodicals existed in the market and they aimed at a very wide readership ranged from the lower to the middle class. Such a growing market of publishing means the circulation of knowledge was far more effective than ever before. Knowledge was now easy to grab, whether it was suitable to be digested. The businesses of publishing and lecturing were not irrelevant to one another – they were two facets of one thing, like the faces of Janus. As I have mentioned in the previous chapters, many lecturers were often authors and inevitably readers. A carpenter or a musician in the late eighteenth century could learn astronomy through reading popular works and eventually become an established lecturer or a recongnised astronomer. People with scientific literacy could not be fewer in the age of steam-powered printing industry. Therefore, not only the amount of readers was growing, but also the amount of able lecturers was increasing. Cheap lectures were accompanied by the prevalence of cheap printing and publishing. In the *Poor Man's Guardian*, a penny weekly newspaper published in London, advertisements of cheap lectures on astronomy with free admission or one penny admittance could be found. A lecturer named W. D. Saull – presumably William Devonshire Saull (1783-1855), a radical philanthropist and geological collector – delivered lectures on astronomy, geometry and chemistry at Chapel Court near the high street at Borough every Friday evening. The advertisement also remarked on the charitable cause of the lecture that "[t]he overplus to be given to the Victims." Another advertisement shows that the 'Society for Scientific, Useful, and Literary Information' had free lectures on machinery and astronomy at the Bowling Square Chapel, Lower Whitecross Street, with an astronomical one delivered by a Mr Davenport.[116] These advertisements were surrounded by other notices of cheap publications and meetings of working-class unions.

Although cheap lectures were prevalent, the quality of lecturing could not be ensured. The adjective 'cheap', like 'popular', is a polysemous word. Cheapness may be linked to low price as well as low quality. Such a risk could exist in lectures and publications. An example of a reader's complaint reflected the unreliability of cheap publications, though this case was not for astronomy: A Mr W. Bloor wrote to the editor of the *Mirror* to point out some errata in previous issues. Bloor was an experienced swimmer and was concerned about the number of deaths by drowning. With unusual curiosity, he had made a series of experiments to examine the mechanism of a drowning swimmer under water, including the effect of pressure on eyelids in shallow and deep waters. In this letter to the editor, Bloor complained about some more serious incorrect information he found from other publications:

> [T]here fell into my hands a little publication called Instruction for Swimming; the author of which, I suppose, chose not to put his name, for a very good reason. He asserts that those who dive for any thing in water must go in with their eyes open, for when under water they cannot open them, nor shut them when they are open. About the same time another and similar work met my eye, at the end of which was added, what the author called "Doctor Franklin's Advice to Bathers;" this piece contained the same assertion. I looked one of these catch-penny things through, and found such a variety of wonderful antics taught to be performed in the water, that I never saw performed or heard of, and believe no man ever did

[116] *Poor Man's Guardian* (24 November 1832; 28 December 1833).

> perform.[117]

This mere example just shows how easy it was to disseminate knowledge – whether orthodox or heretical; sound or unreasonable – in the age of industrial printing and publishing. Drowning in the sea of information is not an exclusive privilege of the modern-day Internet users. Early nineteenth-century readers already faced an overwhelming amount of what anthropologist Bronisław Malinowski called 'the brute material of information',[118] or James Secord described as 'an army of lilliputians'.[119] Another example, this time for astronomical lecturing, was an anecdote in the *London Saturday Journal*. The anonymous author, perhaps the editor of the magazine, read "with some spurning feeling of contempt" an intimation from a gentleman "informing the public that he was prepared to lecture on astronomy, on the principle of the *earth being at rest*; and offering his services to mechanics' institutions and scientific associations." The author despised this assertive gentleman for his whimsical idea:

> What! said we, does this feeble body think that he can pull an "enlightened" public back two centuries and a half? – a dwarf holding up his finger to wrestle with the giants who have scaled the heavens![120]

Although it is unknown if this gentleman actually lectured on his astronomical notion in any institution, this anecdote reflects the possible uneven quality of

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[117] 'Swimming – Deaths by Drowning', *The Mirror of Literature, Amusement and Instruction*, vol. 6, no. 156 (20 August 1825), pp. 132-133.

[118] Quoted from Burke (2012), p. 5.

[119] This is a section title in Secord (2000), ch. 2.

[120] 'Faith in Astronomy', *London Saturday Journal*, vol. 1, no. 22 (1 June 1839), p. 350.

lecturing. In an era that anyone could publish or lecture on something, readers were alarmed as well as lecturers.

3.5 Country: Every Nook and Cranny

So far we have already discussed various sites of astronomical lectures ranging from theatres to Mechanics' Institutes. Our journey starts from London yet during the course many sites beyond the metropolis are also explored: we see examples in Manchester, Liverpool and other provincial cities. The diversity of sites existed in many localities. Finally, this journey would end up in much rural areas. This section will mention a more wide range of miscellaneous places, which covers rural regions where no theatres, institutions and galleries were present. Astronomical lecturers' footsteps reached, though maybe not be regularly, every nook and cranny of Britain including the farthest countryside.

Some temporary venues were used to accommodate lectures; their usage reflects the flexibility of early nineteenth-century lectures. When talking about a temporary venue, in the first impression, we might think of the large space for a travelling funfair or an exhibition, such as the Crystal Palace in Hyde Park. Yet there were more examples of a smaller-sized occasion in a public or private venue, where these sites often functioned normally as a meeting place. Town halls, assembly rooms, schools, libraries, churches, or houses of patrons, were all potential venues to be borrowed for a lecture occasion. There were plenty of such instances in local newspapers. A Mr Goodacre delivered astronomical lectures in a riding school at Huddersfield in August 1822.[121]

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[121] 'Astronomical Lectures. Riding-School, Huddersfield', *Leeds Mercury* (31

Robert Children, whom has been discussed in Chapter 2, delivered lectures in the Town Halls at Oxford in November 1835 and at Sudbury, Suffolk, in April 1841. He also delivered two lectures at Mr Hellyer's Library at the seaside town Ryde, Isle of Wight, under the patronage of the Rev. W. S. Phillips in 1844.[122] A series of lectures on astronomy was delivered at the Rev. M'Alister's meeting house at Holywood, northern Ireland, by a Mr MacKeown of Belfast in November 1842.[123] Dr Bateman, who stayed in the spa town Ilkley for a holiday during May 1852, was invited to give a lecture on the astronomical articles shown in the Great Exhibition at Dr Macleod's local hospital.[124] Mr Joseph Freeman, a school conductor, delivered a lecture on astronomy at the Baptist Chapel School, Great Ilford, Essex, in January 1856.[125] We do not know the details of most of the above cases beyond the lecturers' last names and the venues. This fact points out that how numerous and obscure the contemporary astronomy lecturing could be.

How do we interpret such a long list of miscellaneous venues? Most examples above were in small provincial towns or rural settlements. Except for Oxford and Huddersfield, the populations of these localities were about or far fewer than 10,000 during the mid-nineteenth century.[126] There were no local

August 1822).

[122] 'Astronomy', *Hampshire Advertiser* (23 July 1836); 'Sudbary', *Essex Standard* (30 April 1841); 'Lectures on Astronomy', *Hampshire Advertiser* (2 November 1844).

[123] 'Lectures on Astronomy', *Belfast News-Letter* (18 November 1842).

[124] 'Lecture on Astronomy', *Leeds Mercury* (8 May 1852).

[125] 'Ilford and Barking', *Essex Standard* (30 January 1856).

[126] For example, the population of Sudbury: 7,969 (1841); Ryde: 11,795 (1841); Ilkley: 973 (1851); Great Ilford: 4,523 (1851). These census data cover either registration sub-district or parish level unit. All data are from *A Vision of Britain*

scientific institutions or literary and philosophical societies in the neighbourhood of these rural parishes. Theatres for dramas and entertainments, a much more urban product which required a level of theatregoers to support its operation, were hardly able to be sustained in the countryside. Thus a local population's gathering place, such as the town hall, assembly rooms or churches, usually functioned as an alternative venue when itinerant lecturers occasionally visited. When D. F. Walker lectured at Wandsworth, Surrey, on 11th and 13th September 1820, the venue was in the assembly room of a local public house 'Spread Eagle' (Fig. 3.9).[127] Patronage from the local gentry and savants was often important for arranging a guest lecturer to pay a visit; clergymen and schoolmasters were especially willing to support or to organise lecture occasions because of the educational value for pupils. Therefore, schools were also a usual venue for itinerant astronomical lectures.

Since lecturing in the countryside was not on a regular basis, the form of the events could be much more informal and hard to be explained by familiar commercial way as the activities in urban areas. Some of the above examples might be random occasions and the lecturer could be a volunteer or an amateur, such as the case of Dr Bateman who gave a talk during his holiday stay in a spa town. These amateurs and their occasional activities were likely not comparable to those regular lecturers in the field. A country visit might be like a shooting star in the night sky and had no pattern at all. They usually left very few records and could be obscure, and hence easily neglected by modern historians.

Through Time, The Great Britain Historical GIS (University of Portsmouth): http://www.visionofbritain.org.uk/ (data retrieved 26 September 2013).

127 SM: SCM-Astronomy: 1980-930/13. This pub still exists and opens today.

Nevertheless, the long list of lecturing in the country still shows the prevalence of astronomical lectures. Lectures not only took place in the metropolis or a few industrial cities; in every corner across the British Isles, from Aberdeen to the Isle of Wight, popular astronomy was everywhere. As Allan Chapman reminds, in small provincial towns or the countryside there were was a shortage of spectacles and entertainments, especially for the working classes. Astronomical lectures were usually accompanied by the display of orreries or transparencies; the entertaining effect brought by these visual appliances on the nineteenth-century audience was no inferior to that of today's cinema. Therefore a visit by an itinerant lecturer would be a sensation to locals in the humdrum days. In particular, such crowd-drawing power would be more significant when the visitor was a famous one, like the Astronomer Royal.[128] When Airy visited Ipswich to deliver a course of six astronomical lectures in March 1848, around 700 locals attended – considering the population of Ipswich by 1851 was not over 27,000, such attendance was quite significant.[129] Of course, apart from entertainment, itinerant lectures were of immense educational value, especially for those rural areas lacking resources. A short yet warm story in a local newspaper shows such an opportunity for country pupils: when a Mr T. P. Barkas delivered a lecture on astronomy at the Primitive Methodist Chapel, Earsdon, in March 1852, he offered a prize in the conclusion of the lecture. "[A] neat and useful book was presented to a young man who answered correctly the largest number of questions asked by the

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[128] Chapman (1998), p. 166.

[129] *Ibid*. For the population of Ipswich, *op. cit.* (126).

lecturer relative to astronomy."[130] Earsdon was a township, parish and a sub-district in Tynemouth, Northumberland. The population of Earsdon was between 8,400 and 11,000 in 1851, and about sixty percent of the population was labourers and servants.[131] At a small parish far away from the metropolis, a book given to a youngster was like a seed sowed in the soil.

Chapter Conclusion

In this chapter I have explained the spatiality of popular astronomy lectures in nineteenth-century Britain. Though focusing heavily on London, my survey covers some other activities in several provincial places in the rest of Britain. Astronomy lectures took place in different sites, ranging from metropolitan theatres to country public houses. The wide range of lecturing sites indicates the heterogeneity of popular astronomy: there were significant distinctions between the purpose, styles and audiences in different lectures. The heterogeneous locality of popular astronomy accords with previous scholarship on geographies of nineteenth-century science.

Among various sites, theatres were an important venue for popular astronomy lecturing especially in the first half of the nineteenth century. The theatrical turn, as I have argued, was crucial to the development of popular astronomy lecturing during this period. The phenomenon of theatricalised lectures on astronomy indicated the trend of the theatrical turn. However,

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130 *Newcastle Courant* (19 March 1852).

131 *Op. cit*. (126). The data of the occupations was from the census in 1831.The number of the population depends on what unit the census covers. The parish of Earsdon contained a few other neighbouring townships so its population would be larger than the sub-district of Earsdon. Earsdon is a historical parish today, since the original unit was split between several other civil parishes after 1935.

previous scholarship on scientific lecturing pays scant attention to the activities of astronomical showmen in theatres. When discussing theatricalised lectures, I suggest historians should view them in the theatrical context, rather than regarding the lectures as done in any other venue. These theatricalised lectures reflected the constraints and conventions of the theatre itself. By comparison with more widely-known lecturing activities in the scientific establishments, such as the Royal Institution, the prevalence of theatricalised lectures also accords with my main thesis that a contested arena long existed in the nineteenth-century market for popular astronomy.

Table 3.1 Astronomical Courses at the Royal Institution

Year	Lecturer	Title/Subject	Type*
1801	Thomas Young	Astronomy	Course (6)
1809	John Dalton	Natural Philosophy (included astronomy)	Course
	John Pond	Physical Astronomy and its Applications	Course (10)
1810	John Pond	Popular Astronomy	Course (10)
1815	Charles Babbage	Astronomy	Course
1826	John Wallis	Astronomy	Course
	John Wallis	Astronomy	Juvenile
1838	John Wallis	Astronomy	Juvenile (6)
1847	John Wallis	The Rudiments of Astronomy	Juvenile (6)
1850	Baden Powell	Astronomy	Course (8)
1851	Baden Powell	Cosmical Philosophy	Course (7)

(Table 3.1) Lectures on astronomical subjects at the Royal Institution until 1862. This list includes regular courses and juvenile lectures (Christmas Lectures). The juvenile lectures started in 1825. Source: RI: GB, vol. 1: p. 63, 139; GB, vol. 2: p. 47, 56, 61; *Journals of the Royal Institution of Great Britain*, vol. 1 (1802), pp. 86-9, 108-9; *The Quarterly Journal of Science, Literature and the Arts*, vol. 21 (1826), pp. 114-6.

***** The numbers in the brackets indicate how many lectures were included in the curriculum if applicable.

Table 3.2 Friday Discourses on Astronomical Subjects at the Royal Institution

Year	Lecturer	Title	Attendance
1850	Baden Powell	Optical Phenomena in Astronomy	
1851	G. B. Airy	The Total Solar Eclipse of 1851	610
1853	G. B. Airy	The Results of Recent Calculations on the Eclipse of Thales and other Eclipses connected with it.	495
1855	G. B. Airy	The Pendulum-experiments lately made in the Harton Colliery, for ascertaining the mean Density of the Earth.	405
1858	Baden Powell	On Rotatory Stability; and its Applications to Astronomical Observations on board Ships	422
	C. Piazzi Smyth	Account of the Astronomical Experiment on the Peak of Teneriffe in 1856, illustrated by Photographs.	521
1859	J. H. Gladstone	The Colours of Shooting Stars and Meteors	
1861	Michael Faraday	On Mr. Warren De la Rue's Photographic Eclipse Results	783

(Table 3.2) The Friday Evening Discourses on astronomical subject at the Royal Institution until 1862. The Friday evening events started in 1825. Source: RI: GB, vol. 2: p. 55, 76, 89, 104; LE, vol. 4: p. 48, 80.

Chapter 4 Subjects

What topics should be included in an astronomical lecture? A satirical article entitled 'Hints to Lecturers', published in 1808, gave a humorous answer. Under a pseudonym Crop the Conjuror, the author tartly reviewed all fields of lecturing from botany to geology and gave 'advice' to those 'gentlemen' in the trade of philosophy. Astronomy was also on the list. "If astronomy is your forte, I must acknowledge that you have an extensive field;" Crop the Conjuror then said:

> [Y]ou may tell us all that the stars have been doing these thousands years, for nobody can contradict you; then after leading us to the *farthest verge* of *boundless* æther, you may descend to a few private anecdotes of the solar system, talk of the conjunctions of Venus and Mercury, and tell us, with a smile, that, with the exception of the *conjunctions* and *oppositions*, there are no other signs of matrimony in the heaven, but Saturn's *ring* and Lunar's *horns!*[1]

Astronomical lecturing in real life, of course, was not as absurd as Crop the Conjuror suggested. This chapter focuses on the subjects regularly appearing in the syllabuses of popular astronomical lectures. Two arguments will be presented in this chapter. First, I argue that the common subjects of astronomical lectures were a blend of convention and novelty. Second, the choice of subjects in a lecture would depend on their acceptance by the target audience. Lecturers' treatments of controversial issues could be different. One issue might be stressed because it was more welcomed by the public; another might be neglected as it was not widely received.

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[1] 'Hints to Lecturers', *The Satirist, or, Monthly Meteor*, vol. 3 (December 1808), p. 509.

Conventional lecturing subjects in Enlightenment polite science still prevailed in the early nineteenth century. As Chapter 1 noted, popular astronomy in the nineteenth century was the inheritance from the natural philosophy lecturing trade of the previous century. The curriculums exemplified this continuity. Traditional subjects related to unusual celestial phenomena, such as eclipses and comets, or astronomical measurement, such as the phases of the moon and the shape of the Earth, remained familiar topics in lecturers' repertoire. Newtonian experimental philosophy, which eighteenth-century lecturers such as James Ferguson avidly promoted in public discourses, was still a significant part in astronomy lecturing during this period. Isaac Newton and his science were sacred to the British. The Newtonian doctrine of universal gravitation and its related topics, such as the planetary motion and the cause of the tides, plus Newton's sublimity in the history, were often-told stories in British popular astronomy. Also, there was a bond between Newtonian science and natural theology in Britain in which God's role in the universe was a central, though disputed, issue.[2] This bond also was apparent in the rhetoric of popular astronomy. However, as I will elaborate in this chapter, natural theology had complex connotations. Narratives of natural theology in popular astronomy lectures could be soft: they were using as a vehicle for religious sentiments, rather than profound theological or scientific reasoning.

Old subjects ruled the syllabuses; nevertheless, novelties also had their appeal. Accounts of recent astronomical research, or discoveries of celestial objects, were also potential topics. Examples of these fresh stories, as I will

[2] Gascoigne (1988). Divine intervention in the universe constructed by Newton's physical laws was a key element in British Newtonian natural theology in the eighteenth and nineteenth centuries. I will explain this point in detail later. See also Brooke (1991a), ch. 4; Higgitt (2007).

show in Section 4.2, included reports of an experiment expedition and a newly 'discovered' planet. These novel subjects were more frequent in institutional lectures. Some scientific establishments, such as the Royal Institution, tended to arrange authoritative experts to speak about cutting-edge research and sometimes their first-hand experience.

My second argument highlights the crucial position of audiences in decisions about what to include in curriculums. Subjects were often chosen to meet the target audience's taste and expectation; in other words, lecturers tended to talk about what were suitable for the audience. The sublime and didactic religious contents often shown in Lenten lectures could result from such a strategy. A controversial topic might be curtailed or be stressed, depending on whether it was accepted by the target audience. Arrangement of subjects in a lecture could be also influenced by many other factors, including lecturers' expertise, motivations, and employers. Sometimes a choice was forced by exterior limitations; for example, syllabuses trimmed to suit a limited schedule or modified to suit a particular age group such as school pupils. Facilities, timetable, and even charges, were all business matters required to be bargained with employers. Lecturers often had correspondence with secretaries or managers of the sites to negotiate an agreement.[3] Even Michael Faraday had to deal with such trivialities. In a letter replied to an invitation to give a course at the Royal Military Academy, Faraday argued: "I explained to you on Saturday the difficulty of compressing the subject of Chemistry into a course of 20 lectures only and yet to make it clear, complete, and practically useful; and

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[3] For example, a few letters between John Wallis and the Royal Manchester Institution are preserved in the Manchester Archives. See MA: M6/1/51/382; M6/1/49/2/p143; M6/1/49/3/p162; M6/1/49/4/p5, p13.

without I thought I could do this I should not be inclined to undertake the charge you propose to me."[4] This conversation was just one mundane matter in a lecturer's day-to-day practices.

This chapter will develop as follows: First, I will show the common subjects of nineteenth-century astronomical lectures in Section 4.1, in which the 'convention' element is indicated by topics such as Newtonian science. Then, Section 4.2 demonstrates the 'novelty' element of popular astronomy lectures. Section 4.3 introduces an important case of Lenten lectures in the theatre, which discussions will lead to my analysis of religious components in astronomy lecturing in Section 4.4. Finally, in Section 4.5, I will use a comparison between the attitudes towards two controversial issues – the nebular hypothesis and the plurality of worlds – to show why these two subjects received different treatments among lecturers.

4.1 Syllabus in Common

When John Wallis was invited as the speaker for the Royal Institution juvenile lecture in 1846, the task he encountered was not simple. He had to organise a course of six lectures on astronomy for youngsters, each one of which was two hours in length. The major challenge was to cram the whole universe into these six short lectures. The young audience might be short of attention as well as comprehension. The juvenile lectures, now commonly known as the Christmas Lectures, had been a trademark attraction annually run

[4] Faraday to Percy Drummond, 29 June 1829, James, ed. (1991), Letter 404, p. 487.

by the Royal Institution during the holiday since 1825.[5] Wallis was not a novice; prior to this season, he had already delivered twice in this series in 1826 and 1838. For the third time lecturing in Christmas season, Wallis made the course title as 'the rudiments of astronomy', which promised the course to contain the simplest and the most basic facts about this discipline. Like many other contemporary popular lectures on astronomy, Wallis also promised that the course would be "illustrated by an extensive Mechanical Apparatus, and large transparent Scenery."[6]

A copy of Wallis's syllabus of this season's juvenile lectures is preserved in the Royal Institution archives. The syllabus (Fig. 4.1) was printed on the lecture cards, a common form of printed matter sending to the members and subscribers.[7] Each lecture's subjects were listed with brief description in the syllabus. The first lecture started with the general phenomena of the Moon, including its orbit and movement, and then connected to eclipses. Wallis used a "Picture of the curious facts observed during the total eclipse of the sun, as seen in Italy in 1842" as the concluding topic.[8] The second lecture focused on the Earth, including its figure, rotation, and annual revolution, and then concluded with the phenomena of the seasons. The theme of the third lecture was time: computation of time; nature and use of sun-dials; Meridian line; leap year when and why omitted. The plan to arrange 'time' as the theme of this lecture was remarkable because it was going to be delivered on 31st

5 For the history of the Christmas Lectures, see James, ed. (2008).

6 RI: MS GB 2, p. 47: 71D.

7 RI: MS GB 2, p. 47: 71C-71D.

8 This picture was probably the solar corona and prominences, or the 'Baily's beads' effect made by lunar topography. English astronomer Francis Baily (1774-1844) observed this eclipse at Pavia in the northern Italy.

December – the last day of a year would be right to accommodate the feelings of connecting the past and the future. The fourth lecture was on doctrine of universal gravitation, including the nature of planetary motion, the laws of falling bodies, and precession of the equinox. The fifth lecture was on the tides: the relative forces of the sun and moon as concerned in their phenomena. At last, the final lecture jumped away from the ground to the further solar system: planets and comets, telescopic appearances of the sun and planets, and the newly-discovered planets.[9] The last topic in the entire curriculum was the revolving planisphere of stars visible in London – a 'local' subject which encouraged juveniles themselves to explore the night sky.

The syllabus of Wallis's juvenile lectures provides an excellent specimen of astronomical lecture subjects in the early Victorian era. Many astronomical lectures delivered by other individuals elsewhere usually had these subjects in common. The phenomena related to the Earth, the Moon, and the tides, were recurrent topics in conventional astronomical lectures in particular in the first half of the nineteenth century. For instance, D. F. Walker and C. H. Adams's lectures both contained these subjects as the main attractions. A typical Adams's lecture in a theatre often divided into three parts: the Earth, the Moon, and the 'Vertical Orrery' (Fig. 4.2).[10] The first part concerned the Earth, including its shape, dimensions, motions and the cause of the seasons. The

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[9] The newly-discovered planets possibly referred to Neptune, which was just discovered in September 1846. To consider the plural used in the original text, it might also contain Uranus and asteroids such as Ceres and Vesta (they were considered as planets then). These solar system objects were not known until recent time, so they were new planets to the nineteenth-century contemporaries.

[10] C. H. Adams's lecture syllabus can be found from many posters or advertisements in the periodicals. For example, see the advertisement in the *Theatrical Observer* (27 February 1839); SM: SCM-Art 1980-930/1.

second part focused on the Moon – its phases, orbit and motions – and especially emphasised the phenomena of the tides. This part would extensively show “respective influence of the Sun and Moon in producing Spring and Neap Tides, explained upon a Mechanical Transparent Apparatus, of novel Construction”. The third part concerned the whole solar system, wherein included “The Science considered systematically, the Ptolemaic, Egyptian, Tychonic, and Copernican – the Copernican the only true one – Telescopic Views of the Planets – comparative magnitudes, &c.” This three-part structure of syllabus had already formed in the beginning of Adams’s lecturing and Adams kept it throughout his career.[11]

D. F. Walker’s lecture syllabus (Fig. 3.9) was more fragmented. Walker divided a lecture into five parts – he called each part a ‘scene’ and thus seasoned more theatrical flavour onto his lecture.[12] A typical D. F. Walker’s lecture would consist of:

> Scene 1.—Exhibits the EARTH in ANNUAL and DIURNAL Motion: Day, Night, Twilight, long and short Days, the Seasons, Years, &c. &c. are rendered so plain and intelligible, that a bare inspection of the Machine explains their cause, to any capacity. These Phenomena are explained on a new Transparent Globe, two feet diameter, revolving on its inclined axis before the Sun and through the Zodiac, to produce the Seasons. The Stars composing the figures surrounding the whole.
>
> Scene 2.—Exhibits the EARTH and MOON.—In which the

[11] To compare with the syllabuses in Adams’s debut year, see advertisement in the *Theatrical Observer* (8 April 1830), p. 3; SM: SCM-Art 1980-930/2. Though Adams would do minor changes or add new topics into syllabus in later years, this three-part structure and main themes still kept fundamental to his lecture.

[12] D. F. Walker’s lecture syllabus was often printed in detail on posters and handbills. For example, see SM: SCM-Art 1980-930/12; SCM-Art 1980-930/13; King (1978), p. 312, Fig. 19.3.

cause of her different Phases, or change of appearance; her Eclipses and those of the Sun; with the view of her Disk, as seen by the most powerful Telescopes, are the principle Features.

Scene 3.—The TIDES.—Exceptions reconciled, &c. particularly those in the Irish Sea.

Scene 4.—Has every PLANET and SATELLITE in ANNUAL and DIURNAL MOTION at once; a COMET descends from one Side, and retires at the other of the Machine, having its motion accelerated or retarded according to the Law of Planetary Motion.

Scene 5. — The PROBABLE CONSTRUCTION of the UNIVERSE, Exhibiting every Star as a Sun, like ours of the Solar System.[13]

From this syllabus it is obvious to see the theatrical character in Walker's lecture. In addition to the use of the word 'scene', this syllabus described what scenarios were expected to be seen. For example, the appearance of a comet on the stage in Scene 4 was advertised. Some more detailed early-version playbills even remarked on which music would be played during intervals: English composer Callcott's hymn "*These as they change Almighty Father are but the varied God*" was performed between Scene 1 and Scene 2; an air "*Holy, Holy, Lord*" from George Frideric Handel was placed between Scene 2 and Scene 3; a duet "*The Heavens are telling*" from Joseph Haydn's oratorio *The Creation* was performed between Scene 4 and Scene 5.[14] Above arrangements, plus the fact that this lecture was held on the stage, all made Walker's syllabus was more like a programme rather than a curriculum.

These common syllabuses reflected the inheritance of subjects from eighteenth-century public philosophical lecturing. Public lectures on natural

[13] SM: SCM-Art 1980-930/12.

[14] King (1978), p. 312, fig. 19.3.

philosophy in the eighteenth century had two significant characteristics: they were instrument-oriented and based on Newtonian doctrine.[15] Various instruments such as Air-pumps, barometers, and thermometers, were all familiar apparatus used in demonstrations to reveal the secrets of Nature. For astronomical subjects, apparatus usually laid the basis of a lecture: globes and orreries were used to explain celestial phenomena; telescopes and sundials were exhibited to show their utility. This instrument-oriented convention was still significant in the nineteenth century since astronomical lectures kept heavily relying on these visual aids. Lecturers would promise the audience to present the most improved scenery and mechanical apparatus. I will discuss further the apparatus used in astronomical lectures in Chapter 5.

Newtonian science was the other important theme. The laws of motions and gravitation were Newton's great achievement and nothing could exemplify these principles better than the revolution of planets. In William Whewell's words, astronomy is "the queen of sciences" and "the only perfect science" since "[T]he grand law of causation by which they are all bound together has been enunciated for 150 years; and we have in this case an example of a science in that elevated state of flourishing maturity"[16] This high compliment Whewell paid to physical astronomy was a remark about the completion of an old science by Newton's *Principia*. In Britain, the celebrations of Newton's work had been long associated with a mixture of reasons: national pride,

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[15] For the development of public philosophical lectures in eighteenth-century Britain, see Section 1.3. See also Stewart (1992); Morton and Wess (1993); Elliott (2000; 2009).

[16] Quoted from *Report of the Third Meeting of the British Association for the Advancement of Science; held at Cambridge in 1833* (1834), p. xiii.

intellectual genius, morality and religious virtues.[17] Newton's incorporation of divine presence into a scientific framework was deemed by eighteenth- and nineteenth-centuries British people as a proper homage to the Deity, and a tool for refuting Cartesian materialism and the Laplacian entirely-mechanical universe. The narrative of Newton in the prime place among scientific geniuses was familiar. For instance, an article entitled 'Faith in Astronomy' in the *London Saturday Journal*, which acknowledged and introduced the achievement of astronomy, presented this view. The journalist quoted from writer William Godwin (1756-1836), saying "[T]o think with what composure and confidence a succession of persons of the greatest genius have launched themselves in illimitable space; […] The illustrious names of Copernicus, Galileo, Gassendi, Kepler, Halley, and Newton, impress us with awe." Godwin, however, had also expressed doubt on how the astronomers came to be acquainted with the measurements of heavenly bodies. He claimed that he could not find any hint in an encyclopedia article on astronomy: "Is it not enough? *Newton and his compeers have said it!*"[18] This paragraph of Godwin and the *London Saturday Journal* article reflected Newton's sublimity in the shrine of British science.

Newtonian influences were omnipresent in the curriculum and rhetoric of nineteenth-century astronomical lectures. Wallis spent one lecture in the juvenile course to talk about gravitation; Adams advertised his machinery for it

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[17] Yeo (1988); Gascoigne (1988); Higgitt (2007). Higgitt's work emphasises the same period as my thesis. It offers a detailed survey on the changing attitudes, use, and production of Newton's biographies between 1820 and 1870.

[18] 'Faith in Astronomy', *London Saturday Journal*, vol. 1, no. 22 (1 June 1839), p. 350. The quotation was from William Godwin, 'Of Astronomy', *Thoughts on Man, His Nature, Production and Discoveries* (1831).

would "render the famous theorem of Sir Isaac Newton more intelligible than any hitherto exhibited";[19] the comet scene in Walker's lecture also demonstrated "its motion accelerated or retarded according to the Law of Planetary Motion". The significance of Newtonian doctrine can be found in most astronomical lecturer's syllabus.

Eclipses were another popular topic in astronomical lectures, especially when the public's attention soared to a new height during the mid-nineteenth century. Three total eclipses in this period (1842, 1851 and 1860) were major sources of scientific investigations and public interest because they were visible in Europe.[20] English astronomer Francis Baily (1774-1844) contributed to the fervour of eclipse chasing. Baily observed an annular eclipse in Scotland in 1836 and noticed an effect of "a row of lucid points, like a string of bright beads" during the eclipse.[21] Later on, Baily and other astronomers' expeditions during the total eclipse of 1842 also drew the public's attention. His observation of the solar corona and prominence received extensive coverage in the newspapers.[22] Depictions of eclipses, together with the above curious solar

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[19] *Theatrical Observer* (27 February 1839).

[20] The eclipse of 1842 passed through Spain, southern France and northern Italy; the eclipse of 1851 passed through Southern Scandinavia and East Prussia; the eclipse of 1860 passed through Spain and North Africa. Many individual astronomers organised expeditions and some even received state support, such as Airy's team to Spain in 1860. Such enthusiasm for eclipses was not only in Britain but across Europe; for example, French astronomer Arago's activities also gained public interest in France. For eclipse expeditions and nineteenth-century scientific culture, see Pang (2002); Aubin (2010); Levitt (2010), pp. 296-300.

[21] Baily, 'On a Remarkable Phenomenon That Occurs in Total and Annular Eclipses of the Sun', *Memoirs of the Royal Astronomical Society*, vol. 10 (1838), pp. 1-42. This phenomenon was later named 'Baily's beads'. See also Littmann et al. (2008), pp. 69-73.

[22] For example, 'The Solar Eclipse of July 8, 1842', *London Saturday Journal* (2 July 1842), vol. 4, p. 23; 'The Late Solar Eclipse', *The Morning Post* (25 July

phenomena, were deemed to be a main attraction of lectures. C. H. Adams's lecture syllabus in 1839 advertised "A total eclipse, and the annular eclipse of the Sun, as seen at Edinburgh, will be represented."[23] This scene probably referred to Baily's observation of the annular eclipse in Scotland. In the Lenten season of 1858, Adams also advertised that he would "illustrate, with singular effect, the CORONA during TOTAL ECLIPSES of the SUN."[24]

4.2 News of Discovery

Two of the three Friday Discourses at the Royal Institution delivered by the Astronomer Royal G. B. Airy before 1860 were related to eclipses (Table 3.2). The one entitled 'The Total Solar Eclipse of 1851, July 28' was delivered on 2nd May 1851, about three months prior to the eclipse. This lecture was a 'preview' of this coming astronomical spectacle. It was an example of the adoption of scientific news – whether recent stories or the events yet to come – in a lecture.

Airy's discourse was evidently successful. The attendance at this discourse was high with 610 people; it exceeded the average size of Friday Discourse audience in 1851, which was around 565.[25] Airy explained the cause, period, and shadow-paths of eclipses; he also used historical cases to compare with the coming one. In the conclusion, Airy then "adverted to that part of his subject of which all that had been already said was only introductory, namely the

1842), p.5; 'The Late Solar Eclipse', *Illustrated London News* (30 July 1842), p. 180.

23 *Theatrical Observer* (27 February 1839).

24 *The Standard* (30 March 1858).

25 RI: LE 4, p. 48. The average size of Discourse audience refers to James (2002b), Table 6.2 and p. 139. See also James (2004).

approaching eclipse of July 28." Airy quoted an American newspaper to show "the great interest excited by this eclipse beyond Atlantic as one of the strongest inducements for Americans to visit Europe in the coming summer", and he also "trusted that many English travellers might be induced to observe this eclipse." To encourage the audience to join the eclipse chase, Airy asserted that "No particular skill in astronomical observation is required, the phænomena been rather of a more generally physical kind". At last, the Astronomer Royal generously provided his professional support to the public "by saying that a series of suggestions for the observation, accompanied by a map, had been prepared by a Committee of which he is a member, and were nearly ready to leave the printer's hands: and he undertook to transmit a copy of these suggestions to any person who would make application to him."[26] This handbook would be an official guide for enthusiastic sun chasing tourists.

There was no lack of stories about recent astronomical occurrences in other Friday Discourses at the Royal Institution. Charles Piazzi Smyth's discourse on 5th March 1858, entitled 'Account of the Astronomical Experiment on the Peak of Teneriffe in 1856', was a first-hand report of the world's first experiment to examine the effect of elevation on astronomical observation. This experiment was supported by the government and duly advised by the Astronomer Royal, to practically trial "how much telescopic observation can be improved, by eliminating the lower third or fourth part of the atmosphere; in other words, by elevating instruments and observers some 10,000 feet above the sea level."[27]

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[26] *Notices of the Proceedings at the Meetings of Members of the Royal Institution of Great Britain*, vol. 1 (1854), pp. 62-68.

[27] *Notices of the Proceedings at the Meetings of Members of the Royal Institution of Great Britain*, vol. 2 (1858), pp. 493-497.

Smyth led this expedition to the Spanish island during the summer in 1856, and the results of the investigation were transmitted to the Royal Society by the Admiralty for publication in the year after. In the discourse, Smyth did not bother the audience with numerical and technical particulars; he spoke of the journey instead – from the organisation of the expedition to the landscapes of Tenerife, with exhibiting photographs made during the expedition. In the end, Smyth concluded with an idealistic remark on the 'social bearing' of this astronomical experiment on the Peak of Tenerife:

> The claims of sciences to respect amongst men, for its services in promoting the union of nations and the brotherhood of mankind, have been often dwelt on. Of this admirable and humanizing tendency, is not our experiment on Teneriffe an example, within its little range? See an observer sent out by the English Government, received in a fortified town of the Spaniards, not only without distrust, but as frankly as if one of themselves. And did they suffer by it? We took no notes of their forts and guns, and military array, we applied ourselves to our scientific business alone; and if we have brought away anything more from Teneriffe than what I have already had honour of describing to you, it is, respect and admiration for the Spanish character; and grand ideas of the results to astronomy as well as some other sciences, if this first experiment, this mere trial of a new method, be annually repeated, and energetically followed out.[28]

Michael Faraday, too, had delivered a discourse on an astronomical expedition at the age of 69. The lecture, entitled 'On Mr. De la Rue's Photographic Eclipse Results', was delivered on 3rd May 1861. Unlike Airy's preview in 1851, or Smyth's first-hand account, Faraday spoke of the solar eclipse which had occurred in the previous year from the third-person. The

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[28] *Idid.*, p. 497.

object of this discourse was to introduce the photographic work of Warren De la Rue (1815-1889) during the eclipse expedition in Spain with the instrument 'Kew Photoheliograph'.[29] Compared to Smyth's more general traveller narration, Faraday's lecture was substantial in scientific information: he explained the principles of solar eclipses, the design of the instrument, and the phenomena of prominence, corona and sun spots, with the exhibition of De la Rue's photographs. Both discourses had very high attendance: 521 people at Smyth's and 783 at Faraday's when the average size of Friday Discourse audience was around 470 in both years.[30]

Private entrepreneurs' lectures could also carry scientific news and novelties. Lecturers would advertise the mechanical apparatus used in the show was the most innovative or improved, such as C. H. Adams's assurance that new planets had been already added into his orrery.[31] Recent or coming celestial spectacles – eclipses, comets, meteor showers, and so on – could be a sensational topic in the newspapers and were hardly ignored by lecturers. A competent lecturer had to follow headlines. For example, George Bachhoffner's daily lecture at the Colosseum on the solar eclipse of the 18th of July in 1860, which began at least ten days prior to its occurrence, was a

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29 *Notices of the Proceedings at the Meetings of Members of the Royal Institution of Great Britain*, vol. 3 (1861), pp. 362-366. The Kew Photoheliograph was designed by De la Rue in 1857 for particular use of photography of the Sun. The original instrument is preserved in the Science Museum, London (Inventory number: 1927-124).

30 RI: LE 4, p. 80 and p. 99; James (2002b), Table 6.2.

31 "The nine new planets are now added to the Orrery." It is not clear that which new planets were referred to in this advertisement. See *Morning Chronicle* (14 April 1851).

special arrangement which responded to this particular sensation.[32]

One example to show such a headline quality is a poster of C. H. Adams's lecture preserved in the Victoria and Albert Museum, London. This case was related to the 'discovery' of a hypothetical planet, one of the most intriguing mysteries in the history of astronomy in the nineteenth century. To begin with, in November 1859, an abstract from a letter of French mathematician and astronomer Urbain Le Verrier (1811-1877) was translated and published in the journal *Monthly Notices of the Royal Astronomical Society*.[33] The letter, which was originally published in French journal *Comptes rendus hebdomadaires des séances de l'Académie des Sciences* on 12th September 1859, was an assertion of the probable existence of a planet interior to Mercury. Le Verrier studied the motions of Mercury and confirmed the slow perturbation in its orbit, which could not be explained by influence from any known planets; therefore, he inclined to a planet hitherto undetected between Mercury and the sun.[34] Le Verrier published his letter addressed to Hervé Faye, a colleague in the Paris Observatory, and urged astronomical observers to seek this possible 'new planet'. This plea was not an ordinary request. Le Verrier was then the director of the Paris Observatory and was renowned for the discovery of Neptune: about a decade ago, Le Verrier's calculations predicted the position of an

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32 See the advertisement in *The Era* (8 July 1860).

33 'Miscellaneous Intelligence – Suspected existence of a zone of asteroids revolving between Mercury and the Sun', *Monthly Notices of the Royal Astronomical Society*, vol. 20 (November 1859), pp. 24-26.

34 The existence of this hypothetical planet, commonly known as 'Vulcan', had been a controversy and a long-time quest among astronomers until Albert Einstein's general relativity solution in 1916. The perihelion precession of Mercury can be explained by the sun's gravitational field. For a general introduction of this history, see Baum and Sheehan (1997).

unknown planet and led to its discovery in 1846. The discovery of Neptune was (and is still) seen as a triumph of celestial mechanics. Because of this previous achievement and current status, Le Verrier's assertion of an undiscovered planet within the orbit of Mercury was no ordinary one and it quickly stirred great interest among astronomical circles. The abstract of English translation of Le Verrier's letter in the November issue of the *Monthly Notices* reflected the circulation of intelligence and concerns.

The 'discovery' of a new planet within Mercury drew the public's attention in the beginning of the year of 1860. The situation had dramatic development soon after Le Verrier's appeal: A French country physician named Edmond Lescarbault wrote to Le Verrier and claimed that he had observed the new planet earlier in March 1859 yet was not aware until he read Le Verrier's report. Apart from his medical practice, Lescarbault was a keen amateur astronomer and built a private observatory by his house in Orgères-en-Beauce, yet he was unknown to astronomical elites. Towards the close of the year, Le Verrier paid a secret visit to Lescarbault to examine the authenticity of the country doctor's assertion. The January issue of the *Monthly Notices* in 1860 vividly reported this unannounced visit, which source was from the account of the Abbé Moigno in French journal *Cosmos*.[35] According to this account, the poor country physician "was subjected to a severe cross-examination by his unknown visitor, who pressed him hard from step to step till he had obtained such material and verbal evidence as no longer permitted him to doubt the

[35] François-Napoléon-Marie Moigno (1804-1884), known in his later life as the Abbé Moigno, was a French Catholic priest and a prolific author. The Abbé Moigno involved in the establishment and editorial staff of many scientific journals, such as the *Cosmos*. He also contributed numerous articles on science in these periodicals.

reality of the observation or the good faith of the observer."[36] Eventually Le Verrier was convinced. After his return to Paris, Le Verrier announced this discovery at the first sitting of French Academy of Sciences in the new year. Lescarbault suddenly rose from an unknown country doctor to a new celebrity, and even had been made a Chevalier of the Legion of Honour at the end of January. Across the Channel, the news quickly circulated besides academic journals such as the *Monthly Notices*. Many British newspapers also reported the story during January and early February.[37] The dramatic story of the discovery received extensive coverage and became a captivating conversation piece.

Towards the Lenten season in that year, C. H. Adams would not neglect such a headline in his annual lecture. He used the discovery of a new planet as a major attraction in this year's programme. The poster preserved in Victoria and Albert Museum is an impressive piece of evidence to show that an astronomical lecture in a theatre accommodated a sensational headline story (Fig. 4.3).[38] From the top of the poster, it starts with bold type noticing the venue (Princess's Theatre) and time ("ONE WEEK ONLY. THIS EVENING"), and remarks this would be the lecturer's 30th year in London in particular. Then the headline story occupies the middle part of this poster, notices in an eye-catching way: "Another great triumph in astronomical science in M.

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[36] 'Miscellaneous Intelligence – A supposed New Interior Planet', *Monthly Notices of the Royal Astronomical Society*, vol. 20 (January 1860), pp. 98-99.

[37] For example, 'The discoverer of the new planet', *Daily News* (28 January 1860); 'The discoverer of the new planet', *Bradford Observer* (2 February 1860); 'The discoverer of the new planet', *Jackson's Oxford Journal* (4 February 1860); 'An interesting astronomical episode – A new planet within Mercury', *Glasgow Herald* (9 February 1860).

[38] V&A: S. 1702-1995.

Leverrier's [*sic*] splendid discovery of an Intra-Mercurial planet."[39] This was followed by "C. H. ADAMS" and "ORRERY" with the most significant and bold type, which were definitely recognised by a passer-by in the first sight. From this poster we see a plain yet striking design to combine the lecturer's long-time reputation and a sensational headline story. The *Athenæum* published on 7th April 1860, the last day of Adams's lecture this year, also briefly mentioned this season's performance: "At the Princess's Mr. Adams exhibited his Orrery, and delivered his usual Astronomical Lecture, including among its topics M. Leverrier's [*sic*] discovery of an intramercurial planet."[40] It is not clear how Adams narrated this story to the audience since we do not have further details about this lecture. Nevertheless, this case suggests that astronomical lectures in theatres not only provided familiar textbook knowledge but also contained fresh scientific news (or erroneous ones in modern hindsight). Apart from the sun, the moon, the tides, and Newtonian science, there were wide possibilities in popular astronomy lectures.

Although subjects of scientific news existed in private entrepreneurs' shows as well as the Royal Institution lectures, there had some distinctions between the representations in these two kinds. Lecturers at the Royal Institution were usually men of science or working astronomers, hence their lecture topics were related to their own original research, or were inspired by other colleagues' work in progress. As a result, these first-hand reports could contain more specialised material; the sense of 'sensation' or significance of these

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[39] The original text in the poster prints in capital. For the convenience of reading, here I quote in small letters. See also Figure 4.3 and notice the stress on several words such as 'great triumph' and 'splendid discovery'.

[40] *Athenæum* (7 April 1860), p. 481.

specialised topics, often in scientific grounds rather than in popular market. The Friday Discourse series well reflected this tendency (Table 3.2). For example, Airy's discourse on 'The Pendulum-experiments lately made in the Harton Colliery, for ascertaining the mean Density of the Earth' in 1855 and Baden Powell's 'On Rotatory Stability; and its Applications to Astronomical Observations on board Ships' in 1858, were quite technical and hardly appeal to the general public other than specialists. Smyth also mentioned in his talk that the interest in the attempt of Tenerife expedition was initially shown "in the limited circle of working astronomers", hence this experiment was not actually a headline though it had important value in astronomical observation.[41] In contrast, private commercial lecturing, such as D. F. Walker's and C. H. Adams's in theatres, more reflected popular taste and depended largely on other media. Latest celestial spectacles or sensational astronomical discoveries appeared in the newspapers would be more easily transformed into the headlines on the stage.

4.3 A Playwright's Work

In the manuscript submitted to the Lord Chamberlain's Office, Samuel James Arnold, the author and producer of George Bartley's lecture, acknowledged that he applied other sources in his writing. "So many excellent works having been written on this subject it can hardly be expected that any striking novelty either in language or arrangement should be attempted [...] and flights of imagination would be strangely wasted on a Theme so vast, that the clearest intellect becomes bewildered in the contemplation of its immensity."

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[41] *Notices of the Proceedings at the Meetings of Members of the Royal Institution of Great Britain*, vol. 2 (1858), p. 494.

Arnold then explained his intention: “To confine ourselves therefore to what is known, and now proved beyond the chance of future doubt, will be our boarden duty – In so doing we shall draw largely on the works of the best Authors who have written on the subject, because nothing can be added to that which is already complete and full”.[42]

The manuscript of Bartley’s lecture syllabus written by Arnold (see Appendix B) was a valuable document for shedding light on the details of astronomical performances in theatres. Being collected in the *Lord Chamberlain’s Plays*, the presence of this manuscript is an unexpected discovery for my research. The Lord Chamberlain’s power of censorship contributed to the preservation of numerous play scripts including this one. Censorship of dramatic performances had a long history in Britain. Under the Stage Licensing Act of 1737 and the Theatres Act of 1843, the Lord Chamberlain had power to license a theatre and to suppress a play; therefore, any new play intended for public performance was required to be submitted to the Lord Chamberlain’s Office for examination. Though this power had been largely restricted after 1843 and was eventually abolished in 1968, the censorship existed and was in effect throughout the nineteenth century.[43] The plays submitted between 1824 and 1968 are collected in the British Library and are known as the *Lord Chamberlain’s Plays*.[44] However, it was unusual for a

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[42] Arnold, *Ouranologia*, in *Lord Chamberlain’s Plays*, vol. XI (January 1826). BL: Add MS 42875, ff. 443-493[b]. The quotations here are from f. 447[b]. See the full transcript of the manuscript in Appendix B.

[43] For more details about the censorship of British theatres and dramas, see Booth (1991), pp. 145-149; Foulkes (1997), ch. 2.

[44] Manuscripts Collections Reader Guide 3: The Play Collections, British Library, http://www.bl.uk/reshelp/pdfs/readerguide3.pdf (accessed 9 September 2013); *Catalogue of Additions to the Manuscripts: Plays Submitted to the Lord*

lecture syllabus to be submitted to the Lord Chamberlain. Despite performing in the West End theatres, astronomical lectures during Lent seemed no necessity to be submitted to the Lord Chamberlain's Office – There are no records of other similar performances made by Walker, Adams, or anyone else in the *Lord Chamberlain's Plays*. Besides, when Arnold submitted this syllabus in January 1826, Bartley's lecture had already been performed for at least last five years; it was not a new play awaited to be licensed. The register of the plays simply notes the title and theatre without further information.[45]

Samuel James Arnold was a theatre celebrity with a keen interest in science and literature. Being the eldest son of Samuel Arnold (1740-1802), a recognised composer and the organist of Westminster Abbey (since 1793), young Arnold was trained as an artist initially.[46] Part of Arnold's early career was spent on painting;[47] however, Arnold's main interest was in theatre. He had written several plays since his early twenties, including the *Shipwreck* (1796) for Drury Lane. His father's professional high status and resourceful support might contribute to Arnold's early success in the theatre. The Arnolds had extensive cooperation in playwriting, for the father actually composed most of the music in the son's works. Later Arnold also co-wrote plays with the poet laureate Henry James Pye, his father-in-law. In addition to playwriting,

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Chamberlain 1824-1851, London: The Trustees of the British Museum (1964). Plays submitted before 1824 are preserved in the Huntington Library, San Marino, California.

45 BL: Add MS 53702, f. 106b-107.

46 For Arnold's biography, I mainly refer to Jessica Hinings, 'Arnold, Samuel James (1774–1852)', *ODNB* (2004).

47 One portrait of the poet laureate Henry James Pye, Arnold's father-in-law, was painted by Arnold around 1800 and it is in the collection of the National Portrait Gallery, London. (Portrait number: NPG 4253)

Arnold also engaged in theatre management. After a few years of troubled joint management at Drury Lane, he moved back to the old Lyceum Theatre. Arnold rebuilt the Lyceum and renamed it the English Opera House, which was reopened on 15th June 1816.

Perhaps it was also during this time Arnold became acquainted Bartley. Bartley and his second wife Sarah (née Smith, 1783-1850), an acclaimed tragedy actress, both played at Drury Lane in 1814, when Arnold was still joint manager there. After the married couple returned from a successful American trip in 1818, Bartley accepted winter engagement at Covent Garden and played at the English Opera House during summer. Thus, the two men encountered and started their cooperation of astronomical lectures. Apart from painting, writing and theatre management, Arnold was also enthusiastic about science. He was a fellow of the Royal Society, and also actively involved in the activities of the Royal Institution. Arnold's name appeared in the balloting list for the committee of 'General Science, Literature, and the Arts' at the Royal Institution for several times.[48]

Although Arnold acknowledged that he drew largely from popular works of the best authors on astronomy when writing the lecture syllabus, it is not explicit what literature he adopted. The title of the lecture 'Ouranologia' was the same as a simple book printed in 1695 by Thomas Cole, who was 'Student in Astrology, and Practitioner in Physick and Chirurgery'.[49] However, these two works had nothing in common but the title. The *Ouranologia* (1695) was

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[48] RI: GB 1, p. 87 and p. 108. These two records of the balloting list were on 29 November 1810 and 20 April 1811.

[49] The full title of the book was *Ouranologia: being an ephemeris of the motion of the celestial bodies for the year of Our Lord 1695*. It had a reprint edition in 1705.

an ephemeris for astrological use and contained a few essays on astrology while Arnold's work had no relation to astrology. The similarity of the titles was possibly by coincidence since the word 'Ouranologia' derived from *Ouranos*, an ancient Greek word meaning sky or heaven – like the wide usage of the name Uranus or Urania in modern astronomical circles.[50] The most popular and authoritative astronomical textbook in the nineteenth century, John Herschel's *Outlines of Astronomy* (1849), which was derived from his *A Treatise of Astronomy* (1833), had not come out when Arnold wrote the script.[51] The publication of the *Bridgewater Treatises*, the most influential natural theology classics in the early Victorian popular science market, did not start before 1830.[52] These important popular works could not be the sources of Arnold's syllabus.

The most likely candidate, despite being slightly outdated, was James Ferguson's *Astronomy explained upon Sir Isaac Newton's Principles* (1756). As a prominent lecturer and author in the mid-eighteenth century, Ferguson's work still had powerful influence on astronomical education. William Herschel purchased a copy of this book when he started his amateur pursuits at Bath.[53] It had numerous posthumous editions. For example, the second American edition published in Philadelphia in 1809, was edited by Robert Patterson

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50 The use of invented hybrid words in the promotion of early nineteenth-century private astronomical lectures seems extensive: the 'Eidouranion' of the Walkers and the 'Dioastrodaxon' of Lloyd were another two examples.

51 From the first publication in 1849 to 1873, two years after John Herschel's death, the *Outlines of Astronomy* had twelve editions in England. The influence of this work also spread abroad: it was translated into many European languages, Arabic and Chinese. See Rutter (1992); Ruskin (2004), p. 200.

52 For the significance of the *Bridgewater Treatises*, see Topham (1992; 1998).

53 Lubbock, ed. (1933), pp. 59-60.

(1743-1824) "from the last London edition";[54] David Brewster (1781-1868) also edited and republished it at Edinburgh with supplementary chapters in 1811.[55] In any aspect, this book proved to be enduring over half a century after its first publication; it was still instructive for any student or enthusiast of astronomy in the early nineteenth century. Besides, we should keep in mind that Arnold was definitely not a science illiterate; he had been an active participant in many occasions of scientific institutions. Arnold could also learn from contemporary periodicals and other lectures, including the Walkers' Eidouranion.[56]

Arnold divided the whole lecture into three parts. The first part starts with the shape of the Earth by a 'Diagram of Ship' to demonstrate the curve of its surface. Then the lecturer elucidates different cosmic models in the history "in order that we may the better explain the gradual advances of this Science"[57]: the Pythagorean, Ptolemaic, Tychonic, and finally the "genuine one of Copernicus". Arnold introduces Copernicus as "a bold and original genius, adopted the Pythagorean, or true system of the universe, and published it to the world with new and demonstrative arguments in its favour seized with a darling enthusiasm, he laid his hands on the cycles and crystal orbs of Ptolemy,

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[54] See the title page of Ferguson (1809), which noted this edition was revised, corrected and improved by Robert Patterson. Patterson was then a professor of mathematics at the University of Pennsylvania as well as the director of the United States Mint.

[55] Brewster's enlarged edition had three prints; the third edition was published in 1841.

[56] D. F. Walker lectured on the Eidouranion at the English Opera House between 1817 and 1819. It is reasonable to speculate that Arnold copied Walker's successful show and added his own flavour into the production.

[57] Arnold, *op. cit.* (42), f. 451.

and dashed them to pieces."[58] The Copernicus system was followed and reinforced by Galileo and Kepler, whose defence of this doctrine and the application of telescope "made many new and surprising discoveries in the heavens":

> From these discoveries, Astronomy began to assume a new form, and most of the celestial phoenomena [*sic*] were soon accounted for, according to their real or physical causes. Des Cartes, Gassendus, Cassini, and Newton, employed themselves, with the utmost diligence, in improving and perfecting this science: and the last of these great men, in particular, has established the Copernican System upon such an everlasting basis of mathematical demonstration, as can never be shaken, but must last as long as the present frame of nature continues in existence.[59]

This narrative accorded with the familiar rhetoric of Newton's presence in British popular memory and representing the pinnacle of scientific geniuses. After tracing the history and establishing the structure of the solar system, the lecturer then proceeded to the next part.

The second part is an overview of the solar system, which emphasises the telescopic appearances of individual planets. Starting with the Sun, this cruise made in spatial order from the inner to the outer part of the system: Mercury, Venus, the Moon, the Earth, Mars, four newly-discovered tiny planets,[60] Jupiter, Saturn and Uranus. Each major planet has an illustration (a 'scene' in the manuscript) to show its telescopic appearance. The Sun and the Moon are especially elaborated; there are many extra scenes about these two significant

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[58] Arnold, *op. cit.* (42), f. 453.

[59] Arnold, *op. cit*. (42), f. 454.

[60] Vesta, Juno, Pallas and Ceres. Today the former threes are categorised into the main-belt asteroids, while Ceres is categorised as a dwarf planet.

objects, including the Sun's apparent magnitude to the different planets, and the orbit and phases of the Moon. Comets also occupy a great portion of this part. Three scenes of famous comets are exhibited – they are the Comet of 1680, 1811 and 1819, wherein the lecturer always stresses that these scene are "laid down from actual observation when it was in that part of the Heavens", hence they are faithful copies of the appearances.[61] This part concludes with the explanation of the zodiac and the origin of the seasons by the exhibition of a huge planetarium showing the revolution of the Earth.

The third part focuses on the two most interesting astronomical phenomena: eclipses and the tides. The nature, cause, and different types of these two phenomena are explained in detail. Finally, the lecturer would conclude with the display of the extensive orrery, which contains the whole solar system and every planetary movement. It is certainly the grand finale of the evening.

The significance of Newtonian inheritance is obvious in Arnold's *Ouranologia*. Newton is the main protagonist amongst a long line of great geniuses; Arnold's high praise unsurprisingly reflects the status of the English national hero. Arnold concluded in the first part of the lecture: "[A]ll other systems have been wholly exploded by the clear and demonstrative discoveries of our immortal Countryman Sir Isaac Newton".[62] This traditional rhetoric of Newton's place in the history was directly influenced by James Ferguson. Ferguson championed Newton's achievement by putting Copernicus beside Newton, for the "true and rational system" was restored by the former and

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[61] Arnold, *op. cit.* (42), f. 469[b].

[62] Arnold, *op. cit.* (42), f. 457.

demonstrated by the latter.[63] The arrangement of the subjects in the *Ouranologia* is similar to the content of Ferguson's *Astronomy*, in which 'A brief Description of the Solar System', 'The Ptolomean System refuted', 'Of the ebbing and flowing of the Sea' and 'Of Eclipses' are separate chapters.[64] Therefore it is very likely that Arnold's *Ouranologia* was majorly based on Ferguson's popular work. In that case, it is not surprising that this lecture reflected so much Newtonian doctrine. Like the protagonist Sir Isaac Newton, who succeeded and surpassed many geniuses in the past, Arnold's work itself came after a long line of natural philosophy lecturing paradigms since the eighteenth century.

Arnold's manuscript in the *Lord Chamberlain's Plays* also provides valuable information about a producer's working experience. This manuscript is more than a script – it does not actually offer the lecturer to read word by word on stage. It is more like a 'production notes' with the producer's thoughts on what effects the audience could expect to see, or as a report for the Lord Chamberlain to demonstrate how this lecture would be delivered. In the manuscript, sometimes Arnold explained the reason why he adopted or not adopted a scene in a particular part. For example, when introducing the change of lunar phases, he noted the recurring progress "could shew on this apparatus, but as it would only reverse the succession of the same forms which have just been shewn; it might be considered as an unnecessary waste of time: particularly as the nearest Scene will shew in a different manner".[65] Such

[63] Ferguson (1756), p. 31.

[64] These are the titles of Chapter I, III, XIII and XIV, respectively, in the original edition of Ferguson's *Astronomy* published in 1756.

[65] Arnold, *op. cit.* (42), f. 465.

comments allow us to see a producer's consideration for the technique of showmanship and stage setting beyond the scientific content.

Another example in the *Ouranologia* to show the subtle consideration was the scene 'Diagram of Ship'. In this scene, a model vessel would appear on the top of the globe in order to demonstrate the round-shape of the Earth. Because of the different heights spectators seated in the auditorium, this effect may vary. Arnold had noticed such occurrence of spatial difference, thus he explained:

> A Ship will shortly appear on its [the globe] surface, advancing towards the Audience – Those of the Spectators who are situated in the higher parts of the Theatre, will of course behold it first – As a Seaman in the foretop first discovers a Sail at Sea – Those persons in the lower parts of the Theatre will perceive it later – but I trust all of my Auditors who favor me with their attention, will find that its advances are precisely correspondent with my description; thus illustrating the Globular shape of the Earth.[66]

This remark exactly shows a subtle stage detail considered by the producer, and how reliable the showmanship of the lecturer is for the performance. Arnold believed Bartley could easily distract the audience from this slight difference due to unavoidable restriction of the space. This also indicates the importance of Bartley as the lecturer. Though Arnold was the sole author of the *Ouranologia*, Bartley's role in the entire plan should not be neglected. A marvelous script still needs good actors to make the plot come alive. Bartley was the performer to bring Arnold's lecture scheme to the public. Being a recognised actor, Bartley had quality performance and oratory skills to draw

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[66] Arnold, *op. cit.* (42), f. 448[b]-449.

the audience.[67] This lecture could not be fulfilled without the contribution of either person.

4.4 Devotion, "Daughter of Astronomy"

Arnold's manuscript also shows a significant theme which was prevalent in early nineteenth-century astronomical lectures: the wonder of the universe and God's Creation. Religion was a common reflection in astronomical lectures of this period, and a prevalent language to narrate the heavens. Nothing can be better than the infinite universe to arouse the audience's religious thoughts in awe; nothing can be better than such a wondrous awe to enhance the public's interest in this sublime science. As Allan Chapman indicates, the promotion of a cause was an important ingredient in contemporary astronomical lecturing, and the most common single cause promoted by lecturers was that of Christianity itself.[68]

An example to reflect the association between astronomy and religious devotion is a frequently-used quotation: "An undevout Astronomer is mad." This quotation appeared in the very beginning of Ferguson's *Astronomy*, in which the author noted that he was citing Dr Young's *Night-Thoughts*. Edward Young (1681-1765) was an English poet, a contemporary of James Ferguson, and is best known for his long poem *The Complaint: or, Night-Thoughts on Life, Death, & Immortality*, commonly known as *Night-Thoughts*. This long poem was published in nine parts ('Nights') between 1742 and 1746. The line Ferguson quoted is from a passage of the Night Ninth:

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[67] For Bartley's performance and oratory skills, see Section 3.2.

[68] Chapman (1998), pp. 168-170.

In this His universal temple hung
With lustres, with innumerable lights,
That shed religion on the soul; at once,
The temple, and the preacher! O how loud
It calls devotion! genuine growth of Night!
   Devotion! daughter of Astronomy!
An undevout astronomer is mad.
True; all things speak a God; but in the small,
Men trace out Him; in great, He seizes man;
Seizes, and elevates, and wraps, and fills
With new inquiries, 'mid associates new.
Tell me, ye stars! ye planets! tell me, all
Ye starr'd, and planeted, inhabitants! what is it?
What are these sons of wonder? say, proud arch
(Within those azure palaces they dwell),
Built with divine ambition! in disdain
Of limit built! built in the taste of heaven!
Vast concave! ample dome! wast thou design'd
A meet apartment for the Deity?—[69]

Ferguson thought the line "An undevout Astronomer is mad" was too obvious to be with hyperbole. In his book, Ferguson emphasised the moral objective of the study of astronomy, wherein the readers could learn "by what means or laws the Almighty carries on, and continues, the admirable harmony, order, and connexion observable throughout the planetary system".[70]

As a follower of Ferguson's popular work, Arnold also used the quotation in the *Ouranologia*. He wrote in the beginning of the syllabus: "[T]hus Astronomy becomes a handmaid to Devotion, and affords us the most exalted

[69] Edward Young, *Night-Thoughts*, Night IX, lines 767-785. I refer to the edition edited by George Gilfillan (1853). The complete text of this edition is in the Project Gutenberg: http://www.gutenberg.org/files/33156/33156-h/33156-h.htm (accessed 15 October 2014).

[70] Ferguson (1756), p. 1.

ideas of that beneficent Deity who created, guided, and governed, the stupendous whole in matchless harmony. Well has it been said that 'the undevout Astronomer is mad'".[71] A cheap book *The Solar System* (1799), published by the evangelical RTS and aimed at a relatively elementary readership, also quoted this line in its introduction and declared that astronomy "ought to be considered as bearing an intimate relation to religion, and worthy the study of every enlightened Christian."[72] This quotation makes a perfect footnote for a popular attitude towards the study of astronomy in the eighteenth and early nineteenth centuries. On the one hand, astronomers' stargazing practice is benign as it could lead to a religiously beneficial result; on the other hand, an undevout astronomer is mad because he cannot see the manifest displays of the design from an intelligent Creator.[73]

Arnold and Bartley's lecture was not an isolated example. Many other lecturers were also in tune with such religious significance. Lloyd advertised that his lectures were intended to direct the enquiring mind through Nature, "up to Nature's God"; therefore "Seminaries and Families will find the present offer peculiarly interesting and grateful."[74] In the playbill for the Lenten season of 1819, D. F. Walker remarked his objective and endeavour was to elucidate "the sublime Science of Astronomy, on a Scale commensurate to its Importance, to imitate, though humbly, the glorious Phenomena of Creation".[75]

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[71] Arnold, *op. cit.* (42), f. 446.

[72] RTS, *The Solar System* (1799), p. x.

[73] Similar Christian positions were rendered to the exhibits of the Great Exhibition of 1851. See Cantor (2011), especially ch. 5, pp. 128-143.

[74] RAS: Add MS 88: 6.

[75] RAS: Add MS 88: 8.

Not only lecturers themselves stated such a connection between astronomy and religious devotion, patrons also expected to obtain this profitable cultivation of religious sense from lectures. An essay on the recollections of the Rev. John Eyton, formerly Vicar of Wellington, Shropshire, recorded an anecdote about this vicar and a lecturer: A visiting lecturer on astronomy received the permission to give a course in the local free-school. This lecturer arrived on Wednesday and attended the church in the evening to announce his lectures would commence on the following day. In order to make these lectures "really profitable to the young persons of his charge," and also "to prepare them for a right understanding of the sublime science," Mr Eyton preached on Psalm viii. ('When I consider thy heavens') and he "gave such a lecture on astronomy and the greater wonders of redemption, as the stranger was little prepared to hear."[76] Thus the week in which the orrery was fixed in the free-school at Wellington was hoped to be "remembered with gratitude in a blissful eternity."

This anecdote of the Rev. John Eyton reflects the entrenched fear that science might undermine religion and thus the social order. Such the concern had been a recurring theme in literature long before the birth of modern physical sciences. It usually represented as the form of stereotypical arrogant and Godless 'scientists', a variation of Dr Faust or Dr Frankenstein, whose ambitions and carelessness of morality eventually resulted in tragedies.[77] The prevalence of Newtonian science in the eighteenth century deepened this fear. The idea of a 'clockwork universe', which proposes that nature operates in an orderly fashion according to mechanical principles, had long fascinated

[76] 'Recollections of the Rev. John Eyton, A.M., formerly Vicar of Wellington, Salop', *The Wesleyan-Methodist Magazine*, vol. 3 (June 1847), p. 557.

[77] Haynes (1994).

philosophers of the Enlightenment. Newton's mathematical description of the force driving the planetary motion made a mechanical universe more plausible. Although Newton himself affirmed God's conduct in the natural laws he discovered, the physical laws of gravitation could drive the operation of the universe independently of divine activities. A purely mechanical universe, as Laplace's work *Mécanique Céleste* suggests, is a materialist system where God and moral dimensions were no longer needed.[78] Political turmoil after the French Revolution complicated this fear of subversive radicalism. Such connections with atheism and revolution worried many British contemporaries. Astronomy could be benign, yet this requires careful guidance for a right understanding of the sublime science, as what the Rev. John Eyton was doing. Edward Young's *Night-Thoughts* was also full of reflections on the universe and the Creator, in which he claimed the book of stars is universally available and reveals God's existence and nature. Therefore, an undevout astronomer is mad – and could be dangerous. Materialism, atheism and revolution, were all dangerous notions and ought not to be the daughter of astronomy. This was the reason why nineteenth-century British people thought religious reflections in astronomy lecturing were necessary: they performed the function of making the science not only sublime but also 'safe' for the audience.

It is tempting to think that such a religious reflection was exclusively Lenten, since Lloyd, Walker and Bartley were familiar names in theatres during Lent. But the answer is definitely no. Religious rhetoric in astronomical lectures was

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[78] Gascoigne (1988); Brooke (1991a), ch. 4, pp. 117-151. For an introduction of the clockwork universe metaphors in the Enlightenment, refer to Knight (2006), ch. 2, pp. 13-28. For a biography of Laplace and his celestial mechanics, see Hahn (2005). See also Koyré (1957) for Newton's incorporation of divine intervention into his system.

not limited to Lent or theatres. Some astronomical lectures in institutions also shared this common ground; from their syllabuses it is not difficult to find out. Baden Powell had delivered a course of seven lectures on ‘Cosmical Philosophy’ at the Royal Institution in 1851 (Fig. 4.5), which followed his course on astronomy in the previous year. In the beginning of the syllabus, Powell noted the difference between these two courses: “The former course [Astronomy] referred to the phenomena and laws constituting the system of the world: the present [Cosmical Philosophy] relates to the investigation of their causes and the general philosophical principles involved; including a review of the progress of discovery.” This course was a rendition of the history of astronomy in general. In the final lecture, Powell talked more about philosophy, including some topics highly relevant to religion, such as “Better distinction into physical and moral”, “Evidence of design” and “Universality of order”.[79] Another example was at the Royal Manchester Institution: a course of three lectures on ‘Ancient and Scriptural Astronomy’ was delivered by the Rev. St. Vincent Beechey in 1850. This course included many biblical interpretive topics such as “How God endowed his most favoured servants with a special knowledge of the works of nature, that they might be better qualified to sing His praise”[80]

The arrangement of the institutional curriculum might suggest a subtle demarcation was happening. Both lecturers from the above two examples were Anglican priests – Beechey was the Incumbent of Worsley and Powell was a clergyman aside from his professorship of geometry at Oxford. Although they

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79 RI: MS GB 2, p. 61: 126C-126D.

80 MA: M6/1/70/106.

lectured on astronomical subjects with theological contents, it seems that both lecturers aptly dodged potential controversies by the wise choice of the course titles. The title ‘Cosmical Philosophy’ allowed Powell to speak things beyond physical science, whilst he addressed physical knowledge – astronomical facts about the Earth, the sun, planets and planetary laws – in his course on ‘Astronomy’ one year before. Beechey, too, made similar distinction between scriptural and modern astronomy. In another course on the ‘History of Modern Astronomy’ at the Royal Manchester Institution, Beechey plainly talked about the development of astronomy from ancient Greeks to the recent discovery of Neptune, without any rendition of biblical context.[81] This arrangement adopted by Powell and Beechey might suggest a distinction between physics-based astronomical subjects and theology-oriented philosophical discourses had been concurred in institutional lecturing by the mid-nineteenth century, even among those clergymen lecturers. On the other hand, this could be interpreted as reconciliation rather than distinction: Science was commensurate with and justifying Christianity. To talk about mere scientific facts of the physical world was not enough; religious philosophy ought to be as a supplement or a guide to complete the sciences, hence lecturers had to arrange two separate courses so closely.[82]

The rhetoric of natural theology was an important element in popular astronomical lectures in the early nineteenth century. Historians agree natural

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[81] MA: M6/1/71/12.

[82] This intent of ‘drive towards inclusiveness’ had been a characteristic in English philosophy since the Enlightenment. John Brooke quotes Roy Porter to indicate English thought went for comprehension rather than contending opposites; the concern was science *and* religion, not science *versus* religion. See Brooke (1991a), p. 200; Porter (1981), pp. 7-8 and 13.

theology played a decisive role in the promotion and popularisation of science during this period.[83] The success of the *Bridgewater Treatises* in the 1830s was a representative example of the influence of natural theology in popular science. Outstanding savants of science, including William Whewell and William Buckland, were commissioned to publish eight volumes of treatises on "the Power, Wisdom, and Goodness of God as manifested in the Creation" according to the Earl of Bridgewater's will.[84] Though the actual theological definition of natural theology is the attempt to "procure religious truths about God and his relation with humans by the exercise of natural reason, and without recourse to any kind of revelation",[85] the most familiar aspect of natural theology in the history of science is the argument for the creation and design by marvelling at God's handiwork in nature.[86] Nevertheless, we should be cautious when referring to natural theology, for it was an ambiguous term with changing meanings and emphases through time. The attitudes towards natural theology were not homogeneous even among Christianity. Different churches or personnel had variant opinions about natural theology, from ambivalence to opposition.[87]

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[83] Brooke and Cantor (1998), pp. 153-161; Brooke (1991a), ch. 6, pp. 192-225; Topham (2010a). See also Fyfe (2002) on Paleyan natural theology and the scientific canon in the early nineteenth century.

[84] Jonathan Topham provides in-depth studies on the production and readership of the *Bridgewater Treatises*, see Topham (1992; 1998). O'Connor (2007) also draws details on popular geology works including the *Bridgewater Treatises*, especially William Buckland's contribution.

[85] This definition is quoted from Topham (2004), p. 38. See also Topham (2010a), p. 59, in which a description from a British encyclopaedia in the mid-nineteenth century is cited.

[86] Fyfe (2004), pp. 6-7; Bowler and Morus (2005), pp. 350-354. This aspect is particularly influenced by William Paley's classic *Natural Theology* (1802).

[87] Corsi (1988), ch. 12, pp. 178-193; Topham (2004).

A much disputed concern in natural theology linked to astronomy was the level of divine activity in the operation of the universe: to what extent did God design through the ‘general providence’ of natural law versus the ‘special providence’ of direct intervention? This controversy could be traced to the time when Isaac Newton penned the *Principia*. If a mechanical universe can be operated smoothly by general laws, it seems to need no place for God and simultaneously restricts God’s sovereignty. In response to this dilemma, Newton asserted that the solar system still requires God’s regular intervention to prevent its degeneration. However, even Newton and his early disciples were ambivalent about how the Deity intervenes – by a generally controlled mechanism (general providence), or by direct fiat, hence miracles (special providence)?[88] Newton’s position was not quite appreciated by later natural theologians. William Paley (1743-1805) in his classic *Natural Theology* (1802) argued that astronomy “is *not* the best medium through which to prove the agency of an intelligent Creator”. Paley drew God as a skilled watchmaker who carefully adjusts His design. Organic mechanism such as eyes rather than planetary motion, in Paley’s view, suits his watchmaker analogy between an artisan and human contrivance better.[89] William Whewell, however, was much in favour of God’s role as a legislator. He wrote in his *Bridgewater Treatise* that “events are brought about not by insulated interpositions of Divine power, exerted in each particular case, but by the establishment of general laws” and hence considered God as the “*author of the laws*”[90] The above distinction

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[88] Gascoigne (1988); Brooke (1991a), pp. 144-151. See also Koyré (1957).

[89] Paley (1809), p. 378; Topham (2010b), p. 95.

[90] Whewell (1839), p. 356 and p. 361. See also Topham (2010b), in which the theological distinction between Paley’s and Whewell’s views is elaborated.

between Newton's, Paley's, and Whewell's arguments indicates the disputed character of divine design in changing stands of natural theology.

Religious sentiments of the creation and design were evident in Arnold's *Ouranologia*. Arnold repeatedly reminded the audience about the advantage of astronomy, which is a sublime subject affording the knowledge of nature, the true system of the world, and the invariable laws by which it is governed, hence astronomy "has opened to us such a magnificent view of the Creation, that we are struck with astonishment at the grandeur of the spectacle, and the powers of omnipotence."[91] When reasoning the Earth's rotation, the lecturer explained that the distances of stars from the Earth are so immerse, and the orbits in which they revolve so prodigiously great, hence they would move incredibly at least a hundred thousand miles in a minute. "[A]s nature never does that in a complicated and laborious manner which may be done in a more simple and easy one," the lecturer concluded: "it is certainly more agreeable to reason, as well as to the power and wisdom of the Creator, that these effects should be produced, by the motion of the Earth." This conclusion is reasonable especially the Earth's rotation preserves the "beautiful simplicity and harmony, which is found to prevail in every other part of the creation."[92] When introducing the cause of the seasons, the lecturer attributed such a wonderful mechanism to the Creator:

> This beneficent and curious provision for the existance [*sic*] and comfort of the Earth's inhabitations cannot too powerfully excite our admiration of the wisdom, or our gratitude for the goodness of the Creator. If it were not for this simple contrivance one part of the

[91] Arnold, *op. cit.* (42), f. 447.

[92] *Ibid*., f. 455.

> Globe would revolve constantly in the full blaze of the Sun's rays – while those regions which are situated near the poles would be almost, wholly, destitute of light and heat, and probably incapable of sustaining either Animal or vegetable life. – But this is not the case, for the remotest points to which the avarice or curiousity of Man has penetrated are sound to be inhabited; and doubtless that power which "tempers the wind to the shorn Lamb" – has so organized their inhabitants as to afford even in those desolate regions the Capability and means of enjoyment.[93]

These narratives, from reasoning the Earth's rotation to the cause of the seasons, all fit the rhetoric of natural theology. By telling these familiar astronomical facts, natural theologians marvelled at the order created by a benevolent designer.

Despite the rhetoric, it is not certain whether Arnold and other peers of popular astronomy intended to advocate serious natural theological ideas. As Jonathan Topham reminds us, although natural theology fulfilled important functions in early nineteenth-century Britain, it is by no means certain that all the references to design in nature in contemporary scientific writings were intended to be read as contributions to natural theology as a doctrine. Their purpose, Topham indicates, was often merely to "link the sacred and the secular, so that those engaged in reading about the sciences would not find their minds taken away from the life of devotion to God."[94] Though there were intense theological debates among scientific elites,[95] those highbrow arguments were

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[93] *Ibid.*, f. 471[b].

[94] Topham (2010b), p. 91. See also Brooke (1991a) and Brooke and Cantor (1998) on the usefulness of natural theology for evoking a sense of wonder at divine evidence in nature or to connect scientific pursuits with Christian devotion.

[95] The theological arguments of Newton and Paley have been discussed in the earlier part of this chapter. Studies involving Whewell's stance on natural theology,

perhaps irrelevant to popular entrepreneurs. As for the disputed issue of general or special providence in Newtonian cosmology, popular astronomy lecturers might not necessarily have something loud to say other than admiration for Newton. In the *Ouranologia*, Arnold praised Newton, who "has shewn that though ingenious Argument might suppose the course of nature to be governed by mere mechanical laws only, the works of nature would then have been incomparably inferior to what they now are both in beauty and perfection, and consequently far less worthy of its ineffable Contriver".[96] Though this passage can be read as championing Newtonian theology of divine intervention, there is no further evidence inside or outside the *Ouranologia* to indicate Arnold's intention.

References to the creation and design in popular astronomy lectures like Arnold and Bartley's likely are pure sentiment, at best soft implication, rather than a strong statement. Popular lecturers used natural theology as a vehicle for sublime religious sentiments as opposed to one for serious theological reasoning. From a commercial point of view, the rhetoric might also serve as convenient justification for persuading audiences to come in theatres. For natural theologians, astronomy was an unrivalled source for imagery of the sublime.[97] Paley noticed the great thing in astronomy was "to raise the imagination to the subject, and that oftentimes in opposition to the impression made upon the senses." Although Paley deemed astronomy not the best medium for his design argument, he agreed that it showed "the magnificence of his [the agency of the Creator] operations. The mind which is once convinced,

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see Cantor (1991) and Brooke (1991b). See also Corsi (1988) on Baden Powell.

96 Arnold, *op. cit.* (42), f. 457. The underlining is in the original source text.

97 Brooke and Cantor (1998), p. 187.

it raises to sublimer views of the Deity than any other subject affords".[98] The immense scales in astronomy, such as the contrast between the proportional sizes of the sun and the earth (nine feet in diameter versus a globe of one inch), or the length of the comet's tail (30 millions of miles), all stimulate the sense of wonder as well as imagination.[99] These rhetorical elements were obvious in many contemporary popular discourses of astronomy, including Arnold and Bartley's.

4.5 Progress and the Plurality of Worlds

Before we conclude this chapter, two topics – or narratives – in nineteenth century astronomical lectures are worth further discussions: the notion of progress and the plurality of worlds. The nebular hypothesis was centred in the former, whilst the latter was linked to the existence of extraterrestrial beings. Unlike the firm status of Newtonian science, both ideas were disputable and controversial in whether scientific or theological aspect. Intriguingly, there was a contrast between the acceptance of the nebular hypothesis and of the plurality idea among the public. This difference made the former was almost neglected and the latter was prevalent in the curriculums.

Progress, or the 'science of progress' as Simon Schaffer calls, was a central debate among scientific elites in early Victorian Britain. Notions and narratives of progress diffused into various disciplines, especially in geology and

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98 Paley (1809), p. 378 and p. 404.

99 These numerals are quoted from Arnold, *op. cit.* (42), f. 460 and f. 470. The use of wonder in dimensions also appeared in Whewell's *Bridgewater Treatise*, in which Whewell used the comparison of a very large basin and very small marble pellets to describe the motion of the planets in the solar system. See Whewell (1839), pp. 152-153.

astronomy.[100] Recent geological findings of rock strata and fossils challenged the conventional Genesis story, and could provide an alternative scope for the progressive history of the Earth and life. In this alternative narrative, the Creation and the Flood seemed unable to fit the enormous time scale of the Earth. Geologists such as William Buckland were carefully handling such progressive issues, and tried to reconcile science and theological exegesis – the geology of progress is harmless to Christian belief; the story of progress could be divinely directed to 'prepare the earth to humans'.[101] The caution of geologists, many of whom were clerics, was not without reason. Progress and the corresponding cosmogony was a "consciously fashioned tool with distinct persuasive purposes".[102] The science of progress had been easily connected to the evolutionary debate, radical reformation and revolutions. This dangerous connection had been invoked long before the anonymous publication of Robert Chambers's *Vestiges* (1844), or Charles Darwin's *Origin of Species* (1859). For the proponents of progress, the image of universal progressive development reflected not only on the Earth but also in human society; the science of progress justly endorsed their visions by the rock formations and the celestial nebulae.[103]

In the circle of astronomy, the nebular hypothesis was in the central place of this progressive debate. Although its root can be traced to Kant, Laplace and William Herschel, the term 'nebular hypothesis' had not been coined until

[100] Schaffer (1989); Secord (2000), pp. 56-61.

[101] Secord, *ibid.*, p.57 and the bibliography listed in n. 39; see also O'Connor (2007).

[102] Quoted from Schaffer (1989), p. 134.

[103] Ruse (2010) offers a concise introduction on the history of evolution and the idea of social progress.

Whewell's *Bridgewater Treatise*.[104] The nebular hypothesis proposed a scenario of the origin of the Solar System. It started with a mass of gaseous nebula. Through the action of the natural laws, this condensing and rotating nebula contracted, and the matter precipitated into separate rings. These rings of matter eventually made the Sun and planets. Whewell described this hypothesis in his *Bridgewater Treatise* on astronomy and general physics in 1833. As those geologists' efforts to accommodate science and religion, Whewell interpreted the hypothesis as a divine cause and effectively refused to countenance the dangerous materialism associated with Laplacian cosmogony. "Leaving then to other persons and to future ages, to decide upon the scientific merits of the nebular hypothesis, we conceive that the final fate of this opinion can not, in sound reason, affect at all the view which we have been endeavouring to illustrate; – the view of the universe as the work of a wise and good Creator." Whewell concluded:

> If we establish by physical proofs, that the first fact which can be traced in the history of the world, is that "there was light;" we shall still be led, even by our natural reason, to suppose that before this could occur, "God said, that there be light."[105]

Whewell's *Bridgewater Treatise* brought the nebular hypothesis into the sight of popular readership, yet it was another work by an author with the contrary point of view to make the nebular hypothesis noticeable. John Pringle Nichol (1804-1859), a Scottish astronomer and political economist, published his

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[104] Schaffer (1989) provides a remarkable analysis on the nebular hypothesis, especially focuses on its development in the early Victorian era. See also Ogilvie (1975); Numbers (1977); Brush (1987). For an account from a scientist's point of view, Woolfson (1993) has a neat historiography on the origin and evolution of the solar system.

[105] Whewell (1839), p. 191. See also Secord (2000), pp. 57-60.

popular book *Views of Architecture of the Heavens* in 1837, in which he strongly promoted the nebular hypothesis. Nichol had radical background: before he gained the professorship of astronomy at the University of Glasgow, he worked as a journalist in writing on political economy for several liberal or radical magazines. Nichol's radicalism stands dominated his career, whether in science or in education. His enthusiasm for the science of progress clearly declared in the *Architecture*. Nichol claimed:

> Suppose we are yet mistaken; suppose the Nebular Hypothesis, with all its grasp, not to be the true key to the mystery of the origin and destinies of things, what is gained – what new possession – by that course of bold conjecture on which we have ventured to embark? This, at least, is established on grounds not to be removed. In the vast Heavens, as well as among phenomena around us, all things are in a state of change and PROGRESS:[106]

In addition to being a popular author, Nichol was also a successful lecturer. He propagated the nebular hypothesis through his lecturing. Nichol had delivered courses on astronomy in the Royal Manchester Institution for several times; the syllabuses of the courses in October 1850, September 1851 and April 1858, were preserved in the Manchester Archives (Fig. 4.6).[107] The nebular hypothesis, or the science of progress, was a significant subject in Nichol's lectures, such as the titles "Speculations concerning the Origin of the Solar System" and "Relation of Astronomical with Geological Epochs.—Sketches of the Evolution of the Earth". Nichol would not miss any chance of lecturing when he traveled to the metropolis. For example, the managing committee of

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[106] Nichol (1839), p. 210. See also Secord, *ibid.* For the career and radical background of Nichol, see Schaffer (1989), pp. 144-153.

[107] MA: M6/1/70/104; M6/1/71/9; M6/1/71/71.

the Whittington Club and Metropolitan Athenaeum "have much pleasure in announcing that J. P. NICHOL […] has acceded to their request to deliver an Illustrative Course of Six Lectures ON THE PHYSICAL STRUCTURE OF THE SOLAR SYSTEM, during a short business visit to London."[108] Nichol's influence even spread across the Atlantic: he lectured in the eastern United States between 1847 and 1848, and Edgar Allan Poe was among the audience at New York.[109]

Despite the heated debate about the nebular hypothesis among scientific elites, this subject was absent in the curriculum of many popular lectures except for Nichol's. The nebular hypothesis never appeared, or at least not occupied a noticeable place, in D. F. Walker's, C. H. Adams's and John Wallis's syllabuses. It seems that these lecturers were content to show the Solar System present, rather than the Solar System past. Perhaps this was due to the uncertainty and their wish to avoid the controversy generated by the nebular hypothesis. For a popular lecture aimed to a broad audience including children and parents, controversial issues like the nebular hypothesis were inappropriate and unnecessary. Newton's physical laws had been concrete and stable; the wonders of the heavens were already absorbing enough. Why bother to touch an uncertain hot potato?[110] Besides, many astronomical showmen, if not a working astronomer or natural philosopher, relied on the published works of

[108] *The Athenæum* (24 March 1849), p. 289.

[109] Numbers (1977), p. 36; Schaffer (1989), p. 145.

[110] Here is another analogy: in today's cosmology, dark matter and dark energy are hot topics concerning the expansion of the universe. Although accepted by the mainstream, the existence of dark matter lacks direct evidence of observations, whilst dark energy is merely the most accepted hypothesis. Debates in edging researches of dark matter and dark energy might be heated, but relevant topics do not necessary appear in a college-level course of astronomy and physics.

authoritative men of science. These lecturers might be more familiar with traditional sources such as Ferguson's *Astronomy* rather than controversial new accounts lacking the consensus in the mainstream.

John Herschel, the grand seigneur in British astronomy and the leading man of science in early Victorian Britain, represented the reserved attitude of the mainstream astronomy towards the nebular hypothesis. In the presidential address to the BAAS at Cambridge in 1845, Herschel spoke gingerly about the nebular hypothesis.[111] On the one hand Herschel acknowledged this idea of Laplace that "it is impossible to deny the ingenuity", but on the other hand he pointed out that the theory still lacked acceptable evidence from observation. "If, therefore, we go on to push its application to that extent, we clearly theorize in advance of all inductive observation." He asserted:

> I am by no means disposed to quarrel with the nebulous hypothesis even in this form, as a matter of pure speculation, and without any reference to final causes; but if it is to be regarded as a demonstrated truth, or as receiving the smallest support from any observed numerical relations which actually hold good among the elements of the planetary orbits, I beg leave to demur. Assuredly it receives no support from observation of the effects of sidereal aggregation, as exemplified in the formation of globular and elliptic clusters, supposing *them* to have resulted from such aggregation.[112]

Because of this cautious view, Herschel did not like Nichol's *Architecture* and

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[111] Herschel (1846). The rise of the nebular hypothesis to some extent benefited from the advance of telescopic technology, which was contributed by astronomers like William Herschel and Lord Rosse. John Herschel defended the newborn nebular astronomy constructed by his father, and distinguished his father's cosmology from the then inflated nebular hypothesis. See also Schaffer (1989) and Hoskin (1987).

[112] Herschel, *ibid.*, p. xxxviii.

privately condemned it as a sensational potboiler.[113] For Herschel, as a fellow astronomer, Nichol was out of bounds. Similar criticism was also held by John Wallis. Although Wallis had not referred to the nebular hypothesis in his lecture syllabuses, he wrote a pamphlet to attack it in the same year when Herschel delivered the BAAS presidential address at Cambridge.[114]

Compared to the troubles caused by the nebular hypothesis, another controversial issue of extraterrestrial life seems to be less problematic. Debates on the existence of extraterrestrial life were highly associated with the assumption of the plurality of worlds, which provided grounds for extraterrestrial beings – especially humanoid intelligence – to stand on. Neither of the two ideas was fresh. Similar arguments had already appeared since the ancient Greeks and shown in different eras and regions; for example, Johannes Kepler (1571-1630), Christaan Huygens (1629-1695) and Bernard Le Bovier de Fontenelle (1657-1757), had elaborated the notion in their works. Copernicus's heliocentric cosmology, along with many later astronomical discoveries, was an important factor to increase such a corresponding enthusiasm for a fully populated universe. By the mid eighteenth century, heliocentrism had essentially accepted by the public, and many intellectuals had adopted the idea of a plurality of inhabited worlds.[115] Edward Young's

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113 Secord (2000), p 60.

114 Wallis (1845). Aside from the nebular hypothesis, Wallis's pamphlet and Herschel's BAAS address were also in response to the infamous bestseller *Vestiges*, which was published a year before. See Secord, *ibid.*, pp. 406-407, 450-451.

115 Crowe (2001), p. 211. Many scholarly works are on the background and history of extraterrestrial life debates covering different eras, which includes Dick (1982) and Crowe (1986; 2001). Ruse, ed. (2001) had a concise introduction on the plurality of worlds debate, focusing on the context of William Whewell. Guthke (2003) emphasises secular philosophical concerns rather than theological contexts.

Night-Thoughts was an example to show such the influence, in which a few lines reflected this idea.[116] In nineteenth-century Britain, the eminent Scottish clergyman Thomas Chalmers (1780-1847) was a significant proponent of inhabited extraterrestrial worlds. Chalmers delivered a series of electrifying sermons on astronomy at Glasgow in 1815, of which plurality was one of the topics. He subsequently published *Discourse*, a book based on his sermons in 1817. Chalmers's book was an instant bestseller, which reprinted to the tenth edition within the next five years.[117]

Although the idea of the plurality of worlds could threaten Christian beliefs, it did not disturb the religious communities so much as the problems caused by the science of progress. There was no general consensus on this matter among Christianity. On the one hand, to reject the plurality notion would suggest an unacceptable waste of God's creative abilities; on the other hand, to accept the plurality idea would hinder the unique status of humans as God's favourite child, and even foster the idea of progress. In Scotland, the Presbyterian church much tended to embrace the idea of a plurality of inhabited worlds, since this notion could underline God's omnipotence as well as the insignificance of humans. It stresses the salvation through God's unearned grace, and the wonder that God would care for such insignificant beings as we humans.[118] As a Presbyterian minister and the leader of the later Free Church of Scotland,

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[116] For example, "Tell me, ye stars! ye planets! tell me, all/Ye starr'd, and planeted, inhabitants! what is it?", *Night-Thoughts*, Night IX, lines 778-779, Gilfillan (1853).

[117] Ruse, ed. (2001), p. 6. The full title of Chalmers's book is *A Series of Discourses on Christian Revelation, Viewed in Connection with the Modern Astronomy*.

[118] Ruse, ed. *ibid.*, pp. 6-7.

Chalmers and his *Discourses* was a representative case of this thought. In contrast, the Anglicans were not so certain of the plurality of worlds. The most influential opponent was William Whewell. Initially, Whewell was open to the plurality issue, and agreed such a possibility in his *Bridgewater Treatise* in 1833; however, his position changed radically afterwards. In 1853 Whewell wrote a volume *Of the Plurality of Worlds: An Essay* to refute plurality theorists including Chalmers. He severely disputed the plurality idea and the existence of extraterrestrial intelligence by making scientific and theological arguments. Whewell's essay attracted widespread criticisms, of which the strongest attack was from David Brewster. The criticisms included the voice from within Anglican community: Baden Powell, whose position was more liberal, disagreed with Whewell's extremist defence of the uniqueness of humans.[119]

The prevalence of the plurality idea among the public was also evident in popular astronomical lectures. Unlike the lack of the nebular hypothesis in most syllabuses, the subject or the narrative of inhabited extraterrestrial worlds was common in the nineteenth century. This 'tradition' could be traced to James Ferguson, who expressed the sentiment of plurality in his *Astronomy*.[120] Judging by the profound and lasting influence of Ferguson on astronomical lecturing, it is fair to suggest that later lecturers inherited such narratives from his works. Before Chalmers sensationally preached at Glasgow in 1815, William Walker had already included the plurality subject in his astronomical lectures in the late eighteenth century. "[W]hen we launch in idea into infinite

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119 Ruse, ed. *ibid*., pp. 11-23. See also Brooke (1977).

120 Crowe (2001), p. 220.

space, and contemplate the systems without number that fill it," Walker started with a holy hint: "here indeed we have a subject truly worthy of the DEITY!" He then deduced the immensity of the universe from the vast amount of stars, and finally reached the argument:

> The Sun's light could not therefore reach the fixed stars, and be reflected back again with their lustre; of course, then they shine by their own light; if so, they shine as our Sun, and consequently are Suns themselves. Now as a principle of uniformity runs through the variety of nature, it is reasonable to conclude these Suns to be centres of system like ours; and destined for the same noble purpose, viz. that of giving light, heat, and vegetation, to various worlds that revolve round them, but which are too remote for discovery, even with our best telescope![121]

This argument was elaborated right before the fifth scene of Walker's programme, in which the construction of the universe – "the stars, disposed in constellations, and surrounded by concentric circles" – was shown. William Walker extolled this idea "is infinitely too large for the human mind; or indeed for that of any created being!" The same sentiment also appeared in Arnold and Bartley's lecture syllabus, in which the playwright quoted Ferguson's words as the conclusion: "Thousands of thousands of Suns, multiplied without end, and ranged all around us, at immense distances from each other, attended by ten thousand times ten thousand Worlds."[122] The same exact passage had already been repeatedly quoted (or copied) in many other popular astronomical publications between the late eighteenth and early nineteenth centuries. This

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[121] Walker (1824), p. 33. This is quoted from the last (31st) edition of Walker's book in 1824, in which the content was almost as the same as previous editions published in the late eighteenth century. For further information of Walker's book, see Section 5.3.

[122] Arnold, *op. cit*. (42), f. 493; Ferguson (1756), p. 6.

phenomenon just shows how far Ferguson's influence on popular astronomy prevailed for generations.

A later example of the plurality subject in popular astronomical lectures in the Victorian era was Ebenezer Henderson's *A Treatise on Astronomy* (1843). Ebenezer Henderson (1809-1879) was a fellow of the Royal Astronomical Society as well as a lecturer. A son of a clock maker, Henderson moved to astronomical lecturing from the artisan profession as his hero Ferguson (of whom Henderson collected biographical materials and wrote a biography when retired) had done.[123] The preface of *A Treatise on Astronomy* introduced this book's subjects "formed the basis of a course of Twelve Astronomical Lectures, delivered by the Author, in London, towards the close of the year 1835."[124] One chapter in this book dedicated to the plurality issue in particular. In this chapter, Henderson well summerised the arguments presented by many of his seniors, presumably Chalmers, to form a concise and neat essay for the promotion of the plurality idea.[125] His strategy for the reasoning started with the nature of stars; then he turned to the other planets, to explain the moons of Jupiter and Saturn "can be of no use to the inhabitants of our earth." He then connected the analogy of satellites to the nature of stars, and asked: "Of what use to the Earth are those unseen colours, those periodical changes, those rotations? It would be presumptuous to imagine that such were ushered into existence merely for service to our Earth. […] They must, therefore, have been created for a higher, for a far noble purpose than for the use of the Earth." After

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123 For a brief introduction of Henderson's life, see King (1978), pp. 338-339.

124 Henderson (1843), p. v.

125 *Ibid*., 'On A Plurality of Worlds', pp. 106-112.

all the necessary astronomical facts and analogy were deployed, the conclusion seemed to be crystal clear:

> The great probability is, that every star is a SUN far surpassing *ours* in magnitude and splendour; they all shine by their own *native light*; they do not borrow their light from any body whatever. What a most powerful Sun that apparently little star Vega must be, when it is 53,977 times larger than our Sun! Our Sun, if removed to the distance of about two billions of miles, would appear far less in magnitude than the star Vega. The stars *being thus supposed to be* SUNS, *it is extremely probable that they are the centres* of OTHER SYSTEMS OF WORLDS, round which may revolve a numerous retinue of planets and satellites. Therefore there must be a *plurality of Suns* – A PLURALITY OF WORLDS.[126]

Henderson continued to push this conclusion further. He used the analogy of the microbes to conduct the idea of extraterrestrial inhabitants:

> Man seems, as it were, placed midway between *the "little and the giant"* in creation. The telescopic display of the universe is too extended for his view – the microscopic scenes too minute even for his imagination! We find that matter almost everywhere is accompanied with existences. Then why not carry out the analogy to those immense bodies in the heavens, and suppose that they are inhabited by existences also, for they are material?[127]

To strengthen the plurality argument, Henderson even prepared biblical fortification for criticisms from religious people. He admitted that the Scriptures are "apparently silent on a plurality of worlds, but still they are not at variance with such a supposition." He argued "several remarkable passages which, when brought in connection with this subject, explain themselves with

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[126] *Ibid*., p. 107.

[127] *Ibid*., p. 109.

greater power of meaning”. After discussing a few biblical passages, Henderson concluded: “Reason, analogy, and the Scriptures furnish sufficient evidence to conclude that there is a plurality of worlds, and that they are inhabited by beings capable of appreciating the goodness, and *adoring* the wisdom, of the Creator.” Henderson’s essay could be seen as a typical account for the defense of the plurality idea in early Victorian Britain.

Chapter Conclusion

This chapter argues that the syllabuses of nineteenth-century popular astronomy lectures reflected a mixture of convention and novelty. Traditional topics related to Newtonian science in the previous century’s natural philosophy lectures still prevailed in the curriculums. This also reflected the prestigious status of Isaac Newton in Britain. Sensational astronomical phenomena, such as eclipses, were also captivating topics. Religious reflections, especially the rhetoric of natural theology, were a prominent theme in some lectures. References to the creation and design were usually used to evoke sublime religious sentiments or to prevent possible radical notions such as materialism and atheism from undermining religion and politics. The moral implication of religious devotion was hence a message of ‘safe’ and ‘adequate’ astronomy.

Two major controversial theories of astronomy – the nebular hypothesis and the plurality of worlds – are also analysed. The nebular hypothesis was neglected by most lecturers, since its hint of progress was subversive and more dangerous. The plurality of worlds, in contrast, was less disputed and well received by more people. This distinction made the plurality idea more common in the curriculums. These choices of subjects all took audiences into consideration, whether aiming to attract spectators or by intending to provide suitable contents. The analysis of the curriculums also proves my main thesis of commercial and sublime features in nineteenth-century popular astronomy. Lecturers were responsive to the audiences' expectations; they also exploited the quality of sublimity – awe, wonder and reverence – in discourses.

Chapter 5 Apparatus

The material emphasis in the lecturing business was significant in the nineteenth century. Popular astronomy lecturers extensively used apparatus. Many of the apparatus on display were visual aids. This chapter will show the importance of apparatus in popular astronomy lecturing. Its roles included not only scientific education but also aesthetic and entertaining functions. Entrepreneurs in the market tried hard to blend science with amusement. During their course they introduced innovative techniques based on or derived from conventional devices, such as the vertical orrery and lantern slides. Such blending of science and amusement, however, was not totally effective for contemporaries.

This chapter will also demonstrate the disagreement about the purposes of the apparatus. The development of astronomical visual aids in the nineteenth century exemplified the disagreement between scientific elites and commercial entrepreneurs. The orrery, a type of apparatus for displaying the structure and planetary motion of the solar system (Fig. 1.3), was the epitome of such a disagreement. By comparing different attitudes towards the orrery, I argue, the consideration for priorities in the design of instruments demarcated scientific apparatus from techniques of amusement. Some contemporary experts voiced objections to the sacrifice of scientific accuracy caused by simplified and scenic representation. Moreover, dissatisfied experts drew a line of demarcation between authentic scientific instruments and entertaining devices for achieving scenic effects.[1] The writing of William Pearson on the

[1] A similar comparison refers to Golinski (1989) on the public demonstration of

transparent orrery in encyclopaedias, as I will show in Section 5.3, is the best example to reflect this demarcation. The orreries on display in the Great Exhibition of 1851 reflected a similar dispute over the commercial products of science. Scientific experts were disappointed at orreries in general since their manufacture lacked genuine innovative improvements. However, manufacturers had their own priorities other than scientific experts'. The disagreement was a result of different thinking on commercial, amusement or educational grounds. Either of the examples above reflected a transformation of science to appeal to the mass culture in the nineteenth century, as indicated in Chapter 1.

Mechanical visual aids invented in the previous century for the demonstration of planetary motion, such as orreries and lunariums (for showing the rotation of the moon), were continuously used in lecture theatres and domestic environments during this period.[2] Aside from mechanical apparatus, the application of optical devices including the magic lantern (image projectors) and photography was developing – eventually their prevalence would surpass mechanical visual aids by the early twentieth century. Nevertheless, both mechanical and optical devices were favoured by lecturers in the long nineteenth century. In this chapter I will focus on the mechanical visual aids, especially the large transparent orrery which was popular during this period yet are obscure to modern historians. There is much scholarship on the development and the use of optical devices in the nineteenth century. For

phosphorescence in the early Royal Society. The spectacle of phosphorescence was a wonderful device to extend the appeal of new experimental philosophy. However, fellows including Robert Boyle had concerned potential confusion between the performance of a philosopher and those of a conjuror.

2 King (1978) has substantial surveys on the history of orreries and planetariums.

example, the Magic Lantern Society has published a series of works on this subject and promotes outreach activities; some researches also cover the application of lantern slides in popular astronomy.[3] Therefore, in my study I will stress the mechanical apparatus rather than repeating the focus on optical devices. I will pay further attention to large mechanical devices used on the stage. Institutional lectures, such as the Royal Institution's, certainly used visual aids as well. The physical dimensions of the apparatus demonstrated in institutions were usually not comparable to the scale of its theatrical siblings.[4] This institutional part, however, will be discussed less in this chapter.

I arrange the structure of this chapter as follows: In Section 5.1, I will give an overview of the tradition of the object emphasis, i.e. 'material culture', in public scientific lectures. This overview puts astronomical lecturing into the context of the development of visualisation of science. Orreries are my focus in this chapter, so it is necessary to describe the status of this class of instruments in nineteenth-century Britain. Section 5.2 therefore uses the Great Exhibition of 1851 as the entry to the situation of the nineteenth century. Section 5.3 and Section 5.4 will elaborate the unsolved nature of the transparent orrery, and the contemporary dispute over its merits. Section 5.4 will also show the extensive use of scenic transparencies in astronomical lectures.

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[3] For instance, Butterworth (2005) discusses Robert Ball's use of lantern slides in popular lectures, which was from the Magic Lantern Society publication *Realms of Light: Uses and Perceptions of the Magic Lantern from the 17th to the 21st Century* (London, 2005), edited by Richard Crangle, Mervyn Heard and Ine van Dooren. See also the society website: http://www.magiclantern.org.uk/index.php (accessed 3 August 2014)

[4] Nevertheless, the apparatus used in some spectacle-oriented institutions could be more magnificent. Morus (2007) describes the performance of the optical and electrical apparatus in the Royal Polytechnic Institution.

5.1 Material Culture of Public Lecturing

As indicated in Chapter 1, the astronomy lecturing trade had its own continuity between the eighteenth and nineteenth centuries. It is essential to trace the roots of the material culture in nineteenth-century popular astronomy back to the previous century. The development of eighteenth-century public lectures on natural philosophy had been tightly interwoven with the instrument-making trade. Philosophical instruments such as air-pumps, barometers and thermometers, were frequently used by lecturers to demonstrate experiments. Lecturers would engage in the instrument trade; on the other hand, master craftsmen would deliver discourses. Lecturing and the instrument trade hence formed a close-knit community, and sometimes these two ventures were even synonymous.[5]

It is evident that eighteenth-century lecturers placed great emphasis on this object orientation. In advertisements and publications, lecturers often stressed that the apparatus on display in their course was the most improved or sophisticated. When the itinerant lecturer William Griffis gave a course in Derby in 1743, the local newspaper prominently advertised the fancy equipment travelling with him, which included "a curious Air Gun, a Planetarium, a Cometarium, a Ptolemaic Sphere, and an improv'd Orrery, Tellescopes and Microscopes of all sorts". This "Celebrated Philosophic Apparatus" was sold to another itinerant lecturer, Adam Walker, later in 1766.[6]

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5 Scholarship covering the relationship between instrument trade and natural philosophy lecturing in eighteenth-century Britain includes Millburn (1973); Walters (1992); Morton and Wess (1993); Elliott (2000; 2009). For production and commerce of scientific instruments, see Bennett (2006) and Morrison-Low (2007).

6 Elliott (2000), p. 88.

A fine instrument collection was a stepping stone to the lecturing trade. Apparatus was a crucial investment for natural philosophy lecturers; it was not only indispensible to the curriculum but also a most obvious trademark to demonstrate a lecturer's profession.

Nineteenth-century popular astronomy inherited this material emphasis from the previous century's public demonstrations. It is not surprising: many astronomical lecturers, such as the Walkers, rose from the traditional natural philosophy lecturing trade. The curriculum in astronomy discourses, as shown in the previous chapter, was largely influenced by, or even borrowed from, the conventional subjects related to Newtonian science. Nevertheless, there was still variation. The theatrical turn in popular astronomy, which I have elaborated in this thesis, encouraged lecturers to move into theatres and hence enlarged their apparatus. The 'new' material culture of astronomy lecturing in this century laid particular stress of visual effects – scenic representations and the quality of amusement were more obvious than ever.

This material emphasis on the technique for visualisation in the nineteenth century, in fact, was not only in astronomy lecturing. In various disciplines from anatomy to chemistry, there were many examples of lectures in which the exhibition of objects occupied a central role on the syllabus. Scholarship on nineteenth-century popular science pays much attention to its visual culture. Naturalistic illustrations of human bodies were shown in anatomy textbooks and manuals; wax models of dissected organs and embryos were widely distributed as the replacement of unique specimens. These visual displays served as tools to teach medical students.[7] In many publications on natural history, plates of plants, animals and fossils were deemed more effective than thousands of words to stimulate their readers' interest, especially for laymen and amateur naturalists. When William Buckland lectured in the old Ashmolean Museum at Oxford, he was surrounded by maps of strata and specimen of fossils, including a skull of an ichthyosaur and large ammonites. The visual aids Buckland used in his geology lectures have been identified as the chief means of opening "an amazing field to imagination".[8] Later on, the full-scale models of dinosaurs in the Crystal Palace Park represented the attempt to transform scientific displays into amusements with astonishing visual effects.[9] Lectures on chemistry were also full of sensational visual effects. In some spectacles, such as Henry Noad's lectures on electricity and similar shows at the Polytechnic Institution, giant novel apparatus like the Hydro-electric Machine and the Great Induction Coil were built to make sparks and shock.[10]

5.2 Orreries in the Crystal Palace

The Great Exhibition of 1851 is a good starting point for modern readers to explore Victorian material culture and the significance of instruments in

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[7] The eminent cases of anatomy displays in late-eighteenth and early-nineteenth centuries Britain were from anatomists John Bell, Charles Bell, John Hunter and William Hunter. In Florence, Felice Fontana organised an abundant collection of live-size anatomical models. In the realm of embryology, the modelling of the Ziegler studio in Germany had a significant role after the mid-nineteenth century. See Berkowitz (2013); Mazzolini (2004); Hopwood (2004).

[8] O'Connor (2007), pp. 75-85, wherein Buckland's lecturing scene see fig. 2.1. For the use of visual aids in botany, see also Anne Secord (2002).

[9] Secord (2004b).

[10] Morus (1993; 2007).

contemporary scientific education. It was an unprecedented sensation in any aspect: all sorts of arts and crafts along with industrial manufacturing in the world were gathered inside one magnificent purpose-built glass architecture. No better opportunity could allow a visitor to glance the epitome of human civilizations and industries in one single occasion. Thus the Great Exhibition is convenient for us to find some finest examples of the apparatus used by contemporary astronomy popularisers. Besides, there has been much literature on this sensational event whether primary sources or secondary scholarship.[11] The abundance of the literature provides us a great advantage to see the vivid historical context behind those objects in the exhibition.

Opening at Hyde Park from 1st May to 11th October 1851, the Great Exhibition presented a memorable summer to Londoners. Over four million visitors, of which 58,427 were foreigners, arrived in Britain's capital during this period; these amounts were 50 and 276 percents of increase respectively than the same period in the preceding year. This number of visitors to London was up to one-fifth of the population of Great Britain. Eventually the total number of admissions to the exhibition during the run was over six million, which included repeated visits by season ticket holders.[12] This was the first international fair to exhibit 'the Works of Industry of All Nations' – its official title – on such a large scale. Along with the United Kingdom and its overseas

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[11] For the secondary sources of the Great Exhibition in this section, I mainly refer to Altick (1978), especially pp. 456-460; Auerbach (1999); Bellon (2007); Cantor (2011). Geoffrey Cantor recently edited four volumes of the primary sources containing select correspondence, diaries, periodicals and cartoons about the Great Exhibition, see Cantor, ed. (2013).

[12] Altick (1978), p. 457 and p. 460, in which he quotes from the *Official Catalogue of the Great Exhibition* (1851), supplementary volume, pp. 112-113. See also Auerbach (1999), p. 137.

colonies, over thirty foreign states attended the Great Exhibition, having either manufacturer delegates or local goods and raw materials to 'represent' the nation.[13] During the summer, newspapers and magazines directed their focus on the Crystal Palace, the magnificent glass-and-iron home of the exhibition. This fever prolonged, and the 'void' after its closure even haunted. "At last the fact has become history." One essay in the *Illustrated London News* described the exhibition as "The one great sight of London, of England, of Europe, towards which every eye was turned, and which formed the one monster topic of discussion and admiration, overshadowing and dwarfing all others;" however, this great spectacle "but a week ago existing, flourishing, a part, as it were, of our daily lives and thoughts and sensations, is over and passed, a thing of memory, a vision to be mentally recalled." The reporter admitted: "The blank is curiously great."[14] If London represented the capital of the world during that short summer, the Crystal Palace was the congress gathering the wealth of nations.

On the eve of the closure of the Great Exhibition, the *Standard*, a London newspaper, reviewed the exhibits and urged its readers to grab the last chance to witness this wonderful spectacle. The *Standard* used several passages from *The Lily and the Bee: an Apologue of the Crystal Palace of 1851*, the latest publication of the writer Samuel Warren (1807-1877), to introduce the leading

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[13] Some countries listed in the *Official Catalogue*, such as China, did not send official representatives to the exhibition. However, Chinese articles and teas imported by Western collectors or traders were in exhibit. Another example is Society Islands: there were a few pieces of bead-dresses and clothes made by aboriginal women from this South Pacific archipelago in the exhibition.

[14] 'Town Talk and Table Talk', *Illustrated London News* (18 October 1851), p. 491.

objects "so philosophically and poetically illustrated" in the book.[15] One of the objects of interest was the Vertical Orrery on the southern side of the organ in the western nave. In the book, Warren told an imaginary narrative of the Orrery – a 'ghost story' like his contemporary Charles Dickens depicted in the popular novella *A Christmas Carol* (1843) – and the journalist of the *Standard* apparently enjoyed this story, hence including it in the review:

> Two children, says the author, were standing opposite this Orrery, in the daytime, "merrily telling each other how the planets went round the sun," and even their times and distances the urchins knew – but of the wasting thought, and which, of sleepless centuries, to tell them what they told so trippingly, "recked they nought." At midnight were seen standing before the Orrery, the "sorely amazed ghosts" of the ancient astronomers; seeing it subvert all their own systems – those "of Chaldean and Egyptian sage, and Greek philosopher," and "melting their ancient wisdom into air." Presently Newton, a radiant spirit, is seen explaining to the ancient astronomers the prodigious discoveries of modern astronomy, at the same time paying a majestic homage to revelation.[16]

Though full of imaginations, this ghost story was not as sombre as Dickens's tale and its representation was much closer to Raphael's fresco *The School of Athens*. In the writing, Warren used rhetorical skills of contrast: the same spot at day and midnight; the living and ghosts; children and philosophers. On the one hand, the dissemination of modern astronomical knowledge was so

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[15] *The Standard* (3 October 1851). Samuel Warren was a lawyer and a best-selling author of both fictions and non-fictions. *The Lily and the Bee* (1851) was a creative work inspired by the Great Exhibition in which the author continued to explore philosophical and religious issues which had appeared in his previous books.

[16] *The Standard*, *ibid*. Along with the ghosts of ancient astronomers, the spirits who turn up at midnight include Pythagoras, Ptolemy, Copernicus, Galileo, Kepler and Descartes. See Warren (1851), pp. 140-155.

successful that even the 'urchins' knew the distances and orbits of planets; on the other hand, the correct system the children babbled was easily taken for granted and Warren lamented that they did not appreciate the efforts behind it. This passage also reflected the sublimity of Isaac Newton and the religious meaning behind the cosmology. As many other accounts had asserted, the English national hero was admired by the contemporaries. By speaking loud the correct system and paying homage to the Deity, the spirit of Newton ought to shine out and eclipse other spirits.

Neither Warren nor the *Standard* journalist explicitly indicated the information of the Vertical Orrery they referred to. The best way to find out what the orrery was is to crosscheck the records of the exhibiting articles. A popular source is *Tallis's History and Description of the Crystal Palace* (1852). First published in the year following the Great Exhibition, this extensively illustrative three-volume compendium had established itself as a definitive reference work for contemporary readers. The thirty-third chapter of this compendium is on astronomical and geographical instruments exhibited, as its title "Telescopes, Orreries, Globes, and Model Mapping. – *From the Juries' Report*" designates. This chapter's speciality is that it referred to the reports by the official jury of the Exhibition. The organisers of the Crystal Palace classified all the exhibiting articles into thirty categories, which were called 'classes'. Orreries and other astronomical apparatus belonged to the class of philosophical instruments. The jurors of this class included several prestigious British men of science such as David Brewster and John Herschel; except for British delegates, there were jurors from foreign countries, including Swiss physicist Jean-Daniel Colladon (1802-1893) and French astronomer

Claude-Louis Mathieu (1783-1875).[17] These jurors were competent choices from different subjects of studies or technical professions.

So, what comments about the exhibits of ‘orreries, planetariums, and astronomical machines’ did the jury make? Sadly the jury was not impressed with the general result. It felt that the time and ingenuity which were devoted to the several machines of this class “had not been better directed”, since the instruments on display “did not indicate any improvement over the many which had been constructed”. However, one exception among the kind was “a vertical orrery of large dimensions, made by a working man, after his own design”.[18] This vertical orrery was the invention of a Mr Facey, who, “by becoming a member of Temperance Society, felt it necessary to do something to fill up the vacancy of his idle hours. Accordingly, he was led to the study of astronomy, and this was the result of his labour and ingenuity.”[19] The description of Facey’s Orrery in Tallis’s book was:

> This ingenious piece of mechanism was designed to assist students of astronomy, and was nine feet in diameter. It represented the principal bodies in the solar system, and showed all the planets and other attendant satellites revolving round the sun in their proper order. To effect this in the machine, it was necessary to employ no fewer than 194 accurately adjusted wheels to other apparatus fitted

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[17] This class was Class X., entitled “Philosophical Instruments and Processes depending upon their use; Musical, Horological, and Surgical Instruments”. For the full list of the classes and juries, see *Reports by the Juries* (1852).

[18] Tallis, ed., *Tallis’s History and Description of the Crystal Palace, and the Exhibition of the Worlds Industry in 1851* (1852), vol. 2, p. 245.

[19] *Ibid*., p. 149. The name of this working man in the *Official Catalogue* and the *Reports by the Juries* was registered as ‘Facy’ rather than ‘Facey’; it is not clear if Tallis’s book made misspelling. According to the *Official Catalogue*, this R. Facy was living at Wapping Wall in the East Ends of London, whose article number was 195. See *Official Catalogue*, p. 66.

> up on a new principle. In the limited space within which the exemplifications were confined, it was of course, impossible to show either the comparative sizes or distances of the heavenly bodies. The orrery, however, gave a general idea of the relative positions and revolutions of the planets and satellites, whilst a gentleman attended and gave a description of some particulars relating to them.[20]

The jury voted a Prize Medal to Mr Facey for “the ingenuity displayed by him in the construction of this orrery.”[21] The excellence of Facey’s Orrery, however, lay perhaps in its ‘moral’ inspiration rather than its physical quality. Mr Facey was a perfect example of a working man who converted from a drinker wasting talent with bad hobbies to an industrious person learning beneficial knowledge. Plus, the ingenuity of Mr Facey deserved to be awarded, since it is understood that he “without ever having seen an orrery of any kind.”[22] The whole story suited Victorian morals of personal improvement and making social good. Facey’s Orrery was the epitome of this didactic function served by astronomy.

Facey’s Orrery was the only large-size vertical orrery registered in the Crystal Palace, so it was likely the apparatus Warren and the *Standard* referred to. Its size (9 feet in diameter) made this vertical orrery suitable for displaying in a lecture-room to a large group of children and novices. Nevertheless, Facey’s Orrery was not the only exhibit with similar demonstration purposes. There were over ten other orreries and planetariums in the Great Exhibition. For example, F. Plant of Nottingham exhibited an orrery with the Sun was represented in it by a luminous body; the jury commented that it would be used

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[20] Tallis, ed., *ibid*., pp. 148-149.

[21] *Reports by the Juries* (1852), p. 307.

[22] Tallis, ed. (1852), vol. 2, p. 245.

to the great advantage in a darkened room to demonstrate the seasons, phases of the Moon and other natural occurrences. Newton and Son, a famous firm of globe-makers based at Chancery Lane and Fleet Street, London, also exhibited a planetarium for educational purposes (Fig. 5.1). The selling point of Newton and Son's planetarium was its affordable price. Some manufacturers were from overseas dependencies or foreign countries: Le Feuvre of Channel Islands presented an orrery designed for the use of schools; Masset of Switzerland exhibited a planetarium with extremely simple construction and remarkable cheapness, which received an Honourable Mention from the jury.[23] These articles were not as large as Facey's one; most of them did not exceed 20 inches in diameter and were probably designed to be put on the table.

The unimpressive reception the jury gave for the orreries on display in the Crystal Palace is not surprising. Orrery-making had been a mature trade in the early nineteenth century, but the layout of the products had not continued to be refined. Historian Henry King pointed out that most of the established London orrery-makers in the nineteenth century were content to adopt the basic design of the Jones-type models. This design was derived from the portable orrery invented by Benjamin Martin in the mid-eighteenth century and then refined in the hands of other instrument-makers such as George Adams and W. and S. Jones. Jones-type orreries were simple and easy for manufacturing; they had been popular among customers since their introduction in 1782 and there remained virtually no alteration until the 1850s.[24] King draws this conclusion

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[23] For more details about these exhibits, see Tallis, ed. (1852), vol. 2, p. 245; *Reports by the Juries* (1852), p. 307.

[24] King (1978), pp. 208-212. For Benjamin Martin's reform of portable orrery in the mid-eighteenth century, see Millburn (1973).

from the survey of later orreries made by other firms after W. and S. Jones: he finds that these products had little further improvements and the craftsmen only made a few changes of details, such as adding newly-discovered planets. King's conclusion accords with the criticism of the lack of innovation from the jury's report.

The jury had reasons to criticise; however, the craftsmen also had their own defence. The conventionality of the orrery-making in the early nineteenth century reflected a changing situation of the market. In the eighteenth century, artisans could expect rich patronage from aristocrats or the wealthy for constructing an exquisite clockwork machine. The process of production would be time-consuming and required extensive technique; therefore, it was usually the way for artisans to show their craftsmanship. Yet the time of delicate handicrafts had passed. The growing literate population from the middle or the working classes now became the majority of the customers. These new classes of patrons demanded learning essential scientific knowledge rather than collecting luxuries. For elementary teaching purposes, any overly ornamental or complex part of the apparatus was not necessary; scientific accuracy might also be sacrificed due to simplification. Customers needed cheap and robust products, thus the firms were content to copy a simple and affordable design which had been proved to be workable, like the Jones-type orreries.[25] The instrument-making trade was going through a transition from custom-made handicrafts to mass-produced manufacture. The orreries on display in the Crystal Palace therefore reflected different consideration from manufacturers and expert judges, who stood for commercial and scientific values respectively.

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[25] King, *ibid.*, p. 212.

5.3 Stage Machines: Astronomers are not Amused

Despite most established instrument-makers being satisfied with the basic design of the orrery, there were still a few cases to show further improvement of the orrery in the nineteenth century. Two of the most prominent figures were William Pearson (1767-1847) and John Fulton (1800-1853).[26] William Pearson was from a schoolmaster background with a particular interest in mechanical works. He was one of the original proprietors of the Royal Institution and built several planetary machines for use in large lecture halls, which occasions included Thomas Young's lectures indicated in Section 3.3. Later on, Pearson contributed to the foundation of the Astronomical Society of London (the future Royal Astronomical Society), and kept active in astronomical circles. Pearson publicly criticised the scientific inaccuracy of the contemporary orreries, and made several improved models himself. Pearson's planetary machines were notable for the sophistication and accuracy; for example, an extant orrery preserved in the Science Museum, London, can represent the actual mean motions of planets (Fig. 5.2).[27] A portrait of Pearson and his family (Fig. 5.3), in which he proudly pointed at his orrery, is hung on the wall of the fellows' common room in the RAS at Burlington House.

Compared to Pearson's established reputation within London scientific circles, John Fulton was from a humble background as a cobbler by trade in Fenwick, Scotland. Fulton's amateur fascination with astronomy led him to

[26] For more details of some outstanding nineteenth-century orreries, see King (1978), ch. 20, pp. 322-340. For William Pearson's biography, see also Gurman and Harratt (1994); A. M. Clerke, 'Pearson, William (1767-1847)', D. P. Miller, *ODNB* (2004).

[27] King, *ibid*, p. 334, fig. 20.8; SM: SCM-Astronomy: 1950-55.

construct orreries between 1823 and 1833; his plan was mainly influenced by Ferguson's books and some published articles of Pearson. The last of Fulton's constructions was an excellent large work: its height was 1.37 metres and the longest arm for Uranus was 1.32 metres.[28] The layout of Fulton's Orrery was an enlarged version of Pearson's mean-motion orrery. Fulton completed this orrery in 1833, and was invited to exhibit it around the country, from Glasgow, Edinburgh, Carlisle, Liverpool, Manchester, and eventually to London. This orrery is now preserved and on display at the Kelvingrove Art Gallery and Museum, Glasgow.[29]

These extant orreries are fabulous remains of the planetary machines' glorious past but are not the whole story. Perhaps the most intriguing yet mysterious kind was the large transparent orrery displayed on stage; in other words, those used by showmen like the Walkers, George Bartley and C. H. Adams.[30] This kind of planetary machine is also a great example to show the disagreement over the blending of science and amusement. The transparent orrery is intriguing because of its once popularity among the audience and the immense dimensions. Other large fellows in the orrery family, such as Fulton's Orrery (about 6 feet across) and the Crystal Palace's vertical one (9 feet across), were like dwarves compared to the transparent orrery. The Walkers' Eidouranion, the original as well as the most famous transparent orrery in the

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[28] King, *ibid.*, pp. 337-338.

[29] Kelvingrove Art Gallery and Museum, accession number: T.2002.9.

[30] The term 'the transparent orrery' was originally given by Adam Walker as a plainer alternative name of the 'Eidouranion'. Different lecturers might have a particular name to their own machinery. In this thesis I use this term to designate any onstage large vertical orrery of this kind. See also King (1978), ch. 19, pp. 309-321.

kind, underwent several expansions and eventually reached 27 feet in diameter by 1824.[31] The orrery used in George Bartley's lecture was 'a circle of one hundred and thirty feet', namely about 41 feet in diameter; hence the slogan "MAGNIFICIENT ORRERY of unparalleled extent" on the playbill matched the immense size of the machine.[32] The transparent orrery is also mysterious, because none of the machinery is known to survive – not any piece of the fragments. All the information we know about the transparent orrery is from textual descriptions and very few illustrations, wherein the mechanical details are not explicit. These gigantic spectacles were once popular in many British theatres and lecture halls during their golden age between the late-eighteenth and mid-nineteenth centuries, yet declined and vanished quickly afterwards. They were dinosaurs in the history of geared astronomical mechanism;[33] much worse, they don't even have fossils to be excavated.

As the original inventor and lecturers of the transparent orrery, the Walkers' account was the most important among a few descriptions of the apparatus. *An Account of the Eidouranion*, also entitled *An Epitome of Astronomy* in later editions, was published by the Walkers since about 1782 and reached the thirty-first edition in 1824.[34] Most of the editions appeared under the name of William Walker until the twenty-sixth edition in 1817 after William died and

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[31] Walker (1824); King, *ibid*., p. 313.

[32] RAS: Add MS 88: 7.

[33] The term 'geared astronomical mechanism' is suggested by Henry King, which encompasses two main groups: (1) planetary machines or three-dimensional models to represent planetary motions, such as planetariums and orreries; (2) astronomical clocks or clocks with dials to give astronomical information. See King (1978), p. xiii.

[34] Until the twelfth edition (1795) was still the old title *An Account of the Eidouranion*. The edition number continued despite the title and the lecturer changed. See also King, *ibid*., p. 311.

his youngest brother, Deane Franklin, took over the business. The father was much respected – all editions noticed the name of Adam Walker as the inventor in the title page. This account was a thin book consisting of around 40 pages in duodecimo or octavo, and usually contained a notice of the curriculum in the back matter. To publish syllabuses or monographs as a promotion was the common characteristic of eighteenth-century itinerant lecturers; such publications were often printed for and sold by the author. The sons of Adam Walker learned the tools of the trade from their father and kept this publishing habit in the career. *An Epitome of Astronomy* was a brief introduction of the Walkers' Eidouranion lecture including every scene within. However, even though it was the 'official' guide to the lecture, there were no explicit technical details of the transparent orrery.

According to the Walkers, the Eidouranion "is of a construction new and peculiar, and is designed to give a more natural and comprehensive view of the celestial phenomena than any mode hitherto attempted." D. F. Walker described the machine:

> This elaborate Machine is twenty feet high, and twenty-seven feet diameter: it stands vertically before the spectators; and its globes are so large, that they are distinctly seen in the most distant parts of a Theatre. Every Planet and Satellite seem suspended in space, without any support; performing their annual and diurnal revolutions without any apparent cause.[35]

Hence, the Walkers believed the machine "certainly approaches nearer to the magnificent simplicity of nature, and to its just proportions of magnitude and motion, than any Orrery yet made". Besides, the brothers highlighted the

[35] Walker (1824), p. 3. This quotation is from the last (31th) edition.

Eidouranion's instructive value with aesthetic appeal, claiming the machine "being a most brilliant and beautiful spectacle, conveys to the mind the most sublime instruction; rendering astronomical truths so plain and intelligible, that even those who have not so much as thought upon the subject, may acquire clear ideas of the laws, motions, appearances, eclipses, influences, &c. of the planetary system."[36] This aesthetic intention was obvious, for D. F. Walker even added a note to emphasise one scene: "N.B. The design of this painting was given by one of the first Royal ACADEMICIANS, and executed by one of the first Artists in London."[37] Because the Eidouranion was linked with many scenes in the Walkers' descriptions, perhaps the transparent orrery in its original design was a set of stage machinery rather than a single machine.

However, the scientific value of the transparent orrery was disputable among contemporaries. Such dispute would involve a judgement on the nature of the apparatus: Should the transparent orrery be regarded as a scientific instrument or a stage device for amusement?

One of the representative contemporaries who openly showed disapproval of the transparent orrery was William Pearson. As a specialist in astronomy and the mechanism of planetary machines, Pearson contributed much literature on this subject, including several long entries of 'Orrery', 'Planetarium' and 'Planetary Machines' in Abraham Rees's *Cyclopaedia* and 'Planetary Machines' in David Brewster's *Edinburgh Encyclopaedia*.[38] In these essays Pearson

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[36] *Ibid.*, p. 4.

[37] *Ibid.*, p. 6.

[38] Both works were representative encyclopaedias in early nineteenth-century Britain in which contained substantial scientific subjects. Rees's *Cyclopaedia* was published serialised between 1802 and 1820 in 39 volumes. Brewster's *Edinburgh*

explicitly described his own designs and was very critical of other orreries, whether made by British or Continental makers; old or the latest constructions. Despite Pearson using numerous pages to introduce every case worthy of notice, he almost neglected the transparent orrery at all. There were only a few sentences in these encyclopaedia articles to simply explain the reason of such exclusion. In the *Cyclopaedia*, Pearson wrote: "[…] and with respect to the pendulous orrery of Rittenhouse in Philadelphia, and to that lately exhibited at the Pantheon, London, as well as to Mr. Walker's eidouranion, and Mr. Lloyd's dioastrodoxon, we consider these not as objects of close examination, but as conveying only general information by a scenic effect, not depending on the accuracy of the wheelwork, and therefore not claiming our minute attention."[39] In the *Edinburgh Encyclopaedia*, he justified his choice further:

> […] we presume we shall render a more acceptable service to the public, than if we attached greater importance to more expensive, but less instructive pieces of mechanism, that have survived the estimation in which they were originally held. Of course we do not wish to bring into disrepute those scenic representations of the heavenly bodies, which are produced by moving transparencies, of any description, for the amusement rather than the instruction of a wondering audience; but our aim is to present to our readers, whom we must consider as composing the scientific class of British inhabitants, an account of machinery equally calculated to amuse the learned, and to instruct the learner.[40]

Pearson regarded the theatrical scenic representations of the celestial objects as mere amusement rather than instruction; he despised the transparent orrery for

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Encyclopaedia was published serialised between 1808 and 1830 in 18 volumes.

[39] Pearson (1819).

[40] Pearson (1830), p. 626.

their failings as scientifically accurate performances. Considering the editor of the *Edinburgh Encyclopaedia* was David Brewster, this negative opinion on the transparent orrery was likely not be odd among men of science. John Herschel had also mentioned orreries as “those very childish toys” in *A Treatise on Astronomy* (1833), though his criticism was perhaps about orreries in general rather than the large vertical ones in particular. Herschel criticised that to get correct notions of the scale of the solar system through orreries is “out of the question.”[41] The transparent orrery could not satisfy those learned minds from the circle of specialists. The apparatus which many lecturers worked hard to advertise and used to attract the audiences was the one Pearson tried to repel from the territory of planetary machines.

The inaccuracy of the transparent orrery was an innate defect. Critics in the eighteenth century had already showed the fault of the orrery, such as the circular planetary orbits and the wrong scale of the system. It was a model to demonstrate the cosmological idea of the entire system rather than a realistic representation of each detail. Many instrument-makers had made alterations to remedy the defects. For example, eighteenth-century lecturers had used a device called the cometarium to display the elongated orbit of a comet. Pearson’s mean-motion orrery was another example to push the mechanism more realistic. For those enlarged versions of the orrery, the problem increased as well: to build an accurate geared wheelwork in such large dimensions was difficult. Even if the mechanism was feasible, the cost in finance, time and technique to achieve astronomical accuracy would be astronomical. One of the world’s largest and oldest functioning planetariums is the Eise Eisinga

[41] Herschel (1833), p. 287.

Planetarium in Franeker, the Netherlands.[42] This elaborate ceiling planetarium was constructed by a wealthy wool carder Eise Eisinga (1744-1828), who spent seven years between 1774 and 1781 to complete the entire machinery. The calculated mechanism consisting of a pendulum clock, weights and wooden wheelwork was carefully hidden from view in the ceiling; the complexity of the mechanism made the planetarium was difficult to be removed or dismantled. The Eise Eisinga Planetarium was a unique case – none of the itinerant lecturers would have resources and motivation to construct such handiwork. An over-complex and calculated large orrery would be ‘useless’ to itinerant lecturing: it would be hard to dismantle, travel and assemble. Contrary to the value of scientific accuracy treasured by the learned specialists, the cost to achieve this advantage was a disadvantage for the lecturers on commercial ground.

Many questions remain unanswered since the details of the transparent orrery are not clear. For example, how did the lecturers maintain and operate the transparent orrery? To assemble or dismantle such a giant set of apparatus must have been difficult tasks. In a typical evening lecture of D. F. Walker, Bartley or Adams, the scenes and devices displayed on stage would change throughout its course. Other apparatus such as the globe, the lunarium and the cometarium were also large in size, plus the display of scenic transparencies might need skilled use of the magic lantern. The arrangement of the performing sequence and the smooth operation of different devices could be an art like choreography. In addition, lecturers would not stay in a constant site. C. H.

[42] King (1978), pp. 217-223. The planetarium is now a museum open to the public; see the website: http://www.planetarium-friesland.nl/en (accessed 12 November 2013)

Adams lectured around numerous West End theatres throughout his career, and so did D. F. Walker. Their show business sometimes extended to other towns far away from London. These large machines must be adequate for travelling on the lecture circuit, at least not be too complex to dismantle and assemble repeatedly. Even though Bartley kept performing in the same site every year, he and his colleagues still need to sort out the storage and maintenance of the apparatus. Where was the apparatus stored when not in use? Did the transparent orrery require careful maintenance on a regular basis? These are all questions related to day-to-day operation in popular astronomy lecturing without answers so far. It is reasonable to speculate that the operation and maintenance of the machinery would not be done solely by the lecturer – there should be assistants or even a management team behind the lecturer, like Samuel James Arnold behind George Bartley.

The level of quality of the apparatus in use was uneven among lecturers. Judging by the long-running fame and the amount of acclamation in the newspapers, we could assume the transparent orrery applied by the Walkers, Bartley and Adams were at the best level among this kind. Some other lecturers' apparatus might not match adequate standards, and the poor quality would receive unkind criticisms. John Hollingshead (1827-1904) once recollected his experience of attending a Lenten lecture on astronomy in a theatre. Hollingshead described the orrery he seen at the lecture was the "most creaking and unmanageable", and the style of the anonymous lecturer to play with the apparatus was "so like that of a juggler handling the cups and balls".[43] Charles Dickens, too, had an unpleasant memory for an astronomical lecture in his

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[43] Hollingshead, 'At the Play', *Cornhill Magazine*, vol. 5 (January 1862), p. 89.

childhood, which he remembered as “a slow torture called an Orrery”. Dickens’s impression of the “terrible instrument” was so strong, for he vividly recalled the poor quality of the apparatus: “It was a venerable and a shabby Orrery, at least one thousand stars and twenty-five comets behind the age. […] Then the planets and stars began. Sometimes they wouldn’t come on, sometimes they wouldn’t go off, sometimes they had holes in them, and mostly they didn’t seem to be good likenesses.”[44]

Another negative example was a news report in the *Ipswich Journal* of a popular lecture delivered by a Mr Henry, “who described himself as ‘from the Royal Polytechnic Institution, Regent-street, London.’” Generally, this kind of local news reports of itinerant lectures would be short and simple; they were often written in a few words of plain description or common courtesy of praise. But this *Ipswich Journal* story was unusually critical of Mr Henry’s lecture. “We can neither speak in praise of his felicity of expression, nor of his accuracy of knowledge.” The anonymous journalist attacked: “As to the magnificent Panorama, we look upon the planetarium and orrery as objects only of childish wonder and delight; they convey no idea of the phenomena of nature, and if by chance the lecturer is competent to explain the relative magnitudes, distances, and velocities of the heavenly bodies, their absurdity is evident.”[45] The reviewer was disappointed at the performance, and concluded that “there was nothing worthy the [*sic*] name of a lecture.” We do not know exactly how bad Mr Henry’s speech and apparatus was. However, this *Ipswich Journal* criticism suggests a level of erudite accuracy was necessary: the

[44] Dickens, ‘The Uncommercial Traveller’, *All the Year Round*, vol. 9 (6 June 1863), p. 349; see also Altick (1978), pp. 365-366.

[45] ‘Popular Lectures on Astronomy, &c.’, *Ipswich Journal* (7 March 1846).

apparatus need to “convey idea of the phenomena of nature” and not to be simply “of childish wonder and delight”.

5.4 Scenic Transparencies

Geared mechanisms were not the only visual aid in astronomical lecturers’ repertoire; the use of light was another realm of art to delude the spectators’ eyes. As Michael Faraday’s comment on William Walker’s lecture that astronomy “may be illustrated in a way the most striking by artificial light”, the rendition of optical effects was an important part of popular astronomical lecturing – not for all lectures but at least in the Walkers’ theatrical performance.[46] Not only astronomical lecturers knew the magic of light; in fact, various optical displays were offered in the amusement marketplace. From the small size as the peepshows to the large scale as the panoramas, numerous pictorial entertainments depended on the help of lighting, whether artificial or natural, to achieve the ideal effects. Living in such a vibrant marketplace filled with optical amusements, astronomy popularisers would hardly ignore the great potential of these techniques of optical display.

Two representative examples of the use of light in nineteenth-century amusements were the Diorama and the magic lantern. The Diorama, first developed by French artist Louis Daguerre (1787-1851) in Paris in 1821 and was soon introduced to London in 1823. The Diorama was a meticulous theatre of huge transparent paintings; by elaborate control of skylights and windows behind the painting, the theatre can produce naturalistic lighting effects and

[46] Faraday to Benjamin Abbott, 1 June 1813. James, ed. (1991), Letter 23, p. 56. See also Chapter 3.

delude the spectators that they were seeing life-size three-dimensional sceneries changing with time.[47] The Diorama at Regent's Park was the first of the kind in Britain and was a great success – many imitators and other not-so-relevant shows followed this fervour. Richard Altick points out the fast disintegration of the initially very specific meaning of 'diorama' in the exhibition business: variant pictorial exhibitors used the word in their adoptions, so the 'dioramas' in the mid-nineteenth century might be different scenic shows and this term lost its particularity.[48]

The magic lantern, an early-type image projector developed since the seventeenth century, was another important branch of optical displays. For a long time people were fond of the frightened, mysterious and entertaining optical illusions produced by the magic lantern. It also had many variant applications in shows, such as the phantasmagoria – the dramatic projection of ghosts and fearful figures.[49]

Scenic transparencies were prevalent in nineteenth-century popular astronomical lectures. These scenic displays were usually made by the image projection of lantern slides. It is uncertain who and when first applied lantern projection in astronomical lectures; this application might well have been developed by the dawn of the nineteenth century. According to *London Lions*, a Mr Charles Blunt was arguably the first person who introduced this technique into popular astronomy lectures after the invention of the Eidouranion: "[…] till about the year 1800, when the figures of the constellations and the

[47] Wood (1993); Altick (1978), ch. 12, pp. 163-172. See also Chapter 3 of this thesis for Krystyn Lach-Szyrma's account.

[48] Altick, *ibid.*, p. 174 and ch. 15, pp. 198-210.

[49] Heard (2006).

telescopic views of the planets were first painted on glass, for exhibition, as phantasma in the magic lantern. This originated, as well in the idea as the practical execution, with Mr. Charles Blunt, an optician and artist".[50] Though these origins are not sure, we can ascertain that the use of lantern slides was already common before the mid-nineteenth century. Ebenezer Henderson's *A Treatise on Astronomy* (1843) said popular astronomical lectures of late years "have been rendered very attractive by the introduction of improved transparencies, stationary and revolving, produced by the phantasmagoria."[51] Newspaper reports also mentioned the use of phantasmagoria by astronomical lecturers; some lecture publications were even accompanied by a box of commercial hand-painted lantern slides aimed at domestic use or elementary teaching market.[52] Robert Ball, the foremost astronomical lecturer in Britain after the 1870s, used lantern slides extensively in his lectures, too. Ball had his own collection of slides and frequently requested slides from the Royal Astronomical Society. Ball's meticulous attitude towards lantern slides was shown by some trivia: he had collaborated with a few particular lanternists, and even prepared instruction notes to laneternists to specify his requirements.[53] In the frontispiece of Ball's popular book *Star-Land* (1889), Ball was shown giving a juvenile lecture at the Royal Institution, where a table orrery stood on the desk and a large lantern was set in the background (Fig. 5.4).

50 Wellbeloved (1826), p. 2.

51 Henderson (1843), p. 9.

52 Chapman (1998), p. 178. For the examples of newspaper reports, 'Chelmsford Mechanics Institute', *Essex Standard* (28 April 1837), and 'Phrenological Society', *Preston Chronicles* (23 March 1839), both mentioned the use of the phantasmagoria at local lectures on astronomy.

53 Butterworth (2005).

The disputable nature of the transparent orrery, intriguingly, was also related to the argument about whether its mechanism should be mechanical or optical. We know that the Walkers only described the scenic effect of the Eidouranion rather than its explicit mechanism in their publications, perhaps as it was a trade secret or to retain the audience's (readers') fascination. Historians have two contrasting opinions on the Eidouranion's mechanism. Henry King speculates the construction of the Eidouranion appears to be a modified and enlarged version of Huygens's planetarium, presumably "pinions mounted on a long, single arbour actuated a set of large ring-wheels"; in other words, a geared machine concerns scenic effect instead of accuracy of wheelwork.[54]

In contrast, Wendy Bird inclines to the view that the Eidouranion was an optical device. Bird argues the Eidouranion incorporated phantasmagoria techniques, including a large phantasmagoria on a cart, painted glass slides, parabolic mirrors and a large transparent backdrop. Bird's speculation is based on the records of a contemporary Spanish machinist Francisco Lorenzo, who built a similar spectacle to Spanish royal court and was perhaps inspired by the original Eidouranion whilst visiting England.[55]

The two arguments about the transparent orrery are not totally inconsistent. The transparent orrery, I argue, could be a set of the machinery applied both techniques. Many clues could imply that the transparent orrery was a piece of hybrid apparatus combined with mechanical parts and lantern transparencies. The news story on the vandalism incident of C. H. Adams's apparatus mentioned in Chapter 2 is an example: the intruders raided the theatre to

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[54] King (1978), p. 310.

[55] Bird (2005), pp. 90-91.

"abstract the glass of the lantern, break in the face of the orrery's sun, knot up all the cords". This description indicates that Adams's orrery should be physically able to be broken and contained cords in part, whilst the lantern was also included in the machinery.[56] The introduction of Walker's Eidouranion and Bartley's lecture in *London Lions* began with the expression that "Of those optical exhibitions of the higher class, […] which have been perfected by the aid of painting and mechanics". When tracing the origin of the transparent orrery, *London Lions* also put Adam Walker in a long line of celebrated lecturers including James Ferguson and Benjamin Martin, and credited him for the practical completion to "first actually make a vertical arrangement of the old Orrery, with transparent or luminous planets".[57] This indicates the Eidouranion was derived from the orreries made by Ferguson and Martin, with an alteration to the structure and a touch of transparencies. Ebenezer Henderson, too, introduced his own apparatus 'Astronomion' in his book:

> THE ASTRONOMION is an astronomical machine on an extensive scale, invented by the Author for his Public Astronomical Lectures; it measures about thirty feet in length, by twelve feet in height, the two sides of which are occupied by diagrams; the central part is for the display of STATIONARY and REVOLVING TRANSPARENCIES, DISSOLVING VIEWS, &c., each of which is about TEN FEET in diameter, and set in motion by clock-work. To this machine, and the Astronomical Lectures, the attention of Literary, Scientific, and Mechanics' Institutions is particularly requested.[58]

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[56] 'Mr. Adams' Lectures', *Literary Gazette* (17 March 1832), p. 172. See also Chapter 2.

[57] Wellbeloved (1826), pp. 1-2.

[58] Henderson (1843), p. 171.

Though Henderson claimed this was his original invention, judging by the then popularity of the transparent orrery in astronomical lectures and the wide influence of Walker's prototype, the Astronomion was likely a variant of this kind of apparatus. Thus this description provides another piece of evidence to suggest that the transparent orrery was a combination of mechanical and optical mechanisms.

Despite the popularity enjoyed by the Walkers, Bartley and Adams, most of the transparent scenes they presented in lectures only left textual descriptions. What would those early nineteenth-century transparent sceneries look like? A popular book *The Beauty of the Heavens* (1840) provides a brilliant visual account for modern historians to imagine the magnificence of scenic transparencies in contemporary astronomical lectures. First published in 1840, this quarto volume contained 104 full-page colourful illustrations (also called 'scenes' in the book). Apparently this book was popular, for it continued to reprint at least to the fourth edition in 1849, though the price of a copy was 2 guineas and was not cheap compared with other books.[59] The author was Charles F. Blunt, a lecturer on astronomy and natural philosophy, of whom very little biographical information is known. Perhaps this C. F. Blunt was the very Mr Charles Blunt credited with the first use of lantern slides in astronomical lectures by *London Lions*, or a relation of him.

The arrangement of this book was close to the format of a common popular

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59 The ETH-Bibliothek, Zürich, has a quality on-line version of the second edition (1842): http://dx.doi.org/10.3931/e-rara-1515 (accessed 8 December 2013). The price refers to the newspaper advertisement in *The Examiner* (12 January 1840); it was almost sixfold expensive than the price of the first five editions of *Vestiges of the Natural History of Creation* (7s. 6d.), which was also a commercial success in the mid-1840s.

lecture. Blunt asserted that "The Illustrations form the miniature scenery of a public exhibition, such as is occasionally witnessed in lecture-rooms; the text presenting the substance, the order, and the actual delivery of what becomes, in the present instance, a FAMILY ASTRONOMICAL LECTURE." The author also believed that a family "need not henceforth quit their own parlour, or drawing-room fireside, to enjoy the sublime 'beauty of the heavens;'" with the aid of this book.[60] Therefore, even if this book was not a direct account from a lecture, we can perceive it to be a quality resemblance.

The illustrations in *The Beauty of the Heavens* were aesthetic as well as functional. Scientific truth was important, yet adequate seasoning was necessary, too. Blunt emphasised these illustrations "have been carefully executed from original drawings, paintings, and observatory studies". Though these works were "added, occasionally, by appropriate pictorial embellishment, but with strict adherence to fidelity of detail", he ensured that "great pains have been taken to insure accuracy alike in its pictorial and scientific departments."[61] Several scenes could be seen as the counterparts to the familiar subjects appeared in Walker's, Bartley's and Adams's lectures. For example, Scene No. 2 is the shape of the Earth and the well-known observation about the appearances of masts on an inbound or outbound ship (Fig. 5.5).[62] This scene was included in both Walker's and Bartley's lecture; the only difference between Blunt's book and a real lecture in the theatre was that the former was a static diagram, while the latter was a demonstration with a

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[60] Blunt (1842), p. v.

[61] *Ibid.*

[62] *Ibid.*, p. 14, Scene No. 2.

moving model ship round a physical globe. Other explanatory diagrams such as "The Phenomena of the Seasons"[63] and "The Phenomena of the Tides" (Fig. 5.6),[64] were essential topics in the contemporary astronomical lecturers' repertoire. The telescopic view of individual planets, the celestial hemispheres and constellations were also favourite topics. These elaborate scenes were all elegantly rendered. If the plates in a popular book could evoke the readers' emotion with wonder, it is not surprising that how the audience would feel when seeing a more magnificent representation on the stage.

Chapter Conclusion

This chapter argues that the apparatus used in lecturing helps to reveal the material emphasis and the visual culture of popular astronomy. The orreries, the lantern slides, and other astronomical visual aids, are the embodiment of beauty and awe that numerous nineteenth-century lecturers tried to evoke. These visual aids were not only tools of the trade but also instruments of the sublime. The introduction of the transparent orrery in astronomy lecturing promoted the theatrical turn before the nineteenth century. By presenting scenic effects, these large machines added elements of theatricality into astronomy lectures. Many examples of visual aids discussed in this chapter, such as Blunt's illustrations and Henderson's Astronomion, all reflected the blending of scientific education and aesthetic amusement.

The effectiveness of this blending, however, remained a subject of disagreement among popularisers of science. The debates reflected the

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63 *Ibid*., pp. 81-82, Scenes No. 63 and No. 64.

64 *Ibid*., p. 83, Scene No. 66.

dilemmas over how to make a balance between amusing theatrical effects and satisfactory scientific instruction. This chapter has indicated the undergoing demarcation between scientific instruments and the technique of amusement in the nineteenth century. The criticisms of the orreries on display in the Great Exhibition, and the intentional neglect of the transparent orrery in encyclopaedias, showed this demarcation. Science experts, commercial manufacturers, and theatrical popularisers, all had their own concerns over what the proper quality of the apparatus should be.

Chapter 6 Audiences

Readers did not play a merely passive role in the nineteenth century's popular science publishing trade. Feedback from readers could influence decisions of the editorial staff. In the process of the editing of the Religious Tract Society's popular science publications, the 'invisible hand' of the readers was pronounced. The editorial department of the RTS was assisted by a group of in-house readers and external expert readers. Manuscripts waiting to be published were sent for inspection to an internal reader and an external one sequentially; while the latter was an expert who could assess the subjects, the former's task was to decide whether the manuscript was written in a suitable style and with an adequate Christian tone. The manuscript would be rejected completely if both readers reported unfavourably on it and the editor saw no reason to disagree.[1] This peer-review process not only controlled the quality of the publications but also affected to engage the readers. The RTS was clearly aware of its readership and managed it well.

This chapter discusses audiences of nineteenth-century popular astronomy lectures. The audience of astronomy lectures, I argue, did not consume knowledge and amusement passively. They were actively involved in the moulding of the fashion for astronomy, and lecturers would be responsive to the market. Audiences might interpret the contents of lectures in very different ways from that which lecturers intended. This argument echoes with my main theme 'commercial and sublime'; audiences played the roles of consumers as well as participants in the marketplace.

[1] Fyfe (2004), pp. 144-145.

Scholars in various disciplines have noticed the heterogeneity of audiences in the media, and approaches regarding audiences' perspective have been developed. Reader-response and reception theory are influential models in this direction. Reception theory, originally derived from the reader-response concept in literary studies, is an analytical approach applied widely to analyse the roles of audience in literary, communication and theatre studies. Reader-response emphasises the relationship between readers and texts. It concerns how readers contribute to the meanings of a literary work; in other words, the practice of making interpretations beyond the author's original intention.[2] In science communication, a deficit model of public understanding of science is often promoted by modern science popularisers and policy makers, which assumes the lay public receives scientific knowledge in the mode of pouring water into an empty bucket. However, this conventional top-down view has been criticised for being too prescriptive and scientist-centred, lacking mutual communication between popularisers and the public.[3] Some historical studies also show relations between lecturers and audience included engagement rather than absolute dissemination.[4] Overall, readers or audiences are less and less being seen as passive consumers of information in a number of works of scholarship.

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[2] For further introduction on reader-response and reception theory, especially the use in theatre, see Rabkin (1985); Susan Bennett (1990); Fortier (1997), pp. 87-100.

[3] Gregory and Miller (1998), pp. 89-90; Locke (1999); Broks (2006), pp. 122-123.

[4] For example, van Wyhe (2007) indicates that the diffusion of phrenology in nineteenth-century Britain depended on an effective lecturing strategy: lecturers converted the audience into practising phrenologists, who not only adopted the theories but also used and preached again. Moore (1985) uses the story of a banquet homily by Herbert Spencer during Spencer's American visit in 1882 to show how the prominent audience were inspired to other views and hence influenced the American public.

In terms of the history of science, many researchers also employ approaches from cultural history and the history of the book to investigate the readership of popular science publications. James Secord's work *Victorian Sensation* (2000) on Robert Chambers's anonymously published *Vestiges* is an impressive milestone of this genre. Secord claims his work has been an 'experiment' in a different kind of history, for he uses sources from everyday practices – diary keeping, letter writing, displaying, debating, lecturing and conversation – to explore a major historical episode of an evolutionary account and its aftermath from the perspective of reading.[5] Another representative example is Jonathan Topham's works on the *Bridgewater Treatises*. Topham analyses different classes of the readers from fashionable society to radical artisans; he also demonstrates the readership was largely shaped by a series of elaborate negotiations between authors, publishers, printers, booksellers and libraries. The case of the *Bridgewater Treatises* shows that publishing, as well as the reading of books, are "embedded in a complex and varied series of social relations."[6] In addition to the print press, there are studies of audiences of variant events including lectures, exhibitions and museum visiting. For example, scholarship on the lecturing at the Royal Institution provides detailed analysis of the audience size and formation during the early and mid nineteenth century, especially emphasising the prominence of Faraday's activities.[7]

[5] Secord (2000), p. 518.

[6] Topham (1998), p. 261. See also Topham (1992; 2000) for further discussions on the *Bridgewater Treatises* and the historiography of the reading of science in the nineteenth century. Other case studies on the readership include Fyfe (2004) on the RTS evangelical publications and Fyfe (2007) on the cheap weekly *The Pictorial Museum of Animated Nature* (1848-1849) published by Charles Knight.

[7] For example, James (2002b) and Morus (1998) have discussions on Faraday's day-to-day preparatory work and operation of lecturing. Berman (1978) and

Geoffrey Cantor's editing of the guides and visitors' accounts of the Great Exhibition of 1851 presents an extensive documentary sources of spectators' experience.[8] Samuel Alberti charts Victorian visitors to the museums of natural history and anatomy. He analyses the audience constituencies and the range of sensations that had been involved in the museum visit.[9] These studies build on a well-trodden path that is useful for my research in this chapter.

This chapter will develop in this sequence: First, an analysis of the audience composition was essential for drawing an outline of who is discussed. Section 6.1 will explain the methods which I use and the problems emerging from these tools. Section 6.2 emphasises spectators' experience. In particular, I use a recollection from John Hollingshead, whose vivid first-hand account spoke of an orrery lecture attendance. Motivations for attending discourses will be discussed in the Section 6.3. Among various motivations, following fashion was a significant factor though few historians emphasise this aspect. Science was fashionable in the period and had noticeable influence on the contemporary social culture. Finally, in Section 6.4, I will use a controversial case to discuss contrasting attitudes towards astronomy lectures. This case highlights the conflicts between different religious, as well as political, views; the conflicts also accord with my argument of this thesis that there had been a contested sphere of popular astronomy in the nineteenth century.

Forgan (2002) have analysis of members and audiences of the Royal Institution in the nineteenth century.

[8] Cantor, ed. (2013). This is a massive four-volume documentary title containing the accounts of every stage of the exhibition from organisation to the closing ceremony and assessments. The parts of guides and visitors' accounts are mainly in Volume 3.

[9] Alberti (2007).

6.1 Audience Composition

Identifying the right target audience is critical. A successful author has to know what classes of readers would turn over the pages. In the preface to the book *The Earth's Crust* (1864), a popular geology work written by David Page (1814-1879), the author recognised the readers for whom he wrote: these readers included "young men striving after self-instruction", "men in business, whose time will merely permit a cursory acquaintance with a subject", the "leisurely, who seek information simply as an accomplishment", and the "gentler sex, unprepared for technicalities".[10] Page claimed that his handy and intelligible form of useful outlines was made to meet these readers' needs. Authors' appeals were usually the first hint for historians to investigate who constituted the readership.

To trace the readership of a book is never an easy task. Studies of popular lecturing, too, confront the same problem of mapping the audience composition. Figure 6.1 is an artist's sketch of a large audience in a theatre; the situation that a researcher would encounter is best represented by analogy with this sketch: the majority of the audience in the background is blurred or even faceless; images of a few individuals in the foreground are sharp, but historians' partial understanding of the audience usually consists of this very small portion of attendee.

I use the methods from the studies on the readership of nineteenth-century popular science publishing in my research. One direct way to find out

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[10] Lightman (2007b), p. 227; Page (1864), p. iii. For further biographies of Page, refer to Lightman (2007b), pp. 223-238; J. A. Secord, 'Page, David (1814-1879)', *ODNB* (2004).

readership is accounts from readers themselves: diaries, letters and publications which reveal the personal reading experience. This method allows historians to understand subtle details by examining the authorship of the account, yet individual cases are hard to effectively quantify in a survey of a few samples. Authors' or publishers' declared objectives, like what Page wrote in his preface, were another important clue to indicate the potential readership. Another common but indirect method was to derive a big picture from the circulation of books: editions, prices and number of prints are all clues. Different editions of a book would be issued to suit different economic levels of customers; the qualities of papers, printing and bindings could all indicate the variation in prices. For example, the cheapest 'Monthly Series' volumes published by the RTS were available for 6d., which were bound in green paper covers and printed in black ink. The same series bounded in cloth-covered boards, with blind embossing and gilt edges, were available for a slightly higher price of 10d.[11] The *Vestiges* also had cheaper 'people's editions' priced at 2s. 6d. after the previous more expensive collectable editions, which cost 7s. 6d. or 9s. The popularity and great controversy of the *Vestiges* even attracted piracy. A shortened volume *Expository Outline of Vestiges* (1846) with an extra review on the original book's impact was available for only 4d.[12]

These cases of cheaper editions and potted piracy show the availability of a popular science book could reach readers of all the social classes. The improvement of literacy and the prevalence of steam-powered printing both

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[11] Fyfe (2004), pp. 157-158.

[12] Secord (2000), pp. 136-137. For the case studies of the production, distribution and circulation of popular science books in this period, refer to Topham (1998), Secord (2000) and Fyfe (2004).

contributed to a wider range of readers. Although the level of literacy might be disputable, the number of literate people was slowly increasing between the late eighteenth and mid nineteenth centuries.[13] The spread of Sunday and day schools, as well as the activities of many religious societies, contributed to this improvement. Steam-powered printing made cheap and mass publications possible. Publishers found a new market of cheap pamphlets, tracts and periodicals, which reached the middle and working classes.

Many indicators in my research reflect that nineteenth-century popular astronomy lecturing had a heterogeneous audience. These indicators include admission charges, personal accounts, lecturers' or institutional agenda and visual evidence of lecture scenes (Table 6.1). However, no method is perfect. As I will show later, even a piece of direct visual evidence of the audience could be problematic. In terms of availability, institutional lecturing had more advantages of preserving records of day-to-day operation than private business. In the preceding chapters many institutions and their differing target audiences are introduced. The audience who turned out at Albemarle Street was different from the people who appeared at Southampton Buildings, the site of the London Mechanics' Institution. As the prices of books, the admission fees of membership subscription could be an indicator of the audience formation.[14] The wide range of subscription fees varying from institution to institution,

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[13] Some statistics suggest that around 60 percent of males and 40 percent of females in England and Wales were literate in the late eighteenth century, and the numbers increased to 69.3 and 54.8 percents, respectively, in 1851. However, these statistics often simply rely on the signatures in marriage registers, so cannot guarantee those enrolled among the literate could functionally read or write something else than their names. Besides, these estimates often neglect all regional and social variation. See Altick (1998), pp. 166-172; Fyfe, *ibid*., pp. 26-27.

[14] See also the comparison between the Royal Institution, the Royal Manchester Institution and various Mechanics' Institutes in Chapter 3.

suggests the same broad spectrum of audiences. The objectives claimed by institutions' founders also indicate the particular groups they aimed for, though the original statements might not be always reliable – the prospect of the board could change and sometimes compromise with financial reality was inevitable.[15]

In the case of private lecturing, especially those itinerant lectures held in provincial towns and the countryside, the sponsors or the sites might be a clue to indicate the audience composition. For instance, if a lecturer was invited to give a discourse in a country school, the pupils, teachers and pupils' families were likely to make up the majority of the audience. When events took place in theatres, especially in large cities, the audience composition was probably more mixed. Theatres in the Regency and Victorian eras were often a microcosm of the society: 'vulgar' sort of working men and women shouted, laughed and even rioted in the gallery; the rich and upper class could afford the private boxes; the pit was an average choice for the middling classes people (Fig. 3.3). Despite the fact that audiences sat at different levels, they were beneath the same ceiling of the auditorium.[16] The variant classes of admission applied in C. H. Adams's and Walker's lectures all reflect the wide range of the audiences.

Before going ahead to further analysis of particular audiences, it is necessary to clarify the categories of audiences which are identified here, and the

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[15] For example, according to Stephens and Roderick (1972), by middle of the century many Mechanics' Institutes had turned to more entertainment or cultural activities rather than serious education originally intended to do. Similar compromise also appeared at the Royal Polytechnic Institution and the Colosseum at Regent's Park, see Chapter 2.

[16] Booth (1991), pp. 1-26; Jackson, ed. (1994), pp. 9-17. See also the admission rates of C. H. Adams's lectures in Chapter 2 and Lach-Szyrma's account in Chapter 3.

weaknesses of my methods. Popular astronomical lectures, no doubt, had a diverse audience in the nineteenth century. Within this broad spectrum of variable spectators, several categories are easier to be observed.[17] Table 6.1 shows the audience coverage which I emphasise in this chapter. The category of age encompasses juveniles and adults with supervisory roles, such as parents, guardians and teachers. The category of gender concerns the place of women in particular. The category of social class, especially referring to financial capability, is the most obvious one to be reflected by admission charges. Politics or religion is another noteworthy category when a lecture was related to a particular stance or controversial issue. My analysis of the audience in the following part of this chapter will cover the above four categories. Of course, these categories are not complete. Some potential categories are more difficult to be examined, such as the vocation, ethnic make-up and education of the audience.

The tools I borrow from the studies on popular science publishing are not flawless. For example, ticket prices could only offer a crude, though reasonable, speculation about the social class of the audience. It is a piece of indirect evidence of the possible range of the audience, rather than a firm proof of the social status of a spectator who was actually sitting in the auditorium. Even if a piece of visual evidence of a lecture scene exists, such as the illustration of D. F. Walker's Eidouranion at the English Opera House (Fig. 3.5), the faithfulness of the picture is hard to avoid questioning. Illustrations might be too idealised,

[17] My categories refer to, but are not as the same as, Alvar Ellegård's classifications of the readership of Victorian periodicals. Ellegård uses several classifications including educational levels, political and religious stands, to summarise the readership of the periodicals having Darwinism coverage. See Ellegård (1990), Appendix II, pp. 368-384.

romantic or simplistic to mirror a real scene.[18] Furthermore, even if a picture is realistic, it might depict a special occasion rather than a regular scene and thus it is not representative of a typical situation. For example, the iconic oil painting of Michael Faraday's Christmas lecture (Fig. 6.2) represents a special moment: the lecturer was a celebrated speaker and the royal family was among the audience. Therefore visual evidence is powerful but careful scrutiny is still required. The methods applied to my study, nevertheless, are feasible options to achieve a reasonable speculation about the audience in the past.

One particular audience of popular astronomy who had become a focus in this trade were the juveniles – adolescents and children; boys and girls. This class of people has often been under the shadow of adult audiences when discussing the audience composition; in fact, juveniles occupied a significant place in the auditorium. Astronomy had been an essential subject in juvenile education by the nineteenth century. This convention had taken root in Enlightenment polite culture, in which the cultivation of astronomy and geography was an important part in the education of gentlemen and ladies.[19] Besides, as we have discussed in the previous chapters, astronomical instruction was often connected with moral and religious teachings. In the view of reformists, the progress of astronomy reflected the achievement of human reason. The application of astronomy in navigation and cartography showed its valuable utility. These influences made astronomy a worthy subject in the

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[18] For instance, Joseph Wright's famous painting, *A Philosopher Giving a Lecture at the Orrery* (Fig. 1.4), is a dramatic setting of an astronomical demonstration. Despite this painting captures the zeitgeist of Enlightenment science culture, it is too romantic to be a realistic scene of a public lecture.

[19] Morton and Wess (1993); Walters (1992; 1997). See also Secord (1985), which focuses on an eighteenth-century author Tom Telescope and his popular book tailored for young gentlemen and ladies on Newtonian science.

curriculum. However, only a small part of juveniles had opportunities to receive elementary school education, not to mention further education, when growing up. In the case of girls, the opportunities were less than for boys.[20] Domestic instruction played an important role in such a shortage of education. Many commodities that furthered astronomy education in domestic environments were produced in the late eighteenth and early nineteenth centuries. These commodities ranged from illustrated books to remarkable visual aids and toys, such as the cardboard celestial sphere and the board game.[21] Their presence reminds historians the often neglected existence of a nineteenth-century market for juvenile popular astronomy. Like domestic instruction, popular astronomical lectures also functioned as a supplement or an alternative to school classes. Juveniles were a major group the lecturers tried to serve. In the lectures of C. H. Adams and Bachhoffner, there were discount offers to encourage parents to bring along children; Bartley's and Walker's shows were recommended by guidebooks such as the *London Lions*, which claimed parents will duly appreciate the lectures "in conveying to the minds of their children the lofty and magnificent ideas that Astronomy supplies."[22] John Wallis delivered juvenile lectures three times at the Royal Institution. The emphasis on children that nineteenth-century popular astronomy lecturing usually placed is significant.

Children, of course, could hardly attend a discourse or read a book on their own initiative. Parents, guardians, governesses or teachers, would accompany

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[20] For the general situation of education in Britain in the nineteenth century, see Kelly (1970) and Stephens (1998).

[21] Taylor (2009); Keene (2011).

[22] Wellbeloved (1826), p. 4.

and supervise children's learning. These adults were the actual customers who paid for the service and commodities, so aiming at juvenile market meant aiming at the adults that would accompany children.[23] "The modern schoolmaster is expected to know a little of every thing [*sic*], because his pupil is required not to be entirely ignorant of any thing", said Charles Lamb, who criticised contemporary schoolmasters for their desire to instil knowledge, even during school-intervals: "[F]or commonly he [the schoolmaster] has some intrusive upper-boy fastened upon him at such times; some cadet of a great family; some neglected lump of nobility, or gentry; that he must drag after him to the play, to the Panorama, to Mr. Bartley's Orrery, to the Panopticon, or into the country".[24] This requirement or fashion of instruction was encouraged both by teachers and parents. The author of the popular astronomy book *The Beauty of the Heavens*, which has been introduced in Chapter 5, claimed that a family could benefit from this illustrative volume. He suggested how it was to be used: "The Lecture [text] may be read aloud by a parent, teacher, or any member of a party, the Scenes being exhibited, at the same time […] It would be impossible to devise a more rational, or, to a well-regulated mind, a more cheerful mode of passing an evening".[25] Similar promotions which appealed to family members were common among producers of popular astronomical commodities in the

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[23] A *Punch* cartoon in 1855, 'A visit to the antediluvian reptiles at Sydenham – Master Tom strongly objects to having his mind improved', reflected that children were not always the enthusiastic audience for 'improving' scientific education: A gentleman dragged a reluctant (and perhaps terrified) boy through the Crystal Palace dinosaurs. See Rudwick (1992), p. 145.

[24] Lamb, 'The Old and the New Schoolmaster', *The London Magazine*, vol. 3 (May 1821), p. 495; Altick (1978), p. 228. Charles Lamb was a renowned writer and is best remembered for the pseudonymous essays of *Elia*. For biographies of Lamb, refer to Peter Swaab, 'Lamb, Charles (1775-1834)', *ODNB* (2004).

[25] Blunt (1842), p. vi.

early nineteenth century. A family value blended with communal recreation and domestic education was the core of this appeal. Thus, parents and teachers were also an important class of audience in the popular astronomy market.[26]

The above discussions on juveniles and parents inevitably lead our attention to the presence of women within the audience of popular astronomy. Historians usually depicted science in early nineteenth-century Britain as being dominated by gentlemen, especially in the elite circles of the Royal Society and the BAAS. This perception, however, neglects the participation of female audience in science. Scholarship of women and science often emphasise the achievements and difficulties of a few prominent females who contributed to studying or popularising scientific knowledge, such as Caroline Herschel (1750-1848) and Mary Somerville (1780-1872). The role of women as consumers of science is a relatively lesser-known aspect to be discussed.[27] In fact, women were a prominent part within the audience. The presence of women in the BAAS meetings reflects the acceptance – even a welcome to some extent – of female audiences in scientific activities. This acceptance of females' involvement was based on social and cultural reasons; as Rebekah Higgitt and Charles Withers argue, "women's traditional supporting roles as wives and daughters were extended to support the BAAS."[28] Allan Chapman's investigation of female members of amateur astronomical societies during the late nineteenth and early

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[26] Keene (2011). For more details on the history of middle-class family in this period, see Davidoff and Hall (1987).

[27] Higgitt and Withers (2008); Morrell and Thackray (1981), pp. 148-157. Bernard Lightman also stresses on Victorian female popularisers and readers in his studies; see Lightman (2007b), especially pp. 123-128. For some biographies of women in British astronomy, see Ogilvie (2000); Neeley (2001); Brück (2002; 2009).

[28] Higgitt and Withers, *ibid*., p. 25.

twentieth centuries indicates that women were active participants in these communities. Some of these female members were not merely passive audiences but enthusiastic observers, writers and lecturers.[29] Female audiences had been present in astronomical lecturers' auditoriums throughout the nineteenth century, whether at Walker's Eidouranion at the English Opera House in 1817, or at Mr Perini's planetarium in 1879 (Fig. 6.3).[30] These illustrations suggest that a mixture of women and children within the audience was common in popular astronomical lectures.

The prevalence of astronomical lectures was evident in the existence of audiences across all levels of social strata. All people, poor and rich, could find an affordable discourse. Table 6.2 summarises the charges of admittance to astronomical lectures in London. The wide range of the prices shows the same wide range of social classes within the audience. I have introduced the situation of cheap lectures in Mechanics' Institutes or other establishments in the previous chapters. These cheap lectures, sometimes even for free admission, aimed at the working classes. Members of the aristocracy could afford private tutors in the courts or in their country estates. John Bird, who enjoyed the patronage of King William IV and the Duke of Wellington, was the astronomical preceptor of the eldest son of the duke. Bird had also occasionally lectured before the royal family at the Pavilion at Brighton.[31] Again, these

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[29] Chapman (1998), ch. 14, pp. 273-293. Another example of study on women teachers of science, though not in British astronomy, is Kohlstedt (2010). Kohlstedt focuses on nature study for children beyond classrooms by women popularisers in North America.

[30] RAS: Add MS 88: 35. Little is known about Mr Perini and his planetarium. We only know Mr Perini was an Italian and he introduced this new amusement into London in the late nineteenth century.

[31] 'A Lecturer of the Old School', *The Leisure Hour*, vol. 95 (20 October 1853), p.

examples show the diverse audience in nineteenth-century popular astronomy. The wide varieties of audiences have been identified in this section, which includes fashionable gentlemen and ladies; artisans and countrymen; parents and pupils.

Nevertheless, this chapter does not mean to map a comprehensive audience composition. What I depict in this section is a rough but reasonable picture of the spectators who were sitting in an auditorium, and then we can further discuss the motivations and reactions of the audiences. In the following sections I am going to show a few noteworthy accounts from contemporary periodicals; these examples might be implicit or exaggerated, yet can still be considered as a cross-section of the audience's views. To start with, let us see an account of the experience of seeing a Lenten astronomical lecture.

6.2 Reminiscences of Show Visiting

Among the numerous accounts of theatregoers on the experience of seeing dramas, John Hollingshead's essay 'At the Play', published in the *Cornhill Magazine* in January 1862, is a nostalgic and humorous piece. Hollingshead was then a young and talented journalist. He had contributed to many periodicals, including *Household Words* edited by Charles Dickens, of whom Hollingshead emulated the writing style (to Dickens's approval). Like the novelist he emulated, Hollingshead was skilful in depicting current incidents of London life with lively details. When the editor of the newly-founded *Cornhill Magazine* William Thackeray asked Hollingshead where he learned his 'pure style', Hollingshead replied '[i]n the streets, from costermongers and

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skittle-sharps.'[32] These characters all featured in the essay 'At the Play'. In this article, an old playbill made Hollingshead to reminisce about his very early play-going experience in youth – around his ninth year to be exact. Hollingshead's own early experiences on the theatre coincided with several occasions of running away from home: "[…] I was let out of a back-door when the whole household thought I was in bed, and allowed to feast myself, unguided, in the theatrical orchid, between the hours of six and nine P.M." Escaping from the house, Hollingshead trotted down the streets, and joined the crowd at the gallery entrance of his favourite play-house. Such excitement and guilty pleasure undoubtedly imprinted on his young mind. "The gust of escaped gas and old orange-peel which welcomed me at the door was never forgotten", Hollingshead confessed: "When I smell any thing like it now, whether in chapel, lecture-hall, or law court, it always suggests a theatre; and visions of old actors, old green curtains, and old orchestras rise up before me, which I cannot drive away."[33]

With the experience of many secret visits to a play-house, young Hollingshead was amused to hear one day that a family friend meant to treat him to a theatre tour. Although this guardian was a severe schoolmaster and "objected to theatres upon principle", he "saw no harm in going to a play-house during Passion-week to hear an astronomical lecture, illustrated by an Orrery. That was what he called amusement and instruction combined". So off they went, with the family's permission. The experience at that day would remain

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[32] For Hollingshead's biography, I refer to A. F. Sieveking and H. C. G. Matthew, 'Hollingshead, John (1827-1904)', *ODNB* (2004).

[33] Hollingshead, 'At the Play', *Cornhill Magazine*, vol. 5 (January 1862), pp. 85-87.

vivid in Hollingshead's memory after over twenty years.[34] The lecture, unfortunately, had shown bad omens before its start. "The empty orchestra was like a chilling tank of cold water," Hollingshead recollected: "the silent stage, half filled with a few tables, and the lecturer's apparatus was like a deserted shop; while the bare benches and the gaping boxes made the few people in the pit huddle together for warmth." The audience was unpleasant, too. Hollingshead described those gloomy spectators:

> They were mostly country people, who probably thought they were seeing an ordinary play, or persons who came to perform a solemn duty by learning something about the "solar system". If their faces were any guide to their feelings, they looked bewildered and unhappy, with the exception of one individual, who seemed to despise the wonders of the universe.[35]

Then the show began. Hollingshead recollected:

> This was the entertainment – amusing and instructing – which my guide had brought me to for a treat. My insolvent theatre, in its most degraded period, was never as dull as this. When the lecturer came on with a jaunty air, and began to patronize, without clearly explaining, the Infinite, I thought I knew his voice and manner, although he was disguised in very clerical evening dress. His style of playing with the Orrery – an apparatus, by the way, which was most creaking and unmanageable – was so like that of a juggler handling the cups and balls, that I watched him still closer, instead of picking my cap to pieces, as I, at first, felt inclined to do, and soon traced in him the broken-down manager of my insolvent

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[34] It was not clear when exactly Hollingshead and his guardian went to the astronomical lecture. It might be a few years later than his first theatrical experience at the age of 9, since Hollingshead described the decline of his favourite play-house before this event. Presumably this orrery visit was in his juvenile years between 1837 and 1840.

[35] Hollingshead, *op. cit.* (33), p. 89.

> theatre. I was about to impart my knowledge, with youthful confidence, to my guide, when we were interrupted by a discontented mariner, who had drifted into this unhappy port in search of amusement.
>
> "Hi mate," he said, loudly, to my severe companion, after a number of preparatory grunts, "when's the broad-sword combat goin' to begin?"[36]

Things then became truly dramatic. When realising there would be no play in the evening, the sailor shouted at the lecturer to demand his money back. The row disrupted the show. At last, the grumpy sailor was coaxed out of the theatre by a door-keeper, and the lecturer, "probably glad of an excuse to hurry through his lecture, professed to be so disturbed by the interruption, that he could hardly tell the sun from the moon." On the way home after the show, Hollingshead's serious guardian "mourned over the instruction we had been deprived of by a rude boor".[37]

Hollingshead's essay told his own reminiscences of seeing plays in youth. In the conclusion, Hollingshead encouraged his readers to let children go to play-houses, for it is "part of the education of life". The awkward astronomical show was not the point of this article, yet it did unintentionally provide a vivid account of a Lenten astronomical lecture in an early Victorian London theatre. Despite a probable selection bias in Hollingshead's essay – he might select an atypical awful case and exaggerate the drama for entertaining his readers – this memoir still offers some information. The supposedly instructional amusement which adults considered a 'treat' was a boring disappointment through a young spectator's eye, but the boy's guardian would disagree. We can easily see the

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36 *Ibid*.

37 *Ibid*., p. 89 and p. 92.

dissension within the audience and within generations. Educational benefit and the generation gap were two recurrent themes emerging in contemporary accounts when talking about the experience of visiting an astronomical spectacle. There was a widespread sanction for the proclaimed educational function of popular astronomical lectures among the adults, especially those who played a supervisory role such as parents and teachers. As I mentioned in Section 6.1, astronomy held a significant place within juvenile instruction, which was rooted in Enlightenment polite culture and influenced by the middle classes. This educational value had been advocated by Lenten astronomical showmen for decades. Parents and teachers approved of this advocacy.[38] Thus, even a serious schoolmaster who objected to theatrical entertainment would agree "no harm" – perhaps rather beneficial – in bringing a juvenile to a play-house for an astronomical lecture during Passion Week.

Hollingshead's story was not a lone account; similar childhood experience of a spectacle visit appeared in many other contemporaries' reminiscences. Charles Dickens, too, described an orrery visit at a local theatre, which he recollected in the series *The Uncommercial Traveller* in the journal *All the Year Round* in 1863. Dickens's visit to an orrery was the result of a childhood birthday outing. However, the birthday treat became "a slow torture", as Dickens put it. The quality of the apparatus and performance was poor. Dickens described the lecturer as a "low-spirited gentleman"; the instrument, too, was "a venerable and a shabby Orrery". During the show the stars and planets of the orrery were not functional: "Sometimes they [stars and planets]

[38] Lamb, *op. cit*. (24). See also the *Punch* cartoon mentioned in Rudwick, *op. cit*. (23).

wouldn't come on, sometimes they wouldn't go off, sometimes they had holes in them, and mostly they didn't seem to be good likenesses." Not amused by the orrery show, the young Dickens thought "if this was a birthday it were [*sic*] better never to have been born."[39]

Another example of reminiscences of show visiting came from the writer Edmund Gosse (1849-1928). Gosse's famous memoir *Father and Son* (1907) presented a struggle between two charecters as well as generations. Gosse's naturalist father, Philip Henry Gosse (1810-1888), was portrayed as a stern and repressive parent in the memoir. The book emphasises the uneasy relationship between the two Gosses, the son's gradual coming of age and rejection of his father's fundamentalist religion.[40] In *Father and Son*, Gosse remembered a minor event in his eighth year: he and his father paid a long anticipated visit to the Great Globe in Leicester Square (Fig. 6.4), one of the rare occasions he was ever taken to a place of entertainment.[41] Wyld's Great Globe was a colossal spectacle focusing on geographical education. It could also connect to other related subjects like astronomy, as the proprietor James Wyld elaborated in the compendium published for accompanying the visit.[42] The Globe, however, disappointed Gosse. This small event in Gosse's childhood was unusual, since

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[39] Dickens, 'The Uncommercial Traveller', *All the Year Round*, vol. 9 (6 June 1863), p. 349. Dickens's reminiscence was likely about his childhood at Chatham, Kent, where he lived until his 11th year (1822). See also Altick (1978), p. 365.

[40] Although *Father and Son* was well-received as a successful literature of Victorian adolescence, modern biographers reject this stern portrait of Philip Henry Gosse. Thwaite (2002) points out Edmund Gosse's partial depictions of his father. See also Lee (2003) and Henderson (1989), ch. 3, pp. 117-158.

[41] Gosse (1983), p. 60. The exact date the Gosses visited the Great Globe in Leicester Square was on 10th September 1857, according to Edmund Gosse's diary.

[42] The second chapter in Wyld (1851) introduces the solar system, though it is not clear if Wyld arranged astronomical materials in the actual exhibition. For Wyld's Great Globe, see also Altick (1978); King (1978), pp. 320-321.

Gosse described his parents' indifference to entertainment: "Notwithstanding all our study of natural history, I was never introduced to live wild beasts at the Zoo, nor to dead ones at the British Museum. I can understand better why we never visited a picture-gallery or a concert-room."[43] A serious and religious man of science like Philip Henry Gosse would even consider Wyld's Great Globe worth a visit for his son. This surprising small occasion proves again that those so-considered instructional amusements, whether the Great Globe or the transparent orrery, were deemed worthwhile in Victorian parents' mind.

The lecturer's identity in Hollingshead's account is also worth highlighting. We do not know who the lecturer exactly was. Hollingshead, however, recognised this gentleman. He identified the clumsy lecturer as the "broken-down manager" of an insolvent theatre, disguised in "very clerical evening dress". Such dress was probably the result of self-fashioning as an authority figure or a public's perception that a lecturer should be.[44] The equipment and the theatre facility were as poor as the lecturer's speech. The empty orchestra, the creaking orrery, the deserted-shop-like apparatus, plus the lack of heating in the auditorium, all suggest this lecture was a mediocre show not comparable to a quality one.[45] This also reminds us of the loose qualification required for an astronomical lecturer in the early nineteenth

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[43] Gosse, *op. cit.* (41).

[44] It is perhaps like a common perception today: the general public would associate scientists with white laboratory coats. Hecht (2011) discusses the construction of authority and public images of scientists in the case of marine biologist Rachael Carson. For other studies of the stereotype of scientists, see Haynes (1994) on the images of scientists in western literature, and Frayling (2005) on the cinema.

[45] Bartley's lecture at the English Opera House, for example, would advertise that "The Theatre will be constantly warmed by LARGE STOVES in various parts of the House" in the playbill.

century. Anyone could step into lecturing business whether his previous background was a Cambridge wrangler, a journeyman carpenter or a broken-down theatre manager, yet the success in winning the audience was another story.

6.3 A Fashionable Motive for Science

Spectators went to a Lenten astronomical lecture in the theatre for various reasons. Hollingshead and his guardian sought a show with "amusement and instruction combined". While the adult thought that the balance between amusement and instruction ought to be tipped in favour of the latter, the child was more concerned if the amusement was dull. Other audiences in the theatre, mostly country people, were perhaps indifferent to astronomy. Hollingshead speculated that these country people "probably thought they were seeing an ordinary play". The discontented sailor, too, just drifted into this unhappy port in search of an ordinary play for entertainment. Unfortunately the sailor got the astronomical lecture wrong and all he expected was some exciting "broad-sword combat" scenes. Compared to the assorted audience composition, the reasons motivating people to attend lectures were no less diverse.

It is challenging, too, to find out the exact motivation, which may vary person to person, for attending a discourse. A common conjecture is to presume people went to a Lenten astronomical lecture because of the implicit moral and religious teachings, or people subscribed the Royal Institution's discourses because they wanted to learn some scientific novelties. However, such a presumption is crude and probably untenable. Some spectators, no doubt, came to the theatre or the Royal Institution out of above straight reasons, such as

Hollingshead's guardian, who saw "no harm" to do so. Yet it is partial to think all the audience were motivated by the same expectation. As Jonathan Topham has shown regarding the readership of *Bridgewater Treatises*, "these books were read in a variety of contexts, in which they served radically different purposes and possesses radically different meanings".[46] Topham's argument agrees with reader-response and reception theory, of which he argues: "Once a book has left its context of production, it is transmitted to a multiplicity of contexts of reading – different social and cultural spaces where it may be invested with a variety of meanings." One example Topham takes is William Buckland's *Bridgewater Treatise* on geology and mineralogy, which was read by Sir Charles Bunbury as an illustrated guide to the paleontological collections of the British Museum. The same volume served as a sourcebook for transmutation by atheist Charles Southwell.[47]

This reminds us that the contexts of lecture-going were likely as diverse as readings. We take a show seriously for granted today: people go to a scientific lecture because they want to hear science; people go to a play because they want to watch a play. But things might not be so simple and orderly back in the early nineteenth century.[48] The fashionable spectators who appeared at the English Opera House for D. F. Walker's Eidouranion (Fig. 3.5) were not totally

[46] Topham (1998), p. 249.

[47] Topham, *ibid.*, p. 235.

[48] In the case of theatre-going, some 'terrible' manners for today's audiences would be common in the past. James Grant's account *The Great Metropolis* (1837) described the chaos of the lower classes in the gallery, of whom the contemporaries satirically called the 'gods' of gallery; see Jackson, ed. (1994), pp. 16-17. Things were more without order back in the eighteenth century, when booing, applauding and rioting was even common among the fashionable people; see Picard (2000), pp. 253-257.

engrossed with the lecturer's performance. Some gentlemen and ladies present seemed to carry on conversations without paying attention to the stage; some even seemed to have more interest in flaunting their dresses and fans. Did the wonders of the heavens actually engage these fashionable spectators? Was there any other reason for them to join in a lecture?

Fashion was a noteworthy cause among numerous reasons which motivated people to take part in a lecture. Popular science, along with clothes, arts and other curiosities in town, was a portion of fashion in nineteenth-century culture. Fashions might be vague and unpredictable, yet they could be probed by the wide spread of a physical commodity or activity. Books, exhibitions and lectures, which attached to useful knowledge or scientific curiosities, were a reflection of this phenomenon. In the very first volume of *Punch* magazine published in 1841, an article entitled 'Punch's Information for the People – No. 1. Being a Very Familiar Treatise on Astronomy' already picked astronomy for jokes and ridiculed the fashion of popular science. "Our opinion is, that science cannot be too familiarly dealt with; and though too much familiarity certainly breeds contempt, we are only following the fashion of the day, in rendering science somewhat contemptible, by the strange liberties that publishers of *Penny Cyclopædias*, three-halfpenny *Informations*, and twopenny *Stores of Knowledge*, are prone to take with it."[49] This opening of the article not only made fun of science itself, but also mocked a mass of cheap publications which advertised familiar knowledge.

When discussing the soaring popularity of the title *Vestiges* within weeks of

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[49] 'Punch's Information for the People – No. 1. Being a Very Familiar Treatise on Astronomy', *Punch*, vol. 1 (7 August 1841), p. 41.

its publication, James Secord also links the sensation to Victorian culture of fashion. New books, prints and artworks, were often displayed at social occasions such as soirées, clubs and *conversazioni*. These novelties on display provided conversation pieces to the participants of the events; exchange of opinions and interests also took place in conversation. For authors and publishers, such social occastions were an invisible but critical battlefield, deciding the sales and reputation of the works by word of mouth. The *Vestiges* seized the initiative by successfully serving as a talking point in fashionable conversation.[50] Similar phenomena of fashion also appeared in the rapidly changing market of shows and exhibitions, sometimes in a more avid way. The exhibitions at the Egyptian Hall were usually sensational enough to convince thousands of people to flock to Piccadilly. *Punch* also lampooned the fashion of seeing freaks and wonders, which was described as 'Deformito-mania' (Fig. 6.5). The satire in *Punch* claimed: "[The] taste for the Monstrous seems, at least, to have reached its climax. The walls of the Egyptian Hall in Piccadilly are placarded from top to bottom with bills announcing the exhibition of some frightful object within, and the building itself will soon be known as the Hall of Ugliness."[51]

General knowledge of science could serve as fashionable conversation pieces. As James Secord indicates, conversation played an important role in the genteel society in the nineteenth century. The more formal talks on specialised topics between men of science took place in institutional meetings. Learned societies and institutions would also organise *conversazioni*, meetings that

[50] Secord (2000), pp. 157-166.

[51] 'The Deformito-mania', *Punch*, vol. 13 (4 September 1847), p. 90. See also Altick (1978), ch. 19, pp. 253-267.

planned for an invited speaker and the audience to engage in a discussion on prearranged topics. Soirées and salons were everyday occurrences where gentlemen and ladies participated in relaxed, informal conversation; some scientific topics were adequate options for a rational small talk in these social events. Conversational etiquette, tacitly regulating what topic and language was appropriate in a particular occasion, developed through this polite culture.[52] An accomplished celebrity who attracted the crowd's attention in a party would be the 'literary lion'; in contrast, the 'bore' in a party was despicable and only drove people away.

A satirical essay 'A Discourse of Bores' written by John Poole in the *New Monthly Magazine* in 1838 reflected this culture of conversation and the attitude towards some inappropriate manners.[53] Poole discussed the meaning of the word 'bore', of which he defined that "a bore is somebody who doesn't know when it is time for him to leave off doing something."[54] Poole gave examples of different types of bores, derived from his acute observations on people in social occasions. One particular type was the "*Superficial Bore*", who, "constantly thrusting into your face has little farthing candle of knowledge, which sheds just light sufficient to render visible his own ignorance". Poole described a figure Sam Smatter, who was possibly an anonym or a synthesis of

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[52] Secord (2007). Alberti (2003) also talks about Victorian culture of *conversazioni* for science. For earlier period, Walters (1997) has discussions on conversation in polite culture in eighteenth-century Britain, and her work much focuses on astronomy. For other cases in continental Europe, see Terrall (1996) and Mazzotti (2004).

[53] Poole, 'A Discourse of Bores', *New Monthly Magazine*, vol. 52 (1838), pp. 396-403, 551-561. Poole was a renowned playwright best known for comic dramas and had the reputation as a theatrical wit. For further biographies of Poole, refer to Peter Thomson, 'Poole, John (1785/6-1872)', *ODNB* (2004).

[54] Poole, *ibid.*, p. 396.

separate real persons, as the specimen of the Superficial Bore:

> He talks oracularly about hydrogen and oxygen; nitrates, muriates, carbonates, and sulphates; the gases, the acids, and the alkalis: though not always, perhaps, applying the terms with an exactness that would satisfy a Faraday. He disagrees with many philosophers concerning the nature of the electric fluid, and has made up his mind as to the true cause of magnetic attraction. And why should he not? or he has studied Pinnock's "Chemical Catechism" to very little purpose. Having qualified himself in astronomy by an attendance at two lectures on a Transparent Orrery, he bandies the sun, moon, and stars, as if they were so many cricket-balls; is not quite satisfied with the received theory of the tides; regrets that he is compelled to differ from Newton concerning the principle of gravitation; and […] he sees clearly the practicability of catching a comet, provided he could but find the means of putting a little salt upon its tail.[55]

The Superficial Bore was a new class of spoilsports in the age of mass printing and cheap knowledge; a by-product of the flourish of popular science. Poole satirised Sam Smatter's chief source of information was the *Penny Magazine*, "from this he *crams*; and the great portion of his talk, throughout a whole week, will be of […] according to the contents of his last number."[56] This criticism ridiculed the Superficial Bore's shallowness and constant behaviour of showing-off. The satire on the Superficial Bore reflected a fashion of talking about science. When this fashion went too extreme, it made a counterproductive effect that a poor imitation of the 'lion' only produced the 'bore'.

In such a fashion of popular science, astronomy doubtless occupied a

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55 Poole, *ibid.*, p. 561.

56 *Ibid*.

significant place. Allan Chapman cites a newspaper cutting entitled ‘The Astronomical Mania’ to show the crop of popular astronomical lectures in London during Lenten seasons.[57] This article, written by an anonymous journalist, reviewed the activities of eight lecturers including James Howell and Dr Dionysius Lardner in London theatres last Lent. Like the ‘Deformito-mania’ predicated by *Punch*, the ‘Astronomical Mania’ distinctly satirised a fashion of this kind of Lenten alternative to regular plays. A Lenten astronomical lecture, especially the famous one like Walker’s at a splendour venue, was likely a fashionable social event rather than a serious scientific feast. To receive knowledgeable instruction and sublime inspiration might be important justification according to scientific or religious authorities, yet to seize the latest fashion trend was a more effective cause for the ordinary people. This fashion did not confine to the affluent audience. The working classes were also willing to pay one shilling to gain admittance when C. H. Adams lectured at the Italian Opera House (Her Majesty’s Theatre), though Chapman cites the journalist to suggest that their real motive was “to avail themselves of the opulent delights of being in a great theatre for such a small sum.”[58]

Another account demonstrating this astronomy fever is a long drollery poem ‘Love and Lunacy’ written by Thomas Hood, in which he made a remarkable caricature of a lecture-going enthusiast. ‘Love and Lunacy’ was published in the *Comic Annual* in 1836.[59] The poem, according to Hood’s biography sixty

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[57] Chapman (1998), p. 167. The article entitled ‘London lecturers – The Astronomical Mania’ is a cutting from an unspecified newspaper dated sequentially to around 1839, in the Lee Album, M.H.S. Oxford Gunther 36, 1-3.

[58] Chapman, *ibid*.

[59] Hood, ‘Love and Lunacy’, *Comic Annual*, vol. 7 (1836), pp. 33-82.

years later, was inspired from a joke with a friend Lieutenant de Franck while Hood was living in Coblenz, Germany.[60] It is a farcical romance in which the main character Lorenzo, a boy fond of astronomy, is keen to chase after scientific knowledge. The poet described Lorenzo:

> Ah! had he been less versed in scientifics,
> More ignorant, in short, of what is what;
> He ne'er had flared up in such calorifics;
> But he *would* seek societies, and trot
> To Clubs—Mechanics' Institutes—and got
> With Birkbeck—Bartley—Combe—George Robins—Rennie,
> And other lecturing men. And had he not
> That work, of weekly parts, which sells so many,
> The Copper-bottomed Magazine—or "Penny?"
>
> But, of all learned pools whereon, or in,
> Men dive like dabchicks, or like swallows skim,
> Some hardly damp'd, some wetted to the skin,
> Some drown'd like pigs when they attempt to swim,
> Astronomy was most Lorenzo's whim,
> ('Tis studied by a Prince amongst the Burmans);
> He loved those heavenly bodies, which, the Hymn
> Of Addison declares, preach solemn sermons,
> While waltzing on their pivots like young Germans.[61]

The boy Lorenzo, to some extent, is a character like the Superficial Bore. Although he is not as ostentatious as Sam Smatter, the boy is naïvely arrogant when talking about astronomy. In one point of the plot, Lorenzo even blames himself for his girlfriend's ignorance about astronomy, convinced that he

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[60] Jerrold (1907), pp. 288-290. Thomas Hood was a poet and humorist, whose works were regularly seen in many contemporary periodicals including the *Athenaeum*, *Punch* and *The London Magazine*. For further biographies of Hood, see also Joy Flint, 'Hood, Thomas (1799-1845)', *ODNB* (2004).

[61] Hood, *op. cit*. (59), pp. 37-38.

should lead her to Bartley's Orrery rather than Covent Garden.[62] 'Love and Lunacy' humorously presents an image of a fashionable know-all, a lover of scientific knowledge derived from popular lectures and magazines, yet easily cavils about things might be seen obscure or irrelevant to other people. To read popular periodicals like the *Penny Magazine* was a fashion, as it was also to attend lectures in learned societies and Mechanics' Institutes. Lecturing men and working astronomers were all important sources of knowledge through their discourses or publications; Bartley's orrery was on a par with G. B. Airy and other elite astronomers' works.

The fashion of popular science accorded with another similar trend which the contemporaries often called 'rational amusement'. Historian Richard Altick indicates that this element of rational amusement was an acceptable and efficacious blend between what was thought to be 'useful' or 'improving' and the indulgence of human nature to enjoy oneself.[63] Rational amusement was at its zenith during the late Georgian and the early Victorian eras; a moral philosophy recognised human appetite for enjoyment yet optimistically regarded that instruction would harmonise and utilise human nature. As Altick describes, "If a choice had to be made, there was no question that instruction commanded a high priority over 'mere' enjoyment, of whatever sort."[64] Anne Secord's study on popular botany in the early nineteenth century also stresses the significance of pleasure. She argues that the popularisers in this period had realised the promotion of knowledge would "best be served by adapting to the

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[62] Hood, *op. cit.* (59), p. 79.

[63] Altick (1978), pp. 227-231.

[64] Altick, *ibid.*, p. 227.

popular forms of pleasure of the audiences they wish to reach."[65] There was no lack of such sanguine attempts to make a blend of usefulness and amusement during this period; this initiative was common in a variety of events ranging from the activities of the SDUK to the endeavour of the Great Exhibition of 1851.

Although the influence of this entertaining culture was most powerful in the nineteenth century, its root could be traced to an earlier age. The moral vocabulary of rational amusement emerged before the nineteenth century; similar phrases had already appeared in Enlightenment intellectuals' accounts. For instance, when the Irish writer Richard Steele introduced the orrery, which was then still a novel instrument in 1713, he foresaw the value of this curiosity and linked the orrery to amusement. "It [orrery] administers the Pleasure of Science to anyone, […] All Persons, never so remotely employed from a learned Way, might come into the Interests of Knowledge, and taste the Pleasure of it by this intelligible Method." Steele even claimed further: "This one Consideration should incite any numerous Family of Distinction to have an Orrery as necessarily as they would have a Clock. […] would raise a pleasing, an obvious, an useful, and an elegant Conversation."[66] Rational amusement, fashion of science, along with social practice of conversation, all weaved together in Enlightenment polite culture and later flourished in the nineteenth century.

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[65] Anne Secord (2002), p. 30. Many other studies also emphasise the concept of 'pleasure' and 'amusement' in eighteenth and early nineteenth centuries education. For example, see Kohlstedt (1990); Riskin (2008); Keene (2011).

[66] Steele, *The Englishman* (29 October 1713), p. 52; King (1978), p. 154. See also Walters (1997).

6.4 Reception: A Matter of Truth

Let us turn back once again to the issue of dissension within the audience in Hollingshead's article 'At the Play'. Hollingshead's guardian regarded the lecture as beneficial instruction and mourned its accidental interruption; Hollingshead felt that the show was dull and the lecturer was patronising without clear explaining. Other sections of the audience were probably unsatisfied too according to Hollingshead's description of their "bewildered and unhappy" faces. Not to mention the discontented sailor's disgruntled, noisy outburst. It seems that the majority of the audience in Hollingshead's story were not happy with the show. There appears to be no newspaper reports of the lecture. Even so, the newspapers might just mention casually with few lines – more likely, the show was just not newsworthy enough to elicit a mention. The overall reports of Lenten astronomical lectures in contemporary periodicals usually focused on a few celebrated performances, such as Bartley's and C. H. Adams's. It is not clear what reception many other lesser-known Passion Week astronomical amusements received.

One of the illustrations in Hollingshead's article, which entitled 'Passion Week at the Play', depicts the confused faces of the audience (Fig. 6.6). This illustration neither connects with Hollingshead's text itself, nor indicates a particular Lenten amusement scene. Nevertheless, it is a comical sketch of the audience's response to a Lenten amusement. Heavenly bodies usually replaced earthly dramas in the theatre during Passion Week; therefore, this illustration was perhaps a lampoon of Lenten astronomical shows. Unlike the claims of most advertisements, it seems that these spectators are not amused at all.

Composition and motivations of the audience were diverse, so did reactions.

Reader-response and reception theory suggest the meaning of a text would change. Readers and audience would make their own interpretation depending on personal experience, background and beliefs, rather than passively accepted the original massages which the author tried to transmit. Even if we reject reception theory, from empirical basis we realise that it is never easy to reach an overwhelming consensus on a matter. Thus a varied reception from an audience is nothing strange. Like many other scientific subjects in the early nineteenth century, astronomy could be involved in controversy. An astronomical lecture could win one spectator's approval yet simultaneously incur the wrath of another. Such dissension is understandable with controversial issues related to religion and politics.

In Chapter 4, I have shown the profound connection between astronomy and religion, as well as the relevant debates in which astronomy associated with: the science of progress (nebular hypothesis) and the plurality of worlds. We have seen the examples of J. P. Nichol's radical initiative and John Herschel's reserved stand on the nebular hypothesis debate. As the evolutionary debate later in the mid-nineteenth century shows, the tension during this period was not merely on an intellectual or theological basis. These debates are better understood in the social context of conflicting ideas of conservatism and radicalism.[67] Figure 4.5 has shown the allegory embodied the order of the world and conservatism. The complex entanglements between politics, religion and science, unsurprisingly, could be reflected in the reception of popular astronomy lectures. The following example was an account of a scathing attack

[67] Desmond (1989) is a good example of the scholarship on the relations between politics and evolution in nineteenth-century London.

on an astronomical lecturer, which provides an intriguing case of a 'war' between two opposite religious sides – atheists and Christians. The disagreement, however, might extend to politics beyond religion.

This account, published in the radical journal *The Republican* in 1825, was a letter to an itinerant lecturer Mr Rogers.[68] The letter, under a pseudonym 'A Lover of Truth', was dispatched from Portsmouth and dated 6th January 1825. It was a strong letter to dispute over Mr Rogers's lecture in the previous evening, especially the criticism he made about the 'Infidels'. One of the infidels the lecturer reproachfully mentioned was Richard Carlile, so the 'Lover of Truth' took the liberty of sending Mr Rogers three issues of *The Republican*, edited by Carlile. The Lover of Truth then attacked the religion advocated by the lecturer, and declared his belief in atheism. He addressed clearly his contempt for the lecturer:

> I must now tell you, Sir, that you did not exhibit one single rational and valid argument, to prove the existence of such a God as you appeared so very solicitous to establish in the minds of your audience. They were only such evidences as are calculated to satisfy Priests and Children, and Old Women of both sexes.[69]

The Lover of Truth not only challenged the religion of Mr Rogers, but also called into question his qualification for lecturing on astronomy:

> As to your descriptions of the Moon, Tides, &c. they were upon the whole very poor, and far beneath what I expected to hear from you; and only proved to me, that you have not been a deep

[68] 'Copy of a Letter Sent to Mr. Rogers, Itinerant Lecturer on Astronomy', *The Republican*, vol. 11 (21 January 1825), pp. 88-89.

[69] *Ibid.*, p. 88.

> reflecting Astronomer. Although, before last night, I never saw an Orrery, or ever heard an astronomical or even lunary lecture, I have the vanity to think (if vanity you choose to deem it) that were I only in possession of an equally good voice, power of articulation and delivery as yourself, and had an equal knowledge of the meaning of words, I could prove myself a much better Selenographer than you at present are, […] I would endeavour to become an astronomical lecturer, and your itinerant opponent; and assure you that I should not despair of being able to drive you out of the field, in a very few months; unless you should cease to pursue your present Theistical jargon, and in place of it begin to develop a more rational Theory, and correct knowledge of the attributes of all-puissant Matter; and also more clearly shew the relations and conditions of the stupendous glomerated bodies that float in the universe.[70]

Except for the Moon, the tides and the orrery, Mr Rogers had talked about the microscope, and adduced its vast power "with a view to confound and refute Infidels". To fight back, the Lover of Truth criticised the lecturer's reasoning and conclusions were "extremely fallacious, as well as childish." He saw the power of the microscope in the contrary view, claiming the discoveries revealed by the instrument could only turn people into atheists:

> It is those, who reflect and range fearlessly from the Minutest point, to the Greatest extent of space, that their imagination can possibly carry them; or from the Greatest to the Smallest conceivable atom of Matter or point of Space, who become Atheists; for these things shew them that there is no room left for a God to exist in. But if you should say, that God is not Matter, then, it is only a NONENTITY that you prate about.[71]

In the end, the Lover of Truth said that he would question Mr Rogers in the

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70 *Ibid*.

71 *Ibid*. p. 89.

lecture last night, but this intention was given up due to the "interested parties" in front of him. He accused that such a persecution still existed and ever raged in this country, and concluded: "I trust that the day is at hand when every honest man will boldly spurn at every Law and Custom that has its foundation in tyranny and ignorance."[72]

This letter was an unusual account of a spectator who openly opposed an itinerant astronomical lecturer. Very little is known about both the protester and the lecturer. The lecturer was probably A. F. Rogers, who had delivered discourses on astronomy at the Masonic Hall, Bath, during Lent in 1824. Rogers's lecture had a particular religious agenda of refuting objections which the 'Infidels' levelled against 'Sacred Writings', as he advertised clearly in the poster.[73] The identity of the Lover of Truth remains unknown, except that he claimed himself to be "a poor unlettered, but rational and reflecting mechanic".[74] However, we can look for clues from the journal in which the letter was published. *The Republican* was a radical journal published by Richard Carlile (1790-1843), a famous agitator and materialist in the early nineteenth century.[75] Carlile had been involved in many political activities and the editorial staff of several radical newspapers in London since the 1810s. His efforts of popularising the works of Thomas Paine, plus the ideas of radicalism and atheism spread through his newspapers, had provoked both the government and religious conservatism side against him. He was a witness to the Peterloo

72 *Ibid*.

73 King (1978), p. 317. The full name of A. F. Rogers is unknown.

74 *Op. cit*. (68), p. 88.

75 Philip W. Martin, 'Carlile, Richard (1790-1843)', *ODNB* (2004). Aldred (1923) offers another biography of Carlile in detail, though being strongly partisan, as the author states that it is written "with sympathy and understanding."

massacre and published first-hand accounts in his newspapers, which led to further charges of seditious libel and a six-year sentence between 1819 and 1825. During Carlile's imprisonment, he was granted privileges of continuing his writing in jail, and the publishing of Carlile's work was maintained by his wife and supporters. A monograph, *An Address to Men of Science* (1821), in which Carlile urged men of science to "stand forward and vindicate the truth from the foul grasp and persecution of superstition",[76] was published under the circumstances. Carlile's influence was significant among the working classes, in which "thousands flocked to his defence, to aid in publicity ventures, or help disseminate material, pulled together by religious suspicion, republicanism, and a hatred of privilege."[77] The Lover of Truth must be an acquaintance or a keen supporter of Carlile; Carlile himself could not have attended Rogers's lecture in January 1825, because he was not released from prison until November of that year.

Despite the fact that Carlile was in jail, he certainly knew about the entire row. An article 'Astronomers and Astrologers' written by Carlile was directly following the letter of the Lover of Truth in *The Republican*.[78] Carlile's essay was a more sophisticated attack on Mr Rogers, in which he refuted theism and promoted materialism. "I have traced this man [Rogers], by having had his bills sent to me, from Stockport to Norwich, and now round to Portsmouth", Carlile taunted: "To refute infidelity is his theme; but, I hope, if he comes into Dorsetshire, now he is so near, that he will come and lecture to me. We will

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76 Quoted from the title page of Carlile (1821).

77 Martin, *op. cit.* (75).

78 Richard Carlile, 'Astronomers and Astrologers', *The Republican*, vol. 11 (21 January 1825), pp. 89-195.

then soon see if astronomy demonstrates a God."[79] Carlile also belittled his opponent's motivation, asserting that Rogers was merely a profit-chasing demagogue:

> This Rogers knows well, that his pretending to refute infidelity astronomically will not deter a philosophical infidel from listening to him, whilst, he also knows, that, it is a great attraction to the silly and ignorant Christians. He does a deal of mischief, as far as he fixes that ignorance, or the prejudices associated with it; but then, he wants to fill his pocket, or his belly, and cares not how.[80]

Carlile openly spoke his antipathy towards religious elements in science in his writings. He was a determined champion of materialism, and his religious position progressed from deism to atheism through his life.[81] Carlile supported scientific education as what contemporary reformers like Henry Brougham promoted, but he went further: Carlile asserted that religion should be removed from education. In *An Address to Men of Science*, Carlile particularly criticised men of chemistry and astronomy, for they "have openly countenanced systems of error and imposture, because the institutions of the country were connected with them; or, because they feared to offend those persons who might be deriving an ill-gotten profit from them."[82] He denounced an astronomer who spoke of God as an "astrologer", and claimed that "if he [astronomer] supports the dogmas of the Priest, or the astronomical blunders of any holy book, he is a corrupt and wicked hypocrite, and a disgrace to the science which he studies,

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79 Carlile, *ibid*., p. 92.

80 *Ibid*.

81 Aldred (1923).

82 Carlile (1821), p. 3.

practises, or teaches."[83]

The row between Rogers and Carlile demonstrates an undercurrent of heresy beneath the surface of wide-spread religious narratives of popular astronomy. Undoubtedly, religious narratives, especially natural theology, influenced profoundly early nineteenth-century popular astronomy. Christian people and institutions, whether Anglican or Dissenters, contributed much to the dissemination of astronomical knowledge and the inspiration of the general public's interest in this subject. From Lenten lectures to the *Bridgewater Treatises*, religious tone was very common in astronomical popularisation during the first half of the nineteenth century. While devout Christians employed astronomy as an important instrument of moral and religious teachings, atheists and radicals had an antipathy to religious interpretations. The writings of Richard Carlile were representative examples. Opponents of the establishment would use astronomy to support their radical agenda, too. Carlile's follower thought that science is a path only to atheism. John Pringle Nichol, the radical astronomer discussed in Section 4.5, promoted the nebular hypothesis to endorse the science of progress.

Nevertheless, such a severe attack from the atheist side on a religious astronomy lecturer still seems to be uncommon. Bartley and Walker, the two much famous contemporaries in this trade who also extolled the sublimity of the Creator, had never attracted the same bombardment. In fact, Carlile did not totally oppose what they were doing. He was "much pleased to see that a number of gentlemen are giving lectures on Astronomy in all our towns and cities of any note." Carlile reasoned:

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83 Carlile (1821), p. 29; Carlile, *op. cit.* (78).

> Such men [astronomical lecturers] are worthy of support in preference to the Priest, and although they may jointly, from fear, or other motives, attempt to mix up religious dogmas with their scientific lectures, I know that it must tend to a due enlightenment of the public mind. An Eidouranion or Orrery to have been displayed a few centuries ago would have gathered a pile of faggots for the lecturer, and he would have been burnt as a darling blasphemer, and his machine with him, as the devil's workmanship.[84]

Carlile did not want to lay down the elements of astronomy. Perhaps it was exactly Rogers's overt theme of 'refuting Infidels' to light the fuse. This clash between Rogers and Carlile was the crossfire in a belligerent situation. The letter of the Lover of Truth indicates a war which broke out when an astronomical lecturer crossed the line and tangled with a fervent opponent.

Though the argument in this row was over theism and materialism, considering Carlile's political radicalism and the agenda of *The Republican*, the conflict might not be as simple as it appeared. Modern biographers regarded Carlile as a figurehead of potential revolutions in this period.[85] The Lover of Truth asserted that people will boldly "spurn at every Law and Custom that has its foundation in tyranny and ignorance" in the conclusion of his letter. The row could be stirred up by a mixture of religious scepticism and political radicalism – we will never know if Rogers had an apparent political agenda in the lecture as his religious belief. Unfortunately there exists no account from Rogers to present the other side's voice, nor the subsequent development of the row. The material presented here is partial; it is not clear whether Carlile and his supporter's criticisms of Rogers were fair or mere propaganda. Nonetheless,

84 Carlile (1821), p. 29.

85 Martin, *op. cit.* (75); Aldred (1923).

Roger's agenda on 'refuting Infidels' clearly expressed his views about God's truth, as many other contemporary Christian accounts asserted. For example, an article on astronomy in *The Youth Magazine*, an evangelical periodical aiming at Christian youth, claimed: "every reader of this paper might be enabled with sincerity and truth to adopt this language as his own, when surveying the wonders of the heavens."[86]

Intriguingly, both atheists and Christians would use the same word 'truth' in their rhetoric. Whether God's truth or atoms' truth, each side used science to endorse their belief. A devoted Christian and a subversive radical would agree more or less on the same body of scientific facts, but they could reach opposite conclusions. Lord Rosse's giant telescope at Parsonstown inspired J. P. Nichol to give his lecture audience a vision of an economic and political future, in which the prospects of the working classes would be explained by experts as clear as the heavens revealed by Rosse's great instrument. In contrast, Nichol's enemy, the astronomer Thomas Romney Robinson (1792-1882), told the audience that the giant telescope would reveal 'God is there'.[87] One telescope could lead lecturers to very different views of cosmology, politics and morality. The power of microscopes was another common metaphor used by lecturers. As Section 4.5 and the present section indicate, it could lead to different views regarding materialism, natural theology and the plurality of worlds.

The truth about the audience's reception is, perhaps, that to collect

[86] 'The Wonders of the Heavens', *The Youth's Magazine*, 3rd series, vol. 6 (August 1833), p. 267.

[87] Schaffer (1989), p. 156. Robinson was an Anglican priest and the long-time director of the Armagh Observatory in Ireland. For biographies of Robinson, see J. A. Bennett, 'Robinson, (John) Thomas Romney (1793-1882)', *ODNB* (2004).

audience's reception would face a problem. The difficulty is the fragmentation and partiality of the data. It is hard to reach an unanimous verdict on a performance, and a normalised view about reception could be risky and untenable. The case of the Lover of Truth, and other examples of spectators' reactions in this chapter, remind us to be careful with audience's reception when discussing popular astronomy in the nineteenth century. Political and religious interests could influence reception of lectures; therefore, personal criticisms and reactions have to be scrutinised. Though a religious row is shown in this section, I do not attribute all controversies within popular astronomy to the tensions between materialists and Christians, or between radicals and loyalists. The comparisons in social context are useful for our understanding of the big picture, but do not indicate that every single case could be interpreted in this way. Historians should be cautious about any oversimplified view depicting debates as the 'pure' conflicts between two polarised camps, such as scientists versus the Church or the subordinate populace against the hegemonic elites.[88] These kinds of ideological depictions might provide a particular perspective but the real situations were never clear-cut.

Chapter Conclusion

This chapter has demonstrated the heterogeneous composition of audiences of popular astronomy lectures in nineteenth-century Britain. Juveniles, women and parents, were particularly important target audiences in the market. This

[88] Criticism of Whiggish historiography of science is similar to my point here. For Whiggish historiography of science, see Jardine (2003). Nieto-Galan (2011) has a review on the historiography of ideology-loaded social history of science, and focuses on the hegemony concept of Antonio Gramsci.

tendency accorded with the conventional emphasis on the educational value of astronomy in Enlightenment polite science culture. It also reflected the attitude that astronomy was deemed to be a suitable and beneficial science by accommodating didactic moral and religious teachings. Nevertheless, the motivations and reactions of audiences varied. Contemporaries might attend lectures to follow fashion, seeking knowledgeable instruction, to indulge in plain amusement, and so forth.

Unlike the presumption of viewing audiences as mere consumers of science, nineteenth-century audiences could be avid participants in the arena of popular astronomy. They might also disagree with lecturers on the agenda or performance. Sometimes disagreements were tense due to opposite religious or political stands. The conflict between the religious lecturer Rogers and the radical Carlile exemplified such tensions. The analysis of the Carlile case also agrees my argument that nineteenth-century popular astronomy lecturing was a contested sphere. Lecturers, commentators and audiences had their own say. They all could possibly be caught in the crossfire.

Table 6.1 Categories of the Audience

Category	Subdivisions	Indications
age	• children / juveniles • adults (especially who have supervisory roles, e.g. parents; guardians; teachers)	ABCD
gender	• females • males	BD
social classes / finances	• the upper classes • the middle classes • the working classes	ABCD
political or religious stands	• Christians • atheists • political radicals	BC

(Table 6.1) The main categories of the audience which are covered in this study. The following indications are employed: (A) Admission charges for the lecture. (B) Personal accounts or reports of the lecture, e.g. periodical articles and memoirs. (C) Institution's or lecturer's agenda. (D) Visual evidence of the lecture, e.g. illustrations.

Table 6.2 Admission Charges of Popular Astronomical Lectures

Lecturer	Year	Venue	Charges (Shilling) *
D. F. Walker	1819	English Opera House	5 (B); 3 (P); 2 (G); 1 (UG)
	1838	Colosseum	3 (B); 2 (Pm); 1 (P)
R. E. Lloyd	—	Haymarket Theatre	5 (B); 3 (P); 2 (G); 1 (UG)
G. Bartley	1822	English Opera House	5 (B); 3 (P); 2 (G)
C. H. Adams	1835	King's Theatre	4 (S); 2 (B); 1 (P)
	1854	Adelphi Theatre	21 (PB); 10.5 (PB); 3 (S); 2 (B); 1 (P); 0.5 (G)
J. Wallis	1827	London Mechanics' Institution	24 for annually subscription; 6 for quarterly subscription
	1846	Royal Institution	Non-subscribers: 21 (adults) or 10.5 (children) for a course of six lectures; Subscribers: 42 for a season; Members' children: 21 for all lectures
G. H. Bachhoffner	1845	Polytechnic Institution	1 (adults); 0.5 (schools)
	1859	Colosseum	1 (adults); 0.5 (children and schools)

(Table 6.2) Selected examples of the prices for admittance to an astronomical lecture or a course in London between 1810 and 1860. The unit of the price in this table is shilling. Source: RAS: Add MS 88: 2-8; RI: GB 2: p. 47; *The Athenaeum* (5 March 1859), p. 322; *The Examiner* (15 February 1845), p. 109; *The Examiner* (27 September 1827), p. 623; *The Examiner* (11 March 1838); *Morning Chronicle* (13 March 1835).

***** Abbreviations: Box (B); Private Box (PB); Pit (P); Gallery (G); Upper Gallery (UG); Stall (S); Proscenium (Pm)

Chapter 7 Conclusion

This chapter will conclude my thesis. The development, and various aspects, of popular astronomy lecturing in nineteenth-century Britain have been presented in previous chapters. Aspects covered in my thesis include lecturers, sites, subjects, apparatus and audiences. As the 'sublime science' described by nineteenth-century contemporaries, astronomy drew much attention. Its popularisation exploited sublime appeal and practised in a commercial manner. Private entrepreneurs flourished in the lecturing business before and during the first half of the nineteenth century. However, the trade and market were in transition. Two transitions, the theatrical turn and the decline of opportunities for private lecturers, are central to my thesis. The frame of this concluding chapter is therefore as follows: First, Section 7.1 gives an epilogue. Section 7.2 summarises my main lines of arguments. The summary provides not only a synopsis, but also a comparison with other scholarship. Finally, Section 7.3 will identify several perspectives neglected in my thesis. These perspectives form noteworthy directions for future work.

7.1 Epilogue: The End of an Era

The front page of the journal *Athenæum* was a marketplace for collecting and distributing information. Advertisements and notices related to science, literature, education and fine arts occupied the front page of every issue, such as the issue published on 15th July 1865 (Fig. 7.1). Among myriads of notices, one advertisement particularly addressed to lecturers, institutions and persons who sought a profession. This advertisement was, in fact, an implied message indicating the end of an era. "FOR SALE, the original EIDOURANION, or large transparent Orrery, with which the late Mr. Deane, Franklin-Walker [*sic*] Lecturer on Natural and Experimental Philosophy, illustrated the successful and popular Lectures on Astronomy which he gave in London for many Seasons during Lent." It announced further: "Also, the extensive PHILOSOPHICAL APPARATUS lectured on by him at the Public Schools and Colleges."[1] This sale of the instruments did not work. Four months later, the same advertisement repeated in the *Athenæum*.[2] Unless there was more than one set of the original Eidouranion, it seems no buyers were found. We do not know the fate of the Eidouranion and other instruments. When remarking on the excellent career of D. F. Walker, the obituary in the *Gentleman's Magazine* sentimentally noted:

> The world and science, however, have moved on mightily since the day when "Walker's Lectures" and the starry scenery of "the Eidouranion" were in the height of their popularity, and the generation that used to talk of him has passed away.[3]

This short passage from the obituary of D. F. Walker mourned the passing of the lecturer as well as a trade in decline. The Walkers had been the epitome of Lenten astronomical lectures and the theatrical performance of the transparent orrery since Adam Walker in the late eighteenth century. No known family members of the Walkers inherited this legacy after D. F. Walker. At the moment when the late Mr Walker's property was for sale, many other once-celebrated lecturers also faded out from the stage. C. H. Adams had already retired from his over-thirty-year annual lecturing; George Bachhoffner was no longer the

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[1] *The Athenæum* (15 July 1865), p. 65.

[2] *The Athenæum* (25 November 1865), p. 709.

[3] 'Mr. Deane Walker', *The Gentleman's Magazine*, vol.2 (July 1865), p. 113.

manager of the Colosseum. It does not mean that no further Lenten astronomical lectures occurred hereafter, but this seasonal amusement was indeed less and less noticeable in the public's attention.

There had been attempts to revive Lenten astronomical lectures, but these were fruitless. John Henry Pepper, the renowned scientific showman, once tried to restore astronomical lectures at the Royal Polytechnic Institution after Bachhoffner's departure. During Lenten season in 1871, Pepper revived the Polytechnic's astronomical lectures on Thursday afternoons and the *Theatrical Journal* revisited this faded convention. "Many of us must remember the time when the poor player was not allowed to exercise his calling during the Wednesdays and Fridays of Lent, his place on the boards being taken up on these days by mountebanks, negro melodists, and the like," the anonymous journalist reminded the readers: "the best of the substituted exhibitions being Mr Adams's annual Orrery at the old Adelphi." The journalist said Professor Pepper's astronomical lecture was a reproduction of this "once popular representation of the revolutions of the heavenly bodies".[4]

The *Theatrical Journal* remark shows that the ban on regular plays during Lent was no longer enforced in 1871. Before the mid century, Lenten restrictions on dramatic performances had already been flouted by many minor theatres. By the 1860s, the restrictions seemed to be completely lifted. People no longer refrained from theatre-going and pleasure-seeking. As a result, the initiative for astronomical lectures as an alternative to regular plays during Lent was gone. Besides, conventional Lenten astronomy lectures faced more competition. They encountered not only changing fashion for amusements, but

[4] 'Royal Polytechnic', *Theatrical Journal*, vol. 32 (15 March 1871).

also increasingly institutionalised science.

The nature of London entertainments had changed much in the mid-Victorian era. Not only Lenten astronomical lectures but also many other types of shows were on the wane. Historian Richard Altick has analysed the decline of panoramas and other exhibitions in the post-Crystal Palace era. He argues that several factors changed the pattern of city life and leisure. These factors included changing transportation and social fashion.[5] Railways infrastructure allowed people to conveniently travel to rural regions, which changed patterns of leisure and partly disintegrated the importance of Leicester Square as a recreation centre.[6] Tastes and standards also changed. The Great Exhibition of 1851 spoiled spectators in an incomparable scale with good value on one-shilling days, which made any other Leicester Square spectacles seem meagre. One-man lectures and exhibitions now faced more severe challenge from new entertainments such as music halls, the relocated Crystal Palace at Sydenham, and later state-founding museums and galleries on the South Kensington model.[7]

The demise of Lenten spectacles of astronomy did not represent the end of popular astronomical lectures. Astronomical discourses were flourishing in scientific institutions and local astronomical societies, yet private showmen had less and less room in a world of institutionalised science. There was no lack of

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[5] Altick (1978), pp. 470-473 and pp. 504-509.

[6] Altick, *ibid*. For the significant influence of railways on Victorian culture and everyday life, see Freeman (1999). See also Secord (2000), pp. 24-28; Fyfe (2012), pp. 97-109.

[7] Secord (2004b) uses the Crystal Palace at Sydenham to examine the tangle between spectacle, commerce and expertise. For the rise of public museums and museum visitors' experience in the second half of the nineteenth century, see Forgan (1994, 2005) and Alberti (2007).

working astronomers who engaged in public lecturing or popular writing throughout the nineteenth century. John Pond, John Herschel, J. P. Nichol and G. B. Airy, were much noticeable among astronomical authors and lecturers. Later on, in the late nineteenth century, Richard Anthony Proctor (1837-1888) and Arthur Cowper Ranyard (1845-1894) made enormous efforts to conduct popular astronomy. Each established their credentials as a practising astronomer, but then later turned attention to working as an editor, popular author, or lecturer. Proctor founded the journal, *Knowledge*, a popular science monthly with extensive astronomy coverage. He also made lecture tours across the Atlantic. After Proctor's sudden death, Ranyard took over as *Knowledge*'s editor. He also completed unfinished books left behind by Proctor.[8]

The brightest star in the firmament of British popular astronomy during the last two decades of this century, however, was Irish astronomer Robert Stawell Ball. Ball was Andrews professor of astronomy in Trinity College, Dublin, and later Lowndean professor of astronomy at Cambridge. He was deeply involved in public lecturing and popular writing, hence earned a reputation as a skilful and delightful populariser. Ball's frequent lecturing at the Royal Institution, along with publishing bestsellers such as *The Story of the Heavens* (1886) and *Star-Land* (1889), shows his success in astronomy popularisation (Fig. 5.4). Ball was also renowned for his adept use of lantern transparencies, a visual aid used widely by private astronomical showmen since before the Crystal Palace.[9]

[8] Mussell (2009a); Lightman (2007b), ch. 6, pp. 295-351. For biographies of Proctor and Ranyard, refer to Roger Hutchins, 'Proctor, Richard Anthony (1837-1888)', *ODNB* (2004); W. H. Wesley, Anita McConnell, 'Ranyard, Arthur Cowper (1845-1894)', *ODNB* (2004).

[9] Lightman (2007b), pp. 397-417; Butterworth (2005). Ball presented juvenile lectures at the Royal Institution five times within two decades (1881, 1887, 1892,

Ball's success in both academia and the popular circle indicated the commencement of a new era. Popular astronomy was increasingly the franchise of the new generation of science practitioners. 'Amateur' lecturers without association with scientific bodies, like D. F. Walker and C. H. Adams, were losing their place in a professionalised and specialised world of science.[10] Though there is no sharp periodization, the market for popular astronomy lectures after the 1860s was quite different from the market before.

7.2 Summary of the Thesis

This thesis has presented analyses of the practitioners, sites, curriculums, apparatus and audiences of popular astronomy lecturing in nineteenth-century Britain. Lecturers who were active approximately between 1820 and 1860 have been the focus. The backgrounds, activities, agendas and means of these lecturers have been discussed. My study shows a wide spectrum of astronomical popularisers active during this period: lecturers were talking about the heavens at sites ranging from Mechanics' Institutes to West End theatres. The styles and languages of these lecturers were differently adapted to specific settings and audiences. A discourse delivered by a Cambridge professor at the Royal Institution on Friday evenings was very different from what was performed by an amateur showman on the stage of the English Opera House during Passion Week. My study also shows a competitive market for popular astronomy lectures. As indicated in Chapter 1 and Chapter 3, historians, such as James Secord, David Livingstone and Iwan Morus, stress that

1898 and 1900).

[10] Bernard Lightman uses Ball and Thomas Henry Huxley as role models to discuss this trend of practitioner populariser in the late nineteenth and early twentieth centuries. See Lightman (2007b), pp. 417-421.

nineteenth-century science was a contested space, in which scientific knowledge was produced and propagated in a variety of localities.[11] The results of my research accord with the scholarship.

I argue that ‘commercial’ and ‘sublime’ were the two most significant features in nineteenth-century popular astronomy lecturing. Lecturers competed with each other in the market. In most instances, audiences paid for admission. To attract attention, lecturers were responsive to the audience’s demand. Lecturing could also be a route to gain profit, whether material wealth or social status. These practices all formed commercial components in the lecturing trade.[12] In addition to this economic side, astronomy lecturing was also rich in emotional appeal. Lecturers exploited the sublime – the awe and wonder of the universe, and religious reverence inspired by such sublimity. As indicated in Chapter 4 and Chapter 5, the curriculums and the apparatus used in astronomy lectures exemplified the commercial and sublime features. While traditional natural theology narratives were prevalent in the discourses during the first half of the nineteenth century, lecturers would also include novel topics from sensational headlines in the syllabuses. The visual aids they used were tools of the sublime – the aesthetic and dramatic representations embodied the sensational feeling popularisers tried to evoke.

In this thesis, particularly in Chapter 2, I draw a comparison between two presumably distinct groups – institutional men of science and private lecturing

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[11] See, for example, Livingstone (2003); Secord (2004a); Morus (2006). For further references, refer to Chapters 1 and 3.

[12] See Secord (2000), ch. 13, pp. 437-470, for his explanation of ‘commercial science’. My adoption of the phrase ‘commercial and sublime’ is explained in Section 1.5.

entrepreneurs. Such a dichotomy is a rough division and we should be careful with this categorisation. The boundary was blurred in the first half of the nineteenth century. The identity of an astronomical lecturer was mixed. The demarcation between 'professional' and 'amateur', or between 'institutional' and 'private', was slight and sometimes a practitioner could belong to both.[13] Furthermore, popularity and credibility did not necessarily follow one's identity as a 'professional' or 'amateur' practitioner. When contemporary laypersons looked for particular answers to astronomical phenomena, they could seek George Bartley's orrery lecture as well as William Whewell's *Bridgewater Treatise*. As historians Ruth Barton and Allan Chapman indicate, there was no consistent association of amateur with lower scientific standing before and during the mid-Victorian era, especially in the realm of astronomy where most practitioners were amateurs on financial grounds.[14]

Although different classes of lecturers are all in my study's coverage, I emphasise a group of private lecturing entrepreneurs. This group of popularisers includes itinerant lecturers, spectacle exhibitors and theatre showmen. I focus on the Walkers, George Bartley, John Wallis, C. H. Adams and George Bachhoffner. My thesis has original contributions to the biography of these individuals. For example, I provide new biographical information about C. H. Adams's astronomy lecturing career. The collaborations between George Bartley and the playwright Samuel James Arnold are identified. My study includes a full transcript of their lecture syllabus *Ouranologia* from the

[13] Lightman has the same observation about popularisers and practitioners in the second half of the nineteenth century; see Lightman (2007b), pp. 494-496. The boundary in the first half of the century was even vaguer.

[14] Barton (2003); Chapman (1998). See also the discussions in Chapter 2.

British Library, which provides a valuable instance of a Lenten lecture. The significance of John Wallis and the Walkers in popular astronomy are also elaborated. My emphasis accords with Bernard Lightman's aim of securing a distinctive place for non-practitioner popularisers who were frequently at odds with scientific naturalists on the 'topography' of British science.[15]

This emphasis on private entreprenuers has two reasons. First, conventional scholarship of science popularisation has given much attention to eminent men of science. Many of these figures in the spotlight were either intellectual elites or professional specialists, such as Humphry Davy, Michael Faraday, John Herschel and William Buckland. These famous men of science, no doubt, made substantial contributions to popularisation. There is relatively abundant biographical and historical material about these prominent individuals; their social status and links with scientific establishments also give them more visibility. However, non-practitioner popularisers who lacked institutional affiliation also existed in the market. Some of them enjoyed similar recognition to those celebrated men of science. These private popularisers had the ability to reach a great number of audiences. The language they spoke was plain; the representation they made was sensational. The influence they exerted on audiences is usually underestimated by modern readers. Most of these private popularisers are long forgotten. My thesis fills up the gaps in the scholarship.

Second, the lecturing done by these private popularisers was often located in venues other than explicitly prescribed scientific sites. Theatres, for example, were sites which not many studies of history of science have covered. My thesis highlights onstage astronomical lectures in theatres, of which many were

[15] Lightman (2007b), pp. 489-494.

held during Lent. Theatrical effects and natural theological narratives of Lenten astronomical lectures made this kind of performance very distinct from the ones in a scientific institution. The practice of science is usually associated with places where original researches are conducted, such as laboratories and observatories. In the case of communicating scientific ideas to the public, the same stereotypical view would lead us to pedagogical sites like formalised institutions and schools. However, recent studies have revisited this perspective and showed more possibilities. Communication of scientific knowledge could take place in various venues outside conventional pedagogical sites. It could be prevalent in domestic environment or at the sites for amusement.[16] Livingstone and Secord both argue that scientific knowledge has been produced and propagated in a wide range of spaces, where science has been part of the public sphere and has been practiced in a variety of popular arenas.[17] In response to this argument, Lightman indicates that in order to understand the communication of scientific ideas, historians "must think about how lecturing was experienced differently by audiences depending on the sites of delivery."[18] My emphasis of Lenten lectures in theatres follows these scholars' point.

My thesis is a good comparison with Lightman's work *Victorian Popularizers of Science* (2007). Lightman focuses on the second half of the nineteenth century, a period when Darwinian evolution and scientific

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[16] For example, Kohlstedt (1990), Taylor (2009), Al-Gailani (2009) and Keene (2011) demonstrate case studies of science education in domestic environment. The Great Exhibition of 1851 and the later Crystal Palace at Sydenham, along with various spectacles in nineteenth-century London, provided examples of the mixture of science and amusement. For the cases above, see Secord (2004b), O'Connor (2007), Bellon (2007) and Morus (1998; 2007).

[17] Livingstone (2003); Secord (2004a).

[18] Lightman (2007a), p. 98.

naturalism prevailed in an increasingly professionalised space. It was also the period which Richard Altick calls the 'post-Crystal Palace era', when London's social milieu for exhibitions and amusements changed significantly. My research emphasises the period from 1820 to 1860, and thus offers an 'extension' of Lightman's perspective into earlier decades.

One important aspect Lightman stresses relates to how the development of professional and popular science in adjacent (sometimes even overlapping) spaces led to mutual influence with each other. Professionalisation created or left behind a space for popularisers. Likewise, the success of popularisers was partly responsible for compelling professional practitioners to engage more in popularisation.[19] Lightman's observation is based on the comparison between practitioners of science (of whom scientific naturalists were significant) and non-practitioner popularisers.[20] This demarcation was, however, much vaguer before mid-century. Amateur astronomers and private lecturers were active and occupied a large space in popular astronomy lecturing in the first half of the nineteenth century. Many of them had weak or no connections with scientific institutions or elite coteries. These non-practitioner popularisers thrived before the rise of scientific naturalists in the late nineteenth century. The young generation of scientific naturalists, such as Thomas Henry Huxley and John Tyndall, tried hard to secure autonomy for science by advocating the strategy

[19] Lightman (2007b), pp. 495-496.

[20] Lightman uses the phrase 'practitioner of science' to distinguish between those who were engaged in conducting research and those popularisers who focused on writing and lecturing. In my thesis, non-practitioner popularisers therefore mean who did not do astronomical observation or research. See Lightman (2007b), pp. 9-13; see also my definitions in Chapter 1, n. 4.

of professionalisation.[21] They made the demarcation clear and some practitioners who had originally happily working in the grey zone were banished to the fringe, or even the outside, of professional science. As I have claimed in Chapter 2, the trend of popular science was therefore an exclusion of old practitioners from autonomous professional science, rather than a newborn class of non-practitioner popularisers filled the space left by professionalised scientists. Lecturers like the Walkers, John Wallis and George Bachhoffner, exemplified the practitioners who had been marginalised. There were still many non-practitioner astronomy popularisers in the end of the nineteenth century, but they either attached themselves to institutions or were accepted by elite scientists.[22] Agnes Mary Clerke (1842-1907), for example, acquired a good reputation by her extensive writing on popular astronomy.[23] Clerke did not have any institutional post but kept good relations to scientific communities. She received the Actonian Prize from the Royal Institution in 1893 and was elected an honorary member of the Royal Astronomical Society in 1903.

Two significant transitions of popular astronomy occurred before and during the nineteenth century. These form my main lines of arguments. The first transition was the theatrical turn – theatricalising of astronomy lectures, which

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[21] Many of Lightman's works address this point. For example, see Lightman (2004; 2014). See also Lightman and Reidy, ed. (2014); Dawson and Lightman, ed. (2014).

[22] Peter Bowler's work on popular science writing in the early twentieth century is a good comparison with this point. Bowler indicates that many semi-professional authors, who were not active scientists, exploited close contacts with the scientific community. See Bowler (2006; 2009).

[23] For Agnes Mary Clerke's biography, see Brück (2002); H. P. Hollis, *rev* M. T. Brück, 'Clerke, Agnes Mary (1842-1907)', *ODNB* (2004).

began in the late eighteenth century and became extensive before the 1820s. The theatrical turn transformed natural philosophy demonstrations into onstage astronomical shows. The key feature of this transition was the use of large apparatus such as the transparent orrery and the likes for adding theatricality. The proprietors of these onstage machines stressed scenic effects to offer the audience sensational splendours of the universe. As indicated in Chapter 3 and Chapter 5, this trend towards theatricality was welcomed by many audiences and commentators. Nevertheless, it was also criticised by some specialists of science for failing accurate scientific instruction. The theatrical turn and its reception reflected a dilemma about handling of dramatic performance in scientific demonstration. On the one hand, elements of theatricality could seize audiences and be a device for gaining public appreciation. On the other hand, such a device also had potential dangers of undermining credibility.[24]

The other transition was the decline of private entrepreneurs after the 1860s. Traditional showmen fell out of favour; the transparent orrery shows were no longer fashionable whether as entertainment or instruction. Although this kind of sensational science had been replaced by other new amusements and lost its glory in theatres, the new generation of science practitioners learned and exploited its visual culture in institutional lecturing. Ball's good use of lantern slides, plus his exercise of showmanship, provided a good model of practitioner populariser in the late nineteenth century. Performers and sites might change, but theatricality did not diminish. Audiences had already

[24] Golinski (1989) uses the case of public demonstrations of phosphorescence in the early Royal Society to explore this dilemma. To present a spectacular novelty like phosphorus could risk creating confusion between the role of an experimental philosopher and that of a charlatan. See also Morus (2010a) and Wintroub (2010) on performativity.

accepted the representation of sensational science. To make science accessible, Ball and Huxley had to adopt sensational narratives in their popular writing by telling the story of evolutionary epic or through a focus on common objects – a method which had been employed by many pioneer popularisers.[25] Whether they liked it or not, professional scientists who wanted to speak to public could not get away from popular language, narratives and representation. They had to appeal for both sense and sensibility, just as their predecessors had done. Professional scientists might not appeal to religious reverence, but they still framed their work in the language of awe and wonder in the universe. In other words, they continued to exploit the sublime.

Although opportunities for private lecturers declined after the 1860s, they were flourishing in the first half of the nineteenth century. One of my central arguments is the continuous prosperity of private lecturers in the market for astronomy lecturing during this period. In his article on early nineteenth-century London lecturing scenes, Jo N. Hays argues that scientific lecturing in London was decisively institutionalised by the 1820s. He claimed the scientific lecturing trade had changed notably in the direction of formalisation since then and the importance of private lecturers was seriously undermined.[26] My study, however, disagrees with Hays's point. As I have shown in Chapter 2, private lecturers in the area of astronomy continued to thrive until the 1860s. The growth of institutions did contribute to a level of formalisation and refinement of scientific lecturing; nevertheless, private

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25 Lightman (2007b), ch. 7, pp. 353-421. The use of familiar objects in popular writing, lectures and domestic education of science was common in the nineteenth century. Michael Faraday's lecture on the chemical history of a candle was the foremost instance. See Faraday (2011) and Keene (2014).

26 Hays (1983).

showmen co-existed with institutional lecturers in the marketplace. They were competitive and were not inferior to institutional rivals during the first half of the century. The major cause of the different observations between Hays's and mine is the sites we focus on. Hays emphasises the activities in scientific institutions, specialised societies, colleges and hospitals for medical training. In contrast, my study encompasses the venues outside the above prescribed scientific sites, such as theatres and spectacles.

7.3 Future Work

Several perspectives are not covered or mentioned little in this thesis. The first among the list is the issue of professionalisation. The course of professionalisation in astronomy or science at large is beyond the scope of my thesis, for my study is more a practical survey in empiricist view than a theoretical analysis. What I have done is to include a wide variety of relevant individuals and use porous categories for identifying practitioners in popular astronomy lecturing. I have discussed several aspects related to professionalisation, including the dichotomy between institutional and private popularisers, the qualification for astronomy lecturing, and the demarcations asserted by scientific naturalists. Nevertheless, this thesis does not present an account of the process of professionalisation of British astronomy or the astronomy lecturing trade.

The second perspective I omit in this thesis is regional difference. Although the geography coverage in my study does not exclude any part of the British Isles, this thesis actually focuses heavily on the activities in London. Outside the metropolis, a few provincial towns in England are another focus of my attention, especially the industrial urban North such as Manchester and Liverpool. Nonetheless, the coverage of the Northern cities in this thesis is still far less than the report of London, not to mention the situation in other parts of Britain. Such regional preference also reflects on the choices of the focusing institutions. The Royal Institution and the Royal Manchester Institution are the two particular cases I discuss more extensively in this thesis. The reasons for choosing these two samples are plain: partly because both were then representative scientific bodies in their locales, and partly also due to the archival materials I receive during the course of this study. No doubt, there were far many other institutions across Britain; the two institutions were not the sole players at their cities, either. The omission of inspecting more institutions in the provinces could produce a critical imbalance in my research. However, this thesis does not intend to be a definitive or comprehensive survey; my focus on the capital is still reasonable. As indicated in Chapter 3, London had been a world-class metropolis by the early nineteenth century. The finest commodities and the most peculiar spectacles gathered there. There were examples of prominent lecturers, such as Adam Walker, who started their careers in the provinces and then moved to London.[27] The commercial arena in the metropolis was more competitive than in other places. Success in London market could be a shining endorsement of a lecturer's competence when he went on the lecture circuit.[28] Londoners' fashion and taste influenced

[27] Adam Walker began to lecture on astronomy and natural philosophy in Manchester around the 1760s. Before he permanently settled in London after 1780, Adam Walker had temporarily moved to London and paid a few lecture visits to the Midlands. See Altick (1978), pp. 309-310.

[28] For example, the advertisement of R. E. Lloyd's lecture visit to Edinburgh noted that "With all the Splendid Scenery annually displayed in London." *The Edinburgh Literary Journal*, vol. 29 (30 May 1829), p. 20.

provincial audiences. Therefore, my emphasis of London is a practical starting point of a broader scheme. Many issues related to geographical difference such as interactions between the metropolis and the provinces, or comparisons between centre and periphery, are not discussed in this thesis.[29] I have shown that variant popular astronomy lectures took place in every corner of Britain, even at remote frontiers such as Guernsey.[30] There is much space for future studies.

The third perspective relates to the images of science and its practitioners. Studies of science popularisation often meet some fundamental problems: Who speaks for scientific issues? Who has the authority to represent science? What if a presenter of science is not the very person who works on science? Similar questions, as Lightman and many other scholars have asked, are continually challenging our perceptions of the images of science.[31] These questions can be linked to the perspective of professionalisation as well as boundary-work – how we define the boundaries between science and non-science, between science and popular science, and between science and alternative science. One of the most distinct human activities in comparison with science is the arts. Art is beyond the realm of science, yet there are plenty of examples of artistic

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[29] There are many researches regarding the provinces or the periphery in the history of science. For example, Jones (2008) and Elliott (2009) focus on the scientific culture in the Midlands (Birmingham and Derby, respectively) during the Enlightenment and the Industrial Revolution. See also Inkster and Morrell, ed. (1983); Papanelopoulou et al., ed. (2009).

[30] William Berry (1774-1851) was an English genealogist and is best known in Guernsey as the author of the first published history of the bailiwick. However, Berry also lectured on astronomy with the transparent orrery in Guernsey. The Priaulx Library preserves Berry's materials including a lecture poster dated 1811. For William Berry's life and his connections with Guernsey, see Clark (1987).

[31] See, for example, Lightman (2007b), p. 496.

creations to be inspired, interpret, or even represent science. From Dr Frankenstein to Dr Strangelove, for a long time the general public perceive science by the depiction of artistic creations.[32] The public image of science is usually constructed upon the ‘hybrid’ of science and the arts, rather than ‘pure’ – if there is any – scientific practice itself. In the case of nineteenth-century popular astronomy, astronomical lectures were mixed with the theatre or other forms of entertainment, of which Lenten orrery shows and the Polytechnic Institution’s exhibitions were fine examples. Lecturers who spoke for astronomy on the stage could be an actor, an entertainer, or any other profession without scientific training. Insofar as the twilight zone between science and the arts, there is immense grey area between scientific lecturing and dramatic performance. Samuel James Arnold’s *Ouranologia* was a scientific lecture syllabus, yet could be also interpreted as a well-adapted performance starring an actor as the lecturer.[33] Elements of the arts, the theatre and entertainment in popular science are an important allusion in my thesis, yet I have not discussed this notion in detail. This perspective connects the history of popular science to a broader cultural context, and would help us to better understand the faces and the voices which shape the images of science.

The links with the arts in popular science direct us at a broader interpretation of scientific lectures. John van Wyhe reminds historians that we should pay attention to public lectures as an overall experience. Lectures were not merely

[32] Haynes (1994); Frayling (2005).

[33] Another example I have not discussed in my thesis was an astronomical extravaganza ‘The New Planet’, produced by James Planché following the discovery of Neptune. It was an intriguing example showing the dramatist’s sensitivity for catching passing fashion of a scientific sensation. See newspaper story ‘The Theatres’, *Illustrated London News* (10 April 1847), p. 234.

"a speaker and an audience at a specific time in a particular space"; they were a group of activities clustered around lecturers to engender and diffuse thoughts.[34] These activities included opportunities for visiting local institutions, meeting and conversation with the lecturer, display and sale of related artefacts, and other more private occasions such as inviting the lecturer for dinners and so on. These events could last over a period of days before and after the actual lectures. Through this cluster of social and intellectual events which were accommodated around lectures, thoughts advocated by lecturers diffused to attendee. John van Wyhe uses this aspect from the interdisciplinary field 'diffusion of innovations' to analyse the spread of phrenology in nineteenth-century Britain.[35] Although astronomy was not an innovation like phrenology in the early nineteenth century, van Wyhe's claim about viewing lectures as overall experience is worth considering. Popular astronomy lecturing also usually consisted of commercial and social elements: exhibition, promotion and sale of instruments and books; chances of interacting with visiting lecturers. Furthermore, we should think of those extra fillings in science discourses, such as music, lighting, visual displays and dramatic effects, which were prevalent in nineteenth-century popular astronomy. They offered the audience amusing experience and conversation pieces before, during and after the lecture. This broadening viewpoint of lectures covers things behind and beyond auditoriums.

Finally, although this thesis focuses on the nineteenth century, I would suggest a broader perspective of my research beyond this period. Today's

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[34] van Wyhe (2007), p. 71 and pp. 82-83.

[35] For scholarship on diffusion of innovations, see references listed in van Wyhe (2007).

audiences are familiar with those purpose-built planetariums at museums or science centres, where the firmament is projected onto the dome by the optical projector, like a genie being released from a magic lamp. The history of modern planetarium projector is not long. The world's first model was constructed by the Carl Zeiss works and was installed at the Deutsches Museum in Munich, of which the first public showing was on 21st October 1923. Many elements of the shows in twentieth-century planetariums can be found in nineteenth-century lectures in theatres. The glorious days of the Walkers' Eidouranion passed and Lenten astronomical spectacles were gone; however, their spirit lingers. Old theatrical showmanship, perhaps, had been adapted for new technology and tactics in twentieth-century lecturing scenes.[36] This thesis, I expect, not only presents popular astronomy lectures in the nineteenth century, but also bridges the gap between the past and the present of astronomical shows.

[36] Bowler (2009) provides a good survey of British popular science writing in the early twentieth century until the outbreak of World War II. There are studies on the development of planetariums in the twentieth century. For example, King (1978), ch. 21, pp. 341-368; Marché (2005).

Appendix A

Directory of Astronomical Lecturers in Britain, 1800-1870

This directory lists people known to have delivered at least one public lecture on astronomy in Britain between 1800 and 1870. It collects lecturers of different background, affiliation and agenda. In **bold** are all individuals, with evidence for delivering multiple lectures in two consecutive years, or lectures in any three non-consecutive years. Noted with an asterisk (*) are individuals receiving special attention in this thesis, i.e. having detailed biographical coverage.

Sources for this directory include advertisements, playbills, syllabuses, reviews, and news reports in the periodicals. These references are seen in the main text of this thesis and hence do not repeat here. Some biographical information refers to the *Oxford Dictionary of National Biography* online (*ODNB*, 2004). The main limitation of this directory is therefore excluding lecturers who did not advertise or receiving other coverage.

The format of each entry follows this order:

Name (birth and death) / affiliation or occupation / place of lecturing / years of lecturing or active period

* **Adams, Charles Henry** (1803-1871) / private; schoolmaster / King's Theatre (Her Majesty's Theatre); Haymarket Theatre; Lyceum; Adelphi Theatre; Princess's Theatre / 1830-1861

Airy, George Biddell (1801-1891) / Astronomer Royal (1835-1881); FRS; FRAS / Royal Institution / 1848, 1851, 1853-1855

Babbage, Charles (1791-1871) / FRS / Royal Institution / 1815

* **Bachhoffner, George Henry** (1810-1879) / principal, Royal Polytechnic Institution (1838-1855); manager and proprietor, Colosseum (1856-1864); FCS / Polytechnic Institution; Colosseum / 1845-1863

Barkas, T. P. (unknown) / private / Primitive Methodist Chapel, Earsdon / 1852

* **Bartley, George** (c. 1782-1858) / private; theatre actor / English Opera House (Lyceum) / 1820-1829

Bateman, Dr. (unknown) / private; possibly a medical doctor / a local hospital at Ilkley / 1852

Beechey, St. Vincent (1806-1899) **/** Vicar of Worsley (1850-1872) / Royal Manchester Institution / 1850-1852

Berry, William (1774-1851) / private, schoolmaster and genealogist / Theatre Gurnesey / 1811

* **Bird, John** (d. 1840) **/** private; journeyman carpenter / local assembly venues including the town hall of Abingdon; public schools including Charter House, Westminster and Eton; Russell Institution / 1814-1840

Chalmers, Thomas (1780-1847) / Minister of Tron Church (1815-1819) / Tron Church, Glasgow / 1815

* **Children, Robert** (unknown) / private; boot-maker / local assembly venues including town halls of Oxford and Sudbury, Suffolk / 1835-1844?

Dalton, John (1766-1844) / senior member of the Manchester Literary and Philosophical Society; FRS / Royal Institution / 1809

Davenport, Mr. (unknown) / unknown / Bowling Square Chapel, London (free lectures provided by the Society for Scientific, Useful, and Literary Information) / 1833

Faraday, Michael (1791-1867) / professor, Royal Institution (since 1833); FRS / Royal Institution / 1861

Freeman, Joseph (unknown) / private; schoolmaster / Baptist Chapel School, Great Ilford / 1856

Gladstone, John Hall (1827-1902) / FRS / Royal Institution / 1859

Goodacre, Mr. (unknown) / private / a riding school at Huddersfield / 1822

Henderson, Ebenezer (1809-1879) / private; clock-maker; FRAS / Liverpool and London, probably at London Mechanics' Institution / 1835-1843?

Henry, Mr. (unknown) / unknown, describing himself as a lecturer from the Polytechnic Institution / an unknown venue at Ipswich / 1846

Holden, Moses (1777-1864) / senior member of the Institution for the Diffusion of Knowledge in Preston and the BAAS; instrument-maker / Mechanics' Institutes in northern English towns, particularly in Preston / 1815-1852

Howell, James (unknown) / private; clerk in the City / Adelphi Theatre; Her Majesty's Theatre / 1836-1840?

Lardner, Dionysius (1793-1859) / editor and writer; member of the council of the BAAS (1838-1840); FRS / place unknown, perhaps institutions and theatres in London / around 1839

Lloyd, R. E. (unknown) / private; itinerant lecturer / Haymarket Theatre; Caledonian Theatre, Edinburgh; local assembly venues including the Music Room, Oxford / 1792-1829?

MacKeown, Mr. (unknown) / private / the Rev. M'Alister's meeting house at Holywood, Ireland / 1842

Nichol, John Pringle (1804-1859) / professor, University of Glasgow (since 1836) / Royal Manchester Institution; Sheffield Mechanics' Institute; Whittington Club and Metropolitan Athenaeum / 1849-1851, 1858

Pond, John (1767-1836) / Astronomer Royal (1811-1835); FRS; FRAS / Royal Institution / 1809-1810

Popham, C. (unknown) / private; itinerant lecturer / Philosophical Hall, Huddersfield; Theatre Royal, Birmingham / 1850-1851

Powell, Baden (1796-1860) / professor, University of Oxford (since 1827); FRS; FRAS / Royal Institution / 1850-1851, 1858

Saull, William Devonshire (1783-1855) / private; radical philanthropist and geological collector / Chapel Court at Borough, London / 1832

Smyth, Charles Piazzi (1819-1900) / Astronomer Royal for Scotland (1846-1888); FRS; FRAS; FRSE / Royal Institution / 1858

Rogers, A. F. (unknown) / private; itinerant lecturer / local assembly venues in provincial towns including the Masonic Hall, Bath / 1824-1825

Strutt, John William (1842-1919) / Senior Wrangler of Cambridge (1865) / Witham Literary Institution / 1865

* **Walker, Deane Franklin** (1778-1865) / private; experimental philosophy lecturer / English Opera House (Lyceum); King's Theatre; Strand Theatre; Colosseum; theatres and local assembly venues in provincial towns including Aberdeen Theatre, town hall of Oxford, etc. / 1817-1846?

* **Walker, William** (c. 1766-1816) / private; experimental philosophy lecturer /

Haymarket Theatre; theatres and local assembly venues in provincial towns including Lancaster Theatre, etc. / 1782-1815

* **Wallis, John** (1788-1852) **/** private; lecturer on contract basis / Royal Institution; London Mechanics' Institution; Russell Institution; Liverpool Mechanics' Institution; Royal Manchester Institution; Leeds Literary Institution, etc. / 1825-1851

Watson, Mr. (unknown) / unknown, probably private / Chelmsford Mechanics' Institution / 1837

Wheeler, J. (unknown) / private / Cosmorama Rooms, London / 1838

Young, Thomas (1773-1829) / professor of natural philosophy, Royal Institution (1801-1803); FRS / Royal Institution / 1801

Appendix B

Transcription of Samuel James Arnold's *Ouranologia*

Editorial Notes

The source manuscript of the *Ouranologia* is held by the Manuscript Collections, British Library, located in the *Lord Chamberlain's Plays*, vol. XI (January 1826), reference number Add MS 42875, ff. 443-493b. The *Lord Chamberlain's Plays* is a series of plays submitted to the Lord Chamberlain's Office, from 1824 to 1968, when that office held the power to censor performances. For further information about the current status of the collection, refer to the British Library's official guide.[†]

The inscriptional history for the documents incorporated into the *Lord Chamberlain's Plays* is not clear. The source text contains a covering letter from Samuel James Arnold to the Lord Chamberlain's Office, plus a detailed syllabus of the lecture. The lecture syllabus is divided into three parts; it was written on both sides of the folio in black ink. The original hand-writing is mostly clean and tidy, and contains few corrections. Two separate sets of pagination appear together in the source text. One set is the folio numbers archived by the British Library; the other, the page numbers noted in the syllabus, is not continued between each part of the lecture. The latter is probably original pagination.

The present edition was transcribed by Hsiang-Fu Huang. The transcription has been verified by proofreading against digital scanned images of each page. The proofreader was Tom O'Donnell.

For convenience of reading here, line breaks in the original text are not preserved, except at page breaks and quotations from poems or psalms. Paragraph breaks follow the original. Spelling, grammar, and stylistic consistency remain as in the original. Symbols of corrections and underlining within the source text are also preserved as in the original. Except for the above conventions, all editorial interpolations are annotated by Huang. Editorial interventions are indicated by [ ] brackets.

The two sets of pagination in the original text are provided in this transcription. To avoid confusion, they are presented in separate places. The British Library folio numbers are marked in the right margin of the text; a folio number indicates the present folio starts from this line. The presumably-original syllabus page numbers are indicated by [ ] brackets within the text. In summary, pagination follows these formats:

f. x Folio x in the source text (recto).

[b] The verso of a folio.

[**x**|**y**] Page transition in the source text, from page x to page y.

[**x**|**y***] Page transition in the source text, from page x to page y, occurs within a word. To preserve clarity, the transitional word is preserved in page x.

Samples of Facsimiles

Figures A.1 to A.3 show the scanned images of the title page, the covering letter from Arnold to the Lord Chamberlain's Office, and one sample of the lecture syllabus, respectively. The transcription starts following the figures.

[†] 'The Manuscript Collections Reader Guide 3: The Play Collections', British Library. http://www.bl.uk/reshelp/pdfs/readerguide3.pdf (accessed 1 September 2014)

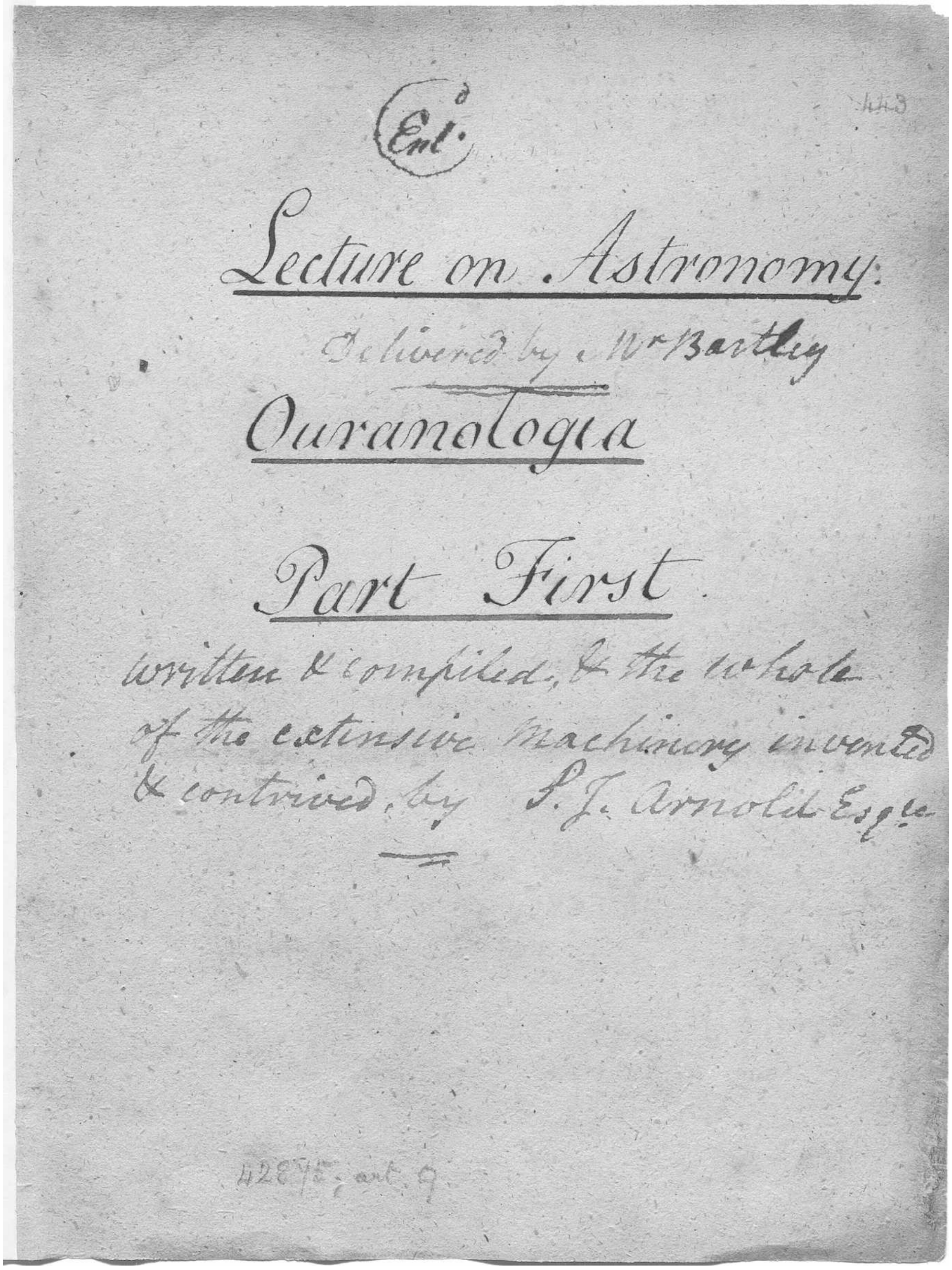
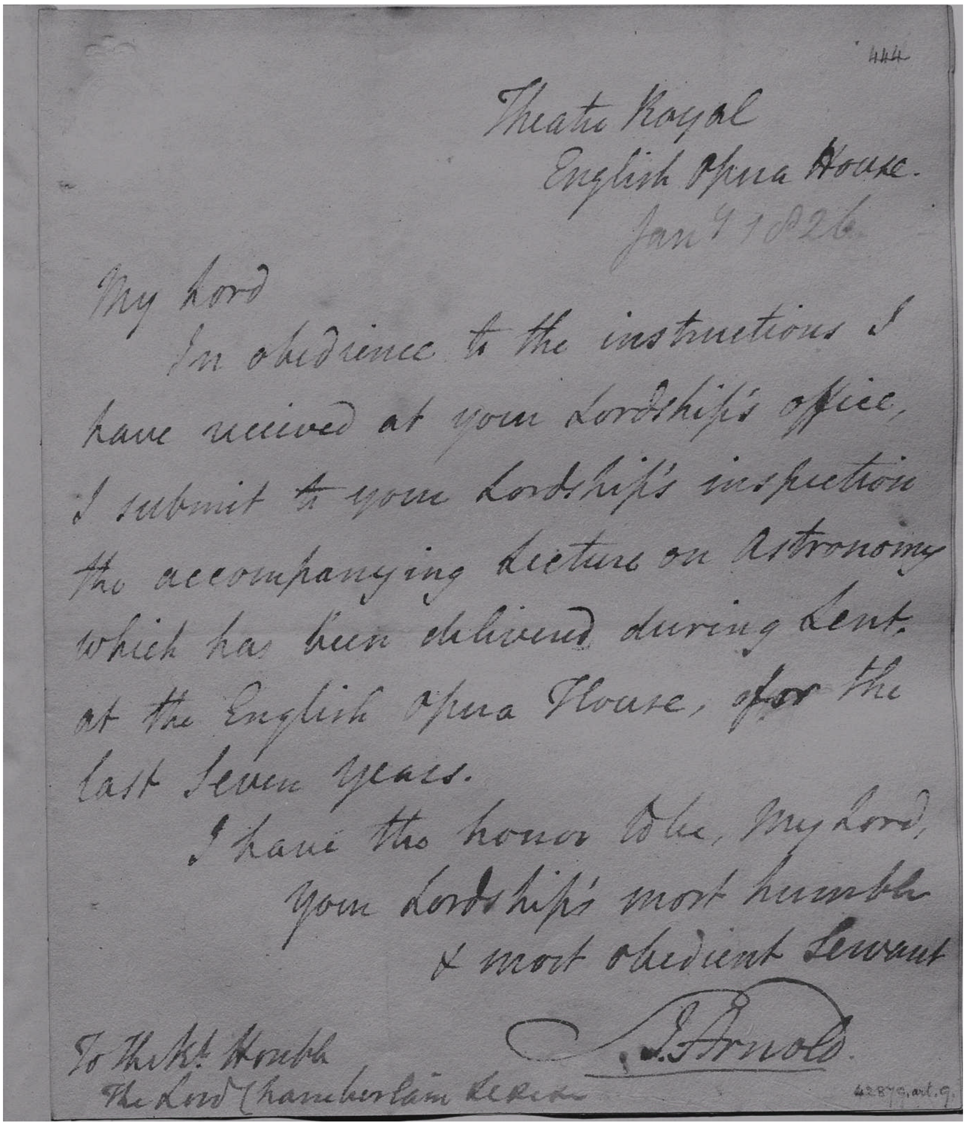


Figure A.1 The title page of the *Ouranologia*. BL: Add MS 42875, f. 443. (Permission from the British Library)



444

Theatre Royal
English Opera House.
Jan 9 1826

My Lord

In obedience to the instructions I have received at your Lordship's office, I submit to your Lordship's inspection the accompanying Lecture on Astronomy which has been delivered during Lent at the English Opera House, for the last Seven years.

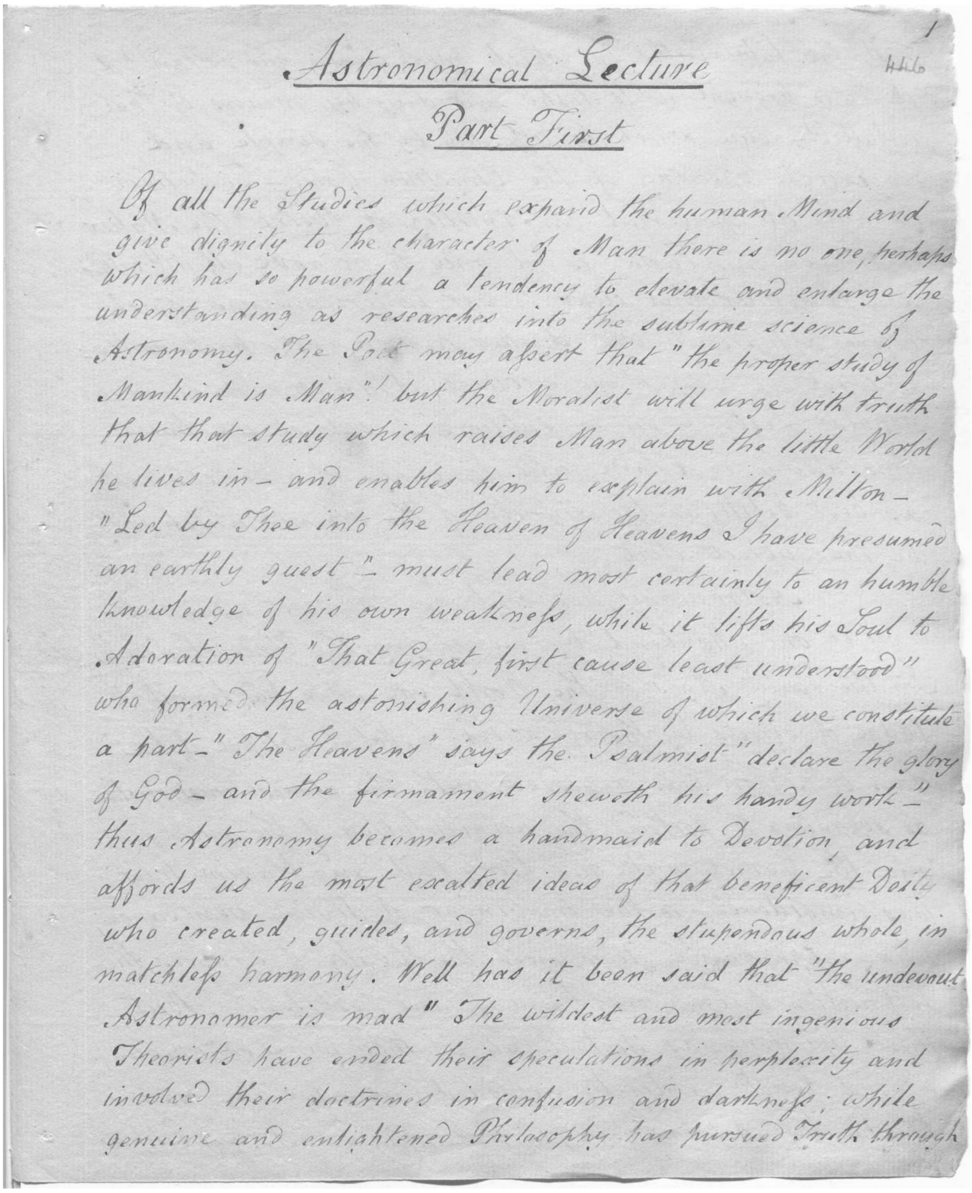
I have the honor to be, My Lord,
Your Lordship's most humble
& most obedient Servant

S. J. Arnold

To the Rt. Honble
The Lord Chamberlain &c &c

42879. art. 9.

Figure A.2 Covering letter, Samuel James Arnold to the Lord Chamberlain's Office, 9th January 1826. BL: Add MS 42875, f. 444. (Permission from the British Library)



1
446

Astronomical Lecture

Part First

Of all the Studies which expand the human Mind and give dignity to the character of Man there is no one, perhaps which has so powerful a tendency to elevate and enlarge the understanding as researches into the sublime science of Astronomy. The Poet may assert that "the proper study of Mankind is Man"! but the Moralist will urge with truth that that study which raises Man above the little World he lives in – and enables him to explain with Milton – "Led by Thee into the Heaven of Heavens I have presumed an earthly guest" – must lead most certainly to an humble knowledge of his own weakness, while it lifts his Soul to Adoration of "That Great, first cause least understood" who formed the astonishing Universe of which we constitute a part – "The Heavens" says the Psalmist "declare the glory of God – and the firmament sheweth his handy work" – thus Astronomy becomes a handmaid to Devotion, and affords us the most exalted ideas of that beneficent Deity who created, guides, and governs, the stupendous whole, in matchless harmony. Well has it been said that "the undevout Astronomer is mad" The wildest and most ingenious Theorists have ended their speculations in perplexity and involved their doctrines in confusion and darkness; while genuine and enlightened Philosophy has pursued Truth through

Figure A.3 The first page of the first part of the lecture syllabus. BL: Add MS 42875, f. 446. (Permission from the British Library)

f. 443

<u>Lecture on Astronomy.</u>

<u>Delivered by Mr Bartley</u>

<u>Ouranologia</u>

<u>Part First</u>

Written & compiled, & the whole
of the extensive machinery invented
& contrived, by S.J. Arnold Esq. &c

f. 444

Theatre Royal
English Opera House
Jan 9 1826

My lord

In obedience to the instructions I have received at your Lordship's office, I submit to your Lordship's inspection the accompanying Lecture on Astronomy which has been delivered during Lent, at the English Opera House, afar the last seven years.

I have this honor to be, my Lord,
your Lordship's most humble
& most obedient Servant

S. J. Arnold

To The Kt. Hon.ble
The Lord Chamberlain's [unknown words]

<u>Astronomical Lecture</u>
<u>Part First</u> **f. 446**

Of all the studies which expand the human Mind and give dignity to the character of Man there is no one, perhaps which has so powerful a tendency to elevate and enlarge the understanding as researches into the sublime science of Astronomy. The Poet may assert that "the proper study of Mankind is Man"! but the Moralist will urge with truth that that study which raised man above the little World he lives in – and enables him to explain with Milton – "Led by Thee into the Heaven of Heavens I have presumed an earthly guest" – must lead most certainly to an humble knowledge of his own weakness, which it lifts his Soul to Adoration of "That Great, first cause least understood" who formed the astonishing Universe of which we constitute a part – "The Heavens" says the Psalmist "declare the glory of God – and the firmament sheweth his handy worth –" thus Astronomy becomes a handmaid to Devotion, and affords us the most exalted ideas of that beneficent Deity who created, guides, and governs, the stupendous whole, in matchless harmony. Well has it been said that "the undevout Astronomer is mad" The wildest and most ingenious Theorists have ended their speculations in perplexity and involve their doctrines in confusion and darkness; while genuine and enlightened Philosophy has pursued Truth through [**1**|**2**]

[cont.] all the labyrinths in which mere fancy had entangled it, and brought it to light and day by means of that infallible clue which is afforded by the simple and majestick opening of the Christian Creed – To believe in one all powerful and intelligent Being "The Maker of Heaven and Earth" is at once to remove all difficulties and to render that clear to our understandings which before appeared to our darker reason incomprehensible. I trust we may stand excused, if, in opening even a popular Lecture on so sublime a subject we have thus assumed a tone and language of a serious cast, as best belitting the dignity of the science which is to be the subject of it. **[b]**

Astronomy has conferred the most essential benefits on Mankind by expanding the understanding". In the early Ages of the World, ere men had learnt to judge of effects by their Causes, a total Eclipse of the Sun or Moon was regarded with the almost consternation, as seeming to portend the annihilation of the universe; and the Comet with his fiery tail and blazing hair, was considered as the harbinger of divine vengeance; whose appearance denounced the Death of Princes, the destruction of Empires, famine and pestilence. But these Opinions, as distressing as they were erroneous, are, at length, entirely exploded; and we are now taught, by Astronomers, to look upon Comets and Eclipses [**2**|**3**]

[cont.] with tranquility and Composure." **f. 447**

To Astronomy we also owe the regulation and measure of time – and all our most important discoveries in Geography and Navigation. The dark and gloomy fears of superstition have vanished before the light of truth and reason – and the frauds practiced for Ages by designing Imposters, and Pretenders to learning in Astrology, have been exposed and ridiculed. "Such are the advantages which society have derived from the cultivation of this science; but there is yet another, which, though less evident to the world in general, is nevertheless inestimable in the Eyes of a Philosopher. This is the knowledge which it affords us of nature; of the true system of the World; and the invariable laws by which it is governed. Astronomy has opened to us such a magnificient view of the Creation, that we are struck with astonishment at the grandeur of the spectacle, and the powers of Omnipotence. By looking abroad into the universe, we exalt our ideas of the supreme intelligence, and extend the narrow sphere of human conceptions; the faculties are strengthened and improved; the understanding is enlarged; and the Mind in the contemplation of so many glorious objects, finds itself drawn to that Being who informs, directs, and animates the whole." [**3**|**4**]

I shall now proceed to explain in what we trust will be found an easy and familiar manner, the most striking Phaenomena of the subject we wish to illustrate. **[b]**

So many excellent works having been written on this subject it can hardly be expected that any striking novelty either in language or arrangement should be attempted – known and admitted Truths allow of no decorations from Fancy; and flights of imagination would be strangely wasted on a Theme so vast, that the clearest intellect becomes bewildered in the contemplation of its immensity. so stupendous indeed is the Theme that the human Mind shrinks into conscious insignificance when attempting to push inquiry, or thoughts beyond certain limits into the boundless regions of eternity and space.

To confine ourselves therefore to what is known, and now proved beyond the chance of future doubt, will be our bounden duty – In so doing we shall draw largely on the works of the best Authors who have written on the subject, because nothing can be added to that which is already complete and full; and to vary language which expresses its object with perspicuity and precision, merely for the sake of variety, might [**4**|**5**]

f. 448

[cont.] more probably involve failure than elicit improvement.

The grand improvement <u>we</u> hope to accomplish is in the mode of illustrating by explanatory Scenery produced on Optical principles those doctrines which never can be so well conveyed to the understanding as thro' such a medium.

"As the Earth we inhabit is constantly subject to our observation, and is that with which we are the best acquainted, a description of its form and magnitude naturally first excites our Curiosity and attention.

This vast body was long considered as a large circular plane spreading out on all sides to an infinite distance: and the Heavens, above it, in which the Sun, Moon and Stars appear to move daily from East to West, (that is, in the same way as the hands of a Watch move) were imagined to be at no great distance from it, and to have been created solely for the use and ornament of our Earth. But it is now well known to Mathematicians and Philosophers, that the Earth is of a round or spherical figure, nearly resembling that of a Globe.

The truth of this doctrine, without having recourse to scientific principles, will appear sufficiently evident from the voyages of those celebrated Navigators Magellan, Sir Francis Drake, Lord Anson, Cook, &c. who all set out, at different times, to sail round the [**5**|**6**]

[b]

[cont.] World; and, by steering their course continually westward, arrived, at length, at the shore they departed from; which could never have happended, had the Earth been of any other than a spherical or globular figure.

This form is also obvious, from the circular appearance of the Sea itself, and the circumstances which attend large objects when seen at a distance on its surface. Thus, when a Ship leaves the shore, we first lose sight of the hull, or body of the Vessel; afterwards of the rigging ; and at last discern only the top of the Mast; which is evidently owing to the convexity of the water between the Eye and the object; or otherwise, the largest and most conspicuous part would have been visible the longest, as is manifest from experience. The same remark holds good in the case of a ship approaching the shore. The top of the Mast is first to be discerned, afterwards the rigging and sails, and lastly the hull of the Vessel. This doctrine I shall now illustrate by experiment.

Scene 1st Diagram & Ship

This Globe has been prepared for the purpose – A Ship will shortly appear on its surface, advancing towards the Audience – Those of the Spectators who [**6**|**7**]

[cont.] are situated in the higher parts of the Theatre, will of course behold it first – As a Seaman in the foretop first discovers a Sail at Sea – Those persons in the lower parts of the Theatre will perceive it later – but I trust ~~each~~ all of my Auditors who favor me with their attention, will find that its advances are precisely correspondent with my description; thus illustrating the Globular shape of the Earth. **f. 449**

The Vessel is now in motion – it is probably visible to a part of the Audience – as it approaches it will meet the observation of others – while its appearance encreases to those who first perceived it – as it advances the whole of the Auditory will behold it; – and now – having reached its destination. I flatter myself the illustration has been sufficiently evident.

"Another proof &c. ——— [**7**|**8**]

"Another proof, which is of no less force than either of the former, is taken from the shadow of the Earth, when the face of the Moon, in the time of a lunar Eclipse. For as the Moon has no light but what it receives from the Sun, and the Earth being, at this time, interposed between them, the Moon must either wholly, or in part, become obscure. And since in every Eclipse of this kind, which is not total, the dark part always appears to be bounded by a circular line, the Earth itself, for that reason, must be spherical; because it is evident, that none but a spherical body can, in all **[b]** situations, cast a circular shadow. Nor are the little unevenesses on the Earth’s surface, arising from Hills and Valleys, any material objection to its being considered as a round body; since the highest Mountains we are acquainted with, bear a less proportion to the whole bulk of the Earth, than the small risings on the Coat of an Orange bear to that fruit; or a grain of Sand, to an artificial globe of a foot in diameter. And accordingly we find, that these trifling protuberances occasion no irregularities in the shadow of the Earth, during the time of a lunar Eclipse; but that the circumference of it always appears to be even and regular, as if cast by a body perfectly globular.”

“A number of other proofs might be given to the same [**8**|**9**]

[cont.] purpose, but these are the most popular, and such as I apprehend must entirely convince every impartial enquirer, whose object is truth; It will not be amiss in this place to offer a summary description “of the different opinions of Philosophers, concerning the situation of the heavenly Bodies, or the place which they possess in the universe; and we collect from several testimonies, that the true doctrine of the planetary motions was known in the world from the most early ages, and taught by some of the greatest and wisest men of antiquity. That admirable Philosopher Pythagoras, who flourished near five hundred years before the Christian Era, was undoubtedly acquainted with this doctrine. We accordingly find that many of his followers had just notions of the planetary system; and not only taught that the Earth moved daily on its own axis, and revolved annually round the Sun, but gave such an account of the Comets as is agreeable to modern discoveries. They also taught that every Star was a world, having each of them something corresponding to our Earth, such as air and water; and that the Moon, in particular, was inhabited by larger and more beautiful Animals than those of our [**9**|**10**] **f. 450**

[cont.] Globe. **[b]**

At this period however, great as might be the merit of Theory, little could be ascribed to Discovery; the telescope, which has since opened so vast and splendid a field of observation in the Heavens, was then unknown – any attempt therefore at arrangement respecting a System impervious to the unassisted Eye must have been necessarily involved in error in many essential points – Be this as it may, the real merit of the first suggestion of the now proved and acknowledged system can be fairly traced no farther backward than to Pythagoras, who therefore must be considered as the first promulgator if not the discoverer of the true System which is now admitted by every civilized country on the Globe.

"This System, however, was so extremely opposite to the prejudices of sense and opinion, that it never made any great progress in the ancient world. The Philosophers of antiquity (despairing of being able to overcome ignorance by reason.) set themselves to adapt the one to the other, and to form a reconciliation between them.

The most celebrated of those who undertook to establish an hypothesis of this kind, and to defend it [**10**|**11**]

[cont.] with a show of reason and argument, was Ptolemy, an Egyptian Philosopher, who lived in the time of the Emperor Adrian, about an hundred and thirty year after the Christian Era." and in order that we may the better explain the gradual advances of this Science, we will here with your permission present to you a representation of his system called the Ptolemaic. **f. 451**

Scene Ptolemaic System

"He supposed with the vulgar, who measure every thing by their own conceptions, that the Earth was fixed immoveably in the centre of the universe; and that the Moon, Mercury, Venus, the Sun, Mars, Jupiter and Saturn, revolve round it in the order they are here pointed out. Above those was the firmament of the fixed stars beyond this, he imagined were crystalline orbs, the primum mobile, and last of all, the coelum empyrium, or heaven of heavens. All these vast orbs he imagined to move round the Earth once in twenty-four hours, and also in certain stated or periodical times, agreeable to their annual changes and appearances. Every Star he supposed to be fixed in a solid transparent sphere, like crystal; and to account for their different motions, he was obliged to conceive a number of circles called [**11**|**12**]

[cont.] eccentrics and epicycles, which crossed and intersected each other in various directions. And if any new motion was discovered, a new heaven of crystal was formed to account for it. So that, as Fontenelle observes, heavens of crystal cost him nothing, and he multiplied them without end, to answer every purpose. **[b]**

This absurd system is referred to by Milton, in the 8th book of his Paradise Lost, where, speaking of the dreams of visionary Philosophers, concerning the nature and motion of the heavenly bodies, he says, __________________ "Or if they list to try

Conjecture, he his fabric of the Heavens
Has left to their disputes, perhaps to move
His laughter at their quaint opinions wide
Hereafter, when they come to model heaven
And calculate the Stars, how they will wield
The mighty frame, how build, unbuild, contrive
To save appearances, how gird the sphere
With centrie and eccentrie scribbled o'er,
Cycle and epicycle, orb in orb"

But independently of those considerations, this rude system was soon found incapable of standing the test of observation and experiment; and, notwithstanding the opposition of blind and zealous bigots, it has long [**12**|**13**]

[cont.] been rejected by all mathematicians and true Philosophers. The planets, Mercury and Venus, are now well known not to include the Earth in their orbits; and the Comets move through the Heavens in all manner of directions, so that they must infallibly have met with continual obstructions, and would, long ere this, have broken all those crystal spheres to pieces, and rendered them totally unlit for the purposes for which they were designed. **f. 452**

The contradictions and perplexities attending the Ptolemaic hypothesis, were indeed so numerous and evident, that it was impossible they should ever be reconciled upon that supposition. But notwithstanding this, mankind were not easily induced to give up their darling prejudices, and embrace the truth, however beautiful the form in which she presented herself to them. Many early habits must be corrected, and vulgar prepossessions eradicated from the mind, before we can be brought to reckon the Earth as a planet, and to consider this prodigious Globe, which , of all things in nature, appears to be the most fixed and stable, to be carried round the Heavens with the rapidity of fifty eight thousand miles an hour.

To humour these prejudices, by keeping the [**13**|**14**]

[cont.] Earth still fixed in the centre, but at the same time to remove some of the most palpable absurdities attending that doctrine, was the design of Tycho Brahe, who attempted to establish a new system, and to account for the celestial motions by a more plausible hypothesis. This noble Dane, who flourished in the latter end-of the sixteenth century, had furnished himself with an excellent collection of mathematical instruments, and by that means, had made himself too well acquainted with the motions of the heavenly bodies, to imagine their centre to be any where else than in the Sun. He was struck with the Beauty, simplicity and harmony of the Pythagorean system, which Copernicus had lately revived; but out of respect for some passages of scripture, which seemed to contradict this doctrine, he set himself about to reconcile his learning with his faith; and in his system (which I now show you) **[b]**

Scene – Tychonic System

You will perceive, in order that the Earth might remain quiescent, he supposed the Sun, with all the Planets, to be carried about it it [sic] in the space of a Year; whilst these, by their proper motions, revolved round the Sun in their several periods. "In this new system of Tycho's, there is some ingenuity, though but little conformity [**14**|**15***]

[cont.] to truth and observation[.] For having rejected the diurnal rotation of the Earth on its axis, he was obliged to retain the most absurd part of the Ptolemaic hypothesis, by supposing that the whole universe, to its farthest visible limits, was carried by the primum mobile about the axis of the Earth continuably every day. But in this, however, he was abandoned by some of his followers, who chose rather to save this immense labour to the spheres, by ascribing a diurnal motion to the Earth; on which account they were distinguished by the name of Semi-Tychonics. **f. 453**

It was about the middle of the sixteenth century that Copernicus, a bold and original genius, adopted the Pythagorean, or true system of the universe, and published it to the world with new and demonstrative arguments in its favour seized with a darling enthusiasm, he laid his hands on the cycles and crystal orbs of Ptolemy, and dashed them to pieces. And, with the same noble phrensy, he took the unwieldy earth and sent her far from the centre of the systems both of Ptolemy & Tycho Brahe to move round the Sun with the rest of the Planets; so that of all the celestial equipage, with which she had been formerly dignified, there only remained [**15**|**16**]

[cont.] the Moon to attend and accompany her on her Journey. We remove this ideal system – to prepare for the introduction of the genuine one of Copernicus[.] **[b]**

Scene
Copernican – System

You will here see the Sun in the Centre, and the Planets revolving round him in their proper orbits, but without their satilytes; for it was torwards the end of the same century, and about the beginning of the next that those great men Galileo and Kepler particularly distinguished themselves in the defence of this doctrine; and by means of the Telescope, which was the invention of that time, made many new and surprising discoveries in the heavens. By applying this Instrument to the planets, Galileo first observed, that the phases of the Moon; and thence inferred that she revolved round the Sun as a centre. He also proved the revolution of the Sun on its axis, from the motion of his Spots; and by that means rendered the diurnal rotation of the earth more credible. The four satellites which attend Jupiter, in his revolution about the Sun, represented, likewise, in miniature, a just [**16**|**17**]

[cont.] image of the great solar system, and rendered it more easy to conceive how the Moon might attend the Earth, as a satellite, in her annual revolution. In short, by his discovering hills and cavities in the Moon, and spots in the Sun, he proved, clearly, that there was not so great a difference between celestial and sublunary bodies as Philosophers had vainly imagined. **f. 454**

From these discoveries, Astronomy began to assume a new form, and most of the celestial phoenomena [sic] were soon accounted for, according to their real or physical causes. Des Cartes, Gassendus, Cassini, and Newton, employed themselves, with the utmost diligence, in improving and perfecting this science: and the last of these great men, in particular, has established the Copernican System upon such an everlasting basis of mathematical demonstration, as can never be shaken, but must last as long as the present frame of nature continues in existence.

Scene
Copernican or Newtonian System

And now, before I proceed to describe this part of the universe which Astronomers have called the "Visible World", or Solar System – it will be proper [**17**|**18**]

[cont.] to state that by the universe we are to understand the whole frame of nature, as extended throughout infinite space. And, by the Solar System, is meant that portion of the universe only, which comprehends our Sun, planets, Satellites and Comets. Of which system, though contrary to what was formerly supposed, by these ancient as well as by many modern Astronomers, the Sun is now well known to be placed in the centre and to have eleven primary planets moving round him, each in its own path or orbit." **[b]**

"The names of these planets, according to their distance from the centre or middle point of the Sun, are Mercury, Venus, the Earth, Mars, Vesta, Juno, Pallas, Ceres, Jupiter, Saturn, and Uranus, or the Georgium Sidus; the latter of which was discovered in the year 1781, and Vesta, Juno, Pallas, and Ceres, since the commencement of the present century; among which it is to be observed, that the two first, Mercury and Venus, having their orbits within that of the Earth." or, in other words, revolving in smaller circles round the Sun "are called inferior planets, and the others, which revolve beyond it, are called superior planets.

Now if we can form a notion of the manner [**18**|**19**]

[cont.] in which our Earth moves, we shall easily conceive the motions of all the rest of the planets, and by that means abtain a complete idea of the order and oeconomy of the whole system. For which purpose, nothing more is necessary than to consider the common appearances of the Heavens, which are constantly presented to our view, and attend to the consequences that follow from such observations. For since it well known that the Sun and Stars appear to move daily from East to West, and to return nearly to the same places in the Heavens again in twenty four hours, **f. 455** it follows that they must really move, as they appear to do, or else that we ourselves must be moved, and attribute our motion to them; it being a self evident principle, that, if two things change their situation with respect to each other, one of them, at least must be moved. But if this change be owing to the revolution of the Stars, we must suppose them to be endowed with a motion so amazingly rapid, as to exceed all conception. Since it is known, by calculations founded on the surest observations, that their distances from us are so immense, and the orbits in which they revolve so prodigiously great, that the nearest of them would move at least [**19**|**20**]

[cont.] a hundred thousand Miles in a minute. Now as nature never does that in a complicated and laborious manner which may be done in a more simple and easy one, it is certainly more agreeable to reason, as well as to the power and wisdom of the Creator, that these effects should be produced, by the motion of the Earth; especially as such a motion will best account for all the celestial appearances, and, at the same time, preserve that beautiful simplicity and harmony, which is found to prevail in every other part of the creation. **[b]**

This argument will also appear still more forcible, if we compare the vast bulk of the celestial bodies with the bulk of our Earth. For it is well known to Astronomers, that the Sun in bulk is above a million of times bigger than the Earth; and consequently, judging from analogy, it follows that many of the Stars are at least of an equal magnitude. It is much more probable, therefore, that the Earth revolves round its axis, with an easy natural rotation, once in twenty-four hours, than that those vast bodies should be carried from one place to another, with such incredible velocities. [**20**|**21**]

The absurdity of supposing the Earth a sedentary and immoveable body is sufficiently exposed in the sublime speech of Adam to the Angel Raphael when he is inquiring the nature of the celestial motions: **f. 456**

When I behold this goodly frame; this World
Of heav'n and earth consisting, and compute
Their magnitudes; this earth, a spot, a grain
An atom, with the firmament compar'd
And all her number'd stars, that seem to roll
Spaces incomprehensible (for such

Their distance argues, and their swift return
Diurnal) merely to officiate light
Round this ~~spacious~~ earth, this punctual spot
One day and night; in all their vast survey
Useless besides; reasoning I oft admire
How nature, wise and frugal, could commit
such disproportions. –

Nor is it any objection to this rotation of the Earth, that we are unable to perceive it. For as the motion of a Ship at Sea, when the sails swiftly over the smooth surface of the water, is almost, if not wholly imperceptible to the passengers and company on abroad; much more so must it be with such a large body as the Earth, that has no impediments or obstacles of any kind [**21**|**22**]

[cont.] in its way, to disturb its motion. A Balloon, turning upon its axis, as it floats through the atmosphere, affords an apposite representation of the Earth, in its annual progress round the Sun: **[b]**

"That spinning steeps,
On her soft axle, as she paces even,
And bears us swift with the smooth air along."

This motion of the Earth round its axis, which, from the instances already given, has been rendered sufficiently evident, is called its diurnal, or daily motion; and is that which occasions the regular return of day and night, and all the celestial appearances before mentioned. But there is also <u>another</u> motion of the Earth, called its <u>annual</u>, or <u>yearly</u> motion, which occasions the various vicissitudes of the <u>Seasons</u>, Summer, Winter, Spring, and Autumn."

But as a particular description of this Scene will be necessary, and least we should extend this part of the Lecture to a length which might exhaust your attention, I shall, with your permission reserve till towards the close of the Evening, the <u>minute</u> detail of the particulars; which will be given on the extensive apparatus prepared for that purpose.

Enough, in this place to observe; that all other [**22**|**23**]

[cont.] systems have been wholly exploded by the clear and demonstrative discoveries of our immortal Countryman Sir Isaac Newton; **f. 457** who has shewn that though ingenious Argument might suppose the course of nature to be governed by mere mechanical laws only, the works of nature would then have been incomparably inferior to what they now are both in beauty and perfection, and consequently far less worthy of its ineffable Contriver,

"Whose mighty hand,
For ever busy, wheels the silent spheres;
Works in the secret deep; shoots, streaming thence,
The fair profusion that o'erspreads the spring;
Flings from the Sun direct the flaming day;
Feeds every creature; hurls the tempest forth:
And, as on Earth this grateful change revolves
With transport touches all the springs of Life.

End of Part First

Lecture on Astronomy **f. 458**

Ouranologia

Part Second

Part Second **f. 459**

Telescopic Appearances of the Planets

Having given a general idea of the figure and motion of the Earth, before we proceed to a more minute explanation it may not be amiss to turn our attention in a similar detached manner to the rest of the planets, and I shall accordingly take them in the order in which they revolve round the Sun.

The comparative distances and periods of revolution will be reserved for the grand Scene I have before alluded to but a particular notice of each may be properly taken in this place. It is to be observed, that the Planets are all opake spherical bodies, like our Earth, that have no proper light of their own, but shine by means of the borrowed light which they receive from the Sun – and therefore only that side of them which is turned towards him, can receive the benefit of his light, whilst the opposite side, which the borrowed rays cannot reach, remains in obsecurity; till, by the rotation of the planet on its axis, that part is also turned towards the [**1**|**2**]

[cont.] Sun; and thus, the alternations of day and night, are produced on the surface of those Worlds, as they are on ours. But before I speak of the planets, it will be proper to offer a few remarks on the phaenomena and affections of that immense Globe, from which they all derive the blessings of light and heat; that glorious Sun; upon whose influence, the very existence of the Worlds that revolve around him may be said to depend. – And although to attempt a representation of this brilliant and stupendous Mass, must be inevitably attended with failure – it may be well (for the purpose of illustration) to offer something like a view of his telescopic appearance to the Eye of the spectators. We shall do this particularly with a view to show the comparative magnitudes of the Sun and Earth, from whence a more clear notion will be obtained of the enormous bulk of this Magnificent Star. **[b]**

Scene – Sun and Earth.

We will suppose then that this resembles the Sun – a great stretch of complasance I confess is necessary on this occasion – but in point of fact such as are here represented, are the appearances of Spots [**2**|**3**]

[cont.] which are noticed on his surface, when viewed through a powerful Telescope, assisted by a smoked Glass; without which his intense brightness would defy inspection. In this part you will perhaps be able to discover a small speck, which is placed there in order to represent the comparative size of the Globe we inhabit – and this is really correct, for if you will suppose an artificial Sun – nine feet in diameter, the Earth will be pretty accurately represented as a Globe of only one inch – **f. 460**

The Sun was generally considered by the Antients as a Globe of pure fire, but from a ~~num~~ number of dark spots, which, by means of a Telescope may be seen on different parts of his surface, it appears that this opinion was ill founded. These spots consist, in general, of a nucleus, or central part, much darker than the rest, and seems to be surrounded by a mist or smoke.

About the time that they were first discovered by Galileo, forty or fifty of them might be frequently seen on the Sun at a time, but at present we can [**3**|**4**]

[cont.] seldom observe more than thirty; and there have been periods of seven or eight years, in which none could be seen. **[b]**

The general opinion concerning the Solar spots is, that they are occasioned by the smoke and opake matter thrown out by volcanos or burning mountains of immense magnitude; and that when the eruption is nearly ended, and the smoke dissipated, the fierce flames are exposed; and appear like faculæ, or luminous spots. the motion of the spots appears to be from East to West, and as they are observed to move quicker, when they are near the central regions than when they are near the limb; it follows that the Sun must be a spherical body; and, that he revolves on his axis, in a contrary direction; or, from West to East. – The time in which he performs this revolution, is twenty five days, and about 6 Hours; and from the line of the motion of the Spots, which is sometimes straight, but oftener crooked or elliptical, it is discovered that his axis is not perpendicular to the plane of the ecliptic, but [**4**|**5**]

[cont.] inclined to it, so as to make an Angle with the perpendicular of about seven degrees and a half[.] **f. 461**

The Sun's apparent magnitude to the different Planets

It will naturally be conceived that owing to the greater proximity of some of the Planets to the Sun, and the distance of others, the appearance and magnitude of that immense body must fluctuate according to those distances. To the inhabitants of Mercury (who is situated so closely in his neighbourhood) he must indeed appear of a most stupendous bulk, and of inconceivable brightness, but as the other planets gradually recede from him, his bulk and brightness will be sensibly diminished. I shall now exhibit this fact by a transparent Scene which represents his comparative magnitudes to all his attendants.

Scene

It is here shewn from actual calculation that to this planet which represents Mercury the Sun will appear of this enormous bulk. To Venus of these dimensions. To the Earth as here shewn. To [**5**|**6**]

[cont.] Mars of this Diameter – To Jupiter of this – To Saturn of this diminished size, and to the Georgium Sidus he will seem only a very large and brilliant Star. **[b]**

What provision the bountiful hand of nature may have made for the light and warmth of these remote planets is beyond human reason to conjecture; but from the contrivance which we discover in all that is within the reach of our senses for the happiness of his creatures; no rational doubt can exist that the Deity has afforded to the whole of his creation an equal distribution of the blessings we enjoy.

Of the Planet Mercury, which is the nearest to the Sun, we can say but little – His proximity to that luminous body renders observation upon him extremely difficult and rare – but we shall introduce to your notice the next Planet, Venus, whose greater distance from the source of light has enabled Astronomers to make accurate observations on her nature and Appearances –

Scene – Phases of Venus [**6**|**7**]

This transparency represents the Phases of this planet as well as her appearance at full; and it will be observed that she bears a striking resemblance in her changes to our Moon – It is certain that wherever the Sun may be placed, the orbit of Venus surrounds and encloses him within herself, and therefore Venus, while she describes this orbit must really move round the Sun. For this planet is observed to be sometimes above, or beyond the Sun; and sometimes below him; or between the Sun and us: and the same argument holds good in regard to Mercury. This is clearly ascertained by the appearances of these phases which are proofs that she [word correction] encircles the Sun in an orbit smaller than that of our Earth, or these phaenomena would never appear to us any more than they do in the superior planets, which describe larger orbits round the Sun than the Globe we inhabit. – Venus also is found to be diversified with spots. **f. 462**

Mountains and Valleys have been discovered in this planet, by means of good instruments; [**7**|**8**]

[cont.] and from the motion of her spots it is determined, that she revolves **[b]** round her axis from West to East in the space of about twenty-three hours.

As our Earth is the next in distance from the Solar regions – we now naturally proceed to a consideration of its placid & useful attendant the Moon –

Of all the discoveries which have been made by means of the Telescope, those relating to the Moon are the most curious & interesting. This planet being much nearer to us than any of the rest, is the first that offers herself to our inspection, and is the best adapted for examination.

Scene – The Moon

By viewing her with the naked eye we discern a number of spots, which the imagination naturally supposes to be Seas, Continents, and the like; and on a more accurate inspection, with a telescope, the hypothesis of planetary worlds receives additional confirmation. Vast cavities and asperities are observed upon various parts of her surface, exactly resembling valleys and Mountains; and every other appearance seems to indicate, that she is [**8**|**9**]

[cont.] a body of the same nature with our Earth. We can scarcely hope to make optical instruments sufficiently perfect to render animals visible at such a distance; but Herschel, sometime ago discovered a manifest volcano in the Moon; and if improvements are pursued, we may, perhaps, receive indubitable proofs of her being an inhabited World. **f. 463**

Galileo, when he first saw this planet through his Telescope, was struck with the singularity of her Appearance; and being free from the prejudices of the Schools, soon discovered a striking similarity between her and the Earth. This is what Milton finely alludes to when he describes the Shield of Satan, in the first book of his Paradise Lost.

______________ "The broad circumference
Hung on his Shoulders like the Moon; whose orb
Through optic glass the Tuscan artist views,
At Evening; from the Top of Fesole;
Or in Valdarno: to descry, new Lands,
Rivers or Mountains in her spotty globe".

Several Astronomers have given us tolerably exact Maps of the Moon, with figure of every spot, as it appears through the best telescopes, distinguishing each of them by a proper name " – This which we now display is copied from a very accurate and faithful Map, laid down [**9**|**10**]

[cont.] from actual observations by D[r] Kitchener, and executed under his immediate superintendence and direction. **[b]**

"That the spots in the Moon, which are taken for Mountains and Valleys, are in reality such, is evident from their shadows. For in all situations of the Moon, the elevated parts are constantly found to cast a triangular shadow, in a direction opposite to that of the Sun; and, on the contrary, the cavities are always dark on the side next the Sun, and illuminated on the opposite one; which is exactly conformable to what we observe of Hills and Valleys on the Earth.

These appearances of the Moon are explained by Astronomers, as caused by the varieties of her surface. The brightest parts being supposed to be eminences of Mountains, in several places heightened by Volcanos. – The darker spots, shadows of those Mountainous regions, and the broad dark places, Seas and Lakes, which conformably to the known properties of Water, reflect a very small portion of Light. All Bodies reflect, light in the proportion of their Density.

In looking at the Moon through a Telescope, we constantly observe the same face; from which it is evident that she turns only once round upon her axis in the time of every periodical revolution; so that the [**10**|**11**]

[cont.] inhabitants of the Moon have but one day and night in the course of a month. **f.464**

One of the most remarkable phaenomena attending the Moon, is the continual change of figure to which she is subject. Sometimes she appears perfectly full, or circular, at other times only half or a quarter illuminated, changing through a great variety of shapes. And as these changes are always the same at the same elongation from the Sun, they prove that she receives her light from that Luminary: for the Moon being enlighteded on that side only which faces the Sun, a greater or less quantity of that enlighteded part will be visible, according as it is turned towards us, or from us; and her figure will consequently appear to vary through the whole of her revolution."

By the assistance of a new moving apparatus we shall be enabled to show all the varieties of form which the Moon periodically undergoes from this, her appearance at the full, to her disappearance at the change: presenting with minute accuracy her various forms during her Wane. You will be enabled to observe in this progress – her Gibbous or Oval shape, her form when she is in her last quarter, and only half of her enlightend side is visible: and her appearance on her arrival at her last Octant; When her visible enlightend part assumes the form of a Crescent. [**11**|**12**]

Commence the movement of the Scene. **[b]**

A part of her Limb becomes obscured, and she begins to shew the Gibbous or Oval form, which is apparent when she reaches her third Octant, where she arrives about 3 days and a half after the full. And we have here displayed her ragged edges which clearly demonstrate the mountainous construction of her surface: this edge which fringes the dark side of the Moon is uneven, and broken in upon, by luminous points. There are unquestionably occasioned by the mountains which catch the rays of the Sun before he illumines the valleys below. Every one [sic] must have observed a similar effect on our own Globe at the rising and setting of the Sun: and this effect continues during all the changes of form which the Moon undergoes. She further decreases as her enlightened part becomes more withdrawn from the Earth: We now perceive only one half of her enlightened side, precisely as she appears when she reaches the last quarter: and this Scene possesses the advantage of shewing every possible gradation of form, to which the Moon is subject with the minutest accuracy; and even more clearly than can be discerned by the most assiduous astronomer, because, some of these varieties occur, both when the Moon is below the horizon, and when she is above it during our day [**12**|**13**]

[cont.] light; at each of which periods. no observations can be made. A still greater part of her enlightened side is turned from us, as she approaches her last octant, when she becomes horned as she now appears, and this Crescent form gradually diminishes until we lose the whole of the enlightened part of the Moon and she arrives at the Change. After which, the New Moon goes through precisely the same gradations of form on the increase, which have here been shewn on her decrease, until she again arrives at her full or circular appearance: Which progress we **f. 465** could shew on this apparatus, but as it would only reverse the succession of the same forms which have just been shewn; it might be considered as an unnecessary waste of time: particularly as the nearest Scene will show in a different manner, not only all these varieties of the Moon in her orbit, but also her relative situation to the Earth during her Monthly revolution.

Scene Moon’s orbit and Phases.

We will suppose the Sun to be placed so as to enlighten this; the Earth in the centre, the former surrounding it describing the orbit and Phases of the Moon. Then when the Moon is here, in conjunction with the Sun, her dark side being turned towards the [**13**|**14**]

[cont.] Earth, she will disappear as represented in this circle, and is now called the New Moon. When she comes to her first octant at this place, or has gone through one eighth of her orbit, a quarter of her enlightened hemisphere will be turned towards the Earth, and she will then appear horned as in this place. **[b]**

When she appears here, or has gone thro’ a quarter of her orbit, she shews us one half of her enlightened hemisphere, and is then said to be a quarter old. At the next point she is in her second octant and by shewing us more of her enlightened hemisphere she appears Gibbous, as here described. – At this place her whole enlightened side is turned towards the Earth, and now she appears round, and is said to be at her full – In her third Octant part of her dark side being turned towards the Earth she again appears gibbous and is on the decrease: – When she arrives to this point we see just one half of her enlightened side, at which time she appears still farther decreased; When she comes to her fourth octant we only see a quarter of her enlightened hemisphere, which occasions her to appear horned; and here again having now completed her course, [**14**|**15**]

[cont.] she again disappears, and becomes a new Moon as before. **f. 466**

Precisely similar appearances must our Earth present to the Lunar inhabitants; with this difference, that the enlighten’d face of our Globe must appear thirteen times larger to them than the Moon does to us. It may not perhaps be consider’d a waste of time to shew the curious appearance our Earth must exhibit.

Scene
Europe – Asia and New Holland.

We have here the great continent of Europe, Asia, and Africa; and new Holland. The Eastern Ocean, and Indian Sea. The Ethiopic Ocean, and branching from the Western or Atlantick ocean, the mediterranian Sea, and hence it may be easily conceived how vast and glorious an object to the inhabitants of the lunar regions a Moon of such dimensions must appear. I now come to a brief description of the Planet Mars, the next beyond our Earth – The face of Mars, unlike that of Venus, is always found to be round and full, as his superior situation required; excepting at the time of the quadratures, [**15**|**16**]

[cont.] when a small part of the unenlightened hemisphere being turned towards us, his disc appears, like the Moon about three days after the full. **[b]**

Scene – Mars.

This planet is also diversified with spots like the Moon, by which his diurnal revolution is ascertained in the direction from West to East; and from his ruddy and obscure appearance, as well as from other circumstances, it is concluded that his atmosphere is nearly of the same density with that of the Earth. Herschel has observed that two circles surrounding the poles of this planet, are very white and luminous, which he considers as probably owing to great quantities of Snow lying there without melting."

The next objects of attention in our system, are the four newly discovered Planets, Vesta, Juno, Pallas and Ceres but they are by far too small to admit of such accurate observations to be made upon them as is necessary for ascertaining any particular spots, or other phaenomena, which might be observed upon their discs. [**16**|**17**]

Scene Jupiter **f. 467**

The Telescopic appearance of Jupiter, affords a vast field for the curious enquirer. This Planet is surrounded by several faint stripes called belts or bands, which are parallel to the plane of his orbit, and consequently to each other. They are not regular or constant in their appearance: for sometimes only two are to be seen, and sometimes four or five; When their number is most considerable, one or more dark spots are frequently formed between the belts, which increase till the whole is united into one large dusky band. This planet is also diversified with a number of large Spots, which are the brightest part of his surface; but, like the belts, they are subject to various mutations, both in their figure and periods. It has been conjectured that these belts are Seas, and that the variations observed, both in them and the spots, are occasioned by tides, which are differently affected according to the positions of his Moons. The four Satellites of Jupiter were first observed by Galileo, the 7th of January 1610, soon after the invention of the Telescope, but the belts were not discovered till [**17**|**18**]

[cont.] near twenty years afterwards. **[b]**

The next planet which claims our notice, is Saturn, he is at too great a distance for us, to distinguish (without powerful instruments) those varieties, which have been observed upon his surface, and therefore, it is but lately that the time of his diurnal rotation has been determined.

Scene – Saturn.

It is now ascertained that this diurnal revolution is performed in ten hours, sixteen minutes and nineteen seconds. With a good Telescope, we also discover on the disc of Saturn, the faint appearance of belts, resembling those of Jupiter, and which are probably of a similar nature. The magnificient Ring, which encircles the body of this planet, is inclined to the plane of the ecliptic in an angle of about thirty degrees; in consequence of which its apparent figure is continually varying[.]

This Ring has the appearance of a large flat circle, turned edgewise towards the Body of the planet, without touching it; its distance from Saturn being nearly equal to its breadth, [**18**|**19**]

[cont.] which is about thirty thousand Miles. It was first discovered by Huygens, and for a considerable time was supposed to be a single undivided body. The great improvements which have been made in the construction of Telescope enable Astronomers to distinguish two rings very easily. By means of spots that have been observed on the surface of these rings, Sir Wm Herschell [sic] discovered, that they revolve about an **f. 468** axis, which is perpendicular to their plane, in ten hours, sixteen minutes and nineteen seconds; being the same time in which the planet itself performs his diurnal rotation; Besides this ring, that serves as a sort of perpetual Moon to enlighten the inhabitants of Saturn, he has the advantage of seven Satellites. Two of these Satellites are here described within the ring, in which situation they have been seen – these revolve about him in the same manner as our Moon revolves about the Earth; and thus furnishing his dreary regions with that constant supply of light, which his remote situation, with respect to the Sun, seems to render so peculiarly necessary.

The next, and highest planet in our system, [**19**|**20**]

[cont.] which has yet been discovered, is called Uranus, or the Georgium Sidus – the honor of this discovery belongs to the late Sir William Herschell [sic], And if the immense distance of "Saturn" from the Sun, render any observations upon him extremely difficult and uncertain, without the aid of the most powerful instruments; much more will these difficulties be increased with regard to Uranus which revolves at nearly double the distance of Saturn; and therefore, none of those varieties can be discovered on the Disc which are observed in the less remote planets; consequently, nothing can with certainty be known of the duration of its diurnal motion. However, Sir W^{m} Herschell [sic] ascertained with his Forty feet Reflector, that it has six Satellites revolving about it, and it is probable, judging from analogy, that it is attended by a still greater number; but which, on account of his immense distance from us, are beyond the reach of telescopic observation. **[b]**

Comets

The Planets are not the only moving bodies visible in the Heavens. There are others which appear [**20**|**21**]

[cont.] at uncertain intervals and with a very different aspect from the planets. These are very numerous, and no fewer than 450 are supposed to belong to our solar system. They are called Comets. And some Comets have appeared, which were as well designed, and as round as planets: but in general they have a luminous matter diffused around them, or projecting out from them, which to appearance very much resembles the **f. 469**

Aurora Borealis. Comets come in a direct line towards the Sun, as if they were <u>going to fall into his body</u>; and after having disappeared for some time in consequence of their proximity to that luminary, they fly off again on the other side as fast as they came, projecting a tail much greater and brighter in their recess from him than when they advanced towards him; but, getting daily at a farther distance from us in the Heavens, they continually lose a part of their splendour, and at last totally disappear. Their apparent Magnitude is very different; sometimes they appear only of the bigness of a fixed Star of the second Magnitude [**21**|**22**]

[cont.] at other times they equal the diameter of Venus, and sometimes even of the Sun or Moon. These bodies will also sometimes lose their splendour suddenly, while their apparent bulk remains unaltered. With respect to their apparent motions, they have all the inequalities of the planets; sometimes seeming to go forwards, sometimes backwards, and sometimes to be stationary. **[b]**

The Comets, viewed through a Telescope, have generally very different appearances from any of the planets. The nucleus, or Body of a Comet, seems much more dim. Sturmius tells us, that observing the extraordinary Comet of 1680 with a telescope, it appeared like a Coal dimly glowing; or a rude mass of matter illuminated with a dusky fumid light, less sensible at the extremes than in the middle; and not at all like a star, which appears with a round disc and a vivid light."

This most extraordinary Comet I shall now show you as it was seen by Newton and laid down from actual observation when it was in that part of the Heavens in which the Constellation Lyra is situated, and which is also here represented[.] [**22**|**23**]

<u>Scene, Comet of 1680</u> **f. 470**

This Comet was remarkable for its near approach to the Sun; so near, that in its peribelion [sic] it was not above a sixth part of the diameter of that luminary from the surface thereof. The tail like that of other Comets, increased in length and brightness as it came nearer and pass'd towards the Sun; and became shorter & fainter as it went farther from <u>him</u> and from the <u>Earth</u>, till that and the Comet were too far off to be any longer visible.

The Comet of 1811 is doubtless in the Recollection of most of my hearers – The representation of it which I shall now produce is a faithful Copy of its appearance in the Constellation Ursa Major.

Scene – Comet 1811

This Comet was first noticed in France in the Arctic Sky in the Month of March. He traversed our system from South to North and was first seen in this Island in August. Early in September it arrived at its perehelion [sic] at which period it was about 100 Millions of Miles from the Sun. The tail of this Comet, (soon after it began its retrogradation) [**23**|**24**]

[cont.] was about 30 Millions of Miles in length. It approached within little more than 100 Millions of Miles of the Earth, and totally disappeared in January 1812. **[b]**

As we are upon the subject of Comets, we will with your permission give a representation of the Comet of 1819 as it presented itself to the Telescope in the Constellation Taurus.

Scene – Comet 1819

The progress of this Comet was similar to others, therefore it is exhibited only to gratify those who had not an Opportunity of ascertaining its Telescopic Appearance. And now having shewn the most accurate representations of the Planets and the most interesting objects of the Solar System, we will with all speed present to your view the different revolutions of the Earth and Moon on the extensive Planetarium prepared for that purpose. –

Planetarium

In this apparatus we endeavour to convey an idea of the Sun situated in the centre of the System with the Earth and Moon performing their Annual [**24**|**25**]

[cont.] diurnal and monthly revolutions. **f. 471**

Previous to putting it in in motion, it will be proper to offer a few remarks upon each of the objects individually. I will commence with the Sun, which will be represented as revolving on his Axis in twenty five of our days, and about six hours. The Sun’s day therefore (if we may use the expression) is of that length – and this fact has been accurately ascertain’d by means of the motion of the spots on his surface. –

The rotation of the Earth on its Axis, is performed in twenty four hours, forming our day and night, according as we are advanced towards the Sun or withdrawn from his rays. The motion in its ~~annual revolution~~ orbit (being the path it describes during its annual revolution round the Sun) is completed in 365 days and 6 hours forming our Year – You will clearly perceive that The Axis of the Earth is not perpendicular, but that it inclines 23 degrees and a half, from a perpendicular to the plane of its orbit, and by that Axis keeping always parallel to itself during the Earth’s annual revolution round the [**25**|**26**]

[cont.] Sun, the northern and southern hemispheres alternately receive the benefit of the Sun’s light and heat, producing all the phenomena of the Seasons. **[b]**

This beneficent and curious provision for the existance [sic] and comfort of the Earth’s inhabitations cannot too powerfully excite our admiration of the wisdom, or our gratitude for the goodness of the Creator. If it were not for this simple contrivance one part of the Globe would revolve constantly in the full blaze of the Sun’s rays – while those regions which are situated near the poles would be almost, wholly, destitute of light and heat, and probably incapable of sustaining either Animal or vegetable life. – But this is not the case, for the remotest points to which the avarice or curiousity of Man has penetrated are found to be inhabited; and doubtless that power which “tempers the wind to the shorn Lamb” – has so organized their inhabitants as to afford even in those desolate regions the Capability and means of enjoyment.

This Phenomenon of the Seasons will be evidently demonstrated presently, as the Earth travels over its annual road. [**26**|**27**]

I have now described two of the Earth’s revolutions, its diurnal and its annual; but it has a third – namely – its monthly revolution with the Moon round a common centre of gravity. All these various motions will be distinctly visible on this apparatus. – And I venture particularly to call your attention to the fact – that both the Earth and Moon, will, during their course round the Sun receive their light (and we may consequently suppose their heat) from the object which is here placed to represent that luminary, at this moment the Sun would appear to the inhabitants of this Earth to be situated in that Constellation or sign of the Zodiac which is called Aries (the Ram) which sign the Sun appears to enter about the 20th March, the commencement of our Spring – it is now therefore the vernal Equinox and when the Earth is thus situated, you will observe that one half of the Globe (divided as it were from pole to pole) is completely enlighten'd by the rays of the Sun – at this period of the Year the length of the days and nights are equal all over the Earth. – it is therefore called the Equinox. – Precisely similar circumstances will occur by [**27**|**28**]

[cont.] and bye, when the Earth has made one half of its annual journey and arrives at the Autumnal Equinox, of which we shall speak at the proper time. **[b]**

We will now commence the revolutions of these bodies and while they are revolving round their centre of attraction the Sun, and during their progress I will explain to those who may not be previously acquainted with the subject, what is meant by the twelve Signs of the Zodiac, which are here represented. –

The ancient Astronomers in order to distinguish the various parts of the Heavens formed certain sets of Stars into Constellations; and in order to impress their localitites on the recollection and to communicate a description of them in an easy and intelligible manner, gave to these Constellations the names of certain Animals, Persons, or things, accordingly as the fancy suggested them, and as we occasionally conceive forms in a good Winter Fire.

These constellations so fancied and designated they afterwards divided into three sets – Those of the Northern Hemisphere – Those of the Southern [**28**|**29**]

[cont.] and those of the Zodiac. **f. 473**

The Zodiac of which we are now to speak, is a Zone or girdle of about Eighteen degrees ~~round~~ broad, in the centre of which is the Ecliptic or that path in the Heavens in which the Sun appears to move, and which is so called because eclipses usually take place when the Moon is either crossing or nearly approaching to, this apparent road of the Sun. – In this circle of the Heavens, the Orbits of all the Planets belonging to our system are included; and is so called because the names of the signs are taken from Animals and other living Creatures – Zodiac being a Greek word signifying such a collection.

Through all these various signs of the Zodiac the Sun was observed to appear to move annually. – but in fact the Sun as relates to them is stationary it is the Motion of the Earth which produces this effect; for when the Earth is here – we see the Sun in the Constellation opposite to us – and we say the Sun is in the Constellation, Gemini, the Twins and as the Earth travel still further on, the Sun still appears to shift his place as relates to that Constellation. [**29**|**30**]

[Page number is incorrectly written as page 20 in the original text.] **[b]**

The constellation in the right side of the Scene is called Aries the Ram, and this is the form which the fancy of the Antients has given to it. the next is Taurus the Bull – Gemini the Twins – Cancer the Crab – Leo the Lion – Virgo the Virgin – Libra the Balance – Scorpio the Scorpion – Sagittarius the Archer – Capricornus the Goat – Aquarius the Waterbearer – and Pisces the Fishes. –

The Earth having pass'd thus far on its journey, has been the Sun appear to move from Aries through the signs of Taurus – and Gemini: and now to the Inhabitants of this Globe he would appear to be gradually entering Cancer the Crab. It is therefore our Summer Solstice: and you will I trust observe, that the Southern parts of the Earth are no longer within the Sun's rays. – The Earth's Axis having kept parallel to the plane of it's orbit, it is now the <u>North</u> pole which is illuminated: and therefore, <u>we</u>, the inhabitants of this Country (which is situated so far to the North of the Equator) enjoy our Summer season, our longest days and shortest Nights. –

It will next be observed that a great deal of meaning was attached to these different Charaters [sic] of [**30**|**31**]

[cont.] the Zodiac – For as the Earth performs its annual~~ly~~ Journey round the Heavens, and the Sun appears progressively to enter these signs, they will all be bound in some degree indicative of the Seasons, nearly corresponddent [sic] with the Twelve Months of our Year. – **f. 474**

Beginning at Aries the Ram – and preceeding round the circle to Virgo the Virgin – These first six are called the Northern Signs – proceeding on from Libra the Balance to Pisces the Fishes – These lower six are called the Southern signs. The first mentioned being our Summer, and the last our Winter signs.

The Ram – The Bull – and the Twins.
were selected as characteristic of Spring –
The Crab – The Lion – and the Virgin.
as emblimatical [sic] of Summer.
The Balance – The Scorpion – and the Archer
as descriptive of Autumn – and
The Goat – The Waterbearer – and the Fishes
as illustrative of Winter. –

The Earth has now completed one half of its annual journey – it has pass'd from Libra the Balance, and will shortly enter Aries the Ram – and the Sun has consequently [**31**|**32**]

[cont.] appeared to the Inhabitants of that Globe to travel from Aries through Taurus, Gemini, Cancer, Leo, Virgo, and is now seen by the inhabitants of that Globe it would appear to be entering in Libra the Balance. At this time then it is the Autumnal Equinox, or the 21st Septr. – and as the Earth proceeds you will again perceive the days and nights are equal all over the Globe: from Pole to Pole. **[b]**

For the better illustration of this subject. It may be proper in this place to direct your attention to the Mechanism of this Planetarium. You may have noticed that the Sun revolves on his Axis, which is clearly distinguishable from the Spots on his surface – but it may not have been noticed that the number of his revolutions are strictly conformable to truth and nature. He turns on his Axis once, in precisely the same time that the Earth revolves on it's Axis, twenty five times and one quarter – And thus performs in the course of our Year, 14 revolutions and one third. –

This Globe which is here placed to represent the Earth, you will also perceive not only preserves it's parallelism, of which I have already spoken, but actually performs the precise number of revolutions on the axis, which the earth we inhabit performs (namely 365 and [**32**|**33**]

[cont.] one quarter) in the course of its annual journey round the Sun. **f. 475**

It will also be seen that it revolves round it's common centre of gravity with the Moon at the same time that all the the [sic] other complicated motions are produced, and conformably to the exact periods in which they are performed in Nature. –

The Moon too must claim some part of your attention – she performs twelve revolutions and one third during her journey round the Earth, and with the Earth round the Sun. – the Earth performs 30 revolutions while she completes one.

The Earth is now arrived to that point of it's annual journey when it's inhabitants will see the Sun appearing in Capricorn the Goat – You will perceive that it is now the Southern regions which receive in turn the genial blessings of the Sun's light and warmth – It is therefore our Winter – the rays of the Sun pass obliquely upon us, and that for a very short duration our nights are now the longest, and our days the shortest, and we are arrived at the 21st December. From this time the sun begins to appear ascending: and the inhabitants of our climate again to look forward with Cheerfulness to lengthning [sic] days, and the Animating Scenes [**33**|**34**]

[cont.] of reviving nature and parturient spring. – **[b]**

I have already noticed that the Earth revolves 365 times and one quarter during its annual journey – now, as we reckon only 365 days in our Year, it will be clear that we lose in every year 6 hours – or one quarter of a day: and in order to avoid the confusion which this error formerly created, and which was rectified some years ago by the alteration of the Style, we have now ev'ry fourth Year an extra day added namely the 29th February; which is called the Bissextile or Leap Year. – Thus compensation is made for the loss on the three preceeding years of 6 hours each, and the redeem'd 6 hours on the fourth, make together the 24 hours, or one day; which would otherwise have been missing in our calculation of the Year. –

Thus the Earth has completed its ~~Animal~~ annual journey round the Sun, and I trust we have shewn satisfactorily, the obvious causes of the succession of the Seasons, the alternations of day and night, and their respective duration during the different periods of the Year.

And these gradations have been established by the bountiful hand of Nature, to heighten our pleasures and our comforts by variety. – The Scene is perpetually [**34**|**35**]

[cont.] changing, but the order of things is immutable and eternal[.] **f. 476**

Look nature through, tis revolution all,

All change, no death: day follows night; & night
The dying day: Stars rise, and set, and rise;
Earth takes th' example: See the summer gay
With her green chaplet, and ambrosial flowr's,
Droops into pallid Autumn; Winter gray
Ho'rid with frost, and turbulent with storm
Blows Autumn and her golden fruits away
Then melts into the Spring; soft Spring with breath
Favonian, from warm chambers of the South
Recals the first: all, to reflourish fades
As in a wheel all sinks to reascend."

Our next subject will be to explain some of the Phenomena attendant on the Earth, especially the Solar and Lunar Eclipses, and the Tides – and these with your permission we shall receive for a new Scene at the opening of the next part.

End of Part Second.

Lecture on Astronomy. f. 477

Ouranologia

Part Third

Part Third f. 478

I now proceed to a description of the interesting subject of Eclipses.

Of all the phaenomena of the Heavens, there are none that engage the attention of Mankind more than Eclipses of the Sun and Moon, and to those who are unacquainted with Astronomical principles, nothing appears more extraordinary than the accuracy with which they can be predicted. To enter into a popular explanation of all the principles of this doctrine would be almost impossible; – I shall therefore only attempt to give a general idea of the subject, and to shew without the embarrassment of calculations, the foundation upon which it depends.

In the first place then, it is to be observed that all opake or dark bodies, when they are exposed to the light of the Sun, cast a shadow behind them in an opposite direction, and as the Earth is a body of this kind, whose shadow extends over a large sphere, and to a great distance, it is plain that the Moon, in passing through this space, must be deprived of her light, or suffer an Eclipse. The Sun being larger than the Earth, the Earth's shadow is conical, and ends in a [**1**|**2**]

[cont.] point. The figure of the Moon's shadow is also that of a Cone; indeed this must be invariably the case when ever [sic] the body which emits the light, is larger than the body which receives it – as this simple experiment will sufficiently prove. The central light of this Theatre is so much larger than this small Globe that you will perceive as I withdraw it from this spot the shadow will gradually decrease and at last end in a point – This shadow of the Moon then when it falls upon any part of the Earth, the inhabitants of that part will be involved in darkness, and the Sun will seem to them to be eclipsed ~~as~~ so long as the shadow covers them. But as the Moon is much less than the Earth, and as its shadow can extend over but a small portion of the Earth's surface, there will be total darkness, only in that space where the shadow falls; and in the circumjacent places, the inhabitants will see a greater or less part of the Sun's Disc obscured, according as they are nearer to or farther from the Shadow: so that Eclipses of the Sun are always confined to particular places; but those of the Moon may be observed from every part of the Earth, when she is above the horizon at the time the Eclipse happens. **[b]**

From what has been said, it is plain that there [**2**|**3**]

[cont.] can be no lunar eclipse but at the time of full Moon, or when she is opposite to the Sun; and that an Eclipse of the Sun can never happen but at the time of a new Moon, or when she is in conjunction with that luminary: for it is only at those times that the Earth and Moon are in a straight line with the Sun, or that the shadow of the one can fall upon the other. And since there is a new and full Moon every Month, it may be naturally enough imagined that there should be two Eclipses in a Month, one of the Sun, and the other of the Moon: but this is far from being the case; for there **f. 479** are but few Eclipses in comparison to the number of new and full Moons. If, indeed, the plane of the Moon's orbit were coincident with that of the Earth's, the Moon would then pass through the middle of the Earth's shadow, and be eclipsed at every full: and, in like manner, the Moon's shadow, falling upon some part of the Earth, would occasion an Eclipse of the Sun at every change. But one half of the Moon's orbit being elevated about five degrees and a third above the plane of the Ecliptic, and the other half as much depressed below it, the Moon can never come in the same plane with the Earth, but when she is in the nodes, or one of the two points where the orbits intersect each [**3**|**4**]

[cont.] other. And, therefore, as the Moon may make a number of revolutions round the Earth, before a new or full Moon takes place in one of those points, it is plain that there may be no Eclipse, either of the Sun or Moon, in the space of several Months. **[b]**

When the Nodes, or two points of intersection, are in a right line with the centre of the Sun, at the time of a new Moon, the Moon's shadow will fall upon the Earth, and occasions a Solar Eclipse; and if they have the same situation at the time of a full moon, the Earth's shadow will fall upon the Moon, and occasion a Lunar Eclipse. But when the Sun and Moon are more than seventeen degrees from either of the Nodes at the time of conjunction, the Moon is then generally too high or too low in her orbit for any part of her shadow to fall upon the Earth. And when the Sun is more than twelve degrees from either of the Nodes, at the time of opposition, the moon is commonly too high or too low in her orbit to go through any part of the Earth's shadow; so that in both these cases there will be no Eclipse.

It will now be necessary to give you some account of the different kind of Eclipses, and the causes which produce them. And here nothing more is requisite to be observed, than that every variety of [**4**|**5**]

[cont.] this kind that can take place, (either with respect to the Sun or Moon) is owing to the elliptical figure of their orbits, and the position they are in at the time the Eclipse happens. **f. 480**

When the Moon changes at her least distance from the Earth, and is within the proper limits of the Node, she will appear large enough to cover the whole Solar Disc; and those inhabitants of the Earth where her shadow falls, will have the Sun entirely hid from their sight. – But when the Moon changes at her greatest distance from the Earth, and is near enough to the Node, her diameter will subtend a less angle than the Sun's, and, on that account, her dark shadow must terminate in a point before it reaches the Earth, and to the inhabitants of that part of our Earth over which the dark shadow hangs, the Sun's edge will appear like a luminous Ring, all round the body of the Moon.

For the better illustration of the subject, we have prepared a moving optical apparatus – and four descriptive Scenes will now be shewn in succession. The first will describe the progress of a Total Solar Eclipse: – the second will represent an annular Eclipse. and, the third will shew the progress of a partial Solar Eclipse. The Fourth will be spoken of previous to its appearance. [**5**|**6**]

This is to represent the Disc of the Sun previous to the commencement of the obscuration; which will now proceed, and produce (I trust) an accurate idea of the progress of that rare and interesting Spectacle[.] **[b]**

Total Eclipse

It is worthy of particular remark, that as the Moon's apparent diameter when largest, exceeds the Sun's when least, by only about a minute and a half of a degree, the total darkness, in the greatest Eclipse of the Sun that can happen at any time and place, will continue no longer than whilst the Moon goes through a Minute and a half of her orbit from the Sun; which she describes in a little more than three minutes of time. But when the change happens within seventeen degrees of the Node, and the Moon is at her mean distance from the Earth, the point of her shadow will just reach the Earth, and the darkness, on the small spot where it falls, can be only of a moment's continuance. A total Eclipse of the Sun is a very curious Spectacle. Clavius who observed the one which happended on the 21st of August 1560 at Coimbra in Portugal, observes, that the obsecurity was greater, or at least more striking and sensible than that of the Night. It was so dark for some time, that he could scarcely see his hand; [**6**|**7**]

[cont.] some of the largest Stars made their appearance for about a minute or two, and the Birds were so terrified that they fell to the ground. These Eclipses however happen but seldom at any particular place. **f. 481**

Annular Eclipses are much less common. The last remarkable one of this kind being that of the 1st April 1764 which was seen at Rennes, Calais, and Pello in Lapland.

Scene – Annular Eclipse

This is an exact portrait of an Annular Eclipse. Which curious and beautiful appearance is thus produced. When the Moon changes at her greatest distance from the Earth, and is still near enough to the Node, her diameter will subtend a less angle than the Sun's, and on that account, her dark shadow must terminate in a point before it reaches the Earth; and at that place over which it hangs, the Sun's edge will appear like this luminous ring all round the body of the Moon.

We now proceed to the third Scene the progress of a partial Eclipse of the Sun – and the one selected will represent the Eclipse which happended in [Folio is damaged here and might cause some loss of words] September 1820 which doubtless most of my Auditors beheld[.] [**7**|**8**]

Scene, Partial Solar Eclipse **[b]**

We are again to consider this the Disc of the Sun, and the obscuration commences. Astronomers, in order to calculate accurately the extent of Eclipses; divide the Sun's Disc into twelve equal parts or digits – in the Eclipse here shewn ten of those digits were obscured; – the greatest obscuration being on at this moment – after which, the Moon passed from before the face of the Sun and the Eclipse terminated as here represented.

Besides the dark shadow of the Moon already mentioned, there is another fainter one, called the Penumbra, which always accompanies a Solar Eclipse, and takes place upon those parts of the Earth which are only partially deprived of the Sun's rays. This fact will be next represented as well as the penumbral Shadow of the Earth upon the face of the Moon during the progress of a Lunar Eclipse – indeed, you will I hope perceive by the ingenious mechanism which gives motion to the next Scene, all the circumstances and varieties which attend both Solar and Lunar Eclipses.

Scene

We here represent the Sun, Earth and Moon, and in the first place allow me to call your attention to the contrivance by which [**8**|**9**]

[cont.] the Moon as she travels in her orbit round our Globe has her enlighten'd side turned constantly towards the Sun, as she actually appears in nature. The Moon is now approaching to the change when she will become a new Moon. The Nodes or two points of intersection will then be in a right line with the centre of the Sun, and a Solar Eclipse will consequently take place. You now, I hope, perceive the penumbra or faint shadow passing along this spot. The dark shadow now passes also, and to the inhabitants of this part of the Globe the Sun now suffers a total Eclipse: which to those situated within the circle of the penumbra a partial Eclipse only take place. The entire shadow has passed over the Earth and the Solar Eclipse is at an end. **f. 482**

Having shewn the appearances of Solar Eclipses upon the Earth, I shall now illustrate a lunar Eclipse. You will presently perceive that the Earth's dark shadow is also encompassed by a penumbra in the same manner as the Moon's, which is faint towards the edges, and more obscure towards the centre, and this is the reason why it is so difficult to observe exactly either the beginning or end of a lunar Eclipse [**9**|**10**]

[cont.] even with a good Telescope – for the Earth's shadow is so faint and ill-defined about the edges, that when the Moon is either just touching or leaving it, the obscuration of her Limb is scarcely sensible – But both the beginning and end of Solar Eclipses are visible instantaneously for the moment the edge of the Moon's Disc touches the Sun's his roundness seems a little broken on that part; and the moment she leaves it, he appear perfectly round again. The Moon is now falling into the fainter shadow of the Earth, and the Eclipse begins – she now enters into the darker part, or centre of the Conical Shadow, and becomes what is called totally eclipsed – but the Moon when totally eclipsed is seldom invisible, but generally appears of a dusky colour, resembling tarnished Copper, which some have thought to be owing to her own native light; but the true cause of this appearance is the scattered beams of the Sun, which are so bent into the Earth's shadow, in their passage through the atmosphere, as to afford us a sufficient quantity of light to render the Moon still visible. – She has now passed thro' the dark shadow and again becomes – partially illuminated – She now emerges from the [**10**|**11**] **[b]** [cont.] Penumbra, and is again exposed to the full light of the Sun. These are the principal particulars relating to the doctrine of Eclipses which admit of a familiar illustration; and if they be properly considered it will not be difficult to conceive how Astronomers are able to foretel [sic] the <u>exact</u> <u>time</u> when any Phaemomenon of this kind will <u>happen</u>. For as an Eclipse can only take place at the time of a New or full Moon, it appears, that if the two Luminaries are <u>within</u> the proper limits of the Node – there will be an Eclipse; or otherwise not, agreeably to what has been already observed upon this subject. **f. 483**

<u>Tides</u>

Having taken a general view of total Solar and Lunar Eclipses, we now come to speak of that most interesting subject the nature and cause of the Tides.

The Ocean, it is well known, covers more than one half of the Globe; and this large body of Water is found to be in continual motion, ebbing and flowing alternately, without the least intermission. What connection these motions have with the Moon, we shall see as we proceed; but, at present, it will be sufficient to observe that they always follow a certain general rule. For instance, if the Tide be now at high water mark, [**11**|**12**]

[cont.] in any port or harbour which lies open to the Ocean, it will presently subside, and flow regularly back, for about six hours, when it will be found at low-water mark. After this, it will again gradually advance for six hours, and then return back, in the same time, to its former situation; rising and falling alternately, twice a day, or in the space of about twenty-four hours. **[b]**

The interval between its flux and reflux, is however, not precisely six hours, but about eleven minutes more; so that the time of high water does not always happen at the same hour, but is about three quarters of an hour later every day, for thirty days, when it again recurs as before.

This exactly answers to the motion of the Moon; she rises every day about three quarters of an hour later than upon the proceeding one; and,
by moving in this manner round the Earth, completes her revolution in about thirty days, and then begins to rise again at the same time as before.

It will be proper to observe, that the Earth and Moon mutually attract each other; in consequence of which they would approach towards the same point, if it were not for a contrary force acting in an opposite direction; which being such as [**12**|**13**]

[cont.] to cause an equilibrium of the two, their mean distance is preserved. The latter of these is called the centrifugal force, being that by which revolving bodies have a tendency to recode from their centres of motion; as a stone, when whirled round in a sling, has a tendency to fly off, and which requires a greater or less force to counteract it, according to the velocity with which it revolves. And as the Earth and Moon may be considered as revolving about their common centre of gravity, it is obvious, that they will have a mutual tendency to recede from each other, or from their common centre of gravity. **f. 484**

Now this centrifugal force by which the Earth is prevented from approaching towards the Moon, acts equally on all its particles; since each of them, moving with the same velocity, has the same tendency to recede. But the force by which they have a tendency to approach, is not equal in every particle; it being a law of attraction, that the force increases as the squares of the distances decrease. Whence it is obvious, that the surface of the Earth, or Ocean, nearest the Moon, is attracted by a greater force than the centre; and therefore the Waters will have a tendency to rise in those parts [**13**|**14**]

[cont.] immediately under the attracting body.” **[b]**
We shall illustrate this by a new optical instrument now for the first time presented to the public which the inventor respectfully hopes will render the subject more distinctly intelligiale to those previously unacquainted with it, than any of the usual modes of explaining it[.]

Scene

I will first explain the principles of the motion of the Tides, and then cause this newly invented apparatus to be put in motion, which will I hope clearly illustrate to the sight this interesting subject.

First Figure of Tides.

We here represent the Earth and Moon and for the sake of perspicuity let us suppose the Earth entirely covered by the Ocean – Then the Moon will act upon the surface of the Sea at these points, as well as upon the centre <u>here</u> –

But this point being nearer to the Moon than this point which represents the centre of the Earth the attraction at this place will be greater than at <u>this</u> – and at any other intermediate points, the attractive force will be different, according to their different distances from the Moon. [**14**|**15**]

Now as every particle has an equal tendency to recede from the Moon, but an unequal one to approach towards it; and since the attractive force is greatest on the part of the Ocean, which lies immediately under the Moon, the waters will, of course, flow ~~constant~~ constantly to that part, and be elevated or depressed at different places, according as her situation changes with respect to those places. So far then it must appear perfectly clear, that the tides are occasioned by the attractive power of the Moon: – but what is the reason that twelve hours <u>afterwards</u>, when she passes the meredian [sic] <u>below</u> the horizon, the waters at the same place, are <u>then</u> <u>also</u> elevated? – **f. 485**

We know from experience, that, whether the Moon be in the zenith or nadir, the phaenomenon is nearly the same; it being high water with us at the same time that it is high water with our Antipodes.

This circumstance seemed, at first, so opposite to the nature of attraction, that some philosophers, who did not examine it with proper attention, thought it a sufficient refutation of that doctrine. But the edifice of Newton is built upon a Rock, and is not to be shaken by every idle wind that blows.

We have before seen that the Waters at this [**15**|**16**]

[cont.] point, nearest the Moon, will be elevated, because this point is more strongly attracted by the Moon than the centre <u>here</u> – and because <u>this</u> point is still more remote than the centre, the attractive power of the Moon will be still less at <u>this</u> point than at <u>this</u> – whence, since every particle has an equal rendency to recede from the Moon, but an unequal one to approach towards it, it follows that these parts which are the least attracted with recede the farthest – that is; the waters here will recede the farthest from the Moon, and consequently be equally elevated at this as at this" – so that the <u>attractive</u> force of the Moon will evidently raise the **[b]**

Waters on this side of the Globe, and by her diminished attraction will allow the centrifugal force to act on the waters opposite in an equal degree, which will cause them to fly off from the centre and produce a corresponding Tide in that direction.

"Following this system, then, it is to be observed that at any port or harbor which lies open to the Ocean, the action of the Moon will tend to elevate the Waters there, when she is on the Meridian of that place, whether it be above the horizon or below it. But the water cannot be raised at one place, without [**16**|**17**]

[cont.] flowing from, and being depressed at another; and these elevations and depressions will obviously be the greatest at opposite points of the Earth's surface. When the Moon raises we will say, the waters, here and here – they will be depressed at these points – and when raised by her here and here – they will be depressed where you now see them elevated – And as the Moon passes over the meridian and is in the horizon, twice every day, there will therefore be two tides of floods and two of Ebb in that time, at the interval of about six hours and eleven minutes each; which is exactly conformably to theory and experience. **f. 486**

From what has been hitherto said, it may be supposed that the Moon is the sole Agent concerned in producing the Tides. But it will be necessary to observe, before we quit the subject, that the influence of the Sun would also produce a similar effect; though in a much less degree, than, from his superior magnitude, we should naturally be led to imagine.

The whole attractive force of the Sun is far superior to that of the Moon; but as his distance from the Earth is near four hundred times greater, the forces with which he acts upon different parts of it, will [**17**|**18**]

[cont.] approach much nearer to equality than those of the Moon; and consequently will have a less effect in producing any change of its figure. Newton has calculated the effect of the Sun's influence, in this case; and found that it is about one third of that of the Moon. The action of the Sun alone would, therefore, be sufficient to produce a flux and reflux of the Sea; but the elevations and depressions occasioned by this means, would be about three times less than those produced by the Moon. Properly speaking then there are two Tides, a solar, and a Lunar, which have a joint or opposite effect, according to the situation of the bodies that produce them. When the actions of the Sun and Moon conspire together, as at the **[b]** time of new and full moon, the flux and reflux becomes more considerable: and these are then called the Spring Tides. But when one tends to elevate the waters, whilst the other depresses them, as at the Moon's first and third quarters, the effect will be exactly the contrary; the flux and reflux, instead of being augmented, as before, will now be diminished; and these are called the Neap Tides.

But as this is a matter of some importance, [**18**|**19**]

[cont.] we will now enter into a more minute explanation of it. For which purpose we will call another object to our aid. **f. 487**

Second Figure of Tides.

Which let us call the Sun – this the Earth and this, the Moon – Then because the Sun and the New Moon are nearly in the same right line with the centre of the Earth their actions will conspire together, and raise the waters about the zenith, or the point immediately under them to a greater height than if only one of these forces acted alone. But it has been shown, that when the water is elevated at the zenith, it is also elevated at the opposite point, or Nadir, at the same time, and therefore in this situation of the Sun and Moon the tides will be augmented. –

The Moon will now be seen moving round the Earth and receding from the Sun, and now the causes of the Neap tides will be clearly explained. – You plainly perceive that the waters appear to be following the course of the Moon in obedience to the attraction of that Planet, and you will please to notice that as the Moon retreats farther from a right line with the sun, the forces of the Sun and Moon will tend to produce contrary effects; because the one raises the [**19**|**20**]

[cont.] waters in that part where the other allows them to be depress'd. – **[b]**
The Sun's attraction on these points will diminish the effect of the Moon's attraction at these – so that the Water's will rise a little at the points under and opposite the Sun, and fall as much at the points under and opposite the Moon; and (of course) the Lunar Tides will be diminished at these times. This respects the Moon in her first quarter; where she is at present situated; – and the same reasoning will evidently hold when she presently appears in her third quarter. –

As the Moon approaches the full and comes to her opposition to the

Sun, she raises the waters on one side, and allows them to be raised on the other, and the Sun still acting in a right line, will also raise the waters on his side, and allow them to be raised on the other by his diminished attraction; therefore, in this situation also the Tides will be augmented: their joint efforts and diminished power, being nearly the same at the full as at the change, and in both these cases they occasion unusual elevation of the waters, and these are called Spring tides.

As the Moon approaches her third quarter, the tides will be diminished – for, as the Sun and Moon again act in right angles, they must produce the [**20**|**21**]

[cont.] same diminution as before, and in the cases of the first and third quarters, they occusion what is called Neap Tides. **f. 488**

These are the principal phaenomena of the Tides; and where no local circumstances interfere, the theory and facts will be found to agree. But it must be observed, that what has been here said; relates only to such places as lie open to large oceans. In Seas and Channels, which are more confined, a number of causes concur, which occasion considerable deviations from the general rule. Thus, it is high water at Plymouth about the sixth hour; at the Isle of Wight about the ninth hour; and at London Bridge about the fifteenth hour, after the Moon has passed the meredian [sic]. And at Batsha, in the Kingdom of Tonquin, the Sea ebbs and flows but once a day; the time of high water being at the setting of the Moon, and the time of low water at her rising. There are, also, great variations in the height of the Tides, according to the situation of Coasts, or the nature of the streights [sic] which they have to pass thro'. Thus, the Mediterranian and Baltic Seas [**21**|**22**]

[cont.] have very small elevations; which, at the Port of Bristol, the height is sometimes Forty feet; and at St. Malo's it is said to be near a hundred. **[b]**

Having proceeded thus far with the Lecture, allow me to express my respectful acknowledgments for the attention with which you have honour'd what has hitherto been submitted to your observation – and express my hope that the display of the extensive Orrery, which, like the Planetarium, has been prepared with infinite labour and expence; and with, it is hoped, great accuracy of calculation, for the concluding Scene, will receive that approval which it is so much our Ambition to obtain.

The Orrery

As the figure and motion of the Earth are now sufficiently established, it will be proper to turn our attention to the rest of the Planets; and to exhibit a summary view of the whole system.

I have already observed that the Planets are all opake spherical bodies like our Earth, that have no proper light of their own, but shine by means of the borrowed light which they receive from the Sun; and therefore, only that side of them which is [**22**|**23**]

[cont.] turned towards him, can receive the benefit of his light. This fact as imitated with great truth and accuracy on the machine I have now the honor to submit to your observation. – All the Planets have their enlighten'd sides constantly opposite to the source of that light: and it will be particularly worthy your attention, that this beautiful effect is invariably produced on the Earth & Moon, throughout their entire journey round the Sun, as well as during their Monthly journey round their common centre of gravity – which motion you will find to be distinctly visible on this apparatus. – **f. 489**

The Planets are also not only similar to our Earth in form and structure, but they are likewise known to perform their revolutions round the Sun in the same manner; and, this is here represented with mathematical accuracy.

Mercury, the nearest planet to the Sun, goes round him in about 87 days, and 23 hours, or, a less than three Months; which is the length of his year. But being seldom seen, on account of his proximity to the Sun, and no spots appearing on his [**23**|**24**]

[cont.] surface, or disk, the time of his rotation upon his axis, or the length of his days and nights, is not so accurately determined as in most of the other planets[.] His distance from the Sun is computed (speaking in round numbers) to be about 36 Millions of Miles, and his diameter three thousand one hundred and twenty; and in his course round the Sun, he moves at the rate of a hundred and five thousand Miles an hour. **[b]**

This Planet, when viewed, in different positions, with a good Telescope, seems to have all the phases, or appearances of the Moon, except that he can, at no time, be seen entirely round, or quite full; because his enlightened side is never turned directly towards us, except when he is so near the Sun as to be hid in the splendour of his beams. Hence, from these phases, it is evident, that he shines not by any light of his own, as the Sun does, as he would in that case certainly appear, at all times, round like that luminary. – Venus, the next planet above Mercury, is computed to be 68 millions of Miles from the Sun, and by moving at the rate of 76 thousand miles an hour, she completes her [**24**|**25**]

[cont.] annual revolution in 224 days and 16 hours, or about seven months and a half. Her diameter is seven thousand, seven hundred miles, and her diurnal rotation on her Axis, is performed in 23 hours, and 21 minutes. **f. 490**

When this planet appear to the West of the Sun, she rises before him in the Morning, and is called the Morning Star; and when she appears to the East of the Sun, she shines in the Evening after he sets, and is then called the evening Star; being in each situation, alternately; for about 290 days. –

The next Planet above Venus in our system is the Earth, with her attendant satellite, The Moon. Their distance from the Sun is 93 millions of miles, and by moving at the rate of 58 thousand miles an hour, the annual revolution is performed in 365 days and 6 hours, or the space of a year; which motion though 120 times swifter than that of a Cannon Ball, is but little more than half the velocity of Mercury in his orbit. The Earth's diameter is about Seven thousand nine hundred miles; and as it turns round it's Axis every 24 hours, from West to East, it occasions the apparent motion of all [**25**|**26**]

[cont.] the heavenly bodies, from East to West in the same time. – The diameter of the Moon is about two thousand miles and her distance from the Earth Two hundred and Forty thousand Miles. – **[b]**

Next above the Earth's orbit is Mars whose distance from the Sun is computed to be about 142 Millions of Miles. He moves at the rate of fifty five thousand miles an hour, and completes his revolution round the Sun in a little less than 2 of our Years. His diameter is four thousand three hundred and ninety miles; and his diurnal rotation upon his Axis is performed in about 24 hours and 39 minutes.

The next are the four newly discover'd Planets, Vesta, Juno, Pallas and Ceres. – The extreme minuteness of these Planets, as well as the little time since they have been discovered, and their great distance from us; render the results of all observations upon them, in some measure uncertain; we have, however, reason to conclude that none of their diameters exceed four hundred miles, nor are less than one hundred. – But, at present, no accurate estimate can be made of the time of their diurnal rotation. –

Thus far on this Orrery, the relative distances of the Planets from the Sun are correctly [**26**|**27**]

[cont.] represented and the periods of their several revolutions presented with great accuracy: The Sun itself excepted; **f. 491**

We come next to Jupiter – which is placed to the right hand of the Audience the largest of all the Planets, and is reckoned to be about Four hundred and Eighty five millions of miles from the Sun; and by going at the rate of 29 thousand Miles an hour, he completes his annual revolution in something less than twelve of our Years. His diameter is computed to be ninety one thousand five hundred miles; and by a prodigiously rapid motion upon his axis, he performs his diurnal rotation in 9 hours and 55 Minutes.

Saturn, the next planet in the system; which is placed opposite to Jupiter, is about eight hundred and ninety Millions of Miles from the Sun; and by moving at the rate of twenty-two thousand miles an hour, he performs his annual circuit round that liminary in a little less than 29 & 1/2 of our years. His Diameter is computed to be about 76 thousand miles; but, on account of his immense distance, and the deficiency of light occasioned by such a remote situation, the time of his diurnal [**27**|**28**]

[cont.] rotation upon his axis was formerly unknown. It is now however ascertained to be about 10 hours 16 minutes. **[b]**

The next and last planet in our system at present known is Uranus or the Georgium Sidus. which (is here placed at the top of the Orrery) first discovered by the late Sir William Herschel, March 13th 1781. The Elements of this planet have been now accurately determined; from which it appears, that its mean distance from the Sun is about one thousand eight hundred Millions of miles, and its diameter 35 thousand.

Its annual revolution is performed in about 84 Years; but the time of its revolving on its axis has not been discovered by observation; although, from analogy, La'place conceives that it must be performed in about the same time, or rather less, than that of Saturn."

I have already noticed and endeavoured to explain the secondary planets or Satellites with which the primary Planets are attended – These Moons revolve round their respective primaries themselves revolve about the Sun and as it is known that the Sun himself changes his [**28**|**29**]

[cont.] place in the universe, together with the countless millions of Suns with which the firmament is spangled – it is hardly to be doubted that all the systems of Worlds we contemplate, & myriads more which neither Eye nor thought can reach, themselves revolve around some other centre. **f. 492**

"Having thus enumerated the Planets and their attendants; the Comets are now the only bodies belonging to our system, which remain to be mentioned; and of these the number is unknown. But from a variety of observations which have been made on some of the most remarkable ones, it has been found that they move round the Sun, and cross the orbits of the Planets in various directions. They are also solid opake bodies, of different magnitudes, like the Planets. The orbits in which these vast bodies move, are exceeding long ovals, or very excentric [sic] ellipses, of such amazing circumferences that in some parts of their journey through the Heavens, they approach so near the Sun, as to be almost vitrified by his heat; and then go off again into the regions of infinite space, to such immense distances, as must nearly deprive them of the light and heat which the rest of the Planets receive from that luminary[.] [**29**|**30**]

We have prepared a representation of a Comet, describing its elliptical orbit round the Sun – which will here be shewn **[b]**

Comet appears.

You perceive the Tail projects in opposition to the Sun, and it will not only retain that position till it reaches and passes the Perehelion, but after it has pass'd the Sun, it will be the first to recede. – That is, the Nucleus will always be the nearest to that luminary.

The Mechanism is however so accurate, that, in fact, it will best explain itself, and therefore I merely solicit your attention to its progress.

Comet passes the Sun.

What a magnificent idea of the Creator and his works is here presented to the imagination! The Sun placed in the centre of the system; round whose orb, the Planets, Satellites and Comets, perform their revolutions. with an order & regularity that must fill our minds with the most exalted conception of their divine original! But what must be our astonishment when we are told, that this glorious system, with all its superb furniture is only a small part of the universe; and if it could be wholly annihilated, would be no more miss'd [**30**|**31**]

[cont.] by an eye that could take in the whole Creation, than a grain of sand from the Sea shore! **f. 493**

To form a proper idea of the extent of the universe, and the more glorious works of the Creation, we must turn our attention to the starry firmament; and visit those numerous and splendid orbs which are every where dispersed through the heavens, far beyond the limits of our planetary system.

By contemplating the magnitudes and distances of the fixed Stars, all partial Considerations of high and low, great and small, vanish from the mind; and we are presented with such an unbounded view of nature and the immensity of the works of Creation, as overpowers all our faculties, and makes us ready to exclaim with the Psalmist "Lord, what is Man that thou art mindful of him, or the Son of Man that thou regardest him? –

To conclude, in the words of an admired writer on this subject "What an august, what an amazing conception (if human imagination can conceive it) does this give of the works of the Creator! Thousands of thousands of Suns, multiplied without end, and ranged all around us, at immense [**31**|**32***]

[cont.] distances from each other, attended by ten thousand times ten thousand Worlds; yet calm, regular, and harmonious, invariably keeping the paths prescribed them; and these Worlds peopled with myriads of intelligent beings, formed for an endless progression in perfection and felicity. If so much power, goodness and magnificence, be displayed in the material creation, (which is the least considerable part of the universe) how great, wise and good must He be, who made and governs the whole!" **[b]**

Finis

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List of Archives and Databases

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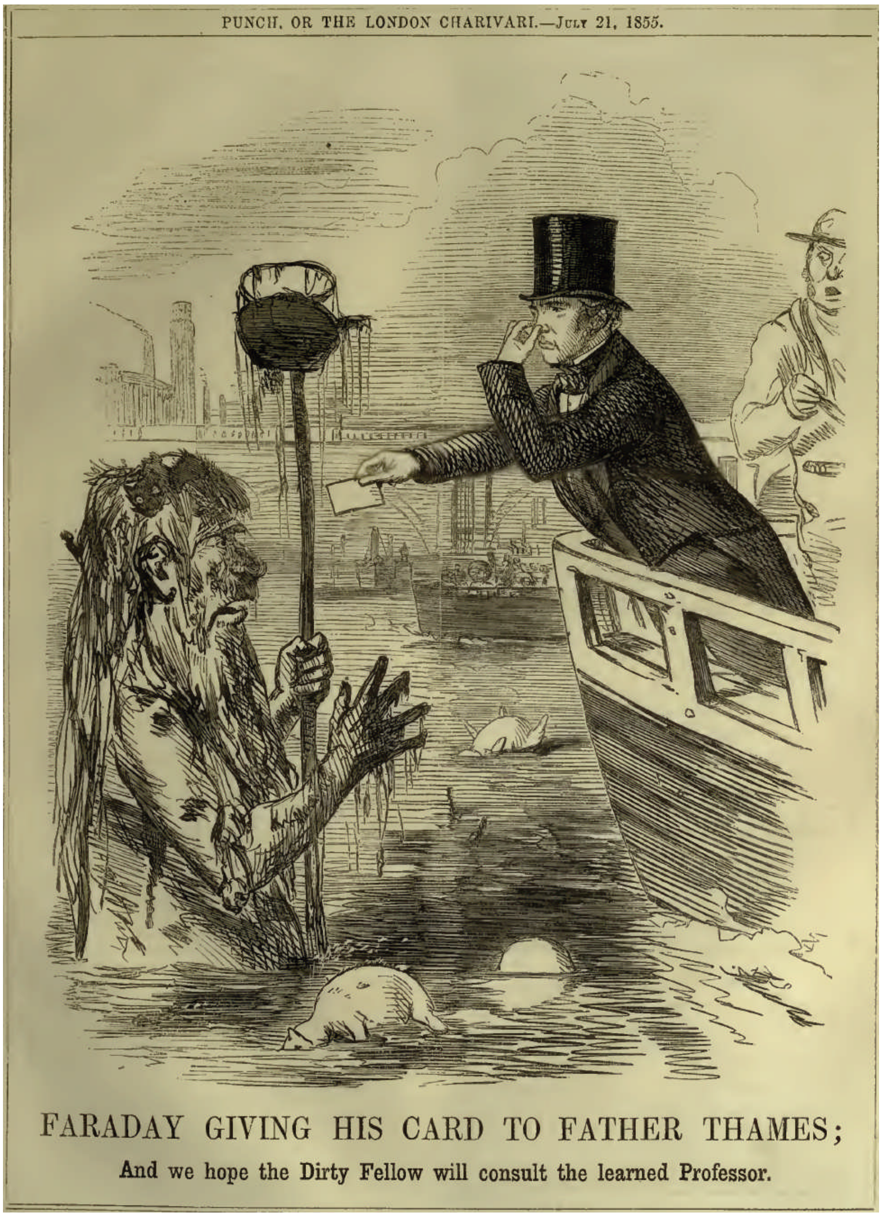
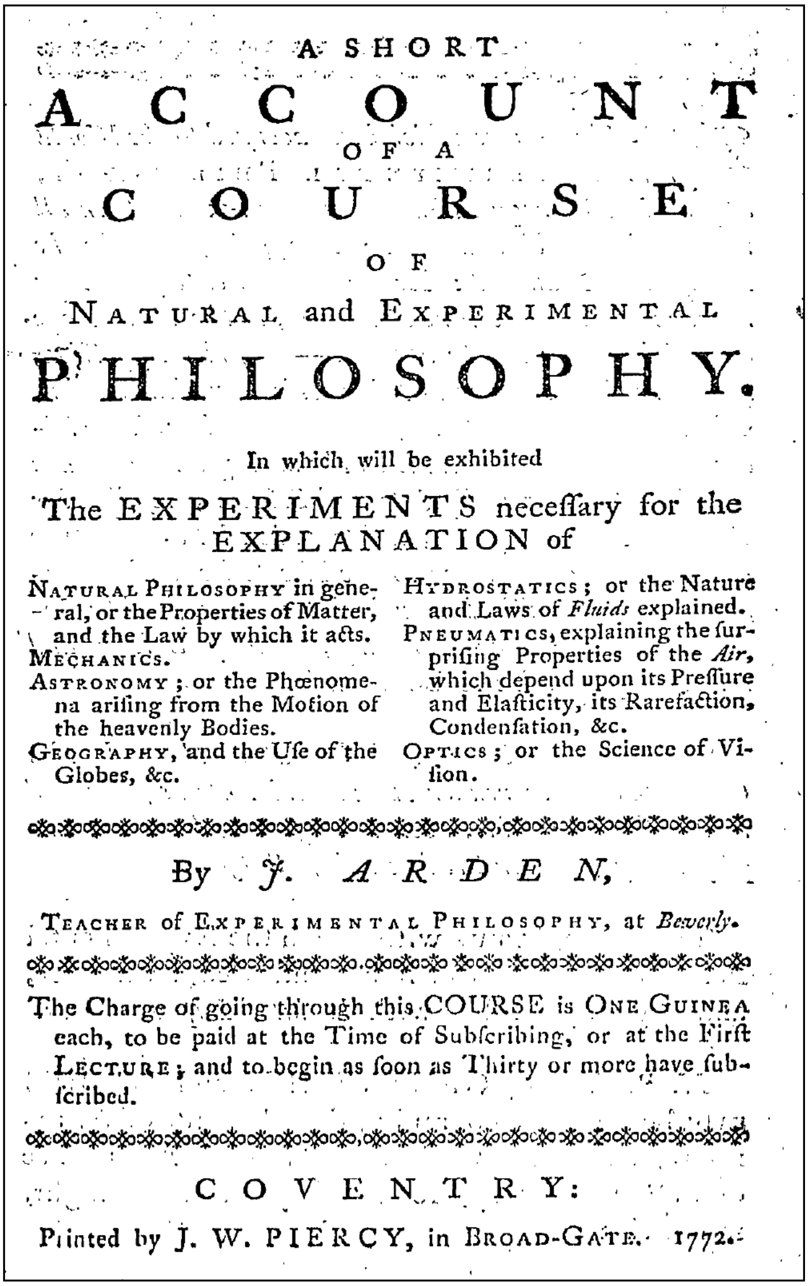


Figure 1.1 "Faraday giving his card to Father Thames; And we hope the Dirty Fellow will consult the learned Professor." *Punch*, vol. 29, 21st July 1855, p. 27. Michael Faraday embodied the prowess of science, as the contemporaries thought it could solve problems such as the pollution in the Thames.



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OF A
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OF
NATURAL and EXPERIMENTAL
PHILOSOPHY.

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NATURAL PHILOSOPHY in general, or the Properties of Matter, and the Law by which it acts.
MECHANICS.
ASTRONOMY; or the Phœnomena ariſing from the Motion of the heavenly Bodies.
GEOGRAPHY, and the Uſe of the Globes, &c.
HYDROSTATICS; or the Nature and Laws of *Fluids* explained.
PNEUMATICS, explaining the ſurpriſing Properties of the *Air*, which depend upon its Preſſure and Elaſticity, its Rarefaction, Condenſation, &c.
OPTICS; or the Science of Viſion.

By *J. ARDEN*,

TEACHER of EXPERIMENTAL PHILOSOPHY, at *Beverly*.

The Charge of going through this COURSE is ONE GUINEA each, to be paid at the Time of Subſcribing, or at the Firſt LECTURE; and to begin as ſoon as Thirty or more have ſubſcribed.

COVENTRY:
Printed by J. W. PIERCY, in BROAD-GATE. 1772.

Figure 1.2 The title page of *A Short Account of a Course of Natural and Experimental Philosophy*, John Arden (or his son James Arden), 1772. The curriculum, the charge and the subscription rules were advertised. Astronomy was one of the subjects in the list. (Copyright: © 2008 Cengage)

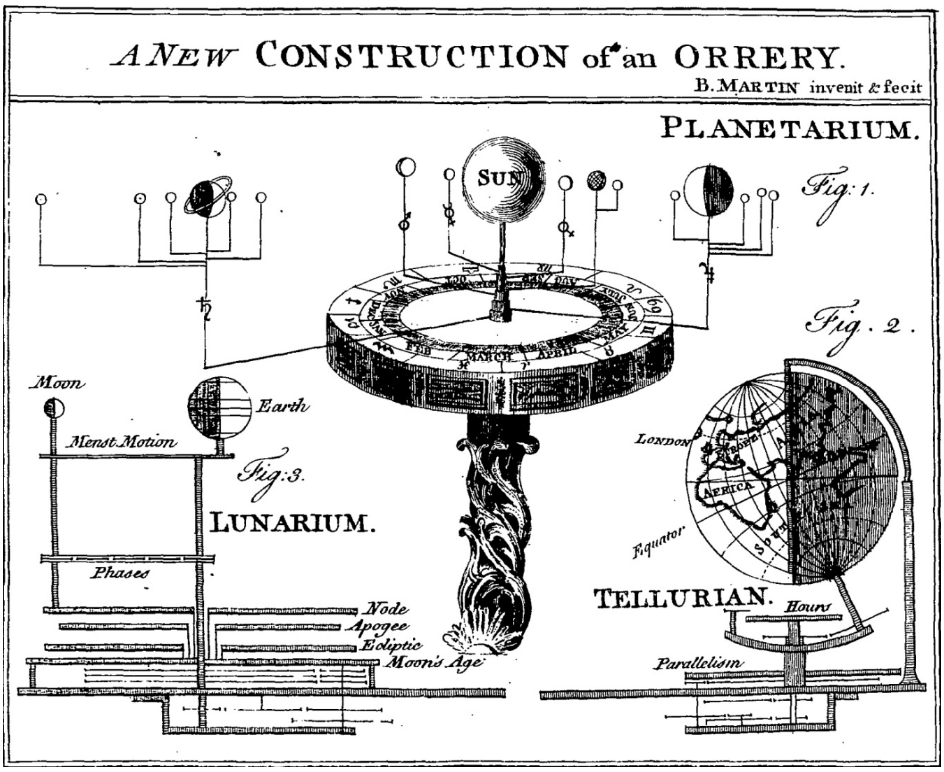


Figure 1.3 "A New Construction of an Orrery", a plate from *The Description and Use of an Orrery of a New Construction*, Benjamin Martin, 1771. This illustration shows Martin's designs of the Lunarium, the Tellurian and the Planetarium, which were invented for the display of the earth-moon system, the earth, and the whole solar system, respectively. (Copyright: © 2008 Cengage)

Figure 1.4 *A Philosopher giving that Lecture on the Orrery, in which a lamp is in place of the Sun*. Joseph Wright, 1766. (Permission from the Derby Museums and Art Gallery)

Figure 1.5 Timeline of popular astronomical lecturers in London and vicinity between 1800 and 1870. This diagram shows a lecturer's approximate active period. The start and the end are according to the earliest and the latest record of lecturing or the date of death.

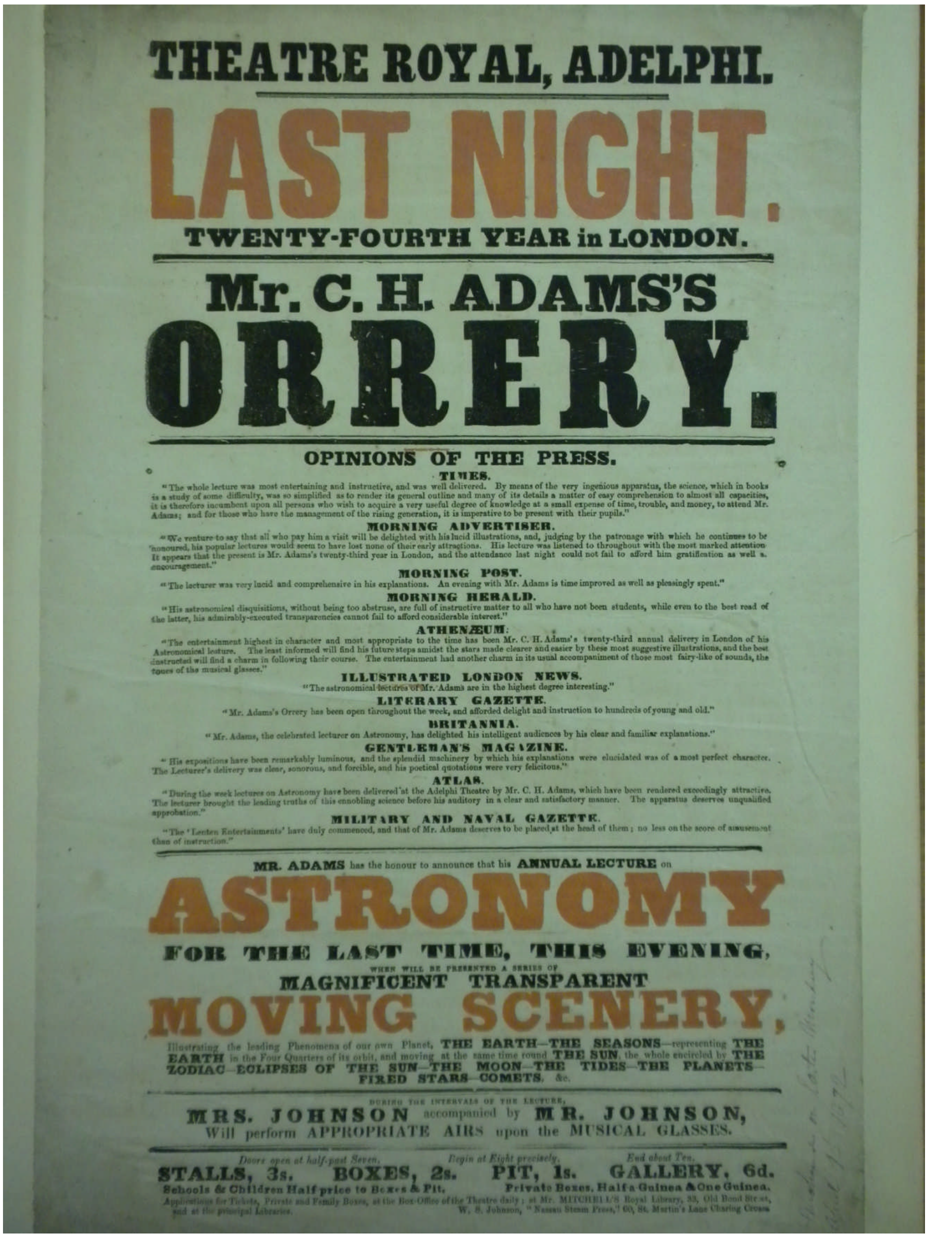


Figure 2.1 Playbill of C. H. Adams's lecture, 15th April 1854. It noticed that this was the last night of the twenty-fourth year in London. Opinions from the press were also advertised. RAS: Add MS 88: 4 (Permission from the Royal Astronomical Society)

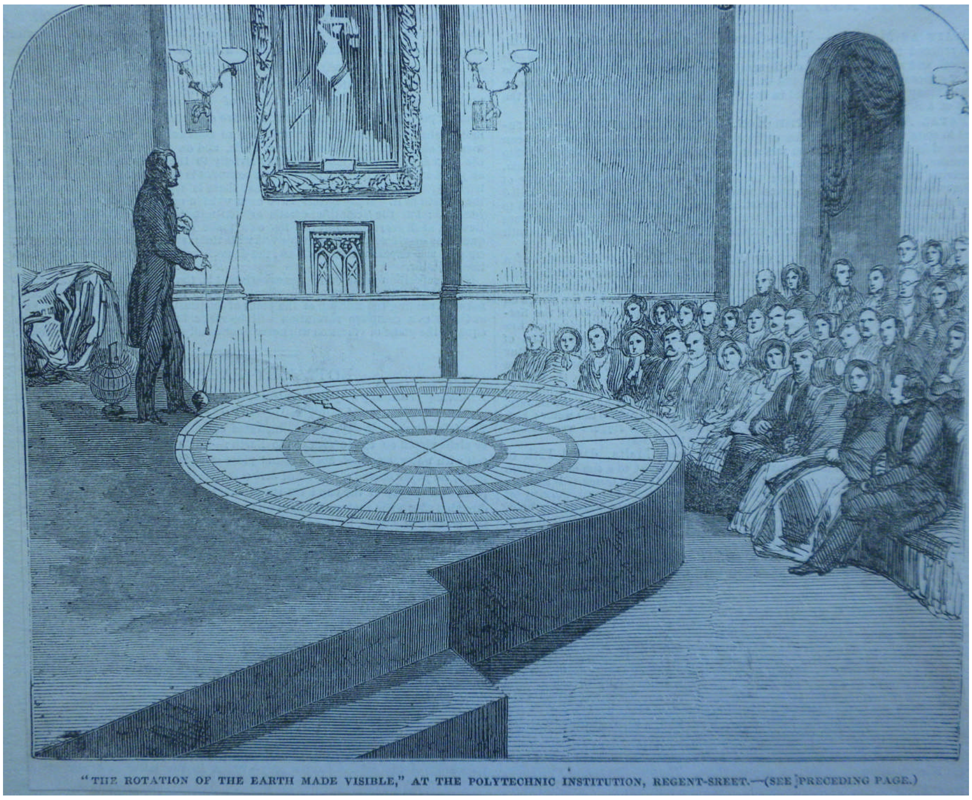


Figure 2.2 "'The rotation of the Earth made visible,' at the Polytechnic Institution, Regent-Street." Engraving from the *Illustrated London News* (3rd May 1851), p. 346. The journalist wrote: "Dr. Bachhoffner professes to conduct the experiment after the manner employed at the Pantheon at Paris, and on the principles laid down by the French mathematicians, adhering strictly to the definitions of M. Foucault, as given in the Paris journals." The image is a cutting from a scrapbook. RAS: Add MS 88: 79b. (Permission from the Royal Astronomical Society)

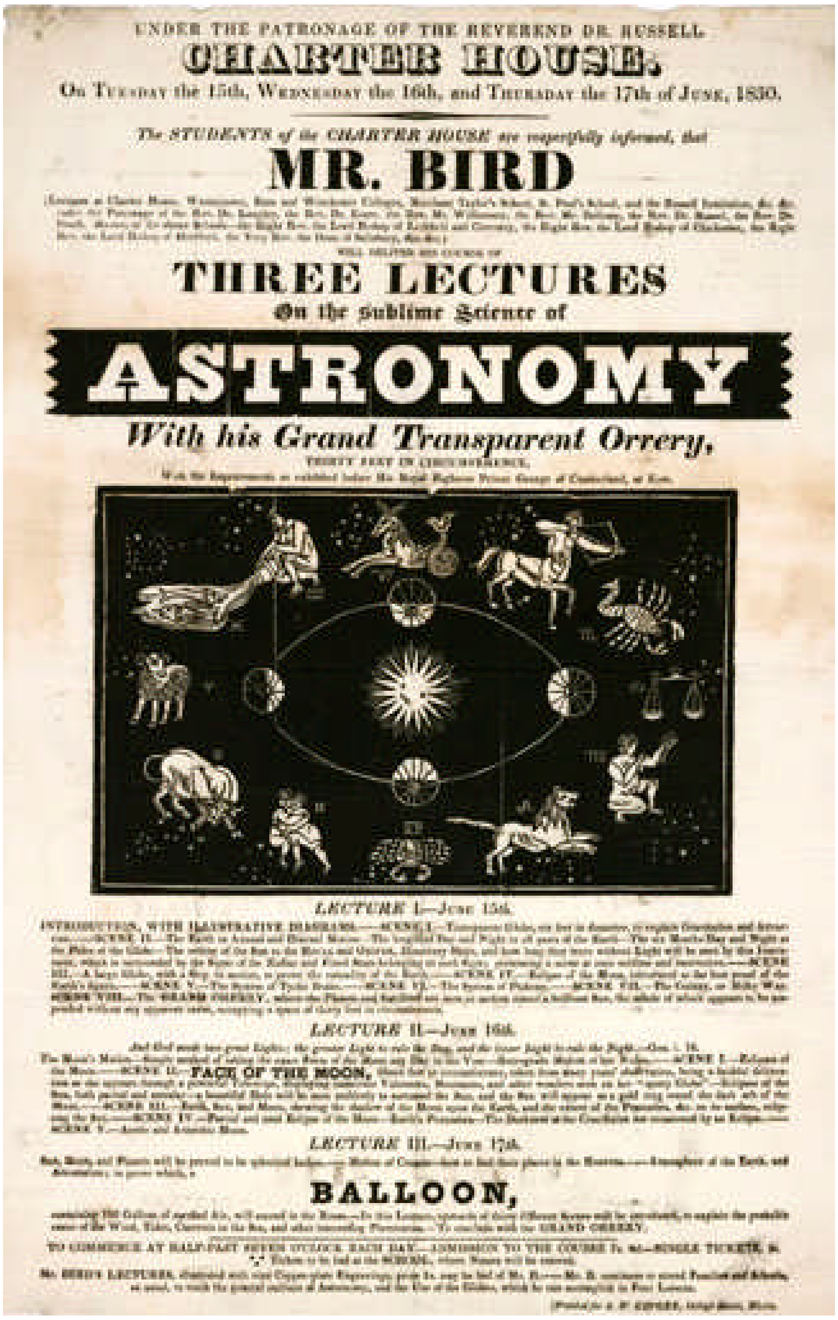


Figure 2.3 Handbill of John Bird's lectures at Charter House, 15th to 17th June 1830. A long list of affiliations and patronage follows the lecturer's name as a self-promotion. SM: SCM-Art: 1980-930/4. (Permission from the Science Museum / Science and Society Picture Library)

Figure 3.1 A partial mosaic of *Cruchley's New Plan of London Improved to 1827*, G. F. Cruchley (publisher), 1827. (Copyright: David Hale / MAPCO 2006. http://mapco.net) Legends are added as follows:

Institutions A: Royal Institution **B:** London Institution **C:** Russell Institution **D:** London Mechanics' Institution
Theatres 1: King's (Her Majestic's) **2:** Haymarket **3:** Adelphi **4:** English Opera House (Lyceum) **5:** Strand **6:** Princess's

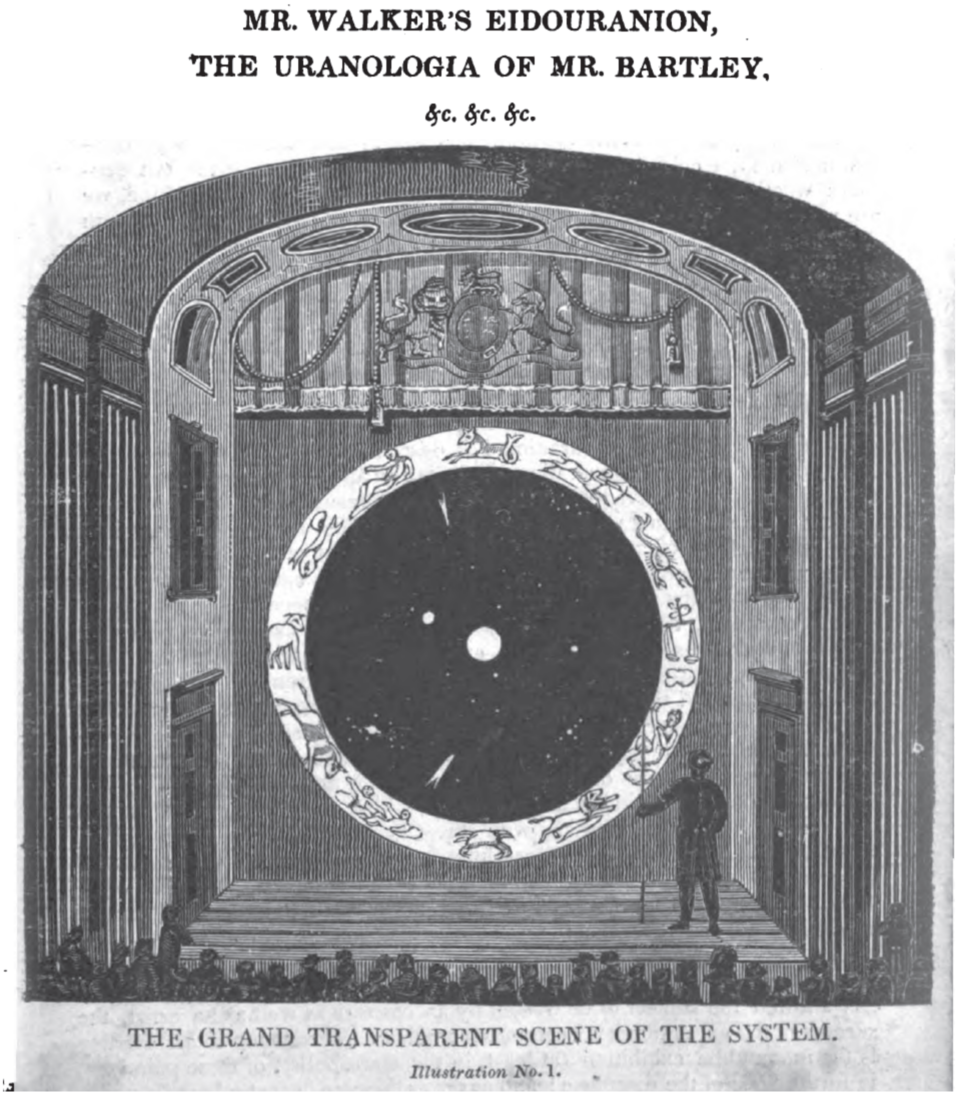


Figure 3.2 "The Grand Transparent Scene of the System", *London Lions for Country Cousins and Friends about Town* (1826), p. 1. (Copy digitised by Google)

Figure 3.3 "Pit, Boxes and Gallery", George Cruickshank (draughtsman), 25th June 1836. V&A: S.382-2009 (Permission from the Victoria and Albert Museum)

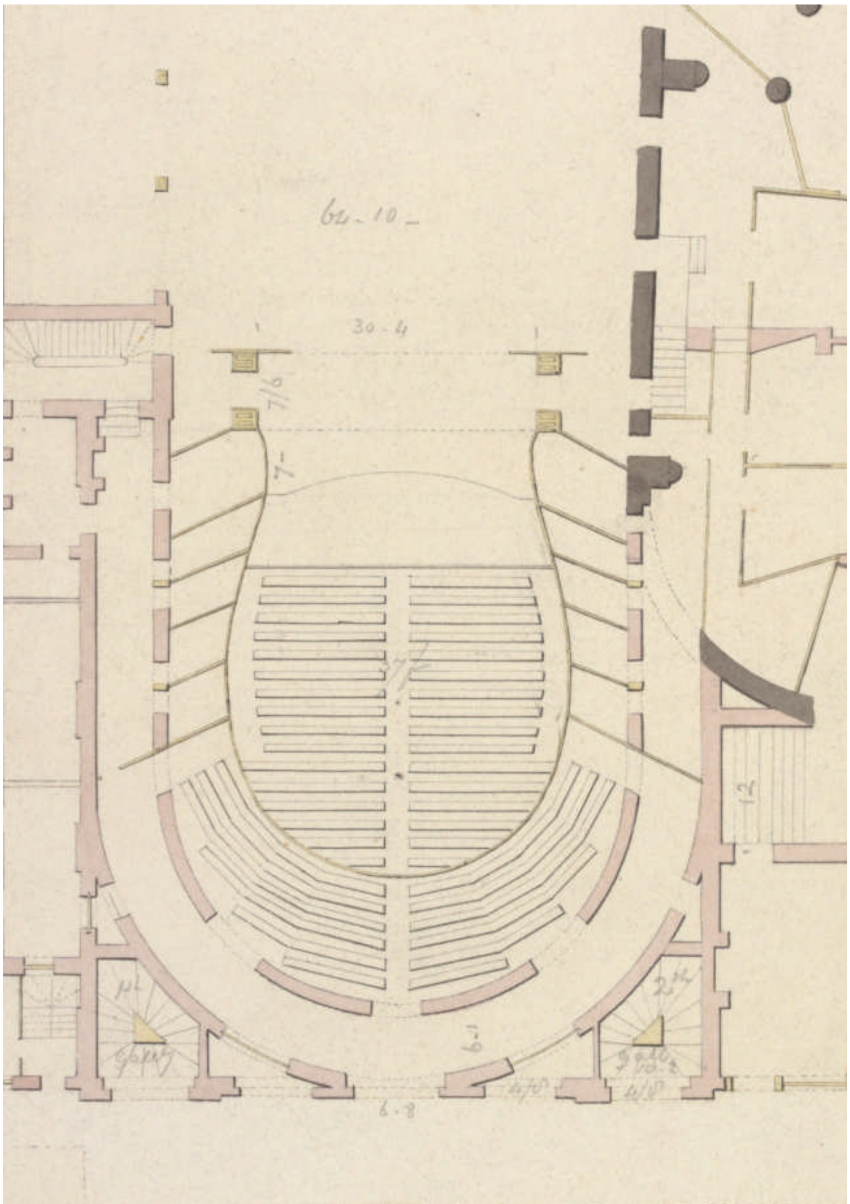


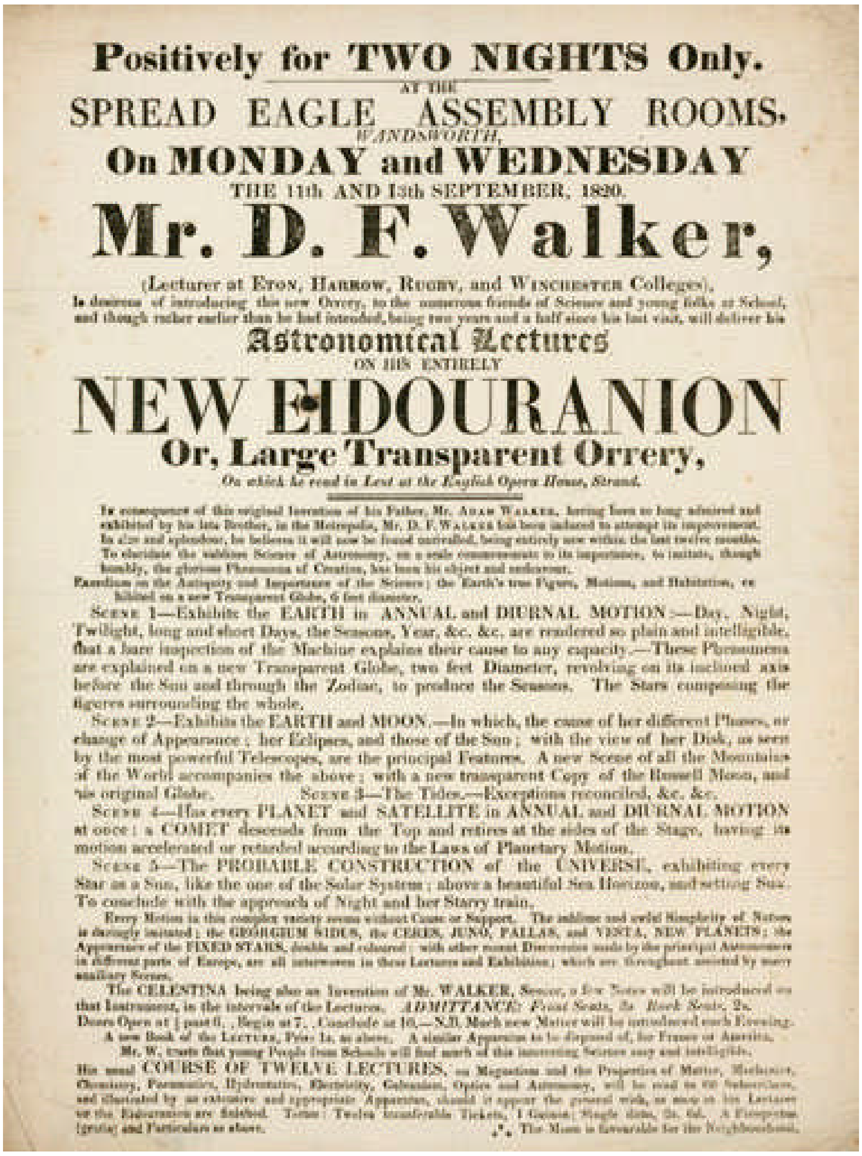
Figure 3.4 Ground plan (partial) for the new Lyceum Theatre, Samuel Beazley (probably, draughtsman), c. 1816. Beazley had designed the building first in 1816 and rebuilt in 1834. It is unclear whether this plan was from original design in 1816 or at another point in the building's history. V&A: S.398-1989 (Permission from the Victoria and Albert Museum)

Figure 3.5 "The proscenium of the English Opera House in the Strand, (Late Lyceum.) as it appeared on the Evening of the 21st March 1817, with Walker's Exhibition of the Eidouranian." E. F. Burney (artist); I. Stow (engraver); Robert Wilkinson (publisher), 11th October 1817. V&A: S.176-1997 (Permission from the Victoria and Albert Museum)

Figure 3.6 Playbill of George Bartley's lecture at the English Opera House during Lent 1827. RAS: Add MS 88: 7 (Permission from the Royal Astronomical Society)

Figure 3.7 Attendance record of John Wallis's juvenile lectures at the Royal Institution in 1838. RI: MS LE 2, p. 127. (Permission from the Royal Institution of Great Britain)

Figure 3.8 Stranger's tickets of the Royal Manchester Institution, c. 1851. A ticket was required to be signed up by a member for introducing a stranger (visitor) into the lecture. MA: M6/1/71/2; M6/1/71/3; M6/1/71/4; M6/1/71/5 (Permission from the Manchester Archives)



Positively for TWO NIGHTS Only.

AT THE

SPREAD EAGLE ASSEMBLY ROOMS,

WANDSWORTH,

On MONDAY and WEDNESDAY

THE 11th AND 13th SEPTEMBER, 1820.

Mr. D. F. Walker,

(Lecturer at Eton, Harrow, Rugby, and Winchester Colleges),

[illegible]

Astronomical Lectures

ON HIS ENTIRELY

NEW EIDOURANION

Or, Large Transparent Orrery,

On which he read in Lent at the English Opera House, Strand.

[illegible]

Scene 1—Exhibits the EARTH in ANNUAL and DIURNAL MOTION.—Day, Night, Twilight, long and short Days, the Seasons, Year, &c. &c. are rendered so plain and intelligible, that a bare inspection of the Machine explains their cause to any capacity.—These Phenomena are explained on a new Transparent Globe, two feet Diameter, revolving on its inclined axis before the Sun and through the Zodiac, to produce the Seasons. The Stars composing the figures surrounding the whole.

Scene 2—Exhibits the EARTH and MOON.—In which, the cause of her different Phases, or change of Appearance; her Eclipses, and those of the Sun; with the view of her Disk, as seen by the most powerful Telescopes, are the principal Features. A new Scene of all the Mountains of the World accompanies the above; with a new transparent Copy of the Russell Moon, and his original Globe. Scene 3—The Tides.—Exceptions reconciled, &c. &c.

Scene 4—Has every PLANET and SATELLITE in ANNUAL and DIURNAL MOTION at once: a COMET descends from the Top and retires at the sides of the Stage, having its motion accelerated or retarded according to the Laws of Planetary Motion.

Scene 5—The PROBABLE CONSTRUCTION of the UNIVERSE, exhibiting every Star as a Sun, like the one of the Solar System; above a beautiful Sea Horizon, and setting Sun. To conclude with the approach of Night and her Starry train.

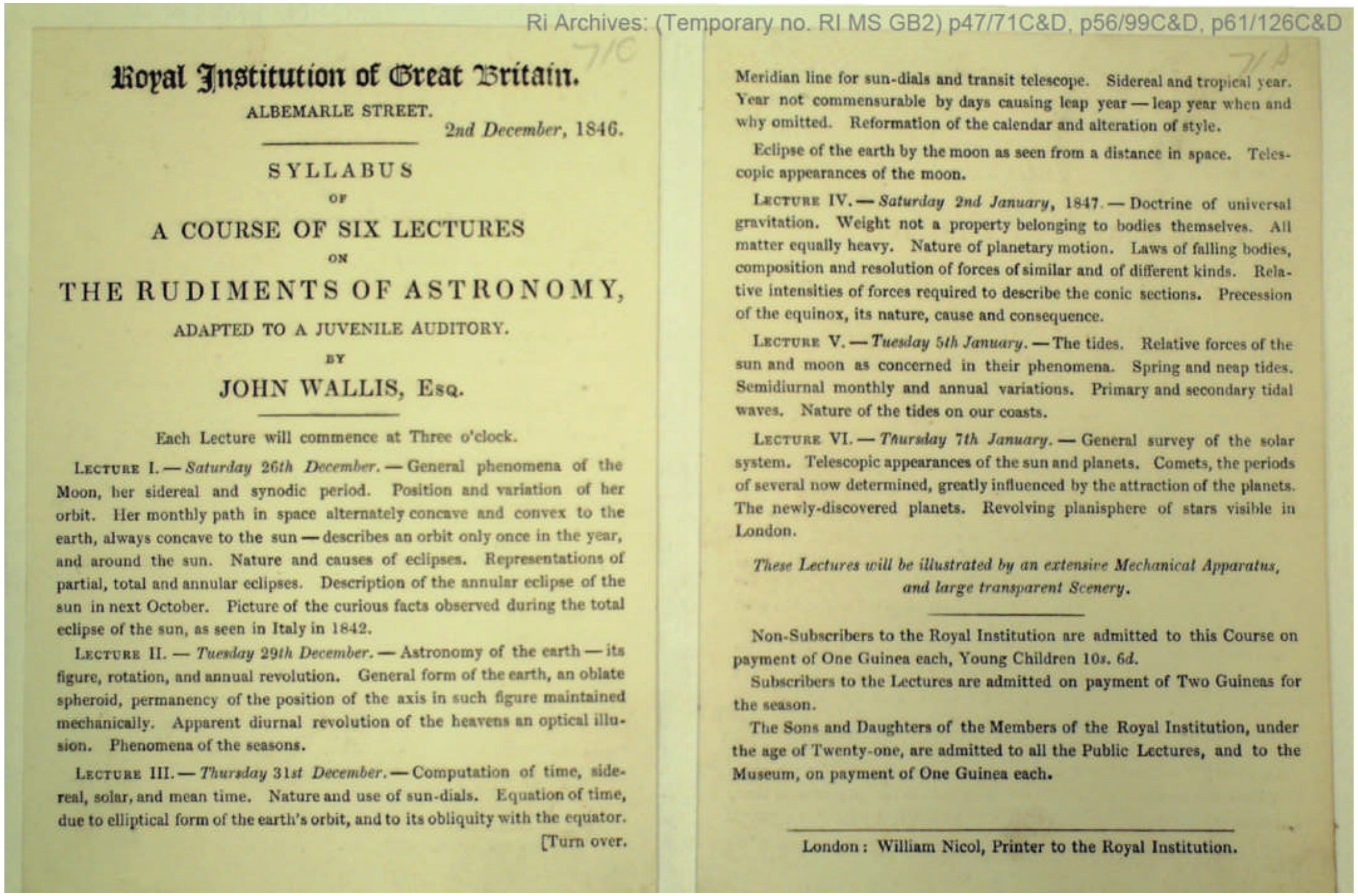
[illegible]

The CELESTINA being also an Invention of Mr. WALKER, Senior, a few Notes will be introduced on that Instrument, in the intervals of the Lectures. ADMITTANCE: Front Seats, 3s. Back Seats, 2s. [illegible]

[illegible]

His usual COURSE OF TWELVE LECTURES, on Magnetism and the Properties of Matter, Mechanics, Chemistry, Pneumatics, Hydrostatics, Electricity, Galvanism, Optics and Astronomy, [illegible]

Figure 3.9 Handbill of D. F. Walker's lectures at 'Spread Eagle', a public house at Wandsworth, Surrey, September 1820. Local population's meeting places were potential venues for visiting lecturer's use in rural areas. SM: SCM-Art: 1980-930/13 (Permission from the Science Museum / Science & Society Picture Library)


Ri Archives: (Temporary no. RI MS GB2) p47/71C&D, p56/99C&D, p61/126C&D

Royal Institution of Great Britain.

ALBEMARLE STREET.

2nd December, 1846.

SYLLABUS

OF

A COURSE OF SIX LECTURES

ON

THE RUDIMENTS OF ASTRONOMY,

ADAPTED TO A JUVENILE AUDITORY.

BY

JOHN WALLIS, Esq.

Each Lecture will commence at Three o'clock.

Lecture I. — *Saturday 26th December.* — General phenomena of the Moon, her sidereal and synodic period. Position and variation of her orbit. Her monthly path in space alternately concave and convex to the earth, always concave to the sun — describes an orbit only once in the year, and around the sun. Nature and causes of eclipses. Representations of partial, total and annular eclipses. Description of the annular eclipse of the sun in next October. Picture of the curious facts observed during the total eclipse of the sun, as seen in Italy in 1842.

Lecture II. — *Tuesday 29th December.* — Astronomy of the earth — its figure, rotation, and annual revolution. General form of the earth, an oblate spheroid, permanency of the position of the axis in such figure maintained mechanically. Apparent diurnal revolution of the heavens an optical illusion. Phenomena of the seasons.

Lecture III. — *Thursday 31st December.* — Computation of time, sidereal, solar, and mean time. Nature and use of sun-dials. Equation of time, due to elliptical form of the earth's orbit, and to its obliquity with the equator.

[Turn over.

Meridian line for sun-dials and transit telescope. Sidereal and tropical year. Year not commensurable by days causing leap year — leap year when and why omitted. Reformation of the calendar and alteration of style.

Eclipse of the earth by the moon as seen from a distance in space. Telescopic appearances of the moon.

Lecture IV. — *Saturday 2nd January*, 1847. — Doctrine of universal gravitation. Weight not a property belonging to bodies themselves. All matter equally heavy. Nature of planetary motion. Laws of falling bodies, composition and resolution of forces of similar and of different kinds. Relative intensities of forces required to describe the conic sections. Precession of the equinox, its nature, cause and consequence.

Lecture V. — *Tuesday 5th January.* — The tides. Relative forces of the sun and moon as concerned in their phenomena. Spring and neap tides. Semidiurnal monthly and annual variations. Primary and secondary tidal waves. Nature of the tides on our coasts.

Lecture VI. — *Thursday 7th January.* — General survey of the solar system. Telescopic appearances of the sun and planets. Comets, the periods of several now determined, greatly influenced by the attraction of the planets. The newly-discovered planets. Revolving planisphere of stars visible in London.

These Lectures will be illustrated by an extensive Mechanical Apparatus, and large transparent Scenery.

Non-Subscribers to the Royal Institution are admitted to this Course on payment of One Guinea each, Young Children 10*s*. 6*d*.

Subscribers to the Lectures are admitted on payment of Two Guineas for the season.

The Sons and Daughters of the Members of the Royal Institution, under the age of Twenty-one, are admitted to all the Public Lectures, and to the Museum, on payment of One Guinea each.

London: William Nicol, Printer to the Royal Institution.

Figure 4.1 Syllabus of the Royal Institution juvenile lectures in Christmas 1846, in which John Wallis lectured on "The Rudiments of Astronomy", 2nd December 1846. RI: MS GB 2: p47/71C&D. (Permission from the Royal Institution of Great Britain)

Theatre Royal, Haymarket.

Mr. C. H. ADAMS,

Who has for the last SEVEN YEARS, delivered his LECTURE on

ASTRONOMY

At Her Majesty's Theatre, will have the honour to present the same at the Haymarket Theatre,

Every Wednesday and Friday,

DURING LENT.

Part I.--The EARTH.

Its shape and dimensions—diurnal revolution, from which the true figure is inferred, and finally demonstrated by experiment—annual motion—the Season illustrated in a novel manner by means of

A SPLENDID TELLEURIAN,

Representing the Earth in the Four Quarters of its orbit, and moving at the same time round the Sun, showing in the clearest manner the cause of the Seasons—the whole encircled by

A Zodiac, 111 Feet in Circumference

Part II.--THE MOON

revolves round the Earth—receives its light from the Sun—rotation, though imperceptible, proved to be completed in the same time as its revolution—Phases—Orbit in relation to the Earth's—Nodes' and their connection with Eclipses—A total eclipse, and the annular eclipse of the Sun, as seen at Edinburgh, will be represented.

THE TIDES

respective influence of the Sun and Moon in producing Spring and Neap Tides, explained upon a Mechanical

Transparent Apparatus, of novel Construction,

Representing the Earth and Moon, with the Water following the latter as the Moon revolves round the Earth; also the Solar Tide alternately raised and depressed by the Sun, as the Sun and Moon respectively change their line of direction—some apparent exceptions to the theory accounted for. The machinery will render the famous theorem of Sir Isaac Newton more intelligible than any hitherto exhibited

PART III.—The Science considered Systematically, the Ptolemaic, Egyptian, Tychonic, and Copernican—the Copernican the only true one—Telescopic Views of the Planets—comparative magnitudes, &c.

The Illustrations will conclude with a Magnificent

Vertical Orrery!

On which every Planet is represented of proportional Magnitude.

Each Lecture will be illustrated by the same Series of

TRANSPARENCIES!

And Costly Apparatus,

As exhibited by Mr. ADAMS, at Her Majesty's Theatre last Year.

Printed & Published, every Morning, by E. & J. THOMAS, 6, Exeter Street, Strand.—All Letters to be post paid.—Printing in General,

Figure 4.2 Playbill of C. H. Adams's lecture at Theatre Royal, Haymarket. *The Theatrical Observer*, 27th February 1839. (Copyright: © 2007 ProQuest)

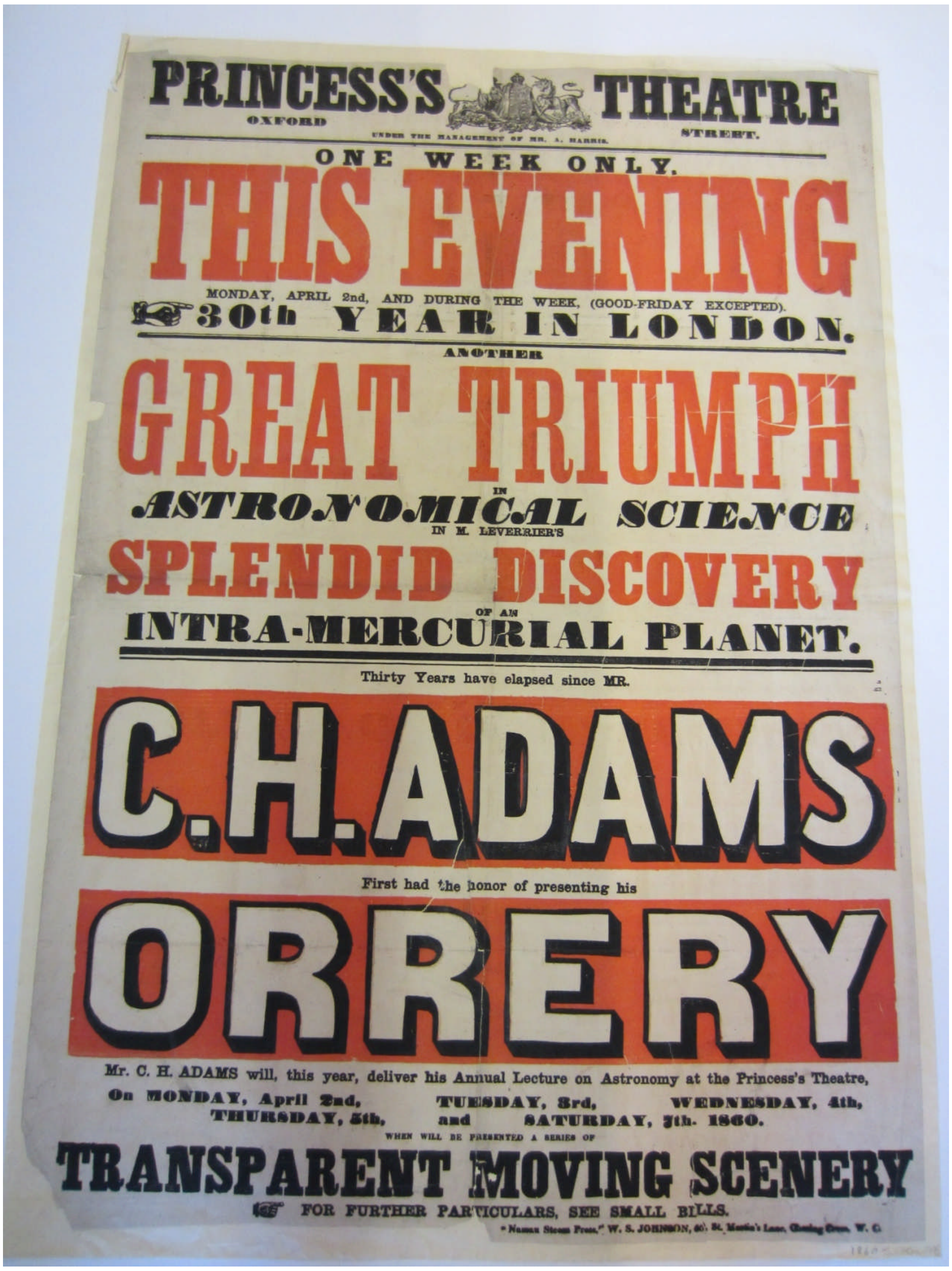


Figure 4.3 Poster of C. H. Adams's lecture at the Princess's Theatre, 2nd April 1860. The headline of this season's show was the latest discovery of an "intra-Mercurial planet". V&A: S.1702-1995 (Permission from the Victoria and Albert Museum)

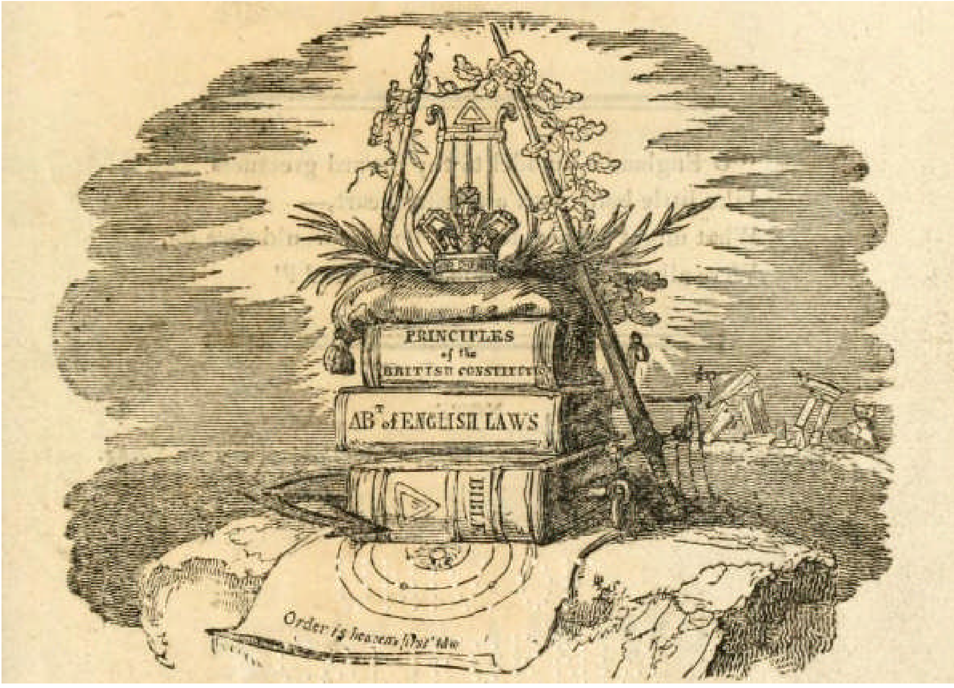
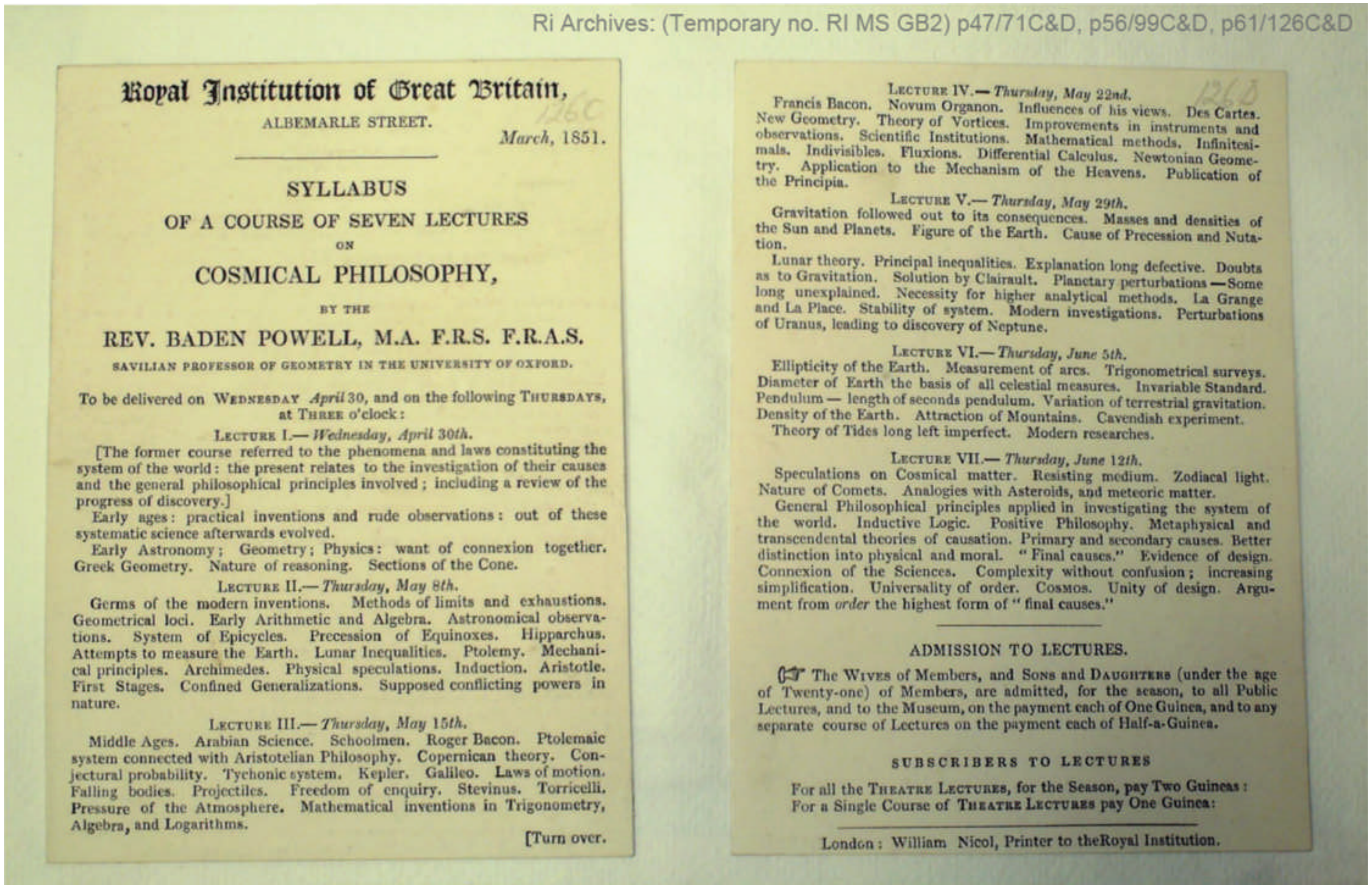


Figure 4.4 "Order is Heaven's First Law", vignette from the title page of the *Real or Constitutional House that Jack Built*, J. Asperne (publisher), 1819. This allegorical woodcut depicts the social stability constructed upon the constitutional principles, English laws, the Bible, and a drawing of the planetary system representing the order of the universe. In contrast, the house in the other side of the Channel crumbles, implies the devastation caused by the French Revolution. (Copy digitised by the Internet Archive)



Ri Archives: (Temporary no. RI MS GB2) p47/71C&D, p56/99C&D, p61/126C&D

Royal Institution of Great Britain,

ALBEMARLE STREET.

March, 1851.

SYLLABUS

OF A COURSE OF SEVEN LECTURES

ON

COSMICAL PHILOSOPHY,

BY THE

REV. BADEN POWELL, M.A. F.R.S. F.R.A.S.

SAVILIAN PROFESSOR OF GEOMETRY IN THE UNIVERSITY OF OXFORD.

To be delivered on WEDNESDAY *April* 30, and on the following THURSDAYS, at THREE o'clock:

LECTURE I.—*Wednesday, April 30th.*

[The former course referred to the phenomena and laws constituting the system of the world: the present relates to the investigation of their causes and the general philosophical principles involved; including a review of the progress of discovery.]

Early ages: practical inventions and rude observations: out of these systematic science afterwards evolved.

Early Astronomy; Geometry; Physics: want of connexion together. Greek Geometry. Nature of reasoning. Sections of the Cone.

LECTURE II.—*Thursday, May 8th.*

Germs of the modern inventions. Methods of limits and exhaustions. Geometrical loci. Early Arithmetic and Algebra. Astronomical observations. System of Epicycles. Precession of Equinoxes. Hipparchus. Attempts to measure the Earth. Lunar Inequalities. Ptolemy. Mechanical principles. Archimedes. Physical speculations. Induction. Aristotle. First Stages. Confined Generalizations. Supposed conflicting powers in nature.

LECTURE III.—*Thursday, May 15th.*

Middle Ages. Arabian Science. Schoolmen. Roger Bacon. Ptolemaic system connected with Aristotelian Philosophy. Copernican theory. Conjectural probability. Tychonic system. Kepler. Galileo. Laws of motion. Falling bodies. Projectiles. Freedom of enquiry. Stevinus. Torricelli. Pressure of the Atmosphere. Mathematical inventions in Trigonometry, Algebra, and Logarithms.

[Turn over.

LECTURE IV.—*Thursday, May 22nd.*

Francis Bacon. Novum Organon. Influences of his views. Des Cartes. New Geometry. Theory of Vortices. Improvements in instruments and observations. Scientific Institutions. Mathematical methods. Infinitesimals. Indivisibles. Fluxions. Differential Calculus. Newtonian Geometry. Application to the Mechanism of the Heavens. Publication of the Principia.

LECTURE V.—*Thursday, May 29th.*

Gravitation followed out to its consequences. Masses and densities of the Sun and Planets. Figure of the Earth. Cause of Precession and Nutation.

Lunar theory. Principal inequalities. Explanation long defective. Doubts as to Gravitation. Solution by Clairault. Planetary perturbations—Some long unexplained. Necessity for higher analytical methods. La Grange and La Place. Stability of system. Modern investigations. Perturbations of Uranus, leading to discovery of Neptune.

LECTURE VI.—*Thursday, June 5th.*

Ellipticity of the Earth. Measurement of arcs. Trigonometrical surveys. Diameter of Earth the basis of all celestial measures. Invariable Standard. Pendulum—length of seconds pendulum. Variation of terrestrial gravitation. Density of the Earth. Attraction of Mountains. Cavendish experiment.

Theory of Tides long left imperfect. Modern researches.

LECTURE VII.—*Thursday, June 12th.*

Speculations on Cosmical matter. Resisting medium. Zodiacal light. Nature of Comets. Analogies with Asteroids, and meteoric matter.

General Philosophical principles applied in investigating the system of the world. Inductive Logic. Positive Philosophy. Metaphysical and transcendental theories of causation. Primary and secondary causes. Better distinction into physical and moral. "Final causes." Evidence of design. Connexion of the Sciences. Complexity without confusion; increasing simplification. Universality of order. COSMOS. Unity of design. Argument from *order* the highest form of "final causes."

ADMISSION TO LECTURES.

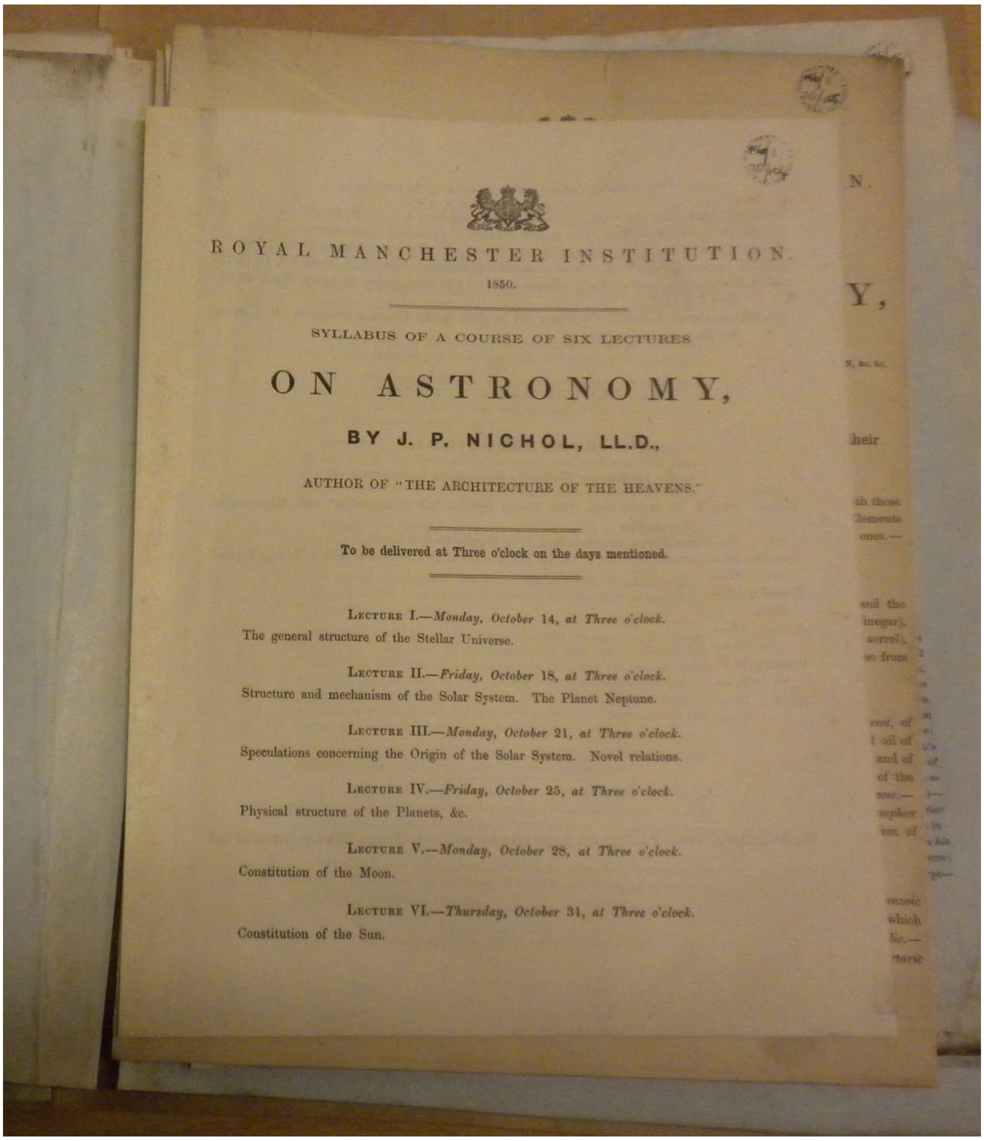
☞ The WIVES of Members, and SONS and DAUGHTERS (under the age of Twenty-one) of Members, are admitted, for the season, to all Public Lectures, and to the Museum, on the payment each of One Guinea, and to any separate course of Lectures on the payment each of Half-a-Guinea.

SUBSCRIBERS TO LECTURES

For all the THEATRE LECTURES, for the Season, pay Two Guineas:
For a Single Course of THEATRE LECTURES pay One Guinea:

London: William Nicol, Printer to the Royal Institution.

Figure 4.5 Syllabus of a course of seven lectures on cosmical philosophy by Baden Powell at the Royal Institution during May and June 1851. The last lecture (Lecture VII) contained a large amount of religious and moral subjects. RI: MS GB 2: p61/126C&D (Permission from the Royal Institution of Great Britain)


ROYAL MANCHESTER INSTITUTION.
1850.

SYLLABUS OF A COURSE OF SIX LECTURES

ON ASTRONOMY,

BY J. P. NICHOL, LL.D.,

AUTHOR OF "THE ARCHITECTURE OF THE HEAVENS."

To be delivered at Three o'clock on the days mentioned.

Lecture I.—*Monday, October* 14, *at Three o'clock.*
The general structure of the Stellar Universe.

Lecture II.—*Friday, October* 18, *at Three o'clock.*
Structure and mechanism of the Solar System. The Planet Neptune.

Lecture III.—*Monday, October* 21, *at Three o'clock.*
Speculations concerning the Origin of the Solar System. Novel relations.

Lecture IV.—*Friday, October* 25, *at Three o'clock.*
Physical structure of the Planets, &c.

Lecture V.—*Monday, October* 28, *at Three o'clock.*
Constitution of the Moon.

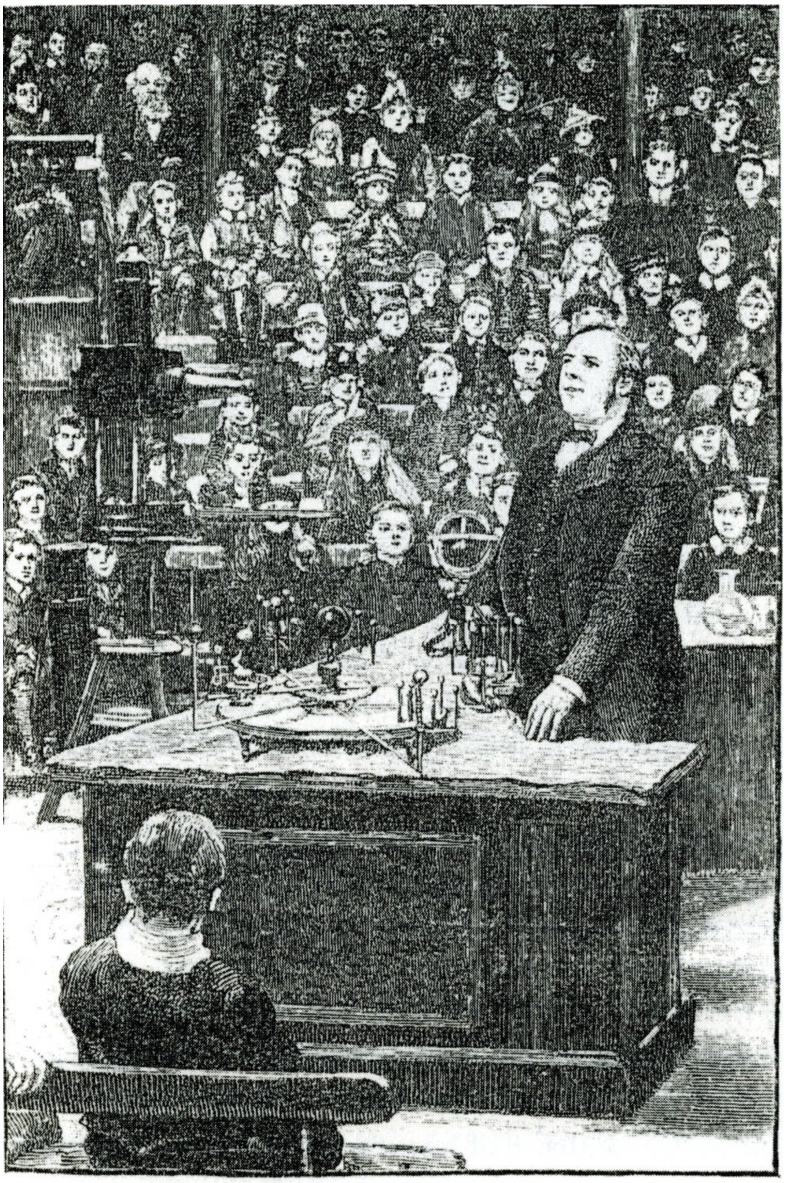
Lecture VI.—*Thursday, October* 31, *at Three o'clock.*
Constitution of the Sun.

Figure 4.6 Syllabus of John Pringle Nichol's lectures on astronomy at the Royal Manchester Institution, October 1850. MA: M6/1/70/104 (Permission from the Manchester Archives)

Figure 5.1 An orrery with brass gearwork and wooden base made by Newton and Son (Newton and Company after 1851), 3 Fleet Street, London, 1851-1856. This simple design was common in the contemporary instrument trade after Jones-type orrery in the late eighteenth century. It was likely the same cheap product exhibited by Newton and Son in the Great Exhibition. SM: SCM-Astronomy: 1869-48 (Permission from the Science Museum / Science & Society Picture Library)

Figure 5.2 The mean-motion orrery with brass drum case on claw foot stand, designed by William Pearson and made by Robert Fidler, 1813-1822. This type of orrery had been described in Rees's *Cyclopaedia* in 1813. SM: SCM-Astronomy: 1950-55 (Permission from the Science Museum / Science & Society Picture Library)

Figure 5.3 Family portrait of William Pearson, his wife and daughter. Thomas Philips (artist), date unknown (after 1800). Pearson is pointing at an orrery, one of his works of planetary machines. (Permission from the Royal Astronomical Society)



A JUVENILE LECTURE AT THE ROYAL INSTITUTION.

Figure 5.4 "A Juvenile Lecture at the Royal Institution", frontispiece of the *Star-Land* (1889), Robert Stawell Ball (author). This illustration shows many visual aids which Ball used in the lecture, including a table orrery in front of him and the magic lantern in the background.

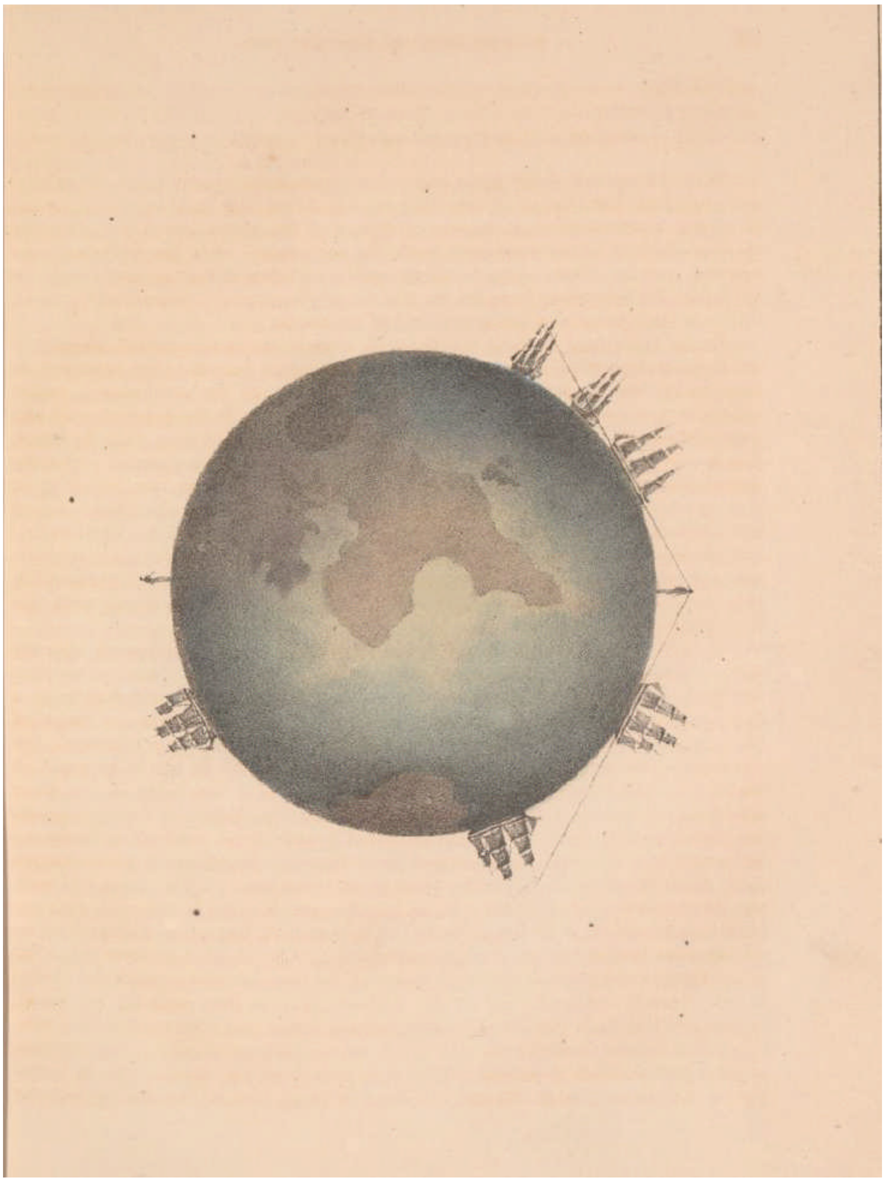


Figure 5.5 "The Earth: its Form and Position in Space", Scene No. 2 from *The Beauty of the Heavens* (1842), Charles F. Blunt (author), p. 14. (Copy digitised by ETH-Bibliothek Zürich)

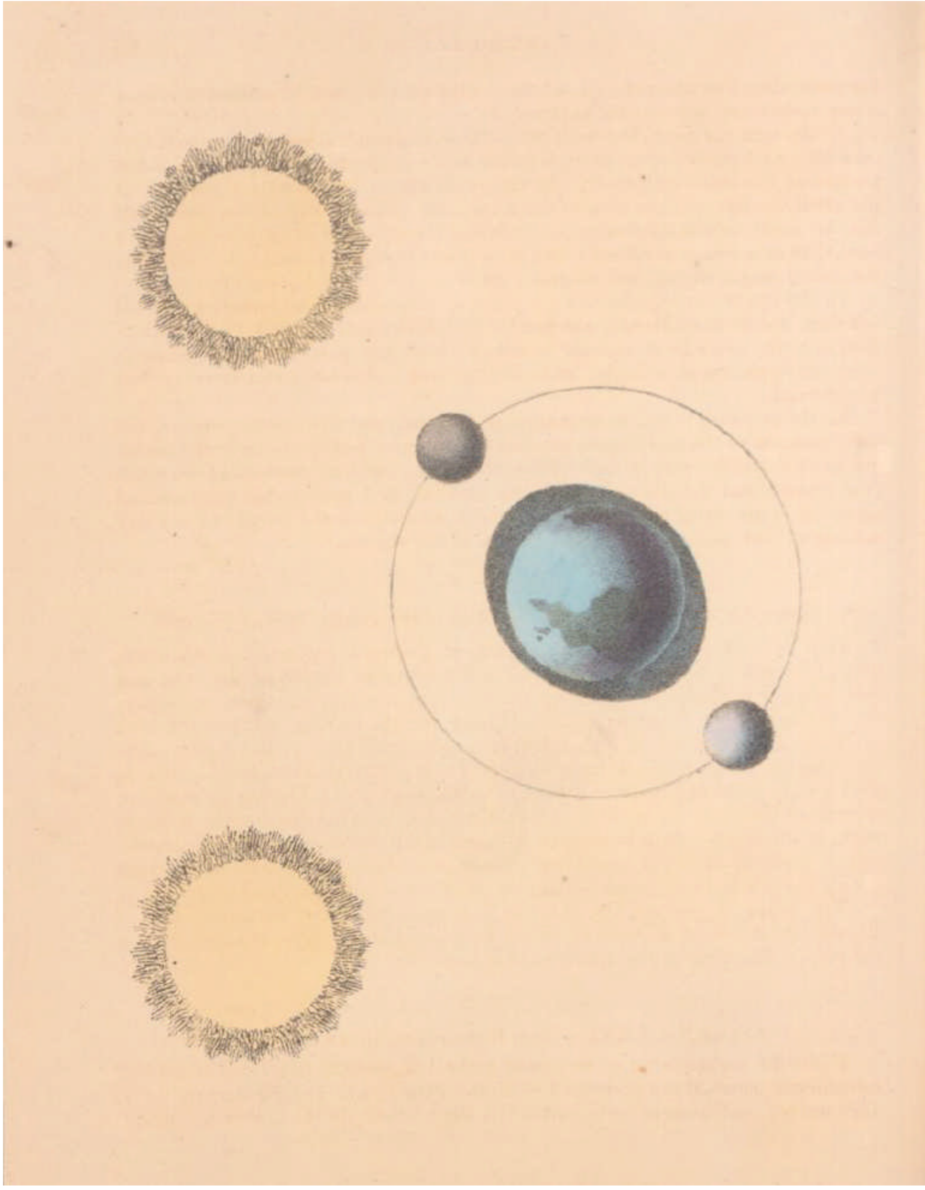


Figure 5.6 “The Phenomena of the Tides”, Scene No. 83 from *The Beauty of the Heavens* (1842), Charles F. Blunt (author), p. 83. (Copy digitised by ETH-Bibliothek Zürich)

Figure 6.1 "The Audience in a Theatre", Luke Fildes (artist), date unknown. Luke Fildes (1843-1927) was a Liverpool-born painter and later moved to London. He was trained in the South Kensington and Royal Academy schools. This watercolour and ink sketch of theatre audience was drawn in a social realist style, which was typical of Fildes's works. It is unclear where the artist sketched this scene. V&A: E.638-2003 (Permission from the Victoria and Albert Museum)

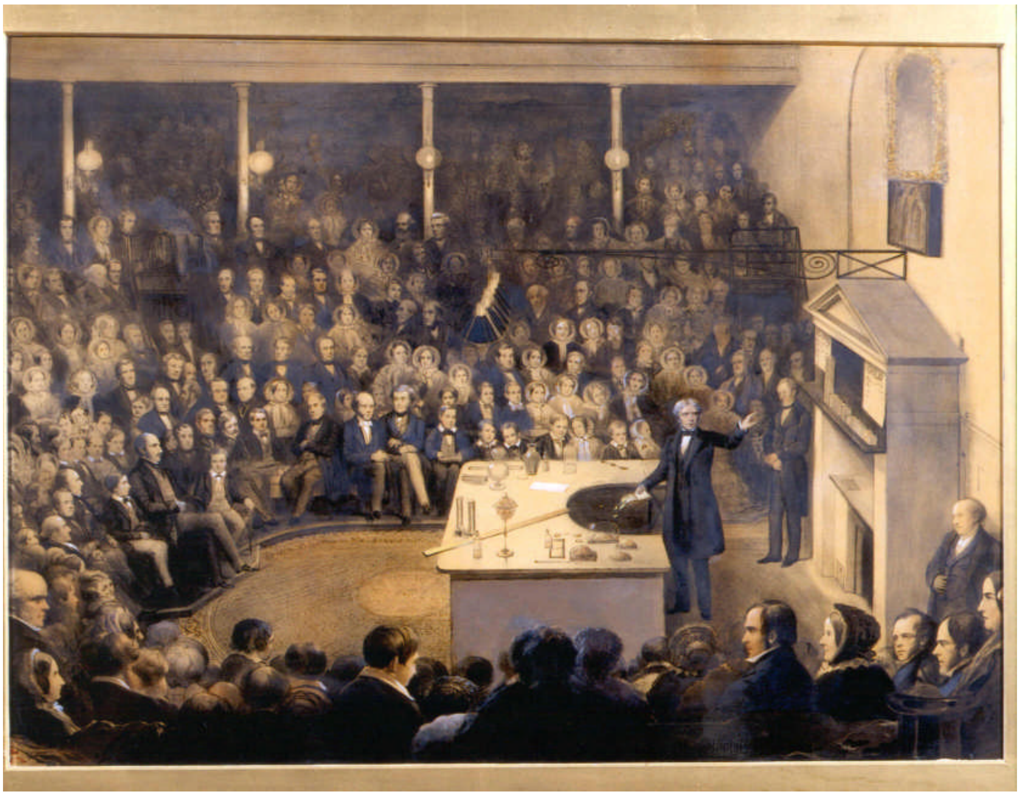


Figure 6.2 *Michael Faraday Lecturing in the Theatre at the Royal Institution*. Alexander Blaikley, c. 1856. This particular lecture was delivered on 27th December 1855, as one of the course of the Juvenile Lectures on ‘The distinctive properties of the common metals’. Prince Albert and his two sons, Princes Edward and Alfred, attended this lecture. In this painting , Prince Albert was sitting in the front middle of the auditorium with his two sons beside him. (Permission from the Royal Institution of Great Britain)

Figure 6.3 “Interior of Signor Perini’s new planetarium”, around 1879. The image is a cutting from a scrapbook. RAS: Add MS 88: 35 (Permission from the Royal Astronomical Society)

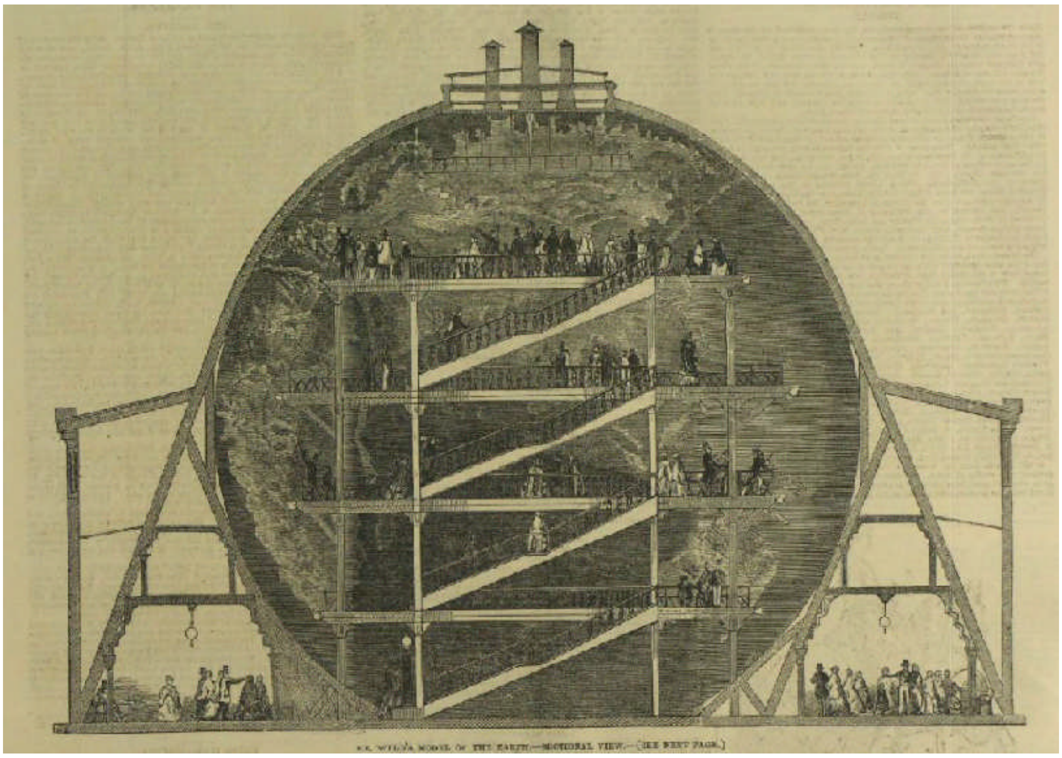


Figure 6.4 "Mr. Wyld's Model of the Earth.– Sectional View." Engraving from the *Illustrated London News*, vol. 18 (7th June 1851), p. 511. Wyld's Great Globe was a sensational attraction for Londoners. It opened to the public in Leicester Square between 1851 and 1862. The building was demolished after its closure. (The *Illustrated London News* Historical Archives. Copyright: © 2014 Gale)

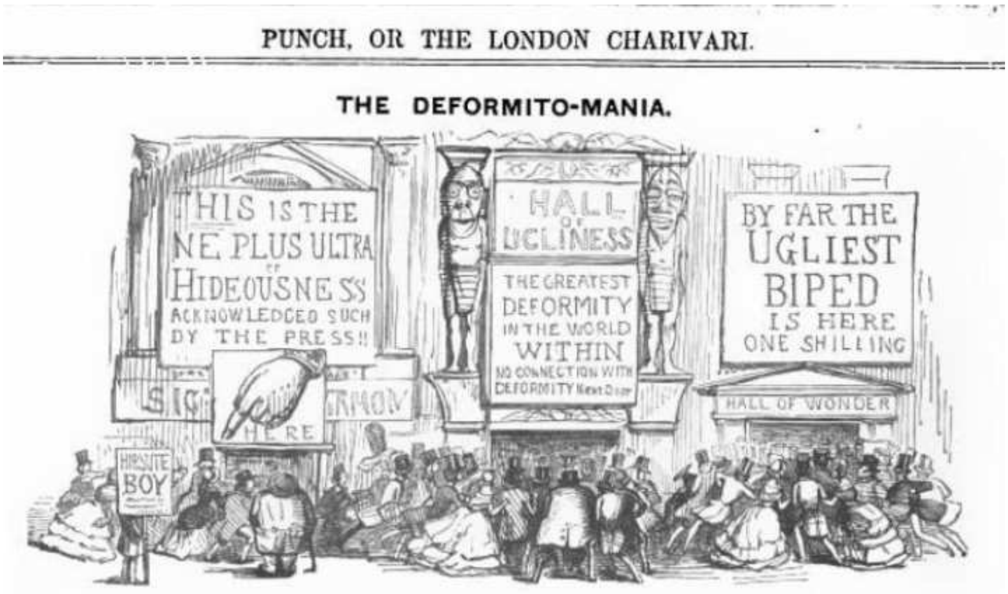
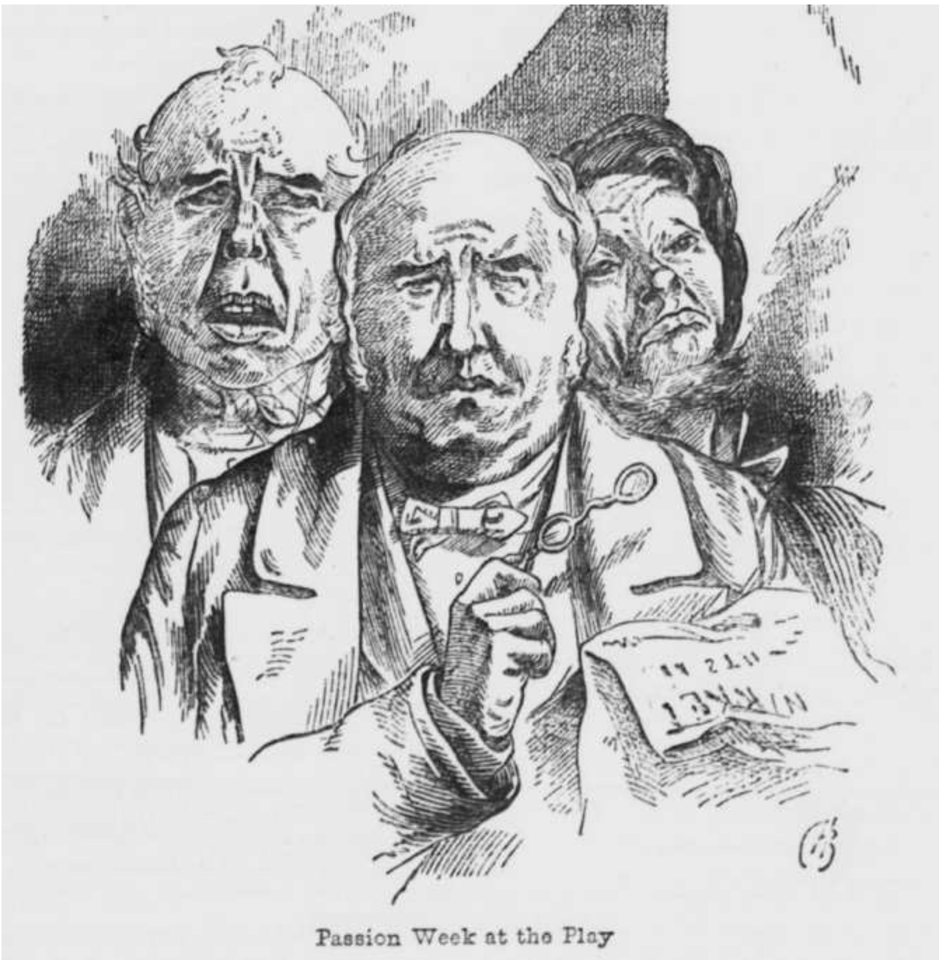


Figure 6.5 "The Deformito-mania", *Punch*, vol. 13 (1847), p. 90. This cartoon lampoons Londoners' frenzy over exhibitions of freaks and monsters. (Copy digitised by Google)



Passion Week at the Play

Figure 6.6 "Passion Week at the Play". *Cornhill Magazine*, vol. 5 (January 1861), p. 87. This cartoon humorously depicts the audience's reactions to Lenten amusements in a theatre. (Copyright: © 2008 ProQuest)

THE ATHENÆUM

Journal of English and Foreign Literature, Science, and the Fine Arts.

No. 1968. LONDON, SATURDAY, JULY 15, 1865. PRICE THREEPENCE Stamped Edition, 4d.

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Figure 7.1 The (partial) front page of the *Athenæum*, 15th July 1865. The arrow indicates the advertisement of the original Eidouranion for sale. (Copyright: © 2008 ProQuest)