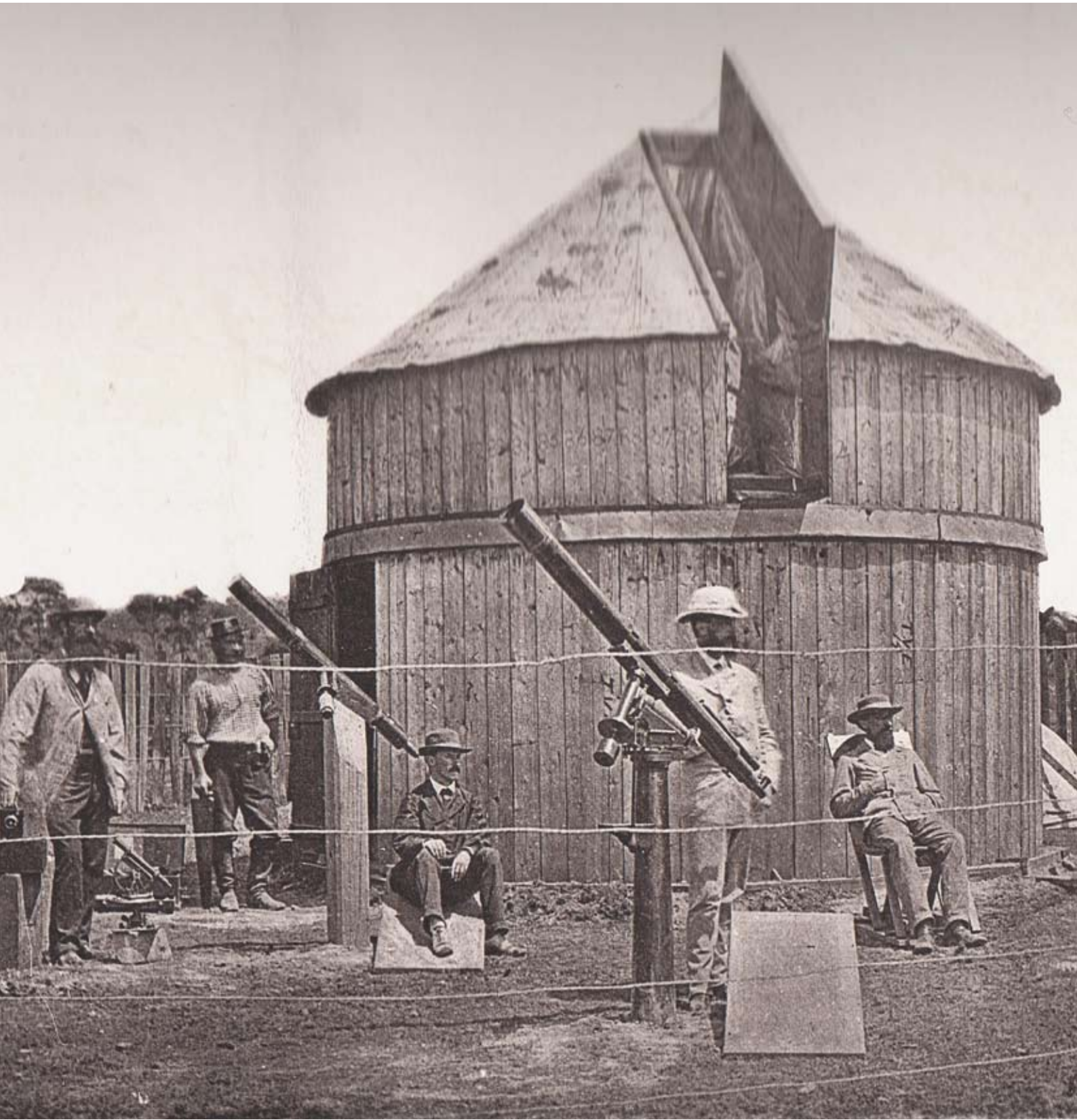
powerhouse museum
science + design

Early astronomical telescopes and equipment at Sydney Observatory

CURATORIAL RESEARCH SERIES



INTRODUCTION

In 2008 the Powerhouse Museum introduced a new series of research publications, which it has made available online in PDF format. The stories and information arise out of current collection research and provide more detailed information about the collection than is available through the Museum's online database.

This is one of a number of online publications the Museum is developing. Other series include facsimile copies of old or out-of-print catalogues, books and brochures as well as collection information sheets and peer reviewed research. These are all available through the Museum's on-line collection database OPAC.

CONTENTS

For much of the period covered by this book the imperial system of weights and measures was used exclusively and, in accordance with historical practice, I have remained faithful to this system wherever appropriate. However, for the benefit of young readers, the metric conversion for 1 inch is 2.54 centimetres (cm).

phm powerhouse museum
science + design

Curatorial Research Series
Early astronomical telescopes and equipment at Sydney Observatory
First published 2008
www.powerhousemuseum.com/

Text: Geoff Barker
Desktop publishing: Anne Slam
Editing: Judith Matheson

Cover photo: 'Waiting for the Transit of Venus, Woodford, NSW, 1874', from Observations of the Transit of Venus, 9 December 1874.

THE FORMATIVE YEARS OF SYDNEY OBSERVATORY 1857–1926

In June 1847 the colonial government received a report from Captain Phillip P King on the state of the observatory established 26 years earlier at Parramatta. It contained the following comments 'Sir, we regret to state that the building is in a very dilapidated state of repair, and the instruments are likely, unless they are immediately protected from the weather, to be very much injured'.[1]

As a result the observatory was closed and its instruments put into storage. The colony seemed to have sufficient scientific supporters for a new observatory in Sydney but initially the idea floundered. One of the reasons was the scepticism of colonial authorities and George Biddell Airey, President of the Royal Astronomical Society in England, who were less than enthusiastic. This was all the more surprising given the need for accurate timekeeping, tidal monitoring and weather predication in a city so reliant on the sea.

It was not until the arrival of Sir William Denison as NSW's Governor in 1855 that a new observatory became a real possibility. Denison had served as an observer at the Royal Greenwich Observatory and gave the go ahead for establishing an observatory at Sydney. The first astronomer appointed to Sydney's new observatory was Reverend William Scott who arrived in 1856. He supervised the construction of the new building which was completed in early 1859 at a cost of 8100 pounds.

Scott found most of the old Parramatta instruments inadequate. The exceptions being the Jones transit circle (the whereabouts of this instrument is no longer known), the Banks equatorial, and the Hardy and Breguet clocks.[2] In 1860 Scott ordered new instruments, the biggest of which was a 7¼-inch Merz refracting telescope.

In 1864 Scott was replaced by George Roberts Smalley who had been an assistant astronomer at the Royal Observatory at the Cape of Good Hope. Smalley was also a capable mathematician having lectured at Kings College in London. In addition to astronomical work his duties included surveying, time-keeping, meteorology, magnetic observations and tidal studies. Smalley focused on survey work but unfortunately died in 1870 aged 48.[3]

Henry Chamberlain Russell was the first Australian-born Government Astronomer. Under Russell the observatory began to focus on astronomical work and its profile expanded over the next 30 years. One of Russell's first projects was to organise the NSW contingent of observers for the 1874 Transit of Venus. He organised the photographic equipment for the viewing, although the resulting glass negatives were not as good as were hoped for.

The second major international project Russell was involved in was the project to map the entire heavens using photography. This massive project was estimated to take over 428,000 glass plates to achieve and involved observatories around the world as well as close involvement with local observatories like the one in Melbourne.[4] A special kind of telescope called an 'astrograph' was ordered for photographing the stars.

By 1892 Russell had a complete 'astrograph' with a set of optics from Howard Grubb of Dublin; the rest of the instrument was made in Sydney. Russell designed the mechanical parts and an electrical control to govern the movement of the telescope during exposure of the plates. Two Sydney manufacturers, Morts Dock Engineering Company and Atlas Engineering Company, worked on the mounting. Making telescope lenses was a long and laborious process and while Russell was waiting on the arrival of the Grubb lens he took some photographs using a 6-inch portrait lens made by J H Dallmeyer. These were probably among the first star photographs taken in Australia.

Russell died in 1905 and the observatory entered a more tumultuous period as its funding was called into question. William Ernest Cooke became Government Astronomer in 1912 and worked hard to move the observatory to a new site in Wahroonga and to purchase new instruments. His plans were thwarted with the outbreak of World War I and Cooke was forced to retire in 1926.

The observatory continued to make stellar observations even though the large numbers of electric lights which illuminated the area made it more difficult. It continued to be involved in both the international Carte du Ciel (Mapping the Stars) project and providing time services to NSW until the 1960s.

MERZ TELESCOPE

n Lens, 1860–1861. H10187
In 1860 William Scott ordered a 7¼-inch refracting telescope. Arriving in June 1861 it was made by the German firm of Georg Merz & Sons (1793–1867).[1] This lens also made by Merz & Sons was used in conjunction the Merz telescope. Like many of the instruments ordered by the observatory this telescope and lens were not without problems but overall they appear to have been a good purchase.

In 1870 the then Government Astronomer H C Russell found problems with the lens while using the instrument for double star measures. As a result he adjusted the lenses by separating them with thin pieces of tin and '… after many attempts, I found the definition wonderfully improved'.[2] The lens has a focal length of 315 cm.

In 1871 Russell used it to make observations on the positions of stars in the Nebula about Argus.[3] In 1872 he was using it to look at the coloured cluster of stars around Kappa Crucis which had previously been looked at by Sir Thomas Brisbane's 2-inch mural circle.[4] In 1874 the Merz telescope went to Eden with Scott to observe the Transit of Venus.

By 1878 the worth of this instrument was no longer in doubt as illustrated by the following comments by H C Russell, 'Of the quality of the 7¼-inch telescope I need say nothing more now than it is a first-class instrument …'[5] from 1890 to 1947 it was used as the guide telescope for the Sydney astrographic telescope.[6] It is clear from the continued use of this telescope, and its lens, that it was an integral part of the observatory's operations and played a significant role in the early development of astronomy in Australia.

n Filar telescope micrometer, 1860–1878. H10006
This micrometer made by Merz & Sons was used in conjunction with a 7¼-inch Merz telescope purchased by Scott around 1860.

In October 1878 Russell made a trip with this micrometer to Woodford in the Blue Mountains. While there he did a number of tests to find out whether the performance of the observatory's astronomical equipment was improved in the mountain air. Among the instruments he took with him were the 7¼-inch Merz telescope and this Merz micrometer.[7] This micrometer was also used in conjunction with the 6-inch refracting telescope (H9887) installed in the north dome of Sydney Observatory.[8]

Eyepieces used with the Merz 7¼-inch telescope. Photo by Chris Brothers.

n Astronomical eyepiece lenses (5), 1895–1905. H10287
These eyepieces were purchased for use with the Merz telescope. They were brought between 1895 and 1915 from A Hilger of London when the telescope was being set up for use as the guide telescope for the photographing the stars project.[9]

n Stellar spectroscope, 1876. H9974
This spectroscope was made by the German instrument maker Adam Hilger who opened his premises at 192 Tottenham Court Road, London in 1875.[10] This instrument must have been one of the earliest spectroscopes made by Hilger as it was ordered in the same year.[11] The spectroscope arrived in Sydney the following year and before being sent to Australia it was personally tested by Hilger who also sent handwritten instructions and diagrams on its use.[12]

By the end of the 19th century Hilger had a well established reputation for the making of high quality optical instruments, especially spectroscopes and rangefinders.[13] Certainly Russell felt this particular instrument was important for in his 1878 Report he described it as being the 'most powerful and perfect one in the world at the time of its manufacture'.[14] The spectroscope has three

Hilger spectrograph. Photo by Chris Brothers.

prisms of 64° each so arranged that any power may be obtained from two prisms to 18 by reflecting the light up to six times through the prisms.[15]

Perhaps as a result of this use the spectroscope exhibits many signs of use and the surfaces of most of the tubes are covered with scratches while the surface of the stand is covered with a heavy patina of cracks. There also appear to have been some modifications made to the instrument, perhaps in an attempt to retrospectively mount the spectrograph for some other purpose. There is also an original box containing two of the spectroscopes prisms in excellent condition.

In the 19th century Adam Hilger Ltd was acknowledged as the world's premier maker of spectroscopes and the fact that this is one of its earliest instruments lends further weight to the significance of this spectroscope. While the signs of use have affected the appearance of the instrument they are also direct links to the useful life of this instrument at the observatory.

SCHROEDER EQUATORIAL TELESCOPE

n 11½-inch equatorial refracting telescope, 1874. H9886

There are two main types of telescopes. One uses a curved reflecting mirror to capture an image. The other uses a refracting lens to magnify the image.

In 1874, after two years of enquiries, Russell acquired a number of new instruments in preparation for the upcoming Transit of Venus. One of these was a new 11½-inch telescope purchased for the observation of double stars from the optician and instrument maker, Hugo Schroeder.[16]

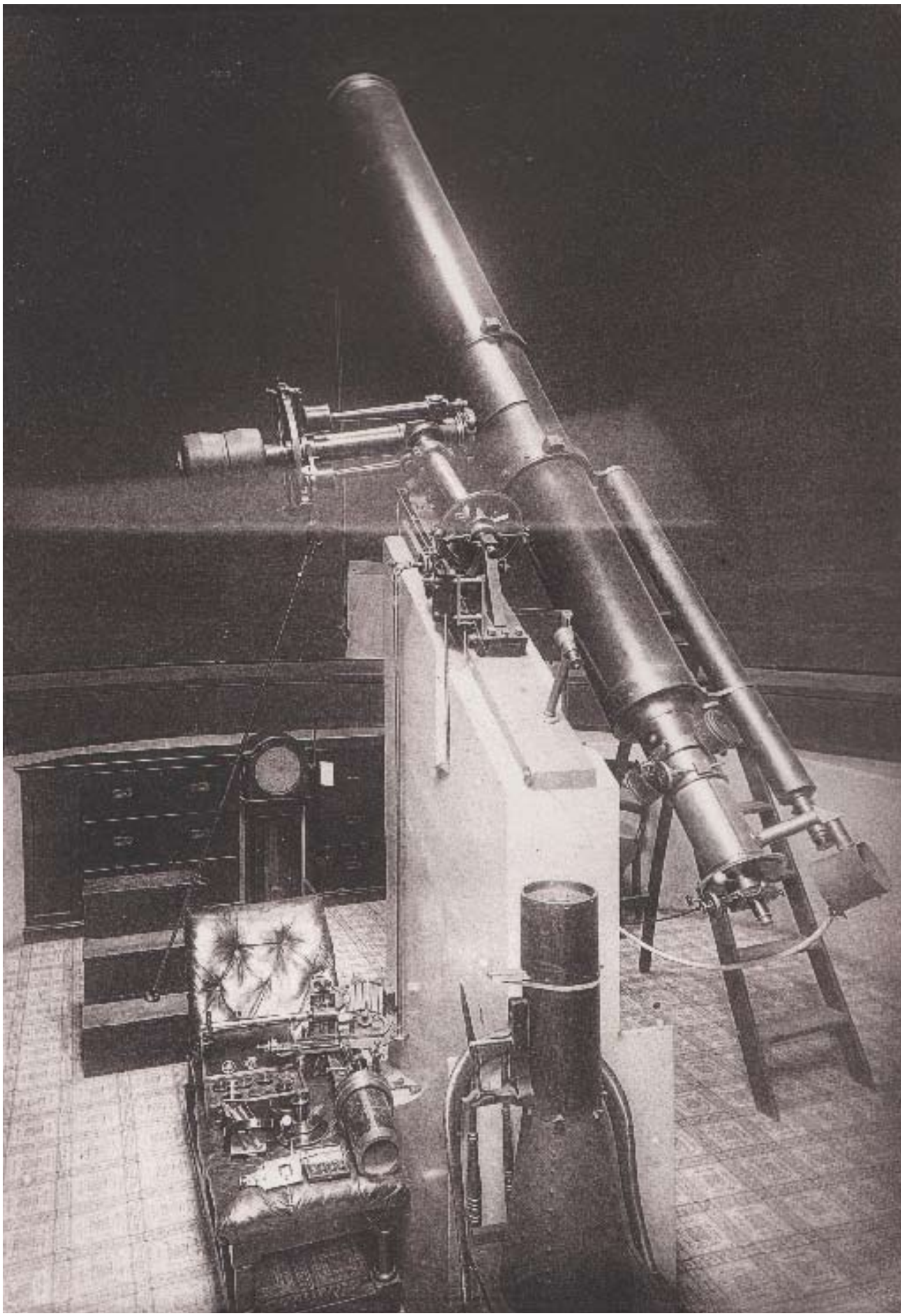
Russell was impressed by a Schroeder telescope owned by Alfred Fairfax, a Sydney jeweller and amateur astronomer and this may have been one of the reasons he ordered the new telescope from Schroeder.[17] A 4½-inch Schroeder telescope owned by Fairfax was used at Woodford during the observation of the Transit of Venus in 1874.[18]

As well as the telescope Russell purchased some additional instruments from Schroeder.[19] These were a solar polarising eyepiece (H10380) designed for viewing the sun, a filar micrometer mounted on a graduated circuit (H10007) and some eyepieces (H10294). A sun diagonal (H10295) used in conjunction with the Schroeder telescope was purchased separately.

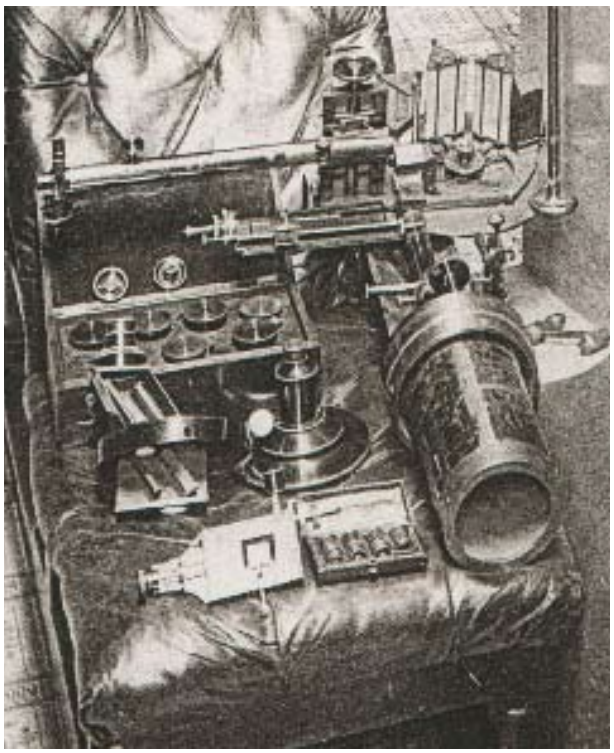
The telescope was specially made to fit into Sydney Observatory's south dome which was rebuilt in 1858 to fit the telescope.[20] The telescope had a clear aperture of 11½ inches and a focal length 375 cm and Russell commented that while this shortened focal length was a disadvantage to definition it was an advantage to its light catching power.[21]

The telescope was adapted for taking photographs of the Transit of Venus in December of 1874.[22] The setup of the lenses was also modified by Russell who, once this was completed, felt that the definition of the telescope was superb especially when using the achromatic eyepieces supplied by Dr Schroeder.[23] For the Transit of Venus it was fitted with a camera and enlarging lens that magnified the sun's image to 4 inches. The wet collodion photographic plates were placed at the end of the camera and held in place by a spring. The camera end passed into a dark room tent raised inside the dome and connected to the telescope by a flexible sleeve. A shutter was used to take the picture which was developed on the spot and another inserted immediately. Three people working in this way managed to take one photo per minute.[24] The telescope was also used by Russell on 7 May 1879 to measure the Gem star clusters in Arago.[25]

Over the course of the next 30 years other changes were made to both the telescope and its accessories



Schroeder 11½-inch telescope in the south dome of Sydney Observatory, from Observations of the Transit of Venus.



Eyepieces, spectroscope lenses used with the Schroeder 11½-inch telescope, from Observations of the Transit of Venus.

to increase the usefulness of the instrument. The filar micrometer was worked on by the E Esdaile, a local instrument maker who replaced the original micrometer. In 1883 the mount for the telescope was redesigned by a local manufacturer The Mort Dock Engineering Company.[26] Another accessory that was used with the telescope was a Star Diagonal (H10295) with an adaptor for the 11½ inch telescope. This was made by T Cooke and Sons after 1922.[27] Lastly a drive mechanism (H10268) made by Guster Heyde of Germany was added sometime around 1914 to drive the rotation of the telescope.

n Polarising helioscopic eyepiece, 1874. H10380
This solar polarising eyepiece enabled the observer to look at the sun without coloured glasses, so that the actual colouring of the sun's surface could be seen.[28]

In the following excerpt from the 1874–75 Astronomer's Report Russell describes its operation, 'In this eye-piece advantage is taken of the polarisation of light reflected from a glass surface, and two pairs of reflectors are used and so arranged that one pair might be made polarise at right angles to the other, in which position it stops nearly all of the sunlight; by altering this angle the sunlight may be made of any convenient intensity, and the alteration is made by simply turning a handle'.[29]

n Filar micrometer, 1874. H10007
This micrometer was primarily used for measuring double star positions. It was still in use in the 1940s when it was worked on by the local instrument maker E Esdaile who replaced the original micrometer.

n Telescope eyepieces, 1874. H10294
These quality eyepieces made by Carl Zeiss of Jena, were used with the 11½-inch telescope but it is uncertain as to whether they were purchased at the same time. The fact the Zeiss lenses are all contained in a wooden box with Scroeder's name plate on it implies this may have been the case. The quality of these eyepieces was commented on by Russell who felt that the definition of the telescope was superb especially when using the achromatic eyepieces supplied by Dr Schroeder.[30]

n Star diagonal, 1897–1922
This sun diagonal used in conjunction with the Schroeder telescope was purchased separately. The sun diagonal was attached to the view end of the telescope and allowed for the dissipation of heat caused by the magnification of the sun's rays.

ALVAN CLARK & SONS ASTRONOMICAL LENS

n Astronomical lens, 1875–1885. H9978
This important lens was purchased from Alvan Clark one of the most famous of the 19th century astronomical opticians. Made sometime between 1875 and 1885 the lens was used by Russell and Pollack in 1886 and 1887 to make experimental measurements of double stars using photography.[31]

The perfection of the lens can be measured by the fact that in 1919 this lens was sent to Professor T H Laby, at the University of Melbourne, to aid his research on the work of fellow Australian Henry Joseph Grayson.[32] Laby's primary focus was on precision experimental physics and the optical instruments essential to many scientific experiments.[33]

It was more than likely that the lens was used in connection with the plates made by the micro-ruling machine invented by Grayson in 1898. This machine was capable of ruling up to 40,000 lines an inch. Grayson's Gratings, as they became known, achieved international fame when the famous

optician Carl Zeiss commissioned a plate with rulings up to 120,000 lines per inch.[34]

TROUGHTON & SIMMS TRANSIT TELESCOPE

n 6-inch transit telescope, 1875–1877. H9899
'I gave the order for a new transit circle with 6-inch telescope to Mr Simms, of Charlton, near London, requesting him to make certain alterations in the usual form, which experience has shown to be desirable. The instrument will combine all the most recent improvements and some that are used for the first time. I believe it will be one of the finest instruments extant.' H C Russell, 1875.[35]

This telescope, ordered from Troughton and Simms of London in 1875 arrived in Australia in 1877. It is one of the most significant of the museum's astronomical instruments because it was used to record transits for Sydney time measurement as well as much of the observatory's observational work.[36] Upon its arrival it replaced the old transit circle, which was thought to be deficient, and Russell used it to acquire accurate positions of stars for the trigonometrical survey of NSW.[37]

One of the new innovations included in its design was the casting of circle from solid metal circles rather than in parts or leaving areas open. This was done to ensure temperature effects were more equally spread across the circles to decrease distortion. Russell believed this telescope was the first to be cast in this way by Troughton and Simms.[38]

This telescope also has a number of accessories made by Troughton and Simms which aided in the setting up and use of the instrument including: a level trier (H9957); testing equipment (H9976); lifting jack (H10005) and pivot apparatus (H10202) and (H10306). There is also a specially designed observation chair (H9901) which was probably locally made.

Another important job was its use as a support instrument in the mapping the stars project where it was used to acquire accurate positions of reference stars. The project was initiated in 1887 at a meeting of the International Congress of Astronomers in Paris. Henry Russell from the Sydney Observatory attended and was one of the many who accepted the proposal put forward by Dr David Gill to map of the stars by photography.[39] The importance placed on this project can be gauged by the fact that it dominated the activities of the Sydney Observatory into the 1960s.

n Astronomical observation couch, 1877–1900. H9900
This couch was used in conjunction with the six inch transit telescope made by Troughton and Simms.[40] The couch was specially designed to accommodate the astronomer who spent long hours looking through the eyepiece of the telescope. It was probably made locally, although the maker's name is unknown.

n Level trier, 1875–1877. H9957
This level trier was used in conjunction with the 6-inch transit telescope (H9899) made by Troughton and Simms, which arrived in Australia in 1877. The trier was used to set up and align the telescope and presumably arrived at the same time.[41] It has a scale graduated in minutes and seconds of arc which was used to ensure the telescope was perfectly level.

n Pivot testing apparatus, 1875–1877. H9976
This pivot testing equipment was specially designed to test the circularity of the pivots in the 6-inch telescope (H9899). Thus ensuring that the pivots on which the telescope turned were on exactly the same level. The errors which crept in were checked daily.

n Lifting jack, 1875–1877. H10005
This lifting jack equipment was specially designed to lift the 6-inch telescope (H9899). The jack was used to lift the telescope off its pivots for maintenance and also to enable the telescope to be changed from a northward to southward facing orientation. The jack moved on small-gauge metal tracks laid in the floor of the transit room.

PHOTOHELIOGRAPHIC TELESCOPE

n Photoheliographic telescope, 1873–1874. H10211
'I do not suggest that photographic observations should displace eye observations; on the contrary, I think that both eye and photographic observations ought to be made.' Warren de la Rue, 1873[42]

This is one of the most significant telescopes held in the Powerhouse Museum's collection. While not officially part of the British Government's observation program this telescope was purchased

by the observatory and sent to Australia in 1874 along with attachments to photograph the Transit of Venus. A special stand was constructed in Sydney to support it during the observations.[43] The telescope was made by J H Dallmeyer and was among the first to be used for astronomical photography in Australia.

For the observation of the 1874 Transit of Venus this telescope was set up at Woodford in the Blue Mountains at the residence of A Fairfax. There were seven observers present for the occasion: P F Adams, Surveyor-General; Hirst, a well known amateur astronomer; Mr Vessy, of the Trigonomical Survey; Mr Du Faur, of the Survey Department; Mr Bischoff, the photographer; and two unnamed carpenters.[44]

The telescope and attachments are the same as those at five other observatories that were part of the Royal Observatory Transit of Venus program. The others went to Honolulu, Mokkatam, Rodriguez, Kereguelen and Burnham.[45] It was made by J H Dallmeyer to accommodate a special piece of photographic apparatus designed by Janssen and de la Rue which took 6½-inch circular photographic plates (H10213, H10379).[46]

Unfortunately of the 14 Janssen plates taken at Woodford none have survived. Twelve of the resulting Janssen photographs (60 on each plate), and 36 normal plates were sent to the Royal Observatory in Greenwich and have since been lost.[47] The whereabouts of the other two is not known although they may have found their way into the NSW Government Printing Office.[48]

Only one of the unexposed Janssen plates has survived (H10379). One reason the plates sent to England were not well cared for is that, like the other photographs sent in from observatories around the world, the plates proved to be less than successful.[49]

The reasons for this were described by George Airy, Astronomer Royal at the Greenwich Observatory, in 1881, 'After laborious measures and calculation it was thought best to abstain from publishing the results of the photographic measures as comparable with those deduced from telescopic view. The consideration which led to this decision are … that, however well the Sun's limb on the photograph appeared to the naked eye to be defined, yet on applying to it a microscope it became indistinct and untraceable'.[50]

Dallmeyer photoheliograph from Observations of the Transit of Venus.

While the photographs proved less than successful the observations themselves played an important part in the official report made by Captain Tupman to the British Government. Of the 61 reliable reports of Venus crossing the sun which were recorded at points around the British Empire 22 were from Australia.[51]

n Janssen's photographic apparatus, 1874. H10213
This photographic apparatus was made by J H Dallmeyer based on a unique design by Janssen modified by de la Rue in Britain and took 6½-inch circular photographic plates (H10379).[52] Of all the British sets of apparatus made for the 1874 Transit of Venus this is the only known one to have survived and this adds substantially to its significance.

n Box, metal rings and glass plate, 1874
This unexposed Janssen photographic plate is the only one which has survived from the NSW project to photograph the 1874 Transit of Venus. These circular plates were used in conjunction with Janssen's photoheliograph.

SIR HOWARD GRUBB TELESCOPE

n 6-inch equatorial telescope, 1880–1882. H9887
This 6-inch refracting telescope was made by Sir Howard Grubb of Dublin. It was ordered for the 1882 Transit of Venus and was shipped out of Dublin around July 1882.[53] Unfortunately there were problems with Australian customs and it sat on the dock and missed out on being used to observe the transit.[54] It was used in the north dome of the observatory and was probably used by Lawrence Hargrave who worked at the observatory from _____.[55]

The order for the telescope included a comprehensive list of pulleys, weights and clamps along with a 4½-inch guide telescope and micrometers and eyepieces for both the 6-inch and the 4½-inch.[56] There were only two other Australian orders for 6-inch Grubb telescopes in the 19th century, one went to W J Macdonnell at Port Macquarie in the 1870s or 1880s while the other went to F D G Stanley in Brisbane sometime before 1895.[57]

SYDNEY ASTROGRAPHIC TELESCOPE

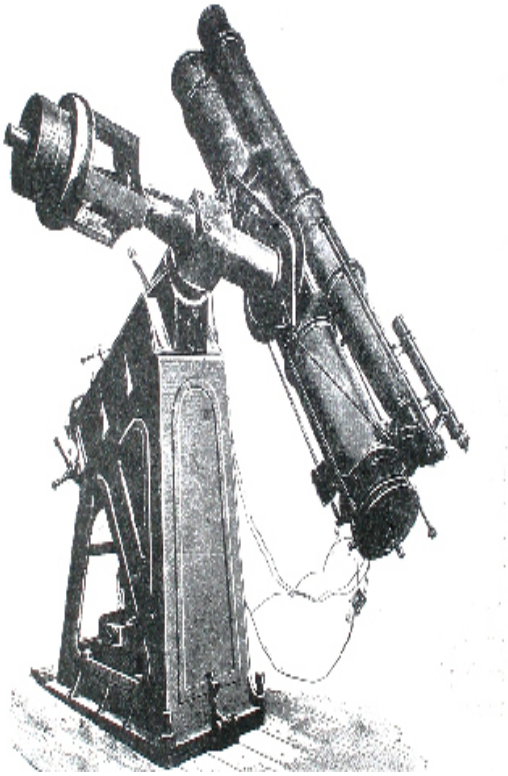
n Parts of Sydney astrograph and graduated wheel, 1887–1890. H10255
'The important place which photography has now assumed as a means of promoting astronomical discovery and research, demands some record should be preserved of the instruments, more especially of those used for carrying out the great work which was the outcome of the Congress of the world's astronomers which met at Paris, in 1887.'
H C Russell[58]

In 1887 astronomers from around the world embarked a massive new enterprise. Known as the Carte du Ciel (Mapping the Stars) project, it involved photographing and measuring the stars in both hemispheres. Australia was actively involved in the project with observatories in Sydney, Melbourne, and Perth keen to participate in this international project. Each observatory was allocated a zone of the sky and was expected to record it using instruments of a standard pattern.[59]

British institutions preferred to patronise a British maker Howard Grubb of Dublin who took on the work of constructing seven of the astrographs needed.[60] Melbourne and Perth requested Grubb telescopes but Sydney only wanted the lens. This was because Russell believed there was now enough expertise in the colony to finish the rest of the instrument and perhaps also because he was aware of the pressure Grubb would be under to complete his orders on time. As it was the equipment ordered for Melbourne and Sydney 1888 did not arrive till in 1890.[61] The Perth telescope arrived in 1897.[62]

The casing and mounts for the 13-inch refracting telescope which housed the Grubb lens were made in NSW. This illustrates how the skills of local manufactures had developed since Australia's formative years when all instruments were ordered from Europe or America. The making of the casing and mounts for the telescope was divided between two local Sydney firms, Mort's Dock and Engineering Co and the Atlas Engineering Co. The clockwork microscopes, all the smaller parts and the assembly of the instrument were all done by Mr W I Masters, the instrument maker at the observatory.[63]

However there were still some aspects of instrument making which were beyond the skills of



Grubb astrographic telescope, similar to the one made for Melbourne, etching from Stars and Telescopes.

Irish?

Australian manufacturers. One of these was the making of high quality lenses and this led Russell to recommend the purchase of a photographic objective from Sir Howard Grubb which arrived some time after the casing and fittings had been completed.[64] Another part which could not be made locally was a wheel which needed to be marked with very fine graduations which had to be made using the dividing engine owned by Troughton and Simms of London.[65]

This astrographic telescope had two tubular casings; one of sheet steel for the photographic lens and camera plates and the other with an eyepiece was used by the observer as a guide (H10374). A sun diagonal or Herschel wedge (H10025) was also used in conjunction with this guiding instrument.

As the main part of the telescope was completed before the arrival of the photographic lens from Grubb Russell took some preliminary photographs using a 6-inch Dallmeyer portrait lens (H10186) in his possession. Using this lens Russell took photographs of the Milky Way and did some further experiments with stellar photography.[66]

Only parts of this instrument remain but they are significant for the role they played in the international Carte du Ciel project and the fact that they were once part of one of the earliest astrograph's constructed in Australia.

n Guiding telescope with Merz lens, 1888–1890. H10374
This guiding telescope was used in conjunction with Sydney astrograph (H10255) employed in the Carte du Ciel project. It was probably put together at the same time as the Sydney astrograph, perhaps by I W Masters who worked at Sydney Observatory. The telescope has an aperture of 18 cm and the lens was taken from a telescope brought from Merz and Sons in 1861. The guiding telescope was rigidly fixed to the astrograph and guiding wires were fitted in the eyepiece to allow movement in two direction.[67]

n Portrait lens 6-inch, 1880–1890. H10186
In 1882 David Gill, astronomer at the Royal Observatory at the Cape of Good Hope, attached an dry plate camera with a Ross lens to a refracting telescope to take photographs.[68] While taking photographs of the Great Comet C/1882 R1 as it passed over South Africa, Gill saw the potential of constructing star maps from the photographic plates. He ordered a 6-inch portrait lens from J H Dallmeyer and this lens provided him with the photographs of stars which were good enough to be measured for mapping.[69]

Russell took a leaf from Gill's book making some preliminary photographs using a 6-inch Dallmeyer portrait lens (H10186) in his possession. Using this lens Russell took photographs of the Milky Way and other stellar bodies which are among the earliest taken in Australia.[70]

PHOTOGRAPHIC PLATE MEASURING INSTRUMENTS

n Instruments for measuring astronomical photographs, 1892–1915. H10139, H10140
This instrument, designed by H H Turner, made by Troughton & Simms, was used in conjunction with the photographic plates taken with the astrographic cameras supplied for the Carte du Ciel project.[71] Originally the plates were to be measured at a central plate-measuring facility in Paris but when this failed to materialise Melbourne and Sydney set up a shared facility located in Melbourne.

By 1915 there was a huge backlog of unmeasured photographs and Sydney Observatory purchased their own plate measuring machines to try to clear the backlog.[72]

Although made by Troughton and Simms this machine was based on an innovative design by Professor H H Turner. Turner found that the screw system initially used to measure plates was very labour intensive and instead devised an eyepiece scale measuring machine. This reduced the time taken to measure the stars on each photographic plate.[73]

n Reseaux plates, 1885–1895. H10270, H10271
The reseau (or lined plate) was placed in the dark slide in direct contact with photographic plate from the astrographic camera and exposed for a second or two to imprint the lines on the emulsion. The resulting image, traversed by a series of very fine lines, could then be used to measure the plates with respect to the lines.[74]

It is likely that this reseau and dark slide came from Melbourne to Sydney Observatory around 1915. Once in Sydney they were used to continue the work on measuring the photographic plates taken by the observatory.

ADAM HILGER SPECTROGRAPH

n Optical equipment, stellar spectrograph and accessories, 1915. H9955
Spectrographs like astrographs were photographic apparatus attached to telescopes to record the stellar activity. They were similar to the spectroscope except the photographic plate was used instead of the eye-piece.[75]

The spectroscope used prisms to spread stellar images out into lines of spectral wavelengths rather than providing an image of what was seen through the lens of a telescope. The light from stellar objects is passed through a slit and collimator to produce a parallel beam of radiation passed through a prism, or prisms, to disperse it into different wavelengths.[76]

It was an American Henry Draper who successfully introduced the use of the camera to photograph spectra and introduced the spectrograph to the world. His first successful photograph was taken in 1872 and was of the star Lyrae.[77] In 1876 Draper made a piece of apparatus he called a 'spectrograph' which comprised of a '… Browning direct-vision prism train and a 7-inch Voightlander portrait lens.[78] Draper conducted numerous experiments on the arrangement of prisms and lens but he died unexpectedly in 1882 before his experiments were finalised.

The work of Draper was carried on by was carried on by another pioneer stellar photographer Professor Pickering, Director of the Harvard College Observatory. In 1885 Pickering installed an 8-inch Voigtlander lens configured by Clarke at Cambridge. He later worked on the Bruce telescope which was able to impress as many as 400,000 stars on a single 14 x 17 inch plate due to the great aperture of the lens combined with a relatively short focal length.[79]

These telescopes were used for both spectral and point photography but the use of spectroscopes attached to telescopes have afforded the best results for stellar photography allowing many more stars which could not be seen with the naked eye to be measured for the first time by astronomers.[80]

Although significant for being made by one of the leading instrument makers it is reputed to have been little used during its tenure at the

Hilger spectrograph. Photo by Chris Brothers.

observatory.[81] This was probably through no fault of the instrument which although very sensitive to small changes in focus was still in use as late as 1939. See associated exercise book (H9955–5) with graphs and notes made using the spectrograph.

NOTES

[need to number consecutively]

1. King, P P, Forwarded to H M Secretary of State by Despatch, No 141, 1847, cited in Federation and Meteorology, www.austehc.unimelb.edu.au, cited 27/06/2007
2. Scott, W, Astronomical Observations made at the Sydney Observatory in the Year 1860, Thomas Richard, Government Printer, Sydney, 1861, p vi
3. Bhathal, R, Australian Astronomer; John Tebbutt, Kangaroo Press, Kenthurst, NSW, 1993, p 18
4. Ellery, R L J, 'Photographic Charting of the Heavens', cited in Proceedings of the Royal Society of Victoria, Volume IV, part 1, Stillwell and Co, Collins Street, Melbourne, 1892, p 48
1. Haynes, Raymond, Haynes, Roslynn, Malin, David, McGee, Richard, Explorers of the Southern Sky, Cambridge University Press, 1996, pp 51–52
2. Russell, H C, Astronomical and Meteorological Papers, Thomas Richards, Government Printer, 1880, p 13
3. Russell, H C, Nebula About Argus, cited in 'Scientific Papers 1871 to 1879', NSW Government Printer, 1879, p 3
4. Russell, H C, The Coloured Cluster About Kappa Crucius, cited in 'Scientific Papers 1871 to 1879', NSW Government Printer, 1879, p 1
5. Russell, H C, Astronomical and Meteorological Papers, Thomas Richards, Government Printer, 1880, p 2

6. Lomb, Nick, conversation, June 2007
7. Russell, H C, Astronomical and Meteorological Papers, Thomas Richards, Government Printer, 1880, p 2
8. Note in Blue File
9. Lomb, Nick, conversation, June 2007
10. Russell, H C, Report of Astronomer for 1874 & 1875, NSW Government Printer, 1876, p 4
11. Russell, H C, 'Scientific Notes', in Transactions and Proceedings of the Royal Society of NSW for the Year 1875, Volume IX, Thomas Richards, Government Printer, Sydney, 1876, p 144
12. Russell, H C, Astronomical and Meteorological Papers, Thomas Richards, Government Printer, 1880, p 4
13. McConnell, A, Instrument Makers to the World; a History of Cooke, Troughton and Simms, William Sessions, York, England, 1992, p 76
14. Russell, H C, Report of Astronomer for 1874 & 1875, NSW Government Printer, 1876, p 4
15. Russell, H C, 'Scientific Notes', in Transactions and Proceedings of the Royal Society of NSW for the Year 1875, Volume IX, Thomas Richards, Government Printer, Sydney, 1876, p 144
16. Lomb, Nick, conversation, June 2007
17. Lomb, Nick, conversation, June 2007
18. Russell, Transit of Venus, p 13
19. Russell, H C, 'Report of Astronomer for 1874 & 1875', NSW Government Printer, 1876, p 4
20. Lomb, Nick, conversation, June 2007
21. Russell, H C, 'Report of Astronomer for 1874 & 1875', NSW Government Printer, 1876, p 4
22. Russell, Transit of Venus, p x
23. Russell, H C, Astronomical and Meteorological Papers, Thomas Richards, Government Printer, 1880, p 14
24. Russell, H C, Report of Astronomer for 1874 & 1875, NSW Government Printer, 1876, p 2
25. Russell, H C, Astronomical and Meteorological Papers, Thomas Richards, Government Printer, 1880, p 14
26. Haynes, Raymond, Haynes, Roslynn, Malin, David, McGee, Richard, Explorers of the Southern Sky, Cambridge University Press, 1996, p 62
27. McConnell, A, Instrument Makers to the World; a History of Cooke, Troughton and Simms, William Sessions, York, England, 1992, p 47
28. Russell, H C, Report of Astronomer for 1874 & 1875, NSW Government Printer, 1876, p 4
29. Russell, H C, Report of Astronomer for 1874 & 1875, NSW Government Printer, 1876, p 4
30. Russell, H C, Report of Astronomer for 1874 & 1875, NSW Government Printer, 1876, p 2
31. Lomb, Nick, conversation, June 2007
32. Original note in Blue File dated 13.2.19
33. Evans, Joanne, Thomas Howell Laby, 1880–1946, cited http://www.asap.unimelb.edu.au/bsparcs/exhib/omp/people/laby.htm, June 2006
34. Bolton, H C, Grayson, Henry Joseph (1856–1918), cited in http://www.adb.online.anu.edu.au/biogs/A090090b.htm, June 2006
35. Russell, H C, Report of Astronomer for 1874 & 1875, NSW Government Printer, 1876, p 3
36. Lomb, Nick, conversation, 4 May 2007
37. Haynes, Raymond, Haynes, Roslynn, Malin, David, McGee, Richard, Explorers of the Southern Sky, Cambridge University Press, 1996, p 56
38. Russell, H C, 'Scientific Notes', in Transactions and Proceedings of the Royal Society of NSW for the Year 1875, Volume IX, Thomas Richards, Government Printer, Sydney, 1876, p 138
39. Haynes, Raymond, Haynes, Roslynn, Malin, David, McGee, Richard, Explorers of the Southern Sky, Cambridge University Press, 1996, p 61
40. Russell, H C, Report of Astronomer for 1874 & 1875, NSW Government Printer, 1876, p 3
41. Russell, H C, Report of Astronomer for 1874 & 1875, NSW Government Printer, 1876, p 3
42. De la Rue, W, Extracts, cited in Russell, H C, Scientific Papers 1871 to 1879, NSW Government Printer, 1879
43. Russell, H C, Scientific Papers 1871 to 1879, NSW Government Printer, 1879, p 8
44. Russell, H C, Scientific Papers 1871 to 1879, NSW Government Printer, 1879, p vi
45. Todd, David P, Stars and Telescopes, Sampson Low, Marston, and Co, 1900, p 259
46. Airy, G B, Account of the Observation of the Transit of Venus, 1874, December 8, Made Under the Authority of the British Government and of the reduction of the Observations, Her Majesty's Stationary Office, 1881, p 15
47. Russell, H C, Report of Astronomer for 1874 & 1875, NSW Government Printer, 1876, p xviii
48. Lomb, Nick, conversation, June 2007
49. Russell, H C, Report of Astronomer for 1874 & 1875, NSW Government Printer, 1876, p 2
50. Airy, G B, Account of the Observation of the Transit of Venus, 1874, December 8, Made Under the Authority of the British Government and of the reduction of the Observations, Her Majesty's Stationary Office, 1881, p 18

51. Russell, H C, Astronomical and Meterological Papers, Thomas Richards, Government Printer, 1880, p 10

52. Airy, G B, Account of the Observation of the Transit of Venus, 1874, December 8, Made Under the Authority of the British Government and of the reduction of the Observations, Her Majesty's Stationary Office, 1881, p 15

53. Grubb, 'Advice of Goods' docket, 1882, cited in Powerhouse Museum blue file

54. Lomb, Nick, conversation, June 2007

55. Lomb, Nick, conversation, June 2007

56. Grubb, 'Advice of Goods' docket, 1882, cited in Powerhouse Museum blue file

58. Russell, H C, Description of the Star Camera at the Sydney Observatory, Alfred James Kent, Government Printer, 1892, p 4

59. Glass, I S, Victorian Telescope Makers, the Lives and Letters of Thomas and Howard Grubb, Institute of Physics Publishing, Bristol and Philadelphia, 1997, p 133

60. Glass, I S, Victorian Telescope Makers, the Lives and Letters of Thomas and Howard Grubb, Institute of Physics Publishing, Bristol and Philadelphia, 1997, p 153

61. King, H C, The History of the Telescope, Dover Publications, New York, 1955, p 300

62. Glass, I S, Victorian Telescope Makers, the Lives and Letters of Thomas and Howard Grubb, Institute of Physics Publishing, Bristol and Philadelphia, 1997, Appendix C, p 251

63. Russell, H C, Description of the Star Camera at the Sydney Observatory, Alfred James Kent, Government Printer, 1892, p 4

64. Russell, H C, Description of the Star Camera at the Sydney Observatory, Alfred James Kent, Government Printer, 1892, p 4

65. Russell, H C, Description of the Star Camera at the Sydney Observatory, Alfred James Kent, Government Printer, 1892, p 4

66. Russell, H C, Description of the Star Camera at the Sydney Observatory, Alfred James Kent, Government Printer, 1892, p 4

67. Wood, Harley, Astrographic Catalogue 1900.0, Sydney Section, Dec –51° to –65°, V C N Blight, Government Printer, NSW, 1971, p 8

68. Glass, I S, Victorian Telescope Makers, the Lives and Letters of Thomas and Howard Grubb, Institute of Physics Publishing, Bristol and Philadelphia, 1997, Appendix C, p 126

69. King, H C, The History of the Telescope, Dover Publications, New York, 1955, p 297

70. Russell, H C, Description of the Star Camera at the Sydney Observatory, Alfred James Kent, Government Printer, 1892, p 4

71. Powerhouse Museum, H10139, Blue File

72. Haynes, Raymond, Haynes, Roslynn, Malin, David, McGee, Richard, Explorers of the Southern Sky, Cambridge University Press, 1996, p 64

73. Durand, D, The Royal Observatory at Greenwich, http://www2.cadc-ccda.hia-iha.nrc-cnrc.gc.ca/astrocat/acs/node37.html, cited July 2007

74. Ellery, R L J, 'Photographic Charting of the Heavens', cited in Proceedings of the Royal Society of Victoria, Volume IV, part 1, Stillwell and Co, Collins Street, Melbourne, 1892, p 52

75. King, H C, The History of the Telescope, Dover Publications, New York, 1955, p 292

76. Walker, P, Chambers Science and technology Dictionary, Clays Ltd, St Ives, 1991

77. King, H C, The History of the Telescope, Dover Publications, New York, 1955, p 291

78. Barker, G, Memoir of Henry Draper, 1888, cited in King, H C, 'The History of the Telescope', Dover Publications, New York, 1955, p 291

79. Todd, David P, Stars and Telescopes, Sampson Low, Marston, and Co, 1900, pp 352–353

80. Todd, David P, Stars and Telescopes, Sampson Low, Marston, and Co, 1900, pp 352–353

81. Conversation with Nick Lomb, Curator, Sydney Observatory, June 2007

BIBLIOGRAPHY

Airy, G B, Account of the Observation of the Transit of Venus, 1874, December 8, Made Under the Authority of the British Government and of the reduction of the Observations, Her Majesty's Stationary Office, 1881

Auerbach, F, The Zeiss Works and the Carl Zeiss Foundation in Jena, W & G, Foyle, London, England, about 1925?

Bhathal, R, Australian Astronomer; John Tebbutt, Kangaroo Press, Kenthurst, NSW, 1993

Bolton, H C, Grayson, Henry Joseph (1856–1918), cited in http://www.adb.online.anu.edu.au/biogs/A090090b.htm, June 2006

Chaldecott, J, 'Printed Ephemera of Some Nineteenth Century Instrument Makers', in Blondel, C, Parot, F, Turner, A, Williams, M, (eds), Studies in the History of Scientific Instruments, Rogers Turner Books, London, 1989

De-Clerq, P R, Nineteenth Century Instruments and their Makers; Rodopi, Amsterdam, 1985

Ellery, R L J, 'Photographic Charting of the Heavens', cited in Proceedings of the Royal Society of Victoria, Volume IV, part 1, Stillwell and Co, Collins Street, Melbourne, 1892

Evans, Joanne, Thomas Howell Laby, 1880–1946, cited http://www.asap.unimelb.edu.au/bsparcs/exhib/omp/people/laby.htm, June 2006

Fresneau, A, Argyle, R W, Mirano, G, Messina, S, Potential of Astrographic Plates for Stellar Flare Detection, http://www.journals.uchicago.edu/AJ/journal/issues/v121n1/200282/200282.html, cited July 2007

Gascoigne, S C B, 'The Great Melbourne Telescope', in Historical Records of Australian Science, Volume 10, Number 3, Panther Publishing, Canberra, Australia, 1995

Glass, I S, Victorian Telescope Makers; the Lives and Letters of Thomas and Howard Grubb, Institute of Physics Publishing, Bristol and Philadelphia, 1997

Haynes, Raymond, Haynes, Roslynn, Malin, David, McGee, Richard, Explorers of the Southern Sky, Cambridge University Press, 1996

Hünsch, Matthias, Hamburg Observatory — Overview: Buildings & Telescope, http://www.hs.uni-hamburg.de/EN/Oef/Stw/aequator/aequator.html

King, H C, 'The History of the Telescope', Dover Publications, New York, 1955

King, P P, Forwarded to H M Secretary of State by Despatch, No 141, 1847, Federation and Meteorology, http://www.austehc.unimelb.edu.au/fam/1541.html

Knight, E H, (ed), 'Knights American Mechanical Dictionary', Vol III, J B Ford and Company, New York, 1874

McConnell, A, Instrument Makers to the World; a History of Cooke, Troughton and Simms, William Sessions, York, England, 1992

Russell, H C, Nebula About Argus, cited in 'Scientific Papers 1871 to 1879', NSW Government Printer, 1879

Russell, H C, Report of Astronomer for 1874 & 1875, NSW Government Printer, 1876

Russell, H C, The Coloured Cluster About Kappa Crucis, cited in 'Scientific Papers 1871 to 1879', NSW Government Printer, 1879

Russell, H C, Astronomical and Meterological Papers, Thomas Richards, Government Printer, 1880

Russell, H C, 'Scientific Notes', in Transactions and Proceedings of the Royal Society of NSW for the Year 1875, Volume IX, Thomas Richards, Government Printer, Sydney, 1876

Russell, H C, Observations of the Transit of Venus, 9 December, 1874; made at Stations in NSW, Charles Potter, Government Printer, 1892

Russell, H C, Description of the Star Camera at the Sydney Observatory, Alfred James Kent, Government Printer, 1892

Scott, W, Astronomical Observations made at the Sydney Observatory in the Year 1860, Thomas Richard, Government Printer, Sydney, 1861, p vi

Todd, David P, Stars and Telescopes, Sampson Low, Marston, and Co, 1900

Turner, H H, The Great Star Map, John Murray, London, 1912