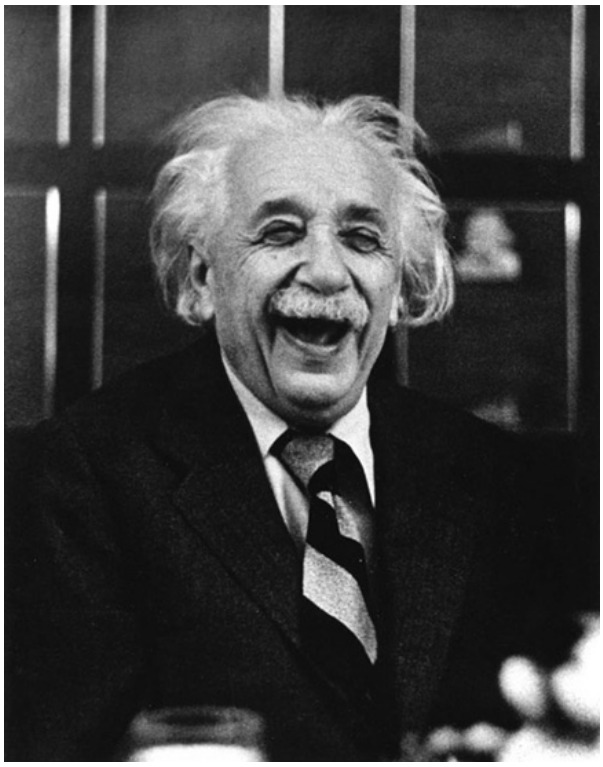
Dr Faustus of Modern Physics



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Preface

This book describes how modern physics based on relativity theory and quantum mechanics was born in the beginning of the 20th century from a collapse of classical physics. The new baby was the result of a couple of scientific paradoxes, which appeared unsolvable using classical deterministic continuum models, crowned by Maxwell's equations for electromagnetics formulated in 1865 by the British physicist Clerk Maxwell.

Theoretical science cannot tolerate paradoxes or contradictions, because in a contradictory theory everything is both true and false at the same time, and thus a paradox presented by some critics of a theory must be handled one way or the other by the proponents of the theory. A paradox can be deconstructed by showing that it is only an apparent paradox, not a real paradox, which is the only scientifically acceptable solution.

If this turns out to be impossible, a second defense line may be to simply deny the existence of the paradox, another to claim that even if the paradox appears to be a real contradiction, such as the contradicting wave and particle pictures of quantum mechanics, it can be accomodated as *wave-particle duality* or *wave-particle complementarity* as a form of augmented reality without contradiction.

I shall present evidence in the form of a little tribunal that modern physics never really resolved the paradoxes of classical physics from which it was born, and that this failure has developed into a trauma of modern physics with negative consequences in fact for all of science ultimately based on physics.

I have to chosen to present the key issues in common language without mathematical formulas to a tribunal with the reader as the jury, where the main "fathers of modern physics" Boltzmann, Planck, Einstein, Bohr and Prandtl, are faced with certain accusations, and the jury listens to confessions by the accused and to witnesses, all in the form of direct quotes from the

Figure 1: Einstein in front of a critical skeptical jury at Oxford University in May 1931, defending his equations of general relativity.

scientists involved.

The reader will find that the Faust legend describes the dilemma which confronted the fathers when they took on the role of saving science from collapse: To succeed they had to pay the price of selling out their (classical) scientific souls. The price was to give up of the basic classical concepts of space and time and determinism, and the basic classical principle of cause-effect, a very high price and accordingly the fathers came to suffer much like Dr Faustus did...

But the responsibility is not only carried by the fathers but all of us who who confess to the religion of science in the postmodern world coming out from the trauma of the modern world. In fact, the modernity of physics came together with modernity in the arts (cubism, atonal music,...) and in politics as the classical world of Enlightenment collapsed into the 1st World War and never really recovered from the 2nd...

We shall see that the political ambitions of the emerging strong Germany required German science to take the lead and open the door to modernity, and there were young ambitious German scientists ready to take on the duty...at any price by any means...

The politics and the science of the 20th century were dominated by the two World Wars followed by a cold war, as the ultimate expression of a deal with the Devil.

More detailed accounts of the various trauma which afflicted the key persons involved are given in the following upcoming books:

- *The Tragical Story of Boltzmann and his Molecular Disorder*
- *The Tragical Story of Planck and his Quanta*
- *The Tragical Story of Einstein and his Covariance*
- *The Tragical Story of Bohr and his Duality*
- *The Tragical Story of Schrödinger and his Cat*
- *The Tragical Story of Prandtl and and his Boundary Layer.*

At the end of the book another door is opened towards resolutions some of the paradoxes without paying the high price the fathers felt obliged to pay.

Stockholm April 1st 2011,

Claes Johnson

Part I

Dr Faustus

Chapter 1

Deal with the Devil

> Newton, forgive me. (Einstein)
>
> The devil has put a penalty on all things we enjoy in life. Either we suffer in health or we suffer in soul or we get fat. (Einstein)

1.1 Einstein: The Icon of Modern Physics

The relation between modern physics and Albert Einstein can summarized as:

- Einstein initiated the development of modern physics as an (incompatible) combination of quantum mechanics and relativity theory, as patent clerk at the age of 25.
- The physics community exploited Einstein as the icon of modern physics, while judging him at the age of 45 to be senile and unable to understand what Aladdin lamp he had touched.

This is a classical Greek tragedy with success inseparable from failure, with failure ultimately taking the game. It is a true story about a Doctor Faustus, who sells his young soul to Lucifer the Devil to get access to the magics of science and pays the price of facing Hell already in this world, when the science he values the most in life is taken away from him.

This book analyzes the transformation of classical physics into modernity in the early 20th century formed by Einstein together with the following leading scientists, each one with his own Faustian story:

Figure 1.1: Einstein as young ambitious patent clerk ready for a deal in 1904 with his new theory of relativity: *I was sitting in a chair in the patent office at Bern when all of a sudden a though occurred to me: "If a person falls freely he will not feel his own weight". I was startled. This simple thought made a deep impression on me. It impelled me toward a theory of gravitation.*

- Ludwig Boltzmann (1844 - 1906)
- Max Planck (1858 - 1947)
- Niels Bohr (1885 -1962)
- Ludwig Prandtl(1875 - 1953).

Generations of modern physicists (and scientists) have followed selling their souls of different dimensions to acquire the magics of science. This book seeks to analyze this deal from both sides of the game:

- What science was won and what soul was lost?
- What is the deal for the 21st century?

We shall find that Planck, Bohr and Prandtl built scientific empires of this world, while Boltzmann tended to philosphy and Einstein was lonely idealist in search of an empires not of this world. All of them started out young with big ambitions.

1.2 Boltzmann: Tragedy of Classical Physics

The German physicist Ludwig Boltzmann had taken on the duty to free physics from the paradoxes of the new field of thermodynamics opened by the German physicist Rudolf Clausius, paradoxes which had to be solved by the science of the emerging German Empire with ambitions.

Boltzmann was searching for a mechanical model of thermodynamics based on an atomistic theory of a gas as as large collection of particles or atoms or molecules interacting by collisions. This was before the physical reality of atoms had been confirmed and Boltzmann met a lot of opposition, in particular from the Austrian physicist Ernst Mach advocating positivist phenomenalism instead of materialistic atomism. Boltzmann's goal was to give Clausius 2nd law of thermodynamics a mechanical atomistic basis, and to this end he was ready to make any deal, even introducing statistics in the form of *molecular disorder*...But misgivings took over and Boltzmann hanged himself, shortly before atomistic theory started to boom crowned by quantum mechanics...

Boltzmann took the game, but had to pay the price of giving up his life...the essence of tragedy. Boltzmann did not doubt atoms; it was the molecular disorder that wrecked his life.

Figure 1.2: Boltzmann determined to save German physics in 1888: *We must further admit that the orientation of research, which I have called classical theoretical physics, led to occasional excrescences against which a reaction was necessary. Every Tom, Dick and Harry felt the call to excogitate some structure, some vortices and concatenations, of atoms, believing thereby to have spotted the Creators plan once and for all.*

1.3 Planck: Father of Modern Physics

In Einstein, Bohr and the Great Debate about the Nature of Reality, Manjit Kumar concludes the Prologue by the following introduction of Max Planck:

- *In the 1890s some of Germany's leading physicists were obsessively pursuing a problem that had long vexed them: what was the relationship between the temperature, the range of colors, and the intensity of light emitted by a hot iron poker? It seemed a trivial problem compared to the mystery of X-rays and radioactivity that had physicists rushing to their laboratories and reaching for their notebooks. But for a nation forged only in 1871, the quest for the solution to the hot iron poker, or what became known as the blackbody radiation problem, was intimately bound up with the need to give the German lighting industry a competitive edge against its British and American competitors. But try as they might, Germany's finest physicists could not solve it. In 1896 they thought they had, only to find within a few short years that new experimental data proved that they had not. It was Max Planck who solved the blackbody problem, at a cost.* **The price was the quantum**.

The essence of the Faustian dilemma is expressed in *The Dilemmas of an Upright Man* [7] as follows:

- *Planck's confidence in himself and his ideas increased in step with Prussia's triumphs on the battlefield and with the new Reich's rise to dominance among European nations. Although personally the mot modest of men, Planck identifed his own development so fully with Germany's that the preservation of its cultural capital was inseparable from the preservation of personal values and professional life. Over all these values stood the ideal of unity, which in the political sphere inspired the creation of the Wilhelmian empire and in the cultural sphere inpired belief in the interconnectednes of all respectable barnches of learning. Planck's pride in imperial Germany and his commitment to the acaddemic ideal of unity of knowledge were the pillars on which he raised his science policy*

Figure 1.3: Planck just after his blackbody deal in 1900: *I had to obtain a positive result, under any circumstance and at whatever cost.*

1.4 Bohr: Director of Modern Physics

In 1921 the Theoretical Institute of Physics of Copenhagen University was created by the Danish physicist Niels Bohr, after a clever deal with Carlsberg brewery. Bohr had as a post doc of Ernst Rutherford in Manchester developed the first first quantized atomic model inspired by Planck, which gave him the 1922 Nobel Prize in Physics, at the same time as Einstein was awarded his 1921 Prize. Niels Bohr had taken on the duty to give Danish science back its past glory after Hans Christian Oersted (1777-1851), who discovered that electric currents create magnetic fields and thus opened to modern physics of electromagnetics. The pressure on Bohr to deliver was strong and the temptation to make a deal on the must have appeared irresistable... Bohr was a heavy pipe smoker.

1.5 Prandtl: Father of Modern Fluid Mechanics

The German physicist Ludwig Prandtl became the father of modern fluid mechanics by boldly facing the main open problem of classical continuum mechanics of turbulence in fluid flow as manifested in *d'Alembert's paradox* formulated in 1755 but still unsolved at the start of the 20th century. Prandtl extended the ambitions of Boltzmann and Planck of given the science of the German Empire a leading role, from basic physics to the main area of applied physics of fluid mechanics.

D'Alembert had shown that the equations of fluid mechanics predicted zero drag in flows of vanishingly mall viscosity suggesting that it should be possible to move through air or water without resistance, at varaiance with all observation. To solve the paradox Prandtl came up with the idea of a *boundary layer* as a thin zone connecting the free flow around a body moving through a fluid with the flow attaching to the boundary of the body. Prandtl claimed that the observed drag resulted from vorticity generated in the boundary layer and changing the global flow pattern.

This (eventually) brought Prandtl world fame, but we shall see that his solution has devilish qualities, as it builds on a large effect from a vansihingly small cause which as working hypothesis is poison...

Figure 1.4: Bohr caught while plotting to take control of modern physics in 1914: *In order to describe our mental activity, we require, on the one hand, an objectively given content to be juxtaposed to a perceiving subject, while, on the other hand, no sharp separation between object and subject can be maintained, since the perceiving subject also belongs to our mental content.*

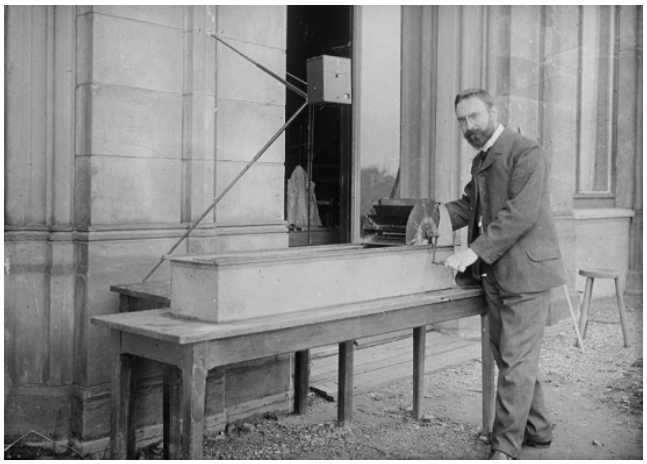

Figure 1.5: Prandtl in 1904: *I have now set myself the task to investigate systematically the laws of motion of a fluid whose viscosity is assumed to be very small.*.

Figure 1.6: Prandtl in 1904: *A very satisfactory explanation of the physical process in the boundary layer [Grenz-schicht] between a fluid and a solid body could be obtained by the hypothesis of an adhesion of the fluid to the walls, that is, by the hypothesis of a zero relative velocity between fluid and wall.*

1.6 Rewriting the History

We know that the history is written, or rather reconstructed by the winners who construct the truth according to their needs.

Einstein was questioned all through his life, as a young unknown patent clerk, as mature scientist with a theory nobody could understand and as senile "petrified object" unable to understand quantum mechanics, and his iconic stature was formed only after his death in 1954.

Boltzmann met serious opposition to his statistical mechanics, which made him end his life, and was later resurrected not for his statistics which nobody could understand, but because he early on"trusted atoms" which turned out to be a good idea.

Prantdl had to wait for 30 years before his boundary layers became an accepted truth.

Planck never accepted the quanta he had introduced but was anyway later elected as the founder of quantum mechanics.

Today the history is rewritten to give a consistent picture where the once strong and articulated criticism is put into the wardrobe of scientific misconceptions and delusions only carried by crackpots. This book invites the reader to question this official view presented by a pontificat of physics.

1.7 The Faustus Legend

Dr. Faustus (Latin for "auspicious" or "lucky" is according to the legend a scholar who makes a deal with the devil and exchanges his soul to get access to knowledge, or rather as we shall see, to the *magics of knowledge*.

The legend of course connects to the Fall of Man, with Adam eating the fruit of the tree of knowledge offered by Eve, with the result that the young couple is expelled from Paradise.

The adjective *Faustian* is used to describe the surrender of moral integrity of an ambitious person in order to achieve power and success.

The story was popularised in England by Christopher Marlowe as the tragedy The Tragical History of the Life and Death of Doctor Faustus from 1604, where Lucifer collects his due and Doctor Faustus ends up in Hell.

In Goethe's reworking of the story 200 years later, Faust becomes a dissatisfied intellectual who yearns for "more than earthly meat and drink" and is saved by Gods grace because of his constant striving, with a bit of help

from the pleading of his fiancee Gretchen.

The story in short is as follows: Despite his scholarly eminence, Faust is bored and disappointed. He decides to call on the Devil for further knowledge and magic powers with which to indulge all the pleasure and knowledge of the world. In response, the Devil's representative, Mephistopheles, appears. He makes a bargain with Faust: Mephistopheles will serve Faust with his magic powers for a term of 24 years, but at the end of the term, the devil will claim Faust's soul and Faust will be eternally damned.

Figure 1.7: The deal in Goethe's Faust.

Chapter 2

The Sacrifice

> The sacrifice which causes sorrow to the doer of the sacrifice is no sacrifice. Real sacrifice lightens the mind of the doer and gives him a sense of peace and joy. The Buddha gave up the pleasures of life because they had become painful to him.... A man who was completely innocent, offered himself as a sacrifice for the good of others, including his enemies, and became the ransom of the world. It was a perfect act. (Mahatma Gandhi)
>
> A thing is not necessarily true because a man dies for it. (Oscar Wilde)

The idea and practice of sacrifice is central in many religions including Christianity, with Jesus Christ's death on the cross the ultimate atonement for the sins of humankind. There is correspondence between the sacrifice and the gain from the sacrifice. The bigger the sacrifice, the bigger the gain. To get something you must give something. To get something big you must give away something big. A dinner at a top restaurant costs a fortune, and this is an essential part of the experience: You get what you pay for.

Dr Faustus sacrifices his soul to win the magics of science: An ultimate sacrifice to win an ultimate capacity.

Einstein sacrificed the notion of space and time, the ultimate sacrifice in science. This made him the hero of modern physics: Einstein saved physics by sacrificing physics: The ultimate tragedy.


SACRIFICE
All We Ask Here is that You Give Us Your Heart.
www.despair.com

Chapter 3

The Tragical History of the Life and Death of Doctor Faustus

> O what a world of profit and delight, of power, of honour, and omnipotence is promis'd to the studious artisan! (Dr Faustus)

3.1 Faustus by Christopher Marlowe

Christopher Marlowe (1564-1593), a foremost Elizabethan tragedian next to William Shakespeare, is known for his blank verse, his overreaching protagonists, and his mysterious death.

A warrant was issued for Marlowe's arrest on 18 May 1593, probaly connected to allegations of blasphemya manuscript believed to have been written by Marlowe was said to contain "vile heretical concepts". He was brought before the Privy Council for questioning on 20 May, after which he had to report to them daily. Ten days later, he was stabbed to death by Ingram Frizer. Whether the stabbing was connected to his arrest has never been resolved.

Doctor Faustus was first published in 1604, eleven years after Marlowe's death and at least twelve years after the first performance of the play. No Elizabethan play outside the Shakespeare canon has raised more controversy than Doctor Faustus.

The main thematic idea is the quest for knowledge as rational science of Enlightenment replaces religion and opens new worlds, coupled with the religious theme of hubris of man replacing God as the Master of the Universe.

Watch the play.

3.2 The Quest for Knowledge

Dr Faustus in his study in the first scene of *The Tragical History of the Life and Death of Doctor Faustus* (Quarto 1604):

- *These metaphysics of magicians,*
  And necromantic books are heavenly;
  Lines, circles, scenes, letters, and characters;
  Ay, these are those that Faustus most desires.
  O, what a world of profit and delight,
  Of power, of honor, of omnipotence,
  Is promisd to the studious artizan!
  All things that move between the quiet poles
  Shall be at my command: emperors and kings
  Are but obeyed in their several provinces,
  Nor can they raise the wind, or rend the clouds;
  But his dominion that exceeds in this,
  Stretcheth as far as doth the mind of man;
  A sound magician is a mighty god:
  Here, Faustus, tire thy brains to gain a deity.

Dr Faustus is ready to give his soul to Lucifer if he gets access to the magics of science, which is also the credo of modern man. To give up rationality for magics, in its ultimate form as the nuclear bomb.

Faustus' tale is likened to that of Icarus, who flew too close to the sun and fell to his death when the sun melted his waxen wings, as an expression of the consequences of too much (scientific) hubris.

3.3 The Quest for Magics of Science

He calls upon his servant Wagner to bring forth Valdes and Cornelius, two famous magicians. The Good Angel and the Bad Angel dispense their own perspective of his interest in Satan. Though Faustus is momentarily dissuaded, proclaiming "How am I glutted with conceit of this?", he is apparently won over by the possibilities Magic offers to him. Valdes declares that if Faustus

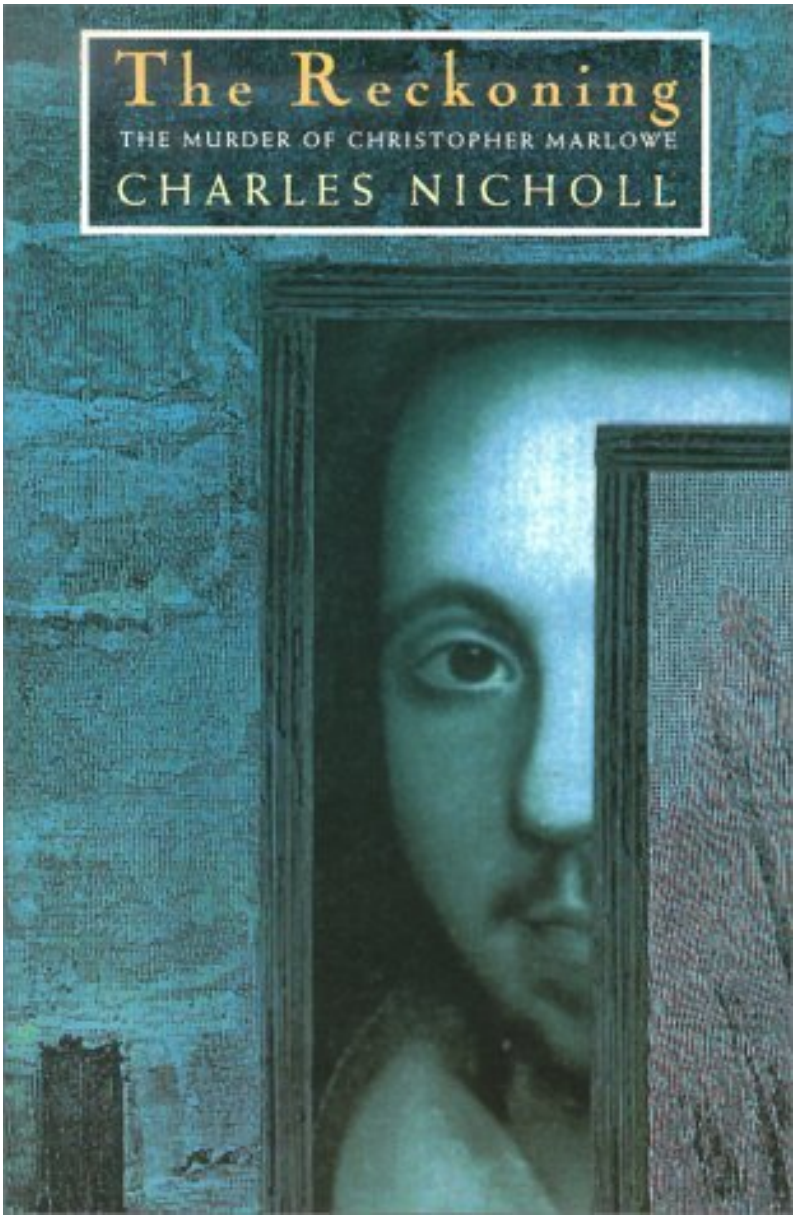

Figure 3.1: Christopher Marlowe was stabbed to death at the age of 29.

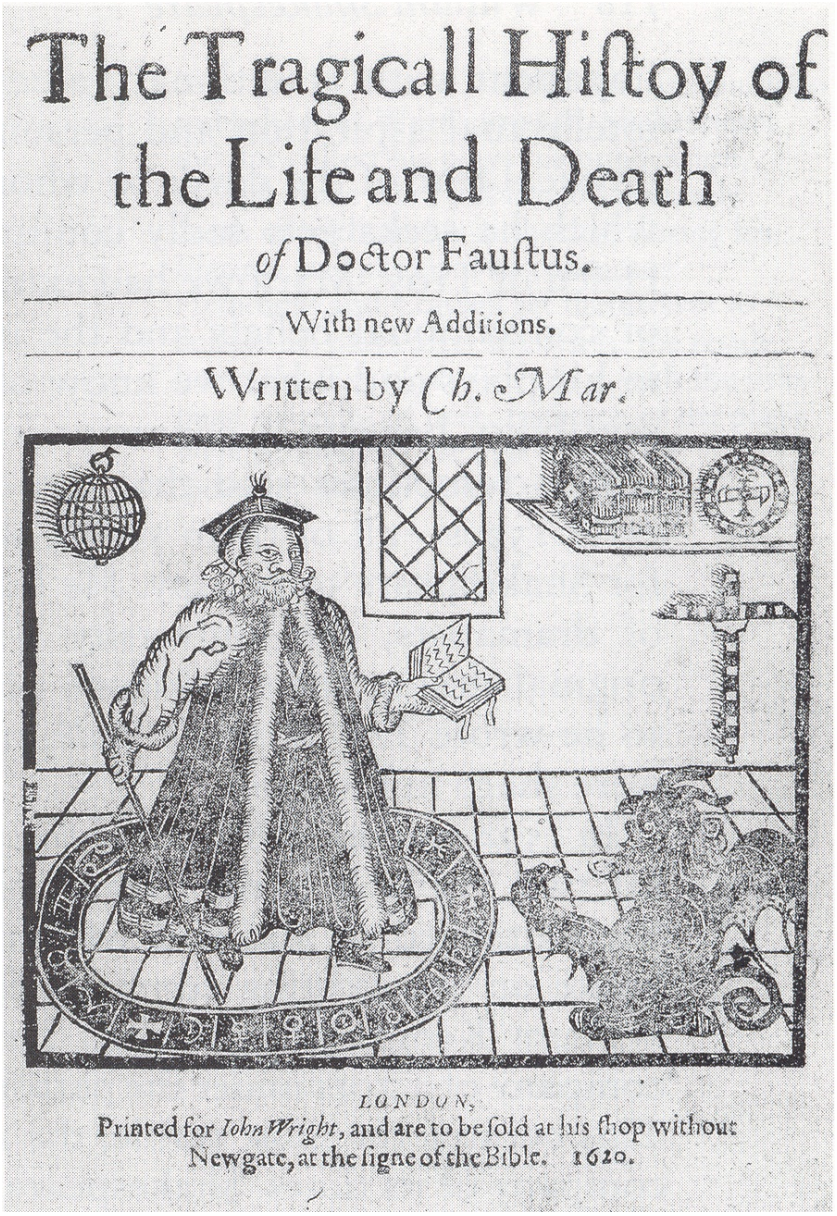

Figure 3.2: Dr Faustus by Christopher Marlowe.

devotes himself to Magic, he must vow not to study anything else and points out that great things are indeed possible with someone of Faustus' standing.

3.4 The pact with Lucifer

Using Mephistophilis as a messenger, Faustus strikes a deal with Lucifer: he is to be allotted twenty-four years of life on Earth, during which time he will have Mephistophilis as his personal servant. At the end he will give his soul over to Lucifer as payment and spend the rest of time as one damned to Hell.

Faustus begins by asking Mephistophilis a series of science-related questions believing he would be able to do anything. In reality he accomplishes nothing but refuses to repent and in the end Mephistophilis comes to collect his soul.

3.5 Dr Faustus Speaks

- *Consummatum est; this bill is ended, And Faustus hath bequeath'd his soul to Lucifer.*
- *Come, shew me some demonstrations magical, That I may conjure in some lusty grove, And have these joys in full possession.*
- *Then there's enough for a thousand souls. Here, Mephistophilis, receive this scroll, A deed of gift of body and of soul: But yet conditionally that thou perform. All articles prescrib'd between us both.*
- *Now would I have a book where I might see all characters and planets of the heavens, that I might know their motions and dispositions.*
- *Nay, let me have one book more,–and then I have done,–wherein I might see all plants, herbs, and trees, that grow upon the earth.*
- *Come, Mephistophilis, let us dispute again, And argue of divine astrology. Tell me, are there many heavens above the moon. Are all celestial bodies but one globe, As is the substance of this centric earth?*

Christopher Marlowe,1585. Unknown artist.
"The Corpus Christi Portrait." Corpus Christi College, Cambridge.

Figure 3.3: Christopher Marlowe.

Figure 3.4: Scientific Hubris of Icarus.

Figure 3.5: Physics Deal with the Devil.

Chapter 4

Faust by Goethe

> What a man does not understand, he does not possess...An intelligent man finds almost everything ridiculous. (Goethe)

In Goethe's tragic play *Faust* we hear Faust saying:

- *Now I have studied philosophy, medicine and the law,and unfortunately, theology, wearily sweating, yet I stand now, poor fool, no wiser than I was before; I am called Master, even Doctor, and for these last ten years have led my students by the nose–up, down, crosswise and crooked. Now I see that we know nothing finally.*

- *What a man knows not, he to use requires, And what he knows, he cannot use for good.*

- *Therefore myself to magic I give, In hope, through spirit-voice and might, Secrets now veiled to bring to light, That I no more, with aching brow, Need speak of what I nothing know; That I the force may recognize That binds creation's inmost energies*

- *A wondrous show! but ah! a show alone! Where shall I grasp thee, infinite nature, where?*

And Mephistopheles saying:

- *In the end, you are exactly–what you are. Put on a wig with a million curls, put the highest heeled boots on your feet, yet you remain in the end just what you are.*

- *Physics and metaphysics weird and grey! Away!*

Watch Richard Burton as Faust and Elisabeth Taylor as Gretchen. Or this version.

Figure 4.1: The Birth of Science.

Chapter 5

Oxford Faust Festival 2011

The Oxford Faust Festival 2011 is presented as follows:

- *If anyone is planning a trip to Oxford later this month, there is still time to see a couple of the events that are part of the Oxford Faust Festival. The story of the scholar who sells his soul to the devil Mephistopheles in exchange for secret knowledge had an important influence on many gothic writers. The world-famous Blackwell's bookshop is the stage for The Creation Theatre company's production of Christopher Marlowe's Doctor Faustus, with the demon Mephistopheles wandering among the bookshelves.*

Creation actor Gus Gallagher, who is playing the title role of Dr Faustus, presents his character as follows:

- *Faustus is one of these types you get a lot of round here, I suspect. He's something of a perpetual student.*
- *The opening text tells that he arrived at Wittenberg, his university town, at a very early age it could have been as young as 13 or 14. We've got him down as something of a childhood genius so far as his intellect is concerned.*
- *Having arrived at university very early, hes been there for some time. He's now in his late twenties, he's done his first degree, his PhD, and his research fellowship.*
- *He's done everything. He's excelled at divinity, at law, at medicine, at philosophy. He's an all-round absolute brainiac.*

- *At the point where the play opens, he is searching to quench his ongoing thirst for knowledge, answers, and unresolved ambiguities.*
- *In the play, Faustus ultimately sells his soul to the devil in return for power and knowledge.*
- *At the time Doctor Faustus was written, there was a much more solid belief system shared by just about everybody.*
- *And that system was as much about what not to do, as what to do. So there was the shared idea of Satan, and Hell. But now we live in a more secular, pragmatic society, where were forgiven for not being terrified of the fellow with the red tail, and the poky ears.*

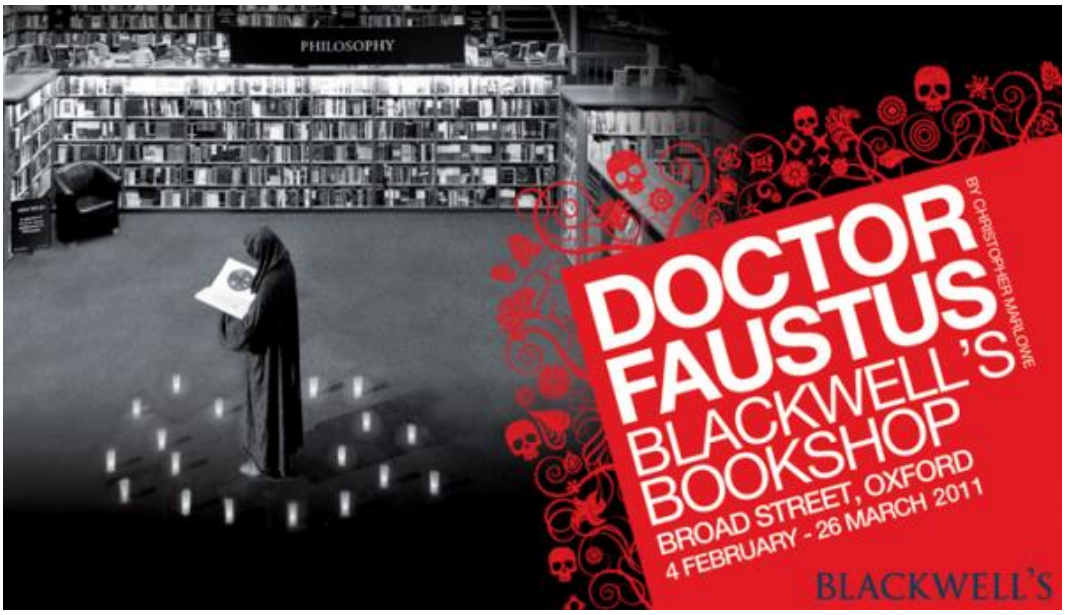

Figure 5.1: Doctor Faustus of today in Oxford.

Chapter 6

Battle: Continuous vs Discrete

> Since time is a continuum, the moment is always different, so the music is always different. (Herbie Hancock)

6.1 Development of Physics

The development of physics can be seen as a battle between the continuous and the discrete, between a God and a Devil, between light and darkness, between idealism and materialism, with

- the discrete originating in the *atomism* of Democritus followed by Plato and Arsitotle,
- the continuum of the continuous taking over in the classical physics of scientific revolution based on the Calculus of derivatives and integrals cluminating in the late 19th century with Maxwell's field equations for electro-magnetics,
- atomism resurfacing with the development of chemistry and the work on thermodynamics by Boltzmann in the 19th century, under heavy attack by the *phenomenalism* of the continuum advocated by Mach,
- modern physics being born from a contradiction between the continuum of field theory and the discrete of particle physics with the key words of *quanta* and *quantum*.

6.2 Marriage: Mr Quantum and Ms Field

Modern physics culminated in the mid 20th century as *Quantum Field Theory*, which is a marriage between the discrete Quantum and the continuous Field, a very unhappy marriage and mesalliance, as you will see if you have the courage to continue to read...

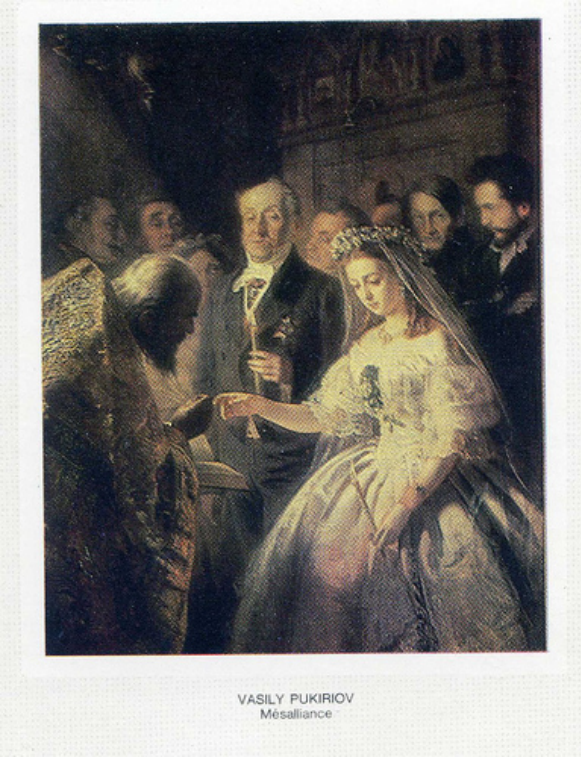

Figure 6.1: Mesalliance between Mr Particle Quantum and Ms Continuous Field.

6.3 Confusion: Eigenvalue vs Eigenfunction

We shall see that the trauma of modern physics with a hopeless mixture of particles and fields has resulted from mixing up eigenvalues (discrete numbers) with eigenfunctions (continuous functions), with an eigenvalue representing the *frequency* of a vibrating string or membrane, and the eigenfunc-

tion representing the continuous *shape* of the string or membrane. Clearly, frequency and shape of a vibration are two different aspects of one and the same phenomenon, and there is nothing mysterious with one phenomenon having several aspects, like e.g. weight and form. But modern physics has managed to turn this into something completely mysterious by asking the different aspects to be one and same, but at the same time different, expressed as "duality" and "complementarity" in the physics of Bohr...

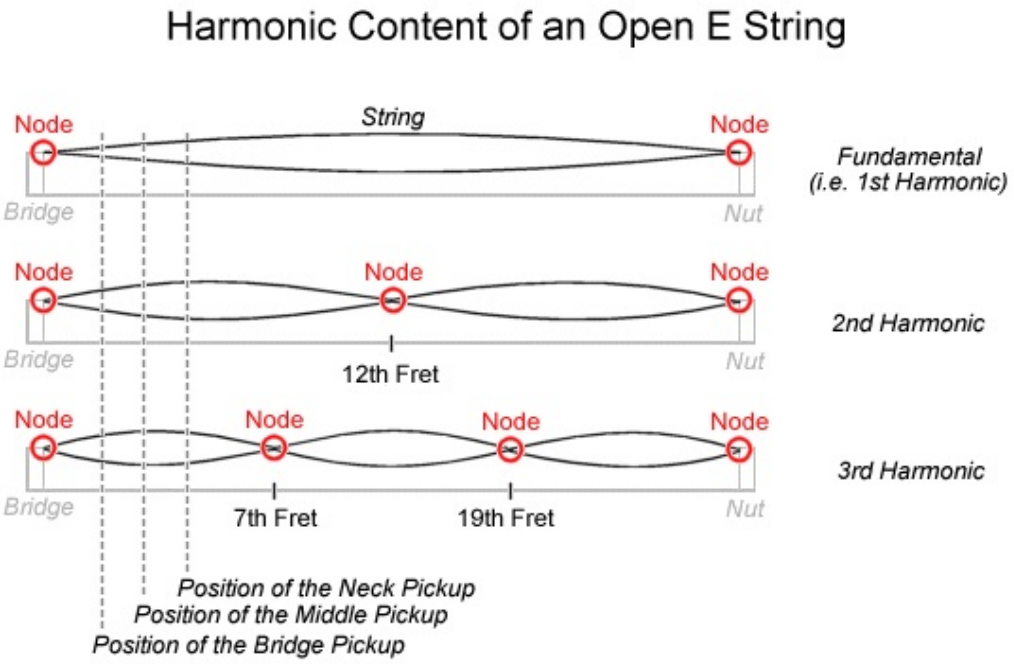

Figure 6.2: The harmonics (eigenvalues) of a vibrating guitar string (eigenfunction). To confuse eigenvalue with eigenfunction is silly.

6.4 Damned Quantum Jumping

Erwin Schrödinger invented the mathematics of quantum mechanics as the Schrödinger wave equation, but when he saw his creation being sold out to

the Devil by his physics colleagues, he retratced in disgust (and gave his soul instead to the question of What Is Life?):

- *Had I known that we were not going to get rid of this damned quantum jumping, I never would have involved myself in this business!*

This book describes this drama.

6.5 Quantum Leap

Quantum Leap is an American television series that was broadcast on NBC from March 26, 1989 to May 5, 1993, for a total of five seasons. The series was created by Donald Bellisario, and starred Scott Bakula as Dr. Sam Beckett, a physicist who becomes lost in time following a time travel experiment, temporarily taking the places of other people to "put right what once went wrong".

Quantum leap may also refer to atomic electron transition.

6.6 Quantum Satis

Quantum satis (qs or QS) is a Latin term meaning **the amount which is needed**. It has its origins as a quantity specification in medicine and pharmacology[citation needed], where a similar term **quantum sufficit** has been used (abbreviated Q.S.)

Figure 6.3: Quantum Satis: 4 cl Swedish Vodka.

Chapter 7

Zeno's Paradox

> Hide our ignorance as we will, an evening of wine soon reveals it. (Heraclitus)

7.1 The Deadly Threat of Zenos Arrow

The battle between the continuous and discrete is exhibited in Zeno's Paradoxes about *motion* as the most basic aspect of the dynamics of the World:

- **Achilles and the Tortoise**: In a race, the quickest runner can never overtake the slowest, since the pursuer must first reach the point whence the pursued started, so that the slower must always hold a lead.
- **Dichotomo**: That which is in locomotion must arrive at the half-way stage before it arrives at the goal.
- **Arrow**: If everything when it occupies an equal space is at rest, and if that which is in locomotion is always occupying such a space at any moment, the flying arrow is therefore motionless.

Zeno of Elea (490 - 430 BC) was a pre-Socratic Greek philosopher of southern Italy and a member of the Eleatic School founded by Parmenides based on the idea that phenomena of motion and change are simply appearances of a *static eternal reality* as an expression of *duality* of appearance and reality. His work is described in Plato's dialogue Parmenides.

Zeno's Arrow Paradox is the toughest and in fact is a deadly threat to any physicist asking for money, because the following question can be posed

by any funding agency or competitor: If you cannot answer even the simplest question of motion, why should you have any grant at all?

Figure 7.1: Zeno presenting his Arrow Paradox preparing Quantum Mechanics.

7.2 Parmenides Resolution

Parmenides resolution was radical: There is no motion. See, if there is no motion, there is no paradox.

7.3 Heraclitus: The Weeping Philosopher

Heraclitus objected to Parmenides static world with his *Panta Rei*: Everything flows. Everything is motion. But then Heraclitus had the Arrow Paradox around his neck. From the riddling evasive nature of his philosophy (and his sorrow over the human condition), he was called the "Weeping Philosopher".

Heraclitus believed in the unity of opposites stating that "the path up and down are one and the same" according to a principle of "duality", which was also the key element in Bohr's resolutions of the paradoxes of quantum mechanics. But Bohr did not weep, just smoked his pipe and talked and talked until all resistance was eliminated. Bohr was more like Democritus, the "Laughing Philosopher", who developed an atomistic theory anticipating Bohr's atomic theory 2500 years later. According to Seneca Democritus was

laughing at his fellow-citizens as an expression of his contempt for the human condition, and therefore was also called "the mocker".

7.4 Who Resolved Zeno's Arrow Paradox?

We shall find that Zeno's arrow paradoxes were never really resolved and drove modern physics into its deal with Devil, essentially to resolve the Arrow Pardox: Is the arrow jumping from one place to the next as time increases, or is it still at each time instant? And time itself: Is it ticking ahead in discrete jumps, or is just flowing?

After pasing through the Purgatory of Paradoxes we shall at the end of the book open a door to resolution of this question without any deal with any devil. If you want to take a look through the door, browse the following knols:

- Zeno's Paradox of Particle Motion
- Slinky as Resolutions of Zeno's Arrow Paradox

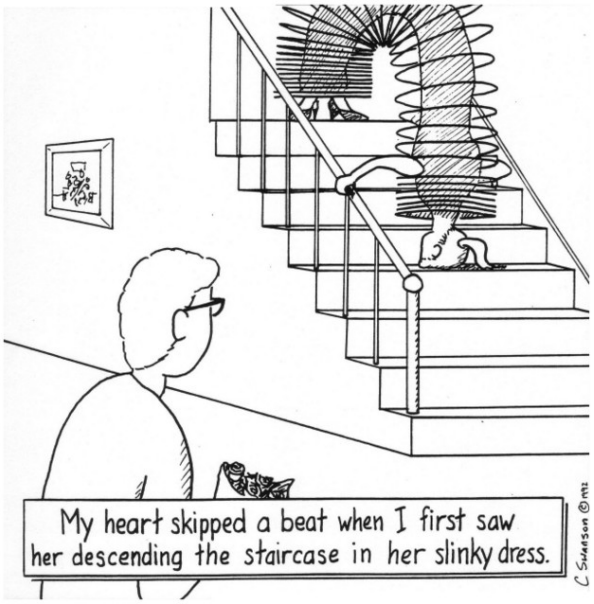

Figure 7.2: Resolution of Zeno's Arrow Paradox: Slinky.

Figure 7.3: Heraclitus as the weeping philosopher and Democritus as the laughing philosopher.

Chapter 8

Wellposed vs Illposed

> I do 10 times as many errors as my students. But I correct myself 20 times as fast. (Hadamard)

8.1 Small Cause - Small Effect: Wellposed

A mathematical model where small perturbations of input data gives a small effect of the output, is said to be *wellposed* or *correctly-set*. In a non-wellposed or *illposed* model a small perturbation of input can give a big effect on the output, which means that the output cannot be trusted. To work with illposed models is like walking on a string all the time risking to fall off at any small puff of the wind.

There are illposed problems, like walking on a string, but if you want to form a coherent scientific theory of some phenomenon, you need a wellposed mathematical model. This was pointed out by the French Mathematician Jacques Hadamard in the 1902 article *On partial differential equations and their physical relevance*, one of the most important mathematics articles all times.

To give up wellposedness is like giving up rational thinking for magical thinking with invisible ghosts controling the world beyond human understanding.

To say that a small cause can have a large effect in the model you are dealing with, is to say that the model is illposed, and thus is not scientifically credible.

8.2 Causality as Wellposedness

The most basic principle of science may be viewed to be *causality*, that a certain cause has a certain effect, or that a certain effect results from a certain cause. Causality has an essential time aspect in the sense that an effect has to come after a cause. By causality predictions can be made: If the cause is known an effect can be predicted to occur at a later time.

Causality is directly connected to wellposedness: If an arbitrarily small cause can have a substantial effect, that is if the model is illposed, then causality is lost in the sense that the cause of an effect is no longer known, that is the coupling cause-effect is lost.

Figure 8.1: Riding a unicycle is like balancing an inverted pendulum: An illposed problem.

8.3 Pendulum: Wellposed and Illposed

The motion of a pendulum of a clock is wellposed with a period which is not sensitive to perturbations. This is why a pendulum can be used to keep track of time.

On the other hand, the motion of an inverted pendulum is illposed if the pendulum reaches the top position with small velocity, in which case a small perturbation may change the direction of the motion. The illposedness is expressed as the difficulty of balancing an inverted pedndulum.

8.4 Small Cause - Big Effect: Illposed

Prandtl said that a small cause (an arbitrarily thin boundary layer) can change the global features of a flow around a body and cause substantial drag. Prandtl thus claimed that his flow problem was illposed, but insisted that his model anyway was scientifically acceptable. This was breach of the fundamental principle of wellposedness. Prandtl commited the crime in order to resolve d'Alembert's paradox, because it appeared that it could not be solved within the laws of rational wellposed science.

At the end of the book you will be invited to a wellposed scientifically lawful resolution and discover that Prandtl's sacrifice was meaningless. But to get there you have to browse the book.

Figure 8.2: Wellposed Newtonian models.

Chapter 9

Doped Scienctists or Science

I have nothing to worry about on any level. (Lance Armstrong)

To seek means to enhance human capabilities beyond natural limitations, is a temptation which a young mind may not resist and an old mind can get used to. To resort to performance-enhancing drugs or doping to win Tour de France is a veritable Faustian deal: It gives immense immediate fame which is instantly defamed once it is discovered.

Through the history many artists, writers, musicians, performers and politicians, have been using drugs to improve their creativivity and performance, with varying success. Hemingway is the icon of a successful writer/alcoholic with an unsuccessful ending. President Kennedy used amfetamine to resist Khrushchev during the Cuba Missil crisis, but no drugs helped in Dallas.

Doping in science can be given two meanings:

- Scientists are taking drugs to liberate themselves from the restrictions of rationality.
- Science itself is being doped to liberate it from restrictions of rationality.

No drug seemed to help scientists to solve the paradoxes confronting classical physics at the turn to the 20th century, and so what remained was to try to dope science itself by removing restrictions of determinsim, causality, reality of space-time and logic. This book asks if this was done and if so if it was a crime. The reader is invited to give an answer.

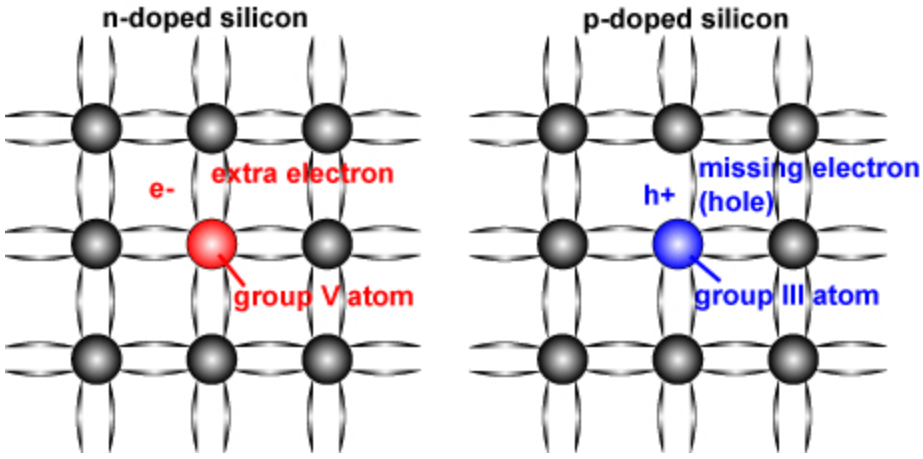

Figure 9.1: Semiconductors require doping to work.

Figure 9.2: Invinsible Lance Armstrong.

Part II

Modern Physics

Chapter 10

Birth of Modern Physics

> We have found a strange footprint on the shores of the unknown. We have devised profound theories, one after another, to account for its origins. At last, we have succeeded in reconstructing the creature that made the footprint. And lo! It is our own. (Sir Arthur Eddington (1882 - 1944) in *Space, Time and Gravitation* 1920)

10.1 Contradiction of 2nd Law and Radiation

Classical physics culminated in the 19th century on the basis of Calculus laid by Descartes, Leibniz and Newton and formulated as Hamiltonian mechanics by the mathematicians Euler and Lagrange.

However, in the late 19th century certain problems within Hamiltonian mechanics turned up, which seemed impossible to handle using Calculus and thereby threatened to crush the beautiful building of physics, namely

- the 2nd law of thermodynamics,

and the related problem of

- blackbody radiation.

Both thermodynamics and blackbody radiation in reality showed a fundamental property of *irreversibility* with an *arrow of time pointing forward*, but Hamiltonian mechanics was seen to be *formally reversible* and thus without preferred direction of time. The *contradiction* between an irreversible reality and reversible theory put a strong blow to physics, which would be lethal unless a counterattack could be mounted.

Figure 10.1: A mathematical theory with a contradiction is useless, because from a contradiction everything can be proved and a theory where everything is true is useless.

A contradiction in science threatens to collpse the whole building, and thus has to be handeled one way or the other. The best is of course to simply eliminate the contradiction by showing that it is only apparent, and not real. If this is impossible, the contradiction can temporarily be tolerated by referring to it as an (interesting) "paradox", but eventually also such a "paradox" becomes intolerable. If the paradox cannot be resolved, the cover-up starts with the objective of finding a way of viewing the paradox instead as a non-contradicting "duality". We shall meet several examples of such cover-up operations below, and we shall come to understand that they represent Deals with the Devil, demonstrated by the agony striking the scientists making the deals.

10.2 Contradiction of Missing Uniqe Aether

Physicists were also deeply troubled by a problem related to the the mathematical model of electromagnetics formulated by Maxwell in 1865:

- what is the nature of the *aether* as the medium through which electromagnetic waves propagate?

Maxwell's equations is a set of differential equation expressed in a certain standard space-time coordinate system, and the question to be answered

concerned the physical significance of the chosen coordinate system. Was it some form of luminiferos aether analogous to to air for sound propagation, an invisible "lightbearing medium" through which Maxwell's electromagnetic waves could propagate? The experimental physicists Michelson and Morley measured the speed of light in different directions to determine the speed of Earth through the aether on its path around the Sun, but could not detect any speed, as if the Earth all the time dragged the aether along. The observation was thus that the following statement was wrong:

- There is a unique aether through which the Earth plows on its lonely path around the Sun.

It seemed as if there was no "preferred coordinate system" representing Newtonian "absolute space", but instead many equally possible coordinates systems, compare with [**?**]

10.3 Contradiction of Zero Drag in Potential Flow

D'Alembert formulated his paradox of zero drag in potential flow of vanishingly small viscosity in 1755, which already at the birth of mathematical physics with Euler and Lagrange in the first half of the 18th century separated fluid mechanics into a theoretical fluid mechanics explaining phenomena which could be observed (zero drag) from experimental fluid mechanics or hydraulics observing phenomena which could not be observed. In other other words, fluid mechanics as a mathematical science was a joke from start, which in the early 19th century with modern physics waiting to be born no longer could be tolerated.

10.4 Cover Up by Statistics

With the rising aspirations of European nationalism and science, the two German physicists Ludwig Boltzmann and Max Planck bravely took on the task of removing the reversibility contradiction and thus open to progress into modernity.

But the problem seemed unsurmountable requiring major surrender of scientific conscience, Boltzmann followed by Planck in a Faustian drama

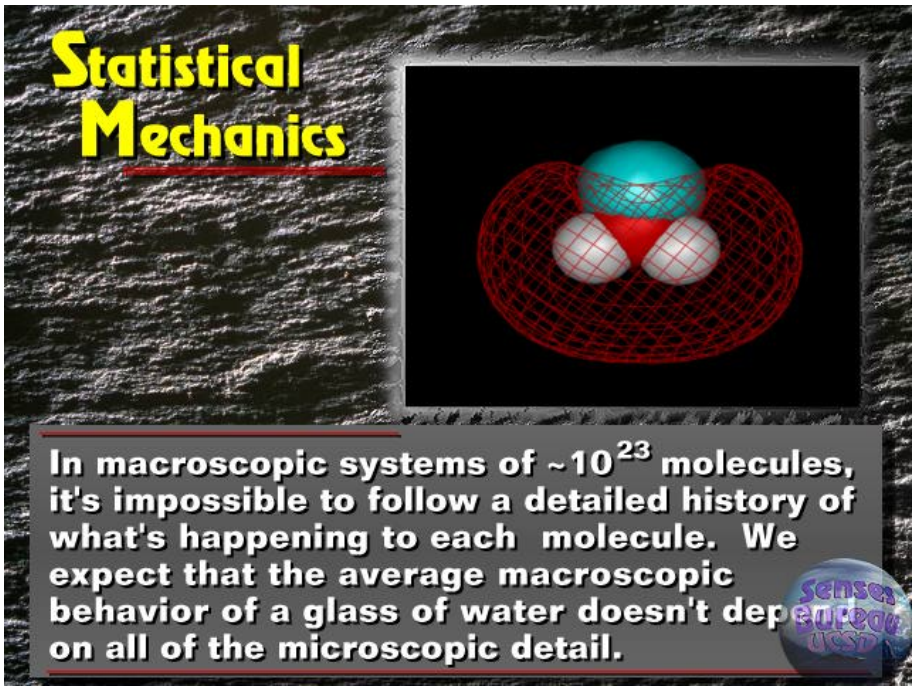

Figure 10.2: Cover-up as statistical microscopics.

Figure 10.3: The deal of microscopic games of dice.

sold their rational souls by resorting to *statistics of quanta* as the quick fix of irreversibility: With little microscopic games of roulette of quanta jumping around, the reversible Hamiltonian mechanics suddenly became irreversible and the society of physicists was saved from bankruptcy. At least for some time...

But we shall see a*microscopic game of roulette* also is contradictory, and so the contradiction was only shifted from one place to another. Macroscopic games of roulette make sense, but not microscopic because it leads to microscopics of microscopics in a never-ending recursion.

10.5 Cover Up: There is no Aether

It was Einstein who covered up the paradox of the mysterious luminiferos aether, using the same radical solution as Parmenides, by boldly stating:

- *There is no aether!*

See, if there is no aether we don't have to worry about the nature of the aether. This statement made Einstein into the unchallenged hero of 20th century physics: Einstein dared what no other scientist dared to do, namely to start off with an assumption combining breathtaking boldness with simplicity into a sword that could cut the Gordian knot of the paradox threatening to strangle science. To claim that "there is no aether" was as brave as claiming that there is no God in front of the Inquisition.

But physics without any from of aether was like a human being without any form of soul, and thus Einstein got drawn into a Faustian drama which will uncovered by continuing reading.

At the end the reader will discover another way around the paradox which is less radical, more clever and does not require any deal. Here is a little hint:

10.6 Marriage and Aether

Suppose you have found by going through (infinitely) many dates that following statement is is not true:

- There is unique (ideal) partner only waiting to marry you.

What conclusion will you draw: There is no partner for you in the world? Is that all? Isn't there another option, which you could explore? If you find that there is one such option, then you are on the right track. But you have to find out yourself be exploring the logical converse of *there is a unique aether*, confirmed by the Michelson-Morley experiment.

10.7 From One to Many

Here is another clue: Greek mythology with is rich variety of different gods of different qualities and capabilities, was followed by the monotheistic islamic and christian religions with one allmighty god. In the Kingdom of Sweden King Gustav Vasa merged in 1527 the Lutheran church with the kingdom into one state-church or hurch-state. The Kingdom of Sweden was transformed into a parliamentary democracy in 1917, the present King Carl XVI Gustaf lost all political power in 1973, and the church was separated from the state 1995. This is a process is from one mind to many minds, from feudalism and monopoly to pluralistic market economy of the many. From centralization to decentralization. Is there a similar developement in physics, from monotheistic physics of one universal observer to a pluralistic physics of many observers?

Figure 10.4: The trap of statistical physics based on microscopic games of dice.

10.8 Snapshot from Birth of Quantum Mechanics

The worlds leading physicists assembled at the Fifth Solvay International Conference on Electrons and Photons to draw the map of 20th century physics. Watch the main actors in their elegant hats.

10.9 Cover Up: Boundary Layer

Prandtl's deal was to claim that a small cause can have a large effect, which can be seen as poker bid which is difficult to subject to a call: To directly prove that the flap of a butterfly in the Amazonas cannot set off a tornado in Texas is difficult because it requires the solution of very precise multiscale mathematical equations encompassing both butterflies and tornados and this was unthinkable 100 years ago is equally unthinkable today. A poker bid which cannot be called will win the game, and it worked also for Prandtl, but there is a drawback: the theory cannot be experimentally verified. It is a pseudo-scientific theory with can neither be disproved nor proved, and as such represents a deal with the Devil.

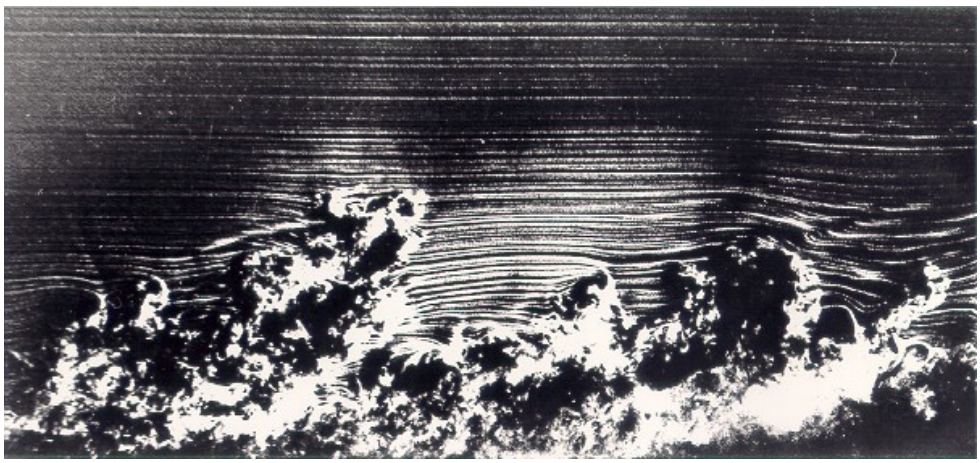

Figure 10.5: Turbulent boundary layer explaining everything.

Chapter 11

The Fall of Science

> It is impossible to trap modern physics into predicting anything with perfect determinism because it deals with probabilities from the outset. (Sir Arthur Eddington (1882 - 1944) in *The World of Mathematics* 1956)

11.1 Causality, Determinism and Reality

We shall find evidence of violation the following basic principles of classical physics:

- causality and determinism,
- small effect of small cause: wellposedness,
- reality of space and time.

11.2 Violation of Logic

We shall also find evidence of violation of basic principles of scientific logic in the form of

- dressing a definition into a physical fact (Einstein's speciality),
- confusing doublethink and doublespeak (Bohr's speciality).

11.3 Overview to Browse

To get an overview you can browse the following Knols:

- Why Schrödinger Hates His Equation
- The Dark Age of the Uncertainty Principle
- The Brainwash by Bohr
- Waves or Particles or Both?
- The Desperation of Planck
- Observation vs Computation in Quantum Mechanics
- The Microscopic World Cannot be a Casino
- Are All Grey Cats Identical?

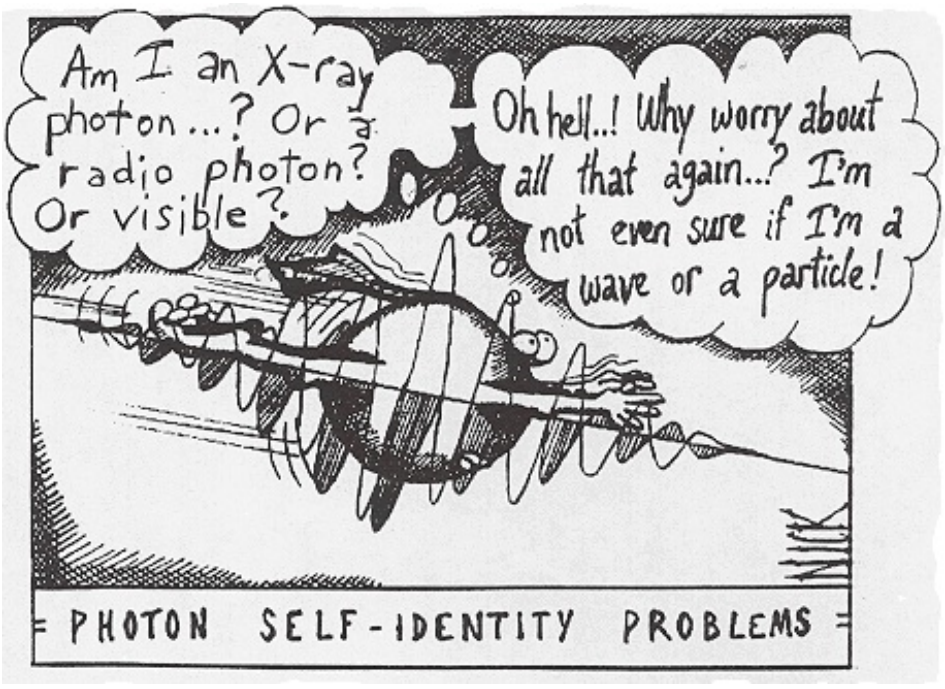

Figure 11.1: Wave-particle duality explained.

11.4 Planck: Last Classic First Modern

Planck never felt comfortable with the new quantum mechanics magically emerging from the Aladdin lamp he had touched:

- *The assumption of an absolute determinism is the essential foundation of every scientific enquiry.*
- *The quantum hypothesis will eventually find its exact expression in certain equations which will be a more exact formulation of the law of causality.*
- *Hitherto the principle of causality was universally accepted as an indispensable postulate of scientific research, but now we are told by some physicists that it must be thrown overboard. The fact that such an extraordinary opinion should be expressed in responsible scientific quarters is widely taken to be significant of the all-round unreliability of human knowledge. This indeed is a very serious situation.*

Planck died in 1947 and with him the skeptic rationality of classical physics, according the Darwinian evolution of science:

- *A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it.*

Modern physics had won the battle (with the help of some bombs), and was ready to take over.

11.5 Contradiction as Duality

Modern physics contains contradictions, which are handeled by Orwellian doublespeak twisting unacceptable contradiction into acceptable:

- wave-particle duality,
- complementarity,

which fits Orwell's description of doublethink:

Figure 11.2: Emblem of the Theosophical Society: Matter is merely the material counterpart of consciousness (Bohr's view)

- *... the power of holding two contradictory beliefs in one's mind simultaneously, and accepting both of them. ... To tell deliberate lies while genuinely believing in them, to forget any fact that has become inconvenient, and then, when it becomes necessary again, to draw it back from oblivion for just so long as it is needed, to deny the existence of objective reality and all the while to take account of the reality which one deniesall this is indispensably necessary. Even in using the word doublethink it is necessary to exercise doublethink. For by using the word one admits that one is tampering with reality; by a fresh act of doublethink one erases this knowledge; and so on indefinitely, with the lie always one leap ahead of the truth.*

The connection to the Devil was expressed by Einstein as follows:

- *On the one hand waves, on the other quanta! The reality of both is firm as a rock. But the devil makes a verse out of this (which really rhymes).*

11.6 Microscopic Casino

Statistical Mechanics is a macroscopic mathematical model based on an assumption of "molecular chaos" that is a microscopic statistical model. But a statistical model represents some form unpredictable microscopics, and thus statistical mechanics is based on

- microscopics of microscopics.

The difficulty with such a model is that it is impossible to directly test the basic statistical assumptions of the model, because they as microscopics are beyond inspection. Testing of the model can thus only be made indirectly on the macroscopic level, as pointed out by Einstein:

- *Neither Herr Boltzmann nor Herr Planck has given a defnition of W... Usually W is put equal to the number of complexions. In order to calculate W, one needs a complete (molecular-mechanical) theory of the system under consideration. Therefore it is dubious whether the Boltzmann principle has any meaning without a complete molecularmechanical theory or some other theory which describes the elementary processes (and such a theory is missing).*

11.7 Formality as Reality

Modern theoretical physicists have been educated to believe that mathematical formulas can reveal a deep truths about reality way beyond the comprehension of the physicists writing down the formulas: It is a from of kabbalistic science where signs on a piece of paper become deeply meaningful. This is demonstrated by the

- *Lorentz transformation of special relativity*,

which is a simple linear coordinate transformation, believed to reveal some deep truths about the space and time we are part of, truths which are so startling, contradictory and contra-intuitive that an endless number of books have been written to explain what the meaning is without clarifying anything.

Other examples of such overinterpretations of mathematical formulas are:

- Schrödinger's linear multidimension wave equation with solutions without physical interpretation.

- Einstein's equations of general relativity, so deep that they are beyond human understanding.

Of course a modern physicist will vigorously deny that this is mysticism, and in the next moment turn the discussion to wave-particle duality, complementarity, 11-dimensional string theory, mutiverses, dark matter and energy, all without connection to mysticism.

11.8 Modern Physics and Climate Alarmism

Recall that the climate alarmism of our time is rooted in an idea about a mystical form of "backradiation" threatening humanity with "global warming", all based on a misinterpretation of a formula by Planck based on statistics of energy quanta.

Recall also that those responsible (Boltzmann, Planck and Einstein) for introducing statistics of quanta into physics, never could embrace what they had done (B took his life, E could not accept that "God played dice" and P never gave up his dream of microscopic reality), and so the fruits of their deed were harvested by the crowd entering the wonderful new world of quantum mechanics described by the guru of physics Richard Feynman in The Character of Physical Law (1965):

- *I think I can safely say that nobody understands quantum mechanics.*

To believe in something you don't understand is mysticism. Or? Today Feynman would have said:

- *I can safely say that no physicist understands the physics of climate science.*

Chapter 12

Fall of The Nobel Peace Prize

> During my service in the United States Congress, I took the initiative in creating the Internet. (Al Gore)

The Nobel Peace Prize 2007 was awarded jointly to Intergovernmental Panel on Climate Change (IPCC) and Albert Arnold (Al) Gore Jr:

- *for their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change.*

In the Award Ceremony Speech, Professor Ole Danbolt Mjos, Chairman of the Norwegian Nobel Committee, expresses:

- *The ice is melting more rapidly in the Arctic, the desert is spreading more quickly in Africa, the glaciers are shrinking in the Himalayas.*
- *Some say that the world's scientists do not all agree in their analyses of human-induced global warming. Things which all the world's scientists are fully agreed on are few and far between. That is in the nature of research.*
- *But there is little doubt about the main trends: more and more scientists have reached ever closer agreement concerning the increasingly dramatic consequences that will follow from global warming.*
- *There was for a long time great doubt about whether global warming was man-made. Thanks to the IPCC there is very little such doubt today.*

- *Again and again, Gore has hammered in his message, not least to Americans. The USA is, along with China, the great polluter.*
- *No one can charge Gore with lacking concrete guidelines for what individuals can do.*
- *Whereas in the 1980s global warming might be viewed as an interesting hypothesis, the 1990s produced firmer evidence of the real situation. In the last few years, the connections have become much clearer and the consequences still more apparent.*
- *A committee of prominent American military officers recently stated that climate changes are 'a threat multiplier for instability in some of the most volatile regions of the world".*
- *We thank Al Gore for his great courage and unremitting struggle!*
- *We thank the IPCC for its outstanding scientific work!*

Figure 12.1: Did Al Gore and IPCC Pachauri sell their souls to save humanity?

Chapter 13

Falls of Music and Physics

> The 12 tone technique is a method of composing with twelve tones which are related only with one another. (Schoenberg)

13.1 First Fall: The Well-tempered Scale

The introduction of the *well-tempered* musical scale with 12 equal half-tone intervals over an octave, given as the twelvth root of two, during the Baroque period and explored by Bach in his Well-Tempered Clavier, represents a breach or (First) Fall from the heavenly harmonics and keys of Pythagorean scales of natural numbers, to mathematical scales invariant under change of key. Before the uniformization of the well-tempered scale different keys acquired character from their distance to the basic major scale of C of the white keys of a piano representing light and Enlightenment, arranged by the circle of 5ths:

- A-minor: a somewhat dark complement to C major,
- G major: happy and benedictory,
- E minor: purgatorial with connection to crucifixion,
- D major: power and glory,
- B minor: pathos, anguish and suffering,
- A major: youth and innocence,

- F sharp minor: painful extraordinary experience,
- E major: heaven and grace
- C sharp minor: grave and tragic,
- B major: sparkling,
- G sharp minor: obscure and scary,
- F sharp major: shining ligh and radiance,
- E flat minor: darkness and death,
- D flat major: romantically sensuous and assuaging,
- B flat minor: dark and simple,
- A flat major: soft and lugubre,
- F minor: tragic,
- E flat major: trinitarian godliness and human heroism,
- C flat minor: tragic
- B flat major: will and power,
- G minor: tragic and weeping,
- F major: pastoral
- D minor: devotional and demonic.

With the Fall of the well-tempered scale the qualities of the different keys in principle lost their physical basis, but yet was present to the composers of the classsic and romantic periods following the baroque of Bach.

Figure 13.1: Arnold Schoenberg:: Inventor of the 12 tone technique.

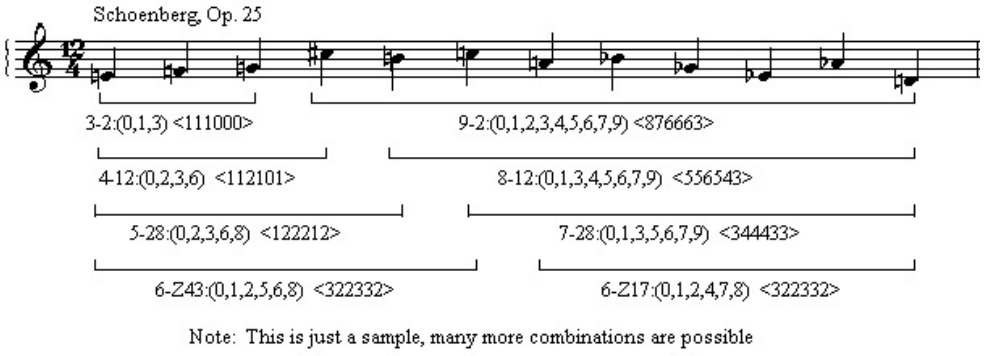

Figure 13.2: A 12 tone scale by Schoenberg.

13.2 Second Fall: Atonal Music

A Second Fall occurred in the early 20th century with the emergence of the atonal 12-tone scale without any key signature, developed in a new (mathematical) theory of composition by Arnold Schoenberg.

Schoenberg was not only a very serious composer but also enjoyed recreation and humor, and got a second youth by marrying a 24 years younger woman after his first wife passed away.

The First Fall can be seen as a parallel to the Galilean invariance of Newtonian mechanics against a background of absolute space, while the Second Fall reflects the loss of absolute space in Lorentz invariance of relativity theory.

12-tone music peaked in the mid 20th century and contemporary composers have largely escaped from its artificial tonal relativity, while physicists trapped by a relativity theory which refuses any combination with quantum mechanics, are getting increasingly desperate.

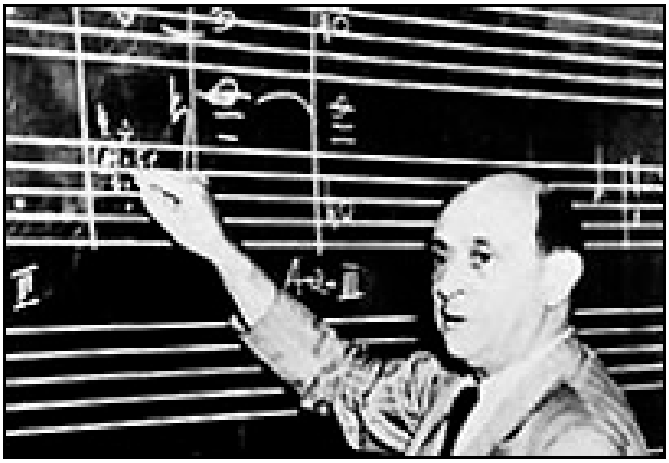

Figure 13.3: Schoenberg writing formulas on the blackboard: *Whether one calls oneself conservative or revolutionary, whether one composers in a conventional or progressive manner, whether one tries to imitate old styles or is destined to express new ideas - one must be convinced of the infallibility of one's own fantasy and one must believe in one's own inspiration.*

Chapter 14

Mysticism of Modern Physics

> I think it is safe to say that no one understands quantum mechanics. Do not keep saying to yourself, if you can possibly avoid it, 'But how can it possibly be like that?' because you will go down the drain into a blind alley from which nobody has yet escaped. Nobody knows how it can be like that...If your model contradicts quantum mechanics, abandon it! (Richard Feynman)

Modern physics is based on

- theory of relativity,
- quantum mechanics.

The dream of Einstein was to combine relativity and quantum mechanics into a unified field theory including the four basic forces of physics (gravitation, electromagnetic, weak and strong nuclear forces), but his dream remains unfulfilled.

The mysticism of modern physics thrives within both relativity theory and quantum mechanics, as witnessed by all Nobel Laurates of physics: Relativity theory and quantum mechanics cannot be understood by humans, but has to be accepted as a gift from an all-wise mathematical Creator keeping his Grand Unified Theory GUT as a secret.

Quantum mechanics is based on Schrödinger's equation with wave function solutions, formulated by Erwin Schrödinger in 1925. Schrödingers equation is a linear differential equation over a continuum, which is not the usual continuum of 3-dimensional space and time, but over $3N$-dimensional space

(and time) with N the number of elementary particles involved (electrons and atomic kernels).

The formal simplicity of the linearity of Schrödingers equation is thus combined with a monstrous complexity of dimensions which makes the wave into monster without physical correspondence, because monsters don't exist in reality.

The problem of the physical interpretation of Schrödinger's wave function presented itself already for the 2-electron Helium atom with wave function in 6-dimensional space. After a heated debate between Schrödinger on one side and Bohr-Heisenberg-Born on the other side, it was dictated to the community of physicists that the wave function should not be considered as a physical state variable, which was impossible because of the high dimensionality, but as a probability of particle distribution. Schrödinger heavily objected supported by Einstein, but had to give in because his own interpretation as some form "presence of particles" was vague and not convincing.

Schrödinger and Einstein were thus run over by the *Copenhagen Interpretation* of quantum mechanics of Bohr&Co. which took control of modern physics ultimately based on statistics.

The idea of introducing statistics into physics came from the work of Boltzmann on thermodynamics followed by Planck on blackbody radiation, who were the first to make the Faustian deal of selling out deterministic continuum physics, also under urgent pressure to solve the main physics problem of their time (late 19th century). This deal did not come easily because the most holy principel of causality and physicl reality had to be given up. The fact that Boltzmann and Planck accepted the deal shows that they were under intense pressure.

To bring in statistics comes along with the severe side-effect of (i) missing direct physical reality, because a probability is something in the mind of a probabilist as observer and not in physics without observer, and (ii) impossibilty of experimental verification of basic assumptions.

To understand why physcists sacrificed the most holy principles of science, we must understand that there was an urgent need to save physics from a threatening credibility collapse because of two apparent contradictions had presented themselves:

- Reversibility paradox of Hamiltonian mechanics,
- ultraviolet catastrophy of blackbody radiation.

The solution to both problems were sought in statistics with the price of giving up causality.

The basic mystery of quantum mechanics is thus the statistical interpretation of the wave function prepared in

- statistical thermodynamics used by Boltzmann to avoid the reversibility paradox,
- statistics of energy quanta used by Planck to avoid the ultraviolet catastrophy of blackbody radiation

But the effect of selling out the rational soul has shown up as an aspect of mysticism of modern physics, which has become so accepted that it is no longer viewed as mysticism. The mysticism is rooted in a belief that mathematical formulas can harbour deep truths about our world of physics unknown to the physicist writing down the formula.

The magics is the same as first saying something and then analyzing the meaning of the statement. Instead of first having a meaningful thought and then expressing it. Of course, occasionally this leads to very profound insights, but usually it is only shallow nonsense.

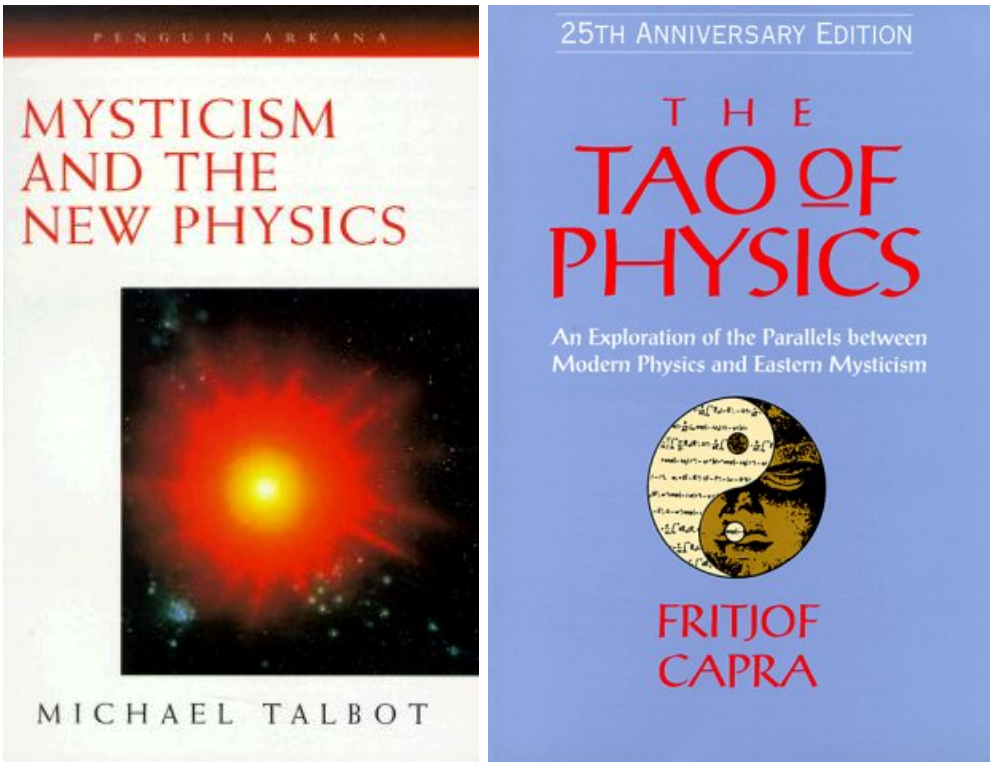

Figure 14.1: Two of many books explaining the Mysticism of Modern Physics.

Chapter 15

Einstein's Annus Mirabilis 1905

> The secret to creativity is knowing how to hide your sources. (Einstein)
>
> There's a Genius in all of us...Do not worry about your problems with mathematics, I assure you mine are far greater. (Einstein)

Einstein on his first job as a patent clerk in Bern signed the deal which gave him the following four wondrous articles published during his marvelous year of 1905:

- Brownian motion,
- photoelectric effect,
- special theory of relativity,
- matter and energy $E = mc^2$.

Einstein's special theory of relativity are based on the following axioms:

- *The laws by which the states of physical systems undergo change are not affected, whether these changes of state be referred to the one or the other of two systems of co-ordinates in uniform translatory motion.*
- *The speed of light is the same for every observer.*

We find here the "method" of Einstein's magical science: The first axiom is a triviality and the second is a definition. From the triviality and the definition Einstein's then derives startling results about the nature of time and space. Truly Mirabilis or Magical: To get more input, listen to the documentary How I See the World.

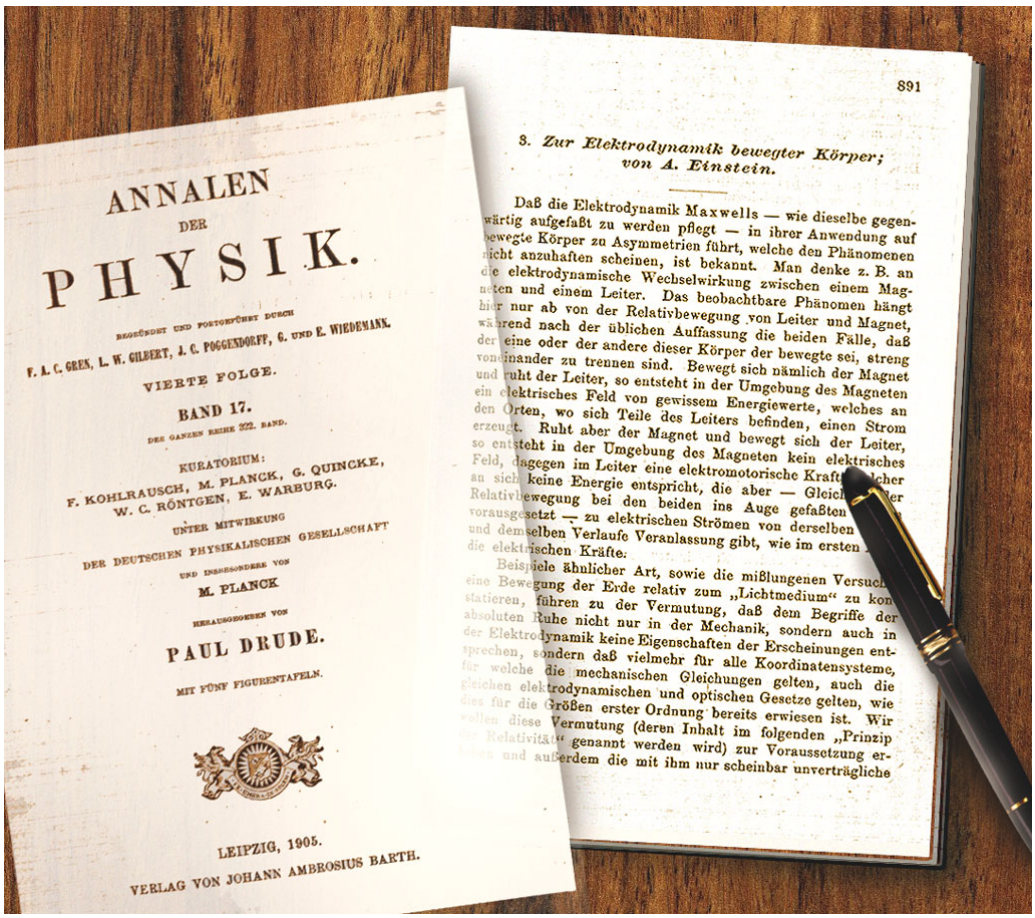

Figure 15.1: The Special Relativity article from Annus Mirabilis1905.

Chapter 16

Did God Not Create Universe?

One cannot really argue with a mathematical theorem. (Hawking)

Stephen Hawking is the ultimate representative of the modern physicist offering to replace God, as announced by BBC:

- *In his new book The Grand Design Britain's most famous physicist sets out to contest Sir Isaac Newton's belief that the universe must have been designed by God as it could not have sprung out of chaos.*

Hawking tells us:

- *Because there is a law such as gravity, the universe can and will create itself from nothing. Spontaneous creation is the reason there is something rather than nothing, why the universe exists, why we exist. It is not necessary to invoke God to light the blue touch paper and set the universe going.*
- *If we discover a complete theory, it would be the ultimate triumph of human reason - for then we should know the mind of God.*
- *The Universe can create itself from nothing.*

Hawking also wants to shows a bit of humble faith:

- *But as I look at the universe, and as many people who are much more understanding of cosmology than I, and mathematics, as they look at it, through the eyes of faith, they see a universe which is still very coherent with what we believe about God and His nature*

The deep mathematical mysticism of Hawking is expressed as:

- *Even if there is only one possible unified theory, it is just a set of rules and equations. What is it that breathes fire into the equations and makes a universe for them to describe?*
- *God not only plays dice, He also sometimes throws the dice where they cannot be seen.*
- *My goal is simple. It is a complete understanding of the universe, why it is as it is and why it exists at all.*
- *Someone told me that each equation I included in the book would halve the sales.*
- *There are grounds for cautious optimism that we may now be near the end ofthe search for the ultimate laws of nature.*
- *All the evidence shows that God was actually quite a gambler, and the universe is a great casino, where dice are thrown, and roulette wheels spin on every occasion.*

Figure 16.1: Stephen Hawking: The Universe can create itself from Nothing.

Chapter 17

Physics Today: String Theory

> I think all this superstring stuff is crazy and is in the wrong direction (Richard Feynman)

17.1 The Impossible Call of String Theory

From the impressive results of modern atomic physics culminating in the atomic bomb, physics has developed from atomic scales of size 10^{-10} meters into an exploration of smaller sub-atomic scales ending up today with a string theory at Planck scales of size 10^{-35} meters, where string theorists are searching for the origin of gravitation acting of cosmic scales of size 10^{20-25} meters, thus with a span of 70 orders of magnitude. Modern string theory physicists have thus raised the bet in the poker game of science to such a level that any form of call is impossible. But science which can not be called, cannot be called science, only religion or magics.

17.2 What Are Modern Physicists Saying?

- *The effort to understand the universe is one of the very few things that lifts human life a little above the level of farce, and gives it some of the grace of tragedy.* (Steve Weinberg)

- *But the beauty of Einstein's equations, for example, is just as real to anyone who's experienced it as the beauty of music. We've learned in*

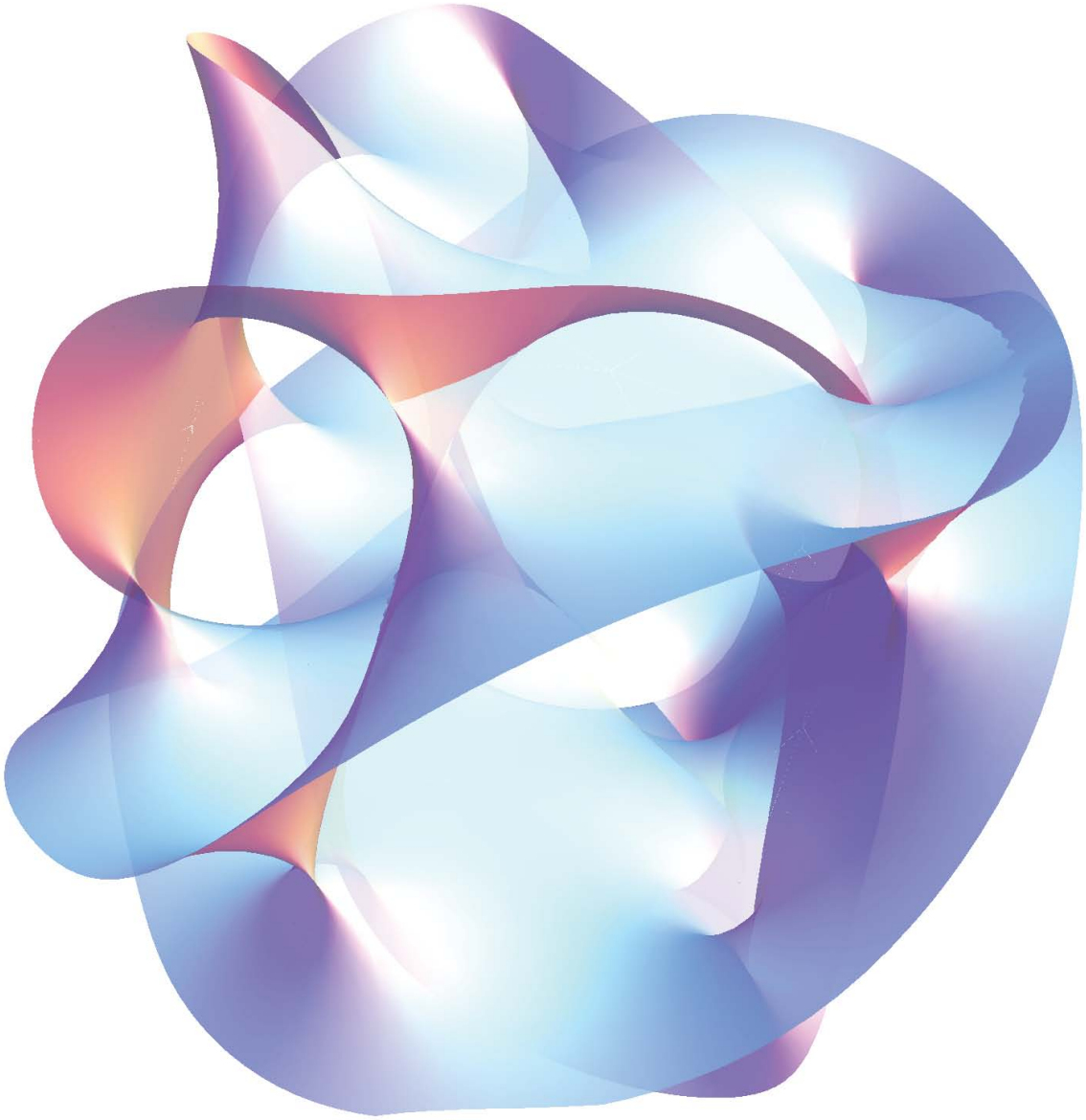

Figure 17.1: Calabi-Yau manifold revealing the nature of space-time at Planck scales.

the 20th century that the equations that work have inner harmony. (Ed Witten)

- *Even before string theory, especially as physics developed in the 20th century, it turned out that the equations that really work in describing nature with the most generality and the greatest simplicity are very elegant and subtle. (Ed Witten)*

- *On the other hand, we don't understand the theory too completely, and because of this fuzziness of space-time, the very concept of space-time and spacetime dimensions isn't precisely defined.* (Ed Witten)

- *In physics, your solution should convince a reasonable person. In math, you have to convince a person who's trying to make trouble. Ultimately, in physics, you're hoping to convince Nature. And I've found Nature to be pretty reasonable.* (Frank Wilczek)

- *For more than ten years, my theory was in limbo. Then, finally, in the late 1980s, physicists at Princeton said, 'There's nothing wrong with this theory. It's the only one that works, and we have to open out minds to hyperspace.' We weren't destined to discover this theory for another 100 years because it's so bizarre, so different from everything we'd been doing. We didn't use the normal sequence of discoveries to get to it.* (Michio Kaku in Voices of Truth by Nina L. Diamond (2000), Describing reaction to his superstring theory of hyperspace which mathematically relates the universe's basic forces).

- *There are 60 sub-atomic particles they've discovered that can explain the thousands of other sub-atomic particles, and the model is too ugly. This is my analogy: it's like taking Scotch tape and taping a giraffe to a mule to a whale to a tiger and saying this is the ultimate theory of particles. ... We have so many particles that Oppenheimer once said you could give a Nobel Prize to the physicist that did not discover a particle that year. We were drowning in sub-atomic particles. Now we realize that this whole zoo of sub-atomic particles, thousands of them coming out of our accelerators, can be explained by little vibrating strings.* (Michio Kaku)

- *The theory (string theory) is safe, permanently safe. I ask you, is that a theory of physics or a philosophy?* (Sheldon Glashow)

- *Is string theory a futile exercise as physics, as I believe it to be?* (Phil Anderson)
- *Just like an ordinary guitar string, a fundamental string can vibrate in different modes. And it is these different modes of vibration of the string that are understood in string theory as being the different elementary particles.*(Lee Smolin)

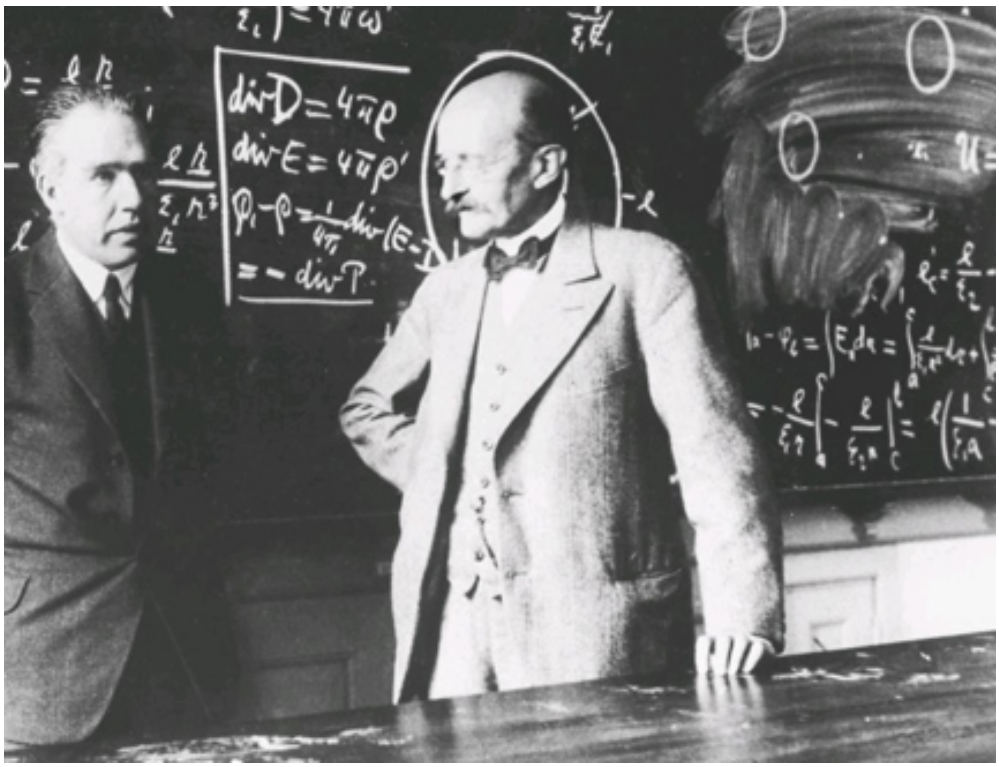

Figure 17.2: Planck telling Bohr that classical physics should not be abandoned. On the blackboard you see Maxwell's equations, the fundamental mathematical model describing virtually all of (classical) electro-magnetics.

Chapter 18

End of Physics?

> Up to now, most people have implicitly assumed that there is an ultimate theory, that we will eventually discover. Indeed, I myself have suggested we might find it quite soon. (Hawking)

18.1 Books Predicting End of Physics

In recent years a growing skepticism has been articulated directed to methods and questions pursued in modern physics:

- The End of Physics by David Lindley.
- Not Even Wrong by Lee Smolin.
- A Different Universe: Reinventing Physics from the Bottom Up by Robert Laughlin.

18.2 Hawking: No End of Physics

From a lecture by Stephen Hawking we collect in condensed form the following summary of modern physics:

- *Will we ever find a complete form of the laws of nature? It was Newton's Principia Mathematica in 1687, containing his theory of universal gravitation, that made the laws quantitative and precise. This led to the idea of scientific determinism: If at one time, one knew the positions*

and velocities of all the particles in the universe, the laws of science should enable us to calculate their positions and velocities, at any other time, past or future.

- *At first, it seemed that these hopes for a complete determinism would be dashed, by the discovery early in the 20th century, that events like the decay of radio active atoms, seemed to take place at random. It was as if God was playing dice, in Einstein's phrase. But science snatched victory from the jaws of defeat, by moving the goal posts, and redefining what is meant by a complete knowledge of the universe.*

- *It was a stroke of brilliance, whose philosophical implications have still not been fully appreciated: Dirac showed how the work of Erwin Schroedinger and Werner Heisenberg, could be combined in new picture of reality, called quantum theory, described by a single quantity named the wave function interpreted as a configuration probability*

- *Quantum theory, and the Maxwell and Dirac equations, indeed govern much of our life, but there are two important areas beyond their scope. One is the nuclear forces. The other is gravity.*

- *We are now seeking a complete theory of the universe, in order to control it, in a sense. Constructing a quantum theory of gravity, has been the outstanding problem in theoretical physics, for the last 30 years. Then Ed Witten declared that string theory, was the true quantum theory of gravity.*

- *Some people will be very disappointed if there is not an ultimate theory, that can be formulated as a finite number of principles. I used to belong to that camp, but I have changed my mind. I'm now glad that our search for understanding will never come to an end, and that we will always have the challenge of new discovery.*

Chapter 19

Quantum Field Magics

19.1 Quantum and Field

The code words of modern physics are

- *quantum*
- *field*

which combine into *Quantum Field Theory* as explained in [14]:

- *In the years leading up to 1925 the quantum idea was applied to the* **mechanics** *of atomic motion, which resulted in* **wave-particle duality** *and the Schrödinger equation for electrons.*
- *In 1950 the electromagnetic field was quantized with quanta called photons, thus coming a full circle back to Planck and completing a quantization of a major area of classical physics.*
- *Now, in a sense, quantization blurs the distinction between particles and fields; point particles become fuzzy and subject to a wave equation, and the (electromagnetic) field, classically represented as a continuum, takes on a particle-like nature (the photon)...which renders the particle and field rather similar.*
- *The salinet point is that the photons are the quanta of the fields which describes the interaction between particles of matter. The electrons "happen to be there" and because they interact, the electromagnetic field and photons become compulsory.*

- *The gravitational field is described by the general theory of relativity, but the quantization of this theory is beset by great problems. In som sense we are faced with quantization of space-time; what is the meaning of this?*

- *There should, in principle, be a possibility of observing individual* **gravitons**, *quanta of the field...but the observation of individual gravitons must be a next-generation problem!*

19.2 The Mantra of Modern Physics

We meet here the mantra of modern physics with fields "quantized" into particles, and particles "blurred" into fields, as the ultimate form of the mysticism of the quantum mechanics of Schrödinger, which Schrödinger did rejected in order to save his soul, and which Bohr exploited to give modern physics a direction and philosophy at the price of soul.

Of course, your scientific soul asks why fields need to be "quantized"? Why is it necessary to insist on the existence of particles like photons and gravitons even if they can never be observed? The following questions present themselves:

- Why does Lucifer demand a "quantization" of all fields?

- Who is today demanding political correctness of all ideas?

- Why did Planck "quantize" blackbody radiation?

To seek answers we now proceed to a Physics Tribunal after first listen to the scientist who did what was necessary to do but did not get credit (until 30 years later): Max Born.

Chapter 20

Max Born: I Did It!

> First of all, I will explain how quantum mechanics and its statistical interpretation arose. Mathematics, as often happens, was cleverer than interpretative thought. (Born)

20.1 Statistical Interpretation

It was Max Born who in 1927 gave (the modulus squared of) the Schrödinger wave function of quantum mechanics an interpretation as a particle configuration probability, and thereby allowed Bohr to "brainwash a whole generation of modern physicists" with his Copenhagen Interpretation and in particular send the dissidents Schrödinger and Einstein into permanent intellectual exile.

To introduce statistics into physics was monumental sacrifice of classical scientific values, and the executioner Born did not become eligible for the Nobel Prize until 1954, when his awful deed had been forgotten. His student Heisenberg got the Prize already in 1932, and so Born had to wait long to get his due. He suffered for 22 years. He did it, but did not get the credit, because his hands were bloody?

Born expresses his feelings in [4]:

- *The fact that I did not receive the Nobel Prize in1932 together with Heisenberg hur me very much at the time, in spite of a kind letter from Heisenberg.*

- *My surprise and joy were thus all the greater, especially as I was awarded the prize, not for the work done jointly with Heisenberg, but for the statitical interpretation of Schrödinger's wave function...*

- *It is not surprising that this acknowledgement was delayed for 28 years, for all the great names of the initial period of the quantum theory were opposed to the statistical interpretation: Planck, deBroglie, Schrödinger and, not least, Einstein himself.*

- *It cannot have been easy for the Swedish Academy to act in opposition to voices which carried as much weight as theirs; therefore I had to wait until my ideas had become the common property of all physicists. This was due in no small part to the cooperation of Niels Bohr abd his Copenhagen school, which today lends its name almost every where to the line of thinking I originated,*

20.2 Nobel Presentation Speech

- *When the young Heisenberg, formerly a pupil of Sommerfeld in Munich and of Bohr in Copenhagen, published his epoch-making preliminary work on the exact laws for atomic phenomena in 1925, he was Born's assistant in Göttingen.*

- *His work was immediately continued by Born, who gave logical mathematical form to the Heisenberg theory. Owing to this progress, Born, in collaboration with his pupil Jordan and later with Heisenberg also, was able to expand the latter's original results into a comprehensive theory for atomic phenomena. This theory was called quantum mechanics.*

- *Born found that the Schrödinger wave function determines the probability of the measuring results. For this reason, according to Born, quantum mechanics gives only a statistical description.*

- *Such a radical break with older ideas could not of course prevail without opposition. But Born's conception is now generally accepted by physicists, with a few exceptions.*

Figure 20.1: Classical physics just before.

20.3 Born's Nobel Lecture

Sacrifice good values has to be motivated by necessity. To send in fresh young innocent soldiers to a sure death needs to be motivated by necessity with no other options. Born explains what he did in his Nobel Lecture in 1954:

- *The first point is this: the work at the Göttingen school, which I directed at that time (1926-I927), contributed to the solution of an intellectual crisis into which our science had fallen as a result of Planck's discovery of the quantum of action in 1900.*

- *I do not mean here its entanglement in politics and economics as a result of the mastery of a new and frightful force of Nature, but I am considering more the logical and epistemological problems posed by nuclear physics.*

- *when I say that the physicists had accepted the concepts and mode of thought developed by us at the time, I am not quite correct. There are some very noteworthy exceptions, particularly among the very workers who have contributed most to building up the quantum theory. Planck,*

himself, belonged to the skeptics until he died. Einstein, De Broglie, and Schrödinger have unceasingly stressed the unsatisfactory features of quantum mechanics and called for a return to the concepts of classical, Newtonian physics while proposing ways in which this could be done without contradicting experimental facts. Such weighty views cannot be ignored. Niels Bohr has gone to a great deal of trouble to refute the objections. I, too, have ruminated upon them and believe I can make some contribution to the clarification of the position. The matter concerns the borderland between physics and philosophy, will partake of both history and philosophy, for which I must crave your indulgence.

- *However, a paper by Heisenberg 19, containing his celebrated uncertainty relationship, contributed more than the above-mentioned successes to the swift acceptance of the statistical interpretation of the -function. It was through this paper that the revolutionary character of the new conception became clear. It showed that not only the determinism of classical physics must be abandoned, but also the naive concept of reality which looked upon the particles of atomic physics as if they were very small grains of sand. At every instant a grain of sand has a definite position and velocity. This is not the case with an electron. If its position is determined with increasing accuracy, the possibility of ascertaining the velocity becomes less and vice versa.*

- *How does it come about then, that great scientists such as Einstein, Schrodinger, and De Broglie are nevertheless dissatisfied with the situation? Of course, all these objections are leveled not against the correctness of the formulae, but against their interpretation. Two closely knitted points of view are to be distinguished: the question of* **determinism** *and the question of* **reality**.

- *This idea of complementarity is now regarded by most physicists as the key to the clear understanding of quantum processes. Bohr has generalized the idea to quite different fields of knowledge, e.g. the connection between consciousness and the brain, to the problem of free will, and other basic problems of philosophy. To come now to the last point: can we call something with which the concepts of position and motion cannot be associated in the usual way, a thing, or a particle? And if not, what is the reality which our theory has been invented to describe?*

- *The lesson to be learned from what I have told of the origin of quantum mechanics is that probable refinements of mathematical methods will not suffice to produce a satisfactory theory, but that somewhere in our doctrine is hidden a concept, unjustified by experience, which* **we must eliminate** *to open up the road.*

20.4 The Necessity

In his textbook *Atomic Physics* Born describes the physics problem demanding a solution:

- *Classical electrodynamics and mechanics absolutely fail to account for the processes of absorption and emission of radiation.*

20.5 The Execution

After this preparation as necessity, Born proceeds to kill determinism and causality by the axe of probability:

- *The wave-particle dualism compels us to abandon any attempt to set up a deterministic theory.*

- *In reply to the question whether a law a causation still holds good in the new theory, two standpoints are possible:*

- *Either we may look upon processes from the pictorial side, holding fast to the wave-particle picture – in this case the law of causality certainly ceases to hold.*

- *Or (with the square of the modulus of the wave function as deterministically determined probability), the initial value of the wave function is not completely definable. This view of the matter is equivalent to the assertion that events happen indeed in a strictly casual way, but that we do not know the initial value exactly.*

- *In this sense the law of causality is therefore empty; physics is in the nature of the case-indeterminate, and therefore the affair of statistics.*

- *It is necessary to bf drop completely the physical pictures of Schrödinger which aim at a revitalization of classical continuum theory, to retain only the formalism and to fill that with a new physical content.*

20.6 Einstein to Born

The Born-Einstein Letters 1916-1955 [4] collects the life-long correspondence between Born and Einstein with comments by Born. Einstein writes to Born:

- *Your concept is completely untenable. I do not want to take part in any further discussion, as you seem to envisage*
- *We have become Antipodean in our scientific expectations. You believe in the God who plays dice, and I in complete law and order in a world which objectively exists, and which I, in a wildly speculative way, am trying to capture.*
- *Even the great initial success of the quantum theory does not make me believe in the fundamental dice-game, although I am well aware that your younger colleagues interpret this as a consequence of senility (1944).*
- *I was very pleased to hear that you have been awarded the Nobel Prize, although strangely belatedly, for your fundamental contributions to the present quantum theory. In particular, of course, it was your subsequent statistical interpretation of the description which has decisively clarified our thinking (1954).*

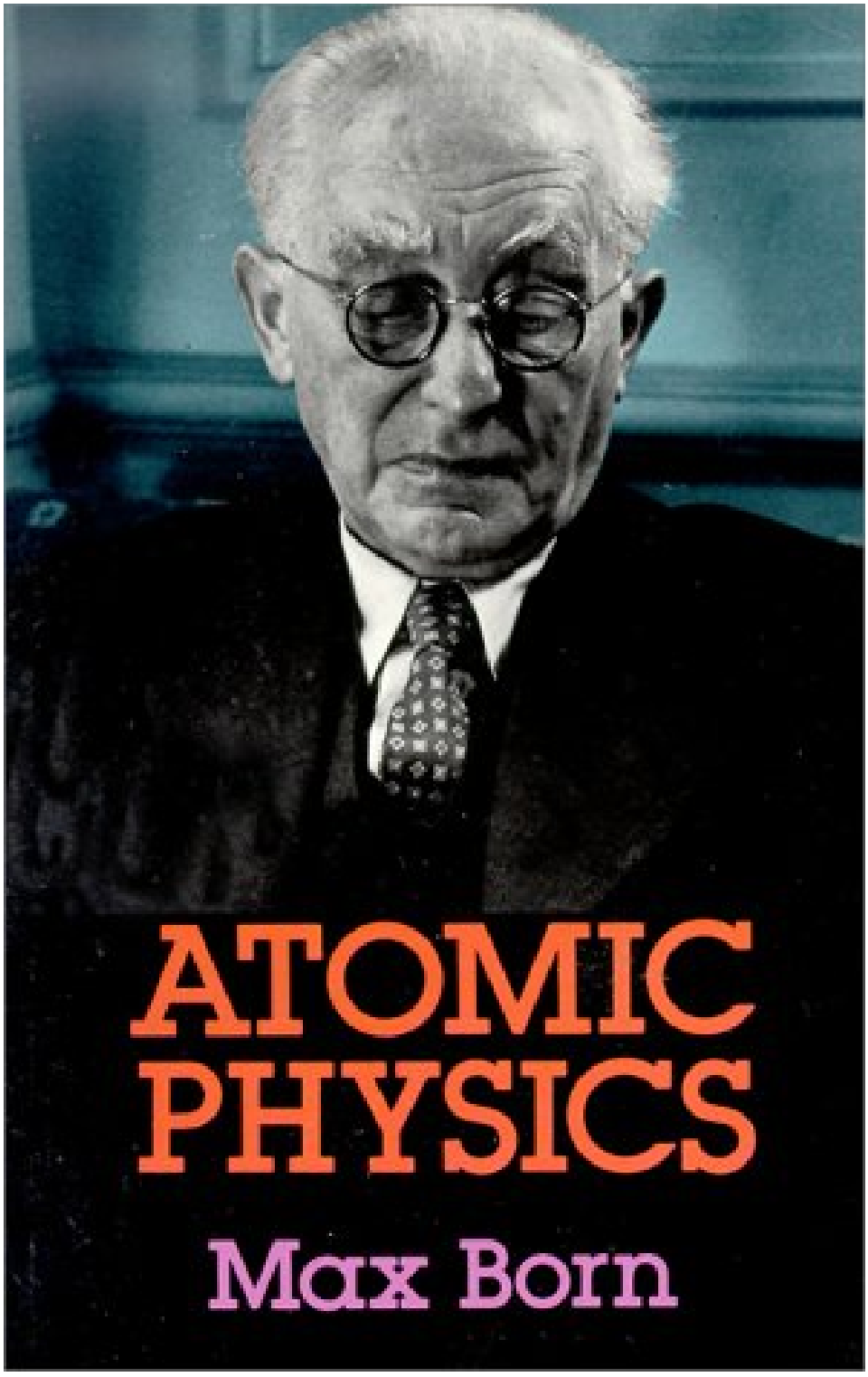

Figure 20.2: Max Born when receiving the message the he had been awarded the Nobel Prize in Physics in 1954 after having sold out determinism and casuality in 1927.

Chapter 21

Einstein: I Did It!

> What does a fish know about the waters in which he swims all life? (Einstein)
>
> For the most part I do the thing which my own nature drives me to do. It is embarrasing to earn so much respect and love for it. (Einstein)
>
> The super-national character of scientific concepts and scientific language is due to the fact tha they have been set up by the best brains of all countries and all times. (Einstein)

21.1 Analytic and Synthetic Statements

If Born sacrificed causality, it was Einstein who gave up the reality of space and time. Einstein did this using a special technique which he developed to mastery, namely to mix up the fundamental distinction between *synthetic* and *analytic* statements as identified in Kant's Critique of Pure Reason.

An analytic statement is a statement about language and not about reality, in mathematical physics usually a definition where one word or concept is specified in terms of already specified concepts of words. One cannot ask if a definition is true, since by construction it cannot be false. A synthetic statement is a statement about some reality, which may be true or false depending on the reality, and thus (in principle) can be checked by observation of reality.

The statement "one meter is 100 centimeters", is analytic, while the statement "this stick is 1 meter", is synthetic. If you know what a meter is the

statement "one meter is 100 centimeters" can be used to define what a centimeter is, and vice versa.

To subject an analytic statement to experimental observation would be ridiculous: To check by experiment if there are 100 centimeters on a meter would not give a Nobel Prize, just laughs.

So if an experiment is set up to test a statement, that is a sign that the statement is viewed to be synthetic.

A definition in mathematics is an analytic statement, while an axiom as basic postulate is to be viewed as a synthetic statement, which in principle may be true or false, but as an axiom is assumed to be true.

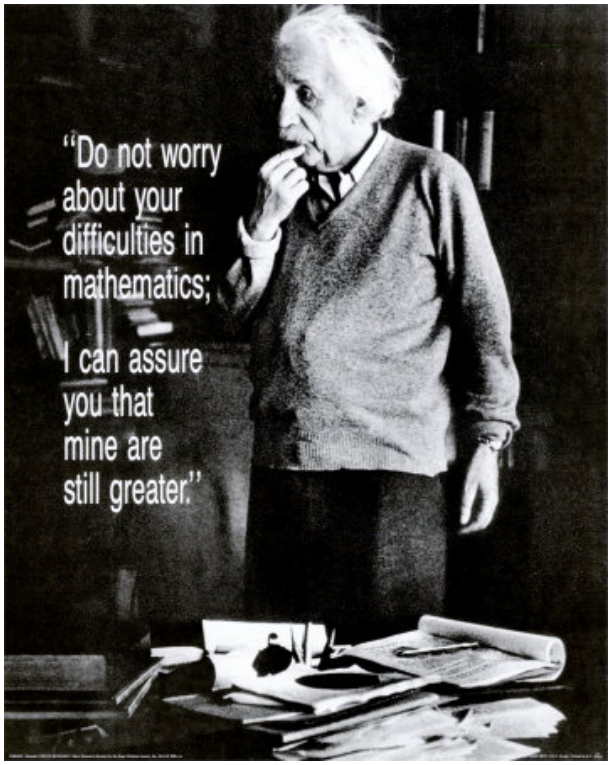

Figure 21.1: To understand the difference between a definition and an axiom is essential in mathematics.

21.2 Double Analytic-Synthetic Statements

In modern physics the distinction between a definition (analytic statement) and synthetic statement is sometimes blurred into statements which are viewed to be both analytic (true by definition) and synthetic about some reality (true or false), or rather sometimes analytic and sometimes synthetic, sometimes definition and sometimes fact.

Such a statement makes it possible to say something about reality which cannot be denied, and it is directly recognized as such. When you hear a physicist making a statement claiming that something cannot be denied, then the statement is such a double analytic-synthetic statement.

As a preparation you may ask yourself if the statement "well educated people are superior to not so well educated people" is analytic or synthetic? Maybe the answer is not so clear. Is it in fact such a double analytic-synthetic statement? See also my knol Is One Dollar = One Euro?

Einstein's mastery can be admired in his careful choice of axioms of special and general relativity:

- *The speed of light in vacuum is constant.*
- *Heavy mass is equal to inertial mass.*

The constancy of the speed of light is a definition since according to the 1983 standard length unit of a meter is defined as a certain fraction of a lightsecond = the distance traveled by light in one second. The speed of light is thus by definition equal to 1 lightsecond per second, no more no less.

On the other hand, a physicist is convinced that the speed of light **is constant** as a physical fact. A physicist would say that because the speed of light is constant in reality, it can be used to define the length standard. So we have a definition which is a physical fact at the same time: Double analytic-synthetic.

Einstein was a master of this form of double-play: The basic assumption of special relativity is that the speed of light is constant, and Einstein uses this statement sometimes as analytic and sometimes as synthetic. Very clever and very confusing. But according to Kant it is not reasonable.

In general relativity Einstein uses the equality of heavy and inertial mass both as definition and physical fact. In this case experimental verification of equality could give a Nobel Prize.

We shall see that the constancy of the speed of light is to be viewed as a definition and thus as analytic, while the equality of inertial and heavy mass is still an open game. Accordingly general relativity is much more difficult to assess than special.

21.3 Einstein's Double Analytic-Synthetic Law

Let us see how Einstein argues to make the constancy of the speed of light into a definition, which can be misinterpreted as a synthetic statement thus a double analytic-synthetic statement [6]:

- *The validity of the Law of constancy of the speed of light for all inertial systems (moving with constant velocity with respect to each other) makes it necessary to postulate invariance of all systems of physical equations which express general laws, with regard to the Lorentzian transformation.*
- *The elaboration of this requirementfroms the content of the special therory of relativity.*
- *This theory is compatible with the wave equations of Maxwell (because they are Lorentzian invariant); but, it is incompatible with the basis of classical mechanics (which is Galilean invariant).*
- *This leads to the result that the Lorentz transformation - applied to space and time coordinates - must govern the transition from one inertial system to another.*

We read that Einstein starts from a **Law** of constancy of the speed of light, which when expressed as a Law appears to be synthetic as a statement about physical reality, a Law which requires the space and time of different inertial systems to be related by a Lorentz transformation. But by insisting that a Lorentz transformation must be used, turns the Law into an analytic statement ,which cannot be false: Length and time scales **must be transformed** according to Lorentz to make the speed of light constant: *length contraction* and *time dilation* **must be accepted**.

By a clever double-play Einstein builds his special theory of relativity on a Law the validity of which cannot be denied. Mission complete! Special relativity cannot be disproved because it is based on a definition.

As indicated, it is still almost 100 years later unclear if the equality of inertial and heavy mass as the basic Law underlying general relativity, is a definition or a fact, a clear sign of mastery or the inventor of the Law.

21.4 Kant's Synthetic A Priori

Kant helped Einstein to formulate his double analytic-synthetic axioms of relativity by suggesting that there are synthetic propositions which can be decided to be true before observation of reality, referred to as synthetic a priori propositions. So Kant himself mixed analytic with synthetic, which Einstein played on so cleverly.

Kant suggests that the truth of a synthetic a priori statement is based on *pure intuitions* or our *a priori formal representations of space and time*. In other words, we can use our own brains as the test bench for the truth of a non-analytic statement without reference to any exterior reality. Thus the brain is supposed to check out itself in a self-referential procedure, which connects to deep questions about mind and self...

A synthetic a priori statement could thus be true for all humans with rational human brains, but not necessarily in all logically possible worlds, where only analytic statements could be true a priori without exterior observation.

In the spirit of Kant we may thus ask if Einstein's Laws of constancy of the speed of light and the equality of intertial and heavy mass, are synthetic a priori statements, which we can verify by "pure intuition"? Maybe Einstein could but it is not all clear that anyone of us is able to do so. Maybe Einstein by "pure intuition" could understand that "space-time is curved", but my intuition seems to lack this capability...

In any case, in science it is essential to make a clear distinction between a definition and synthetic statement and not flip back an forth using double definition-synthetic statements. To nevertheless do so represents a deal with the Devil, which ultimately will take its toll.

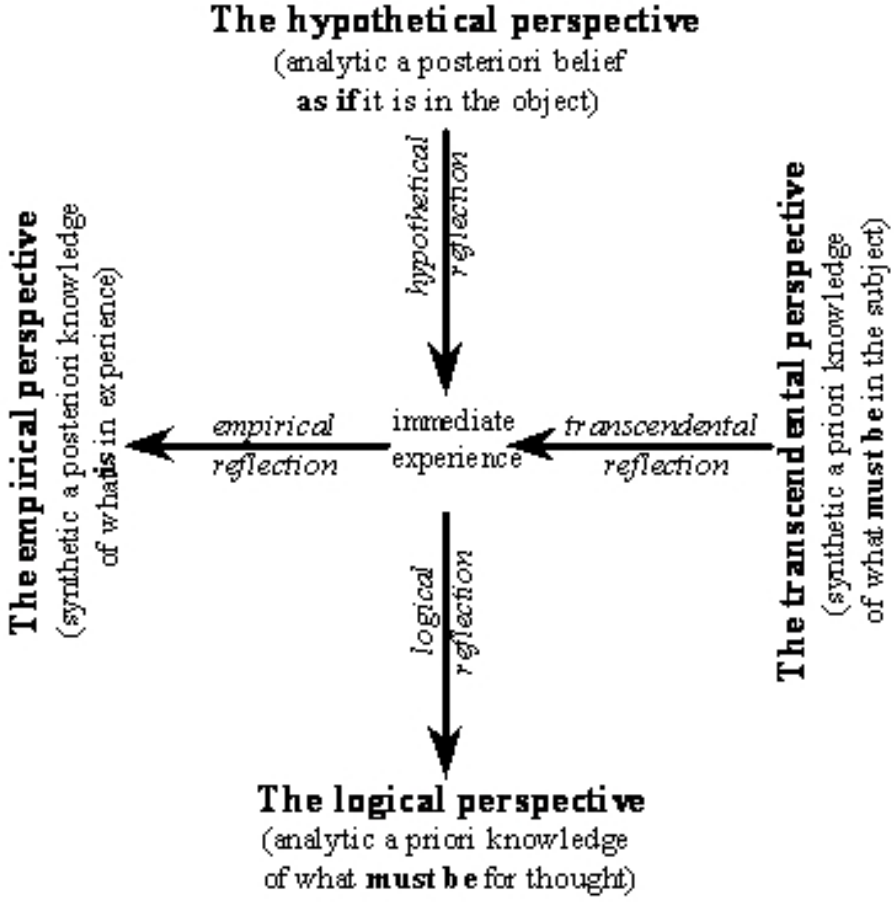

Figure 21.2: Kant's four combinations of analytic-synthetic and a priori-a posteriori.

Part III

Paradoxes and Catastrophes

Chapter 22

Loschmidt's Reversibility Paradox

> Since a given system can never of its own accord go over into another equally probable state but into a more probable one, it is likewise impossible to construct a system of bodies that after traversing various states returns periodically to its original state, that is a perpetual motion machine. (Boltzmann)

The Translators foreword to *Lectures on Gas Theory* by Boltzmann, confesses

- *There is apparently a contradiction between the law of increasing entropy and the principles of Newtonian mechanics, since the latter do not recognize any difference between past and future times. This is the so-called reversibility paradox (Umkehreinwand) which was advanced as an objection to Boltzmann's theory by Loschmidt 1876-77.*

Loschmidts paradox formulated in 1876 by Johann Josef Loschmidt, compares the time-reversibility of Hamiltonian systems with the irreversibility of the 2nd Law of thermodynamics:

If microscopically matter consists of atoms and molecules ruled by reversible Hamiltonian mechanics, from where does the irreversibility of macroscopic physics? This was the problem Boltzmann set out to solve in his 1877 article

- *On the Relation of a General Mechanical Theorem to the Second Law of Thermodynamics*,

and his answer was what his teacher and mentor Loschmidt questioned in his paradox.

To solve the problem Boltzmann introduced microscopic statistics and thus replaced microscopic reversible Hamiltonian mechanics by irreversible statistical mechanics, and thus circumvented the reversibility paradox, but Loschmidt never accepted Boltzmann's solution.

Loschmidt also objected to the prediction by Maxwell and Boltzmann that a gas column in thermal equilibrium in a gravitational field has the same temperature at all heights. We shall see below that Loschmidt was right. Loschmidt was smarter than Boltzmann. Listen to some soft words about reversibility and watch a Short Emotional Film on Time-Reversibility.

Figure 22.1: Johann Josef Loschmidt.

Chapter 23

The Ultraviolet Catastrophe

> The plain fact is that there are no conclusions. (James Jeans)
>
> Examples ... show how difficult it often is for an experimenter to interpret his results without the aid of mathematics. (Lord Rayleigh)

The Ultraviolet Catastrophe also referred to as the Rayleigh-Jeans catastrophe refers to the apparent infinite energy radiating from a source of ultraviolet light without frequency limitation, according to classical linear wave mechanics.

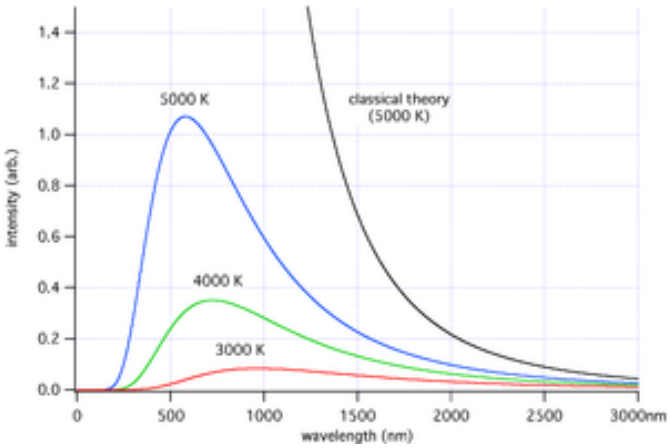

Figure 23.1: The black curve showing the radiance of the classical theory, increases to infinity as the wavelength tends to zero, while the experimental curves decay to zero.

- Listen to a presentation hopefully triggering curiosity.
- Watch a short movie about Planck and his quanta.

Looking at the radiance (energy emitted as radiation) as a function of the wave-length in Fig. **??**, you see two things to explain:

- why is there a cut-off to zero radiance at very small wavelengths?
- why is the peak of the radiance curve shifted to smaller wave-lengths as the temperature increases (Wien's displacement law)?

It appeared that classical wave mechanics could not give any answers to these questions, which added to the emerging credibility crisis of continuum physics. Wilhelm Wien received the 1911 Nobel prize in Physics with the motivation:

- *...for your discoveries concerning the laws of thermal radiation. You have devoted your researches to one of the most difficult and spectacular problems of physics, and among the researchers now living it is you who has succeeded in making the greatest and most significant contributions to the solution of the problem.*

But Wien did not solve the riddle, simply passed it on to Planck...

Chapter 24

The Twin Paradox

> Since the mathematicians have invaded the theory of relativity, I do not understand it myself anymore. (Einstein)

Special relativity is loaded with paradoxes:

- Twin paradox
- Ladder paradox
- Bell's spaceship paradox
- Submarine paradox.

In fact, from one contradiction/paradox follows infinitely many paradoxes. So there are many more than those listed above. Check a typical presentation of today: "It is not bogus bogus".

In modern physics, the infinite number of paradoxes of the special theory of relativity, is viewed as a proof that the theory correctly describes the true nature of the space and time we live in.

Einstein understood quickly that his theory was void of content and moved on to his general theory of relativity, also based on a triviality and a definition, but so complicated that paradoxes did not show up, because it was impossible to know if a contradiction was reached or not.

When questioned about his general theory of relativity, Einstein moved on to cosmology and his dream of a unified filed theory unifying the theory of relativity he had abandoned and the quantum mechanics he did not accept.

Einstein thus use the tactics of raising the bet in a poker so as to never be called. This technique is today used in string theorists seeking the truth of space and time eleven dimensional vibrations of such small size that a call is impossible.

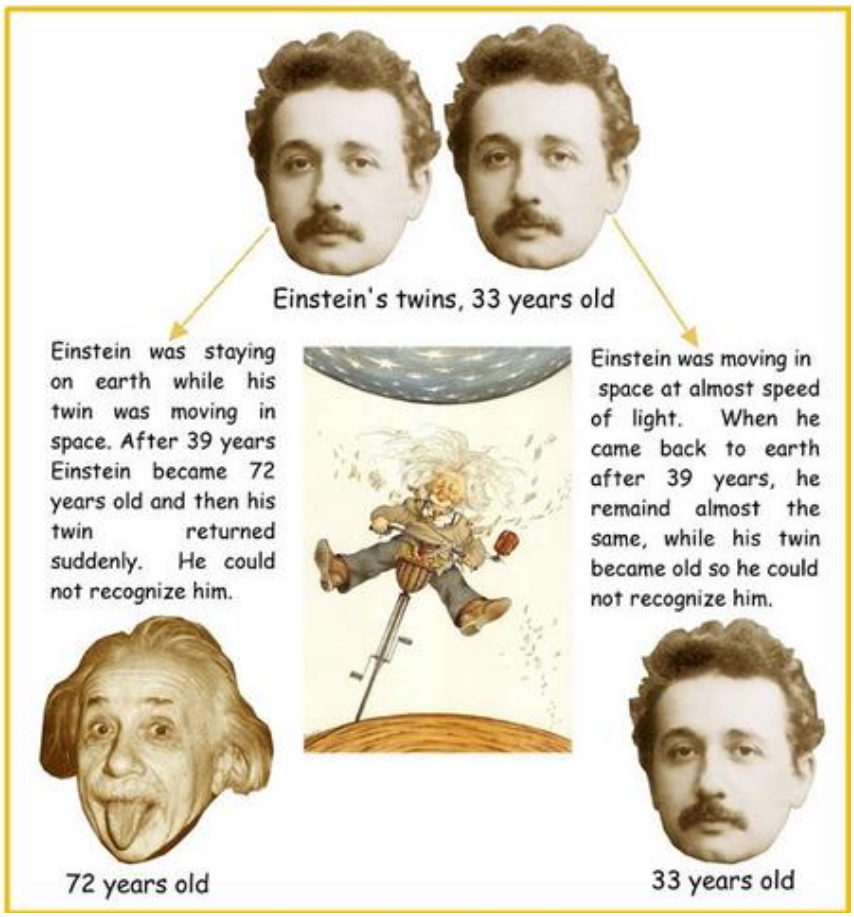

Figure 24.1: One twin paradox generates inifintely many paradoxes.

Chapter 25

Collapse of Schrödinger's Cat

> Marvelous, what ideas the young people have these days. But I don't believe a word of it. (Einstein)
>
> Had I known that we were not going to get rid of this damned quantum jumping, I never would have involved myself in this business! (Schrödinger)

Erwin Schrödinger formulated the basic equation of quantum mechanics as a wave equation over a continuum named *Schrödinger's equation* with solutions named *wave functions*, in an outburst of creativity in 1925 in the Alps together with a new girl friend. The question of the physical meaning of the wave function came up as soon as more than one particle was involved, that is already for the Helium atom with two electrons.

It was Niels Bohr with the help of Max Born, who took up the challenge to give the wave function a physical meaning. Bohr said that the wave function itself had no physical meaning, but that the wave function could "collapse" into something with a physical meaning.

Schrödinger responded with a thought experiment with Schrödinger's Cat, a cat in box representing the wave function before collapse, a strange unreal cat which is in a strange unreal combined state as both alive and dead, followed by a "collapse" into a real cat either alive or dead depending on radioactive decay as the box is opened. Watch a presentation and try to make sense of it (I can't: Schrödinger's objection with his cat experiment is fine, but the refutation (by Bohr) is questionable).

The Schrödinger got so disappointed with the whole thing he had created, and left quantum mechanics, or rather was kicked out by Bohr, who took over

and sent Schrödinger into collapse:

- *I don't like it (quantum mechanics), and I'm sorry I ever had anything to do with it.*

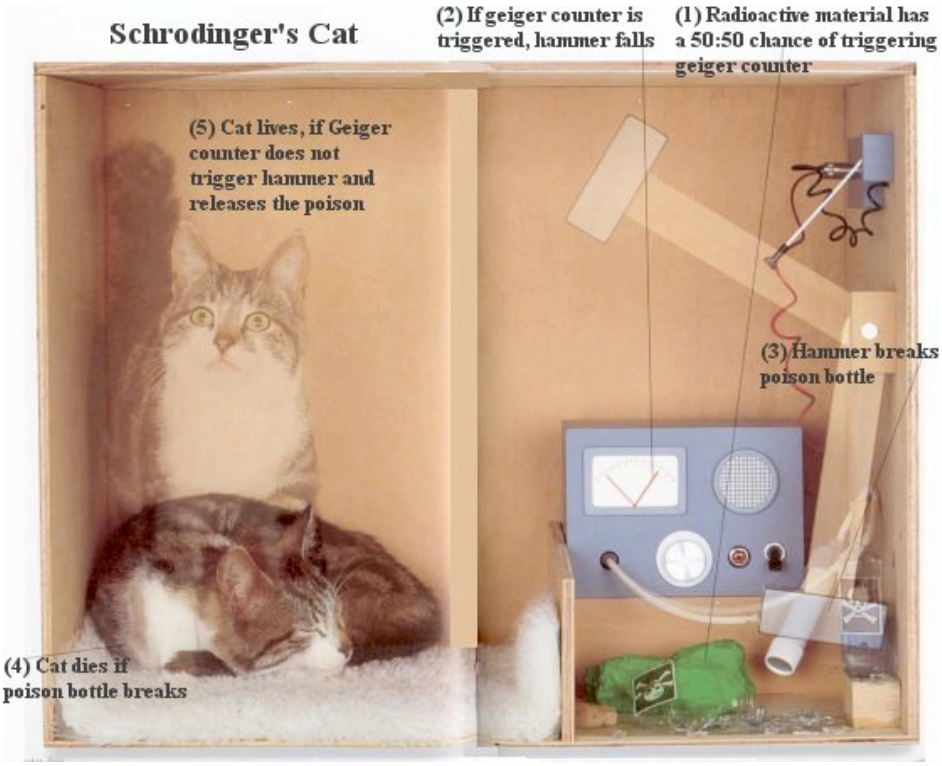

Figure 25.1: Schrödinger's cat both alive and dead.

Chapter 26

D'Alembert's Paradox

> How wonderful that we have met with a paradox. Now we have some hope of making progress. (Nils Bohr)
>
> Science cannot solve the ultimate mystery of Nature, because in the last analysis we ourselves are part of the mystery we are trying to solve. (Max Planck)

In *Essai d'une nouvelle théorie de la résistance des fluides* published in 1752, d'Alembert formulated his famous Paradox on page 34: "Je fais voir que si on suivit une telle hypothese pour déterminer la résistance d'un Fluide, cette résistance se trouveroit nulle, ce qui est contraire à toute experience".

More precisely, d'Alembert showed by mathematical arguments that the drag, or resistance to motion, of a body moving through an *ideal* fluid with zero (or very small) viscosity, should be zero (or very small). d'Alembert stated that this conclusion is against all experience for motion through e.g. air or water, which are fluids with very small viscosity, for which the drag is not small at all. More precisely there was no net force from the fluid acting on the moving body, in particular no lift force on a wing contradicting the undeniable flight of birds.

The Paradox remained unsolved, despite many efforts to come up with an explanation for the striking difference between mathematical prediction and physical observation, until 1904 when Ludwig Prandtl in the short note *Motion of fluids with very little viscosity* read before the Third International Congress of Mathematicians at Heidelberg in 1904, presented his by now accepted solution to the Paradox. This saved Fluid Dynamics as a mathematical science for the rest of the century, as expressed in Prandtls own

words:

- *It is known, however, that the solutions of the Euler equations generally agree very poorly with experience. I will recall only the Dirichlet sphere which, according to the theory, should move without friction.*

- *I have now set myself the task to investigate systematically the laws of motion of a fluid whose viscosity is assumed to be very small. The viscosity is supposed to be so small that it can be disregarded wherever there are no great velocity differences nor accumulative effects.*

- *This plan has proved to be very fruitful, in that, on the one hand, it produces mathematical formulas, which enable a solution of the problem and, on the other hand, the agreement with observations promises to be very satisfactory.*

- *The most important aspect of the problem is the behavior of the fluid on the surface of the solid body, assuming that the fluid adheres to the surface and that, therefore, the velocity is either zero or equal to the velocity of the body. In the thin transition layer, the great velocity differences will then produce notable effects in spite of the small viscosity.*

- *The most important practical results of these investigations is that, in certain cases, the flow separates from the surface at a point entirely determined by external conditions. A fluid layer, which is set in rotation by the friction on the wall, is thus forced into the free fluid.*

- *On the one hand, we have the free fluid, which can be treated as non-viscous, while, on the other hand, we have the transition layers on the solid boundaries, impart their characteristic impress on the free flow by the emission of turbulent layers.*

- *No. 7-10 show the flow around a cylindrical obstacle. No. 7 shows the beginning of the separation; Nos. 8-9, subsequent stages. No. 10 shows the permanent condition. The wake of turbulent water behind the cylinder swings back and forth, whence the momentary unsymmetrical appearance (referring to the pictures in Fig. 26.2).*

When PrandtI "set himself the task to investigate systematically the laws of motion of a fluid whose viscosity is assumed to be very small" he reacted

to the pressure of resolving d'Alembert's paradox which had reached untolerable levels when the Wright brothers with their *Flyer* in 1903 showed that powered sustained heavier-than-air flight was possible in practice. A theory had to be found "under any circumstance and at whatever cost". It was Prandtl who was chosen to do the job, and he did it like Born by making a deal.

However, Prandtl did not, unlike Born, get any Nobel Prize as consolation for a lost soul...below we seek to answer why below...

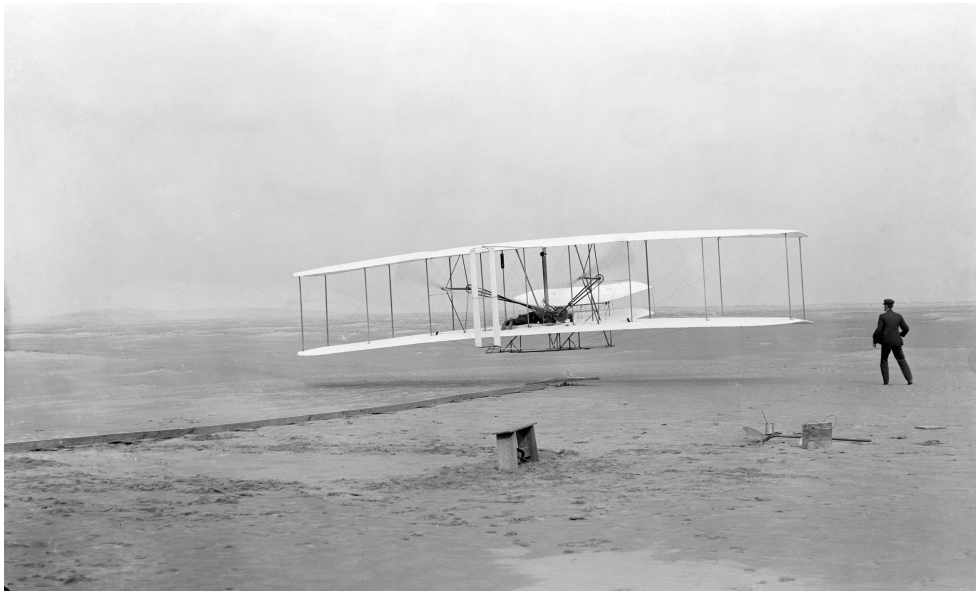

Figure 26.1: Wilbur Wright lifting with the Flyer in Dec 1903 while his brother Orwille is watching.

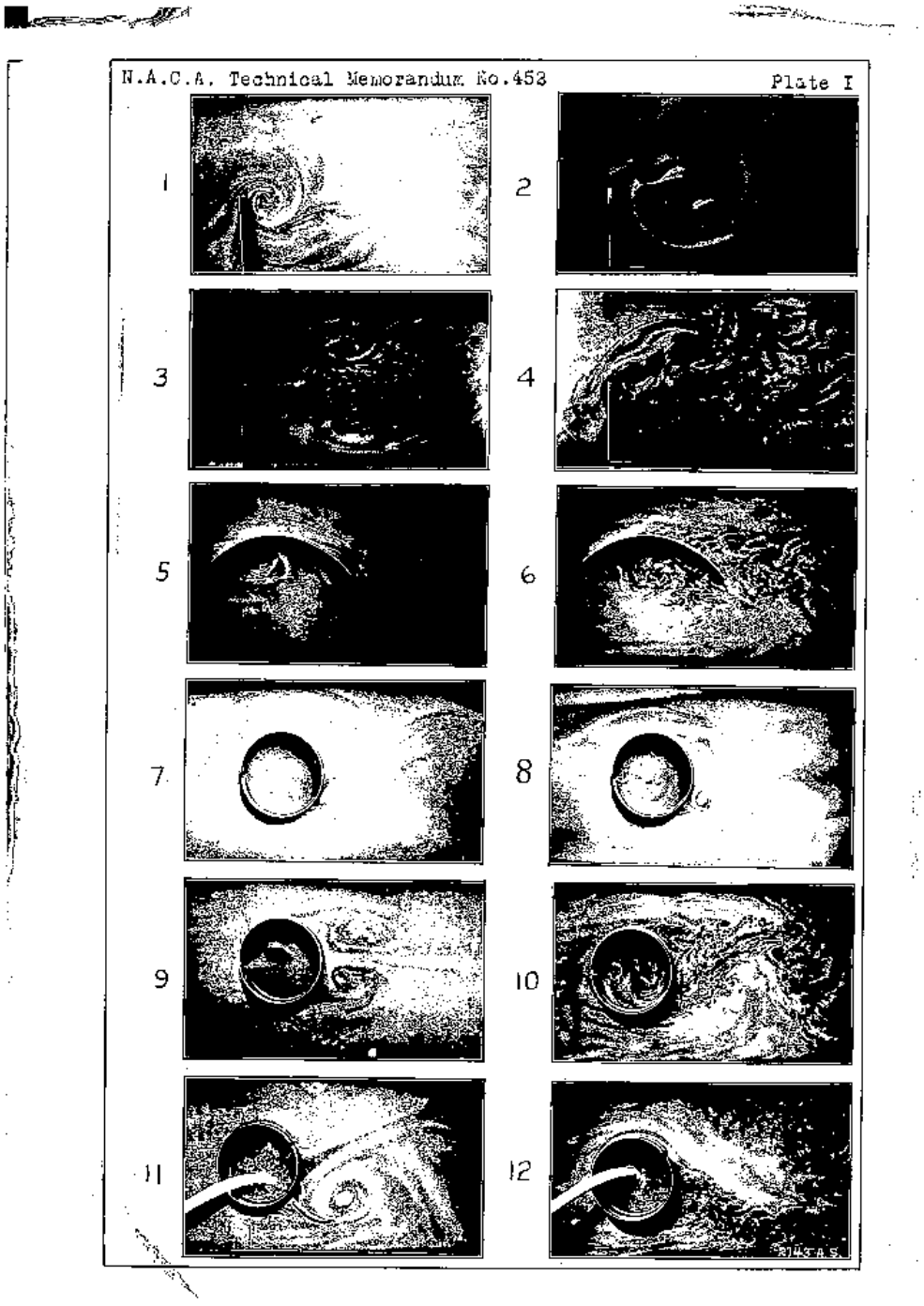

Figure 26.2: Pictures 1-12 from Prandtl's Technical Memorandum 452.

Part IV

Physics Tribunal

Chapter 27

Accusations

> We cannot teach people anything; we can only help them discover it within themselves. (Galileo)

The reader is asked to act as jury in a trial against Boltzmann, Planck, Einstein and Bohr to decide if scientific crimes have been committed in the following cases:

- 2nd Law of Thermodynamics by Boltzmann,
- Blackbody Radiation by Planck,
- Special Relativity by Einstein,
- Copenhagen Interpretation of Quantum Mechanics by Bohr.

The jury will be presented confessions by the accused, listen to witnesses and background material, in order to make a fair verdict based on evidence.

The jury will hear the accused "gang of four" confess that violations were made, but defend themselves by claiming that what they did was necessary to save science from collapse, and if they hadn't done it, someone else would, and so they only did what science asked them to do. The jury will also hear the accused witness about the sorrow and emptiness in their hearts after trading their scientific souls in the deal.

The accusations against the individual scientists are listed below with short descriptions under different headlines:

Figure 27.1: Bohr seeking to convince Einstein who sees no reason to listen.

27.0.1 Corruption of Science into Epistemology

- Boltzmann: unclear formulation of 2nd law of thermodynamics
- Einstein: unreal space and time
- Bohr: observer dependent reality

27.0.2 Corruption of Science into Statistics of Particles

- Boltzmann: molecular chaos

27.0.3 Corruption of Science into Statistics of Quanta

- Planck: Smallest quanta of energy

27.0.4 Resolution of Contradiction by Sophistry

- Bohr: complementarity, correspondence principle, collapse of wave function

27.0.5 Mixing Definition with Physical Fact

- Einstein: constancy of speed of light.

27.0.6 Work on Atomic Bomb

- Einstein: $E = mc^2$. Letter to Roosewelt
- Bohr: Discovery of U-235 fission capability, Manhattan project

27.0.7 Big Effect from Vanishingly Small Cause

- Prandtl: Drag and lift as boundary layer effect.

27.0.8 Corruption of Physics into Philosophy

Boltzmann, Einstein and Bohr appeared as both physicists and philosophers, and used philosophy (or sophistry) to twist obviously contradictory physics into seemingly non-contradictory meta-physics.

Figure 27.2: Bohr directing his disciple Heisenberg and Pauli inventor of the Pauli exclusion principle.

Part V

Confessions

Chapter 28

Boltzmann

28.1 Life and Work

- *All of us younger mathematicians stood by Boltzmann's side.* (Sommerfeld)

- *Let a drop of wine fall into a glass of water; whatever be the law that governs the internal movement of the liquid, we will soon see it tint itself uniformly pink and from that moment on, however we may agitate the vessel, it appears that the wine and water can separate no more. All this, Maxwell and Boltzmann have explained, but the one who saw it in the cleanest way, in a book that is too little read because it is difficult to read, is Gibbs, in his* Principles of Statistical Mechanics. (Poincare)

Stanford Encyclopedia of Philosophy:

- *Ludwig Boltzmann (1844-1906) is generally acknowledged as one of the most important physicists of the nineteenth century. Particularly famous is his statistical explanation of the second law of thermodynamics. The celebrated formula* $S = k \log(W)$*, expressing a relation between entropy* S *and probability* W *has been engraved on his tombstone (even though he never actually wrote this formula down). Boltzmann's views on statistical physics continue to play an important role in contemporary debates on the foundations of that theory.*

- *However, Boltzmann's ideas on the precise relationship between the thermodynamical properties of macroscopic bodies and their microscopic*

Figure 28.1: Ludwig Boltzmann: *it would be impossible without this assumption (molecular disorder) to prove the theorems of gas theory*

constitution, and the role of probability in this relationship are involved and differed quite remarkably in different periods of his life. Indeed, in his first paper in statistical physics of 1866, he claimed to obtain a completely general theorem from mechanics that would prove the second law. However, thirty years later he stated that the second law could never be proved by mechanical means alone, but depended essentially on probability theory.

- *In his lifelong struggle with the problem he employed a varying arsenal of tools and assumptions. (To mention a few: the so-called Stosszahlansatz, the ergodic hypothesis, ensembles, the permutational argument, the hypothesis of molecular disorder.) However, the exact role of these assumptions, and the results he obtained from them, also shifted in the course of time. Particularly notorious are the role of the ergodic hypothesis and the status of the so-called H-theorem.*

- *Moreover, he used "probability" in four different technical meanings. It is, therefore, not easy to speak of a consistent, single "Boltzmannian approach" to statistical physics. It is the purpose of this essay to describe the evolution of a selection of these approaches and their conceptual problems.*

Wikipedia:

- *Around 1900 Boltzmanns science was being threatened by physicists claiming that all electromagnetic behavior is continuous and that all physical behavior ultimately is electromagnetic (more or less the authors view). This deeply depressed Boltzmann since it could mean the end of his kinetic theory and statistical interpretation of the second law of thermodynamics.*

- *After Mach's resignation in Vienna in 1901, Boltzmann returned there and decided to become a philosopher himself to refute philosophical objections to his physics, but he soon became discouraged again. In 1904 at a physics conference in St. Louis most physicists seemed to reject atoms and he was not even invited to the physics section.*

- *Rather, he was stuck in a section called "applied mathematics," he violently attacked philosophy, especially on allegedly Darwinian grounds but actually in terms of Lamarcks theory of the inheritance of acquired*

characteristics that people inherited bad philosophy from the past and that it was hard for scientists to overcome such inheritance.

- *In 1906 his mental condition became so bad that he had to resign his position and he committed suicide in September of that same year by hanging himself while on vacation.*

28.2 Confession

- *Who ... is not familiar with Maxwell's memoirs on his dynamical theory of gases? ... from one side enter the equations of state; from the other side, the equations of motion in a central field. Ever higher soars the chaos of formulae. Suddenly we hear, as from kettle drums, the four beats, "put $n = 5$". The evil spirit vanishes; and ... that which had seemed insuperable has been overcome as if by a stroke of magic ... One result after another follows in quick succession till at last ... we arrive at the conditions for thermal equilibrium together with expressions for the transport coefficients.*

- *A closer look at the course followed by developing theory reveals for a start that it is by no means as continuous as one might expect, but full of breaks and at least apparently not along the shortest logical path. Certain methods often afforded the most handsome results only the other day, and many might well have thought that the development of science to infinity would consist in no more than their constant application. Instead, on the contrary, they suddenly reveal themselves as exhausted and the attempt is made to find other quite disparate methods. In that event there may develop a struggle between the followers of the old methods and those of the newer ones. The former's point of view will be termed by their opponents as out-dated and outworn, while its holders in turn belittle the innovators as corrupters of true classical science.*

- *The most ordinary things are to philosophy a source of insoluble puzzles. In order to explain our perceptions it constructs the concept of matter and then finds matter quite useless either for itself having or for causing perceptions in a mind. With infinite ingenuity it constructs a concept of space or time and then finds it absolutely impossible that there be objects in this space or that processes occur during this time ... The*

source of this kind of logic lies in excessive confidence in the so-called laws of thought.

- *That is is necessary to the rigor of the proof to specify this assumption (molecular disorder) in advance...Because the impossibility of calculating the positions of all the molecules at each time, as the astronomers calculates the positions of all the planets, it would be impossible without this assumption (molecular disorder) to prove the theorems of gas theory.*

- *One is almost tempted to assert that quite apart from its intellectual mission, theory is the most practical thing conceivable, the quintessence of practice as it were, since the precision of its conclusions cannot be reached by any routine of estimating or trial and error; although given the hidden ways of theory, this will hold only for those who walk them with complete confidence....besides, a man with a new idea is a crank until he succeeds...*

- *Will the mechanist view of nature one day win the decisive battle for the discovery of the luminous aether?*

- *It is clear that the various gas molecules will go through all possible states of motion*

- *So far I have however neglected almost completely many broad and significant chapters os mathematical physics....I realize that it would strain my eyes too much...* (turning down a job offer on Berlin)

- *There is a need for making the utmost use of what powers of perception we possess, and since the eye allows us to take in the greatest store of facts at once, this givs rise to the need to represent the results of calculations and not only for the imagination but visibly for the eye a palpably for the hand, with cardboard and plaster.*

- *...were more in tune with the spirits of science than the old hypotheses, besides being more convenient for the scientist himself. For the old hypotheses cold be upheld only so long everything went well; but now the occasional lack of agreement was no longer harmful, for one cannot reproach a mere analogy for being lame in some respects...In the end,*

philosophy generalized Maxwell's ideas to the point of maintaining that knowledge itself is noting else than finding of analogies.

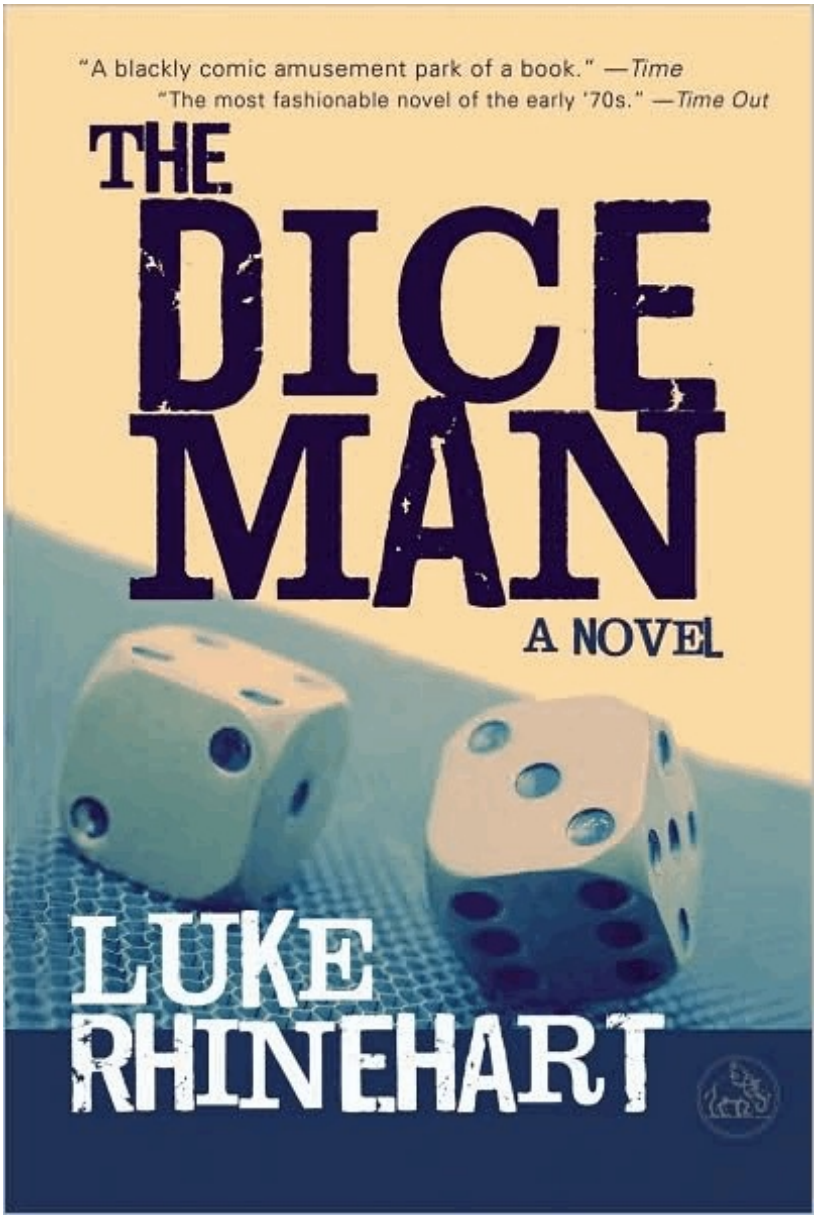

Figure 28.2: Life as playing dice.

Chapter 29

Planck

29.1 Life and Work

Wikipedia:

- *Max Planck (1858 1947) was a German physicist who is regarded as the founder of the quantum theory, for which he received the Nobel Prize in Physics in 1918.*

- *The central assumption behind his new derivation, presented to the DPG on 14 December 1900, was the supposition, now known as the Planck postulate, that electromagnetic energy could be emitted only in quantized form, in other words, the energy could only be a multiple of an elementary unit $E = h\nu$, where h is Planck's constant, also known as Planck's action quantum (introduced already in 1899), and ν is the frequency of the radiation. Physicists now call these quanta photons, and a photon of frequency will have its own specific and unique energy. The amplitude of energy at that frequency is then a function of the number of photons of that frequency being produced per unit of time.*

- *Subsequently, Planck tried to grasp the meaning of energy quanta, but to no avail. "My unavailing attempts to somehow reintegrate the action quantum into classical theory extended over several years and caused me much trouble."*

- *Max Born wrote about Planck: "He was by nature and by the tradition of his family conservative, averse to revolutionary novelties and*

skeptical towards speculations. But his belief in the imperative power of logical thinking based on facts was so strong that he did not hesitate to express a claim contradicting to all tradition, because he had convinced himself that no other resort was possible."

Einstein:

- *The longing to behold this pre-established harmony [of phenomena and theoretical principles] is the source of the inexhaustible patience and perseverance with which Planck has devoted himself ... The state of mind which enables a man to do work of this kind is akin to that of the religious worshiper or the lover; the daily effort comes from no deliberate intention or program, but straight from the heart.*

- *In the temple of science are many mansions, and various indeed are they that dwell therein and the motives that have led them thither. Many take to science out of a joyful sense of superior intellectual power; science is their own special sport to which they look for vivid experience and the satisfaction of ambition; many others are to be found in the temple who have offered the products of their brains on this altar for purely utilitarian purposes. Were an angel of the Lord to come and drive all the people belonging to these two categories out of the temple, the assemblage would be seriously depleted, but there would still be some men, of both present and past times, left inside. Our Planck is one of them, and that is why we love him.*

Prandtl lost his son Karl in combat during 1st World War and his son Erwin was executed after a plot against Hitler at the end of the 2nd World War. Planck signed together with 93 German intellectuals the *Appeal to the Cultured Peoples of the World*: on 4 October 1914:

- *We declare the leaders of German art and science to be at one with the German army.*

Planck reports as Rector of Berlin University in 1914:

- *The German people ha found itself again. One thing only we know, that we members of our university...will stand together as one man and hold fast until - despite the slander of our enemies - the entire world comes to recognize the truth and German honor.*

Figure 29.1: Max Planck: *...the whole procedure was an act of despair because a theoretical interpretation had to be found at any price, no matter how high that might be...* (Planck on the statistical mechanics basis of his radiation law)

29.2 Confession

- About God.
- *We shall now derive strange properties of heat radiation described by electromagnetic wave theory.*
- *...the whole procedure was an act of despair because a theoretical interpretation had to be found at any price, no matter how high that might be...* (Planck on the statistical mechanics basis of his radiation law)
- *Either the quantum of action was a fictional quantity, then the whole deduction of the radiation law was essentially an illusion representing only an empty play on formulas of no significance, or the derivation of the radiation law was based on sound physical conception. Mechanically, the task seems impossible, and we will just have to get used to it (quanta).* (Max Planck)
- *My futile attempts to fit the elementary quantum of action into classical theory continued for a number of years and cost me a great deal of effort. Many of my colleagues saw in this something bordering on a tragedy* (Planck shortly before his death).
- *I tried immediately to weld the elementary quantum of action somehow in the framework of classical theory. But in the face of all such attempts this constant showed itself to be obdurate...My futile attempts to put the elementary quantum of action into the classical theory continued for a number of years and they cost me a great deal of effort.*
- *The assumption of an absolute determinism is the essential foundation of every scientific inquiry.*
- *There are different sorts of Jews (to Hitler), some valuable for mankind and others wortless.*
- *All matter originates and exist only by virtue of a force which brings the particle of an atom to vibration and hold this most minute solar system of the atom together. We must assume behind the existence of this force the existence of a conscious and intelligent mind. This mind is the matrix of all matter*

- *In order to find the correct resonator entropy S it must be assume that the energy U of a resonator with frequency ν can only take on* **discrete** *energy values, to wit,* **integer** *multiples of h times ν, in contrast to classical theory where U can be any multiple, integer or not, of ν. We now say that U is quantized.*

- *My maxim i always this: consider every step carefully in advance, but then, if you believe you can take the responsibility for it, let nothing stop you.*

- *For by nature I am peaceful and disinclined to questionable adventures...for unfortunately I have not been given the capacity to react quickly to intellectual stimulation.*

- *But we shall also see an feel how, in the fearful seriousness of the situation, everything that a country could call its own in physical and moral power came together with the speed of lightning and ignited a flame of holy wrath blazing to the heavens, while so much that had been considered important and desirable fell to the side, unnoticed, as worthless frippery.*

Chapter 30

Einstein

30.1 Life and Work

- Some photos
- *Albert Einstein (1879 1955) was a German-born theoretical physicist who discovered the theory of general relativity, effecting a revolution in physics. For this achievement, Einstein is often regarded as the father of modern physics.* (Wikipedia)
- *Einstein uses his concept of God more often than a Catholic priest. Once I asked him: "Tomorrow is Sunday. Do you want me to come to you, so we can work?" "Why not?' "Because I thought perhaps you would like to rest on Sunday." Einstein settled the question by saying with a loud laugh: "God does not rest on Sunday either."* (Infeld)
- *People complain that our generation has no philosophers. They are wrong. They now sit in another faculty. Their names are Max Planck and Albert Einstein. (Even several years later, other physicists like Rayleigh, Jeans, and Lorentz set Planck's constant to zero in order to align with classical physics, but Planck knew well that this constant had a precise nonzero value. " I am unable to understand Jeans stubbornness.* (Adolf von Harnack upon appointment as the first president of the Kaiser Wilhelm Society, Berlin, formed for the advancement of science in 1911).
- *It appears that the solution of the problem of time and space is reserved*

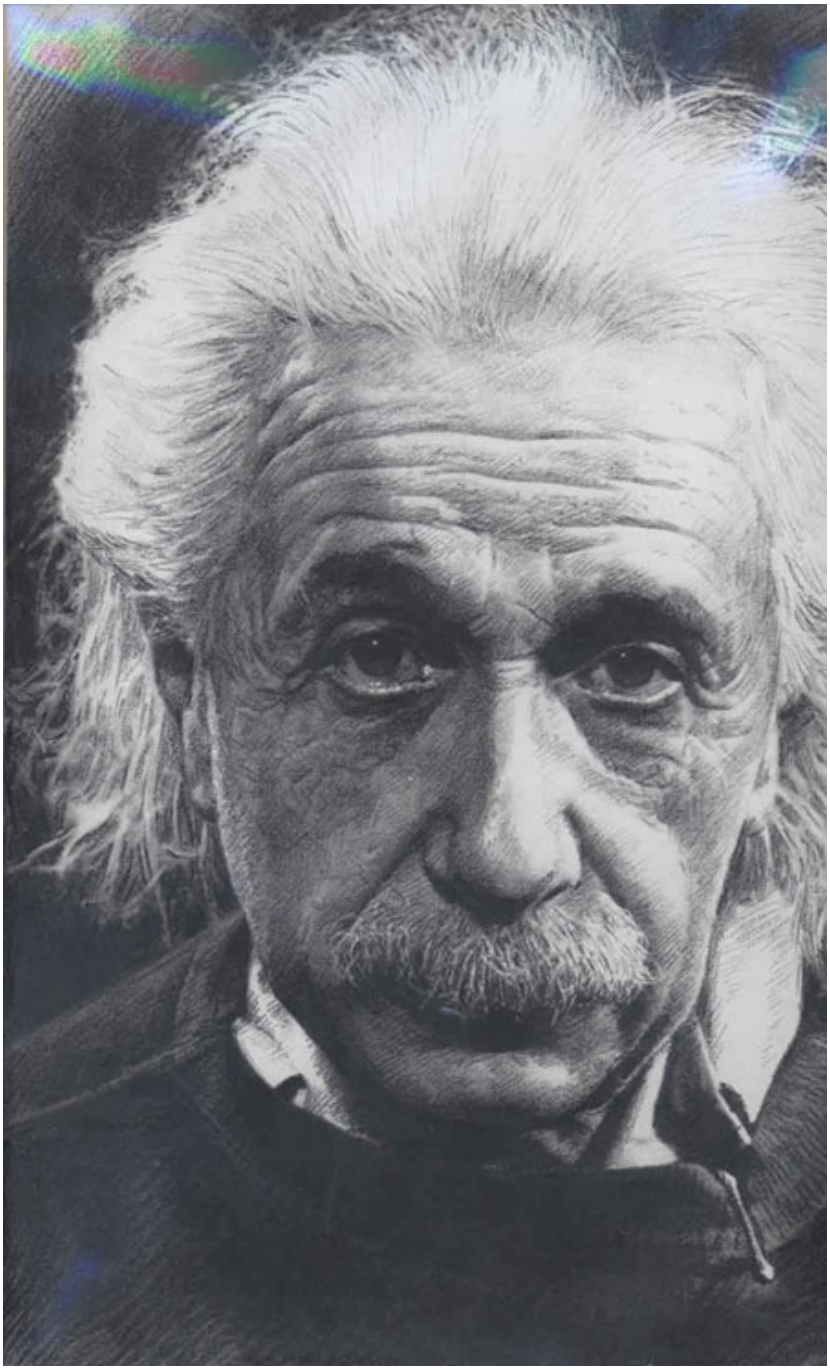

Figure 30.1: *What I wanted to say was just this: In the present circumstances, the only profession I would choose would be one where earning a living had nothing to do with the search for knowledge. Statement* (Einstein's last letter to Born).

to philosophers who, like Leibniz, are mathematicians, or to mathematicians who, like Einstein, are philosophers. (Reichenbach)

- *I think a strong claim can be made that the process of scientific discovery may be regarded as a form of art. This is best seen in the theoretical aspects of Physical Science. The mathematical theorist builds up on certain assumptions and according to well understood logical rules, step by step, a stately edifice, while his imaginative power brings out clearly the hidden relations between its parts. A well constructed theory is in some respects undoubtedly an artistic production. A fine example is the famous Kinetic Theory of Maxwell. ... The theory of relativity by Einstein, quite apart from any question of its validity, cannot but be regarded as a magnificent work of art.* (Rutherford)

- *Einstein arrived at the special theory of relativity after thinking for 10 years about the properties of light. He arrived at the general theory of relativity after thinking for eight years about gravitation [13].*

30.2 Confession

- *I do not consider the main significance of the general theory of relativity to be the prediction of some tiney observable effects, but rather the simplicity of its foundations and its consistency.*

- *The idea of general relativity is a purely formal point of view and not a definite hypothesis about nature.* (Relativity is thus not a physical theory)

- *In my opinion general relativity possesses little inner probability.*

- *Physicists will be brought back to the Maxwell's programmee: the description of Physical Reality by fields which satisfy without singularity a set of partial differential equations.*

- *I have become an obstinate heretic in the eyes of my colleagues. I am generally regarded as some kind of petrified object rendered blind and deaf by the years. I find this role not too distasteful, as it corresponds very well with my temperament.*

- *I believe less than ever in the statistical nature of events and have decided to use the little energy still given to me in ways which are independent of the current bustle.*
- *What separates me from most of so-called atheists is a feeling of utter humility towards the unattainable secrets of harmony of the cosmos*
- *I don't like your kind of physics.* (Einstein to Bohr)
- *Why is it that nobody understands me, and everybody likes me?* (Einstein in New York Times, March 12, 1944)
- *The question whether the Lorentz contraction does or does not exist is confusing. It does not really exist in so far as it does not exist for an observer who moves (with the rod); it really exists, however, in the sense that it can as a matter of principle be demonstrated by a resting observer.*
- *I neglected mathematics...because my intuition was not strong enough to differentiate the fundamentally important from the dispensable erudition...*[**?**]
- *The question whether the Lorentz contraction does or does not exist is confusing. It does not really exist in so far as it does not exist for an observer who moves (with the rod);* **it really exists**, *however, in the sense that it can* **as a matter of principle be demonstrated** *by a resting observer* 1911 [**?**, **?**].
- *It strikes me as unfair, and even bad taste, to select a few individuals for boundless admiration, attributing superhuman powers of mind and character to them. This has been my fate, and the contrast between the popular assessment of my powers and achievements and the reality is grotesque.*
- *Newton, forgive me*
- *The scientist must appear to the systematic epistemologist as a type of unscrupulous opportunist: he appears as realist insofar as he seeks to describe a world independent of the acts of perception; as idealist insofar as he looks upon the concepts and theories as the free inventions of the human spirit (not logically derivable from what is empirically given); as positivist insofar as he considers his concept and theories justified only*

to the extent to which they furnish a logical representation of relations among sensory experience. He may even be viewed as Platonist or Pythagorean insofar as he considers the viewpoint of logical simplicity as an indispensable and effective tool of his research.

- *It seems to me to be in the nature of the subject, that what is to follow might already have been partially clarified by other authors. However, in view of the fact that the questions under consideration are treated here from a new point of view, I believed I could dispense with a literature search which would be very troublesome for me, especially since it is to be hoped that other authors will fill this gap, as was commendably done by Herr Planck and Herr Kaufmann on the occasion of my first paper on relativity.* 1906.

- *Time and space are modes in which we think and not conditions in which we live.*

- *I feel like a prima-donna.... It is like a Circus Barnum, although I believe it would be more fun (for the people) to watch an elephant or a giraffe than an old scientist... I have become rather like King Midas, except that everything turns not into gold but into a circus* 1921 NY.

- *All these fifty years of conscious brooding have brought me no nearer to the answer to the question, "What are light quanta?". Nowadays every Tom, Dick and Harry thinks he knows it, but he is mistaken.*

- *Surprisingly, however, it turned out that a sufficiently sharpened conception of time was all that was needed to overcome the difficulty discussed. One had only to realize that an auxiliary quantity introduced by H. A. Lorentz, and named by him "local time", could be defined as "time" in general. If one adheres to this definition of time, the basic equations of Lorentz's, theory correspond to the principle of relativity.* 1907

- *The question whether the Lorentz contraction does or does not exist is confusing. It does not really exist in so far as it does not exist for an observer who moves (with the rod); it really exists, however, in the sense that it can as a matter of principle be demonstrated by a resting observer.*

- *The special theory of relativity creates a* **formal** *dependence between the way in which the space and time coordinates* **must** *enter into natural laws.*

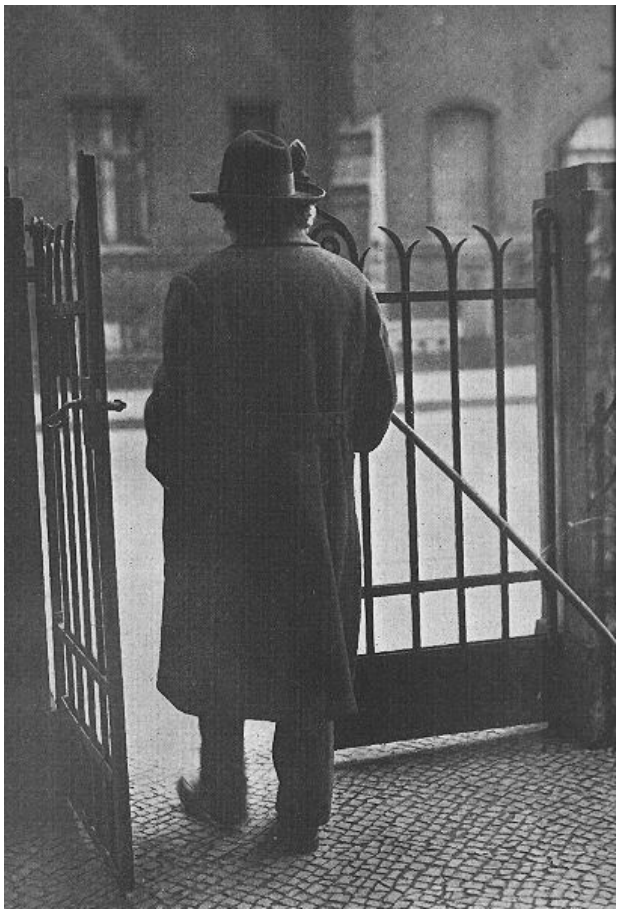

Figure 30.2: Einstein leaving the scene in 1955, or 1933 or 1925: *Here in Princeton I am considered an old fool.*

Chapter 31

Bohr

31.1 Life and Work

- *You can talk about people like Buddha, Jesus, Moses, Confucius, but the thing that convinced me that such people existed were the conversations with Bohr.* (Wheeler)

- *People were pretty well spellbound by what Bohr said While I was very much impressed by [him], his arguments were mainly of a qualitative nature, and I was not able to really pinpoint the facts behind them. What I wanted was statements which could be expressed in terms of equations, and Bohr's work very seldom provided such statements. I am really not sure how much later my work was influenced by these lectures of Bohr's... He certainly did not have a direct influence because he did not stimulate one to think of new equations.* (Dirac)

- *I admired Bohr very much. We had long talks together, long talks in which Bohr did practically all the talking.* (Dirac)

- *Bohr's standpoint, that a space-time description is impossible, I reject a limine. Physics does not consist only of atomic research, science does not consist only of physics, and life does not consist only of science. The aim of atomic research is to fit our empirical knowledge concerning it into our other thinking. All of this other thinking, so far as it concerns the outer world, is active in space and time. If it cannot be fitted into space and time, then it fails in its whole aim and one does not know what purpose it really serves.* (Schrödinger)

Stanford Encyclopedia of Philosophy:

- *As the theory of the atom, quantum mechanics is perhaps the most successful theory in the history of science. It enables physicists, chemists, and technicians to calculate and predict the outcome of a vast number of experiments and to create new and advanced technology based on the insight into the behavior of atomic objects. But it is also a theory that challenges our imagination. It seems to violate some fundamental principles of classical physics, principles that eventually have become a part of western common sense since the rise of the modern worldview in the Renaissance. So the aim of any metaphysical interpretation of quantum mechanics is to account for these violations.*

- *The Copenhagen interpretation was the first general attempt to understand the world of atoms as this is represented by quantum mechanics. The founding father was mainly the Danish physicist Niels Bohr, but also Werner Heisenberg, Max Born and other physicists made important contributions to the overall understanding of the atomic world that is associated with the name of the capital of Denmark.*

- *In fact Bohr and Heisenberg never totally agreed on how to understand the mathematical formalism of quantum mechanics, and none of them ever used the term the "Copenhagen interpretation" as a joint name for their ideas. In fact, Bohr once distanced himself from what he considered to be Heisenberg's more subjective interpretation (APHK, p.51). The term is rather a label introduced by people opposing Bohr's idea of complementarity, to identify what they saw as the common features behind the Bohr-Heisenberg interpretation as it emerged in the late 1920s. Today the Copenhagen interpretation is mostly regarded as synonymous with indeterminism, Bohr's correspondence principle, Born's statistical interpretation of the wave function, and Bohr's complementarity interpretation of certain atomic phenomena.*

31.2 Confession

- *It is really necessary that the practitioners carry out and guide scientific experiments in direct connection with the theoretical investigations.* (to motivate his proposal for an Institute of Theoretical Physics)

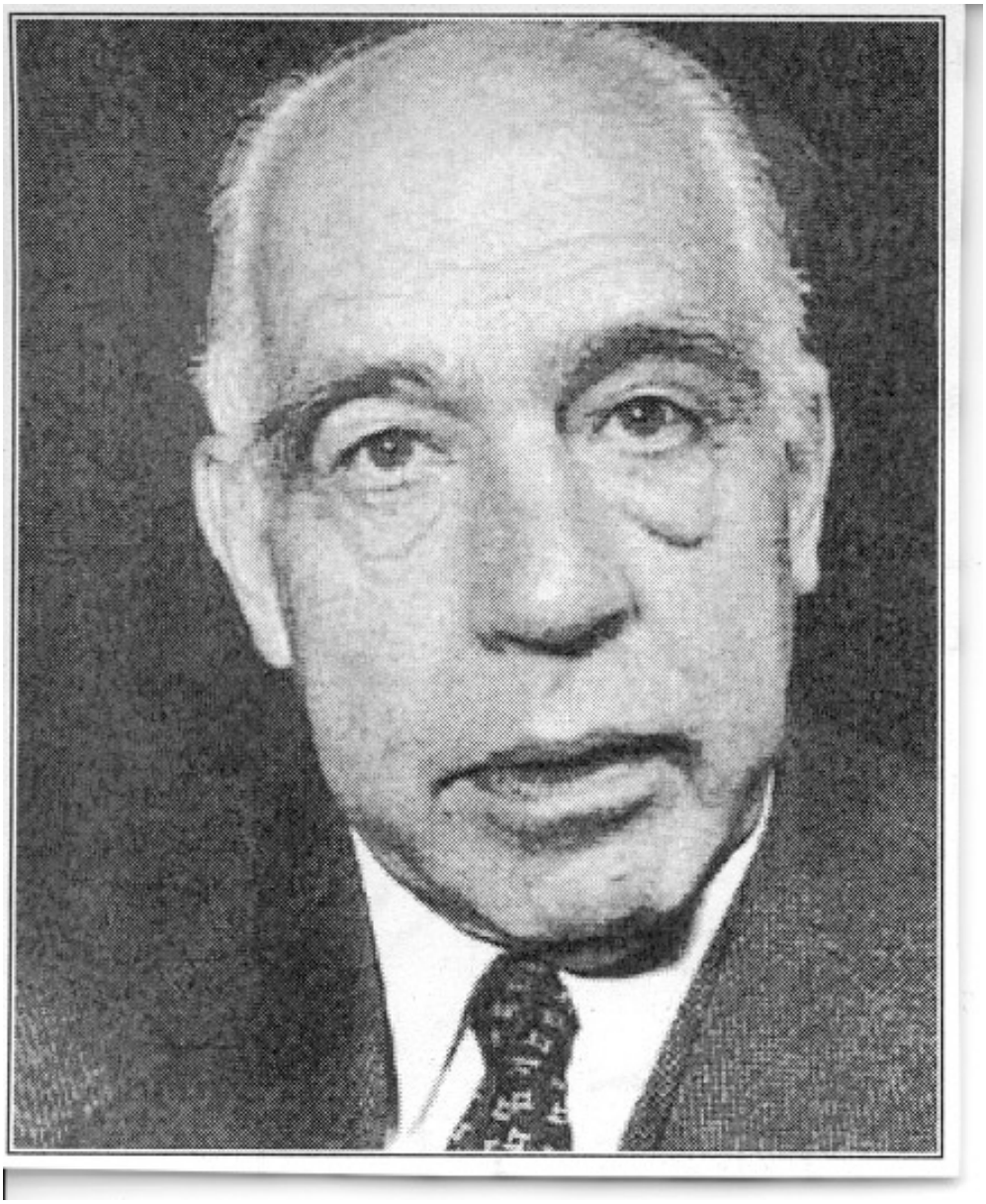

Figure 31.1: Niels Bohr: *We are all agreed that your theory is crazy. The question which divides us is whether it is crazy enough to have a chance of being correct. My own feeling is that it is not crazy enough..*

- *I am really an amateur. And if they go really into high mathematics I cant follow.*
- *Opposites are complementary.*
- *When it comes to atoms, language can be used only as in poetry.*
- *You must come to Copenhagen to work with us. We like people who can actually perform thought experiments!*
- *If anybody says he can think about quantum physics without getting giddy, that only shows he has not understood the first thing about them.*
- *It is only when an observation or measurement is made that the "wave function collapses" as one of the "possible" states of the electron becomes the "actual" state and the probability of all other possibilities becomes zero*
- *If quantum mechanics hasn't profoundly shocked you, you haven't understood it yet.*
- *There is no quantum world. There is only an abstract quantum mechanical description. It is wrong to think that the task of physics is to find out how Nature is. Physics concerns what we say about Nature.*
- *When it comes to atoms, language can be used only as in poetry. The poet, too, is not nearly so concerned with describing facts as with creating images.*
- *We are suspended in language.*
- *The opposite of a true statement is a false statement, but the opposite of a profound truth is usually another profound truth.*
- *It is maintained (in the Como lecture) that the fundamental postulate of the indivisibility of the quantum of action is itself, from the classical point of view, an irrational element which inevitably requires us to forego a causal description and which, because of the coupling between phenomena and their observation, forces us to adopt a new mode of description designated as complementary in the sense that any given application of classical concepts precludes the simultaneous use of other*

classical concepts which in a different connection are equally necessary for the elucidation of the phenomena. (Atomic Physics and the Description of Nature, 1934, introduction, p. 10)

- *It is apaulling and high treason that Schrödinger and Einstein want to strike a blow against quantum mechanics*

Chapter 32

Prandtl

32.1 Life and Work

From Aeronautics Learning Laboratory:

- *Ludwig Prandtl was born in Freising, Germany on 4 February 1875. He was an engineer by training and was endowed with rare vision for the understanding of physical phenomena, and the unusual ability to put them into simple mathematical form. Prandtl was a most able researcher and teacher, becoming professor of mechanics at the University of Hanover in 1901. From 1904 to 1953 he served as professor of applied mechanics at the University of Gottingen where he established a school of aerodynamics and hydrodynamics that achieved world renown.*

- *Prandtls discovery, in 1904, of the boundary layer led to an understanding of skin friction and drag and of the way in which streamlining reduces wing drag. His initial work on wing theory, which followed similar work by Frederick Lanchester but was carried out independently, elucidated the process of flow over an airfoil of finite span and is known as the Lanchester-Prandtl wing theory. Subsequently, Prandtl made decisive advances in boundary layer and wing theories and his work became the basic material of aerodynamics. He later contributed the Prandtl-Glaubert rule for subsonic airflow to describe compressibility effects of air at high speeds. Prandtl also made important advances in developing theories of supersonic flow and turbulence.*

- *Prandtl gave modern wing theory its practical mathematical form. He*

is considered the father of aerodynamic theory, for there is hardly a part of it to which he did not contribute, and many of its fundamental concepts originated in his fertile mind.

- *A Biographical Scetch by Johanna Vogel-Prandtl.*

Ludwig Prandtl died in Gottinger, Germany on 15 August 1953.

32.2 Confession

- *I am an engineer. If you want that way, a theoretician in engineering subjects, and I have used mathematics in the different cases of problems that I have addressed. But I have never furthered the science of mathematics through any contribution.*

From Prandtl's 1904 article *Motion of Fluids with Very Little Viscosity*:

- *A very satisfactory explanation of the physical process in the boundary layer [Grenz-schicht] between a fluid and a solid body could be obtained by the hypothesis of an adhesion of the fluid to the walls, that is, by the hypothesis of a zero relative velocity between fluid and wall. If the viscosity was very small and the fluid path along the wall not too long, the fluid velocity ought to resume its normal value at a very short distance from the wall. In the thin transition layer, however, the sharp changes of velocity, even with small coefficient of friction, produce marked results.*

- *This plan has proved to be very fruitful, in that, on the one hand, it produces mathematical formulas, which enable a solution of the problems and, on the other hand, the agreement with observations promises to be very satisfactory. To mention one instance now: when, for example, in the steady motion around a sphere, there is a transition from the motion with viscosity to the limit of non-viscosity, then something quite different from the Dirichlet motion is produced. The latter is then only an initial condition, which is soon disturbed by the effect of an ever-so-small viscosity.*

- *Sufficient account can be taken of the physical phenomena in the boundary layer between the fluid and the solid body by assuming that the fluid*

adheres to the surface and that, therefore, the velocity is either zero or equal to the velocity of the body. If, however, the viscosity is very slight and the path of the flow along the surface is not too long, then the velocity will have its normal value in immediate proximity to the surface. In the thin transition layer, the great velocity differences will then produce noticable effects in spite of the small viscosity constants.

- *As shown by closer consideration, the necessary condition for the separation of the flow is that there should be a pressure increase along the surface in the direction of the flow. As a plausible reason for the separation of the flow it may be stated that, with a pressure increase, the free fluid, its kinetic energy is partially converted into potential energy. The transition layers, however, have lost a large part of their kinetic energy and no longer possess enough energy to penetrate the region of higher pressure. They are therefore deflected laterally.*

- *On an increase of pressure, while the free fluid transforms part of its kinetic energy into potential energy, the transition layers instead, having lost a part of their kinetic energy (due to friction), have no longer a sufficient quantity to enable them to enter a field of higher pressure, and therefore turn aside from it.*

- *In given cases in certain points fully determined by external conditions, the fluid flow ought to separate from the wall. That is, there ought to be a layer of fluid which, having been set in rotation by the friction on the wall, insinuates itself into the free fluid, transforming completely the motion of the latter, and therefore playing there the same part as the Helmholtz surfaces of discontinuity.*

- *While dealing with a flow, the latter divides into two parts interacting on each other; on one side we have the "free fluid" which [is] dealt with as if it were frictionless, according to the Helmholtz vortex theorems, and on the other side the transition layers near the solid walls. The motion of these layers is regulated by the free fluid, but they for their part give to the free motion its characteristic feature by the emission of vortex sheets.*

Figure 32.1: Prandtl as the father of modern fluid mechanics recalling his 1904 break-through to modernity: *A very satisfactory explanation of the physical process in the boundary layer [Grenz-schicht] between a fluid and a solid body could be obtained by the hypothesis of an adhesion of the fluid to the walls, that is, by the hypothesis of a zero relative velocity between fluid and wall.*

Chapter 33

Motives

> Feeling and longing are the motive forces behind all human endeavor and human creations. (Einstein)

In a criminal case, a prime first question is why? Why was the crime committed? What was the motive to breach the law and risk punishment. In a criminal investigation this is often the key to resolving the case.

So why then did Boltzmann, Planck, Einstein and Bohr sell out their scientific souls? To get fame and glory? Maybe to some part, but the main motive must have been different, because the suffering was bigger than the glory and in fact the glory received largely added to the pain.

So what was then the main motive? We shall find that the sacrifice was made in the name of science, to save science from collapse, a necesssary act to remove an intolerable threat.

We shall describe the development of modern physics in physical terms of force and reaction to force. The forces present themselves as apparent paradoxes of theoretical physics, which have to be solved to save physics from credibility collapse. The forces are strong because a collapse of credibility has to be avoided, by any means at any price.

Like in a true Greek tragedy the paradoxes seem to be unsolvable without a monumental sacrifice and the drama concerns the fight between the necessity to resolve the paradox and the agony of the monumental sacrifice. It is a true Faustian drama of selling the soul in order to liberate the soul.

The forces in the form of paradoxes were:

1. Reversibility of Hamiltonian mechanics: Loschmidt's paradox.

2. Ultraviolet catastrophe of blackbody radiation.
3. Constancy of speed of light independent of observer speed: Michelson-Morley paradox.
4. d'Alembert's paradox of zero drag of inviscid flow.

The reactions to the forces of paradox and catastrophe were, respectively:

1. Molecular statistics of statistical mechanics.
2. Microscopic statistics of energy quanta.
3. Lorentz transformation of space-time.
4. Boundary layer as origin of turbulence.

The reactions came with the high price of giving up the most fundamental aspects of classical physics of

- causality and determinism,
- reality of space-time.
- large effect from small cause.

The sacrifices were monumental and had a devastating effect on modern physics letting scientific values be corrupted in politically controled climate science with consent from scientific academies.

33.1 Summary of Motives

We collect the main scientific motives:

- Boltzmann introduced statistics to explain the irreversibility of the 2nd Law.
- Planck introduced statistics of energy quanta to avoid the ultraviolet catastrophe.
- Einstein sold out space-time to solve the apparent paradox of the independence of the speed of light to an observer speed, by introducing an unphysical Lorentz transformation of space-time, to boost his career as scientist from zero.

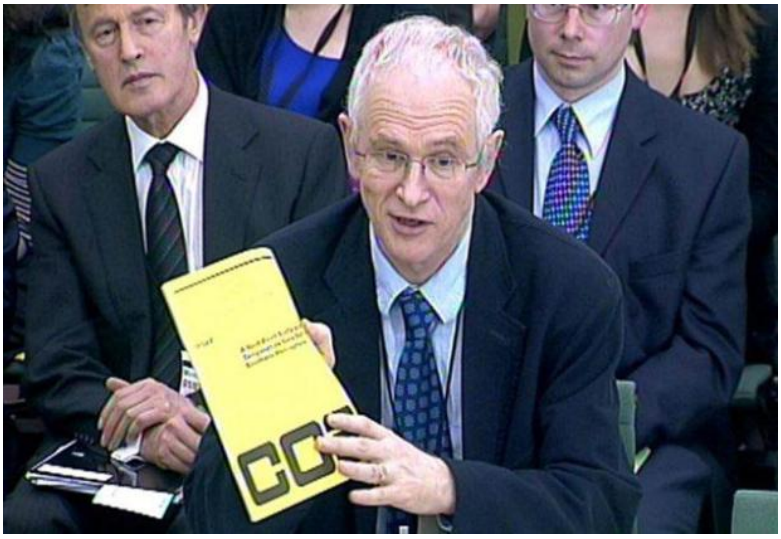

Figure 33.1: Climategate hearing with Phil Jones.

- Bohr introduced duality to get around the contradiction of being both particle and wave.
- Prandtl introduced boundary layer effects to resolve d'Alembert's paradox of zero drag of inviscid flow.

We complement with political motives and personal career motives:

- Boltzmann wanted to boost his scientific career.
- Planck had to deliver as chosen to give German science a leading position in physics.
- Einstein wanted to start a career as scientist.
- Bohr had to deliver to support his new Institute of Theoretical Physics.
- Prandtl had to deliver as chosen to give German science a leading position in mechanics.

Part VI

Witnesses

Chapter 34

Statistics: Boltzmann

34.1 Maxwell

- *By the study of Boltzmann I have been unable to understand him. He could not understand me because of my shortness, and his length was and is a stumbling blck to me.*

34.2 Schrödinger

- *Bolttzmann' circle of ideas may be aclled my first love in science. No other has thus enraptured me or will ever do so again*

34.3 Einstein

- *Neither Herr Boltzmann nor Herr Planck has given a definition of W... Usually W is put equal to the number of complexions. In order to calculate W, one needs a complete (molecular-mechanical) theory of the system under consideration. Therefore it is dubious whether the Boltzmann principle has any meaning without a complete molecular-mechanical theory or some other theory which describes the elementary processes (and such a theory is missing).*

- *Boltzmann's work is not easy to read. There are great physicists who have not understood it (e.g. Bohr).*

34.4 Sommerfeld

- *Thermodynamics is a funny subject. The first time you go through it, you dont understand it at all. The second time you go through it, you think you understand except a few small points. The third time you go through it, you know that you dont understand it, but by that time you are so used to it, that it doesnt bother you any more.* (Sommerfeld).

34.5 Loschmidt

- *There is apparently a contradiction between the law of increasing enropy and the principles of Newtonian mechanics, since the latter do not recognize any difference between past and future times. This is the so-called reversibility paradox (Umkehreinwand) which was ad- vanced as an objection to Boltzmann's theory by Loschmidt 1876-77.* (Translators foreword to Lectures on Gas Theory by Boltzmann [3]).

34.6 Bohr

- *In my impudent way I would say that...no one...not even the dear Lord himself - can know what an expression like throwing a dice means.*

34.7 Feynman

- *Where does irreversibility come from? It does not come form Newton's laws. Obviously there must be some law, some obscure but fundamental equation. perhaps in electricity, maybe in neutrino physics, in which it* **does** *matter which way time goes.* (The Feynman Lectures on Physics 1963)

34.8 Various

- *The 2nd Law cannot be derived from purely mechanical laws. It carries the stamp of the essentially statistical nature of heat.* (Bergman in Basic Theories of Physics 1951)

Chapter 35

Radiation: Planck

Where the senses fail us, reason must step in. (Galileo)

35.1 Schrödinger

- *That the photoelectric effect...offers the greatest conceptual difficulty for the achievement of the a classical theory is becoming ever more evident to me. Unfortunately I can find so far...no solution at all to the problem. I mean I se no concrete idea or calculation that could bring one closer to understanding it. And to phantasize about it, as could perhaps be done, is in my view as easy as it is worthless...*

35.2 James Jeans

- *This was completely in accordance with current ideas, but Planck now introduced the startling assumption that the vibrators did notemit energy in a continuous stream, but by a series of instantaneous gushes. Such an assumption was in flagrant opposition to Maxwell's electromagnetic laws and to the Newtonian mechanics; it dismissed continuity from nature, and introduced a discontinuity for which there was so far no evidence. Each vibrator was supposed to have a certain unit of radiation associated with it, and could emit radiation only in complete units.*

35.3 Einstein

- *Plancks derivation (of his radiation law) was of unmatched boldness*

- *There are now two theories of light, both in-dispensible and - as one admit despite twenty years of tremendous effort on the part of theoretical physicists - without any logical connection*

35.4 Bohr

- *A new epoch was inaugurated in physical sciences by Planck's discovery of the quantum of action*

35.5 Millikan: NP in Physics 1923

- *But the conception of localized light-quanta out of which Einstein got his equation must still be regarded as far from established. Whether the mechanism of interaction between ether waves and electrons has its seat in the unknown conditions and laws existing within the atom, or is to be looked for primarily in the essentially corpuscular Thomson-Planck-Einstein conception of radiant energy, is the all-absorbing uncertainty upon the frontiers of modern Physics* (*The electron and the light-quanta from the experimental point of view*, Nobel Lecture, May 23, 1923).

- *Despite the apparently complete success of the Einstein equation (for the photoelectric effect), the physical theory on which it was designed to be the symbolic expression, is found so untenable that Einstein himself, I believe, no longer holds to it .*

35.6 Bohr

- *To derive the Planck radiation law, it is essential that the energy of the atom has discrete vakues and change discontinuosly.*

35.7 Lotte Warburg sister to Otto Warburg NP in Physics

- *Planck has become a stone-aged man, stooped, pitiful. I saw shuffling through the park, untidy and unkempt. He said that no on asked him about things anymore, that science was no longer worth anything.* (1933)

- *Why does he not resign. Why does he stay on and allow himself to discharge people from the Kaiser Wilhelm Institute?*
- *A senile old man who is losing the remnants of the courage he apparently never had.*

Chapter 36

Relativity: Einstein

The Milky Way is nothing else but a mass of innumerable stars planted together in clusters. (Galileo)

36.1 Lorentz

- *I call the variable t' "local time" and emphasize that it should* **not be confused with real time**.

- *Length contraction and time dilation are ways of regarding things and do not correspond to physical reality.* (Max Born, the inventor of the statistical interpretation of the wave function)

- *Lorentz: A transformation of the time was necessary. So I introduced the conception of a local time which is different for all systems of reference which are in motion relative to each other. But I never thought that this had anything to do with real time. This real time for me was still represented by the old classical notion of an absolute time, which is independent of any reference to special frames of coordinates. There existed for me only this true time. I considered my time transformation only as a heuristic working hypothesis*(Lorentz)

Figure 36.1: The accussed with witness.

36.2 Wilhelm Wien

Wilhelm Wien (1864 - 1928) received the NP for Physics in 1911 for his displacement law concerning the radiation emitted by the perfectly efficient blackbody.

- *But no Anglo-Saxon can understand relativity.* (Said at a dinner in 1910, teasing Ernest Rutherford, who replied, *No, they have too much sense.*)

36.3 Hannes Alfvén NP for Physics in 1970

- *Many people probably felt relieved when told that the true nature of the world could not be understood except by Einstein and a few other geniuses who were able to think in four dimensions. They had tried to understand science, but now it was evident that science was something to* **believe in**, *not something which should be* **understood** [**?**].

36.4 Oppenheimer

- *Princeton is a madhouse and Einstein is completely cuckoo.*

36.5 Ehrenfest

- *Einstein I am ashamed of you...you are arguing against the new quantum theory jsut as your opponents argue about relativity theory.*

36.6 Louis Essen

The world's leading scientist on time measurement, Louis Essen (1908-97), Fellow of the Royal Soceity and inventor of the atomic clock (used with his approval in relativity experiments), rejects Einstein's relativity:

- *Einstein's theory of relativity is invalidated by its internal errors. Einstein's use of a thought experiment, together with his ignorance of experimental techniques, gave a result which fooled himself and generations*

of scientists. Claims frequently made that the theory is supported by experimental evidence do not withstand a close scrutiny.; Insofar as the theory is thought to explain the result of the Michelson-Morley experiment I am inclined to agree with Soddy that it is a swindle; and I do not think Rutherford would have regarded it as a joke [as said in 1954] had he realised how it would retard the rational development of science.

Chapter 37

Quantum Mechanics: Bohr

> Could one not maintain determiism by making it an acrticle of faith? Must one necessarily elevate indeterminism to a principle? (Lorentz)

37.1 Lost Souls of Modern Physics

The rumble in the jungle big controversy of modern physics is that between Einstein-Schrödinger on one side and Bohr-Heisenberg as the advocates of the Copenhagen Interpretation of quantum mechanics on the other side, a battle eventually lost by Einstein-Schrödinger as the preparations for Wold War II took over science.

Einstein got the quantum ball rolling in a deal with Lucifer, but repented and maybe was saved like the Faustus of Goethe, while Bohr jumped on the roller coaster and never showed any inclination to repent, and maybe his fate is closer to that of the Faustus of Marlowe.

Einstein lost against Bohr, but saved his soul from Lucifer, while Bohr won both war and science but lost his soul to Lucifer.

37.2 Einstein

- *The soothing philosophy – or religion? – of Hesienberg-Bohr is so cleverly concocted that fro the present it offers the believers a sof resting pillow from which they are not easily chased away. Let us therefore let them rest...This religion dose damned little for me.*

- *Bohr thought clearly, wrote obscurely, and thought of himself as a prophet*
- *But what is light really? Is it a wave or a shower of photons? There seems no likelihood for forming a consistent description of the phenomena of light by a choice of only one of the two languages. It seems as though we must use sometimes the one theory and sometimes the other, while at times we may use either. We are faced with a new kind of difficulty. We have two contradictory pictures of reality; separately neither of them fully explains the phenomena of light, but together they do.* (with Leopold Infeld in The Evolution of Physics).
- *You (Born) believe in the God who plays dice, and I in complete law and order in a world which objectively exists, and which I, in a wildly speculative way, am trying to capture...Even the great initial success of quantum theory does not make me believe in the fundamental dice game, although I am well aware that our younger colleagues interpret this as a consequence of senility. No doubt that day will come when we shall see whose instinctive attitude was the correct one.*
- *What we call science has the sole purpose of determining what* **is**.
- *This epistemology-soaked orgy ought to come to an end...No doubt, however, you smile at me and think that, after all, many young heretic turns into an old fanatic, and many young revolutionary becomes an old reactionary.*
- *Almost all other fellows do not look from facts to the theory but from the theory to the facts; they cannot extricate themselves from a once accepted conceptual net, but only flop about it in a grotesque way.*

37.3 Dirac

- *Now we have to start all over again, because Einstein proved that it does not work*

37.4 Bohr

- *Einstein, stop telling God what to do*

in response to Einstein's: *God does not play dice with the universe.*

37.5 Heisenberg

- *The Copenhagen interpretation of quantum theory starts from a paradox.*

37.6 Dirac

- *I feel that we do not have definite physical concepts at all if we just apply working mathematical rules; that's not what the physicist should be satisfied with.*

37.7 Schrödinger

- *I am opposing not a few special statements of quantum physics held today (1950s), I am opposing as it were the whole of it, I am opposing its basic views that have been shaped 25 years ago, when Max Born put forward his probability interpretation, which was accepted by almost everybody.*

- *If all this damned quantum jumping were here to stay, then I shall be sorry I ever got involved with quantum theory.*

- *There is a difference between a shaky or not sharply focused photograph and a photograph of clouds and fog banks.* (Schrödinger on the Copenhagen Interpretation in *The Present Situation in Quantum Mechanics* 1935)

- *Bohr's standpoint, that a space-time description is impossible, I reject ad limine...Today I no longer like to assume that an individual process of this kind is "absolutely random" that is completely undetermined. I no longer believe today that this conception accomplishes much.* (1926)

- *With very few exceptions (such as Einstein and Laue) all the rest of the theoretical physicists were unadulterated asses and I was the only sane person left...The one great dilemma that ail us... day and night*

is the wave-particle dilemma... So unable is the good average physicist to believe that any sound person could refuse to accept the Copenhagen oracle... (Schrödinger in a letter to Synge 1959)

- *I no longer like to assume with Born that an individual process is "absolutely random". I no longer believe that this conception accomplishes much.* (Schrödinger in a letter to Wilhelm Wien in 1926)

- *It seems to me that the concept of probability is terribly mishandled these days. A probabilistic assertion presupposes the full reality of its subject. No reasonable person would express a conjecture as to whether Caesar rolled a five with his dice at the Rubicon. But the quantum mechanics people sometimes act as if probabilistic statements were to be applied just to events whose reality is vague.* (Schr odinger to Einstein 1950)

- *De Broglie, the creator of wave mechanics, accepted the results of quantum mechanics just as Schr odinger did, but not the statistical interpretation.* (Born in the Born-Einstein Letters)

- *This inhibits us from accepting in a naive way a "blurred model" as an image of reality...There is a difference between a shaky or not sharply focussed photograph and a photograph of clouds and fog banks.* (Schrödinger about the Copenhagen interpretation)

- *Bohr wants to complement away all difficulties.*

- *Almost all other fellows do not look from the facts to the theory but from theory to the facts; they cannot extricate themselves from a once accepted conceptual net, but only flop about it in a grotesque way.*

- *Bohr is completely convinced that any understanding in the usual sense of the word, is impossible. Therefore the conversation is almost immediately driven into philosophical questions, and soon you no longer know whether you really take the position he is attacking, or whether you really must attack the position that he is defending.*

- *We cannot really change our forms of thought, and what we cannot understand within these forms, we cannot understand at all.*

- *If I were not thoroughly convinced that Bohr is honest and really believes in the relevance of his - I do not say theory but - catchword (complementarity), I should call it intellectually wicked.*

- *Most of my nearer colleagues (theoretical physicists) have formed the opinion that I am - naturally enough - in love with "my" great success in life (wave mechanics) reaped et the time I still had all my wits at my command (in 1926 at the age of 36) and therefore, so they say, I insist upon the view that "all is waves". Old-age dot-age closes my eyes towards the marvelous discovery of "complementarity". So unable is the good average theoretical physicist to believe that any sound person could refuse to accept the Copenhagen oracle.*

37.8 Heisenberg

- *Bohr was trying to allow for the simultaneous existence of both particle and wave concepts, holding that, though they were mutually exclusive, both together were needed for a complete description of atomic processes.*

- *Bohr's influence on the physics and the physicists of our century was stronger than that of anyone else, even that of Einstein.*

37.9 Richard Feynman NP in Physics 2965

- *I think I can safely say that nobody understands quantum mechanics.* (Richard Feynman in The Character of Physical Law 1965).

37.10 Murray Gell-Mann NP in Physics 19??

- *Quantum mechanics, that confusing discipline which none of us really understands, but which we know how to use*

Figure 37.1: Shadows by Feynman.

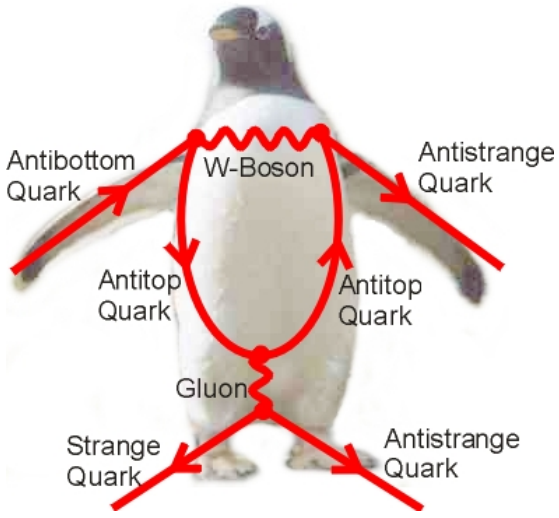

Figure 37.2: Feynman diagram explaining the meaning of quantum field theory.

37.11 Sir Roger Penrose

- *Quantum mechanics is an incredible theory that explains all sorts of things that could not be explained before ...but it doesn't make any sense, and there is a simple reason: It should describe the world in a completely deterministic way, but it doesn't. The biggest figures in quantum mechanics, Schrdinger, Einstein, and Paul Dirac, were all quantum skeptics in a sense. I blame quantum mechanics, for increasingly fantastical theoretical physics, because people say, Well, quantum mechanics is so nonintuitive; if you believe that, you can believe anything that is non intuitive. When physicists finally understand the core of quantum physics, I think it will be a beautiful theory.* (Sir Roger Penrose in Princeton Lecture 2003

- *Can it really be true that Einstein, in any significant sense, was so profoundly "wrong" as the followers of Bohr maintain? I do not believe so. I would, myself, side strongly with Einstein in his belief in a submicroscopic reality, and with his conviction that present-day quantum mechanics is fundamentally incomplete.*

37.12 Murray Gell-Mann NP in Physics 1969

- *Niels Bohr brainwashed a whole generation of theorists into thinking that the job of interpreting quantum theory was done 50 years ago.*

37.13 Various Voices

- *For Bohr, complementarity was an almost religious belief that the paradoxes of the quantum world must be accepted as fundamental, not to be "solved" or trivialized by attempts to find out "whats really going on down there." Bohr used the word in an unusual way: the "complementarity" 'of waves and particles, for example (or of position and momentum), meant that when one existed fully, its complement did not exist at all* (Louisa Gilder, The Age of Entanglement).

37.14 Walter Kohn NP in Chemistry 1998

- *In general the many-electron wave function $\psi(x_1, ..., x_N)$ for a system of N electrons is not a legitimate scientific concept when $N \geq N_0$, where $N_0 \approx 10^2 - 10^3$.*

37.15 Einstein

- *You are the only person with whom I am actually willing to come to terms. Almost all the other fellows do not look from the facts to the theory but from the theory to the facts: they cannot extricate themselves from a once accepted conceptual net, but only flop about in it in a grotesque way.* (Einstein to Schrödinger on the Copenhagen Interpretation 1935)

37.16 Pauli

- *I was unable to give a logical reason for the exclusion principle or to deduce it from more general assumptions. I had always the feeling and I still have it today, that this is a deficiency... From the point of view of logic, this lecture has no conclusion.* (Wolfgang Pauli, Nobel Lecture 1945 On Exclusion principle and quantum mechanics)

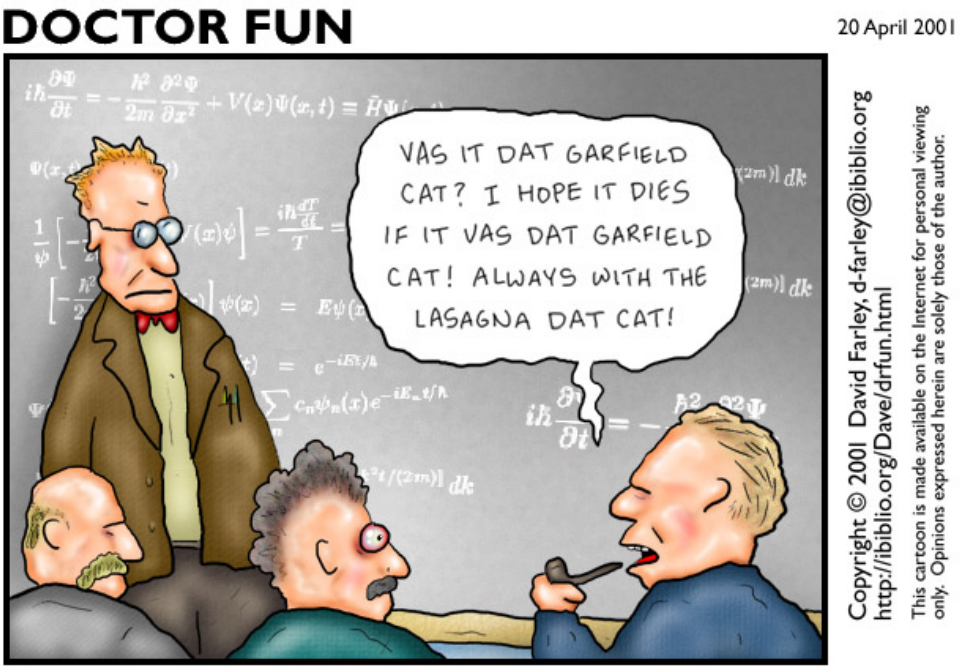

Figure 37.3: The unbearable Bohr.

Chapter 38

Boundary Layer: Prandtl

Prandtl's control of mathematical method and tricks was limited. (Von Karman, Prandtl's student)

38.1 Ludwig Föppl, Prandtl's Teacher

- *By that time, there had been no theoretical explanation for the drag experienced by a body in a flowing liquid or in the air. The same applies to the lift on an airplane. Classical mechanics was either based on frictionless flow, or, when friction was taken into account, mathematical difficulties were so enormous that hitherto, no practicable solution had been found. Prandtl's idea that led out of this bottleneck was the assumption that a frictionless flow was everywhere with the exception of the region along solid boundaries. Prandtl showed that friction, however small, had to be taken into account in a thin layer along solid walls. Since that time, this layer has been known as Prandtl's boundary layer. Prandtl could prove theoretically and experimentally that the boundary layer can separate from the surface of a body immersed in a flowing fluid at suitable points, to roll up and leave the body as an isolated vortex.*

38.2 Von Karmann

- *Prandtl, an engineer by training, was endowed with rare vision for the understanding of physical phenomena and unusual ability in putting them into relatively simple mathematical form. His control of mathematical method and tricks was limited; many of his collaborators and followers surpassed*

him in solving difficult mathematical problems. But his ability to establish systems of simplified equations which expressed the essential physical relations and dropped the nonessentials was unique, I believe, even when compared with his great predecessors in the field of mechanics men like Leonhard Euler and d'Alembert.

38.3 Prandtl and the Nobel Prize

- *Prandtl was never awarded a Nobel Prize for his work in fluid dynamics because rumor had it that the Committee was reluctant to award the prize for work in classical physics.*

38.4 John D. Anderson [2]

- *During the week of 8 August 1904, a small group of mathematicians and scientists gathered in picturesque Heidelberg, Germany, for the Third International Mathematics Congress.*
- *One of the presenters at the congress was Ludwig Prandtl, a 29-year-old professor at the Technische Hochschule (equivalent to a US technical university) in Hanover. Prandtls presentation was only 10 minutes long, but that was all the time needed to describe a new concept that would revolutionize the understanding and analysis of fluid dynamics.*
- *His presentation introduced the concept of the boundary layer in a fluid flow over a surface. The companion paper, entitled 'On the Motion of Fluids with Very Little Friction, was only eight pages long, but it would prove to be one of the most important fluid dynamics papers ever written.*
- *In 2005, concurrent with the World Year of Physics celebration of, among other things, Albert Einstein and his famous papers of 1905, we should also celebrate the 100th anniversary of Prandtls seminal paper. The modern world of aerodynamics and fluid dynamics is still dominated by Prandtl's idea.*
- *By every right, his boundary layer concept was worthy of the Nobel Prize.*
- *Prandtls idea went virtually unnoticed by anybody outside of Gottingen for several years, the aerodynamics community paid little attention, especially outside of Germany. Finally in 1921, with Theodore von Karman, a former student of Prandtl's, the boundary-layer theory finally began to receive more attention and acceptance in the technical community. Since the mid 1920s,*

work aimed at advancing, extending, and applying boundary layer theory has increased exponentially.

- *Such work has created lifetime careers for a large number of fluid dynamicists and aerodynamicists.*

38.5 Von Karman

- *Prandtl, an engineer by training, was endowed with rare vision for the understanding of physical phenomena and unusual ability in putting them into relatively simple mathematical form.*
- *His control of mathematical method and tricks was limited.*
- *But his ability to establish systems of simplified equations which expressed the essential physical relations and dropped the nonessentials was unique, I believe, even when compared with his great predecessors in the field of mechanics - men like Leonhard Euler and d'Alembert.*

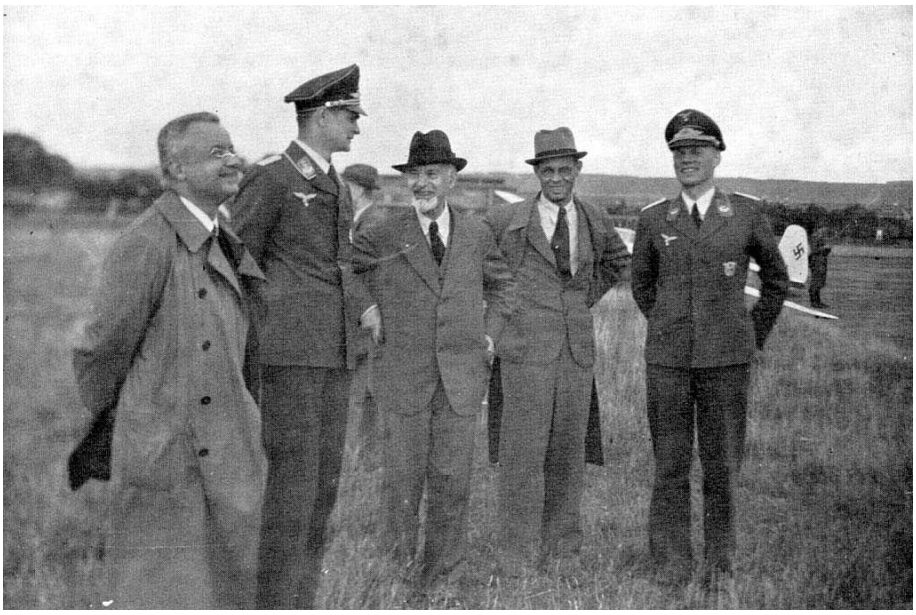

Figure 38.1: Prandtl inspecting the The Ho III 1938 Rhön Contest Challenger
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Part VII

Background Material

Chapter 39

Nobel Prize: Planck

The Nobel Prize in Physics 1918 was awarded (in 1919) to Max Planck:

- *in recognition of the services he rendered to the advancement of Physics by his* **discovery of energy quanta**.

It took the Nobel Committee more than 10 years to come to this conclusion, because Planck's new concept of a smallest quantum of energy was so difficult to swallow, described by the Swedish mathematician Ivar Fredholm as "hardly plausible". In 1918 the Committee gave in under pressure to give the prize to Bohr and Einstein, which required a prize to Planck first. The presentation speech by Ekstrand stated:

- *Planck's radiation theory is, in truth, the most significant lodestar for modern physical research, and it seems that it will be a long time before the treasures will be exhausted which have been unearthed as a result of Planck's genius.*

- *Planck's formula contained two constants; one, as was demonstrated, gave the number of molecules in a gram molecule of matter. Planck was also the first to succeed in getting, by means of the said relation, a highly accurate value for the number in question, the so-called Avogadro constant.*

- *The other constant, the so-called Planck constant, proved, as it turned out, to be of still greater significance, perhaps, than the first. The product $h\nu$, where ν is the frequency of vibration of a radiation, is actually the smallest amount of heat which can be radiated at the vibration frequency ν. This theoretical conclusion stands in very sharp opposition to our earlier concept of the radiation phenomenon.*

Planck was thus viewed as having "discovered" a physical phenomenon of "energy quanta", which in fact was a "theoretical conclusion". This contradiction has come to form the ideology of modern physics made possible by breaching the classical holy distinction between reality and mathematical model allowing concepts like duality and complementarity.

Chapter 40

Nobel Prize: Einstein + Bohr

In 1922 the Nobel Prize in Physics was awarded to Bohr and at the same time with a one-year delay the 1921 Prize was given to Einstein. The pressure to give Einstein the Prize had mounted in the aftermath of the First World War with Einstein rising as a symbol for German-British reconciliation, but relativity theory skeptics had been dominating the Nobel Committee, until in two of them (Hasselberg and Granquist) passed away and were replaced by a strong proponent of modern physics Oseen and Siegbahn. The 1922 Prize came out from a battle between to following key actors:

- Gullstrand (against Einstein),
- Arrhenius (against Einstein),
- Oseen (for Einstein), new member of the Committee 1922.

Gullstrand had consistently blocked giving the Prize to Einstein despite many nominations during 1910-21, including one by Bohr in 1920, based on his harsh criticism: of Einstein's relativity theory:

- *Time and space can be described variously, but even if absolute time cannot be measured, thereof one cannot deduce that that time in its essence is relative, or even that it is advantageous to describe time a relative.*
- *.(Einstein's thought experiments concern)...relativity that lies entirely outside the realm of experience and can therefore only be embraced by belief.*
- *Relativity theory has the character of an article of faith rather than a scientific hypothesis, and in accordance with the doctrine's own needs Nature is rearranged so that any falsification is unthinkable.*

Gullstrand thus had demolished Einstein's relativity theory and Einstein's 1905 work on the photoelectric effect was by Arrhenius put into perspective as follows:

- *It cannot be denied that Einstein's idea (the law of the photoelectric effect) was a stroke of genius. However, it was natural and lay close to hand after the results of Leonard's, J-J- Thompson's and Planck's great contributions. When it was formulated it was only a tentatively poorly developed hunch, based on qualitative and partially correct observations. It would look peculiar if a prize was awarded to this particular work.*

The negative attitude to Einstein changed with the report by the new member of the Committee Oseen entitled *Einstein's law of the photoelectric effect* plus a second report that also landed Bohr a prize [1]:

- *Convincing the other three members that Einstein's "law" was a fundamental law of Nature . and that Bohr's atomic theory directly rested on it, he managed to pilot the two cases through unproven waters into a new and safe harbor where fundamental laws and constants still counted as benchmarks.*

- *It was formally decided that an official clarification should be inserted into Einstein's diploma saying that the prize had nothing to do with either of the man's theories of relativity.*

In his report to the committee Oseen argues as follows:

- *The one who pulled the theory of heat radiation out of that isolation (black-body radiation), the first one to show that the magnitude of (Planck's constant) h has a radical significance for the whole of atomic physics, is Einstein.*

- *This, the very first of his contributions to quantum theory is the one that reaches deepest, his proposition that the emission and absorption of light occurs in such a way that light quanta with energy $h\nu$ are emitted and absorbed. The law of the photoelectric effect was an immediate application of this proposition...an analysis which in its originality and penetrating mind has few equals in theoretical physics.*

- *The validity of Einstein's original proposition regarding the quantum character of absorption and emission of light (at its microphysical interface with matter) quantitatively expressed in his law of the photoelectric effect was one of the prerequisite conditions on which Bohr built his atomic theory. Almost all confirmations of Bohr's theory and with it all spectroscopic confirmations are at the same time confirmation's of Einstein's law.*

- *The Einsteinian proposition and Bohr's content-wise identical frequency conditions are currently one of the most certain laws that obtain in physics.*

The Einstein Prize motivation found the thin edge between plus and minus infinity:

- *For his services to theoretical physics, in particular for his* **discovery of the law of the photoelectric effect** *($P + W = h\nu$).*
- *...without taking into account the value which will be accorded your relativity and gravitation after these are confirmed in the future (in a cover letter).*

In short: Einstein's derivation of the law of the photoelectric effect and his relativity theory were rejected and what remained was only a "discovery" of a physical law (which in fact had been "discovered" before by Hertz), which was then boosted as the foundation of modern physics.

40.1 Double Play of Quantum Mechanics

Quantum mechanics is based on a confusion between eigenvalues (discrete numbers) and eigenstates (continuous functions):

- discrete quanta of energy and light (eigenstates)
- discrete atomic energy levels (eigenvalues)

Chapter 41

Atomic Bomb: Einstein + Bohr

41.1 Einstein

Einstein did not directly participate in the invention of the atomic bomb, but he was instrumental in facilitating its development. Einstein started out as an "absolute pacifist", changed his mind when Hitler took power in 1933. Einstein's greatest role in the invention of the atomic bomb was signing a letter to President Franklin Roosevelt urging that the bomb be built. The splitting of the uranium atom in Germany in December 1938 plus continued German aggression led some physicists to fear that Germany might be working on an atomic bomb.

The atomic bombings of Japan occurred three months after the surrender of Germany, whose potential for creating a Nazi a-bomb had led Einstein to push for the development of an a-bomb for the Allies. Einstein withheld public comment on the atomic bombing of Japan until a year afterwards. In November 1954, five months before his death, Einstein summarized his feelings about his role in the creation of the atomic bomb:

- *I made one great mistake in my life... when I signed the letter to President Roosevelt recommending that atom bombs be made; but there was some justification - the danger that the Germans would make them.*
- *I am sure that President Roosevelt would have forbidden the atomic bombing of Hiroshima had he been alive.*

41.2 Bohr

Bohr showed in 1939 that a chain reaction was theoretically possible for the rare U-235 isotope, and thus in a sense invented the atomic bomb, but believed, because

U-235 comprised less than 1% of uranium and was so difficult to separate, that a bomb could not be made in the near future.

Bohr joined the Manhattan project in Dec 1943 under the code name *Nicholas Baker* and played an important role as the knowledgeable "father" of the project. Bohr played down his role by:

- *They didn't need my help in making the atom bomb.*

During World War II Bohr did not argue against using the atomic bomb, focussing instead on international control and scientific openness. But after the atomic bomb was used on Japan Bohr told friends: *The frightening thing was... that it was not necessary at all.* Bohr continued to work for international control of nuclear weapons until his death in 1962.

Figure 41.1: The mushroom cloud of the atomic bomb over Nagasaki Aug 9 1945 11.02 am.

Chapter 42

Copenhagen Interpretation

I cant imagine that an electron hops around like a flea. (Schrödinger)

- *I don't like it (quantum mechanics) and I'm sorry I ever had anything to do with it.* (Schrödinger)
- *The verbal interpretation, on the other hand, i.e. the metaphysics of quantum physics, is on far less solid ground. In fact, in more than forty years physicists have not been able to provide a clear metaphysical model.* (Schrödinger)
- *The soothing philosophy - or religion? - of Heisenberg-Bohr is so cleverly concocted that for the present it offers the believers a soft resting pillow from which they are not easliy chased away. Let us therefore let them rest.* (Einstein)

The Schrödinger equation developed by the 39 year old Austrian physicist Erwin Schrödinger in a sequence of 4 articles in 1926, expresses a balance of kinetic and potential energies of a set of interacting negatively charged electrons and positively charged kernels in the form of a partial differential equation. The potential energy has contribution from attractive and repulsive forces. A solution of Schödinger's equation is called a wave-function . Schrödinger solved the equation for the one-electron problem of the Hydrogen atom.

Formally the Schrödinger equation is a differential equation in $3N$ space dimensions plus time, where N is the number of electrons and kernels, which makes it impossible to solve exactly even for N rather small, and Nobel Laureate Walter Kohn insists that for $N > 100 - 1000$ the wave-function is not

a legitimate scientific concept. In other words, it does not exist! Schrödinger writes in the 4th article:

The wave-function itself cannot be given a direct interpretation in three-dimensional space, as in the one-electron problem, because it is a function in configuration space, not in real space.

The wave equation apparently exists as a string of symbols on piece of paper or computer screen, but a wave-function as a well defined mathematical object satisfying the equation, does not seem to exist. What are the consequences of Kohn's insight? Is it important, or of marginal interest? Let's seek an answer.

Lets start with making clear that there is a difference between saying "golden mountain" and a physical mountain made out of gold. Just by pronouncing the properties of something, it does not magically bring what you describe into physical existence, unless you are magician.

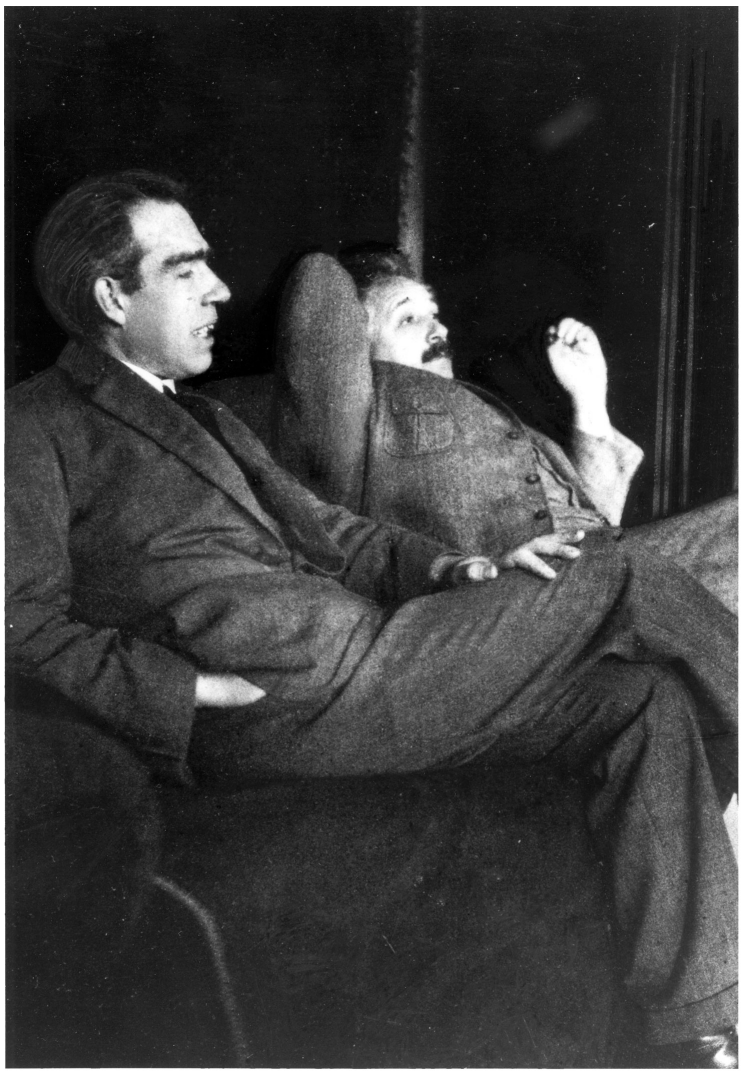
As soon as Schrödinger had formulated his formally multi-dimensional wave equation acting in a $3N$-dimensional "configuration space", heated debates started with Bohr , Heisenberg and Born on how to interpret the wave-function in physical terms. Born came up with a probabilistic interpretation which forcefully was advocated by Bohr and Heisenberg into the Copenhagen Interpretation :

the square of the modulus of the multi-dimensional wave-function is a probability distribution of the configurations of N interacting particles.

Schrödinger objected to any talk about "particles" since his equation was a wave equation and not a particle equation, and thus objected to the Copenhagen Interpretation leading into the cumbersome concepts of wave-particle duality, wave-function collapse and complementarity.

But Schrödinger had no better interpretation of the multi-dimensional wave-function and thus was overpowered in particular during a visit to Bohr's institute in Copenhagen in September 1926 as described by Heisenberg:

- *The discussion between Bohr and Schrödinger began at the railway station in Copenhagen and was tried on every day from early morning to late night....It will scarcely be possible to reproduce how passionate the discussion was carried from both sides....After some days Erwin became ill with a feverish cold. Bohr sat on the bed and continued the argument: "But surely Schrödinger, you must see". But Erwin did not see, and indeed never did see, why it was necessary to destroy the space-time description of atomic processes.*



NIELS BOHR OG ALBERT EINSTEIN,
1925,
FOTOGRAFERET AF PAUL EHRENFEST

Figure 42.1: Bohr and Einstein deep into a debate about the physical meaning of quantum mechanics.

42.1 The 5th Solvay Conference 1927

The objective of the fifth Solvay Conference in Brussels in 1927 on *Electrons and Photons* was to find the soul of modern physics by clarifiying the meaning of quantum mechanics and its description of the nature of reality. Bohr believed he had found the answer, but it remained for Bohr to convince Einstein who had not yet been dethroned as the king of physics and so the leading physicists of the world assembled with great expectancy to witness a shoot-out between two giants.

- *We consider quantum mechanics to be a closed theory, whose fundamenta physical and mathematical assumptions are no longer susceptible of any modification.* (Born-Heisenberg)

- *Mr Schrödinger says at the end of his report that the discussion he has given reinforces the hope that when our knowledge will be deeper it will be possible to explain and to understand in three dimensions the results provided by the multi-dimensional theory. I see nothing in Mr Schrödinger's calculation that would justify this hope.* (Heisenberg)

- *Bohr towering completely over everybody. At first not understood at all (Born was not there), then step by step defeating everybody....Einstein all the time with new examples...Bohr constantly searching for the tools to crush one example after the other...Oh that was priceless. (Ehrenfest)*

42.2 The EPR Controversy 1935

Together with Podolsky and Rosen, Einstein posed in May 1935 the *Can Quantum Mechanical Description of Physical Reality be Considered Complete?* in a four page article in *Physical Review*, referred to as the EPR paper. New York Times took up the story under the the headline *Einstein Attacks Quantum Theory*

- *Professor Einstein will attack science's important theory of quantum mechanics, a theory of which he was sort of grandfather*

The idea of EPR was to give an example showing that both momentum and position of a particle could be viewed to be determined at the same time,

thus contradicting *Heisenberg's Uncertainty Principle*, which was the loophole though which the Copenhagen Interpretation always managed to escape contradictions.

Bohr responded in July in *Physical Review* using his usual tactics of rejecting physical reality independent of observations insisting that observations are both necessary for the existence of the physical reality and also disturb the same physical reality. This was the final punch below the belt which sent Einstein down for good, and Bohr then turned from philosophic sophistry to the practical physics of the atomic bomb predicting that the uranium-235 isotope would undergone nuclear fission when bombarded by slow-moving neutrons. The game was over.

Chapter 43

Copenhagen Play

Copenhagen is a play by Michael Frayn, based around an event that occurred in Copenhagen in 1941, a meeting between Bohr and Heisenberg, which debuted in London in 1998. It ran for more than 300 performances at the National Theatre in London and opened on Broadway at the Royale Theatre on April 11, 2000 and ran for 326 performances.

The play is about the development of the atomic bomb during the 2nd World War: Bohr left Denmark for the US to join the Manhattan project leading to the bombs over Hiroshima and Nagasaki, while Heisenberg remained in Germany and (according to the play) discouraged German war effeorts from constructing a bomb.

Theatrically, the most dramatic moment in the play occurs as Heisenberg, at Bohr's urging, performs the crucial calculation for the critical mass of U-235 that would have given Germany the key to the bomb:

Bohr: *Why are you confident that it is going to be so reassuringly difficult to build a bomb with 235? Is it because you've done the calculation?*

Heisenberg: *The calculation?*

Bohr: *Of the diffusion in 235. No, it's because you haven't calculated it. You haven't considered calculating it. You hadn't consciously realized there was a calculation to be made.*

Heisenberg: *And of course now I have realized. In fact it wouldn't be all that difficult. Let's see t he scattering cross-section is s about 6 x 10-24, so the mean free path would be , Hold on...*

Bohr knew how to make the calculation and did it. Heisenberg probably knew how to make it, but did not do it.

When history was written after the war, Bohr came out as the good guy who constructed the bomb that saved the free world, while Heisenberg on the other side was the bad guy who did not construct the bomb that would have killed the free world.

This is the most basic Faustian drama of all: What is the responsibility of the scientist? To science, to society, to freedom of thought. What is the scientists responsibility for a bomb which can save his country, and maybe the world?

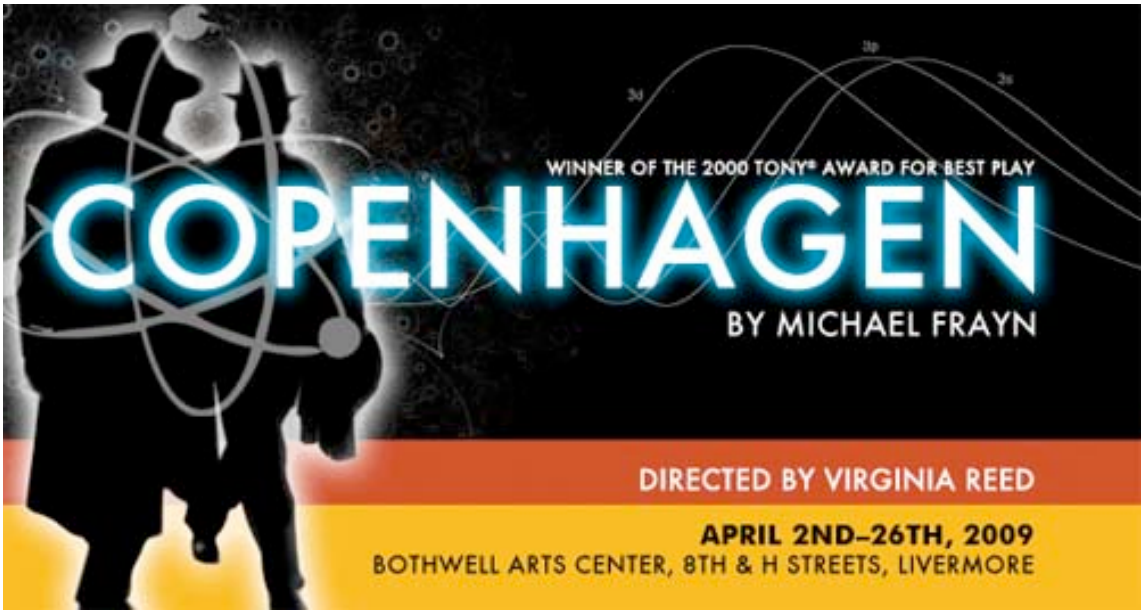


Figure 43.1: Play of Atoms.

Chapter 44

Corruption of Climate Science: IPCC

The crimes of science of the early 20th century prepared for a corruption of science which in our time has come to full expression in climate science by the UN Intergovernmental Panel for Climate Change (IPCC) asking the governments of the world to limit the emission of CO_2 from burning of fossil fuels to save humanity from "global warming", but thereby removing the hope of a better life for the poor people of world.

IPCC is political with a political agenda, but IPPC is unconditionally supported by many scientific institutions and academies pretending that IPCC is scientific, in a Deal with the Devil between governments and institutions feeding on an endless flow of tax money. The corruption of climate science was exposed in climategate and analyzed in Slaying the Sky Dragon: Death of the Greenhouse Gas Theory.

44.1 Loschmidt on Climate Science

Our old friend Johann Josef Loschmidt was a clever guy who not only questioned Boltzmann's 2nd Law but also the claim put forward of Maxwell and Boltzmann that a vertical column of gas or a solid would not show a temperature gradient under the influence of gravity. Loschmidt claimed that the column would have a temperature gradient or *lapse rate* and thus be cold at the top and warm at the bottom, just as is observed in the atmosphere of the Earth.

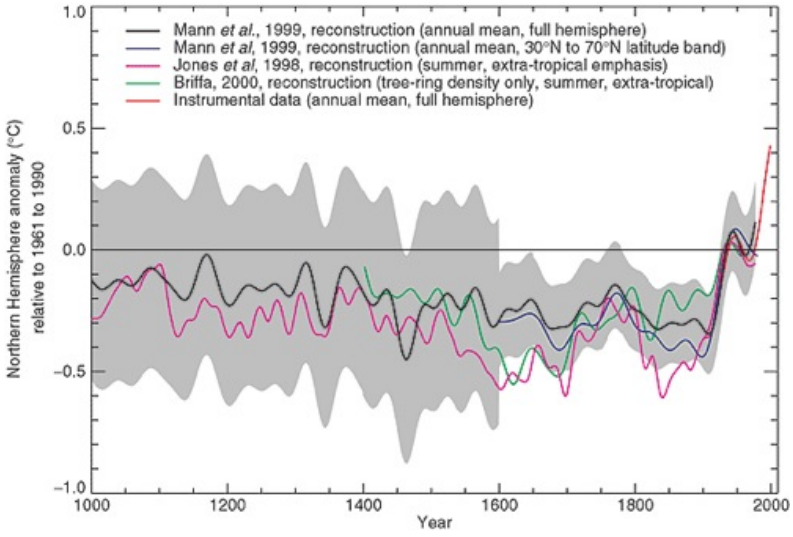


Figure 44.1: The Hockey Stick by Michael Mann.

Climate alarmists could refer to Boltzmann and Maxwell to downplay gravity and upgrade radiation with its "greenhouse effect" as a main factor determining the lapse rate and thus the temperature of the Earth surface, while climate skeptics would say that Loschmidt was correct: the "greenhouse effect" is fiction.

Thus the debate between Boltzmann and Loschmidt on the foundations of thermodynamics was never concluded and is today being fought beween climate alarmists and skeptics.

Chapter 45

Large Hadron Collider Physics

45.1 The Large Hadron Collider

The Large Hadron Collider (LHC) is the world's largest and highest-energy particle accelerator. It is expected to address some of the most fundamental questions of physics, advancing the understanding of the deepest laws of nature.

The LHC lies in a tunnel 27 kilometre in circumference, as much as 175 metre beneath the Franco-Swiss border near Geneva, Switzerland. This synchrotron is designed to collide opposing particle beams of either protons at an energy of 7 tera-electronvolt (7 TeV or 1.12 microjoules) per particle, or lead nuclei at an energy of 574 TeV per nucleus. The term hadron refers to particles composed of quarks.

45.2 Time Machine and Higgs Boson

The Vanderbilt Universisty announces bravley in March 2010 the

- *Large Hadron Collider (LHC) could be world's first time machine capable of causing matter to travel backwards in time.*

- *Our theory is a long shot, but it doesn't violate any laws of physics or experimental constraints*, says physics professor at Vanderbilt University,

- *One of the major goals of the collider is to find the elusive Higgs boson: the particle that physicists invoke to explain why particles like protons, neutrons and electrons have mass.*

The Higgs boson is a crucial missing part of the *Standard Mode* of sub-atomic physics developed by Gell-Mann with the basic particles of atom physics of electrons, protons and neutrons made up by smaller particles named *quarks*.

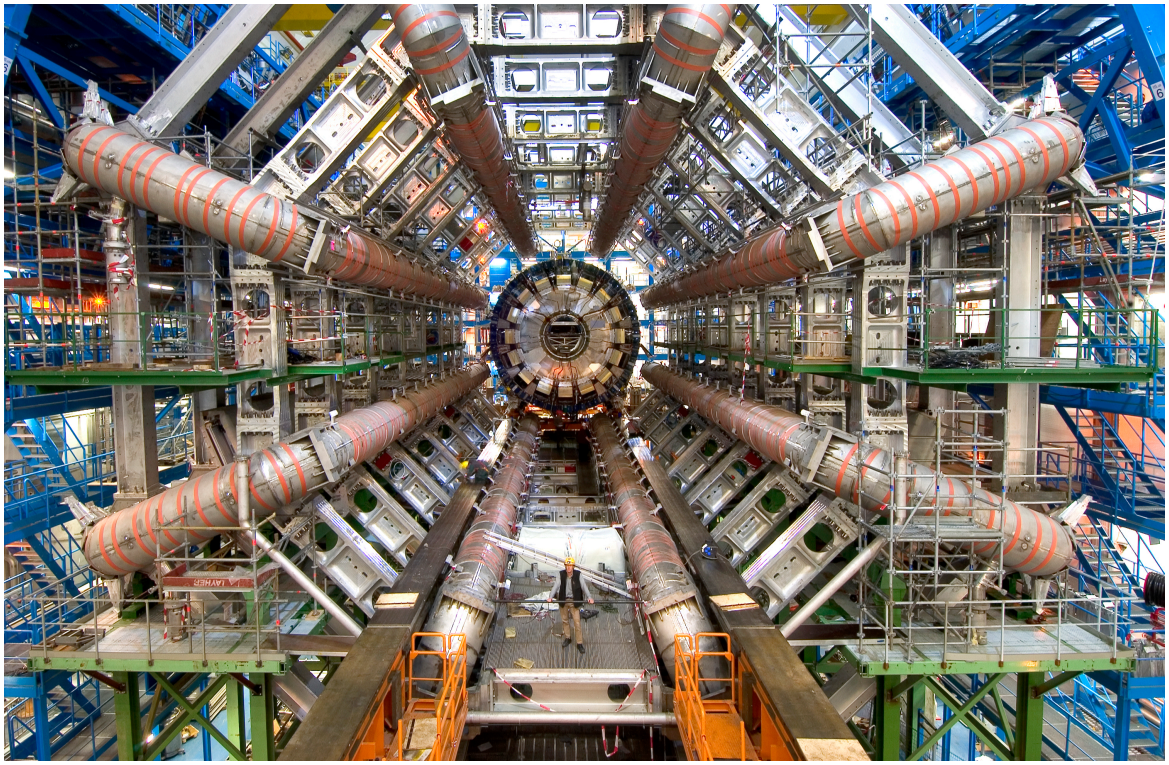


Figure 45.1: Inside the Large Hadron Collider.

Chapter 46

Mathematics as Magics

- *Even if there is only one possible unified theory, it is just a set of rules and equations. What is it that breathes fire into the equations and makes a universe for them to describe?*(Stephen Hawking)
- *In mathematics you don't understand things. You just get used to them.* (von Neumann)
- *One cannot escape the feeling that these mathematical formulae have an independent existence and an intelligence of their own, that they are wiser than we are, wiser even than their discoverers, that we get more out of them than we originally put in to them.* (Hertz)
- *The mathematician who pursues his studies without clear views of this matter, must often have the uncomfortable feeling that his paper and pencil surpass him in intelligence.* (Mach)

The idea that mathematics is the basis of science and society and as such is very important and powerful is implanted by the school system, in particular into the souls of the large group of people who got little out of school mathematics. We give some examples of the admiration of mathematics expressed by people who knew little math:

- *The mathematical sciences particularly exhibit order, symmetry, and limitation; and these are the greatest forms of the beautiful.* (Aristotle)
- *For the things of this world cannot be made known without a knowledge of mathematics.* (Bacon)

- *The bird is an instrument functioning according to mathematical laws, and man has the power to reproduce an instrument like this with all its movements.* (da Vinci)

- *Yes, we have to divide up our time like that, between our politics and our equations. But to me our equations are far more important, for politics are only a matter of present concern. A mathematical equation stands forever.* (Einstein)

- *Mathematics allows for no hypocrisy and no vagueness.* (Stendhal)

- *But the creative principle resides in mathematics. In a certain sense, therefore, I hold true that pure thought can grasp reality, as the ancients dreamed...Do not worry about your difficulties in mathematics, I assure you that mine are greater.* (Einstein)

- *The understanding of mathematics is necessary for a sound grasp of ethics.* (Socrates)

- *Let no one ignorant of geometry enter here.* (Inscription above Plato's Academy)

But there are other viewpoints:

- *I have hardly ever known a mathematician who was capable of reasoning.* (Plato)

- *Mathematicians are like Frenchmen: whatever you say to them they translate into their own language and forthwith it is something entirely different.* (Goethe)

- *As far as the laws of mathematics refer to reality, they are not certain; and as far as they are certain, they do not refer to reality.* (Einstein)

- *Mathematicians, who are only mathematicians, have exact minds, provided all things are explained to them by means of definitions and axioms; otherwise they are inaccurate and insufferable, for they are only right when the principles are quite clear.* (Pascal)

Chapter 47

God as Mathematician or Mathematician as God

The idea the Nature has a mathematical structure is deeply rooted in Western civilization from the early Greeks over the Scholasticism to the Enlighment and Scientific Revolution into our days of the physicists dream of Grand Unification Theory and Large Hadron Collider as if God is mathematician:

- *If there is a God, he's a great mathematician.* (Dirac)
- *The laws of nature are but the mathematical thoughts of God.* (Euclid)
- *God ever geometrizes.* (Plato)
- *Let no one ignorant of geometry enter here.* (Inscription above Plato's Academy)
- *The mathematical sciences particularly exhibit order, symmetry, and limitation; and these are the greatest forms of the beautiful.* (Aristotle)
- *For the things of this world cannot be made known without a knowledge of mathematics.* (Bacon)
- *The bird is an instrument functioning according to mathematical laws, and man has the power to reproduce an instrument like this with all its movements.* (da Vinci).
- *Geometry is the only science that it hath pleased God hitherto to bestow on mankind.* (Hobbes)

- *I believe the geometric proportion served the creator as an idea when He introduced the continuous generation of similar objects from similar objects.* (Kepler)
- *I am so in favor of the actual infinite that instead of admitting that Nature abhors it, as is commonly said, I hold that Nature makes frequent use of it everywhere, in order to show more effectively the perfections of its Author.* (Leibniz)
- *God created everything by number, weight and measure.* (Newton)
- *The latest authors, like the most ancient, strove to subordinate the phenomena of nature to the laws of mathematics.* (Newton)
- *All the pictures which science now draws of nature and which alone seem capable of according with observational fact are mathematical pictures ... From the intrinsic evidence of his creation, the Great Architect of the Universe now begins to appear as a pure mathematician.* (Jeans)
- *An equation means nothing to me unless it expresses a thought of God.* (Ramanujan)
- *God exists since mathematics is consistent, and the devil exists since we cannot prove the consistency.* (Morris Kline)
- *Yes, we have to divide up our time like that, between our politics and our equations. But to me our equations are far more important, for politics are only a matter of present concern. A mathematical equation stands forever.* (Einstein)
- *But the creative principle resides in mathematics. In a certain sense, therefore, I hold true that pure thought can grasp reality, as the ancients dreamed.* (Einstein)
- *God used beautiful mathematics in creating the world.* (Dirac)
- *The universe is an enormous direct product of representations of symmetry groups.* (Weyl)
- *The miracle of the appropriateness of the language of mathematics to the formulation of the laws of physics is a wonderful gift which we neither understand nor deserve.* (Wigner)

- *Even if there is only one possible unified theory, it is just a set of rules and equations. What is it that breathes fire into the equations and makes a universe for them to describe?* (Hawking)

Some believe that it is instead the Devil who is mathematician:

- *The good Christian should beware of mathematicians and all those who make empty prophecies. The danger already exists that mathematicians have made a covenant with the devil to darken the spirit and confine man in the bonds of Hell.* (St. Augustine)

There are also (some) doubts:

- *A mathematician is a blind man in a dark room looking for a black cat which isn't there.* (Darwin)
- *I have hardly ever known a mathematician who was capable of reasoning.* (Plato)
- *Mathematicians are like Frenchmen: whatever you say to them they translate into their own language and forthwith it is something entirely different.* (Goethe)
- *Mathematics has the completely false reputation of yielding infallible conclusions.* (Goethe)
- *As far as the laws of mathematics refer to reality, they are not certain; and as far as they are certain, they do not refer to reality.* (Einstein)
- *Mathematicians, who are only mathematicians, have exact minds, provided all things are explained to them by means of definitions and axioms; otherwise they are inaccurate and insufferable, for they are only right when the principles are quite clear.* (Pascal)

Altogether, there is an over-whelming concert of voices connecting God with mathematics, or mathematics with God. Or Mathematics with Infinity and Infinity with God as exposed in a the BBC series Dangerous Knowledge propagating an idea of dark religious mysticism, way beyond Harry Potter, in our time of rationality based on mathematics: "What is the system everything has to adhere to if there is no God?"

Chapter 48

Penguin Logic

> Man has such a predilection for systems and abstract deductions that he is ready to distort the truth intentionally, he is ready to deny the evidence of his senses only to justify his logic. (Dostoyevsky)
>
> Logic is one thing, the human animal another. You can quite easily propose a logical solution to something and at the same time hope in your heart of hearts it won't work out. (Luigi Pirandello)
>
> Logic is neither an art nor a science but a dodge. (Stendhal)

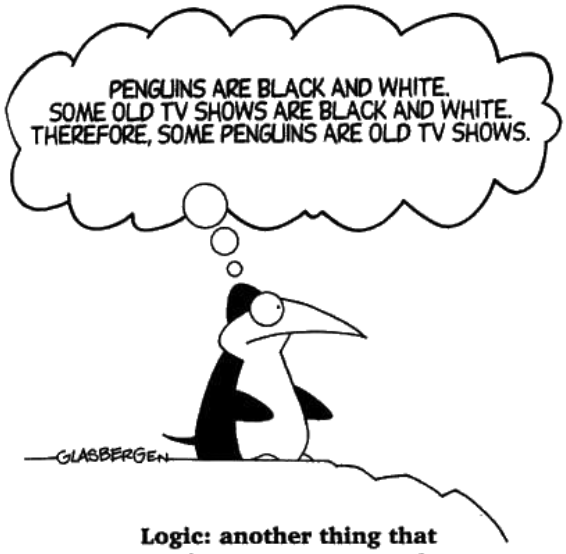
The statement A implies B means that if A is true, then B is also true. An elementary mistake in logical scientific reasoning is to conclude that if A implies B and B is observed to be true, then A is true. But this is to confuse A implies B with B implies A.

We illustrate: Let

- A = You bang your head into a wall.
- B = You have a headache.

We could probably agree that there is theoretical evidence that A implies B: Head bang leads to head ache, in theory at least. Suppose now that B is true, that is suppose that you have a headache. Can we then conclude that A is true, that is that you bang your head into a wall? Not necessarily: You may get a headache from other causes, like drinking to much alcohol. It can even be that the implication that you get a headache from head bang is incorrect, so that there is no connection at all; you may have an unusually solid skull.

Yet this type of logic is a trademark of modern physics/science:



Logic: another thing that penguins aren't very good at.

- If we assume that a gas is in a state of molecular chaos with the velocities of two molecules before collision being statistically independent, then we can theoretically derive Boltzmann's equation, which has certain solutions which agree with certain observations. Hence the gas in a state of molecular chaos.

- If we assume that there is a smallest quantum of energy, then we can theoretically derive a formula for the spectrum of black-body radiation, which agrees with observation. Hence there is a smallest quantum of energy.

- If we assume that light consists of particles named photons, then we can theoretically derive a formula for photoelectricity, which agrees with certain observations. Hence light consists of photon particles.

- If we assume Pauli's exclusion principle, then we can explain certain observed atomic electron configurations. Hence electrons obey Pauli's exclusion principle.

- If we assume that the wave function collapses at observation, then we can theoretically explain an certain observed blips on a screen. Hence the wave function collapses at observation.

- If we assume Heisenberg's uncertainty principle for elementary particles, then we can theoretically explain an observed interaction between observer and observed particle. Hence elementary particles obey Heisenberg's uncertainty principle.

- If we assume that a proton consists of three quarks, then we can theoretically derive a formula for the observed mass of a proton. Hence a proton consists of three quarks.

- If we assume that space-time observations of different observers are connected by the Lorentz transformation of special relativity, then we can theoretically explain the observation that the speed of light is the same for all observers. Hence space-time observations of different observers are connected by the Lorentz transformation.

- If we assume that space-time is curved, then we can theoretically explain observed gravitation. Hence space-time is curved. If we assume there was a Big Bang, then we can theoretically explain the observed expansion of the Universe. Hence there was a Big Bang.

- If we assume there is a black hole at the center of a galaxy, then we can theoretically explain the observed shape of a galaxy. Hence there is a black hole in the center of a galaxy.

- If string theory would predict an observable phenomenon, it would follow that matter consists of tiny vibrating strings.

- If we assume that the Earth rests on four invisible tortoises, then we can theoretically explain why the Earth does not fall down. Hence the Earth rests on four invisible tortoises.

- If we assume that CO2 is a critical greenhouse gas, then we can theoretically explain observed global warming. Hence CO2 is a critical greenhouse gas.

Do you see the possibly incorrect logic in these statements? If so, do you see the potential danger of such possibly incorrect logic? Do you think such possibly incorrect logic represents science or pseudo-science?

Notice that in all the above cases, the fact that a certain phenomenon is observed, which can be theoretically explained from a certain assumption, is

used to motivate that the assumption is not just an assumption but a true fact: There is molecular chaos and a smallest quantum of energy, electrons do respect the exclusion principle, the Lorentz transformation must connect different observations, space-time is curved, light is photons, there was a Big Bang, there is a black hole in the center of a galaxy, a proton is three quarks, the Earth is resting on four tortoises, CO2 is a critical greenhouse gas.

Notice also that in all cases, it is impossible to directly check if the assumption is valid, which is part of the beauty. The assumption is hidden to inspection and can only be tested indirectly: It is impossible to directly observe molecular chaos, a smallest quantum of energy, photon, electron, particle exclusion, wave-function collapse, uncertainty, quark, space-time curvature, black hole, tortoise, string...or that CO2 is a critical greenhouse gas. It is therefore impossible to directly disprove their existence...Clever, but there is an obvious drawback, since the existence is also impossible to verify...science or pseudo-science?

The argument is that the assumption must be true, because this is the only way a theoretical explanation seems to be possible. Our inability to come up with an alternative explanation thus is used as evidence: The more we restrict our creativity and perspective, the more sure we get that we are right. Convincing or penguin science?

Compare the same logic in a trial: If we assume X had a reason to kill Y, then we can theoretically explain the observed murder of Y. Hence X had a reason to kill Y. And thus probably did it! What if you were X?

Notice in particular that present climate politics is based on the idea that CO2 is the cause of the observed global warming, with the motivation that certain theoretical climate models show global warming from CO2. But the observed modest global warming during the 20th century of 0.7 degrees Celsius may have natural causes rather than anthropogenic burning of fossil fuels. What do you think? What does a penguin in the Antarctic think? Compare e.g. EIKE.

Part VIII

One Mind vs Many Minds

Chapter 49

Galileo's Dialog

> By denying scientific principles, one may maintain any paradox... All truths are easy to understand once they are discovered; the point is to discover them... I have never met a man so ignorant that I couldn't learn something from him... It is surely harmful to souls to make it a heresy to believe what is proved.

The Dialogue Concerning the Two Chief World Systems was a 1632 Italian bestseller by Galileo Galilei comparing the Copernican system with the traditional Ptolemaic system. The book is presented as a series of discussions, over a span of four days, among two philosophers and a layman:

- *Salviati* is an academician arguing for the Copernican position
- *Sagredo* is an intelligent layman who is initially neutral.
- *Simplicio* is a dedicated follower of Ptolemy and Aristotle, and presents the traditional views and the arguments against the Copernican position.

In the next chapters we revive Salvati and Sagredo and equip them with with a computer and a surfboard allowing them to surf both the Internet and physical reality.

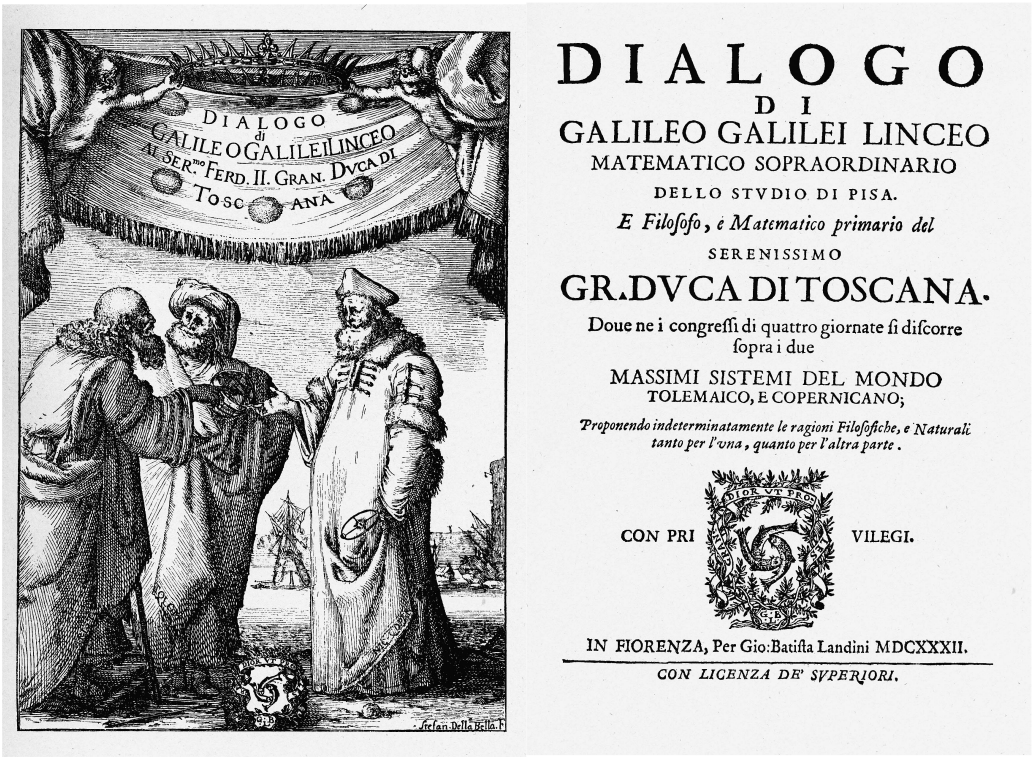


Figure 49.1: Galileo's Dialog.

Chapter 50

QFT and Murderer-Victim

> In questions of science, the authority of a thousand is not worth the humble reasoning of a single individual. (Galileo)
>
> Often, the less there is to justify a traditional custom, the harder it is to get rid of it. (Mark Twain)

Quantum Field Theory (QFT) describes the quantum mechanics of the sub-atomic world as the result of *interaction* of certain particles through forces carried by other particles:

- photons are the quanta of the electromagnetic field establishing electromagnetic interaction,
- gravitons are the quanta of the gravitational field establishing gravitational interaction.

Both photons and gravitons are hypothetical particles which have not been observed. Below we shall argue that they cannot be observed because they have no real role to play as force-carrying particles: The fields can take on the role to carry the interactions and using Ockham's razor particles can thus be left out from the discussion.

The physical Gilbert Lewis, who coined the term *photon*, advocated a bond between source and absorber like the bond between murderer an victim which we will follow up on below:

- *I am going to make the...assumption that an atom never emits light except to another atom...it is absurd to think of light emitted by an*

> *atom regardless of the existence of a receiving atom as it would be to think of an atom abssorbing light without the existence of light to be absorbed. I propose to eliminate the idea of mere emission of light and substitute the idea of* transmission*, or a process of exchange of energy between two definite atoms...*

The same idea was picked up by Einstein pointing to the view of the German physicist H. Tetrode:

- *The sun would not radiate if it were alone in space and no other bodies could absorb the radiation.*

Hint: This idea is followed up in a new treatment of blackbody radiation: The absorber-emitter and emitter-absorber are as intimately coupled as the victim-murderer and murderer-victim, or Faustus-Devil for that matter (recalling the murder of Marlowe from interaction with an unknown but existing murderer).

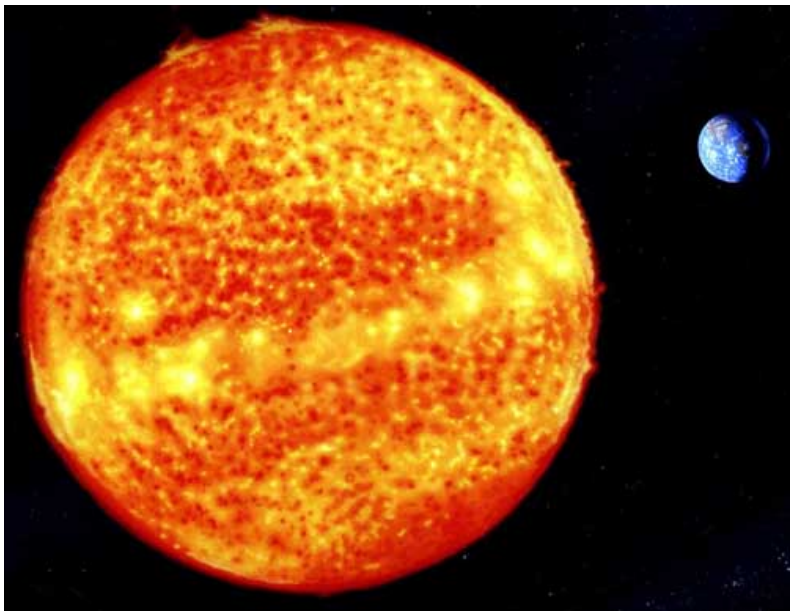


Figure 50.1: The Earth is bound to the Sun in a master-slave relation.

Chapter 51

Finite Precision Computation

> The underlying physical laws necessary for the mathematical theory of a large part of physics and the whole of chemistry are thus completely known, and the difficulty lies only in the fact that the exact application of these laws leads to equations much too complicated to be soluble. (Paul Dirac 1929)
>
> Measure what is measurable, and make measurable what is not so. (Galileo)

51.1 To Read

In the following books I develop an alternative to statistical physics based on microscopic games of roulette, where the statistics is replaced by *finite precision computation* appearing in analog form in real physics and in digital form in mathematical modeling of real physics.

- The Clock and the Arrow: A Brief Theory of Time
- Computational Turbulent Incompressible Flow
- Computational Thermodynamics
- Mathematical Physics of Blackbody Radiation

The alternative includes a new approach to turbulence simulation and a resolution of d'Alembert's paradox without Prandtl's boundary layers.

51.2 Analog and Digital Computation

Finite precision computation has the following qualities:

- simple microphysics,
- basic assumption (of finite precision) possible to test directly,

to be compared with those of statistical physics:

- complex microphysics,
- basic assumption (e.g. equidistribution) impossible to test directly.

Note that Boltzmann's basic microscopic assumption of statistical independence in a gas with each mole consisting of 6×10^{23} molecules, seems to be beyond the possibility of any kind of conceivable experiment or mathematics; only indirect evidence in the form of macroscopic observations seem to be possible, which is far from enough. In fact, it is known that Boltzmann's assumption can only be (nearly) true in the very special case of a very dilute gas with rare collisions, and the derivation of Boltzmann equations for more general situations seems to pose unsurmountable problems.

In the above books I show that with finite precision computation it possible to mathematically prove and thus theoretically understand, without resorting to statistics,

- 2nd law of thermodynamics expressed in terms of kinetic energy, heat energy, work and turbulent dissipation, with explicit reference to entropy,
- direction of time,
- Planck's radiation law,
- basic aspects of turbulence including a resolution of d'Alembert's paradox,

and also related other results traditionally approached by statistical arguments.

In short, finite precision computations opens to resolving some of the basic mysteries of physics. You don't have to dwell into this if you don't feel that you have to. In a way it is enough to understand that the old dead-lock

that troubled Boltzmann, Planck and Prandtl can be circumvented without giving away any scientific soul.

Next to Einstein and Bohr: Is there a way get around their hang-ups also?

Chapter 52

Many-Minds Physics

> There is but One God, His name is Truth, He is the Creator, He fears none, he is without hate, He never dies, He is beyond the cycle of births and death, He is self illuminated, He is realized by the kindness of the True Guru. He was True in the beginning, He was True when the ages commenced and has ever been True, He is also True now. (Guru Nanak ,Indian Spiritual leader (1469-1539))
>
> It is dangerous to be right in matters on which the established authorities are wrong. (Voltaire)

52.1 Unique vs Universal vs Many Observers

Both relativity theory and quantum mechanics in its classical formulation struggles with the relation between the observer and the physics subject to observation.

We shall indicate a possibility of handling this relation which can be a seen as physics version of the familiar feature of modern society with a multitude of viewpoints of different members of modern society society as compared to the single "'royal mind" of the Kingdom, or the single "mind of God" of a mono-teistic religion. We shall be led to try a scientific leap from a medieval darkness of

- One (Universal) Observer: One (Universal) Mind: One (Universal) Perspective: (Universal) Kingdom

into an Enlightenment of

- Many Observers: Many Minds: Many Perspectives: Democracy.

Classical physics is based on the idea of One Mind as a unique aether or reference frame, but this idea collapsed with the Michelson-Morley experiment, and then came Einstein's bold elimination of the aether altogether leaving an emptiness filled with "relative" space and time against a universal background of "invariant physical laws". Einstein thus took the step from "unique" to "universal" with the magic of "universal" of being many-faceted while at the same time One, like God.

Einstein gave the observer not one reference frame or coordinate system, but overwhelmed the observer with all reference frames asking the observer to coordinate observations in all frames. This is like giving a person an infinite set on eyes moving with respect to the observer and asking the observer to coordinate all the images from all the eyes. To do this Einstein asked the observer to change his concept of space and time according to certain (Lorentz) transformations required to maintain "invariance".

But Einstein's Universal Mind was led to very strange paradoxes imbedded in the Lorentz transformations of Einstein's special theory of relativity, and the strangeness became monumental in Einstein's general theory of relativity with a "curved space-time" which nobody could come to grips with.

In politics the idea of democracy is still strong and spreading over the world and maybe it is now for its counterpart in physics to emerge in the form of *many-minds physics*. In many-minds physics the idea of a unique or universal observer is abandoned, and instead it is accepted that different observers can have different perspectives without one perspective being chosen as the "preferred one", like a unique aether. Each observer ties his coordinate system to himself, that is each observer only observes through his own pair of eyes and does not worry about what observation he would make with eyes detached from his body.

In many-minds physics the pertinent question is to what extent different observers agree on e.g. distances between different objects.

52.2 The Observer of Relativity Theory

The mantra in relativity is that somehow observations should be made invariant under choice of coordinate systems or observer reference frame. In Einstein's special relativity the basic postulate is that all observers should

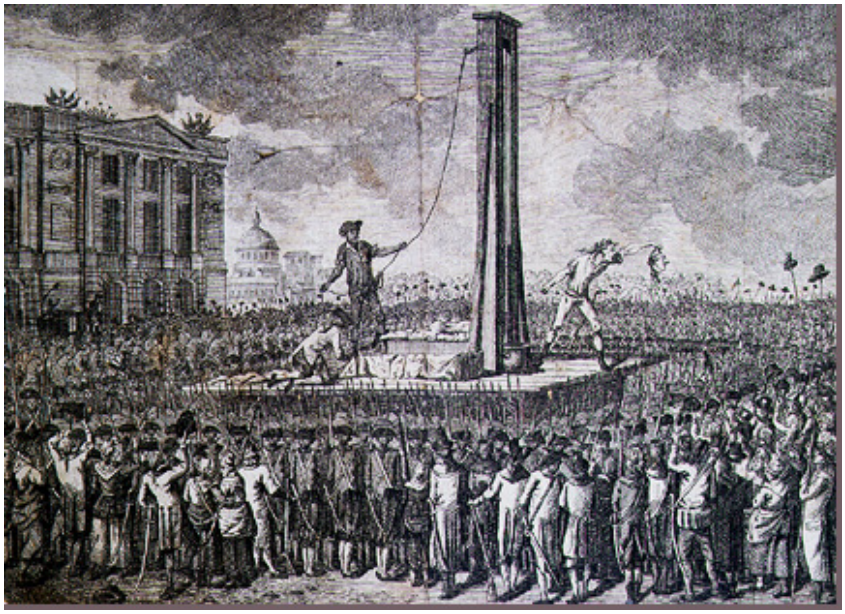


Figure 52.1: There is no King no more: The beheading of Louis XVI in 1793 witnessed by Many Minds.

measure the same speed of light independent of rectilinear motion with constant speed. This is a very strong requirement since observations in general depends on the motion of the observer: If you stand still or move about in your car your perceptions differ. To a naive physicist, like myself and maybe the reader, Einstein's postulate appears unnatural, and yes indeed, it also leads to very strange conceptions of space and time.

52.3 Cunnigham: Many-Minds Physics

Ebenezer Cunningham (1881-1977) was a British mathematician who is remembered for his research and exposition at the dawn of special relativity. We shall see that Cunningham opened a door to circumvent the obstacles of both relativity and quantum mechanics, into what we describe as *many-minds relativity* and *many-minds quantum mechanics* and develop in the following books:

- Many-Minds Quantum Mechanics: Knol

Figure 52.2: Ebenezer Cunningham: *The aether is in fact, not a medium with an objective reality, but a mental image which is only unique under certain limitations...Two frames of reference imply two aethers.*

- Many-Minds Relativity
- Many-Minds Quantum Mechanics: Book
- Many-Minds not Many-Worlds Quantum Mechanics

The starting point is the following observation by Cunningham stated in *The Structure of the Ether* (Nature 76:222.):

- *The aether is in fact, not a medium with an objective reality, but a mental image which is only unique under certain limitations...Two frames of reference imply two aethers.*

However, Einstein's bold dismissal of the aether as non-existing altogether, was more impressive than Cunningham's more low-key multivalued many-minds aether. We present in the book Many-Minds Relativity evidence that Cunningham's approach makes a lot of sense, while Einstein's does not. Without some form of (non-material) aether, electromagnetic waves and light cannot propagate and thus cannot be subject to observation. And so there is light at the end of the tunnel...

52.4 Many-Mind vs Master-Mind

Einstein's approach to relativity can be described as Master-Mind Relativity with the Master-Mind representing a Universal Observer without position and motion. Einstein seeks to captures this form of (inhuman) observer by his principle of *invariance of physical laws* asking the mathematical expression of a law to be the same in different coordinate systems. This was (and still is) a completely stunning principle which gave so strange results that scientists were asked to adopt a completely new concepetion of space and time as curved space -time as led to his invariance principle by the Michelson-Morley experiment indicating that the speed of light was independent of observer motion, that seemed to contradict the classical concept of space and time or classical space-time.

But Cunningham and also the mathematician Poincare envisioned a different resolution of the Michelson-Morley paradox; which in fact is what is today adopted in the choice of length scale according to the 1983 standard, with length scale being *lightsecond*, the distance traveled by light in one

second. With this length scale the speed of light by definition is 1 light-second/second, the same for all observers independent of motion. And now the Many-Minds concept enters in the discussion, with the question to what extent different observers traveling with different velocities will agree on different distances. In Many-Minds Relativity two observers will agree on their mutual distance, but not in general on the distance to a third part.

52.5 Many-Minds Quantum Mechanics

Many-Minds Quantum Mechanics (MMQM) is based on a different version of the Schrödinger equation as a system of three-dimensional wave equations (one equation for each electron), to be compared with the usual version as a scalar high-dimensional equation. MMQM gives each electron a simple "mind" which allows each electron to solve its own three-dimensional Schrödinger equation with the other electrons entering through potentials. The usal high-dimensional Schrödinger equation require a Master-Mind which "knows everything", while MMQM involves many small minds knowing only a part of everything.

52.6 There Are Many Aethers

Cunningham was an ardent pacifist, strongly religious, a member of Emmanuel United Reformed Church, Cambridge. When drafted for the war in 1915 he did alternative service growing food and in an office at the YMCA. He held a university lectureship from 1926 to 1946. His book The Principle of Relativity (1914) was one of the first treatises in English about special relativity.

He followed with Relativity and the Electron Theory (1915) and Relativity, Electron Theory and Gravitation (1921). Cunningham had doubts whether general relativity produced "physical results adequate return for mathematical elaboration."

In Many-Minds Relativity you find a presentation of special relativity based on Cunningham's idea of many aethers, one for each observer. More precisely, each observer uses a coordinate system which is fixed to the observer, and the pertinent question concerns the agreement on distances an velocities which can be perceived by different observers moving with respect

to each other.

In the preface to *The Principle of Relativity* Cunningham cannot hide his critique of Einstein:

- *The controversial note which has been characteristic of discussions in respect of the Principle of Relativity has prevented the significance of the principle from being seen in its proper proportions and in its relation to general physical theory.*

- *On the one hand, there have been those who have magnified its importance, and assigned to it an unduly revolu- tionary power, while on the other hand, there are those who have scoffed at it as fantastic and reared on the most slender of physical bases*

- *It is hoped that by drawing a clear distinction between the "mode of measurement", and the "nature" of space and time, the author will escape from the charge of venturing unduly upon debatable metaphysical questions.*

- *In the Second Part an attempt has been made to present in a simple form the more attractive of the two mathematical methods devised by Minkowski for the purpose of putting in evidence the relative nature of electrical and other phenomena.*

- *No attempt has been made to present the highly speculative attempt of Einstein at a generalization of the principle in connection with a physical theory of gravitation.*

- *Throughout the intention has been as far as possible to consider those aspects of the principle which bear directly on practical physical questions. The mathematical part has been compressed to as small a compass as is consistent with furnish- ing sufficient apparatus for a systematic consideration of the problems suggested.*

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Back Cover: Dr Faustus of Modern Physics

This book presents the Faustian drama of the transition from classical to modern physics at the turn to the 20th century, when leading scientists sacrificed basic principles of rationality of classical science in order to save science from collapse when faced with certain seemingly intolerable paradoxes, and thereby rose to great fame.

The book is written as a tribunal against five accused: Boltzmann, Planck, Einstein, Bohr in physics and Prandtl in fluid mechanics, with the reader as judge. The accusations concern violation of the principles of rationality of causality and determinism, reality of space and time, well-posedness and logic.

The book presents evidence in the form of general background material, witnesses and confessions by the accused from the literature, and leaves to the reader to decide if crimes against science were committed and if so mitigations can be found.

The book addresses the following questions: What was the nature of the sacrifice? Was it a crime? Is the crime repeated in education today? Are we being brainbwashed to give up rationality? What was the motivation to give up rationality? Why did Einstein never accept giving up causality and determinism? What are the consequences today? Are there other solutions of the paradoxes which do not require giving up basic principles of rationality?

The book is directed to a general audience using a non-technical language without mathematical notation.