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Topics from 20th century physics.
An introductory course for students in mathematics

APPENDIX E: BIOGRAPHICAL NOTES

This appendix contains short biographical notes on the mathematicians and physicists mentioned in the text of this course. The two main sources for this collection are:

- *A Dictionary of Scientists*
John Daintith, Derek Gjertsen, general editors
Oxford University Press 1999
ISBN 0 19 280086 8

- *The Cambridge Dictionary of Scientists*
David, Ian, John and Margaret Millar, editors
Cambridge University Press 1996
ISBN 0 521 56718 1 (paperback)

Aristotle (384-322 BC): In his early years he was a member of the Academy of Plato, the other major philopher of classical antiquity. Later, after Plato's death, he founded a school of his own, the Lyceum. He developed a broad and systematic philosophy, which he applied to most of the knowledge of his time. He wrote treatises on logics, metaphysics, ethics, political science, but also on physics and astronomy. He was particularly interested in biology; his knowledge on this subject was based on careful observations. In cosmology he adhered to a picture in which planets and stars rotated in circles around a fixed earth. Matter was supposed to be composed of the four elements – earth, water, fire and air. His works reached medieval Europe, partly in latin translations from Arabic sources; his ideas became very influential and dominated western thinking until the renaissance. Nevertheless, liberation from his way of thinking was in a certain sense a necessary condition for the birth of modern science.

Niels Bohr (1885-1962): Born in Copenhague. His father was a professor of physiology, his brother Harald became later a distinguished mathematican. After obtaining his PhD in 1911, he went to the UK, first to Cambrigde, and then to Manchester where he worked with Rutherford for four years. In this period he developed his revolutionary model of the structure of the atom, using the insights obtained by Rutherford from his experiments, in combination with Planck's idea of an elementary quantity of action h. Back in Copenhague he became director of the recently founded Institute of Theoretical Physics. This became one of the most important centres for the new quantum mechanics, with Bohr at the middle of all new ideas and discussions, interacting with all other participants in the development of the subject. Famous were his ongoing discussions on quantum mechanics with Einstein. It is not always easy to say what precisely Bohr's contributions to quantum mechanics are. His papers, especcially his later ones, lack the clarity of style of for instance Pauli or Dirac. He was sometimes more a philosopher than a physicist. Ideas like 'complementarity' or the 'correspondence principle' have lost some of the immediate appeal which they had for his contemporaries. He got the Nobel prize in 1922.

Max Born (1882-1970): Born at the formerly German town of Breslau. Professor of physics at Göttingen. Left Germany during the Nazi period, Taught in Edinburgh. Developed the matrix-mechanics version of quantum theory together with Pascual Jordan and Werner Heisenberg. He proposed the now generally accepted probabilistic interpretation of the wave function in quantum mechanics. Nobel prize in 1954.

Tycho Brahe (1546-1601): Danish astronomer. Born in Knudsrup (Denmark). He started to study law in Leipzig in 1562, but his interest was soon deflected to astronomy, which he then studied at various universities in northern Europe, making himself also familiar with the building of astronomical instruments. A publication on the nova, which appeared dramatically as a new star in the sky in 1572, made him internationally famous. In order to keep him in Denmark, Frederick II, the king of Denmark, gave him the island of Hven and money to build an observatory at Uraniborg there. Brahe had become aware of the fact that the astronomical tables of his time were inexact and unreliable, and he embarked therefore on what was to become his main achievement, the collection of data for new tables. Telescopes did not yet exist, so he had to do his observations, precise measurements of positions of stars and planets, by means of the naked eye, helped in this by special instruments that he built himself. He quarelled with Frederick's successor Christian IV and left Denmark in 1596. After travelling around for a while, carrying around his enormous instruments, he finally became Imperial Mathematian, i.e. Imperial Astronomer, of the mad renaissance emperor Rudolph II in Prague, who gave him for his work a castle at Benadek outside Prague. Here he stayed untill his sudden death in 1601. His life's work, published posthumously by his assistant, the young Johannes Kepler in 1627, was an extensive set of new astronomical tables, which became of very great importance for the development of astronomy, and which were in particular used by Kepler himself in his path-breaking work on the motion of the planets in the solar system.

Louis de Broglie (1892-1987): French physicst. He was descended from a noble family and was born in Dieppe. He started as a historian, became interested in science when he was a signaller at the Eiffel Tower during World War I. He studied physics at the Sorbonne and got a PhD there in 1924. His thesis contained what was to be his major contribution to the founding of quantum mechanics; the suggestion that a particle of momentum p is in a certain sense carried along by a travelling wave with wavelength $\lambda = h/p$, with h Plancks constant. This idea led Schrödinger to the formulation of his wave equation. De Broglie never accepted the probabilistic interpretation of quantum mechanics, keeping his belief in a basic deterministic description of nature. Feeling himself in a minority position, he kept silent on this. After getting the Nobel prize in 1929, he became the most influential physicist in France. He kept this position by his lectures and textbooks. After World War II his interest in a nonprobabilistic fornulation of quantum mechanics was revived by papers of David Bohm. He started to work on this, publishing a sequence of papers in collaboration with a few faithful followers. The result was complete isolation from the mainstream of physics; his death in 1962 was not even noticed in the newspapers. All his live he remained a bachelor, 'married to physics', living very soberly in his ancestral castle, cared for in his old age by a few faithful servants.

Arthur Compton (1892-1962): American physicist, born in Wooster, Ohio. Obtained his PhD at Princeton. He held professorships at Washington and Chicago. He is best known for the experimental discovery and theoretical explanation of a typical quantum phenomenon, the 'Compton effect', the fact that x-rays can behave as particles, are scattered by electrons and have a definite linear momentum in this process. He did also important work in cosmic ray physics. He got a Nobel price, shared with Charles Wilson, in 1927.

Nicolaus Copernicus (1473-1543): Born in Torun (Poland), and brought up by his uncle, a bishop. He studied at Cracow and later at Bologna and Padua. He became a cleric and obtained through nepotism the position of canon at

Frauenburg, a sinecure which he held for the rest of his life. Copernicus became dissatisfied with the then dominant picture of the universe in which all the heavenly bodies, stars and planets, moved around a fixed the earth in the centre, a picture sanctioned by the authority of Plato and Aristotle, the two main philosophers of classical antiquity, and worked out in full mathematical detail by Ptolemy in his *Almagest* in the 2^{nd} century AD. In opposition against this he developed his heliocentric system in equally great detail, first in an unpublished manuscript, then in his great work *De Revolutionibus Orbium Coelestium*, finished between 1530 and 1535 and published in 1543, in the month of his death. Many astronomers and mathematicians – these terms were often used indiscriminately – accepted his views immediately, at least as a useful mathematical working hypothesis, leaving open the question whether it described reality. Some but by no means all theologians and philosophers objected; overall opposition from the Catholic Church grew however and the book was finally placed on the Index of forbidden books in 1616, from which it was removed only in 1835.

Paul Dirac (1902-1984): Born in Bristol (UK). Graduated in electrical engineering and went then on to study mathematics at Cambridge. Obtained his PhD in 1926. He held a professorship there from 1931 until his retirement in 1969. He made important contributions to quantum theory in its early years, in particular to the mathematical formalization of the theory. His book *The Principles of Quantum Mechanics*, of which the first edition appeared in 1930, remains a classic in this respect. He introduced in 1930 a relativistic wave equation which gave a correct description of particles with spin, and predicted the existence of anti-particles. Several of his heuristic mathematical ideas gave rise to important new fields in pure mathematics: his δ-function calculus became the theory of distributions of Laurent Schwartz; the 'Dirac operator', the differential operator appearing in his wave equation, became the basis for spin structures and index theory. He was a man of few words; there are many anecdotes about his extremely sober way of communicating with others. He shared a Nobel prize with Schrödinger in 1933.

Albert Einstein (1879-1955): Born at Ulm (Germany). Studied physics at the ETH at Zürich. While working as a technical expert at the Swiss Patent Office at Bern, he wrote in his spare time several papers of fundamental importance, in particular his 1905 paper on special relativity. After this he soon got soon academic recognition and got successively professorships at Bern, Prague, Zürich and finally Berlin. His main paper on the general theory of relativity appeared in 1916. After measurements on a sun eclipse in 1919 confirmed his prediction of the deflection of light by matter he became known to a wide public. He never fully accepted quantum mechanics, in particular its nondeterministic aspects; he had many discussions with Bohr on this matter. He left Nazi-Germany in and took up a position at the Institute of Advanced Studies at Princeton in the US, where he stayed till his death, working without much success on the dream of his later years, a general unified field theory. Nobel prize in 1921.

Galileo Galilei (1564-1642): Born in Pisa (Italy).

Sir William Rowan Hamilton (1805-1865): Irish mathematician. In mechanics he introduced the dynamical equations, now known as 'Hamilton's equations'. Invented quaternions. At a later age he became a recluse, drinking excessively.

Werner Heisenberg (1901-1976): Born in Würzburg (Germany). One of the founders of quantum mechanics, in particular of matrix mechanics. His first paper on this appeared in 1925. The quantum mechanical uncertainly relation between position and momentum is named after him. Later he made important contributions to nuclear physics. Like Einstein he worked in his later years on a unified field theory, with a similar lack of lasting results. His activities during the second world war, directing the German attempts to build a nuclear bomb, remain controversial. Nobel prize in 1932.

Pascual Jordan (1902-1980): Born in Hannover (Germany). He was one of the founders of quantum mechanics, collaborating with Born and Heisenberg on the first papers on 'matrix mechanics'. He held professorships in Rostock, Berlin and Hamburg.

Johannes Kepler (1571-1630): Born at Würtemberg (Germany). He studied theology and obtained a teaching post in mathematics at the seminary in Gratz (Austria). He became interested in astronomy and in particular in the ideas of Copernicus. Kepler very much believed in an underlying mathematical harmony of the universe; the search for this harmony was the driving force in his work during most of his life. One of the ideas that he pursued for a long time was a model of the universe in terms of Plato's five regular solids. As a Lutheran he had to leave Gratz in 1598. He became the assistent of Tycho Brahe, then Imperial Mathematician (Astronomer) in Prague, who gave him the problem of working out the orbit of Mars. He worked on this for eight years. This led him to the formulation of the first two of his three laws of planetary motion. They were published in his *Astronomia Nova*.

Joseph Louis Lagrange (1736-1813): Born in Turin (Italy). He later moved to France and became internationally famous as a mathematician. He made very important contributions to the development of mechanics, in particular celestial mechanics. His most important work is 'Mécanique Analytiqu', in which among other things he introduced his calculus of variations. Laplace's comment on this work was that he could not find any diagrams in it.

Pierre Simon de Laplace (1749-1827): Born in Beaumont-en-Auge. He became at an early age professor of mathematics at the Ecole Militaire in Paris. His greatest work is *Traité de Mécanique Céleste*. Also important is his *Exposition du Système du Monde* in which one finds the nebular hypothesis for the birth of the solar system. (He is reported to have said to Napoleon that he did not need God as a hypothesis in his system). He laid the foundations for the mathematical formulation of probability theory.

James Clerk Maxwell (1831-1879): Born in Edinburgh. He became professor of natural philophy at Aberdeen and at King's College London. He was of independent means and resigned his professorship in 1865 to continue his work at his estate in Scotland. He became in 1871 professor of experimental physics at Cambridge. Probably the most important theoretical physicist of the 19^{th} century. His greatest contribution to physics was his general theory of electromagnetism, one of the two pillars of classical physics. He was also one of the founders of statistical mechanics.

John von Neumann (1903-1957):

Sir Isaac Newton (1642-1727): Born in Woolsthorpe (Lincolnshire, England). Studied at Cambridge University, but had to leave because of the plague. Returned when this died down. His important work was done during his time as a fellow of Trinity college and later professor at the university. His most important work is *Principia* or in full *Philosophiae Naturalis Principia Mathematica*, published in 1687. Its influence was immense. Newton became Master of the Mint in 1699, an office which he carried out with great zeal, and which involved, among other things, bringing counterfeiters to justice. Newton had a fairly unpleasant character, which led him into acrimonious controversies about priority questions.

Wolfgang Pauli (1900-1958): He was known for his sardonic wit, which he exercised freely at meetings and seminars.

Max Planck (1858-1947):

Henri Poincaré (1854-1912): Born in Nancy (France). Studied at the École Polytechnique and the École des Mines, in order to become an engineer, but finally became a mathematician. From 1881 untill his death he was professor of mathematics at the University of Paris. He was exceptionally broad in his scientific interests, contributing to a wide variety of subjects both in mathematics and mathematical physics. In his *Analysis Situs* he created point set topology; he discovered automorphic functions, in mechanics he analysed with the help of new methods the three-body problem and in physics he discovered independently several results from Einstein's theory of relativity. In his later years he also wrote on the philosophy of science.

Ernest Rutherford (1871-1937):

Erwin Schrödinger (1887-1961):