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Oxford DICTIONARY OF SCIENTISTS

牛津科学家词典

上海外语教育出版社
SHANGHAI FOREIGN LANGUAGE EDUCATION PRESS
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出版说明

随着改革开放的不断深入以及国际交流的日趋广泛,外语学习已经不仅仅局限于语言技能的培养。通过英语获取专业知识、提高专业水平、跟踪学科的最新发展已经成为时代的要求。因此,目前国内急需一批用英语编纂的专业词典。

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该系列词典可作为大专院校各专业的学生以及专业技术人员学习专业知识、提高专业英语能力的参考书。

本社编辑部

Preface

This book is a shortened and updated version of *An Encyclopedia of Scientists*, published by the Institute of Physics in 1993. In compiling this edition we have followed the intention of the original editors – to say as much about science as about the scientists who have created it.

All the entries contain basic biographical data – place and date of birth, posts held, etc. – but do not give exhaustive personal details about the subject's family, prizes, honorary degrees, etc. Most of the space has been devoted to their main scientific achievements and the nature and importance of these achievements. This has not always been easy; in particular, it has not always been possible to explain in relatively simple terms work in the higher reaches of abstract mathematics or modern theoretical physics.

Perhaps the most difficult problem was compiling the entry list. We have attempted to include people who have produced major advances in theory or have made influential or well-known discoveries. A particular difficulty has been the selection of contemporary scientists, in view of the fact that of all scientists who have ever lived, the vast majority are still alive. In this we have been guided by lists of prizes and awards made by scientific societies and we have included all Nobel prizewinners in physics, chemistry, and physiology or medicine. A full list of Nobel prizewinners is given in the back of the book. We have to a great extent concentrated on what might be called the traditional pure sciences – physics, chemistry, biology, astronomy, and the earth sciences. We also give a more limited coverage of medicine and mathematics and have included a selection of people who have made important contributions to engineering and technology. A few of the entries cover workers in such fields as anthropology and psychology, and a small number of philosophers are represented.

Where appropriate, entries contain cross-references to other relevant entries. These are given in small capital letters. We have also included an index of key topics in science.

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A

Abbe, Cleveland (1838–1916) *American meteorologist*

Abbe was born in New York City and educated there at City College; he later taught at the University of Michigan. He then spent two years (1864–66) in Russia at the Pulkovo Observatory under Otto Struve. On his return to America he worked as director of the Cincinnati Observatory (1868–70).

Abbe was the first official weather forecaster in America. He was appointed, in 1871, chief meteorologist with the weather service, which was later formed into the US Weather Bureau (1891), and remained in this organization for the rest of his life. He was one of the first scientists to see the revolutionary role the telegraph had to play in weather forecasting and used reports conveyed to him from all over the country.

Abbe published over 300 papers on meteorology and from 1893 he was in charge of the journals published by the US Weather Bureau. He was also responsible for the division of America into time zones in 1883.

Abbe, Ernst (1840–1905) *German physicist*

Abbe, who was born in Eisenach (now in Germany), came from poor parents but managed to become a lecturer at the University of Jena, where in 1886 he collaborated with Carl Zeiss, a supplier of optical instruments to the university, to improve the quality of microscope production. Up till then, this had been an empirical art without rigorous theory to aid design. Abbe's contribution was his knowledge of optical theory. He is known for the *Abbe sine condition* – a necessary condition for the elimination of spherical aberration in an optical system; such a system he described as aplanatic. He also invented the apochromatic lens system (1886), which eliminated both primary and secondary color distortions and the *Abbe condenser* (1872) – a combination of lenses for converging light onto the specimen in microscopes.

The partnership between Abbe and Zeiss was a productive combination of Zeiss's practical knowledge and Abbe's mathematical and theoretical ability. After Zeiss's death, Abbe became the sole owner of the Zeiss company.

Abegg, Richard (1869–1910) *German physical chemist*

Abegg was born in the German port of Danzig (now Gdańsk in Poland); he studied chemistry at Kiel, Tübingen, and Berlin. He graduated in 1891 as a pupil of Wilhelm Hofmann. Initially an organic chemist, he was attracted by the advances being made in physical chemistry, and in 1894 moved to Göttingen as an assistant to Hermann Nernst. Here, he worked on electrochemical and related problems and with G. Bodländer produced an important paper on valence, *Die Elektronaffinität* (1899; Electron Affinity). He is remembered for *Abegg's rule* (partially anticipated by Dmitri Mendeleev), which states that each element has two valences: a normal valence and a contravalence, the sum of which is eight. In 1899 he became a professor at Breslau (now Wroclaw in Poland) and was about to become the director of the Physico-Chemical Institute there when he was killed in a ballooning accident.

Abel, Sir Frederick Augustus (1827–1902) *British chemist*

Abel was born in London, the son of a well-known musician and the grandson of a court painter to the grand duke of Mecklenberg-Schwerin. Despite this artistic background, Abel developed an early interest in science after visiting his uncle A. J. Abel, a mineralogist and pupil of Berzelius. In 1845 he was one of the first of the pupils to study at the Royal College of Chemistry under August von Hofmann, remaining there until 1851. After a brief appointment as a chemical demonstrator at St. Bartholomew's Hospital, London, he succeeded Michael Faraday in 1852 as a lecturer in chemistry at the Royal Military Academy at Woolwich. In 1854 he became ordnance chemist and chemist to the war department.

Abel's career was thus devoted exclusively to the chemistry of explosives. New and powerful explosives, including guncotton and nitroglycerin, had recently been invented but were unsafe to use. Abel's first achievement was to show how guncotton could be rendered stable and safe. His method was to remove all traces of the sulfuric and nitric acids used in its manufacture by mincing, washing in soda until all the acid had been removed, and drying. In 1888 he was appointed president of a government committee to find new high explosives. The two existing propellants, Poudre B and ballistite, had various defects, most important of which was a tendency to deteriorate during storage. Together with Sir James Dewar, Abel introduced the new explosive, cordite, in 1889. This was a mixture of guncotton and nitroglycerin with camphor and petroleum added as stabilizers and preservatives.

Abel was honoured for his services by being made a knight in 1891 and a baronet in 1893.

Abel, John Jacob (1857–1938) *American biochemist*

Abel was born in Cleveland, Ohio, the son of a farmer. He was educated at the University of Michigan and Johns Hopkins University. He spent the years 1884–90 in Europe studying at Leipzig, Heidelberg, Würzburg, Vienna, Bern, and Strasbourg, where he gained an MD in 1888. On his return to America he worked briefly at the University of Michigan before being appointed in 1893 to the first chair of pharmacology at Johns Hopkins, a post he retained until his retirement in 1932.

Abel approached biology with a first-rate training in chemistry and with the conviction that the study of molecules and atoms was as important as the observation of multicellular tissues under the microscope. He thus began by working on the chemical composition of various bodily tissues and fluids and, in 1897, succeeded in isolating a physiologically active substance from the adrenal glands, named by him epinephrine, also known as adrenalin. This extract was actually the monobenzoyl derivative of the hormone. It was left to Jokichi Takamine to purify it in 1900.

As early as 1912 Abel clearly formulated the idea of an artificial kidney and in 1914 isolated for the first time amino acids from the blood. He was less successful with his search (1917–24) for the pituitary hormone, being unaware that he was dealing with not one but several hormones. His announcement in 1926, that he had crystallized insulin met with considerable skepticism, especially regarding its protein nature. This work was not generally accepted until the mid 1930s.

After his retirement Abel devoted himself to a study of the tetanus toxin.

Abel, Niels Henrik (1802–1829) *Norwegian mathematician*

Abel was born in Froland, the son of a poor pastor; he was educated in mathematics at the University of Christiana (Oslo). After the death of his father, Abel had to support a large family; he earned what he could by private teaching and was also helped out by his teacher. He was eventually given a grant by the Norwegian government to make a trip to France and Germany to visit mathematicians. In Germany he met the engineer and mathematician August Crelle, who was to be of great assistance to him. Crelle published Abel's work and exerted what influence he could to obtain him a post in Germany. Tragically Abel died just when Crelle had succeeded in getting him the chair in mathematics at Berlin.

With Evariste Galois (whom he never met), Abel founded the theory of groups (commutative groups are known as *Abelian groups* in his honor), and his early death ranks as one of the great tragedies of 19th-century mathematics. One of Abel's first achievements was to solve the longstanding problem of whether the general quintic (of the fifth degree) equation was solvable by algebraic methods. He showed that the general quintic is not solvable algebraically and sent this proof to Karl Gauss, but unfortunately Gauss threw it away unread, having assumed that it was yet another unsuccessful attempt to solve the quintic.

Abel's greatest work was in the theory of elliptic and transcendental functions. Mathematicians had previously focused their attention on problems associated with elliptic integrals. Abel showed that these problems could be immensely simplified by considering the inverse functions of these integrals – the so-called 'elliptic functions'. He also proved a fundamental theorem, *Abel's theorem*, on transcendental functions, which he submitted to Augustin Cauchy (and unfortunately fared no better than he did with Gauss). The study of elliptic functions inaugurated by Abel was to occupy many of the best mathematicians for the remainder of the 19th century. He also made very important contributions to the theory of infinite series.

Abelson, Philip Hauge (1913–) *American physical chemist*

Abelson, who was born in Tacoma, was educated at Washington State College and at the University of California at Berkeley, where he obtained his PhD in 1939. Apart from the war years at the Naval Research Laboratory in Washington, he spent most of his career at the Carnegie Institution, Washington, serving as the director of the geophysics laboratory from 1953, and as president from 1971 to 1978. He subsequently became the editor of a number of scientific journals including the important periodical *Science*, which he edited from 1962 to 1985.

In 1940 he assisted Edwin McMillan in creating the first transuranic element, neptunium, by bombardment of uranium with neutrons in the Berkeley cyclotron. Abelson next worked on separating the isotopes of uranium. It was clear that a nuclear explosion was possible only if sufficient quantities of the rare isotope uranium–235 (only 7 out of every 1000 uranium atoms) could be obtained. The method Abelson chose was that of thermal diffusion. This involved circulating uranium hexafluoride vapor in a narrow space between a hot and a cold pipe; the lighter isotope tended to accumulate nearer the hot surface. Collecting sufficient uranium–235 involved Abelson in one of those massive research and engineering projects only possible in war time. In the Philadelphia Navy Yard, he constructed a hundred or so 48-foot (15-meter) precision-engineered pipes through which steam was pumped. From this Abelson was able to obtain uranium enriched to 14 U-235 atoms per 1000.

Although this was still too weak a mixture for a bomb, it was sufficiently enriched to use in other separation processes. Consequently a bigger plant, consisting of over 2000 towers, was constructed at Oak Ridge, Tennessee, and provided enriched material for the separation process from which came the fuel for the first atom bomb.

After the war Abelson extended the important work of Stanley Miller on the origin of vital biological molecules. He found that amino acids could be produced from a variety of gases if carbon, nitrogen, hydrogen, and oxygen were present. He was also able to show (1955) the great stability of amino acids by identifying them in 300-million-year-old fossils and later (1956) identified the presence of fatty acids in rocks.

Adams, John Couch (1819–1892)
British astronomer

Adams was born in the small Cornish town of Launceston, where his father was a tenant farmer. He developed an early interest in astronomy, constructing his own sundial and observing solar altitudes, and pursuing his astronomical studies in the local Mechanics Institute. He graduated brilliantly from Cambridge University in 1843, and became Lowndean Professor of Astronomy and Geometry there in 1858; in 1860 he was appointed director of the Cambridge Observatory.

His fame rests largely on the dramatic events surrounding the discovery of the planet Neptune in 1846. Astronomers had detected a discrepancy between the observed and predicted positions of Uranus and thus it appeared that either Newton's theory of gravitation was not as universal as had been supposed, or there was an as yet undetected body exerting a significant gravitational influence over the orbit of Uranus. There is evidence that Adams had decided to work on this problem as early as 1841. He had a general solution to the problem by 1843 and a complete solution by September, 1845. It was then that he payed a visit to George Airy, the Astronomer Royal, with the exact position of the new planet.

Airy payed little attention to it and was moved to action only when, in June 1846, the French astronomer, Urbain Leverrier, also announced the position of a new planet. It was within one degree of the position predicted by Adams the previous year. Airy asked James Challis, director of the Cambridge Observatory, to start looking for the new planet with his large 25-inch (63.5-cm) refractor. Unfortunately Challis decided to cover a much wider area of the sky than was necessary and also lacked up-to-date and complete charts of the area. His start was soon lost and Johann Galle in Berlin had no difficulty in discovering the planet on his first night of observation. All the fame, prizes, and honors initially went to Leverrier.

When it was publicly pointed out, by Challis and John Herschel, that Adams's work had priority over Leverrier's, the shy Adams wanted no part of the controversy that followed. In fact he seemed genuinely uninterested in honors. He declined both a knighthood and the post of Astronomer Royal, which was offered him after Airy's retirement in 1881. He later worked on the perturbations of the planets (1866), and on the secular variation of the mean motion of the Moon (1852), both difficult questions of mathematical astronomy. His scientific papers were published by his brother in two volumes, in 1876 and 1901.

Adams, Walter Sydney (1876–1956)
American astronomer

Adams was born in Antioch (now in Turkey). He was the son of missionaries working in Syria, then part of the Ottoman Empire, who returned to America in 1885. Adams graduated from Dartmouth College in 1898 and obtained his AM from the University of Chicago in 1900. After a year in Munich he began his career in astronomy as assistant to George Hale in 1901 at the

Yerkes Observatory. He moved with Hale to the newly established Mount Wilson Observatory in 1904 where he served as assistant director, 1913–23, and then as director from 1923 until his retirement in 1946.

At Mount Wilson Adams was able to use first the 60-inch (1.5-m) and from 1917 the 100-inch (2.5-m) reflecting telescopes in whose design and construction he had been closely associated. His early work was mainly concerned with solar spectroscopy, when he studied sunspots and solar rotation, but he gradually turned to stellar spectroscopy. In 1914 he showed how it was possible to distinguish between a dwarf and a giant star merely from their spectra. He also demonstrated that it was possible to determine the luminosity, i.e. intrinsic brightness, of a star from its spectrum. This led to Adams introducing the method of spectroscopic parallax whereby the luminosity deduced from a star's spectrum could be used to estimate its distance. The distance of many thousands of stars have been calculated by this method.

He is however better known for his work on the orbiting companion of Sirius, named Sirius B. Friedrich Bessel had first shown in 1844 that Sirius must have a companion and had worked out its mass as about the same as our Sun. The faint star was first observed telescopically by Alvan Clark in 1862. He succeeded in obtaining the spectrum of Sirius B in 1915 and found the star to be considerably hotter than the Sun. Adams realized that such a hot body, just eight light-years distant, could only remain invisible to the naked eye if it was very much smaller than the Sun, no bigger in fact than the Earth. In that case it must have an extremely high density, exceeding 100,000 times the density of water. Adams had thus discovered the first 'white dwarf' – a star that has collapsed into a highly compressed object after its nuclear fuel is exhausted.

If such an interpretation was correct then Sirius B should possess a very strong gravitational field. According to Einstein's general theory of relativity, this strong field should shift the wavelengths, of light waves emitted by it toward the red end of the spectrum. In 1924 Adams succeeded in making the difficult spectroscopic observations and did in fact detect the predicted red shift, which confirmed his own account of Sirius B and provided strong evidence for general relativity.

Adhemar, Alphonse Joseph (1797–1862) *French mathematician*

Adhemar, who was born and died in Paris, France, was a private mathematics tutor who also produced a number of popular mathematical textbooks.

His most important scientific work was his *Les Revolutions de la mer* (1842) in which he was the first to propose a plausible mechanism by which astronomical events could produce ice ages on Earth. It had been known for some time that while the Earth moved in an elliptical orbit around the Sun it also rotated about an axis that was tilted to its orbital plane. Because the orbit is elliptical and the Sun is at one focus, the Earth is closer to the Sun at certain times of year. As a result, the southern hemisphere has a slightly longer winter than its northern counterpart. Adhemar saw this as a possible cause of the great Antarctic icesheet for, as this received about 170 hours less solar radiation per year than the Arctic, this could just be sufficient to keep temperatures cold enough to permit the ice to build up.

Adhemar was also aware that the Earth's axis does not always point in the same direction but itself moves around a small circular orbit every 26,000 years. Thus he postulated a 26,000-year cycle developing in the occurrence of glacial periods, but his views received little support.

Adler, Alfred (1870–1937) *Austrian psychologist*

Adler was born in Penzing, Austria, the son of a corn merchant, and was educated at the University of Vienna, where he obtained his MD in 1895. After two years at the Vienna General Hospital he set up in private practice in 1898.

In about 1900 Adler began investigating psychopathology and in 1902 he became an original member of Sigmund Freud's circle, which met to discuss psychoanalytical matters. His disagreements with Freud began as early as 1907 – he dismissed Freud's view that sexual conflicts in early childhood cause mental illness – and he finally broke away from the psychoanalytic movement in 1911 to form his own school of individual psychology. Adler tended to minimize the role of the unconscious and sexual repression and instead to see the neurotic as overcompensating for his or her 'inferiority complex', a term he himself introduced. His system was fully expounded in his *Practice and Theory of Individual Psychology* (1927). In 1921 Adler founded his first child-guidance clinic in Vienna, which was to be followed by over 30 more before the Nazi regime in Vienna forced their closure in 1932. From 1926 onward he began to spend more and more time in America, finally settling there permanently in 1932 and taking a professorship of psychiatry at the Long Island College of Medicine, New York, a post he retained until his death from a heart attack while lecturing in Aberdeen in Scotland.

Adrian, Edgar Douglas, Baron Adrian of Cambridge (1889–1977)
British neurophysiologist

Adrian, a lawyer's son, was born in London and studied at Cambridge University and St. Bartholomew's Hospital, London, where he obtained his MD in 1915. He returned to Cambridge in 1919, was appointed professor of physiology in 1937, and became the master of Trinity College, Cambridge, in 1951, an office he retained until his retirement in 1965. He was raised to the British peerage in 1955.

Adrian's greatest contribution to neurophysiology was his work on the nerve impulse. When he began it was known that nerves transmit nerve impulses as signals, but knowledge of the frequency and control of such impulses was minimal. The first insight into this process came from Adrian's colleague Keith Lucas, who demonstrated in 1905 that the impulse obeyed the 'all-or-none' law. This asserted that below a certain threshold of stimulation a nerve does not respond. However, once the threshold is reached the nerve continues to respond by a fixed amount however much the stimulation increases. Thus, increased stimulation, although it stimulates more fibers, does not affect the magnitude of the signal itself.

It was not until 1925 that Adrian advanced beyond this position. By painstaking surgical techniques he succeeded in separating individual nerve fibers and amplifying and recording the small action potentials in these fibers. By studying the effect of stretching the sternocutaneous muscle of the frog, Adrian demonstrated how the nerve, even though it transmits an impulse of fixed strength, can still convey a complex message. He found that as the extension increased so did the frequency of the nerve impulse, rising from 10 to 50 impulses per second. Thus, he concluded that the message is conveyed by changes in the frequency of the discharge. For this work Adrian shared the 1932 Nobel Prize for physiology or medicine with Charles SHERRINGTON.

Agassiz, Jean Louis Rodolphe
(1807–1873) *Swiss-American biologist*

Generally considered the foremost naturalist of 19th-century America, Agassiz was born in Motier-en-Vuly, Switzerland. He was educated at the universities of Zurich, Heidelberg, and Munich, where he studied under the embryologist Ignaz Döllinger. At the instigation of Georges Cuvier, he cataloged and described the fishes brought back from Brazil by C.F.P. von Martius and J.B. von Spix (*Fishes of Brazil*, 1929), following this with his *History of the Freshwater Fishes of Central Europe* (1839–42) and an extensive pioneering work on fossil fishes, which eventually ran to five volumes: *Recherches sur les poissons fossiles* (1833–43; Researches on Fossil Fishes). These works, completed while Agassiz was professor of natural history at Neuchâtel (1832–46), established his reputation as the greatest ichthyologist of his day. Agassiz's best-known discovery, however, was that of the Ice Ages. Extensive field studies in the Swiss Alps, and later in America and Britain, led him to postulate glacier movements and the former advance and retreat of ice sheets; his findings were published in *Etudes sur les glaciers* (1840; Studies on Glaciers).

A successful series of lectures given at Boston, Massachusetts, in 1846 led to his permanent settlement in America. In 1847 he was appointed professor of zoology and geology at Harvard, where he also established the Museum of Comparative Zoology (1859). Agassiz's subsequent teachings introduced a departure from established practice in emphasizing the importance of first-hand investigation of natural phenomena, thus helping to transform academic study in America. His embryological studies led to a recognition of the similarity between the developing stages of living animals and complete but more primitive species in the fossil record. Agassiz did not, however, share Darwin's view of a gradual evolution of species, but, like Cuvier, considered that there had been repeated separate creations and extinctions of species – thus explaining changes and the appearance of new forms. Unfortunately, one of Agassiz's most influential pronouncements was that there were several species, as distinct from races, of man: an argument used by slavers to justify their subjugation of the negroes as an inferior species. His ambitious *Contributions to the Natural History of the United States* (4 vols. 1857–62) remained uncompleted at his death.

Agricola, Georgius (1494–1555)
German metallurgist

Agricola's true name was Georg Bauer but, as was the custom of the day, he latinized it (Agricola and Bauer both mean 'farmer'). Beyond his place of birth – Glauchau (now in Germany) – little is known about him until his entry into the University of

Leipzig in 1514. He later pursued his studies of philosophy and medicine in Italy at Bologna, Padua, and Venice (1523–27). In 1527 he was engaged as physician to the Bohemian city of Joachimsthal – the center of a rich mining area – moving in 1534 to another celebrated mining town, Chemnitz, near his birthplace. Here he became burgomaster in 1545. He wrote seven books on geological subjects but these were so illuminating of other subjects that he was known in his lifetime as 'the Saxon Pliny'.

His most famous work, *De re metallica* (1556), concentrates on mining and metallurgy with a wealth of information on the conditions of the time, such as management of the mines, the machinery used (e.g. pumps, windmills, and water power), and the processes employed. The book is still in print having the unique distinction of being translated and edited (1912) by a president of the United States, Herbert Hoover, with Lou Henry Hoover (his wife).

Agricola is often regarded as the father of modern mineralogy. In the Middle Ages, the subject was based on accumulated lore from the Orient, the Arabs, and antiquity. Stones were believed to come in male and female form, to have digestive organs, and to possess medicinal and supernatural powers. Agricola began to reject these theories and to provide the basis for a new discipline. Thus in his *De ortu et causis subterraneorum* (1546; On the Origin and Cause of Subterranean Things) he introduced the idea of a lapidifying juice (or *succus lapidescens*) from which stones condensed as a result of heat. This fluid was supposedly subterranean water mixed with rain, which collects earthy material when percolating through the ground.

Agricola also, in *De natura fossilium* (1546), introduced a new basis for the classification of minerals (called 'fossils' at the time). Although far from modern, it was an enormous improvement on earlier works. Agricola based his system on the physical properties of minerals, which he listed as color, weight, transparency, taste, odor, texture, solubility, combustibility, and so on. In this way he tried to distinguish between earths, stones, gems, marbles, metals, building stone, and mineral solutions, carefully describing his terms, which should not be assumed to be synonymous with today's terms, in each case.

Airy, Sir George Biddell (1801–1892)

British astronomer

Airy, the son of a tax collector, was born in Alnwick in the north-east of England. He attended school in Colchester before going to Cambridge University in 1819. He met with early success, producing a mathematical textbook in 1826 and numerous papers on optics. He became Lucasian Professor of Mathematics at Cambridge in 1826 and two years later was made Plumian Professor of Astronomy and director of the Cambridge Observatory. In 1835 he was appointed Astronomer Royal, a post he held for 46 years.

Airy was a very energetic, innovative, and successful Astronomer Royal. He re-equipped the observatory, installing an altazimuth for lunar observation in 1847, a new transit circle and zenith tube in 1851, and a 13-inch (33-cm) equatorial telescope in 1859. He created a magnetic and meteorological department in 1838, began spectroscopic investigations in 1868, and started keeping a daily record of sunspots with the Kew Observatory heliograph in 1873. In optics he investigated the use of cylindrical lenses to correct astigmatism (Airy was astigmatic) and examined the disklike image in the diffraction pattern of a point source of light (in an optical device with a central aperture) now called the *Airy disk*. Also named for him is his hypothesis of isostasy: the theory that mountain ranges must have root structures of lower density, proportional to their height, in order to maintain isostatic equilibrium.

Despite his many successes he is now mainly, and unfairly, remembered for his lapses. When John Adams came to him in September, 1845, with news of the position of a new planet, Airy unwisely ignored him, leaving it to others to win fame as the discoverers of Neptune. He also dismissed Michael Faraday's new field theory.

Aitken, Robert Grant (1864–1951)

American astronomer

Born in Jackson, California, Aitken obtained his AB in 1887 and his AM in 1892 from Williams College, Massachusetts. He began his career at the University of the Pacific, then in San Jose, as professor of mathematics from 1891 until 1895 when he joined the staff of Lick Observatory, Mount Hamilton, California. He remained at Lick for his entire career, serving as its director from 1930 until his retirement in 1935.

Aitken did much to advance knowledge of binary stars, i.e. pairs of stars orbiting about the same point under their mutual gravitational attraction. He described over 3000 binary systems and published in 1932 the comprehensive work *New General Catalogue of Double Stars Within 120° of the North Pole*. He also produced the standard work *The Binary Stars* (1918).

Al-Battani (*or* Albategnius) (*c.* 858–929) *Arab astronomer*

Al-Battani was the son of a maker of astronomical instruments in Harran (now in Turkey). He worked mainly in Raqqah on the Euphrates (now ar-Raqqah in Syria) and was basically a follower of Ptolemy, devoting himself to refining and perfecting the work of his master. He improved Ptolemy's measurement of the obliquity of the ecliptic (the angle between the Earth's orbital and equatorial planes), the determination of the equinoxes, and the length of the year. He also corrected Ptolemy in various matters, in particular in his discovery of the movement of the solar perigee (the Sun's nearest point to the Earth) relative to the equinoxes. His work was widely known in the medieval period, having been translated by Plato of Tivoli in about 1120 as *De motu stellarum* (On Stellar Motion), which was finally published in Nuremberg in 1537.

Alcmaeon (*fl.* 450 BC) *Greek philosopher and physician*

Alcmaeon was born in Croton (now Crotone in Italy). Details of his work come from the surviving fragments of his book and through references by later authors, including Aristotle. He was probably influenced by the school of thought founded by Pythagoras in Croton and originated the notion that health was dependent on maintaining a balance between all the pairs of opposite qualities in the body, i.e. wet and dry, hot and cold, etc. Imbalance of these qualities resulted in illness. This theory was later developed by Hippocrates and his followers.

Alcmaeon performed dissections of animals and possibly of human cadavers also. He demonstrated various anatomical features of the eye and ear, including their connections with the brain, and correctly asserted that the brain was the control center of bodily functions and the seat of intelligence.

Alder, Kurt (1902–1958) *German organic chemist. See* DIELS, OTTO.

Alembert, Jean Le Rond d' *See* D'ALEMBERT, JEAN LE ROND.

Alfvén, Hannes Olof Gösta (1908–1995) *Swedish physicist*

Alfvén, who was born in Norrkoeping, Sweden, was educated at the University of Uppsala where he received his PhD in 1934. He subsequently worked at the Royal Institute of Technology, Stockholm, where he served as professor of the theory of electricity (1940–45), professor of electronics (1945–63), and professor of plasma physics (1963–73)

Alfvén is noted for his pioneering theoretical research in the field of magnetohydrodynamics – the study of conducting fluids and their interaction with magnetic fields. This work, for which he shared the 1970 Nobel Prize for physics with Louis NÉEL, was mainly concerned with plasmas; i.e. ionized gases containing positive and negative particles. He investigated the interactions of electrical and magnetic fields and showed theoretically that the magnetic field, under certain circumstances, can move with the plasma. In 1942 he postulated the existence of waves in plasmas; these *Alfvén waves* were later observed in both liquid metals and ionized plasmas.

Alfvén also applied his theories to the motion of particles in the Earth's magnetic field and to the properties of plasmas in stars. In 1942, and later in the 1950s, he developed a theory of the origin of the solar system. This he assumed to have formed from a magnetic plasma, which condensed into small particles that clustered together into larger bodies. His work is also applicable to the properties of plasmas in experimental nuclear fusion reactors. Alfvén's books include *Cosmical Electrodynamics* (1950), which collects his early work, *On the Origin of the Solar System* (1954), and *On the Evolution of the Solar System* (1976, with G. Arrhenius).

In his later years Alfvén argued against the current orthodoxy of the big-bang theory of the origin of the universe. Space, he argued, is full of immensely long plasma filaments. The electromagnetic forces produced have caused the plasma to condense into galaxies. As for the expansion of the universe, he attributed this to the energy released by the collision of matter and antimatter. Whereas Alfven's critics charged him with vagueness, he responded by arguing that cosmologists derive their theories more from mathematical considerations than from laboratory experiments.

Alhazen (*or* Abu Ali Al-Hassan Ibn Al Haytham) (*c.* 965–1038) *Arabian scientist*

Born in Basra (now in Iraq), Alhazen was one of the most original scientists of his time. About a hundred works are attributed to him; the main one was translated into Latin in the 12th century and finally published in 1572 as *Opticae thesaurus* (The Treasury of Optics). This was widely studied and extremely influential. It was the first authoritative work to reject the curious Greek view that the eye sends out rays to the object looked at. Alhazen also made detailed measurements of angles of incidence and refraction. He studied spherical and parabolic mirrors, the camera obscura, and the role of the lens in vision. While the Greeks had had a good understanding of the formation of an image in a plane mirror, Alhazen tackled the much more difficult problem of the formation of images in spherical and parabolic mirrors and offered geometrical solutions. It is difficult to think of any other writer who had surpassed the Greeks in any branch of the exact sciences by the 14th let alone the 11th century. He was, however, unfortunate in his relationship with the deranged caliph al-Hakim. Having rashly claimed that he could regulate the flooding of the Nile, he was forced to simulate madness to escape execution until the caliph died in 1021.

Al-Khwarizmi, Abu Ja'far Muhammad Ibn Musa (*c.* 800–*c.* 847) *Arab mathematician, astronomer, and geographer*

Al-Khwarizmi takes his name from his birthplace, Khwarizm (now Khiva in Uzbekistan). His importance lies chiefly in the knowledge he transmitted to others. Very little is known about his life except that he was a member of the academy of sciences in Baghdad, which flourished during the rule (813–33) of caliph al-Ma'mun. Al-Khwarizmi's main astronomical treatise and his chief mathematical work, the *Algebra*, are dedicated to the caliph. The *Algebra* enlarged upon the work of Diophantus and is largely concerned with methods for solving practical computational problems rather than algebra as the term is now understood. Insofar as he did discuss algebra, al-Khwarizmi confined his discussion to equations of the first and second degrees.

His astronomical work, *Zij al-sindhind*, is also based largely on the work of other scientists. As with the *Algebra*, its chief interest is as the earliest Arab work on the subject still in existence.

Al-Khwarizmi's other main surviving works are a treatise on the Hindu system of numerals and a treatise on geography. The Hindu number system, with its epoch-making innovations, for example the incorporation of a symbol for zero, was introduced to Europe via a Latin translation (*De numero indorum*; On the Hindu Art of Reckoning) of al-Khwarizmi's work. Only the Latin translation remains but it seems certain that al-Khwarizmi was the first Arab mathematician to expound the new number system systematically. The term 'algorithm' (a rule of calculation) is a corrupted form of his name. His geographical treatise marked a considerable improvement over earlier work, notably in correcting some of the influential errors and misconceptions that had gained currency owing to Ptolemy's *Geography*.

Allen, Edgar (1892–1943) *American endocrinologist*

Allen, the son of a physician, was born in Canon City, Colorado, and educated at Brown University. After war service he worked at Washington University, St. Louis, before being appointed (1923) to the chair of anatomy at the University of Missouri. In 1933 he moved to a similar post at Yale and remained there until his death.

In 1923 Allen, working with Edward Doisy, began the modern study of the sex hormones. It was widely thought that the female reproductive cycle was under the control of some substance found in the corpus luteum, the body formed in the ovary after ovulation. Allen thought rather that the active ingredient was probably in the follicles surrounding the ovum. To test this he made an extract of the follicular fluid and found that on injection it induced the physiological changes normally found only in the estrous cycle. Allen had in fact discovered estrogen although it was only identified some six years later by Adolf Butenandt.

Allen, James Alfred Van *See* VAN ALLEN, JAMES ALFRED.

Alpher, Ralph Asher (1921–) *American physicist. See* GAMOW, GEORGE; DICKE, ROBERT.

Altman, Sidney (1939–) *American chemist*

Born in Montreal, Canada, Altman was educated at the University of Colorado, Boulder, where he obtained his PhD in 1967. He moved to Yale in 1971, becoming professor of biology in 1980 and a naturalized US citizen in 1984.

In 1982 Thomas CECH at Colorado had shown that RNA sometimes served as a biocatalyst – a role previously thought to be exclusive to protein enzymes. Cech's work was on a reaction in which the RNA was a self-catalyst. Altman set out to investigate other catalytic activity of RNA.

He worked with ribonuclease-P, an enzyme composed of both RNA and a protein, which catalyzes the processing of transfer RNA (tRNA). For the enzyme to work at the cellular level, it was thought that both protein and RNA were needed. It could, however, be possible that the RNA was merely a kind of structural support for the protein enzyme. Altman found that, *in vitro*, ribonuclease-P alone could splice the tRNA molecule at the correct place; the unaccompanied protein displayed no such activity.

Final proof came when a recombinant DNA template was used to produce only the RNA part of the ribonuclease-P. The artificial RNA still catalyzed the appropriate activity without any associated protein whatsoever. Altman had thus helped to break down the previously unquestioned dogma that molecules could either carry information, like RNA, or catalyze chemical reactions, like proteins, but they could not do both. The discovery could also throw light on the puzzle that if proteins are needed to assemble RNA, and RNA to assemble proteins, then how did the process ever get started? The answer could lie in the catalytic activity of RNA itself.

For his work on ribonuclease-P Altman shared the 1989 Nobel Prize for chemistry with Thomas CECH.

Alvarez, Luis Walter (1911–1988)
American physicist

Alvarez, the son of a research physiologist, was born in San Francisco and educated at the University of Chicago where he gained his PhD in 1936. He moved soon after to the University of California, Berkeley. Apart from wartime work on radar at the Massachusetts Institute of Technology Radiation Laboratory (1940–43) and on the Manhattan Project at Los Alamos (1943–45), Alvarez spent his entire career at Berkeley, serving as professor of physics from 1945 until his retirement in 1978.

In 1938 Alvarez reported his first major discovery, namely, the phenomenon of orbital electron capture. In 1936 Hans Bethe had argued that an excited nucleus could decay by capturing one of its own orbiting electrons, a process known as K-capture as the electron is taken from the innermost (K) electron shell. Alvarez succeeded in detecting the process experimentally by identifying the characteristic x-rays emitted during K capture as a result of electrons moving from outer orbits into the vacant K orbit.

Alvarez followed this by making (1939) the first measurement, with Felix BLOCH, of the neutron's magnetic moment. He also demonstrated that hydrogen-3 (tritium) was radioactive, work which proved to be of significance in the later development of the hydrogen bomb.

While working on radar during the war Alvarez had what he later described as one of his most valuable ideas. If radar could be used to track approaching aircraft then, he argued, the same information should be adequate to guide a pilot to a safe landing in bad weather. There were many obstacles to be overcome before GCA (Ground Controlled Approach) could be adopted. By early 1943, however, Alvarez was able to talk down a distant plane he could follow only on radar.

Soon after he moved to Los Alamos where he worked on the problem of detonating the bomb. It was necessary for 32 detonators to fire simultaneously. Alvarez was an observer in a follow-up plane of the Hiroshima bomb.

After the war Alvarez remained as creative as ever. His most important work was in the field of particle physics. By the early 1950s experimentalists had begun to find it difficult to track particles. Cloud chambers took too long to operate, emulsions could only pick up charged particles and consequently much was being missed. In April 1953 Alvarez was introduced by Donal GLASER to the idea that particles passing through a small glass bulb containing diethyl ether would produce bubble tracks. The chamber operated by suddenly reducing the pressure causing the liquid to 'boil' and leave a bubble track where a particle had passed.

Alvarez immediately began to design a much larger bubble chamber using liquid hydrogen as a fluid. After a few test runs with some small chambers Alvarez proposed to build a 72-inch model at a cost of 2.5 million dollars. It first came into operation in March, 1959, and was used to discover a large number of elementary particles. For his work in this field Alvarez was awarded the 1968 Nobel Prize for physics.

Alvarez also investigated other phenomena. In 1977 his son Walt, a geologist, showed him a rock from Gubbio in the Italian Apennines. It was aged 65 million years and consisted of two layers of limestone, one from the Cretaceous, the other from the Tertiary, separated by a thin clay strip. During the rock's formation the dinosaurs had flourished and passed into extinction.

Alvarez was intrigued by the presence in the clay of unusually high concentrations of iridium. No more than about 0.03 parts per billion are normally to be found in the Earth's crust. The geologists, however, reported that there was 300 times as much iridium in the clay layer than in the surrounding limestone samples (an example of what is now known as the 'iridium anomaly'). The clay, it was calculated, had formed over a mere 1000 years, and was located in time at the KT boundary (K = *Kreide*, German for Cretaceous, T = Tertiary). Could the thin strip of clay and its iridium content throw any light on the mass extinctions that were taking place during its formation?

He first suggested that the iridium could have come from a nearby supernova explosion. This was soon rejected after a fruitless search in the clay for traces of plutonium-244, another supernova byproduct. Alvarez began to consider another possibility, namely, a collision with a large asteroid. It would certainly bring along with it the observed iridium, but it was not immediately apparent how the asteroid could produce a global extinction. Further reflection suggested that an asteroid 10 kilometers in diameter would throw sufficient dust into the atmosphere to darken the sky for several years. This in turn would prevent photosynthesis, destroy plant life and, along the way, all other dependent creatures.

Alvarez published his theory in 1980 and spent much of the remaining decade of his life explaining and defending his views. Some geologists objected that dinosaurs had become extinct some 20,000 years before the iridium layer was deposited. Others claimed that prolonged darkness would have been as damaging to marine as to terrestrial life, whereas marine life suffered no comparable mass extinction. Despite these and other objections Alvarez's impact theory survived the 1980s as the most favored account of the death of the dinosaurs.

Alvarez left a vivid account of his life in his *Alvarez, Adventures of a Physicist* (1987).

Alzheimer, Alois (1864–1915) *German psychiatrist*

Alzheimer was born in Markbreit in Germany and studied medicine at the universities of Würzburg and Berlin. After working in hospitals in Frankfurt and Heidelberg, he joined the Munich Psychiatric Clinic of Emil Kraepelin (1856–1926) as head of the anatomy department. He worked in Munich from 1904 until 1912 when he was appointed professor of psychiatry and neurology at the University of Breslau (now Wrocław in Poland).

In 1907 Alzheimer treated a 51-year-old woman with a growing memory loss. Her condition rapidly deteriorated into severe dementia. On autopsy, he identified a number of pathological conditions including shrinking of the cortex and the presence of neurofibrillary tangles and neuritic plaques. The plaques and tangles were distinctive enough to warrant a diagnosis of senile dementia or, as it later became known, *Alzheimer's disease.*

Amagat, Emile Hilaire (1841–1915) *French physicist*

Born at Saint-Satur, Amagat obtained his doctorate in 1872 from Paris and became a professor of physics at the Faculté Libre des Sciences at Lyons and eventually a full member of the French Academy of Sciences.

He is noted for his work on the behavior of gases. He started work plotting isotherms of carbon dioxide at high pressures, expanding the results of Thomas ANDREWS; this research was published in 1872 as his doctoral thesis. In 1877 followed a publication on the coefficient of compressibility of fluids, showing conclusively that this decreased with an increase in pressure, a result contradicting the results of other scientists. Between 1879 and 1882 Amagat investigated a number of gases, publishing data on isotherms and reaching the limit of pressures obtainable using glass apparatus – about 400 atmospheres. To get yet further Amagat invented a hydraulic manometer that could produce and measure up to 3200 atmospheres. (This manometer was later used in firearms factories for testing purposes.)

Ambartsumian (*or* Ambartsumyan), Viktor Amazaspovich (1908–1996) *Armenian astrophysicist*

Ambartsumian was born in Tbilisi (now in Georgia), the son of a distinguished Armenian philologist. He graduated from the University of Leningrad in 1928 and did graduate work at Pulkovo Observatory, near Leningrad, from 1928 to 1931. He was professor of astrophysics from 1934 to 1946 at Leningrad and held the same post from 1947 at the State University at Yerevan in Armenia. In 1946 he organized the construction, near Yerevan, of the Byurakan Astronomical Observatory, having been appointed its director in 1944. He remained as director until 1988.

Ambartsumian's work was mainly concerned with the evolution of stellar systems, both galaxies and smaller clusters of stars, and the processes taking place during the evolution of stars. The idea of a stellar 'association' was introduced into astronomy by Ambartsumian in 1947. Associations are loose clusters of hot stars that lie in or near the disk-shaped plane of our Galaxy. They must be young, no more than a few million years old, as the gravitational field of the Galaxy will tend to disperse them. This must mean that star formation is still going on in the Galaxy.

He also argued in 1955 that the idea of colliding galaxies proposed by Rudolph Minkowski and Walter Baade to explain such radio sources as Cygnus A would not produce the required energy. Instead, he proposed that the source of energy was gigantic explosions occurring in the dense central regions of galaxies and these would be adequate to provide the 10^{55} joules emitted by the most energetic radio sources.

Amontons, Guillaume (1663–1705)
French physicist

Amontons, a Parisian, who had been deaf since childhood, invented and perfected various scientific instruments. In 1687 he made a hygrometer (an instrument for measuring moisture in the air); in 1695 he produced an improved barometer; and in 1702–03 a constant-volume air thermometer. In 1699 he published the results of his studies on the effects of change in temperature on the volume and pressure of air. He noticed that equal drops in temperature resulted in equal drops in pressure and realized that at a low enough temperature the volume and pressure of the air would become zero – an early recognition of the idea of absolute zero. These results lay largely unnoticed and the relationship between temperature and pressure of gases was not reexamined until the next century (by scientists such as Jacques Charles).

Amontons also published in 1699 the results of his studies on friction, which he considered to be proportional to load.

Ampère, André Marie (1775–1836)
French physicist and mathematician

Ampère was born in Lyons, France, where his father was a wealthy merchant. He was privately tutored, and to a large extent self-taught. His genius was evident at an early age. He was particularly proficient at mathematics and, following his marriage in 1799 he was able to make a modest living as a mathematics teacher in Lyons. In 1802 he moved first to Bourg-en-Bresse to take up an appointment, then to Paris as professor of physics and chemistry at the Ecole Centrale.

His first publication was on the statistics of games of chance *Considérations sur la théorie mathématique de jeu* (1802; Considerations on the Mathematical Theory of Games) and his work at Bourg led to his appointment as professor of mathematics at the Lyceum of Lyons, and then in 1809 as professor of analysis at the Ecole Polytechnique in Paris. His talents were recognized by Napoleon, who in 1808 appointed him inspector general of the newly formed university system – a post Ampère held until his death.

Ampère's most famous scientific work was in establishing a mathematical basis for electromagnetism. The Danish physicist Hans Christian Oersted had made the important experimental discovery that a current passing through a wire could cause the movement of a manetic compass needle. Ampère witnessed a demonstration of electromagnetism by François Arago at the Academy of Science on 11 September, 1820. He set to work immediately on his own investigations, and within seven days was able to report the results of his experiments.

In a succession of presentations to the academy in the next four months, he developed a mathematical theory to explain the interaction between electricity and magnetism, to which he gave the name 'electrodynamics' (now more commonly: electromagnetism) to distinguish it from the study of stationary electric forces, which he christened 'electrostatics'.

Having recognized that electric currents in wires caused the motion of magnets, and that a magnet can affect another magnet, he looked for evidence that electric currents could similarly influence other electric currents. The simplest example of this interaction is found by arranging for currents to flow through two parallel wires. Ampère discovered that if the currents passed in the same direction the wires were attracted to each other, but if they passed in opposite directions the wires were repelled. From this he went on to consider more complex configurations of closed loops, helices, and other geometrical figures, and was able to provide a mathematical analysis that allowed quantitative predictions.

In 1825 he had been able to deduce an empirical law of forces (*Ampère's law*) between two current-carrying elements, which showed an inverse-square law (the force decreases as the square of the distance between the two elements, and is proportional to the product of the two currents). By 1827 he was able to give a precise mathematical formulation of the law, and it was in this year that his most famous work *Mémoirs sur la théorie mathématique des phénomènes electrodynamiques uniquement déducte de l'expérience* (Notes on the Mathematical Theory of Electrodynamic Phenomena, Solely Deduced from Experiment) was published.

Besides explaining the macroscopic effects of electromagnetism, he attempted to construct a microscopic theory that would