THE EPS
EUROPEAN PHYSICIST BIOGRAPHY POSTERS

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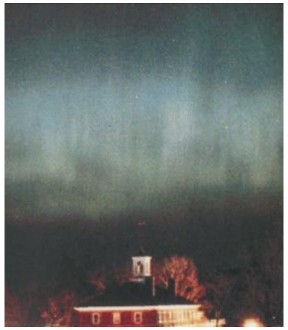
Hannes Olaf Gösta Alfvén (1908 – 1995)

Awarded the Nobel Prize for Physics in 1970

Hannes Olaf Gösta Alfvén was the first space scientist to receive the Nobel Prize. He was noted for his pioneering theoretical research in the field of magnetohydrodynamics (MHD) – the study of electrically conducting fluids and their interactions with magnetic fields. MHD mainly concerns plasmas, i.e. ionised gases existing at very high temperatures and containing both free positive ions and free electrons.

Many of Alfvén's ideas came from his consideration of sunspots. In 1942 he proposed the existence of MHD waves in plasmas (Alfvén waves) and these were later confirmed. His ideas have been applied to plasmas in stars and in nuclear fusion reactors. He also explained in his early research the aurora borealis. The solar wind comprises a stream of particles ejected from the Sun; when these particles enter the Earth's magnetic field, they are diverted towards the poles, and their collisions in the ionosphere produce the auroral display.

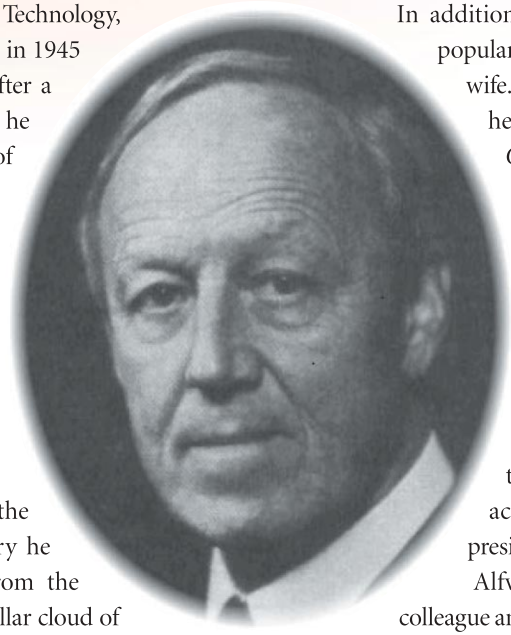
He explained the aurora borealis



Alfvén was born in Nörrkoping, Sweden, into a family of physicians. He said that there were two things that influenced him in an important way. One was that at an early age he read the Swedish edition of the French astronomer Camille Flammarion's book *Astronomie populaire*. The other was a widespread enthusiasm for radio. 'These two things shaped my life, astronomy and electronics'.

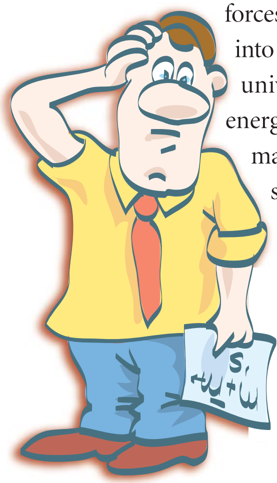
Alfvén was educated at the University of Uppsala and later worked as a research physicist at the Nobel Institute of Physics.

In 1940 he moved to the Royal Institute of Technology, Stockholm, becoming professor of electronics in 1945 and professor of plasma physics in 1963. After a disagreement with the Swedish government he accepted a professorship at the University of California, San Diego. Later he divided his time between the Institute of Technology and the University of California. He was a strong supporter of research on controlled thermonuclear reactions.



In 1935, he married Kerstin Erikson, whom he had met while they were both students in Uppsala. They had five children and later nine grandchildren.

Alfvén's later works have dealt with the formation of the solar system. In his theory he hypothesised that planets were formed from the material captured by the Sun from an interstellar cloud of gas and dust. He argued against the current big-bang theory as the origin of the universe. According to him electromagnetic forces caused the plasma to condense into galaxies. As for expansion of the universe, he attributes this to the energy released by the collision of matter and antimatter. Not everyone shared his cosmological views.



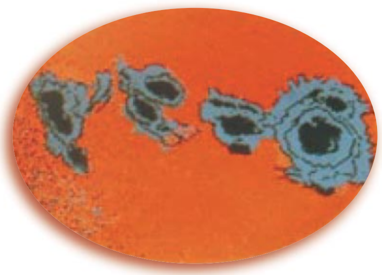
He had some strange ideas about the reason for the expansion of the universe

In addition to his scientific papers, he wrote popular science books, sometimes with his wife. Under the name Olaf Johannesson, he wrote a science fiction novel, *The Great Computer: A Vision* (1968), which describes how increasingly sophisticated computers gain control firstly over governments and then over the Earth.

Although he started as a supporter of the development of nuclear power as an energy source for Sweden, later he actively opposed the use of nuclear energy. He was active in Pugwash, and later its president.

Alfvén is remembered as a reliable colleague and an entertaining companion.

Sunspots are the result of vibrant solar eruptions



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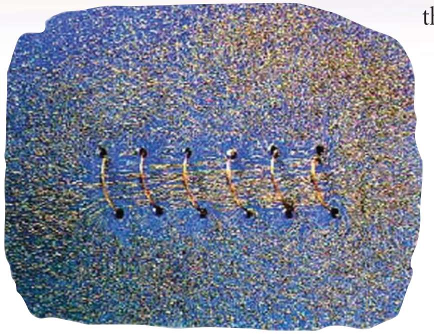
André Marie Ampère (1775 – 1836)

Many people use the word 'ampere' for the unit of electrical current knowing nothing about the great genius French scientist, André Marie Ampère, after whom it is named.

Ampère's life was rather restless and unhappy, despite being born into a wealthy silk trader's family. Before being able to read, the young Ampère's greatest pleasure was to listen to passages from Buffon's *Natural History*. Soon, the reading of history books in his father's library attracted him but mostly he was interested in the Encyclopedia. His mathematical ability became evident at an early age. The little boy tried to solve problems with the help of stones and even using biscuits.

At the age of 13 he taught himself Latin in order to read the mathematical work of Euler. Apart from mathematics, young Ampère was fond of botany and poetry and wrote verses by himself. He studied Greek so that he could read classical poetry.



A coil carrying a current behaves like a bar magnet

His father went to the guillotine…

Ampère's childhood ended in 1789 with the outbreak of the French Revolution. His father was appointed to the post of judge, became involved in political intrigue and finally was tried and guillotined. The news of the death of his father deeply affected the young man. Ampère became deeply depressed and for a year he retreated within himself, not speaking to anyone. Only an interest in botany and a volume of Roman poetry seemed to save him.

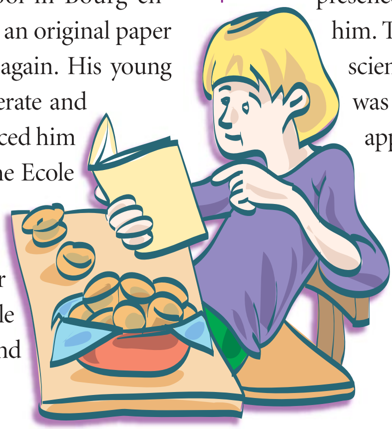
He was 21 when he met Julie, a young golden-haired lady. The romantic young man fell in love with her. They married three years later when André Marie was able to earn a living as a mathematics teacher in Lyon. The next four years were the happiest of Ampère's life. A son was born to them in 1800.

In 1802 André Marie obtained the post of Professor of Physics and Chemistry at the central school in Bourg-en-Bresse. At the same time he began to work on an original paper on probability theory. Then tragedy struck again. His young wife died of tuberculosis. Ampère was desperate and wanted to commit suicide. The family convinced him to take a poorly paid position as a tutor at the Ecole Polytechnique in Paris.

A second marriage in 1806 was a catastrophe from the very beginning. Even after the birth of a daughter, his life was so unbearable that Ampère decided to divorce. His mother and aunt took care of both his children. An appointment to the post of Inspector General of the University of Paris improved his finances. Being a brilliant mathematician he was interested in dozens of questions at once: in atomic theory, in the structure of crystals, in chemistry, and in philosophy.

In 1820 Ampère learned about the result of the Danish physicist, Ørsted, that a magnetic needle is deflected by a conductor through which a current is sent. Soon, Ampère reported to the French Academy of Sciences: 'two parallel electric currents attract one another when the currents move in the same direction; they repel if they move in opposite directions'. He demonstrated that a coil through which currents flowed had the properties of a bar magnet and therefore proved that electricity in motion and magnetism were linked.

Ampère was known as a kind, sensitive, poetic man, with a streak of absent-mindedness. It is a legend that once at his lecture before the Academy Ampère failed to recognise the presence of Napoleon I, who was sitting right in front of him. The Emperor was not insulted and invited the great scientist for lunch on the next day. However, Ampère was so preoccupied with his work that he forgot the appointment!



The little boy tried to solve problems with the help of biscuits

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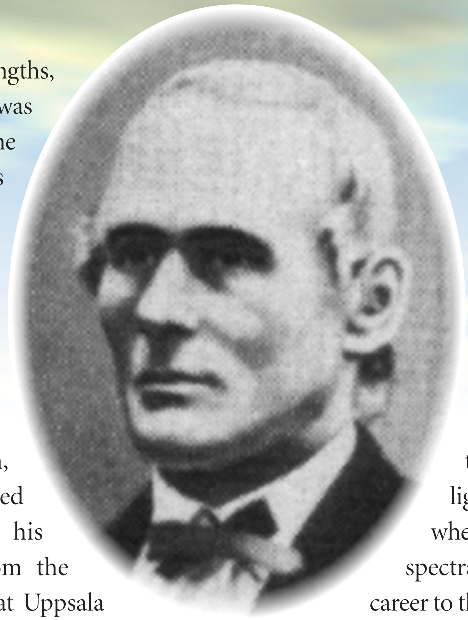
Anders Jonas Ångström (1814 – 1874)



For the purpose of measuring very short lengths, such as those of light, the unit 'Ångström' was introduced. One Ångström (Å) is equal to one hundred-millionth part of a centimetre. It is named in honour of the 19th-century physicist Anders Ångström who, with Kirchhoff, founded modern spectroscopy.

Spectroscopy is the method of investigating matter by the registration and analysis of spectral lines of light emitted from a substance when it is heated.

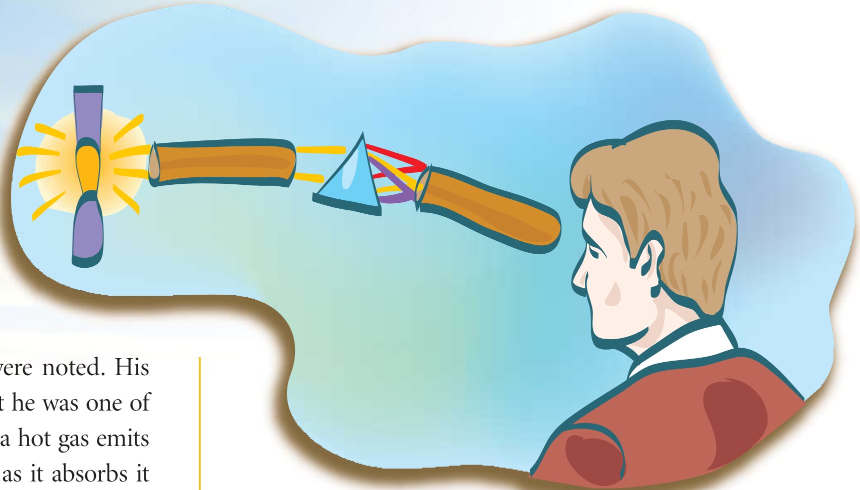
Ångström was born at Medelpad, Sweden, in 1814, the son of a chaplain. He was educated at the University of Uppsala, obtaining his doctorate in 1839. After graduating from the University, Ångström worked for a while at Uppsala Observatory. Later, he was appointed to the chair of physics at the University of Uppsala.

Ångström's first investigation was into the conduction of heat. He also measured atomic spectra, particularly those produced by electric arcs, where lines in the spectrum due to both electrode and gas were noted. His main achievement was that he was one of the first to understand that a hot gas emits light at the same wavelength as it absorbs it when it is cooled. Ångström was so interested in spectral analysis that he devoted the rest of his career to this problem.

The connection between absorption and emission spectra has been much used in astronomy, since spectra from heavenly bodies can indicate the elements present.

For two years (1861-62) Ångström investigated the spectrum of the Sun, and announced that hydrogen was present there.

He studied the light from the Sun in great detail



He examined the lines in the spectrum from powerful electric arcs

In 1868 he published his *Researches on the Solar System*, a famous work in which he presented measurements of more than 100 lines. He also published his map of the normal solar spectrum, which remained a standard reference work for nearly twenty years. Ångström was the first to examine the spectrum of the aurora borealis.

Despite the importance of his work he was not immediately recognised either abroad nor even in his own country. In part it was probably because he was a very modest and reserved person. But eventually his works were valued. He became a member of the Stockholm and Uppsala Academies, and in 1870 he was made a Fellow of the Royal Society of London from which he received the Rumford Medal in 1872.

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Dominique François Jean **Arago** (1786 – 1853)

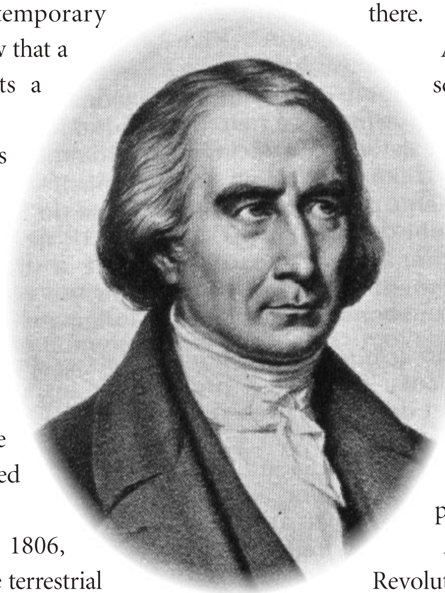
As minister, he signed decrees abolishing slavery in the French colonies

Dominique François Jean Arago was one of the most prominent statesmen and scientists in the early 19th century. He made contributions to the development of many areas of physics and astronomy.

In physics his first investigations concerned the polarisation of light and he confirmed Fresnel's light wave theory. He also found that an electric current produces temporary magnetisation in an iron coil and later he saw that a rotating non-magnetic metal disc deflects a magnetic needle placed above it.

As an astronomer, Arago is remembered as the discoverer of the solar chromosphere (the atmosphere just above the Sun's surface) and for its accurate study.

Arago was born in 1786, in Estagel, France. The family moved to Perpignan in 1795 when Arago's father was made cashier at the mint. There, Arago completed his classical education. He studied at the École Polytechnique in Paris and was then appointed to the Bureau of Longitudes.



He travelled to Spain with Jean Biot in 1806, where they intended to measure an arc of the terrestrial meridian. After being held prisoner in Spain and Algeria, where he only just escaped from being sold into slavery, he returned to France and was elected to membership of the French Academy of Sciences. In the same year (1809) Arago was appointed to the chair of analytical geometry at the École Polytechnique, a post he held until 1830. Later he became a permanent secretary there.

Arago had a stormy relationship with other scientists, such as Biot, Thomas Young, and Brewster.

As a person he was (according to his biographers) restless, inquisitive, volatile and full of enthusiasm and optimism. Married in 1811, Arago had three sons and lived in an apartment at the observatory. In his later years he gradually lost his eyesight, and went blind. He wished to find how a medium affected the speed of light in it, but the French Revolution and his blindness prevented him.

Arago also played a part in the July Revolution, and, as a member of Chamber of Deputies, voted with the extreme left wing. In 1848 he became a member of the provisional government and was named minister of the navy and the army. As minister, he signed decrees abolishing slavery in the French colonies.

He resigned his post upon the coronation of Emperor Napoleon III, refusing to take the Oath of Allegiance to the Emperor. He died soon afterwards in Paris in 1853.

From C Wolf: Histoire de l'Observatoire de Paris

He was the Director of the Paris Observatory

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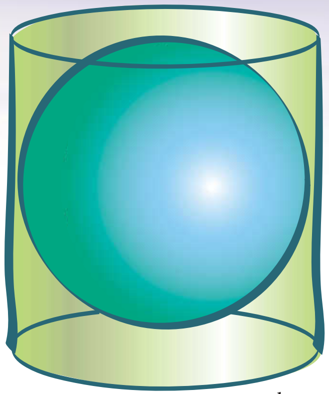
Archimedes (287 – 212 B.C.)

Archimedes is probably the most famous ancient Greek mathematician, inventor and astronomer. The year of his birth is usually stated to be 287 B.C. He was born in Syracuse, Sicily, then a Greek colony.



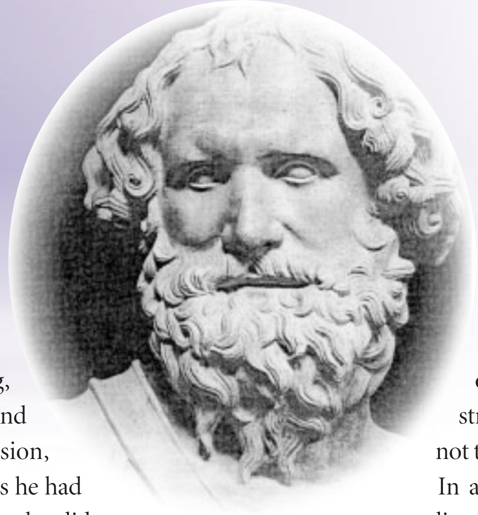
$$V = \frac{4}{3}\pi r^3$$
$$A_s = 4\pi r^2$$
$$V_{cyl} = 2\pi r^3$$

According to one version he was poor and of humble birth, but the ancient historian Plutarch reports on his family connections and his intimate relation with King Hieron II of Syracuse.

He spent some time in Alexandria studying mathematics, and most probably visited Spain, but he spent most of his life in Syracuse under the patronage of King Hieron.

Archimedes discovered the relation between the areas and volumes of a sphere and its circumscribing cylinder. He is also known for his formulation of the hydrostatic principle, known as *Archimedes' Principle: the upthrust on a submerged body is equal to the weight of fluid displaced*. He designed all sorts of pumps, and the *Archimedean water-screw* is still widely used.

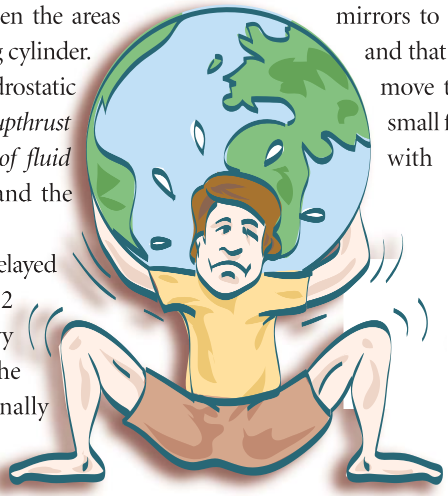
War machines of his construction greatly delayed the capture of Syracuse by Roman forces in 212 B.C. Powerful machines discharged heavy blocks of stone from a distance on the Roman legions; however, Syracuse was finally captured by the Roman general Marcellus and Archimedes was killed. In one of the versions of his death, he was ordered by a soldier to follow him to Marcellus. But Archimedes refused to do so until he had finished the problem that he was studying, upon which the soldier became enraged and killed him. According to another version, Archimedes, while intent on some figures he had drawn in the dust, was killed by a soldier who did not know who he was.



Plutarch tells us that few people have been so preoccupied with mathematics: 'He forgot to nourish himself and omitted to care for his body, and when, as would often happen, he was urged by force to bathe and anoint himself, he would still be drawing geometrical figures in the ashes or with his finger would draw lines on his anointed body'.

Many details survive about the life of Archimedes but they are largely anecdotal, reflecting the popularity of the genius inventor. Examples are the stories that he used a huge array of mirrors to burn the Roman ships besieging Syracuse and that he said, 'Give me a place to stand and I will move the Earth', after he had found how a very small force is capable of moving a very large weight with the help of levers. The story that he determined the proportion of gold and silver in a wreath by weighing it in water is probably true but the version that has him leaping from the bath in which he got the idea of his *Principle* and running naked through the street shouting: **"Eureka!"** (I have found it!) is not to be taken seriously.

In antiquity, Archimedes was also known as an outstanding astronomer: his determination of solstices (the days of maximum daylight or night-time hours) were used by other ancient astronomers.



'Give me a place to stand and I will move the Earth'
(Archimedes)

Archimedes discovered his 'Principle' (perhaps!)

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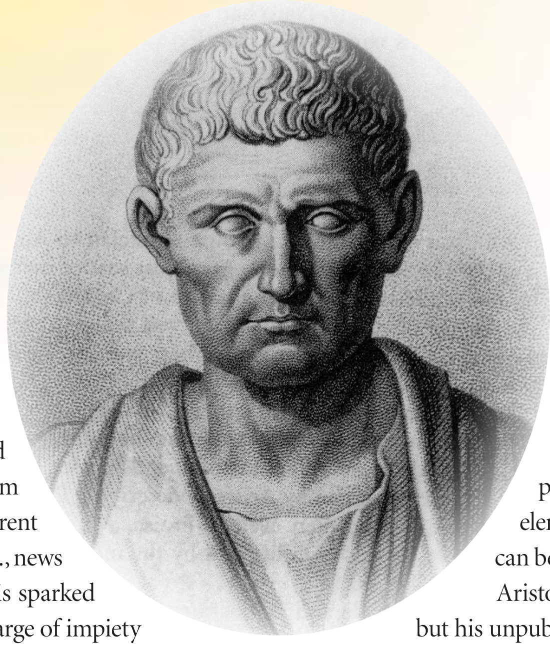
Aristotle (384 – 322 B.C.)

Aristotle was a Greek philosopher and scientist. He was a famous investigator and scholar. Aristotle was born in 384 B.C. at Stagira, a small town in Chaldice in northern Greece. His father was court physician to Amyntas II, King of Macedon and Aristotle was introduced to Greek medicine and biology at an early age.

At the age of 17, Aristotle was sent to the Academy in Athens, where for twenty years he was a pupil of Plato, the head of the Academy. Aristotle was interested in the whole range of the Academy's activities.

After Plato's death, in 347 B.C., as he was not appointed head of the Academy, probably because of the rise of anti-Macedonian mood of the city, Aristotle left Athens. He went to Assus in Asia Minor at the invitation of Hermeias, the ruler of Atarneus. He spent three years there pursuing the problem of practical politics and also biological investigation. Aristotle was close to his patron, Hermeias, and married his niece, Pythias. She bore Aristotle a daughter, whom he called by her mother's name. Pythias did not live long and after her death, Aristotle had another companion, Herpyllis, and they had a son.

In late 343 B.C. or early 342 B.C. he was asked by Philip II of Macedonia to become tutor to his thirteen-year-old son, the future conqueror Alexander the Great. Alexander succeeded his father in 340 B.C. and Aristotle probably spent the next five years in Stagira. In 335 B.C., he returned to Athens and founded his own school, Lyceum, where he could teach on his own account and coordinate the work of a number of philosophers and scientists. Under Aristotle, a wide program of research was initiated in many different fields of knowledge. But when, in 323 B.C., news of Alexander's death reached Athens, this sparked an anti-Macedonian revolution and a charge of impiety was trumped-up against Aristotle. He withdrew to Chalcis. There he died from a stomach illness at the age of 62.



Aristotle was tutor to the future Alexander the Great

We have little reliable information about Aristotle's private life. We know that he was a man of means and that he cared for his wife and two children. He promised freedom to several of his slaves on his death. According to a few sources he was not very handsome, but refined, particularly in his dress.

The range of his interests was very wide, covering metaphysics, logic, ethics, biology, psychology, physics, cosmology, zoology, literary theory and politics. According to his theory of nature, the individual substances interact in various ways to produce objects different in such properties as substance, quantity, quality, time, position and condition of action. Aristotle developed a hierarchy of existence that begin with the four primary elements: earth, water, fire and air. These elements then make up more complex substances. Aristotle paid particular attention to the question of elemental changes, whereby one element can become another.

Aristotle's original written works were lost, but his unpublished manuscripts were collected and preserved. His texts were written in dialogue or other literary forms. Many philosophical movements were based on his ideas.

Earth Water Fire Air
Aristotle's four primary elements

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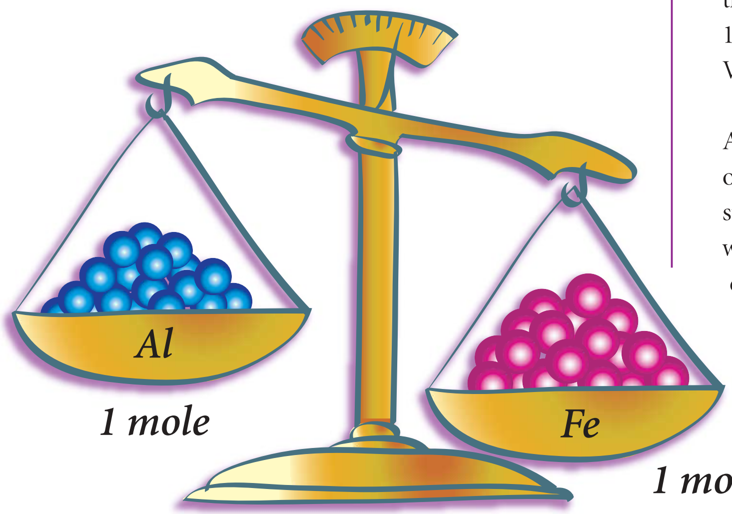
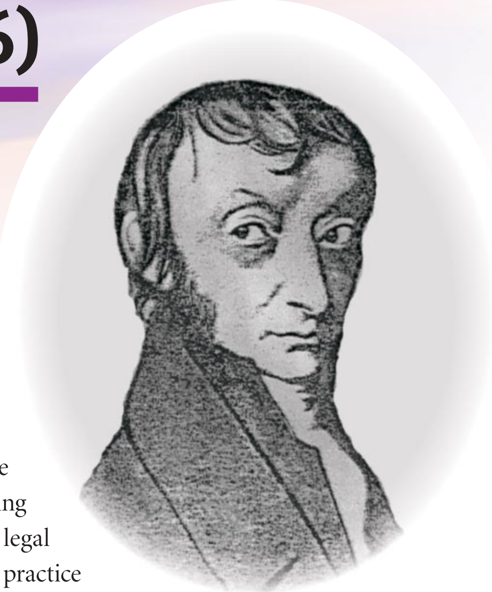
Amedeo Avogadro (1776 – 1856)

Amedeo Conta de Quaregna Avogadro was one of the founders of physical chemistry. Although he was a professor of physics, he acknowledged no boundary between physics and chemistry, and based most of his findings on a mathematical approach.

What did this great man contribute to science? His main achievement was the so-called 'Avogadro's law'. This law states that equal volumes of all gases, kept at the same temperature and pressure, contain the same number of molecules. Using his theory, Avogadro concluded that hydrogen and oxygen are diatomic molecules (H_2 and O_2). He also assigned the formula H_2O to water.

It follows from Avogadro's law that a mole of any substance (the number of grams equal to the molecular weight) contains the same number of molecules. This is $N = 6.022137 \times 10^{23}$ and is called Avogadro's number.





It was very sad that leading scientists of the day did not recognise the importance of his hypothesis for 50 years. It was two years after Avogadro's death when the physicist Stanislao Cannizzaro showed how the application of Avogadro's idea could be used to obtain the atomic composition of all molecules.

Avogadro was born in 1776, in Turin, the capital of the Italian province Piemont. Following the family tradition, Amedeo joined the legal profession. However, he was soon bored by the practice of law. Since his youth he had been interested in geometry and experimental physics, but he had not had the necessary education to pursue them seriously. When Avogadro was 25 years of age, however, he began to devote all his free time to teaching himself physics and mathematics.

In 1803 he and his brother (also a physicist) presented for the first time two papers on electricity to the Turin Academy. In 1809 he became Professor of Physics at the Royal College at Vercelli, where he taught physics and mathematics.

In 1819 Avogadro was elected as a full member of the Turin Academy and in 1820, by royal decree, he was appointed Head of the Physics Department at Turin University. But in 1822 after student disturbances, the department was closed and Avogadro was moved to the post of senior inspector of government expenses, a position very far from science.

Avogadro was well over 30 years of age when he met his future wife, the daughter of a notary. She was 18 years younger than him. They had two sons and six daughters.

In 1832 he once again took over the Physics Department at Turin University and remained there until his retirement in 1850.

His contemporaries described him as a wise, modest, very sincere and kind person. He despised luxury and was indifferent to his own fame and glory.

A year after Avogadro's death, a bronze bust was put up in his memory in Turin University.

He was soon bored by the practice of law

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Hertha Ayrton (1854-1923)

She studied at Girton College, Cambridge

Hertha Ayrton, a famous English physicist, is known for her research into the electric arc. She was the first woman member of the Institute of Electrical Engineers. She also wrote *The Electric Arc*, which became a standard textbook in the field.

Hertha Ayrton (Sarah Marks) was born in Portsea, England, into a Jewish family. Her father was a clock maker and jeweller. She was the third of five children. After her father's death, her mother supported the family by selling her needlework. Young Hertha was a very serious and independent girl.

She dreamed of studying but at an early age (about 16) she had to leave school in order to earn money for her family. Fortunately, Hertha met Barbara Bodichon, a philanthropist, who supported gifted women and was one of the founders of Girton College at Cambridge.

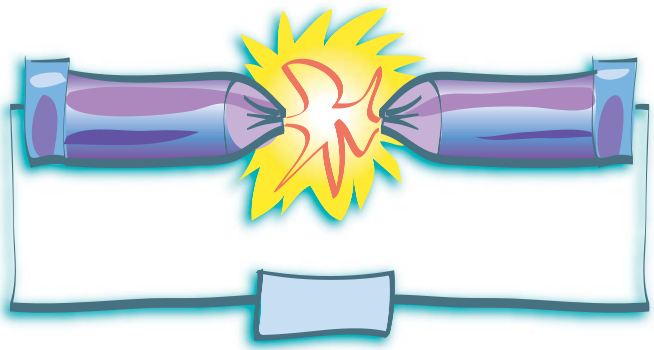
Hertha, with financial assistance from Bodichon, entered Girton in 1879. Very soon she showed extraordinary ability in science. Barbara Bodichon introduced her to Mary Ann Evans, the future great novelist who named herself George Eliot. Somebody said that she probably made use of the young Jewish girl in developing the character of Mirah in her novel, Daniel Deronda.

After finishing at Cambridge, Ayrton taught and carried out her own research. In 1884 she received a patent for the invention of the 'line divider' — an instrument that could rapidly divide a line into any given number of equal parts. This inspired her to continue her scientific education and, again with Bodichon's financial support, she entered the Finsbury Technical College in London. There she worked with Professor W.E. Ayrton, a notable physicist and engineer. The couple married in 1885. They together had one child, a daughter Barbara.

In 1893, Professor Ayrton was lecturing in Chicago and Hertha had to take over his experiment on arc lamps, which were widely used in lighting at the time. There were many problems with these lamps: they hissed, hummed, and burned unsteadily. Hertha Ayrton's work solved many of these problems. She published all her results in *The Electrician*.

She became an expert and recognised authority on arc lamps, and she was admitted as a member of the Institution of Electrical Engineers — the first women ever. Soon after she published a compilation of all her findings (*The Electric Arc*) which became a popular textbook.

Later in her studies, Hertha Ayrton was fascinated by the action of the ocean's waves and the formation of sand ripples. However, in spite of her successful research she was refused admittance to The Royal Society, apparently because of her sex (just as her long-life friend, Marie Curie, was not elected to the French Academy of Sciences).



She was an expert on the electric arc

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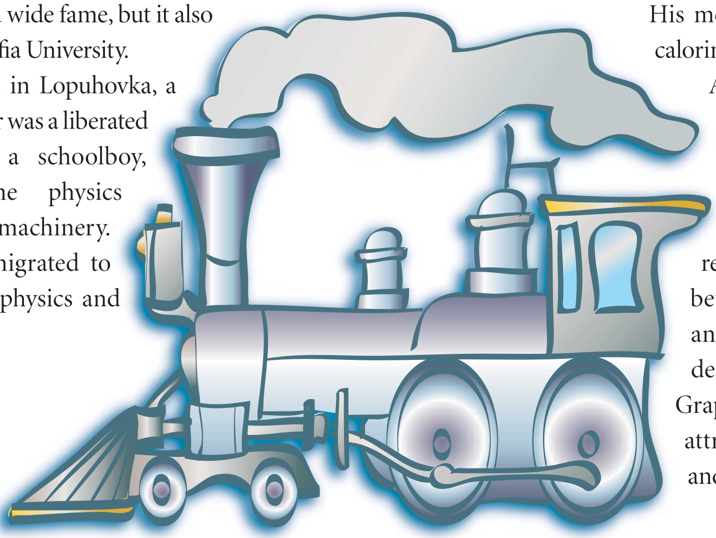
Porphiry Bachmetjew (1860 – 1913)

Porphiry Bachmetjew was a Professor of physics in Bulgaria. His discovery of anabiosis (a state 'between life and death') brought him world wide fame, but it also led to his removal from Sofia University.

Bachmetjew was born in Lopuhovka, a village in Russia. His father was a liberated serf peasant. Even as a schoolboy, Bachmetjew did some physics experiments and built machinery. When he was 20, he emigrated to Switzerland. He studied physics and chemistry at Zurich University, ignoring mathematical topics. He was intelligent and had a tendency to daydream. His first articles were on acoustics, thermoelectricity and magnetism.

Even as a boy he built machinery



In 1885 he put forward a contrivance for transmitting pictures over long distances, called the telephotograph.

Bachmetjew returned from Zurich and joined the Physics-Mathematics Department of Sofia University in 1890. As the first Professor of Experimental Physics, he established two physics laboratories and constructed many instruments.

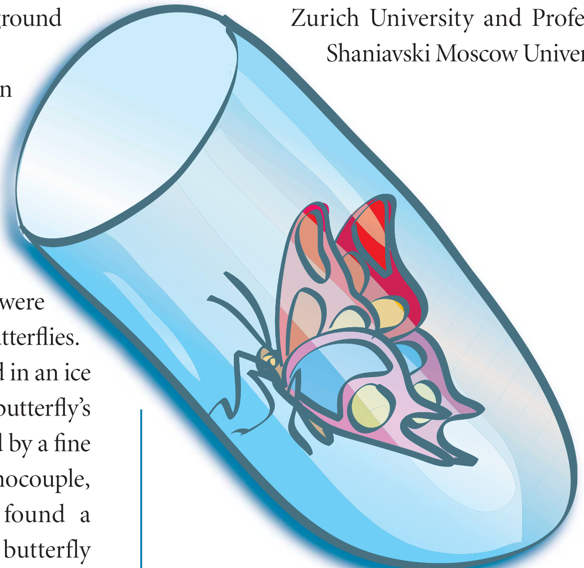
The Elisabeth Thompson Science Foundation at Boston University financed his geophysical investigations on ground electricity in Bulgaria.

Bachmetjew married a Bulgarian woman and had a son and two daughters. Bachmetjew was quite a colourful personality. He had an unusual liveliness, vitality and power. He liked having a beer, collecting butterflies and writing science fiction stories. He was 2 metres tall and weighed 125 kilograms.

His most famous observations were calorimetric experiments with butterflies. A living butterfly was placed in an ice cooled metal tube. The butterfly's temperature was measured by a fine nickel-manganese thermocouple, made by himself. He found a reversible state of the butterfly between life and death, called anabiosis. Bachmetjew also tried to demonstrate anabiosis with bats. Graphical representation of his results attracted his interest to supercooling and the physical reasons for anabiosis.

He investigated the supercooling of some organic crystal melts. The recently discovered 'Lehmann liquid crystals' also inspired numerous biological analogies in Bachmetjew's mind. Bachmetjew's general physics course was put aside because of these studies, which were published in two entomological monographs. The University Council was not impressed, and it presented valid indictments against Bachmetjew's lecturing performance. In 1906 he was expelled from Sofia University.

Despite his problems, Bachmetjew became a member of the Bulgarian Academy of Sciences, Honoured Doctor of Zurich University and Professor of Biophysics in Shaniavski Moscow University.



He placed a butterfly in an ice-cooled tube and discovered 'anabiosis'

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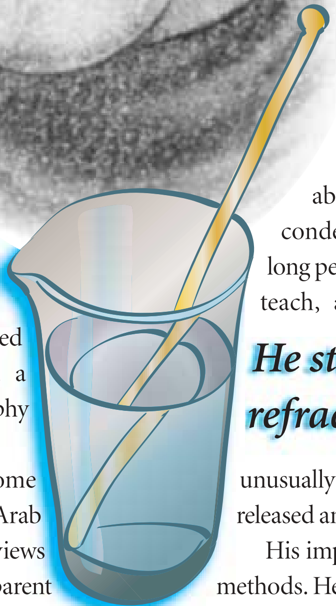
Roger Bacon (1220 – 1292?)

Roger Bacon was one of the most influential teachers of the 13th Century. An English philosopher, he has been described as 'a man born out of due time' and he was the first among his contemporaries to advocate experimental methods as necessary, in order to give certainty to a scientific theory.

He was born in Ilchester in Somerset and was educated at the universities of Oxford and Paris. After completing his studies, he remained in Paris and taught for a time in the university, where he became aware of the work of Thomas Aquinas.

In about 1257 he returned to England and entered the Franciscan Order as a monk. He acquired a reputation for unconventional learning in philosophy and magic, and he was known as Doctor Mirabilis.

Many inventions were credited to him, some undoubtedly derived from his study of the work of Arab scientists. His writings brought new and ingenious views on optics, particularly on refraction and on the apparent increase in size of the sun and moon at the horizon.



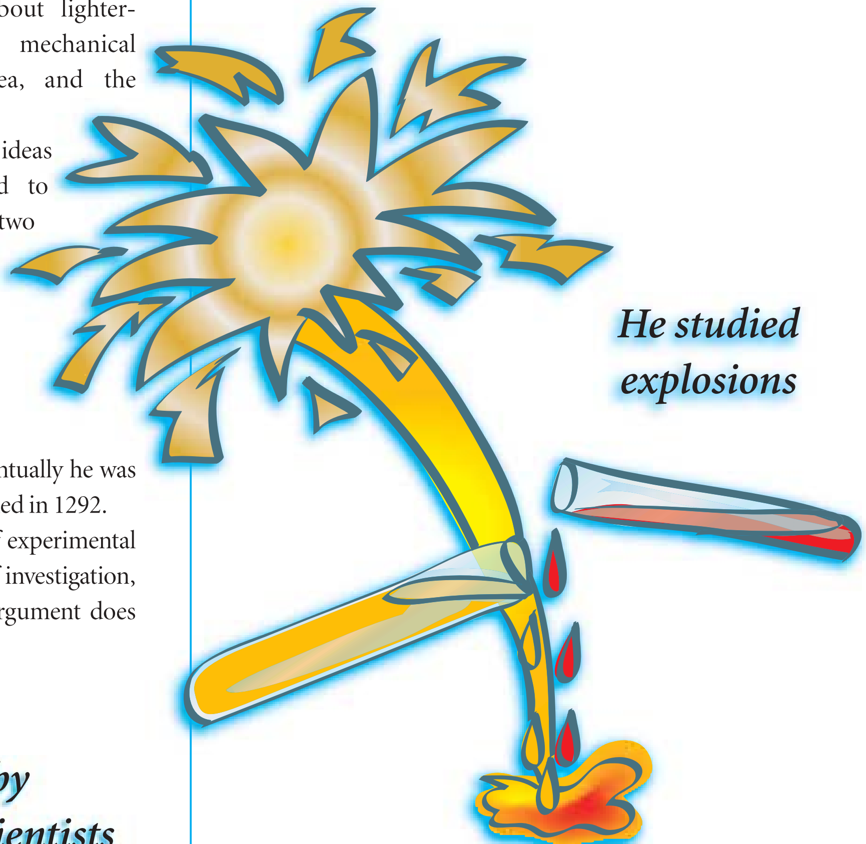
He studied the refraction of light

He found that with sulphur, saltpeter and charcoal, a substance could be produced that imitated lightning and caused explosions - in other words he experimented with gunpowder, though he never progressed very far with it. He published some remarkable speculations about lighter-than-air flying machines, mechanical transport on land and sea, and the construction of microscopes.

Eventually, his revolutionary ideas about the study of science led to condemnation by his superiors. For two long periods he was forbidden to write or teach, and was even imprisoned, an unusually harsh treatment at that time. Eventually he was released and returned to Oxford, where he died in 1292.

His importance lay in his appreciation of experimental methods. He wrote, 'There are two methods of investigation, through argument and through experiment. Argument does not suffice, but experiment does'. Bacon deserves to be remembered for his glimpse of the true scientific method, a method which would not be generally accepted until three centuries later. He has perhaps the right to be called the first English scientist.

J.L.L.



He studied explosions

He was influenced by the work of Arab scientists

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Antoine Henri Becquerel (1852 – 1908)

Awarded the Nobel Prize for Physics in 1903

Antoine Henri Becquerel, the famous French physicist, is known for his discovery of radioactivity. He was born into a distinguished family in Paris, on December 15th, 1852. His grandfather, who had fought at the Battle of Waterloo in 1815 afterwards devoted himself to science and made an important contribution to the study of electrochemistry. His father, also a scientist, studied photography, heat and luminescence. His grandfather, father and then Henri himself were members of the Academy of Sciences. Henri held chairs of physics at the Ecole Polytechnique and at the Conservatoire National des Arts et Metiers and became the chief engineer in the National Administration of Bridges and Highways.

Becquerel began his early education at the Lycée Louis le Grand, and continued at the École Polytechnique, then went to the École des Ponts et Chaussées. In 1877 he was awarded his engineering degree.

In 1874 Becquerel married the daughter of a physics professor. The marriage was not to last very long, however, because she died in 1878, a few weeks after the birth of their only son Jean.

Becquerel pursued a variety of research interests. He investigated the properties of a number of materials in

His grandfather fought at the Battle of Waterloo

magnetic fields, absorption of light in crystals and luminescence. He also studied the effect of the earth's magnetic field on the atmosphere.

In 1890 Becquerel married his second wife. She was the daughter of the inspector general of a mine. The couple had no children.

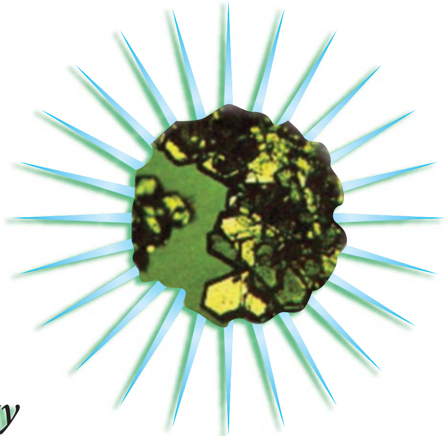
Educated mainly at the École Polytechnique, he became Professor of Physics there in 1895. One year later he discovered radioactivity almost by chance. He wondered whether the production of Rontgen's X-rays might always be associated with luminescence. To test this hypothesis, Becquerel wrapped photographic plates in black paper and placed potassium uranyl sulphate on top of them and all the assemblage was then placed in sunlight. After the photographic plates were developed, he concluded that sunlight had caused the uranium salt to luminesce, thereby giving off X-rays. The rays penetrated the black paper and exposed the photographic plates.

On March 1, 1896, Becquerel decided to develop the photographic plates, which he had used in his experiments but without sunlight and had stored together with crystals in a dark place. Surprisingly, he found that the plates had been exposed as if they had been set in the sunlight. Some sort of radiation other than X-rays had been emitted from the uranium salt and affected the plates. When he found later that a pure uranium metal also produced the penetrating rays, Becquerel's discovery of radioactivity was established.

His immediate successors, Marie and Pierre Curie, looked for unknown elements and discovered other radioactive materials: polonium and radium. Becquerel, Marie Curie and her husband, Pierre Curie, were all awarded the Nobel Prize in 1903 for the discovery of spontaneous radioactivity.

In 1908 Becquerel became the President of the Academy of Sciences but soon after he died at his wife's family estate in Brittany.

Becquerel discovered radioactivity



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John Stuart Bell (1928 – 1990)

Very few people have changed our general view of the physical world in a really profound way. In this century this can be said of two physicists: Albert Einstein and John Bell.

Bell was born in the working-class back streets of Belfast in Northern Ireland. He first went to the nearby Queen's University as a laboratory assistant, but soon enrolled to study science. It became clear that he was destined for a career in research. By 1960 he had found his way to the Mecca of high energy physics, CERN in Geneva. In 1964 he wrote the paper that was to immortalize his name, but nobody paid much attention at the time. Decades passed before its full significance was recognized.

He had chosen to re-examine an old problem, upon which Einstein and others had worked, somewhat inconclusively. It addressed one of the more disconcerting aspects of quantum mechanics, which even sober academics sometimes call "spooky". The theory dictates that particles that become involved with one another and then fly far apart retain a direct mutual influence over each other. This contradicts the instincts of most of us. Ever since Newton, it has been assumed that there is no "action at a distance". Anywhere that it appears in classical physics (e. g Coulomb's law) it is only an approximation to a deeper truth: distant objects are not supposed to exert instantaneous effects on each other.

While Einstein and others were much concerned with this uncomfortable feature of the new theory they could see no way to test it experimentally. The effect seemed so elusive that it was thought by many to be more philosophy rather than physics, and hence a waste of time. Bell showed how the required test could be done, after all. When it was finally carried out, it confirmed the long-distance effect. Bell explained that this does not contradict relativity.

Bell's Theorem has since been embraced by philosophers, religious thinkers and others, since it bears some relation to those 'holistic' principles that stress the interrelation of everything. Meanwhile it has led physicists into further strange and sensational territory, such as "teleportation" and "quantum cryptography", which our daily newspapers struggle to interpret for us.

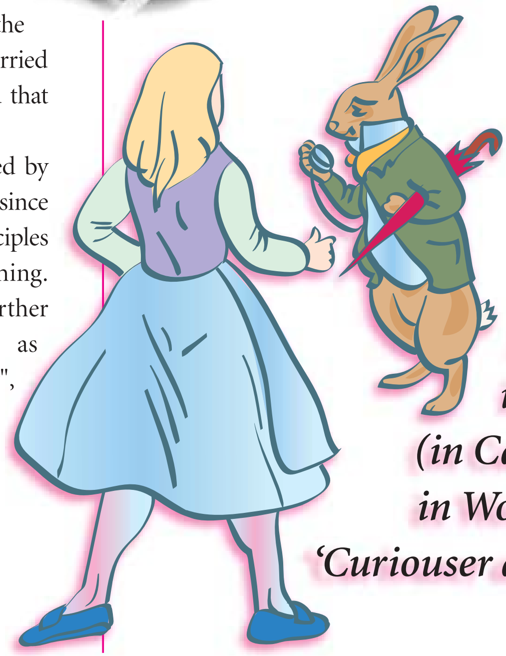
'Curiouser and curiouser!' as Alice said in Wonderland.

'John was rather diffident about the entire matter. In this he showed one of his many striking qualities: modesty about his own work, praise for the work of others, but scepticism in the face of inflated claims, even if they were extolling his own contribution' (R. Jackiw, 'Remembering John Bell').

He was married to Mary Bell who became his life-long collaborator.

D.W.

Bell worked at the giant Accelerator Laboratory, (CERN) in Geneva



Bell's Theorem is, as Alice said (in Carroll's 'Alice in Wonderland') 'Curiouser and curiouser!'

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Daniel Bernoulli (1700 – 1782)

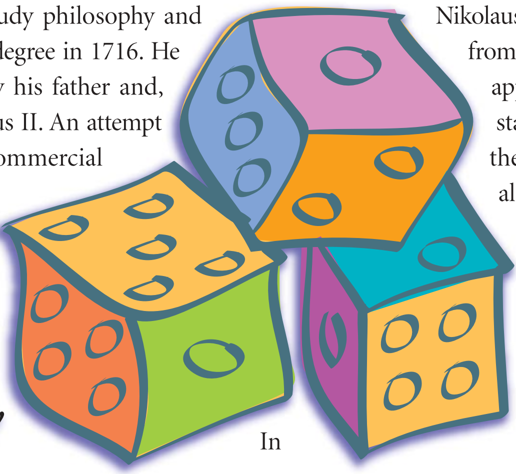
You will come across the name 'Bernoulli' very frequently in scientific textbooks. At least eight members of this family were prominent scientists who made great contributions to the development of mathematics and physics. Daniel was probably the most outstanding of them all and certainly, the one with the widest scientific interests. He developed the theory of probability and worked in astronomy, hydrodynamics, electrostatics and physiology.

You may already know of Bernoulli's principal law, which relates that the pressure of a fluid varies according to its speed, an increase in speed producing a decrease in pressure. This principle explains the pressure difference on each surface of an airfoil, which gives lift to the wings of an aeroplane.

He was born in 1700 in Groningen, the Netherlands, the second son of Johann I Bernoulli and Dorothea Faulkner. Daniel's father was professor of mathematics in Groningen, and later took the chair in Basel, Switzerland, that became vacant upon the death of Daniel's uncle, Jakob I. His mother came from an aristocratic family.

In 1713, Daniel began to study philosophy and logic and obtained his master's degree in 1716. He was also taught mathematics by his father and, especially, by his brother Nikolaus II. An attempt to place young Daniel as a commercial apprentice failed, and he was allowed to study medicine, first in Basel then in Heidelberg and Strasbourg.

He studied the laws of Probability



In 1721 he obtained his doctorate with a thesis on respiration and applied for the professorship in anatomy and botany, but without success. He went to Venice where he continued to study medicine. A severe illness prevented him from realising his plan to work in medicine in Padua. In 1724 he published a paper on mathematical research – one of his outstanding works on differential equations – and won the prize awarded by the Paris Academy of Sciences, the first of ten he was to win.

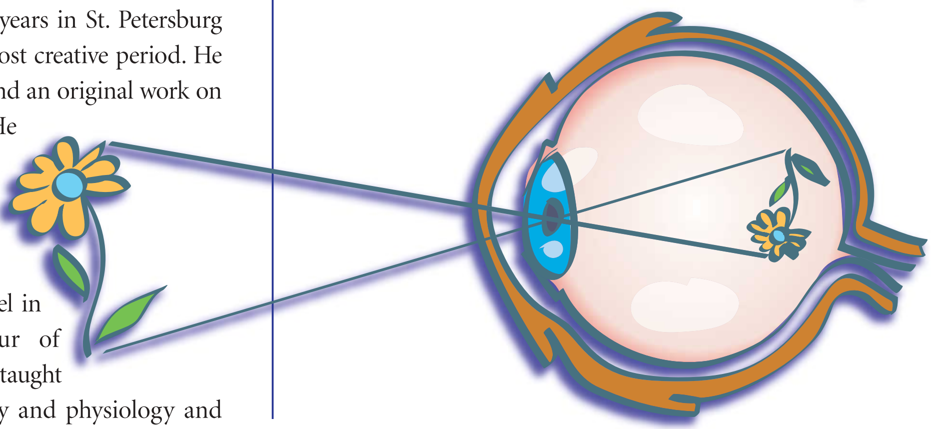
Soon his name became famous in Europe and he received an invitation from the St. Petersburg Academy, where he went in 1725 following in the steps of his elder brother Nikolaus, who had died there. Although Daniel suffered from the rigorous climate, the years in St. Petersburg appeared to have been his most creative period. He started his *Hydrodynamica* and an original work on the theory of probability. He also published a mechanical theory of muscular contraction and studied the human eye.

He came back to Basel in 1733 after a long tour of Europe. On returning he taught mathematics, later botany and physiology and finally, in 1750, he was awarded the chair of physics. He held this post for thirty years.

Daniel completed his *Hydrodynamica* in 1734 but published it only in 1738. It is said that his father published his own *Hydraulica* at about the same time, but predated it to 1732, in an attempt to ensure priority for himself!

Contemporaries considered Daniel Bernoulli a kind and warm person. Apparently, he had no family of his own. After his death in 1782 he was buried in the Peterskirche, not far from his apartment in Klein Engelhof.

He studied the human eye



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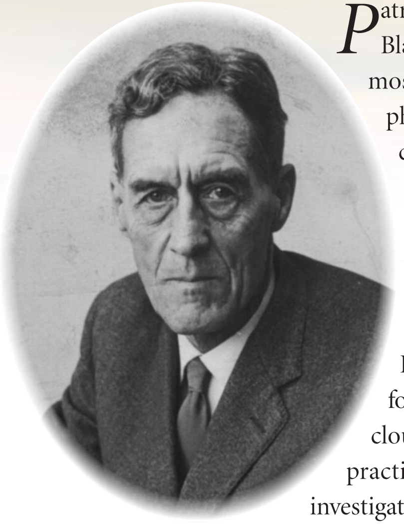
Patrick Maynard Stuart Blackett (1897 – 1974)

Awarded the Nobel Prize for Physics in 1948



Patrick Maynard Stuart Blackett was one of the most distinguished British physicists of the 20th century. He is known for his improvements of the Wilson cloud chamber and for his study of the Earth's magnetism. He was awarded the Nobel Prize for Physics in 1948 for the development of the cloud chamber into a practical instrument for the investigation of cosmic rays and fundamental particles.

Blackett was born in Kensington, London, in 1897. His father was a stockbroker. His mother came from a family which had served in India at the time of the Indian Mutiny. As a child he was very interested in nature, especially birds. At the age of 9 he was sent to a small preparatory school. Following the maternal family tradition, he decided to start a naval career. When he was 12 years old he entered first the Osborne Royal Naval College and then continued training at Dartmouth.

Blackett served in the sea battle at Jutland in 1914

Blackett began his naval duty when World War I broke out in 1914. He saw action at sea in the Battles of the Falkland Islands and at Jutland. After the war he and other young officers were sent to Cambridge for a six-month course of general studies, and Blackett found himself in Magdalene College. After a visit to the Cavendish Laboratory he decided to leave the Navy to become an undergraduate student of physics.

His scientific career began in the autumn of 1921 as a research student under Rutherford who was the head of the Cavendish Laboratory, one of the world's foremost centres of physics. Rutherford put him to work with the Wilson cloud chamber. A cloud chamber is a cylinder filled with supersaturated water vapour. The cylinder is set between the pole of an electromagnet. When charged particles are fired into it, the water vapor condenses on the resulting ions and creates traces which can be photographed.

With the help of a modified chamber, Blackett succeeded in making a photograph of an atomic transmutation, which was of nitrogen into an oxygen isotope.

In 1932, Blackett, in collaboration with the Italian physicist Occhialini, designed a new instrument by combining a cloud chamber with two Geiger counters. This apparatus allowed a reduction in the huge number of photographs usually taken because it worked only when the Geiger counters were triggered by a particle. With this device they studied cosmic rays and found the pair production of electrons and positrons by γ-radiation.

In 1937, Blackett was appointed to a professorship in Manchester and finally at Imperial College, London. During World War II he served the Admiralty as a researcher into naval problems. But Blackett opposed Britain's effort to develop its own nuclear weapon, and, though he supported the American bomb project, he was highly critical of Allied nuclear policy during and after the war. He was branded as a near-Communist. He returned to public service just after the election of a Labour government in 1964 but he was too inexperienced to be an effective politician.

After the war his interest had turned to fundamental problems in magnetism. In 1951 he assembled a research group to study the magnetism of rocks and in a few years he confirmed that 150 - 200 million years ago the land mass which now formed Britain was in a position near the Equator.

Blackett became President of the Royal Society in 1965 and a life peer in 1969, but spoke only four times in the House of Lords.

In 1924 he married Constanza Bayon, by whom he had a daughter, Giovanna, and a son, Nicholas.

He received numerous awards in addition to the Nobel Prize, including twenty honorary degrees.

He contributed to the idea of 'Continental Drift'.

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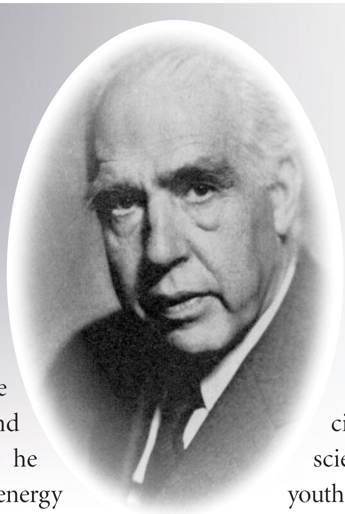
Niels Bohr (1885 – 1962)

Awarded the Nobel Prize for Physics in 1922

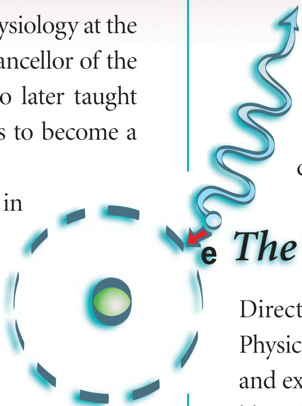


Niels Bohr was one of the most famous physicists of the 20th century, a founder of quantum mechanics. He received the 1922 Nobel Prize for Physics, 'for his study of the structure of atoms and of the radiation emanating from them'.

He was born on October 7th, 1885 in Copenhagen in the very intelligent and happy family of Christian Bohr and his wife, Ellen Adler. Niels' father was Professor of Physiology at the University of Copenhagen and later the Vice Chancellor of the University. Niels had an older sister, Jenny, who later taught history and a younger brother, Harald, who was to become a prominent mathematician.

During the years of their childhood, and also in later life, Niels and Harald were almost inseparable. At the University, they both played modern soccer. Harald even played for the national team and became famous as one of Denmark's best soccer players.

Niels chose for his first research in physics a precision measurement of the surface tension of water. He completed it in 1906, when he was still a student at Copenhagen University, and it won him a Gold Medal from the Academy of Sciences. After finishing his studies in Copenhagen in 1911, Bohr went to Cambridge and then to Manchester, where the physicist Ernest Rutherford had established a flourishing laboratory. There, Bohr laid the foundations for his most important scientific discovery: the model of the atom. While considering the simplest atom, hydrogen, and studying its atomic line spectrum, he postulated that its electron radiated energy only when it dropped from one allowed level to a lower energy level. The atom can absorb and emit energy only in quanta, which correspond to the energy differences between allowed levels.



The 'Bohr atom'

He was against the atomic bomb

Bohr returned to Copenhagen in 1916 as a Professor, and in 1920 he became the Founder and Director of the newly established Institute of Theoretical Physics. In 1936 he proposed a model for the atomic nucleus and explained the fission process in which the nucleus behaves like a deformable drop of liquid. In Copenhagen, Bohr gathered round him many of the to-be-prominent young quantum physicists.

Bohr married Margrethe Nørlund. She was a perfect and invaluable support to her husband and their marriage lasted over 50 years. They had six sons. Bohr's greatest grief was when his eldest son drowned before his eyes in a sailing accident.

During World War II, in 1943, under the threat of immediate arrest, Bohr and his family escaped from occupied Denmark, first to Sweden, then by plane to England and at last to the USA where he and his son, Aage, participated in the atomic bomb 'Manhattan' project at Los Alamos. On returning to Copenhagen in 1945, Bohr engaged in the peaceful uses of atomic energy and international atomic control. He was strongly interested in philosophy and coined the term 'complementarity'. He was honoured by the highest Danish medal 'Order of the Elephant' and chose as his heraldic emblem the yin-yang symbol.

Bohr was very fond of the arts and literature. His circle of friends was large and included artists, scientists and acquaintances of his childhood and youth. He liked to ski and used to travel to the Institute by bicycle. He and his friends had their own sailing boat.

Bohr was a very kind and open-minded person. Everybody who knew him, even slightly, mentioned 'the feeling of warmth and affection arising from his humanity and kindness'.

Bo Bojesen for the Copenhagen newspaper Politiken

'And now our distinguished guest will repeat his famous lecture on chain reactions'

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Ludwig Boltzmann (1844–1906)

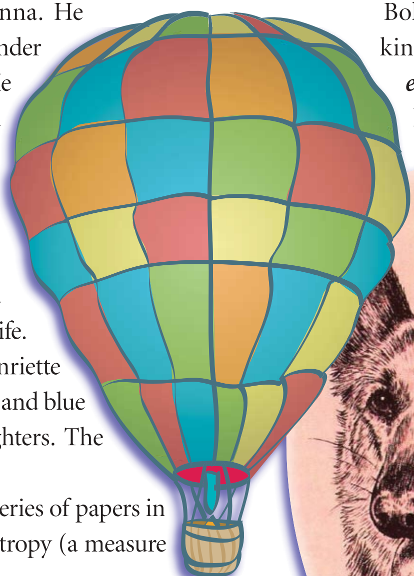
Ludwig Boltzmann was an outstanding Austrian physicist whose great achievement was in the development of the atomic theory of matter.

Boltzmann was born in Vienna on 20th February, 1844. His father's income was not very large, but his mother came from quite a rich family. There were three children in the family.

Ludwig obtained an elementary education at home, under private tutors. After he graduated from a local Gymnasium in Linz, he entered the University of Vienna. He received his doctorate in 1866 for work under Stefan on the kinetic theory of gases. He held professorships in mathematics and physics at Vienna, Graz, Munich and Leipzig.

Boltzmann was 25 years old when he became full professor of mathematical physics at the University of Graz. There he spent the happiest time of his life. In 1876 he married a young student, Henriette von Aigentler, 'a girl with long blonde hair and blue eyes'. They had two sons and two daughters. The marriage was a happy one.

In the 1870's Boltzmann published a series of papers in which he developed the idea that heat, entropy (a measure of the disorder of a system), and other thermodynamic properties were the result of the behavior of large numbers of atoms, and could be treated by mechanics and statistics. He introduced the equation (now known as ***Boltzmann's equation***), for the relation of entropy (S) to probability (p): $S = k \log p + b$, where k is known as Boltzmann's constant and has the value 1.38054×10^{-23} joule per kelvin; b is a constant.



His 'kinetic theory of gases' explains why a hot-air balloon rises

"π = 3.141592654..."

Boltzmann had an amazing memory

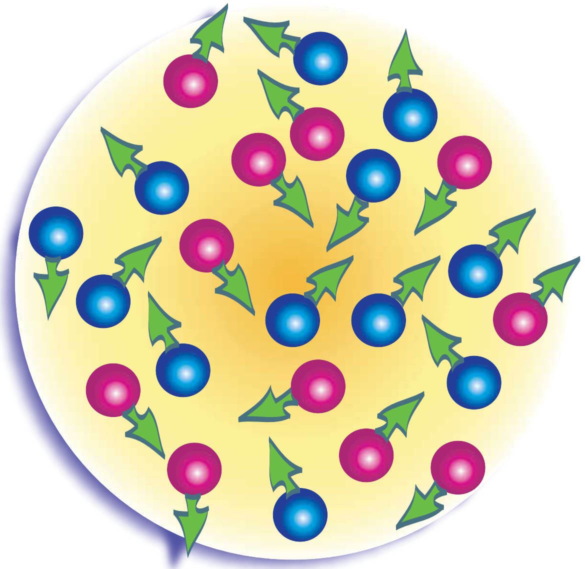
Boltzmann made important contributions to the kinetic theory of gases. He developed the ***law of equipartition of energy*** (the Maxwell-Boltzmann law). This law states that the total energy of an atom or molecule is, on average, equally distributed over the motions.

His atomic theory had many opponents, and he lost much time and energy in his struggle for scientific truth. Boltzman was an excellent teacher. He had an amazing memory and lectured completely without notes.

A feature of Boltzmann's personality was that he never stayed very long in one place, a fact due to his being somewhat emotionally unstable. Although he had a marvellous sense of humour, he sometimes fell into a deep depression. Nevertheless, he was very kind in his relations with his wife and children and most of his students admired him. He loved nature and used to take long walks. He had an Alsatian dog, who very often waited for him outside the Institute and accompanied his master to a nearby pub for lunch. Boltzmann played the piano and wrote poems and novels.

He had an Alsatian dog

As his health declined, he became more and more depressed. In the summer of 1906, whilst on holiday in the beautiful Bay of Duino near Trieste, tragically, he committed suicide by hanging himself while his family enjoyed a swim.



He was an expert on atomic collisions

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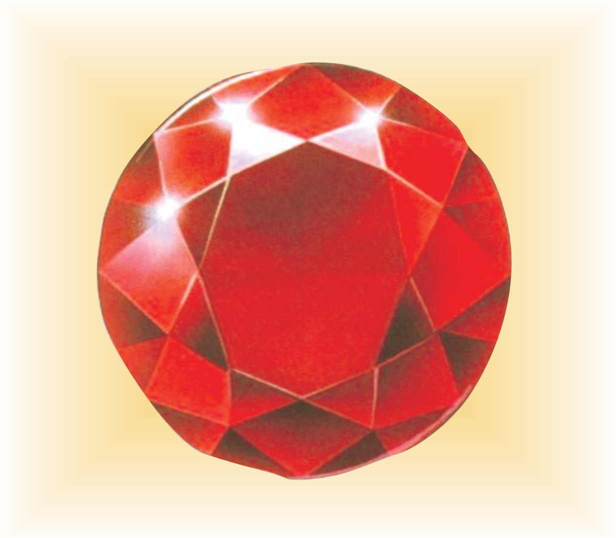
Max Born (1882 – 1970)

Awarded the Nobel Prize for Physics in 1954

Max Born was one of the famous physicists who pioneered quantum mechanics — the mathematical explanation of the behaviour of electrons in the atom. The high significance of Born's work on quantum theory was recognised by the award of the Nobel Prize for Physics in 1954.

Born's early work was on crystals, particularly the vibrations of atoms in crystals. He was able to determine the energies involved in lattice (in the framework) formation, from which the properties of crystals could be derived.

Max Born was the son of a professor of anatomy at the University of Breslau. His mother died when he was four, and he was brought up by his maternal grandmother. He inherited from his mother a great love of music.



Born studied the vibrations of atoms in crystals

On his father's advice he attended courses at Breslau University on a wide range of subjects in both sciences and the arts, including philosophy. Born also studied mathematics and astronomy at Heidelberg and Zurich. In 1904 he enrolled at the University of Gottingen — the Mecca of German mathematics at that time.

After receiving his doctorate, Born went into military service but was discharged because of a severe asthmatic condition. He then left for Cambridge University where he studied physics with the famous physicist J.J. Thomson.

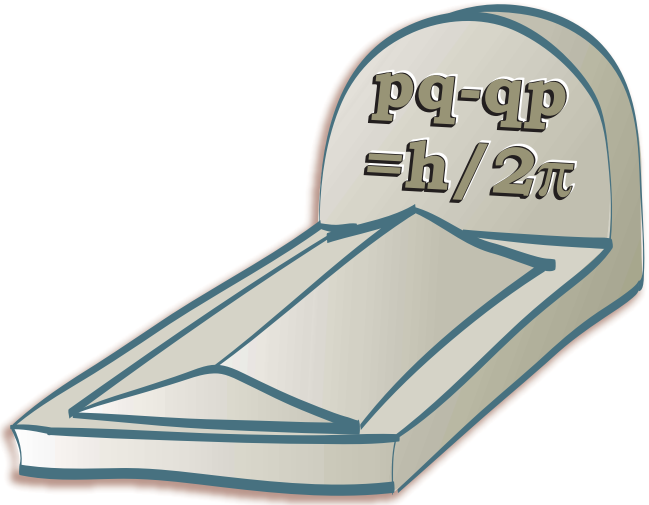
The outbreak of war in 1914 coincided with Born's acceptance of a chair in the University of Berlin. There he had the opportunity to work with Plank and Einstein, with whom he formed a lifelong friendship. It is known that, as a talented pianist, he shared with Einstein a love of music.

From 1909 until 1933 he taught at Gottingen, being appointed professor of physics in 1921. There he developed his new quantum theory. At the time, it was known that in some circumstances light, electrons, etc., behaved as waves, whereas in others they acted like particles. Born's interpretation was that the particles exist but are 'guided' by a wave. The square of the wave amplitude indicates the probability of finding a particle there.

In 1933, with the rise of Hitler he, as a Jew, left Germany, and went to Cambridge. Whilst there he wrote his popular books: *Atomic Physics* and *The Restless Universe*. Later, he became Tait Professor of Natural Philosophy at the University of Edinburgh.

Born married Hedwig Ehrenberg, the daughter of a professor of Law. The couple had three children, and their son, Gustav, would later become a pharmacologist.

Born retired at the age of 70 and returned to Germany. In his last years, he was especially active in writing and speaking about the social responsibility of scientists. He was one of the signatories of the Declaration condemning the development of atomic weapon.



He is buried in Göttingen, where his tombstone displays his fundamental equation

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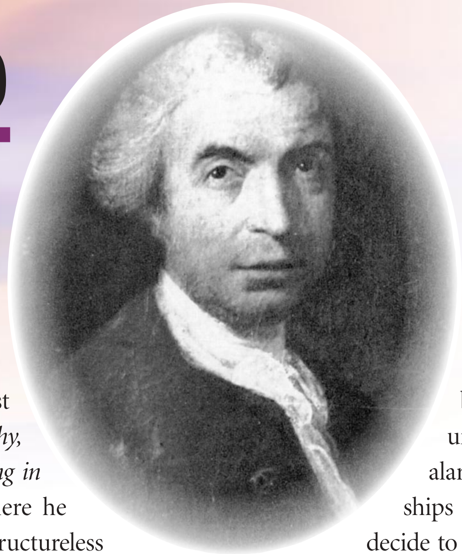
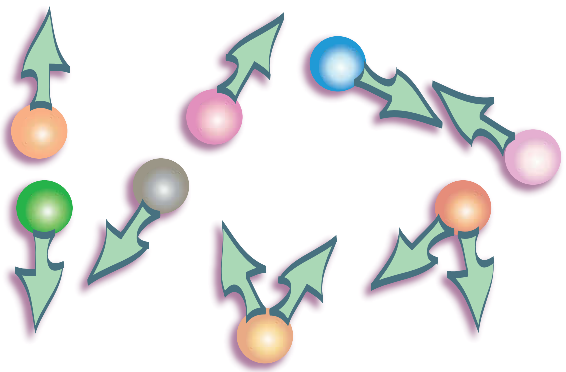
Rudjer Boscovich (1711 – 1787)



Boscovich was a natural philosopher with broad interests who was known for his ideas about the structure of matter. He was born in 1711 in Dubrovnik, at the time an independent Republic. His father, who came from a village not far from the sea, was successful in commerce and married in Dubrovnik. He died when Rudjer was about 10. His mother, a robust and active woman with a happy temperament, lived to the age of 103. Rudjer was the eighth of nine children. His eldest sister Maria, nineteen years his senior, was the only member of his family to marry.

The initial education of Rudjer was provided in a school run by the Jesuits. His capabilities were noticed and he was recommended for further study. At the age of 14 he was sent to Rome where he remained for three decades, at first as a student in the Jesuit Collegium Romanum and later as its professor.

Later he held the chair of mathematics in Pavia, organised an astronomical observatory in Brera near Milan and on the invitation of the French king became director of optics for the navy.



He had ideas about 'atoms' and the forces between them

He was an ardent traveller and visited many places from London and Constantinople, but his plans for scientific missions in Brazil and California did not materialise.

Among about 70 publications, the most important is his *Theory of natural philosophy, reduced to a single law of the actions existing in nature* published in 1758 in Vienna. There he advocates the idea that matter consists of structureless point-like 'atoms' which interact with a strong repulsive force at small distances and weakly attract each other at large distances. At intermediate distances he assumed that the force alternates between attraction and repulsion. This led him to conclude the existence of particular stable orbits of the particles around each other. These ideas had their reflection in the subsequent work of Faraday, Maxwell, Kelvin and Thomson.

Boscovich was a strong supporter of Newton's philosophy and in 1758 he clearly stated determinism as a basic scientific principle. He wrote: 'In this manner all other motions will be determined for all time, and thus the whole of Nature, depending as it does on motions, distances, positions and velocities of all points, will be determined only by the number of points and by the position, direction and velocity imparted to individual points at the moment of their creation, and by the single law of force which determines changes and which will therefore also include the force of inertia and all other active forces which determine all phenomena.'

He participated in the measurement of the meridian between Rome and Rimini, devised a geometric method for the study of the trajectories of comets, and expressed his views on the relativity of time and space.

On two occasions he provided his good offices to help Dubrovnik. In the first instance the authorities in Dubrovnik were afraid that there might be retaliatory action by the British because a French ship was undergoing repairs in the city port. In the other alarming situation there was a fear that Russian ships at the time of their war with Turkey might decide to act against the continuing commercial links between Dubrovnik and Turkey.

The last years of his life were tragic. His mental powers declined. He was pursued by ideas of persecution, the fear of poverty, of losing his reputation and overlooking errors in his work. His closest friend saved him from suicide. On February 13, 1787 Rudjer Boscovic passed away.

He worked out the paths of comets

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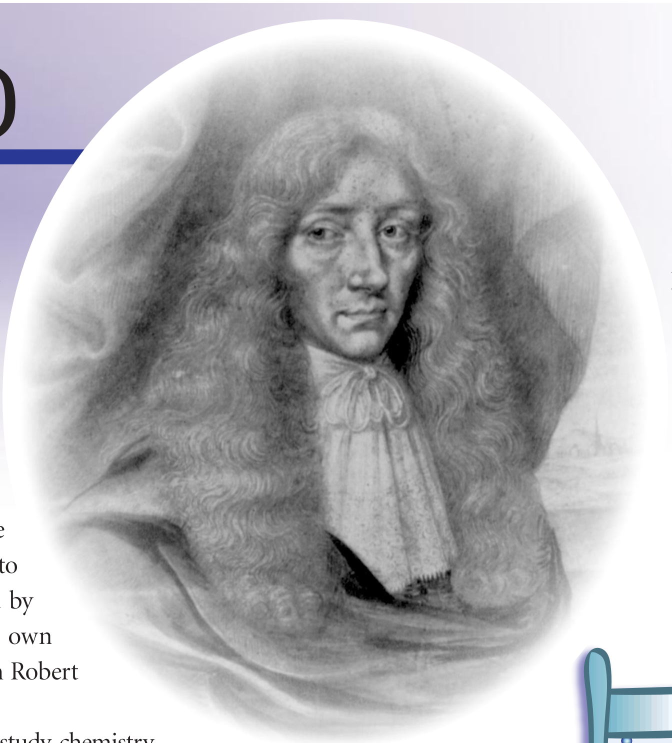
Robert Boyle (1627 – 1691)



Robert Boyle, a brilliant and prolific chemist and philosopher, was noted for his pioneering experiments on the properties of gases. Boyle's law (also called Mariotte's law) states that at a constant temperature the volume of gas is inversely proportional to the pressure. Boyle was indeed the leading English scientist of his time and the most influential member of the Royal Society of London.

Though he refused all honours and would not even accept the Presidency of the Royal Society, he dominated the scientific scene of the day. When the Royal Society had a problem of science or scientific method the members turned to Boyle; when they sought influence at Court, they turned to him equally.

Boyle was born on January 25th, 1627, the fourteenth child of the Earl of Cork at Lismore Castle in Munster, Ireland. Like all boys of genteel family, Robert Boyle began his education at home, learning French and Latin. Later, he was sent to Eton College, after which he spent several years with a tutor in Europe, for the most part in Switzerland and Italy. From 1645 to 1655 Boyle lived partly at Stallbridge in Dorset, where he began his experimental work and wrote moral essays. One of his essays is reputed to have inspired Jonathan Swift to write Gulliver's Travels. He had sufficient wealth not to have to earn a living and by the age of 27 had his own laboratory in Oxford with Robert Hooke as his assistant.

His work is reputed to have inspired 'Gulliver's Travels'

The initial impulse to study chemistry came from the interest in preparing of medical drugs. Boyle desired to test and try chemical remedies both for the benefit of mankind and for his own use. He suffered from malaria, with a severe cough. He appears to have collected and published the best available remedies for all the diseases of the day.

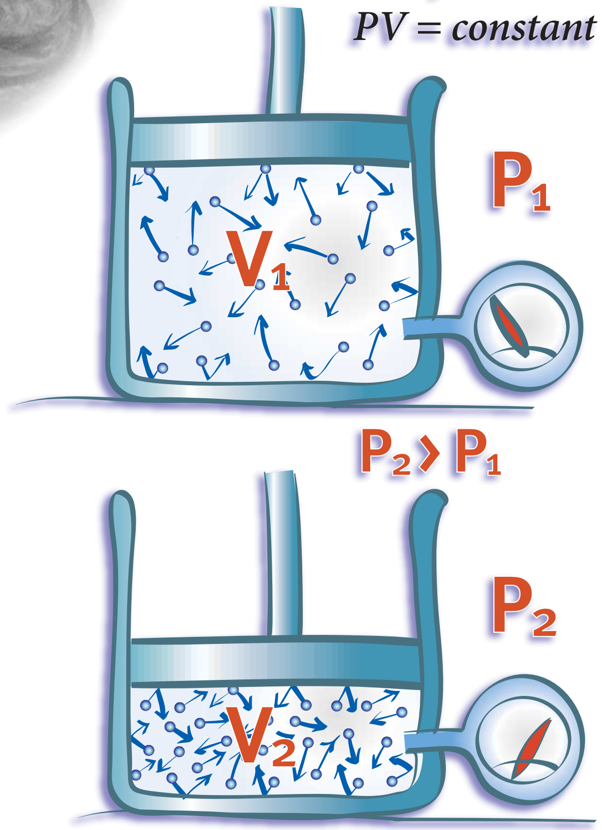
He carried out experiments on air, he studied the nature of vacuum, and he showed that air had weight. He studied combustion and respiration, and the properties of acids and alkalis. In 1661 he published a book *The Sceptical Chemist* in which he supposed that all matter consisted of 'primary particles' that could collect together to form 'corpuscles'. He believed that science could be put to practical use.

Boyle took a special interest in promoting Christianity in the East. He circulated Irish and Turkish translations of the Bible at his own expense, and founded the Boyle Lectures in defence of Christianity.

In 1668 Boyle came to London and until his death devoted much time to the Royal Society. He died on the 30th of December 1691, after a very brief illness. The welfare of science, the promotion of scientific discovery, whether by himself or by others, had been his life's work.

'Boyle's Law'

$PV = constant$



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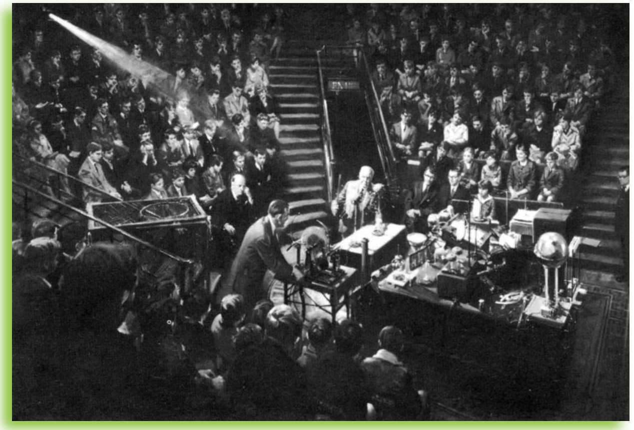
William Henry Bragg (1862 – 1942)

Awarded the Nobel Prize for Physics in 1915

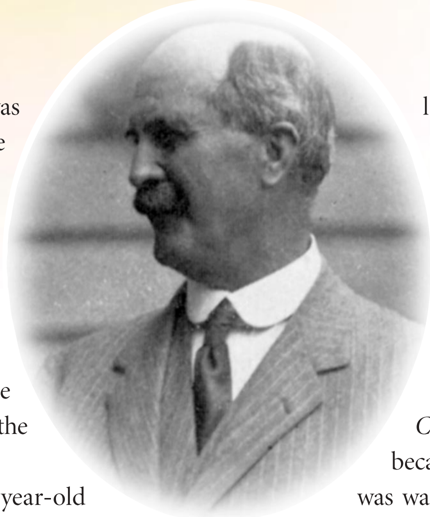
William Henry Bragg was a pioneer British scientist in solid-state physics. He was born on July 2, 1862, in Wigton, Cumberland, England. Bragg's father came from a family of farmers and merchant seamen. His mother, a sweet and kind woman, was the daughter of the local vicar. Bragg did not remember her very well, as she died when he was about seven. The small boy was taken to the family of his uncle, the owner of a pharmacy and grocery shop. In 1875 his father took him back and sent him to school at King William's College, Isle of Man. Bragg was good in his lessons and sports and became the head boy. He was fond of all games and played them rather well.

In 1881 Bragg applied to Cambridge University, **but the first interview was not a success**, and he had to return to school. After the next attempt he was granted a scholarship to Trinity College. There he worked very hard at mathematics and two years later obtained third place in the final examination.



Both he and his son lectured at the Royal Institution

Bragg played tennis and hockey well. His teacher was the famous physicist J.J. Thomson with whom he also played tennis. Thomson advised him to send an application for the post of professor of mathematics and physics at Adelaide University in Australia. After an interview Bragg was appointed and went to Australia where he began his career. In Adelaide the young professor became one of the best lecturers and a brilliant experimentalist. He himself designed the instruments and, indeed, all the equipment he needed for the practical laboratory.



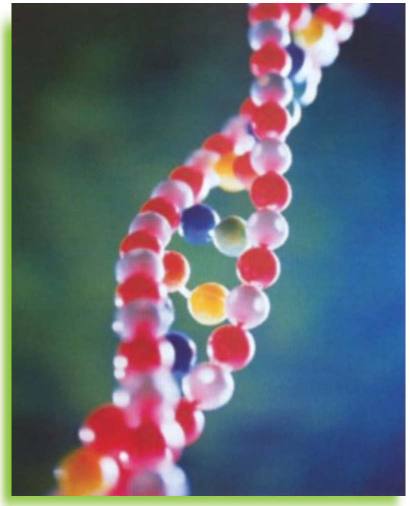
In 1889, in Adelaide, Bragg married 19 year-old Gwendoline, the daughter of the postmaster and government astronomer, Charles Todd. Gwendoline was lively, sociable, not very well educated but the best pupil at the Design School. They had three children. The eldest son William Lawrence Bragg went on to became the famous physicist-crystallographer. In 1904 Bragg started his experiments on the absorption of alpha particles from radioactive sources.

In 1907 Bragg was elected to a Fellowship of the Royal Society and within a year was offered a professorship in Leeds, where he developed the view that both gamma rays and X-rays have particle-like properties. Later, in 1912, the German physicist Max Von Laue announced that a crystal could diffract X-rays, thus implying that X-rays must be waves like light, but of shorter lengths. Bragg, and his son, who studied physics at Cambridge, began to apply X-rays to study crystal structures. On the basis of the 'law' that they derived they constructed a spectrometer for the analysis of crystals. For this work they both were awarded the 1915 Nobel Prize for Physics.

After World War I, Bragg founded a school of crystallographic research at the Royal Institution of London, the famous laboratory where Michael Faraday had worked in the previous century. Many young and energetic physicists gathered around him. They began to analyse organic crystals. X-rays became an important tool for research in molecular biology.

Bragg was a perfect popular science lecturer and writer. He gave the *Christmas Lectures* for children, which became bestsellers after their publication. He was warm, generous, free from pretension and proud of his son. He was knighted and received many honours.

His technique was used in identifying the 'double helix' of human DNA



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William Lawrence Bragg (1890 – 1971)

Awarded the Nobel Prize for Physics in 1915

William Lawrence Bragg was born on March 31st, 1890, in Adelaide, Australia, the first son of William Henry Bragg and Gwendoline Todd. His father, professor of physics and mathematics, had come to Adelaide after he had graduated from Cambridge University. His mother was the daughter of the government astronomer, who had lived in Australia since 1855 and had been given the particular task of installing an electric telegraph system in South Australia.

Bragg attended a convent school when he was five. Still a small boy, he was pushed by his younger brother while riding his tricycle and damaged his left elbow. After home treatment he was left with a slightly shorted hand. Only 40 years later he had an operation to relieve the pressure on the nerve that was paralysing his left hand. This event brought Bragg into his first encounter with X-rays, which had just been discovered. His father set out the apparatus for the first time to examine his son's elbow; it was the first recorded medical use of X-rays in Australia.

When he was 11, the young Bragg was sent to St. Peter's College, where he learned languages, literature, mathematics and chemistry. Bragg was 15 when his father decided that he should enter Adelaide University.

In 1909 Bragg's father accepted the Chair of Physics at Leeds University and the family left Australia. Following his father's example, Bragg entered Trinity College, Cambridge.

During the summer of 1912 Bragg discussed a recent book on the work of the German physicist Max Von Laue, who assumed that X-rays could be diffracted by crystals. After several original experiments, the young Bragg obtained an equation which described the connection between the X-ray diffracted angle, wavelength and distances between the atoms in a crystal lattice. It was named 'Bragg's Law' and is essential in the determination of crystal structure. i.e. the atomic arrangement in a crystal. Meanwhile, his father designed a new instrument for measuring the wavelengths of X-rays, which was named the spectrometer. William Lawrence and his father were awarded the 1915 Nobel Prize in Physics for their work.

After World War I, Bragg was appointed professor at the Victoria University of Manchester and later succeeded the famous Ernest Rutherford at Cambridge. He was knighted in 1941. During his career Bragg studied metals and alloys, silicates and proteins.

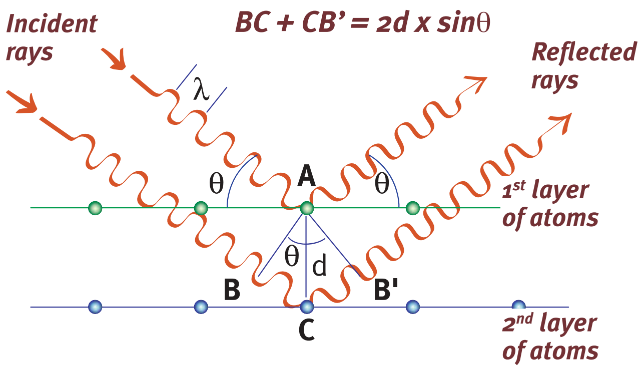
In 1921 he married Alice Hopkinson, the daughter of a physician. They had two daughters and two sons. His charming wife greatly helped him throughout his busy life.

In 1954 Bragg was appointed as the Director of the Royal Institution in London. He devoted much of his time to year-round lectures for schoolchildren, illustrated by the demonstration of interesting apparatus. He also gave popular and successful lectures for civil servants.

Although he worked until the end of his life Bragg spent many holidays sailing with his family. Sometimes, before getting down to business, he proudly demonstrated another of his hobbies, his latest roses.

Bragg's Law:

$$n\lambda = 2d \cdot \sin\theta$$



Bragg was very proud of his roses

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Tycho Brahe (1546 – 1601)

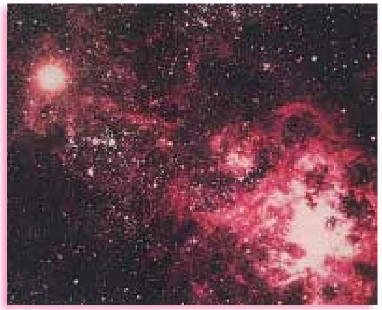
The great Danish astronomer, Tycho Brahe, was born in 1546, in Skaane, Denmark, into a noble and wealthy family. His father, Otte Brahe, was governor of the castle of Helsingborg, which controlled the main waterway to the Baltic Sea. His mother, Beate Bille, came from an aristocratic family. Among the twelve children she had in twelve years eight survived. Tycho was about two years old when he was adopted (some say 'abducted'!) by his childless uncle Jorgen Brahe, who brought him up and financed his education.

Tycho was sent to a grammar school in his seventh year and studied there until he was about twelve. Tycho began his university education in 1559 in Copenhagen and continued in the University of Leipzig. Tycho himself acquired elementary astronomy books and pursued astronomy study with much success. He divided his time between lectures on law, in response to the wishes of his uncle, and his night-time observation of the stars.

In August 1563 he made his first recorded observation, that of a conjunction (i.e. a lining-up) of Jupiter and Saturn.

Inheriting the estates of his uncle, Tycho went to Europe. During his long travels he studied alchemy, mathematics and acquired astronomical instruments, including a 'huge quadrant'. Having returned home because of his father's illness

He suddenly saw a new star (supernova) brighter than Venus



Tycho noticed on November 11th, 1572 **a new star** that was shining **brighter than all others**. This discovery (now called the ***Tycho Supernova***) and its explanation made him famous.

It was apparently at this time that he met the woman who became his life long companion. She was, unfortunately, a commoner and, because of their social difference, they could not be formally married; nevertheless, they had eight children.

In 1576 the King of Denmark, Frederick II, who was interested in astrology, granted him the title to the Island of Hven (where there is a small museum) together with financial support for designing a laboratory and observatory. Tycho decided to build a great house on the island which would have many functions: residence, observatory, alchemical laboratory and administrative centre. He drew up the plans, and supervised the construction of buildings and instruments himself. Uraniborg, as it was called, was ready in 1580 and Tycho with the whole household moved there. During all this time Tycho continued his investigation of comets. Measuring the position of 777 stars with great accuracy, he prepared a *star catalogue*. He was interested in everything - from alchemy and astrology to astronomy.

After the death of King Frederick II he lost royal favor and financial support. Because of difficulties in his social and private life Tycho was forced to leave Denmark in June 1597.

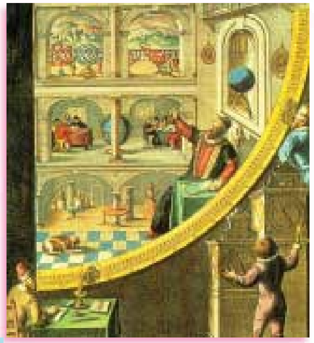
When he was about two he was adopted by his childless uncle

Spectacular discoveries in lunar theory were the most remarkable result of Tycho's last years. After a short stay in Germany he settled in Prague, in 1600. He was given a castle near Prague as an observatory, but soon, in 1601, he died, leaving all his observational data to Johannes Kepler, his pupil and assistant. He was buried in the Great Cathedral of Prague. The magnificent Uraniborg was burned down during the Thirty Years War.

There are many legends about Tycho. **One was that in his youth he lost his nose in a duel and he felt ashamed of its silver replacement ever after**. He served the aristocrats as astrologer and perhaps, not surprisingly, he was afraid of black cats crossing the street!

S.E.

He acquired an astronomical instrument



Tycho built a great house and observatory called Uraniborg

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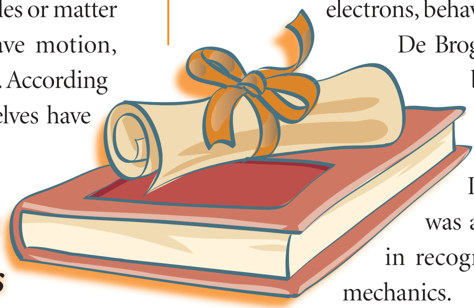
Louis-Victor De Broglie (1892 – 1987)

Awarded the Nobel Prize for Physics in 1929

Prince Louis-Victor Pierre Raymond de Broglie, the famous French physicist, is best known as the 'father' of wave mechanics.

At the start of the 20th century, physicists explained phenomena in terms of particles (such as electrons and protons) and electromagnetic radiation (light, ultraviolet radiation, etc.). Particles formed atoms and molecules or matter in general. Electromagnetic radiation was a wave motion, involving oscillation of electric and magnetic fields. According to de Broglie's theory, particles can in fact themselves have wave-like properties.

His famous theory was described in his Doctoral thesis



Louis de Broglie was born on August 15th, 1892 in Dieppe, France, as the son of Duc Victor and Pauline d'Armaille Broglie. His father's family was of noble origin, having served French monarchs for centuries, and the head of the family had been rewarded in 1740 with the title of 'Duc' by King Louis XIV. Later, de Broglie's ancestor received the title 'Prinz' for his service to the Austrians during the Seven Years War of 1756-1763.

De Broglie was the youngest of five children in the family. His early education was obtained at home, as usual in a great French family of the time. After the death of his father, when de Broglie was fourteen, his eldest brother Maurice arranged his education and sent him to the Lycée Janson de Sailly in Paris. Louis obtained a degree in history from the Sorbonne in 1909, and a Licence in Science in 1913 from the University of Paris.

Throughout World War I, de Broglie served in the French Engineers, spending much of this period working at the wireless station on the Eiffel Tower.

His brother Maurice, who was also a physicist, kept a well-equipped laboratory in the family mansion in Paris and, it is claimed, this is where Louis began his investigation into the nature of matter.

In 1924 de Broglie presented his doctoral thesis at the Sorbonne. In it he postulated that all matter, including electrons, behaves like particles and waves.

De Broglie's wave-matter theory was proved by the diffraction and interference experiments which demonstrated the wave-like properties of electrons.

In 1929, at the age of 37, de Broglie was awarded the Nobel Prize for Physics in recognition of his contribution to wave mechanics.

He worked at the wireless station on the Eiffel Tower

De Broglie devoted the rest of his career to teaching and developing his theory. He published numerous research papers on gamma rays, optics, atomic particles, and the history of physics. He was awarded the first Prize for excellence in science writing by the Kalinga Foundation in 1952. He was a member of the Academie des Sciences and a foreign member of the Academies of many other countries.

He died of natural causes on March 18th, 1987, at the age of ninety five.

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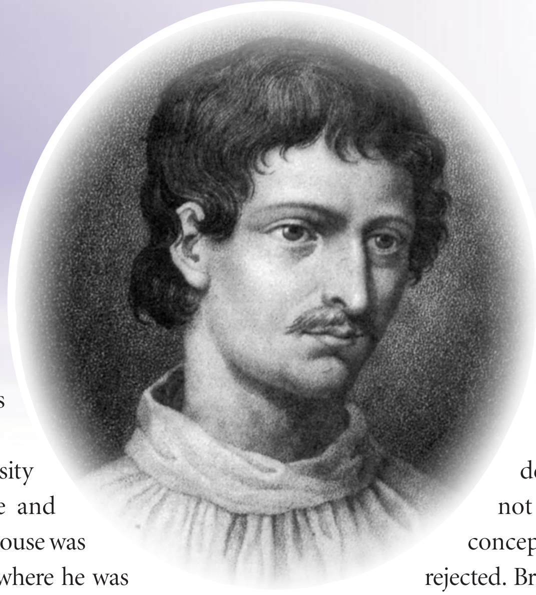
Giordano Bruno (1548 – 1600)



Giordano Bruno was an Italian philosopher, astronomer and mathematician. He was born near Nola in the province of Napoli in 1548. His father baptised him Filippo. When he was seventeen, he entered the Dominican monastery in Napoli, where he received the name of Giordano. In the monastery he read for the first time Copernicus' book *On the Revolutions of the Celestial Spheres* and grasped Copernicus' world-view, that the sun is the centre of our local system, not the earth. As he did not accept all Catholic doctrines, he was soon threatened with prosecution. At the age of twenty-eight he left his monastery for Rome. But his stay in Rome was not very pleasant. He fled when he realised that he was under suspicion by the Napoli Church. In May 1579, he inscribed his name in the Rector's Book of the University of Geneva and in August of the same year he published a pamphlet on a distinguished professor of philosophy 'who made twenty errors in a single lecture'! Both Bruno and his printer were promptly arrested. After rehabilitation he was allowed to leave the city.

Bruno attended Queen Elizabeth's Court

Bruno moved to France. At the University of Toulouse he acquired his doctorate and lectured on astronomy but his stay in Toulouse was not very successful. He moved to Paris, where he was immediately successful. His reputation for teaching and especially his excellent memory reached even King Henry III, who appointed him as his temporary lecturer. In 1582 Bruno published a comedy *Il Candelaio*, which exposed the moral and social corruption of the time.

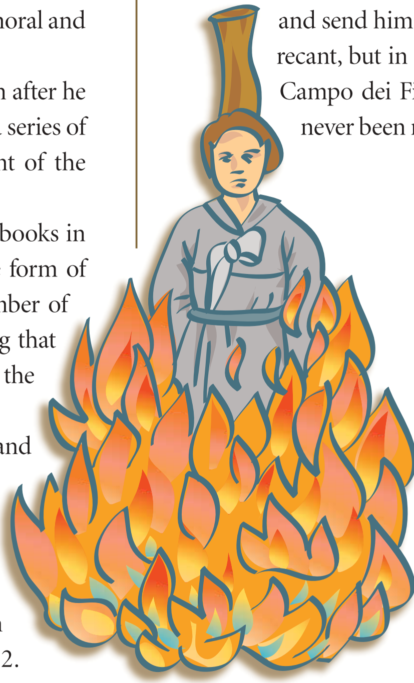
In the spring of 1583 Bruno went to London. Soon after he was appointed to Oxford University where he started a series of lectures on the Copernican theory of the movement of the Earth. He frequented the court of Queen Elizabeth I.

Between 1583 and 1585 Bruno published several books in London. He presented his cosmological views in the form of dialogues. He conceived that each of an infinite number of worlds was moving in relation to other worlds, saying that 'all estimates of a direction, position and weight within the whole must be relative'.

He spent the following years travelling in France and Germany. While in Frankfurt, he received two letters from Giovanni Mocenigo, perhaps an agent of the Venice Inquisition, inviting him to become his teacher of arts. In 1591 the unsuspecting Bruno went to Venice, where his promising 'pupil' threatened him and delivered him to the Inquisition in May 1592.

Although the Venetian verdict of the trial was not very severe to Bruno, the later Roman Inquisition required his extradition.

During the seven year period in Rome for the trial, Bruno tried to demonstrate that his views were not incompatible with the Christian conception of God, but his argument was rejected. Bruno was ordered to retract his theories of the Universe, but he declared that he had nothing to retract. Finally the Pope, Clement VIII, ordered Bruno be sentenced as an impenitent and pertinacious heretic and send him to jail where he 'was given eight days to recant, but in vain'. Soon after, he was brought to the Campo dei Fiori in Rome and burned alive. He has never been rehabilitated into Catholic Church.



Bruno was burned at the stake for his views

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Leonard Sadi Carnot (1796 – 1832)

The French engineer and physicist, Leonard Sadi Carnot, was born in Paris, in the Palais du Petit-Luxemburg, to the family of Lazare Carnot, a major figure of the French Revolution and the man named as the 'Architecte de la Victoire' of Napoleon's Army. Lazare had a wife, Sophie, and two sons, Sadi and Hippolite. Carnot's family suffered from many changes during this unstable period in the history of France.

Lazare himself was a good mathematician and published work on mathematics and mechanics as well as on military and political matters. Withdrawing from public life in 1807, Lazare Carnot concentrated on the scientific education of his sons.

From his father, the young Carnot received a good training in mathematics and mechanics, physics, languages and music. In 1812, following a few months' preparation at the Lycée Charlemagne, he was admitted to Polytechnique, an institution providing an exceptionally fine education with the help of famous scientists.

Ranking sixth in his class, Carnot finished his studies at Polytechnique and was sent to the École du Genie in Metz as a second lieutenant student.

By the time Carnot graduated in 1814, Napoleon's empire was being rolled back. During Napoleon's brief return to power in 1815, Lazare Carnot was the Minister of the Interior, and his sons became the object of special attention from his superiors. This ended in 1815, when Lazare was exiled after the Restoration and fled to Germany, never to return to France.

Carnot's father served under Napoleon

Carnot became an army engineer, at first inspecting and reporting on fortifications. In 1819, after passing a competitive examination, he gained a post in the army general staff corps in Paris. He soon retired on half pay, living in Paris and turning to science.

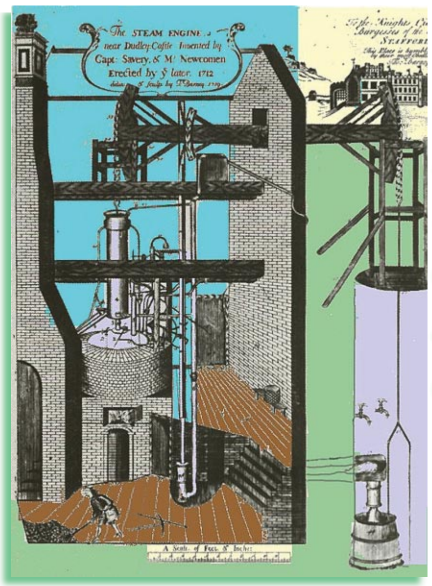
L.S. Carnot had many interests: industrial development, tax reform, mathematics and fine arts. He was particularly interested in problems related to the steam engine and its efficiency; steam power already had many uses, such as draining water from mines, excavating ports and rivers, forging iron, grinding grain and spinning and weaving clothes. However, it was inefficient.

In 1824, Carnot published his classic work, *Reflection on the Motive Power of Heat*. There he analysed the efficiency of engines in converting heat into work. He found that the efficiency of an idealised engine depends only on the temperature difference of its hottest and coldest parts and not on intermediate stages through which the engine passes. He introduced the theorem of reversibility in the form of the ideal *Carnot cycle*. Using this idea he derived an early form of the second law of thermo-dynamics, stating that heat always flows from hot to cold.

Although his result was presented to the Academy of Sciences and given an excellent review in the press, this work had been completely forgotten until 1834, when Emile Clapeyron, the railroad engineer, started to extend Carnot's views.

Carnot is described by his biographers as being a very sensitive and perceptive person, although introverted in his relations even with his close friends.

In 1831 Carnot began to investigate the physical properties of gases and vapours. In June 1832 he contracted scarlet fever. His health was so badly damaged that on 24th of August in 1832 he fell victim to a cholera epidemic and died within the day. According to the custom of the time, all his belongings, including nearly all his papers, were burned.



He studied the science of the steam engine

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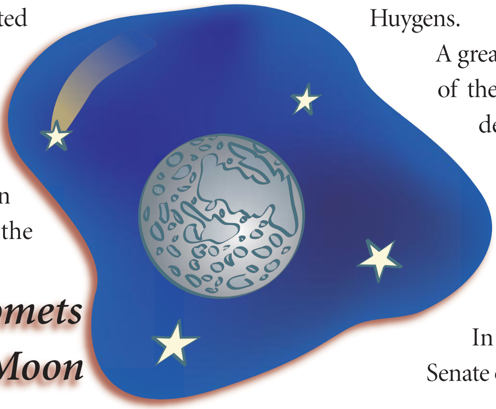
Gian Domenico Cassini (1625 – 1712)

Gian Domenico Cassini holds a considerable position in the history of astronomy for the remarkable impetus he gave to the development of this discipline. In France he had the honour to be referred to as Cassini I.

He was born in June 1625 in Perinaldo, in the county of Nice, when that territory still belonged to Italy. He finished his studies in the Jesuit college in Genoa showing a special interest in poetry and astronomy. Still during his youth he became so famous as an astronomer that the Marquis Cornelio Malvasia, senator of the city of Bologna and lover of astronomy, proposed that he should take care of his private observatory. Cassini arrived in Bologna in 1649 and a brilliant, meteoric career began.

Observing the comet of 1652, Cassini demonstrated, as Tycho Brahe had suggested for the 1577 comet, that it was much more distant than the Moon. It became evident that comets were celestial bodies which moved among planets perforating their incorruptible spheres and not exhalations of the terrestrial atmosphere, as asserted by the old Aristotelian physics views.

One of his most important masterpieces was the construction, of the biggest world meridian line in the big San Petronio Church of Bologna. With accurate observations of the Sun's disk projected on the floor of the church he measured how much the diameter and the velocity of the solar image varied during the year. In this way he demonstrated that the apparent motion of the Sun was in agreement with the expectations of Kepler's Second Law, i.e. that celestial bodies move more quickly when they are closer to the Sun and slower when they are distant from it.



He showed that comets were beyond the Moon

Thanks to the excellent telescopes produced by skilled Italian instrument makers, he discovered the "Big Red Spot" on Jupiter and calculated the rotation period of the big planet. He observed details on the surface of Mars and determined the rotation period of this planet too. He carried out such accurate observations of the motion of Jupiter's satellites that these studies were used for a long time in the attempt to solve a fundamental problem; the determination of terrestrial longitude, a longstanding problem for sailors.

Cassini's fame reached France and Louis XVI invited him to Paris to set up the new *Observatoire Royal*. Cassini carried out further astronomical observations and discovered, among other things, Saturn's satellites and the separation in the rings (now carrying his name) which surround the planet. In his honour and of the great Saturn researcher Huygens, the space mission heading towards this planet was named Cassini-Huygens.

A great importance has to be given to his calculation of the distance from the Earth to the Sun that he derived using Kepler's Third Law from the simultaneous observation of Mars carried out by himself in Paris and by Jean Richer in Cayenne. At last, astronomers were able to assign to the Solar System its right dimensions.

In 1673, despite being recalled to Italy by the Senate of Bologna and by the Pope, Cassini decided to stay in Paris. He married, and his son Jacques, born in 1677, was brought up at the observatory where he was destined to succeed his father.

The Cassini dynasty ended with his grandnephew, Cassini IV's son, Alexandre, jurist and botanist, who was arrested and imprisoned during the French revolution. Close to death, and almost blind, Cassini dictated his biography before he died in Paris on 14th September 1712 at the age of eighty seven. He was buried in the church of Saint Jacques du Hautpas with a very simple gravestone "J.D. Cassini Astronome".

'the Cassini Division'
Image of Saturn from the Hubble Space Telescope

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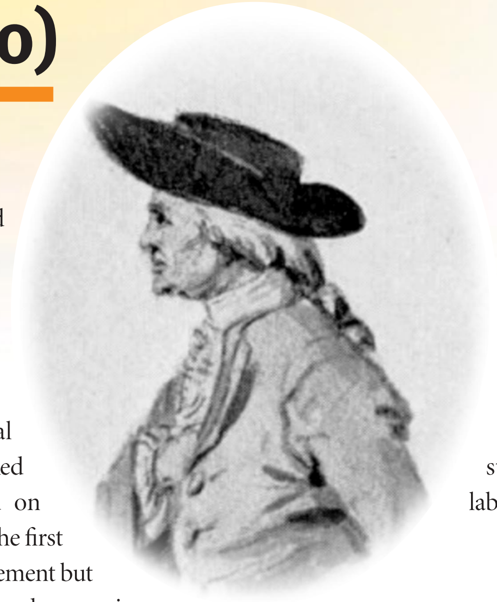
Henry Cavendish (1731 – 1810)



Henry Cavendish, the famous British physicist and chemist, was the son of Lord Charles Cavendish, himself an experimentalist, Fellow of The Royal Society and an administrator of the British Museum. Henry's mother, formerly Lady Anne Grey, was the fourth daughter of the Duke of Kent. Her health seemed to be poor, for which reason she went to Nice, where Henry was born on October 10th, 1731. She died two years later, shortly after giving birth to a second son, Frederick.

The two boys attended school in Hackney in London. At the age of eighteen Henry entered St. Peter's College, Cambridge, but left without a degree. He went to London, resided with his father and apparently continued to live with him until the death of his Lordship in 1783. The whole of his electrical and most of his chemical research was carried out in the laboratory of his father, who put all of his instruments at his son's disposal.

Much of Cavendish's work remained unpublished in his lifetime. He wrote no books and less than twenty articles in all his fifty year career. Using his notebooks and manuscripts, his electrical studies were edited by the physicist James Clerk Maxwell in 1879. The work included the distinction between electrical quantity i.e. charge, and potential.

He measured the electrical conductivity of salt solutions and worked on the effect of water vapour and on compression. He seemed to be one of the first who understood that water is not an element but a compound and consists of hydrogen and oxygen in the proportion of 2:1 by volume.

One of his main results, which was published, was the mean density of the Earth determined by means of the torsion balance (right).

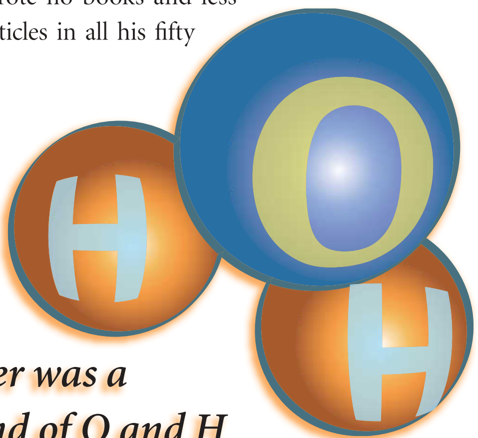
Cavendish inherited from his relatives a remarkable fortune with which he built up a large library and an apparatus collection.

He had a most peculiar personality, rarely appearing in public, chiefly at scientific meetings. Throughout his long life he seemed to have been terrified of women. He was never married. It is said that once he chanced to meet a housemaid on the stairs carrying a broom and pail, which so upset him that he immediately ordered a back staircase to be built !

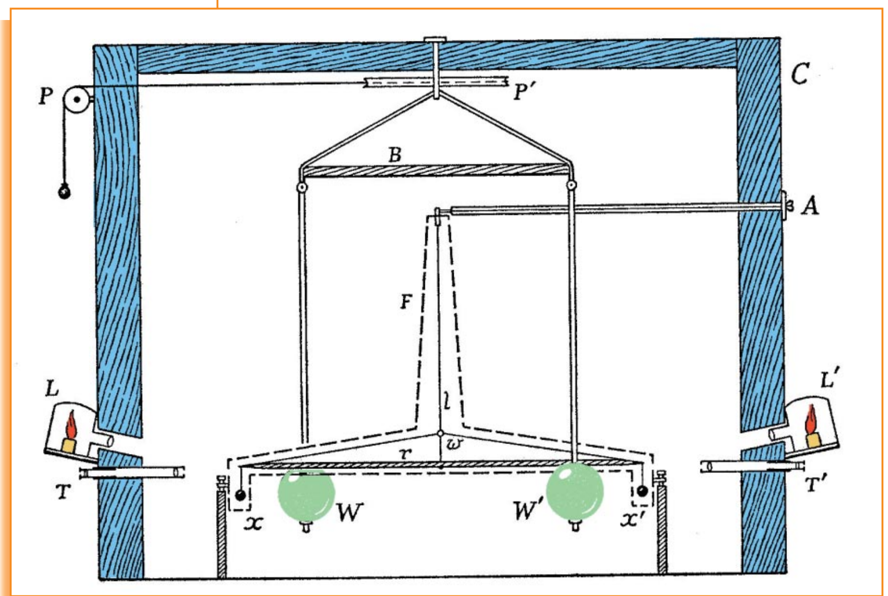
In appearance, Cavendish was tall and thin. His voice was hesitant; he wore the costume of the XVII century. When out of doors he was to be seen wearing a three-cornered hat.

In spite of his peculiarities, Cavendish was greatly respected by his scientific colleagues, but he had really very few friends.

He died in 1810 after a short illness. On his death Cavendish left about a million pounds sterling to his relatives. The famous physics laboratory in Cambridge is named after him.



He showed that water was a compound of O and H in proportion 1:2



Cavendish's apparatus

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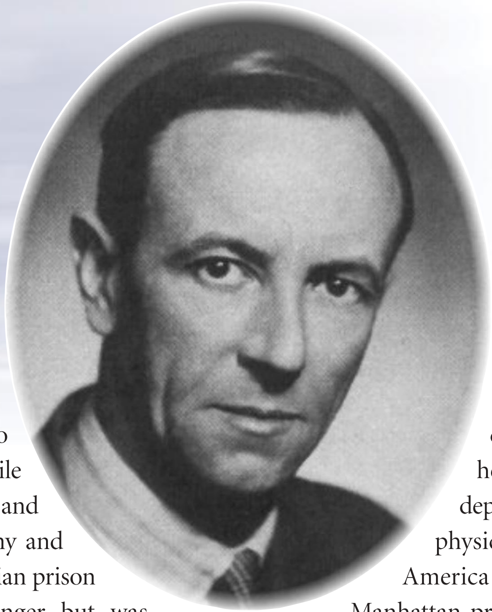
James Chadwick (1891 – 1974)

Awarded the Nobel Prize for Physics in 1935



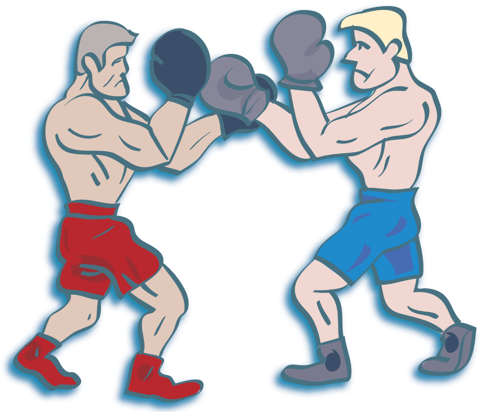
It is known that everything is made up of trillions of incredibly tiny particles called atoms.

By 1911, Ernest Rutherford had shown that an atom has a heavy central part, called the nucleus. This contains the sub-atomic particles named protons and neutrons. Lighter particles called electrons orbit around it. Each proton has a positive electric charge, the electron has a negative one. Neutrons are the same size as protons but they have no electrical charge at all.

The famous British physicist James Chadwick determined the existence of neutrons and for this discovery he was awarded the Nobel Prize in 1935.

Chadwick was born in Bollington, Cheshire, near Manchester. He was the eldest of the four children of Anne Mary and John Joseph Chadwick. His father had a laundry business. After attending Manchester Secondary School, James went to the local university to study mathematics but by mistake he was admitted to physics! Being so shy, Chadwick did not make known the mistake and decided to continue with physics. After graduating he went to Cambridge and started research into atomic structure under Rutherford.

He had an argument with Rutherford



In 1913 he was awarded a scholarship which enabled him to go to Germany to study radioactivity with Hans Geiger. While he was in Germany, World War I broke out and Chadwick was interned as a foreign enemy and confined for more than four years in a civilian prison camp. He suffered from cold and hunger but was permitted, with the help of the German physicists, Planck, Nernst, and Meitner, to carry out some experiments. On his return to Britain in 1919 he received a scholarship at Cambridge and continued to work with Rutherford on the alpha-particle experiments and soon afterwards they discussed the concept of the neutron.

From 1923 to 1935 Chadwick was an assistant director of research at the Cavendish Laboratory. It was during this period, in 1932, that he made his discovery. He investigated the radiation given off when beryllium is bombarded by alpha-particles (helium nuclei). He proposed that alpha-particles knock neutrons out of the nuclei of beryllium atoms and that these neutrons in turn knock protons out of the paraffin. Energy measurements confirmed his suggestion. Performing the same experiment with other targets he calculated the mass of the neutron. This discovery was of great importance for the investigation of nuclear structure because the neutron, being uncharged, can penetrate deep into atoms.

Chadwick's relationship with Rutherford was very close and friendly but in the early 1930s some disagreement between them arose. Chadwick believed that the cyclotron particle accelerator would become an essential tool for nuclear research, and he wanted a cyclotron at Cambridge but Rutherford refused it. In 1935, Chadwick left Rutherford and accepted the Lyon Jones chair at the University of Liverpool. Soon he had his cyclotron and this made the department there a leading centre for atomic physics. He spent most of World War II in America as head of the British mission to the Manhattan project on the development of the atomic bomb. He was knighted in 1945. He also received many scientific honours and awards.

Chadwick was tall and slender with dark hair and a swarthy complexion. By nature he was shy and reserved but full of kindness. He had a deep voice and a dry sense of humour. Chadwick married Aileen Stewart-Brown from Liverpool in 1925, and they had twin daughters. At the end of his life they lived in Cambridge near their children.

He was interned for 4 years in Germany as an enemy alien

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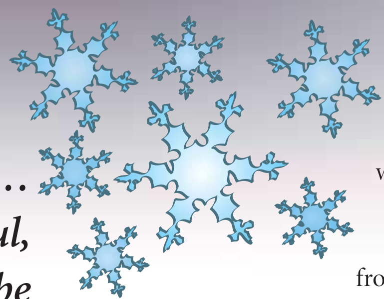
Pavel Alexeevich Cherenkov (1904 – 1990)

Awarded the Nobel Prize for Physics in 1958

Snowflakes… beautiful, but maybe tasty, too?



In modern nuclear physics, the following terms are very common: Cherenkov counters: (even called 'Cherenkators'), Cherenkov angle, Cherenkov radiation. Nowadays, not all physicists are aware that these terms come from the Russian surname Cherenkov. This is how it happened.

At the beginning of the last Century, on 28th July, 1904, a boy, Pavel, was born to a peasant family, the Cherenkovs, in the village of Novaya Chigla, Voronezh province. Two years later his mother died. He and his sister were brought up by a stepmother – not as evil as in fairytales – but not as good as every child would have wished either. Pavel grew up very curious. In winter a heavy frost covered the metal handle of the outside door with sparkling snowflakes. And one day he wanted to touch it with his tongue: it was beautiful, but was it tasty too?! His tongue immediately froze to the handle; the boy guessed how to defrost it on his own, without adult help. He loved reading. He was lucky that their village had a library, the only one in the region. He was a good student and his teachers said he would have a great future.

He grew up at a time of war and revolution. In 1928 he graduated from the Physics and Mathematics Department of Voronezh University. In 1930 he started postgraduate work at the Academy of Sciences in Leningrad (now St. Petersburg). Working with his supervisor, the great physicist and great man, Sergei Vavilov, in the field of optics, Cherenkov discovered a weak shining background light, which impeded his main research. He devoted 6 years to studying this weak blue light. His experiments resulted in the discovery of a new phenomenon in physics, now termed Cherenkov radiation.

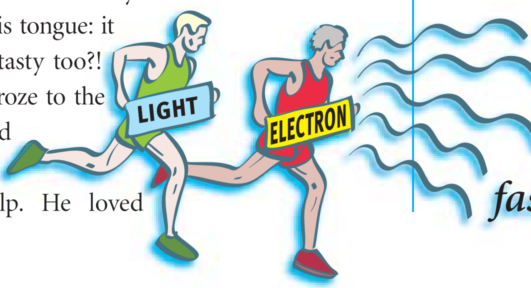
In 1958 he, and the theoretical physicists Frank and Tamm, were awarded the Nobel Prize for the discovery and explanation of the Cherenkov effect. Cherenkov radiation is interesting because it is caused by elementary particles, moving faster than light. But how can that be?! It's easy: the speed of light in matter is less than in a vacuum, and the particles can overtake it. This property is so useful for scientists carrying out experiments that they even use it for studying very distant galaxies.

In later years, Cherenkov's research was related to the physics of cosmic rays, the physics and technology of large installations, the so-called 'accelerators' of elementary particles.

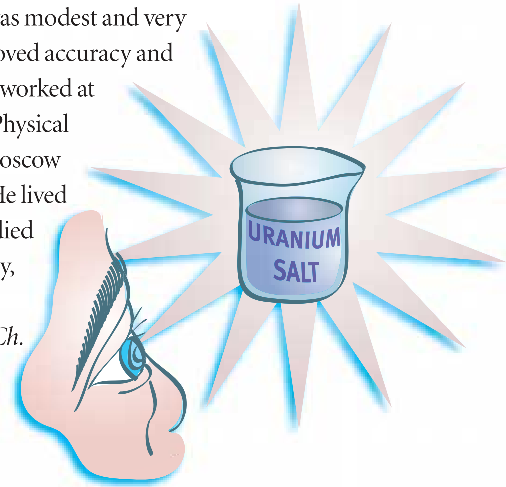
Cherenkov had many difficulties in his life in addition to his orphan childhood. In 1938 his father Aleksei Yegorovich Cherenkov was shot as a 'kulak' (i.e. a 'rich' peasant). His father-in-law, a Professor of Russian literature, was also oppressed and spent 2 years in a labour camp. When Cherenkov was a postgraduate, his experimental work, which was to receive a Nobel Prize, was described by his colleagues as the study of 'dirt' and of no importance; later on there was an attempt to undermine the significance of his contribution to the discovery. Cherenkov was able to overcome these problems with dignity.

He married Marya Putintseva, a wonderful and kind woman. They had two children, Aleksei and Elena, and two grandchildren. He enjoyed photography, tennis and history and his pets. He was modest and very reserved; he loved accuracy and precision. He worked at the Lebedev Physical Institute in Moscow for 60 years. He lived to be 85 and died on 6th January, 1990.

E. Ch.



Cherenkov radiation… is caused by elementary particles moving faster than light in a medium!



He devoted 6 years to studying this weak blue light

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John Douglas Cockcroft (1897 – 1967)

Awarded the Nobel Prize for Physics in 1951

John Douglas Cockcroft was one of the leading scientists of his generation. With his colleague Ernest Walton he built the first particle accelerator, in which lithium was split by bombarding it with protons accelerated to a very high velocity. Cockcroft and Walton shared the award of the 1951 Nobel Prize for Physics for this achievement. Particle accelerators became an important tool in nuclear physics research. They also have many applications in industry, such as detecting flaws in metal castings, and, in medicine, for the treatment of cancer.

Cockcroft was born at Todmorden, Yorkshire, England, where his family ran a small textile business. When his mother was widowed she opened a hat shop in the town. John was the first of five sons in the family. At the age of 11 he was sent to the local Grammar School where physics and mathematics were well taught. He was one of the best students and also one of the best sportsmen at school. It was there that he met Elizabeth Crabtree who would later become his wife, partner in every way, and a devoted mother.

The modern version of the Cockcroft and Walton's 'atom smasher'

In 1914 he was admitted to the University of Manchester to study mathematics but left a year later for military service. After returning to Manchester in 1919, Cockcroft decided to do a degree in electrical engineering. In 1920 he became a college apprentice at the Metropolitan Vickers Electrical Company. Then he moved to Cambridge University, achieving a BA in mathematics in 1924. After his long period of training, Cockcroft was granted a scholarship at Cambridge. He started to work at the Cavendish Laboratory under the leadership of Rutherford, where he studied radioactivity.

At the Cavendish, Cockcroft first helped P. Kapitza in the design of powerful electromagnets. Later, he collaborated with Walton on the construction of the apparatus that would permit them to accelerate atomic particles. The apparatus they created was essentially a vacuum discharge tube to which up to 600000 volts was applied. They placed hydrogen nuclei, which consist of just one proton, into the accelerator, and concentrated them into a very fine beam on to a lithium target. After bombardment, the nuclei of lithium were disintegrated and the emission of alpha particles (helium-4) was observed. Later they disintegrated other elements such as boron.

He was one of the best sportsmen at school

Cockcroft was entirely immersed in his work and this helped him deal with his private tragedy, the death of his first son from asthma. He and his wife later had four daughters and a further son.

During World War II, Cockcroft was responsible for the development of short-wave radar equipment for controlling anti-aircraft guns. He became chief superintendent of the Air Defense Research, and Prime Minister Winston Churchill sought his advice, and they often toured England's bombed cities together. In 1944 he supervised the construction of the first nuclear reactor in Canada. After returning to Britain he was appointed the first director of the Atomic Energy Research Establishment at Harwell.

He had a bad experience with the media when he was 'trapped' into saying that his group had discovered neutrons from nuclear fusion; they hadn't!

Cockcroft was knighted in 1948. He was president of the Harwell Angling Club, and enjoyed tennis, gardening, music and literature. He wrote few scientific papers, and from 1935 onwards he was occupied in organisation and administration of research. He was still Master of Churchill College at Cambridge when he died suddenly at the age of 70.

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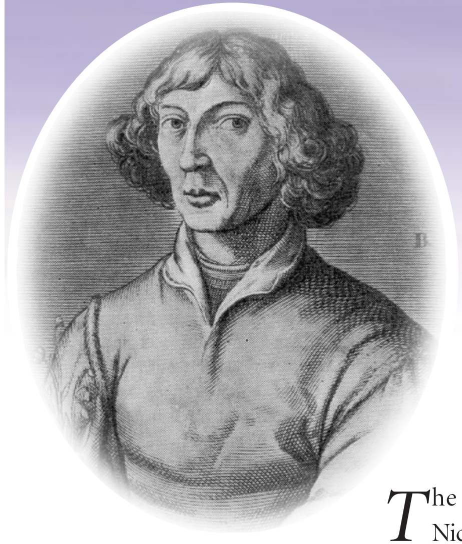
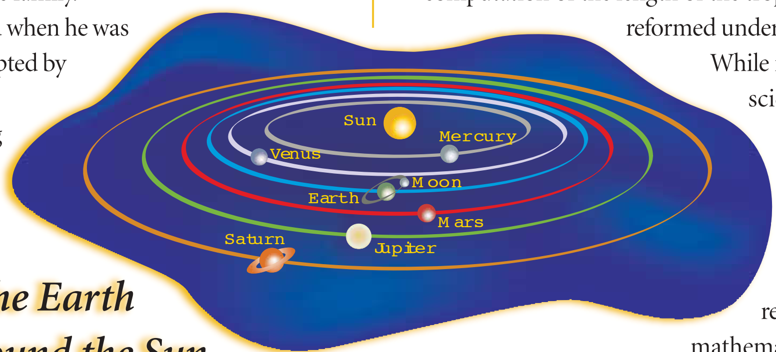
Nicolaus Copernicus (1473 – 1543)



The Polish astronomer Nicolaus Copernicus is noted for his revolutionary theory of the heavens, now known as the Copernican theory. He was born at Torun, now in Poland, on February 19th, 1473.

He was a quiet man, without great power, titles or wealth — an astronomer and a humanist, who observed, calculated and thought. His father was a gentleman 'who bought real estate and brought law suits' as is known from the Torun judicial records. His mother was the daughter of a wealthy Torun merchant. There were four children in the family. The father of Copernicus died when he was ten and the children were adopted by their maternal uncle, Lukas Watrenrode, a man of a strong character, who served the Church as a Bishop.



He showed that the Earth revolved around the Sun

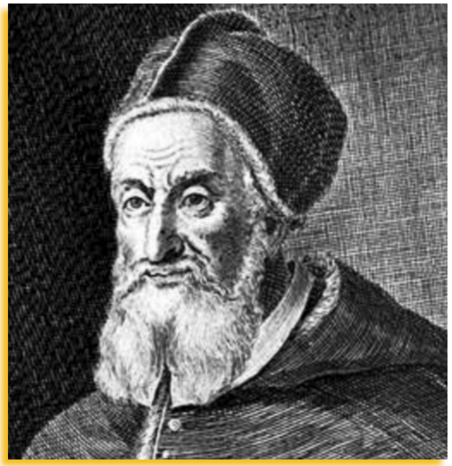
Lukas sent his nephew to the elementary school at Torun and later to the University of Cracow, where Copernicus became interested in the study of astronomy and accustomed to the use of astronomical instruments. Bishop Lukas was eager to provide for his nephew's future by having him elected as a Canon, but his first attempt was not successful and Copernicus was sent for further training to the University of Bologna. There he made his first recorded observation of the heavens — an eclipse of the star Aldebaran by the Moon in 1497. The same year he was elected a Canon of Frauenburg (now Frombork, Poland). In 1501 he returned to Italy under special leave of absence to continue his studies at the University of Padua. As the result of his education in Cracow and Italy, Copernicus may be said to have mastered all the knowledge of the day in mathematics, astronomy, medicine, theology and Greek.

He returned to Poland in 1503 and took up residence in Frombork. In 1514 he was invited to give his opinion on calendar reform to the Lutheran Council. Copernicus asked the Council not to reform the calendar because the courses of the Sun and the Moon had not been determined with sufficient accuracy. Many years later, after the publication of his computation of the length of the tropical year, the calendar was reformed under Pope Gregory XIII.

While reading the works of Greek scientists, and analysing his own great number of observations, Copernicus concluded that the idea of the Earth moving around the Sun is preferable to the reverse. After many years of mathematical calculations he became convinced that his new idea was true, yet he was in no hurry to publish. His first short manuscript with this idea was privately circulated among friends in 1514. Not until 1540 did he consent to the publication of his complete work, On the Revolutions of the Celestial Spheres (De Revolutionibus Orbium Coelestium). Its main point was the so-called heliocentric system and it adopted the following order from the stationary Sun: Mercury, Venus, Earth with the Moon orbiting around it, Mars, Jupiter, and Saturn. He gave a mathematical description of the Earth's motion, including the precession of the equinoxes, caused by the gyration of the Earth's axis.

A copy of his great work is believed to have been brought to Copernicus at Frauenburg on the last day of his life, May 2nd, 1543. He lived and died very lonely. It is said that before his death the poor old man's companion or nurse, Anna, had been driven from his home by so-called friends.

His work led to the new Gregorian Calendar



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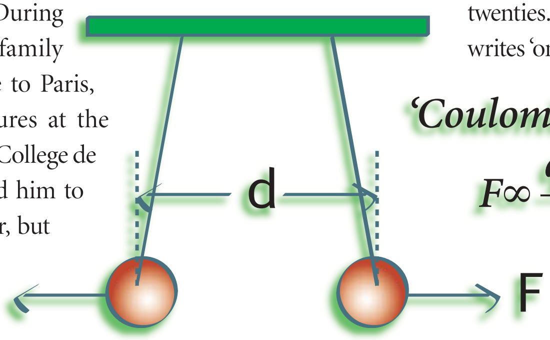
Charles Augustin Coulomb (1736 – 1806)

Charles Augustin Coulomb was the physicist and engineer who established the laws governing electric charge and magnetism. Coulomb's law states that the force between two electric charges is proportional to the product of the charges and inversely proportional to the square of the distance between them. He also held important positions of service to the French government both before the Revolution and in the first years of the Empire.

Coulomb was born on June 14th, 1736, in Angoulême, France. His mother, Catherine Bajet, was related to the wealthy de Sénac family. His father, Henry Coulomb, had begun a career in the military, but then left for a government post. It is said that Henry Coulomb was involved in financial speculation and finally lost all his money. During Coulomb's youth the family moved from Angoulême to Paris, where he attended lectures at the College Mazarin and the College de France. Catherine wanted him to become a medical doctor, but Charles announced that he was going to study mathematics.



'Coulomb's Law'

$$F \propto \frac{q_1 q_2}{d^2}$$

Continuing to deny his mother's desire that he should study medicine, he was disowned (fortunately only temporarily). Penniless, Charles was forced to go to his father in Montpellier, where he joined the scientific circle – the second royal scientific society in France. It was here that Coulomb read his first papers on astronomy and mathematics. Unfortunately he had no financial support and he had to find a post which would provide him a living and at the same time allow him to continue his scientific studies; eventually he choose a career as a military engineer. In 1760 he enrolled in the military school at Mézières.

Coulomb spent nine years in Martinique (in the West Indies) as a military engineer but returned to France because of ill health. He entered the French Academy of Sciences in 1781. He participated in the administration of waters and fountains, the reform of hospitals and the system of weights and measures. In 1787 he published the paper where he proved his famous law.

Upon the outbreak of the French Revolution he retired to a small estate at Blois where he devoted himself to scientific research. This included research on the friction of machinery, torsion, on windmills and on the elasticity of metal and silk fibres. The 'coulomb', the unit of electric charge, was named in his honour.

Charles Augustin had taken as his wife a Doué girl in her twenties. She was a wonderful wife and mother. As his biographer writes 'one wonders if the young wife did more than tolerate the old physicist who was thirty years her senior'. Their first son was born in Paris in 1790 and the second in 1797.

Living in Blois with his family he made several experiments in botanical physiology. Coulomb loved the country and spent much time tutoring his small son Charles.

He left the property near Blois only once during the Reign of Terror in May 1794, when he risked his life to enter Paris for the funeral of Lavoisier, who had been guillotined. In June, 1806, Coulomb contracted a fever which confined him to bed and finally caused his death.

Coulomb can be considered one of the great engineers and physicists not only of France but indeed of Europe as a whole in the eighteenth century.

He carried out research on windmills

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Marie Sklodowska Curie (1867 – 1934)

Awarded the Nobel Prizes for Physics in 1903 and for Chemistry in 1911

Marie Sklodowska Curie, the Polish born French physicist, was famous for her work on radioactivity. Along with Henri Becquerel and her husband, Pierre Curie, she was awarded the Nobel Prize for Physics in 1903 for their investigation of radioactivity. Later, she was the sole winner of the 1911 Nobel Prize for Chemistry. She is the only person yet to receive two Nobel Prizes.

Marie Sklodowska was born on November 7th, 1867, near the ancient centre of Warsaw. Her father, Wladyslaw Sklodowski, a very intellectual man, was a teacher of mathematics and physics. Marie was six years old when her father was forced out of his supplementary school post of under-inspector and had to give tuition to schoolboys. Her mother, Bronislawa Boguska, was a convent-educated woman and she was a headmistress of a private school for girls. She suffered from tuberculosis and died when Marie was only ten.

From an early age Marie had intense powers of concentration and a remarkable memory. At the age of 16 she won a gold medal on completion of her secondary education at the Russian lycée. Marie began her independent life as a governess. She had to divide her time during that first year between giving lessons and self education. In 1891 Marie went to Paris to follow lectures on physics in the Sorbonne. Her allowance from Poland was small and she virtually lived on bread and tea.

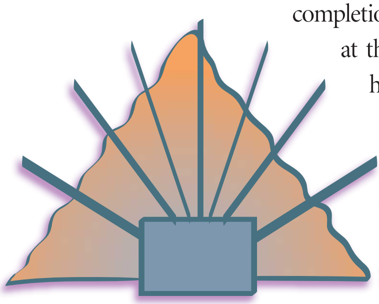
She was young and attractive when she met Pierre Curie in 1894. Pierre was a handsome and already famous physicist. Their marriage marked the start of a partnership that was soon to achieve results of world significance. They discovered Polonium in the summer of 1898 and Radium a few months later. The birth of her two daughters, Irène and Eve, in 1897 and 1904 did not interrupt Marie's intensive scientific work.

The phenomenon of radioactivity, discovered by Henri Becquerel in 1896, had attracted Marie Curie's attention and she devoted herself to study the new phenomenon. In June, 1903, Marie Curie received her Doctorate of Science for the study of radioactivity and in December of the following year she was appointed as chief assistant in the laboratory directed by Pierre Curie.

The English magazine *Gentle Woman* described the Curies' way of life: "they were loving comrades in their lifes' work in the laboratory as well as in their home life, which was no less charming because of their scientific achievement and distinction". The sudden death of Pierre Curie —he was knocked down by a horse-drawn cab— changed her life. She had to take on the whole role that she and her husband had once shared. Within a month of Pierre's death the Faculty of Science offered her an assistant professorship, the first woman to reach professorial rank in France, and within two years she was named titular professor.

Two families, the Curies and the Langevins were close friends. The mutual sympathy between Marie Curie and Paul Langevin, himself a famous physicist, eventually turned into love. The relationship between them would probably have continued but for another event, which brought Marie into public view. She was proposed for election to the prestigious Academie des Sciences. She was not elected, apparently because she was a woman.

Being a member of the Academy of Medicine from 1922, Marie devoted her research to the study of radioactive substances and their medical applications. She initiated construction of the Radium Institute in Warsaw (Poland), opened in 1932, for cancer disease treatment by radium therapy. Marie Curie died in 1934 as a result of leukemia caused by the action of radiation. Her contribution to physics had been invaluable.



They discovered radium in 1898

At the age of 16 she won a gold medal

She virtually lived on bread and tea

The birth of daughters did not interrupt Marie's intensive scientific work

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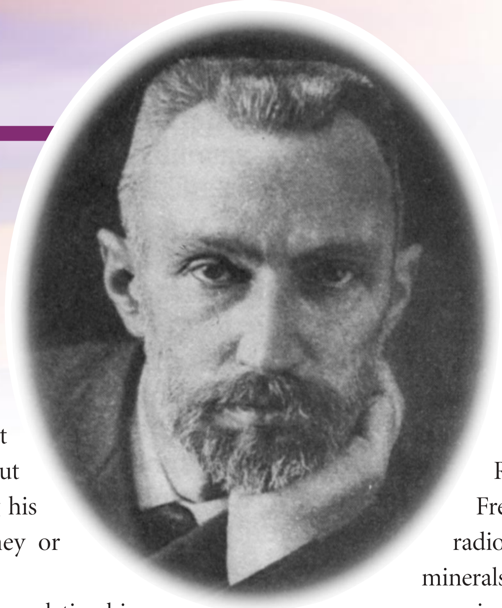
Pierre Curie (1859 – 1906)

Awarded the Nobel Prize for Physics in 1903



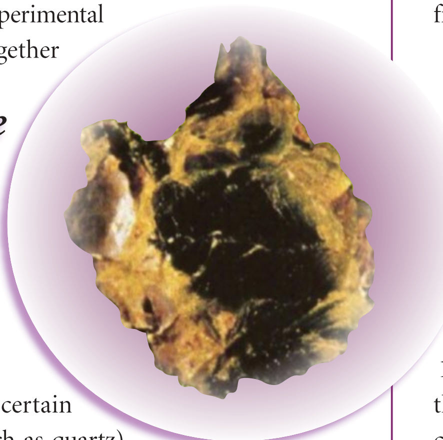
Pierre Curie was awarded the 1903 Nobel Prize together with his wife, Marie Curie, and Henri Becquerel, for their investigation of radioactivity.

He was born on May15th,1859, the second son of Sophie-Claire Depouilly and Eugene Curie. His mother was the daughter of a prominent manufacturer, and his father, a physician, who advocated revolutionary ideas.

From an early age Pierre was a 'dreamer' and he was thought to have a 'slow mind'. Unlike his elder brother, Jacques, a more conventional learner, Pierre needed to focus exclusively and deeply on one thing at a time. Therefore, it was decided that he should be educated at home. First, he was taught by his mother, then by his father and brother; at fourteen he studied with an excellent professor of mathematics. Soon it became clear that he had exceptional intellectual qualities.

At the age of 16, Pierre went to the Sorbonne. After the university he did experimental work with his brother. Together they discovered that certain nonconducting crystals (such as quartz) developed an electric charge if distorted by increasing the pressure. Later, they showed experimentally that the inverse was also true. This phenomenon they named the piezoelectric effect. Nowadays, this effect is used in a wide range of instruments, such as microphones.

He and Marie discovered radium and polonium

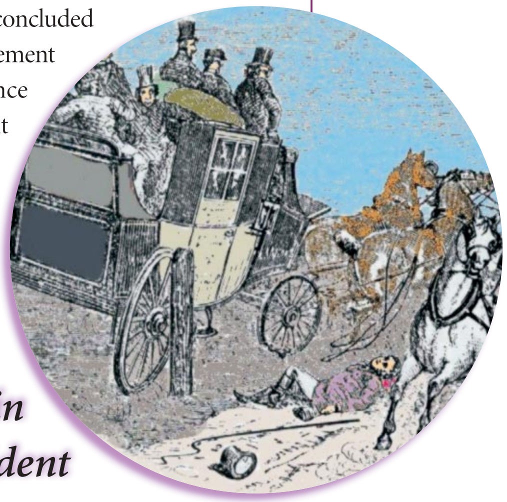


At the age of 32 Pierre Curie had been appointed to the head of the laboratory at the Ecole Municipale de Physique et Chimie. This was a prestigious post, but Curie was more interested in continuing his own experimental work than in money or prestige.

At the time Pierre met Marie he was completing his doctorate on the effect of heat on magnetic properties. He had discovered that above a certain crystal temperature (now named the Curie Point) ferromagnetics, such as iron or nickel, lose their ferromagnetic qualities. Marie also studied the magnetic properties of a certain steel. They soon became friends.

Pierre still remembered the tragic incident with the death of a young woman he had known and loved since his childhood. He seemed to have concluded that his intense and deep involvement in his work made romance impossible. But gradually it became clear that they had no future without each other, and so Marie and Pierre married in 1895. During their honeymoon, the newlyweds spent weekends cycling out in the countryside. At home and in the laboratory they became very close: they shared and discussed everything that interested them. They had two daughters, Irene and Eve.

Pierre died in a carriage accident



In the first years of the Curies' marriage, the German experimentalist Rontgen discovered X-rays (1895), and the French physicist Becquerel revealed radioactivity. The Curies began to investigate minerals which had radioactivity superior to that of pure uranium, and soon they discovered the elements Radium and Polonium.

In 1904 Pierre Curie was appointed as professor of physics at the Sorbonne, but was unable to realize his dream of working in the new laboratory that he had equipped. He died in his forty seventh year after being struck by a carriage while crossing the rue Dauphine in Paris.

S.E.

His discovery led to the microphone

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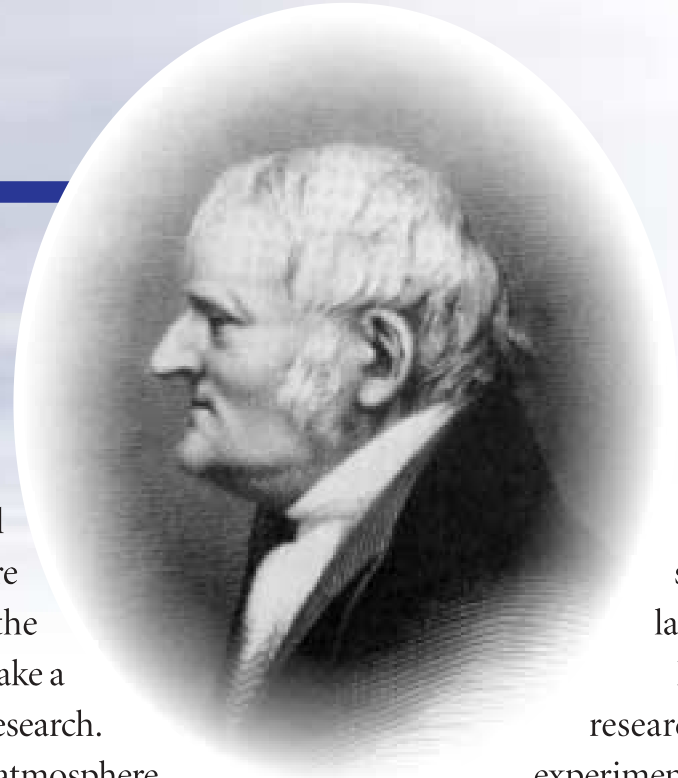
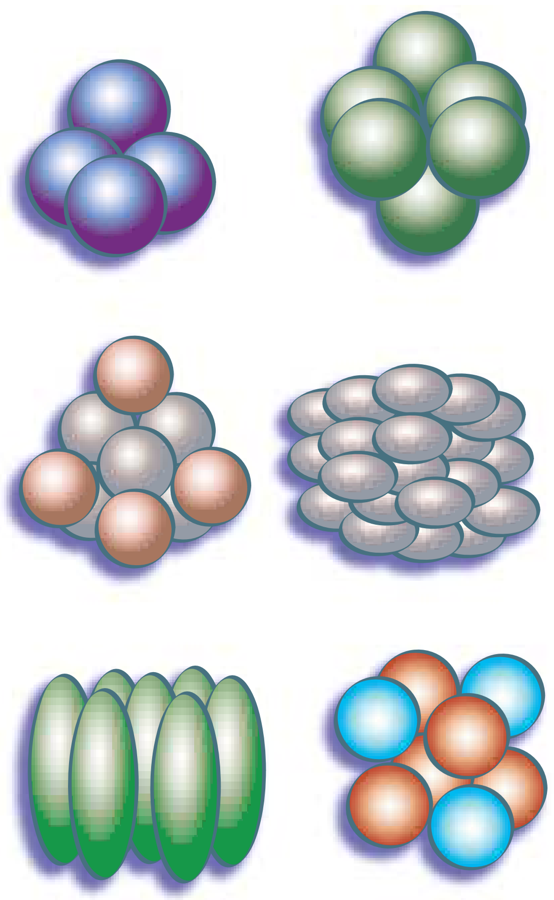
John Dalton (1766 – 1844)



Dalton was one of the founders of Atomic Theory. Both Chemistry and Physics have been completely changed by Dalton's work. Dalton's name is also remembered in connection with colour blindness, the so called 'Daltonism'. Both Dalton and his brother were colour blind and he was the first to describe this phenomenon in his work 'Extraordinary Facts Relating to the Vision of Colours'.



Matter is made of atoms

John Dalton was born in the village of Eaglesfield in Cumbria. He was the third of six children of a Quaker weaver, who did not register the date of his son's birth. John was educated at the village school until the age of 11, but he was largely self-taught. At the age of only 12, Dalton himself started to teach in the village school and after two years he joined his elder brother as an assistant at a school in Kendal. His wealthy friend and tutor, Quaker Robinson, first encouraged his interest in meteorology and until his death Dalton maintained a diary of weather observations.

In 1793 Dalton moved to Manchester and was appointed as a teacher of mathematics at New College Presbyterian Institute.

In 1794 he was elected to the Manchester Literary and Philosophical Society at which most of his papers were read. After six years he resigned from the College and worked as a private tutor to make a living and in order to provide for his own research.

Studying the physical properties of the atmosphere and other gases, he obtained the law of partial pressures in a mixture of gases, (Dalton's law), and asserted that air is a mixture, not a compound, in which the various gases exert a pressure on the wall of a vessel independently of each other.

His atomic theory recognized that all matter is made up of combinations of atoms. The atoms of different elements have different weights and properties. He presented a list of atomic weights (many of which were improved later). Dalton concluded that in the chemical combinatior different elements, atoms join together in defi simple numbers to form compound atoms (n called molecules). Dalton used spherical balls the representation of atoms and molecules, as still often done today.

After he had produced his atomic theor Dalton was offered nomination to the Roy Society in 1810, but he refused. Apparently, h regarded himself as merely a school teache However, he was elected to the Royal Society i 1822 without his consent!

According to his biographers, Dalton wa duly honoured in his lifetime abroad sooner tha in England, or, one should say, than in Londo

However, he did receive an Honorary Degree from Oxford in 1832. When Dalton traveled to Paris in 1822 he had the privilege of being introduced to distinguished French scientists, and he visited Ampere`s laboratory.

It is said that in his chemical and physical research Dalton was a somewhat crude experimentalist. His instruments were simple and some of them even made by himself. He distrusted the results of other scientists, preferring to rely on his own experiments.

Throughout his life Dalton retained his Quaker habits and dress; and his life was 'monotonous in form and in detail'. He never married. As he became older he had fewer and fewer friends and he became even more deeply engrossed in his research.

S.E.

He was colour blind

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Peter Joseph William Debye (1884 – 1966)

Awarded the Nobel Prize in 1936 for Chemistry

Debye's name is frequently mentioned in both physics and chemistry. His most famous works involved the application of the laws of physics to the structure and behaviour of molecules. Studying the 'dipole moment', or degree of polarity (positive-to negative orientation) of many molecules and their property to rotate in an external magnetic field, he showed how these can be measured, and how they can be used to define the shapes of molecules, e.g. the simple molecule of water, H-O-H, is not linear but bent. He was able to show that the benzene ring is flat. The unit of electric dipole moment, the debye (D), is named in his honour; 1D =3.336.10-30 (C.m) in SI units.

Peter Joseph William Debye was born in 1884, in Maastricht, in the Netherlands. His father was a foreman at a metalwork factory and his mother was a theatre cashier before their marriage. Debye attended the Hoogere Burger School in Maastricht. He then enrolled at the Technische Hochschule in Aachen. The family was not very wealthy, but Peter's father said that ' he would work night and day to keep his son at school'.

Debye eventually completed his studies at Aachen and received his degree in electrical engineering in 1905. He then became assistant to Arnold Sommerfeld (the famous German physicist) at the University of Munich, and gained his PhD in 1910. The next year he succeeded Einstein as Professor of Theoretical Physics in Zurich. After short time in Zurich he moved to the University of Utrecht and two years later to the University of Gottingen and then to Leipzig

The period from 1911 to 1916 was perhaps the most productive for Debye. In spite of holding three professorships in the first years of the period, he produced his theory on specific heats, the concept of permanent molecular dipole moments, and, with Paul Scherrer, he developed the powder method of X-ray analysis.

Debye is also known for the Deby-Huckel theory of electrolytes (1923) which takes account of the fact that an ion in solution tends to attract other ions of opposite charge. This was a theory that could be applied to a very dilute solution.

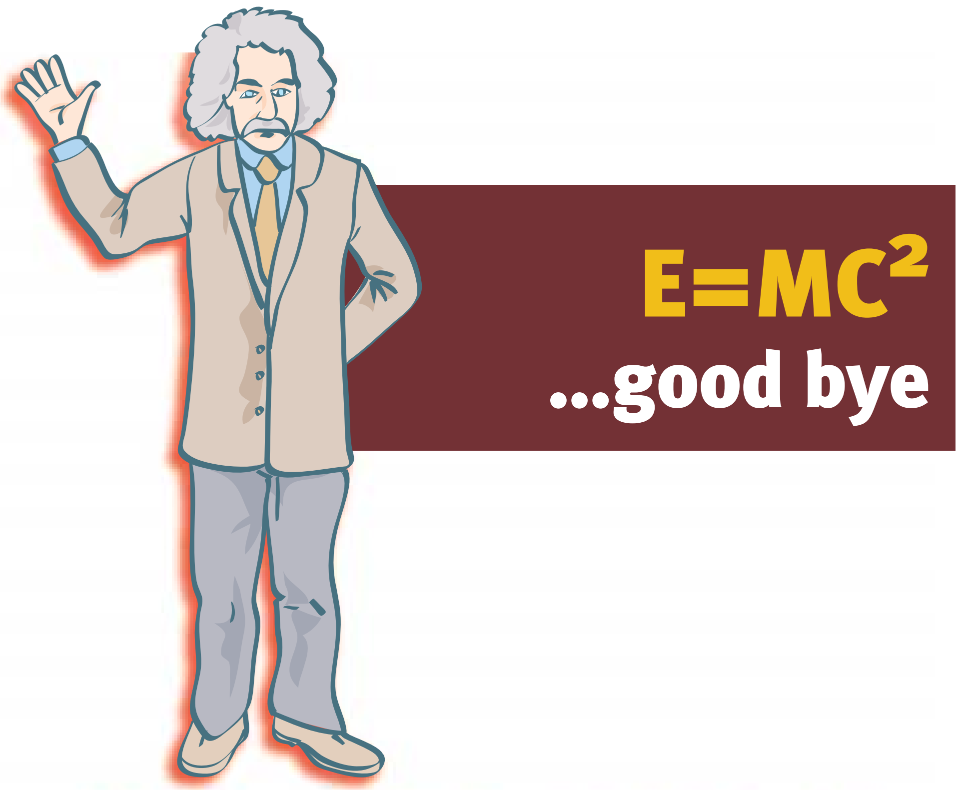
In 1934 Debye went to Berlin to built the new Kaiser Wilhelm Institute.

In the late 1930s Debye found himself in difficulties with the Nazi authorities in Germany - mainly because of his Dutch nationality. Refusing to become a German citizen, he went to the USA and accepted the post of Professor and Head of the Chemistry Department at Cornell University. He retired in 1952, but continued his research in the field of polymer chemistry for another decade. He was a member of many academies and was awarded many medals.

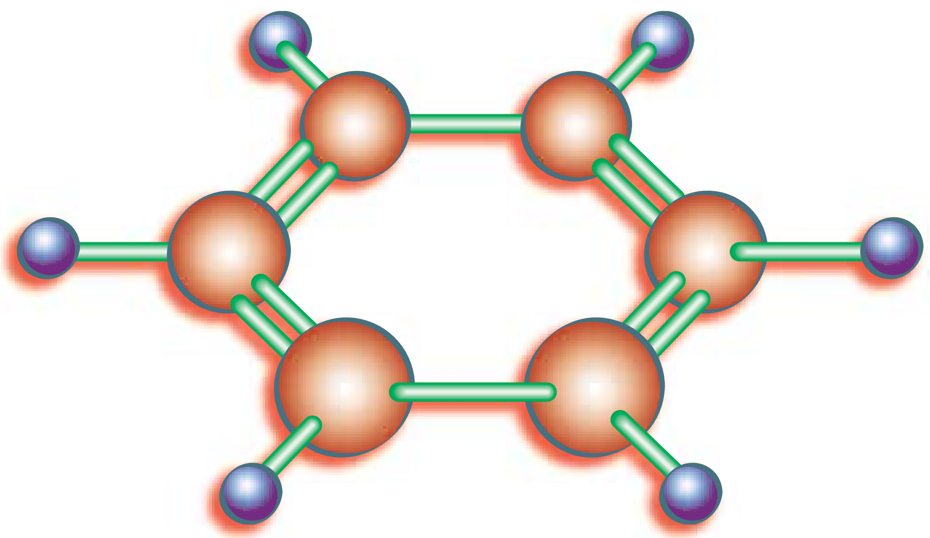
During his stay at Utrecht, Debye married Mathgilde Alberer. She was one of three daughters of the owner of the boarding house where Debye lived. The Debyes eventually had two children, a son and a daughter. The young Peter Debye became a physicist and sometimes collaborated with his father in research.

Debye was considered by his contemporaries as an accessible man and an excellent lecturer. He enjoyed fishing in his leisure time. He died of a heart attack in 1966.

S.E.



He succeeded Einstein in Zurich



He confirmed the planarity of the benzene molecule

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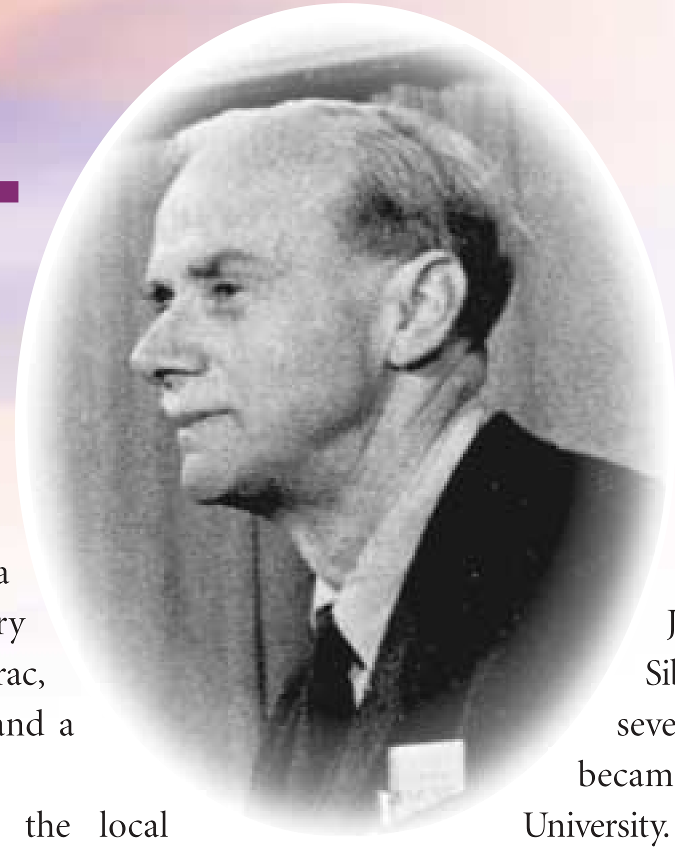
Paul Dirac (1902 – 1984)

Awarded the Nobel Prize for Physics in 1933



Do you know what an antiworld is? Some believe that there are such things, made up of antiparticles. Each elementary particle has an antiparticle that has the same mass but an opposite electric charge. An electron's antiparticle, the positron, has the charge +e and the same mass as the electron. A proton's antiparticle, the antiproton, is charged by -e. Antiparticles do not live long in our part of the universe since they quickly join their oppositely charged particles, causing an annihilation that converts all their mass into energy, often in the form of electromagnetic radiation. Perhaps there is a part of the universe made of antiparticles that have not annihilated and constitute antiworlds - but many scientists disagree.

Paul Dirac predicted the existence of positrons mathematically. Soon afterwards, in 1932, the prediction was confirmed by the discovery of the positron by the American physicist, Carl Anderson, during his studies of the cosmic radiation. Later, many other antiparticles were discovered.

Paul Adrien Maurice Dirac was a very great theoretical physicist and an impressive man. He was born in Bristol, England, on August 8th, 1902. His father, Charles Adrien Ladislas Dirac, came to Bristol from the French speaking part of Switzerland and took up a position as a teacher of French at a secondary school. His mother, Florence Hannah Dirac, was British. Paul had an elder brother and a younger sister.

Paul's primary learning began at the local elementary school. Apparently he had a rather unhappy childhood; his father was known to be a strict person and he forced the children to speak French at the table. That is why the small boy often did not speak at home - he did not find it easy to explain what he wanted in French.

Paul's mathematical ability became clear while he was a schoolboy. In 1918 he started education as a student of electrical engineering at the University of Bristol. After graduating he sought a job as an electrical engineer but failed and decided to take two more years of lectures on mathematics at the University. He was the best among all the students in the final examination and was awarded a postgraduate studentship by St. John's College, Cambridge. He obtained his PhD in 1926, followed by a Professorship there from 1932 to 1969. He was a quiet but effective teacher.

Dirac married Margit Wigner and they brought up two daughters from her previous marriage.

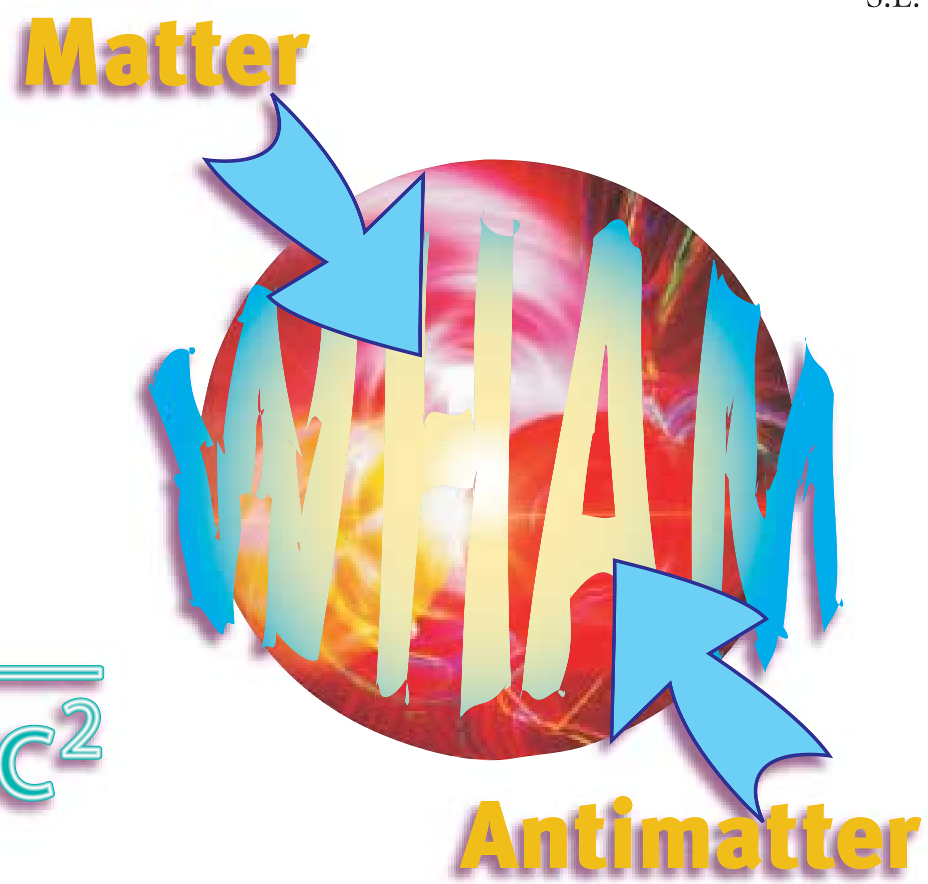
Travel attracted Dirac; he worked at many foreign universities. In 1929 he visited Japan and returned to England by way of Siberia (Russia). He was visiting professor of several American universities and in 1971 he became professor of physics in Florida State University.

In 1933 Dirac and Schrodinger were awarded the Nobel Prize for Physics.

S.E.

Travel attracted Dirac

$$E = \pm\sqrt{m^2c^4 + p^2c^2}$$



He was a brilliant mathematician

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Christian Johann Doppler (1803 – 1853)

When a car blowing its horn passes by we first hear a higher pitch as it approaches and then a lower pitch when the car is going away. This sudden change of tone is due to the 'Doppler Effect'. Christian Doppler discovered, or rather predicted, this phenomenon during his stay in Prague in 1842. He supposed that when an observer is in relative motion to a source of sound or light, a change of registered frequency or colour occurs.

Doppler's original work was entitled "On the coloured light of the double stars and certain other stars in the heavens". Doppler supposed that two components of a double star circling each other should have different colours; the star which moves towards us should be bluish and the other one more reddish. Astronomers, of course, denied that such a thing happens and Doppler's result was not generally accepted at first. But when spectral analysis was introduced, small Doppler shifts of spectral lines made it possible to measure the radial velocities of stars and even the expansion of the whole Universe.

The Doppler effect is widely used in modern physics and technology. The speed of cars, ships and planes can be measured from the frequency change of electromagnetic waves reflected from the moving object; ultrasound waves can penetrate the human body and, according to the Doppler effect, make visible the motion of the heart or the circulation of the blood.

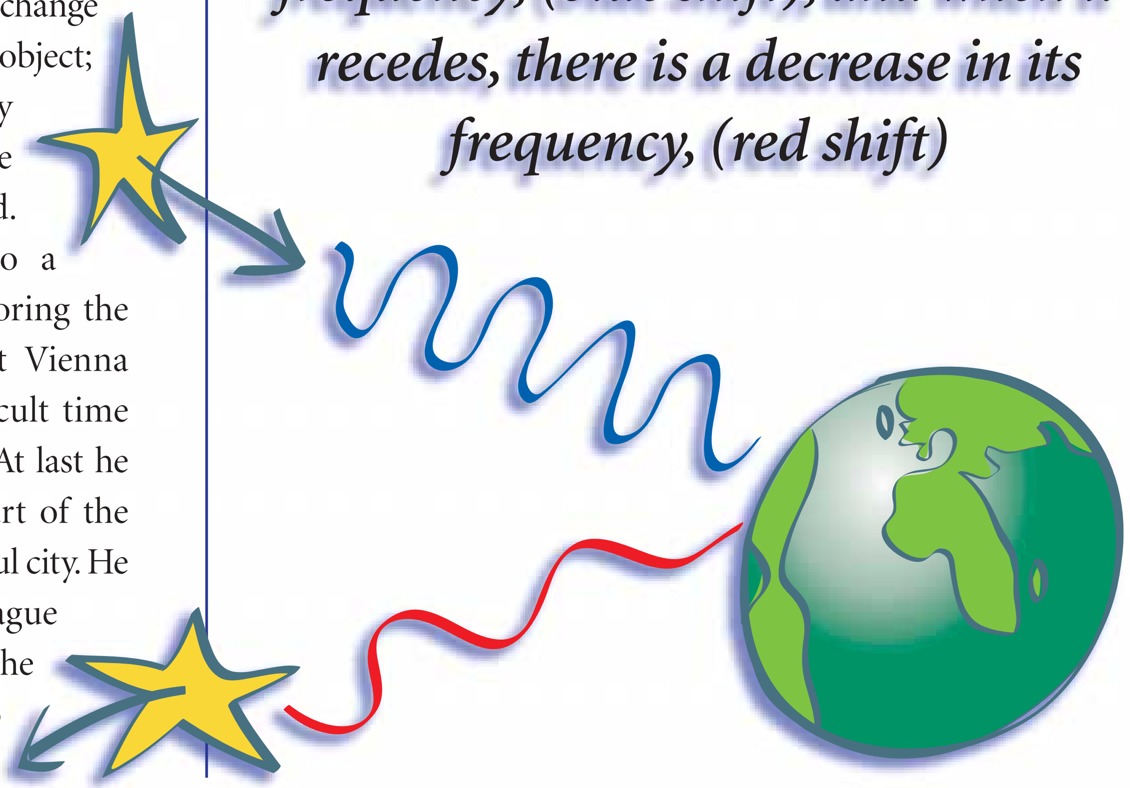
Doppler was born in Salzburg, Austria, into a stonemason's family. Their house was just neighboring the house of the Mozart family. Doppler studied at Vienna Polytechnic and Vienna University, but had difficult time finding a suitable position as a teacher or scientist. At last he accepted an offer from Prague, Bohemia (then part of the Austro Hungarian Empire) and moved to that beautiful city. He spent 12 years in Prague teaching at the Prague Polytechnic and doing research. He married here the love of his youth, Mathilde Sturm of Salzburg, who bore him five children.

In 1848 Doppler travelled to Banska Stiavnica, Slovakia, to become a teacher at the famous Academy of Mines. There he took an interest in the problem of the earth's magnetism. After the revolution swept over Hungary, Doppler finally moved to Vienna and organized the first Austrian Physics Institute. He occupied himself with many scientific problems, but his name will always be remembered in connection with his famous effect. At the age of 50 Doppler felt exhausted and his health deteriorated. He sought relief in sunny Venice, but he died soon after arrival and is buried there on the island of San Michele.

I.S.

Policemen can measure the speed of a car by the Doppler radar and fine the driver.

When a light source approaches, there is an increase in its measured frequency, (blue shift); and when it recedes, there is a decrease in its frequency, (red shift)



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- By year of birth in the **Birth index**
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About the project

Sir Arnold Wolfendale started the project in 2000, engaging S. Erlykin to do research on the physicists themselves, and to find suitable illustrations and do some of the writing. The project was immediately popular throughout the EPS, and many of the biographies were contributed from physicists around Europe.

Editing was a long process, involving members of the Executive Committee, the students at Malvern College in the UK, and members of EPS Staff. From the original design proposed by S. Erlykin, the posters have evolved to what they are at present through the input of P. Stearn and C. Staebler.

More than 150 biographies have been produced. This is the first volume of 38 biographies covering the physicists from A to D.

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The EPS is a not for profit organisation established in 1968 to promote physics and physicists in Europe.

The EPS provides an international forum to discuss science and policy issues of interest to its members. It represents over 90,000 members and physicists through its 38 national member societies. It also provides a forum for over 3500 individual members. Applied research in industry, and academic and other research institutes are also present as associate members.

The Executive Committee with the support of the Secretariat, is responsible for running and operating the EPS. The Council, which meets once a year, establishes the strategic orientation of the society. Scientific activities are undertaken by EPS Divisions and Interdivisional Groups. The EPS Committees run programmes and provide advice in other important areas.

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