Albert Einstein: a centenary tribute

March 14 this year marked the centenary of the birth of Albert Einstein, the scientist who formulated the theory of nuclear energy and the laws of relativity. This article is a tribute to that centenary.

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It is a remarkable coincidence that the two scientists who did so much to formulate the theories of nuclear energy were both born, within a week, one hundred years ago.

Albert Einstein, the founder of the Theory of Relativity and the father of nuclear energy was born on March 14, 1879 in Ulm; Otto Hahn, the discoverer of nuclear fission, on March 8, 1879 in Frankfurt-Main, Germany. Their birth places were not far apart, but they were only destined to meet when both were celebrities in their respective fields — relativity and nuclear chemistry.

It is also notable that Einstein's birth and James Clerk Maxwell's death concur in 1879. Einstein's theories made much use of Maxwell's theory of electromagnetism. The only other similar coincidence between giants of science occurred in 1642 when Galileo died and Newton, his supreme scientific successor, was born.

Numerous universities and learned societies all over the world commemorated Einstein's 100th birthday this March. In particular, ceremonials took place in the USA, his adopted country; in Switzerland, the birthplace of Special Relativity; in Israel, his national country; and in India, where another famous scientist, S.N. Bose contributed in a way to the theory of relativity.

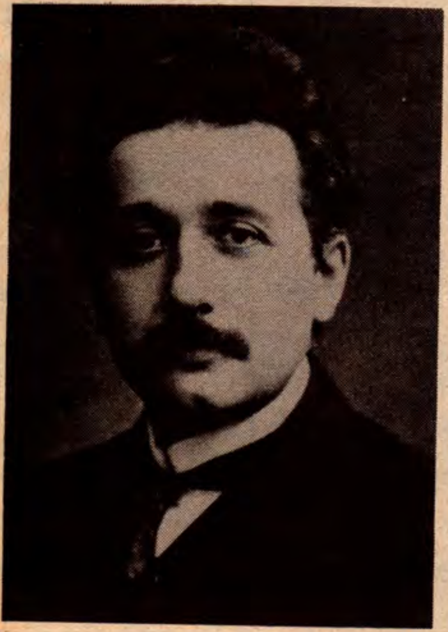
Einstein's life — a summary

Albert Einstein's early years were spent in Munich, Germany, the family having moved there soon after his birth in 1879. At first, Albert appeared retarded and withdrawn, avoided physical exercise, and did not mix readily with other children. He seemed to daydream a lot.

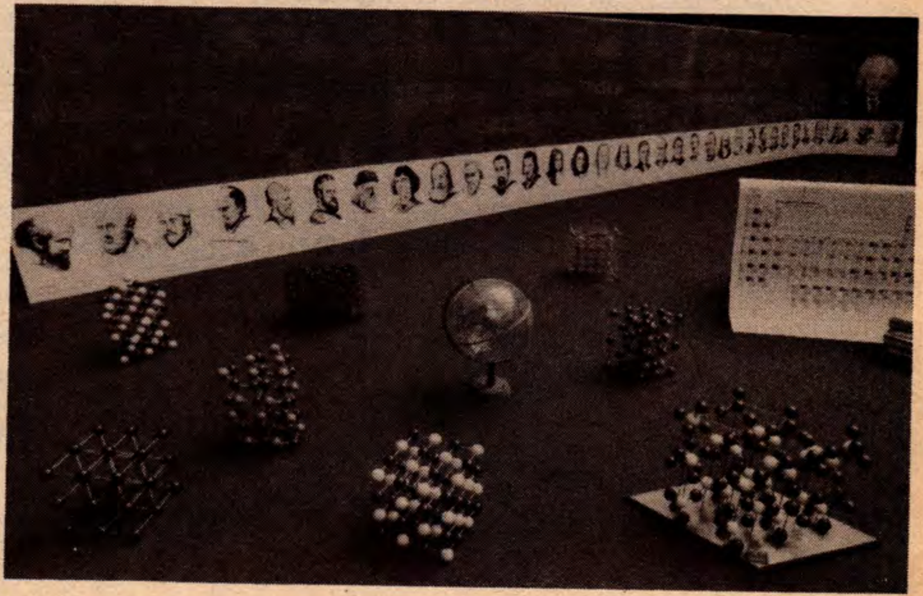
His mother loved music, Beethoven in particular, and arranged violin lessons for the six year old Albert. At first he did not like violin; but as his skills improved so did his enthusiasm and he especially enjoyed playing Mozart sonatas. The violin gave him many blessed moments of relaxation throughout his later life.

Although the Einstein family was Jewish, young Albert entered a neighbourhood Catholic primary school and thereafter a nearby high school. He disliked most of the subjects because of rote learning, except mathematics and physics. His interest in these was promoted by his uncle, an

BELOW: A photograph of Einstein, taken around the time of the formulation of the Theory of Special Relativity.



BELOW: A symbolic display at Macquarie University to commemorate Einstein's centenary. Life-size portraits of great scientists serve as milestones leading from the early Greek era of Aristotle, Euclid and Archimedes to the mighty trio of Newton, Maxwell and Einstein. The crystal structure and the sky globe signify the impact of Einstein's theories in nuclear physics.



engineer, and by a young relative who studied medicine and fed science-hungry Albert with books on mathematics and physics. His first memorable experimental gadget was a simple magnetic compass whose behaviour intrigued him for years.

When his father's business failed in Munich, the family resettled in Milan. Only Albert stayed behind to complete his high school education. But he badly failed in exams.

Although a high school drop-out he firmly decided to study physics at the famous Swiss Federal Polytechnic, the ETH in Zurich. Once again he failed the entrance examinations. But his mathematical papers were so brilliant that the Director of ETH personally encouraged him to complete an entrance course in Zurich. This time he was successful and was admitted to the university.

Once in university he again preferred to read books on physics instead of attending lectures and practicals. Professor Pernet who was in charge of practical physics commented "Why don't you study law or medicine rather than physics?"; and Professor Weber:"...but you have one fault: one can't tell you anything". Some of the exams he passed only with the help of lecture notes by his good friend Marcel Grossmann, a talented mathematician who later was helpful in discussing the mathematical formulation of the theory of relativity.

After graduation in 1900 he could not find a professional job. Grossmann's father recommended him to the Swiss Patent Office where he became a Patent Examiner in 1902. But whenever possible, and in all his spare time, he tried to solve the enigmatic problems of contemporary physics — the constancy of the speed of light, the Fitzgerald contraction, Lorentz mass enlargement and Poincare's arguments against absolute time and space; also Mach's views about their interdependence.

Then suddenly in 1905 at the age of 26, dissociated from any university, he published five "breakthrough" papers in rapid succession. The most important one, termed the *Theory of Special Relativity*, comprehensively and logically explained the length contraction, mass increase and time dilation in fast moving systems, and later the mass-energy equivalence.

It took a few years for the importance of the Theory of Special Relativity to be fully recognised. Then in 1909 he was offered professorships in Prague and Zurich, and in 1913 became Director at the famous Kaiser Wilhelm Institute in Berlin on the recommendation of two eminent physicists, Planck and von Laue.

The Theory of Special Relativity deals only with uniformly moving bodies. In 1915 Einstein published his *Theory of General Relativity*, involving accelerated motion in curved space caused by massive bodies; and gravitation as an effect of space curvature.

In 1933, at the beginning of Hitler era, he was on a lecture tour in the USA and decided to stay. He accepted the directorship of the School of Mathematics and Physics at the Institute of Advanced Studies in Princeton, where he died on April 18, 1955.

Einstein was showered with numerous academic and civil honours during his life, among them the Nobel Prize in 1921 for his work on the photoelectric effect. He was invited to lecture in England, the USA, Japan, Spain and many other countries. On tours he discussed science and politics with Lloyd George, Churchill, Roosevelt, Truman, and many other top statesmen. He knew every top scientist of his era: Lorentz, Bohr, Planck, von Laue, Rutherford, Dirac, Minkovski, Hahn, Oppenheimer, Millikan, de Broglie, Curie, Yukawa, Schrodinger, Heisenberg, Fermi, Szilard, and others.

Philosophically, Einstein had a few ups and downs. One mistake was his firm belief in causality: every event in nature could be explained by its antecedent conditions. The arrival of Quantum Physics with Heinsenberg's Uncertainty Principle blew that theory.

The laws of relativity ...

(1) The laws of mechanics are not affected by a uniform rectilinear motion of the system of co-ordinates to which they are referred. One cannot find the absolute velocity of such a system from observations within, but only relative to another system. Einstein's theory postulates that the observed value of the velocity of light is constant, and is independent of the motion of the observer.

(2) Mass, length, time and energy are not absolute and independent quantities as assumed by Newton, but depend on each other and upon relative motion according to Einstein. Newton's laws of classical mechanics operate in space with three dimensions, but the relativistic laws — because of their velocity-dependence — always involve time. Hence the relativistic laws operate in space-time with four dimensions.

However, the relativistic effects on mass, length and time are never noticed in our everyday activities. They become significant only at "relativistic" speeds exceeding 100,000km/sec; ie 1/3 the speed of light. Such relativistic speeds can only be found in atomic physics and astronomy.

(3) In a relativistically fast-moving system, time slows down when observed from a stationary system. A twin making a trip on a fast spaceship to a distant star will return to Earth younger than his twin brother, the difference in age depending on the speed of travel, the time taken, and the acceleration involved in turning and landing.

(4) All lengths in a fast moving system will contract in the direction of the movement, while all masses will increase — approaching infinity at the speed of light. Hence the speed of light is the speed limit for all physical bodies.

(5) Mass is a concentrated form of energy, related by the equation $E = mc^2$, where m is the mass and c is the speed of light in vacuum (3×10^8m/s). If completely converted into electrical energy, one litre of water would yield 25,000 million kWh, worth around $375 million at existing rates.

Since the discovery of nuclear fission in 1938, only a small fraction of the mass of uranium and plutonium nuclei can be economically converted into energy. Conversely, energy can be converted into mass; eg. the production of electrons from energetic gamma rays.

(6) Any mass curves space around it, the curvature depending on the amount of mass. Gravitation is the effect of space curvature. The curved space around a mass forms a spatial sink into which another mass will fall as if pulled by gravitation. The curvature of space around the Sun manifests itself, for example, in bending the light rays passing the rim of the Sun. Such bending has been verified during many eclipses.

(7) The curvature of the space of the whole universe depends on the amount and density of the matter in it. This determines whether the vast universe we live in is (a) closed and steady, or (b) periodically expanding and contracting, or (c) expanding infinitely.

The curvature of the space around an extremely dense and massive star may locally close the space around it, forming a "black hole" from which nothing, not even light, can escape.