ALBERT EINSTEIN

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This year marks the centenary of the birth of Albert Einstein, the most famous scientist of recent times. We take a look at the life and times of this extraordinary man who not only revolutionised modern physics, but captured the imagination of the age.

Albert Einstein was born in Wurttemburg in Southern Germany in 1879, son of Hermann and Paulina Koch Einstein. In 1880, the family moved to Munich where Hermann and his brother set up an electrochemical business. Albert did not speak until he was three. It was even thought that he was sub-normal and a governess dubbed him "Master Slow-coach". He became a silent solitary child. His family was Jewish, but not orthodox, and sent Albert to the nearest school, a Catholic one. Later, he entered the Luitpold Gymnasium, a leading high school in Munich, where the learning of Greek and Latin was enforced by severe discipline. Only a few memories of his early school days were pleasant: the mystery of a magnetic compass, his discovery of Euclid, some books on science and mastering the violin. In 1894, his father's business failed and the family moved to Milan in Italy, leaving Albert behind to finish his schooling. He was thoroughly miserable and concocted a plan to rejoin his parents by pretending to have a nervous breakdown. However, this proved to be unnecessary because he was expelled from the school for being a "disruptive influence". The school maintained that his indifference for every subject except mathematics, in which he excelled, was destroying the respect of the other students for their teachers. So he renounced his German citizenship and lived happily for a while in Italy until his father's electrical business collapsed again and the reality of supporting himself had to be faced. It was decided that Albert should become an electrical engineer and so he took the entrance examination at the famous Zurich Polytechnic Academy. However, despite his exceptional mathematical ability, he failed. To make up his deficiencies in other subjects, he went back to school in Aarau in Switzerland. He thrived in the freer atmosphere of this school and, a year later, at the age of 18, he entered the Zurich Polytechnic. He abandoned electrical engineering and took the course for teachers in mathematics and physics. He studied there for four years, just managing to live on the meagre allowance scraped together by his relatives. Apparently, he did not benefit greatly from his

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teachers; he missed many of their lectures and "swotted up" for examinations from his friends' lecture notes. He graduated in 1901 and acquired Swiss nationality, but his future was still uncertain. He worked on and off as a temporary teacher in a provincial school and then as a private tutor for two backward children until, in 1902, he got a job as a clerk at the Swiss Patent Office in Berne. Here he was happy. He scrutinised patent applications, doing the official day's work in 3 or 4 hours, and then, to fill in the rest of the day, he scrutinised the laws of physics. In 1903, he married Mileva Maric, a fellow-student from the Zurich Polytechnic, and to complete his happiness, their first son was born in 1904.

And so we come to the epoch-making year of 1905. In that year, Einstein published three papers of world-shattering importance embodying his secret research in the Patent Office. The first of these papers gave an explanation of the photoelectric effect and early hints of quantum mechanics and the possibility of lasers. This work won him a Nobel Prize in 1922. The second paper related to Brownian motion, the agitated erratic motion observed when dust particles are immersed in water. This was an important milestone in the acceptance of the atomic theory of matter. The third was Einstein's first paper on relativity. Of this he said, "If my theory is proven correct Germany will hail me as a great German and the French will hail me as a citizen of the world. If it is proven false, the French will call me a German and the Germans will call me a Jew". The 1905 paper dealt with Special Relativity, that is uniform motion at speeds approaching the speed of light. In 1907, Einstein published his first results on General Relativity, dealing with motion subject to uniform acceleration in a straight line. One of the predictions of the theory was that light must be deflected by gravity. In 1909, Einstein was invited to speak about his work at the Conference of German Scientists in Salzburg and later that year he got his first academic post, a rather lowly one, at the University of Zurich. In 1913, he was offered a professorship at the Kaiser Wilhelm Institute in Berlin. This finally gave him freedom from financial worries and from all teaching and administrative duties and, at that time, Berlin was the scientific capital of Europe. So, despite his dislike of Germany with its rigidity and militarism, he accepted the post. However, for his wife, Berlin was the last straw in a troubled marriage and she returned to Zurich with their two boys and later agreed to a divorce. The year 1914 brought further difficulties with the outbreak of war. Einstein courageously joined the pacifists and refused to sign the notorious manifesto of the leading 93 German intellectuals, which accused Germany's enemies of a conspiracy against a peaceful nation. He was treated as a moral leper, but his fame saved him from persecution. While all this was going on, Einstein was working to extend his General Relativity to curved motion. The solution, probably his greatest intellectual achievement, appeared in 1916.

The bending of light, predicted by General Relativity, was difficult to measure. Of nearby bodies, only the sun deflects star light by a (barely) observable amount and this can only be measured during a total solar eclipse. The War foiled the first attempt to use the eclipse of 1914. In 1919, an expedition led by Eddington tried again. This attempt was nearly ruined by clouds and rain, but one photograph showed a star shifted by just the minute amount Einstein had predicted from its true position. This international cooperation between a German and a British scientist seemed a happy omen to people tired of mutual slaughter and Einstein was idolised by millions although (or because) it was all beyond them.

After the war, Einstein lived on in Berlin. He married his cousin Elsa and again enjoyed a happy family life with his wife and two step-daughters. But now he became the target of a well-organised

campaign of public meetings at which German nationalists tried to discredit him as a fraud and a charlatan, to feed the myth that the undefeated German army had been stabbed in the back by intellectuals and Jews. The atmosphere in Germany became steadily tenser. The Nazis feared Einstein and even placed him on their list of "dangerous people". When they burned books by enemies of the state, Einstein's Theory of Relativity was included. Still he could not bring himself to leave his friends and the stimulating intellectual atmosphere in Berlin. When Hitler became Chancellor in 1933, Einstein was fortunately abroad and he did not return to Germany. The family settled in Princeton and Einstein worked at the newly founded Institute of Advanced Study. As the horrors of persecution in Nazi Germany multiplied, Einstein shelved his lifelong pacifism. When, in 1939, Szilard brought him a letter warning President Roosevelt that Germany might develop an atomic bomb, he signed the letter; he feared that Hitler might make the bomb first. His wife had died in 1937, and his own health declined. But he continued his efforts to find a "unified field theory" explaining both gravity and electromagnetism. Each failure he published "to save another fool from wasting time on the same idea". Few physicists were interested in his work at the time, but his ideas are still bearing fruit. In 1952, he was offered the Presidency of Israel in recognition for his support of Zionism, but he declined saying "I know a little about nature, but hardly anything about men". A few days before he died in 1955, he signed the manifesto drafted by Bertrand Russell, urging scientists to combine in preventing atomic war. It led to the Pugwash Conferences which have kept governments and public opinion aware of that mortal danger and helped to reduce it.

Although Einstein's hopes for a unified field theory were not realised, his General Theory of Relativity is an amazing achievement and its predictions continue to match the latest experimental findings. Within the last year, gravity waves, which Einstein predicted in 1918, have been observed. The theory predicts that a pair of stars orbiting about each other should radiate part of their kinetic energy in the form of gravitational waves. The energy loss is too weak to measure directly, but it reveals itself in a gradual decrease in the distance separating the two stars and a corresponding decrease in the orbital period. This test of the theory became possible with the discovery of a pulsar in orbit about an invisible companion. The beam from the pulsar acts like an extremely accurate clock to time the motion of the system. The results seem to agree very well with Einstein's theory and to rule out some rival versions of general relativity. (For more details, see Scientific American, May 1979, page 75.)

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Nature and Nature's laws lay hid in night,
God said, "Let Newton be!" and all was light.
—Alexander Pope

It did not last: the Devil howling "Ho!
Let Einstein be!" restored the status quo.
—Sir John Collins Squire