



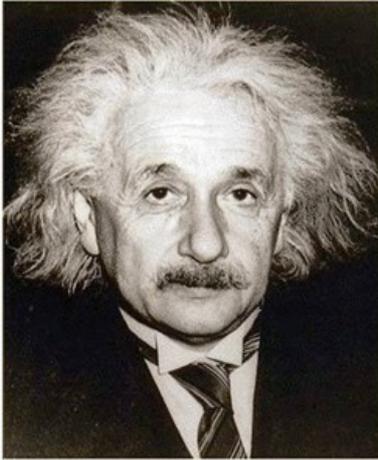
NEW

March 2011

From the Annals of the World History

Albert Einstein

March 14, 1879 - April 18, 1955



Albert Einstein was a German-born theoretical physicist who discovered the theory of general relativity, effecting a revolution in physics. For this achievement, Einstein is often regarded as the father of modern physics. He received the 1921 Nobel Prize in Physics "for his services to theoretical physics and especially for his discovery of the law of the photoelectric effect". Near the beginning of his career, Einstein thought that Newtonian mechanics was no longer enough to reconcile the laws of classical mechanics with the laws of the electromagnetic field. This led to the development of his special theory of relativity. He realized, however, that the principle of relativity could also be extended to gravitational fields, and with his subsequent theory of gravitation in 1916, he published a paper on the general theory of relativity. He continued to deal with problems of statistical mechanics and quantum theory, which led to his explanations of particle theory and the motion of molecules. He also investigated the thermal properties of light which laid the foundation of the photon theory of light. In

1917, Einstein applied the general theory of relativity to model the structure of the universe as a whole.

Einstein published more than 300 scientific papers along with over 150 non-scientific works, and received honorary doctorate degrees in science, medicine and philosophy from many European and American universities; he also wrote about various philosophical and political subjects such as socialism, international relations and the existence of God. His great intelligence and originality have made the word "Einstein" synonymous with genius.

Early life and education

Albert Einstein was born in Ulm, in the Kingdom of Württemberg in the German Empire on 14 March 1879. His father was Hermann Einstein, a salesman and engineer. His mother was Pauline Einstein. In 1880, the family moved to Munich, where his father and his uncle founded Elektrotechnische Fabrik J. Einstein & Cie, a company that manufactured electrical equipment based on direct current.

The Einsteins were non-observant Jews. Albert attended a Catholic elementary school from the age of five for three years. Later, at the age of eight, Einstein was transferred to the Luitpold Gymnasium where he received advanced primary and secondary school education till he left Germany seven years later. Although Einstein had early speech difficulties, he was a top student in elementary school. His father once showed him a pocket compass; Einstein realized that there must be something causing the needle to move, despite the apparent "empty space". As he grew, Einstein built models and mechanical devices for fun and began to show a talent for mathematics.

In 1889, Max Talmud (later changed to Max Talmey) introduced the ten-year old Einstein to key texts in science, mathematics and philosophy, including Immanuel Kant's Critique of Pure Reason and Euclid's Elements (which Einstein called the "holy little geometry book"). Talmud was a poor Jewish medical student from Poland. The Jewish community arranged for Talmud to take meals with the Einsteins each week on Thursdays for six years. During this time Talmud wholeheartedly guided Einstein through many secular educational interests.

In 1894, his father's company failed: direct current (DC) lost the War of Currents to alternating current (AC). In search of business, the Einstein family moved to Italy, first to Milan and then, a few months later, to Pavia. When the family moved to Pavia, Einstein stayed in Munich to finish his studies at the Luitpold Gymnasium. His father intended for him to pursue electrical engineering, but Einstein clashed with authorities and resented the school's regimen and teaching method. He later wrote that the spirit of learning and creative thought were lost in strict rote learning. In the spring of 1895, he withdrew to join his family in Pavia, convincing the school to let him go by using a doctor's note. During this time, Einstein wrote his first scientific work, "The Investigation of the State of Aether in Magnetic Fields".

Einstein applied directly to the Eidgenössische Polytechnische Schule (ETH) in Zurich, Switzerland. Lacking the requisite Matura certificate, he took an entrance examination, which he failed, although he got exceptional marks in mathematics and physics. The Einsteins sent Albert to Aarau, in northern Switzerland to finish secondary school. In Aarau, Einstein studied Maxwell's electromagnetic theory. At age 17, he graduated, and, with his father's approval, renounced his citizenship in the German Kingdom of Württemberg to avoid military service, and in 1896 he enrolled in the four year mathematics and physics teaching diploma program at the Polytechnic in Zurich.

Marriages and children

In early 1902, Einstein and Mileva Maric had a daughter they named Lieserl in their correspondence, who was born in Novi Sad where Maric's parents lived. Her full name is not known, and her fate is uncertain after 1903.

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Einstein and Maric married in January 1903. In May 1904, the couple's first son, Hans Albert Einstein, was born in Bern, Switzerland. Their second son, Eduard, was born in Zurich in July 1910. In 1914, Einstein moved to Berlin, while his wife remained in Zurich with their sons. Maric and Einstein divorced on 14 February 1919, having lived apart for five years. Einstein married Elsa Löwenthal on 2 June 1919, after having had a relationship with her since 1912. In 1933, they moved permanently to the United States. In 1935, Elsa Einstein was diagnosed with heart and kidney problems and died in December 1936.

Patent office

After graduating, Einstein spent almost two frustrating years searching for a teaching post, but a former classmate's father helped him secure a job in Bern, at the Federal Office for Intellectual Property, the patent office, as an assistant examiner. He evaluated patent applications for electromagnetic devices. In 1903, Einstein's position at the Swiss Patent Office became permanent, although he was passed over for promotion until he "fully mastered machine technology".

Much of his work at the patent office related to questions about transmission of electric signals and electrical-mechanical synchronization of time, two technical problems that show up conspicuously in the thought experiments that eventually led Einstein to his radical conclusions about the nature of light and the fundamental connection between space and time. With a few friends he met in Bern, Einstein started a small discussion group, self-mockingly named "The Olympia Academy", which met regularly to discuss science and philosophy. Their readings included the works of Henri Poincaré, Ernst Mach, and David Hume, which influenced his scientific and philosophical outlook.

Academic career

In 1901, Einstein had a paper on the capillary forces of a straw published in the prestigious *Annalen der Physik*. On 30 April 1905, he completed his thesis, with Alfred Kleiner, Professor of Experimental Physics, serving as pro-forma advisor. Einstein was awarded a PhD by the University of Zurich. His dissertation was entitled "A New Determination of Molecular Dimensions". That same year, which has been called Einstein's *annus mirabilis* or "miracle year", he published four groundbreaking papers, on the photoelectric effect, Brownian motion, special relativity, and the equivalence of matter and energy, which were to bring him to the notice of the academic world.

By 1908, he was recognized as a leading scientist, and he was appointed lecturer at the University of Bern. The following year, he quit the patent office and the lectureship to take the position of physics docent at the University of Zurich. He became a full professor at Karl-Ferdinand University in Prague in 1911. In 1914, he returned to Germany after being appointed director of the Kaiser Wilhelm Institute for Physics (1914-1932) and a professor at the Humboldt University of Berlin, although with a special clause in his contract that freed him from most teaching obligations. He became a member of the Prussian Academy of Sciences. In 1916, Einstein was appointed president of the German Physical Society (1916-1918).

In 1911, he had calculated that, based on his new theory of general relativity, light from another star would be bent by the Sun's gravity. That prediction was claimed confirmed by observations made by a British expedition led by Sir Arthur Eddington during the solar eclipse of May 29, 1919. International media reports of this made Einstein world famous. In 1921, Einstein was awarded the Nobel Prize in Physics. Because relativity was still considered somewhat controversial, it was officially bestowed for his explanation of the photoelectric effect. He also received the Copley Medal from the Royal Society in 1925.

Travels abroad

Einstein visited New York City for the first time on 2 April 1921, where he received an official welcome by the Mayor, followed by three weeks of lectures and receptions. He went on to deliver several lectures at Columbia University and Princeton University, and in Washington he accompanied representatives of the National Academy of Science on a visit to the White House. On his return to Europe he was the guest of the British statesman and philosopher Viscount Haldane in London, where he met several renowned scientific, intellectual and political figures, and delivered a lecture at Kings College.

In 1922, he traveled throughout Asia and later to Palestine, as part of a six-month excursion and speaking tour. His travels included Singapore, Ceylon, and Japan, where he gave a series of lectures to thousands of Japanese. His first lecture in Tokyo lasted four hours, after which he met the emperor and empress at the Imperial Palace where thousands came to watch. Einstein later gave his impressions of the Japanese in a letter to his sons: "Of all the people I have met, I like the Japanese most, as they are modest, intelligent, considerate, and have a feel for art."

On his return voyage, he also visited Palestine for 12 days in what would become his only visit to that region. "He was greeted with great British pomp, as if he were a head of state rather than a theoretical physicist", writes Isaacson. This included a cannon salute upon his arrival at the residence of the British high commissioner, Sir Herbert Samuel. During one reception given to him, the building was "stormed by throngs who wanted to hear him". In Einstein's talk to the audience, he expressed his happiness over the event:

Emigration from Germany

In 1933, Einstein decided to emigrate to the United States due to the rise to power of the Nazis under Germany's new chancellor, Adolf Hitler. While visiting American universities in April, 1933, he learned that the new German government had passed a law barring Jews from holding any official positions, including teaching at universities. A month later, the Nazi book burnings occurred, with Einstein's works being among those burnt, and Nazi propaganda Minister Joseph Goebbels proclaimed, "Jewish intellectualism is dead." Einstein also learnt that his name was on a list of assassination targets, with a "\$5,000 bounty on his head". One German magazine included him in a list of enemies of the German regime with the phrase, "not yet hanged".

Einstein was undertaking his third two-month visiting professorship at the California Institute of Technology when Hitler came to power in Germany. On his return to Europe in March 1933 he resided in Belgium for some months, before temporarily moving to England.

He took up a position at the Institute for Advanced Study at Princeton, New

Jersey,http://en.wikipedia.org/wiki/Albert_Einstein - cite_note-princeton-42 an affiliation that lasted until his death in 1955. There, he tried to develop a unified field theory and to refute the accepted interpretation of quantum physics, both unsuccessfully. He and Kurt Gödel, another Institute member, became close friends. They would take long walks together discussing their work. His last assistant was Bruria Kaufman, who later became a renowned physicist.

World War II and the Manhattan Project

In 1939, a group of Hungarian scientists that included Hungarian emigre physicist Leo Szilard attempted to alert Washington of ongoing Nazi atomic bomb research. The group's warnings were discounted. In the summer of 1939, a few months before the beginning of World War II in Europe, Einstein was persuaded to lend his prestige by writing a letter, with Leo Szilard, to President Franklin D. Roosevelt, in order to alert him of the possibility that Nazi Germany might be developing an atomic bomb. At the same time, the letter recommended that the U.S. government should pay attention to and become directly involved with Uranium research, and associated chain reaction research. Einstein and Szilard, along with other refugees such as Edward Teller and Eugene Wigner, "regarded it as their responsibility to alert Americans to the possibility that German scientists might win the race to build an atomic bomb, and to warn that Hitler would be more than willing to resort to such a weapon."

The letter is believed to be "arguably the key stimulus for the U.S. adoption of serious investigations into nuclear weapons on the eve of the U.S. entry into World War II". President Roosevelt could not take the risk of allowing Hitler to possess atomic bombs first. As a result of Einstein's letter and his meetings with Roosevelt, the U.S. entered the "race" to develop the bomb, drawing on its "immense material, financial, and scientific resources" to initiate the Manhattan Project. It became the only country to develop an atomic bomb during World War II.

For Einstein, "war was a disease . . . [and] he called for resistance to war." But in 1933, after Hitler assumed full power in Germany, "he renounced pacifism altogether . . . In fact, he urged the Western powers to prepare themselves against another German onslaught." In 1954, a year before his death, Einstein said to his old friend, Linus Pauling, "I made one great mistake in my life - when I signed the letter to President Roosevelt recommending that atom bombs be made; but there was some justification - the danger that the Germans would make them..."

U.S. citizenship

Einstein became an American citizen in 1940. Not long after settling into his career at Princeton, he expressed his appreciation of the "meritocracy" in American culture when compared to Europe. According to Isaacson, he recognized the "right of individuals to say and think what they pleased", without social barriers, and as result, the individual was "encouraged" to be more creative, a trait he valued from his own early education.

As a member of the National Association for the Advancement of Colored People NAACP at Princeton who campaigned for the civil rights of African Americans, Einstein corresponded with civil rights activist W. E. B. Du Bois, and in 1946 Einstein called racism America's "worst disease". After the death of Israel's first president, Chaim Weizmann, in November 1952, Prime Minister David Ben-Gurion offered Einstein the position of President of Israel, a mostly ceremonial post. The offer was presented by Israel's ambassador in Washington, Abba Eban, who explained that the offer "embodies the deepest respect which the Jewish people can repose in any of its sons". However, Einstein declined, and wrote in his response that he was "deeply moved", and "at once saddened and ashamed" that he could not accept it:

Death

On April 17, 1955, Albert Einstein experienced internal bleeding caused by the rupture of an abdominal aortic aneurysm, which had previously been reinforced surgically by Dr. Rudolph Nissen in 1948. He took the draft of a speech he was preparing for a television appearance commemorating the State of Israel's seventh anniversary with him to the hospital, but he did not live long enough to complete it. Einstein refused surgery, saying: "I want to go when I want. It is tasteless to prolong life artificially. I have done my share, it is time to go. I will do it elegantly."http://en.wikipedia.org/wiki/Albert_Einstein - cite_note-54He died in Princeton Hospital early the next morning at the age of 76, having continued to work until near the end.

Einstein's remains were cremated and his ashes were scattered at an undisclosed location. During the autopsy, the pathologist of Princeton Hospital, Thomas Stoltz Harvey, removed Einstein's brain for preservation, without the permission of his family, in hope that the Neuroscience of the future would be able to discover what made Einstein so intelligent.

Scientific career

Throughout his life, Einstein published hundreds of books and articles. Most were about physics, but a few expressed leftist political opinions about Pacifism, Socialism, and Zionism. In addition to the work he did by himself he also collaborated with other scientists on additional projects including the Bose-Einstein statistics, the Einstein refrigerator and others.

Annus Mirabilis papers

The Annus Mirabilis papers are four articles pertaining to the photoelectric effect, Brownian motion, the special theory of relativity, and $E = mc^2$ that Albert Einstein published in the *Annalen der Physik* scientific journal in 1905. These four works contributed substantially to the foundation of modern physics and changed views on space, time, and matter.

Thermodynamic fluctuations and statistical physics

Albert Einstein's first paper submitted in 1900 to *Annalen der Physik* was on capillary attraction. It was published in 1901 titled *Folgerungen aus den Capillaritätserscheinungen*, which was translated as "Conclusions from the capillarity phenomena". Two papers he published in 1902-1903 (thermodynamics) attempted to interpret phenomena from a statistical atomic point of view. These papers were the foundation for the 1905 paper on Brownian motion. These published calculations (1905) showed that Brownian

movement can be understood as firm evidence that molecules exist. His research in 1903 and 1904 was mainly concerned with the effect of finite atomic size on diffusion phenomena.

Theory of relativity and $E = mc^2$

Einstein's "Zur Elektrodynamik bewegter Körper" ("On the Electrodynamics of Moving Bodies") was received on June 30, 1905 and published September 26 of that same year. It reconciles Maxwell's equations for electricity and magnetism with the laws of mechanics, by introducing major changes to mechanics close to the speed of light. This later became known as Einstein's special theory of relativity. Consequences of this include the time-space frame of a moving body slowing down and contracting (in the direction of motion) relative to the frame of the observer. In his paper on mass-energy equivalence, which had previously been considered to be distinct concepts, Einstein deduced from his equations of special relativity what has been called the 20th century's best-known equation: $E = mc^2$. This equation suggests that tiny amounts of mass could be converted into huge amounts of energy and presaged the development of nuclear power. Einstein's 1905 work on relativity remained controversial for many years, but was accepted by leading physicists, starting with Max Planck.

Photons

In a 1905 paper, Einstein postulated that light itself consists of localized particles (quanta). Einstein's light quanta were nearly universally rejected by all physicists, including Max Planck and Niels Bohr. This idea only became universally accepted in 1919, with Robert Millikan's detailed experiments on the photoelectric effect, and with the measurement of Compton scattering. Einstein concluded that each wave of frequency f is associated with a collection of photons with energy hf each, where h is Planck's constant. He does not say much more, because he is not sure how the particles are related to the wave. But he does suggest that this idea would explain certain experimental results, notably the photoelectric effect.

Zero-point energy

Einstein's physical intuition led him to note that Planck's oscillator energies had an incorrect zero point. He modified Planck's hypothesis by stating that the lowest energy state of an oscillator is equal to $1/2hf$, to half the energy spacing between levels. This argument, which was made in 1913 in collaboration with Otto Stern, was based on the thermodynamics of a diatomic molecule which can split apart into two free atoms.

General relativity and the Equivalence Principle

General relativity (GR) is a theory of gravitation that was developed by Albert Einstein between 1907 and 1915. According to general relativity, the observed gravitational attraction between masses results from the warping of space and time by those masses. General relativity has developed into an essential tool in modern astrophysics. It provides the foundation for the current understanding of black holes, regions of space where gravitational attraction is so strong that not even light can escape.

As Albert Einstein later said, the reason for the development of general relativity was that the preference of inertial motions within special relativity was unsatisfactory, while a theory which from the outset prefers no state of motion (even accelerated ones) should appear more satisfactory. So in 1908 he published an article on acceleration under special relativity. In that article, he argued that free fall is really inertial motion, and that for a freefalling observer the rules of special relativity must apply. This argument is called the Equivalence principle. In the same article, Einstein also predicted the phenomenon of gravitational time dilation. In 1911, Einstein published another article expanding on the 1907 article, in which additional effects such as the deflection of light by massive bodies were predicted.

Modern quantum theory

In 1917, at the height of his work on relativity, Einstein published an article in *Physikalische Zeitschrift* that proposed the possibility of stimulated emission, the physical process that makes possible the maser and the laser. This article showed that the statistics of absorption and emission of light would only be consistent with Planck's distribution law if the emission of light into a mode with n photons would be enhanced statistically compared to the emission of light into an empty mode. This paper was enormously influential in the later development of quantum mechanics, because it was the first paper to show that the statistics of atomic transitions had simple laws. Einstein discovered Louis de Broglie's work, and supported his ideas, which were received skeptically at first. In another major paper from this era, Einstein gave a wave equation for de Broglie waves, which Einstein suggested was the Hamilton-Jacobi equation of mechanics. This paper would inspire Schrödinger's work of 1926.

Bose-Einstein statistics

In 1924, Einstein received a description of a statistical model from Indian physicist Satyendra Nath Bose, based on a counting method that assumed that light could be understood as a gas of indistinguishable particles. Einstein noted that Bose's statistics applied to some atoms as well as to the proposed light particles, and submitted his translation of Bose's paper to the *Zeitschrift für Physik*. Einstein also published his own articles describing the model and its implications, among them the Bose-Einstein condensate phenomenon that some particulates should appear at very low temperatures. It was not until 1995 that the first such condensate was produced experimentally by Eric Allin Cornell and Carl Wieman using ultra-cooling equipment built at the NIST-JILA laboratory at the University of Colorado at Boulder. Bose-Einstein statistics are now used to describe the behaviors of any assembly of bosons.

Political and religious views

Albert Einstein's political views emerged publicly in the middle of the 20th century due to latter's fame and reputation for genius, who offered and was called on to give judgments and opinions on matters often unrelated to theoretical physics or mathematics. The question of scientific determinism gave rise to questions about Einstein's position on theological determinism, and whether or not he believed in God, or in a god. He once said:

You may call me an agnostic... I do not share the crusading spirit of the professional atheist whose fervor is mostly due to a painful act of liberation from the fetters of religious

indoctrination received in youth. I prefer an attitude of humility corresponding to the weakness of our intellectual understanding of nature and of our own being.

He also said:

"It seems to me that the idea of a personal God is an anthropological concept which I cannot take seriously. I feel also not able to imagine some will or goal outside the human sphere. My views are near those of Spinoza: admiration for the beauty of and belief in the logical simplicity of the order which we can grasp humbly and only imperfectly. I believe that we have to content ourselves with our imperfect knowledge and understanding and treat values and moral obligations as a purely human problem-the most important of all human problems."

Awards and honors

In 1922, Einstein was awarded the 1921 Nobel Prize in Physics, "for his services to Theoretical Physics, and especially for his discovery of the law of the photoelectric effect". This refers to his 1905 paper on the photoelectric effect, "On a Heuristic Viewpoint Concerning the Production and Transformation of Light", which was well supported by the experimental evidence by that time. In 1929, Max Planck presented Einstein with the Max Planck medal of the German Physical Society in Berlin, for extraordinary achievements in theoretical physics. In 1936, Einstein was awarded the Franklin Institute's Franklin Medal for his extensive work on relativity and the photo-electric effect.

The International Union of Pure and Applied Physics named 2005 the "World Year of Physics" in commemoration of the 100th anniversary of the publication of the *annus mirabilis* papers.

The chemical element 99, Einsteinium, was named for him in August 1955, four months after Einstein's death. 2001 Einstein is an inner main belt asteroid discovered on 5 March 1973. In 1999 Time magazine named him the Person of the Century, ahead of Mahatma Gandhi and Franklin Roosevelt, among others. In the words of a biographer, "to the scientifically literate and the public at large, Einstein is synonymous with genius". Also in 1999, an opinion poll of 100 leading physicists ranked Einstein the "greatest physicist ever".http://en.wikipedia.org/wiki/Albert_Einstein - cite_note-104 A Gallup poll recorded him as the fourth most admired person of the 20th century in the U.S. In 1990, his name was added to the Walhalla temple for "laudable and distinguished Germans", which is located east of Regensburg, in Bavaria, Germany. The United States Postal Service honored Einstein with a Prominent Americans series (1965-1978) 8¢ postage stamp.

Awards named after Einstein

The Albert Einstein Award (sometimes called the Albert Einstein Medal because it is accompanied with a gold medal) is an award in theoretical physics, established to recognize high achievement in the natural sciences. It was endowed by the Lewis and Rosa Strauss Memorial Fund in honor of Albert Einstein's 70th birthday. It was first awarded in 1951 and included a prize money of \$ 15,000, which was later reduced to \$ 5,000. The winner is selected by a committee (the first of which consisted of Einstein, Oppenheimer, von Neumann and Weyl) of the Institute for Advanced Study, which administers the award.

The Albert Einstein Medal is an award presented by the Albert Einstein Society in Bern, Switzerland. First given in 1979, the award is presented to people who have "rendered outstanding services" in connection with Einstein. The Albert Einstein Peace Prize is given yearly by the Chicago, Illinois-based Albert Einstein Peace Prize Foundation. Winners of the prize receive \$50,000.