



## Relativity: The Special and General Theory

*Albert Einstein (1879 - 1955)*

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The image is popular and general: A young man sits under an apple tree. An apple falls, strikes him and sets him on a course to receive those epiphanies, eureka moments, in which he deduces how the physical world works. The young man was Isaac Newton and the consequent laws are known as Newtonian physics. Move ahead two hundred years and the second image, though less well known, is of another young man with unruly hair, sitting on a hillside in Germany not far from the patent office where he worked. There Albert Einstein received his own epiphany, followed by several eureka moments, from which he deduced those laws of physics, now termed the Theory of Relativity, a theory that superseded Newton's 200 year old theories of mechanics, and, in no small part, ushered in the Modern Era. The Theory of Relativity, is actually comprised of two theories: special relativity and general relativity. The concepts

introduced in these two theories are three-fold: (1) The measurement of certain quantities is dependent upon the speed of the observer; (2) Space and time ("spacetime") should be considered in relation to one another; and (3) The speed of light is, nonetheless, an absolute constant, invariant and the same for all observers. In any construct that allows for the relative nature of relationships, the observer must seek out the sole constant on which all relationships depend for their accurate expression. Einstein found it in the speed of light, and from that constant looked anew at the behavior of the smallest elements of matter (Special Relativity, 1905), as well as the projected behavior of an infinite cosmos (General Relativity, 1916). (Summary by Michael Hogan)

Whenever we think of the idea of genius, the image of Albert Einstein (March 14, 1879 – April 18, 1955) inevitably comes to mind. He was the uber scientist in a century dominated by science, and Time magazine recognized him as such by naming him the person of the century. He is often associated with  $e=mc^2$ , the "world's most famous equation," which may well be the most important breakthrough in theoretical physics. Einstein's discovery began with the recognition that Newtonian mechanics were unable to fully explain the laws of electromagnetic fields, which led to the special theory of relativity. He then realized that the principle of relativity applied to gravitational fields, which led to the general theory. His investigations led further to explanations of particle theory and the motion of molecules, all of which contributed mightily to the establishment of quantum theory. His investigations into the thermal properties of light laid the foundation of the photon theory of light. He became world famous in 1919 when his predictions that the sun would bend light from another star were confirmed by observations of the solar eclipse. He was awarded the Nobel Prize in Physics in 1921 for his work.

Einstein was born in Ulm and raised in Munich, where his father and uncle owned a factory that made electrical equipment. He attended Catholic elementary school and then the Luitpold Gymnasium until age 15, when the failure of his father's firm caused the family to move to Italy. At age 16 he renounced his German citizenship to avoid military service and enrolled in the Zurich Polytechnic, where he met his future wife Mileva Maric. In 1901 he became a Swiss citizen and went to work in the Swiss patent Office. In 1905, which has been called his "miracle year" he received a PhD from the University of Zurich and published four groundbreaking papers. He progressed through academic positions in Switzerland and German before emigrating to the United States in 1933, where he became a resident scholar at Princeton's Institute for Advanced Study, where he remained until his death.