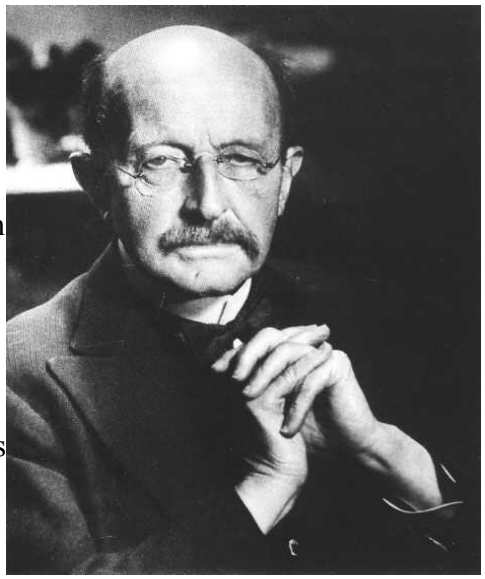
Max Planck

The work of Nobel Prize winning German theoretical physicist **Max Karl Ernst Ludwig Planck** (April 23, 1858 - October 4, 1947) on the second law of thermodynamics and black body [a hypothetical body that is able to absorb all the radiant energy falling on it] radiation led him to formulate the revolutionary quantum theory. On October 19, 1900, he initiated the transition from classical to modern physics when at a meeting of the German Physics Society he presented what has come to be known as *Planck's Radiation Law*. Quantum theory owes its origin to Planck's profound insight into thermodynamics. Some describe his law as "miraculous" because he initially wrote it down without derivation, simply a guess due to his "lucky intuition," by considering experimental data. If it were to be taken seriously, it would have to be derived from first principles. By December 14, 1900, he had succeeded, but at the cost of surrendering one of his cherished beliefs that the second law of thermodynamics was an absolute law of nature. The quantum concept was used to explain atomic structure and the photoelectric effect. It has since become the basis for much of modern physics.



Born in Keil, Planck was the sixth child of an academic family. His father was a professor of civil law at the University of Keil, and both his grandfather and great-grandfather had been professors of theology at Göttingen. Planck enthusiastically embraced his family's long tradition of devotion to church and state, excellence in scholarship, conservatism, idealism, reliability, and generosity. When he was nine years old, he entered Munich's distinguished Maximilian Gymnasium, where he excelled in mathematics and physics. He showed great promise in music, becoming an excellent pianist, but his

mathematics teacher turned his interest towards science. Planck later recalled that his

> "original decision [to devote himself to science] was a direct result of the discovery … that the laws of human reasoning coincide with the laws governing the sequences of impressions we receive from the world about us; therefore pure reasoning can enable man to gain an insight into the mechanism of the [world]…."

At the age of 16, Planck entered the University of Munich. His physics professor, Philipp von Jolly, told Planck that there was nothing remaining to be discovered in physics. Despite this gloomy warning, Planck embarked on a path that gave the world a new physics in which there is still much to discover. Planck moved to Berlin where he studied with Hermann von Helmholtz, the discoverer of the law of conservation of energy and Gustav Kirchhoff, a pioneer in spectroscopy. Planck returned to Munich to receive his doctorate, at the age of 21, for a thesis on the second law of thermodynamics. Planck was *Privatdozent* at the University of Munich from 1880 to 1885, at which time he was appointed Associate Professor of Theoretical Physics at Kiel. When Kirchhoff died in 1887, Planck succeeded him at the University of Berlin, holding the post for 38 years until his retirement in 1927. Afterwards Planck became president of the Kaiser Wilhelm Institute, from which he resigned in 1937 to protest the treatment of Jewish scientists by the Nazis. At the end of WWII, the Institute was moved to Göttingen and was renamed the Max Planck Institute, with Planck appointed its president.

Planck's earliest work on the subject of thermodynamics and black body radiation led him to abandon classical Newtonian principles, and he moved towards the study of the problem of distribution of energy in the spectrum of full radiation. Planck's experimental observations on the wavelength distribution of the energy emitted by a black body as a function of temperature were at variance with the predictions of classical physics. He was able to deduce the relationship between the energy and the frequency of the radiation. To further this work, Planck postulated that energy must exist in multiples

of a fundamental quantity, the quantum. This assumption was the basis of his radiation law. Planck was awarded the Nobel Prize in 1919 for his discovery of energy quanta. At first there was resistance to quantum theory but it rapidly gained acceptance due to the work of Einstein, Niels Bohr, and Werner Heisenberg. When Louis De Broglie, Werner Heisenberg, Erwin Schrödinger, Paul Dirac, and others showed in the 1920s how to express all the new concepts consistently, the full quantum theory had arrived. Quantum mechanics experienced considerable growth with the publication of Hermann Weyl's book *Quantum Mechanics and Group Theory*, with its special emphasis on the role of symmetry in the study of the laws of nature.

Planck's personal life was marked by tragedy. He and his first wife, Marie Merck, had two sons and twin daughters. Marie died after 23 years of marriage. Planck later married Marie's cousin, Marga von Hosslin, and had one more son. His eldest son was killed in WWI, his twin daughters both died in childbirth. In 1944, Planck's house in Berlin was completely destroyed by bombs and his son, Erwin, died a horrible death at the hands of the Gestapo for his part in the July 1944 plot to assassinate Hitler. Despite being an ardent anti-Nazi, Planck felt it was his duty to remain in Germany. Einstein never forgave him for not taking a stronger stand against the Nazis, although what more Planck could have done is not clear. Planck died at Göttingen on October 3, 1947. The Max Planck Society maintains numerous institutes that are dedicated to basic research. The institutes specialize in exploring new innovative fields of research.

Quotation of the Day: "A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it." - Max Planck