

Max Planck – Founder of Quantum Theory

Max Karl Ernst Ludwig Planck – in short, Planck – is a towering figure of modern physics, the father of the quantum theory. He was born a century and a half ago, on 23 April, 1858, in Kiel in Germany where his father was Professor of Constitutional Law at the University. At age 17, he entered the University of Munich to study Physics, even though advised that all important work in the subject had been completed. In 1878, he moved to the University of Berlin as a student of Gustav Kirchoff, also attending lectures by Hermann von Helmholtz and Karl Weierstrass. In view of later developments, Kirchoff is aptly called the grandfather of the quantum theory.

Planck obtained his doctorate degree – ‘summa cum laude’ – from the University of Munich in 1879, the year of birth of Albert Einstein. He then continued as Privatdozent there. In 1885 he became Professor at Kiel, and in 1889 Professor Extraordinarius at Berlin. Finally in 1892, he succeeded his teacher Kirchoff as Full Professor at Berlin. In 1912 he became Permanent Secretary of the Prussian Academy of Sciences, and was awarded the Physics Nobel Prize in 1918. In 1926 he retired from Berlin, becoming Professor Emeritus. He was succeeded by Erwin Schrödinger, just fresh from his creation of wave mechanics while in Zurich.

The first Max Planck medal of the German Physical Society was awarded jointly to Planck and Einstein in 1929. In 1930, Planck became the President of the Kaiser Wilhelm Society for Advancement of Science, the highest academic position in Germany. Many years later, over 1946-48, this was transformed into the Max Planck Society.

Planck died in 1947, close to ninety.

This issue of *Resonance* carries two excellent general articles, by G S Ranganath and M Harbola, describing in pedagogical fashion the background and the details of Planck’s monumental work of 1900, its consequences and later developments in the hands of Einstein, Niels Bohr and others. Just a few added comments will suffice here. Planck took up the study of black body radiation – the search for Kirchoff’s universal function – in 1894. For some time, he evidently believed that a formula guessed by Wilhelm Wien in 1896 was exact. Then, on Sunday 7th October, 1900 (incidentally the fifteenth birthday of Bohr), the experimental physicist Heinrich Rubens and his wife visited the Plancks for tea. Rubens told Planck about the failure of the Wien formula for long wavelengths, where another classical formula of Lord Rayleigh and James Jeans worked better. After the Rubens left, Planck set to work to find a formula interpolating between the Wien and the Rayleigh–Jeans expressions, and then arrived at his famous radiation law.



Thus quantum theory was born in the space of a few hours on a Sunday evening. Ranganath mentions that Planck sent a postcard to Rubens with his result the same evening, and it was received the next morning – the postal system must have been remarkably efficient then. This result was presented at a meeting of the German Physical Society on Tuesday, 9th October, 1900. Then as he recalled later: “On the very day when I formulated the radiation law, I began to devote myself to the task of investing it with true physical meaning”. Two months later, at another German Physical Society meeting on Friday 14th, December 1900, Planck was able to present a derivation incorporating his revolutionary idea of quantization of energy. In his own words, this was “an act of desperation... I had to obtain a positive result, under any circumstances and at whatever cost.” As Abraham Pais wrote: “His reasoning was mad, but his madness has that divine quality that only the greatest transitional figures can bring to science”. Bohr expressed it in this way: “Scarcely any other discovery in the history of science has produced such extraordinary results within the short span of our generation as those which have directly arisen from Max Planck’s discovery of the elementary quantum of action”.

Planck has been called a ‘reluctant revolutionary’. He was a transitional figure heralding the passage from a classical past to the modern era. How happy that this happened in the closing months of the 19th century! In a letter to a colleague he said: “By nature I am peacefully inclined and reject all doubtful adventures...”. While he was an enthusiastic supporter of Einstein’s Special Theory of Relativity right from the beginning, he was for long very skeptical of Einstein’s light quantum concept. Indeed he wrote to Einstein in 1907: “I do not search for the meaning of the elementary quantum of action in the vacuum but at the points of absorption and emission, and I assume that processes in the vacuum are exactly represented by the Maxwell equations”. Going even further, when in 1913 he – along with Nernst, Rubens and Warburg – recommended Einstein for election to the Prussian Academy of Sciences, he wrote : “That he may sometimes have missed the target in his speculations, as, for example, in his hypothesis of light quanta, cannot really be held too much against him, for it is not possible to introduce really new ideas even in the most exact sciences without sometimes taking a risk”.

Quoting from a brief essay by James Murphy, Planck regarded “... physical science as part of human culture, forming an integral part with the other branches of human learning and exercising its influence on the destiny of humanity not merely in a material way but even more deeply in a spiritual way”.

In his personal life Planck faced repeated tragedies. His first wife Marie died in 1909. All their children died in tragic circumstances within Planck’s life time: the elder son Karl of wounds in World War I; the younger son Erwin executed by the Nazis in 1945; and their twin daughters Emma and Grete both in childbirth. His son Hermann by his second wife Marga was ‘mentally



challenged'. Planck lived through two World Wars and the Nazi nightmare; in William Cropper's words "He deplored everything the Nazis did, but chose to remain in Germany, with the hope that he could help pick up the pieces after it was all over". No wonder that late in life he wrote these sadly profound yet inspiring words:

"For no man is born with a legal claim to happiness, success and prosperity in life. We must therefore accept every favourable decision of Providence, each single hour of happiness, as an unearned gift, one that imposes an obligation. The only thing that we may claim for our own with absolute assurance, the greatest good that no power in the world can take from us, and that can give us more permanent happiness than anything else, is integrity of soul, which manifests itself in a conscientious performance of one's duty."

N Mukunda

Centre for High Energy Physics

Indian Institute of Science, Bangalore 560 012, India.

Email: nmukunda@gmail.com

