

LETTERS TO PROGRESS IN PHYSICS**Max Karl Ernst Ludwig Planck: (1858–1947)**

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October 4th, 2007 marks the 60th anniversary of Planck's death. Planck was not only the father of Quantum Theory. He was also a man of profound moral and ethical values, with far reaching philosophical views. Though he lived a life of public acclaim for his discovery of the Blackbody radiation formula which bears his name, his personal life was beset with tragedy. Yet, Planck never lost his deep faith and belief in a personal God. He was admired by Einstein, not so much for his contributions to physics, but rather, for the ideals which he embodied as a person. In this work, a brief synopsis is provided on Planck, his life, and his philosophical writings. It is hoped that this will serve as an invitation to revisit the philosophical works of the man who, more than any other, helped set the course of early 20th century physics.

“Many kinds of men devote themselves to science, and not all for the sake of science herself. There are some who come into her temple because it offers them the opportunity to display their particular talents. To this class of men science is a kind of sport in the practice of which they exult, just as an athlete exults in the exercise of his muscular prowess. There is another class of men who come into the temple to make an offering of their brain pulp in the hope of securing a profitable return. These men are scientists only by the chance of some circumstance which offered itself when making a choice of career. If the attending circumstance had been different, they might have become politicians or captains of business. Should an angel of God descend and drive from the temple of science all those who belong to the categories I have mentioned, I fear the temple would be nearly emptied. But a few worshippers would still remain — some from former times and some from ours. To these latter belongs our Planck. And that is why we love him. . .

. . . (Planck's) work has given one of the most powerful of all impulses to the progress of science. His ideas will be effective as long as physical science lasts. And I hope that the example which his personal life affords will not be less effective with later generations of scientists.”

Albert Einstein, 1932

Biography

Max Planck, the father of quantum theory, was born on the 23rd of April 1858 in the town of Kiel, Germany [1–5]. His father had been a professor of law in the same town, while his paternal grandfather and great grandfather had been leading Lutheran theologians at the University of Göttingen. In 1867, when Planck reached the age of nine, his father received an academic appointment at the University of Munich and the Planck family relocated to this city. In Munich, he would at-

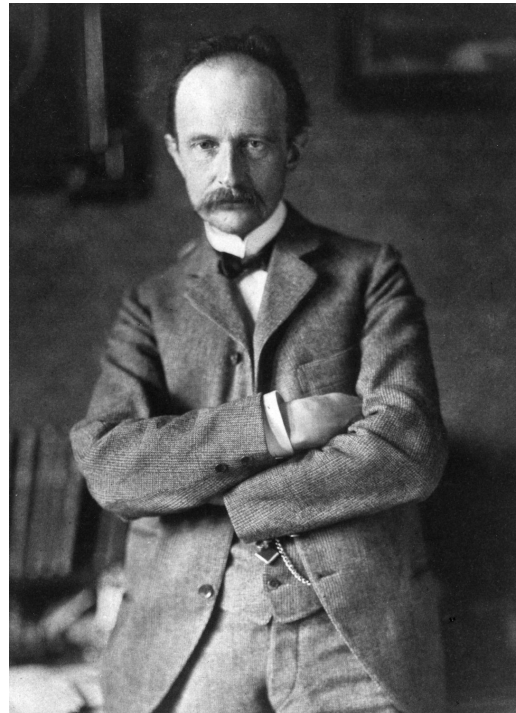


Fig. 1: Max Planck in his earlier years. AIP Emilio Segre Visual Archives, W.F. Meggers Collection. Reproduced through permission.

tend the Maximilian Gymnasium and there gained his first love for Physics and Mathematics. In 1874, while still only 16, he enrolled at the University of Munich to study Physics. Beginning in 1877, he would spend one year at the University of Berlin where he was taught by Gustav Robert Kirchhoff and Hermann von Helmholtz, both of whom had been eminent physicists of the period. He was impressed with both of these men, but had little regard for the quality of their lectures. During his studies, Planck took an early interest in ther-

modynamics and immersed himself in Rudolf Clausius' work on the subject. He would receive his doctorate in physics in 1879 from the University of Munich at the age of 21. His thesis was focused on the second law of thermodynamics. In 1885, through the influence of his father, Max Planck received an appointment as an associate professor of physics at the University of Kiel. Later, he would present a paper on thermodynamics that would result in an appointment for him at the University of Berlin upon the death of Kirchoff in 1889. Kirchoff had been the chair of theoretical physics in Berlin and Planck would become the only theoretical physicist on the faculty. He would hold this chair until his retirement in 1927, having become a full professor in 1892 [1–5].

In 1913, Planck would offer Albert Einstein a professorship in Berlin. The two of them, along with Planck's student, Professor Max von Laue, would remain close personal friends and scientific colleagues even after Einstein departed for Princeton. Rosenthal-Schneider [6] describes Planck as gentle, reserved, unpretentious, noble-minded and warm-hearted. He deeply loved mountain-climbing and music. He might well have been a concert pianist rather than a theoretical physicist, but he believed that he would do better as an average physicist than as an average pianist [1, 6].

While in Berlin, Planck would turn his attention to the emission of heat and light from solids. From these studies, his famous equation would emerge and quantum theory, through "the discovery of the elementary quantum of action", would be born [7]. Planck recognized the far reaching impact of his discovery:

"(The essence of Quantum Physics) . . . consists in the fact that it introduces a new and universal constant, namely the elementary Quantum of Action. It was this constant which, like a new and mysterious messenger from the real world, insisted on turning up in every kind of measurement, and continued to claim a place for itself. On the other hand, it seemed so incompatible with the traditional view of the universe provided by Physics that it eventually destroyed the framework of this older view. For a time it seemed that a complete collapse of classical Physics was not beyond the bounds of possibility; gradually, however, it appeared, as had been confidently expected by all who believed in the steady advance of science, that the introduction of Quantum Theory led not to the destruction of Physics, but to a somewhat profound reconstruction, in the course of which the whole science was rendered more universal. For if the Quantum of Action is assumed to be infinitely small, Quantum Physics become merged with classical Physics. . ." [8, p. 22–23].

Planck also believed that his equation could be applied to all objects independent of the phases of matter:

"According to the Kirchoff law this radiant energy is independent of the nature of the radiating substance and therefore has a universal significance" [9, p. 18].

Planck's personal life would take a tragic turn after his discovery of the quantum in 1900 [7]. In 1909, he would lose

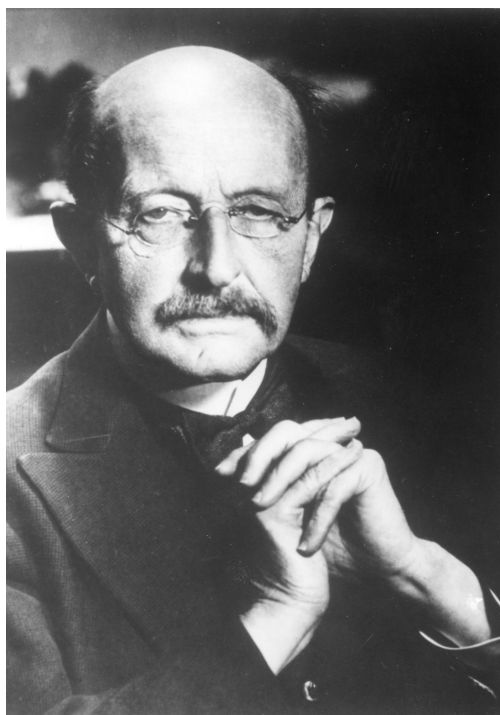


Fig. 2: Max Planck, the 1930's. AIP Emilio Segre Visual Archives. Reproduced through permission.

his wife of 22 years. His oldest son, Karl, would be killed in action at Verdun in 1916. In 1917, his daughter Margerite would die in childbirth. In 1919, his second daughter Emma would suffer the same fate. In the meantime, though the First World War had just ended, Planck would win the 1918 Nobel Prize in Physics [2–5].

Unfortunately however, Planck's misfortunes continued. His home would be demolished in an ally air raid in 1944. Planck would later acknowledge gifts of food shipped from Australia by his former student Iles Rosenthal-Schneider [6]. Beginning in the early 1930's, Planck had expressed strong private and public views against the Nazi regime. Little did he realize at that time the price that he, and indeed much of the free world, would have to pay for the curse of this regime. Thus, in January 1945, his son Erwin was charged with an attempt on Hitler's life. Erwin was his only remaining child from his first marriage. Once his son was charged, Planck and von Laue tried to intervene before Heinrich Himmler, the second most powerful man in Germany [4]. But upon his arrival to Berlin, Hitler himself ordered the execution and immediate hanging of Planck's son. It is said that this execution robbed Planck of much of his will to live. Then in August 1945, the atomic bomb would be dropped on Hiroshima. Planck would express concern for the fate of mankind over these developments [6]. Eventually, Planck would be taken by the allies to Göttingen to live with his niece. He was accompanied by his second wife and their son. He would die in Göttingen on October 4, 1947 [1–5].

Philosophy of life

As Planck began to age, he devoted much of his time to philosophical works [1, 8, 9, 10]. These centered on the search for an absolute truth and on other philosophical aspects of Physics and Religion. Planck viewed science as the primary means of extracting the absolute. Planck believed that it was possible to move from the relative to the absolute. He thought that the Theory of Relativity itself promoted the absolute by quantifying in absolute terms the speed of light in a vacuum and the amount of energy within an object at rest ($E = mc^2$).

Planck saw the physical world as an objective reality and its exploration as a search for truth. Philosophers have often questioned physical reality, but men like Einstein and Planck viewed the physical world as real and the pursuit of science as forever intertwined with the search for truth [6]. These men saw the search for truth as elevating humanity. In Planck's words:

"Science enhances the moral values of life, because it furthers a love of truth and reverence — love of truth displaying itself in the constant endeavor to arrive at more exact knowledge of the world of mind and matter around us, and reverence, because every advance in knowledge brings us face to face with the mystery of our own being" [9, p. 122].

Thus, Planck had a deep love and respect for truthfulness. He regarded it as a central human virtue and as the most important quality of the scientist:

"But truthfulness, this noblest of all human virtues, is authoritative even here over a well-defined domain, within which its moral commandment acquires an absolute meaning, independent of all specific viewpoints. This is probing to one's own self, before one's own conscience. Under no circumstances can there be in this domain the slightest moral compromise, the slightest moral justification for the smallest deviation. He who violates this commandment, perhaps in the endeavor to gain some momentary worldly advantage, by deliberately and knowingly shutting his eyes to the proper evaluation of the true situation, is like a spendthrift who thoughtlessly squanders away his wealth, and who must inevitably suffer, sooner or later, the grave consequences of his foolhardiness" [1, p. 79].

He saw his quest for truth and the absolute as a never ending struggle from which he could take no rest:

"We cannot rest and sit down lest we rust and decay. Health is maintained only through work. And as it is with all life so it is with science. We are always struggling from the relative to the absolute" [9, p. 151].

As he continued his works in search of truth and the absolute, Planck was guided by his undying scientific faith:

"Anyone who has taken part in the building up of science is well aware from personal experience that every endeavor in this direction is guided by an unpretentious but essential principle. This principle is faith — a faith which looks ahead" [10, p. 121].

At the same time, Planck recognized that one could never arrive at the absolute truth. This did not deter him:

"What will be the ultimate goal? ... research in general has a twofold aim — the effective domination of the world of senses, and the complete understanding of the real world; and that both these aims are in principle unattainable. But it would be a mistake to be discouraged on this account. Both our theoretical and practical tangible results are too great to warrant discouragement; and every day adds to them. Indeed, there is perhaps some justification for seeing in the very fact that this goal is unattainable, and the struggle unending, a blessing for the human mind in its search after knowledge. For it is in this way that its two noblest impulses — enthusiasm and reverence — are preserved and inspired anew" [8, p. 61].

For Planck, the understanding of physical laws would occupy his entire adult life. He would write:

"The laws of Physics have no consideration for the human senses; they depend on the facts, and not upon the obviousness of the facts" [8, p. 73].

When he formulated his now famous Law of Thermal Radiation [7], he must have encountered tremendous opposition for what he was proposing went well beyond the senses:

"An important scientific innovation rarely makes its way by gradually winning over and converting its opponents: it rarely happens that Saul become Paul. What does happen is that its opponents gradually die out and that the growing generation is familiarized with the idea from the beginning: another instance of the fact that the future lies with youth" [10, p. 97].

One can but imagine the courage and scientific faith he must have held, but Planck himself summarizes well for us:

"...in science as elsewhere fortune favors the brave" [10, p. 112].

According to Thomas Braun *"Planck was a man of deeply religious outlook. His scientist's faith in the lawfulness of nature was inseparable from his faith in God"* [6, p. 23]. Planck believed that *"man needs science for knowledge and religion for his actions in daily life"* [6, p. 106]. For Planck: *"religion and natural science are fighting a joint battle in an incessant, never relaxing crusade against scepticism and against dogmatism, against disbelief and against superstition..."* [1, p. 186–187].

Yet, Planck made a clear distinction between science and religion stating that:

"Religion belongs to that realm that is inviolable before the laws of causation and therefore closed to science" [9, p. 121].

Planck seemed to marvel at the mystery of scientific discovery in a manner that most clearly conveys his religious philosophy:

"In fact, how pitifully small, how powerless we human beings must appear to ourselves if we stop to think that the planet Earth on which we live our lives is just a minute, in-

finitesimal mote of dust; on the other hand how peculiar it must seem that we, tiny creatures on a tiny planet, are nevertheless capable of knowing though not the essence at least the existence and the dimensions of the basic building blocks of the entire great Cosmos!" [1, p. 174].

Perhaps there is no more suitable way of closing a work on Max Planck than to recall the memorial address delivered by Professor Max von Laue at the Albani Church in Göttingen on October 7, 1947 [1, p. 7–10]. Max von Laue was a colleague of Max Planck at the University of Berlin. In 1914, he had received the Nobel Prize in Physics for his study of the diffraction of X-rays by crystals.

My Fellow Mourners:

We stand at the bier of a man who lived to be almost four-score-and-ten. Ninety years are a long life, and these particular ninety years were extraordinarily rich in experiences. Max Planck would remember, even in his old age, the sight of the Prussian and Austrian troops marching into his native town of Kiel. The birth and meteoric ascent of the German Empire occurred during his lifetime, and so did its total eclipse and ghastly disaster. These events had a most profound effect on Planck in his person, too. His eldest son, Karl, died in action at Verdun in 1916. In the Second World War, his house went up in flames during an air raid. His library, collected throughout a whole long lifetime, disappeared, no one knows where, and the most terrible blow of all fell when his second son, Erwin, lost his life in the rule of terror in January, 1945. While on a lecture tour, Max Planck, himself, was an eye-witness of the destruction of Kassel, and was buried in an air raid shelter for several hours. In the middle of May, 1945, the Americans sent a car to his estate of Rogatz on the Elbe, then a theatre of war, to take him to Göttingen. Now we are taking him to his final resting-place.

In the field of science, too, Planck's lifetime was an epoch of deep-reaching changes. The physical science of our days shows an aspect totally different from that of 1875, when Planck began to devote himself to it — and Max Planck is entitled to the lion's share in the credit for these changes. And what a wonderful story his life was! Just think — boy of seventeen, just graduated from high school, he decided to take up a science which even its most authoritative representative who he could consult, described as one of mighty meager prospects. As a student, he chose a certain branch of science, for which even its neighbor sciences had but little regard — and even within this particular branch a highly specialized field, in which literally nobody at all had any interest whatever. His first scientific papers were not read by Helmholtz, Kirchhoff and Clausius, the very men who would have found it easiest to appreciate them. Yet, he continued on his way, obeying an inner call, until he came face to face with a problem which many others had tried and failed to solve, a problem for which the very path taken by him turned out to have been the best preparation. Thus, he was able to recognize and formulate, from measurements of radiations, the law

which today bears and immortalizes his name for all times. He announced it before the Berlin Physical Society on October 19, 1900. To be sure, the theoretical substantiation of it made it necessary for him to reconsider his views and to fall back on methods of the atom theory, which he had been wont to regard with certain doubts, And beyond that, he had to venture a hypothesis, the audacity of which was not clear at first, to its full extent, to anybody, not even him. But on December 14, 1900, again before the German Physical Society, he was able to present the theoretic deduction of the law of radiation. This was the birthday of quantum theory. This achievement will perpetuate his name forever.

Max von Laue, 1947

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