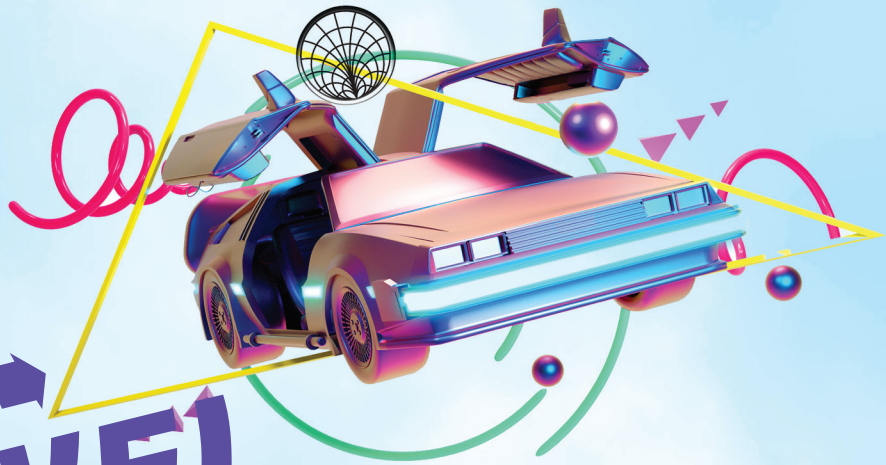

TIME TRAVEL

Eric Higham, Microwave Journal Technical Editor

Laying the Foundation for Quantum Applications: Max Planck

Quantum technology is an emerging field of physics and engineering that promises to fundamentally change the way we do things. As we prepare for IMS2023 and the latest developments in quantum, photonic and wireless applications, it seems appropriate to commemorate the life of the man credited with what the Nobel Prize Organization claimed is a turning point in the history of physics.[1] Max Planck is widely recognized as the originator of quantum theory and for introducing Planck's Constant.

Planck was reportedly a gifted musician but chose to pursue physics and focus on thermodynamics despite an early professor at the University of Munich telling him "In this field, almost everything is already discovered and all that remains is to fill a few holes."[2]

In 1889, Planck succeeded Gustav Kirchhoff, creator of the famous Kirchhoff's Voltage and Current Law. Planck remained in that position until his retirement in 1926, where he began investigating the problem of black body radiation, identified by Kirchhoff 35 years previously.

Kirchhoff had defined a black body as a perfect emitter and absorber of radiation, where all the energy incident on an object is re-radiated. He questioned how the intensity of the electromagnetic (EM) radiation emitted by a black body depends on the frequency of the radiation and the temperature of the body. For the next three decades, physicists couldn't develop a theory that predicted experimental results across all frequencies. Planck set out to answer this question, and he presented a theory known as the Planck postulate. Planck's paper theorized that EM energy could not be emitted continuously, but only as quantized or discrete values. This theory ran counter to the principles of classical physics and it was not widely acknowledged until it began accounting for discrepancies between observed results and classical theory in many areas. The

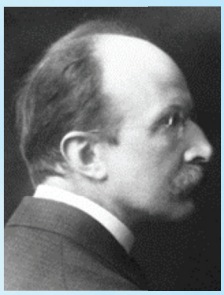

Photo from the Nobel Foundation archive.

relationship is summarized as:

$$E = hv$$

Where: E = Energy of a photon or one quantum of energy

h = Planck's Constant ($6.62607015 \times 10^{-34}$ joule-second)

v = Oscillator frequency

Planck's work was rewarded with the Nobel Prize for Physics in 1918 and is also credited as the origin of quantum physics, with this theory serving as the basis for all the quantum work that has followed.

References

1. "Max Planck – Biographical," Nobel Prize Outreach AB, 2023, Web: www.nobelprize.org/prizes/physics/1918/planck/biographical.
2. A. P. Lightman, "The discoveries: great breakthroughs in twentieth-century science, including the original papers," 2005, p. 8.