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The Development of Elementary Quantum Theory

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Abstract

Planck's introduction of the quantum of action in 1900 was followed by 25 years of trial and error in quest of the understanding of the quantum world; different ideas and directions had to be pursued until the path leading to the elementary quantum theory was discovered. Radical changes away from traditional perceptions about natural phenomena were necessary, and the entire system of basic concepts in classical physics had to be abandoned and replaced by a new mode of thought. Continuity and determinism of classical laws were no longer applicable on the quantum scale, where dynamical behavior proceeds by discontinuous and statistical quantum transitions. Albert Einstein laid the essential foundations for the new concept; Max Born made the decisive step further leading to the breakthrough in 1925. The development of the ideas, which eventually resulted in the elementary quantum theory in 1925/26, will be described, relying on original publications and letters written during that period in time by the major contributors. The fundamental laws of quantum theory derived by Max Born and Pascual Jordan may mathematically be represented in many different ways, and particular emphasis is given to the distinction between physical content and mathematical representation.