From Propagation to Structure: Experimental Research in Berlin and its Role in The Emergence of Early Quantum Physics

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Abstract:

Quantum physics emerged at the turn of the last century when physics had shifted its concern from propagation phenomena to questions of structure. This transition occurred with the development of a new experimental technique, the bombardment method. This development of a new experimental technique was conceived when physics turned its attention from macrophysical to microphysical problems. The new experimental technique emerged when it became clear that rays and particles of known properties could be manipulated and used as probes that could impinge on, collide with, or plunge through the object under study. By examining the reaction of the object to the probes, that is, by studying the object or its fragments in the wake of the interaction, the nature and in particular the structure of the object could be revealed. This development stands in contrast to the general scheme of nineteenth-century experimental physics, which was concerned mainly with propagation phenomena.

The transition is well exemplified by the move from the experimental studies of Heinrich Hertz to those of Ernest Rutherford, and from those of Heinrich Hertz and Philipp Lenard to those of James Franck and Gustav Hertz. We trace the history of Rutherford's experimental bombardment method as it emerged from nineteenth-century propagation studies. We indicate the use of the bombardment method in another experimental context, namely, in the celebrated experiment of Franck and Hertz. This change of experimental method occurred within a distinct institutional context which we will analyze in detail. For instance, when Hans Geiger moved to Berlin (1912) he imported the Rutherford method and developed the famous counting technique. We will describe the Berlin tradition of cathode rays research which served as an important background to Franck-Hertz experiment. Berlin was well known for its radiation physics and low temperature research, so that when the bombardment technique was added to its arsenal or physical researches Berlin became an important early center of experimental research in quantum physics, although many of the local actors pursued their research mostly within the framework of classical physics.