

Proximity of Theory and Experimental Practice in Göttingen's Physical Institutes 1920-1933: Work of Maria Göppert as Exemplar of an Institutional Culture

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Abstract:

I posit that the impact of proximity and the role of collaboration between theory and experimental practice was seminal in the development of quantum mechanics in Göttingen in the 1920's. Dr. Max Born, Professor, Direktor des Instituts für Theoretische Physik der Universität Göttingen [theory group] and Dr. James Franck from 1921-1933, Professor, Direktor des zweiten Physikalischen Instituts der Universität Göttingen [experimental group] closely interacted as seen in the thesis work of Born's graduate student Maria Göppert and her Göttingen Dissertation work on two-photon processes (today's major nonlinear optical imaging technique in biology). I reconstruct the interactions between theory groups and experimental groups in the advancement of quantum mechanics in Göttingen in the 1920's until 1933. Furthermore, fruitful insights come from re-evaluation of the Göttingen school of mathematics (Klein) and its interaction with the theoretical and experimental physics groups in the advancement of quantum mechanics. I elucidate the roles of visitors, graduate students, and assistants in the development of quantum mechanics in Göttingen in the 1920's to 1933? Maria Göppert worked in Max Born's Institute for about a decade; during that period Max Born's Institute hosted a number of important physicists for various periods of time: Delbrück, Fermi, Heitler, Hund, London, Nordheim, Oppenheimer, Rosenfeld, Uhlenbeck, Weisskopf, and Wigner, and Paul Dirac. I have deconstructed the two parts of her thesis work in order to extract the portions that derived from the work of others: for example she used second-order, time-dependent perturbation theory and standing waves in a cavity, in her dissertation research of two-photon transitions. Furthermore, I show the roles of textbooks, monographs, and handbook articles on the development, codification, and promotion of the quantum mechanics in Göttingen in the 1920's to 1933. I will focus on the impact of the following books from the Göttingen mathematicians and physicists. Richard Courant and David Hilbert's *Methods of Mathematical Physics* which contained a clear expositions of the algebra of linear transformations, the calculus of variations, eigenvalue problems including a section on eigenvalue problems of the Schrödinger type. It served as a mathematical reference for matrix mechanics of Max Born, Werner Heisenberg, and Pascual Jordan. Max Born's monograph *Vorlesungen über Atommechanik*, written with the help of his assistant Dr. Friedrich Hund. In 1926, James Franck and Pascual Jordan completed their textbook, *Anregung von Quantensprüngen Durch Stösse*. It provided a summary of all the experimental work carried out in Franck's Zweiten Physikalischen Instituts der Universität Göttingen up to 1926. Max Born and Pascual Jordan who was now a

Professor in the Universität Rostock, completed their book *Elementare Quantenmechanik*, that Verlag Von Julius Springer published in 1930. Earlier, Arnold Sommerfeld's two-volume *Atombau und Spektrallinien* educated a whole generation of theoretical physicists. Maria Göppert was well aware of the experiments as well as the content of all of these books as is evident from her thesis paper. She contributed a section in *Elementare Quantenmechanik* on Dirac's theory of emission, absorption and dispersion.