Application, Extension, and Alteration: The many-body Problem in early Quantum Mechanics.

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Abstract:

Several of the innovators of quantum theory maintained an interest in questions regarding the constitution and behavior of matter that they expected, or at least hoped, could be resolved through the development of quantum theory, but for which the canonical formulation of quantum mechanics provided no immediate solution. Among these lingering questions were riddles regarding the stability of molecules, the persistence of ferromagnetism, the conductivity of metals, and the various observed nuclear processes. Hence one can find questions related to quantum theory raised in seminars on the constitution of matter at Copenhagen, in discussions of alpha and beta ray experiments, or even in dissertations on the stability of molecules and of molecular ions that remained unresolved for months, years, or even decades after the publication of the epochal papers of 1925-27.

Although physicists published solutions to these problems in a punctuated and piecemeal fashion over the subsequent years, many of these solutions contributed to and relied upon the development of a common stock of new techniques appropriate to quantum mechanics for addressing what is known as the "many-body problem." With several of the key figures surrounding the genesis of quantum mechanics researching these problems, and promising junior scholars rapidly joining them, it is not particularly surprising that historians cite the solutions to some of these problems as amongst the earliest successful applications of the new quantum mechanics. But regarding these solutions as "applications" rather than extensions, or even alterations, of quantum mechanics begs numerous questions regarding the interaction between the earliest formulations of quantum mechanics and the new techniques embodied in these solutions. Among the questions that we argue deserve more careful consideration are: To what extent did the new techniques for addressing the many-body problem alter the practice and the perceived limitations of quantum mechanics? And to what extent did physicists consider the potential to solve such problems definitive of a successful and complete quantum theory?