

The Formation of the Sommerfeld Quantum Theory of 1916

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I. Introduction

In 1916 Arnold Sommerfeld published a series of papers dealing with the quantum theory of spectra in *Annalen der Physik*,¹ in which the 1913 Bohr theory of the structure of the atom was greatly generalized and a general theory of relativistic Keplerian motion was developed. As I pointed out in my earlier paper,² the Bohr theory of 1913 was unable to determine the arrangement of electrons in the atom. At the earlier stage of development of the theory of atomic constitution in the 1910's, consideration of the chemical properties of elements played the cardinal part in unravelling the configuration of electrons in the atom. It was Sommerfeld's theory that first provided an actual starting-point for discussion of the structure of the atom on the basis of spectra. Sommerfeld thus brought about an important extension and refinement of the quantum theory of the atomic structure. On the basis of the Sommerfeld theory, the old quantum theory of spectra was developed, and this development led Bohr to formulate the correspondence principle, which in its turn opened the way to matrix mechanics. The aim of the present paper is to enquire into factors which contributed towards the formation of the Sommerfeld theory.

It was in 1911 that Sommerfeld first took up quantum theory. His first paper dealing with quantum theory was presented on January 7, 1911 to the Munich Academy of Science.³ Its subject was the theory of γ - and X-bremsstrahlung. In the same year he published two further papers, one of which was read at the 83rd meeting of German Scientists and Physicians on September 23,⁴ and the other at the first Solvay Congress held from October 30 to November 3.⁵

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¹ A. Sommerfeld, "Zur Quantentheorie der Spektrallinien, I. Theorie der Balmerischen Serie", *Ann. d. Phys.*, **51** (1916), 1-44; "II. Die Feinstruktur der Wasserstoff- und der wasserstoffähnlichen Linien", *Ibid.* (1916), 44-94; "III. Theorie der Röntgenspektren", *Ibid.* (1916), 125-167.

² S. Nisio, "The Role of the Chemical Considerations in the Development of Bohr Atom Model", *Jap. Stud. Hist. Sci.*, No. 6 (1967), 26-40.

³ A. Sommerfeld, "Über die Struktur der γ -Strahlen", *Sitzb. Bayer. Akad. Wiss.* (1911), 1-60.

⁴ A. Sommerfeld, "Das Plancksche Wirkungsquantum und seine allgemeine Bedeutung für die Molekularphysik", *Phys. ZS.*, **12** (1911), 1057-1069.

⁵ A. Sommerfeld, "Application de la théorie de l'élément d'action aux phénomènes moléculaires non périodiques", in P. Langevin et M. de Broglie (eds.), *La théorie du rayonnement et les quanta* (Paris, 1912), 313-392.