

The van den Broek Hypothesis

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1. Introduction

In the development of the study of the atomic structure during the 1910's, the foundation of models of the atom was provided by van den Broek's hypothesis. The van den Broek hypothesis states that the electric charge of the nucleus or the number of intra-atomic electrons of a chemical element is equal to its ordinal number in the periodic system. Once the hypothesis was proposed by A. van den Broek in 1913, it exerted considerable influence upon N. Bohr, H. G. J. Moseley, and F. Soddy and was soon accepted by most of those who were interested in the atomic physics. This rapid acceptance may presumably be accounted for by the fact that it was just the time when various inquiries into the number of intra-atomic electrons were converging to a nearly correct conclusion. No settled conclusion, however, had yet been pronounced. The van den Broek hypothesis gave a clear and definite expression to this vaguely felt conclusion, and thus greatly advanced the atomic physics. To attach an essential significance to the atomic number was van den Broek's most original idea, which had occurred to no one before him.

E. Whittaker, in his *History of the Theories of Aether and Electricity II*, wrote about the van den Broek hypothesis as though it were originated in an examination of experimental results of α -particle scattering.¹ According to the Rutherford formula, the number of particles scattered by an atomic nucleus to a given angle is proportional to the square of the nuclear charge. H. Geiger and E. Marsden in 1913 carried out careful experiment and concluded that the Rutherford formula would be approximately fulfilled if the nuclear charge was assumed to be half the atomic weight.² "But van den Broek now," says Whittaker, "pointed out that it would be satisfied with far greater accuracy if the nuclear charge were assumed to be proportional to the number representing the place of the element in the Newlands-Mendelev periodic table."

Whittaker's account, however, is somewhat misleading. For, first, van den Broek proposed his hypothesis in its original form not after, but before the result of Geiger and Marsden's experiment was published. The paper in which van den

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¹ E. Whittaker, *A History of the Theories of Aether and Electricity, II* (London, 1953), pp. 23-24.

² H. Geiger and E. Marsden, "The Laws of Deflexion of α -Particles Through Large Angles," *Phil. Mag.* (6), 25, 604-623 (April 1913).