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Modeling and Reality in Early Twentieth-Century Physics

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Towards the end of 1913, Arnold Sommerfeld, Professor of theoretical physics at Munich University, sent a letter of congratulations to a young Niels Bohr. The Dane's now-classic trilogy of papers, which coupled Rutherford's conception of the atom with a "planetary" configuration of electrons, had just appeared. Sommerfeld saw the calculation of the Rydberg constant as a singular triumph and immediately spotted an opportunity to try to explain the Zeeman effect. Yet he also sounded a note of caution, confessing that he remained "somewhat skeptical" of atomic models in general. In this, of course, he was hardly alone. Bohr's atom was a particularly egregious example of a peculiar model, one requiring what even its creator considered "horrid assumptions." Nonetheless, success bred conviction. Expanding upon Bohr's original ideas, Sommerfeld soon produced the so-called "Bohr-Sommerfeld quantization conditions," using them to calculate a myriad of results. Experimental evidence, Sommerfeld argued in 1915, showed that quantised electron-paths "correspond exactly to reality" and possess "real existence." This kind of realism would not, of course, last long. In 1925, Werner Heisenberg (earlier a student of Sommerfeld's) made scepticism about the details of the Bohr model into a methodological dictum, one later enshrined in the "Copenhagen interpretation" of quantum mechanics. This paper uses Sommerfeld's work from the turn of the twentieth century to the mid-1920s as a window onto a landscape involving multiple contestations over the legitimacy of atomic modelling. The surprise that greeted Heisenberg's and others' phenomenological insistences, we will see, can only be understood with reference to what should be considered a "realist interlude" in the history of twentieth century atomic physics, one inspired by the astonishing successes of Rutherford's and Bohr's imaginings.