

## ESSAY 115: THE TRUE ORBITALS OF THE SOMMERFELD ATOM

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Arnold Sommerfeld used the lagrangian and hamiltonian of special relativity as the starting point for the first theory of relativistic quantum mechanics known as the Sommerfeld atom of 1913. So the methods of solving these described in the previous two essays can also be applied to the Sommerfeld atom to find its true orbitals. This is more than an academic exercise because the Sommerfeld atom led to the Dirac atom and many foundational discoveries.

He was nominated more than eighty times for a Nobel Prize and produced many Nobel prize winners from among his students and post doctorals, notably Peter Debye (doctoral thesis 1908), Wolfgang Pauli (doctoral thesis 1921), Werner Heisenberg (doctoral thesis 1923) and Hans Albrecht Bethe (doctoral thesis 1928). He attended the Altstaedtisches Gymnasium (Grammar School) in Koenigsberg in East Prussia from 1875 to 1886, then Koenigsberg University. Minkowski and Wien attended the same Gymnasium. He obtained his doctorate in 1891 on arbitrary functions in mathematical physics. In 1893 he went to Goettingen, the seat of mathematical high culture, and produced his Habilitaet under Felix Klein in 1895. From October 1897 he taught at the forward thinking University of Clausthal, the University attended by Horst Eckardt, from which the latter earned a doctoral degree. Sommerfeld then taught at Aachen, then in 1906 he moved to Muenich as a full professor, where an institute had been set up for him. He became interested in the then new quantum theory and made the first attempt to quantize special relativity in 1913. He discovered the magnetic quantum number in 1916, and the inner quantum number in 1921, work which led to the inference of electron spin. He had a friendly and informal way of teaching and was a strong opponent of the Nazi regime. He got away with it because of the high regard in which he was held, and the Nazi's dared not touch him. He became a proponent of a pacified Europe.

The Sommerfeld atom is based on his own method of quantization of the lagrangian and hamiltonian of special relativity. In two dimensions the classical orbit of the electron around the proton is given by the precessing ellipse just produced correctly for the first time by Horst Eckardt and myself in UFT328. So this precessing elliptical orbit can be extended to three dimensions using spherical polar coordinates, and Sommerfeld quantization applied. This procedure will give the true relativistic orbitals of the hydrogen atom for example. The Sommerfeld quantization is similar to the Bohr quantization, the Bohr atom being the first attempt to apply Planck / Einstein quantum theory to the atom. Sommerfeld introduced another type of quantization and extended the work of Bohr

In theory the orbits of planets can also be subjected to Sommerfeld quantization, because the inverse square law of attraction is used both in planetary theory and in atomic theory.

It can be claimed that the Sommerfeld group produced nearly all the major advances of the golden era of quantum mechanics, (known as the new quantum theory), and also influenced famous discoveries such as that of the Schroedinger equation following a suggestion of Peter Debye to Erwin Schrodinger at Zuerich in Switzerland. Following the inference of the electron spin, the subject was advanced by Paul Dirac in 1928, whose equation has evolved into the fermion equation. On the classical relativistic level the hamiltonian and lagrangian used by Sommerfeld and Dirac are the same. Only the methods of quantization differ. The other major contribution of the golden era was that of Louis de Broglie, who produced wave particle dualism. Peter Debye suggested to Erwin Schrodinger that he produce a wave equation explanation of the wave particle dualism of de Broglie. This

became the Schroedinger equation.

So the discovery by Horst Eckardt and myself of the true precessing orbit of planets has implications throughout the quantum theory and relativistic quantum theory.