Bohr's theory of hydrogen atom

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1 Introduction

In this research paper, I'm going to analyze the definition and the structure of the bohr's theory of hydrogen atom.

2 Definition

A simple definition of Bohr's atomic model is: electrons orbit the nucleus at set distances. When an electron changes orbits, it does so in a sudden quantum leap. The energy difference between the initial and final orbit is emitted by the atom in bundles of electromagnetic radiation called photons

3 Formula

Angular Momentum Quantization: In the Bohr model, the wavelength associated with the electron is given by the DeBroglie relationship:

$$\lambda = \frac{h}{mv}$$

The standing wave condition that circumference= whole number of wavelength. In the hydrogenic case, the number n is the principal quantum number.

$$2\pi r = n\lambda_n$$

Those can be combined to get an expression for the angular momentum of the electron in orbit.

$$L = mvr = \frac{hr}{\lambda} = \frac{nh}{2\pi}$$

Bohr Orbit: Combining the energy of the classical electron orbit with the quantization of angular momentum, the Bohr approach yields expressions for the electrons orbit radio and energies.

$$\frac{mv^2}{2} = \frac{(mvr)^2}{2mr^2} = \frac{n^2h^2}{8\pi^2}$$

4 Triumphs and Limitations

Bohr did what no one had been able to do before. Not only did he explain the spectrum of hydrogen, he correctly calculated the size of the atom from basic physics. Some of his ideas are broadly applicable. Electron orbital energies are quantized in all atoms and molecules. Angular momentum is quantized. The electrons do not spiral into the nucleus, as expected classically (accelerated charges radiate, so that the electron orbits classically would decay quickly, and the electrons would sit on the nucleus—matter would collapse). These are major triumphs.

The Bohr Model was an important step in the development of atomic theory. However, it has several limitations.

It is in violation of the Heisenberg Uncertainty Principle.

The Bohr Model considers electrons to have both a known radius and orbit, which is impossible according to Heisenberg.

The Bohr Model is very limited in terms of size. Poor spectral predictions are obtained when larger atoms are in question.

It cannot predict the relative intensities of spectral lines.

It does not explain the Zeeman Effect, when the spectral line is split into several components in the presence of a magnetic field.

The Bohr Model does not account for the fact that accelerating electrons do not emit electromagnetic radiation.

5 Hydrogen Spectrum

The movement of electrons between these energy levels produces a spectrum. The Balmer equation is used to describe the four different wavelengths of Hydrogen which are present in the visible light spectrum. These wavelengths are at 656, 486, 434, and 410nm. These correspond to the emission of photons as an electron in an excited state transitions down to energy level n=2. The Rydberg formula, below, generalizes the Balmer series for all energy level transitions.

6 Lyman series

The Lyman series is a hydrogen spectral series of transitions and resulting ultraviolet emission lines of the hydrogen atom as an electron goes from n 2 to n = 1 (where n is the principal quantum number) the lowest energy level of the electron.