Bohr's model of the hydrogen atom
Essays
Physics class section 13

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1 Definition

Bohr's Model depicts the atom as a small, positively charged nucleus surrounded by electrons that travel in circular orbits around the nucleus—similar in structure to the solar system, but with attraction provided by electrostatic forces rather than gravity.The Bohr model is a relatively primitive model of the hydrogen atom, compared to the valence shell atom.

2 Basic Principle

The Bohr Model is probably famillar as the "planetary model" of the atom illustrated in the adjacent figure that, for example, is used as a symbol for atomic energy (a bit of a misnomer, since the energy in "atomic energy" is actually the energy of the nucleus, rather than the entire atom). In the Bohr Model the neutrons and protons (symbolized by red and blue balls in the adjacent image) occupy a dense central region called the nucleus, and the electrons orbit the nucleus much like planets orbiting the Sun (but the orbits are not confined to a plane as is approximately true in the Solar System). The adjacent image is not to scale since in the realistic case the radius of the nucleus is about 100,000 times smaller than the radius of the entire atom, and as far as we can tell electrons are point particles without a physical extent.

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.

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

3 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.

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. You can't see this light.

Paschen series are the series of lines in the spectrum of the hydrogen atom which corresponds to transitions between the state with principal quantum number n = 3 and successive higher states. You can't see this light.