

4.4: Bohr's Atomic Model



Figure 4.4.1 (Credit: Courtesy of the U.S. Department of Agriculture; Source: http://commons.wikimedia.org/wiki/File:Ladder_and_telegraph_pole.jpg (opens in new window); License: Public Domain)

How does this worker's energy change as he climbs up and down the ladder?

Climbing a ladder takes energy. At every step, you push yourself up against gravity, and accumulate potential energy. Coming back down releases that potential energy as you descend step by step. If you are not careful, you can release that potential energy all at once by falling off the ladder (never a good thing). In addition, you take the climb or descent in steps. There is no "in-between" position on the ladder—your foot either hits a rung, or it hits empty space, and you are in trouble until you find a rung to stand on.

Bohr's Atomic Model

Following the discoveries of hydrogen emission spectra and the photoelectric effect, the Danish physicist Niels Bohr (1885-1962) proposed a new model of the atom in 1915. Bohr proposed that electrons do not radiate energy as they orbit the nucleus, but exist in states of constant energy that he called **stationary states**. This means that the electrons orbit at fixed distances from the nucleus (see below). Bohr's work was primarily based on the emission spectra of hydrogen. This is also referred to as the planetary model of the atom. It explained the inner workings of the hydrogen atom. Bohr was awarded the Nobel Prize in physics in 1922 for his work.

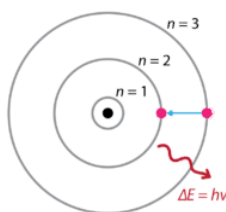


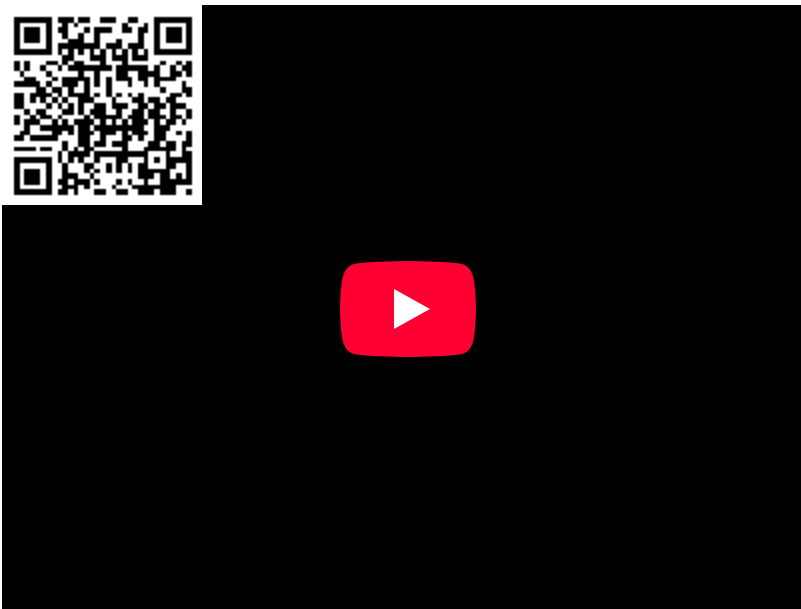
Figure 4.4.2: Bohr's atomic model hydrogen emission spectra. (Credit: Zachary Wilson; Source: CK-12 Foundation; License: [CC BY-NC 3.0](#) (opens in new window))

Bohr explained that electrons can be moved into different orbits with the addition of energy. When the energy is removed, the electrons return back to their ground state, emitting a corresponding amount of energy—a quantum of light, or photon. This was the basis for what later became known as **quantum theory**. This is a theory based on the principle that matter and energy have the properties of both particles and waves. It accounts for a wide range of physical phenomena, including the existence of discrete packets of energy and matter, the uncertainty principle, and the exclusion principle.

According to the Bohr model, often referred to as a **planetary model**, the electrons encircle the nucleus of the atom in specific allowable paths called orbits. When the electron is in one of these orbits, its energy is fixed. The ground state of the hydrogen atom, where its energy is lowest, is when the electron is in the orbit that is closest to the nucleus. The orbits that are further from the nucleus are all of successively greater energy. The electron is not allowed to occupy any of the spaces in between the orbits. An everyday analogy to the Bohr model is the rungs of a ladder. As you move up or down a ladder, you can only occupy specific rungs and cannot be in the spaces in between rungs. Moving up the ladder increases your potential energy, while moving down the ladder decreases your energy.

Bohr's work had a strong influence on our modern understanding of the inner workings of the atom. However, his model worked well as an explanation for the emissions of the hydrogen atom, but was seriously limited when applied to other atoms. Shortly after

Bohr published his planetary model of the atom, several new discoveries were made, which resulted in, yet again, a revised view of the atom.



Summary

- The Bohr model postulates that electrons orbit the nucleus at fixed energy levels.
- Orbits further from the nucleus exist at higher energy levels.
- When electrons return to a lower energy level, they emit energy in the form of light.

Review

1. When did Bohr propose his model of the atom?
2. What is a stationary state?
3. What is the ground state?
4. Can the electron occupy any space between the orbits?

This page titled [4.4: Bohr's Atomic Model](#) is shared under a [CK-12](#) license and was authored, remixed, and/or curated by [Theodore Chan](#) via [source content](#) that was edited to the style and standards of the LibreTexts platform.

- **5.6: Bohr's Atomic Model** by [CK-12 Foundation](#) is licensed [CK-12](#). Original source: <https://flexbooks.ck12.org/cbook/ck-12-chemistry-flexbook-2.0/>.