

Difference Between Bohr and Quantum Model

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Key Difference - Bohr vs Quantum Model

The Bohr model and quantum model are models that explain the structure of an [atom](#). Bohr model is also called Rutherford-Bohr model because it is a modification of the [Rutherford model](#). Bohr model was proposed by Niels Bohr in 1915. Quantum model is the modern model of an atom. The key difference between Bohr and quantum model is that **Bohr model states that electrons behave as particles** whereas **quantum model explains that the electron has both particle and wave behavior**.

What is Bohr Model?

As mentioned above, the Bohr model is a modification of the Rutherford model since the Bohr model explains the structure of the atom as composed of a nucleus surrounded by [electrons](#). But Bohr model is more advanced than the Rutherford model because it says that, the electrons are always traveling in specific shells or orbits around the nucleus. This also states that these shells have different energies and are spherical in shape. That was suggested by observations of the [line spectra](#) for the [hydrogen atom](#).

Due to the presence of discrete lines in the line spectra, Bohr stated that the orbitals of an atom have fixed energies and electrons can jump from one energy level to the other emitting or absorbing energy, resulting in a line in the line spectra.

Main Postulates of Bohr Model

- The electrons move around the nucleus in spherical orbitals which have a fixed size and energy.
- Each orbit has a different radius and is named from nucleus to the outside as $n=1, 2, 3, \text{etc.}$ or $n= K, L, M, \text{etc.}$ where n is the fixed energy level number.
- The energy of an orbital is related to its size.
- The smallest orbit has the lowest energy. The atom is completely stable when electrons are in the lowest energy level.
- When an electron is moving in a certain orbital, the energy of that electron is constant.

- Electrons can move from one energy level to another by absorbing or releasing energy.
- This movement causes [radiation](#).

Bohr model perfectly fit the hydrogen atom which has a single electron and a small positively charged nucleus. Apart from that, Bohr used the Plank's constant to calculate the energy of the energy levels of the atom.

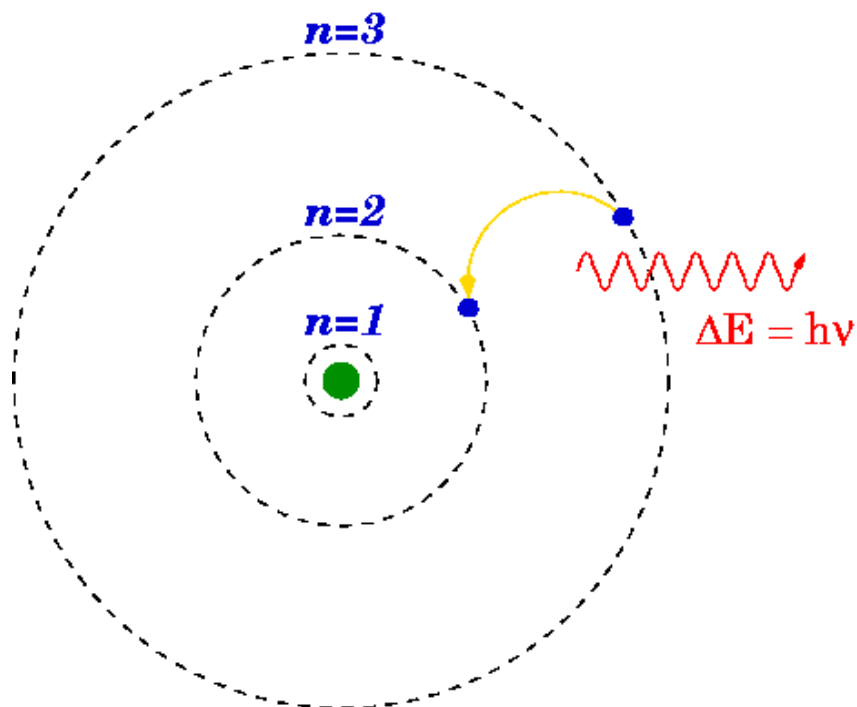


Figure 01: The Bohr Model for Hydrogen

But there were few drawbacks of Bohr model when explaining the atomic structure of atoms other than Hydrogen.

Limitations of Bohr Model

- The Bohr model could not explain the Zeeman effect (effect of [magnetic field](#) on the atomic spectrum).
- It could not explain the Stark effect (effect of electric field on the atomic spectrum).
- Bohr model fails to explain the atomic spectra of larger atoms.

What is Quantum Model?

Although the quantum model is much harder to understand than Bohr model, it accurately explains the observations regarding the large or complex atoms. This quantum model is based on quantum theory. According to quantum theory, an electron has particle-wave duality and it is impossible to locate the exact

position of the electron (uncertainty principle). Thus this model is mainly based on the probability of an electron to be located anywhere in the orbital. It also states that the orbitals are not always spherical. The orbitals have particular shapes for different energy levels and are 3D structures.

According to the quantum model, an electron can be given a name with the use of quantum numbers. Four types of quantum numbers are used in this;

- Principle quantum number, n
- Angular momentum quantum number, l
- Magnetic quantum number, m_l
- Spin quantum number, m_s

The principle quantum number explains the average distance of the orbital from the nucleus and the energy level. The angular momentum quantum number explains the shape of the orbital. The magnetic quantum number describes the orientation of orbitals in the space. The spin quantum number gives the spinning of an electron in a magnetic field and the wave characteristics of the electron.

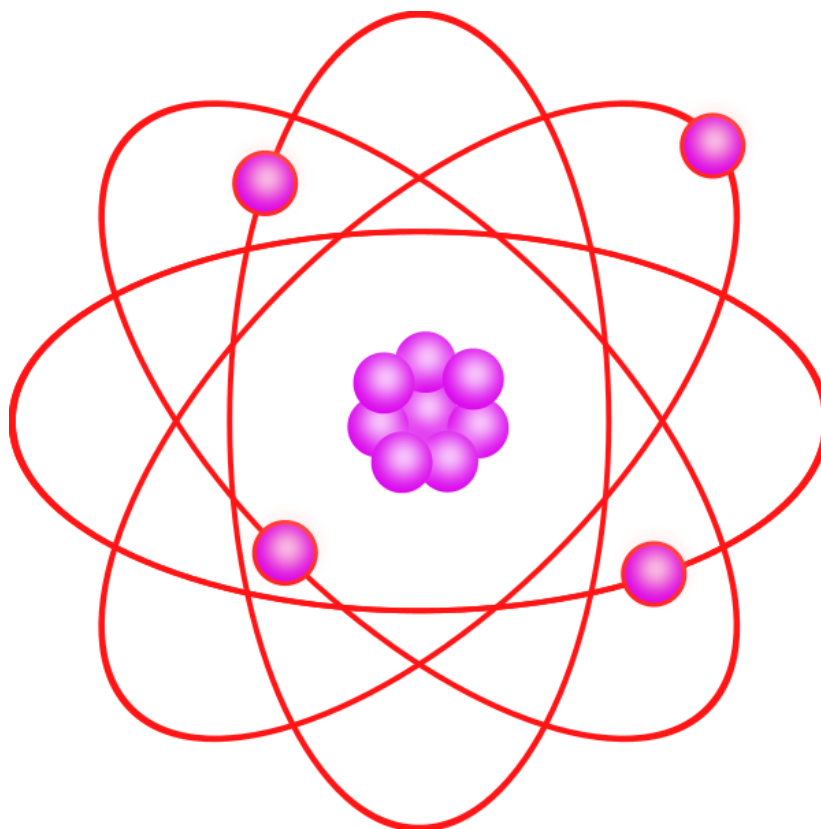


Figure 2: Spatial structure of atomic orbitals.

What is the difference between Bohr and Quantum Model?

Bohr vs Quantum Model	
Bohr model is an atomic model proposed by Niels Bohr (in 1915) to explain the structure of an atom.	Quantum model is an atomic model which is considered as the modern atomic model to explain the structure of an atom accurately.
Behavior of Electrons	
The Bohr model explains the particle behavior of an electron.	Quantum model explains the wave-particle duality of an electron.
Applications	
Bohr model can be applied for hydrogen atom but not for large atoms.	Quantum model can be used for any atom, including smaller ones and large, complex atoms.
Shape of Orbitals	
Bohr model does not describe the exact shapes of every orbital.	Quantum model describes the all possible shapes an orbital can have.
Electro-Magnetic Effects	
Bohr model does not explain the Zeeman Effect (effect of magnetic field) or Stark effect (effect of electric field).	Quantum model explains the Zeeman and Stark effects precisely.
Quantum Numbers	
Bohr model does not describe the quantum numbers other than the principle quantum number.	Quantum model describes all four quantum numbers and the characteristics of an electron.

Summary - Bohr and Quantum Model

Although several different atomic models were proposed by scientists, the most notable models were Bohr model and quantum model. These two models are closely related but the quantum model is much more detailed than Bohr model. According to the Bohr model, an electron behaves as a particle whereas quantum model explains that the electron has both particle and wave behavior. This is the main difference between Bohr and quantum model.

References:

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2. "Atomic Structure: The Quantum Mechanical Model." Dummies. N.p., n.d. Web. [Available here](#). 05 June 2017.

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