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**Niels Bohr**

**Nobel Prize for Physics, 1922**

Niels Bohr, born Neils Henrik David Bohr, was born in Copenhagen on October 7, 1885. He grew up with his mother and father, Ellen and Christian Bohr. Bohr also had a younger brother, Harald, who became a future Professor in Mathematics. Bohr's father was a well-known physiologist and was a Professor of Physiology at Copenhagen University who made Bohr interested in physics. Bohr's mother came from a well-educated family.

Bohr studied at the Gammelholm Grammar School, and in 1903, he entered Copenhagen University where he studied under Professor C. Christiansen, and earned his Master's degree in Physics in 1909 and his Doctor's degree in 1911. When Bohr was still a student, the Academy of Sciences in Copenhagen offered a prize for the solution of a certain scientific problem. Bohr worked out the problem in his father's laboratory, and he received a gold medal as a prize and was published in the Transactions of the Royal Society. However, Bohr's studies soon became theoretical, which helped him explain the properties of metals with the aid of the electron theory. This was when Bohr was first challenged with the implications of Planck's quantum theory of radiation.

In 1911, Bohr stayed at Cambridge where he studied at the Cavendish Laboratory under Sir J.J. Thomson's guidance, while pursuing his own studies. In 1912, he went to work in

Professor Rutherford's laboratory in Manchester, where he discovered the basics of radioactivity. He worked on a theoretical piece of work on alpha rays and how they are absorbed. This work was published in the *Philosophical Magazine* in 1913. He then decided to study the structure of atoms on what Rutherford had discovered earlier: the atomic nucleus. Using concepts for the Quantum Theory, he created an atomic structure that shows the physical and chemical properties of the elements. Recognition of his work on the structure of atoms led to the Nobel Prize for Physics in 1922.

In 1912, Bohr married Margrethe Norlund, and they had six sons. Two of them died, but the other four went on to have good careers. Hans Henrik became a doctor, Erik became a chemical engineer, Aage became a theoretical physicist, and Ernest became a lawyer. His son Aage also won the Nobel Prize for Physics in 1975 for the discovery of the connection between collective motion and particle motion in atomic nuclei and the development of the theory of the structure of the atomic nucleus based on this connection. From 1913 to 1914, Bohr held a Lectureship in Physics at Copenhagen University and from 1914 to 1916 he had a similar job at the Victoria University in Manchester. In 1916 he was appointed Professor of Theoretical Physics at Copenhagen University, and from 1920 until death, he was at the head of the Institute for Theoretical Physics. Niels Bohr died from a heart attack in Copenhagen on November 18, 1962.

Bohr was awarded the Nobel Prize for physics in 1922 for his work on the structure of the atom. Bohr's model of the atom explains the emissions and absorbing of radiation as transitions between stationary electronic states in which the electron orbits the nucleus at a definite distance. An incorrect model was created by J.J. Thompson in 1904 that was called the "plum pudding model," where the electrons were embedded in an electron sphere. In Bohr's

model, the electron of the hydrogen model orbits around the nucleus. When jumping from one orbit to an inner orbit, the atom emits light of a certain frequency which depends on the orbits concerned. His model contributes to the line spectra, that when a solid material is heated, it becomes incandescent, meaning it emits light. The same is true for gases, vapors, and their atoms or molecules are heated. The light produced is different, but light is still produced. Bohr's atomic theory can be summarized by saying that:

- Electrons can only occupy certain orbits or shells in an atom. Each orbit represents a definite energy for the electrons in it.
- Light is emitted by an atom when an electron jumps from one of its allowed orbits to another. Because each orbit represents definite electron energy, this transition represents certain energy jump. This change in electron energy leads to emission of light of energy or wavelength.

Bohr's model was applied to hydrogen as well as more complicated atoms known at the time. In 1922, nine years later, Bohr received the Nobel Peace Prize for Physics for his explanation of the hydrogen line spectrum, using his model.

During Nazi occupation of Denmark in World War II, Bohr escaped to Sweden in 1933. Even though he was Christian, Bohr had Jewish origins on his mother's side. He escaped on a fishing boat. From there, he flew to England to work on the nuclear fission bomb. He discovered that uranium could be fissionable using isotope U-235, which created a nuclear fission reaction. After a few months, he went with the British research team to Los Alamos in the United States. He then became associated with the Atomic Energy Project. Bohr brought his son, Aage, with him as an assistant and secretary, which also developed Aage's knowledge on the topic. Bohr

later decided that he should devote his work to a peaceful use of atomic physics and to political problems arising from the development of atomic weapons. He tried to persuade Winston Churchill and Franklin Roosevelt for the need of international cooperation and control of nuclear weapons, instead of using nuclear weapons. After the war was over, Bohr returned to Copenhagen, advocating the peaceful use of nuclear energy.

Niels Bohr developed his atomic model by using knowledge. He was one of Rutherford's students, and Rutherford's model thought that electrons just moved around the nucleus randomly. However, Bohr changed Rutherford's model due to newer discoveries about how the energy of an atom changes when it absorbs or emits light. Because of these new discoveries about energy levels of electrons, Bohr proposed a new model for the atom. Because there are fixed energy levels and sublevels that electrons can be in, Bohr assumed that electrons traveled in perfectly circular paths around the nucleus of the atom at fixed distances from the nucleus depending on the energy levels. As long as electrons stay in these energy levels, they are stable. Electrons give or take energy only when they change their energy levels. If the electron gains energy, it would leap a level further from the nucleus; if it lessens in energy, the electron would fall a level closer to the nucleus. Though electrons make small changes in energy, an electron that is not in its original energy level always has to go back to its original level. Bohr used knowledge that Rutherford did not have when he created Rutherford's model. Bohr studied the patterns of electrons and their paths, noting the fixed energy levels and the location of the nucleus in the atom. Rutherford did not take in account the behavior of gases when creating his model. Bohr's discovery of a nucleus surrounded by electron shells aided Bohr to create his model.

Niels Bohr died from a heart attack on November 18, 1962 at age 77. Bohr's planetary model was used until 1926, when the quantum mechanical model was created by Erwin Schrodinger. Bohr's model was inconsistent with new theoretical calculations and experimental results were inconsistent with describing electron motion. Bohr's model had minor problems, such as constant electron motion that lead to his model being replaced four years later. Bohr's model allowed for the current model to be created, and Bohr has since remained an established physicist.

## **Sources**

1. [http://groups.dcs.st-and.ac.uk/~history/Printonly/Bohr\\_Niels.html](http://groups.dcs.st-and.ac.uk/~history/Printonly/Bohr_Niels.html)
2. [http://www.daviddarling.info/encyclopedia/B/Bohr\\_atom.html](http://www.daviddarling.info/encyclopedia/B/Bohr_atom.html)
3. <http://atomicarchive.com/Bios/Bohr.shtml>
4. <http://chemed.chem.purdue.edu/genchem/history.bohr.html>
5. [http://en.wikipedia.org/wiki/Niels\\_Bohr](http://en.wikipedia.org/wiki/Niels_Bohr)
6. [http://nobelprize.org/nobel\\_prizes/physics/laureates/1922/bohr-bio.html](http://nobelprize.org/nobel_prizes/physics/laureates/1922/bohr-bio.html)
7. <http://csep10.phys.utk.edu/astr162/lect/light/bohr.html>
8. <http://bohr.jegli.net/Bohr.htm>