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- **Albert Einstein**
- **Niels Bohr**
- **Sir Isaac Newton**
- **Neil deGrasse Tyson**
- **Rosalind Franklin**
- **Gregor Mendel**
- **Nikola Tesla**
- **Marie Curie**
- **Stephen Hawking**
- **Carl Sagan**
- **Leonardo da Vinci**
- **Galileo Galilei**
- **Amedeo Avogadro**
- **Robert Hooke**
- **Thomas Edison**
- **Edwin Hubble**

Niels Bohr

Born October 7, 1885, in Copenhagen, Denmark

Died November 18, 1962, in Copenhagen, Denmark



Overview:

Niels Bohr was a world-class scientist and peacemaker. Although he was involved in the controversial making of the atomic bomb, he promoted the peaceful use of atomic physics and peace between nations. His Bohr Atomic Model and work with nuclear fission made great contributions to the fields of chemistry and quantum physics. We will discuss his life, struggles, and accomplishments.

His Life:

Niels Bohr was born on October 7, 1885 in Copenhagen, Denmark. His mother came from an educated family, and his father was a physiology professor at Copenhagen University. Bohr and his younger brother, Harold, were raised in an academic environment, and both were interested in math and science from an early age. Harold would later become a mathematics professor.

In 1903, Bohr enrolled in Copenhagen University. He received a **gold medal** from the Academy of Sciences in Copenhagen for his work on researching “surface tension by means of oscillating jet fluids.” The **Royal Society**, the oldest and most prestigious scientific society in Britain, later

published Bohr's award winning work on surface tension. Bohr received his doctorate degree in Physics in 1911, just four years before he presented his Bohr's Model of atomic structure.

Bohr has been described as being "day-dreamy", and "too stuck in his own head to notice worldly things." In fact, Bohr was nearly run over by a horse and carriage in front of the **Tech Area of Los Alamos**, a popular area for scientists to take walks late at night to think about their work.

Bohr married in 1912 to Margrethe Nørlund. They had 6 kids. One of their sons, Aage, would go on to receive a Nobel Prize in physics like his father. Bohr passed away November 18, 1962 in Denmark.



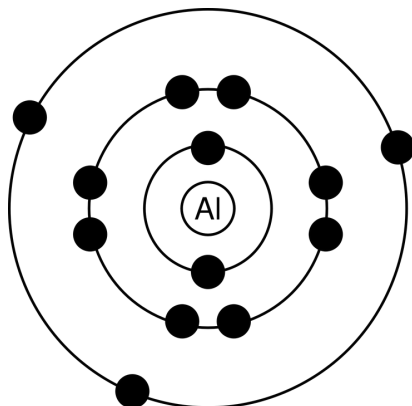
Niels Bohr and Margrethe Nørlund
- 1910

Struggles:

Bohr was forced to escape from Denmark after the Nazi occupation during World War II. After his escape, he began work on the Atomic Energy Project. After the war, Bohr devoted much of his time to promoting the peaceful use of atomic physics in applications such as nuclear power generation. He published a paper named ***Open Letter to the United Nations*** in 1950 to promote openness and peace between countries after the advent of the atomic bomb.

What He Accomplished:

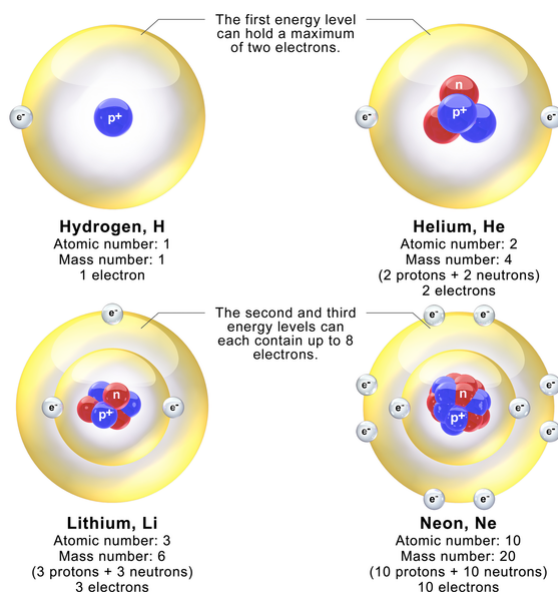
The most important properties of atomic and molecular structure are demonstrated using **Bohr's Model**, which Bohr presented in 1915. Bohr's ideas of the working of electrons are what differs his



The Bohr Atomic Model

model from that of others. He proposed that the outermost "**shell**", a grouping of electrons surrounding the nucleus of an atom, determines the chemical properties of the atom. He also suggested that as electrons move around the nucleus, they give off electromagnetic radiation, eventually running out of energy and colliding with the nucleus. In the picture below, we can see some atoms and their electron shells. The individual rings around the nuclei are called **orbitals**. Bohr found that electrons are **always** in one of the orbitals, and are **never** found between them. The way an electron moves from one orbital to another therefore is by

jumping from one of the outermost orbitals to one of the innermost orbitals until the electron eventually reaches the nucleus. When an electron goes from an outer orbital to an orbital closer to the nucleus, it absorbs electromagnetic radiation and emits **photons**, tiny particles of light, otherwise known as electromagnetic radiation. Bohr's work with atoms would eventually lead to him receiving a **Nobel Prize** in 1922.



The Bohr Atomic Model - Credit BruceBlau

In 1921, Bohr opened the Institute of Theoretical Physics, which today is known as the **Niels Bohr Institute**. For decades, the Institute was central to researchers working in theoretical physics, and is still the largest institution of research in Denmark.

Another great accomplishment by Bohr was his finding that light both behaves as waves and particles, but is **never** wavelike and particle-like at the same time. He called this idea **complementarity**. Bohr's principle of



Niels Bohr Institute



Bohr and Einstein - 1925

complementarity still holds today, and is a very important principle in modern physics.

Bohr also composed the **liquid droplet theory**. The theory explains how "spherical nuclei may be distorted into a dumbbell shape and then split at the neck into two nearly

equal fragments.” The liquid droplet theory cannot be used for all nuclear phenomena, but is very useful for estimating averages of nucleic properties. The theory is fundamental to understanding **nuclear fission**.

In 1981, Peter Armbruster, Gottfried Münzenberg, and colleagues discovered an element and named it Bohrium after Bohr, because he had earlier predicted its existence.

Reading Comprehension Questions

1. Why did Bohr receive a gold medal from the Academy of Sciences in Copenhagen during his college years? What prestigious scientific society published Bohr’s work?
2. What was the name of the popular area for scientists to take walks late at night to think about their work? What almost happened to Bohr at this location?
3. How many children did Bohr and his wife have? What was the name of his son who would later receive a Nobel Prize in Physics?
4. What discovery by Bohr exemplified the most important properties of atomic and molecular structure? What were Bohr’s findings on electrons and orbitals?
5. What institute did Bohr open? What is the institute called today?
6. What discoveries did Bohr make about light?
7. Which element was named after him?

Extension Questions

8. After the advent of the atomic bomb, Bohr devoted much of his time to promoting peace between nations and peaceful uses of atomic physics. Do you think he felt guilty for his work on the atomic bomb? Do some research on the letter Bohr wrote to the United Nations, and use it to explain why you think science is an important subject for the world.
9. Research the teamwork between Bohr and colleagues. Who are some notable scientists that Bohr worked with? Do you think collaboration is important in scientific research?
10. Why is the Bohr Atomic Model sometimes called the Bohr-Rutherford Atomic Model? How did Bohr expand on the work of Rutherford?

Reading Comprehension Questions- Answer Key

1. Why did Bohr receive a gold medal from the Academy of Sciences in Copenhagen during his college years? What prestigious scientific society published Bohr's work? **Bohr received a gold medal from the Academy of Sciences in Copenhagen for his work on researching the "surface tension by means of oscillating jet fluids." The Royal Society published Bohr's work.**
2. What was the name of the popular area for scientists to take walks late at night to think about their work? What almost happened to Bohr at this location? **The area was the Tech Area of Los Alamos. Bohr was almost run over by a horse and carriage at the Tech Area after going for a walk in the area.**
3. How many children did Bohr and his wife have? What was the name of his son who would later receive a Nobel Prize in Physics? **Bohr and his wife had 6 kids. Their son Aage received a Noble Prize in Physics.**
4. What discovery by Bohr exemplified the most important properties of atomic and molecular structure? What were Bohr's findings on electrons and orbitals? **Bohr produced the Bohr's Atomic Model. Bohr found that electrons are always in one of the orbitals, and are never found in between them.**
5. What institute did Bohr open? What is the institute called today? **Bohr opened the Institute of Theoretical Physics. Today, the institute is called the Niels Bohr Institute.**
6. What discoveries did Bohr make about light? **Bohr found that light behaved like waves and particles, but was never wavelike and particle-like at the same time.**
7. Which element was named after him? **The element Bohrium was named after Bohr.**

Extension Questions – Answer Key

8. After the advent of the atomic bomb, Bohr devoted much of his time to promoting peace between nations and peaceful uses of atomic physics. Do you think he felt guilty for his work on the atomic bomb? Do some research on the letter Bohr wrote to the United Nations, and use it to explain why you think science is an important subject for the world. **Possible answers may include that science is an important subject because it can be used to promote peace between nations, but if misused can have detrimental consequences for the world.**
9. Research the teamwork between Bohr and colleagues. Who are some notable scientists that Bohr worked with? Do you think collaboration is important in scientific research? **Possible answers may include that scientific collaboration is essential to good scientific research, and is important for having more than one set of eyes figuring out difficult theoretical and experimental problems.**
10. Why is the Bohr Atomic Model sometimes called the Bohr-Rutherford Atomic Model? How did Bohr expand on the work of Rutherford? **Answer should focus on the point that Bohr's atomic model was heavily based on the work of Rutherford with the addition of the "orbitals" where the electrons would be found exclusively.**

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