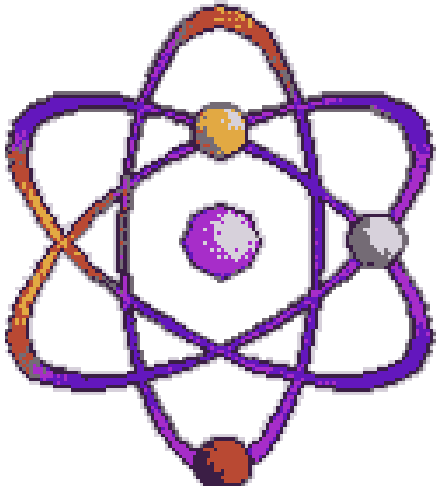
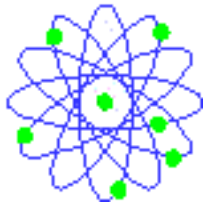
NOTES – Introduction to Atomic Theory (4.1-4.2)



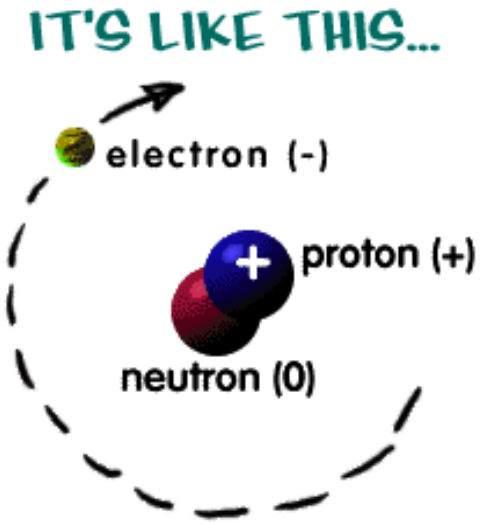
Atomic Structure



- **ATOM**: the smallest particle of matter that has the properties of an element.

- From the early Greek concept of the atom to the modern atomic theory, scientists have built on and modified existing models of the atom.

ATOM BASICS



- Atoms are composed of a positively charged nucleus surrounded by an electron cloud.

  -**Nucleus** (99% of atom's mass): uncharged neutrons and positively charged protons.

  -**Electron cloud**: negatively charged electrons in constant motion creating a "cloud" like a fan.

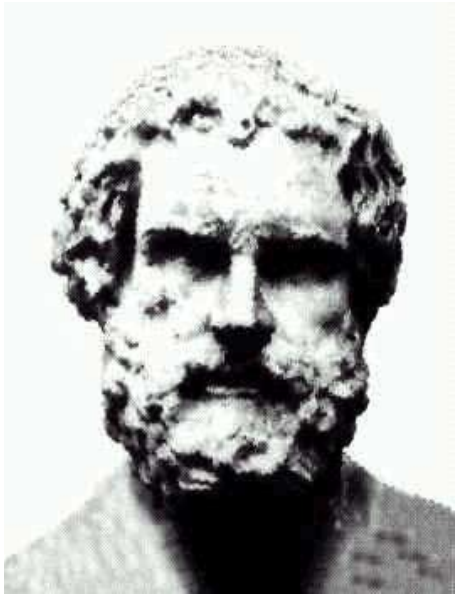
What discoveries lead to the Atomic Theory?

- **DEMOCRITUS** – "Father of the Atom"

  -400 B.C.E.

  -teacher / philosopher in ancient Greece

  -**atomus** – "indivisible"



John Dalton (1766-1844) – Father of the Modern Atom

- In 1808, this English schoolteacher proposed:

1) All elements are composed of **tiny indivisible particles called atoms**.

2) Atoms of the **same element are identical**. Atoms of different elements are different.

John Dalton (1766-1844) – Father of the Modern Atom

3) Atoms **combine in simple whole number ratios**.

4) Atoms of one element are never changed to atoms of another element during chemical reactions. (**but they can be rearranged**!)

- As it turns out, the atom can be divided into **<u>subatomic particles</u>**.
- **Thompson** and **Millikan** are given credit for the first discoveries relating to electrons.

Millikan

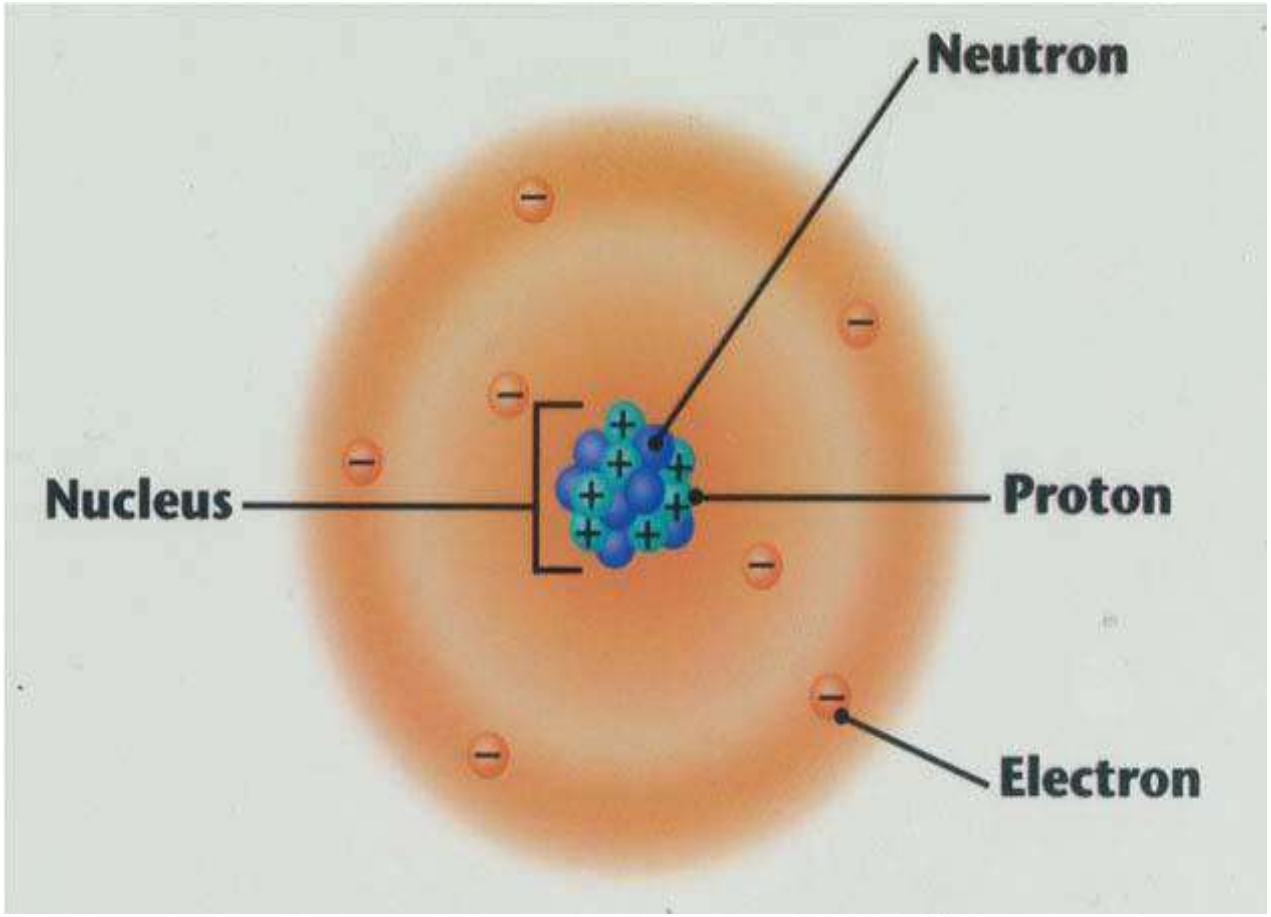
Thompson

- **Rutherford** discovered the positively charged nucleus

Ernest Rutherford

Subatomic Particles

- Electrons
- Protons
- Neutrons
- Nucleus



Electrons

- J.J. Thomson – 1897
- Discovered the electron using a cathode ray tube (CRT) – fig. 4.4, p. 105
- Determined the electron mass to be roughly 1/2000 amu
- **Robert Millikan** – 1916 - determined the electric charge to be (-1) and the mass to be exactly 1/1840 the mass of a hydrogen atom

Protons

- E. Goldstein – 1886
- discovered the proton
- Mass = 1 amu and charge = (+1)
- Thomson put both the electron and proton together and proposed the “Plum Pudding” model of the atom

Neutrons

- James Chadwick – 1932
- discovered the neutron
- Mass = 1 amu and there is no charge
- Neutron is located in the nucleus with the proton

Nucleus

- **Ernest Rutherford** – 1911
- Using the "Gold Foil" experiment (fig. 4.7, p. 108), Rutherford determines:

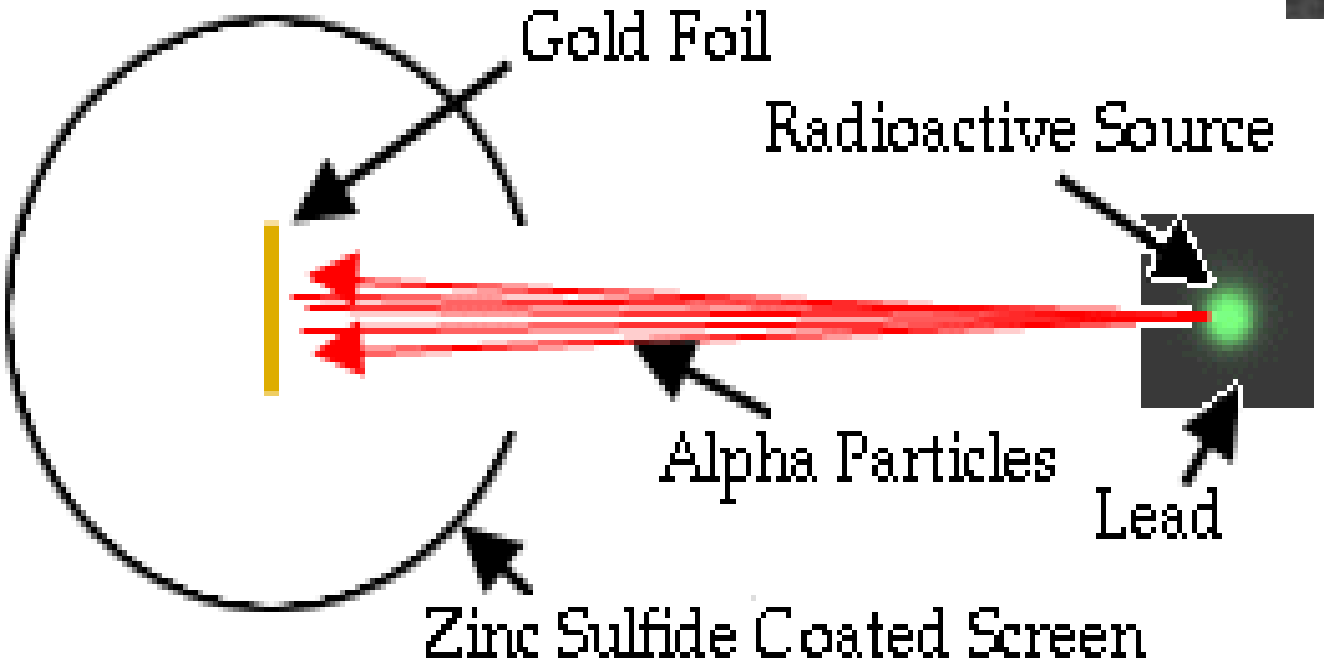
1) An atom is mostly space;

2) There is a nucleus in the middle of the atom containing the protons & neutrons;

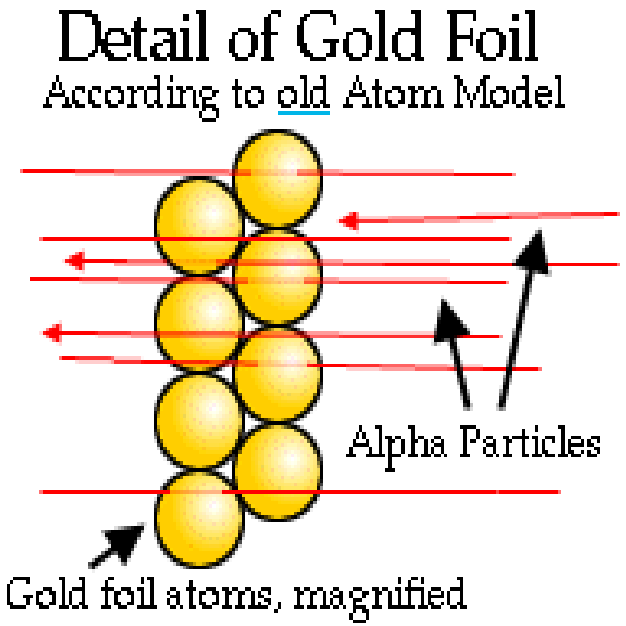
3) The electrons orbit a large distance away from the nucleus;

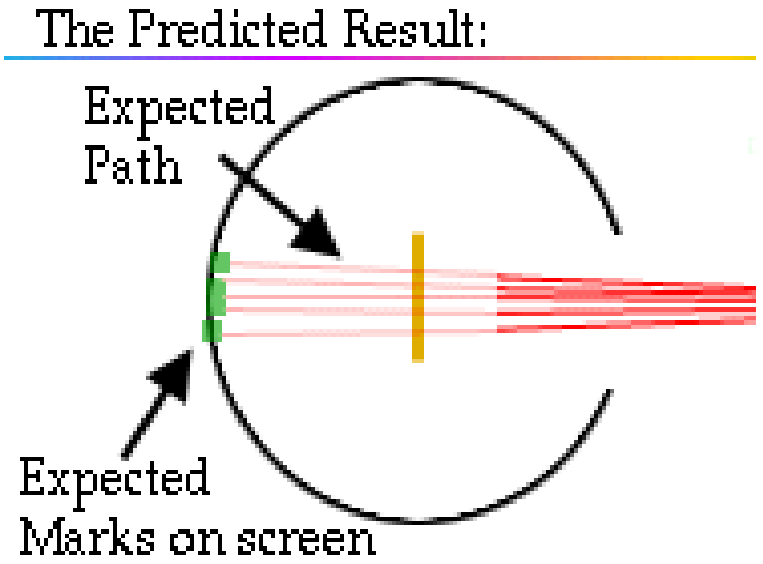
4) Proposes the "Solar System" model of the atom.

Rutherford "Scattering" Experiment



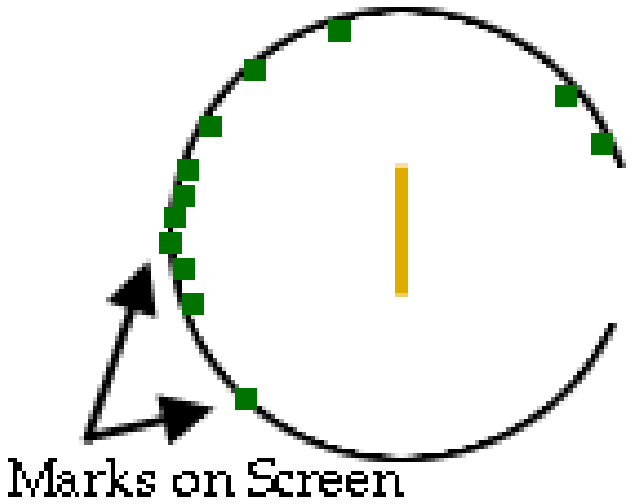
Rutherford "Scattering" Experiment



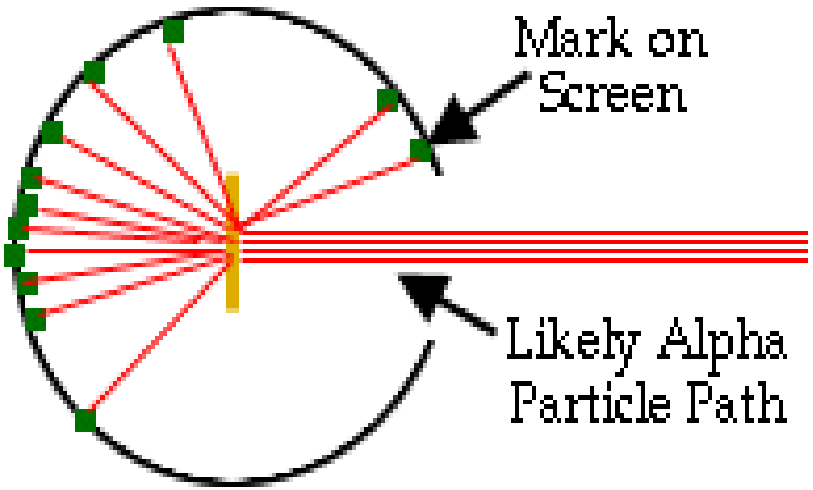


Rutherford "Scattering" Experiment

The Result



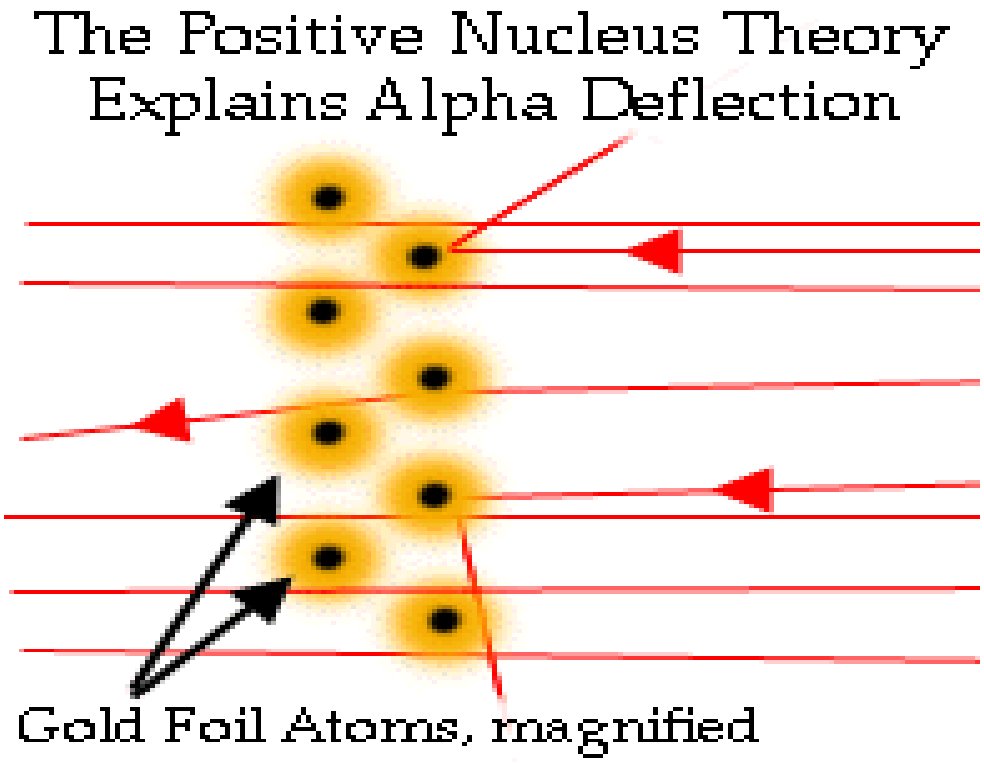
Extrapolation of Result:



"I remember Geiger coming to me in great excitement and saying, "We have been able to get some of the alpha-particles coming backwards." It was quite the most incredible event that has ever happened to me in my life. It was almost as incredible as if you fired a 15 inch shell at a piece of paper and it came back and hit you."

Ernest Rutherford

Rutherford "Scattering" Experiment



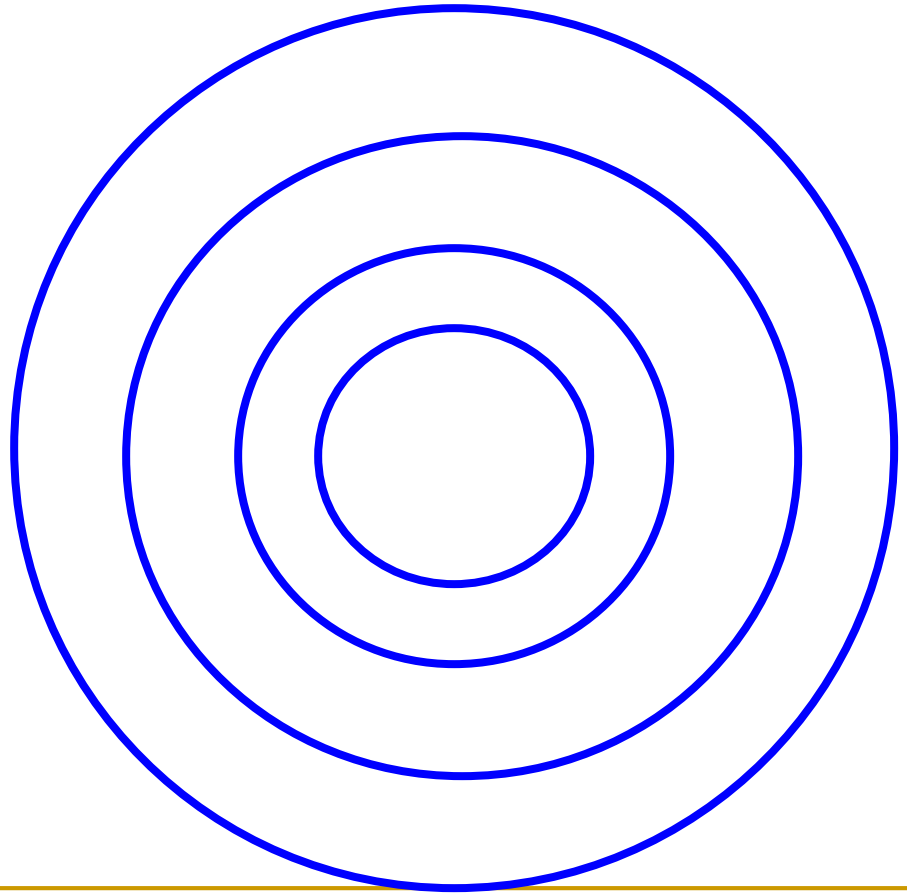
Rutherford proposed the nucleus, and the "solar system" model.

NIELS BOHR

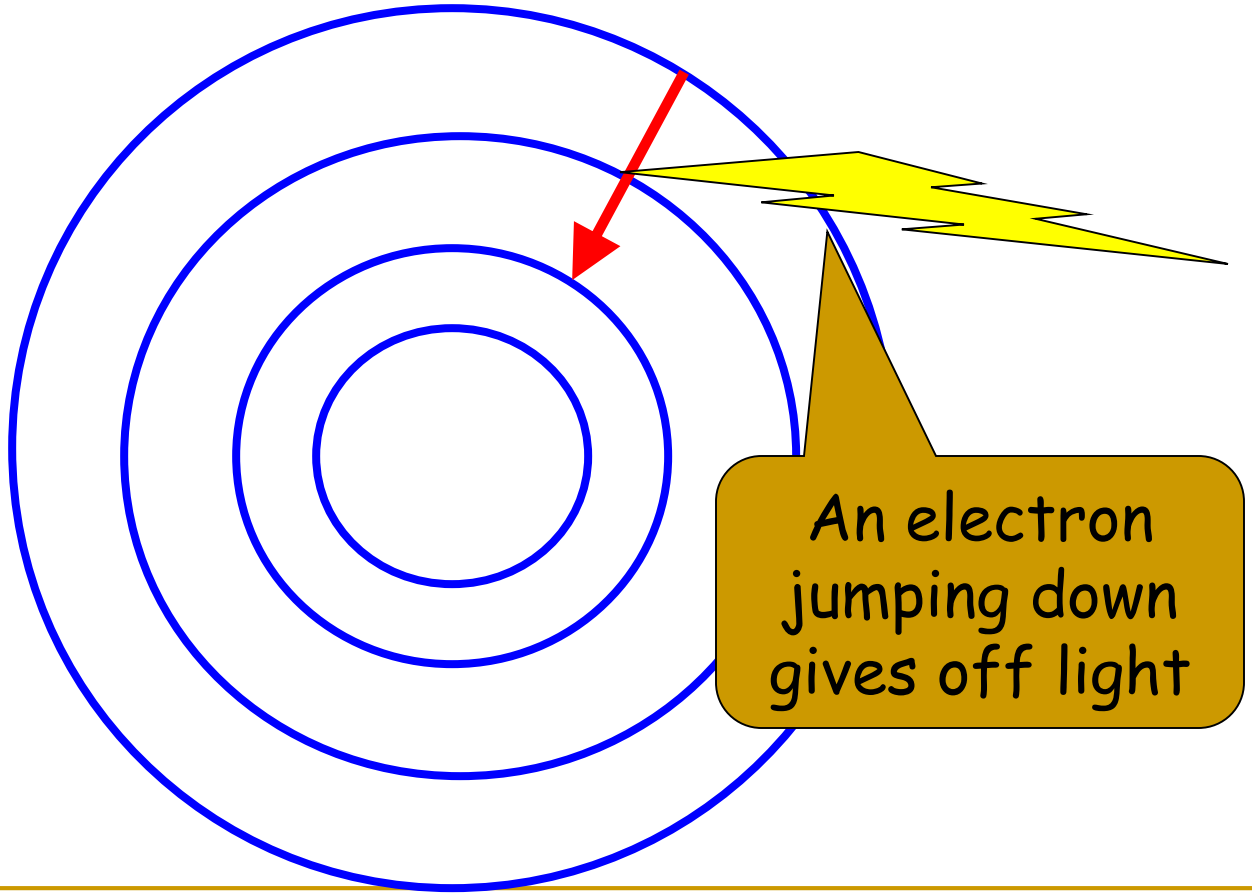
- In 1913, this Danish scientist suggested that electrons “orbit” the nucleus.
- In Bohr’s model, electrons are placed in different energy levels based on their distance from the nucleus.

***Electrons are like books in a book case. They can only exist on certain levels.*

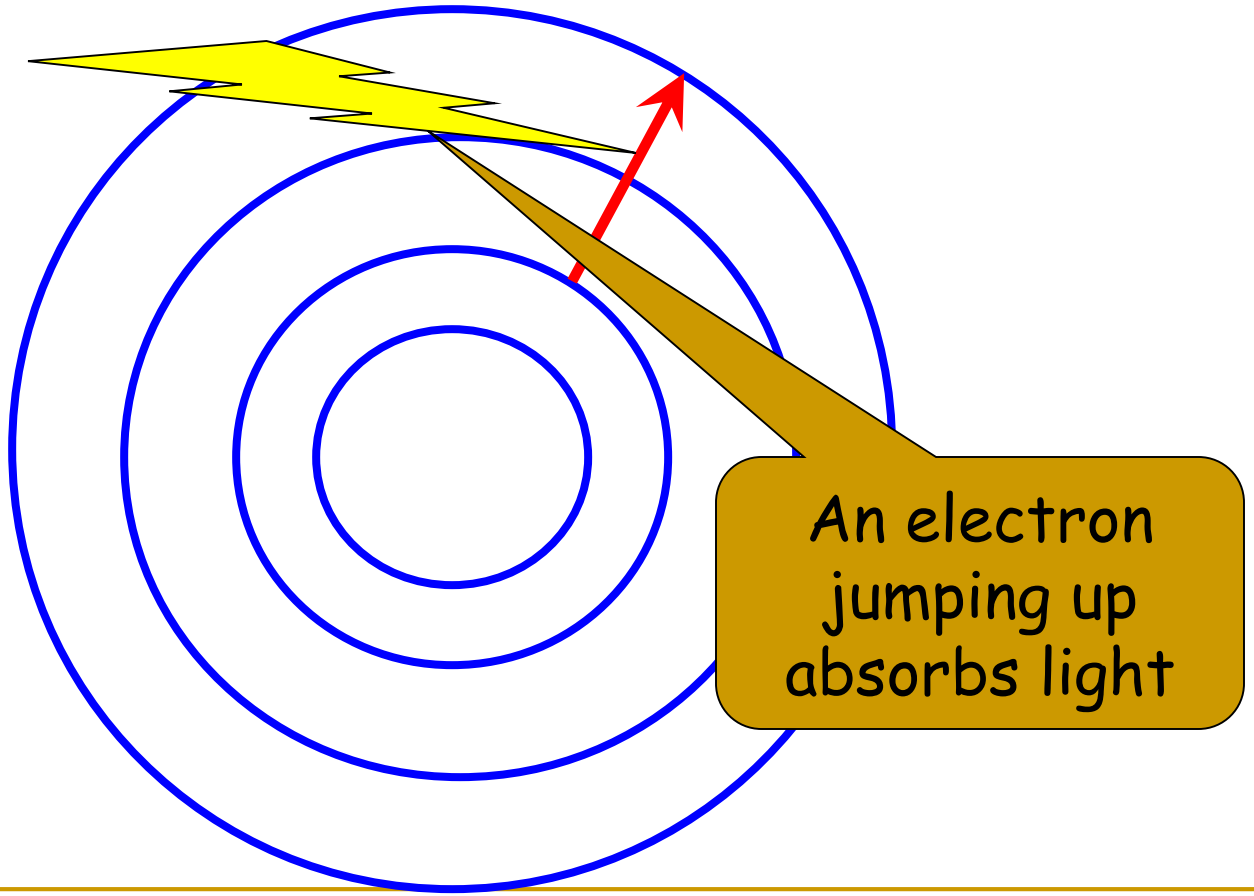
Only certain orbits are “allowed”



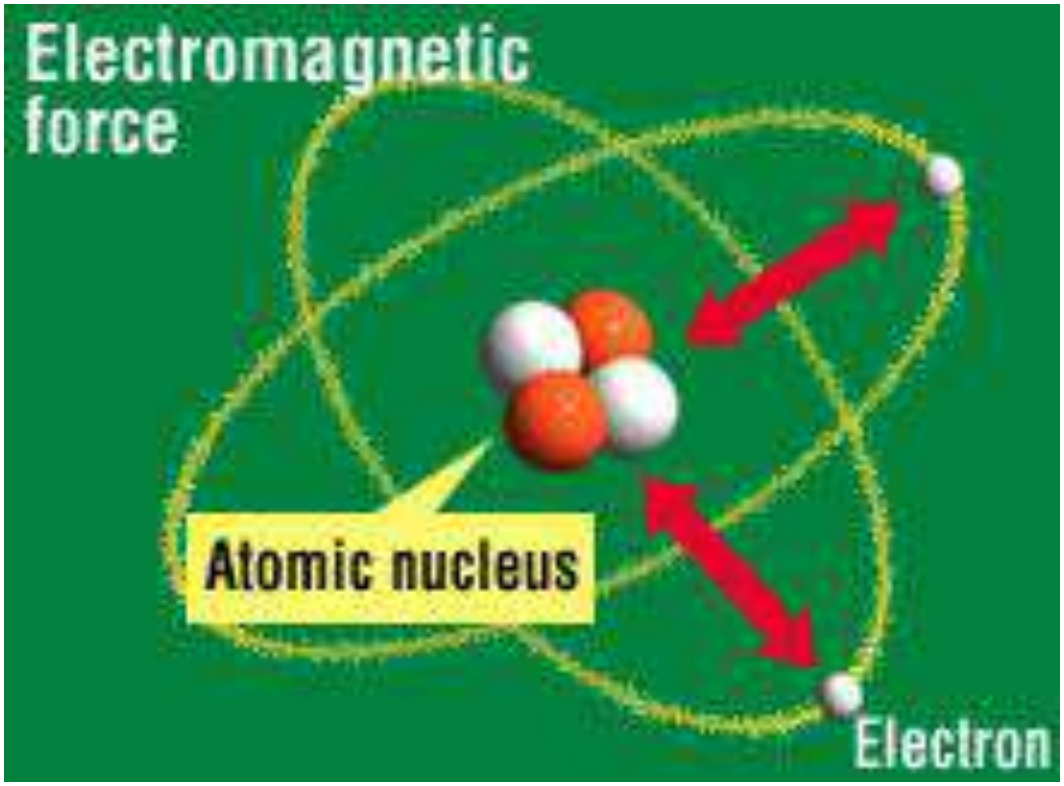
Only certain orbits are “allowed”

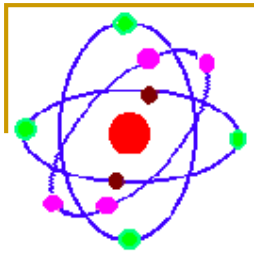


Only certain orbits are “allowed”



The Bohr Atom was a “Solar System” model.





MODERN ATOMIC MODEL

- By 1925, Bohr's model of the atom no longer explained all observations. Bohr was correct about energy levels, but wrong about electron movement.
- Electrons occupy the lowest energy levels available.
- Energy increases as distance from the nucleus increases.
- Electrons move in patterns of "wave functions" around the nucleus.
- It is impossible to know an electrons velocity and location at any moment in time.