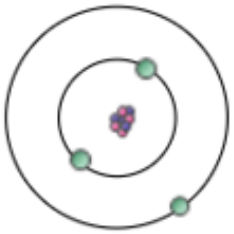
Atomic Theory
History of Atomic Theory

Honors Chemistry
Unit 2: Atomic Theory and Structure

Learning Objectives:

Dalton's model
(1803)

I can describe the key ideas of Dalton's Atomic Theory.



Bohr's model
(1913)

I can describe the experimentally driven transition to the Bohr model of the atom.

LO: I can describe the key ideas of Dalton's Atomic Theory.

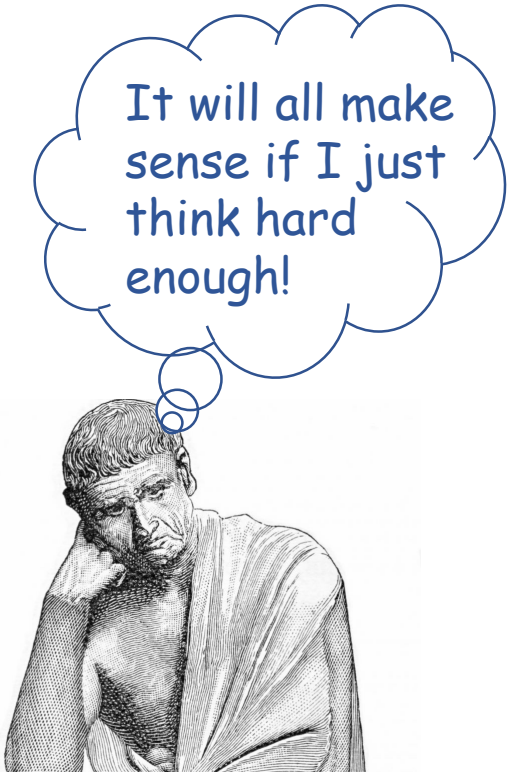
Early Atomic Theory

Democritus and early Greeks (460-370 BC)

- World must be made up of tiny, indivisible particles
- Atomos meaning indivisible

Plato and Aristotle (300 BC) disagreed instead proposing four essential elements:

- Earth, Fire, Water, and Air



Not a scientist!

LO: I can describe the key ideas of Dalton's Atomic Theory.

Early Atomic Theory

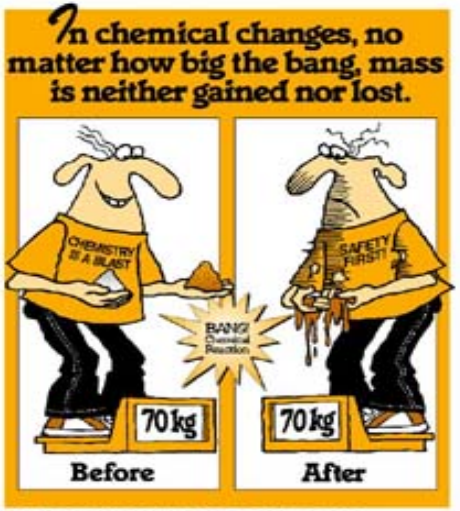
Antoine Lavoisier (1794) Law of Conservation of Mass

Matter cannot be created or destroyed, only rearranged

Joseph Proust (1797) Law of Definite Proportions

Elements combine to make compounds in the same proportions each time no matter the sample

H_2O is always 2 H and 1 O



LAW OF CONSERVATION OF MATTER: Matter cannot be made or destroyed by ordinary chemical means.

LO: I can describe the key ideas of Dalton's Atomic Theory.

Dalton's Atomic Theory (1803-1807):

(1766-1844)

1. All matter is made of atoms that are **INDIVISIBLE**
2. Atoms of the **SAME** element are the **SAME**; Atoms of **DIFFERENT** elements are **DIFFERENT**
3. Atoms are **NOT** changed into atoms of different elements during chemical reactions
4. Atoms combine in whole number ratios to make **COMPOUNDS**

LO: I can describe the experimentally driven transition to the Bohr model of the atom.

Dalton's Atomic Theory was supported by the work of other scientists:

Gay-Lussac (1808)

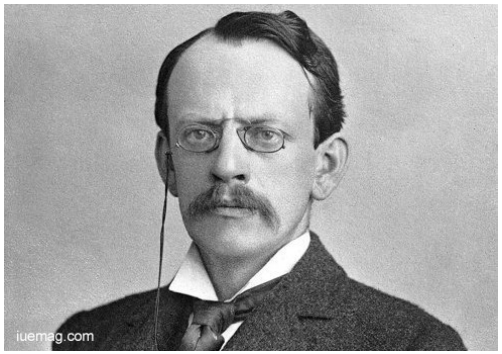
Law of Combining Volumes –Volumes of reacting gases and gaseous products are in the ratio of small whole numbers.

Avogadro's Hypothesis – Equal volumes of gases have the same number of particles

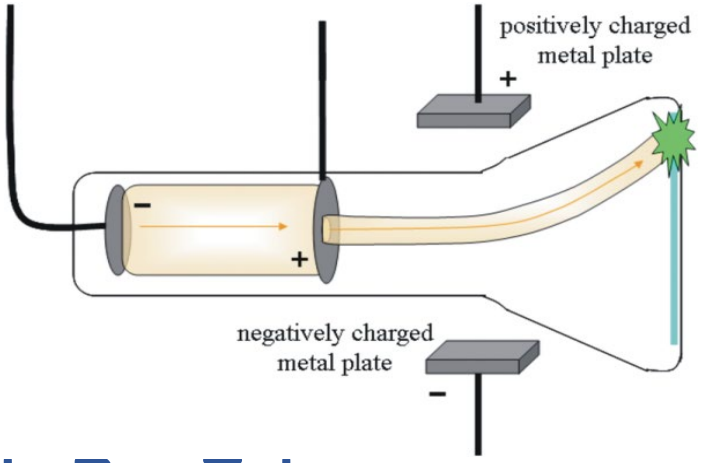
Amadeo Avogadro (1811)

LO: I can describe the experimentally driven transition to the Bohr model of the atom.

Discovery of Subatomic Particles



J.J. Thomson (1897)

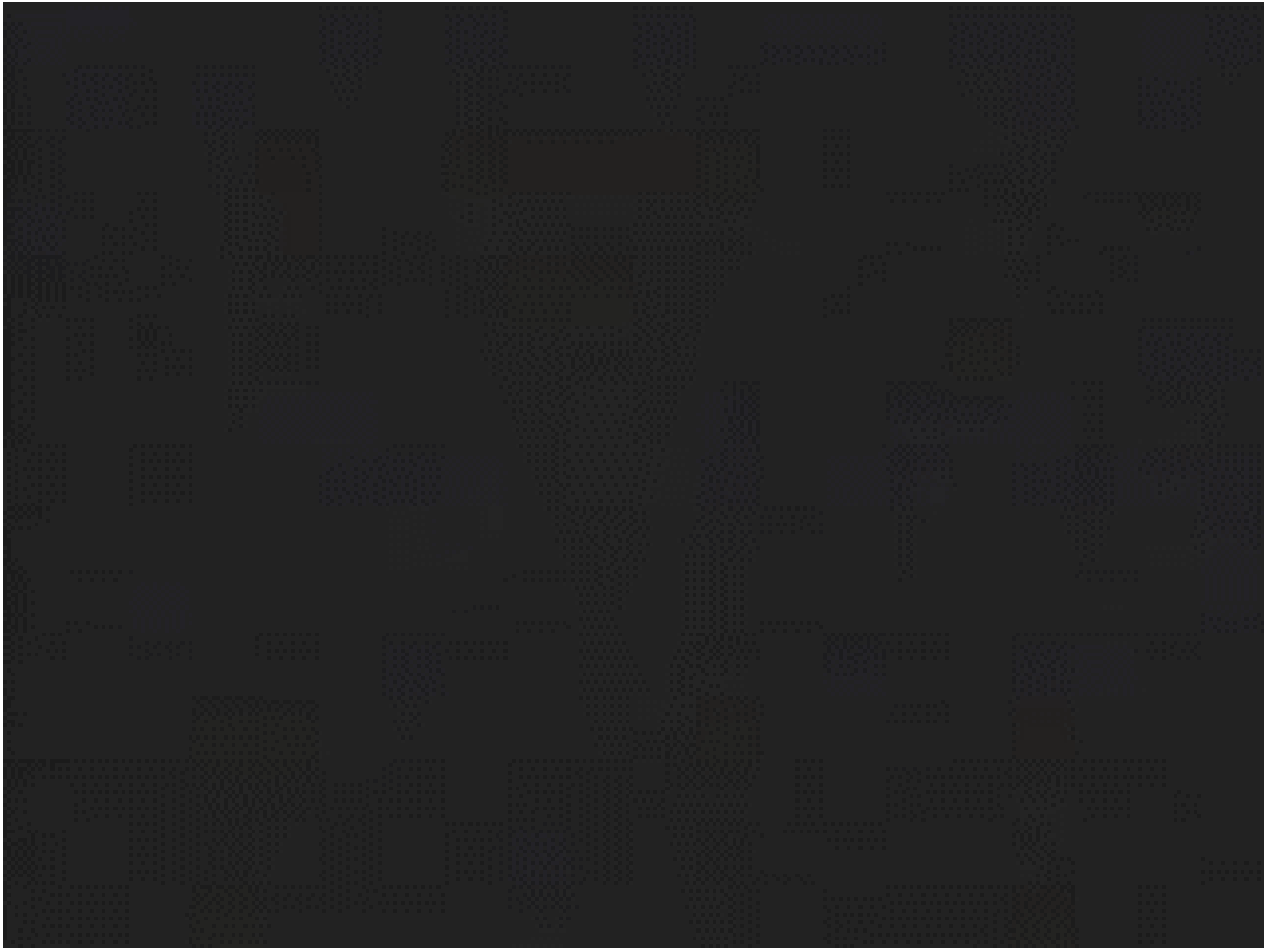


Observations of Cathode Ray Tubes:

- Nature of ray independent of cathode material
- Metal plate exposed to cathode rays becomes negatively charged
- Measured mass to charge ratio of rays

Conclusion: Cathode rays a streams of negatively charged particles with mass—ELECTRONS!

Cathode Ray Tube Experiment



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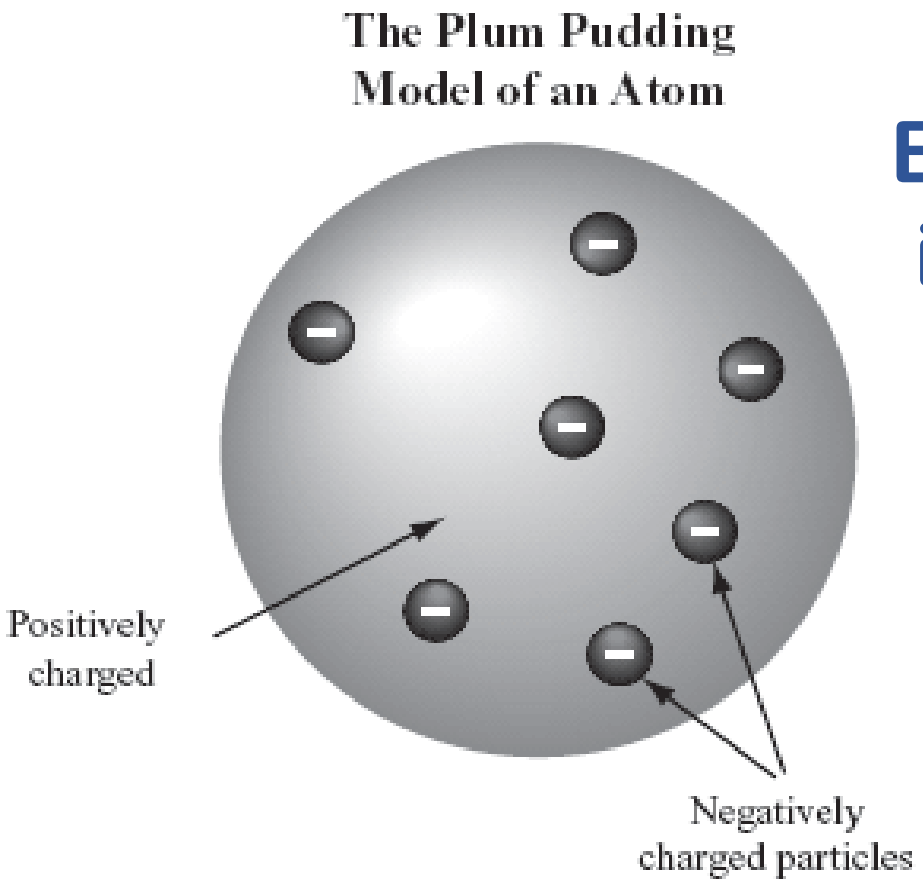
Thomson's Model of the Atom



Electrons embedded in atoms like raisins in pudding

Further experiments failed to support this model.

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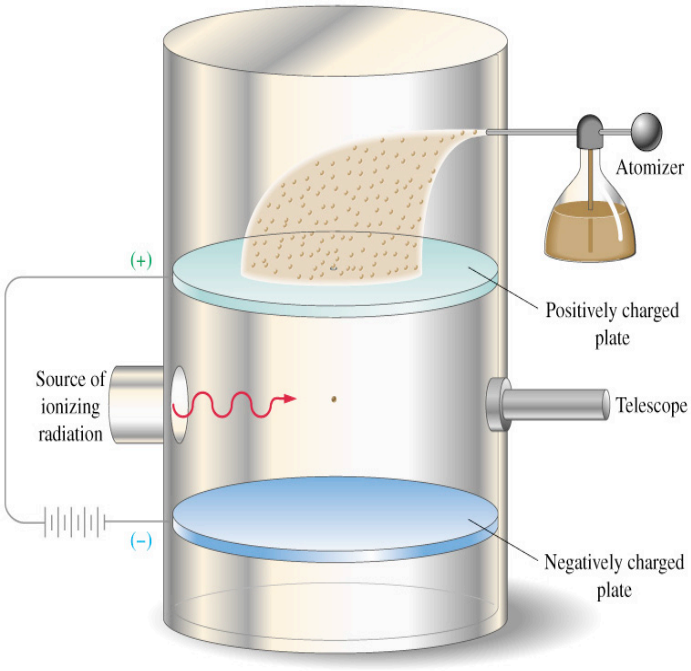
Millikan's Oil Drop Experiment (1909)



The experiment:

- Sprayed oil mist into the chamber
- Transferred electrons to the oil mist
- Charged mist fell due to gravity
- Measured how plate voltage affected rate of fall
- Charge of the electron calculated
- Also calculated mass e- with Thomson's data

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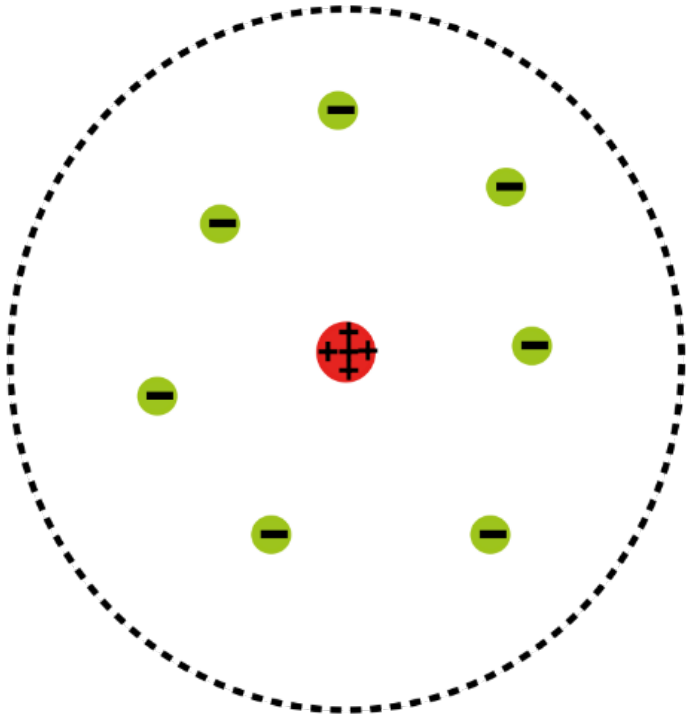
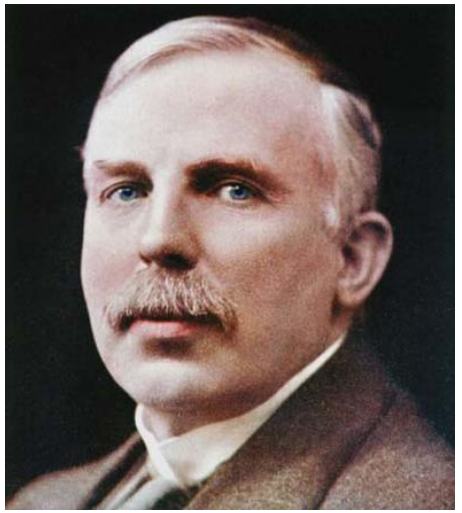
Nuclear Model of the Atom (1911)



- Atom is mostly empty space
- Atom has a (+) dense core called the nucleus



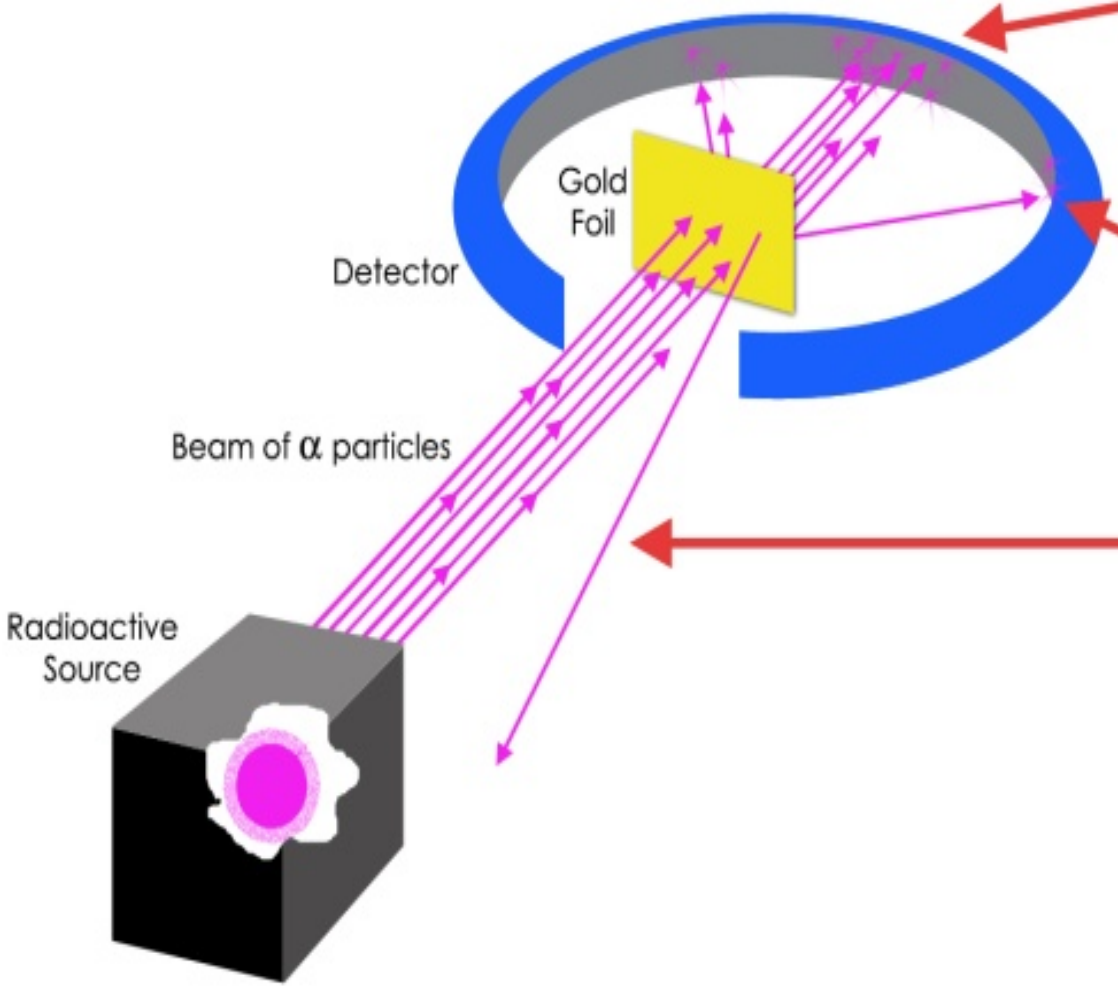
Also discovered protons (1919)

Replaces Plum-Pudding Model…more to come

LO: I can describe the experimentally driven transition to the Bohr model of the atom.

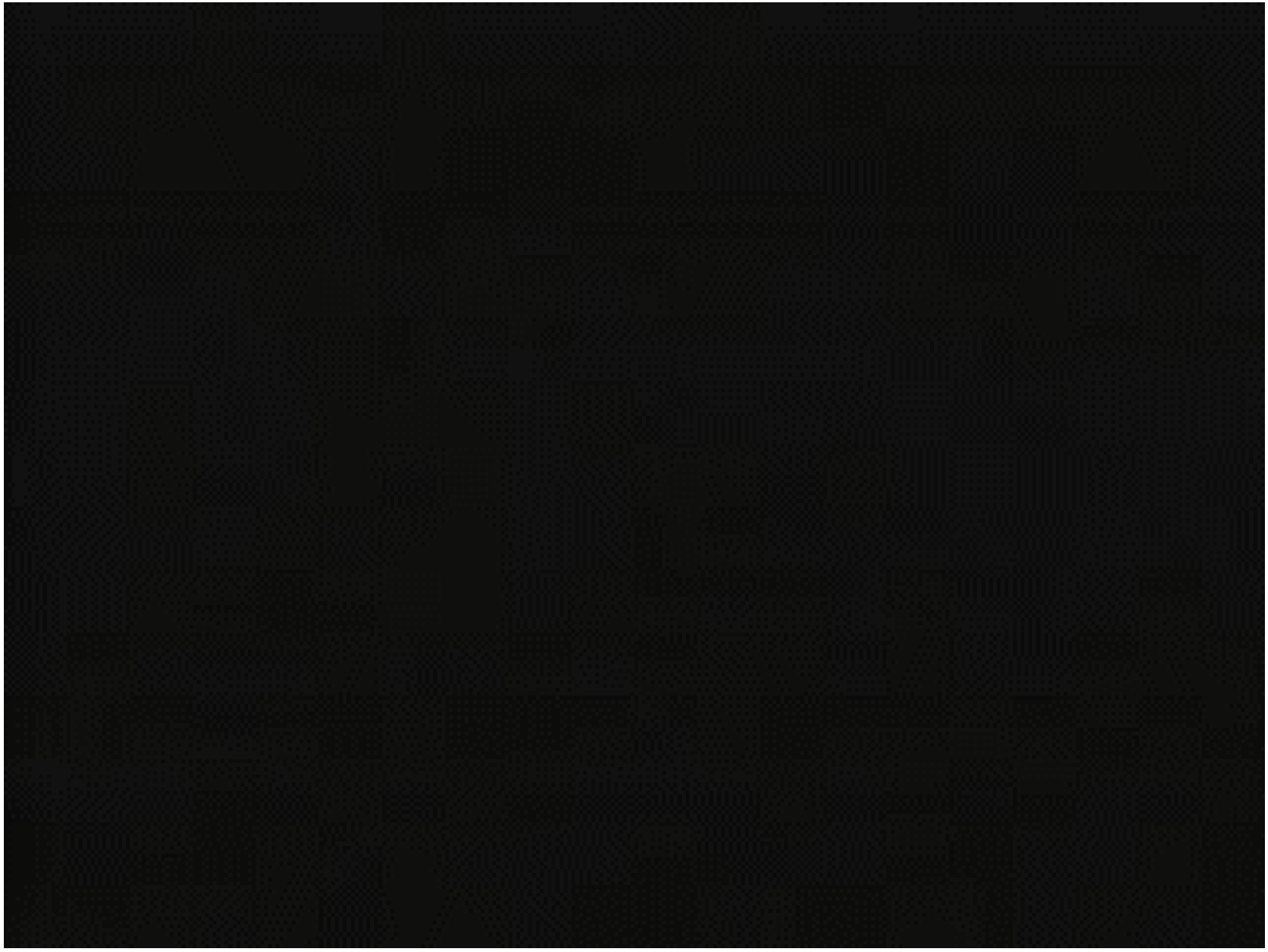
Rutherford's Gold Foil Experiment

(1911)



Observation	Interpretation
Most α particles travel through the foil undeflected	The atom is mostly empty space
Some α particles are deflected by small angles	The nucleus is positively charged, as is the α particle
Occasionally, an α particle travels back from the foil	The nucleus carries most of the atom's mass

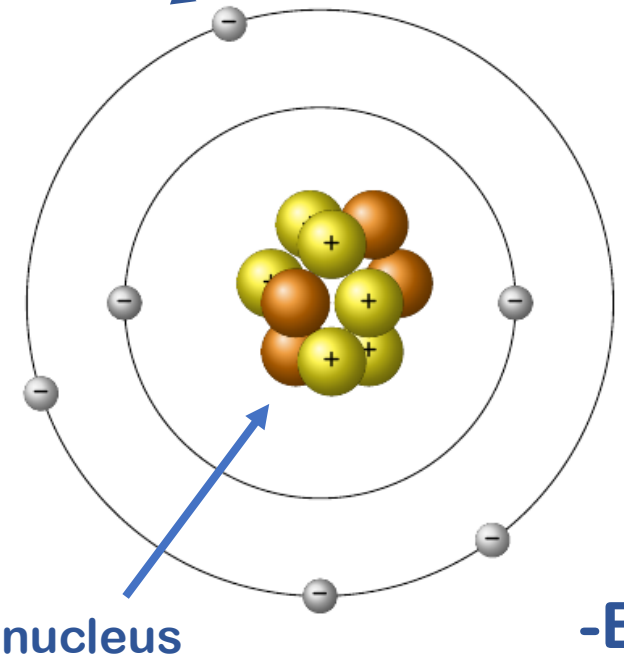
Gold Foil Experiment



LO: I can describe the experimentally driven transition to the Bohr model of the atom.

Why don't electrons crash into the nucleus?

Electrons are in fixed orbits!!



-Orbits like planets around the sun.

-Orbits correspond to specific energies.

-Electrons move to other orbits by gain or loss of energy.

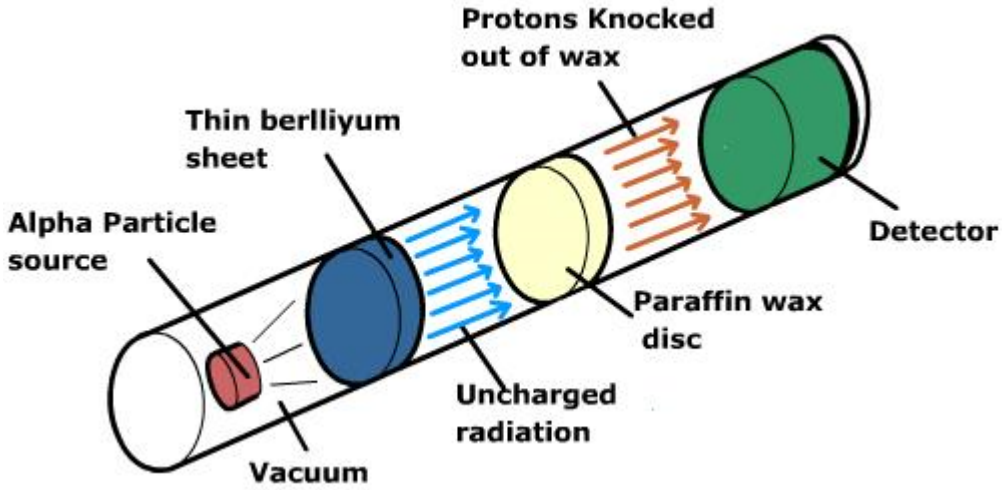
-Energy change observed as spectra.

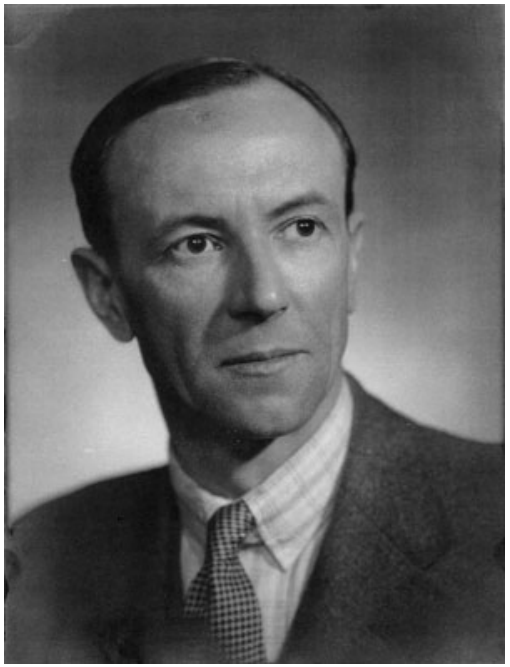
Neils Bohr (1913)

LO: I can describe the experimentally driven transition to the Bohr model of the atom.

Discovery of the Neutron (1932)

Challenge: How to detect a neutral particle?





James Chadwick

Use chain reaction:

1. Fire radioactive particles at thin Be sheet
2. Knock out neutral particles that hit paraffin disc
3. Protons knocked out of paraffin and measured at detector

Conclusion: Uncharged particles are NEUTRONS!!

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Revisions to Dalton's Atomic Theory

1. Atoms are not indivisible and indestructible:

Protons, Electrons and Neutrons

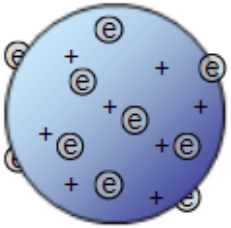
2. Atoms of the same element are NOT exactly alike:

Same number of **protons**

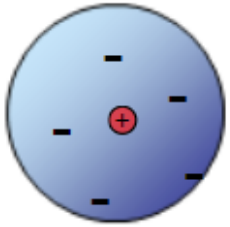
Same or different numbers of **neutrons**

Models of the Atom

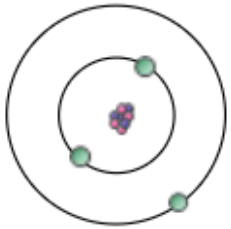
Dalton's model (1803)



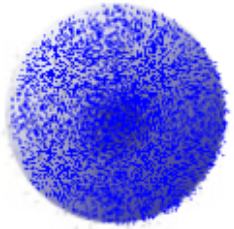
Thomson's plum-pudding model (1897)



Rutherford's model (1909)



Bohr's model (1913)



Charge-cloud model (present)

1803 John Dalton pictures atoms as tiny, indestructible particles, with no internal structure.

1897 J.J. Thomson, a British scientist, discovers the electron, leading to his "plum-pudding" model. He pictures electrons embedded in a sphere of positive electric charge.

1911 New Zealander Ernest Rutherford states that an atom has a dense, positively charged nucleus. Electrons move randomly in the space around the nucleus.

1913 In Niels Bohr's model, the electrons move in spherical orbits at fixed distances from the nucleus.

1926 Erwin Schrödinger develops mathematical equations to describe the motion of electrons in atoms. His work leads to the electron cloud model.

1800 1805 ..... 1895 1900 1905 1910 1915 1920 1925 1930 1935 1940 1945

1904 Hantaro Nagaoka, a Japanese physicist, suggests that an atom has a central nucleus. Electrons move in orbits like the rings around Saturn.

1924 Frenchman Louis de Broglie proposes that moving particles like electrons have some properties of waves. Within a few years evidence is collected to support his idea.

1932 James Chadwick, a British physicist, confirms the existence of neutrons, which have no charge. Atomic nuclei contain neutrons and positively charged protons.

Dorin, Demmin, Gabel, Chemistry The Study of Matter , 3rd Edition, 1990, page 125