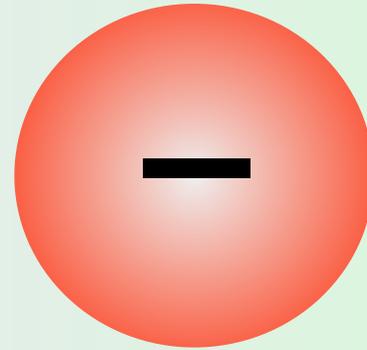
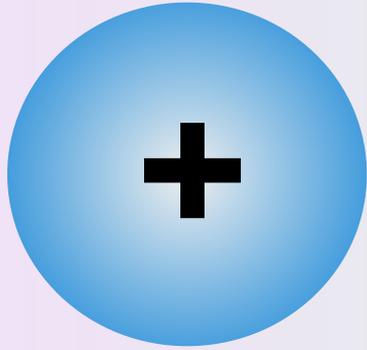


Updating the Atomic Theory

Three major differences between modern atomic theory and Dalton's atomic theory

1. Atoms are **NOT** indivisible. They are made up of smaller particles: electrons, protons and neutrons.
2. Atoms **CAN** be changed from one element to another, but **NOT** by chemical reactions.
3. Atoms of the same element are **NOT** exactly alike. They can have different masses.

Interactions Between Electric Charges



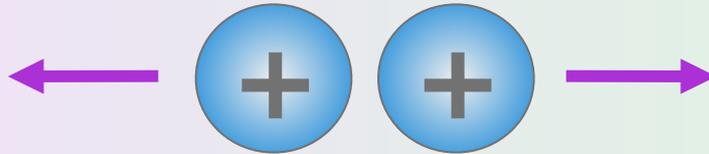
positive and negative charges

- **objects with an equal amount of positive and negative charge are said to be electrically neutral**

Forces between charges

Electrostatic Force

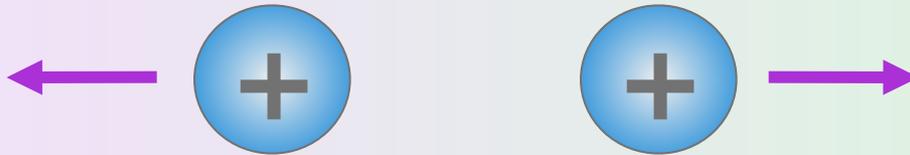
- objects with like charge repel



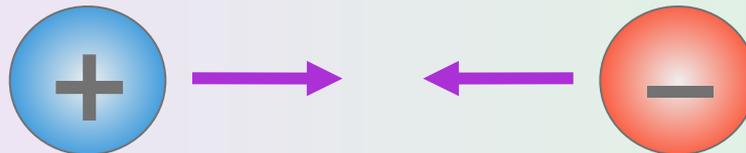
Forces between charges

Electrostatic Force

- objects with like charge repel



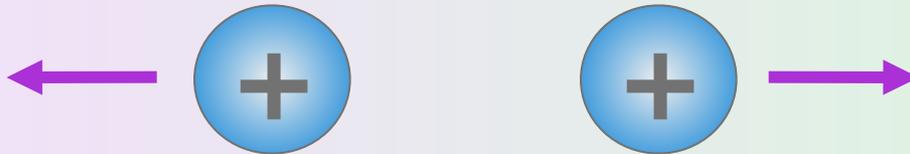
- objects with opposite charge attract



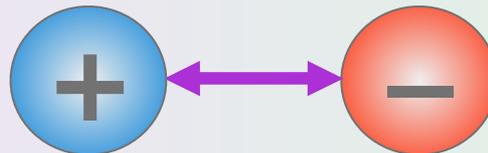
Forces between charges

Electrostatic Force

- objects with like charge repel



- objects with opposite charge attract



Forces between charges (cont...)

- **electrostatic force becomes greater the more excess charge**
- **electrostatic force becomes smaller the greater the distance separating the charges**

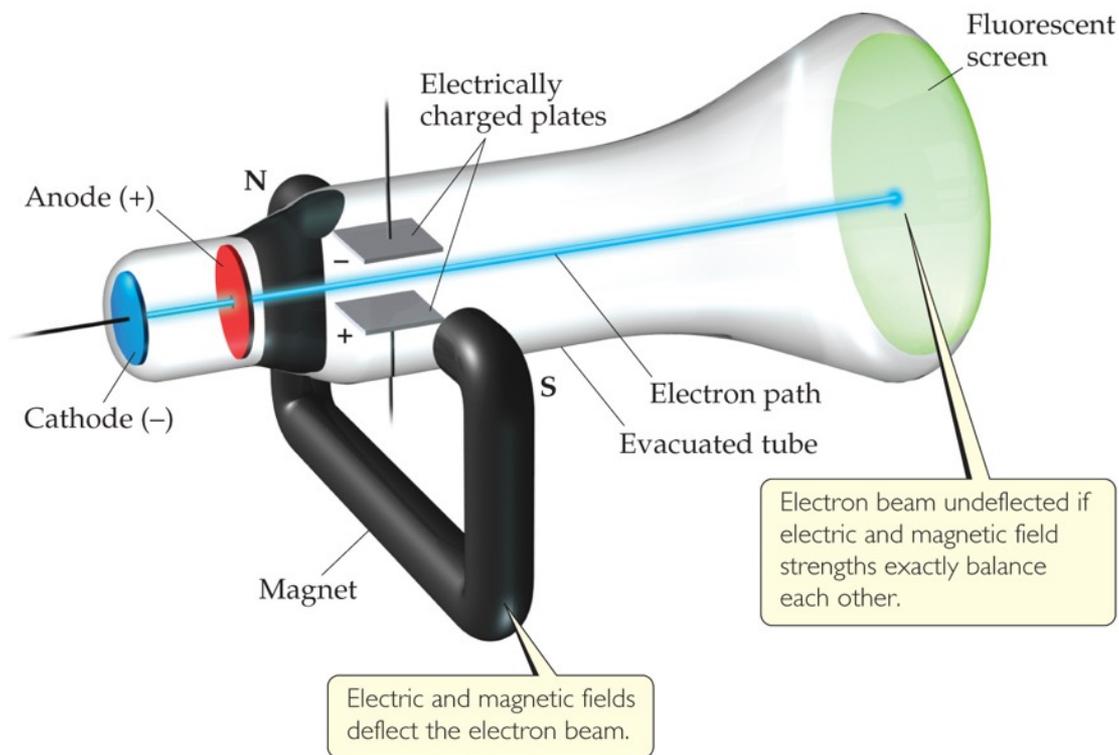
Searching for Atomic Structure

The Electron

The charge-to-mass ratio of an electron was determined by physicist **J.J. Thomson** in a series of experiments done between 1908 and 1917.

charge-to-mass ratio = -1.76×10^8 coulomb/g

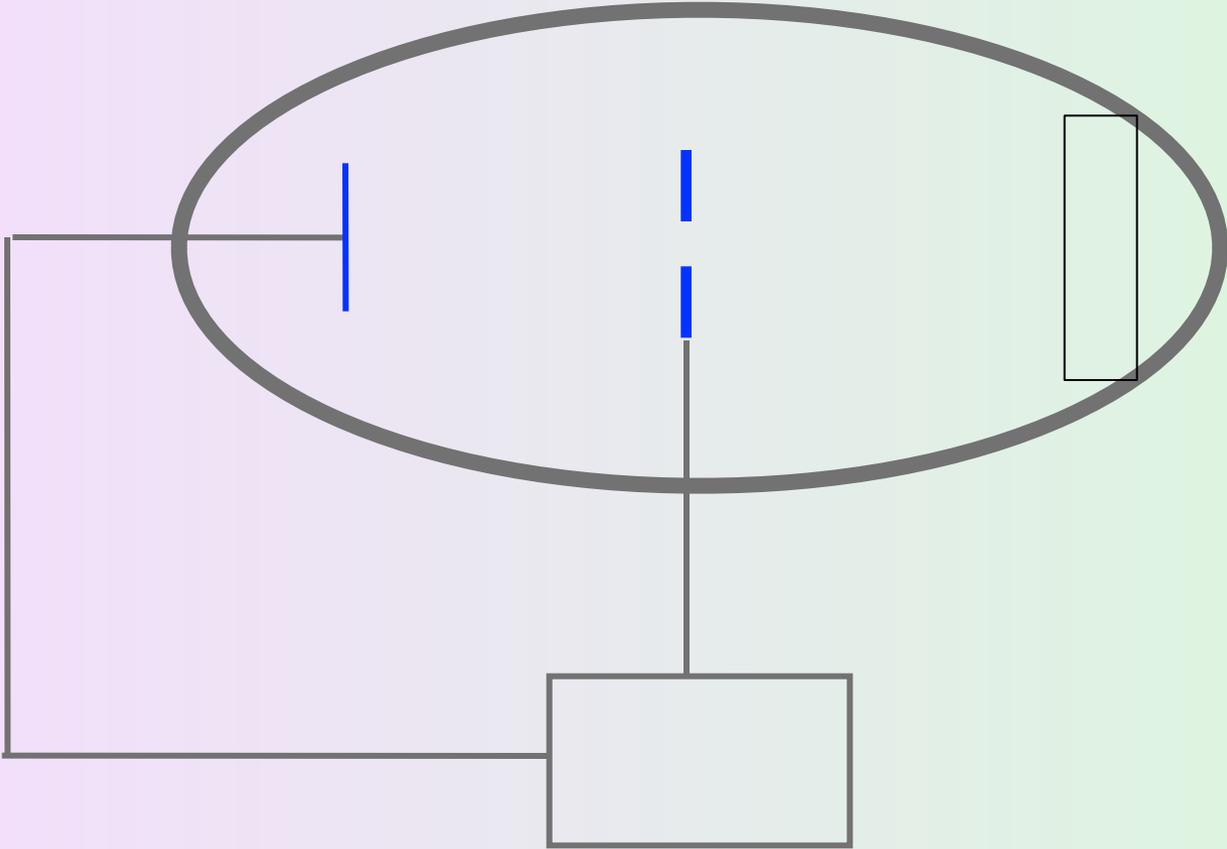
The Electron



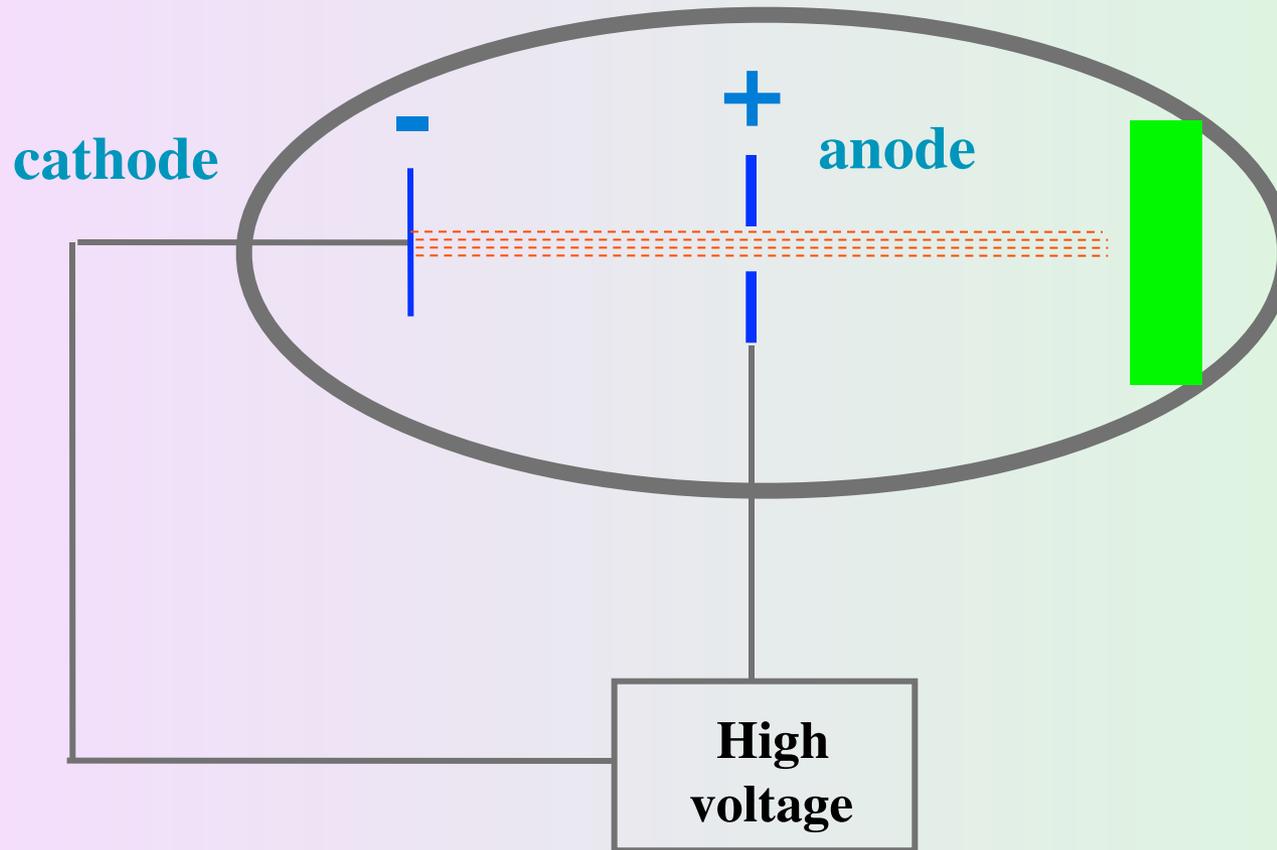
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Thomson measured the charge/mass ratio of the electron to be 1.76×10^8 coulombs/gram (C/g).

Cathode Ray Tube

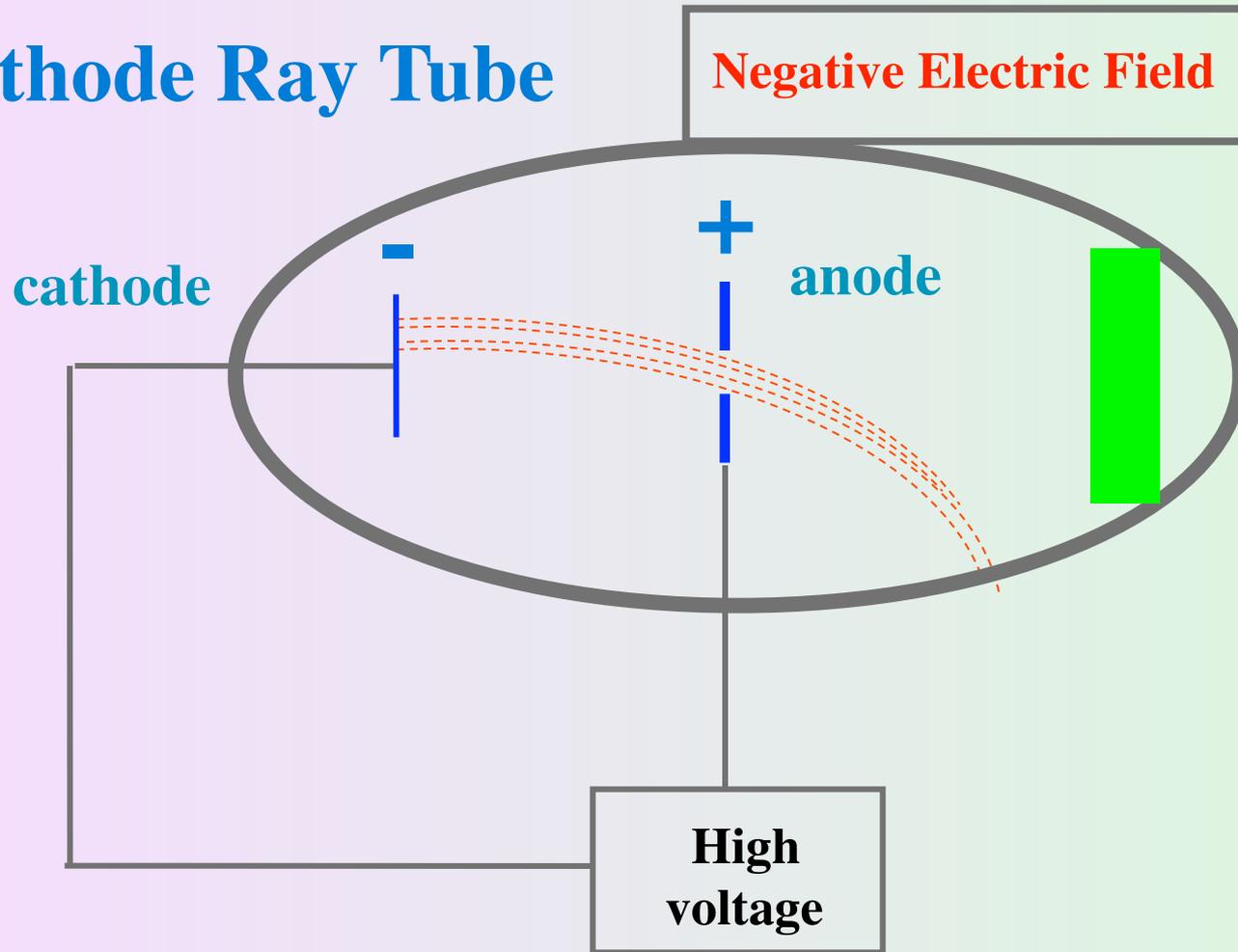


Cathode Ray Tube



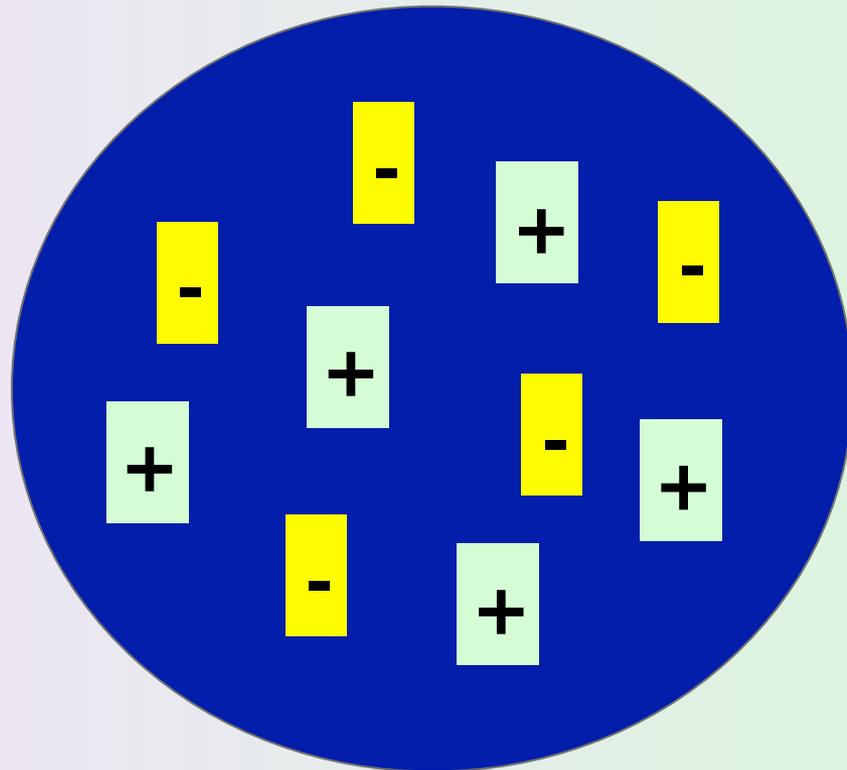
When high voltage is applied to the electrodes a glow was noticed between them.

Cathode Ray Tube



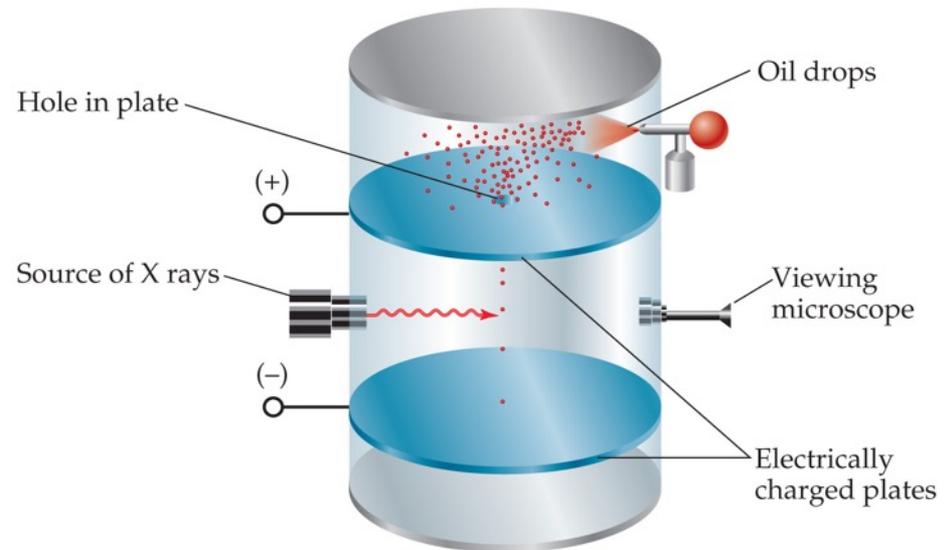
The fact that the rays were repelled by the negative electric field indicated that they had a negative charge with an e/m ratio of -1.76×10^8

J.J. Thomson's plum pudding model



Millikan Oil-Drop Experiment

Robert Millikan
(University of Chicago)
determined the charge
on the electron in
1909.



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The Electron

R.A. Millikan measured the charge of an electron to be -1.60×10^{-19} coulomb

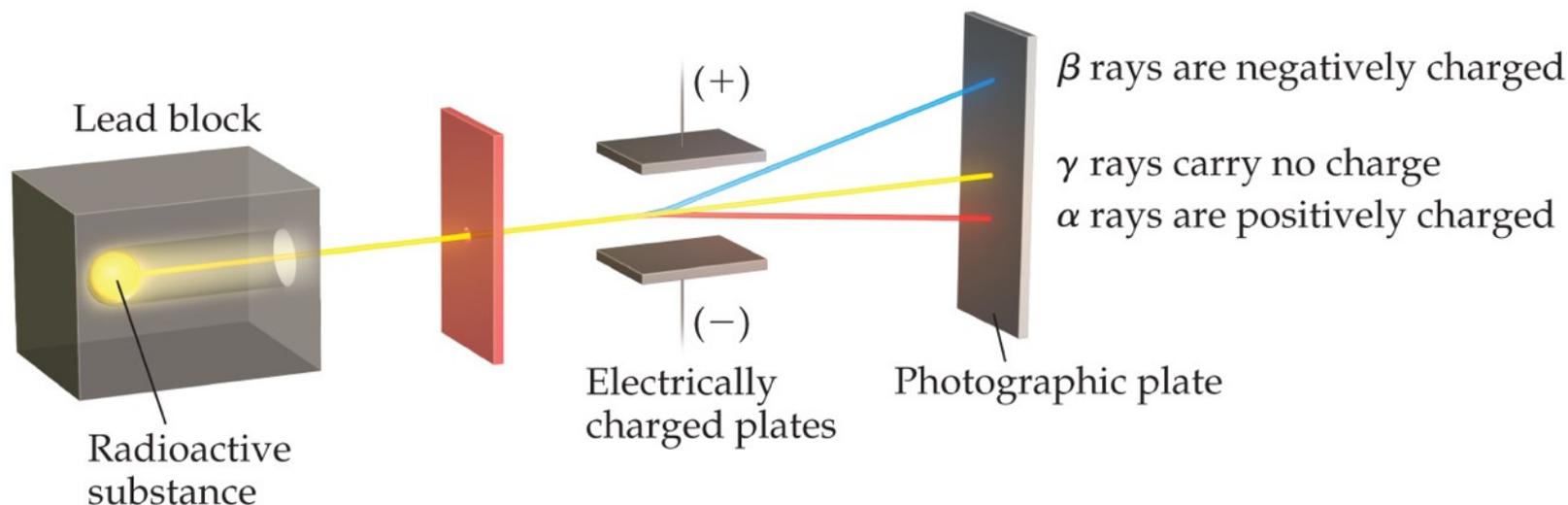
Since the charge-to-mass ratio is -1.76×10^8 coulomb/g, the mass of an electron must be 9.11×10^{-31} kg.

Radioactivity

- **Radioactivity** is the spontaneous emission of radiation by an atom.
 - It was first observed by Henri Becquerel.
 - Marie and Pierre Curie also studied it.

Radioactivity

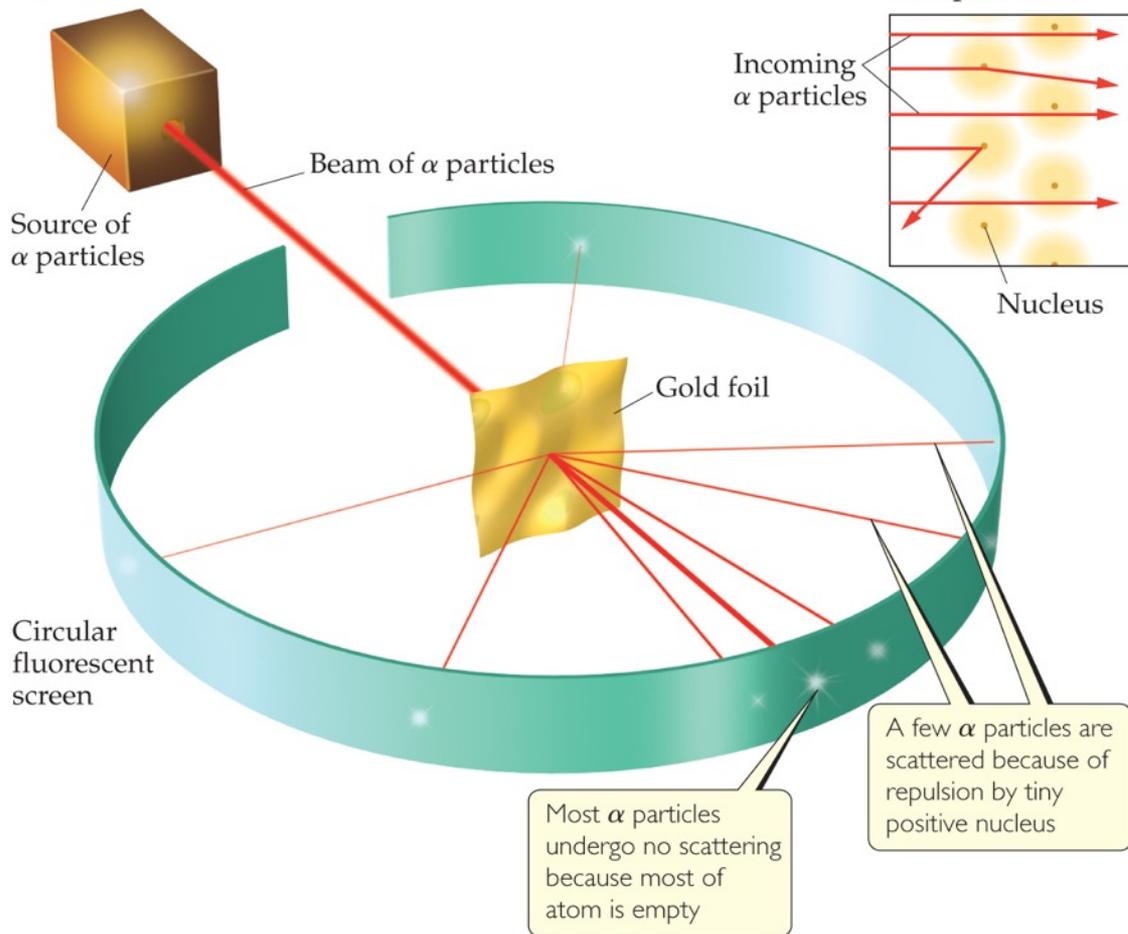
- Three types of radiation were discovered by Ernest Rutherford:
 - α particles
 - β particles
 - γ rays



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Discovery of the Nucleus

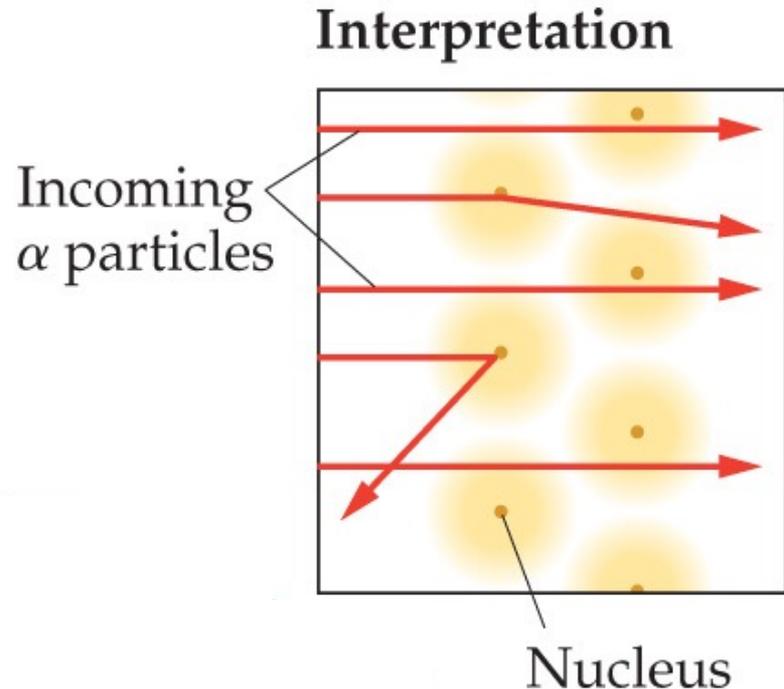
Experiment



Ernest Rutherford shot α particles at a thin sheet of gold foil and observed the pattern of scatter of the particles.

The Nuclear Atom

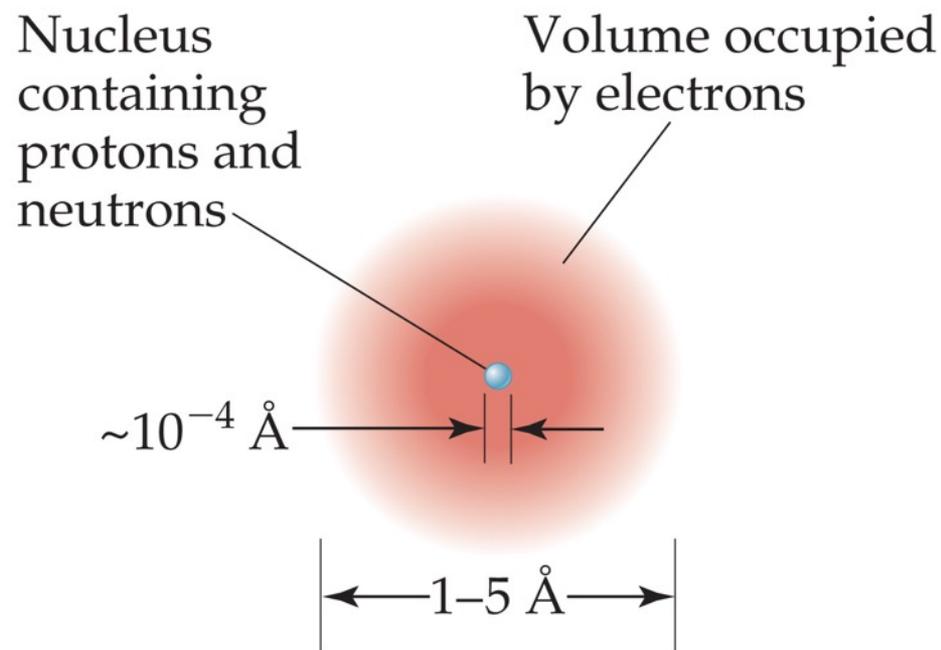
Since some particles were deflected at large angles, Thomson's model could not be correct.



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The Nuclear Atom

- Rutherford postulated a very small, dense nucleus with the electrons around the outside of the atom.
- Most of the volume of the atom is empty space.



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The Proton

The positively charged particles in the nucleus are called protons. They have the same charge as an electron but have almost 2,000 times more mass.

Rutherford's Atomic Model left one major problem

It was known that the hydrogen atom contained one proton and that the helium atom contained two protons. So the mass ratio should have been 2:1.

In reality the ratio is 4:1.

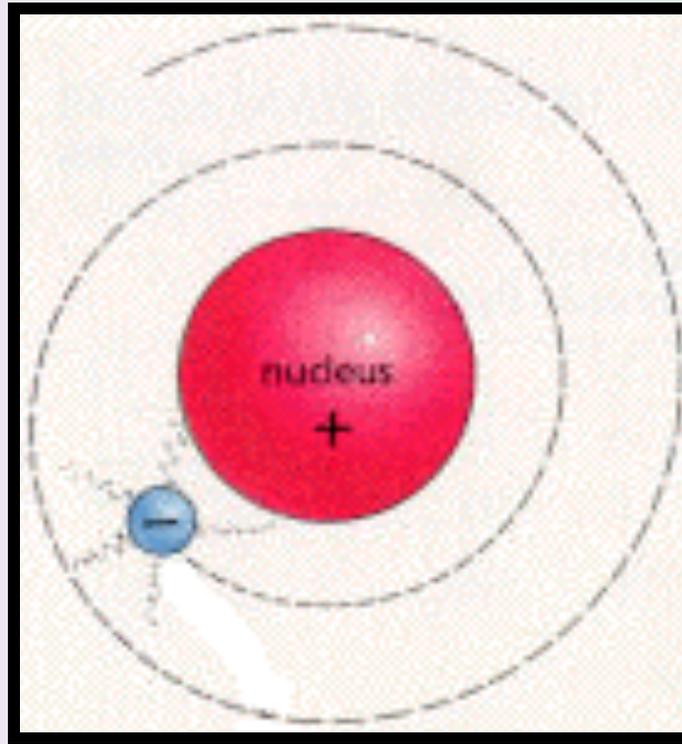
There must be another particle...

The Neutron

Was discovered by **James Chadwick** in 1932. It is neutral (uncharged) and has slightly greater mass than a proton.

Mystery solved.

Shortcomings of Rutherford's Model



Classical physics states that a charged particle traveling in a curved path radiates energy.

Electrons would continually give off energy, slow down and spiral in towards the nucleus.

The properties of atoms and molecules are not governed by the same physical laws as larger objects.

Quantum Mechanics:

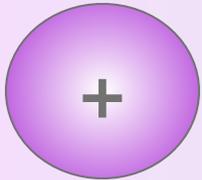
the physics of the very small

To be continued

The Modern View of Atomic Structure

Atoms are composed of

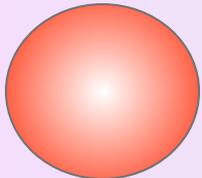
PROTONS



positively charged

mass = 1.6726×10^{-27} kg

NEUTRONS



neutral

mass = 1.6750×10^{-27} kg

ELECTRONS



negatively charged

mass = 9.1096×10^{-31} kg