



one nucleus, a set of shells, and rules for who lives where

Three particles inside the atom *

Electron

e^- , found by J.J. Thomson (cathode ray tube); charge -1 , mass $\approx 1/1837$ of a proton's

Proton

found by Goldstein (canal rays / anode rays); charge $+1$, mass ≈ 1 amu

Neutron

found by Chadwick; no charge, mass ≈ 1 amu, a touch more than a proton's

Thomson's model: plum pudding

- the atom pictured as a uniform sphere of positive charge, with electrons embedded in it like seeds in a melon
- explained why atoms are electrically neutral overall: the positive and negative charge simply balance
- gave no real account of how the electrons are arranged, and was overturned entirely by the scattering experiment that followed

Rutherford's alpha-scattering experiment

- a beam of α particles (He^{2+}) was fired at a thin gold foil, only a few atoms thick
- most passed straight through undeflected: the atom is mostly empty space
- a small fraction deflected through large angles, and a very small fraction, about 1 in 20,000, bounced almost straight back
- that rebound could only mean a tiny, dense, positively charged core: the nucleus

Rutherford's nuclear model, and where it broke

- almost all the mass and all the positive charge sit in a tiny central nucleus (radius $\sim 10^{-15}$ m), with electrons revolving in the largely empty rest of the atom (radius $\sim 10^{-10}$ m)
- modelled the electrons like planets, orbiting the nucleus under electrostatic attraction
- problem 1: an orbiting charge must radiate energy by classical electromagnetism, so the electron should spiral into the nucleus almost instantly, yet atoms plainly don't collapse
- problem 2: it says nothing about why an electron sits at a particular distance, so it can't explain the sharp, discrete line spectrum of hydrogen

each model fixed the one thing the last couldn't explain: Thomson gave neutrality, Rutherford gave a nucleus, Bohr gave the atom stability

Atomic number, mass number, notation

atomic number, fixes the element

$$Z=p$$

mass number, protons + neutrons

$$A=p+n$$

standard notation for a nuclide

$${}_Z^AX$$

protons decide WHICH element it is; neutrons can vary without changing the element at all

