

from a plum pudding to four quantum numbers

The three subatomic particles, and who found them

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- electron**: discovered in cathode ray experiments, charge to mass ratio by Thomson, charge itself by Millikan's oil drop, so the mass follows from the two together
- proton**: found in anode (canal) rays, and unlike cathode rays their charge to mass ratio **DEPENDS** on the gas, which is the clue that they are ionised gas atoms
- neutron**: Chadwick, from bombarding beryllium with alpha particles, and it carries no charge at all
- atomic number Z** is the proton count and fixes the element; **mass number A** is protons plus neutrons; isotopes share Z , isobars share A , isotones share the neutron count

Two models, and exactly what killed each

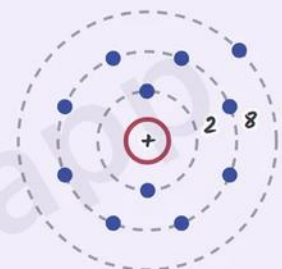
- Thomson**, positive sphere with electrons embedded: explained neutrality, but could not survive the alpha scattering result
- Rutherford's foil experiment**: most alpha particles passed straight through, a few deflected sharply and about one in twenty thousand came back, so the atom is mostly empty with a tiny dense positive nucleus
- the fatal objection to Rutherford**: an electron moving in a circle is accelerating, an accelerating charge radiates, so the electron should spiral into the nucleus in about 10^{-8} s. Matter would not exist
- it also gave no account of the line spectrum, which is the second thing any model has to explain

Light, in the words used later

- for a wave, $c = v \lambda$, and **wavenumber** is $1/\lambda$, usually quoted per cm
- Planck**: energy is emitted or absorbed in packets, $E = h\nu = hc/\lambda$, with $h = 6.626 \times 10^{-34}$ J s
- photoelectric effect**: electrons come out only above a **threshold frequency**, instantly, and their kinetic energy depends on **FREQUENCY** while their number depends on intensity, which no wave picture can give
- the equation of it is $h\nu = h\nu_0 + (1/2)mv^2$, work function first and kinetic energy after

Bohr's model, and the two postulates that carry it

- an electron moves only in certain **stationary orbits** in which it does NOT radiate, which is asserted rather than derived and is the model's honest weak point
- angular momentum is **quantised**: $mvr = nh/2\pi$, and n is the whole number that everything else follows from
- energy is absorbed or emitted only when the electron **JUMPS** between orbits, and $\Delta E = h\nu$, which is why the spectrum is lines and not a smear
- limits**: it works for hydrogen and for one electron ions such as He^+ and Li^{2+} , and fails for every atom with two or more electrons, for fine structure and for the Zeeman effect



the nucleus with its shells drawn as dashed circles, the electrons spaced around each and the count written beside it

