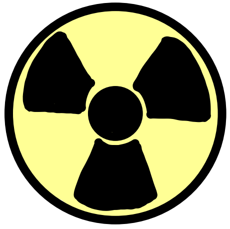
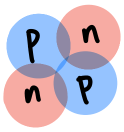
NUCLEAR PHYSICS

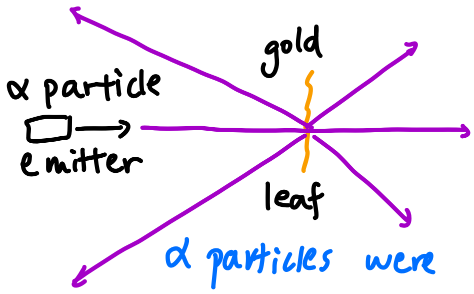


Alpha particle: Helium nucleus



$^4_2\alpha$

Rutherford's gold leaf experiment



proof that atoms aren't plums

α particles were reflected!

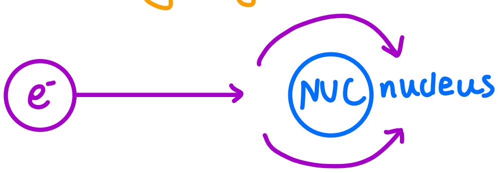
most α particles didn't deflect → most of the atom is empty space

some α particles were deflected → nucleus is +vely charged

only a small number were deflected greater than 90° → nucleus is a concentrated mass

Another De Broglie Thing

e^- travelling very fast → wave-like properties

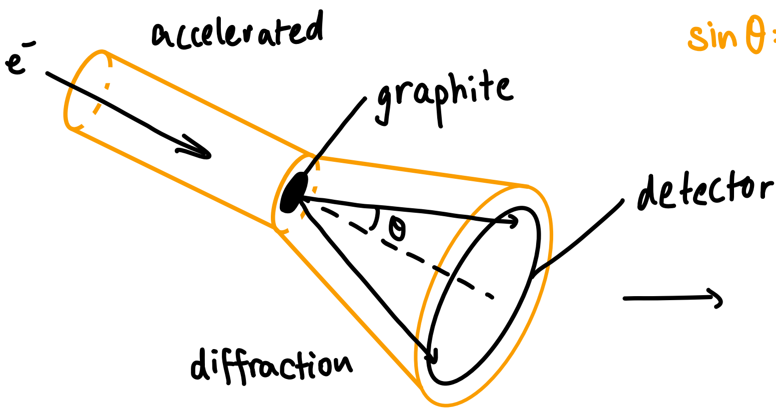


$\lambda = \frac{h}{mv}$

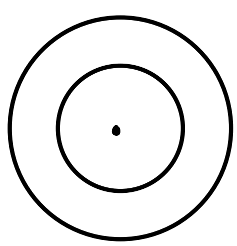
($\lambda \approx$ gap size)

for diffraction, λ has to be small
↓
v has to be large

$\sin\theta = \frac{1.22\lambda}{2R}$ } do not need to memorize

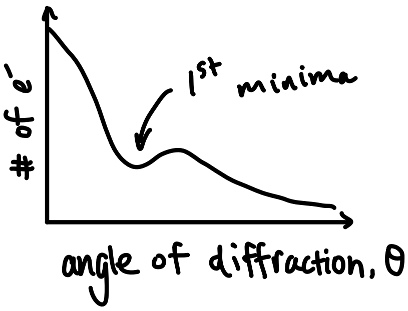


→



circular diffraction pattern

Circular diffraction pattern of e^-



E=hf can be used on fast particles, not just photons.

Example

300 MeV e^- fired at thin foil
1st minimum of diffraction = 30°

$$E = hf = \frac{hc}{\lambda}$$

$$\lambda = \frac{hc}{E} = \frac{6.63\times10^{-34} \times 3\times10^{8}}{300\times10^{6} \times 1.6\times10^{-19}} = 4.14\times10^{-15}\,m$$

$$R = \frac{1.22\lambda}{2\sin\theta} = \frac{1.22\times4.14\times10^{-15}}{2\sin30°} = 5.06\times10^{-15}\,m$$

Size of a nucleus: $R = A_0 A^{\frac{1}{3}}$

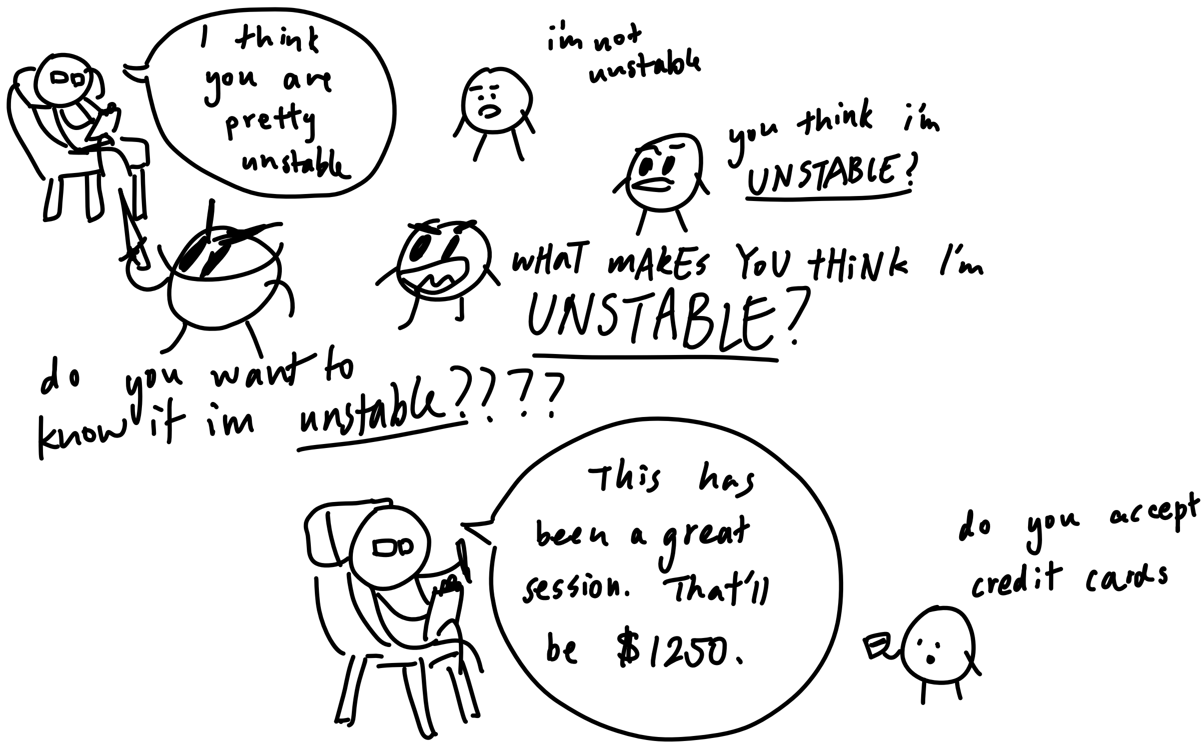
radius of nucleus

size of nucleon $\approx 1.4\,fm$

mass number

Radioactive Emissions

Some nuclei are unstable



Reasons for instability:

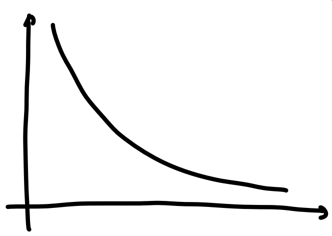
- Too many / too few neutrons
- Too much energy in nucleus
- Abuse during childhood

Releasing stuff to become more stable (e.g. α or β particles)

IONISING RADIATION: radiation can knock off e^- and ionise things

↳ ∴ radioactive emissions are also known as ionising radiation

- Rate of decay decreases over time



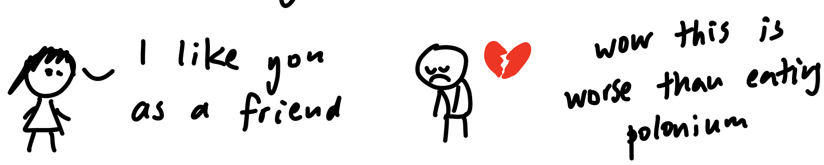
- decay is random and spontaneous

4 types of Nuclear Radiation

			charge	mass
Alpha	α	2p and 2n (He nucleus)	+2	4
Beta minus	β^-	e^- electron	-1	negligible
Beta plus	β^+	e^+ positron	+1	negligible
Gamma	γ	$\lambda\downarrow$, $f\uparrow$, em wave	0	0

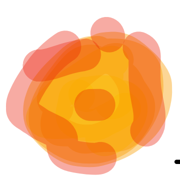
	ionising	speed	penetration	affected by magnetic field
α	strongly	slow	absorbed by paper or air	Yes
β^+	weakly	fast	absorbed by ~3mm of aluminium	Yes
β^-	⟵ Annihilation by electron ⟶			
γ	very weakly	c	absorbed by many cm of lead or few metres of concrete	No

Alpha: if particles that emit it are ingested, they ionise the inside of you and causes damage inside

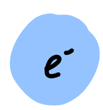


Beta: can travel through metres of air and millimetres of skin and tissue causes burns (like severe sunburn)

Who will burn the guy more?

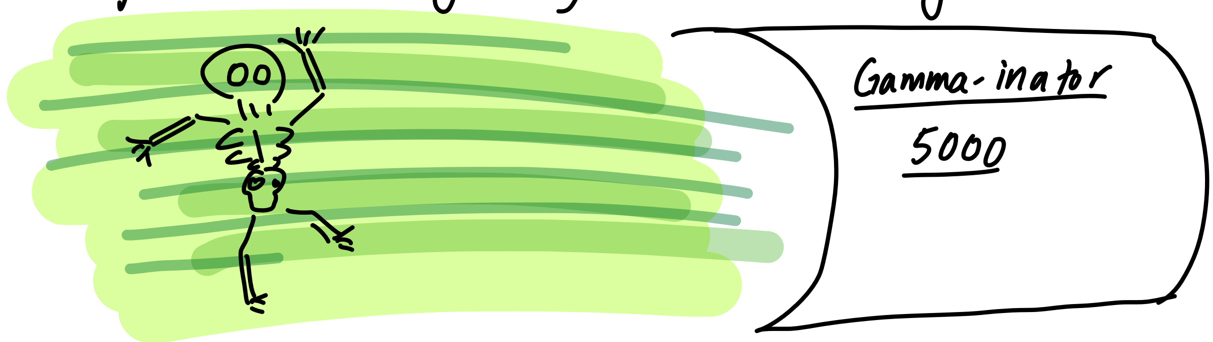


The SUN
- Nuclear fusion
- Solar flares
- More than 5000 °c on the surface
- Single-handedly sustains life
- Can burn your retinas



Some tiny thing
- Moves fast
- Doesn't do nuclear fusion
- Can't even see it
- Not hot

Gamma Rays: Penetrate through body, all tissues damaged



Preventing radioactive accidents

Time: ↓time, ↓exposure

Distance: ↑distance, ↓ exposure

Shielding: ↑shielding, ↓exposure

INVERSE SQUARE LAW (thing far, thing weak)

Gamma emits in all directions

$I = \frac{k}{x^2}$ I=intensity x= distance k= constant

α and β follow this but only in a vacuum