PARTICLES & QUANTUM

PARTICLES
- HADRONS
  - BARYONS (have B number)
    - n, p
    - QUARKS
  - MESONS ($q\bar{q}$)
    - π^+, π^-
    - particle + anti-particle
- LEPTONS (fundamental)
  - e^-, e^+ (positron), ν, $\bar{\nu}$, μ^- (muon) (have L number)

Q, L, B always conserved in interactions.
S only conserved in strong.
(If leptons involved, is weak interaction)
(μ^- is 'heavy e^-')

e^-, ν: L = +1

α: HIGHLY IONISING, WEAKLY PENETRATING (paper) (few cm of air)
($_2^4He$)

β: e^- → MEDIUM IONISING + PENETRATING ABILITY (few mm of Al)

γ: EM → WEAKLY IONISING, HIGHLY PENETRATIVE (reduced by concrete, lead)

$^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}\alpha$

$^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}\beta + \bar{\nu}_e$

p (or u) → n (or d) + β^- + $\bar{\nu}_e$ (via W^-)

1eV = 1.6×10⁻¹⁹ J
1MeV = 1.6×10⁻¹³ J

n: udd
p: uud

ISOTOPES: SAME ELEMENT (PROTONS), DIFFERENT #NEUTRONS
$^{12}_{6}C$ $^{14}_{6}C$

SPECIFIC CHARGE = $\frac{Q}{m}$ (Ckg⁻¹) (HUGE!)

4 FORCES (QED) — gauge boson/exchange particle
- *EM → virtual photon γ
- *Strong → pion/gluon
- *Weak → W^+/W^- (Z^0)
- *Gravity → graviton

nucleus → EM, strong

F: REPULSIVE 0.5fm; ATTRACTIVE range ~3-4fm

ENERGY LEVELS → raised by - collisions - absorb γ
n=3 IONISED, n=2, n=1; γ (E=hf)
Abs/emi spectrum - shows what elements present

Mass ⇌ Energy
$E = mc^2$ (rest E)

ANNIHILATION
$e^- + e^+$ → γ (E=hf) + γ (E=hf)
(e^+: $E = mc^2 + \frac{1}{2}mv^2$)

PAIR PRODUCTION
γ (E=hf) → e^+ ($E = mc^2 + \frac{1}{2}mv^2$) + e^-
if enough E

deBroglie λ
matter/particles have λ

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

$mE = \frac{1}{2}m^2v^2 = \frac{1}{2}p^2$

$\therefore p = \sqrt{2mE}$

e^- → graphite → I, d

FLUORESCENT TUBE
1. Thermionic emission at cathode.
2. e^- acc, collides with mercury atoms, visible γ, UV γ, e^-
3. UV γ emitted, absorbed by coating
4. Visible light emitted.

"When photons of sufficient energy are absorbed by electrons on surface of metal, liberating them"

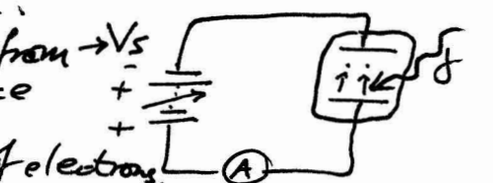
$E_{kmax} = hf - \phi$
- E_{kmax}: E (leftover) after e^- liberated
- hf: E of photon
- ϕ: work function (min E needed to liberate electron) ($\phi = hf_0$)

- Proved particle nature of light; one-to-one interactions between photons + electrons.
- If only wave, increasing Intensity would increase E_{kmax}.
- Instead, it only increases #electrons emitted.

E_{kmax} vs f: f_0 → h (Planck's); $-\phi$; f_0 (threshold f → min f needed to liberate electrons).

*E_{kmax} calculated from → V_s
- p.d. needed to reduce current to 0
∴ "cancelling out" E_k of electrons.

$E_{kmax} = eV_s$ ← 'stopping potential'



Video