

Particle Forces

force	affects	exchange particles	range
strong nuclear	hadrons	pion/gluon	none- >4fm, attrac 0.5<x<4fm, repul <0.5fm
em	charged particles	photons	infinite
weak nuclear	all	$W^{+/-}$	10^{-18}
gravity	all	graviton	infinite

the strong nuclear force holds nucleons together in a nucleus. the repulsion at <0.5fm stops the nucleus imploding.

specific charge

specific charge:
charge to mass ratio
for an atom, is the charge (typically proton number unless an ion then the charge eg 2+ only) over the overall mass (proton and neutron number)

nuclear decay equations

unstable nuclei decay to become more stable emitting radiation. these can ionise other atoms/molecules which can be dangerous

Alpha decay (larger nuclei):

4 on the top, 2 on the bottom

Beta decay (smaller nuclei):

+ - $p \rightarrow n$

- - $n \rightarrow p$

*make sure lepton numbers are balanced

eg. beta- decay has anti electron neutrino

gamma radiation:

is a high energy EM wave that can be emitted but this isnt due to decay but due to nucleus being in an metastable state (excess energy)

in a decay equation you would write the product number at the top with a small m

in a separate equation you take the element with the m and write it out with the product being without the m and the gamma ray

conservation

charge, energy and momentum, baryon/lepton number must all be conserved in any interaction.

strangeness doesnt need to be conserved, only in *strong* interaction rules:

- particle decay > strangeness is not always conserved
- pair production > strangeness is always conserved

strangeness:

- strange particles are produced by strong interaction
- to conserve strangeness they are always created in pairs eg. $p + p = u\bar{s}s$
- they decay via weak interaction but don't need to be created in pairs (don't have to be conserved)

proving conservation: (Relating to particle interactions)

$B^{+/-} \rightarrow$ occurs in a neutron (decay) - $B^+ = p+n$

electron scatter $\rightarrow$ come close and repel due to charge

P-N bond $\rightarrow$ occurs in nucelus due to strong force (also em however em is weaker than strong)

electron capture $\rightarrow$ electron captured by a proton, therefore exchange particle is always from the proton (W^+)

E-P collision $\rightarrow$ electron collides with proton so exchange particle comes from the electron (W^-)

Annihilation and pair production

these are possible due to the fact that **mass can be converted ubti energy and vice versa**

Annihilation:

particle and antiparticle collide- mass is converted to two photons

minimum energy/frequency:

$$2mc^2 = 2hf$$

if the particles have kinetic energy this is added to the photons energy

Pair production:

a photon of sufficient energy is converted into a particle and its antiparticle

minimum freq photon for this:

$$hf = 2mc^2$$

if photon has more than minimum needed, it is converted into E_k



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