

Beta Decay

There exists three varieties of β decay:

- 1) β^- , 2) β^+ , 3) Electron capture $\leftarrow$ In all these types A remains constant

β^- decay:

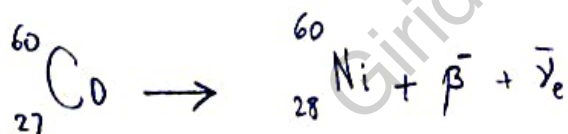
How come a nucleus emit an e^- if there aren't any e^- 's inside the nucleus?

Actually if we free a n from the nucleus, it decays in about 15 min.



For β^- decay to occur, the mass of the original neutral atom should be larger than that of the final atom.

Ex: β^- decay of ${}^{60}_{27}\text{Co}$, an odd-odd unstable nucleus which is used in medical & industrial applications of radiation



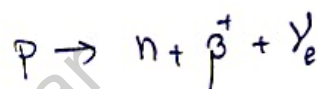
NB: Unlike the α -decay where there were two decay products, in the β -decay we cannot predict precisely how will the energy be shared among decay products

The β^- decay occurs with nuclides that have too large a N/Z ratio (obviously after decay we get $\frac{N}{Z} \rightarrow \frac{N-1}{Z+1}$)

β^+ decay

For nuclides having N/Z too small, they emit a e^+ for stability.

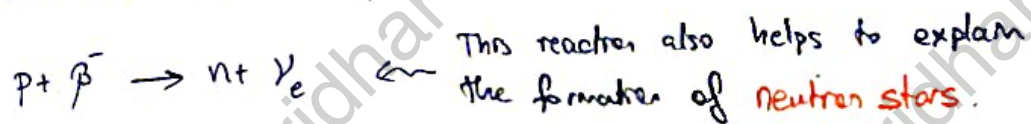
The basic process is:



β^+ decay can occur whenever the mass of the original neutral atom is at least two e^- masses larger than that of the final atom.

e^- capture

There are a few nuclides for which β^+ emission is not energetically possible but in which an orbital e^- (usually in the K shell) can combine with a proton in the nucleus to form a n and a ν_e . The n stays in the nucleus and ν_e is emitted. The basic process is:



This reaction also helps to explain the formation of **neutron stars**.

e^- capture can occur whenever the mass of the original neutral atom is larger than that of the final atom.

Note that all these three β decays occur **within** a nucleus.

β^- decay can also occur outside the nucleus

β^+ decay is forbidden by conservation of mass-energy for a p outside nucleus.

The e^- capture can occur outside the nucleus only with the addition of some extra energy, in a collision.