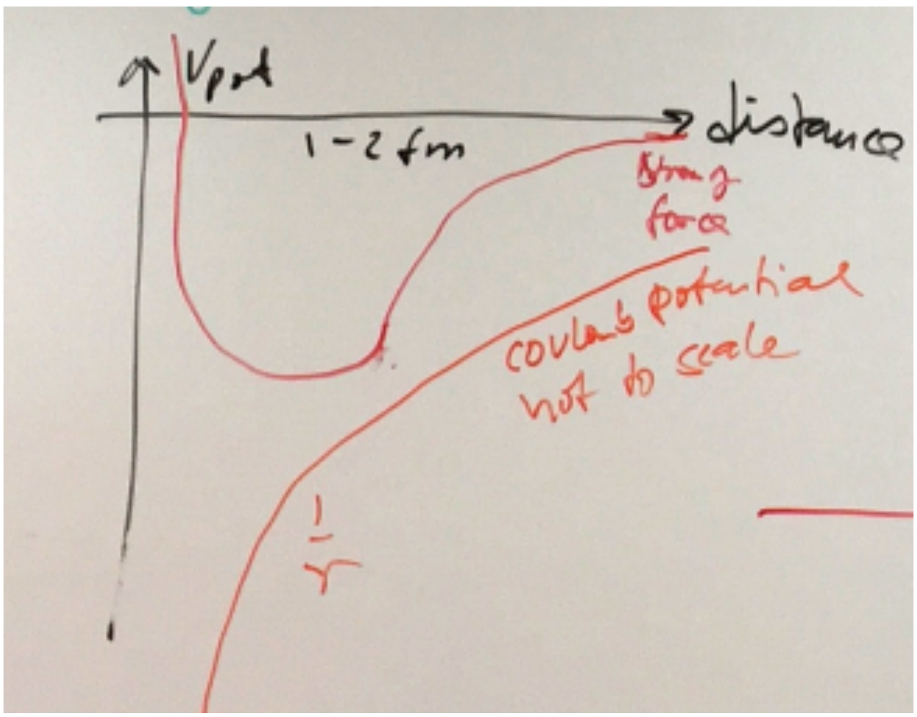
Nuclei:

- Made of neutrons and protons ("nucleons"), $A = Z + N$
- Mass of a nucleus= $Z * m_p + N * m_r - |BE|/c^2$
- Binding energy (BE) is roughly proportional to A (around 8-9 MeV/nucleon)
  - => binding only due to next neighbors, not all nucleons in the nucleus
- Isotope: same Z, but different N(A)
- Decays
- Size few times $10^{-15}m = fm = 1\ Fermi$
  - To resolve, use electrons with a few 100 to thousands of MeV
  - $volume \sim A$ => roughly constant density

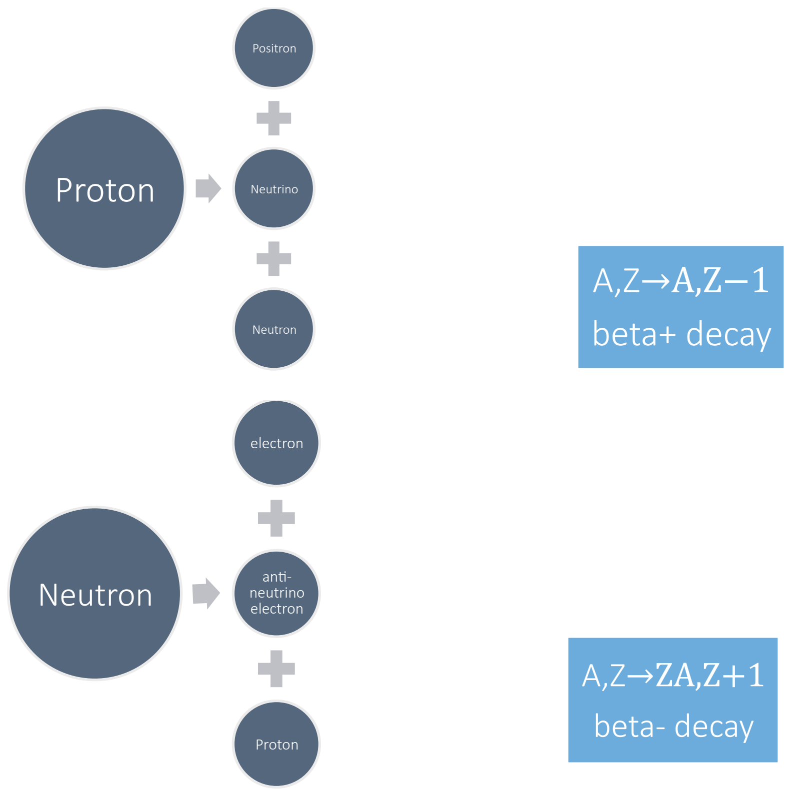
Strong Nuclear Force

MUCH stronger than electrostatic force between protons, but

VERY short-ranged (after a few fm distance, it has NO effect).



Weak Nuclear Force



$\alpha - decay$ $\qquad$ $a = \ ^4He$ nucleus

$A, Z \rightarrow A - 4, Z - 2$ $\qquad$ strong and electromagnetic

$\gamma\ decay\ (\gamma = photon)$: Going from excited nuclear state to less excited (lower energy) state

All Decays are spontaneous and largely unaffected by anything outside the nucleus - QM says we can not predict the moment of a decay, just the probability that it decays at a certain time.

Exponential Decay Law: The decay rate ("activity") at any time is proportional to the number of radioactive nuclei (of the species under consideration) at that time. With τ = mean life time:

$$\frac{\Delta N_{decay}}{\Delta t}(t) = \frac{1}{\tau} * N_{nuclei}(t)$$

$$N_{nuclei} = N_0 e^{\frac{-t}{\tau}}$$

Half Life

$$t_{\frac{1}{2}} = ln2\ \tau$$