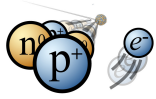
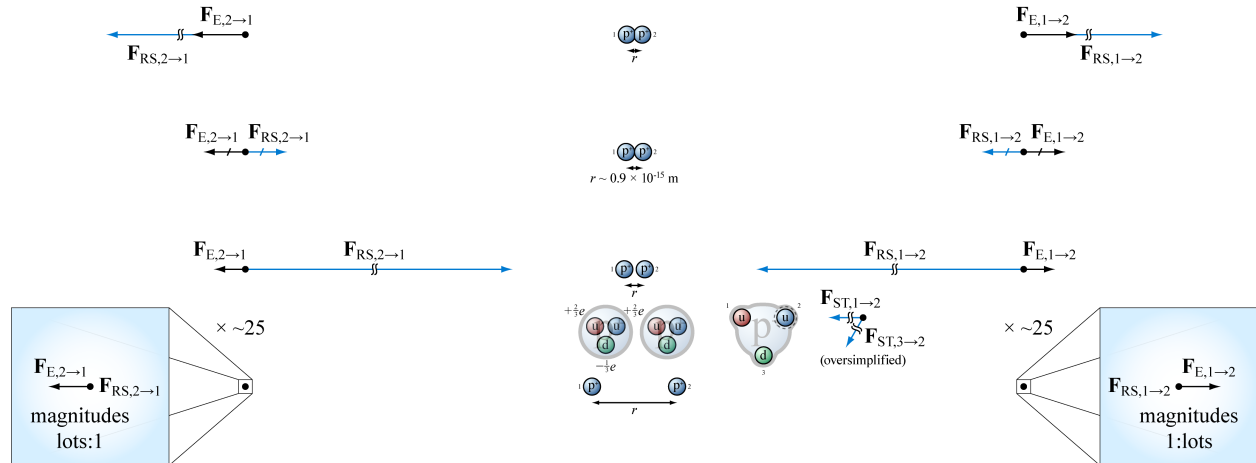


Subatomic physics (for AP Physics 2)

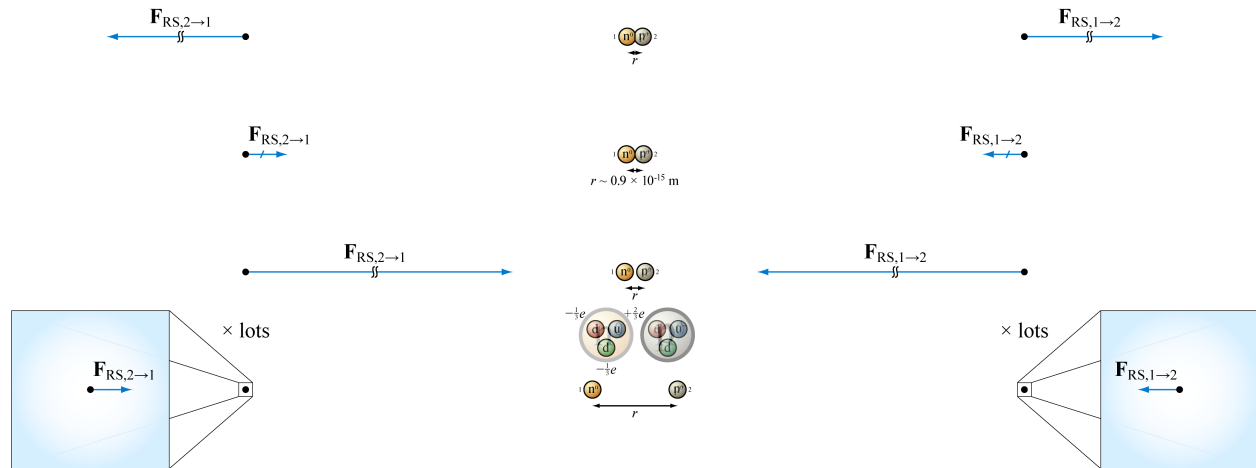
Nuclear force ("residual strong force")



The protons of an atom are concentrated in the atom's nucleus, a region of space much smaller than the atom itself. Pairs of protons repel each other Coulombically. What prevents the protons in a nucleus from flying apart?

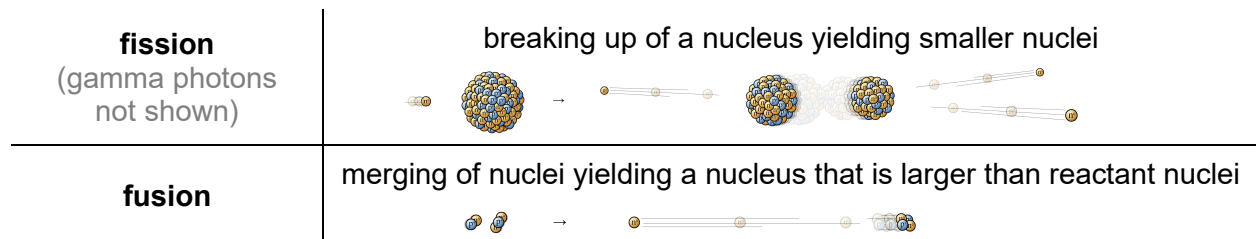


The nuclear force is a residual of the fundamental strong force. The nuclear force dominates for small nucleon separations (on the order of 10^{-15} m) and can be attractive.

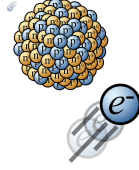


Sometimes, the stability of a nucleus can be increased by adding neutrons.

Separating and combining nucleons



Subatomic physics (for AP Physics 2)



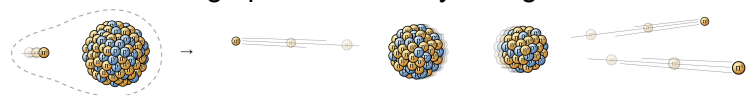
${}^{238}_{92}\text{U}$

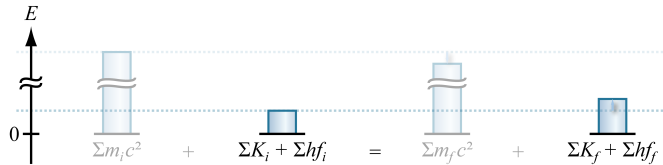
${}^A_Z\text{X}$

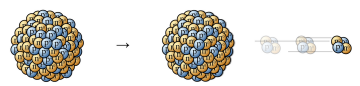
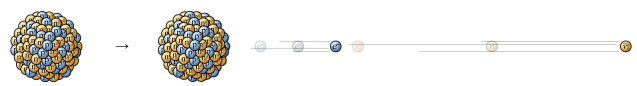

A – baryon (nucleon) number (combined number of protons and neutrons)
 Z – charge (in units of proton charge)
 X – symbol of particle

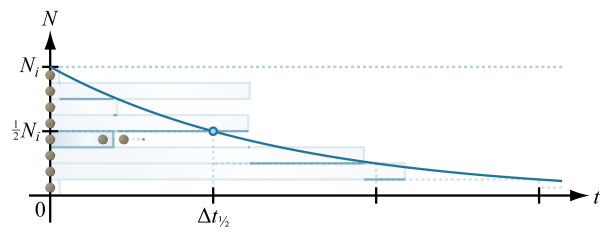
Fission
(gamma photons not shown)

breaking up of a nucleus yielding smaller nuclei





fusion	merging of nuclei yielding a nucleus that is larger than reactant nuclei
Alpha (α) decay	${}^A_Z\text{X} \rightarrow {}^{A-4}_{Z-2}\text{Y} + {}^4_2\text{He}$ 
Beta (β) decay	${}^A_Z\text{X} \rightarrow {}^{A}_{Z+1}\text{Y} + {}^0_{-1}\text{e} + \bar{\nu}_e$ 
Gamma (γ) decay	${}^A_Z\text{X}^* \rightarrow {}^A_Z\text{X} + {}^0_0\gamma$ 



half-life – time duration for not-yet-decayed population to decrease (on average) to half its original value

Conservation laws continue to hold (when quantities are defined relativistically)

$$\Sigma \vec{p}_i + \overbrace{\Sigma \Delta \vec{J}_{\text{EXT} \rightarrow \text{SYS}}}^{\Delta \vec{J}_{\Sigma \vec{F}, \text{EXT} \rightarrow \text{SYS}}} = \Sigma \vec{p}_f$$

$$\Sigma q_i + \Delta q_{\text{EXT} \rightarrow \text{SYS}} = \Sigma q_f$$

$$\Sigma Z_i + \Delta Z_{\text{EXT} \rightarrow \text{SYS}} = \Sigma Z_f$$

$$\Sigma A_i + \Delta A_{\text{EXT} \rightarrow \text{SYS}} = \Sigma A_f$$

$$\Sigma m_i c^2 + \Sigma K_i + \Sigma hf_i + \Sigma \Delta W_{\text{OUF}} = \Sigma m_f c^2 + \Sigma K_f + \Sigma hf_f$$

“Missing” Σmc^2 after a binding reaction is called binding energy. 1 amu = 1.66×10^{-27} kg