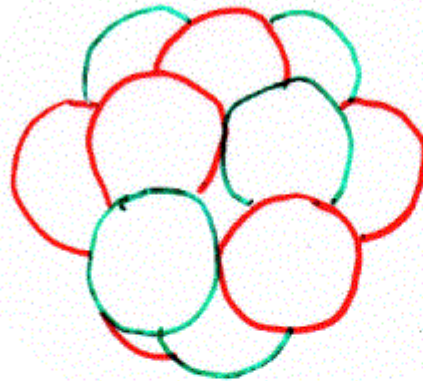


SEMI-EMPIRICAL LIQUID DROP MODEL OF NUCLEUS



PROTONS
NEUTRONS

LIQUID

- CONSTANT BINDING ENERGY PER MOLECULE
 - SHORT RANGE V.d.W FORCE
- CONSTANT DENSITY
 - INCOMPRESSIBLE LIQUID

NUCLEUS

- BINDING ENERGY PER NUCLEON IS CONSTANT
- DENSITY OF NUCLEAR MATTER IS CONSTANT

U - ENERGY OF EACH NUCLEON-NUCLEON BOND
- SHARED BY 2 NUCLEONS $\frac{BE}{\text{NUCLEON}} = \frac{U}{2}$

• CLOSELY PACKED SPHERES \rightarrow EACH IN CONTACT WITH 12 OTHERS $BE \text{ OF INTERIOR NUCLEON} = 12 \times \frac{U}{2} = 6U$

• IF ALL NUCLEONS INTERIOR

TOTAL BINDING ENERGY $E_V = 6AU$

• VOLUME ENERGY OF NUCLEUS

$$E_V = 9, A \propto A$$

- SURFACE NUCLEONS < 12 NEIGHBORS
- NUMBER OF SURFACE NUCLEONS PROPORTIONAL TO SURFACE AREA $4\pi r^2 = 4\pi r_0^2 A^{2/3}$
ELECTRON SCATTERING
- NUMBER OF SURFACE NUCLEONS $\propto A^{2/3}$
- REDUCES BINDING ENERGY/NUCLEON FROM THAT OF AN "∞" NUCLEUS
- SURFACE ENERGY OF NUCLEUS

$$E_S = -a_2 A^{2/3}$$

REDUCES BINDING ENERGY

EXPECT NUCLEI TO BE SPHERICAL

- DROP OF LIQUID IS SPHERICAL (ON ISS)
- NUCLEUS WILL ADOPT ENERGY MINIMUM
- BINDING ENERGY \rightarrow MAXIMUM
- MINIMIZE SURFACE AREA AS IT REDUCES BINDING ENERGY \rightarrow SURFACE TENSION



SPHERE HAS LEAST SURFACE AREA FOR A GIVEN

VOLUME \rightarrow

RADIOISOTOPES ARE SPHERICAL

COULOMB REPULSION

PROTONS REPEL → DECREASE BINDING ENERGY

E_c WORK DONE TO ASSEMBLE Z PROTONS
FROM ∞ → COULOMB IN LONG RANGE FORCE
INTO A VOLUME RADIUS r

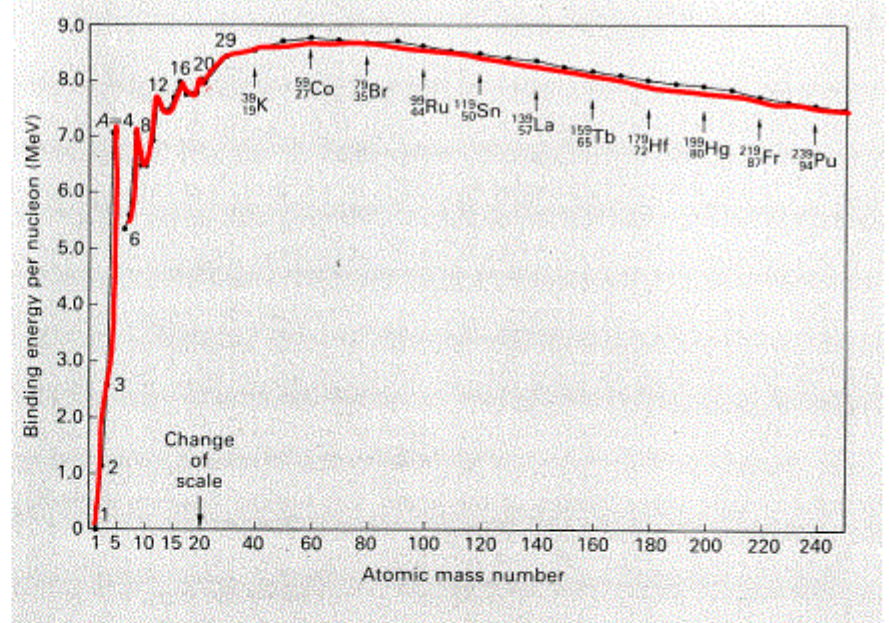
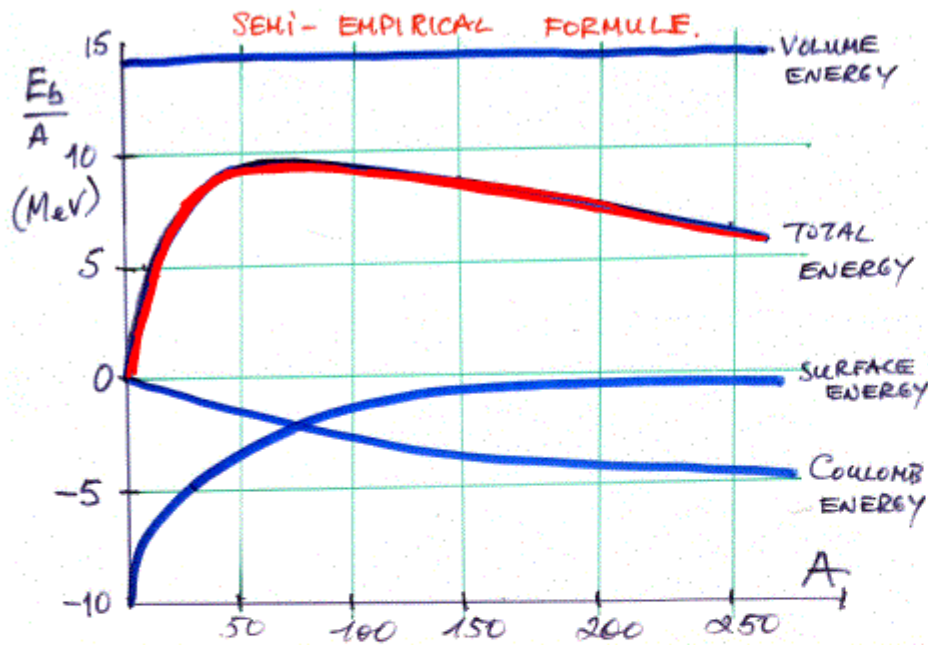
$$E_c \propto \frac{Z(Z-1)}{2} \leftarrow \text{NUMBER OF PAIRWISE PROTON COMBINATIONS}$$

$$E_c \propto \frac{1}{r} \propto \frac{1}{r_0 A^{1/3}}$$

$$E_c = - a_3 \frac{Z(Z-1)}{A^{1/3}}$$

REDUCES BINDING ENERGY

NUCLEAR BINDING ENERGY



$$E_b = E_v + E_s + E_c = a_v A - a_s A^{2/3} - a_c \frac{Z(Z-1)}{A^{1/3}}$$

a_v
 a_s
 a_c

BINDING ENERGY
PER NUCLEON

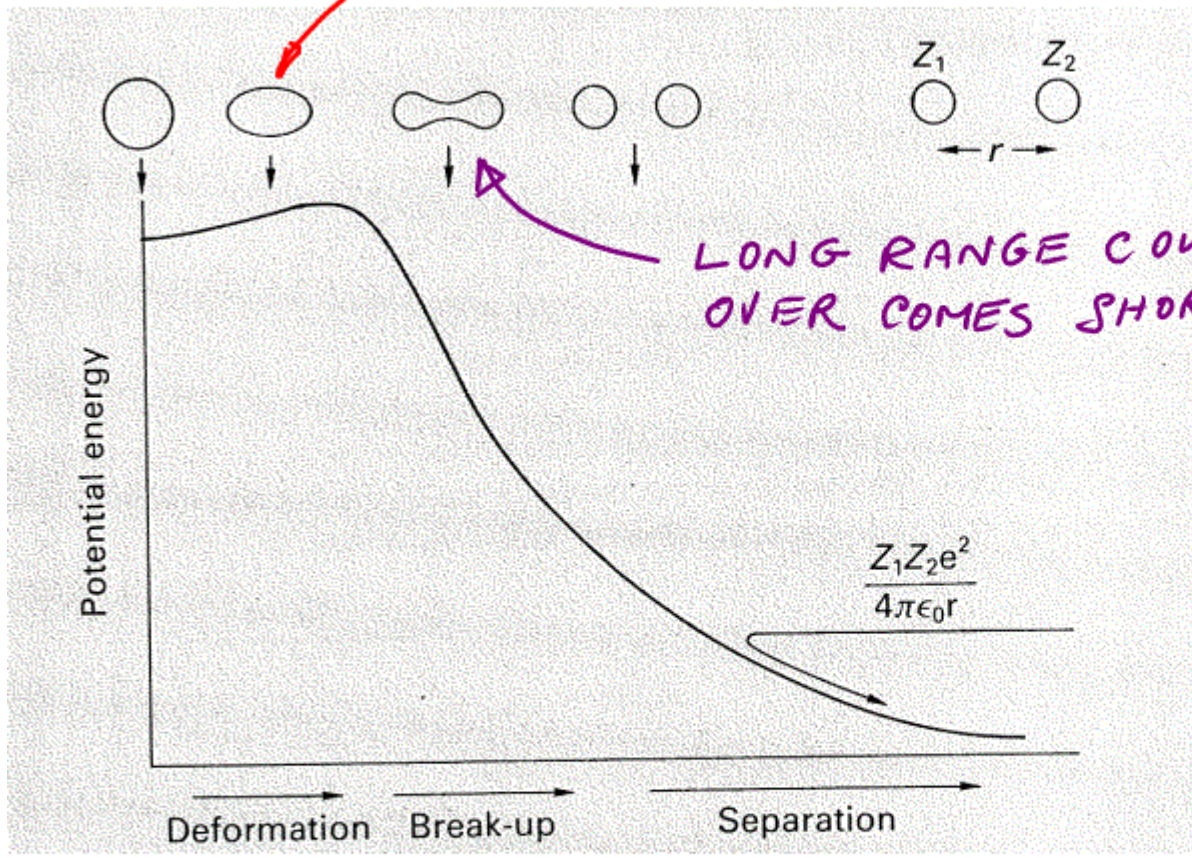
$$\frac{E_b}{A} = a_1 - \frac{a_2}{A^{1/3}} - a_3 \frac{Z(Z-1)}{A^{4/3}}$$

$\sim Z^2$

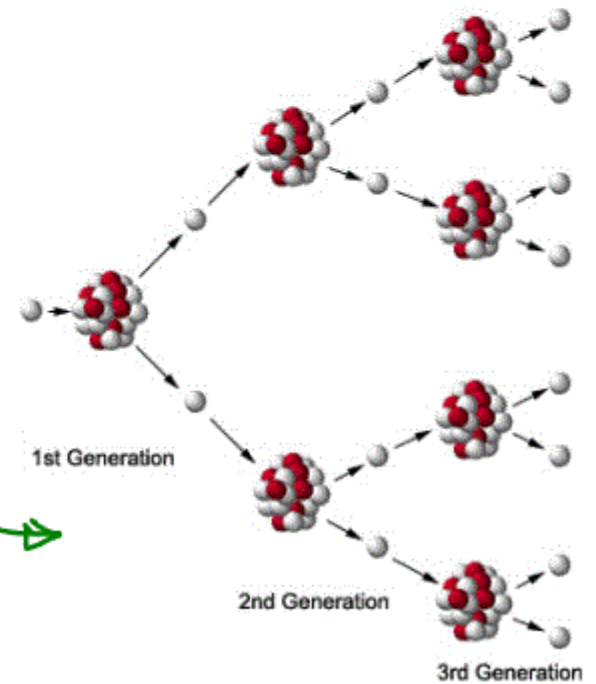
FISSION OF HEAVY NUCLEI

EQUILIBRIUM DISTURBED BY eg.

STRAY NEUTRONS



LONG RANGE COULOMB REPUSSION OVER COMES SHORT RANGE ATTRACTION



CHAIN REACTION

Uranium-235 atom neutron