Homework 8, due 11-10

Consider the semi-empirical formula for the binding energy

$$B = a_V A - a_{sur} A^{2/3} - a_{sym} \frac{(Z - A/2)^2}{A} - a_C \frac{Z^2}{A^{1/3}} \pm \delta,$$

with $a_V = 15.85$ MeV, $a_{sur} = 18.34$ MeV, $a_{sym} = 92.86$ MeV and $a_C = 0.71$ MeV. Ignore the pairing energy δ.

1. Give a general formula for the nuclear charge Z of the most tightly bound nucleus with a given A. What is the nuclear charge Z for mass number $A = 56, 208$?

2. Find the condition for α instability,

   $$(A, Z) \to (A - 4, Z - 2) + \alpha$$

   Use the experimental value for α particle binding energy, $B_\alpha = 28.28$ MeV. For what mass number A do nuclei become unstable towards α emission?

3. Find the condition for (symmetric) spontaneous fission,

   $$(A, Z) \to (A/2, Z/2) + (A/2, Z/2).$$

   For what mass number A do nuclei become unstable towards fission?