Homework 7, due 11-1

Consider the semi-empirical formula for the binding energy

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

with \( a_V = 15.85 \text{ MeV} \), \( a_{\text{sur}} = 18.34 \text{ MeV} \), \( a_{\text{sym}} = 92.86 \text{ MeV} \) and \( a_C = 0.71 \text{ MeV} \). Ignore the pairing energy \( \delta \).

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 \( A = 56 \) ans \( A = 208 \)?

2. Find the condition for \( \alpha \) instability,

\[ (A, Z) \rightarrow (A - 4, Z - 2) + \alpha \]

For what mass number \( A \) do nuclei become unstable towards \( \alpha \) emission?

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

\[ (A, Z) \rightarrow (A/2, Z/2) + (A/2, Z/2). \]

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