

1130: Why there are no elements in nature greater than uranium, which has an atomic number of 92

This is also common knowledge about atoms.

Key words: nuclear force; Coulomb repulsion; nuclear fission; uranium, competition between Coulomb force and nuclear force

The reason that there are no elements in nature larger than uranium, which has atomic number 92, is the competition between the nuclear force between nucleons and the Coulomb repulsive force between protons. Nuclear forces only act between nucleons, and have a range of approximately 10^{-15} m. On the other hand, although the Coulomb force is inversely proportional to the square of the distance¹), it still reaches much farther than the nuclear force. Nuclear forces are strong binding forces, but as the number of protons in an atomic nucleus increases, the Coulomb repulsions between protons accumulate and exceed the nuclear force. When this happens, the nucleus splits. The limit is nuclei near uranium.

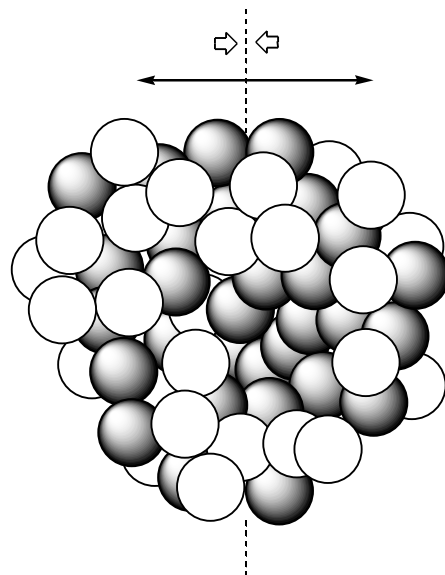


Figure 1. Nuclear fission. Black circles = protons, white circles = neutrons. Nuclear force is a strong attractive force, but it only acts on adjacent nucleons. On the other hand, Coulomb repulsion also affects distant protons. When the sum of the repulsive forces exceeds the nuclear force near the secant line, the nucleus splits.

¹ The force (Coulomb force) f acting between charges Q_1 and Q_2 , which are separated by a distance r , is

$$f = \frac{Q_1 Q_2}{4\pi \epsilon_0 r^2}$$

where ϵ_0 is a constant called the dielectric constant of a vacuum and has a value of $8.853 \times 10^{-12} [\text{C}^2 \text{N}^{-1} \text{m}^{-2}]$ (see 1170).