Atomic stability

The fizzics organisation
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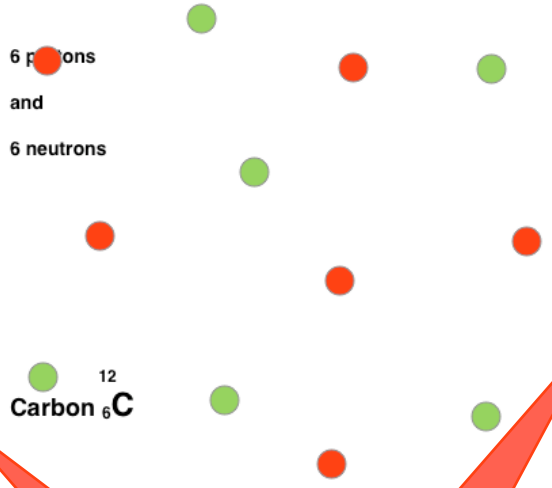
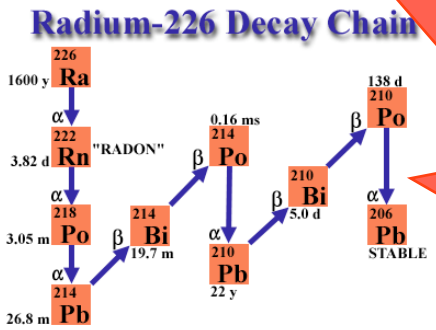
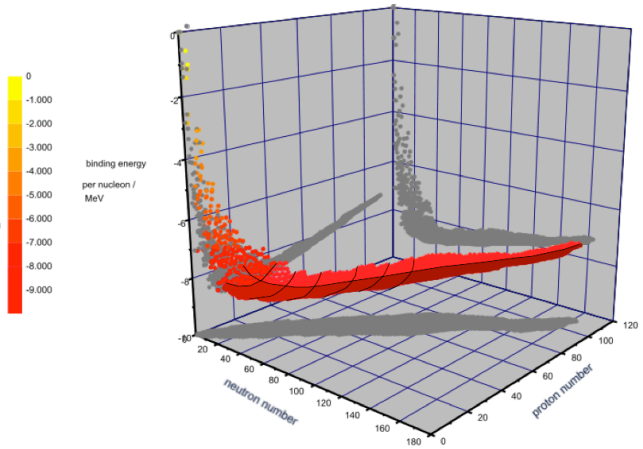
The **nucleon number** is the number of major particles (protons and neutrons) in the nucleus.



Acting together these cause a long **decay chain to contain both beta and alpha** emission.



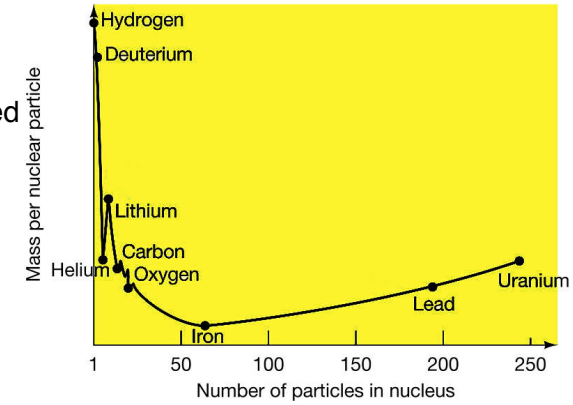
The alpha particles reduce the mass but increases the relative number of neutrons. The beta emission converts a neutron to a proton and restores the “ideal” ratio.



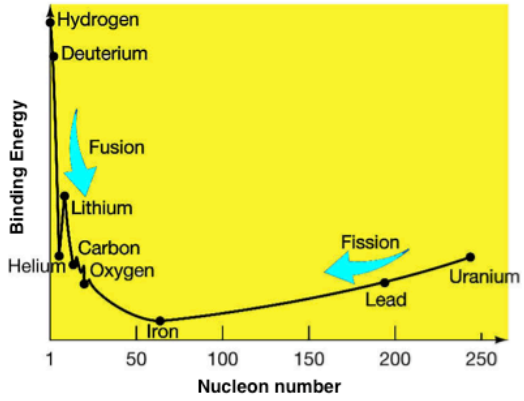
If these two factors are put together in a 3D graph then there is a valley of stability, sometimes called the **iron lake**.

The binding energy of the nucleus is the energy required to completely separate all the major particles of the nucleus. In reverse the energy released if all the particles come together.

Shown as negative in the graphs because a nucleus has less energy than the separate particles.



The binding energy per nucleon (that’s total binding energy divided by the number of nucleons in the nucleus) is high for small atoms and for big atoms. The most stable atoms are about the size of iron (nucleon number 56).



Big atoms tend to be naturally unstable (radioactive and can be artificially split releasing large amounts of energy (fission) as in an atomic bomb and a nuclear reactor.

Very small atoms can be combined to make larger ones (fusion) but the high pressure and temperature conditions to initiate this can (currently) only be seen naturally in stars or artificially in a hydrogen bomb.

A second significant factor for stability is the **ratio of the numbers of protons and neutrons**. The repulsion between the positive protons in larger atoms has to be “diluted” by greater numbers of neutrons, The observed balance for stability is shown in the graph on the left.