

















Ruth E. Schmitz, May 25th, 2006



Phenomenology of Stability

- Stability strongly favors nuclides with even numbers of protons and/or neutrons
 - » ~50% are Even-Even
 - » ~25% are Odd-even
 - » ~25% are Even-Odd
 - » Only 4 out of 266 stable nuclides are Odd-Odd! The heaviest stable Odd-Odd nuclide is ¹⁴N.
- "Magic Numbers" -- analogous to closed atomic shells
 - » Result in many stable isotopes or isotones
 - » Magic nuclei are particularly stable and more "inert"
 - » Magic #'s: 2,8,20,28,50,82,126

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Nuclear Binding and Stability

- Protons and neutrons are more stable in a nucleus than free. The binding energy is the amount by which the nucleus' energy (i.e. mass) is reduced w.r.t. the combined energy (i.e. mass) of the nucleons.
- Example: N-14 atom Measured mass of N-14 = 14.0037
 - mass of 7 protons = 7 * (1.00727 amu) = 7.05089 amu
 - mass of 7 neutrons = 7 * (1.00866 amu) = 7.06062 amu
 - mass of 7 electrons = 7 * (0.00055 amu) = 0.00385 amu
 - mass of component particles of N-14 = 14.11536 amu
- Binding energy is mass difference: $E_{bind} = 0.11229 \text{ amu} = 104.5$ MeV

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Not used in medical imaging

 ${}^{A}_{Z}X \rightarrow {}^{A4}_{Z2}Y + {}^{4}_{2}He^{+2}$ + transition energy

Example: ${}^{220}_{86}\text{Rn} \rightarrow {}^{216}_{84}\text{Po} + {}^{4}_{2}\text{He}^{+2} + 6.4 \text{ MeV transition energy}$

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What's next Next week we will take a look at Radiation detection and measurements Dr. Lawrence MacDonald