# Binding Energy

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## Homework Review

$m_p = 1.0072766$ amu

$m_n = 1.0086654$ amu

Pu-245 = 245.0675 amu

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$94(1.0072766) + 151(1.0086654) = 246.9924758$ amu

(mass of protons) (mass of neutrons)

Making Pu-245 from seperate parts is an exothermic reaction!

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What is holding all these nucleons together?

→ Strong Nuclear Force

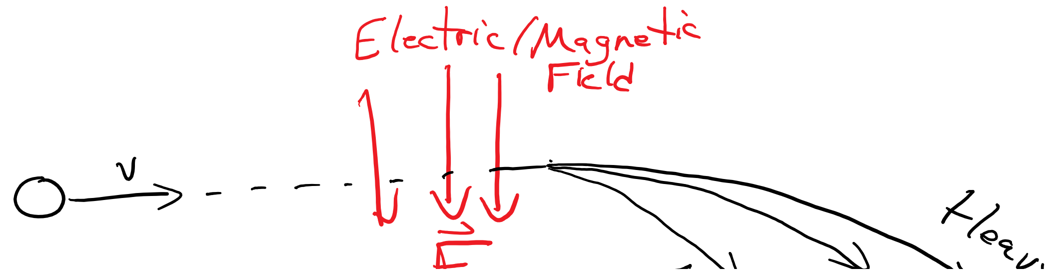
→ Very Strong

→ *Very* Short range

The Strong Nuclear Force does work to keep the nucleus together. This work is called <u>Binding Energy</u>

How can we measure these masses?

<u>Mass Spectroscopy</u>




$p + n \longrightarrow$ nucleus    Exothermic

The release of energy means there is less mass. This is called mass defect ($\Delta m$).

We can convert between mass defect and Binding Energy with $E = mc^2$.

## Units

Mass Defect

$$1\ \text{amu} = 1.6605 \times 10^{-27}\ \text{kg}$$

Binding Energy

MeV = mega-electron Volts

mega → $\times 10^6$

$M\,e\,V$

Volts $\frac{J}{C}$

$e$ ↑ the charge of an electron $1.6 \times 10^{-19}\ C$

$$1\ \text{MeV} = 1.6 \times 10^{-13}\ J$$

MeV ⇌ amu

$$931.49\ \text{MeV} = 1\ \text{amu}$$

$$E = mc^2$$

$$E = (1.6605 \times 10^{-27})(3 \times 10^8)^2$$

$$E = 1.49445 \times 10^{-10}\ J$$

$$1.49445 \times 10^{-10}\ J \times \frac{1\ \text{MeV}}{1.6 \times 10^{-13}\ J} = 934\text{ish}$$

**Example:** Find the mass defect of Lithium-6.

Li-6 - 6.015122 amu    $m_p = 1.007276$ amu

$m_n = 1.00860$ amu

$3p + 3n =$ Lithium

$3(1.007276) + 3(1.008665) = 6.047823$ amu

$\Delta m = 6.047823 - 6.015122 = 0.032701$ amu

What is its BE?

$0.032701 \times 931.49 = 30.461$ MeV

## Binding Energy Per Nucleon

Is a direct guage of the stability of a nucleus. The higher the Energy per particle the more stable the nucleus.

Iron-56 is the most stable nucleus

$$BEPN = \frac{BE}{A}$$

↖ number of nucleons