

Intro to Nuclear Structure

D. Craig

February 15, 2006

Properties of nuclei

Nuclei are made of *protons and neutrons*.*

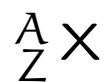
Several standard terms are used to describe nuclei

- The **atomic number**, Z , or charge number, is the number of protons.
- The **neutron number**, N .
- The **mass number**, $A = Z + N$.

*Which in turn are made of quarks with an unusual binding potential.

Symbol system for nuclides

To describe all the elements and their isotopes (the nuclides) this symbolism is used:



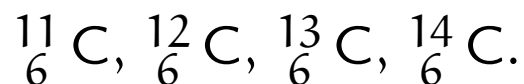
where A is the mass number, Z the charge, and X is the element symbol.

For example, ${}_{26}^{56}\text{Fe}$ has a mass number of 56, atomic number 26, and $A - Z = 30$ neutrons.

Isotopes

The isotopes of an element have the same Z but different N and A values.

Some isotopes are more stable than others, and the natural abundances can be quite different. For example carbon has



98.9% of natural carbon is ${}^{12}_6\text{C}$.

Isotopes can occur naturally or be produced in nuclear reactions.

Charge and mass

A proton carries a charge of $+e$.

Masses are measured in *atomic mass units*, u.

$$1 \text{ u} = \frac{1}{12} m({}_{6}^{12}\text{C})$$

In these units

$$m_p = 1.007\,276\,5 \text{ u} \quad (1)$$

$$m_n = 1.008\,664\,9 \text{ u} \quad (2)$$

$$m_e = 0.000\,548\,579\,90 \text{ u} \quad (3)$$

A proton is about 1836 times more massive than an electron.

In terms of $E = mc^2$ we can write a mass as an energy:

$$1 \text{ u} = 931.494\,3 \text{ MeV}/c^2$$