0302463
Nuclear Physics

http://nuclear.bau.edu.jo/ju/ju-nuclear-undergrad

or

http://nuclear.dababneh.com/ju/ju-nuclear-undergrad

Before we start, let us tackle the following:

- Why nuclear physics?
- Why radiation physics?
- Why in Jordan?
- Interdisciplinary.
- Applied.

This is a phenomenological course.

General Course Content

- Nuclear properties.
- Binding energy and nuclear stability.
- Spin, parity and moments.
- Nuclear forces.
- The structure of the nucleus.
- Nuclear models.
- Radioactive decays.
- Nuclear reactions: energetics and general cross-section behavior.

Grading

First Exam	25%
Second Exam	25%
Quizzes and HWs	10%
Final Exam	40%

- Homeworks are due after one week unless otherwise announced.
- Remarks or questions marked in red without being announced as homeworks should be also seriously considered!
- Some tasks can (or should) be sent by email.

Scales

Dimensional scale:

Order of magnitude of 1 x 10^{-15} m ≡ 1 femtometer ≡ 1 fm ≡ 1 fermi.

Too small for direct investigation.

Time scale:

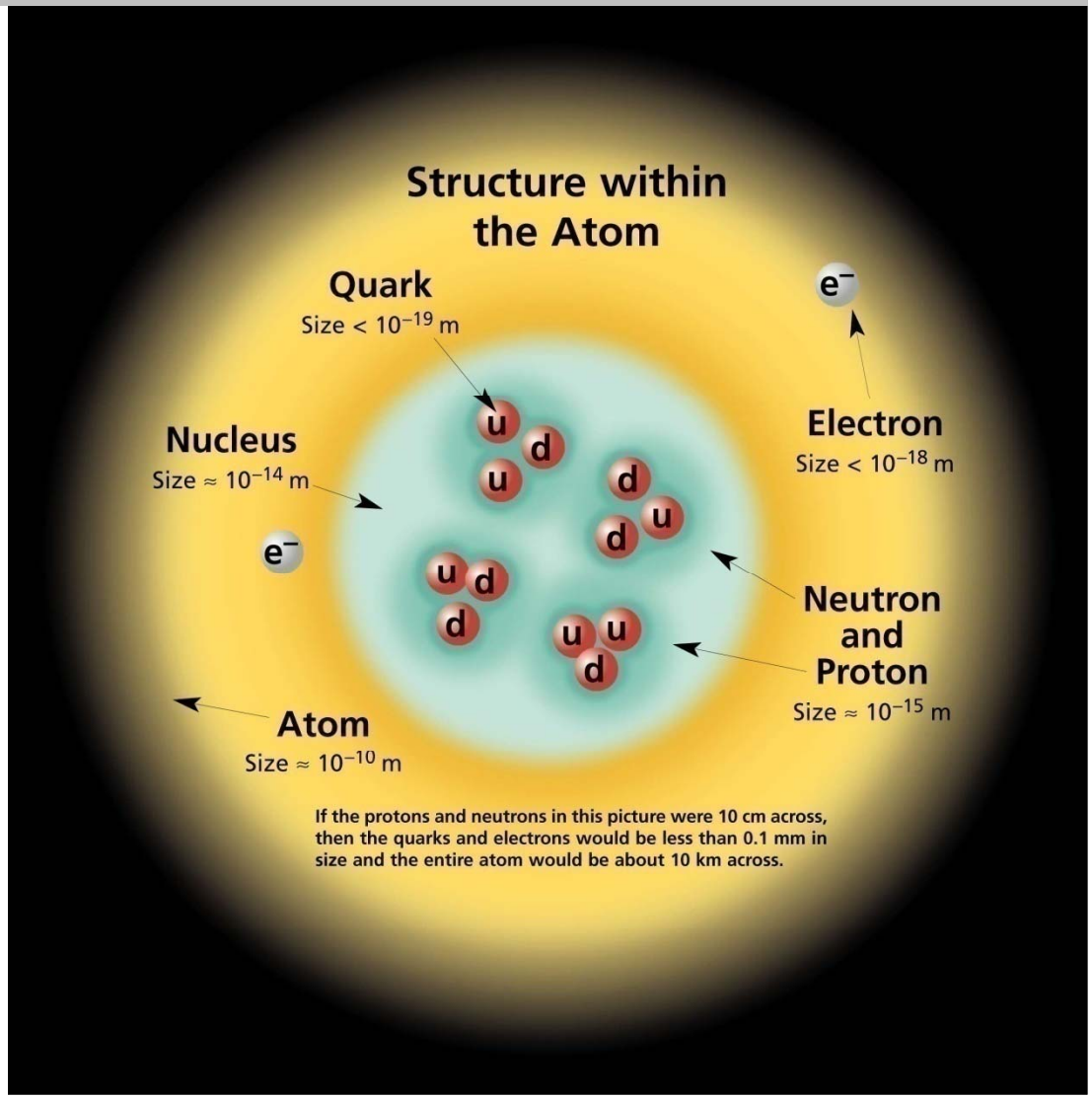
10^{-20} s to millions of years.

Energy scale:

MeV

Mass:

- Unified atomic mass unit u based on ^{12}C.
- Replaced both physical and chemical amu based on ^{16}O and natural oxygen, respectively (Find conversion factors).



Scales

- 1 u = M(^{12}C)/12 = …… kg = …… MeV/c^2.
- Rest masses

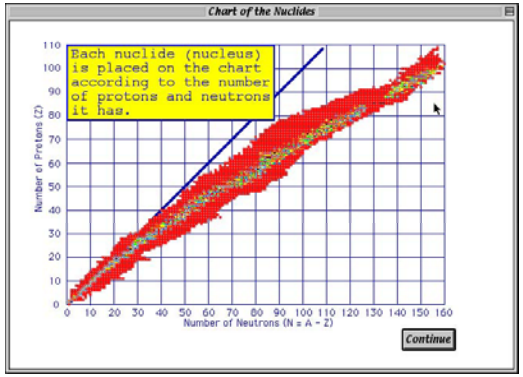
	u	MeV/c^2	kg
electron	……	……	……
proton	……	……	……
neutron	……	……	……
^{12}C	12	……	……

Atomic masses:
http://physics.nist.gov/cgi-bin/Compositions/stand_alone.pl?ele=&all=all&ascii=ascii&isotype=all
Constants:
http://physics.nist.gov/cuu/Constants/index.html

Nomenclature

Chart of Nuclides

http://www.nndc.bnl.gov/chart/



Element vs. Nuclide.

>90 natural chemical elements, total > 100.

Element ▶ Atomic number (Z) ▶ chemically identical.

~3000 nuclides……? How many are stable?

Same Z but different neutron number (N) ▶ Isotopes.

Total number of nucleons = Z+N = A ▶ mass number.

$${}^{A}_{Z}X_{N} \qquad {}^{A}X \qquad {}^{22}_{11}Na_{11} \qquad {}^{23}Na \qquad {}^{24}Na$$

redundant

Radioactive Stable Radioactive

Same mass number ▶ Isobars ▶ chemically dissimilar, parallel nuclear features (Radius …). β decay.

Same neutron number ▶ Isotones.

Same Z and same A ▶ Isomers ▶ metastable.

$${}^{Am}X$$

Stable isotope ▶ (Isotopic) Abundance.

Radioactive isotope ▶ Half-life.

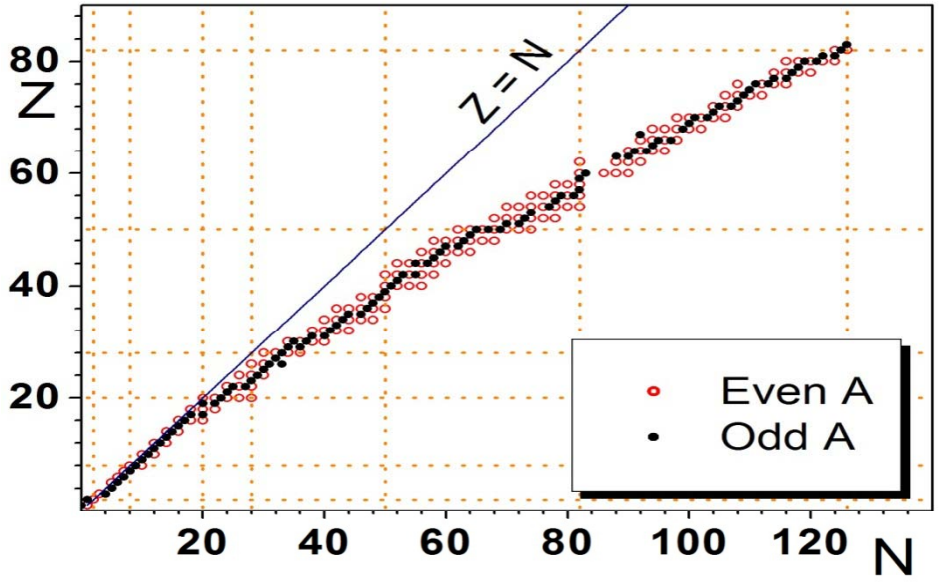
Stable Nuclides

HW 1

	Odd A		Even A	
Nuclide	N	Z	N	Z

Then plot Z vs. N.

Odd A Even A



Basic Calculations

The energy of the nucleon in the nucleus is in the order of 10 MeV.

HW 2 Calculate the velocity of a 10 MeV proton and show that it is almost 15% of the speed of light. (Perform both classical and relativistic calculations).
∴ Relativistic effects are not important in considering the motion of nucleons in the nucleus.

HW 3 Calculate the wavelength of a 10 MeV proton. Compare it to the nuclear scale.

HW 4 Calculate the wavelength for an electron of the same energy to show that it is much too large to be within the nucleus.

Read the proton-electron nuclear hypothesis! (Page 4)

Chadwick, neutron.