PHYS 4134, Fall 2016, Homework #3

Due Wednesday, September 15 2016, at 1:00 pm

1. Semi empirical mass formula and nuclear radii

Derive an expression for the Coulomb energy of a uniformly charged sphere, total charge Q and radius R. [Hint: refer to any E&M book for help here. This problem is very similar to problem 2.1 in your text.] If the binding energies of the mirror nuclei ³⁹K and ³⁹Ca are 333.724 and 326.409 MeV, respectively, estimate the radii of the two nuclei by using the semi-empirical mass formula (SEMF). Discuss the contribution of each term individually to this difference in binding energy.

2. Semi empirical mass formula

Use the SEMF to obtain an expression for the Z value of the isobar which will have the lowest mass for a given A. Hence, determine which isobar with A = 86 is predicted to be the most stable. [Hint: this is a lot like problem 2.3 in the text. Take A and Z to be independent, and vary N to keep A constant. Re-write any terms which go like N, using N=A-Z. Hint: this is a lot like problem 2.3 in the text.]

3. Nuclear Shell Model

Find the spin and parity of for the ground state and first excited state of ⁷Li and ³³S and ⁹⁹Tc (a good source for this might be the National Nuclear Data Center; <u>http://www.nndc.bnl.gov</u>, then click on "Structure and Decay" and "Chart of the Nuclides"). Using Fig. 1, determine the single particle shell model configuration for these states and compare them to the observed values.



Figure 1: Single particle shell model states for protons (Z) and neutrons (N).