QUANTUM MECHANICS II

PHYS 517

Problem Set #4

Distributed April 29, 2011

Due May 6, 2011

Nuclear Ground States

Prelude: Identify the notation you are using to identify nucleon orbitals.

1. Write down the nuclear ground state configuration of: $^{207}_{82}$Pb, $^{208}_{82}$Pb, and $^{209}_{82}$Pb. For each, what the the ground state nuclear spin?

2. Write down the ground state configuration of all calcium isotopes from $^{40}_{20}$Ca to $^{48}_{20}$Ca. For each, what is the ground state nuclear spin?

3. Write down the ground state configuration of all isoto*n*es from $^{48}_{20}$Ca to $^{56}_{28}$Ni. For each, what is the ground state nuclear spin?

4. How many stable odd-odd nuclei are there? What are they? For each, what is the ground state nuclear configuration? What is the ground state nuclear spin?

5. An ^{27}Al nucleus in a crystal field is subject to an electrostatic perturbation. The crystal field perturbation has a dipole contribution $\mathcal{H}_d = DJ_z$ and a quadrupole contribution $\mathcal{H}_q = Q(J_+^2 + J_-^2)$.

a. Write down the ground state nuclear configuration of this nucleus. What is the ground state spin?

b. Draw a diagram illustrating how the ground state energies split under $\mathcal{H}_d$ alone.

c. Draw a diagram illustrating how the ground state energies split under $\mathcal{H}_q$ alone.

c. Draw a diagram illustrating how the ground state energies split under $\mathcal{H}_d + \mathcal{H}_q$. Assume $D = Q > 0$ for this calculation.