Ph203 HW 5

1. The single particle shell model can be used to calculate the magnetic moments of odd-even nuclei (by assuming that the magnetic moment is due to the odd nucleon only). Using the formula for magnetic momen derived for the deuteron, we can write the magnetic moment operator for a heavy nucleus A as

$$\hat{\mu}_A^n = 2\mu_n \hat{s}_3 \; ; \text{ for an odd neutron} \quad \left(\hat{s}_3 = \tfrac{1}{2}\hbar\sigma_3\right)$$

$$\hat{\mu}_A^p = 2\mu_p \hat{s}_3 + \mu_N \hat{L}_3 \; ; \text{ for an odd proton}$$

Use these operators and the Clebsch-Gordan coefficients (see CG PDF) to derive the shell model predictions:

$$\hat{\mu}_A^n = \mu_n \; ; \text{ for } j = l + \frac{1}{2}$$

$$\hat{\mu}_A^n = -\mu_n \left(\frac{j}{j+1}\right) \; ; \text{ for } j = l - \frac{1}{2}$$

$$\hat{\mu}_A^p = \mu_p + \mu_N (j - \frac{1}{2}) \; ; \text{ for } j = l + \frac{1}{2}$$

$$\hat{\mu}_A^p = \left(\frac{j}{j+1}\right)\left[-\mu_p + \mu_N \left(j + \frac{3}{2}\right)\right] \; ; \text{ for } j = l - \frac{1}{2}$$

2. There are only 4 stable odd-odd nuclei (odd proton # and odd neutron #). List them and comment on why there are no more.

3. Bhaduri Exercise 1.1

4. Using your results from Prob. 3, calculate the invariant mass W^2 of the final state for inelastic electron scattering in terms of M, Q^2, and $\nu = E - E'$.

5. Bhaduri Exercise 1.3. Note that the factor on the 2nd term on the right should be 1/9.