Homework 5

1. (30 **point**) Show that for any L and S :

ψ_{l,m_l,s,m_l} is an eigenstate of $\hat{J}_z$ operator and $m_j = m_l + m_s$.

However, show that ψ_{l,m_l,s,m_l} is not an eigenstate of $\hat{J}^2$ operator in general.

2. (40 **points**) Express Φ_{j,m_j} through ψ_{l,m_l,s,m_s} for a system consisting of $s = 1/2$ and $l = 1$.

3. (40 **points**) Express Φ_{j,m_j} through ψ_{l,m_l,s,m_s} for general case of $s = 1/2$ and l.

4. (40 **points**) Obtain Recursion Relation for Clebsch - Gordan coefficients

5. (40 **points**) Obtain the Hamiltonian of the deuteron nucleus. Show why it has only $l = 0$ and $l = 2$ orbital angular momentum sates and why the total spin of proton and neutron; $S = Sp + Sn = 1$

6. (40 **points**) Express the deuteron wave function at different total angular momentum J projections (1, 0, -1) through the radial wave functions and spherical wave functions1.

7. (30 **points**) Construct the total spin state of bound quark - antiquark system.