Lecture 9. Problems.

1. Estimate for which energies of γ-quantum the long wavelength approximation for electromagnetic operators is valid.

2. Calculate the reduced transition probability from the first excited state to the ground state $B(E2; \frac{1}{2}^+ \to \frac{5}{2}^+)$ in ^{19}O, for ^{16}O being a core active particles occupying $(1d_{5/2})$ orbital.

3. Calculate the reduced transition probability from the first excited $\frac{3}{2}^-$ state to the ground $\frac{7}{2}^-$ state $B(E2; \frac{3}{2}^- \to \frac{3}{2}^-)$ in ^{43}Sc, for ^{40}Ca being a core and active particles occupying $(1f_{7/2})$ orbital.

4. Let us assume that the total angular momentum J of a state is a coupled value of the angular momenta of two groups of nucleons, labelled by A and B with the angular momenta J_A and J_B ($\vec{J} = \vec{J_A} + \vec{J_B}$). Let us assign g-factors g_A and g_B to the groups A and B, respectively. The magnetic moment of the system is

$$\mu = gJ\mu_N \ = \langle JM = J | g_A J_{Az} + g_B J_{Bz} | JM = J \rangle \mu_N \ .$$

   Derive the additivity relation for the magnetic moments:

$$g = \frac{1}{2}(g_A + g_B) + \frac{1}{2}(g_A - g_B)\frac{J_A(J_A+1) - J_B(J_B+1)}{J(J+1)} \ .$$

5. Calculate the quadrupole moment of the first 2^+ excited state in ^{210}Po, assuming that the valence protons occupy a single j-shell.

6. Calculate the magnetic moment of ^{51}V ground state $J^\pi = \frac{7}{2}^-$ for the valence particles being in $f_{7/2}$ orbital only.

7. Calculate the matrix element for the β-decay of a free neutron.