PROBLEMS

Lecture 6

1. Consider exciton in a strong magnetic field ($\hbar\omega_c \gg \mathrm{Ry}$) (*Diamagnetic exciton*). Find energies of the ground state and excited states. Find intensity of light absorption. Show that magnetic field resolves the forbidden transitions and hence increases the intensity of light absorption. Look especially at the transition into ground state of exciton.

2. Consider an exciton bound to an impurity, which itself may be considered as a point-like shallow potential. Let the binding energy E_b is much smaller, than the exciton Rydberg ($E_b \ll \mathrm{Ry}$). How the oscillator strength of light absorption depends on binding energy (*E.I.Rashba*).

3. Consider a permitted light absorption in a direct-gap semiconductor in the presence of a strong electric field. Find a red shift of fundamental edge due to electric field (*W.Franz - L.V.Keldysh*)

4. Consider the light backward scattering on free electrons in magnetic field. Let the direction of light propagation is parallel to direction of magnetic field. Discuss combination scattering (Raman effect) with changes of the frequency of the scattered light compare to that of the incident one.

5. Consider generation of electrons and holes in cubic $A-3B_5$ semiconductors by absorption of a circularly polarized light

at the frequency ω larger than the fundamental edge, but smaller that that for the spin-orbit splited branch of the valence band ($E_g < \hbar\omega < E_g + \Delta_{SO}$). Show that photogenerated electrons are spin-polarized and find degree of polarization.

6. Show that in the medium without inversion center d.c. current $\mathbf{j}$ may be generated by circularly polarized light with complex amplitude $\mathbf{E}(\omega)$. Show that, in the lowest order in light intensity, the current is coupled with t he light amplitude as

$$\mathbf{j} = A[\mathbf{E} \times \mathbf{E}^*]$$