PROBLEMS

Lecture 2

1. Consider crystal with a single substitution-type impurity, which differs from atoms of the matrix only by its mass M is much bigger (smaller) that the mass m of the atoms of the matrix ($M \gg (\ll) m$). Find spectral density of frequencies for such a crystal. How does the probability of Mössbauer effect on this heavy (light) nucleus depends on the temperature T? How does nuclear spin-lattice relaxation rate for the same nucleus depends on T? (see problems **1.3, 1.7**). (*Hint*: Treat local perturbation using the Green's function of the host crystal).

2. A crystal with impurities has local modes, which correspond to bound states of optic phonons on those impurities. If the binding energy E_b goes to zero, the intensity of light adsorption diverges (*E.I.Rashba*). Find an explanation.

3. Spin-lattice relaxation of a local spin polarized along z-axis occurs due to density dependence of the strength of magneto-dipole interaction, or spin-orbit interaction or hyperfine interaction. It could be described by the Hamiltonian:

$$H_{sl} = f_1 \mathrm{div}\mathbf{u}(S^+ + S^-) + f_2(\mathrm{div}\mathbf{u})^2(S^+ + S^-).$$

   The first term is responsible for the processes of spin-flip accompanied by sound emission, while the second one describes Raman-like processes at which a phonon scatters on spin losing part of its energy and flipping the spin. Find temperature dependence and dependence on Zeemann energy E_Z due to both processes.