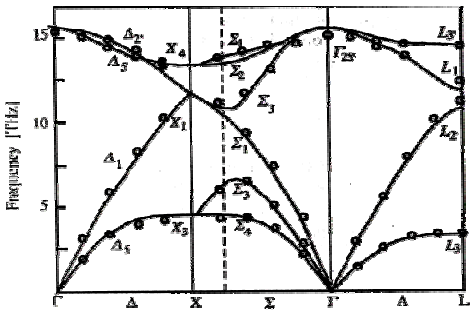
PHYS 774 Fall 2007

Homework Assignment 3 Due Nov 12th

1. Brillouin scattering of a monochromatic light, the wavelength $\lambda_i = 514.53$ nm, from water at room temperature leads to a Brillouin peak shifted from the excitation line by $\Delta\nu = 4.3\times10^9$ Hz at the scattering angle 90°. The refractive index of water is 1.33. What is the sound velocity at this temperature?
2. NaCl has a high-frequency value of the optical index of refraction 1.5 and longitudinal and transverse optical phonon frequencies $\omega_L = 5.0\times10^{13}$ rad/s, $\omega_T = 3.08\times10^{13}$ rad/s. Calculate the static dielectric constant $\varepsilon_r(0)$ and the percentage contribution of the ionic polarizability.

3. Calculate the plasma frequency for n-type GaAs (at room temperature) for the concentration of shallow donors 5×10^{17} cm^{-3}. Electronic effective mass is $m_e = 0.063m_0$. At what donor concentration the plasma frequency is equal to that of the longitudinal optical phonon (which energy is 36 meV)?
4. Which crystal has this phonon dispersion diagram ?



5. Calculate the temperature dependence of the Stokes-to-AntiStokes intensity ratio. Use Planck formula for the number of phonons vs. T and energy. Plot this function for the phonon frequency of 100 cm^{-1}. You may find it useful to convert phonon energy to the units of kT to simplify calculations. Hint:

Number of phonons is given by : (T – temperature)

$$n = \frac{1}{e^{\hbar\omega/kT} - 1}$$

$$Stokes \sim n+1$$

$$anti-Stokes \sim n$$