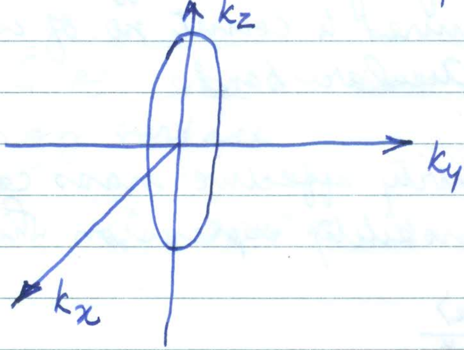
Some more light on effective mass:

For GaAs we get a band centered at $\vec{k} = 0$, which is its Γ band and hence in its case we get a spherical equi-energy surfaces.

Whereas in case of Si or Ge this is not the case. In Si we have 6 CB minima. Therefore we get 6 constant energy surfaces for electrons and hence these are ellipsoidal.



with one major and two minor axes. And hence the mass along these axes would differ.

Let m_l be along k_z (longitudinal)

and m_t be along k_x & k_y (transverse)

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And therefore in case of Si & Ge the concept of effective mass splits further in two ways :

i) for conductivity effective mass which should be used for charge transport problems

ii) for density-of-states effective mass which is required to count no. of carriers in that particular band.

For Si the conductivity effective mass calculation is done from the mobility expression which is

$$\langle v_x \rangle = \frac{\langle p_x \rangle}{m_n^*}$$

Since we have $1/m_n^*$ in the mobility expression, by using dimensional equivalence, we can write the conductivity effective mass as the harmonic mean of the band curvature effective masses, i.e.,

$$\frac{1}{m_n^*} = \frac{1}{3}\left(\frac{1}{m_l} + \frac{2}{m_t}\right)$$

For Si, $m_l = 0.98\ m_0$

$m_t = 0.19\ m_0$

$$\Rightarrow \frac{1}{m_n^*} = \frac{1}{3}\left(\frac{1}{0.98\ m_0} + \frac{2}{0.19\ m_0}\right)$$

$$= \frac{1}{0.26\ m_0}$$

$$\Rightarrow \quad m_n^* = 0.26\ m_0$$

For GaAs sine we have only one equi-energy surface

$$m_n^* = 0.067\ m_0 \quad .$$

For calculating density of state effective mass, we pick up formula of mass from density of state expression, which is

$$N_c = 2\left(\frac{2\pi m_n^* kT}{h^2}\right)^{3/2}$$

This m_n^* corresponds to 6 minima of CB and therefore from dimensionality equivalence

$$(m_n^*)^{3/2} = 6(m_l m_t^2)^{1/2}$$

Again for Si

$$m_n^* = 6^{2/3}\left[0.98 \times (0.19)^2\right]^{1/3} m_0$$

$$m_n^* = 1.1\, m_0$$

whereas for GaAs
it is again $m_n^* = 0.067\, m_0$.