Optical Joint Density of State:

No. of emission (or) Absorption per unit volume is given by

$$n = \int n(E_2)\, dE_2 = \int \rho(E)\, f(E)\, dE \rightarrow (1)$$

$$p = \int p(E)\, dE_2 = \int \rho(E)\, [1 - f(E)]\, dE_2 \rightarrow (2)$$

No. of pairs of states in conduction and valence band

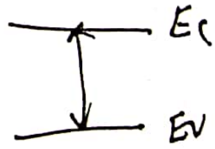
$$E_2 = E_c + \frac{\hbar^2 k^2}{2m_c} \rightarrow (3)$$

↳ parabolic approximation

$$E_1 = E_v - \frac{\hbar^2 k^2}{2m_v} \rightarrow (4)$$

$$E_2 - E_1 = E_c - E_v + \frac{\hbar^2 k^2}{2}\left[\frac{1}{m_c} + \frac{1}{m_v}\right]$$

$$E_2 - E_1 = E_g + \frac{\hbar^2 k^2}{2m_r} \rightarrow (5)$$



$$\therefore h\nu = E_g + \frac{\hbar^2 k^2}{2m_r}$$

(or)

$$(h\nu - E_g) = \frac{\hbar^2 k^2}{2m_r}$$

$$\therefore k^2 = \frac{2m_r}{\hbar^2}(h\nu - E_g) \rightarrow (6)$$

using eq (6) in eq (3) we get

$$E_2 = E_c + \frac{m_r}{m_c}(h\nu - E_g) \rightarrow (7)$$

Or $$\boxed{(E_2 - E_c) = \frac{m_r}{m_c}(h\nu - E_g)} \rightarrow (8)$$

optical Joint density of State

$$\rho_{cv}(\nu)\, d\nu = \rho_c(E_2)\, dE_2 \rightarrow (9)$$

$$\therefore \rho(\nu) = \rho_c(E_2)\frac{dE_2}{d\nu}$$

$$= \frac{1}{2\pi^2}\left(\frac{2m_c}{\hbar^2}\right)^{3/2}(E_2 - E_c)^{1/2}\, h\frac{m_r}{m_c}$$

$$= \frac{1}{2\pi^2}\left(\frac{2m_c}{\hbar^2}\right)^{3/2}\left(\frac{m_r}{m_c}\right)^{1/2}(h\nu - E_g)^{1/2}\, h\frac{m_r}{m_c}$$

$$\rho(\nu) = \frac{1}{\pi\hbar^2}(2m_r)^{3/2}(h\nu - E_g)^{1/2} \rightarrow (10)$$

Eq (10) is optical Joint DOS