

Answer on Question #51576, Physics, Solid State Physics

What is the significance of a negative effective mass?

Solution

The effective mass is given by Eq.(1)

$$m^* = \frac{\hbar^2}{d^2E / dk^2} \quad (1)$$

If $E = A \sin^2 \alpha k$, then $\frac{dE}{dk} = 2\alpha k A \sin(\alpha k) \cos(\alpha k) = A \sin(2\alpha k)$, $\frac{d^2E}{dk^2} = A(2\alpha) \cos(2\alpha k)$.

So, effective mass in this case is given by Eq.(2)

$$m^* = \frac{\hbar^2}{A(2\alpha)^2 \cos(2\alpha k)} \quad (2)$$

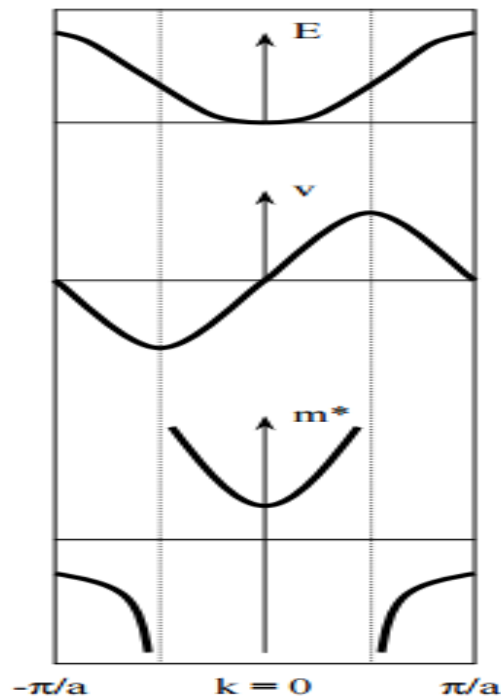


Fig.1

States of positive mass occur near the bottom of the bands due to positive band curvature. States of negative mass occur at the top of bands. Physically, it means that on going from k to $k + \Delta k$ the momentum transfer to the lattice from the electron is larger than that of the momentum transfer from the applied force to the electron (see Fig.1)..