Answer on Question #51236, Physics, Solid State Physics

In a one dimensional diatomic crystal, the velocity of sound is 1500 m/s and the lattice constant 4.0Å. The relationship between the mass of the atoms is M/m = 0.8. Calculate the gap in the frequency at the Brillouin zone boundary.

Solution

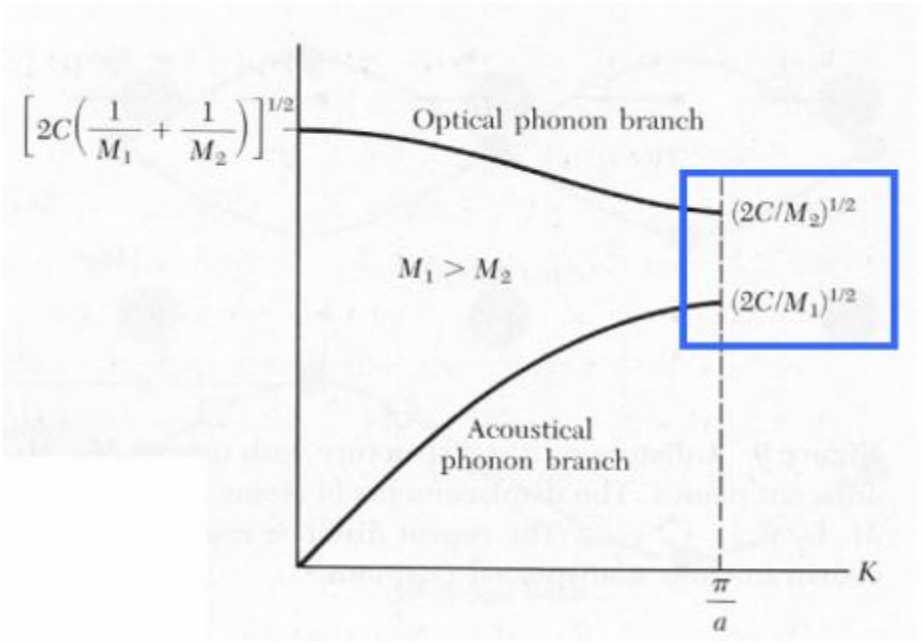

Fig.1

The gap in the frequency at the Brillouin zone boundary.

$$\begin{cases} f_1 = \dfrac{\omega_1}{2\pi} = \dfrac{1}{2\pi}\sqrt{\dfrac{2C}{M}} \\ f_2 = \dfrac{\omega_2}{2\pi} = \dfrac{1}{2\pi}\sqrt{\dfrac{2C}{m}} \end{cases} \quad (1)$$

The velocity of sound is given by Eq.(2)

$$v = \sqrt{\frac{C}{m}}a \quad (2)$$

Than

$$\begin{cases} f_1 = \dfrac{\sqrt{2}}{2\pi}\dfrac{v}{a}\sqrt{\dfrac{m}{M}} = \dfrac{\sqrt{2}}{2\pi}\dfrac{1500}{4\cdot 10^{-10}}\sqrt{1/0.8} = 8.44GHz \\ f_2 = \dfrac{\sqrt{2}}{2\pi}\dfrac{v}{a} = \dfrac{\sqrt{2}}{2\pi}\dfrac{1500}{4\cdot 10^{-10}} = 9.44GHz \end{cases} \quad (3)$$

Answer: the gap in the frequency is $[8.44GHz; 9.44GHz]$