

Answer on Question #73081, Physics / Mechanics | Relativity

What do you understand by the normal modes of a coupled oscillator? If a coupled system has many normal modes, do all normal modes have the same frequency? In a solid, the speed of elastic longitudinal wave is 1.35 m/s if the Young's modulus of elasticity of the solid is 2×10^{11} N/m², calculate its mass density.

Answer:

The normal mode of the oscillatory system is a motion scheme in which all parts of the system move sinusoidally with the same frequency and with a fixed phase relation. The normal mode is a characteristic of the entire system. The most common motion of a connected oscillator system is the superposition of its normal modes. Even though the disjoint angular frequency does not necessarily have to be the same, for normal mode, the effect of the connection is that all the bodies fluctuate with the same frequency. For a system of N connected oscillators there are N normal modes in which all the bodies fluctuate with the same frequency. For a system of N connected oscillators there are N normal modes in which all oscillators move at the same frequency and, thus, have fixed amplitude ratios.

The velocity of longitudinal waves in solid materials can be calculated according to the following formula:

$$v = \sqrt{\frac{E}{\rho}}$$

So, density is equals

$$\rho = \frac{E}{v^2}$$
$$\rho = \frac{2 \cdot 10^{11}}{1.35^2} = 1.1 \cdot 10^{11} \text{ kg/m}^3$$

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