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Medical physics Department

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Out lines :-

- Phase velocity
- Group velocity

Introduction :-

◆ The difference between the phase velocity and the group velocity of a wave is a concept of general significance for many different waves in physics: electromagnetic waves, elastic waves, particle waves.

◆ The phenomenon of scattering can be described as the change in the velocity of the wave in the material medium with the wavelength or frequency.

◆ The individual particles that make up the medium do not travel with the wave, but rather vibrate locally around their equilibrium points, On this basis, the particles can be considered as oscillators that vibrate with a simple harmonic motion about their equilibrium position

◆ Naturally, these oscillators do not vibrate in the same phase, but in different phases that change periodically.

◆ There are two speeds in the wave motion, and they are related to each other by mathematical relationships.

◆ We start by considering a general one-dimensional wave :-

$$A(x, t) = A_0 \exp i (k x - w(k) t)$$

where :

A_0 : The amplitude .

k : The wave number.

$w(k)$: The angular frequency.

t : The time .

◆ We note that the angular frequency (w) depends on the wave number or wavelength. This phenomenon is called scattering.

◆ From the dispersion relation (W), the phase velocity can be determined.

◆ The phase velocity is defined as the velocity of a particular phase of a wave and is equal to the product of frequency times the wavelength.

$$V_P = \omega / K = \vartheta \lambda$$

◆ In the case of dealing with a number or group of waves of different wavelengths in a dispersed material medium, the collective behavior of all waves should be dealt with at the same time and not to deal with each wave individually. In this case, it is expressed by the velocity of the group and is given by the following relationship

$$v_g = \partial \omega / \partial k$$

◆ We note that the group velocity is the differential of the angular frequency with respect to the wave number.

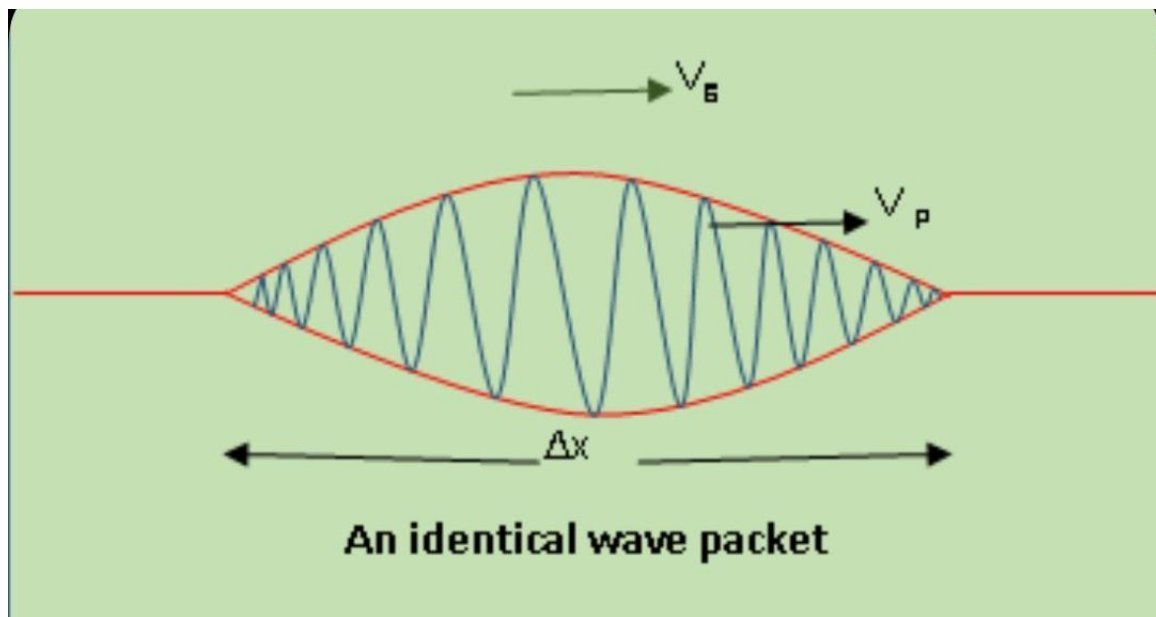


Fig. 1 group velocity and phase velocity

◆ What is the difference between phase velocity and group velocity?

Phase velocity is defined for both single waves and compound waves, while group velocity is defined only for compound waves.

The phase velocity is the velocity of the high-frequency wave, and the group velocity is the velocity of the low-frequency wave.