How can we determine the group velocity of a wave? We can do so by examining the phase difference between the electric and magnetic fields. In general, the group velocity is given by:

$$v_g = \frac{\partial \phi}{\partial k}$$

where $\phi$ is the phase of the wave and $k$ is the wave vector. The group velocity is always in the direction of the phase gradient.

To find the group velocity, we need to consider the superposition of many waves. The group velocity is the velocity at which the amplitude of the group of waves is propagated. This is different from the phase velocity, which is the velocity at which the phase of the wave is propagated.

In other words, we can think of the group velocity as being a kind of average velocity of the wave. The group velocity is always the same for any specific frequency of the wave, and it is independent of the amplitude of the wave.

We can also use the group velocity to calculate the time it takes for a wave to propagate from one point to another. This is known as the group delay.

$$\tau = \frac{d}{v_g}$$

where $d$ is the distance between the two points. The group delay tells us how much the time of arrival of the wave changes as it propagates through different media.

In conclusion, the group velocity is an important concept in wave propagation, and it helps us understand how waves behave in different environments.

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**Figure:**

- A graph showing the relationship between frequency and amplitude, with a peak at a specific frequency.
- A diagram illustrating the phase and group velocity of a wave.