Welcome back to PHY 3305

Today's Lecture:

Transmission & Reflection

Max Born

1882 - 1970

He is the one who figured out $P(x) = \psi^*\psi$ and got the 1954 Nobel prize for it.

ANNOUNCEMENTS

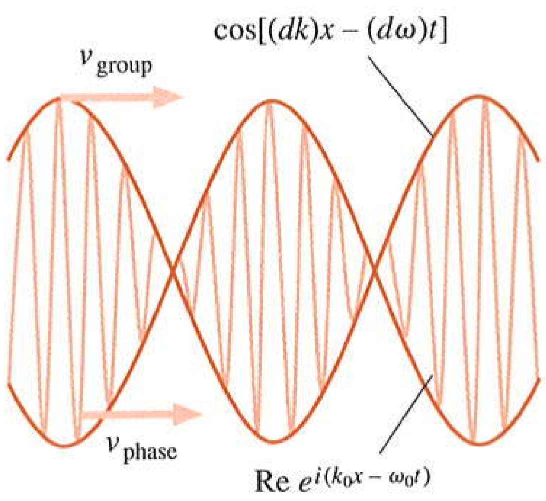
- Reading Assignment for Thursday, Nov 2rd: Krane 7.1 - 7.3.
- Problem set 11 is due Tuesday, Nov. 7th at 12:30 pm.
- Regrade for problem set 10 is due Tuesday, Nov 7th at 12:30 pm.
- Second draft slides of presentation are due next week, Tuesday, Nov. 7th at 12:30 pm. Email your slides to Dr. Cooley (cooley@physics.smu.edu).
- Dr. Cooley will be out of town Nov 5 - 9th. Mr. Thomas will lecture in her place.
- Dr. Cooley's office hours are cancelled on Nov. 6th - 7th.

What is a wave packet or group?

The sum of a number of plane waves, with different contributions from plane waves of different frequencies.

The most general way to express a wave group is

$$\Psi(x,t) = \frac{1}{\sqrt{2\pi}} \int_{\infty}^{-\infty} A(k) e^{i(kx - \omega(k)t)} dk$$



Phase Velocity (ν_p):

Velocity of an individual crest.

$$\nu_p = \lambda f = \frac{\omega}{k}$$

For EM waves: $\omega = ck$

For Matter waves:

$$\frac{\hbar^2 k^2}{2m} = \hbar\omega \longrightarrow \omega = \frac{\hbar k^2}{2m}$$

Group Velocity (ν_g):

Velocity of the wave "envelope".

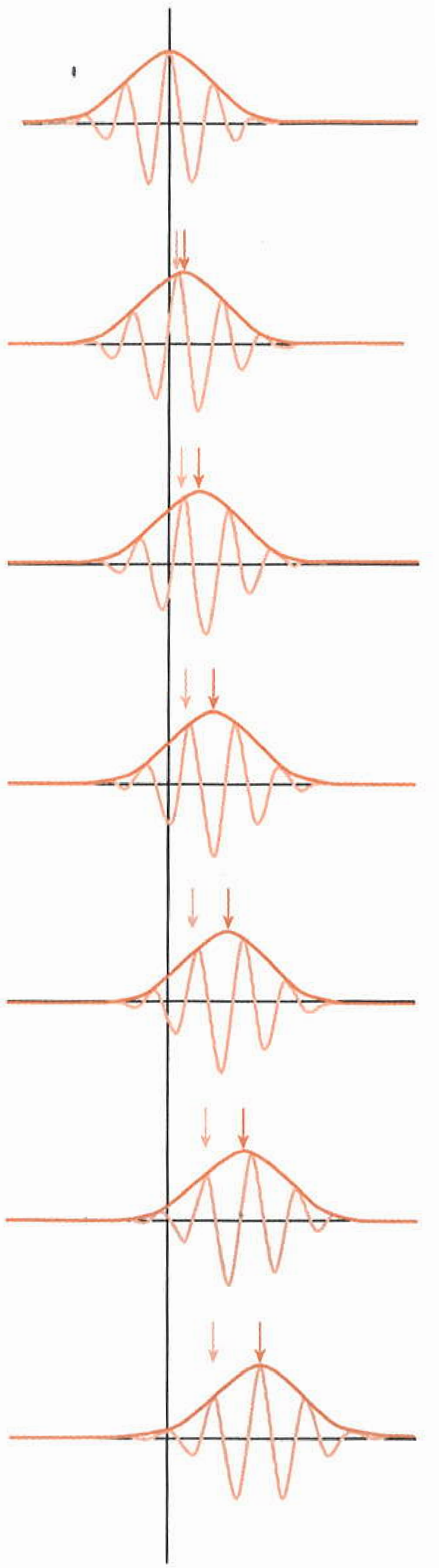
$$\nu_g = \frac{d\omega(k)}{dk}$$

For EM waves:

$$\frac{d\omega}{dk} = c$$

For Matter waves:

$$\frac{d\omega}{dk} = \frac{\hbar k}{m}$$



Notes:

- The group velocity of an EM pulse in vacuum is c. This is due to the fact all the constituent waves share that phase velocity.
- Matter wave's constituent waves move at different speeds, but the same group velocity.
- The group velocity (not the phase velocity) is the velocity of the particle!
- As time progresses, crests of waves in the packet move at different velocities than the envelope. However, the envelope, a smooth pulse moves at the group/particle velocity.

Examine in Detail

We defined wave functions for plane wave moving in the positive and negative directions.

$$\Psi(x,t) = Ae^{i(kx-\omega t)} \qquad \text{(positive)}$$

$$\Psi(x,t) = Ae^{-i(kx-\omega t)} \qquad \text{(negative)}$$

We probed the situation with barriers, defining wave functions and expressions for transmission and reflection under certain scenarios using the Phet simulator.

Examine these scenarios.

PhET demonstration - Quantum Tunneling

1. Plane wave - Potential Step:
    a. No step
    b. step height < E
    c. step height > E

2. Plane wave - Potential Barrier
    a. No barrier
    b. barrier height < E
    c. barrier height > E

3. Make a measurement

The end
(for today)