Phys 301 Classes 22-23
Wavefunctions

Why did we spend all of last class talking about probability?

- Allow 2-slit interference pattern to build up over time...

$$\text{Prob}(\text{in } \delta x \text{ at } x) \propto |A(x)|^2 \delta x$$

Probability of finding photon in region width δx centered at x

Amplitude of light wave (E-field)

Width

- So amplitude of light wave squared is proportional to *probability density*.

What is the amplitude of a matter wave?

- I don't know!
- But let's call it the **wave function**
- Lower case Greek psi: $\psi(x)$

$$\text{Prob}(\text{in } \delta x \ at \ x) = |\psi(x)|^2 \delta x$$

Probability density, $\rho(x) = |\psi(x)|^2$

(I'll stick to "rho" $\rho(x)$ for probability density instead of *P*)

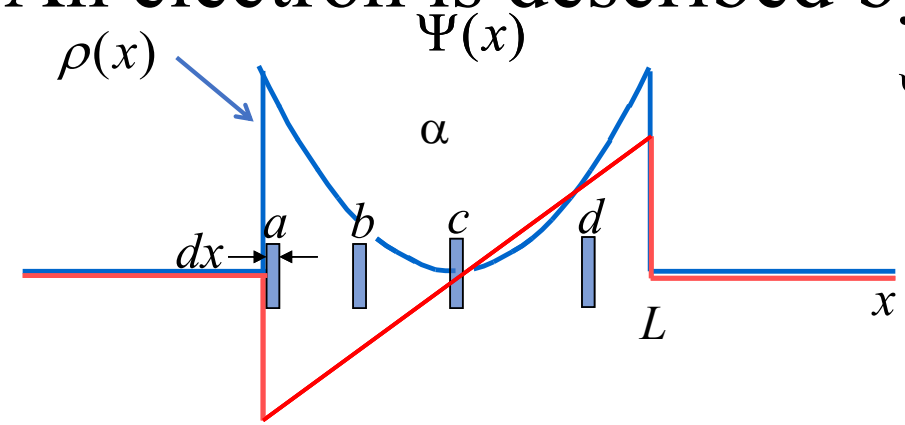
But really… WHAT IS $\psi(x)$???

- It's a *descriptor* of a particle.
- It is related to the probability of finding a particle in a given place ($|\psi(x)|^2$, which we can determine experimentally).
- It's consistent with the theory of quantum mechanics.
- Our goal today: Practice with $\psi(x)$ in general.
- Rest of semester: What forms might $\psi(x)$ take in real situations?

Some Practice

- Handout Part I
- Integrals
- More notes about $\psi(x)$:
  - It is *not unique* for a given probability density function.
  - We must always be sure $|\psi(x)|^2$ is normalized.
  - We will find: it will be a solution to a wave equation.

An electron is described by the following wave function:



$$\Psi(x) = \alpha x / L \quad \text{from } x = -L \text{ to } x = +L$$

$$= 0 \text{ elsewhere}$$

$$\rho(x) = |\Psi(x)|^2 = \frac{\alpha^2 x^2}{L^2}$$

How do the probabilities of finding the electron near (within dx) of a, b, c, and d compare?

A) $d > c > b > a$
B) $a = b = c = d$
C) $d > b > a > c$
D) $a > d > b > c$

Complex Numbers Review

- Handout Part II
- If $|\psi(x)|^2$ is what is observed experimentally (probability), and $\psi^*(x)\psi(x)$ is always real,
- Then $\psi(x)$ can be complex (include an imaginary component).

A More Complex Wavefunction

- Rest of Handout