Quantum Mechanical States

- Two versions of the Schrödinger eqn.
  dependent & time-independent

- Picked $\psi(x)$ over $\psi(p)$
- t&E are related by Fourier-Transform

* Meaning of the wave function: see postulate 4

In QM: eigenvalues are obtained (an exact number), but this number will change every "scan". The probability of obtaining a value can be obtained

See x/p plot from lecture notes:

takeaway

$\Delta x \Delta p = \hbar/2$ does not limit accuracy when calculating x

$[\psi(x) = f(x - x_n)]$

any value of momentum is possible

A molecule is in a state $\psi(x,t)$.

we have an observable (could be anything) A which has an operator "A"

- what are values of A that can be measured?

If $\hat{A}$ has eigenvalues a_n and eigenfunction $\psi_n(x) \Rightarrow a_n$ are the only values that can be measure, with probability

$$P(A = a_n @ \text{time } t) = \left| \int_{-\infty}^{\infty} \psi_n^*(x) \cdot \psi(x,t) \right|^2$$

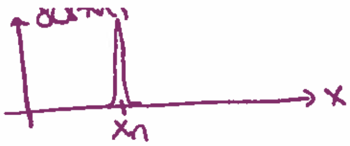
If $\psi(x)$ looks very different from $\psi(x,t)$ then the integral is ~~not going~~ going to be 0

If state of system looks like the state of the observable, you will obtain values

Multi a vector x a matrix and you get a multiple of the matrix back, that was an eigenvector

- x^2 is not an eigenfunction $\partial/\partial x$

- e^{-x} is an eigenfunction of $\partial/\partial x$
  eigenvalue is -1



delta function:

Example: observable is position

A: position $x \Rightarrow \hat{A} = x \Rightarrow x\,\varphi_n(x) = x_n \varphi_n(x)$

$$\underbrace{\varphi_n = \delta(x - x_n),\; = x_n\,\delta(x-x_n)}_{\text{true for all values of } x}$$

if $x \neq x_n$ $\delta(x-x_n) = 0$
and $x \cdot 0 = x_n \cdot 0$

if $x = x_n$; $\delta(x - x_n) \neq 0$
and $x_n(\delta x - x_n) = x_n\,\delta(x - x_n)$

$\Rightarrow P(x = x_n \text{ at time } t)$

$$= \left| \int_{-\infty}^{\infty} dx\, \delta(x - x_n)\, \psi(x,t) \right|^2$$

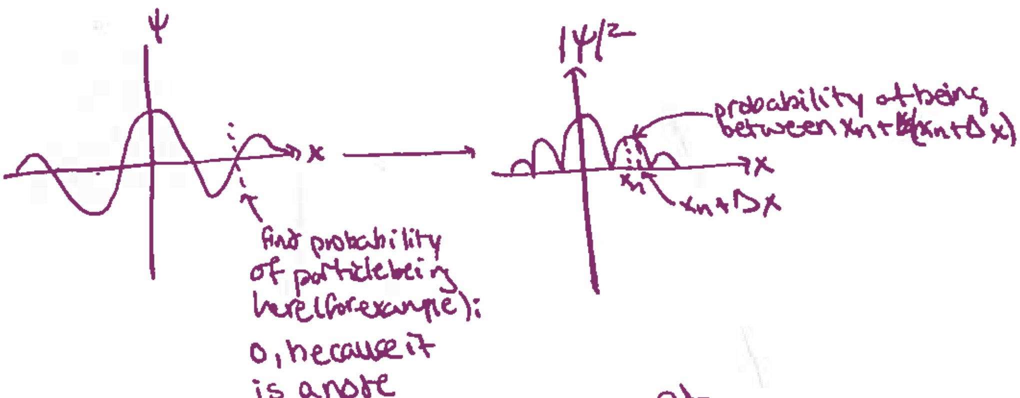
if $x \neq x_n \Rightarrow \delta(x - x_n) = 0$
value is 0

$$= |\psi(x_n, t)|^2$$

$$= \psi^*(x,t) \cdot \psi(x,t) \geq 0 \text{ \& real}$$

(negative probabilities don't make sense)

$|\psi(x_n,t)|^2$ is the probability that the molecule is at position x_n and time t



Probability of finding the particle at all values of x is 1

$$\Rightarrow \underbrace{\int_{-\infty}^{\infty} dx\, |\psi(x,t)|^2 = 1 = \int_{-\infty}^{\infty} dx\, \psi^*(x,t)\, \psi(x,t)}_{\text{normalization of a wavefunction}}$$