

$$\underline{[X, P]}$$

$$[X], [P]$$

$$[X, P] = i\hbar$$

$$[X][P] - [P][X]$$

$$\frac{\partial}{\partial t} [X] = i\hbar [X, H] \quad H = \frac{1}{2m} P^2$$

$$\begin{bmatrix} \vdots \\ \vdots \\ \vdots \end{bmatrix}$$

1926 Schrod.

$$i\hbar \frac{\partial}{\partial t} \psi(x, t) = -\frac{1}{2m} \frac{\partial^2}{\partial x^2} \psi + V(x) \psi$$

$$P = i\hbar \frac{\partial}{\partial x}$$

$$\psi(x, t) \longrightarrow |\psi\rangle$$

$$|\phi\rangle, |\psi\rangle \Rightarrow |\phi\rangle + |\psi\rangle$$

$a|\phi\rangle$ — vectors in Hilb. Sp.

Inner product.

$$\langle\psi|\phi\rangle$$

$$\langle a|\psi\rangle|\phi\rangle = a^* \langle\psi|\phi\rangle$$

$$\langle\psi|\psi\rangle \geq 0$$

(= 0 only
for $|\psi\rangle = 0$)

$$\psi(x) \longrightarrow |\psi\rangle$$

$$\langle\psi| \longrightarrow \psi^*(x)$$

$$\langle\phi|\psi\rangle = \int \phi^*(x) \psi(x) dx$$

Operators. Linear

$$A(a|\phi\rangle + b|\psi\rangle) = aA|\phi\rangle + bA|\psi\rangle$$

$$|\psi(x)|^2$$

$$\int_{-\infty}^{\infty} |\psi(x)|^2 dx = 1$$

$$+ |\psi''(x)|^2$$

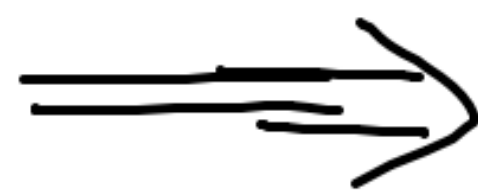
$\langle \psi | \psi \rangle = 1$ prob of something = 1.

$$A|a\rangle = a|a\rangle$$

$$A^\dagger = A$$

↑
Real
 $\dagger = (A^T)^*$

$$\{|a\rangle\}$$



$$|\psi\rangle = \sum \langle a|\psi\rangle |a\rangle$$

if

$$\langle a|a\rangle = 1$$

$$\langle a|a'\rangle = 0 \quad a \neq a'$$

Meas. quantities must be Herm. Mat.

$$\partial_t |\psi\rangle = i\hbar H |\psi\rangle$$

$$\partial_t \langle \psi | \psi \rangle = \underbrace{\langle \psi | -i\hbar H^\dagger + i\hbar H | \psi \rangle}_{=0}$$

If state $|\phi\rangle$ is
e.g., $t \rightarrow \infty$ of meas then

$$|\langle \phi | \psi \rangle|^2 \rightarrow \text{Prob of}$$

getting $\langle \phi |$ when meas
"unitarity"

$|\psi\rangle, A, |a\rangle$ a/

$$|\langle a | \psi \rangle|^2 = \text{Prob}^a_{\text{meas } A}$$

$$\psi(x) = \langle x | \psi \rangle$$

$A \rightarrow$ time indep

$|\psi\rangle \rightarrow$ " indep.

$$\partial_t |\psi\rangle = i\hbar |\psi\rangle$$

$$\partial_t A = i\hbar [A, H]$$

$|\psi\rangle \rightarrow$ time indep.

Interp.

$|\psi\rangle$ A
after meas

$|\psi\rangle \Rightarrow |\psi, t\rangle$

$|\psi\rangle \Rightarrow |a\rangle$

$\psi(x, t)$

[physical reality?

$P_a = |\langle a | \psi \rangle|^2$
 $|\psi\rangle \Rightarrow |a\rangle$
 $\Rightarrow$ Schrod.
 $\Rightarrow$ Meas.

$$\partial_t A = i\hbar [A, H]$$

$$|\psi\rangle \Rightarrow |\psi\rangle \quad \frac{\text{prob.}}{|a, t\rangle}$$

$A \Rightarrow$ eigenstates.

$$P_a \quad |\langle a, t | \psi \rangle|^2$$

Dynamics $\rightarrow$ operators.
 state $\Rightarrow$ Probabilities
 initial cond.

$|\psi\rangle \rightarrow$ like
 $A \rightarrow$ dynamics.

Unitary transf.

