E. Schrodinger Eqn. $\longleftrightarrow$ <u>Wave mechanics</u> psi ψ

W. Heisenberg QM $\longleftrightarrow$ <u>Matrix Mechanics</u>

1927 Paul Dirac unifies both!

Operator Math

Linear Eqns

x position $\longrightarrow$ $\Psi(x)$ $\longleftarrow$

p_x momentum $\underline{\underline{\Psi(p)}}$

$\cdot$ A

E.M

"t"

$\cdot$ B

$\underbrace{x(0),\ p_x(0)}$

$\underbrace{x(t),\ p_x(t)}$

$\Psi(x,t)$

TSE

$$H\Psi(\cancel{x}, t) = \frac{d}{dt}\Psi(x,t)\,(i\hbar)$$

Hamiltonian

$\sqrt{-1}$

$$\boxed{H\Psi_{(x)} = E\Psi(x)}$$

Observation

Dirac.

Operator Math

(operator) (operand) $\equiv$

function

$$\frac{d}{dx} f(x) \longrightarrow \text{Slope of the } f^n?$$

$$\int_a^b f(x) \longrightarrow \text{Area bound by } a \,\&\, b \text{ limits of } f(x)$$

$$\left.\begin{array}{l} \hat{x} \longrightarrow \text{position} \\ \hat{p}_x \longrightarrow \text{momentum} \end{array}\right\} \text{operator}$$

$$[\hat{x}, \hat{p}_x] \longrightarrow \hat{x}\hat{p}_x - \hat{p}_x\hat{x} \neq 0$$

function

$\hat{x}$

$\hat{x}.f \to x$

$\hat{p}_x f \to p$

A i B

$$\underline{\hat{\Omega}\,\Psi = \omega\,\Psi}$$

f

Operator

value

$\hat{x}\,\Psi \longrightarrow \phi$

Eigenvalue - function Eqn.

Characteristic Eqns

$$\boxed{H\Psi = E\Psi}$$

$\hat{H} \rightarrow$ Hamiltonian $\longleftrightarrow$ Energy

Operator

$\hat{H}\psi = E\psi$

(measure) result

$E \longleftrightarrow \hat{H} = \widehat{KE} + \hat{V}$

$\hat{T}$

PE

p_x, position

operators $\hat{p}_x$

operators $\hat{x}$

$$\hat{H} = \frac{\hat{p}_x^2}{2m} + \hat{V}$$

$$\hat{p}_x = \underbrace{\pm i\hbar \frac{d}{dx}}$$

$$\hat{p}_x^2 \rightarrow \hat{p}_x \cdot \hat{p}_x$$

$$-i\hbar \frac{d}{dx}$$

$$\underbrace{-\hbar^2 \frac{d^2}{dx^2}}$$

1-D

$V = 0$