Classical description of electron:

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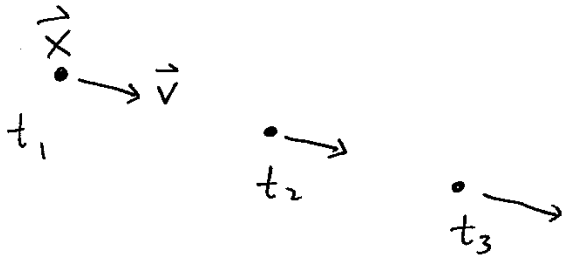

$\vec{x}(t)$: satisfies Newton's Laws

$$m\frac{d^2\vec{x}}{dt^2} = \vec{F}$$

Quantum description of electron:

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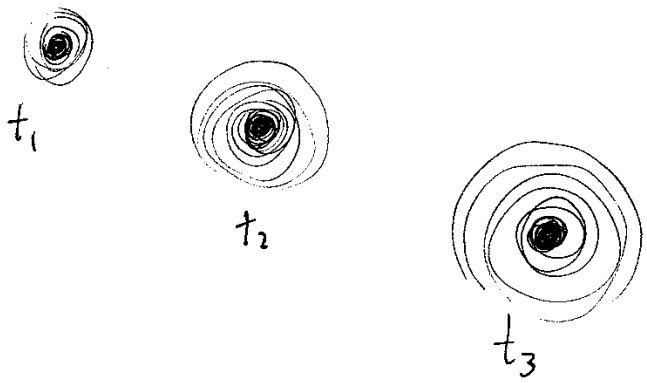
$\psi(x)$ → tells us amount of each position eigenstate in quant. superposition.

→ can evolve w. time

Need eqn of motion for $\psi(\vec{x},t)$:

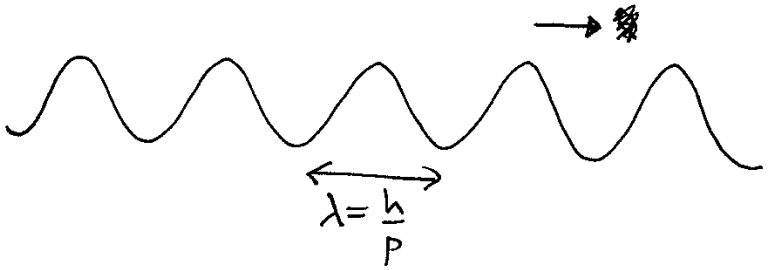
SCHRÖDINGER EQUATION.



Diffraction experiments: electron with momentum p exhibits wavelength $\frac{h}{p}$

at given time,

guess: wavefunction for fixed momentum looks like



$$\psi(x) = Z\, e^{i\frac{2\pi p}{h}x}$$

complex wave

real part is

$$|Z|\cos\left(\frac{2\pi p}{h}x + \phi\right)$$

Problem: $\int |\psi|^2 dx = \infty$

- infinitely spread out
- can't be NORMALIZED

BUT: real waves always have finite extent: WAVE PACKETS

Spatial extent of wave must be greater than wavelength.

⇒ particles with well defined momentum (wavelength) have spread out wavefunctions

∴ more UNCERTAINTY in their position

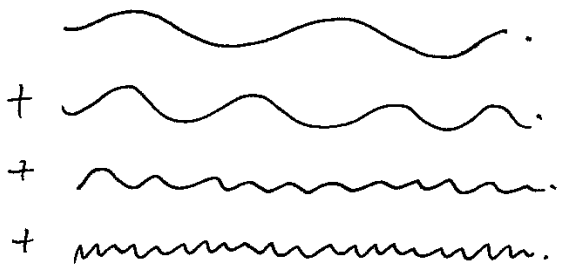
MORE PRECISE: Wavepackets actually come from sum of waves w. different wavelength.

Can represent wavepacket (or any $\psi(x)$) as

superposition of position eigenstates

OR

superposition of "pure waves" = momentum eigenstates



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