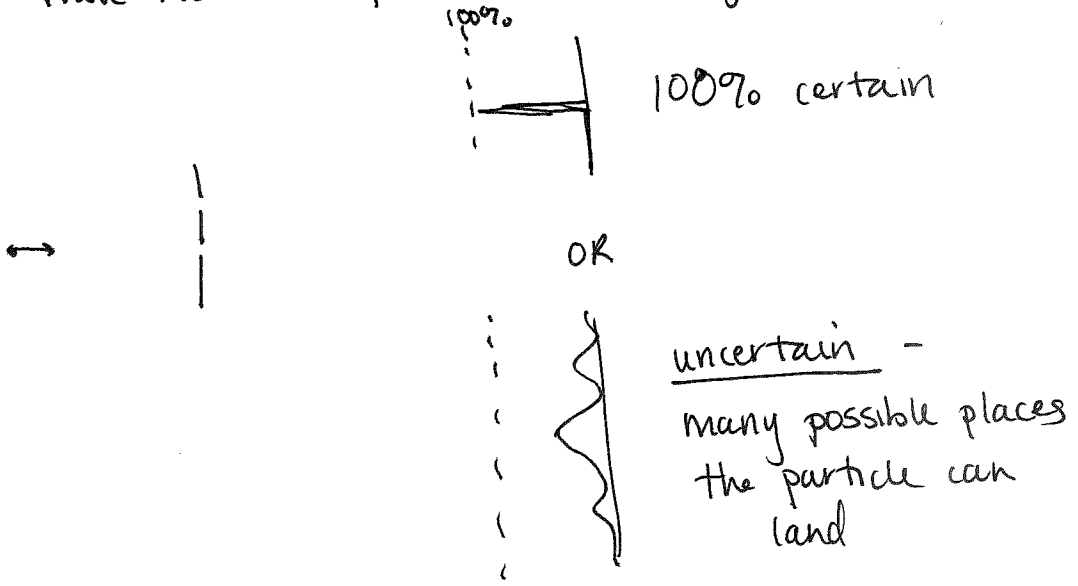
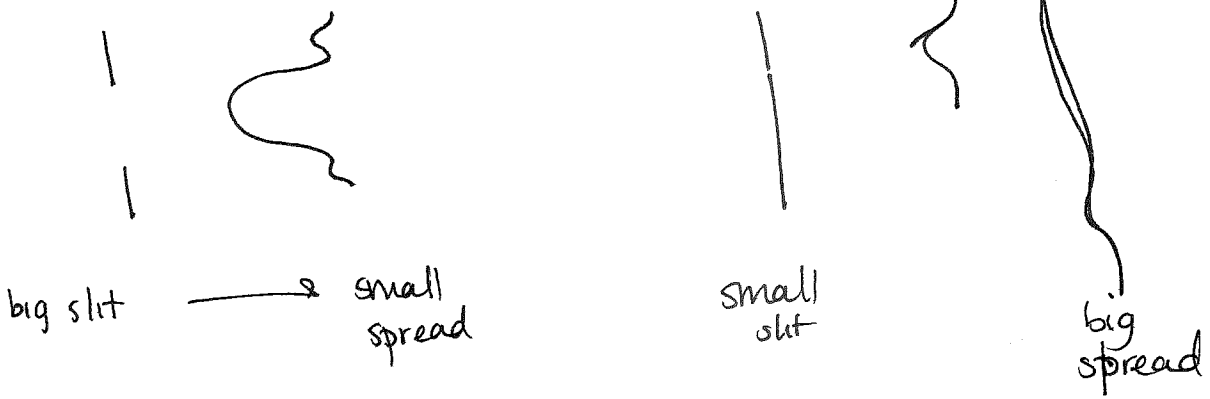
Uncertainty

Wave nature implies uncertainty:

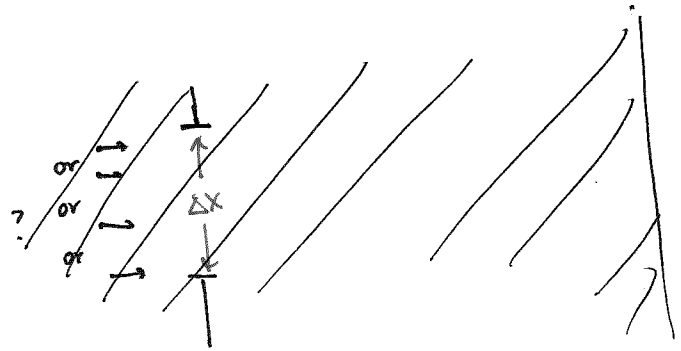


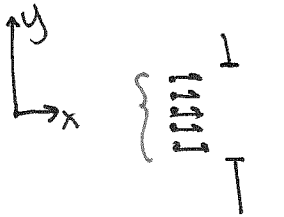
existence of wavefunction $\Longrightarrow$ uncertainty

how uncertain are we?



Single Slit - Uncertainty

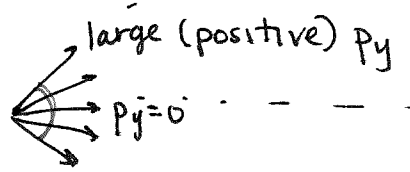




uncertainty in position (y)

Δy

uncertainty

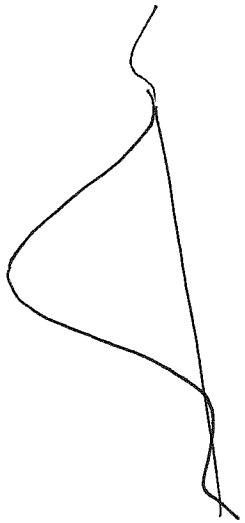


$p = mv$

uncertainty in momentum (p_y)

Δp_y

case 1



Δy = BIG
really uncertain

Δp_y = ~~BIG~~ SMALL

case 2

Δy = SMALL
really certain

Δp_y = BIG

write down relation between Δy and Δp_y

Conjugate Variables

for two conjugate variables a and b, we know $\Delta a \propto \frac{1}{\Delta b}$

very certain of a $\leftrightarrow$ very uncertain of b (and vice versa)

exact relationship: $\Delta a \, \Delta b \geq \frac{\hbar}{2}$ Heisenberg Uncertainty Principle

$\hbar = 1.05 \times 10^{-34}$ J·s small!

a	b
x	p_x
y	p_y
z	p_z
r	p_r
θ	p_θ
E	t
f	λ

$$\Delta x \, \Delta p_x \geq \frac{\hbar}{2}$$

$$\Delta y \, p_y \geq \frac{\hbar}{2}$$

this tells us that there is a maximum amount of knowledge that we can have (there is a min uncert.)

min uncert. = max knowledge

$$\Delta E \, \Delta t \geq \frac{\hbar}{2}$$