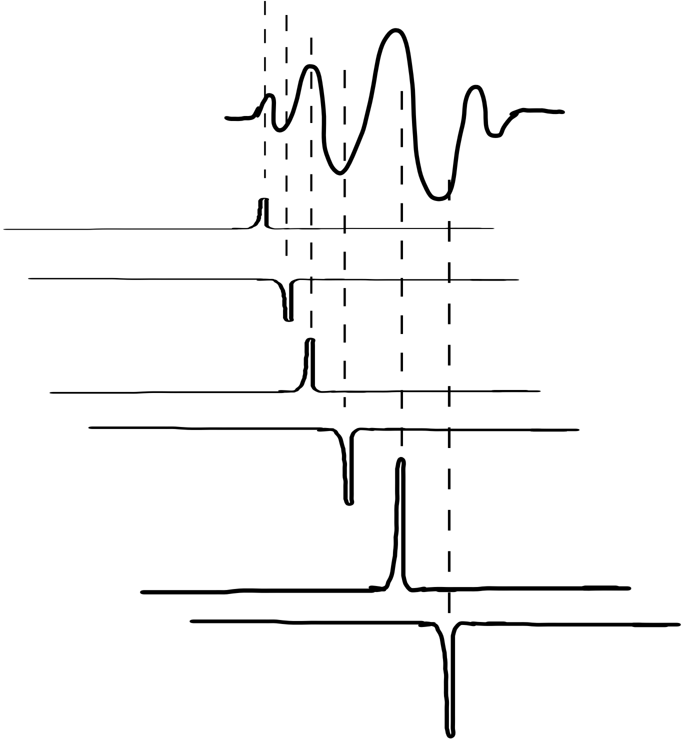
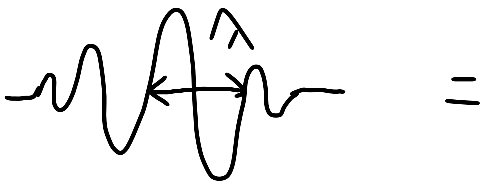
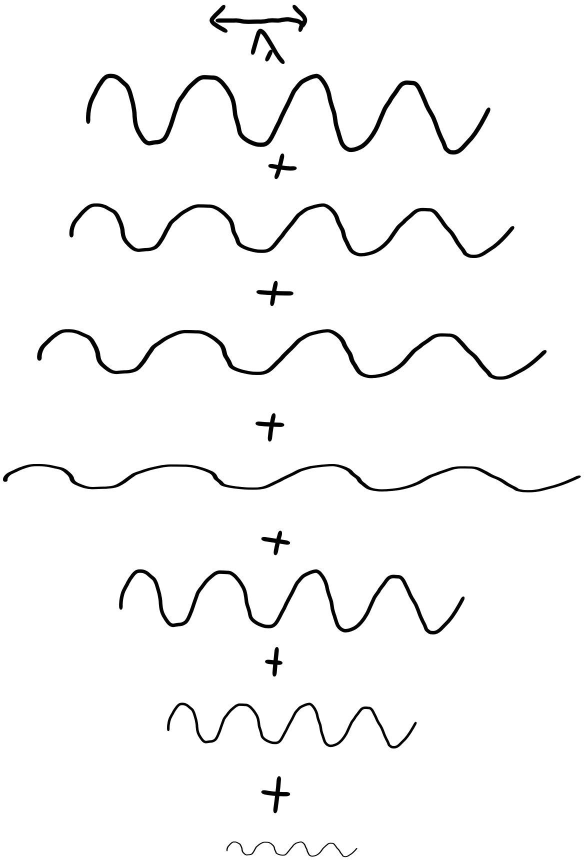
Last time we talked about the properties of wavepackets: these are wavefunctions for electrons which have a fairly well defined (but not perfectly defined) position and momentum. We can think of a wavepacket in two ways:

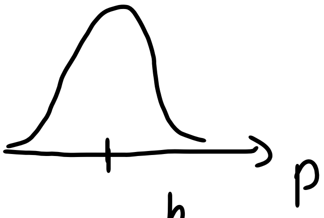
As a sum of well-defined position eigenstates...



or, as a sum of well-defined momentum eigenstates







$p = h/\lambda$

The narrower wavepacket you want, the wider the required momentum amplitude function.
The narrower the momentum amplitude function, the wider the wavepacket.

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

Perfectly well defined momentum (momentum eigenstate) = planewave, spread over all positions equally $|\psi(x)|^2 = 1$

Perfectly well defined position (position eigenstate) = superposition of all momentum eigenstates with equal weight. $|\tilde{\psi}(p)|^2 = 1$

-> clicker question -> slides -> 3 clicker questions

	Polarizer at 0°	Polarizer at 45°
eigenstates	$\|0°\rangle$, $\|90°\rangle$	$\|45°\rangle$, $\|{-45°}\rangle$
general quantum state	$a_0 \, \|0°\rangle \; + \; a_{90}\|90°\rangle$	$a_{45} \, \|45°\rangle \; + \; a_{-45}\|{-45°}\rangle$
	$a_0 = \frac{a_{45} + a_{-45}}{\sqrt{2}}$ $a_{90} = \frac{a_{45} - a_{-45}}{\sqrt{2}}$	$a_{45} = \frac{a_0 + a_{90}}{\sqrt{2}}$ $a_{-45} = \frac{a_0 - a_{90}}{\sqrt{2}}$

The better we can predict the outcome for one polarizer, the less we know about the outcome for the other polarizer.

	Position	Momentum
eigenstates	$\|x\rangle$, for any x	$\|p\rangle$, for any p
general quantum state	$\int \; \Psi(x) \; \|x\rangle \; dx$	$\int \; \tilde{\Psi}(p) \; \|p\rangle \; dp$
	$\Psi(x) =$ $\displaystyle\int \tilde{\Psi}(p) \; e^{i\frac{2\pi}{h}px} \; dp$	$\tilde{\Psi}(p) =$ $\displaystyle\frac{1}{2\pi}\int \Psi(x) \; e^{-i\frac{2\pi}{h}px} \; dx$

The better we can predict the outcome of a position measurement, the worse we can predict the outcome of a momentum measurement, and vice versa.