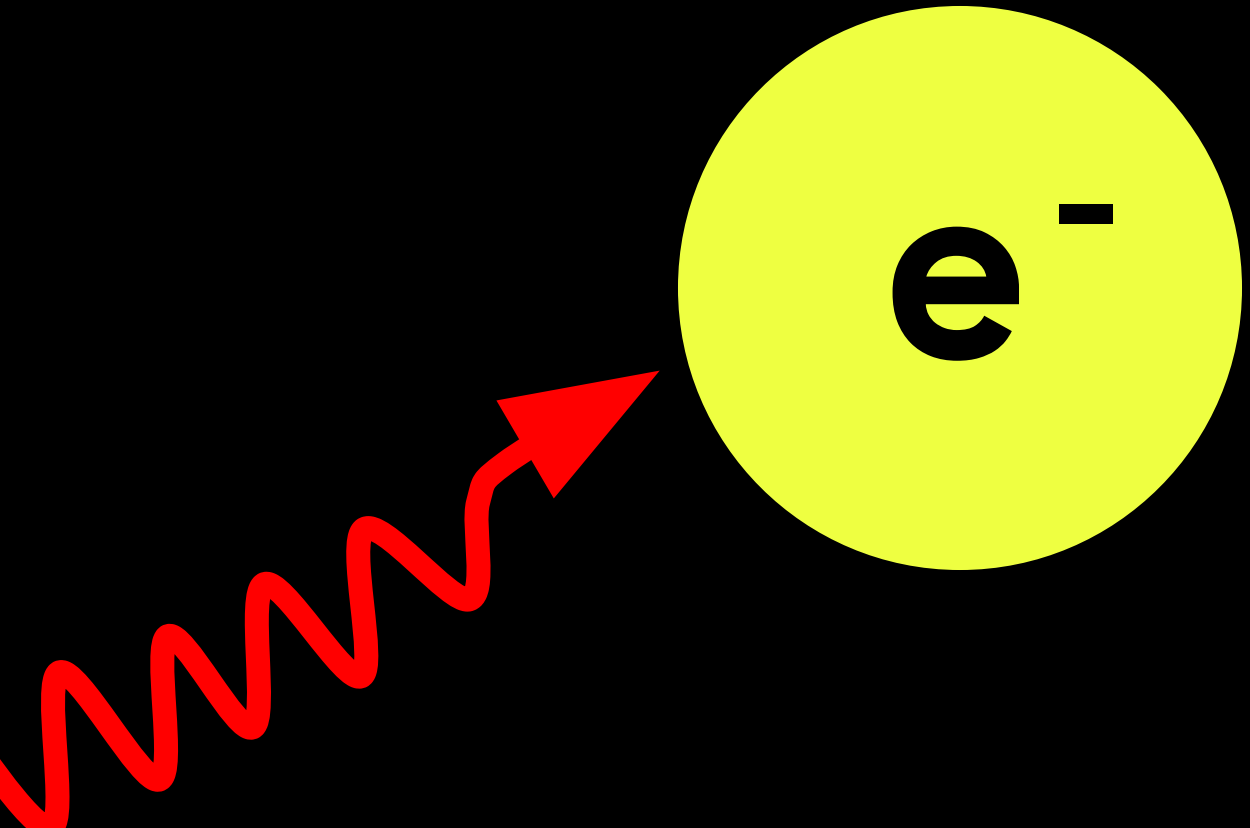


CP*

Light

- Also known as:
  - Electromagnetic radiation
  - Solutions to Maxwell's equations
- Includes visible spectrum that we can see
- Usually behaves like a wave

Some history

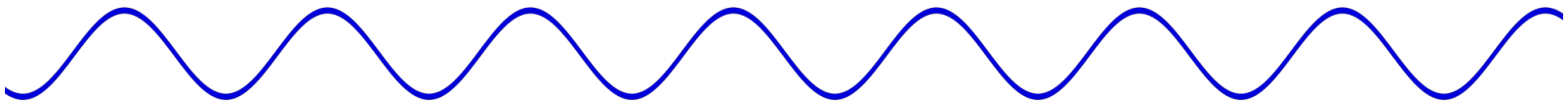
- ➔ 1900 Planck’s theory of blackbody radiation
- ➔ 1905 Einstein explains photoelectric effect
- ➔ 1925 Schrödinger equation
- ➔ 1927 Quantization of the electromagnetic field

Quantized electromagnetic field

- ➔ Model of field as oscillator

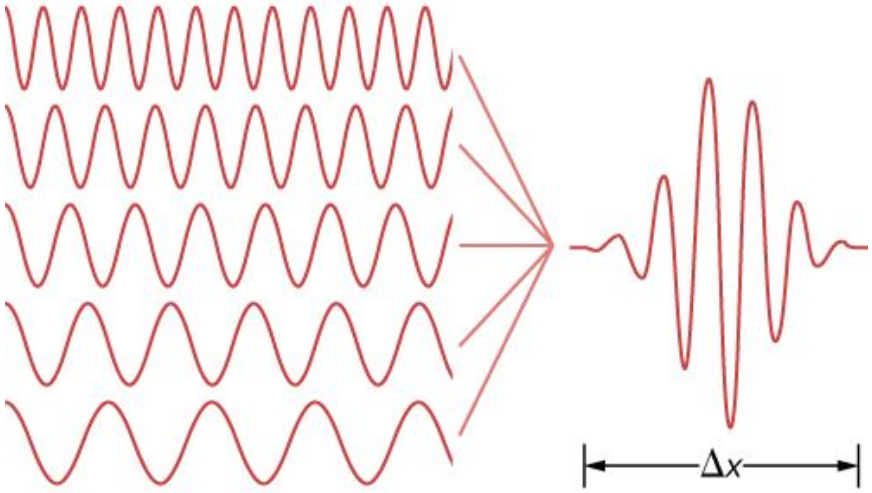
$$E = \sum_k h\nu \left(n + \frac{1}{2} \right)$$

- ➔ Photon emerges as smallest increment in energy
- ➔ Definite momentum/wavelength, non-localizable

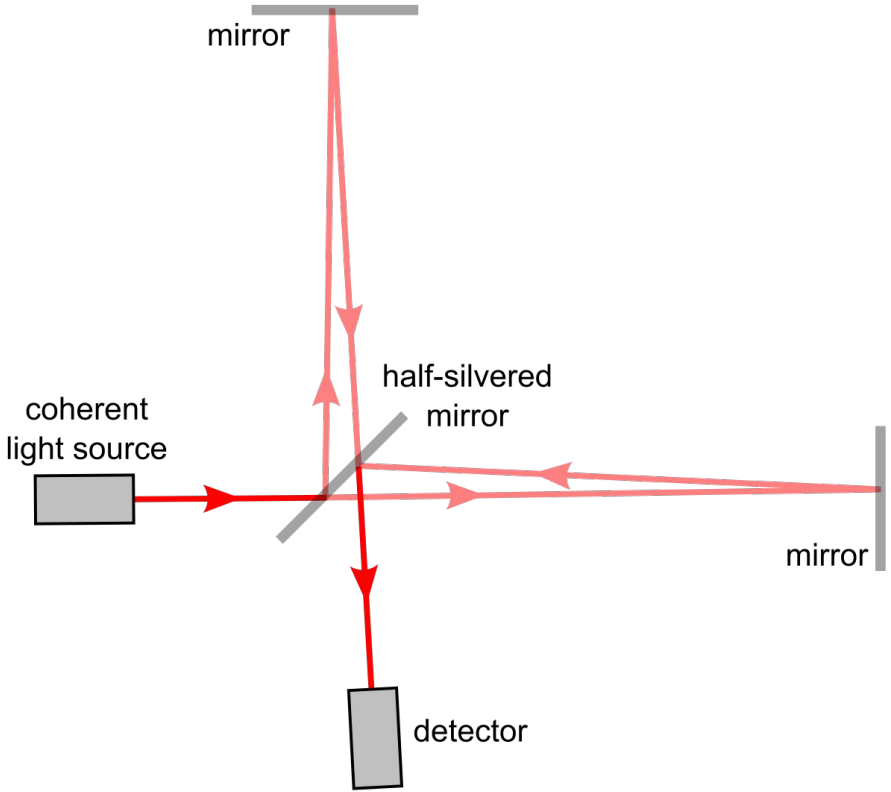


Coherent states

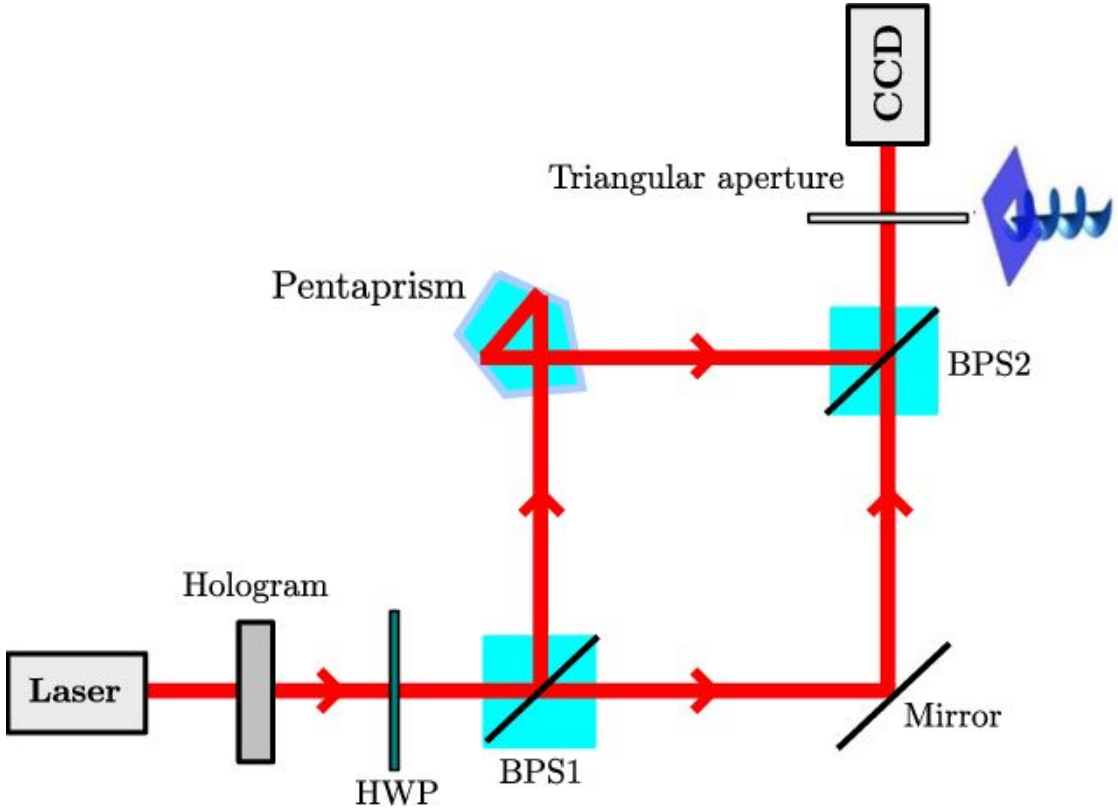
- ➔ Localized wave packet
- ➔ Saturates Heisenberg uncertainty principle $\Delta x \Delta p \geq \frac{h}{4\pi}$



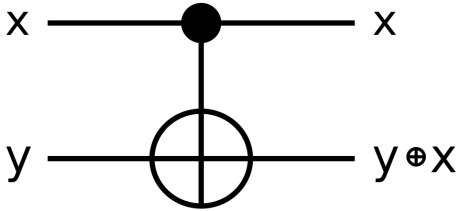
Interferometry

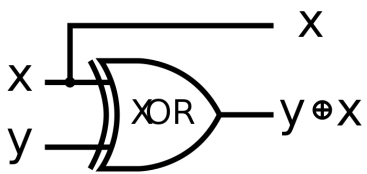


Controlled NOT (CNOT) circuit



CNOT circuit logic





input		output	
x	y	x	y+x
|0⟩	|0⟩	|0⟩	|0⟩
|0⟩	|1⟩	|0⟩	|1⟩
|1⟩	|0⟩	|1⟩	|1⟩
|1⟩	|1⟩	|1⟩	|0⟩

input		output	
x	y	x	y+x
0	0	0	0
0	1	0	1
1	0	1	1
1	1	1	0

So… what is a photon?

- ➔ Word used for two different concepts
- ➔ Einstein’s version: smallest possible packet of energy
- ➔ Coherent states: localized wave packet with range of frequencies