

# Physics 102 - October 19, 2009

- EXAM 1 GRADED
  - Solns to be posted
  - GRADES on BB
  - HAND BACK Wed.
  - REGRADE Policy

■ Recitations      Tues - Fri - Mon

■ Project

# Last Time

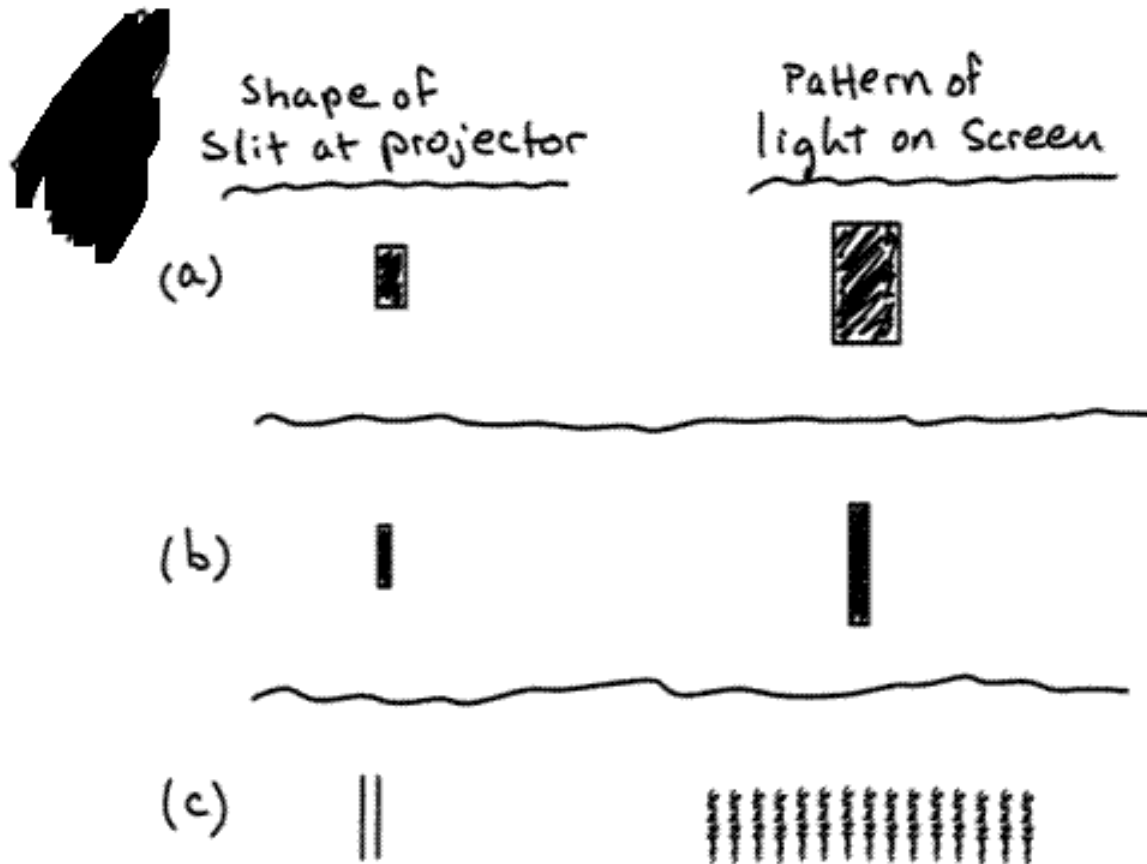
House-Quantum  
Mechanics  
Analogy

$\Psi^2 \approx$  Probability

could imagine making a  
good guess as to how much  
time a person spends in  
a room  
say 8 hours  
a day  
in the bedroom



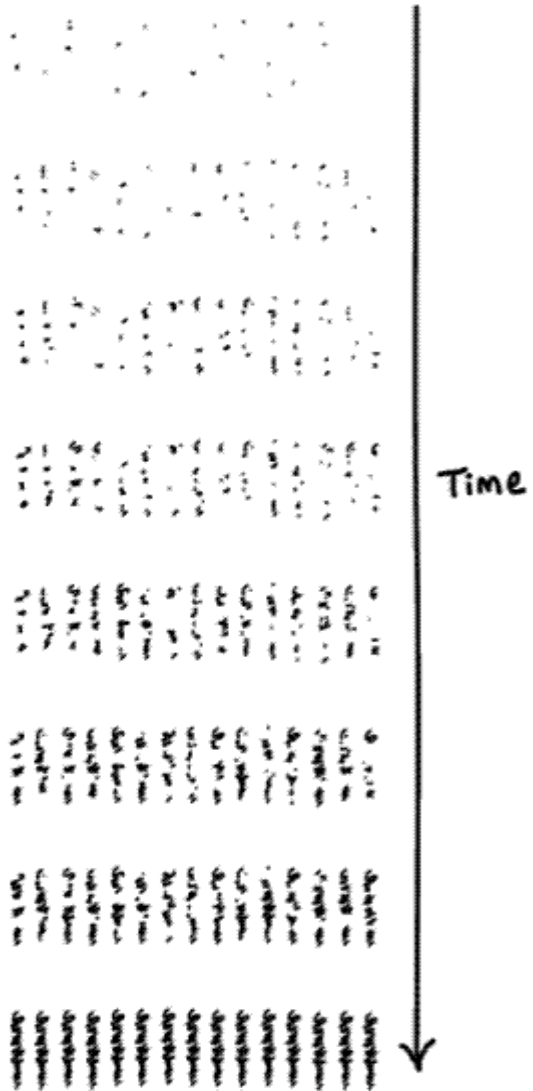
But - at any given moment  
you can't know where the  
person is in the house  
without looking



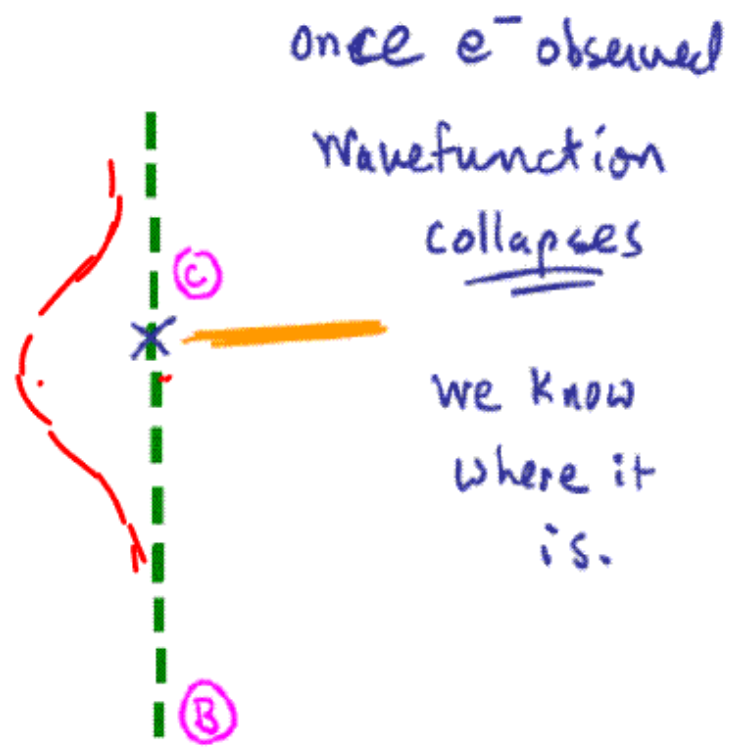
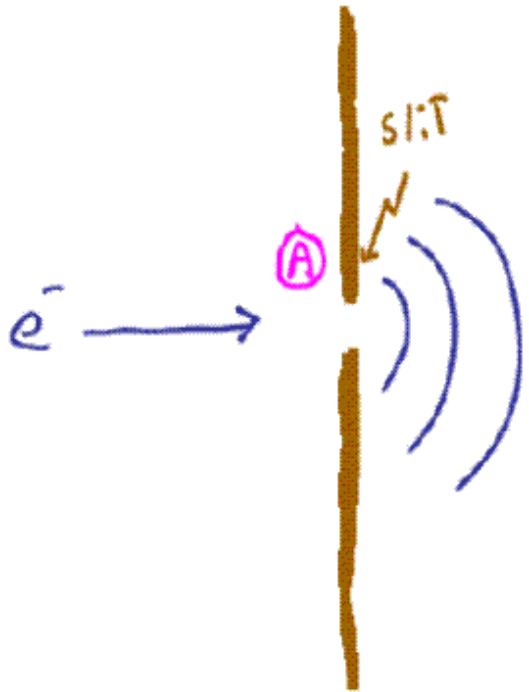
Even single  
photons act  
as waves.



Image  
forming as a  
function of  
time.



Single  $e^-$



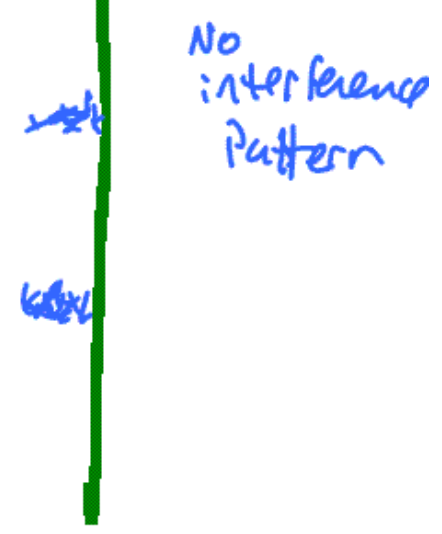
$\rightarrow e^-$



observation collapses the wavefunction?

non destructive detectors

$\rightarrow e^-$



observation of system (even if non destructive) collapses the wavefunction.

# Schrödinger's Cat



Copenhagen  
Interpretation

$$\text{nucleus quantum state} = \frac{1}{2}(\text{decayed}) + \frac{1}{2}(\text{not decayed})$$



$$\text{cat state} = \frac{1}{2}(\text{dead}) + \frac{1}{2}(\text{alive})$$





Hugh  
Everett (1957)

Bryce DeWitt  
1960's + 70's

↳ Many  
Worlds  
interpretation

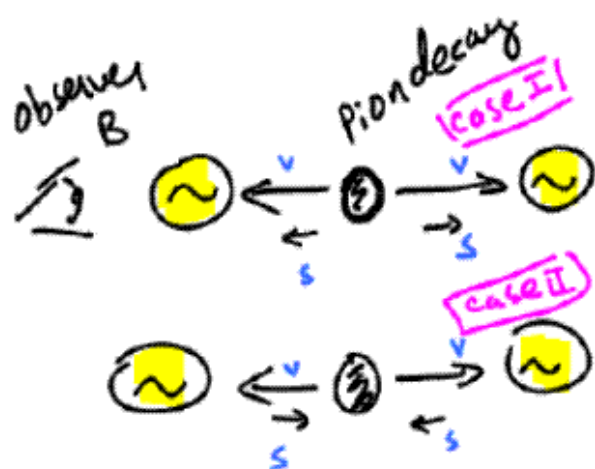


# EPR Paradox — Einstein, Podolski, Rosen

1935

8

"Spooky Action at a distance"



photon spin = 1



Two photons are produced at once — They are correlated.

If one has spin one way the other has spin the other way.

They are in an "entangled quantum state"

When observer A observes the spin of photon — The wavefunction collapses and the spin of the photon observer B will observe is determined.

But collapse instantaneous and observers A + B far apart

Does this mean information conveys faster than speed of light?

# The Multiverse of Wishful Thinking

Proponents claim wavefunction collapse caused by conscious observer ... and NOT before

Is there an external reality?

Is mind entangled w/ wavefunction?

Fun to think about ... perhaps open to scientific investigation

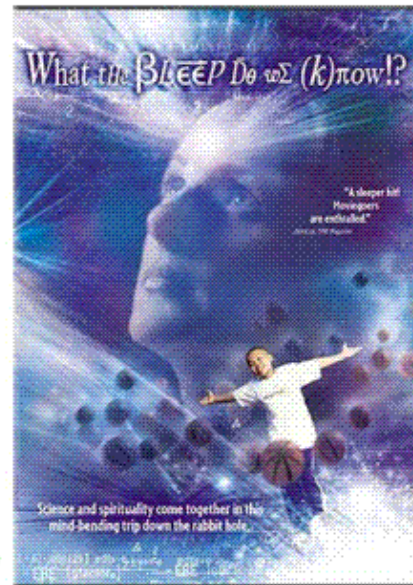
Many worlds + decoherence avoids wavefunction collapse altogether

## Law of Attraction

If you want something at truly believe it is possible, you'll get it.

Four things must be done:

- 1) Know exactly what you want.
- 2) ASK the universe for it.
- 3) Feel, behave and know as if the object of your desire is already yours.
- 4) Be open to receive it and let go of the outcome



Somehow the mind chooses the path or causes the collapse so that the universe gives you what you want... so says the proponents

# Heisenberg's Uncertainty Principle

~1927

$$\Delta x \Delta p \geq \frac{h}{2\pi}$$

uncertainty  
in  
position

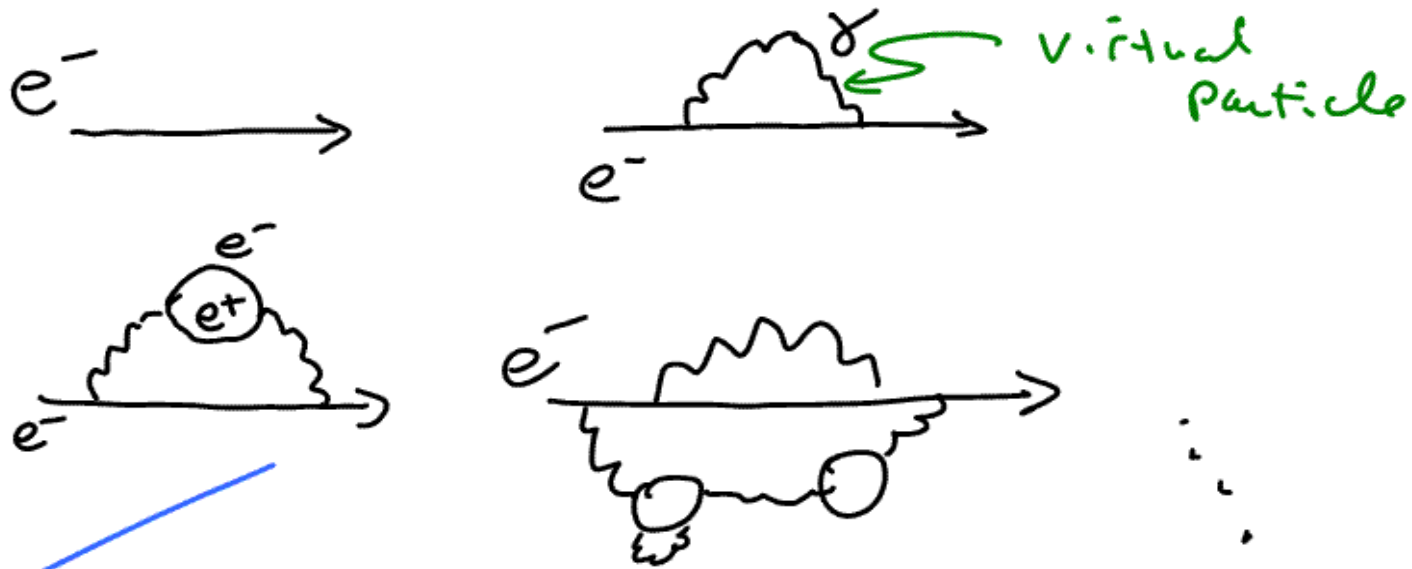
uncertainty  
in  
momentum  
( $mv$ )



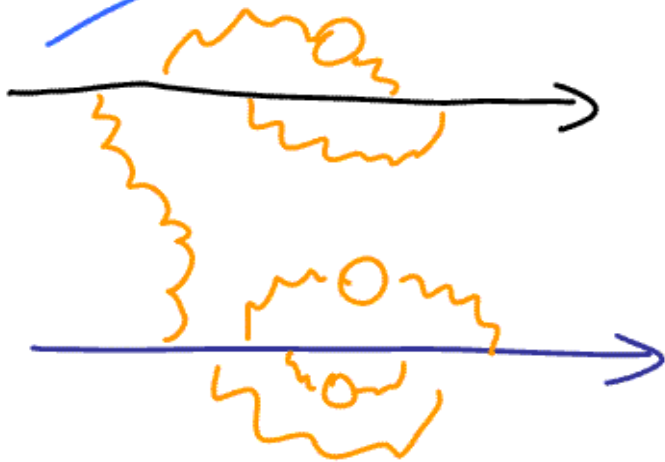
$$\Delta E \Delta t > \frac{h}{2\pi}$$

uncertainty  
in  
energy

Time over  
which  
system exists



Quantum Field theory

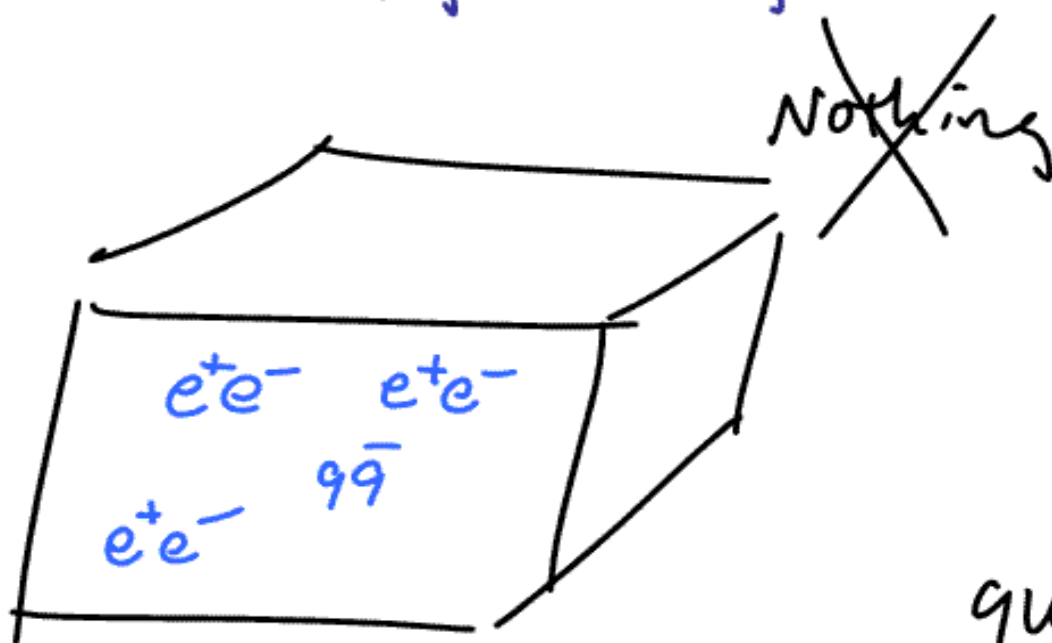


Quantum Electrodynamics  
Richard Feynman

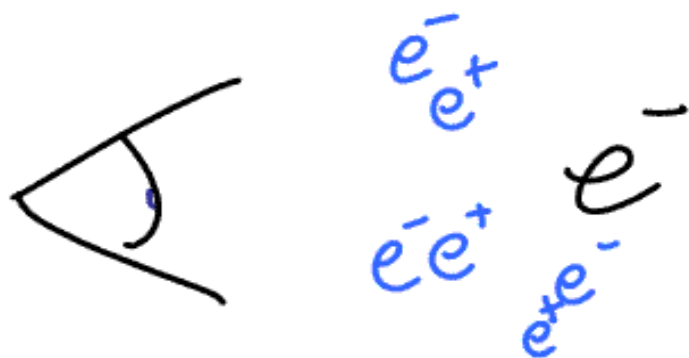
essence of force in quantum field theory is exchange of virtual particles

Vacuum is NOT empty - fleeting Particle - Antiparticle pairs

Appear  
consistent w/  
Heis. Unc.  
Principle



Quantum  
Vacuum



Vacuum polarization -

can actually see  
an effect on Atomic  
spectra (Lamb shift)