Entanglement

If we have two quantum systems, there are two possibilities for the total quantum state:

1. can be written as a product of the two individual systems:

$$\psi_{total} = \psi_1 \psi_2$$

2. cannot be written as a product:

$$\psi_{total} \neq \psi_1 \psi_2$$

We've seen several examples before in this course:

Atom that just emitted a photon:

$$\psi_{total} = \int d\vec{k}\ \psi_{atom}(\vec{k})\psi_{photon}(-\vec{k})$$

Photon emitted in all directions; atom must recoil in opposite direction.

S. cat:

$$\psi_{total} = \psi_{atom}(excited)\psi_{cyanide\ vial}(\text{"unbroken"})\ \psi_{cat}(\text{"alive"}) + \psi_{atom}(decayed)\psi_{cyanide\ vial}(\text{"broken"})\ \psi_{cat}(\text{"dead"})$$

Double slit with quantum which-path detector:

$$\psi_{total} = \psi_{photon}(\text{"upper slit"})\psi_{detector\ 1}(\text{"yes"})\ \psi_{detector\ 2}(\text{"no"}) + \psi_{photon}(\text{"lower slit"})\psi_{detector\ 1}(\text{"no"})\ \psi_{detector\ 2}(\text{"yes"})$$