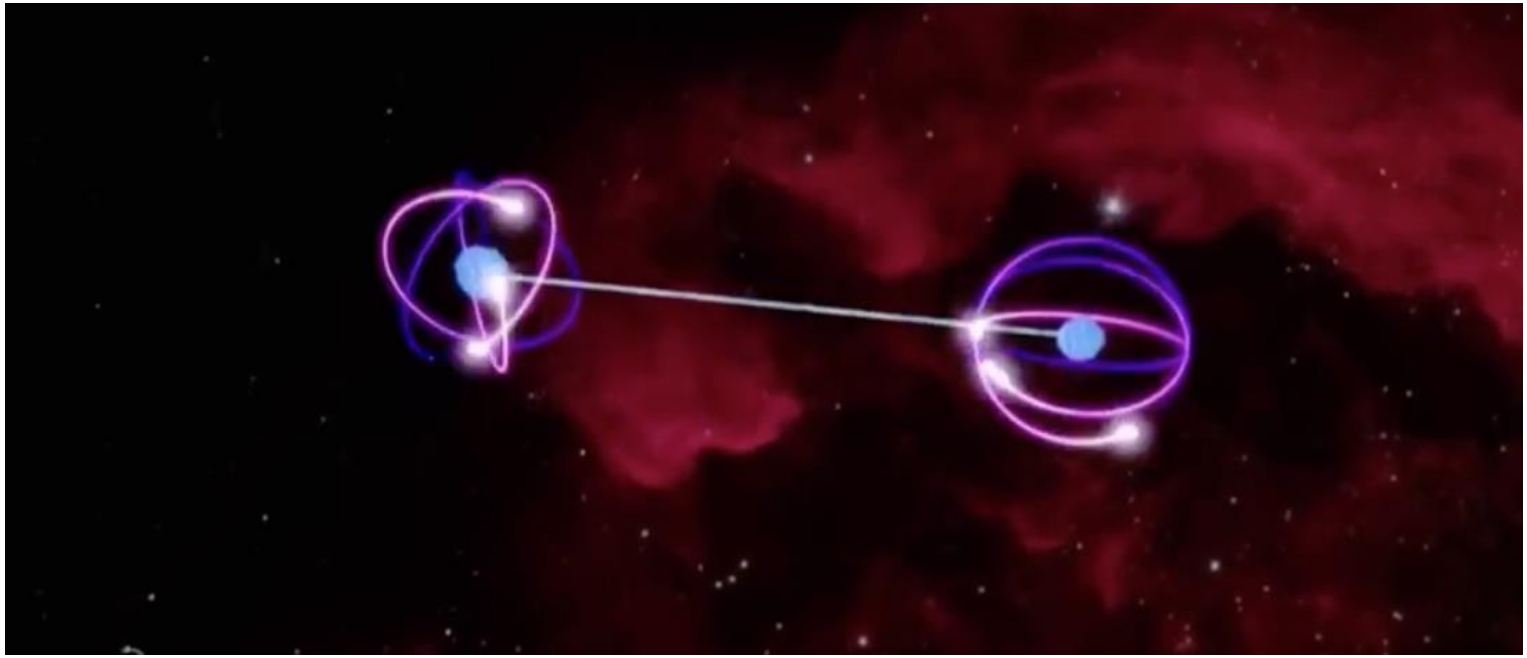
Superposition and entanglement



Superposition

An example of superposition:

- A coin that keeps spinning until it is observed.
- While spinning, the coin is in a superposition of the states **heads** and **tails**

A superposition

- collapses when it is observed
- the coin resolves into one of the two states, either heads or tails (a coin on its edge in this example, is not considered a state.)

Quantum objects can exist in two or more states

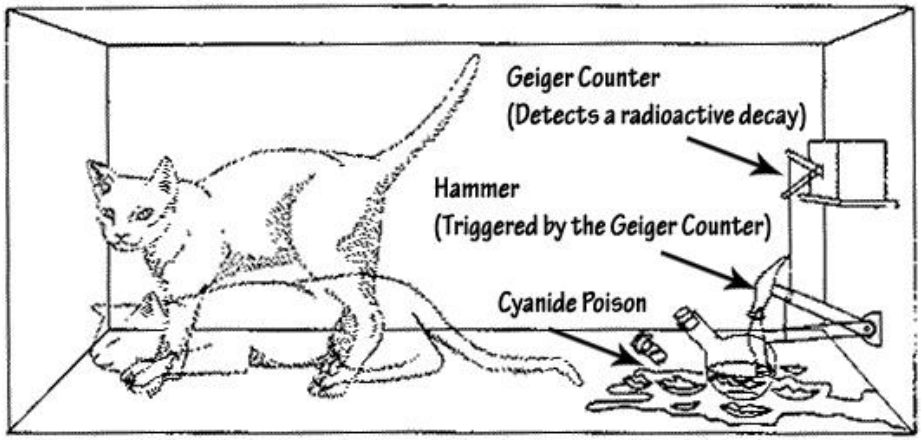
at once e.g. an electron in superposition could Simultaneously move clockwise and anti-clockwise through a closed circuit.

Schrődinger's cat

Schrődinger's cat was a thought experiment created in by Austrian physicist Erwin Schrődinger. His notion was to explore the limits of the idea that objects can be in more than one state at once until we observe them.

The thought experiment involved placing the cat in a sealed room with a Geiger counter, a radioactive source and a vail of poisonous gas.

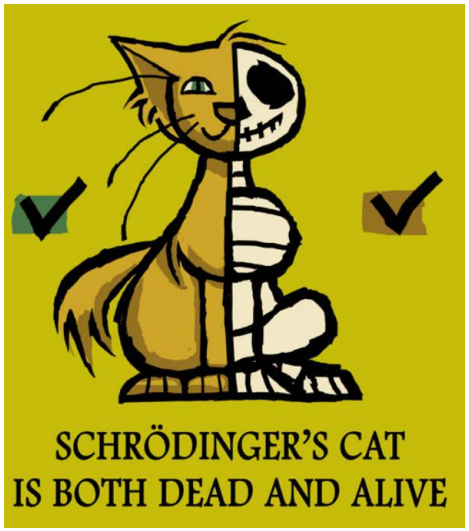
Within an hour, one of the atoms in the radioactive source has a 50-50 chance of decaying or not decaying. If the atom decays, it will release a particle which will set off the Geiger counter which would then trigger the release of the gas, which would kill the cat.



Kitty alive or dead?

Since the room is sealed you would not know if the cat were dead or alive until you actually opened the door and checked. So until the door is opened the cat is said to be both ‘dead’ and ‘alive’.

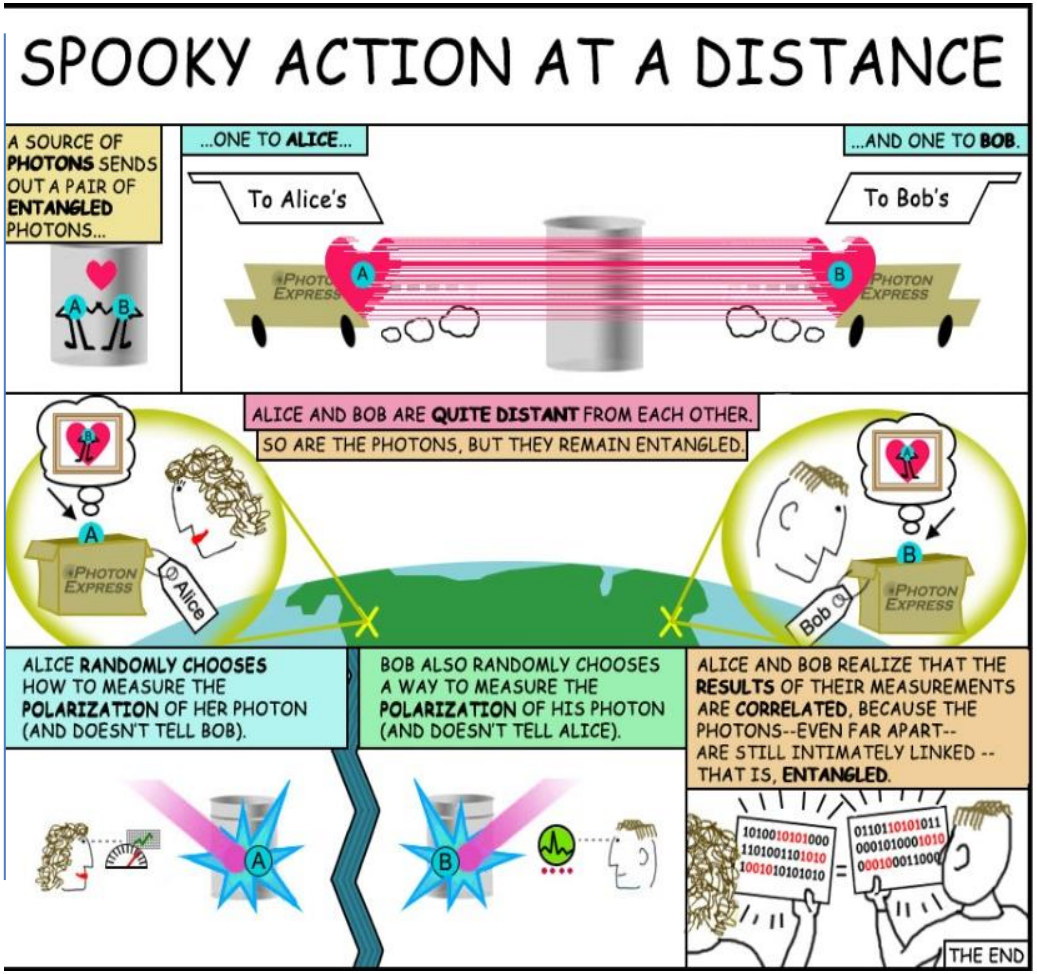
By opening the door and looking at the experiment, the observer influences the experiment causing the cat to either be ‘dead’ or ‘alive’ collapsing the original superposition. Schrődinger used this example to highlight that in a practical example common sense tells us that the cat is either dead or alive whether or not it is observed.



Quantum entanglement

Quantum entanglement describes a system containing two or more objects linked in such a way that a change in one particle affects the other one at exactly the same time.

The result is that even if these particles are very far away from each other, the act of observing the state of one particle means that the other particle will resolve its state instantaneously



Quantum entanglement

An example of **entanglement** would be if we made two cups of coffee and put sugar in only one of the cups. We can say that these two cups are entangled: they look exactly the same and a superposition exists for both cups.

To determine which one has the sugar and which does not, we would need to taste one of the cups, which would measure its quantum state.

After tasting one of the cups, we would instantly know the quantum state of both cups of coffee. By tasting the coffee with sugar, we instantly know that the coffee in the second cup must have no sugar.