# Quantum Entanglement and the EPR Paradox

Quantum entanglement is what happens when any two quantum particles interact. The result is that their quantum states are interdependent or they are entangled. So if one particle is one particle state other has to be in the other state. An analogy to understand this would be by using the electron spin. If two electrons are entangled, then those two are correlated to each other in such a way that if one of the electron is measured to spin up, the other would be spin down. This meant that we could get to know the spin of the one particle by just knowing spin of the other. We have to remember here that the electrons are in superposition and do not have definite spin until measured. Which makes us think that measurement of one of the particle somehow affected the result of the other or when one particle was measured, information travelled from that particle to the other. Particles can be entangled and be kept at any distance we like and if we kept them apart by a very large distance, information could be travelling at a velocity greater than that of light. This made Einstein really uncomfortable because according to his theory of relativity, nothing could be moving at a higher velocity than that of light. Einstein called this “spukhafte fernwirkung” spooky action at a distance as there was no way information could travel at a speed greater than that of light. So Einstein with two of his colleagues Boris Podolsky and Nathan Rosen proposed in 1935 that there was there was no way instantaneous transformation could happen, so there might be some property in the particle which we cannot observe but they fix the states. He called them hidden variables, they cannot be observed but influence the result. So at that time there were two theories explaining quantum entangled, one given by Niels Bohr based on the Copenhagen interpretation and the other given by Einstein. There was no way we could tell if the result was due to hidden variables as suggested by Einstein or due to the suggestions given by Bohr. This changed in 1964 when John Bell proposed a thought experiment and gave what were called as Bell’s inequalities. There have many practical demonstrations to verify them have been done and one of them is using polarising filter. Here we take three polarising filters at an angle 22.5 degrees to each other and pass light through it. When we do it we observe that 85% light passes through the filter. If there is only one filter, 100% of light will pass through and if two filters at 45 degrees 50% light will pass through. Here we cannot get the observed result without violating Bell’s inequalities. If we find the experimental value upholding the inequalities we get 75% as the answer which is not equal to observed 85%. But the

Bohr’s interpretation can explain the observed result. So, when two particles are entangled, there are no hidden variables that decide the out coming values instead there is a weird correlation between the two entangled pair which influence the outcome. We can also say that once two particles are entangled they are a single entity so changes in one will influence the other no matter what the distance between those two particles is.