



## Double slit Experiment with Electrons

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### Abstract:-

This article is about the famous double slit experiment on electrons which sparked up many among the prominent scientists about the interpretation of the result of the interpretation.

### Young's double slit experiment:

Originally this experiment was done by Thomas Young. This proved the wave nature of light. When waves of light came out from the slit, they interfered with each other, crests of two waves superposed, constructive interference occurred and bright fringe was seen in the screen. If the crest and trough of the wave met, the result was destructive interference and there would be dark fringe. So, on the screen, we would observe alternative bright and dark fringes.

### Wave nature of particles:-

de Broglie hypothesized about the wave of particles and in 1927, Division-Germer found that electron indeed behave like wave and show diffraction patterns like X rays. In 1961, double slit experiment was performed for the first time.

### The experiment:-

Classically, if you think electrons as tennis balls, and when you throw them two slits, you expect marks of the balls of the same length and size, corresponding to the slits they went through. But that didn't happen, they show the interference pattern just like light, with bright fringe consisting of huge population of electrons and dark fringe of electrons with very few electrons. In the wave particle duality

theory, scientists consider particles as localized wave. The electrons hit the screen as a particle or very localized wave but somehow managed to form interference pattern in groups. Scientists thought, may be they are somehow interfering each other, or many be some types of collision happening or may be some misunderstanding about the subatomic world were prevailing.

So, scientists, started throwing electrons one by one, with enough time in between, so that there is no chance of getting interfered by other electrons. But, the electrons hit the screen randomly after passing through the double slits, not the places you expect classically. So, somehow, the electron was interfering with itself, but how is that possible? Does the electron split itself into two, went through both the slit and interfered with each other and combined before hitting the screen? But, the electron must pass through one the slits. Scientists tried to be sneaky and put a detector to detect the slit through which the electron passes. The pattern that formed was not an interference pattern, but two straight lines in accordance of the slits as expected classically. It was somewhat like, observation messed up the result. So, the scientists put the detector there, but unplugged it, as a way, no information was there about the slit chosen by the electron.

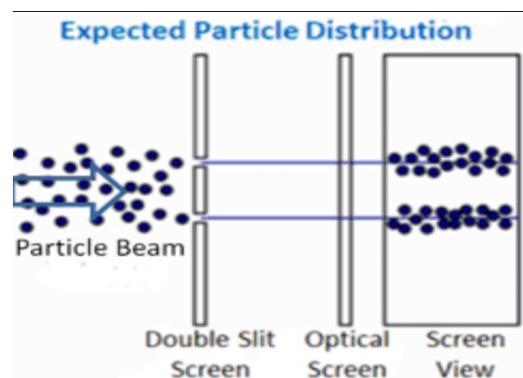


Image1: expected pattern classical

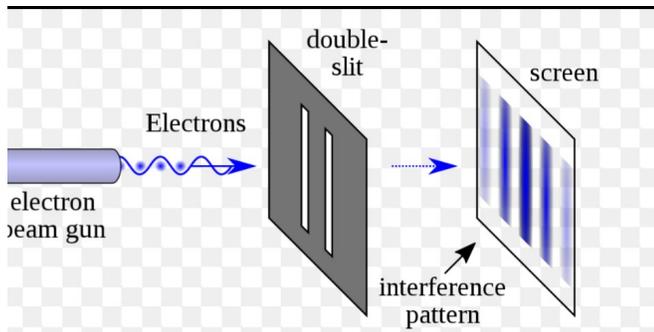


Image 2:- Interference pattern that was actually found.

### Interpretation:-

There are several interpretation of this behavior, the most popular being observer effect. When a measurement of the wave of the particle is made, the wave function collapses. This was introduced in the famous Copenhagen interpretation. But there is a problem with the word observation. In an experiment, what does observation means, does it mean keeping a record or to have a conscious mind interpret it. The problem with this interpretation is the meaning of the word observation. Because when ever scientists tried to observe, interference pattern didn't appear. In the famous, delayed choice quantum eraser experiment with entangled particles, classical picture showed up earlier than the detection occurred. So, if we observe, there will be collapse and there is no way to cheat. It brings up a very fundamental question, does consciousness create reality? This might be very intuitive to think. There is another very popular interpretation- many world interpretation. It says that, there is no collapse in wave function and all the possible outcomes are happening in other universes. In a very a recent experiment, scientists stored the detection information of the pathways in the form of atoms and scientists couldn't access that, but as the information available to the universe, the interference pattern didn't come. So, the observer

effect interpretation may be correct but there is lot more to know and explore.

### Reference:-

Wikipedia  
Does consciousness change reality- Arvin Ash  
[abyss.uoregm](http://abyss.uoregm)

Image 1: mpoweruk  
Image 2: Wikipedia