New Method of Doing Double Slit Experiment Making A Better Understanding of The Concept.

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Abstract- This paper will establish new arrangements for conducting the double slit experiments to illustrate the concept in a better way and to remove some of the misconceptions. It also makes people to think in a new direction about double-slit experiment. With a simple analogy, this paper illustrates that the reason for not getting the fringe pattern is not due to the property of light but due to the fact that most of the sensing methods of photon will actually absorb it or alter its path.

Indexed Terms- Double slit experiment, photon, particle, wave, new experiment, path of photon, lens.

I. INTRODUCTION

The arrangement in figure-1 shows the conventional way of doing the experiment.

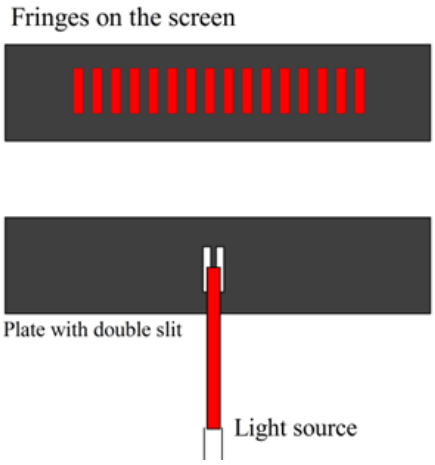

Figure-1. Conventional double-slit experiment

The problem here is that when the observer detects from which slit the photon is actually coming, the fringe pattern will vanish.

A. The reason for this problem.

The real reason for not getting the fringe pattern is not due to the property of light but due to the fact that most of the sensing methods of photon will actually absorb it or alter its path. This will be illustrated with a simple analogy.

Let us consider one example. An opaque pipe consists of a funnel with some cricket balls. Every minute, a cricket ball is allowed to fall through a pipe. It falls on a bell and the bell rings.

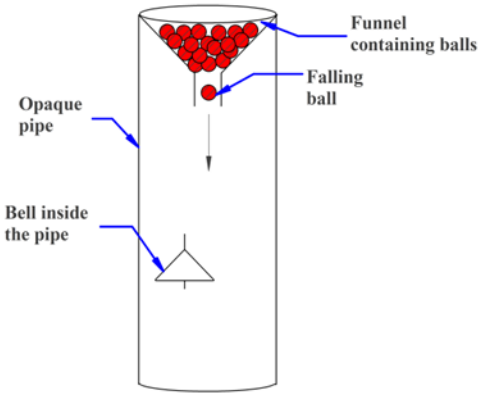

Figure-2. Bell and ball arrangement.

Now let a man wants to check whether the ball is actually falling and hitting the bell or something else is making the bell to ring.

He makes a small hole so that he can insert a stick to detect the movement of the ball.

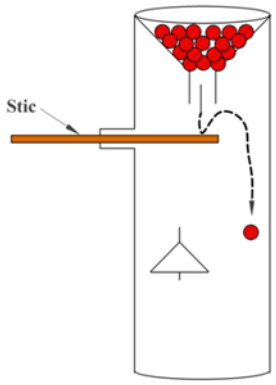

Figure-3. Detection of the ball with a stick

He inserts the stick and make sure that the ball is falling. But he notices that whenever he checks the ball, bell will not ring! Assume that he cannot thing logically. Since the pipe is opaque, he concludes like this: "*If the ball is detected, the bell will not ring.*"

The logical reason is that *when he inserts the stick to detect the ball, he will change the path of the ball as shown in the figure-3, so that it will not fall on the bell and hence the bell will not ring.*

The above example will show that in the conventional experiments, we will do the same thing for the photon while detecting and so fringe patterns will vanish. We will either change the path of the photon or absorb it in the process of detecting it.

Let us modify the above experiment, as shown in figure-3, so that we can detect it with stick only but with a small difference.

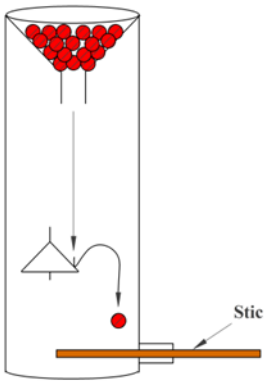

Figure-4. Detecting the ball after the bell

Let us place the stick in the same way but after the ball hitting the bell. Now he will detect the ball after the ringing of the bell. The conclusion is that the ball was making the bell to ring. In this arrangement, we are not disturbing the ball. The same logic is applied in the new experiment on double slit.

Can we use optical sensing method to detect the ball? Yes, in that case, we can detect the ball and also the bell will ring. But we cannot detect a photon by optical sensor because photon is so small that the most sensitive instrument of any kind will considerably disturb it while detecting it.

II. THE NEW METHOD OF DOING DOUBLE SLIT EXPERIMENT

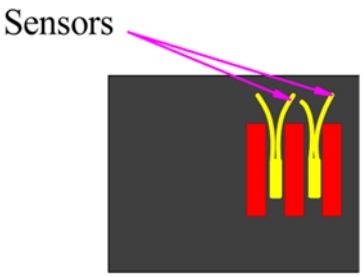

Figure-4. Placing the sensors between fringes.

Figure-4 shows the new arrangement. The slit, light source and screens are same, but the sensors s1, s2... are kept at places where the probability of photon detection is almost zero when both the slits are open. These sensors are connected to beeping sound generators. So, when a photon falls on any one of these sensors, a beep sound is heard. That means, if and when only one of the slit is open, beep sound is heard because light will fall on these places when one of the slit is closed. When the photon is allowed and if there is no beep sound, it implies that both the slits are open and light follows the patterns.

A. Placing a convex lens after the Screen

A convex lens is placed after the screen, but no light will pass through the lens because the screen is not allowing light to pass through. When the Screen is removed but the sensors are retained, the pattern is still there but not falling on the screen. If the pattern changes, sensors will send beep signal!

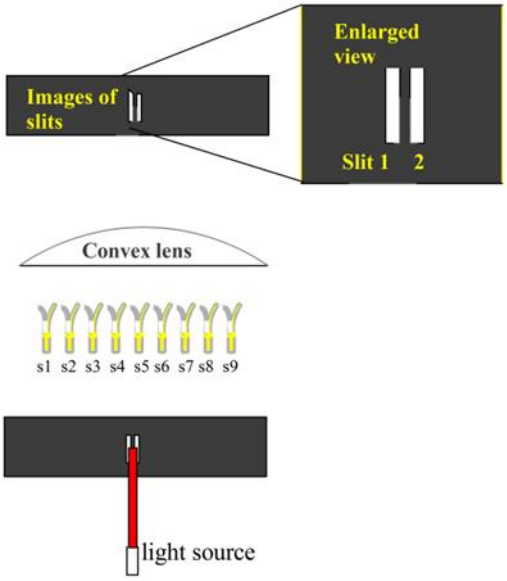

Figure-5. Placing the convex lens.

Now the light passes through the lens and the image of the slits 1 and 2 will be seen on the screen. The limitation to resolve two points or slits when the lens is used to focus is given by the wave equation given by *Rayleigh Criterion* is

$\theta = 1.22\frac{\lambda}{D}$, where

θ = the least angle between two points that can be separated,

D = the diameter of the aperture of the lens

λ = wave length of light.

So, here *Lens focusing method* is shown just to emphasize that the photon will retain its property and an effort can be made to detect it after the fringes.

Now, if the bright beam is reduced to Single photons, then we cannot see the slit image, as our eye is not so sensitive to recognize single photon.

Now let us put two separate photon counters for slit 1 and slit 2. So, when photon strikes the counters, we will see the corresponding number of photon on digital indicator, as shown.

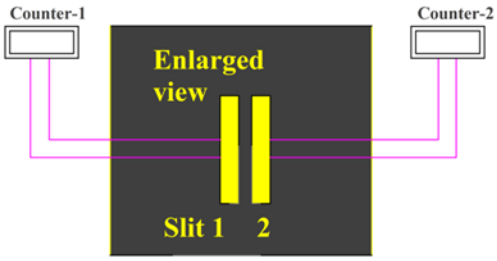

Figure-6. Connecting separate counters for each slit.

The possibilities are shown in the form of a flow chart.

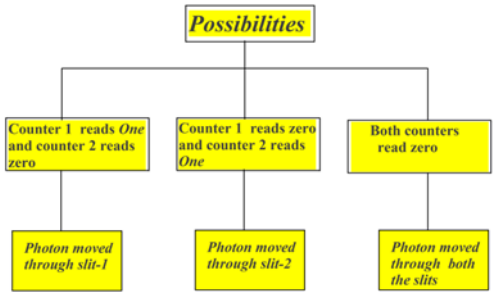

Figure-7. Possibilities.

As the figure indicates, there are three possibilities.

a) Counter-1 indicates one and counter-2 indicates zero- This means that photon came through slit-1 only.
b) Counter-1 indicates zero and counter-2 indicates one- This means that the photon came from Slit-2 only.
c) Both counters indicating one- This means that photon came from *both the slits at the same time, indicating that it is a wave.*
d) *There is a remote 4th possibility that both the counters indicating zero- This means that the photon hits a sensor S1 or S2 ..... - In such a case we should get a beep sound! This is because that the probability of a photon falling on the dark region is very low but not zero*.

III. DICUSSION

Normally, there are two groups of people in the double-slit experiment.

- Wave theory supporters and
- Particle theory supporters.

Wave theory supporters – The argument:
"The wave entered through both the slits simultaneously and hence we are getting fringe pattern"
This argument is logical

Particle theory supporters – The argument:
"Photon particle enters any one slit and still the fringes are formed, which is yet to be reasoned out and we cannot find through which slit it moved"

Logical analisys:
A particle moving through only one slit cannot recognize the open or closed status of the other slit. If we assume that some field is surrounding the photon particle so that it is getting the information about the other slit, it is equivalent to assuming it as a wave.

Also, the thing to be noted here is that the particle supporters cannot assume that the lens cannot focus the slits due to Rayleigh Criterion because;

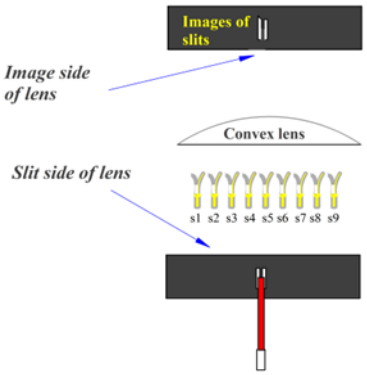

Figure-8. Slit side and focusing side of the lens.

They have assumed photon as a particle on the slit side of the lens. So, they cannot assume as a wave on the image side of the lens.

Even when electrons are used for the experiment, we will get the fringe pattern of probability because of wave nature of electrons. If it were to be the phenomenon exhibited by a particle, we should have noticed it even if we conduct the experiments with tennis ball or glass marbles through big slits.

REFERENCES

[1] Aharonov, Yakir, Eliahu Cohen, Fabrizio Colombo, Tomer Landsberger, Irene Sabadini, Daniele C. Struppa, and Jeff Tollaksen. "Finally making sense of the double-slit experiment." *Proceedings of the National Academy of Sciences* 114, no. 25 (2017): 6480-6485

[2] Bauer, M. "On time and space double-slit experiments." *American Journal of Physics* 82, no. 11 (2014): 1087-1092.

[3] Duffy, John, and Ted Loch-Temzelides. "A double-slit experiment with human subjects." *Plos one* 16, no. 2 (2021): e0246526.

[4] Frabboni, Stefano, Gian Carlo Gazzadi, and Giulio Pozzi. "Young's double-slit interference experiment with electrons." *American Journal of Physics* 75, no. 11 (2007): 1053-1055.