Diffraction experiment rejects wave models of light

John C. Hodge[1*]
[1]Retired, 477 Mincey Rd., Franklin, NC, 28734

Abstract

The interpretation of Young's double slit experiment of diffraction and interference remains controversial. The experiment uses an image resulting from a single slit projected onto a second mask. If the second mask slit is placed at the center of the image, a Fraunhofer diffraction pattern is projected onto the screen. One side of a slit in the minima examined the result of varying the intensity of the coherent illumination across the slit. One slit of two in the minima examined the result of only one of the double slits being illuminated. The resultant patterns on a screen were photographed and are on the opposite side of center from the illuminated side of the second mask. These observations reject wave models of light and do not reject the Newtonian model of light.

Diffraction, Interference, Young's experiment, Afshar's experiment, Newton Interpretation.

1 INTRODUCTION

A single model of light has remained a mystery. Black body radiation, the photoelectric effect, and the Compton effect observations reject the wave-in-space models of light. The reflection, diffraction, interference, polarization, and spectrographic observations reject the traditional particle models of light. Explaining the behavior of light as particles reduces to explaining just one experiment, Young's double slit experiment conducted in 1801.

Scientists in Newton's time knew of diffraction effects. Newton (1730) speculated light was a stream (ray) of particles. The wave in the aether in query 17 overtakes (travels faster than) the rays of light and directs the rays' (corpuscles') path. Newton's analogy was of water waves. The particles of light recede from denser parts of the aether in query 19. The aether grows denser from bodies in query 20 and this causes gravity in query 21. Newton seems to have suggested light is particles that are directed by the divergence of the aether and that produce the wave phenomena in the aether. The prevailing interpretation

*E-mail: jchodge@frontier.com

of Newton's model is that Newton was suggesting light is both a wave and a particle. However, he thought of light as two entities having differing effects like a rock (photon) creating waves in water (aether).

Several models have been developed that describe the intensity pattern of light on the screen. Young noticed in his diffraction experiment that the slit edges appear luminous (Jenkins and White 1957, p.379) and that the light producing the diffraction pattern was coherent. The only model for coherence in Young's time was of wave action. Starting with Young's experiment, the prevailing models of the 19th century considered light to be a wave. Therefore, his model consisted of the interference of the waves assumed to originate at the edges and of the direct wave. Fraunhofer, Fresnel, Sommerfield and Kirchhoff models assumed the waves originated before the slit and the diffraction occurred in a plane across the slit. These models depended on the Huygens-Fresnel principle that stated each point along the wave crest is a source of a new, spherical wave. Because this was inconsistent with wave observations in the classical domain that waves are emitted in all directions from a source, an ad hoc postulate that the wavelets were not emitted backward had to be made (the "obliquity factor"). The points on the wave in the plane of the slit produced the diffraction pattern. These models were poor close to the slit (Jenkins and White 1957, Section 18.17). Some models were better close to the slit but degenerated into the Fraunhofer equation farther from the slit.

Wave models suggest the waves fan out from the slit such that waves through the left side of the slit form the left side of the image or fan out over the entire image. This suggested the present experiment.

This paper examines an experiment with varying, coherent light across the slits. Section 2 describes the experiment and the results for slits. Section 3 show the results for edge experiments. The discussion is in section 4 and conclusion is in section 5.

2 The experiment

Introducing a second mask was used to achieve coherent photons through one side of a slit. Figure 1 shows a diagram of the experiment. The laser was a 635nm, 5 mW laser pointer. The second mask was 157 cm from the first mask. The first mask slit was 1 mm wide and was 10 cm from the laser. The distance to the second mask was such that the slit was half the width of the first mask's central peak. The second mask single slit was 2 mm wide. The second mask double slits were 0.5 mm wide and 2 mm between centers. The screen was 638 cm from the second mask.

The second mask was placed in the center of the first mask's diffraction pattern. The image was shown to produce the diffraction and interference patterns of standard experiments. This establishes a "control" in the experiment such that no additional fixtures to "collapse the wave function" are required. Next the second mask was shifted to allow light to vary across the slit.

Figure 2(TOP) shows the diffraction pattern for a single slit from the first

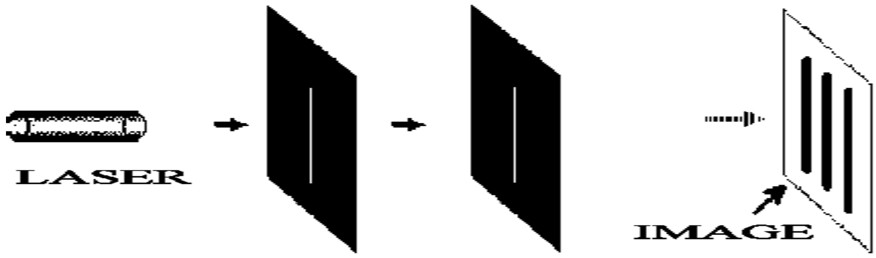

Figure 1: Diagram of the experimental fixtures.

mask. The figure was converted to two colors for printing. Each fringe shows as a band of bright light with dimmer light between the bands on a screen. The minima have very little light intensity at the minima.

Figure 2(TOP) shows the placement of the second mask slit relative to the image of the pattern from the first mask. "Slit pos. 1" is the control to show the light impinging on the second mask is coherent and is according to previous observation.

The Fig. 2(BOTTOM) shows the screen pattern result. This is a partial Fraunhofer pattern. It shows the light through the second mask is coherent as expected. The pattern shows the fringes slightly closer because the second mask is closer to the screen than the first mask.

The top image of Fig. 3 shows the placement of the second mask slits partly over the minima of the first mask image. The goal is to have a large difference between the intensity on one side of the slit and the intensity on the other side. The bottom image is the photograph of the result on the screen. Most of the light enters the slit on the left when viewed from the laser. The image is on the right and it is a diffraction image. Note the placement of the secondary fringes on the right match the right side fringes of the Fraunhofer diffraction pattern. The image on the left was too faint for the camera to capture.

The top image of Fig. 4 shows the placement of the slits on the first slit image for a double slit experiment. The middle image had an exposure to show the double slit interference pattern. The bottom image had an exposure to detect the outer fringes.

Most of the light entered the left slit. The image is on the right and it is a double slit diffraction image.

3 Edge experiments

The equipment and performance of this experiment is the same except the second mask is an edge rather than slits. Figure 5 is a diagram of the experiment.

3 EDGE EXPERIMENTS

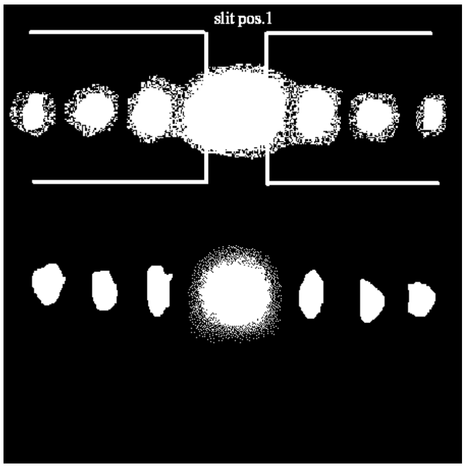

Figure 2: Photograph converted to 2-color shows (top) the diffraction pattern through the first slit and the placement of the second mask slit that produces the (bottom) diffraction pattern in the screen.

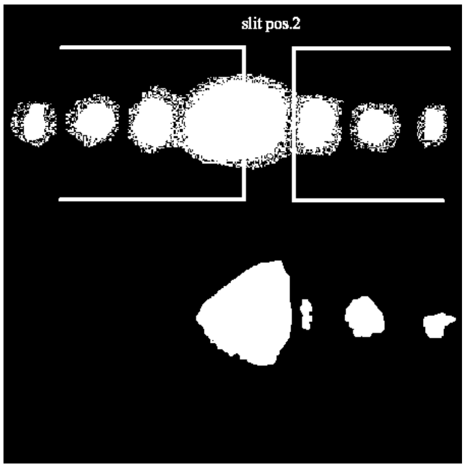

Figure 3: The top image shows the placement of the second mask slits relative to the first mask image. The bottom image is the photograph converted to black and white result on the screen.

3 EDGE EXPERIMENTS

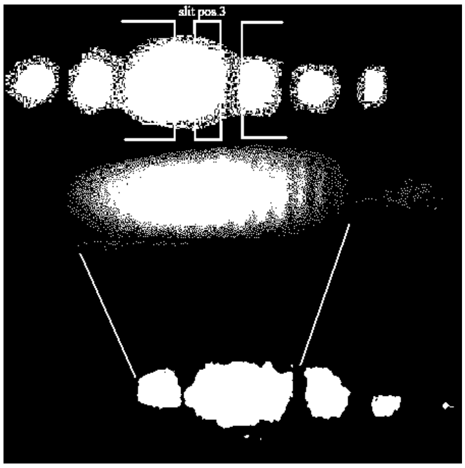

Figure 4: Photographs converted to two color of images. The top image shows the placement of the double slits on the first slit image. The middle image had an exposure to show the double slit interference pattern. The bottom image had an exposure to detect the outer fringes.

Figure 5: Diagram of the experimental fixtures.

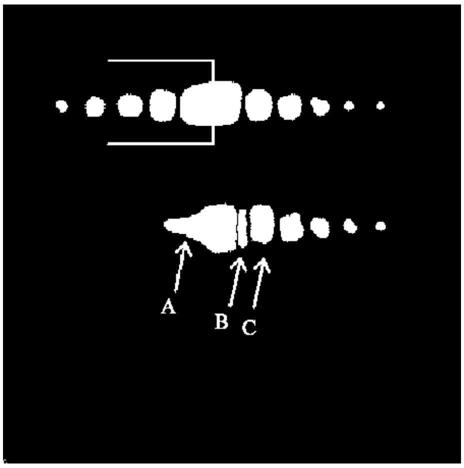

Figure 6: (TOP) The placement of the edge relative to the diffraction pattern from the first mask. (BOTTOM) The image on the screen.

Figure 6 shows the placement of the edge relative to the diffraction pattern maximum from the first mask (top) and the image on the screen (bottom).

Figure 7 shows the placement of the edge relative to the diffraction pattern minimum from the first mask (top) and the image on the screen (bottom).

4 Discussion

The placement of the second mask in relation to the minima is delicate. The reproduction of the exact images is, therefore, delicate. The important point is that the diffraction image appears more intense on the opposite side of the illuminated part of the slit.

The "walking drop" experiments also show a diffraction pattern of a single drop in the experiment at a time (Bush 2015, Figure 5.(c)). Walking drops that go through the slit on the left also tend to go to the right side of the screen. When the drop is between the mask and screen, part of the waves in the medium reflect off the mask and part go through the slit to disappear from influence.

Any model that uses the Huygens-Fresnel principle cannot produce the observed distribution.

These experiments avoid some of the potential objections to the Afshar Experiment such as the wires collapse the wave function and the existence of the interference pattern in the plane of the wires is inferred rather than experienced (no measurement).

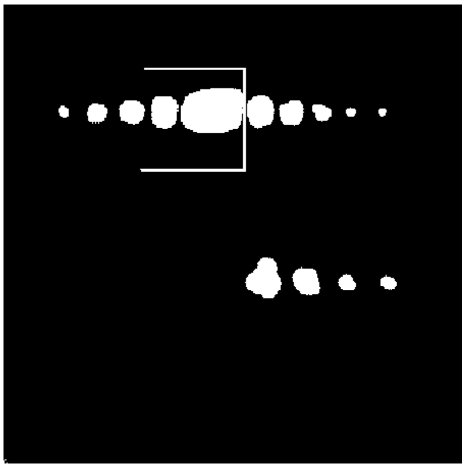

Figure 7: (TOP) The placement of the edge relative to the diffraction pattern from the first mask. (BOTTOM) The image on the screen.

5 Conclusion

The Huygens-Fresnel principle is inconsistent with the observations in these experiments. Therefore, these experiments falsify the Huygens-Fresnel principle and the wave models based on it. That is, all wave models of light are falsified.

These experiments do not reject the Newtonian Interpretation.

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