

# Light Strands not Wave Interference: Clarification of the Double Slit Experiment

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## Research Article

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# Abstract

**Objective** Modern understanding of light has fluctuated between particle and wave theory. The classic double slit experiment provided crucial support of wave theory with its description of wave interference fringe patterns. To our knowledge, no significant study has been performed on light propagation in free space after exiting the slit. To further understand the double slit results we analyzed light behavior in free space using novel visualization techniques.

**Methods** A micro-particle environment was developed that remained transparent to visible light. Coherent light was observed in this environment in settings of diffraction, refraction, and reflection.

**Results** Experimental generation of distinct light strands after diffraction through double slits is visualized. Definitive images of discrete light strands, not waves, were noted as light propagated through free space. Light strands were visualized directly creating the pseudo-interference fringe pattern, refuting the concept of wave interference.

**Conclusions** Novel generation and visualization of light strands confirms the particle theory of light and counters two hundred years of wave doctrine. The finding that diffractive fringe patterns and other observations of light are due to the phenomena of discrete radiating strands, not wave interference, will have implications in physics, quantum mechanics, and technology.

## Introduction

Since early times, civilizations have strived to understand light. Modern theories have equivocated between particle and wave descriptions<sup>1,2</sup>. In the 1600's, Isaac Newton described the corpuscular or particle theory of light<sup>1</sup>. Huygens, Young and others used experiments with slits, interference patterns, and wave propagation analysis to support the wave nature of light<sup>1,3</sup>. However, Planck, describing spectral radiation, introduced the idea of quanta of energy<sup>4</sup>. Einstein, expounding on this, elucidated the photoelectric effect by utilizing the discrete, particle nature of photons<sup>4</sup>. Schrodinger, Bohr, Heisenberg, de Broglie, and others developed quantum mechanics and probability of waves theorems to try to reconcile the dual nature of light<sup>2,4,5</sup>. The classic double slit experiment by Young provided strong support for wave theory<sup>7</sup>. The interference fringe pattern has been accepted as proof of wave behavior. In this paper we investigate the double slit experiment and its fringe pattern in order to better understand and study its properties. To our knowledge, no significant study has looked at light behavior after exiting the slit in the intervening space between the double slit and screen. Employing techniques to directly visualize this trajectory pattern in free space, we revisited the double slit experiment. We report our findings on the diffractive interference pattern as well as refraction and reflection settings.

## Methods

Double slits from 3B Scientific were used in slide format with slit width of .15mm, and spacing of .30mm. A coherent light source was obtained with a laser of 532nm wavelength and 5mW output. A micro-particle environment was created that would detect light pathways while remaining transparent using heated water vapor for wide field imaging and hydrated gelatin for macro imaging. A light box was used to contain the water vapor for some images. Photography was obtained with Sony NEX-5N mirrorless digital camera with 16.1MP Exmor APS HD CMOS image sensor and Sony E 18-55mm f3.5-5.6 OSS lens.

The laser source was placed on a stable platform. The double slit, held with a clamp, was placed 10cm in front of the laser. When laser light was projected on the slit, the resulting light output was captured in the micro-particle environment. Different configurations in addition to the double slit were also used including single slit, circular pinhole,+20D converging lens after the slit, projecting the light output onto a prism, projecting an additional laser on the light output, and applying bar magnets around the light output.

## Results

Novel visualization of discrete strands of light was evident in free space after exiting the double slit (Figs. 1a,1b). Photon trajectory as clearly distinct strands is manifest as they traverse the micro-particle environment. Separation into uniform strands with uniform angles, and clear intervals occurs immediately after exiting the slit. The strands stream out in a geometric fashion, perpendicular to the slit edge. Strands remain in discrete channels as they strike the screen and create the characteristic fringe pattern (Fig. 2). Blocking individual strands at slit exit or at screen does not interfere with other strands and creates a focal, not diffuse, defect. Separation between strands creates the clear intervals.

The further the screen distance is from the slit, the wider the strands and wider the interval between strands (Figs. 3a, 3b, and 4) (Table 1). When graphed, light strands and their clear intervals follow a linear dilation as they propagate in free space (Figs. 5 and 6). Strands are initially linear and become circular, the further the distance from the slit (Fig. 4). The central strands' intensity is greater than peripheral ones.

A reflection was also noted with light strands travelling from the entrance of the slit to the back wall (Fig. 7). This posterior reflection also created a fringe pattern.

A single slit was employed in place of the double slit. Its trajectory map also resulted in visible strands (Fig. 8) causing a fringe pattern as they collided with the screen. Most of the strands coalesced in the center with fewer peripheral strands.

A pinhole was substituted for a slit. Its trajectory map revealed streaming concentric sheaths of light (Fig. 9). In cross section in free space and as these sheaths impacted the screen, a concentric ring pattern was noted.

A fringe pattern was projected onto a + 20D lens. After traversing the lens, convergence of strands was noted to a point at the lens focal distance (Fig. 10).

A prism was placed in the path of the photon strands. The reflected strands displayed the same sharp, fringe pattern.

No discernible changes, movements, or deflections were noted with projecting additional laser light onto the strands. Similarly, magnets did not show any visible effects with either pole nor with any directional movement.

## Discussion

Directly observing the phenomena of light strands and its propagation in free space is strong confirmation of its particle nature. The generation of discrete strands with defined borders contradicts wave theory. Blurred edges or gradients, which would be consistent with wave interference, were not present as the strands are sharply defined. Focal, instead of diffuse, blocking of individual strands at the slit exit and screen supports particle concepts. The immediate splitting into strands upon exiting the slit further opposes wave theory in which interference would occur further away from the slit where expanding waves would have constructive and destructive interference. We show, for the first time, streaming strands of light traversing free space, striking the screen, and creating the classic fringe pattern. This is clear, visible evidence against wave constructive interference as the cause for these fringe marks. Furthermore, the clear spaces are not due to wave destructive interference, but are from the separation of discrete strands. These photon trajectory patterns visibly disprove the longstanding belief that these are wave interference patterns.

The reflection posteriorly from the slit caused its own fringe pattern. Not having gone through the double slit, this reflection should not have a fringe per wave theory as no constructive or destructive wave interference would have occurred. Particle theory explains it as multiple strands reflecting posteriorly from the slit entrance.

A single slit also caused a breakup of light into visible strands causing a fringe pattern. This occurred with a single slit where there would be an absence of interfering waves, again refuting wave theory. Most of the strands coalesced in the center with fewer peripheral strands reflecting away, consistent with observed single slit fringe patterns.

A pinhole created streaming concentric sheaths of light. Having a curved edge, unlike a slit, it reflected strands in concentric halos. As these sheathes collided with the screen, the characteristic concentric ring pattern was created. Interestingly, this ring pattern was visible in cross section of the strands traversing free space.

Convergence of strands occurs with a + 20D lens. This "collapse" of the fringe pattern is noted with visible convergence of the photon strands. This sharp visible deflection of strands further demonstrates the non-wave nature of light. It may also offer an explanation for the puzzling collapse of interference patterns noted in some double slit experiments.<sup>8,9</sup>

Photon strands can also be reflected and still retain discrete borders. When sent through a prism, the reflected strands continued to display sharp, fringe patterns, which would be inconsistent with waves.

Light strands prefer to preserve their tight formation as evidenced by the lack of reaction to additional laser light projection onto the strands. There seems to be a resistance to interference from external photons. This may explain the sharp separation of strands exiting from a slit and the corresponding distinct clear spaces of the fringe pattern.

Magnets did not show any significant visible effects on light strands with either pole nor with any directional movement. This is unexpected if light is part of the electromagnetic spectrum, and requires further exploration.

These observations of visible light strands confirm the particle theory of light. They also directly contradict the 200 year old doctrine that double slit diffraction patterns of light are only attributable to wave interference. Distinct strand channels, not waves, create the alternating marks. In our schematic diagram (Fig. 11) consider the laser beam as being shattered into shards of photons at the periphery where it encounters the slit edges. These photon shards, as they reflect in all directions, appear to quickly re-organize and fuse into evenly separated strands as they stream away from the slits. After traversing free space these strands collide with the screen creating an evenly separated fringe pattern.

The data shows that strands become more cylindrical with greater distance from the slit. We propose that this round configuration is consistent with particles propagating through the strands in a helical, rotational pattern. Particles traversing along tubular channels would be more symmetrical and stable with a helical rotation. Linear point particles would scatter in all different directions. Helical, cylindrical propagations are more likely to stay in defined channels, creating the sharp, alternating bright and dark fringe marks

Strands of helical tunneling photons also provide both particle and oscillatory behavior. As strands, light behaves as a particle that travels linearly. With a helical rotation, it displays oscillatory wave-like behavior with rotational phases. Therefore, this model can be described as a hybrid, though different from the traditional descriptions of transverse light waves.

Photons in the same phase of helical rotation, merging and weaving together tightly, may explain the formation of discrete strands. This coupling mechanism relies on a helical rotational phase matching, while photons out of phase would be repulsed away towards another strand, creating the alternating light and dark fringe pattern. Tight phase integration of strands may also clarify why light beams do not interfere with each other when their paths cross. Photons tunneling through some materials may also be explained by this tight union that may cross through weaker bonds of some materials. Other attractive or repulsive forces may also be present. Cohesiveness of strands does not seem to be due to charge or magnetism as photons do not have charge nor did the strands respond to magnetic fields.

As light strands radiate in uniform angles and intervals (Table 1) (Fig. 12), equations can model the observations. Geometrical dilation of individual light strands over distance can be described by the linear equation (Fig. 5):

$$y = (0.0016) x$$

Dilation of the clear interval can be described with the linear equation (Fig. 6):

$$y = (0.00027) x$$

As angles approximate to isosceles triangles, the vertex angle of a strand or clear interval can be calculated using the equation:

$$\text{Vertex angle } (\Theta) = 2 (\text{ArcTan } (\text{Width}/2) / \text{Slit Distance})$$

The strand (mark) angle is larger than the clear interval angle, consistent with observed greater geometrical dilation of the light strand over distance.

The single light strand triangle can also be used to calculate the linear wavelength of the laser (Table 1) (Fig. 12). One wavelength will create a smaller similar triangle with base width calculated from the previous linear equation of light strands ( $w = 8.512\text{E-}07$ ) and slit distance of  $1 \lambda$ . As these are similar triangles the following equation can be applied:

$$\lambda / D = w / W \text{ and } \lambda = w * D / W$$

Using vertex angles it can be written as:

$$\lambda = w / 2(\text{Tan } (1/2 \Theta))$$

Discrete strands, which stream in straight lines, explain why ray tracing is an effective way of describing light behavior. Calculations based on wave interference patterns<sup>10</sup> will be imprecise. Models using ray diagrams,<sup>11</sup> instead of wave geometry to explain their results, remain effective as they are consistent with linear strands. Precision may improve when adapted to photon strand geometry. Interferometers, thought to be displaying interference patterns of waves<sup>10</sup>, may be better explained as photo-strand interaction patterns. Similarly, diffraction grating<sup>12</sup> effects may not be from waves but rather, photo-strands that are split or reflected apart by slits or grooves. As another example, the Fresnel central bright spot<sup>10</sup> may be better described as the convergence of strands reflecting from an object's round border to the middle of the screen.

Light strands not only explain the pseudo- interference pattern of double slits, but also elucidate how single photons or electrons display pseudo-interference patterns.<sup>5, 13, 14</sup> Superposition of the same wave passing through both slits, interfering with itself and collapsing as a particle on the screen has a simpler alternative. Single photons or electrons follow these discrete cylindrical channels instead of scattering

diffusely, thus creating a pseudo-wave interference fringe. There still is noise on the fringe pattern of single photons with indistinct marks as some photons land in the clear spaces. This would be consistent with single photons generally propagating helically along a set channel but not as steadily as multiple photons travelling together in tight strands.

These findings require us to re-assess the idea, which was supported by Young's original double slit experiment,<sup>15</sup> of light as a wave. The fringe pattern is a pseudo-interference pattern and not wave interaction. Wave equations, being a foundation of modern quantum mechanics,<sup>6,14,16</sup> will need to be re-evaluated to incorporate these findings. Though, accurate in describing some of what we are observing, quantum mechanics is presently a probability model of possible chance outcomes. Conceivably these new findings may help its progression into a model that describes subatomic particles and fields with more certainty. Perhaps photons, electrons, and matter can be described, not as waves, but as focal helical oscillation functions.

Particle- wave duality of light has perplexed the scientific community for several centuries. Our novel visualization of light behavior in free space encompassing settings of diffraction, refraction, and reflection has supported the particle theory and refuted wave concepts. In particular, the double slit fringe pattern has been directly shown to be pseudo-wave interference marks, contradicting 200 years of doctrine supporting wave concepts of light. As observations of optical properties are better explained by this model of discrete photon strands, we may return to Newtonian particle theory with a modern revision. We expect that this discovery of photon strands, which have not been described before, will have implications in physics, quantum mechanics, and technology and involve areas of optics, communication, computer science, and medical care. With the scientific method, we revise and improve upon traditional ideas with new information. We anticipate that this novel information about photon strand propagation of light will provide a launching point for further discovery.

## References

1. Kuhn KF, Noschese, F. Light. Wave or Particle? In: *Basic Physics*. Ed 3. New Jersey: Wiley; 2020:227–236.
2. Carroll, G, *Quantum Physics for Beginners*. Carroll; 2020:46–112.
3. Walker J, Halliday, D, Resnick, R. Interference In: *Fundamentals of Physics*. Ed 10. New Jersey: Wiley; 2014:1048–1055.
4. Kuhn, KF, Noschese, F. The Quantum Nature of Light. In: *Basic Physics*. Ed 3. New Jersey: Wiley; 2020:242–245.
5. Griffiths, DJ, Schroeter, DF. *Introduction to Quantum Mechanics*. Ed 3. Cambridge: Cambridge University Press; 2020:13–37.
6. Fiman, N. *Quantum Physics for Beginners*. Gazzoli; 2020:33–34
7. Born, M, Wolf, E. *Principles of Optics*. Cambridge: Cambridge University Press;1999.

8. Jacques, V et al. Experimental Realization of Wheeler’s Delayed-Choice Gedanken Experiment. *Science*. 2007; 315(5814): 966–968.
9. Kim Y, Yu R, Kulik SP, Shih, YH, Scully, M. A Delayed Choice Quantum Eraser. *Physical Review Letter*, 2000;84(1):1–5.
10. Walker J, Halliday, D, Resnick, R. Diffraction. In: *Fundamentals of Physics*. Ed 10. New Jersey: Wiley; 2014:1082–1084.
11. Nave, CR. Hyperphysics. <http://edu>; Dept. of Physics and Astronomy, Georgia State University, Atlanta, GA; 2017.
12. Kuhn, KF, Noschese, F. Light as a Wave. In: *Basic Physics*. Ed.3. New Jersey: Wiley; 2020: 302–311.
13. Frabboni, S et al. The Young-Feynman Two-slits experiment with single electrons: Build-up of the interference pattern and arrival time distribution using a fast readout pixel detector. *Ultramicroscopy*. 2012; 116:73–76.
14. Feynman, R, Leighton R, Sands, M. *The Feynman Lectures on Physics*. Vol 3. Addison –Wesley; 1965:1.1–1.8.
15. Young, T. Bakerian Lecture: Experiments and calculations relative to physical optics. In: *Philosophical Transactions of the Royal Society*. 1804:94:1–16.
16. Greene, B. *The Elegant Universe*. New York: WW Norton; 1999:97–109.

## Declarations

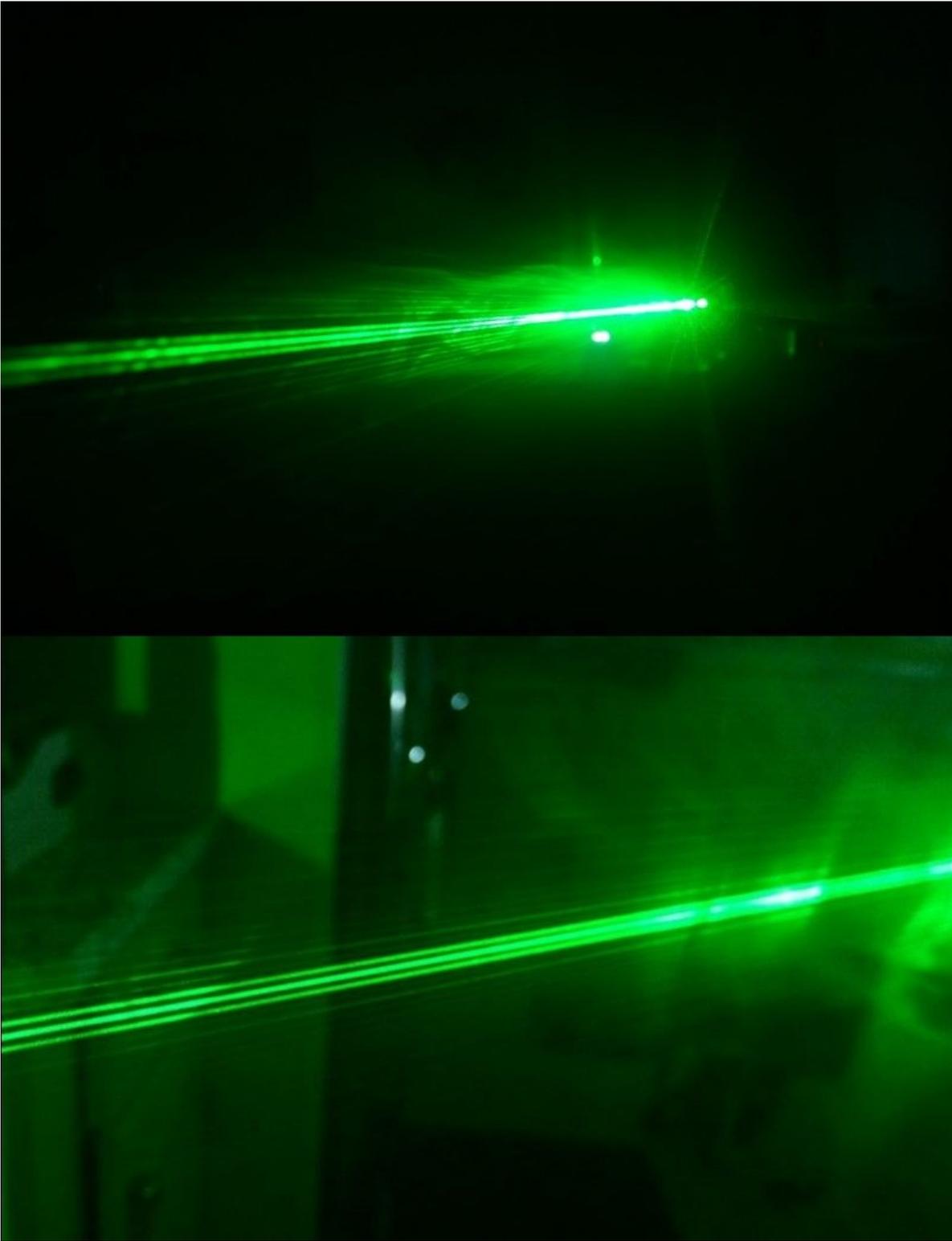
## Competing interests:

The authors declare no competing interests.

## Table

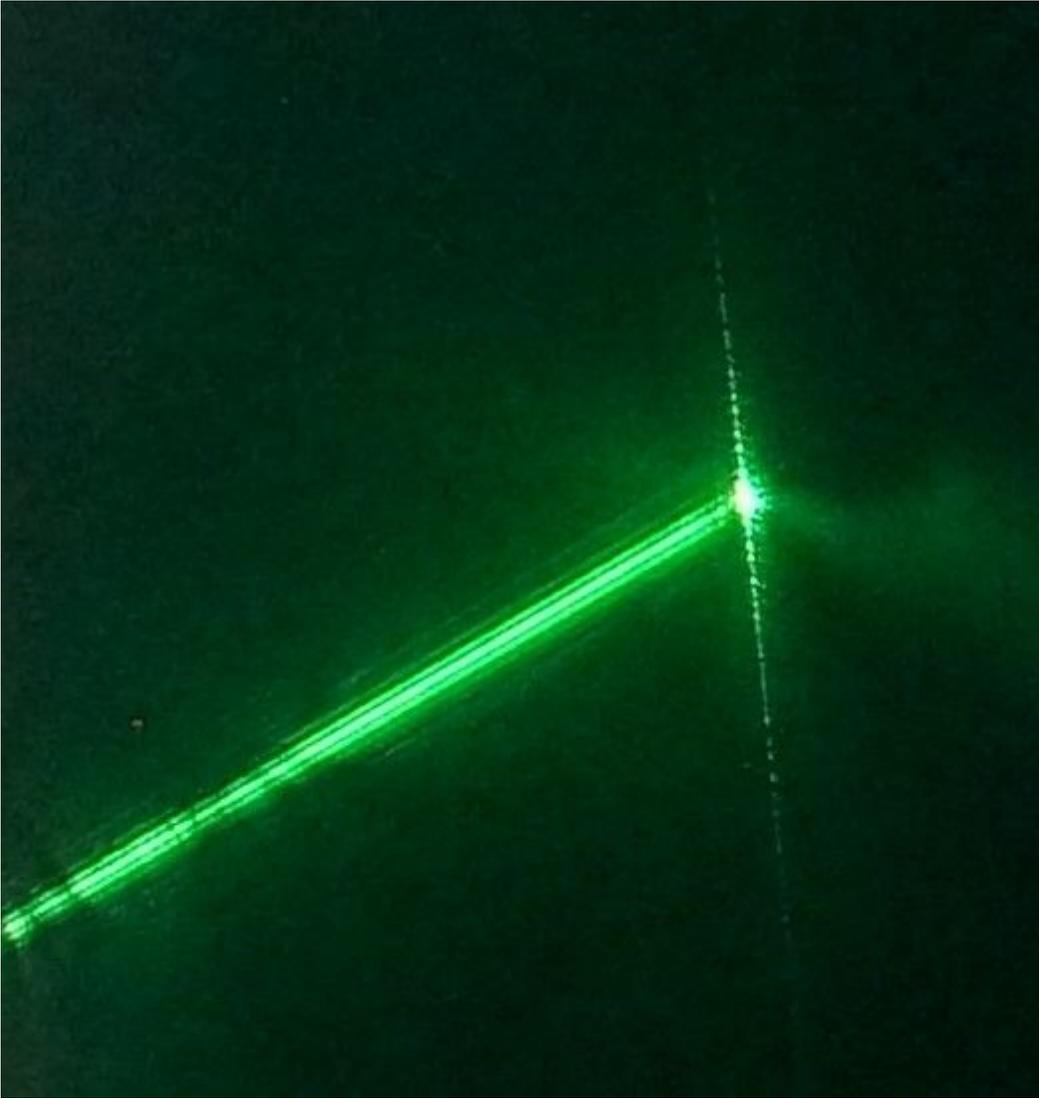
Table 1 is available in the Supplementary Files.

## Figures



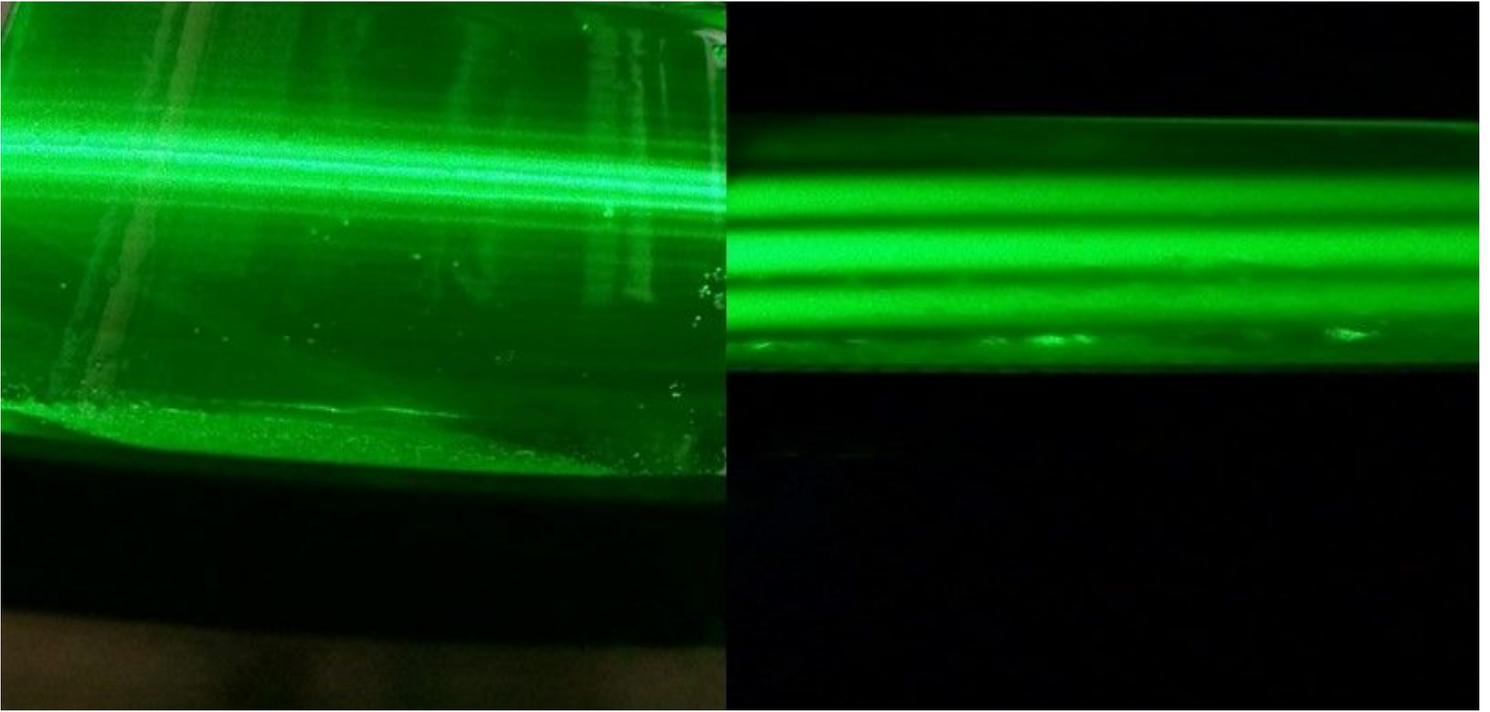
**Figure 1**

Visualized discrete light strands (a,b), not waves, streaming from a double slit at regular intervals and angles



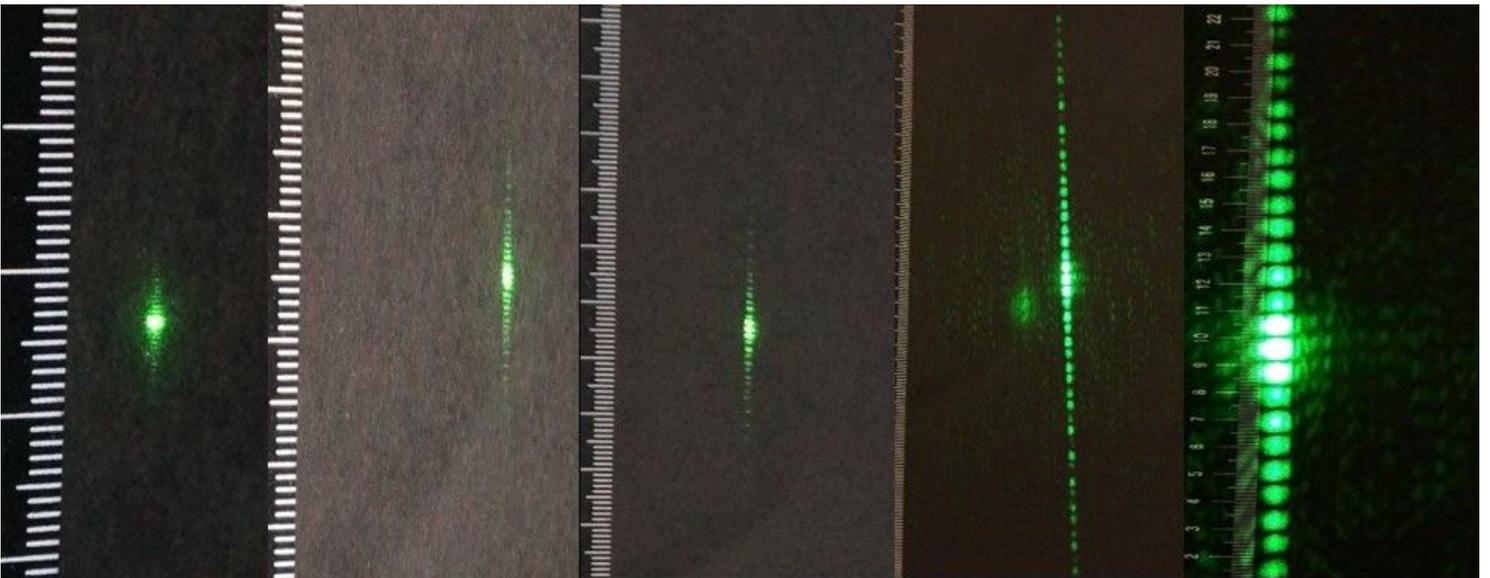
**Figure 2**

Photon strands creating the pseudo-interference fringe pattern



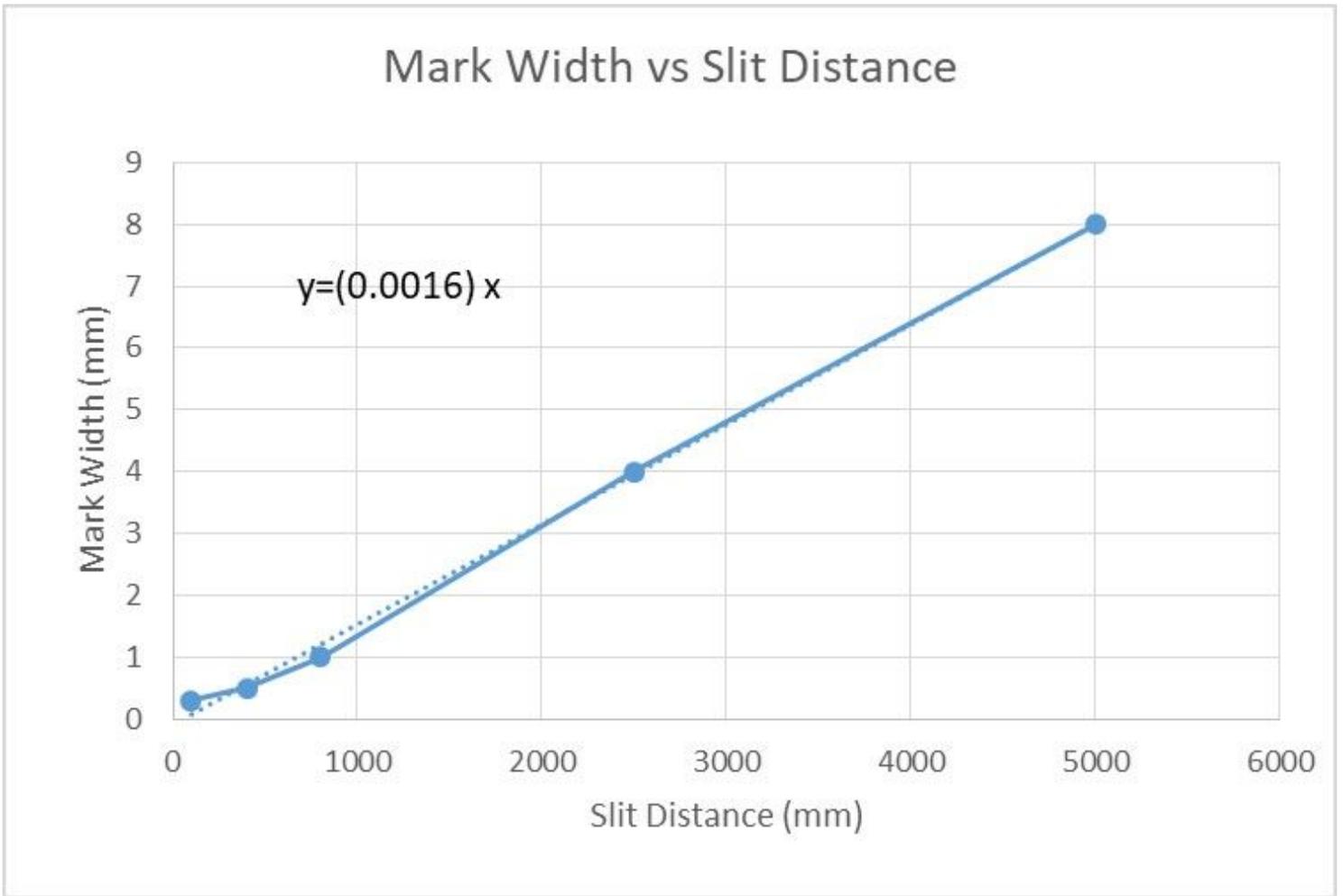
**Figure 3**

Photon strands at 100 (a) and 500 cm (b) from slit



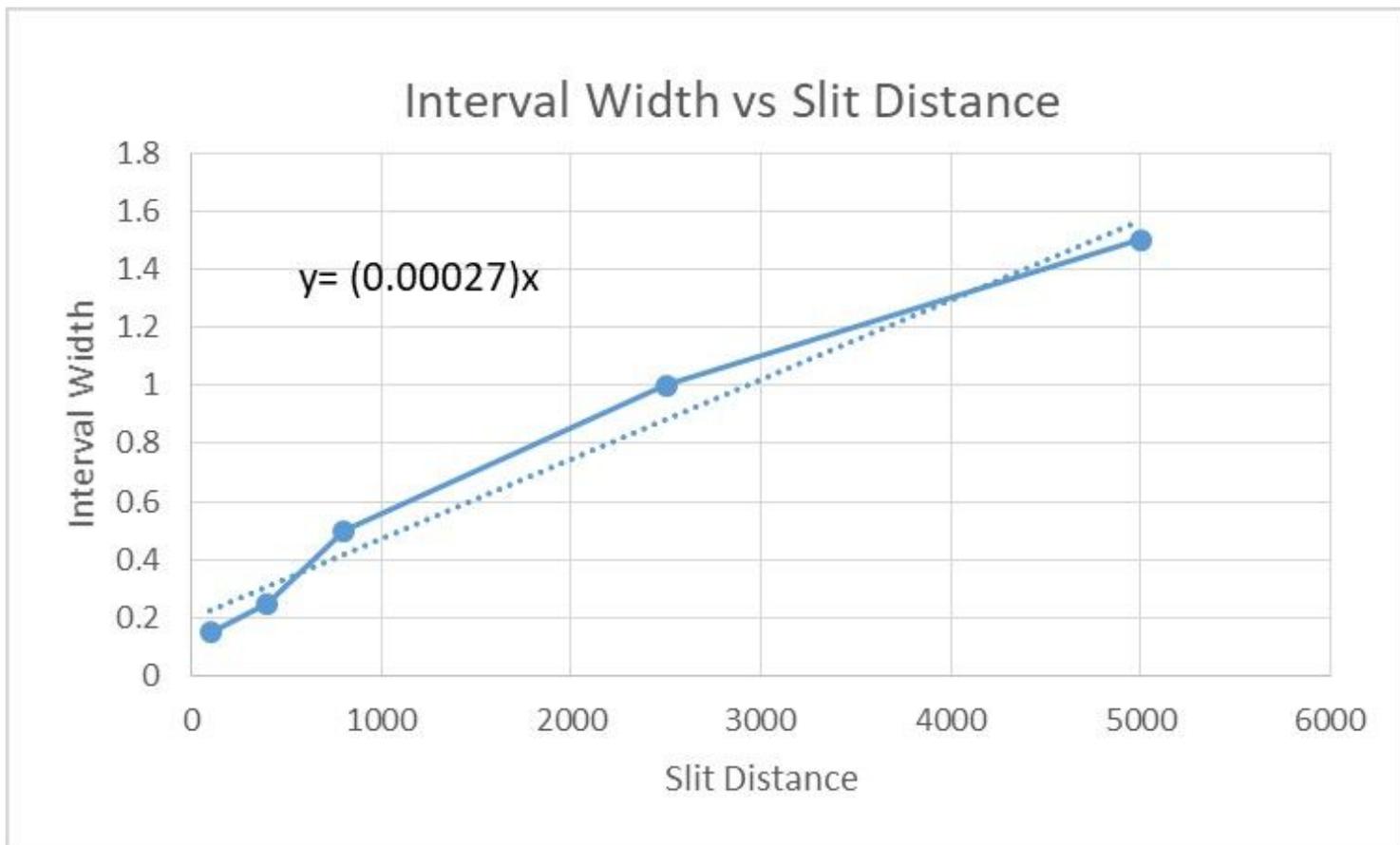
**Figure 4**

Fringe patterns with increasing distance between slit and screen (10cm-40cm-80cm-250cm-500cm)



**Figure 5**

Linear graph of strand mark width vs slit distance



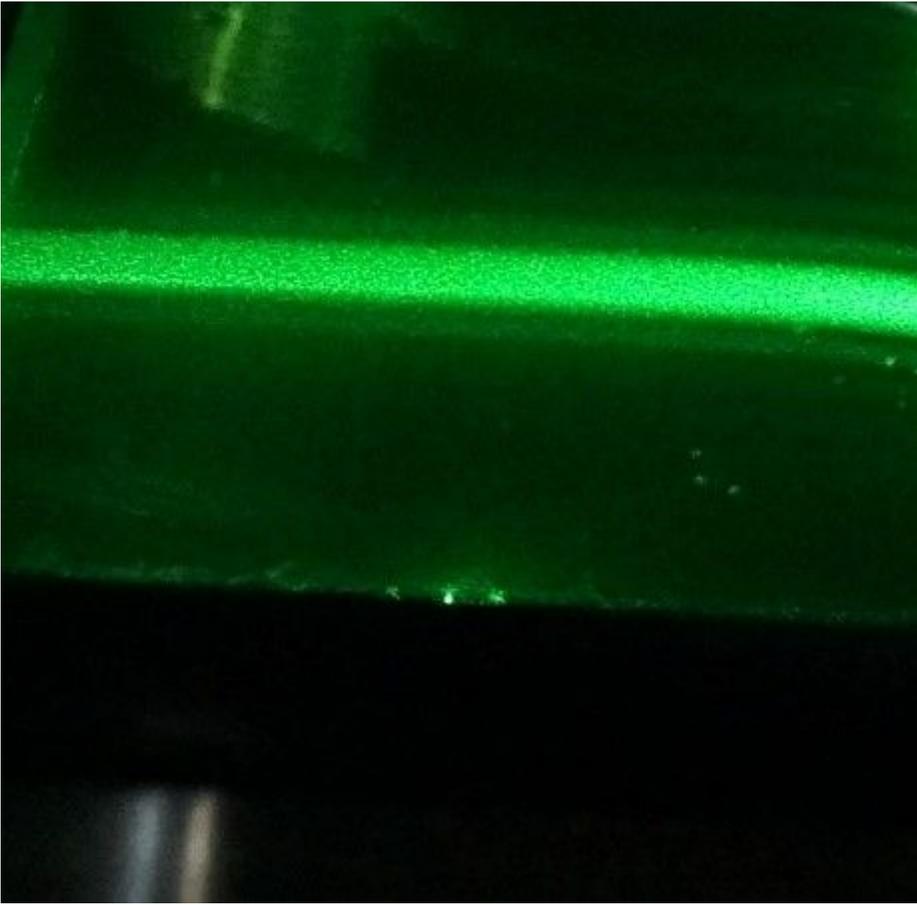
**Figure 6**

Linear graph of clear interval width vs slit distance



**Figure 7**

Light strands reflecting posteriorly before entering double slit creating its own strands and fringe marks



**Figure 8**

Single slit causing characteristic dense central strand with faint peripheral ones



Figure 9

Light strands radiating from pinhole in cylindrical sheaths, creating concentric rings in cross section

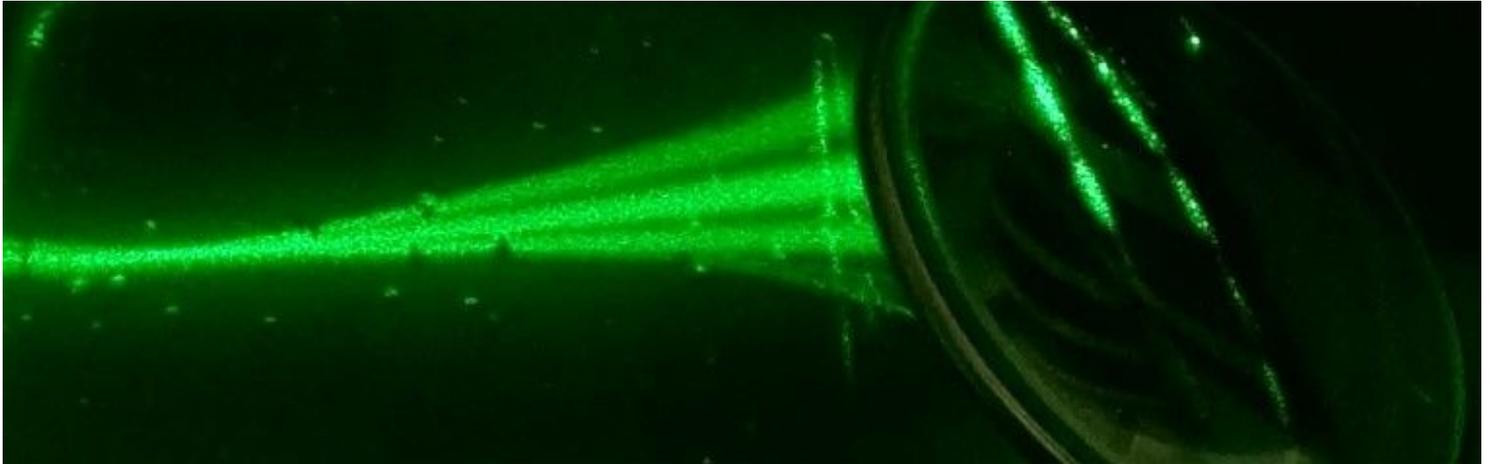


Figure 10

Collapse of fringe pattern upon projection onto 2D lens due to convergence of photon strands

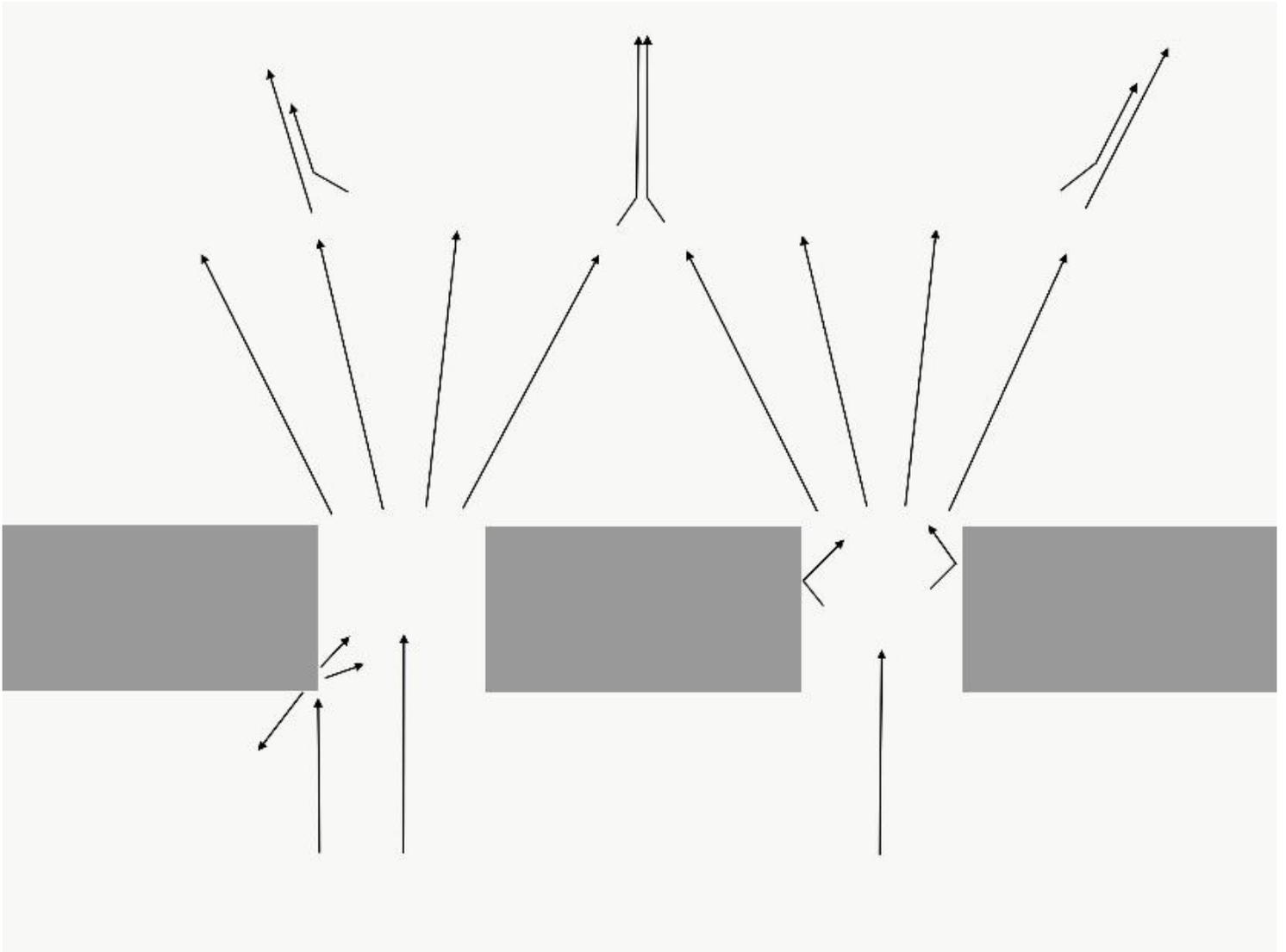


Figure 11

Schematic diagram of photon patterns after slit interaction

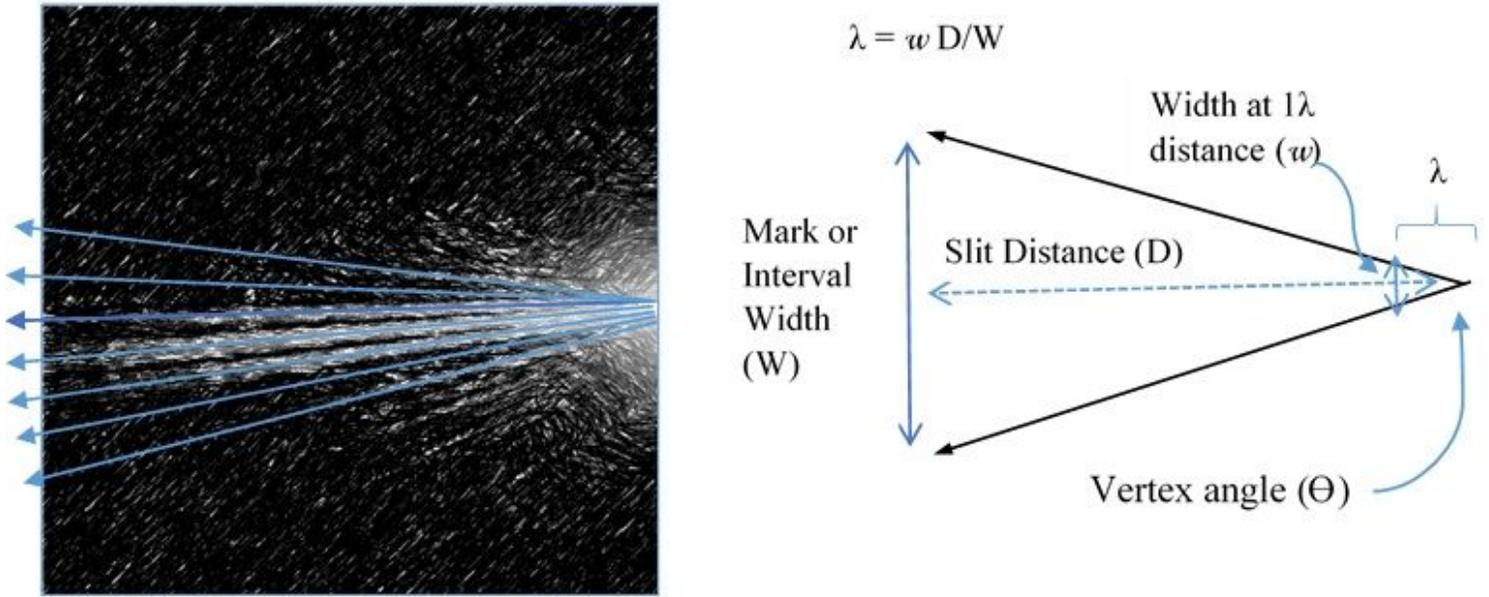


Figure 12

Light strands radiating in regular angles and intervals with geometric representation of a single strand

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Table1.Fringemarkstrandandclearintervalwidththatincreasingslitdistance.jpg](#)