A Discussion on the Quantization of Diffraction Phenomena

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Abstract

In the development of modern physics, the quantum properties of the microcosm have been conclusively verified by important theories and practices such as Planck's blackbody radiation theory, Einstein's photoelectric effect theory, and Compton scattering experiments. However, the current theoretical system used to explain diffraction phenomena is essentially a wave theory that took shape before the birth of quantization theory and relativity. Although the wave theory can effectively explain most diffraction phenomena at the present stage, it is undeniable that the physical processes described by this theory show continuous characteristics, which is in sharp contradiction with the quantized nature of the microcosm. This incompatibility at the level of theoretical foundations means that the wave theory has not accurately touched the physical reality of the microcosm, thus becoming a key obstacle to the construction of a unified theory. This leads to a profound question: Can the stripes formed by diffraction phenomena only be explained by the principle of wave interference? Is there a new interpretive perspective that is more consistent with the quantum properties of the microcosm?

First, wave-wave interference is a continuous process. Regardless of the number of sub-waves, they can only interfere with each other once to form a continuous set of fringes. However, the fringes in single-thin wire diffraction (Figure 1a) are similar to those in the double-slit experiment (Figure 1b), both exhibiting nested patterns. The overall fringes are discontinuous, consisting of multiple sets of parent fringes with nested sub-fringes. This characteristic makes it difficult to explain these phenomena solely through the traditional theory of wave interference.

Secondly, according to the wave theory, diffraction occurs when the size of the obstacle is close to or smaller than the wavelength of light waves, which is thought to more readily give rise to diffraction phenomena (commonly, the wavelength of visible light used in double-slit experiments ranges approximately from 400 to 780 nanometers). When a laser beam illuminates a human hair, diffraction can be observed, yet the diameter of a hair, ranging from about 50,000 to 100,000 nanometers, is far larger than the wavelength of light waves. Moreover, the obstacle used in the Poisson's spot experiment can be even larger. Therefore, the statement that diffraction is more likely to occur when the size of the obstacle is close to or smaller than the wavelength of light waves is not entirely rigorous.

In this paper, I will prove the following point through three experiments designed by myself and theoretical derivations: The fringes generated by diffraction phenomena are

the result of photons bypassing obstacles and distributing regularly on the light screen, rather than being formed by interference.

Experiment 1: Double-Slit Experiment with Dynamically Symmetrically Adjusted Slit Widths

We know that the width of the double slits is inversely proportional to the fringe spacing. When the widths of the left and right slits switch between extremely large and extremely small values, how does the fringe spacing change? To address this question, I designed a double-slit experiment with dynamically symmetrically adjusted slit widths.

The double-slit structure can be disassembled into a left baffle, a right baffle, and a thin wire. A bidirectional screw rod connects the left and right baffles to form a single slit. By turning the bidirectional screw rod, the width of the single slit can be changed. A thin wire is placed at the center of the single slit, splitting it into two symmetric double slits (Figure 2).

Initially, the width of each double-slit is set to 10 mm. At this time, the point light source can only illuminate the thin wire, resulting in single-thin wire diffraction. When the left and right slits are symmetrically narrowed to approximately 0.5 mm, the fringes of single-thin wire diffraction gradually stretch towards both sides, and the spacing between them increases. When the double-slit width is further reduced to 0.1 mm, standard double-slit experiment fringes are formed.

During the experimental process, it was observed that the fringes evolved from the highly bright single-thin wire diffraction fringes at the center, gradually stretching towards both sides to form uniformly bright double-slit experiment fringes. Both the fringes of the double-slit experiment and those of the single-thin wire diffraction are nested patterns. The fringes consist of multiple sets of parent fringes, and each set of parent fringes is composed of multiple sub-fringes. The three central sub-fringes of the double-slit experiment were already formed during the single-thin wire diffraction stage, but at that stage, their spacing was very small and their brightness was very high.

Experiments on Photon Paths

To prove that photons have a definite path when passing through a double-slit, rather than following a probabilistic behavior as proposed by the Copenhagen interpretation, I designed Experiment 2 and Experiment 3.

Experiment 2

Experiment 2 is a modified version of Experiment 1. In this experiment, I retained only one-side baffle and the thin wire of the double-slit setup. The distance between the baffle and the thin wire was set at 10 mm. The point light source illuminated only the thin wire, generating single-thin wire diffraction fringes. Then, the baffle was gradually moved closer to the central thin wire. Similarly, when the distance between them reached approximately 0.5 mm, the single-thin wire diffraction fringes on the side with the baffle began to stretch outward. When the distance between the baffle and the thin wire was about 0.1 mm, the single-thin wire diffraction fringes on the baffle-side were stretched and magnified into fringes identical to those of the double-slit experiment (Figure 3). Meanwhile, the fringes on the side without the baffle showed no significant changes. This experiment demonstrates that the baffle only affects the photons on its adjacent side.

Experiment 3

In Experiment 3, two different-colored transparent films, pink and yellow, were used to cover the two slits of the double-slit setup respectively, with one color for each side. Eventually, alternating bright and dark fringes were formed on the light screen, and the color of the fringes was consistent with that of the transparent film covering the corresponding slit (Figure 4). Evidently, after white light passes through the color-filtering films, only photons with wavelengths corresponding to the films can pass through the slits and form diffraction fringes on the same side.

Understanding of Diffraction Fringes

In Experiment 1, the light source irradiates the center of the double-slit vertically and stably, where the central thin wire is located. A right triangle is formed by connecting the light source, the thin wire, and either the left or right slit; in a right triangle, the hypotenuse is longer than either leg, meaning photons first reach the thin wire, generating single-thin wire diffraction. As the baffles move toward the center, the single-thin wire diffraction fringes gradually stretch and expand outward, eventually forming double-slit experiment fringes. This confirms that both single-thin wire diffraction fringes and double-slit fringes share a nested structure—and that double-slit fringes are, in fact, a locally magnified result of the central region of single-thin wire diffraction fringes. Thus, the focus should be on explaining the formation mechanism of single-thin wire diffraction.

Experiment 2 shows that the baffle only acts on photons near its side, pulling them away from their original positions, while the fringes on the side without the baffle remain largely unchanged.

In Experiment 3, photons passing through the left slit clearly land on the left side of the screen, and those passing through the right slit land on the right side. This directly demonstrates that photons have a definite path when passing through the double-slit and landing on the screen, rather than following a probabilistic distribution.

Based on the above observations, we can make the following theoretical deductions. Diffraction phenomena occur because obstacles disrupt the dynamic equilibrium of photons. According to the theory of relativity, massive objects can bend the spacetime around them. The left and right baffles and the thin wire that constitute the double-slit can distort the surrounding spacetime. The spacetime curvature generated by the sides of the left and right baffles adjacent to the thin wire points towards the two sides of the double-slit, while the curvature generated by the thin wire points towards its own center. These directions are exactly opposite, meaning that the gravitational force of the thin wire acts towards the center of the double-slit, while the gravitational force on the inner sides of the baffles acts towards the two sides of the double-slit (Figure 5).

When the slit width is large, photons reach the thin wire first, and their dynamic equilibrium is disrupted by the thin wire, resulting in single-thin wire diffraction. Photons passing through the curved spacetime created by the thin wire are analogous to a person standing in flowing water. Just as the person's body obstructs the path of the water, reducing its flow velocity and converting kinetic energy into potential energy, creating circular eddies around the body before the water continues to flow forward, I propose that photons behave similarly. When photons encounter the thin wire during their movement, the curved spacetime generated by the thin wire disrupts their dynamic equilibrium. To maintain a net external force of zero, photons perform transverse wave-like motions around the obstacle (Figure 6). Numerous photons, influenced by the curved spacetime created by the same obstacle, form convergent motion paths, creating circular eddies around the thin wire and then bypassing it to reach the area behind（Figure 7）. Since there are no further obstacles to disrupt their motion equilibrium, photons continue to propagate in a straight line, maintaining their positions at the peaks or troughs of these eddies. The regions between the peaks and troughs remain dark because no photons reach these areas, forming dark fringes.

If we assume that the obstruction of the thin wire altering the motion state of photons is equivalent to a physical body altering the flow of water, it becomes easier to understand how photons bypass the thin wire and form diffraction fringes on the screen. The path by which photons bypass the thin wire, whether from the left or right, depends on their point of incidence. As the baffles move towards the center, photons are subjected to a new gravitational force in the opposite direction. This force gradually pulls photons from the inner sub-fringes to the outer ones, level by level (Figure 8). As a result, the bright central sub-fringes observed during the single-thin wire diffraction stage gradually dim, the spacing between sub-fringes increases, and uniformly bright double-slit experiment fringes are formed. Additionally, new sub-fringes appear on the outer sides of each set of parent fringes. Given that the brightness of a light beam depends on the number of photons, this theoretical deduction is in perfect agreement with the experimental observations. This also reasonably explains why in the single-electron double-slit experiment, even when electrons are emitted one by one, alternating light and dark fringes still form on the screen. The reason is that after passing through the double slits, electrons naturally exhibit a regular distribution, rather than the fringes being formed by self-interference.

When photons move through curved spacetime, their energy and trajectory undergo changes. If the energy of a photon is insufficient to enable it to traverse the curved spacetime created by the thin wire—specifically, when the geodesic path is excessively long—diffraction will not occur. Conversely, when the geodesic path is relatively short, the photon retains residual energy after bypassing the thin wire and continues to propagate forward, thereby generating a diffraction phenomenon. Notably, the smaller the obstacle, the shorter the geodesic path becomes. Consequently, the photon retains more residual energy, resulting in a more pronounced diffraction effect.

Diffraction is a multi-stage dispersion phenomenon. Short-wave photons, with their higher frequencies and greater energy, generate turbulence with shorter wavelengths, which are located closer to the inner side of the spectrum and correspond to narrower fringe spacing. In contrast, long-wave photons, characterized by lower frequencies and less energy, produce turbulence with longer wavelengths. These are positioned towards the outer side of the spectrum and are associated with wider fringe spacing. Moreover, the longer the wavelength of the turbulence, the larger the obstacles it can bypass.

Conclusion

The formation of diffraction fringes arises because obstacles disrupt the dynamic equilibrium of photons. A large number of photons, influenced by the curved spacetime created by the same obstacle, follow convergent paths, generating turbulence around the obstacle. After bypassing the obstacle, photons retain excess energy and continue propagating forward while remaining in the peaks or troughs of the turbulence. This results in alternating bright and dark fringes on the screen: bright fringes correspond to regions where photons land (peaks or troughs), while dark fringes occur in the spaces between them, where no photons arrive. Thus, diffraction fringes are the product of photons' regular, spaced distribution on the screen after passing an obstacle—not the result of wave interference.

Notably, double-slit experiment fringes are a locally magnified version of the central region of single-thin wire diffraction fringes. If Experiment 1 were viewed as a short video, the fringes observed at a specific slit width would be merely a single frame within that video.

Commitment

The author pledges that this paper was completed independently by the author alone and is not subject to any form of dispute with others.

Data Availability Statement

The data used and/or analyzed during the current study are included within the article.

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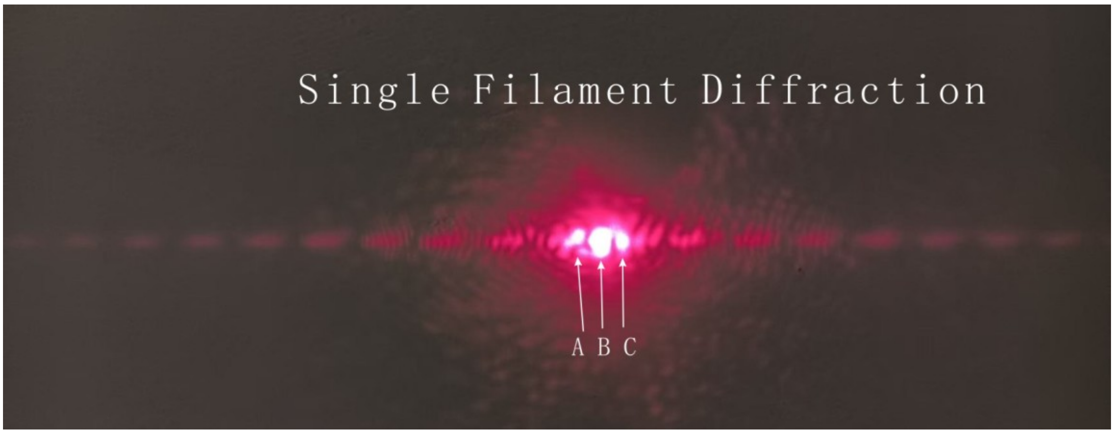
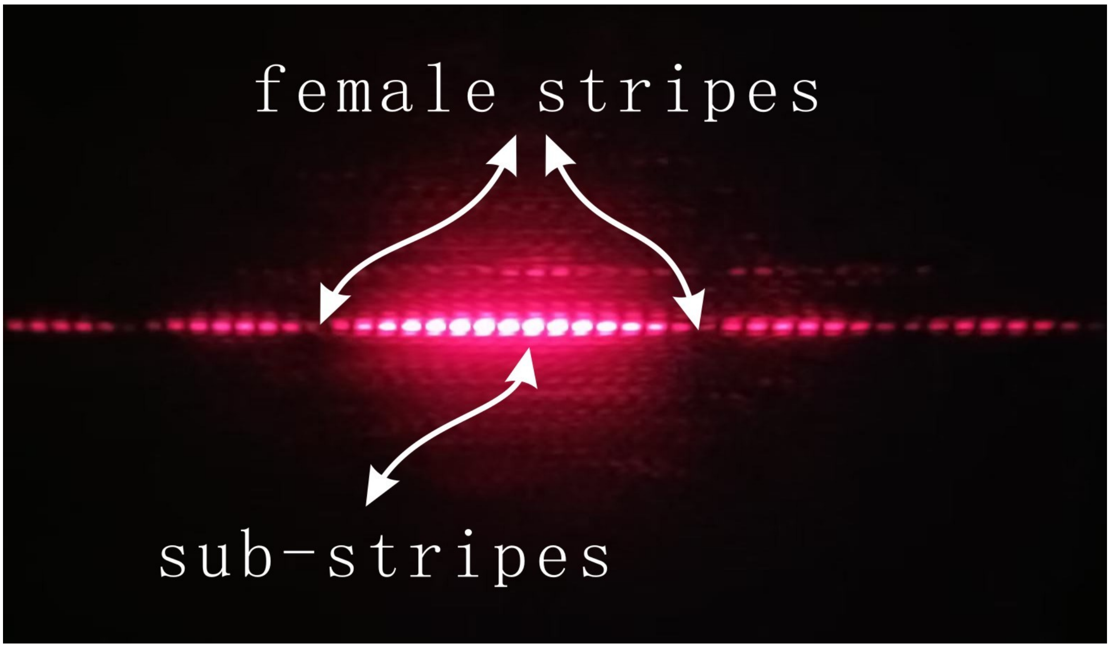


Single Filament Diffraction
a



Double-slit Experiment
b
Figure1

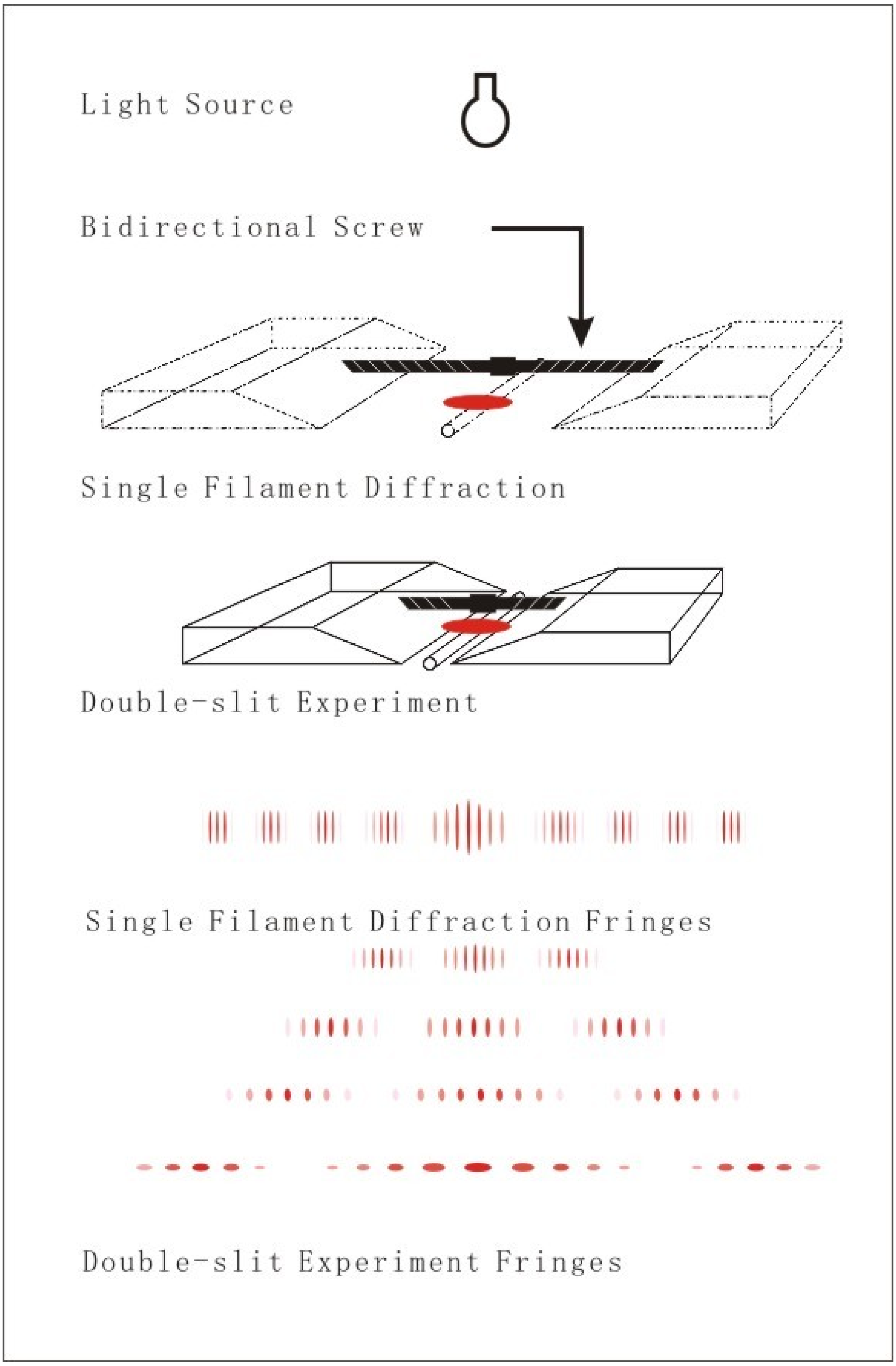
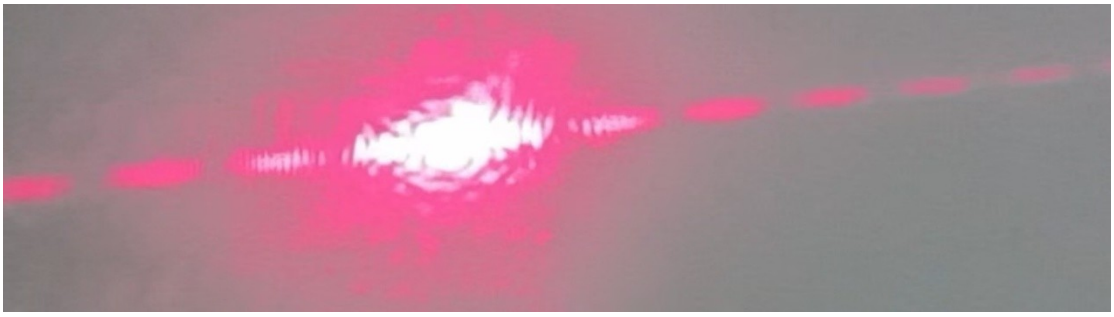
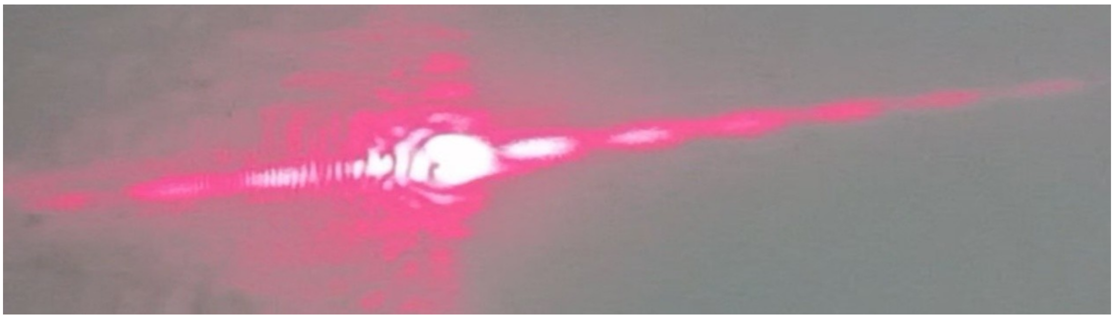

Light Source
Bidirectional Screw
Single Filament Diffraction
Double-slit Experiment
Single Filament Diffraction Fringes
Double-slit Experiment Fringes

Figure2



The fringes appear when the baffle is 10 millimeters away from the filament.



The fringes when the baffle is 0.1 mm away from the filament.

Figure3

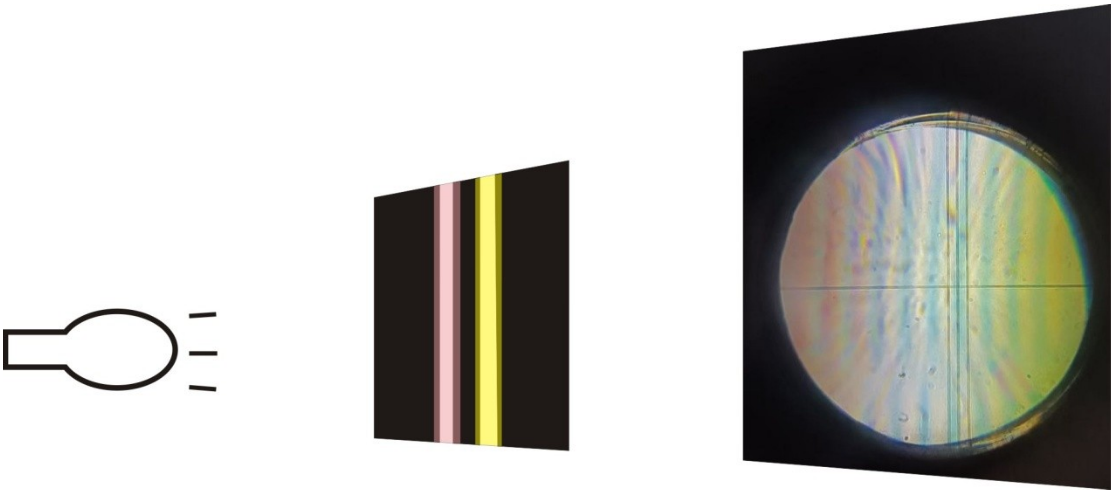


Figure4

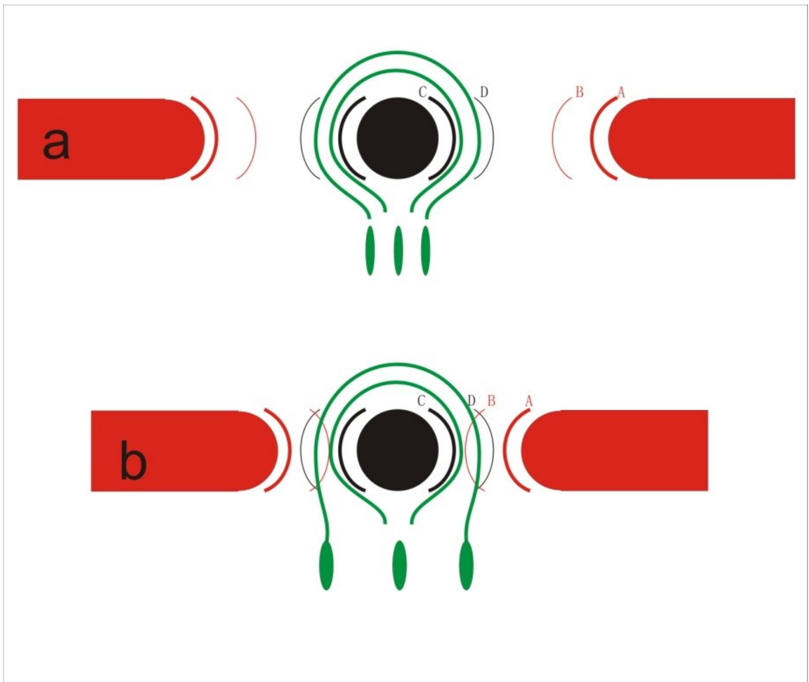
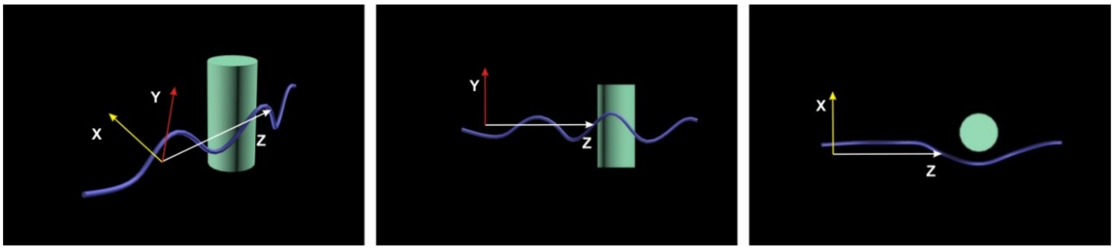


Figure 5



The flowing river forms turbulence, which is affected by the Earth's gravity and its own internal friction in addition to its own kinetic energy. Since photons have no mass, the force for photons to form turbulence comes from their own kinetic energy and the space-time distortion of obstacles. For example, when a photon encounters the space-time distortion generated by an obstacle, it shifts upward from the axis. To keep its resultant external force zero, the photon will shift downward from the axis, and so on, forming turbulence to go around the rear of the obstacle. This offset must be along the edge of the obstacle.

Figure6

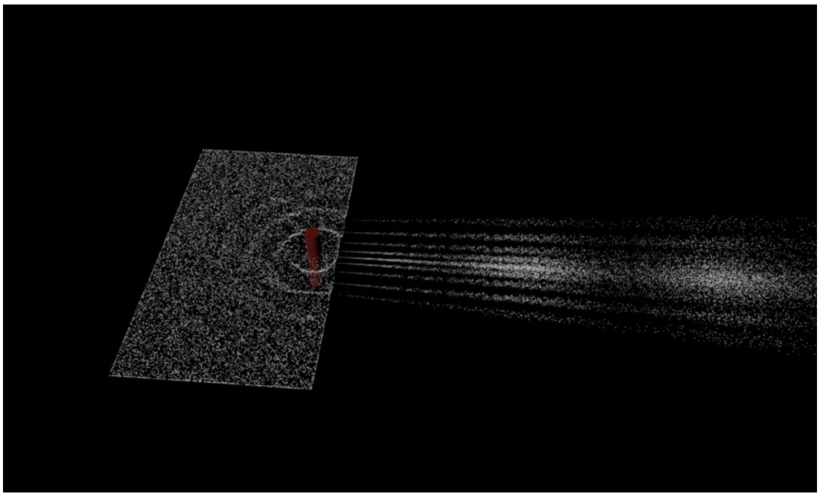


Figure 7

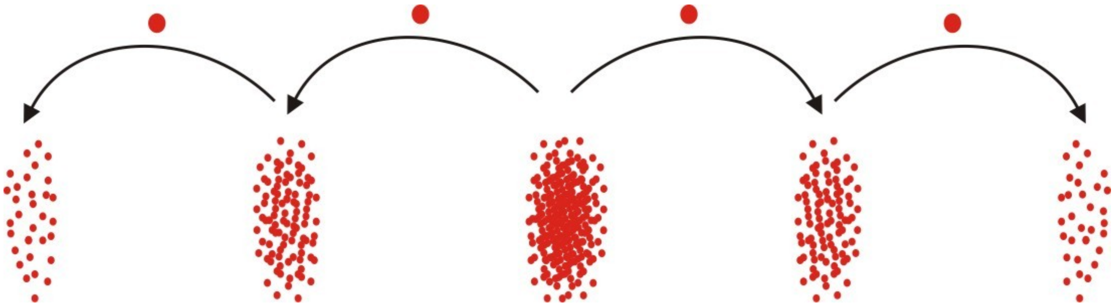


Figure 8