New experiments/phenomena in optics
--- Photoelectric Effect to Photowave Phenomena

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ABSTRACT

The classical interpretation of Young's double slit experiment is that, before and after passing through the diaphragm of the double slit, the light behaves as waves. In 1905, Einstein interpreted Photoelectric effect by photon theory of light that revived, in some sense, particle theory. Feynman called the double slit experiment "the only mystery [of quantum mechanics]. For studying the mystery, we propose for the first time both the photon chamber and Postulates of convex lens, and utilize both to the classical wave experiments. Experiments show new phenomena in the classical wave experiments: (1) the non-interference patterns near the diaphragm and interference patterns near the screen coexist; (2) the non-interference patterns evolve to the interference patterns; (3) the interference patterns and the non-interference patterns are produced independently and partially; (4) the light is not EM waves; (5) the light is photons not only in Photoelectric effect but also in the classical wave experiments, and the photons distribute as waves near the screen and on the screen, we referred the phenomena as Photowaves Phenomena. The experimental results in this article are consistent. New phenomena require a consistent interpretation. Author believes that students would be interested in those DIY experiments. Students, while learning/performing, would propose their owe interpretations.

Keywords: Double slit, cross double slit, grating, non-interference patterns evolve to interference patterns, photon chamber, photon track, convex lens, focal point of lens

1. INTRODUCTION

Historically, the study of the nature of light reached basically two concepts: wave and particle.

(1) Wave concept: In 1690, Christiaan Huygens established the wave theory of light.
(2) Particle concept: In 1704, Newton established particle/corpuscles theory.
(3) Wave concept: In 1801, Young's double slit experiment and Arago experiment revived Huygens' wave theory.
(4) Particle concept: In 1905, Einstein interpreted "Photoelectric effect" as photon/particle phenomenon.
(5) Wave particle duality: In 1927, to coordinate particle concept and wave concept of light, Bohr proposed the complementarity principle that stating that the wave and particle phenomena cannot be observed simultaneously
(6) Feynman's mystery: Until 1950s, wave-particle duality still puzzled physicists. Einstein (1951) wrote to M. Besso: "All these 50 years of conscious brooding have brought me no nearer to the answer to the question: What are light quanta?". Feynman (1956) called the interference pattern of the double slit experiment "a phenomenon […] has in it the heart of quantum mechanics. In reality, it contains the only mystery [of quantum mechanics]."

In this article, we show new experiments/phenomena that the light is photons not only in Photoelectric effect but also in the wave experiments, and the photons distribute as waves near/on the screen, we referred the phenomena as "Photowaves Phenomena". The nature and characteristics of the patterns of the classical wave experiments are distance-dependent. It is a challenge to consistently interpretate the new phenomena.

2. NEW EXPERIMENTS/PHENOMENA IN OPTICS

2.1. New phenomena: Fringes of interference patterns are formed independently and partially[1]

Experiment-1: In the classical double slit experiment, we add blockers, shields and conductive metal tube to show the particle nature of the light in the wave experiments (Figure 1).

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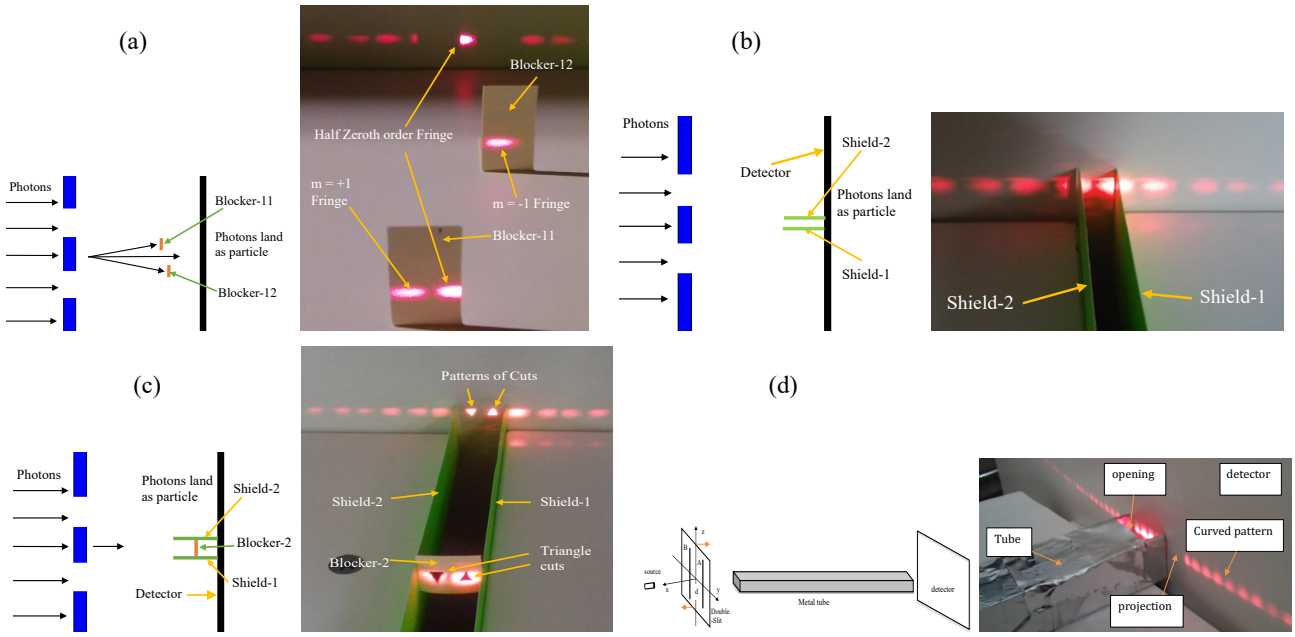

Figure 1 Classical double slit experiment with blockers, shields and conductive tube: the light is photons

Figure 1(a) shows that the portions of the zeroth-order fringe are formed on screen and blocker-11 respectively, which indicates that the fringe can be formed partially. The m = +1 fringe and m = -1 fringe are formed on blocker-11 and blocker-12, respectively, i.e., formed independently. Figure 1(a) would be expected only if the light behaves as photons. Figure 1(b) and 1(c) show that the shields do not affect the patterns, which indicates that the light does not behave as optical waves. Figure 1(d) show that the conductive tube does not affect the patterns, which indicates that the light does not behave as EM waves.

2.2. New phenomena: Photon chamber: light is photons near screen[2] and near diaphragm of double slit[3]

Experiment-2: we introduce Photon Chamber that is a transparent container filled with a mix of water and fine powder.

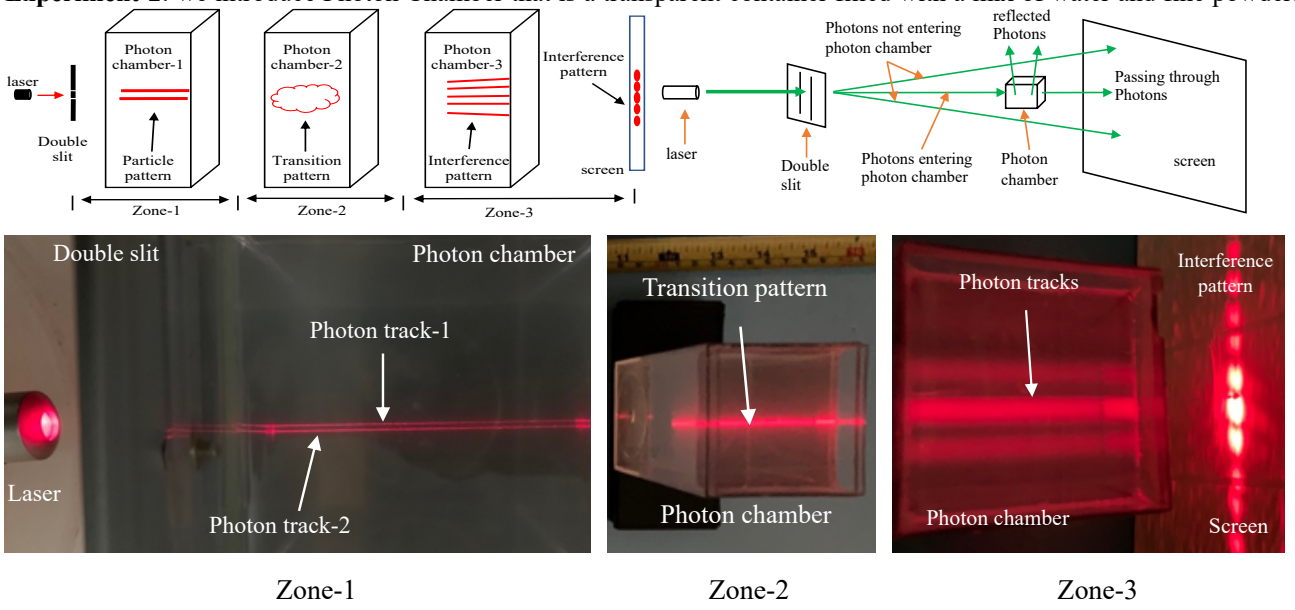

Figure 2 Experiments with Photon Chamber: Particle pattern, Transition pattern and Interference pattern

We divide the space between the screen and the diaphragm of the double slit into three Zones. The photon chamber is moved in three Zones. Figure 2 shows the following: In Zone-1, Zone-2 and Zone-3, the patterns are Particle pattern,

Transition pattern and Interference pattern, respectively. Particle pattern and Transition pattern are non-interference patterns. Particle pattern contains two photon tracks shown in the photon chamber-1, which indicates that up to certain macroscopic distance, the light propagates as photons along the straight-line trajectories, but the trajectories do not distribute as waves. While in Zone-3 the photon tracks show that the light is photons, and the photon tracks distribute as wave. On the screen, we observe the standard interference pattern, which indicates that the light distributes as waves.

2.3. New phenomena: Non-interference Particle patterns in Zone-1 evolving to Interference patterns in Zone-3

For studying the evolution, especially in Zone-2, photon chamber is not suitable. So, we utilize the lens for the first time.

2.3.1. Postulates of Convex Lens[4]

For utilizing a convex lens in the classical wave experiments, we propose Postulates as the precise rules of convex lens:
First Postulate: the convex lens enlarges the input image that arrives at the input surface.
Second Postulate: The convex lens does not change the nature and characteristics of the input pattern.
Third Postulate: The convex lens breaks the evolution of the patterns.

2.3.2. Non-interference patterns evolving to Interference patterns

Based on Postulates, we utilize a convex lens in three Zones to study the evolution of the patterns.

Experiment-3: Evolution of pattern of double slit: patterns are distance dependent

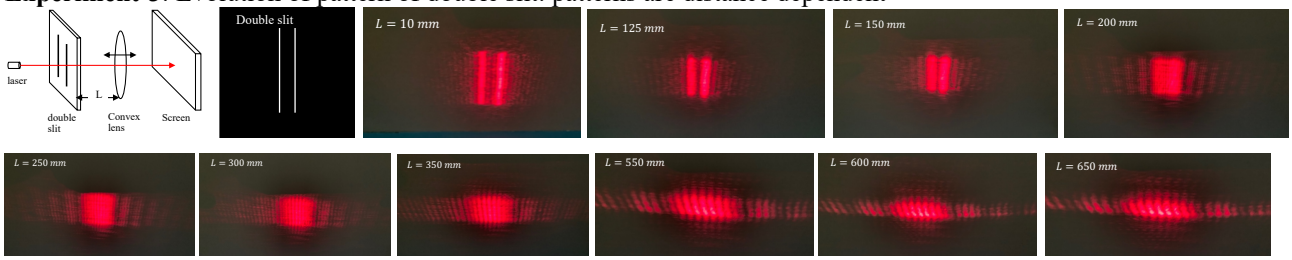

Figure 3 Evolution of patterns of double slit experiment

Experiment-4: Evolution of pattern of cross double slit: patterns are distance dependent

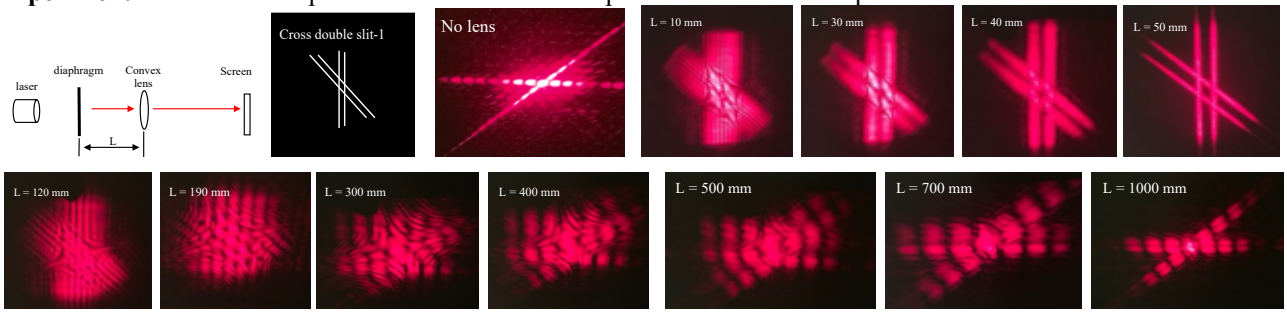

Figure 4 Evolution of patterns of cross double slit experiment

Experiment-5 (Figure 5): Evolution of pattern of disc ring: patterns are distance dependent

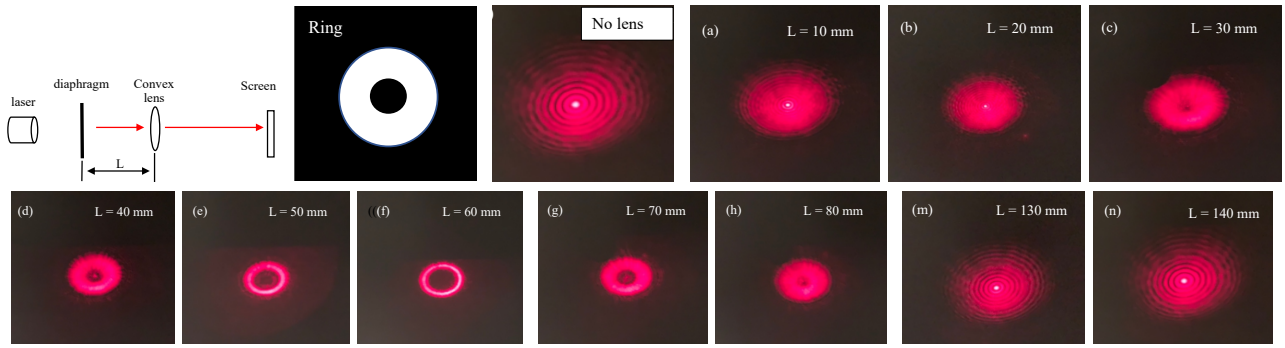

Figure 5 Evolution of patterns of disc ring experiment

Experiment-6 (Figure 6)**: Evolution of patten of 1D grating:**

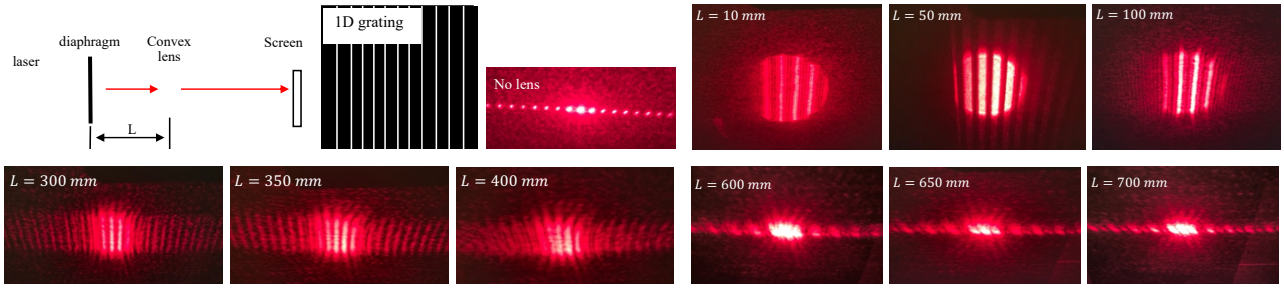

Figure 6 Evolution of patterns of 1D grating experiment

Experiment-7 (Figure 7)**: Evolution of pattern of 2D grating:**

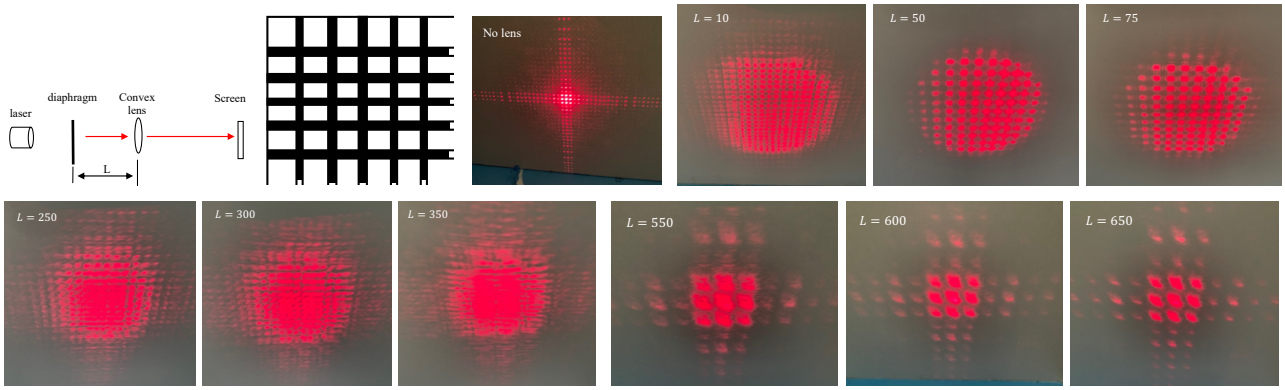

Figure 7 Evolution of patterns of 2D grating experiment

Experiment-3 to -7 show the universal phenomena that in classical wave experiments, Particle patterns evolve to Transition patterns, both are non-interference patterns, and finally evolve to orthogonal interference patterns.

2.4. New phenomena: Co-existence of Non-interference patterns and Interference patterns

Experiment-8 (Figure 8): placing Lens-1, lens-2 and lens-3 in Zone-1/path-1, Zone-2/path-2, and Zone-3/path-3, respectively.

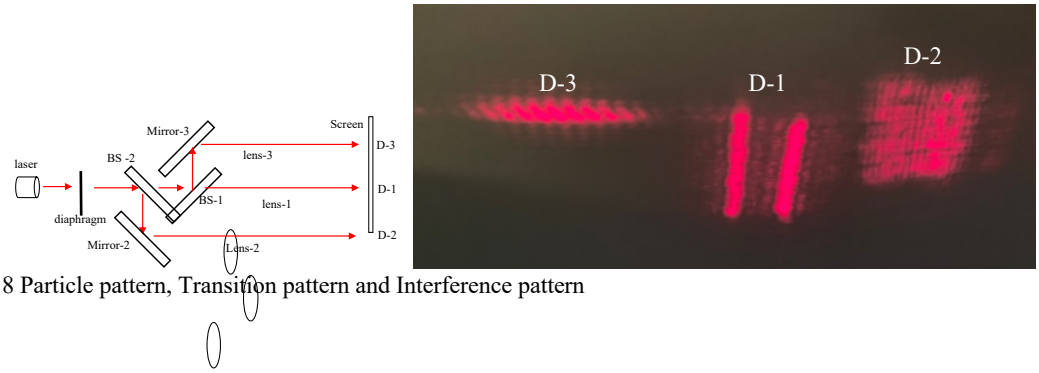

Figure 8 Particle pattern, Transition pattern and Interference pattern

Experiment-8 shows that Particle pattern, Transition pattern (both are the non-interference patterns), and Interference pattern are simultaneously observed at D-1, D-2 and D-3, respectively. Namely, the particle nature and wave distribution of the light coexist in the same double slit experiment, which indicates that the pattern is formed independently.

2.5. New phenomena: the light is not Electromagnetic (EM) waves

Experiment-9 (Figure 9): utilizing the conductive metal-tube to test whether the light is EM waves.

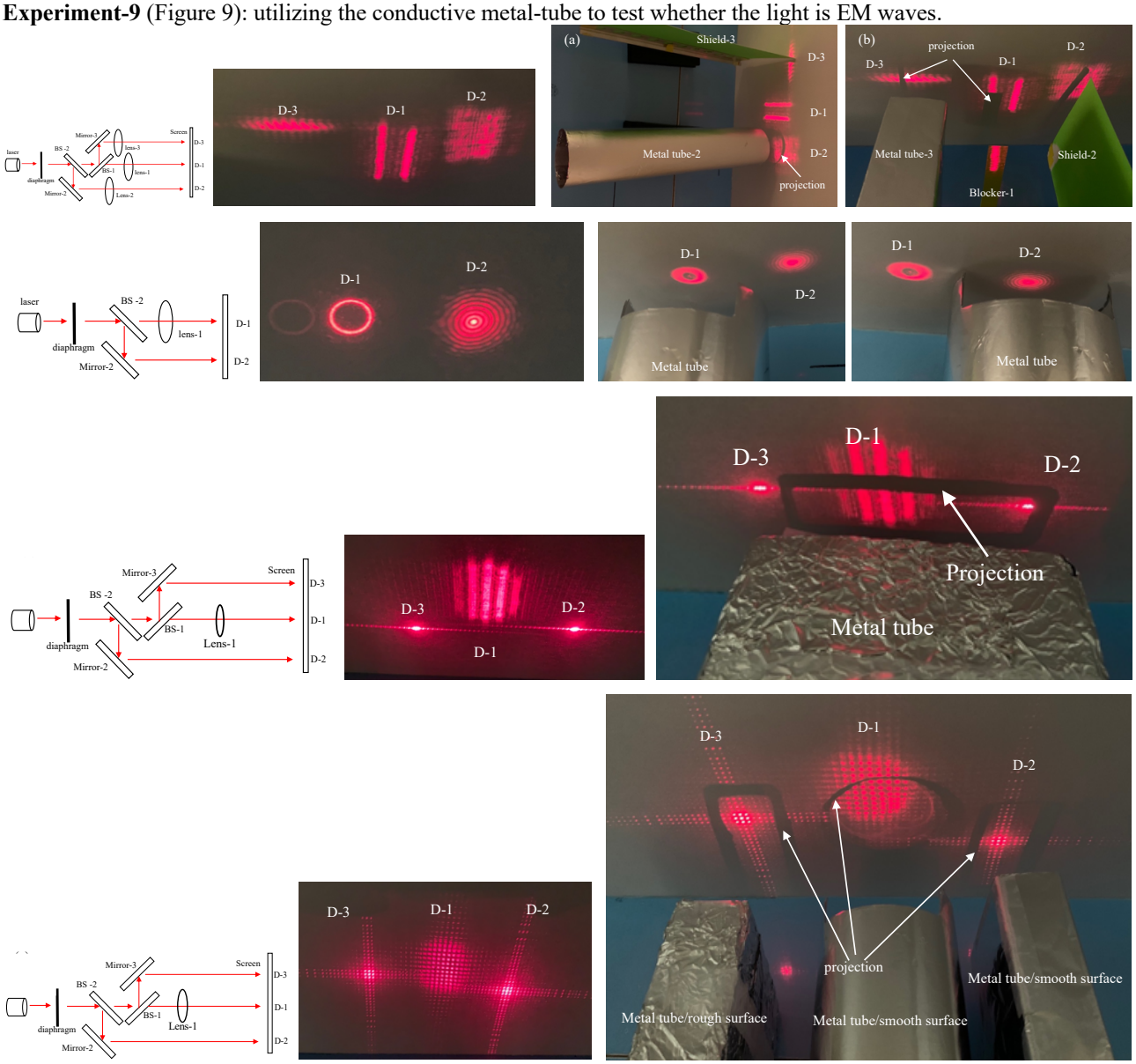

Figure 9 Classical wave experiments with lens, blocker, shield and conductive metal tube

Figure 9 shows that the shield and metal tube do not affect the patterns, which indicates that the light is neither optical wave nor EM waves.

2.6. Focal point of convex lens in wave experiments[5]

We have shown the interference patterns in Zone-3. Now let us place the lens in Zone-3.

Experiment-10 (Figure 10): Placing the lens in Zone-3. Using 100x300 mm photon chamber.

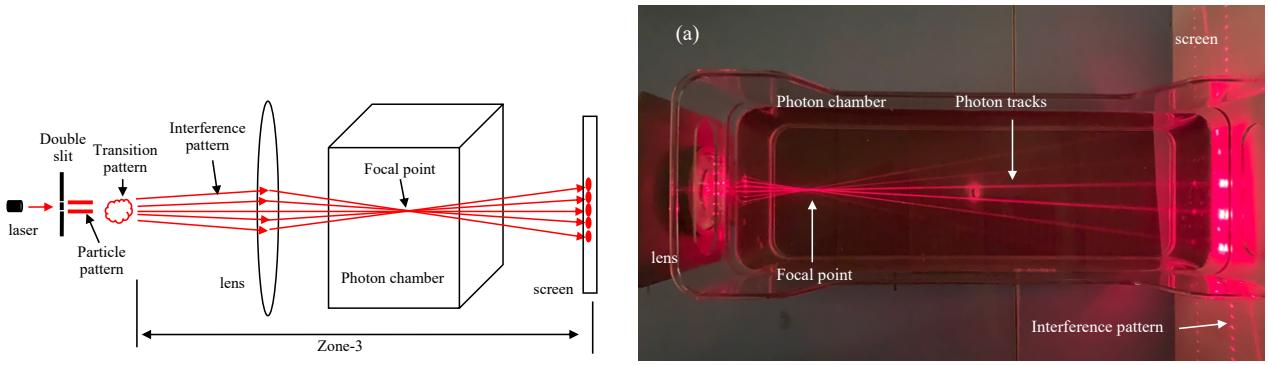

Figure 10 Light beams (Interference pattern) brought to focus by convex lens

Figure 10 shows the focal point in the photon chamber that obeys the geometrical theory of thin lens theory. The pattern at the focal point is neither non-interference pattern nor interference pattern, but is a cross point of photons trajectories.

3. CYLINDRICAL SCREEN

We proposed the cylindrical screen for studying the rotation-angular-dependence of the pattern.

Experiment-11 (Figure 11):

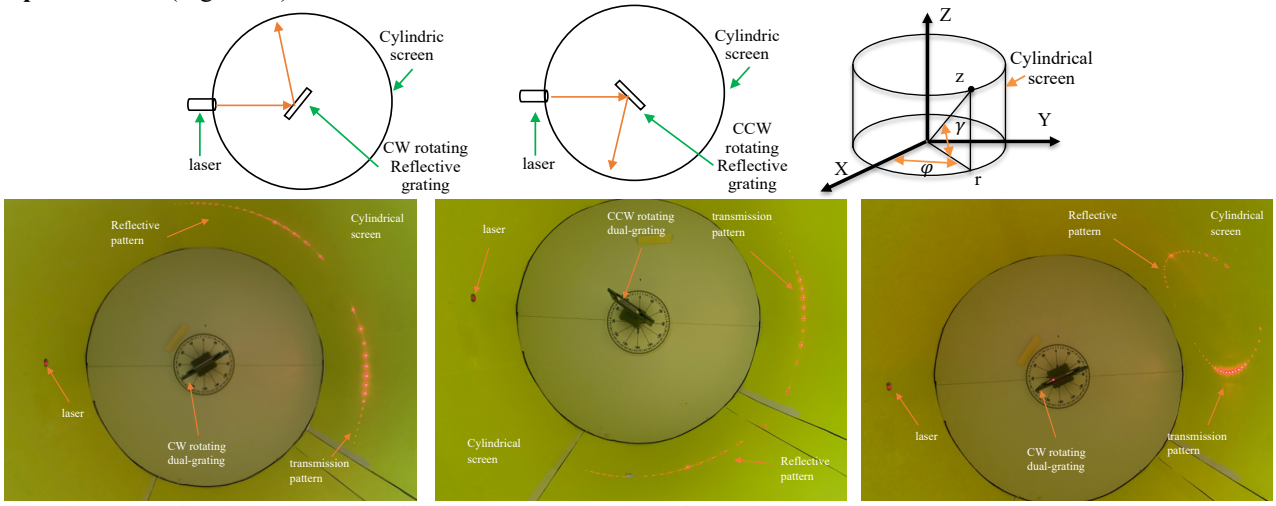

Figure 11 Cylindrical screen for studying rotation-angular-dependence of patterns

When we rotate the diaphragm, the patterns change, namely the phenomena are rotation-angular-dependent. The cylindrical screen can be utilized to study the phenomena.

The new phenomena shown in this article require consistent interpretation.

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