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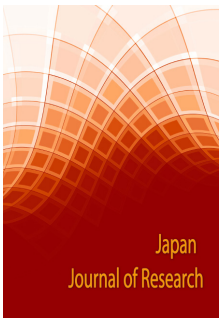

Advance Double Slit Experiments Showing New Mysteries

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Abstract

The normal double slit experiments (we refer to it as Straight-Parallel-double-slit) are basic experiments and Feynman's mystery in the optics/quantum mechanics. In this article, we show the following new mysteries: the characteristics of the interference patterns of the optical slit experiments depend on whether the slits are straight-lines or curve-lines and whether two slits are parallel or non-parallel; and independent on whether there are missing segments at the intersection of, for example, cross-double-slit. We ignore the effects of both the width of the slits and the distance between two slits and then, show the following: there is no variable in Straight-Parallel-double-slit; Straight-Non-Parallel-double-slit has one variable, the angle between two slits; Curve-Parallel-double-slit has one variable, the curvature of the slits; Curve-Non-Parallel-double-slit has two variables, the angle and curvature, and the curvatures of two slits may be either the same or different. The characteristics of patterns depend on those variables. The complete and consistent interpretation is a challenge. The above experiments show deeper mysteries and would motivate further study of optics.

Introduction

The straight single slit (the standard single slit) and straight parallel double slit (the standard double slit) experiments are basic experiments in the optics and physics, and are foundation of the wave-particle duality and quantum theory [1]. In those experiments, the slit of the single slit is straight lines, and the slits of the double-slit is straight lines and parallel to each other. Feynman referred to the double slit experiment as the mystery of the optics/quantum mechanics [2], and Penrose stated that the quantum mechanics is inconsistent theory [3]. Recently, the PhotoWave phenomena were reported [4-8]. To study the mystery further, in this article, we present the experiments of the Curve-single-slit, Cross-Curve-single-slit, Non-Parallel-double slit, Curve-Parallel-double slit, Curve-Non-Parallel-double slit, single-ring and double-ring. We show the following: the characteristics of the interference patterns of the above optics slit experiments depend on both whether the slits are straight-lines or curve-lines and whether slits are parallel or non-parallel; and independent on whether there are missing segments at the intersection of, for example, cross-double-slit. The Straight-Parallel-double-slit has no variable (in this article, we assume that the wavelength, the width of the slits, and the distance between the two slits are constant); the Straight-Non-Parallel-double-slit has one variable, the angle between two slits; the Curve-Parallel-double-slit has one variable, the curvature; the Curve-Non-Parallel-double-slit has two variables, the angle and curvature. Those new experiments show that the slight differences in the slits produce the significant differences in the patterns and the pattern evolutions. We referrer to the phenomena as the Optics-Butterfly-phenomena.

Regular and Irregular Slit Experiments

Experimental Setup

All of experiments in this article utilize the same Experimental setup (Figure 1):

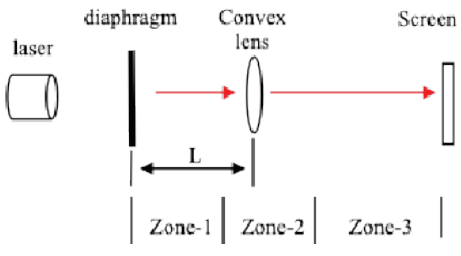

Figure 1. *Experimental setup: lens placed at different positions between diaphragm and Screen*

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Note:

1. All of experiments in this article utilize the experimental setup of Figure 1.
2. The diaphragm represents the slits of different configuration, such as double slit, single slit, curve double slit, curve single slit, non-parallel-double slit, and curve-non-parallel-double slit, etc.
3. The lens does not change the input pattern, namely, the output pattern is the same as the input pattern.
4. A lens can be placed in Zone-1 (observe Particle pattern on Screen), Zone-2 (observe Transition pattern on Screen), and Zone-3 (observe Interference pattern on Screen), respectively.

Straight-Single-Slit vs. Curve-Single-Slit.

The straight-single-slit has no variable. The Curve-single-slit has one variable, i.e., the radian (rad) (Figure 2).

Figure 2. *Curve-single-slit with different radians*

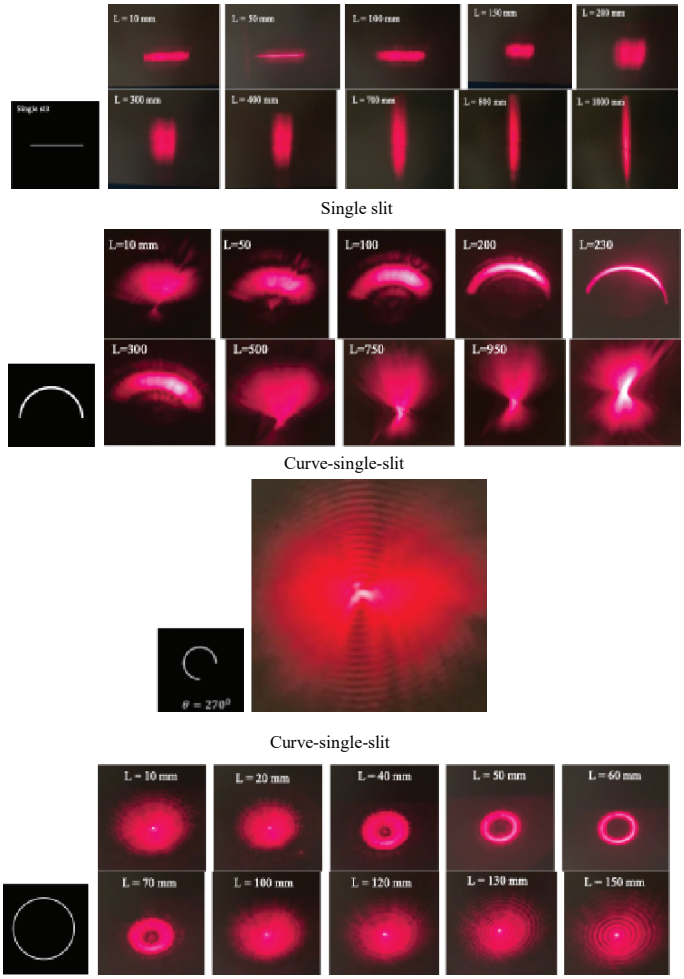


Figure 3. *Straight single slit and curve single slits*

In this article, we assume that the radiuses of curves are constant and show: (1) the patterns and the pattern evolution of a straight-single-slit; and (2) the pattern evolution and the radian-dependence of the patterns of the curve-single-slits.

Experiment-1: Pattern and pattern evolution of a straight-single-slit and curve-single-slits (Figure 3).

Figure 3 shows the patterns and the pattern evolutions of both the straight single slit and the curve single slits.

The patterns are profoundly different: the pattern of a straight single slit is one dimension, while the patterns of the curve-single-slits are two dimensions. The patterns are curvature dependent.

Cross-Straight-Single-Slit vs Cross-Curve-Single-Slit

Next, let us compare a cross-straight-single-slit and a cross-curve-single-slit.

Experiment-2 (Figure 4). Pattern and pattern evolution of a cross-straight-single-slit and cross-curve-single-slit.

Figure 4 shows the cross-straight-single-slit and cross-curve-single-slit

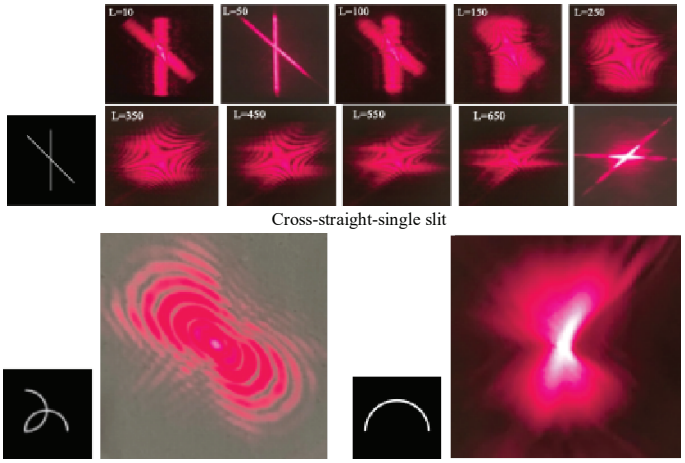


Figure 4. *Curve-single-slit and cross-curve-single-slit*

Figure 4 shows the following: the pattern of the cross-curve-single-slit is an interference pattern, and complicate than both the patterns of the cross-straight-single-slit, and the patterns of the curve-single-slit. Three patterns are completely different.

Straight-Parallel-Double-Slit vs. Curve-Parallel-Double-Slit

Let us consider the patterns and pattern evolutions of both Straight-parallel-double slit and Curve-Parallel-Double-Slit (Figure 5)

Figure 5. *Curve-parallel-double-slits with different curvatures.*

Figure 2. *Curve-single-slit with different radians*

Experiment-3: Straight-parallel-double slit experiment and Curve-parallel-double-slit Experiments (Figure 6)

Figure 6 shows the comparison of Pattern and pattern-evolution of both Straight-parallel-double slit and Curve-parallel-double-slit.

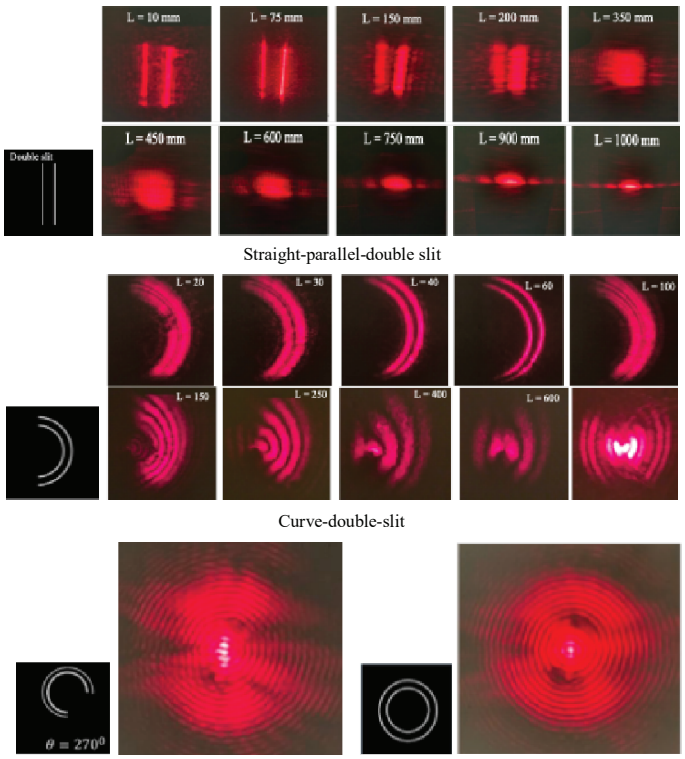


Figure 6. *Straight-parallel-double slit and Curve-parallel-double-slit*

Figure 6 shows the following: the patterns and the pattern evolutions of both the straight double slit and the curve double slits. The patterns are profoundly different: the pattern of a straight double slit is one dimension, while the patterns of the curve-double-slits are two dimensions. The patterns are radian-dependent.

Cross-Straight-Parallel-Double-Slit vs Cross-Curve-Parallel-Double-Slit

Experiment-4 (Figure 7): The patterns of cross-straight-parallel-double-slits and curve-parallel-double-slits.

Figure 7 shows that the patterns of cross-cross-straight-double-slits and of cross-curve-double-slits are profoundly different.

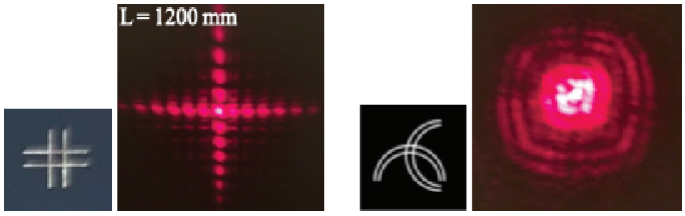


Figure 7. *Patterns of cross-straight-double-slits and of cross-curve-double-slits.*

Straight-Parallel-Double-Slit vs. Straight-Non-Parallel-Double-Slit

Experiment-5 (Figure 8 and Figure 9): The patterns of non-parallel-double-slits are angle-dependent.

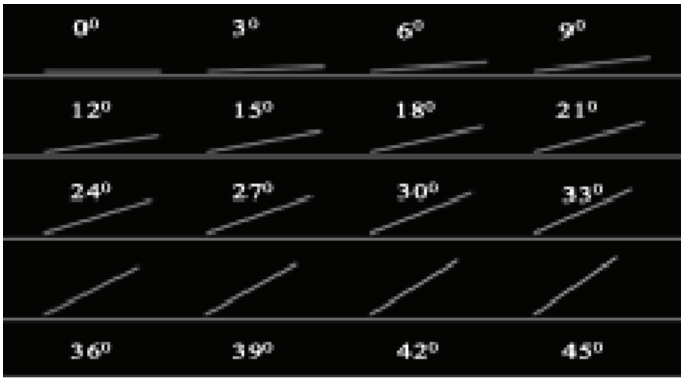


Figure 8. *No-parallel-double-slits with different angles*

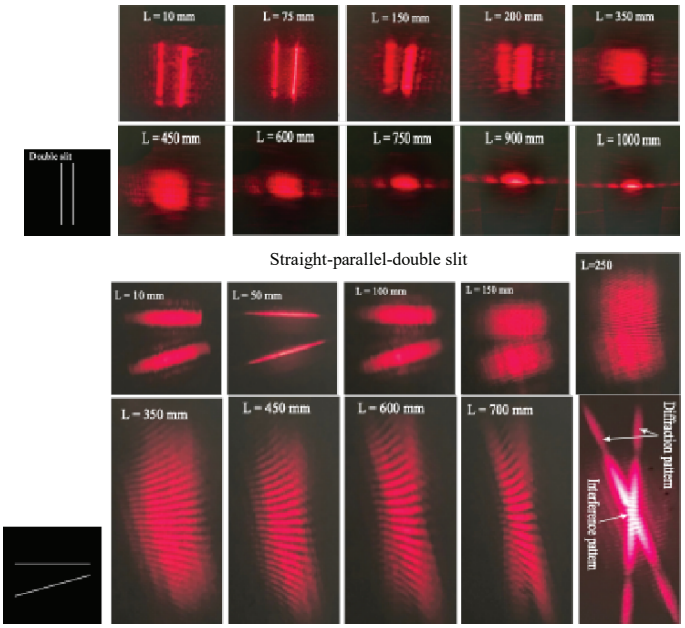


Figure 9. *Comparison of patterns of non-parallel-double-slits and parallel-double-slit*

For clear comparison, we still show the straight-parallel-double slit first in Figure 9.

Figure 9 shows the patterns and the pattern evolutions of both the straight-parallel-double slit and the straight-non-parallel-double slit. The patterns are profoundly different: the pattern of a straight double slit is one dimension, while the patterns of the straight-non-parallel-double slit are two dimensions, referred to it as Hybrid-interference-pattern, which is angle dependent.

Straight-Parallel-Double-Slit vs. Curve-Non-Parallel-Double-Slit

Experiment-6 (Figure 10 and Figure 11): The patterns of the curve-non-parallel-double-slits are angle-dependent.

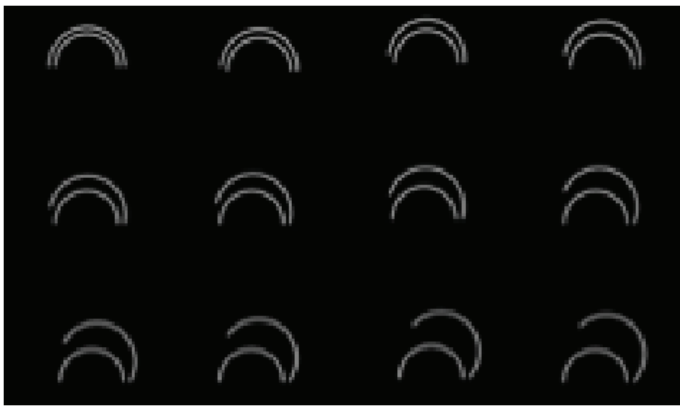


Figure 10. *Curve-non-parallel-double-slits with different angles*

Figure 10 shows the curve-non-parallel-double-slits with different angles. Here we only show the curve-slits with the same curvature.

For clear comparison, we still show the straight-parallel-double slit in Figure 11.

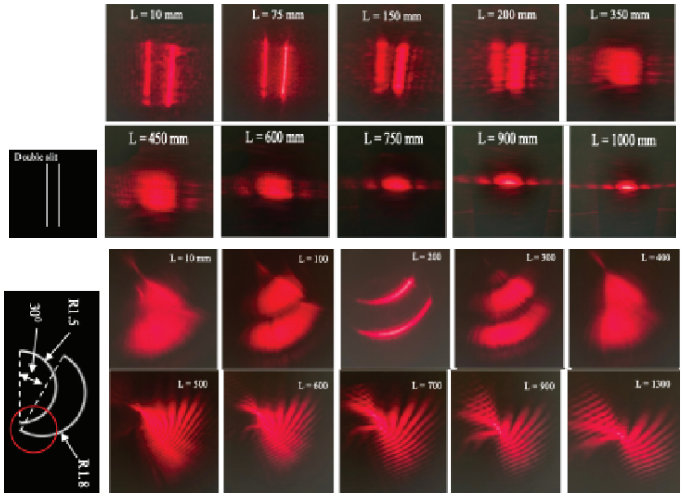


Figure 11. *Comparison of patterns of curve-non-parallel-double-slits and straight-parallel-double-slit.*

The patterns are profoundly different: the pattern of a straight-parallel-double slit is one dimension, while the patterns of the curve-non-parallel-double slit are two dimensions, referred to it as Butterfly-interference-pattern, which is angle dependent. The Butterfly-interference-patterns are also dependent on the curvatures, which is not shown in this article.

3. Missing Segments of Each Slit Do Not Affect Final Interference Patterns at Far-Detector.

In this Section, utilize the fact that each slit of the cross-straight-parallel-double slit (a straight-parallel-double slit crossing another straight-parallel-double slit) is divided into three segments by other two slits crossing.

We experimentally show the function of each segment of each slit in producing both non-interference patterns (including Pre-Particle patterns, Particle patterns and Transition Patterns) and the Interference patterns by eliminate the segment respectively. Then, we compare with the patterns of the standard cross-double-slit experiment.

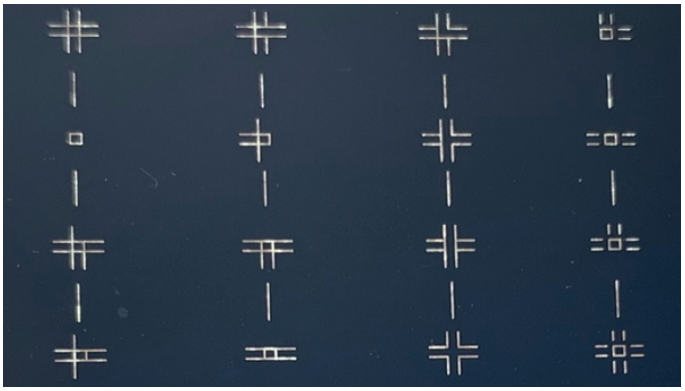
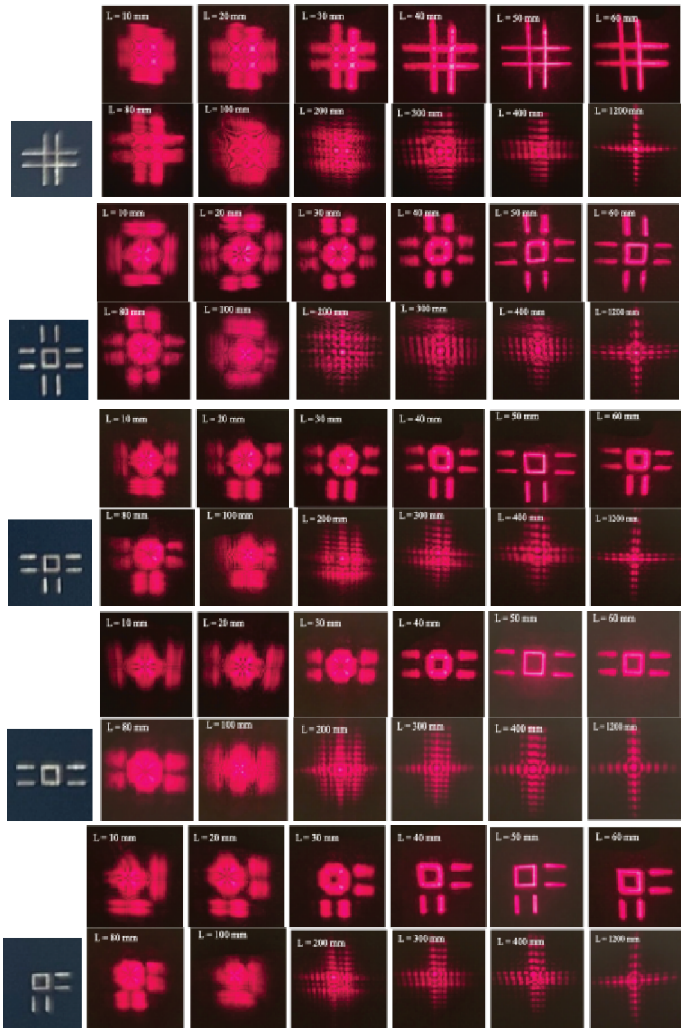


Figure 12. *Cross-straight-parallel-double slit with missing segments*

Figure 13 shows the Function of each segment of a cross-double slit in producing patterns and pattern-evolutions

Figure 13 shows that although the non-interference patterns of the different modified cross-double-slits are different, for example, by placing the lens between $L = 10$ mm and $L = 400$ mm, the final interference patterns are surprisingly similar, at $L \geq 1200$ mm. This phenomenon is a new mystery and needs a consistent theoretical interpretation.



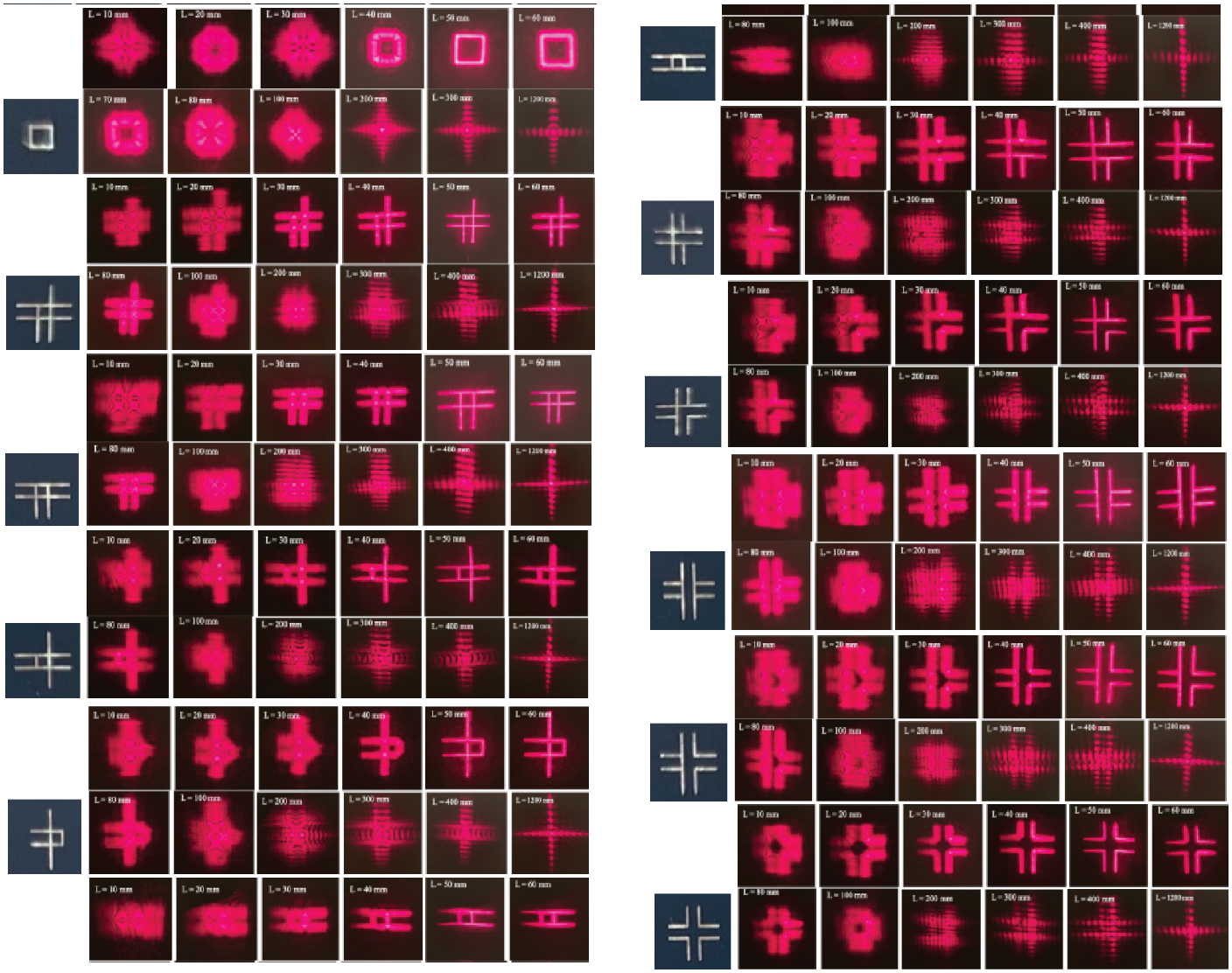


Figure 13: *Patterns and Pattern Evolutions of cross-double-slits with missing segments*

Summary and conclusion

Experiments in this article show the following:

1. A curve-slit, including curve-single-slit, curve-parallel-double-slit, and curve-non-parallel-double-slit produces significantly different 2D patterns and completely different pattern evolutions.
2. A straight-non-parallel-double-slit produces a 2D Hybrid-interference pattern.
3. Missing segments of each slit of a double slit do not affect the final interference pattern.
4. A complete and consistent interpretation of above experiments is needed.

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