Arc-Interference Pattern and Point-Symmetry Interference Pattern of Curved-Double Slit

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Abstract:
The interference and the diffraction are two basic phenomena in physical optics. It has been shown that: in the experiment of a double slit, the patterns depend on the shape of the double slit, e.g., a non-parallel double slit produces the hybrid pattern, the interference pattern embedded in the diffraction pattern; a curved double slit produces Point-Symmetry-Interference-Patterns. In Section 2, we show the pattern evolution of a curved-double slit experiment: near the curved double slit, the pattern is Pre-Particle pattern (at L = 10 mm), then evolve sequentially to Particle pattern (at L = 60 mm), to Transition pattern-1 (at L = 130 mm), to Arc-interference-pattern (at L = 200 mm), to Transition pattern-2 (at L = 400 mm), and finally, to Point-Symmetry-interference-pattern (at L = 900 mm) which has the point symmetry.

We interpret Arc-interference-pattern (at L = 200 mm) in Section 4, and show the curvature-dependence of Point-symmetry interference patterns in Section 3. It is challenge to interpret Point-Symmetry-interference-pattern and to interpret pattern evolution.

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1. Introduction

The interference and the diffraction are two basic phenomena in physical optics. It has been shown that, in the double slit experiments, the patterns depend on the characteristic of the double slit \([1,2]\), i.e., the double slits with different characteristics produce remarkable different patterns (Figure 1):

![Double slit and pattern](image1)

Top of Figure 1 shows the standard Interference pattern of the standard parallel double slit; Bottom of Figure 1 shows the Hybrid pattern of the non-parallel double slit.

In this article, we show the pattern evolution of the curved double slit: near the curved double slit, the pattern is Pre-Particle pattern, then evolve sequentially to Particle pattern, to Transition pattern-1, to Arc-interference-pattern, to Transition pattern-2, and finally, to Point-Symmetry-interference-patterns of point-symmetry.

2. Experiments: pattern evolution of curved-double slit

Experiment-1: curved double slit and its pattern

Experimental setup (Figure 2):

![Experimental setup](image2)

Utilizing Experimental setup of Figure 2.

Observation: We observe the Point-symmetry interference pattern (Figure 3).
We have shown that the patterns of both the parallel-double slit and the non-parallel double slit depend the distance from the double slit, i.e., the patterns are evolving with distance. To study the evolution of the patterns of the curved double slit, we use the Experimental setup with lens (Figure 4).

**Experiment-2: pattern evolution of curved-double slit**

**Experimental setup:**
The lens is placed at different positions “L” (mm) between the diaphragm of the curved double slit and the screen, and the light patterns arriving at the input surface of the lens are different.

With the lens, the patterns shown on the screen are the cross-sectional views of the patterns at the lens.

To utilize the convex lens to study the evolution of patterns, Postulates of convex lens were proposed and experimentally confirmed [3].
Figure 5. Pattern Evolution of curved double slit

Figure 5 shows the patterns of the curved double slit when the lens placed at different ‘L’.

**Observation:** we observe for the first time the following pattern and its evolution:

1) \( L = 10 - 30 \text{ mm} \), Pre-particle pattern;
2) \( L = 40 - 90 \text{ mm} \), Particle pattern;
3) \( L = 100 - 140 \text{ mm} \), Transition pattern-1;
4) \( L = 150 - 300 \text{ mm} \), Arc-interference-pattern, or One-curved-interference-patterns with Arc-shape;
5) \( L = 350 - 600 \text{ mm} \), Transition pattern-2;
6) \( \geq 700 \text{ mm} \), Point-Symmetry-interference-pattern, or Two-curved-interference-patterns with Point-symmetry
**Note:** (1) the evolution gradually takes place, there is no clear cut:

- between Pre-Particle patterns and Particle patterns,
- between Particle patterns and Transition patterns-1,
- between Transition patterns-1 and Arc-interference-patterns,
- between Arc-interference-patterns and Transition patterns-2, and
- between Transition patterns-2 and Point-Symmetry-interference-patterns.

3. **Experiments: curvature-dependence of Point-symmetry interference patterns of curved-double slit**

   Figure 6 is the diaphragm of the curved-double slits with different curvatures.

   ![Curved Double Slit Diaphragm](image)

   Figure 6. Variety of curved double slit

**Experimental setup:** as shown in Figure 2.

Next, we show experimentally the curvature dependence of Point-symmetry interference patterns.
Observation: Figure 7 shows the curvature-dependence of Point-symmetry interference pattern of the curved double slit experiments. 

Note: the pattern evolution of each curved-double slit of Figure 6 is similar to that of Figure 5.

4. Interpretation of Arc-interference-pattern

Imaging dividing the curved-double slit into number of segments, such that, each segment can be considered as a parallel double slit and produces a standard interference pattern (Figure 8).

Note: the curved double slit in Figure 8 is for showing the relative position of each interference pattern. Challenge is to interpret the Point-symmetry interference pattern (Figure 3) and the pattern evolution.

5. Comparison of parallel double slit, non-parallel double slit and curved double slit

Table compares the pattern evolutions of the Curved Double Slit, Parallel double slit and Non-parallel double slit. Table. Pattern evolution of Curved Double Slit, Parallel-double slit and Non-parallel double slit

<table>
<thead>
<tr>
<th>L: mm</th>
<th>Curved double slit</th>
<th>Parallel double slit</th>
<th>Non-parallel double slit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="image" alt="Curved double slit" /></td>
<td><img src="image" alt="Parallel double slit" /></td>
<td><img src="image" alt="Non-parallel double slit" /></td>
</tr>
<tr>
<td>Distance (mm)</td>
<td>Normal pattern without lens</td>
<td>Interference pattern</td>
<td>Diffraction pattern</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------------------</td>
<td>----------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>0* (No Lens)</td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
<tr>
<td>10</td>
<td>L = 10 mm</td>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
</tr>
<tr>
<td>50</td>
<td>L = 50 mm</td>
<td><img src="image6.png" alt="Image" /></td>
<td><img src="image7.png" alt="Image" /></td>
</tr>
<tr>
<td>70/75 /80</td>
<td>L = 75 mm</td>
<td><img src="image8.png" alt="Image" /></td>
<td><img src="image9.png" alt="Image" /></td>
</tr>
<tr>
<td>100</td>
<td>L = 100 mm</td>
<td><img src="image10.png" alt="Image" /></td>
<td><img src="image11.png" alt="Image" /></td>
</tr>
<tr>
<td>150</td>
<td>L = 150 mm</td>
<td><img src="image12.png" alt="Image" /></td>
<td><img src="image13.png" alt="Image" /></td>
</tr>
</tbody>
</table>
0* indicates the pattern without a lens.

Table shows the remarkable differences between the patterns of double slits with the different characteristics.

6. Conclusion
In this article, we show, in the same curved-double slit experiment, the following:

(1) Pattern evolution.
(2) Arc-interference-pattern (at \(L = 200\) mm of Figure 5).
(3) Point-Symmetry-interference-pattern (at \(L \geq 900\) mm of Figure 5, and Figure 7).
(4) Interpretation of Arc-interference-pattern (Figure 8).
(5) Curvature-dependence of Point-symmetry interference patterns (Figure 7).

It is challenge to interpret Point-Symmetry-interference-pattern (Figure 3), and to interpret pattern evolution. The consistent and complete physical/mathematical interpretations are demanded.

References
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