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Construct, Conduct & Comprehend Physics Experiments

LEOK-3-14 Studying on Interference of Fresnel's Mirrors

- *Cost effective solution*
- *Detailed instructional manual*
- *Easy alignment*

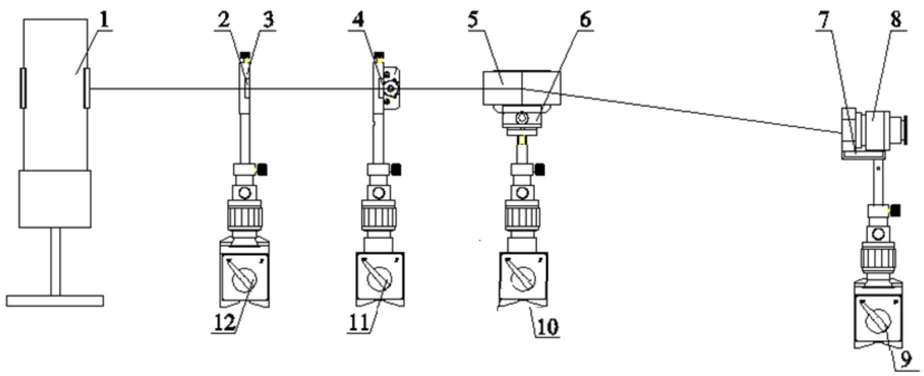

Figure 14-1 Schematic of experiment setup

1: Sodium Lamp (LLE-2, w/small hole)
2: Lens L_1 (f'= 50 mm)
3: Lens Holder (SZ-08)
4: Adjustable Slit (SZ-27)
5: Double Mirrors Assembly (SZ-31)
6: Plate Holder (SZ-12)
7: DMM Holder (SZ-36)
8: Eyepiece of DMM
9-12: Magnetic Base (SZ-04)

Other: a He-Ne or diode laser for measuring intersection angle of the double mirrors (not included).

Theory

Fresnel's Mirrors have a structure as shown in Figure 14-2. Two plane mirrors M_1 and M_2 are orientated with a very small variable angle. Light from point source S is incident on the two mirrors, and the reflection form two virtual images S_1, S_2 of light source S, which act as coherent sources .

If $SO = a$, then $S_1O = S_2O = a$. The distance between S_1 and S_2 is

$$d = 2a\sin\theta \tag{14-1}$$

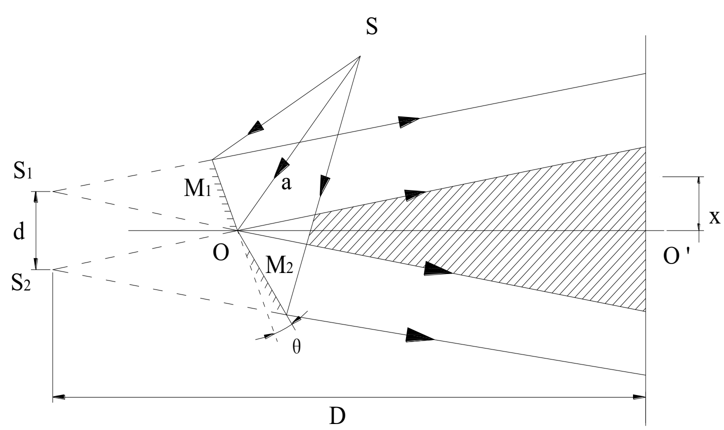

Figure 14-2 Schematic of Fresnel's double mirror interference

where θ is the angle between the mirrors. As in Young's experiment, we get the formulae:

$$d\frac{x}{D} = \pm(2k+1)\frac{\lambda}{2} \quad \text{(Dark interference fringes),} \tag{14-2}$$

$$d\frac{x}{D} = \pm k\lambda \quad \text{(Bright interference fringes),} \tag{14-3}$$

$$\lambda = \frac{d}{D}\Delta x = \frac{2a\sin\theta}{a\cos\theta + OO'}\Delta x \approx \frac{2a\theta}{a + OO''}\Delta x \tag{14-4}$$

Experiment Procedures

1. The key to the success of this experiment is to align the directions of the two mirrors by adjusting the three screws on the back of one mirror, so as to guarantee the normal of the two mirrors in one plane, and an appropriate angle between them;

2. To fulfill the above condition, use a small laser beam to illuminate the adjacent area of the two mirrors (half beam on each mirror), and two reflected beam spots can be observed on a remote screen. By fine adjustment of the three screws on the back of one mirror, the input beam and the two reflected beams are in one plane. The intersection angle θ of the two mirrors can be obtained by calculating the ratio of the two beam spots on the screen and the distance between screen and the mirrors (here we align them at about 0.5 degree);

3. Refer to Figure 14-1, align all components in same height;

4. Focus the light source onto the single slit by lens L_1, rotate single slit direction and align it parallel to the mirrors' intersection;

5. Use direct measurement microscope (or the eyepiece) to observe the interference pattern that has equal-interval bright/dark fringe pairs;

6. Measure the fringe interval Δx between two adjacent fringes using the direct measurement microscope and the path length D from single slit to the microscope via the intersection of the two mirrors;

7. To obtain the interval d between the two virtual images S_1, S_2 of the slit light source S, multiply the double angle of two mirrors 2θ (measured in above step 2) by the distance a between the single slit and the mirrors;

8. Use d, Δx, D and equation (14-4) to calculate the wavelength l of the illumination light.

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