III. Experiments and Procedures

A. Double-slit interference

1. Components needed:

   a) optical bench, b) light source, c) 0.11 mm light-source single-slit, d) two short sliders, e) 0.08 mm double-slit, f) holder, g) long slider, and h) observation tube.

2. The experimental setup is shown in Figure 3.

Figure 3 Photo of setup for double slit interference experiment

3. Experimental procedure

1) Mount the light source onto a short slider and place it at one end of the optical rail. Align the light beam propagating along and parallel to the optical rail.

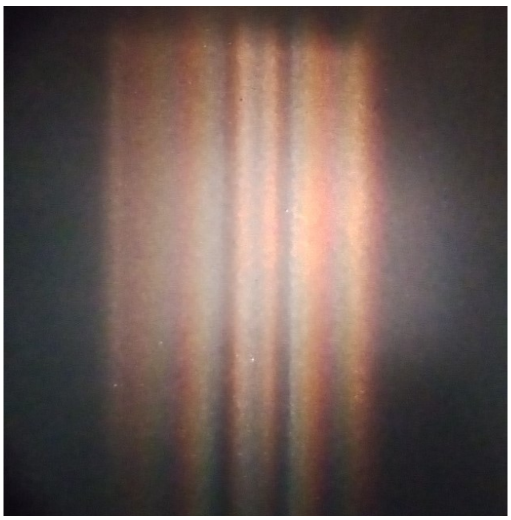
2) At the exit of the light source, mount the 0.11 mm light-source single-slit to get a line-type beam from the light source and set it to vertical direction.

3) Place a holder onto the other short slider, mount the double-slit into the holder, and align the double-slit approximately in vertical direction. The double-slit should be approximately 50 to 100 mm away from the light-source single-slit.

4) Mount the ground glass screen to the long slider located at the other end of the optical rail.

5) Rotate the double-slit finely and slowly to align it parallel to the light-source single-slit. At the same time, observe the interference pattern on the ground-glass screen till optimal interference stripes can be seen.

6) Replace the ground-glass screen by the observation tube and move it forward and backward while observing the change in the spacing between the interference stripes on the ground glass in the tube (the segment of the magnifying lens should be removed). As the distance between the double-slit and the screen is about 800 mm, more than five stripes can be seen. If necessary, put back the magnifying lens to achieve a better observation effect.



B. Fresnel bimirror interference

1. Components needed:

a) optical bench, b) 0.025 mm light-source single-slit, c) light source, d) Fresnel bimirror, e) trapezoid block/medium slider, f) long slider, g) observation tube, & h) ground-glass screen.

2. The experimental setup is shown in Figure 4.

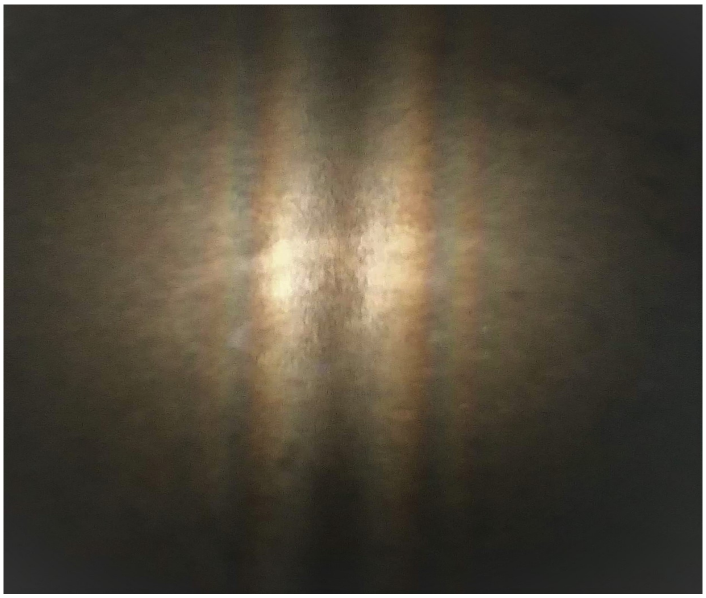
Figure 4 Photo of setup for Fresnel bimirror interference experiment

3. Experimental procedure

1) Place the medium slider (with the trapezoid block) at one end of the rail.
2) Mount the post of the light source to mount hole (5) or (1) on the medium slider/trapezoid block and fix it with screw. Place the 0.025 mm light-source single-slit at the exit of the light source and set it to vertical direction.
3) Mount the post of the Fresnel bimirror to one of these mount holes (2), (3) or (4) on the medium slider/ trapezoid block and fix it with screw.
4) Let the incident ray shine evenly on the adjacent area of the two glass pieces of the Fresnel bimirror.
5) Mount the long slider at the other end of the optical rail.
6) Look into the bimirror straightly from the long slider while slowly rotating the Fresnel bimirror until two virtual images are observed and the images are parallel to the light source slit. (If not parallel, rotate the direction of light-source single-slit finely).
7) Mount the ground glass screen onto the long slider. On the ground glass, the phenomenon of the interference of Fresnel bimirror can be observed. Finely adjust the direction of the light source single-slit to achieve optimal interference fringes.
8) Replace the ground-glass screen by the observation tube to observe the phenomenon.

<u>Note:</u> this experiment requires a proper supplementary angle of the bimirror (i.e. 0.5° to 1°). It was set at factory. To measure the angle value, 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 (e.g. on a wall). The intersection angle θ of the two mirrors can be obtained by calculating the division between the spacing of the two beam spots on the screen and the distance from the screen to the mirrors. To change the angle, please loosen the 8 fixing screws, insert a piece of paper (proper thickness) under one mirror near the outer edge, then fix the 8 screws with proper pressure again (<u>Do not tighten too much to avoid damaging the mirrors</u>).



C. Newton's ring interference

1. Components needed:

   a) optical bench, b) light source, c) trapezoid block/medium slider, d) 2 short sliders, e) Newton's ring w/supporter, f) projection lens, g) ground-glass screen, h) long slider.

2. The experimental setup is shown in Figure 5.

As shown in Figure 5, the Newton's ring assembly is located at the left end of the rail (10 mm), with the lens, the light source, and the ground-glass screen located at 80 mm, 150 mm, and 330 mm away from the Newton's ring, respectively (numbers are only for reference).

Figure 5 Photo of setup for Newton’s ring interference experiment

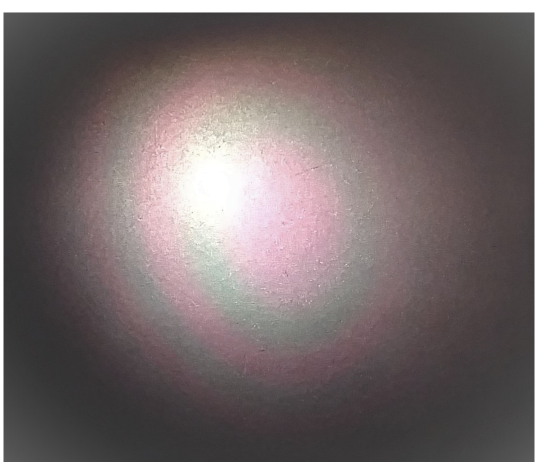
3. Experimental procedure

1) Mount the Newton’s ring and the projection lens to two short sliders, respectively.

2) Mount the light source to mounting hole (2) on the trapezoid block, and mount the ground glass screen to the long slider.

3) Carefully adjust the Newton’s ring screws to let the interference rings locate at the center (**warning**: do not tighten the screws too much as otherwise the device could be damaged), and then place it to the Newton’s ring supporter.

4) Let the light source shine on the Newton’s ring. Move the lens backward and forward until clear and distinct interference rings are observed on the ground glass screen.



D. Single-slit diffraction

1. Components needed:

a) optical bench, b) light source, c) 0.11 mm light-source single-slit, d) 0.08 mm diffraction single-slit, e) holder, f) two short sliders, g) ground-glass screen, h) observation tube, i) long slider.

2. The experimental setup is shown in Figure 6.

Figure 6 Photo of setup for single-slit diffraction experiment

3. Experimental procedure

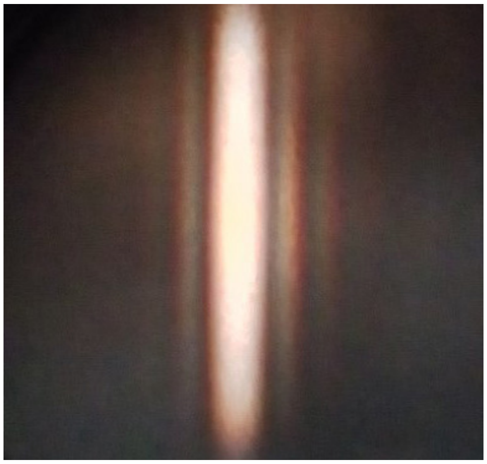
1) Mount the light source onto a short slider, and place it at one end of the rail. Align the light beam parallel to the rail. At the exit of the light source, place the 0.11 mm single-slit.

2) Mount the 0.08 mm diffraction single-slit to a holder, and put it onto the rail about 50 to 100 mm away from the light-source single-slit using the other short slider. Rotate the diffraction single-slit to align it in vertical direction.

3) Mount the ground glass screen to the long slider located at the other end of the optical rail.

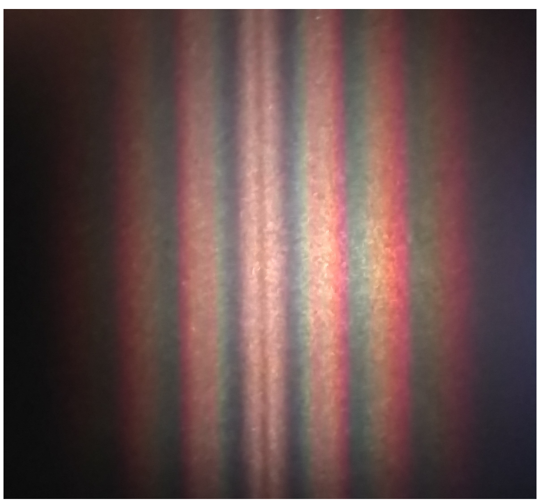
4) Slowly rotate the light-source single-slit to align it parallel to the diffraction single-slit until clear stripes are seen on the ground-glass screen.

5) Replace the ground-glass with the observation tube to observe the phenomenon of single-slit diffraction.



E. Multi-slit diffraction

In this experiment, the components needed and the experimental procedure are similar to those described in Experiment D, except the 0.11 mm light-source single-slit and the diffraction single-slit should be replaced with the 0.025 mm single-slit and the multi-slit, respectively.



F. Grating diffraction

1. Components needed:

a) optical bench, b) 0.025 mm light-source single-slit, c) light source, d) projection lens, e) trapezoid block/medium slider, f) 2 short sliders, g) ground-glass screen, h) long slider.

2. The experimental setup is shown in Figure 7.

Figure 7 Photo of setup for grating diffraction experiment

As shown in Figure 7, the lens, the grating, and the ground-glass screen are located at about 90 mm, 200 mm, and 350 mm away from the light-source single-slit, respectively.

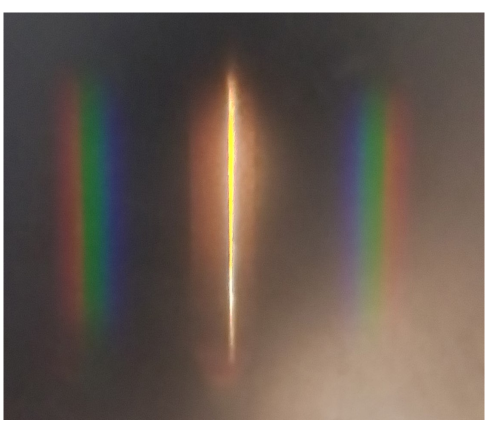
3. Experimental procedure

1) Mount the light source to mounting hole (1) on the medium slider and place the 0.025 mm light-source single-slit at the exit of the light source.

2) Place the lens to mounting hole (5) on the medium slider.

3) Mount the ground glass screen to the long slider. Move the long slider till the slit forms a clear image on the ground glass.

4) Mount the grating to a holder and place it onto the rail using a short slider. Change the position of the grating until the zeroth stripe is observed clearly. Rotate the light-source single-slit to align it parallel to the grating lines. Now, the phenomenon of grating diffraction can be clearly observed.



G. Polarization by reflection

1. Components needed:

a) optical bench, b) light source, c) trapezoid block/medium slider, d) polarizer-by-reflection, e) polarizer (analyzer), f) holder, g) ground-glass screen, h) long slider.

2. The experimental setup is shown in Figure 8.

Figure 8 Photo of setup for polarization by reflection

As shown in Figure 8, the polarizer, as a polarization analyzer, is placed to a holder located about 100 mm away from the polarizer-by-reflection device.

3. Experimental procedure

(1) Experiment for partial polarization at an incident angle of 45°

Mount the light source to mounting hole (4) on the trapezoid block and the polarizer-by-reflection device to mounting hole (5) on the medium slider, respectively. Align the light rays along the connection line of mounting holes (4) and (5). Rotate the polarizer-by-reflection to make the reflected rays shine on the analyzer. Axially rotate the analyzer (i.e. its polarization direction) and observe light intensity on the ground glass screen to demonstrate partial polarization.

(2) Experiment for complete polarization at an incident angle of 57°

Keep the polarizer-by-reflection, the analyzer and the ground glass screen in place as above. Move the light source to mounting hole (3) on the trapezoid block and align the light rays along the connection line of mounting holes (3) and (5). Rotate the polarizer-by-reflection to make the reflected rays shine on the analyzer. An incident angle of about 57° for the light source relative to the polarizer-by-reflection is achieved. Axially rotate the analyzer and observe the ground glass screen to demonstrate complete polarization.

(3) Experiment for partial polarization at an incident angle 65°

Keep the polarizer-by-reflection, the analyzer and the ground glass screen in place as above. Mount the light source to mounting hole (2) on the trapezoid block and align the light rays along the connection line of mounting holes (2) and (5). Rotate the polarizer-by-reflection to make the reflected rays shine on the analyzer. An incident angle of about 65° for the light source relative to the polarizer-by-reflection is achieved. Axially rotate the analyzer and observe the ground glass screen to demonstrate partial polarization.

H. Polarization by polarizer

1. Components needed:

a) optical bench, b) light source, c) two polarizers (polarizer and analyzer), d) two holders, e) two short sliders, f) long slider, g) ground-glass screen.

2. The experimental setup is shown in Figure 9.

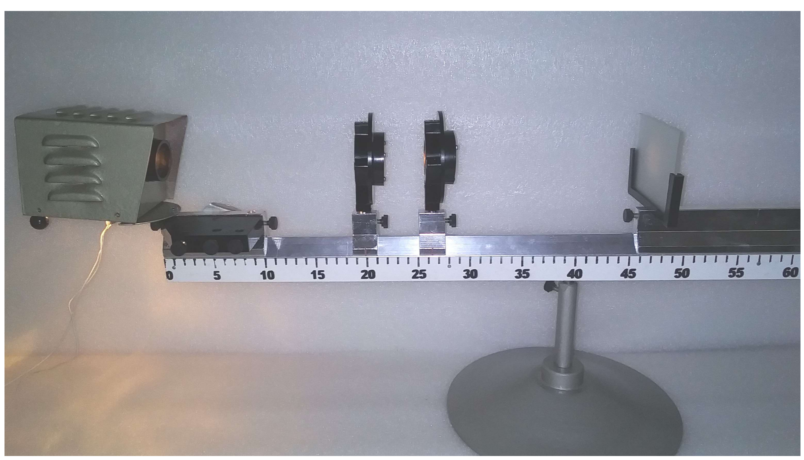


Figure 9 Photo of setup for polarization by polarizer experiment

As seen in Figure 9, there is no special requirement for the relative positions of the components, as the light rays can pass through the polarizer, the analyzer, and the ground-glass.

3. Experimental procedure

In this experiment, the voltage of light source can be 8-10 V.

IV. Precaution and Maintenance

1. Do not touch the surfaces of optical components. Use Q-tips or lens tissues with isopropyl alcohol to clean dust or grease on the surfaces of optical components.

2. The light source uses a 12V/50 W Halogen-Tungsten bulb. Never use a power supply with voltage higher than 12 V. When adjusting brightness, the voltage to the bulb should be raised slowly. To prolong the lifetime of the bulb, d**o not keep the bulb at high working voltage for a long period**. **It is not necessary to use the highest brightness for all experiments and set to low voltage when not in use**. Do not move the light source around unless the bulb is cooled down. When replacing the bulb, the position of the filament should be aligned to the middle of the condensing lens (turn off power before replacing bulb).