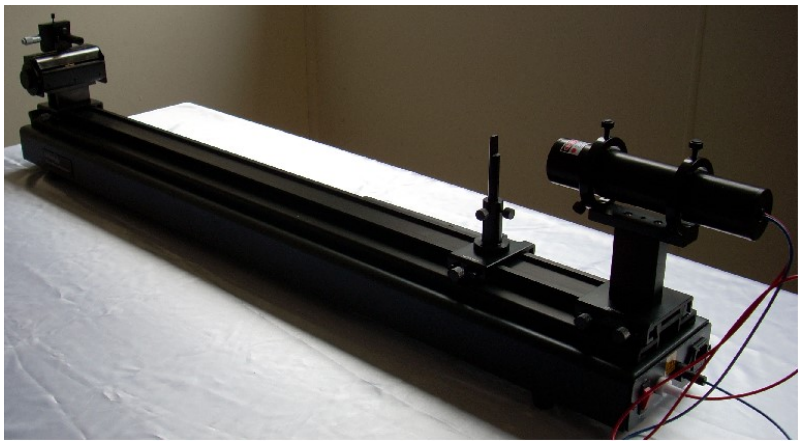
5. Experiments

5.1 Fraunhofer Diffraction (far-field)

5.1.1 Fraunhofer Diffraction through a Single Slit

Note: Warm up He-Ne laser for about ten minutes before use

1) Mount the laser tube in its holder on the carrier. Place it at the end of the optical rail. Install the optical receiver into its carrier and place it at the other end of the optical rail. Insert alignment aperture in carrier and place it on optical rail. Remove all other carriers.

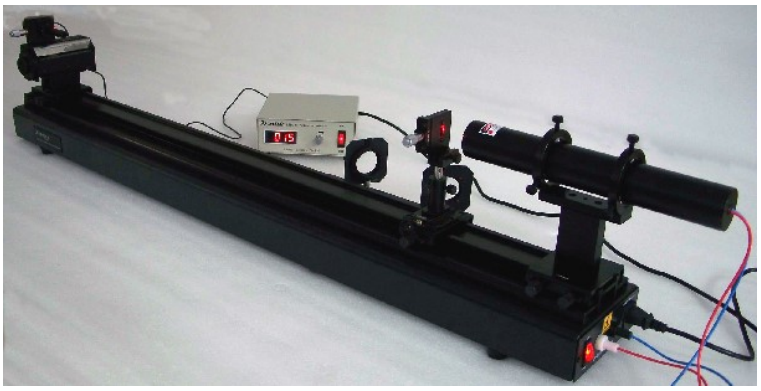


2) Set the transversal measurement stage to its zero point.

3) Turn on the He-Ne laser. Slide the alignment aperture back and forth along the optical rail, carefully adjust laser height and directions (using the 6 adjustable screws on the laser holder), till the laser beam passes through the aperture along the entire optical rail.

4) Remove the alignment aperture from the optical rail. Insert adjustable slit into plate holder on a carrier. Adjust the slit to let the beam hit the center of the slit.

Note: The flat plane of the slit should face the incident light. Keep two edges of the slit from contacting each other.



5) Move the adjustable slit approximately 85 cm away from the optical receiver and then adjust the slit's height. Place the white screen in carrier in front of the optical receiver to observe the diffraction phenomena. Remove the white screen and make any necessary adjustments so that the brightest spot enters the tube of the optical receiver.

6) Turn on the photocurrent amplifier, and monitor the reading while moving the diffraction slit right and left, until a peak intensity reading is achieved. Record the readings on the drum and photocurrent amplifier. Rotate the drum in the same direction along any orientation, and record the data every 0.1 mm (every 10 divisions of the drum).

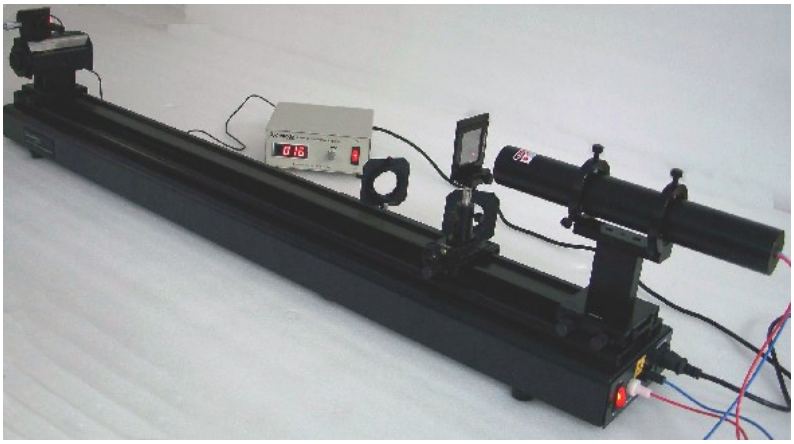
Figure 7 Diffraction pattern of single slit

7) Draw the distribution intensity of Fraunhofer diffraction on a piece of graph paper.

5.1.2 Fraunhofer Diffraction through a Multi-Slit Plate

1) Re-setup and Re-align the laser as per 5.1.1.

2) Insert Multi-slit plate into plate holder with carrier. Adjust the plate so that the beam hits the centre of the slit of choice. Coarse adjustment can be made by hand, fine adjustment is provided by the carrier.



3) Move the Multi-slit plate approximately 85 cm away from the receiver. Place the white screen in carrier in front of the optical receiver to observe the diffraction phenomena. Remove the

white screen and make any necessary adjustments so that the brightest spot enters the tube of the optical receiver.

4) Turn on the photocurrent amplifier, and monitor the reading while moving the diffraction slit right and left, until a peak intensity reading is achieved. Record the readings on the drum and photocurrent amplifier. Rotate the drum in the same direction along any orientation, and record the data every 0.1 mm.

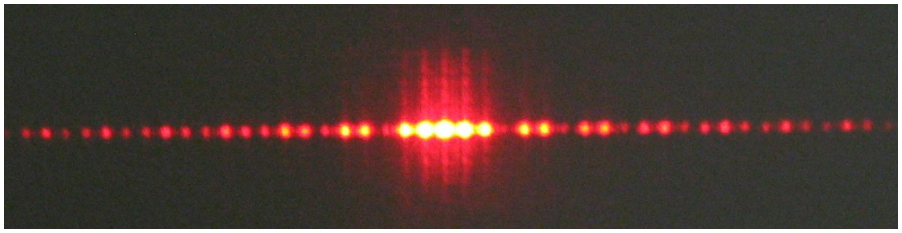


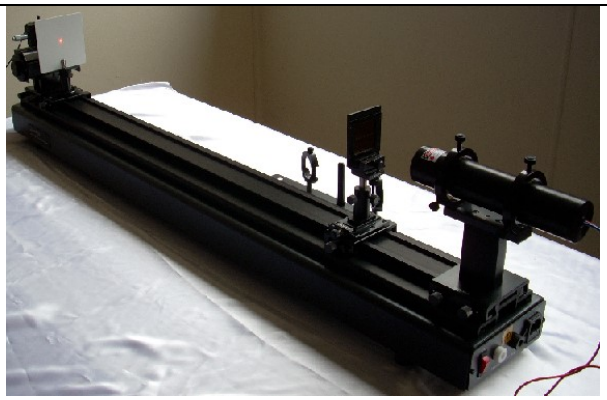
Figure 8 Diffraction pattern of multiple slits

5) Draw the distribution intensity of Fraunhofer diffraction on a piece of graph paper.

5.1.3 Fraunhofer Diffraction through a Single Circular Aperture

1) Re-setup and Re-align the laser as per 5.1.1.
2) The rest processes are the same as before (5.1.1 and 5.1.2) just replace the Multi-slit plate with the Multi-pinhole plate.

Suggestion:
The side of the multi-pinhole plate without the print should face the incident light.



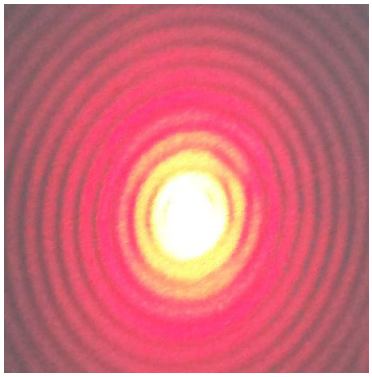


Figure 9 Diffraction pattern of circular aperture

5.1.4 Fraunhofer Diffraction through a Transmission Grating

1) Re-setup and Re-align the laser as per 5.1.1.
2) Insert Transmission Grating into lens holder with carrier. Adjust the holder so that the beam strikes the centre of the grating.
3) The rest processes are the same as before (5.1.1 and 5.1.2).

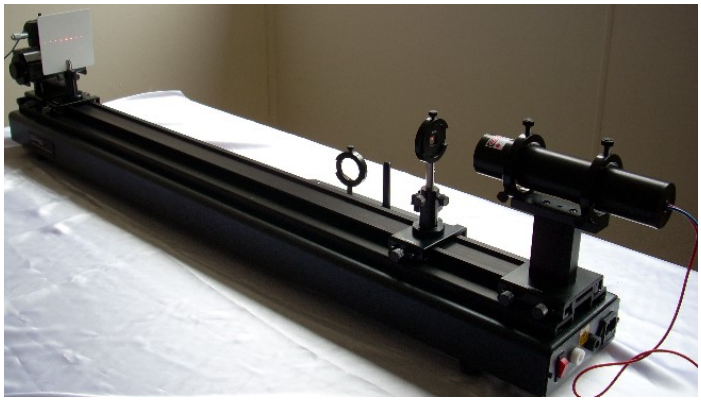
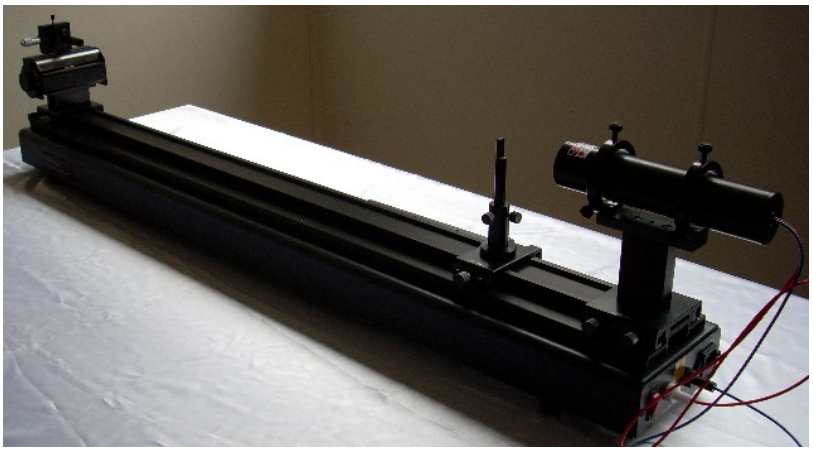


Figure 10 Diffraction pattern of transmission grating

5.2 Fresnel Diffraction (near-field)

5.2.1 Fresnel Diffraction through a Single Slit

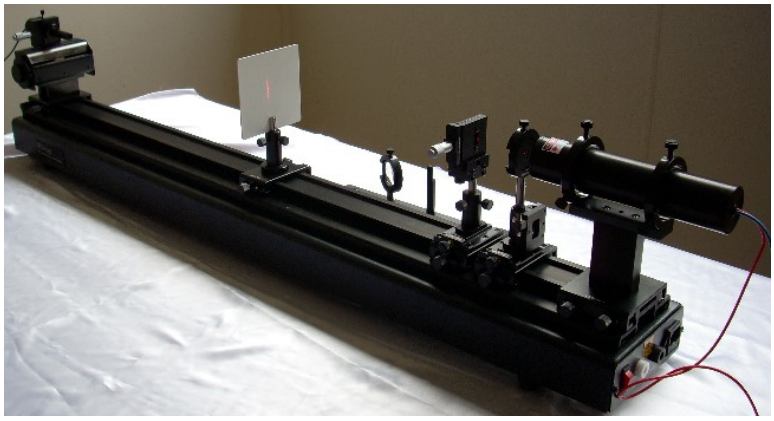
1) Insert laser tube in laser holder with carrier. Place it at the end of optical rail with laser power output. Install the optical receiver into its carrier and place it at the other end of the optical rail. Insert alignment aperture in carrier and place it on optical rail. Remove all other carriers.



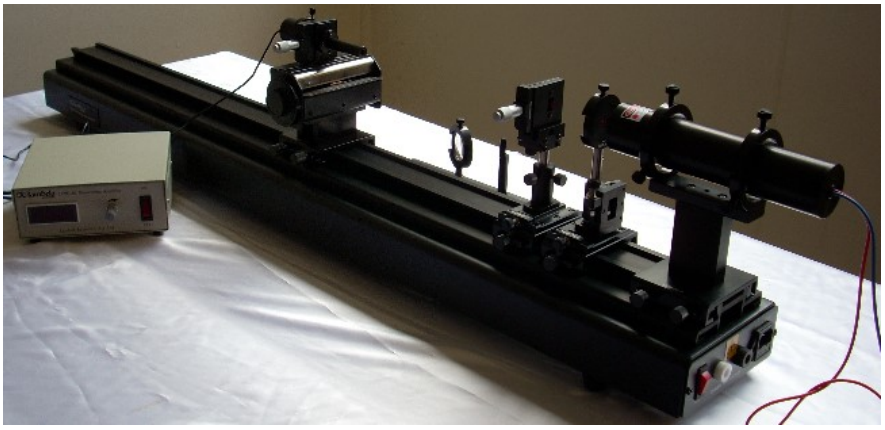
2) Turn on the He-Ne laser. Slide the alignment aperture back and forth along the optical rail, carefully adjust laser height and directions (using the 6 adjustable screws on the laser holder), till the laser beam passes through the aperture along the entire optical rail.
3) Use the two lenses to form a beam expander into carriers. The divergent angle of the beam can be controlled by changing the spacing of the two lenses. The carriers provide fine position adjustments. Secure the carriers near laser tube. Adjust the heights until the laser beam always passes through the centre of the expander when sliding expander backward and forward so that the centre of the expanded beam does not deviate. Now the optical axis of the expanded laser beam will coincide with the laser beam.
4) Insert adjustable slit into the plate holder and put onto a carrier. Adjust the slit so that the laser beam is incident on the slit.

Note:
The flat plane of the slit should face the incident light. Keep two edges of the slit from contacting each other. This is best viewed in a dark environment.

5) Insert white screen into carrier to observe diffraction pattern. Slide white screen and observe diffraction pattern when distance between the screen and the slit varies. Adjust the slit width and observe the changes in the diffraction strips.

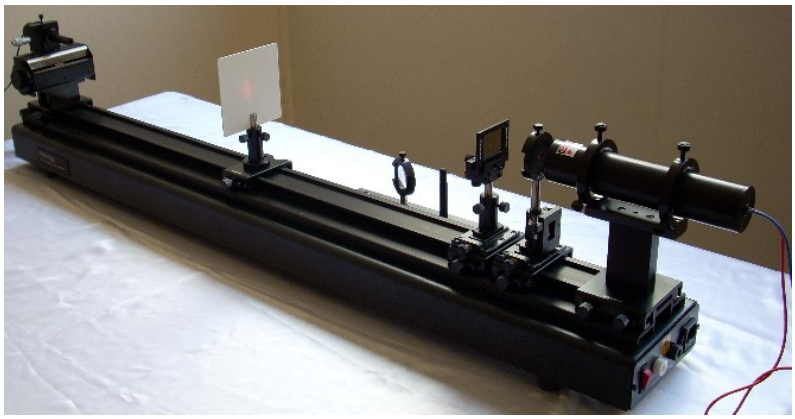


6) Remove the white screen and align diffraction strips into the collecting tube of the optical receiver.
7) Rotate the drum on the optical receiver and record the coordinate readings of the receiver in step of 0.1 mm (10 divisions of the drum). Draw a diffraction intensity distribution curve from the data collected.

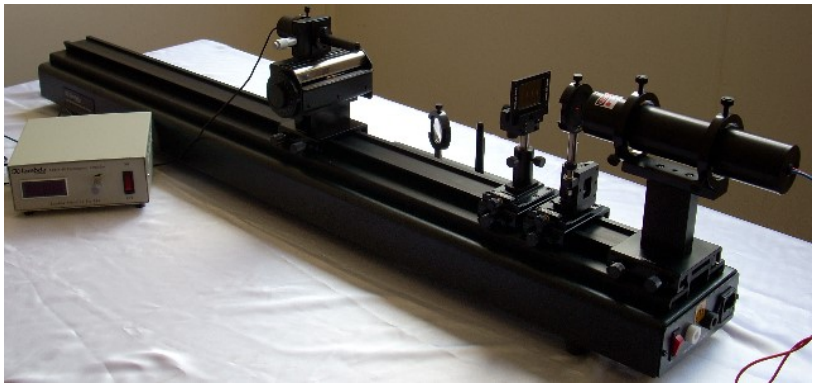


5.2.2 Fresnel Diffraction through a Multi-Slit Plate

1) Please refer to 5.2.1 and place laser, beam expander on optical rail.
2) Insert multi-slit into plate holder, then into carrier and place the assembly onto the rail. Adjust height of multi-slit plate so that the laser beam strikes one of the slits. Carefully adjust the beam expander until the diffraction pattern is aligned into the collecting tube of the optical receiver.
3) Observe the diffraction strips with a white screen. Slide the white screen and observe changes of diffraction pattern while the distance between the screen and the multi-slit plate varies. Slide multi-slit plate and observe changes of diffraction strips on white screen.



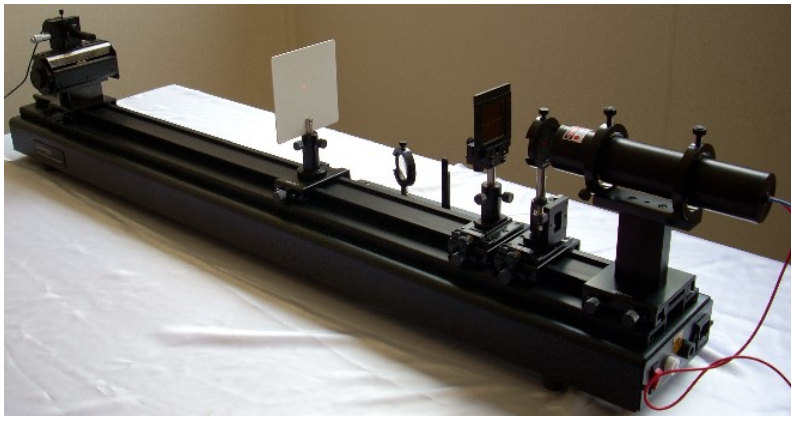
4) Remove the white screen and align the diffraction strips into the collecting tube of the optical receiver. Rotate the drum of the optical receiver and record the coordinate reading of optical receiver in step of 0.1 mm. Draw a diffraction intensity distribution curve from the data.



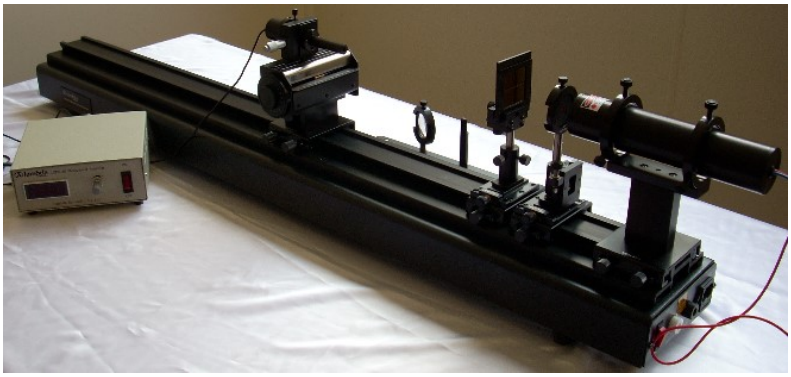
5) Repeat above steps for other slits.

5.2.3 Fresnel Diffraction through a Circular Aperture

1) Please refer to 5.2.1 and place laser, beam expander on optical rail.
2) Insert multi-hole plate into plate holder and then carrier. Place the assembly on to the rail. Adjust height of multi-hole plate so that the laser beam hits one of the holes. Carefully adjust the beam expander until the diffraction pattern is aligned into the collecting tube of optical receiver.
3) Observe the diffraction pattern with a white screen. Slide the white screen and observe changes of diffraction pattern while the distance between the screen and the multi-hole plate varies. Slide multi-hole plate and observe changes of diffraction pattern on white screen.



4) Remove the white screen and align the diffraction pattern into the collecting tube of optical receiver. Rotate the drum of the optical receiver and record coordinate reading of optical receiver in step of 0.1 mm. Draw a diffraction intensity distribution curve from the data.



5) Repeat above steps for other hole with different diameter

5.2.4 Fresnel Diffraction from a Straight Edge (optional)

1) Please refer to 5.2.1, place laser tube and beam expander on the optical rail.
2) Hold the edge of a blade (not provided) by plate holder. Make sure the edge is vertical to the optical rail and illuminated by the expanded laser beam.
3) Observe the diffraction strips with the white screen.

6. Laser safety and lab requirements

Follow the corresponding laser safety guidelines based on AS/NZS 2211.1:1997 and other lab instructions about optical components etc.