Experiment 7: Diffraction and holography

1 Diffraction from a hard edge

Light waves incident on the sharp edge of an opaque object exhibit an effect called diffraction. This phenomenon cannot be explained by the geometric theory of light that predicts a simple shadow.

Expand the laser beam with a Galilean telescope ($f = -25$ mm and $f = 100$ mm). Position the aperture mask such that half of the beam is blocked by one edge of the aperture. Observe the behavior of the beam after the edge. Note in particular the distribution right after the edge and far from it.

2 Diffraction from a single slit

Expand the laser beam with a Galilean telescope ($f = -25$ mm and $f = 100$ mm). Position the slide containing single slits of various widths in the beam path. Use the aperture mask to select an individual slit. Observe the changes in the diffraction pattern as the light propagates away from the slit. In the far field, measure the distance between the zeros on either side of the main lobe. Calculate the slit width from this measurement and compare with the given value. What do you think is the functional dependence of the intensity on the horizontal axis? Why do you see diffraction only in the horizontal plane? How far do you have to be from the slit for the far field approximation to be valid? Repeat for all the slits on the slide.

3 Diffraction from a circular aperture

Position the 80 μm circular aperture on the laser beam. (Do not expand the beam.) Observe the changes in the diffraction pattern as the light propagates away from the aperture. In the far field, measure the distance between the zeros on either side of the main lobe. Calculate the aperture diameter from this measurement and compare with the given value. Repeat for the 40 μm circular aperture.

4 Diffraction grating

The theory of diffraction gratings is outlined on pages 60 through 62 of the textbook. Verify Equation (2.4-10) for an incidence angle of zero using the laser beam. The diffraction grating has 528 lines/mm.

Position the diffraction grating right after a single slit illuminated by the laser. Observe the resulting diffraction pattern. Which Fourier transform theorem does this experiment illustrate?

5 Holography

Create a diverging Gaussian beam by positioning a negative lens ($f = -25$ mm) as close to the laser as possible. Position the transmission hologram in the beam path at an incidence angle of approximately 60°. Make sure that the entire hologram is illuminated. View the hologram from the side.