Physics 510

Experiment 0-3

A Study of Diffraction

Objects:

1. Autocollimate the light from a narrow slit illuminated with the mercury source and a 5460 Å filter. Bring the collimated light to a focus at the cross-hairs of a traveling eyepiece, i.e. a telescope. Measure the fringe spacing in the pattern produced by a calibrated variable slit interposed in the parallel beam as a function of slit opening. Make a plot and calculate the wavelength. Study the patterns (no measurements) produced by two, three,....., six equally spaced, equally wide slits.

2. Try the measurement above with a very small pin hole source and a small diffraction aperture in the beam. (Tough-intensity low.) Then do it with the screen of random circular apertures placed in the beam (beautiful)!

3. Using the mercury arc unfiltered and the slit again, observe spectra produced by a variable width coarse grating. Count the minimum number of slits required for resolving the yellow lines from the green line in the various orders out to about the ninth.

4. Check the fringe spacing when a wire is substituted for the single slit in the beam. Compare with what would be found from an equally wide slit produced in #1 above. This demonstrates Babinet's principle.

5. Observe (filtered mercury source) the Fresnel diffraction of a circular aperture (neither source nor observer at infinity). Make a plot of zone number vs. the reciprocal of distance of the eyepiece from the aperture. Using the unfiltered arc and a pin hole, observe Arago's central spot in the shadow of a circular obstacle. Repeat with several closely spaced point sources aligned as the letter E. Observe the imaging by a zone plate of the long, floor model, mercury source.

6. With a slit source replacing the pin hole in Fresnel diffraction, observe and measure fringe position in the shadow of a straight edge. With the calibrated variable slit in a fixed position, determine successive slit widths for which the pattern central intensity goes through maximum and minimum. Analyze both with Cornu's spiral and calculate wavelength, plotting fringe position against v. Analyze also in terms of the zone picture.

7. Set up to demonstrate (point source, plane wave, monochromatic illumination and the grid screen object) some of the features of Abbe's theory of the microscope.

References:

Feynman Lectures, Vol. 1, Ch. 30
Fowles, Introduction to Modern Optics, Ch. 5
A. Sommerfeld, Optics , Academic Press (1954)
M. Born and E. Wolff, Principles of Optics, 6th ed., Pargamon (1980)

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