

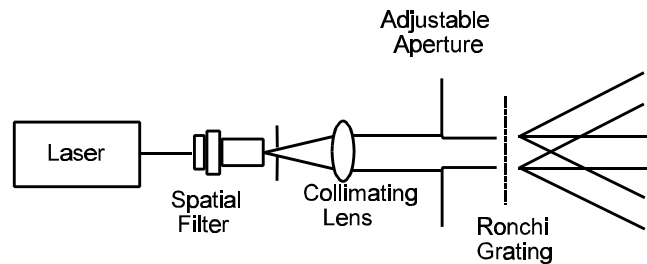
### Lab 10 - Diffraction II

The purpose of this lab is to observe diffraction from gratings, volume diffraction, properties of zone plates, and introduce basic concepts of Rayleigh scattering.

#### Preparation:

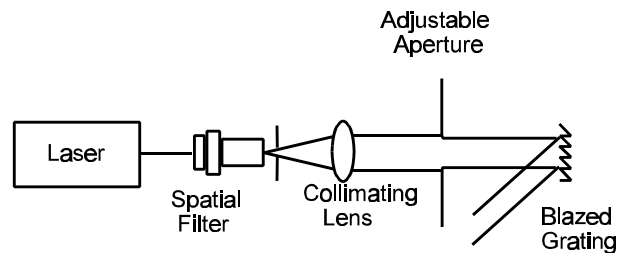
Review notes on diffraction, gratings, volume (Bragg) diffraction, zone plates, and scattering. See Yariv, Optical Electronics, Chapter 12, for a discussion of Bragg diffraction in acousto-optic cells. See Collier, Burckhardt, and Lin, Optical Holography, for a discussion of off-axis holograms (zone plates). See Stone, Radiation and Optics, Section 14-2, for a discussion of Rayleigh scattering.

#### Ronchi Grating:



- 1) Observe and sketch the diffraction pattern. The sketch should show the approximate scale of the intensity changes.
- 2) Determine which orders are missing, and try to determine the duty cycle of the grating.

#### Blazed Grating:



- 1) Observe the diffraction pattern, and note the large percentage of light falling on one order.
- 2) Determine the grating frequency.

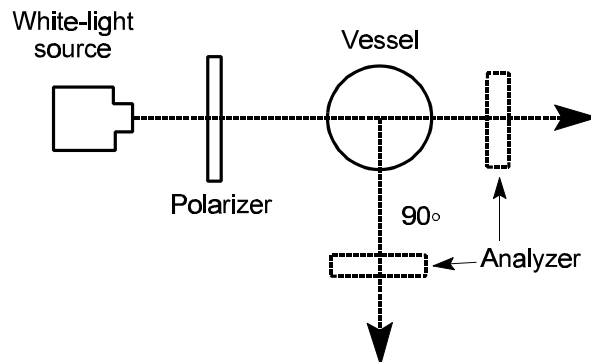
**Zone Plate(s):**

- 1) Determine the focal length(s) of the on-axis zone plate by measuring the diameter of the first zone.
- 2) Measure the on-axis irradiance versus distance from the on-axis zone plate.
- 3) Observe the diffraction pattern of the off-axis zone plate. Note how many orders you can see.
- 4) Determine the primary focal length of the zone plate.
- 5) Determine how far off axis the zone plate is.
- 6) Estimate the angular sensitivity of the zone plate.

**Volume Diffraction:**

- 1) Set up the acousto-optic deflector and obtain maximum intensity in one diffracted order.
- 2) Observe the diffraction pattern.
- 3) Estimate the sensitivity to angular alignment.

**Scattering:**



- 1) Fill the high-tech scattering vessel about 3/4 full of clean water from the fountain. Add a small amount of powdered creamer, which consists of a collection of colloidal particles in solution, to the water. Place the cap on the scattering vessel and stir until the solution is uniform.

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- 2) Shine the lamp through the jar. Observe the transmitted light and the light scattered at  $90^\circ$ . Note the color and polarization. Use the analyzer to determine polarization.
  - 3) Place a polarizer between the lamps and the vessel. Rotate the polarizer and observe the transmitted light and the light scattered at  $90^\circ$  with the unaided eye (no analyzer).

**Questions:**

- 1) If the transparent and opaque lines of the Ronchi gratings have equal widths, which orders should be missing from the diffraction pattern?
- 2) Sketch the diffraction pattern that would be observed from a Ronchi grating with a 25% duty cycle.
- 3) Sketch an optical setup that could be used to make an off-axis zone plate.
- 4) Why did you observe different colors in the scattering experiment? How can this be used to explain why the sky is blue and why sunsets are orange-red?
- 5) Explain differences in polarization phenomena observed in the scattering experiment. How can this information be used to explain why skylight is partially polarized in certain directions?
- 6) Why is the Bragg element so much more sensitive to angular displacements?