电子科技大学
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Physical Experiment II

Prelab Report

Lab Title:	To use a spectrometer to measure the apex angle of a prism and the wavelengths of lines in the spectra of mercury
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Answers to Questions (20 points)

1. What is autocollimation? Describe the concept briefly in words with the aid of a diagram.

Answer:

Autocollimation is a method used to precisely align an optical instrument, such as a telescope, so that its optical axis is perpendicular to a reflective surface. In this state, a beam of light originating from the instrument's eyepiece (often from an illuminated crosshair) travels through the optical system, reflects off the surface, and travels back along the same path, forming a sharp image of the crosshair that coincides with the original crosshair itself. This alignment indicates that the outgoing light rays are parallel and strike the mirror at a 90° angle.

Diagram:

The concept can be illustrated by Figure 3.9-12 from the lab manual, which shows the reflected "image of the cross" perfectly overlapping with the "upper node of the crosshairs" in the telescope's field of view. This perfect overlap signifies that autocollimation has been achieved.

2. Some of the gratings used in the lab have 600 lines/mm etched on them.

I. Find the distance, d, between the lines for such a grating.

Answer:

To find the distance d between the lines of the grating, we take the reciprocal of the number of lines per millimeter.

Given: 600 lines/mm

$$d = \frac{1}{600\ \text{lines/mm}} \approx 1.667 \times 10^{-3}\ \text{mm/line}$$

Converting to nanometers (since the wavelength is in nm):

$$1.667 \times 10^{-3}\ \text{mm} \times \frac{10^{6}\ \text{nm}}{1\ \text{mm}} = 1667\ \text{nm}$$

So, the distance **d** between the lines is approximately **1667 nm**.

II. Suppose the wavelength of the incident light is 435.83 nm, compute the first-order diffraction angle.

Answer:

We use the grating equation for the first-order diffraction maximum (where k=1):

$$d \sin \varphi = k\lambda$$

Where:

- $d \approx 1667 \text{ nm}$
- $\lambda = 435.83 \text{ nm}$
- $k = 1$ (for the first-order diffraction)

Rearranging for the angle φ:

$$\sin \varphi = \frac{k\lambda}{d}$$

$$\sin \varphi = \frac{1 \times 435.83 \text{ nm}}{1667 \text{ nm}} \approx 0.26144$$

$$\varphi = \arcsin(0.26144) \approx 15.15^\circ$$

The first-order diffraction angle is approximately **15.15 degrees**.