MEASURING THE WAVELENGTH OF LIGHT USING A RULER

Professors Masud Mansuripur and Stephen F. Jacobs
College of Optical Sciences – The University of Arizona

A simple and dramatic measurement that's an exercise in trigonometry.

Figure 1 shows the arrangement that might be called a grazing incidence diffraction grating. It is easy to see many orders of interference. The hard part is quantifying how near to grazing incidence.

The ruler should have a scale that is either raised or indented and at least as fine as 1 mm. We used a machinist's vernier caliper scale. The light source was a green laser pointer.

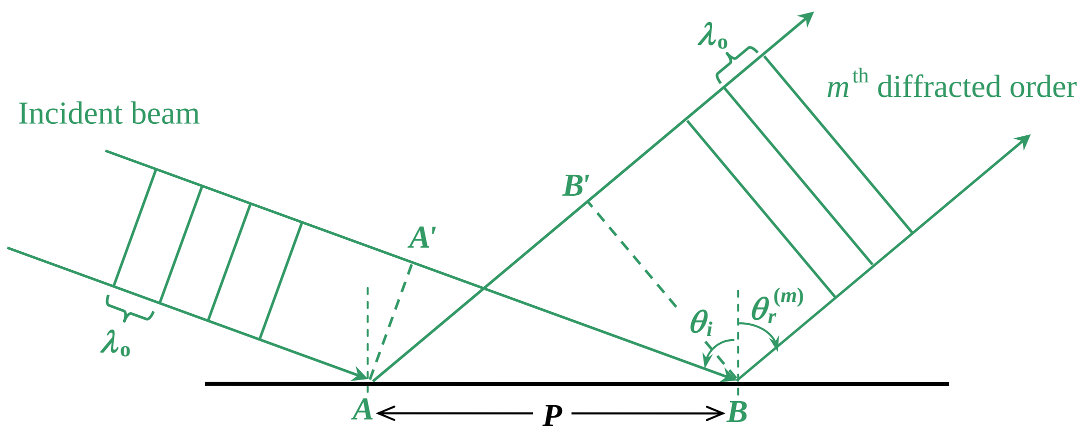

Figure 1. The incident plane-wave arrives on the grating surface at an angle θ_i. The m^{th} diffracted order leaves the grating at an angle $\theta_r^{(m)}$. The grating period P is the distance between points A and B. The line AA' is perpendicular to the incident rays; the distance between A' and B, which is given by $P\sin\theta_i$, is the extra path-length covered by the upper incident ray relative to the lower incident ray. Similarly, BB' is perpendicular to the m^{th} order diffracted rays; the distance between A and B', which is given by $P\sin\theta_r^{(m)}$, is the extra path-length covered by the upper diffracted ray relative to the lower diffracted ray. The difference between AB' and $A'B$ must be an integer-multiple of the wavelength λ_o, that is,

$$P\sin\theta_r^{(m)} - P\sin\theta_i = m\lambda_o.$$

This is the grating equation for the m^{th} diffracted order. In the experiment with the ruler, $P = 0.635$ mm, $\theta_i = 88.5°$, $\theta_r^{(m)} = 87.2°$, and $m = -1$, yielding $\lambda_o = 0.54$ µm.

It is a pleasure to acknowledge publication of a similar analysis by a great teacher, Arthur L. Schawlow.

"Measuring the Wavelength of Light with a Ruler," American Journal of Physics, Volume 33, Issue 11, pp 922-923 (1965).