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MULTIPLE INTERNAL REFLECTION IN A PRISM

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In using the spectrometer for determining the index of refraction of a prism by the well-known method of minimum deviation, frequently a line is observed which does not follow the motion of the spectrum as a whole. Rotation of the prism near the position of minimum deviation causes the line to move rapidly across the lines of the spectrum. This line results from rays which have undergone triple reflection within the prism (Fig. 1).

The following observations are made: (1) $h=h'$. Each of the triply reflected rays leaves the prism at an angle h′ exactly equal to the angle of incidence h. In the diagram a=a′ b=b′, c=c′, etc., until finally h=h′. Since b must equal b′, the prism must be isosceles, but the relation h=h′ is independent of the wave length of light or the type of glass in the prism.

(2) *The "spurious" line is of the same color as the light originally leaving the collimator.* This follows from the fact that h=h′ independently of the wave length of light. The parallel rays leaving the collimator are dispersed at the first face into different directions, but at the last face the components are all bent back parallel again. They proceed to the objective lens, or lens of the eye, slightly displaced from each other but all in the same dirction so that the lens focuses them all back together to form light of

the original color. As a matter of fact, combination to give the original color occurs even before the lens is reached, the red component of one of the original rays combining with the green of another, the blue of another, etc. The effect is like that of light passing at an angle through a plate of glass with parallel faces. The dispersion at the first face is counteracted by the oppositely directed dispersion at the second face, instead of being augmented by it.

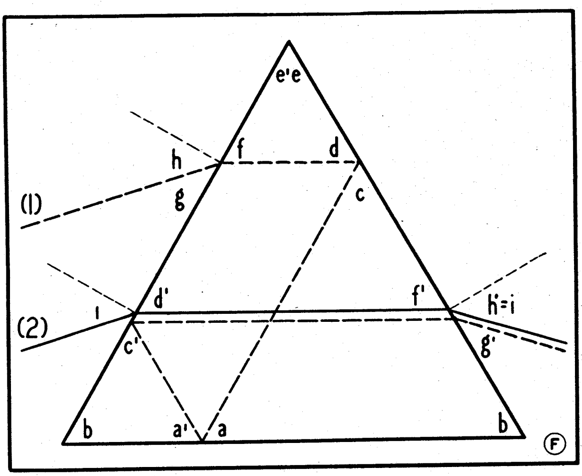

Fig. 1. Multiple internal reflection in a prism. (1) Typical path of one of the triply reflected rays causing the "spurious" line. (2) Typical path of a ray of the regular spectrum.

(3) *The angle of minimum deviation is attained when the "spurious" line and the chosen line of the regular spectrum are made to coincide,* that is, when $h'=i'$, where i' is the angle of refraction from the last face for the regular spectrum line. For $i'=h'=h=i$; therefore $i'=i$, which is characteristic for the minimum angle of deviation setting. This may be demonstrated experimentally. If a screen with a narrow slit cut in it is placed between the collimator and the prism, only a narrow layer of light will pass through the prism. The place at which the light enters the prism may be found by sighting across its top to the slit in the screen, or by holding a piece of paper in front

of the prism and observing where the light falls. The path that the layer of light should follow during the triple reflections may be traced out geometrically and the places found at which the reflections should occur. Each of these may be checked by painting lampblack over them to destroy the reflection. The test is more convincing if only part of the strip along which reflection takes place in each case is painted over, so that some of the "spurious" line is left for comparison.

This line may be used to adjust the prism quickly and accurately to the angle of minimum deviation for the various lines of the spectrum.