Abdelhafid Boussouf University Center- Mila **Academic Year: 2023-2024**
Natural and Life Science Institute
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Practical Work N° 3: The Prism Spectrogoniometer

1. The Objective of the Experiment

This practical work addresses the study of the prism using an instrument allowing angles to be measured with great precision: the goniometer. This practical work will be an opportunity to familiarize with the following aspects:

- ✓ The phenomenon of dispersion of light by the prism
- ✓ Calculate prism angle A
- ✓ Study of the variation of the minimum deviation and determine the refractive index n

2. Theoretical Aspects

The prism is an association of two non-parallel plane diopters which limit a transparent medium of index n. Their intersection defines the edge of the prism and the dihedral angle A is the angle of the prism. In practice it is limited by a third face, the base

- The faces of the prism are the two previous flat surfaces.
- The edge of the prism is the intersection of the two faces of the prism.
- A principal section is the intersection of the prism by a plane perpendicular to the edge of the prism.
- The prism angle is the apex angle of the main section.

2.1 Dispersion of White Light by a Prism

The phenomenon of splitting of white light into its seven constituent colors when it passes through a glass prism is called dispersion of white light. The various colors seen are **Violet, Indigo, Blue, Green, Yellow, Orange and Red**. The sequence of colors remembers as VIBGYOR. The band of seven colors is called the spectrum. Each light wave has a different

wavelength and will therefore deviate differently; Red has the highest wavelength and Violet the lowest.

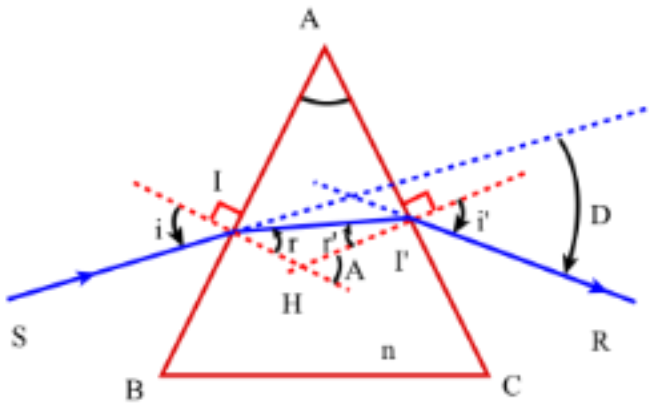
Colors	Violet	Indigo	Blue	Green	Yellow	Orange	Red
Wavelength (nm)	400	430	450	490	570	600	630

Table 1: Wavelengths of visible radiation from Sodium (Na) vapor lamp

2.2 Prism Formulas

Consider a prism defined in its main section plane by its angle A and its relative index n > 1. We recall that by hypothesis, the ambient environment is air.

Let SI be any incident ray which strikes at I the entry face AB of the prism; coming from a less refractive medium than that of the prism, this ray undergoes the phenomenon of refraction in I respecting the two laws of Descartes.



The prism formulas are summarized as follows:

$$\sin i = n \sin r$$

$$\sin i' = n \sin r'$$

$$D = i + i' - A$$

$$A = r + r'$$

D: is the angle of deviation

When the angle of incidence increases, the deviation begins by decreasing until reaching a minimum then increases. Furthermore, by applying the Snell-Descartes law, we arrive at the relationship which allows us to calculate the value of the index n which is

$$\mathbf{n = \frac{\sin \frac{1}{2}(A + D_m)}{\sin \frac{A}{2}}}$$

n is prism refractive index

D_m is the minimum deviation

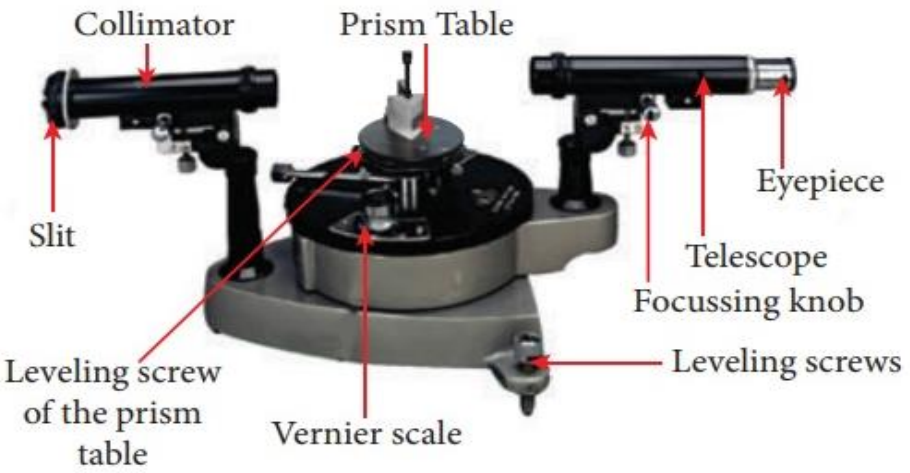
This relationship is important, because it is the basis of the measurement of refractive indices by the method known as the minimum deviation of the prism. This, which consists of experimentally searching for the value of A and that of the deviation D_m undergone by a monochromatic light ray, makes it possible to reach n with 5 exact decimal places.

3. Tools and Manipulation

3.1 Description of the spectrogoniometer

The essential components of a spectrogoniometer are given below:

- **Collimator:** which provides the parallel incident rays
- **Rotating base:** (or prism holder plate) on which the prism is placed
- **Goniometer:** or vernier scale
- **Telescope:** which receives the parallel emerging rays



- **Explain the role of each component of the instrument**

4. Required Questions

1. Give a definition of light dispersion?
2. Calculate the angle A

θ_1 (°)	θ_2 (°)	A (°)	ΔA (°)

3. Visualization of the ray spectrum using mercury Hg, cadmium Cd, or sodium Na vapor lamp; describe this spectrum
   What is the color of the most deviated ray?
   What is the color of the least deviated ray?
   The deviation of radiation depends on their wavelength? How?

4. Calculation of minimum deviation D_m and index n

Colors	λ (nm) Hg	A (°)	D_m (°)	n	Δn
Red	690.7				
Yellow	577-579.1				
Green	491.6-496				
Blue	435.8				

5. Compare the wavelength λ and D_m
6. Calculate n and Δn
7. Draw the graph n = f ($1/\lambda^2$)
8. Discuss the results and give a conclusion