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B.Sc (Part-II) Hons
Paper-III

Resolving power of a Spectroscope and a Microscope.

Resolving power of a Spectroscope:— The resolving power R of a spectroscope is defined as the ratio of the wavelength λ to the smallest change in wavelength $d\lambda$, that can be resolved.

Thus $R = \frac{\lambda}{d\lambda}$

If $d\theta$ be the smallest angle that can be resolved in the image space

we may put

$$d\lambda = \frac{d\theta}{D}$$

Where D is dispersive power of the spectroscope and is defined as the rate of variation of deviation with wavelength $\left(D = \frac{d\theta}{d\lambda}\right)$

$$\therefore R = D\frac{\lambda}{d\theta}$$

As we have shown above for a rectangular aperture of width e, we have

$$d\theta = \frac{\lambda}{e}$$

Hence the above expression becomes

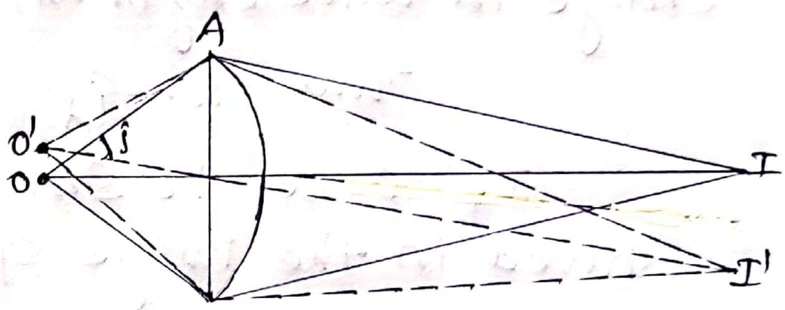
$$R = De$$

This is required formula of resolving power of a spectroscope.

Resolving power of a Microscope:

—— The resolving power of a microscope represent its ability to form distinctly separate image of two objects lying close together. It is measured by the Smallest distance between two point-objects whose images are just resolved by the objective of the microscope. The Smaller is the distance, the higher is said to be the Resolving power.

Let o and o' be two point-objects whose images are just resolved by the



objeetive AB of a microscope. Let i be the semi vertical angle of the Cone of rays received by the objective from O.

The boundary of the objective acts as a circular aperture. Hence the images of o and o' formed by the objective are actually Fraunhofer diffraction pattern. Each pattern consists of a central brights disc Surrounded by a Series of alternate dark and bright rings. The centres of the discs lie at I and I' the geometrical images of of o and o' respectively.

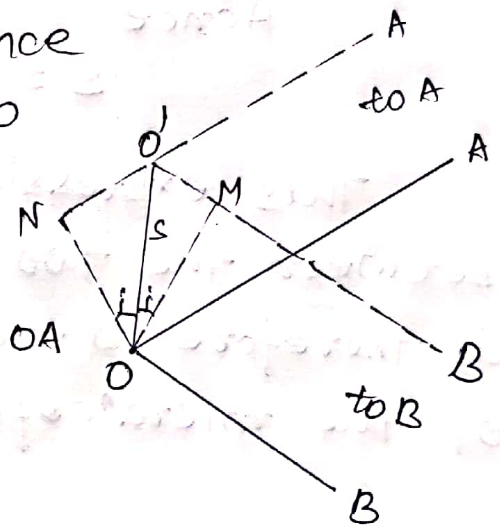
According to criterion o and o' will be just resolved when the Centre I of the disc due to o falls on the first dark ring due to O' and vice-versa. This means that for just resolving, the waves from O', after diffraction by the objective, must from the first dark ring passing through I. Airy has shown that this will happen the path difference between the extreme rays, O'BI − O'AI is given by

$$O'B - O'AI = 1.22\lambda$$

Since the path AI and BI are equal, the above Condition becomes

$$O'B - O'A = 1.22\lambda \quad \text{——} (1)$$

Let s be the distance between O and O'. As O and O' are very close together, we can take O'A to be parallel to OA and O'B, parallel to OB



from the figure

$$O'B - OB = O'M = s\sin i$$

and $OA - O'A = O'N = s\sin i$

Adding these equations and remembering that $OA = OB$, we get

$$O'B - O'A = 2s\sin i$$

Substituting this value of $O'B - O'A$ in eqn (1)

$$2s\sin i = 1.22\lambda$$

$$\text{or } s = \frac{1.22\lambda}{2\sin i}$$

If the space between the object and the objective is filled with an oil of refractive index μ, then

$$S = \frac{1.22\lambda}{2\mu \sin i}$$

because the path difference $O'B - O'A$ is then multiplied by μ.

The quantity $\mu \sin i$ is called the numerical aperture (NA) of the objective

Hence

$$S = \frac{1.22\lambda}{2 \cdot N.A}$$

This expression gives the linear distance between the two objects just resolved and is therefore, a measure of the resolving power of the microscope.