Experiment No. 5

Object: To verify the expression for the resolving power of a Telescope.

Apparatus Required: Telescope, a rectangular adjustable slit with micrometer arrangement, parallel double slit scratched on glass slide, light source of narrow opening and meter scale.

Formula Used:

(i) The theoretical value of the resolving power of telescope is

$$RP_T = \frac{a}{\lambda}$$

(ii) The experimental value of the resolving power of telescope is

$$RP_E = \frac{D}{d}$$

Hence, verify that

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

Where, λ = mean wavelength of light employed,

a = width of the rectangular slit for just resolution of two slits,

d = separation between the two nearby slits,

D = distance of the double slits from the objective of the telescope.

Procedure:

- First, mount the double slit glass on a stand such that the two slits are vertical and then place it closer to the source of light so that the two slits are clearly visible through the telescope.
- Then, mount the telescope on another stand such that its axis lies horizontal. Fix the adjustable slit vertically on the objective of the telescope. Place the two stands at a suitable distance.
- Now open the adjustable slit completely with the help of micrometer screw provided and adjust the focus using rack and pinion screw of the telescope so that the two slits are sharply visible in the field of view of the eyepiece of telescope.
- Decrease the width of the slit with the help of micrometer screw till the two slits come closer and closer to attain the just resolved position. At this point, the two slits just merge and appear like one. Note down the reading of the micrometer. Further decrease the width of the slit such that the field of view becomes completely dark and note down the micrometer reading. The difference of the two readings gives the width of the slit a just sufficient to resolve the two slits.
- Measure the distance between the rectangular slit on the telescope and the double slit which gives D.
- Repeat the experiment by increasing the distance D in equal steps.
- Measure the separation between the two slits d with the help of traveling microscope. Set the crosswire tangential on the left slit and note down the reading on horizontal scale. Then set the crosswire tangential on the right slit and again note down the reading. The difference between two readings for the two positions of the crosswire gives the separation between the slits.
- Repeat the above exercise at five places along the vertical line. The mean of five readings gives the mean separation between the two slits d.

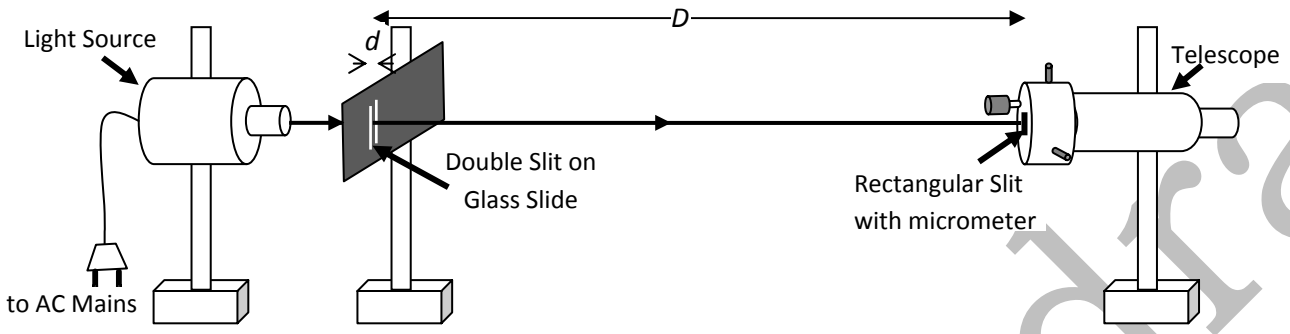

Figure: Experimental arrangement to observed just resolved position of the two slits.

Observations:

(i) Mean value of wavelength of light used, λ = 5500 Å = 5500 x 10^{-8} cm.

(ii) Table for determination of width of slit (a) for just resolve position:

Least count of micrometer screw = …….. cm

Sr. No.	**Distance D in cm**	**Micrometer reading in cm**						**Difference a=(TR_1 ~ TR_2)**
		When two slits merge and appear one			**When two slits completely disappear**			
		MSR	**VSR**	**TR_1**	**MSR**	**VSR**	**TR_2**	
1	D_1 = 100							a_1 =
2	D_2 = 120							a_2 =
3	D_3 = 140							a_3 =
4	D_4 = 160							a_4 =

(iii) Table for determination of the separation between two slits (d):

Least count of microscope = ……. cm

Sr. No.	**Travelling microscope reading in cm**						**Difference d=(L~R)**
	For Left Slit			**For Right slit**			
	MSR	**VSR**	**TR(L)**	**MSR**	**VSR**	**TR(R)**	
1							
2							
3							
4							
5							
						Mean, d	

Calculation:

The theoretical value of the resolving power of telescope is

$$RP_T = \frac{a}{\lambda}$$

The experimental value of the resolving power of telescope is

$$RP_E = \frac{D}{d}$$

Sr. No.	Distance *D* in cm	Theoretical Resolving Power	Experimental Resolving Power
1	$D_1 = 100$	$a_1 / \lambda =$	$D_1 / d =$
2	$D_2 = 120$	$a_2 / \lambda =$	$D_2 / d =$
3	$D_3 = 140$	$a_3 / \lambda =$	$D_3 / d =$
4	$D_4 = 160$	$a_4 / \lambda =$	$D_4 / d =$

Result: The values of theoretical and experimental resolving powers of the telescope at each distance are exactly matching. Hence the expression for the resolving power of telescope is verified.

Precautions and Sources of Errors:

(1) The axis of telescope should be horizontal and perpendicular to the plane of the double lit.
(2) The double slit on glass slide and adjustable rectangular slit should be vertical.
(3) Double lit and the telescope should exactly at the same height.
(4) Backlash error in the micrometer screw should be avoided.
(5) The just resolved position of the slits must be exactly located.
(6) The distance *D* should be measured from the rectangular slit of the telescope to the double slit.