EXPERIMENT

Object: **To determine diameter/thickness of a thin wire by diffraction method.**

Apparatus: Optical bench, spirit level, wire fixed in a frame, slit, micrometer with eye-piece and monochromatic source of light (Na lamp)

Formula Used: The diameter d of the wire is given by

$$d = \lambda D_0/\beta$$

where λ is the wavelength of the monochromatic light, β is the fringe width and D_0 is the actual distance between the wire and the screen (eye-piece).

Procedure: The following adjustment must be done prior to the actual measurement:

(1) First of all see with the naked eye whether the direction of the light from the sodium lamp is along the axis of the optical bench or not If no so adjust the bench to get the light from the sodium lamp along it.

(2) Using the spirit level the bed of the optical bench should be made horizontal with the help of the levelling screws.

(3) Mount the slit in its place. Insert the eye piece in its groove and focus it on the cross-wires. One of the cross wires is made vertical. Adjust the eyepiece height equal to that of the slit.

(4) Rotate the slit to make it parallel to the vertical cross-wire with the help of its side screw.

(5) Mount the wire-frame inbetween the slit and the eyepiece at a proper height. Adjust the wire parallel to the slit (or vertical crosswire). Now if the wire, the eyepiece and the slit are collinear, a darker region is seen in the field of view. It is the geometrical shadow region of the wire where diffracted light from both the sides of the wire overlap and hence the interference fringes (similar to the case of double slit interference fringes) would be observed in this darker region.

(6) With the proper adjustment of the slit width and the side screws of the wire frame interference fringes are distinctly seen when the wire is exactly parallel to the slit.

4a. Removal of the lateral shift and measurement of β:

(1) The eye piece is moved away from the wire and the fringe pattern is constantly observed through the eye piece. If the line joining the wire and the slit is not parallel to the bench axis, the fringe pattern shifts either towards right or left from the cross wire during this process.

Precautions:

1. Lateral shift must be removed before measuring β.
2. While using the micrometer screw for fringe width, back-lash error should be avoided by maintaining its motion unidirectional.
3. The slit width should be made as narrow as possible.

This is called lateral shift. To remove this the wire-mount is slightly moved in a direction opposite to the direction of the fringe shift.

(2) Step (1 is to be repeated till the cross wire remains at the same fringe while the eye piece is moved away from the wire and the lateral fringe shift is completely removed.

(3) Now the fringe width β can be measured and the data can be collected as shown in the observation table.

4b. Measurement of D_0 : The bench correction

Since the marks engraved on the mounts of slit, wire and the eye piece in order to read their positions are not at the proper place, the actual value of D_0 is different from its apparent value read on the bench. To find out the actual value of D_0 a rod of known length is held in such a way that its one end just touches the wire and the other end just touches the cross wire. Let the apparent distance between the wire and the eye piece on the bench in this situation be q cms and the actual length of the rod be p cms then

Bench correction $S = q - p$

And actual distance $D_0 = D - S$

5. Observations: (A) Measurement of D:

Actual length of the rod	p =	cm
Apparent length of the rod read from the bench	q =	cm
Bench error correction	=	cm
Uncorrected D	=	cm
Corrected	=	cm

(B) Measurement of β:

Pitch of the screws of the micrometer

No.of division on the circular scale

Least count of the micrometer

5a. Observation Table for β:

S. No. of fringes	Micrometer Reading			Separation of n fringes, n =	Average
	MS	CS	Total		

Calculations: Now using the measured D and β and the known value of λ the diameter of the wire is calculated.

Result: The diameter/thickness of the given wire is calculated to be ± cm

References: Principle of Optics by B.K. Mathur