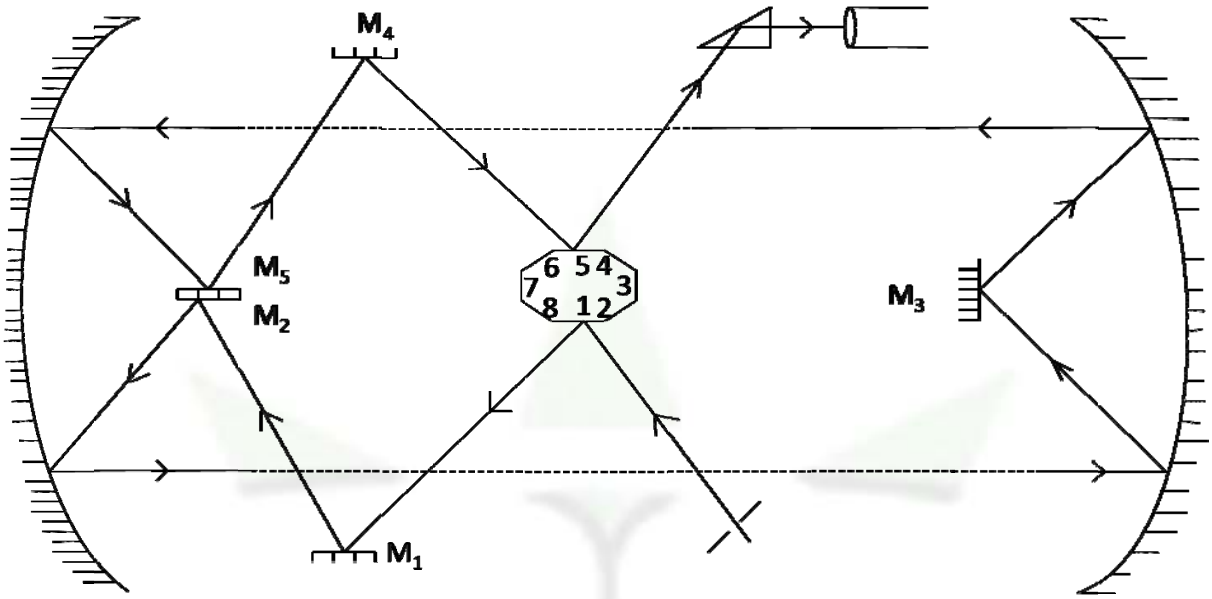
Velocity Of Light – Michelson Octagonal Mirror Method

Velocity of light: by Michelson's octagonal mirror method



Michelson's octagonal mirror M consists of an equiangular octagonal mirror of highly polished metallic faces and the mirror can be rotated about a horizontal axis passing through its centre at a constant speed by a motor.

Ray from slid S is incident at the point A on face no. 1 (say) of the octagonal mirror M. The ray reflected from M suffers successive reflections at M_1 and M_2 to fall on a very large concave reflector R of about 930 cm radius. Since M_2 is at the focus of R_1 ray after reflection from R_1 becomes parallel to the principal axis and traveling through a long distance, the ray is incident on an exactly similar concave mirror R_2 and comes to focus on the mirror M_3. Ray reflected from M_3 falls on R_2 gets reflected parallel to the principal axis and comes to focus at M4 by the concave mirror R_1. From M_4 it is further reflected by the mirror M_5 and falls at the point E on face no. 5 of the octagonal mirror M. From E the ray is deviated by a total reflecting prism P and is received by a telescope on the cross-wire of the telescope an image of slit S is formed.

The mirror M is now set into rotation at a constant speed, consider an instant when the position of M is as shown, at that instant flash of light is reflected from A and by the time it reaches the point E via the path shown the face no 5 changes its position and since the mirror (face no 5) has rotated by some angle light reflected from it will also rotate twice of that angle and following a different path, it does not produce any image at the cross wire of the telescope.

The speed of rotation of mirror is increased continuously till the image of the slits reappears at the cross wire for the first time. This will happen if the face no. 4 can exactly occupy the position of face no. 5 as shown i.e. the mirror M can make $1/8^{th}$ of a complete rotation by the time ray from A goes up to E. The frequency of rotation of mirror M is noted.

The speed of rotation of M is increased further the image of slits disappears from cross-wire and reappears again when the speed of rotation is such that the face no. 3 exactly occupies the position of the face no. 5 i.e. the mirror makes 2/8th of a complete rotation and so on.

Calculation:

Let

2d = optical path covered by the ray in going from point A to E

n = frequency of rotation of the mirror M when the image reappears at the cross wire for the first time.

Time taken to make one complete rotation = 1/n sec

Time taken to make 1/8th complete rotation=1/8n sec

$$c = \frac{2d}{t} = \frac{2d}{1/8n} = 16nd$$