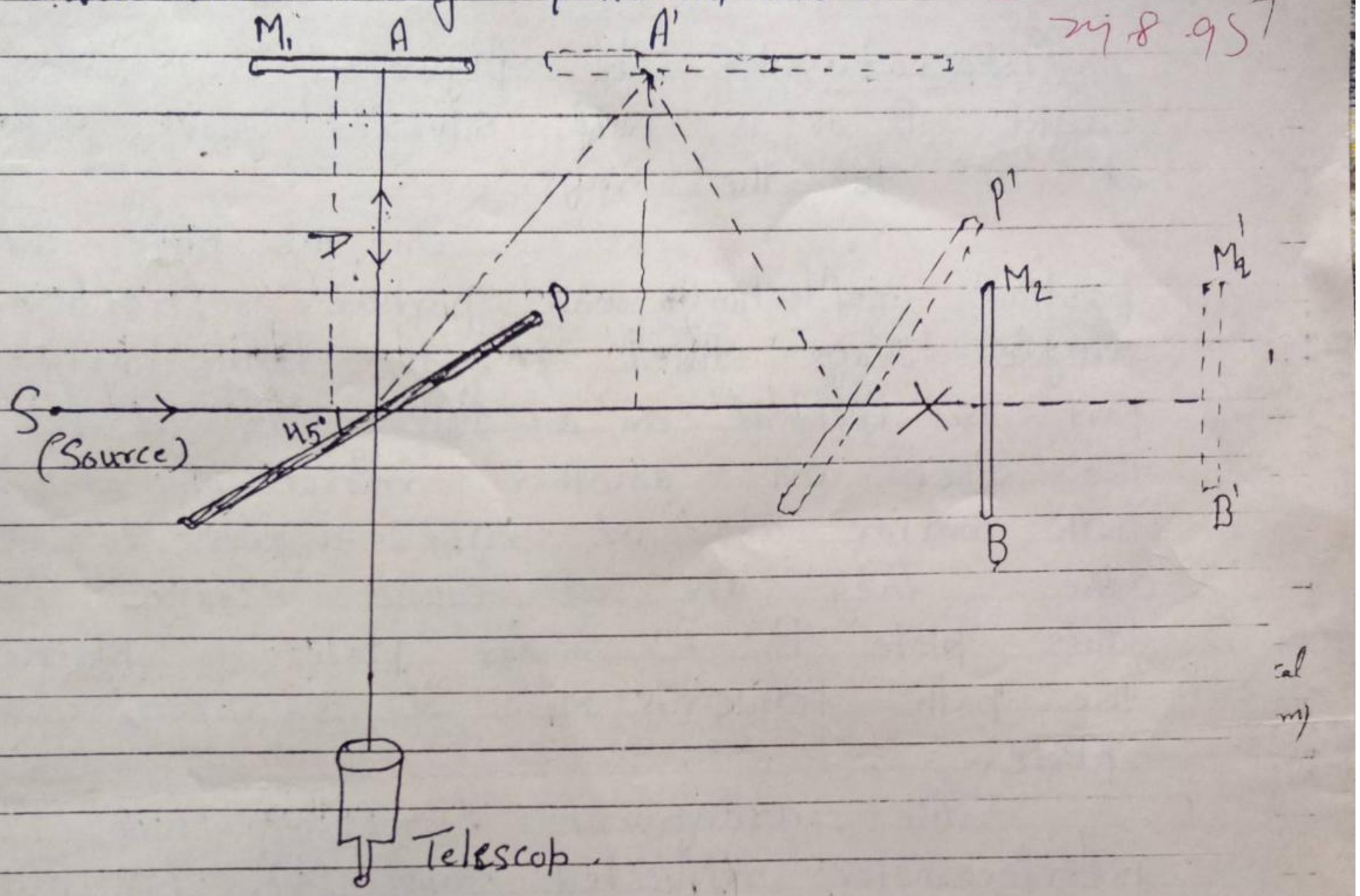
MICHELSON-MORLEY EXPERIMENT

① Discribe Michelson-Moredy experiment. Discuss the importantace of the experiment in the develop-ment of the special theory of relativity.

Ans :⇒ Michelson-Morley experiment (1887) :



Aim of the experiment :⇒ From Newton mechanics we assume on absalute frame of refrence fixed in distant stars. All displacements and velocity are measured with respect to that frame. Inetial frame of refrence was a derivation frome this absolute frame of refrence. But such absolute frame was never found. Finaly it was assumed that Superflous medium called 'ether' was all pervading. Velocity of light is measured with respect to ether.

According to Gallilean relativity velocity of light should be C+V or C-V. experimental measurment claim that

velocity of light is always constant irres
-pective of frame of refrence. To test the
existence of ether. Michelson-Mordey perfor
-med the following experiment.

Apparatus :→ In figur. S is source of
light. P is a helf silvered glass plate inclined
at 45° to the rays.

On the plate there is
partial reflection and partial refrection A
Single rays divied in to two parts. One
part is incident on a mirrer M_2 at B' and
the other on another mirrer M_1 at A'.
Both mirror are at right angles to each
other. They are at eaual distance from the
glass plate P. A similar plate is placed in
the path towords M_2. It is called Compensating
plate.

The arangment is nothing. But Michdson
interferometer reffdected rays from M_1 and M_2
interfere in the telescop. Bright and dark
fringes are froned.

Calculation :→ Let C = velocity of light
V = velocity of earth throu
-gh ether.

There earth is moving from deft to right
D = distance of mirror from the
Time for round trip from P to my
back.

$$t_1 = \frac{D}{C-V} + \frac{D}{C+V} = D\left\{\frac{C+V+C-V}{C^2-V^2}\right\}$$

$$= \frac{2DC}{C^2-V^2}$$

$$= \frac{2DC}{C^2\{1 - v^2/C^2\}} = \frac{2D}{C\{1 - v^2/C^2\}} = \frac{2D(1 - v^2/C^2)^{-1}}{C}$$

$$\therefore t_1 = \frac{2D\{C + v^2/C^2\}}{C} \quad \text{---------- (i) \{from Bionomical theorm\}}$$

With the velocity of the earth, the mirror M_1 also moves. Hence resultant velocity of light $= \sqrt{C^2 - v^2}$

Hence time for round trip to M_1.

$$t_2 = \frac{2D}{\sqrt{C^2 - v^2}} = \frac{2D}{C\{1 - v^2/C^2)^{1/2}}$$

$$\therefore t_2 = \frac{2D\{1 - v^2/C^2)^{-\frac{1}{2}}}{C} \quad \text{---------- (II) (form Bionomical theorem)}$$

Time difference $= t_1 - t_2$

$$= \frac{2D(1 + v^2/C^2)}{C} - \frac{2D(1 + \frac{1}{2}v^2/C^2)}{C}$$

$$= 2D\{1 + v^2/C^2 - 1 - \tfrac{1}{2}v^2/C^2\}$$

$$= \frac{2Dv^2}{2C \cdot C^2} = \frac{Dv^2}{C^3} \quad \text{---------- (III)}$$

Therefore,

Corresponding path difference

$$= \frac{\lambda Dv^2}{TC^3}$$

$\because CT = \lambda$

$\therefore$ Path difference $= \frac{\lambda \cdot Dv^2}{CT \cdot C^2} = \frac{\lambda \cdot Dv^2}{\lambda \cdot C^2}$

$\therefore$ Number of fringe shift $= \frac{Dv^2}{\lambda C^2}$ ---------- (iv)

To make the result more clear the whole apparatus was roteted by 90°. Thus fringe shift was double.

$$\text{i-e. Fringe shift} = \frac{2Dv^2}{\lambda c^2} \quad \text{---(v)}$$

The experiment was repeated for a number of time.

But no - fring shift was round.

Hence it was confirned that these in no medium like ether in the nature

Postulates of Special theory of relativity.

(v) All physical law have Some from in all intetial frame of refrence.

(2) Velocity of light remains Consdant irrespective of the relative motion between Source and Observer.