Michelson interferometer

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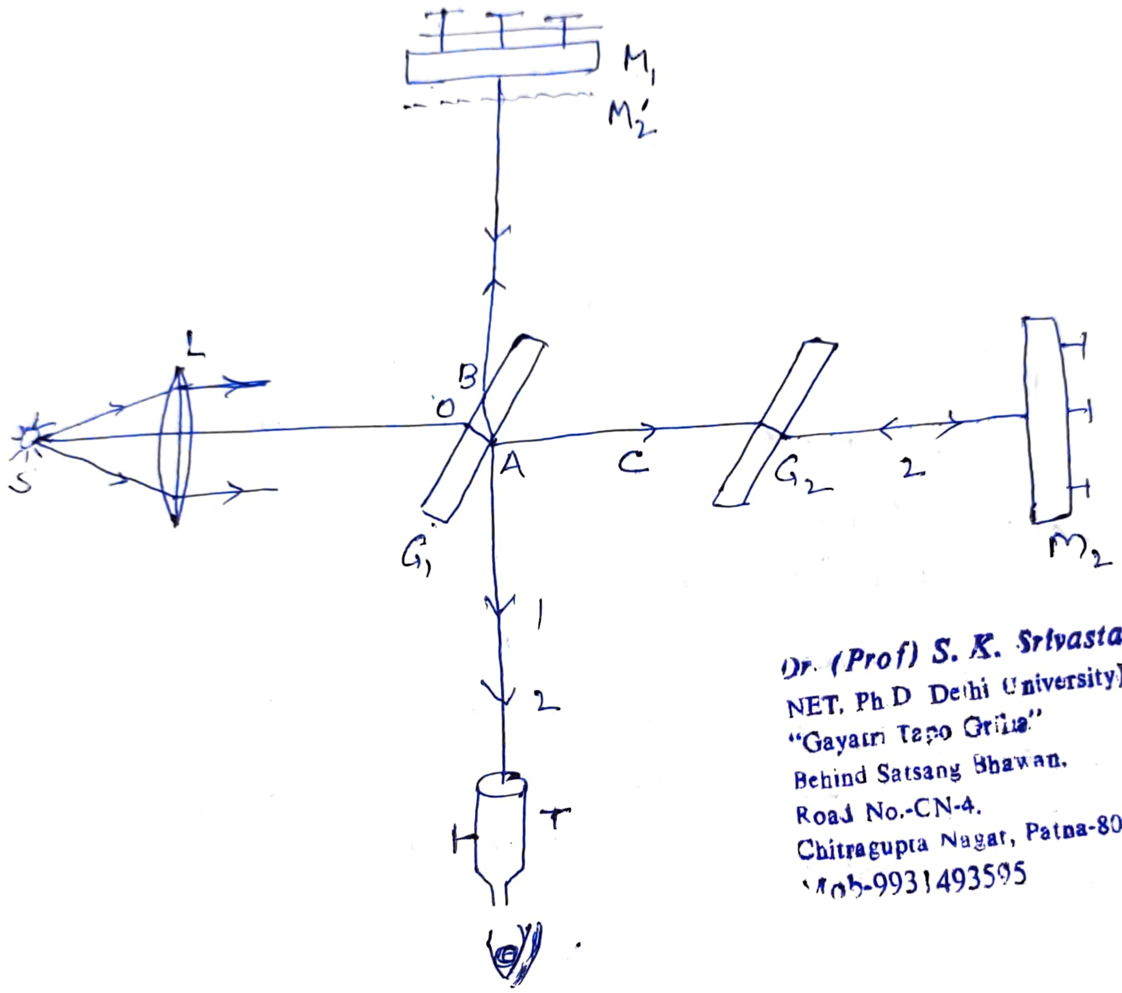
Q Describe the construction and working of Michelsons interferometer. Describe the formation of sharp fringes and explain how is this interferometer is used to measure the wavelength of monochromatic light?



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An interferometer is an instrument in which the phenomenon of interference is used to make precise measurements of wavelengths.

In Michelson interferometer, a beam of light from an extended source is divided into two parts of equal intensities by partial reflection and refraction. These beams travel in two mutually perpendicular direction and come together after reflection from plane mirrors. The beams overlap on each other and produces interference fringes.

Construction :-

It Consists of a beam splitter G_1, a Compensating plate G_2, and two plane mirrors M_1 and M_2. The beam Splitter G_1 is partially silvered plane parallel glass plate. The Compensating plate G_2 is a simple plane parallel glass plate having the same thickness as G_1. The two plates G_1 and G_2 are held parallel to each other and are inclined at an angle of 45° with respect to the mirror M_2. The mirror M_1 is mounted on a Carriage and Can be moved exactly parallel to itself with the help of a micrometer Screw. The distance through which the mirror M_1 is moved Can be read with the help of a graduated drum attached to the screw. Displacement of order of $0.1\,\mu m$ ($1000\,\text{Å}$) can be easily read.

The Plane mirrors M_1 and M_2 Can be made perfectly perpendicular with the help of the fine Screws attached to them. The interference bands are observed in the field of view of the telescope T.

Working

Monochromatic light from an extended source S is rendered parallel by means of a Collimating lens L and is made incident on the beam splitter G_1. It is partly reflected at the back surface of G_1 along AB and partly transmitted along AC.

The beam AB travels normally towards the plane mirror M_1 and is reflected back along the same path and comes out along AT.

The transmitted beam travels towards the mirror M_2 and is reflected back along the same path. It is reflected at the back surface of G_1 and proceed along AT. The two beams received along AT are produced from a single source through division of amplitude and are hence Coherent. The superposition of these beams leads to interference and produces interference fringes.

From fig. it is clearly seen that a light ray starting from S and undergoing reflection at the Mirror M_1 passes through the glass plate G_1 three times. On the other hand, in the absence of plate G_2, the ray reflected at M_2 travels through the glass plate G_1 only once. For compensating this path difference, a compensating plate G_2 of the same thickness is inserted into the path AC and is held exactly parallel to G_1.

If we look into the instrument from T, we see mirror M_1 and in addition we see a virtual image M_2' of M_2. Depending on the position of the mirrors, image M_2' may be in front of, or behind, or exactly coincident with mirror M_1.

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