THE MICHELSON INTERFEROMETER AS AN APPARATUS FOR LECTURE DEMONSTRATIONS

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FEW instruments have played a role in history comparable with that of the Michelson interferometer. Therefore, familiarity with the construction and operation of this instrument is important to students of optics. We have in mind not the repetition in the auditorium of the classical experiment of Michelson, but the demonstration of certain interference phenomena with the help of this apparatus.

In recent years, the demonstration of the Michelson interferometer has obtained a secure place in lectures on optics at Moscow University. We have not encountered any indications in the literature of a similar use of this instrument. Therefore, we shall comment briefly on our experience in setting up new lecture demonstrations with this instrument.

We have used an educational interferometer, of type IZK-452, prepared by our industry for the Moscow University, where it was mounted on a special trolley constructed by S. I. Usagin. Without spending time on the well-known arrangement of the instrument, we point out that our model has a mirror 70 mm in diameter and optical arms 320 mm long. The dimensions of the apparatus make it possible for students to examine its construction during the lecture and especially during the time between lectures, when the apparatus is available for close scrutiny. The quality of the optics of the interferometer is entirely satisfactory for demonstration purposes, but the mechanical construction of the apparatus, which was carried out without any consideration of the specific requirements of demonstration work, required a number of alterations (Fig. 1).

The following were used as light sources for the interferometer: a 100-watt concentrated incandescent light, an 18-watt sodium-vapor light (DNaS18) and a 20-watt cadmium vapor light (DKdS20), all prepared by our industry. The light intensity of the entire system of the interferometer is sufficient for use in auditoria seating up to 500. The interference phenomena are demonstrated by projection on a screen placed at a distance of 3 — 5 meters from the apparatus.

We demonstrate the following phenomena with the help of the interferometer:

1. Interference fringes of equal thickness produced in an air wedge formed when the mirrors of the apparatus are not strictly perpendicular to each other. During the course of the demonstration, it is easy to show the dependence of the width of the interference fringes on the taper of the wedge by varying the angle between the mirrors. The dependence of the location of the fringes on the screen on the orientation in space of the edge of the wedge can also be demonstrated. These experiments are carried out with white light from the incandescent lamp and with the slit located at the entrance to the collimator of the apparatus.

2. The dependence of the number of visible interference orders on the degree of monochromaticity of the light beams used can be demonstrated by the use of interference light filters with a pass band of the order of 100 — 300 A and a white light source (Fig. 2). In this experiment, as in the subsequent demonstrations, the dependence of the visibility of the observed fringes on the path difference of the interfering light beams can be shown by a parallel displacement of one

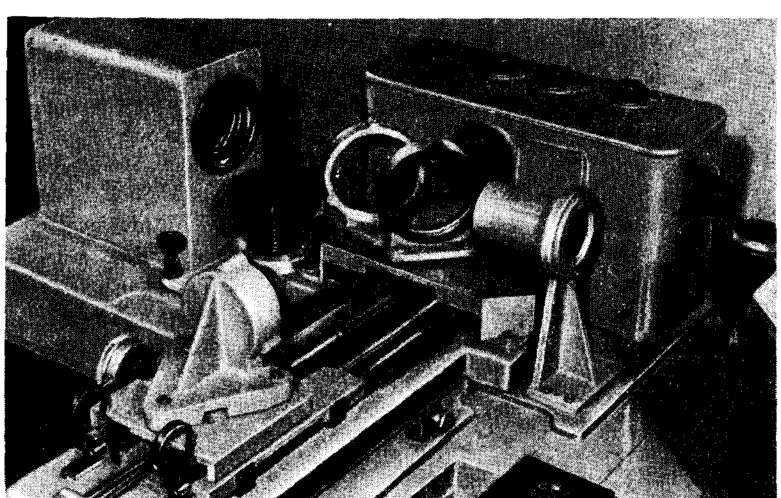

FIG. 1. Student model of the Michelson interferometer.

FIG. 2. Interference fringes of equal thickness.

of the mirrors of the apparatus by means of a lead screw.

3. By use of the sodium lamp, one can demonstrate the periodic increase and decrease of the visibility of the interference images, produced by the presence of a spectral doublet in the radiation of the light source.

4. By introduction of a heated body, the arm of a man, a gaseous jet, etc. in one of the arms of the apparatus, the sensitivity of the interference picture to a small change in the optical properties of the medium can be demonstrated. The possibility is shown of the measurement of the index of refraction of the medium by the interference method as well as of the study of its optical inhomogeneities.

5. When the mirrors of the interferometer are strictly perpendicular and a wide beam of rays from the cadmium lamp is used without an entrance slit, the classical case of interference in a plane-parallel air layer is first demonstrated to the auditorium: a system of concentric bands of equal inclination (rings) is obtained in the focal plane of the viewing objective of the instrument. This picture is either projected on the screen in the usual fashion or is back-projected on a translucent screen of ground glass. Rings of diameter greater than two meters can be seen on the screen.

From what has been said above, it follows that the Michelson interferometer makes it possible to show in the lecture practically the entire set of interference phenomena studied in the general physics course. Naturally, however, it is also desirable to use this method to demonstrate another condition for observation of clear-cut optical interference, namely the necessity of identical polarization of the interfering light beams. The Michelson interferometer is also suitable for these purposes because of the wide separation of the

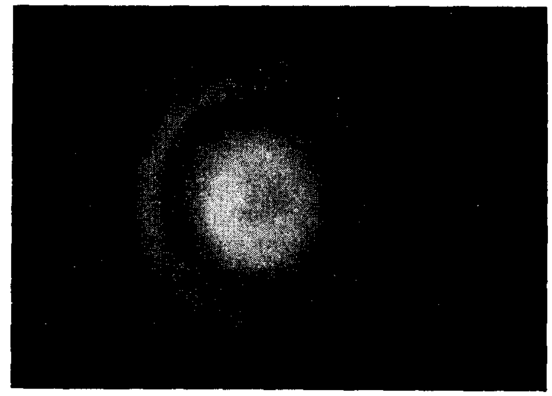

FIG. 3. Interference rings.

light beams. But the following technical difficulty is encountered here. All ready-made polarization devices available to us proved to be of insufficiently high quality for the interference experiments, including the experiment for the observation of fringes of equal inclination. A polaroid film, used without any base layer, gives the best results. But we have not succeeded to date in preparing satisfactory discs of these polaroids of diameter greater than 15 – 20 mm. This circumstance sharply decreases the transmission of the apparatus, although the experiment devised for explaining the role of polarization of light in interference has been successful.

We made up for the partial failure of the polarization experiments with the Michelson interferometer in the lecture with a corresponding successful demonstration with the Jamin apparatus, in which the diameter of the light beams make it possible to use the small polaroid discs. We can recommend that this demonstration which is easily set up and is very significant in its physical scope be given everywhere where there is Jamin demonstration equipment available.

In conclusion, we observe that in accordance with our experiment, the demonstration model of the Michelson interferometer can be prepared successfully directly in the physics demonstration room with appropriate mirrors and plane-parallel glass plates. The quality of the planes of these elements of the apparatus should be maintained with accuracy to within 0.1 of the optical wavelength. The collimating and observing objectives of the apparatus should have focal lengths of about 250 mm; the projecting objective can have a focus of about 30 mm. Regular parallel displacement of the movable mirror amounts to several millimeters and is sufficient to change the inclination of the second mirror within the limits of 1 – 2 degrees.

Translated by R. T. Beyer