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Methodological Notes

HOME MADE MICHELSON INTERFEROMETER FOR EDUCATIONAL PURPOSES

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THE use of Michelson interferometers for physical demonstrations was dealt with in an earlier basic paper[1]. Inasmuch as the IZK-452 interferometer has been built to order for the Moscow State University and is not readily available, nor are also the plane parallel (to 0.1λ) plates mentioned in[1], the instrument is customarily not used for demonstrations. We describe in this connection a Michelson interferometer constructed in the physics laboratories of the Tomsk University. The plate used in it was polished plane-parallel accurate to 1 micron and plane to one-half ring, after which it was cut in two. One half (3) is coated with a semitransparent silver layer by evaporation in vacuum, and the other (4) is used for compensation. Each half measures 60×90 mm. Mirrors 1 and 2 are front-silvered and commercially obtainable (they can be taken from an epidiascope projector, from a microprojection attachment, etc.). The translational motion of mirror 2 is by means of mechanism 10, taken from the tube drive of an old microscope. The rotation of the "stationary" mirror about the vertical axis is by micrometer 7 and by coil spring 12, while rotation about the horizontal axis is by screw 8 and spring 11. The vertical and horizontal axes are set by means of pin 5 and 6 (see end of this note). In order to mount the moving mirror and the plates 3 and 4 vertically, three screws pass through the jaws of the clamps, which press against a metal liner. A wire is soldered horizontally in the middle of the opposite side and serves as the fulcrum for rotation. The glass is protected with a flannel lining.

The instrument is mounted on a $300 \times 300 \times 10$ mm metal plate. It is secured with bolt to a marble plate lying on felt. The interference pattern produced in this case is quite stable. The length of the optical arms of the instrument is 180 mm, making it possible to place glass-filled cuvettes along the ray paths.

The adjustment of the instrument begins with mounting the mirrors and the plates vertically against a plumb line, and equalizing the lengths of the arms to within 1 mm. In order to mount plates 3 and 4 parallel, a piece of cardboard with a hole is placed along the path of a parallel beam from a home-made collimator. The observation is carried out in such a way that the light spot is on the image of the pupil in the semitransparent plate. In this case the rays are normal to the first plate. By turning screw 9, both images of the light spot are made to coincide. The remaining operations are in darkness. A PRK mercury lamp fed from an induction coil is placed at the focus of a condenser ($F \approx 100$ mm). The condenser is covered with a piece of cardboard, through which a hole is pricked with a needle. The parallel beam from the condenser is aimed at the semitransparent plate in such a way that the rays strike the mirrors normally. The observer looking through the semitransparent plate sees two images of the hole in the cardboard. By manipulating screws 7 and 8 he causes them to coincide. This can also be done with a source of white light (which is brighter). Three or four images of the hole are thus seen, and in the case of the arrangement corresponding to Fig. 1 it is necessary to align the two right-side images. If the cardboard is removed, a system of interference fringes should appear in the light of the mercury lamp. If not, mirror 1 is rotated about the axes until the fringes appear. Then, again manipulating screws 7 and 8, the central part of the ring pattern is brought into the field of view, and the same screws are manipulated in such a way that when the eye is moved from right to left and up and down new rings enter or leave the center of the pattern. This means that mirrors 1 and 2 are mounted perpendicular. Mirror 2 is then moved in a direction as to make the rings vanish as they enter the center. If mirror 2 is slightly turned in this case, then the center of the ring pattern will go out of the field of view. It is returned to its position by screws 7 and 8, and the operation is repeated until the dimensions of the rings become large and one or two rings fill the field of view. Then the mercury lamp is replaced by an incandescent lamp with a small illuminated surface or with a straight filament (a pinpoint lamp is best); the condenser is covered with a piece of tracing cloth and mirror 2 is alternately moved very slowly to and fro until rainbow-like interference fringes flash past against the background of the illuminated tracing cloth.

To exhibit the demonstration we use a home made collimator made of a tinplate tube with a slot 2 mm wide and a lens with $F = 240$ mm. The white-light source is a 17-volt, 170-watt incandescent lamp with a coiled flat filament measuring $\sim 3 \times 5$ mm, or an arc lamp.

The projection on the screen is effected in the following way. A short-focus lens (in our case—a condenser with $F \approx 50$ mm) is placed near the semitransparent plate to produce a near-focus image of the interference pattern. This image is projected on a screen located 4—5 meters away by a "Gelios" photo-

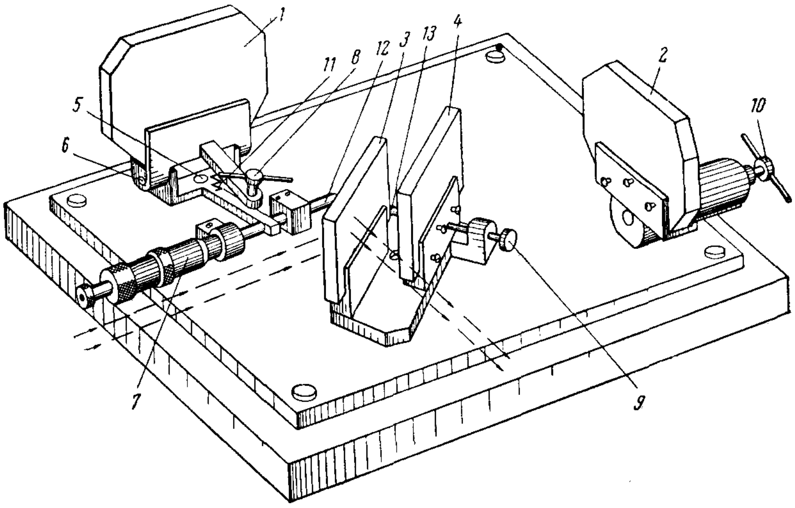

FIG. 1

graphic lens (F ≈ 40 mm). The pattern obtained is sufficiently bright and large, and can be shown in large lecture rooms (Fig. 2). By manipulating screws 7 and 8 one can vary the angle between the mirrors and show the variation of the widths of the fringes and in the orientation as functions of the position of the edge of the "imaginary" air wedge. The displacement of the fringes is demonstrated by placing a hand or a heated object in the path of the beam. A similar effect is obtained by passing a jet of hydrogen from a Kipp's apparatus or by inserting a thin film of a solution in the path of the ray. If a sodium lamp is available (DNAS, 18 or 140 watts), it is possible to demonstrate with the instrument the periodic variation of the visibility of the fringes as the mirror is displaced. In white light the fringe visibility decreases monotonically with increasing order of the interference.

To obtain equal-inclination curves, the mirrors are set strictly perpendicular and a converging beam from a DRSh-500 mercury lamp is focused on the mirror. Since such a setup can readily go out of adjustment, this experiment is best demonstrated with a Fabry-Perot etalon at an interval of 0.1—0.2 mm, as described in [2].

We note also that a very effective and bright picture of interference fringes of mixed origin can be demonstrated without any projection optics, by aiming onto the semitransparent plate a strongly converging beam of rays from a condenser illuminated by a source of white light with a small glowing surface (for example, a 17-volt 170-watt lamp with the filament assembly placed "edgewise"). The resultant pattern obtained at the center consists of large-diameter rings of great brightness, and is rich in very beautiful colors and hues, reminiscent of the wealth of color produced by interference of polarized rays. The central part of the pattern is made up of colors of one order of interference. It is quite sensitive to the least change in the path difference: a negligible amount of heating is sufficient to change the colors of the central spot radically, etc.

We note that the instrument can be used successfully as part of the physics laboratory experiments.

The use of the instrument for a considerable period of time has shown that it is more advantageous to locate the horizontal axis of rotation half-way in the plane of the mirror. In this case the horizontal bands will vary in width as the mirror is rotated about the horizontal axis, but the central achromatic fringe will retain its position.

FIG. 2

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[1] Velichkina, Shustin, and Yakovlev, UFN **74**, 381 (1961), Soviet Phys. Uspekhi **4**, 523 (1961).

[2] B. Sh. Perkal'skis and V. L. Larin, UFN **79**, 743 (1963), Soviet Phys. Uspekhi **6**, 326 (1963).

Translated by J. G. Adashko
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LENIN PRIZES FOR 1964

THE Lenin prizes, announced on 22 April 1964, included two for work in physics and radiophysics. A prize for basic research leading to the development of semiconductor quantum generators was awarded to B. M. Vul, head of the laboratory of the P. N. Lebedev Physics Institute of the Academy of Sciences and corresponding member of the Academy, to the staff members of the same institute Candidates of Physico-mathematical Sciences O. N. Krokhin, Yu. M. Popov, and A. P. Shotov, to the head of the laboratory of the Ioffe Physico-technical Institute, Doctor of Physico-mathematical Sciences D. N. Nasledov, to laboratory head S. M. Ryvkin, and to the staff members of the same institute A. A. Rogachev and V. V. Tsarenkov.

A prize for radar investigations of Venus, Mercury, and Mars was awarded to the director of the Institute of Radio and Electronics of the Academy of Sciences and chief of the project, Academician V. A. Kotel'nikov, and to the staff members of the same institute: Doctor of Physico-mathematical Sciences M. D. Kislik, V. M. Dubrovin, V. A. Morozov, G. M. Petrov, O. N. Rzhiga, Candidate of Technical Sciences A. M. Shakhovskiĭ, and chief of the Laboratory of the State Research Institute of the Communications Ministry, Candidate of Technical Sciences V. P. Minashin.

V. Vlasov