Michelson Interferometer

08557.00

Operating Instructions

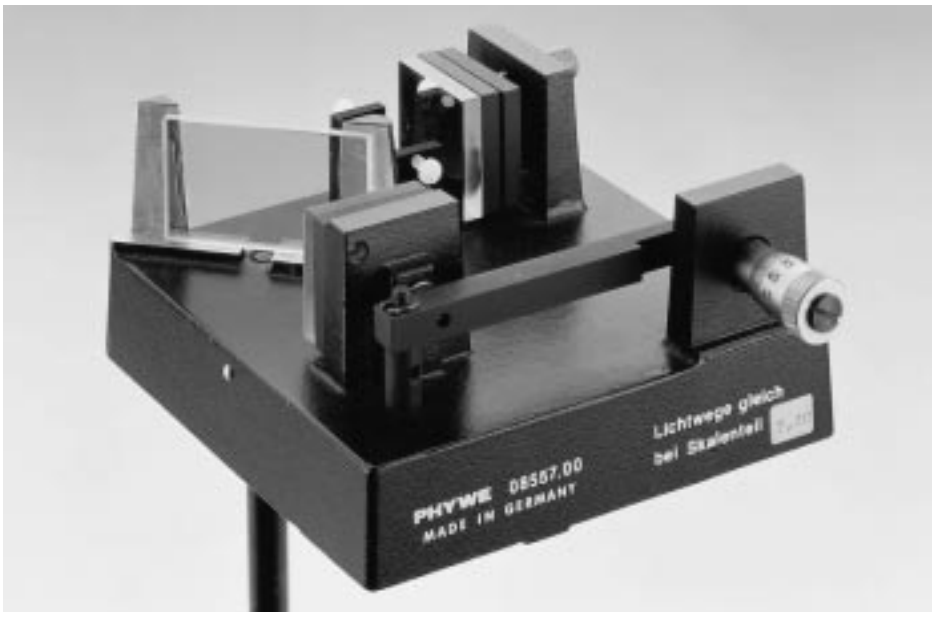

Fig. 1

1 PURPOSE AND FEATURES

In the Michelson interferometer, a light beam is divided into two beams of equal intensity which combine together again before leaving the interferometer. The path difference of the two beams can be changed by integer multiples of the wavelength, with simultaneous observation of the interference patterns which it generates.

The change in the path length can be read off from the interferometer, and allows the determination of wavelength when monochromatic light is used.

When spectrum lamps are used as light source, and with appropriate filters, the interferometer can also be used to determine coherence lengths.

In addition, the refractive index of suitable liquids, of air and of other gases can be determined.

2 FUNCTIONAL AND OPERATING ELEMENTS

The Michelson arrangement on the carrier plate (Fig. 2) consists of two surface mirrors S_1 and S_2 which are positioned at right angles to each other. Mirror S_1 is fixed, but can be tilted about two axes which are perpendicular to each other by means of adjusting screws on the back of it. Mirror S_2 can be moved in a direction perpendicular to itself by means of a micrometer screw and a 1:10 reduction lever. One graduation on the micrometer screw therefore corresponds to a mirror displacement of 1 µm.

The partially silvered mirror S_3 is positioned at the intersection of the normals to the two mirrors. It serves to divide the incident beam into two equal beams.

A holder between S_1 and S_3 accepts a measuring cell for the examination of gases. The rods supplied can be fitted into the threaded bore in the underside of the carrier plate.

3 HANDLING

Screw the longer rod into the interferometer (the shorter rod is for holding it in a magnetic base) to fix it in an optical bench at a distance of approximately 30 cm from the light

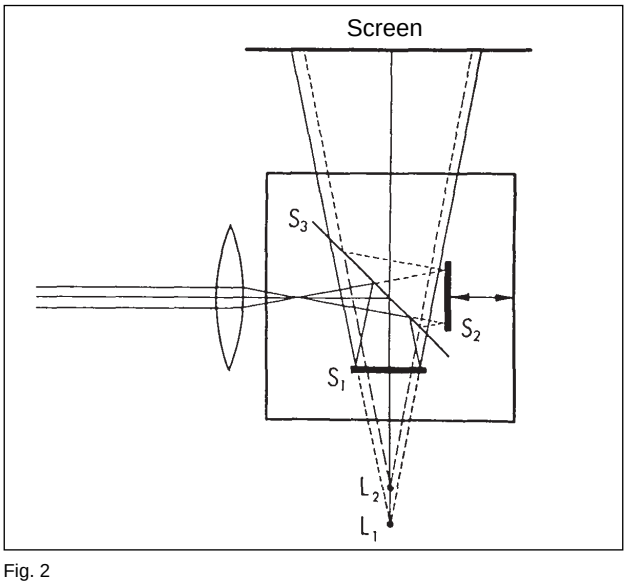

Fig. 2

source. When a laser is used as light source, as is most practical, then position a lens (f = 20 mm) halfway between the laser and the interferomenter to widen the laser beam. Before doing this, however, adjust the arrangement without the widening lens. The laser beam should meet the partially silvered mirror at a 45° angle. Two patches of light are to be seen on a screen, perpendicular to the incident light. Use the adjusting screws to bring these patches to exactly coincide on top of each other (two further light reflections of less intensity, which result from reflection from the treated back of the mirror, have no effect on the measurement).

Now place the lens for widening the light beam in position. As a rule a streaky interference pattern, resulting from a non-parallel alignment of the two mirrors, is now already to be seen. Carry out a sensitive re-adjustment with the adjusting screws to bring the interference pattern to the wanted concentric form.

The interferometer has an individual marking for the micrometer screw setting at which the paths of the divided beams are equal.
Because of the different light paths 2*d* (Fig. 3: think here of one mirror turned in the direction of the other) the divided beams have the phase difference:

$$\delta = \frac{2\pi}{\lambda} 2d \cos \theta \qquad (1)$$

(λ = the wavelength of the light)

As both divided beams have the same amplitude α, the intensity distribution is:

$$I \sim 4a^2 \cos^2 \frac{\delta}{2} \qquad (2)$$

Maximums therefore occur when δ is a multiple of 2π.
We have then:

$$2d \cos \theta = m\lambda; m = 1, 2, \ldots \qquad (3)$$

i.e. annular patterns are given for fixed *m* and *d*, as θ is a constant.
When the position of the mirror S_2 is changed, so that e.g. *d* increases, then according to (3) the ring diameter will increase, as *m* is fixed for this ring. A ring therefore disappears each time *d* is increased by $\lambda/2$.
To determine the wavelength of the light, it is best to start with an interference pattern with dark center, and then to displace mirror S_2 by the path distance *d* so that *n* dark zones are passed through. The wavelength is then:

$$\lambda = \frac{2d}{n} \qquad (4)$$

The direction in which the displacement mechanism is turned should not be reversed during a measurement, as otherwise measurement errors will occur because of the unavoidable deadtime of the micrometer screw.
With a recommended maximum value of *n* = 200, the possible setting error is:

$$\Delta d \leq \frac{d}{n} mit\ n = 200 \frac{\Delta d}{d} \leq 0{,}005 \qquad (5)$$

The wavelength determination can so be made with a relative error of 0.5%.
As the speed of propagation of the light, and so also the wavelength, is dependent upon the medium in which it is propagated, the Michelson interferometer can be used with additional accessories (see the List of Equipment) to determine the refractive index of air and of other gases, as well as of liquids (e.g. alcohol).
After carrying out an experiment with liquids, dry the interferometer with a warm current of air and subsequently put a few drops of oil on the bearings.
When the instrument is not in use, cover it with the plastic hood to protect the high-quality surface mirror from dust.

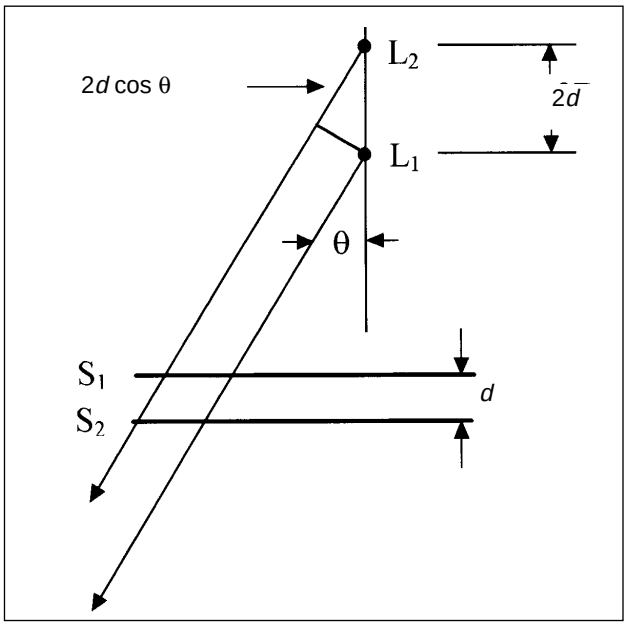

Fig. 3

4 LITERATURE

Versuchseinheiten Physik, Lichtwellen 2	16051.51
Laboratory Experiments Physics	16502.12

5 LIST OF EQUIPMENT

Michelson interferometer	08557.00
Laser, He-Ne, 0.2/1.0 mW, 220 V AC	08180.93
Lens, mounted, *f* +20 mm	08018.01
Lens holder	08012.00
For measurements with liquids	
Glass cell, 130 x 65 x 88 mm	08326.00
Lab lifting apparatus 200 x 230 mm	02074.01
For measurements with air/gases	
Glass cell for Faraday effect	08625.00
Digital manometer	03106.00
Hand-pump	

6 NOTE ON THE GUARANTEE

We guarantee the instrument supplied by us for a period of 6 months. This guarantee does not cover natural wear nor damage resulting from improper handling.
The manufacturer can only be held responsible for the function and safety characteristics of the instrument, when maintenance, repairs and changes to the instrument are only carried out by the manufacturer or by personnel who have been explicitly authorized by him to do so.