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Production of Near–Perfect Interferograms of Variable Visibility

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A method is given for producing interferograms of fringes that are straight and equally spaced. The intensity distribution obeys the cosine law. The visibility can be controlled over the entire range from zero to unity. The interferometer is rugged and practically free from vibration effects.

Key Words: Interference fringes, interferograms.

There appears to be considerable need for a method of producing interferograms (sets of interference fringes) of very straight, equally spaced, cosine-distribution fringes whose frequency (width) can be varied over a wide range with minimal change in intensity and with a wide range of controlled visibility. Figure 1 shows a method of accomplishing this. A cube-type [1][1] wavefront shearing prism receives monochromatic light from a point or narrow slit source. Nonlocalized fringes may be observed anywhere in the beam after its emergence from the prism. Fringes localized in the pupil of the lens (shown in fig. 1) may be observed by the eye when it is focused on the lens. The lens serves only as a light collector and need not be of high quality. A discussion of the fringes that appear in the pupil of the lens also applies to those appearing elsewhere.

The fringes may be photographed either by replacing the eye (shown in fig. 1) with a camera or by replacing the lens with a sheet of photographic emulsion.

The relative position of the fringes and their order at any chosen point depend upon the position of the source. A point source produces fringes of unit visibility. Small movements of the point source, parallel to the fringes, cause little or no change either in visibility or order at any chosen point in the field. Consequently, a narrow slit source, parallel to the fringes, also produces unit visibility, with considerable increase in available light.

If the source is moved perpendicular to the fringes, the fringe pattern moves, causing a uniform change in the order over the entire field. Consequently, a rotation or increase in width of the slit causes a decrease in visibility. The visibility is a function of width and orientation of the slit source.

If either a point or narrow slit source is adjusted for unit visibility, the visibility can be varied by the simple rotation of a plate of calcite (cut parallel to one of the cleavage planes), located as shown in figure 1. This provides two mutually noncoherent sources, each of which (when acting alone) produce fringes of unit visibility. A lateral separation of the two sources, produced by a rotation of the calcite plate, causes one set of fringes to become laterally displaced relative to the other. When this displacement equals one-half the fringe width, the visibility of the fringes is zero. When the displacement is zero the visibility is unity. Thus any desired visibility may be obtained.

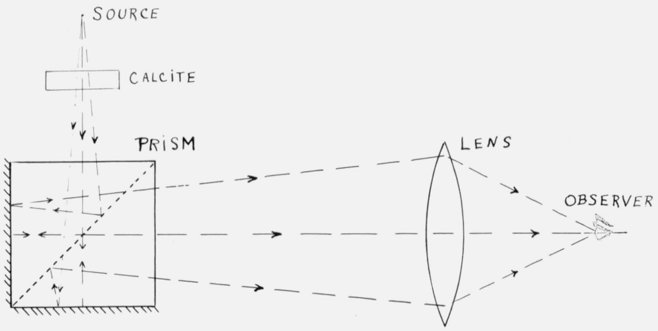

FIGURE 1. *Optics of an interferometer for obtaining straight, equally spaced fringes of variable visibility.*

The thickness of the calcite plate determines the sensitivity of its rotation relative to changes in visibility. The thinner the plate, the less is the change in visibility for a given rotation. However, if the full range of visibility is required then the thickness must be sufficient to provide a change in separation of the two sets of fringes of one-half fringe width.

[1] Figures in brackets indicate the literature references at the end of this paper.

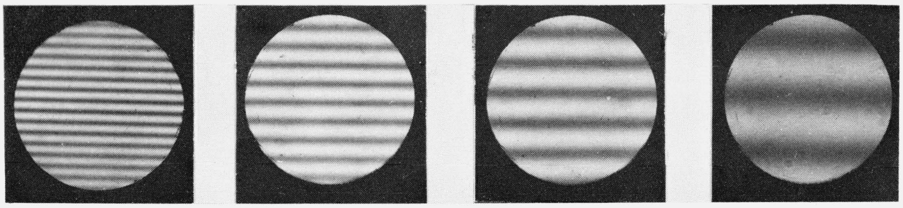

FIGURE 2. *Several interferograms of straight, equally spaced fringes of different widths.*

The width of the fringes, in the pupil of the lens, is

$$W = K(\Phi\rho)$$

where K is a constant, Φ is the angle of shear [2] and ρ the optical path from the source to the lens. Since the optical path, through the calcite plate, is different for the differently polarized images of the source the width of the two sets of fringes are slightly different. This difference, however, may be removed by using two similar calcite plates, cemented together with a 90° relative rotation [3].

The width of the fringes may be varied (fig. 2) by varying either Φ or ρ. Variation of ρ is obtained by varying the distance, from the prism to either the source or the lens. The angle of shear, Φ, can be varied by rotating one component of the prism relative to the other about an axis normal to the beam dividing plane. A more practical method of varying the fringe width is to use several prisms of different shear values and to perform intermediate variations in width by varying ρ.

It should be mentioned that if the angle of divergence of the beam of light, used for the interferogram, is too large, spherical aberration of plane surfaces (both of the calcite plate and the outer faces of the prism) will produce distortion in the fringe pattern.

References

[1] Saunders, J. B., A Simple, inexpensive wave front shearing interferometer, Applied Optics, **6,** No. 9, 1581 (Sept. 1967).

[2] Saunders, J. B., Wave front shearing prism interferometer, J. Res. Nat. Bur. Stand. (U.S.), 74C1&2, (Engr. and Instr.), No. 3, 155–171 (July–Sept. 1968).

[3] Strong, J., Concepts of Classical Optics, p. 133 (W. H. Freeman & Co., San Francisco, 1958).

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