535.4

A LECTURE DEMONSTRATION ON HOLOGRAPHY

O. A. SHUSTIN

Moscow State University

Usp. Fiz. Nauk 105, 361–362 (October, 1971)

As a result of the development of holographic methods of registration of the images of objects, the fundamental questions of holography now occupy a noticeable place in the general physics course offered in physics and physics-mathematics departments. However, no concrete descriptions exist at present which are suitable for showing a reconstructed holographic image simultaneously to a large audience.

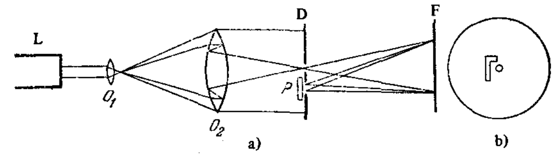
We have realized a demonstration of this sort, which allows us to demonstrate in a large auditorium, using comparatively simple means, the reconstruction of the image of a plane object and elucidate the basic properties of holograms.

The scheme for obtaining the hologram is similar to the one described before in[1] and is shown in Fig. a. An OSK-2 optical bench telescope, set to infinity, was used to broaden the light beam emerging from a He-Ne gas laser. Light from the laser L passed first through the 8.3× eyepiece of the telescope O_1 and then through the objective O_2 of focal length 1 m. From the objective of the telescope emerged, as a result, a broad beam of parallel rays (a plane wave).

However, besides this light beam, a converging light wave was also formed in the objective from the rays which had undergone reflection at, first, the front and, then, the rear surfaces of the objective. Two such rays are shown in Fig. a. This converging spherical wave was the reference light beam.

A transparency D (Fig. b), which was an opaque screen with two apertures cut in it, was placed perpendicular to the optical axis of the system at the place of convergence of the reference wave. The first circular aperture was in the center of the screen. The reference light wave propagated further through this aperture. The second aperture, cut in the form of the letter Γ, was the object whose hologram was being recorded on the photographic plate F. The dimensions of the letter Γ were 12 × 8 mm (width of cut ~ 2 mm), and was cut at a distance of 10 mm from the central circular aperture. A frosted glass P, placed in front of and close to the object (the Γ-shaped cut), scattered the light rays falling on the object. The use of the scatterer was essential, in order to get every region of the prospective hologram carry information about the whole object. A photographic plate of resolving power ~ 600 lines/mm was situated at a distance of about 20 cm from the object.

Thus, an interference pattern arising from the superposition of the spherical light waves, coming from the various points of the object, and the reference spherical light wave was recorded on the photoplate. Since the radii of curvature of the interfering waves near the photoplate are approximately the same, the method described corresponds to the production of a Fourier hologram[2].



The reconstruction of the holographic image was done in the following fashion. On illuminating the Fourier hologram with a parallel pencil of rays, we obtain, as is well known, real and virtual images at ±∞, or at the focal point of the lens used for the recovery of the image. Therefore, if we place the hologram in a beam of light emerging directly from a laser, then we may at a sufficiently large distance from the hologram, observe on the screen, without the aid of a lens, two sufficiently sharp images of the object, situated symmetrically about the undeflected laser beam. We used precisely this method for the recovery of the holographic image. When the distance from the hologram to the screen was ~ 5 m, the dimensions of the image in our case were 30 × 20 cm. To increase the degree of contrast for the image on the screen, the central undeflected beam may be removed by means of a black hollow catcher.

When a gas laser of optical power 10–15 mW is used, the illumination of the restored images on the screen is quite sufficient for them to be viewed in an auditorium seating 500 people.

Since the cross section of a laser beam is fairly small (diameter ~ 5 mm), a small part of the hologram participates in the recovery of the image. By moving the hologram in the plane perpendicular to the light beam, we can easily demonstrate the property that any section of the hologram can restore the image of the whole object.

Before showing the restored image, we can show on the screen through an epidiascope the photographic plate on which the hologram is recorded, and draw the attention of the audience to the fact that the distribution of the blackening on the photoplate bears no geometrical resemblance to the image restored with its help.

[1] J. W. C. Gates and S. J. Bennet, Nature 218, No. 5145, 942 (1968).

[2] G. W. Stroke, Introduction to Coherent Optics and Holography, Academic Press, New York, 1969.

Translated by A. K. Agyei