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Methodological Notes

DEMONSTRATION OF THE COHERENT PROPERTIES OF A GAS LASER

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IT is well known that it is impossible to produce a stationary interference pattern by illuminating two slits with an ordinary light source. To produce such a pattern it is necessary to decrease artificially the angular dimensions of the light source. This is why in Young's experiment an additional slit was introduced in the light beam propagating from the light source; the permissible width of this slit and the distance from the screen with the two slits can be estimated in simple fashion. However, the introduction of this slit, which ensures coherent illumination of the two initial slits, greatly reduces the useful light flux, thus making demonstration of this classical experiment difficult. At the same time, interference of light passing through two neighboring slits can be readily observed if they are illuminated with laser light, proving thereby that laser is a spatially coherent source of light. In the literature (see "Lazery" (Lasers), IL, 1963) such an experiment is described for a ruby laser and an infrared gas laser ($\lambda = 1.15\,\mu$). In this note we propose to use for this purpose a neon-helium laser operating at $0.63\,\mu$, which is more effective and more convenient for demonstration in a larger auditorium.

To set up this experiment it is necessary to scratch (with a diamond) on the metallic surface of a mirror two almost parallel lines (the distance between them is approximately 0.3 mm). By placing these two slits in the laser beam (outside the resonator and directly at the end of the laser) and by moving them within a small area in a plane perpendicular to the beam, it is easy to obtain maximum visibility of the interference pattern. No optical focusing system is necessary in this experiment. The laser is placed 5—6 meters from the screen so that the beam makes an angle of approximately 30° with the surface of the screen. Under these conditions, the width of the interference pattern is about 1 cm, and the illumination and the contrast of the picture are perfectly sufficient to observe it at a distance 15—20 meters.

Having demonstrated the coherence of laser emission, it is possible to interpret the following experiments, which are carried out at the same setting of the neon-helium laser relative to the screen.

Introduction of not too strong a scattering lens (~ 2 diopters) in to the laser beam reveals a clear-cut structure with axial symmetry on the increased light spot on the screen. This beam structure is an interference effect due to the structure of the electromagnetic field inside the resonator. The structure of the beam can be varied by placing inside the resonator an ordinary iris diaphragm near one of the mirrors. By varying the dimensions of the diaphragm, we observe the change of the structure of the spot on the screen. This change of the observed picture is connected with separation of different types of oscillations of the electromagnetic field in the resonator (the so-called transverse modes). At the same time, structure of the spot becomes gradually more complicated changing from a very simple picture (one central mode, occurring when the diaphragm aperture is small) to a very complicated structure with axial symmetry, due to superposition of a large number of different modes.

Translated by J. G. Adashko