Scientific session of the Division of General Physics and Astronomy and the Division of Nuclear Physics of the Academy of Sciences of the USSR (25–26 September 1985)

Usp. Fiz. Nauk 148, 535–548 (March 1986)

A joint scientific session of the Division of General Physics and Astronomy and the Division of Nuclear Physics of the Academy of Sciences of the USSR was held on September 25 and 26, 1985, at the S. I. Vavilov Institute of Physical Problems, Academy of Sciences of the USSR. The following reports were presented at the session:

September 25

1. *Yu. N. Denisyuk*. Imaging wave fields by means of static and Doppler three-dimensional holograms.
2. *Yu. T. Mazurenko*. Holography of time-varying waves through diffraction of pulsed light.
3. *G. I. Lashkov*. Energy transport involving triplet states in a phase recording of light.
4. *V. I. Sukhanov*. Phase holograms in recording media with dispersive refraction.
5. *K. K. Rebane*. Space-time holography of ultrafast events through spectral hole burning.

September 26

6. *I. B. Levinson*. Propagation of highly nonequilibrium phonons.
7. *N. N. Sibel'din*. Phonon-wind drag of electron-hole droplets.
8. *I. K. Yanson*. Nonequilibrium electrons and phonons in microcontacts.

Six of these reports are summarized below.

Yu. N. Denisyuk. *Imaging wave fields by means of static and Doppler three-dimensional holograms.* The introduction of a third coordinate—the depth—in holography has led to a substantial increase in the amount of information on the wave fields which is recorded in a hologram.[1,2] Three-dimensional holograms are distinguished from two-dimensional holograms in that they unambiguously reproduce the phase of the object wave and its spectral composition. In addition, they are completely reversible, by which we mean that, during reconstruction by a wave which is the conjugate of the reference-source wave, holograms of this type reproduce a single wave, which is the conjugate of the object wave.[2] All these unique properties of three-dimensional holograms, with a recording of a static pattern of standing waves, have now been studied quite thoroughly. They have already found several practical applications in graphics technology and in the development of holographic optical elements.[3–5]

The general nature of the mechanism for the reproduction of wavefronts by a static three-dimensional hologram suggests that imaging properties are also inherent in the three-dimensional dynamic model of a traveling intensity wave which is formed in the interference of waves with different frequencies. In particular, traveling intensity waves of this type arise during the recording of a hologram of a moving object, which shifts the frequency of the light which is reflected by virtue of the Doppler effect.

A detailed analysis of a traveling intensity wave shows that, although its configuration is distorted with respect to the corresponding standing wave, the structure obtained by recording this wave in a nonlinear medium—a "Doppler hologram"—exactly reproduces the wave field of the object, generating, in addition to all the parameters, a frequency shift of this field. These distortions incorporate the change in the reflection law for the light as the light interacts with a moving medium.[6] This property is preserved, regardless of the nature of the dispersion of the medium in which the Doppler hologram is recorded, and despite the fact that the geometry of the formation of a traveling intensity wave becomes very complex indeed.[7]

In the case of a Doppler hologram, certain dynamic effects can be achieved by means of agents differing from those which are used in recording a standing wave. In particular, if a nonlinear medium is resonant, a harmonic of the refractive index is shifted by a quarter of a wavelength, leading to an energy exchange, which leads in turn to an intensification of the Stokes component.[8]

In research on the conjugation of Doppler holograms it is becoming obvious that the conjugate wave is somewhat distorted and is propagating along a path different from that traveled by the object wave.[6] A more detailed analysis shows that if the Doppler hologram is formed by a wave which is reflected from the moving object, the wave conjugated by this hologram, propagating in the opposite direction, is focused not on the object itself but at a point slightly in front of it. An important circumstance here is that the focusing point is precisely that point to which the object moves over the time the conjugate wave took to propagate from the holo-

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gram to the object.[9,10]

This slightly unusual effect becomes more understandable when we transform to a coordinate system moving with the object. In this coordinate system, a Doppler hologram becomes an ordinary static hologram, and the prediction of future events reduces to the trivial inevitability of focusing of the conjugate wave on the object.

This effect also occurs during the recording of a hologram in a medium whose refractive index differs from unity. In this case, however, this effect occurs only for angles which are paraxial with respect to the normal to the surface of the hologram. Furthermore, certain conditions are imposed on the dispersion of the medium in this case.[11]

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[10] Yu. N. Denisyuk, Zh. Tekh. Fiz. **52**, 1338 (1982) [Sov. Phys. Tech. Phys. **27**, 815 (1982)].

[11] Yu. N. Denisyuk, Zh. Tekh. Fiz. **53**, 100 (1983) [Sov. Phys. Tech. Phys. **28**, 58 (1983)].