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BRIEF COMMUNICATIONS

EFFECT OF VELOCITY-CHANGING GAS PARTICLE COLLISIONS ON THE TEMPORAL SHAPE OF AN OBJECT LASER PULSE IN STIMULATED ECHO-HOLOGRAM RESPONSES

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The effect of collisions with changes in the direction of the particle velocities in a gas on the reproduction of information in stimulated echo-hologram responses is examined. Because of these collisions, the frequency shifts of atomic emission in the gas vary randomly (spectral diffusion within an inhomogeneously broadened line). It is shown that this leads to uncorrelated inhomogeneous broadening in the gas at different times and to partial loss of phase memory. This results in partial loss of reproducible information that was coded in the temporal shape of the object laser pulse.

Keywords: *spectral diffusion, stimulated echo hologram, inhomogeneous broadening, velocity-changing collisions.*

In gaseous media the formation of echo holograms differs qualitatively from their analogs in solids [1–4]. The differences are related to the motion of "working" particles, so it is necessary to account for collisions and random reorientations of the particles during formation of optically coherent responses of the medium. In a solid, each "working" particle has its own transition frequency (inhomogeneous broadening of a resonance line). During formation of echo signals in solids, at each point within the sample there is phasing of the induced dipole moments as the response develops and the phasing does not depend on the direction of the excitation. In gases, on the other hand, the velocities of individual particles are vector quantities, so at each point of a sample of this kind, the spatial direction is coupled (the directed nature of the Doppler effect). Thus, the amplitude and phase information contained in the object wave is "coded" in the fluxes of the particles moving at certain velocities. In addition, phasing of individual dipole moments in a gas at the time an echo is formed does not necessarily occur at each point of the sample, but phasing of individual velocity "packets" of particles moving with different velocities does take place [2–4].

The most promising mode for recording echo holograms is stimulated photon echo, since in this case it is possible to avoid strict conditions for spatial phasing synchrony. Formation of a stimulated echo hologram (SEH) requires the use of three pulses of resonance light. The first pulse creates a coherent ensemble of active particles, the second transforms optical coherences in the populations of the levels, and during the delay between the second and third pulses the Doppler phases are maintained without change. The third pulse converts the populations into optical coherence and inverts the phases to create the conditions for formation of a coherent response in the form of an SEH.

Elastic collisions lead to random changes in the angle between the observation vector and a particle velocity vector. This, in turn, causes random shifts in the frequencies of each particle (spectral diffusion). This can affect the formation of the SEH response even when the wave vectors of the exciting laser pulses are parallel. Photon echo is observed on the $^1S_0(6s^2)$–$^3P_1(6s6p)$ transition in ^{174}Yb vapor (a $0 \leftrightarrow 1$ transition) [5]. Thus, in the following we examine the effect of velocity-changing collisions on the reproducibility of information in an SEH response that is coded in the temporal shape of the object laser pulse in the $^1S_0(6s^2)$–$^3P_1(6s6p)$ transition in ^{174}Yb vapor.

A description of the formation of echo holograms in gases requires simultaneous accounting for the Doppler shifts of the emission frequencies of the particles, for the changes in their position and orientation in space, for particle collisions,

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