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Theory of propagation of spectrum and correlations of radiation in optically dense gas in the case of the closed excitation contour

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Abstract. This work is devoted to generalization of the semi-classical theory of interaction of broadband laser radiation with the atomic gas at the room temperature in the cell in the case of the closed excitation contour. The atomic density matrix equations and spectrum and correlations transport equations have been derived for excitation by fluctuating field with Gaussian statistics. It is shown that the spatial oscillations of radiation intensity and atomic density matrix can be excited. It was found that such medium can serve as a filter of incoherent part of the radiation.

In the field of atomic spectroscopy the coherent population trapping (CPT) effect attracts particular attention [1]. This effect arises when a three-level quantum system (atom) is excited by two-frequency laser radiation. When two-photon resonance takes place, the atom switches to not-absorbing "dark" state, and the medium becomes transparent in some spectral range - region of the CPT-resonance. Width of this resonance can be several orders smaller than the natural width of atomic line. This fact allows to apply CPT in such areas as quantum frequency standards [2], magnetometers [3, 4], quantum memory and slow light [5, 6], etc.

Theory which describes interaction of an atomic gas with the two-frequency laser radiation in the condition of CPT-resonance is well designed. So, in the work [7] appearance of the pseudoresonance was considered in the field of two collinear waves. The optical pumping of Cs atoms by the perpendicular laser fields and CPT effect in these atoms were investigated theoretically and experimentally in [8]. The theory of Dicke narrowing for the CPT-resonance in the cell with buffer gas was built in [9].

The other series of investigations was devoted to CPT effect which is controlled by microwave field forming the closed excitation contour. It was shown that in this case it is possible both destroy and restore CPT by changing in the total phase of the fields [10, 11]. In [12] possibility to control absorption and refraction of the medium by changing in the total phase of the control radiation was demonstrated.

The works [10-12] use the atomic density matrix equations in the approximation when each frequency component of radiation is monochromatic. But in reality, the radiation always has the amplitude and frequency fluctuations. It leads to broadening of the

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frequency components. In the present work the generalization of the theory of interaction of multifrequency radiation with hot atoms was done in the case of amplitude and phase fluctuations for the closed excitation contour. The equations for transport of energy spectrum and correlations of the radiation were derived for optically dense gas of hot atoms in the cell with buffer gas.

It is demonstrated, that at a certain total phase the spatial oscillations of the radiation intensity and index of refraction appear in the medium. The period and attenuation of these oscillations can be controlled by variation of the microwave field. Propagation of the correlation between the frequency components was analyzed for different degrees of correlation in the input of the medium. It was found that the correlation coefficient can be increased when radiation passes through the medium in the conditions of CPT-resonance. We propose to apply this effect for filtering of incoherent component of the radiation.

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