Free Induction Decay and Echo Phenomena in Media with Dipole-Dipole Interaction

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The dynamics of dense atomic ensemble in coherent radiation fields differs from that would be displayed by the individual constituent oscillators. The classic example of this is the Lorentz-Lorenz shift, which results in a shift of the resonance frequency of a dense material. This shift arises because the electric field at a given oscillator is modified by the reradiated field from all of the other oscillators in the medium. As a result, interaction of the system with the coherent field occurs on the red wing of the spectral line. The very interaction among the oscillators is the key phenomenon in dense resonant media, changing to a considerable extent the behavior of a system of coupled atoms in a field of coherent light in both stationary and in nonstationary regimes [1].

The main goal of this paper is to study the effect that may be exerted by an interatomic dipole-dipole interaction (DDI) upon optical transient processes and, in particular, upon the character of the free induction (FI) decay and echo phenomena in dense resonant media. Specific features of spontaneous responses in such media are that all of them are phase modulated with the oscillation frequency varying with time and being dependent on the DDI constant, on the detuning of the exciting pulse carrier frequency from the resonance δ, and on the pulse intensity and its spectral width. The law and rate of the FI signal relaxation also depend on the ratio of the above parameters. The decay of the FI signal in time may occur either by the power or by the exponential law, depending on the value of total detuning δ ωL, where ωL is the Lorentz frequency. The FID peculiarities in media with homogeneous and inhomogeneous broadening as a function of spectral linewidth are discussed. At that, the excitation induced dephasing processes and other relaxation canals are taken into account. The conditions for single pulse photon echo (PE) generation are analysed. It is shown that in media with DDI such an echo can be excited by pulse at the smaller pulse area than it is nec-

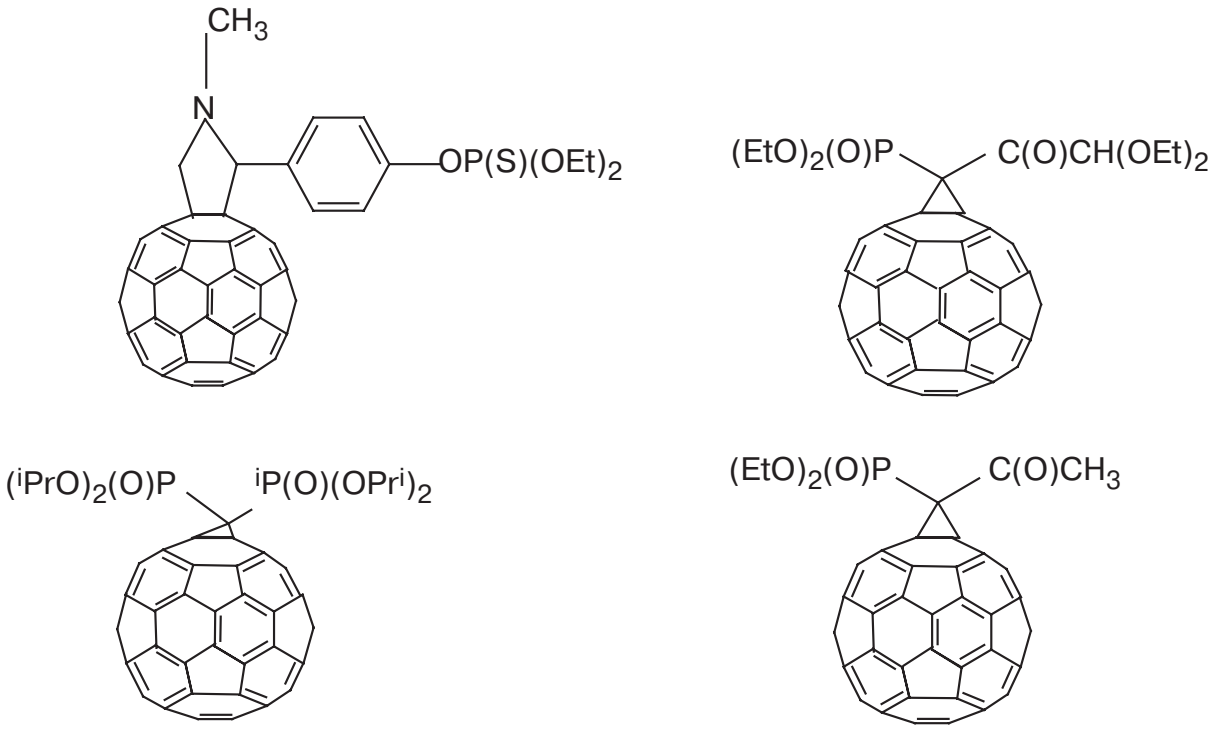

Fig. 1. Organophosphorus fullerene derivatives.

essary for its generation when the DDI is negligible. Besides, Organophosphorus fullerene derivatives are shown on Fig. 1 [2–4].

As for primary PE generation, we should note one of remarkable peculiarities connected with possibility of observation of signals under different phase matching conditions. The observation time of these signals is also different. When such relaxation canal as up-conversion process becomes significant, it results in not only the signal amplification but acceleration of its observation time. The possibility of echo-like responses generation in homogeneously broadened dense media and their registration by phase sensitive methods are discussed. The conditions of experimental realization of above-mentioned results in dense Yb vapors are analyzed.

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