Femtosecond pulse propagation in a resonant medium

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The subject of coherent interaction of a short laser pulse and a two-level atomic system has been investigated extensively in literature, both theoretically and experimentally [1]. Many effects in gaseous and solid-state media have demonstrated both the linear absorptive and dispersive nature of the interaction and the nonlinear properties of short-pulse propagation. In particular, effects that are due to coherence, such as self-induced transparency, free-induction decay, optical nutation and photon echo have been observed in experiments in which relaxation times of the medium were longer than the duration of the pulse. Additionally, the reshaping and breakup of low-intensity, or 0π pulses, was reported [2].

In this work we investigate the propagation of an ultrashort (100 fs) laser pulse in the optically thick Rb atomic vapor, in the case when the pulse duration is smaller than the inverse spectral width of the absorption line. The envelope of such a pulse experiences strong reshaping effects and develops an oscillatory temporal structure, as a result of the strong nonlinear behavior of the refractive index over the broad pulse spectrum.

The pulse reshaping is investigated experimentally for different laser detunings and Rb atom concentrations. We imploy a simple theoretical model to interpret the results and demonstrate good agreement with the observations.

References

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