Transient switching of the Kerr nonlinearity and effect of Doppler broadening in a five- level Quantum system

H. R. Hamedi[1] and G. Juzeliunas[1]

[1] *Institute of Theoretical Physics and Astronomy, Vilnius University, A. Gostauto 12, Vilnius LT-01108, Lithuania*

Presenting Author: hamid.r.hamedi@gmail.com

The third order susceptibility [1] is investigated in a five-level quantum scheme in which four strong laser components couple a pair of atomic internal states to another pair of states in all possible ways to form a closed loop configuration of the atom-light interaction.

First, a comparison is made between the Kerr nonlinear indices for the five-, four- and three- level systems. It is realized that the magnitude of the Kerr nonlinearity for the five- level system is larger than that of the three- and four- level counterparts.

Subsequently, the temporal evolution of the Kerr nonlinearity and the required optical switching time in the nonlinear regime is studied in this atomic system by using the density matrix equations of motion. It is demonstrated that such a medium can be employed as an optical switch in which the propagation of the laser pulse is controlled by another laser field. The results presented may be useful for understanding the switching feature of the EIT-based slow light Kerr nonlinearity, and be helpful for the realization of fast optical nonlinearities and optically controlled devices.

Finally, it is shown that effect of the Doppler broadening can lead to an enhanced Kerr nonlinearity while maintaining linear and nonlinear absorption [2].

References

[1] R. W. Boyd, Nonlinear Optics (Academics, San Diego, 1992)

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