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Control of group index in two level system by Kerr nonlinearity

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Group velocity control of light is of fundamental as well as practical interest for the construction of various optical devices such as optical buffers and quantum memories. In recent decades, great attention has been paid to the study of conditions and techniques for obtaining subluminal and superluninal light. It is found that the presence of Kerr nonlinearity can be usefull tool for group index control.

In this paper, the interaction of a laser with a two-level system was studied and the Kerr coefficient was calculated using the density matrix formalism. By solving the optical Bloch equations, the expressions for the linear and nonlinear part of susceptibility were obtained, as well as the expression for the Kerr coefficient. The dependence of the group refractive index depending on the laser intensity and its detuning was studied. The contributions of linear and nonlinear parts were considered separatlly. It has been noticed that with the increase of laser intensity, the type of dispersion changes from normal to anomalous. Also, the values of detuning, depending on laser intensity, where superluminal or subluminal light is observed, were found.

Our study consists of analytical approach and numerical simulations. For simulations we used the parameters of the real two level physical system in ^{87}Rb atoms: $5S_{1/2}(F = 1, m_F = 1) \rightarrow 5P_{1/2}(F = 2, m_F = 0)$.

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