Variations of Dispersion and Transparency in Four-Level N-Scheme Atomic Systems

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Positive and negative dispersions are of interest for numerous applications especially when accompanied by transparency. In this work, we study the variation of the sign of dispersion in the case of four-level N-Scheme system. The different dynamics of the sign and value of dispersion and transparency are explored in light of three resonances.

The dependence of the group velocity of a pulse on dispersion makes the sign of the dispersion and its value a delicate subject of interest in a variety of applications which depends on slow, fast, superluminal, or negative propagations of light. After the anomalously negative dispersion in the highly absorptive two-level system, and the positive dispersion in the transparent three-level system (typically the standard lambda scheme), comes the two-sign dispersion in the transparency varying four-level N-Scheme (Fig. [1]). This system was first proposed by Harris [1] and later experimentally studied by Braje et. al [2] and also Kang et. al [3].

In this work, we study the variations of the dispersion and transparency of a probe field in a four-level N-scheme system in terms of three resonances which we derived in a previous work [4]. The changes in the resonances function of the varying fields are directly responsible for the sign and value of the dispersion, the creation of a reduction or induction of absorption, and the ranges over which these characteristics occur.


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