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Analytic Solutions of Solitary Waves in Three-Level Unbalanced Dense Media

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Abstract : We explore the analytical soliton-pair solutions for unbalanced coupling between the two coherent lights and the atomic transitions in a dissipative three-level system in lambda configuration. The two allowed atomic transitions are interacting resonantly with two laser fields. For unbalanced coupling, it is possible to derive an explicit solution for non-linear differential equations describing the soliton-pair propagation in this three-level system with the same velocity. We suppose that the spontaneous emission rates from the excited state to both ground states are the same. In this work, we focus on such case where we consider the coupling between the transitions and the optical fields are unbalanced. The existence conditions for the soliton-pair propagations are determined. We will show that there are four possible configurations of the soliton-pair pulses. Two of them can be interpreted as a couple of solitons with same directions of polarization and the other two as soliton-pair with opposite directions of polarization. Due to the fact that solitons have stable shapes while propagating in the considered media, they are insensitive to noise and dispersion. Our results have potential applications in data transfer with the soliton-pair pulses, where a dissipative three-level medium could be a realistic model for the optical communication media.

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