Derivation of a generalized double-sine-Gordon equation describing ultrashort-soliton propagation in optical media composed of multilevel atoms

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Résumé en anglais	We consider the propagation of ultrashort optical solitons in media described by a general Hamiltonian of multilevel atoms. Assuming that all transition frequencies of the medium are well below the typical wave frequency, i.e., only the contribution of infrared transitions is taken into account, we use a short-wave approximation and a rigorous application of the reductive perturbation formalism to derive a cumbersome coupled system of nonlinear partial differential equations describing ultrashort soliton evolution in such systems. The rather complicated set of coupled equations can be simplified to a generic double-sine-Gordon equation for a special case of identical three-level atoms, whereas for a special case of identical four-level atoms the system of coupled equations can be reduced to a generalized double-sine-Gordon equation. Numerical simulations showing the formation of robust breather-type solutions of both the standard double-sine-Gordon and of the generalized double-sine-Gordon equations from sinusoidal inputs with Gaussian envelopes are also presented.
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