Collision Dynamics of Polarized Solitons in Linearly Coupled Nonlinear Schrödinger Equations

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Abstract. The system of linearly coupled nonlinear Schrödinger equations is solved by a conservative difference scheme in complex arithmetic. The initial condition represents a superposition of two one-soliton solutions of linear polarizations. The head-on and takeover interaction of the solitons and their quasi-particle (QP) behavior is examined in conditions of rotational polarization and gain. We found that the polarization angle of a quasi-particle can change independently of the collision.

Keywords: Linearly coupled nonlinear Schrödinger equations, rotational polarization, breathing solitons
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INTRODUCTION

Investigating the soliton dynamics in both linearly and nonlinearly Coupled Nonlinear Schrödinger Equations (CNLSEs) is of great importance from several different perspectives. They main ones are the propagation of optical pulses in optical fibers [1, 5] and the investigation of the quasi-particle (QP) behavior of soliton solutions. The essential new feature of CNLSEs in comparison with the single NLSE is the polarization, which is related to relative amplitudes of the components. Keeping in mind the fact that each component is actually a complex-valued function, one can appreciate the complexity of the possible soliton interactions. The role of the nonlinearity in the interaction of initially linearly and elliptically polarized solitons was investigated in [8, 10]. It was uncovered that depending on the magnitude of the cross-modulation parameter (presenting the nonlinear coupling), the interaction between the modes during the collision, changes the polarization of the QPs, and/or gives birth to one or more QPs. On the other hand, the CNLSEs model has richer phenomenology when a linear coupling is considered alongside with the main, nonlinear coupling (see, e.g., [7] and the literature cited therein). This quantity generates rotational polarization which is independent of initial polarization of the soliton system. This is the reason to focus our attention to the dynamics of the soliton solutions in the Manakov system when a linear coupling is present.

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