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Multisoliton solutions and energy sharing collisions in coupled nonlinear Schroedinger equations with focusing, defocusing and mixed type nonlinearities

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1 Abstract

Bright and bright-dark type multisoliton solutions of the integrable N-coupled nonlinear Schroedinger (CNLS) equations with focusing, defocusing and mixed type nonlinearities are obtained by using Hirota's bilinearization method. Particularly, for the bright soliton case, we present the Gram type determinant form of the n-soliton solution (n:arbitrary) for both focusing and mixed type nonlinearities and explicitly prove that the determinant form indeed satisfies the corresponding bilinear equations. Based on this, we also write down the n-soliton form for the mixed (bright-dark) type solitons. For the focusing and mixed type nonlinearities with vanishing boundary conditions the pure bright solitons exhibit different kinds of nontrivial shape changing/energy sharing collisions characterized by intensity redistribution, amplitude dependent phase-shift and change in relative separation distances. Due to the nonvanishing boundary conditions the mixed N-CNLS system can admit coupled bright-dark solitons. Here we show that the bright solitons exhibit nontrivial energy sharing collision only if they are spread up in two or more components, while the dark solitons appearing in the remaining components undergo mere standard elastic collisions. Energy sharing collisions lead to interesting applications such as collision based optical computing and soliton amplification. Finally, we briefly discuss the energy sharing collision properties of the line solitons and dromions of the (2+1) dimensional long wave-short wave resonance interaction (LSRI) system, which is a higher dimensional version of the CNLS equations.

References

[1] M. Vijayajayanthi, T. Kanna, and M. Lakshmanan: Bright-dark solitons and their collisions in mixed N-coupled nonlinear Schroedinger equations. *Phys. Rev. A* **77** (2008) 013820.

[2] T. Kanna, M. Vijayajayanthi, K Sakkaravarthi, and M. Lakshmanan: Higher dimensional bright solitons and their collisions in a multicomponent long wave–short wave system . *J. Phys. A: Math. Theor* **42** (2009) 115103.

[3] R. Radha, C. Senthil Kumar, M. Lakshmanan and C. R. Gilson: The collision of multimode dromions and a firewall in the two-component long-wave–short-wave resonance interaction equation . *J. Phys. A: Math. Theor* **42** (2009) 102002-FTC.