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A moduli space analysis for complex stable multi-soliton solutions in a 1+1-dimensional field theory

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Abstract: We discuss the stability properties of complex soliton solutions in the Bullough-Dodd scalar field theory. We exactly identify the one-shape modes in form of a bound state solution and scattering states which when linearly perturbed remain stable. The auxiliary Sturm-Liouville eigenvalue equation in the stability analysis can be solved exactly by supersymmetrically mapping it to an isospectral partner system involving a shifted and scaled inverse cosh-squared potential. The one-shape modes are subsequently used in the analysis of the moduli space (collective coordinate) analysis for the solutions of the Bullough-Dodd model. We show, by comparing with the exact solutions, that a one-dimensional moduli space captures well the main feature of the centre of mass motion of the one and two-soliton solutions. We demonstrate that even the time-delay and spatial displacements occurring for the one-soliton constituents in a multi-soliton scattering process can be extracted from a moduli space analysis. We propose a two-dimensional moduli space to describe the newly found triple bouncing scattering amongst the constituents of a dark two double peakon scattering.