Scattering of sine-Gordon kinks with internal structure in an extended nonlinear O(3) sigma model

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In this work, we present topological defects in (1,1) dimensions, described by an extended nonlinear O(3) sigma model. We consider spherical coordinates (ϕ,χ) in the S^2 isotopic space and a potential V(ϕ,χ). For specific forms of the potential, it is possible to apply the Bogomol'nyi method, resulting in first-order equations of motion with solutions that minimize energy. We study a model with an explicit solution for the field ϕ that resembles the ubiquitous sine-Gordon kink/antikink, but with an internal structure given by the field χ with a form antilump/lump that depends on a constant *C*. The soliton-antisoliton scattering process depends on *C* and on the initial velocity of the pair. Some results are reported, such as: one-bounce scattering for ϕ, or strong emission of radiation for ϕ, followed by i) annihilation of χ; ii) same pattern antilump-antilump or lump-antilump for χ; iii) inversion antilump-antilump to lump-lump for χ; iv) inversion antilump-lump to lump-antilump for χ. Other findings are: v) annihilation of the pair soliton-antisoliton with the emission of scalar radiation; vi) emission of pairs of oscillations around the vacuum for ϕ and χ. The energy density shows that the defect has an internal structure as a nested defect of an antilump inside a kink. The lump core of the defect is responsible for the emission of radiation. The changing of structure of the defects during the scattering is analyzed not only with the field profiles in the physical (1,1) space, but also in the internal S^2 space, which gives some new insight into the process.