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Arbitrary-angle interaction of spatial solitons with layered photonic structures

E. A. McCoy, J. M. Christian, and G. S. McDonald

Materials & Physics Research Centre, University of Salford, Greater Manchester M5 4WT

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The behaviour of light at the interface between different adjoining materials underpins the entire field of Optics. In nonlinear photonics, a fundamental geometry comprises a spatial soliton incident on the planar boundary between two dissimilar Kerr-type media. Seminal analyses by Aceves *et al.* [Phys. Rev. A **39**, 1809 (1989)] were ground-breaking and highly instructive, but they remain limited by the assumptions of the paraxial approximation. Interface geometries are, in general, intrinsically nonparaxial: angles of incidence, reflection, and refraction (measured relative to the interface *in the laboratory frame*) may be of arbitrary magnitude.

In earlier collaborations, we derived a Snell law governing arbitrary-angle refraction of spatial solitons at the interface between different Kerr materials [Opt. Lett. **35**, 1347 (2010); **32**, 1127 (2007)]. Analyses were facilitated by solution of an underlying nonlinear Helmholtz equation, and they completely lifted the angular limitation that is inherent to paraxial theory.

Novel material considerations have been central to our most recent studies of spatial soliton refraction. In this presentation, we extend our preliminary Kerr-based analyses to non-Kerr regimes involving optical media with cubic-quintic nonlinear susceptibilities [Opt. Quantum Electron. **11**, 471 (1979)]. A key result is the derivation of a generalized Snell law, which was obtained through the deployment of exact analytical bistable Helmholtz solitons [Phys. Rev. A **76**, 033833 (2007)]. Excellent agreement has been uncovered, across wide parameter ranges, between theoretical predictions and direct numerical calculations. Simulations have also identified qualitatively new phenomena, strongly dependent on the beam incidence angle, that were not captured by analysis.