Black and grey soliton refraction at interfaces

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Dark Kerr soliton refraction at planar boundaries is analysed and simulated *for the first time.*

A new generalisation, consisting of a simple law for refraction of all spatial Kerr solitons, is derived. Earlier, we analyzed *bright* spatial soliton refraction at nonlinear interfaces using Helmholtz theory [1], which preserves the full inherent angular content of the problem. Our findings have now been generalized to a law that describes the behaviour of *both bright and dark* soliton refraction at nonlinear interfaces (see Figure 1).

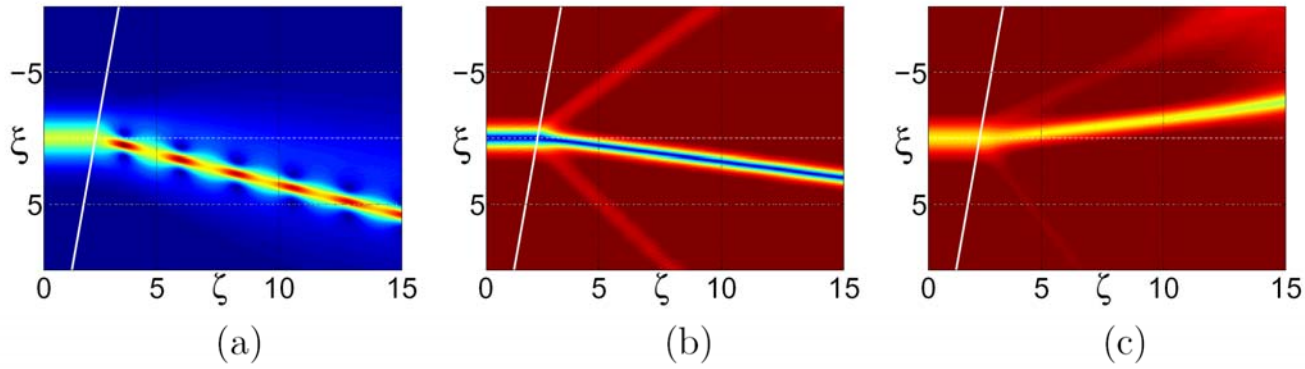

Figure 1: Surface plots of soliton refractions at an interface (white lines). Each interface shown arises from a fixed change in linear and nonlinear refractive indices. Refraction of: (a) bright, (b) black and (c) gray solitons is simulated and analysed.

Spatial soliton refraction at interfaces has traditionally been studied in terms of the paraxial Nonlinear Schrödinger Equation, which limits the validity of results to vanishingly small angles of incidence. This restriction is removed in a Helmholtz nonparaxial framework, in which a Nonlinear Helmholtz (NLH) equation describes the evolution of a broad beam (when compared to the wavelength) propagating at arbitrary angles.

Grey soliton refraction is found to exhibit the most complex features; analysis predicts a sensitive dependence on the soliton greyness parameter. Excellent agreement between analysis and simulations will be reported; quantitative predictions will be verified through presentation of a series of simulation results. For example, investigations reveal that variation of only the greyness parameter can result in a transition from external to internal refraction regimes.

References

[1] Sánchez-Curto J, Chamorro-Posada P and McDonald G S, *Opt. Lett.* **32**, 1126–28 (2007)
Sánchez-Curto J *et al.*, *J. Opt.* A: Pure & Appl. Opt. **11**, art. no. 054015 (2009)

[2] Sánchez-Curto J, Chamorro-Posada P and McDonald G S, Dark Kerr soliton refraction at interfaces, *accepted for Opt. Lett.* (2010)