Total non-refraction angle at Kerr defocusing interfaces

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Spatial soliton refraction at interfaces separating two nonlinear media has traditionally been studied in terms of the paraxial Nonlinear Schrödinger (NLS) Equation, thus restricting the validity of results to vanishingly small angles of incidence [1]. This limitation is overcome within a Helmholtz nonparaxial framework [2], where a Nonlinear Helmholtz (NLH) equation [3] addresses the full evolution of a broad beam (when compared to the wavelength) propagating at arbitrary angles in relation to the longitudinal axis [4, 5].

This inherent nonparaxial character of solitons evolving at planar interfaces is captured in an unified, and generalized, Snell's law [6] that addresses the evolution of both bright [6] and dark [7] solitons impinging either focusing or defocusing Kerr interfaces, respectively. As regards gray solitons, the Snell's law also predicts the existence of a *total non-refraction angle* which establishes that total non-refraction (if possible) can only be achieved for a unique angle of incidence [8]. Unlike bright and black solitons, gray solitons can undergo internal refraction, external refraction or total transparency at the same nonlinear interface depending solely on the angle of incidence. This novel property has been proposed to lie in the core of either positive or negative lensing operations to be performed on dark soliton arrays.

Bibliografía

[1] A.B. Aceves, J.V. Moloney, and A.C. Newell, "Theory of light-beam propagation at nonlinear interfaces. I. Equivalent-particle theory for a single interface", Phys. Rev. A **39**, p. 1809 (1989).

[2] P. Chamorro-Posada, G.S. McDonald, and G.H.C. New, "Nonparaxial solitons," J. Mod. Opt. **45**, p. 1111 (1998).

[3] G. Fibich, "Small beam nonparaxiality arrests self-focusing of optical beams," Phys. Rev. Lett. **76**, p. 4356 (1996).

[4] P. Chamorro-Posada, G.S. McDonald, and G.H.C. New, "Exact soliton solutions of the nonlinear Helmholtz equation," J. Opt. Soc. Am. B **19**, p. 1216 (2002).

[5] P. Chamorro-Posada and G.S. McDonald, "Helmholtz dark solitons," Opt. Lett. **28**, p. 825 (2003).

[6] J. Sánchez-Curto, P. Chamorro-Posada, and G.S. McDonald, "Helmholtz solitons at nonlinear interfaces," Opt. Lett. **32**, p. 1126 (2007).

[7] J. Sánchez-Curto, P. Chamorro-Posada, and G.S. McDonald, "Dark solitons at nonlinear interfaces," Opt. Lett. **35**, p. 1347 (2010).

[8] J. Sánchez-Curto, P. Chamorro-Posada, and G.S. McDonald, "Black and gray Helmholtz Kerr soliton refraction" *Accepted for publication in Phys. Rev. A*

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