Helmholtz spatial solitons and oblique propagation in coupled-waveguide arrays

Christian, JM, McCoy, EA, McDonald, GS, Sanchez-Curto, J and Chamorro-Posada, P

Helmholtz spatial solitons and oblique propagation in coupled-waveguide arrays

J. M. Christian[1], E. A. McCoy[1], G. S. McDonald[1],
J. Sánchez-Curto[2], and P. Chamorro-Posada[2]

[1] *Materials & Physics Research Centre, University of Salford, Greater Manchester M5 4WT, U.K.*

[2] *ETSI Telecomunicación, Universidad de Valladolid, Campus Miguel Delibes Paseo Belén 15, E-47011 Valladolid, Spain*

The interaction between light waves and layered host media is a fundamental class of problem in nonlinear photonics. For example, the interest may lie with studying the behaviour of a spatial optical soliton: (i) at the planar boundary between otherwise homogeneous materials [Aceves *et al.*, Phys. Rev. A **39**, 1809 (1989)], or (ii) coupling from a homogeneous medium into a waveguide array (an optical structure with periodic refractive-index modulations). In the latter case, one typically considers head-on or side-coupling geometries [Mandelik *et al.*, Phys. Rev. Lett. **92**, 093904 (2004)].

Oblique (off-axis) propagation effects play a central role in essentially all photonic device architectures, and they lie at the heart of interface and coupled-waveguide contexts (where, in the laboratory frame, light may encounter an optical boundary at any angle). Previously, Helmholtz soliton theory has provided an ideal mathematical platform for fully capturing the angular degrees-of-freedom associated with single-interface problems [Sánchez-Curto *et al.*, Opt. Lett. **32**, 1127 (2007); **35**, 1347 (2010)].

We will present an overview of what is, to the best of our knowledge, the first nonparaxial model capable of describing arbitrary-angle evolution in coupled-waveguide arrays. Paraxial theory, with its small-angle limitations, cannot facilitate such general analyses. The governing envelope equation is of the scalar Helmholtz type with a Kerr nonlinearity, and exact spatial solitons [Chamorro-Posada *et al.*, J. Mod. Opt. **45**, 1111 (1998)] have been used as basis functions. Extensive computations have predicted a wide range of new qualitative phenomena when combining structural periodicity with non-trivial beam propagation angles.