Helmholtz surface wave propagation along nonlinear interfaces

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When two dissimilar nonlinear photonic materials are placed together, the boundary between them forms an optical interface. A light beam (typically from a laser source) may then travel along the boundary as a surface wave, remaining trapped within the vicinity of the interface and possessing a stationary (invariant) spatial profile. This type of bi-layer structure is an elementary geometry for integrated-optic device architectures. For two Kerr-type materials, surface-wave solutions to the governing equation have been known for many years [e.g., Aceves *et al.*, Phys. Rev. A vol. 39, 1809 (1989)]. To date, many research groups worldwide have performed numerical investigations of related phenomena. A recurrent theme in the literature is the replacement of the underlying Helmholtz equation with a simpler Schrödinger-type model (by assuming slowly-varying envelopes). Hence, there has been essentially no analysis of surface waves in the Helmholtz context.

In this presentation, we will give a detailed account of Helmholtz surface waves propagating along nonlinear interfaces – this is the first analysis of its kind [Christian *et al.*, J. Atom. Mol. Opt. Phys. vol. 2012, art. no. 137967 (2012)]. Theoretical predictions of surface-wave stability (made by deploying the classic Vakhitov-Kolokolov integral criterion) are tested against fully-numerical Helmholtz-type computations using our (custom) difference-differential algorithm [Chamorro-Posada, McDonald, & New, Opt. Commun. vol. 192, 1 (2001)]. Extensive simulations have uncovered a wide range of new qualitative and quantitative phenomena in the Helmholtz regime that depend on the interplay between a set of system parameters (material mismatches, nonlinearity exponent, and the optical beam waist).