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Nonparaxial refraction and giant Goos-Hänchen shifts at nonlinear optical interfaces

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THEME 1: NONLINEAR DYNAMICS

APPLICATION THEME 1: PHYSICAL SCIENCES

The scattering of spatial optical solitons (self-localizing beams of laser light) at the interface between two dissimilar materials is a problem of fundamental importance in nonlinear photonics. Theoretical analyses must take into account a highly complex interplay between diffraction, self-lensing, finite beam waists, and discontinuities in both the linear and nonlinear properties of the host medium at the boundary. Over the past three decades, various research groups worldwide have resorted to simplified mathematical descriptions based on the universal nonlinear Schrödinger equation [A.B. Aceves *et al.*, Phys. Rev. A vol. 39, 1809 (1989)].

Our approach deploys the nonlinear Helmholtz equation [J. Sánchez-Curto *et al.*, Phys. Rev. A vol. 85, 013836 (2012)]. We have been able to relax the strong angular constraint that is inherent to essentially all previously-published works in this arena. More specifically, we can now solve the class of problem where beam angles of incidence, reflection, and refraction may be arbitrarily large.

A compact law governing arbitrary-angle refraction will be discussed. Theoretical predictions are in excellent agreement with those obtained from exhaustive numerical simulations. Striking examples will also be given of Goos-Hänchen (GH) shifts (a phenomenon whereby, close to the critical angle of incidence, the reflected beam undergoes a displacement along the interface) [F. Goos and H. Hänchen, Ann. Phys. vol. 1, 333 (1947)]. Such shifts are an inherent property of beam-interface interactions, and they can be strongly enhanced in the presence of nonlinearity. We will report what we believe to be the largest GH shifts uncovered to date.