



University of
Salford
MANCHESTER

Refraction at interfaces with X(5) nonlinearity: Snell's law & Goos-Hänchen shifts

McCoy, EA, Christian, JM and McDonald, GS

Title	Refraction at interfaces with X(5) nonlinearity: Snell's law & Goos-Hänchen shifts
Authors	McCoy, EA, Christian, JM and McDonald, GS
Type	Conference or Workshop Item
URL	This version is available at: http://usir.salford.ac.uk/id/eprint/29299/
Published Date	2013

USIR is a digital collection of the research output of the University of Salford. Where copyright permits, full text material held in the repository is made freely available online and can be read, downloaded and copied for non-commercial private study or research purposes. Please check the manuscript for any further copyright restrictions.

For more information, including our policy and submission procedure, please contact the Repository Team at: usir@salford.ac.uk.

Refraction at interfaces with $\chi^{(5)}$ nonlinearity: Snell's law & Goos-Hänchen shifts

E. A. McCoy, J. M. Christian, and G. S. McDonald

Materials & Physics Research Centre, University of Salford, U.K.

Email: e.mccoy1@edu.salford.ac.uk

Keywords: vector solitons, spatiotemporal dispersion, *energy theme*

In this presentation, we give the first detailed overview of spatial soliton refraction at the planar interface between materials whose nonlinear polarization has contributions from both $\chi^{(3)}$ and $\chi^{(5)}$ susceptibilities [1]. The governing equation is of the inhomogeneous Helmholtz class with a cubic-quintic nonlinearity, and analysis is facilitated through the exact bright soliton solutions of the corresponding homogeneous problem [2]. By respecting field continuity conditions at the interface, a universal Snell's law may be derived for describing the refractive properties of soliton beams. This compact equation contains a supplementary multiplicative factor that captures system nonlinearity, discontinuities in material properties, and finite beam waists. Extensive numerical calculations have tested analytical predictions and provided strong supporting evidence for the validity of our modelling approach across wide regions of a six-dimensional parameter space. Theoretical predictions for critical angles are generally in good agreement with simulations of beams at linear and weakly-nonlinear interfaces, and we have quantified Goos-Hänchen shifts [3,4] in such systems (see Fig. 1).

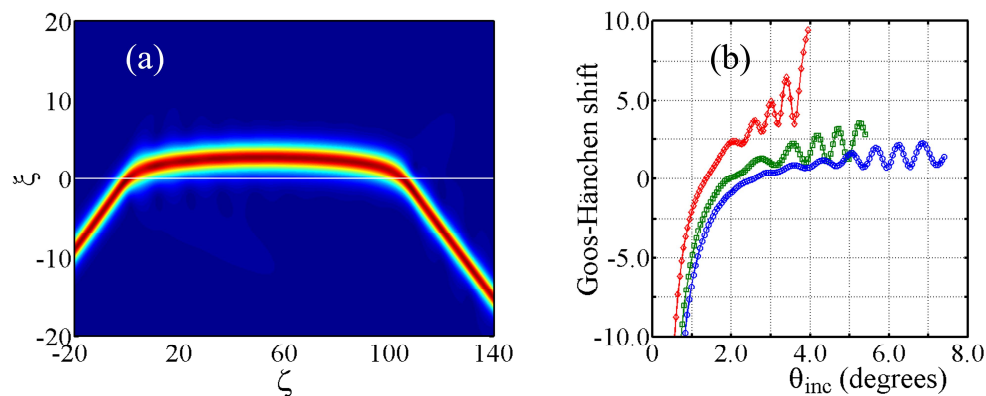


Figure 1. (a) A typical giant Goos-Hänchen (GH) shift at a cubic-quintic interface with external linear refraction [where the linear refractive index is higher in the second medium (region $\xi > 0$)]. (b) GH shifts at nonlinear interfaces can exhibit non-monotonic behaviour. In these simulations, the $\chi^{(3)}$ susceptibility is lower the second medium (while $\chi^{(5)}$ is uniform throughout) and the incident solitons have relatively high peak intensities to enhance self-focusing

References

- [1] K. I. Pushkarov, D. I. Pushkarov, and I. V. Tomov, *Opt. Quantum Electron.* **11**, 471 (1979).
- [2] J. M. Christian, G. S. McDonald, and P. Chamorro-Posada, *Phys. Rev. A* **76**, 033833 (2007).
- [3] F. Goos and H. Hänchen, *Ann. Phys.* **1**, 333 (1947).
- [4] J. Sánchez-Curto, P. Chamorro-Posada, and G. S. McDonald, *Opt. Lett.* **36**, 3605 (2011).