



University of  
**Salford**  
MANCHESTER

# Helmholtz surface wave propagation along nonlinear interfaces

McCoy, EA, Christian, JM and McDonald, GS

<b>Title</b>	Helmholtz surface wave propagation along nonlinear interfaces
<b>Authors</b>	McCoy, EA, Christian, JM and McDonald, GS
<b>Publication title</b>	
<b>Publisher</b>	
<b>Type</b>	Conference or Workshop Item
<b>USIR URL</b>	This version is available at: <a href="http://usir.salford.ac.uk/id/eprint/29316/">http://usir.salford.ac.uk/id/eprint/29316/</a>
<b>Published Date</b>	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: [library-research@salford.ac.uk](mailto:library-research@salford.ac.uk).

# Helmholtz surface wave propagation along nonlinear interfaces

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

*Materials & Physics Research Centre, University of Salford, Greater Manchester M5 4WT*

*Key words:* Helmholtz equation; nonlinear materials; nonparaxial optics;  
optical interfaces; surface waves

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).