



University of  
**Salford**  
MANCHESTER

# Two-colour spatial optical solitons: new stability analyses for off-axis propagation

Bostock, C, Christian, JM and McDonald, GS

<b>Title</b>	Two-colour spatial optical solitons: new stability analyses for off-axis propagation
<b>Authors</b>	Bostock, C, Christian, JM and McDonald, GS
<b>Type</b>	Conference or Workshop Item
<b>URL</b>	This version is available at: <a href="http://usir.salford.ac.uk/id/eprint/23003/">http://usir.salford.ac.uk/id/eprint/23003/</a>
<b>Published Date</b>	2012

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](mailto:usir@salford.ac.uk).

## Two-colour spatial optical solitons: new stability analyses for off-axis propagation

C. Bostock<sup>1</sup>, J. M. Christian, and G. S. McDonald

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

Two-colour spatial optical solitons comprise a pair of stationary continuous-wave light beams at two well-separated temporal frequencies. The components overlap in the propagation plane and are coupled through system nonlinearity (e.g., the Kerr-type response in the host material of a planar waveguide) [Opt. Commun. **88**, 419 (1992)]. Such configurations have huge potential for future photonic device applications such as multi-channel waveguiding [Opt. Lett. **19**, 945 (1994)]. To date, analyses of such geometries have been mainly within the arena of paraxial wave optics.

Our research goes beyond the slowly-varying envelope approximation, into regimes where two-colour light fields may propagate and interact off-axis at arbitrary angles and orientations. The coupled governing equations are of the nonlinear *Helmholtz* (as opposed to *Schrödinger*) type [Phys. Rev. E **74**, 066612 (2006)]. In an essential way, this more general system involves the interplay between nonlinear (self- and cross-focusing) processes and, crucially, fully two-dimensional diffraction.

We will present the first analysis of off-axis two-colour light fields. Four families of exact analytical two-colour soliton (bright-bright and bright-dark for a focusing Kerr nonlinearity; dark-bright and dark-dark for defocusing) have been derived, each of which has co- and counter-propagation classes that are related by geometrical transformations. Solution of the plane wave modulational instability problem, obtained by generalizing our established Helmholtz linearization techniques [J. Phys. A **39**, 1535 (2006)] to vector regimes, has provided further insight into the propagation properties of those two-colour solitons with dark-type components. Unexpected regions of stability, mediated by cross-focusing, have been uncovered in certain parameter regimes.