J. M. Christian[1] and R. Yang[2]
1. Joule Physics Laboratory, University of Salford, Greater Manchester M5 4WT, United Kingdom
2. College of Physics & Electronics Engineering, Shanxi University, Taiyuan, China

Ultranarrow Helmholtz solitons from nonlinear Maxwell's equations:
the role of rotational covariance in oblique propagation problems

TALK ABSTRACT

Helmholtz solitons are robust self-localizing excitations that play a key role in the description of wave-based phenomena in a broad class of nonlinear system. As exact analytical solutions to underlying scalar Helmholtz equations, they are uniquely placed to model laser-optics contexts involving off-axis regimes beyond the near-universal assumptions of wave paraxiality. Elementary geometries with arbitrary-angle considerations include the multiplexing of soliton beams, refraction at material interfaces (well described by a Snell-type law), and oblique injection into periodic media (such as coupled waveguide arrays). A key mathematical property underpinning the angular properties of Helmholtz solitons is covariance of the governing equations under in-plane rotational transformations.

We will present a survey of soliton modelling using Helmholtz equations. Particular attention is paid to a recently-developed framework for deriving new families of exact bright and dark solitary solutions. The governing equations are derived from an order-of-magnitude assessment of nonlinear vector Maxwell equations, where the tensor character of the third-order susceptibility is taken into account. Distinguishing our analysis from other works, we relax various perturbative elimination approximations and our model thus retains a Helmholtz signature. We will also consider the fifth-order susceptibility, where the nonlinear response of the medium is described by a sixth-rank tensor.