Nonlinear Helmholtz Standing Waves and Soliton-Soliton Interactions

Pedro Chamorro-Posada* and Graham S. McDonald**

* Departamento de Teoría de la Señal y Comunicaciones e Ingeniería Telemática, ETSI Telecomunicación, Universidad de Valladolid, Campus Miguel Delibes s/n, 47011 Valladolid, Spain.

** Joule Physics Laboratory, School of Computing, Science and Engineering, University of Salford, Salford M5 4WT, UK.

In recent works, the use of the full nonlinear Helmholtz equation (NHE) has permitted to extend the study the propagation properties of bright [1] and dark [2] spatial solitons to arbitrary angles, beyond the limits imposed by paraxiality to the nonlinear Schrödinger equation (NSE). Both the NHE and the numerical methods developed for its analysis [3] support counterpropagating solutions. In this presentation, we address precisely this new type of Helmholtz nonparaxiality arising from counterpropagating waves configurations where previous analysis both for plane waves within resonators or NSE counterpropagating soliton solutions [5,6] have relied in the use of two coupled (by XPM terms) paraxial NSEs describing the propagation at the forward and backward direction, respectively. Exact analytical solutions for Helmholtz plane waves and approximate solutions, obtained using a perturbative technique, for counterpropagating solitons will be presented which provide their corresponding paraxial counterparts in the small amplitude limit, along with a full numerical study of counterpropagating Helmholtz soliton solutions using well-tested numerical techniques [3].

REFERENCES

1. P. Chamorro-Posada, G.S. McDonald and G.H.C. New, J. Opt. Soc. Am. B, 19, 1216-1217 (2002).
2. P. Chamorro-Posada, G.S. McDonald and G.H.C. New, Opt. Commun., 192, 1-12 (2001).
3. P. Chamorro-Posada and G.S. McDonald, Opt. Lett. 28, 825 (2003).
5. M. Haelterman, A.P. Sheppard and A.W. Snyder, Opt. Commun., 103, 145 (1993).
6. O. Cohen, R. Uzdin, T. Carmon, J.W. Fleischer, M. Segev and S. Pdouov, Phys. Rev. Lett, 89, 133901 (2002).