



University of
Salford
MANCHESTER

The spatiotemporal ginzburg-landau equation: Dissipative solitons & stability

Bresnahan, DW, Christian, JM and McDonald, GS

Title	The spatiotemporal ginzburg-landau equation: Dissipative solitons & stability
Authors	Bresnahan, DW, Christian, JM and McDonald, GS
Type	Conference or Workshop Item
URL	This version is available at: http://usir.salford.ac.uk/id/eprint/29297/
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.

The spatiotemporal Ginzburg-Landau equation: dissipative solitons & stability

D. W. Bresnahan, J. M. Christian, and G. S. McDonald

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

Email: d.bresnahan@edu.salford.ac.uk

Keywords: dissipative solitons, Ginzburg-Landau, spatiotemporal dispersion, *energy theme*

The complex Ginzburg-Landau (GL) equation describes universal wave propagation in dispersive systems that also exhibit competition between amplification and dissipation [1,2]. The balance between dispersive effects (group-velocity dispersion and self-phase modulation), linear gain and nonlinear loss can, in principle, lead to the formation of a stationary wavepacket (or *soliton*) in the local time frame. Here, we propose a novel two-fold generalization of the traditional GL equation to accommodate additional physical effects: (i) spatiotemporal dispersion [3], and (ii) power-law nonlinearity [4]. Exact analytical bright solitons of the new model have been derived, with asymptotic analysis demonstrating the emergence of well-known solutions [1,2] in a simultaneous multiple limit. Extensive simulations have revealed that, like its conventional counterpart (see Fig. 1), the new class of spatiotemporal dissipative soliton is also susceptible to a blow-up phenomenon (where the zero-amplitude continuous-wave solution is modulationally unstable against background fluctuations of arbitrarily-small magnitude). However, a route to stabilization may be possible by coupling the soliton to a non-dispersing linear wave [5].

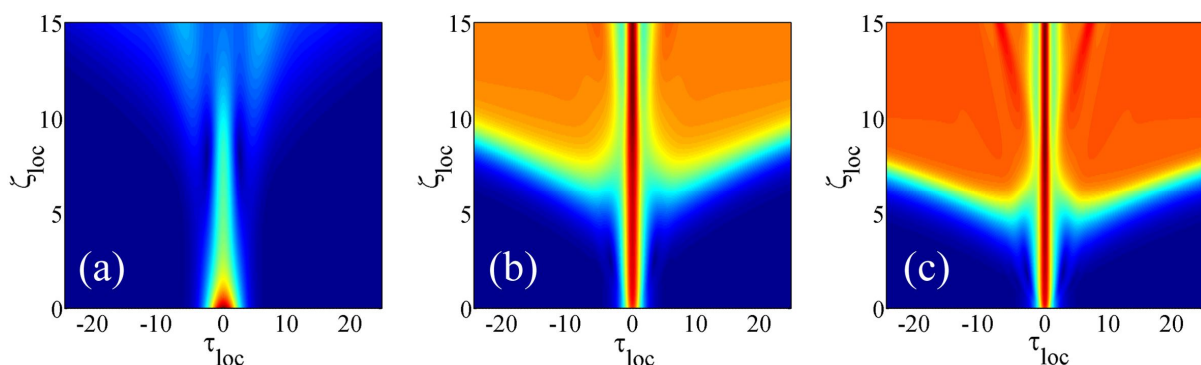


Figure 1. Instability in the conventional complex GL equation in the local time frame $(\tau_{loc}, \zeta_{loc})$ [2] for increasing strength of power-law nonlinearity. The perturbed initial-value problem corresponds to launching an input pulse whose peak intensity is lower than that predicted by the stationary solution for (a) sub-Kerr, (b) Kerr, and (c) super-Kerr systems.

References

- [1] N. R. Pereira and L. Stenflow, *Phys. Fluids* **20**, 1733 (1977).
- [2] C. Paré, L. Gagnon, and P. Bélanger, *Opt. Commun.* **74**, 228 (1989).
- [3] J. M. Christian, G. S. McDonald, T. F. Hodgkinson, and P. Chamorro-Posada, *Phys. Rev. Lett.* **108**, 034101 (2012).
- [4] J. M. Christian, G. S. McDonald, R. J. Potton, and P. Chamorro-Posada, *Phys. Rev. A* **76**, 033834 (2007).
- [5] N. Efremidis *et al.*, *Phys. Scr.* **T84**, 18 (2000).