



University of
Salford
MANCHESTER

The absorptive ring cavity: Dynamics & patterns beyond the mean-field limit

Readman, SL, Christian, JM, Bostock, C and McDonald, GS

Title	The absorptive ring cavity: Dynamics & patterns beyond the mean-field limit
Authors	Readman, SL, Christian, JM, Bostock, C and McDonald, GS
Type	Conference or Workshop Item
URL	This version is available at: http://usir.salford.ac.uk/id/eprint/29303/
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 absorptive ring cavity: dynamics & patterns beyond the mean-field limit

S. L. Readman, J. M. Christian, C. Bostock, and G. S. McDonald

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

Email: s.l.readman@edu.salford.ac.uk

Keywords: thin-slice approximation, ring cavity, saturable absorber, *energy theme*

An optical ring cavity filled with an absorptive material is a fundamental spontaneous pattern-forming system [1]. Analyses of Turing bifurcations in these (uni-directional) cavity configurations [see Fig. 1(a)] can be simplified by deploying the thin-slice limit, wherein the host nonlinear medium (typically of the Maxwell-Bloch type) has a near-negligible thickness [2]. Our most recent research has investigated the emergence of spontaneous *simple* [see Fig. 1(b)] and *fractal* patterns (which are defined by the presence of a *single dominant scale length* and *multiple scale lengths of proportional amplitude*, respectively) in absorptive thin-slice cavities [3]. Extensive simulations have demonstrated that the plane-wave limit of our model (where transverse effects are neglected) tends to be stable and well behaved: the cavity dynamics lack the Ikeda-type instabilities that can dominate purely-dispersive systems [4]. We have also started to generalize earlier analyses [3] by accommodating a finite light-medium interaction length. Such considerations will, potentially, facilitate the description of fully-nonparaxial fractal light patterns in bulk-medium geometries [5].

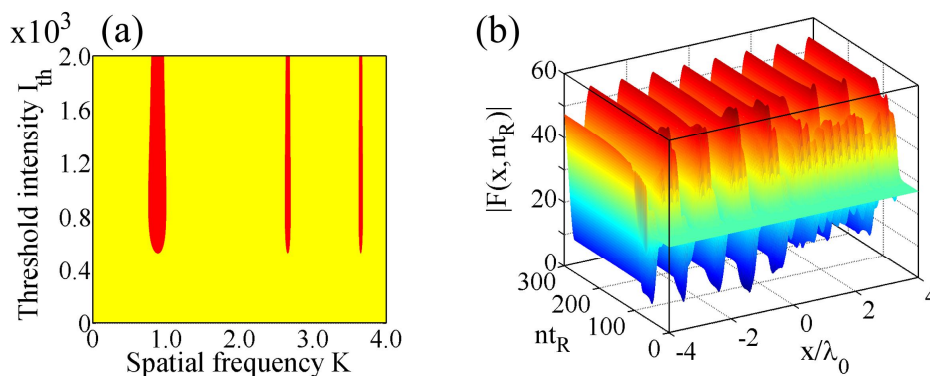


Figure 1. (a) A typical multi-Turing threshold spectrum for an absorptive ring cavity containing a thin slice of saturable absorber material [3]. (b) Simulation showing the spontaneous emergence of a spatial pattern whose most-unstable wavelength is $\lambda_0 = 2\pi/K_0$, where K_0 corresponds to the minimum of the first instability lobe [see part (a)].

References

- [1] A. S. Patrascu, C. Nath, M. Le Berre, E. Ressayre, and A. Tallet, *Opt. Commun.* **91**, 433 (1992).
- [2] M. Le Berre, A. S. Patrascu, E. Ressayre, and A. Tallet, *Opt. Commun.* **123**, 810 (1996).
- [3] J. G. Huang, J. M. Christian, and G. S. McDonald, *J. Nonlin. Opt. Mat. Phys.* **21**, 1250018 (2012).
- [4] K. Ikeda, H. Daido, and O. Akimoto, *Phys. Rev. Lett.* **45**, 709 (1980).
- [5] M. Brambilla, L. Columbo, and T. Maggipinto, *J. Phys. B: Quantum Semiclass. Opt.* **6**, S197 (2004).