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Authors	Patel, S, 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/29302/
Published Date	2013

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The nonlinear Fabry-Pérot cavity: complexity in a simple optical feedback system

S. Patel, J. M. Christian, C. Bostock, and G. S. McDonald

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

Email: s.patell@edu.salford.ac.uk

Keywords: complexity, Fabry-Pérot cavity, optical feedback, *energy theme*

The nonlinear Fabry-Pérot (FP) cavity [see Fig. 1(a)] is a generalization of the classic diffusive Kerr slice with a single feedback mirror [1,2]. Such apparent simplicity is deceptive. Historically, analysis of the FP geometry has proved to be a non-trivial problem [3]: it is the epitome of a complex system capturing the interplay between diffraction (in the free-space path), counter-propagating fields, transverse diffusion of carriers (driven by local incoherent light intensity) and a host of cavity effects (periodic pumping, mirror losses, and interferomic mistuning). In addition, phenomena can be present on several distinct time-scales. We have considered an instantaneous medium response in the plane-wave limit (where transverse effects such as diffraction and diffusion have been neglected). Even with these simplifications the FP cavity routinely exhibits remarkably complicated dynamics. The behaviour has been investigated as functions of system parameters (such as slice reflectivity and mistuning) using time series to visualize phase-space attractor geometries. Careful inspection of bifurcation diagrams [see Fig. 1(b)] has also shown that Ikeda-type instabilities [4] can dominate the system response. These plane-wave results are expected to play a key role in the subsequent analysis of spontaneous spatial pattern-forming instabilities.

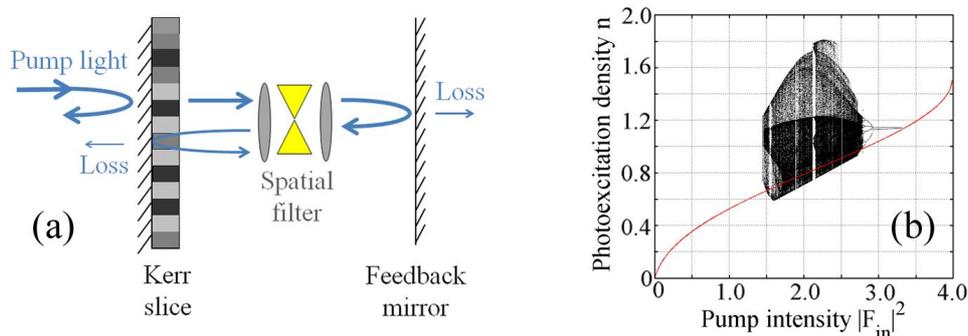


Figure 1. Schematic diagram of the nonlinear FP cavity, formed by allowing the input face of the Kerr slice to be partially reflecting. (b) Ikeda-type instabilities have been uncovered on the lower branch of the stationary state solution (red line) for cavities with moderate slice feedback.

References

- [1] G. D'Alessandro and W. J. Firth, *Phys. Rev. Lett.* **66**, 2597 (1991).
- [2] J. G. Huang and G. S. McDonald, *Phys. Rev. Lett.* **95**, 174101 (2005).
- [3] G. S. McDonald *et al.*, *Proceedings on Nonlinear Dynamics in Optical Systems 7*, OSA, Oklahoma, June 4–8 (1990).
- [4] K. Ikeda, H. Daido, and O. Akimoto, *Phys. Rev. Lett.* **45**, 709 (1980).