Excitability of localized structures in nonlinear optical cavities

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Localized structures (LS) are found in optical cavities through the interplay between diffraction, nonlinearity, driving and dissipation. Due to dissipation, LS are unique once the parameters of the system have been fixed. LS may develop a number of instabilities, for instance their amplitude can oscillate in time while remaining static in space. Furthermore, it has been shown that this structures can display excitable behavior even if the dynamics of the system is not locally excitable [1]. For a homogeneous pump the mechanism leading to excitable behavior is a saddle-loop (homoclinic) bifurcation, through which an stable oscillating LS collides with a unstable saddle LS.

Here we consider a system pumped by a localized Gaussian beam on top of a homogeneous background. The scenario is richer, and one finds two different mechanisms leading to excitability. One is based on a saddle-loop bifurcation as above, while the other takes place through the saddle-node in the invariant circle (SNIC) bifurcation. In this last case there is in phase space a stable fixed point (stable LS) and a neighboring saddle point (unstable LS), which coalesce at the SNIC. The stable manifold of the saddle acts as a threshold, so that small perturbations relax linearly, while large perturbations originate a long excursion in phase space of the LS, signalling excitable behavior. Beyond the SNIC the LS exhibits oscillatory behavior.

[1] D. Gomila, M.A. Matías, and P. Colet, Phys. Rev. Lett., **94**, 063905 (2005)