Homoclinic snaking in a semiconductor based optical system

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Abstract:

We present experimental results on the formation and control of single and cluster states of Cavity Solitons (CSs) in a vertical cavity semiconductor optical amplifier. CSs are self-localized states appearing in extended nonlinear dissipative systems. In optics, they have been found in several systems and in particular in semiconductor microcavities [1,2] where their potential use as pixels for all-optical processing of information has raised a great interest. They generally appear as bright spots sitting on a dark background and are spatially controllable. When cavity solitons are far away from each other, they are independent objects while at short distances they can form bound-states. Understanding and control of these cluster states are of crucial importance for applications, while it sheds some light on the relation between localized states and patterns on a more fundamental viewpoint. Our experimental system is composed of a Vertical Cavity Semiconductor Optical Amplifier [3]. Experiments are carried out in quasi-1D and 2D configurations. As a parameter is varied (the pump intensity), a bifurcation sequence (homoclinic snaking curve) is recorded. It is in very good qualitative agreement with what is expected from theoretical calculations [4]. In 2D, the situation is slightly more complex given the additional degrees of freedom in the system. We nevertheless evidence multistability between multi-peaked structures. However, in our system, there is not coexistence of all the different localized states due to a tilt in the bifurcation sequence. We show in particular the possibility to excite only single-peaked CSs in certain parameter ranges and this proves very important for applications: it means that independently of the local excitation power needed to switch-on one CS, only single peaked CSs (corresponding to a unique bit of information) can form.

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