Front dynamics in periodic modulated media

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Front propagation in non equilibrium systems is a very rich and interesting phenomenon, present in many different systems such as magnetic domains, chemical reactions or population dynamics [1]. Fronts are non linear solutions connecting two metastable states and propagating with a dynamics that depends on the nature of the states connected. For example, in a variational system, a front connecting two stable states moves at a constant speed and always in such a way to develop the most stable state. In that situation, when one moves a single parameter, there is only one point where the energy of the two states is equal and therefore, the front is motionless. A question that can be rised is how this motionless behavior can be extended to a large range of values of one control parameter. An answer to this question was given by Pomeau [2], predicting that for fronts connecting a stable homogeneous state and a periodic state, a pinning phenomenon of the front exists. Following this idea, the addition of spatial modulations on the originally homogeneous states, should be an efficient way to block the front over a large range of the control parameter. In our work, we have investigated both experimentally and theoretically the pinning-depinning phenomenon in spatially modulated media. Experimentally, we have used a Liquid Crystal Light Valve (LCLV) with optical feedback. In a situation where fronts between two homogeneous states can be observed, spatial intensity modulations were added on the input beam profile by using a Spatial Light Modulator. A 1d characterization of the dynamics with respect to the voltage applied to the liquid crystal have been made first, and, then with respect to the spatial forcing parameters. The existence of a pinning range was clearly highlighted and a front propagation by periodic leaps apart from this range was observed as well [3]. We have compared the experimental results with the theoretical predictions obtained for the LCLV model accounting for the orientation of the liquid crystal molecules in presence of an optical feedback and with spatial modulations of the input beam. It appears that close to the point of nascent bistability, it is possible to develop the model on a forced extended pitchfork bifurcation normal form. Both results obtained with the complete LCLV model and with the normal form are in good agreement with the experimental ones. A 2d extension of the 1d case was performed experimentally using stripe intensity masks as well as square and hexagonal modulations. The pinning phenomenon is observed and characterized too. Finally, we show out that localized structures of different shape and size can be stabilized inside the pinning range.

Bibliography

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