Coupling to mechanical and reservoir modes in microcavity polaritons

N. Bobrovska[1], M. Matuszewski[1], T. C. H. Liew[2] and O. Kyriienko[3]

[1]*Institute of Physics, Polish Academy of Sciences, Aleja Lotnikow 32/46, PL-02668, Warsaw, Poland*

[2]*Division of Physics and Applied Physics, School of Physical and Mathematical Sciences, Nanyang Technological University, 21 Nanyang Link, Singapore 637371*

[3]*The Niels Bohr Institute, University of Copenhagen, Blegdamsvej 17, DK-2100 Copenhagen, Denmarki*

Here we present two separate topics concerning the nonlinear system of strongly interacting matter quasiparticles with light in a microcavity.

The first topic is devoted to the relation between two commonly used models describing the dynamics of nonresonantly pumped exciton-polariton condensates: the complex Ginzburg-Landau equation (CGLE) and the open-dissipative Gross-Pitaevskii equation coupled to a separate equation for the reservoir density (ODGPE). Here we concentrate on the validity of the adiabatic approximation and small density fluctuations approximation that allow one to reduce the coupled condensate-reservoir dynamics to a single partial differential equation. We find that the adiabatic approximation consists of three independent analytical conditions that have to be fulfilled simultaneously. By investigating stochastic versions of the two corresponding models, we verify that the breakdown of these approximations can lead to discrepancies in correlation lengths and distributions of fluctuations [1].

In the second topic we consider the systems of exciton-polaritons and dipolaritons inside the optomechanical microcavity. The presence of the mechanical mode and the resonance frequency of the microcavity results in an interactive type of optomechanical coupling which generate the effective optical nonlinear high order terms. We show that this effective optical nonlinearity can exceed in magnitude the strength of Kerr nonlinear terms. We show numerically that the higher order terms influence the generation of the localized bright flat-top solitons in polariton condensates, see Fig. 1.

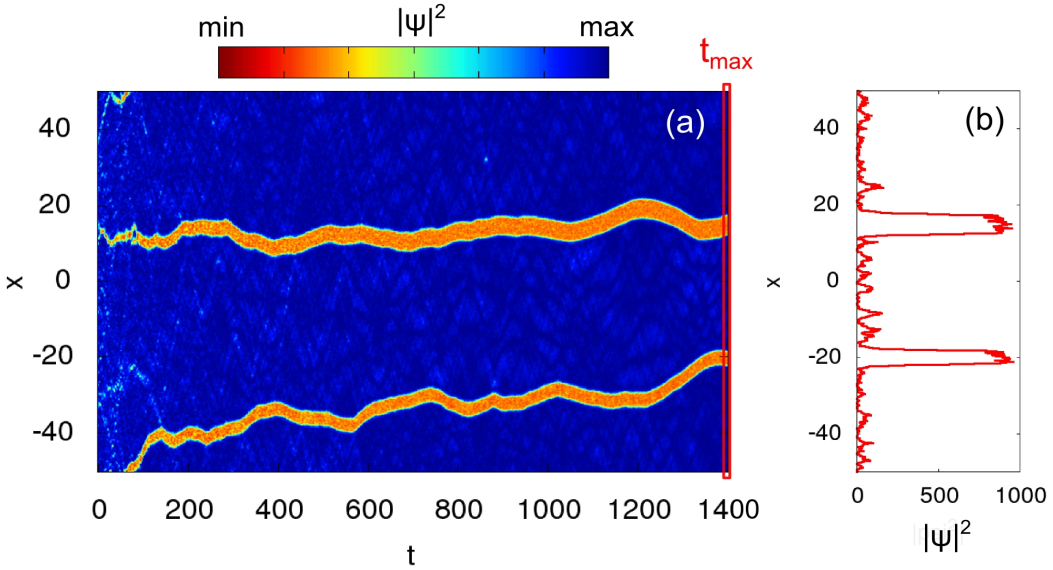

Figure 1. (a) Stable flat-top solitons, spontaneously formed from an initial random noise, and (b) their spatial profile at t_{max}.

[1] N. Bobrovska and M. Matuszewski, Phys. Rev. B 91, 245310 (2015).