One Dimensional Incoherently Pumped Polariton Condensate Flowing Against an Obstacle

A. Opala, M. Pieczarka, G. Sęk

Laboratory for Optical Spectroscopy of Nanostructures, Division of Experimental Physics, Faculty of Fundamental Problems of Technology, Wrocław University of Science and Technology, Wrocław, Poland

Exciton-polaritons, are bosonic quasiparticles that arise from strong coupling between exciton and photon modes in a semiconductor microcavity. Polaritons form condensates similar to atomic Bose-Einstein condensates, which can be described in the mean-field theory by a modified open-dissipative Gross-Pitaevskii equation [1]. The dissipative nature of exciton-polariton condensate comes from their intrinsic short lifetime of the order of ps, which is caused by the escape rate of photons outside the microcavity. Additionally, semiconductor microcavities are always under influence of some level of disorder naturally present in the sample. For this reason, exciton polaritons are a great platform to investigate bosonic condensation in random disorder potentials in analogy to atomic Bose-Einstein condensates in randomly generated optical potentials. Additionally, special attention is paid to condensates of lowered dimensionality, where the influence of disorder is enhanced.

In polariton systems dimensionality can be reduced by spatial patterning of the sample, creating quasi-one-dimensional microwires. Here we present theoretical investigations of a one-dimensional polariton condensate, created with nonresonant pumping and flowing against a localized obstacle. We employ an open-dissipative Gross-Pitaevskii equation, coupled to a reservoir rate equation, which captures the full reservoir-condensate dynamics, contrary to single-equation description [1],[2]. We investigate different wave patterns induced by an obstacle and demonstrate features controlling the flow velocity of the condensate and the system parameters, exploring the phase diagram of stability of a exciton-polariton condensate. Additionally, linear Bogoliubov-de Gennes analysis is performed to check stability conditions of the polariton condensate flow.

[1] N. Bobrovska, M. Matuszewski, Phys. Rev. B 92, 035311 (2015)

[2] P.-É. Larré, N. Pavloff, and A. M. Kamchatnov Phys. Rev. B 86, 165304 (2012)