All-optical flow control of a polariton condensate using nonresonant excitation

P. Lewandowski[1]*, J. Schmutzler[2], Marc Aßmann[2], Dominik Niemietz[2], Stefan Schumacher[1], Martin Kamp[3], Christian Schneider[3], Sven Höfling[3,4], and Manfred Bayer[1,5]
[1]Universität Paderborn, Department of Physics and CeOPP
[2]Technische Universität Dortmund, Experimentelle Physik 2
[3]Universität Würzburg, Wilhelm Conrad Röntgen
Research Center for Complex Material Systems
[4]University of St Andrews, School of Physics and Astronomy, SUPA
[5]Russian Academy of Sciences St Petersburg, A. F. Ioffe Physical-Technical Institute
* Corresponding Author, plewando@mail.uni-paderborn.de

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Abstract

The properties of exciton-polaritons in planar semiconductor-microcavities make them promising for realization of all-optical circuits [1]. In case of nonresonant excitation, the spontaneous condensation of polaritons has been subject of high interest over the past decade [2]. However, this condensation process is driven indirectly by incoherent excitons and therefore accompanied by the loss of the details (frequency, momentum) of the optical excitation.

Here, we demonstrate that control of the condensate can still be achieved using only nonresonant optical excitation. Using spatially structured intensity profiles for the excitation, the background-carriers act as a source for the condensate while at the same providing a potential energy landscapes to control the polariton flow. We present both experimental and theoretical results and show that it is possible to, e.g., trap the condensate or to generate a directed polariton flow using spatially structured excitation geometries [3] (cf Fig 1 a,b). Once created, a directed polariton flow can be controlled further by interaction with additional all-optically imprinted potential landscapes, e.g. re-collected (cf Fig 1 c,d) or redirected. Since the incoherent excitons provide both potential landscape and 'gain medium', the condensate is also re-amplified during this interaction, making this process potentially cascadable.

We will also discuss scattering experiments and trajectories of condensates colliding with excitonic targets providing further insight into the interaction between coherent polaritons and incoherent excitons.

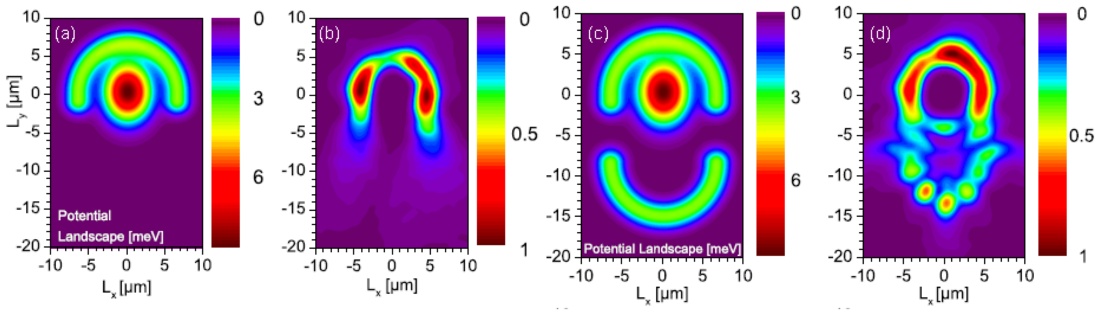

Figure 1.Shown are different optically generated excitonic potential landscapes (a,c) and simulations for the time-integrated photoluminescense of the polariton condensates (b,d). The potential geometry of (a) generates polaritons with a directed flow of the condensate (b). An additional semicircle (c) in the geometry can block, recollect and re-amplify the polariton flow (d).

Our simulations that well reproduce the experimental observations are based on a microscopic semiconductor theory in meanfield approximation including all coherent third-order nonlinearities extended by an active and an inactive reservoir of excitations.

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