Topological edge and corner states in coupled wave lattices (AAH-SSH) in nonlinear polariton condensates

T. Schneider [1,3,*], W. Gao [2], T. Zentgraf [1,3], S. Schumacher[1,3,4], X. Ma[1]

[1]Department of Physics and CeOPP, Paderborn University, 33098 Paderborn, Germany
[2]EIT Institute for Advanced Study, Ningbo China
[3]Institute for Photonic Quantum Systems (PhoQS), Paderborn University, 33098 Paderborn, Germany
[4]Wyant College of Optical Sciences, University of Arizona, Tucson, Arizona 85721, USA

Topologically protected states are of great interest due to their robustness against perturbations, hence they have been widely investigated in many physical systems including microcavity exciton polaritons [1]. In this work, we explore topological states in exciton polariton condensates in our newly designed double-wave (DW) lattices (AAH-SSH) [2]. For this purpose we calculate the lattices eigenstates, the time evolution of these states in a nonlinear regime, and their Chern number using the bulk edge correspondence [3] [4]. The 1D DW chains we proposed enable multiple types of edge states in both the linear and the nonlinear regime, in which they are shown to be multistable. The strong nonlinearity of polaritons can also lead to the formation of new types of edge states that originate from the bulk eigenstates, i.e. nonlinearity-enhanced edge localization. The 1D lattice can be expanded into a 2D lattice structure, with SSH like structures in the new dimension. The combination of the perpendicular DW and SSH lattices allows the formation of higher-order topological insulator states (0D corner states). These corner states are also shown to be multistable in the nonlinear regime, offering potential for all-optical switching.

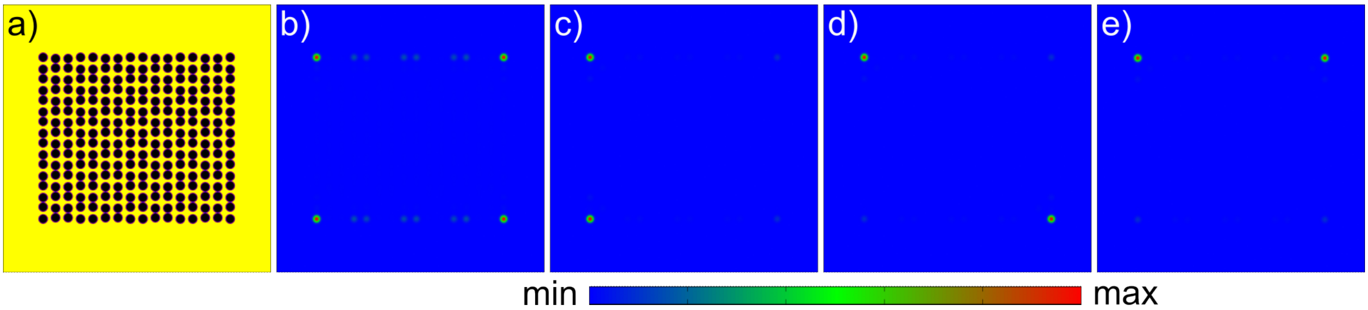

Figure 1: (a) The 2D double-wave lattice (AAH-SSH). (b)-(e) Four multistable topological corner states excited within the double-wave lattice.

The same results depicted in Figure 1 (b)-(e) can also be calculated using significantly larger DW lattices. These demanding calculations can be efficiently solved using the PHOENIX solver [5], allowing speedups of up to two magnitudes and energy savings of up to 95% compared to the equivalent matlab code.

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*E-mail: saibot@campus.uni-paderborn.de