Macroscopically coupled polariton condensates

Töpfer, Julian[1,2,*], Sigurdsson, Helgi[1,2], Pickup, Lucinda[1], Alyatkin, Sergey[2], Askitopoulos Alexis[2], Lagoudakis Pavlos[1,2]

[1]*Dept of Physics and Astronomy, University of Southampton, Southampton, UK*
[2]*Skolkovo Institute of Science and Technology, Moscow Region, Russian Federation*
**e-mail: j.d.toepfer@soton.ac.uk*

Networks of interacting polariton condensates have been shown to offer a versatile platform for engineering and studying complex systems such as phase or spin-synchronized lattices [1, 2]. In this work we present an in-depth study of the nature of interaction and synchronization between two spatially separated, non-trapped and ballistically expanding polariton condensates. We show that this system differs from a conventional Josephson-junction of trapped condensates since the coupling is not mediated by a tunneling current but by radiative coupling inherently connected with finite time of particle transfer [3]. Synchronization is observed over macroscopic distances as large as d = 114 µm (Fig.1a) for two tightly-pumped condensates, which is more than 50x larger than the FWHM of each condensate (~2 µm). We demonstrate that interactions in-between condensates can be optically controlled (Fig.1b) [4] and are described by delay-differential equations which makes networks of non-trapped polariton condensates a promising platform to study time-delay coupled systems [5], that arise in many areas of nature, and can be attractive for implementing artificial neural networks.

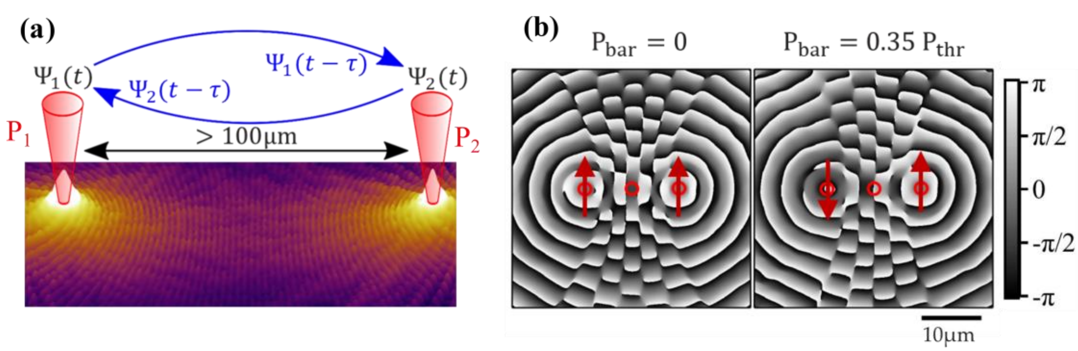

Fig. 1. (a) Two macroscopically separated and ballistically expanding polariton condensates. Interference fringes visualize the synchronization of both condensates. (b) Optical control of synchronization between two condensates locked in-phase (left) and anti-phase (right) by modulation of the optical-pump intensity of an additional potential barrier in-between the two condensates (middle red circle).

References

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