Polariton Stirring and Storage of Quantized Vortices

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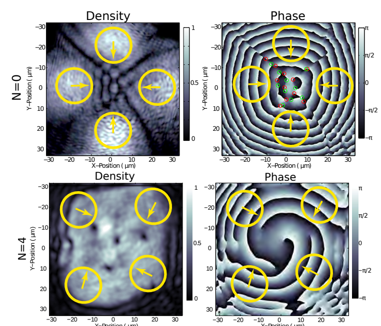

Density and phase of merging of four polaritons fluid. In the linear regime with the azimuthal angle $\varphi = 0$ (up). In the nonlinear superfluid regime with $\varphi = 21°$ (down).

When an exciton and a photon in a planar semiconductor microcavity are strongly coupled, a new particule arises. Theses particles, called exciton-polaritons, are bosons and inherit specific properties from both their light and matter components, such as low effective mass and nonlinear interactions. They are easily controllable by optical techniques and offer a handy system to study light-matter interaction and nonlinear behaviors such as condensation, superfluidity and vortices. Also, their short life-time allow to investigate out-of-equilibrium phenomena.

In this work we investigate the propagation of four polariton flows towards each other in a square geometry (see the hereby figure) [1]. In the experiment, the direction and the modulus of the wave vector can be easily tuned by changing the pump beams incident angle. This way we can merge four polariton fluids with a continuous and inject a continuous and controllable orbital angular momentum in the system.

The density of polaritons is directly linked to the laser pump intensity, allowing a complete control of the nonlinearities in the system. By tuning the polariton density, we observe the transition between the linear regime (where polaritons behave like optical waves) and the nonlinear regime (where polaritons can form a superfluid). In the latest, the polariton-polariton interaction is dominant and we observe the vanishing of the interference pattern, as well as the annihilation of all vortex-antivortex pairs [2]. As shown in Ref. 1, the integer part of the continuous orbital angular momentum injected by the pump corresponds to the quantized number of vortices N in the superfluid phase. This allows to store quantized vortices (topological charges) by injecting a classical orbital angular momentum in a controllable way. Moreover, our study indicates that, in the steady-state regime, the angular momentum continuously injected by the pumps compensates the loss of angular momentum in the system.

1. Boulier, T., E. Cancellieri, N. D. Sangouard, Q. Glorieux, A. V. Kavokin, D. M. Whittaker, E. Giacobino and A. Bramati, *Injection of Orbital Angular Momentum and Storage of Quantized Vortices in Polariton Superfluids*, Phys. Rev. Lett., Vol. 116, 116402, 2016.

2. Cancellieri, E., T. Boulier, R. Hivet, D. Ballarini, D. Sanvitto, M. H. Szymanska, C. Ciuti, E. Giacobino and A. Bramati, *Merging of vortices and antivortices in polariton superfluids*,Phys. Rev. B, Vol 90, 214518, 2014.