Exciton-polariton vortices in magnetic fields

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Exciton-polaritons are quasi-particles, which can form in an optical micro-cavity due strong coupling between cavity photons and excitons in a quantum well. Many interesting effects can be studied in this system, such as Bose-Einstein condensation and superfluidity, which have attracted a great amount of interest recently. The superfluid property of this system is particularly important as the remarkable effects as vortices, vortex streets, dark and bright solitons can be observed. The fact that the collective wave function can be observed optically enables interesting studies of different phase singularities that appear in this system.

In our work we extend the already existing studies in exciton-polariton superfluid to account for the spinor nature of polaritons. Polaritons have a two spin projections on the axis of the quantum well. The polariton condensate can be therefore formed of two spin-polarized subsystems. By embedding manganese ions in the (Cd,Zn,Mn)Te quantum well, we are able to achieve semi-magnetic properties of the condensate, thus enabling the use of an external magnetic field as an additional parameter to influence or tune the system from spin-mixed to single component, spin polarized condensate [1,2].

In order to observe all collective phenomena revealed by the singularities in the phase coherence, we have built an advanced stabilized interferometer and we performed interferometric measurements on semi-magnetic polariton condensates as a function the externally applied magnetic field.

The interferograms reveal the magnitude of coherence as well as the phase of the polariton condensate, thus exposing the vortices forming in the condensate (Figure), as well as their behavior as the external magnetic field is increased.

We find clear evidence of quantized vortex formation where the sample's intrinsic disorder favors the generation of pinned vortices. Furthermore, our data suggests the tendency for vortices transforming into pairs of half-vortices as the magnetic field is increased, which we attribute to the change in the condensate polarization.

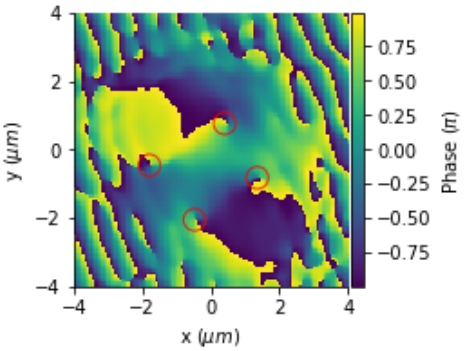

Figure: Measured semi-magnetic polariton phase in a magnetic field containing two individual vortices and their mirror images.

[1] B. Piętka, N. Bobrovska, D. Stephan, M. Teich, M. Król, S. Winnerl, A. Pashkin, R. Mirek, K. Lekenta, F. Morier-Genoud, H. Schneider, B. Deveaud, M. Helm, M. Matuszewski, and J. Szczytko, "Doubly Dressed Bosons: Exciton Polaritons in a Strong Terahertz Field," Phys. Rev. Lett., vol. 119, no. 7, p. 77403, 2017.

[2] J.-G. Rousset, B. Piętka, M. Król, R. Mirek, K. Lekenta, J. Szczytko, W. Pacuski, and M. Nawrocki, "Magnetic field effect on the lasing threshold of a semimagnetic polariton condensate," *Phys. Rev. B*, vol. 96, no. 12, p. 125403, 2017.