Quantised Vortices in an Exciton-Polariton Condensate

K. G. Lagoudakis[1], M. Wouters[2], M. Richard[1], A. Baas[1], I. Carusotto[3], R. André[4], Le Si Dang[4], B. Deveaud-Plédran[1]

[1]IPEQ, Ecole Polytechnique Fédérale de Lausanne(EPFL), Lausanne, Switzerland.
[2]ITP, Ecole Polytechnique Fédérale de Lausanne(EPFL), Lausanne, Switzerland.
[3] INFM-CNR BEC and Dipartimento di Fisica, Universita di Trento, Trento, ITALY.
[4] Institut Néel, CNRS, Grenoble, France.

The quantum nature of low temperature interacting Bosons may give rise to superfluidity. First observed in liquid ^{4}He this phenomenon has been intensively studied in various systems for its amazing features such as the vanishing of viscosity and the appearance of vortices with quantised angular momentum. The achievement of Bose-Einstein condensation (BEC) in dilute atomic gases provided an exceptional opportunity to observe and study superfluidity and its features. In the solid state, exciton polaritons have proved very good candidates for the achievement of BEC due to their extremely low effective mass. Exciton-polaritons are strongly interacting light-matter bosonic quasi-particles, naturally occurring in semiconductor microcavities in the strong coupling regime and constitute a very interesting example of composite bosons. Although BEC of exciton polaritons has now been reported several times, the superfluid nature of their quantum phase still remains an open question.

In the present experimental work, we report the spontaneous formation of deterministic pinned quantised vortices in the condensed phase of a polariton fluid by means of phase and amplitude imaging. Additionally, we provide a theoretical insight to the possible origin of such vortices by means of a model based on the generalised Gross-Pitaevskii equation that captures the mean field dynamics of the polariton condensate, and we discuss fundamental differences and similarities with vortices in different optical systems.

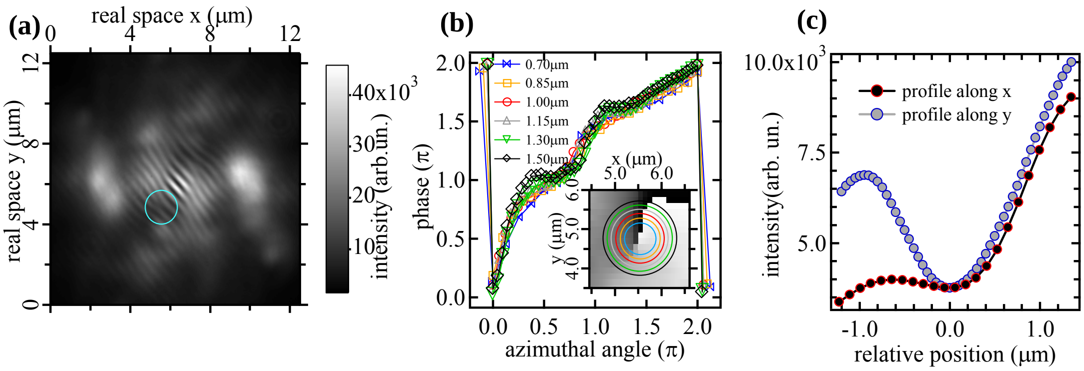

Figure: **(a)** Real space interferogram of the condensate luminescence containing a vortex. The vortex singularity is evidenced by the forklike dislocation of the interference fringes (here located within the solid circle). **(b)** Extracted phase of the polariton quantum fluid around the vortex core for different radii. The phase is always giving a well defined 2π phase shift. **(c)** population at the location of the vortex along the x and y directions. The vortex is located to a population minimum.

Reference: *arXiv*:0801.1916 and references therein. Nature Physics in press.