Persistent currents and quantized vortices in a polariton superfluid

D. Sanvitto[1], F. M. Marchetti[2], M. H. Szymańska[3,4], G. Tosi[1], M. Baudisch[1], F. P. Laussy[5], D. N. Krizhanovskii[6], M. S. Skolnick[6], L. Marrucci[7], A. Lemaître[8], J. Bloch[8], C. Tejedor[2] and L. Viña[1]

[1]Departamento de Física de Materiales, Universidad Autónoma de Madrid, Spain
[2]Departamento de Física Teórica de la Materia Condensada, Universidad Autónoma de Madrid, Spain
[3]Department of Physics, University of Warwick, UK
[4]London Centre for Nanotechnology, London, UK
[5]School of Physics and Astronomy, University of Southampton, UK
[6]Department of Physics and Astronomy, University of Sheffield, UK
[7]Dipartimento di Scienze Fisiche, Università di Napoli Federico II and CNR-SPIN, Napoli, Italy
[8]LPN/CNRS, Route de Nozay, Marcoussis, France

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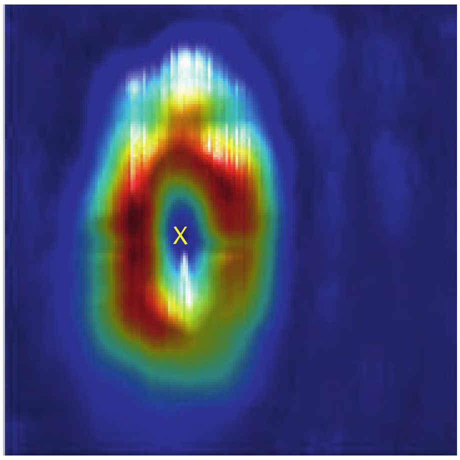
After the discovery of zero viscosity in liquid helium, other fundamental properties of the superfluidity phenomenon have been revealed. One of them, irrotational flow, gives rise to quantized vortices and persistent currents. Those are the landmarks of superfluidity in its modern understanding. Recently, a new variety of dissipationless fluid behavior has been found in microcavities under the optical parametric regime. In this paper, the authors report the observation of metastable persistent polariton superflows sustaining a quantized angular momentum, $m\hbar$, after applying a 2-ps laser pulse carrying a vortex state. The latter was prepared by diffraction of an input Gaussian beam on suitable holograms specifically developed in CNR-SPIN. Different holograms were used for injecting different values of angular momentum m, or to obtain more complex superposition states. In all cases, the authors observe a transfer of angular momentum to the steady-state condensate, which then sustains vorticity for as long as it can be tracked.



False-colors image of a metastable polariton superfluid vortex. The "x" labels the vortex core.

The stability of quantized vortices with m = 2 was also investigated. The appearance of secondary vortices of various signs around the injected vortex was finally observed and explained (in follow-up studies) thanks also to theoretical insights from researchers of CNR-SPIN. All experiments were analyzed using a generalized two-component Gross–Pitaevskii equation. These results demonstrate the control of metastable persistent currents and show the peculiar superfluid character of non-equilibrium polariton condensates.