Hyperbolic Spin vortices and Textures in Spinor Polariton Condensates

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Symmetry considerations and topological arguments are successfully employed to unveil intriguing analogies between natural phenomena that would otherwise appear different from each other. From cosmology down to quantum systems, the description of phase transitions passes through symmetry breaking arguments, which are associated with the generation of topological defects. In view of the study of such topological defects, Bose-Einstein condensates[1], superfluids and superconductors have proved to be prominent systems.

Extremely unconventional vorticity is predicted to occur in spinor quantum fluids, where the unique combination of quantum coherence and spin properties allows for the existence of quantized spin vortices, signatures of spontaneous breaking of the chiral symmetry in the system. Their observation and stability conditions represent an open and debated question. Spin topological entities are also expected to yield specific spatial structures - spin textures - in the condensate polarization structure.

Polaritons condensates have the unique advantage of non-destructive optical access to the condensate complex order parameter and spin properties. Spinor polariton condensates have recently been demonstrated, by identification of their fundamental fractional vortical excitations[2]. Higher order spin vorticity – spin vortices and monopoles - are predicted to occur in the systems[3], although up to now elusive to experimental observation.

In this work we demonstrate stable spin vortices, spontaneously arising in the steady state of a spinor polariton condensate. We provide a comprehensive measurement of the spin vortical entity, by complete characterization of the condensate spin texture. The observation proves occurrence of chiral symmetry breaking, which is the very mechanism underlying the formation of Dirac monopoles, conceivably paving the way for the identification of such non-classical entities with purely radial magnetic flux.

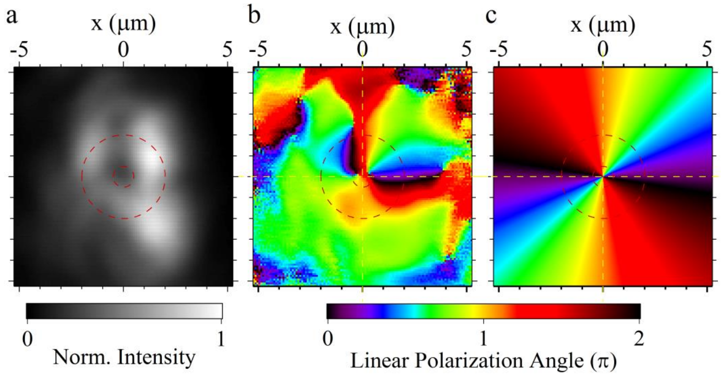

Fig. 1: (**a**) Polariton density distribution around the spin vortex core. (**b**) Measured and (**c**) theoretical linear polarization angle map, indicating the direction of the linear polarization when circumventing the spin vortex core in the Stokes parameters representation. Dashed red circles mark the vortex position.

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[3] Solano, M. T. & Rubo, Y. G., J Phys Conf Ser **210**, (2010).