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Theory of polariton condensation and superfluidity[1]

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Exciton-polaritons in planar microcavities have two allowed spin projections on the axis of the structure, which is why they can be considered as a two-component weakly interacting Bose gas. The order parameter for BEC or the superfluid phase transition in this gas is a 2D vector analogous to the Jones vector of classical light. The build-up of the order parameter results is the build up of vector polarisation of light emitted by the polariton condensate. Recently observed appearance of the spontaneous vector polarisation stochastically changing from one experiment to another [1] manifests the spontaneous symmetry breaking in a polariton system and confirms observation of the polariton BEC at room temperature in bulk GaN microcavities. The spin dependence of polariton-polariton interactions in quantum well microcavities favours formation of linearly polarised superfluids. The sound velocity in such superfluids is polarisation-dependent [2]. We show that the static potential disorder provokes generation of vortices having a semi-integer topological charge [3]. These half-vortices are lowest energy excitations in two-component superfluids. They can be observed by polarisation-resolved near-field spectroscopy. We show also that the polarisation bistability in optically driven polariton condensates allows for optical excitation of the "spin rings" spreading in the real space [4] and paves way to fabrication of "polariton neurons" assembled in all-optical integrated circuits [5].

[1] J. J. Baumberg, A. V. Kavokin, et al Phys. Rev. Lett. 101, 136409 (2008).
[2] I. A. Shelykh, et al, Phys. Rev. Lett. **97**, 066402 (2006).
[3] T. C. Liew, Yuri G. Rubo, and A. V. Kavokin, Phys. Rev. Lett. **101**, 187401 (2008).
[4] I. A. Shelykh, T. C. Liew, and A. V. Kavokin, Phys. Rev. Lett. 100, 116401 (2008).
[5] T. C. Liew, A. V. Kavokin, and I. A. Shelykh, Phys. Rev. Lett. 101, 016402 (2008).

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