Spatial Control of Exciton-Polariton Condensates Properties Using External Magnetic Field

M. Furman[1], R. Mirek[1], M. Król[1], W. Pacuski[1], H. Sigurðsson[1,2], J. Szczytko[1], B. Piętka[1]

[1] *Institute of Experimental Physics, Faculty of Physics, University of Warsaw, Poland*
[2] *Science Institute, University of Iceland, Reykjavik, Iceland*

Manipulation of light is challenging, because photons typically have a limited response to external fields. However, an effective strategy for gaining additional control over light is to strongly couple photons with matter. For example, excitons exhibit direct response to external electric and magnetic fields. Magnetic field dependence can be additionally increased by doping with magnetic ions, leading to materials known as semimagnetic semiconductors. This tunable characteristic can be extended to light in a semimagnetic microcavity [1], where photons can be strongly coupled to excitons, leading to the formation of hybrid quasiparticles known as exciton-polaritons. At a sufficiently high density, such polaritons undergo a phase transition to coherent condensate state. Multiple of such condensates can couple between each other by ballistic exchange of particles and synchronize to form an extended "supermode" [2].

Depending on the phase accumulated by the particles traveling between condensates, they can synchronize in phase or antiphase. Those two possibilities can be distinguished by the number of interference fringes appearing between the sites.

In our study, we used an external magnetic field to influence the coherent synchronization of the condensate. Magnetic field influences the effective mass of the polaritons, consequently affecting the phase accumulation of particles traveling between the condensates. Our observations reveal a flip in the number of interference fringes generated in the light emitted from the supermode by applying an external magnetic field. Initially, at a specific fringe parity, we observe a loss of synchronization with increasing magnetic field. Later on, as the magnetic field increases, we observe a transition to a supermode with opposite parity.

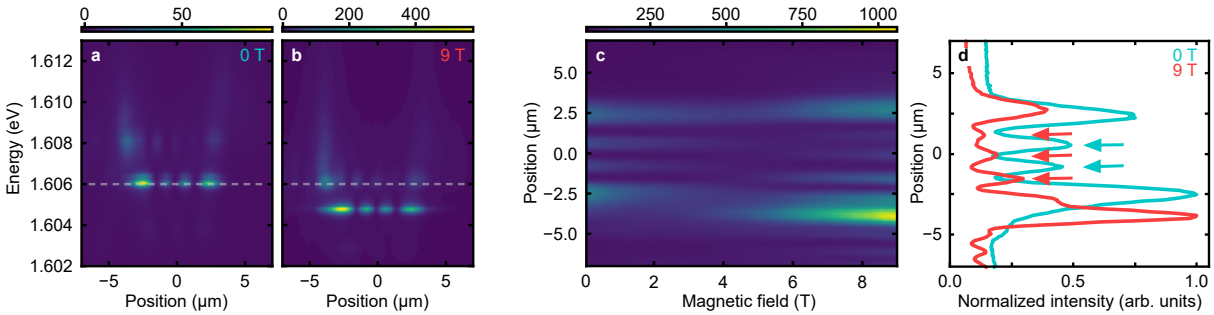

Figure: Spatially-resolved emission spectra from the condensate supermode: **a** without external magnetic field and **b** at magnetic field of 9 T. **c** Cross section at energy 1.606 eV (marked with dashed grey lines on **a** and **b** in external magnetic field). **d** Cross sections of **c** at 0 T and 9 T magnetic fields. Arrows marks positions of the constructive interference fringes.

[1] R. Mirek, et al., *Phys. Rev. B* **107**(12), 125303, (2023).
[2] M. Furman, et al., *Commun. Phys.* **6**, 196 (2023).