# The Role of Magnetic Fields in Synchronization of Two Polariton Condensates

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Photons are insensitive to external fields, which makes manipulation of them challenging. One way to enable additional control over the light is through strong coupling with matter. For example, excitons exhibit direct response to external electric and magnetic fields. The sensitivity to the external magnetic field can be additionally increased by doping microcavity structures with magnetic ions, leading to materials known as semimagnetic semiconductors [1]. Such tunability can be carried to light in a semimagnetic microcavity in which photons can be strongly coupled to excitons, leading to creation of mixed quasiparticles called exciton-polaritons. At sufficiently high polariton densities they create coherent, condensate states. Interestingly, separated condensates can ballistically exchange particles between each other, and synchronize into extended condensate "supermode"' [2].

Depending on the phase accumulated by the particles traveling between the condensates, they can synchronize in phase or in antiphase, what can be distinguished by the number of the 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.

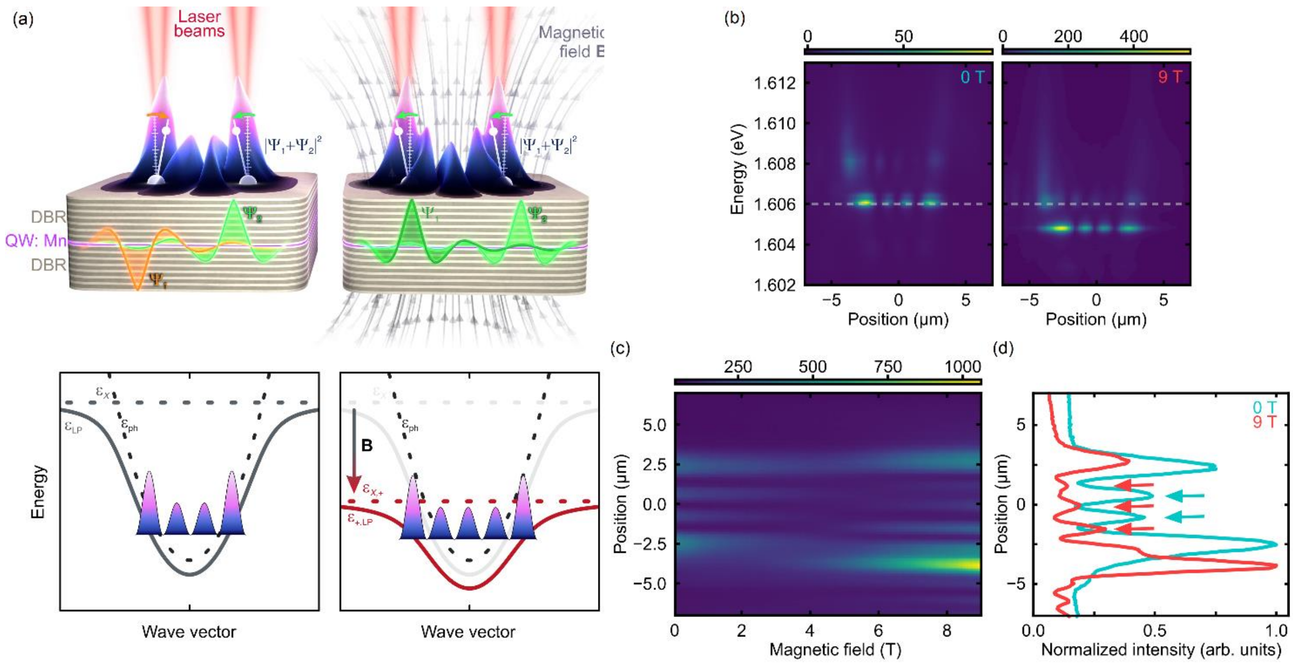


Fig. 1. (a) Schematic image and schematic dispersion relation of an odd parity polariton condensate supermode created by a ballistic synchronisation of two condensates excited with two laser beams. In external magnetic field the parity changes to even. (b) Spatially-resolved emission spectra of the condensate supermode in the absence of an external magnetic field and under a magnetic field of 9 T. (c) A cross-section at an energy level of 1.606 eV (indicated by dashed grey lines in 0 T and under external magnetic field). (d) Cross-sections of (c) under 0 T and 9 T magnetic fields. Arrows indicate the positions of 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).