Polarisation-selective Condensates in $CsPbBr_3$ as a way to Non-resonant Polariton Vortices

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Optical microcavities represent small-scale devices where the unique characteristics of light and matter converge, giving rise to a novel form of matter known as exciton-polaritons. These emergent quasiparticles have the capability to form liquid light or polariton condensates, exhibiting exceptional properties not observed in conventional condensed matter systems. These properties include phenomena such as driven-dissipative superfluidity, vorticity, and spontaneous synchronization, all of which stem from the intricate dynamics governing the evolution of the polariton fluid. The practical use of these systems can be increased if we can observe them at room temperature (RT). Lead-halide perovskites are particularly intriguing for RT semiconductor applications because they offer excellent light emission and higher exciton binding energies compared to other materials commonly used in microcavities. This makes them very promising for advancing polaritonic devices to operate effectively at RT. In our experiment, we demonstrate RT polariton condensation under pulsed non-resonant excitation. The sample used was a perovskite waveguide [1] sandwiched in an optical microcavity equipped with DBRs (10.5 pairs of SiO_2/Si_3N_4 both sides). Furthermore, because of natural birefringence in the $CsPbBr_3$ perovskite, the pumped polariton condensates are highly linearly, horizontally polarised. We will exploit the strong repulsive exciton-exciton interactions to optically trap the condensate using an axicon lens on the excitation beam, leading to the spontaneous formation of RT quantized polariton vorticity in a confining potential [2].

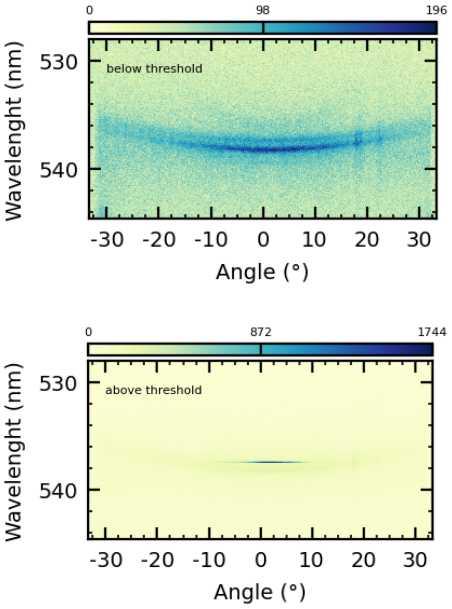

Figure 1: Polarisation-selective exciton polariton condensate in $CsPbBr_3$. Upper panel shows situation below threshold with two polariton states with orthogonal polarisation. Lower panel is above threshold and condensation is observed in only one linear polarisation.

Our investigation takes a step towards the development of an optically tunable polariton room temperature platform for ultralow threshold lasing of coherent singular light with variable topological charge under the influence of external factors such as laser radiation intensity and trap size.

[1] M. Kędziora et al., (2023), under review.

[2] X. Ma et al., *Nature Communications*, **11**, 897, (2020).