Electrically switchable spin-polarized polariton condensate flow in a perovskite crystal

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The ability to manipulate the flow and spin of polariton condensates is a key step toward applications in nonlinear optical switching and spin-polarized transport. Despite the plethora of available semiconductors, room-temperature polariton condensation can be achieved in lead halide perovskites. Over the past years, it has been shown that propagating polaritons in perovskites can be spin-polarized, but only in the linear regime [1]. Here, we present a previously unachieved regime of switchable spin-polarized polariton condensate flow at room temperature.

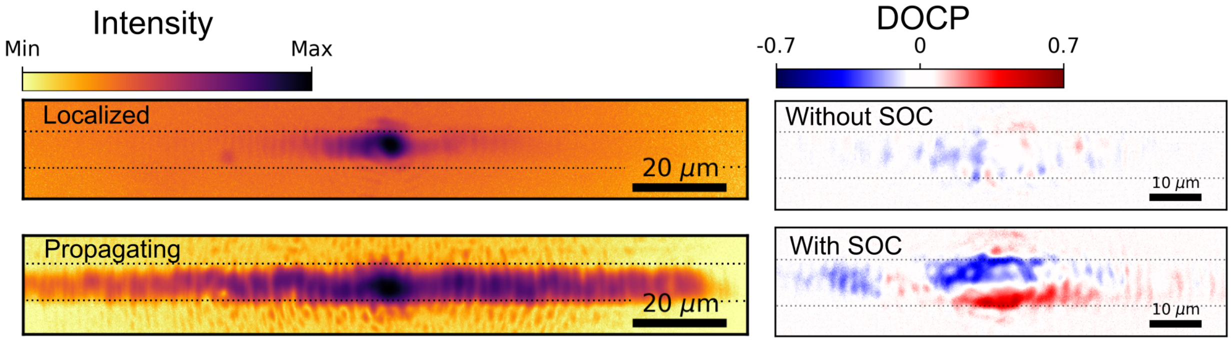

Figure 1: Left panel shows spatial distrubutions of polariton condensate, demonstrating switching between localized and propagating states. Right panel shows distribution of the degree of circular polarization (DOCP) of the condensate without or with SOC. The edges of the perovskite crystal are marked by dashed lines.

We created an electrically controlled device composed of a microcavity with perovskite microwires, fabricated by microfluidic-assisted pseudomorphosis [2], and a liquid crystal layer. Mode quantization due to the effective photonic potential created by high refractive index of microwire is directed across the wire and depends on its width. Owing to the high-quality resonator and stable excitons in $CsPbBr_3$, we demonstrate power-driven nonequilibrium polariton condensation, as well as condensate propagation over tens of micrometers along the wire, all at room temperature. Depending on whether condensation occurs at zero or nonzero wave vector, we can switch this propagation on or off.

Since the microcavity is filled with an electrically tunable birefringent material, we can also control the polarization of the microwire cavity via the optical spin-orbit coupling (SOC) effect. Both switching mechanisms are realized using an external electric field at room temperature, making them easily applicable in practice. The experimental results are consistent with a model based on the solution of the Gross-Pitaevskii equation with a potential derived from the perovskite crystal.

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References

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