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Narrow-linewidth exciton-polariton laser

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Exciton-polariton condensates are non-equilibrium quantum fluids formed by short-lived hybrid light-matter particles in a semiconductor microcavity. In the steady-state regime, these particles decay via photon emission that inherits the coherence properties of the condensate. This so-called exciton-polariton laser is a promising source of coherent light for low-energy applications due to its low-threshold operation. However, a detailed experimental study of its spectral purity, which directly affects its coherence properties, is still missing. Here, we present a high-resolution spectroscopic investigation of the energy and linewidth of an exciton-polariton laser in the single-mode regime, which derives its coherent emission from an optically pumped exciton-polariton condensate. We report an ultra-narrow linewidth of 56 MHz or 0.24 μeV, the narrowest on record [1], corresponding to a coherence time of 5.7 ns. The narrow linewidth is achieved by using an exciton-polariton condensate with a high photonic content confined in an optically induced trap that minimizes an overlap between the condensate and the excitonic reservoir [2]. Contrary to previous reports [2,3], we observe that the excitonic reservoir injected by the pump and responsible for creating the trap does not strongly affect the emission linewidth, as long as the condensate is trapped and the pump power is well above the condensation (lasing) threshold. The long coherence time of the exciton-polariton system uncovered here opens opportunities for manipulating its macroscopic quantum state, which is essential for applications in classical and quantum computing.

References

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Short bio (50 words) or link to website

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