Exciton-polariton condensates in semiconductor microcavities

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Strongly coupled semiconductor microcavities support the formation of exciton-polaritons, which can condense into macroscopically occupied quantum states or quantum liquids[1]. The investigation of such systems revealed a number of effects commonly associated with the formation of a macroscopic phase, for instance superfluid-like behaviour[2] or the appearance of quantized vortices. One of the focal points of current research regards the possibility of optically manipulating polariton condensates to realize new experiments and potential applications like all-optical polariton circuits. We develop this vision by employing a spatial light modulator to create arbitrary excitation patterns, where nonresonant excitation of polariton condensates allows us to define the potential landscape experienced by the condensates.
Novel effects regarding the interaction of multiple polaritonic quantum liquids are revealed, in particular phase-locking between freely-flowing condensates[3], the formation of vortex lattices for multiple pump spots at large separations and the transition to a trapped configuration as the pump spots are moved closer together[4]. These results enhance our ability to explore new features in macroscopic coherent systems and bring us closer to practical applications with polariton condensates such as creating all-optical coherent circuits.

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