Non-equilibrium universal features in exciton-polariton condensates

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Many systems, classical or quantum, closed or open, exhibit universal statistical properties. Exciton-polariton condensates, being intrinsically driven-dissipative, offer a promising platform for accessing to non-equilibrium steady states and observing non-equilibrium universal features. By conducting extensive numerical simulations of an incoherently pumped and interacting condensate coupled to an exciton reservoir we show that the effective nonlinearity of the condensate phase dynamics can be finely adjusted across a broad range, by varying the exciton-polariton interaction strength, allowing one to probe three main universal regimes with parameters accessible in current experiments: the weakly nonlinear Edwards-Wilkinson (EW) regime, where the phase fluctuations dominate, but the phase profile does not become rough, the strongly non-linear Kardar-Parisi-Zhang regime, experimentally observed in one dimension in [1], where the condensate phase fluctuations grow in a superdiffusive manner leading to roughening of the phase, and a vortex-dominated phase emerging at stronger interactions, where both density and phase dynamics play significant roles. Our results provide a unified picture of the phase diagram of one-[2] and two-dimensional [3,4] exciton-polariton condensates under incoherent pumping, and shed light on recent experimental and numerical observations.

References

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