Driven-dissipative quantum fluids of light

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Driven-dissipative quantum fluids of light, experimentally realised in systems such as semiconductor microcavities, dye-filled photonic cavities, and circuit or cavity QED platforms, can differ profoundly from their equilibrium counterparts and provide a unique setting for exploring non-equilibrium quantum critical phenomena.

In this talk, we will discuss how these systems exhibit unconventional phase transitions and emergent forms of order, together with flow properties related to – but distinct from – conventional superfluidity. In particular, the long-wavelength phase dynamics of polariton and photon Bose-Einstein condensates have been shown to obey the celebrated Kardar-Parisi-Zhang (KPZ) equation, a paradigmatic model of non-equilibrium criticality that describes an increasingly broad range of physical systems. Because the condensate phase is a compact variable, topological defects in the form of vortices can proliferate and disrupt KPZ scaling. The resulting interplay between non-equilibrium KPZ physics and topological defects is highly nontrivial and has become a central topic of both experimental and theoretical interest.

Finally, when subjected to lattice potentials, polariton fluids can realise topological states of light. For example, they may condense into rotating states associated with the lowest Landau level, forming vortex arrays and spontaneously breaking time-reversal symmetry.

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