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Lecture I: Spatial pattern formation in nonequilibrium BECs.

Microcavity exciton-polaritons are quasi-particles that result from the hybridisation of excitons (bound electron hole pairs) and light confined inside semiconductor microcavities. At low enough densities, they behave as bosons according to Bose-Einstein statistics, and so one may investigate Bose-Einstein condensation (BEC) of these particles. Because of the imperfect confinement of the photon component, exciton-polaritons have a finite lifetime, and have to be continuously re-populated. Therefore, exciton-polariton condensates lie somewhere between equilibrium Bose-Einstein condensates and lasers. I review in particular the evidence for condensation, the coherence properties studied experimentally, and the wide variety of spatial structures either observed or predicted to exist in exciton-polariton condensates, including quantised vortices and other coherent structures.

Lecture II: Vortices and turbulence in exciton-polariton condensates.

Nonequilibrium condensate systems such as exciton-polariton condensates are capable of supporting a spontaneous vortex nucleation. The spatial inhomogeneity of pumping field or/and disordered potential creates velocity flow fields that may become unstable to vortex formation. I will present ways in which turbulent states of interacting vortices can be created. It is shown that by combining just two pumping intensities it is possible to create a superfluid turbulence state of well-separated vortices, a strong turbulence state of de-structured vortices, or a weak turbulence state in which all coherence of the field is lost and motion is driven by weakly interacting dispersive waves. The decay of turbulence can be obtained by replacing an inhomogeneous pumping by a uniform one.