2D Quantum Turbulence and Onset of Vortex Clustering in a Quantum Fluid of Light

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Quantum turbulence is the study of the turbulent motion of fluids in the quantum realm. In the last two decades, quantum turbulence has been mostly studied and demonstrated in Bose-Einstein condensates (BEC) of ultracold atoms [1]. Exciton-polaritons are hybrid particles resulting from the strong coupling of excitons and photons in semiconductor optical microcavities. In this work, we present the numerical and experimental attempts to explore turbulent and vortex-clustering regimes [2] in two-dimensional nonequilibrium exciton-polariton condensates. First, we numerically investigate the properties of a confined fluid of light where a gas of topological defects are initially injected by means of a quasi-resonant pulsed excitation. Using numerical simulations, we provide insight into the vortex clustering processes that emerge during the relaxation dynamics. Simulations reveals that onset of vortex clustering in both cases strongly depends on the interplay between the different characteristic physical lengths [3].

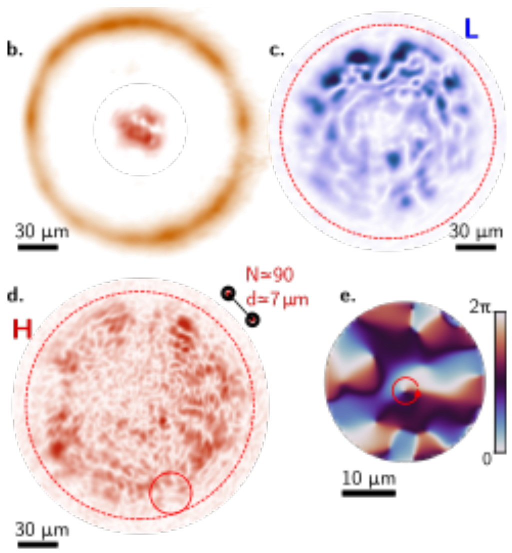

Fig. 1 (b,c,d) Density and phase (e) along the dynamics of a dissipative polariton condensate exhibiting turbulent behaviour

Numerical prediction are eventually compared to experimental measurements [4] where turbulent flows result from the collision of the injected polariton fluid with the potential barrier (see Fig. 1). The tracking of a large number of topological defects demonstrate that the formation of clusters of quantum vortices is triggered by the increase of the incompressible kinetic energy per vortex, showing the tendency of the vortex-gas towards highly excited configurations [4] despite the dissipative nature of our system. Our results demonstrate the possibility of exploring turbulent states in quantum fluids of light.

Example References

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