Inverse energy cascade in two-dimensional quantum vortex turbulence

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Abstract:

We demonstrate an inverse energy cascade in a minimal model of forced 2D quantum vortex turbulence. We simulate the Gross-Pitaevskii equation for a moving superfluid subject to forcing by a stationary grid of obstacle potentials, and damping by a stationary thermal cloud. The forcing injects large amounts of vortex energy into the system at the scale of a few healing lengths. A regime of forcing and damping is identified where vortex energy is efficiently transported to large length scales via an inverse energy cascade associated with the growth of clusters of same-circulation vortices, a Kolmogorov scaling law in the kinetic energy spectrum over a substantial inertial range, and spectral condensation of kinetic energy at the scale of the system size. Our results provide clear evidence that the inverse energy cascade phenomenon, previously observed in a diverse range of classical systems, can also occur in quantum fluids.