ENGINEERING VORTEX MATTER IN STRONGLY-CORRELATED SUPERFLUIDS

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Topological defects determine properties and structure of disparate out-of-equilibrium physical and biological matter over a wide range of scales, from planetary atmospheres, turbulent flow in hydrodynamic classical and quantum fluids, up to electrical signalling in excitable biological media. For example, in superfluids and superconductors, the motion of quantised vortices is associated with the onset of dissipation, limiting the superflow. Understanding vortex dynamics is a formidable challenge because of the complex interplay between moving vortices, disorder and system dimensionality that encumbers predictability. In this work, we approach this challenge by realizing a novel programmable vortex platform in planar and homogeneous atomic Fermi superfluids. We engineer on-demand vortex configurations and we monitor their evolution by directly tracking vortex trajectories. The demonstrated ultimate control on the vortex dynamics makes our platform the ideal quantum laboratory where to elucidate the intimate nature of vortex-driven instabilities, opening important prospects towards the understanding of out-of-equilibrium dynamics and of exotic vortex-matter phase transitions in strongly-correlated superfluids.

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