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Vortex dynamics in strongly-interacting atomic Fermi superfluids: from few to many

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The dynamics of quantized vortices underlies many phenomena of different quantum systems, from superconductors to neutron stars, and represent a particularly hard problem to tackle in fermionic systems. In this talk I will report a series of experiments on vortex dynamics in strongly-interacting Fermi superfluids, highly controllable systems where the dynamic of vortices can be studied in a bottom-up approach. Thanks to a micron-scale control over the external potential acting of the superfluid, we can arrange arbitrary configurations of vortices. We create on-demand vortex dipoles, namely a vortex-antivortex pair, representing the minimal configuration to study vortex motion and dissipative dynamics. By tracking the motion of a single vortex-dipole we measure the transverse and longitudinal mutual friction components characterizing the motion of vortices at finite temperature. Then, by adding a second vortex-dipole we engineer controlled dipole-dipole collision and unveil the interaction of vortices with sound excitations in the superfluid. Finally, we create an ordered structure of many vortices of the same charge by merging two counterflowing concentric superfluids, and we study the stability of such a vortex necklace. For large number of vortices, the symmetry is broken by vortex pairing in small clusters, occurring with a growth rate that follows the same scaling of the classical Kelvin-Helmholtz instability, characterizing the merging of counterflowing fluids.

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