A quantum vortex collider revealing sound emission and annihilation

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Vortices are at the heart of numerous fluid phenomena both in classical and quantum systems. Dissipation of the energy of quantum vortices, whose topological nature protects them against diffusing their vorticity, constitutes a central concept in describing quantum hydrodynamics, such as superfluid turbulence and its decay. Interestingly, a vortex can dissipate its kinetic energy via phonon emissions due to vortex-sound coupling (or interaction). However, the scarcity of convincing experimental demonstrations of sound radiation from decaying quantum vortices has limited our deep understanding. To unveil the nature of vortex dissipation, we realize a deterministic, programmable quantum vortex collider in homogeneous, planar atomic Fermi superfluids and directly observe sound-mediated dissipation and its ultimate form, i.e., vortex annihilation. Our experiment provides direct evidence of sound emissions from quantum vortex decay and a starting point for understanding vortex collisions that underlie quantum turbulence.

References:
1. W. J. Kwon et al., “Sound emission and annihilations in a programmable quantum vortex collider,” Nature 600, 64 (2021).