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The Life and Times of a Superfluid Vortex Ring

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In this talk I will present an overview of superfluid dynamics in fermionic systems by telling the tale of a superfluid soliton. Starting its life as a phase imprinted domain wall in cold cloud of 6Li at MIT [1], it behaved mysteriously, moving an order of magnitude more slowly than expected. Using some of the largest computer simulations, we demonstrated [2] that the wall is rapidly promoted to a vortex ring, explaining almost all aspects of the experiment, including some subtle effects due to the imaging process. Improved observations [3] reveal that the soliton is a vortex - an early retirement of the vortex ring induced by asymmetries present in the trap. This suggests that cold atoms may provide an excellent forum for studying the microscopic nature of the vortex crossing and recombination processes at the heart of quantum turbulence. Agreement between experiment and simulation validates superfluid density functional theory (DFT), paving the path towards understanding complex superfluid dynamics in cold atoms, nuclear matter, and neutron stars.

In collaboration with Aurel Bugac, University of Washington; Michelle Kelley, University of Illinois; Kenneth Roche, PNNL and University of Washington; and Gabriel Wlazlowski, Warsaw University of Technology, University of Washington.

[1] Yefsah et al., Nature 499, 426 (2013) [arXiv:1302.4736].

[2] Bulgac, Forbes, et al, PRL 112, 025301 (2014) [arXiv:1306.4266].

[3] Ku et al. (2014) [arXiv:1402.7052].