Measuring angular momentum in a ring-shaped Fermi superfluid

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We report on the in-situ measurement of the angular momentum per particle on fermionic superfluid rings, trying to answer the question "are Cooper pairs really made by two atoms?". We excite two counter-propagating phonons, which in presence of a rotating superfluid, change their dispersion relation due to a Doppler shift. We use the recent development of persistent currents in ring traps [1] to implement this experimental scenario. This Sagnac-like interferometric protocol allows a direct measurement of the angular momentum by measuring the precession rate of the phonon interferometric signal. Contrary to simple bosonic superfluids [2, 3], where $\ell_z = \hbar$, for fermi superfluids $\ell_z = \hbar/2$, due to the pairing of two opposite spin fermions, required for superfluidity. The tunability of our system allows us to explore the BEC-BCS crossover, probing the angular momentum from tightly bound bosonic molecules to loosely coupled fermionic Cooper pairs.

[1] G. Del Pace et al., Phys. Rev. X 12, 041037 (2022).
[2] A. Kumar et al., New J. Phys. 18 p. 025001 (2016).
[3] Ch. W. Woffinden et al., SciPost. Phys. 15 p. 128 (2023).