OBSERVATION OF HALF-QUANTUM VORTICES IN TOPOLOGICAL SUPERFLUIDS

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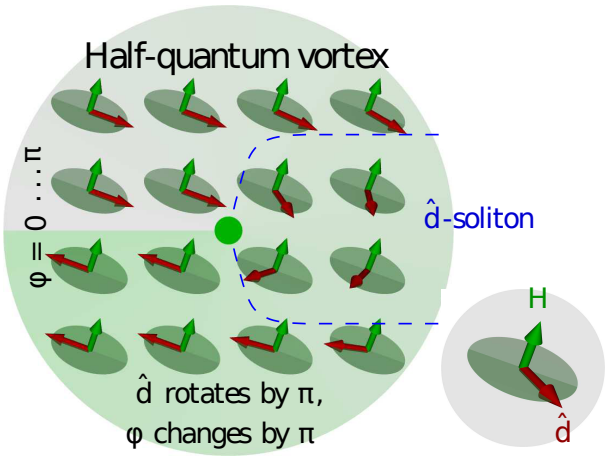
Topology plays a central role in modern physics. Superfluid phases of ^{3}He provide a versatile platform for studying topological properties of quantum matter, especially various topological defects such as half quantum vortices (HQVs). Despite the promising theoretical predictions and several attempts, HQVs in superfluid ^{3}He-A were never resolved experimentally. Here we report an observation of HQVs in the recently discovered polar phase of superfluid ^{3}He. The polar phase can be stabilized in ^{3}He confined in an aerogel-like structure called nafen with nearly parallel strands [1].

We cooled a sample of 94% open nafen filled with ^{3}He down to the polar phase. When the cool-down proceeds in rotation, we observe a satellite peak in the nuclear magnetic resonance spectrum. Dependence of the satellite on the rotation velocity, temperature and the field orientation identifies it as a signal from the $\hat{\mathbf{d}}$ solitons that are formed between pairs of HQVs.

HQVs in Fermi superfluids and superconductors have received great attention recently owing to predicted existence of unpaired Majorana fermions in their cores. Our discovery provides a potential pathway for experimental studies of such core physics in the polar-distorted A phase.



Half-quantum vortex: on a path around the core the order parameter phase φ (background color) rotates by π and the spin vector $\hat{\mathbf{d}}$ (red arrows) also by π. Magnetic field direction (green arrows) can be freely rotated in the experiment.

[1] V. V. Dmitriev *et al*: *Polar Phase of Superfluid ^{3}He in Anisotropic Aerogel*, PRL **115**, 165304 (2015)