Experimental report

01/09/2022

Proposal: **5-31-2911** **Council:** 4/2021

Title: Continuation: Self Organisation of the IMS under the Application of a Current

Research area: Physics

This proposal is a continuation of 5-31-2748

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Samples: Nb

Instrument	Requested days	Allocated days	From	To
D33	5	3	13/09/2021	16/09/2021

Abstract:

The microscopic coexistence of complete flux expulsion (Meissner state) and the penetration of an array of supercurrent vortices (mixed state) in the intermediate mixed state (IMS) is one of the most prominent examples of intertype behavior in superconductors (SC), outside the type I/II dichotomy. More than 50 years after its first observation via Bitter decoration, the IMS is still an ongoing research topic, relevant not only for the understanding of exotic magnetic matter in SC, but more importantly due to its role as a model system for universal domain physics, e.g., shown by the analogy of clusters of magnetic Skyrmions in the cubic helimagnet Cu2 OSeO3.

We have established the existance of the IMS in the steady state flux flow and observed an elongation of the IMS spatial domains indicative of a self organisation towards a stripe pattern orthogonal to the applied current in the direction of the flux line movement (5-31-2748 and EASY-568 beamtimes, a paper is in progress).

In this continuation proposal we want to (i) study the effect of the mixed state filling factor on the rearrangement process and (ii) investigate the magnetic field dependant spatial current distribution.

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We measured the effect of a transport current on the vortex matter in Nb in a range of fields inside the intermediate mixed state and the homogenous mixed state. We observed a discrepancy between the critical current from neutron measurements I_{cN} (first appearance of azimuthal anisotropy, broadening of the vortex lattice bragg peak rocking curve) and the critical current from transport measurements I_{cV} (first appearance of a voltage). This discrepancy seems to vanish at the transition towards the homogenous mixed state and is getting more pronounced for low applied fields.

The experiment was a success. Analysis is ongoing.

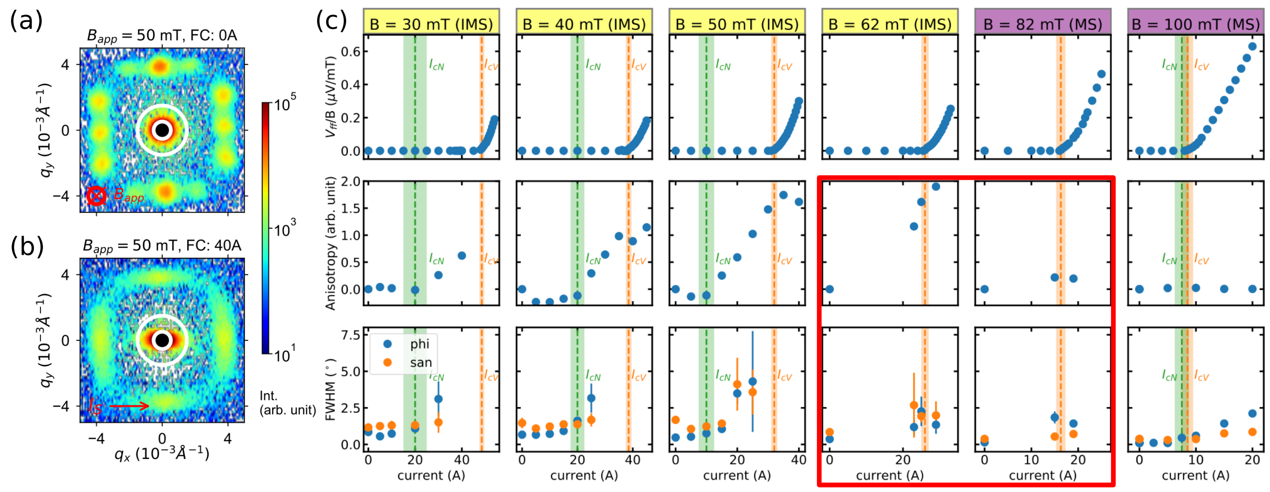

Figure 1: (a,b) SANS images in B app = 50 mT with zero current and I = 40 A, respectively. The anisotropy in the VSANS regime (within the white circles), caused by the tail of the power law scattering from the IMS domains is clearly visible. (c) Field-normalized voltage (row 1), azimuthal IMS anisotropy (row 2), and Bragg peak rocking scan FWHM (row 3) as a function of applied current for fields in the IMS (yellow columns) and in the pure mixed state (purple). The azimuthal IMS anisotropy is a measure for the current-induced anisotropy of the VSANS scattering resulting from the IMS domain structure found in vicinity of the blacked out direct beam within the white circles shown in panel (b). The two critical currents I_{cV} and I_{cN} are marked with orange and green dashed vertical lines, respectively.