Contribution ID: **112** Type: **Poster**

Current-induced Self-organisation of Vortex Matter Studied by SANS

Tuesday, 21 March 2023 16:00 (2 hours)

In the superconductor Niobium the vortex-vortex interaction shows in addition to the purely repulsive also an attractive term. This leads to the formation of the intermediate mixed state (IMS) where flux-free Meissner state domains and vortex clusters coexist. Besides being a prominent example of exotic vortex matter this two-domain structure can also act as a highly tunable model system for universal domain physics [1]. Vortices in a superconductor can be depinned using transport currents resulting in the flux flow state: For currents higher than the depinning current I_c vortices move orthogonal to the direction of the applied current. In contrast to the pure mixed state non-trivial ordering phenomena are expected in the flux flow state of the IMS due to its highly heterogeneous domain structure. Small-angle neutron scattering (SANS) is the perfect technique to study such a system as we can analyse Bragg peaks from the local vortex lattice and in parallel the very small angle scattering (VSAS) from the larger micron scale domain structure. We verified [2] the existence of the IMS in the flux flow state in a Nb single crystal sample. Our main result is the transition from isotropic to anisotropic VSAS indicating that the IMS rearranges into a stripe superstructure in the flux flow state. The stripe pattern is aligned perpendicular to the current direction.
[1] M. Seul and D. Andelman 1995 Science 267(5197):476–483
[2] Xaver S Brems et al 2022 Supercond. Sci. Technol. 35 035003

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Session Classification: Poster session TUESDAY

Track Classification: Magnetism, Superconductivity, Topological Systems, Magnetic Thin Films an other electronic phenomena