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Vortex Matter of Intertype Superconductors studied by Neutron Methods and Molecular Dynamics Simulations

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In the intermediate mixed state (IMS) in superconducting niobium, the mixed attractive/repulsive vortex interaction leads to the clustering of vortices into domains. Not fitting into the conventional type-I and type-II categories, this regime is denoted intertype superconductivity [1].

Using a combination of neutron techniques, we have studied the hierarchical properties of the IMS in bulk niobium on length scales of the vortex lattice (~100nm, SANS), the domain structure (~10mum, VSANS/USANS) and the sample size (~10mm, NGI). The results give detailed insight into the properties of the IMS focusing on the domain formation as function of temperature, magnetic field and sample quality [2,3,4].

However, the knowledge of the nanoscale vortex arrangement is still incomplete, including the domain structure and the impact of disordered vortices. In order to complement the experiments we have used molecular dynamics simulations. In a novel approach, the vortex interactions are based on an extended Ginzburg-Landau formalism [1]. The focus of the simulations was on the influence of pinning and the external field on the IMS. Our combination of neutron techniques with molecular dynamics simulations pave the way to a quantitative analysis of vortex matter of intertype superconductors.

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