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Vortex Lattice Studies in Type-II Superconductors by SANS

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When a type-II superconductor is placed in a magnetic field, it is threaded by swirling whirlpools of electric current known as vortices. The vortices behave like massive entities and provide a unique probe into the nature of the superconducting state in the host material. Furthermore, the collective vortex behavior is of crucial importance for practical applications since vortex motion will lead to dissipation. I will discuss two recent vortex lattice (VL) studies using small-angle neutron scattering (SANS) that exemplify the continuous evolution of this technique. In the first example we used SANS to determine the superconducting anisotropy of Sr2RuO4 (SRO) that is among the few superconductors believed to exhibit p-wave pairing [1]. While there is significant experimental support for unconventional pairing, there is a discrepancy between the anisotropies of the upper critical field and the Fermi surface. Taking advantage of the significant transverse VL field component that arises due to the large anisotropy of SRO we measured the superconducting anisotropy ≈ 60, roughly three times greater than the upper critical field anisotropy. This result imposes significant constraints on possible models of triplet pairing in SRO. In the second example we used a stop-motion technique to study VL transition dynamics in MgB2 [2,3]. Here the VL exhibit extensive metastability in connection with a second order rotational phase transition that cannot be understood based on the single VL domain free energy or vortex pinning. Instead, we have proposed that a jamming of VL domains acting as granular entities is responsible for the metastability. We have performed extensive SANS experiments, as the VL is driven from the metastable to the ground state by small-amplitude AC magnetic field oscillations. This shows a dual power-law behavior indicating a two-step process for the transition to the ground state. Supported by the US Department of Energy (Grant No. DE-FG02-10ER46783).

[1] *C. Rastovski et al., Phys. Rev. Lett. 111, 087003 (2013),* ***[2]*** *P. Das et al., Phys. Rev. Lett. 108, 167001 (2013),* ***[3]*** *C. Rastovski et al., Phys. Rev. Lett. 111, 107002 (2013).*

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