# Metastable Vortex Lattice Dynamics Studied by Small Angle Neutron Scattering

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**Abstract**

Using the technique Small Angle Neutron Scattering (SANS), I studied the VL in $MgB_2$ for a number of field-temperature histories mapping out the ground state vortex lattice phase diagram and fully exploring the second order rotation transition behavior of the lattice. The ground-state vortex lattice (VL) phase diagram was found to differ substantially from theoretical predictions. Additionally, long lived metastable vortex lattice phases were discovered, the existence of which was very unexpected in such a clean sample.

To explore the origin of the metastable vortex lattice phases in $MgB_2$ I performed a detailed study of the metastable VL in $MgB_2$ as it was gradually driven to the ground state by small decreases in the applied magnetic field using SANS. Our measurements showed that metastable VL domains persist in the presence of substantial vortex motion and thus provide definitive evidence that the metastability cannot be attributed to the pinning of vortices to defects in the crystal.

Using SANS in combination with a small AC magnet, I studied the vortex lattice in $MgB_2$ as it was driven from a metastable to the ground state by application of a few mT AC magnetic field oriented either parallel or perpendicular to the vortices in the sample. The transition to the ground state showed two distinct power-law behaviors: a slow transition followed by a much faster transition after some critical point. This behavior indicates a novel kind of vortex motion.