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A Dichotomy in the Metastable-to-Ground State Vortex Lattice Transition in MgB_2[1] M.R. ESKILDSEN, E.R. DE WAARD, A. LEISHMAN, University of Notre Dame, J. ARCHER, University of Dallas, C.D. DEWHURST, Institut Laue-Langevin, France, L. DEBEER-SCHMITT, Oak Ridge National Laboratory, J. KARPINSKI, EPFL, Switzerland, N.D. ZHIGADLO, ETH, Switzerland — The vortex lattice (VL) in the type-II superconductor MgB_2 can serve as a model for out-of-equilibrium systems. Previous small-angle neutron scattering (SANS) studies of the VL in this material have revealed an unprecedented degree of metastability that is demonstrably not due to vortex pinning, [C. Rastovski *et al.*, Phys. Rev. Lett. **111**, 107002 (2013)]. We used a stop-motion SANS technique to image the VL between successive applications of a controlled number of AC magnetic field cycles. This allows us to study in detail how the metastable VL is driven back to the ground state. Our results show a dichotomy in the behavior for metastable configurations induced by crossing the equilibrium, second order phase transition in different directions. For a metastable state induced by super heating, the VL returns to the ground state through a continuous domain rotation. In contrast, in the super cooled case, VL ground state domains nucleate and grow at their final orientation.

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Morten Eskildsen
Univ of Notre Dame

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