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**Metastable Vortex Lattice Phases in MgB<sub>2</sub>** M.R. ESKILDSEN, T.R. O'BRIEN, P. DAS, University of Notre Dame, IN, USA, C.D. DEWHURST, R. CUBITT, Institut Laue Langevin, France, N. ZHIGADLO, J. KARPINSKI, ETH Zurich, Switzerland — We present results of recent small-angle neutron scattering (SANS) measurements in MgB<sub>2</sub> which reveal an unprecedented degree of vortex lattice (VL) metastability. Three different VL phases are observed, all of which have a triangular symmetry. At low fields the VL is aligned with the crystalline  $a$ -axis. At intermediate fields the VL rotates away from the  $a$ -axis, leading to two degenerate domain orientations. Once the rotation reaches 30° a single domain, high field VL is reformed, now aligned along the  $a^*$ -axis. These three VL orientations are consistent with our earlier reports [R. Cubitt *et al.*, PRL **91**, 047002 (2003)]. Metastable configurations are obtained when crossing the equilibrium VL transition lines by cooling or heating in a constant field. At any given field and temperature the equilibrium VL can be obtained either by inducing vortex motion by a small amplitude field oscillation or by a zero field cooling (ZFC) procedure. The equilibrium VL phase diagram differ significantly from our earlier published report and from theoretical predictions [M.E. Zhitomirsky *et al.*, PRB **69**, 054508 (2004)]. The implications of these results and how they affect our understanding of two-gap superconductivity in MgB<sub>2</sub> will be discussed.

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