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Observing artificial-field-driven vortex nucleation in a BEC via bulk response L.J. LEBLANC[1], K. JIMÉNEZ-GARCÍA[2], R.A. WILLIAMS[3], M.C. BEELER[4], A.R. PERRY, I.B. SPIELMAN, Joint Quantum Institute, NIST and University of Maryland — By exploiting the quantum mechanical phase's relationship to velocity, we extracted information about a Bose-Einstein condensate's (BEC's) order parameter through time-of-flight (TOF) imaging. In these experiments, trapped BECs were equilibrated in Raman-induced artificial gauge fields, then released and imaged. The removal of the artificial field at the moment of release caused a shearing of the atomic distribution as the BEC evolved in field-free TOF. The quantitative measure of the cloud's shear increased suddenly at magnetic fields sufficient to nucleate vortices. Using superfluid hydrodynamics and Gross-Pitaevskii equation calculations, we confirmed the critical field for this structural phase transition from the vortex-free state. We discuss the relationship between the apparatus and the vector potential's "natural gauge" in quantum gas experiments with artificial magnetic fields.

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