

Abstract Submitted  
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**Torque measurements in underdoped  $\text{Bi}_2\text{Sr}_{2-x}\text{La}_x\text{CuO}_{6+\delta}$  single crystals**<sup>1</sup> T. HU, Kent State University, Kent, Ohio, USA and University of California, Davis, CA, USA, H. XIAO, Kent State University, Kent, Ohio, USA and Institute of Physics, Beijing, China, P. GYAWALI, Kent State University, Kent, Ohio, USA, H.H. WEN, Institute of Physics, Beijing, China, C.C. ALMASAN, Kent State University, Kent, Ohio, USA — We report in-plane and out-of-plane angular-dependent torque measurements on underdoped  $\text{Bi}_2\text{Sr}_{2-x}\text{La}_x\text{CuO}_{6+\delta}$  single crystals both below and above the zero-field superconducting transition temperature  $T_c(0)$  and in applied magnetic fields  $H$  up to 14 T. The out-of-plane torque data show that a diamagnetic signal persists into the normal state, which is consistent with previous reports on  $\text{Bi}_2\text{Sr}_2\text{Ca}_2\text{CuO}_{8+\delta}$ . These data also reveal that the vortex matter in the superconducting state has lower dimensionality compared to the one in the normal state. Furthermore, in-plane torque measurements show that the presence of vortices above  $T_c(0)$  destroys the phase coherence of the Cooper pairs.

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