Anisotropic Spin Magnetism and Diamagnetic Response in Stripe Ordered La$_{1.875}$Ba$_{0.125}$CuO$_4$

M. H"ucker, G. D. Gu, Tranquada J. M. (Brookhaven National Laboratory, Condensed Matter Physics); E. S. Choi (NHMFL)

Introduction
The role of charge and spin stripes in the cuprates and their possible relevance for high temperature superconductivity are currently at the center of attention. A question of particular interest is whether stripe correlations are supporting or interfering with superconducting phase order [1,2]. The cleanest system to resolve this problem is the prototypical stripe compound La$_{2-x}$Ba$_x$CuO$_4$ (LBCO) with x = 1/8 hole concentration. At this particular hole concentration 3D superconductivity is suppressed to below 3K, while stripe order is observed below T$_{CO}$=54K [2]. Our concern was with the magnetic properties in the normal state, which can be characterized by a weak diamagnetic contribution for H||c above T$_{CO}$, and a strongly anisotropic spin susceptibility below T$_{CO}$ [3]. To understand either of these contributions, it is necessary to separate them by means of their distinctive field dependence at high magnetic fields [3,4].

Experimental
The LBCO crystal was grown at Brookhaven with the traveling-solvent floating-zone technique. For the torque experiment at the NHMFL three bar shaped samples (2mm x 1.2mm x 0.4mm) with different orientations were prepared. The samples were mounted onto a 0.002" CuBe cantilever. Field sweeps between plus and minus 35T (cell 8) were performed at different fixed temperatures below 70K, using a sweep rate of 3T/min. A small number of temperature sweeps at fixed magnetic fields were performed as well.

Results and Conclusion
Figure 1 shows $\Delta C/H$ torque data on LBCO with H applied at 15° to the CuO$_2$ planes, after subtraction of a dominant linear contribution as well as a significant non-linear background signal. Two transitions have been observed, both of which represent a decrease of the anisotropy between $\chi_{ab}$ and $\chi_c$. The spin-flop transition at 7T was identified previously [3]. The second feature is a new transition which may indicate a rotation of the spins out of the CuO$_2$ plane (out-of-plane gap). For H applied at 15° away from the c-axis, we have not been able to resolve a field dependence of the diamagnetic contribution above T$_{CO}$. In this case experiments with a more sensitive cantilever have to be performed, complemented by high resolution measurements at low fields.

Acknowledgements
The work at BNL was supported by the Office of Science, U.S. Department of Energy, Contract No. DE-AC02-98CH10886.

References

Figure 1: Torque measurements on LBCO with x=0.125 for H tilted from Cu-O-Cu direction by 15° towards c-axis. The data shows the capacity change $\Delta C$ divided by the magnetic field H, after subtraction of a dominant linear contribution, as well as a non-linear background signal. Below T$_{CO}$ one can see two transitions. The first at 7T was observed previously [3]. The second transition, starting at 15T, is a newly-identified. The shaded area at low fields masks the region with low resolution.