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Fermi Surface of Nd-LSCO via Angle-Dependent Magnetoresistance

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Introduction

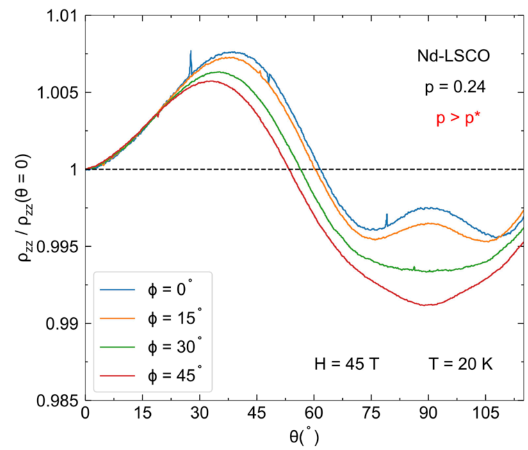
Identifying the origin and nature of the pseudogap state in hole-doped cuprates is a key issue of high-Tc superconductivity. As the doping increases across the pseudogap critical point p*, the Fermi surface of cuprates goes from a small hole-like Fermi surface in the pseudogap state (p < p*), containing a carrier density n = p, to a large hole-like Fermi surface containing a carrier density n = 1+p for p > p* [1]. Understanding the mechanism of this Fermi surface transformation across p* could lead to the identification of the pseudogap state. Previous angle-dependent magnetoresistance (ADMR) measurements on two hole-doped cuprates enabled the mapping of the 3D Fermi surface in two specific regions of the phase diagram: well above p*, in Tl2201 [2], and in the region of charge order well below p*, in YBCO [3]. What we are seeking in this project is to carry out the same kind of study in one material (Nd-LSCO) as we go across p* (p* = 0.23 [4]). The measurements we took this year continued the previous experiments in 2017.

Experimental

We performed ADMR measurements on five Nd-LSCO samples (with dopings p = 0.20, 0.21, 0.22 and 0.23, two samples were at doping p = 0.22), at low temperature (between 16 K and 30 K) and in magnetic fields up to 45 T (we were in cell 15 at NHMFL-Tallahassee). We measured the c-axis resistivity, sitting at a fixed field and rotating the angle θ between the c axis and the magnetic field. We repeated this for different azimuthal angles Φ.

Results and Discussion

The results on samples p = 0.23 and p = 0.24 obtained in 2017 were of good quality. This year, we pursued the measurements on the p = 0.23 sample and we improved the temperature stability of the set-up, allowing us to get very good data on samples p = 0.20, 0.21 and 0.22. These new data enable us to distinguish the ADMR curves between p > p* and p < p* (see **Fig.1**): the θ and Φ dependence of the magnetoresistance is clearly different between p = 0.24 and p = 0.21, highlighting a transformation of the Fermi surface between the two dopings.



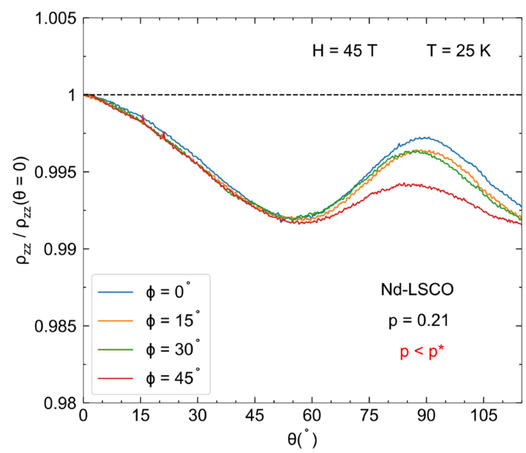


Fig.1 ADMR curves for Nd-LSCO at p = 0.24 (top) and p = 0.21 (bottom), at H = 45 T, for various values of the azimuthal angle Φ.

Conclusions

We obtained clean ADMR data for Nd-LSCO single crystals with several dopings below p*, at various azimuthal angles. The 45T field enabled us to suppress the superconductivity down to low T at almost every θ. The ongoing simulations of this magnetoresistance data above and below p* will bring valuable information about the change in geometry of the Fermi surface while crossing the pseudogap critical point.

Acknowledgements

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References

[1] Badoux, S., *et al.*, Nature, **531**, 210–214 (2016).
[2] Hussey, N. E., *et al.*, Nature, **425**, 814-817 (2003).
[3] Ramshaw, B. J., *et al.*, npj Quantum Materials, **2**, 8 (2017).
[4] Collignon, C., *et al.*, Physical Review B, **95**, 224517 (2017).

[5] Matt, C. E., *et al.*, Physical Review B, **92**, 134524 (2015).