**Determination of the Upper Critical Field of Cuprates by Electrical Transport under**

**High Magnetic Field**

Wu, J.; Bozovic, I. (Brookhaven National Laboratory) and Boebinger, G.S. (National High Magnetic Field Laboratory)

**Introduction**

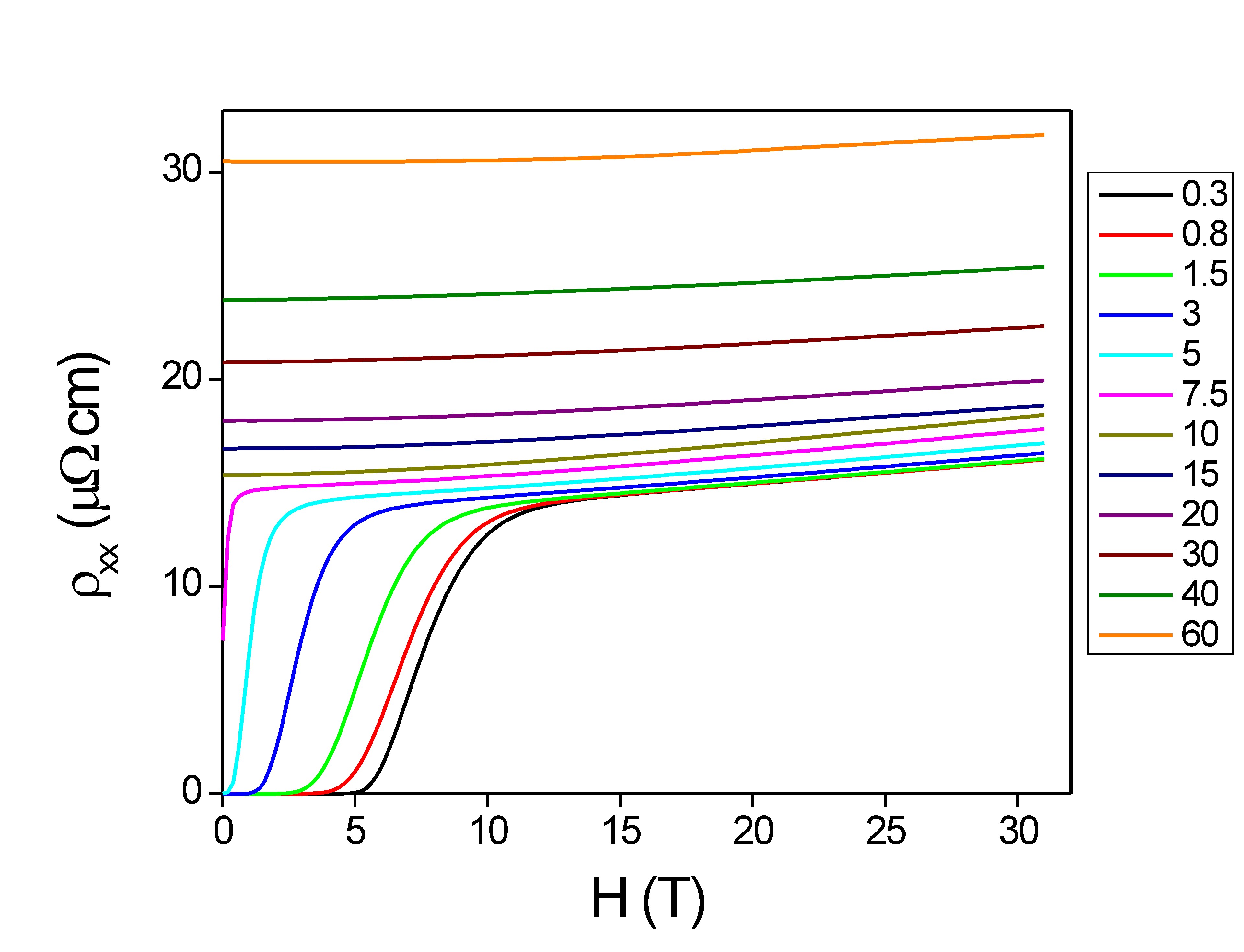
The upper critical magnetic field (Hc2), defined as the strength of the magnetic field that breaks the Cooper pairs, is one of the most characteristic parameters of a high temperature superconductors (HTS). Intense efforts have been devoted to determine Hc2 for different materials and different dopings. The reported results in the literature, however, are still highly controversial. We propose to perform the magneto-transport measurement on the best LaxSr2-xCuO4 samples and retrieve the doping-dependent, temperature-dependent and magnetic-field-dependent longitudinal resistivity and Hall resistivity. Our goal is to identify Hc2 for different doping levels and further the nature of superconducting fluctuations of HTS.

**Experimental**

The high quality single crystalline LaxSr2-xCuO4 thin films were synthesized by the Atomic-Layer-by-Layer Molecular Beam Epitaxy (ALL-MBE) technique located at Brookhaven National Laboratory. Then we brought our samples together with home-built electronics to NHMFL to perform magneto-transport measurements at temperatures as low as 300 mK. We used both the 31 T DC electromagnet and the 60 T long pulse AC magnet to suppress the superconductivity. With our unique combinatorial sample synthesis technique [1], we performed 30-channel resistance/Hall effect measurement simultaneously to retrieve resistance/Hall resistance signal on 30 different dopings at the same time, greatly enhancing the output of the limited magnet time.

**Results and Discussion**

We have obtained a huge amount of magneto-transport data at the dopings covering the whole doping range from optimal to extremely overdoped LSCO samples. Here is one representive set of magneto-resistance measurements performed at systematically-varying temperatures for one particular doping.



**Fig. 1:** The magneto-resistance of overdoped LaxSr2-xCuO4 film at systematically-varying temperatures.

The magneto-resistance of a normal metal is expected to show B2 dependence. Thus this dependence could be used as an indicator of the recovery of Fermi-liquid like behavior of cuprate. The critical field Hc2 can be directly identified as the threshold field where the recovery occurs.

**Conclusions**

By studying the temperature- and doping- dependence of Hc2, we may find clues about the mechanism of the superconducting fluctuations and further the nature of the superconducting state.

**Acknowledgements**

A portion of this work was performed at the National High Magnetic Field Laboratory, which is supported by National Science Foundation Cooperative Agreement No. DMR-1157490, the State of Florida, and the U.S. Department of Energy. Our research is also supported by the U.S. Department of Energy, Basic Energy Sciences, Materials Sciences and Engineering Division.

**References**

[1] Wu, J., *et al.*, Nature Materials, **12**, 877 (2013).