Approaching the Quantum Limit of the Electron Gas at the $LaAlO_3/SrTiO_3$ Interface

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Introduction

The discovery of conducting electrons at the $LaAlO_3/SrTiO_3$ (LAO/STO) interface [1] has led to extensive research on this system. Recent magneto-transport studies revealed two-dimensionality (2D) of the interfacial electrons [2, 3], although many questions remain in part owing to low sample quality and small magnetic field for approaching the quantum limit. In this study, we aim to unravel the nature of the 2D electrons using a high-quality sample and pulsed field facility.

Experimental

Pulsed-field measurements were performed on a recently grown low-density high-mobility LAO/STO sample with a 65 T short pulse magnet in the NHMFL-PFF. A DC bias was applied to the sample in order to measure the high resistivity (~1 kΩ or larger).

Results and Discussion

Figure 1(a) shows clear Shubnikov-de Haas (SdH) oscillations of the sample's longitudinal resistance (R_{xx}), indicating that the system is nearing the quantum limit. This can also be confirmed from small nonlinearity in the Hall resistance (R_{xy}). Additionally, there was a splitting of the SdH oscillation peaks at ~50 T, which may be reminiscent of Zeeman effect. **Figure 1(b)** shows the detailed features of the SdH oscillations and its Fourier transform. This indicates multiple electrons from subband quantization. Further angle and temperature dependent measurements are expected to give crucial information that will quantify the Zeeman effect and subband structure.

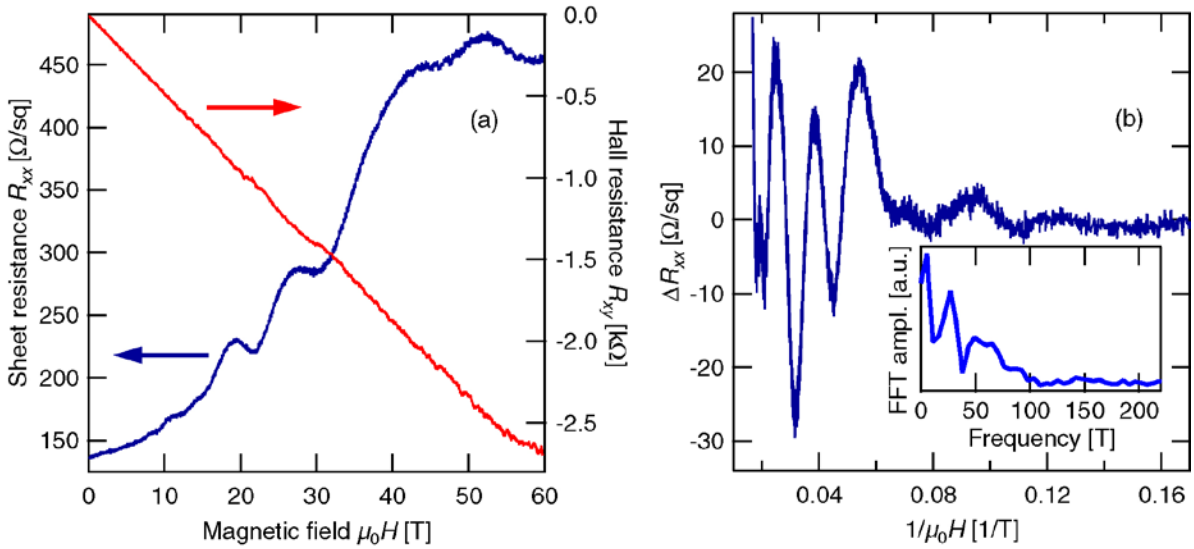

Figure 1 (a) Magnetoresistance and Hall resistance of the LAO/STO sample measured at 0.5 K with magnetic field applied perpendicular to the substrate plane. (b) Magnetoresistance, after background subtraction, versus reciprocal magnetic field. Inset: Fast Fourier transform (FFT) of the data.

Acknowledgements

This work was partly supported by the Department of Energy, Office of Basic Energy Sciences, Materials Sciences and Engineering Division, under contract DE-AC02-76SF00515.

References

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