High-Mobility Boron Ntride/$SrTiO_3$ Heterostructures

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Introduction

A classic correlated material, in which much of the electronic properties are understood, is $SrTiO_3$ (STO) and its related compounds like interfaces between $LaAlO_3$ (LAO) and STO. Recently investigation into transport in high-quality STO and LAO/STO interfaces have shown departures from conventional metallic behavior, including superconductivity and ferromagnetism. Understanding the band structure and low-temperature ground state in low-density, high-mobility samples is an outstanding experimental goal in the field [1,2].

Experimental

We measured heterostructures of Boron-Nitride and STO and modulated the density of carriers in the two-dimensional system of electrons via ionic gating. Typical electron densities explored where ~$1x10^{13}$ cm^{-2}, lower than is typically achieved in these systems. Magnetoresistance was measured via typical low-frequency lock-in techniques using the magnetic in Cell 9 (31T) and the sample temperature was varied between 300mK and 10K.

Results and Discussion

The sample measured in Cell 9 at the NHMFL had a low density of $1.0x10^{13}$ cm^{-2} while maintaining a high mobility of 7000 cm^2/Vs. This sample showed oscillations in both R_{XX} and $R_H=R_{XY}/B$. Fig. 1(a) shows both R_{XX} and R_{XY} as a function B up to 31T. Strong oscillations are seen in R_{XX}, especially in the highest attainable field (around 30T). The oscillations are made more clear by plotting R_H [Fig. 1(b)], where oscillation peaks are seen at values of B=10.7, 17.7 and 27.0T. Oscillations at such low fields and with this small of frequency have not yet been observed in STO. Experimental challenges postponed the conclusion to this interesting data. We plan on finishing out the measurements to get a good handle on the low-energy band structure in two-dimensional STO, a currently debated subject [1,2].

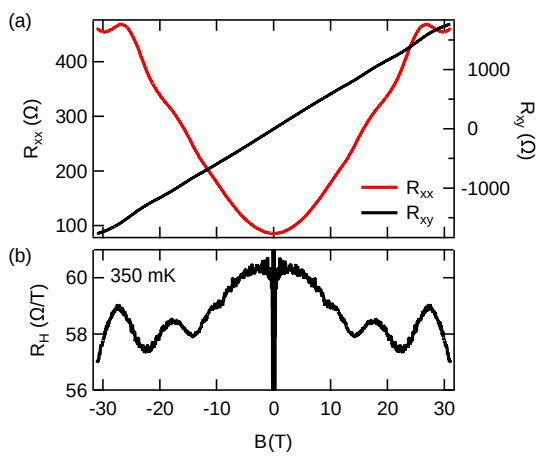

Fig 1: Data taken at the NHMFL up to B=31T. (a) Longitudinal (R_{XX}, red) and transverse (R_{XY}, black) as a function of B up to 31T taken at 350mK. Strong oscillations in R_{XX} are clearly seen. (b) Hall resistance (R_H) as a function of magnetic field. Oscillations in R_H are also clearly visible.

Conclusions

Oscillations in magnetoresistance in low-density, high-mobility have been observed, making future experiments on probing the low-energy band structure possible.

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References

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