Revealing the complex band structure of $LaAlO_3/SrTiO_3$ interface by high magnetic field quantum transport

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Despite theoretical and experimental efforts realized in the past decade, the intimate electronic properties of the two-dimensional electron gas at the $LaAlO_3/SrTiO_3$ (LAO/STO) interface remains an open question. The band-structure is complex since it emerges from the 3d $Ti^{3+/4+}$ atomic orbitals of the host STO material, with strong electronic interactions. The electronic states are modulated by several parameters such as the lattice distortion induced by the lattice mismatch between LAO and STO together with the confining potential (which must be taken into account self-consistently). The large Rashba spin-orbit coupling is another ingredient which comes into play. Furthermore the spatial extension of the electronic gas and its actual dimensionality is as well questioned.

o gain further knowledge on this long-standing issue, we performed magneto-transport measurements on LAO/STO Hall bars at low temperature (500 mK) under high magnetic field up to 70 T. A complex Shubnikov de-Haas oscillations pattern appears in the longitudinal magneto-resistance $R_{XX}(B)$, which shows several frequencies in the FFT (Fast Fourier Transform) spectrum.

The analysis of results suggests two distinct regimes under and above a threshold magnetic field B~18T. We propose a model based on magnetic-field dependent multi-subbands occupation. Nevertheless, the carrier densities deduced from the frequencies of the SdH oscillations remain lower than the averaged carrier density extracted from the Hall coefficient. This issue, together with a selective effect of the back-gate voltage on $R_{XX}(B)$ and $R_{XY}(B)$, requires further experimental investigations .

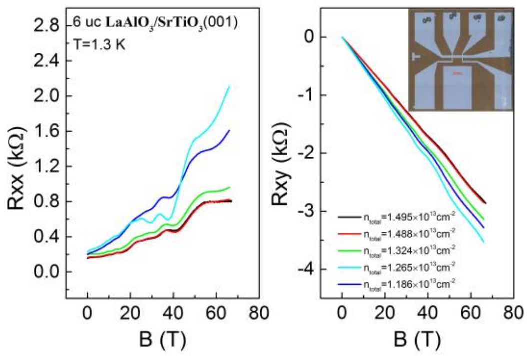

Figure 1. $R_{XX}(B)$and $R_{XY}(B)$of LAOSTO system under 70T magnetic field.