On the superconducting and the insulating states of (111) $SrTiO_3/LaAlO_3$ interface

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The two dimensional electron liquid formed at the (111) interface between $SrTiO_3$ and $LaAlO_3$ is a laboratory for studying electronic properties in tunable correlated hexagonal systems. Symmetry changes imposed by the interface and by various structural transitions in the bulk can affect the electronic properties at the interface. In addition, this system can be smoothly tuned from the superconductor deep into the insulator regime.

The normal state properties of the (111) $LaAlO_3/SrTiO_3$ interface are indicative of contributions from electron-type and hole-type charge carriers. The latter are also consistent with the polar structure of this interface. Upon applying gate voltage to add electrons, a band with a higher spin state gets populated, resulting in a six-fold anisotropic magnetoresistance [1].

Superconductivity is observed in a dome-shaped region in the carrier density – temperature phase diagram. The upper critical field is strongly anisotropic and exceeds the Clogston-Chandrasekhar limit. This suggests strong spin-orbit interaction ε_{so}. Surprisingly, ε_{so} is also nonmonotonic as a function of gate voltage as found both from analysis of the superconducting properties and of the weak antilocalization measurements [2].

Finally, in the depleted region we can probe the highly insulating regime, where the sheet resistance is significantly larger than the quantum one. Despite the large resistance, the interface exhibits the sharp increase in resistance under applied magnetic field characteristic of a SIT, indicating the dominance of superconducting fluctuations over magneto-transport properties in this regime. The highly disordered region has not been previously researched experimentally and our results hint the generally accepted theory may be incomplete [3]. We also compare the transitions for perpendicular and parallel magnetic fields and show that the effect of the perpendicular field is orders of magnitude larger, reinforcing the claim that the insulating state is a result of vortex condensation.

[1] P.K. Rout, I. Agireen, E. Maniv, M. Goldstein, Y. Dagan Physical Review B **95** (24), 241107
[2] P.K. Rout, E. Maniv, Y. Dagan, arXiv:1706.01717 (Accepted in Phys. Rev. Lett.)
[3] M. Mograbi et al. To be published