Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

A Universal Critical Density Underlying the Physics of Electrons at the $LaAlO_3/SrTiO_3$ Interface ARJUN JOSHUA, S. PECKER, J. RUHMAN, E. ALTMAN, S. ILANI, Weizmann Institute of Science — The two-dimensional electron system formed at the interface between the insulating oxides $LaAlO_3$ and $SrTiO_3$ exhibits ferromagnetism, superconductivity, and a wide range of unique magnetotransport properties. A key challenge is to find a unified microscopic mechanism that underlies these emergent phenomena. Here we show that a universal Lifshitz transition between d-orbitals lies at the core of the observed transport phenomena in this system. Our measurements find a critical electronic density at which the transport switches from single to multiple carriers. This density has a universal value, independent of the $LaAlO_3$ thickness and electron mobility. The characteristics of the transition, its universality, and its compatibility with spectroscopic measurements establish it as a transition between d-orbitals of different symmetries. A simple band model, allowing for spin-orbit coupling at the atomic level, connects the observed universal transition to a range of reported magnetotransport properties. Interestingly, we also find that the maximum of the superconducting transition temperature occurs at the same critical transition, indicating a possible connection between the two phenomena. Our observations demonstrate that orbital degeneracies play an important role in the fascinating behavior observed so far in these oxides. Ref: arxiv.org/abs/1110.2184

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Date submitted: 06 Nov 2011 Electronic form version 1.4