THEORY OF THE TWO-DIMENSIONAL AIRY ELECTRON GAS

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ABSTRACT

Transition-metal oxides are one of the most interesting and heavily researched materials in condensed matter physics for the range of unique properties they exhibit, like colossal magnetoresistance and high temperature superconductivity. With the recent fabrication of superlattices of these materials, and studies on the nature and properties of interface states, several interesting properties, not found in the bulk components of the superlattice, have been revealed. Also, what is noteworthy is that the quality of the fabricated superlattices is easily comparable to semiconductor superlattices, which raises the hope of being able to fabricate devices of these materials.

The Airy electron gas model discussed in this dissertation, describes the interface in some transition-metal oxide superlattices, for example, the recently fabricated $(LaTiO_3)_1/(SrTiO_3)_n$ superlattice. We analyze the system, using two methods - the Hartree-Fock approximation and Density-functional theory. We examine several properties of interest like, the electron distribution at the interface and the effect of the dielectric constant of the medium, in which the electrons are embedded. We focus on the $(LaTiO_3)_1/(SrTiO_3)_n$ system, and calculate the spread of the electron wavefunction using density-functional theory and obtain results consistent with experiments.