Multiple Quantum Criticality in a two-dimensional superconducting oxides interfaces

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Abstract

The achievement of high-quality epitaxial interfaces involving transition metal oxides gives a unique opportunity to engineer artificial materials where new electronic orders take place. It has been shown recently that a two-dimensional electron gas 2DEG could form at the interface of two insulators such as LaAlO3 and SrTiO3, or LaTiO3 (a Mott insulator) and SrTiO3. We studied the magnetic field driven Quantum Phase Transition (QPT) in electrostatically gated superconducting LaTiO3/SrTiO3 interfaces. Through finite size scaling analysis, we showed that it belongs to the (2+1)D XY model universality class. The system can be described as a disordered array of superconducting islands coupled by a two dimensional electron gas (2DEG). Depending on the 2DEG conductance tuned by the gate voltage, the QPT is single (corresponding to the long range phase coherence in the whole array) or double (one related to local phase coherence, the other one to the array). By retrieving the coherence length critical exponent n, we show that the QPT can be "clean" or "dirty" according to the Harris criteria, depending on whether the phase coherence length is smaller or larger than the puddles size. The overall behaviour is well described by a model of coupled superconducting puddles in the framework of 2D superconducting QPT.

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