Metal-to-superconductor transition, mesoscopic disorder and intrinsic charge instability in oxide heterostructures

M. Grilli

Physics Department, University of Rome "Sapienza",Rome, Italy

marco.grilli@roma1.infn.it

Keywords: oxide heterostructures, electronic phase separation, inhomogeneous superconductivity, quantum criticality

Motivated by experiments in oxide interfaces like $LaAlO_3/SrTiO_3$ or $LaTiO_3/SrTiO_3$ (LXO/STO) heterostructures, we investigate the occurrence of a metal-to-superconductor transition in a two-dimensional electron system with disorder on the mesoscopic scale and possible microscopic mechanisms for electronic phase separation (EPS) based on Rashba spin-orbit coupling (RSOC) [1,2] and/or electrostatic electron confinement at the interface [3]. Disorder induces a distribution of local superconducting critical temperatures accounting well for the transport (resistivity [4] and Hall [5]) and tunnel spectrosopy [6]. With lowering the temperature, global superconductivity establishes as soon as percolation occurs within the superconducting clusters.
Both RSOC and electrostatic confinement could provide an intrinsic mechanism for the observed inhomogeneous phases at the LAO/STO or LTO/STO interfaces and open the way to new interpretations of the observed quantum critical behaviour of LTO/STO [6]. We investigate the effects of temperature and magnetic field on the charge instability finding a novel type of quantum critical point related to the vanishing of the critical temperature of the EPS [2,3].

---

[1] S. Caprara, F. Peronaci, and M. Grilli, Phys. Rev. Lett. 109, 196401 (2012)
[2] D. Bucheli, M. Grilli, F. Peronaci, G. Seibold, and S. Caprara,Phys. Rev. B 89, 195448 (2014).
[3] N. Scopigno, D. Bucheli, S. Caprara, J. Biscaras, N. Bergeal, J. Lesueur, and M. Grilli, in preparation.
[4] S. Caprara, et al., Phys. Rev. B (Rapid Communications) 88, 020504(R);
S. Caprara, D. Bucheli, N. Scopigno, N. Bergeal, J. Biscaras, S. Hurand, J. Lesueur, and M. Grilli, Supercond. Sci. Technol., to appear.
[5] D. Bucheli, S. Caprara, and M. Grilli, arXiv:1405.4666, .
[6] J. Biscaras, N. Bergeal, S. Hurand, C. Feuillet-Palma, A.Rastogi, R. C. Budhani, M. Grilli, S. Caprara, J. Lesueur, Nature Materials 12, 542 (2013).