MAR17-2016-020472

Abstract for an Invited Paper
for the MAR17 Meeting of
the American Physical Society

Tuneable highly-correlated phases in two-dimensional superconductors

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Research on two-dimensional (2D) crystals, triggered by the discovery of graphene, is now expanding towards more complex strongly-correlated materials like superconductors, Mott insulators, and antiferromagnets. The ability to access different many-body phases by electrostatic gating and to finely tune to critical transition regions of the phase diagram, offers an exciting platform for studying strongly-correlated materials. Recently we demonstrated the electrostatic tuning of atomically thin $TiSe_2$ across charge density wave order and superconductivity [1]. Here I will also discuss the extension of such experiments to ultrathin layers of high-temperature cuprate superconductors that could help shed more light on the rich phase diagram and pairing mechanism. We studied the 2D phases and gate-tunability of exfoliated few-layers samples. We found that they exhibit a zero-resistance state, which is different from the Meissener superconductivity of the bulk, and is highly sensitive to external magnetic fields. [1] Controlling many-body states by the electric field effect in a two-dimensional material;
Li, L. J., O'Farrell, E. C. T., Loh, K. P., Eda, G., Özyilmaz, B., and Castro Neto, A. H., Nature 529, 185–189 (Jan 2016)