Spectroscopic Study of Strong Correlations and Unconventional Superconductivity in Magic-Angle Twisted Trilayer Graphene

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Magic-angle twisted trilayer graphene (MATTG) has emerged as a novel moire material that exhibits strong electronic correlations and unconventional superconductivity[1,2].

In this talk, I will discuss high-resolution scanning tunneling microscopy and spectroscopy measurments[3] of MATTG that reveal extensive regions of atomic reconstruction that favor mirror-symmetric stacking. We observe a cascade of symmetry-breaking electronic transitions and doping-dependent band structure deformations similar to those realized in magic-angle bilayers in these regions. More importantly, in a density window spanning two to three holes per moire unit cell, we also observe spectroscopic signatures of superconductivity that are manifest as pronounced dips in the tunneling conductance at the Fermi level accompanied by coherence peaks. Furthermore, the evolution of the tunneling profile with doping is consistent with a gate-tunable transition from a gapped to a nodal superconductor, which we show theoretically is compatible with a sharp transition from a Bardeen-Cooper-Schrieffer (BCS) to a Bose-Einstein-condensation (BEC) superconductor. Outside coherence peaks, within this doping window, we also detect peak-dip-hump structures indicating that superconductivity is driven by strong coupling to bosonic modes. These results highlight the unusual nature of superconductivity in MATTG.

References

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