Chez Pierre

Presents ...

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Chez Pierre Seminar

Pablo Jarillo-Herrero - Massachusetts Institute of Technology

"Moiré Magic 3.0"

Moiré superlattices have recently emerged as a novel platform where correlated physics and superconductivity can be studied with unprecedented tunability. Although correlated effects have been observed in several other moiré systems, magic-angle twisted bilayer graphene (MATBG) remains the only one where robust superconductivity has been reproducibly measured. In this talk I will present a new moiré superconductor, mirror symmetric magic-angle twisted trilayer graphene (MATTG) with dramatically richer tunability in electronic structure and superconducting properties. Hall effect and quantum oscillations measurements as a function of density and electric field allow us to determine the system's tunable phase boundaries in the normal state. Zero magnetic field resistivity measurements then reveal that the existence of superconductivity is intimately connected to the broken symmetry phase emerging at two carriers per moiré unit cell. Strikingly, we find that the superconducting phase gets suppressed and bounded at the van Hove singularities (vHs) partially surrounding the broken-symmetry phase, which is difficult to reconcile with weak-coupling BCS theory. Moreover, the extensive in situ tunability of our system allows us to achieve the ultra-strong coupling regime, characterized by a Ginzburg-Landau coherence length reaching the average inter-particle distance and very large T_BKT/T_F ratios in excess of 0.1. These observations suggest that MATTG can be electrically tuned close to the two-dimensional BCS-BEC crossover. Our results establish a new generation of tunable moiré superconductors with the potential to revolutionize our fundamental understanding and the applications of strong coupling superconductivity.