Electric field tunable superconductivity with competing orders in near magic-angle twisted bilayer graphene

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Superconductivity (SC) in twisted bilayer graphene (tBLG) has been explored with varying carrier concentrations, twist angles, and screening strength, aiming to uncover its origin and connection to correlation or broken symmetry. The link between tBLG's electronic band structure features and the onset of SC remains unclear. In this study, we address this gap by examining in-situ band structure tuning and its simultaneous impact on SC. Our report focuses on tuning the superconducting phase in a near magic-angle tBLG device ($\theta \approx 0.95^{\circ}$) using a displacement field (D). At zero D, the device exhibits superconducting signatures without resistance peaks at half fillings. As D increases, the SC is suppressed, accompanied by the appearance of a resistance peak at half-filling. Hall density measurements reveal that at zero D, SC arises around the Van Hove singularity (VHS) from an Isospin-unpolarized band. At higher D, the suppression of SC coincides with broken Isospin symmetry near half-filling, leading to lifted degeneracy ($g \sim 2$). Additionally, when SC is suppressed at higher D, density waves around the superconducting dome becomes evident. These findings highlight the competition among the orders in tBLG, offering valuable insights into this phenomenon.

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