

Probing electric field tunable multiband superconductivity in alternating twisted quadralayer graphene

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Abstract

Alternating twisted multilayer graphene presents a compelling multiband system for exploring superconductivity. Here we investigate robust superconductivity in alternating twisted quadralayer graphene, elucidating carrier contributions from both flat and dispersive bands. The superconductivity is robust, with a strong electrical field tunability, a maximum BKT transition temperature of 1.6 K, and high critical magnetic fields beyond the Pauli limit. We disentangle the carrier density of Dirac bands and flat bands from the Landau fan diagram. Moreover, we could estimate the flatband Fermi velocity from the obtained high critical current near half-filling when superconductivity is killed at finite magnetic fields, and further quantify the superfluid stiffness from the low critical current in the superconducting regime. Our results exhibit the electric field-tunable coupling strength within the superconducting phase, revealing unconventional properties with vanishing Fermi velocity and large superfluid stiffness. These phenomena, attributed to substantial quantum metric contributions, offer new insights into the mechanisms underlying unconventional superconductivity in moiré systems.

References

- [1] Le Liu, Yu Hong, Chengping Zhang, Jundong Zhu, Jingwei Dong, Kenji Watanabe, Takashi Taniguchi, Luojun Du, Dongxia Shi, Kam Tuen Law, Wei Yang, Guangyu Zhang. Probing electric field tunable multiband superconductivity in alternating twisted quadralayer graphene. arXiv:2501.06460

Figures

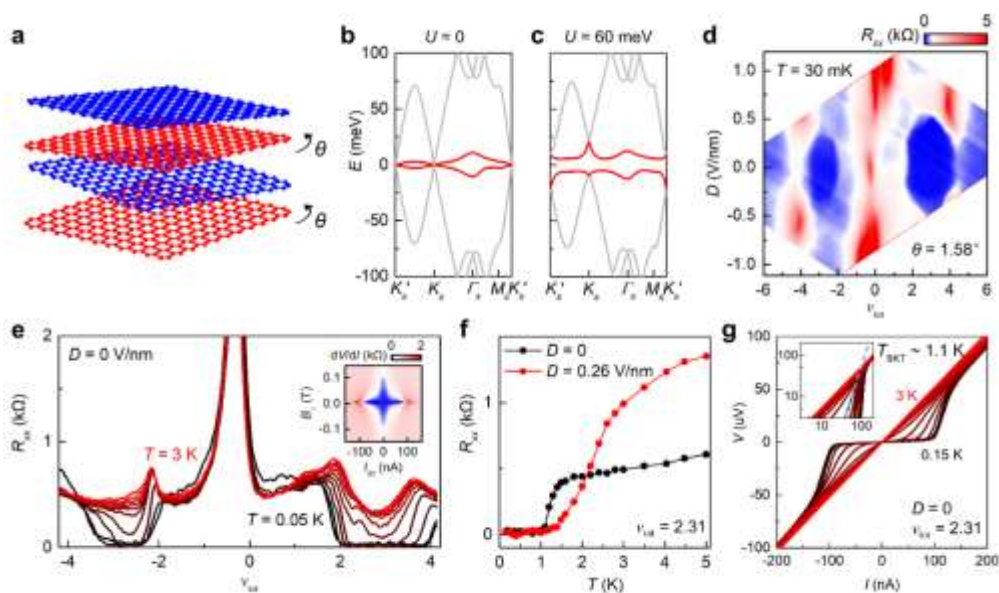


Figure 1: Superconductivity in alternating twisted quadralayer graphene.