Tunable quantum interferometer for correlated moiré electrons

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We realize a gate-defined quantum interferometer (Fig. 1a) in magic-angle twisted bilayer graphene (MATBG) and observe coherence effects such as the Little–Parks and the Aharonov–Bohm effect [1]. In the device architecture, we exploit the variety of tunable correlated states in MATBG and confine a superconducting or normally conducting ring by a correlated or band insulator (Fig. 1b). For a superconducting ring, we observe the Little–Parks effect as oscillations in the resistance and critical current of the ring in magnetic field. Additionally, we also show a novel probe of the Little–Parks effect by directly measuring the oscillation of the superconducting phase diagram as a function of carrier density and magnetic field. From the $h/2e$-periodicity of the oscillations, we confirm an effective charge of 2e for the superconducting carriers. In the normal conducting regimes, we report h/e-periodic Aharanov-Bohm oscillations and demonstrate that the phase coherence length of moiré electrons exceeds several microns at 50 mK. Intriguingly, we identify a regime where h/e-periodic oscillations coexist with superconductor-like transport. We have shown previously that gate-defined devices are excellent platforms for studying and controlling superconductivity in MATBG [2, 3, 4]. In this work we demonstrate that tunable quantum interferometers enable the study of coherent phenomena of correlated quantum states.

References

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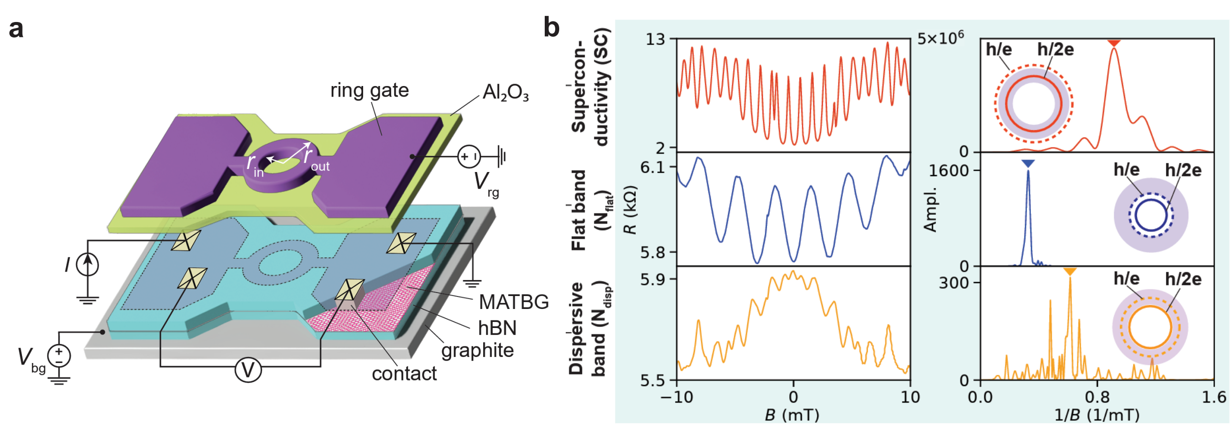

Fig. 1. (a) Device schematics. (b) Overview of quantum-interference effects in the superconducting and normal conducting regimes of the ring defined in a correlated insulator. Figure taken from reference [1].