Magnetic Josephson Junctions and Superconducting Diodes in Magic Angle Twisted Bilayer Graphene

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Abstract

The simultaneous co-existence and tunability of the superconducting, magnetic and topological orders in magic angle twisted bilayer graphene (MATBG) open up new possibilities for the creation of complex hybrid Josephson junctions. Here we report on the creation of gate-defined magnetic Josephson junctions in MATBG, where the weak link is gate tuned closed to the correlated state at a moiré filling factor of $\nu = -2$. A highly unconventional Fraunhofer pattern emerges, which is phase-shifted and asymmetric with respect to the current and magnetic field directions, and shows a pronounced magnetic hysteresis. The combination of magnetization and its currents induced switching allows us to realize a programmable zero field superconducting diode, a major building block for a new generation of superconducting electronics.

References

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Figure 1. Device schematic and measuring circuit. The combination of the graphite back gate and split top gates allow us to realize a gate tunable Josephson junction in the MATBG.

Figure 2. Fraunhofer pattern of the Josephson junction with the weak link set closed to $\nu = -2$. The pattern displays a shift from the zero-field value, and is asymmetric with respect to both the current and magnetic field directions.