Magnetoresistance Effect with Significant Gate Tunability in Fe_3GeTe_2/Graphene Heterostructures

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Van der Waals (VdW) heterostructures incorporating graphene have attracted significant interest due to their tunable electronic properties via the proximity effect [1]. In particular, integrating graphene with a ferromagnet (FM) enables the combination of graphene's gate tunability with the nonvolatility of magnetization, paving the way for multifunctional and reconfigurable devices. The recent emergence of VdW FMs, which allow atomically flat interfaces with graphene, has further sparked interest in fundamental physics and applications for ultracompact devices [2].

In this work, we report a gate-tunable magnetoresistance effect in a heterostructure comprising monolayer graphene (MLG) and the VdW FM Fe_3GeTe_2, encapsulated with hexagonal boron nitride. The longitudinal resistance as a function of the out-of-plane magnetic field exhibits a butterfly-shaped hysteresis, whose sign reverses with carrier type in MLG controlled through back-gate voltage, as shown in Figure 1. Our experimental results, supported by theoretical calculations, indicate that the gate-tunable magnetoresistance effect arises from the interplay between Dirac fermions in MLG, 2D magnetism in Fe_3GeTe_2, and a strong magnetic proximity effect in MLG [3].

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References

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Figures

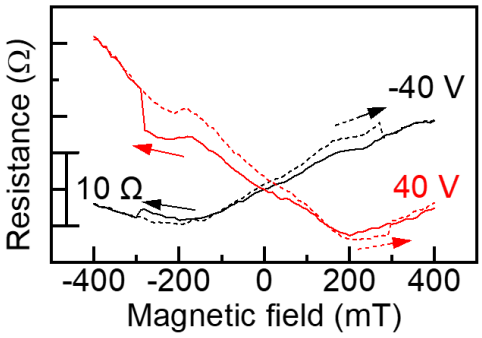

Figure 1: Longitudinal resistance as a function of magnetic field at gate voltage of ±40 V. Solid and dotted lines represent magnetic field sweep downwards and upwards, respectively.