Acoustically-induced pseudo-gauge fields and anomalous transport phenomena in graphene

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Abstract

We will demonstrate that acoustically stimulated carrier transport in graphene at 4 Kelvin signals the presence of artificial gauge fields through the build-up of a transversal voltage at zero magnetic field. We fabricated a gate-tunable graphene Hall bar on a hybrid piezoelectric $LiNbO_3$ on insulator substrate. A nearby interdigitated transducer (IDT) can launch a surface acoustic wave (SAW) that acoustically accelerates the carriers in the graphene layer. The propagating SAW induces an acoustic current whose sign and magnitude reflect the carrier concentration and type reversal at the charge neutrality point. (Fig. 1a). At zero magnetic field, we observe large anomalous acoustically-induced synthetic Hall voltages up to ~200 μV, depending on the carrier type, concentration and the SAW power (Fig. 1b). The synthetic Hall voltage can modulate a conventional Hall voltage arising in a large external magnetic field (Fig. 1c). Our observation is consistent with studies of strain-induced pseudo-gauge fields [1-4]. We developed a model that successfully maps the mechanical deformation within the graphene, precipitated by the SAW in the substrate, to the presence of a gauge field and the observed synthetic Hall voltage [5].

References

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Figures

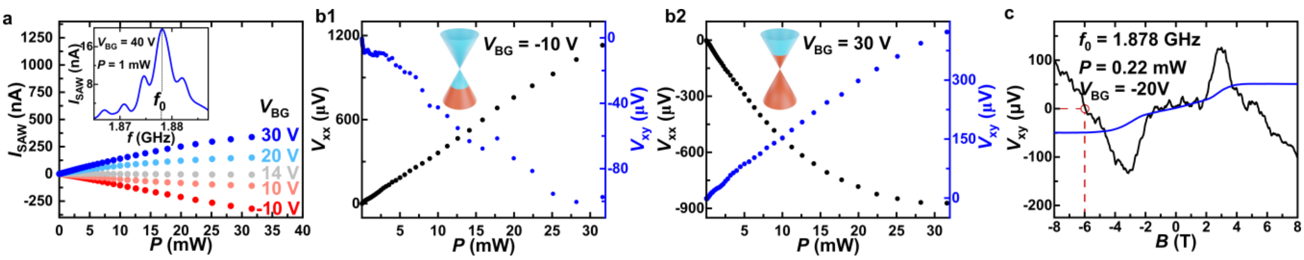

Figure 1: (a) Acoustic current measured at the resonance frequency f_0 of the IDT (inset) for different gate voltages and SAW powers. (b) Exemplary acoustically induced longitudinal and artificial Hall voltages in the hole (b1) and electron (b2) regime. (c) Transversal voltage component under an external magnetic field measured with a regular current superimposed on an acoustic current (black) shows the complete compensation of V_{xy} at finite B. The conventional Hall voltage (blue) [that measured separately] is shown for comparison.