Light-induced anomalous Hall effect in graphene

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Many non-equilibrium phenomena have been discovered or predicted in quantum solids driven by femtosecond pulses of light. Examples include photo-induced superconductivity [1] and Floquet-engineered topological phases [2]. These effects are expected to lead to measurable changes in electrical transport. However, the timescales involved far exceed those accessible using conventional fast electronics.

In this talk, I will present results on the transport properties of monolayer graphene illuminated by a femtosecond pulse of circularly polarized light [3]. This was achieved using an ultrafast device architecture based on laser-triggered photoconductive switches. We observed a light-induced Hall effect in the absence of an applied magnetic field. The dependence of the effect on a gate potential used to tune the Fermi level revealed multiple features that reflect a Floquet-engineered topological band structure, similar to the band structure originally proposed by Haldane [4]. This includes a ~60 meV wide conductance plateau centered at the Dirac point, where a gap of equal magnitude is predicted to open based on Floquet theory. We find that when the Fermi level lies within this plateau, the non-equilibrium anomalous Hall conductance saturates around ~1.8+/-0.4 e^2/h.

References

[1] D. Fausti et al. Science **331**, 189-191 (2011)
[2] T. Oka & H. Aoki. Phys. Rev. B **79**, 081406 (2009)
[3] J.W. McIver et al. Nature Physics **16**, 38-41 (2020)
[4] F.D.M. Haldane, Phys. Rev. Lett. **61**, 2015-2018 (1988)

Figures

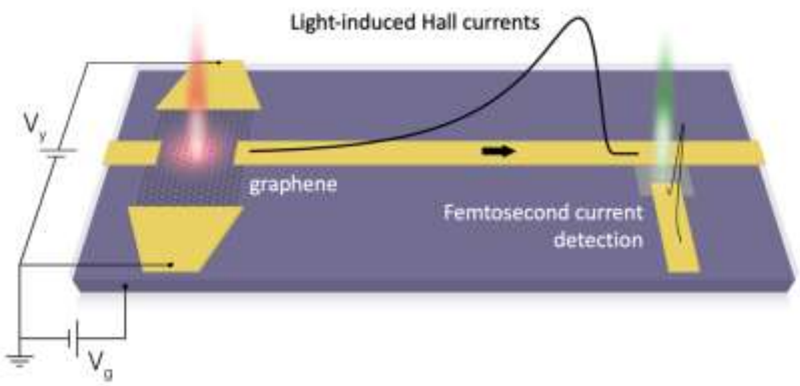

Figure 1: Schematic of the device architecture used to detect ultrafast light-induced anomalous Hall currents in graphene.