Giant magneto-photoelectric effect at a graphene edge

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Graphene is a promising material for optical or infrared absorption, as its pseudo-relativistic energy-momentum relation in the vicinity of the Dirac points allows for a broad absorption bandwidth. It can be shown that particles and holes which are generated due to photon absorption move in antipodal directions if the graphene edge is subject to a perpendicular magnetic field [1].

Motivated by this proposed mechanism, the optical response of a suspended field-effect transistor was experimentally studied [see Fig.1]. With an illumination power of only 3µW, a surprisingly large photocurrent of up to 400nA has been measured, which we believe to be one of the highest values ever measured in single-layer graphene (2). We estimate that every absorbed photon creates more than 8 electron-hole pairs.

A natural candidate to explain the generation of secondary electron-hole pairs is carrier multiplication via inelastic Auger-type scattering at the graphene edge where the perpendicular momentum is not conserved (see Fig. 2). Due to the fact that the effective fine-structure constant in graphene is of order unity, we find a rather large probability for secondary particle-hole pair creation.

References

Figures

Figure 1: Schematic of the photocurrent measurement.

Figure 2: Sketch of Auger scattering in an energy-momentum diagram.