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

[1] F. Queisser and R. Schützhold, Phys. Rev. Lett. 111, 046601 (2013).
[2] J. Sonntag, A. Kurzmann, M. Geller, F. Queisser, A. Lorke and R. Schützhold, New J. Phys. 19, 063028 (2017).

Figures

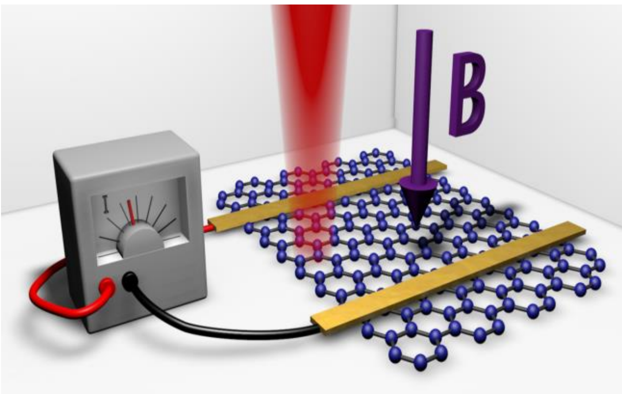

Figure 1: Schematic of the photocurrent measurement.

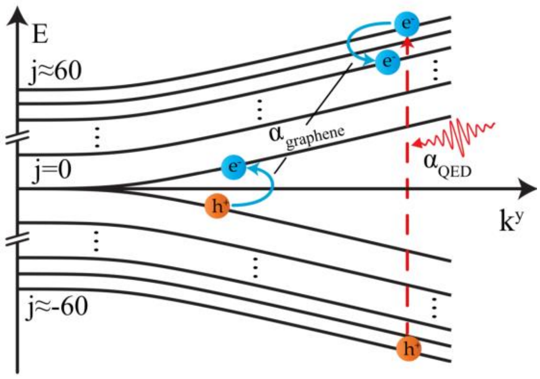

Figure 2: Sketch of Auger scattering in an energy-momentum diagram.