Spectroscopy on Landau-quantized charge neutral graphene

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Landau level spectroscopy is a powerful tool to determine the Fermi velocity in Dirac-like materials. In our study, we investigate the optical properties of charge neutral graphene on SiC in presence of strong magnetic fields applied perpendicularly to the sample. For details about this neutral large-area monolayer graphene, see [1]. We measured the linear transmission in dependence of the magnitude of the magnetic fields from 0 to 8 T for photon energies up to 100 meV. We observe a broad resonance resulting from the $LL_{-1}(LL_0) \rightarrow LL_0(LL_1)$ transition. It corresponds to a low Fermi velocity of 0.85×10^6 m/s, which is the limit of low electron-electron interaction [2]. The efficient screening is supported by the dielectric environment of the polymer layer on top of the graphene [3]. We support our understanding of the low Fermi velocity by density functional theory (DFT) calculations. In addition, we studied the dynamics of the $LL_{-1} \rightarrow LL_0$ and $LL_0 \rightarrow LL_1$ transitions using circularly polarized light at 75 meV. We observe a fast decay of about 10 ps. Addressing the transitions with all four combinations of pump and probe beam polarizations, we obtain only one negative differential transmission signal. Following [4], we attribute this and the fast decay to very efficient Auger scattering processes. The observed fluence dependence of the relaxation with time constants decreasing with increasing fluence is also in accordance with this interpretation.

References

[1] H. He, K. H. Kim, A. Danilov et al., Nat. Comm., 9, (2018) 3956.
[2] D. Siegel, C.-H. Park, C. Hwang et al., PNAS, 108, 28 (2011) pp. 11365-11369.
[3] P. Yadav and S. Ghosh, AIP Conference Proceedings, 1665, (2015) 050075.
[4] M. Mittendorff, F. Wendler, E. Malic et al., Nat. Phys., 11 (2015) pp. 75-81.

Figures

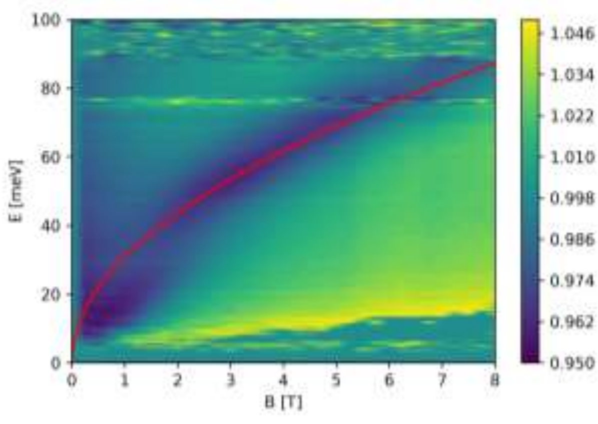

Figure 1: Dependence of the normalized transmission on the applied magnetic field and the photon energy for charge neutral graphene. The red line shows the calculated position of the LL0→LL1 resonance.