

# Genzel Prize: Terahertz magneto-optics and magneto-plasmonics of graphene and graphite

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Graphene attracts a lot of attention as a novel optical and plasmonic material. Its optical response is exceptionally sensitive to a magnetic field due to the small cyclotron mass of the Dirac-like charge carriers. This does not only make magneto-optics a useful tool to study this material but also gives rise to giant magneto-optical effects, potentially useful for terahertz applications. In this talk, I'll overview our magneto-optical studies of large-scale single- and multilayer graphene grown epitaxially on the Si- and C-faces of silicon carbide respectively [1,2,3]. In the highly doped monolayer graphene we observe a strong Drude peak at zero field and a quasiclassical, field-linear, cyclotron resonance at finite fields, which gives rise to a giant Faraday rotation exceeding 0.1 radians at modest fields [1]. In this type of graphene we also found an unexpectedly strong terahertz plasmonic absorption [3] due to natural defects such as terrace steps in SiC. When a field is applied, the plasmon peak splits in two modes, which is a hallmark of the magnetoplasmon physics found earlier in 2D electron gases in semiconductors [4] and on the surface of liquid helium [5]. In quasineutral twisted multilayer graphene, often regarded as a set of decoupled monolayers, we observe quantum LL transitions with the expected square-root like dependence on magnetic field. However, the optical intensity of these transitions is several times smaller than the Kubo formula predicts and its field dependence is not square-root like, as one would expect in ideal and decoupled monolayers [2]. I'll contrast this serious discrepancy to our recent magneto-optical Kerr rotation spectroscopy experiments in Bernal stacked graphite [6], where a very good agreement between the experiment and the tight-binding Kubo formula is achieved in a broad range of magnetic fields.

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[2] I. Crassee, J. Levallois, D. van der Marel, A. L. Walter, Th. Seyller, and A. B. Kuzmenko, *Phys. Rev. B* 84, 035103 (2011).

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