Optics and magneto-optics of graphene

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The recent research activities in LNCMI-Grenoble, CNRS, focused on investigations of various graphene-based materials will be reviewed. These investigations involve studies of multi- and mono-layers of epitaxial graphene, decoupled graphene flakes on the surface of graphite as well as bulk graphite. The applied experimental methods − infrared and THz magneto-spectroscopy and magneto-Raman scattering techniques − mostly serve us as a tool of Landau level spectroscopy [1] and they are employed to study the characteristic response due to massless or massive Dirac-type particles. This response includes both intraband and excitations and allows us to get precise insights into electronic band structures of particular graphene-based materials and study effects of electron-phonon and electron-electron interactions [2,3]. Links to the magneto-optical response of other intriguing materials, hosting relativistic-like particles, will be provided as well [4]. A special attention will be paid to recent optical spectroscopy studies of Landau-quantized graphene using time-resolved techniques, which reveal surprisingly strong effects of electron-electron interactions, having a form of extremely fast inter-Landau-level Auger scattering [5]. Implication towards a possible construction of the long-time searcher Landau level laser will be discussed.

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[4] M. Orlita et al.: *Observation of three-dimensional massless Kane fermions in a zinc-blende crystal.* Nature Phys. **10**, 233 (2014).

[5] M. Mittendorff et al.: *Carrier dynamics in Landau-quantized graphene featuring strong Auger scattering*, Nature Phys. **11**, 75 (2015).