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Nonequelibrium carrier dynamics in Landau quantized graphene and mercury cadmium telluride

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The narrow-gap semiconductor mercury cadmium telluride (MCT) is used for decades as a material for applications in the mid- and far infrared, in particular for detectors. Graphene, on the other hand, has been explored in recent years regarding THz detection, modulation, generation and harmonic generation [1]. In magnetic fields, both materials exhibit strongly non-equidistant Landau-level (LL) systems. Here we present an overview that sheds light into the carrier dynamics of in Landau-quantized Dirac electrons in graphene and Kane electrons in MCT. The non-equidistant Landau-ladder makes these materials highly attractive for realizing the old dream of the semiconductor physics community to fabricate a Landau-level laser. For a recent review on this topic, see Ref. [2]. In such a laser, stimulated emission is achieved between a pair of Landau levels and the emission wavelength can be tuned by the strength of the magnetic field. In graphene, we found evidence for strong Auger scattering for the lowest allowed transitions $LL_{-1} \rightarrow LL_0$ and $LL_0 \rightarrow LL_1$ [3]. These energetically degenerate transitions can be distinguished by applying circularly polarized radiation of opposite polarization. In this configuration, Auger scattering can cause depletion of the LL_0 level even though it is optically pumped at the same time. Recently, we have investigated the $LL_{-2} \rightarrow LL_1$ and $LL_{-1} \rightarrow LL_2$ transition under strong optical pumping. This transition is a candidate for the lasing transition for a Landau-level laser. We observed non-equilibrium carrier distributions by selective pumping before thermalization occurred. MCT, on the other hand, is even more attractive because of much longer relaxation times [4]. They are on the ns scale while in graphene thermalization occurs on a timescale of a few ps. The reason for the longer timescale is the different Landau ladder due to spin splitting.

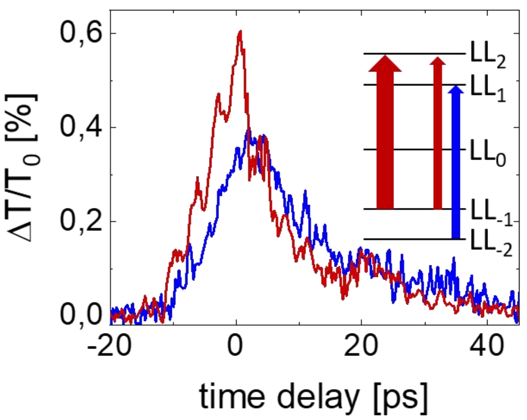

Fig. 1: Pump-induced transmission of graphene for copolarized and counterpolarized excitation with circularly polarized radiation and Landau-level scheme.

REFERENCES

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