Terahertz and Mid-Infrared studies of pseudo-relativistic fermions in HgCdTe heterostructures

F. Teppe[1], S.S. Krishtopenko[1,2], S. Ruffenach[1], M. Marcinkiewicz[1], C. Consejo[1], W. Knap[1], M. Orlita[3], J. Torres[4], S.V. Morozov[2], N.N. Michailov[5], S.A. Dvoretskii[5]

[1] *L2C, UMR CNRS 5221, Montpellier University, 34095 Montpellier, France.*
[2] *IPM, Russian Academy of Sciences, 603950, GSP-105, Nizhny Novgorod, Russia.*
[3] *LNCMI, CNRS-UJF-UPS-INSA, 38042 Grenoble, France.*
[4] *IES, UMR 5214 CNRS, Montpellier University, 34095Montpellier, France.*
[5] *ISP, Russian Academy of Sciences (SB), pr. Akademika Lavrent'eva 13, Novosibirsk, 630090 Russia.*

Bulk films and heterostructures based on HgCdTe compounds can be engineered to fabricate "gapped-at-will" structures. Therefore, 1D [1], 2D [2] and even 3D [3] massless particles can be observed in topological phase transitions driven by intrinsic (quantum well thickness, Cd content) and external (magnetic field, temperature or pressure) physical parameters. So far, the phases of 2D [1] and 3D [4] topological insulator have already been experimentally demonstrated in HgCdTe-based heterostructures. More recently, clear experimental evidence of the existence of 3D electronic states with conical-like spectrum was obtained in HgCdTe bulk films at specific Cd content [3]. These 3D massless particles, called Kane fermions, have unique symmetry properties, which are not equivalent to any well-known case of massless particles in the relativistic limit of the quantum electrodynamics.

In this work, we report on our experimental results obtained by Terahertz (THz) and Mid-Infrared magneto-spectroscopy, on topological phase transitions driven by temperature in HgCdTe-based QWs [5] and bulk films [6]. These transitions are accompanied with the appearance of 2D and 3D massless electrons called Dirac and Kane fermions, respectively. We will also present first results on our investigation of 3D topological insulators surface states.

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