Topological Transitions in Dirac-type Electronic Systems Probed by Magneto-Optical Spectroscopy

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This presentation will consist of two parts, describing two quite different phenomena, whose relation is mostly terminological: both are called electronic topological transitions.

In the first part, we will discuss the spectrum of cyclotron resonance in the situation when the *topology of the electronic Fermi surface* is about to change. Such a change is known as Lifshitz transition. It turns out that the bulk graphite is quite close to such Lifshitz transition, which would occur if the Fermi level could be tuned by just 6 meV. A consequence of such proximity to a Lifshitz transition is the presence of a large number of harmonics in the cyclotron resonance spectrum, which was observed recently [1]. Such behavior can be understood from a purely classical picture of motion near a separatrix in the phase space.

The second part is dedicated to the magneto-optical proporties of the bulk $\mathrm{Hg}_{1-x}\mathrm{Cd}_x\mathrm{Te}$ at the critical point $x_c \approx 0.17$ where the *topology of the electronic band structure* changes. At $x > x_c$, this compound is a conventional (narrow-gap) zinc-blende semiconductor with the standard sequence of different symmetry bands: the s-type Γ_6 band lies above the p-type Γ_8 bands. Instead, at $x < x_c$, the band order is inverted: the Γ_6 band lies below the Γ_8 bands, so the band structure is gapless, and the material is a semimetal. At the transition point, $x = x_c$, the gap shrinks to zero, and the electronic dispersion relation resembles that of massless Dirac electrons. This behavior is manifested in the dynamical conductivity increasing linearly with the photon frequency. In a strong magnetic field B, such dispersion leads to a $\sqrt{B}$ dependence of dipole-active inter-Landau-level transitions on the magnetic field. Both these features can be detected experimentally [2]. The spin splitting of Landau levels also follows the $\sqrt{B}$ dependence, in contrast to the conventional Zeeman effect.

[1] M. Orlita, P. Neugebauer, A.-L. Barra, M. Potemski, F. M. D. Pellegrino, and D. M. Basko, *Phys. Rev. Lett.* **108**, 017602 (2012).
[2] M. Orlita, D. M. Basko, M. S. Zholudev, F. Teppe, W. Knap, V. I. Gavrilenko, N. N. Mikhailov, S. A. Dvoretskii, P. Neugebauer, C. Faugeras, A.-L. Barra, and M. Potemski, *Nature Phys.* **10**, 233 (2014).