Topological Insulator State and Beatings in Shubnikov – de Haas Oscillations in a Wide HgTe Quantum Well

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At the present time HgTe quantum well is one of the most intensively investigated subject of two-dimensional electron system physics. Due to the strong relativistic effects, and particularly spin-orbit interaction, different electron systems can be realized in these wells: ordinary insulator, 2D massless Dirac Fermions, 2D and 3D topological insulator, 2D semimetal.

This work is devoted to the investigation of a wide (~20 nm) HgTe quantum well. Together with being semimetallic in recent work [1] this well was shown to be an analog of 3D topological insulator with a quantum well instead of 3D crystal. The point was that electrons in the conduction band at large energies transform from “volume” ones, localized in the center of the well, to the surface ones, localized near two well surfaces. In this work manifestation of these surface states in magnetotransport was studied. Shubnikov – de Haas (ShdH) oscillations in 18-22 nm HgTe quantum wells with orientations (001) and (013) versus magnetic field and gate voltage were measured. As expected, due to different concentration of surface electrons at surfaces closer and farther from the gate, beatings occur in ShdH oscillations with gate voltage increase (see Fig. 1). The data obtained versus magnetic field can be well described by the suggested model of surface electrons. ShdH oscillations versus gate voltage were found to have more complicated behavior (see Fig. 1, b). In particular together with the appearance of the expected beatings in oscillations the equidistance between oscillation extrema becomes broken with gate voltage increase, what can be attributed to the spectrum characteristics.

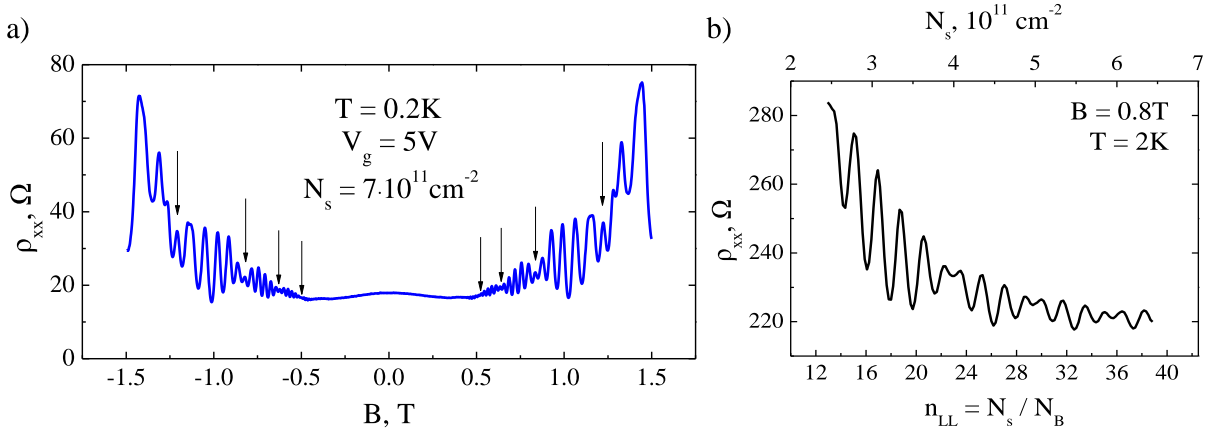

Fig. 1. Shubnikov – de Haas oscillations versus magnetic field (a), versus Landau level number ($N_B = eB/hc$ – Landau level degeneracy) and electron concentration (b) in a wide HgTe quantum well.

References

[1] A.A. Dobretsova, L.S. Braginskii, M.V. Entin, Z.D. Kvon, N.N. Mikhailov, S.A. Dvoretsky, *JETP Letters* **101**, 330 (2015).