Weak anti-localization in 2D Dirac fermions in CdHgTe/HgTe/CdHgTe quantum well

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Weak localization in a system of gapless two-dimensional Dirac fermions in HgTe quantum wells with thickness $d = 6.6$ nm, which corresponds to the transition from a normal to an inverted spectrum and linear energy dispersion law for both electrons and holes, has been investigated experimentally. The experimental samples studied were 6.6 nm $Cd_{0.7}Hg_{0.3}Te/HgTe/Cd_{0.7}Hg_{0.3}Te$ QW grown by molecular beam epitaxy on a (013) CdTe/ZnTe/GaAs substrate. The magnetotransport measurements were carried out on hundred μm-sized hallbars. Samples were covered by $SiO_2 + Si_3N_4$ insulator with total thickness of 300 nm and metallic Ti-Au gate. The main results of the work are following:

1. Magnetotransport measurements were carried out in the temperature range of 0.2-10 K in magnetic fields of up to 1 T. Typical dependence $\rho_{xx}(V_g)$ is a smooth curve with a single maximum which corresponds Fermi energy crossing the Dirac point (fig. 1, left). The maximum value of $\rho_{xx}^{\max}(V_g)$ at $T = 4$ K is $8 - 16$ kOhm (vary for different samples) and curve $\rho_{xx}(V_g)$ is symmetric in the region of ± 0.4 V from the maximum. Such behavior corresponds system of gapless Dirac fermions better then in [1].

2. We investigated quantum corrections to the conductivity for Dirac electrons, holes and for the carriers directly in the Dirac point. A negative logarithmic correction to the conductivity of the system has been observed both at the Dirac point and in the vicinity of this point (fig. 1, middle).

3. The anomalous magnetoresistance of two-dimensional Dirac fermions is positive (fig. 1, right). This indicates that weak localization in the system of two-dimensional Dirac fermions occurs owing to localization and interaction effects in the presence of rapid spin relaxation.

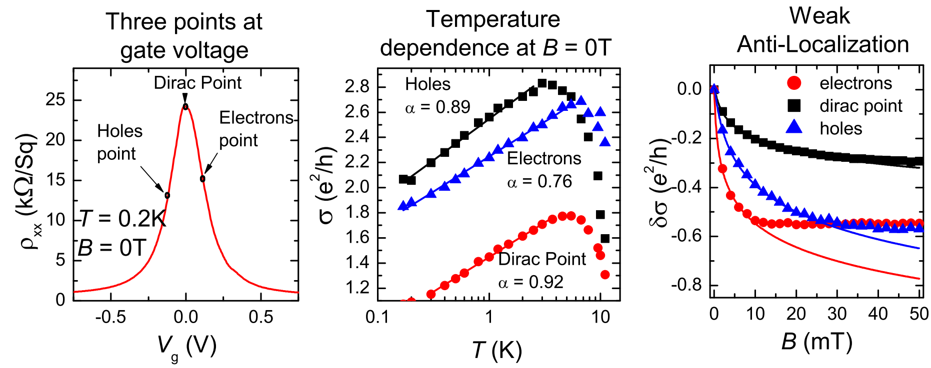

Figure 1: Gate voltage dependence, temperature dependencies and magnetic field dependencies of the resistivity.

[1] B. Büttner *et al.*, Nature Phys **7**, 418 (2011).
[2] D. A. Kozlov *et al.*, JETP Letters, **96** (11), 730 (2012).