Quantum Magnetotransport in the HgTe Double Quantum Well with Inverted Energy Spectrum

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The energy spectrum of the HgTe quantum well wider than 6.3 nm radically differs from a traditional one as it is inverted, thus both its valence and conduction subbands are of the Γ_8 nature. This results in a strong nonparabolicities, large spin splittings [1], strong manifestations of the spin polarization effects [2], overlaps of the conduction and valence subbands *etc.* The question arises: how would manifest such an unusual combination of properties in a double quantum well (DQW) made of HgTe layers? Existence of an additional degree of freedom connected with the possibility for an electron to reside in one of the two interconnected layers is known to result in a formation of new correlation states of the electronic system. Then, how would manifest here the addition of one more degree of freedom – a well pronounced spin degree? And further, how would manifest the inverted energy band structure of HgTe in the DQW? The interest to this subject is still enhanced by the prediction that a special kind of topological insulator may be created in the HgTe DQW.

We present the first experimental study of the DQW system created on the basis of 2D HgTe layers with inverted energy spectrum. The quantum magnetotransport (Fig. 1) reveals a dramatic overlap of the conduction and valence bands, much stronger than in any known single quantum well, which manifests in a pronounced *N*-shaped and double-*N*-shaped Hall magnetoresistance (MR) with multiple quantum features superimposed upon it. In the quantum Hall range of fields, the Hall MR reveals a reentrant behavior between electronic and hole conductivities and a zero resistivity state. The latter appears when the Fermi level enters the gap between the lowest electron and the highest hole Landau levels, while the whole experimental picture is much influenced by the nonmonotonous course of the valence band levels with field connected with its lateral maxima.

[1] M.V. Yakunin, S.M. Podgornykh, N.N. Mikhailov, S.A. Dvoretsky, Physica E **42**, 948 (2010).
[2] M.V. Yakunin, A.V. Suslov, S.M. Podgornykh, N.N. Mikhailov, S.A. Dvoretsky, Phys. Rev. B **85**, 245321 (2012).

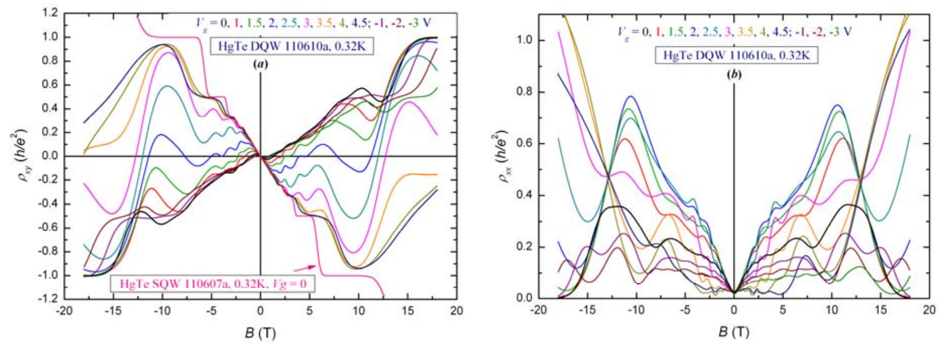

Fig. 1. DQW (a) Hall and (b) longitudinal magnetoresistivities at different gate voltages as compared to a similar single QW [in (a)].