Overlapped Conduction and Valence Bands in the HgTe/CdHgTe Heterostructures

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Introduction

Heterostructures based on HgTe are promising for spintronics as spin polarization is easily achievable here [1]. But many issues about this material remain unclear. Thus the spatially quantized energy band structure of a quasi-two-dimensional HgTe layer is very complicated due to the Γ_8 character of the conduction subband for layers wider than 6.3 nm and its possible overlap with the valence subband. The conditions for the overlap are not clear but known is that they depend on the layer crystallographic orientation and its deformation. The overlap was revealed in some recent investigations. But it did not manifest in other works on similar structures, thus this issue is actual for further investigations.

Experimental

The quantum magnetotransport in a set of HgTe/$Hg_{0.35}Cd_{0.65}Te$ single and double quantum wells (DQW), some of them with the upper gate, has been measured up to 18 T at 0.32 K at NHMFL in SCM-2.

Results and Discussion

The measured Hall and longitudinal magnetoresistivity $\rho_{xy,xx}(B)$ plots indicate a mixed character of conductivity (**Figure 1**). Simultaneous existence of the small mass electrons and holes manifests in *N*-shaped $\rho_{xy}(B)$ and concomitant parabolic $\rho_{xx}(B)$ traces at relatively small fields. Also indications of a new kind of electrons, with a larger mass, were found in the DQWs at higher fields. All these data point to the overlapped subbands: small mass electrons correspond to the upper overlapping subband, holes – to lateral maxima of the lower overlapping subband, and the larger mass electrons – probably to the part of the lower subband between zero wave vector and the lateral maxima. Variations with gate voltage U_g indicate a pronounced redistribution between the three kinds of charges. The existence of the second layer in the DQW possibly promotes manifestation of the larger mass electrons as they have not been seen in a single QW so far.

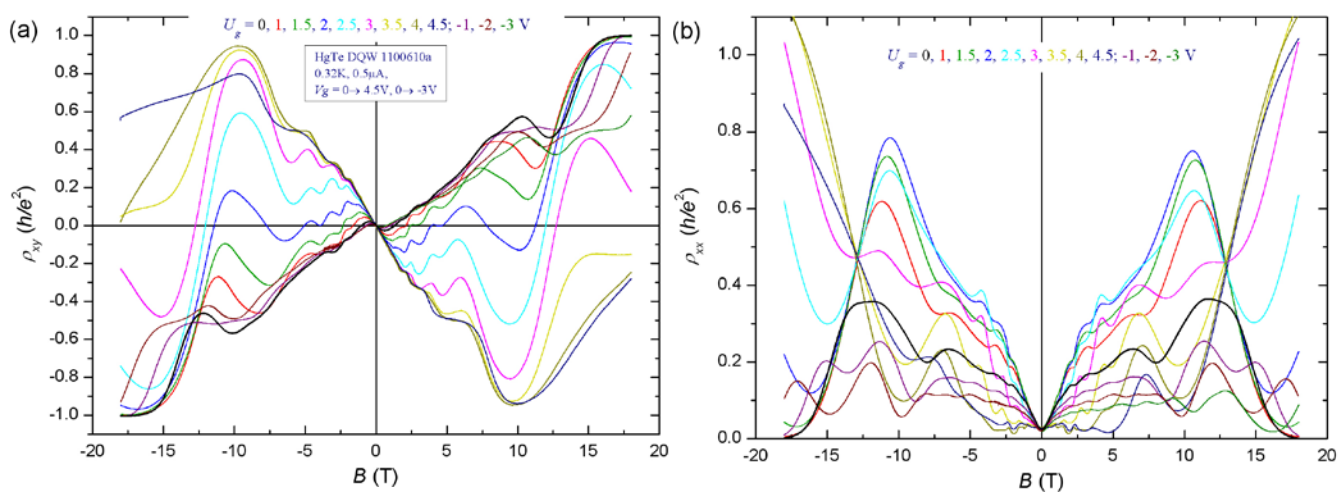

Figure 1. (a) $\rho_{xy}(B)$ and (b) concomitant $\rho_{xx}(B)$ of a DQW for perpendicular fields, T = 0.32 K and different U_g.

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References

[1] Yakunin, M.V., Suslov, A.V. *et al.*, Phys. Rev. B, **85**, 245321 (2012).