HL 28: Focus Session: Topological Insulators (jointly with MA, TT)

Time: Tuesday 9:30–10:30 Location: ER 164

HL 28.1 Tue 9:30 ER 164

Edge channel mixing in HgTe/HgCdTe Quantum point contacts — •Mathias J. Mühlbauer, Timo Wagner, Philipp Leubner, Christopher Ames, Christoph Brüne, Hartmut Buhmann, and Laurens W. Molenkamp — Physikalisches Institut (EP3), Universität Würzburg, 97074 Würzburg, Germany

In this project we study the properties of Quantum Point Contacts (QPCs) that were fabricated in HgTe/HgCdTe high mobility inverted quantum well structures, using e-beam lithography and dry-etching techniques. However, the realization of QPCs in these structures is not trivial due to the narrow band gap and the presence of the Quantum Spin Hall Effect (QSHE) [1]. We demonstrate that these structures are controllable using top gate electrodes and confirm this by low temperature conductance measurements at 4 K and 1.8 K, which indicate steps in $2e^2/h$. The residual conductance in these measurements can be explained by the helical Quantum Spin Hall edge channels which are still present during the transition from the n-conducting region to the p-conducting part. Deviations of ideal conductance plateau values could be explained with the changing transmission probability due to the mixing of these channels because of their finite extension [2].

[1] M. König, S. Wiedmann, C. Brüne, A. Roth, H. Buhmann, L. W. Molenkamp, X-L. Qi, S. C. Zhang, Science, 318, 766, (2007).

[2] Zhou, B., Lu, H-Z., Chu, R-L., Shen, S-Q. & Niu, Q., Phys. Rev. Lett. 101, 246807 (2008)

HL 28.2 Tue 9:45 ER 164

Topological surface states in a strained three-dimensional HgTe — •Elena G. Novik[1], Chaoxing Liu[1], Christoph Brüne[1], Ewelina M. Hankiewicz[2], Hartmut Buhmann[1], Shoucheng Zhang[3], and Laurens W. Molenkamp[1] — [1]Physikalisches Institut (EP3), University of Würzburg, 97074 Würzburg — [2]Institut für Theoretische Physik und Astrophysik, University of Würzburg, 97074 Würzburg — [3]Department of Physics, McCullough Building, Stanford University, Stanford, California 94305-4045, USA

Three-dimensional (3D) HgTe is a semimetal which is charge-neutral when the Fermi energy is at the touching point between the light-hole and heavy-hole Γ8 bands at the Brillouin zone center. With applied strain a gap of about 20 meV opens up between the light-hole and heavy-hole bands, so that strained 3D HgTe is expected to be a 3D topological insulator with Dirac-like surface states [1]. In most of 3D topological insulators the observation of surface charge transport is obscured by the bulk conductivity. The voltage applied to the gate on top of the HgTe structure allows the suppression of the bulk transport contribution, thus only the surface electrons can be accessed in transport when the Fermi energy is shifted into the gap. The self-consistent calculations of the band structure and density of states for a strained HgTe layer have been done for different values of the gate voltage.

[1] C. Brüne et al. Phys. Rev. Lett. 106, 126803 (2011).

HL 28.3 Tue 10:00 ER 164

Induced superconductivity in the surface state of mercury telluride (HgTe) — •Luis Maier, Daniel Knott, Christopher Armes, Christoph Brüne, Philipp Leubner, Jeroen Oostinga, Hartmut Buhmann, and Laurens W. Molenkamp — Physikalisches Institut (EP3), Universität Würzburg, 97074 Würzburg

It has been recently shown that the strained epitaxial growth of bulk HgTe layers opens a band gap in the normally semi-metallic material [1]. This means that strained HgTe meets all prerequisites of a topological insulator, i.e. surface states and an insulating bulk, which does not contribute to transport measurements. The interfaces between topological insulators and superconductors are especially interesting due to the possibility of creation and detection of majorana fermions [2].

Our current work is focussing on investigating contacts between strained HgTe and Nb as a superconducting material. First results show proximity effect and multiple sub gap features which will be discussed in detail.

[1] C. Brüne et al. Phys. Rev. Lett. 106, 126803 (2011)

[2] L. Fu and C. L. Kane, Phys. Rev. Lett. 100, 096407 (2008)

HL 28.4 Tue 10:15 ER 164

Cyclotron resonance of two-dimensional Dirac fermions in HgTe-based quantum well structures — Z.D. Kvon[1,2], S.N. Danilov[3], D.A. Kozlov[1,2], •C. Zoth[3], N.N. Mikhailov[1], S.A. Dvoretsky[1], V.V. Bel'kov[4], and S.D. Ganichev[3] — [1]Institute of Semiconductor Physics, Novosibirsk, Russia — [2]Novosibirsk State University, Novosibirsk, Russia — [3]Terahertz Center, Rgensburg, Germany — [4]Ioffe Institute, St. Petersburg, Russia

We report on the observation and investigation of cyclotron resonance (CR) of one-valley two-dimensional Dirac fermions in HgTe-based quantum well (QW) structures [1]. Terahertz photoconductivity was measured in (013)-grown QWs with widths of 6.4 and 6.6 nm, which are close to the critical thickness, when the band structure changes from normal to inverted. We show that these QWs are characterized by a linear energy dispersion and, consequently, by nonequidistant Landau levels. Our experiments show a shift by a factor of three of resonance position to smaller magnetic fields in comparison to larger QW widths having a parabolic energy spectrum. Moreover, our data demonstrates that the CR position changes by a factor of three upon variation of carrier density. This observation provides a further proof for nonequidistant Landau levels in our samples. The role of fluctuations of structure parameters, such as QW thickness and magnitude of impurity potential is discussed.

[1] Z.D. Kvon, S.N. Danilov, D.A. Kozlov *et al.*, *Pis'ma ZhETF* **94**, 895 (2011) (*JETP Lett.* in print)