HL 80: Quantum transport and quantum Hall effects

Time: Friday 9:30–12:00 Location: POT 51

HL 80.1 Fri 9:30 POT 51

Resolution of the "exponent puzzle" for the Anderson transition in doped semiconductors — Edoardo Carnio[1], •Rudolf Römer[2,3], and Nicholas Hine[2] — [1]Albert-Ludwigs-Universität Freiburg, 79104 Freiburg, Germany — [2]University of Warwick, Coventry, UK — [3]Université de Cergy-Pontoise, Institut d'Études Avancées, and LPTM (UMR8089 of CNRS), F-95302 Cergy-Pontoise, France

The Anderson metal-insulator transition (MIT) is central to our understanding of the quantum mechanical nature of disordered materials. Despite extensive efforts by theory and experiment, there is still no agreement on the value of the critical exponent ν describing the universality of the transition*the so-called *exponent puzzle.* In this Rapid Communication, going beyond the standard Anderson model, we employ ab initio methods to study the MIT in a realistic model of a doped semiconductor. We use linear-scaling density functional theory to simulate prototypes of sulfur-doped silicon (Si:S). From these we build larger tight-binding models close to the critical concentration of the MIT. When the dopant concentration is increased, an impurity band forms and eventually delocalizes. We characterize the MIT via multifractal finite-size scaling, obtaining the phase diagram and estimates of ν. Our results suggest an explanation of the long-standing exponent puzzle, which we link to the hybridization of conduction and impurity bands.

HL 80.2 Fri 9:45 POT 51

Model wavefunctions for interfaces between lattice Laughlin states — •Blazej Jaworowski and Anne Nielsen — Max Planck Institut für Physik Komplexer Systeme, 01187 Dresden, Germany

Interfaces between different topological orders, e.g. different fractional quantum Hall states, are predicted to exhibit nontrivial phenomena, such as anyonic Andreev reflection or parafermion zero modes. However, microscopic descriptions of such systems are quite rare, as they are difficult to study using exact diagonalization. In this work we use conformal field theory to construct microscopic model wavefunctions for interfaces between lattice Laughlin states, describing both the ground states and quasihole excitations [1]. We find that requiring trivial mutual statistics of particles on different sides puts a restriction on possible fillings, coinciding with a similar condition based on K-matrices known in the literature. Next, using the Monte Carlo methods, we show that the entanglement entropy at the interface is higher than in the bulk on the either side, which is expected if some quasiparticles are not able to cross through the interface. This is indeed the case * we find that although all quasiholes remain well-localized when crossing the interface, the statistics of some of them become ill-defined in such a process. Although our work is partly numerical, the closed-form expressions for the wavefunctions allow us to study systems too large for exact diagonalization.

[1] B. Jaworowski, A. E. B. Nielsen, *Model wavefunctions for interfaces between lattice Laughlin states*, submitted to *Physical Review B*

HL 80.3 Fri 10:00 POT 51

Magnetotunnelspectroscopy of Double-Quantum-Wells in GaAs/AlGaAs Heterostructures — •Maximillian Mischke[1], Gunnar Schneider[1], Werner Dietsche[2], and Rolf J. Haug[1] — [1]Leibniz Universität Hannover, Institut für Festkörperphysik, Germany — [2]Max-Planck Institut für Festkörperforschung, Stuttgart, Germany

In order to investigate the influence of a parallel magnetic field on bilayer phenomena, we performed magnetotunnel measurements on GaAs/AlGaAs double quantum wells. Therefore the tunneling current between the two quantum wells was measured dependent on applied bias voltage, electron densities in the individual wells and a magnetic field oriented parallel to the 2D layers. We observe a systematic dependence of the tunneling resonance on the energetic difference of the two wells due to imbalanced densities. The applied bias compensates the mismatch. The parallel magnetic field introduces an additional term to the wave vector of the electrons, leading to a shift of the Fermi circles of the two quantum wells against each other [1]. This shift has an influence on the tunneling resonance since 2D-2D-tunneling requires not only energy conservation but also conservation of momentum [2]. Our measurements reveal an energetic splitting of the tunneling conductance with magnetic field. This splitting starts at a certain magnetic field depending on the density ratio. We expect many-particle-effects to influence this offset field.

[1] G.S. Boebinger et al, Phys. Rev. B 43, 12673 (1991)
[2] J.P. Eisenstein et al, Appl. Phys. Lett. 58, 1497 (1991)

HL 80.4 Fri 10:15 POT 51

Helical quantum Hall phase in graphene on SrTiO3 — •Louis Veyrat[1,7], Corentin Deprez[1], Alexis Coissard[1], Xiaoxi Li[2,3,4], Frédéric Gay[1], Kenji Watanbe[5], Takashi Taniguchi[5], Zheng Vitto Han[2,3,4], Benjamin Piot[6], Hermann Sellier[1], and Benjamin Sacépé[1] — [1]Univ. Grenoble Alpes, CNRS, Grenoble INP, Institut Néel, Grenoble, France — [2]SYNL, Chinese Academy of Sciences, P.R. China — [3]SMSE, University of Science and Technology of China, P.R. China — [4]State Key Laboratory of Quantum Optics and Quantum Optics Devices, SXU, P.R. China — [5]NIMS, Tsukuba, Japan — [6]LNCMI-CNRS-UGA-UPS-INSA-EMFL, Grenoble, France — [7]Physikalisches Institut and Würzburg-Dresden Cluster of Excellence ct.qmat, Univ. Würzburg, Germany

The ground state of charge neutral graphene under perpendicular magnetic field was predicted to be a quantum Hall topological insulator with a ferromagnetic order and spin-filtered, helical edge channels. In most experiments, however, an otherwise insulating state is observed and is accounted for by lattice-scale interactions that promote a broken-symmetry state with gapped bulk and edge excitations. We tuned the ground state of the graphene zeroth Landau level to the topological phase via a suitable screening of the Coulomb interaction with a SrTiO3 high-k dielectric substrate. We observed robust helical edge transport emerging at a magnetic field as low as 1T and withstanding temperatures up to 110K over micron-long distances [1]. This new and versatile graphene platform opens new avenues for spintronics and topological quantum computation. [1] Veyrat et al., arXiv:1907:02299

30 min. break

HL 80.5 Fri 11:00 POT 51

2-dimensional superconductivity in the Weyl Semi-metal trigonal-PtBi2 — •Arthur Veyrat — IFW, Dresden, Germany

PtBi2 has attracted attention in recent years with the discovery of the unsaturated Extremely Large Magnetoresistance (XMR) (11.2M % at 33T) in its pyrite structure. In this talk, I will report on our study of quantum transport in exfoliated microstructures of trigonal-PtBi2, patterned using usual e-beam lithography techniques. I will report on the discovery of superconductivity at very low temperatures (~300mK) in this compound, as well as the fitting of our measurements of the microsctructures by a 2D superconductivity model.

HL 80.6 Fri 11:15 POT 51

Anomalous Floquet Anderson Insulators in Quantum Hall Systems — •Hui Liu[1], Ion Cosma Fulga[1], and Janos Asboth[2] — [1]IFW Dresden and Wrzburg-Dresden Cluster of Excellence ct.qmat, Helmholtzstrasse 20, 01069 Dresden, Germany — [2]Institute for Solid State Physics and Optics, Wigner Research Centre for Physics, Hungarian Academy of Sciences, H-1525 Budapest P.O. Box 49, Hungary

Recently, the anomalous Floquet Anderson insulator (AFAI) has attracted significant attention due to its coexistence of chiral edge modes and fully localized bulk. Here we study how an AFAI may be obtained by periodically kicking a quantum Hall system, without using multiple-step, periodic driving procotol. By computing the conductance and topological invariant of the system, we find that the AFAI phase survives even in the strong disorder limit. Our results are general, and therefore applicable to a variety Floquet topological systems, and may provide a more accessible way to construct AFAIs in cold atom experiments.

HL 80.7 Fri 11:30 POT 51

Proximity-Induced Superconductivity in top-down fabricated bulk-insulating TI nanowires — •Matthias Rössler, Dingxun Fan, Junya Feng, Andrea Bliesener, Gertjan Lippertz, Alexey Taskin, and Yoichi Ando — II. Physikalisches Institut, Universität zu Köln, Zülpicher Str. 77, D-50937 Köln, Germany

With proximity-induced superconductivity, bulk-insulating topological insulator nanowires (TINWs) are expected to serve as a robust platform for realizing Majorana bound states (MBSs). Thanks to their predicted non-Abelian exchange statistics, MBSs could enable realizations of topological quantum computation schemes. In previous reports, TINWs grown by the usual vapour-liquid-solid (VLS) method offer limited possibilities for device layouts and their finite bulk transport contribution yet showed potential for improvements.

We have been performing fabrication of TINWs based on an alternative and scalable approach, namely, etching of bulk-insulating MBE-grown high-quality $(Bi_{1-x}Sb_x)_2Te_3$ thin films. So far, we have been able to prepare such top-down TINWs with a quality close to that of the pristine films and to achieve high gate tuneability. However, proximity-induced superconductivity was never achieved in such systems. In this presentation, we report our success in observing proximity-induced superconductivity in these TINWs and present our characterizations based on Josephson junctions. These results enable further studies on narrower TINWs with quantized 1D surface subbands, which could potentially host MBS when proximitized.

HL 80.8 Fri 11:45 POT 51

Measurements of large density of states in 2D systems: case of narrow HgTe quantum wells — •Aleksandr Kuntsevich[1], Grigorii Minkov[2], Nikolai Mikhailov[3], and Sergei Dvoretsky[3] — [1]P.N. Lebedev Physical Institute, Moscow, Russia — [2]Ural Federal University,Ekaterinburg, Russia — [3]Institute of Semiconductor Physics, Novosibirsk, Russia

For heavy carriers, mobility and cyclotron splitting are small, magneto-oscillations are damped, and it is hard to access experimentally the density of states or effective mass. Narrow HgTe quantum wells serve as a model system. The valence band in such structures contains well-conductive Dirac-like light holes at the Γ point and poorly conductive heavy hole subband located in the local valleys.

We propose and employ two methods to measure the density of states for these heavy holes. The first method uses a gate-recharging technique to measure thermodynamical entropy per particle. As the Fermi level is tuned with gate voltage from light to heavy subband, the entropy increases dramatically, and the value of this increase gives an estimate for the density of states. The second method determines the density of states for heavy holes indirectly from the gate voltage dependence of the period of the Shubnikov-de Haas oscillations for light holes. The results obtained by both methods are in the reasonable agreement with each other. Our approaches can be applied to measure large effective carrier masses in other two-dimensional gated systems.[To be published in PRB]