HL 47: Quantum Hall Effect

Time: Wednesday 9:30–11:45 Location: H14

HL 47.1 Wed 9:30 H14

Impact of the dynamically tuned 2DEG density on the photoluminescence of modulation-doped CdTe and CdMnTe quantum wells — •Janina Rautert[1], Dion Braukmann[1], Jörg Debus[1], Vitalii Yu. Ivanov[2], Dmitri R. Yakovlev[1,3], Grzegorz Karczewski[2], Tomasz Wojtowicz[2], and Manfred Bayer[1,3] — [1]Experimentelle Physik 2, Technische Universität Dortmund, 44227 Dortmund, Germany — [2]Institute of Physics, Polish Academy of Sciences, 02668 Warsaw, Poland — [3]Ioffe Institute, Russian Academy of Sciences, 194021 St. Petersburg, Russia

A highly concentrated two-dimensional electron gas (2DEG) in a modulation-doped semiconductor quantum well (MDQW) shows many interesting features in both transport measurements and optical spectroscopy, like the integer and fractional quantum Hall effect (QHE). It is known that the formation of trion and exciton complexes in a MDQW strongly depends on the 2DEG density, which can be controlled by the laser power and its energy as well as by an external magnetic field. We study the competition between the 2DEG and negative trion photoluminescence (PL) in the stationary and time-resolved regime (showing up for several hundreds of μs) for a CdTe MDQW at different magnetic fields. By comparison, in a CdMnTe MDQW the exciton magneto-PL shows variations in the energy for transitions between different QHE regimes at elevated temperatures above 1.5 K. Moreover, the 2DEG and exciton PL lines may anticross at different points of time with increasing magnetic field.

HL 47.2 Wed 9:45 H14

Terahertz induced oscillations of magnetoresistivity in AlGaAs/GaAs quantumwells (QW) — •Tobias Herrmann[1], Ze Dong Kvon[2], Dmitriy A. Kozlov[2], Vasily V. Bel'kov[3], Bruno Jentzsch[1], Martin Schneider[1], Peter Olbrich[1], Dominique Bougeard[1], Dieter Weiss[1], and Sergey D. Ganichev[1] — [1]University of Regensburg, Regensburg, Germany — [2]Institute of Semiconductor Physics, Novosibirsk, Russia — [3]Ioffe Institute, St. Petersburg, Russia

We report on the observation of MIRO-like oscillations (Microwave Induced Resistivity Oscillations) in GaAs-based two dimensional electron systems (2DES). The 1/B periodic oscillations are detected in corbino disk very low and high mobility QW samples excited by radiation with $f = 0.69$ THz. Strikingly we observe that the oscillations* amplitudes, in contrast to cyclotron resonance (CR), only slightly depend on the radiation helicity, even in the vicinity of CR. This result is insofar important that existing theories predict the amplitude of MIRO to depend on the helicity of the circular polarization via the factor $1/[(\omega \pm \omega_c)^2 + 1/\tau^2]$, where the minus (plus) sign corresponds to active (inactive) polarization[1]. Furthermore, scanning the beam across the sample with the beam size smaller than the corbino disc diameter we observed that the oscillations are excited in the 2DES and not at the structure edges. This observation demonstrates that edge effects caused by pondermotive forces[2] are not responsible for the observed MIRO-like oscillations. [1] Dmitriev et al., Rev. Mod. Phys., 84. 1709 (2012) [2] Mikhailov, Phys. Rev. B, 89, 045410 (2014)

HL 47.3 Wed 10:00 H14

GaSb/InAs double quantum wells for Topological Insulator application — •Maximilian Schwarz[1], Georg Knebl[1], Pierre Pfeffer[1], Monika Emmerling[1], Lukas Worschech[1], Sven Höfling[1,2], and Martin Kamp[1] — [1]Technische Physik and Wilhelm Conrad Röntgen Research Center for Complex Material Systems, University of Würzburg — [2]SUPA, School of Physics and Astronomy, University of St. Andrews, St. Andrews KY16 9SS, United Kingdom

The topological insulator phase is theoretical predicted for InAs/GaSb double quantum wells (DQW) embedded in AlSb barrier layers. In HgTe/CdTe-QW structures the transition between the normal and the topological insulator state can only be achieved by variation of the QW-thickness. For InAs/GaSb-DQW structures it is shown that one can tune between trivial and topological phase by front and back gates. Dry and wet etching as well as optical and electron beam lithography were used and compared processing structures. Transport data for differently processed samples will be compared and reversible switching majority carriers from electrons to holes by optical doping will be shown.

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HL 47.4 Wed 10:15 H14

Probing magnetic nanostructures with non-diffusive Hall crosses — •Stefan Fasbender[1], Jakob Schluck[1], Mihai Cerchez[1], Thomas Heinzel[1], Klaus Pierz[2], Sibylle Sievers[2], and Hans Werner Schumacher[2] — [1]Heinrich Heine Universität Düsseldorf — [2]PTB Braunschweig

Hall sensing is performed on a localized magnetic field pattern using a Hall cross device that can be tuned from diffusive to ballistic by decreasing the temperature. As the ballistic regime is entered, the Hall resistance develops a pronounced peak as a function of the magnetic field amplitude. This non-monotonic response exemplifies qualitatively the failure of conventional Hall sensing with ballistic Hall crosses. It is shown that the magnetization can still be determined from such measurements by a numerical correction based on the Landauer-Buettiker model as long as the functional form of the magnetic field profile is known.

30 min. Coffee Break

HL 47.5 Wed 11:00 H14

Narrow-gap semiconductor nanostructures in the quantum Hall regime — •Olivio Chiatti[1], Christian Riha[1], Johannes Boy[1], Sergio Pezzini[2], Steffen Wiedmann[2], Christian Heyn[3], Wolfgang Hansen[3], and Saskia F. Fischer[1] — [1]Novel Materials Group, Humboldt-Universität zu Berlin, 12489 Berlin, Germany — [2]High Field Magnet Laboratory, Radboud University Nijmegen, 6525ED Nijmegen, The Netherlands — [3]Institut für Angewandte Physik, Universität Hamburg, 20355 Hamburg, Germany

The quantum Hall edge channels (QHECs) are crucial for our understanding of the underlying physics of the quantum Hall effect (QHE). Our experimental work has been directed at studying the role of spin-orbit interaction (SOI). We have combined quantum point contacts (QPCs) with in-plane gates and Hall-bars in a narrow-gap semiconductor heterostructure with strong SOI. The constriction was fabricated by micro-laser photolithography and wet-chemical etching from an InGaAs/InAlAs quantum well with an InAs-inserted channel [1]. We have performed transport measurements at temperatures down to 300 mK in the combined QPC and Hall-bar structures in magnetic fields perpendicular to the 2DEG up to 33 T. We observe conductance quantization through the QPC when QHECs are formed. We investigate the effect of symmetric and asymmetric in-plane gate voltages on the transport by QHECs through the QPC.

[1] Chiatti *et al.*, Appl. Phys. Lett. **106**, 052102 (2015).

HL 47.6 Wed 11:15 H14

Coupling non-equilibrium transport and the stationary many particle Fermi Sea for numerical modelling of the integer quantum Hall effect regime — •Josef Oswald[1] and Rudolf Römer[2] — [1]Institute of Physics, Leoben University, Franz Josef Str. 18, A-8700, Leoben, Austria — [2]Department of Physics, University of Warwick, Coventry CV4 7AL, UK

Even 35 years after discovery, the quantum Hall effect (QHE) remains an interesting and still challenging topic of research. The challenge of modelling experiments in the QHE regime is the need of a link between the Fermi Sea as a stationary many particle quantum state and the experimentally injected non-equilibrium.

This is handled by two modules : One addresses the stationary many particle Fermi sea on the basis of a self-consistent numerical Hartree-Fock (HF) approach and the other addresses the non-equilibrium electron transport by a network approach. It allows us to simulate directly the distributions of the experimentally injected non-equilibrium potentials at arbitrary contact configurations in arbitrarily shaped sample geometries, including native and artificial in-homogeneity. The associated resistances need to be calculated only in a post processing step like it is also the case in real experiments. The screening behaviour of the electron system is addressed by the HF module that allows seeing effects like filling factor dependent screening, Landau-level broadening and enhanced g-factor. These effects enter the properties of the trans-

port module and allow a modelling that is much more close to real systems and real experiments then most of other models.

HL 47.7 Wed 11:30 H14

The Physics of the Integer and Fractional Quantum Hall Effects — •Horst Jürgen Andrä — Former member of Institut für Kernphysik, Universität Münster, Wilhelm-Klemm-Str. 9, 48149 Münster

A framework is presented for the understanding of both the Integer(I)- and the Fractional(F)-Quantum Hall Effect (QHE), including the widths of their plateaus. It is based on the condition of neutrality which enforces any change in the population of the 2-Dimensional Electron System (2DES) to also occur in an adjacent positive 2-Dimensional Hole Layer (HL). The near perfect exchange between the 2DES and the HL allows the description of the IQHE independent of any potential distribution across the 2DES. When on the contrary the HL is nearly constant for all magnetic fields then also the number of electrons in the 2DES has to be nearly constant for all magnetic fields. This is the condition for the description of all ever observed FQHE-signals as the result of a spatial electron and magnetic flux quantization. Experiments are proposed to proof these descriptions. The particular ν=5/2-, 7/2-, 9/2-, etc. FQHE states are interpreted as due to inter-Landau electron-electron interactions with specific selections rules. Tilted field experiments can be interpreted in terms of symmetry breaking. Hints on the origin of the reentrant integer quantum Hall states are given. For more details see DOI: 10.13140/RG.2.1.3864.7766