interference of hot electrons in a Mach-Zehnder geometry, where phonon emission gives rise to a significant source of decoherence. Here we show how phonon-induced decoherence grows with increasing magnetic field and separation between the two arms of the interferometer. Understanding how coherence is lost, and hence how these effects can be mitigated, is vital for the development of quantum technologies, such as quantum metrology, using these techniques.

P1_198 Simulation of Spatiotemporal Wave Packet Dynamics and Capture Processes in Semiconductor Heterostructures

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Text As the technological possibilities move further into nanometric length and subpicosecond time scales, quantum mechanical descriptions of transport phenomena become more and more important. As an example for a process occurring on those scales we study the localized photoexcitation of carriers and subsequent capture processes in a semiconductor heterostructure. To be specific, we consider a 1D GaAs quantum wire and an embedded 0D quantum dot. When optically exciting carriers in the quantum wire far from the dot with a localized low intensity pulse, electron and hole wave packets are formed which then travel towards the dot where they can be captured by emission of longitudinal optical phonons. The main feature of the capture process is its local nature because the carriers can only be captured when they are in the vicinity of the quantum dot. We treat this problem in a density matrix formulation where all diagonal and non-diagonal matrix elements have to be considered to account for locality. The description of the phonon-induced carrier capture is treated by a Markovian Lindblad single-particle (LSP) equation of motion, which has been shown to efficiently describe capture processes when compared to quantum kinetic studies[1]. We further simulate localized pump-probe signals in order to see if the capture dynamics can be monitored in optical signals. Indeed we find that the capture dynamics can be well extracted from the pump probe spectra at the frequencies of the quantum dot transitions. [2] Because for a correct description of optical spectra in semiconductors the Coulomb interaction plays a vital role, the question arises how the wave packet dynamics changes when the carrier densities are increased. While in homogeneous systems only the Fock contributions exist and give rise to excitonic effects, in inhomogeneous systems the Hartree contributions give rise to an electrostatic potential due to charge imbalance. At high carrier densities the latter becomes important and we show how this alters the wave packet dynamics and capture efficiencies. [1] R. Rosati, D. E. Reiter, and T. Kuhn, Phys. Rev. B 95, 165302 (2017) [2] F. Lengers, R. Rosati, T. Kuhn, and D.E. Reiter, Acta Physica Polonica A 132, 372 (2017)

P1_199 Remotely sensed microwave reflection in the photo-excited GaAs/AlGaAs 2D electron system

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Text Microwave-induced zero-resistance-states in the photo-excited high quality GaAs/AlGaAs system evolve from the minima of microwave photo-excited 1/4-cycle shifted magnetoresistance oscillations.[1] Such magnetoresistance oscillations are known to exhibit nodes at cyclotron resonance, and cyclotron resonance harmonics. The effective mass extracted from the radiation-induced magnetoresistance oscillations is known to differ from the standard effective mass ratio for electrons in the GaAs/AlGaAs system.[1] To identify the origin of this difference, we have looked for cyclotron resonance (CR) in the microwave reflection from the high mobility 2DES and attempted to correlate the observations with observed oscillatory magnetoresistance over the $30 < f < 330$ GHz band. For linearly polarized microwave/terahertz photo-excitation over the examined frequency band, experiments indicate strong reflection resonance on both sides of the magnetic field axis. In addition, there is evidence for electronic heating in the vicinity of CR, which is indicated by a reduced amplitude of the Shubnikov-de Haas oscillations. Such results are correlated here to extract the cyclotron effective mass at low magnetic fields and high filling factors in the GaAs/AlGaAs 2D system. Further, this cyclotron effective mass is compared with the effective mass determined from the radiation-induced magnetoresistance oscillations. References [1] R. G. Mani, J. H. Smet, K. von Klitzing, V. Narayanamurti, W. B. Johnson, V. Umansky, Phys. Rev. Lett. 92, 146801(2004).

P1_201 Electron transit time and AC measurements in quantum Hall conductors

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Text In a two dimensional electron gas, low energy transport in presence of a magnetic field occurs in chiral 1D channels located on the edges of the sample. In the Buttiker's description of a.c. quantum transport [1], the emittance determines the amplitude of the imaginary part of the admittance, whose sign and physical meaning are determined by the topology: in the case of an Hall bar the emittance is an inductance [1,2], while it is a capacitance in the case of a corbino sample [1]. Emittance is related to the density of states and to the drift velocity of carriers. So quantum capacitances and inductances give the lower bound of the access time to nano circuits. More, inner capacitances affect the metrological measurement of the von Klitzing constant in the Ohm's metrology [3]. We performed systematic studies on samples with different topologies : Hall bars and Corbino disks. Our samples have no gate, which make us able to observe the inner properties of the quantum states. We have measured the ac admittance of quantum Hall samples using standard electrical techniques in the [0.1-100] kHz frequency range, at low temperature under high magnetic field. We measured kinetic inductances of Hall bars - as it is done in supraconductors- and quantum capacitances of Corbino disks. We show the proportionnality between the emittance and the density of states. We obtain the transit time of electrons through the device, and the drift velocity on edge states

P1_202 2D Rutherford-like scattering inside a ballistic semiconductor nanodevice

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Text The famous Rutherford formula constitutes one of the most fundamental descriptions of the interaction between a beam of particles and a scatterer, as it links in a simple way the differential cross section to the scattering angle and energy of incident beam. This formula has been extensively used in high energy physics, where the situation is ideal : particles propagate in vacuum, only interact with the scatterer, and measurement of the differential cross section can be made with high precision, if one uses a large number of detectors around the interaction region. The question that we want to tackle here is : is it possible to reach such an ideal description, i.e. analog to Rutherford scattering, in the case of electron scattering inside a solid state semiconducting device ? Here, we address this question by studying a nanoring-like geometry with two entrances, patterned within a two-dimensional electron system, where charge transport occurs in the ballistic regime at low temperature. In a semiclassical view, most electrons entering the dot bounce against the central antidot as soon as they enter in the ring through the entrance lead. We use the tip of a scanning gate microscope to tune the electrostatic potential in the vicinity of this central antidot, in front of the ring entrance lead, and therefore tune the scatterer. As we gradually deplete this region by applying a negative voltage on the tip, we suprisingly find that the ring conductance significantly increases. Conversely, as a positive voltage on the tip tends to accumulate charges in the vicinity of the antidot, the conductance significantly decreases. This anomalous behaviour is reproduced in tight-binding simulations of transport through a device with the same geometry. Plotting the current density distribution in the device, we find that a tip-induced repulsive potential redirects current towards the ring arms, while an attractive potential focuses current lines towards the antidot hard wall, which then enhances scattering and reflection back to the entrance lead. Scanning gate experiments on a ballistic QR, and simulations of the conductance of the same device, both agree to show that the new effect is proportional to the ratio between the strength of the perturbation and the Fermi energy. This rule is analog to the prediction of Rutherford formalism in two-dimensions in the classical limit.

P1_203 Interplay between weak localization and antilocalization in graphene: non-diffusion theory.

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Text Recent studies of perfect graphene layers gave a new impulse for experimental and theoretical investigation of two- and three-dimensional structures with the linear energy spectrum of the carriers. This dependence leads to the weak antilocalization (WAL) and positive magnetoresistance in classically weak magnetic fields if all relaxation processes take place inside one dispersion cone [1,2]. As long as the zero of the energy in graphene is located at the Brillouin zone boundary in K point, a significant role in transport phenomena is also played by the intervalley transitions between equivalent points K and K' which are connected by the time inversion. It leads [3] to the weak localization (WL) when the phase relaxation time in each valley is larger than the intervalley transition time. The ratio of these times in graphene may be controlled by changing the gate bias. Calculations of the weak localization in two-dimensional graphene layers were performed for the whole range of a classically weak magnetic field with an account on intervalley transitions [4]. Theory demonstrates the transition from WAL to WL under the change of the concentration and explains recent experimental works [5]. Contribution to the quantum correction which stems from closed trajectories with few scatterers is carefully taken into account. For the first time we develop the non-diffusion theory for the Dirac spectrum and show that intervalley transitions leads to the transition from WAL to WL and nonmonotonous dependence of the conductivity on the magnetic field. [1] E. McCann, K. Kechedzhi et al, Phys. Rev. Lett. 97, 146805 (2006). [2] M. O. Nestoklon, N. S. Averkiev, S. A. Tarasenko, Solid State Communications 151, 1550 (2011). [3] M. O. Nestoklon and N. S. Averkiev, EPL (Europhysics Letters) 101, 47006 (2013). [4] M. O. Nestoklon and N. S. Averkiev, Phys. Rev. B 90, 155412 (2014). [5] G. Yu. Vasileva et al., APL 110, 113104 (2017).

P1_204 Landau levels in HgTe quantum well - system with strong spin-orbit

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Text CgHgTe/HgTe/CdHgTe quantum wells due to strong relativistic effects caused by large Hg mass, differ a lot from other known quantum wells based on semiconductor heterostructures. Thus HgTe quantum wells are known to have different energy spectra and properties depending on a well width [1]: it is an ordinary insulator at width d<6.3nm; it has linear spectrum of so called Dirac fermions at d~6.3nm; inverted spectrum being 2D topological insulator at d>6.3nm; semimetallic spectrum with a small overlap between the conduction and valence bands at d~20nm; finally at width d>70nm it is 3D topological insulator [2]. Our work is devoted to the investigation of wide (20-22nm) HgTe quantum wells, known to have inverted spectrum and thus strong spin-orbit coupling in the conduction band. We were interested in conduction band Landau levels behavior and found their non-trivial behavior with magnetic field increase: Landau levels non-degenerated at low magnetic field (~1T) come closer to each other with magnetic field increase and then degenerate (at ~2.5T). We have calculated Landau levels by 6-band Kane model and found the same behavior. To clarify the reason of Landau levels shift we have use the semiclassical approach. We have found that electron phase changes with energy increase due to mixing the first hole-like conduction band states with total momentum 3/2 (due to inverted band structure) with states of the second conduction band, which is trivial and has momentum 1/2. Electron phase change result in change of Landau levels energy and thus their shift occurs. [1] Raichev, PRB 85, 045310 (2012). [2] Bernevig et al., Science 314, 1757 (2006); Konig et al., Science 318, 766 (2007); Buttner et al., Nat. Phys. 7, 418 (2011); Kvon et al., JETP Letters 87, 588 (2008); Brune et al., PRL 106, 126803 (2011).

P1_205 Pushing photons with electrons: observation of the polariton drag effect

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Text We have observed a drag effect of electrons on photons. In a semiconductor microcavity, the polariton effect in strong coupling means that photons spend part of their time as excited electron-hole pairs (excitons), which recoil from collisions with moving electrons and then impart that momentum to the photons. We see a definite shift of the momentum of the emitted photons when an electrical current is passed through the polariton population. Our experiments use quantum wires for the polaritons which allow long-distance transport over 100 microns, made possible both by the high quality of our structures and by the coherent transport of the polaritons in the regime in which the polaritons can be described as a Bose-Einstein condensate. This allows us to perform velocity measurements of the polaritons over a long distance. In this regime, we also see evidence for a critical velocity of the polaritons that depends on their density.

P1_206 A Platform for Edgeless and Purely Gate-Defined Nanostructures in InAs Quantum Wells

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Text Due to its high spin-orbit interaction and low effective mass, indium arsenide (InAs) is a semiconductor material of high interest for nanostructures by itself, or in conjunction with superconductors for realizing predicted topological states. At the surface of InAs the Fermi level is pinned in the conduction band, which leads to carrier accumulation there. Fabricating structures in a two-dimensional electron gas (2DEG) in a semiconductor heterostructure for mesoscopic transport usually requires etching in order to define a mesa geometry. This creates new surfaces along the sidewalls of the etched geometry. In the case of InAs quantum wells (QWs) however, these sidewalls show a carrier accumulation and thus form conductive channels, recently measured and termed trivial edge states [1-3]. Using standard semiconductor nanofabrication techniques in order to form nanostructures such as quantum point contacts (QPCs) or quantum dots (QDs) is therefore not feasible, as it is being hindered by the parasitic parallel conduction. Here we show a new technique to circumvent the aforementioned issue of trivial edge conduction and define nanostructures exclusively by electrostatic gating. A large rectangular frame gate (FG) separated from the wafer surface by a dielectric layer is employed that, much like in a Corbino disk geometry, defines an inner and an outer part of the chip. Ohmic contacts are fabricated on the inner part of the FG. A second dielectric layer allows to employ another layer of gates on top, which can be used to electrostatically define QPCs or QDs without any parallel conduction. This is shown by measuring the current as a function of the voltage applied to a pair of split gates, which drops to zero once full pinch-off is reached. Multiple resonances are observed, which form plateaus under applied magnetic field. In conclusion we present that full electrostatic definition of nanostructures in InAs QWs is possible by employing a FG geometry. This opens the path to observing quantized conduction through QPCs in an InAs 2DEG without parallel conduction, as well as to performing experiments on single electrons trapped in QDs. This can pave the way for manipulating their states, exploiting the high spin-orbit interaction and observing topological phenomena. [1] Mittag et al., APL 111, 082101 (2017) [2] Mueller et al., PRB 96, 075406 (2017) [3] De Vries et al., PRL 120, 047702 (2018)

P1_207 Direct probing and manipulation of the nuclear spins in individual II-VI CdTe/ZnTe quantum dots

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Text Nuclear spin fluctuations in III-V quantum dots (QDs) have plagued the electron spin coherence in dense nuclear spin baths such as InGaAs/GaAs QDs. The II-VI QD system offers an attractive alternative, since the majority of nuclei have no spin (I = 0), while the electronic and optical properties are comparable with III-V QDs. Due to the small effective field from the nuclei felt by the electron (Overhauser field), experimental observations of nuclear spin effects are challenging and so far were limited to indirect detection via the electron spin polarization rate (Le. Gall et al., 2012). Understanding the properties and developing the techniques for nuclear spin manipulation is thus required in order to develop II-VI materials as a platform for QD spin qubits with dilute nuclear spin baths. Here we present the first direct observation of the Overhauser field in single CdTe/ZnTe self-assembled QDs, by detecting the change in splitting of the neutral exciton (X0) Zeeman doublet. Overhauser shifts of up to +/-2 ueV are detected but only in a sample containing a quantum well (QW), which suggests that the QW states play a crucial role in the generation of DNP. The dilution leads to significantly faster nuclear spin dynamics: the nuclear spin build-up time is found to be 1.1 ms and the lifetime of the resulting polarization is T1 = 1.6 s. Finally, optically detected nuclear magnetic resonance (ODNMR) experiments were performed and resolution limited NMR peaks were observed for both Cd and Te isotopes. The peak was accompanied by a broad tail, which is a sign of strong inhomogeneous broadening likely due to charge fluctuations. Our experiments are the first demonstration of manipulating the nuclear spin bath in a single II-VI QD with both optical and radio-frequency fields and is a first step towards developing QD spin qubits in nuclear-spin-free materials.

P1_208 Interplay between localization and magnetism in (III,Mn)V dilute ferromagnetic semiconductors

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Text Although the interplay between hole-mediated ferromagnetism and hole localization has long been recognized as the central issue in dilute ferromagnetic semiconductors (DFSs), its understanding remains in a nascent stage and contradicting approaches are under consideration [1]. Some of the difficulties lie in the sample preparation: the dual role of Mn in III-V (providing spins and holes), the poor control over donor defects. In this contribution, we examine the influence of localization on the hole-mediated ferromagnetism in (III,Mn)V by utilizing the well-developed ion-beam technology for microelectronics which can overcome the aforementioned difficulties [2]. First, we have used ion implantation of Mn combined with pulsed laser melting to prepare Ga1-xMnxAs and In1-xMnxAs with x from 0.3% to 1.8% covering both sides of the insulator-metal transition [3]. The system evolves with x from a paramagnetic phase, to a superparamagnetic material, to reach, via a mixed phase consisting of percolating ferromagnetic clusters and superparamagnetic grains, a global ferromagnetism. On the insulating side, ferromagnetic signatures persist to higher temperatures in In1-xMnxAs compared to Ga1-xMnxAs with the same x. This substantiates theoretical suggestions that stronger p-d coupling results in an enhanced contribution to localization, which reduces hole-mediated ferromagnetism. Second, we use inert Helium ions to precisely compensate holes by donor defects, thereafter to shift the Fermi energy in DFSs while keeping x constant [4]. For a broad range of samples, we observe a monotonous decrease of Curie temperature TC down to zero and a spin-reorientation transition with hole compensation while the conduction is changed from metallic to insulating. The previously questioned existence of TC below 10 K is also confirmed in heavily compensated samples. Our comprehensive results support the heterogeneous model of electronic states at the localization boundary and point to the crucial role of weakly localized holes in mediating spin-spin interactions even on the insulator side of the metal-insulator transition. [1] M. Sawicki, et al.,Nat. Phys. 6, 22 (2010), M. Kobayashi, et al., PRB 89, 205204 (2014). [2] SZ, JPhysD 48, 263001 (2015) [3] SZ et al., APEX 5, 093007 (2012), JPhysD 48, 235002 (2015), PRB 92, 224407 (2015), PRM. 1, 054401 (2017), JPCM 30, 095801 (2018). [4] SZ, et al., JPhysD 44, 099501 (2011), PRB 95, 075205 (2016), PRB 97, 054413 (2018), JPhysD in press (2018).

P1_210 Electrical initialization of electron and nuclear spins in a single quantum dot at zero magnetic field

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Text The emission of circularly polarized light from a single quantum dot relies on the injection of carriers with well-defined spin polarization. Here we demonstrate single dot electroluminescence (EL) with a circular polarization degree up to 35% at zero applied magnetic field. This highly efficient electrical injection of spin polarized electrons is achieved by combining ultrathin CoFeB electrodes on top of a spin-LED device with p-type InGaAs quantum dots in the active region [1].