7 NCCR NANO

Monday, 21.06.2010, Room 118

Time	ID	NANO I: Theory of Quantum Systems *Chair: B. Braunecker jr., Uni Basel*
13:30	701	**Spin transport in insulating magnets** *Kevin van Hoogdalem, Daniel Loss* *Departement Physik, Universität Basel, Klingelbergstrasse 82, 4056 Basel* The dissipation of energy in electronic devices is a generally undesired effect resulting from the transport of charges. In the field of spintronics, however, this effect can be avoided: Spin can be transported without involving moving charges. An example is the transport of magnetic moments in insulating spin chains. Here we propose the spin analogue in such insulating systems of a component that is widely used in electronic devices, the diode. We analyze both ferro- and AF-spin chains between two magnetic reservoirs. In the former case we use a spin-wave description, in the latter case the system allows a Luttinger Liquid formulation. Using non-equilibrium methods we find that we can design the diode either by tuning the coupling parameters in the chain such that the system is in a gapped phase at half-filling, and work at the edge of this gap to achieve the required rectifying effect, or alternatively we can introduce an impurity which flows to strong coupling at low energies to achieve the rectifying effect.
13:45	702	**Energy relaxation in Coulomb coupled edge channels** *Simon Nigg, University of Geneva, 24 Quai Ernest Ansermet, 1211 Genf* In the integer quantum Hall effect regime, there exist extended chiral states at the edges of the sample. In a non-interacting picture, electrons can propagate freely along such edge channels, which can be viewed as electronic waveguides. The latter are of interest for fundamental experiments on electron interferometry in solids (quantum optics with electrons). However, due to their charge, electrons couple to each other. We investigate the effect of inter-edge channel Coulomb interaction on the energy distribution function of two co-propagating channels [1,2]. The outermost channel is put out of equilibrium at a quantum point contact (QPC), after which it is allowed to interact with an inner channel. We calculate the energy distribution as a function of distance away from the QPC and compare our results with a recent experiment. [1] A. M. Lunde, S. E. Nigg and M. Buttiker, Phys. Rev. B 81, 041311(R) (2010) [2] C. Altimiras et al, Nature Physics 6, 34 (2009)
14:00	703	**Perturbative Schrieffer-Wolff transformation and the Kitaev model** *Fabio Pedrocchi , Daniel Loss* *Departement Physik, Universität Basel, Klingelbergstrasse 82, 4056 Basel* The aim of the present work is to apply the perturbative Schrieffer-Wolff procedure, a unitary transformation which brings a Hamiltonian into block-diagonal form giving an effective Hamiltonian in a smaller Hilbert space, to a general class of discrete Hamiltonians and calculate the effective low-energy Hamiltonian up to fourth order. As an example, we show that our calculation can be applied to the problem of

		establishing the equivalence between the Kitaev model and the toric code up to fourth order in perturbation theory. This is an alternative solution to the Green's function formalism originally used by Kitaev.
14:15	**704**	**Mesoscopic Coulomb drag, broken detailed balance and fluctuation relations** *Rafael Sánchez [1], Rosa López [2], David Sánchez [2], Markus Büttiker [1]* *[1] Département de Physique Théorique, Université de Genève, 24, quai E. Ansermet, 1211 Genève* *[2] Departament de Fisica, Universitat de les Illes Balears, Palma de Mallorca, Crta. Valldemossa km. 7.5, ES-07122 Palma de Mallorca* The fluctuations in one system can be enough to induce a finite response in another system that, not being externally forced, interacts with the first one. In electric transport, a direct current is obtained in an unbiased conductor which is capacitively coupled to a biased one. This effect is known as Coulomb drag. For that, detailed balance must be broken by an asymmetry in the drag system. We propose a minimal four-states model consisting in two capacitively coupled quantum dots, where drag induced current cross-correlations allow to verify non-equilibrium fluctuation relations [1]. [1] R. Sánchez, R. López, D. Sánchez, and M. Büttiker, Phys. Rev. Lett. 104, 076801 (2010).
14:30	**705**	**Edge states and enhanced spin-orbit interaction at graphene/graphane interfaces** *Manuel Schmidt, Daniel Loss* *Departement Physik, Universität Basel, Klingelbergstr. 82, 4056 Basel* We study interfaces between graphene and graphane, a hydrogenated version of graphene. If the interface is oriented along a zigzag direction, edge states are found hor the two possible interface types (if the graphane region is removed from the interface, the resulting graphene edge may be bearded or not). These edge states at graphene/graphane interfaces have, unlike edge states at structural graphene edges, a considerable bandwidth. Furthermore, we find a strong amplification of effects related to the spin-orbit interaction of the edge states (up to two orders of magnitude). The enhanced spin splitting of the edge states allows the construction of a device which is capable of converting spin-polarized electrons into valley-polarized electrons at temperatures near one Kelvin. We also show that these edge states give rise to quantum spin and/or valley Hall effects.
14:45	**706**	**On long-time Environment-induced Entanglement of bipartite Systems** *Maximilian Schultz, Dept. Physik, Uni Basel, Klingelbergstr. 82, 4056 Basel* As in recent years the possibility of a heat bath not only to destroy but also to create entanglement between two qubits has been investigated, I address the question under which circumstances, that is, properties of the system-bath coupling, finite entanglement can persist for long times. Particular attention is hereby given to the role of the Lamb shift and small detunings of the two qubits.

15:00	**707**	**Spin susceptibility of interacting two-dimensional electrons in the presence of Rashba spin-orbit coupling** *Robert Zak [1], Dmitrii Maslov [2], Daniel Loss [1]* *[1] University of Basel, Klingelbergstrasse 82, 4056 Basel* *[2] University of Florida, P.O. 118440, USA-Gainesville, FL 32611* A long-range interaction via virtual particle-hole pairs between Fermi-liquid quasiparticles leads to a nonanalytic behavior of the spin susceptibility as a function of the temperature (T), magnetic field (B), and wavenumber. We study the effect of the Rashba spin-orbit (SO) coupling on the nonanalytic behavior of the spin susceptibility of a two-dimensional electron liquid. We show that, although the SO coupling breaks SU(2) symmetry, it does not eliminate nonanalyticity but rather makes it anisotropic: while the linear scaling of χ_{zz} with T and $\|\mathbf{B}\|$ saturates at the energy scale set by the SO coupling, that of χ_{xx} ($=\chi_{yy}$) continues through this energy scale. An immediate consequence of SO-induced anisotropy is a possible instability of a second-order ferromagnetic quantum phase transition with respect to a first-order transition into an XY ferromagnetic state. We also discuss the renormalization of the backscattering amplitude in the Cooper channel derived both perturbatively and within the renormalization group theory framework.
15:15	**708**	**One-step Multi-qubit GHZ State Generation in a Circuit QED System** *Ying-Dan Wang, Stefano Chesi, Daniel Loss, Christoph Bruder* *Department of Physics, University of Basel, Klingelbergstrasse 82, 4056 Basel* We propose a one-step scheme to generate GHZ states for superconducting flux qubits or charge qubits in a circuit QED setup. The GHZ state can be produced within the coherence time of the multi-qubit system. Our scheme is independent of the initial state of the transmission line resonator and works in the presence of higher harmonic modes. Our analysis also shows that the scheme is robust to various operation errors and environmental noise.
15:30		***Coffee Break***
		NANO II: Nanomechanics *Chair: L. Marot, Uni Basel*
16:00	**711**	**Improved atomic scale contrast via bimodal dynamic force microscopy** *Shigeki Kawai, Thilo Glatzel, Sascha Koch, Bartosz Such, Alexis Baratoff, Ernst Meyer* *Department of Physics, University of Basel, Klingelbergstrasse 82, 4056 Basel* We incorporate bimodal DFM into atomically resolved FM-DFM for a further improvement of spatial resolution in ultra-high vacuum [1]. The first and second flexural resonance modes of a Si cantilever are simultaneously self-excited with given amplitudes (A1st and A2nd), and these resonance frequency shifts (df1st and df2nd) are demodulated by two PLL circuits. The combination of sub-angstrom A2nd with the commonly used large A1st enables high-resolution imaging at a closer tip-sample distance while avoiding atomic jump-to-contact instabilities. df2nd gives a more detailed information of the short-range interaction, like deforms of the tip and sample.

		In order to achieve further resolution, we use the flexural and torsional resonance modes [2]. Since non-site-dependent interaction causes no lateral interaction force, an extremely high sensitivity to the short-range interaction is achievable in the dfTR signal. and hence gives an atomically resolved image on Graphite(0001) at RT. [1] S. Kawai, et al., PRL103 220801 (2009). [2] S. Kawai, et al., PRB 81 085420 (2010).
16:15	**712**	**Non-contact friction measurements done with nc – AFM in the pendulum mode** *Marcin Kisiel, Urs Gysin, Laurent Marot, Ernst Meyer* *Institute of Physics, University of Basel, Klingelbergstrasse 82, 4056 Basel* The origins of friction are investigated by highly sensitive force microscopy in the pendulum geometry at separations of 1 - 5 nm and under ultra high vacuum (UHV) conditions. Ultra sensitive cantilevers oriented perpendicularly to the sample surface were used to probe non - contact friction on 1ML thick NaCl islands grown onto Cu(100) surface. The surface topography measurement together with Kelvin Probe Force Microscopy (KPFM) were done. Both allows to distinguish between metallic and insulating areas of the sample. The non - contact friction measurement shows a reduction of dissipation for the insulating state compared to the metal state. We also present temperature dependent friction measurements at separations of 1 - 5 nm on Nb-films in the region of metal-superconductor transition. Temperature dependent friction measurements across the critical temperature T_C of Nb films, reveal a reduction of dissipation in the superconductive state compared to the normal state by a factor 4. Therefore, electronic friction is found to be the dominant dissipation mechanism with power losses of $6 \cdot 10^{-20}$ W (70 meV / cycle) at separations of 1 - 5 nm.
16:30	**713**	**Size-dependent spin structures in supported iron nanoparticles** *Armin Kleibert [1], Arantxa Fraile Rodriguez [1], Joachim Bansmann [2],* *Andris Voitkans [3], Laura J. Heyderman [4], Frithjof Nolting [1]* *[1] Swiss Light Source, Paul Scherrer Institut, 5232 Villigen PS* *[2] Institut für Oberflächenchemie und Katalyse, Universität Ulm,* *Albert-Einstein-Allee 47, DE-89069 Ulm* *[3] Institut für Physik, Universität Rostock, Universitätsplatz 3, DE-18051 Rostock* *[4] Lab. for Micro- and Nanotechnology, Paul Scherrer Institut, 5232 Villigen PSI* Nanoscale magnets exhibit a variety of unusual phenomena when compared to respective bulk materials, particularly when the dimensions involved are comparable to critical magnetic length scales such as the exchange length. Below a critical size, the formation of domain walls is suppressed and the nanostructures are uniformly magnetized, i.e. in a single domain state. Using photoemission electron microscopy, we study the magnetization orientation in single 5 to 25 nm iron particles coupled to a ferromagnetic cobalt support. We find a non-collinear alignment between the particle and substrate magnetization above about 6 nm and a parallel alignment for smaller sizes. Numerical calculations reveal an exchange- to anisotropy-dominated transition on increasing the particle height: the smaller particles are in a single-domain collinear state while larger particles exhibit a spin-spiral magnetic structure determined by the magnetic anisotropy energy.

16:45	**714**	**Optomechanical Coupling of Ultracold Atoms and a Membrane** *Maria Korppi [1], Stephan Camerer [1], David Hunger [1], Andreas Jöckel [2], Matthias Mader [1], Philipp Treutlein [2], Theodor W. Hänsch [1]* *[1] Ludwig-Maximilians Universität München / Max-Planck Institut for Quantum Optics, Schellingstr. 4/III, DE-80799 München* *[2] Departement Physik, Universität Basel, Klingelbergstrasse 82, 4056 Basel* We report the recent results of our experiment, where we couple a single mode of a high-Q membrane-oscillator to the motion of laser-cooled atoms in an optical lattice. The optical lattice is formed by retroreflection of a laserbeam from the oscillator surface. Quantum fluctuations of the lattice laser light mediate coupling between the motion of the atoms and the membrane. When the trap frequency of the atoms is matched to the eigenfrequency of the membrane, the coupling leads to resonant energy transfer between the two systems. We have observed such resonant energy transfer both from the membrane to the atoms and, more significantly, the back-action of the atoms on to the membrane. In the long term, such coupling mechanism could be exploited in developing hybrid quantum systems between atoms and solid-state devices.
17:00	**715**	**Effect of Uniaxial Strain on Transport Properties of Silicon Nanowires** *Giorgio Signorello, Emanuel Lörtscher, Siegfried Karg, Bernd Gotsmann, Heinz Schmid, Mikael Björk, Walter Riess, Kirsten Moselund, Dirk Obergfell, Heike Riel* *IBM Research GmbH, Säumerstrasse 4, 8803 Rüschlikon* Strain engineering in CMOS technology is a common tool to increase charge-carrier mobility and transistor performance. In silicon nanowires (Si NWs), such effect may even be more significant because of their one-dimensional geometry. We have developed a technique that enables the electronic transport properties and the local strain induced on Si NWs to be measured as a function of mechanical stress. Si NWs are deposited, contacted on a flexible polymer/metal substrate and bent in a three-point bending mechanism to apply linear-uniaxial mechanical stress to the NWs. We characterize for different values of applied tensile and compressive stress, the transport properties through Si NWs by measuring 4-probe resistance, as well as the local strain of the Si NW by tracking the shift of the Raman peak. We will report on the effect of compressive and tensile strain effects for n- and p- doped Si NWs having different diameter.
17:15	**716**	**Surface-assisted cyclodehydrogenation – a synthetic route towards processable and chemically tailored nanographenes** *Matthias Treier [1], Carlo Pignedoli [1], Teodoro Laino [2], Daniele Passerone [1], Roman Fasel [1]* *[1] EMPA, Feuerwerkerstrasse 29, 3602 Thun* *[2] IBM, Säumerstrasse 4, 8803 Rüschlikon* Processability and the precise tailoring of graphene-derived structures such as nanoribbons and nanographenes are still a major hindrance on the way towards applications of graphene. We investigate on a surface chemical route that allows for the fabrication of tailored nanographenes on single crystal surfaces. The cyclodehydrogenation of the prototypical polyphenylene cyclohexaphenylene to tribenzocoronene on Cu(111) is studied by scanning tunneling microscopy as a model case. We find that the thermally induced cyclodehydrogenation proceeds via two intermediate steps which can both be stabilized on the Cu(111) surface,

		yielding detailed insight into a dehydrogenative intramolecular aryl-aryl coupling reaction. The experimental observations are rationalized by ab initio simulations. Two additional reaction intermediates, which are however not stable on Cu(111), are identified by the simulations. The possible use of surface-assisted cyclodehydrogenation in the production of chemically tailored nanographene structures will be outlined.
17:30	**717**	**Atomically precise bottom-up fabrication of graphene nanoribbon** *Jinming Cai [1], Pascal Ruffieux [1], Rached Jaafar [1], Marco Bieri [1], Thomas Braun [1], Stephan Blankenburg [1], Matthias Muoth [2], Ari Seitsonen [3], Moussa Saleh [4], Xinliang Feng [4], Klaus Müllen [4], Roman Fasel [1]* *[1] EMPA, Feuerwerkerstrasse 39, 3602 Thun* *[2] ETH Zürich, Dep. of Mechanical & Process Engineering, Tannenstr. 3, 8092 Zürich* *[3] Univ. of Zürich, Physical Chemistry Institute, Winterthurerstr. 190, 8057 Zürich* *[4] Max Planck Institute for Polymer Research, Ackermannweg 10, DE-55124 Mainz* Graphene nanoribbons (GNRs) are predicted to exhibit remarkable properties making them suitable for future electronic applications. Contrary to their two-dimensional parent material graphene, which exhibits semimetallic behaviour, GNRs with widths smaller than 10 nm are predicted to be semiconductors due to quantum confinement and edge effects. However, despite significant advances in GNR fabrication using chemical, sonochemical and lithographic methods, the production of sub-10 nm GNRs with chemical precision remains a major challenge. Here we report a simple GNR fabrication method that allows for the production of atomically precise GNRs of different topologies and widths. Our bottom-up approach consists in the surface-assisted coupling of suitably designed molecular precursors into linear polyphenylenes and their subsequent cyclodehydrogenation, and results in GNRs whose topology, width and edge periphery are exactly defined by the precursor monomers.
17:45	**718**	**Sumanene: Intermolecular interaction-driven bowl inversion** *Rached Jaafar [1], Pascal Ruffieux [1], Carlo Pignedoli [2], Oliver Gröning [1], Toshikazu Hirao [3], Roman Fasel [1]* *[1] EMPA, Feuerwerkerstrasse 39, 3600 Thun* *[2] EMPA, Überlandstrasse 129, 8600 Dübendorf* *[3] Osaka University, Yamada-oka, Suita, 565-0871, 0871 Osaka, Japan* Bowl-shaped π-conjugated compounds are important not only as model compounds of fullerenes but also as possible hosts for different guest molecules. Recent studies regarding the possible storage of possible energy carriers such as hydrogen and methane have further increased the interest in a detailed understanding of host-guest interactions in order to optimize the storage capacity of carbon-based nanomaterials at sufficiently low pressures. Within this context we investigated the structural properties of monolayer films of sumanene ($C_{21}H_{12}$) deposited on Ag(111). Based on STM experiments we find that the fraction of molecules oriented with their concave molecular part away from the surface is coverage-dependent, indicating that the bowl-inversion state is determined by intermolecular interactions. Beside the structural phase transition we will discuss its impact on the host-guest interactions with methane.

18:00	719	**Controlled Manipulation of Arbitrarily Shaped Nanoparticles** *Enrico Gnecco, Akshata Rao, Ernst Meyer* *Department of Physics, University of Basel, Klingelbergstrasse 82, 4056 Basel* We demonstrate how the direction of motion of a nanoparticle sliding on a surface can be controlled by tapping-mode AFM with a proper choice of the scan pattern. Model results are presented for different geometries of the nanoparticles, and compared to experiments on Au nanospheres and nanorods on SiO_2 and irregularly shaped Sb islands on HOPG. Numeric solutions of the equations of motion show that sliding is generally accompanied by wobbling or rotation of the nanoparticle. Analytic expressions are derived in the case of nanospheres and thin nanowires. The role of friction between particle and substrate is also discussed. [1] A. Rao et al., Nanotechnology 20 (2009) 115706 [2] E. Gnecco et al., Nanotechnology (2010), to appear [3] A. Rao et al., Phys. Rev. B 79 (2009) 193405
18:15		
18:30		***Postersession, Apéro, Barbecue***

Tuesday, 22.06.2010, Room 118

Time	ID	**NANO III: Experiments on Quantum Systems** *Chair: T. Clark, Uni Basel*
13:15	**721**	**Cooper pair splitter realized in a two-quantum-dot Y-junction** *Szabolcs Csonka [1], Lukas Hofstetter [1], Jesper Nygard [2], Christian Schönenberger [1]* *[1] Department of Physics, University of Basel, Klingelbergstr. 82, 4056 Basel* *[2] Nanoscience Center, University of Copenhagen, Universitetsparken 5, DK-2100 Copenhagen* An important step towards the realization of solid state based quantum computer is the demonstration of entangled spatially separated electrons. Cooper-pairs of superconductors are a natural source of spin entangled electrons, the separation of these electron pairs is the underlying concept of several theoretical proposals. In this work [1] we present the first experimental realization of a tunable Cooper Pair Splitter. The device contains a superconducting electrode coupled to two quantum dots, which is fabricated based on InAs Nanowire. In a superconducting beam splitter configuration two basic processes can happen with a Cooper-pair: the two electrons either split up into the two arms of the beam splitter or they leave the device in the same arm. The charging energy strongly suppresses to put two electrons on the same quantum dot, therefore implementing quantum dots into the arms of the beam splitter serves as a filter for the desired splitting process. Performing non-local transport measurements on such devices, we have demonstrated the Cooper-pair splitting process. [1] L. Hofstetter, S. Csonka et. al., Nature 461, 960 (2009).

13:30	**722**	**Nuclear Spin Relaxation in an All-Electrical Lateral Spin Transport Device** *Dominikus Koelbl [1], Andreas Fuhrer [2], Gian Salis [2], Santos F. Alvarado [2], Dominik M. Zumbühl [1]* *[1] Physics Department, University of Basel, Klingelbergstrasse 82, 4056 Basel* *[2] IBM Research - Zürich, Säumerstrasse 4, 8803 Rüschlikon* Using all-electrical Fe/GaAs lateral spin-injection devices operated in a non-local geometry, we study nuclear spin relaxation in a one micron thick n-doped GaAs epilayer as a function of temperature in a dilution refrigerator, investigating unprecedented temperatures well below 1 K. We create a dynamic nuclear spin polarization via the hyperfine coupling using spin polarized electrons injected from surface Fe bars. Nuclear spin signatures in non-local electron transport include a depolarization peak centered around zero magnetic field when the field is applied along the Fe injector bars. Further, Hanle satellite peaks appear away from zero field when a magnetic field perpendicular to the sample surface and Fe injectors is applied using a home-built vector magnet system. Using these signatures, we investigate the nuclear spin relaxation time as a function of temperature and compare it with the Korringa law which is known to be applicable in metals.
13:45	**723**	**Oxide-/Schottky-gate Hybride Quantum Dots** *Clemens Rössler, Thomas Ihn, Klaus Ensslin* *Departement Physik, ETH Zürich, Schafmattstrasse 16, 8093 Zürich* Electrostatically defined few-electron quantum dots are well suited to investigate the electronic properties of artifical atoms. Metal top gates provide control of the electrostatic confinement potential while allowing fast pulsing operations which are necessary for qubit operations. The readout of the qubit operation can be performed via a detector quantum point contact in the vicinity of the quantum dot. However, metal top gates reduce the readout fidelity due to electrostatic screening, limiting the signal-to-noise ratio and hence the highest possible readout speed. We present a novel way of defining quantum dots by combining top gates with local anodic oxidation. A proof of principle is presented, demonstrating high tunability while maintaining good capacitive coupling to the detector circuit.
14:00	**724**	**Ferromagnetic proximity effect in InAs nanowire hybrid structures** *Lukas Hofstetter [1], Szabolcs Csonka [1], Attila Geresdi [2], Jesper Nygard [3], Christian Schönenberger [1]* *[1] Departement of Physics, University of Basel, Klingelbergstrasse 82, 4056 Basel* *[2] Department of Physics, Budapest University of Technology and Economics, Budafoki u. 6, HU-1111 Budapest* *[3] Nanoscience Center, University of Copenhagen, Universitetsparken 5, DK-2100 Copenhagen* Ferromagnetic proximity effect is studied in InAs nanowire (NW) based quantum dots (QD) strongly coupled to a ferromagnetic (F) and a superconducting (S) lead. The influence of the F lead is detected through the splitting of the spin-1/2 Kondo resonance. We show that the F lead induces a local exchange field on the QD, which has a varying amplitude and a sign depending on the charge states. The interplay of the F and S correlations generates an exchange field related subgap feature.

14:15	**725**	**Method for Cooling Nanostructures to Microkelvin Temperatures** *Kai K. Schwarzwälder, Anthony C. Clark, Tobias Bandi, Dario Maradan, Dominik M. Zumbühl* *Physics Department, University of Basel, Klingelbergstrasse 82, 4056 Basel* We propose a new scheme aimed at cooling nanoscale electronic circuits to microkelvin temperatures. Each measurement lead of the device includes a separate nuclear adiabatic demagnetization refrigerator, thereby placing the circuit into direct electrical and thermal contact with a reservoir at microkelvin temperatures. We have designed, built, and tested a prototype incorporating our novel scheme, including silver sinters for precooling (located in the mixing chamber), superconducting Aluminium heat switches, high conductivity silver leads, ~0.5 mol Copper pieces for demagnetization and a home built chip carrier allowing direct wire-bonding from the silver leads to the sample. Bulk electron temperatures in the Copper pieces of ~1 mK have been achieved simultaneously on ten measurement leads, thus completing the first steps toward ultracold nanostructures.
		NANO IV: **Nanostructures and Molecular Nanosystems** *Chair: J. Trbovic, Uni Basel*
14:30	**731**	**Multiple Roles of Carbon Chains in Quinacridone Monolayers** *Huanyao Cun [1], Yeliang Wang [2], Lei Zhang [2], Bing Yang [2], Xiaobo He [2], Shixuan Du [2], Werner Hofer [3], Hongjun Gao [2]* *[1] Physik-Institut Universität Zürich, Winterthurerstrasse 190, 8057 Zürich* *[2] Institute of Physics, Chinese Academy of Sciences, Nansanjie 8, Zhongguancun, Haidian, 100190 Beijing, China* *[3] Surface Science Research Centre, University of Liverpool, UK-Liverpool 169 3BX* The adsorption of a quinacridone derivative with alkyl chains of 16 carbon atoms (QA16C), an organic semiconductor material, on Ag(110) was investigated by variable temperature scanning tunneling microscopy. We show for the first time how the length and arrangement of carbon ligands of QA molecules affect the properties of self-assembled structures in a very subtle manner. It is established that the involvement of different bond hierarchies, from strong covalent bonding of the backbones to weak hydrogen- and van der Waals bonds, results in eight different well-ordered superstructures between 0.3 to 0.7 molecules/nm^2. At low density, the alkyl chains function as spacers and determine the distance between molecules. At higher coverage, the chains are partly uplifted and increase the intermolecular bonding. The detailed insight emerging from this analysis will lead to a much better control in the fabrication of hybrid devices with interfaces between metals and organic molecules.
14:45	**732**	**The Nernst limit in dual-gated FET sensors** *Alexey Tarasov, Oren Knopfmacher, Wangyang Fu, Mathias Wipf, Michel Calame, Christian Schönenberger* *Departement Physik, Universität Basel, Klingelbergstr. 82, 4056 Basel* Field effect transistors (FETs) are widely used for the label-free detection of analytes in chemical and biological experiments. Here we demonstrate that the apparent sensitivity of a dual-gated silicon nanowire FET to pH can go beyond the Nernst limit of 60mV/pH at room temperature. This result can be explained by a simple capacitance model including all gates. The consistent and reproducible results build

		to a great extent on the hysteresis- and leakage-free operation of the devices. The dual-gate approach can be used to enhance small signals that are typical for bio- and chemical sensing at the nanoscale.
15:00	**733**	**Molecular assembly and exchange coupling of paramagnetic porphyrins on ferromagnetic thin film** *Christian Wäckerlin [1], Dorota Chylarecka [1], Kathrin Müller [1], Frithjof Nolting [2], Armin Kleibert [2], Nirmalya Ballav [1], Thomas A. Jung [1]* *[1] Lab. for Micro- and Nanotechnology, Paul Scherrer Institute, 5232 Villigen PSI* *[2] Swiss Light Source, Paul Scherrer Institut, WSLA/120, 5232 Villigen PSI* We report on the distinctive molecular assembly and exchange coupling of paramagnetic manganese(III) porphyrin chloride (MnTPPCl) molecules on a metallic cobalt (Co(001)) and on an oxygen reconstructed cobalt (O/Co(001)) substrate, the latter substrate being fabricated by surfactant-mediated growth. On the Co(001), MnTPPCl molecules were coupled ferromagnetically (FM) while on the O/Co(001) an antiferromagnetic (AFM) exchange coupling was identified. The random adsorption of MnTPPCl on Co(001) is turned into a self-assembled and well-ordered 2D molecular layer on O/Co(001). Different oxidation states for Mn-ions are found to exist on different substrates. The here presented spectro-microscopy correlation approach, involving X-ray magnetic circular dichroism (XMCD) spectroscopy, X-ray photoelectron spectroscopy (XPS), low-energy electron diffraction (LEED) and scanning tunneling microscopy (STM) demonstrates its strength to look into the mechanisms involved in organic spintronic interfaces.
15:15	**734**	**Guided-Patterning of Gold Nanoparticles using Block Copolymer Templating Methods** *Li Wang, Raphaël Pugin, Harry Heinzelmann, Franck Montagne* *CSEM, Jaquet Droz 1, 2000 Neuchâtel* The ability to achieve precise control on the spatial arrangement of nanometric structures, such as nanoparticles (NPs), is one of the key requirement for the design of new functional materials and devices with enhanced optical, electronic or catalytic properties. Beside the use of sophisticated lithography techniques allowing the formation of patterns with a resolution below 50 nm, self-assembling block copolymers (BCPs) offer a simple and low cost alternative to create periodic chemical or topographic nanodomains capable of guiding the placement of inorganic NPs on surfaces. Here, we describe the use of alternative approaches for fabricating periodic and tunable arrangements of gold NPs on silicon surfaces using self-assembling block copolymer films as templates. In a first method, the hierarchical positioning of NPs is achieved in one-step during the spontaneous phase inversion of spherical micelles into nanorings occurring in aqueous solution. The second method uses BCP micelle etching mask to create periodic arrays of chemical nanopatterns which are then used as immobilization sites for the positioning of gold NPs. For both methods, the hierarchical placement is governed by the establishment of electrostatic interactions between the micelles and the gold NPs. After removal of the polymer template, we show the formation of ordered arrangements of individual gold NPs or NP clusters on silicon surfaces whose morphologies, densities and periodicities can be tuned by simply varying initial block copolymer molecular weights or deposition conditions. The methods are applicable to a wide range of functional nanoparticles and are fully compatible with standard fabrication process for the production of hybrid surfaces at wafer-scale.
15:30		***Coffee Break***

Time	ID	NANO V: Nanobiology *Chair: C.-A. Schönenberger, Uni Basel*
16:00	741	**Imaging, sensing and manipulating single biomolecular transporters at work** *Daniel J. Müller, Christian Bippes* *ETH Zürich, Biosystems Science and Engineering (BSSE), Mattenstr. 26, 4058 Basel* Cellular membranes are vital for life. They confine cells and cellular compartments and are involved in virtually every cellular process. Cellular membranes form cellular contacts and focal adhesions, anchor the cytoskeleton, generate energy gradients, transform energy, transduce signals, move cells, and actively form compartments to assemble different membrane proteins into functional entities. But how do cellular membranes perform these tasks? What do the machineries of cellular membranes look like, and how are they controlled and guided? Using high-resolution atomic force microscopy (AFM) we image the assembly and conformation of single native membrane proteins and watch them at work. To understand how interactions determine the folding, structure, function, assembly, and communication of membrane proteins, we have developed single-molecule force spectroscopy (SMFS) to manipulate individual molecules and to structurally precisely locate and quantify such interactions. Specific interactions detected in a force-distance spectrum serve as a 'functional fingerprint' that characterizes the functional state of a membrane protein. Interactions established upon ligand-binding can be located and distinguished from those established upon inhibitor-binding and signal transduction events can be traced towards reprogramming the function of a membrane protein. Dynamic SMFS (DFS) obtains insights into the mechanical rigidity, transition state, lifetime, and free energy stabilizing the functional state a membrane protein. Using DFS we reveal mechanistic insights how drug-binding modulates these energetic parameters to deactivate the function of a membrane protein.
16:30	742	**The role of ATP and DNA in opening and closing of the N-gate in B.subtilis gyrase** *Airat Gubaev, Dagmar Klostermeier* *Biozentrum, Basel University, Klingelbergstr. 50/70, 4056 Basel* The DNA topoisomerase gyrase catalyzes the ATP-dependent negative supercoiling of DNA. Gyrase forms two cavities, delimited by three gates. During negative supercoiling, a coordinated opening and closing of these three gates has been suggested to allow for the required strand passage reaction. Here we present single molecule FRET experiments that monitor the conformation of the N-gate during the supercoiling cycle. The N-gate closes upon binding of a non-hydrolyzable ATP analog. Surprisingly, and contradicting the current model, plasmid DNA and dsDNA of >120 bp trigger closure of the N-gate, but not 60 or 90 bp dsDNA, suggesting that wrapping of larger DNA around the C-terminal domains of gyrase contributes to N-gate closure. Preliminary experiments with gyrase lacking these domains support this conclusion. Nucleotide binding may lead to a further stabilization of the closed N-gate, and ATP hydrolysis provides a timing mechanism for conformational changes in the supercoiling cycle.

16:45	**743**	**Melting of short DNA Hairpin Structures using Micromechanical Cantilevers** *François Huber, Hans Peter Lang, Christoph Gerber, NCCR Nanoscale Science, Department of Physics, University of Basel, Klingelbergstrasse 82, 4056 Basel* The three dimensional structure of Proteins, DNA and RNA is important for the highly specific binding of ligands. Three dimensional structures usually exhibit a certain flexibility to accommodate a ligand. Binding of ligands usually results in stabilization of the three dimensional structure of the receptor. The stabilization is accompanied by an increased resistance to denaturation of the receptor. With proteins, DNA or RNA the denaturation process shows a sharp transition between conditions that favor the native structure and conditions that are denaturing. One method to investigate the unfolding process is to change the temperature and observe the transitions from native to denatured state using micromechanical cantilevers. The transition of native structures to denatured structures should result in a distinct deviation of the signal during the temperature induced bimetallic response. We investigate the transition of closed DNA hairpin structures to open single stranded DNA on the surface of micro-cantilevers.
17:00	**744**	**Mechanical markers of tumor progression in breast cancer** *Marija Plodinec [1], Ellen C. Obermann [2], Rosmarie Sütterlin [1], Rosanna Zanetti-Dällenbach [3], Serenella Eppenberger-Castori [2], Ueli Aebi [1], Cora-Ann Schönenberger [1]* *[1] M. E. Müller Institute/Biozentrum, Klingelbergstrasse 50-70, 4056 Basel* *[2] Institute for Pathology, University of Basel, Schönbeinstrasse 40, 4031 Basel* *[3] University Women's Hospital Basel, Spitalstrasse 21, 4056 Basel* *Abstract withdrawn.*

17:15	**745**	**Synthetic Protein Targeting** *Janne Hyötylä [1], Roderick Lim [1], Jie Deng [2]* *[1] Biozentrum und Swiss Nanoscience Institute, Universität Basel, Klingelbergstr. 50/70, 4056 Basel* *[2] Institute of Materials Research and Engineering, A*STAR, 3 Research Link, 117602 Singapore, Singapore* "Protein targeting" refers to the sorting mechanism by which proteins are delivered to the correct spatial location within the cell. This ability to direct specific molecules from a biologically complex bulk liquid environment to site-selective locations is unprecedented. Here, we have conceived of a synthetic system that reproduces the biochemical selectivity and protein targeting control with nanometer-scale precision. Using polyethylene glycol (PEG)-binding antibodies (anti-PEG) as "transport receptors", we have targeted specific IgG molecules to PEG-gated nanopores in the presence of other non-specific molecules, and particularly, in blood serum. By harnessing the protein-like behaviour of polymers for biomolecular recognition, synthetic protein targeting imparts hierarchical control over molecular transport processes in multi-component systems. This shows potential benefits in applying synthetic protein targeting for biomolecular separation, the nanoscale miniaturizing of array-based bio-sensing technologies, and in regulating diverse nanofluidic transport more generally.
17:30		***END***

ID	NANO Poster
751	**Brownian Motion in Viscoelastic Fluids** *Matthias Grimm [1], Sylvia Jeney [2], Thomas Franosch [3]* *[1] EPFL SB ICMP LNNME PH D3 345 (Bâtiment PH) Station 3, 1015 Lausanne* *[2] Biozentrum, Universität Basel, Klingelbergstrasse 50/70, 4056 Basel* *[3] Inst. für Theoretische Physik, Univ. Erlangen-Nürnberg, Staudtstrasse 7, DE-91058 Erlangen* Recent techniques like optical trapping in combination with interferometric position detection systems allow to measure the position fluctuations of a micron-sized bead on the nanometer scale with a very high bandwidth. In order to predict the behavior of such an optically trapped Brownian particle immersed in a viscoelastic fluid, we studied different statistical functions by introducing the Maxwell model into the solution of the Langevin equation. We validated our model in experiments using typical Maxwell fluids like solutions of wormlike micelles and polymers.
752	**Microfabricated cantilever array sensors for electronic nose measurements** *Hans Peter Lang [1], Andreas Filippi [2], Andreas Tonin [1], François Huber [1], Natalija Backmann [1], Jiayun Zhang [1], Christoph Gerber [1]* *[1] NCCR Nanoscale Science, Department of Physics, University of Basel, Klingelbergstrasse 82, 4056 Basel* *[2] Institute for Dental Medicine, University of Basel, Hebelstrasse 3, 4056 Basel* Microfabricated silicon cantilever sensors and sensor arrays represent a powerful platform for a broad range of detection applications in physics, chemistry, material science, biology and medicine. The sensor response, e.g. is mechanical bending due to absorption of molecules. Microcantilever arrays can be operated in different environments such as ambient condition

	or liquids. When operated in gaseous environment, polymer-coated cantilever array sensors are applied as kind of electronic nose for characterization of vapors, whereby cantilever bending is caused by swelling of the polymers upon exposure to volatile vapors, e.g. from solvents. Medical applications involve fast characterization of exhaled patient's breath samples for detection of diseases, based on the presence of vapors in exhaled breath. Different applications and evaluation techniques will be presented.
753	**Scale-dependent dynamic stiffness analysis of articular cartilage by atomic force microscopy (AFM)** *Marko Loparic [1], Dieter Wirz [2], A. U. Dan Daniels [2], Roberto Raiteri [3], Mark R. VanLandingham [4], Geraldine Guex [5], Ivan Martin [5], Martin Stolz [6], Ueli Aebi [1]* *[1] M. E. Müller Institute, Biozentrum, University of Basel, Klingelbergstr. 50-70, 4056 Basel* *[2] Laboratory for Biomechanics & Biocalometry, University of Basel Faculty of Med., Klingelbergstr. 50-70, 4056 Basel* *[3] Dep. of Biophysical and Electronic Engineering, University of Genova, Via Opera Pia, IT-16145 Genova* *[4] Army Research Laboratory, Aberdeen Proving Ground, Adelphi 21005, United States* *[5] Dep. of Surgery and of Biomedicine, University Hospital Basel, Hebelstrasse 20, 4031 Basel* *[6] nCATS (national Centre for Advanced Tribology at Southampton), School of Engineering Sciences, University of Southampton, United Kingdom* Articular cartilage exhibits a scale-dependent stiffness when probed by AFM. A micrometer-size spherical tip revealed unimodal stiffness distribution (microstiffness), whereas measurements with a nanometer-size pyramidal tip revealed bimodal nanostiffness distribution. Our hypothesis is that nanometer scale indentation of the cartilage's soft proteoglycan gel corresponds to the lower peak, whereas deformation of stiffer collagen fibrils yielded the higher peak. To test our hypothesis, we produced a composite (agarose gel/chondroitin-sulfate and fibrillar PEGT-PBT copolymer). Similarly to articular cartilage, unimodal microstiffness and bimodal nanostiffness distribution was observed. Moreover, negatively charged chondroitin-sulfate induces increase of the both nano- and microstiffness in high ionic strength solution. However, only the lower peak of the nanostiffness was altered while the higher remain unchanged. Conclusively, the micrometer scale measurements fail to resolve separately stiffness of proteoglycans and collagen fibril. Therefore, we propose nanostiffness as a new biomarker to analyze structure-function relationships in normal, diseased and engineered cartilage!
754	**Characterization of pulmonary surfactant lipids and blood plasma proteins binding to different functionalized multi-walled carbon nanotubes** *Michael Gasser [1], Barbara Rothen-Rutishauser [1], Harald Krug [2], Peter Gehr [1], Bing Yan [3], Peter Wick [2]* *[1] Institute of Anatomy, University of Bern, Baltzerstrasse 2, 3000 Bern* *[2] Laboratory for Materials Biology Interactions, EMPA, Lerchenfeldstr. 5, 9014 St. Gallen* *[3] Chemical Biology & Therapeutics, St. Jude Children's Research Hospital, 262 Danny Thomas Place, Memphis, United States* During production and processing of multi-walled carbon nanotubes (MWCNTs), they may be inhaled and may enter the pulmonary circulation. It is essential that interactions with involved body fluids like the pulmonary surfactant, the blood and others are investigated, particularly as these interactions could lead to coating of the tubes and may affect the chemical and physical characteristics. The aim of this study was to characterize the possible coatings of MWCNTs on their pathway through the epithelial airway barrier in a cell free environment. To simulate the first contact in the lung, the tubes were coated with pulmonary surfactant and subsequently bound lipids

were characterized. The further coating in the blood circulation was simulated by coating the tubes with blood plasma proteins.
The tubes were functionalized with positively (-NH_2) and negatively (-COOH) charged side groups in order to investigate the influence on the bound lipid and protein patterns. Experiments revealed that surfactant lipids bind unspecifically to the different MWCNTs, in contrast to the blood plasma proteins which showed characteristic binding patterns. In addition we found that bound plasma protein patterns were altered when MWCNTs were previously coated with pulmonary surfactant.
We conclude that for the binding of blood plasma proteins the functionalization of the MWCNTs and the pre-coating with pulmonary surfactant are important factors which may influence their behaviour in biological systems. Further studies will be needed to assess possible adverse effects of various functionalized and coated MWCNTs on lung cells in vitro.

755 Uptake kinetics of aerosolized cerium oxide nanoparticles into lung cell cultures exposed at the air-liquid interface

David O. Raemy [1], Ludwig K. Limbach [2], Robert N. Grass [2], Peter Gehr [1], Detlef Günther [3], Karin Birbaum [3], Christina Brandenberger [1], Wendelin J. Stark [2], Barbara Rothen-Rutishauser [1]
[1] Institute of Anatomy, Division of Histology, University of Bern, Baltzerstrasse 2, 3000 Bern
[2] Functional Materials Laboratory, D-CHAB, ETH Zürich, Wolfgang-Pauli-Str. 10, 8093 Zürich
[3] Lab. of Inorganic Chemistry, D-CHAB, ETH Zürich, Wolfgang-Pauli-Str. 10, 8093 Zürich

Nowadays, aerosol processes are widely used for the manufacture of nanoparticles (NPs), emphasizing an increased occupational exposure risk of workers, laboratory personnel and scientists to particle aerosols. The classical dose-response paradigm links possible adverse effects with the accumulation of NPs in target cells, pointing out the importance of understanding the kinetics of particle internalization.
In this context, the uptake kinetics of a representative airborne NP over 30 min and its internalization after 24h post-exposure was investigated by the use of a recently established in vitro exposure system. It combines the production of aerosolized cerium oxide (CeO_2) NPs by flame spray synthesis with its simultaneous particle deposition from the gas-phase on A549 lung cells, cultivated at the air-liquid-interface. Particle uptake was quantified by mass spectrometry after several epxosure times (0, 5, 10, 20 and 30 min). Over 35% of the deposited mass was found internalized after 10 min exposure, a value going up to 60% after 30 min. Following additional 24h post-incubation, a time span, after which adverse biological effects were observed in previous experiments, 85% of total CeO_2 could be detected intracellularly. On the ultrastructural level, focal cerium aggregates were present on the apical surface of A549 cells, and could also be localized intracelularely in vesicular structures.
The uptake behaviour of aerosolized CeO_2 is in line with observations on aqueous cerium suspensions, where particle mass transport was identified as the rate limiting factor for NP uptake.

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756 The mesoscopic capacitor as a single electron source

Mathias Albert, Christian Flindt, Markus Büttiker, Departement de Physique Theorique, Université de Geneve, 24, quai Ernest Ansermet, 1211 Genève

A periodically driven mesoscopic capacitor may behave has a single electron source as it has been recently demonstrated experimentally. Here we consider the efficiency of such device through the determination of its noise power spectrum and its full counting statistics. Simple analytical results are obtained from a semi-classical model of the dynamics and compared to the scattering matrix approach as well as experimental results.

757	**Spin-selective Peierls transition** *Bernd Braunecker [1], Daniel Loss [1], Jelena Klinovaja [1], George I. Japaridze [2]* *[1] Departement Physik, Univ. Basel, Klingelbergstr. 82, 4056 Basel* *[2] Andronikashvili Institute of Physics, Tamarashvili 6, GE-0177 Tbilisi* We show that a spin-selective Peierls transition can be obtained in one-dimensional conductors with spin-orbit interaction. The transition turns only one-half of the conducting modes into an insulator, yet involves both spin components. The resulting state is a mixed spin-charge electron density wave, coexisting with a renormalized spin-filtered electron liquid formed by the remaining half of modes. Electron interactions substantially enhance the gap of the insulating modes and strongly modify the characteristics of the conducting modes. As an example we discuss single-wall carbon nanotubes and show that an enhancement of the gap by more than an order of magnitude can be obtained.
758	**Resistance Anisotropy in Natural Graphite and HOPG** *Lucas Casparis, Dominik M. Zumbühl* *Physics Department, University of Basel, Klingelbergstrasse 82, 4056 Basel* Despite several decades of investigation, the transport properties of graphite are not well understood. Here, we employ modern nanofabrication methods to shed new light onto some unsolved and fundamental problems in graphite transport. Using a simple scotch-tape exfoliation technique, we produce micron size graphite pieces with thicknesses between 10 nm and 200 nm. We use natural graphite from Madagascar and India but also HOPG. We define electrodes with electron beam lithography and measure the in-plane and c-axis resistivity with standard techniques. Interestingly, all our nanofabricated samples - natural and HOPG - display very similar behavior. Our hand-fabricated macroscopic samples, however, exhibit different behavior for natural graphite and HOPG, in good agreement with literature. Our experiments show that these differences disappear at the nanoscale, converging to HOPG behavior, presumably because impurity or stacking-fault enhanced transport mechanisms become irrelevant in sufficiently small, nanoscale graphite samples.
759	**RKKY interaction in a disordered two-dimensional electron gas with Rashba and Dresselhaus spin-orbit couplings** *Stefano Chesi, Daniel Loss* *Department of Physics, University of Basel, Klingelbergstrasse 82, 4056 Basel* We study the RKKY exchange interaction between localized magnetic moments in a disordered two-dimensional electron gas with Rashba and Dresselhaus spin-orbit couplings. A diagrammatic calculation of the variance over the disorder realizations of the magnetic interaction shows that it decays with the same power-law of the clean case. While an isotropic form of the Heisenberg type is valid at distance smaller than the spin-orbit length, the interaction becomes strongly anisotropic at larger distance. We study in detail the crossover to the asymptotic regime, realized when the impurities are a few spin-orbit lengths apart and the variance of the exchange energy is independent of the orientations of the two localized moments. Our results apply to nuclear moments embedded in III-V two-dimensional heterostructures or magnetic impurities deposited on metals or metal alloys, where the surface states display a sizable Rashba spin-orbit coupling.

760	**EDSR effects in a carbon nanotube** *Jelena Klinovaja, Daniel Loss* *Departement of Physics, Universität Basel, Klingelbergstrasse 82, 4056 Basel* Spin relaxation in carbon nanotubes for extended or confined states is studied. Due to spin-orbit interaction there is a gap between states from opposite spin orientation even without magnetic field. Applying an oscillating electric field we can induce Rabi oscillations of the spin. Taking into account electron-phonon coupling we analyze a realization of a such EDSR effects in a carbon nanotube.
761	**A Self-Correcting Quantum Memory in a Thermal Environment** *Beat Röthlisberger, Departement Physik, Universität Basel, Klingelbergstrasse 82, 4056 Basel* The ability to store information is of fundamental importance to any computer, be it classical or quantum. Identifying systems for quantum memories which rely, analogously to classical memories, on passive error protection ('self-correction') is of greatest interest in quantum information science. While systems with topological ground states have been considered to be promising candidates, a large class of them was recently proven unstable against thermal fluctuations. Here, we propose new two-dimensional (2D) spin models unaffected by this result. Specifically, we introduce repulsive long-range interactions in the toric code and establish a memory lifetime polynomially increasing with the system size. This remarkable stability is shown to originate directly from the repulsive long-range nature of the interactions. We study the time dynamics of the quantum memory in terms of diffusing anyons and support all our analytical results with extensive numerical simulations. Our findings demonstrate that self-correcting quantum memories can exist in 2D at finite temperatures.
762	**Spin-Electric Coupling in Molecular Magnets** *Dimitrije Stepanenko [1], Mircea Trif [1], Filippo Troiani [2], Daniel Loss [1]* *[1] Department of Physics, University of Basel, Klingelbergstrasse 82, 4056 Basel* *[2] CNR-INFM National Research Center S3, via G. Campi 213/A, IT-41100 Modena* We study the triangular antiferromagnet Cu_3 in external electric fields, using symmetry group arguments and a Hubbard model approach. We identify a spin-electric coupling caused by an interplay between spin exchange, spin-orbit interaction, and the chirality of the underlying spin texture of the molecular magnet. This coupling allows for the electric control of the spin (qubit) states, e.g. by using an STM tip or a microwave cavity. We propose an experimental test for identifying molecular magnets exhibiting spin-electric effects.
763	**Relaxation of Hole Spins in Quantum Dots via Two-Phonon Processes** *Mircea Trif [1], Pascal Simon [2], Daniel Loss [1]* *[1] Departement Physik, Universitat Basel, Klingelbergstrasse 82, 4056 Basel* *[2] Laboratoire de Physique des Solides, CNRS UMR-8502 University Paris Sud, Orsay Cedex, FR-91405 Paris* We investigate theoretically spin relaxation in heavy-hole quantum dots in low external magnetic fields. We demonstrate that two-phonon processes and spin-orbit interaction are experimentally relevant and provide an explanation for the recently observed saturation of the spin-relaxation rate in heavy-hole quantum dots with vanishing magnetic fields. We propose further experiments to identify the relevant spin-relaxation mechanisms in low magnetic fields.

764	**Signatures of the 5/2 wave functions on the cotunneling current between fractional quantum Hall edge states** *Robert Zielke, Departement Physik, Universität Basel, Klingelbergstr. 82, 4056 Basel* We investigate tunneling between edge states of a fractional quantum Hall system through a quantum dot. The focus is specifically on the cotunneling regime both elastic and inelastic. In this work we focus only on quantum dots with real electrons.
765	**Spin-1 Bosons in Optical Superlattices** *Andreas Wagner, Christoph Bruder* *Department Physik, Universitaet Basel, Klingelbergstrasse 82, 4056 Basel* We examine spinor Bose-Einstein condensates in optical superlattices. We assume that a small number of spin-1 bosons is loaded in an optical potential and study the phenomenon of single-particle tunneling. Single-particle tunneling occurs when one lattice site is ramped up relative to a neighbouring site or when an inhomogeneous magnetic field is applied. The model used is a two-site Bose-Hubbard hamiltonian which takes spin effects into account. These spin effects modify the interaction in a qualitative and a quantitative way.
766	**Ferromagnetic Permalloy contacts to carbon nanotube spin transport devices** *Hagen Aurich, Andreas Baumgartner, Frank Freitag, Jelena Trbovic, Christian Schönenberger* *Departement Physik, Universität Basel, Klingelbergstrasse 82, 4056 Basel* In spintronic devices the injection and detection of spin-polarized currents is usually achieved by ferromagnetic contacts. We show that Permalloy (Py, $Ni_{81}Fe_{19}$) contacts meet the requirements for spin injection and detection in carbon-based structures. We demonstrate a three-step material characterization consisting of vibrating sample magnetometer (VSM) measurements of a thin film as a fast quality test and VSM experiments on a large grid of contacts which give direct information on the magnetization of the contacts. In the third step we use low-temperature four-terminal AMR measurements to demonstrate that a single strip of Py exhibits sharp in-plane magnetization switching tuneable by geometry. In addition, we show that Py contacts strongly couple to CNTs, thereby forming well defined quantum dots at low temperatures. We also present first results obtained on a Py-based CNT spin-valve device.
767	**Inverted GaAs 2D Electron Gas in Close Proximity to InAs Quantum Dots** *Florian Dettwiler [1], Parisa Fallahi [2], Antonio Badolato [3], Atac Imamoglu [2], Dieter Schuh [4], Werner Wegscheider [5], Dominik M. Zumbühl [1]* *[1] Physics Department, University of Basel, Klingelbergstrasse 82, 4056 Basel* *[2] Institute of Quantum Electronics, ETH Zürich, Wolfgang-Pauli-Strasse 16, 8093 Zürich* *[3] Department of Physics and Astronomy, University of Rochester, Bausch & Lomb Hall, P.O. Box 270171, USA-Rochester, NY, 14627* *[4] Institute for Experimental and Applied Physics, University of Regensburg, Universitätsstrasse 32, DE-93053 Regensburg* *[5] Solid State Physics Laboratory, ETH Zürich, ETH Hönggerberg, 8093 Zürich* We present a novel type of inverted 2D electron gas (2DEG) with self-assembled, optically active InAs quantum dots in close proximity. A tunneling-coupling between the 2DEG and the quantum dots creates a hybrid system, opening the door for combining quantum transport with quantum optics experiments. We have grown and characterized several wafers - both in transport and optics. We find high-

	quality 2DEGs with rather large mobilities and nicely optically active self-assembled quantum dots as indicated by photoluminescence measurements. The mobility of the 2DEG depends strongly on the width of the tunnel barrier between the 2DEG and the quantum dots. Shubnikov-de Haas oscillations indicate a single-subband 2DEG, with a depth - as extracted from top-gate capacitance measurements – consistent with the expected depth. The deformation field of the quantum dots is clearly visible on the surface with an AFM, even though the dots are buried about 500 nm below the surface. This allows precise localization of individual quantum dots, paving the way towards integrating single quantum dots in surface gate defined nanostructures in the 2DEG.
768	**Superconductivity enhanced conductance fluctuations in few-layer graphene ribbons** *Frank Freitag, Jelena Trbovic, Nikolas Minder, Christian Schönenberger* *Departement Physik, Universität Basel, Klingelbergstrasse 82, 4056 Basel* We investigate the mesoscopic disorder induced rms conductance variance δG in graphene nanoribbons (GNR) contacted by two superconducting (S) Ti/Al contacts. By sweeping the back-gate voltage, we observe pronounced conductance fluctuations superimposed on a linear background of the two terminal conductance G. The fluctuations δG depend on temperature T and source-drain voltage V_{sd}. δG increases with decreasing T and $\|V_{sd}\|$. When lowering $\|V_{sd}\|$, a cross-over at a voltage corresponding to the superconducting energy gap Δ is observed. Expressed in the conductance variance G_{GS} of one graphene-superconducutor (G-S) interface, values of 0.58 e^2/h are obtained at the base temperature of 230 mK. The conductance variance in the sub-gap region are larger by up to a factor of 1.4 - 1.8 compared to the normal state. The observed strong enhancement is due to phase coherent charge transfer caused by Andreev reflection at the nanoribbon-superconductor interface.
769	**Miniature Cryogenic Microwave Filters for Low Electron Temperatures** *Christian Scheller [1], Sarah Heizmann [1], Dominic Giss [1], Kristine Bedner [1],* *Dominik M. Zumbühl [1], Jeramy D. Zimmerman [2], Arthur C. Gossard [2]* *[1] Physics Department, University of Basel, Klingelbergstrasse 82, 4056 Basel* *[2] Materials Department, University of California, USA-Santa Barbara 93106* We present a new generation of miniature microwave filters allowing us to achieve very low electron temperatures in semiconductor nanostructures. We wind several meters of thin Copper wire while minimizing parasitic capacitive coupling between windings and cast it in conducting sliver epoxy, allowing efficient thermal heat sinking in a dilution refrigerator. The measured attenuation reaches about 100 dB or more above ~130 MHz and - when capacitors are added - already above ~30 MHz, showing no noticeable degradation at cryogenic temperatures. Combined with ~1.5 m of thermocoax, we measured electron temperatures as low as 18 ± 3 mK using a GaAs surface gate defined quantum dot in deep Coulomb blockade as an electron thermometer. Between ~ 40 mK and 1.3 K, the quantum dot electron temperature agrees very well with RuO_2 and CMN thermometers on the mixing chamber.

770 **Quantum dots in p-GaAs tuned by combined in-plane and top-gates**

Yashar Komijani [1], Miklos Csontos [1], Thomas Ihn [1], Klaus Ensslin [1], Dirk Reuter [2], Andreas D. Wieck [2]
[1] Departement Physik, ETH Zürich, Schafmattstrasse 16, 8093 Zürich
[2] Angewandte Festkörperphysik, Ruhr-Universität Bochum, Universitätsstr. 150, DE-44780 Bochum

Low-dimensional hole-doped systems have more pronounced spin-orbit and carrier-carrier Coulomb interactions compared to n-type systems. The experimental investigation of p-type nanostructures has been hampered by technological difficulties in fabricating stable p-type nanostructures.
We present a novel method to fabricate stable p-type nanostructures by local anodic oxidation lithography which allows to tune the electrical properties of the confined holes with in-plane gates. The tunability of such structures can be greatly improved by the deposition of AFM patterned top-gates separated from the wafer surface by a 10-20 nm thick insulating HfO_2 layer.
The effect of the combined side- and top-gate electrodes on the tunability has been tested on a quantum dot device. We have measured the charge occupation and the electronic spectrum of the quantum dot by transport experiments. The obtained improved tunability will be crucial in order to reach the single-hole regime and to investigate strongly coupled quantum systems.

771 **Spin-orbit interaction in semiconductor quantum wells with varying symmetry of the doping profile**

Matthias Walser [1], Matthias Studer [1], Gian Salis [1], Klaus Ensslin [2], Dieter Schuh [3], Werner Wegscheider [2]
[1] IBM Research, Zurich Research Laboratory, Säumerstrasse 4, 8803 Rüschlion
[2] Laboratory for Solid State Physics, ETH Zürich, Schafmattstrasse 16, 8093 Zürich
[3] Faculty of Physics, University of Regensburg, Universitätsstr. 31, DE-93040 Regensburg

Employing a pump-probe technique based on the magneto-optical Kerr effect, we study the spin-orbit interaction in a series of (001)-grown GaAs/AlGaAs multiple quantum wells. The spin-orbit interaction in the two-dimensional electron gas is described by the Rashba and Dresselhaus terms that have different wavevector dependencies. We determine the size of both terms and study their interplay by tailoring the doping profile of the quantum well samples with the goal to obtain a situation where both terms have a comparable magnitude. In such a sample, we expect anisotropic spin lifetimes and a spatial modulation of the spin polarization related to a persistent spin helix.

772 **Friction Anisotropy on Layer Compound Crystals**

Gregor Fessler [1], Iwan Zimmermann [2], Pascal Steiner [1], Thilo Glatzel [1], Enrico Gnecco [1], Tony Keene [2], Shi-Xia Liu [2], Silvio Decurtins [2], Ernst Meyer [1]
[1] Department of Physics, University of Basel, Klingenbergstrasse 82, 4056 Basel
[2] Department of Chemistry and Biochemistry, University of Bern, Freiestrasse 3, 3012 Bern

Atomic-scale manipulation is strongly affected by the crystallographic orientation of the underlying substrate. The tip apex of a scanning probe microscope is one of the simplest objects whose motion can be controlled on atomic scale. The influence of a crystal lattice with square or hexagonal symmetry on the sliding of an atomically sharp tip is well explained by the Prandtl-Tomlinson model. The friction force experienced by the tip depends on the sliding direction and takes extreme values when the tip is scanned along the principal crystallographic axes of the substrate. Here, we extend the discussion to more complex surface structures formed by copper oxalate layers sandwiched between stereoregular

	organic cations. The organic molecules forming the surface are arranged so that a highly anisotropic behavior of friction can be expected. Measurements in ambient conditions and ultra-high vacuum are presented and compared with numeric simulations.
773	**Optomechanical coupling of ultracold atoms and a membrane** *Andreas Jöckel [1,2], Stephan Camerer [2], Maria Korppi [2], David Hunger [2], Matthias Mader [2], Theodor W. Hänsch [2], Philipp Treutlein [1,2]* *[1] Department of Physics, University of Basel, Klingelbergstrasse 82, 4056 Basel* *[2] Max-Planck-Institute of Quantum Optics and Department of Physics, LMU München, Schellingstraße 4, DE-80799 München* We report the progress of our experiment which aims at coupling a single mechanical mode of a high-Q SiN-membrane-oscillator to the motion of laser-cooled atoms in an optical lattice. The optical lattice is formed by retroreflection of a laserbeam from the oscillator surface. When the trap frequency of the atoms is matched to the eigenfrequency of the membrane, the coupling leads to resonant energy transfer between the two systems. This allows to observe the back-action of the atoms onto the membrane. A possibility to further enhance the coupling lies in improving the membranes properties. Structuring leads to smaller effective mass and larger per phonon motional amplitude, while the application of a gold mirror enhances the membranes reflectivity. In the long term, the coupling mechanism could be exploited in developing hybrid quantum systems between atoms and solid-state devices.
774	**Contrast Inversion of h-BN Nanomesh on Rh(111) analyzed by KPFM and bimodal nc-AFM** *Sascha Koch [1], Markus Langer [1], Shigeki Kawai [1], Jorge Lobo-Checa [2], Thomas Brugger [3], Ernst Meyer [1], Thilo Glatzel [1]* *[1] Departement Physik, Universität Basel, Klingelbergstrasse 82, 4056 Basel* *[2] CIN2, Campus Universitat Autònoma de Barcelona, Bellaterra, ES-08193 Barcelona* *[3] Physik Institut, Universität Zürich, Winterthurerstr. 190, 8057 Zürich* High temperature exposure of Borazine on Rh(111) under UHV conditions forms a superstructural hexagonal graphenelike but insulating monolayer [1]. Former STM measurements showed frequently a contrast inversion of the nanomesh which could not be explained [3]. Experiments as well as theoretical calculations predict electrostatic variations in terms of different mesh sites. Here we used advanced nc-AFM techniques like Kelvin Probe Force Microscopy, bimodal dynamic force microscopy and 3D spectroscopy [2] to analyze and describe this inversion. With these techniques, very high sensitivities of local contact potential differences as well as for short range forces can be achieved so that high resolution AFM topography as well as LCPD maps of the h-BN Nanomesh on Rhodium could be obtained for the first time. [1] M. Corso et al., Science 303, 217 (2004) [2] S. Kawai et al., PRL 103, 220801 (2009) [3] S. Berner et al., Angew.Chem.Int.Ed. 46, 5115-5119 (2009)

775 2D force spectroscopy on the h-BN nanomesh with bimodal dynamic force microscopy

Markus Langer [1], Shigeki Kawai [1], Sascha Koch [1], Thomas Greber [2], Thomas Brugger [2], Ernst Meyer [1], Thilo Glatzel [1]
[1] Departement Physik, Universität Basel, Klingelbergstrasse 82, 4056 Basel
[2] Physik-Institut, Universität Zürich, Winterthurerstrasse 190, 8057 Zürich

Boron-Nitride forms a highly regular, hexagonal, corrugated mono-layer (h-BN nanomesh or white graphene) on a Rhodium(111) substrate [1]. Because of a lattice mismatch between the layer and the rhodium surface a superstructure with a periodicity of about 3.2nm and a hole size of 2nm is build up [2]. In STM measurements a contrast inversion in the topography signal was observed [3] as well as in the AFM studies which could not be explained yet.
Bimodal noncontact dynamic force microscopy improves sensitivity for short range forces [4]. In this mode two flexural cantilever resonances can be mechanically excited and read out by two independent PLL systems. One mode is used to achieve a stable frequency shift signal for distance control while the second mode oscillates at amplitudes in the picometer range. The usage of small amplitudes significantly enhances the sensitivity to short range forces. The detected frequency shift is then proportional to the averaged force gradient over a large oscillation at the fundamental frequency.
In our measurements we used this technique to analyze in detail locale force variations on the h-BN nanomesh The height is controlled by the second flexural resonance at an amplitude of 600pm to have an even further improved sensitivity for short-range forces. Additional bimodal excitation of the first torsional cantilever resonance with an amplitude below 100pm offers an extremely high lateral sensitivity. We clearly achieve stable atomic resolution in the torsional mode. Those high resolution measurements as well as 2D force-distance spectroscopy reveal height dependent variations of the force field on the h-BN nanomesh and are discussed in respect to measured contrast inversion.

[1] M. Corso, et al., Science 303, 217-220, (2004)
[2] R. Laskowski et al., Phys. Rev. Lett. 98, 106802, (2007)
[3] S. Berner et al., Angewandte Chemie, Int. Edition 46, 5115 (2007)
[4] S. Kawai et al., Phys. Rev. Lett. 103, 220801 (2009)

776 Novel aspects of atomic-scale friction force microscopy

Alexis Baratoff, Pascal Steiner, Raphael Roth, Enrico Gnecco, Thilo Glatzel, Ernst Meyer
Departement Physik, Universität Basel, Klingelbergstr. 82, 4056 Basel

Lateral forces, static and kinetic friction have been computed for arbitrary scan directions along surfaces with square symmetry within a separable 2D Tomlinson model and interpreted in terms of tip trajectories. Comparison with images on cleaved NaCl(001) samples indicate that the main deformation is at the tip apex and essentially isotropic. The computed effects of thermal activation and perpendicular actuation are then quite similar to previous predictions based on the 1D model [1]. Analytic predictions are confirmed by dynamic simulations assuming overdamped tip motion. Continuous sliding sets below the threshold corrugation amplitude previously determined using the 1D model. Deviations from the predicted angular dependence might reveal finer details of the tip-sample corrugation potential.
The occurrence of slips over several lattice spacings with increased load can be explained by a gradual transition from overdamped to slightly underdamped tip motion. A comparison of slip-length histograms provides estimates of the lateral damping in contact [2].

[1] P. Steiner et al., Phys. Rev. B79, 045414 (2009)
[2] R. Roth et al., Tribol. Lett., in press

777 Dynamics of the Polarization Charges on Plasmonic Nanostructures

Banafsheh Abasahl, Olivier J. F. Martin, EPFL STI IMT NAM, Station 11, 1015 Lausanne

We study the time evolution of the polarization charges induced in metallic nanoparticles. The calculations are performed by means of a two-dimensional time-domain numerical method. In low symmetry metallic nanoparticles, each plasmonic mode is associated with a specific charge distribution, which determines the distribution of the field scattered by the particle. The dynamics of these polarization charges provides new insights on how these plasmonic modes are established in the particle, especially how "hot-spots", with very strong field enhancement can be obtained at specific locations on the particle.

778 Towards an Experiment to Simultaneously Measure Electrical and Optical Transport in Plasmonic Nano Junctions

Banafsheh Abasahl [1], Christian Santschi [1], Olivier J. F. Martin [1], Toni Fröhlich [2], Michel Calame [2], Christian Schönenberger [2]
[1] EPFL STI IMT NAM, Station 11, 1015 Lausanne
[2] Department of Physics, University of Basel, Klingelbergstrasse 82, 4056 Basel

The study of surface plasmon resonances in atomic junctions as is of interest, since extremely strong optical fields can be produced this way. In a nanometer dipole antenna, as the gap size reduces to a few nanometers, the optical absorption peak experiences a drastic red shift. To maintain this peak at the optically-measurable wavelengths, the lateral dimension of the structure has to be shortened. However, in order to enable the simultaneous measurement of electrical transport in these junctions, one needs to engineer a DC electrical connection with the two metallic arms, which becomes difficult if the plasmonic structure is too short. To circumvent this problem, we explore a number of solutions, including: additional contacting arms perpendicular to the antenna; ITO or a partially doped silicon substrate; utilization of propagating surface plasmons instead of localized ones; and structures with a smaller effective optical length than their physical length. The feasibility of each of these solutions will be discussed.

779 Preparation and transport measurements on patterned networks of gold nanoparticles bridged by a single or a few molecules

Jon S. Agustsson, Claire Barrett, Michel Calame, Christian Schönenberger
Department Physik, Universität Basel, Klingelbergstrasse 82, 4056 Basel

Arrays of ligand–protected gold nanoparticles were prepared using self assembly at a water/air interface and transferred to a substrate using micro contact printing.[1] Conjugated molecules were inserted into the arrays using molecular place exchange. Transport measurements and optical characterization were used to demonstrate the exchange.[2] Dithiolated molecules effectively bridge neighboring nanoparticles, forming a network of molecular junctions.[3] Function was added to the gold nanoparticle arrays by bridging the nanoparticles by dithiolated photochromic diarylethene molecules[4] and by redox–active dithiolated tetrathiafulvalene derivatives.[5]
Currently, we explore the non–linear response of the arrays to better understand the molecular nature of the junctions as well as uncover additional electrical and mechanical properties of the arrays.

[1] Advanced Materials 18, 2444–2447 (2006).
[2] J. Phys. Chem. C 111(50), 18445–18450 (2007).
[3] New J. Phys. 10, 065019 (2008).)
[4] Nano Letters 9(1), 76-80 (2009).
[5] Nano Letters 10(3), 759–764(2010)

780	**Conductance Fluctuations in Molecular Junctions**

Jan Brunner [1], Teresa González [2], Christian Schönenberger [1], Michel Calame [1]
[1] Department of Physics, University of Basel, Klingelbergstrasse 82, 4056 Basel
[2] IMDEA-NanoScience, Madrid Institute of Advanced Research in Nanoscience, Av. Fco. Tomás y Valiente, 7, ES-28049 Madrid

The reliable formation of stable electrical contacts to single molecules at room temperature remains a challenge. A possible technique consists in contacting the molecule via the two broken ends of a suspended Au nanowire (mechanically controllable break junction). It has been successfully applied to several molecules.
In this work, we have investigated the conductance fluctuations observed in break junctions immersed in a solvent with and without alkanedithiols. The fluctuations were recorded for successive fixed gold electrodes separations. In the presence of alkanedithiols, we could clearly observe random telegraph signals (RTS). We find that these signals can show different relative amplitudes with state lifetimes ranging between 0.1 ms and 0.1 s. We also show that for measurements in pure solvents, RTS are much rarer while the amplitude of the conductance fluctuations remain substantially smaller.

781	**Towards an Optoelectronic Characterization of Molecules**

Toni Fröhlich [1], Banafsheh Abasahl [2], Michel Calame [1], Christian Schönenberger [1], Olivier Martin [2]
[1] Departement Physik, Universität Basel, Klingelbergstrasse 82, 4056 Basel
[2] Nanophotonics and Metrology Laboratory, EPFL, ELG 241, Station 11, 1015 Lausanne

Nanoantennas can represent an elegant way to couple light into nanoelectronic devices. Such antennas can be typically formed by two metallic arms spaced by a nanometer-scale gap, where a strong field-enhancement will take place upon illumination. The control of the gap size is critical for such structures and we will show here recent results obtained by electron beam lithography and feedback controlled electromigration. In the future we would like to combine the concept of nanoscale antennas with transport measurements of single molecules. This will allow an optoelectronic characterization of molecules trapped inside the antenna gap.

782	**Force spectroscopy and charge transport in molecular junctions**

Cornelia Nef [1], Patrick Fredericks [2], Jan Brunner [1], Christian Schönenberger [1], Michel Calame [1]
[1] Department of Physics, University of Basel, Klingelbergstrasse 82, 4056 Basel
[2] Biozentrum, University of Basel, Klingelbergstrasse 70, 4056 Basel

While research on molecular electronics has gained a lot of attention during the last decade, most experimental methods focus on electrical measurements. Until today, the influence of mechanical forces and contact geometries on the transport properties remain poorely understood. Conducting atomic force microscopy (C-AFM) represents an attractive approach, due to its ability to measure both, electrical currents and forces in the nano-Newton range.
We first measured force and conductance during the breaking of gold-gold contacts. A quantum unit of conductance could be observed, representing a single atom contact. In parallel the force needed to break the gold-gold junctions was measured. We then characterized gold-molecule-gold junctions. Here, conductance steps due the presence of molecules were observed and found to correlate with force jumps. These results help achieving a more complete characterisation of molecular junctions and provide the basis for a better understanding of the physics involved in molecular contacts.

783 Towards Fully Tunable Carbon Nanotube Quantum Dots

Markus Weiss, Alexander Eichler, Christian Schönenberger
Department Physik, Universität Basel, Klingelbergstrasse 82, 4056 Basel

Electronic devices made out of Carbon Nanotubes have played an important role in quantum dot physics over the last decade. Due to their strong lateral confinement they allow to reach parameter regimes that cannot easily be achieved in quantum dot devices realized from a different class of materials. In addition the important field of hybrid devices, quantum dots with superconducting and/or ferromagnetic electrodes, has emerged thanks to Carbon Nanotubes, as they were the first material system that could be coupled to non normal metal contacts in a straightforward way.
One feature that Carbon Nanotube quantum dots have been lacking is the precise and individual control over the electrode-dot couplings. We have developed a top-gated Carbon Nanotube quantum dot device that should allow control over the coupling to source and drain contact independently. We will present first experimental results obtained on devices with normal metal and superconducting contacts.

784 Linked Nanorods as Bottom-Up Molecular Electronics Devices

Antje Rey [1,3], Titoo Jain [2], Emanuel Lörtscher [1], Cyrill Kümin [1,4], Heiko Wolf [1], Thomas Bjørnholm [2], Andreas Stemmer [3], Heike Riel [1]
[1] IBM Research - Zürich, Säumerstrasse 4, 8803 Rüschlikon
[2] Nano-Science Center and Department of Chemistry, University of Copenhagen, Universitetsparken 5, DK-2100 Copenhagen
[3] Nanotechnology Group, ETH Zürich, Tannenstrasse 3, 8092 Zürich
[4] Laboratory for Surface Science and Technology, ETH Zürich

The prospect of molecular electronics is to fabricate electronic devices employing single molecules as functional building blocks. In order to create individual metal-molecule-metal junctions, atomic-sized electrodes are required. Nanorods grown from Au seed particles represent ideal electrodes to contact small ensembles or even single molecules due to their high aspect ratio. A recently reported seed-mediated growth of end-to-end linked Au nanorods was used to synthesize in-situ Au-molecule-Au junctions [1]. The resulting width of the nanogaps is defined by the polyethylene glycol (SH-PEG-SH) linker molecule and is measured to be 1-2 nm.
We have investigated approaches to deposit and assemble nanorods on substrates compatible with silicon technology. The nanorods were electrically addressed using standard electron-beam lithography and their electrical transport properties were studied. Measurements reveal Au resistivity of 2.3E-8 Ωm measured across the nanorods which corresponds perfectly to the literature values. In addition, we fabricated devices with end-to-end linked nanorods employing them as nano-electrodes for molecular transport measurements at variable temperatures.

[1] T. Jain et al., ACS Nano, 4, 828, (2009).

785 Effect of Annealing Temperature and Dwelling Time on the Photoelctrochemical Behavior of Nanostructured Hematite Thin Film

Debajeet Bora [1], Artur Braun [2], Thomas Graule [2], Edwin C. Constable [1]
[1] Department of Chemistry, University of Basel, Spitalstrasse 51, 4056 Basel
[2] Laboratory for High Performance Ceramics, EMPA, Überlandstrasse129, 8600 Dübendorf

Hematite with low band gap of 2.2 eV and high chemical stability is most important metal oxide semiconductor for solar photooxidation process. In this study, hematite film has been synthesized by sol gel approach and post annealing technique. The synthesized film was

	further characterized by XRD and FESEM to determine the presence of hematite phase and its morphology. It was further optimized for different annealing temperature and dwelling time to study the effect on the photoresponse. It was found that photocurrent increase in a systematic manner from 350 degree to 500 degree and after that it decreased down again at 600 degree. This was due to the presence of surface states existing in the electrode annealed at a lower (350 degree), and higher (600) temperatures which basically favors the trapping of electrons. These trapped electrons are difficult to transfer to the oxidized species resulting in decreased photocurrent.
786	**Controlled Release From PVA Hydrogels Via Polymeric Vesicles** *Sindhu Menon, University of Basel, Klingelbergstrasse 80, 4056 Basel* Hydrogels have spawned several unique applications in sustained drug delivery systems. The controlled release of water soluble drugs, however, remains a challenge owing to its fast diffusion from the hydrogel network. To circumvent this problem we proposed the development of polymeric vesicle embedded hydrogels. Environmentally triggerable vesicles assembled from polyacrylic-based (PAA) copolymers would serve as barriers to molecular diffusion. PAA is known to be sensitive to pH and divalent ions like calcium. Our studies so far indicate the formation of stable vesicles by these copolymers with extreme pH sensitivity which can serve as environmentally responsive nanocompartments for tunable release from the hydrogel.
787	**Protein Coupled Copper-Catalysts for Atom Transfer Radical Polymerization in Pure Water** *Kasper Renggli, Nico Bruns* *Physikalische Chemie, Universität Basel, Klingelbergstrasse 80, 4056 Basel* Atom transfer radical polymerization (ATRP) has emerged as one of the most powerful synthetic techniques in polymer science. Similarly to other controlled radical polymerization (CPR) methods, it allows the synthesis of polymers with predetermined molecular weight, narrow molecular weight distribution, as well as desired composition and molecular architecture. ATRP is a metal complex-mediated reaction with copper-based catalysts being most commonly used. Recent advances have provided access to polymers with protein-reactive end groups synthesized by ATRP and other CPR methods. Conjugates have also been prepared by polymerizing directly from the proteins. To the best of our knowledge, preparation of protein catalyst conjugates for ATRP have not yet been reported. Here we present an easy and efficient way to couple Cu-based catalysts to BSA, a serum albumin protein. The resulting nanoscale catalyst enables ATRP in pure water and shows similar behavior than conventional, low molecular weight catalysts.
788	**Reversible Self-Assembly of an Amphiphilic Oligopeptide into Microspheres** *Thomas Schuster [1], Dirk de Bruyn Ouboter [1], Enrica Bordignon [2], Christian Dittrich [1], Gunnar Jeschke [2], Wolfgang Meier [1]* *[1] Department Chemistry, University Basel, Klingelbergstrasse 80, 4056 Basel* *[2] Laboratory for Physical Chemistry, ETH Zürich, Wolfgang-Pauli-Str. 10, 8093 Zürich* There is an increasing interest in nanostructures and artificial compartments for e.g. drug delivery systems accomplished by block-co-polymers, peptide based hybrids or pure peptids. Herein we present a small synthetic amino acid sequence of only eleven residues with amphiphilic character. The hydrophobic repetitive L-tryptophan – D-leucine motif has a defined secondary structure and was inspired by gramicidin A. The peptide was found to be able to assemble into micelles and massive microspheres. These architectures were characterised by microscopically means as well as by Electron Paramagnetic Resonance

(EPR) and Dynamic Light Scattering (DLS) with a main focus on the formation process itself. The equilibrium between micelles and microspheres in ethanol-water-mixtures was investigated and found to be reversible and independent on the sample preparation. Results suggest that the assembly takes place in a hierarchical manner from the formation of micelles to microspheres.

789 **Collagen Model Peptides with Sites for Functionalization**

Roman Erdmann, Helma Wennemers
Departement Chemie, Universität Basel, St. Johanns-Ring 19, 4056 Basel

Collagen is the most abundant protein in mammals. Many diseases such as scurvy or brittle bone disease are linked to faults in the structure of collagen.[1] Cross linking of collagen strands is part of the natural ageing process of our skin.[2] Thus, understanding the triple helical collagen structure and factors that have an influence on this structure is important. The collagen triple helix consists of Xaa-Yaa-Gly repeat units, with Pro-(4R)Hyp-Gly (Hyp = (4R)Hydroxyproline) as the most abundant repeat unit in natural collagen which provides the highest stability.[3] Raines et al. showed by replacing (4R)Hyp with (4R)fluoroproline that stereoelectronic effects contribute to the stability of the collagen triple helix.[4] Recently, the Wennemers group showed that the azido group exerts a similarly strong stereoelectronic effect as fluorine[5] and demonstrated that (4R)azidoproline (Azp) can be used to stabilize the PPII conformation within oglioprolines.[6] In this work we tested the effect of (4S)Azp and (4R) Azp on the stability of collagen. Incorporation of Azp into host/guest collagen model peptides (figure 1) demonstrated that (4R)Azp has a comparable stabilizing effect as (4R)Hyp.

[1] B. Brodsky, J. Baum, Nature 2008, 453, 998-999.
[2] M. Yamauchi, P. Prisayanh, Z. Haque, D. T. Woodley, J. Invest. Dermatol. 1991, 97, 937-941.
[3] J. Engel, H.P. Baechinger, Top. Curr. Chem. 2005, 247, 7-33.
[4] S. K. Holmgren, K. M. Taylor, L. E. Bretscher, R. T. Raines, Nature 1998, 392, 666-667.
[5] L.-S. Sonntag, S. Schweizer, C. Ochsenfeld, H. Wennemers, J. Am. Chem. Soc. 2006, 128, 14697-14703.
[6] M. Kümin, L.-S. Sonntag, H. Wennemers, J. Am. Chem. Soc. 2007, 129, 466-467.

790 **A new apparatus for the study of ultracold ion molecule chemical reactions.**

Felix Hall, Stefan Willitsch
Physical Chemistry Department, University of Basel, Klingelbergstrasse 80, 4056 Basel

A new experiment for the study of chemical reactions between molecular ions and atoms at ultralow temperatures ($T \leq 1$ mK) has been conceived and developed, allowing to probe chemical processes at energies three orders of magnitude lower than previously investigated [1]. Ultracold molecular ions are produced by sympathetic cooling with a Ca^+ coulomb crystal in a linear rf quadrupole trap. Ultracold atoms are generated in a magneto-optical trap. The combination of both traps completely in vacuo leads to a highly flexible apparatus, enabling the study of molecular interactions in a regime where quantum mechanical effects may dominate reactions. The design and construction of the experiment are discussed and prospects for future investigations are highlighted.

[1] S. Willitsch et al, PRL 100, 043203 (2008)

791 **A novel surface-electrode trap for the sympathetic cooling of molecular ions**

Iulia Georgescu, Stefan Willitsch
Departement Chemie, Universitaet Basel, Klingelbergstrasse 80, 4056 Basel

Surface-Electrode (SE) ion traps are versatile devices for novel experiments in quantum computation, the study of cold collisions between ions and neutrals, and ultralow-temperature chemistry. Based on numerical calculations of the trapping potentials and the simulation of the ion dynamics, we designed a novel SE trap for the sympathetic cooling of molecular ions. First, we investigated the effect of the static potentials on the effective trapping potential and

	estimated the potential depth and trapping height above the surface under various conditions. The dynamics of trapped ions was studied using molecular dynamics simulations based on the numerically calculated potentials. A SE trap with large electrodes and small inter-electrode gaps was constructed. The trap has six control electrodes and was produced by laser-cutting in thin gold-coated stainless-steel foil. We will discuss numerical results on the trap characterization, describe our experimental setup and present preliminary experimental data.
792	**Generation and Charge-Transfer Spectroscopy of State-Selected and Translationally Cold N_2^+ Molecular Ions** *Xin Tong, Alex Winney, Stefan Willitsch* *Department of Chemie, University of Basel, Klingelbergstrasse 80, 4056 Basel* The generation and study of translationally cold molecules and ions represents one of the most recent and exciting new developments in physical chemistry. Although the complex internal structure of molecules has precluded the application of laser cooling, molecular ions can be cooled and Coulomb crystallised by exchanging kinetic energy with laser cooled atomic ions by means of the Coulomb interaction ("sympathetic cooling"). Sympathetically cooled molecular ions are translationally cold, however their internal degrees of freedom are generally in thermal equilibrium with the environment because of the coupling to the ambient black-body radiation (BBR) field. For a number of applications it is essential to prepare internally state-selected species which has only very recently been achieved in polar molecular ions using optical pumping methods.[1] However, there techniques are not applicable to non-polar ions of fundamental interest like H_2^+ and N_2^+. We presently develop a new experimental setup which will allow for the first time to produce Coulomb crystals of state-selected non-polar molecular ions based on the combination of threshold-photoionization with sympathetic-cooling methods. In our current experiment, molecular N_2^+ ions are produced in a well-defined rotational quantum state by resonance-enhanced multiphoton ionisation (REMPI) of neutral N_2 molecules inside an ion trap. Rovibronic state selection is achieved by ionizing only slightly above the required rotational ionization threshold accessible from a selected rovibronic intermediate level used in the excitation process (see Figure). Such state-selected ions are then sympathetically cooled by the Coulomb interaction with laser-cooled Ca^+ atomic ions. State-selective preparation and the lifetimes of the prepared rotational states are studied using a spectroscopic scheme based on the laser induced charge transfer reaction: $N_2^+ + Ar \rightarrow Ar^+ + N_2$.[2] [1] M. Drewsen et el. New J. Phys., 11, 055026, (2009). [2] D. Gerlich et el. Int. J. Mass Spectrom., 187, 589, (1999).
793	**Peptides involved in the antimicrobial interaction with silver ions** *Sonja Eckhardt, Katharina Fromm, University of Fribourg, Chemin du musée 9, 1700 Fribourg* Ageing society and improved medical technology lead to an increase of implants inserted into the human body. In parallel, the number of implant infections is rising, especially with augmenting bacterial resistance against antibiotics, leading to high social and health costs. Thus, the development of novel antimicrobial implant coatings is highly required e. g. silver coordination compounds for which antimicrobial activity has been demonstrated. It is therefore fundamental to learn about the molecular mechanism of action of this metal ion. Here we present the structural analysis of peptide sequences in order to understand the molecular mechanism of the antimicrobial action of silver ions as well as the formation of silver nanoparticles (AgNPs).

794 Synthesis and “migration” of silver nanoparticles in polyelectrolyte matrix

Jérôme Girard, Katharina M. Fromm
University of Fribourg, Chemistry Departement, Ch. du Musée 8, 1700 Fribourg

Nowadays, a wide variety of composite materials consisting of polymers containing metal nanoparticles have been extensively investigated to realize their potential applications ranging from optoelectronics to biomaterials. Nanostructured materials consisting of silver nanoparticles (Ag-NPs) embedded in polymeric matrices show physico-chemical, optical and antibacterial properties [1, 2]. A simple method to prepare a AgNP/polyelectrolyte composite was successfully used. Thus, Ag-NPs were obtained through spontaneous formation of nanostructured silver from an Ag_2O/polystyrene sulfonate (PSS) solution. The nanoparticle size was determined by SEM, and related morphology was investigated by X-ray diffraction techniques. Nanocrack formation was observed during the ageing of the polymer, these cracks were spontaneously filled by silver. The synthesis of the Ag-NP/PSS composite was performed by mixing a PSS solution in water with a Ag_2O solution in diluted ammonia during 48 hours.

[1] Mantion, A., et al., Soft Matter, 2008. 4(3): p. 606-617.
[2] Belser, K. et al., Angew. Chem. Int. Ed. Eng. 2009, 48(20): p. 3661-3664

795 Benzylthioether stabilized gold nanopoarticles: tuning size and interlinking properties

Jens Peter Hermes, Torsten Peterle, Fabian Sander, Marcel Mayor
Departement Chemie, Universität Basel, St. Johanns-Ring 19, 4056 Basel

The full control over both, size and surface functionalization of metal nanoparticles would allow their integration in devices as stable building blocks. Size control enables to tune the particles' physical properties while the control over the functionalization allows adjusting its chemical behavior.
It was shown that oligomeric ligands based on benzylic thioethers are able to enwrap and stabilize gold nanoparticles with low integer numbers of ligands [1]. The ligands have been monofunctionalized to enable wet chemistry reactions of the stabilized nanoparticles to make them "artificial molecules" with defined surface functionalities for the formation of nanoparticle superstructures. [2]
The oligimeric ligands have been modified to different dentritic structures to gain more control over the size, the monodispersity and the desired monofunctionalization of the formed particles.

[1] T. Peterle, A. Leifert, J. Timper, A. Sologubenko, U. Simon, M. Mayor, Chem. Commun. 2008, 29, 3438.
[2] T. Peterle, P. Ringler, M. Mayor, Adv. Funct. Mater. 2009, 19, 3497–3506.

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Loops vs. Stems: Benzylic Sulfide Oligomeres Forming Carpet Type Monolayers

Fabian Sander, Torsten Peterle, Nirmalya Ballav, Florian von Wrochem, Michael Zharnikov, Marcel Mayor
Departement Chemie, Universität Basel, St. Johanns-Ring 19, 4056 Basel

Chain-like oligomers consisting of several in meta position interlinked benzylic sulfides and terminal benzylic thiols were synthesized and the nature of the molecular monolayers formed by their self-assembly on gold (111) substrates was investigated. The fabricated films were characterized by high-resolution X-ray photoelectron spectroscopy and near-edge X-ray absorption fine structure spectroscopy. In the case of the short oligomers, the spectroscopic studies were additionally supported by scanning tunneling microscopy experiments. The target molecules were found to form dense and contamination-free SAM-like “carpet” films on gold (111). In spite of the multidentate nature of the benzylic sulfides oligomers, the predominant molecular conformation in these films were bridges (“loops”) formed by the covalent attachment of both terminal thiols with a minor amount of molecules which were bound by only one thiol group as upright standing “stems” protruding the SAM. The films exhibited only a limited degree of order, with a slight preference of the perpendicular-to-the-surface orientation of the individual phenyl rings of the oligomer chains.