Coherent wavefunction superposition allows for new manifestations of resonant behavior in quantum systems, most notably in the case of the Fano resonance. Originally revealed in atomic autoionization, this resonance arises from the distinctive coupling of a continuum to a discrete quantum level, thus providing two interfering pathways for a transition between an initial and final state. While the details of this resonance have been studied for more than half a century, recent advances in nanotechnology now allow the realization of Fano resonances in mesoscopic systems based on quantum dots [1]. The important feature of these systems is that, in contrast to their atomic counterparts, the key parameters describing their resonance, most notably the transmission amplitudes via the continuum and the discrete state, can be controlled \textit{in situ}, providing unparalleled control of the resonant interaction. As such, mesoscopic Fano systems represent a highly promising means to manipulate the interactions among discrete components of complex quantum systems.

Recently, we have demonstrated a novel form of all-electrical Fano resonance in structures based on the simplest of mesoscopic devices, namely quantum point contacts (QPCs). While there is still controversy surrounding this issue, our experiments provide strong support for the idea that QPCs can function as a single-spin trap near pinch-off, confining an electron to a bound state (BS) that is formed by Friedel oscillations in their self-consistent potential [2]. In prior work, we have provided evidence for this spin binding by studying the conductance of a (detector) QPC in close proximity to another (swept) QPC in which a BS is formed [3-7]. A resonance occurs in the detector conductance when the swept QPC pinches off and has been attributed [4] to an unusual Fano effect [6], due to the wavefunction overlap between the BS and the detector. The resonance develops Zeeman splitting in a magnetic field, consistent with occupation of the BS by a single, well-defined spin [5].

In this presentation, I discuss several new features of the Fano resonance in coupled-QPC systems, including the demonstration of coherent coupling between BSs on spatially separated QPCs (an implementation of a multi-state Fano resonance), and a novel form of “non-linear” Fano resonance. The latter effect can controlled by the application of an external magnetic field, or of a significant source-drain bias across the QPCs. Our results suggest the promise of using these nanostructures to build up more complex systems of multiply-entangled quantum states.

The emergence of a new field in electronics is in view, with the contemporary evolution of two disciplines, spintronics and molecular electronics. A fundamental link between these two fields can be established using molecular magnetic materials and, in particular, single-molecule magnets, which combine the classical properties of a macroscopic magnet with the quantum properties of a single nanoscale entity. 

The resulting field, known as ‘molecular spintronics’, aims at manipulating spins and charges in electronic devices containing one or more molecules that are magnetically active. The talk will discuss this emerging by proposing model devices able to read and manipulate molecular spin states of the molecule and to perform basic quantum operations. Two different paths are followed: the first path, known as ‘direct coupling’ directly probe the molecule by placing it between contacts electrodes (source and drain). The transport current flowing through the molecule contains signatures of the molecule spin state and is reminiscent to the quantum dot configuration. Following that concept, spin-valves, spin filters and spin transistors can be realized. In the molecular spin-transistor configuration, the molecule is coupled to a third gate electrode which control the molecule chemical potential. The magnetic properties and its anisotropy are measured as a function of the oxidation state (i.e. the number of extra electrons sitting on the molecule) which is tuned by the gate. I will present results on the observation of Kondo effect in C60 molecules.

The second path, known as ‘indirect coupling’ use a non-magnetic sensing device placed in direct vicinity to the magnetic molecule which probe its magnetic states. The spin to charge conversion is realized using different physical effects such as quantum interference (realized by inductive coupling of the magnet to a carbon nanotube nano-SQUIDs) or magneto-Coulomb effects such as observed in molecular double-quantum dot devices.
Spin dynamics and magnetic anisotropy

Anna Delin
KTH, Sweden

Understanding spin relaxation in zero-dimensional (0D) and one-dimensional (1D) magnetic systems and long-range order in 1D magnetic chains are questions of fundamental interest which have recently also become core technological issues in the quest for ever-smaller nanosized magnetism-based information storage systems. Generally, as the dimensionality of a system is reduced, fluctuations become larger and more important and the tendency toward magnetic ordering decreases. According to spin-lattice models, infinite 1D chains with sufficiently short range magnetic interactions should spontaneously break up into segments with different spin orientation. This in turn implies that long-range order be impossible in these systems. However, these early spin-lattice models assume the absence of kinetic barriers as well as anisotropies. Thus, by introducing such barriers one might hope to built 1D magnetic systems with long-range magnetic order and even zero-dimensional magnetic systems with the capability to store magnetic information on a macroscopic time scale. In practice, barriers can be introduced by growing 1D systems on a substrate and by using magnetic species with substantial orbital moments.

In this paper, we explore the spin dynamics of a chain of platinum atoms using atomistic spin dynamics where the interactions are calculated from first principles. Platinum has a strong-spin orbit coupling, which translates into a large magneto-anisotropy which may affect the spin dynamics in fundamental ways. We analyze how the spin dynamics is altered when we include colossal magnetoanisotropy (CMA) into our model compared to if we assume that the size of the atomic spins remain unaltered (uniaxial model). We find that according to our relaxation time calculations, the magnetic behavior of the CMA wire should be possible to resolve experimentally at the picosecond time scale for temperatures below 5 K. Possible experimental probes could be free electron laser, MOKE and XMCD.

Perpendicular spin torque in magnetic tunnel junctions

Olle Heinonen
Materials Science Division, Argonne National Laboratory, Lemont, IL 60439

The prediction by Slonczewski and Berger that currents in magnetic heterostructures can exert a torque on the magnetization in the structures has lead to intense research over the past decade. This is both because of a new area of fundamental physics made possible by coupling DC currents and spin dynamics, as well as technological applications, such as magnetic random access memories and nanoscale high-frequency oscillators. In magnetic tunnel junctions (MTJs) consisting of two magnetic layers separated by an insulator, spin torque exerted on the magnetic layers has components in the plane of the layers as well as perpendicular to the planes, and both components are appreciable. Unfortunately, the perpendicular component is difficult both to calculate and to measure. However, in MTJs the ferromagnetic resonance frequencies are sensitive to the perpendicular torque, while the linewidth of the resonances are sensitive to the in-plane torque. This means that frequency measurements can be used to determine the spin torque components. Recent measurements of the ferromagnetic resonance frequencies in MTJs have yielded a perpendicular torque linear in the applied voltage across the junction, and of the same magnitude as the in-plane component.
Manipulation and analysis of single magnetic impurities in semiconductors by STM

Paul Koenraad
COBRA, Eindhoven University of Technology, P.O.Box 513, 5600 MB, The Netherlands

We have recently shown that one can ionize single impurities [1,2] and spatially resolve the shape of the wavefunction of a single hole bound to a single Mn-impurity by using Cross-sectional Scanning Tunneling Microscopy (X-STM) [3,4]. Such information about the wavefunction is very valuable as it allows a direct identification of the character of the electronic state and visualization of the interaction between Mn-impurities. This interaction plays an essential role in the magnetic properties of GaMnAs as the magnetic coupling between the localized spin of the Mn-acceptors is assumed to be hole-mediated. In this presentation we will review our recent results on wavefunction imaging of single Mn-impurities with and without an external magnetic field, strained Mn-impurities, and Mn-impurities in self-assembled InAs quantum dots.

The X-STM measurements were performed at room temperature in UHV (P<2*10^{-11} torr) at the cleaved (110) surface of GaAs. By changing the tip polarity we were able to change the charge state (A'/A^0) of individual Mn-acceptors in lightly doped (3*10^{18} cm^{-3}) Mn:GaAs. In the neutral state (A^0) the X-STM images clearly showed that Mn in GaAs acts as an effective mass acceptor where a single hole is bound to a Mn^{2+} 3d^5 core. The strong anisotropy that was observed could be related to the cubic symmetry of the GaAs and was successfully reproduced in both envelope function effective mass model (EFM) and tight binding model (TBM) calculations.

We analyzed the effect of strain on the shape of the acceptor wavefunction [5]. In a structure where we were able to image a Mn-impurity close to an InAs-self-assembled quantum dot we could observe how the strain profile in the close neighborhood of dot affects the acceptor state. The images showed a surprisingly strong symmetry breaking of the shape of the wavefunction if the strain was aligned in a (111) direction. The TBM and EFM calculations confirmed the strong effect of strain on the wavefunction symmetry. The influence of surface relaxation induced strain on the acceptor wavefunction has been shown to break the symmetry of the wavefunction of acceptors close to the semiconductor-vacuum interface [6,7]. Finally some recent observations of InAs self-assembled nanostructures where Mn impurities were incorporated during their growth will be shown [8].

References
I. Wijnheijmer et al. PRL 102, 166101 (2009)
A. Yakunin et al. PRL 95, 256402 (2005)
J. Garleff et al. PRB 78, 075313 (2008)
C. Celebi et al. PRL 104, 086404 (2010)
M. Bozkurt et al, APL 96, 042108 (2009)
From molecular magnetism to magnetic molecules on surfaces

Jens Kortus
Institute for Theoretical Physics, Freiberg, Germany

In order to store information in any magnetic material one needs an energy barrier preventing the flip of the direction of the magnetization. The height of the barrier determines the temperature up to which the device will function properly. Therefore one of the major hopes in the field of molecular magnetism is the rational design of this magnetic anisotropy barrier, which depends on the total magnetic moment of the molecule and the magnetic anisotropy, by means of electronic structure calculations [1].

There is considerable knowledge about the magnetic exchange coupling which determines the total spin. In contrast there is not much known about magnetic anisotropy which is mainly determined by the spin-orbit coupling. Only recently it became possible to predict the value of the magnetic anisotropy by means of electronic structure calculations. I will discuss the interplay of the magnetic anisotropy and magnetic exchange interaction in case of two Mn6 complexes. The results suggest that large magnetic anisotropy is not favoured by a high spin state of the ground state [2].

In the second part I will focus on electronic properties of magnetic molecules on surfaces, where electronic structure calculations can provide information required for interpretations of experimental data [3].

How to build molecules with large magnetic anisotropy

Can large magnetic anisotropy and high spin really coexist?


Spin electric effects in molecular antiferromagnets

Daniel Loss
Department of Physics, University of Basel, Switzerland

Molecular nanomagnets show clear signatures of coherent behavior and have a wide variety of effective low-energy spin Hamiltonians suitable for encoding qubits and implementing spin-based quantum information processing [1]. At the nanoscale, the preferred mechanism for control of quantum systems is through application of electric fields, which are strong, can be locally applied, and rapidly switched. In this work, we provide the theoretical tools for the search for single molecule magnets suitable for electric control. By group-theoretical symmetry analysis we find that the spin-electric coupling in triangular molecules is governed by the modification of the exchange interaction, and is possible even in the absence of spin-orbit coupling. In pentagonal molecules the spin-electric coupling can exist only in the presence of spin-orbit interaction. This kind of coupling is allowed for both s=1/2 and s=3/2 spins at the magnetic centers. Within the Hubbard model, we find a relation between the spin-electric coupling and the properties of the chemical bonds in a molecule, suggesting that the best candidates for strong spin-electric coupling are molecules with nearly degenerate bond orbitals. We
also investigate the possible experimental signatures of spin-electric coupling in nuclear magnetic resonance and electron spin resonance spectroscopy, as well as in the thermodynamic measurements of magnetization, electric polarization, and specific heat of the molecules. A most promising candidate for such spin-electric coupling are Cu3-rings where the chirality of the spin texture defines a scalable qubit that can be controlled and measured by electric fields, e.g. by using an STM tip or a microwave cavity.


Effects of magnetic field on transport and noise in nanostructures

M. Macucci\textsuperscript{1}, P. Marconcini\textsuperscript{1}, R. S. Whitney\textsuperscript{2}, G. Iannaccone\textsuperscript{1}, M. Totaro\textsuperscript{1}, D. Logoteta\textsuperscript{1}

\textsuperscript{1}Dipartimento di Ingegneria dell’Informazione, Università di Pisa, Pisa
\textsuperscript{2}Institut Laue-Langevin, Grenoble

In this presentation we focus on the effect of magnetic field on transport and, especially, noise in some relevant nanostructures. In particular, we focus on transport and noise in mesoscopic cavities, addressing also the numerical techniques most suitable for the analysis of the different cases. While it has been shown that, from the point of view of a semiclassical model, shot noise in a series of barriers is suppressed by a factor 1/3, a quantum calculation yields quite a different result, that may appear surprising at first. The Fano factor, i.e. the ratio of the actual noise power spectral density to that expected from Schottky’s theorem for uncorrelated carriers, does not converge to 1/3 as the number of barriers is increased, but, rather, takes on different values depending on barrier transparency, approaching unity in the case of opaque barriers. The reason behind this apparent contradiction is that all semiclassical models are based on the definition of a well defined occupancy in each region between two barriers, an occupancy that depends only on energy. In the presence of 1-D disorder (represented by the barriers) this is not possible, because there is no mixing between different transverse modes. The presence of a magnetic field does, however, introduce mode mixing, and, under proper conditions, can lead to the 1/3 shot noise suppression limit predicted by semiclassical theories. An equivalent approach to the physical system we are considering is in terms of localization length: in the presence of mode mixing, the localization length is much larger, because it corresponds to the one we would have without mixing multiplied by the number of modes and can therefore exceed the length of the device, if the number of modes is large enough. The effect of magnetic field in terms of mode-mixing and suppression of localization can easily be seen also from the dependence of device resistance as a function of the number of barriers, which crosses over from an exponential to a linear behavior as the value of the magnetic field is increased.

Another interesting effect of magnetic field is shot noise suppression in mesoscopic cavities. As well known, shot noise, in the absence of magnetic field, is suppressed by a factor 0.25 in a symmetric mesoscopic cavity with narrow constrictions, and it has been experimentally shown that it drops down towards zero as a magnetic field perpendicular to the plane of the cavity is increased. Previous interpretations in the literature connected this effect with the ratio of the semiclassical cyclotron radius and cavity size, while we have determined that there is a much simpler explanation, based on the suppression of scattering (which is at the origin of the chaotic behavior of these systems) at the constrictions defining the cavity when the cyclotron radius becomes smaller than the constriction width. This offers an explanation that is fully consistent with existing experimental data and does not need to rely on the presence of any disorder in the cavity. Finally, we discuss a somewhat unexpected conductance enhancement effect that can be observed when a tunnel barrier is surrounded with two symmetric constrictions, thereby defining a cavity around it. It is possible to show that, as a result of coherent path interference, the conductance of the complete structure can be much larger than that of the barrier. This effect is not a simple resonance, such as in a Fabry-Perot cavity, but is much more general, because it survives over a wide energy range. Application of a magnetic field breaks the symmetry of the structure and suppresses the enhancement. Therefore it is possible to conceive a magnetic field detector based on such an effect. We
discuss, on the basis of the results of numerical simulations, the feasibility of an experiment demonstrating the conductance enhancement effect and its dependence on magnetic field.

Spin-valley blockade in carbon-based quantum dots

Andras Palyi
University of Konstanz, Germany

In recent experiments demonstrating spin qubit manipulation in semiconductor quantum dots the spin blockade effect has been utilized for initialization and readout of the state of the qubit. In these experiments the main cause of spin decoherence is the interaction between the spin of the electron and the nuclear spins of the atoms forming the crystal lattice of the semiconductor. As the dominant 12C isotope (99%) has no nuclear spins, carbon-based quantum dots in graphene and nanotubes hold the promise for improved spin coherence times. This expectation is a strong motivation to implement the spin blockade functionality in carbon-based quantum dots. In the talk I will (1) introduce the concept of spin blockade, (2) give an overview of the experiments and theory of this effect in conventional semiconductor quantum dots, and (3) review how the characteristic features of carbon-based systems, such as valley degeneracy, strong spin-orbit interaction, disorder-induced valley-mixing and a peculiar type of hyperfine interaction, affect the properties of the spin blockade.

Spin Effects in One Dimensional Electronic Conduction

Mike Pepper
Department of Electronic and Electrical Engineering
and
London Centre for Nanotechnology
University College London

A review is presented of recent results on the role of spin in electron transport in quasi-one dimensional channels in the GaAs-AlGaAs heterostructure. In the regime of strong confinement the conductance takes on quantized values given by $2ne^2/h$ where $n$ is the number of one dimensional subbands. Lifting the momentum degeneracy, with a source-drain voltage, results in structure appearing at 0.25 and 0.85, in units of $2e^2/h$, indicating a lifting of the spin degeneracy. This conclusion is supported by detailed measurements of the dc conductance and effects of application of a magnetic field.

When the confinement potential decreases the electron wavefunctions relax in the second dimension. In order to minimise the electron-electron repulsion, an array is formed in which a two row configuration becomes the ground state and is the prelude to formation of a Wigner Lattice. The rows can be separate but as they are forced back together hybridization can be observed prior to the formation of a single row. As these transitions occur a range of spin effects can be observed.

In the low carrier concentration limit the exchange energy between neighbouring electrons becomes less than $kT$ and the spin direction can no longer be defined. This spin incoherent regime has been investigated and will be discussed.
Ab initio calculations for magnetic tunnel junctions and model-based description of spin flip scattering

Ivan Rungger, Tom Archer, Nuala M. Caffrey, Aaron Hurley, and Stefano Sanvito
Trinity College Dublin, Ireland

In the computational spintronics group in Dublin [1] we have developed the ab initio code SMEAGOL [2], which is based on density functional theory (DFT), and which uses the non-equilibrium Green's functions formalism to calculate the transport properties of nano-devices. In the first part of the talk the results of calculations for different types of magnetic tunnel junctions (MTJs) are presented. The general concepts behind MTJs are outlined, and the transport properties of ideal, defect-free, single and double barrier Fe/MgO(100) MTJs are investigated. Two features are found to determine the I-V characteristics [3]: 1) interface states, and 2) Fe band-edges. The movement of these electronic levels with the applied bias voltage causes the decay of the tunneling magnetoresistance (TMR) with bias. It is also shown how defects reduce the TMR. To conclude this part two other types of MTJs are shown. The first class are junctions with a ferroelectric BaTiO3 barrier sandwiched between Fe and SrRuO3 electrodes. These junctions present both the TMR and the tunneling electroresistance (TER) effect. The second type are spin-filter junctions, where half-metallic EuO is used as tunnel barrier between non-magnetic electrodes.

In the second part of the talk a model for describing inelastic spin flip spectroscopy is presented. They key concept is that the spin-dependent inelastic contributions are collected in a self-energy term used within the Keldysh Green's function formalism. A theoretical study has been carried out on the transport properties of single and multiple chains of atomic spins incorporating inelastic interactions. In particular the I-V characteristics for a single atom of iron and for a one dimensional chain of anganese atoms are calculated and compared with experimental results.


Magnetic imaging and excitation of nanostructures built from individual atoms

Jens Wiebe
Institute of Applied Physics, University of Hamburg, 20355 Hamburg, Germany

Nanostructures composed of a few magnetic atoms adsorbed onto or doped into a nonmagnetic substrate are a perfect model system to investigate the fundamentals of magnetism at the nanoscale. In view of their future data storage, spintronics or quantum computing applications, two of the most basic questions are (i) what determines the lifetime of an atomic-spin excitation, and (ii) how strong are the interactions between individual atomic spins. We use spin-polarized scanning tunneling spectroscopy (SP-STS) [1] to read out, and inelastic STS [2] to excite the magnetization of individual atoms in order to tackle these questions.

In this talk I will review our recent research on magnetic atoms on various substrates. By choosing semiconducting or metallic substrates, the degree of hybridization of the atomic states with the substrate conduction electrons is varied. For weakly hybridizing semiconducting substrates our results can be described within an “isolated spin Hamiltonian” including the substrate in lowest order approximation by a magnetic anisotropy term [3]. Instead, for strongly hybridizing metals [1] the itinerant electrons of the substrate have to be considered. For the latter case we can map the RKKY-like exchange in atom pairs with distances of several lattice spacings and compare to calculations using the Korringa-Kohn-Rostoker Greenfunction method [4].
will show that we can use the map to tailor nanostructures with interesting functionalities which are then being built atom by atom using atom manipulation.

Contributed talks:

**RKKY coupling in graphene**

Annica Black-Schaffer  
Uppsala University, Sweden

We demonstrate that the carrier-mediated exchange interaction, the so-called RKKY coupling, between two magnetic impurity moments in graphene is significantly modified in the presence of electron-electron (el-el) interactions. Within the mean-field approximation of the Hubbard-U model we show that for increasing el-el interactions the oscillations disappear and the power-law decay becomes more long ranged. In zigzag graphene nanoribbons the effects are even more striking, with any finite U rendering the RKKY coupling distance independent. Comparing our results with first-principles results, we can also extract a surprisingly large value for U, indicating that graphene is very close to an antiferromagnetic instability. Since the RKKY coupling is directly proportional to the magnetic susceptibility, these results are important for any physical property of graphene related to magnetism.

**Ab-initio calculations and synthesis of the off-stoichiometric half-Heusler phase Ni$_{1-x}$Mn$_{1+x}$Sb.**

Marcus Ekholm and Igor Abrikosov  
Linköping University, Sweden

We have performed a combined theoretical and experimental study of the phase stability and magnetism of the off-stoichiometric Ni$_{1-x}$Mn$_{1+x}$Sb in the half-Heusler crystal phase. Our work is motivated by the need for strategies to engineer the magnetism of potentially half-metallic materials, such as NiMnSb, for improved performance at elevated temperatures. By means of ab-initio calculations we investigate Ni$_{1-x}$Mn$_{1+x}$Sb over the whole composition range 0$\leq$ x $<$ 1 of Ni replacing Mn and show that at relevant temperatures, the half-Heusler phase should be thermodynamically stable up to at least x=0.20 with respect to the competing C38 structure of Mn$_2$Sb. Furthermore we find that half-Heusler Ni$_{1-x}$Mn$_{1+x}$Sb retains half metallic band structure over the whole concentration range and that the magnetic moments of substitutional Mn atoms display magnetic exchange interactions an order of magnitude larger than the Ni-Mn interaction in NiMnSb. We also demonstrate experimentally that the alloys indeed can be created by synthesizing off-stoichiometric Ni$_{1-x}$Mn$_{1+x}$Sb films on MgO substrates by means of magnetron sputtering.

**Dynamical Exchange Interaction Between Localized Spins in Non-Equilibrium**

Jonas Fransson  
Uppsala University, Sweden

The electron mediated exchange interaction between local spins adsorbed on two-dimensional surface is studied under non-equilibrium conditions. The effective spin-spin interaction is found to depend both on time and the spin-polarization of the substrate. For spatially anisotropic spin-polarization of the substrate, the spatial dependence of the interaction comprise components decaying as $\sin(2k_F R)/(2k_F R)$ and $\sin(2k_T R)/(2k_T R)^2$. 
First-principle studies of Mn impurities in GaAs in the presence of spin-orbit interaction

M. Fhokrul Islam and C. M. Canali
School of Computer Science, Physics and Mathematics, Linnaeus University, Kalmar, Sweden

We report on density-functional theory studies of substitutional Mn impurities in GaAs. Our calculations include the effect of spin-orbit interaction, which has not been considered in detail so far. For single Mn impurity we have investigated how electronic structure is influenced by spin-orbit coupling and strong correlation among the d electrons of a Mn atom. For two interacting magnetic impurities in bulk, we calculate the effective exchange interaction constant defined as the difference between the ground state energies for the ferromagnetic and antiferromagnetic configuration of the magnetic moments. We find that for Mn impurities, the ferromagnetic alignment is energetically favorable. In all cases, the exchange constant is strongly anisotropic, as a function of both the pair orientation and, due to the spin-orbit interaction, the direction of the magnetic moment. We also have studied the case where the Mn impurities substitute Ga atoms on the (110) surface of GaAs, which recently has been investigated experimentally by novel STM techniques.

Spin-electric coupling in the \{Cu3\} single-molecule magnet

M. Fhokrul Islam, Javier F. Nossa, and C. M. Canali
School of Computer Science, Physics and Mathematics, Linnaeus University, Kalmar, Sweden

Mark Pederson
Naval Research Laboratory, Washington, USA

We investigate the electronic and magnetic properties of the triangular antiferromagnetic \{Cu3\} single-molecule magnet by means of spin density functional theory. Our calculations show that the low-energy magnetic properties are correctly described by an effective three-site spin $s = \frac{1}{2}$ Heisenberg model, with an antiferromagnetic exchange coupling $J \approx 5$ meV. The ground state manifold of the model is composed of two degenerate spin $S = 1/2$ doublets of opposite spin chirality. Due to lack of inversion symmetry in the molecule these two states are coupled by an external electric field, even when spin-orbit interaction is absent. The spin-electric coupling can be viewed as originating from a modified exchange constant $\delta J$ induced by the electric field. We find that the calculated transition rate between the chiral states yields an effective electric dipole moment $d = 3.38 \times 10^{-33}$ Cm $\approx 10^{-4} a$, where $a$ is the Cu separation. For external electric fields $\varepsilon \approx 10^8$ V/m this value corresponds to a Rabi time $\tau \approx 1$ ns and to a $\delta J$ of the order of a few $\mu$eV.

Thermoelectrical Manipulation of Nano-Magnets.

M. Kadigrobov, S. Andersson, D. Radic, R. I. Shekhter, M. Jonson, and V. Korenivski.
Chalmers University of Technology, Göteborg, Sweden

We investigate the interplay between the thermodynamic properties and spin-dependent transport in a mesoscopic device based on a magnetic multilayer (F/f/F), in which two strongly ferromagnetic layers (F) are exchange-coupled through a weakly ferromagnetic spacer (f) with the Curie temperature $T_c^{(f)}$ in the vicinity of room temperature. We show that in such an exchange-spring multilayer, an orientational phase transition of the second order takes place, the critical temperature of which $T_c^{(or)}$ being below the Curie temperature of the spacer ($T_c^{(or)} < T_c^{(f)}$). Inside the temperature interval $T_c^{(or)} < T < T_c^{(f)}$ the parallel orientation of the magnetizations inside the multilayer is unstable and the relative orientation of the outer F-layers increases with an increase of temperature becoming anti-parallel at $T > T_c^{(f)}$. It allows a spin-thermo-electronic control of the relative orientation of the outer F-layers in the device. Supporting experimental evidence of such thermally controlled switching from parallel to anti-parallel magnetization orientations in F/f(N)/F sandwiches is presented. Presence of an inductor in the
electrical circuit results in magneto-resistance oscillations whose frequency can be controlled by proper biasing from essentially DC to GHz. We discuss in detail an experimental realization of a device that can operate as a thermo-magneto-resistive switch or oscillator.

**Self-excited Oscillations of Charge-Spin Accumulation Due to Single-electron Tunneling**

Chalmers University of Technology, Göteborg, Sweden

We theoretically study electronic transport through a layer of quantum dots connecting two metallic leads. By inclusion of inductor in series to the junction, we show that steady electronic transport in such a system may be unstable with respect to temporal oscillations caused by an interplay between the Coulomb blockade of tunneling and spin accumulation in the dots. When this instability occurs, a new stationary regime is reached, where the average spin and charge in the dots oscillate in time. The frequency of these oscillations is typically of the order of 1GHz for realistic values of the junction parameters.

**Spectral Adjustment in Nanoscale Transport**

Victor Garcia Suarez, Jaime Ferrer
University of Oviedo, Oviedo, Spain

We implement a general method to correct the low-bias transport properties of nanoscale systems within an ab-initio code based on linear combinations of atomic orbitals. We show how the typical problem of the HOMO-LUMO gap underestimation can be easily corrected, leading to quantitative and qualitative agreement with experiments. We present results for some typical molecules between gold leads and show that this method is an improvement over an alternative method based on calculating the position of the relevant transport resonances and fitting them to Lorentzians.

**Theory of exciton fine structure in cubic semiconductor quantum dots**

Erik Welander and Guido Burkard
Department of Physics, University of Konstanz, D-78457 Konstanz, Germany

We theoretically investigate the radiative recombination of biexcitons in semiconductor quantum dots. The biexciton cascade recombination has been shown to produce entangled photon pairs. The geometry dependent electron-hole exchange interaction is known to lift the degeneracy of the intermediate exciton states. Since spin and energy are coupled, the which-path information would be available by frequency measurements and could prevent the creation of polarization entangled photons. We develop a general model for the quantum dot exciton fine-structure and its dependence on geometry. Explicit results are presented for a spatially asymmetric, harmonically confined GaAs quantum dot.

Bound states, electron localization and conductance in realistic quantum point contacts (QPCs) of different geometry and applied gate voltages will be discussed for a model GaAs/AlGaAs device. Using the local spin density approximation (LSDA) we recover spin-polarized states in the middle of QPC which gives to the 0.7 $(2e^2/h)$ conductance anomaly as well as spin-split states near the two edges of QPC that may be associated with the conductance anomaly in the vicinity of 0.25 $(2e^2/h)$. We have found that the degree of electron localization depends strongly on the type of confinement potential in the system. In the case of the discontinuous potentials of rectangular or square form the localized states of one and more electrons are clearly recognized. When the confinement potential becomes softer the electron localization becomes weaker and disappears eventually in the case of Gaussian type of potential. This result questions the possibility of localized and bound states in the QPCs as well as the dynamical spin polarization model used for explaining conductance anomalies. This model is based essentially on the assumption of local spin inside of QPCs.