TT 11: Spintronics, Spincalorics and Magnetotransport

Time: Monday 15:00–16:30 Location: HSZ 304

TT 11.1 Mon 15:00 HSZ 304

Van der Waals/non-van der Waals hybrids for superconducting spintronics — Roman Hartmann, Alfredo Spuri, Danilo Nikolic, Wolfgang Belzig, Elke Scheer, and •Angelo Di Bernardo — Universität Konstanz, Konstanz, Germany

The realization of Cooper pairs of electrons with parallel-aligned spins (i.e., spin-triplet pairs) has been demonstrated for a variety of three-dimensional (3D) superconductor/ferromagnet (S/F) heterostructures. Several studies have shown that using S/F system with a magnetically inhomogeneous F [1-2] it is possible to convertthe spin-singlet pairs of a conventional S into fully-polarized spin triplets - this has paved the way for superconducting spintronics. Van-der-Waals (vdW) heterostructures host a variety of unconventional phases, both superconducting and magnetic, which can be explored to realize two-dimensional (2D) superspintronic devices with novel functionalities and types of control compared to devices based on 3D S/F hybrids. The conversion of spin singlets into spin triplets across a 2D S/F vdW interface represents, however, the first step towards superconducting spintronics based on vdW hybrids. In this talk, I will show recent magnetotransport experiments obtained on F nanoflakes that are cleaved from 3D ionic F single crystals through a new approach. The unique properties of these nanoflakes are used for the fabrication of novel superspintronics devices, where the nanoflakes are coupled to conventional 2D vdW S materials.

[1] J. W. A. Robinson et al., Science 329, 59 (2010)
[2] A. Di Bernardo et al., Nat. Commun. 6, 8053 (2015)

TT 11.2 Mon 15:15 HSZ 304

Thermal transport in weakly coupled spin-$\frac{1}{2}$ Heisenberg ladders — •Anja Wenger, Christian Northe, and Ewelina Hankiewicz — Institut für Theoretische Physik und Astrophysik, Universität Würzburg, 97074 Würzburg, Germany

We investigate the weakly coupled spin-$\frac{1}{2}$ Heisenberg ladder in the low energy limit. As magnetic excitations significantly contribute to the thermal transport, we expose the ladder to a magnetic field and analyze the thermal conductivity and the specific heat capacity depending on the magnetization. Starting point is the spin-$\frac{1}{2}$ Heisenberg chain and its fermionic and bosonic description by conformal field theory. From coupling two spin chains and applying the (rescaled) bosonisation technique, a free theory for spin-ladders and its spectrum is obtained. Special interest lies on the conformal anomaly and the Tomonaga-Luttinger Liquid parameters. Introducing temperature to the theory gives access to the thermal transport properties.

TT 11.3 Mon 15:30 HSZ 304

Critical current control in ferromagnetic proximity junctions by magnetization and spin injection — •Lukas Kammermeier and Elke Scheer — Universität Konstanz, Konstanz, Germany

We exploit the inverse proximity effect of a ferromagnet on a superconductor to locally suppress the superconductivity in a thin wire and thereby create a Josephson junction.

We show that we can control the critical current I_c over a wider range by manipulating the magnetization state of the ferromagnet, possibly sensitive to single magnetic domains in proximity to the constriction. Additionally, the efficiency of spin injection by running a current from the spin-polarized ferromagnet into the junctions constriction will be presented.

TT 11.4 Mon 15:45 HSZ 304

On the connection between the chiral-induced spin selectivity effect and the chiro-optical activity: The case of an electron in a helix — •Solmar Varela[1], Gianaurelio Cuniberti[1], Rafael Gutierrez[1], Ernesto Medina[2], Vladimiro Mujica[3], and Jesus Ugalde[4] — [1]Chair of Materials Science and Nanotechnology, TU Dresden, Dresden — [2]Departamento de \'isica, Colegio de Ciencias e Ingenier\'ia, Universidad San Francisco de Quito, Ecuador — [3]School of Molecular Sciences, Arizona State University, USA — [4]Kimika Fakultatea, Euskal Herriko Unibertsitatea (UPV/EHU), Spain

We have obtained a connection between the chiro-optical activity and the spin-orbit interaction for a model system of an electron constrained to a helix, taking explicitly spin into account, in the presence of an electromagnetic field as a perturbation. Because of the chiral nature of the system, spatial inversion symmetry is broken, which in turn induces a connection between the electric and the magnetic responses of the system to the external electromagnetic field, that is absent in achiral systems. Despite the apparent simplicity of the model, it contains most of the relevant physics involved in this problem, and we have established a relationship between the optical activity response, via the Rosenfeld tensor and the spin polarization, defined as the average value of the Pauli spin-1/2 matrices. This relationship between the optical response and the CISS responses, can guide new efforts in the fields of reticular chemistry and material design for spintronics, and spin-selective chemistry.

TT 11.5 Mon 16:00 HSZ 304

Electron and spin-phonon interaction in DNA: A minimum analytical model — •Mayra Peralta[1], Solmar Varela[1], Vladimiro Mujica[2], Rafael Gutiérrez[1], Ernesto Medina[3], and Gianaurelio Cuniberti[1] — [1]Institute of Materials Science and Nanotechnology, Technische Universität Dresden, Dresden 01062, Germany — [2]School of Molecular Sciences, Arizona State University, TEMPE, AZ 85287 — [3]Departamento de Física, Colegio de Ciencias e Ingeniería, Universidad San Francisco de Quito, Diego de Robles y Vía Interoceánica, Quito, 170901, Ecuador

We analyze the influence of electron-phonon and spin-phonon interaction in a model for electron transfer(ET) in DNA in terms of the envelope function approach. We are specifically concerned with the effect of these interactions on the coherence of the ET process and how to model the interaction of DNA with phonon reservoirs of biological relevance. We assume that the electron bearing orbitals are half filled and derive the physics of the electron- and spin-phonon coupling in the vicinity in reciprocal space. In a first model for spinless electrons we find that at half filling, the acoustical modes are decoupled to ET at first order, while optical modes are predominant. The latter are associated with inter-strand vibrational modes in consistency with previous studies involving polaron models of ET. Coupling to acoustic modes depends on electron doping of DNA, while optical modes are always coupled within our model. When the spin is included, through the Spin-orbit coupling whose intensity is geometry dependent, we find that acoustical phonons become coupled independently of the doping.

TT 11.6 Mon 16:15 HSZ 304

Gate-tunable insulator-metal transition and weak antilocalization in two-dimensional tellurium — •Dorsa Fartab[1], José Guimarães[1,2], Marcus Schmidt[1], and Haijing Zhang[1] — [1]Max Planck Institute for Chemical Physics of Solids, 01187 Dresden, Germany — [2]School of Physics and Astronomy, University of St Andrews, St Andrews KY16 9SS, UK

Charge carrier density control is a key factor to modify the electronic functionality of materials. The ability to induce high charge carrier concentration into various two-dimensional materials has led to exotic phenomena such as insulator-metal transition and superconductivity. So far, different techniques have been used to achieve this. Meanwhile, electric double layer transistor (EDLT) is a highly promising platform as it can provide high charge carrier density of up to $10^{15} cm^{-2}$ in its channel material. This is two orders of magnitude larger than that in the conventional transistors as a result of using ionic liquids instead of common solid dielectrics. First, I will give a short overview on the EDLTs, then I will present our experimental results of ionic liquid gated two-dimensional tellurium (Te). Our results show the possibility of gate tuning insulator-metal phase transition and the gate and temperature-dependent weak antilocalization in p-type Te films. More interestingly, we have shown the ability of controlling the spin-orbit interaction in the material by changing the applied gate voltage.