SYCZ 1: Czech Republic as Guest of Honor

Time: Thursday 9:30–12:45 Location: H4

Invited Talk SYCZ 1.1 Thu 9:30 H4
Crystal symmetries and transport phenomena in antiferromagnets — •Tomas Jungwirth — Institute of Physics, Czech Academy of Sciences, Cukrovarnicka 10, 162 00 Praha 6, Czech Republic — School of Physics and Astronomy, University of Nottingham, Nottingham NG7 2RD, United Kingdom

The suppression of dipolar fields in antiferromagnets is favorable for high density integration of memory elements and makes them robust against magnetic field perturbations. Other unique merits of antiferromagnetic spintronics include the multi-level switching, suitable for integrating memory with logic or neuromorphic functionalities, and the ultra-fast THz spin dynamics. In the lecture we will first give a brief overview of the multiple directions in current research of antiferromagnetic spintronics [1]. We will then outline the rich symmetry landscape of antiferromagnets which allows for a range of transport phenomena suitable for manipulating and detecting antiferromagnetic spins. Our main focus will be on electrical readout of spin-reversal in antiferromagnets. This can be facilitated by a second-order magnetoresistance effect in antiferromagnets with broken time and space-inversion symmetries [2]. In the linear response, we introduce a mechanism of the spontaneous Hall effect in collinear antiferromagnets in which the required breaking of time-reversal and other symmetries is caused by the arrangement of non-magnetic atoms in the lattice [3].

[1] T. Jungwirth et al., Nature Physics 14, 200 (2018). [2] J. Godinho et al., Nature Communications 9, 4686 (2018). [3] L. Šmejkal et al., arXiv:1901.00445.

Invited Talk SYCZ 1.2 Thu 10:00 H4
Terahertz subcycle charge and spin control — •Rupert Huber — Department of Physics, University of Regensburg, 93040 Regensburg

With conventional electronics approaching its ultimate limits, novel concepts of fast quantum control have been sought after. Lightwave electronics – the foundation of attosecond science – has opened a new arena by utilizing the oscillating carrier wave of intense light pulses to control electrons faster than a cycle of light. We employ atomically strong terahertz electromagnetic pulses to drive Bloch oscillations, quasiparticle collisions, and high-harmonic generation in bulk and atomically thin semiconductors. In monolayers of transition metal dichalcogenides, we switch the electrons' valley pseudospin and we resolve subcycle terahertz-driven spin switching in an antiferromagnet, opening the door to valleytronics and spintronics at multi-terahertz clock rates.

Invited Talk SYCZ 1.3 Thu 10:30 H4
1D molecular system on surfaces — •Pavel Jelinek — Institute of Physics of Czech Academy of Sciences, Prague, Czech Republic — Palacky University, Olomouc, Czech Republic

Low dimensional materials offer very interesting material and physical properties due to reduced dimensionality. At present, 2D materials are the focus of attention. However, 1D systems often show far more exotic behaviour, such as Luttinger liquid, Peierls distortion, Majorana states etc.. We will present different classes of 1D molecular chains formed on metallic surfaces, which physical properties were investigated by scanning probe microscopy supported by theoretical simulations. We will discuss a presence of non-trivial topological end states rationalized by Su-Schrieffer-Heeger model. We will also demonstrate interesting mechanical and electronic properties of organometalic chains resulting from on surface polymerization of ferrocene molecules.

15 min break

Invited Talk SYCZ 1.4 Thu 11:15 H4
Tunneling microscopy on insulators provides access to out-of-equilibrium charge states — Laerte L. Patera, Fabian Queck, Philipp Scheuerer, and •Jascha Repp — Department of Physics, University of Regensburg, 93040 Regensburg, Germany

Scanning Tunneling Microscopy (STM) is a powerful tool for the investigation of individual molecules, being able to probe their orbitals with sub-molecular resolution [1]. However, the requirement of a conductive substrate strongly limits the accessible electronic transitions. Conversely, atomic force microscopy (AFM) can be extended to insulating substrates, providing structural and electrostatic information. However, electronic states are generally not accessible by AFM. Here, we exploit the single-electron sensitivity of AFM [2] in detecting electrostatic forces to establish a novel mode in scanning probe, in which an alternating current instead of a direct current probes the sample. Only a single electron per oscillation cycle of the AFM cantilever tunnels between tip and investigated structure back and forth, enabling operation in absence of any conductance of the underlying substrate. Our results unveil the effects of electron-transfer and polaron formation on the single-orbital scale [3]. References: [1] J. Repp et al., Phys. Rev. Lett. 94, 026803 (2005); [2] J. Klein et al., Appl. Phys. Lett. 79, 1828 (2001); [3] L. L. Patera et al., in press (2019).

Invited Talk SYCZ 1.5 Thu 11:45 H4
Occam's razor and complex networks from brain to climate — •Jaroslav Hlinka — Institute of Computer Science, Czech Academy of Sciences, Prague, Czech Republic

Brain dynamics constitute one of the archetypal complex systems showing a plethora of rich emergent phenomena. To understand the mechanisms behind the observed properties, computational modeling and sophisticated data analysis approaches are increasingly adopted. However, the complexity of the applied approaches may lead into a new set of problems related to the ambiguity of the appropriate interpretation of the analysis or modeling results. In such cases, it may be suitable to apply the general heuristic principle of parsimony, known as the Occam's razor. In this contribution we shall demonstrate how some rich and complex properties of brain dynamics and connectivity structure can be explained from relatively simple principles and models such as purely linear stochastic dynamics. The specific examples include small-world property of brain networks [1], detecting brain states [2] and (non)linear network inference utility [3]. Relevance to other complex systems (climate dynamics, stock networks) will be highlighted on examples.

[1] Hlinka, J. et al., M. Small-world bias of correlation networks: From brain to climate Chaos, 2017, 27, 035812

[2] Hlinka, J. & Hadrava, M. On the danger of detecting network states in white noise. Front. Comp. Neurosci., 2015, 9, 11

[3] Hlinka, J. et al. Functional connectivity in resting-state fMRI: Is linear correlation sufficient? NeuroImage, 2011, 54, 2218-2225

Invited Talk SYCZ 1.6 Thu 12:15 H4
Long range temporal correlations in complex systems — •Holger Kantz[1], Marc Hoell[1,2], Mozhdeh Massah[1], Philipp Meyer[1], and Katja Polotzek[1] — [1]Max Planck Institute for the Physics of Complex Systems, Dresden, Germany — [2]Department of Physics, Bar Ilan University, Israel

In the past 3 decades, hundreds of measured time series data from physical, environmental, biological, and economic systems have been shown to exhibit long range temporal correlations (LRC), which usually is attributed to some kind of memory in a system. Since first principles' models are usually memory-less ODEs or PDEs, it seems to be the complex dynamics of such systems which creates memory. In this talk, we will present the current state of understanding of LRC, starting with the detection and quantification of LRC which includes some pitfalls. We show some consequences of LRC on statistical inference, we present paradigmatic models for LRC data, and we address the issue of the source for such correlations. We exemplify these issues by an analysis of precipitation data and of global mean surface temperatures.