SYES 2: Spain as Guest of Honor II

Time: Thursday 15:00–17:45 Location: HSZ 01

Invited Talk SYES 2.1 Thu 15:00 HSZ 01
Interactions in assemblies of surface-mounted magnetic molecules — •Wolfgang Kuch — Institut für Experimentalphysik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany

Organic magnetic molecules have great potential for defining the spin of electrons, logic operations, or data storage in future miniaturized electronic devices. For that, the molecules need to be immobilized and contacted, which involves adsorption on solid surfaces. Understanding and controlling the interactions of adsorbed metal–organic magnetic molecules with each other and the environment is thus an important step towards a surface-mounted molecular spin electronics.

X-ray absorption spectroscopy (XAS) is particularly well suited for the experimental investigation of such interactions. The elemental specificity of X-ray magnetic circular dichroism allows to explore the magnetic interaction between ferromagnetic substrates and adsorbed molecules. It is found to persist even across a layer of graphene and could be used, for example, to stabilize the molecule's magnetic moments against thermal fluctuations. Field-dependent measurements yield insight into the magnetic interaction between neighboring molecules in one- or two-dimensional molecular surface assemblies. The decisive role of the substrate on the magnetic properties of adsorbed molecules is emphasized by the change in spin state caused by a relatively subtle modification of the substrate such as a different crystallographic surface orientation. Finally, directly probing the d occupation by XAS, cooperativity in the thermally induced spin-state switching between adsorbed spin-crossover molecules is identified.

Invited Talk SYES 2.2 Thu 15:30 HSZ 01
Towards phononic circuits based o optomechanics — •Clivia M. Sotomayor-Torres — Catalan Institute of Nanoscience and Nanotechnology (ICN2), CSIC and BIST,*Campus UAB, Bellaterra, 08193 Barcelona, Spain ICREA, Passeig Lluis Companys, 08010 Barcelona, Spain — ICREA, Passeig Lluis Companys, 08010 Barcelona, Spain

he optomechanical interaction using suspended nanobeams where overlapping confined mechanical and optical modes is chosen to realise circuit elements. Room temperature mechanical quality factors reached Q > 103. We demonstrated a coherent phonon emitter at 0.3 GHz via self-pulsing and up to 5 GHz via dynamical back-action. The nanobeam is coupled evanescently via a tapered fibre either directly to the OM cavity or to an integrated photonic waveguide. The non-linear interactions can be controlled to reach a chaotic regime and, with an external laser, the coherent phonon emission can be modulated. The physics of synchronisation, of nanobeams coupled to optical waveguides and the coupling to surface acoustic waves to excite and detect phononic signals have been studied and reproducible functionalities demonstrated. We report on the progress to integrate elements in a proof-of-concept phononics chip.

Work in collaboration with D. Navarro-Urrios, M. Colombano, G. Arregui, J. Maire, N. Capuj, A. Griol, A. Martinez, J. Ahopelto, T. Makkonen, A. Pitanti, S. Zanotto, B. Djafari-Rouhani, Y. Pennec, D. Mencarelli and L. Pierantoni , partners of the EU H2020 FET Open project PHENOMEN (713450) www.phenomen-project.eu

Invited Talk SYES 2.3 Thu 16:00 HSZ 01
Optical properties of 2D materials and heterostructures — •Janina Maultzsch — Department of Physics, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

The physical properties of two-dimensional semiconductors, such as transition-metal dichalcogenides (TMDCs), can be modified through the presence of adjacent materials, as in van-der-Waals heterostructures or in covalently functionalized layers. As an example for such an interlayer interaction, we present recent results on the interlayer excitons in $MoSe_2$-WSe_2 and MoS_2-WSe_2 heterostructures [1]. We show that the interlayer excitons are indirect both in real space and in reciprocal space. Furthermore, we predict the structures and properties of two-dimensional antimony oxide [2], which may form if few-layer antimonene is oxidized in ambient conditions. Depending on the stoichiometry, the oxidized antimonene layers are semiconducting with band gaps between 2.0 eV and 4.9 eV. Therefore, oxidation of few-layer antimonene may result in natural heterostructures composed of semiconducting antimonene oxide and semimetallic few-layer antimonene.

[1] R. Gillen and J. Maultzsch, Phys. Rev. B 97 (2018), pp. 165306. [2] S. Wolff, R. Gillen, M. Assebban, G. Abellán, J. Maultzsch, https://arxiv.org/abs/1909.01204

Coffee Break

Invited Talk SYES 2.4 Thu 16:45 HSZ 01
Bringing nanophotonics to the atomic scale — •Javier Aizpurua — Center for Materials Physics (CSIC-UPV/EHU), San Sebastian, Spain

A plasmonic nanogap is a superb configuration to explore the interplay between light and matter. Light scattered off, or emitted from a nanogap carries the information of the surrounding electromagnetic environment with it. In metallic nanocavities with ultrasmall gaps, electron currents across the gap at optical frequencies efficiently produce a strong nonlinear optical response. All these effects can be further controlled when a bias is applied across the gap, enabling the possibility of active control of light emitted from the cavity. This situation becomes even more appealing when a molecule is located in the gap of the plasmonic cavity or in its proximity, with the molecule playing an active role either in the electromagnetic coupling with the cavity, or even participating in processes of charge injection and transfer, which can be revealed through molecular electroluminescence. Here, we will address situations of light emission in electron tunneling configurations where atomic-scale resolution is achieved due to the presence of picocavities within the gap. The process of interaction between a molecular emitter and a tunneling cavity will be addressed both in the weak and strong coupling regimes, as revealed in light absorption and in emission. Strong coupling between a molecule and a plasmonic cavity shows great technological potential as it produces hybrid molecule-cavity polaritonic states which can be used for quantum information or in induced chemical reactivity.

Invited Talk SYES 2.5 Thu 17:15 HSZ 01
Infrared signatures of the coupling between vibrational and plasmonic excitations — •Annemarie Pucci — Kirchhoff-Institut für Physik (KIP), Ruprecht-Karls-Universität Heidelberg, Im Neuenheimer Feld 227, 691210 Heidelberg, Germany

Related to confinement, free charge carriers in nanostructures show strong plasmonic resonances in the infrared. Depending on the charge carriers' plasma frequency and on electronic damping, the coherent oscillations are accompanied by a more or less enhanced resonant electro-magnetic nearfield. So, at the plasmonic resonance of a tailored nanostructure, an extraordinarily high nearfield enhancement and thus strong surface enhanced infrared absorption (SEIRA) of a vibrational dipole with the same resonance frequency and sitting inside the nearfield can be obtained, see our work together with J. Aizpurua (Donostia-San Sebastian), for example [1-3]. Combining the ideas of the nearfield enhancement in narrow gaps and tailored resonant plasmonic structures leads the application of nano-apertures for vibrational sensing, for example of ultrafine silica particles. The SEIRA signal of a single particle with diameter below 50 nm could be seen as a Fano-type anti-absorption on the background of resonant plasmonic extinction measured with a commercial infrared-spectroscopic microscope.[4] [1] F. Neubrech et al., Appl. Phys. Lett. 89 (2006) 253104. [2] F. Neubrech et al., Phys. Rev. Lett. 101 (2008)157403. [3] T. Neuman, er al., J. Phys. Chem. C 119 (2015) 26652. [4] C. Huck, et al., Phys. Rev. Applied 11(2019) 014036.