# HL 20: Focussed Session: Geometry- and Topology-Controlled Nanoarchitectures II

Organizers: Paul M. Koenraad (TU Eindhoven) and Vladimir M. Fomin (IFW Dresden)

Time: Tuesday 14:00–15:45 Location: EW 015

HL 20.1 Tue 14:00 EW 015

**Optical Aharonov-Bohm oscillations with disorder effects and Wigner molecule in a single quantum ring** — •Kwangseuk Kyhm — Pusan National University, Busan, South Korea

The Aharonov-Bohm (AB) effect is observed mostly by electrical measurements at extremely low temperatures (<100 mK) through oscillations of the conductance and persistent current with external magnetic field. Very recently, the AB effect became accessible to optical experiments at tens of Kelvin by using type-II quantum dots (QDs) and quantum rings (QRs) in ensembles. However, the exciton Aharonov-Bohm oscillations in a single QR are rarely observed. This difficulty is associated with disorder effects. In the presence of structure anisotropy, localisation, in- ternal electric field, and impurity scattering, we found that optical Aharonov-Bohm oscillations of an electron-hole pair become modulated. Additionally, provided that a strongly correlated exciton pair is formed in a single quantum ring similar to the Wigner molecule, novel oscillations can be observed for increasing magnetic field. In this case, the biexciton emission energy changes abruptly at transition magnetic fields with a fractional oscillation period compared to that of the exciton, the so-called fractional optical Aharonov-Bohm oscillations.

HL 20.2 Tue 14:30 EW 015

**Gold-dye plexcitonic Fano systems** — •Carola Kryschi and Johannes Kupka — Friedrich-Alexander University of Erlangen, 91058 Erlangen, Germany

Coherent coupling between surface plasmons of noble-metal nanostructures and molecular excitons may create particular polaritonic modes, the so-called plexcitons. In this contribution we report surface-structure mediated stationary optical properties and ultrafast excitation relaxation dynamics of plexcitonic gold-nanostructure dye nanohybrid systems. Optical excitation of self-organized assemblies of spherical gold nanoparticles and laser dye molecules resulted into the generation of plexcitonic Fano resonances in absorption which manifest the interference between the plasmonic and molecular resonances. Moreover, we could show that spaser emission can be generated by amplifying longitudinal surface plasmon modes in gold nanorods by optically pumping surface-attached resonantly-coupled laser dyes.

HL 20.3 Tue 14:45 EW 015

**Engineering topological states, spin textures and spin interferometers by shape deformations** — •Carmine Ortix — Institute for Theoretical Physics, Utrecht University, Princetonplein 5, 3584 CC Utrecht, Netherlands

I will discuss the possible interplay between curvature effects on the electronic properties and the topological properties of the quantum states in low-dimensional nanomaterials. In particular, I will present the intricate twist between spin textures and spin transport in shape deformed nanostructures. Non-uniform Rashba spin-orbit coupling in shape deformed quantum rings leads to spin textures with a tunable topological character. These topologically non trivial spin patterns affect the electron spin interference, thereby resulting in different geometry-driven electronic transport behavior

HL 20.4 Tue 15:00 EW 015

**Stretchable and Imperceptible Magnetoelectronics** — •Michael Melzer[1], Martin Kaltenbrunner[2], Denys Makarov[3], Daniil Karnaushenko[1], Dmitriy Karnaushenko[1], and Oliver G. Schmidt[1,4] — [1]IFW Dresden, Institute for Integrative Nanosciences, 01069 Dresden, Germany — [2]JKU Linz, Soft Matter Physics, 4040 Linz, Austria — [3]HZDR, Institute of Ion Beam Physics and Materials Research, 01328 Dresden, Germany — [4]TU Chemnitz, Material Systems for Nanoelectronics, 90107 Chemnitz, Germany

Future electronic skin aims to mimic nature's original in functionality and appearance. While several of its features have recently been demonstrated in artificial counterparts, magnetoception allows going even beyond imitation and equip us with unfamiliar cognition.

Here we introduce e-skins with a magneto-sensory system[1] able to perceive the presence of static or dynamic magnetic fields. The demonstrated ultra-thin giant magnetoresistive (GMR) sensor foils are less than 2 um thick, extremely lightweight and feature unmatched flexibility and mechanical endurance, while maintaining the sensor characteristics of their rigid chip-based counterparts. A geometric transition from flat to a highly wrinkled surface on top of an elastic support, generates an outstanding stretchability of up to 270% with high long term stability.

Our ready-to-use sensing elements offer magnetic functionalities as well as motion and displacement sensorics for e-skins, soft robotics and medical implants.

[1] M. Melzer et al. Nature Communications 6, 6080 (2015).

HL 20.5 Tue 15:15 EW 015

**Intrinsic spin-orbit coupling and spin-Hall effect in graphene** — •Marta Prada[1], Jonas Sichau[2], and Robert H Blick[2] — [1]I. Institute for Theoretical Physics, Jungiusstr. 9, Hamburg (Germany) — [2]Center for Hybrid Nanostructures (ChyN), Luruper Chaussee 149, Hamburg (Germany)

The fundamental assumption of graphene is the celebrated linear energy dispersion relation for charge carriers, as it occurs in the Dirac equation. However, zooming in the low energy scales, a finite gap, and hence, a finite mass is expected. The magnitude of this gap in graphene is of great interest, determining the possibility to observe a topological (spin Hall) insulator. However, controversy exists around the value of this gap, with theoretical predictions varying within two orders of magnitude, while an experimental value has not been determined to this date.

Here, we present evidence that intrinsic spin-orbit interaction in monolayer graphene leads to a measurable bulk gap of 42 $\mu$eV [J. Sichau, M. Prada, T. J. Lyon, B. Bosnjak, L. Tiemann, and R. H. Blick arXiv:1709.05705 (2017).]. We experimentally resolve the spin and pseudo-spin states using microwave excitation in a resistively detected electron spin resonance experiment. We develop a theoretical model that includes the effects of the d-orbitals in a rectangular sample of graphene, and find perfect agreement with the experimental data. Our results are consistent with a spin Hall insulator to a Dirac semimetal phase transition.

HL 20.6 Tue 15:30 EW 015

**Manipulating quantum Hall edge channels through Scanning Gate Microscopy** — Lennart Bours[1], Stefano Guiducci[1], Alina Mrenca–Kolasinska[2], Bartłomiej Szafran[2], Jan C. Maan[3], and •Stefan Heun[1] — [1]NEST, Istituto Nanoscienze–CNR and Scuola Normale Superiore, Piazza San Silvestro 12, 56127 Pisa, Italy — [2]AGH University of Science and Technology, Faculty of Physics and Applied Computer Science, al. Mickiewicza 30, 30–059 Kraków, Poland — [3]Radboud University Nijmegen, High Field Magnet Laboratory, Toernooiveld 7, 6525 ED Nijmegen, The Netherlands

We show evidence of the backscattering of quantum Hall edge channels in a narrow graphene Hall bar, induced by the gating effect of the conducting tip of a Scanning Gate Microscope, which we can position with nanometer precision. We show full control over the edge channels and are able, due to the spatial variation of the tip potential, to separate co-propagating edge channels in the Hall bar, creating junctions between regions of different charge carrier density, that have not been observed in devices based on top– or split–gates. The solution of the corresponding quantum scattering problem is presented to substantiate these results, and possible follow–up experiments are discussed.