HL 23: 2D materials: Graphene and BN (joint session HL/DS)

Time: Tuesday 14:00–15:45 Location: A 151

HL 23.1 Tue 14:00 A 151

Field-effect proximity exchange coupling in bilayer graphene on ferromagnetic insulator — •Klaus Zollner, Martin Gmitra, and Jaroslav Fabian — Institute for Theoretical Physics, Regensburg, Germany

Graphene can be made magnetic by proximity effect through ferromagnetic substrates. We show, by realistic first-principles calculations, that bilayer graphene on $Cr_2X_2Te_6$, a family of ferromagnetic insulators that can be exfoliated in single layers (X = Si and Ge), experiences a layer dependent proximity exchange effect [1]. Due to short range of this proximity effect and the intrinsic layer dependent formation of low energy bands in bilayer graphene, only the valence band gets spin split. In addition, we apply realistic electric fields across the heterostructure, to tune the potential energy of the bilayers and find that we can switch electron and hole bands, along with the exchange splitting. With that we predict fully electrically tunable magnetism for transport carriers, which opens a vast field of proximity spintronics.

This work was supported by DFG SPP 1666, SFB 689, SFB 1277, and by the European Unions Horizon 2020 research and innovation programme under Grant agreement No. 696656.

[1] K. Zollner, M. Gmitra, and J. Fabian, arXiv:1710.08117 (2017).

HL 23.2 Tue 14:15 A 151

Spin-relaxation and Yu-Shiba-Rusinov states in Superconducting Graphene — •Denis Kochan — University of Regensburg, Regensburg, Germany

2D materials in a proximity of superconductor are expected to host a wide spectrum of different phenomena. In my talk I will focus on spin-relaxation in graphene proximitized by an s-wave superconductor. Adatom impurities can affect spin-relaxation via locally enhanced spin-orbit coupling (SOC) and local magnetic moments. I will discuss their impact on quasiparticle spin-relaxation with an attempt to disentangle contributions from the local SOC and local magnetic moments. Moreover, I will analyze a stability of the induced local magnetic moments and the emergence of Yu-Shiba-Rusinov (YSR) bound states in such proximity induced superconducting systems.

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HL 23.3 Tue 14:30 A 151

Magnetic field-induced metal-insulator transition of graphene at filling factor ν=0 — •Sung Ju Hong, Christopher Belke, Johannes C. Rode, Benedikt Brechtken, and Rolf J. Haug — Institut für Festkörperphysik, Leibniz Universität Hannover, Hannover, Germany

We have observed magnetic field-induced metal-insulator transition (MIT) at filling factor ν=0 of hexagonal boron nitride (h-BN) encapsulated single-layer graphene. The temperature dependent longitudinal resistance (R_{xx}) with ν=0 shows MIT at critical magnetic field, $B_c \approx 8$T below (above) which metallic (insulating) behavior occurs. In the metallic regime, the negative magnetoresistance appears, which can be explained by counter-propagating opposite-spin polarized edge state [1,2]. In the insulating regime, the divergence of the R_{xx} was obtained and the resistance showed thermal activation gap behavior. We attribute the MIT with ν=0 to the magnetic field-induced transition from spin polarized state to valley polarized state at B_c.

[1] Peng Wei *et al.*, Nature Mater. **15**, 711 (2016).
[2] Javier D. Sanchez-Yamagishi *et al.*, Nature Nanotech. **12**, 118 (2017).

HL 23.4 Tue 14:45 A 151

Graphene Nanoribbons on Hexagonal Boron Nitride: Deposition and Transport Characterization — Christian Kick[1], Andreas Lex[1], •Tobias Preis[1], Akimitsu Narita[2], Kenji Watanabe[3], Takashi Taniguchi[3], Klaus Müllen[2], Dieter Weiss[1], and Jonathan Eroms[1] — [1]Institute of Experimental and Applied Physics, University of Regensburg, Regensburg, Germany — [2]Max Planck Institute of Polymer Research, Mainz, Germany — [3]National Institute for Materials Science, Tsukuba, Japan

We contacted cove-type graphene nanoribbons (cGNRs) of different widths (4 and 6 carbon dimers) with different metals (NiCr-Au and Pd) and measured their *I*-*V*-characteristics. The cGNRs were chemically synthesized and are solution processable in THF or chlorobenzene after sonification (see [1] for the synthesis). This solution was subsequently drop-cast onto exfoliated hexagonal boron nitride (hBN) on an SiO_2 wafer. With AFM we observe the formation of ordered cGNR domains that are aligned along the crystallographic axes of the hBN. With electron beam lithography and metalization, we successfully contacted the cGNRs with NiCr-Au and Pd contacts and measured their *I*-*V*-characteristics. The transport through the ribbons was dominated by the Schottky behavior of the contacts between the metal and the ribbon. We could not observe any gate dependence so far which could be due to screening effects of the metal contacts.

[1] A. Narita, *et al.*, Nature Chemistry **6**, 126 (2014).

HL 23.5 Tue 15:00 A 151

Plasmons and excitons in few layer graphenes — •Jorge Enrique Olivares Peña and Sam Shallcross — FAU Erlangen-Nürnberg

We present a general method for studying plasmons and excitons in low dimensional systems, based on (i) an operator equivalence method to establish a continuum $H(\mathbf{r},\mathbf{p})$ Hamiltonian from a general underlying tight-binding method, and (ii) application of the bootstrap functional within the framework of time dependent density functional theory to study excitonic effects. We apply this method to the graphene twist bilayer, finding that the excitonic correction to the optical absorption spectrum is important in the small angle limit.

[1] S. Shallcros et al., arXiv 1607.00920 (2016)
[2] S. Shallcross et al. , Phys. Rev. B 93,035452 (2016)

HL 23.6 Tue 15:15 A 151

Towards gate-controlled photoluminescence of hexagonal boron nitride quantum emitters — •Alessio Scavuzzo[1], Christian Strelow[2], Marko Burghard[1], Alf Mews[2], and Klaus Kern[1,3] — [1]Max Planck Institute for Solid State Research, Stuttgart, Germany — [2]Institute of Physical Chemistry, University of Hamburg, Germany — [3]École Polytechnique Fédérale de Lausanne, Switzerland

In the past few years, quantum emission from defect states embedded in crystalline structures has attracted increasing interest due to its promising applications in future quantum information technologies. While the properties of color centers in large band-gap 3D semiconductors like diamond or 4H-SiC are well-established, more recently attention is directed toward quantum emission from 2D systems. Along these lines, hexagonal boron nitride (hBN) has recently emerged as a very attractive 2D platform to host robust, visible light single photon emitters. Here, we report our experiments that address the possibility to control the quantum emission from hBN monolayers through electrostatic gating. To this end, we use confocal microscopy to probe the lifetime and intensity of the light emission from hBN quantum emitters within hBN/graphene vertical heterostructures as a function of temperature and back gate voltage. Moreover, through complementary Raman mapping, we demonstrate the importance of the hBN and graphene layer thickness, as well as the quality of the interface between the layers.

HL 23.7 Tue 15:30 A 151

Quantum Light in 1D and 2D Curved Hexagonal Boron Nitride Systems — •Nathan Chejanovsky[1,2], Youngwook Kim[2], Andrea Zappe[1], Benjamin Stuhlhofer[2], Takashi Taniguchi[3], Kenji Watanabe[3], Durga Dasari[1,2], Amit Finkler[1], Jurgen H. Smet[2], and Jörg Wrachtrup[1,2] — [1]3rd Physics Institute, Universität Stuttgart, Pfafenwaldring 57, 70569, Stuttgart, Germany — [2]Max Planck Institute for Solid State Research, Heisenbergstr. 1, 70569, Stuttgart, Germany — [3]National Institute for Materials Science, 1-1 Namiki, Tsukuba, 305-0044, Japan

Low-dimensional wide bandgap semiconductors open a new playing field in quantum optics using sub-bandgap excitation. 2D hexagonal boron nitride (h-BN) has been reported to host single quantum emitters (QEs), linking QE density to perimeters. [1] We investigate a curvature and perimeter-abundant BN system - one-dimensional BN nanotubes (BNNTs).

I discuss our recent publication [2] demonstrating similarities between QEs in BNNT and h-BN for: Emission spectra, anti-bunching, SEM imagery, curvature effects, boron-oxide emission and sensitivity to commercial solvents.

These findings open possibilities for precision engineering of QEs, puts h-BN under a similar umbrella of transition metal dichalcogenides QEs and provides a model explaining QEs spatial localization and formation using electron and ion irradiation and chemical etching.

[1] Chejanovsky, N. et al. Nano letters 2016, 16, 7037-7045. [2] Chejanovsky, N. et al. Scientific reports 2017, 7, 14758 (1-14)