IAP Seminar

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Friday, 10.7.2020, 15:00 s.t.
TU Wien,
1040 Wien, Wiedner Hauptstraße 8-10
Green Tower „A“, 2nd floor, FH Hörsaal 5 (room no DA02G15)

Electronic structure control in 2D matter

Two-dimensional (2D) materials allow for on-demand control of their physical properties by chemical functionalization and by stacking 2D layers into heterostructures. My group uses this approach to induce new quantum phases in epitaxially grown 2D layers and to control their physical properties. I will show how to induce superconductivity, flat bands, topologically non-trivial states and a 2D Fermi gas. For investigation, my group employs a unique combination of ultra-high vacuum (UHV) Raman/luminescence and angle-resolved photoemission (ARPES) spectroscopies.
Chemical doping of graphene by alkali metals enables tuning of the charge carrier density into the superconducting regime. ARPES and UHV Raman reveal a strong renormalization of electrons and phonons because of electron-phonon coupling [1,2]. I will show how to realize a flat energy band at the Fermi level by encapsulating graphene in between two layers of alkali metals [3]. For even larger alkali metal coverages, a heavily strained (~10%) alkali metal quantum well can be grown on intercalated bilayer graphene [4]. In this system massive and massless charge carriers coexist. The massive quantum well states have high electronic quality and realize a 2D Fermi gas [4].
For phosphorene, chemical doping induces a staggered potential resulting in a band inversion that is driven by the Coulomb interaction between the layers [5]. The observed band inversion control is required for the realization of a novel topological field effect transistor.
Regarding transition metal dichalcogenides (TMDCs), I present the observation of a charge density wave in monolayer TaS_2/graphene [6] and show that MoS_2/graphene heterostructures have a record narrow photoluminescence amongst epitaxially grown samples [7]. These two observations highlight the importance of the environmental effect in 2D matter.

[1] Nano Letters 18, 9, 6045 (2018).
[2] Nature Comm. 5, 3257 (2014).
[3] ACS Nano 14, 1, 1055 (2020).
[4] Nature Comm. 11, 1340 (2020).
[5] Physical Review B 97, 045143 (2018).
[6] ACS Nano 13, 9, 10210 (2019).
[7] 2D Materials 6, 1, 011006 (2018).

All interested colleagues are welcome to this seminar lecture (45 min. presentation followed by discussion).

Friedrich Aumayr
(LVA-Leiter)

Ulrike Diebold
(Seminar Chair)