Seminar announcement

Tuesday, January 28, 2025
1:00 pm
ZNN, Seminar room EG 0.001
Exclusively in person

"Optical signatures of inhomogeneities and phase transitions in 2D materials"

Two-dimensional (2D) materials are atomically thin crystalline layers with physical properties that dependent on the layer number. They are typically characterized by strong in-plane chemical bonds and weak van der Waals (vdW) coupling between adjacent layers allowing to assemble vdW stacks. Heterobilayers of transition-metal dichalcogenides such as MoSe2/WSe2 host dense ensembles of interlayer excitons potentially forming a coherent many-body state at low temperature [1]. Twisted homobilayers such as tWSe2 are prone to the formation of moiré minibands [2]. Half-vdW 2D polar metals, a novel class of atomically thin 2D materials, realized by confinement heteroepitaxial growth (CHet) results in large area, environmentally stable, 2D metals with a bonding gradient in z-direction [3]. These materials feature interesting properties such as superconductivity at cryogenic temperatures [4] and large plasmonic response in the visible range [5].
Both materials classes are impacted by lateral disorder and inhomogeneities influencing their light matter interaction. In the first part, we demonstrate, that this twist-disorder can be accessed by lateral force microscopy and correlated to optical signatures, particularly Raman spectroscopy on phonon modes. Moreover, we approach collective electronic excitations such as inter-moiré miniband excitations in tWSe2 bilayers by means of low-temperature resonant inelastic light scattering (RILS) spectroscopy [3]. In the second part, we employ variable temperature spectroscopy imaging ellipsometry (VT-SIE) down to 1K and trace changes in the dielectric response of the atomically thin metal layers with a focus on 2D gallium bilayers. While the dielectric response is laterally homogeneous at room-temperature, it becomes inhomogeneous at cryogenic temperatures indicating a structural phase transition of the material.

References:
[1] M. Troue et al. Phys. Rev. Lett. 131, 036902 (2023).
[2] N. Saigal et al. Phys. Rev. Lett. 133, 046902 (2024).
[3] M. A. Steves et al. Nano Letters 20.11, 8312–8318 (2020).
[4] S. Rajabpour et al. Adv. Mater. 2104265 (2021).
[5] K. Nisi et al., Adv. Funct. Mater. 31, 2005977 (2020).

Prof. Ursula Wurstbauer
Institute of Physics and
Center for Soft Nanoscience (SoN)
University of Münster, Germany