PHYSIKALISCHES KOLLOQUIUM

Sommersemester 2025

Das Kolloquium findet (soweit nicht anders angegeben) **jeweils montags um 14:15 Uhr in Präsenz im Röntgen-Hörsaal** des Physikalischen Instituts, Hubland Campus Süd, Universität Würzburg **und online via Zoom statt**.
Zugangsdaten siehe https://www.physik.uni-wuerzburg.de/aktuelles/veranstaltungen-aus-der-physik/physikalisches-kolloquium/

12.05.2025

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Optical and Chemical Control of Spin Functionalities in Non-Magnetic Molecular Hybrid Structures

Abstract

Fundamental to the advancement of spintronics and quantum technology in solids is our ability to encode, manipulate, and store information about the spin angular momentum of electrons at increasingly shorter lengths and faster timescales. While ferromagnets have long been the natural driving target for these efforts, their intrinsic limitations in miniaturization, efficiency, and susceptibility to external stray fields have prompted the search for non-magnetic material systems that can still support spin functionalities.

In this contribution, I will introduce two different classes of non-magnetic hybrid structures that enable optical and chemical control of spin functionalities at the nanoscale.

First, I will focus on heterostructures consisting of molecules and non-magnetic transition metal dichalcogenides (TMDs) with hidden spin polarization [1]. Such hidden spin polarizations arise in centrosymmetric layered TMDs with subunits exhibiting spin polarization bands, see Fig. 1a. Using time-, spin-, and momentum-resolved photoemission, I will show how optically induced interfacial charge transfer processes at the molecule/WSe2 interfaces can transiently alter the layer-dependent valence band structure of WSe2, ultimately revealing the hidden spin polarization of the system on a fs timescale [2].

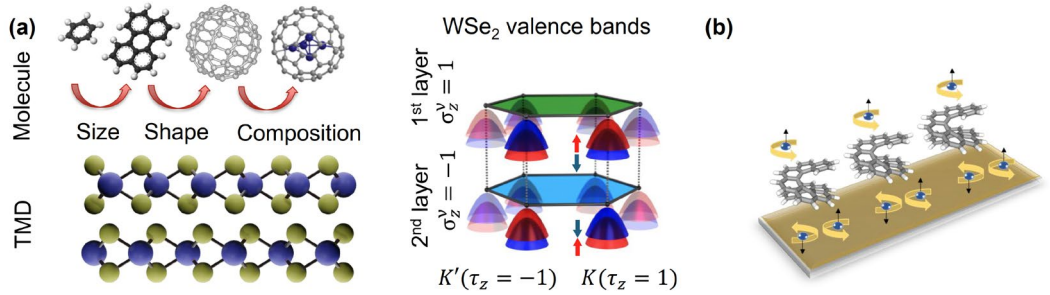

Fig.1 *(a) Graphical representation of the tunability of molecular TMD heterostructures and sketch of the layer- and spin-dependent valence band structure of the two non-interacting WSe_2 layers of the bulk unit cell, where the spin polarization vanishes at each point in the Brillouin zone. (b) Illustration of the spin dependent electron transmission through chiral molecules due to the CISS effect.*

I will then turn to non-magnetic chiral metal-organic interfaces, where spin functionalities such as spin filtering are attributed to the so-called chiral-induced spin selectivity or CISS effect, see Fig. 1b. Here, we focus mainly on non-helical complexes on chiral surfaces. I will show the vectorial character of the spin filtering of all chiral metal-organic interfaces [3] and provide first evidence for adsorption-induced chirality of achiral molecules on natural chiral surfaces. Taken together, these results highlight the crucial role of the molecule-surface interaction for the tunability of the CISS effect.

References

[1] J. M. Riley et al Nat. Phys. 10, 835–839 (2014)
[2] B. Arnoldi et al. Nat. Commun. 15, 3573, (2024
[3] C. Badala Viswanatha et al, J. Phys. Chem. Lett. 13, 6244−6249 (2022)

Für die Dozentinnen bzw. Dozenten der Fakultät

Prof. Dr. Hankiewicz, Prof. Dr. Hinkov, Dr. Meyer, Dr. Feichtner, Hr. Baumbach