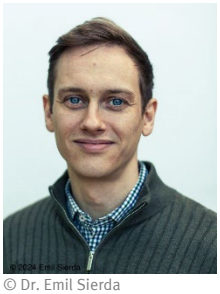
Universität Münster

Aktuelle Fragen der Nanophysik

Montag, 06.05.2024 um 15:15 Uhr
R87, Wilhelm-Klemm-Str. 10

Quantum simulations on the surface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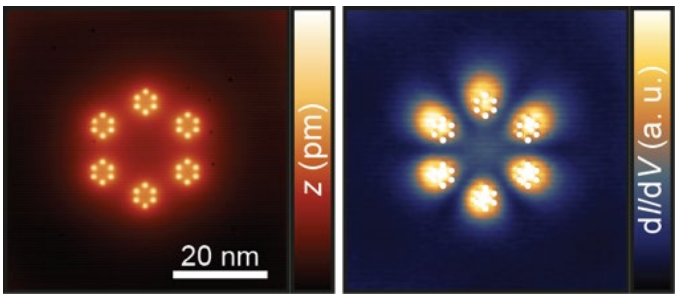
Designing materials with tailored physical and chemical properties requires a quantitative understanding of interacting quantum systems. In order to provide predictability, a promising route is to create bottom-up platforms, where the electronic properties of individual and interacting atoms can be emulated in a tunable manner. In my talk I will present a solid state quantum simulator based solely on patterned Cs atoms adsorbed on the surface of semiconducting InSb(110). This system is characterized by a dilute two-dimensional electron gas decoupled from the substrate's bulk bands which is essential in order to preserve fragile electronic states. By precise positioning of Cs atoms using atom manipulation in scanning tunneling microscopy (STM) we created various structures – zero-dimensional electron traps emulating artificial atoms, one-dimensional (1D) chains and two-dimentional (2D) lattices as well as assemblies resembling molecular structures. In the latter case artificial atoms serve as building blocks to realize molecular orbitals of different symmetries; from σ and π to hybrid orbitals (e.g. sp_2). Based on these artificial orbitals and various atomic patterns, it is possible to emulate the structure and orbital landscape of known planar organic molecules, including antiaromatic molecules. [1] Uniform and dilute distribution of Cs atoms within 1D chains and 2D lattices can still be described by single particle Hamiltonians. However, in the limit where Cs atoms are at much smaller separations, we observe experimental indications for many-body effects which can be extended to complex quantum states based on arbitrary lattices. This hold promise that our quantum simulator can help to control and study correlation effects beyond the current capabilities of theoretical descriptions.



STM image of artificial atoms in hexagonal arrangement resembling benzene structure and spatial distribution of one of its molecular orbitals probed in the experiment.