UNIVERSITÄT DUISBURG ESSEN

PHYSIK

Physikalisches Kolloquium

Mittwoch, 20.05.2026
13:00 Uhr
MC 122 und Zoom

https://uni-due.zoom-x.de/j/64228670246?pwd=RjVQeFNIUkRKRkpiNVpKYXhJaFNLdz09 (gilt für alle Vorträge)

Emulating the behavior of electrons in atoms, molecules and solids in extreme magnetic fields

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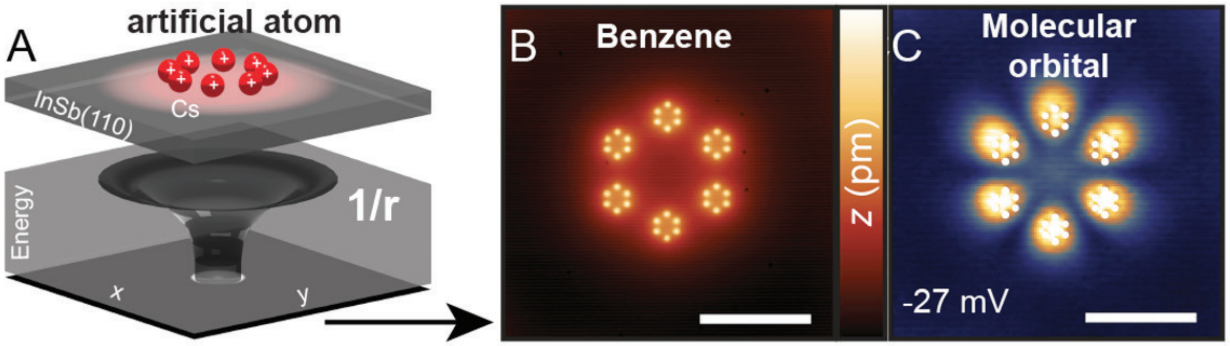

Quantum simulators are a pathway to study novel physical phenomena which are difficult to predict or observe in synthesized materials. To this end, the physical behavior of materials ranging from gasses to superconducting qubits has been used to emulate Hamiltonians. The most iconic of which is the Hubbard model, where previously unobserved phenomena were seen. To date, there is still a lack of viable platforms for quantum simulation to study confined electrons in strong magnetic fields, where the magnetic length is on the order of the periodicity of the lattice. For typical crystals, this corresponds to magnetic fields that are unattainable with common laboratory magnets. Moreover, it is still a grand challenging to control the orbital and lattice symmetries in such platforms, as well as the long-range nature of the coupling.

In this talk I will discuss a new quantum simulator we developed to study electronic structure going from individual atoms and their internal interactions, towards molecules and lower dimensional crystals. This is based on patterning atomic-scale quantum dots using scanning tunneling microscopy and patterning individual Cs atoms on the semiconducting surface of InSb. We begin by patterning Cs atoms on the surface, sculpting confinement potentials on the 2DEG which act as artificial atoms (i.e. quantum dots). I will show how these states can be coupled to create molecular-like electronic structure with multi-orbital symmetry and tunable spin-orbit coupling. I will then focus on the magnetic field response. I will show the response of these artificial atoms to strong magnetic fields, where they exhibit Fock-Darwin states. I will link this to the concept of the Hofstadter butterfly and further comment on perspectives to use this platform to study the role of spin-orbit coupling, interactions, and topology.