GRK 2905 Ultrafast Nanoscopy

Seminar

Monday, Sept 22, 2025
10:00 h
RUN Auditorium

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From microscopic to macroscopic phenomena: Bridging length scales in two-dimensional quantum materials

Two-dimensional quantum materials have driven a revolution in condensed matter physics through the realization of a large variety of exotic quantum phenomena, ranging from strong correlations and quantum magnetism to topological states. At the core of this revolution is the unique tunability of the quantum phases emergent at the macroscopic scale through variations in the microscopic properties of the material. Despite decades of intensive theoretical and experimental endeavors, bridging these two length scales has remained a major challenge, leaving numerous questions unanswered.

In this talk, we demonstrate how atomic force microscopy (AFM) can be used not only to (i) probe quantum electronic states across multiple length scales, but also to (ii) locally control and engineer the interplay between microscopic and macroscopic properties in van der Waals materials. Using the AFM tip as a mechanical actuator we bend narrow van der Waals ribbons, realizing (moiré) heterostructures with engineered twist angle and strain gradients. Combining these structures with low-temperature conductive AFM imaging not only reveals their unique electronic properties, but also opens exciting avenues for studying the interplay between microscopic and macroscopic length scales through versatile and novel AFM techniques.