Observation of competing, correlated ground states in the flat surface band of rhombohedral graphite

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In crystalline solids the interactions of charge and spin can result in a rich variety of emergent quantum ground states. A prime example is twisted bilayer graphene, where measurements have demonstrated the presence of superconductivity, ferromagnetism, and Mott insulator quantum states due to the enhanced correlation effects of the partially filled flat bands. Rhombohedral graphite (RG) is perhaps the simplest and structurally most perfect condensed matter system to host a flat band, which is also protected by the symmetry [1]. In this talk we provide detailed investigation of the flat band in RG by using low temperature (9 K) Scanning Tunneling Microscopy (STM) measurements combined with electronic structure calculations [2]. By STM we map the flat band charge density of 8, 10 and 17 layers and identify a domain structure emerging from a competition between a sublattice antiferromagnetic insulator and a gapless correlated paramagnet state up to a temperature of 20 K. Our density-matrix renormalization group (DMRG) calculations explained this observation by revealing a degenerate ground state of the system and demonstrate the important role of the correlation effects. Our work establishes RG as a new platform to study many-body interactions beyond the mean-field approach, in a topological 2D electron system.

References

[1] S. Slizovskiy et al., Communications Physics **2**, 164 (2019)
[2] I. Hagymási et al., arXiv:2201.10844 (2022)

Figures

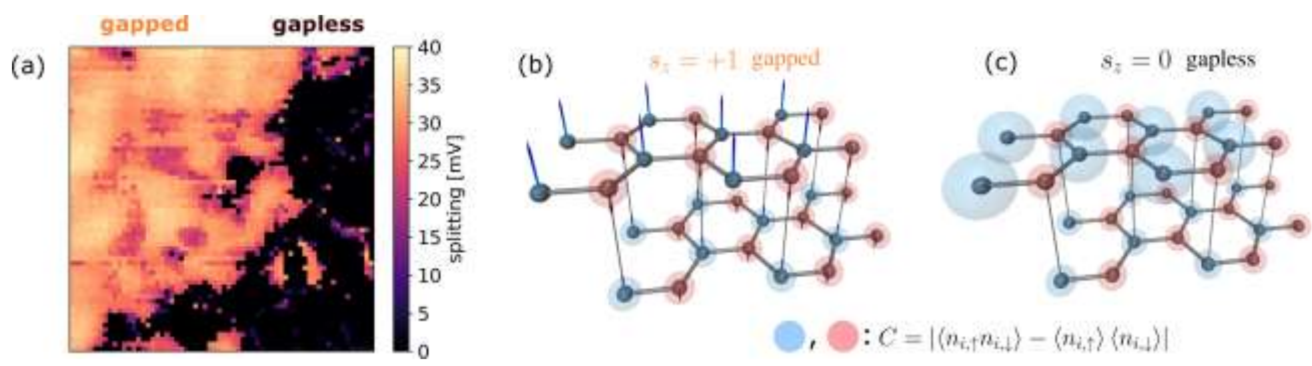

Figure 1: (a) Gapped and gapless domains measured over an 80×80 nm area of the sample. (b-c) DMRG calculations of the sublattice antiferromagnetic and correlated paramagnetic states. Colored arrows show the distribution of magnetic moments, while the radius of the opaque spheres is proportional to the local electronic correlation C values, as defined by the relation shown.