Observation of strongly correlated electronic ground state in rhombohedral graphite

I. Hagymási,[1,2] M. Syahid Mohd Isa,[3] Z. Tajkov,[3,4] K. Márity,[3] L. Oroszlány,[5] J. Koltai,[4] A. Alassaf,[5] P. Kun,[3] K. Kandrai,[3] A. Pálinkás,[3] P. Vancsó,[3] L. Tapasztó,[3] and P. Nemes-Incze[3]

[1] *Helmholtz-Zentrum Berlin für Materialien und Energie, Germany*
[2] *Freie Universität Berlin, Germany*
[3] *Centre for Energy Research, Institute of Technical Physics and Materials Science, Hungary*
[4] *Department of Biological Physics, ELTE Eötvös Loránd University, Hungary*
[5] *Department of Physics of Complex Systems, ELTE Eötvös Loránd University, Hungary*

In crystalline solids, the interactions of charge and spin can result in a variety of emergent quantum ground states, especially in partially filled, topological flat bands such as Landau levels or in "magic angle" graphene layers. 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.

In this talk we provide detailed investigation of the flat band in RG by using low temperature Scanning Tunneling Microscopy (STM) measurements combined with electronic structure calculations [1]. We measured the flat surface band of 8,10 and 17 layers of RG at various charge densities and found correlated behavior up to a temperature of 20 K. At charge neutrality we also identified a degenerate ground state, forming a competing domain structure between a sublattice antiferromagnetic insulator and a gapless, correlated paramagnet. 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 platform to study many-body interactions beyond the mean-field approach, where quantum fluctuations and entanglement dominate.

References:

[1] Hagymási, I., Syahid Mohd Isa, M., Tajkov, Z., Márity, K., Oroszlány, L., Koltai, J., Alassaf, A., Kun, P., Kandrai, K., Pálinkás, A., Vancsó, P., Tapasztó, L., Nemes-Incze, P. (2022), Observation of competing, correlated ground states in the flat band of rhombohedral graphite, Sci. Adv. **8**, eabo6879