Unconventional quantum phases and their visualization with atomic resolution

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Newly discovered properties of magic angle graphene and other systems from the same family propelled the field of twistronics and motivated new research into tunable unconventional quantum phases. The research is driven in part by the search for robust quantum anomalous Hall insulators, topological superconductivity, correlated electronic states, and fractional statistics, and by the prospect of quantum simulation in solid state. In this lecture, I will showcase the exciting recent developments in the field of tunable 2D platforms highlighting the role played by scanning tunneling microscopy (STM) (Fig. 1). Through high-resolution magnetic-field scanning tunneling spectroscopy, surprising insights into quantum geometry and strongly correlated physics can be gained (Fig. 2). Specifically, I will report on the detection of the orbital magnetic moment and the emergent, anomalously large orbital magnetic susceptibility in twisted double bilayer graphene (TDBG)[1]. I will also discuss the potential in the field of quantum materials, combining STM, atomic manipulation, epitaxial growth, and stacked 2D devices.

References

[1] Y. Maximenko, M. R. Slot, P. M. Haney, et al, and J. A. Stroscio s, Science, 6666 (2023) 81-87

Figures

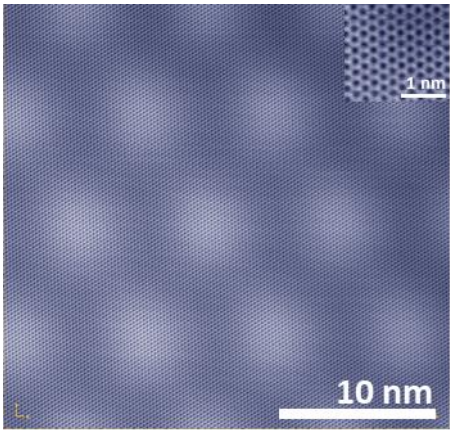

Figure 1: Topographical STM image of TDBG [1].

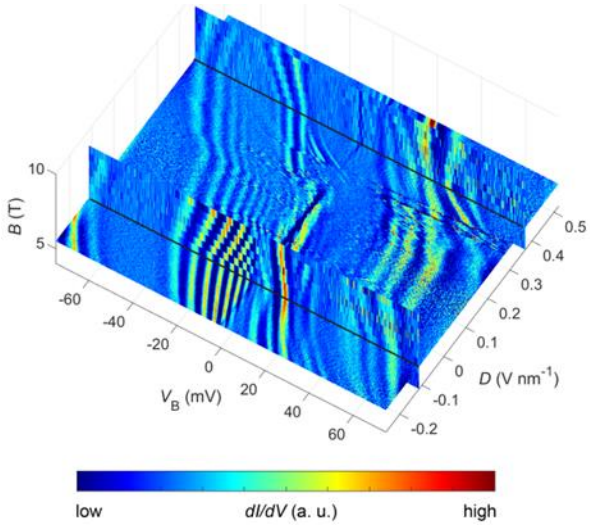

Figure 2: Slices of a 3D local density of states map in TDBG showing Landau levels, where x,y, and z axes are respectively displacement field, sample bias, and magnetic field [1].