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Unconventional quantum phases and their visualization with atomic resolution

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, fractional statistics, and quantum simulation in solid state. In this colloquium, I will showcase the exciting recent developments in the field of tunable 2D platforms highlighting twisted moiré systems and atomic manipulation. Scanning tunneling microscopy (STM) has proved crucial for the progress of this field. Through high-resolution magnetic field scanning tunneling spectroscopy, we have demonstrated the importance of the fine details of quantum geometry in these novel 2D platforms. Specifically, I will report on our discovery of the emergent anomalously large orbital magnetic susceptibility in twisted double bilayer graphene, along with the orbital magnetic moment. I will also discuss the exciting potential in the field of quantum materials, combining STM, epitaxial growth, and stacked 2D devices.

Short Bio

Dr. Maximenko received a Ph.D. in Physics from the University of IL at Urbana-Champaign (2020) and both M.S. and B.S. in Physics and Applied Math from Moscow Institute of Physics and Technology. After PhD, Dr. Maximenko worked with Joseph Stroscio at the National Institute of Standards and Technology as a postdoctoral researcher using a state-of-the-art mK transport and probe microscopy instrument. As an assistant professor at Colorado State University, Dr. Maximenko focuses on scanning probe microscopy, molecular beam epitaxy (MBE), and device nanofabrication, which are used to create exotic solid-state platforms and to investigate the emergent quantum phases with atomic resolution at ultralow temperatures. This research is motivated by pushing the fundamental understanding and limits of many-body quantum effects as much as by the search of novel electromagnetic properties directly applicable in device engineering.