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Abstract:

Title: Understanding quantum materials with strong electron-electron interactions and disorder through computational tools

Abstract: Functional quantum materials, including Mott insulators and high-temperature superconductors, are at the forefront of condensed matter research. These materials are being actively explored for transformative technological applications, including efficient energy generation, storage, and transmission. Understanding the fundamental mechanisms behind the exotic phases of matter emerging in quantum materials is a grand challenge, which must be overcome to maximize technological advancement. Due to the complexity of the many-electron problem numerical treatment is often required. Over the past decades, numerical analysis has become a very powerful tool for studying strongly correlated electron systems, both clean and materials with defects.

The focus of our group is to numerically model electron localization using the quantum many-body techniques for strongly-correlated and disordered electron systems. Electron localization (driven by electron interactions or disorder) is a key feature of numerous quantum materials. Various exotic phases of matter with dramatic changes in electronic, magnetic, transport properties find their roots at electron localized states. Hence, its understanding is critical for further control and optimization of quantum materials and their applications. In this talk, I will first present our results on electron localization in the Hubbard model and beyond using the Dynamical Mean Field Theory and its cluster extension. I will demonstrate how the Mott metal-insulator transition can be described in the framework of the quantum critical phase transition. These theoretical predictions have been recently confirmed experimentally by four independent experimental groups. I will also share our recent results on treating electron localization in disordered electron systems using the typical medium approach.

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Speakers Bio: Hanna Terletska received her Ph.D. in Physics from the Florida State University (2011). She had several postdoctoral appointments, including a joint appointment at Brookhaven. Nat. Lab/Louisiana State University (2011-2015), a short stay at Ames Lab, and two-year Simons Foundation Many Electron Collaboration Postdoc Research Fellowship at the University of Michigan-Ann Arbor. Since 2017, Hanna is an assistant professor at Middle Tennessee State University. She has received several national awards, including the NSF CAREER Award in 2020, and the KITP scholar award 2018-2020.