Physics Colloquium

Prof. Dr. Fakher Assaad
Institut für Theoretische Physik und Astrophysik
Julius-Maximilians-Universität Würzburg, Germany

"Numerical simulations of Dirac systems"

The Dirac vacuum provides a remarkable starting point to understand a number of phases and phase transitions in the solid state. This includes one-dimensional spin systems, superconductors, de-confined quantum critical points as well well as topological insulators. Model hamiltonians of Dirac fermions supplemented by electronic interactions, are amenable to large scale quantum Monte Carlo simulations. As a consequence they provide a golden route to investigate a number of exotic phenomena in the solid state. After introducing the method [1], I will concentrate on two subjects. The first one is experimentally driven, and concentrates on magnetic ad-adtoms on metallic surfaces [2]. Here we will show that phenomena such as Kondo breakdown transitions are achievable in these systems. In the second part of the talk, I will introduce a model in which the quantum spin Hall (QSH) state is dynamically generated. The key point of this state is that Skyrmions of the QSH order parameter carry charge 2e. This provides a novel route to superconcductivity [3] and new realizations of deconfined quantum critical points [4].

[1] ALF Collaboration, F. F. Assaad, M. Bercx, F. Goth, A. Goetz, J. S. Hofmann, E. Huffman, Z. Liu, F. Parisen Toldin, J. S. E. Portela, and J. Schwab, arXiv:2012.11914 (2021).
[2] B. Danu, M. Vojta, F. F. Assaad, and T. Grover, Phys. Rev. Lett. 125 (2020), 206602.
[3] Z. Wang, Y. Liu, T. Sato, M. Hohenadler, C. Wang, W. Guo, and F. F. Assaad, Phys. Rev. Lett. 126 (2021), 205701.
[4] Y. Liu, Z. Wang, T. Sato, M. Hohenadler, C. Wang, W. Guo, and F. F. Assaad, Nature Communications 10 (2019), no. 1, 2658.

Fakher Assaad is an expert in various aspects of quantum many-body phenomena in the solid state. His theoretical interest and contributions in this area span the physics of the Hubbard model and its descendents, Kondo lattice problems, Holstein models, interplay between disorder and interactions, etc., with applications to magnetism, superconductivity, and, more recently, two-dimensional crystals and interacting topological insulators. He frequently tackles these problems with a combination of analytical and numerical techniques, notably quantum Monte Carlo methods. He is currently a Professor of Physics at the Institut für Theoretische Physik und Astrophysik, Julius-Maximilians-Universität Würzburg and the Spokesperson of the German Research Foundation Research Unit FOR1807 on Advanced Computational Methods for Strongly Correlated Quantum Systems.

Thursday, November 4 via Zoom
On the regular schedule that starts at 4:25 PM
Meeting ID: 972 1274 7894
Passcode: 631869
(This is an online colloquium)