Dynamical Cluster Quantum Monte Carlo Studies on Strongly Correlated Electron Systems

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Abstract

Using large-scale dynamical cluster quantum Monte Carlo simulations, we study the properties of the two dimensional Hubbard model on square and triangular lattices. In the square lattice case, the control parameters are hole doping, temperature T and next-near-neighbor hopping t'. We find that for t'>0, a line of finite temperature second order transition points converges to the quantum critical point at t'=0 and zero temperature; for t'<=0, we identify a line of Lifshitz transition points associated with a change of the Fermi surface topology at zero temperature. At the Lifshitz transition points, a van Hove singularity in the density of states crosses the Fermi level. Such an unambiguous numerical observation of the Lifshitz transition at t'<=0 extends our understanding of the nature of the quantum critical point underneath the superconducting dome in the 2D square lattice Hubbard model. In the triangular lattice case, we focus on half-filling and use interaction strength U/t and temperature as the control parameters, our preliminary data suggest a quantum critical Mott transition separating a Fermi liquid metal and possibly a spin liquid Mott insulator at Uc~9t. The finite temperature crossovers from the quantum critical region to a marginal Fermi liquid and furthermore to the Fermi liquid are observed. Our results are consistent with the recent quantum field theory proposal on the same model.

Reference:

Lifshitz Transition in the Two Dimensional Hubbard Model, Kuang-Shing Chen, Zi Yang Meng, Thomas Pruschke, Juana Moreno, Mark Jarell, Phys. Rev. B 86, 165136 (2012).

About the speaker

Dr Ziyang Meng recently joined the Department of Physics and Astronomy, and the Center for Computation and Technology of Louisiana State University as a postdoctoral fellow. He graduated from the University of Stuttgart, Germany, with a Ph.D. in theoretical condensed matter physics in 2011. His research interest is numerical investigation on strongly correlated electronic systems, particularly using quantum Monte Carlo and cluster dynamical mean field theories to study systems in quantum magnetism, graphene-related material, interacting topological insulators, and quantum spin liquids.