

Massachusetts Institute of Technology
Department of Physics

Condensed Matter Theory Seminar

"Non-perturbative Results for Itinerant Ferromagnetism in Multi-orbital Systems on Square and Cubic Lattices"

Yi Li, Princeton University

Abstract: Itinerant ferromagnetism (FM) is one of the major challenges of condensed matter physics. FM is not only a strong-correlation phenomenon but also a non-perturbative problem. Even at infinite U , FM is not guaranteed. For example, the Lieb-Mattis theorem proved that itinerant electrons with the nearest neighboring hopping in 1D can never be FM no matter how strong interaction is. Exact theorems are, therefore, indispensable for understanding the mechanism of FM. Previously known examples of FM in 2D and 3D usually fall into one of the two types: the 'Nagaoka FM' as a result of coherent hopping of a single hole in lattices under $U=\infty$, or, the 'flat-band FM' on line graphs, like the Kagome lattice, where zero penalty from kinetic energy greatly assists the development of FM.

In this talk, new exact results of itinerant FM in certain multi-orbital Hubbard models in two-dimensional square and three-dimensional cubic lattices will be discussed. In the strong coupling limit where doubly occupied orbitals are prohibited, the fully spin-polarized states can be proved as the unique ground states, apart from the trivial spin degeneracy. Our result differs from that of Nagaoka in that it is valid for a large region of filling factors in both 2D and 3D. It is also different from flatband FM, in which fermion kinetic energy differences are suppressed.

Possible applications to p-orbital systems of ultracold fermions in optical lattices, and 3d-orbital systems in transition-metal oxides such as the $\text{LaAlO}_3/\text{SrTiO}_3$ interfaces, will be discussed. The ferromagnetic phases established by this theorem is free of the quantum Monte-Carlo sign problem. Therefore, a lot of open problems of thermodynamic properties of itinerant ferromagnetism can be addressed at high numerical accuracy.

12:00noon
Wednesday, March 18, 2015
Duboc Seminar Room (4-331)