Syllabus: PHYS562 Special topics in condensed matter II

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Topics: electron correlation, magnetism (non-relativistic and relativistic Zeeman effect), crystaly field theory, strongly correlated models (Hubbard model, Heisenberg model, t-J models), Mott metal-insulator transitions, mean-field theory, variational solutions (Baeriswyl variational wavefunction, Gutzwiller variational wavefunction), exact solutions for one-dimensional systems (Bethe ansatz), numerical approaches (quantum Monte Carlo, DMRG), many-body theory of polarization (Berry phase), related phenomena of interest (superconductivity, quantum Hall effect, topological insulators)

Literature:

Textbooks:

1. P. Fazekas: *Lecture Notes on Electron Correlation and Magnetism*, World Scientific, (1999).
2. F. H. L. Essler, H. Frahm, F. Göhmann, A. Klümper, and V. E. Korepin: *The One-Dimensional Hubbard Model*, Cambridge (2005).
3. V. E. Korepin, N. M. Bogoliubov, and A. N. Izergin: *Quantum Inverse Scattering Method and Correlation Functions*, Cambridge Monographs on Mathematical Physics, (1997).

Some suggested articles for specific topics:

1. Berry phase: D. Xiao, M.-C. Chang, and Q. Niu, Rev. Mod. Phys. **82** 1959 (2010).
2. Polarization: R. Resta, *Rev. Mod. Phys.* **66** 899 (1994).
3. Topological insulators: M. Z. Hasan and C. L. Kane, *Rev. Mod. Phys.* 82 3045 (2010), X.-L. Qi and S.-C. Zhang, Rev. Mod. Phys. **83** 1057 (2011).

Evaluation:

1. Oral exam (1/2) *or* class participation (1/4) and quizzes (1/4)
2. Presentation (25 min. presentation based on a selected topic) (1/2)

Office Hours: by appointment