Dynamical Mean-Field Theory for ultra-cold atoms

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Dynamical Mean-Field Theory (DMFT) is a non-perturbative scheme for the efficient simulation of strongly correlated quantum systems in higher dimensions. This scheme has achieved unprecedented precision in the description of Hubbard model in conventional condensed matter systems. The core of the DMFT is based on a mapping from Hubbard model onto an Anderson impurity model. This map preserve all physical properties of the original model and then greatly benefits from all available (numerical) tools for the impurity models.

Ultra-cold quantum gases in optical lattices have provided also an excellent realization of strongly correlated systems with the highest precision and controllability. Many features of strongly correlated systems have been successfully observed by ultra-cold gases, for instance the seminal experiment of Mott transition. Therefore these cold-atomic systems are believed to be an ideal *quantum simulator* for the condensed matter and atomic physic.

Within the school program, in the first lecture we aim to systematically present the original idea of DMFT, connection between Hubbard and Anderson model and impurity solver(s) [1]. In the second lecture we discuss the potential of DMFT for ultra-cold atoms in optical lattices. Its applications to the calculation of static, dynamic, and thermodynamic quantities in these systems are reviewed here. This will cover Real-space DMFT, bosonic systems, quantum magnetism and thermodynamic. Finally we mention applicability of DMFT to tackle *some* current experiments in quantum optics e.g quantum gases in a high-finesse cavity.

References

[1] A. Georges, G. Kotliar, W. Krauth, and M. J. Rozenberg, Rev. Mod. Phys. **68**, 13 (1996).