Dynamics of strongly correlated electrons

Ultrafast control of quantum materials, where correlated electrons in solids are exposed to time-dependent perturbations, allows to "Floquet" engineer through periodic driving novel metastable phases of matter for a transient regime[1]. On longer time scales the system is expected to thermalise back to equilibrium via electron-electron interactions and scattering with other excitations[2,3]. A complete understanding of the landscape of metastable phases and dynamical phase transitions that can be achieved in this way is still lacking and novel methods to address these questions are needed.

The goal of this Internship proposal is to study the real-time dynamics of correlated electrons using Nonequilibrium Dynamical Mean-Field Theory[4]. This maps the problem to a self-consistent quantum impurity model describing a single site coupled to a bath. As working example we will consider the single band Hubbard model under periodic driving or photo-excitation, possibly including the effect of broken symmetry phases. To solve the quantum impurity model we will use and extend complementary techniques including weak-coupling perturbation theory, to be extended to the case of symmetry broken phases, or slave-spin techniques. For the latter, we will consider mean-field decoupling schemes as well as the role of quantum fluctuations. Applications will range from the study of driven dynamics in Mott insulators and correlated metals, to superconductors, alternamagnets or excitonic insulators.

(Internship in collaboration with Luca de Medici, LPEM ESPCI)

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