Accurate and universal characterization of strong correlated electronic systems from the perspective of quantum dissipation

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A hierarchical equations of motion (HEOM) formalism has been developed based on a formally exact quantum dissipation theory, which characterizes the reduced dynamics of general open dissipative systems coupled to surrounding fermionic environment [1]. Recently, the HEOM approach has been successfully applied to calculate the dynamical properties of strongly correlated quantum impurity systems [2]. For equilibrium cases, the HEOM approach achieves the same level of accuracy of the latest state-of-the-art numerical renormalization group method [3], as affirmed by the calculated spectral function of a single-impurity Anderson model system in the Kondo regime. More importantly, the HEOM approach provides a unified framework to treat nonequilibrium cases, including the steady states and transient dynamics driven by time-dependent external fields [4]. Quantitative accuracy is achieved as long as the calculation outcomes converge with respect to the truncation level of the hierarchy. Moreover, various dynamical observables, such as the dynamic conductance and dynamic magnetic susceptibility, can be obtained via the evaluation of response and correlation functions of strongly correlated systems by using the HEOM approach [5]. Furthermore, an HEOM-based dynamical mean-field theory approach is also developed for characterization of strongly correlated lattice models.

In this presentation, the theoretical aspects of the HEOM approach will be introduced, which is followed by some numerical demonstrations.

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