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Fachbereich Physik, Universität Stuttgart
Max-Planck-Institut für Festkörperforschung
Max-Planck-Institut für Intelligente Systeme

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Taking locality to the next level: vertex-based extensions of dynamical mean-field theory and their application

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Abstract

Strong correlations are almost a guarantor for the emergence of intriguing physics with the Mott metal-to-insulator transition, cuprate superconductivity and quantum criticality as famous examples. The advance of the dynamical mean field-theory (DMFT) revolutionized their theoretical description in being able to treat quantum correlations exactly, while spatial correlations are only included on a mean-field level. The recent development of diagrammatic extensions of DMFT, based on vertex functions, aims at including these spatial fluctuations in order to describe regimes of strong correlations, where they are becoming substantial (e.g. in the vicinity of phase transitions).

In this talk I will review some of the recent developments of cutting-edge methods for the description of strong correlations. First, I will present a synopsis of basically all the available methods ("multi-method") for the Hubbard model, the most fundamental correlated model, in an arguably simple regime of small interaction. Despite its simplicity, this regime exhibits a series of salient physical crossovers, that manifest themselves in a multitude of observables ("multi-messenger"), both at the one- and two-particle level. In the second part of the talk, I will review the application of the dynamical vertex approximation (DΓA) on the Hubbard model and the periodic Anderson model for magnetic classical and quantum criticality. The results underline the power of this method in the description of critical phenomena, in particular the calculation of critical exponents.

In the final part I will give a brief outlook on the research directions I will pursue as the Head of the Max Planck Research Group "Theory of Strongly Correlated Quantum Matter" at the MPI-FKF.