Influence of the cluster-shape on the d-wave-transition temperature $T_c$ in the dynamical cluster approximation: A case study for the 2D repulsive Hubbard model

PETER STAAR, ETH Zurich, THOMAS MAIER, Oak Ridge National Laboratory (ORNL), THOMAS SCHULTHESS, ETH Zurich, ITP ETH ZURICH - ORNL TEAM — The dynamical cluster approximation (DCA) is a systematic extension beyond the single site approximation of dynamical mean field theory to include non-local correlations. The method maps the infinite lattice self-consistently on a cluster with $N_c$ sites, which is embedded into a mean field. Since the correlations within the cluster are treated exactly, it is ideal to investigate phase-transitions such as d-wave superconductivity. Since a Quantum Monte Carlo integration is used to obtain the DCA self-consistency, the sign-problem prevents us to solve large cluster problems ($N_c > 32$). Meanwhile, the transition temperatures $T_c$ from smaller clusters fluctuate due to a large dependency on the cluster-shape. Here, we investigate whether this cluster-dependency originates from the quantum impurity problem, or from the mesh on which we solve the Bethe-Salpeter (BS) equation. By exploiting the localized nature of the self-energy $\Sigma$ and the vertex function $\Gamma$ in real space, we can reconstruct these functions on arbitrary fine meshes in momentum-space and investigate its impact on the solutions of the BS equation. We will show that the 8-site cluster has a finite $T_c$ for small doping-levels and that the 16-site clusters have converged transition temperatures.