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DCA study of magnetic mediated superconductivity in the Hubbard model[1]

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The Dynamical Cluster Approximation (DCA) with quantum Monte Carlo as a cluster solver is used to study pairing in the two dimensional Hubbard model. The DCA adds non-local corrections to dynamical mean field theory by mapping the lattice onto a self-consistently embedded periodic cluster. The qualitative features of the cuprate phase diagram are captured by the DCA with a 2x2 cluster, which provides a mean field solution of the model. With increasing cluster size, the results are found to converge and display a finite d-wave transition temperature, establishing the presence of superconductivity in the model. A decomposition of the pairing interaction into its cross channels reveals that pairing is mediated by S=1 spin fluctuations. A simple renormalized spin fluctuation model is found to capture many of the properties of pairing and the spectra, including the high-energy kink waterfall structure and the structure of the leading order parameter. However, it fails to capture realistic features including long-ranged hopping, phonons and the pseudogap. Phonons, in particular, are found to enhance the paring interaction by enhancing antiferromagnetism. Despite this, superconductivity is suppressed by local (Holstein, Breathing and Buckling) phonon modes through the formation of polarons which dramatically reduce the particle mobility.

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