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Superconductivity enhancement and particle-hole asymmetry: interplay with electron attraction in doped Hubbard model

The role of near-neighbor electron attraction V in strongly correlated systems has been at the forefront of recent research of unconventional superconductivity. However, its implications in the doped Hubbard model on expansive systems remain predominantly unexplored. In this study, we employ the density-matrix renormalization group to examine its effect in the lightly doped t-t′-Hubbard model on six-leg square cylinders, where t and t′ are the first and second neighbor electron hopping amplitudes. For positive t′ in the electron-doped case, our results show that the attractive V can significantly enhance the superconducting correlations and drive the system into a pronounced superconducting phase when the attraction exceeds a modest value Vc≈0.7t. In contrast, in the hole-doped regime with negative t′, while heightened superconducting correlations have also been observed in the charge stripe phase, the systems remain insulating with pronounced charge density wave order. Our results demonstrate the importance of the electron attraction in boosting superconductivity in broader doped Hubbard systems and highlight the asymmetry between the electron and hole-doped regimes.

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