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Orbital-selective Mott transitions in the degenerate Hubbard model

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Strongly correlated electron systems with multi-orbital bands possess various unusual properties. Here we address how the multi-orbital nature affects the Mott transition and under which conditions consecutive orbital-selective Mott transitions may occur upon growing electron correlations. We study a model of an extended two-orbital Hubbard model (including onsite intra-orbital repulsion U, onsite inter-orbital repulsion U' and Hund coupling J_H with $U = U' + 2J_H$) with distinct hopping matrix elements for the two orbitals. By combining dynamical mean-field theory with exact diagonalization, the stability of itinerant quasi-particle states in each band is examined. There is a single Mott transition, simultaneously for both orbitals, in the absence of the Hund coupling, when the electron interaction is gradually increased. Once the Hund coupling is introduced, the Mott transitions splits into two, such that an intermediate region appears where the system consists of localized electronic degrees of freedom and of itinerant, though strongly renormalized, electrons. We also discuss the finite-temperature properties by means of Quantum Monte Carlo simulation. This allows us to elucidate the behavior of spin and orbital fluctuations in the vicinity of the Mott transition by analyzing the spin, charge and orbital susceptibilities as well as the one-particle spectral function. Moreover we study the effect of hybridization between the orbitals which leads to some essential modifications of the properties compared to the case of non-hybridized orbitals.