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Phase Diagrams, Crossovers and Charge-Spin Separation in Small Clusters ARMEN KOCHARIAN, California State University, GAYANATH FERNANDO, KALUM PALANDAGE, University of Connecticut, JAMES DAVENPORT, Brookhaven National Laboratory — The charge-spin separation effect and response thermodynamics in the presence of a magnetic field are calculated using exact analytical diagonalization and grand canonical ensemble method for small clusters. Rigorous criteria for the Mott-Hubbard, Néel and zero-magnetic field (spin) weak singularities (*saddle points*) in the thermodynamic charge and spin densities of states *versus* chemical potential and magnetic field are found in the exactly solvable two and four site Hubbard ($U \mp 0$) clusters. Large quantum spin fluctuations are signaled by the presence of spin and charge density peaks, pseudogaps and corresponding temperature driven crossovers. The numerically evaluated, exact expressions for the charge, spin susceptibilities and specific heat demonstrate separation of charge and spin degrees and presence of pseudogaps that disappear at the distinct critical temperatures of crossovers. The phase diagram in the ground state, when monitored as a function of doping, displays the presence of clearly identifiable quantum phase transitions and critical points (QCP). In overall, the obtained spin pseudogap, magnetic correlations with antiferromagnetic (spin) pseudogap structure and crossovers in small clusters at $U > 0$ closely resemble the pseudogap phenomena and the normal-state phase diagram in high T_c superconductors.

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