Pseudogap, non-Fermi-liquid behavior, and particle-hole asymmetry in the high-Tc cuprates

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The transition from Fermi-liquid to non-Fermi-liquid behavior for decreasing hole doping in the 2D Hubbard model is studied within finite temperature exact diagonalization and cluster dynamical mean field theory. The self-energy component Sigma_X associated with X=(pi,0) is shown to exhibit a collective mode at about 20 to 50 meV above the Fermi level, which gives rise to a pseudogap and to increasing particle-hole asymmetry as the system approaches the Mott transition, in agreement with recent ARPES measurements on Bi_2Sr_2CaCu_2O_{8+delta}. The phase diagram reveals that the onset of non-Fermi-liquid behavior occurs at a critical hole doping of about 0.15 to 0.20 which coincides with the optimal doping observed in a variety of high-Tc cuprates. For electron doping, the collective mode seen in Sigma_X and the concomitant pseudogap are located below the Fermi energy, and the critical doping which marks the onset of non-Fermi-liquid behavior is systematically smaller than for hole doping.

[1] A. Liebsch and N.-H. Tong, arXiv/0907.3058