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Doping Evolution and Charge Ordering in Ca2-xNaxCuO2Cl2 from ARPES

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The evolution of $Ca_{2-x}Na_xCuO_2Cl_2$ from Mott insulator to superconductor was studied using ARPES, where we tracked both the doping dependence of the electronic structure and the chemical potential. Our work reveals failures in the conventional quasiparticle theory, including the broad lineshapes of the insulator and the apparently paradoxical shift of the chemical potential within the Mott gap. To resolve this, we develop a model where the quasiparticle is vanishingly small at half filling and grows upon doping, allowing us to unify properties such as the dispersion and Fermi wavevector with the behavior of the chemical potential. Comparisons of the lineshape and temperature dependence of the lower Hubbard band states to other states in the valence band and core levels indicate that lattice relaxation effects have a strong influence on the broadened lineshapes of the parent insulator, suggesting that the photoholes form polaron states. In addition, we have observed signatures of the unusual $4a_0 \times 4a_0$ checkerboard charge-ordered state recently observed by STM. Our results show a striking dichotomy between the real and momentum space probes, with well-nested but extremely weak antinodal sections of Fermi surface coexisting with sharp nodal QP-like excitations.