Spins and charges in Sr₁₄Cu₂₄O₄₁

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The spin-chain-spin-ladder system, Sr₁₄Cu₂₄O₄₁ is the parent compound of the Sr_{14-x}Ca_xCu₂₄O₄₁ family, whose members with Ca doping close to $x \equiv 11$ are the first cuprate superconductors with a non-square lattice [1]. Their structure consists of CuO₂ chain layers and Cu₂O₃ ladder planes, separated by Sr atoms. Like in other non-conventional superconductors, the interplay of spin and charge degrees of freedom is here of great interest, as the best candidate for the Cooper pair formation mechanism seems to be the spin-fluctuation-glue. These compounds have a particular type of collective spin excitations, called triplons, which we studied in Sr₁₄Cu₂₄O₄₁ by Resonant Inelastic X-ray Scattering (RIXS) at the Cu L edge [2]. The distribution of charge degrees of freedom have been studied by the O K edge polarization dependent X-ray absorption (XAS) spectra few times, with different conclusions [3,4,5]. We performed a complete 316 atom antiferromagnetic unit cell LDA+U calculations of the O K edge polarization dependent low temperature XAS spectra [6] and discovered that switching on the correlations results in a strong chain hole-appeal. For the remaining small number of holes accommodated on ladders, leg sites are preferred to rung sites. The small hole affinity of rung sites explains naturally the onedimensional to two-dimensional crossover in the underdoped part of the phase diagram of (La,Y,Sr,Ca)₁₄Cu₂₄O₄₁ [7].

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