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Order parameter of the paired hole states in $Sr_{14}Cu_{24}O_{41}$ studied by optics and UV-resonance Raman scattering ANDRIVO RUSYDI, B. SCHULZ, R. RAUER, I. MAHNS, University of Hamburg, H. EISAKI, Nanoelectronics Research Institute, AIST, Y. FUJIMAKI, S. UCHIDA, University of Tokyo, P. ABBAMONTE, University of Illinois, M. RÜBHAUSEN, University of Hamburg
— The order parameter of the paired hole states of hole Wigner crystal (HC) in the self-doped spin (S)=1/2 two-leg ladders of $Sr_{14}Cu_{24}O_{41}$ (SCO) is studied with optics and UV-resonance Raman scattering. We observe a pair breaking excitation of the holes ($2\Delta_{h-h}$) at 200 meV which can be attributed to the rungs of the ladders. The intensity of the $2\Delta_{h-h}$ peak as function of temperature matches very well with the formation of HC at about 250 K (T_{HC}). The energy of $2\Delta_{h-h}$ is temperature independent, even at its transition temperature indicating a remaining short range order with a strongly decreased volume fraction. The order parameter of the paired hole states develops in a non-mean-field fashion and $2\Delta_{h-h}/k_bT_{HC}$ is about 11, i.e. in the strong coupling limit. Our optics studies also show low- and high-spin transitions along the legs and rungs below 130 K. Our measurements confirm theoretical predictions of the existence of the paired hole states outlining the strong local pairing of the holes.

Andrivo Rusydi
University of Hamburg

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