Charge order and its dynamics in overdoped Cuprates

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Charge orders (CO) are considered a significant competitor of high-temperature superconductivity in underdoped cuprates [1]. In contrast, overdoped cuprates have traditionally been viewed as conventional Fermi liquids without collective electronic order. Determining the extent of CO across different doping and temperature ranges can help disentangle the relationship between superconductivity, pseudogap, and CO phases, which is critical to understanding high-temperature superconductivity. Using Cu L_3 edge and O K edge resonant x-ray scattering, we have revealed the presence of CO in overdoped $La_{2-x}Sr_xCuO_4$ ($0.35 \leq x \leq 0.6$) beyond the superconducting dome [2]. We observed similar in-plane momentum and polarization dependence and dispersive excitations as the CO of underdoped cuprates, but its maximum intensity differed along the c-direction and persisted up to 300 K. The Fermi surface instability cannot explain this CO, and its origin remains to be understood. Our results suggest that CO is prevalent in the overdoped metallic regime, requiring a reassessment of the traditional understanding of overdoped cuprates as weakly correlated Fermi liquids. We also employ time-resolved resonant X-ray scattering to examine CO dynamics on heavily overdoped Bi2201. We found that the charge order dynamics were distinct from those observed in underdoped cuprates under 800 nm and 400 nm laser pumps, suggesting that the origins of CO in underdoped and overdoped cuprates differ from each other.

References

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2. Li et al., Prevailing charge order in overdoped cuprates beyond the superconducting dome, Physical Review Letters 131, 116002 (2023).