The microscopic structure of charge order in cuprates

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The spontaneous self-arrangement of electrons into periodically modulated patterns, a phenomenon commonly termed as charge order or charge-density-wave, has recently resurfaced as a prominent, universal ingredient for the physics of high-temperature superconductors. Its antagonist coexistence with superconductivity, together with its possible connection to a quantum critical point beyond optimal doping, are symptomatic of a very fundamental role played by this symmetry-broken collective electronic state.

In such context, resonant x-ray scattering (RXS) has rapidly become the technique of choice for the study of charge order in momentum space, owing to its ability to directly identify a breaking of translational symmetry in the electronic density, even when the latter only involves a fraction of the electronic charge and its coherence does not extend beyond a few lattice constants.

In this talk, I will present our recent RXS studies of charge order in Bi2201, which reconciled years of apparently disconnected findings in different cuprate families by showing how charge order is a universal phenomenon in hole-doped cuprates [1]. Contextually, I will discuss very recent findings of charge order NCCO, which extend such phenomenology to the electron-doped materials [2].

Furthermore, in YBCO, we have succeeded to fully reconstruct the charge order parameter in the two-dimensional momentum space and demonstrate how resonant x-ray methods can be used to peer into the microscopic structure and symmetry of the charge. Using this new method, we have been able to demonstrate the presence of charge stripes at the nanoscale [3], as well as evaluate the local symmetry in the charge distribution around the Cu atoms, which was found to be predominantly of a d-wave bond-order type [4].

References

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