Doping evolution of intertwined electronic orders in cuprates

Tejas Parasram Singar, Ivan Maggio-Aprile, and Christoph Renner

DQMP, University of Geneva, 24, Quai Ernest-Ansermet, 1211 Geneva 4, Switzerland

Hole-doped cuprates exhibit a complex phase diagram characterized by the coexistence of multiple electronic orders, including superconductivity, magnetism, the pseudogap and charge order. Hole doping of the CuO_2 planes via interstitial oxygen atoms modifies the electronic structure, leading to pronounced changes in both the superconducting gap and the pseudogap.

Here, we investigate the doping evolution of the local density of states (LDOS) modulations in the $Bi_2Sr_2CaCu_2O_{8+\delta}$ (Bi-2212) superconductor using scanning tunneling microscopy (STM). We focus on the evolution of the vortex core electronic structure, where superconductivity is locally suppressed, providing access to the underlying non-superconducting ground state across the phase diagram [1-3].

We further examine the doping dependence of zero-field periodic charge modulations and their relationship with superconducting and pseudogap orders through spectroscopic imaging of local electronic variations. Our results provide insight into how intertwined electronic orders evolve with carrier concentration in the Bi-2212 high temperature superconductor.

[1] T. P. Singar et al., arXiv:2512.13588 (2025).
[2] I. Maggio-Aprile et al., Physica C: Superconductivity and its Applications 615 (2023) 1354386.
[3] T. Gazdić et al., Physical Review X 11, 031040 (2021).