Dynamical vertex theory of superconductivity in infinite-layer nickelates

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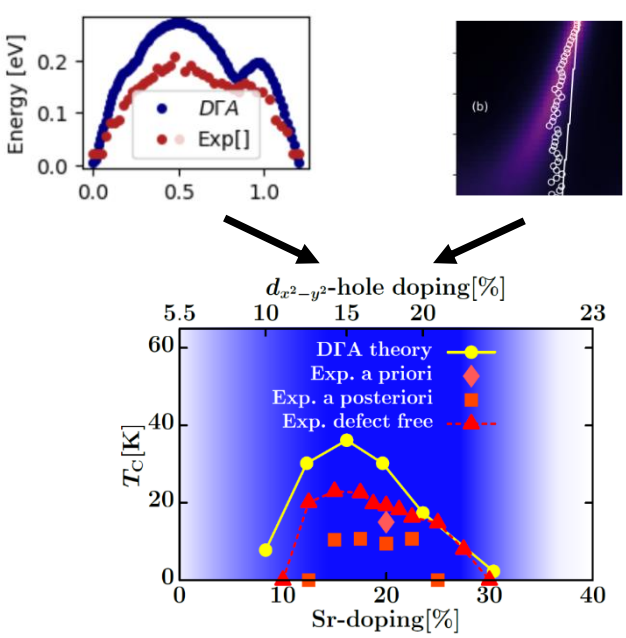
Infinite-layer nickelates are at the same time strikingly similar to cuprates but also decisively different, an ideal combination to discriminate the essentials from the incidentals for superconductivity in both systems. Using the dynamical vertex approximation (DΓA) and a minimal single-band Hubbard model plus electron pockets that merely act as charge reservoirs, we have predicted [1] the phase diagram of nickelate superconductors in excellent agreement with later defect-free experiments, see Figure. This includes the quantitative value of T_c, the doping region of the dome and its skewness. Later, RIXS and ARPES were found to agree also with the calculated spin susceptibility and correlated electronic structure. Both enter the calculation of T_c, see Figure.

Altogether we are thus confident that we arrived at a theoretical description of infinite-layer nickelates with an accuracy that is quite unprecedented for an unconventional superconductor. As a further distinctive prediction to test our theory, we hold infinite-layer nickelates to become superconducting even without chemical doping if a pressure of 50-100 GPa is applied [2]; also palladates are conjectured to be superconductors [3]. Further, we observe and explain waterfalls in the electronic dispersion as *"umbilical cords"* connecting the developing Hubbard band to the quasiparticle band.



The experimental RIXS (top left) and ARPES (top right) dispersion excellently aggrees with the prior DΓA calculaltions, as does the superconducting Tc (lower panel).

[1] M. Kitatani … KH, Nature physics journal Quantum Materiasl 5, 59 (2000); L. Si … KH, Phys. Rev. Lett. 124, 166402 (2020).

[2] S. Di Catalo … KH, Nature Comm. 15, 3952 (2024).

[3] M. Kitatani … KH, Phys. Rev. Lett. 130, 166002 (2023).