Marginal-Fermi-Liquid-Like Strange Metal Behavior without Pseudogap in Infinite-Layer Nickelates

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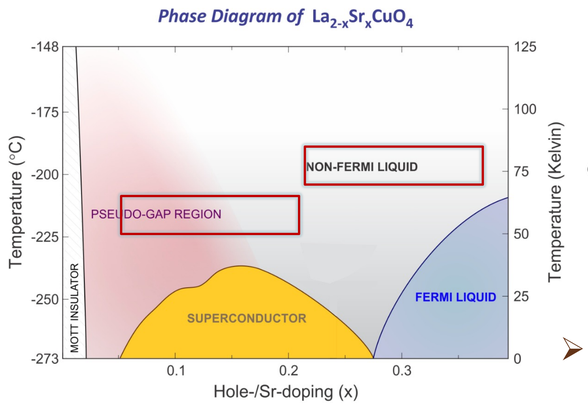
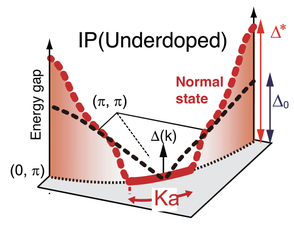
From Challenge to Breakthrough: ARPES Study of Infinite-Layer Nickelates

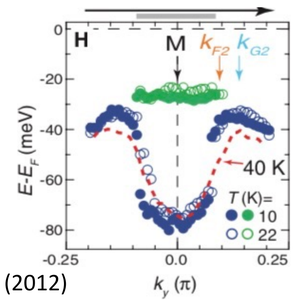
Pseudogap as a Hallmark of Cuprate Superconductors



Chang, J., et al., Nat. Commun., (2013)



Ideta, S.-i., et al., Phys. Rev. B, (2012)

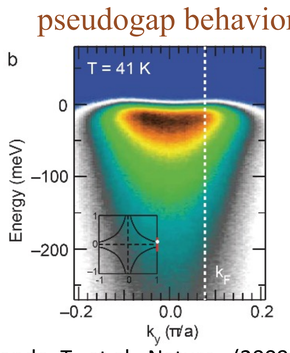


He, R.-H., et al., Science, (2011)

➢ Whether and how this phenomenon extends to cuprate-like superconductors, such as infinite-layer nickelates?

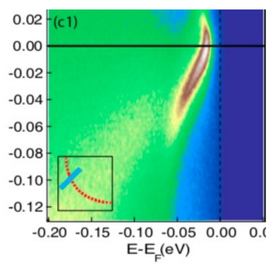
Challenge: Reliable Gap Detection Requires High-Quality ARPES Spectra

pseudogap behavior



Kondo, T., et al., Nature, (2009).

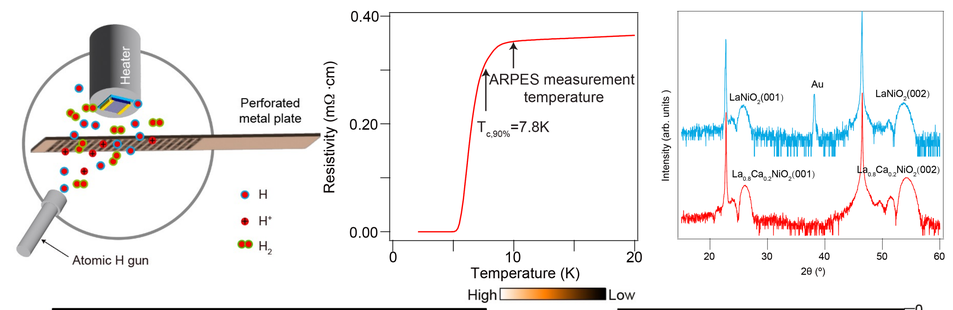
Superconducting gap behavior

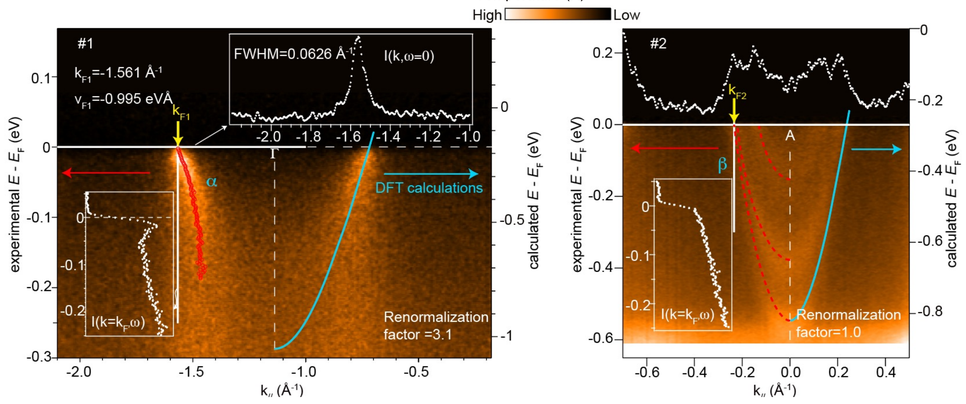


Vishik, I.M., et al., Proc. Natl. Acad. Sci. U.S.A.,(2012).

➢ A well-defined Fermi-edge cutoff and coherent quasiparticle spectral weight are required to resolve possible gap opening.

Breakthrough: Quasiparticle-Resolved ARPES in Infinite-Layer Nickelates

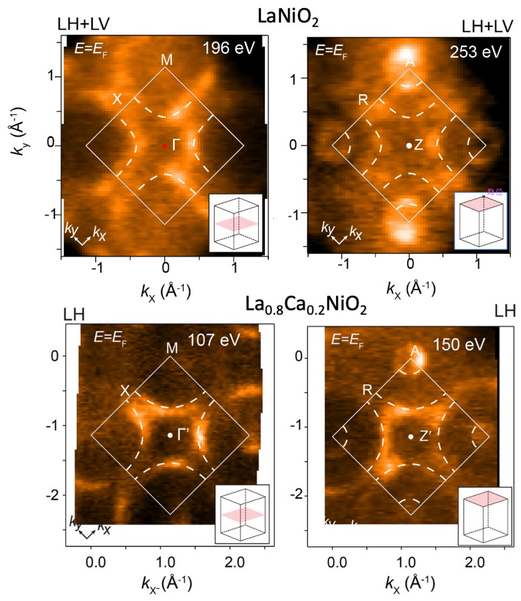




➢ By optimizing thin-film growth, surface preparation, and atomic-hydrogen reduction, we achieve enhanced near-E_F spectral weight and clear quasiparticle features, enabling reliable pseudogap analysis in infinite-layer nickelates.

Experiment Results

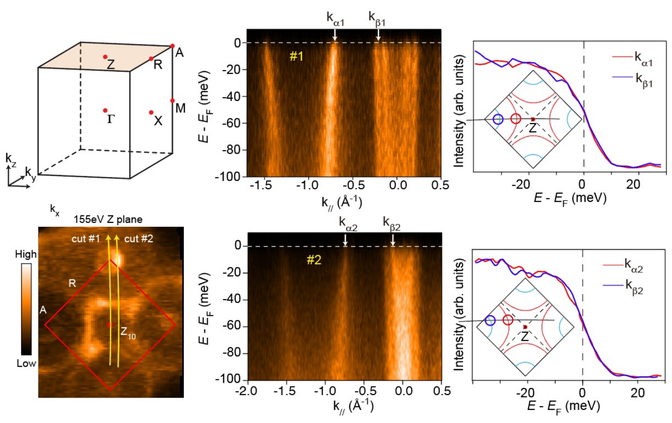
1. Fermi surface topology of parent and optimally-doped films



X. Ding, Y. Fan, et al., National Science Review **11**, nwae194 (2024).

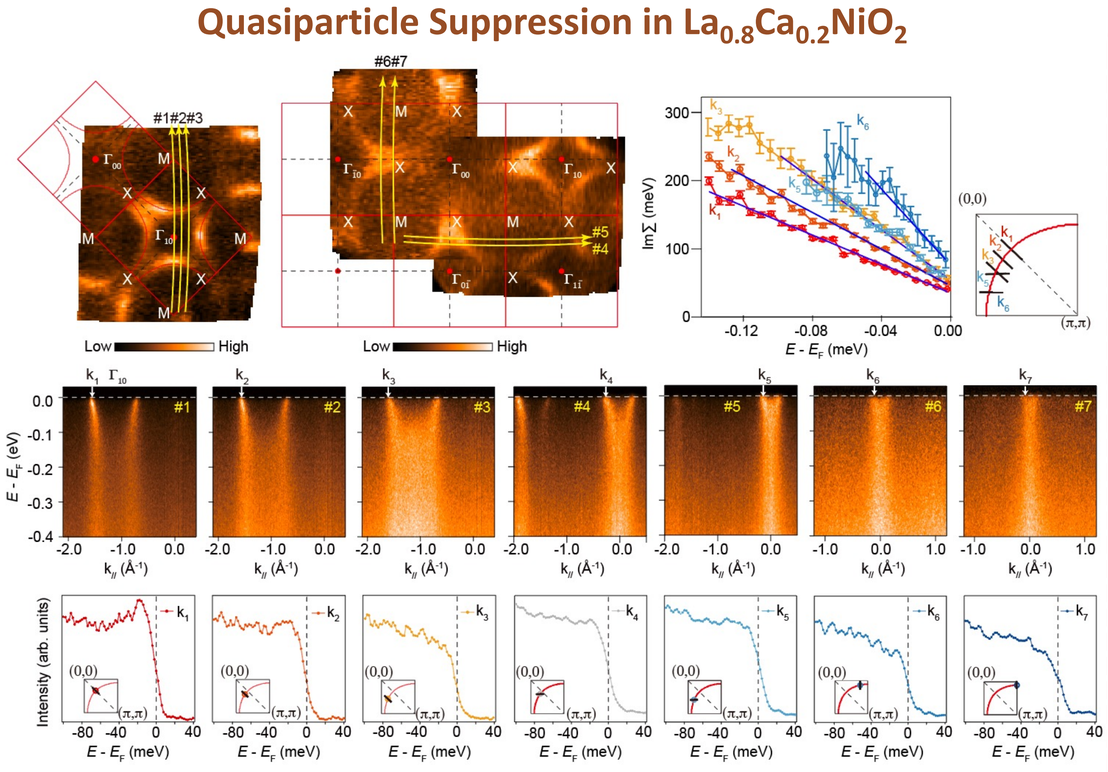
➢ Both $LaNiO_2$ and optimally doped (La,Ca)NiO_2 exhibit cuprate-like $d_{x^2-y^2}$-derived Fermi-surface

2. β Band Remains Gapless across Different Momenta



➢ The interstitial-s-dominated β band crosses E_F along both high-symmetry and off-symmetry directions

3. Gapless α Pocket with Momentum-dependent Quasiparticle Suppression in $La_{0.8}Ca_{0.2}NiO_2$

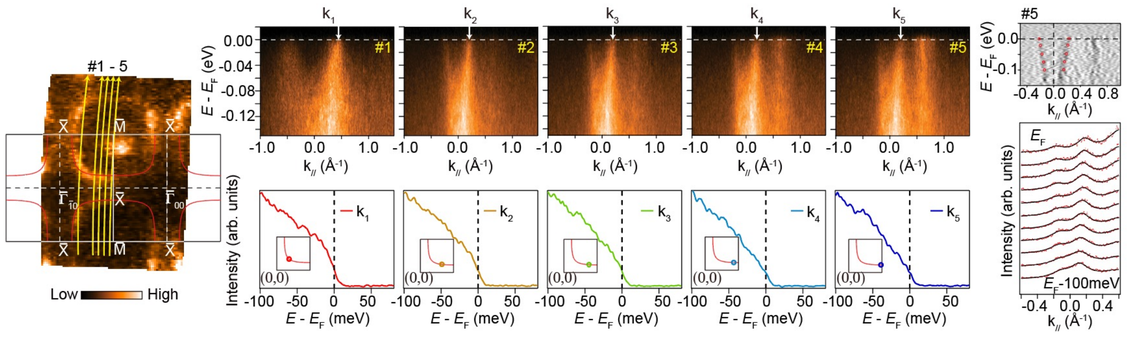


➢ The leading edge remains pinned at E_F.

➢ The quasiparticle peak is progressively suppressed from ($A = \pi/2$, π /2) toward (π,0).

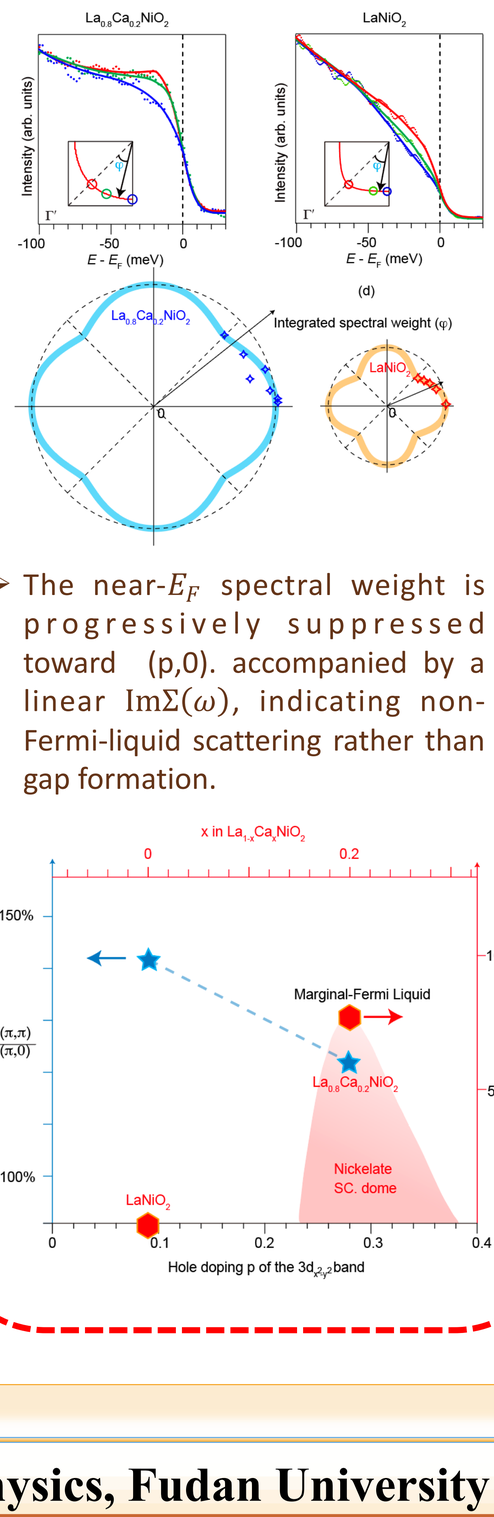
➢ The linear E-dependence of $\mathrm{Im}\Sigma$ indicates marginal-Fermi-liquid-like scattering

4. Stronger Incoherence without Gap Opening in Undoped $LaNiO_2$



➢ the α band still disperses continuously across E_F near (π,0)

Conclusion



➢ The near-E_F spectral weight is progressively suppressed toward (p,0). accompanied by a linear $\mathrm{Im}\Sigma(\omega)$, indicating non-Fermi-liquid scattering rather than gap formation.

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