Spectroscopy evidences for true Landau Fermi quasiparticles in LSCO

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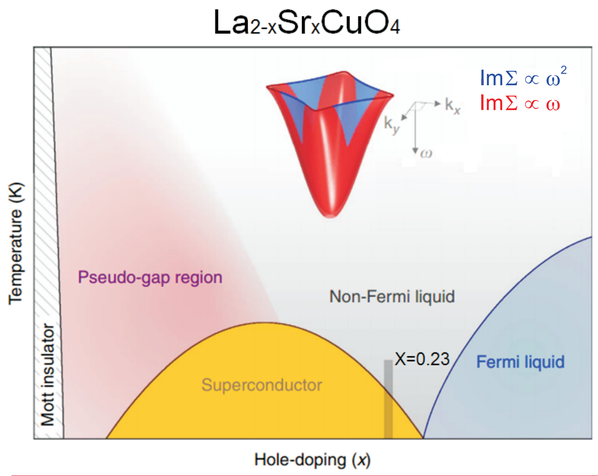


Definitions:

A(k,ω) Spectral function
Σ(k,ω) Self-energy
ε_k Observed band
ε_b Bare band
ω_c Fermi liquid cut-off
Z quasiparticle residue

Formulae used:

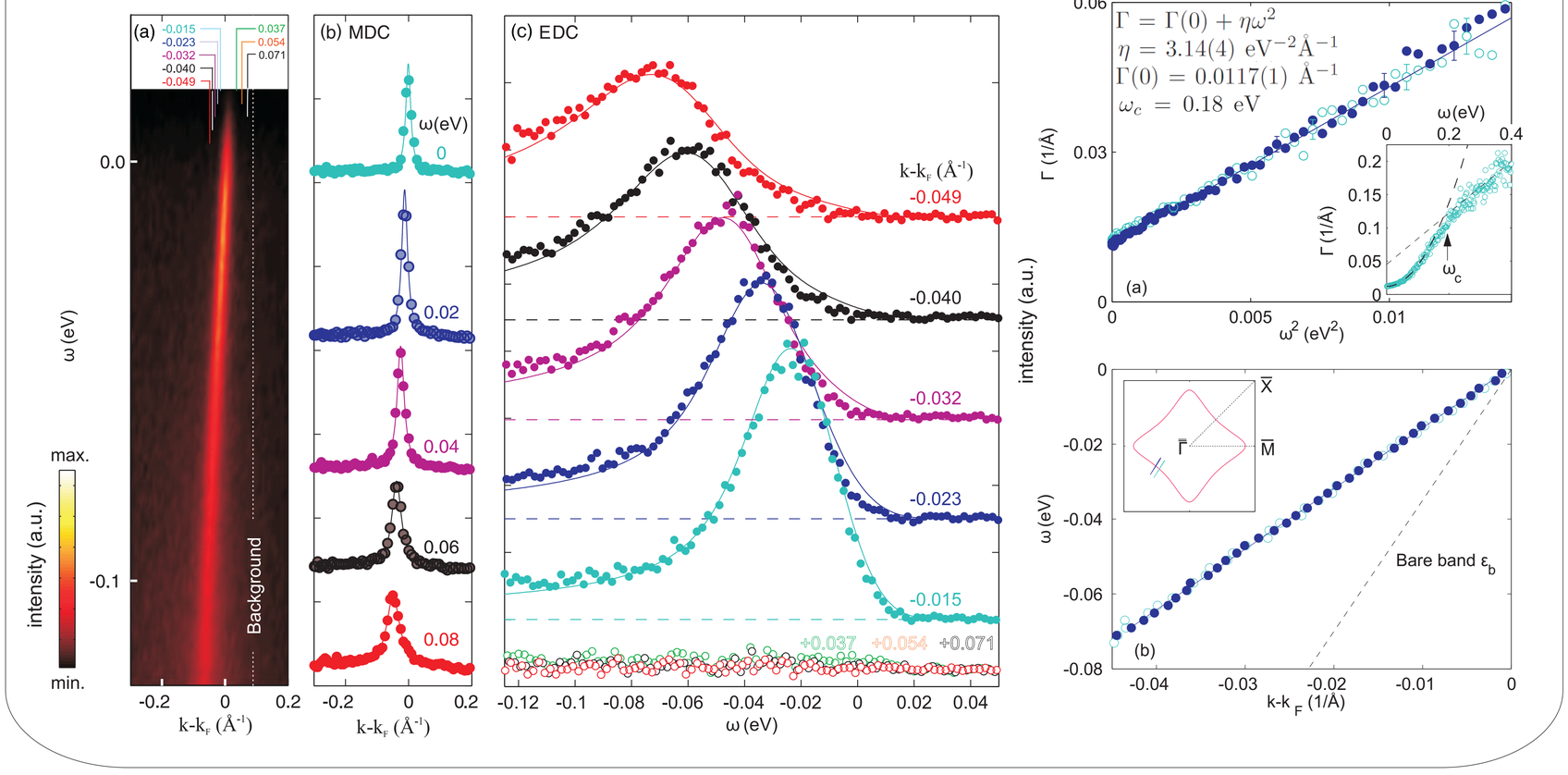
ARPES Spectral function: $$A_{coh}(k,\omega) = \frac{-1}{\pi}\frac{\Sigma''(k,\omega)}{(\omega - \Sigma'(k,\omega) - \varepsilon_b)^2 + \Sigma''(k,\omega)^2}$$

Kramers-Kronig relation: $$\Sigma' = \frac{\mathcal{P}}{\pi}\int_{-\omega_c}^{\omega_c}\frac{\Sigma''(\omega')}{\omega'-\omega}d\omega' \pm \frac{\mathcal{P}}{\pi}\int_{\pm\omega_c}^{\pm W}\frac{\Sigma''(\omega')}{\omega'-\omega}d\omega'$$

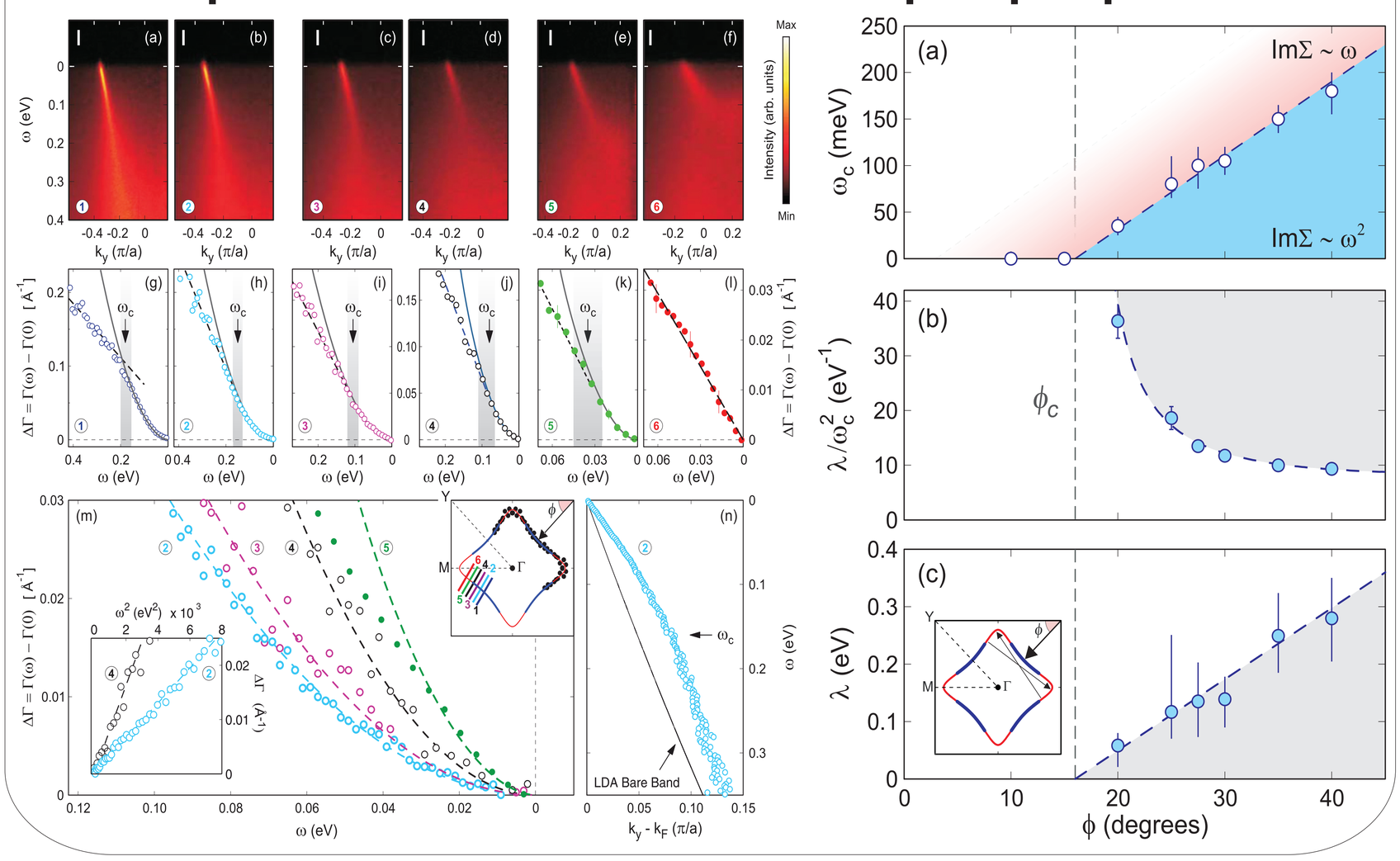
quasiparticle residue: $$Z \equiv (1 - \partial\Sigma'/\partial\omega)^{-1}$$

Angle-Resolved Photemission Spectroscopy Experiments:

Nodal Landau Fermi liquid quasiparticles



Anisotropic breakdown of Landau Fermi liquid quasiparticles



Analysis:

I. MDC fits: $$I(k) = I_0\frac{\Gamma}{(\omega-\varepsilon_k)^2+\Gamma^2}$$

$$\varepsilon_k = v_F(k-k_F)$$
$$v_F = 1.62 \text{ eVÅ}$$

II. Model:

·matrix elements M(k,ω)~costant

·linear bare band $\varepsilon_b \simeq v_b(k-k_F)$

·Σ(k,ω)~Σ(ω) at the node

$$A_{\text{coh}}(k,\omega) = \frac{-1}{\pi}\frac{\Sigma''(\omega)}{[\omega - \Sigma'(\omega) - v_b(k-k_F)]^2 + \Sigma''(\omega)^2}$$

$$\Gamma(\omega) = -\Sigma''(\omega)/v_b$$

$$\Sigma'' = -\eta v_b \omega^2$$

$$Z\Sigma'' = -v_F\eta\omega^2$$

$$-Z\Sigma'' < |\omega|$$

Landau quasiparticles are coherent for ω<0.19 eV

III. Kramers-Kronig consistency:

$$\Sigma' \simeq -\gamma\omega$$

$$\gamma = 2v_b\eta\omega_c/\pi$$
$$Z \simeq 1/(1+\gamma) = v_F/v_b$$
$$Z = 0.42(7)$$

$$v_b = \pi v_F/(\pi - 2\eta\omega_c v_F)$$
$$= 3.8 \text{ eV Å}$$

$v_{LDA} = 3.5$ eVÅ

References
[1] C. G. Fatuzzo et al., PRB, 89, 205104 (2014)
[2] J. Chang et al., Nature Communications, 4, 2559 (2013)

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