Modeling Quasiparticles and Pseudogap in Cuprates in Presence of Charge Ordering Potential

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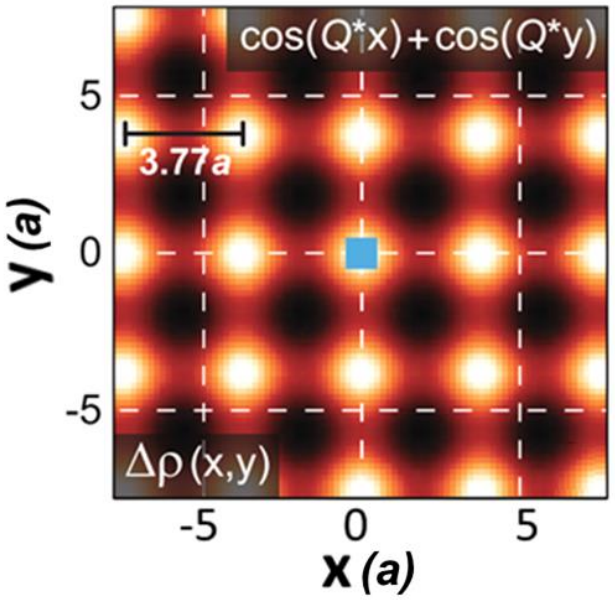
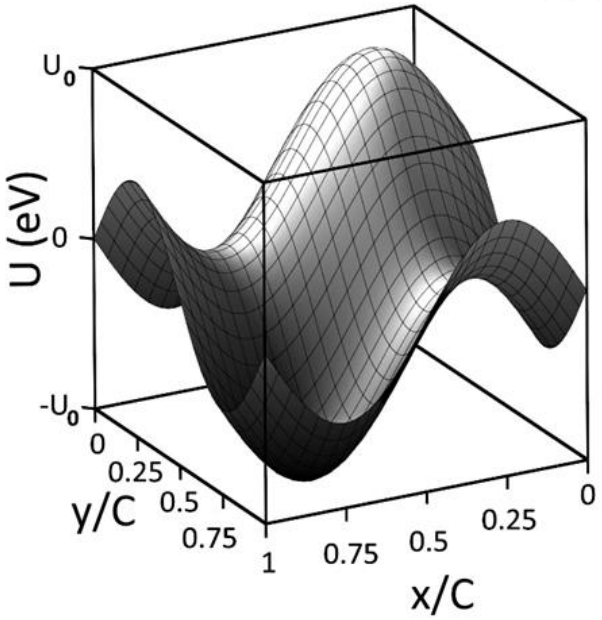
Modeling the charge ordering potential in cuprates.

At strong Frohlich electron-phonon coupling CO is formed by large (bi)polarons. This explains CO wave vector K_{CO} dependence on doping and softening of phonon modes at K_{CO} [A.E. Myasnikova et al., J. Phys.: Condens. Matter **31**, 235602 (2019)]. Here we study delocalized electrons/holes in the additional potential of CO.



R. Comin et al., Nat. Mat. 14, 796 (2015)

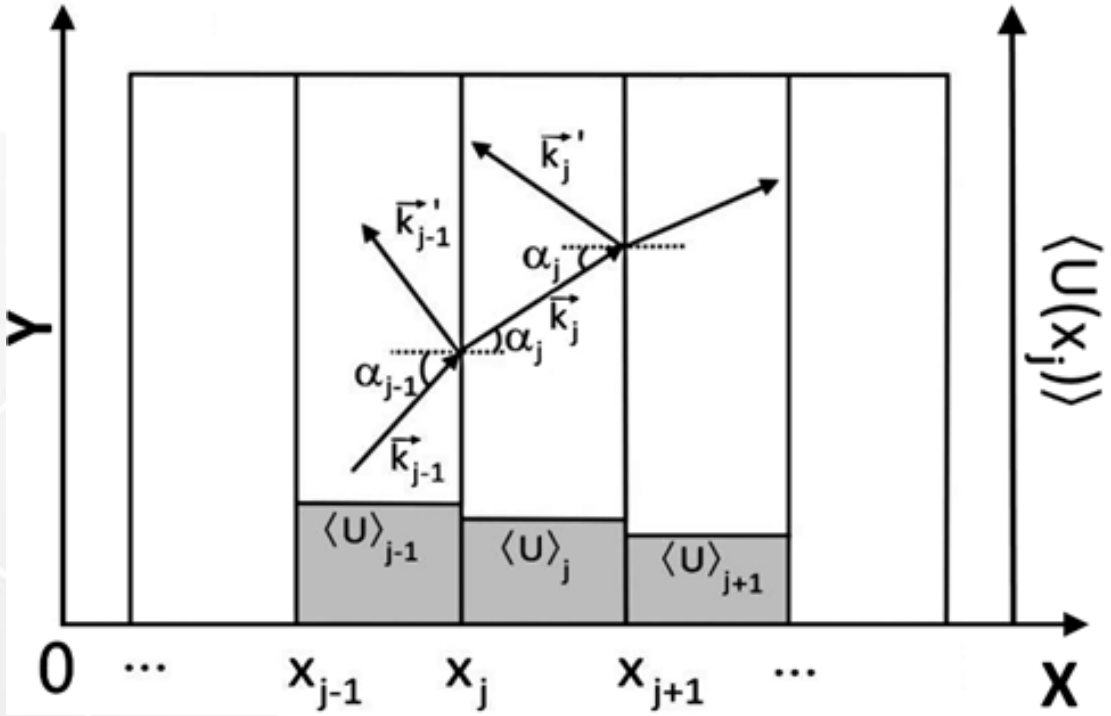


$q_{bip}=2e/\varepsilon_0 \rightarrow U_0$

$$\mathbf{U(x,y) = U_0\left(\sin(K_{CO\,x}\,x) + \sin(K_{CO\,y}\,y)\right)/2} \qquad \mathbf{(1)}$$

$$\mathbf{k_y \ll k_x \rightarrow \quad U(x) = U_0 \sin(K_{CO\,x}\,x)} \qquad \mathbf{(2)}$$

The calculation method. QPs are distributed wave packets



$$\begin{cases} \varepsilon(\mathbf{k_j}) = \mathbf{E} - \mathbf{U_j} \\ \mathbf{k_y} = \mathbf{const} \end{cases}$$

$$\begin{cases} \varepsilon(\mathbf{k_j}) = \mathbf{E} - \mathbf{U_j} \\ \mathbf{k}_{\mathbf{y_{j-1}}} = \mathbf{k}_{\mathbf{y_j}} \end{cases} \quad (3)$$

$$\begin{cases} \varepsilon(\mathbf{k_j}) = \mathbf{E} - \mathbf{U_j} \\ \mathbf{k}_{\mathbf{x_{j-1}}} = \mathbf{k}_{\mathbf{x_j}} \end{cases}$$

$$\left[-\frac{\hbar^2\nabla^2}{2m} + V + U_j\right]\Psi_j = E(\mathbf{k}_0)\Psi_j \qquad \Psi_j = \sum_{\mathbf{k}} C_{\mathbf{k},j}\psi_{\mathbf{k}}.$$

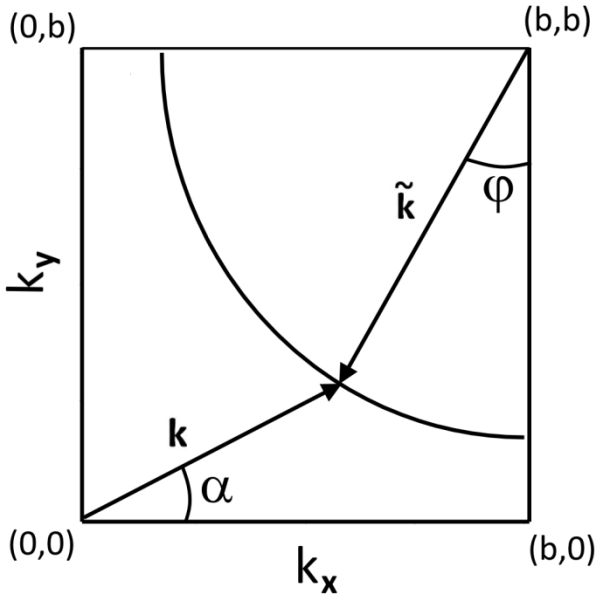
$$\sum_{\mathbf{k}} [\varepsilon(\mathbf{k}) + U_j - E(\mathbf{k}_0)]C_{\mathbf{k},j}\psi_{\mathbf{k}} = 0,$$

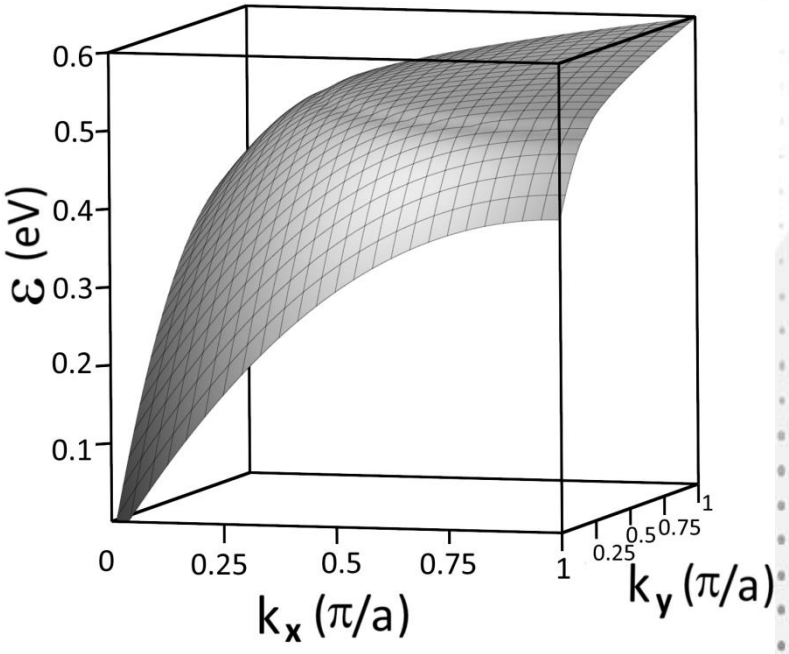
ε_{min}=E-U_0

ε_{max}=E+U_0

S. V. Doronkina, A.E. Myasnikova, A. H. Dzhantemiov, A. V. Lutsenko, arXiv preprint, ***arXiv:2007.16064***

Modeling cuprates dispersion in the vicinity of FS and antinodes (with arc FS and the most flat near FS)

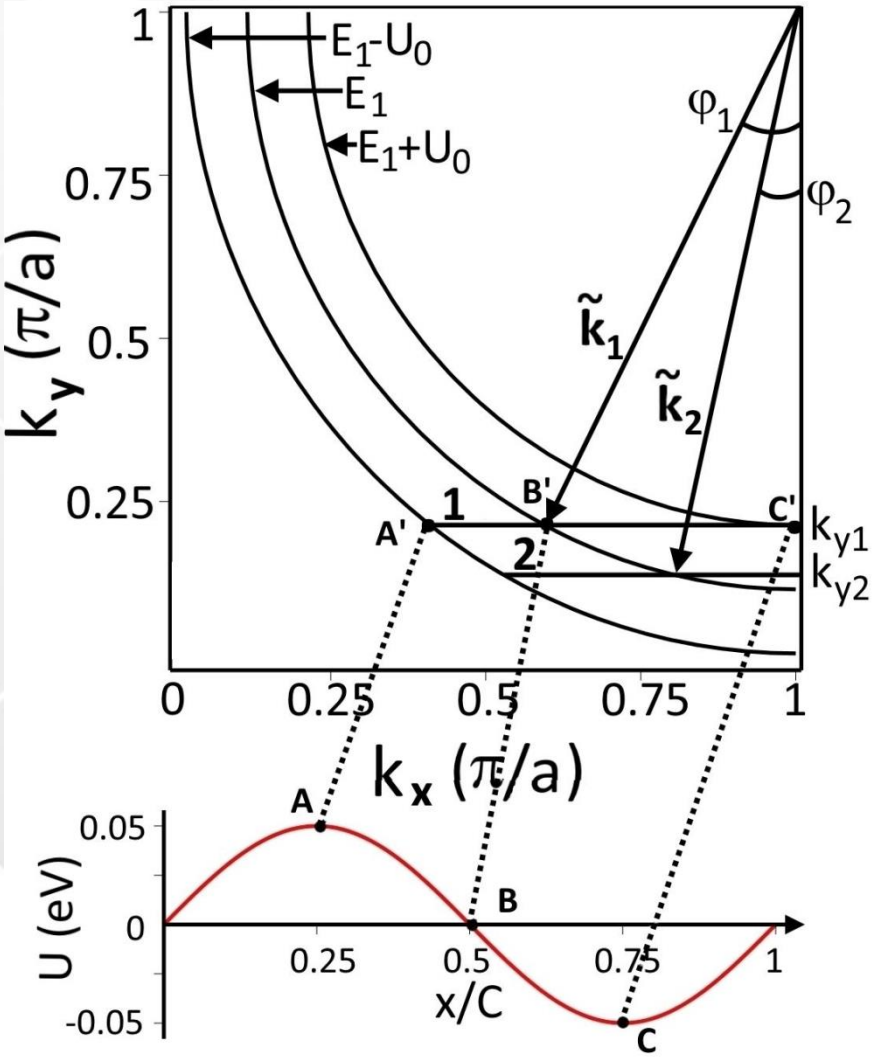


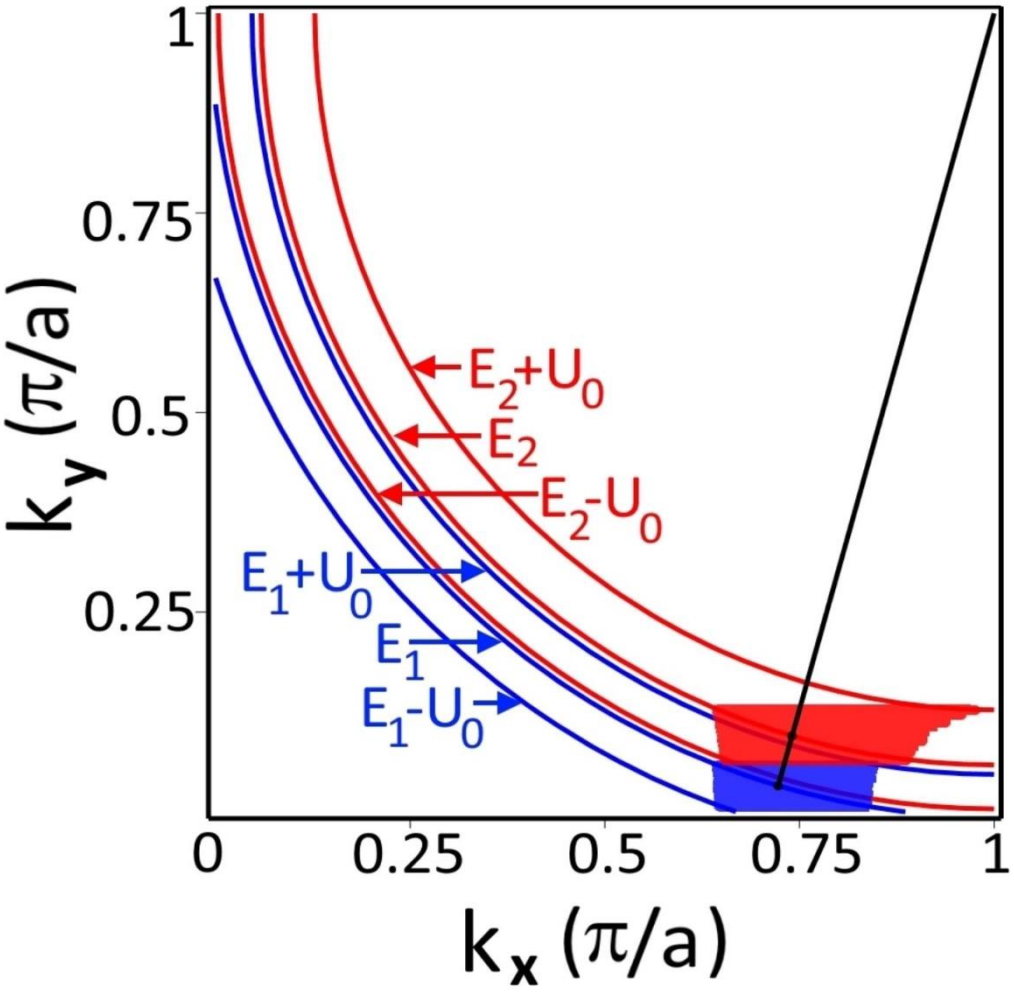


$$\varepsilon(\mathbf{k}) = 0.5 - c * \left(\sqrt{(k_{j,x} - b)^2 + (k_{j,y} - b)^2} - \tilde{k}_0 \right)^d, \varepsilon \le 0.5$$

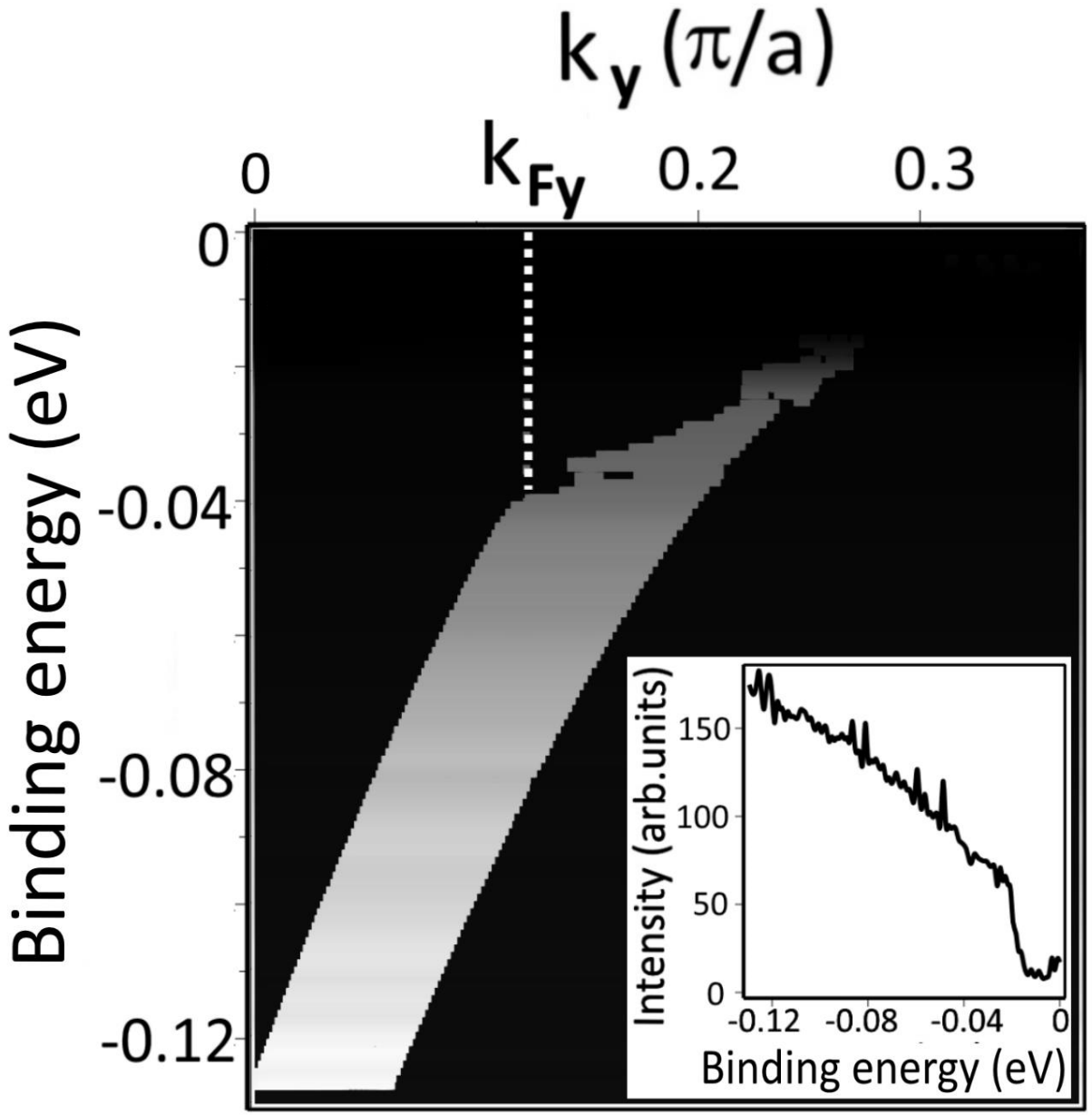
$$\varepsilon(\mathbf{k}) = 0.5 + c' * \left(\tilde{k}_0 - \sqrt{(k_{j,x} - b)^2 + (k_{j,y} - b)^2} \right)^{d'}, \varepsilon(\mathbf{k}) > 0.5$$

Momentum-space trajectories of quasiparticles for U(x) and U(x,y) cases, respectively

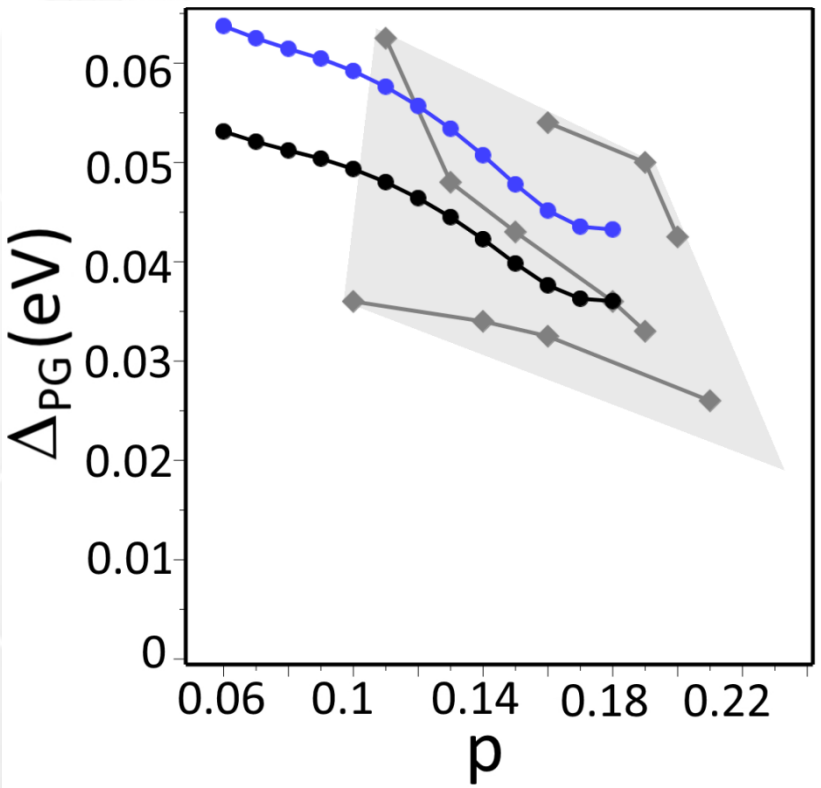


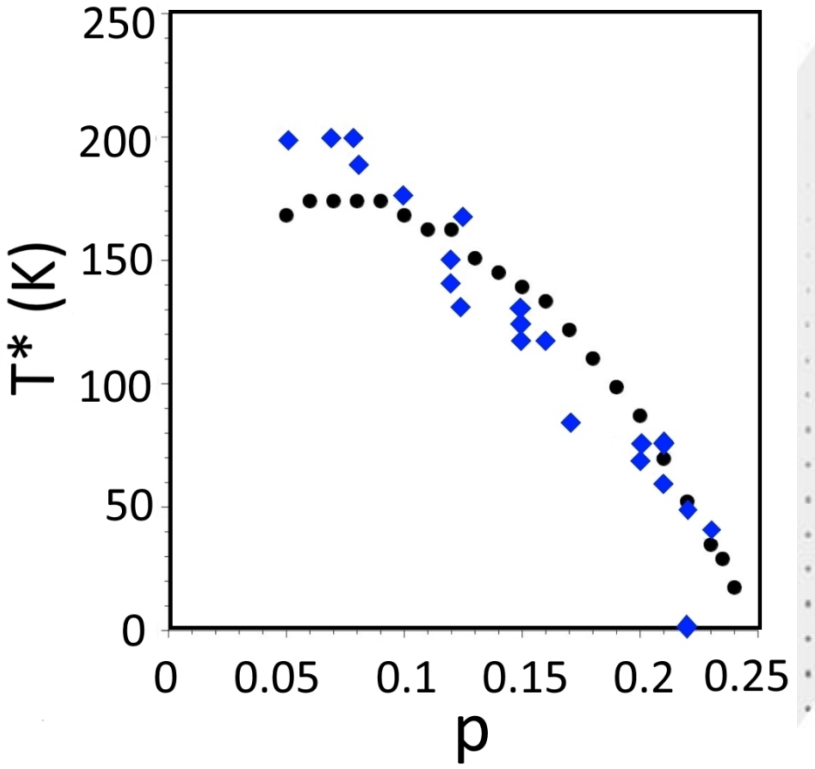


Calculated antinodal ARPES spectrum



Calculated doping dependences of the pseudogap width and the pseudogap onset temperature





1. *Ø. Fischer, M. Kugler, I. Maggio-Aprile, C. Berthod, and C. Renner, Rev. Mod. Phys.* ***79****, 353 (2007);*
2. *A. E. Myasnikova, E. N. Myasnikov, D. V. Moseykin, and I. S. Zuev, Phys. Lett. A* ***379****, 458 (2015);*
3. *N. Doiron-Leyraud et al., Nat. Comm.* ***8****, 2044 (2017).*