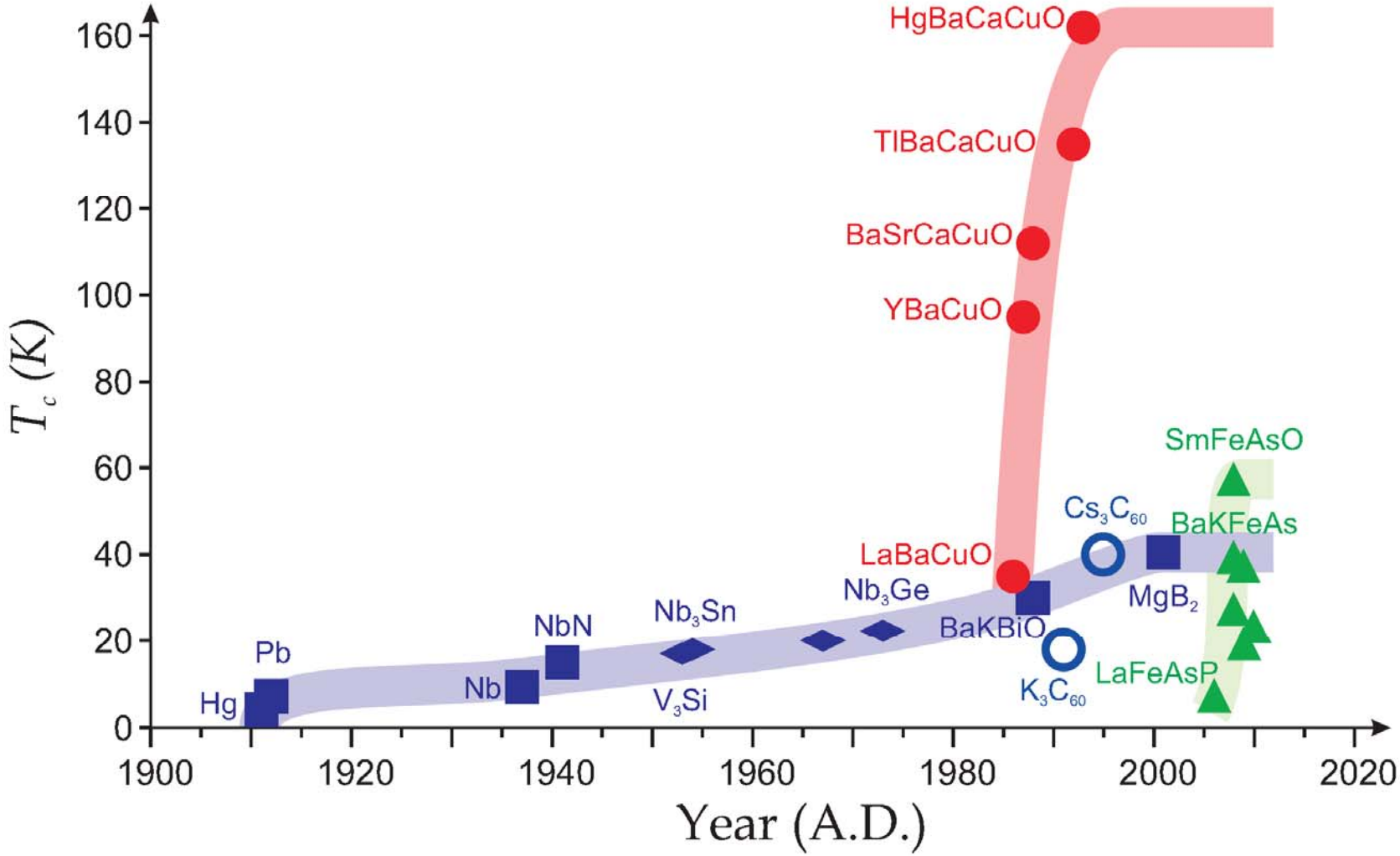
Leibniz-Institut
für Festkörper- und
Werkstoffforschung
Dresden

ARPES on iron-based superconductors: leading role of *xz/yz* orbitals

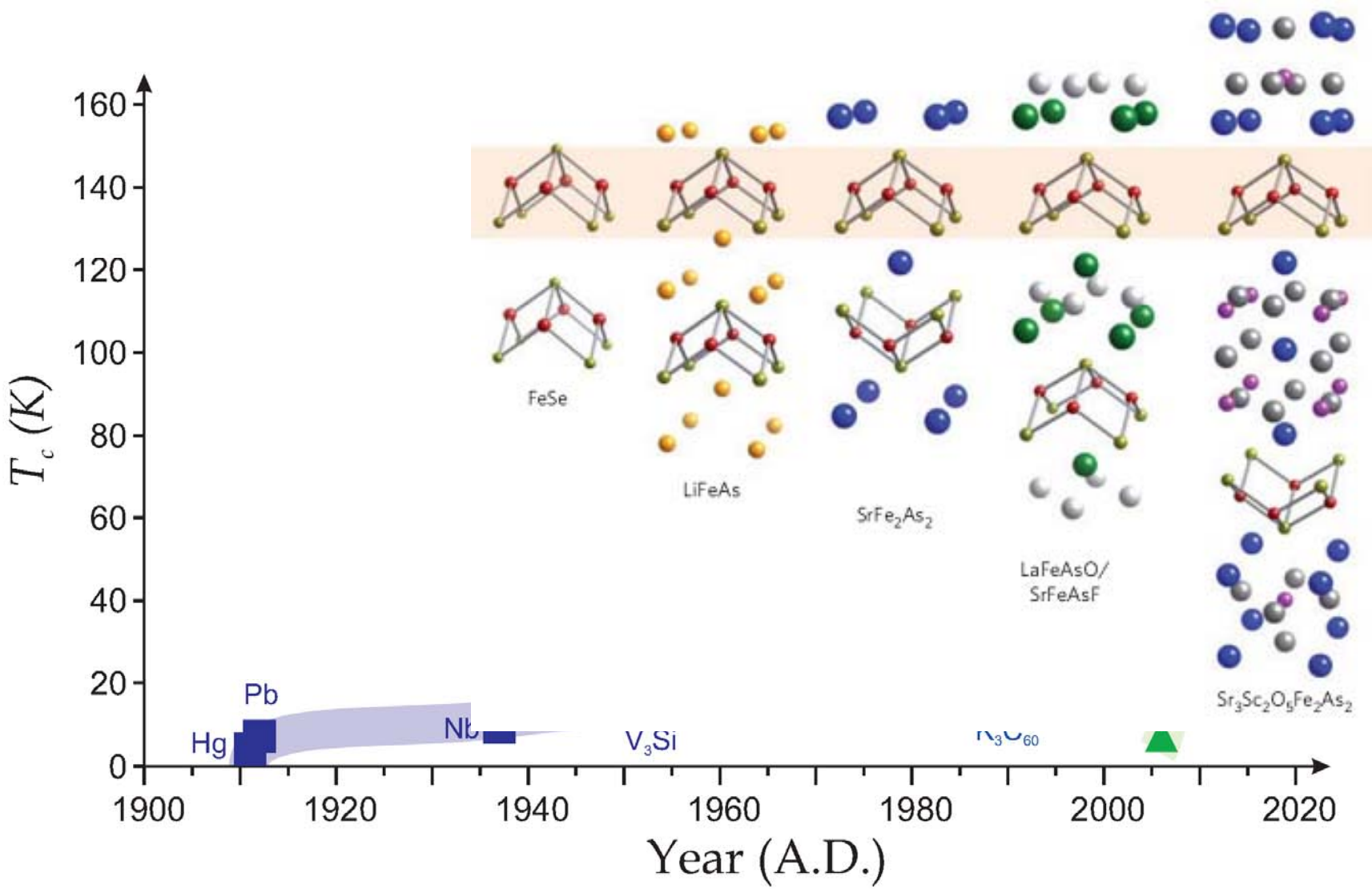
Evtushinsky Daniil

ES&ES, Kiev, May 23rd

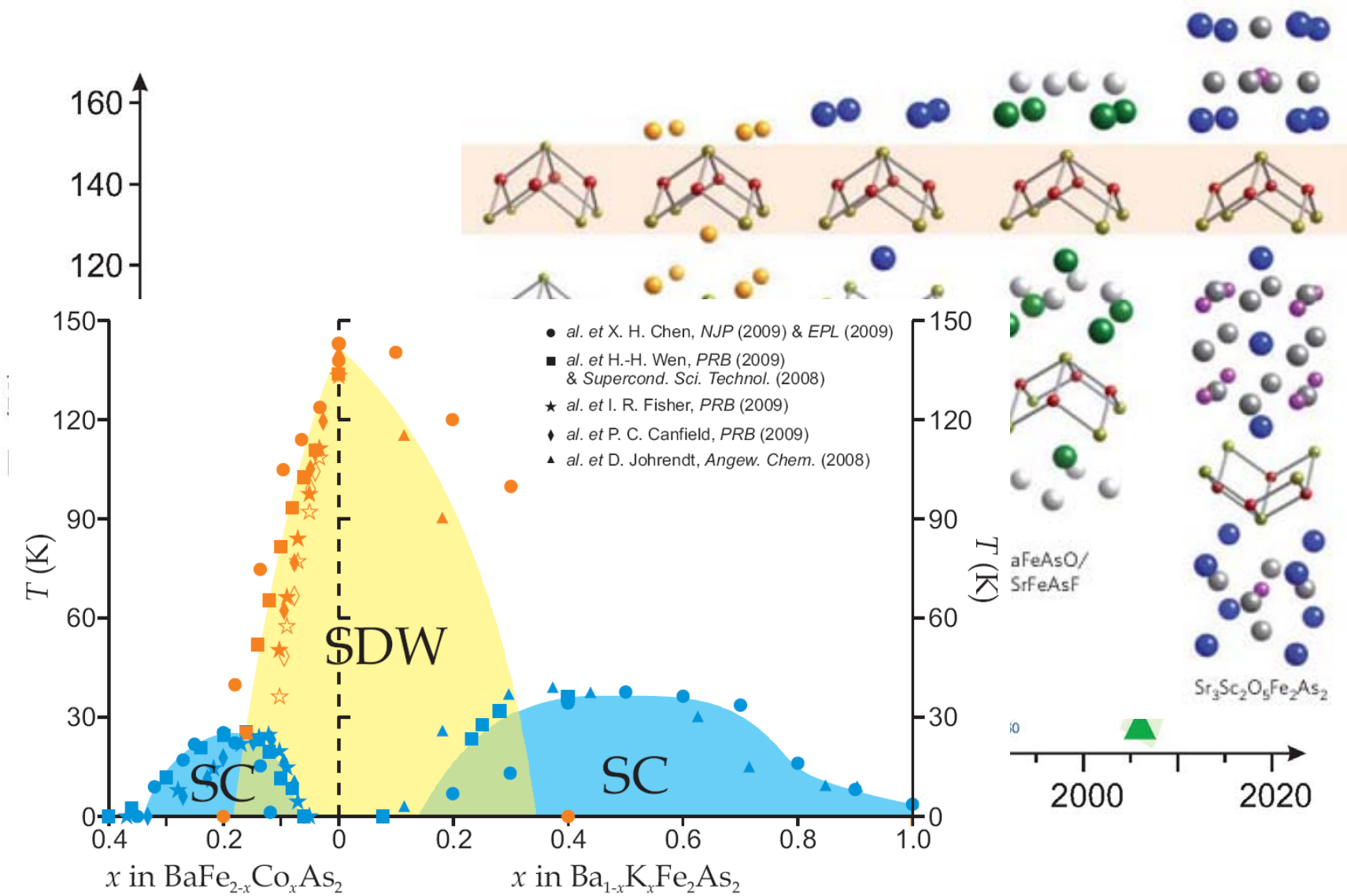
Iron-based superconductors



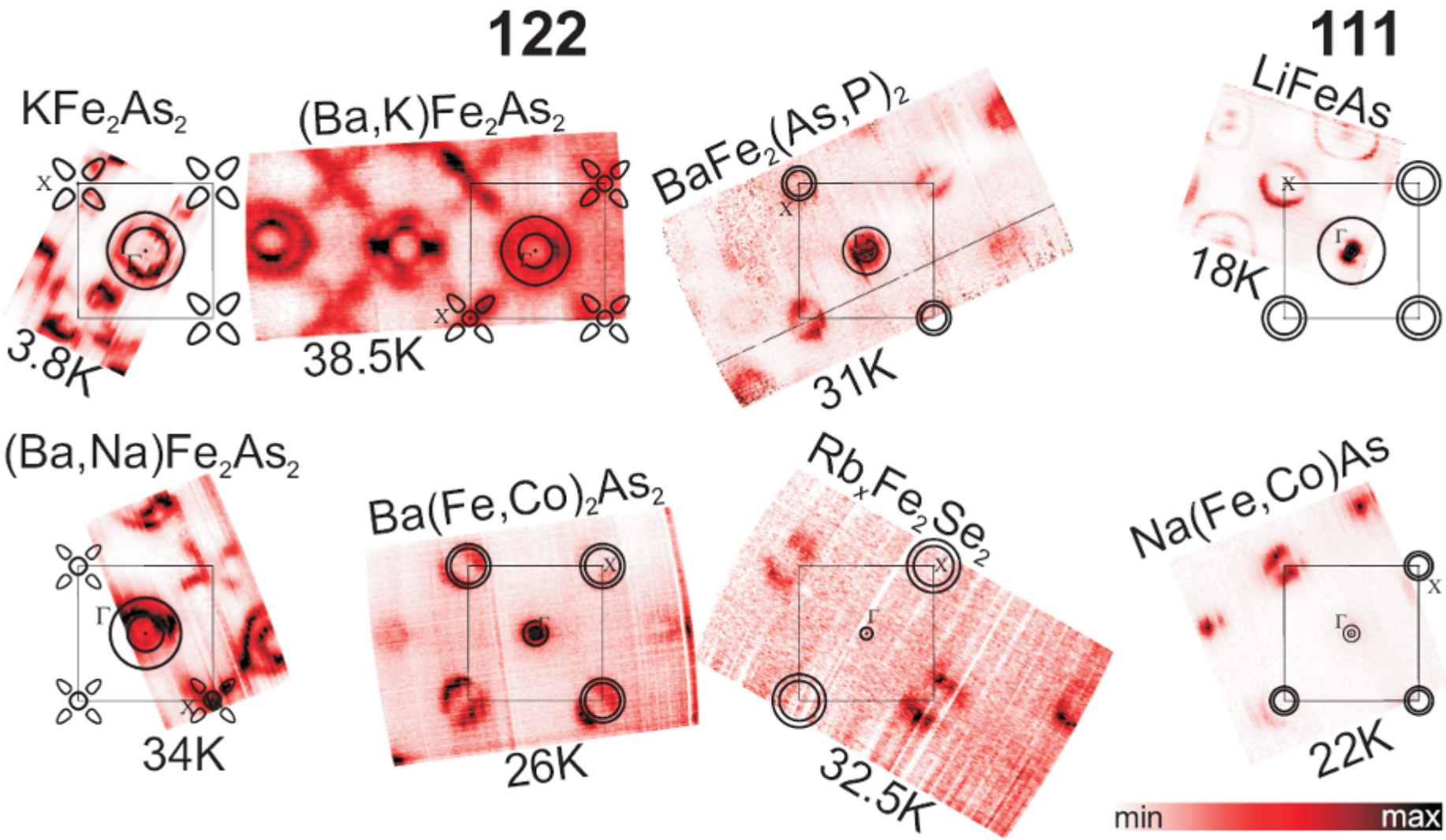
Iron-based superconductors



Iron-based superconductors



Fermi surfaces of iron-based superconductors

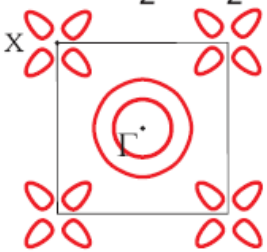


Fermi surfaces of iron-based superconductors

122

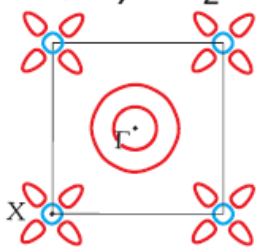
111

KFe_2As_2



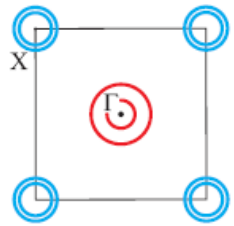
3.8K

$(Ba,K)Fe_2As_2$



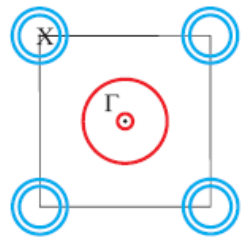
38.5K

$BaFe_2(As,P)_2$



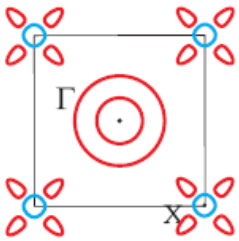
31K

LiFeAs



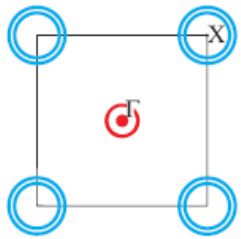
18K

$(Ba,Na)Fe_2As_2$



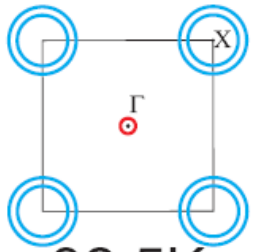
34K

$Ba(Fe,Co)_2As_2$



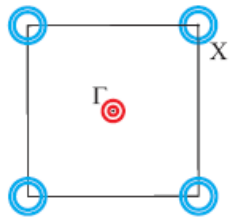
26K

$Rb_xFe_2Se_2$



32.5K

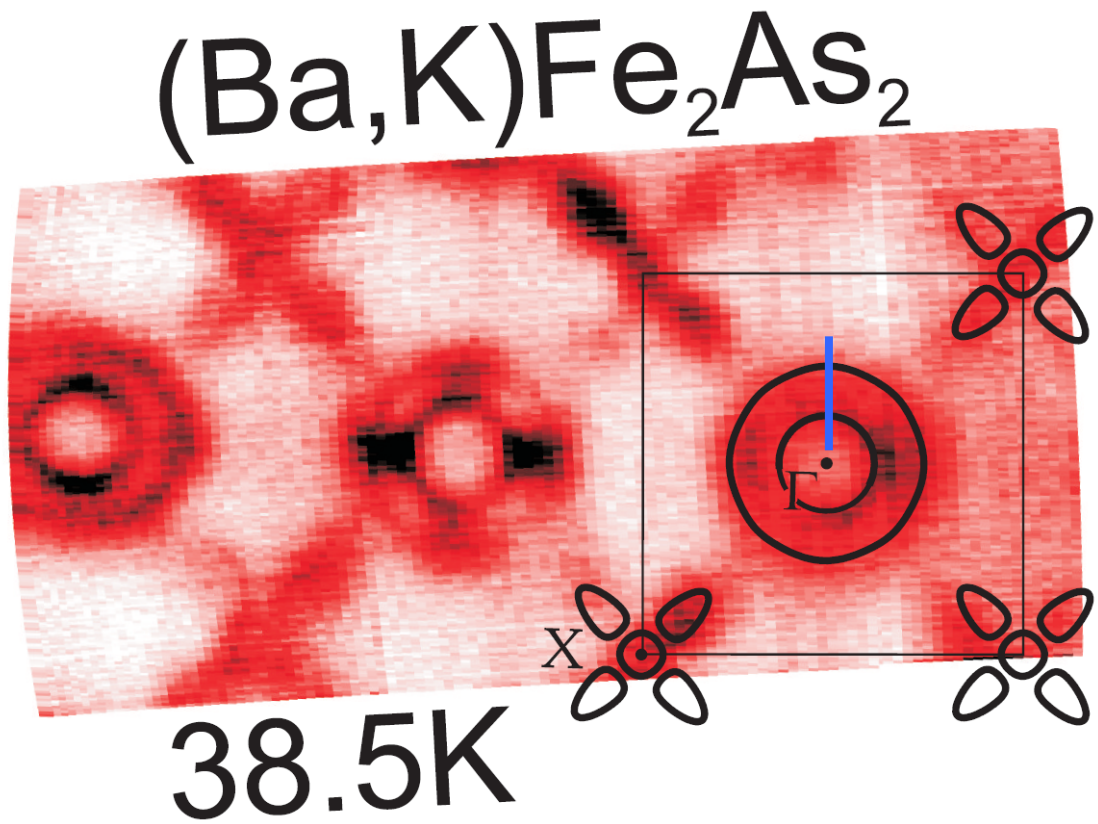
Na(Fe,Co)As



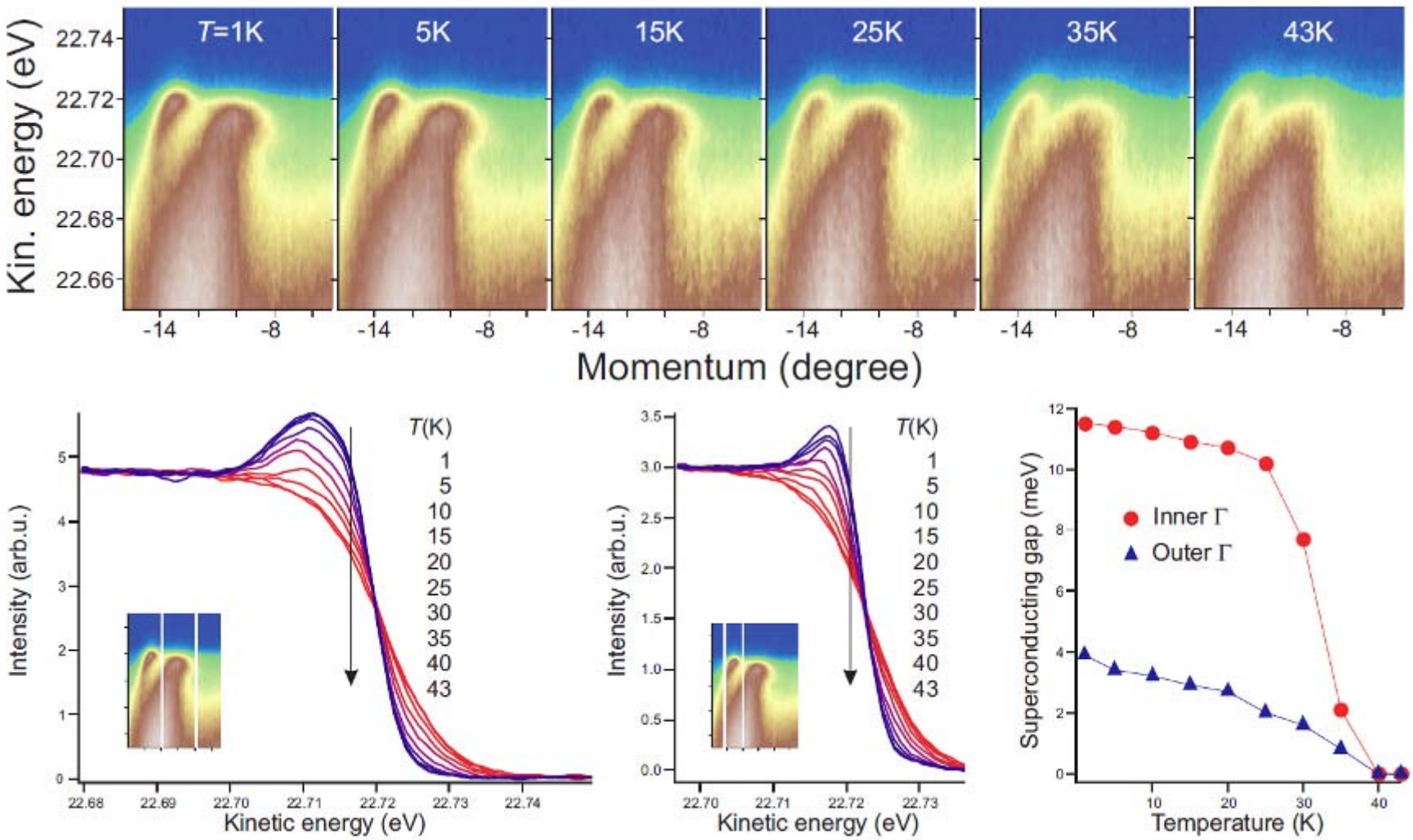
22K

Superconducting gap

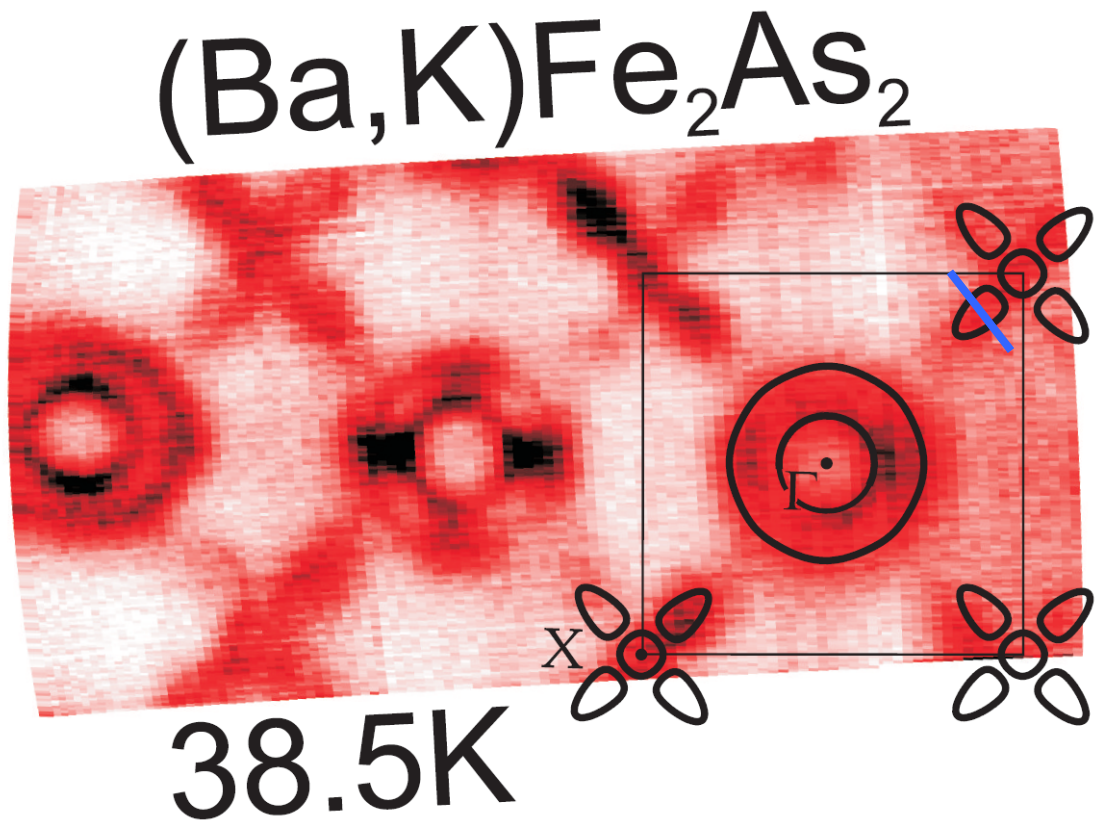
Hole-doped $BaFe_2As_2$



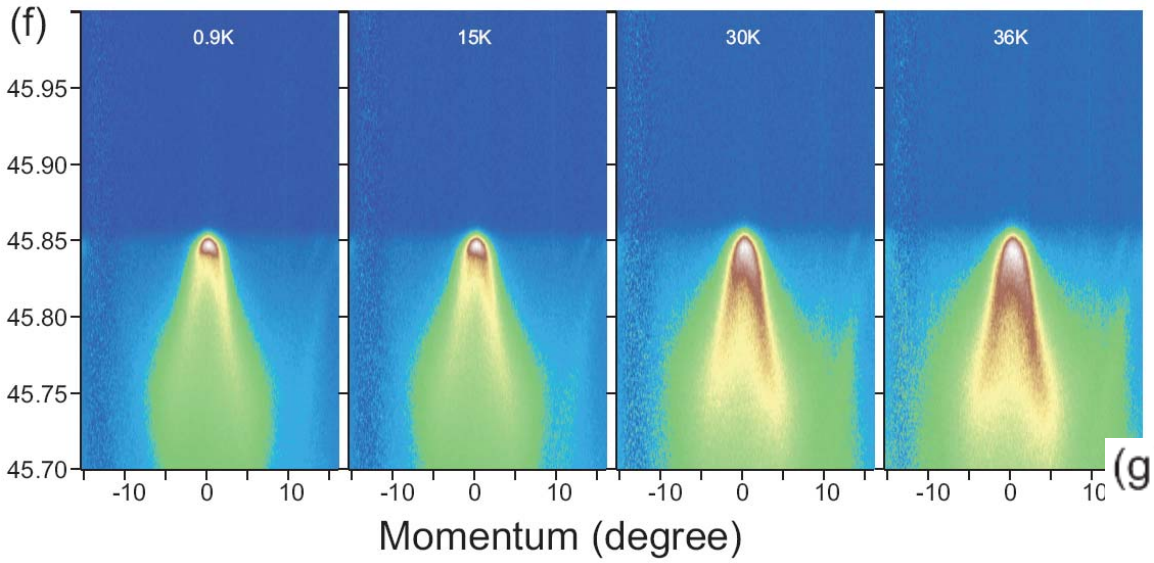
Superconducting gap in $Ba_{1-x}K_xFe_2As_2$

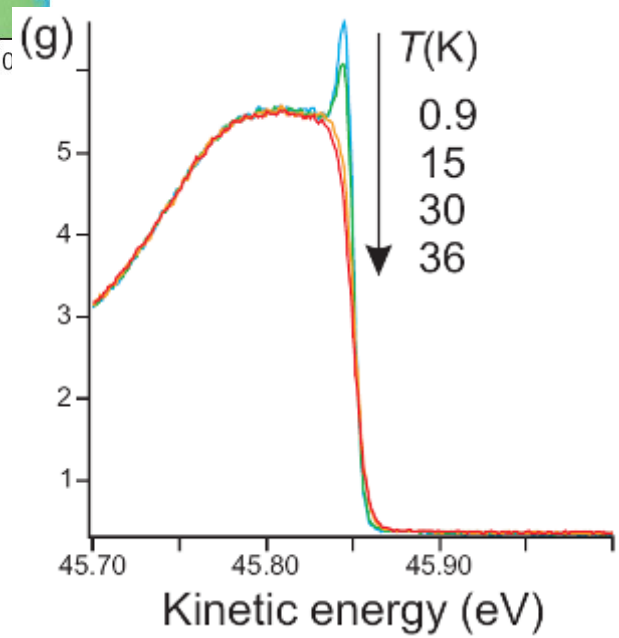


Hole-doped $BaFe_2As_2$

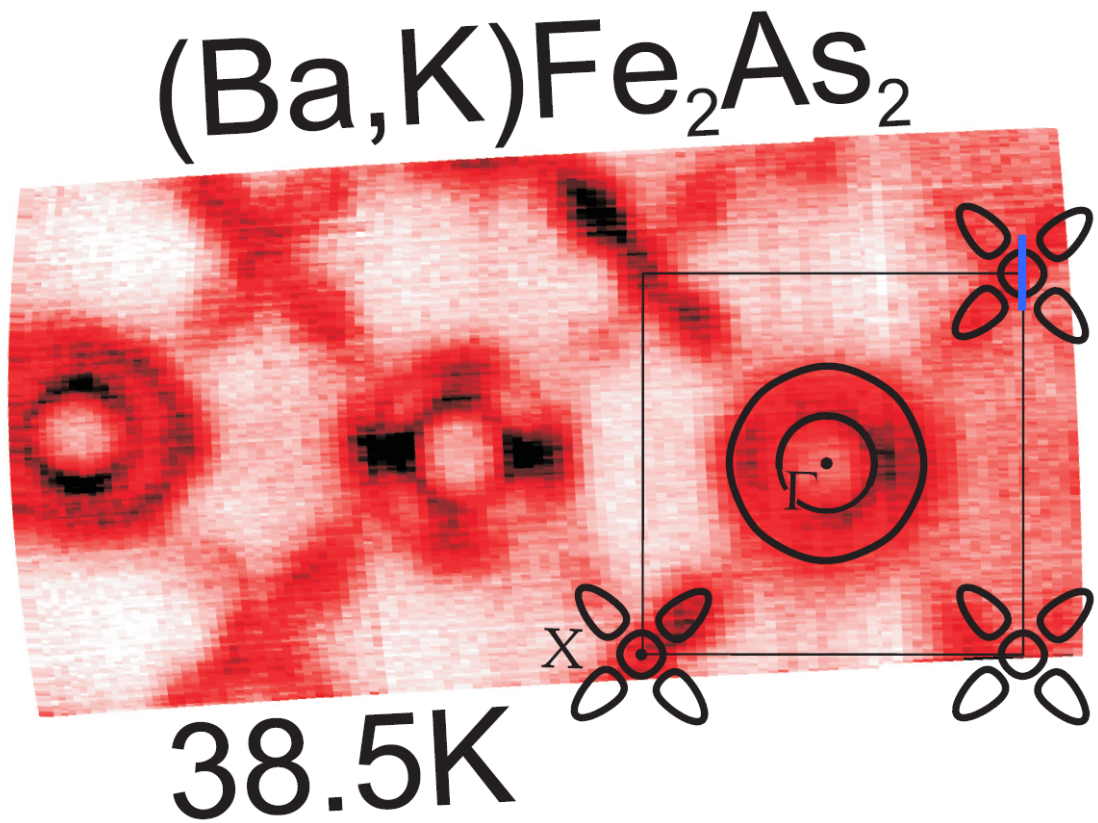


Gap on propeller-like structure

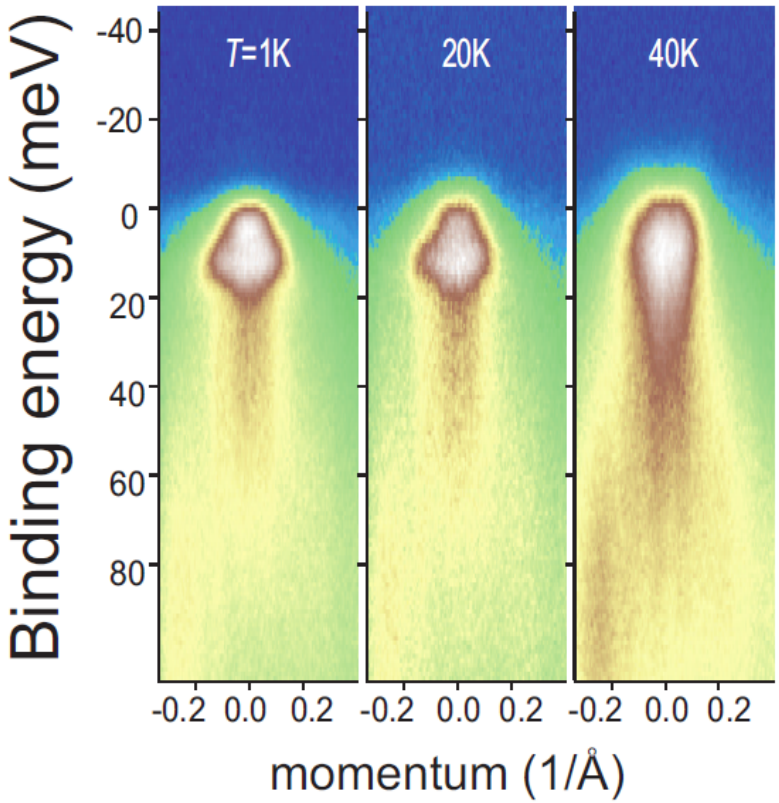


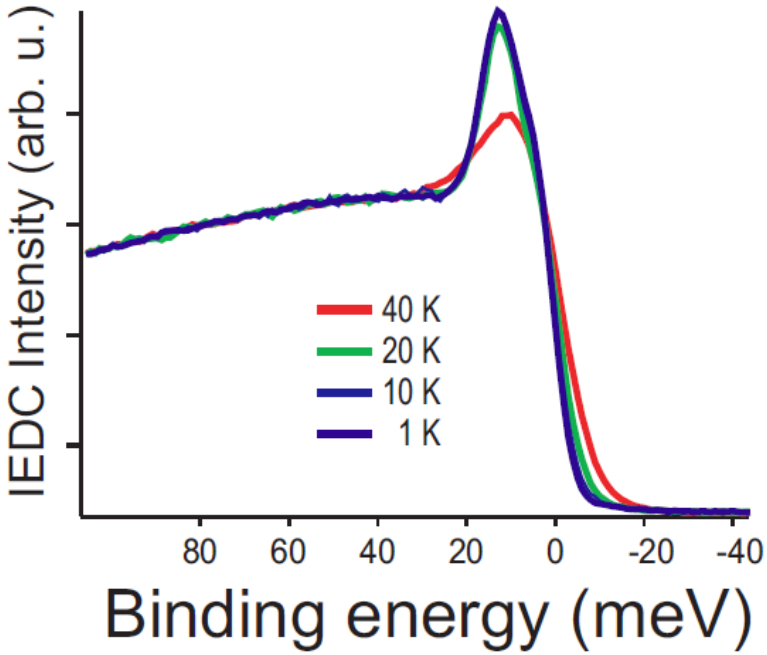


Hole-doped $BaFe_2As_2$

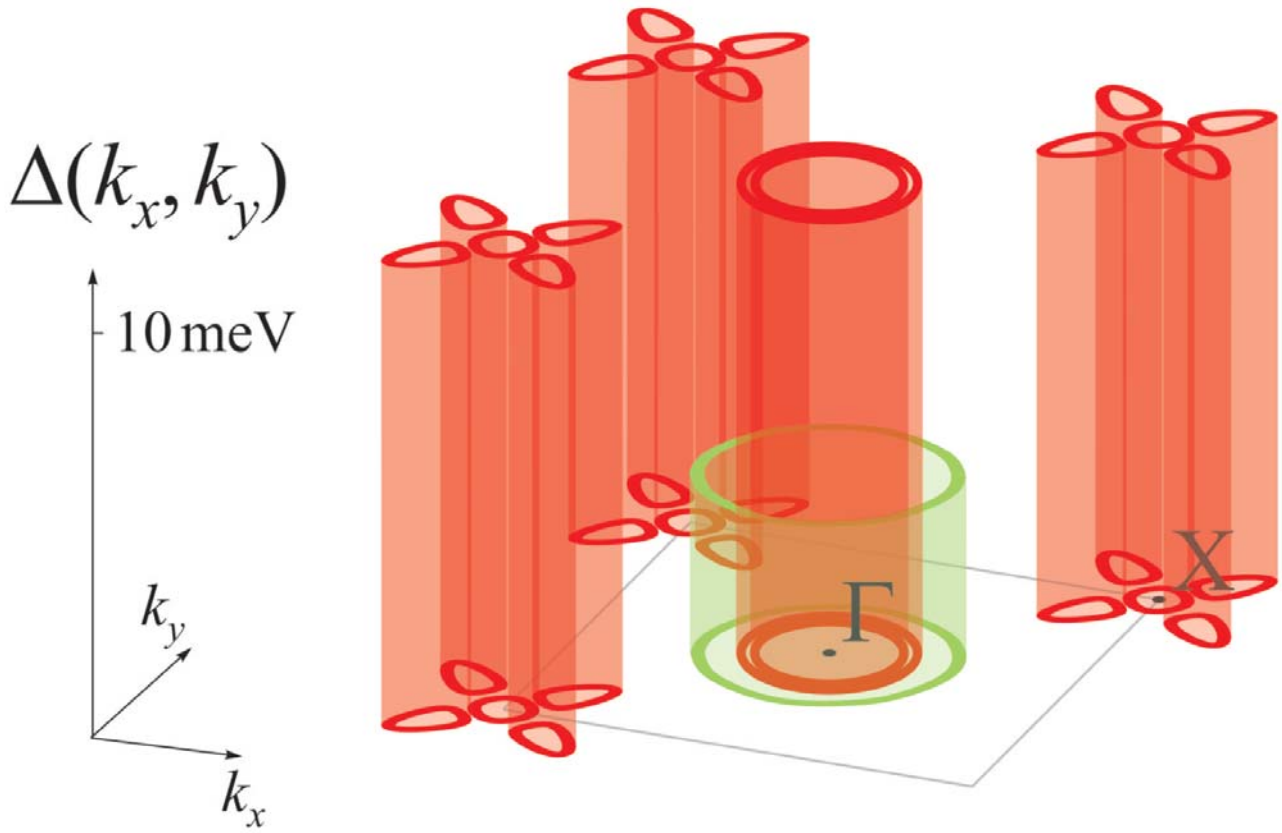


Gap on propeller-like structure

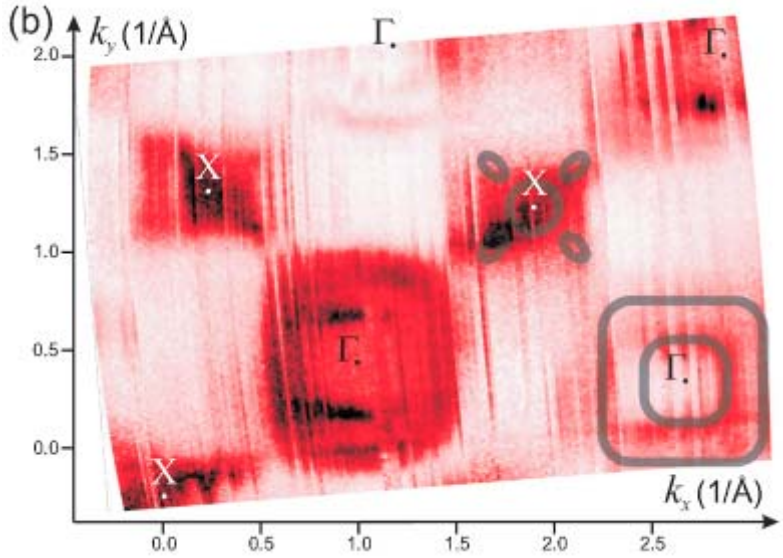


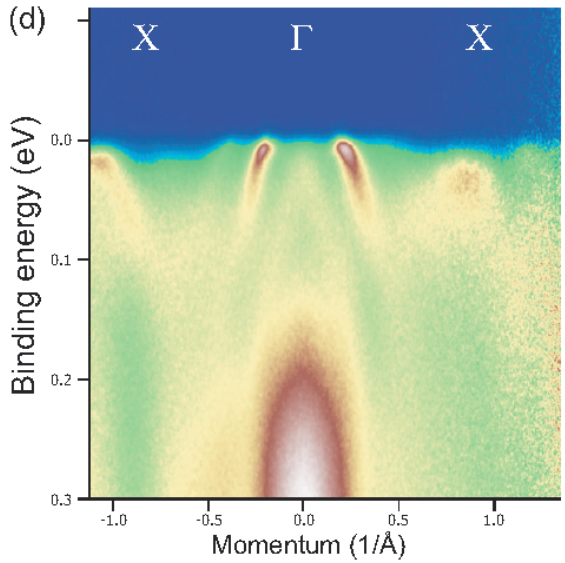


Momentum dependence of the superconducting gap in $Ba_{1-x}K_xFe_2As_2$

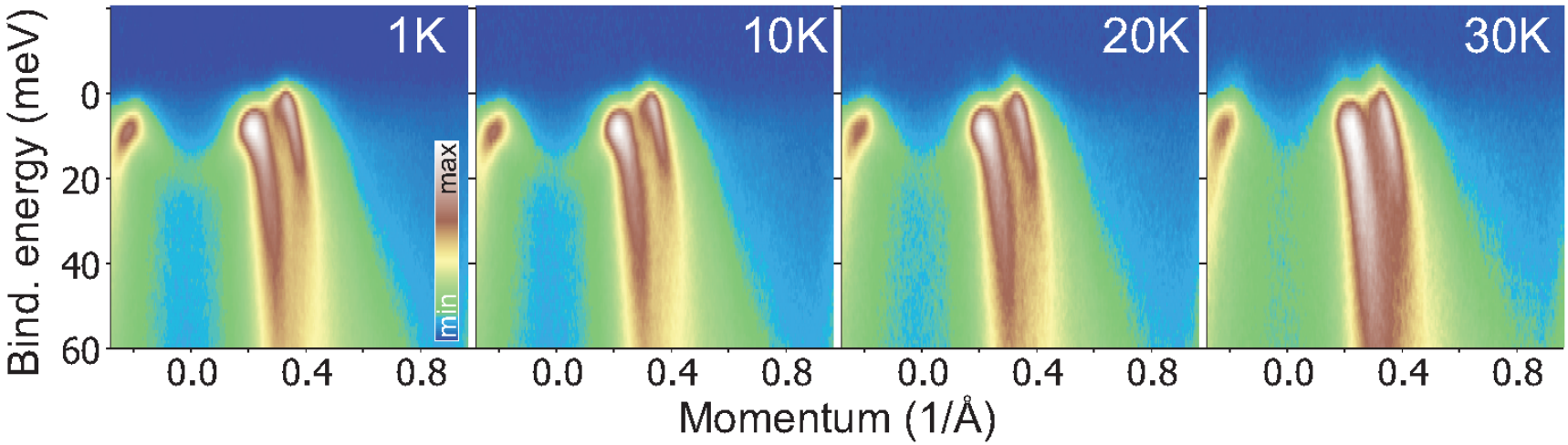


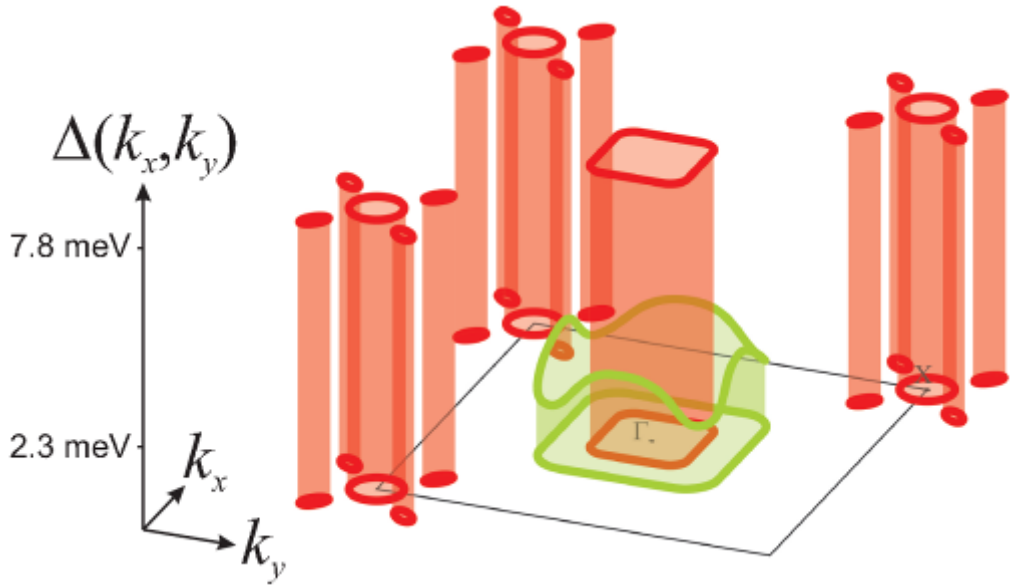
Electronic band structure of $Ca_{1-x}Na_xFe_2As_2$



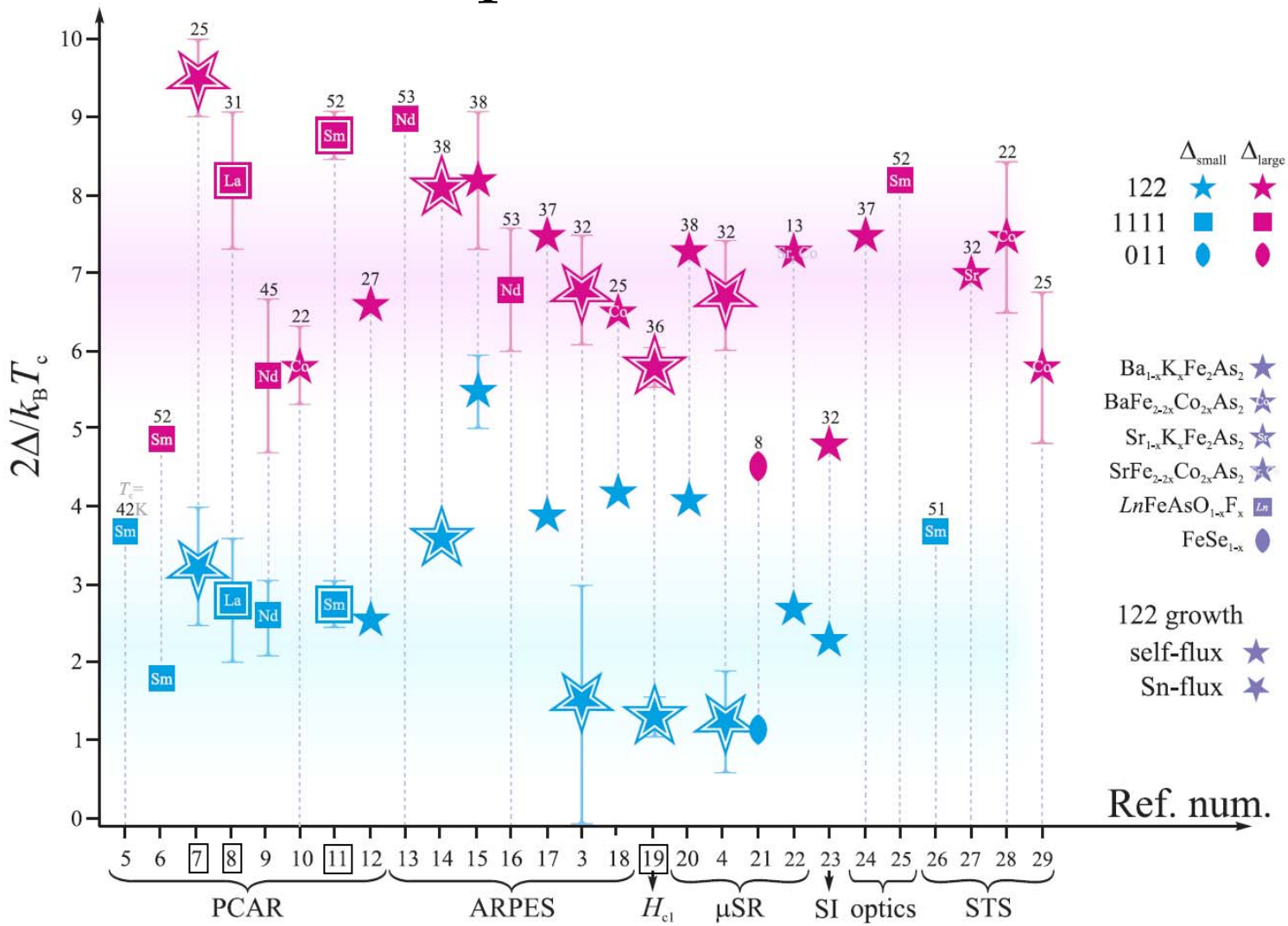


Superconducting gap in $Ca_{1-x}Na_xFe_2As_2$ with T_c=33K

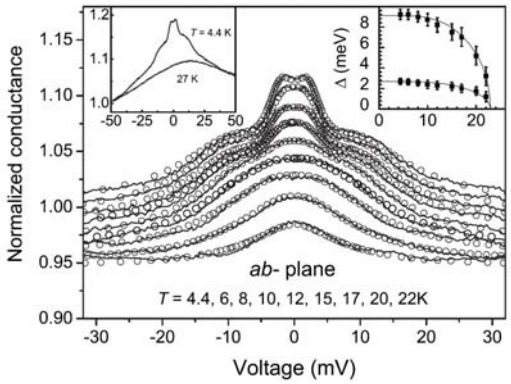




Coupling strength, $2\Delta/k_BT_c$, in iron-arsenide superconductors

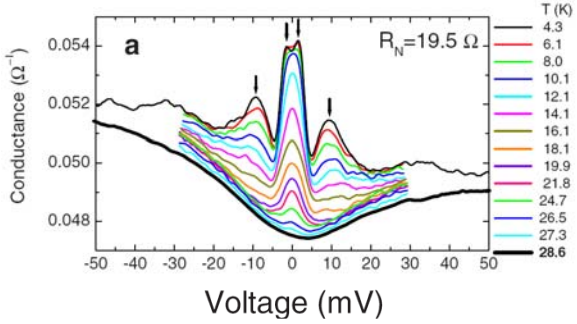


$Ba_{1-x}K_xFe_2As_2$



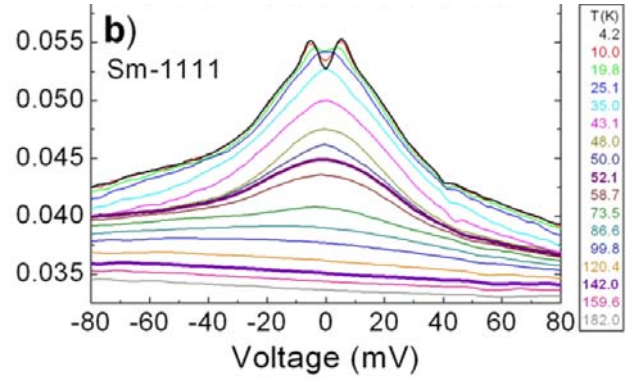
P. Szabo *et al., PRB* (2009)

$LaFeAsO_{1-x}F_x$

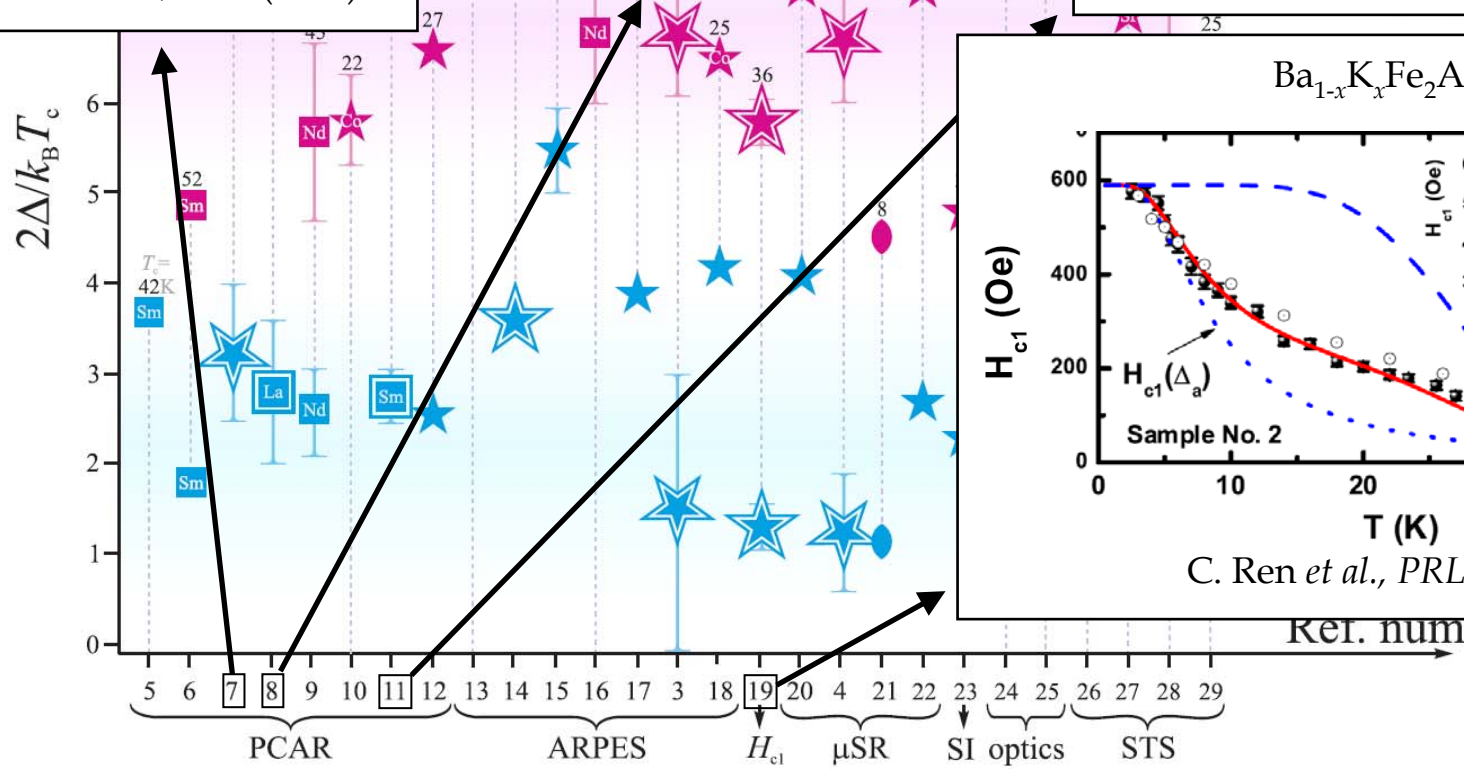


R. S. Gonnelli *et al., PRB* (2009)

$SmFeAsO_{1-x}F_x$



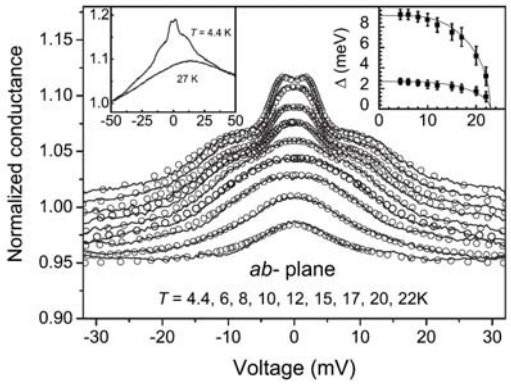
R. S. Gonnelli *et al., Physica C* (2009)



$Ba_{1-x}K_xFe_2As_2$

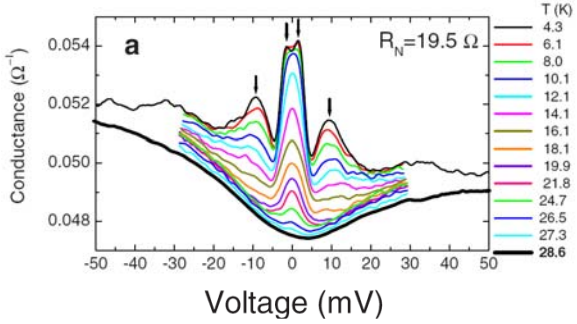
C. Ren *et al., PRL* (2008)

$Ba_{1-x}K_xFe_2As_2$



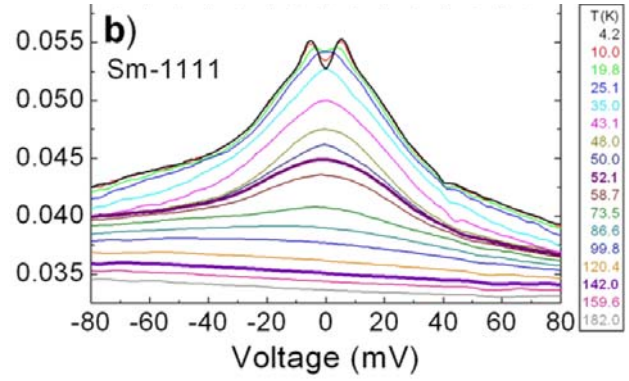
P. Szabo *et al.*, *PRB* (2009)

$LaFeAsO_{1-x}F_x$



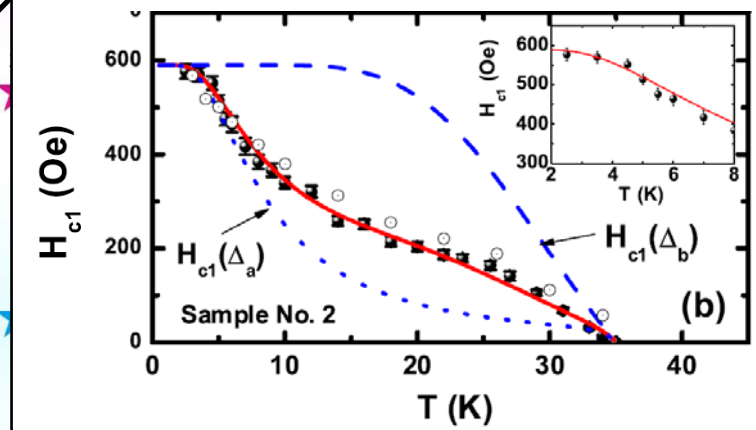
R. S. Gonnelli *et al.*, *PRB* (2009)

$SmFeAsO_{1-x}F_x$

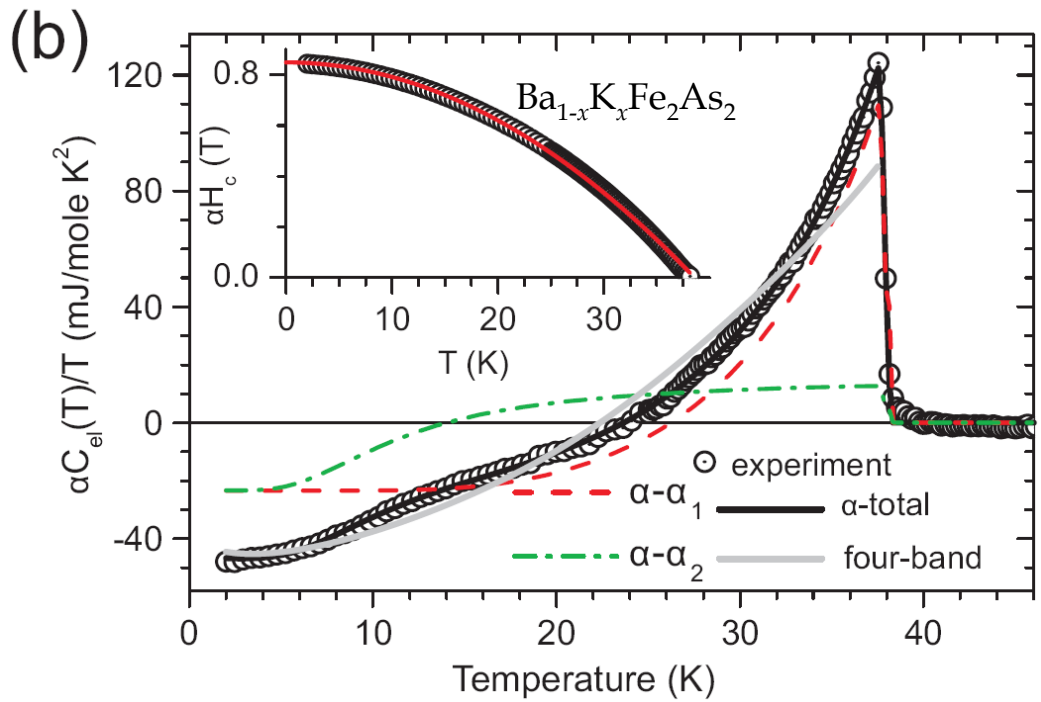


R. S. Gonnelli *et al.*, *Physica C* (2009)

$Ba_{1-x}K_xFe_2As_2$



C. Ren *et al.*, *PRL* (2008)



Ref. num.

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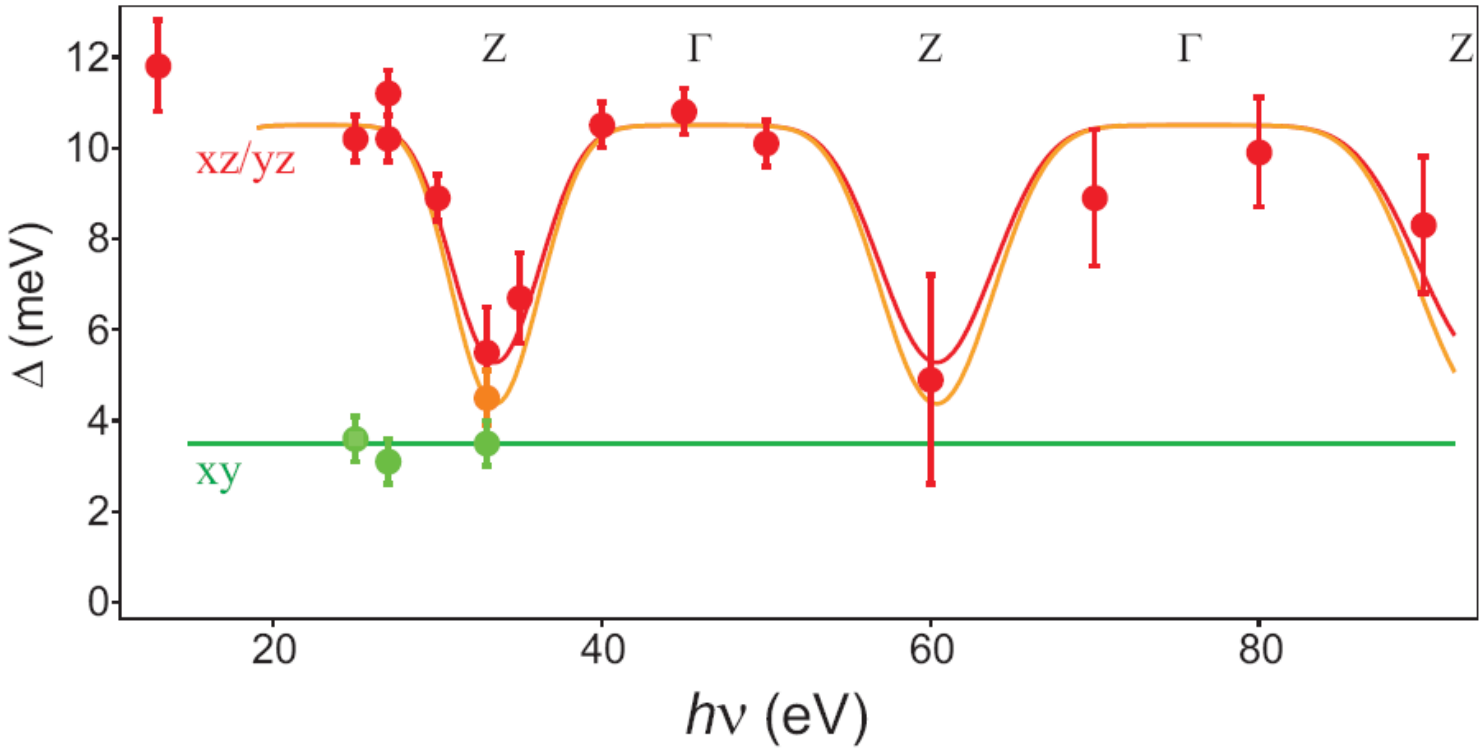
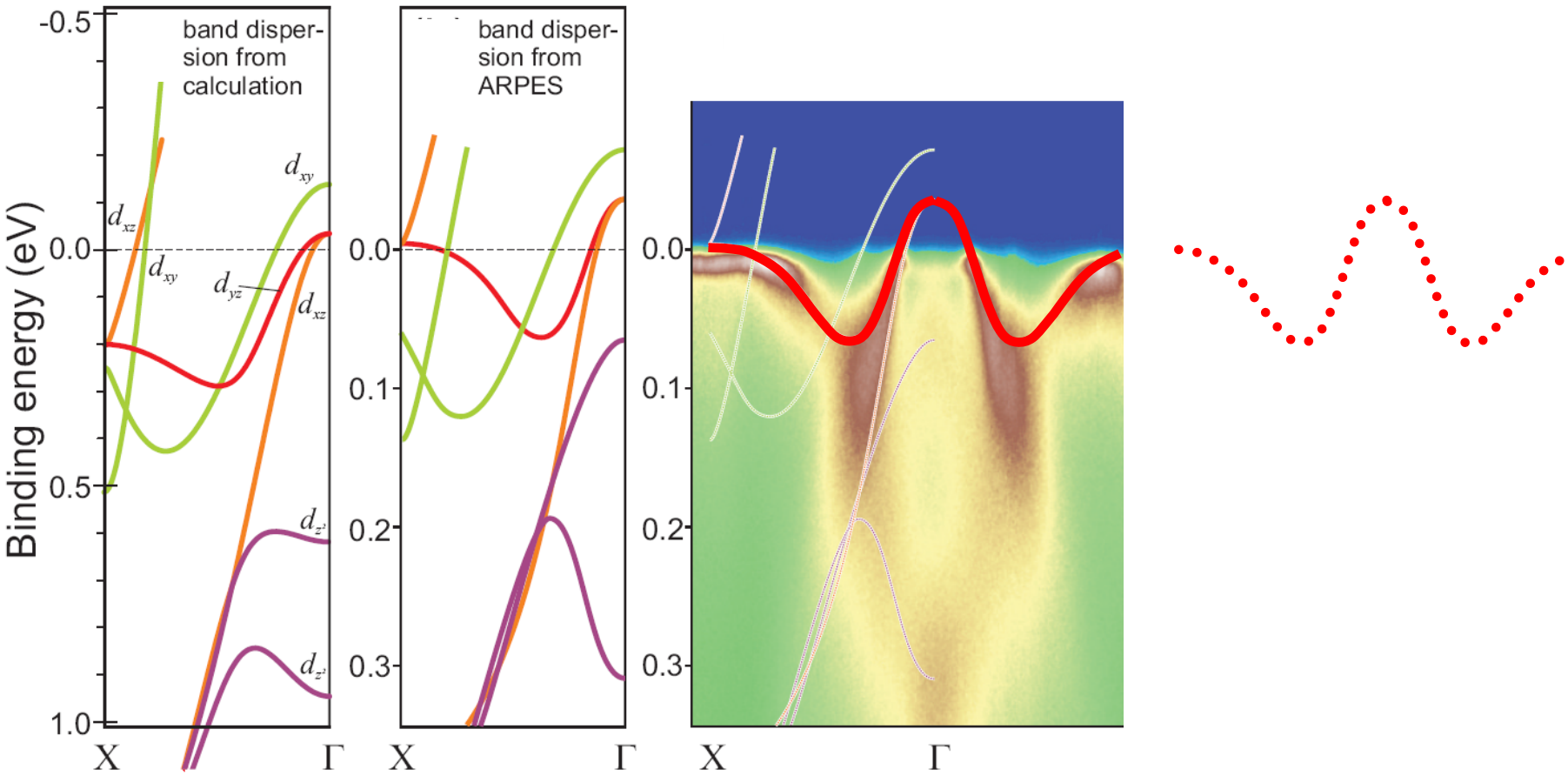
SI optics STS

k_z-dependence of the gap?

3D gap in hole-doped $BaFe_2As_2$

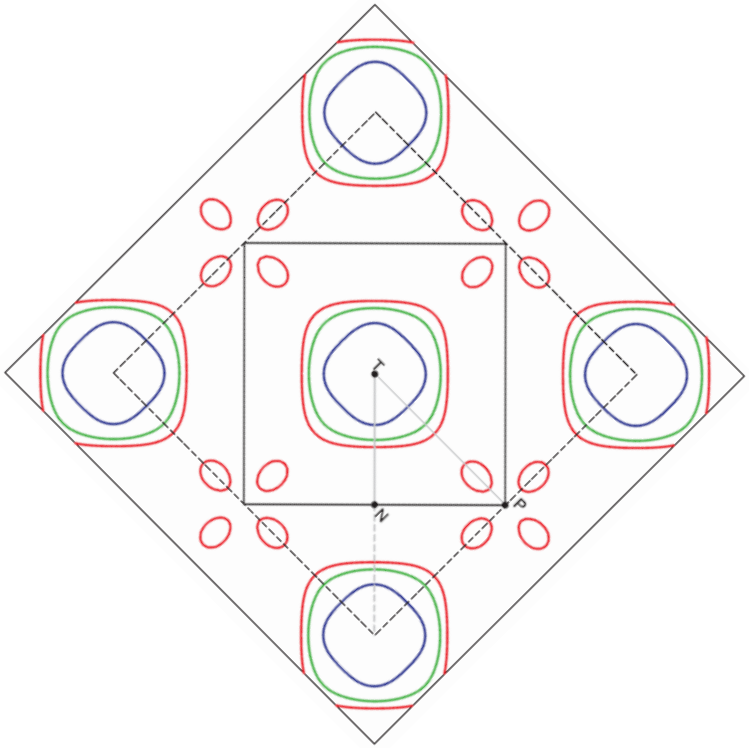


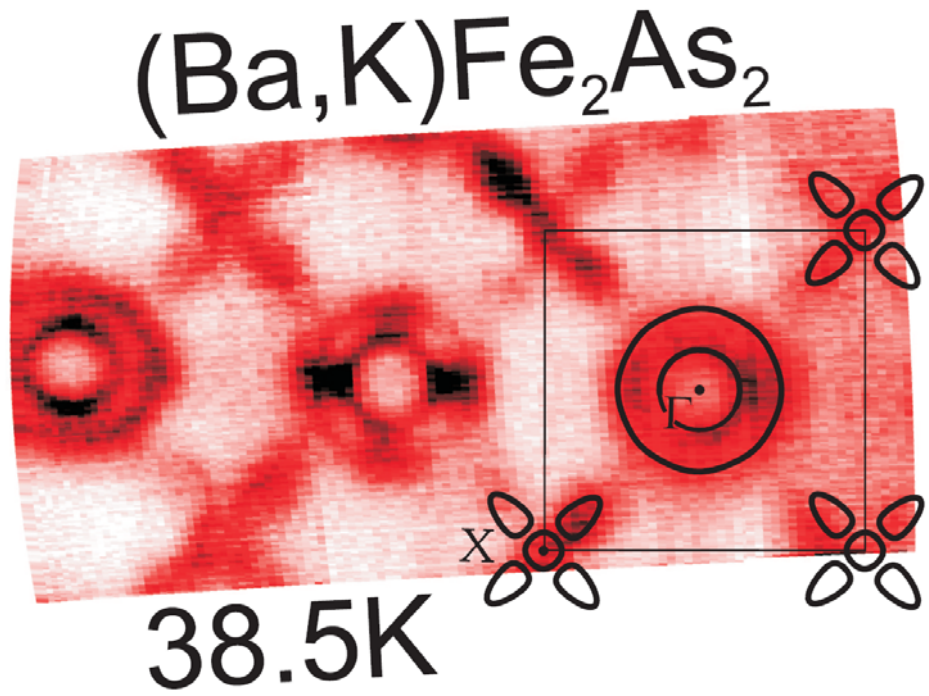
Polarization analysis of electronic states



Calculation by A. Yaresko

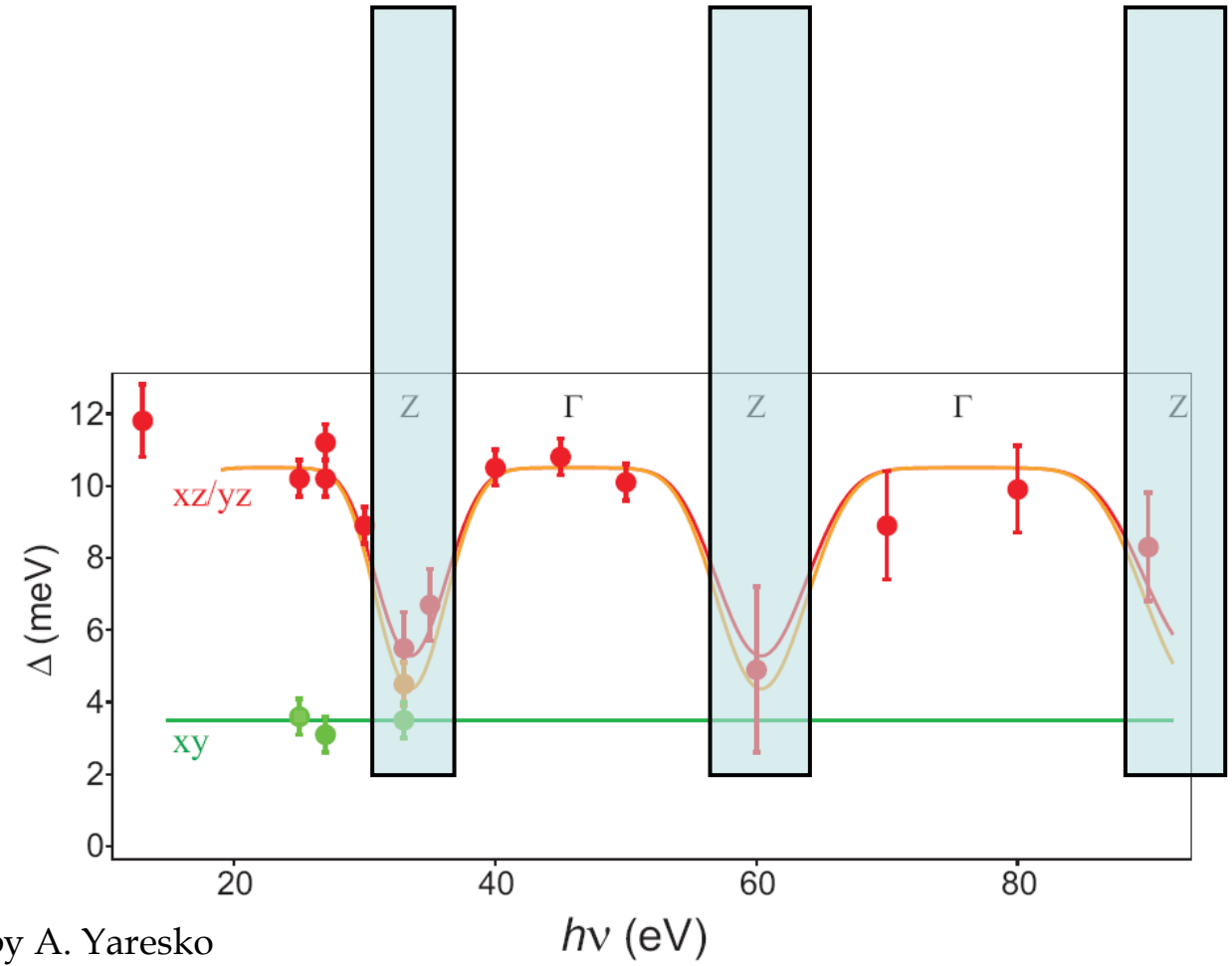
Comparison of calculated and measured band dispersions





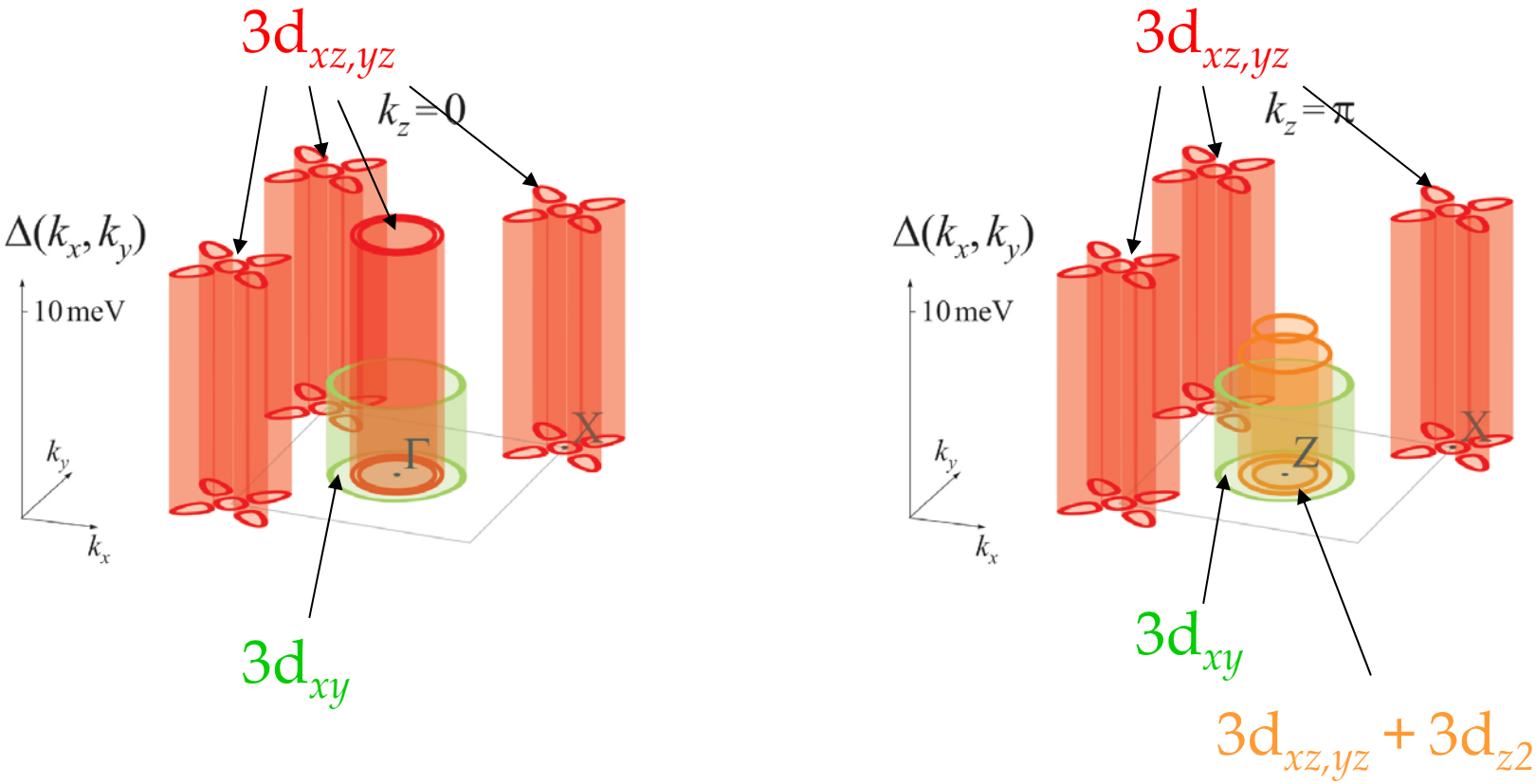
Calculation by A. Yaresko

3D gap in hole-doped $BaFe_2As_2$



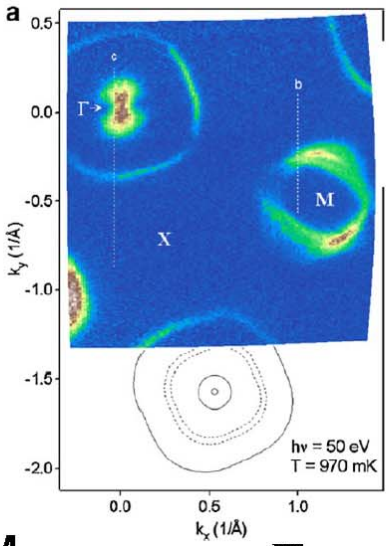
Calculation by A. Yaresko

Strong pairing at iron $3d_{xz/yz}$ orbitals in $Ba_{1-x}K_xFe_2As_2$

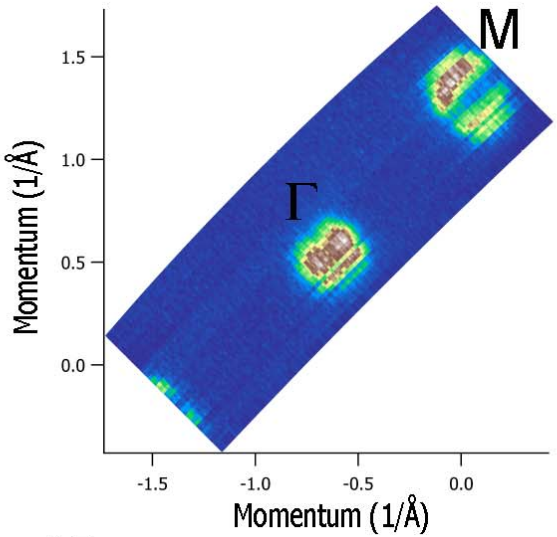


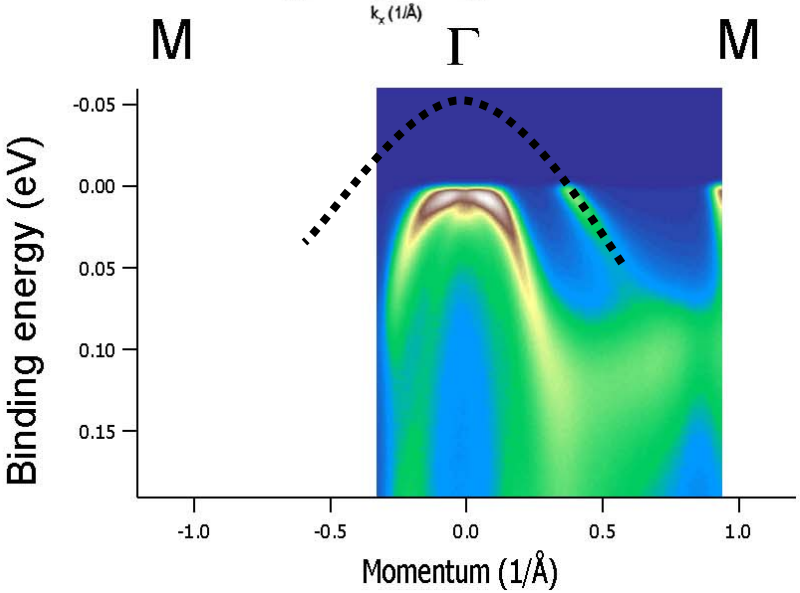
Electronic structure of LiFeAs and $Na_{1-x}Co_xFeAs$

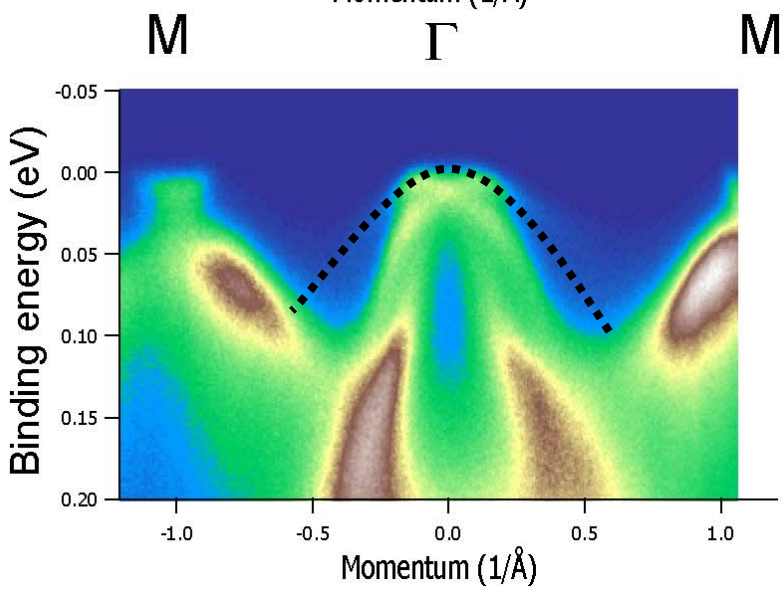
LiFeAs, T_c=18K



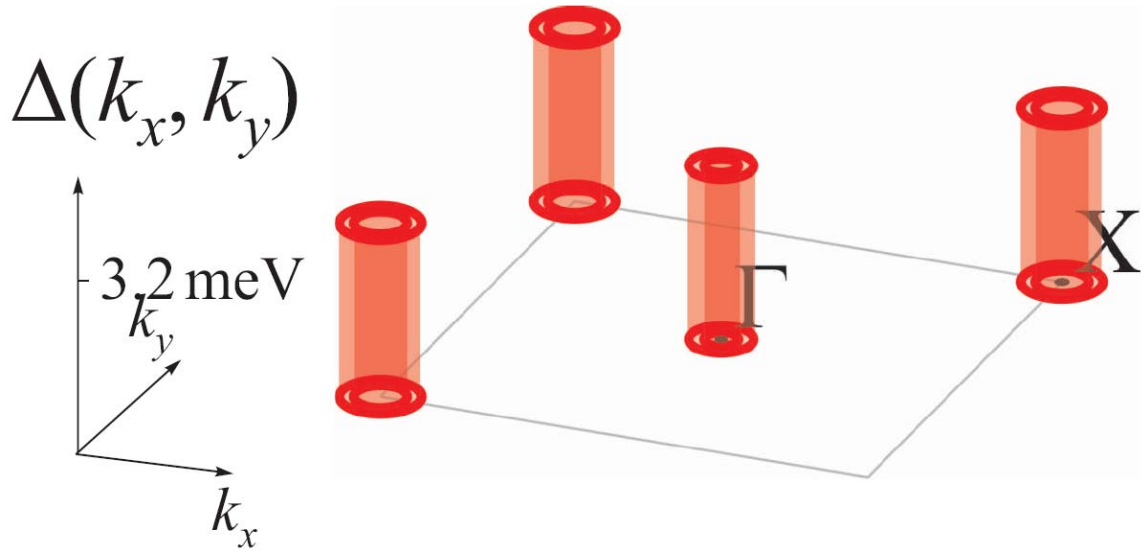
$Na_{1-x}Co_xFeAs$, T_c=21K





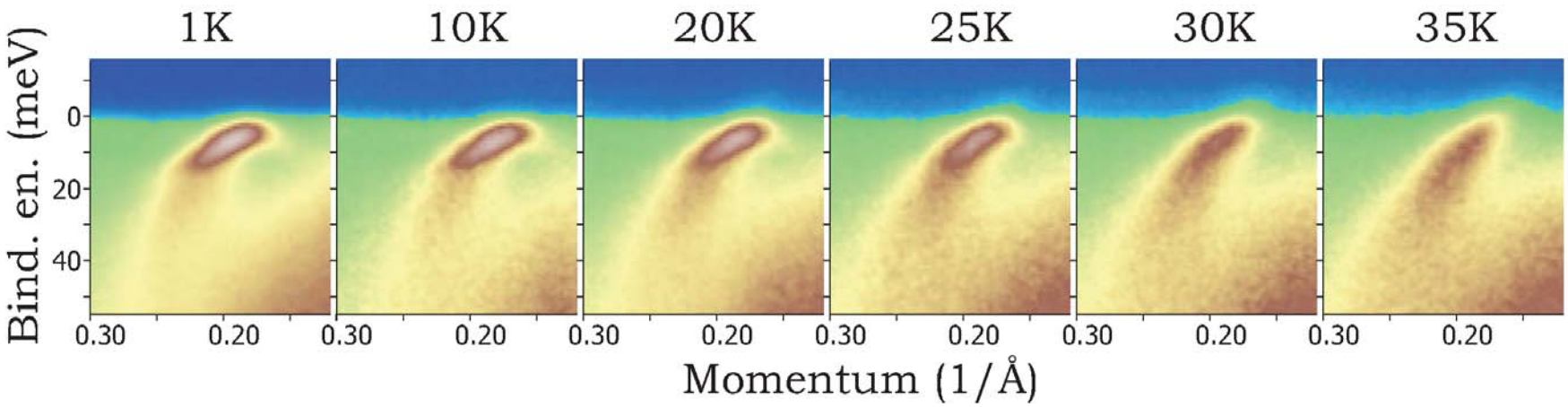


Superconducting gap in $Na_{1-x}Co_xFeAs$

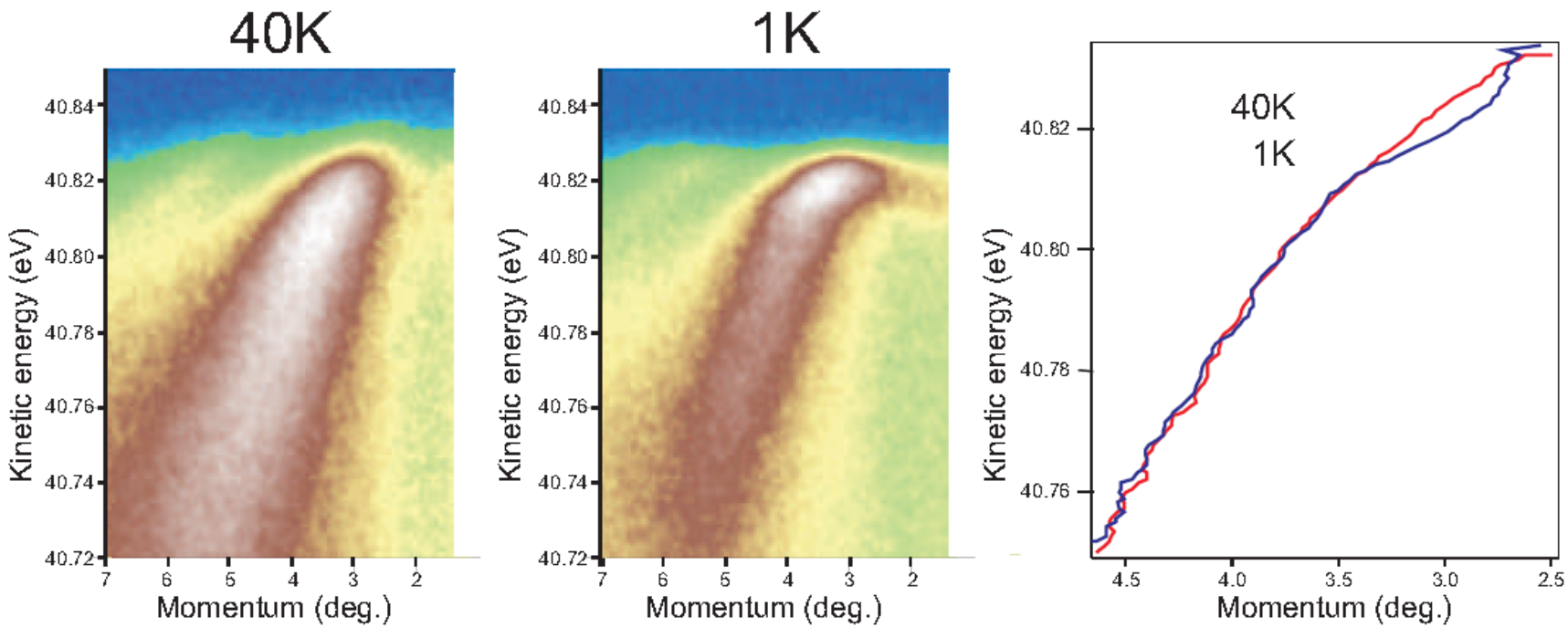


Effects of interaction with a bosonic mode in superconducting state

Interaction with a bosonic mode in $Ca_{1-x}Na_xFe_2As_2$ below T_c=33K



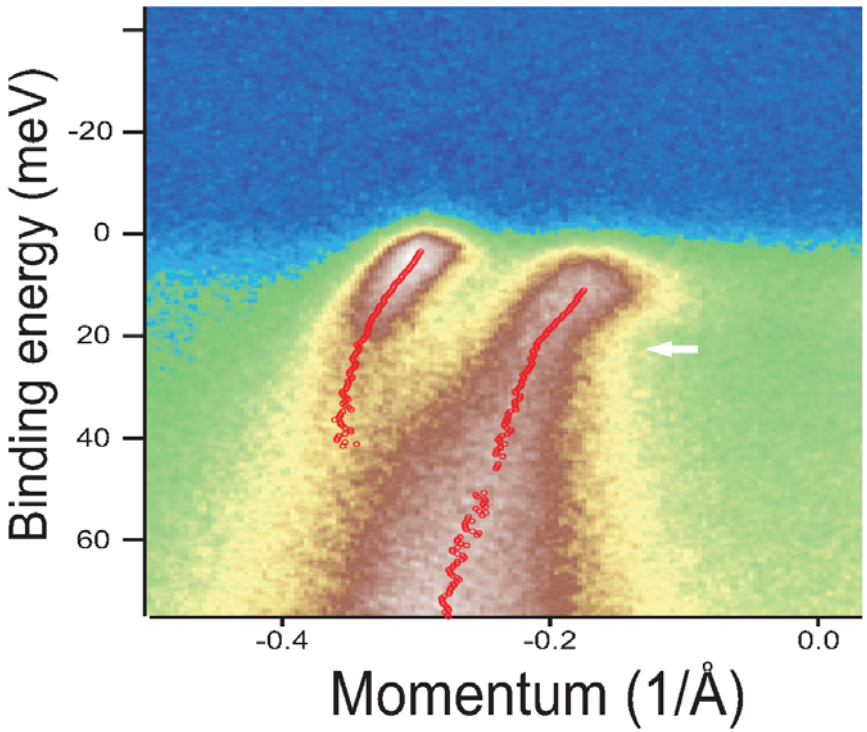
Interaction with a bosonic mode in $Ba_{1-x}Na_xFe_2As_2$ below T_c=34K



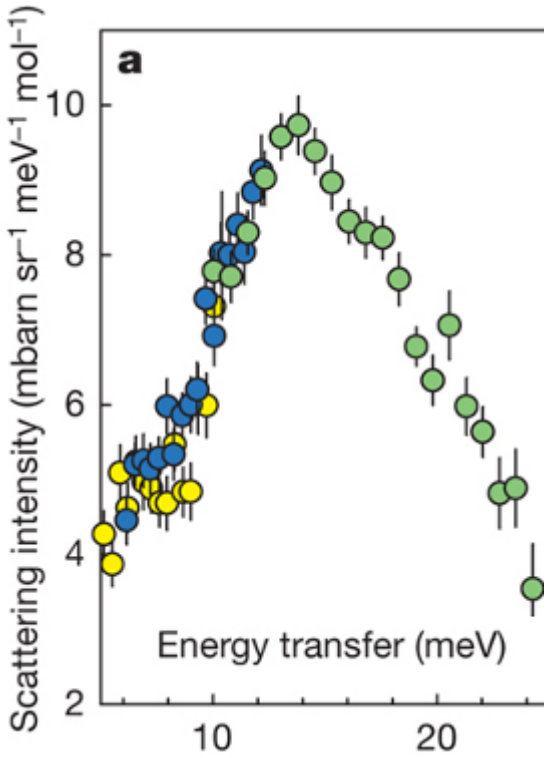
Mode = spin resonace in $Ba_{1-x}K_xFe_2As_2$ (T_c=38.5K)

kink energy = 23 meV

Δ = 10.5 meV



Ω_M = 13..14 meV



Christianson *et al.*, *Nature* (2008)

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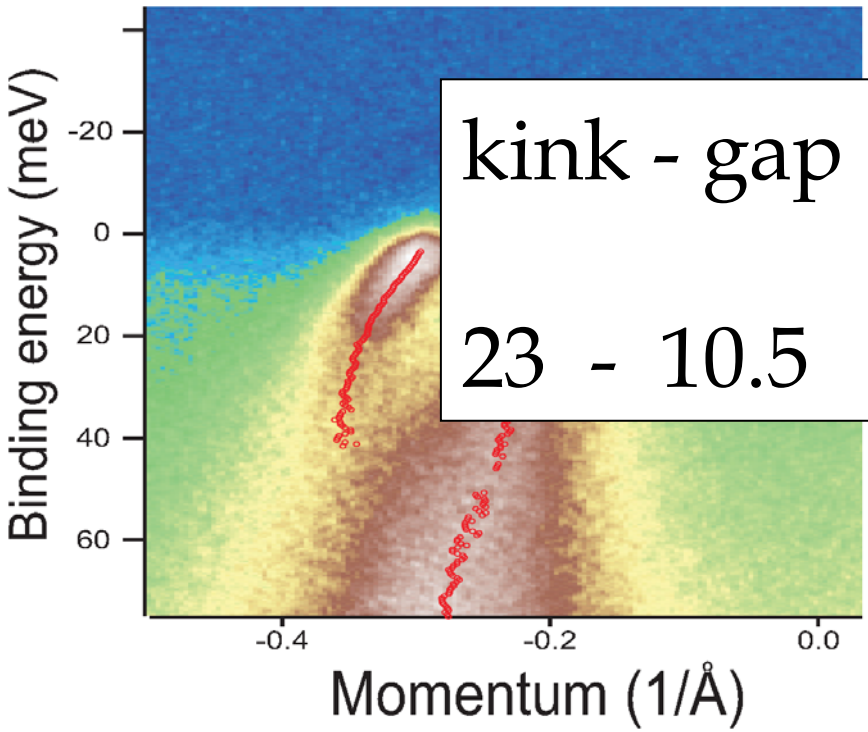
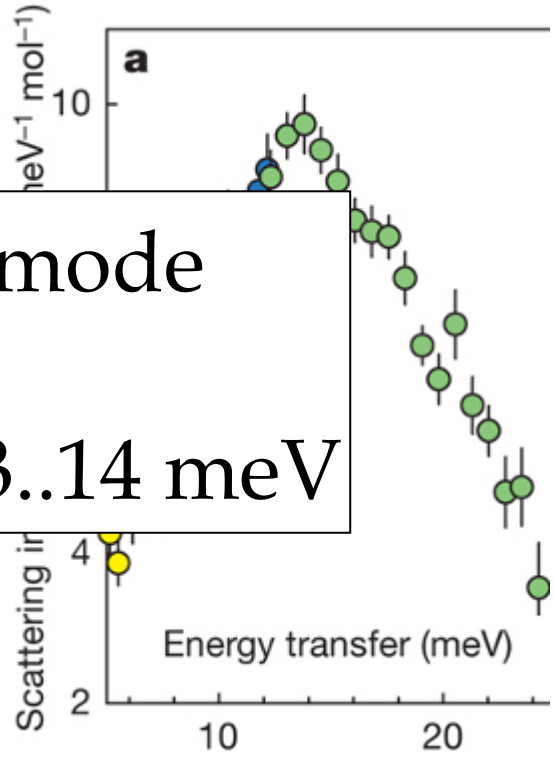


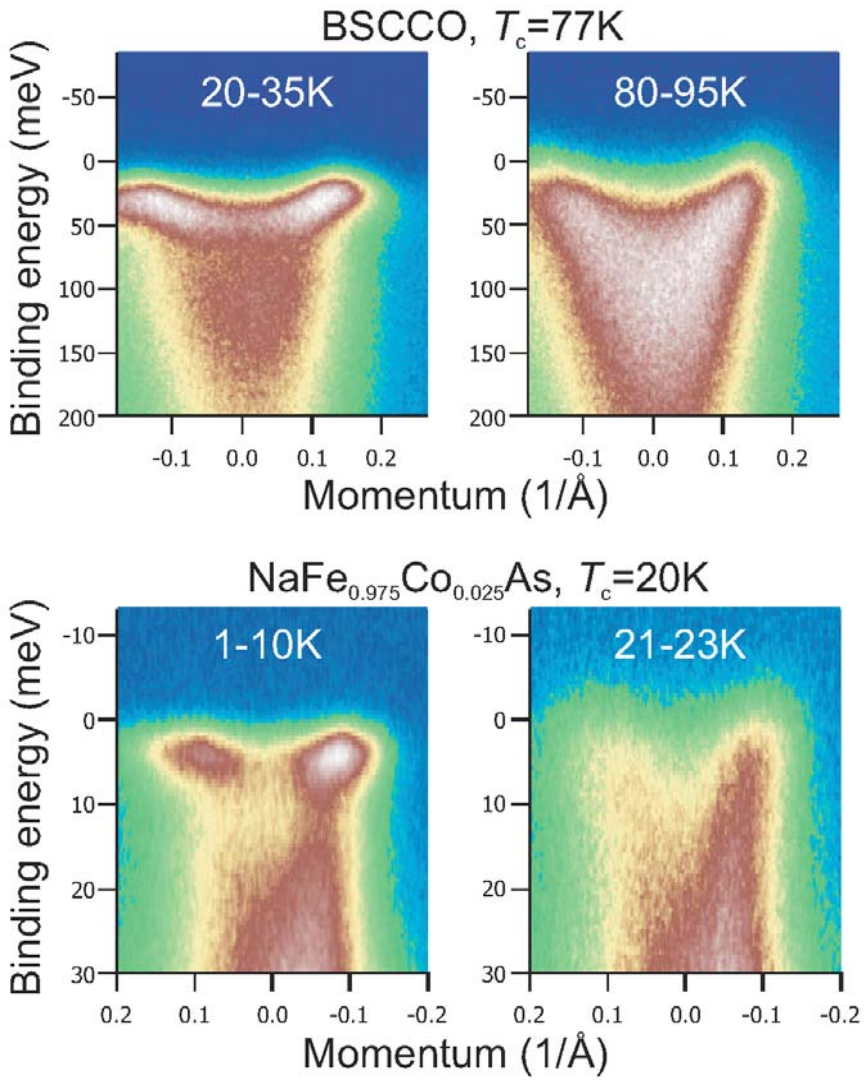


kink - gap ≈ mode

23 - 10.5 ≈ 13..14 meV

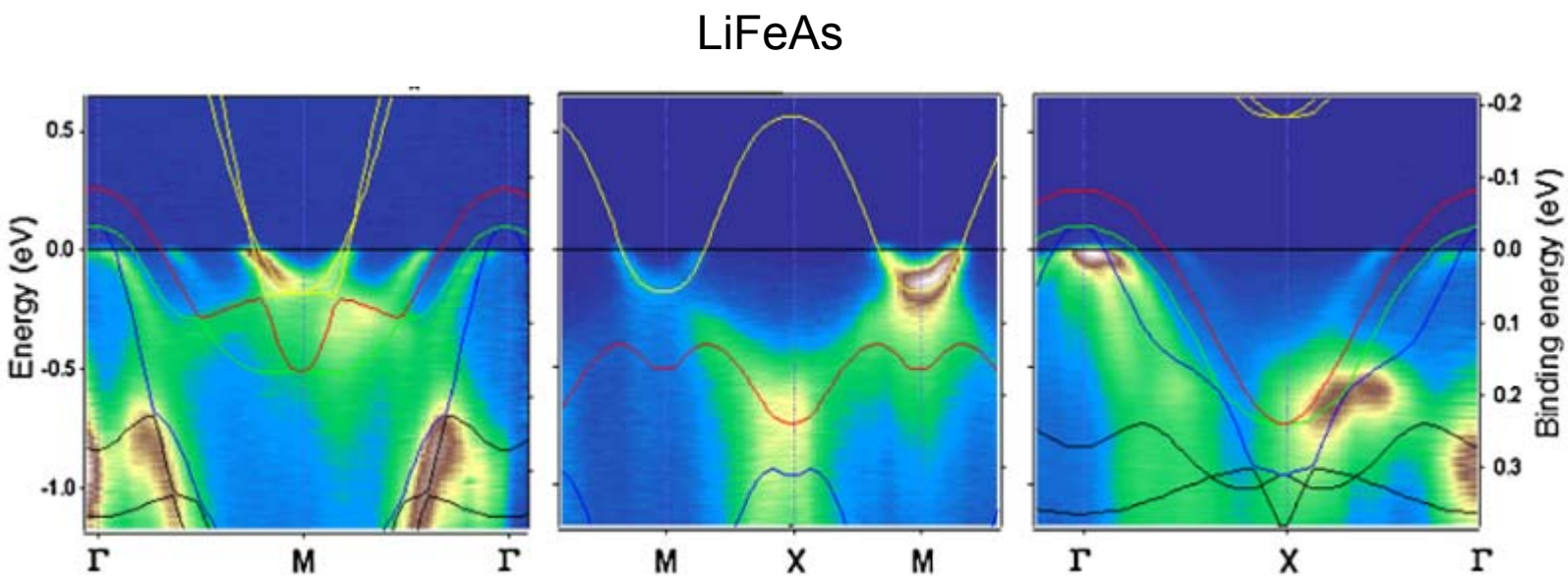
Christianson *et al.*, *Nature* (2008)

Similar mode effects in SC state for cuprates and iron arsenides



High energy band renormalization

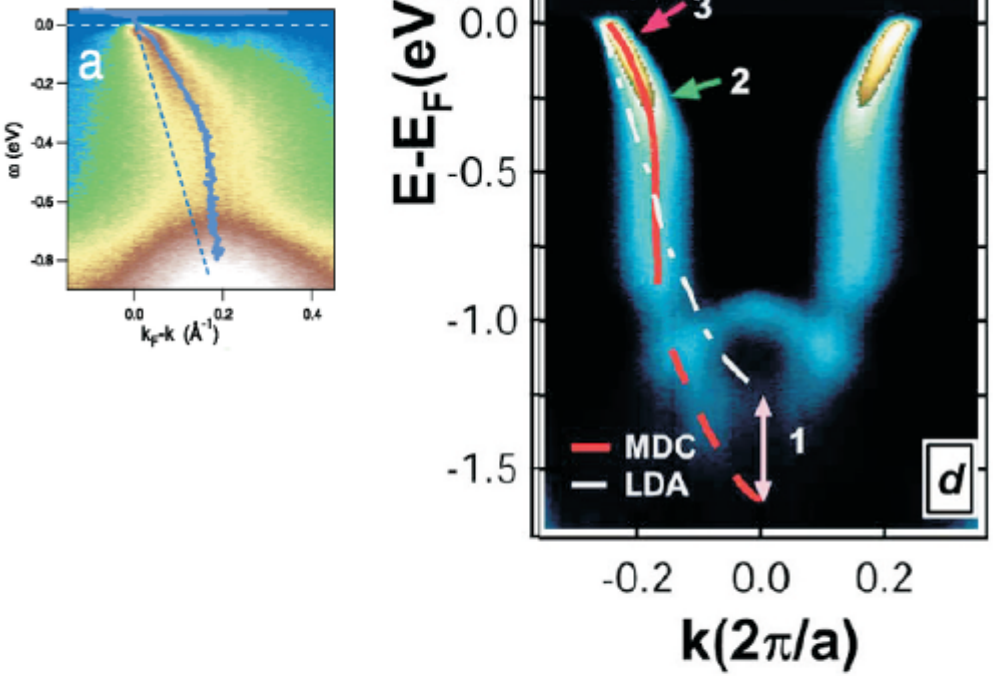
Band renormalization of ~3 in iron arsenides



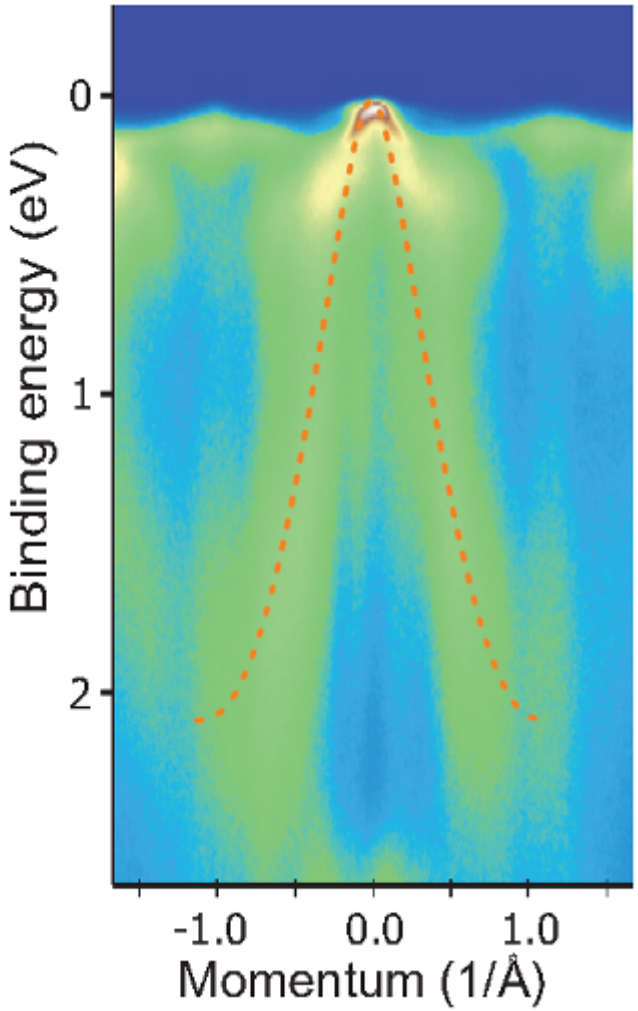
Borisenko *et al.*, *PRL* (2009)

High energy kink in cuprates

cuprates



iron arsenides



Valla *et al.*, *PRL* (2007)

Meevasana *et al.*, *PRB* (2007)

Phenomenological conclusions for iron-based superconductors

- Various Fermi surface shape
- Large and small superconducting gaps for *xy* and *xz/yz* orbitals respectively
- Effects of electron coupling to a low energy bosonic mode below T_c, stronger for *xz/yz* orbitals
- Electronic structure can be understood as theoretical bare bands plus interaction with a bosonic spectrum

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