Angle Resolved Photoemission studies of the Charge Density Wave in RTe_3 (R = Y, La, Ce…)

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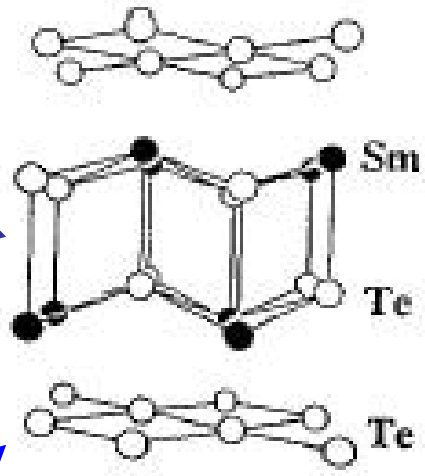
Angle Resolved Photoemission studies of the Charge Density Wave in RTe_3 (R = Y, La, Ce…)

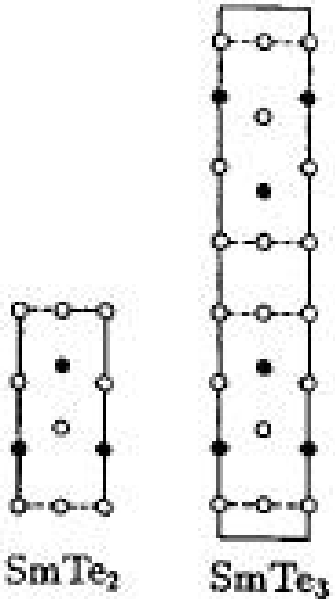
- RTe_2 and RTe_3 structure
- RTe_3 electronic structure determined by ARPES
- Location and magnitude of the CDW gap along the Fermi Surface
- Residual metallic pockets due to imperfect nesting

RTe_2 and RTe_3 structure

R/Te slab

almost insulating

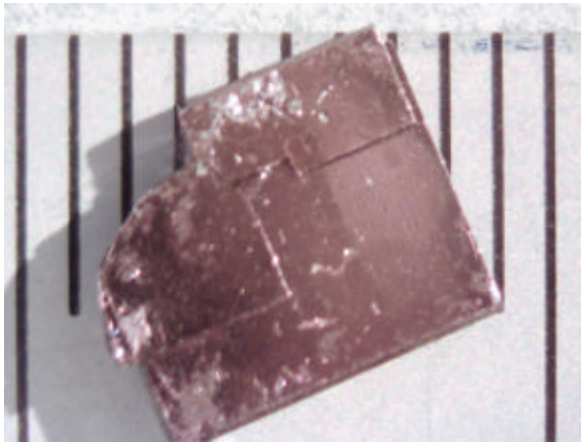




Te (s^2p^4) square plane … with … 7 6.5 electrons per Te

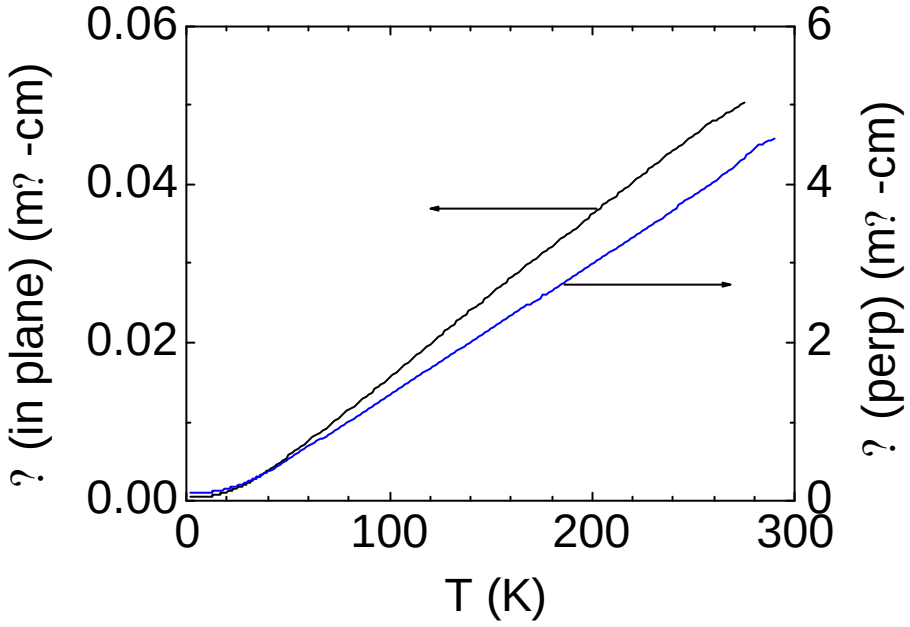
Transport anisotropy

RTe_3



Crystal growth from binary melt

$LaTe_3$



$?_c$ / $?_a$ ~ 100

RRR ~ 50-120

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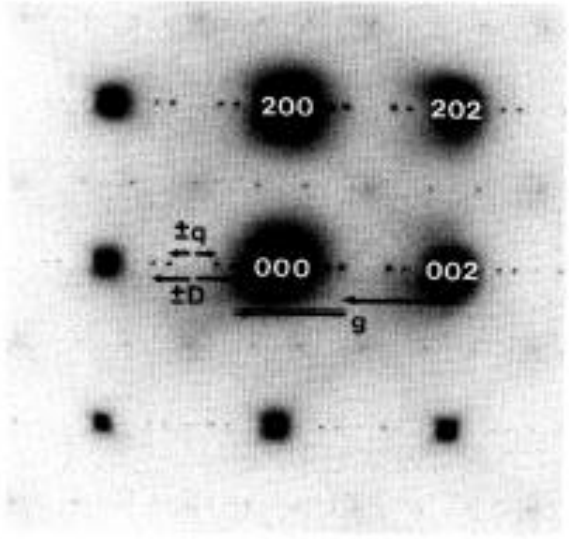
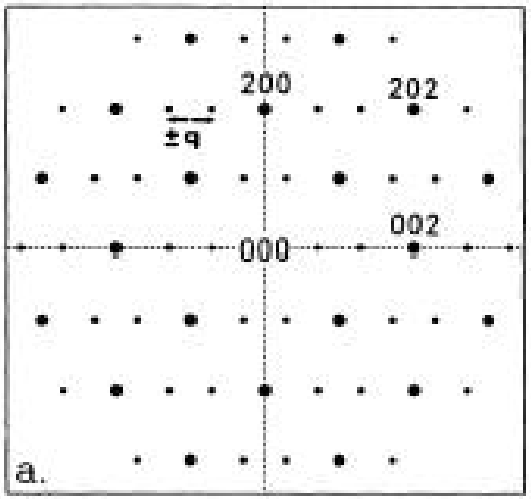
Charge density wave detected by transmission electron microscopy (300 K)





$SmTe_{3,}$ - Satellites pour q = 1.4 ??a

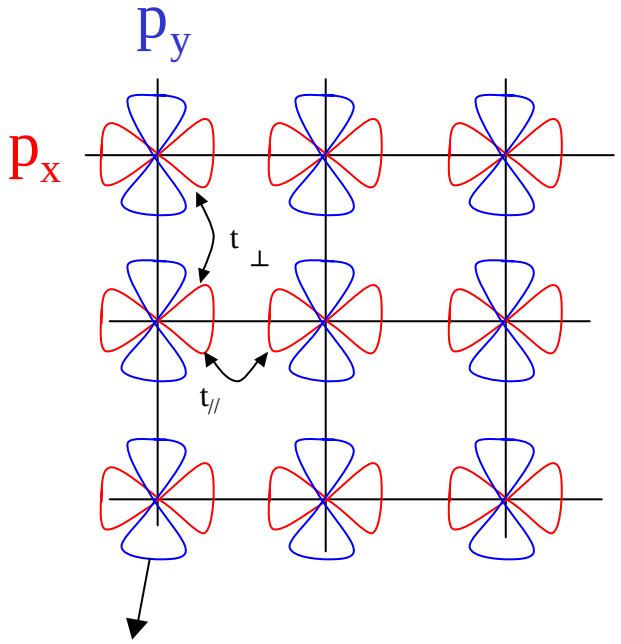
E. DiMasi, M.C. Aronson, J.F. Mansfield, B. Foran and S. Lee,

Phys. Rev. B 52, 14516 (95)

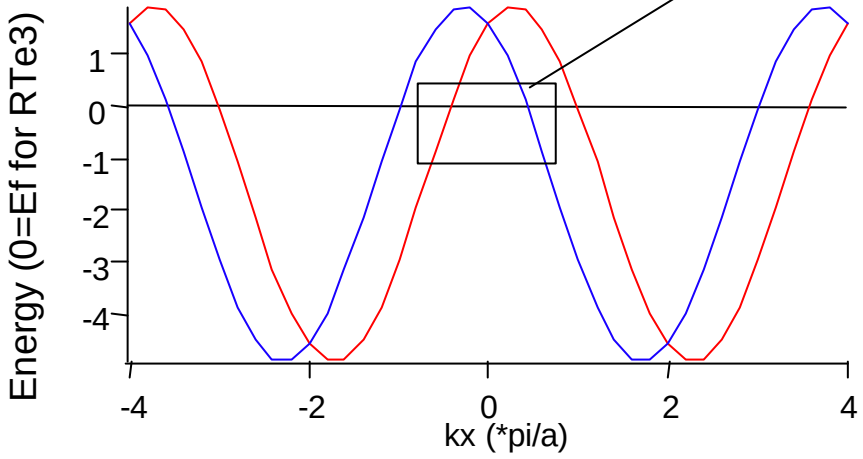
RTe_3 electronic structure

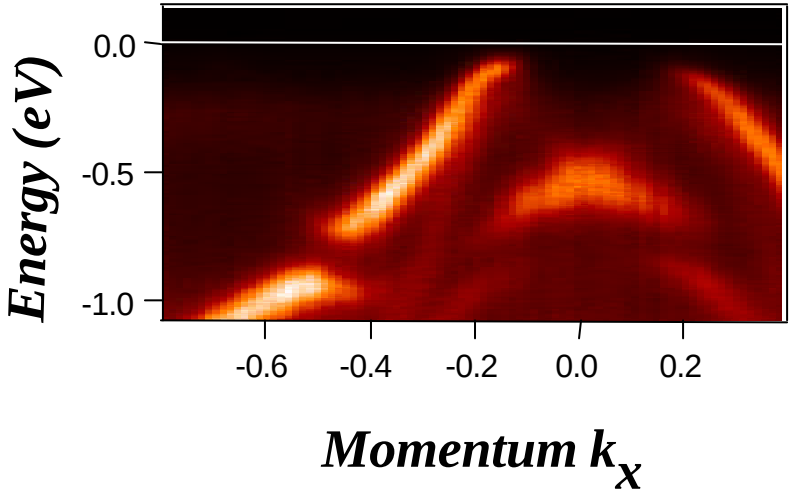
Electronic structure in a plane

Square Te plane in $CeTe_3$



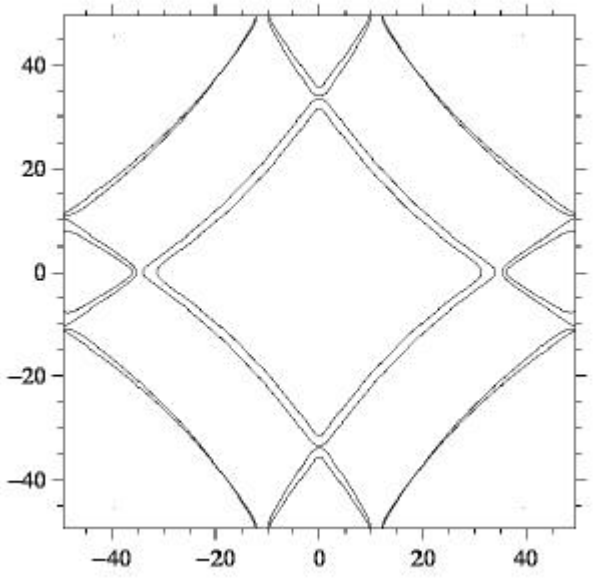
Tight-binding model



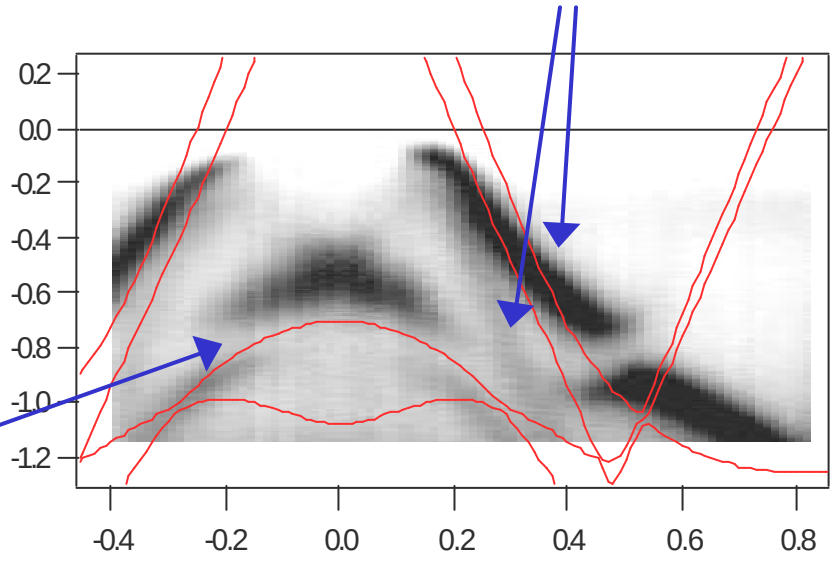


More realistic FS calculation

Fermi Surface in YTe_3 (S. Dugdale, Bristol university)



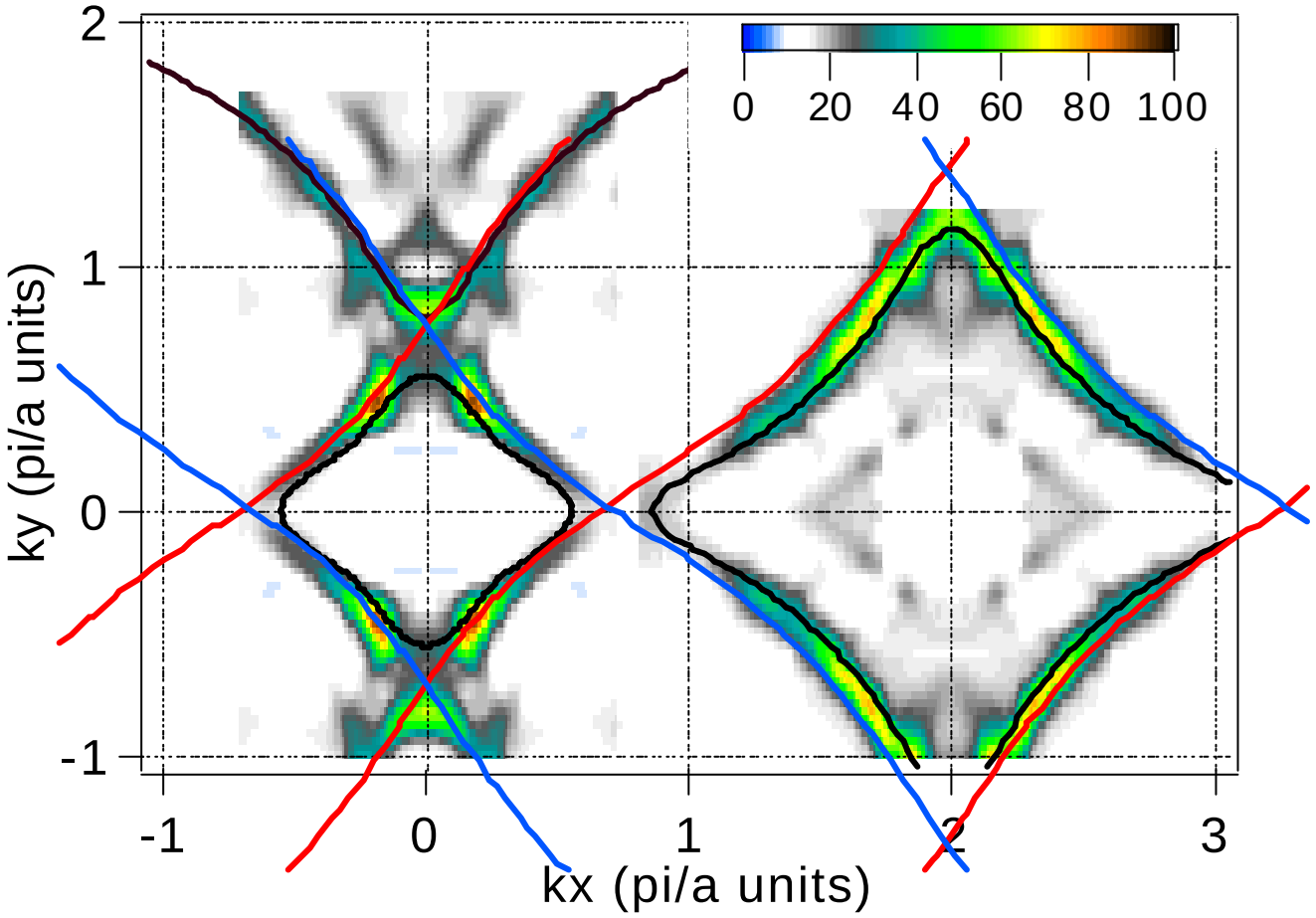
« Bilayer splitting »



Te p_z orbital

$CeTe_3$ Fermi Surface

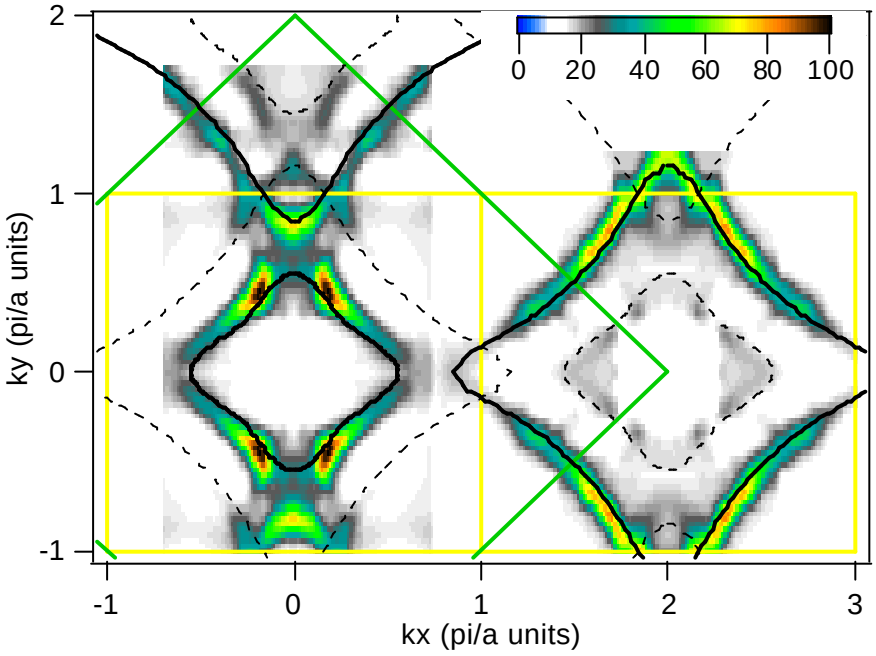
h?=55eV – 20K – **A** para.

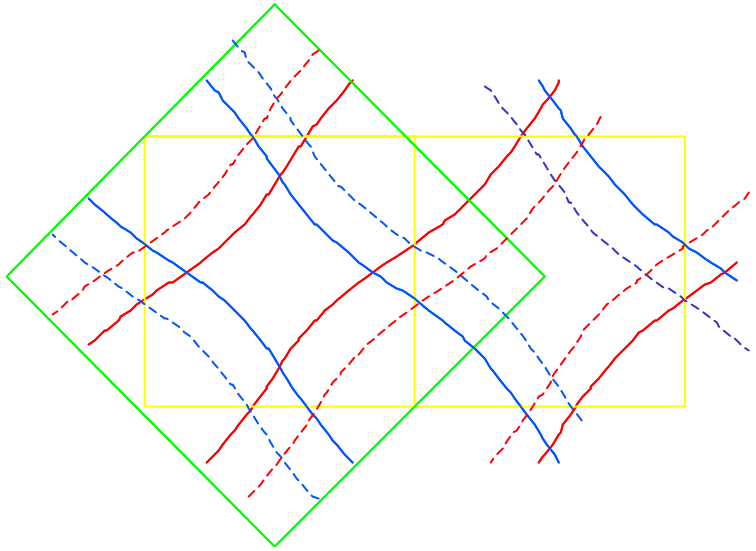


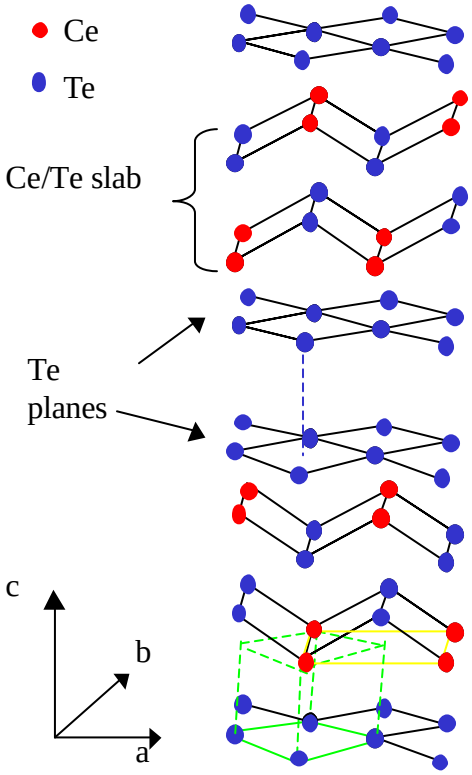
Spectral weight integrated between E_f and E_f-200 meV

First observation (in $SmTe_3$) :
Gweon et al. *Physical Review Letters* ***81***, *886 (1998)*

Folding of $CeTe_3$ Fermi Surface



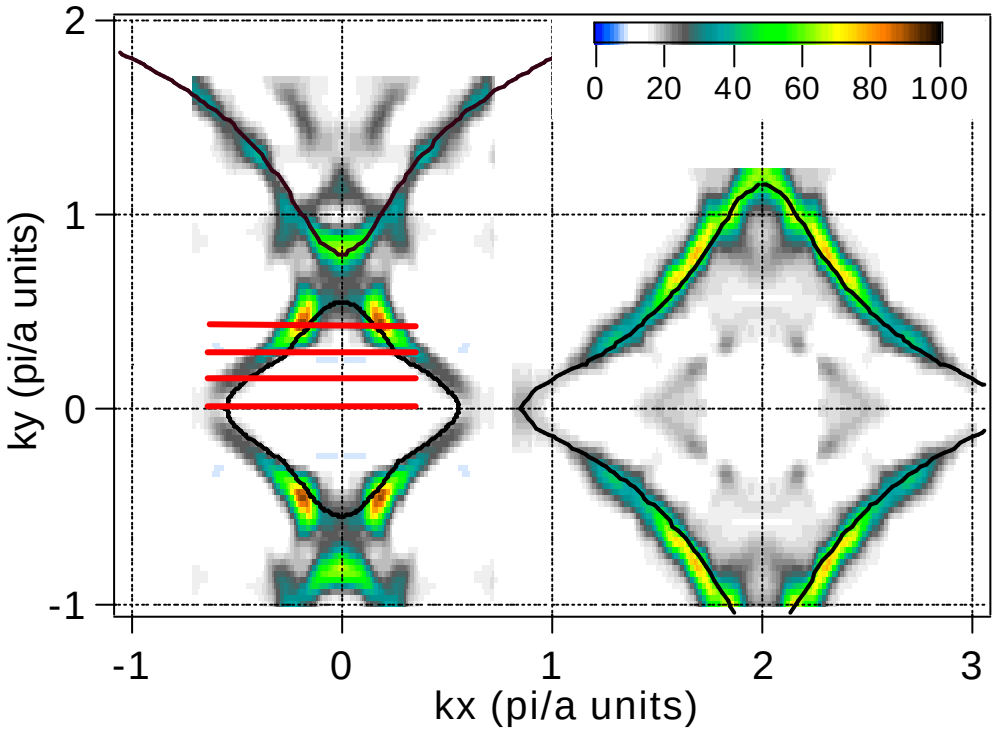


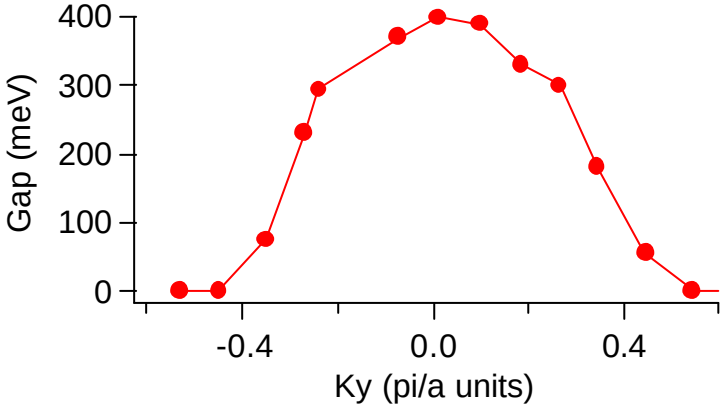


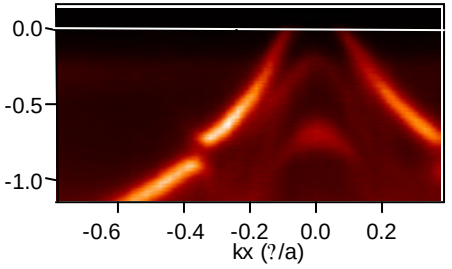
The low intensity of the folded Fermi Surface reflects the 2D character of the compound

Location of the CDW gaps

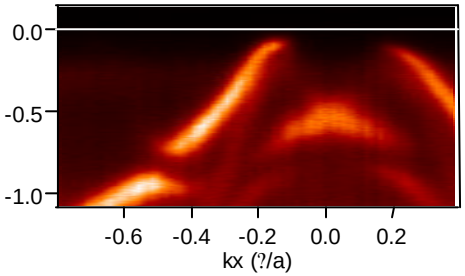
Gap opening on the best nested parts of the Fermi Surface (I)



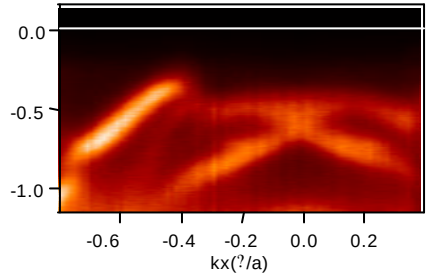




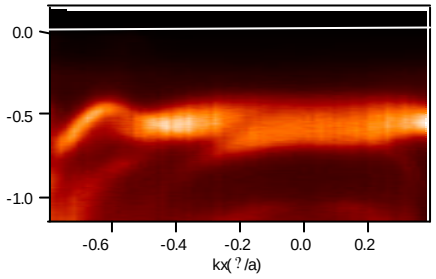
K_y=0.63



K_y=0.45

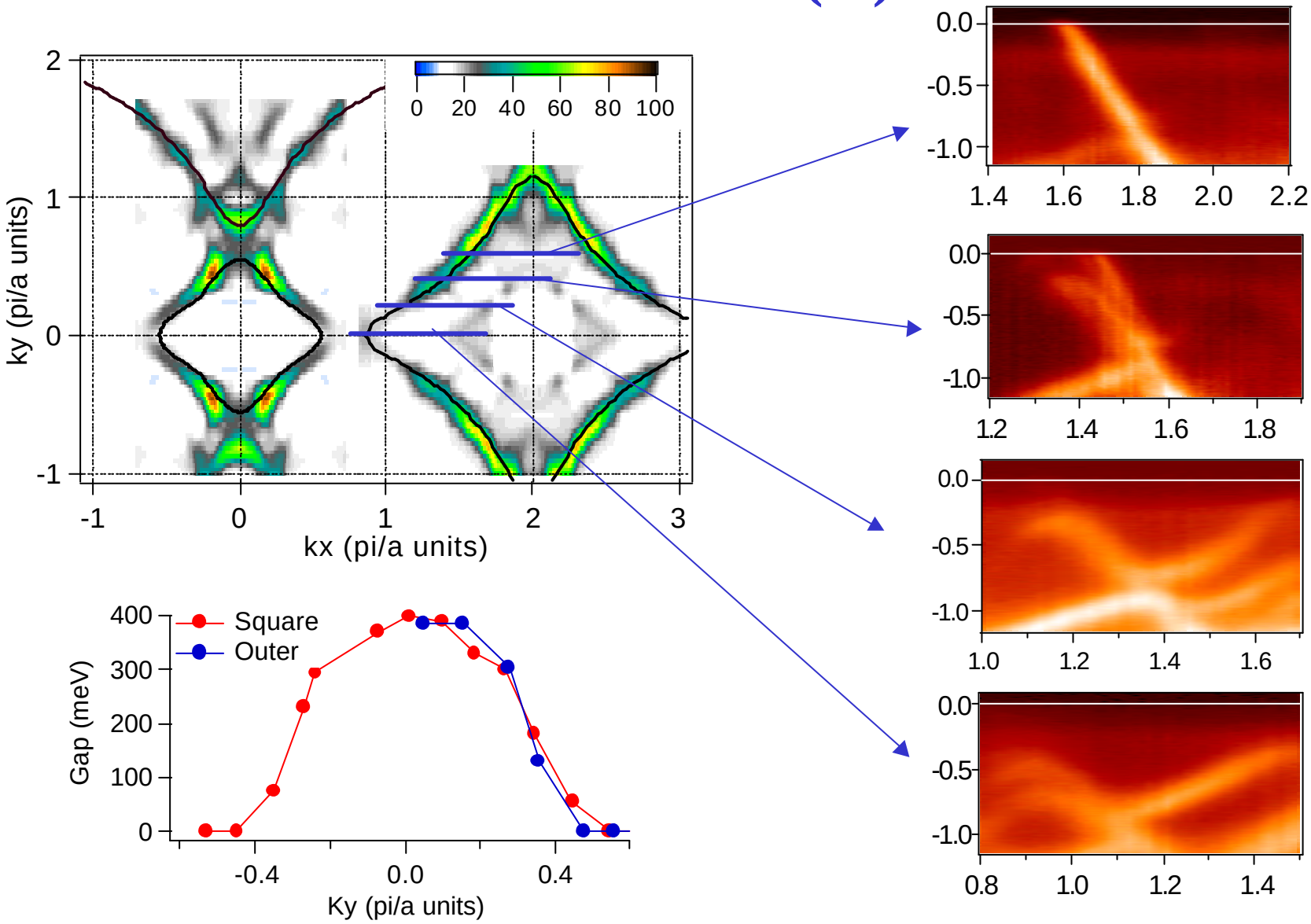


K_y=0.27

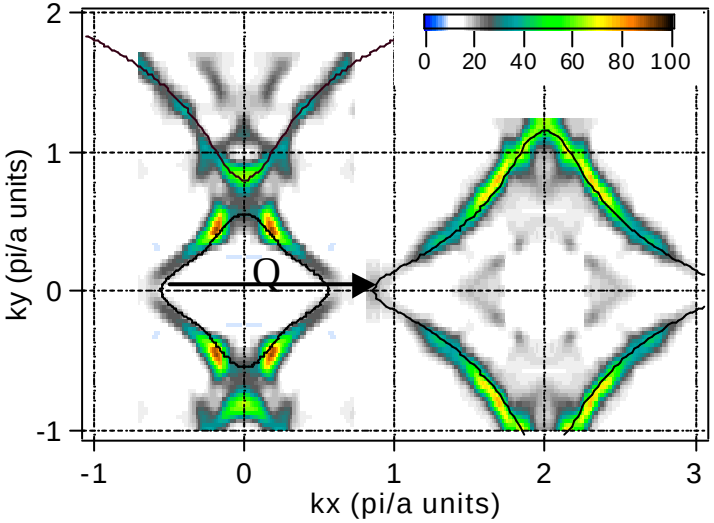


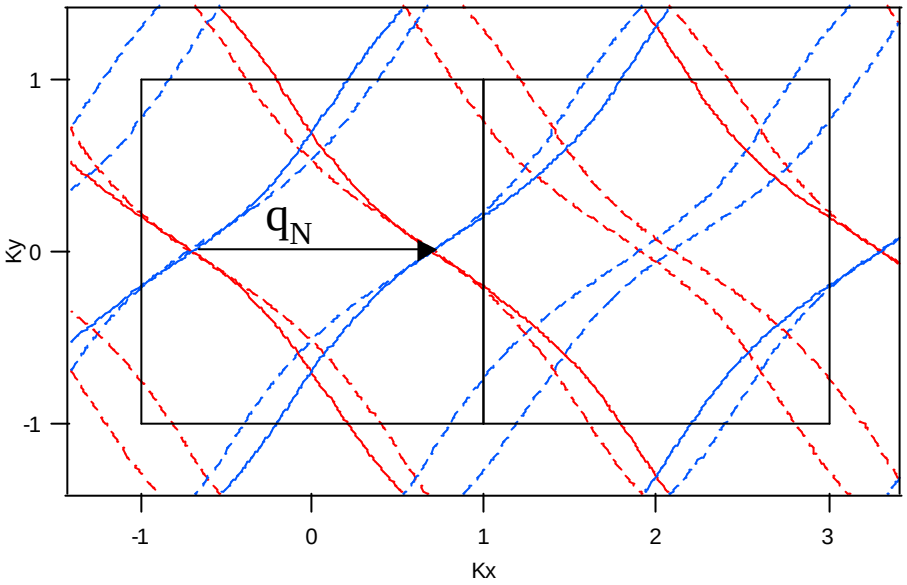
K_y=0

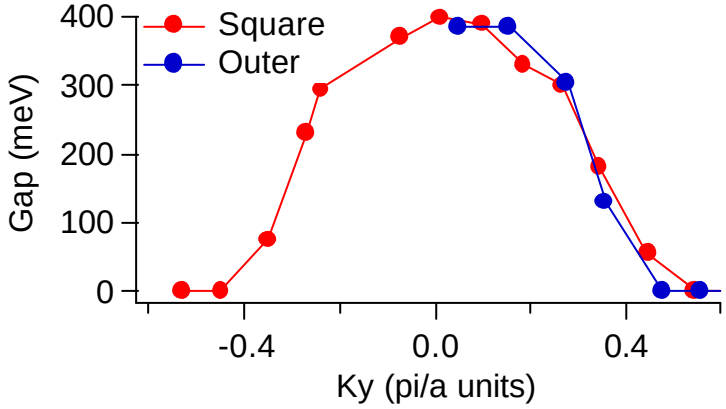
Gap opening on the best nested parts of the Fermi Surface (II)



The gap opens on parts of the Fermi Surface exhibiting the best “nesting”



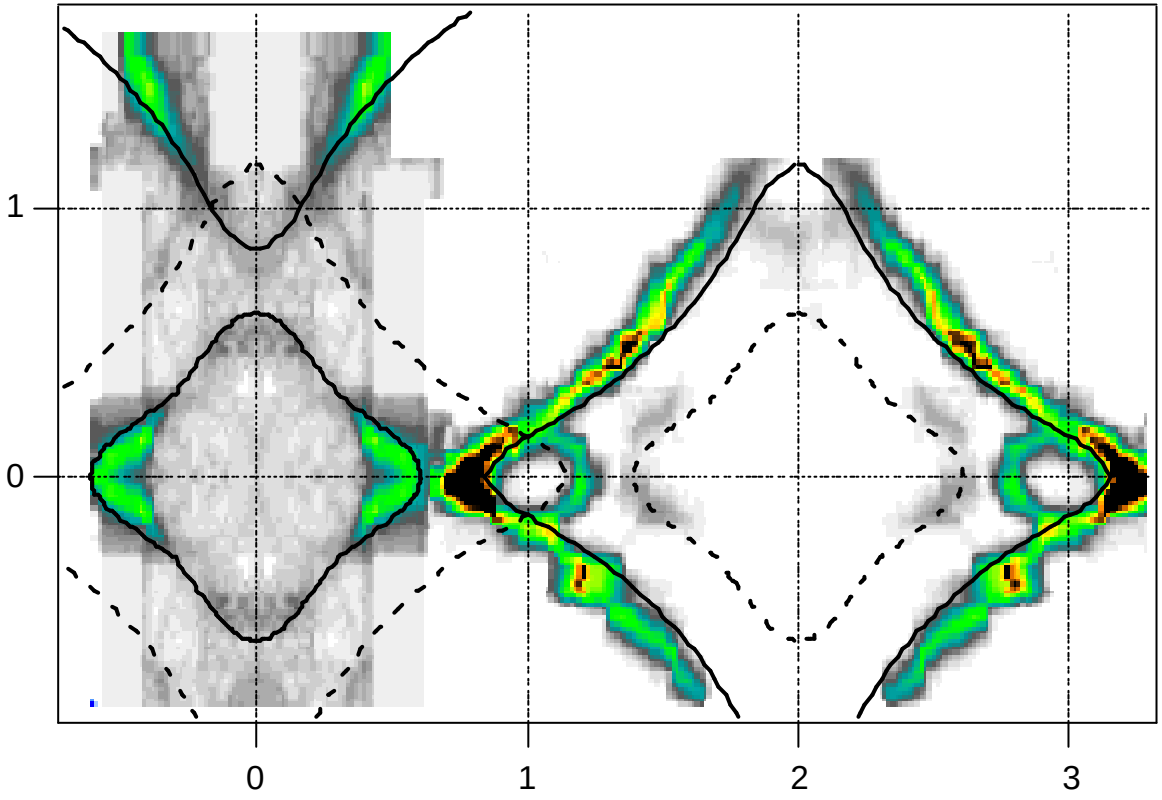




Q=1.4 ?/a corresponds to the satellites seen by TEM

YTe_3 Fermi Surface

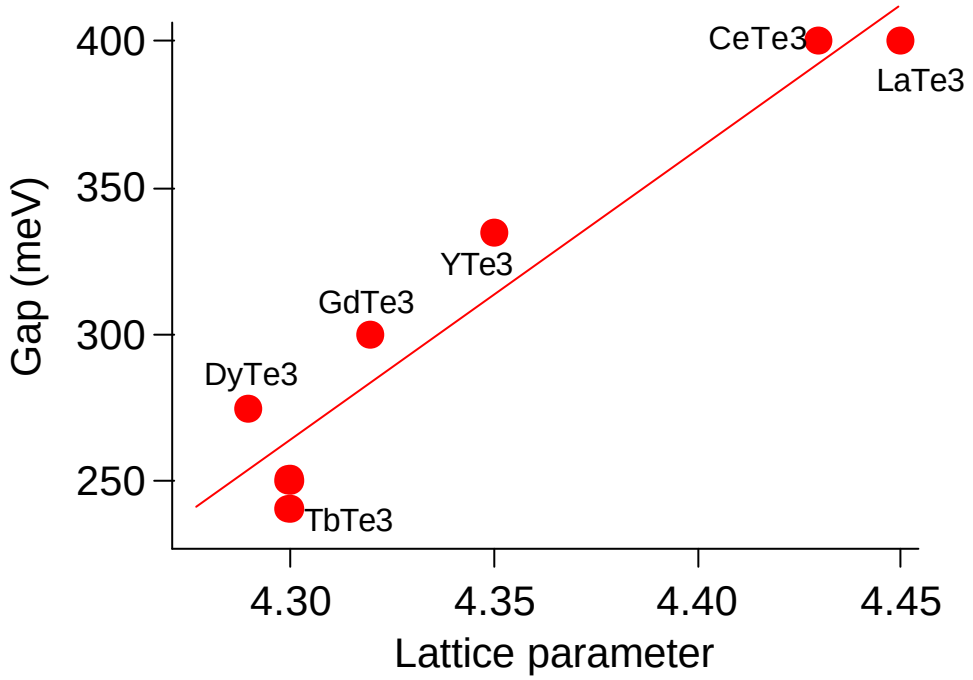
h?=35eV – 20K – **A** para.



The gap is found along ky.

Evolution of the CDW properties as a function of rare earth

Gap measured by ARPES

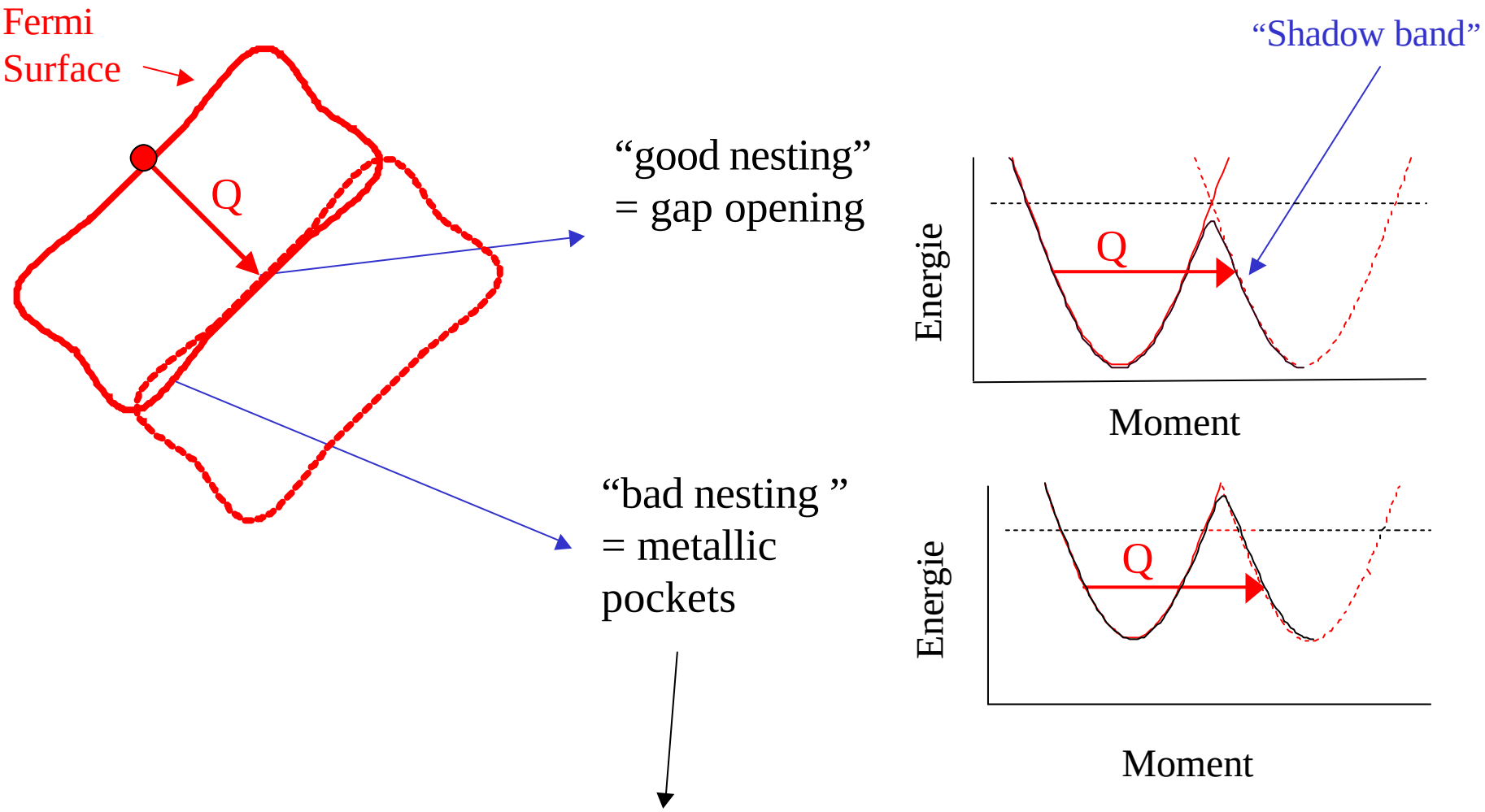


$N(E_f)$ increases with the lattice parameter, which probably stabilizes the CDW.

This supports the description as a nesting driven CDW (also DiMasi et al. PRB 95).

Imperfect nesting :
residual metallic pockets in $CeTe_3$

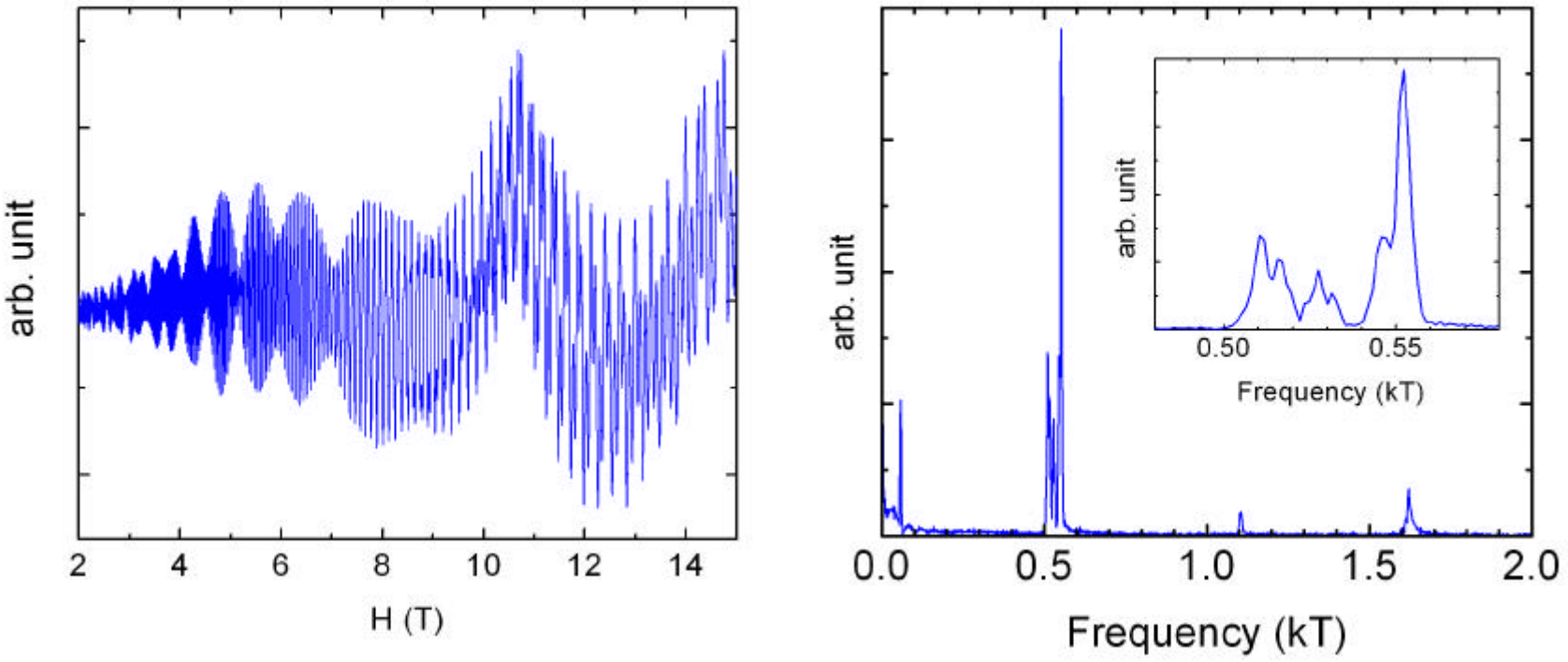
Imperfect nesting



Residual metallicity

The size of the metallic pockets can be deduced for example from de Haas van Alphen oscillations.

Oscillations in magnetization of $LaTe_3$



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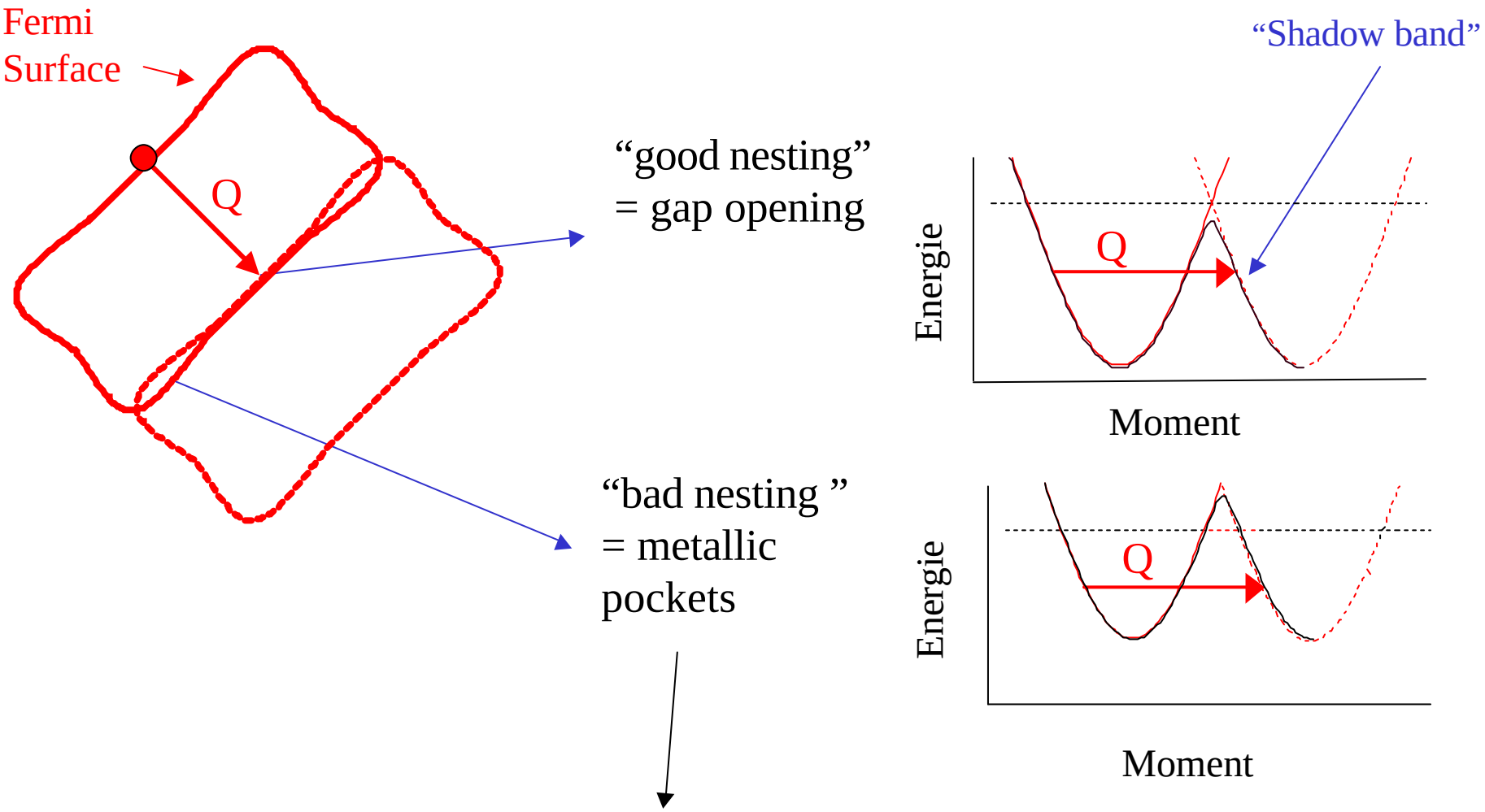
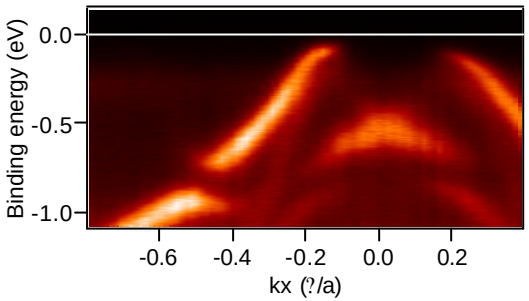
Imperfect nesting

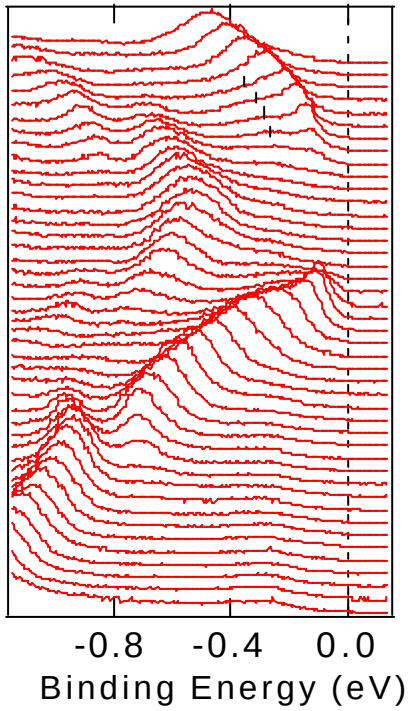


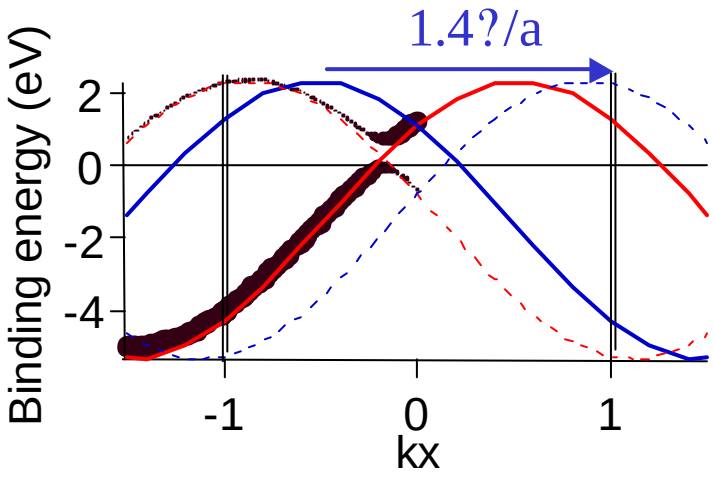
Residual metallicity

The size of the metallic pockets can be deduced for example from de Haas van Alphen oscillations.

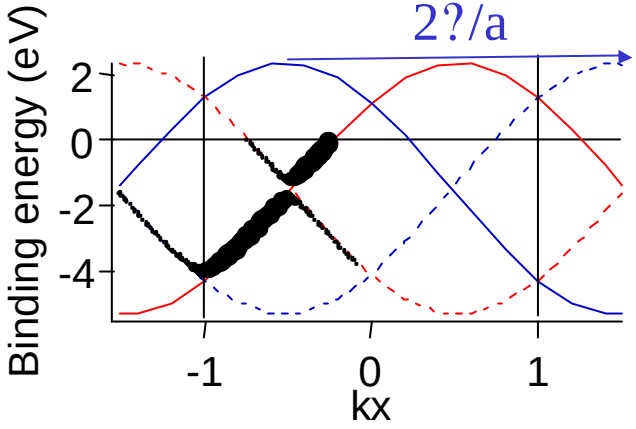
Folded and shadow bands







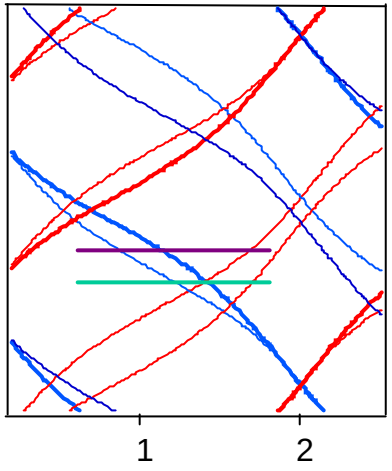
Shadow band
(CDW)

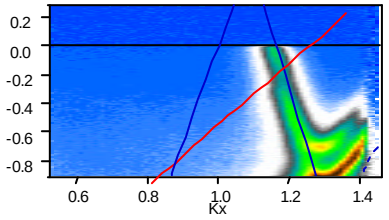


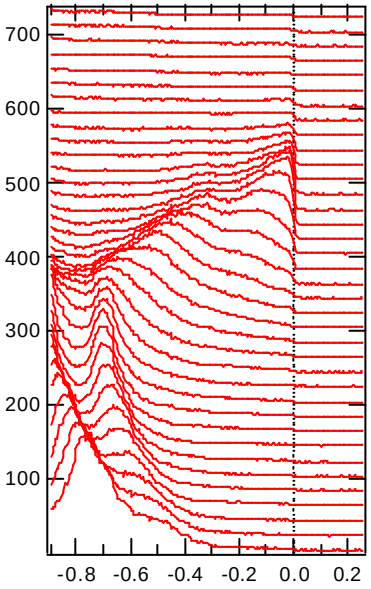
Folded bands
(3D structure)

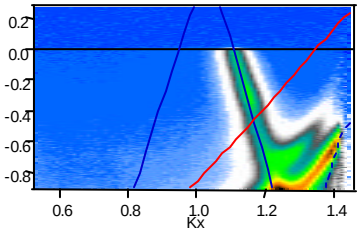
Crossing of CDW shadow bands in metallic parts of the CDW

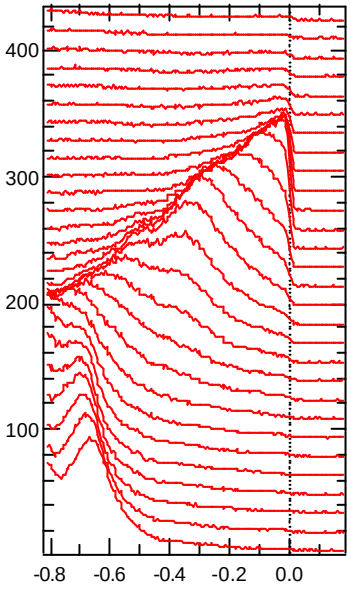
YTe_3



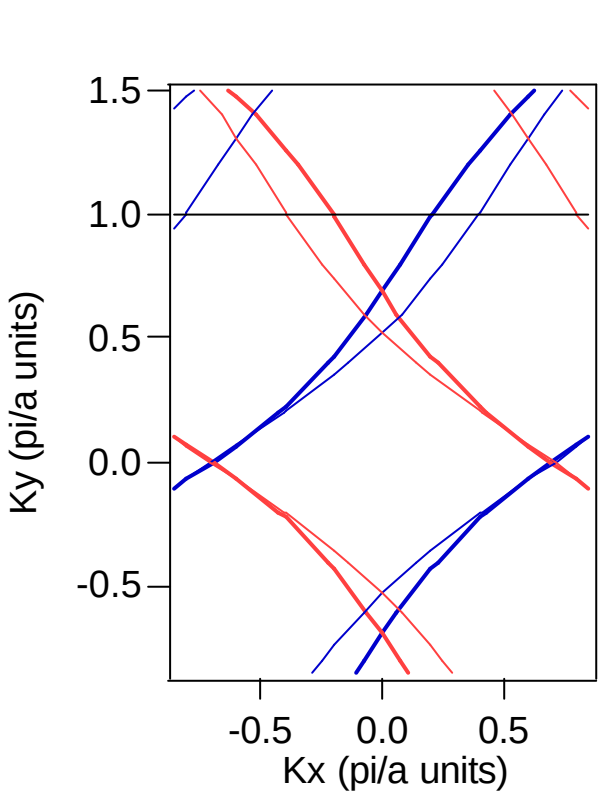


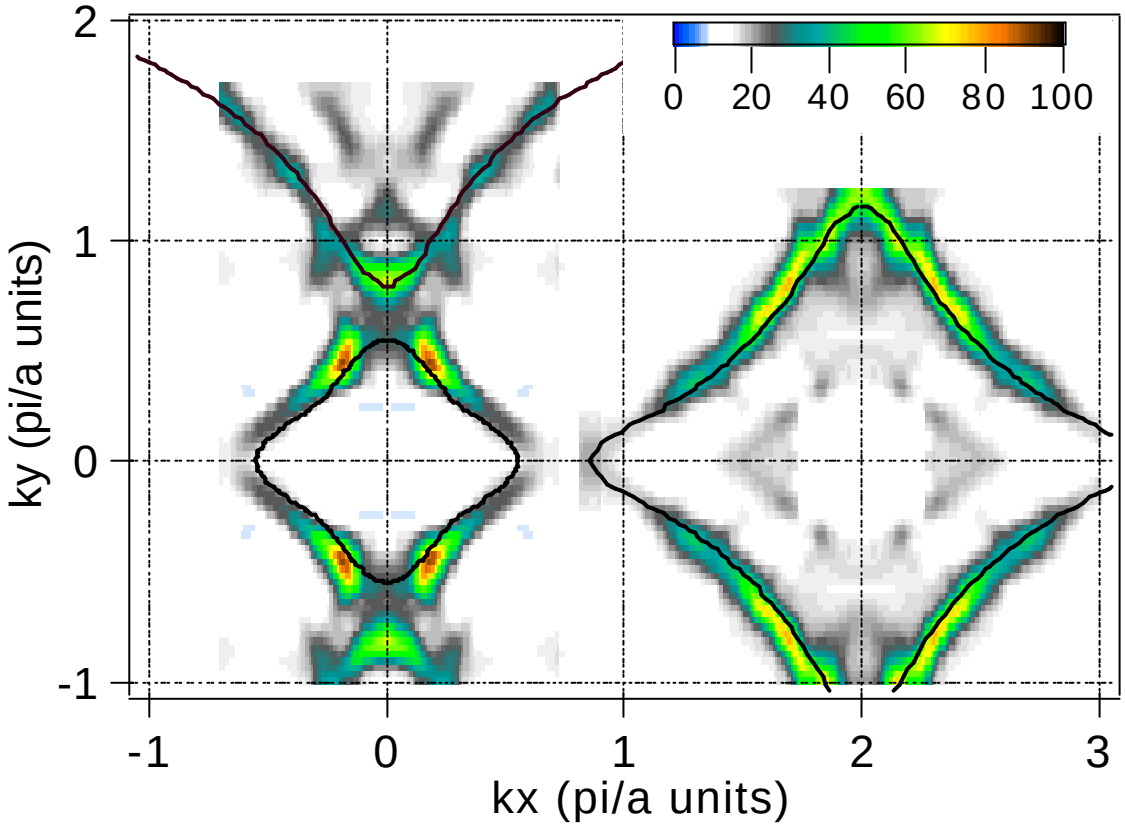






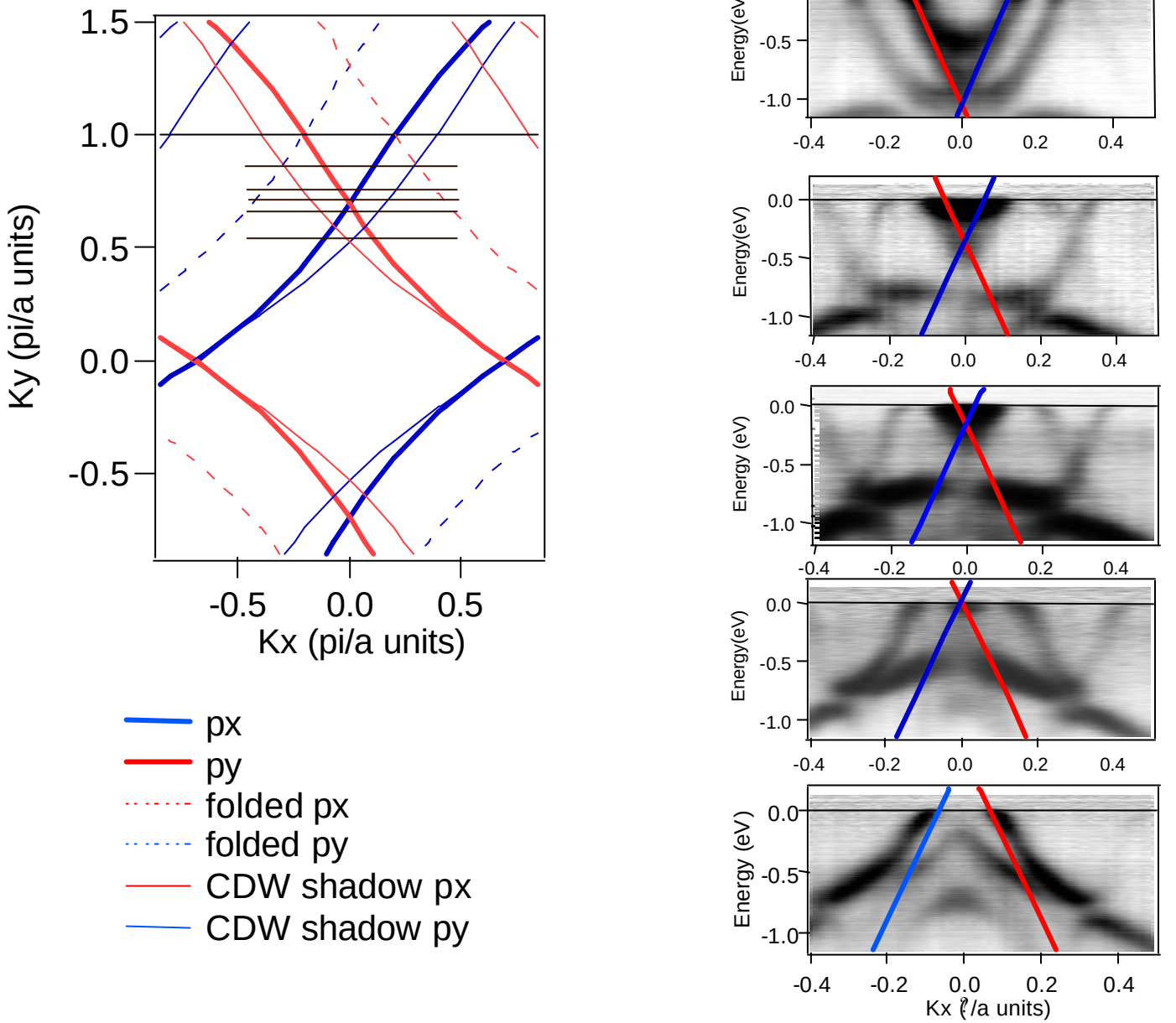
Determination of metallic pockets



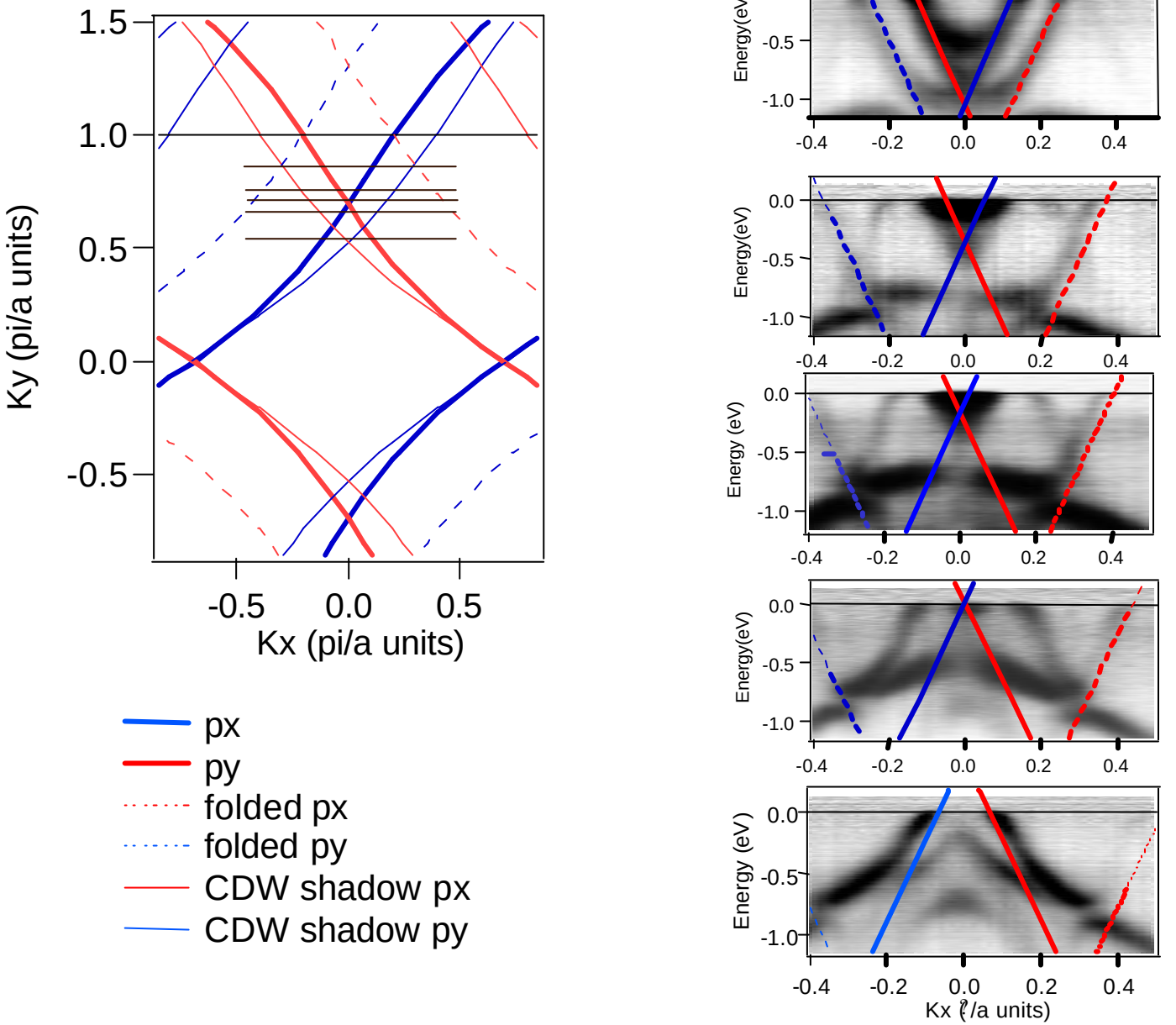


The Fermi surface seems to be made out of « arcs »,
but a closed contour is expected.

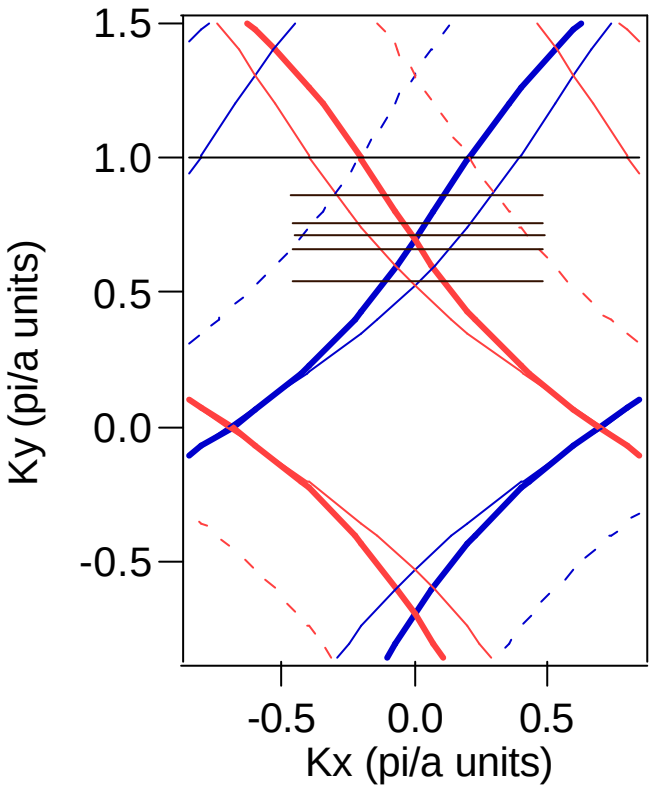
Determination of metallic pockets

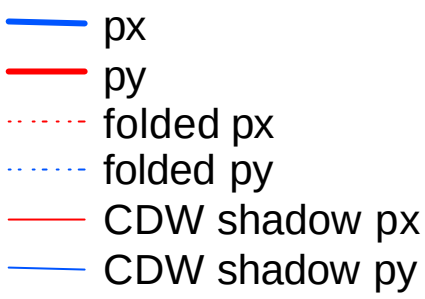


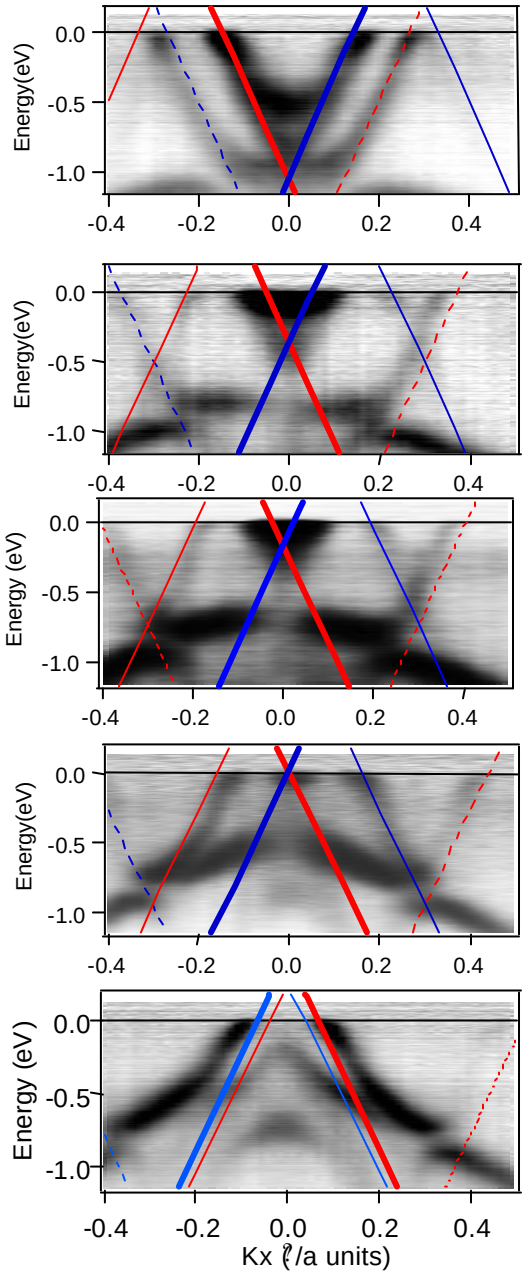
Determination of metallic pockets



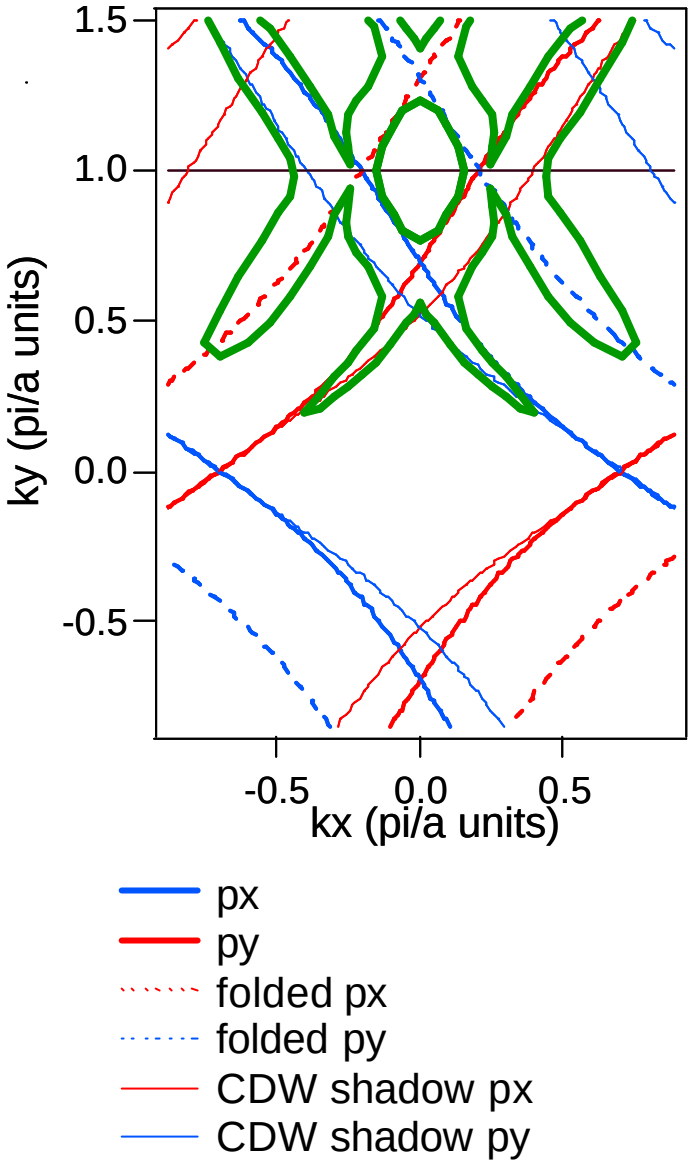
Determination of metallic pockets

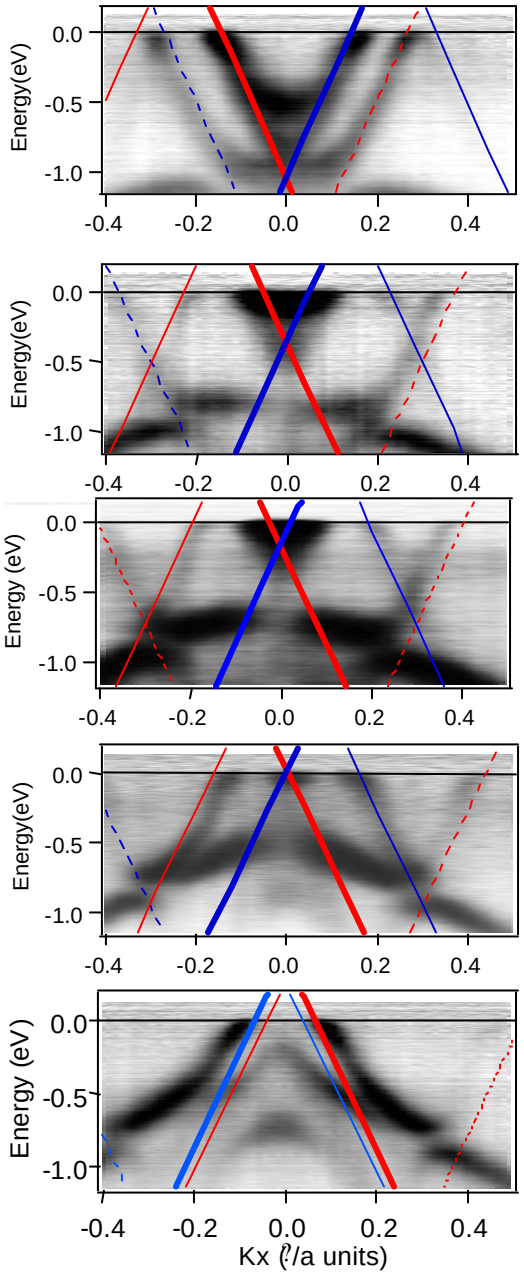




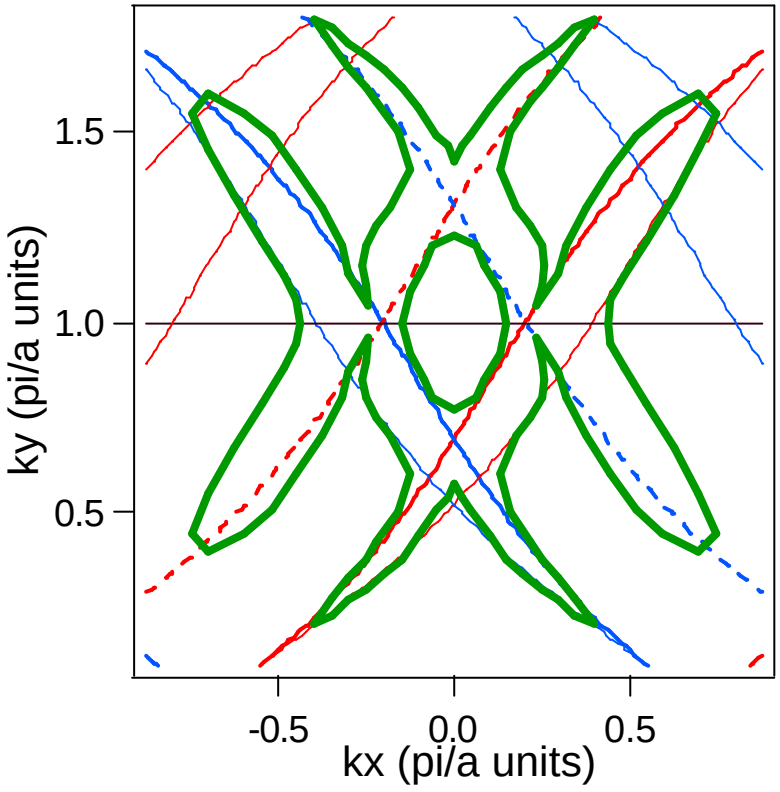


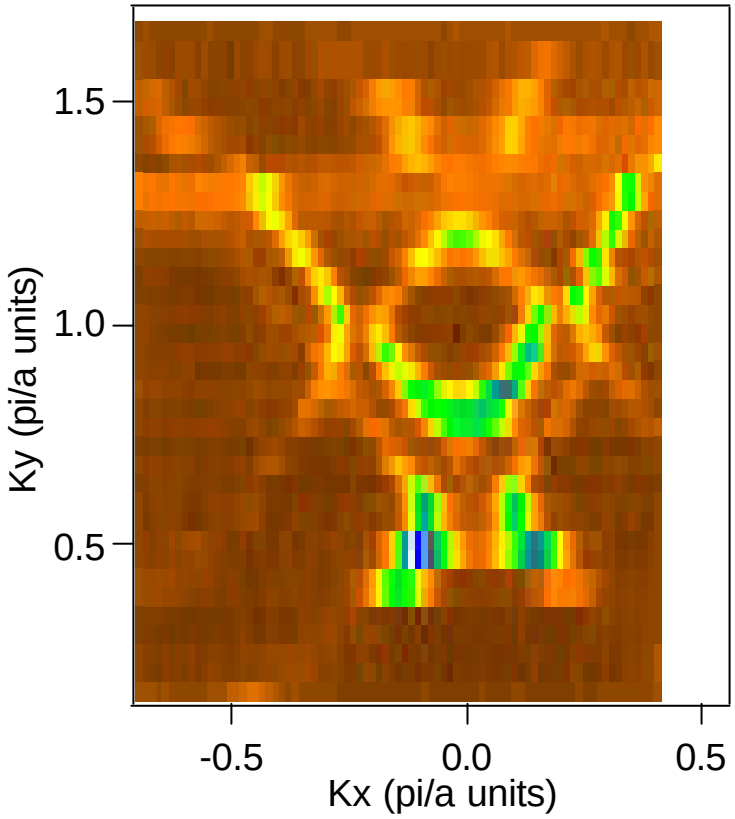
Determination of metallic pockets





Metallic pockets





ARPES allows to get the details of the Fermi Surface pockets

V. Brouet et al., PRL **93** 126405 (2004)

Conclusion

- ARPES gives support for the charge density wave in $CeTe_3$ to be described as a nesting driven Fermi Surface instability.

- The detailed topology of the residual Fermi surface has been obtained.

- RTe_3 might be an interesting example of 2D Fermi liquid to study further.