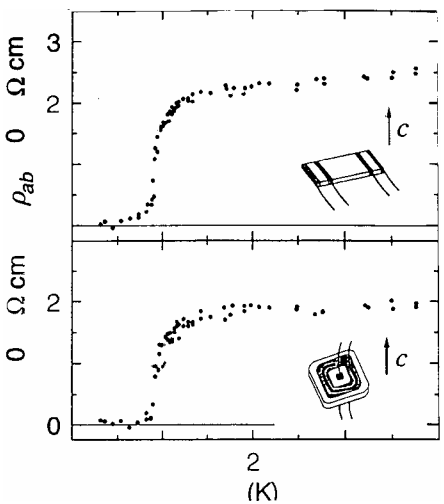
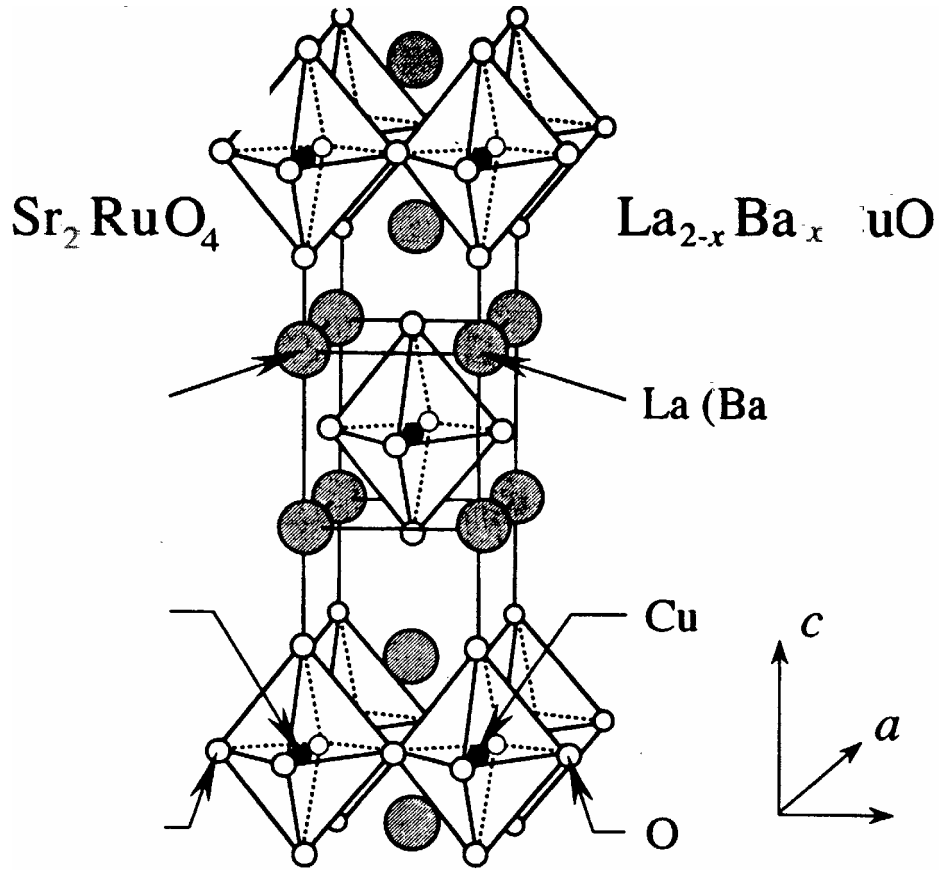
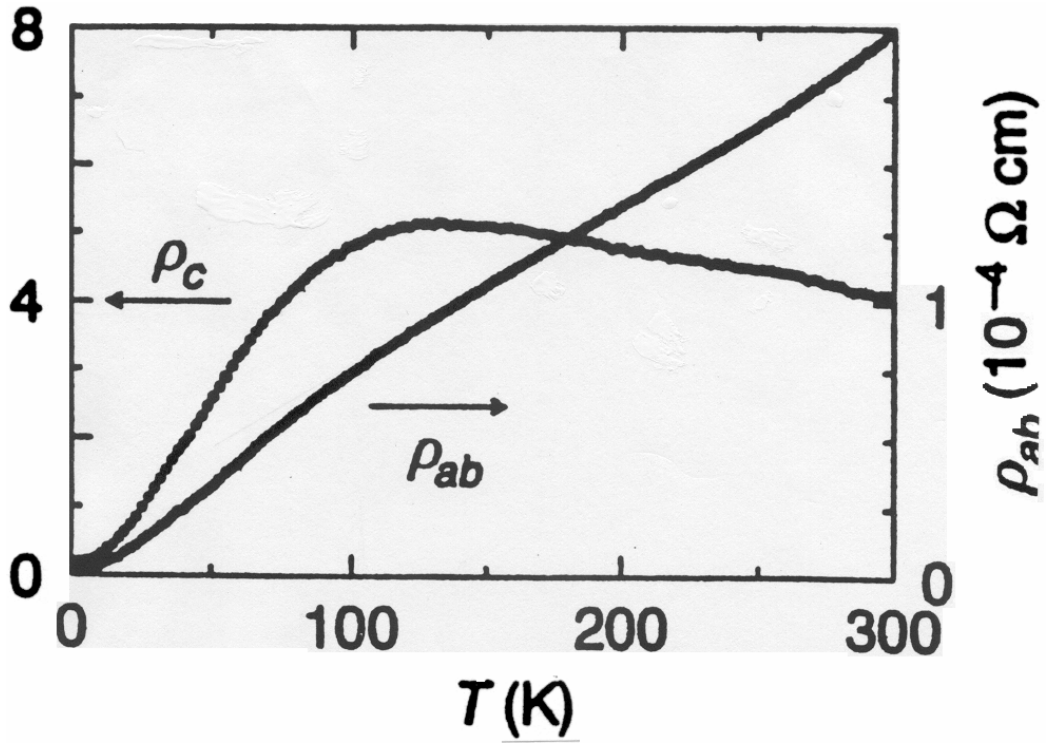
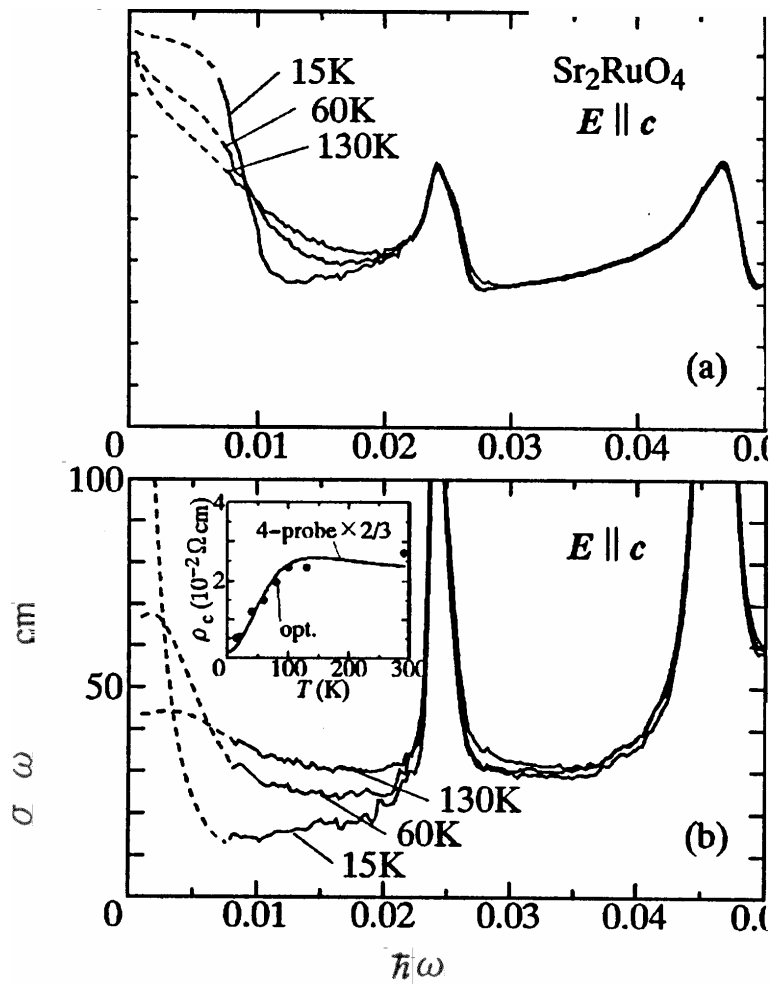
ARPES studies of Sr_2RuO_4:
Fermi surface, excitation gaps, and dimensional crossover

Peter Johnson`s group, BNL
in collaboration with
Robert Cava`s group, Princeton University

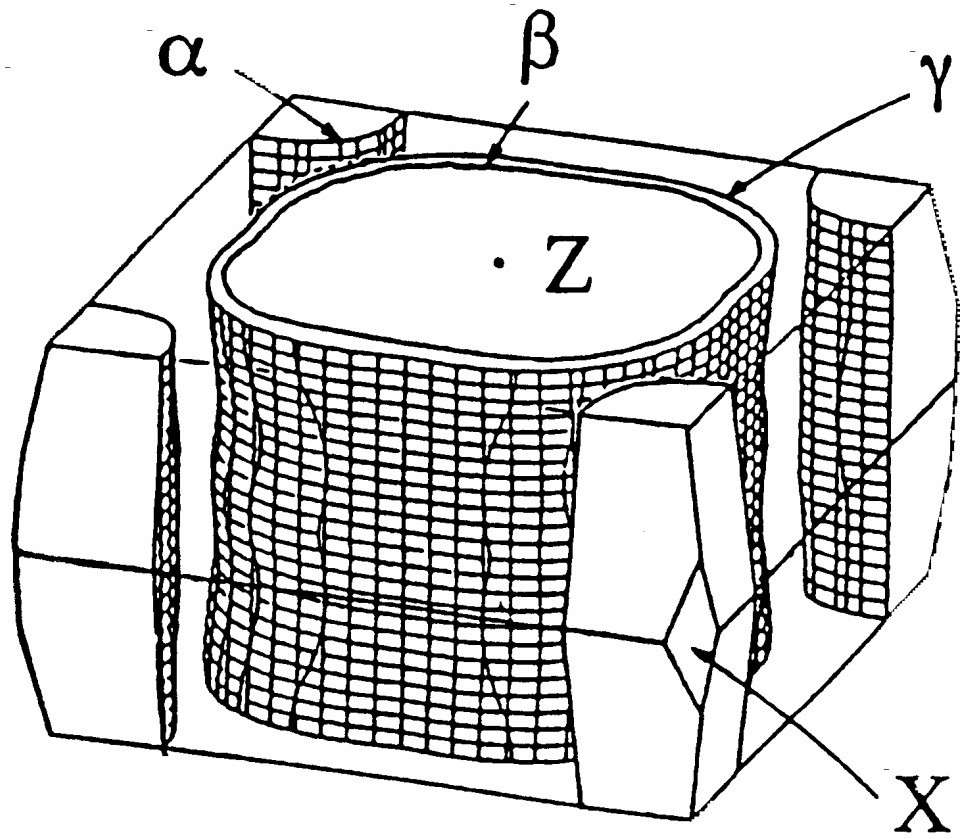

3
2
0 Ω cm
ρ_{ab}
c
2
0 Ω cm
0
c
2
(K)


Sr_2RuO_4
$La_{2-x}Ba_x$ uO
La (Ba
Cu
O
c
a

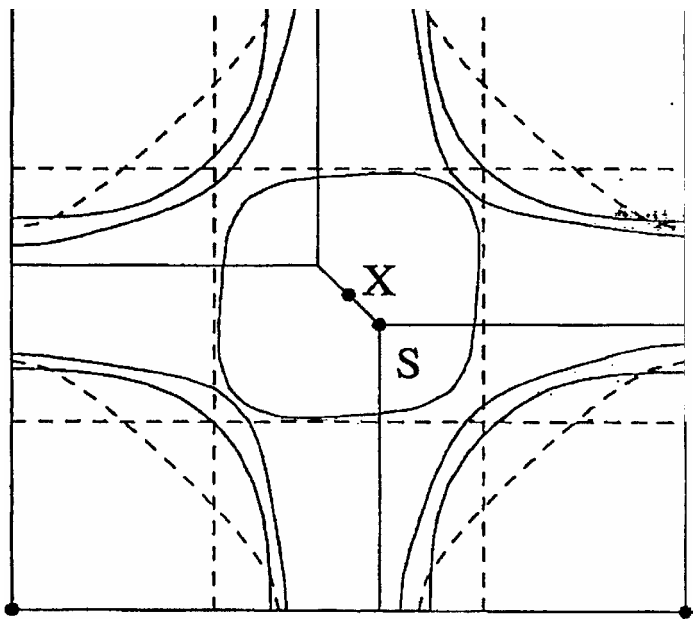

8
4
0
0
100
200
300
T (K)
ρc
ρab
1
0
ρab (10⁻⁴ Ω cm)


15K
60K
130K
Sr_2RuO_4
$E \parallel c$
(a)
0
0.01
0.02
0.03
0.04
100
50
σ ω cm
4-probe × 2/3
ρ_c ($10^{-2}\Omega$ cm)
opt.
T (K)
$E \parallel c$
130K
60K
15K
(b)
$\hbar\omega$

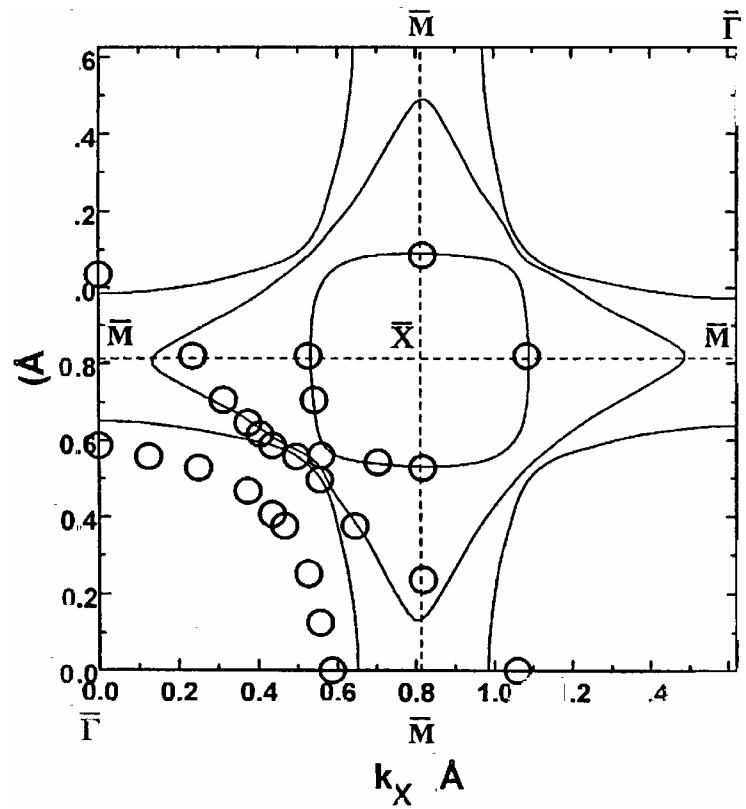
de Haas van Alphen Fermi surface

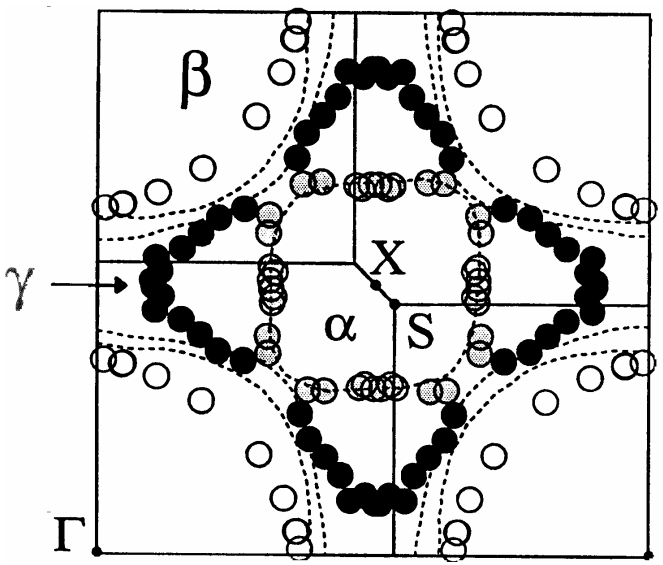


First calculation



First ARPES experiment





Van Hove singularity
/analogy to HTSC/

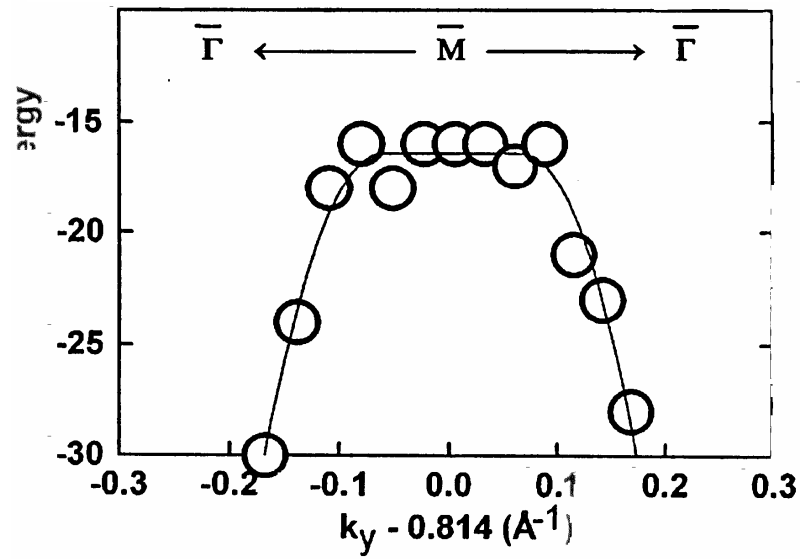
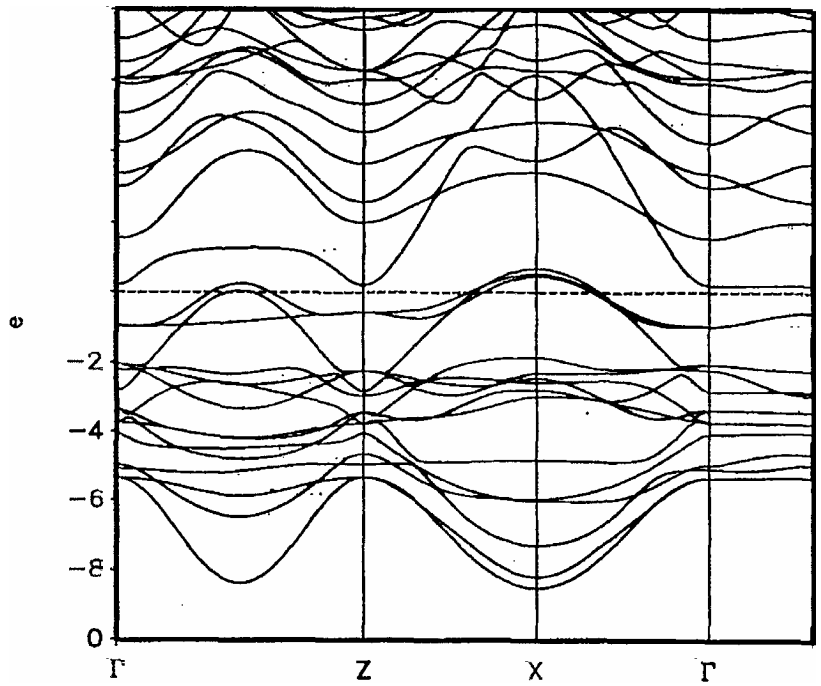
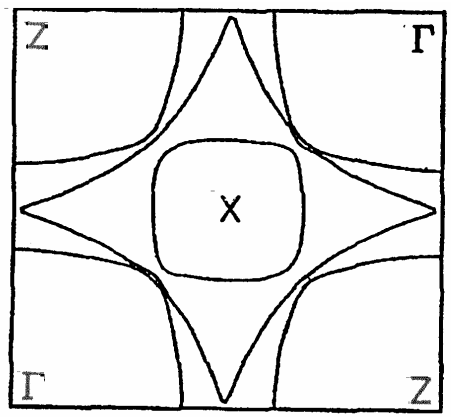


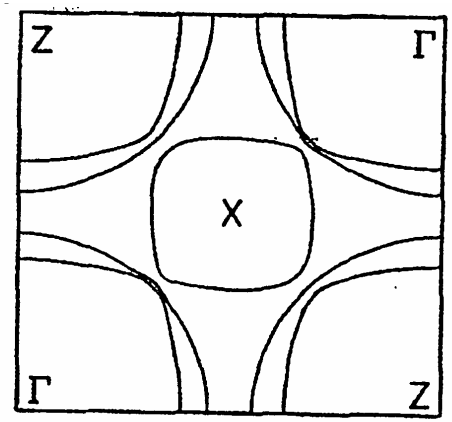
TABLE I. The superconducting transition temperature, the temperature dependence of the in-plane normal-state resistivity, and the position of the VHs relative to E_F for cuprate superconductors and Sr_2RuO_4.

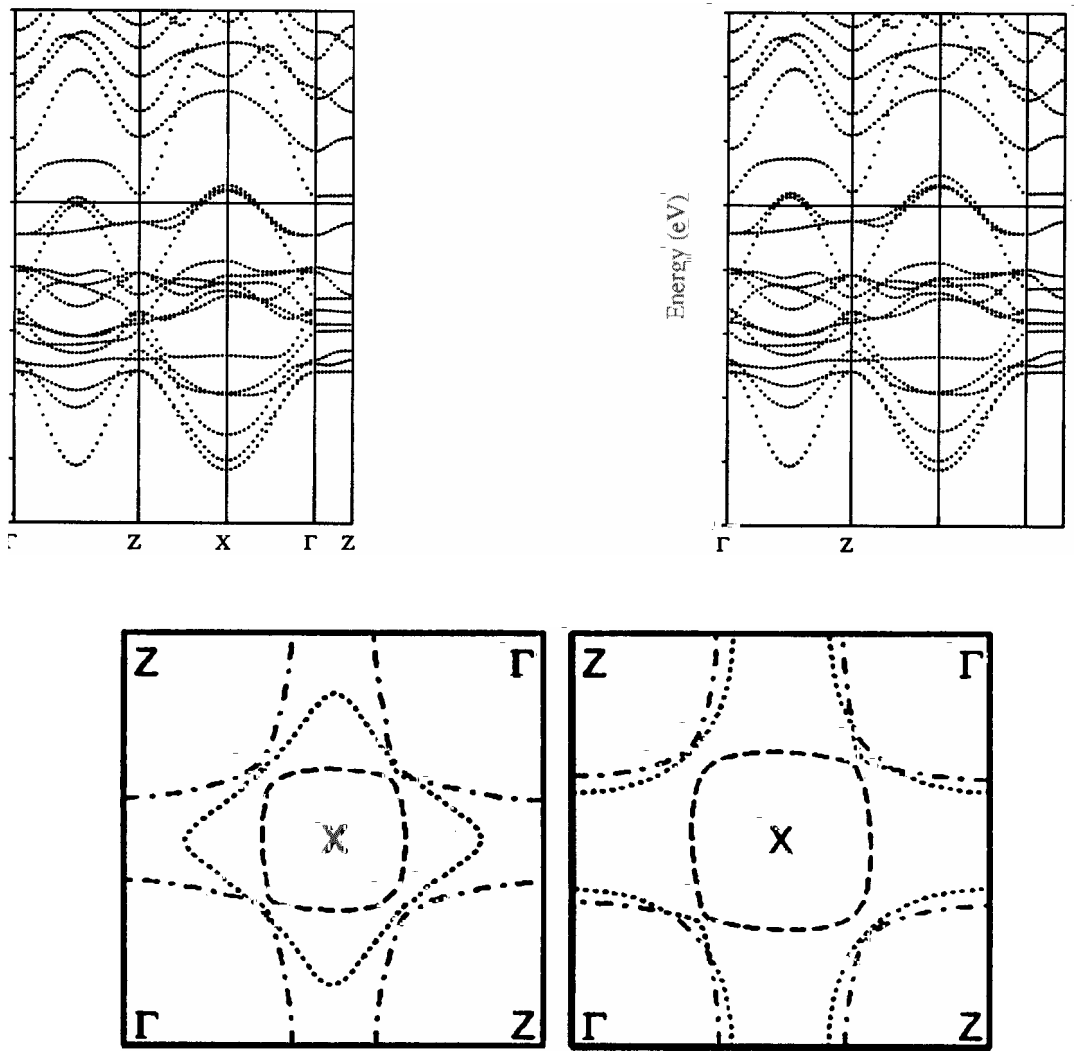
	T_c (K)	$\rho_{ab}(T)$	E_{VHs} (meV)
$YBa_2Cu_3O_{7-\delta}$	92	linear	<10[a]
$YBa_2Cu_4O_8$	82	linear	19[b]
$Bi_2(Sr_{0.97}Pr_{0.03})_2CuO_6$	10	linear	<30[c]
$Bi_2Sr_2CaCu_2O_{8+\delta}$	83	linear	<30[d]
$Nd_{1.85}Ce_{0.15}CuO_4$	25	quadratic	350[e]
Sr_2RuO_4	0.93	≈ linear[f]	17[g]

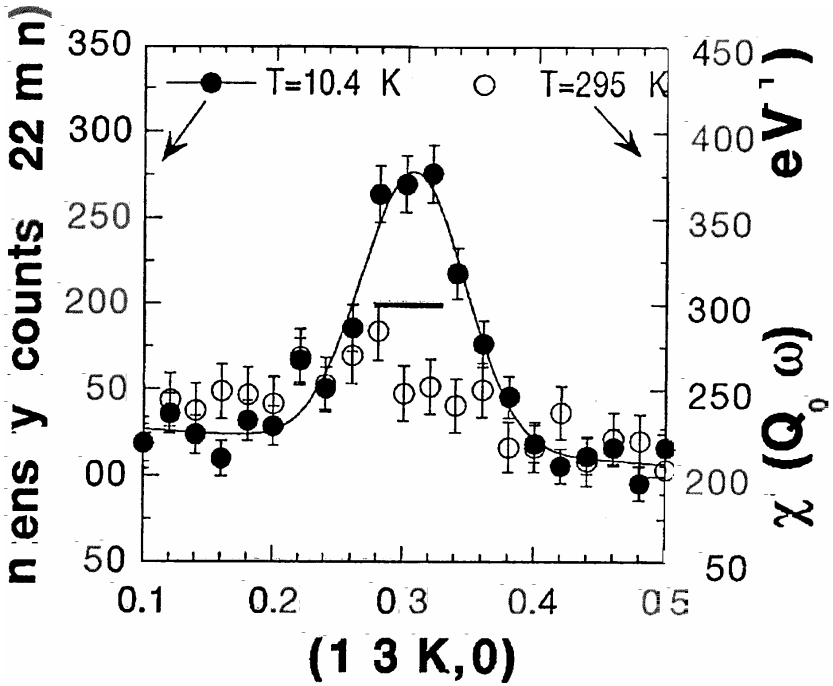
[a]Ref. [11], [b]Ref. [11,12], [c]Ref. [13], [d]Ref. [14], [e]Ref. [15], [f]Ref. [20], and [g]this work.

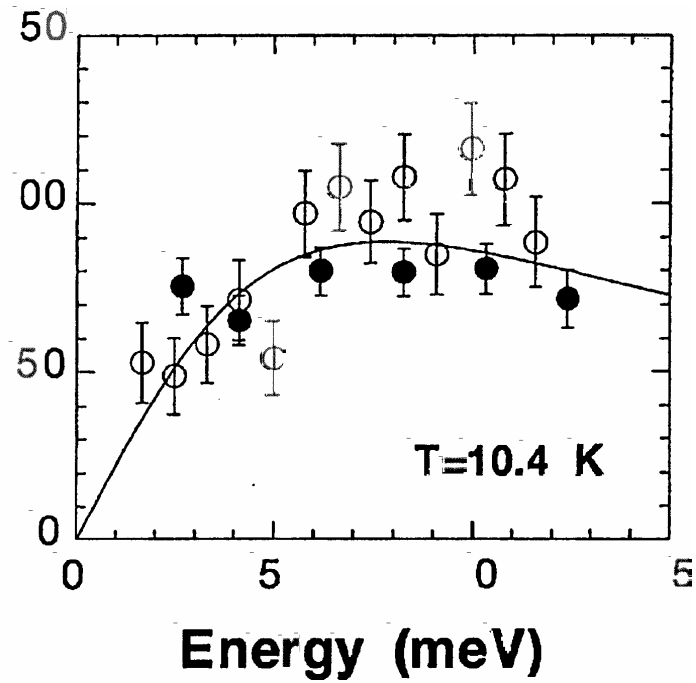

e
−2
−4
−6
−8
0
Γ
Z
X
Γ

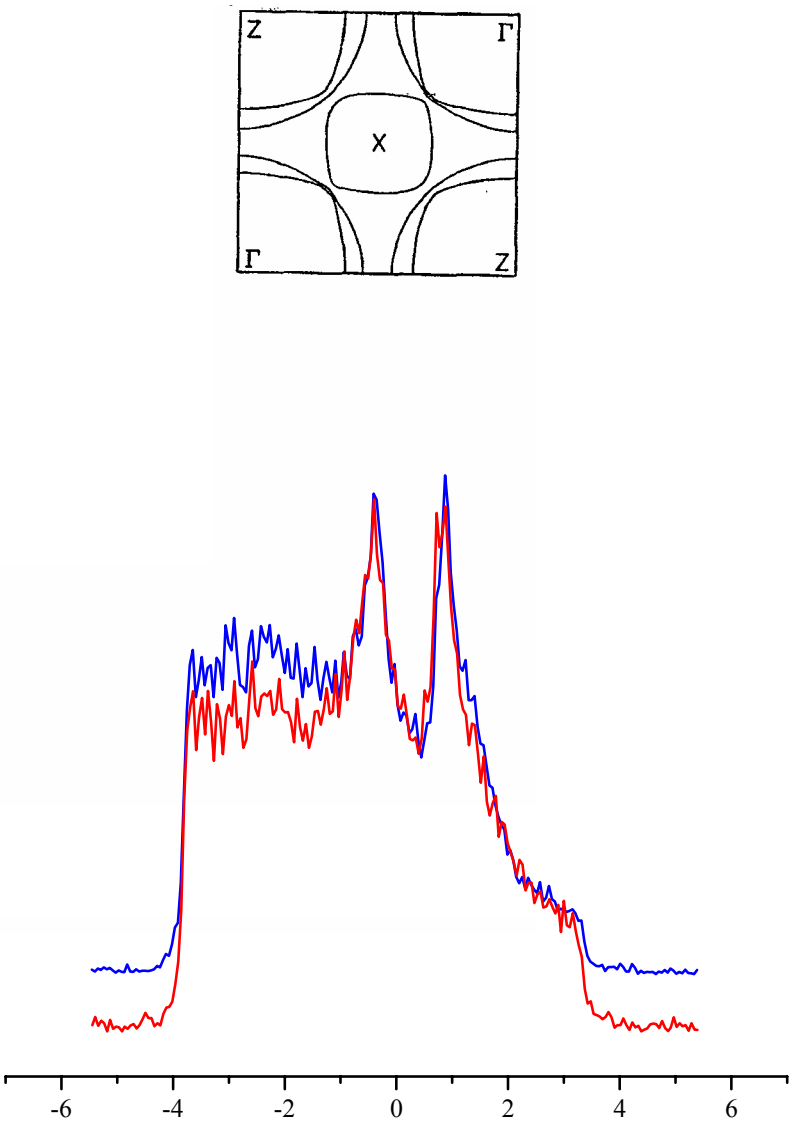

Z
Γ
X
Γ
Z

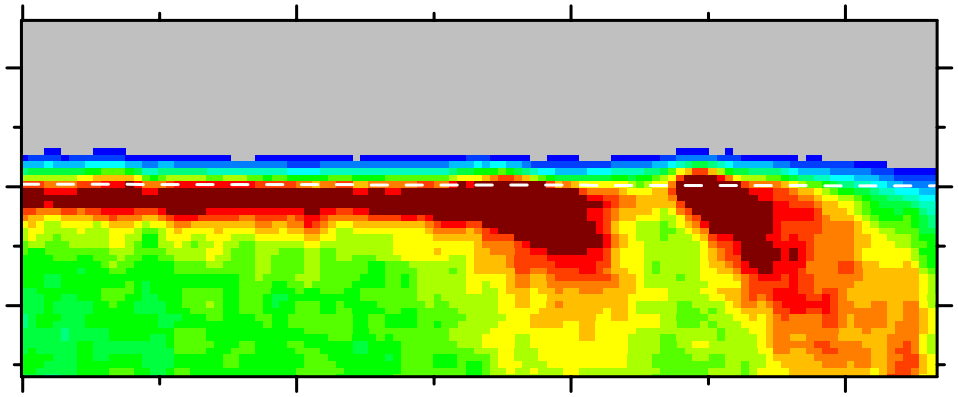

Z
Γ
X
Γ
Z

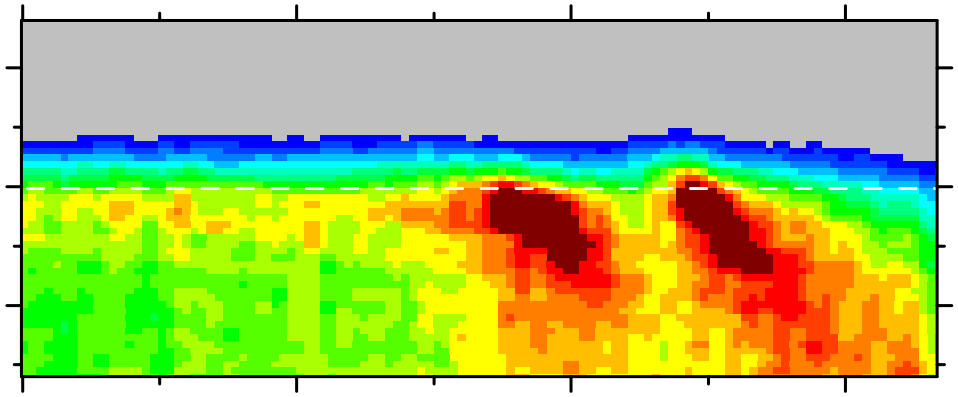

Energy (eV)
Γ
Z
X
Γ
Z
Γ
Z
Z
Γ
X
Γ
Z
Z
Γ
X
Γ
Z

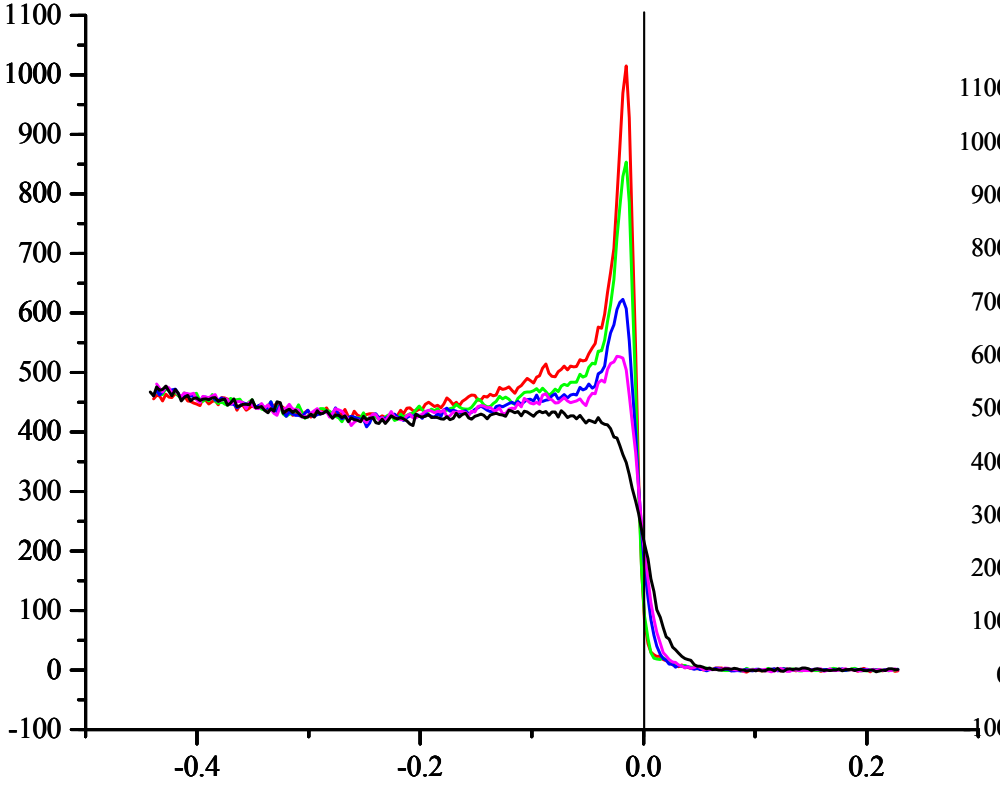

T=10.4 K
T=295 K
(1 3 K,0)

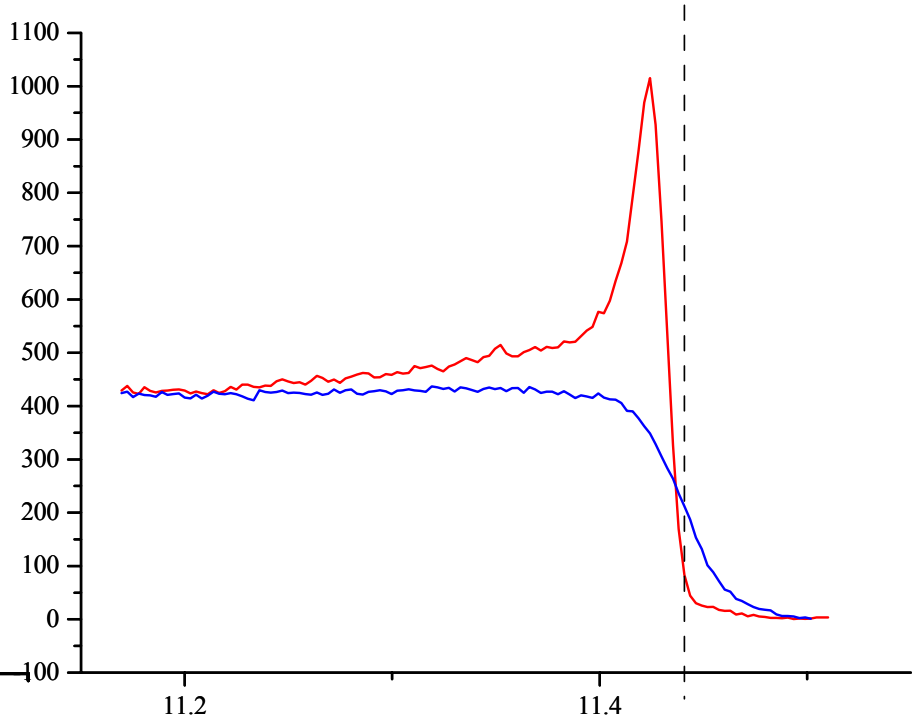

T=10.4 K
Energy (meV)

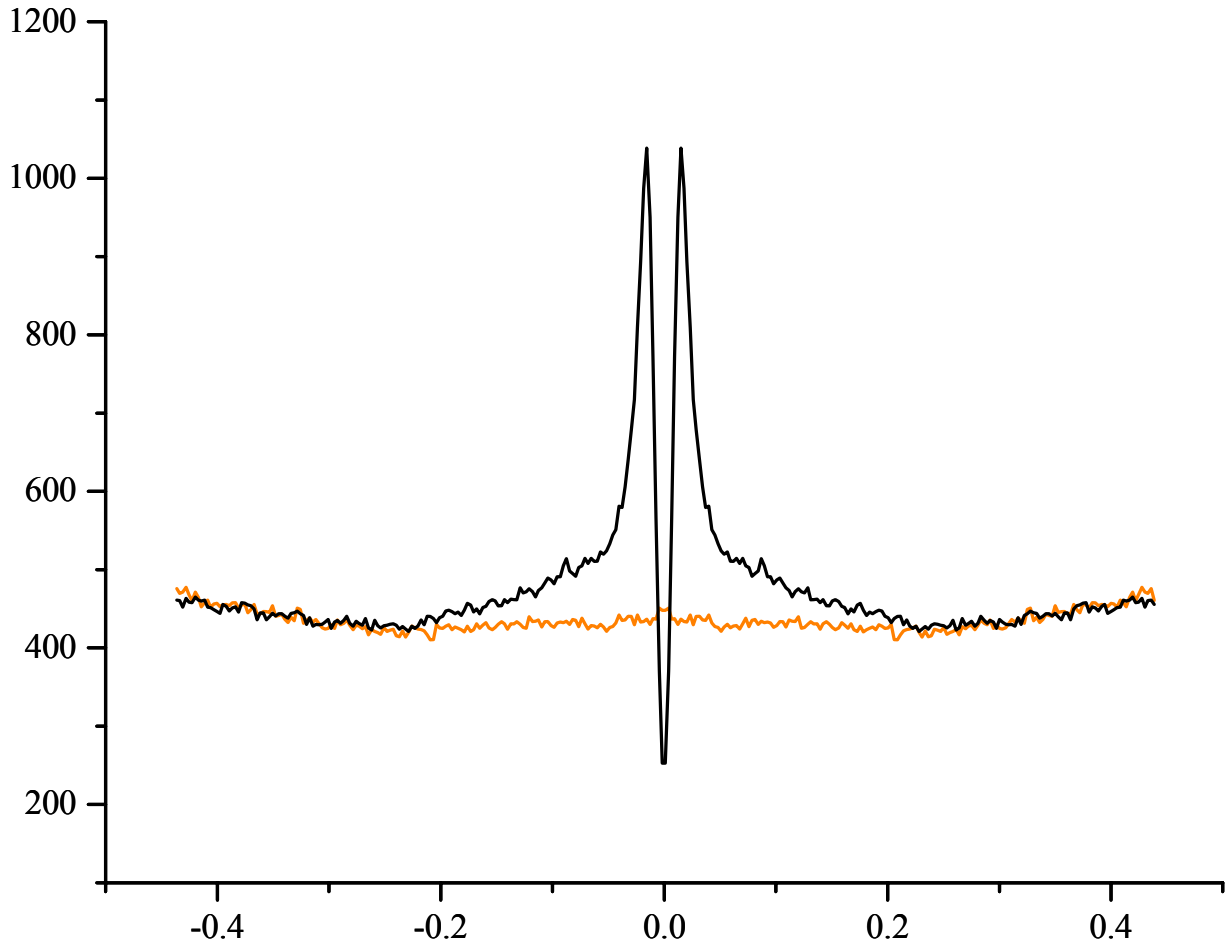

Z
Γ
X
Γ
Z
-6
-4
-2
0
2
4
6

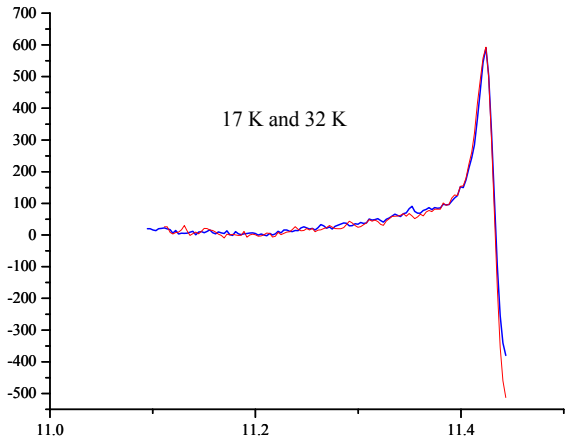


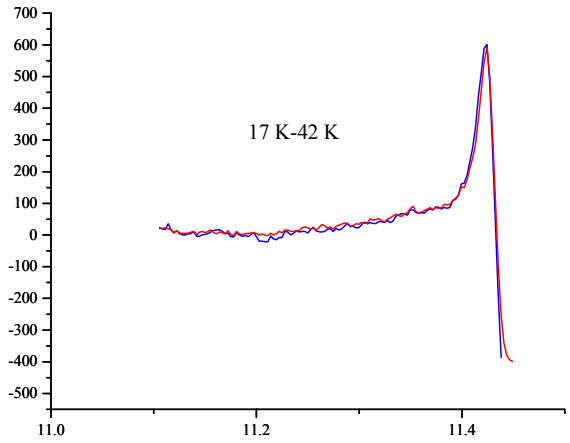


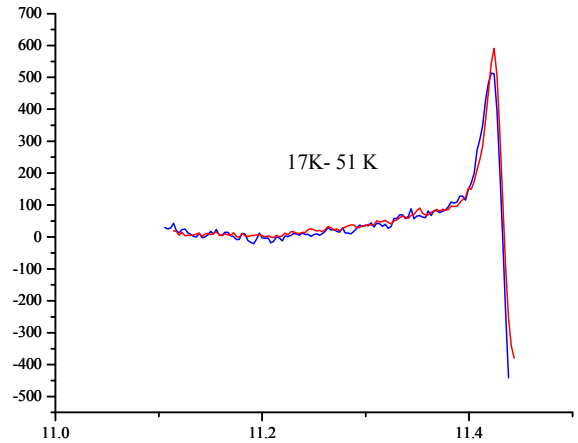

1100
1000
900
800
700
600
500
400
300
200
100
0
-100
-0.4
-0.2
0.0
0.2

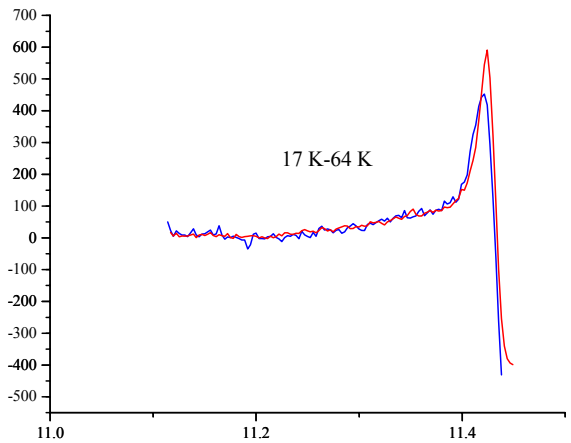

1100
1000
900
800
700
600
500
400
300
200
100
0
-100
11.2
11.4

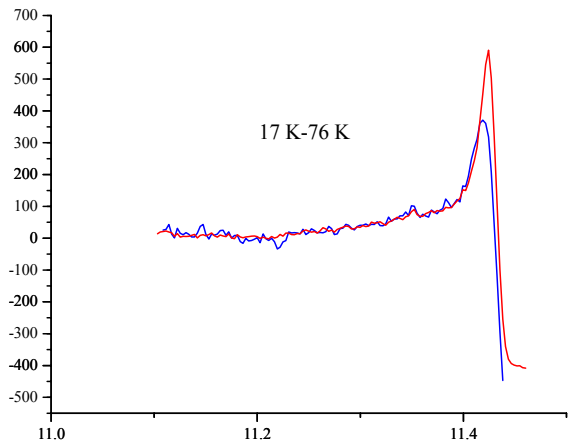

1200
1000
800
600
400
200
-0.4
-0.2
0.0
0.2
0.4

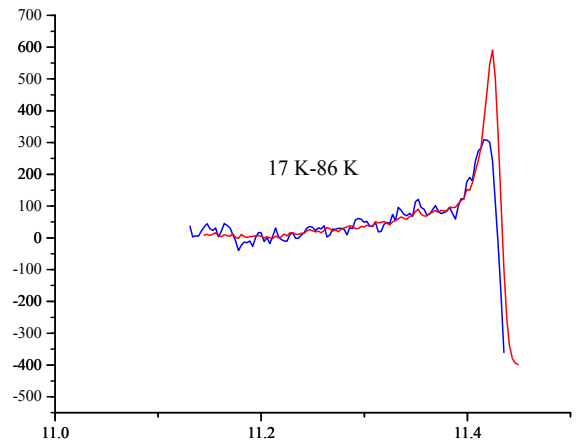

17 K and 32 K
700
600
500
400
300
200
100
0
-100
-200
-300
-400
-500
11.0
11.2
11.4

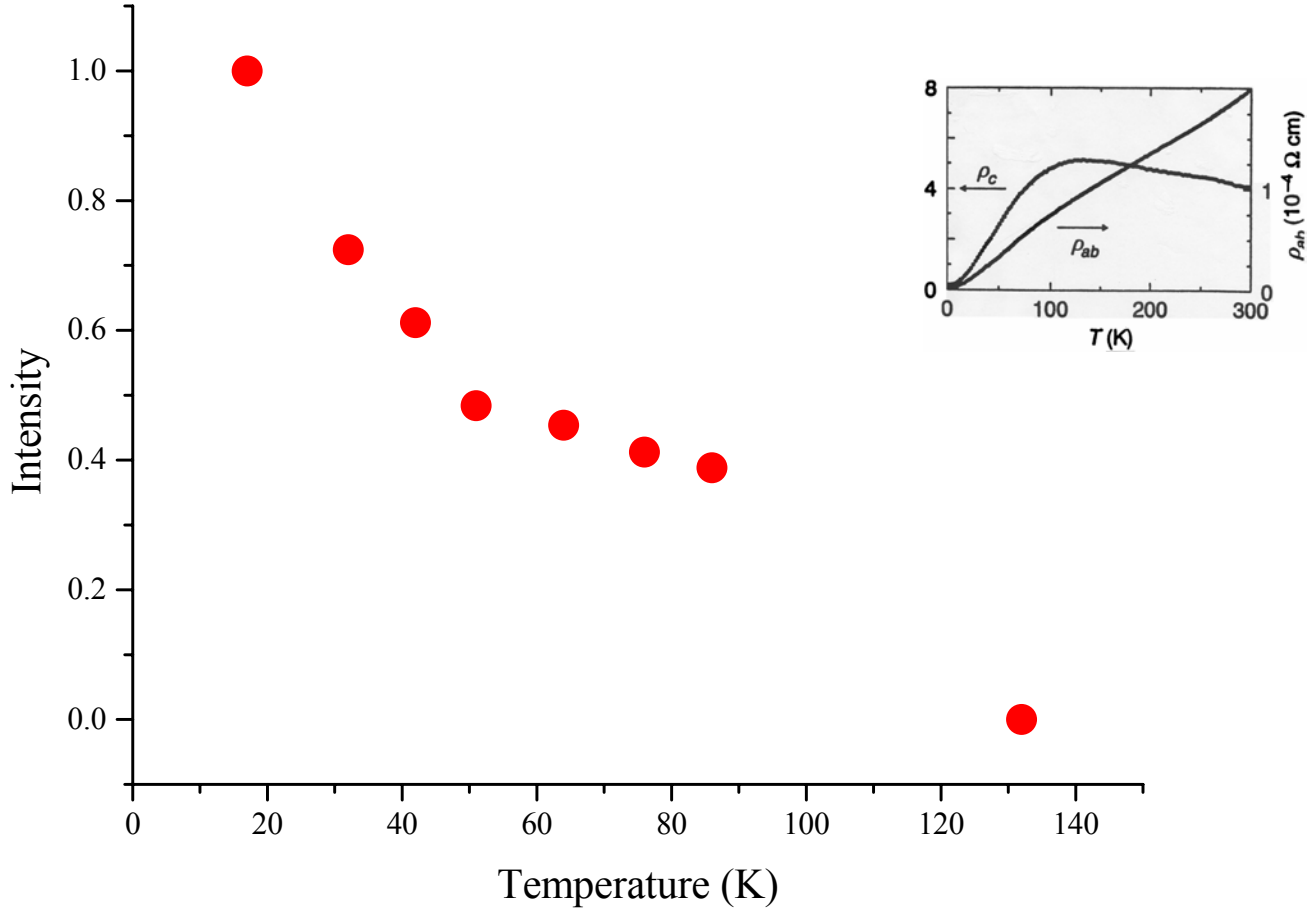

17 K-42 K
700
600
500
400
300
200
100
0
-100
-200
-300
-400
-500
11.0
11.2
11.4

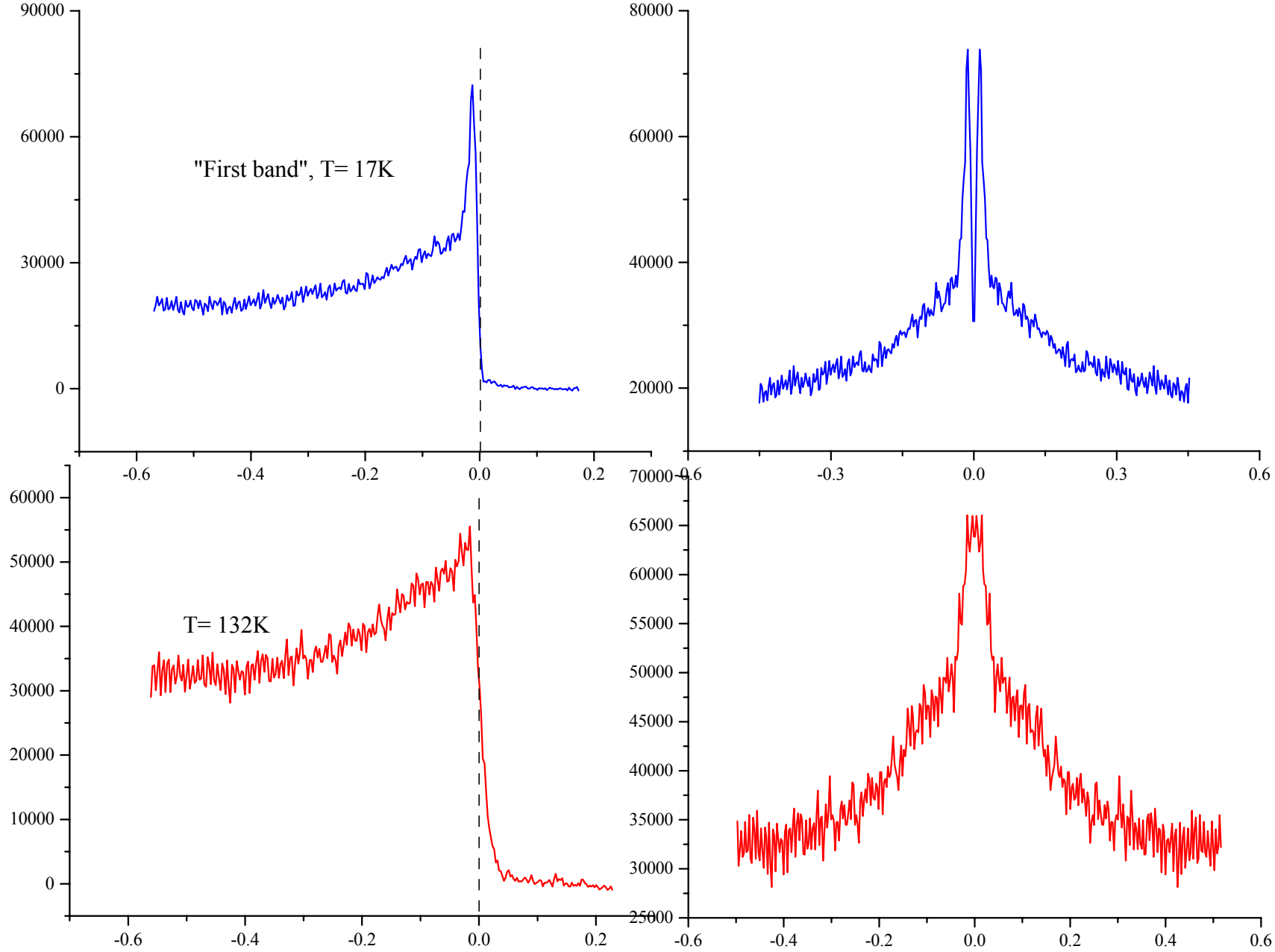

17K- 51 K
700
600
500
400
300
200
100
0
-100
-200
-300
-400
-500
11.0
11.2
11.4

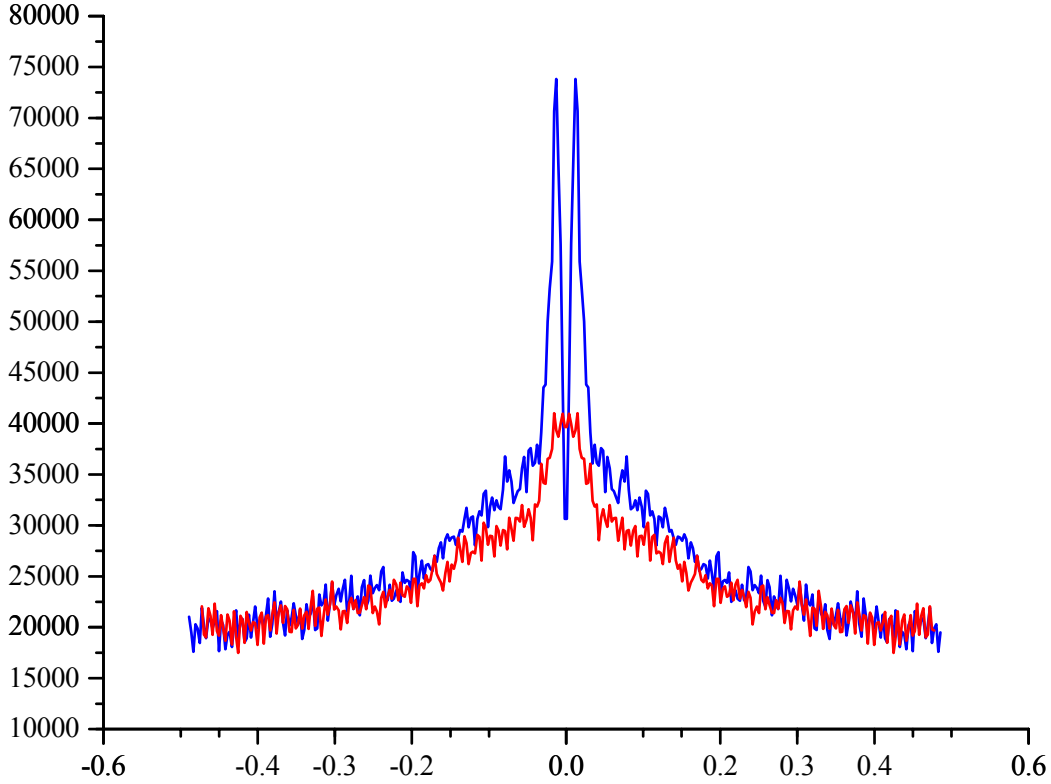

17 K-64 K
700
600
500
400
300
200
100
0
-100
-200
-300
-400
-500
11.0
11.2
11.4

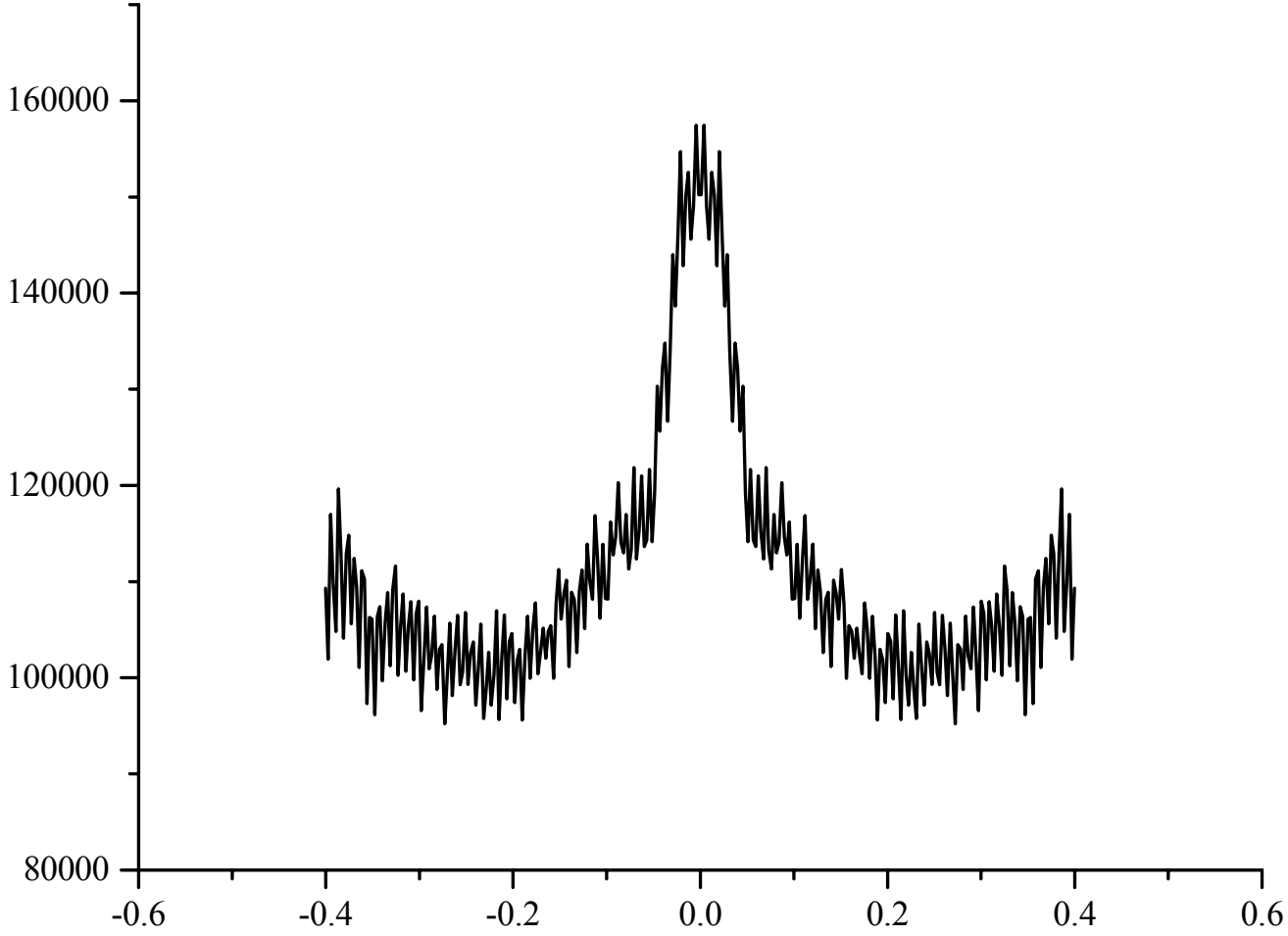

17 K-76 K
700
600
500
400
300
200
100
0
-100
-200
-300
-400
-500
11.0
11.2
11.4


17 K-86 K
700
600
500
400
300
200
100
0
-100
-200
-300
-400
-500
11.0
11.2
11.4


Intensity
1.0
0.8
0.6
0.4
0.2
0.0
0
20
40
60
80
100
120
140
Temperature (K)
8
4
0
0
100
200
300
T (K)
ρ_c
ρ_{ab}
1
0
ρ_{ab} (10^{-4} Ω cm)


"First band", T= 17K
T= 132K
90000
60000
30000
0
80000
60000
40000
20000
60000
50000
40000
30000
20000
10000
0
70000
65000
60000
55000
50000
45000
40000
35000
30000
25000
-0.6
-0.4
-0.2
0.0
0.2
-0.3
0.3
0.6
0.4


80000
75000
70000
65000
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
-0.6
-0.4
-0.3
-0.2
0.0
0.2
0.3
0.4
0.6


160000
140000
120000
100000
80000
-0.6
-0.4
-0.2
0.0
0.2
0.4
0.6