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SMR 1232 - 43

XII WORKSHOP ON
STRONGLY CORRELATED ELECTRON SYSTEMS

17 - 28 July 2000

MAGNETICALLY MEDIATED SUPERCONDUCTIVITY IN HEAVY FERMION SYSTEMS

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Superconductivity on the Border of Metallic Magnetism in Heavy Fermion Systems

Low Density of Holes in Narrow f Bands

MnSi :

Pfleiderer, McMullan, Julian & GGL (PRB **55** (1997) 8330)

Thompson, Fisk & GGL (Physica **B161** (1987) 317)

Sr_2Ru0_4 :

Julian *et al.* (Physica B **259-261** (1999) 928)
Mackenzie, Haselwimmer, Tyler & GGL
Mori, Nishizaki & Maeno (PRL **80** (1998) 161)

$CePd_2Si_2$, $CeIn_3$:

Mathur, Grosche, Julian, Freye, Walker, Haselwimmer & GGL (Nature **397** (1998) 39)

$CeNi_2Ge_2$:

Grosche, Agarwal *et al.*

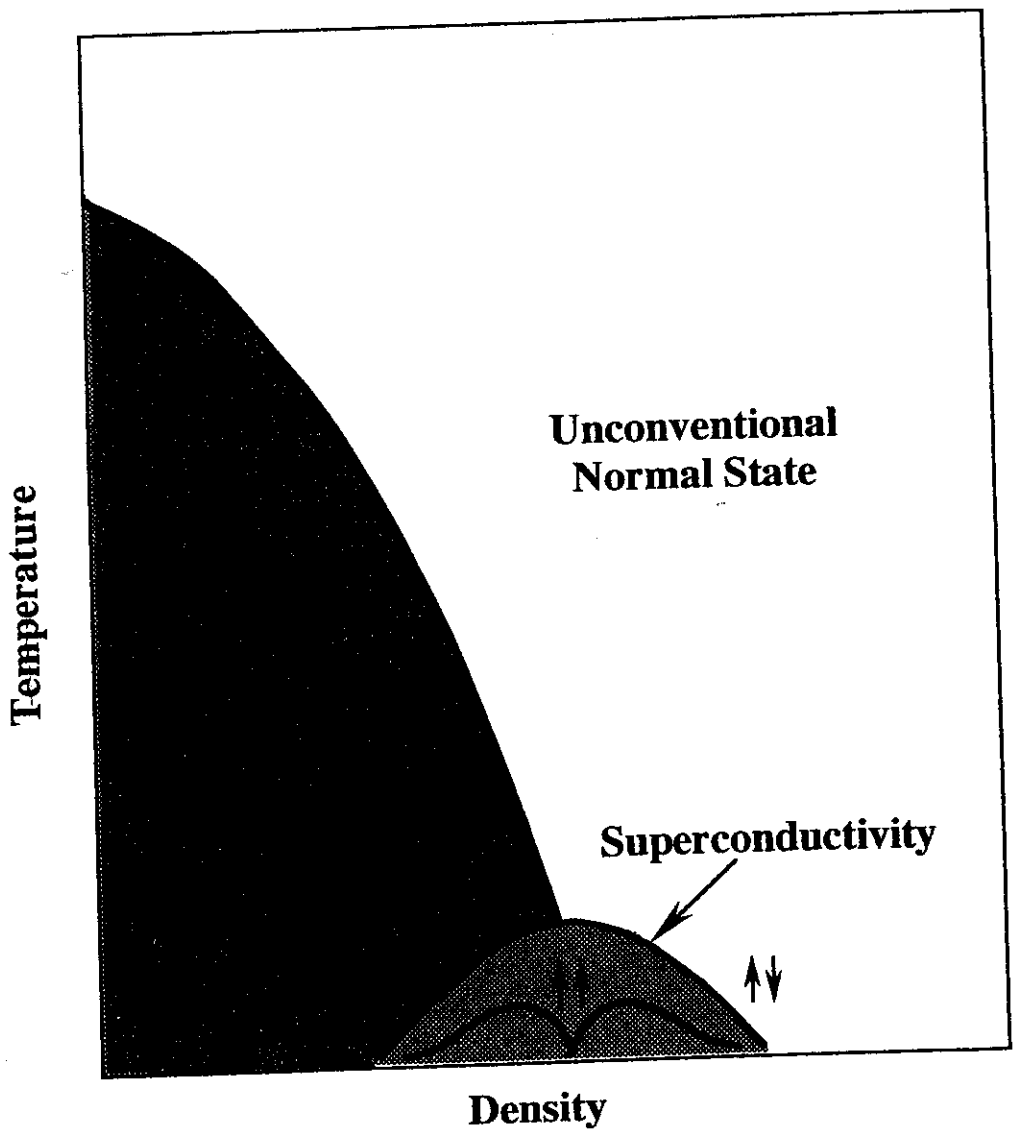
UGe_2 :

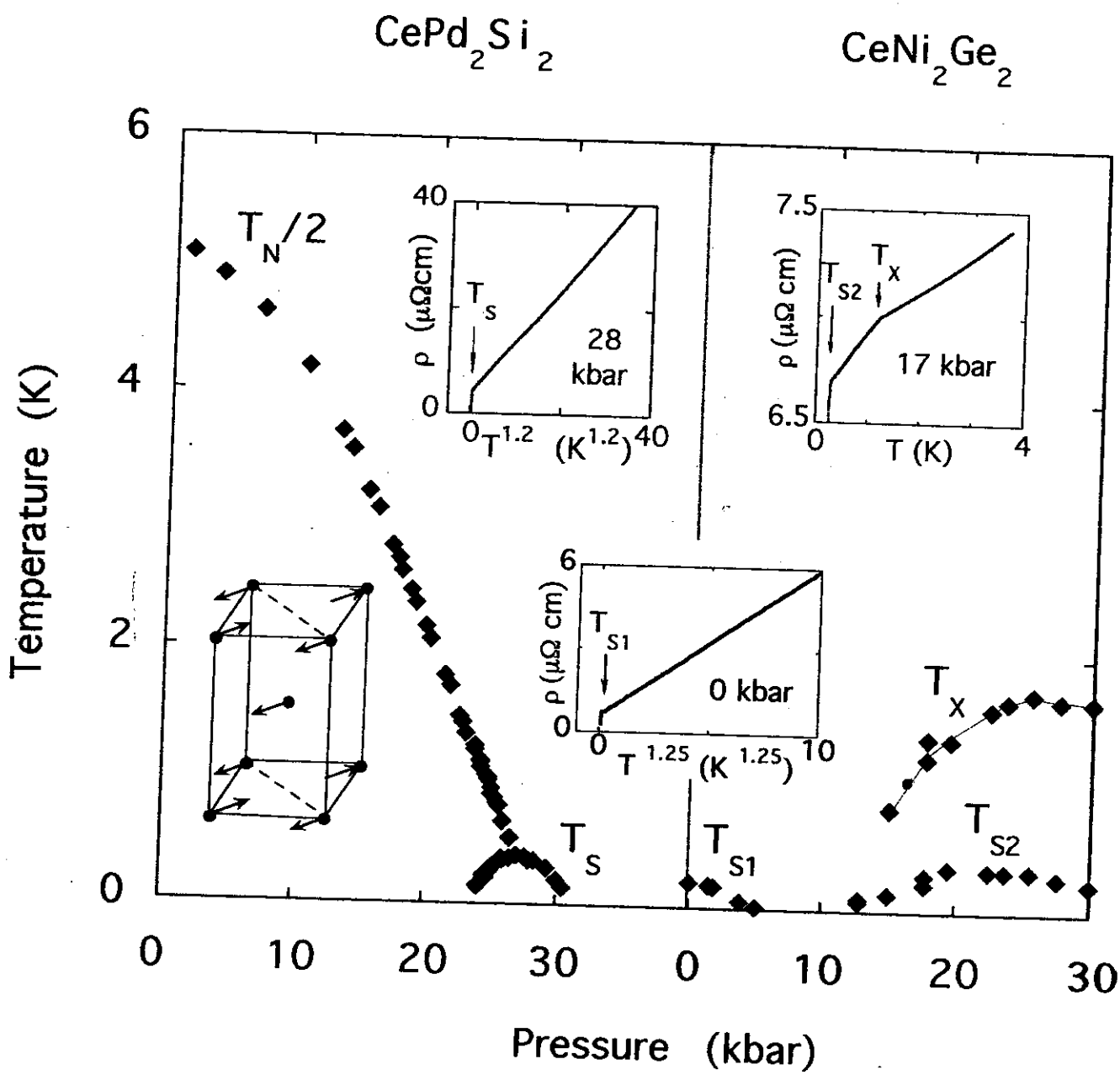
Saxena, Agarwal, Ahilan *et al.*; Huxley *et al.*
(to appear in Nature)

Discussions

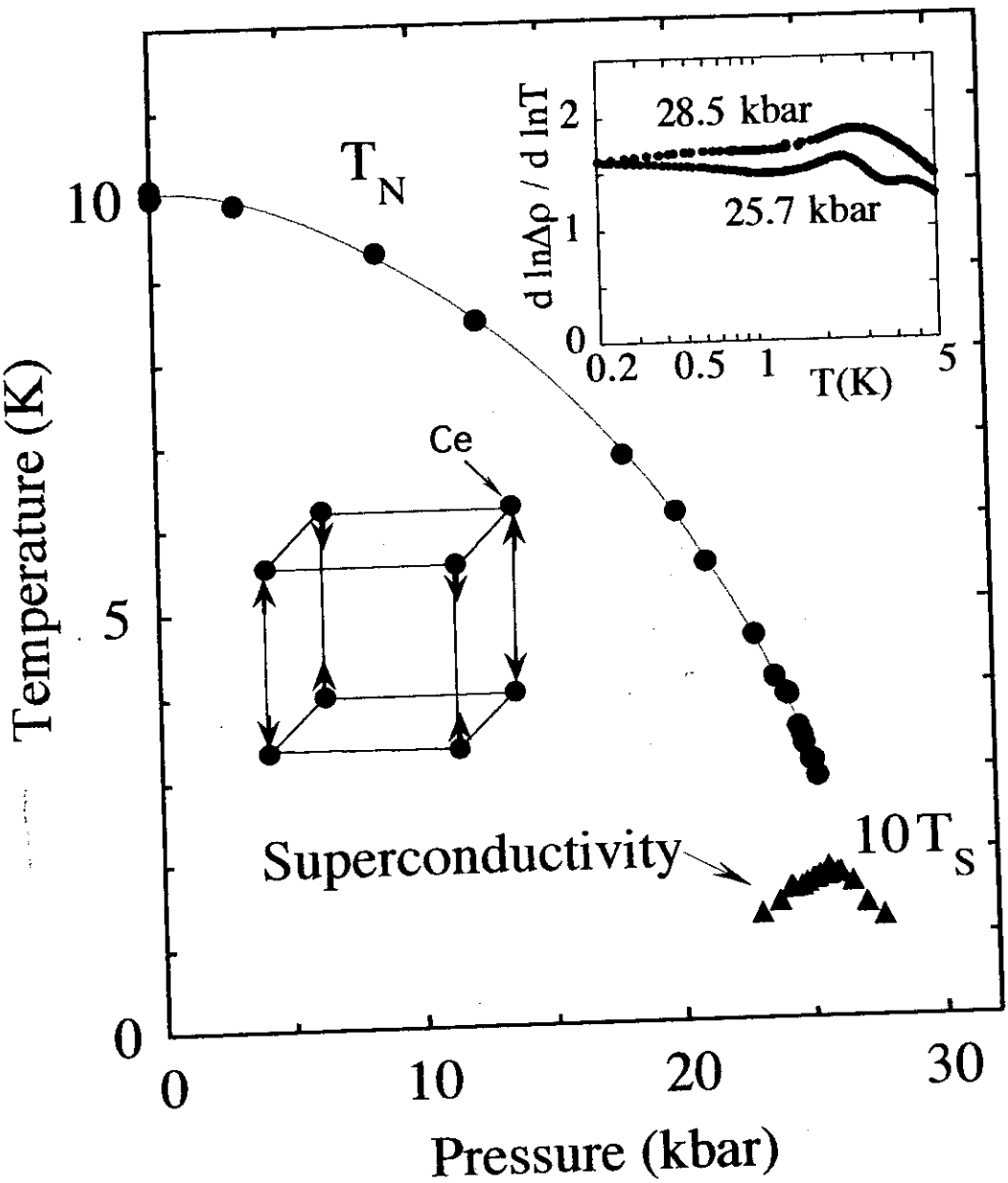
P Coleman
D Khemelnitskii
P Littlewood
A J Millis
P Monthoux
A J Schofield
B Simons
A Tsvelik

Magnetically Mediated Superconductivity



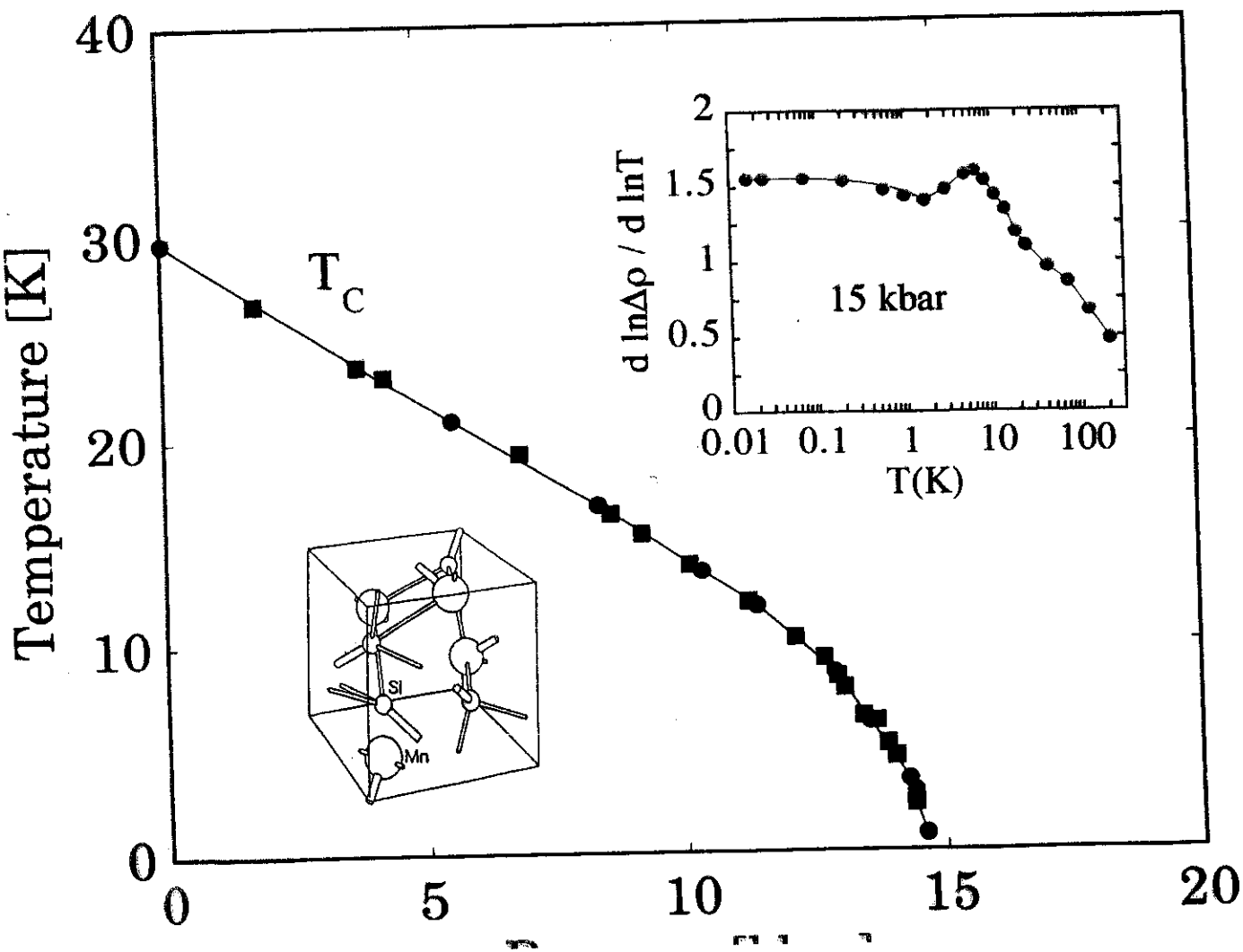

CePd2Si2
CeNi2Ge2
Temperature (K)
Pressure (kbar)
TN/2
TS
TS1
TS2
TX
28 kbar
17 kbar
0 kbar
ρ (μΩcm)
ρ (μΩ cm)
T1.2 (K1.2)
T (K)
T 1.25 (K 1.25)

$CeIn_3$

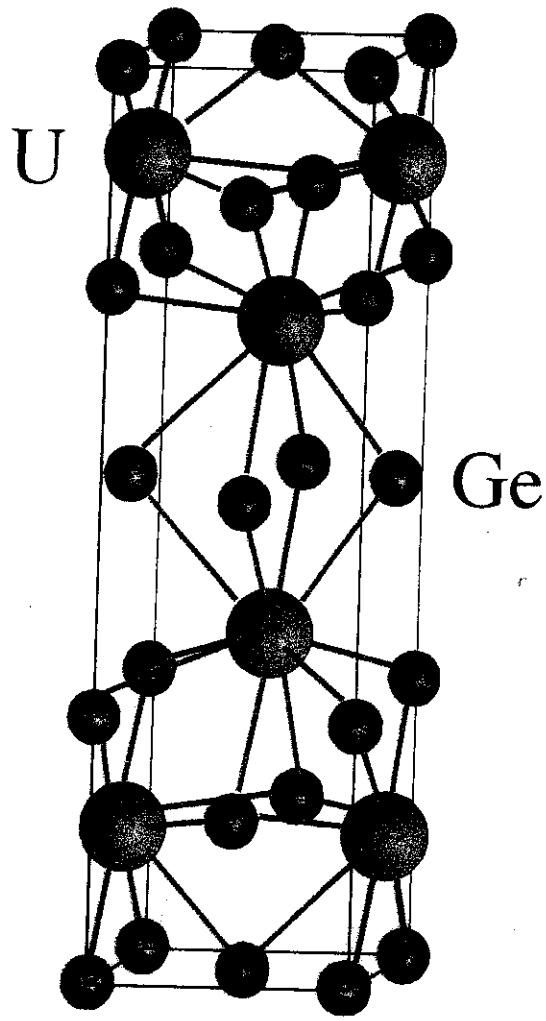

Temperature (K)
Pressure (kbar)
T_N
10
5
0
0
10
20
30
Ce
Superconductivity
$10\,T_S$
d lnΔρ / d lnT
28.5 kbar
25.7 kbar
2
1
0
0.2
0.5
1
5
T(K)

$CeCu_2Si_2$	Steglich et al.
$CeCu_2Ge_2$	Jaccard et al.
$CeRh_2Si_2$	Movshovich et al.
$CeCu_2$	Jaccard et al.
$CeRhIn_5$, $CeIrIn_5$	Los Alamos

MnSi

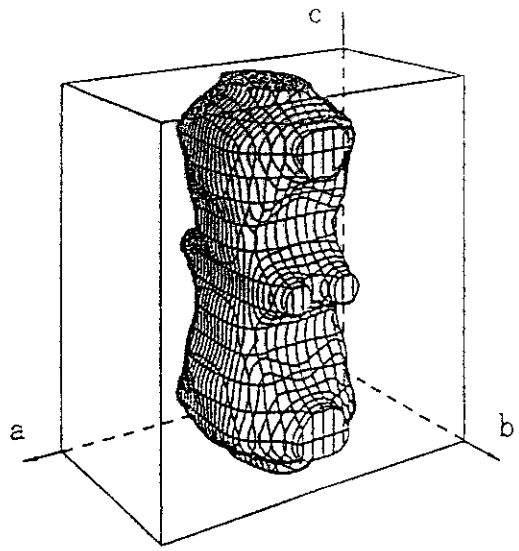

Temperature [K]
40
30
20
10
0
0
5
10
15
20
T_C
d lnΔρ / d lnT
2
1.5
1
0.5
0
15 kbar
0.01
0.1
1
10
100
T(K)
Si
Mn

UGe_2

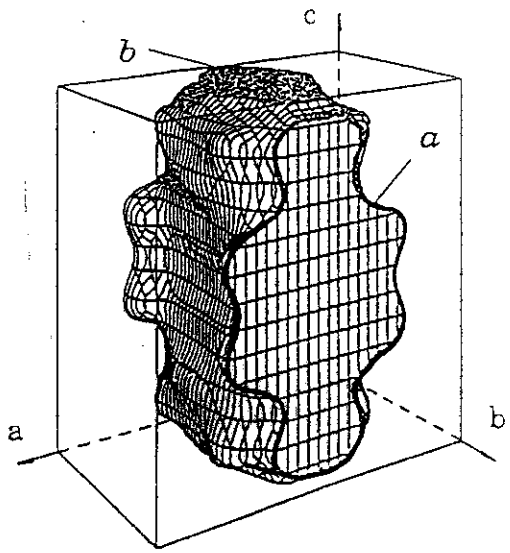


See e.g., Menovsky et al. in High Field Magnetism
(Ed. Date, North-Holland, 1983)

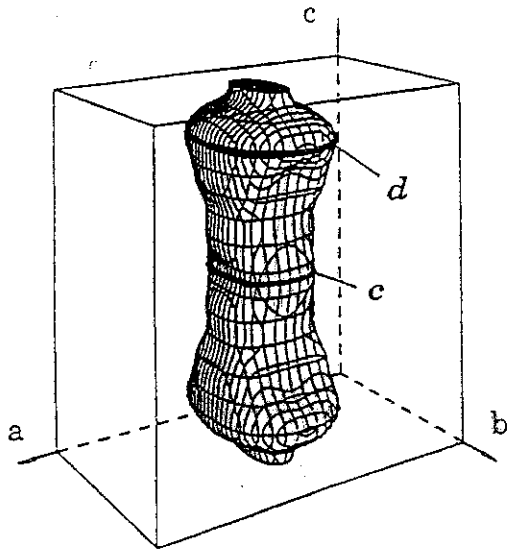
UGe_2: Spin Splitting of Electron Sheet of the Fermi Surface



Paramagnetic State



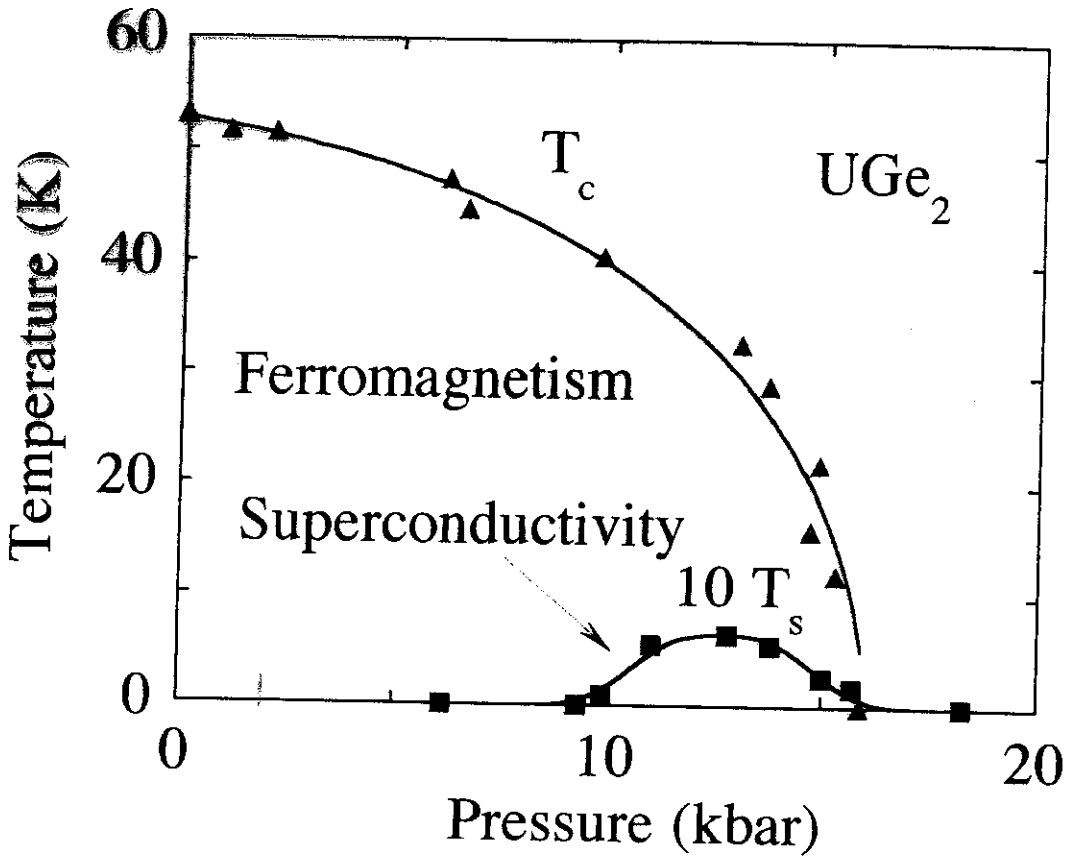
Majority Spin

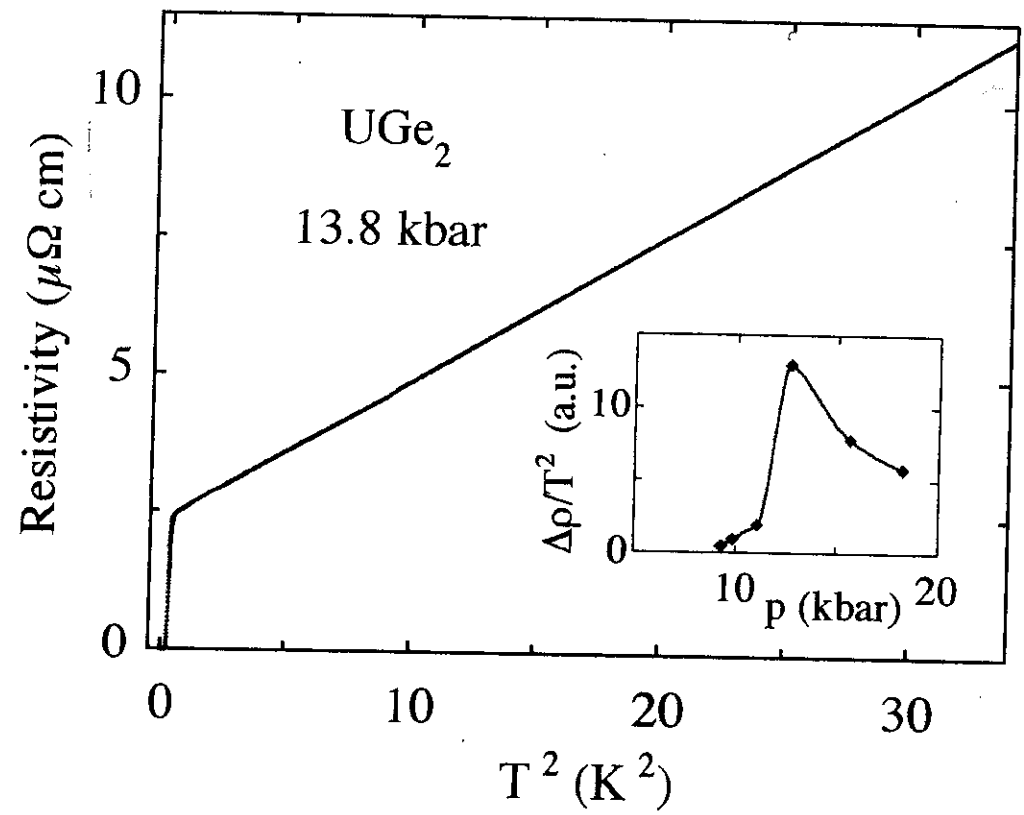


Minority Spin

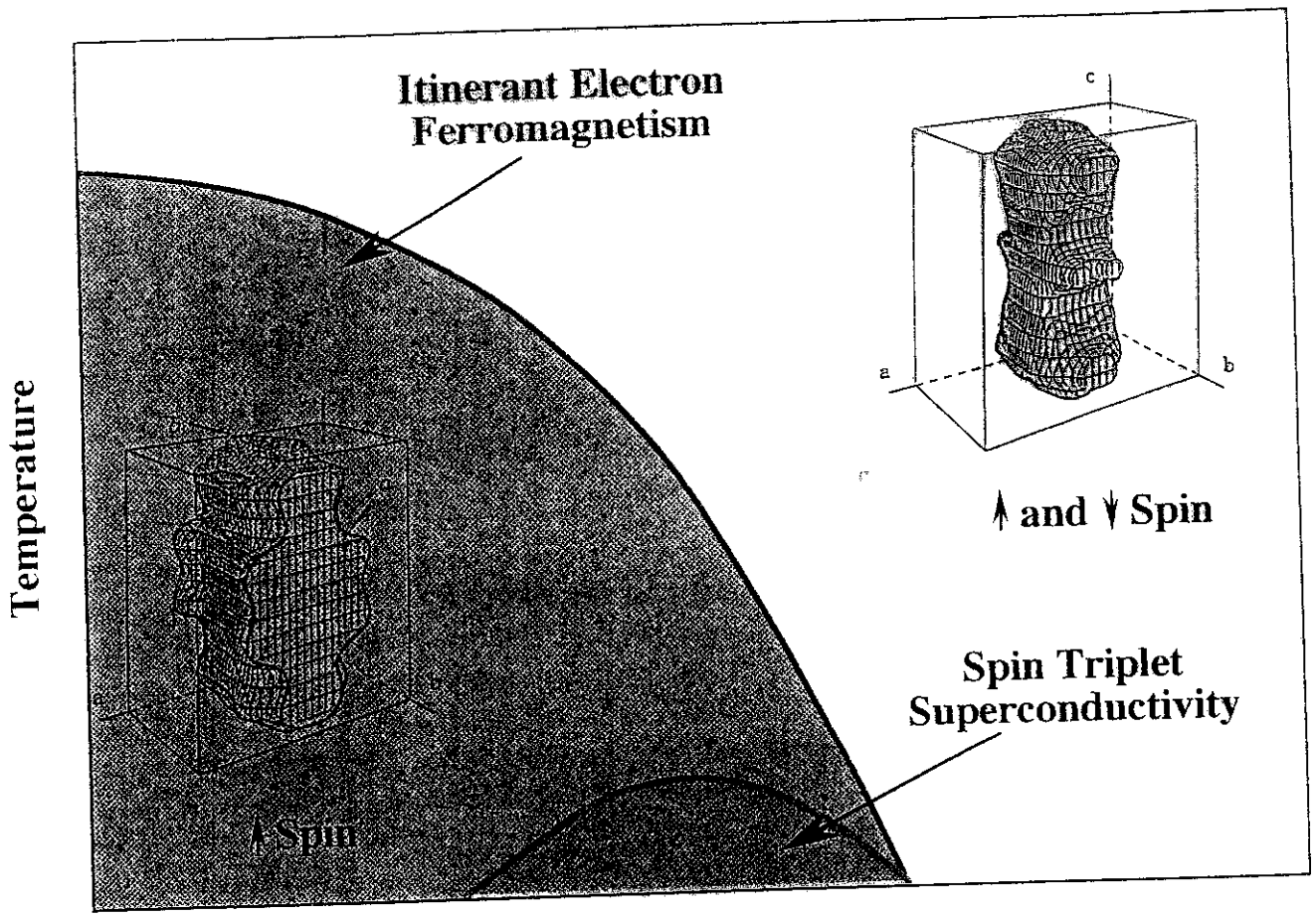
Ferromagnetic State

After Yamagani *et al.*, Physica B 1993
and Satoh *et al.*, JPS Japan 1992


60
40
20
0
Temperature (K)
T_c
UGe_2
Ferromagnetism
Superconductivity
10 T_s
0
10
20
Pressure (kbar)


10
5
0
Resistivity ($\mu\Omega$ cm)
UGe_2
13.8 kbar
$\Delta\rho/T^2$ (a.u.)
10
0
10
p (kbar)
20
0
10
20
30
T^2 (K^2)

UGe_2 : Possible Effect of the Electron Sheet of the Fermi Surface



Conclusions

Superconductivity is predicted and observed on the border of magnetic order when

- **the magnetic transition is continuous**
- **the mean free path exceeds the superconducting coherence length**
- **the crystal has inversion symmetry (in the case of ferromagnetism)**