Short range order and criticality …?

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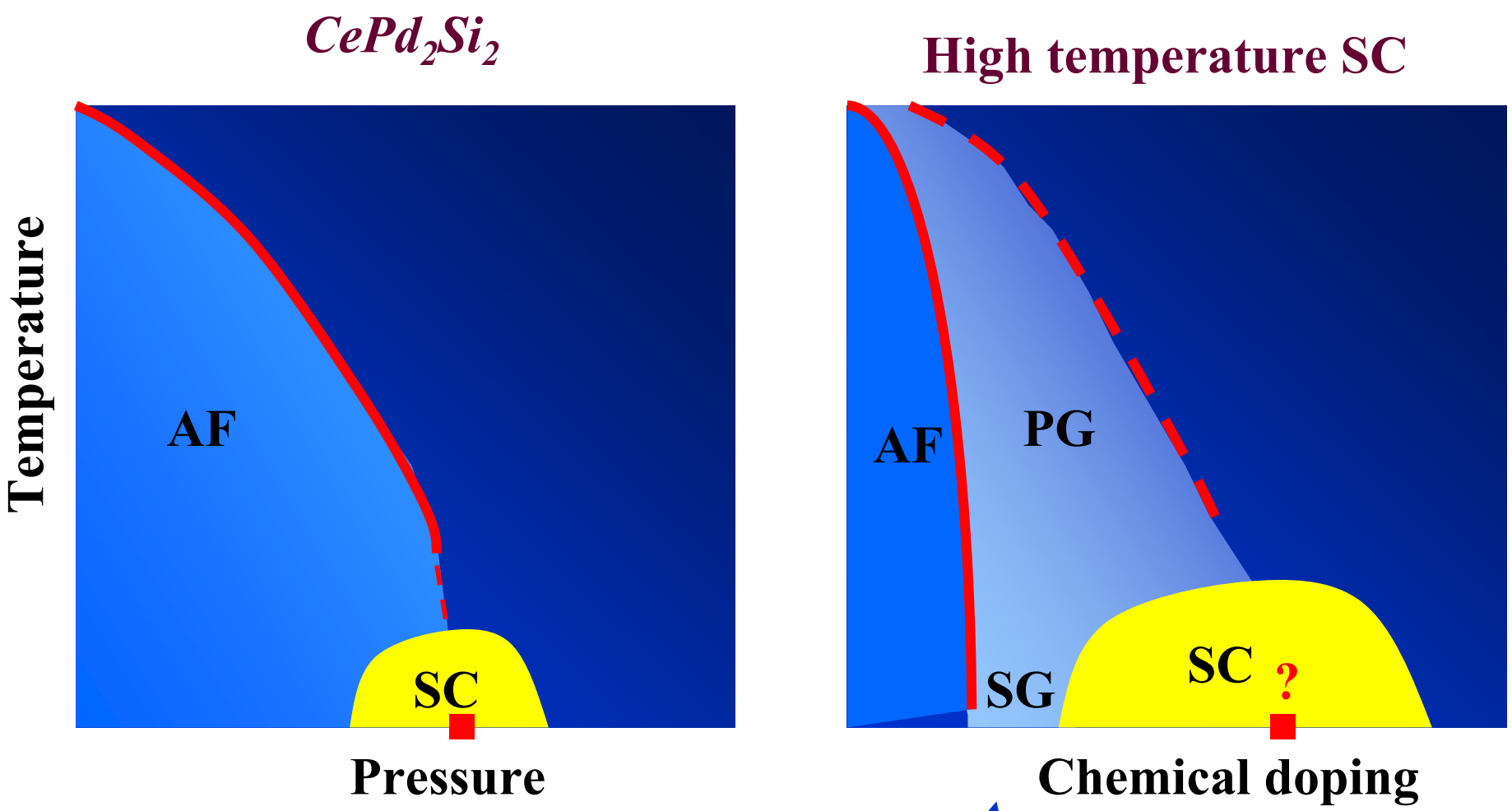
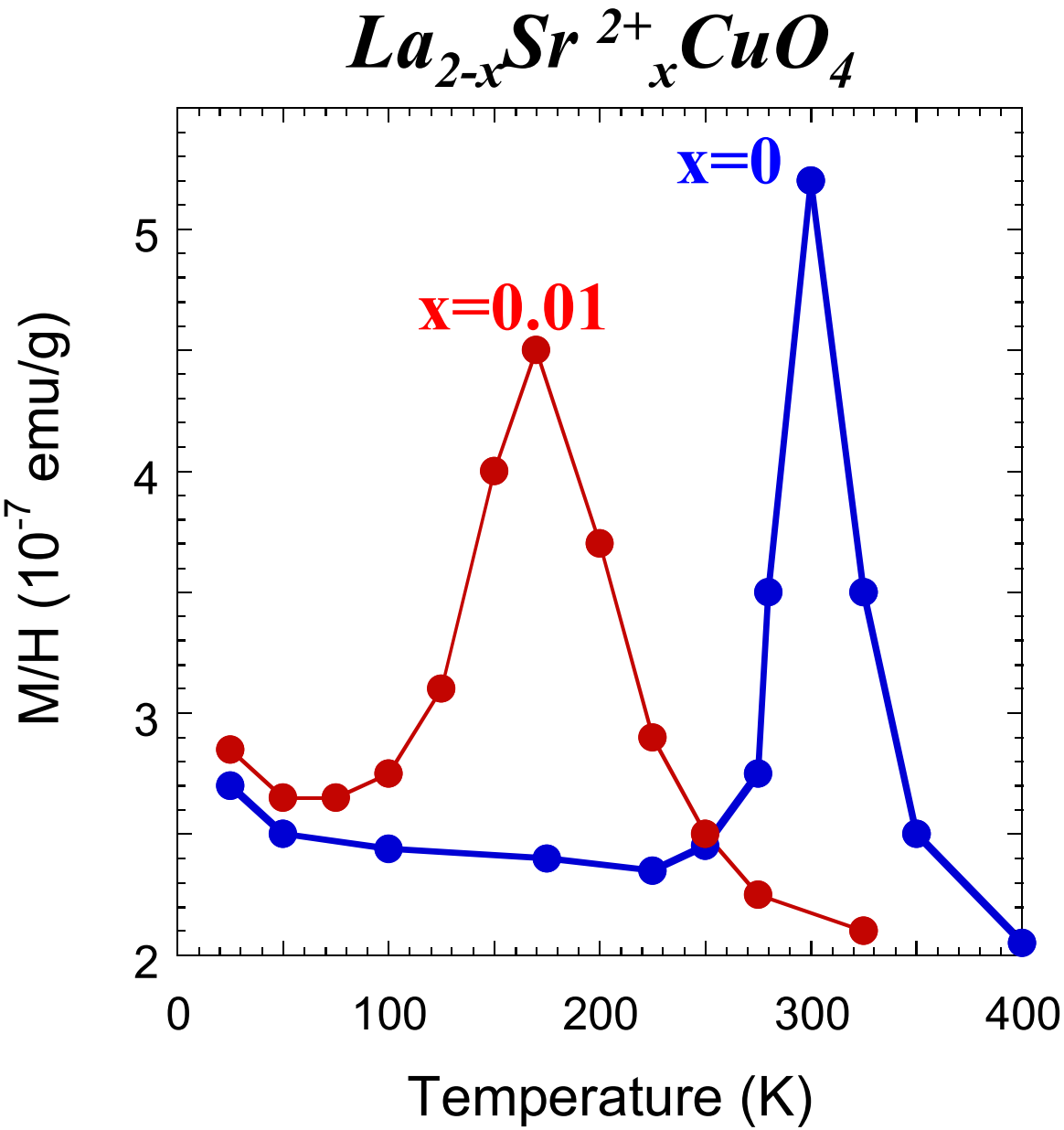
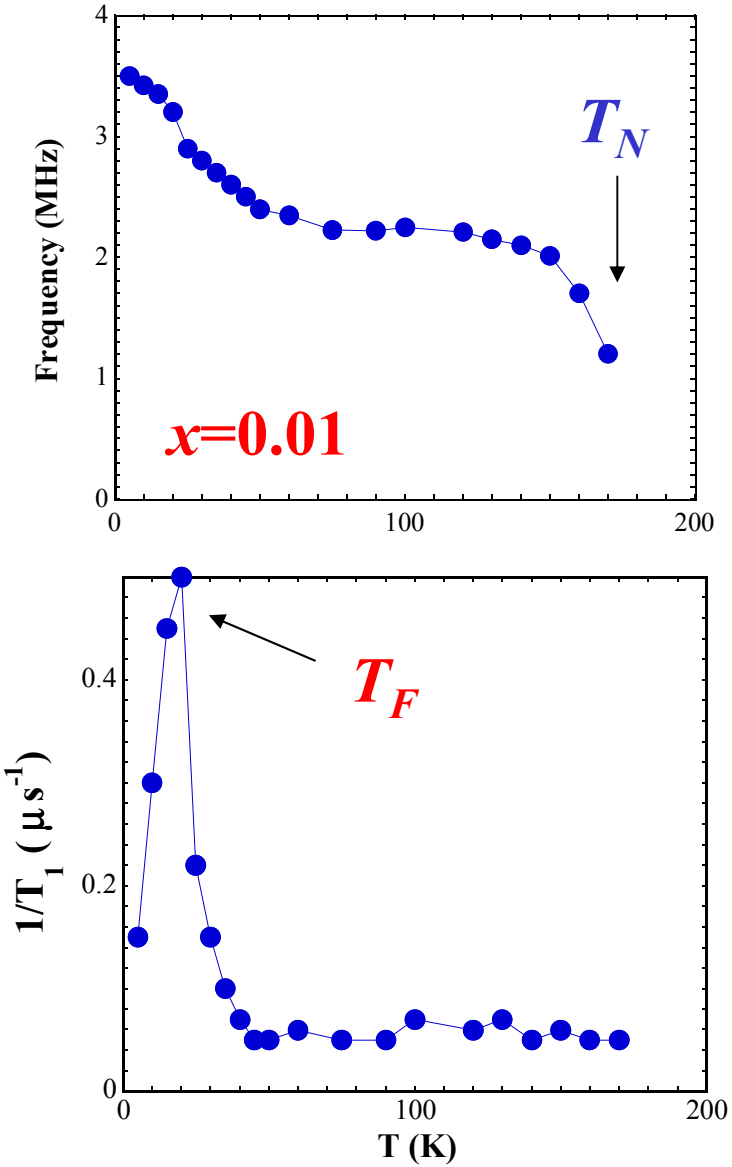
ISIS


$CePd_2Si_2$
High temperature SC
Temperature
AF
SC
AF
PG
SG
SC
?
Pressure
Chemical doping
Stochiometric vs. chemically disordered alloys

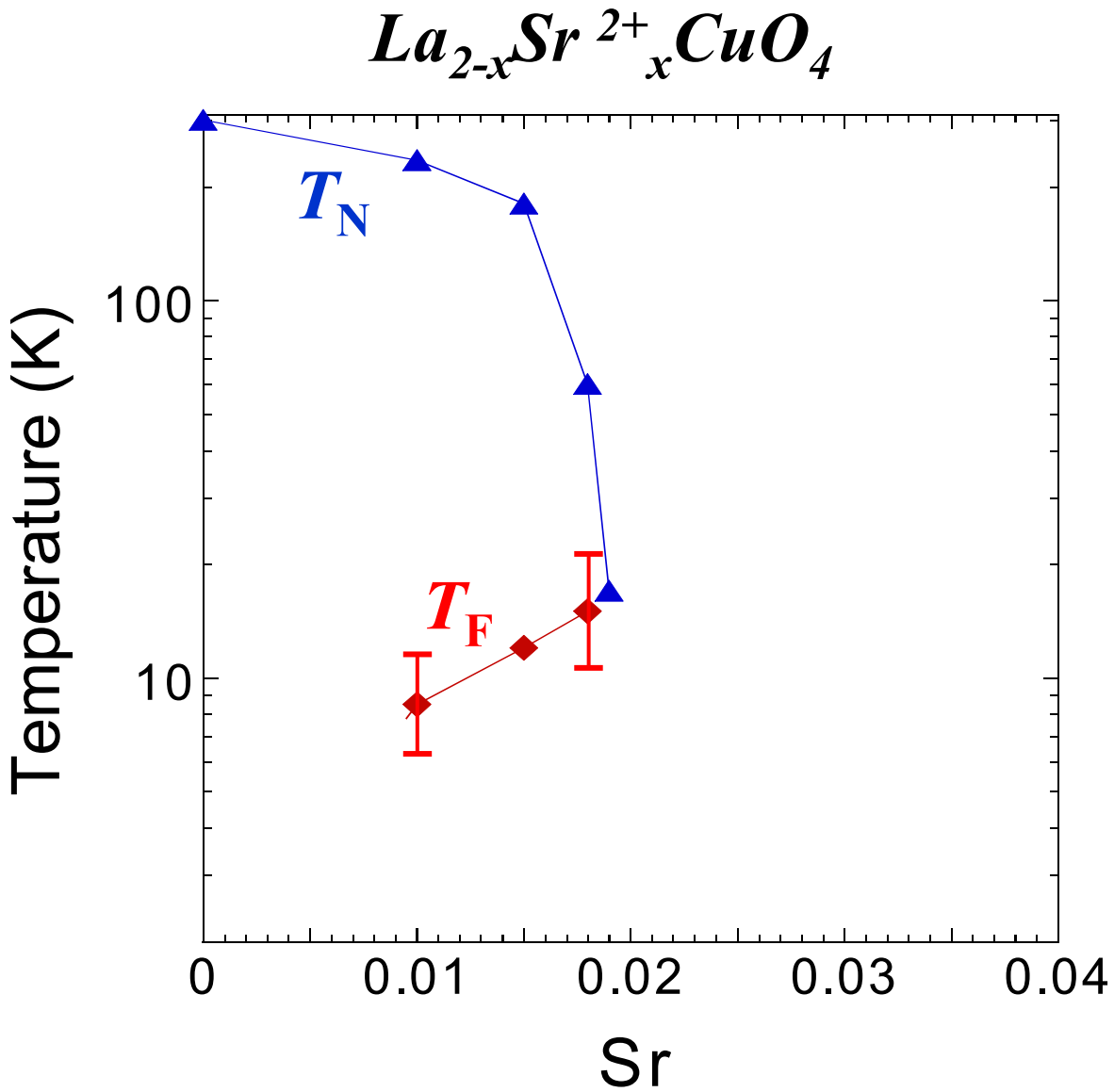

$La_{2-x}Sr^{2+}_{x}CuO_4$
x=0
x=0.01
M/H (10^{-7} emu/g)
5
4
3
2
0
100
200
300
400
Temperature (K)

An upturn of the muon spin precession freq. below T_N and a peak in the longt. relax. rate indicate a second freezing transition at lower temp.



C.P. *et al*., Solid State Comm. 126, 47 '03

Eds Y.J. Uemura & A.J. Millis



C.P. *et al*., Solid State Comm. 126, 47 '03

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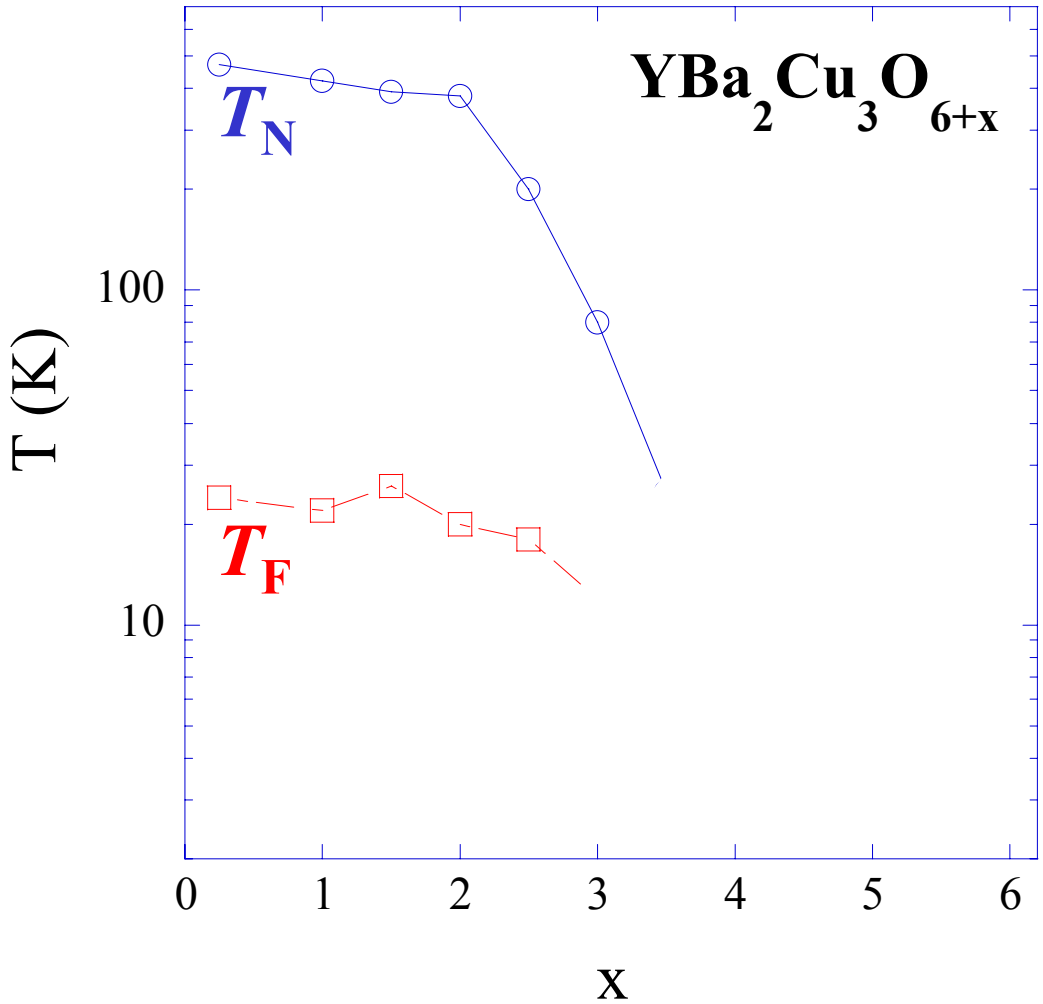
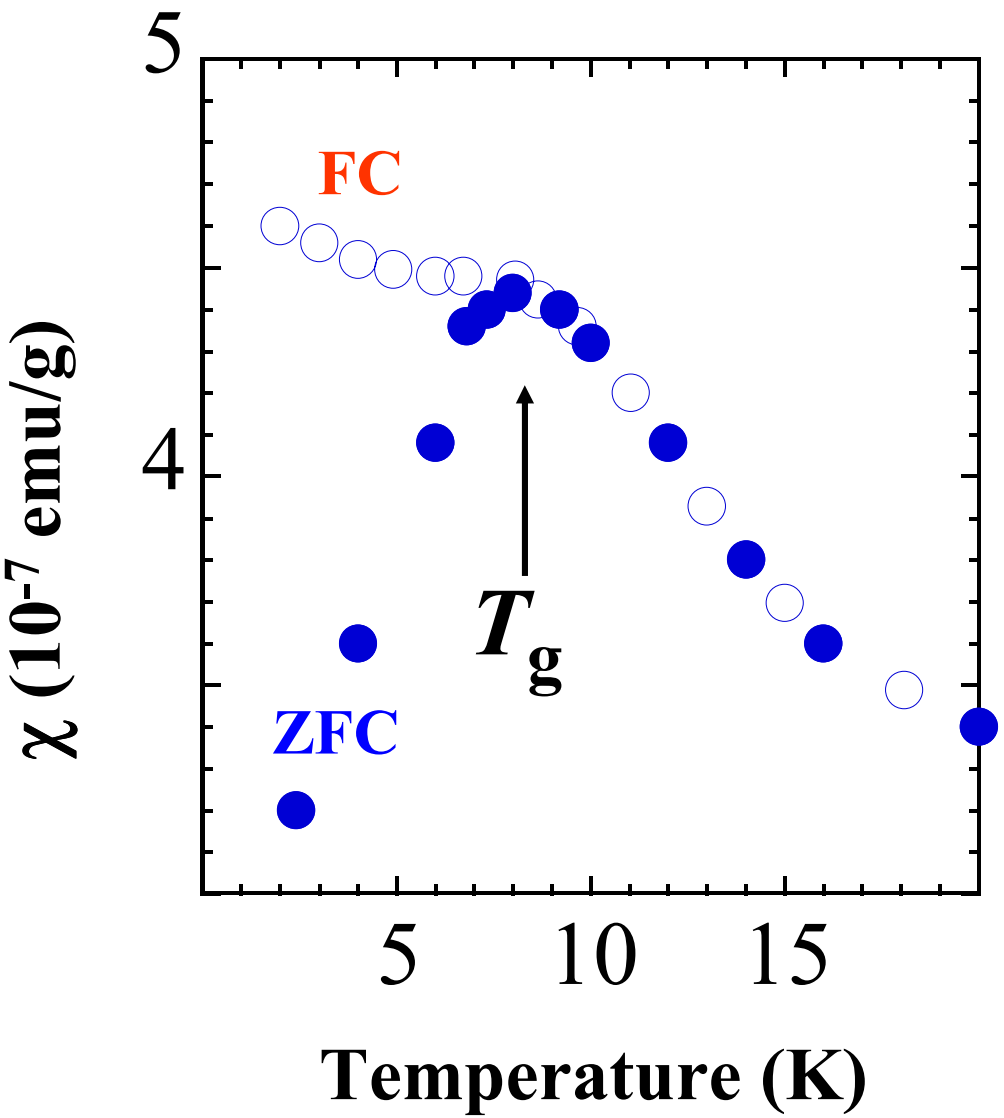


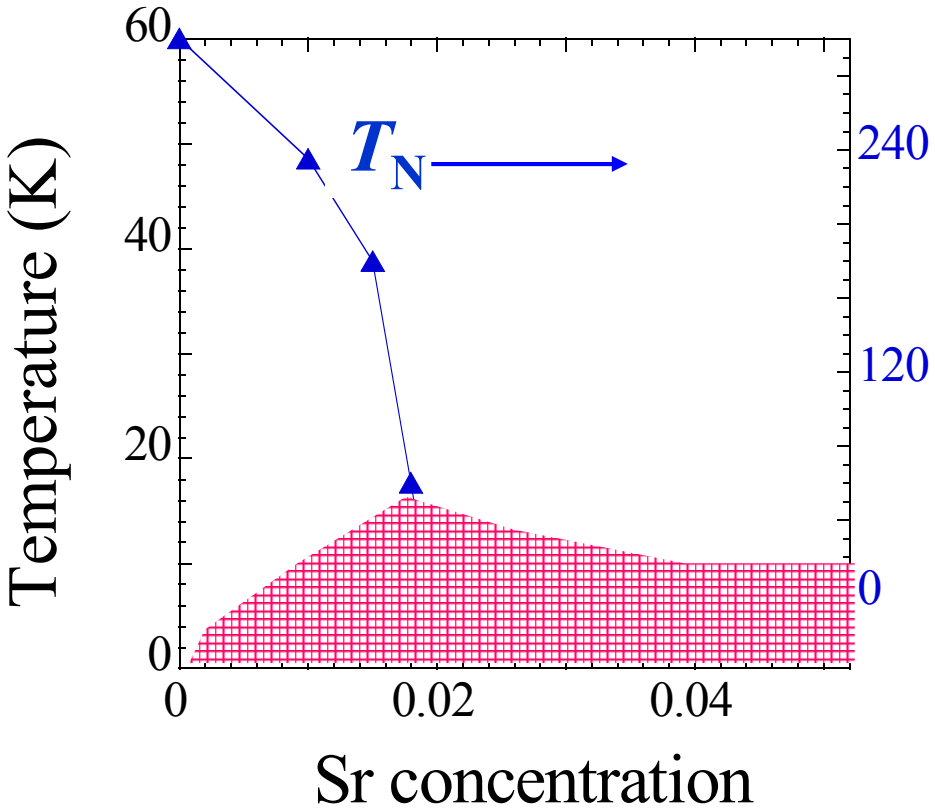
S. Sanna *et al.* Phys. Rev. Lett '04

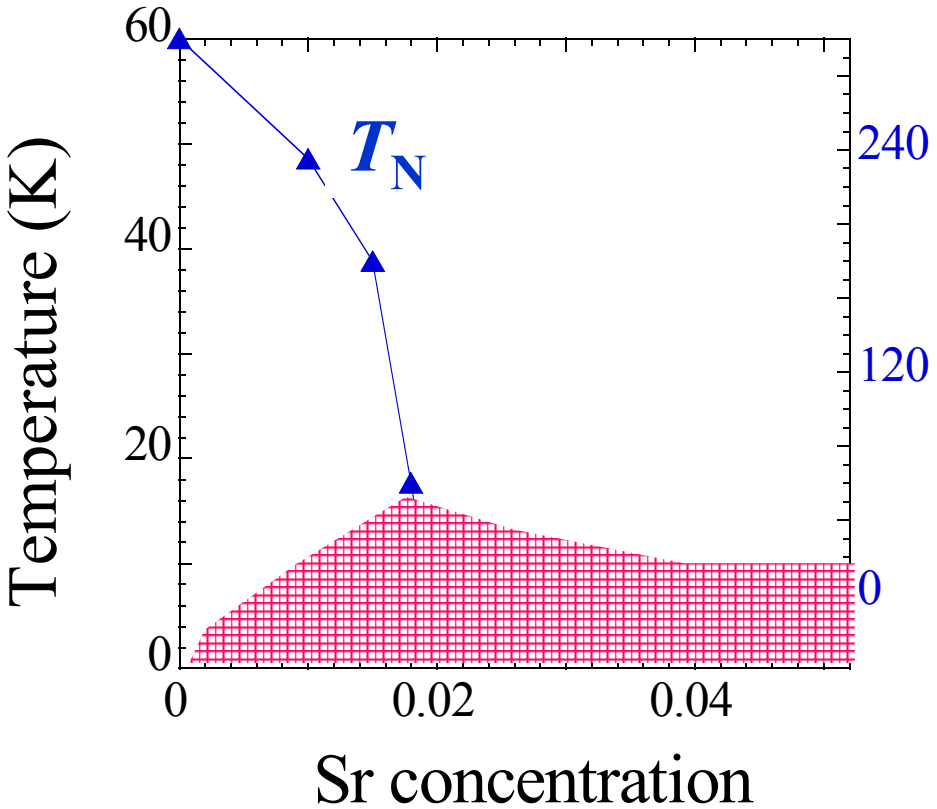
$La_{2-x}Sr_xCuO_4$ $x=0.03$



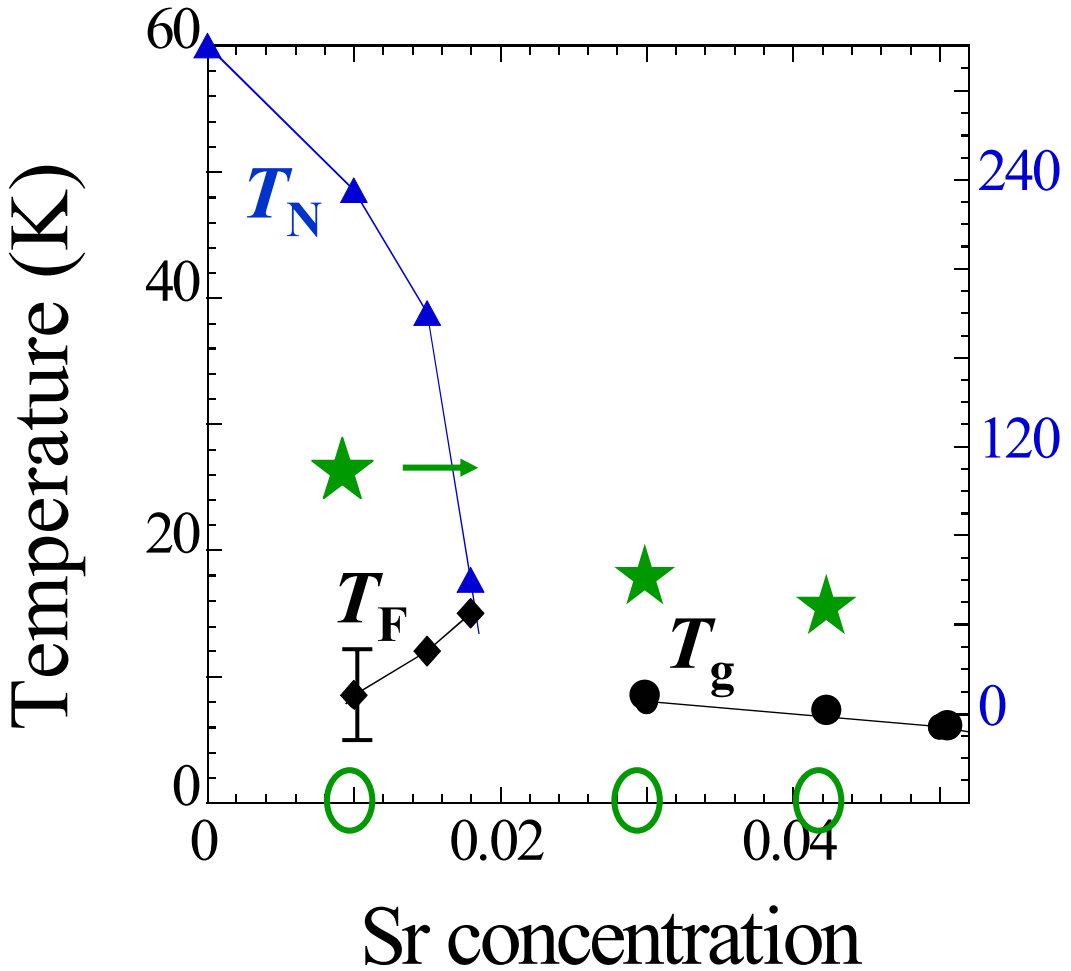
C.P. and V. Dobrosavljevic, cond-mat/0410111

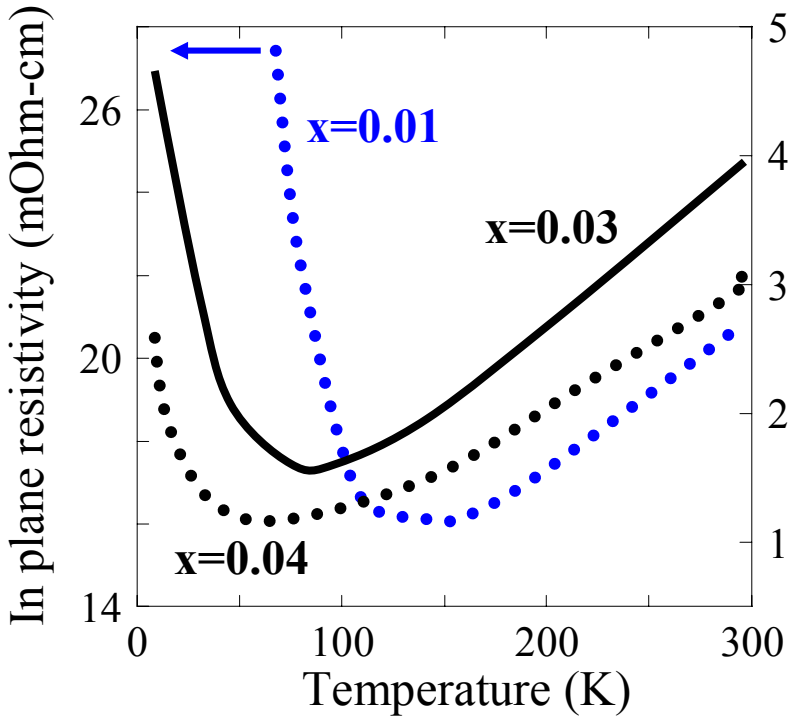
Immediate generation of a Glassy State with the first added carriers





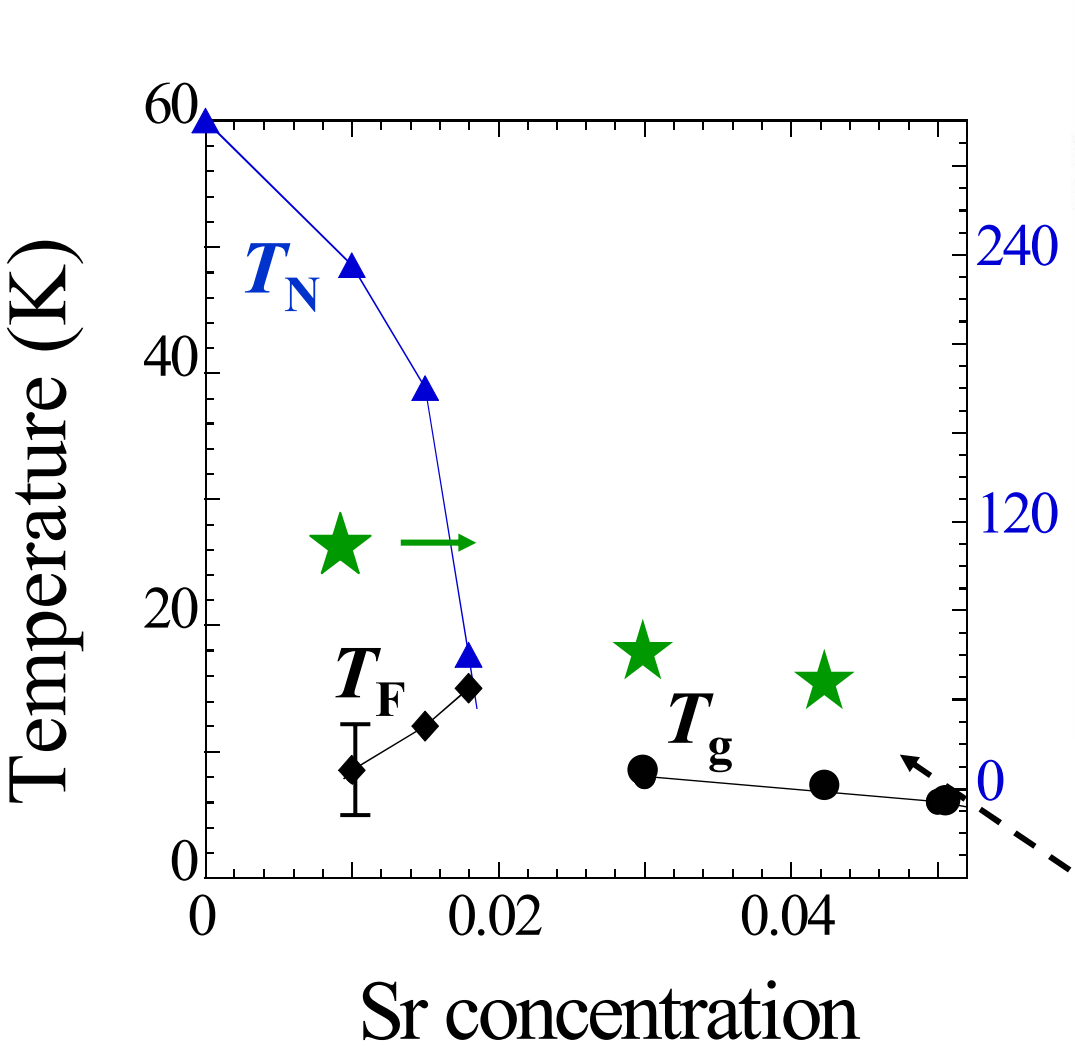
Is there a trend in the correlation between glassiness and charge transport … ?

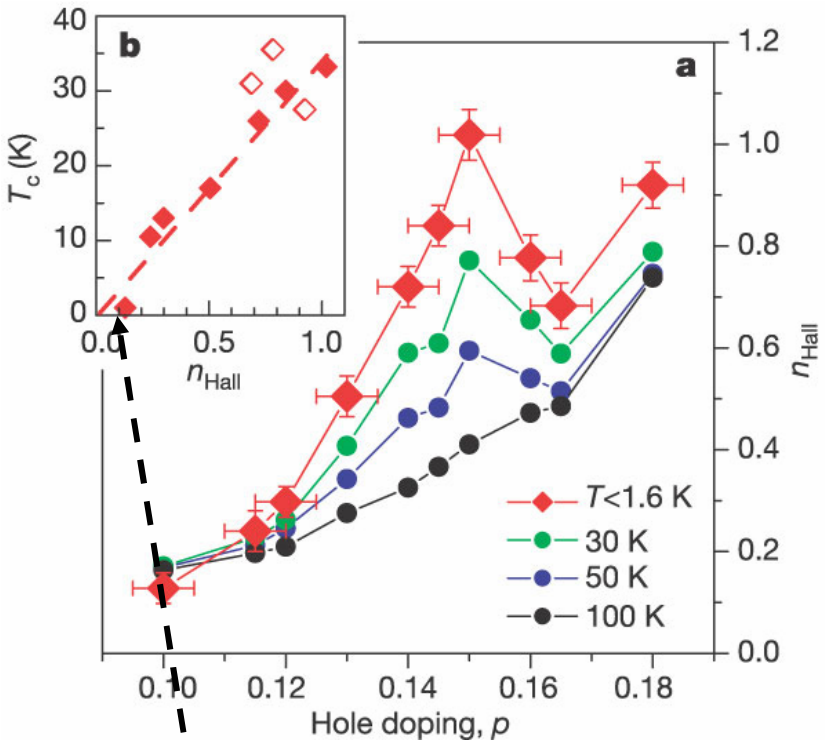




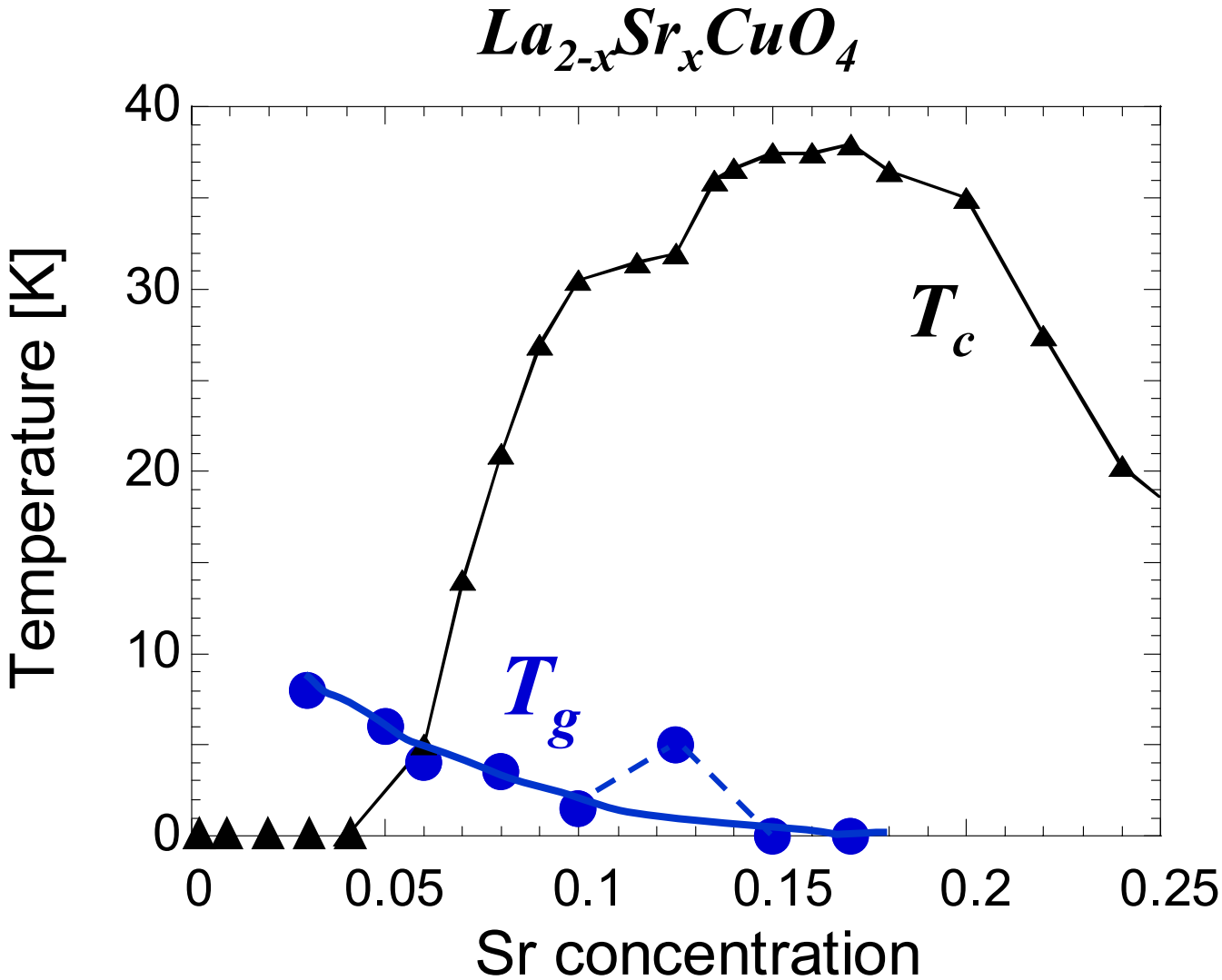
C.P. and V. Dobrosavljevic, cond-mat/0410111

F. Balakirev et al., Nature 424, 912 '03





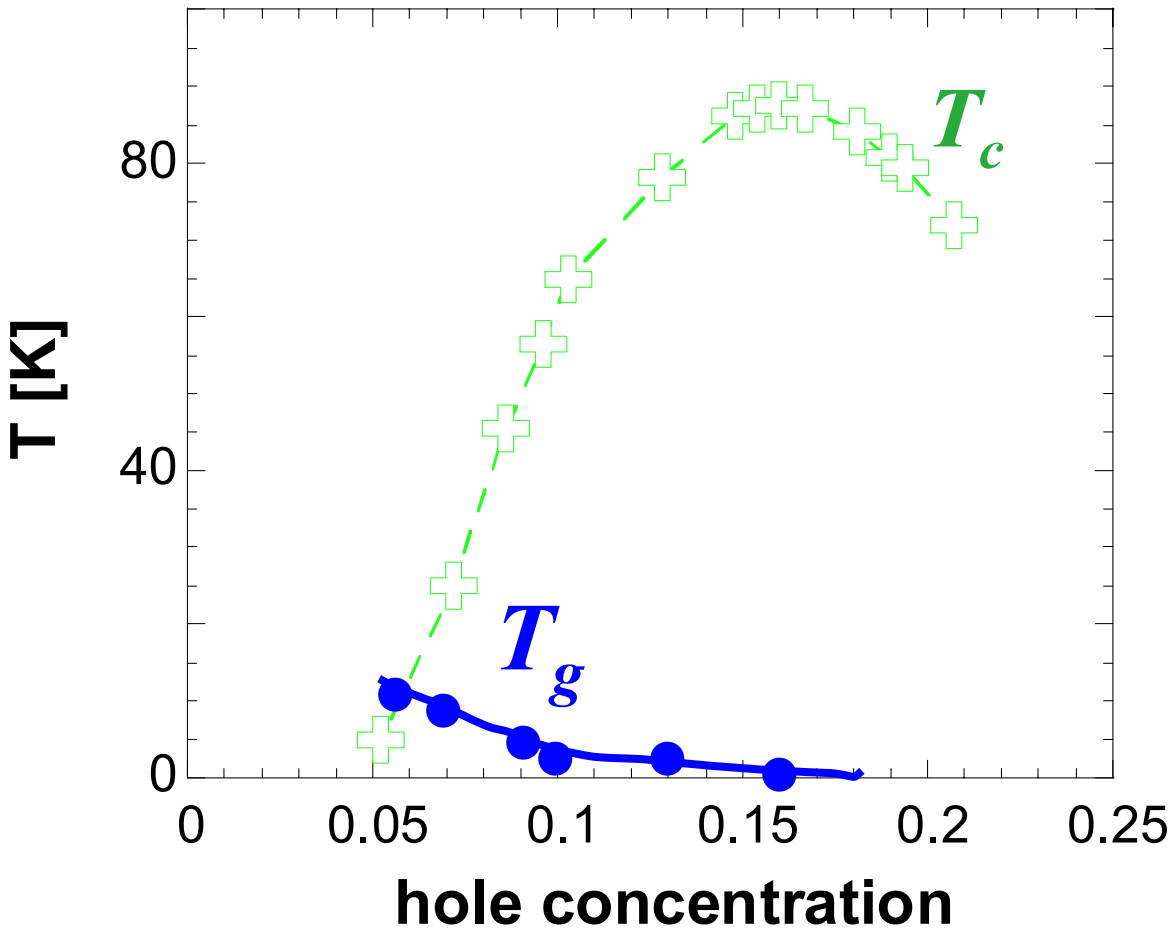
Glassy insulator



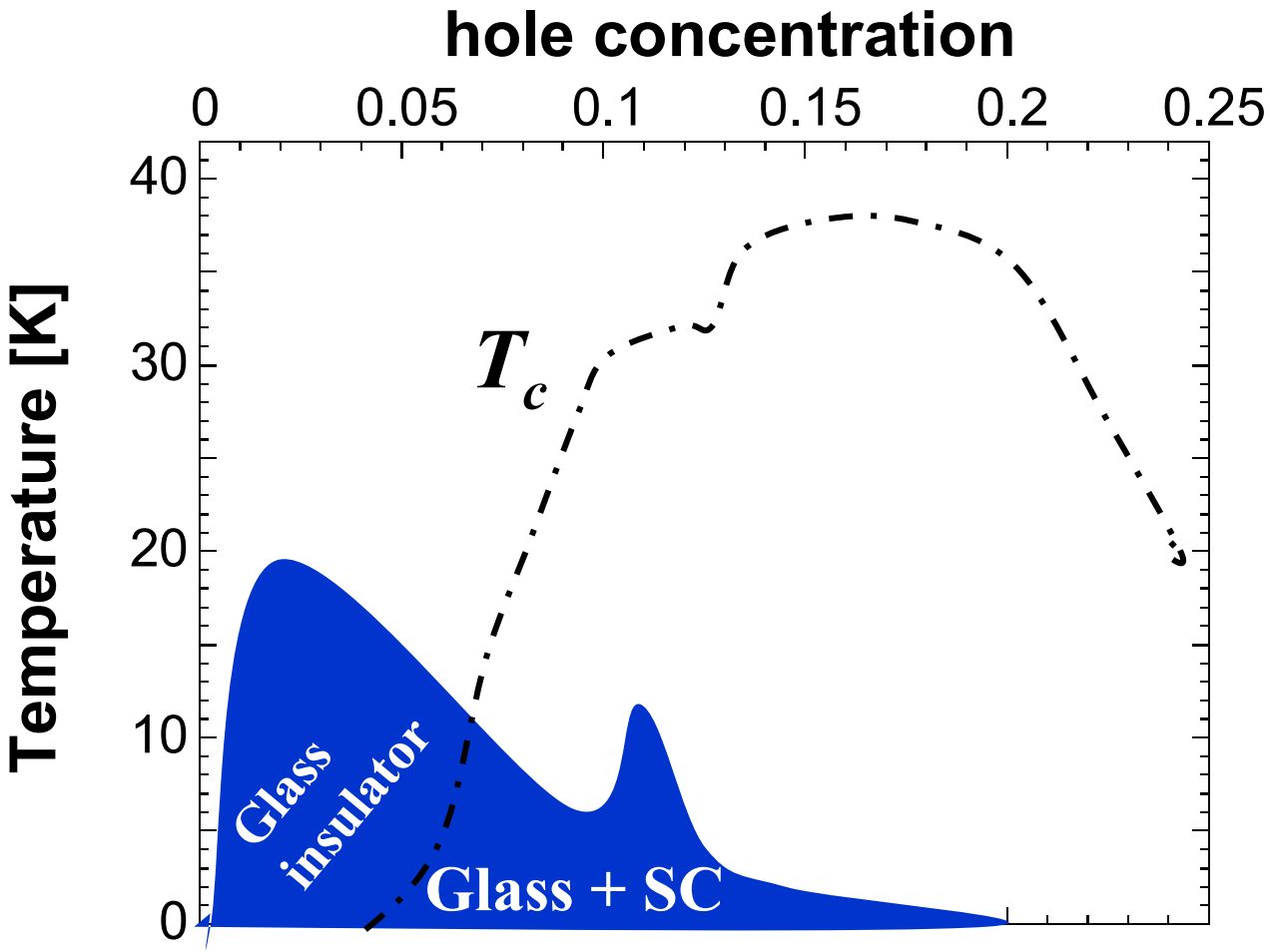
C.P. *et al.*, Physica C 341-348, pp. 843-846 '00 (M²S Houston)

C.P. *et al.*, PRB 66, 064501 '02

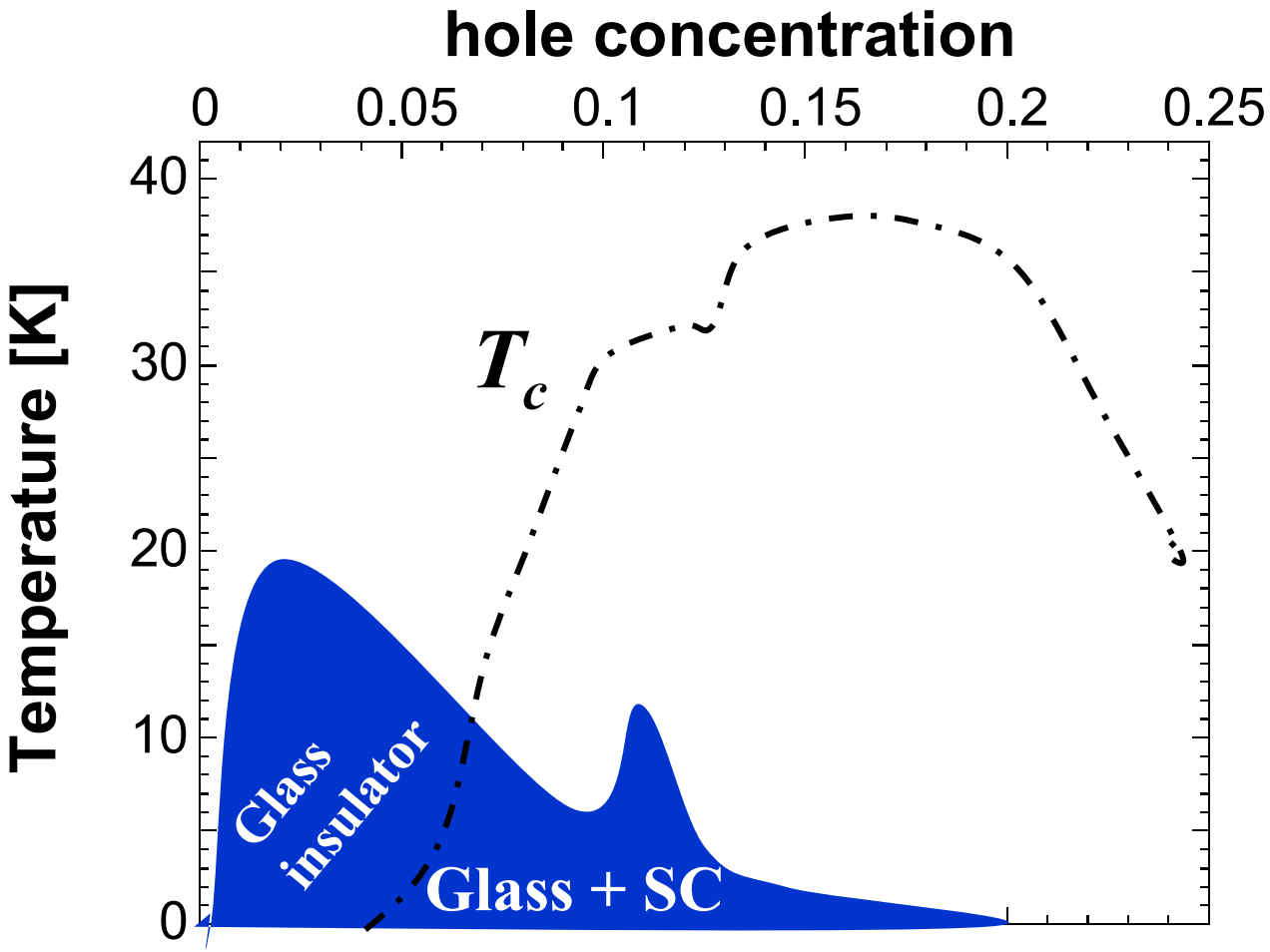
… and in Bi-2212



C.P. *et al.*, PRB 66, 064501 '02



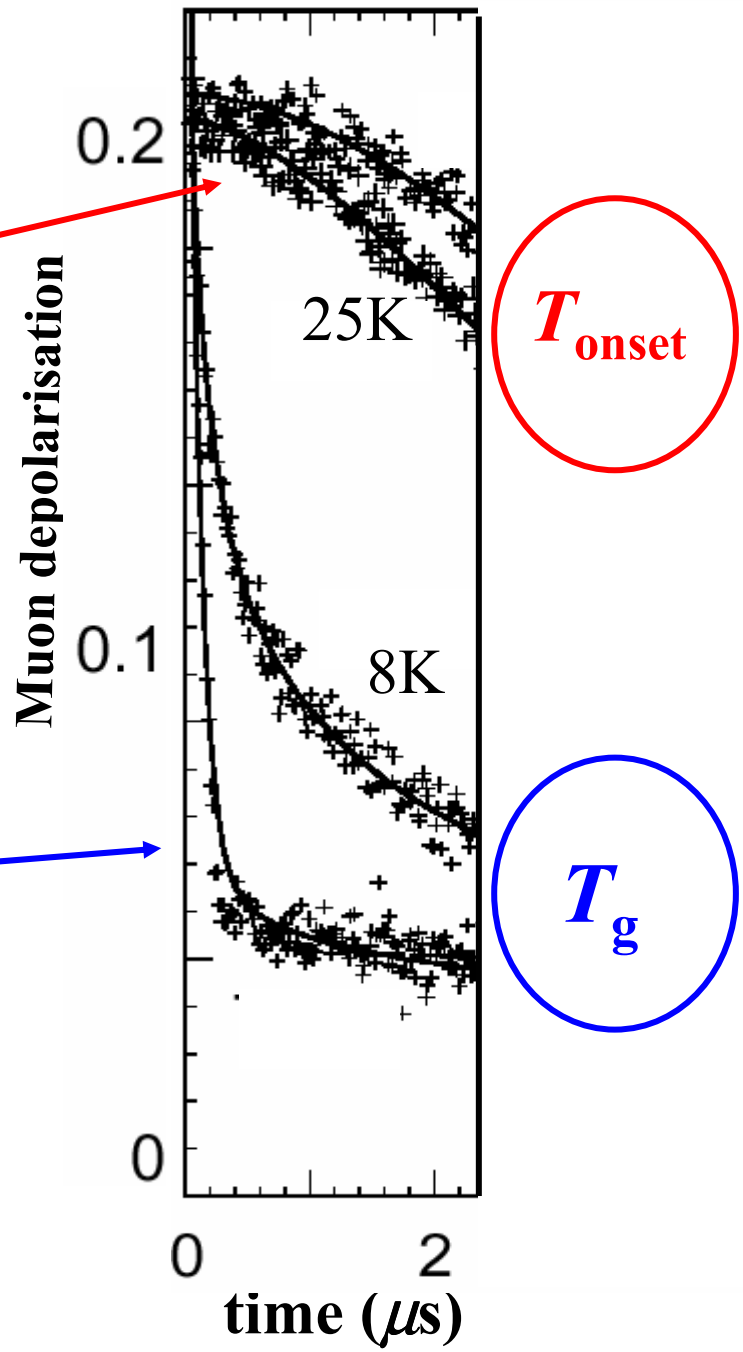
Glass Insulator followed by Glass order coexisting with SC

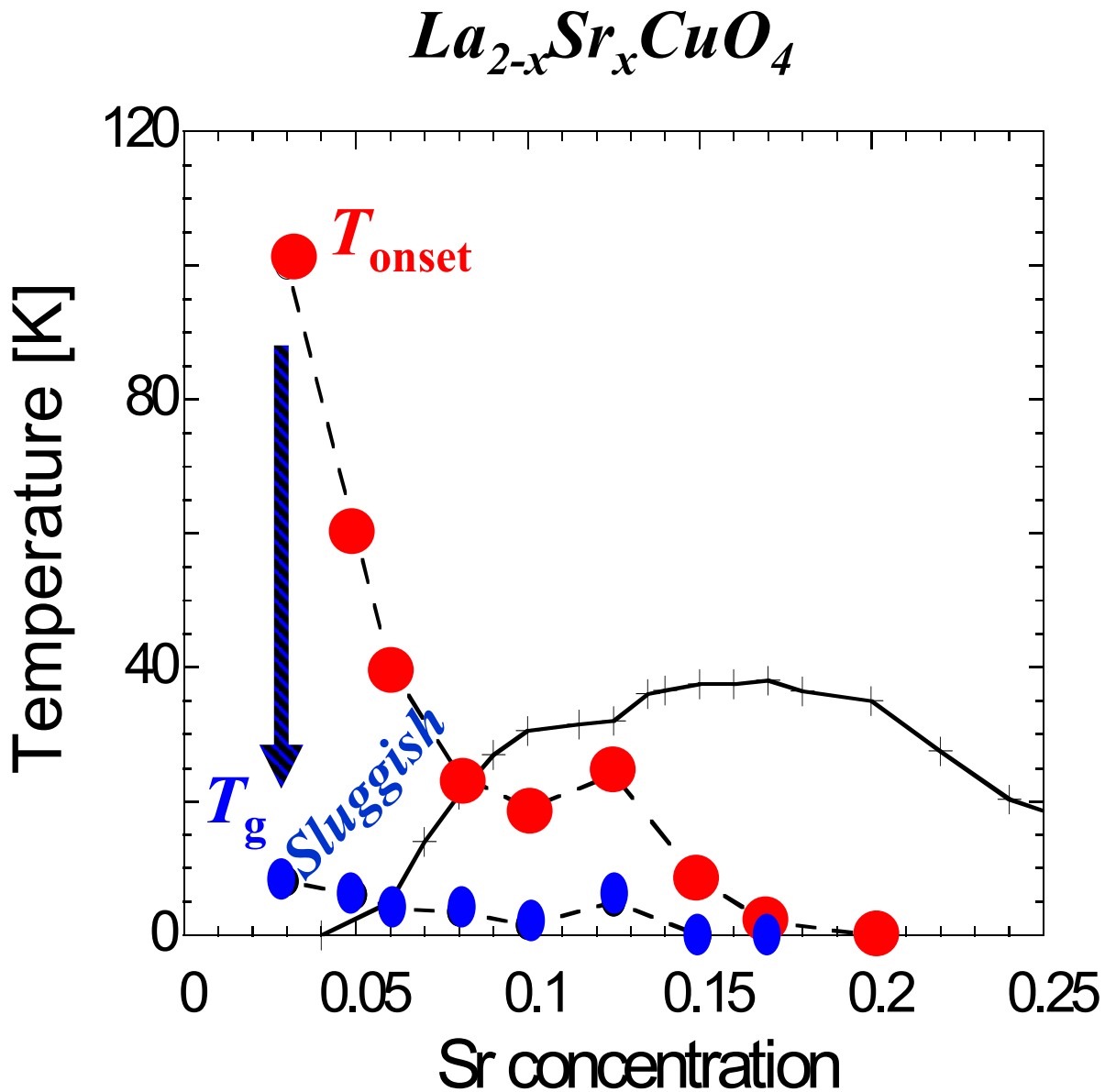


What happens above the Glass Transition Temperature?

At ***intermediate T*** where ***electronic moments*** *first* ***slow down***

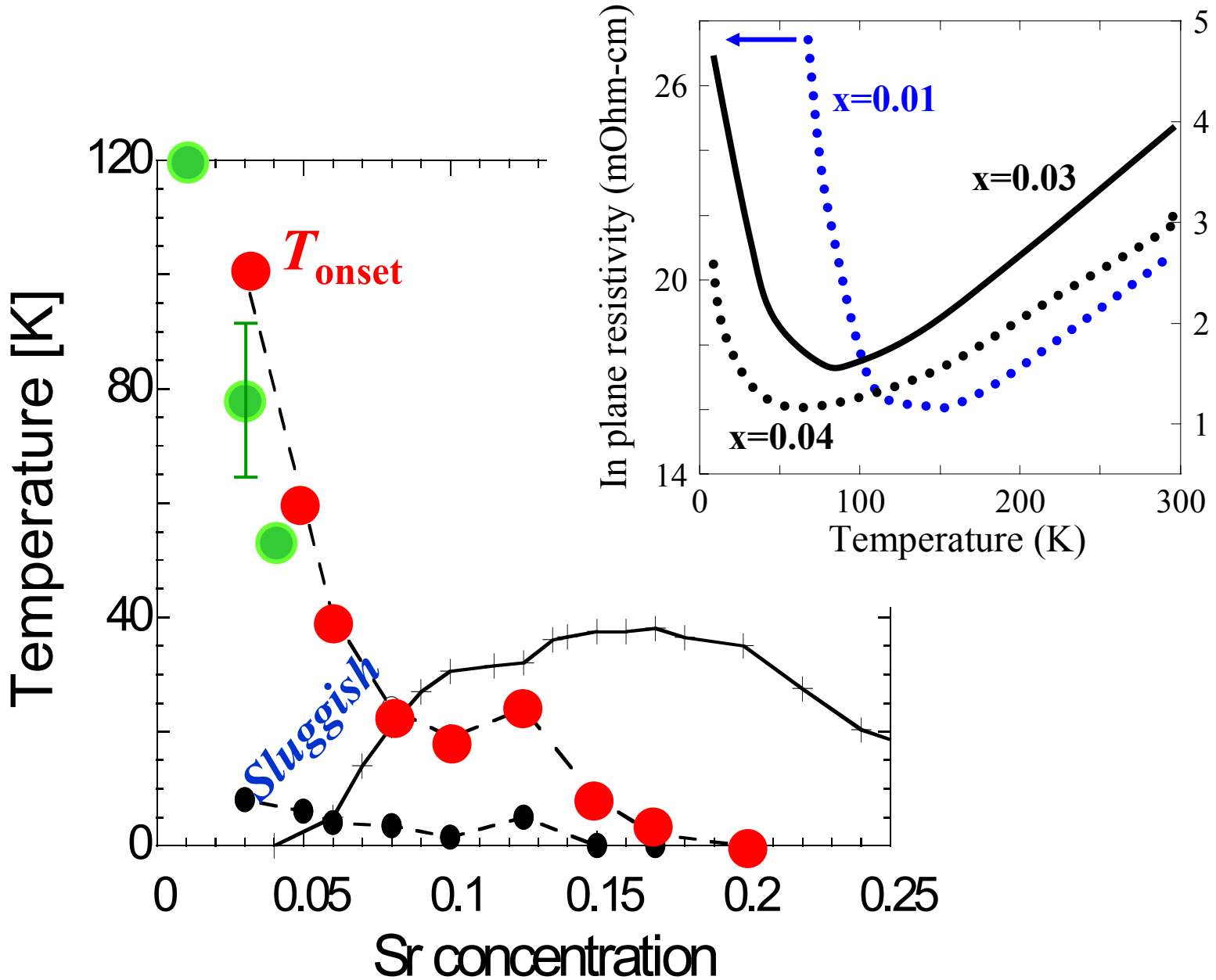
At ***low T*** where ***electronic moments freeze***





C. P *et al.*, PRB 66, 064501 '02

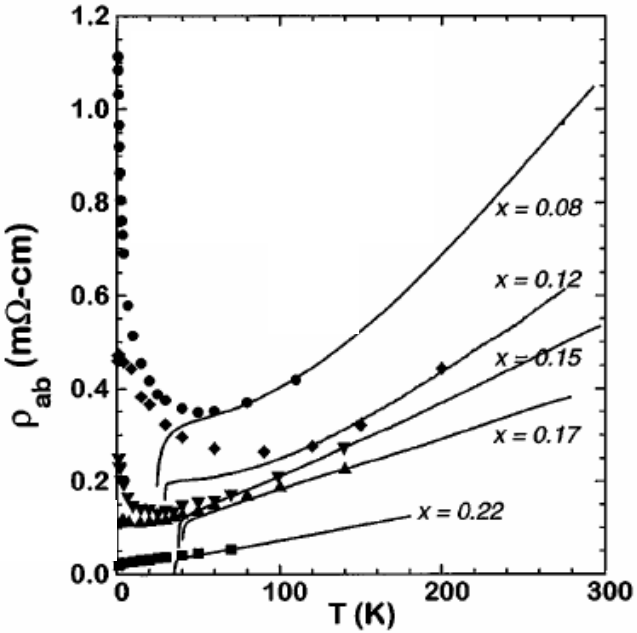
CP *et al.*, Physica C 341-348, pp. 843-846 '00 (M^2S Houston)

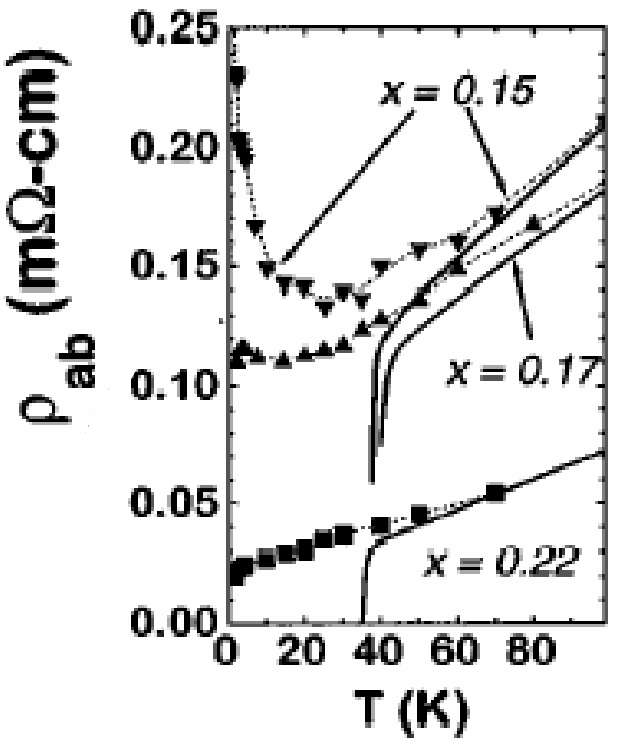


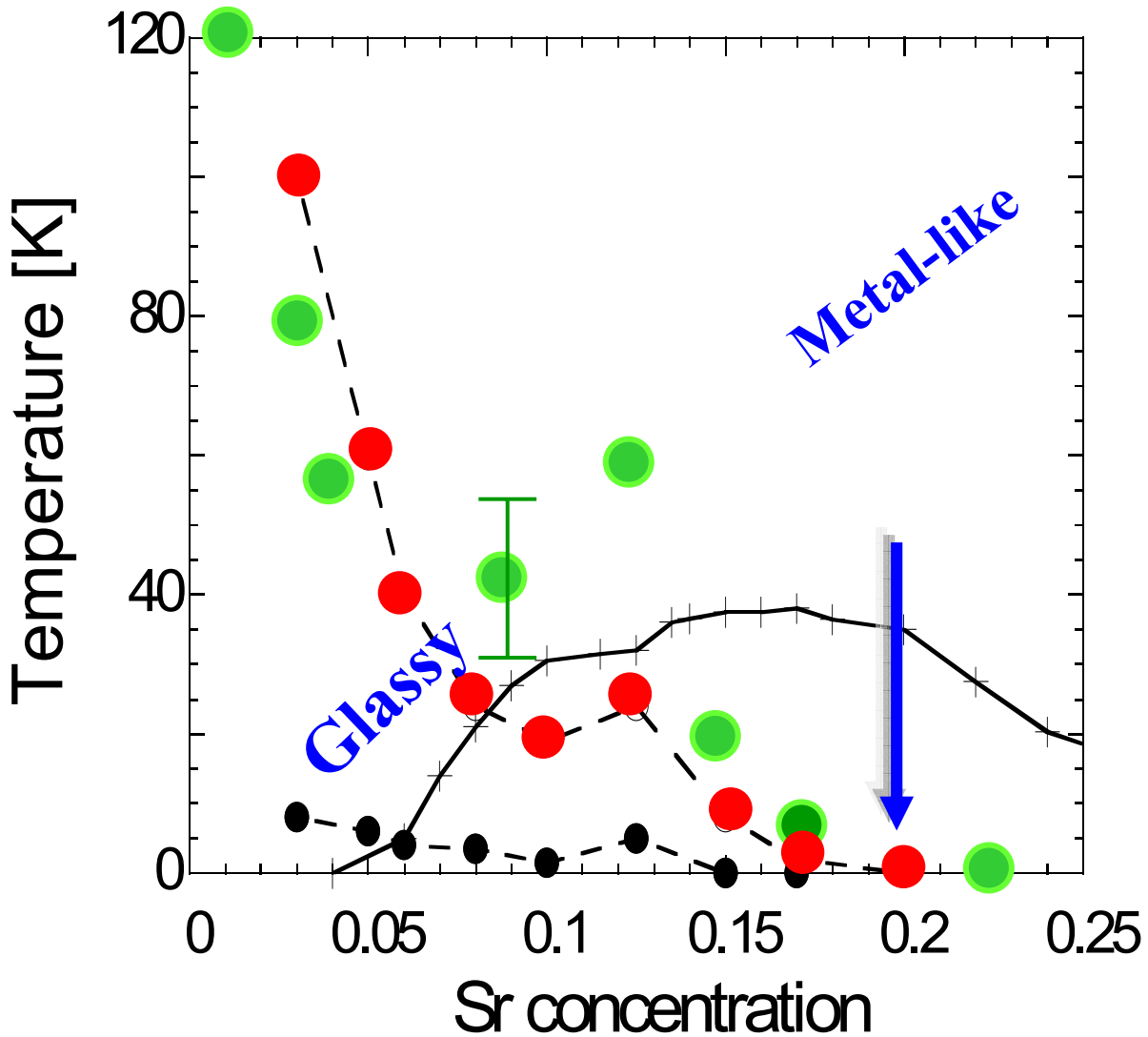
C. P *et al.*, PRB 66, 064501 '02

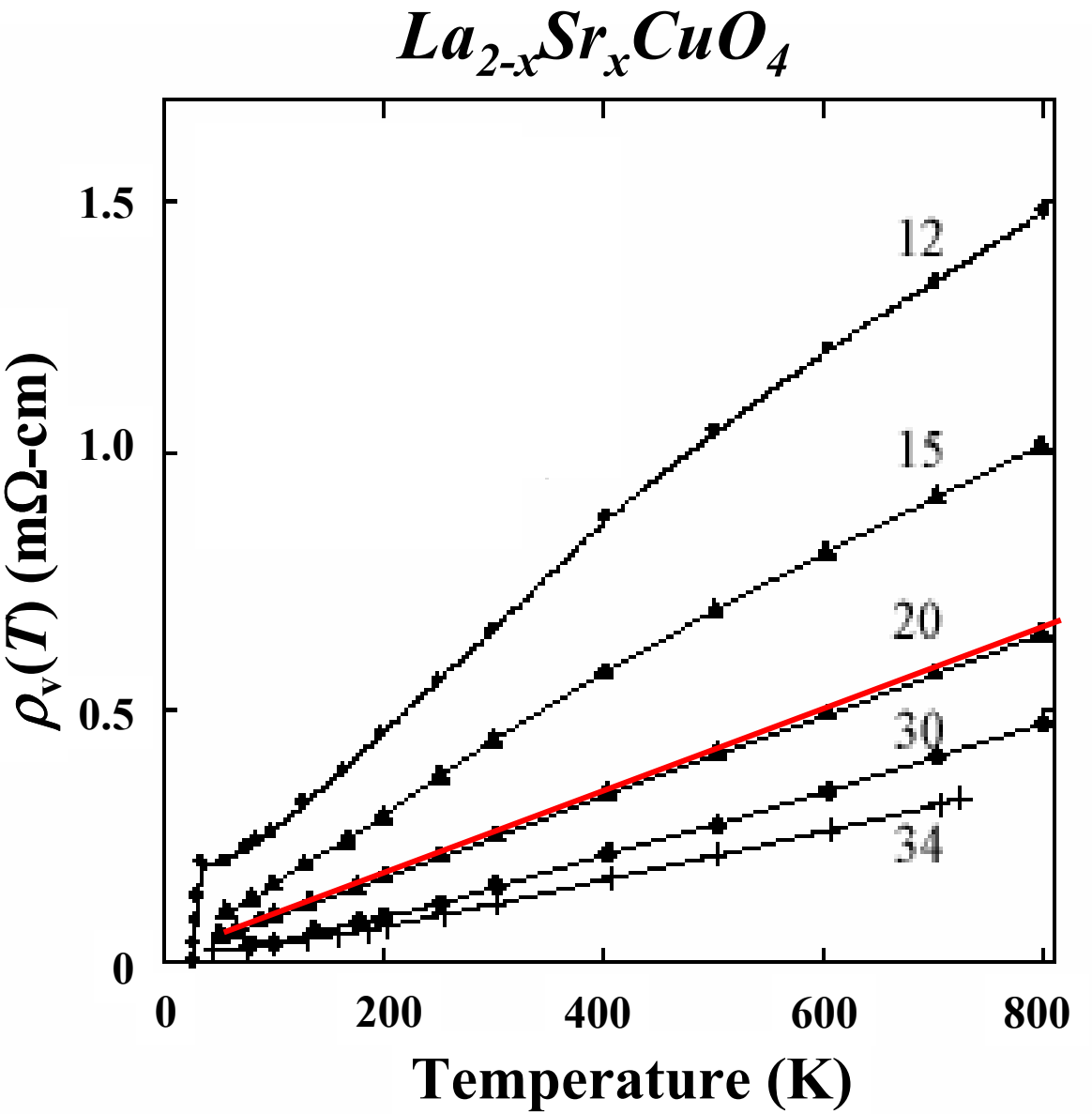
CP *et al.*, Physica C 341-348, pp. 843-846 '00 (M^2S Houston)

G. Boebinger et al. PRL '96









Data from T. Takagi *et al*., PRL ’92 - **corrected for volume changes**

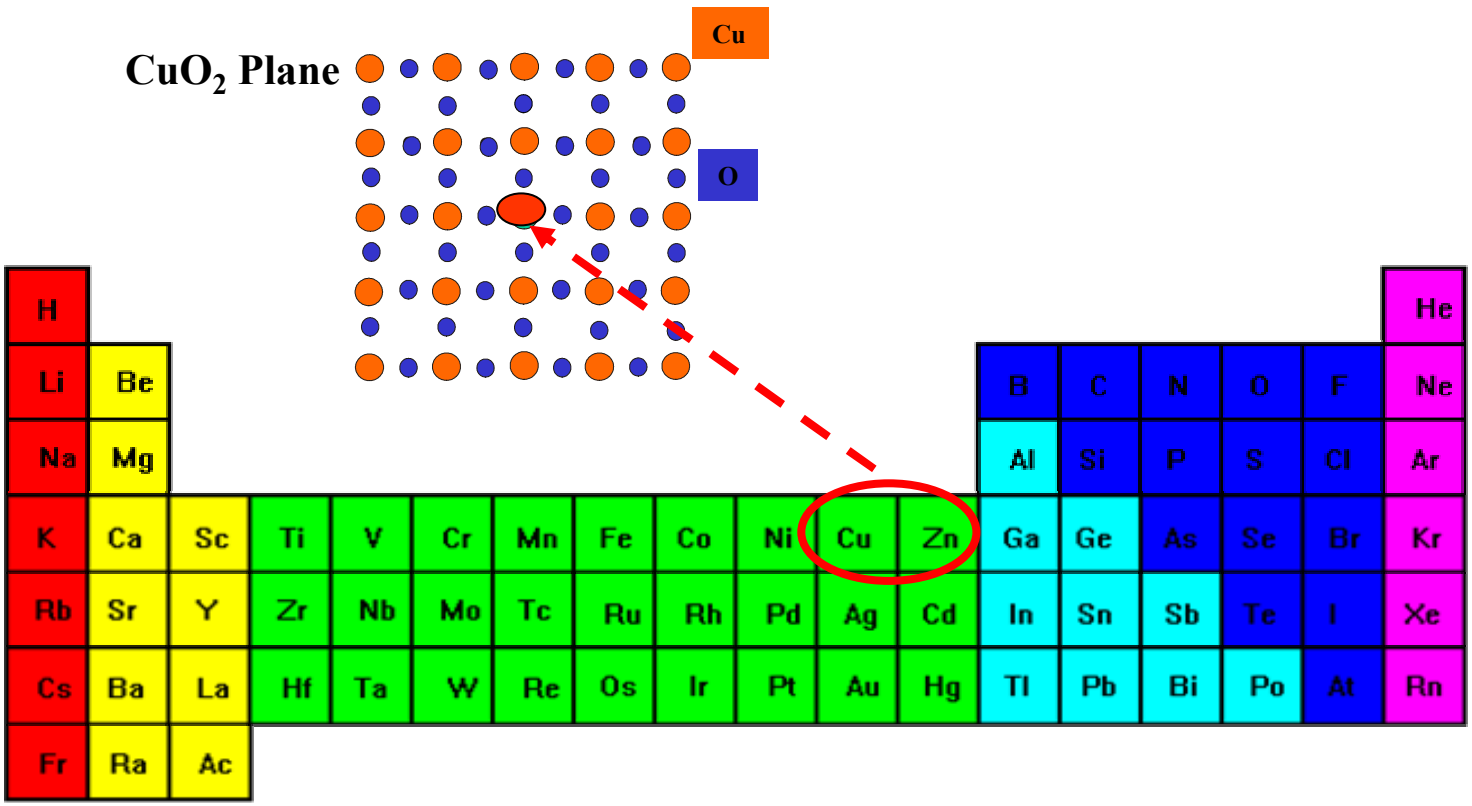
Therefore, charge and spin glassiness are inter-related up to high temperatures

1. ***Is glassiness caused by extrinsic disorder?***

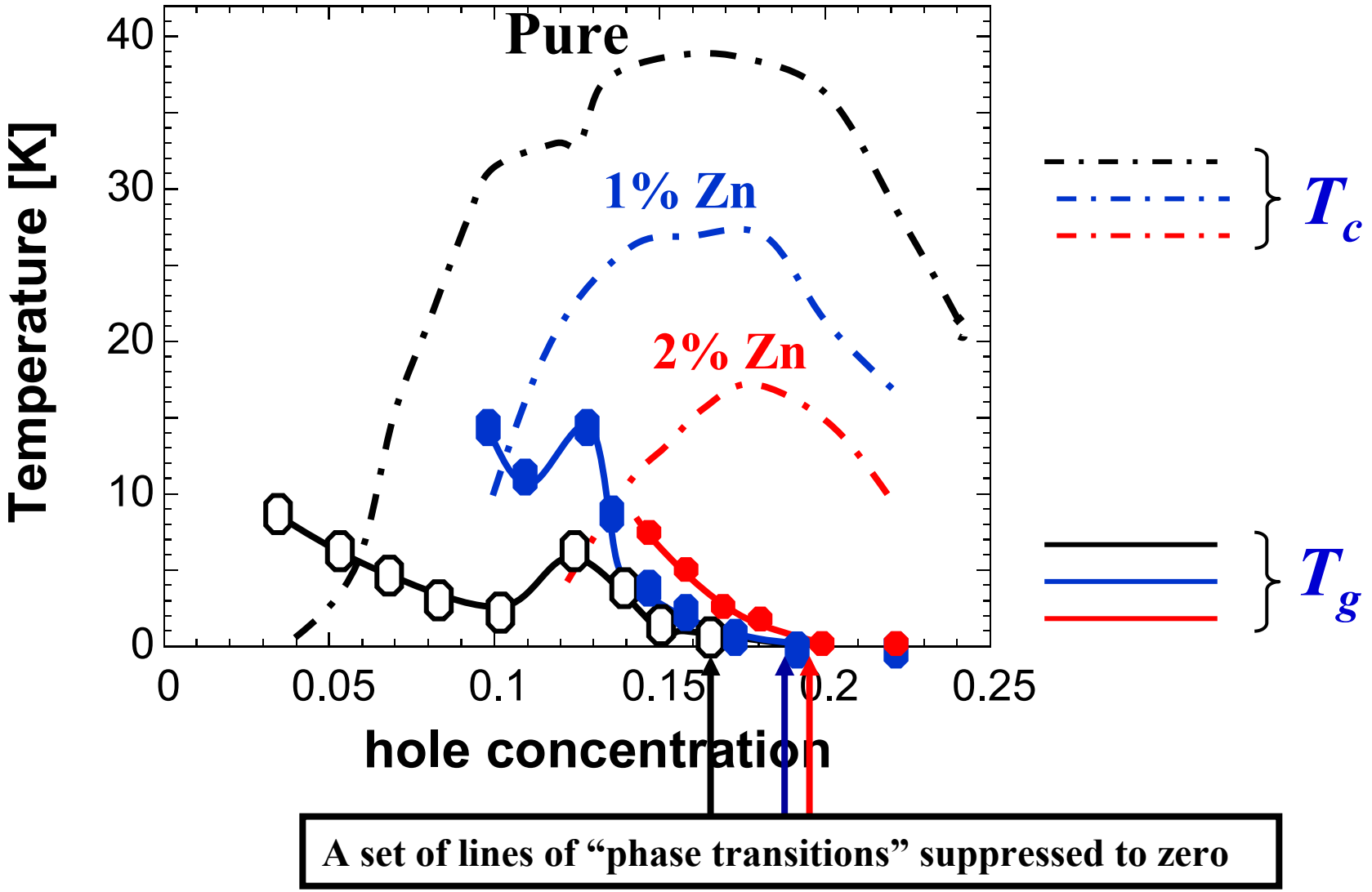
2. ***Is there a change in the ground state separating the system from an underdoped glassy regime to a metal-like overdoped regime?***

We dope with non-magnetic Zn^{++}:

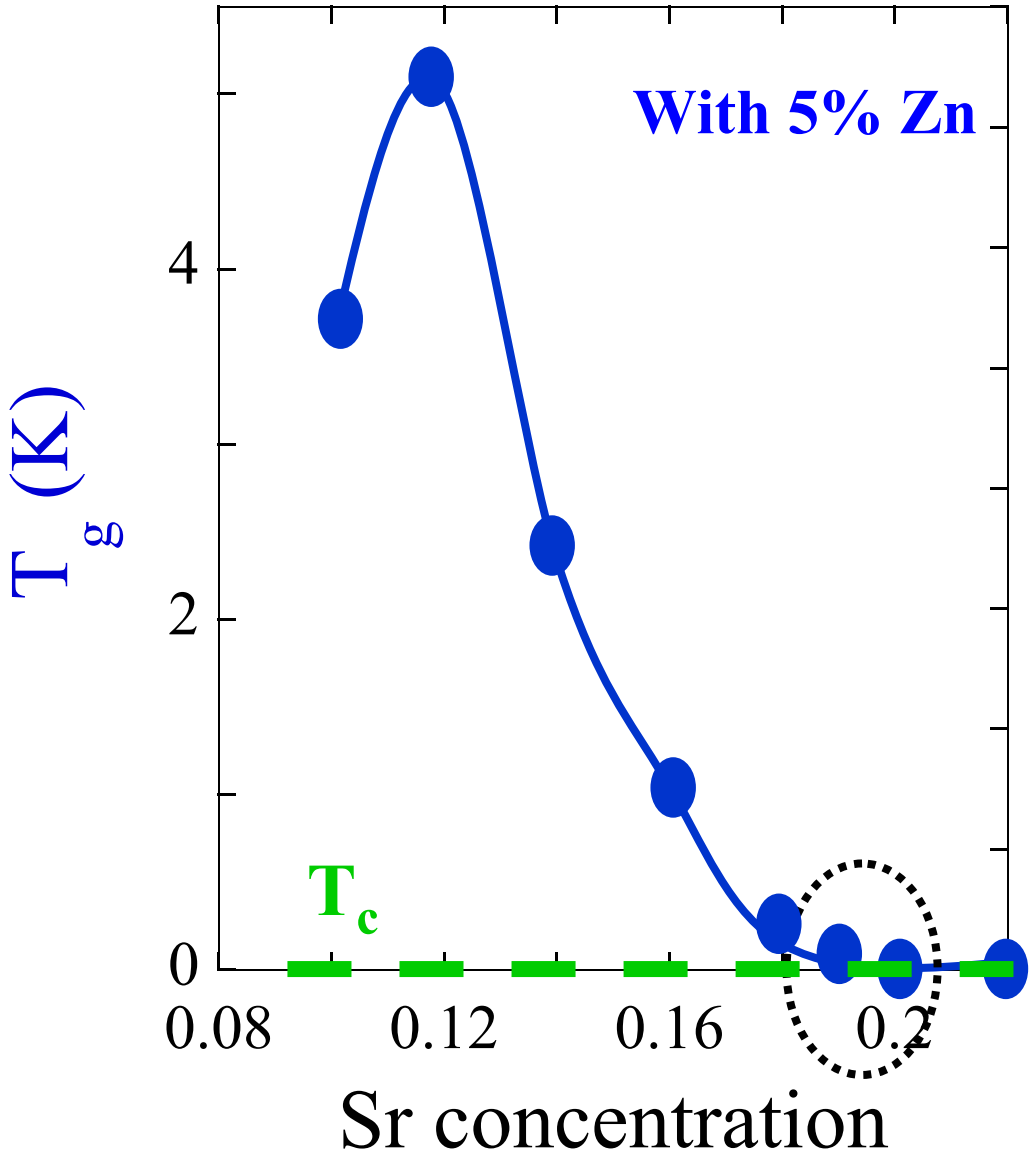
- **Degrades long range order** (*e.g.* elastic incommensurate magnetic peaks are weakened)
- **Enhances magnetic correlations** (*e.g.* produces broadening of ^{63}Cu NMR spectra and increases low energy magnetic fluctuations as detected in ^{63}Cu spin lattice relax. rate)
- **Suppresses superconductivity** (both T_c and superfluid density)



$La_{2-x}Sr_xCu_{1-y}Zn_yO_4$



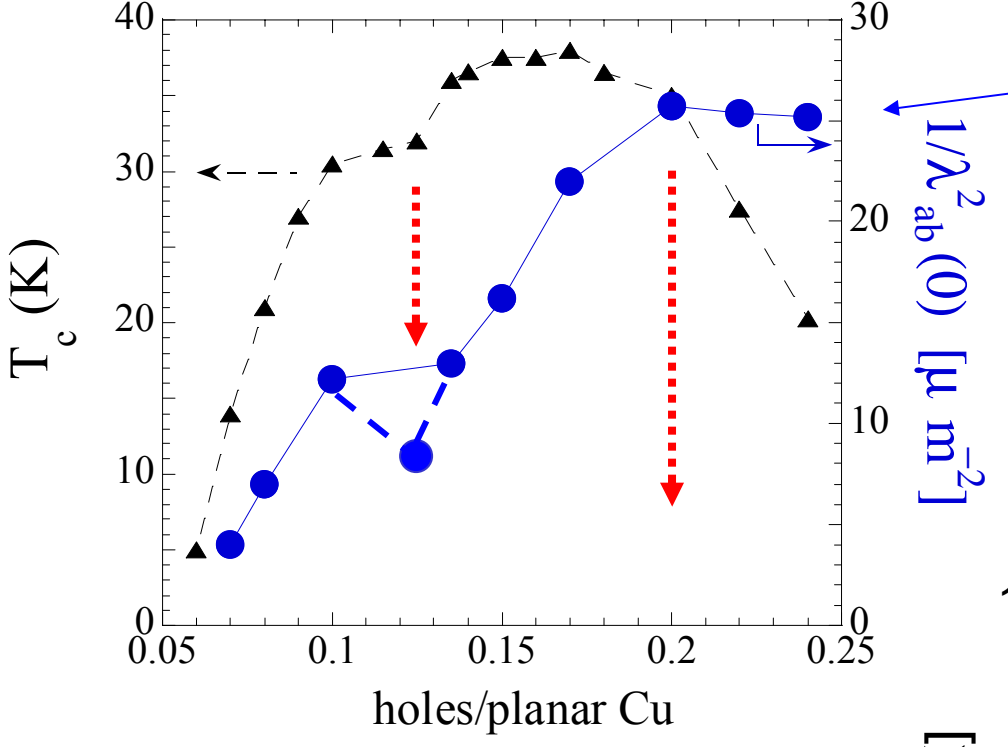
C.P. *et al.*, PRB 66, 064501 '02



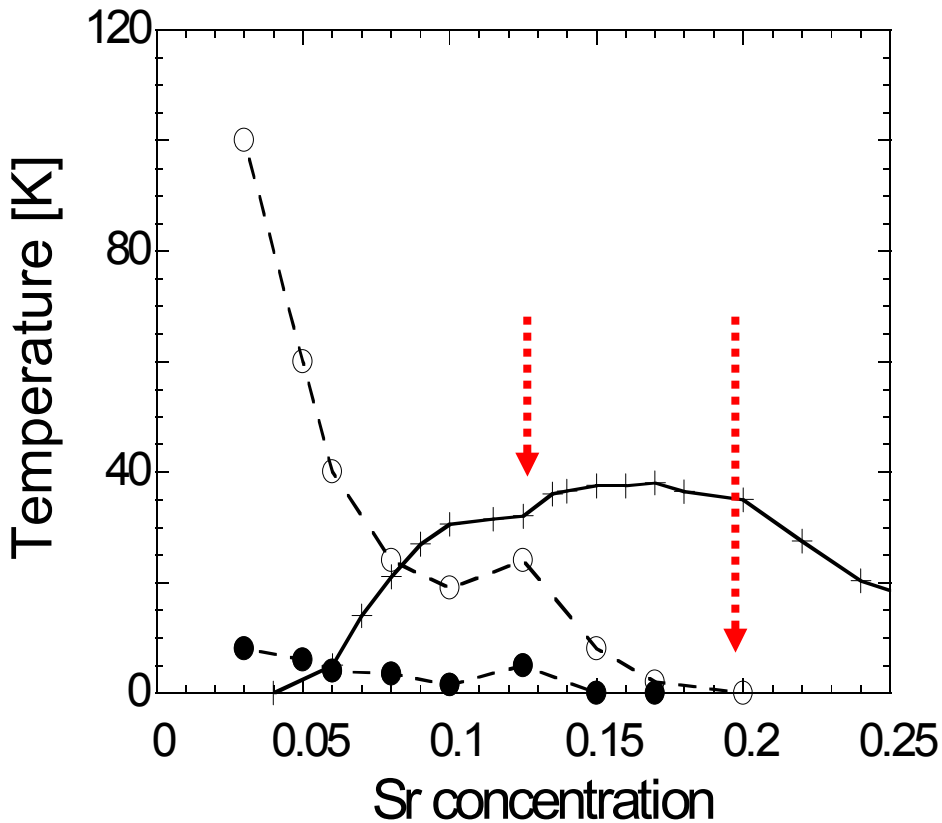
Glassiness regardless of SC

Ground state (at least at 40mK) is separated in two distinct regions: with and without glass

C.P. *et al.*, PRB 69, 1444510 '04



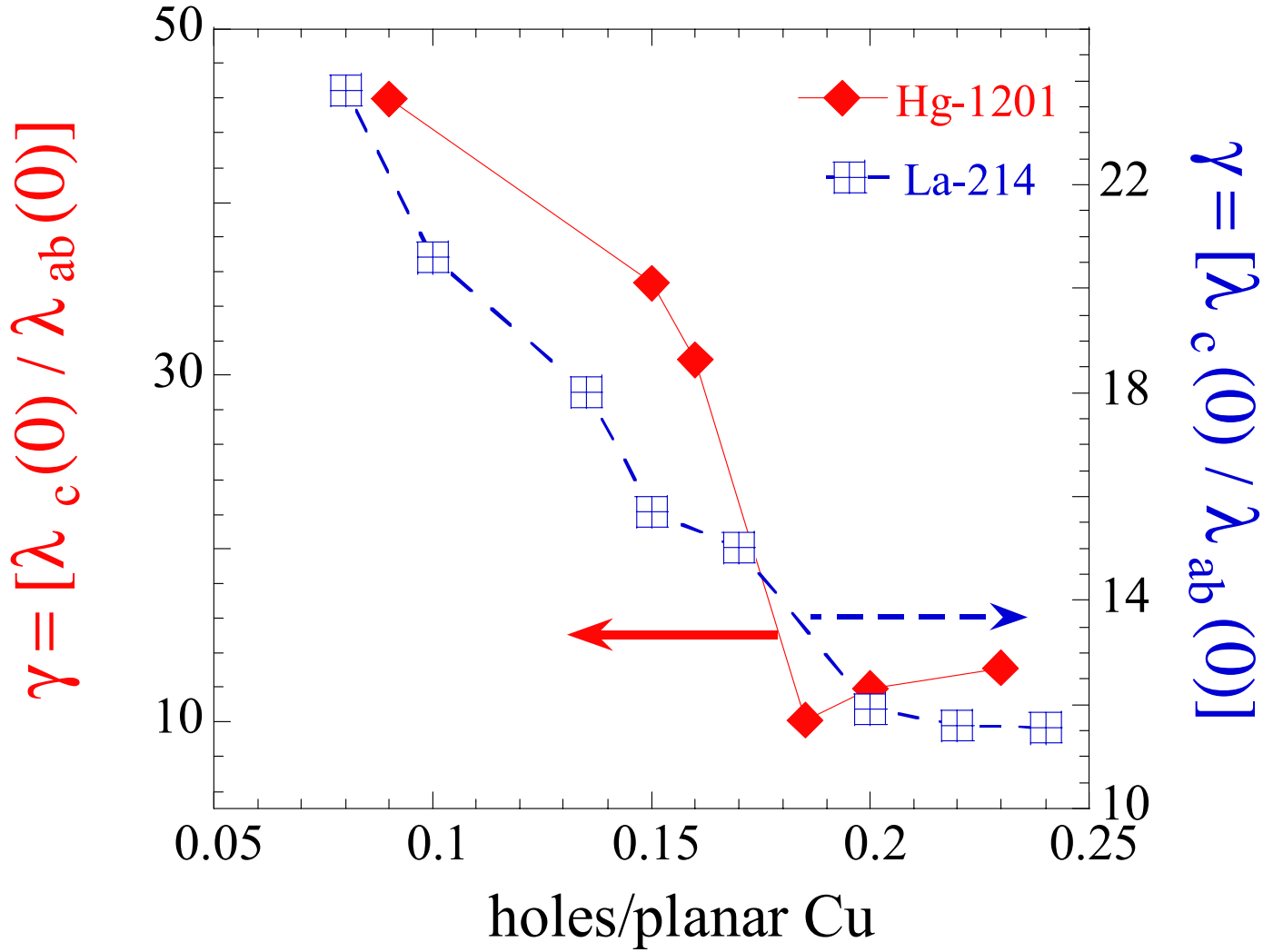
16 samples per doping



CP *et al.*, PRB 60, 14617 '99

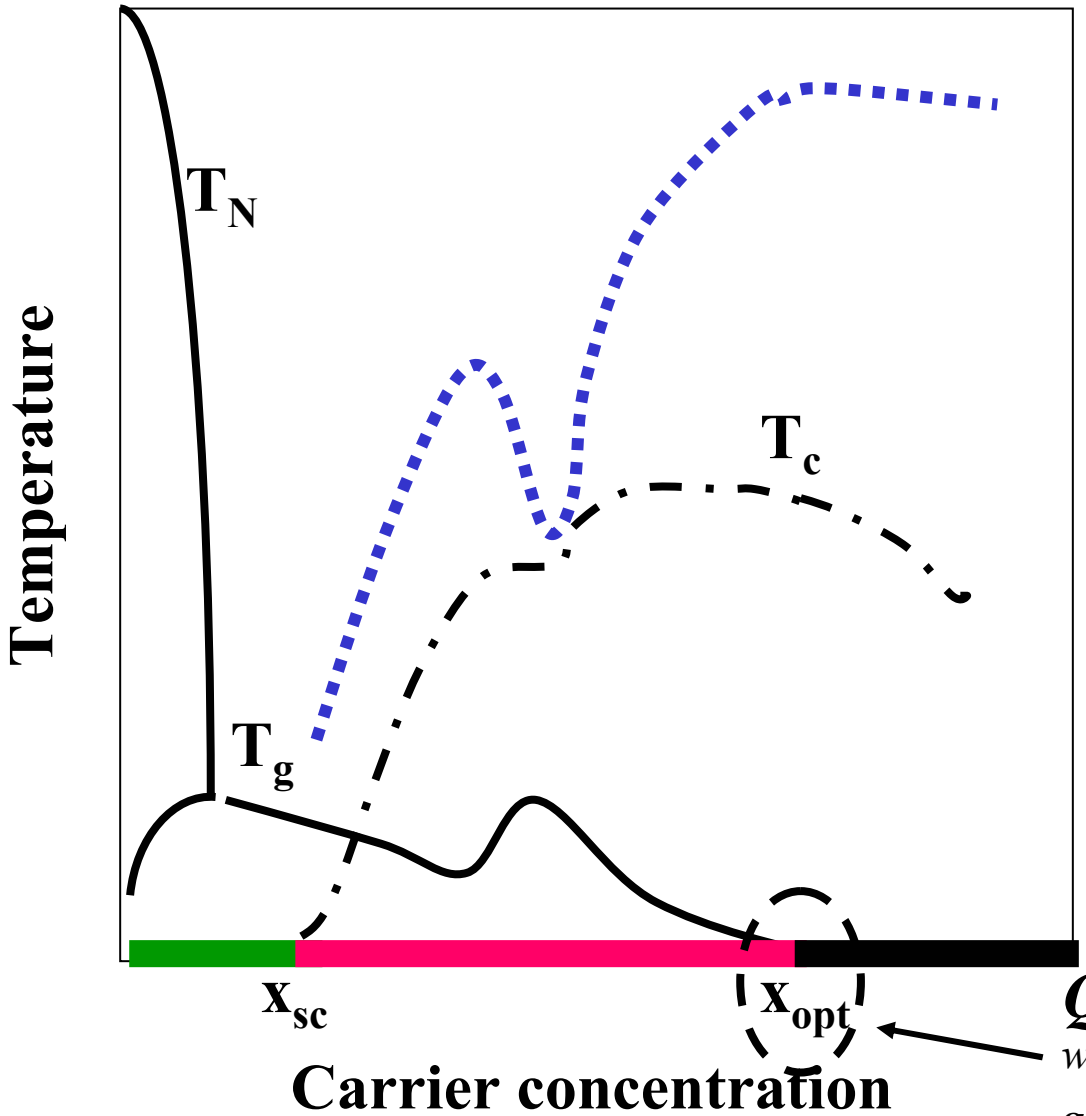
PRB 67, R220502 '03

Anisotropy



CP *et al.*, PRB 67, R220502 '03

CP *et al.*, PRB 61 R3808 '00



QGT- *a QCP associated with the emergence of a glassy state*

Glassy Insulator
- frozen moments
- Insulating resistivity
- $n_{Hall}(T=0)=0$

$x_{sc} \rightarrow$ ***Glass + SC***
SC is optimum at the **QGT**

Homogeneous
BCS like SC