Zeitschrift: Helvetica Physica Acta

Band: 62 (1989)

Heft: 6-7

Artikel: Magnetic correlations and antiferromagnetic order in La_2-x Sr_x CuO_4

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DOI: https://doi.org/10.5169/seals-116101

MAGNETIC CORRELATIONS AND ANTIFERROMAGNETIC ORDER IN $La_{2-x}Sr_xCuO_4$

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Abstract: From ^{139}La and ^{63}Cu NQR relaxation it is found that the Cu++ long-range in-plane magnetic correlation is strongly limited by mobile charge defects introduced by the Sr doping. Both NQR relaxation and specific heat measurements indicate that at low temperature the antiferromagnetic order is restored at T_N (x) as a consequence of a freezing of the mobile defects.

The ^{139}La and ^{63}Cu spin-spin and spin-lattice relaxation measurements for x ranging from 0 to x=0.3 and in the temperature range 1.6 — 450 K, when analyzed in terms of the possible relaxation mechanisms allow one to conclude that over most of the x and T range the relaxation is controlled by the Cu^{++} - Cu^{++} in plane (2D) magnetic correlation length ξ (1).

An x and T dependence of ξ, which is unconventional with respect to the behavior of 2D doped Heisenberg paramagnets is deduced through standard relationships of the relaxation rate T_1^{-1} vs ξ . On the basis of an interpretative model whereby the degree of magnetic correlation that would result from the strength of the Cu^{++} - Cu^{++} exchange coupling is controlled by an effective correlation time, one derives

$$1)\quad \xi(x, T) = \frac{1}{\sqrt{n(x,T)}} = \frac{1}{\sqrt{x}}\, e^{b/2xT} \qquad \text{(in lattice units)}$$

where b/2x is an effective activation energy with b $\simeq$ 0.9 K that has been deduced by the low T behavior of T_1^{-1} for various x (see Fig.1).

When the magnetic order is restored at low temperature as a consequence of the decrease of the concentration of the mobile defects n(x, T) (see Eq.1), one observes a peak in (T_1^{-1}) and a small anomaly in the specific heat $C_p(T)$. The maximum value $(T_1^{-1})_{max}$ is about the same for all x although $T_N(x)$ ranges from ~ 300 to ~ 2 K. This is taken as an indication that the ordering is triggered by a 2D correlation length ξ^*_{2D} which is about the same at T $\simeq$ T_N, regardless the x value. This unexpected result could imply an interplane coupling J' which sharply decreases with x or which is not in competition with the thermal fluctuations.

No information can be derived from the NQR data on the character of the 3D order, i.e. antiferromagnetic vs spin-glass. However the anomalies in C_p around T_N are in favour of a 3D antiferromagnetic state. In Fig.2 we show the phase diagram for our samples as deduced from a variety of measurements.

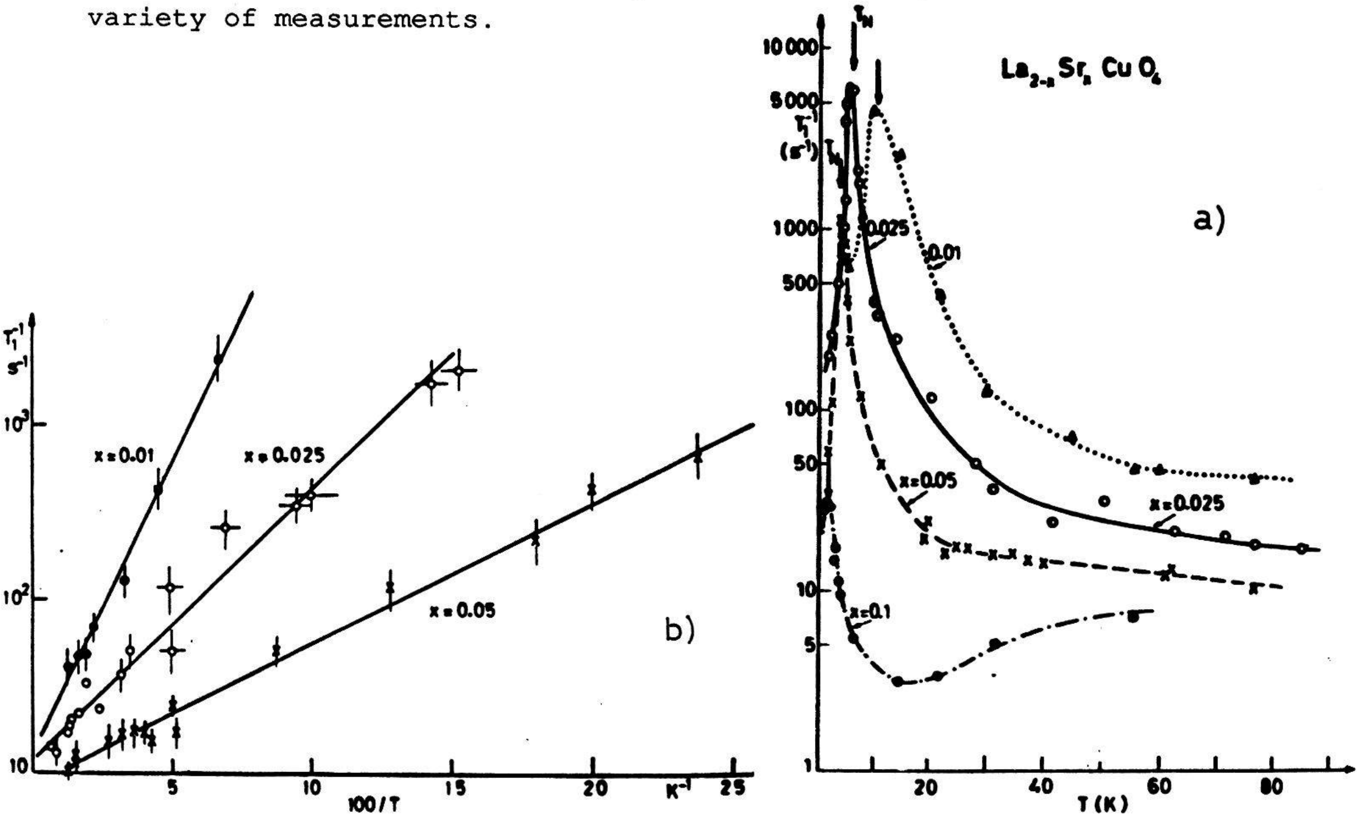

Fig.1 - (a) Temperature behaviours of the ^{139}La relaxation rates for different x in $La_{2-x} Sr_x CuO_4$. (b) Evaluation of the activation energy for ξ ; note that according to the interpretative model $T_1^{-1} \propto n^{-1} = \xi^2$

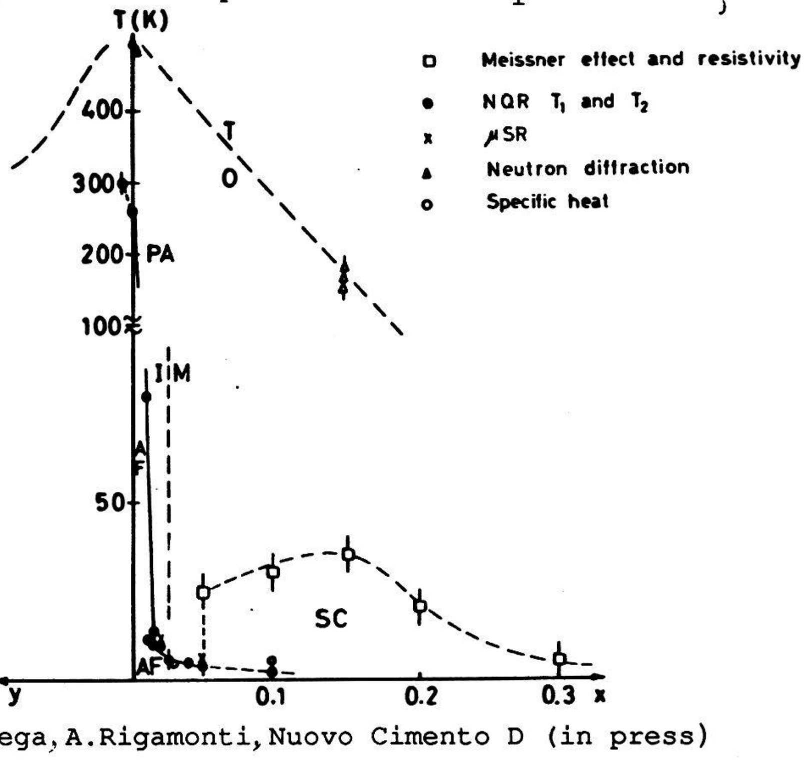

Fig.2 Phase diagram for $La_{2-x} Sr_x Cu O_{4-y}$ as deduced in the present work (ϕ □ , ○) and published data (x, ● , ▲)

References

1. F.Borsa, M.Corti, T.Rega, A.Rigamonti, Nuovo Cimento D (in press)