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COOPER PAIR-LIKE SYSTEMS AT HIGH TEMPERATURE AND THEIR ROLE ON FLUCTUATIONS NEAR THE CRITICAL TEMPERATURE

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A logarithmic behavior is hidden in the linear temperature regime of the electrical resistivity $R(T)$ of some YBCO sample below $2T_c$ where "pairs" break apart, fluctuations occur and "a gap is opening". An anomalous effect also occurs near 200 K in the normal state Hall coefficient. In a simulation of oxygen diffusion in planar 123 YBCO, an anomalous behavior is found in the oxygen-vacancy motion near such a temperature. We claim that the behavior of the specific heat above and near the critical temperature should be reexamined in order to show the influence and implications of fluctuations and dimensionality on the nature of the phase transition and on the true onset temperature.

Among the relevant problems of high-T_c superconductors (HTS) are questions on the existence of Cooper pair-like systems at high temperature, "pseudo gap opening", order parameter symmetry, dimensionality effects, phase transition order and so on.

As early as 1991,[1] following very precise measurements of the electrical resistivity ρ, on a very extensive temperature range and with a precision within the standards of measurements necessary near a critical temperature, we have observed a 250 K temperature crossover in the paraconductivity of a well oxygenated granular $YBa_2Cu_3O_{7-\delta}$ (YBCO). We have substracted a linear regime at high temperature and have taken the temperature derivative of the excess resistivity $\Delta\rho$ and related it to the paraconductivity[2] calculated by Aslamazov and Larkin[3] on one hand and Maki and Thompson (MT)[4,5] on the other hand. The latter predicted a logarithmic behavior to exist due to a finite life time of Cooper pairs. A plot of $\Delta\rho$ in terms of $\epsilon = (T - T_c)/T_c$ indicates without any doubt that a logarithmic term extends at high-T, hidden in the linear temperature regime of $R(T)$ above T_c. The Maki–Thompson regime is seen to extend to ca. $2.5T_c$, more exactly 225 K (Fig. 1). The critical temperature of that sample was 90.5 K as measured from the $R(T)$ inflexion point. Thus we claim that 250 K is close to the highest temperature at which

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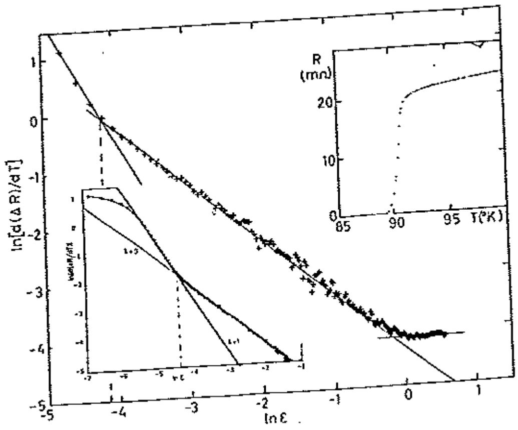

Fig. 1. Log-Log plot of the excess resistivity temperature derivative for an YBCO polycrystalline sample; the straight lineindicates the MT region; $T_c = 90.5$ K.

"pairs" could start breaking apart and where "fluctuations" start to occur. Nowadays this is a so-called "gap opening", i.e. there is a finite life time for a fluctuating gap. Notice that such an estimate of the gap opening temperature agrees with those from the antiferromagnetic scenario of Dagotto RPA-Hartree caculation.[6]

Moreover, Sergeenkov *et al.*[7] have discussed an anomalous effect occuring in the normal state Hall coefficient at 200 K or so. The effect is clearly seen and is again in agreement with the so-called pseudogap opening.

In a Monte Carlo simulation of oxygen diffusion on 123 YBCO planes, the "low temperature" regime and effects of trapping barriers[8,9] have been also examined. It has been shown that "something anomalous" is happening near 180–250 K in the tracer diffusion coefficient. This has been related to an anomalous behavior in the oxygen-vacancy motion and to oxygen patterns which occur following well established specific oxygen trajectories.[10]

Recent related findings in SUPRAS on the type of order parameter can be recalled starting from the in-plane electronic thermal conductivity. The very low temperature behavior, i.e. $T \to 0$ certainly indicates the likeliness of $d_{x^2-y^2}$ wave pairing.[11,12]

Let us recall the demonstration of the existence of the d-wave order parameter at T_c from data on the magneto electro-thermal conductivity.[13] The data can only be fitted below T_c only by a d-wave based theory. Therefore it is of interest to examine the d-wave signature in one of the most relevant properties, i.e. the electronic specific heat. It has been recently argued that a first order transition exists at T_c.[14] We warn that critical fluctuations and exponent values above and below T_c should be well examined before any definite conclusion is made on the order of the transition. In fact, the phonon term might be different above and below T_c and in view of the above remarks, the electronic term should be carefully investigated over a wide range of temperature. In Fig. 2, the behavior of the normal state electronic specific

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