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# Paraconductivity and dimensionality along two different directions in a plane of a thin film of YBaCuO with c-axis in it

S.K. Patapis[a] , D. Yarmis[a], Ch. Katsoura[a], G. Wagner[b], R. Herzog[b], R.E. Somekh[b], and S. Kruchinin[c]

[a]University of Athens, Physics Department, Solid State Section, Panepistimiopolis, Athens GR 15784, Greece

[b]University of Cambridge, Department of Materials Science and Metallurgy, Pembroke Str. CB2 3QZ, U.K.

[c]Bogolyubov Institute of Theoretical Physics, Ukranian Academy of Sciences, Metrologicheskaya 14-b, 252143 Kiev, Ukraine

Thin films of YBaCuO have been grown with the c-axis aligned in the plane of films. Fluctuation conductivity has been measured along the c-axis direction on this plane and along a direction perpendicular to c-axis, that is in the a-b plane. Two different dimensionalities are inferred for this two configurations.

## 1. INTRODUCTION

An important feature of the high temperature superconductors is the large fluctuation effects observable near the transition temperature $T_c$ which influence their conductivity. These effects have as result an increase of conductivity or an excess conductivity in this temperature region. The theoretical model to explain this effect is that of Aslamasov-Larkin [1] but also that of Maki-Thompson [2] and Lawrence-Doniach [3]. From the elaboration of the fluctuation conductivity data in relation to the above models the dimensionality of the system can be concluded.

## 2.THE SAMPLE

The YBaCuO thin film was homoepitaxially grown on $PrBa_2Cu_3O_{7-x}$ template [4,5]. The thickness of the film is about 200nm and the c-axis is on the plane (as confirmed by x-ray measurements) and parallel to one edge of the film (indicated also from the higher resistivity compared to that of the other edge). Four gold dots were sputtered on it in a tetragonal arrangement parallel to the edges of the substrate.DC technique was used for the conductivity measurements [6].

## 3.EXPERIMENTAL RESULTS

The analysis of the results follows a specific procedure [7]. Instead of $\Delta\sigma$ , $\Delta R$ is used and the dependence of $d(\Delta R)/dT$ on $(T-T_c)/T_c$ is examined on a log-log plot.

For the current flow parallel to the short edge of the film and hence along the c-direction we have the following results. Fig.1 displays the resistance dependence on temperature from where the transition temperature is also inferred from $dR/dT$. Fig.2 shows a representative data analysis in a $\log d(\Delta R)/dT$ vs. $\log((T-T_c)/T_c)$. From the plot we conclude the critical exponent $\lambda$ equal to 2 which according to the relation $D=4-2\lambda$ gives a curious dimension equal to 0. Although such a dimensionality is consistent to the physics of fluctuations.

Along c-direction the 'transverse' component of fluctuation conductivity is modified [8,9,10]. If coherence length $\xi_c$ is smaller than the space between the layers we may speak for fluctuation of zero dimensionality since


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superconductivity electrons have difficulty to jump from plane to plane.

For the current flowing along the long edge of the film, in a direction vertical to c and hence in a-b plane we have the fluctuation data from the elaboration of which we take the plot of Fig.3. From this plot in a more extensive region of $\ln((T-T_c)/T_c)$ an exponent equal to 1 is dominant. Such an exponent is characteristic of a dimensionality equal to 2. Such a dimensionality and in such a clear 2D behavior (without the presence at all of 3D) is not often observed in YBaCuO material and may be caused from the geometry of the sample e.g. the a-b planes are grown vertically to the plane of the film.

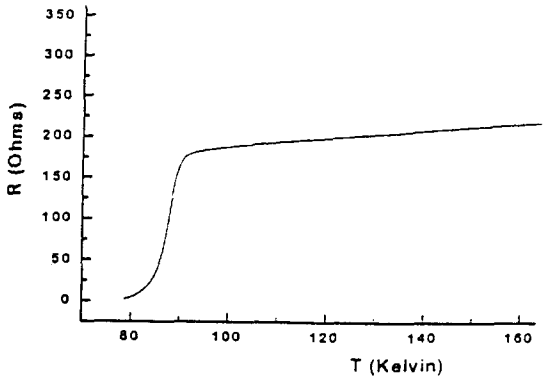


Fig.1 Resistance with temperature along c-axis direction

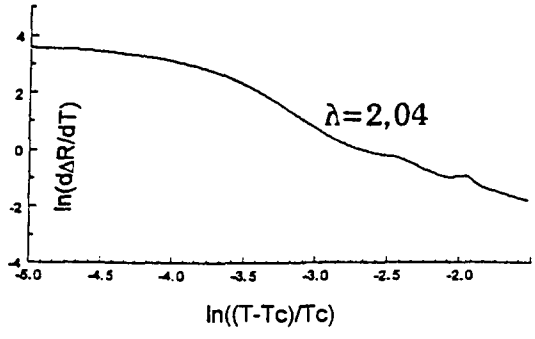


Fig.2 $\ln[d(\Delta R/dT)]$ vs. $\ln((T-T_c)/T_c)$ for the c-axis direction from where critical exponent 2 emerges

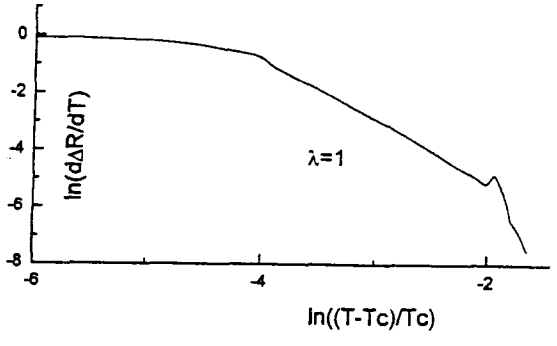


Fig.3 The same as above (Fig.2) but with the conductivity along a direction perpendicular to c-axis

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