INVESTIGATION OF COEXISTENCE OF SUPERCONDUCTIVITY AND MAGNETISM IN CERAMICS $YBa_2Cu_3O_{6+x}$

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The experimental researches of the characterictics of both the magnetic ordered and the superconducting states in $YBa_2Cu_3O_{6+x}$ ceramic samples were carried out by the polarized muons. The changing of the oxygen contents has been produced by the slow annealing [1]. Despite of the found dependence of the local field dispersion value in the mixed state on the heat treatment conditions (fig.1, σ = const $<\Delta h^2>^{1/2}$), the

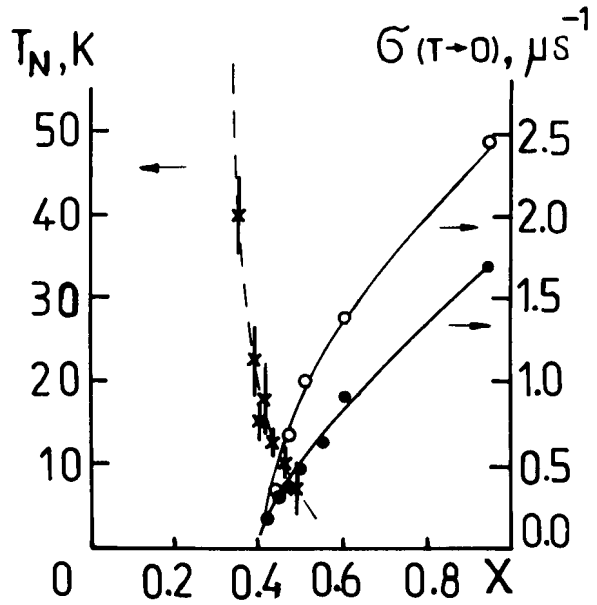

Fig.1. Dependences of magnetic transition temperature T_N (cross) and of vortex local field dispersion σ on oxygen contents x in ceramics $YBa_2Cu_3O_{6+x}$. Initial concentration $x = 0.95$ have been achieved by annealing in oxygen at $T = 920^0C$ for time intervals about 48 hours (dark points) and about 1 hour (while points).

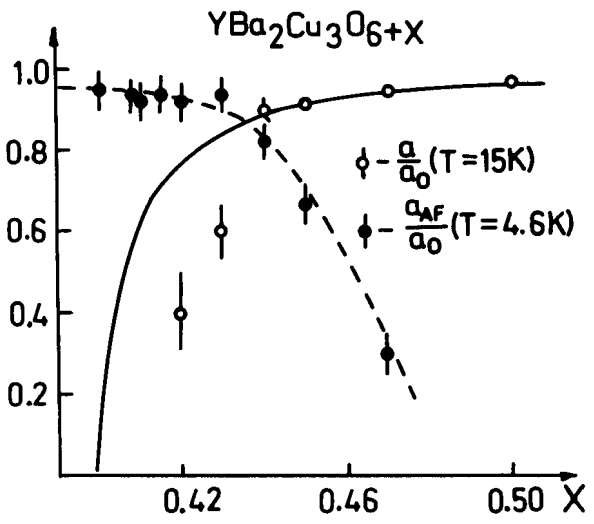

Fig.2. Relative volumes of magnetic ordered state (dark points, from μSR-data) and of superconducting phase (solid line, from susceptibility data) measured at $T = 4.6$ K. White points represent the relative volume occupied by vortex structure at $T = 15$ K (from μSR-data)

superconducting transitions were observed in all the samples with $x > 0.40$. For $x \geq 45$ ($T_c > 30$ K) the vortex structure occupied not less than 90% of the total sample's volume at $T \geq 15$ K (fig.2).

On the other hand, in all the samples with $x \leq 0.50$ the appearence of the spontaneous local magnetic fields as a result of the transition into an ordered magnetic phase was found below some temperature T_N (fig.1). For $x \leq 0.43$ at $T = 4.6$ K the mentioned fields were quasistatic ($\tau_c > 10^{-5}$) and occupied not less than 80% of the sample's volume. The abrupt decrease of T_N for $x \geq 0.30$ was accompanied by the significant increase of the disordering of the magnetic subsystem but the measured average local field remained nearly the same up to $x \approx 0.42$—0.43. It was established that the magnetic order was not qualitatively changed during the transition into the superconducting region, but the magnetic transition temperature began to decrease more slowly with the increase of x here.

To determine the superconducting phase volume in the samples with $0.41 \leq x \leq 0.43$ at $T = 4.6$ K the measurements of the magnetic susceptibility have been used in comparison with the ones for the lead sample of the same shape and sizes (fig.2). Since the shielding of the small external magnetic field was not less than 60% and taking into account the long-range character of the dipole fields it can be concluded that the high-T_c superconductivity and strongly disordered (maybe, short-range) magnetism coexist, at least, for the spatial length of about several elementary cells.

Reference

Barsov S.G., Getalov A.I., Koptev V.P. et al. //Hyperfine Int., 1990. V.63. P.161.