UNIVERSITÀ DEGLI STUDI DI MILANO
DIPARTIMENTO DI FISICA

SUPERCONDUCTING FLUCTUATIONS IN CALCIUM BASED HIGH-T_C SUPERCONDUCTORS

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Introduction

We present an experimental study of the superconducting fluctuations in the family of compounds with formula $Ca_xLa_{1-x}Ba_{1.75-x}La_{1.25+x}Cu_3O_{6+y}$ where $0.0 \le x \le 0.4$ and $7.0 \le 6+y \le 7.15$, by means of M(T) and M(H) curves collected in the range $2 \le x \le 300$ K and $0 \le \mu_0 H \le 7$ Tesla, respectively. The data were collected on quasi-optimally- and under- doped compounds and compared with the ones of optimally-doped (OD) YBCO. The results allowed us to highlight the presence of an anomalous diamagnetism and an upturn field that, for $T > T_c$, increases with temperature.

Models for fluctuations

Starting from **Ginzburg-Landau Theory (GL)** one finds the temperature dependence of the order parameter, Fig.1. The behaviour for $T > T_c$ is associated with the presence of metastable Cooper pairs. A more complete theory by Romanò et al . [1,2], that introduces phase fluctuations of the order parameter, can be used to describe the behaviour of M(H) for $T > T_c$, see Fig.2 for a sketch.

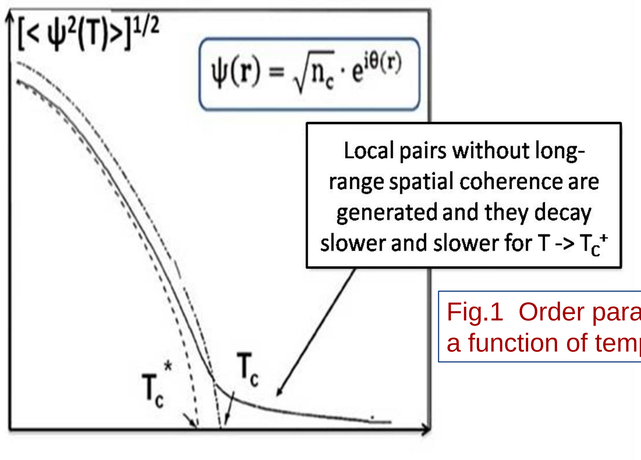


Fig.1 Order parameter ψ(r) as a function of temperature

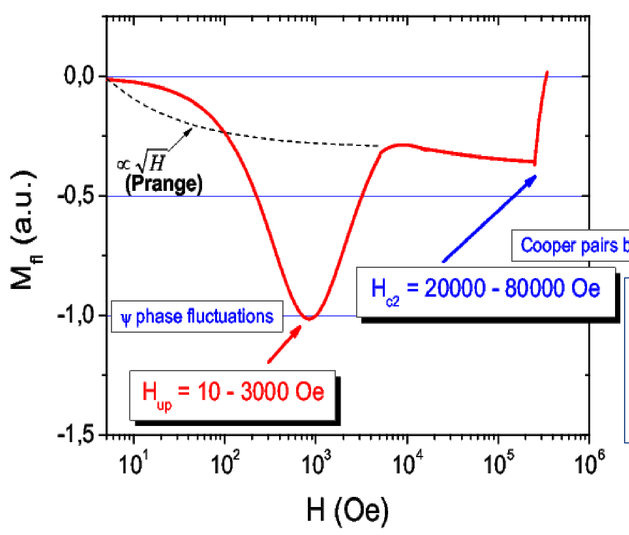


Fig.2 Theoretical behaviour of M(H) for $T > T_c$ with upturn field due to anomalous diamagnetism at low applied field.

Experimental settings and samples

- Eight samples with different Ca and O "doping", shown in Fig.4
- M(H) and M(T) were investigated by means of SQUID measurements (ZFC-FC vs T at 0.5 mT, M(H) at constant $T < T_c$ and $T > T_c$)

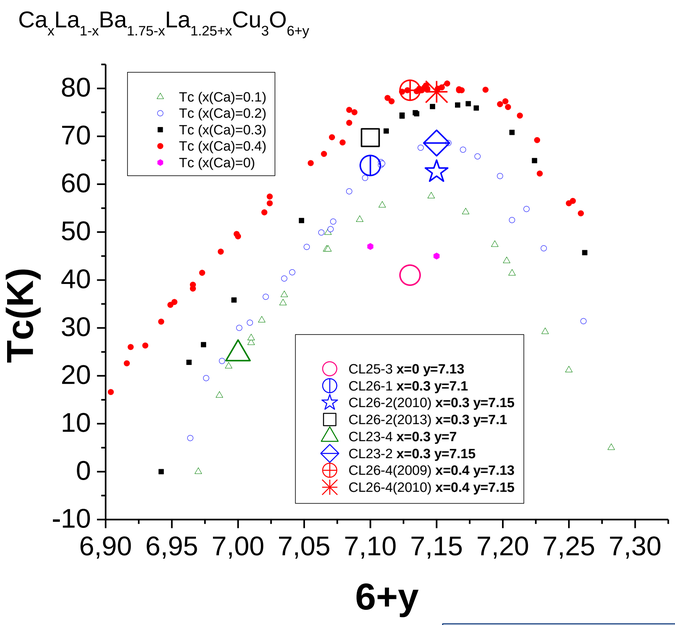
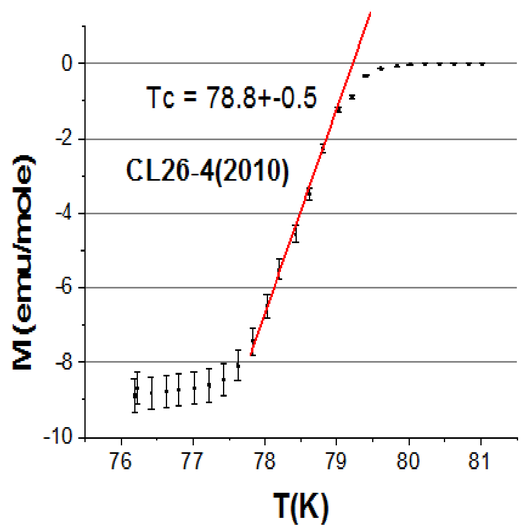


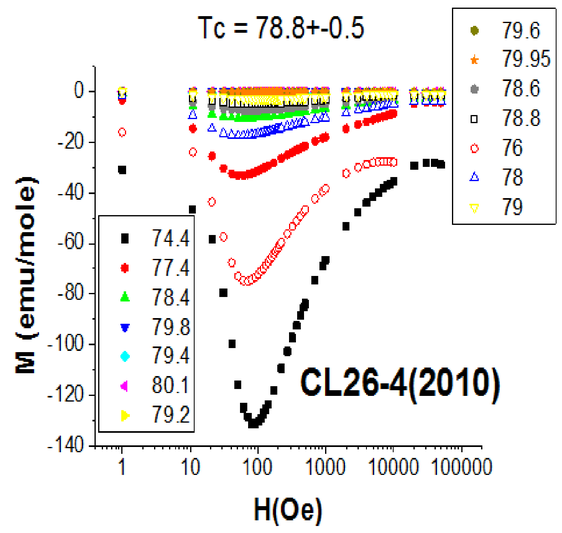
Fig.5
SQUID magnetometer

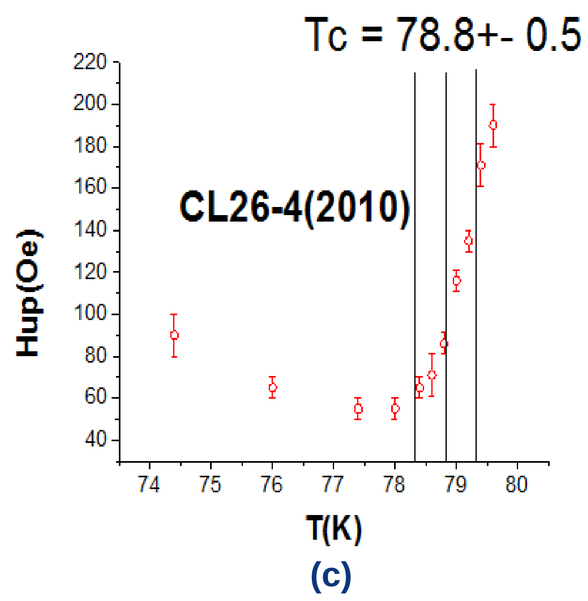
Fig.4 Phase diagram for $Ca_xLa_{1-x}Ba_{1.75-x}La_{1.25+x}Cu_3O_{6+y}$

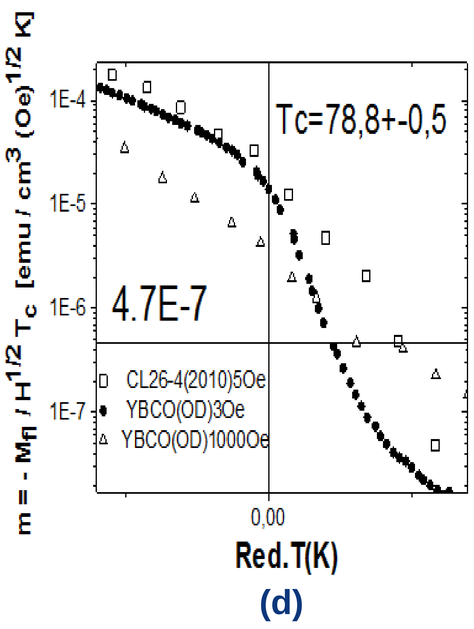
Results

The critical temperature of all samples has been estimated and the **presence of an anomalous diamagnetism** has been confirmed for all samples. The upturn field H_{up} **was found to increase for increasing T, for all samples**. The reduced magnetization curves as a function of reduced temperature, revealed for all Ca-based samples, even those nearly optimally doped, a higher anisotropy with respect to OD-YBCO [3].









Conclusions

- The M(H) curves in all compounds showed that the fluctuating magnetization $|M_{fl}|$ assumes values higher than the ones expected within the GL theory, confirming the presence of an anomalous diamagnetism.
- All systems were found to have an upturn field H_{up} in M(H) for T slightly above T_c, that increases for increasing temperature.
- The study of anisotropy $\gamma = (\xi_{||}/\xi_{\perp})$ through the reduced magnetization, showed for Ca-based systems an anisotropy higher that OD-YBCO ($\gamma \approx 7$), confirming an extra contribution to M.

References

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