Abstract for International μSR Conference (Oxford) April 1990

TRANSVERSE- AND ZERO-FIELD μSR INVESTIGATION OF MAGNETISM AND SUPERCONDUCTIVITY IN $(Y_{1-x}Pr_x)Ba_2Cu_3O_7$

D. W. Cooke,* M. S. Jahan,# and R. S. Kwok
Los Alamos National Laboratory, Los Alamos, NM 87545 USA
R. L. Lichti and T. R. Adams
Department of Physics, Texas Tech University, Lubbock, TX 79409 USA
C. Boekema and W. K. Dawson
Department of Physics, San Jose State University, San Jose, CA 95192 USA
A. Kebede, J. Schwegler, J. E. Crow, and T. Mihalisin
Department of Physics, Temple University, Philadelphia, PA 19122 USA

Zero-field μSR measurements on $(Y_{1-x}Pr_x)Ba_2Cu_3O_7$ (x = 1.0, 0.8, 0.6, and 0.54) show evidence for antiferromagnetic ordering of the Cu moments within the Cu-O planes, with Néel temperatures 285, 220, 35, 30, and 20 K, respectively.[1] For x = 1.0 the local muon magnetic field is ~ 16 mT, but decreases to ~ 12 mT at 17 K, due to additional magnetic ordering. These fields are comparable to those observed in $YBa_2Cu_3O_6$.[2] The zero-field μSR data, in conjunction with transport measurements,[3] allow construction of a complete phase diagram for this system, which is shown in Fig. 1.

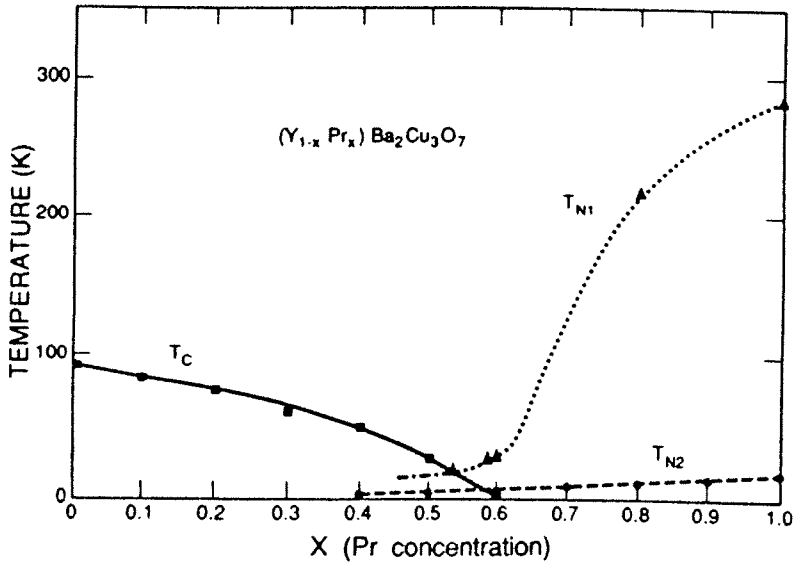

FIG. 1. Phase diagram for $(Y_{1-x}Pr_x)Ba_2Cu_3O_7$. T_{N1} corresponds to antiferromagnetic ordering of Cu moments within the Cu-O planes. T_{N2} presumably corresponds to Pr-moment ordering. Spin-glass-like magnetism occurs for $x < 0.54$ (dot-dashed line).

Note that for x ~ 0.5 there exists a crossover region of the ground state from magnetism to superconductivity. Muon depolarization for x = 0.5, taken at 5 K, is characterized by a fast-relaxing component in addition to a long-time tail, indicative of spin-glass-like magnetism. We conclude that antiferromagnetism (associated with Cu-plane ordering) and superconductivity do not simultaneously exist in this system, in agreement with the conclusion of Ref. 4, but that superconductivity and spin-glass-like magnetism do coexist.

Transverse-field μSR data were taken for x = 1.0, 0.6, 0.5, 0.4, and 0.2 in an applied field of 0.1 T. For large x the measured muon relaxation rates are high (~ 8 μs^{-1}) and the data are difficult to analyze. On the other hand, for small x (0.2) the sample is superconducting (T_c ~ 75 K) with the muon relaxation rate being determined primarily by the Cu nuclear moments above T_c, and by the vortex state below T_c. Shown in Fig. 2 are data for x = 0.2. Below T_c two distinct μSR signals are observed, one presumably associated with the superconducting state and the other with the normal conducting state.

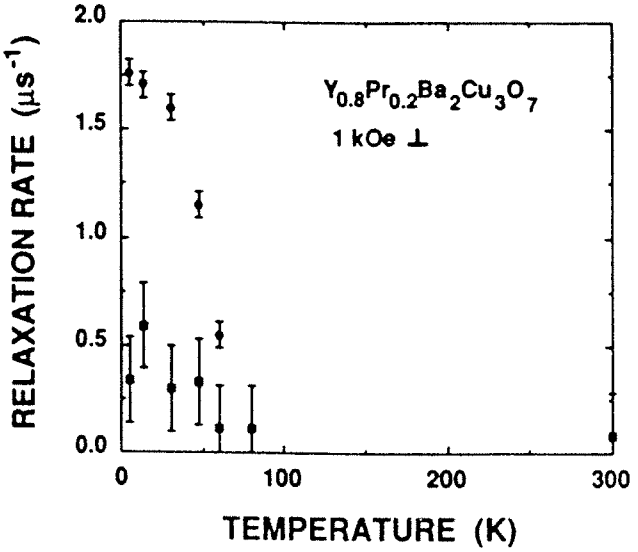

FIG. 2. Muon relaxation rates for $Y_{0.8}Pr_{0.2}Ba_2Cu_3O_7$ taken in a 1 kOe transverse field. T_c is ~ 75 K.

Permanent Address: Memphis State University, Memphis, TN 38152 USA

1. D. W. Cooke, et al., Phys. Rev. B. To be published.
2. N. Nishida, et al., Jpn. J. Appl. Phys. Part 2 **26**, L1856 (1987).
3. A. Kebede, et al., Phys. Rev. B **40**, 4453 (1989).
4. I. Felner, et al., Phys. Rev. B. To be published.