^{17}O NMR Study of Under-doped Single Crystals of the High Temperature Superconducting Compound Hg1201

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Introduction

There has been intense scientific interest in charge ordering and magnetism and their interplay with superconductivity and the pseudogap phenomena in cuprates. In this study, we performed high field ^{17}O NMR measurements on planar oxygen in isotope exchanged underdoped single crystals of $HgBa_2CuO_{4+\delta}$ (Hg1201), a compound with known tetragonal symmetry. The local charge environment around the oxygen sites can be inferred from the quadrupolar satellites and the local magnetic environment from the Knight shift parameters.[1],[2]

Experimental

NMR ^{17}O spectra were taken in the range of 4 K < T < 400 K and 6 T < H < 30 T with a goniometer to precisely orient crystals relative to the magnetic field. Measurements up to 17 T were performed at the NHMFL in a superconducting magnet and up to 30 T in the resistive magnet in cell 2, with different field orientations relative to the *c*-axis. Measurements at 6 T were performed at Northwestern University. Crystals of Hg1201 were grown at the University of Minnesota and were processed at Northwestern University for ^{17}O isotope exchange, doping, and annealing.

Results and Discussion

Our ^{17}O data, Fig.1 and 2, for two underdoped samples (T_c = 79 K and 87 K) indicate that there are inequivalent planar oxygen sites based on comparison of the linewidths of upper and lower quadrupolar satellites <±5/2↔±3/2>, <±3/2↔±1/2> as well as the central transition <-1/2↔+1/2>, that can be attributed to differences in both Knight shift parameters and quadrupolar frequencies. Magnetic and electric field gradient contributions to the spectrum must both be different at each site for asymmetry in the upper and lower satellite linewidths. From Fig.2 it appears that there are likely just two inequivalent sites.

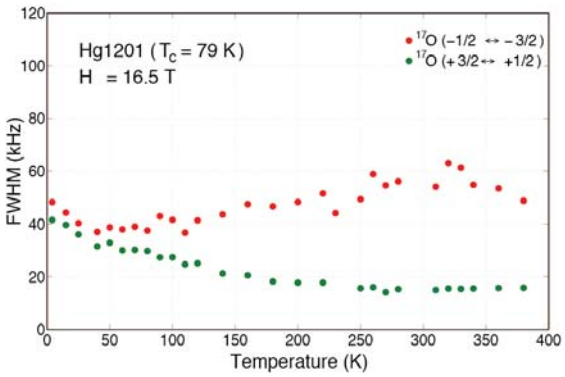

Fig.1 NMR linewidth as a function of temperature comparing upper and lower quadrupolar satellites.

Conclusions

Our preliminary results from two moderately underdoped samples (T_c = 79 K and 87 K) suggest that there are inequivalent planar oxygen sites but no evidence for field or temperature induced charge ordering to within the resolution of the experiments.

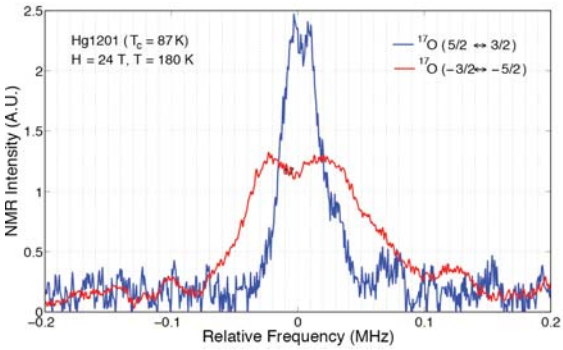

Fig.2 Spectra comparing upper and lower satellite spectra at 24 T show different linewidths and possibly a resolved splitting suggesting mainly two inequivalent planar oxygen sites.

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References

[1] Mounce, A.M., *et al*., Phys. Rev. Lett., **187**, 111003 (2013).
[2] Wu, T. *et al.* Nature *et al*. **477**, 191 (2011); Nature Comm. **4**, 2113 (2013).