Search for Charge Order in $HgBa_2CuO_{4+\delta}$

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Introduction

The nature of the pseudogap phase in cuprates is somewhat of a puzzle, variously identified with magnetic or charge ordering, a spin-gap or stripe-phase formation. One theoretical explanation of the pseudogap,[1] implies orbital current-loop ordering, thereby breaking time reversal symmetry. The currents have a three dimensional structure where local fields have been estimated [2] to be as large as ~200 G based on neutron scattering experiments on $YBa_2Cu_3O_{7-\delta}$ (Y123), discernible by NMR if there is no cancellation owing to symmetry. We have investigated this problem using ^{17}O NMR in $HgBa_2CuO_{4+\delta}$ (Hg1201).[3] However, recent NMR studies on $YBa_2Cu_3O_{7-\delta}$ have found field-induced charge ordering.[4] We have initiated a high-field study of ^{17}O NMR spectra in $HgBa_2CuO_{4+\delta}$ (Hg1201) to look for this phenomenon.

Experimental

We have performed ^{17}O NMR on the planar and apical sites of the single-layer, high-transition temperature cuprate Hg1201 in the underdoped pseudogap regime. Comparison of planar and apical ^{17}O NMR lines was performed in magnetic fields from 6.4 to 16.5 T from room temperature to 4 K on an underdoped single crystal having T_c of 74 K ($T_{c,opt}$ = 95 K). For magnetic fields lower than 9 T the work was performed at NU. The crystals were grown at the U of M. Oxygen isotope exchange and annealing and characterization was performed at NU.

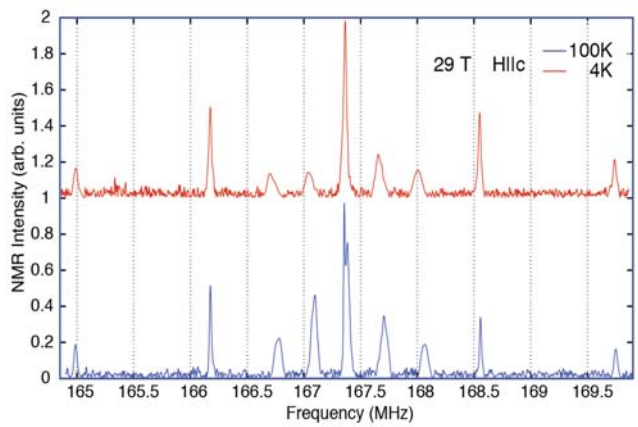

Figure 1. Oxygen NMR spectra in Hg1201 at H = 29 T. The frequency shifts with magnetic field constrain the existence of static loop currents. In future work we will look for field-induced charge ordering from temperature dependence vs. field of the shifts.

Results and Discussion

We measured magnetic field and angular dependence of the spectral shifts from 6.4 T to 16.5 T. The predictions for loop currents would engender a splitting at the apical site or produce broadening. Our resolution in each of these approaches is better than 1G with no evidence for static loop currents having two orders of magnitude higher resolution than required by theory.[2] A typical ^{17}O NMR spectrum, Fig. 1, shows planar and apical sites, central transition and quadrupolar satellites in the form of families of five lines per site. Weak hyperfine coupling of the apical oxygen leads to very narrow spectra. We show spectra for H = 29 T at 4 and 100 K. Field-induced charge ordering would be manifest in a change in the separation of the pairs of high and low order satellites not evident in this preliminary data.

Conclusions

We have not found evidence for orbital loop currents in $HgBa_2CuO_{4+\delta}$ from NMR.[3]

Acknowledgements

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