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Reduced size of ordered moments of a quasi 1d antiferromagnet Sr_2CuO_3

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The quasi one-dimensional antiferromagnet Sr_2CuO_3 exhibits Néel order of Cu^{2+} moments (S=1/2) at T_N = 5.41(1) K, as demonstrated by (1) almost resolution-limited magnetic Bragg reflections in neutron scattering measurements, and (2) spontaneous muon spin precession in zero-field muon spin relaxation (μSR) measurements. The temperature dependence of the order parameters are consistent between the two experimental techniques. From the neutron data, we obtained an upper-limit for the ordered moment size of $\sim 0.06\,\mu_B$. This indicates a significant moment reduction from quantum fluctuations. *

1. INTRODUCTION

One-dimensional spin systems with antiferromagnetic interactions have been investigated eagerly, because of pronounced quantum mechanical effects reflecting the low-dimensionality. For example, the 1d Heisenberg model with antiferromagnetic interactions takes a singlet ground state, regardless of the spin value of the localized moments. For the half odd-integer cases, the excitation spectrum is gapless and the correlation function shows a power-law decay [1, 2]. These features indicate the 'almost-Néel-ordered' ground-state of half-odd integer spin-chain. Hence, with finite couplings between the chains, half-odd-integer spin-chains are expected to show a Néel order, which has been observed in S=1/2 quasi one-dimensional antiferromagnets, such as $KCuF_3$ (T_N = 39K), $CuCl_2{\cdot}NC_5H_5$ (T_N = 1.7K) and Sr_2CuO_3 (T_N = 5.5K). Intuitively, the ratio of the Néel temperature to the intra-chain coupling (T_N/J) is a parameter to measure the extent to which a material is one-dimensional. So far, the antiferromagnet Sr_2CuO_3 has the smallest such ratio ($T_N/J \sim 5.5/1307 \sim 0.004$) [3, 4], suggesting that this compound is the best one-dimensional spin system currently available. We have investigated the magnetic ordered state of this material with muon spin relaxation (μSR) and elastic neutron scattering measurements.

2. RESULTS

Single crystal Sr_2CuO_3 ($\sim \phi 3\,\mathrm{mm} \times 2\,\mathrm{cm}$) was grown at Department of Applied Physics, University of Tokyo, employing the traveling-solvent-floating-zone (TSFZ) method. The crystal structure of Sr_2CuO_3 is shown in Fig.1. Chains of corner sharing

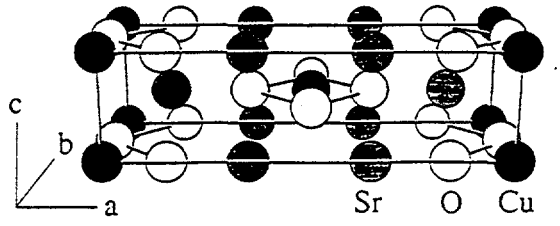

Figure 1:
The crystal structure of Sr_2CuO_3. The Cu-O antiferromagnetic spin-chain runs in the b-axis direction.

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