

Paramagnetic excitations in the spin ladder materials BaKFe_2S_3

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1. Introduction

Very recently, inelastic neutron scattering is performed on the polycrystalline samples of BaFe_2S_3 [9]. By fitting with a Heisenberg Hamiltonian, it shows that the one-dimensional antiferromagnetic ladder exhibits a strong nearest neighbor ferromagnetic exchange interaction ($S_{JR}=71\pm 4\text{meV}$) along the rung direction, an antiferromagnetic ($S_{JL}=49\pm 3\text{meV}$) along the leg direction and a ferromagnetic ($S_{J2}=-11\pm 2\text{meV}$) along the diagonal direction. The results reveal that the 1D AF-ordered ladder parent state of the BaFe_2S_3 exhibits similar spin interactions as parent compound of iron-based superconductors [4,9]. However, why the superconductivity is absent in the hole-doped $\text{Ba}_{1-x}\text{K}_x\text{Fe}_2\text{S}_3$, it still is an open question to be further clarified after mapping out the spectrum of magnetic excitations.

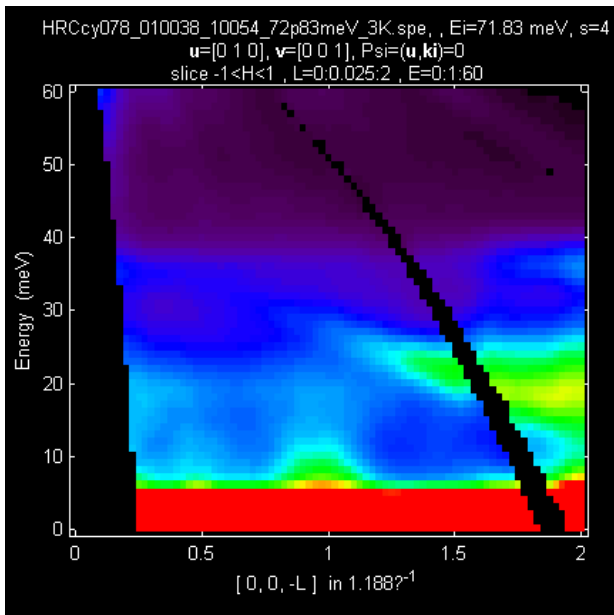
Recently, we have also performed time-of-flight neutron scattering experiments at HRC, JPARC on the BaFe_2S_3 single crystal samples. Spin fluctuations up to 80 meV are found to be similar with powder data but more details about the dispersion along L direction. This result agrees with an effective Heisenberg mode with a strong nearest neighbor ferromagnetic exchange interaction [9]. We then prepare about 5g $\text{Ba}_{0.85}\text{K}_{0.15}\text{Fe}_2\text{S}_3$ single crystal samples to measure the low energy excitation at TAIPAN triple-axis spectrometer at ANSTO. Because of the limit energy range and intensity, we only figure out the gapless spin excitations from 2- 15 meV, similar to iron pnictides [10]. To get the full picture about the high energy excitations, time-of-flight experiment is highly desired.

2. Experiment

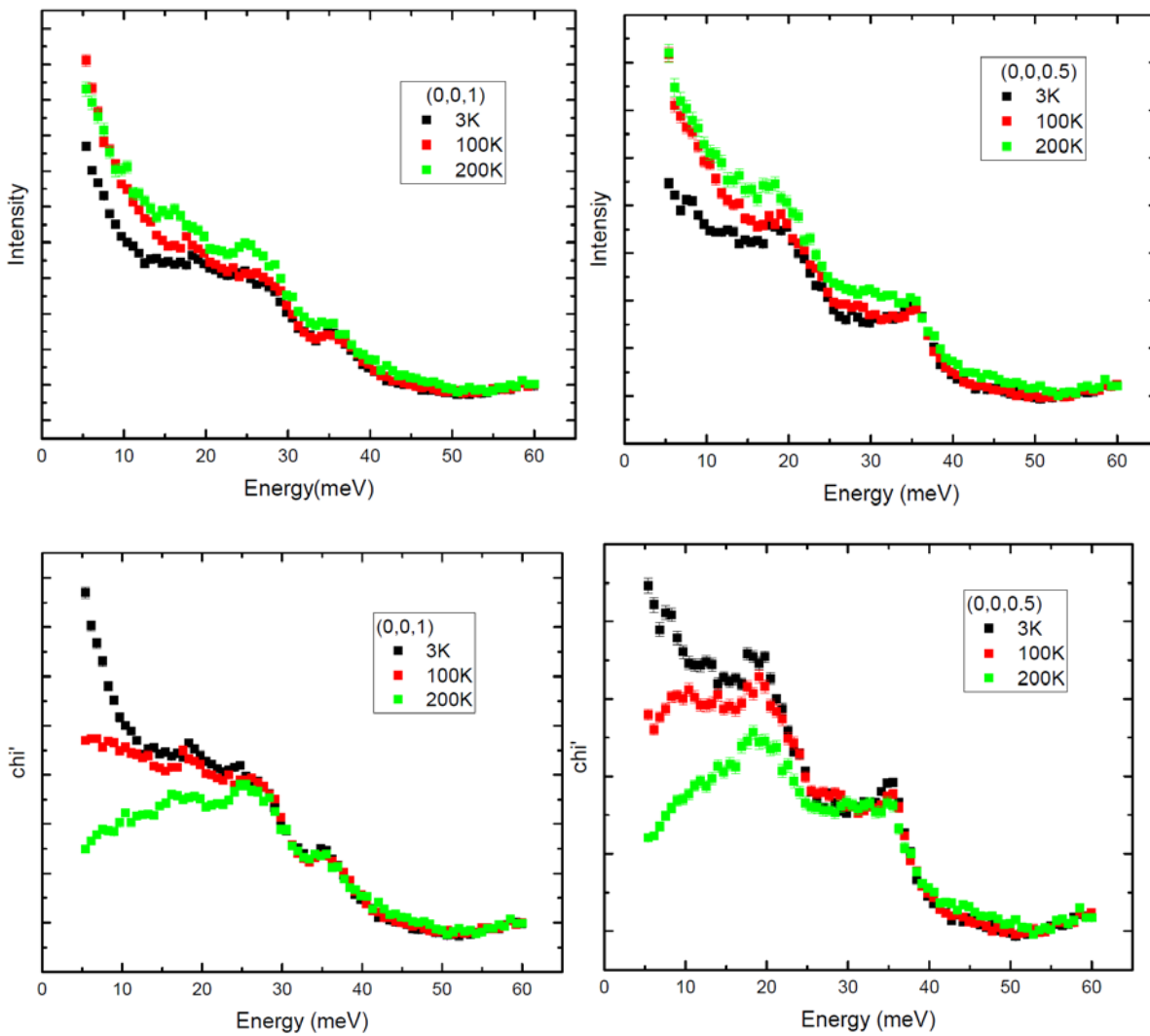
We thus try to study the paramagnetic excitations above T_N of $\text{Ba}_{0.85}\text{K}_{0.15}\text{Fe}_2\text{S}_3$ system. About 5 grams high quality single crystals have already been grown by self-flux method, more crystals will be prepared for this high temperature experiment. All of them will be co-aligned on aluminum plates with same orientation along c-axis due to the needle-like shape. This will allow us to measure the spin excitations along the leg of ladder. Incident neutron beam will be perpendicular to the plates. Several $E_i= 80, 150$ meV will be used to fully map the spin spectrum at high temperature $T=3\text{K}, 50\text{K}, 100\text{K}, 200\text{K}, 300\text{K}$.

3. Results

The mean dispersion is as shown figure.



A spin excitation could be clearly seen in the E-q relationship.



4. Conclusion

The spin excitation is looks like typical spin glass like excitation. The temperature dependence shows a big difference of parent compound. Further analysis is needed to compare with BaFeS