実験報告書様式（一般利用課題・成果公開利用）

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Experimental Report	承認日 Date of Approval 2014/6/14 承認者 Approver Ryoichi Kajimoto 提出日 Date of Report 2014/6/12
課題番号 Project No. 2013B0061 実験課題名 Title of experiment High-energy spin excitations in hole doped (Ba,K)Fe_2As_2 実験責任者名 Name of principal investigator Kazumasa Horigane 所属 Affiliation Aoyama-Gakuin University	装置責任者 Name of Instrument scientist Ryoichi Kajimoto 装置名 Name of Instrument/(BL No.) 4SEASONS/BL-01 実施日 Date of Experiment 2014 3/20-3/25 2014 4/5-4/7

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。（適宜、図表添付のこと）

Please report your samples, experimental method and results, discussion and conclusions. Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.

$Ba_{0.5}K_{0.5}Fe_2As_2$ (4.6g, single crystal)

KFe_2As_2(5.0g, single crystal)

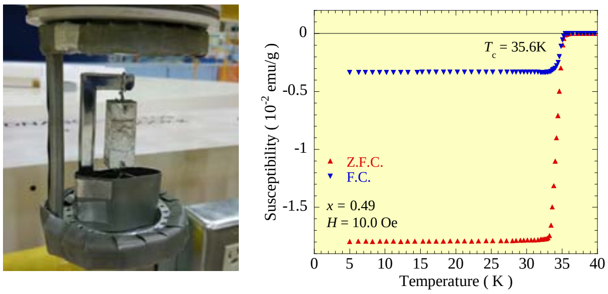

Fig.1 Photograph of the sample holder (left) and typical magnetic susceptibility data of our sample (right).

2. 実験方法及び結果（実験がうまくいかなかった場合、その理由を記述してください。）

Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.

We employed the multi-E_i method with incident neutron energies of E_i=201.8, 409, 720meV and incident beam was parallel to the c-axis. The measurement temperature was 5.5K and 45K at the beam power of 300kW. Throughout this report, wave vectors are specified in the tetragonal reciprocal lattice.

Figure 2-(a) shows the magnetic excitations of $Ba_{0.5}K_{0.5}Fe_2As_2$ (T_c=35.6K) for E_i=30meV data projected in the wave vector (Q_a=[h,h]) and energy transfer at T=5.5K. On cooling into the superconducting state, the resonance peak that is strongly coupled to the superconducting gap was observed around 16meV. This result is consistent with the previous our triple-axis measurement of this material.

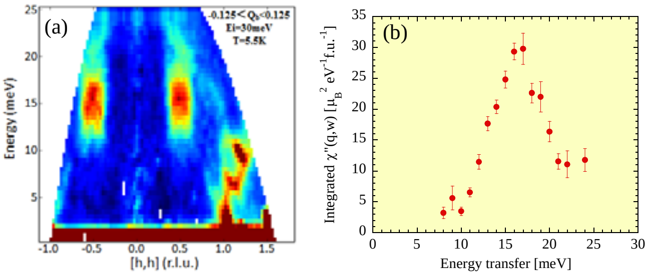

Fig.2 (a) Observed magnetic excitations in $Ba_{0.5}K_{0.5}Fe_2As_2$ at T=5.5K with an incident energy Ei=30meV along [h,h]. (b) Energy dependence of resonance peak intensity.

Figure 3-(a),(b) show the magnetic excitations for E_i=200meV data projected in the wave vector Q_a and Q_b(=[h,-h]), respectively. As for the longitudinal

direction, a practically vertical dispersion was discovered up to 100meV (Fig.3-(a)). On the other hand, we can see the clear dispersion along the transverse direction (Fig.3-(b)). To quantitative determine the spin-wave dispersion, the data were fit to Gaussian line shapes to estimate the peak positions of magnetic excitations.

We summarized the fitting result in Fig.3-(c). We found that the magnetic peak at Q_b=0 start to split into two peaks towards [h,-h] direction at 38meV and merge around magnetic zone boundary at 200meV. These data are compared to the dispersion relation in the linear approximation for a Heisenberg model with nearest-neighbor (J_{1a} and J_{1b}) and next-nearest-neighbor (J_2) interactions [1]. The red line in Fig.3-(c) show the expected zone-boundary spin waves assuming SJ_{1a}=62.9, SJ_{1b}=-26.0 and SJ_2=0.6meV. Heisenberg model can describe spin excitations of $Ba_{0.5}K_{0.5}Fe_2As_2$ below 200meV. Above 200meV, we newly found the very chimney structure such as magnetic excitation of Cr around magnetic zone boundary and persist up to 250meV (Fig.3-(d)). These results suggest that the magnetism of this compound is neither purely local nor purely itinerant, rather it is a complicated mix of the two.

As for the KFe_2As_2, we also performed inelastic neutron scattering in April 2014 because magnetic excitations still exist above 100meV (Fig.4-(a)). Fig 4-(b) shows E-Q map slices through the [h,-h] direction at 20K. Unfortunately, we can not see the magnetic signal above 20meV because of the sample degradation. However, it is noteworthy that this result is very similar to the previous INS of KFe_2As_2 [2]. In previous INS work on KFe_2As_2, incommensurate spin excitations converge into a broad spin excitation near E=20meV and disappear for energies above 25meV. Discrepancy between our data (Dec. 2012) and the previous INS work probably comes from the sample quality.

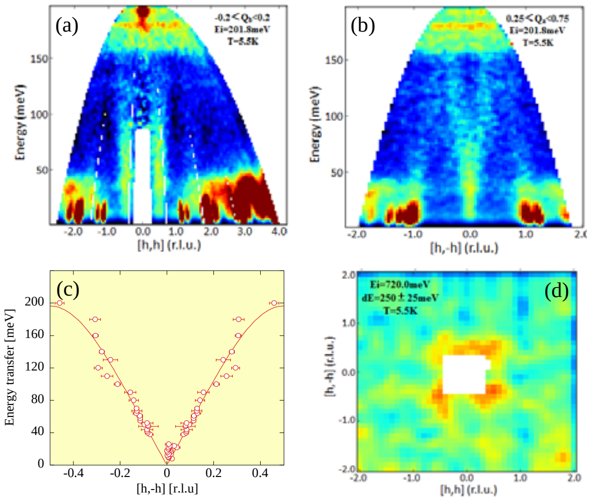

Fig.3 Observed magnetic excitations in $Ba_{0.5}K_{0.5}Fe_2As_2$ at T=5.5K with an incident energy Ei=200meV along (a) longitudinal and (b) transverse direction. (c) Spin-wave dispersion along [h,-h]. Solid line is model fit to the data. (d)Q_a-Q_b map (dE=250±25meV).

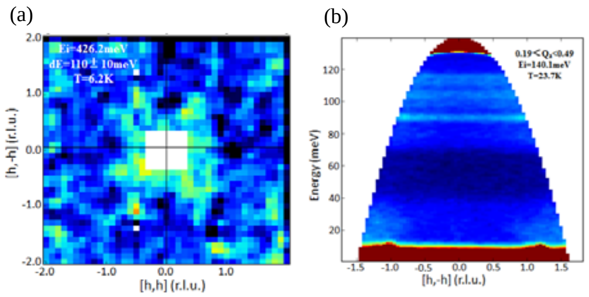

Fig.4 (a) Qa-Qb map (dE=110±10meV) of KFe_2As_2 (Dec. 2012) and E-Q map of KFe_2As_2 (Apr. 2014).

Reference

[1] J. Zhao et al., Nature Physics **5**, 555 (2009)

[2] M. Wang et al., Nature Communications **4**,2874 (2013)