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|  MLF Experimental Report | 提出日 Date of Report May, 24 2014 |
| 課題番号 Project No. 2013B0167 実験課題名 Title of experiment Spinon Excitations in an S=1/2 Antiferromagnetic Heisenberg Chain KCuGaF ₆ with Strong Dzyaloshinsky-Moriya Interaction 実験責任者名 Name of principal investigator Hidekazu Tanaka 所属 Affiliation Tokyo Institute of technology | 装置責任者 Name of responsible person Kenji Nakajima 装置名 Name of Instrument/(BL No.) AMATERAS (BL14) 実施日 Date of Experiment March 13 to 17, 2014 |

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.

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| 1. 試料 Name of sample(s) and chemical formula, or compositions including physical form. |
| KCuGaF ₆ |

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| 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. |
| <p>KCuGaF₆ is monoclinic $P2_1/c$ with lattice parameters $a=7.2856 \text{ \AA}$, $b=9.8951 \text{ \AA}$, $c=6.7627 \text{ \AA}$ and $\beta=93.12^\circ$. KCuGaF₆ is described as an S=1/2 one-dimensional (1D) antiferromagnet with the large antisymmetric interaction of the Dzyaloshinsky-Moriya (DM) type [1]. The 1D chain runs parallel to the c axis. The exchange constant was evaluated from susceptibility measurement as $J/k_B=103 \text{ K}$. No magnetic ordering was observed down to 0.35 K, which suggests good one-dimensionality. When an external magnetic field is applied in KCuGaF₆, a staggered magnetic field is induced perpendicular to the external field. Owing to the staggered field, the system can be mapped onto the quantum sine-Gordon model [2]. The elementary excitations characteristic of the quantum sine-Gordon model are solitons and breathers. The breathers are bound states of soliton and antisoliton and have hierarchical structures. All of these excitations were observed by high-frequency ESR measurements [1]. The ESR is limited to $Q=0$ excitations. Magnetic excitations over wide momentum in KCuGaF₆ have not been investigated so far.</p> <p>In the present experiment, we measured magnetic excitations in KCuGaF₆ using a cold-neutron diskchopper spectrometer AMATERAS (BL14) installed at J-PARC, Japan. the wave vector k_i of incident neutron was set to</p> |

2. 実験方法及び結果(つづき) Experimental method and results (continued)

be perpendicular to the c^* axis, assuming good one-dimensionality. Excitation data were collected at around 5K. Figure 1 shows contour maps of scattering intensity along the $\mathbf{Q}=(0, 0, Q_c)$ measured at zero field. Observed scattering spectrum consists of continuum with the period of $Q_c=2$, and the lower bound of the continuum excitation has a period of $Q_c=1$. These features of the scattering spectrum are characteristic of the 1D spin-1/2 Heisenberg antiferromagnet. The lower bound of magnetic excitations is well described by the des Cloizeaux and Pearson (dCP) mode [3]. Solid and dashed lines in Fig. 1 are the dCP mode and the upper bound of the spinon continuum [4] calculated with $J/k_B=103$ K, which was determined from previous magnetic measurement. Experimental result is in good agreement with theory. It is noted that the best fit to the dCP mode is obtained with a slightly large exchange constant of $J/k_B=106$ K. The sharp dCP mode observed in the present experimental setup of $k_i \perp c^*$ guarantees good one-dimensionality in KCuGaF_6 . Although KCuGaF_6 has large DM interaction, its remarkable effect on the magnetic excitations was not observed at zero magnetic field.

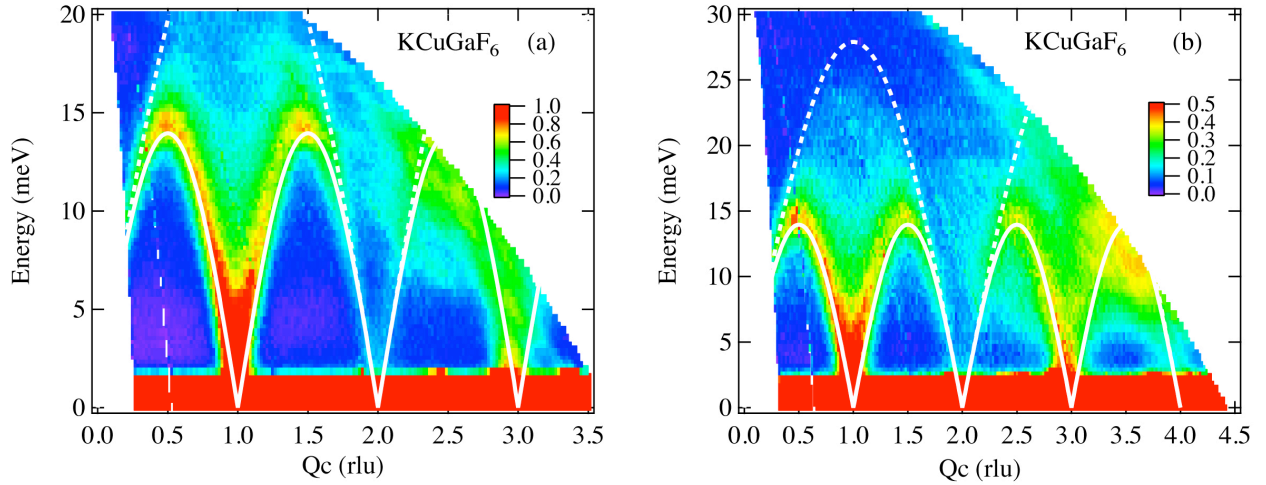


Fig. 1: Contour maps of scattering intensity along the $\mathbf{Q}=(0, 0, Q_c)$ measured with (a) $k_i=23.7$ meV and (b) $k_i=35.0$ meV. Solid and dashed lines denote the dCP dispersion relation and the upper bound of spinon continuum, respectively, calculated with $J/k_B=103$ K.

References

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