CROSS TOKAI Experimental Report J-PARC	承認日 Date of Approval 2017/9/19 承認者 Approver Ryoichi Kajimoto 提出日 Date of Report 2017/9/19
課題番号 Project No. 2016A0171 実験課題名 Title of experiment Spin dynamics of diluted triangular antiferromagnet hexagonal YMn0.8Al0.2O3 実験責任者名 Name of principal investigator Je-Geun Park 所属 Affiliation Seoul National University, Korea	装置責任者 Name of responsible person Kazuya Kamazawa 装置名 Name of Instrument/(BL No.) BL-01 4SEASONS 実施日 Date of Experiment April 22, 11:00 – April 27, 9:00

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.

15% Alumninum doped hexagonal manganite.

$YMn_{1-x}Al_xO_3$ (x=0.15)

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.

In low-dimensional systems, any kind of weak perturbation can induce new competing ground states and so lead to a novel rich phase diagram. A particularly important case is the spin system with nonmagnetic impurities. A single vacancy in non-collinear magnets can lead to qualitatively different behavior, which is completely different from that of the collinear magnets. Recent theoretical works predicted that dilute magnetic impurities may also affect the dispersion of magnetic excitation as well as the magnetic ground state. This impurity-induced texture should in turn affect thermal or spin transport through the material and may thus be of more than fundamental interest.

$YMn_{1-x}Al_xO_3$ is a promising model system as a two-dimensional dilute triangular antiferromagnet. Previous measurements on pure $YMnO_3$ showed that its dispersion is close to that of a non-collinear 120° spin structure. Substituting the magnetic Mn ion by non-magnetic Al and Ga showed a gradual decrease of T_N, which may be due to the impurity-induced spin canting as discussed above.

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

We performed INS experiment on h-$YMn_{0.85}Al_{0.15}O_3$ single crystals using thermal neutron time-of-flight (TOF) spectrometer 4SEASONS beamline. For this experiment, we co-aligned 4 crystals with total mass 1.5 g using our X-ray Laue diffractometer.

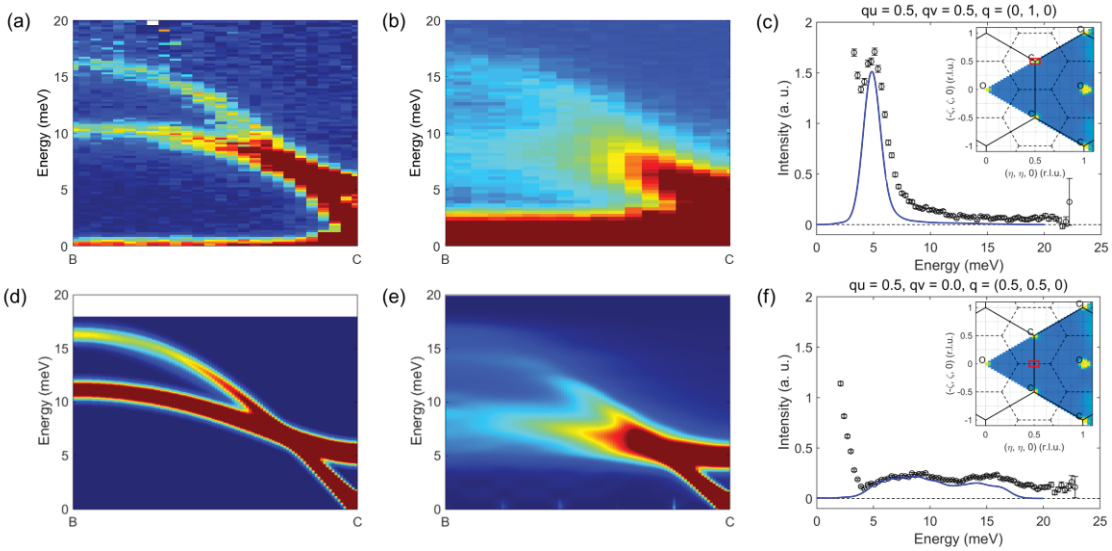

Figure 1. (a, b) INS spectra along B (1/2 1/2 0) – C (0 1 0) direction of (a) pure $YMnO_3$ obtained at MAPS beamline at ISIS and 15 % Al-doped $YMnO_3$ measured at 4SEASONS at J-Parc. (d, e) Theoretically calculated dynamical structure factor along B – C direction of (c) pure $YMnO_3$ and (d) 15 % Al-doped $YMnO_3$. (c,f) Constant-Q cuts at the (c) C point and (f) B point.

While the magnon of pure $YMnO_3$ shows the clear and sharp peak shape, nonmagnetic impurities in Al doped samples make the magnon signal broader and weaker (See Fig. 1 (a, b)). As the doping ratio increases, lower magnon branch also have a downward shift at the B point (zone boundary). It is noteworthy that the broadening effect in non-collinear system is not uniform over the Brillouin zone. Fig. 1 (c) and (f) show the constant-Q cuts at the magnetic Brillouin zone center (C point) and zone boundary (B point) of 15 % doped samples. At C point, linewidth of magnon branch remains unchanged. However, at B point the magnon undergoes the drastic broadening effect.

To explain such behavior, we constructed spin Hamiltonian of diluted magnetic system. Randomly distributed vacancy was addressed into the triangular lattice with 30 * 30 size. To find the resultant magnetic ground sate, optimization in mean-field level was carried out. It is consistent with the algebraic decay law predicted by previous theoretical study. Calculated dynamical structure factor (Fig. 1 (d) and (e)) show overall agreement with the experimental data.

In conclusion, we have identified the magnon modes and its linewidth broadening effect in diluted atiferromagnets $Mn_{1-x}Al_xO_3$ single crystals. The linewidth broadening has some momentum dependence. A possible scenario is the Umklapp scattering by the impurity-induced spin texture in non-collinear system. Upcoming INS experiment on 10 % Al – doped sample on 4SEASONS would help making a complete set of data and deepen our understanding on this system.