実験報告書様式（一般利用課題・成果公開利用）

（ ※本報告書は英語で記述してください。ただし、産業利用課題として採択されている方は日本語で記述していただいても結構です。）

CROSS TOKAI **Experimental Report** J-PARC	承認日 Date of Approval 2015/9/15 承認者 Approver Jun-ichi Suzuki 提出日 Date of Report 2015/5/9
課題番号 Project No. 2014B0102 実験課題名 Title of experiment Uniaxial-pressure control of skyrmion lattice phase in MnSi 実験責任者名 Name of principal investigator Taro Nakajima 所属 Affiliation RIKEN Center for Emergent Matter Science	装置責任者 Name of Instrument scientist Jun-ichi Suzuki, Kazuki Ohishi 装置名 Name of Instrument/(BL No.) TAIKAN/BL15 実施日 Date of Experiment 8th April, 2015 – 13th April 2015

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.

Name : MnSi
Chemical formula : MnSi
Form : Single crystal

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.

A chiral itinerant magnet MnSi is known to exhibit several helimagnetic phases including the skyrmion lattice phase below the magnetic transition temperature Tc～29 K [1]. Recent ultrasonic measurements on MnSi have revealed that magnetic phase transitions in this system are accompanied by anisotropic changes in elastic constants [2]. This implies that the application of anisotropic stress can be used to control the magnetic orders in MnSi. Actually, we have recently performed ac magnetic susceptibility measurements on MnSi under applied uniaxial stress and magnetic field, revealing that a uniaxial stress of up to 100 MPa applied parallel to the magnetic field suppresses the skyrmion lattice phase[3].

In the present study, we have performed small-angle neutron scattering (SANS) measurements on MnSi under applied magnetic field and “tunable” uniaxial stress at BL15(TAIKAN) in J-PARC, in order to directly observe the uniaxial-stress effects on magnetic orders in MnSi.

A single crystal of MnSi was grown by the Czochralski method. We cut the sample into a rectangular shape with dimensions of 3.6 mm × 2.3 mm × 2.4 mm. Each surface was normal to <100> direction of the crystal. We developed a uniaxial-stress insert, which is essentially the same as that used in Ref. 4, and loaded it into a vertical-field superconducting magnet. The uniaxial stress was applied on the smallest surfaces of the sample.

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

Note that by using this uniaxial-stress insert, we can control the magnitude of the applied uniaxial stress without changing temperature and magnetic field.

The relationships among the directions of the incident neutron beam, crystallographic axes, applied uniaxial stress and magnetic field are summarized in Fig. 1.

Figures 2(a)-2(c) show the uniaxial-stress dependence of the SANS pattern measured at 27.7 K under a magnetic field of 0.19 T, where the system exhibits the skyrmion lattice phase at 0 Pa. Since the magnetic field (H) was applied along the q_z direction, six-fold Bragg peaks corresponding to the SkX phase appear on the q_x-q_y plane, as was demonstrated in the previous work[1]. We observed two of the six magnetic reflections when the (110) direction is parallel to the q_y direction, and when the (110) direction is rotated by +/- 60 degrees from q_y direction toward the q_x direction. This is consistent with the previous study reporting the weak Q-anisotropy along (110) direction [1]. With increasing uniaxial stress (σ) applied along the q_z direction, two Bragg reflections corresponding to the conical phase appear along q_z direction. Figure 3 shows the σ-dependence of the integrated intensities of the magnetic reflections corresponding to these two phases, exhibiting that the system undergoes a σ-induced phase transition from the skyrmion lattice phase to the conical phase. This is consistent with the results of our ac magnetic susceptibility measurements.

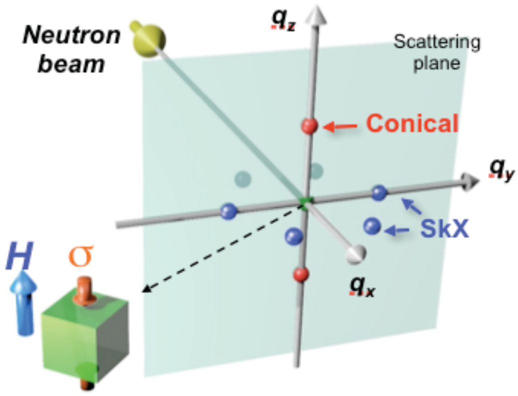

Fig. 1: Experimental configuration of in-situ small-angle neutron scattering measurement under tunable uniaxial stress. The σ and H were applied along [001] direction, and incident neutron beam is along [110] direction.

We also measured uniaxial-stress variations of the SANS patterns in the zero-field helical magnetic phase and the intermediate phase. The data analysis is in progress, and these results will be published elsewhere.

References: [1] S. Muhlbauer *et al.* Science **323**, 915 (2009), [2] Y. Nii *et al.* PRL **113**, 267203 (2014), [3] Y. Nii and T. Nakajima *et al.* (submitted), [4] T. Nakajima and S. Mitsuda *et al.* PRB **83**, 220101 (2011).

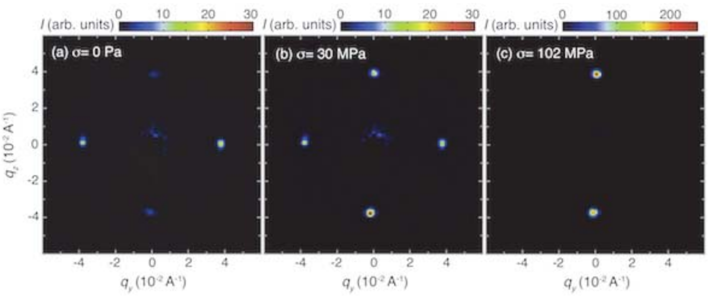

Fig. 2: Typical SANS patterns measured at (a) 0, (b) 30 and (c) 102 MPa at 27.7 K under applied magnetic field of 0.19 T.

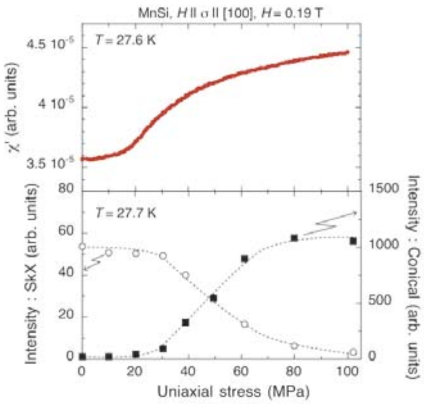

Fig. 3: Uniaxial-stress variations of ac magnetic susceptibility (upper panel) and integrated intensities of the magnetic Bragg reflections corresponding to the conical and skyrmion lattice phases (lower panel) measured at 27.6 K and 27.7 K under applied magnetic field of 0.19 T, respectively.