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Deciphering the New Magnetic State, "B-Phase", Found in MnSi at Low Temperatures, Using SANS and μSR Techniques

In cubic chiral magnets, Dzyaloshinskii-Moriya (DM) interactions within the chiral crystal structure result in diverse magnetic textures, including skyrmion lattices (SkL) and chiral soliton lattices, which hold promise for spintronic and magnonic devices. Among these, MnSi has been extensively studied due to the SkL formation in the so-called "A-phase"just below Tc.
Recently, it was suggested theoretically that at low temperatures, another metastable SkL phase, or a new phase of unknown nature, could exist near the critical magnetic field (Bc). This prediction of a new SkL phase at low T is in good agreement with the experiments reported in MnSi and Cu2OSeO3. On the other hand, ac susceptibility measurements in MnSi at low temperature, revealed a new anomalous region, termed "B-phase" , when the magnetic field was applied along the main diagonal <111>.
To clarify the nature of the "B-phase", we performed SANS measurements at TAIKAN in J-PARC and transverse field (TF)-μSR experiments at TRIUMF. At low temperatures and fields near Bc, SANS patterns revealed two peaks along the horizontal axis, corresponding to the magnetic Bragg peaks of the CH state. Notably, no diffraction peaks indicative of a six-fold-symmetric SkL were observed. Meanwhile, μSR results showed a distinct internal magnetic field distribution in the "B-phase", different from those in the CH or FFM phases, suggesting that the "B-phase"could involve a reorientation of Mn helices within the unit cell.

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