Neutron scattering study of an Eu-based diamond-lattice magnet

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Since the discovery of skyrmion lattice state in the chiral magnet MnSi [1], exotic spin textures carrying a topological number in magnets have been explored in this decade. While most of studies have focused on noncentrosymmetric magnets, recent research from our group reported discoveries of skyrmion lattice state in centrosymmetric intermetallics such as Gd_2PdSi_3 [2]. They have clarified that the skyrmions can be squeezed to 2-3 nm enhancing the topological Hall signal and at the same time, establishing a new design principle for topological spin textures.

Up to now, most skymion-hosting centrosymmetric magnets are categorized either hexagonal or tetragonal lattices, where competing exchanging interactions among the magnetic sites in (001) layers play an essential role to stabilize the modulated spin state. Limited number of studies has investigated centrosymmetric cubic lattices, except for a spinel sulfide $MnSc_2S_4$ [3], where more exotic spin textures have been proposed. The purpose of this study is to identify new topological spin textures in a metallic analogue $EuTi_2Al_{20}$ [4] and clarify the link between the spin structures and exotic magnetotransport properties due to emergent electromagnetic fields.

We performed neutron diffraction experiment at PONTA-5G using a single crystal of $EuTi_2Al_{20}$ in zero field. Figure 1(a) shows the intensity profile in the (*h*, *h*, 0) scan. We observed a magnetic diffraction peak at (1, 1, 0) at below the magnetic transition temperature, T_N = 3.2 K. The onset of the magnetic scattering coincides with the T_N as confirmed in the temperature dependence of the integrated intensity (Fig. 1(b)). We collected multiple magnetic diffraction peaks to clarify the extinction rule and found that the magnetic structure is consistent with longitudinal commensurate SDW with q = (1, 0, 0). This observation is an important step towards the understanding of the magnetic phase diagram and provide useful information for the in-field neutron diffraction measurement scheduled near future.

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[2] T. Kurumaji *et al.*, Science **365**, 914 (2019).
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[4] K. R. Kumar *et al.*, J. Phys.: Condes. Matter 28, 436002 (2016).

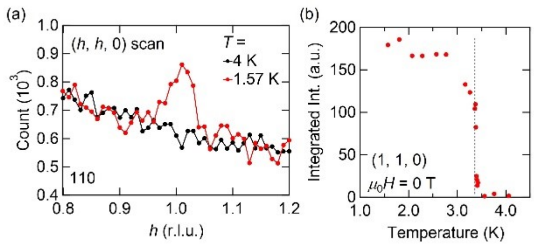

Fig. 1. (a) Neutron diffraction profile in the (*h*, *h*, 0) scan of an $EuTi_2Al_{20}$ single crystal measured below (red) and above (black) the transition temperature, 3.2 K. (b) Temperature dependence of integrated intensity of the (1, 1, 0) peak.