

Experimental report

27/06/2024

Proposal:

5-41-1261

Council:

4/2024

Title:

Magnetic order and magnetically-induced topological states in EuAgAs

Research area:

Physics

This proposal is a new proposal

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Samples:

EuAgAs

Instrument	Requested days	Allocated days	From	To
D9	4	4	13/06/2024	17/06/2024

Abstract:

This is a proposal to investigate two weak diffraction features observed previously in neutron and synchrotron x-ray diffraction experiments on the topological semimetal EuAgAs. Measurements on D3 established that EuAgAs orders into a helical magnetic structure below $T_N = 12$ K. However, a separate weak diffraction peak appears below 8K, suggestive of a possible second magnetic transition which may be associated with a peak observed in the susceptibility at $T = 8$ K. In addition, 2q satellites were observed below T_N in the x-ray experiment. We should like to investigate these two unexplained features in order to gain a more complete picture of the magnetic ordering in EuAgAs. We will accomplish this using D9 with hot neutrons, which are advantageous for this highly absorbing sample. We will measure the Q and temperature dependence of the unexplained peaks, and record the integrated intensities of selected peaks for structural analysis.

The aim of this measurement was to extend and complete a study of the intermetallic compound EuAgAs, which is a candidate for a magnetically induced nodal metal. Previously, we studied the magnetic order in this compound using spherical neutron polarimetry on D3 [1].

The hexagonal unit cell of EuAgAs is described by space group $P6_3/mmc$, with two formula units per unit cell, see Fig. 1. Magnetic order occurs below $T_N = 12$ K [2]. The Eu atoms have a localized spin $S = 7/2$, and the Ag and As atoms do not carry a magnetic moment. In previous measurements at the BESSY synchrotron using X-ray resonant magnetic scattering at the Eu M_5 edge we found magnetic Bragg peaks corresponding to Eu magnetic order with an incommensurate propagation vector $\mathbf{q} = (0, 0, q)$ with $q = 0.52$ to 0.55 depending on temperature. We also observed weak $2\mathbf{q}$ satellites, whose origin could be either magnetic or structural.

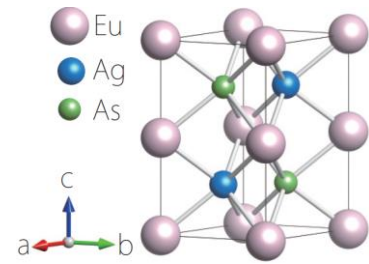


Figure 1. Unit cell of EuAgAs.

During the prior measurement on D3 we had performed a few Q scans parallel to $(0, 0, L)$ and noticed that in addition to the magnetic Bragg reflections at $(0, 0, q)$ positions, a small secondary peak appeared on the side of the main peak at temperatures below about 8K. The objectives of the measurements on D9 were to characterise this secondary order parameter and to search for any evidence for a lattice distortion due to magnetostriction, which could perhaps be linked to the $2\mathbf{q}$ scattering observed in the resonant magnetic X-ray scattering data.

The measurements were performed on D9 with a wavelength of $\lambda = 0.84$ Å. Hot neutrons are advantageous for Eu compounds because the strong neutron absorption has a minimum for wavelengths of around 0.7 to 0.8 Å. We employed one of the two single crystals measured previously on D3. The crystal has a mass of 103 mg. It was mounted in the D9 4-circle cryostat with $(H, H, 0)$ and $(0, 0, L)$ in the horizontal plane. We performed Q scans parallel to $(0, 0, L)$ through a number of magnetic Bragg peaks to establish the position which gave the best resolution. Based on the results, we subsequently performed $(1, 1, L)$ scans at a number of temperatures from 2 K to 15 K. The results are shown in Fig. 2. On cooling below $T_N = 12$ K, the magnetic propagation vector $\mathbf{q} = (0, 0, q)$ shifts from $q = 0.55$ to 0.52 , and then below $T = 8$ K a second peak appears with propagation vector $(0, 0, 0.48)$. The second peak grows with decreasing temperature down to 2 K.

In addition to the Q scans, we recorded large sets of nuclear Bragg reflections at $T = 2$ K and 15 K. and also performed Q scans parallel to $(0, 0, L)$ for a few selected Bragg reflections. These data are being analysed to look for any changes in structure that might accompany the two magnetic order parameters.

References

- [1] ILL Experimental Report on DIR-295 (2023).
- [2] A. Laha *et al*, Phys. Rev. B **104**, L241112 (2021)

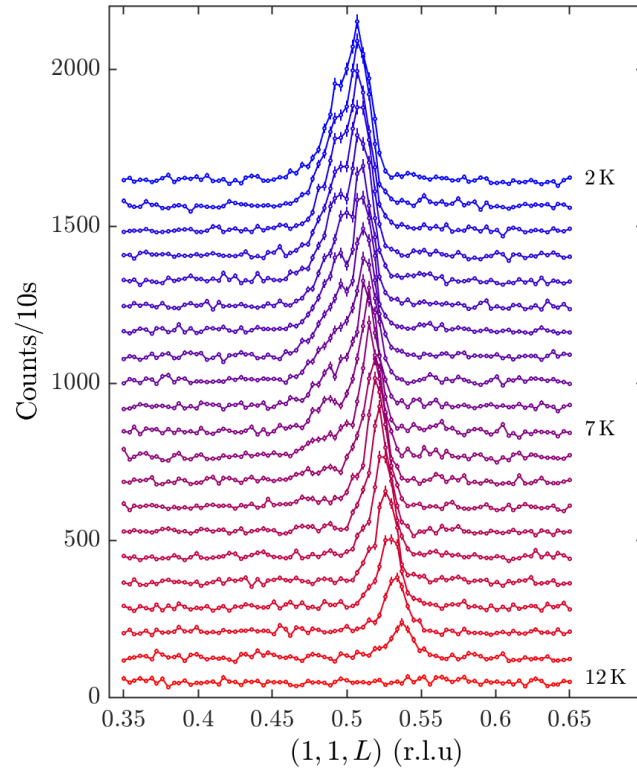


Figure 2. Temperature dependence of the scattering from EuAgAs along $(1, 1, L)$. Between 8K and $T_N = 12$ K there is a single beak whose position varies slightly with temperature. Below 8K, a second peak appears at $L = 0.48$.