Experimental report

02/05/2022

Proposal: 5-41-1176 **Council:** 4/2021

Title: Ground state magnetic structure ofaxion insulator candidates EuIn2As2 and EuIn2P2.

Research area: Physics

This proposal is a new proposal

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Samples: EuIn2As2
EuIn2P2

Instrument	Requested days	Allocated days	From	To
D3 CPA	8	5	11/06/2021	17/06/2021

Abstract:

Axions particles are excitations of a quantum field that has been proposed 40 years ago to reconcile a key problem with the current standard model of particle physics. This proposal relates to the search for condensed matter systems that can harbor axions, which have not yet been observed in vacuum. Very recently, the layered antiferromagnets EuIn2As2 and EuIn2P2 were proposed as examples of crystalline materials that can host axion-like quasi-particles. However, the true ground state magnetic structure of these materials, crucial for the stabilization of axions, remain ambiguous. We aim to perform careful spherical neutron polarimetry measurements with the CRYOPAD to elucidate if the Eu moments display the proposed "broken" helix magnetic order. The results will establish whether or not EuIn2As2 and EuIn2P2 can host axion quasi-particles.

Recently, theoretical studies have predicted that axions can live in certain crystals that possess very specific coupling between electric and magnetic properties. These materials (axion insulators) are ideal testbeds for the understanding the behaviour of axion quasi-particles. One candidate material class is the hexagonal EuIn2P2, which crystallises in the P63/mmc space. The magnetization as a function of temperature of both compounds display an anomaly at ~25 K, signalling the onset of anti-ferromagnetic (AFM) order on the Eu sublattice. To predict the magneto-electric properties of EuIn2P2, which are crucial to the behaviour of the axion quasiparticles in the material, it is imperative to identify the Eu spin configuration of EuIn2P2.

We performed spherical neutron polarimetry on a single crystal of EuIn2P2. We find that a L even reflection appears below 25 K. The full polarization matrix of these reflections suggest that the magnetic order is a commensurate spin helix. Upon further cooling, below 20 K, we find that the L even reflections also gain in intensity, which is indicative of a spin reorientation of the Eu moments. Further experiments are currently underway to test the various hypothesis.