Experimental report

15/02/2018

Proposal: 5-32-834 **Council:** 4/2016

Title: Investigation of the exotic low temperature ground state of the S_eff=1/2 pyrochlore antiferromagnet Ce2Sn2O7 - continuation

Research area: Physics

This proposal is a continuation of 5-32-809

Main proposer: **Romain SIBILLE**

Experimental team: Romain SIBILLE
Tom FENNELL
Elsa LHOTEL

Local contacts: Andrew WILDES

Samples: Ce2Sn2O7

Instrument	Requested days	Allocated days	From	To
D7	4	4	02/12/2016	06/12/2016

Abstract:

We have recently pointed out the existence of a novel exotic magnetic state developing at subKelvin temperatures in the Ce3+ pyrochlore stannate. The spin system of this compound is characterized by a thermally isolated mJ=3/2 Kramers' doublet at low temperature, providing effective spin 1/2 moments on a pyrochlore lattice. These spins are characterized by a strong Ising <111> anisotropy and the material does not order down to the lowest investigated temperature (0.02 K). However, Ce2Sn2O7 develops a correlated regime for temperatures below 1 K, as evidenced by a drop of the effective magnetic moment. In a previous experiment on D7 we have used XYZ polarization analysis in order to look for magnetic correlations at low temperatures but we did not find anything. Here, we really want a basic magnetic signal from Ce2Sn2O7 by comparing different temperatures in the paramagnetic regime. Ce2Sn2O7 is a very intriguing compound and so far we have the only sample and no magnetic signal from the groundstate doublet, so we need to define where one does exist and where it vanishes.

Experimental report for experiment 5-32-834 on D7

"Investigation of the exotic low temperature ground state of the S_{eff} = 1/2 pyrochlore antiferromagnet $Ce_2Sn_2O_7$ - continuation"

After the initial experiment using a dilution fridge on D7, and the absence of apparent magnetic scattering that would characterize the low-temperature correlated liquid state of $Ce_2Sn_2O_7$, we have realized a second experiment on D7 using an orange cryostat. Our aim was to follow the evolution of the magnetic moment between the high- (uncorrelated, first CEF level partially populated) and moderate- (uncorrelated, ground CEF level solely populated) temperature regimes. If we had managed to observe this change expected from the paramagnetic behavior of $Ce_2Sn_2O_7$, our vanishing signal at low temperature might then point to an exotic singlet state. We didn't see anything different between 1.5 and 300 K. We didn't recover a larger response from the full moment, but, after intense discussions with our instrument scientist, we believe possible that one has to scatter inelastically from the excited states, and this inelastic scattering cannot be accepted by the mirrors of D7, so that one cannot see any additional response due to the partial population of the first CEF level.

We are continuing our efforts to understand the true nature of the low-temperature state of $Ce_2Sn_2O_7$. One interesting possibility is that – given the dipole-octupole nature of the ground state doublet determined from INS, see experiment 4-03-1716 report – the reduction of the effective magnetic moment measured in the macroscopic susceptibility could be due to octupolar correlations. We plan to produce new samples and to investigate this using, for instance, TOF INS with access to a large range of scattering angles in order to look for signatures of octupolar correlations.