Experimental report

24/09/2024

Proposal: **5-31-2933** **Council:** 10/2022

Title: Magnetic transitions in the quasi-two-dimensional van der Waals system Ce2Te5

Research area: Physics

This proposal is a new proposal

Main proposer: **Devashibhai T. ADROJA**

Experimental team: Clemens RITTER

Local contacts: Clemens RITTER

Samples: Ce2Te5

Instrument	Requested days	Allocated days	From	To
D20	3	3	29/06/2023	02/07/2023

Abstract:

Low-dimensional systems often exhibit electronic instabilities leading to charge density waves (CDWs) or superconductivity. Recent studies have focused on the high-temperature CDW materials RTen (R= rare earth, n = 2, 3). Ce2Te5 has a crystal structure intermediate between that of CeTe2 and CeTe3, consisting of alternating single and double Te planes sandwiched between CeTe block layers. Magnetic studies show two clear anomalies at 5.1 and 2.3 K, which correspond to a ferrimagnetic and a possible AFM transition, respectively. Resistivity and heat capacity studies further confirm a third transition at 0.9 K and a fourth at 0.4 K. This cascade of phase transitions in Ce2Te5 has been confirmed through our very recent muon spin rotation measurements, which reveals changes in the internal field across theses transitions. To get direct information on the magnetic structures across these transitions, we propose to carry out a neutron powder diffraction study on the D20 high-flux diffractometer.

Magnetic transitions in the quasi-two-dimensional van der Waals system Ce_2Te_5

Proposal No. 5-31-2933, 23-04- EASY-1185

Abstract: Low-dimensional systems often exhibit electronic instabilities leading to charge density waves (CDWs) or superconductivity. Recent studies have focused on the high-temperature CDW materials RTe_n (R= rare earth, n = 2, 3). Ce_2Te_5 has a crystal structure intermediate between that of $CeTe_2$ and $CeTe_3$, consisting of alternating single and double Te planes sandwiched between CeTe block layers. Magnetic studies show two clear anomalies at 5.1 and 2.3 K, which correspond to a ferrimagnetic and a possible AFM transition, respectively. Resistivity and heat capacity studies further confirm the third transition at 0.9 K and a fourth at 0.4 K. This cascade of phase transitions may be caused by the presence in Ce_2Te_5 of two distinct instabilities responsible for the magnetic orders in $CeTe_2$ and $CeTe_3$. To clarify the complex magnetic behaviour, we propose to carry out a neutron diffraction study on D20 high-flux diffractometer.

Experimental results and discussion:

D2B: We check the quality of Ce2Te5 powder sample on the high resolution diffractometer D2B at 300K. We found that about 9% of impurity phase of Tellurium.

On D20 we first measure the Ce_2Te_4 powder sample in a dilution fridge using a Cu-can and He-exchange gas. We collected data at 0.13 K, 0.6 K, 1.5 K, 2.6 K, 4.1 K,4.4 K, 4.7 K, 5.1 K, 5.6 K, 6.1 K, 7.1 K and 8 K. It was found that there is no change of magnetic peak positions as the temperature is changed. There is only one type of magnetic order over the whole range of temperatures.

In the second measurements on D20 neutron diffraction study was performed on the same sample using He-4cryostate between Data were collected at 1.7 K, 3 K and 8 K to investigate the magnetic structure.

The ND pattern at 8 K, above the magnetic ordering temperature, confirmed the single phase nature of Ce_2Te_5 sample Fig. 1(a). The difference pattern between 1.5 K and 8 K revealed magnetic ordering of Ce ions. Using the Fullprof suite's K-Search program, a commensurate propagation vector k = [0, 0, 0] was identified for the magnetic peaks at 1.5 K. Refinement showed ferromagnetic alignment of Ce moments along the b-axis, with only one Ce site (Ce1) carrying a magnetic moment of ~0.8 μ_B/Ce-atom at 1.5 K see Figs. 1(b) and Fig.2 (magnetic structure).

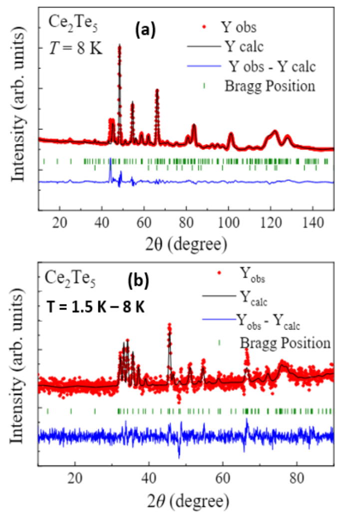

Fig.1 Refinement of the diffraction pattern of Ce_2Te_5 (a) at 8 K and (b) at temperature difference data 1.7 – 8 K.

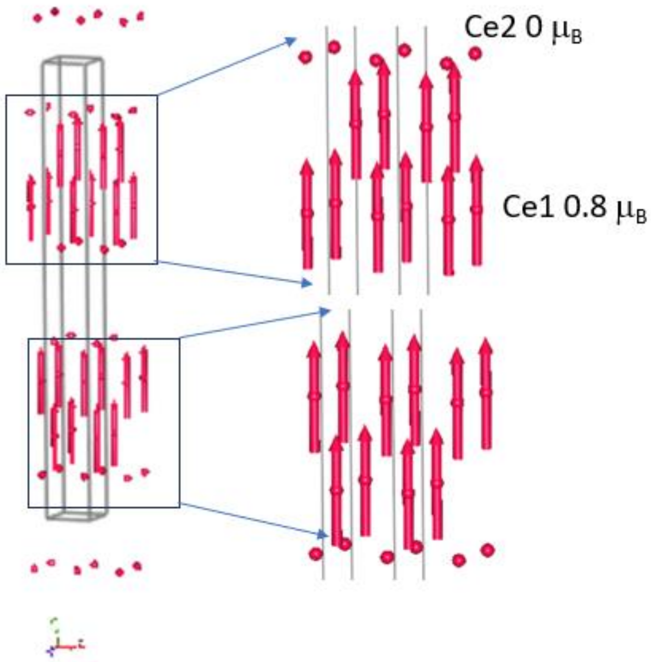

Fig. 2 Magnetic structure of Ce_2Te_5 at 1.5 K