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M.N. Miheev Institute of Metal Physics UB RAS

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MAGNETIC PROPERTIES OF Cu_2MnBO_5 LUDWIGITE IN WEAK MAGNETIC FIELDS

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Cu_2MnBO_5 ludwigite is one of the most prominent heterometallic representative of the oxyborate family with a ludwigite structure. Nowadays, this compound is the only heterometallic ludwigite whose magnetic structure has been investigated experimentally using the neutron diffraction [1]. Compared to other isostructural analogues [2,3], Cu_2MnBO_5 has a relatively high magnetic ordering temperature $T_C = 92$ K and a sufficiently high magnetic moment, indicating a ferrimagnetic type of ordering. The quasi-low-dimensional ludwigite structure contains such structural elements as zig-zag walls and three-legged ladders consisting of metal-oxygen octahedra [4]. The unit cell of ludwigites contains $Z = 4$ formula units and thus has 12 magnetic ions in the case of Cu_2MnBO_5. There are 4 nonequivalent positions for metal cations. According to neutron diffraction data the compound under investigation has a complex magnetic structure which contains 4 pairwise almost anticollinear magnetic sublattices (see Fig. 1). The directions of magnetic moments do not coincide with the directions of the main crystallographic axes. The sublattices oriented at an angle of approximately 60 degrees to each other [1].

Initially, the study of Cu_2MnBO_5 magnetic properties was carried out using PPMS manufactured by Quantum Design [5]. The magnetization of a single-crystal sample was measured in a magnetic field applied both along the a axis of the crystal and in the plane perpendicular to one. The range of the magnetizing field was up to $H = 1$ kOe. During the measurements, it was revealed in the ZFC mode the region of negative magnetization fixed in a fairly wide temperature range in the ordered phase (see Fig. 2). This observation was an artifact of the experiment. Thus, it was not allowed to obtain the real dependences of magnetization in the ZFC mode using the PPMS device.

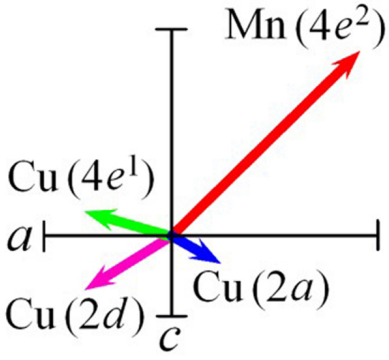

Figure 1. Orientations of the magnetic moments [1]

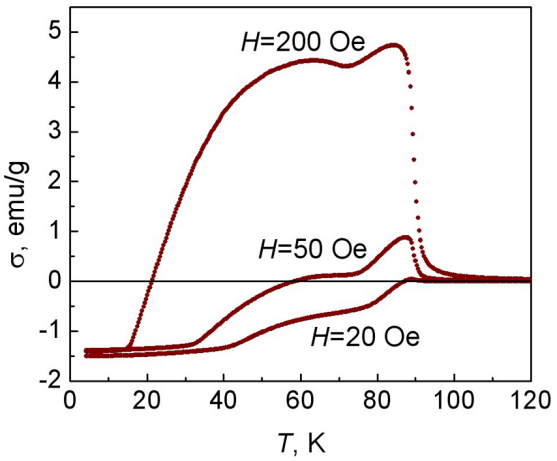

Figure 2. Temperature dependences of magnetization measured in the ZFC mode with PPMS

Since there was not enough confidence in the reliability of the obtained results, precision measurements of the single-crystal Cu_2MnBO_5 magnetization were performed with a highly sensitive SQUID

magnetometer [6] designed and made in Kirensky Institute of Physics. Cu_2MnBO_5 single crystal weighting 14.4 mg was oriented by the crystallographic *a*-axis parallel to the magnetizing field. Measurements of the magnetic moment of the sample were performed in low and ultralow magnetic fields ($0 < H < 10$ Oe), and the field sign was both positive and negative. It was found that the behavior of the magnetic moment during the inversion of the magnetizing field of 1÷10 Oe is absolutely symmetric (see Fig. 3 (*a*, *b*). Slight asymmetry begins to appear in a weaker field $H = 0.1$ Oe (see Fig. 3(*c*)). This is most likely caused by the presence of a slight bias of the magnetizing field. Fig. 3(*d*) shows the results of magnetic measurements in a quasi-zero field. The feature observed here in the temperature range 80÷92 K is probably related to the compensation point which is typical for ferrimagnets. Seeing the linear magnetic field dependence of the magnetization the estimation of the residual field is about 0.005 Oe. The incomplete shielding of the geomagnetic field in particular could cause it.

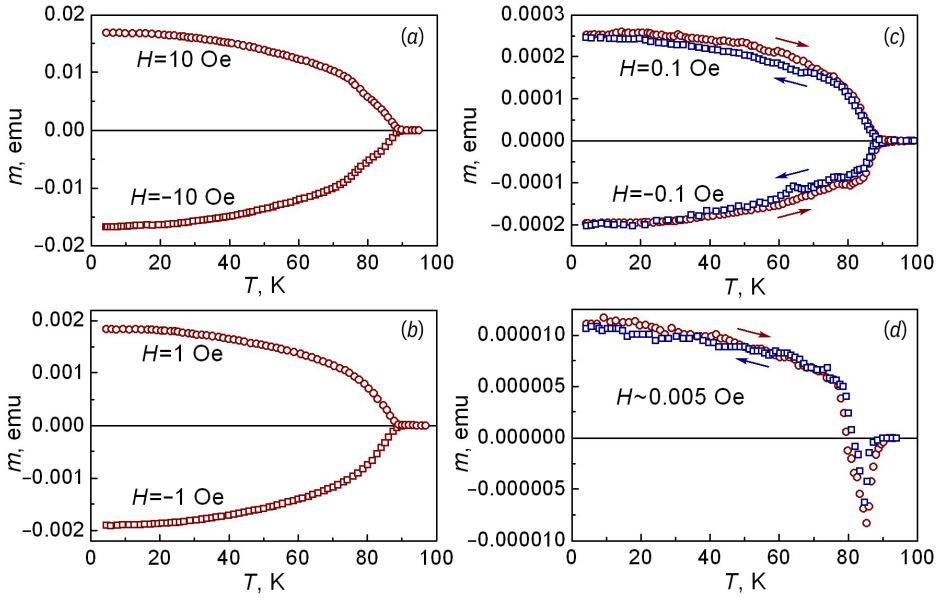

Figure 1. Temperature dependences of Cu_2MnBO_5 magnetic moment measured in a magnetic field of ±10 Oe (*a*); ±1 Oe (*b*); ±0.1 Oe (*c*); ∼0.005 Oe (*d*)

Thus, a carefully performed study of Cu_2MnBO_5 ludwigite magnetization in weak magnetic fields using SQUID magnetometer [6] definitely proves the absence of a magnetic moment at $H = 0$ in the ZFC mode. Incorrect data was obtained with the PPMS due to the presence of an uncontrolled significant residual magnetic field in a superconducting solenoid. The appearance of the residual field is evidenced by both our own observations and by the observations of the others authors [7].

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