Spin Dimer Magnet $SrCu_2(BO_3)_2$ and Dioptase Minerals in High Fields

The goal of this project was to complete the high-field neutron scattering investigations of Shastry-Sutherland frustrated magnet $SrCu_2(BO_3)_2$ and prepare for the new neutron experiments in high magnetic fields under pressure. In addition systematic magnetization measurements in pulsed magnetic fields up to 30 T have been performed on a low dimensional magnetic system – natural gem crystal green dioptase and its dehydrated modifications blue and black dioptase.

The single visit program can be divided in three parts. The first one was dedicated to discussion of the results obtained on $SrCu_2(BO_3)_2$ (SCBO) in the previous neutron experiment in high fields and preparation for the next high-field neutron experiment under high pressure [1]. SCBO is one of the most prominent examples of coupled spin dimer magnet with strong frustration, a realization of Shastry-Sutherland system, which has stimulated a large number of experimental and theoretical investigations, see e.g. [2] and references therein. As a result of these discussions, a dedicated 1 GPa high-pressure cell compatible with a dilution cryostat of the 26T magnet at HZB has been designed as shown in Fig.1 The application of high pressure should allow reaching the first (1/3) magnetization plateau of SCBO at fields lower than 26T (see Schneider et al, Phys. Rev. B 93 241107 2016) which are accessible at HFM/EXED at HZB.

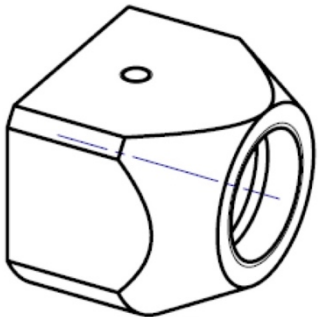

Fig. 1 High-pressure cell designed by Prof Uwatoko (ISSP, Kashiwa) for the HFM/EXED experiment on SCBO.

The second part was devoted to the magnetization measurements in pulsed fields up to 30 T on another quantum magnet – gem crystal of natural (green) dioptase (GD), $Cu_6[Si_6O_{18}]\cdot 6H_2O$, and its high-temperature dehydrated modifications blue (BD) and

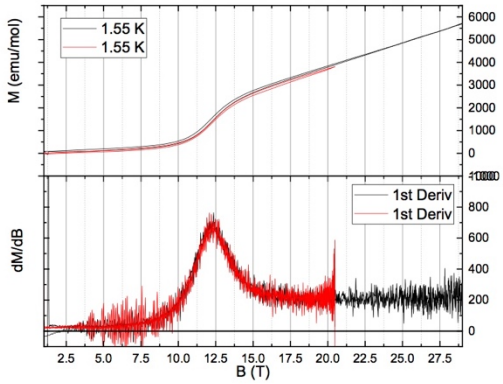

Fig. 2 High-field magnetization measurements (top) and (its first derivative) as function of magnetic field for green dioptase.

the c-axis of the hexagonal lattice and only one Cu in-plane neighbor forming a threefold spin-1/2 network. It is known that if a magnetic field is applied along the c-axis in GD there is a spin-flop transition around 13 T (Fig. 2) [4]. Nothing is however known about high field behavior of the BD and DD. We performed measurements for all three samples and could detect the spin-flop transition in GD at 12.5T and similar transitions in BD and DD appearing at lower fields [5].

Finally, following the recently signed MoU between Tohoku University and HZB, possible collaboration project have been discussed. They include common use of IMR instruments at JRR3 research reactor after its restart and development of pulsed magnetic field capabilities for synchrotron BESSY-II at HZB.

References

[1] K. Kakurai et al, Research proposal HFM-191-00024 "Direct observation of spin superlattice under pressure and magnetic field in the Shastry-Sutherland system SrCu2(BO3)2"

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