Magnetism of single-crystalline clinoatacamite, $Cu_2Cl(OH)_3$, a distorted antiferromagnetic kagome compound

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Model compounds of frustrated (quantum) spin systems can often be found realized in natural minerals. Among them the mineral clinoatacamite, $Cu_2Cl(OH)_3$, has been discussed as a frustrated quantum spin system in the past [1–5]. It is the end-member compound of the $Cu_{4-x}Zn_x(OH)_6Cl_2$ family with $x = 0$ and thus is structurally related to the mineral herbertsmithite with $x = 1$. Clinoatacamite crystallizes in a monoclinic structure with the space group $P2_1/n$ [6]. In the past, studies on polycrystals have shown that this material undergoes magnetic transitions at 18.1 K and 6.4 K [1]. A neutron diffraction study on deuterated clinoatacamite powder has revealed magnetic reflections with a propagation vector $\mathbf{q} = (0, 0, 0)$ below the lower transition temperature [3]. Recently, we have carried out band-structure calculations for clinoatacamite which indicate that its crystal structure can be read as antiferromagnetic kagome layers which are coupled ferromagnetically.

Here, we present the results of our magnetic characterization of mineral clinoatacamite single crystals by means of thermodynamic as well as neutron diffraction measurements in zero and applied magnetic fields. We have found that at low temperatures ~ 6.4 K there is a double magnetic transition and that the region of the phase diagram between 6.4 and 18.1 K contains several field-induced phases of unknown nature with a complex field-evolution ($\mathbf{H} \parallel b$ axis). We further characterize the magnetic behavior of clinoatacamite by means of single-crystal neutron diffraction.

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