TECHNISCHE UNIVERSITÄT DRESDEN

IFMP Institut für Festkörper- & Materialphysik

IFMP Seminar

Date: Tuesday, December 07, 2021, at 14:50

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Speaker: **Leonie Heinze**
TU Braunschweig

Title: **The Natural Mineral Atacamite, $Cu_2Cl(OH)_3$, as Model Compound of the Frustrated $S = ½$ Sawtooth Chain**

Abstract: In frustrated magnetic systems the local geometries and the magnetic interactions are incompatible, which can lead to the suppression of magnetic order. As a consequence, a multitude of complex and novel magnetic states can arise, such as quantum spin liquids and magnetization plateaus. In order to test these theoretical concepts, suitable model systems are identified and studied experimentally and it has been shown in the past that some can be found among natural minerals (see for instance Refs. [1,2]). Recently, the mineral atacamite, $Cu_2Cl(OH)_3$, has been established as a unique model compound of the $S = ½$ sawtooth chain [3,4], which is a seminal model of frustrated quantum magnetism. Theoretically, this model of corner-sharing triangles arranged in a chain has been studied for decades (see for instance Ref. [5]) and, *e.g.*, ½-magnetization plateaus were predicted.

In the case of atacamite, the dominant magnetic coupling $J_4 \sim 360$ K runs linearly along the chain spine, the secondary magnetic coupling $J_3 \sim 102$ K within the sawtooth triangles. Together with residual interchain couplings of a few Kelvin, atacamite is driven into a long-range ordered antiferromagnetic (AFM) ground state below $T_N = 8.4$ K. Here, the spin systems of the two inequivalent Cu sites are aligned almost perpendicular to each other [3]. This AFM phase is suppressed in magnetic fields of ~ 30 T for $\mathbf{H} \parallel b$, where an unusual and wide plateau-like magnetization at $M \sim M_{sat}/2$ has been found. This magnetization behavior, however, is not originating from plateau physics of the quantum sawtooth chain and is likely to stem from the weak 3D connectivity of the sawtooth chains [3].
In my presentation, I will introduce the magnetism of atacamite, discuss its magnetic phase diagram and its unusual high-field behavior. Further, I will present the results of additional experiments studying the plateau-like state by means of thermodynamic as well as microscopic measurement techniques [6].

[1] H. Kikuchi *et al.*, Phys. Rev. Lett. **94**, 227201 (2005).
[2] A. U. B. Wolter *et al.*, Phys. Rev. B **85**, 014407 (2012).
[3] L. Heinze *et al.*, Phys. Rev. Lett. **126**, 207201 (2021).
[4] L. Heinze *et al.*, Physica B **536**, 377 (2018).
[5] J. Richter *et al.*, J. Phys. Condens. Matter **16**, S779 (2004).
[6] T. Reimann *et al.*, in preparation.

Host: D. Peets