Unusual high-field state discovered in mineral atacamite $Cu_2Cl(OH)_3$

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Magnetically, the mineral atacamite can be called a "sawtooth chain" because, in its crystal structure, the copper ions carrying a magnetic moment are arranged in a chain of triangles resembling a saw (see **Figure** inset). *In atacamite, all magnetic moments favor an antiparallel alignment with respect to their nearest neighbors, which, however, cannot be achieved. As such, the system is called "frustrated". Frustrated systems can host a multitude of complex and novel states of matter, including classical and novel quantum spin liquids*.

The model of the quantum sawtooth chain has attracted interest from theorists, and a "magnetization plateau" was predicted for certain sawtooth chain configurations. As such, there was a strong motivation to measure the magnetization of atacamite in pulsed magnetic fields in the quest to reach magnetization saturation. *This experiment showed a surprising result that deviates from theory predictions: while a plateau-like region above 31.5T (see **Figure**) was indeed found, the plateau is much wider than expected and is found in an unexpected range of magnetic field*. This implies that the novel plateau-like magnetization observed in atacamite is of an unknown nature not described by existing theoretical calculations for a bare chain and, instead, might be the result of a 3D chain network.

Future work will be directed towards a better understanding of the unexpected magnetic-field-induced state found in atacamite, knowledge that could help engineer future quantum spin liquid candidate materials.

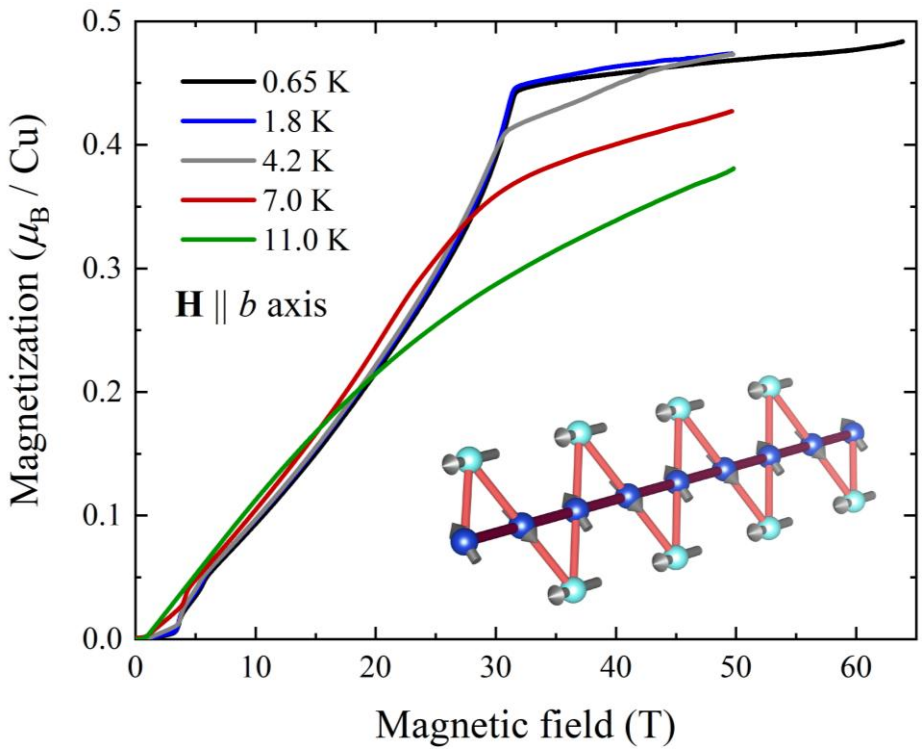

Figure: In a high-field experiment at the MagLab, the magnetization of atacamite was measured up to 65T in pulsed magnetic fields. The magnetization is plateau-like above 31.5T. The inset shows part of the magnetic structure of atacamite in zero magnetic field.

Facilities and instrumentation used: National High Magnetic Field Laboratory (NHMFL), 65T Magnet at the Pulsed-Field Facility.

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