Quantum criticality and dimensional reduction in the sawtooth chain material atacamite

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Quantum magnets with geometrical frustration stand out due to their highly degenerate ground states and their susceptibility to be tuned by applying pressure or magnetic field [1]. Such tuning can lead to quantum phase transitions from ordered to disordered states, or vice versa, with the emergent quantum critical points (QCPs) determining the deformed entropy landscapes in the respective phase diagrams. While, in general, there is fundamental interest in using the properties arising from such distorted entropy landscapes for applications (e.g. the magnetocaloric effect for low-temperature cooling [2,3]), I address here the role of residual exchange interactions in real materials. I demonstrate that a QCP can develop on a lower energy scale measured against the leading exchange couplings in the system.

In this talk, I present the case of the mineral atacamite $Cu_2Cl(OH)_3$, a sawtooth-chain compound where the non-uniform antiferromagnetic chain units [J ~ 336 K (basal-basal), J' ~ 102 K (basal-apical)] are embedded into a weak 3D network of interchain couplings [4]. I will show that the magnetic phase diagram of atacamite contains a field-induced quantum critical point at 21.9(1) T (**H** || *c* axis) which emerges on a much lower energy scale compared to the leading terms in the spin Hamiltonian derived by means of density-functional theory [4,5]. The QCP separates field regions with and without long-range magnetic order. In the latter, underpinned by numerical results, the sawtooth chains decompose, but far away from full field polarization [5].

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