Unconventional spin freezing in a highly two-dimensional spin-1/2 Kagome antiferromagnet $Cd_2Cu_3(OH)_6(SO_4)_2{\cdot}4H_2O$: evidences of partial order and co-existing spin singlet state on distorted Kagome lattice

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The magnetic phases of geometrically frustrated magnets have been rigorously studied both theoretically and experimentally in the last two decades. The Kagome antiferromagnet, a two-dimensional net of corner-sharing triangles, is an excellent choice for investigating spin liquid and other exotic states, because it is expected to be one of the most highly frustrated systems. However, the Kagome system is still not completely understood, leading to many unanswered questions. Even the most essential issue of whether the ground state is a gapped spin liquid or a gapless one remains undetermined. Besides the difficulties of theoretically dealing the quantum spins on the Kagome lattice (which is much more complicate than the simple triangular lattice), the lack of such compounds has been a major obstacle.

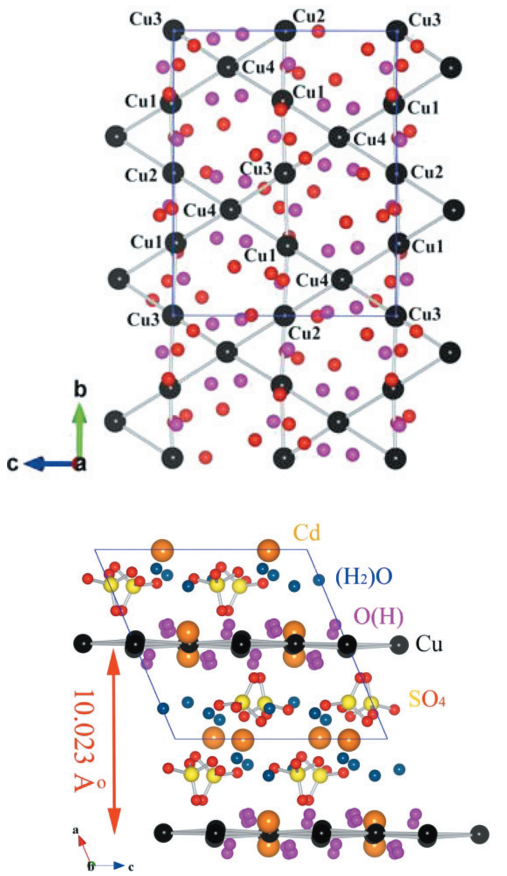

Fig. 1. Structure of $Cd_2Cu_3(OH)_6(SO_4)_2{\cdot}4H_2O$.

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We have recently found a new Kagome antiferromagnet, $Cd_2Cu_3(OH)_6(SO_4)_2{\cdot}4H_2O$. It possesses a monoclinic crystal structure identical to that for the previously reported mineral Edwardsite [1]. It crystallizes in the space group P 21/c with lattice parameters of a = 10.8887(2) Å, b = 13.1745(2) Å, c = 11.2258(2) Å, and β = 112.994(1)°. As illustrated in Fig. 1, four Cu^{2+} sites exist, forming a Kagome lattice for the S = 1/2 spins. The structural information show that $Cd_2Cu_3(OH)_6(SO_4)_2{\cdot}4H_2O$ is a slightly distorted Kagome lattice with high two-dimensionality, which is a great advantage in studying the intrinsic spin behaviors on distorted Kagome lattices; it also serves as a reference system for undistorted Kagome lattices.

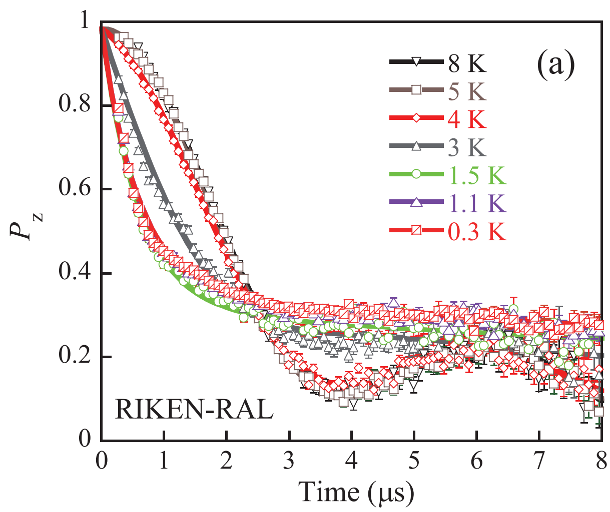

Fig. 2 Zero-field μSR asymmetry spectra at various temperatures.

μSR, having a large gyromagnetic ratio, is a sensitive microscopic probe for magnetic order and spin fluctuations. Figure 2 shows the zero-field (ZF) asymmetry spectra at various temperatures. The asymmetry spectra change obviously from T = 5 K. Detailed analysis showed the formation of static magnetism below 5 K. The magnetic behaviors are distinctly different from the spin liquid sate on an undistorted Kagome lattice, demonstrating the critical role of lattice distortion.

References

1) P. Elliott, J. Brugger, T. Caradoc-Davies, Mineralogical Magazine 74, 39 (2010).