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Enhanced Fluctuations in the Quantum Kagome Antiferromagnet Yttrium Kapellasite ($Y_3Cu_9(OH)_1 9Cl_8$) under Pressure

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"The Kagome lattice, characterized by a 2D arrangement of corner-sharing triangles, exemplifies frustration's pivotal role in the emergence of intriguing magnetic phases and quantum spin liquids. The pursuit of materials realizing such quantum states recently led to the discovery of a new family of kagome compounds. These compounds arise from substituting Zn^{2+} with Y^{3+} in the renowned spin liquid candidate, herbertsmithite ($ZnCu(OH)_6Cl_2$), initially aiming to charge-dope a gapless quantum spin liquid. Despite not achieving charge doping, the resulting insulating materials, named Y-kapellasite ($YCu3(OH)_{6+x}Cl_{3-x}$, x=0 or ⅓), persist as intriguing frustrated magnets with well-isolated kagome layers and minimal magnetic lattice dilution.

Focusing on the anisotropic x=1/3 counterpart, $Y_3Cu_9(OH)\ _{19}Cl_8$, this variant materializes in an anisotropic kagome lattice with three different nearest neighbor interactions, showing significant development in theoretical [1] and experimental [2],[3] realms in recent years. The corresponding theoretical model [1] hosts a rich classical phase diagram, including an exotic spin liquid phase and long-range orders. Phase-pure single crystals of $Y_3Cu_9(OH)\ _{19}Cl_8$ exhibit a magnetic transition at 2.1 K, as confirmed by complementary experimental methods [2], aligning with the theoretical prediction [1] of a (1/3,1/3) long-range ordering with a notably reduced ordered moment for Cu^{+2} [3].

These observations naturally instigate further investigation, with a focus on perturbing the system and exploring the phase diagram [1]. Specifically,hydrostatic pressure effects has been emphasized in this abstract, which can potentially influence the exchange couplings within the anisotropic kagome network. Due to its extreme sensitivity to even small magnetic moments, µSR experiment stands out as a particularly well-suited technique for monitoring the system's evolution under pressure. A gradual decrease in T_N has been observed with an increase in pressure within the Kbar range in our µSR experiment. The system exhibits a strong suppression of magnetism under pressure, and beyond the pressure of 18 Kbar, no magnetic ordering has been observed, indicating a potential dynamic ground state.

References:

[1] M.Hering et al , npj Comput Mater 8, 10 (2022).

[2] Q.Barthelemy et al , Phys. Rev. Materials, 3 (7), 074401 (2019).

[3] D.Chatterjee et al , Phys. Rev. B 107, 125156 (2023)"

Primary author: Dr CHATTERJEE, Dipranjan (University of Oxford)

Presenter: Dr CHATTERJEE, Dipranjan (University of Oxford)

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