

# 15th International Conference on Muon Spin Rotation, Relaxation and Resonance



Contribution ID: 290

Type: Oral

## Searching for Spin Liquids in Buckled Compounds

Thursday, 1 September 2022 10:00 (20 minutes)

The phrase ‘quantum spin liquid’ (QSL) refers to a system in which strong quantum fluctuations prevent long-range magnetic order from being established, even at temperatures well below any interaction energy scale. No spontaneous symmetry breaking is involved, nor a conventional local order parameter. Thus, it is not described using the Landau theory of phase transitions and constitutes a novel phase of matter. These systems exhibit a wealth of exotic phenomena like long-range entanglement and fractional quantum excitations, which are of fundamental interest but also hold great potential for quantum communication and computation.

Magnetic species decorating a two dimensional kagome lattice constitute the most heavily studied QSL candidates. Quantum fluctuations are prevalent due to geometrical magnetic frustration, low coordination number and quasi low dimensionality. Two particularly well-studied experimental realisations are volborthite, where it is believed spatial anisotropy plays an important role and herbertsmithite  $\text{ZnCu}_3(\text{OH})_6\text{Cl}_2$ . However, the presence of excess  $\text{Cu}^{2+}$  replacing the nonmagnetic  $\text{Zn}^{2+}$  induces randomness in the magnetic exchange coupling, complicating explanations of the experimental observations.

Our focus is the investigation of a series of newly synthesised QSL candidates. The insulating materials  $\text{YCu}_3(\text{OH})_6\text{O}_x\text{Cl}_{3-x}$  ( $x = 0, 1/3$ ) display a kapellasite-like structure and no sign of Cu/Y mixing from single crystal x-ray refinements. In the  $x = 0$  compound, the kagome lattice is perfect; in the  $x = 1/3$  compound, it is slightly buckled.

In  $\text{Ba}_4\text{Ir}_3\text{O}_{10}$ ,  $\text{Ir}^{4+}(5d^5)$  ions form  $\text{Ir}_3\text{O}_{12}$  trimers of three dimensional face-sharing  $\text{IrO}_6$  octahedra, which are vertex-linked, forming wavelike 2D sheets. However, it is proposed that intra-trimer exchange is reduced and the lattice recombines into an array of coupled 1D chains with additional spins. As such, the compound is a candidate Tomonaga-Luttinger liquid (TLL) and presents a novel route to exploring quantum liquid behaviour. A muon spin relaxation investigation of these novel compounds is discussed.

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**Session Classification:** Oral contributions

**Track Classification:** Spin liquids and related phenomena