Recent progress in probing triangular-lattice quantum magnets with μSR

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The standard use of μSR in the study of frustrated magnets involves measuring the temperature dependence of the muon spin relaxation in zero applied field (ZF) to search for possible magnetic ordering or spin freezing at low temperatures. In the absence of such evidence for static spins, the material may be classified as a promising candidate to be a quantum spin liquid (QSL). In such a case the spins remain fluctuating down to very low temperatures. In order to gain further information about the nature of this fluctuating state it is necessary to go beyond ZF-μSR and use longitudinal applied fields (LF) to probe the spectral density of the spin fluctuations. Such LF-μSR studies can provide a fingerprint of the nature of these fluctuations. In two recent studies [1,2] a 2D diffusion model was shown to provide a good description of the LF-μSR over a range of temperatures [1]. In suitable cases the temperature dependence of the diffusion rate was found to track the crossover between quantum and classical regimes that takes place around T = J, where J is the exchange coupling. Quantum entanglement is a key feature of a QSL state that sets it apart from a simple paramagnetic state and this can be derived from knowledge of the frequency dependent dynamic susceptibility [3]. Since the dynamic susceptibility can be derived from the spectral density of the spin fluctuations, this offers a new method for deriving the quantum entanglement from LF-μSR data [2].

[1] S. Mañas-Valero et al, npj Quantum Materials 6, 69 (2021).

[2] F. L. Pratt et al, Phys. Rev. B 106, L060401 (2022).

[3] P. Hauke et al, Nature Physics 12, 778 (2016).