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Studying spin diffusion and quantum entanglement with LF-µSR

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LF- μ SR studies of spin diffusion started with mobile solitons [1] and polarons [2] in conducting polymers. Spin 1/2 antiferromagnetic chains can also support diffusive spin excitations in a certain parameter range of the XXZ model [3], showing either diffusive [4] or ballistic transport [5]. Recent LF- μ SR studies of layered triangular lattice quantum spin liquid materials such as 1T-TaS₂ [6] and YbZnGaO₄ [7] have shown spin dynamics that is extremely well described by a 2D spin diffusion model, fitting much better than previously proposed models for spin correlations. In YbZnGaO₄ the diffusion rate shows a clear crossover between classical and quantum regimes as T falls below the exchange coupling J. That the spin diffusion approach works well in the high T classical region might be expected, but it is found that it also works equally well in the low T quantum region. This allows a T dependent length scale to be derived from the data that can be assigned to a quantum entanglement length ξ . Another entanglement measure, the Quantum Fisher Information F_Q [8] can also be obtained from the LF- μ SR data and compared with ξ .

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