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Hyperfine-Enhancement as a Route to Persistent Spin Dynamics in Singlet-State Systems

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Many magnetically frustrated systems exhibit what is known as persistent spin dynamics (PSD) in μSR experiments, the origin of which has remained mysterious since their discovery in the 1990s. As the temperature is lowered, the muon-spin relaxation rate rises (as would be expected for the slowing-down of spin fluctuations) but this rate then saturates at low temperature, the low-temperature fluctuations being interpreted as PSD. To explain this phenomenon, we describe how muons can couple to singlet states and illustrate this with experimental data taken on $Tm_2Ti_2O_7$. The key idea is that the hyperfine interaction, usually neglected in treatments of electronic magnetism, provides a route in which excited states can be mixed into the ground state, and this new state can couple to the "quantum muon" [1]. This mechanism lies behind the effect found in some quantum spin ice compounds [2], but here it is not based on the distortion effects surrounding the muon. We will show how this idea can be extended to understand the way muons couple to a variety of systems exhibiting highly frustrated magnetism, as well as to dynamical problems more generally [3].

[1] S. J. Blundell, J. Phys.: Conf. Ser. **2462**, 012001 (2023).
[2] F. R. Foronda, F. Lang, J. S. Möller, T. Lancaster, A. T. Boothroyd, F. L. Pratt, S. R. Giblin, D. Prabhakaran and S. J. Blundell, Phys. Rev. Lett. **114**, 017602 (2015).
[3] S. J. Blundell *et al.*, in preparation.

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