Muon Spin Relaxation Studies of Critical Fluctuations and Diffusive Spin Dynamics in Molecular Magnets

F.L. Pratt[1], T. Lancaster[2], P. Baker[2], S.J. Blundell[2], W. Kaneko[3], M. Ohba,[3], S. Kitagawa[3], S. Ohira-Kawamura[4], S. Takagi[5], M. Kurmoo[6], Y. Shimizu[7], K. Kanoda[8] and G. Saito[9]

[1]*ISIS Facility, Rutherford Appleton Laboratory, Chilton, Oxfordshire OX11 0QX, UK*
[2]*Clarendon Laboratory, University of Oxford, Oxford OX1 3PU, UK*
[3]*Department of Synthetic Chemistry, Kyoto University 615-8510, Kyoto, Japan*
[4]*Academic and Information Board, Ochanomizu University, Tokyo 112-8610, Japan*
[5]*Department of Physics, Faculty of Engineering, Kyushu Institute of Technology, Kitakyushu 804-8550, Japan*
[6]*Laboratoire de Chimie de Coordination Organique, CNRS-UMR7140, Université Louis Pasteur, 67000 Strasbourg, France*
[7]*Institute for Advanced Research, Nagoya University, Nagoya 464-8601, Japan*
[8]*Department of Applied Physics, University of Tokyo, Tokyo 113-8356, Japan*
[9]*Division of Chemistry, Kyoto University, Kyoto 606-8502, Japan*

The wide critical fluctuation region for local moment magnetic systems allows systematic studies to be made of their magnetic critical exponents. By combining different μSR measurements, a complete set of static and dynamic critical exponents can be obtained and compared with appropriate models. This procedure is applied to molecular magnets with 1D, 2D and 3D structures, with both simple collinear and non-collinear [1] magnetic structures. The effect of chirality on the critical spin fluctuations has also been studied.

In an ideal S=1/2 1D Heisenberg antiferromagnet (1DHAF) the magnetic ordering is fully suppressed by quantum fluctuations. The radical-ion salt DEOCC–$TCNQF_4$ provides an extremely good example of this. μSR measurements have shown no magnetic order down to 20 mK and the presence of one-dimensional spinon excitations propagating along the chains [2]. The on-chain to inter-chain anisotropy of the exchange coupling is estimated to be greater than 10^4, making it one of the best 1DHAFs currently known.

Frustration can also suppress magnetic order and the organic radical system κ-$(BEDT\text{-}TTF)_2Cu_2(CN)_3$ has a highly frustrated 2D triangular lattice of S=1/2 spins, that appears to be a very good example of a 2D spin-liquid. No magnetic ordering has been detected down to 20 mK, even though the exchange coupling is estimated to be 250 K from the high temperature magnetic susceptibility. The field dependent muon spin relaxation suggests the presence of unpaired spin excitations within the spin-liquid state, that show 2D diffusive dynamics with very weak effective coupling between the spins.

[1] F.L. Pratt, P.J. Baker, S.J. Blundell, T. Lancaster, M.A. Green and M. Kurmoo, Phys. Rev. Lett. 99 (2007) 017202.
[2] F.L. Pratt, S.J. Blundell, T. Lancaster, C. Baines and S. Takagi, Phys. Rev. Lett. 96 (2006) 247203.