Exotic magnetic orders studied by μSR: what we learnt from geometrically frustrated magnetic materials

A. Yaouanc1, P. Dalmas de Réotier1, Y. Chapuis1 and P.C.M. Gubbens2

1CEA/DSM/Institut Nanosciences et Cryogénie, 38054 Grenoble, France
2Fundamental Aspects of Materials and Energy (FAME), Delft University of Technology, 2629 JB Delft, The Netherlands

As the temperature is decreased, conventional magnetic materials exhibit a slowing down of the magnetic fluctuations as the temperature approaches the critical point, $T_c$. Crossing $T_c$, the fluctuations disappear rapidly. The magnetic modes are frozen at $T < T_c$. From the combined detailed analysis of muon spin relaxation, powder neutron diffraction and neutron spin-echo data, we show that the canonical behaviour is not observed in geometrically frustrated magnetic materials. Explicitly, our studies of the pyrochlore $\text{Tb}_2\text{Sn}_2\text{O}_7$ and the triangular layer compound $\text{NiGa}_2\text{S}_4$ point to a large distribution of the fluctuation times and show striking different μSR signatures although their characteristics are closeby. In addition, for $\text{NiGa}_2\text{S}_4$ we unveil the transition to the paramagnetic phase at a temperature smaller that the temperature at which the specific heat displays a low-temperature peak. This experimental fact suggests that the observed transition corresponds to the unbinding of $Z_2$ vortices.

A detailed study for $\text{Gd}_2\text{Ti}_2\text{O}_7$ of the effect of an applied field on the spin-lattice relaxation rate, $\lambda_Z$, reveals an unconventional field response at low field in the paramagnetic state, close to the critical point. This behaviour is somewhat reminiscent of the one already reported for $\text{Tb}_2\text{Sn}_2\text{O}_7$ at low temperature. However, in contrast to a previous report (D.E. MacLaughlin et al., Physica B 374-375, 142 (2006)), a conventional Lorentzian field dependence of $\lambda_Z$ is observed at higher fields.