CRYSTAL FIELD EFFECTS ON THE MAGNETIC FLUCTUATIONS IN RAl₂ and RNi₂

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Zero-field μSR spectra have been recorded for some ferromagnetic Laves phase compounds. A comparison of the temperature dependence of the exponential damping rate, λ(T), for our samples shows that λ(T) is strongly influenced by crystal field effects.

The Laves phase intermetallics with heavy rare earth ions have already been studied by μSR spectroscopy [1–3], although with limited accuracy. In this paper we present μSR data on rare earth intermetallics obtained at the Rutherford Appleton Laboratory (RAL). The spectra were recorded with no applied magnetic field. This means that the problems related to the demagnetisation field [1,2] do not exist for these data. The measurements have been performed on a number of cubic Laves phase compounds: ErAl₂, HoAl₂, HoNi₂ and DyNi₂. These intermetallics are simple ferromagnets with 14 K ≤ Tc ≤ 30 K. In a companion copy [4] it is shown that in the Laves phases the muon is static below ≈ 80 K and occupies an interstitial site with two rare earth and two transition element ions as nearest neighbors. This means that in these intermetallics, spectra recorded below ≈ 80 K are not influenced by trapping problems and therefore we have chosen to study only low Tc Laves phase compounds.

The spectra can always be analysed with exponential depolarisation functions. Each spectrum is therefore characterised by two parameters: the asymmetry (signal amplitude), a, and the damping rate, λ. We have used the analysis methods given in ref. [5].

In figs. 1 and 2 we present the results obtained for ErAl₂ and HoAl₂. The ErAl₂ signal can not be followed below 27 K because the damping is too large to
be detected by the pulsed-muon spectrometer. As expected, $a(T)$ for this sample is temperature independent. Because the $a(T)$ behaviour for HoAl$_2$ is relatively smooth near $T_c$, the phase transition is not sharp. This is confirmed by bulk magnetic measurements. This might be due to imperfections in the sample. This result is in contrast to what has been seen for GdNi$_5$. In that case a sharp transition in $a(T)$ occurs within less than 0.05 K [7]. The different $\lambda(T)$ behaviour for the two compounds can be explained qualitatively by the value of the crystal field energy levels shown in fig. 3. $\lambda$ is temperature independent at high temperatures [1] (we exclude the temperature region where the muon is diffusing). But at low temperatures (still above $T_c$), depending on the rare earth, the $\lambda(T)$ behaviour is different. When the temperature is near $T_c$ the energy gap to the next available energy level ($\Gamma_6$ for Er and $\Gamma_5^{(2)}$ for Ho) is much larger for Er than Ho. Therefore the rare earth spin-spin relaxation is faster in the Ho than in the Er compounds. Notice that for a detailed understanding the transition probability between the energy levels should be taken into account. Preliminary results obtained on HoNi$_2$ indicate that in this compound and in HoAl$_2$, $\lambda(T)$ has the same behaviour. This is not surprising because the energy levels are at similar positions.