Transverse Field Depolarization Functions for Muons in Metals with Metal Quadrupole Interactions*

By L. M. Cameron and C. A. Sholl

Physics Department, University of New England, Armidale, NSW 2351, Australia

Muons in metals | Depolarisation | Quadrupole interactions

Transverse field depolarization functions for muons in metals are calculated for the case of quadrupolar metal nuclei interacting with the electric field gradient due to the muons and in the absence of muon diffusion. Second moments of the local magnetic field distribution at a muon site deduced using the commonly used Gaussian approximation for the depolarization function can be in error by ~10% and the Gaussian form is inadequate at long times since oscillations in the function can occur, as in the case for non-quadrupolar metal nuclei.

1. The depolarization function

The depolarization function for muons in a transverse magnetic field in metals depends on the distribution of local fields at the muon site due to the magnetic moments of the metal nuclei. When the metal nuclei have an electric quadrupole moment the quadrupolar interaction of the nuclei with the electric field gradient (EFG) due to the muons modifies the axis of quantisation of the nuclear magnetic moments and Hartmann [1] has calculated the second moment M_2 of the local field distribution at the muon site for such cases. In the absence of the quadrupolar interaction, the form of the depolarization function can be obtained and it can be significantly different from the commonly assumed Gaussian approximation used to deduce the second moment M_2 from the experimental data [2]. The present work calculates the depolarization function including the effects of the nuclear quadrupolar interaction in the absence of muon diffusion.

The muon – metal system in the presence of an EFG at the metal sites and a magnetic field **B** directed along the z axis has the spin Hamiltonian

$$\mathcal{H} = \mathcal{H}_{ZI} + \mathcal{H}_{ZS} + \mathcal{H}_Q + \mathcal{H}_{d(IS)} + \mathcal{H}_{d(SS)}$$

$$= \hbar\omega_I I_z + \hbar\omega_s \sum_j S_{jz} + \mathcal{H}_Q + \mathcal{H}_{d(IS)} + \mathcal{H}_{d(SS)} \tag{1}$$