Spin-Exchange of Axially Symmetric Mu States in Polycrystalline Media

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The scattering of a paramagnetic species and a Mu state strongly influences the time evolution of the muon spin, constituting what is termed in μSR literature as spin-exchange dynamics. The effect of the scattering is conveyed to the muon spin via the hyperfine interaction, and as such depends on its magnitude and symmetry features. In particular, for axially symmetric states with a strong dipolar character, the relative orientation between the symmetry axis and the externally applied field is a major factor determining the value of the longitudinal-field relaxation rate, which typically spans several orders of magnitude along the full solid angle (Fig. 1).

Recently, the μSR investigation of local charge conduction in molecular organic semiconductors [1] lead our group to the consideration of that dependence in the μSR signal, since these novel materials cannot be grown in single crystals large enough to use in a μSR experiment, nor are soluble enough to use liquid samples in order to average out the anisotropy of the hyperfine interaction. We present here a theoretical discussion of the features expected for the longitudinal-field signal of axially symmetric Mu states in polycrystalline samples. It is shown that the signal may be expressed as the sum of a damped lorentzian component and a constant value, where the relaxation of the lorentzian component and its relative amplitude to the constant component are a function of the hyperfine parameters, the external field and the spin-flip rate. That functional dependence is set-up in an analysis model, and seen to reproduce well the field dependence of the experimental data.

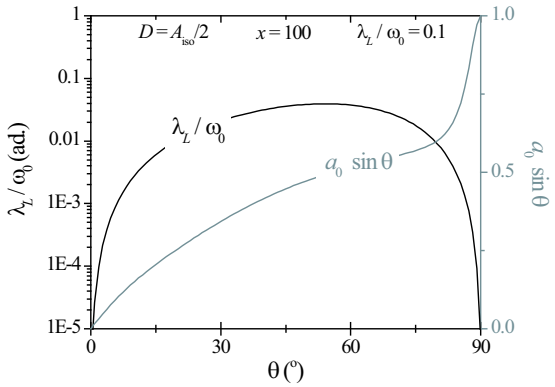

Fig. 1: Orientation dependence of the LF relaxation rate and the non-oscillating relative amplitude for an axially symmetric Mu state with a large dipolar parameter ($D = A_{iso}/2$) undergoing slow spin-exchange dynamics at a reduced field $x = 100$.

[1] J. Piroto Duarte et al., Phys. B: Cond. Matt. 374-375 (2006) 426-429.