ANISOTROPIC MAGNETIC PROPERTIES OF GADOLINIUM

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We report measurements on a single crystal sphere of hexagonal Gd metal. These were carried out as an addition to the high pressure studies on ferromagnetic Gd [1]. Data were taken slightly above and below the Curie temperature ($T_C = 293$ K) for two different crystalline directions ($c$-axis parallel and perpendicular to the $\mu$-beam) with $\approx 90$ MeV/c muons at the $\mu$E4 beamline of PSI where the muon spins were polarized parallel to the beam.

The spontaneous muon spin rotation frequency below $T_C$ has been observed previously in polycrystalline material (e.g. [2]). As normally expected, our single crystal data (fig. 1) show no dependence of the frequency on sample orientation and are in general accordance with the temperature variation of the $\mu$SR frequency in the ferromagnetic regime as reported in [2]. The complicated temperature dependence has been explained by the interplay between contact and dipolar field. The latter changes because the direction of magnetization starts to

![Fig. 1. Temperature dependence of the muon spin rotation frequency in a single crystal sphere of Gd metal below $T_C$.](https://example.com/figure1.png)
turn out of the hexagonal c-axis near 230 K. The maximum turning angle of \( \Theta = 60^\circ \) is reached at 200 K. The magnetization then slowly turns back to \( \Theta = 30^\circ \) between 200 K and 50 K. If a single crystal sample is used, as in the present experiment, the variation of spin re-orientation angle is reflected directly in the temperature dependence of the magnitude of initial anisotropy of \( \mu \)SR spectra taken for a fixed orientation of the crystalline axis. Fig. 2 presents the result of such a measurement with the c-axis parallel to the beam. These data show that the initial increase of spin turning angle is much steeper than anticipated from the previous \( \mu \)SR measurements [2] or from neutron scattering results [3]. We could also resolve finer details of the temperature variation in damping

Fig. 2. Temperature dependence of initial anisotropy for c\textparallel beam, i.e. to the initial muon polarization.

Fig. 3. Temperature dependence of damping rate in ferromagnetic Gd. The two orientations gave the same result.