The Study of the Magnetically EXCited State by using Mössbauer Time Spectra with PolariZation Analyzer Crystal

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1. Introduction

Recently, we studied the dynamics of the polarization state of the nuclear forward scattering (NFS) in the system that the hyperfine field oscillates on the plane perpendicular to the light axis [1]. As a result, NFS showed the temporal change of the polarization state, and it is caused by the rotation of the hyper fine field in the target material. (See Fig. I .) In the present work, as a new type experiment by using this phenomenon, we investigated the magnetically excited state of the $^{57}FeBO_3$ anti-ferromagnetic single crystal.

2. Experimental

The experiment was performed at the BL09 undulator beamline of SPring-8. The storage ring was operated in 21-bunch mode at 20mA. A pulse emitted only in 228ns with typically 100ps width. The experimental set-up is shown in Fig.2. The $^{57}FeBO_3$ crystal was excited magnetically by the switch of the external pulse magnetic field. The magnetic field was phase locked by the SR pulse signal. (Magnetic field parameters: strength 28Oe, pulse width 80ns, and fall off time 7ns, frequency ~400kHz) The Mössbauer time spectra were measured with and without the Si(840) polarization analyzer crystal. (This crystal reflect only the (σ -polarization.) In this measurement system, at the same time, we could get 11 time spectra in the time range of 2.5μs after the fall off.

3. Results and Discussion

The parameter $p(t)=\left(\tilde{I}^{\pi+\sigma}(t)-\tilde{I}^{\pi+\sigma}(t)\right)/\tilde{I}^{\pi+\sigma}(t)$ (depolarization factor) is determined by the obtained time spectra. Here, I (t) is the integral intensity of the time spectra in the specific time region. Then, the value of P(t) relates the rotation of hyper-fine field in the magnetic easy plane (111) during that time region [2]. When the specific time regions are set at both 10~20ns (fast rotation) and 20~60ns (slow rotation), the parameters P(t) of each observed time spectra are shown in Fig.3. As a result, $P(t)_{10\sim20ns}$ shows the speedy reduction, on the other hand, $P(t)_{10\sim20ns}$ keeps about fixed value. It indicates that the rotation speed of the local hyper-fine field in the $^{57}FeBO_3$ crystal is decreases by the magnetic relaxation.

References

[1] T.Mitsui,et al.Hyper fine Interact., in press
[2] S.Kikuta.Hyper fine Interact 90(1994)335.

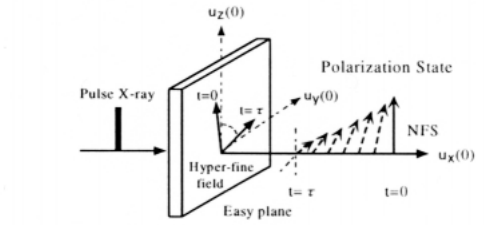

Fig.1. The rotation of the polarization plane of NFS.

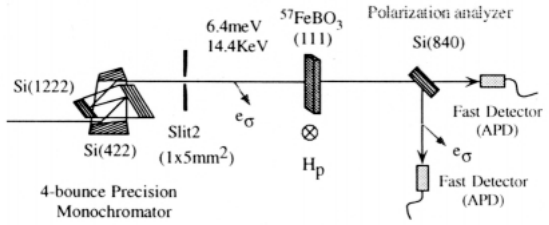

Fig.2. Experimental Set-up

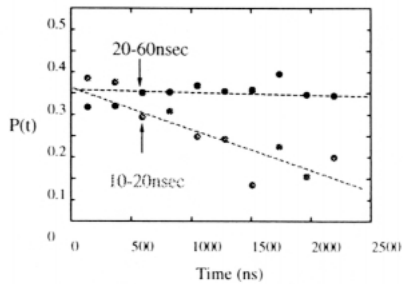

Fig.3. The time dependent depolarization factor