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MAGNETIC HYPERFINE STRUCTURE IN ^{125}Te

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ABSTRACT

Mössbauer spectra of ^{125}TeFe with improved resolution yield μ(35.5 keV) = +0.60 ± 0.02 nm. The effect of this value on hyperfine spectra of ^{125}Te are discussed.

Hyperfine structure for ^{125}Te in ferromagnetic metals has been reported before[1,2], but no accurate value has been reported for the magnetic moment of the first excited state, of spin 3/2, at 35.5 keV. This magnetic moment is difficult to measure because the line widths of the hyperfine components are larger than the excited-state splitting, even in TeFe, the most favorable case known. Recently Ullrich and Vincent reported[3] a magnetic hyperfine field for $CuCr_2Te_4$ of 148 kOe and a magnetic moment of +0.74 ± 0.07 nm for $\mu(35.5)$. These two parameters were derived simultaneously by fitting the Mössbauer spectrum of ^{125}Te in $CuCr_2Te_4$, and are therefore related. We have made a careful study of the spectrum of ^{125}Te in TeFe, using a source of ^{125}SbFe and a ZnTe absorber, and have derived the value $\mu(35.5)$ = +0.60 ± 0.02 for the excited-state moment.

Several studies of the ^{125}Te spectrum have been made since our earlier work[2] with the goal of resolving the hyperfine components. The best results to date are shown in fig. 1. The evidence for a six-line hyperfine spectrum with relative intensities 3:2:1:1:2:3 is much more compelling than in other published spectra[1-3]. In this experiment the source of ^{125}Sb in iron was prepared by electroplating the ^{125}Sb from 3N HCl solution onto 99.99% Fe foil. The foil was melted at 1550°C and quenched to room temperature. After the resulting ingot was pounded to several thousandths of an inch thickness, it was annealed at 830°C for four hours and at 700°C for one hour. The absorber was enriched ZnTe prepared by direct reaction of the elements at 800°C in an H_2 atmosphere and carefully sealed to avoid reaction with water vapor. The linewidth of this absorber against a ^{125}TeCu source was 0.71 cm/sec. The minimum theoretically possible is 0.50(3) cm/sec. A Ge(Li) detector with 3 keV resolution allowed us to observe a maximum absorption of about 3% with the ^{125}SbFe source. The linewidth with this source was 0.98 cm/sec.

A least-squares fit of the spectrum in fig. 1 gave $\mu(35.5)/\mu(0) = -.678$. Conbining this with the known ground-state moment $\mu(0) = -0.8872$ nm[4], we have $\mu(35.5) = +0.60 \pm 0.02$. This is in very good agreement with the values derived from several other spectra, and we suggest that this value be adopted for analyzing partially-resolved hfs spectra of ^{125}Te. Comparison with the $CuCr_2Te_4$ spectrum reported by Ullrich and Vincent suggests that constraining $\mu(35.5)$ to +0.60 nm would raise their derived H_{hf} to about 160 kOe, in better agreement with the NMR value of Budnick, Berger, and Burch[8]. From spectra of ^{125}Sb in Fe, Co, and Ni at 4.2°K we find, using this moment, $H_{hf}(^{125}\text{Te}\underline{\text{Fe}}) = +657 \pm 20$ kOe $|H_{hf}(^{125}\text{Te}\underline{\text{Co}})| = 505 \pm 20$ kOe, and $H_{hf}(^{125}\text{Te}\underline{\text{Ni}}) = +170 \pm 10$ kOe, in reasonable agreement with our earlier values for Fe and Ni.

Finally, Kisslinger and Sorensen have predicted[6], that this state has mostly $d_{3/2}$- proton quasiparticle character, with small admixtures of quasiparticle-plus-phonon character. They calculated magnetic moments of +0.56 if the phonon g_R is zero or +0.64 if $g_R = Z/A$. Either of these is in excellent agreement with our result.

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Footnotes and References

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1) N. Shikazono, J. Phys. Soc., Japan 18, 925 (1963).

2) R. B. Frankel, J. Huntzicker, E. Matthias, S. S. Rosenblum, D. A. Shirley, and N. J. Stone, Phys. Letters 15, 163 (1965).

3) J. F. Ullrich and D. H. Vincent, Phys. Letters 25A, 731 (1967).

4) H. E. Weaver, Jr., Phys. Rev. 89, 923 (1953).

5) S. Berger, J. I. Budnick, and T. J. Burch (preceding paper).

6) L. S. Kisslinger and R. A. Sorensen, Rev. Mod. Phys. 35, 853 (1963).

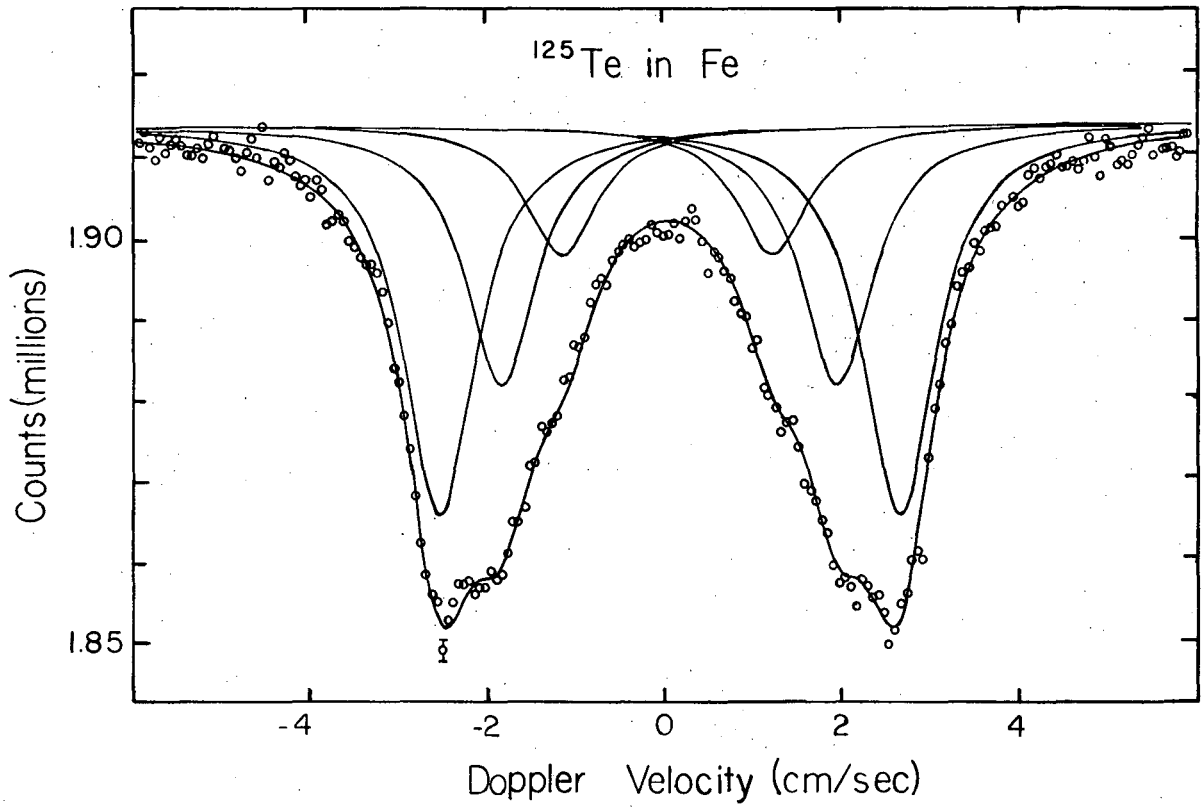

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Fig. 1. Mössbauer hyperfine spectrum for ^{125}TeFe with a ZnTe absorber.