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MAGNETIC HYPERFINE STRUCTURE IN ^{125}Te

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ABSTRACT

Mössbauer spectra of $^{125}\text{TeFe}$ with improved resolution yield $\mu(35.5 \text{ keV}) = +0.60 \pm 0.02 \text{ nm}$. 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 reported³⁾ a magnetic hyperfine field for CuCr_2Te_4 of 148 kOe and a magnetic moment of $+0.74 \pm 0.07 \text{ nm}$ 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 $^{125}\text{SbFe}$ and a ZnTe absorber, and have derived the value $\mu(35.5) = +0.60 \pm 0.02$ for the excited-state moment.

Several studies of the ^{125}Te spectrum have been made since our earlier work²⁾ 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 spectra¹⁻³⁾. 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 $^{125}\text{TeCu}$ 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 $^{125}\text{SbFe}$ source. The linewidth with this source was 0.98 cm/sec.

A least-squares fit of the spectrum in fig. 1 gave $\mu(35.5)/\mu(0) = -.678$. Combining this with the known ground-state moment $\mu(0) = -0.8872 \text{ nm}^4$, 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 $+0.60 \text{ nm}$ would raise their derived H_{hf} to about 160 kOe, in better agreement with the NMR value of Budnick, Berger, and Burch⁸⁾. From spectra of ^{125}Sb in Fe, Co, and Ni at 4.2°K we find, using this moment, $H_{\text{hf}}(^{125}\text{TeFe}) = +657 \pm 20 \text{ kOe}$, $|H_{\text{hg}}(^{125}\text{TeCo})| = 505 \pm 20 \text{ kOe}$, and $H_{\text{hf}}(^{125}\text{TeNi}) = +170 \pm 10 \text{ kOe}$, in reasonable agreement with our earlier values for Fe and Ni.

Finally, Kisslinger and Sorensen have predicted⁶⁾, 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 $g_{\text{R}} = Z/A$. Either of these is in excellent agreement with our result.

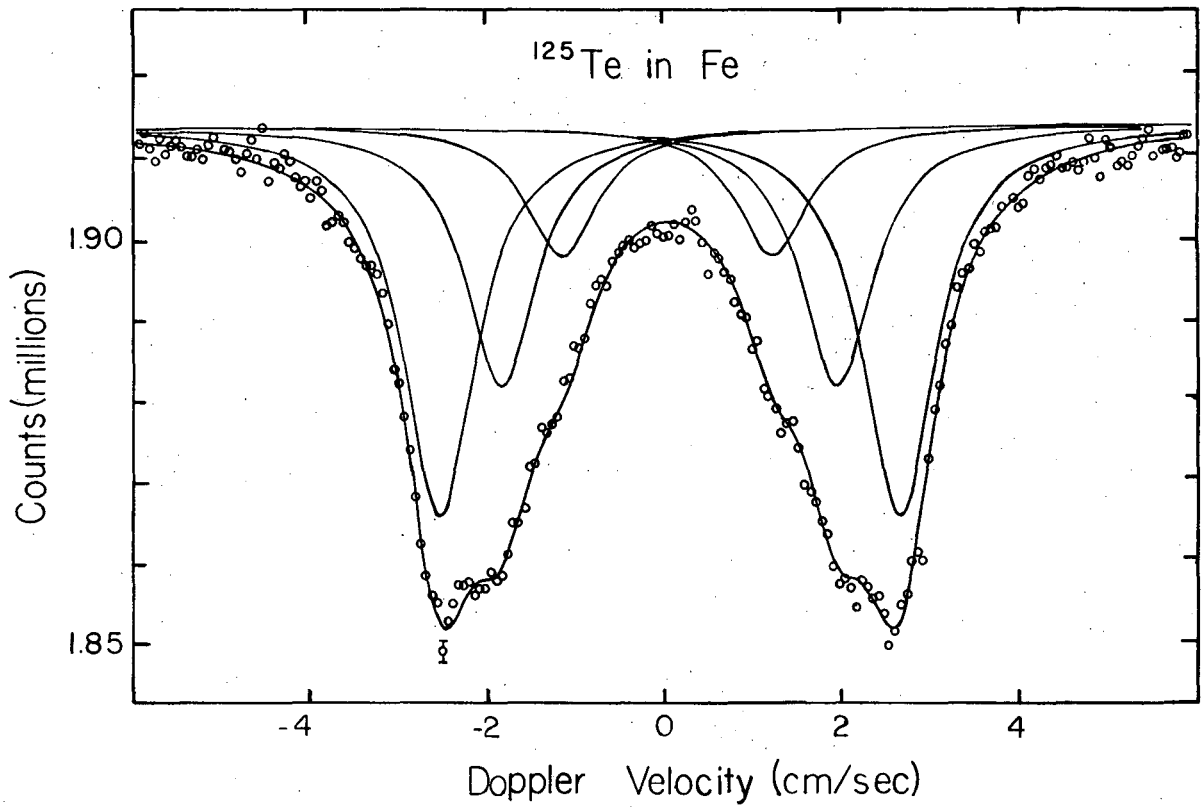
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Footnotes and References

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

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