bauer levels, namely by (n,γ) and $(d,p\gamma)$ have been reported: D. W. Hafemeister and E. Brooks Shera, Phys. Rev. Letters 14, 593 (1965), and S. L. Ruby and R. E. Holland, Phys. Rev. Letters 14, 591 (1965).

MÖSSBAUER EFFECT FROM COULOMB-EXCITED LEVELS IN Fe^{57}†

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We have observed a large Mössbauer effect in Fe^{57} following Coulomb excitation. Our results indicate that despite the large recoil energy of the nucleus following the Coulomb excitation, the Mössbauer fraction is essentially undiminished.

Recently, the presence of recoilless emission of γ rays from nuclei which have been excited by processes which impart large recoil energies to the excited nuclei has been reported by others.[1-4] The observation of a large Mössbauer effect in Fe^{57} is significant for the investigation of these phenomena.

Coulomb excitation was produced by a 1.5-μA beam of 3-MeV alpha particles from the Johns Hopkins University Van de Graaff accelerator. The target and absorber were 1.9 mg/cm^2 of 91% enriched Fe^{57}. The target was thermally coupled to an aluminum backing which was cooled by contact with an alcohol–dry-ice mixture.

The recoilless emission of the 14.4-keV level was observed following Coulomb excitation of the 137-keV level. The 14.4-keV γ ray was detected in coincidence with the preceding 122-keV γ ray (Fig. 1). This was necessary due to the large Mössbauer fraction which allowed self-absorption in the target making it difficult to observe directly the 14.4-keV line in the presence of x rays and bremsstrahlung background.

The detectors were thin NaI(Tl) crystals. The coincidence circuit had a resolving time of 0.5 μsec. The coincidence technique reduced the total background to less than 8%. The rate of 137-keV level excitation to be expected was calculated according to Alder et al.[5] and was in agreement with the rate of 122-keV γ rays observed. On the basis of the 122-keV γ-ray counting rate, one can estimate the number of 14.4-keV γ rays which should be detected in the absence of nuclear resonant self-absorption. However, the observed coincidence counting rate of 3 counts per second was several times less than that expected from this calculation. The existence of self-absorption in the target suggests that perhaps a correction should be made to the $E2$ nuclear matrix element for the 14.4-keV transition as reported by Thomas and Grace.[6]

The width and depth of the absorption dips indicate that the difference in hyperfine splitting between source and absorber is less than 10%. Additional spectra including all the hyperfine lines will be taken to obtain a more accurate determination of the hyperfine splitting of the Coulomb-excited nucleus.

The central absorption dip, uncorrected for background, is 17% of the nonresonant transmission (Fig. 2). Because of the very thick target and uncertainties due to vibrations, it is difficult to obtain a value for f, the Mössbauer fraction for the source. Comparison of the Coulomb-excitation results with those ob-

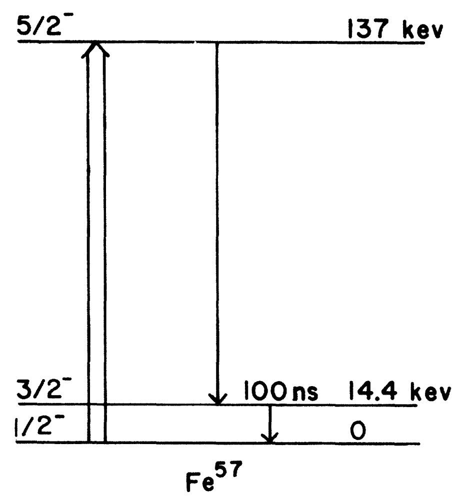

FIG. 1. Energy-level diagram indicating Coulomb excitation of the 137-keV level. The 14.4-keV γ rays were detected in coincidence with the preceding 122-keV γ rays.

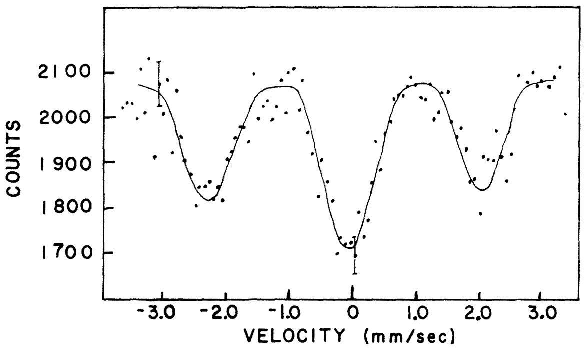

FIG. 2. Mössbauer spectrum from Coulomb-excited levels in Fe^{57}.

tained using a standard unsplit Co^{57} source placed in the same geometry and counting in coincidence at a comparable rate indicate that f is larger than 0.5 for the Coulomb-excited nucleus.

The data show an indication of a small shift (0.07 ± 0.03 mm/sec) of the central absorption dip. This is most probably a temperature shift caused by the heating of the target by the beam. If the observed shift is due entirely to the temperature effect it implies that the target was about 100 C° hotter than the absorber. This is reasonable, considering the beam power dissipated in the foil and the visible indications of heating of the target.

Since it is no longer required that Mössbauer levels be populated by beta decay, a large number of isotopes can now be considered as candidates for the Mössbauer effect.

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