are necessary. We shall try to make them shortly with a paraperiodate source.

Note added in proof. This trial has been successful. A first determination gives $|Q^{129*}/Q^{131}| = 4.0$. From this $|Q^{129*}| = 0.48$ b, $e^2qQ^{131} = 680$ Mc/sec, and $U_p = 1.3$ in XeF_4. Additional measurements are in progress.

ACKNOWLEDGMENTS

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CONTRIBUTED PAPERS FOR SESSION II

The Mössbauer Effect in Pt^{195}†

G. M. Rothberg, N. Benczer-Koller, and J. R. Harris, *Rutgers University*

Recoilless absorption was observed in Pt^{195}, as well as in some of its compounds and alloys. The ambiguity in previously published level schemes of Pt^{195} was partly resolved by observing that only the 99-keV and not the 31-keV gamma rays could be resonantly absorbed, thus confirming the 99-keV gamma ray as a ground-state transition. The absorption of the 99-keV gamma ray was observed as a function of absorber thickness (from 1.1 to 11.1 mils), and of temperature (from 4 to 300°K). The full width at half-maximum of the absorption line at zero absorber thickness is $P = (1.7 \times 0.2)$ cm/sec, corresponding to a half-life for the 99-keV state of $T_{1/2} = (1.6 \pm 0.2) \times 10^{-10}$ sec in agreement with the electronic measurements. The observed fractions of the recoilless γ rays emitted, f_s, or absorbed, f_a, varied from $f_s(20°K) = (0.091 \pm 0.001)$ to $f_s(77°K) = (0.022 \pm 0.003)$ and from $f_a(20°K) = (0.140 \pm 0.007)$ to $f_a(77°K) = (0.050 \pm 0.007)$ and yielded effective Debye temperatures $\theta_s = (209 \pm 5)°K$ and $\theta_a = (240 \pm 8)°K$. θ_a was calculated assuming a total internal conversion coefficient $\alpha = 9$. Preliminary measurements with absorbers of PtO_2, $PtCl_2$, $PtIn_2$, Pt_3Fe, and $Pt_{0.3}Fe_{0.7}$ were carried out at 77°K. None of these compounds exhibit a significantly larger Debye temperature than platinum metal. At 20°K the $Pt_{0.3}Fe_{0.7}$ spectrum showed two lines separated by 8.2×10^{-6} eV.

† This work was supported by the National Science Foundation and the Air Force Office of Scientific Research.

Inhomogeneous Quadrupole Interactions and the Mössbauer Effect in Ta^{181}†

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J. I. Budnick, *Fordham University*

A search has been made for the recoil-free resonant absorption of the 6.25-keV transition in Ta^{181} at room temperature, in view of the great interest attached to the possibility of obtaining extremely narrow recoil-free absorption lines (ideally $\Delta E/E = 1.1 \times 10^{-14}$ might be reached). Most combinations of source and absorber gave negative results, but a weak resonant line (maximum change in absorption -0.6%) has been detected using a tungsten source and a tantalum carbide absorber, whose width was about 9 times the minimum width which could be ideally obtained. In order to reconcile the smallness of the observed effect with the relative narrowness of the line, the results are interpreted in terms of inhomogeneous quadrupole interactions in the source and absorber. The observed line is attributed to one of a number of possible γ transitions (in both emission and absorption) between the sublevels produced by the quadrupole splitting, namely, to the $\pm\frac{3}{2} \rightarrow \pm\frac{3}{2}$ transitions, the energies of these particular transitions being relatively independent of the magnitude of the electric field gradient at the nucleus. NMR data on tantalum are used in the interpretation. According to this analysis, the magnitude of the spread in quadrupole interactions in the source, resulting from inhomogeneity, is of the order of 10 mc/sec.

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Kr^{83}

Y. Hazony and R. Simons, *Sorea Research Establishment, I.A.E.C., Yavne, Israel*
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We have continued our measurements on the Kr^{83} 9.3-keV line. We have attempted to obtain a line narrower than the 4–5 natural linewidths originally obtained with a clathrate absorber and irradiated clathrate source. By recrystallizing the source after irradiation, we have achieved about 3 natural linewidths, but we have obtained worse results with sources of frozen krypton and of a Br^{83} parent in AgBr. Varying the krypton content of the source clathrate from 10–80% filled holes showed no change in the Mössbauer efficiency or linewidth. Meanwhile, calculations are proceeding, with some success, on initial fits of the specific heat of krypton in a clathrate using a potential well model that we hope may also fit the unusual temperature dependence of the Mössbauer fraction.

Mössbauer Measurements on the 73-keV State in Ir^{193}

J. O. Thomson, A. H. Werkheiser, and M. W. Lindauer,* *University of Tennessee*

Using a neutron-activated metallic Os source enriched in Os^{192}, we have observed the Mössbauer effect on the 73-keV state in Ir^{193}. A study of the linewidth for 3 metallic Ir absorbers ranging from 48 to 530 mg/cm² Ir^{193} yields a linewidth extrapolated to zero absorber thickness of 1.1 ± 0.1 mm/sec, corresponding to a lower limit for the half-life of this state of 3×10^{-9} sec. The electronically measured half-life is 6×10^{-9} sec. The source of this discrepancy is not known but could be accounted for by a quadrupole splitting of the order of 10^{-3} cm^{-1} in the hexagonal Os source. The isomer shift for the source of Ir in Os was $+0.6 \pm 0.1$ mm/sec with respect to metallic Ir. Mössbauer spectra have also been taken for several compounds of Ir

at 4.2°K. K_2IrCl_6 showed a single line absorption spectrum whose width was comparable to the widths observed in metallic Ir. The isomer shift in K_2IrCl_6 was -1.1 ± 0.2 mm/sec, with respect to metallic Ir. For IrO_2, the absorption spectrum consisted of two resolved lines separated by 3.0 ± 0.2 mm/sec. The center of this pattern was shifted by -0.8 ± 0.2 mm/sec with respect to metallic Ir. Preliminary measurements were made on the hydrated compounds $IrCl_3 \cdot nH_2O$, $IrCl_4 \cdot nH_2O$, and $Ir_2O_3 \cdot nH_2O$. The chlorides showed single line absorption spectra, while the hydrated oxide showed a much broadened line which may have been a barely resolved doublet. The isomer shifts for these were -1.1 ± 0.2, -0.8 ± 0.3, and -0.6 ± 0.2, respectively, measured from Ir metal.

* NSF summer participant from Valdosta State College, Valdosta, Georgia.

The Mössbauer Effect in Iodine-129

H. deWaard, G. DePasquali, and D. Hafemeister, *University of Illinois*

Strong recoilless resonance absorption of the 26.8-keV gamma line emitted in the decay of 70-min Te^{129} has been observed in absorbers of a number of iodine-129 compounds. As a source, $Zn^{66}Te^{129}$ (cubic crystals) has been used most of the time. Some experiments were also done with sources of $PbTe^{129}$ (cubic) and $CrTe^{129}$ (hexagonal, ferromagnetic). Source and absorber were always cooled to liquid-nitrogen temperature in a symple cryostat. From the measurements the values given in Table I have been obtained for the isomeric shift relative to ZnTe (positive shifts correspond to decreased s electron density).

TABLE I

Compound	Isomeric shift (cm/sec)
KI	$+0.051 \pm 0.0025$
KIO_3	-0.156 ± 0.020
NH_4IO_3	-0.131 ± 0.020
$Ba(IO_3)_2$	-0.111 ± 0.020
KIO_4	$+0.234 \pm 0.006$
PbTe	-0.022 ± 0.005

Of these compounds only the iodates show a quadrupole splitting. From the KIO_3 spectrum a value $\mathbf{Q}^*/\mathbf{Q} = 1.23 \pm 0.02$ was obtained for the ratio of the 26.8-keV $(\frac{5}{2}+)$ and ground-state $(\frac{7}{2}+)$ electric quadrupole moments. The sign of the electric field gradient in the iodates is shown to be negative. The observed isomer shifts are in qualitative agreement with expectations based on the chemical structure of the compounds. The isomer shift scale can be calibrated in terms of s electron density by correlating the isomer shifts in the alkali iodides and the chemical shifts of these iodides, that may have been measured earlier (see following abstract). From the chemical shifts the percentages p hole in the $5p$ shell of the iodine ions have been obtained and, using a Slater shielding coefficient 0.35 for the $5p$ shielding, the change of the $5s$ electron density is found. The calibration constant is found to be

$$(1/\delta)\{\Delta|\psi_s(0)|^2/|\psi_s(0)|^2\} = -0.8$$

(δ is the isomer shift in cm/sec).

From this a 30% decrease of the total $5s$ electron density is derived in going from KIO_3 to KIO_4. Using this calibration and a value $|\psi_s(0)^2 = 4.8 \times 10^{27}/cm^3$, a fractional change $\Delta R/R = 3 \times 10^{-5}$ results for the charge radius. This is widely different from the single-particle estimate $\Delta R/R = -2 \times 10^{-3}$ and also quite different from a collective model estimate $\Delta R/R = 1.2 \times 10^{-4}$ (the latter value derived from the known quadrupole moments).

Isomeric Shifts and Recoilless Fractions of I^{129} in Alkali Iodides

H. de Waard, G. De Pasquali, W. Flygare, and D. Hafemeister, *University of Illinois*

The Mössbauer effect has been used to determine the isomeric shift δ of I^{129} in the alkali iodides. In Table I positive values of δ correspond to a decrease in s electron density with respect to the $ZnTe^{129}$ source. To a first approximation one would expect the iodine $5p$ electron density to increase with increasing difference of electronegativity. This increase will shield out and decrease the $5s$ electron density. Such an effect is seen in going from LiI to NaI and KI, but is not observed for RbI and CsI. The $5s$ electron density that is measured here is found to be linearly shielded by the percent p hole on the iodine ion as determined by chemical shifts[1] and dynamical quadrupole interaction.[2]

For the same compounds the recoilless fraction f has been determined at 80°K by the linewidth method, and the ratio f/f_{NaI} has been determined by the area method. The approximate constancy of f disagrees with both the Debye theory and with Kagan and Maslov.[3]

TABLE I

Absorber	δ (cm/sec) ± 0.0025	Electronegativity	$f \pm .05$	f/f_{NaI}
LiI	+0.038	1.0–0.95	0.21	0.99 ± 0.35
NaI	+0.046	0.9	0.27	1
KI	+0.051	0.8		
RbI	+0.043	0.8		0.81 ± 0.25
CsI	+0.037	0.7–0.75	0.22	0.93 ± 0.25

[1] N. Bloembergen and P. Sorokin, Phys. Rev. **110**, 865 (1958).
[2] M. Menes and D. I. Bolef, J. Phys. Chem. Solids **19**, 79 (1961).
[3] Yu. Kagan and V. A. Maslov, Zh. Eksperim i Teor. Fiz. **41**, 1296 (1961) [English transl.: Soviet Phys.—JETP **14**, 922 (1962)].

Resonance Absorption Experiments with the 63-sec Ag^{107} Isomeric State

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In this paper we describe experiments on resonant excitation of the 93.5-keV isomeric state of Ag^{107} whose mean lifetime is 63 sec. The method is a special application of the Mössbauer effect and was suggested by the authors and independently by Tsara. A radioactive source of high gamma activity was placed near the sample to be excited. Both the source and the sample were metal silver plates of 99.999% purity. After sufficient exposure at liquid-helium temperature and at a low level of acoustic noise, the sample was brought close to a scintillation counter with low background connected to a one-channel differential pulse analyzer for 93.5-keV gamma-ray detection. The count rate was measured for 20 min, the first 4 min being used for a determination of sample activity. The mean background was determined through the numbers of counts detected from the 5th up to the 20th min. According to previously made estimates, the effective linewidth must be 10^5 times

larger than its natural value due to the interaction between magnetic moments of neighboring nuclei. It would result in a gamma-ray resonant scattering cross section of 5.6×10^{-30}cm^2. The measured value of this cross section was $(0.74 \pm 0.20) \times 10^{-30}$cm^2. The true nature of this discrepancy will be established after a direct determination of the line form.

The Mössbauer Effect in Te^{125}

E. P. Stepanov, K. P. Aleshin, B. N. Samoilov, and V. V. Sklyarevsky, *Academy of Sciences, USSR*

The Mössbauer spectra of the 35.5-keV gamma rays of Te^{125} have been investigated at $T = 80°K$ for some Te compounds with the help of a xenon-filled proportional counter, the compounds being PbTe, TeO_2, as well as "amorphous" and crystalline tellurium. An unsplit line has been found in PbTe. With the help of this line a quadrupole splitting with different intensities of the doublet components was found in the other Te compounds. The asymmetry of the intensities increases with increasing temperature.

A Study of Precipitation from Solid-State Solution and Association of Point Imperfections by Means of the Mössbauer Effect*

James G. Mullen, *Argonne National Laboratory*

Co^{57} ions were diffused into NaCl and the recoilless resonance absorption spectra were examined as a function of temperature at large and dilute concentrations of Co ions. Three distinct resonances were observed. At high concentrations, $CoCl_2$ precipitated from solution in NaCl with the same color and Mössbauer absorption peaks as observed for anhydrous $CoCl_2$. The angular dependence of the intensities of the two lines observed indicates that the precipitated crystals near the surface are partially aligned in their spatial orientation. The data indicates one charge state, Fe^{2+}, and no evidence was found for higher charge states resulting from Auger transitions. When tracer quantities of $Co^{57}Cl_2$ were diffused into NaCl, two types of spectra were observed: a doublet with a 0.5 mm/sec quadrupole splitting and a 0.5 mm/sec isomer shift relative to stainless steel (80°K) and a broad unsplit line at about -2 mm/sec (80°K). The temperature dependence of these two resonances and quenching experiments indicate that the first of these two spectra corresponds to an aliovalent charge state for the iron ion in the presence of an associated positive ion vacancy, and a monovalent charge state, for the latter, in a nearly cubic environment. The ratio of the fraction of recoil-free γ rays for these two environments was found to have a huge temperature dependence, being near unity at 80°K and about four at room temperature.

* Based on work performed under the auspices of the U. S. Atomic Energy Commission.

The Optical Rotation of Quartz for 14.4-keV Gamma Rays*

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The rotation of linearly polarized 14.4-keV radiation traversing material interposed between source and absorber has been measured by means of the Mössbauer Zeeman effect. This note reports on the results for the optical activity of quartz whose optical axis is along the photon momentum. The experimental arrangement is similar to that of Perlow *et al.*[1] The source of Co^{57} is diffused into a natural iron foil which is placed across the gap of a small Alnico "C" magnet. The absorber, 90% enriched Fe^{57}, is placed across the gap of another Alnico magnet. When the magnetic domains of both source and absorber foils are parallel, the absorption of the 14.4-keV radiation is maximum; when the domains are perpendicular, the absorption is minimum. The absorption intensity I varies as $I = I_0 + I_1(1 - \cos^2\theta)$, where I_0 is the background. When an optically active material is interposed between source and absorber, the phase shifts, the intensity being $I = I_0 + I_1(1 - \cos^2\theta + \alpha \sin 2\theta)$, where α is the optical rotation of the material. The experiment was performed by alternately interposing left-handed and right-handed quartz between the source and the absorber when magnetizing fields made angles of 45° and subsequently 135° with respect to each other. The optical rotation α is then given by $\alpha = \Delta/4I_1$ rad where $\Delta = I_{\text{left}}(45) + I_{\text{right}}(135) - [I_{\text{left}}(135) + I_{\text{right}}(45)]$. Runs were taken with $\frac{1}{2}$ and with 1-mm quartz. The effect is small and numerous check runs are being made. The data satisfying strict consistency checks yield the result $\alpha = 0.013 \pm 0.003°$/mm. The rotation is in the same direction as for visible light. This result implies that quartz has an optical absorption resonance below about 300 A.

* Supported in part through AEC Contract AT(30-1)-2098.

[1] G. J. Perlow, S. S. Hanna, M. Hamermesh, C. Littlejohn, D. H. Vincent, R. S. Preston, and J. Heberle, Phys. Rev. Letters **4**, 74 (1960).

Meissner Effect in Superconducting Nb_3Sn

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J. G. Dash, *University of Washington* and *Boeing Scientific Research Laboratory, Seattle*

This experiment is an attempt to measure the microscopic distribution of external field penetration in a Nb_3Sn superconductor. A metallic Sn^{119} emitter and powdered[1] Nb_3Sn absorber were studied at room temperature, 77, and 4°K, in transverse fields from 0 to 20 kG. The Doppler spectrum at all temperatures and zero field showed a single line of twice natural width, as did a pattern of the same source and a metallic Sn absorber. Analysis of the resonance pattern in 20 kG was made in terms of the experimental linewidths and the moments and spins of the excited and ground states of Sn^{119}. The calculated limiting conditions of shielding in the Nb_3Sn in 20 kG give intensity ratios at 0 and 1.2 mm/sec: Nb_3Sn completely shielded, $(I_\infty - I_0)/(I_\infty - I_{1.2}) = 0.55$; Nb_3Sn unshielded, $(I_\infty - I_0)/(I_\infty - I_{1.2}) = 2.8$. The experimental patterns yielded the ratios 3.4 ± 0.8 at 77°K, and 2.9 ± 0.7 at 4.2°K. The maximum fraction of completely shielded absorber is estimated accordingly to be 25%. These results may be compared with the behavior of thick-walled cylinders of Nb_3Sn in longitudinal fields[2] that shield the regions near the axis by factors which depend on the magnitude of the external field and the wall thickness. These results, extrapolated to wall thicknesses of 30 μ, which is the average grain size of the resonant absorber, predict that the internal field along the

cylinder axis is within 100 G of an external 20 kG field. We wish to thank R. Dunlap for several helpful discussions and suggestions.

[1] We are grateful to Y. B. Kim for a sample of Nb_3Sn.
[2] Y. B. Kim, C. F. Hemstead, and A. R. Strnad, Phys. Rev. **129**, 528 (1963).

Application of the Mössbauer Technique to the Measurement of Small Vibrations in the Ear

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We have used the Mössbauer technique to improve by an order of magnitude the existing techniques for measuring the tiny movements of the diaphragm and bones of the ear. A knowledge of these movements, whose amplitudes are in the Angstrom range, is vital both clinically and in the attempt to understand the mechanism of hearing.

A resonant system is chosen in which the isomeric shift is such that zero velocity is on the steep slope of a single line. A convenient system consists of a rather broadened Co^{57}-in-copper source and a stainless steel absorber. The counting rate near zero velocity will then be nearly linear with the velocity. The ratio of the counting rates in successive half-cycles of a sinusoidal motion will be proportional to the amplitude. The ratio will, of course, also depend on the phase of the motion with respect to the driving signal and this phase can, thus, be measured also. The direction of motion can be measured by finding the direction of maximum effect.

We have been able to get a sensitivity of better than 1% change in the ratio per 10 Å amplitude, so that with fractional millicurie sources (biologically tolerable) we get to 1 Å accuracy in an hour or two of running. The source weighs less than a milligram and is less than a square millimeter in area, so that it does not seriously disturb the ear motions. It is stuck to the tissue or bone simply by a spot of stiff grease.

Preliminary measurements on various points on the diaphragm and bones of fresh preparations will be presented. Measurements on the inner ear and *in vivo* measurements on animals and human beings are in preparation.

Structure of Ice

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We have begun investigating the Mössbauer effect of Co^{57} dissolved in ice. At temperatures around 100°K, the observed line is sometimes single with isomeric shift zero relative to a stainless steel absorber, but sometimes split into two symmetric lines up to 2.9 mm/sec apart and with center shift 1.4 mm/sec. These differences may be ascribed to the fact that water at very low temperatures may become either crystalline ice or, under certain conditions, apparently a glass. The Mössbauer efficiency for the split-line case is approximately constant at low temperatures, but it begins to decrease rapidly above about 200°K and is practically zero at least by −11°C.

Co^{57} in Diamond

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V. Vali and T. W. Nybakken, *Boeing Scientific Research Laboratories, Seattle*
P. Cannon and F. P. Bundy, *General Electric Research Laboratories, Schenectady*

Co^{57} diamond sources of recoil-free radiation have been prepared by three different techniques. Our first samples were made by reducing $Co^{57}Cl_2$ solutions on the surfaces of natural gems. Strong and broad single-line resonance spectra were found, but, in all cases, the activity could not be diffused into the diamond surface. The two succeeding techniques involved the preparation of Co^{57} graphite sources and their conversion to diamond at high pressures and temperatures. Conversion by the catalytic process[1] in the presence of Ni powder was carried out at about 50 kbar and 1600°C. The diamond yields were polycrystalline, colored, and magnetic, characteristic of yields from undoped graphite. The resonance spectra were quite broad, indicating that the Co^{57} was within the Ni inclusions. Finally, Co^{57} graphite samples have been converted to polycrystalline diamond by the direct process[1] at higher pressures and temperatures. Before conversion the graphite samples gave superimposed spectra characteristic of Co metal and of cobalt interstitial in graphite. After conversion at about 150 kbar and 3500°C, the spectra appear to come from three sites; a 250 kG hfs, and strong broadlines at 0 and at −2.6 mm/sec. We believe that the hfs is due to compressed Co inclusions, but we have not yet identified the remaining lines. From melting-pressure data and expansion coefficients, we estimate that the Co inclusions are now trapped at a pressure of 120 kbar. Therefore, the pressure coefficient of the hfs of Fe^{57} in Co is large and negative. We are grateful to G. B. Benedek for discussions and suggestions.

[1] F. P. Bundy, J. Chem. Phys. **38**, 631 (1963).

Mössbauer Analysis of Iron in Meteorites*

E. L. Sprenkel-Segel, S. S. Hanna, and D. J. Bailey, *Argonne National Laboratory*

A great deal of effort has been devoted to the accurate determination of the composition of meteorites in order to establish their origin and subsequent history.[1] By means of the Mössbauer effect in Fe^{57}, it is possible to study the iron composition of a meteorite without altering the sample by previous chemical processing. A meteorite sample is pulverized carefully to avoid losing any part of it. The absorption spectrum of the powder is measured with a Co^{57}–Cu source. The observed lines are then compared with standard spectra of iron and its compounds. The method readily distinguishes the 6-line patterns of magnetic iron compounds from the 1- or 2-line patterns of nonmagnetic compounds. More careful analysis is required for a quantitative analysis of the various iron compounds. Preliminary measurements have been made on the Holbrook, Plainview, and Johnstown meteorites.

* Work performed under the auspices of the U. S. Atomic Energy Commission.
[1] H. C. Urey and H. Craig, Geochimic. Cosmochim. Acta **4**, 36282 (1953).

The Detection of Nuclear Resonance Using the X Rays from Internal Conversion

D. A. O'Connor, N. M. Butt, and A. S. Chohan, *University of Birmingham, England*

In some experiments on the scattering of nuclear resonant radiation, there is an advantage to be gained in the use of a detector which responds in a positive fashion to resonant radiation. Such a detector can be achieved by measuring the x rays or photoelectrons produced in the internal conversion process following recoilless resonant absorption in a resonant absorber. Such a detector using the x rays will inevitably also respond to nonresonant radiation. The ratio of resonant to nonresonant response has been calculated. The results of measurements on two designs of detector using the Co^{57}–Fe^{57} system and their use in scattering and absorption experiments are described.

A Transducer Giving Equal Times at Each Velocity

D. W. Forester, B. K. Moore, F. E. Obenshain, and L. D. Roberts, *Oak Ridge National Laboratory*
J. O. Thomson, *University of Tennessee*

Various Mössbauer driving mechanisms have been used to produce a periodic motion where equal time intervals are spent at each velocity. With most of these devices the velocity–time function is the same for each period of the motion. Recently we have tried a somewhat different approach using a sinusoidally driven electromechanical transducer. The amplitude V_0 of the motion $V_0 \sin \omega t$ is modulated with a suitable periodic time function having a period which is long compared to ω^{-1}. With this modulation approximately equal time intervals are spent at each velocity. A preliminary model has given useful results.

Recoil-Free Resonance Using Delayed Coincidence Techniques*

P. P. Craig, O. C. Kistner, B. Mozer, and R. Segnan, *Brookhaven National Laboratory*

Nuclear decays preceding Mössbauer transitions can produce localized lattice heating which may last for many Debye periods. Such decays can also produce highly excited electronic states, which in some circumstances may be expected to equilibrate over times comparable to the nuclear state lifetimes. If these relaxation times are within an order of magnitude of the nuclear lifetimes, one may hope to study such processes by measuring recoil-free absorption as a function of time following the population of the resonant level.

Presently, measurements have been made of the time dependence of the recoil-free fraction f for the 14-keV transition in Fe^{57} as an impurity in light and heavy host lattices (Be and Pd) and in Cu. In these cases f is found to be independent of time in the range 20 to 300 nsec. Complications owing to interference effects (time filtering) are minimized by the use of a square absorber[1] given to us by Erickson *et al.*[1] This absorber used in conjunction with the delayed coincidence technique permits a precise determination of f of the sources, independent of background corrections and source linewidths. The recoil-free fractions found for Fe in Pd and Cu are in agreement with the Los Alamos[2] and University of Washington[1] measurements, while the result (74%) obtained for polycrystalline Be is slightly less than that of Erickson *et al.*[1]

* Work performed under the auspices of the U. S. Atomic Energy Commission.

[1] N. E. Erickson, R. M. Housley, and J. G. Dash (to be published).
[2] W. A. Steyert and R. D. Taylor (to be published).