of cases. In other words, the two neighbouring peptide units have a tendency to be at right angles to each other. This may probably be due to the interaction of the π-electrons in the two peptide units. Obviously this requires further careful study.
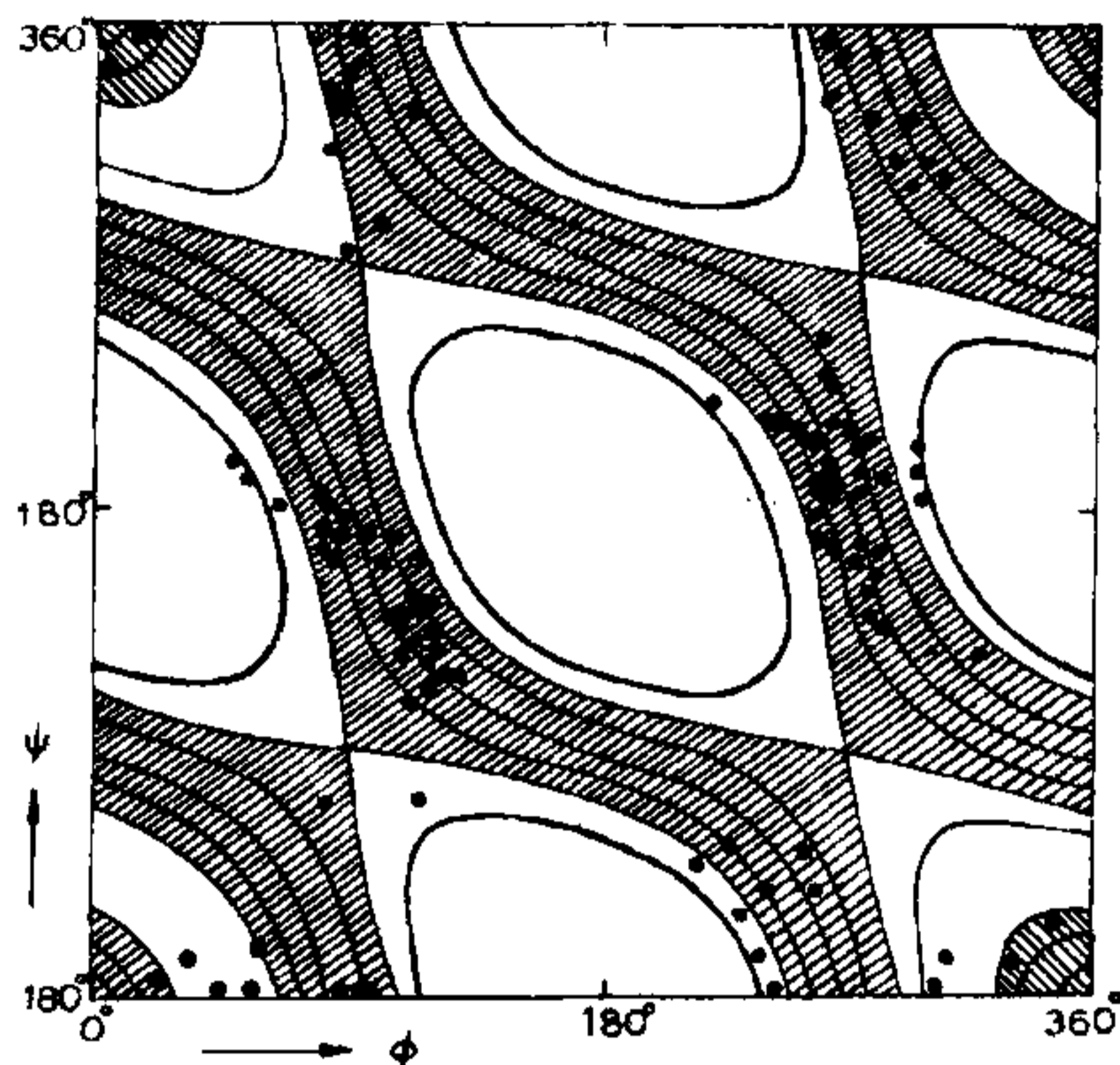

FIG. 4. Distribution of conformations in the (ϕ, ψ) map with regard to the parameter θ, namely, the interplanar angle between two neighbouring peptide units. The shaded region corresponds to $\theta = 90° \pm 20°$. Note the large concentration of points in this region.

Another factor which also requires study is the possible nonplanarity of the peptide unit. Winkler and Dunitz[11] have recently reviewed the nonplanarity of peptide units in cyclic peptides and showed that such a situation is quite common in cyclic compounds having peptide units. From the known fact that there is appreciable nonplanarity at the nitrogen atom in analine[12], there is good reason for the hydrogen atom in the NH group of a peptide unit being out of plane with the rest of the atoms. A preliminary quantum chemical calculation made in our laboratory indicates that such nonplanarity is quite likely to occur. However, this also requires careful examination.

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THE HALF-LIFE OF ^{155}Eu

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A FOURTEEN year old source of ^{155}Eu had larger activity, as determined in terms of the 105 keV γ-ray intensity, than it should have had if its half-life were $1 \cdot 811 \pm 0 \cdot 002$ yrs[1] as it has been believed to be hitherto. These earlier values in the range of $1 \cdot 70$ to $2 \cdot 0$ yrs were based on a few months decay curve. Herein, it is found to be $4 \cdot 53 \pm 0 \cdot 14$ yrs from the relative γ-ray intensities of the same source at different times during these fourteen years.

Figure 1 shows the decay curves with (I) $28 \cdot 8$ mgm/cm^2 Al absorber and (II) 521 mgm/cm^2 Al absorber recorded for six months from January 1958 through July 1958, using an end-window G.M. Counter. These curves were meant mainly to verify the existence of the 15-day ^{156}Eu and longer lived ^{155}Eu, produced in the neutron capture of enriched ^{154}Sm as Sm_2O_3, as supplied by the Oak Ridge National Laboratory and to prove that it was not ^{59}Fe as it had turned out to be in the 1957 supply of the sample under the label of ^{155}Eu. Curve II clearly follows a half-life of $15 \cdot 1 \pm 0 \cdot 9$ days (^{156}Eu). Curve I has this 15-day component and a residual component

(^{155}Eu) with a half-life of 1·21 to ∞ yrs. This decay curve cannot give an exact value for this, even from the six months observations.
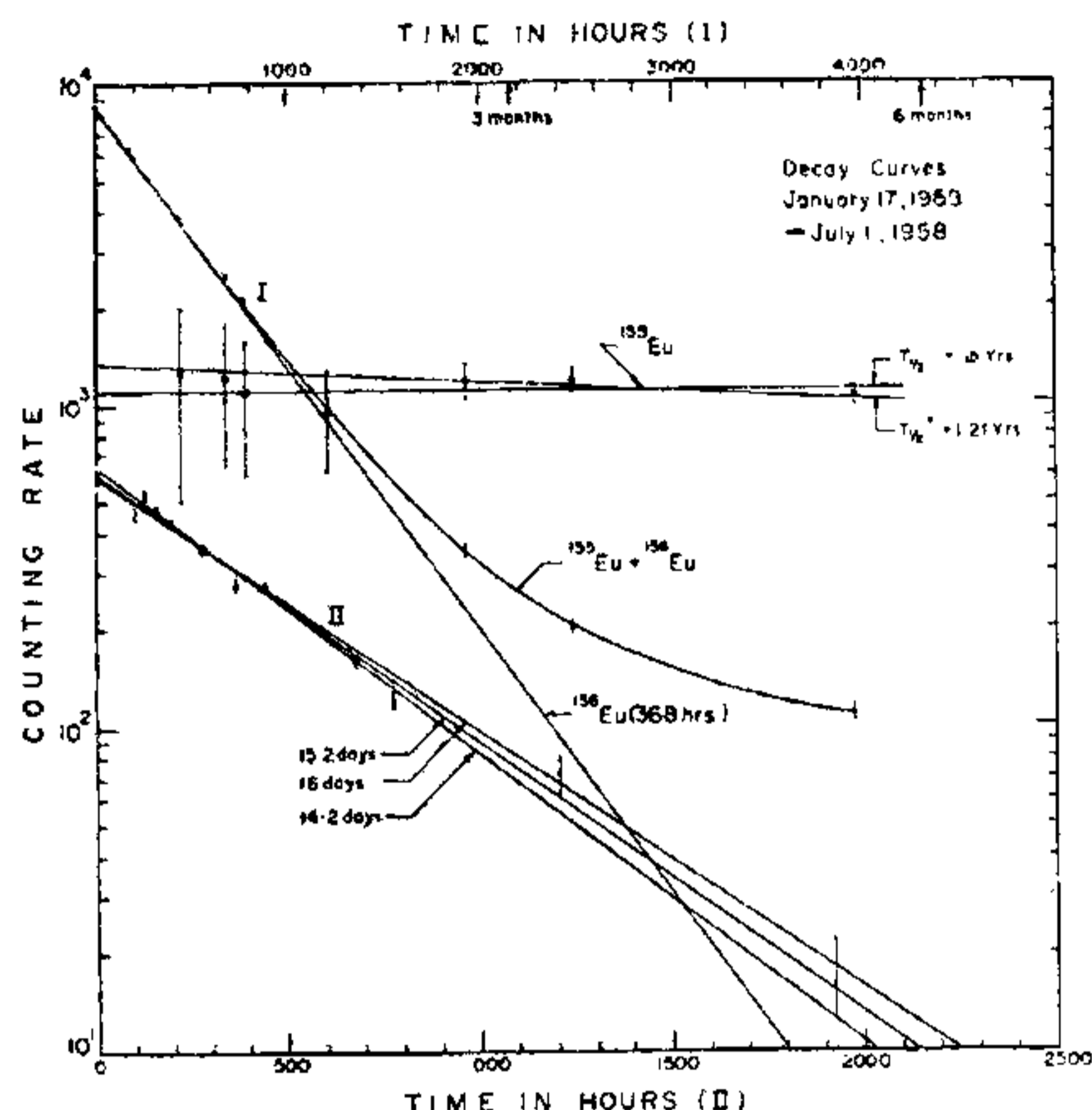

FIG. 1. Decay curves (I) with 28·8 mgm/cm² Al-absorber, with the ^{156}Eu and ^{155}Eu (× 10) components shown, (II) with 521 mgm/cm² Al-absorber corresponding to only ^{156}Eu.

The γ-spectrum recorded with a 1″ × 1″ Na I (Tl) scintillation spectrometer on August 31, 1959 is shown in Fig. 2. The spectrum was analysed into the 122 keV, 105 keV and 86 keV lines as shown in Fig. 2, based on the 86 keV line shape obtained from the critical absorption spectrum with 0·2 gm/cm² lead absorber also shown in the figure. The residual points fit well this line shape as seen in the figure.

On May 9, 1972 the Ge(Li) spectrum indicated a very large intensity of the 105 keV γ-ray. A statistically more weighted 200 min spectrum was recorded with this 20 cc Ge(Li), one end closed coaxial, detector on June 19, 1972 and is shown in Fig. 3. From these γ-spectra relative intensities of the 105 keV (^{155}Eu) and 122 keV (^{152,154}Eu) γ-rays were evaluated. Composition of the 122 keV line as 121·8 keV (^{152}Eu) and 123·1 keV (^{154}Eu) was determined from the 122 keV γ to 344 keV γ relative intensities. From the 105 keV γ to 121·8 keV γ relative intensities on these dates, the half-life of ^{155}Eu has been deduced to be 4·53 ± 0·14 yrs, based on the half-lives of ^{152}Eu and ^{154}Eu as 12·5 yrs and 16 yrs, respectively. These results are summarized in Table I.

As an additional check, source strengths of the sample of ^{155}Eu, earlier used in coincidence, γ-γ angular correlation and related studies[2,3], were determined from a single channel analyzer spectrum

with a 1·5″ × 1·5″ NaI(Tl) recorded on October 5, 1960 to be 1·95 μ Ci and from the Ge(Li) spectrum of June 19, 1972 to be 0·548 μ Ci, based on the absolute intensity of only the 105 keV peak. The variation in source strength over 11·7 yrs also follows a half-life (6·4 ± 2·1 yrs) much longer than 1·81 yrs.
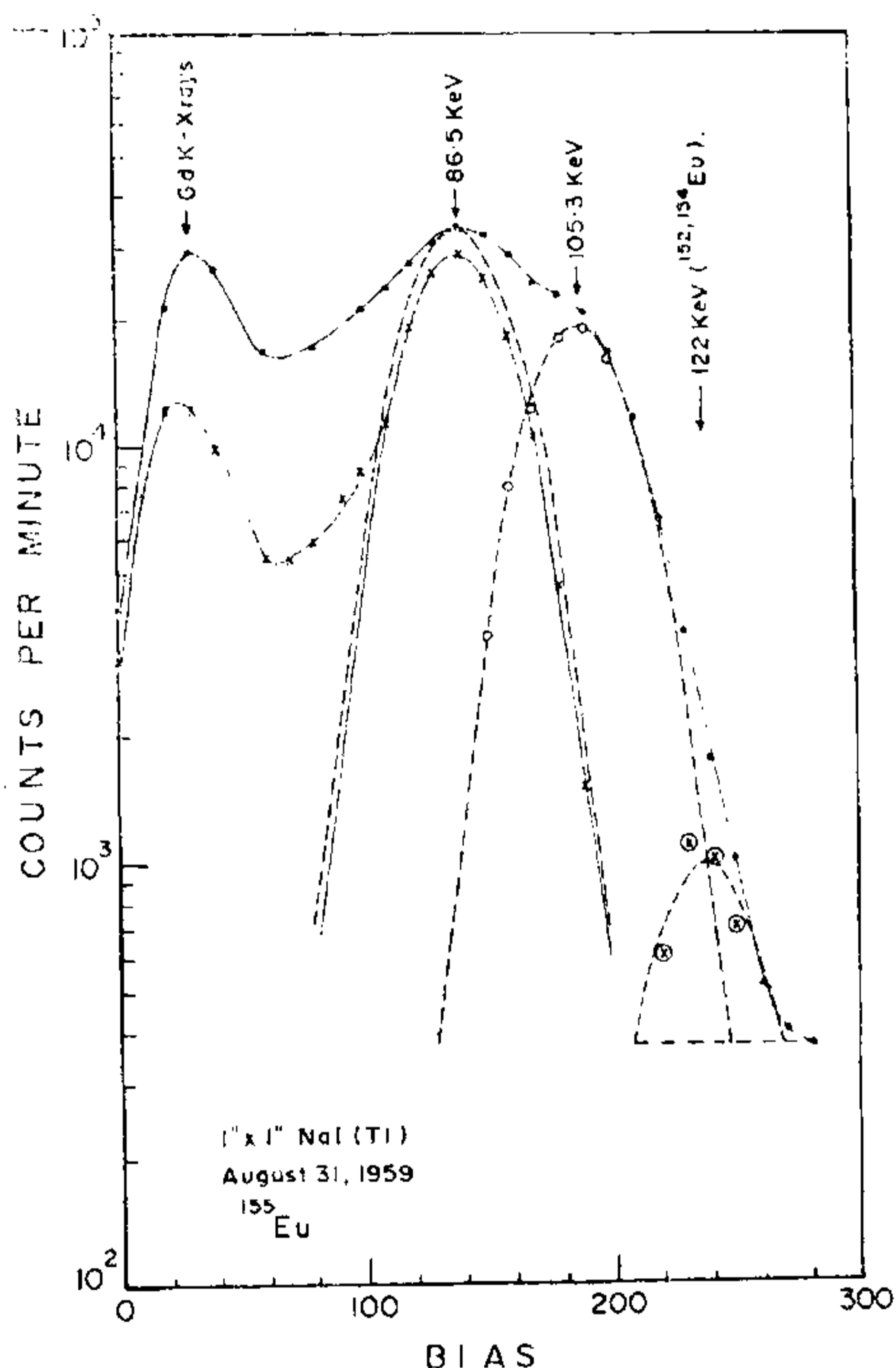

FIG. 2. ^{155}Eu γ-spectrum (.) No-absorber. (×) with 0·2 gm/cm² Pb-absorber (o) Residual points which fit the line of 105 keV shown by hyphens. (×) points left after removing the 86 keV and 105 keV lines which fit the 86 keV line shape standing on the Compton-continuum.

These results from the decay curve (1·21 → ∞ yrs) and source strength (6·4 ± 2·1 yrs) are not in contradiction with the accurate value of 4·53 ± 0·14 yr from the (γ 105/γ 122) ratio, with ^{152,154}Eu component acting as a chronometer.

In view of the large discrepancy between this value and the hitherto[1] accepted value of 1·811 ± 002 yrs, recent literature[4] has been searched. It is observed that while most authors use the value of 1·81 yrs, there are two[5,6] unpublished progress reports and private communications which give 4·9 yrs as the tentative half-life of ^{155}Eu. This

TABLE I

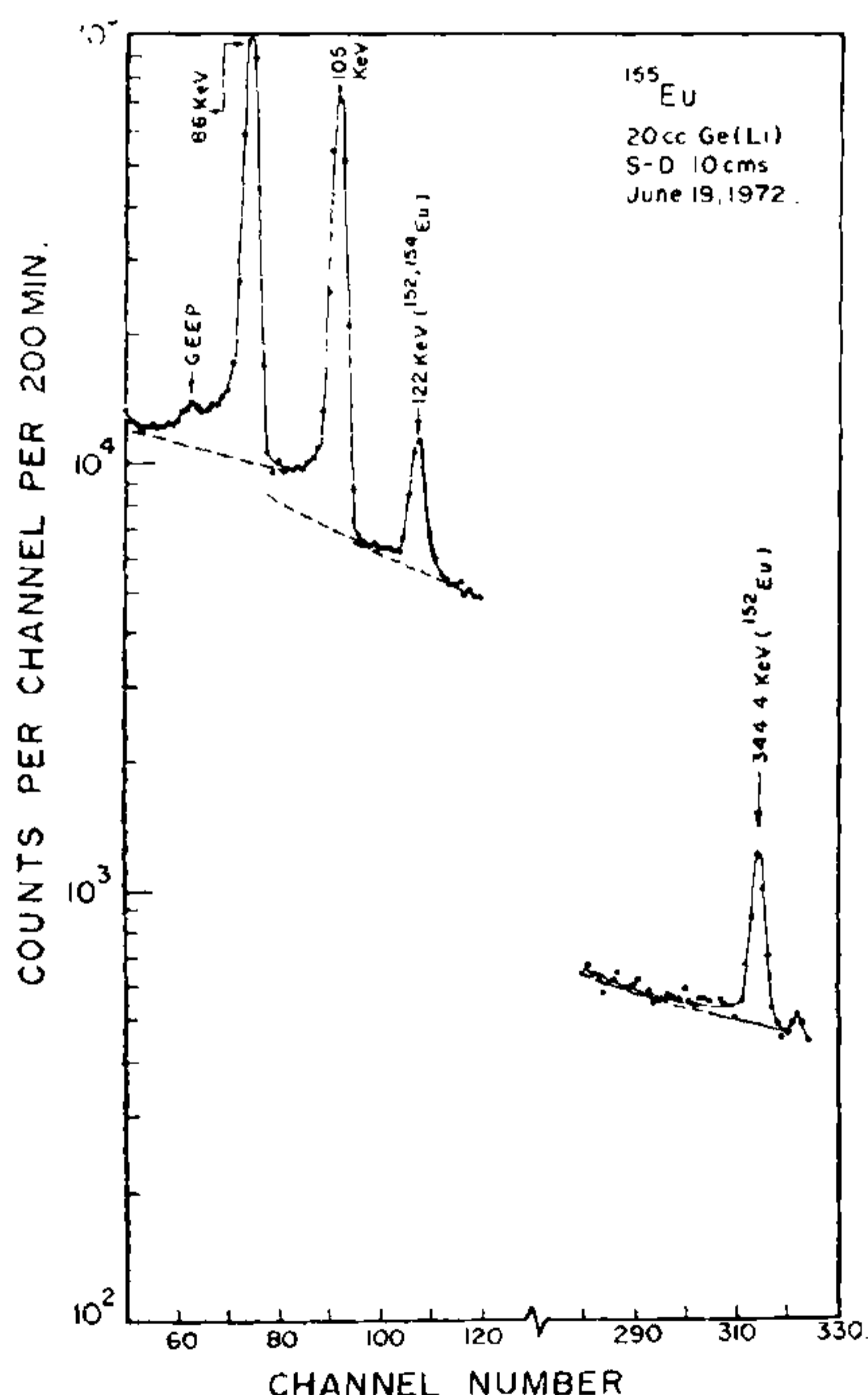| | (A) 1″×1″ NaI (Tl) August 31, 1959 $\gamma_{105}(^{155}Eu)/\gamma_{122}(^{152,154}Eu)$ | (B) May 9, 1972 $\gamma_{105}/\gamma_{122}$ | 20 cc Ge (Li) | | |
| | | | (C) June 19, 1972 | | |
			$\gamma_{105}/\gamma_{122}$	$\gamma_{344}/(^{152}Eu)/\gamma_{122}(^{152,154}Eu)$	$\gamma_{123-1}(^{154}Eu)/\gamma_{121-8}(^{152}Eu)$
Observed value	75950±282	13649±118	199678±569	2221±105	..
	2070±76	1172±37	20713±349	20713±349	
Correction factor due to effective peak detection efficiencies	0·892 / 0·886	0·298 / 0·310	0·298 / 0·310	0·298 / 0·045	..
True value ..	37·0 ±1·4	10·85±0·35	9·27±0·16	0·710±0·036	0·549±0·078
Half-life of ^{155}Eu in yr From (A) and (B)	4·70±0·22				
From (A) and (C)	4·35±0·17				
Mean ..	4·53±0·14				

FIG. 3. ^{155}Eu γ-spectrum with Ge(Li) detector.

value based, apparently on the decay curve followed over a few months, is 7·5% larger than the present value of 4·53 ± 0·14 yrs based on relative γ-ray intensities observed 12 yrs apart.

Further the ORNL-progress report[6] suggests tentative values of 13·5 yrs and 8·5 yrs for the half-lives of ^{152}Eu and ^{154}Eu while 12·5 yrs and 16 yrs have been used in the present work. If the former values are correct, the present result will have to be 4·18 ± 0·12 yrs, which is 14·7% less than their[5,6] value of 4·9 yrs.

In conclusion, it is noted that there is accumulating evidence for a ^{155}Eu half-life much longer than 1·81 yrs. This factor of 2·6 increase shows up only in the β-decay comparative half-life, ft, but enhances the log ft by only 6%. This nuclide is a fission-product entering into the biosphere through radioactive fall-out and this alteration in half-life by a factor of 2·6 may have some significance in fall-out assaying.

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