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RADIOACTIVE ATOMS

Auger-Electron, α-, β-, γ-, and X-Ray Data

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Decay schemes and decay characteristics are presented for 105 radioactive atoms of special importance in nuclear medicine, health physics, and industrial applications. Listed in tabular form are "best" values for half-lives, energies, intensities, equilibrium absorbed-dose constants, and 90% absorbed-dose ranges (in water) for each of the atomic and nuclear radiations emitted by these radioactive atoms. Data basic to the adopted values are also given with appropriate literature references.

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INTRODUCTION

History

Some ten years ago, with the support of the Medical Research Branch of the Atomic Energy Commission, L. Slack and K. Way prepared a report entitled "Radiations from Radioactive Atoms in Frequent Use."* In the foreword Dr. H. D. Bruner, at the time Chief of the Medical Research Branch, wrote: "Neither the biomedical research worker nor the health physicist is in a position to judge which of several decay schemes is the most reliable or most complete, assuming, of course, that he has been able to locate them in the voluminous and often misleadingly titled physical literature. In many instances a complete scheme must be synthesized from the data of several papers. The biologically useful data on the frequency of internal conversion and K-capture electrons seem to be especially elusive.

"The obvious solution to this frustrating situation is to ask a group of physicists acquainted with this literature to collect, evaluate, and codify these biologically useful data into a suitable reference form. The following pages represent such an effort, the first of its kind, so far as is known."

For the first time special attention was given to the explicit presentation of the energies and intensities of the radiations emitted not only by the radioactive nucleus but also by the orbital electrons as a result of rearrangements which follow the nuclear transformation.

Since today the literature is even more voluminous and probably even more "misleadingly titled" than in 1959, the Subcommittee on the Use of Radioactivity Standards,† under the leadership of Bernd Kahn, asked the Nuclear Data Group to undertake a revision and extension of the 1959 work. Emphasis again was to be put on noting all photons and electrons emitted by the radioactive atom rather than by the transforming nucleus alone. A list of 69 radioactive nuclides of importance in medicine was prepared by the subcommittee. Of these, 50 are nuclei which decay to stable products and 19 are nuclei which decay to one or more radioactive descendants. The radiations from these 69 parent and their 36 radioactive descendant atoms are presented here.

*U.S. Government Printing Office Washington, D.C. (February 1959) (Out of print)

†A subcommittee of the National Academy of Sciences—National Research Council Committee on Nuclear Science, D. A. Bromley, chairman. Subcommittee members: B. Kahn, chairman; A. P. Baerg, G. R. Choppin, J. S. Eldridge, H. L. Finston, K. F. Flynn, S. B. Garfinkel, B. Keisch, R. C. Koch, S. A. Reynolds, B. F. Scott, J. G. V. Taylor, and P. E. Zigman

On the advice of the subcommittee it was decided to give here the equilibrium absorbed-dose constant, Δ, and the 90% absorbed-dose range, R_{90}, rather than the dose rate and half-thicknesses in lead and water as previously done.

Acknowledgments

The collaboration of M. J. Berger, Chief of the Radiation Theory Section of the National Bureau of Standards, is greatly appreciated. He provided curves and tables for R_{90}-values for both monoenergetic photons and electrons and also calculated the R_{90}-values for β-groups. These depend on the shape as well as the endpoint energy of the β-spectra and thus must be computed separately for each case. Thanks are due L. C. Northcliffe of Texas A & M University for providing mean ranges for α-particles.

The assistance of several physicists, expert in the measurement and evaluation of half-lives, is also gratefully acknowledged. S. B. Garfinkel of the National Bureau of Standards and G. I. Gleason of Oak Ridge Associated Universities met for two days with J. E. Bigelow, B. H. Ketelle, and S. A. Reynolds of the Oak Ridge National Laboratory and with members of the Nuclear Data Project to review the half-life data and to adopt "best" values for the nuclides included here.

Thanks are due N. B. Gove of the Mathematics Division of the Oak Ridge National Laboratory for assistance in obtaining the electron radial wavefunctions and exchange corrections given in Appendix III. Dr. Gove also provided the β-decay statistical rate functions needed for the calculation of capture-to-positron ratios, β-group average energies, and R_{90}-values.

The assistance of the entire staff of the Nuclear Data Project in checking the basic data and its interpretation and in preparing the manuscript is gratefully acknowledged.

Present Work

The literature received by the Nuclear Data Group has been covered up to September 1, 1969. Energy and intensity data on some of the nuclides included here have been published separately by one of the authors (68B115). The present work supersedes that publication.

REVIEW OF RADIATION PROCESSES

α-Decay

In α-decay, a nucleus with atomic number Z and mass number A emits an α-particle (^{4}He nucleus, $Z = 2$, $A = 4$) and decays to a nucleus with atomic number $Z - 2$ and mass number $A - 4$.

For decay to a particular level in the daughter nucleus, the maximum energy available for the α-particle is

$$E_\alpha = Q_\alpha - E_R - E(\text{level}) = \left(\frac{M}{M + M_\alpha}\right) Q_\alpha - E(\text{level}),$$

where Q_α is the atomic mass difference between ground states of parent and daughter, M_α and M are the masses of the α-particle and daughter nucleus, respectively, and $E_R = M_\alpha Q_\alpha/(M_\alpha + M)$ is the energy carried off by the recoil of the daughter nucleus.

β^--Decay

In β^--decay, a neutrino and a negative electron (hereafter called simply electron) are emitted from the nucleus as a result of the process $n \to p + \beta^- + \nu$. The decay increases the nuclear charge by one unit.

The energy released in a single β-transition is divided between the β-particle and the neutrino in a statistical manner so that, when a large number of transitions are considered, both the neutrinos and β-particles are found to have energy distributions extending from zero up to some maximum value. For decay to a particular level in the daughter nucleus, the maximum energy available is $E_{max} = Q^- - E(\text{level})$, where Q^- is the atomic mass difference between ground states of parent and daughter. The average energy of a β-particle in this transition is given by

$$E_{av} = \int_0^{E_{max}} E \times N(E)dE \Big/ \int_0^{E_{max}} N(E)dE,$$

where N(E) is the number of β-particles with energy between E and E + dE. Thus, the β-particles from a particular transition i, denoted in the main table by β_i, constitute a "group" having a continuous distribution of energies with a definite E_{max} and E_{av}.

β^+-Decay

In β^+-decay, a neutrino and a positive electron (positron) are emitted from the nucleus as a result of the process $p \to n + \beta^+ + \nu$. This decay decreases the nuclear charge by one unit.

As in β^--decay (see above), the β^+-particles emitted in a transition to a particular level in the daughter nucleus have a continuous distribution of energies with a definite E_{max} and E_{av}. For positron decay, $E_{max} = Q^+ - 2mc^2 - E(\text{level})$, where Q^+ is the atomic mass difference between ground states of parent and daughter. Note that β^+-decay to a particular level cannot occur unless $Q^+ - E(\text{level}) > 2mc^2$ ($2mc^2 = 1.022$ MeV).

ϵ-Decay

In electron-capture decay, an atomic electron is captured by a nucleus and a neutrino is emitted as a result of the process $p + e^- \to n + \nu$. This decay decreases the nuclear charge by one unit and leaves the daughter nucleus with a vacancy in one of its atomic shells. An alphabetic subscript on ϵ, as in ϵ_K, denotes an electron-capture process in which the final-state vacancy is in the K-shell. A numeric subscript, as in ϵ_1, denotes a capture branch to a particular level in the daughter nucleus. For the electron-capture branch denoted by ϵ_{1K}, for example, the energy released is given by $Q^+ - E(\text{level } 1) - E_K$, where E_K is the K-shell binding energy in the daughter atom.

The electron-capture process always competes with β^+-decay, but also can occur when the transition energy is too small to allow β^+-emission, that is when $Q^+ - E(\text{level}) < 2mc^2$. See Appendix III for a further discussion of the electron-capture process.

γ-Decay

Electromagnetic radiation is emitted by a nucleus in a transition from a higher to a lower energy state. A numeric subscript on γ, as in γ_1, denotes a gamma ray emitted in the transition between a particular pair of nuclear levels. The energy of this gamma, $E(\gamma_1)$, is equal to the energy difference between the two levels. (Except for a negligible amount of nuclear recoil energy, $E_{recoil} \approx 0.00054\ E^2(\gamma)/A$, where A is the mass number and $E(\gamma)$ is in MeV.) Since a given transition can occur by the emission of gamma rays, conversion electrons, or internal pairs, the gamma-ray intensity, $I(\gamma)$, is in principle smaller than the transition intensity. In practice, however, the fraction of conversion electrons and internal pairs is often negligible.

Internal-Conversion-Electron Emission (ce)

An atomic electron can be emitted as an alternative to gamma-ray emission in the transition of a nucleus from a higher to a lower energy state. In the internal-conversion process, the energy difference between these states is transferred directly to a bound atomic electron which is then ejected from the atom. An alphabetic subscript on ce refers to the shell from which the atomic electron is ejected. Thus, ce_K denotes K-shell conversion; ce_{LMN} denotes conversion in the L-, M-, and N-shells combined; and $ce_{KLM...}$, or merely ce, refers to conversion electrons from all shells. A numeric subscript, as in ce_1, has a meaning analogous to that used above for gamma rays. For a transition with energy $E(\gamma_1)$, the K-shell internal-conversion electron is emitted with energy $E(ce_{1K}) = E(\gamma_1) - E_K$, where E_K is the K-shell binding energy. The energy of an electron converted in one of the other shells is given by the same expression with the replacement of E_K by the binding energy appropriate to that shell.

For a particular transition, the ratio of the probability for emission of a K-conversion electron to that for emission of a gamma ray, $I(ce_K)/I(\gamma)$ or more simply ce_K/γ, is called the K-shell conversion coefficient for that transition. Conversion coefficients for the other shells are defined in an analogous manner.

Internal-Pair Emission ($e^{\pm}$)

Electron-positron pair emission is an alternative to gamma-ray emission in the transition of a nucleus from a higher to a lower energy state. In the internal-pair-formation process, an energy $2mc^2$ (1.022 MeV) is required to create the electron-positron pair. Thus, for a transition with energy $E(\gamma)$, the energy of the corresponding pair is

$$E(e^{\pm}) = E(\gamma) - 2mc^2.$$

In a given transition, the available energy is divided between the electron and positron in such a way that when a large number of transitions are considered, both the positron and the electron are found to have energy distributions extending from zero up to $E(e^{\pm})$. Since the energy distribution function usually is not known and since the intensity of internal pairs is small for all the transitions encountered in this compilation (<0.1 per 100 disintegrations), the pair is treated here as a single particle with energy $E(e^{\pm})$.

For a given transition, the ratio of the probability of emission of an electron-positron pair to that for emission of a gamma ray, $e^{\pm}/\gamma$, is called the internal-pair-formation coefficient.

X-Ray and Auger-Electron Emission (X, e_A)

Whenever a process results in the production of a vacancy in an inner electron shell of an atom, the filling of this vacancy is accompanied by either *X*-ray or Auger-electron emission. Vacancies created by the filling of the initial vacancy will in turn produce further *X*-rays or Auger electrons. This cascade of radiations continues until all vacancies have been transferred to the outermost electron shell. Inner-shell vacancies are always produced in two types of nuclear decay, electron capture and internal conversion. Other processes which produce electron vacancies following a nuclear decay, such as electron shakeoff (the ejection of one or more atomic electrons due to a sudden change in nuclear charge) or the ejection of atomic electrons by escaping β-particles, are not discussed here because of the low probability of their occurrence.

Fluorescence Yield (ω)

The fluorescence yield for a particular atomic shell (ω_K, ω_L, etc.) is defined as the probability that a vacancy in that shell will result in the emission of an *X*-ray. If n_K is the number of K-shell vacancies per disintegration, the number of K *X*-rays will be $n_K\omega_K$, and the number of K-Auger electrons $n_K(1 - \omega_K)$.

The most recent review of fluorescence yields is that of Fink, Jopson, Mark, and Swift (66Fi08). In view of the large spread in experimental results for many of the Z-values, these authors recommend the use of values read from a curve drawn smoothly through the theoretical results of Callan (62Ca32, 66Fi08) and Listengarten (61Li16, 62Li19, 66Fi08). Such a curve yields values in good agreement with those obtained by means of the more accurate experimental techniques. The compilers have adopted this procedure to obtain the values given in Appendix III.

X-Rays

X_K. An *X*-ray emitted as the result of the filling of a K-shell vacancy by an electron from a higher shell, for example the Y-shell, has an energy $E_K - E_Y$, where E_K and E_Y are the electron binding energies in the K- and Y-shells, respectively. This transition can be denoted by K − Y. In order of decreasing intensity, the most important transitions are

$$K_{\alpha 1} = K - L_3 \qquad K_{\beta 3} = K - M_2$$
$$K_{\alpha 2} = K - L_2 \qquad K_{\beta 4} = K - N_2$$
$$K_{\beta 1} = K - M_3 \qquad K_{\beta 5} = K - M_4.$$
$$K_{\beta 2} = K - N_3$$

Measured values of the relative intensities of the groups $K_{\alpha 1}$, $K_{\alpha 2}$, $K'_{\beta 1} = K_{\beta 1} + K_{\beta 3} + K_{\beta 5}$ and $K'_{\beta 2} = K_{\beta 2} + K_{\beta 4}$ are given in Table 7.2-3 of Wapstra, Nijgh, and Van Lieshout (59W11). The K *X*-ray energies given in the present compilation are averages calculated from these relative intensities and electron binding energies of Bearden and Burr (67BeBu).

As already mentioned, the number of K *X*-rays per disintegration is $n_K\omega_K$. The number of K-vacancies per disintegration is the sum of the vacancies produced by K-capture and those produced by internal conversion in the K-shell. Thus,

$$n_K = \epsilon_K + \sum_i \frac{ce_{iK}}{ce_{iK} + \gamma_i} I_i,$$

where ϵ_K is the number of K-captures per disintegration, and ce_{iK} and γ_i are the relative numbers of the K-conversion electrons and γ-rays, respectively, emitted in a nuclear transition, i, whose intensity is I_i per disintegration.

X_L. As in the case of the K-shell, many transitions contribute to the L X-ray spectrum. However, since the relative intensities of these transitions are not known for all Z-values and since the energy differences between the transitions are small (≤ 1 keV), the total L X-ray radiation is treated here as a single group having the energy of the strongest transition, $L_{\alpha 1} = L_3 - M_5$. For $Z < 37$, the M_5-transitions have not been resolved experimentally from the M_4-transitions. In these cases, the energy given is that for the transition $L_{\alpha 1, \alpha 2} = L_3 - M_4, M_5$.

The calculation of the number of L X-rays per disintegration, $n_L \omega_L$, is similar to that for K X-rays except that, in addition to vacancies produced by direct L-shell capture and by L-shell conversion, those created by the transfer of L-shell electrons to K-shell vacancies must also be included. Thus,

$$n_L = \epsilon_L + \sum_i \frac{ce_{iL}}{ce_{iL} + \gamma_i} I_i + n_{KL} \times n_K,$$

where n_{KL} is the number of L-shell vacancies created per K-shell vacancy, and the other symbols have meanings analogous to those used above for the K-shell.

Values of n_{KL} are given in Appendix III. They have been calculated from the relation (66Fi08)

$$n_{KL} = \omega_K \frac{K_\alpha}{K} + (1 - \omega_K) \frac{2 + \dfrac{KLY}{KLL}}{1 + \dfrac{KLY}{KLL} + \dfrac{KXY}{KLL}},$$

where K_α/K is the ratio of K_α X-rays to all K X-rays, ω_K is the K-shell fluorescence yield, and the other quantities denote Auger transitions defined below. Note that for the KLY and KXY Auger transitions used in the above formula, X and Y refer to shells other than K or L.

K_α/K was taken from Table 7.2-3 of Wapstra, Nijgh, and Van Lieshout (59W11). Auger-intensity ratios were taken from Erman, Rossi, Bonacalza, and Miskel (64Er09).

Auger Electrons (e_A)

The Auger process competes with the emission of X-rays as a means of carrying off the energy released in the filling of an inner-shell vacancy by an electron from an outer shell. In the Auger process, the filling of an inner-shell vacancy is accompanied by the simultaneous ejection to the continuum of an outer-shell electron. The resulting atom is left with two vacancies. The Auger-electron yield per disintegration of a particular atomic shell is $n_K(1 - \omega_K)$, $n_L(1 - \omega_L)$, etc. If the original vacancy is in the K-shell and if this vacancy is filled by an electron from shell X with the ejection of an electron from shell Y, the transition is denoted by KXY. The energy of the ejected electron is $E_K - E_X - E'_Y$, where E_K and E_X are neutral-atom K- and X-shell binding energies, respectively, and E'_Y is the binding energy of a Y-shell electron in an atom containing a vacancy in the X-shell. The most intense K-Auger transitions are of the type KLL. Since the relative intensities of the electrons in the KLL-group are not accurately known and since the energy difference between the transitions is small (≤ 5 keV), the K-Auger electrons are treated here as a single group having the energy of the strongest transition, KL_2L_3. The energies of these transitions as a function of atomic number are taken from Table 1 of Bergstrom and Nordling (65Be37).

In the case of the L-Auger process, very little is known about the energies or relative intensities of the individual L-Auger electrons. For this compilation, the L-Auger electrons are treated as a single group having the energy appropriate to an $L_3M_4M_5$-transition, $\approx(E_{L_3} - E_{M_4} - E_{M_5})$.

Bremsstrahlung

In addition to any monoenergetic X-rays or γ-rays that may be present in radioactive decay, every β-decay produces continuous electromagnetic radiation called bremsstrahlung. Two processes contribute to this continuous spectrum.

1. "External" bremsstrahlung is produced by collisions between β's and the atoms of the material surrounding the radiating atoms. Since the intensity of the external bremsstrahlung depends on the atomic number, Z, of the surrounding material, this radiation is not included in the present tables. In many cases this radiation cannot be neglected in dose calculations. An approximate value for the average energy of the external bremsstrahlung associated with a β-group of maximum energy E_β (MeV) is given by (55E23, p. 619)

$$E_{av} \approx 0.00014\ Z\ E_\beta^2 \text{ MeV per } \beta.$$

In the decay of ^{32}P, where $E_\beta = 1.709$ MeV, the average energy per disintegration of the external bremsstrahlung is ≈ 0.00040 Z MeV.

2. "Internal" bremsstrahlung, originating within a decaying atom, is produced by the sudden change of nuclear charge which occurs in β^+-, β^--, or ϵ-decay. This radiation is not included here because of its low intensity and low average energy. The average energy of the internal bremsstrahlung associated with a β-group of maximum energy E_β (MeV) is given for $E_\beta \gg mc^2$ (0.511 MeV) by (66Sc35, pp. 76–84)

$$E_{av} \approx 0.0015\ E_\beta \log(4E_\beta - 2.2) \text{ MeV per } \beta.$$

In electron capture, the corresponding expression for a transition with energy E_ϵ (MeV) is (66Sc35, pp. 76–84)

$$E_{av} \approx 0.00015\ E_\epsilon^2 \text{ MeV per capture.}$$

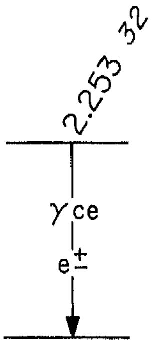
In the decay of ^{32}P, where $E_\beta = 1.709$ MeV, the average internal bremsstrahlung energy per disintegration is ≈ 0.0016 MeV.

EXPLANATION OF TABLE OF RADIATION DATA, POLICIES FOLLOWED

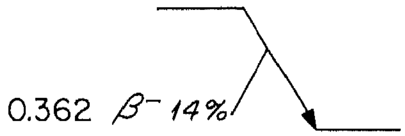
The material for each nucleus is arranged in two main sections headed, respectively, Decay Characteristics and Basic Data, Sources for Adopted Values. The first section contains the decay scheme, half-life, and table of radiation properties. The second section contains the experimental and theoretical data (with references) on which the values given in the first section are based.

Decay Characteristics

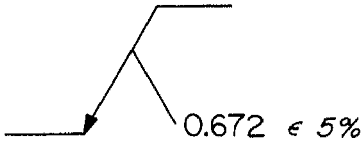
Decay Scheme Drawing



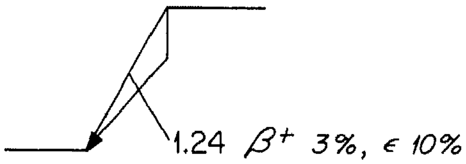
Nuclear transition which decays by γ-, ce-, and e±-emission. The energy of the transition is 2.253 MeV and the intensity (γ + ce + e±) is 32 transitions per 100 decays of the parent. Absence of the symbol ce (or γ or e±) indicates that the ce- (or γ- or e±-) intensity is <0.01 transitions per 100 disintegrations of the parent nucleus



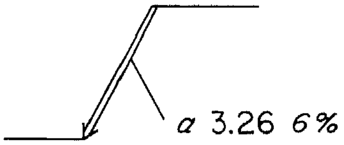
β^--transition with endpoint energy 0.362 MeV and intensity 14 transitions per 100 disintegrations of the parent nucleus



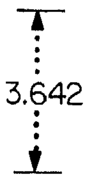
ϵ-transition with energy 0.672 MeV and intensity 5 transitions per 100 disintegrations of the parent nucleus



(β^+ + ϵ)-transition with β^+-endpoint energy 1.24 MeV, β^+-intensity 3 transitions per 100 disintegrations of the parent nucleus, and ϵ-intensity 10 transitions per 100 disintegrations of the parent nucleus. The vertical segment at the top of the lower slant line represents the energy $2mc^2$ needed, in positron decay, to create an electron-positron pair



α-transition with energy 3.26 MeV and intensity 6 transitions per 100 disintegrations of the parent nucleus



Q-value or total disintegration energy in β^+-, ϵ-, β^--, or α-decay

$\frac{1}{2}^-$, $\frac{3}{2}^+$, etc. Spin and parity values for levels

Since the degree of forbiddenness of the β-groups is needed in order to calculate average β-energies and R_{90}-values, the spin and parity values of the nuclear levels, where available, are shown on the decay scheme. Many of the ground-state spins have been measured by the atomic-beam or some other direct method. The values so determined, as given by Fuller and Cohen (69FuCo), are shown underlined. The other spin and parity assignments are taken from Nuclear Data Sheets* or from the Table of Isotopes (67LeHo) if more recent data were available there. Both of these compilations distinguish between "well-established" spins and those which are only tentative. However, since the bases for this distinction are not the same in the two works, the distinction is not carried over in this compilation. Thus, reference should be made to the above works in cases where the degree of certainty of the spin assignment is important.

$T_{1/2}$

Half-lives are given for ground-state and long-lived metastable-state decays. The experimental data from which these values were chosen are given in Appendix I.

Radiations

This table contains data on atomic and nuclear radiations of the type e_A (e_{AK},e_{AL}), X (X_K,X_L), α, $\beta^{\pm}$, γ, ce (ce_K,ce_L, . . .), and $e^{\pm}$ emitted with intensity >0.01 per 100 disintegrations of the parent nucleus (i.e., >0.01%). In those cases where weak radiations (≤0.01%) corresponding to otherwise unobserved transitions have been reported, a reference to these data is given in a note under the decay scheme immediately following the heading $T_{1/2}$. Exceptions to this policy on lower intensity limits occur for the cases of ^{124}Sb, ^{124}I, ^{132}I, ^{226}Ra, and ^{232}Th where, because of the large number of low-intensity γ-rays and the resulting complexity of the decay scheme, a lower limit of 0.1 per 100 disintegrations has been adopted.

Auger electrons and X-rays resulting from the filling of vacancies in the M-, N-, . . . shells, although sometimes occurring with large intensities, are not included because of their low energies (<0.002 MeV in ^{197}Hg decay, <0.0006 MeV in ^{113}Sn decay). These intensities are not in general calculable since the contribution to the total number of, say, M-shell vacancies due to initial K- or L-shell vacancies is not known.

*Nuclear Data Sheets, National Academy of Sciences, Washington, D.C. (1959–1965); Reprint by Academic Press, New York (1966); Nuclear Data, Section B, Vols. 1 and 2 (1966–1969)

The radiations are listed in the first column by type. For an explanation of the notation employed see REVIEW OF RADIATION PROCESSES. Particle radiations (e_A, ce, $e^{\pm}$, β) are given first, followed by the electromagnetic radiations (X, γ). In the case of β-decay, whenever more than one group is present, a separate entry (designated "All β's") is made for the composite spectrum.

Columns 2 and 3 contain, respectively, the energy (in MeV) and intensity (particles or photons per 100 disintegrations of the parent nucleus). For the β-groups, both the maximum and the average energies are given.

In column 4 the value of energy emitted per disintegration, Δ, is presented in units of gm-rad/μCi-h. For an infinite, homogeneous medium in which a source is uniformly dispersed with a concentration of 1 μCi-h/gm, Δ gives the absorbed dose in rads. See also SYMBOLS AND DEFINITIONS.

Column 6 contains the 90% absorbed-dose range, R_{90} (cm), in water. For an infinite, homogeneous medium, R_{90} is the radius of a sphere with a point source as center, within which 90% of the energy of the source is absorbed. See also Appendix IV.

Basic Data, Sources for Adopted Values

Decay Scheme

The Q-values adopted for this compilation have been taken from the 1964 Mainz mass adjustment (65MTW1) except in those cases where more precise values were available from recent β-endpoint measurements. Following the Q-value is a statement, or statements, giving the justification for the placement of any γ-rays present and the basis on which intensities per 100 decays of the parent nucleus were obtained.

Decay Modes

This section contains information basic to the adopted values of energies and intensities given under Decay Characteristics. In general, only experimental data which are quoted with uncertainties were considered. Exceptions occurred for those cases where none of the measurements of a given quantity include uncertainties or, in a few cases, where in the compilers' judgment a particular experimental value with no quoted uncertainty has a comparable or a greater precision than the other experimental values given with uncertainties. In the latter situations, the compilers have assigned uncertainties.

Directly measured energies and intensities are given as weighted or unweighted averages of all the comparably precise experimental determinations. Weighted averages are used except in those cases where the experimental measurements are given without uncertainties or where the measurements differ from each other by more than the quoted uncertainties. For each energy and intensity value, references for the experimental data used in the average are given in the right half of the column.

In addition to the directly measured data, energies and intensities deduced from other experimental data or calculated with the aid of theoretical quantities are also given where available. For example, in the case of β^--decay, the energies of any individual branches not involved in the determination of the Q-value can be obtained from the Q-value and the level energies while the intensities of many β-groups can be obtained from the γ-intensities by requiring an intensity balance at each level in the daughter nucleus. For each energy determined in such a manner, there appears in place of a reference the notation "Q − E(level)" while for the intensity there appears the notation "γ-intensities." As another example of indirectly determined data, the intensity of a particular β^+-group can often be deduced from the theoretical ϵ/β^+-value and the γ-intensity imbalance at the level being fed. For each intensity so determined, there appears the notation "γ-intensities and ϵ/β^+."

When more than one value of energy or intensity is given for a particular transition, an asterisk indicates the value adopted by the compilers.

In the case of the β^+- and β^--average energies, since few experimental data are available, most of the values are calculated from the theoretical spectrum shape. The method of calculation is described in Part C of Appendix III. Except when an experimental value is also available, the calculated average energies appear only under Decay Characteristics and are not given again in this section. For the entry "All β's," the energy given is the sum of the average energies of the individual groups weighted by their intensities. The intensity given is the sum of the intensities of the individual groups except that in the case of β^--emitters with no alternate mode of decay, the intensity is given as exactly 100%. It should be noted that, since the intensities of the individual β^--groups are often determined from the γ-intensities which in turn are usually determined by the requirement that the total ($\beta^- + \gamma$)-feeding of the daughter ground state be 100%, the intensity of the total β^--spectrum as given by the sum of the individual β^--intensities is not necessarily always exactly 100%.

The X-ray and Auger electron energies and intensities are obtained in the manner described in REVIEW OF RADIATION PROCESSES. They appear only under Decay Characteristics and are not given again in this section.

For the ϵ-branches, ce-transitions, and $e^\pm$-transitions, bases are given only for the intensities since the energies are always obtained in the same manner: for ϵ-decay from the Q-value and the level energies, for ce-transitions from the corresponding γ-ray energy and the electron binding energies (taken from 67BeBu), and for $e^\pm$-transitions from the corresponding γ-ray energy minus $2mc^2$ (1.022 MeV).

Auxiliary Data

This section contains the basic data, other than those already included under Decay Modes, which are needed for the calculation of intensities. These include internal-conversion coefficients and conversion ratios (ce_K/γ, ce_L/ce_K, etc.), internal-pair-formation coefficients ($e^\pm/\gamma$), electron-capture and capture-to-positron ratios (ϵ_L/ϵ_K, ϵ_K/β^+, etc.), fluorescence yields and related quantities (ω_K, ω_L, n_{KL}), as well as any other ratios (e.g., γ/β, X/γ, etc.) required for the intensity normalization condition given under Decay Scheme. Note that ratios of γ-, ce, or β-intensities are not given except when required for the intensity normalization. If the multipolarity of a transition is known, theoretical values of conversion coefficients are given with the experimental data. In the case of electron-capture decay, theoretical capture ratios and capture-to-positron ratios can always be obtained and are given with the available experimental data. In principle, capture ratios need to be given for each capture branch. In practice, however, these ratios (especially ϵ_{MN}/ϵ_L) are often the same for each branch in the decay of a particular nucleus. When this situation arises, a single value is given without a numeric subscript. Such a value applies to each transition.

The K-, L-, and M-shell conversion coefficients given as "theory" were taken from Hager and Seltzer (68HaSe). Conversion in the higher shells is taken into account, where necessary and where experimental data are not available, by use of the approximate relation $ce_{MNO...}/ce_L = \frac{1}{3}$. The pair-formation coefficients given as "theory" were taken from Krutov and Gorshkov (61Kr4). The electron-capture and capture-to-positron ratios given as "theory" indicate calculation by the compiler according to the methods described in Appendix III B.

Comparison of Additional Experimental Results with Values Calculated from the Adopted Decay Scheme

In some nuclear decays there are available more intensity ratios than are needed to determine intensities per 100 disintegrations. In such cases, the ratios not used by the compilers are given here for comparison with the values calculated from the adopted decay scheme. Least-squares adjustments were not considered worthwhile.

SYMBOLS AND DEFINITIONS

a	Absorption
av	Average
BF_3	Boron-trifluoride neutron counter
cal	Calorimeter
ce_K, ce_L	K-shell conversion electron, L-shell conversion electron. See REVIEW OF RADIATION PROCESSES
chem	Chemical separation
Ci	Curie
d	1. Day, 2. Deuteron (^2H nucleus)
dis	Disintegration
e_{AK}, e_{AL}	K-shell Auger electron, L-shell Auger electron. See REVIEW OF RADIATION PROCESSES
$e^{\pm}$	Internal electron-positron pair. See REVIEW OF RADIATION PROCESSES
ec	Electron capture. This symbol is used only in Appendix I. See also ϵ
f	1. Fission 2. Statistical rate function for allowed β-decay. See Appendix III C
f_1	Statistical rate function for first-forbidden unique β-decay. See Appendix III C
GM	Geiger-Müller counter
h	Hour
ic	Ionization chamber
J	Total angular-momentum quantum number
m	Minute
max	Maximum
mic	Microwave spectroscopy
ms	Mass spectrometer
n	Neutron
n_{KL}	Number of L-shell vacancies created by a K-shell vacancy. See REVIEW OF RADIATION PROCESSES
N	Number of atoms
p	Proton
pc	Proportional counter
$pc\beta\gamma$	Two proportional counters used to record γ-decay in coincidence with a preceding β-decay
ppl	Photoplate or emulsion
Q^+, Q^-, Q_α	Total disintegration energy in ϵ- or β^+-, β^--, or α-decay. The Q-value is given by the mass difference between parent and daughter neutral atoms
rad	Unit of absorbed dose, equal to 6.25×10^7 MeV/gm
R_{90}	90% absorbed-dose range. See below
s	1. Second, 2. Magnetic spectrometer, 3. Spallation

scin	Scintillation counter
scin $\gamma\pm\gamma\pm$	Scintillation counters for the coincidence detection of the two 0.511 γ's emitted when a positron is annihilated
semi	Semiconductor detector
t	Triton (^{3}H nucleus)
U	Unweighted average. See below
W	Weighted average. See below
well scin	Scintillation counter using a well crystal
X_K, X_L	K X-ray, L X-ray. See REVIEW OF RADIATION PROCESSES
y	Year
α	Alpha particle (^{4}He nucleus). See REVIEW OF RADIATION PROCESSES
β	Beta particle. See REVIEW OF RADIATION PROCESSES
γ	Gamma ray. See REVIEW OF RADIATION PROCESSES
$\gamma\pm$	Annihilation radiation; two 0.511-MeV γ's are emitted when a positron is annihilated at rest
Δ	Equilibrium absorbed-dose constant. See below
ϵ_K, ϵ_L	Electron capture from the K-shell, electron capture from the L-shell. See REVIEW OF RADIATION PROCESSES
λ	Disintegration constant
μCi-h	Microcurie-hour
μs	Microsecond
ν	Neutrino. A particle emitted from the nucleus in β^+-, β^--, and ϵ-decay. The neutrino has neither mass nor charge and this produces negligible interaction with the matter through which it passes
π	Parity
ω_K, ω_L	K-, L-shell fluorescence yield. See Appendix III A
3.624 *12*	3.624 ± 0.012
3.6 *12*	3.6 ± 1.2
*	Value adopted by compilers from possibilities shown

90% Absorbed-Dose Range (R_{90}). For a radioactive point source in an infinite, homogeneous, absorbing medium, the 90% absorbed-dose range is defined as the radius of a sphere with the point source as center, within which 90% of the energy of the source is absorbed. Appendix IV contains a discussion of the method by which the R_{90}-values given in this compilation were obtained.

Unweighted and Weighted Averages. If $x_1 \pm \Delta x_1$, $x_2 \pm \Delta x_2$, . . . $x_n \pm \Delta x_n$ are n independent measurements of a given quantity, Δx_i being the uncertainty in x_i, then the weighted average of these measurements is $\bar{x} \pm \Delta \bar{x}$, where

$$\bar{x} = W \Sigma \frac{x_i}{(\Delta x_i)^2}, \quad W = \Sigma \frac{1}{(\Delta x_i)^{-2}}$$

and Δx is the larger of $(W)^{1/2}$ and

$$(W)^{1/2} \left[\Sigma \frac{(\Delta x_i)^{-2} (x - x_i)^2}{n - 1} \right]^{1/2}.$$

The unweighted average of these same measurements is given by $x \pm \Delta \bar{x}$, where

$$\bar{x} = \frac{1}{n} \Sigma x_i, \quad \Delta \bar{x} = \left[\Sigma \frac{(x - x_i)^2}{n(n-1)} \right]^{1/2}.$$

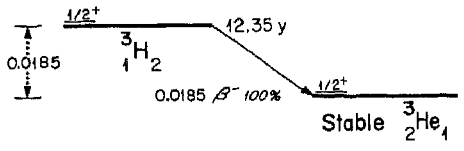
Equilibrium Dose Constant (Δ). For a radioactive source distributed uniformly throughout an infinite, homogeneous, absorbing material, the energy absorbed per gram is in equilibrium with the energy emitted per gram. Under these conditions the equilibrium absorbed dose, D_{eq}, is given by (68L014)

$$D_{eq} = C \times \sum_i \Delta_i \text{ rad},$$

where the cumulated concentration C (μCi-h/gm) is constant, and $\Delta_i = 2.13\ I_i E_i$ gm-rad/μCi-h is the equilibrium (absorbed) dose constant for i-type radiation of average energy E_i (MeV) and intensity per disintegration I_i. Thus Δ_i, the energy emitted per disintegration, depends only on the decay scheme of the radioactive nuclide from which the source is made. It may be interpreted as the equilibrium dose per unit cumulated concentration or as the equilibrium dose rate per unit concentration. The constant 2.13 is the factor required to convert Δ_i from units of MeV/dis to gm-rad/μCi-h. (1 MeV/disintegration $= 3.7 \times 10^4 \times 3.6 \times 10^3 / 6.25 \times 10^7 = 2.13$ gm-rad/μCi-h.)

$^{3}_{1}H_{2}$

Decay Characteristics



$T_{1/2}$ **12.35 y** *1* Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β^-	**0.0185**$_{max}$ *2*				
	0.00568$_{av}$ *7*	100	0.0121	100	0.000219

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^- =$ **0.0185** *2* E(β)
No γ observed (48C27), ∴ I(β^-) = 100

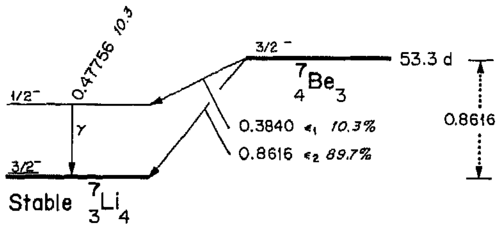
Decay Modes

Type	Energy MeV	Intensity %	
β^-	^{U}**0.0185**$_{max}$ *2*		49C08, 49H01, 51H33, 52L19, 53H55, 59C77, 59P78, 61Pi1
	***0.00568**$_{av}$ *7*		Theory
	^{U}**0.0056**$_{av}$ *1*		50J60, 58G93, 58P64, 61Pi1
		100	Decay scheme

^{U}Unweighted average
^{W}Weighted average
*Value adopted by compilers from possibilities shown

$^{7}_{4}Be_{3}$

Decay Characteristics



$T_{1/2}$ **53.3 d** *2* Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AK}	**0.000054**	≈ 88	0.00010	≈ 0	<0.0001
X_K	**0.000054**	≈ 0	≈ 0	≈ 0	<0.001
γ	**0.47756** *5*	10.3 *2*	0.105	100	43

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^+ =$ **0.8616** *2* 65MTW1
No γ other than 0.47756γ observed 59L30
Intensities per 100 ^{7}Be decays are obtained from I(γ) and the requirement that I($\epsilon_1 + \epsilon_2$) = 100.

Decay Modes

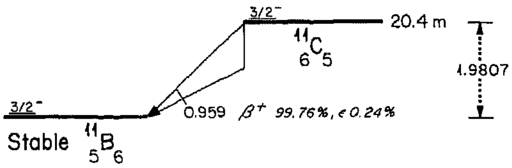
Type	Energy MeV	Intensity %	
ϵ_{1K}		≈ 9.4	I(ϵ_1) and ϵ_L/ϵ_K
ϵ_{1L}		≈ 0.9	
ϵ_1		10.3 *2*	I(γ)
ϵ_{2K}		≈ 79	I(ϵ_2) and ϵ_L/ϵ_K
ϵ_{2L}		≈ 11	
ϵ_2		89.7 *2*	I(ϵ_1) and I($\epsilon_1 + \epsilon_2$) = 100
γ	^{W}**0.47756** *5*		57D37, 65Ro09, 67B103
		10.32 *16*	62Tal1

Auxiliary Data

$\epsilon_L/\epsilon_K \approx 0.1$	53B99	$\omega_K \approx 0$	Appendix III

$^{11}_{6}C_{5}$

Decay Characteristics



$T_{½}$ 20.4 m *3* Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AK}	**0.00018**	0.22 *1*	≈ 0	≈ 0	<0.0001
β^+	**0.959**$_{max}$ *1* **0.3850**$_{av}$ *4*	99.76 *1*	0.818	27.4	0.168
$\gamma^{\pm}$	**0.5110**	199.52 *2*	2.172	72.6	44

Basic Data, Sources for Adopted Values

Decay Scheme

Q^+ = **1.9807** *11* 65MTW1

No γ observed (46S12), ∴ $I(\beta^+ + \epsilon) = 100$

Decay Modes

Type	Energy MeV	Intensity %	
β^+	**0.959** *1*		$Q^+ - 2mc^2$
		99.76 *1*	ϵ_K/β^+, ϵ_L/ϵ_K, and $I(\epsilon + \beta^+) = 100$
ϵ_K		0.22 *1*	
ϵ_L		0.02 *1*	
ϵ		0.24 *1*	$I(\epsilon_K + \epsilon_L)$

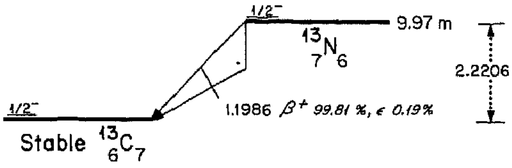
Auxiliary Data

ϵ_K/β^+ = 0.0023 *1*	67Ca09	$\omega_K \approx 0$ Appendix III
*0.0022 *1*[a]	Theory	
ϵ_L/ϵ_K = 0.17 *4*	65Ca11	
*0.09 *1*[a]	Theory	

*Value adopted by compilers from possibilities shown

$^{13}_{7}N_{6}$

Decay Characteristics



$T_{½}$ 9.97 m *2* Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AK}	**0.00027**	0.18 *1*	≈ 0	≈ 0	<0.0001
β^+	**1.1986**$_{max}$ *8* **0.4918**$_{av}$ *3*	99.81 *1*	1.046	32.5	0.226
$\gamma^{\pm}$	**0.5110**	199.62 *2*	2.173	67.5	44

Basic Data, Sources for Adopted Values

Decay Scheme

Q^+ = **2.2206** *8* 65MTW1

No γ observed (46S12, 47L04, 54G66, 58D09),

∴ $I(\beta^+ + \epsilon) = 100$

Decay Modes

Type	Energy MeV	Intensity %	
β^+	[U]**1.202** *6*		39L15, 41T01, 50H01, 58D09
	***1.1986** *8*		$Q^+ - 2mc^2$
		99.81 *1*	ϵ_K/β^+, ϵ_L/ϵ_K, and $I(\epsilon + \beta^+) = 100$
ϵ_K		0.18 *1*	
ϵ_L		0.014 *5*	
ϵ		0.19 *1*	$I(\epsilon_K + \epsilon_L)$

Auxiliary Data

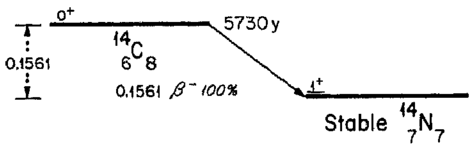
ϵ_K/β^+ = 0.0017 *1*	63Le22	
*0.0018 *1*[a]	Theory	ω_K ≈ 0.003 Appendix III
ϵ_L/ϵ_K = 0.08 *1*[a]	Theory	

[a]Uncertainty assigned by compilers

[U]Unweighted average

$^{14}_{6}C_{8}$

Decay Characteristics



$T_{1/2}$ 5730 y *40* Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β^-	0.1561_{max} *3*				
	0.0493_{av} *1*	100	0.105	100	0.0096

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^- = 0.1561$ *3* 65MTW1

No ce, γ (41R05, 47L08), ∴ $I(\beta^-) = 100$

Decay Modes

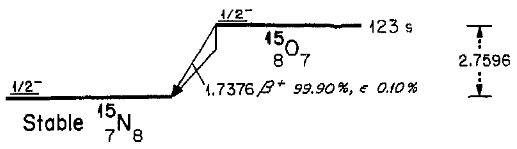
Type	Energy MeV	Intensity %	
β^-	*0.1561 *3*		Q^-
	U0.156 *1*		47L08, 47S26, 48B21, 48C10, 49A03, 49F02, 50W62, 55P04, 66Ha41
		100	Decay scheme

U Unweighted average

*Value adopted by compilers from possibilities shown

$^{15}_{8}O_{7}$

Decay Characteristics



$T_{1/2}$ 123 s *1* Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AK}	0.00039	0.09 *1*	≈0	≈0	<0.0001
β^+	1.7376_{max} *9*				
	0.7378_{av} *4*	99.90 *1*	1.570	41.9	0.361
$\gamma^\pm$	0.5110	199.80 *2*	2.175	58.1	44

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^+ = 2.7596$ *9* 65MTW1

No excited ^{15}N levels observed below 5.27 MeV (67LeHo), ∴ $I(\beta^+ + \epsilon) = 100$

Decay Modes

Type	Energy MeV	Intensity %	
β^+	*1.7376 *9*		$Q^+ - 2mc^2$
	1.725 *5*		57K22
		99.90 *1*	ϵ/β^+ and $I(\beta^+ + \epsilon) = 100$
ϵ_K		0.09 *1*	$I(\epsilon)$ and ϵ_L/ϵ_K
ϵ_L		0.007 *1*	
ϵ		0.10 *1*	ϵ/β^+ and $I(\beta^+ + \epsilon) = 100$

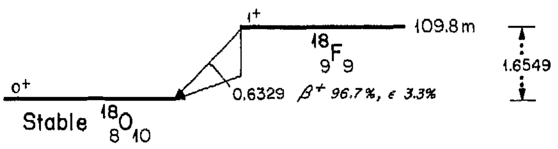
Auxiliary Data

$\epsilon/\beta^+ = 0.0010$ *1*[a]	Theory	$\omega_K \approx 0.007$	Appendix III
$\epsilon_L/\epsilon_K = 0.08$ *1*[a]	Theory		

[a] Uncertainty assigned by compilers

$^{18}_{9}F_{9}$

Decay Characteristics



$T_{1/2}$ 109.8 m 2 Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AK}	0.00052	3.1 *1*	0.000034	≈0	<0.0001
β^+	0.6329$_{max}$ *7* 0.2495$_{av}$ *3*	96.7 *2*	0.514	19.6	0.094
X_K	0.00052	≈0.04	≈0	≈0	<0.001
$\gamma^\pm$	0.5110	193.4 *4*	2.105	80.4	44

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^+ = 1.6549$ *7* 65MTW1

No γ observed (48K13, 49B26), ∴ $I(\beta^+ + \epsilon) = 100$

Decay Modes

Type	Energy MeV	Intensity %	
β^+	*0.6329 *7*		$Q^+ - 2mc^2$
	W0.638 *3*		49B26, 50R59, 51R24, 56M18, 64Ho28
		96.7 *2*	ϵ_K/β^+, ϵ_L/ϵ_K, and $I(\beta^+ + \epsilon) = 100$
ϵ_K		3.1 *1*	
ϵ_L		0.25 *1*	
ϵ		3.3 *1*	$I(\epsilon_K + \epsilon_L)$

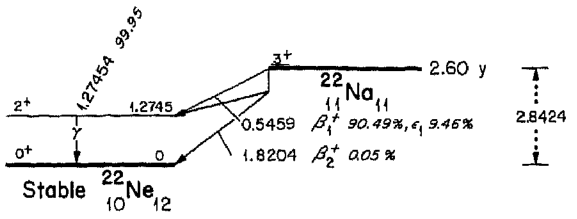
Auxiliary Data

$\epsilon_K/\beta^+ =$ 0.030 *2*	56D38	$\omega_K \approx 0.012$	Appendix III
*0.032 *1*[a]	Theory		
$\epsilon_L/\epsilon_K =$ 0.08 *1*[a]	Theory		

[a]Uncertainty assigned by compilers
WWeighted average
*Value adopted by compilers from possibilities shown

$^{22}_{11}Na_{11}$

Decay Characteristics



$T_{1/2}$ 2.60 y *1* Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AK}	0.00082	8.5 *1*[a]	0.00015	≈ 0	<0.0001
β_1^+	0.5459_{max} *6* 0.2156_{av} *3*	90.49 *5*	0.416	8.2	0.076
β_2^+	1.8204_{max} *6* 0.8348_{av} *3*	0.05 *2*	0.0009	0.02	0.416
All β's	0.2160_{av} *4*	90.54 *2*	0.417	8.2	0.076
X_K	0.00085	≈ 0.22	≈ 0	≈ 0	<0.001
$\gamma^\pm$	0.5110	181.08 *4*	1.971	38.6	44
γ	1.27454 *4*	99.95 *7*	2.713	53.2	58

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^+ = 2.8424$ *6* $E(\beta_1^+) + 2mc^2 + E(1.2745 \text{ level})$

No γ other than 1.27454γ observed 39001, 46G01

Intensities per 100 ^{22}Na decays are obtained from β_2^+/β_1^+, ϵ_1/β_1^+, and the requirement that $I(\beta_1^+ + \beta_2^+ + \epsilon_1) = 100$.[b]

Basic Data, Sources for Adopted Values continued

Decay Modes

Type	Energy MeV	Intensity %	
β_1^+	[W]0.5459 *6*		61Ni11 68Be35, 68We02
		90.49 *5*	ϵ_1/β_1^+, β_2^+/β_1^+, and $I(\beta_1^+ + \beta_2^+ + \epsilon_1) = 100$[b]
β_2^+	*1.8204 *6*		$Q^+ - 2mc^2$
	1.83 *6*		53W13
		0.05 *2*	See $I(\beta_1^+)$
γ	[W]1.27454 *4*		67Bl03, 67Ra03, 67Wh01, 68Le03
		99.95 *7*	$I(\beta_1^+ + \epsilon_1)$
ϵ_{1K}		8.73 *5*	$I(\epsilon_1)$ and ϵ_L/ϵ_K
ϵ_{1L}		0.72 *1*	
ϵ_1		9.46 *5*	See $I(\beta_1^+)$
ϵ_2		≈ 0	$I(\beta_2^+)$ and ϵ_2/β_2^+

Auxiliary Data

$\beta_2^+/\beta_1^+ = 0.0006$ *2*	53W13
$\epsilon_1/\beta_1^+ \doteq$ [W]0.1045 *5*	64Wi04, 67Le07, 68Va13
0.112	Theory
$\epsilon_2/\beta_2^+ = 0.0023$	Theory
$\epsilon_L/\epsilon_K = 0.083$	Theory
$\omega_K \approx 0.025$	Appendix III

[a] Uncertainty assigned by compilers

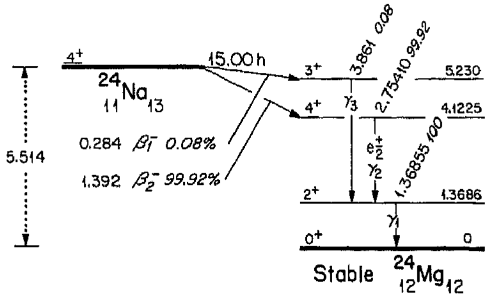
[b] $I(\epsilon_2)$ is negligible

[W] Weighted average

*Value adopted by compilers from possibilities shown

$^{24}_{11}Na_{13}$

Decay Characteristics



$T_{1/2}$ **15.00 h** *4* Appendix I

Note

A weak γ of energy 4.23 MeV (60Ar10, 62Mo9) and a weak β of energy 4.17 (51T12) have not been included because of their low intensities (0.004% and 0.003%, respectively). The γ de-excites a level at 4.23 MeV, and the β feeds the 1.3686 level.

Radiations

Type	Energy MeV	Intensity %	$\Delta \left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
$e_2^\pm$	**1.73210** *9*	0.072 *3*	0.0027	0.03	0.63[a]
β_1^-	**0.284**$_{max}$ *5* **0.091**$_{av}$ *2*	0.08 *2*	0.00016	≈ 0	0.0261
β_2^-	**1.392**$_{max}$ *1* **0.5550**$_{av}$ *5*	99.92 *2*	1.181	11.9	0.272
All β's	**0.5546**$_{av}$ *5*	100	1.181	11.9	0.272
γ_1	**1.36855** *4*	100	2.915	29.3	59
γ_2	**2.75410** *9*	99.85 *2*	5.857	58.8	≈80
γ_3	**3.861** *5*	0.08 *2*	0.007	0.07	≈ 90

[a]Range for electron member of the internal pair

Basic Data, Sources for Adopted Values

Decay Scheme

Q^- = **5.514** *1* $E(\beta_2^-)+E(\gamma_1+\gamma_2)$

Levels in ^{24}Mg are well known from reaction studies (67EnVa). The ^{24}Na γ's, on the basis of their energies, can be uniquely placed among these levels.

No ground-state β-group 51T12

Intensities per 100 ^{24}Na decays are obtained from relative γ-intensities, $e_2^\pm/\gamma_2$, and the requirement that $I(\gamma_1) = I(\gamma_2 + e_2^\pm + \gamma_3) = 100$.[b]

Decay Modes

Type	Energy MeV	Intensity %	
$e_2^\pm$		0.072 *3*	$I(\gamma_2)$ and $e_2^\pm/\gamma_2$
β_1^-	**0.284** *5*	0.08 *2*	$Q^- - E(\gamma_1+\gamma_3)$ $I(\gamma_3)$
β_2^-	[U]**1.392** *1*	99.92 *2*	46S09, 57P36, 58D10, 61De25, 63Pa20, 64Le09, 65Be24 $I(\gamma_2 + e_2^\pm)$
γ_1	[W]**1.36855** *4*	100	65Mu03, 65Re17 Decay scheme
γ_2	[W]**2.75410** *9*	99.85 *2*	65Mu03, 68Gu05 $I(\gamma_3)$ and $I(\gamma_2 + e_2^\pm + \gamma_3) = I(\gamma_1)$
γ_3	**3.861** *5*	[U]0.08 *2*	64Ew05 γ_3/γ_1 60Ar10, 62Mo9

Auxiliary Data

$e_2^\pm/\gamma_2 = $ 0.00068 E2 Theory

$ = $ *[U]0.00072 *3* 50M82, 51C50, 52B53, 52S52, 65Sp08

[b]$I(\beta)$ to 1.3686 level is negligible. See "Note" under decay scheme drawing

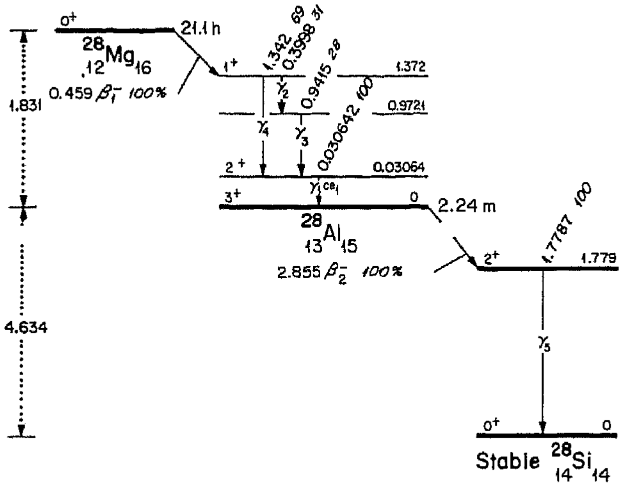
[U]Unweighted average

[W]Weighted average

*Value adopted by compilers from possibilities shown

$\left({}^{28}_{12}\mathrm{Mg}_{16} - {}^{28}_{13}\mathrm{Al}_{15}\right)$-1

Decay Characteristics



$T_{1/2}$	21.1 h 1	(^{28}Mg)	Appendix I
	2.24 m 1	(^{28}Al)	

Note

Since the half-life of ^{28}Al is much shorter than that of its parent, ^{28}Mg, the ratio of ^{28}Al activity to that of ^{28}Mg in an initially pure ^{28}Mg source will increase at first and then approach the constant value $T_A/(T_A-T_B)^a = 1.00$ after $\approx 10T_B$ ($\approx$ 23m). When the ratio of activities has reached this constant value, the parent and daughter are in equilibrium and the total activity is $1+1.00=2.00$ times the ^{28}Mg activity.

Radiations

Type	Energy MeV	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AK}	0.00140	5 3	0.00015	≈ 0	<0.0001
ce_1	0.029082^b 2	5 3	0.0031	0.032	0.0012
β_1	0.459$_{max}$ 2 0.1560$_{av}$ 7	100	0.332	3.45	0.0562
β_2	2.855$_{max}$ 4 1.240$_{av}$ 2	100	2.641	27.4	0.65
All β's	0.698$_{av}$ 1	200	2.973	30.9	0.63

$^a T_A = T_{1/2}$ (^{28}Mg), $T_B = T_{1/2}$ (^{28}Al)
^{b}Energy of K-line given
^{W}Weighted average
*Value adopted by compilers from possibilities shown

Decay Characteristics continued

Radiations continued

Type	Energy MeV	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
X_K	0.00149	≈0.2	≈ 0	≈ 0	0.00017
γ_1	0.030642 2	95 3	0.0620	0.64	10
γ_2	0.3998 10	31 2	0.264	2.74	41
γ_3	0.9415 10	28 1	0.562	5.84	52
γ_4	1.342 2	69 2	1.97	20.5	59
γ_5	1.7787 2	100	3.79	39.4	65

Basic Data, Sources for Adopted Values

Decay Scheme

^{28}Mg $Q^- = 1.831$ 3 — $E(\beta_1^-) + E(1.372$ level)
Levels in ^{28}Al are well known from reaction studies (67EnVa). The ^{28}Mg γ's, on the basis of their energies and coincidence relationships (54S28), can be uniquely placed among these levels.
No β other than 0.459 β — 53M23
Intensities per 100 ^{28}Mg decays are obtained from relative γ-intensities and the requirement that $I(\gamma_2+\gamma_4) = 100$.

^{28}Al $Q^- = 4.634$ 4 — 65MTW1
No ground-state β-group (<0.8%) — 54003
No γ other than 1.7787γ, — 41W03, 54S28
$\therefore I(\beta_2^-) = I(\gamma_5) = 100$

Decay Modes

Type	Energy MeV	Equilibrium Intensity %	
ce_1		3 7 *5 3	$I(\gamma_1)$ and ce_1/γ_1 $I(\gamma_1)$ and $I(\gamma_1+ce_1) = 100$
β_1^-	*0.459 2		54003
		100	Decay scheme
β_2^-	*2.855 4 ^{W}2.868 8		$Q^- - E(\gamma_5)$ 52M22, 53M23, 54003, 58V31
		100	Decay scheme

continued on next page

$\left({}^{28}_{12}\mathrm{Mg}_{16} - {}^{28}_{13}\mathrm{Al}_{15}\right)$-2

Basic Data, Sources for Adopted Values cont.

Decay Modes continued

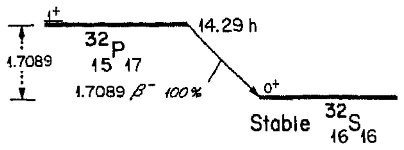
Type	Energy MeV	Equilibrium Intensity %		
γ_1	**0.0306415** *20*			63Ne18
		95 *3*	γ_1/γ_4	54S28
γ_2	**0.3998** *10*			69Ha09
		31 *2*	γ_2/γ_4 and $I(\gamma_2+\gamma_4)=100$	
γ_3	**0.9415** *10*			69Ha09
		28 *1*	γ_3/γ_4	54S28
γ_4	**1.342** *2*			69Ha09
		69 *2*	γ_2/γ_4 and $I(\gamma_2+\gamma_4)=100$	
γ_5	1.77870 *17*			67Wh01
		100		Decay scheme

Auxiliary Data

$ce_1/\gamma_1 = 0.03$ *7*	54S28
$\gamma_2/\gamma_4 = 0.44$ *5*	54S28
$\omega_K \approx 0.05$	Appendix III

${}^{32}_{15}\mathrm{P}_{17}$

Decay Characteristics



$T_{1/2}$	**14.29 d** *3*	Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β^-	**1.7089**$_{max}$ *10*				
	0.6950$_{av}$ *4*	100	1.480	100	0.351

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^- = $ **1.7089** *10*	$E(\beta^-)$
No γ ($<10^{-2}\%$),	53G22
$\therefore I(\beta^-) = 100\%$	

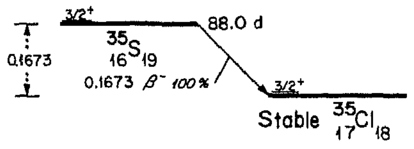
Decay Modes

Type	Energy MeV	Intensity %	
β^-	^{W}**1.7089**$_{max}$ *10*		56P07, 57P36, 58D10, 61Ni2, 62Ch15, 65Pa17, 65Th07, 66Ca10, 67Na15, 67Ze04, 68Fi04
	***0.6950**$_{av}$ *3*		Theory
	^{U}**0.695**$_{av}$ *2*		53B15, 56S137, 61Du08, 62Hu7, 63Bo43
		100	Decay scheme

^{U}Unweighted average
^{W}Weighted average
*Value adopted by compilers from possibilities shown

$^{35}_{16}S_{19}$

Decay Characteristics



$T_{½}$ **88.0 d** *10* Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β^-	**0.1673**$_{max}$ *2*				
	0.04879$_{av}$ *6*	100	0.104	100	0.0105

Basic Data, Sources for Adopted Values

Decay Scheme

Q^- = **0.1673** *2* E(β^-)
No excited ^{35}Cl levels below 1.220 MeV, 67EnVa
∴I(β^-) = 100

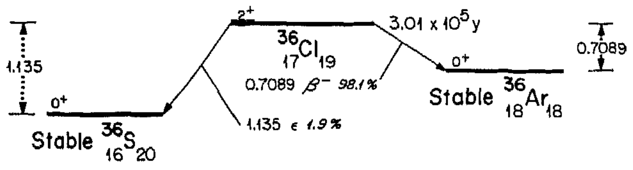
Decay Modes

Type	Energy MeV	Intensity %	
β^-	^{W}**0.1673**$_{max}$ *2*		50L04, 57C62
	*****0.04879**$_{av}$ *6*		Theory
	^{U}**0.0496**$_{av}$ *8*		58S49, 64Ho27
		100	Decay scheme

^{U}Unweighted average
^{W}Weighted average
*Value adopted by compilers from possibilities shown

$^{36}_{17}Cl_{19}$

Decay Characteristics



$T_{½}$ **3.01 × 10⁵y** *3* Appendix I

Note
A weak ground-state β^+-group (62Be29, 67Pi04) has not been included because of its low intensity (0.002%).

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	≈**0.00016**	≈3.2	≈0.000011	≈0	<0.0001
e_{AK}	**0.0021**	1.5 *1*	≈0.0001	≈0	<0.0001
β^-	**0.7089**$_{max}$ *6*				
	0.2514$_{av}$ *2*	98.1 *1*	0.525	100	0.108
X_K	**0.0023**	0.17 *1*	≈0	≈0	0.00060

Basic Data, Sources for Adopted Values

Decay Scheme

Q^- = **0.7089** *6* E(β^-)
Q^+ = **1.135** *9* 65MTW1
No γ 49W15, 55D35
Intensities per 100 ^{36}Cl decays are obtained from ϵ_K/β^-, ϵ_L/ϵ_K and the requirement that I(ϵ+β^-) = 100

Decay Modes

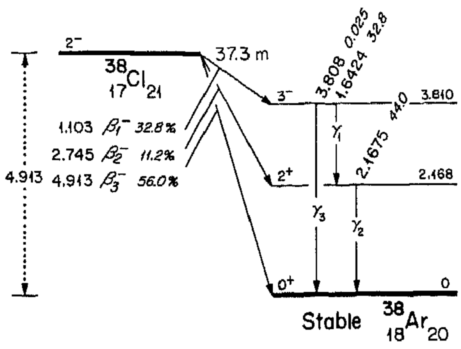
Type	Energy MeV	Intensity %	
β^-	^{W}**0.7089** *6*		52F16, 56J11, 67Ha39, 67Sp06
		98.1 *1*	ϵ_K/β^-, ϵ_L/ϵ_K, and I(ϵ+β^-) = 100
ϵ_K		1.7 *1*	
ϵ_L		0.19 *1*	
ϵ		1.9 *1*	ϵ_K+ϵ_L

Auxiliary Data

ϵ/β^+ ≈ 800	Theory	ω_K = 0.098	Appendix III
ϵ_K/β^- = 0.017 *1*	55D35	ω_L ≈ 0	
ϵ_L/ϵ_K = 0.112 *8*	62Do7	n_{KL} = 1.74	

$^{38}_{17}Cl_{21}$

Decay Characteristics



$T_{1/2}$ 37.3 m *1* Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β_1^-	**1.103**$_{max}$ *5*				
	0.419$_{av}$ *2*	32.8 *6*	0.293	4.6	0.200
β_2^-	**2.745**$_{max}$ *5*				
	1.182$_{av}$ *2*	11.2 *8*	0.282	4.4	0.62
β_3^-	**4.913**$_{max}$ *5*				
	2.246$_{av}$ *3*	56.0 *5*	2.68	41.6	1.23
All β's	**1.527**$_{av}$ *3*	100	3.25	50.5	1.18
γ_1	**1.6424** *2*	32.8 *6*	1.15	17.9	63
γ_2	**2.1675** *1*	44.0 *5*	2.03	31.5	70
γ_3	**3.808** *2*	0.025 *2*	0.0020	0.03	≈ 90

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^- = 4.913$ *5* $E(\beta_3)$

The γ-placements are determined by the precise γ-energies, the observed $\gamma_1\gamma_2$-coincidence (41I01), and the observed β-groups.

Intensities per 100 ^{38}Cl decays are obtained from $\gamma_2/\Sigma\beta^-$ and the requirement that $I(\beta_3^-+\gamma_2) = 100.$[a]

Basic Data, Sources for Adopted Values continued

Decay Modes

Type	Energy MeV	Intensity %	
β_1^-	***1.103** *5*		$Q^- - E(\gamma_1+\gamma_2)$
	1.11 *1*		50L02
		31.3 *6*	68Va06
		*32.8 *6*	γ-intensities
β_2^-	***2.745** *5*		$Q^- - E(\gamma_2)$
	2.77 *5*		50L02
		11.1 *8*	68Va06
		*11.2 *8*	γ-intensities
β_3^-	**4.913** *5*		68Va06
		57.6 *13*	68Va06
		*56.0 *5*	$\gamma_2/\Sigma\beta^-$ and $I(\beta_3^-+\gamma_2) = 100$[a]
γ_1	^{W}**1.6424** *2*		68En01, 68Va06, 69Ba14
		^{W}32.8 *6*	γ_1/γ_2 67Vo07, 68Va06, 69Ba14
γ_2	^{W}**2.1675** *1*		68En01, 68Va06, 69Ba14
		44.0 *5*	$\gamma_2/\Sigma\beta^-$
γ_3	^{W}**3.808** *2*		67Vo07, 68Va06
		^{W}0.025 *2*	γ_3/γ_2 67Vo07, 68Va06

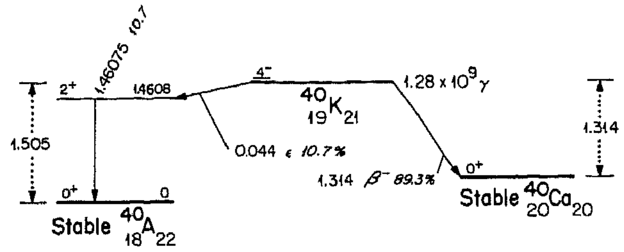
Auxiliary Data

$\gamma_2/\Sigma\beta^- = 0.440$ *5* 69Ba14

[a] $I(\gamma_3)$ is negligible here
[W] Weighted average
*Value adopted by compilers from possibilities shown

$^{40}_{19}K_{21}$

Decay Characteristics



$T_{1/2}$ 1.28×10^{9}y *1* Appendix I

Note

A weak ground-state β^+-group (62En1) has not been included because of its low intensity (0.001%). Since $\epsilon/\beta^+ \approx 1.2$ for this transition, the capture branch has also been neglected.

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00024**	≈16	≈0.00008	0.006	<0.0001
e_{AK}	**0.00269**	7.0 *2*	0.00040	0.028	<0.0001
β^-	**1.314**$_{max}$ *4* **0.562**$_{av}$ *2*	89.3 *2*	1.069	76.2	0.278
X_K	**0.00300**	1.10 *3*	0.00007	0.005	0.013
γ	**1.46075** *6*	10.7 *2*	0.333	23.7	60

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^- = 1.3143$ *34* 65MTW1

$Q^+ = 1.505^a$ *1* 65MTW1

No γ other than 1.46075γ 46H07, 47G07

E(γ) agrees with known ^{40}Ar level. 67EnVa

Intensities per 100 ^{40}K decays are obtained from γ/β^- and the requirement that $I(\gamma+\beta^-) = 100$.

Basic Data, Sources for Adopted Values

Decay Modes

Type	Energy MeV	Intensity %	
ϵ_K		8.15 *15*	I(ϵ), ϵ_{LM}/ϵ_K, and ϵ_M/ϵ_L
ϵ_L		2.24 *4*	
ϵ_M		0.31 *1*	
ϵ		10.7 *2*	I(γ)
β^-	*1.314 *4*		Q^-
	^{w}1.324 *9*		50A07, 50B08, 51G29, 52F16, 55K21, 59K26, 65Le15
		89.3 *2*	γ/β^- and $I(\gamma+\beta^-) = 100$
γ	1.46075 *6*		67Ki10
		10.7 *2*	γ/β^- and $I(\gamma+\beta^-) = 100$

Auxiliary Information

$\epsilon_{LM}/\epsilon_K = 0.34$ *8* 67Mc10

*0.313 *9*[b] Theory

$\epsilon_M/\epsilon_L = 0.137$ *4*[b] Theory

$\gamma/\beta^- = 0.123$ *2* 56M20

0.117 *2* $(\gamma/\text{s-gm})/(\beta^-/\text{s-gm})$ Appendix I

*0.120 *2*

$\omega_K = 0.135$, $\omega_L = 0$, $n_{KL} \approx 1.70$ Appendix III

[a]From a ^{40}K(n,p) Q-value measurement, 68Sc01 deduced $Q^+ = 1.488$ *5* for the ^{40}K-^{40}Ar mass difference. However, Q-value measurements from three ^{40}Ar(p,n)^{40}K experiments (65Be35, 66Pa18, 66Yo02) confirm the value given by 65MTW1

[b]Uncertainty is that due to uncertainty in Q^+

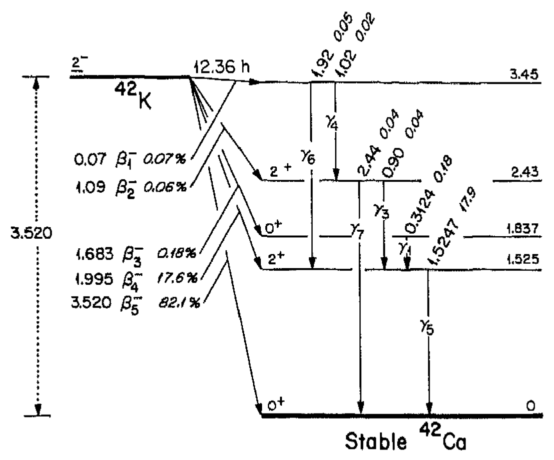
[w]Weighted average

*Value adopted by compilers from possibilities shown

$^{42}_{19}K_{23}$

Decay Characteristics	Basic Data, Sources for Adopted Values

Decay Characteristics



$T_{1/2}$ 12.36 h *1* Appendix I

Radiations

Type	Energy MeV	Intensity %	Δ (gm-rad / μCi-h)	Δ/ΣΔ %	R_{90} (cm) in Water
β_1^-	0.07_{max} 2 0.019_{av} 6	0.07 1	0.00003	≈ 0	0.0022
β_2^-	1.09_{max} 2 0.411_{av} 9	0.06 3	0.00053	0.015	0.196
β_3^-	1.683_{max} 4 0.702_{av} 2	0.18 2	0.0027	0.074	0.364
β_4^-	1.995_{max} 6 0.823_{av} 3	17.6 5	0.308	8.46	0.424
β_5^-	3.520_{max} 4 1.566_{av} 2	82.1 5	2.74	75.3	0.86
All β's	1.432_{av} 2	100	3.05	83.8	0.83
γ_1	0.3124 5	0.18 2	0.0012	0.033	39
$^x\gamma_2$	0.50 2	≤0.02	≤0.0001	≈ 0	44
γ_3	0.90 2	0.04 2	0.0008	0.022	51
γ_4	1.02 2	0.02 1	0.0004	0.011	54
γ_5	1.5247 5	17.9 5	0.581	16.0	62
γ_6	1.92 1	0.05 1	0.002	0.06	67
γ_7	2.44 2	0.04 2	0.002	0.06	74

Basic Data, Sources for Adopted Values

Decay Scheme

Q^- = 3.520 *4* Weighted average of $E(\beta_5^-)$ and $E(\beta_4^- + \gamma_5)$

^{42}Ca levels are known from reaction studies (67EnVa)
The ^{42}K γ's, on the basis of their energies and coincidence relationships (59Ml17, 61Mc3), can be uniquely placed among these levels.

Intensities per 100 ^{42}K decays are obtained from relative γ-intensities, $\gamma_5/\Sigma\beta^-$, and the requirement that $I(\gamma_5+\beta_5^-) = 100$[a].

Decay Modes

Type	Energy MeV	Intensity %		
$\beta_1^- \cdots \beta_3^-$	$E(\beta_1^-$ to $\beta_3^-)$ are calculated from the adopted Q^--value and the level energies. $I(\beta_1^-$ to $\beta_3^-)$ are calculated from the γ-intensities.			
β_4^-	^{W}1.995 6			56P07, 64An05, 68Da12
		*17.6 5		γ-intensities
		18		56P07
β_5^-	^{W}3.520 4			64Da16, 68Va06
		*82.1 5		$I(\gamma_5)$ and $I(\beta_5+\gamma_5)$[a]=100
		82		56P07
γ_1	0.3124 5[b]			66He11
		^{U}0.18 2	γ_1/γ_5	56P07, 59Ml17, 61Mc3
$^x\gamma_2$	^{U}0.50 2			61Mc3, 65Mi09
		≤0.02	γ_2/γ_5	61Mc3
γ_3	0.90 2			61Mc3
		0.04 2	γ_3/γ_5	59Ml17, 61Mc3
γ_4	1.02 2			61Mc3
		0.02 1	γ_4/γ_5	61Mc3
γ_5	^{W}1.5247 4			64Ma05, 66He11[b], 68La07
		17.9 5		$\gamma_5/\Sigma\beta^-$
γ_6	1.92 1			61Mc3
		^{U}0.05 1	γ_6/γ_5	59Ml17, 61Mc3
γ_7	2.44 2			61Mc3
		^{U}0.04 2	γ_7/γ_5	59Ml17, 61Mc3

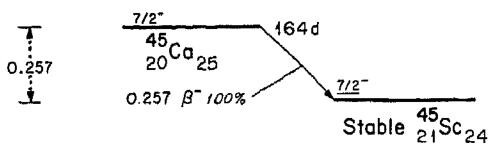
Auxiliary Data

$\gamma_5/\Sigma\beta^- = 0.179$ 5 62Pe19

[a] $I(\gamma_7)$ can be neglected here
[b] Uncertainty of 0.5 keV assigned by compilers
[U, W] Unweighted average, weighted average
[X] Not shown on decay scheme since placement not determined
* Value adopted by compilers from possibilities shown

$^{45}_{20}Ca_{25}$

Decay Characteristics



$T_{1/2}$ **164 d** *1* Appendix I

Note

65Fr12 has observed a weak (0.0014%) ce_K-line which de-excites a known level in ^{45}Sc at 0.0125 MeV. This line and the associated β-group which must feed the 0.0125 level have not been included here because of their low intensities.

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β^-	**0.257**$_{max}$ *2* **0.0773**$_{av}$ *7*	100	0.165	100	0.0217

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^- = 0.257$ *2* — $E(\beta^-)$ 67EnVa

No excited ^{45}Sc levels observed other than at 0.0125 MeV (see Note above),

$\therefore I(\beta^-) = 100$

Decay Modes

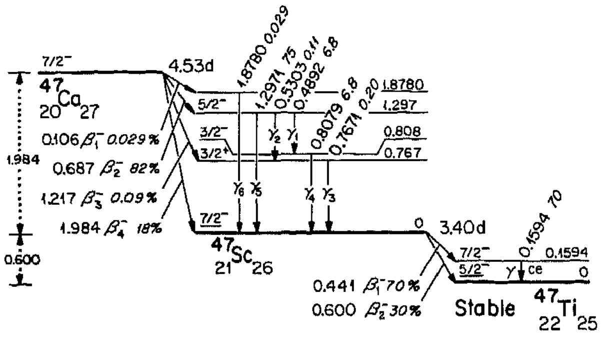
Type	Energy MeV	Intensity %	
β^-	^{U}0.257$_{max}$ *2*		50K60, 50M03, 53M64, 65Fr12
	0.0746$_{av}$ *30*		52C10
	*__0.0773__$_{av}$ *7*		Theory
		100	Decay scheme

^{U}Unweighted average

*Value adopted by compilers from possibilities shown

$\left(^{47}_{20}Ca_{27} - ^{47}_{21}Sc_{26}\right)$-1

Decay Characteristics



$T_{1/2}$ **4.53 d** *1* (^{47}Ca) / **3.40 d** *5* (^{47}Sc) — Appendix I

Note

The ratio of ^{47}Sc activity to that of its parent, ^{47}Ca, is given as a function of time, t, by

$$\frac{T_A}{T_A - T_B}\left[1-\exp\left(0.6931\frac{(T_A-T_B)t}{T_A T_B}\right)\right] = 4.009\left[1-\exp(0.508t)\right]$$

where $T_A = T_{1/2}(^{47}Ca)$, $T_B = T_{1/2}(^{47}Sc)$, t is in days, and the ^{47}Sc activity is taken to be zero at t = 0 (i.e., the ^{47}Ca source is initially pure).

Radiations (^{47}Ca)

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β_1^-	**0.106**$_{max}$ *3* **0.030**$_{av}$ *2*	0.029 *3*	≈0	≈0	0.00476
β_2^-	**0.687**$_{max}$ *3* **0.240**$_{av}$ *2*	82 *2*	0.419	14.0	0.103
β_3^-	**1.217**$_{max}$ *3* **0.493**$_{av}$ *2*	0.09 *3*	0.0009	0.03	0.243
β_4^-	**1.984**$_{max}$ *3* **0.818**$_{av}$ *2*	18 *2*	0.314	10.5	0.422
All β's	**0.344**$_{av}$ *2*	100	0.733	24.4	0.317
γ_1	**0.4892** *1*	6.8 *2*	0.071	2.4	43
γ_2	**0.5303** *4*	0.11 *2*	0.0012	0.04	44
γ_3	**0.7671** *4*	0.20 *2*	0.0033	0.11	49

continued on next page

Decay Characteristics continued

Radiations (^{47}Ca) continued

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
γ_4	**0.8079** *1*	6.8 *3*	0.117	3.9	50
γ_5	**1.2971** *1*	75 *2*	2.072	69.1	58
γ_6	**1.8780** *5*	0.029 *3*	0.0012	0.04	66

Radiations (^{47}Sc)

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00045**	≈ 0.3	≈ 0	≈ 0	< 0.0001
e_{AK}	**0.00400**	≈ 0.2	≈ 0	≈ 0	< 0.0001
ce_K	**0.1544** *1*	≈ 0.2	≈ 0.0007	≈ 0.1	0.022
β_1^-	**0.441**$_{max}$ *2* **0.1428**$_{av}$ *7*	70 *3*	0.213	36.6	0.052
β_2^-	**0.600**$_{max}$ *2* **0.2040**$_{av}$ *7*	30 *3*	0.130	22.4	0.084
All β's	**0.1611**$_{av}$ *7*	100	0.343	59.0	0.065
X_K	**0.00455**	≈ 0.06	≈ 0	≈ 0	0.045
γ	**0.1594** *1*	70 *3*	0.238	40.9	34

Basic Data, Sources for Adopted Values

Decay Scheme

^{47}Ca $Q^- = 1.984$ *3* — $E(\beta_4^-)$

The γ-placements are determined by the precise γ-energies, the observed $\beta_2\gamma_5$-coincidence (55L55) and $\beta_3\gamma_3$-coincidence (68Fi04), and the absence of $\beta_4\gamma$-coincidences (55L55).

Intensities per 100 ^{47}Ca decays are obtained from the relative γ-intensities, $I(\beta_4^-)$, and the requirement that $I(\beta_4+\gamma_3+\gamma_4+\gamma_5) = 100^a$.

^{47}Sc $Q^- = 0.600$ *2* — 65MTW1

No γ other than the 0.1594γ — 56L38

Intensities per 100 ^{47}Sc decays are obtained from $\gamma/(\beta_1^- + \beta_2^-)$ and the requirement that $I(\beta_1^- + \beta_2^-) = 100$.

[a] $I(\gamma_6)$ is negligible here

Basic Data, Sources for Adopted Values cont.

Decay Modes (^{47}Ca)

Type	Energy MeV	Intensity %	Source
β_1^-	**0.106** *3*		Q^--E(1.8780 level)
		0.029 *3*	γ-intensities
β_2^-	***0.687** *3*		Q^--E(1.297 level)
	0.685 *6*		53M64
		82 2_b	γ-intensities
		82 *2*	53M64, 56L38
β_3^-	**1.217** *3*		Q^--E(0.767 level)
		0.09 *3*	γ-intensities
		0.09 *3*	68Fi04
β_4^-	**^{W}1.984** *3*		63La13, 67Hs03, 68Fi04
		18 2^b	53M64, 56L38

$\gamma_1 \cdots \gamma_6$ E(γ) are weighted averages of data of 66Fr14, 66Ko20, 67Hs03, 68Fi04, 68La07, and 69Wo02. I(γ) are weighted averages of data of 66Fr14, 66Ko20, 68Fi04, and 69Wo02. The relative values of each author are normalized so that $I(\gamma_3+\gamma_4+\gamma_5)^a = 100 - I(\beta_4) = 82$.

Decay Modes (^{47}Sc)

Type	Energy MeV	Intensity %	Source
ce_K		≈ 0.2	$I(\gamma)$ and ce_K/γ
β_1^-	***0.441** *2*		Q^--E(0.1594 level)
	^{W}0.438 *2*		53C16, 55N15, 56G12, 56L38
		*70 *3*	γ-intensity
		^{U}69 *5*	55N15, 56L38
β_2^-	***0.600** *2*		Q^-
	^{W}0.604 *4*		53C16, 55N15, 56G12, 56L38
		*30 *3*	$I(\beta_1^-)$ and $I(\beta_1^-+\beta_2^-) = 100$
		^{U}31 *5*	55N15, 56L38
γ	**^{W}0.1594** *1*		66Fr14, 66Ko20, 67Ko01, 69Wo02
		^{W}70 *3*	$\gamma/(\beta_1^- + \beta_2^-)$ 55L34, 64Mi07

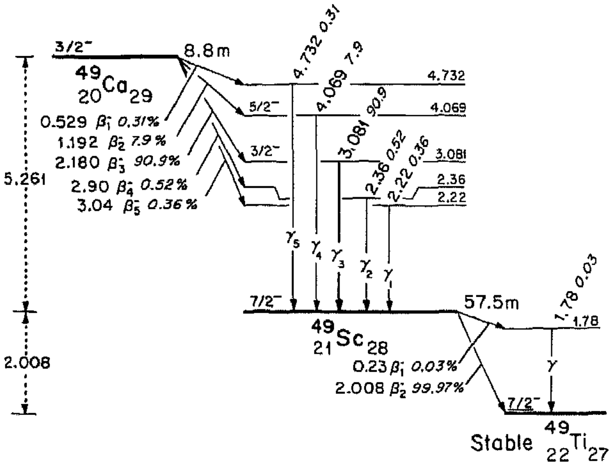
Auxiliary Data

$ce/\gamma = 0.0036$ *9*	53C16	$\omega_K = 0.217$	(Ti) Appendix III
$ce_K/ce_{LMN} \approx 10$	53C44	$\omega_L = 0$	
$\therefore ce_K/\gamma \approx 0.0033$		$n_{KL} = 1.62$	

[b] Uncertainty assigned by compilers
[U] Unweighted average
[W] Weighted average
*Value adopted by compilers from possibilities shown

$\left({}^{49}_{20}Ca_{29} - {}^{49}_{21}Sc_{28}\right)$-1

Decay Characteristics



$T_{1/2}$	8.8 m 2 (^{49}Ca) 57.5 m 2 (^{49}Sc)	Appendix I

Note

Since the half-life of daughter ^{49}Sc is much longer than that of parent ^{49}Ca, the ratio of daughter-to-parent activity increases continuously as a function of time, t, according to

$$\frac{T_A}{T_B-T_A}\left[\exp\left(\frac{0.6931(T_B-T_A)t}{T_AT_B}\right)-1\right] = 0.1807[\exp(0.0667t)-1]$$

where $T_A = T_{1/2}$ (^{49}Ca), $T_B = T_{1/2}$ (^{49}Sc), t is in minutes, and the ^{49}Sc activity is taken to be zero at t = 0 (i.e., the ^{49}Ca source is initially pure).

Radiations (^{49}Ca)

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β_1^-	0.529_{max} 11 0.177_{av} 4	0.31 5	0.0012	0.014	0.069
β_2^-	1.192_{max} 11 0.455_{av} 4	7.9 6	0.077	0.90	0.221
β_3^-	2.180_{max} 11 0.909_{av} 4	90.9 6	1.76	20.5	0.472
β_4^-	2.90_{max} 1 1.253_{av} 5	0.52 10	0.014	0.16	0.66
β_5^-	3.04_{max} 1 1.320_{av} 5	0.36 7	0.010	0.12	0.69
All β's	0.874_{av} 4	100	1.86	21.7	0.469

Decay Characteristics continued

Radiations (^{49}Ca) continued

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
γ_1	2.22 2	0.36 7	0.017	0.20	71
γ_2	2.36 2	0.52 10	0.026	0.30	72
γ_3	3.081 2	90.9 6	5.97	69.5	≈ 80
γ_4	4.069 2	7.9 6	0.68	7.9	≈ 90
γ_5	4.732 2	0.31 5	0.031	0.36	>90

Radiations (^{49}Sc)

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β_1^-	0.23_{max} 4 0.068_{av} 12	0.03 1	≈ 0	≈ 0	0.0179
β_2^-	2.008_{max} 5 0.827_{av} 2	99.97 1	1.76	100	0.427
All β's	0.827_{av} 2	100	1.76	100	0.427
γ	1.78 4	0.03 1	0.0011	≈ 0	65

Basic Data, Sources for Adopted Values

Decay Scheme

^{49}Ca $Q^- = 5.261$ 11 — 65MTW1

The γ-placements are determined from the fact that there are no γγ-coincidences (56M27). Thus all γ's feed the ground state.

No ground state β^- — 56M27

Intensities per 100 ^{49}Ca decays are obtained from the relative γ-intensities and the requirement that I(all γ's) = 100.

^{49}Sc $Q^- = 2.008$ 5 — 65MTW1

No γ other than 1.78γ — 61Re6

Intensities per 100 ^{49}Sc decays are obtained from $\gamma/(\beta_1^-+\beta_2^-)$ and $I(\beta_1^-+\beta_2^-) = 100$.

Decay Modes (^{49}Ca)

See next page

Basic Data, Sources for Adopted Values cont.

Decay Modes (^{49}Ca)

Type	Energy MeV	Intensity %	
β_1^-	0.529 *11*		$Q^- - E(\gamma_5)$
		0.31 *5*	γ-intensities
β_2^-	*1.192 *11*		$Q^- - E(\gamma_4)$
	0.89 *15*	12	56002
		*7.9 *6*	γ-intensities
β_3^-	*2.180 *11*		$Q^- - E(\gamma_3)$
	[W]1.98 *5*		56M27, 56002
		88	56002
		*90.9 *6*	γ-intensities
β_4^-	2.90 *2*		$Q^- - E(\gamma_2)$
		0.52 *10*	γ-intensities
β_5^-	3.04 *2*		$Q^- - E(\gamma_1)$
		0.36 *7*	γ-intensities

$\gamma_1 \ldots \gamma_5$ — $E(\gamma_1)$ and $E(\gamma_2)$ are data of 65Ch04. $E(\gamma_3$ to $\gamma_5)$ are weighted averages of data of 65Ch04 and 68La07. $I(\gamma_1$ to $\gamma_5)$ are data of 65Ch04 normalized so that $I(\gamma_1 + \ldots + \gamma_5) = 100$.

[W]Weighted average

*Value adopted by compilers from possibilities shown

Basic Data, Sources for Adopted Values cont.

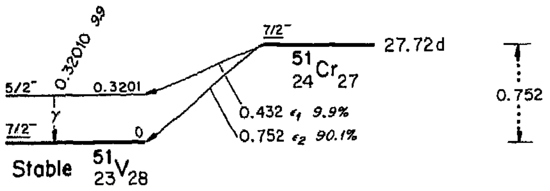
Decay Modes (^{49}Sc)

Type	Energy MeV	Intensity %	
β_1^-	0.23 *4*		$Q^- - E(\gamma)$
		0.03 *1*	$I(\gamma)$
β_2^-	*2.008 *5*		Q^-
	2.010 *5*		61Re6
		99.97 *1*	$I(\beta_1^-)$ and $I(\beta_1^- + \beta_2^-) = 100$
γ	1.78 *4*		61Re6
		0.03 *1*[a]	$\gamma/(\beta_1^- + \beta_2^-)$ 61Re6

[a]Uncertainty assigned by compilers

$^{51}_{24}Cr_{27}$

Decay Characteristics



$T_{1/2}$ **27.72 d** *3* Appendix I

Radiations

Type	Energy MeV	Intensity %	Δ (gm-rad/μCi-h)	Δ/ΣΔ %	R_{90} (cm) in Water
e_{AL}	**0.00051**	152 *2*	0.00165	2.1	<0.0001
e_{AK}	**0.00438**	68.0 *1*	0.00634	8.2	<0.0001
X_K	**0.00499**	21.5 *1*	0.00228	2.9	0.058
γ	**0.32010** *3*	9.9 *1*	0.0675	86.8	39

Basic Data, Sources for Adopted Values

Decay Scheme

Q^+ = **0.7517** *11* 65MTW1
No γ other than 0.32010γ (<0.0001%) 66Ri07, 69Kl01
Intensities per 100 ^{51}Cr decays are obtained from $I(\gamma)$ and the requirement that $I(\epsilon_1+\epsilon_2) = 100$.

Decay Modes

Type	Energy MeV	Intensity %	
ϵ_{1K}		8.9 *1*	$I(\epsilon_1)$, ϵ_L/ϵ_K, and ϵ_M/ϵ_L
ϵ_{1L}		0.92 *1*	
ϵ_{1M}		0.135 *1*	
ϵ_1		9.9 *1*	$I(\gamma)$
ϵ_{2K}		80.6 *1*	$I(\epsilon_2)$, ϵ_L/ϵ_K, and ϵ_M/ϵ_L
ϵ_{2L}		8.30 *1*	
ϵ_{2M}		1.22 *1*	
ϵ_2		90.1 *1*	$I(\epsilon_1)$ and $I(\epsilon_1+\epsilon_2) = 100$
γ	W0.32010 *3*		67Bl03, 67Wh01, 68Le03
		U9.9 *1*	55B01, 55B129, 62En6, 65Dh01, 65Le24

Basic Data, Sources for Adopted Values cont.

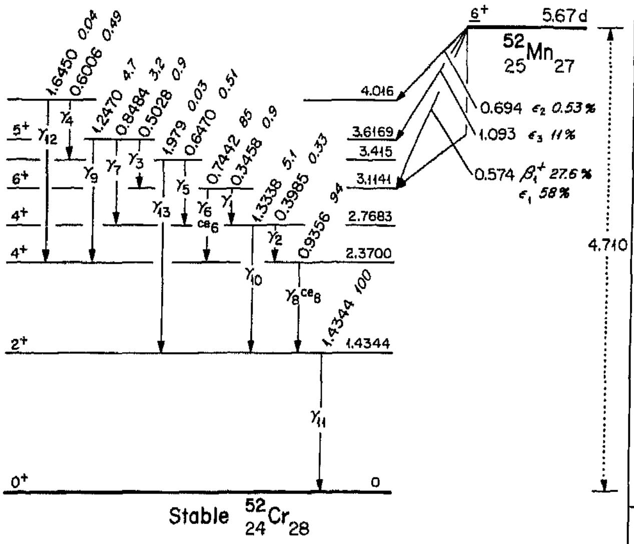
Auxiliary Data

ϵ_L/ϵ_K =	U0.103 *1*	63Ma07, 66He07
	*0.104	Theory
ϵ_M/ϵ_L =	0.147	Theory
ω_K =	0.240	Appendix III
ω_L =	0	
n_{KL} =	1.59	

U Unweighted average
*Value adopted by compilers from possibilities shown

$^{52}_{25}Mn_{27}$-1

Decay Characteristics



$T_{1/2}$ 5.67 d 9 Appendix I

Radiations

Type	Energy MeV	Intensity %	Δ (gm-rad / μCi-h)	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	0.00057	104 4	0.0013	0.02	<0.0001
e_{AK}	0.00478	46 1	0.0047	0.06	<0.0001
ce_{6K}	0.7382 2	0.028 2	0.0004	≈ 0	0.22
ce_{8K}	0.9298 2	0.014 1	0.0003	≈ 0	0.30
β_1^+	0.574$_{max}$ 3 0.243$_{av}$	27.6 5	0.143	1.9	0.083
X_K	0.00547	16.6 5	0.0019	0.03	0.076
γ_1	0.3458 1	0.9 1	0.0066	0.09	40
γ_2	0.3985 6	0.33 7	0.0028	0.04	41
γ_3	0.5028 8	0.9 3	0.01	0.1	44
$\gamma^{\pm}$	0.5110	55 1	0.599	8.1	44
γ_4	0.6006 10	0.49 12	0.0063	0.08	46
γ_5	0.6470 10	0.51 12	0.0070	0.09	47

Decay Characteristics continued

Radiations continued

Type	Energy MeV	Intensity %	Δ (gm-rad / μCi-h)	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
γ_6	0.7442 2	85 4	1.35	18.3	48
γ_7	0.8484 4	3.2 4	0.058	0.78	50
γ_8	0.9356 2	94 4	1.87	25.3	52
γ_9	1.2470 3	4.7 3	0.125	1.7	57
γ_{10}	1.3338 4	5.1 3	0.145	2.0	59
γ_{11}	1.4344 2	100	3.06	41.4	60
γ_{12}	1.6450 13	0.04 1	0.0014	0.02	63
γ_{13}	1.979 2	0.03 2	0.0013	0.02	68

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^+ = 4.710$ 3 $E(\beta_1^+)+2mc^2+E(3.1141$ level)

The γ-placements are determined by the γ-energies and extensive γγ-coincidence measurements (62Wi8, 67Pa22).

Intensities per 100 ^{52}Mn decays are obtained from the relative γ-intensities and the requirement that $I(\gamma_{11}) = 100$.

Decay Modes

Type	Energy MeV	Intensity %	
ϵ_{2K}		0.42 12	$I(\epsilon_2)$, and ϵ_L/ϵ_K
ϵ_{2L}		0.051 12	
ϵ_2		0.53 12	γ-intensities
ϵ_{3K}		10 2	$I(\epsilon_3)$, ϵ_L/ϵ_K and ϵ_{MN}/ϵ_L
ϵ_{3L}		1.0 2	
ϵ_{3MN}		0.16 2	
ϵ_3		8.8 6	γ-intensities
		14 2	$I(\beta_1^+ + \epsilon_1 + \epsilon_2 + \epsilon_3) = 100$
		*11 2	

continued on next page

*Value adopted by compilers from possibilities shown

Basic Data, Sources for Adopted Values cont.

Decay Modes continued

Type	Energy MeV	Intensity %	
ϵ_{1K}		52 *1*	$I(\epsilon_1)$, ϵ_L/ϵ_K, and ϵ_{MN}/ϵ_L
ϵ_{1L}		5.4 *1*	
ϵ_{MN}		0.82 *2*	
ϵ_1		*58 *1*	$I(\beta_1^+)$ and ϵ_1/β_1^+
		58 *3*	γ-intensities and ϵ_1/β_1^+
β_1^+	[W]0.574 *3*		58K57, 60Ka20, 67Ko10
		*[W]27.6 *5*	66Fr05, 67Ko10, 67Pa22
		27.5 *12*	γ-intensities and ϵ_1/β_1^+
ce_{6K}		0.028 *2*	$I(\gamma_6)$ and ce_{6K}/γ_6
ce_{8K}		0.014 *1*	$I(\gamma_8)$ and ce_{8K}/γ_8

$\gamma_1 \cdots \gamma_{13}$ E(γ) are weighted averages of data of 62Wi8, 66Fr05, and 67Pa22.
I(γ) are weighted averages of data of 66Fr05 and 67Pa22. The authors' relative values are normalized so that $I(\gamma_{11}) = 100$.

[a]Uncertainty is that due to uncertainty in Q^+
[W]Weighted average
*Value adopted by compilers by possibilities shown

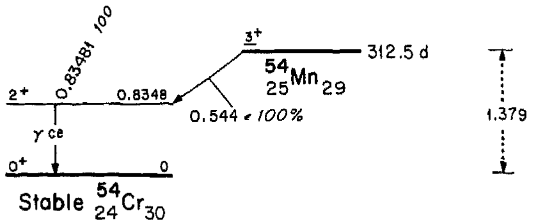
Basic Data, Sources for Adopted Values cont.

Auxiliary Data

$\epsilon_1/\beta_1^+ = 2.10$ *4*[a] $\epsilon_3/\beta_3^+ = 7430$	Theory
$\epsilon_L/\epsilon_K = 0.104$ $\epsilon_{MN}/\epsilon_L = 0.153$	Theory
$\omega_K = 0.265$ $\omega_L = 0$ $n_{KL} = 1.56$	Appendix III
$ce_{6K}/\gamma_6 = 0.000324$	66Fr05
$ce_{8K}/\gamma_8 = 0.000153$	66Fr05

$^{54}_{25}Mn_{29}$

Decay Characteristics



$T_{1/2}$ 312.5 d 5 Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00057**	149 *1*	0.00181	0.10	<0.0001
e_{AK}	**0.00478**	65.6 2	0.00668	0.37	<0.0001
ce_K	**0.82882** *5*	0.022 2	≈0	≈0	0.27
X_K	**0.00547**	23.6 *1*	0.00275	0.15	0.076
γ	**0.83481** *5*	99.978 2	1.778	99.4	50

Basic Data, Sources for Adopted Values

Decay Scheme

Q^+ = **1.3788** *44* 65MTW1

No γ other than 0.83481γ (< 0.1%) 58K34

No β^+ (<8×10^{-5}%) (68Be01), ∴ total branching to ground state is <2×10^{-3}% (ϵ/β^+=20).

∴ I(γ+ce_K^a) = 100.

Decay Modes

Type	Energy MeV	Intensity %	
ϵ_K		89.1 2	I(ϵ), ϵ_L/ϵ_K and ϵ_{MN}/ϵ_L
ϵ_L		9.4 2	
ϵ_{MN}		1.45 *3*	
ϵ		100	I(γ+ce)
ce_K		0.022 2	ce_K/γ and I(γ+ce_K^a) = 100
γ	^{W}**0.83481** *5*		67B103, 67Ch08, 67Ra03, 68Le03, 68Wh03
		99.978 2	ce_K/γ and I(γ+ce_K^a) = 100

Basic Data, Sources for Adopted Values cont.

Auxiliary Data

ϵ_L/ϵ_K = *0.106 2[b] Theory

^{W}0.104 *3* 63Ma07, 63Mo12

ϵ_{MN}/ϵ_L = 0.153 Theory

ce_K/γ = 0.00022 2 66Ha07

ω_K = 0.265, ω_L = 0, n_{KL} = 1.56 — Appendix III

Comparison of Additional Experimental Results with Values Calculated from the Adopted Decay Scheme

$\epsilon_{LMN}/\epsilon_K$ = 0.122 *3* From adopted values

^{W}0.111 *6* 62Kr1, 68Ha47

[a] Conversion in higher shells is negligible here

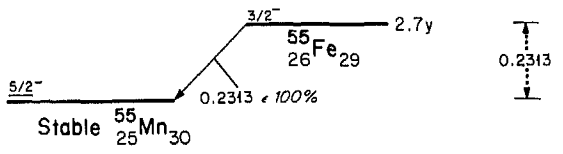
[b] Uncertainty assigned by compilers

[W] Weighted average

[*] Value adopted by compilers from possibilities shown

$^{55}_{26}Fe_{29}$

Decay Characteristics	Basic Data, Sources for Adopted Values



$T_{½}$ **2.7 y** *1* Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00063**	146.4 *1*	0.00196	16.1	<0.0001
e_{AK}	**0.00519**	63.0 *2*	0.00696	57.1	<0.0001
X_K	**0.00595**	25.7 *1*	0.00326	26.8	0.098

Decay Scheme

$Q^+ = $ **0.2313** *13* — 65MTW1

No γ, no ce, — 53M12, 53P02, 54M30, 54S18

$\therefore I(\epsilon) = 100$

Decay Modes

Type	Energy MeV	Intensity %	
ϵ_K		88.73 *8*	$I(\epsilon)$, ϵ_L/ϵ_K and ϵ_{MN}/ϵ_L
ϵ_L		9.76 *9*	
ϵ_{MN}		1.50 *2*	
ϵ		100	Decay scheme

Auxiliary Data

$\epsilon_L/\epsilon_K = {}^{*}0.110$ *1*[a]	Theory
${}^{W}0.106$ *2*	59S32, 62Ma26, 63Ma07, 63Mo12
$\epsilon_{MN}/\epsilon_L = 0.154$	Theory
$\omega_K = 0.290$	Appendix III
$\omega_L = 0$	
$n_{KL} = 1.54$	

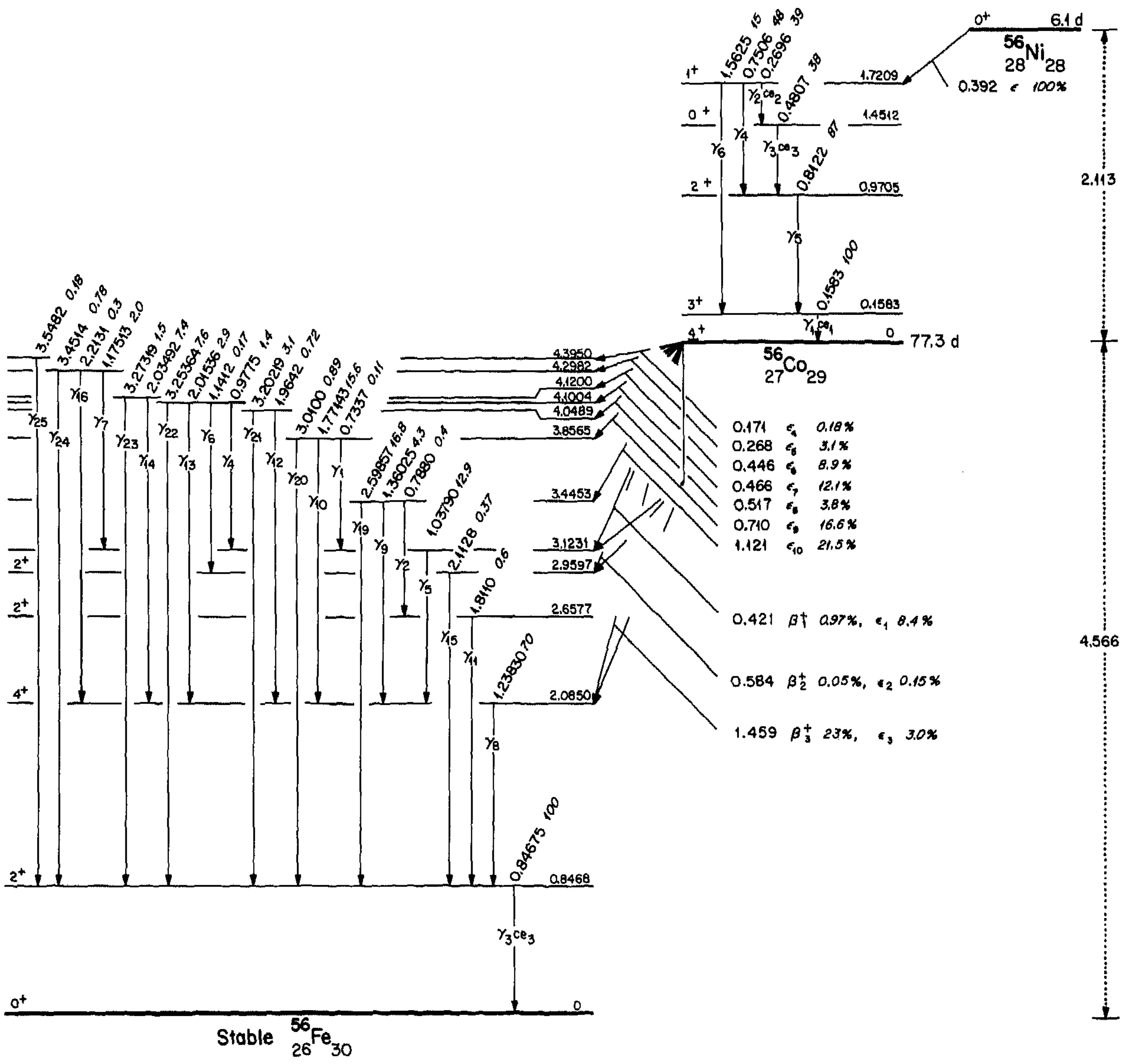
[a]Uncertainty is that due to uncertainty in Q^+

[W]Weighted average

*Value adopted by compilers from possibilities shown

$\left({}^{56}_{28}Ni_{28} - {}^{56}_{27}Co_{29}\right)$-1

Decay Characteristics



$T_{1/2}$	6.1 d *1* (^{56}Ni) 77.3 d *3* (^{56}Co)	Appendix I

Note

Since the half-life of ^{56}Co is much longer than that of its parent, ^{56}Ni, the ratio of ^{56}Co activity to that of ^{56}Ni increases continuously as a function of time, t, according to

$$\frac{T_A}{T_B-T_A}\left[\exp\left(\frac{0.6931(T_B-T_A)t}{T_AT_B}\right)-1\right]=0.0789\left[\exp(0.105t)-1\right]$$

where $T_A = T_{1/2}$ (^{56}Ni), $T_B = T_{1/2}$ (^{56}Co), t is in days, and the ^{56}Co activity is taken to be zero at t = 0 (ie., the ^{56}Ni source is initially pure).

Note

Weak γ's with energy 2.311, 2.524, 3.599, and 3.611 reported by 66Hu17 in ^{56}Co decay have not been included because of their low intensities (<0.02%, < 0.03%, 0.01%, and <0.005%, respectively).

continued on next page

$\left({}^{56}_{28}Ni_{28} - {}^{56}_{27}Co_{29}\right)$-2

Decay Characteristics continued

Radiations (^{56}Ni)

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00077**	143 *1*	0.00235	0.063	<0.0001
e_{AK}	**0.00607**	58.9 *3*	0.00762	0.20	<0.0001
ce_{1K}	**0.1506**	1.2 *1*	0.0038	0.10	0.021
ce_{1LM}	**0.1574**	0.15 *1*	0.00050	0.013	0.022
ce_{2K}	**0.2619**	0.113 *6*	0.00063	0.017	0.050
ce_{3K}	**0.4730**	0.057 *2*	0.00057	0.015	0.12
X_K	**0.00700**	30.8 *2*	0.00459	0.12	0.16
γ_1	**0.1583** *2*	98.7 *1*	0.3328	8.9	34
γ_2	**0.2696** *1*	39 *2*	0.22	5.9	38
γ_3	**0.4807** *1*	38 *1*	0.39	10.4	43
γ_4	**0.7506** *1*	48 *3*	0.77	20.6	49
γ_5	**0.8122** *2*	87 *3*	1.51	40.3	50
γ_6	**1.5625** *2*	15 *1*	0.50	13.4	62

Radiations (^{56}Co)

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00070**	112 *2*	0.00167	0.021	<0.0001
e_{AK}	**0.00562**	47.4 *7*	0.0057	0.071	<0.0001
ce_{3K}	**0.83964** *4*	0.026 *1*	0.00046	0.006	0.26
β^+_1	**0.421**$_{max}$ *2* **0.1786**$_{av}$ *9*	0.97 *5*	0.0037	0.046	0.053
β^+_2	**0.584**$_{max}$ *2* **0.2469**$_{av}$ *9*	0.05 *2*	0.00026	0.003	0.085
β^+_3	**1.459**$_{max}$ *2* **0.6301**$_{av}$ *9*	23 *2*	0.31	3.9	0.292
All β's	**0.6081**$_{av}$ *9*	24 *2*	0.31	3.9	0.291

Decay Characteristics continued

Radiations (^{56}Co) continued

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
X_K	**0.00647**	21.9	0.00301	0.037	0.12
$\gamma^{\pm}$	**0.5110**	48 *4*	0.52	6.5	44
γ_1	**0.7337** *2*	0.11 *4*	0.0017	0.021	48
γ_2	**0.7880** *2*	0.4 *2*	0.007	0.09	49
γ_3	**0.84675** *4*	99.974 *1*	1.803	22.5	50
γ_4	**0.9775** *2*	1.4 *2*	0.029	0.36	53
γ_5	**1.03790** *5*	12.9 *3*	0.285	3.5	54
γ_6	**1.1412** *10*	0.17 *2*	0.0041	0.051	56
γ_7	**1.17513** *6*	2.0 *2*	0.050	0.62	56
γ_8	**1.23830** *4*	70 *2*	1.85	23.0	57
γ_9	**1.36025** *5*	4.3 *2*	0.125	1.6	59
γ_{10}	**1.77143** *9*	15.6 *5*	0.59	7.3	65
γ_{11}	**1.8110** *2*	0.6 *1*	0.023	0.29	66
γ_{12}	**1.9642** *4*	0.72 *7*	0.030	0.37	68
γ_{13}	**2.01536** *7*	2.9 *2*	0.124	1.5	68
γ_{14}	**2.03492** *6*	7.4 *3*	0.321	4.0	69
γ_{15}	**2.1128** *3*	0.37 *6*	0.017	0.21	70
γ_{16}	**2.2131** *5*	0.3 *1*	0.014	0.17	71
$^{x}\gamma_{17}$	**2.274** *2*	0.12 *3*	0.006	0.07	72
$^{x}\gamma_{18}$	**2.374** *2*	0.15 *3*	0.008	0.10	73
γ_{19}	**2.59857** *6*	16.8 *4*	0.93	11.6	76
γ_{20}	**3.0100** *2*	0.89 *12*	0.057	0.71	≈80
γ_{21}	**3.20219** *7*	3.1 *2*	0.21	2.6	≈80
γ_{22}	**3.25364** *6*	7.6 *3*	0.53	6.6	≈80
γ_{23}	**3.27319** *7*	1.5 *1*	0.10	1.2	≈80
γ_{24}	**3.4514** *2*	0.78 *5*	0.057	0.71	≈90
γ_{25}	**3.5482** *2*	0.18 *2*	0.014	0.17	≈90

^{x}Not shown on decay scheme since placement not determined

$\left({}^{56}_{28}Ni_{28}-{}^{56}_{27}Co_{29}\right)$-3

Basic Data, Sources for Adopted Values

Decay Scheme

^{56}Ni $Q^+ = 2.113$ *17* — 65MTW1

^{56}Co levels are known from (d,α) and (^{3}He,p) reactions (68Be10). The ^{56}Ni γ-rays, on the basis of their energies and coincidence relationships, can be unambiguously placed between these levels.

No β^+ (<1%) — 52S30, 52W15

Intensities per 100 ^{56}Ni decay are obtained from the relative γ-intensities, the adopted ce/γ for each transition, and the requirement that $I(\gamma_1 + ce_1) = 100$.

^{56}Co $Q^+ = 4.566$ 2 — $E(\beta_3^+) + 2mc^2 + E(2.0850\ \text{level})$

^{56}Fe levels are known from (p,p′) reactions (66Ka04). The ^{56}Co γ-rays, on the basis of their energies and coincidence relationships, can be unambiguously placed between these levels.

No β^+ with $E_\beta > 1.459$ (<0.03%) — 65Pe18

Intensities per 100 ^{56}Co decay are obtained from relative γ-intensities, ce_{3K}/γ_3, and the requirement that $I(\gamma_3 + ce_{3K}^a) = 100$.

Decay Modes (^{56}Ni)

Type	Energy MeV	Intensity %	
ϵ_K		88.6 *5*	$I(\epsilon)$, ϵ_L/ϵ_K, and ϵ_{MN}/ϵ_L
ϵ_L		9.8 *1*	
ϵ_{MN}		1.55 *3*	
ϵ		100	Decay scheme
ce_{1K}		1.2 *1*	$I(ce_1)$ and ce_{1K}/ce_{1LM}
ce_{1LM}		0.15 *1*	
ce_1		1.34 *12*	See $I(\gamma_1\cdots\gamma_6)$
ce_{2K}		0.113 *6*	$I(\gamma)$ and ce_K/γ
ce_{3K}		0.057 2	

$\gamma_1\cdots\gamma_6$ — $E(\gamma)$ are data of 66Pi01.

$I(\gamma)$ are unweighted averages of relative intensities of 61Mo10, 63We06, 65Oh01, and 66Pi01. Each author's data is normalized so that, in conjunction with ce_1/γ_1, the requirement $I(\gamma_1 + ce_1) = 100$ is satisfied.

Basic Data, Sources for Adopted Values

Decay Modes (^{56}Co)

Type	Energy MeV	Intensity %	
ϵ_K		69.4 *10*	$I(\epsilon)$, ϵ_L/ϵ_K, and ϵ_{MN}/ϵ_L
ϵ_L		7.55 *11*	
ϵ_{MN}		1.17 *7*	
ϵ		78.0 *10*	γ-intensities and ϵ/β^+
ce_{3K}		0.026 *1*	ce_{3K}/γ_3 and $I(\gamma_3 + ce_{3K}^a) = 100$

β_1^+, β_2^+ — $E(\beta_1^+, \beta_2^+)$ are calculated from the adopted Q^--value and the level energies. $I(\beta_1^+, \beta_2^+)$ are calculated from the γ-intensities and ϵ/β^+.

β_3^+ **1.459** 2 — 65Pe18

23 2 — γ-intensities and ϵ/β^+

$\gamma_1\cdots\gamma_{25}$ — $E(\gamma_1$ to $\gamma_{25})^b$ are weighted averages of data of 65Pe18, 65Re14[c], 66Do07, 66Hu17, 66Vo08[c], 67Au01, 67Ba60, 67Ch20, 68Gu05, and 68Sh07.

$I(\gamma_1$ to $\gamma_{25})$ are weighted averages of relative intensities of 65Pe18, 66Do07, 66Hu17, 66Sc01, 67Au01, 67Ba60, 67Ch20, and 68Sh07. Each author's data is normalized so that in conjunction with ce_{3K}/γ_3, the requirement $I(\gamma_3 + ce_{3K}^a) = 100$ is satisfied.

[a] Conversion in higher shells is negligible here

[b] γ_6 observed only by 67Ch20; γ_{17} and γ_{18} observed only by 66Hu17

[c] Energies for γ_3 and γ_{11} only (from ^{56}Mn decay)

Basic Data, Sources for Adopted Values cont.

Auxiliary Data

^{56}Ni $\epsilon_L/\epsilon_K = 0.115\ 6$		67Wi17
$*0.111$		Theory
$\epsilon_{MN}/\epsilon_L = 0.155$		Theory
$\omega_K = 0.343,$	}	Appendix III
$\omega_L = 0$	}	Appendix III
$n_{KL} = 1.48$	}	Appendix III
$ce_{1K}/\gamma_1 = {}^W0.012\ 1$		64Je03, 67Me18
$ce_{1K}/ce_{1LM} = {}^W7.71\ 11$		67Me18
$\therefore ce_1/\gamma_1 = 0.0136\ 12$		
$ce_{2K}/\gamma_2 = 0.0029$	}	M1 Theory
$ce_2/\gamma_2 = *0.0032$	}	M1 Theory
$0.0034\ 2$		64Je03
$ce_{3K}/\gamma_3 = 0.0015$	}	M2 Theory
$ce_3/\gamma_3 = *0.0017$	}	M2 Theory
$0.00150\ 15$		64Je03

[W]Weighted average

*Value adopted by compilers from possibilities shown

Basic Data, Sources for Adopted Values cont.

Auxiliary Data continued

^{56}Co

$\epsilon_L/\epsilon_K = 0.114\ (\epsilon_4)$	}	Theory
$0.111\ (\epsilon_5)$	}	Theory
$0.109\ (\epsilon_6, \epsilon_7, \epsilon_8)$	}	Theory
$0.108\ (\epsilon_9)$	}	Theory
$0.107\ (\epsilon_{10}, \epsilon_1, \epsilon_2, \epsilon_3)$	}	Theory
$\epsilon_{MN}/\epsilon_L = 0.155$		Theory
$\epsilon_1/\beta_1^+ = 8.65\ 15^a$	}	Theory
$\epsilon_2/\beta_2^+ = 2.72\ 4^a$	}	Theory
$\epsilon_3/\beta_3^+ = 0.133\ 1^a$	}	Theory
$\omega_K = 0.316$	}	Appendix III
$\omega_L = 0$	}	Appendix III
$n_{KL} = 1.51$	}	Appendix III
$ce_{3K}/\gamma_3 = 0.00026\ 1^b$		E2 Theory

Comparison of Additional Experimental Results with Values Calculated from the Adopted Decay Scheme

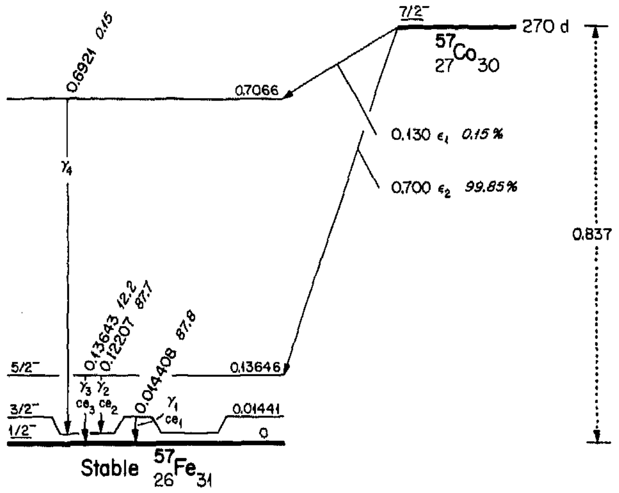
$\gamma^{\pm}/\gamma_3 = 0.44\ 4$	66Sc01
$0.48\ 4$	From adopted values

[a]Uncertainty is that due to uncertainty in Q^+

[b]Uncertainty assigned by compilers

$^{57}_{27}Co_{30}$-1

Decay Characteristics



$T_{1/2}$ **270 d** 2 Appendix I

Note

Weak γ's of energy 0.2303, 0.3525, and 0.3668 de-exciting a level at 0.3668 MeV and of energy 0.3397, 0.5701, and 0.7066 de-exciting the 0.7066 MeV level have not been included because of their low intensities (0.00049, 0.0028, 0.00060, 0.0038, 0.013, and 0.0054%, respectively). These γ's have been reported by 65Ki03, 65Ma38, and 65Sp06.

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00070**	257 *2*	0.00383	1.3	<0.0001
e_{AK}	**0.00562**	105 *2*	0.0125	4.2	<0.0001
ce_{1K}	**0.007296** *5*	69.7 *4*	0.0108	3.5	≈ 0.0001
ce_{1L}	**0.013562**[a] *5*	7.67 *4*	0.0022	0.72	0.00032
ce_{1MN}	**0.014324**[b] *7*	0.93 *4*	0.00028	0.09	0.00035
ce_{2K}	**0.11496** *3*	1.83 *10*	0.0045	1.5	0.014
ce_{2LM}	**0.12130**[a] *3*	0.22 *2*	0.00057	0.19	0.014
ce_{3K}	**0.12933** *5*	1.41 *13*	0.0039	1.3	0.016
ce_{3LM}	**0.13567**[a] *5*	0.16 *1*	0.00046	0.15	0.018

Decay Characteristics continued

Radiations continued

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
X_K	**0.00646**	54 *2*	0.0074	2.5	0.12
γ_1	**0.014408** *5*	9.5 *2*	0.0029	0.95	1.5
γ_2	**0.12207** *3*	85.6 *2*	0.2226	72.9	32
γ_3	**0.13643** *5*	10.6 *2*	0.0308	10.1	33
γ_4	**0.6921** *2*	0.15 *1*	0.0022	0.72	47

Basic Data, Sources for Adopted Values

Decay Scheme

Q^+ = **0.8366** 25 65MTW1

The γ-placements are determined by the precise γ-energies and the observed $\gamma_1\gamma_2$-coincidence (50D06, 55L30, 55M87).

Intensities per 100 ^{57}Co decays are obtained from the relative γ-intensities, ce_2/γ_2, ce_3/γ_3, and the requirement that $I(\gamma_2+\gamma_3+\gamma_4+ce_2+ce_3)^c = 100$

Decay Modes

Type	Energy MeV	Intensity %	
ϵ_{1K}		0.13 *1*	$I(\epsilon_1)$ and $\epsilon_{1L}/\epsilon_{1K}$
ϵ_{1L}		0.015 *1*	
ϵ_1		0.15 *1*	$I(\gamma_4)$
ϵ_{2K}		*w89.7 *10*	63Mo12, 68Ru04
		*88.78 *1*	$I(\epsilon_2)$, $\epsilon_{2L}/\epsilon_{2K}$, and ϵ_{MN}/ϵ_L
ϵ_{2L}		9.59	
ϵ_{2MN}		1.49	
ϵ_2		99.85 *1*	$I(\epsilon_1)$ and $I(\epsilon_1+\epsilon_2)^c = 100$
ce_{1K}		70 *3*	ce_{1K}/ce_{3K} 57B45
		*69.7 *4*	$I(ce_1)$, ce_{1L}/ce_{1K}, and ce_{1LM}/ce_{1K}
ce_{1L}		7.67 *4*	
ce_{1MN}		0.93 *4*	
ce_1		78.3 *4*	ce_1/γ_1 and intensity balance at 0.01441 level

a,b Energy of L_1-, M_1-line given

c The compilers assume there is no capture branch feeding the ground state or the 0.01441 level. This assumption is based on the fact that for a $\Delta J = 2,3$ transition with no parity change, log ft is expected to be $\gtrsim 10$. For $Q^+ = 0.837$ and $T_{1/2}$ (^{57}Co) = 270 d, this log ft value yields $I(\epsilon) \lesssim 0.04\%$ for transitions to either the ground state or the 0.01441 level

w Weighted average

* Value adopted by compilers from possibilities shown

Basic Data, Sources for Adopted Values cont.

Decay Modes continued

Type	Energy MeV	Intensity %	
ce_{2K}		1.83 *10*	I(ce_2) and ce_{2LM}/ce_{2K}
ce_{2LM}		0.22 *2*	
ce_2		2.05 *12*	See I(γ_4)
ce_{3K}		1.41 *13*	I(ce_3) and ce_{3LM}/ce_{3K}
ce_{3LM}		0.16 *1*	
ce_3		1.57 *13*	See I(γ_4)
γ_1	[W]**0.014408** *5*		63Me10[a], 67Ha06
		9.5 *2*	ce_1/γ_1 and intensity balance at 0.01441 level
γ_2	[W]**0.12207** *3*		58C08, 68Le03
		85.6 *2*	See I(γ_4)
γ_3	[W]**0.13643** *5*		58C08, 68Le03
		10.6 *2*	See I(γ_4)
γ_4	[W]**0.6921** *2*		65Ki03, 65Sp06
		0.15 *1*	γ_4/γ_2, γ_3/γ_2, ce_2/γ_2, ce_3/γ_3, and I(γ_2+γ_3+γ_4+ce_2+ce_3)=100

[a]Value given by 63Me10 has been recalculated by 67Jo02 using electron binding energies of 67BeBu
[b]Uncertainty of 5% assigned by compilers
[U]Unweighted average
[W]Weighted average
*Value adopted by compilers from possibilities shown

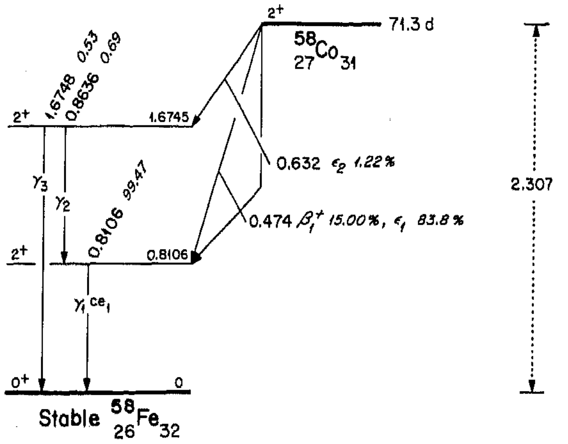
Basic Data, Sources for Adopted Values cont.

Auxiliary Data

$\epsilon_{1L}/\epsilon_{1K}$ = 0.117		Theory
$\epsilon_{2L}/\epsilon_{2K}$ = 0.099 *11*		63Mo12
*0.108		Theory
ϵ_{MN}/ϵ_L = 0.155		Theory
ω_K = [W]0.340 *9*		67Ba61, 67Ha06, 68Ru04
*0.316		Appendix III
ω_L = 0		Appendix III
n_{KL} = 1.51		Appendix III
ce_1/γ_1 = [W]8.26 *20*		65Ki03, 68Ru04
ce_{1L}/ce_{1K} = [W]0.110 *2*		57B45, 67Ha06
ce_{1LM}/ce_{1K} = [W]0.124 *2*		57B45, 67Ha06
ce_{2K}/γ_2 = [W]0.0214 *12*		67Ha06, 67Mu20
ce_{2LM}/ce_{2K} = [U]0.122 *9*		54A06, 51B45, 65Mo22, 67Ha06
$\therefore ce_2/\gamma_2$ = 0.0240 *14*		
ce_{3K}/γ_3 = [W]0.132 *11*		67Ha06, 67Mu20
*0.133		E2 Theory
ce_{3LM}/ce_{3K} = [U]0.116 *7*		54A06, 57B45, 65Mo22, 67Ha06
$\therefore ce_3/\gamma_3$ = 0.148 *1*		
γ_3/γ_2 = 0.124 *2*		65Ki03, 65Ma38, 65Sp06[b]
γ_4/γ_2 = 0.00173 *11*		65Ki03, 65Ma38, 65Sp06[b]

$^{58}_{27}Co_{31}$ -1

Decay Characteristics



$T_{1/2}$	**71.3 d** *2*	Appendix I

Note

A weak β^+-group feeding the ground state (58D03) has not been included because of its low intensity (6.3×10^{-4}%).

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00070**	122 *1*	0.00182	0.085	<0.0001
e_{AK}	**0.00562**	50.0 *7*	0.00599	0.28	<0.0001
ce_{1K}	**0.8035** *2*	0.030 *1*	0.00051	0.024	0.25
β_1^+	**0.474**$_{max}$ *4* **0.201**$_{av}$ *2*	15.00 *5*	0.0642	3.0	0.063
X_K	**0.00647**	25.7 *7*	0.00354	0.16	0.12
$\gamma^{\pm}$	**0.5110**	30.0 *1*	0.327	15.2	44
γ_1	**0.8106** *2*	99.44 *2*	1.717	79.8	50
γ_2	**0.8636** *2*	0.69 *2*	0.0127	0.59	51
γ_3	**1.6748** *3*	0.53 *2*	0.0189	0.88	64

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^+ = $ **2.307** *4* $\quad E(\beta_1^+)+2mc^2+E(\gamma_1)$

The γ-placements are determined by the γ-energies, the observed $\gamma_1\gamma_2$-coincidence (62Ma33, 64Ma09, 66Ra22), and the known level at 0.81 MeV seen in (d,p) (64Bj01) and in (p,p′) (64Sp03).

Intensities per 100 ^{58}Co decays are obtained from the relative γ-intensities, ce_1/γ_1, and the requirement that $I(\gamma_1+ce^a_{1K}+\gamma_3) = 100$.[b]

Decay Modes

Type	Energy MeV	Intensity %	
ϵ_{2K}		1.09 *3*	$I(\epsilon_2)$, ϵ_L/ϵ_K, and ϵ_{MN}/ϵ_L
ϵ_{2L}		0.116 *3*	
ϵ_{2MN}		0.018 *1*	
ϵ_2		1.22 *3*	γ-intensities
ϵ_{1K}		74.6 *1*	$I(\epsilon_1)$, ϵ_L/ϵ_K, and ϵ_{MN}/ϵ_L
ϵ_{1L}		7.98 *1*	
ϵ_{1MN}		1.24 *1*	
ϵ_1		*83.8 *1*	γ-intensities[c] and $I(\beta_1^+)$
		84.4 *4*	γ-intensities[c] and ϵ_1/β_1^+
ce_{1K}		0.030 *1*	See $I(\gamma_1)$
β_1^+	^{W}**0.474** *4*		44D01, 52C31, 55C31, 63Rh02
		*^{W}15.00 *5*	58K64, 66Bi13, 68Ba49
		14.94 *9*	γ-intensities[c] and ϵ_1/β_1^+
γ_1	^{W}**0.8106** *2*		62Ma33, 65Hi12, 66Do07, 68Ri03
		99.44 *2*	γ_3/γ_1, ce_{1K}/γ_1, and $I(\gamma_1+ce^a_{1K}+\gamma_3) = 100$
γ_2	^{W}**0.8636** *2*		62Ma33, 65Hi12, 66Do07, 68Ri03
		^{W}0.69 *2*	γ_2/γ_1 65Hi12, 68Ba49, 68Ri03
γ_3	^{W}**1.6748** *3*		62Ma33, 65Hi12, 66Do07, 68Ri03
		^{W}0.53 *2*	See $I(\gamma_1)$

[a] Conversion in higher shells is negligible here
[b] See note under decay scheme drawing
[c] $I(ce_{1K})$ is negligible here
[W] Weighted average
* Value adopted by compilers from possibilities shown

Basic Data, Sources for Adopted Values cont.

Auxiliary Data

ϵ_{1K}/β_1^+ =	5.03 *15*[a]	Theory
	*[W]4.99 *3*	61Jo22, 62Kr2, 68Ba49
ϵ_L/ϵ_K =	*0.107	Theory
	0.108 *4*	63Mo12
ϵ_{MN}/ϵ_L =	0.155	Theory
ϵ_1/β_1^+ =	*5.61 *4*	ϵ_{1K}/β_1^+, ϵ_L/ϵ_K, and ϵ_{MN}/ϵ_L
	5.82 *10*	62Kr2
ce_{1K}/γ_1 =	0.00030 *1*	62Fr13
	*0.00029	E2 Theory
γ_3/γ_1 =	[W]0.0053 *2*	65Hi12, 68Ba49, 68Ri03
ω_K =	*[W]0.340 *9*	67Ba61, 67Ha06, 68Ru04
	0.319	Appendix III
ω_L =	0	Appendix III
n_{KL} =	1.51	Appendix III

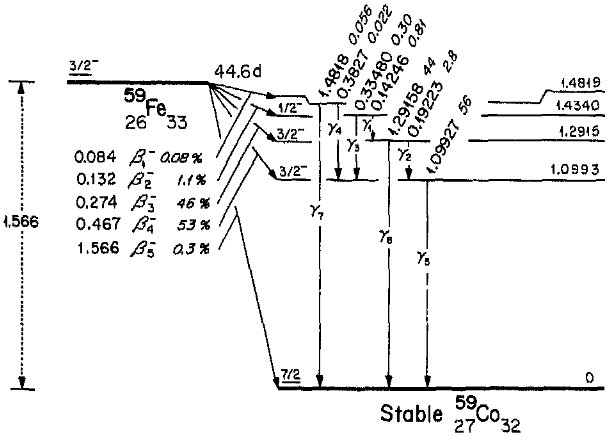
[a]Uncertainty is that due to uncertainty in Q^+

[W]Weighted average

*Value adopted by compilers from possibilities shown

$^{59}_{26}Fe_{33}$

Decay Characteristics



$T_{1/2}$ 44.6 d 4 Appendix I

Radiations

Type	Energy MeV	Intensity %	Δ (gm-rad / μCi-h)	Δ/ΣΔ %	R_{90} (cm) in Water
β_1^-	**0.084**$_{max}$ 3				
	0.022$_{av}$ 1	0.08 2	0.00004	0.0014	0.00299
β_2^-	**0.132**$_{max}$ 3				
	0.036$_{av}$ 1	1.1 1	0.0008	0.029	0.0067
β_3^-	**0.274**$_{max}$ 3				
	0.081$_{av}$ 1	46 1	0.079	2.8	0.0239
β_4^-	**0.467**$_{max}$ 3				
	0.150$_{av}$ 1	53 1	0.169	6.0	0.057
β_5^-	**1.566**$_{max}$ 3				
	0.616$_{av}$ 1	0.3 1	0.004	0.14	0.314
All β's	**0.118**$_{av}$ 1	100	0.251	9.0	0.052
γ_1	**0.14254** 8	0.81 7	0.0025	0.090	33
γ_2	**0.19223** 8	2.8 3	0.011	0.39	36
γ_3	**0.33480** 10	0.30 5	0.0021	0.075	40
γ_4	**0.3827** 5	0.022 5	0.00018	0.006	41
γ_5	**1.09927** 8	56 1	1.31	46.9	55
γ_6	**1.29158** 10	44 1	1.21	43.3	58
γ_7	**1.4818** 5	0.056 12	0.0018	0.064	61

Basic Data, Sources for Adopted Values

Decay Scheme

Q^- = **1.5662** 28 Nuclear Data B2-5-120 (1968)

The γ-placements are determined by the precise γ-energies and the observed $(\gamma_5)(\gamma_2,\gamma_3)$-, and $(\gamma_1)(\gamma_2,\gamma_6)$-coincidences (60Sc16).

Intensities per 100 ^{59}Fe decays are obtained from the relative γ-intensities, $I(\beta_5^-)$, and the requirement that $I(\gamma_5+\gamma_6+\beta_5^-)^a = 100$.

Decay Modes

Type	Energy MeV	Intensity %	
β_1^-	**0.084** 3		Q^--E(1.4819 level)
		0.08 2	γ-intensities
β_2^-	***0.132** 3		Q^--E(1.4340 level)
	0.15 1		60Su10
		*1.1 1	γ-intensities
		5.0 15	60Su10
β_3^-	***0.274** 3		Q^--E(1.2915 level)
	^{W}**0.273** 2		52M53, 60Be6, 60Su10, 63Wo01
		^{U}46 2	
		*46 1	γ-intensities
β_4^-	***0.467** 3		Q^--E(1.0993 level)
	^{W}**0.467** 4		52M53, 60Be6, 60Su10, 63Wo01
		^{U}53 2	
		*53 1	γ-intensities
β_5^-	***1.566** 3		Q^-
	1.573 3		63Wo01
		0.3 1[b]	52M53, 63Wo01

$\gamma_1 \cdots \gamma_7$ E(γ_4,γ_7) are data of 68Ga14. The uncertainties have been assigned by the compilers. The energies of the other γ's are weighted averages of data of 67Be60 and 67He08. I(γ_4,γ_7) are data of 67Be60. The intensities of the other γ's are weighted averages of data of 59F18, 62Ka25, 64Co34, and 67Be60. The relative values of each author are normalized so that $I(\gamma_5+\gamma_6+\beta_5^-)^a = 100$.

[a] $I(\gamma_7)$ is negligible here

[b] Uncertainty assigned by compilers

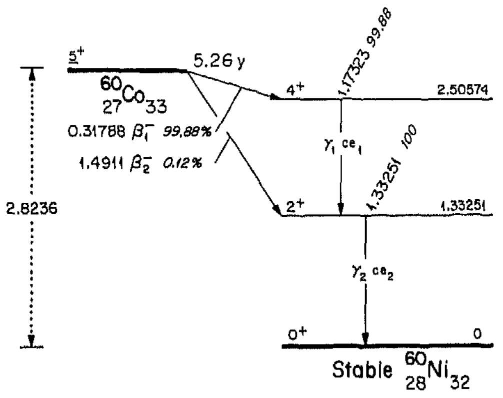
[U] Unweighted average

[W] Weighted average

*Value adopted by compilers from possibilities shown

$^{60}_{27}Co_{33}$

Decay Characteristics



$T_{1/2}$	5.26 y *1*	Appendix I

Note

A weak β-group (0.008%) of energy 0.663 feeding a level at 2.158 MeV and γ's of energy 0.83 (0.007%) and 2.158 (0.0012%) de-exciting this level have not been included because of their low intensities. A γ of energy 2.505 with intensity $\approx 4\times10^{-5}$% has also been omitted. For a discussion of these radiations, with references, see S. Raman, Nuclear Data Sheets for A = 60, Nuclear Data B2-5-50.

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00085**	0.040 *3*	≈ 0	≈ 0	<0.0001
e_{AK}	**0.00654**	0.017 *2*	≈ 0	≈ 0	<0.0001
ce_{1K}	**1.16490** *3*	0.015 *1*	0.00037	≈ 0	0.40
ce_{2K}	**1.32418** *2*	0.012 *1*	0.00034	≈ 0	0.46
β_1^-	**0.31788**$_{max}$ *10* **0.0959**$_{av}$ *4*	99.88 *2*	0.204	3.7	0.0305
β_2^-	**1.4911**$_{max}$ *1* **0.6274**$_{av}$ *3*	0.12 *2*	0.0016	0.029	0.323
All β's	**0.0965**$_{av}$ *4*	100	0.206	3.7	0.0312
γ_1	**1.17323** 2	99.88	2.496	45.0	56
γ_2	**1.33251** 2	100	2.838	51.2	59

Basic Data, Sources for Adopted Values

Decay Scheme

Q^- = **2.82362** *11* $E(\beta_1^-+\gamma_1+\gamma_2)$

The γ-placements are determined by the observed $\gamma_1\gamma_2$-coincidence (45D01) and the known level at 1.33 MeV [seen, for example, in (p,p′), 67Te02]. Intensities per 100 ^{60}Co decays are obtained from β_2^-/β_1^- and the requirement that $I(\beta_1^-+\beta_2^-)=I(\gamma_2)^a=100$.

Decay Modes

Type	Energy MeV	Intensity %	
ce_{1K}		0.015 *1*	$I(\gamma_1)$ and ce_{1K}/γ_1
ce_{2K}		0.012 *1*	$I(\gamma_2)$ and ce_{2K}/γ_2
β_1^-	**0.31788** *10*		68Wo02
		99.88 *2*	β_2^-/β_1^- and $I(\beta_1^-+\beta_2^-)=100$
β_2^-	***1.4911** *1*		$Q^- - E(\gamma_2)$
	1.48		61Ca5
		0.12 *2*	β_2^-/β_1 and $I(\beta_1^-+\beta_2^-)=100$
γ_1	^{W}**1.17323** 2		65Mu03, 65Re17, 68Wh03
		*99.88 *2*	$I(\beta_1^-)^b$
		96 *5*	γ_1/γ_2 53D29
γ_2	^{W}**1.33251** 2		65Mu03, 65Re17, 65Sm06, 68Gu05, 68Wh03
		100	Decay scheme[a]

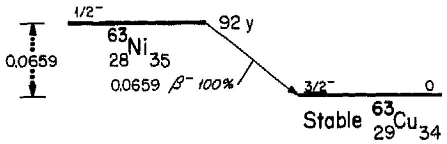
Auxiliary Data

$\beta_2^-/\beta_1^- = 0.0012$ *2*[c]	61Ca5
$ce_{1K}/\gamma_1 = 0.000150$ *6*	58K13
$ce_{2K}/\gamma_2 = 0.000116$ *6*	58K13
$\omega_K = 0.374$ $\omega_L = 0$ $n_{KL} = 1.45$	Appendix III

[a] $I(ce_2)$ is negligible here
[b] $I(ce_1)$ is negligible here
[c] Uncertainty adopted by compilers
[W] Weighted average
*Value adopted by compilers from possibilities shown

$^{63}_{28}Ni_{35}$

Decay Characteristics	Basic Data, Sources for Adopted Values



$T_{1/2}$ 92 y *3* Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β^-	**0.0659**$_{max}$ *2*				
	0.01715$_{av}$ *6*	100	0.0365	100	0.00193

Decay Scheme

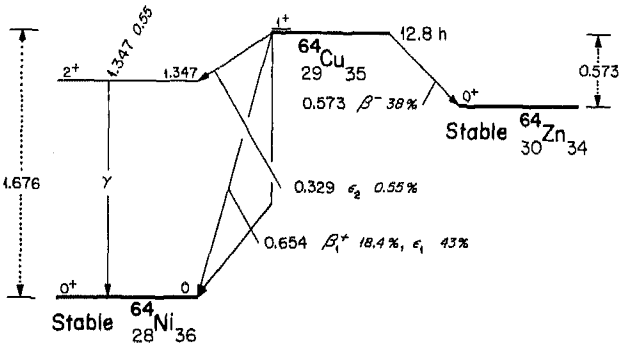
$Q^- = \mathbf{0.0659}$ *2* E(β^-)
No γ (<1%), 49W10, 51W14
$\therefore I(\beta^-) = 100$

Decay Modes

Type	Energy MeV	Intensity %	
β^-	**0.06587** *15*		66Hs01
		100	Decay scheme

$^{64}_{29}Cu_{35}$

Decay Characteristics



$T_{1/2}$	**12.8 h** *1*	Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00085**	59 *4*	0.0011	0.16	<0.0001
e_{AK}	**0.00654**	24 *2*	0.0033	0.48	<0.0001
β^-	**0.573**$_{max}$ *2* **0.1885**$_{av}$ *7*	38 *2*	0.153	22	0.078
β_1^+	**0.654**$_{max}$ *2* **0.2783**$_{av}$ *7*	18.4 *8*	0.109	15.8	0.101
All β's	**0.2178**$_{av}$ *9*	56 *2*	0.260	38	0.088
X_K	**0.00756**	14 *1*	0.0023	0.33	0.20
$\gamma^{\pm}$	**0.5110**	37 *2*	0.403	59	44
γ	**1.347** *1*	0.55 *8*	0.016	2.3	59

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^- =$ **0.573** *2* $\qquad E(\beta^-)$

$Q^+ =$ **1.676** *2* $\qquad E(\beta_1^+) + 2mc^2$

No ^{64}Ni levels, other than at 1.347, observed below 2.272 MeV [H. Verheul, Nuclear Data B2-3-73 (1967)] The first-excited ^{64}Zn level is at 0.9917 MeV [H. Verheul, Nuclear Data B2-3-78 (1967)].

Intensities per 100 ^{64}Cu decays are obtained from $(\gamma+\epsilon_1+\beta_1^+)/\beta^-$, β^-/β_1^+, γ/β_1^+, and the requirement that $I(\gamma+\epsilon_1+\beta_1^++\beta^-) = 100$.

Basic Data, Sources for Adopted Values cont

Decay Modes

Type	Energy MeV	Intensity %	
ϵ_2		0.55 *8*	$I(\gamma)$
ϵ_{1K}		38 *2*	$I(\epsilon_1)$, ϵ_L/ϵ_K, ϵ_{MN}/ϵ_L
ϵ_{1L}		4.2 *2*	
ϵ_{1MN}		0.63 *3*	
ϵ_1		43 *2*	See $I(\gamma)$
β^-	^{W}**0.573** *2*		39T01, 41T01, 48C02, 51H88
		38 *2*	See $I(\gamma)$
β_1^+	^{W}**0.654** *2*		39T01, 41T01, 48C02, 51H88
		18.4 *8*	See $I(\gamma)$
γ	**1.347**^{a} *1*		51H88
		0.55 *8*	$(\gamma+\epsilon_1+\beta_1^+)/\beta^-$, β^-/β_1^+, γ/β_1^+ and $I(\gamma+\epsilon_1+\beta_1^++\beta^-) = 100$

Auxiliary Data

$\beta^-/\beta_1^+ = {}^W2.07$ *3*	47P10, 51H88
$\gamma/\beta_1^+ = {}^U0.030$ *4*	47D07, 50K51, 52V03, 53D30, 59S27
$(\gamma+\epsilon_1+\beta_1^+)/\beta^- = 1.62$ *11*	50R51
$\epsilon_L/\epsilon_K = 0.109$ $\epsilon_{MN}/\epsilon_L = 0.152$	Theory
$\omega_K = 0.374$ $\omega_L = 0$ $n_{KL} = 1.45$ (Ni)	Appendix III

Comparison of Additional Experimental Results with Values Calculated from the Adopted Decay Scheme

$\epsilon_{1K}/\beta_1^+ = {}^W2.10$ *28*	49B16, 49H21, 51P17[b]
2.19 *3*[c]	Theory
2.07 *14*	From adopted values
$\epsilon_K/(\epsilon+\beta_1^++\beta^-) =$ 0.41 *4*	65He08
0.38 *2*	From adopted values

[a] Recalculated by compilers from authors' ce-energy by use of electron binding energy of 67BeBu

[b] If $\omega_K = 0.374$. Author used $\omega_K = 0.47$

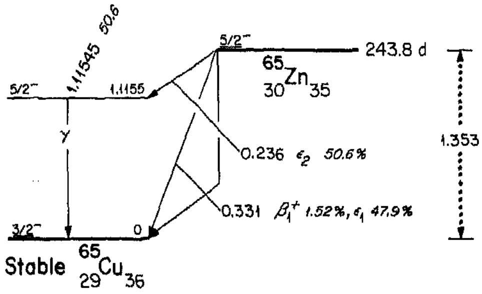
[c] Uncertainty is that due to uncertainty in Q^+

[U] Unweighted average

[W] Weighted average

$^{65}_{30}\mathrm{Zn}_{35}$

Decay Characteristics



$T_{1/2}$ **243.8 d** *7* Appendix I

Note

Two weak γ's of energy 0.344 and 0.771 (68St05) have not been included because of their low intensities (0.0030%). The 0.771γ de-excites a level at 0.771 MeV and the 0.344γ de-excites the 1.1155 level.

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00093**	134 *1*	0.0027	0.21	<0.0001
e_{AK}	**0.00703**	51.6 *4*	0.0077	0.61	≈0.0001
β_1^+	**0.331**$_{max}$ 2 **0.1433**$_{av}$ 5	1.41 2	0.0043	0.34	0.0367
X_K	**0.00813**	35.2 *3*	0.0061	0.49	0.25
$\gamma^\pm$	**0.5110**	2.82 *4*	0.0307	2.45	44
γ	**1.11545** 5	50.6 4	1.202	95.9	55

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^+ = 1.353^a\,2$ Nuclear Data B2-6-133 (1968)
No strong γ other than 1.11545γ. See "Note" above. Intensities per 100 ^{65}Zn decays are obtained from $I(\gamma)$, ϵ_1/β_1^+, and the requirement that $I(\gamma+\epsilon_1+\beta_1^+) = 100$.

[a] Q^+ is obtained from a weighted average of ^{65}Cu(p,n) Q-values of 63OkO1 and 64Jo11. The reason for the discrepancy between this Q^+-value and that obtained from the measured β^+-endpoint energy is not known

U, W Unweighted average, weighted average

*Value adopted by compilers from possibilities shown

Basic Data, Sources for Adopted Values

Decay Modes

Type	Energy MeV	Intensity %	
ϵ_{2K}		44.6 *4*	$I(\epsilon_2)$, $\epsilon_{2L}/\epsilon_{2K}$, and ϵ_{MN}/ϵ_L
ϵ_{2L}		5.17 *4*	
ϵ_{2MN}		0.82 *1*	
ϵ_2		50.6 *4*	$I(\gamma)$
ϵ_{1K}		42.2 *4*	$I(\epsilon_1)$, $\epsilon_{1L}/\epsilon_{1K}$, and ϵ_{MN}/ϵ_L
ϵ_{1L}		4.98 *4*	
ϵ_{1MN}		0.79 *1*	
ϵ_1		48.0 *4*	$I(\gamma)$, ϵ_1/β_1^+, and $I(\gamma+\epsilon_1+\beta_1^+) = 100$
β_1^{+a}	***0.331** *2*		$Q^+ - 2mc^2$
	^{W}**0.325** *1*		49M57, 53B82, 53P14, 53S26, 53Y04, 56A28
		^{U}1.58 *7*	58H109, 59G55, 63Ta04, 66St14
		*1.41 2	$I(\gamma)$, ϵ_1/β_1^+, and $I(\gamma+\epsilon_1+\beta_1^+) = 100$
γ	^{W}**1.11545** 5		67B103, 67Ra03, 68Le03
		^{U}50.6 *4*	63Ta04, 66Ra21, 66St14

Auxiliary Data

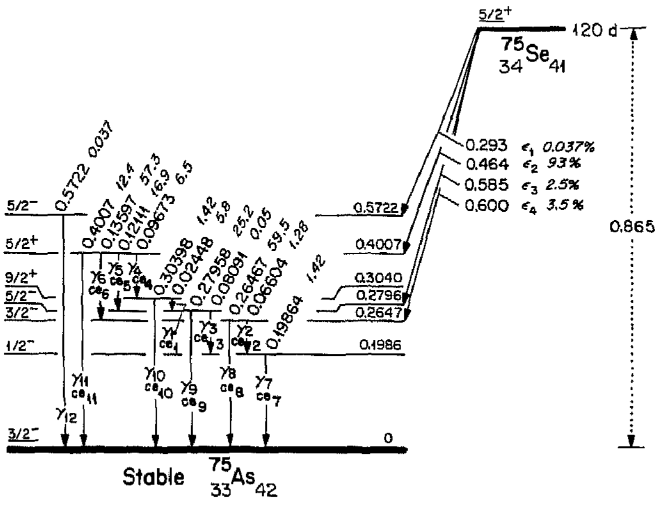
$\epsilon_{1K}/\beta_1^+ = $ *29.9	Theory		$\epsilon_{2L}/\epsilon_{2K} = $ *0.116	Theory
27.7 *15*	68Ha47		^{W}0.119 *3*	68Mc13, 69Hu04
$\epsilon_{1L}/\epsilon_{1K} = $ *0.110	Theory			
0.118 *3*	69Hu04			
$\epsilon_{MN}/\epsilon_L = $ *0.157	Theory		$\omega_K = 0.405$	Appendix III
0.153 *20*	69Hu04		$\omega_L = 0$	
$\therefore\ \epsilon_1/\beta_1^+ = $ 33.7 *1*			$n_{KL} = 1.42$	

Comparison of Additional Experimental Results with Values Calculated from the Adopted Decay Scheme

$\gamma/\beta_1^+ = 35.9$ *6*	From adopted values
^{U}33 *4*	54M19, 54S51, 56D59, 56J24, 60Ri6, 68Ha47
$\epsilon_{2K}/\gamma = 0.879$ *11*	From adopted values
0.875 *5*	62Kr2
$\epsilon_2/(\epsilon_1+\epsilon_2) = 0.514$ *5*	From adopted values
^{W}0.522 *11*	54S51, 59G55, 68Ha47
$(\epsilon_{1L}+\epsilon_{2L})/(\epsilon_{1K}+\epsilon_{2K}) = 0.118$ *1*	From adopted values
^{W}0.114 *5*	62Oc2, 67To04
$X_K/\text{dis} = 0.351$ *3*	From adopted values
0.348 *4*	65Le24
$X_{2K}/\gamma = 0.357$ *5*	From adopted values
0.38 *2*	67Mu15

$^{75}_{34}Se_{41}$ -1

Decay Characteristics



$T_{1/2}$	120 d *1*	Appendix I

Note
Seven weak γ's with energies in the range 0.42 to 0.62 MeV have not been included because of their low intensities (≤0.009%) (68Na10, 69Ra12).

Radiations

Type	Energy MeV	Intensity %	Δ (gm-rad / μCi-h)	Δ/ΣΔ %	R_{90} (cm) in Water
e_{AL}	0.00124	137 *2*	0.00362	0.42	<0.0001
e_{AK}	0.00911	44.8 *4*	0.00869	1.01	0.00016
ce_{1K}	0.01261 *6*	4.9 *6*	0.0013	0.15	0.00028
ce_{1L}	0.02295[a] *6*	0.96 *12*	0.00047	0.055	0.00081
ce_{1M}	0.02428[b] *6*	0.15 *2*	0.00008	0.009	0.00089
ce_{2K}	0.05417 *1*	0.28 *1*	0.00032	0.037	0.0037
ce_{2LM}	0.06451[a] *1*	0.044 *2*	0.00006	0.007	0.0050
ce_{3K}	0.06904 *2*	0.03 *2*	0.00004	0.005	0.0056
ce_{4K}	0.08486 *1*	3.0 *3*	0.0054	0.63	0.0081
ce_{4L}	0.09520[a] *1*	0.40 *3*	0.00081	0.094	0.0099
ce_{4M}	0.09653[b] *1*	0.06 *1*	0.00012	0.014	0.010

Decay Characteristics continued

Radiations continued

Type	Energy MeV	Intensity %	Δ (gm-rad / μCi-h)	Δ/ΣΔ %	R_{90} (cm) in Water
ce_{5K}	0.10924 *1*	0.68 *3*	0.0016	0.19	0.012
ce_{5LM}	0.11958[a] *1*	0.082 *4*	0.00021	0.024	0.014
ce_{6K}	0.12410 *3*	1.6 *1*	0.0042	0.49	0.015
ce_{6LM}	0.13444[a] *3*	0.19 *2*	0.00054	0.063	0.017
ce_{7K}	0.18677 *4*	0.030 *1*	0.00012	0.014	0.029
ce_{8K}	0.25280 *5*	0.39 *1*	0.0021	0.24	0.047
ce_{8LM}	0.26314[a] *5*	0.046 *2*	0.00026	0.030	0.050
ce_{9K}	0.26771 *6*	0.20 *1*	0.0011	0.13	0.051
ce_{9LM}	0.27805[a] *6*	0.025 *2*	0.00015	0.017	0.055
ce_{10K}	0.29211 *7*	0.063 *2*	0.00039	0.045	0.059
ce_{11K}	0.3888 *1*	0.014 *1*	0.00012	0.014	0.090
X_L	0.00128	≈1.4	≈0.00004	0.005	0.0011
X_K	0.01066	54.4 *5*	0.0124	1.44	0.58
γ_1	0.02448 *6*	0.026 *4*	0.00001	0.001	6.1
γ_2	0.06604 *1*	0.97 *2*	0.0014	0.16	25
γ_3	0.08091 *2*	0.02 *1*	0.00003	0.003	27
γ_4	0.09673 *1*	3.16 *6*	0.0065	0.76	30
γ_5	0.12111 *1*	16.2 *4*	0.042	4.9	32
γ_6	0.13597 *3*	55.6 *6*	0.161	18.8	33
γ_7	0.19864 *4*	1.38 *3*	0.0058	0.68	36
γ_8	0.26467 *5*	59.1 *2*	0.333	38.8	38
γ_9	0.27958 *6*	25.0 *3*	0.149	17.4	38
γ_{10}	0.30398 *7*	1.36 *2*	0.0088	1.0	39
γ_{11}	0.4007 *1*	12.4 *3*	0.106	12.3	41
γ_{12}	0.5722 *3*	0.037 *1*	0.00045	0.052	45

[a] Energy of L_1-line given
[b] Energy of M_1-line given

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^+ = 0.865$ *1* Nuclear Data B1-6-131 (1966)

The γ-placements are determined from the precise γ-energies and extensive (ce)(ce)-coincidence measurements (59Bl88, 60De6, and 66Ga13).

Intensities per 100 ^{75}Se decays are obtained from the relative γ-intensities, relative ce_K-intensities, ce_8/γ_8, and the requirement that $I(\gamma_7 + \cdots \gamma_{12} + ce^a_{7K} + \cdots ce^a_{11K}) = 100$.[b]

Decay Modes

Type	Energy MeV	Intensity %	
ϵ_K		88.0 *2*	$I(\epsilon)$, ϵ_L/ϵ_K, and ϵ_M/ϵ_L
ϵ_L		10.3 *2*	
ϵ_{MN}		1.80 *4*	
ϵ		*100	Decay scheme
		99 *2*	(γ + ce)-intensities

$ce_1 \cdots ce_{11}$ $I(ce_K)$ are unweighted averages of data of 60De6, 60Gr3, 61Ed2, 66Ga13, and 68Ja03. The relative values of each author are normalized as described under $I(\gamma)$ below. $I(ce_{L,M})$ are obtained from $I(ce_K)$, ce_K/ce_L, and ce_L/ce_M values.

$\gamma_1 \cdots \gamma_{12}$ $E(\gamma)$ are weighted averages of data of 60De6, 61Ed2, 67Pa14, 68Ja03, 69Pa05, and 69Ra12. $I(\gamma_3)$ is calculated from $I(ce_{3K})$ and ce_{3K}/γ_3. The other γ-intensities are weighted averages of data of 60Gr3, 61Ed2, 66Ra09, 66Vr01, 67Pa14, 68Na10, and 69Pa05. The relative values of each author are normalized so that when combined with the relative ce-intensities and ce_8/γ_8 value, the requirement $I(\gamma_7 + \cdots \gamma_{12} + ce^a_{7K} + \cdots ce^a_{11K}) = 100$ is satisfied.

[a] Conversion in higher shells is negligible here

[b] The compilers assume there is no capture branch feeding the ground state. This assumption is based on the fact that from X_K/γ_{11}, ω_K, ϵ_K/ϵ, ce_8/γ_8, $\Sigma ce_K/\gamma_{11}$, and the requirement that $I(\epsilon) = 100$, the intensity of γ_{11} is found to be 12.9% *3*. The intensity-normalization condition given above under "Decay Scheme" shows that if there is any ground-state ϵ-branch, $I(\gamma_{11})$ must be $<$12.4% *3*. $\therefore$ $I(\epsilon$ to g.s.$) < 0.1\%$

Basic Data, Sources for Adopted Values

Auxiliary Data

X_K/γ_{11}	= 4.22 *5*	66Ra09
ϵ_L/ϵ_K	= 0.117[c] 2[d]	Theory
ϵ_{MN}/ϵ_L	= 0.175 3[d]	Theory
$\therefore \epsilon_K/\epsilon$	= *0.880[c] *2*	Theory
	W0.840[e] *10*	66Ra09, 69Ra12
ω_K	= 0.548	Appendix III
ω_L	≈ 0.010	Appendix III
n_{KL}	= 1.27	Appendix III
ce_{1K}/ce_{1L}	= *5.08	M2 Theory
	U3.9 *8*	60Gr3, 61Ed2
ce_{1L}/ce_{1M}	= U4.6 *8*	60Gr3, 61Ed2
	*6.3	M2 Theory
ce_{2K}/ce_{2LM}	= U6.3 *3*	60Gr3, 61Ed2, 66Ga13
ce_{3K}/γ_3	= 1.50	E2 Theory
ce_{4K}/ce_{4L}	= U7.3 *3*	60Gr3, 68Ja03
	*7.48	E2 Theory
ce_{4L}/ce_{4M}	= *6.7	E2 Theory
	5.3 *8*	60Gr3
ce_{5K}/ce_{5LM}	= U8.8 *10*	60Gr3, 61Ed2, 66Ga13
	*8.25	E1 Theory
ce_{6K}/ce_{6LM}	= U8.4 *3*	60Gr3, 66Ga13
	*8.35	E1 Theory
ce_{8K}/γ_8	= U0.0063 *3*	59B30, 59M76, 60De6
	*0.0066	M1 Theory
ce_{8K}/ce_{8LM}	= *8.57	M1 Theory
	U9.0 *9*	60Gr3, 61Ed2, 66Ga13
$\therefore ce_8/\gamma_8$	= 9.52 *10*	
ce_{9K}/ce_{9LM}	= U8.1 *3*	60Gr3, 61Ed2, 66Ga13

[c] For ϵ_2-branch. The differences between this value and those for the other ϵ-branches can be neglected

[d] Uncertainty assigned by compilers

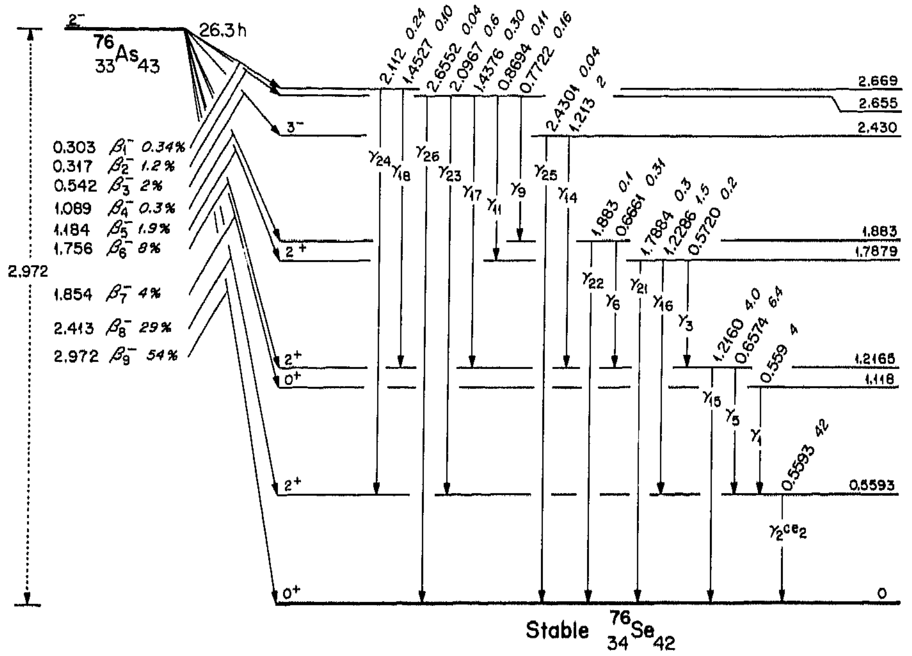
[e] Authors' values of 0.885 *18* (66Ra09) and 0.886 *26* (69Ra12), obtained using $\omega_K = 0.52$, recalculated by compilers using $\omega_K = 0.548$

U Unweighted average

*Value adopted by compilers from possibilities shown

$^{76}_{33}As_{43}$-1

Decay Characteristics



$T_{1/2}$ 26.3 h *3* Appendix I

Radiations

Type	Energy MeV	Intensity %	Δ (gm-rad/μCi-h)	Δ/ΣΔ %	R_{90} (cm) in Water
e_{AL}	**0.00132**	0.091 *5*	0.000003	≈0	<0.0001
e_{AK}	**0.00967**	0.031 *2*	0.000006	≈0	≈0.00018
ce_{2K}	**0.5466** *3*	0.074 *4*	0.00086	0.027	0.15
β_1^-	**0.303**$_{max}$ *10* **0.089**$_{av}$ *4*	0.34 *3*	0.00064	0.020	0.0280
β_2^-	**0.317**$_{max}$ *10* **0.094**$_{av}$ *4*	1.2 *2*	0.0024	0.074	0.0302
β_3^-	**0.542**$_{max}$ *10* **0.175**$_{av}$ *4*	2 *1*	0.007	0.22	0.071
β_4^-	**1.089**$_{max}$ *10* **0.398**$_{av}$ *4*	0.3 *2*	0.003	0.093	0.194
β_5^-	**1.184**$_{max}$ *10* **0.439**$_{av}$ *4*	1.9 *3*	0.018	0.56	0.217

Radiations continued

Type	Energy MeV	Intensity %	Δ (gm-rad/μCi-h)	Δ/ΣΔ %	R_{90} (cm) in Water
β_6^-	**1.756**$_{max}$ *10* **0.696**$_{av}$ *5*	8 *2*	0.12	3.7	0.361
β_7^-	**1.854**$_{max}$ *10* **0.755**$_{av}$ *5*	4 *1*	0.06	1.9	0.407
β_8^-	**2.413**$_{max}$ *10* **1.003**$_{av}$ *5*	29 *3*	0.62	19.2	0.53
β_9^-	**2.972**$_{max}$ *10* **1.274**$_{av}$ *5*	54 *2*	1.47	45.5	0.70
All β's	**1.071**$_{av}$ *5*	100	2.28	70.5	0.64
X_L	**0.00138**	≈0	≈0	≈0	–
X_K	**0.01137**	0.043 *2*	0.000010	≈0	0.70
γ_1	**0.559** *5*	4 *2*	0.56 (γ1+γ2)	17.3 (γ1+γ2)	45 (γ1+γ2)
γ_2	**0.5593** *1*	42 *2*			

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Decay Characteristics continued

Radiations continued

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
γ_3	**0.5720** *9*	0.2 *2*	0.002	0.062	45
$^x\gamma_4$	**0.624** *3*	0.4 *1*	0.005	0.15	46
γ_5	**0.6574** *1*	6.4 *3*	0.090	2.8	47
γ_6	**0.6661** *5*	0.31 *8*	0.0044	0.14	47
$^x\gamma_7$	**0.708** *3*	0.16 *5*	0.0024	0.074	48
$^x\gamma_8$	**0.7399** *5*	0.21 *4*	0.0033	0.10	48
γ_9	**0.7722** *10*	0.16 *5*	0.0026	0.080	49
$^x\gamma_{10}$	**0.858**	0.12 *3*	0.0022	0.068	51
γ_{11}	**0.8694** *9*	0.11 *3*	0.0020	0.062	51
$^x\gamma_{12}$	**0.972** *3*	0.06 *3*	0.0012	0.037	53
$^x\gamma_{13}$	**1.1300** *10*	0.14 *3*	0.0034	0.10	55
γ_{14}	**1.213** *1*	2 *1*	0.05	1.5	57
γ_{15}	**1.2160** *3*	4.0 *5*	0.10	3.1	57
γ_{16}	**1.2286** *3*	1.5 *2*	0.039	1.2	57
γ_{17}	**1.4376** *7*	0.30 *2*	0.0092	0.28	60
γ_{18}	**1.4527** *8*	0.10 *1*	0.0031	0.096	61
$^x\gamma_{19}$	**1.537** *3*	0.025 *6*	0.0008	0.025	62
$^x\gamma_{20}$	**1.610** *2*	≈0.01	≈0.0003	0.009	63
γ_{21}	**1.7884** *5*	0.3 *1*	0.011	0.34	65
γ_{22}	**1.883** *2*	0.1 *1*	0.004	0.12	66
γ_{23}	**2.0967** *7*	0.6 *1*	0.027	0.83	70
γ_{24}	**2.112** *1*	0.24 *3*	0.013	0.40	70
γ_{25}	**2.4301** *9*	0.04 *1*	0.002	0.062	73
γ_{26}	**2.6552** *4*	0.04 *1*	0.002	0.062	76

[a] I(ce_1, γ_{21}, γ_{22}, γ_{25}, γ_{26}) are negligible here
[b] Uncertainty assigned by compilers
[U] Unweighted average
[X] Not shown on decay scheme since placement not determined
* Value adopted by compilers from possibilities shown

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^- = 2.972$ *10*, $Q^+ = 0.924$ *12* — Nuclear Data B1-6-131 (1966)

^{76}Se levels are known from reaction studies [See H. Ikegami, et al., Nuclear Data B1-6-121 (1966)]. The ^{76}As γ's, on the basis of their energies, can be uniquely placed among these levels.

No ϵ ($\epsilon_K < 0.02\%$ 57S23), no β^+ ($< 2\times10^{-4}\%$ 63Ba30).

Intensities per 100 ^{76}As decays are obtained from the relative γ-intensities, I(β_9^-), and the requirement that I($\beta_9 + \gamma_2 + \gamma_{15}$) = 100[a].

Decay Modes

Type	Energy MeV	Intensity %	
ce_{2K}		0.074 *4*	I(γ_2) and ce_{2K}/γ_2
β_1^-	**0.303** *10*		Q^--E(2.669 level)
		0.34 *3*	γ-intensities
β_2^-	**0.317** *10*		Q^--E(2.655 level)
		1.2 *2*	γ-intensities
$\beta_1^-+\beta_2^-$	**0.33** *3*	1.8	63Sa25
β_3^-	***0.542** *10*		Q^--E(2.430 level)
	0.54 *3*	2	63Sa25
		*2 *1*	γ-intensities
β_4^-	**1.089** *10*		Q^--E(1.883 level)
		0.3 *2*	γ-intensities
β_5^-	***1.184** *10*		Q^--E(1.7879 level)
	1.19 *2*	2	63Sa25
		*1.9 *3*	γ-intensities
β_6^-	***1.756** *10*		Q^--E(1.2165 level)
	^{U}1.76 *1*		56P07, 57G76, 63Sa25
		*8 *2*	γ-intensities
		^{U}7	53H47, 57G76, 63Sa25
β_7^-	**1.854** *10*		Q^--E(1.118 level)
		4 *1*	γ-intensities
β_8^-	***2.413** *10*		Q^--E(0.5593 level)
	^{U}2.41 *1*		52T18, 56P07, 57G76, 63Sa25
		*29 *3*	γ-intensities
		^{U}30	52T18, 53H47, 55K10, 57G76, 63Sa25
β_9^-	***2.972** *10*		Q^-
	^{U}2.97 *1*[b]		52T18, 53H47, 55K10, 56P07, 57G76, 63Sa25
		^{U}54 *2*	52T18, 53H47, 55K10, 57G76, 63Sa25

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$^{76}_{33}As_{43}$ -3

Basic Data, Sources for Adopted Values cont.

Decay Modes continued

Type	Energy MeV	Intensity %
$\gamma_1 \cdots \gamma_{26}$	E(γ) are weighted averages of data of 60Ba13, 65Wh01, and 67Mu10, except γ_1 which is a weighted average of data of 59G45, 63Sa25, and 64By02. I(γ) are weighted averages of data of 59G45, 64Vi03, and 67Mu10 with each author's data normalized so that $I(\gamma_2+\gamma_{15}) = 46\%$ [from $I(\beta_9)$ and $I(\beta_9+\gamma_2+\gamma_{15}) = 100.$]	

Basic Data, Sources for Adopted Values cont.

Auxiliary Data

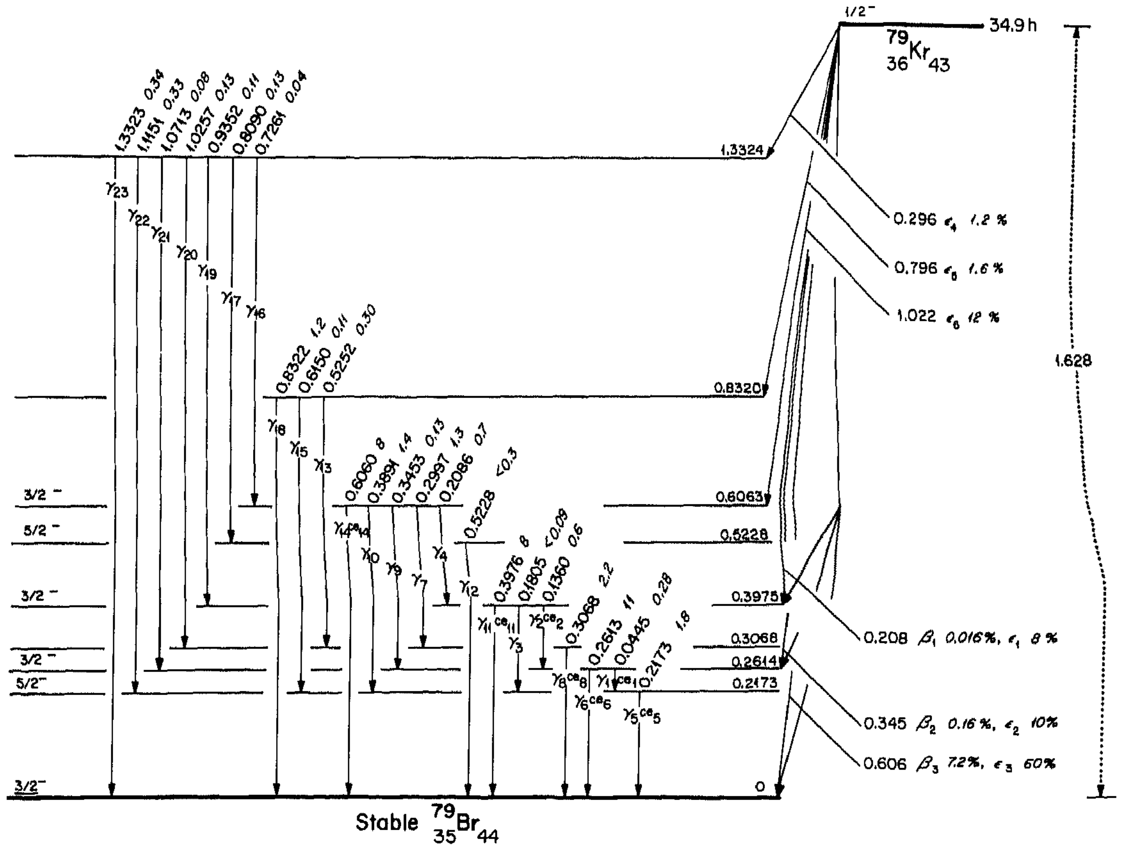
$ce_{1K+2K}/\gamma_{1+2} = {}^{W}0.0019\ 2$	52T18, 57G76
$ce_{2K}/\gamma_2 = {}^{*}0.00175$	E2 Theory
$\omega_K = 0.589$	Appendix III
$\omega_L \approx 0.018$	Appendix III
$n_{KL} = 1.231$	Appendix III

W Weighted average

*Value adopted by compilers from possibilities shown

$^{79}_{36}Kr_{43}$-1

Decay Characteristics



$T_{1/2}$ 34.9 h 2 Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00141**	104 2	0.00312	0.56	<0.0001
e_{AK}	**0.01024**	30.7 4	0.00670	1.20	0.00020
ce_{1K}	**0.0131** 4	0.14 4	0.00004	0.007	0.00030
ce_{1LM}	**0.0427** 4	0.022 7	0.00002	0.004	0.0024
ce_{2K}	**0.1225** 2	0.021 6	0.00005	0.009	0.015
ce_{5K}	**0.2038** 2	0.024 7	0.00010	0.018	0.034
ce_{6K}	**0.2478** 2	0.08 2	0.00042	0.075	0.046
ce_{6LM}	**0.2595** 2	0.012 4	0.00007	0.013	0.049
ce_{8K}	**0.2933** 2	0.013 4	0.00008	0.014	0.059
ce_{11K}	**0.3841** 3	0.021 6	0.00017	0.030	0.089
ce_{14K}	**0.5925** 3	0.011 3	0.00014	0.025	0.17
β_1^+	**0.208**$_{max}$ 6 **0.094**$_{av}$ 3	0.016 6	0.00003	0.005	0.0176
β_2^+	**0.345**$_{max}$ 6 **0.152**$_{av}$ 3	0.16 5	0.00052	0.09	0.0392

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$^{79}_{36}Kr_{43}$-2

Decay Characteristics continued

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β_3^+	**0.606**$_{max}$ *6*				
	0.263$_{av}$ *3*	7.2 *12*	0.040	7.2	0.090
All β's	0.260$_{av}$ *3*	7.4 *11*	0.041	7.3	0.090
X_L	**0.00148**	≈ 3	0.00009	0.016	0.0017
X_K	**0.01208**	51.1 *7*	0.0131	2.3	0.86
γ_1	**0.0445** *4*	0.12 *4*	0.00011	0.020	17
γ_2	**0.1360** *2*	0.6 *2*	0.0017	0.30	33
γ_3	**0.1805** *4*	<0.09	<0.0004	<0.07	35
γ_4	**0.2086** *3*	0.7 *2*	0.0031	0.56	36
γ_5	**0.2173** *2*	1.8 *5*	0.0083	1.5	37
γ_6	**0.2613** *2*	11 *3*	0.061	10.9	38
γ_7	**0.2997** *2*	1.3 *4*	0.008	1.4	39
γ_8	**0.3068** *2*	2.2 *6*	0.014	2.5	39
γ_9	**0.3453** *7*	0.13 *5*	0.0010	0.18	40
γ_{10}	**0.3891** *3*	1.4 *4*	0.012	2.1	41
γ_{11}	**0.3976** *3*	8 *3*	0.07	13	41
$\gamma^{\pm}$	**0.5110**	15 *3*	0.16	29	44
γ_{12}	**0.5228** *3*	<0.3	<0.003	<0.5	44
γ_{13}	**0.5252** *5*	0.30 *9*	0.0034	0.61	44
γ_{14}	**0.6060** *3*	8 *3*	0.10	18	46
γ_{15}	**0.6150** *8*	0.11 *5*	0.0014	0.25	46
γ_{16}	**0.7261** *4*	0.04 *2*	0.0006	0.11	48
γ_{17}	**0.8090** *4*	0.13 *4*	0.0022	0.39	50
γ_{18}	**0.8322** *7*	1.2 *4*	0.021	3.8	50
γ_{19}	**0.9352** *5*	0.11 *3*	0.0022	0.39	52
γ_{20}	**1.0257** *4*	0.13 *4*	0.0028	0.50	54
γ_{21}	**1.0713** *5*	0.08 *2*	0.0018	0.32	55
γ_{22}	**1.1151** *4*	0.33 *9*	0.008	1.4	55
γ_{23}	**1.3323** *5*	0.34 *11*	0.010	1.8	59

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^+ = 1.628$ *6* Nuclear Data B1-4-144 (1966)

The γ-placements are determined from the γ-energies, extensive $\gamma\gamma$-coincidence measurements (64Bo25, 66La06), and Coulomb excitation results (67Ro03). Intensities per 100 ^{79}Kr decays are obtained from the relative γ-intensities, $\Sigma\epsilon/\Sigma\beta^+$, $\beta_3^+/\Sigma\beta^+$, and the requirements that $I(\Sigma\epsilon+\Sigma\beta^+) = 100$ and that the intensity sum for all transitions[a] to the ground state equal 100%.

Decay Modes

Type	Energy MeV	Intensity %	
ϵ_K		81.6 *11*	$I(\epsilon)$, ϵ_L/ϵ_K, and ϵ_{MN}/ϵ_L
ϵ_L		9.47 *12*	
ϵ_{MN}		1.75 *2*	
ϵ		92.8 *12*	See $I(\beta_3^+)$

$ce_1 \ldots ce_{14}$ $I(ce_K)$ are unweighted averages[b] of data of 54T39 and 64Bo25 with the relative values of each author normalized to 0.024% for ce_{5K} so that $ce_{5K}/\gamma_5 = 0.0132$, the adopted K-shell internal-conversion coefficient for this transition. $I(ce_{LM})$ are calculated from $I(ce_K)$ and ce_K/ce_{LM} for each transition.

β_1^+	0.208 *6*		Q^+-2mc^2-E(0.3975 level)
		0.016 *6*	γ-intensities[a] and ϵ_1/β_1^+
β_2^+	*0.345 *6*		Q^+-2mc^2-E(0.2614 level)
	0.325 *20*		54T39
		0.16 *5*	γ-intensities[a] and ϵ_2/β_2^+
β_3^+	*0.606 *6*		Q^+-2mc^2
	[w]0.604 *6*		52B55, 54T39, 64Bo25
		7.2 *12*	$\Sigma\epsilon/\Sigma\beta^+$, $\beta_3^+/\Sigma\beta^+$, and $I(\Sigma\epsilon+\Sigma\beta^+) = 100$

$\gamma_1 \ldots \gamma_{23}$ $E(\gamma_1 \ldots \gamma_{18})$ are weighted averages of data of 54T39 and 67Ro03 except for γ_3, which was not seen by 67Ro03, and $\gamma_{12}, \gamma_{15} \cdots \gamma_{17}$, which were not seen by 54T39.
$E(\gamma_{19} \ldots \gamma_{23})$ are data of 67Ro03.
$I(\gamma)$[c] are unweighted averages of data of 66La06 and 67Ro03. The relative values of each author are normalized so that the sum for all transitions to the ground state equals 100 - $I(\epsilon_3+\beta_3^+) = 33\%$ *9*.

[a] Internal conversion is negligible here
[b] No uncertainties are given. The compilers have assigned uncertainties of 10% to the adopted intensities
[c] No uncertainty is given by 66La06. The adopted uncertainty, in each case, is the larger of that given by 67Ro03 and that given by the unweighted average
[w] Weighted average
* Value adopted by compilers from possibilities shown

$^{79}_{36}Kr_{43}$-3

Basic Data, Sources for Adopted Values cont.

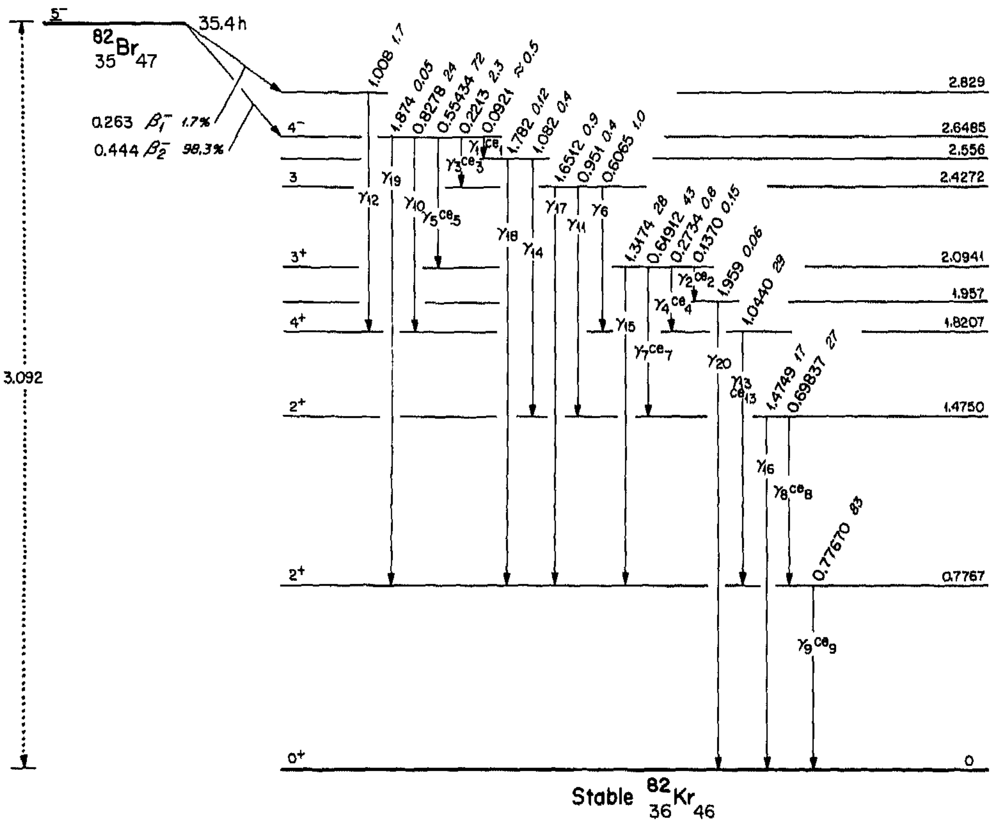
Auxiliary Data

ϵ_L/ϵ_K = *0.116 ($\epsilon_1,\epsilon_2,\epsilon_3,\epsilon_6$)		Theory
*0.123 (ϵ_4)		Theory
*0.117 (ϵ_5)		Theory
^{W}0.110 5		63Dr04, 65Wi13
ϵ_{MN}/ϵ_L = 0.185		Theory
ω_K = 0.625		Appendix III
$\omega_L \approx$ 0.024		Appendix III
n_{KL} = 1.19		Appendix III
$\Sigma\epsilon/\Sigma\beta^+$ = 12 *2*	From $\Sigma\epsilon_K/\Sigma\beta^+$ [a]=^{W}11 *2* and adopted ϵ_L/ϵ_K, ϵ_{MN}/ϵ_L	52B55, 54T39, 55R64
ϵ_1/β_1^+ = *498 *60*[b]		Theory
488 *114*	From ϵ_{1K}/β_1^+ = 430 *100* and adopted ϵ_L/ϵ_K, ϵ_{MN}/ϵ_L	66La06
ϵ_2/β_2^+ = *66 *5*[b]		Theory
65 *11*	From ϵ_{2K}/β_2^+ = 57 *10* and adopted ϵ_L/ϵ_K, ϵ_{MN}/ϵ_L	66La06
ϵ_3/β_3^+ = 8.3 *3*[b]		Theory
$\beta_3^+/\Sigma\beta^+$ = ^{U}0.93 *1*[c]		54T39, 55T01
ce_{5K}/γ_5 = 0.0132	From ce_{5K}/γ_5 = 0.0129 (M1 Theory), 0.0442 (E2 Theory), and E2/M1 = 0.0077 (67Ro03)	
ce_{1K}/ce_{1LM} = *6.4		M1 Theory
7.2		54T39
ce_{6K}/ce_{6LM} = *6.5		M1 Theory
8.0		54T39

[a] Authors values recalculated by compilers to correct for adopted ω_K (0.625)
[b] Uncertainty is that due to uncertainty in Q^+
[c] Uncertainty assigned by compilers
[U] Unweighted average
[W] Weighted average
*Value adopted by compilers from possibilities shown

$^{82}_{35}Br_{47}$-1

Decay Characteristics



$T_{½}$	35.4 h *1*	Appendix I

Radiations

Type	Energy MeV	Intensity %	Δ (gm-rad / μCi-h)	Δ/ΣΔ %	R_{90} (cm) in Water
e_{AL}	**0.00150**	0.7 *4*[a]	0.00002	≈0	<0.0001
e_{AK}	**0.01084**	0.2 *1*[a]	0.00005	≈0	0.00022
ce_1	**0.0778**[b] *2*	≤0.50	<0.0009	<0.015	0.0069
ce_2	**0.1227**[b] *2*	≤0.044	<0.00011	0.002	0.015
ce_3	**0.2070**[b] *1*	≤0.12	<0.0006	<0.01	0.034
ce_4	**0.2591**[b] *1*	≤0.019	<0.00011	≈0	0.049

Radiations continued

Type	Energy MeV	Intensity %	Δ (gm-rad / μCi-h)	Δ/ΣΔ %	R_{90} (cm) in Water
ce_5	**0.54001**[b] *4*	0.057 *5*	0.00066	0.011	0.16
ce_7	**0.60479**[b] *8*	0.066 *5*	0.00085	0.014	0.17
ce_8	**0.68404**[b] *7*	0.034 *5*	0.00050	0.008	0.20
ce_9	**0.76237**[b] *7*	0.076 *1*	0.00123	0.020	0.23
ce_{13}	**1.0297**[b] *1*	0.013 *1*	0.00029	0.005	0.34

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[a] The large uncertainty takes into account the fact that, for several ce-transitions, only upper limits on the intensity are available

[b] Energy of K-line given

$^{82}_{35}Br_{47}$-2

Decay Characteristics continued

Radiations continued

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β_1^-	0.263_{max} 2 0.0758_{av} 4	1.7 3	0.0027	0.045	0.0220
β_2^-	0.444_{max} 1 0.13790_{av} 4	98.3 3	0.289	4.8	0.052
All β's	0.13685_{av} 4	100	0.291	4.8	0.052
X_L	0.00159	≈0.02	≈0	≈0	0.0021
X_K	0.01282	0.4 2[a]	0.00011	0.002	1.1
γ_1	0.0921 2	0.39 7	0.00077	0.013	29
γ_2	0.1370 2	0.15 5	0.00044	0.007	33
γ_3	0.2213 1	2.3 3	0.011	0.18	37
γ_4	0.2734 1	0.8 2	0.005	0.083	38
γ_5	0.55434 4	72 3	0.85	14.2	45
γ_6	0.6065 2	1.0 4	0.013	0.22	46
γ_7	0.61912 8	43 2	0.57	9.5	46
γ_8	0.69837 7	27 1	0.40	6.7	48
γ_9	0.77670 7	83 1	1.37	22.8	49
γ_{10}	0.8278 1	24 1	0.42	7.0	50
γ_{11}	0.951 2	0.4 1	0.0081	0.13	52
γ_{12}	1.008 1	1.7 3	0.036	0.60	54
γ_{13}	1.0440 1	29 1	0.64	10.7	54
γ_{14}	1.082 2	0.4 1	0.0092	0.15	55
γ_{15}	1.3174 1	28 2	0.79	13.2	58
γ_{16}	1.4749 2	17 2	0.53	8.8	61
γ_{17}	1.6512 9	0.9 2	0.032	0.53	63
γ_{18}	1.782 2	0.12 2	0.0046	0.077	65
γ_{19}	1.874 1	0.05 1	0.002	0.033	66
γ_{20}	1.959 3	0.06 2	0.003	0.050	68

[a]See footnote a on preceding page

[b]$I(\gamma_6)$ not measured. Compilers have adopted the value required to give an intensity balance at the 2.4272 level

Basic Data, Sources for Adopted Values

Decay Scheme

Q^- = 3.092 2 $E(\beta_2^-)$+E(2.6485 level)

The γ-placements are determined by the precise γ-energies and extensive γγ-coincidence measurements (64Ke10, 64Ke11, 65Mo03, and 66Et01).

No ε- or β^+-branch, $(\epsilon+\beta^+)/\beta^- < 3\times10^{-4}$ 50R51

No β with $E_\beta > 0.45$ has been observed (<0.6%). 58B81

Intensities per 100 ^{82}Br decays are obtained from the relative γ-intensities and the requirement that $I(\gamma_9+\gamma_{16}) = 100$.[c]

Decay Modes

Type	Energy MeV	Intensity %	
$ce_1 \ldots ce_{13}$			$I(ce_1 \ldots ce_4)$ are obtained from $I(\gamma)$ and the adopted ce/γ for each transition. $I(ce_5 \ldots ce_{13})$ are weighted averages of data of 49S30, 56W24, and 58B81 with the relative values of each author normalized to 0.097% for ce_9 so that ce_9/γ_9 = 0.00092, the adopted internal-conversion coefficient for this transition.
β_1^-	0.263 2		Q^--E(2.829 level)
		1.7 3	$I(\gamma_{12})$
β_2^-	0.444 1		56W24
		99 3	γ-intensities
		*98.3 3	$I(\beta_1^-)$ and $I(\beta_1^-+\beta_2^-=100$
$\gamma_1 \ldots \gamma_{20}$			E(γ) are weighted averages of data of 57H83, 64Re09, 65Re16, 65Gf02, 66Et01, 67Ra01, and 68He21. $I(\gamma)$[b] are unweighted averages of data of 56W24, 57H83, 58B81, 59D103, 64Si13, 65Gf02, 65Ni01, 66Et01, and 67Ra01 with the relative values of each author normalized so that $I(\gamma_9+\gamma_{16}) = 100$.[c]

Auxiliary Data

$\omega_K = 0.655$, $\omega_L = 0.029$, $n_{KL} = 1.16$ — Appendix III

$ce_1/\gamma_1 \leq 1.28$, $ce_2/\gamma_2 \leq 0.295$, $ce_3/\gamma_3 \leq 0.0511$, $ce_4/\gamma_4 \leq 0.0240$ — Multipolarity of these γ's is not known. Compilers assume only E1, M1, or E2 multipolarities are likely. The largest values of ce/γ occur for E2 multipolarity and these values are given here as upper limits.

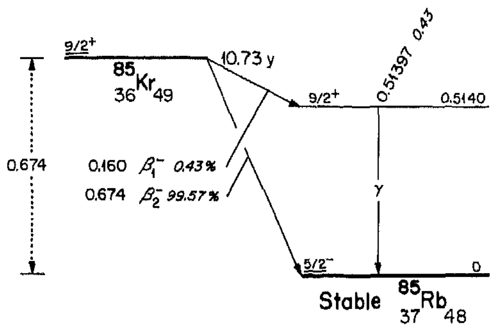
$ce_9/\gamma_9 = 0.00092$ Theory for E2 multipolarity

[c]$I(\gamma_{20})$ and conversion intensities are negligible here

*Value adopted by compilers from possibilies shown

$^{85}_{36}Kr_{49}$

Decay Characteristics



$T_{1/2}$ **10.73 y** *6* Appendix I

Radiations

Type	Energy MeV	Intensity %	Δ (gm-rad / μCi-h)	Δ/ΣΔ %	R_{90} (cm) in Water
β_1^-	**0.160**$_{max}$ *6*				
	0.044$_{av}$ 2	0.43 *1*	0.00040	0.076	0.0094
β_2^-	**0.674**$_{max}$ *6*				
	0.247$_{av}$ 2	99.57 *1*	0.524	99.0	0.107
All β's	**0.246**$_{av}$ 2	100	0.524	99.0	0.107
γ	**0.51397** *3*	0.43 *1*	0.0047	0.89	44

Basic Data, Sources for Adopted Values

Decay Scheme

Q^- = **0.674** *6*	65MTW1
No γ other than 0.51397γ observed	50Z51
Intensities per 100 ^{85}Kr decays are obtained from the measured ratio $\gamma/(\beta_1^-+\beta_2^-)$ and the requirement that $I(\beta_1^-+\beta_2^-) = 100$.	

Basic Data, Sources for Adopted Values

Decay Modes

Type	Energy MeV	Intensity %	
β_1^-	***0.160** *6*		Q^--E(0.5140 level)
	0.15 *2*		50Z51
		0.43 *1*	I(γ)
β_2^-	***0.674** *6*		Q^-
	0.672 *7*		55T01
		99.57 *1*	$I(\beta_1^-)$ and $I(\beta_1^-+\beta_2^-) = 100$
γ	[W]**0.51397** *3*		67Bl03[a], 68Le03[a]
		[W]0.43 *1*	$\gamma/(\beta_1^-+\beta_2^-)$ and $I(\beta_1^-+\beta_2^-) = 100$

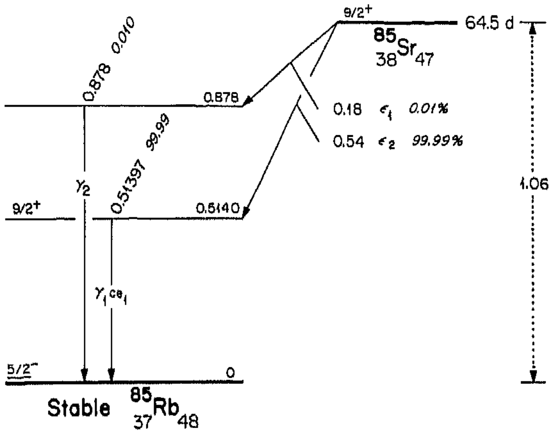
Auxiliary Data

$\gamma/(\beta_1^-+\beta_2^-)$ = [W]0.0043 *1* 64Ea01, 67De05

[a]Measured in the decay of ^{85}Sr
[W]Weighted average
*Value adopted by compilers from possibilities shown

$^{85}_{38}Sr_{47}$

Decay Characteristics



$T_{½}$	**64.5 d** *5*	Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00168**	106 *1*	0.00379	0.34	<0.0001
e_{AK}	**0.01144**	28.1 *1*	0.00685	0.61	0.00023
ce_{1K}	**0.49877**	0.64 *1*	0.0068	0.61	0.13
ce_{1LM}	**0.51191**[a]	0.071 *3*	0.00077	0.068	0.14
X_L	**0.00169**	≈3.8	0.00014	0.012	0.0025
X_K	**0.01361**	59.8 *1*	0.0173	1.54	1.3
γ_1	**0.51397** *3*	99.28 *1*	1.087	96.8	44
γ_2	**0.878** *5*	0.010 2	0.00019	0.017	51

[a]Energy of L_1-line given

[b]The compilers assume that there is no capture branch feeding the ground state. This assumption is based on the fact that for a first-forbidden unique transition, log f_1t is expected to be >7.6. For Q^+ = 1.06 and $T_{½}$ (^{85}Sr) = 64.5 d, this log f_1t value leads to an intensity of <5%

Basic Data, Sources for Adopted Values

Decay Scheme

Q^+ = [W]**1.057** *21*	58E44, 69Mc05
No $\gamma_1\gamma_2$-coincidence	62Ra3
No β^+ (<5×10^{-4}%)	62Ra3

Intensities per 100 decays are obtained from γ_2/γ_1, ce_1/γ_1, and the requirement that $I(\gamma_1 + \gamma_2 + ce_1) = 100$.[b]

Decay Modes

Type	Energy MeV	Intensity %	
ϵ_1		0.010 2	$I(\gamma_2)$
ϵ_{2K}		87.3 *1*	$I(\epsilon_2)$, $\epsilon_{2L}/\epsilon_{2K}$, and ϵ_M/ϵ_L
ϵ_{2L}		10.6 *1*	
ϵ_{2MNO}		2.08 2	
ϵ_2		99.99	$I(\epsilon_1)$ and $I(\epsilon_1 + \epsilon_2) = 100$
ce_{1K}		0.64 2	$I(ce_1)$ and ce_{1K}/ce_{1LM}
ce_{1LM}		0.071 *3*	
ce_1		0.71 2	See $I(\gamma_1)$
γ_1	[W]0.51397 *3*		67Bl03, 68Le03
		99.28 *1*	γ_2/γ_1, ce_1/γ_1, and $I(\gamma_1+\gamma_2+ce_1) = 100$
γ_2	[W]0.878 *5*		62Sa12, 66Va16
		0.010 2	See $I(\gamma_1)$

Auxiliary Data

$\epsilon_{2L}/\epsilon_{2K}$ = 0.121 *1*[c]	Theory
$\epsilon_{MNO}/\epsilon_L$ = 0.197	Theory
ω_K = 0.680	Appendix III
ω_L ≈ 0.035	
n_{KL} = 1.13	
ce_{1K}/γ_1 = *0.0064 *1*[d]	M2 Theory
[U]0.007	52E02, 52S29
ce_{1K}/ce_{1LM} = *9.0	M2 Theory
12 *3*	52E02
∴ ce_1/γ_1 = 0.0071 *1*	
γ_2/γ_1 = 0.00010 2	66Va16

[c]Uncertainty is that due to uncertainty in Q^+

[d]Uncertainty assigned by compilers

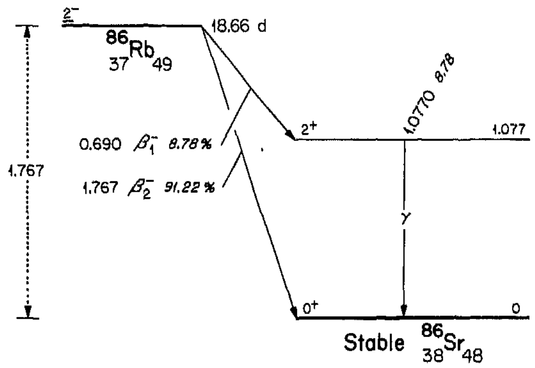
[U]Unweighted average

[W]Weighted average

*Value adopted by compilers from possibilities shown

$^{86}_{37}Rb_{49}$

Decay Characteristics



$T_{1/2}$ 18.66 d 2 Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β_1^-	0.690_{max} 5				
	0.230_{av} 2	8.78 8	0.0430	2.7	0.102
β_2^-	1.767_{max} 5				
	0.709_{av} 2	91.22 8	1.378	85.0	0.383
All β's	0.667_{av} 2	100	1.421	87.6	0.380
γ	1.0770 4	8.78 8	0.201	12.4	55

Basic Data, Sources for Adopted Values

Decay Scheme

Q^- = 1.767 5 — $E(\beta_2^-)$

No γ other than 1.0770γ observed — 48Z02

Intensities per 100 ^{86}Rb decays are obtained from the measured ratio $\gamma/(\beta_1^-+\beta_2^-)$ and the requirement that $I(\beta_1^-+\beta_2^-)$ = 100.

Basic Data, Sources for Adopted Values cont.

Decay Modes

Type	Energy MeV	Intensity %	
β_1^-	^{W}0.704 10		61De26, 66An10, 68Da12
	*0.690 5		Q^--E(1.077 level)
		8.78 8	I(γ)
β_2^-	^{W}1.767 5		64Da16, 65Th07, 66An10
		91.22 8	$I(\beta_1^-)$ and $I(\beta_1^-+\beta_2^-)$ = 100
γ	^{W}1.0770 4		63Ha41, 65Ma09, 67Pi03
		8.78 8	$\gamma/(\beta_1^-+\beta_2^-)$ and $I(\beta_1^-+\beta_2^-)$ = 100

Auxiliary Data

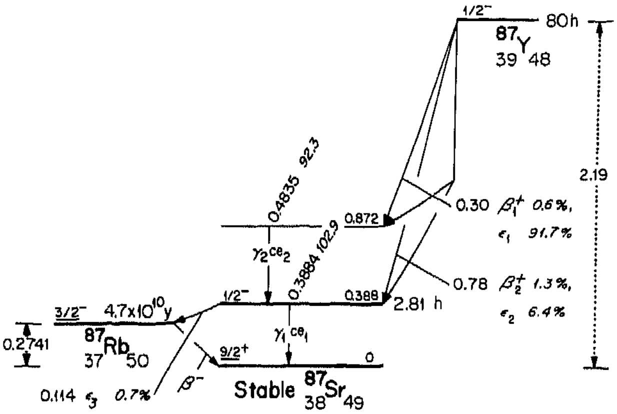
$\gamma/(\beta_1^-+\beta_2^-)$ = ^{W}0.0878 8 — 60Ca18, 62Br15, 65Gu06

^{W}Weighted average

*Value adopted by compilers from possibilities shown

$\left({}^{87}_{39}Y_{48} - {}^{87m}_{38}Sr_{49}\right)$-1

Decay Characteristics



$T_{1/2}$	80 h *1*	(^{87}Y)	Appendix I
	2.81 h *1*	(^{87m}Sr)	
	4.7×10^{10}y *1*	(^{87}Rb)	

Note

Since the half-life of ^{87}Rb is so long, the activity of ^{87}Rb in an ^{87}Y source is negligible. We can thus treat ^{87}Rb as a stable nucleus and ignore its β^- decay to ^{87}Sr.

Since the half-life of ^{87m}Sr is much shorter than that of its parent, ^{87}Y, the ratio of ^{87m}Sr activity to that of ^{87}Y in an initially pure ^{87}Y source will increase at first and then approach the constant value $T_A/(T_A-T_B)^a$=1.036 *1* after $\approx 10T_B$ ($\approx$ 28 h). When the ratio of activities has reached this constant value, the parent and daughter are in equilibrium and the total activity is equal to 1.036 *1* times the ^{87}Y activity.

[a] $T_A = T_{1/2}$ (^{87}Y), $T_B = T_{1/2}$ (^{87m}Sr)
[b] Transition in Rb
[c] Transition in Sr
[d] Energy of L_1-line given
[e] Energy of M_1-line given
[f] 67Mi13 observed a 0.78-MeV *5* β^+-group from the ^{87}Y ground state and a 1.54-MeV β^+-group from the 14-h ^{87}Y isomer at 0.381 MeV. An $\approx$ 0.7-MeV β^+-group from ^{87}Y has also been reported by 50RO3 and 51M46. The two measured β^+-groups of 67Mi13 give $Q^+(^{87}Y)$ = 2.19 *5* and 2.18 MeV, respectively. The compilers adopt the value 2.19 MeV *5*. This Q-value differs considerably from that of 65MTW1 (1.7 2) based on an ^{87}Sr(p,n) Q-value of −2.5 2 (51B57)
[g] In an ^{87}Y-^{87m}Sr equilibrium mixture, the ratio of total activity to that of ^{87}Y is 1.036 *1*. See "Note" above

Decay Characteristics continued

Radiations

Type	Energy MeV	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	0.00168[b] 0.00179[c]	0.7 *2* 120 1	0.00458	0.24	<0.0001
e_{AK}	0.01144[b] 0.01207[c]	0.2 *1* 30.3 *3*	0.00779	0.41	0.00026
ce_{1K}	0.3723 *2*	15.5 *1*	0.123	6.5	0.085
ce_{1L}	0.3862[d] *2*	2.28 *1*	0.0188	1.0	0.090
ce_{1M}	0.3880[e] *2*	0.36 *1*	0.0030	0.16	0.090
ce_{2K}	0.4674 *2*	0.233 2	0.00231	0.12	0.12
ce_{2LM}	0.4813[d] *2*	0.0253 2	0.00026	0.014	0.12
β_1^+	0.30_{max} *5* 0.14_{av} *2*	0.6 *3*	0.0018	0.096	0.0321
β_2^+	0.78_{max} *5* 0.34_{av} *2*	1.3 *3*	0.0094	0.50	0.130
All β's	0.28_{av} *2*	1.9 *3*	0.011	0.58	0.124
X_L	0.00169[b] 0.00181[c]	$\approx$ 0.03 $\approx$ 5.1	$\approx$ 0.00020	$\approx$ 0.01	0.0030
X_K	0.01361[c] 0.01439[c]	0.4 2 71.4 *3*	0.0220	1.2	1.4
γ_1	0.3884 *2*	84.8 *3*	0.702	37.3	41
γ_2	0.4835 *2*	92.0 *9*	0.947	50.3	43
$\gamma^\pm$	0.5110	3.8 *6*	0.041	2.2	44

Basic Data, Sources for Adopted Values

Decay Scheme

Q^+ = 2.19 *5* 67Mi13[f]
Q^- = 0.2741 *27* 65MTW1

Levels in ^{87}Sr at 0.388 and 0.872 MeV are known from ^{87}Rb(p,n) (58E44). The two ^{87}Y γ's can be placed between these known levels and the ground state.

Intensities per 100 ^{87}Y decays are obtained from γ_2/γ_1 measured in an equilibrium ^{87}Y-^{87m}Sr mixture (64Na07), ce_1/γ_1, $\epsilon_3/(\gamma_1+ce_1)$, and the requirement that $I(\gamma_1+ce_1+\epsilon_3)$ = 103.6[g] *1*.

continued on next page

Basic Data, Sources for Adopted Values cont.

Decay Modes

Type	Energy MeV	Intensity	
ϵ_{1K}		80.3 *9*	$I(\epsilon_1)$, ϵ_L/ϵ_K, and $\epsilon_{MNO}/\epsilon_L$
ϵ_{1L}		9.5 *1*	
ϵ_{1MNO}		1.92 *1*	
ϵ_1		91.7 *10*	$(\gamma$+ce)-intensities and ϵ_1/β_1^+
ϵ_{2K}		5.6 *9*	$I(\epsilon_2)$, ϵ_L/ϵ_K, and $\epsilon_{MNO}/\epsilon_L$
ϵ_{2L}		0.66 *11*	
ϵ_{2MNO}		0.13 *2*	
ϵ_2		6.4 *10*	$I(\beta_1^+ + \epsilon_1)$, ϵ_2/β_2^+, and $I(\beta_1^+ + \epsilon_1 + \beta_2^+ + \epsilon_2) = 100$
ϵ_{3K}		0.6 *2*	$I(\epsilon_3)$ and ϵ_L/ϵ_K
ϵ_{3L}		0.09 *3*	
ϵ_3		0.7 *3*	See $I(\gamma_1)$
ce_{1K}		15.5 *1*	$I(ce_1)$, ce_{1K}/ce_{1L}, and ce_{1L}/ce_{1M}
ce_{1L}		2.28 *2*	
ce_{1M}		0.36 *1*	
ce_1		18.1 *1*	See $I(\gamma_1)$
ce_{2K}		0.233 *2*	$I(\gamma_2)$, ce_{2K}/γ_2, and ce_{2K}/ce_{2LM}
ce_{2LM}		0.0253 *2*	
β_1^+	0.30 *5*		$Q^+ - 2mc^2 - E(0.872$ level)
		0.6 *3*	$(\gamma$+ce)-intensities, and ϵ_1/β_1^+
β_2^+	0.78 *5*		67Mi13
		≈ 0.3	51M46
		*1.3 *3*	$I(\beta_1^+ + \epsilon_1)$, ϵ_2/β_2^+, and $I(\beta_1^+ + \epsilon_1 + \beta_2^+ + \epsilon_2) \approx 100$
γ_1	[U]0.3884 *2*		52G14, 63Gr41, 66Sa16
		84.8 *3*	$\epsilon_3/(\gamma_1 + ce_1)$, ce_1/γ_1, and $I(\gamma_1 + ce_1 + \epsilon_3) = 103.6$[a]
γ_2	[U]0.4835 *2*		52G14, 63Gr41
		92.0 *9*	γ_2/γ_1

[a] In an ^{87}Y-^{87m}Sr equilibrium mixture, the ratio of total activity to that of ^{87}Y is 1.036 *1*. See "Note" under decay scheme drawing

[b] Uncertainty is that due to uncertainty in Q^+

[c] Measured in an ^{87}Y-^{87m}Sr equilibrium mixture

[U] Unweighted average

*Value adopted by compilers from possibilities shown

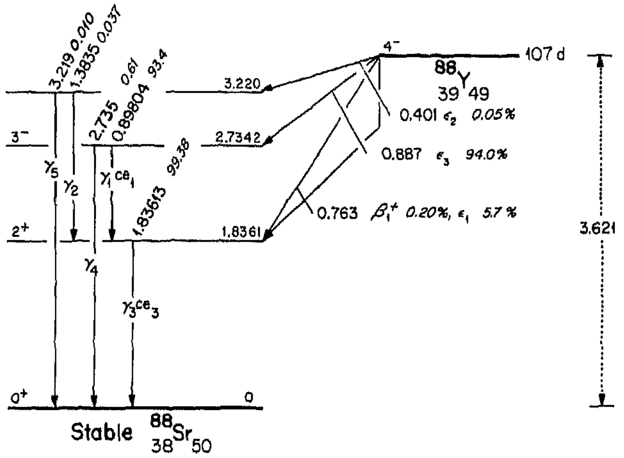
Basic Data, Sources for Adopted Values cont.

Auxiliary Data

$\epsilon_1/\beta_1^+ = 174^{+190}_{-80}$[b]	Theory
$\epsilon_2/\beta_2^+ = 4.9$ *11*[b]	Theory
$\epsilon_L/\epsilon_K = 0.118$ for ϵ_1 and ϵ_2; 0.148 for ϵ_3; $\epsilon_{MNO}/\epsilon_L = 0.203$	Appendix III
$\omega_K = 0.702$, $\omega_L \approx 0.041$, $n_{KL} = 1.11$ (Sr)	Appendix III
$\omega_K = 0.680$, $\omega_L \approx 0.035$, $n_{KL} = 1.13$ (Rb)	Appendix III
$ce_{1K}/\gamma_1 = 0.180$ *15*	61Hu12
*0.183	M4 Theory
$ce_{1K}/ce_{1L} =$ [U]7.1 *3*	63Gr41, 66Sa16
*6.8	M4 Theory
$ce_{1L}/ce_{1M} = 6.4$	M4 Theory
$ce_1/\gamma_1 =$ *0.214 from ce_{1K}/γ_1, ce_{1K}/ce_{1L}, ce_{1L}/ce_{1M}	
0.212 *2*	68Go30
$ce_{2K}/\gamma_2 = 0.0026$ *2*	61Hu12
*0.00253	M1 Theory
$ce_{2K}/ce_{2LM} = 9.2$	M1 Theory
$\therefore ce_2/\gamma_2 = 0.00281$	
$\gamma_2/\gamma_1 = 1.085$[c] *11*	64Na07
$\epsilon_3/(\gamma_1 + ce_1) = 0.0065$ *25*	60Su6

$^{88}_{39}Y_{49}$

Decay Characteristics	Basic Data, Sources for Adopted Values



$T_{1/2}$ 107 d *1* Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00179**	103 2	0.00393	0.068	<0.0001
e_{AK}	**0.01207**	25.8 *3*	0.00663	0.12	0.00026
ce_{1K}	**0.88194** *5*	0.025 *1*	0.00047	0.008	0.28
ce_{3K}	**1.82002** *4*	0.014 *1*	0.00054	0.009	0.66
β_1^+	**0.763**$_{max}$ 5 **0.358**$_{av}$ 3	0.20 *1*	0.0015	0.026	0.135
X_L	**0.00181**	≈ 4	≈ 0.00015	≈ 0.003	0.0030
X_K	**0.01439**	61.2 *7*	0.0188	0.32	1.4
$\gamma^{\pm}$	**0.5110**	0.40 2	0.0044	0.076	44
γ_1	**0.89804** *4*	93.4 *7*	1.80	31.2	51
γ_2	**1.3835** *5*	0.037 *12*	0.0011	0.019	60
γ_3	**1.83613** *4*	99.37 2	3.89	67.5	66
γ_4	**2.735** 2	0.61 2	0.036	0.62	≈ 80
γ_5	**3.219** 2	0.010 *3*	0.0007	0.012	≈ 90

[a] I(ce) are negligible here
[b] Conversion in higher shells is negligible here
[c] Uncertainty assigned by compilers
[d] Measured in ^{88}Rb decay

Decay Scheme

$Q^+ = 3.6208$ *44* — 65MTW1

γ-placements are determined from the precise γ-energies and $\gamma_1\gamma_3$- and $\gamma_2\gamma_3$-coincidences (64Sh16).

No ground-state β^+ observed — 63Rh01

Intensities per 100 ^{88}Y decays are obtained from the relative γ-intensities, ce_{3K}/γ_3, and the requirement that $I(\gamma_3+ce^{b}_{3K}+\gamma_4+\gamma_5) = 100$.

Decay Modes

Type	Energy MeV	Intensity %	
ϵ_K		87.2 *9*	ϵ and ϵ_L/ϵ_K, $\epsilon_{MNO}/\epsilon_L$
ϵ_L		10.5 *1*	
ϵ_{MNO}		2.11 *2*	
ϵ		99.7 *10*	γ-intensities[a], $I(\beta_1^+)$
ce_{1K}		0.025 *1*	$I(\gamma_1)$ and ce_{1K}/γ_1
ce_{3K}		0.014 *1*[c]	$I(\gamma_3)$ and ce_{3K}/γ_3
β_1^+	*0.763 *5*		$Q^+-2mc^2-E(1.8361\ \text{level})$
	0.761 *9*		63Rh01
		0.22 *3*	γ-intensities[a] and ϵ_1/β_1^+
		*0.20 *1*	63Rh01
γ_1	[W]0.89804 *4*		67Bl03, 67Ra03, 68Le03
		93.4 *7*	γ_1/γ_3 60Pe23
γ_2	1.3835[d] 5		69Ra05
		0.037 *12*	γ_2/γ_5[d] 69Ra05
γ_3	[W]1.83613 *4*		67Bl03, 67Ra03, 67Wh01, 68Le03
		99.37 2	ce_{3K}/γ_3, γ_4/γ_3, γ_5/γ_3, and $I(\gamma_3+ce^{b}_{3K}+\gamma_4+\gamma_5) = 100$
γ_4	2.735 2[c]		66Sa08
		0.61 2	See $I(\gamma_3)$
γ_5	[W]3.2194[d] *15*		69Ra05
		0.0095 *30*	See $I(\gamma_3)$

Auxiliary Data

$\epsilon_L/\epsilon_K = 0.120(\epsilon_1^{e})$, $0.120(\epsilon_3)$; $\epsilon_{MNO}/\epsilon_L = 0.203$ — Theory

$\epsilon_1/\beta_1^+ = 26^{e}$ *1*[f] — Theory

$\omega_K = 0.702$, $\omega_L \approx 0.041$, $n_{KL} = 1.11$ — Appendix III

$ce_{1K}/\gamma_1 = 0.000301$ *21* 66Ha07
$= *0.000267$ E1 Theory

$ce_{3K}/\gamma_3 = 0.000144$ E2 Theory

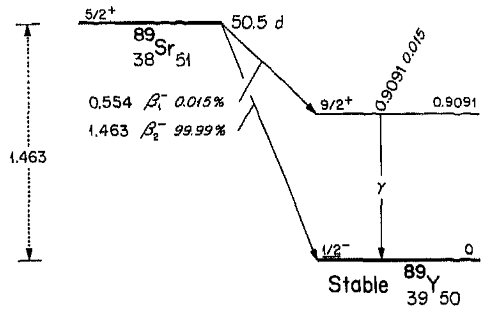
$\gamma_4/\gamma_3 =$ [W]0.0061 *2* 60Pe23, 66Sa08

$\gamma_5/\gamma_3 = 0.000095$ *30* 66Sa08

[e] Calculated for a first-forbidden unique transition
[f] Uncertainty is that due to uncertainty in Q^+
[W] Weighted average
*Value adopted by compilers from possibilities shown

$^{89}_{38}Sr_{51}$

Decay Characteristics



$T_{1/2}$ **50.5 d** *1* Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β_1^-	**0.554**$_{max}$*5* **0.178**$_{av}$*3*	0.015 *5*	0.00006	0.005	0.073
β_2^-	**1.463**$_{max}$*5* **0.573**$_{av}$*3*	99.99 *1*	1.220	100	0.303
All β's	**0.573**$_{av}$*3*	100	1.220	100	0.303
γ	**0.9091** *1*	0.015 *5*	0.00029	0.024	51

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^- = \mathbf{1.463}$ *5* $E(\beta_2^-)$

No γ other than 0.9091 γ observed 62Sa14

Intensities per 100 ^{89}Sr decays are obtained from $\gamma/(\beta_1^- + \beta_2^-)$ and the requirement that $I(\beta_1^- + \beta_2^-) = 100$.

Basic Data, Sources for Adopted Values cont.

Decay Modes

Type	Energy MeV	Intensity %	
β_1^-	**0.554** *5*		$Q^- - E$(0.9091 level)
		0.015 *5*	$I(\gamma)$
β_2^-	**1.463** *5*		49L06
		99.99 *1*	$I(\beta_1^-)$ and $I(\beta_1^- + \beta_2^-) = 100$
γ	**0.9091** *1*		68Hi12
		^{U}0.015 *5*	$\gamma/(\beta_1^- + \beta_2^-)$ and $I(\beta_1^- + \beta_2^-) = 100$

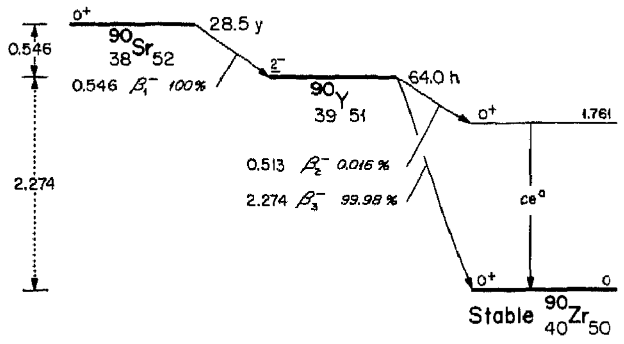
Auxiliary Data

$\gamma/(\beta_1^- + \beta_2^-) = {}^{U}0.00015$ *5* 55L46, 62Sa14

^{U}Unweighted average

$^{90}_{38}Sr_{52}$ - $^{90}_{39}Y_{51}$

Decay Characteristics



$T_{1/2}$ 28.5 y *8* (^{90}Sr); 64.0 h *1* (^{90}Y) } Appendix I

Note

Since the half-life of ^{90}Y is much shorter than that of its parent, ^{90}Sr, the ratio of ^{90}Y activity to that of ^{90}Sr in an initially pure ^{90}Y source will increase at first and then approach the constant value $T_A/(T_A-T_B)^b = 1.000$ after $\approx 10T_B$ ($\approx$ 27d). When the ratio of activities has reached this constant value, the parent and daughter are in equilibrium and the total activity is equal to 1+1.000 = 2.000 times the ^{90}Sr activity.

Radiations

Type	Energy MeV	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
ce	1.7427[c] *6*	0.016 *3*	0.00059	0.024	0.63
β_1^-	0.546$_{max}$ *2* 0.1963$_{av}$ *8*	100	0.418	17.3	0.079
β_2^-	0.513$_{max}$ *3* 0.184$_{av}$ *2*	0.016 *3*	0.00006	0.002	0.074
β_3^-	2.274$_{max}$ *3* 0.936$_{av}$ *2*	99.98 *1*	1.993	82.6	0.52
All β's	0.566$_{av}$ *2*	200	2.413	100	0.49

Basic Data, Sources for Adopted Values

Decay Scheme

Q^- = **0.546** *2*	(^{90}Sr)	E(β_1^-)
2.274 *3*	(^{90}Y)	E(β_3^-)
No γ observed in decay of ^{90}Sr (<0.1%)		50g03
No γ observed in decay of ^{90}Y (<0.001%)		55S05

Equilibrium intensities per 100 ^{90}Sr decays are obtained from ce/($\beta_2^-+\beta_3^-$) and the requirement that I(β_1^-) = I($\beta_2^-+\beta_3^-$) = 100.

Decay Modes

Type	Energy MeV	Equilibrium Intensity %	
ce	1.7427[a] *6*		68Pe01[d]
		0.016 *3*	ce/($\beta_2^-+\beta_3^-$) and I($\beta_2^-+\beta_3^-$) = 100
β_1^-	[W]**0.546** *2*		56Bl47, 56N21, 64Da16
		100	Decay scheme
β_2^-	**0.513** *3*		Q^-(^{90}Y)−E(1.761 level)
		0.016 *3*	I(ce)
β_3^-	[U]**2.274** *3*		56Bl47, 57Y06, 61Ni2, 64An12, 64Da16, 64La13, 66Ri01, 66Ha15
	*0.936$_{av}$ *2*		Theory
	[U]0.934$_{av}$ *18*		61Bi10, 63Bo43
		99.98 *1*	I(β_2^-) and I($\beta_2^-+\beta_3^-$) = 100
All β's	*1.133$_{av}$ *2*		Theory
	1.147$_{av}$ *9*		67Ra29

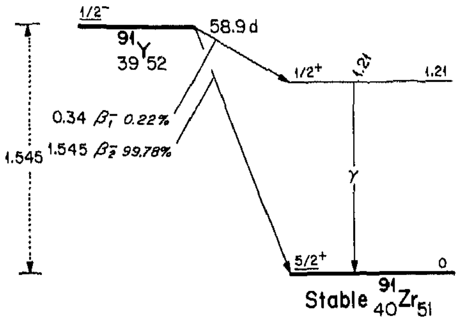
Auxiliary Data

ce/($\beta_2^-+\beta_3^-$) = 0.00016 *3* 57Y06

[a]No photons are emitted in a 0+-0+ transition
[b]$T_A \equiv T_{1/2}$ (^{90}Sr), $T_B \equiv T_{1/2}$ (^{90}Y)
[c]Energy of K-line given
[d]Measured in the decay of ^{90}Nb
[U]Unweighted average
[W]Weighted average
*Value adopted by compilers from possibilities shown

$^{91}_{39}Y_{52}$

Decay Characteristics



$T_{1/2}$ 58.9 d *4* Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β_1^-	**0.34**$_{max}$ *1* **0.101**$_{av}$ *3*	0.22 *2*	0.00047	0.036	0.055
β_2^-	**1.545**$_{max}$ *5* **0.607**$_{av}$ *2*	99.78 *2*	1.290	99.5	0.324
All β's	**0.606**$_{av}$ *2*	100	1.290	99.5	0.324
γ	**1.21** *1*	0.22 *2*	0.0057	0.44	57

Basic Data, Sources for Adopted Values

Decay Scheme

Q^- = **1.545** *5* — $E(\beta_2^-)$

No γ other than 1.21γ observed (<0.01%) — 55K12

Intensities per 100 ^{91}Y decays are obtained from $\gamma/(\beta_1^-+\beta_2^-)$ and the requirement that $I(\beta_1^-+\beta_2^-)$ = 100.

Basic Data, Sources for Adopted Values

Decay Modes

Type	Energy MeV	Intensity %	
β_1^-	**0.34** *1*		Q^--E(1.21 level)
	^{U}0.34 *1*		54B38, 55K12, 60Jo7
		0.22 *2*	$I(\gamma)$
β_2^-	**1.545** *5*		64La13
		99.78 *2*	$I(\beta_1^-)$ and $I(\beta_1^-+\beta_2^-)$ = 100
γ	^{U}1.21 *1*		54B38, 55K12, 60Jo7
		^{W}0.22 *2*	$\gamma/(\beta_1^-+\beta_2^-)$ and $I(\beta_1^-+\beta_2^-)$=100

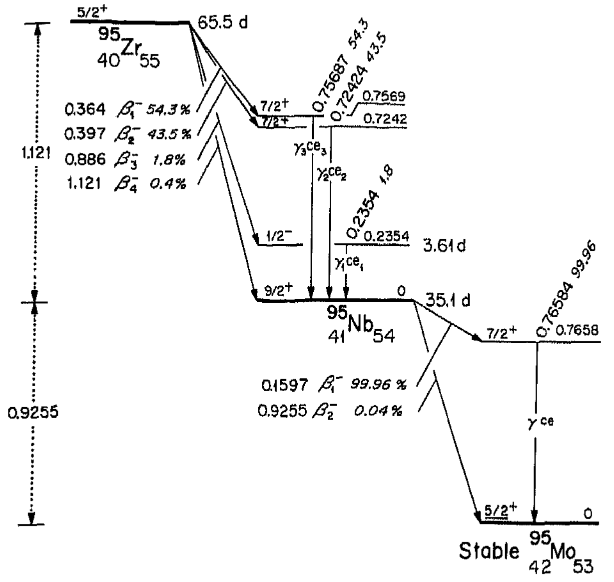
Auxiliary Data

$\gamma/(\beta_1^-+\beta_2^-)$=^{W}0.0022 *2* — 54B38, 55K12

^{U}Unweighted average
^{W}Weighted average

$\left({}^{95}_{40}\mathrm{Zr}_{55}-{}^{95m,95}_{41}\mathrm{Nb}_{54}\right)$-1

Decay Characteristics



$T_{1/2}$	65.5 d *5*	(^{95}Zr)	Appendix I
	3.61 d *4*	(^{95m}Nb)	
	35.1 d *1*	(^{95}Nb)	

Note

Since the half-life of ^{95m}Nb is much shorter than that of its parent, ^{95}Zr, the ratio of ^{95m}Nb activity to that of ^{95}Zr in an initially pure ^{95}Zr source will increase at first and then approach the constant value (0.018 *5*)[a] $\times T_A/(T_A-T_B)$[b] = 0.019 *5* after $\approx 10T_B$ (36 d). When the ratio of activities has reached this constant value, the parent and daughter are in equilibrium and the total activity is equal to 1-(0.018[a] *5*)+(0.019 *5*) = 1.00 *1* times the ^{95}Zr activity.

The ratio of ^{95}Nb activity to that of its parent, ^{95}Zr, is given as a function of time, t, by[b]

$$\frac{T_A}{T_A-T_C}\left[1-\exp\left(-0.693\,\frac{(T_A-T_C)\,t}{T_A T_C}\right)\right]=2.155\left[1-\exp(-0.00916t)\right]$$

where t is in days and the ^{95}Nb activity is taken to be zero at t = 0 (that is, the ^{95}Zr is initially pure).

[a] ^{95m}Nb is populated in 1.8% *5* of the ^{95}Zr decays
[b] $T_A = T_{1/2}$ (^{95}Zr), $T_B = T_{1/2}$ (^{95m}Nb), $T_C = T_{1/2}$ (^{95}Nb)
[c] Energy of L_1-line given
[d] Energy of M_1-line given

Decay Characteristics continued

Radiations (^{95}Zr-^{95m}Nb)

Type	Energy MeV	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	0.00215	1.4 *3*	0.00006	0.003	<0.0001
e_{AK}	0.01405	0.3 *1*	0.00009	0.005	0.00034
ce_{1K}	0.2164 *5*	1.1 *3*	0.0051	0.28	0.037
ce_{1L}	0.2327[c] *5*	0.22 *6*	0.0011	0.061	0.041
ce_{1M}	0.2349[d] *5*	0.058 *8*	0.00029	0.016	0.042
ce_{2K}	0.70525 *6*	0.06 *1*	0.0009	0.050	0.21
ce_{3K}	0.73789 *9*	0.07 *2*	0.0011	0.061	0.22
β_1^-	0.364$_{max}$ *4* 0.109$_{av}$ *2*	54.3 *5*	0.126	7.0	0.0376
β_2^-	0.397$_{max}$ *4* 0.120$_{av}$ *2*	43.5 *5*	0.111	6.1	0.0432
β_3^-	0.886$_{max}$ *4* 0.328$_{av}$ *2*	1.8 *5*	0.012	0.66	0.157
β_4^-	1.121$_{max}$ *4* 0.406$_{av}$ *2*	0.4 *2*	0.003	0.16	0.201
All β's	0.119$_{av}$ *2*	100	0.253	14.0	0.0461
X_L	0.00217	0.09 *2*	≈0	≈0	0.0050
X_K	0.01690	0.9 *2*	0.00032	0.018	2.4
γ_1	0.2354 *5*	0.46 *13*	0.0023	0.13	37
γ_2	0.72424 *6*	43.5 *5*	0.671	37.1	48
γ_3	0.75687 *9*	54.3 *5*	0.875	48.3	49

Radiations (^{95}Nb)

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	0.00227	0.19 *2*	0.00001	≈0	<0.0001
e_{AK}	0.01475	0.04 *1*	0.00012	0.007	0.00037
ce_K	0.74584 *4*	0.17 *2*	0.0027	0.16	0.23
ce_L	0.76298[c] *4*	0.023 *2*	0.00037	0.021	0.24
β_1^-	0.1597$_{max}$ *5* 0.0434$_{av}$ *2*	99.96 *4*	0.0924	5.4	0.0093

$\left({}^{95}_{40}Zr_{55} - {}^{95m,95}_{41}Nb_{54}\right)$-2

Decay Characteristics continued

Radiations (^{95}Nb) continued

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β_2^-	0.9255$_{max}$ 5				
	0.323$_{av}$?	0.04 4	0.00028	0.016	0.155
All β's	0.0435$_{av}$?	100	0.0926	5.4	0.0094
X_L	0.00229	0.013 ?	≈ 0	≈ 0	0.0059
X_K	0.01779	0.13 ?	0.00005	0.0029	2.8
γ	0.76584 4	99.80 4	1.629	94.4	49

Basic Data, Sources for Adopted Values

Decay Scheme

^{95}Zr Q^- = 1.1210 39 — 65MTW1

The γ-placements are determined from the measured β-groups and the adopted Q-value. Intensities per 100 ^{95}Zr decays are obtained from γ_3/γ_2, $I(\beta_3^-)$, $I(\beta_4^-)$, and the requirement that $I(\beta_3^-+\beta_4^-+\gamma_2+\gamma_3)^a = 100$.

^{95}Nb Q^- = 0.9255 5 — $E(\beta^-)$+E(0.7658 level)

No γ other than 0.76584γ — 63La06, 66Ch09

Intensities per 100 ^{95}Nb decays are obtained from $I(\beta_2^-)$ and the requirement that $I(\beta_1^-+\beta_2^-) = 100$.

Decay Modes (^{95}Zr-^{95m}Nb)

Type	Energy MeV	Intensity %	
$ce_{1K}\ldots ce_{3K}$	I(ce) are calculated from $I(\gamma)$ and ce/γ, ce_L/ce_K, ce_M/ce_L.		
β_1^-	^{W}0.361 4		53C23, 54Z05, 55D43
	*0.364 4		Q^--$E(\gamma_3)$
		54.3 5	$I(\gamma_3)^a$
β_2^-	^{W}0.399 4		53C23, 54Z05, 55D43
	*0.397 4		Q^--$E(\gamma_2)$
		43.5 5	$I(\gamma_2)^a$
β_3^-	0.885 10		55D43
	*0.886 4		Q^--$E(\gamma_1)$
		^{U}1.8 5	53C23, 54M28, 54Z05, 55D43

U, W Unweighted average, weighted average

*Value adopted by compilers from possibilities shown

Basic Data, Sources for Adopted Values cont.

Decay Modes (^{95}Zr) continued

Type	Energy MeV	Intensity %	
β_4^-	1.13 4		54Z05
	*1.121 4		Q^-
		0.4 2[b]	54Z05
γ_1	^{W}0.2354 4		53C23, 69Fo01
		0.46 13	$I(\beta_3^-)$ and ce_1/γ_1
γ_2	0.72424 6		68Le03
		43.5 5	See $I(\gamma_3)$
γ_3	0.75687 9		68Le03
		54.3 5	γ_3/γ_2, $I(\beta_3^-)$, $I(\beta_4^-)$, and $I(\beta_3^-+\beta_4^-+\gamma_2+\gamma_3) = 100$

Decay Modes (^{95}Nb)

Type	Energy MeV	Intensity %	
ce_K		0.17 2	ce/γ, ce_K/ce_{LM}, and $I(\gamma+ce) = I(\beta_1^-)$
ce_{LM}		0.023 2	
β_1^-	0.1597 5		63La06
		99.96 4	$I(\beta_2^-)$ and $I(\beta_1^-+\beta_2^-) = 100$
β_2^-	0.924		63La06
	*0.9255 5		Q^-
		0.04 4	Adopted by compilers from the value <0.075% (63La06)
γ	^{W}0.76584 4		67Bl03, 68Le03
		99.80 4	ce/γ and $I(\gamma+ce) = I(\beta_1^-)$

Auxiliary Data

^{95}Zr

ce_{1K}/γ_1	= 2.35 20	69Fo01
	*2.29	M4 Theory
ce_{1L}/ce_{1K}	≈ ^{U}0.217 5	53C23, 54Z05, 69Fo01
	*0.203	M4 Theory
ce_{1M}/ce_{1L}	= 0.27	M4 Theory
ce_{2K}/γ_2	≈ ^{W}0.0013 2	55D43
ce_{3K}/γ_3	= ^{W}0.0013 3	54M28
γ_3/γ_2	= ^{U}1.25 2	65Br37, 66Ts01, 67Br21, 68Hi11, 69Fo01

^{95}Zr continued

$\omega_K = 0.755$, $\omega_L = 0.060$, $n_{KL} = 1.05$ — Appendix III

^{95}Nb

ce/γ = ^{U}0.0017 2 — 52F14, 54S08, 55D43, 63La06

ce_K/ce_{LM} = 0.133 2 — 63La06

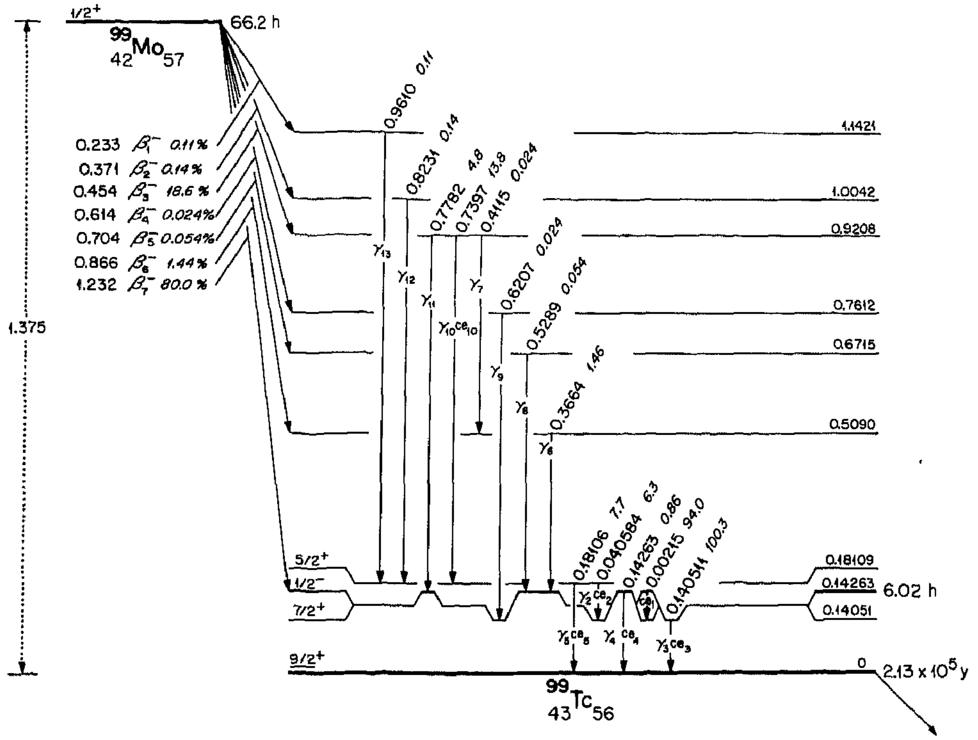
$\omega_K = 0.770$, $\omega_L = 0.065$, $n_{KL} = 1.04$ — Appendix III

[a] Internal conversion negligible here

[b] Uncertainty adopted by compilers

$\left({}^{99}_{42}Mo_{57} - {}^{99m}_{43}Tc_{56}\right)$-1

Decay Characteristics



$T_{1/2}$	66.2 h *5*	(^{99}Mo)	Appendix I
	6.02 h *3*	(^{99m}Tc)	
	2.13×10^5 y *8*	(^{99}Tc)	

Note
Since the half-life of ^{99}Tc is so long, the activity of ^{99}Tc in a ^{99}Mo source is negligible. We can thus treat ^{99}Tc as a stable nucleus and ignore its β^--decay to ^{99}Ru.

Note
Since the half-life of ^{99m}Tc is much shorter than that of its parent, ^{99}Mo, the ratio of ^{99m}Tc activity to that of ^{99}Mo in an initially pure ^{99}Mo source will increase at first and then approach the constant value (0.863 *10*)[a]$\times T_A/(T_A-T_B)$[b] = 0.949 *10* after ≈ $10T_B$ (≈ 60h). When the ratio of activities has reached this constant value, the parent and daughter are in equilibrium and the total activity is equal to 1-(0.863[a] *10*) + (0.949 *10*) = 1.09 2 times the ^{99}Mo activity.

[a] ^{99m}Tc is populated in 86.3% *10* of the ^{99}Mo decays
[b] $T_A = T_{1/2}$ (^{99}Mo), $T_B = T_{1/2}$ (^{99m}Tc)

Note
Weak γ's of energy 0.249, 0.344, 0.409, 0.458, 0.9882, 1.0017, and 1.016 reported by 68Va14 are not included here because of their low intensities ($\leq$0.006%).

Radiations

Type	Energy MeV	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
ce_{1MN}	**0.00161**[d] *3*	94.0 *10*	0.0032	0.21	<0.0001
e_{AL}	**0.00217**	15.8 *10*	0.00073	0.049	<0.0001
e_{AK}	**0.01547**	3.2 *3*	0.0010	0.067	0.00041
ce_{2K}	**0.019540** 2	4.4 *4*	0.0018	0.12	0.00061
ce_{2L}	**0.037542**[c] 2	0.47 *4*	0.00038	0.025	0.0019
ce_{2MN}	**0.04004**[d] *1*	0.16 *3*	0.00014	0.009	0.0022

[c] Energy of L_1-line given
[d] Energy of M_1-line given

$\left({}^{99}_{42}\mathrm{Mo}_{57} - {}^{99m}_{43}\mathrm{Tc}_{56}\right)$-2

Decay Characteristics continued

Radiations *continued*

Type	Energy MeV	Equilibrium Intensity %	$\Delta \left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
ce_{3K}	0.119467 *6*	9.3 *6*	0.0237	1.6	0.014
ce_{4K}	0.12159 *3*	0.61 *3*	0.0016	0.11	0.015
ce_{3L}	0.137469[a] *6*	1.16 *9*	0.0034	0.23	0.018
ce_{4L}	0.13959[a] *3*	0.19 *1*	0.00056	0.038	0.018
ce_{3M}	0.13997[b] *1*	0.22 *2*	0.00066	0.044	0.018
ce_{4M}	0.14209[b] *3*	0.037 *2*	0.00011	0.007	0.019
ce_{5K}	0.16002 *4*	0.83 *7*	0.0028	0.19	0.023
ce_{5L}	0.17802[a] *4*	0.12 *2*	0.00046	0.031	0.027
ce_{5M}	0.18052[b] *4*	0.023 *6*	0.00009	0.006	0.027
ce_{10K}	0.7187 *1*	0.022 *5*	0.00034	0.023	0.22
β_1^-	0.233_{max} *3* 0.066_{av} *1*	0.11 *1*	0.00015	0.010	0.0179
β_2^-	0.371_{max} *3* 0.111_{av} *1*	0.14 *1*	0.00033	0.022	0.0387
β_3^-	0.454_{max} *3* 0.140_{av} *1*	18.6 *6*	0.055	3.7	0.053
β_4^-	0.614_{max} *3* 0.219_{av} *1*	0.024 *4*	0.00011	0.007	0.093
β_5^-	0.704_{max} *3* 0.254_{av} *1*	0.054 *6*	0.00029	0.019	0.114
β_6^-	0.866_{max} *3* 0.298_{av} *1*	1.44 *9*	0.0091	0.61	0.141
β_7^-	1.232_{max} *3* 0.452_{av} *1*	80.0 *11*	0.770	51.6	0.228
All β's	0.392_{av} *1*	100	0.835	56.0	0.223
γ_1	0.00215 *3*	0	0	0	—
X_L	0.00242	1.2 *1*	0.00006	0.004	0.00069
X_K	0.01869	11.6	0.0046	0.31	3.1
γ_2	0.040584 *2*	1.3 *2*	0.0011	0.074	16
γ_3	0.140511 *6*	89.6 *5*	0.268	18.0	33

[a]Energy of L_1-line given
[b]Energy of M_1-line given

Decay Characteristics continued

Radiations *continued*

Type	Energy MeV	Equilibrium Intensity %	$\Delta \left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
γ_4	0.14263 *3*	0.027 *5*	0.00008	0.005	34
γ_5	0.18106 *4*	6.7 *2*	0.0258	1.7	35
γ_6	0.3664 *1*	1.46 *9*	0.0114	0.76	41
γ_7	0.4115 *5*	0.024 *3*	0.00021	0.014	42
γ_8	0.5289 *2*	0.054 *6*	0.00061	0.041	44
γ_9	0.6207 *2*	0.024 *4*	0.00032	0.021	46
γ_{10}	0.7397 *1*	13.8 *5*	0.217	14.6	48
γ_{11}	0.7782 *1*	4.8 *3*	0.080	5.4	49
γ_{12}	0.8231 *1*	0.14 *1*	0.0024	0.16	50
γ_{13}	0.9610 *2*	0.11 *1*	0.0022	0.15	53

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^- = 1.375$ *3* $\quad E(\beta_7^-)+E(0.14263\ \text{level})$

The γ-placements are determined by the precise γ-energies and extensive $\gamma\gamma$-coincidence measurements (65Cr02, 65Cr03, 68Va14).

Intensities per 100 ^{99}Mo decays are determined from the relative γ-intensities, relative ce-intensities, ce_3/γ_3, and the requirement that $I(\gamma_3+\gamma_4+\gamma_5+ce_3+ce_4+ce_5) = 109^c$ *2*.

[c]In a ^{99}Mo-^{99m}Tc equilibrium mixture, the ratio of total activity to that of ^{99}Mo is 1.09 2. See second "Note" under decay scheme on preceding page

$\left({}^{99}_{42}\mathrm{Mo}_{57}-{}^{99m}_{43}\mathrm{Tc}_{56}\right)$-3

Basic Data, Sources for Adopted Values cont.

Decay Modes

Type	Energy MeV	Intensity %	
ce_{1MN}		94.0 *10*	From intensity balance at 0.14051 level and ce_{1MN}/γ_1
ce_{2K}		4.4 *4*	From ce_{2K}/γ_2, ce_{2K}/ce_{2L}, ce_{2L}/ce_{2MN}, and intensity balance[a] at the 0.18109 level
ce_{2L}		0.47 *4*	
ce_{2MN}		0.16 *3*	

$ce_3 \ldots ce_5$ $I(ce_K)$ are weighted averages of data of 61Ra4 and 68Va14. The relative data of each author are normalized as described under $I(\gamma)$ below.

Type	Energy MeV	Intensity %	
ce_{10K}		0.022 *5*	$I(\gamma_{10})$ and ce_{10K}/γ_{10}
β_1^-	*0.233 *3*		Q^--E(1.1421 level)
	0.245 *10*		65Cr02
		0.11 *1*	γ-intensities
β_2^-	0.371 *3*		Q^--E(1.0042 level)
		0.14 *1*	γ-intensities
β_3^-	*0.454 *3*		Q^--E(0.9208 level)
	^{W}0.446 *5*		50B91, 65Cr02, 67Do01
		*18.6 *6*	γ-intensities
		20 *5*	67Do01
β_4^-	0.614 *3*		Q^--E(0.7613 level)
		0.024 *4*	γ-intensities
β_5^-	0.704 *3*		Q^--E(0.6715 level)
		0.054 *6*	γ-intensities
β_6^-	*0.866 *3*		Q^--E(0.5090 level)
	^{W}0.880 *13*		65Cr02, 67Do01
		*1.44 *9*	γ-intensities
		5 *3*	67Do01
β_7^-	^{W}1.232 *3*		65Cr02, 67Na15
		*80.0 *11*	$(\gamma$+ce)-intensities
		75 *10*	67Do01
γ_1	0.00215 *3*		57F35
		0	$I(ce_{1MN})$ and ce_{1MN}/γ_1
γ_2	0.040584 *2*		68Va14
		1.3 *2*	See $I(ce_2)$

$\gamma_3 \cdots \gamma_{13}$ $E(\gamma)$ and $I(\gamma)$ are data of 68Va14. The relative intensity values are normalized so that, in conjunction with the relative ce_K-intensities, ce_{3K}/γ_3, ce_K/ce_L, and ce_L/ce_M values, the requirement $I(\gamma_3+\gamma_4+\gamma_5+ce_3+ce_4+ce_5) = 109^{b}2$ is satisfied.

Basic Data, Sources for Adopted Values cont.

Auxiliary Data

$\omega_K = 0.785$	Appendix III
$\omega_L = 0.071$	Appendix III
$n_{KL} = 1.02$	Appendix III
$ce_{1MN}/\gamma_1 \approx 10^{10}$	E3 Theory
$ce_{2K}/\gamma_2 = 3.2$ *2*	69Ra01
$ce_{2K}/ce_{2L} = 9.3$ *2*	61Ra4
$ce_{2L}/ce_{2M} = 2.9$ *6*	61Ra4
$ce_{3K}/\gamma_3 = 0.104$ *7*	68Va14
$ce_{3K}/ce_{3L} = {}^{W}8.0$ *2*	61Ra4, 68Va14
$ce_{3L}/ce_{3M} = 5.3$	E2, M1 Theory
$\therefore ce_3/\gamma_3 = 0.119$ *8*	
$ce_{4K}/ce_{4L} = 3.26$	M4 Theory
$ce_{4L}/ce_{4M} = 5.0$	M4 Theory
$ce_{5K}/ce_{5L} = 4.9$ *10*	61Ra4
*6.76	E2 Theory
$ce_{5L}/ce_{5M} = 5.4$	E2 Theory
$ce_{10K}/\gamma_{10} = 0.0016$ *4*	68Va14

[a]No β-decay has been observed to the 0.18109 level. For a second-forbidden transition, log ft is expected to be >10. For $Q_\beta = 1.194$ and $T_{1/2}$ (^{99}Mo) = 66.2 h, this log ft value leads to I(β to 0.18109 level) < 0.1%

[b]In a ^{99}Mo-^{99m}Tc equilibrium mixture, the ratio of total activity to that of ^{99}Mo is 1.09 2. See second "Note" under decay scheme

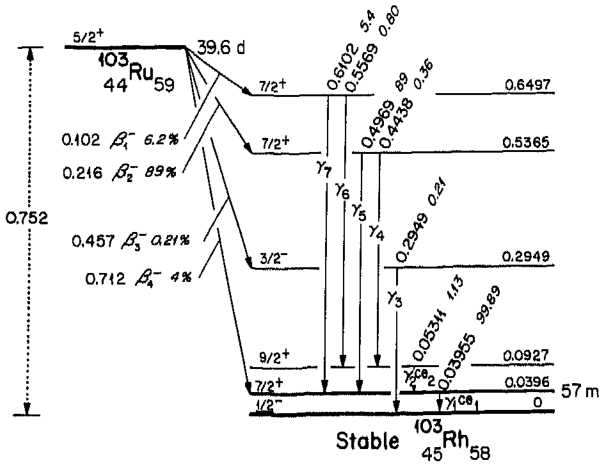
[U]Unweighted average

[W]Weighted average

*Value adopted by compilers from possibilities shown

$\left({}^{103}_{44}Ru_{59} - {}^{103m}_{45}Rh_{58}\right)$-1

Decay Characteristics



$T_{1/2}$	39.6 d *5* (^{103}Ru)	Appendix I
	57 m *1* (^{103m}Rh)	

Note

Since the half-life of ^{103m}Rh is much shorter than that of its parent, ^{103}Ru, the ratio of ^{103m}Rh activity to that of ^{103}Ru in an initially pure ^{103}Ru source will increase at first and then approach the constant value $(0.9979\ 2)^{a}\times T_A/(T_A-T_B)^{b} \approx 0.9989\ 2$ after $\approx 10T_B$ ($\approx$ 9.5 h). When the ratio of activities has reached this constant value, the parent and daughter are in equilibrium and the total activity is equal to $(1-0.9979\ 2)+(0.9989\ 2) = 1.0010\ 3$ times the ^{103}Ru activity.

Radiations

Type	Energy MeV	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00238**	77.9 *3*	0.00395	0.32	<0.0001
ce_{1K}	**0.01633** *4*	9.6 *3*	0.00334	0.27	0.00044
e_{AK}	**0.01696**	1.95 *5*	0.00070	0.056	0.00048
ce_{2K}	**0.02989** *4*	0.68 *11*	0.00043	0.034	0.0013
ce_{1L}	**0.03614**^{c} *4*	74.7 *2*	0.0575	4.61	0.0018
ce_{1M}	**0.03892**^{d} *4*	15.56 *4*	0.01290	1.03	0.0020
ce_{2L}	**0.04970**^{c} *4*	0.083 *13*	0.00008	0.006	0.0031

Decay Characteristics continued

Radiations continued

Type	Energy MeV	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
ce_{2M}	**0.05248**^{d} *4*	0.015 *3*	0.000017	0.0014	0.0035
β_1^-	**0.102**$_{max}$ *6* **0.027**$_{av}$ *2*	6.2 *4*	0.0036	0.29	0.00418
β_2^-	**0.216**$_{max}$ *6* **0.060**$_{av}$ *2*	89 *1*	0.114	9.1	0.0157
β_3^-	**0.457**$_{max}$ *6* **0.140**$_{av}$ *2*	0.21 *2*	0.00063	0.050	0.0539
β_4^-	**0.712**$_{max}$ *6* **0.236**$_{av}$ *2*	4 *1*	0.020	1.6	0.106
All β's	**0.065**$_{av}$ *2*	100	0.138	11.1	0.0267
X_L	**0.00270**	7.05 *3*	0.00041	0.033	0.0097
X_K	**0.02060**	8.3 *2*	0.0036	0.29	4.1
γ_1	**0.03955** *4*	0.056 *5*	0.00005	0.004	15
γ_2	**0.05311** *3*	0.34 *5*	0.00038	0.030	21
γ_3	**0.2949** *2*	0.21 *2*	0.0013	0.10	39
γ_4	**0.4438** *2*	0.36 *3*	0.0034	0.27	42
γ_5	**0.4969** *1*	89 *1*	0.94	75.4	43
γ_6	**0.5569** *2*	0.80 *6*	0.0095	0.76	45
γ_7	**0.6102** *2*	5.4 *4*	0.070	5.6	46

Basic Data, Sources for Adopted Values

See next page

^{a} ^{103m}Rh is populated in 99.79% *2* of the ^{103}Ru decays

^{b} $T_A = T_{1/2}$ (^{103}Ru), $T_B = T_{1/2}$ (^{103m}Rh)

^{c} Energy of L_1-line given

^{d} Energy of M_1-line given

$\left({}^{103}_{44}\mathrm{Ru}_{59}-{}^{103m}_{45}\mathrm{Rh}_{58}\right)$-2

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^- = {}^*0.752\ 6$ — $E(\beta_2^-)+E(0.5365\ \text{level})$
$0.755\ 17$ — From ^{102}Ru(d,p) Q-value (68No02) and ^{102}Ru, ^{103}Rh mass doublet measurements (63Da10)

The γ-placements are determined from the precise transition energies and the extensive $\beta\gamma$- and $\gamma\gamma$-coincidence measurements (52K27, 55S16, 58R07 and 65Mu09).

Intensities per 100 ^{103}Ru decays are obtained from the relative γ-intensities, $I(\beta_4^-)$, and the requirement that $I(\beta_4^-+\gamma_3+\cdots+\gamma_7) = 100$.

Decay Modes

Type	Energy MeV	Intensity %	
ce_{1K}		9.6 *3*	$I(ce_1)$, ce_{1K}/ce_{1L} and ce_{1L}/ce_{1M}
ce_{1L}		74.7 *2*	
ce_{1M}		15.56 *4*	
ce_1		99.83 *2*	$I(\gamma_1)$, $I(\gamma_3)$ and $I(\gamma_1+ce_1+\gamma_3) = 100.10^a$ *3*
ce_{2K}		0.68 *11*	$I(ce_{1L})$ and ce_{2K}/ce_{1L}
ce_{2L}		0.083 *13*	$I(ce_{2K})$, ce_{2K}/ce_{2L} and ce_{2L}/ce_{2M}
ce_{2M}		0.015 *3*	
ce_2		0.78 *11*	$I(ce_{2K}+ce_{2L}+ce_{2M})$
β_1^-	*0.102 *6*		$Q^- - E(0.6497\ \text{level})$
	^{u}0.120 *10*^{b}		55F03, 58R07, 65Mu09
		*6.2 *4*	γ-intensities
		7	65Mu09
β_2^-	^{u}0.216 *6*^{b}		50M26, 52K27, 56S119, 58R07, 65Mu09
		*89 *1*	γ-intensities
		89	65Mu09
β_3^-	0.457 *6*		$Q^- - E(0.2949\ \text{level})$
		0.21 *2*	γ-intensities
β_4^-	*0.712 *6*		$Q^- - E(0.0396\ \text{level})$
	0.699 *10*^{b}		50M26, 52K27, 55F03, 65Mu09
		^{u}4 *1*^{b}	50M26, 55D09, 55D43, 65Mu09
γ_1	0.03955 *4*		68Ma08
		0.056 *5*	γ_1/γ_5 68Ni05
γ_2	0.05311 *4*		68Ma08
		0.34 *5*	γ_2/γ_5 68Ni05
γ_3	0.29488 *16*		68Ma08
		0.21 *2*	See $I(\gamma_5)$

Basic Data, Sources for Adopted Values cont.

Decay Modes continued

Type	Energy MeV	Intensity %	
γ_4	0.44385 *15*		68Ma08
		0.36 *3*	See $I(\gamma_5)$
γ_5	^{w}0.4969 *1*		64Ka23, 68Ma08
		89 *1*	γ_3/γ_5, γ_4/γ_5, γ_6/γ_5, γ_7/γ_5, $I(\beta_4^-)$ and $I(\beta_4^-+\gamma_3+\cdots\gamma_7) = 100$
γ_6	^{w}0.5569 *2*		64Ka23, 68Ma08
		0.80 *6*	See $I(\gamma_5)$
γ_7	^{w}0.6102 *2*		64Ka23, 68Ma08
		5.4 *4*	See $I(\gamma_5)$

Auxiliary Data

$ce_{1K}/ce_{1L} = 0.128$	E3 Theory
$ce_{1L}/ce_{1M} = 4.8$ *8*	68Ma08
$ce_{2K}/ce_{1L} = 0.0091$ *15*	68Ma08
$ce_{2K}/ce_{2L} = {}^*8.15$	M1 Theory
8.5 *9*	68Ma08
$ce_{2L}/ce_{2M} = 5.4$	M1 Theory
$\gamma_3/\gamma_5 = 0.0024$ *2*	68Ni05
$\gamma_4/\gamma_5 = 0.0040$ *3*	68Ni05
$\gamma_6/\gamma_5 \overset{w}{=} 0.0090$ *6*	64Ka23, 68Ni05
$\gamma_7/\gamma_5 \overset{w}{=} 0.061$ *4*	64Ka23, 68Ni05
$\omega_K = 0.810$	Appendix III
$\omega_L = 0.083$	
$n_{KL} = 0.99$	

Comparison of Additional Experimental Results with Values Calculated from the Adopted Decay Scheme

$ce_{1K}/\gamma_1 = 180$ *20*	68Le16
172 *16*	Adopted $I(ce_{1K})$ and $I(\gamma_1)$
140	E3 Theory

^{a}In a ^{103}Ru-^{103m}Rh equilibrium mixture, the ratio of total activity to that of ^{103}Ru is 1.0010 *3*. See "Note" under decay scheme drawing on preceding page

^{b}Uncertainty assigned by compilers

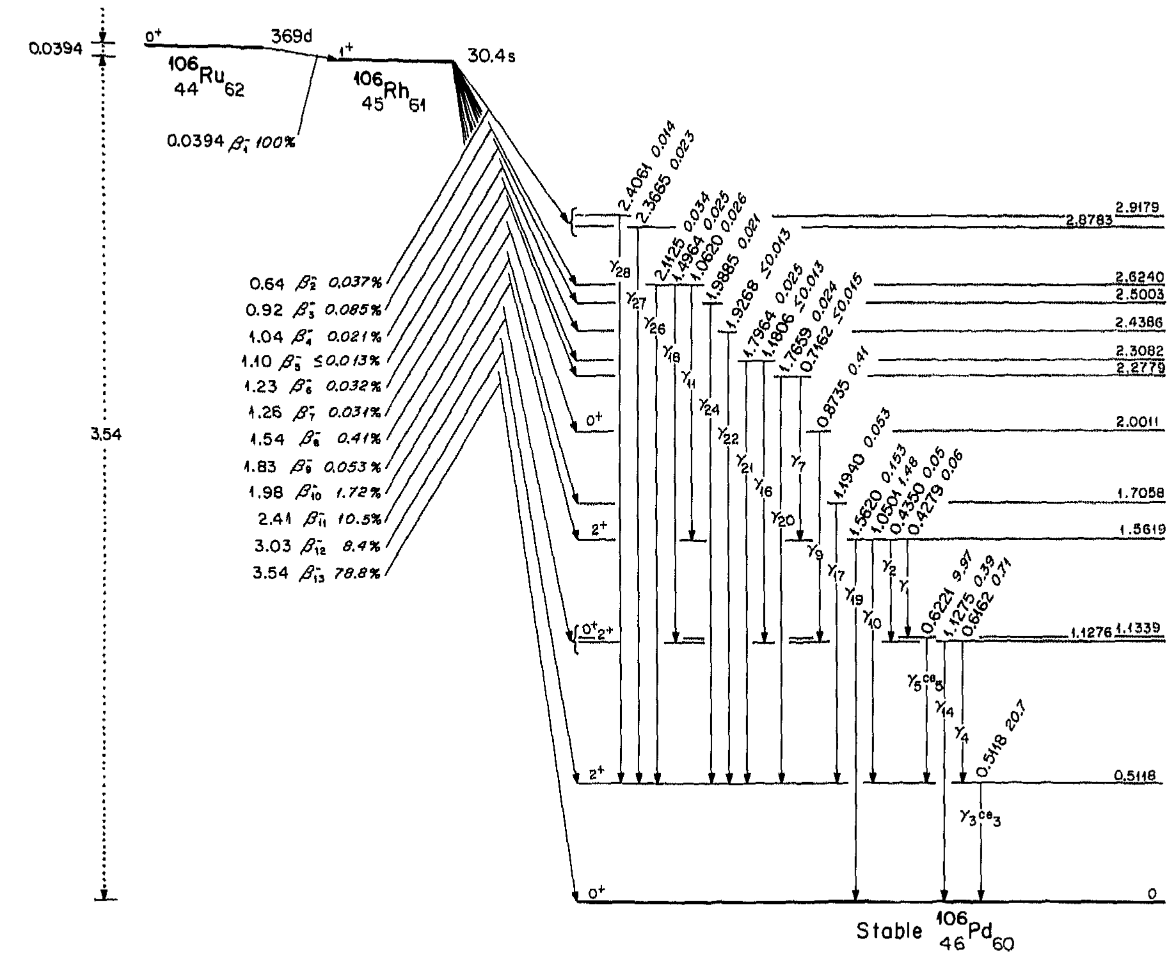
^{u}Unweighted average

^{w}Weighted average

*Value adopted by compilers from possibilities shown

$\left({}^{106}_{44}Ru_{62} - {}^{106}_{45}Rh_{61}\right)$-1

Decay Characteristics



$T_{½}$	**369 d** 2	(^{106}Ru)	} Appendix I
	30.4 s 5	(^{106}Rh)	

Note

Since the half-life of ^{106}Rh is much shorter than that of its parent, ^{106}Ru, the ratio of ^{106}Rh activity to that of ^{106}Ru in an initially pure ^{106}Ru source will increase at first and then approach the constant value $T_A/(T_A-T_B)^a = 1.000$ after $\approx 10T_B$ ($\approx$5m). When the ratio of activities has reached this constant value, the parent and daughter are in equilibrium and the total activity is equal to 1+1.000 = 2.000 times the ^{106}Ru activity.

Note

≈ 80 weak γ's reported by 67Fo09, 67Ra11, 67Vr05, 68Ha35, and 69St03 have not been included here because of their low intensities (<0.01%). The total intensity of the γ's omitted is ≈ 0.14%

Radiations

Type	Energy MeV	Equilibrium Intensity %	Δ (gm-rad / μCi-h)	Δ/ΣΔ %	R_{90} (cm) in Water
e_{AL}	**0.00250**	0.128 4	≈0	≈0	<0.0001
e_{AK}	**0.01773**	0.023 1	≈0	≈0	0.00051
ce_{3K}	**0.4875** 2	0.100 4	0.00104	0.030	0.13
ce_{3LM}	**0.5082**^{b} 2	0.015 1	0.00016	0.005	0.13
ce_{5K}	**0.5978** 2	0.028 1	0.00036	0.010	0.17

$^a T_A = T_{½}(^{106}Ru)$, $T_B = T_{½}(^{106}Rh)$
^{b}Energy of L_1-line given

$\left({}^{106}_{44}Ru_{62}-{}^{106}_{45}Rh_{61}\right)$-2

Decay Characteristics continued

Radiations continued

Type	Energy MeV	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β^-_1	0.0394_{max} 3 0.0101_{av} 1	100	0.0215	0.61	0.00077
β^-_2	0.64_{max} 1 0.207_{av} 4	0.037 2	0.00016	0.005	0.090
β^-_3	0.92_{max} 1 0.318_{av} 4	0.085 3	0.00058	0.017	0.153
β^-_4	1.04_{max} 1 0.372_{av} 4	0.021 2	0.00017	0.005	0.182
β^-_5	1.10_{max} 1 0.394_{av} 4	≤0.013	≤0.0001	≤0.003	0.196
β^-_6	1.23_{max} 1 0.449_{av} 4	0.032 5	0.00031	0.009	0.227
β^-_7	1.26_{max} 1 0.466_{av} 4	0.031 5	0.00031	0.009	0.234
β^-_8	1.54_{max} 1 0.586_{av} 4	0.41 1	0.0051	0.15	0.304
β^-_9	1.83_{max} 1 0.718_{av} 4	0.053 2	0.00081	0.023	0.380
β^-_{10}	1.98_{max} 1 0.786_{av} 4	1.72 4	0.0288	0.82	0.416
β^-_{11}	2.41_{max} 1 0.986_{av} 4	10.5 2	0.220	6.3	0.53
β^-_{12}	3.03_{max} 1 1.280_{av} 4	8.4 15	0.229	6.5	0.69
β^-_{13}	3.54_{max} 1 1.525_{av} 4	78.8 9	2.56	73.1	0.82
All β's	0.719_{av} 2	200	3.06	87.4	0.79
X_L	0.00284	0.013 1	≈ 0	≈ 0	0.011
X_K	0.02158	0.105 4	0.00005	0.001	4.6
γ_1	0.4279 5	0.06 4	0.00055	0.016	42
γ_2	0.4350 15	0.05 2	0.00046	0.013	42
γ_3	0.5118 2	20.6 9	0.225	6.4	44
γ_4	0.6162 2	0.71 4	0.0093	0.27	46

Decay Characteristics continued

Radiations continued

Type	Energy MeV	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
γ_5	0.6221 2	9.94 11	0.132	3.8	46
$^x\gamma_6$	0.6612 4	0.015 2	0.00021	0.006	47
γ_7	0.7162 3	0.015 2	0.00023	0.007	48
$^x\gamma_8$	0.7171 3				
γ_9	0.8735 9	0.41 1	0.0076	0.22	51
γ_{10}	1.0501 2	1.48 4	0.0331	0.94	54
γ_{11}	1.0620 4	0.026 2	0.00059	0.017	54
γ_{12}	1.1086 3	0.012 1	0.00028	0.008	55
$^x\gamma_{13}$	1.1146 3				
γ_{14}	1.1275 1	0.39 2	0.0094	0.27	55
$^x\gamma_{15}$	1.1791 5	0.013 1	0.00033	0.009	56
$^x\gamma_{16}$	1.1806 3				
γ_{17}	1.1940 4	0.053 2	0.00135	0.039	56
γ_{18}	1.4964 4	0.025 1	0.00080	0.023	61
γ_{19}	1.5620 3	0.153 6	0.0051	0.15	62
γ_{20}	1.7659 3	0.024 2	0.00090	0.026	65
γ_{21}	1.7964 3	0.025 2	0.00096	0.027	65
γ_{22}	1.9268 3	0.013 1	0.00053	0.015	67
$^x\gamma_{23}$	1.9272 3				
γ_{24}	1.9885 3	0.021 2	0.00089	0.025	68
$^x\gamma_{25}$	1.989 2	0.026 4	0.0011	0.031	68
γ_{26}	2.1125 4	0.034 2	0.0015	0.043	70
γ_{27}	2.3665 3	0.023 2	0.0012	0.034	73
γ_{28}	2.4061 3	0.014 2	0.0007	0.020	73

Basic Data, Sources for Adopted Values

See next page

^{x}Not shown on decay scheme since placement not determined

$\left({}^{106}_{44}Ru_{62}-{}^{106}_{45}Rh_{61}\right)$-3

Basic Data, Sources for Adopted Values

Decay Scheme

^{106}Ru $Q^- = \mathbf{0.0394}$ *3* — $E(\beta_1^-)$ 50A01

No γ

$\therefore I(\beta_1^-) = 100\%$

^{106}Rh $Q^- = \mathbf{3.54}$ *1* — $E(\beta_{13}^-)$

The γ-placements are determined by the γ-energies and extensive $\gamma\gamma$- and $\beta\gamma$-coincidence measurements (60Bo25, 62Am3, 63Bo31, and 67Ra11).

Intensities per 100 ^{106}Rh decays are obtained from the relative γ-intensities, $\gamma_3/\Sigma\beta^-$, and the requirement that $I(\gamma_3+\gamma_{14}+\gamma_{19}+\beta_{13}^-) = 100$[a].

Decay Modes

Type	Energy MeV	Intensity %	
ce_{3K}		0.100 *4*	$I(\gamma_3)$, ce_{3K}/γ_3, and ce_{3K}/ce_{3LM}
ce_{3LM}		0.015 *1*	
ce_{5K}		0.028 *1*	$I(\gamma_5)$ and ce_{5K}/γ_5
β_1^-	W**0.0394** *3*		50A01, 58G107
		100	Decay scheme

$\beta_2^-\cdots\beta_9^-$ $E(\beta)$ are calculated from $Q^-(^{106}Rh)$ and the ^{106}Pd level energies.
$I(\beta)$ are calculated from the γ-intensities.

Type	Energy MeV	Intensity %	
β_{10}^-	***1.98** *1*		Q^--E(1.5619 level)
	2.0 *1*		52A06
		*1.72 *4*	γ-intensities
		U2.6 *3*	52A06, 62Am3, 63Ke13
β_{11}^-	***2.41** *1*		Q^--E(1.1276, 1.1339 levels)
	U**2.37** *7*		47P07, 52A06
		*10.5 *2*	γ-intensities
		U13 *3*	52A06, 58G107, 62Am3, 63Ke13
β_{12}^-	***3.03** *1*		Q^--E(0.5118 level)
	U**3.04** *2*		60Se5, 62Am3, 67Jo05
		*8.4 *15*	γ-intensities[a]
		U10.2 *20*	52A06, 58G107, 60Se5, 62Am3, 63Ke13, 67Jo05
β_{13}^-	W**3.54** *1*		52A06, 58G107, 60Se5
		*78.8 *9*	$I(\gamma_3)$, γ_8/γ_3, γ_{12}/γ_3, and $I(\gamma_3+\gamma_{14}+\gamma_{19}+\beta_{13}^-) = 100$[a]
		U73 *3*	52A06, 58G107, 60Se5, 62Am3, 63Ke13, 67Jo05

Basic Data, Sources for Adopted Values cont.

Decay Modes continued

Type	Energy MeV	Intensity %	
γ_3	W**0.5118** *2*		65Ro09, 67Fo09, 67Ra11, 67Vr05
		W20.6 *9*	$\gamma_3/\Sigma\beta^-$
γ_5	W**0.6221** *2*		65Ro09, 67Fo09, 67Ra11, 67Vr05
		*9.94 *11*	γ_5/γ_3 67Fo09, 67Ra11, 67Vr05
		10 *1*	$\gamma_5/\Sigma\beta^-$ 66Ov01

$\gamma_1,\gamma_2,\gamma_4$, $\gamma_6\cdots\gamma_{28}$: $E(\gamma)$ are weighted averages of data of 65Ro09, 67Fo09, 67Ra11, 67Vr05, 68Ha35, and 69St03.
$I(\gamma)$ are unweighted averages of data of 67Fo09, 67Ra11, 67Vr05, 68Ha35, and 69St03. The relative values of each author are normalized to 20.6 for γ_3.

Auxiliary Data

$\gamma_3/\Sigma\beta^- =$ W20.6 *9*	53K47, 66Ov01
$ce_{3K}/\gamma_3 = 0.0048$ *8*	67Vr05
*0.00485	E2 Theory
$ce_{3K}/ce_{3LM} =$ U7.0 *5*	52A06, 58G107, 60Se5
*6.7	E2 Theory
$ce_{5K}/\gamma_5 = 0.0030$ *7*	67Vr05
*0.00282	E2 Theory
$\omega_K=0.820$, $\omega_L=0.090$, $n_{KL}=0.98$	Appendix III

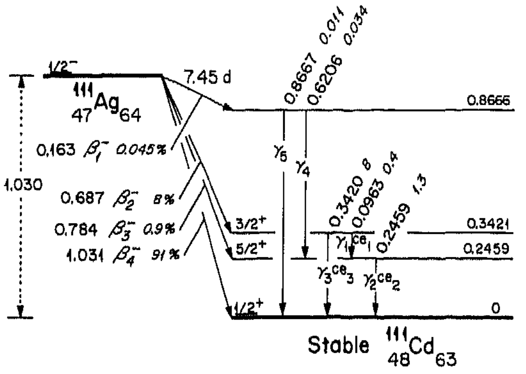
Comparison of Additional Experimental Results with Values Calculated from the Adopted Decay Scheme

$ce_{3K}/\Sigma\beta^- =$ U0.077 *5*	52A06, 58G107
0.100 *4*	From adopted values
$ce_{5K}/\Sigma\beta^- =$ U0.027 *10*	52A06, 58G107
0.028 *1*	From adopted values

[a] $I(ce_3)$ is negligible here
U Unweighted average
W Weighted average
*Value adopted by compilers from possibilities shown

$^{111}_{47}Ag_{64}$-1

Decay Characteristics



$T_{1/2}$	7.45 d 1	Appendix I

Note
Weak γ's of energy 0.076, 0.176, 0.191, 0.267, and 0.367 reported by 64Sa21 [ΣI(all γ's) ≈ 0.4%] and 0.5244 (0.004%) reported by 67Hn01 have not been included.

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00272**	0.34 9	0.00002	0.002	<0.0001
e_{AK}	**0.01932**	0.05 2	0.00002	0.002	0.00060
ce_{1K}	**0.0696** 5	0.15 8	0.00022	0.027	0.0057
ce_{1LM}	**0.0923**[a] 5	0.03 2	0.00006	0.007	0.0094
ce_{2K}	**0.2192** 4	0.06 2	0.00028	0.034	0.038
ce_{2LM}	**0.2419**[a] 4	0.012 4	0.00006	0.007	0.044
ce_{3K}	**0.3153** 4	0.12 3	0.00081	0.10	0.066
ce_{3LM}	**0.3380**[a] 4	0.019 5	0.00014	0.017	0.073
β_1^-	**0.163**$_{max}$ 7 **0.044**$_{av}$ 2	0.045 9	0.000042	0.005	0.0096
β_2^-	**0.687**$_{max}$ 8 **0.225**$_{av}$ 3	8 2	0.038	4.7	0.100
β_3^-	**0.784**$_{max}$ 7 **0.281**$_{av}$ 2	0.9 3	0.0054	0.7	0.131
β_4^-	**1.031**$_{max}$ 9 **0.363**$_{av}$ 3	91 2	0.70	86	0.179
All β's	**0.351**$_{av}$ 3	100	0.748	91.8	0.176

Decay Characteristics continued

Radiations continued

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
X_L	**0.00313**	0.04 1	≈ 0	≈ 0	0.015
X_K	**0.02363**	0.28 8	0.00014	0.017	5.7
γ_1	**0.0963** 5	0.19 5	0.00039	0.048	30
γ_2	**0.2459** 4	1.2 3	0.0063	0.77	37
γ_3	**0.3420** 4	8 2	0.06	7	40
γ_4	**0.6206** 5	0.034 8	0.00045	0.055	46
γ_5	**0.8667** 5	0.011 3	0.00020	0.025	51

Basic Data, Sources for Adopted Values

Decay Scheme

Q^- = [W]**1.030** 7 — $E(\beta_4^-)$, $E(\beta_2^-)$+E(0.3421 level)

The γ-placements are determined by the γ-energies, $\gamma_4\gamma_2$- and $\gamma_1\gamma_2$-coincidences (58M02, 67Hn01), and Coulomb-excitation studies (58M02).

Intensities per 100 ^{111}Ag decays are obtained from γ_2/γ_3, $I(\beta_4^-)$, and the requirement that $I(\gamma_2+\gamma_3+\beta_4^-) = 100$[b].

Decay Modes

Type	Energy MeV	Intensity %	
$ce_1 \cdots ce_3$	I(ce) are calculated from I(γ), ce_K/γ, and ce_K/ce_{LM}		
β_1^-	**0.163** 7	0.045 9	Q^--E(0.8666 level) γ-intensities
β_2^-	[W]**0.687** 8	*8 2 [U]7	58R62, 67Le06 (γ+ce)-intensities 50J53, 50S60
β_3^-	***0.784** 7 **0.793** 15	*0.9 3 1	Q^--E(0.2459 level) 58R62 (γ+ce)-intensities 50J53

continued on next page

[a]Energy of L_1-line given
[b]$I(ce_2)$, $I(ce_3)$ and $I(\gamma_5)$ are negligible here
[U,W]Unweighted average, weighted average
*Value adopted by compilers from possibilities shown

Basic Data, Sources for Adopted Values cont.

Decay Modes continued

Type	Energy MeV	Intensity %		
β_4^-	^{W}**1.031** *9*			58R62, 67Le06
		91 2[a]		50J53
γ_1	**0.0963** *5*[b]			67Hn01
		0.19 *5*	γ_1/γ_3	58M02, 67Hn01
γ_2	^{W}**0.2459** *4*			67Hn01,[b] 68Mc04
		1.2 *3*		See I(γ_3)
γ_3	^{W}**0.3420** *4*			67Hn01,[b] 68Mc04
		8 *2*		γ_2/γ_3, I(β_4^-) and I($\gamma_2+\gamma_3+\beta_4^-$) = 100[c]
γ_4	**0.6206** *5*			67Hn01
		0.034 *8*	γ_4/γ_3	67Hn01
γ_5	**0.8667** *5*			67Hn01
		0.011 *3*	γ_5/γ_3	67Hn01

[a]Uncertainty assigned by compilers

[b]Uncertainty of 0.0005 MeV assigned by compilers to data of 67Hn01

[c]I(ce_2), I(ce_3) and I(γ_5) are negligible here

Basic Data, Sources for Adopted Values cont.

Auxiliary Data

$\omega_K = 0.840$, $\omega_L = 0.101$, $n_{KL} = 0.96$ — Appendix III

$\gamma_2/\gamma_3 = {}^{U}0.16$ *2* — 50J53, 51E09, 58R62, 67Hn01

$ce_{1K}/\gamma_1 = 0.8$ *4*, $ce_{1K}/ce_{1LM} = 6$ *3* — M1,E2 Theory with E2/M1 ≈ 1.0[d] Uncertainty chosen so that ce_K/γ and ce_K/ce_{LM} overlap both E2 and M1 values

$ce_{2K}/\gamma_2 = 0.0525$, $ce_{2K}/ce_{2LM} = 5.4$ — E2 Theory

$ce_{3K}/\gamma_3 = 0.0153$, $ce_{3K}/ce_{3LM} = 6.3$ — M1, E2 Theory with E2/M1 = 0.15 *1* (58M02)

Comparison of Additional Experimental Results with Values Calculated from the Adopted Decay Scheme

$\gamma_2/\Sigma\beta^-$ =	1.0 *5*	58R62
	1.2 *2*	From adopted values
$\gamma_3/\Sigma\beta^-$ =	6.0 *15*	58R62
	8 *2*	From adopted values

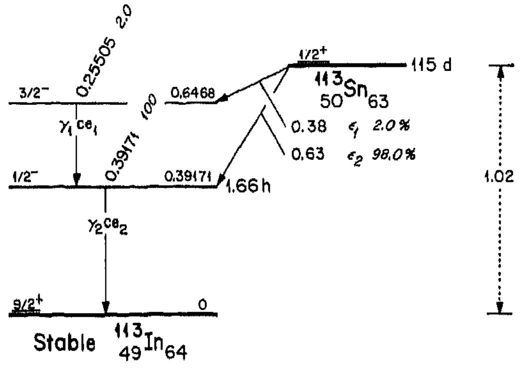
[d]Adopted by compilers. No experimental data available

[U]Unweighted average

[W]Weighted average

$({}^{113}_{50}Sn_{63} - {}^{113m}_{49}In_{64})$-1

Decay Characteristics



$T_{1/2}$	**115 d** *1* (^{113}Sn)		Appendix I
	1.66 h *1* (^{113m}In)		

Note

Since the half-life of ^{113m}In is much shorter than that of its parent, ^{113}Sn, the ratio of ^{113m}In activity to that of ^{113}Sn in an initially pure ^{113}Sn source will increase at first and then approach the constant value $T_A/(T_A-T_B)^a = 1.00060$ *1* after $\approx 10T_B$ ($\approx$ 17h). When the ratio of activities has reached this constant value, the parent and daughter are in equilibrium and the total activity is equal to 1.00060 *1* or $\approx$ 1.000 times the ^{113}Sn activity.

Radiations

Type	Energy MeV	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00284**	112.4 *3*	0.00680	0.76	<0.0001
e_{AK}	**0.02014**	17.0 *1*	0.00729	0.82	0.00064
ce_{1K}	**0.22711** *5*	0.07 *1*	0.00034	0.038	0.040
ce_{2K}	**0.36377** *7*	28.9 *3*	0.224	25.1	0.082
ce_{2L}	**0.38747**[b] *7*	5.59 *6*	0.0461	5.2	0.090
ce_{2M}	**0.39089**[c] *7*	1.12 *3*	0.0093	1.0	0.091
X_L	**0.00329**	13.5 *1*	0.00095	0.11	0.017
X_K	**0.02469**	96.6 *3*	0.0508	5.7	6.2
γ_1	**0.25505** *5*	1.9 *1*	0.010	1.1	38
γ_2	**0.39171** *5*	64.4 *3*	0.537	60.1	41

Basic Data, Sources for Adopted Values

Decay Scheme

Q^+ = **1.023** *19* 65MTW1

No γ other than 0.39171γ observed in decay of ^{113m}In (40L07)

No γ's other than 0.25505γ and 0.39171γ observed in decay of ^{113}Sn (67Bo18, 68Fo07).

No ϵ to ground state expected since $\Delta J = 4$

$\therefore I(\gamma_2 + ce_2) = 100$

Decay Modes

Type	Energy MeV	Intensity %	
ϵ_{1K}		1.7 *1*	$I(\epsilon_1)$, $\epsilon_{1L}/\epsilon_{1K}$, and $\epsilon_{1LMN}/\epsilon_{1K}$
ϵ_{1L}		0.24 *1*	
ϵ_{1MN}		0.06 *2*	
ϵ_1		2.0 *1*	(γ+ce)-intensities
ϵ_{2K}		83.5 *2*	$I(\epsilon_2)$, $\epsilon_{2L}/\epsilon_{2K}$, and $\epsilon_{2LMN}/\epsilon_{2K}$
ϵ_{2L}		11.4 *1*	
ϵ_{2MN}		3.1 *2*	
ϵ_2		98.0 *1*	(γ+ce)-intensities
ce_{1K}		0.07 *1*	$I(\gamma_1)$ and ce_{1K}/γ_1
ce_{2K}		28.9 *3*	$I(ce_2)$, ce_{2K}/ce_{2L}, and ce_{2M}/ce_{2L}
ce_{2L}		5.59 *6*	
ce_{2M}		1.12 *2*	
ce_2		35.6 *3*	ce_2/γ_2 and $I(\gamma_2+ce_2) = 100$
γ_1	[W]**0.25505** *5*	[W]1.9 *1*	68Ba60, 68Fo07; γ_1/γ_2 58G06, 59B208, 67Bo18, 68Fo07
γ_2	[W]**0.39171** *5*	64.4 *3*	68Ba60, 68Fo07; ce_2/γ_2 and $I(\gamma_2+ce_2) = 100$

Auxiliary Data

$\epsilon_{1L}/\epsilon_{1K}$ =	0.144 *2*[d]	Theory
$\epsilon_{1LMN}/\epsilon_{1K}$ =	*0.173 *2*[d]	Theory
	0.33 *14*	67Bo18
$\epsilon_{2L}/\epsilon_{2K}$ =	0.136 *1*[d]	Theory
$\epsilon_{2LMN}/\epsilon_{2K}$ =	*0.173 *1*[d]	Theory
	0.16 *2*	67Bo18

continued on next page

[a] $T_A = T_{1/2}(^{113}\text{Sn})$, $T_B = T_{1/2}(^{133m}\text{In})$

[b] Energy of L_1-line given

[c] Energy of M_1-line given

[d] Uncertainty is that due to uncertainty in Q^+

[W] Weighted average

*Value adopted by compilers from possibilities shown

Basic Data, Sources for Adopted Values cont.

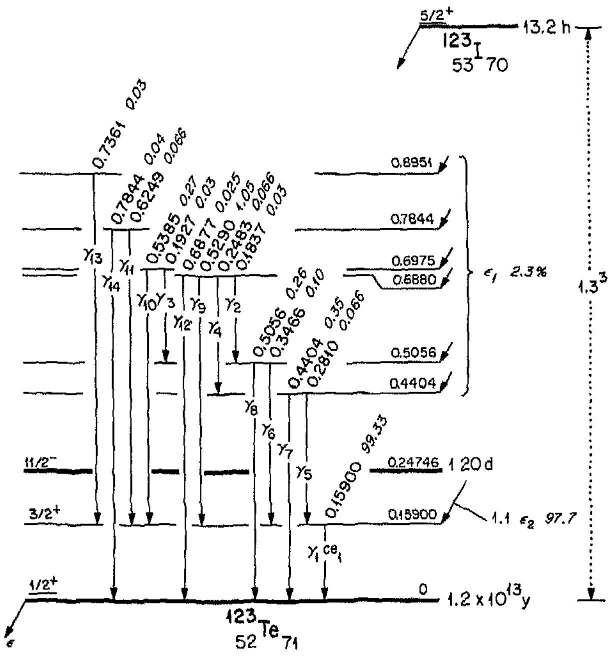
Auxiliary Data continued

$\omega_K = 0.850$		Appendix III
$\omega_L = 0.107$		Appendix III
$n_{KL} = 0.95$		Appendix III
$ce_{1K}/\gamma_1 =$	[w]0.039 4	59B208, 67Bo18, 68Fo07
$ce_{2K}/\gamma_2 =$	*0.450 5[a]	M4 Theory
	[w]0.436 6	65Se08, 68Ta06
$ce_{2K}/ce_{2L} =$	*5.17	M4 Theory
	[w]5.2 1	57G54, 68Fo07
$ce_{2M}/ce_{2L} =$	*0.20	M4 Theory
	[w]0.22 2	56A51, 65Se08[b]
$\therefore ce_2/\gamma_2 =$	0.554 7	

[a]Uncertainty assigned by compilers
[b]From K/LM-measurement and adopted K/L-value
[w]Weighted average
*Value adopted by compilers from possibilities shown

$^{123}_{53}I_{70}$-1

Decay Characteristics



$T_{1/2}$	13.2 h *1*	(^{123}I)	Appendix I
	1.2×10^{13}y	(^{123}Te)	
	120 d *1*	(^{123m}Te)	

Note

Since the half-life of ^{123}Te is so long, the activity of ^{123}Te in a ^{123}I source is negligible. We can thus treat ^{123}Te as a stable nucleus and ignore its ϵ-decay to ^{123}Sb.

Note

Since ^{123m}Te is populated in only ≈0.01% of the ^{123}I decays (68Ra11), the activity of ^{123m}Te in a ^{123}I source is negligible.

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00319**	92.8 *4*	0.00630	1.5	<0.0001
e_{AK}	**0.02272**	13.15 *5*	0.00636	1.5	0.00079
ce_{1K}	**0.12719** *3*	14.1 *3*	0.0382	9.2	0.016
ce_{1L}	**0.15406**[a] *3*	1.88 *5*	0.0062	1.5	0.022
ce_{1MN}	**0.15806**[b] *3*	0.41 *4*	0.0014	0.34	0.023

[a]Energy of L_1-line given
[b]Energy of M_1-line given

Decay Characteristics continued

Radiations continued

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
X_L	**0.00377**	13.3 *1*	0.00011	0.026	0.026
X_K	**0.02803**	86.5 *3*	0.0516	12.4	8.2
γ_1	**0.15900** *3*	82.9 *3*	0.281	67.4	34
γ_2	**0.1837** *10*	0.03 *2*	0.00012	0.029	35
γ_3	**0.1927** *10*	0.03 *2*	0.00012	0.029	36
γ_4	**0.2483** *5*	0.066 *8*	0.00035	0.084	37
γ_5	**0.2810** *5*	0.066 *8*	0.00040	0.096	38
γ_6	**0.3466** *5*	0.10 *2*	0.00074	0.18	40
γ_7	**0.4404** *5*	0.35 *4*	0.0033	0.79	42
γ_8	**0.5056** *6*	0.26 *4*	0.0028	0.67	44
γ_9	**0.5290** *4*	1.05 *9*	0.0118	2.8	44
γ_{10}	**0.5385** *5*	0.27 *2*	0.0031	0.74	44
γ_{11}	**0.6249** *5*	0.066 *8*	0.00088	0.21	46
γ_{12}	**0.6877** *6*	0.025 *8*	0.00037	0.089	47
γ_{13}	**0.7361** *6*	0.03 *1*	0.00047	0.11	48
γ_{14}	**0.7844** *6*	0.04 *1*	0.00067	0.16	49

Basic Data, Sources for Adopted Values

Decay Scheme

Q^+ = 1.3 *3* From β-systematics 67Go30

The γ-placements are determined by the γ-energies, $\gamma\gamma$-coincidence measurements (67Se05, 68Ra11), and levels seen in ^{124}Te(d, t) (64Jo12) and in Coulomb excitation (55F40).

No β^+ (<0.01%) 68Ra11

Intensities per 100 ^{123}Te decays are obtained from the relative γ-intensities, ce_1/γ_1, and the requirement that $I(\gamma_1 + ce_1 + \gamma_7 + \gamma_8)$[c,d] = 100.

[c]$I(\gamma_{12})$ and $I(\gamma_{14})$ are negligible here

[d]The compilers assume there is no capture branch feeding the ground state. This assumption is based on the fact that for a second-forbidden transition, log *ft* is expected to be >10.6. For Q^+ = 1.3 *3*, and $T_{1/2}$ (^{123}I) = 13.2 h, this log *ft* value yields $I(\epsilon$ to g.s.) <0.04%

Basic Data, Sources for Adopted Values cont.

Decay Modes

Type	Energy MeV	Intensity %	
ϵ_K		85.5 *1*	$I(\epsilon)$, ϵ_L/ϵ_K, and $\epsilon_{MNO}/\epsilon_L$
ϵ_L		11.6 *2*	
ϵ_{MNO}		2.9 *5*	
ϵ		100	Decay scheme
ce_{1K}		14.1 *3*	$I(ce_1)$, ce_{1K}/ce_{1L}, and ce_{1MN}/ce_{1L}
ce_{1L}		1.88 *5*	
ce_{1MN}		0.41 *4*	
ce		16.4 *3*	See $I(\gamma_1)$
γ_1	**0.15900** *3*		64Ch08
		82.9 *3*	ce_1/γ_1, γ_7/γ_1, γ_8/γ_1, and $I(\gamma_1+ce_1+\gamma_7+\gamma_8)^a = 100$

$\gamma_2 \cdots \gamma_{14}$ $E(\gamma)$ and $I(\gamma)$ are data of 68Ra11. The authors' relative intensities are normalized so that, in conjunction with ce_1/γ_1, the condition $I(\gamma_1+ce_1+\gamma_7+\gamma_8)^a = 100$ is satisfied.

[a] $I(\gamma_{12})$ and $I(\gamma_{14})$ are negligible here

Basic Data, Sources for Adopted Values cont.

Auxiliary Data

$\epsilon_L/\epsilon_K = 0.136^b\ 2^c$	Theory
$\epsilon_{MNO}/\epsilon_L = 0.250$	Theory
$ce_{1K}/\gamma_1 = {}^W0.170$ *4*	64Ch08, 66Ha03
$ce_{1K}/ce_{1L} = {}^W7.5$ *2*	66Ha03, 68Ka20
$ce_{1MN}/ce_{1L} = 0.22$ *2*	66Ha03
$\therefore ce_1/\gamma_1 = 0.198$ *5*	
$\gamma_7/\gamma_1 = 0.0042$ *2*	68Ra11
$\gamma_8/\gamma_1 = 0.0031$ *5*	68Ra11
$\omega_K = 0.868$	Appendix III
$\omega_L = 0.125$	
$n_{KL} = 0.93$	

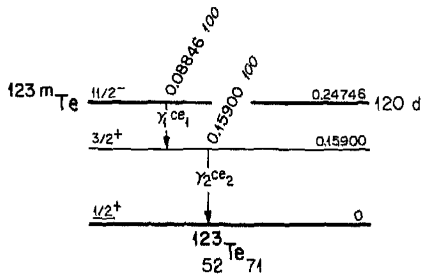
[b] Evaluated for the ϵ_2-branch. The difference between the value for this branch and that for the low-intensity group ϵ_1 will produce a negligible effect on the total ϵ_K-, ϵ_L-, and ϵ_{MNO}-intensities

[c] Uncertainty is that due to the uncertainty in Q^+

[W] Weighted average

$^{123m}_{52}Te_{71}$

Decay Characteristics



$T_{1/2}$ 120 d *1* Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00319**	86.5 *6*	0.00588	1.1	<0.0001
e_{AK}	**0.02272**	7.50 *6*	0.00363	0.69	0.00079
ce_{1K}	**0.05665** *2*	43.0 *4*	0.0519	9.9	0.0039
ce_{1L}	**0.08352**[a] *2*	44.5 *4*	0.0792	15.1	0.0079
ce_{1M}	**0.08745**[b] *2*	10.2 *5*	0.0190	3.6	0.0085
ce_{1N}	**0.08829**[c] *2*	2.2 *8*	0.0041	0.78	0.0087
ce_{2K}	**0.12719** *3*	14.19 *7*	0.0384	7.3	0.016
ce_{2L}	**0.15406**[a] *3*	1.89 *5*	0.0062	1.2	0.022
ce_{2MN}	**0.15806**[b] *3*	0.42 *4*	0.0014	0.27	0.023
X_L	**0.00377**	12.4 *1*	0.00100	0.19	0.026
X_K	**0.02803**	49.3 *4*	0.0294	5.6	8.3
γ_1	**0.08846** *2*	0.088 *1*	0.00017	0.03	29
γ_2	**0.15900** *3*	83.5 *3*	0.283	54.1	34

Basic Data, Sources for Adopted Values

Decay Scheme

No γ other than 0.08846 and 0.15900 γ's	51H40
$\gamma_1\gamma_2$-coincidence	50K04, 53G07
$\therefore I(\gamma_1+ce_1) = (\gamma_2+ce_2) = 100$	

Basic Data, Sources for Adopted Values cont.

Decay Modes

Type	Energy MeV	Intensity %	
ce_{1K}		42.6 *4*	ce_{1K}/γ_1, ce_{1K}/ce_{1L}, ce_{1M}/ce_{1L}, ce_{1N}/ce_{1L}, and $I(\gamma_1+ce_1)=100$
ce_{1L}		44.1 *4*	
ce_{1M}		10.9 *5*	
ce_{1N}		2.2 *8*	
ce_{2K}		14.19 *7*	ce_{2K}/γ_2, ce_{2K}/ce_{2L}, ce_{2MN}/ce_{2L}, and $I(\gamma_2+ce_2)=100$
ce_{2L}		1.89 *5*	
ce_{2MN}		0.42 *4*	
γ_1	**0.08846** *2*		64Ch18
		0.088 *1*	See $I(ce_1)$
γ_2	**0.15900** *3*		64Ch08
		83.5 *3*	See $I(ce_2)$

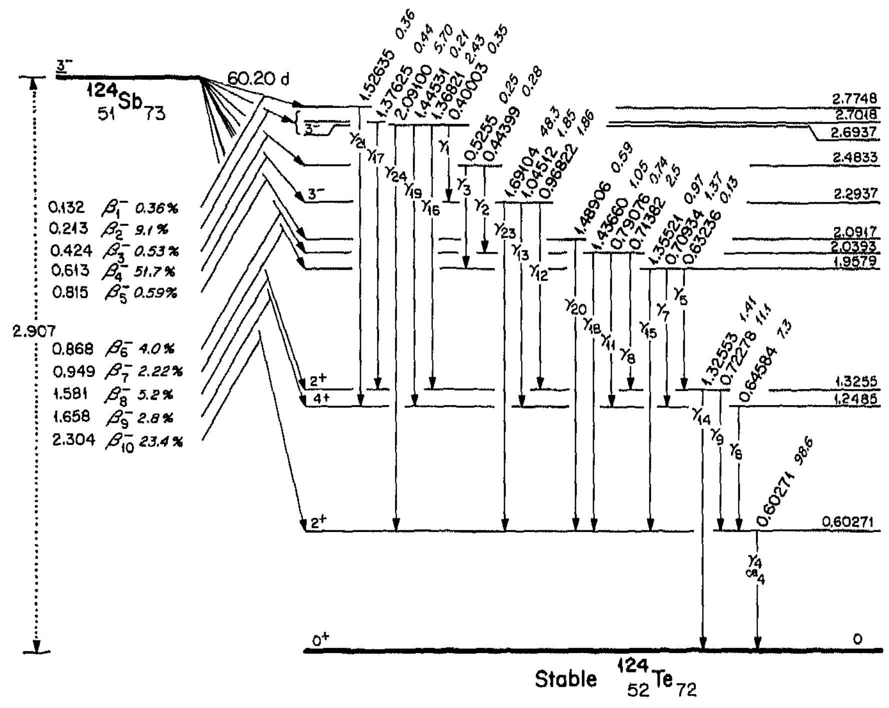
Auxiliary Data

$ce_{1K}/\gamma_1 = 490$	M4 Theory
$ce_{1K}/ce_{1L} = {}^{*}0.966$	M4 Theory
${}^{W}0.96$ *3*	64Ch18, 68Ka20
$ce_{1M}/ce_{1L} = {}^{*}0.247$	M4 Theory
${}^{W}0.23$ *1*	64Ch18, 68Ka20
$ce_{1N}/ce_{1L} = 0.05$ *2*	68Ka20
$ce_{2K}/\gamma_2 = {}^{W}0.170$ *4*	64Ch08, 66Ha03
$ce_{2K}/ce_{2L} = {}^{W}7.5$ *2*	66Ha03, 68Ka20
$ce_{2MN}/ce_{2L} = 0.22$ *2*	66Ha03
$\omega_K = 0.868$	Appendix III
$\omega_L = 0.125$	
$n_{KL} = 0.93$	

[a]Energy of L_1-line given
[b]Energy of M_1-line given
[c]Energy of N_1-line given
[W]Weighted average
*Value adopted by compiler from possibilities shown

$^{124}_{51}Sb_{73}$-1

Decay Characteristics



$T_{1/2}$	60.20 d 2	Appendix I

Note

Because of the large number of low-intensity γ-rays and the resulting complexity of the ^{124}Sb decay scheme, only γ's with intensity $\geq 0.1\%$ are included here. The total intensity of the ≈ 50 γ's not included is $\leq 1.5\%$. For a list of these γ's and additional levels not shown above, see 69Me04.

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00319**	0.340 *1*	0.000023	≈0	<0.0001
ce_{4K}	**0.57090** 2	0.417 *1*	0.00507	0.11	0.16
β_1^-	**0.132**$_{max}$ *3*				
	0.0352$_{av}$ *10*	0.36 *3*	0.00027	0.006	0.0066
β_2^-	**0.213**$_{max}$ *3*				
	0.0589$_{av}$ *10*	9.1 2	0.0114	0.24	0.0152

Radiations continued

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β_3^-	**0.424**$_{max}$ *3*				
	0.1273$_{av}$ *10*	0.53 *10*	0.0014	0.029	0.0476
β_4^-	**0.613**$_{max}$ *3*				
	0.1953$_{av}$ *10*	51.7 *5*	0.215	4.5	0.0844
β_5^-	**0.815**$_{max}$ *3*				
	0.2731$_{av}$ *10*	0.59 *5*	0.0034	0.071	0.128
β_6^-	**0.868**$_{max}$ *3*				
	0.2942$_{av}$ *10*	4.0 *2*	0.025	0.53	0.140
β_7^-	**0.949**$_{max}$ *3*				
	0.3270$_{av}$ *10*	2.22 *8*	0.0155	0.33	-0.159
β_8^-	**1.581**$_{max}$ *3*				
	0.5983$_{av}$ *10*	5.2 *2*	0.066	1.4	0.314
β_9^-	**1.658**$_{max}$ *3*				
	0.6327$_{av}$ *10*	2.8 *1*	0.038	0.80	0.333

$^{124}_{51}Sb_{73}$-2

Decay Characteristics continued

Radiations continued

Type	Energy MeV	Intensity %	$\Delta \left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β^-_{10}	2.304_{max} *3* 0.9283_{av} *10*	23.4 *6*	0.463	9.7	0.498
All β's	0.3837_{av} *10*	100	0.817	17.2	0.414
X_K	0.02803	0.362 *1*	0.000216	0.004	8.3
γ_1	0.40003 *6*	0.35 *15*	0.0030	0.063	41
γ_2	0.44399 *5*	0.28 *8*	0.0026	0.055	42
γ_3	0.5255 *1*	0.25 *6*	0.0028	0.059	44
γ_4	0.60271 *2*	98.2 *1*	1.261	26.5	46
γ_5	0.63236 *10*	0.13 *3*	0.0018	0.038	46
γ_6	0.64584 *3*	7.3 *1*	0.100	2.1	46
γ_7	0.70934 *5*	1.37 *5*	0.0207	0.43	48
γ_8	0.71382 *4*	2.5 *1*	0.038	0.80	48
γ_9	0.72278 *3*	11.1 *2*	0.171	3.6	48
$^{x}\gamma_{10}$	0.7357 *1*	0.13 *1*	0.00204	0.043	48
γ_{11}	0.79076 *4*	0.74 *1*	0.0125	0.26	49
γ_{12}	0.96822 *3*	1.86 *4*	0.0383	0.80	53
γ_{13}	1.04512 *4*	1.85 *4*	0.0412	0.87	54
γ_{14}	1.32553 *3*	1.41 *6*	0.040	0.84	59
γ_{15}	1.35521 *5*	0.97 *4*	0.028	0.59	59
γ_{16}	1.36821 *3*	2.43 *9*	0.071	1.5	59
γ_{17}	1.37625 *6*	0.44 *3*	0.013	0.27	59
γ_{18}	1.43660 *5*	1.05 *6*	0.032	0.67	60
γ_{19}	1.44531 *8*	0.21 *1*	0.0065	0.14	60
γ_{20}	1.48906 *8*	0.59 *5*	0.019	0.40	61
γ_{21}	1.52635 *9*	0.36 *3*	0.012	0.25	62
γ_{22}	1.69104 *3*	48.3 *5*	1.74	36.6	64
γ_{23}	2.09100 *5*	5.70 *9*	0.254	5.3	69

[a]Conversion in higher shells is negligible here

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^- = 2.907$ *3* — $E(\beta^-_{10})+E(0.60272$ level)

The γ-placements are determined by the γ-energies and extensive $\gamma\gamma$- and $\beta\gamma$-coincidence measurements (67St05, 68Zi04, 69Me04).

No β to ground state — 50L51

Intensities per 100 ^{124}Sb decays are obtained from the relative γ-intensities, ce^a_{4K}/γ_4, and the requirement that $I(\gamma_4+ce^a_{4K}+\gamma_{14})=100$.

Decay Modes

Type	Energy MeV	Intensity %	
ce_{4K}		0.417 *1*	See $I(\gamma)$

$\beta^-_1 \cdots \beta^-_7$ — $E(\beta)$ are calculated from Q^- and the ^{124}Te level energies. $I(\beta)$ are calculated from the γ-intensities.

Type	Energy MeV	Intensity %	Source
β^-_8	*1.581 *3*		Q^--E(1.3255 level)
	^{U}1.591 *6*		53L35, 53T05, 56Z06
		*5.2 *2*	γ-intensities
		^{U}7 *2*	53L35, 53T05, 54M83, 55A29, 56Z06
β^-_9	*1.658 *3*		Q^--E(1.2485 level)
	1.658	5	53T05
		*2.8 *1*	γ-intensities
β^-_{10}	^{W}2.304 *3*		56Z06, 65Hs02, 66Ca10
		*23.4 *6*	(γ+ce)-intensities
		^{U}23 *2*	53L35, 53T05, 54M83, 55A29, 56Z06

$\gamma_1 \cdots \gamma_{23}$ — $E(\gamma)$ are weighted averages of data of 68Ra16 (^{124}I decay), 69Au01 (^{124}Sb decay), and 69Me04 (^{124}Sb decay). $I(\gamma)$ are weighted averages of data of 66Vr01, 67St05, 68Zi04, 69Au01, and 69Me04. The relative values of each author are normalized so that $I(\gamma_4+ce_4+\gamma_{14})=100$.

Auxiliary Data

$ce_{4K}/\gamma_4 = $ *0.00425 — E2 Theory

0.0042 *3* — 52M21

$\left.\begin{array}{l}\alpha_K = 0.868 \\ \alpha_L = 0.125 \\ n_{KL} = 0.93\end{array}\right\}$ Appendix III

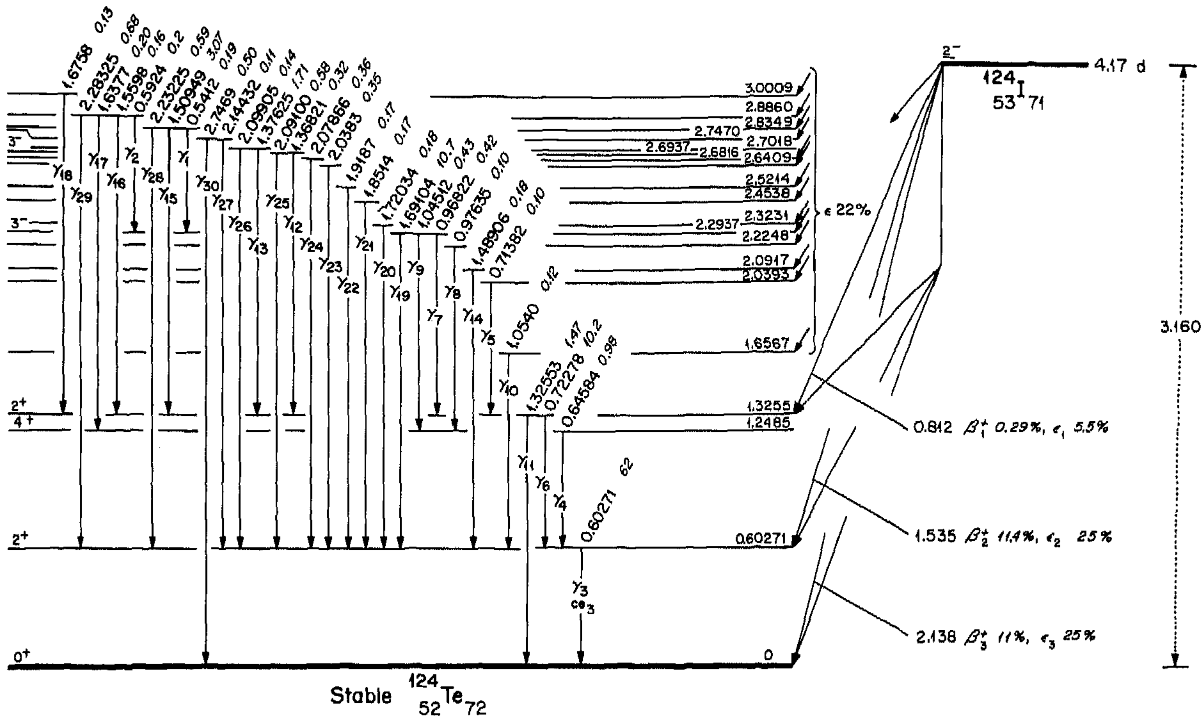
U, W Unweighted average, weighted average

X Not shown on decay scheme since placement not determined

*Value adopted by compilers from possibilities shown

$^{124}_{53}I_{71}$-1

Decay Characteristics



$T_{1/2}$	4.17 d 7	Appendix I

Note

Because of the large number of low-intensity γ-rays and the resulting complexity of the ^{124}I decay scheme, only γ's with intensity $\gtrsim 0.1\%$ are included here. The total intensity of the $\approx$32 γ's not included is $\leq$1%. For a list of these γ's and additional levels not shown above, see 68La21 and 68Ra16.

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00319**	61 *3*	0.0041	0.15	<0.0001
e_{AK}	**0.02272**	8.7 *4*	0.0042	0.15	0.00079
ce_{3K}	**0.57090**	0.26 *1*	0.0032	0.12	0.16
β_1^+	**0.812**$_{max}$ *8* **0.366**$_{av}$ *3*	0.29 *2*	0.0023	0.084	0.138
β_2^+	**1.535**$_{max}$ *8* **0.684**$_{av}$ *3*	11.4 *6*	0.166	6.1	0.312

Radiations continued

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β_3^+	**2.138**$_{max}$ *8* **0.971**$_{av}$ *4*	11 *1*	0.23	8.4	0.485
All β's	**0.811**$_{av}$ *4*	23 *1*	0.40	14.7	0.431
X_L	**0.00377**	8.8 *4*	0.00071	0.026	0.026
X_K	**0.02803**	57 *3*	0.034	1.2	8.3
$\gamma^{\pm}$	**0.5110**	46 *2*	0.50	18.3	44
γ_1	**0.5412** *1*	0.19 *1*	0.0022	0.081	44
γ_2	**0.5924** *2*	0.2 *1*	0.003	0.11	45
γ_3	**0.60271** *2*	62 *2*	0.80	29.3	46
γ_4	**0.64584** *3*	0.98 *3*	0.0135	0.49	46
γ_5	**0.71382** *4*	0.10 *2*	0.0015	0.055	48

continued on next page

Decay Characteristics continued

Radiations continued

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
γ_6	**0.72278** *3*	10.2 *3*	0.157	5.7	48
γ_7	**0.96822** *3*	0.42 *1*	0.0087	0.32	53
γ_8	**0.97635** *12*	0.10 *2*	0.0021	0.077	53
γ_9	**1.04512** *4*	0.43 *3*	0.0096	0.35	54
γ_{10}	**1.0540** *2*	0.12 *1*	0.0027	0.099	54
γ_{11}	**1.32553** *3*	1.47 *5*	0.041	1.5	58
γ_{12}	**1.36821** *4*	0.32 *8*	0.0093	0.34	59
γ_{13}	**1.37625** *6*	1.71 *2*	0.0501	1.8	59
γ_{14}	**1.48906** *8*	0.18 *2*	0.0057	0.21	61
γ_{15}	**1.50949** *4*	3.07 *3*	0.0987	3.6	62
γ_{16}	**1.5598** *2*	0.16 *2*	0.0053	0.19	62
γ_{17}	**1.6377** *5*	0.20 *2*	0.0070	0.26	63
γ_{18}	**1.6758** *4*	0.13 *3*	0.0046	0.17	64
γ_{19}	**1.69104** *3*	10.7 *3*	0.385	14.1	64
γ_{20}	**1.72034** *10*	0.18 *2*	0.0066	0.24	64
γ_{21}	**1.8514** *4*	0.17 *3*	0.0067	0.25	66
γ_{22}	**1.9187** *2*	0.17 *2*	0.0069	0.25	67
γ_{23}	**2.0383** *3*	0.35 *2*	0.015	0.55	69
γ_{24}	**2.07886** *7*	0.36 *2*	0.016	0.59	69
γ_{25}	**2.09100** *5*	0.58 *2*	0.026	0.95	70
γ_{26}	2.09905 *7*	0.14 *1*	0.0063	0.23	70
γ_{27}	2.14432 *9*	0.11 *1*	0.0050	0.18	70
γ_{28}	2.23225 *7*	0.59 *2*	0.028	1.0	71
γ_{29}	2.28325 *8*	0.68 *5*	0.033	1.2	72
γ_{30}	2.7469 *1*	0.50 *5*	0.029	1.1	≈80

[a] Conversion in higher shells is negligible here

[b] $q_{L,K}$ are neutrino energies. See Appendix III

[c] Uncertainty assigned by compilers

[U, W] Unweighted average, weighted average

*Value adopted by compilers from possibilities shown

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^+ = 3.160$ *8* $\quad E(\beta_3^+)+2mc^2$

The γ-placements, from 68La21 and 68Ra16, are determined by the γ-energies and $\gamma\gamma$-coincidence data. Intensities per 100 ^{124}I decays are obtained from γ_{11}/γ_3, γ_{30}/γ_3, ce_{3K}/γ_3, $\Sigma\beta^+/\gamma_3$, $\beta_3^+/\Sigma\beta^+$, ϵ_3/β_3^+, and the requirement that $I(\gamma_3+\gamma_{11}+\gamma_{30}+ce^a_{3K}+\beta_3^++\epsilon_3) = 100$.

Decay Modes

Type	Energy MeV	Intensity %	
ϵ_K		66 *3*	$I(\epsilon_3)$ is calculated as described under $I(\beta_3)$ below. Intensities of other ϵ-groups are obtained from γ-intensities, ϵ/β^+, ϵ_L/ϵ_K, and $\epsilon_{MNO}/\epsilon_L$.
ϵ_L		8.8 *3*	
ϵ_{MNO}		2.2 *1*	
ϵ		77 *3*	
ce_{3K}		0.39 *3*	See $I(\beta_3^+)$
β_1^+	*0.812 *8*		$Q^+-2mc^2-E(1.3255\ \text{level})$
	U0.79 *5*		59Ml22, 67Ru04
		0.29 *2*	γ-intensities and ϵ_1/β_1^+
β_2^+	*1.535 *8*		$Q^+-2mc^2-E(0.60272\ \text{level})$
	W1.535 *13*		59H27, 59Ml22, 67Ru04
		11.4 *6*	(γ+ce)-intensities and ϵ_2/β_2^+
β_3^+	W2.138 *8*		59H27, 59Ml22, 67Ru04
		11 *1*	$\beta_3^+/\Sigma\beta^+$, $\Sigma\beta^+/\gamma_3$, ϵ_3/β_3^+, γ_{11}/γ_3, γ_{30}/γ_3, ce^a_{3K}/γ_3, and $I(\gamma_3+\gamma_{11}+\gamma_{30}+ce^a_{3K}+\beta_3+\epsilon_3)=100$

$\gamma_1\cdots\gamma_{30}$ E(γ) are weighted averages of data of 68Ra16 (^{124}I decay), 69Au01 (^{124}Sb decay), and 69Me04 (^{124}Sb decay).
I(γ) are data of 68La21 and 68Ra16. The relative values of each author are normalized as described under $I(\beta_3^+)$ above.

Auxiliary Data

$\left.\begin{array}{l}\epsilon_1/\beta_1^+ = 18.7\ 7^d\\ \epsilon_2/\beta_2^+ = 2.19\ 4^d\\ \epsilon_3/\beta_3^+ = 2.26^e 3^d\end{array}\right\}$ Theory

$\left.\begin{array}{l}\gamma_{11}/\gamma_3 = {}^W0.0237\ 8\\ \gamma_{30}/\gamma_3 = {}^W0.0080\ 7\end{array}\right\}$ 68La21, 68Ra16

$ce_{3K}/\gamma_3 = {}^*0.00425$ E2 Theory
$\qquad 0.0042\ 3$ 52M21

$\left.\begin{array}{l}\epsilon_L/\epsilon_K = 0.129 q_L^2/q_K^2\ {}^b\\ \epsilon_{MNO}/\epsilon_L = 0.250\end{array}\right\}$ Appendix III

$\beta_3^+/\Sigma\beta^+ = {}^W0.455\ 10^c$ 59Ml22, 67Ru04

$\left.\begin{array}{l}\omega_K = 0.868\\ \omega_L = 0.125\\ n_{KL} = 0.93\end{array}\right\}$ Appendix III

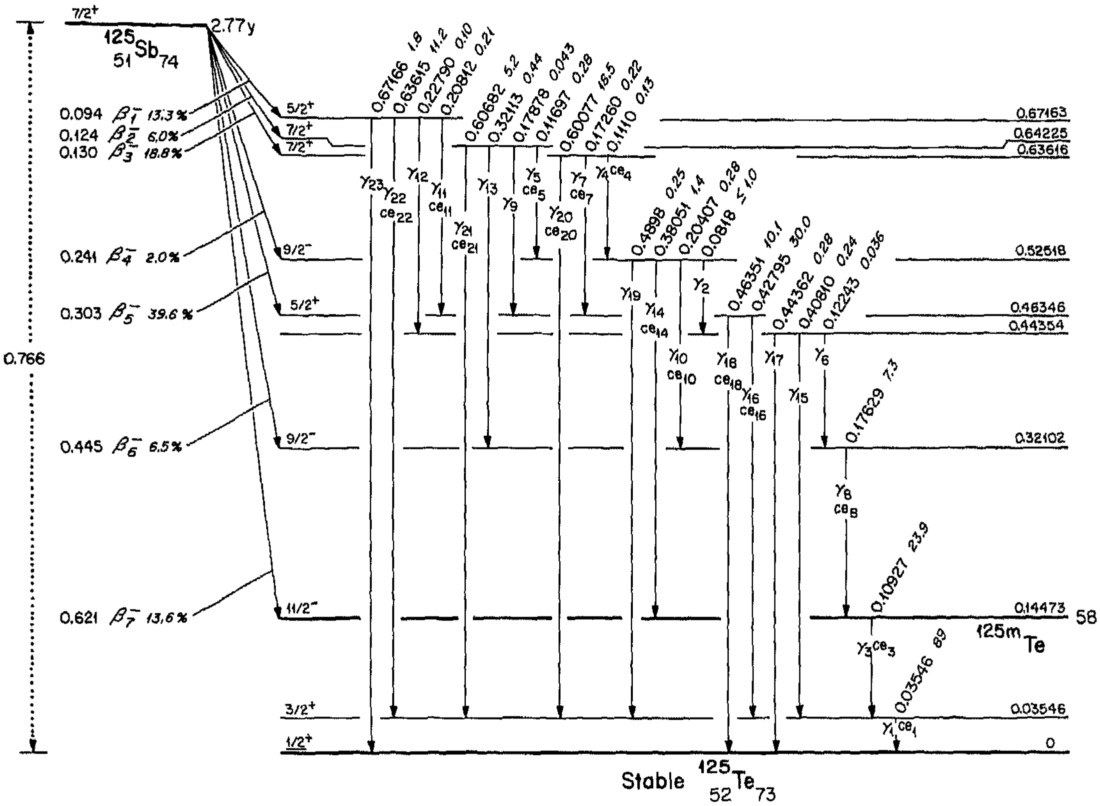
$\Sigma\beta^+/\gamma_3 = {}^W0.39\ 3$ 59G59, 59Ml22, 67Ru04

[d] Uncertainty is that due to uncertainty in Q^+

[e] Calculated for a first-forbidden unique transition

$\left({}^{125}_{51}Sb_{74}-{}^{125m}_{52}Te_{73}\right)$-1

Decay Characteristics



$T_{½}$	**2.77 y** *4*	(^{125}Sb)	Appendix I
	58 d *1*	(^{125m}Te)	

Note

The ratio of ^{125m}Te activity to that of ^{125}Sb in an initially pure ^{125}Sb source is given by

$$\frac{T_A}{T_A-T_B}\left[1-\exp\left(-0.693\left(\frac{T_A-T_B}{T_AT_B}\right)t\right)\right]=1.061[1-\exp(-4.11t)]$$

where $T_A=T_{½}$ (^{125}Sb), $T_B=T_{½}$ (^{125m}Te), and t is in years.

For $t \gtrsim 10T_B$ (≈ 1.6y), this ratio $=1.061$ *1* and the parent and daughter are in equilibrium. For $t \lesssim 1.6$y, the equilibrium ^{125m}Te radiations given in the following table should be decreased according to the above expression.

See (^{125}Sb-^{125m}Te)-3 for a separate list of the ^{125m}Te radiations.

[a]Energy of L_1-line given

[b]Energy of M_1-line given

Radiations (^{125}Sb-^{125m}Te)

Type	Energy MeV	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00319**	84 *2*	0.0057	0.47	<0.0001
ce_{1K}	**0.00365** *3*	72 *2*	0.0056	0.46	<0.0001
e_{AK}	**0.02272**	11.1 *3*	0.0054	0.45	0.00079
ce_{1L}	**0.03052**[a] *3*	9.1 *2*	0.0059	0.49	0.0013
ce_{1MN}	**0.03445**[b] *3*	1.66 *4*	0.0012	0.099	0.0016
ce_{3K}	**0.07746** *2*	12.1 *7*	0.020	1.7	0.0069
ce_{4K}	**0.0792** *1*	0.034 *9*	0.00006	0.005	0.0072
ce_{5K}	**0.08516** *5*	0.021 *2*	0.000038	0.003	0.0081
ce_{3L}	**0.10433**[a] *2*	9.1 *4*	0.020	1.7	0.011

Decay Characteristics continued

Radiations (^{125}Sb-^{125m}Te) continued

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
ce_{3MN}	**0.10826**[a] 2	2.5 2	0.0058	0.48	0.012
ce_{7K}	**0.14079** 5	0.018 2	0.000054	0.004	0.019
ce_{8K}	**0.14448** 2	0.88 5	0.0027	0.22	0.019
ce_{8L}	**0.17135**[b] 2	0.15 1	0.00055	0.045	0.025
ce_{10K}	**0.17226** 4	0.027 2	0.000099	0.008	0.026
ce_{8MN}	**0.17528**[a] 2	0.050 3	0.00019	0.016	0.027
ce_{11K}	**0.17631** 4	0.022 2	0.000083	0.007	0.027
ce_{14K}	**0.34870** 4	0.021 2	0.00016	0.013	0.077
ce_{16K}	**0.39614** 2	0.340 8	0.00287	0.24	0.093
ce_{16L}	**0.42301**[b] 2	0.045 1	0.00041	0.034	0.10
ce_{18K}	**0.43170** 4	0.083 3	0.00076	0.063	0.11
ce_{18L}	**0.45857**[b] 4	0.0118 5	0.00012	0.010	0.11
ce_{20K}	**0.56896** 6	0.074 2	0.00090	0.074	0.16
ce_{21K}	**0.60434** 4	0.019 2	0.00024	0.020	0.17
ce_{22K}	**0.63985** 4	0.045 2	0.00061	0.050	0.18
β_1^-	**0.094**$_{max}$ 2 **0.0246**$_{av}$ 6	13.3 6	0.0070	0.58	0.00360
β_2^-	**0.124**$_{max}$ 2 **0.0329**$_{av}$ 6	6.0 4	0.0042	0.35	0.0059
β_3^-	**0.130**$_{max}$ 2 **0.0346**$_{av}$ 6	18.8 6	0.0139	1.1	0.0064
β_4^-	**0.241**$_{max}$ 2 **0.0675**$_{av}$ 6	2.0 6	0.0029	0.24	0.0188
β_5^-	**0.303**$_{max}$ 2 **0.0870**$_{av}$ 6	39.6 7	0.073	6.0	0.0276
β_6^-	**0.455**$_{max}$ 2 **0.1381**$_{av}$ 6	6.5 10	0.019	1.6	0.053
β_7^-	**0.621**$_{max}$ 2 **0.2160**$_{av}$ 6	13.6 9	0.063	5.2	0.094
All β's	**0.0861**$_{av}$ 6	100	0.183	15.1	0.061

[a]Energy of M_1-line given
[b]Energy of L_1-line given

Decay Characteristics continued

Radiations (^{125}Sb-^{125m}Te) continued

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
X_L	**0.00377**	12.0 3	0.00096	0.079	0.026
X_K	**0.02803**	73 2	0.044	3.6	8.3
γ_1	**0.03546** 3	5.9 1	0.0045	0.37	13
γ_2	**0.0818** 2	$\leq$1.0	$\leq$0.0017	$\leq$0.14	28
γ_3	**0.10927** 2	0.066 3	0.00015	0.012	31
γ_4	**0.1110** 1	0.098 9	0.00023	0.019	31
γ_5	**0.11697** 5	0.26 2	0.00065	0.054	32
γ_6	**0.12243** 5	0.036 9	0.00009	0.007	32
γ_7	**0.17260** 5	0.20 1	0.00074	0.061	35
γ_8	**0.17629** 2	6.3 3	0.024	2.0	35
γ_9	**0.17878** 5	0.043 8	0.00016	0.013	35
γ_{10}	**0.20407** 4	0.25 3	0.0011	0.091	36
γ_{11}	**0.20812** 4	0.19 2	0.0008	0.066	36
γ_{12}	**0.22790** 7	0.10 1	0.00049	0.040	37
γ_{13}	**0.32113** 7	0.44 3	0.0030	0.25	39
γ_{14}	**0.38051** 4	1.4 1	0.011	0.91	41
γ_{15}	**0.40810** 7	0.24 6	0.0021	0.17	41
γ_{16}	**0.42795** 2	29.6 5	0.270	22.3	42
γ_{17}	**0.44362** 7	0.28 2	0.0026	0.21	42
γ_{18}	**0.46351** 4	10.0 4	0.099	8.2	43
γ_{19}	**0.4898** 2	0.25 8	0.0026	0.21	43
γ_{20}	**0.60077** 6	18.4 6	0.235	19.4	46
γ_{21}	**0.60682** 4	5.2 3	0.067	5.5	46
γ_{22}	**0.63615** 4	11.2 6	0.152	12.5	46
γ_{23}	**0.67166** 4	1.8 2	0.026	2.1	47

continued on next page

$\left({}^{125}_{51}Sb_{74} - {}^{125m}_{52}Te_{73}\right)$-3

Decay Characteristics continued

Radiations (^{125m}Te)

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00319**	150 *3*	0.0102	3.4	<0.0001
ce_{1K}	**0.00365** *3*	81 *2*	0.0063	2.1	<0.0001
e_{AK}	**0.02272**	17.4 *3*	0.0084	2.8	0.00079
ce_{1L}	**0.03052**[a] *3*	10.4 *2*	0.0068	2.2	0.0013
ce_{1MN}	**0.03445**[b] *3*	1.82 *3*	0.0013	0.43	0.0016
ce_{3K}	**0.07746** *2*	50.8 *10*	0.084	27.8	0.0069
ce_{3L}	**0.10433**[a] *2*	38.2 *7*	0.085	28.1	0.011
ce_{3MN}	**0.10826**[b] *2*	10.8 *2*	0.0249	8.2	0.012
X_L	**0.00377**	21.4 *4*	0.00172	0.57	0.026
X_K	**0.02803**	114 *2*	0.068	22.5	8.3
γ_1	**0.03546** *3*	6.76 *10*	0.00511	1.7	13
γ_3	**0.10927** *2*	0.276 *6*	0.00064	0.21	31

Basic Data, Sources for Adopted Values

Decay Scheme

^{125}Sb-^{125m}Te

$Q^- = 0.766$ *2* $\qquad E(\beta_7^-)+E(0.14473$ level)

The γ-placements are determined by the γ-energies and extensive $\gamma\gamma$- and $\beta\gamma$-coincidence studies (54M43, 63Ch13, 64Ma30, 68In01, and 68Wo04).

Equilibrium intensities per 100 ^{125}Sb decays are obtained from the relative γ-intensities, relative ce-intensities, ce_{16}/γ_{16}, $I(\beta_7^-)$, and the requirement that $I(\gamma_8+\gamma_{14}+\cdots\gamma_{23}+ce_8+ce_{14}+\cdots+ce_{22}+\beta_7^-)=100$.

^{125m}Te

$\gamma_1\gamma_3$-coincidence observed $\qquad$ 52M03, 53G07

Intensities per 100 ^{125m}Te decays are obtained from ce_1/γ_1, ce_3/γ_3, and the requirement that $I(\gamma_1+ce_1) = I(\gamma_3+ce_3) = 100$.

[a]Energy of L_1-line given
[b]Energy of M_1-line given
[U]Unweighted average
[W]Weighted average
*Value adopted by compilers from possibilities shown

Basic Data, Sources for Adopted Values cont.

Decay Modes (^{125}Sb-^{125m}Te)

Type	Energy MeV	Intensity %	
ce_{1K}, ce_{1L}, ce_{1MN}, ce_{3K}, ce_{3L}, ce_{3MN}			I(ce) are calculated from ce_{1K}/γ_1, ce_{3K}/γ_3, ce_K/ce_L and ce_L/ce_{MN} values for each transition, the requirement of an intensity balance at the 0.03546 and 0.14473 MeV levels, and the requirement that the ratio of ^{125m}Te activity to that of ^{125}Sb in an equilibrium mixture is 1.061 *1*. See ''Note'' under decay scheme drawing.
$ce_4\cdots ce_{22}$			$I(ce_K)$ are weighted averages of data of 59N06, 64Ma30, and 66Ma49. The relative values of each author are normalized so that, in conjunction with the relative γ-intensities, ce_{16K}/γ_{16}, ce_K/ce_L and ce_L/ce_{MN} values, and $I(\beta_7^-)$, the requirement on the intensities given above under ''Decay Scheme'', is satisfied.
$\beta_1^-\cdots\beta_4^-$			$E(\beta)$ are calculated from Q^- and the ^{125}Te level energies. $I(\beta)$ are calculated from the γ-intensities.
β_5^-	*0.303 *2*		Q^--E(0.46346 level)
	0.302 *4*		66Ma49
		*39.6 *7*	(γ+ce)-intensities
		[U]47	50S19, 54M43
β_6^-	*0.445 *2*		Q^--E(0.32102 level)
	0.444 *8*		66Ma49
		*6.5 *10*	(γ+ce)-intensities
		7.2 *14*	59N06
β_7^-	[W]0.621 *2*		59N06, 64Ma30, 66Ma49
		[W]13.6 *9*	59N06, 64Ma30
$\gamma_2,\gamma_4\cdots\gamma_{23}$			$E(\gamma)$ are data of 66Ma49. $I(\gamma)$ are weighted averages of data of 59N06, 68In01, 68Wo04, and 69Ch06. The relative values of each author are normalized as described under $I(ce_4\cdots ce_{22})$ above.
γ_1, γ_3			$E(\gamma)$ are data of 66Ma49. $I(\gamma)$ are calculated from ce_1/γ_1, ce_3/γ_3, the requirement of an intensity balance at the 0.03546 and 0.14473 MeV levels, and the requirement that the ratio of ^{125m}Te activity to that of ^{125}Sb in an equilibrium mixture is 1.061 *1*. See ''Note'' under decay scheme drawing.

Basic Data, Sources for Adopted Values cont.

Decay Modes (^{125m}Te)

Type	Energy MeV	Intensity %	
ce_{1K}, ce_{1L}, ce_{1MN}, ce_{3K}, ce_{3L}, ce_{3MN}		I(ce) are calculated from ce_{1K}/γ_1, ce_{3K}/γ_3, ce_K/ce_L, and ce_L/ce_{MN} values for each transition and the requirement that $I(\gamma_1+ce_1) = I(\gamma_3+ce_3) = 100$.	
γ_1	**0.03546** *3*		66Ma49
		6.76 *10*	See I(ce) above
γ_3	**0.10927** *2*		66Ma49
		0.276 *6*	See I(ce) above

Basic Data, Sources for Adopted Values cont.

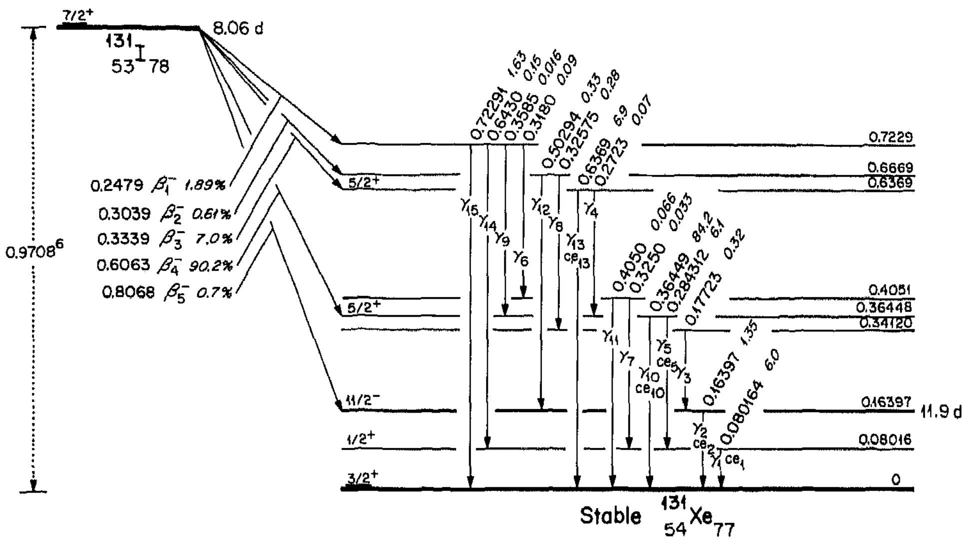
Auxiliary Data

$\omega_K = 0.868$	Appendix III
$\omega_L = 0.125$	Appendix III
$n_{KL} = 0.93$	Appendix III
$ce_{1K}/\gamma_1 = {}^U11$ *3*	50F60, 52B16
$*12.0$ *1*	M1+E2 theory for E2/M1 = 0.08 *3* (66Ma49)
$ce_{1K}/ce_{1L} = *7.8$ *1*	M1+E2 theory for E2/M1 = 0.08 *3* (66Ma49)
${}^U7.3$ *13*	52B16, 59N06
$ce_{1L}/ce_{1MN} = {}^U5.7$ *11*	52B16, 59N06
$\therefore ce_1/\gamma_1 = 13.8$ *2*	
$ce_{3K}/\gamma_3 = 160$ *20*	52B16
$*184$	M4 Theory
$ce_{3K}/ce_{3L} = {}^U1.35$ *10*	59N06, 64Ma30, 66Ma49
$*1.33$	M4 Theory
$ce_{3L}/ce_{3MN} = 3.54$ *15*	59N06
$\therefore ce_3/\gamma_3 = 361$ *7*	
$ce_{8K}/ce_{8L} = {}^W5.9$ *4*	64Ma30, 66Ma49
$*6.0$ *1*	M1+E2 Theory for E2/M1 = 0.39 *3* (66Ma49)
$ce_{8L}/ce_{8MN} = 2.8$ *5*	59N06
$ce_{16K}/\gamma_{16} = 0.0115$ *2*	M1+E2 Theory for E2/M1 = 1.0 *3* (66Ma49)
$ce_{16K}/ce_{16L} = *7.5$ *1*	M1+E2 Theory for E2/M1 = 1.0 *3* (66Ma49)
${}^W7.3$ *4*	59N06, 64Ma30, 66Ma49
$ce_{16L}/ce_{16MN} = 3.8$ *8*	59N06
$\therefore ce_{16}/\gamma_{16} = 0.0134$ *3*	
$ce_{18K}/ce_{18L} = {}^W7.0$ *6*	59N06, 64Ma30, 66Ma49
$*7.05$	E2 Theory

^{U}Unweighted average
^{W}Weighted average
*Value adopted by compilers from possibilities shown

$^{131}_{53}I_{78}$-1

Decay Characteristics



$T_{1/2}$ 8.06 d 1 (^{131}I)
11.9 d 1 (^{131m}Xe) } Appendix I

Note

The ratio of ^{131m}Xe activity to that of its parent, ^{131}I, is given, as a function of time, t, by

$$\frac{T_A}{T_B-T_A}\left[\exp\left(0.693\frac{(T_B-T_A)t}{T_A T_B}\right)-1\right] = 2.077\left[\exp(0.0279t)-1\right]$$

where $T_A = T_{1/2}$ (^{131}I), $T_B = T_{1/2}$ (^{131m}Xe), t is in days, and the ^{131m}Xe activity is taken to be zero at t = 0 (that is, the ^{131}I is initially pure). When the ^{131}I and ^{131m}Xe activities are equal, the two sources are in a state of ''ideal equilibrium.'' This condition occurs at t ≈ 14.1 d. The intensity per 100 ^{131}I decays of the ^{131m}Xe transition (γ_2+ce$_2$) given below under ''Radiations'' is the value at ideal equilibrium.

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00343**	5.3 4	0.00039	0.032	<0.0001
e_{AK}	**0.02456**	0.67 5	0.00035	0.029	0.0009
ce_{1K}	**0.045603** 8	3.0 4	0.0029	0.24	0.0027
ce_{1L}	**0.074711**[a] 8	0.42 5	0.00067	0.055	0.0065

Radiations continued

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
ce_{1MN}	**0.079022**[b] 8	0.11 3	0.00019	0.015	0.0072
ce_{2K}	**0.12941** 2	0.75 5	0.0021	0.17	0.016
ce_{3K}	**0.14267** 3	0.046 4	0.00014	0.011	0.019
ce_{2L}	**0.15852**[a] 2	0.43 3	0.0015	0.12	0.022
ce_{2MN}	**0.16283**[b] 2	0.15 1	0.00052	0.042	0.023
ce_{5K}	**0.249751** 10	0.24 2	0.0013	0.11	0.046
ce_{5L}	**0.278859**[a] 10	0.041 5	0.00024	0.020	0.055
ce_{10K}	**0.32993** 2	1.48 4	0.0104	0.85	0.071
ce_{10L}	**0.35904**[a] 2	0.24 1	0.0018	0.15	0.080
ce_{10MN}	**0.36335**[b] 2	0.062 4	0.00048	0.039	0.082
ce_{13K}	**0.6023** 2	0.028 3	0.00036	0.029	0.17
β_1^-	**0.2479**$_{max}$ 6 **0.0695**$_{av}$ 2	1.89 5	0.00279	0.23	0.0197

[a] Energy of L_I-line given
[b] Energy of M_I-line given

Decay Characteristics	Basic Data, Sources for Adopted Values

Decay Characteristics

Radiations continued

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β_2^-	0.3039$_{max}$ 6 0.0871$_{av}$ 2	0.61 4	0.00113	0.092	0.0277
β_3^-	0.3339$_{max}$ 6 0.0968$_{av}$ 2	7.0 2	0.0144	1.2	0.0323
β_4^-	0.6063$_{max}$ 6 0.1922$_{av}$ 2	90.2 6	0.369	30.1	0.083
β_5^-	0.8068$_{max}$ 6 0.2844$_{av}$ 2	0.7 1	0.0042	0.34	0.136
All β's	0.1834$_{av}$ 2	100	0.391	31.9	0.082
X_L	0.00411	0.86 6	0.000075	0.006	0.033
X_K	0.03040	4.9 4	0.0032	0.26	10
γ_1	0.080164 8	2.45 9	0.0042	0.34	27
γ_2	0.16397 2	0.023 2	0.000080	0.007	35
γ_3	0.17723 3	0.27 1	0.00102	0.083	35
γ_4	0.2723 5	0.07 1	0.00041	0.033	38
γ_5	0.284312 10	5.8 2	0.035	2.9	38
γ_6	0.3180 4	0.09 1	0.00061	0.050	39
γ_7	0.3250 4	0.033 9	0.00023	0.019	40
γ_8	0.32575 4	0.28 3	0.0019	0.15	40
γ_9	0.3585 5	0.016 4	0.00012	0.010	40
γ_{10}	0.36449 2	82.4 5	0.640	52.2	40
γ_{11}	0.4050 5	0.066 6	0.00057	0.046	41
γ_{12}	0.50294 10	0.33 3	0.0035	0.29	44
γ_{13}	0.6369 2	6.9 2	0.094	7.7	46
γ_{14}	0.6430 4	0.15 1	0.0021	0.17	46
γ_{15}	0.72291 5	1.63 5	0.0251	2.04	48

[a]Except for I(ce$_2$) and I(γ_2). These intensities are calculated from I(β_5), I(γ_3), I(γ_{12}), ce$_2$/γ_2, and the requirement of an intensity balance at the 0.16397 level
[b]I(ce$_3$) and I(ce$_{13}$) are negligible here
[U]Unweighted average
[W]Weighted average
*Value adopted by compilers from possibilities shown

Basic Data, Sources for Adopted Values

Decay Scheme

Q^- = 0.9708 6 E(β_4^-)+E(0.36448 level)

The γ-placements are determined by the γ-energies, the observed β-groups, and extensive $\gamma\gamma$- and $\beta\gamma$-coincidence measurements (51B17, 51K29, 52B26, 63Ju02, 67Gr05, and 67Yt02).

No β-transition to the ground state or to the 0.08016 level (<0.2%, 52B95).

Intensities per 100 ^{131}I decays are obtained from the relative γ-intensities, relative ce-intensities, ce$_{10}$/γ_{10}, I(β_5^-), and the requirement that I(γ_1+γ_3+γ_{10}+γ_{11}+γ_{12}+γ_{13}+γ_{15}+ce$_1$+ce$_{10}$+β_5^-)[b]=100.

Decay Modes

Type	Energy MeV	Intensity %	
ce$_1$···ce$_{13}$	I(ce$_K$)[a] are weighted averages of data of 62Wo9 and 64Da19. The relative values of each author are normalized so that, in conjunction with the relative γ-intensities, ce$_{10K}$/γ_{10}, ce$_K$/ce$_L$ and ce$_L$/ce$_{MN}$ values, and I(β_5^-), the requirement on the intensities given above under "Decay Scheme" is satisfied.		
β_1^-	*0.2479 6		Q^--E(0.7229 level)
	0.249 3		64Sn01
		1.89 5	γ-intensities
β_2^-	0.3039 6		Q^--E(0.6669 level)
		0.61 4	γ-intensities
β_3^-	*0.3339 6		Q^--E(0.6369 level)
	0.333 3		64Sn01
		*7.0 2	γ-intensities
		[U]12 2	48M28, 51V05, 52B95, 52R16
β_4^-	[W]0.6063 6		51V05, 52R16
		*90.2 6	γ-intensities
		[U]85 2	48M28, 49K14, 51V05, 52B95, 52R16
β_5^-	*0.8068 6		Q^--E(0.16397 level)
	[W]0.810 5		51Z01, 52B95, 52R16
		[U]0.7 1	51E21, 51V05, 52B26

γ_1···γ_{15} E(γ) are weighted averages of data of 53H28, 62Ge9, 62Wo9, 66Mo10, 67Fi12, 67Gr05, and 67Yt02.

I(γ)[a] are weighted averages of data of 63Ha08, 66Mo12, 67Gr05, and 67Yt02. The relative values of each author are normalized as described under I(ce$_K$) above.

Auxiliary Data

See next page

$^{131}_{53}I_{78}$ -3

Basic Data, Sources for Adopted Values cont.

Auxiliary Data

ω_K	=0.880	Appendix III
ω_L	=0.137	Appendix III
n_{KL}	=0.91	Appendix III
ce_{1K}/ce_{1L}	$=^{W}7.0$ *4*	51V05, 54N09
ce_{1L}/ce_{1MN}	= 3.9 *8*	64Da19
ce_{2K}/γ_2	= 32.1 *4*	66Kn03
	=*32.2	M4 Theory
ce_{2K}/ce_{2L}	$=^{U}1.94$ *11*	62Ge9, 62Wo9
	=*1.76	M4 Theory
ce_{2L}/ce_{2MN}	= 2.9 *2*	52B55
$\therefore ce_2/\gamma_2$	=56.8	
ce_{5K}/ce_{5L}	$=^{W}5.5$ *5*	52R16, 62Wo9
	=*5.85	E2 Theory
ce_{10K}/γ_{10}	=0.0180 *5*	51V05, 52R16
ce_{10K}/ce_{10L}	$=^{U}6.3$ *3*	52R16, 62Wo9, 64Da19
ce_{10L}/ce_{10MN}	=3.8 *2*	64Da19

^{U}Unweighted average

^{W}Weighted average

*Value adopted by compilers from possibilities shown

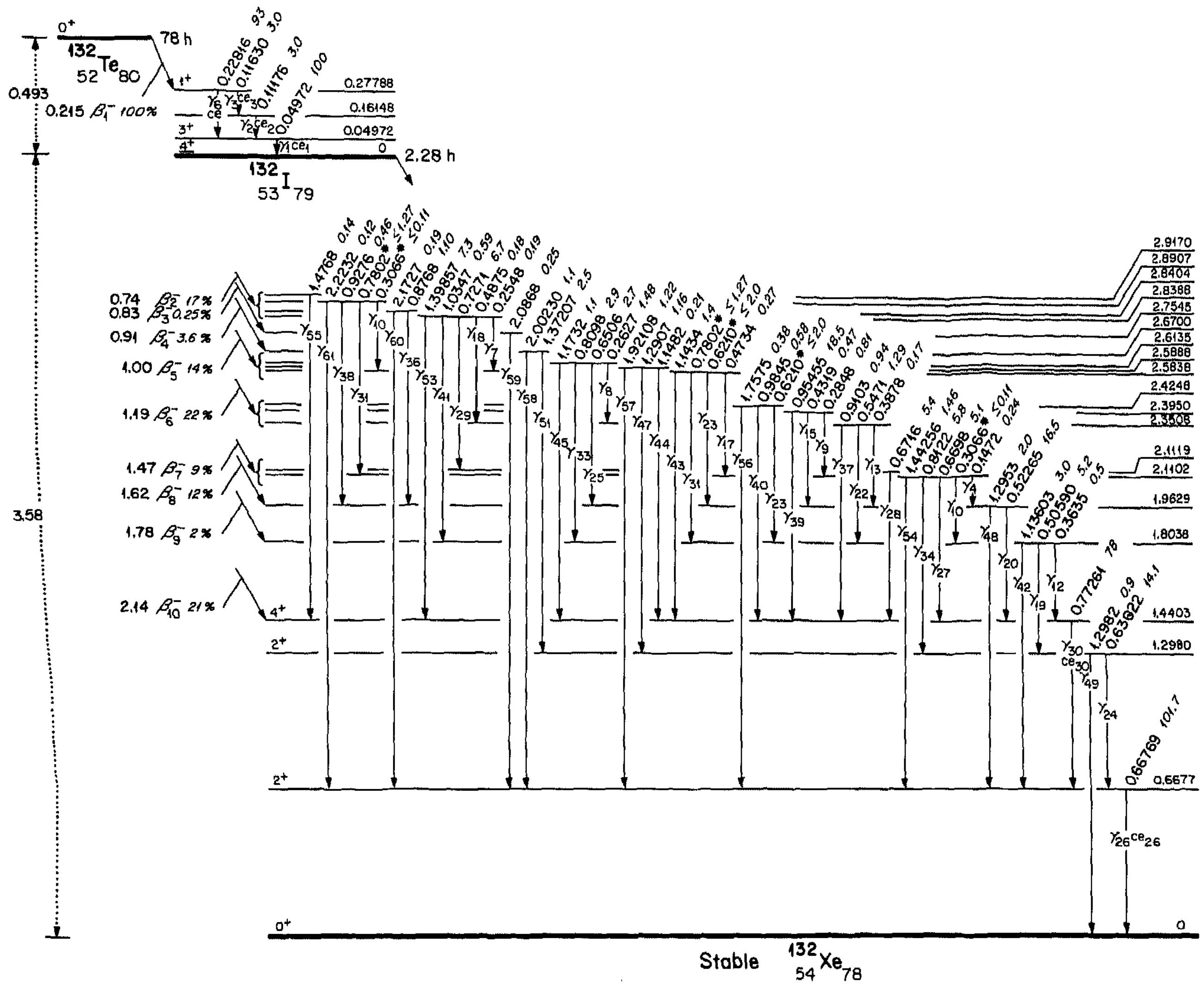
Basic Data, Sources for Adopted Values cont.

Comparison of Additional Experimental Results with Values Calculated from the Adopted Decay Scheme

ce_{1K}/γ_1	$=^{W}1.81$ *14*	52B26, 52C17
	1.2 *2*	From adopted values
ce_{5K}/γ_5	$=^{W}0.037$ *2*	51V05, 52B95, 52R16
	= 0.041	E2 Theory
	= 0.041 *4*	From adopted values
E_{av}(all β's)	$=^{U}0.189$ *8*	52C10, 63Bo43
	= 0.1834 *2*	Theory

$\left({}^{132}_{52}\mathrm{Te}_{80} - {}^{132}_{53}\mathrm{I}_{79}\right)$-1

Decay Characteristics



$T_{1/2}$	78 h *1*	(^{132}Te)	Appendix I
	2.28 h *2*	(^{132}I)	

Note

Since the half-life of ^{132}I is much shorter than that of its parent, ^{132}Te, the ratio of ^{132}I activity to that of ^{132}Te in an initially pure ^{132}Te source will increase at first and then approach the constant value $T_A/(T_B-T_A)^a = 1.026$ *1* after $\approx 10T_B$ ($\approx$ 1 d). When the ratio of activities has reached this constant value, the parent and daughter are in equilibrium and the total activity is equal to 1+(1.026 *1*)=2.026 *1* times the ^{132}Te activity.

[a] $T_A = T_{1/2}$ (^{132}Te), $T_B = T_{1/2}$ (^{132}I)

Note

Because of the large number of low-intensity γ-rays and the resulting complexity of the ^{132}I decay scheme, only γ's with intensities $\geq 0.1\%$ are included here. The total intensity of the $\approx 60\,\gamma$'s not included on this basis is $\leq 2\%$. (See 69Ca05)

$\left({}^{132}_{52}Te_{80} - {}^{132}_{53}I_{79}\right)$-2

Decay Characteristics continued

Radiations

Type	Energy MeV	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}[a]	0.00331	75 7	0.0053	0.079	<0.0001
ce_{1K}	0.01655 1	73 7	0.026	0.39	0.00045
e_{AK}[a]	0.02362	10 2	0.0050	0.074	0.00085
ce_{1L}	0.04453[b] 1	10.1 10	0.0096	0.14	0.0026
ce_{1MN}	0.04865[c] 1	3.0 3	0.0031	0.046	0.0030
ce_{2K}	0.07859 8	0.88 8	0.0015	0.022	0.0071
ce_{3K}	0.08313 8	0.87 8	0.0015	0.022	0.0078
ce_{2L}	0.10657[b] 8	0.24 2	0.00054	0.008	0.012
ce_{3L}	0.11111[b] 8	0.19 2	0.00045	0.007	0.013
ce_{6K}	0.19499 6	6.4 9	0.027	0.40	0.031
ce_{6L}	0.22297[b] 6	1.2 2	0.0057	0.085	0.039
ce_{6MN}	0.22709[c] 6	0.36 6	0.0017	0.025	0.040
ce_{26K}	0.63313 8	0.36 1	0.0049	0.073	0.18
ce_{30K}	0.73805 8	0.19 1	0.0030	0.045	0.22
β_1^-	0.215_{max} 4 0.0595_{av} 12	100	0.127	1.9	0.0155
β_2^-	0.74_{max} 2 0.243_{av} 7	17 1	0.088	1.3	0.111
β_3^-	0.83_{max} 2 0.278_{av} 7	0.25 4	0.0015	0.022	0.131
β_4^-	0.91_{max} 2 0.310_{av} 7	3.6 2	0.024	0.36	0.150
β_5^-	1.00_{max} 2 0.347_{av} 7	14 2	0.10	1.5	0.171
β_6^-	1.19_{max} 2 0.426_{av} 8	22 1	0.20	3.0	0.216
β_7^-	1.47_{max} 2 0.547_{av} 8	9 2	0.10	1.5	0.285
β_8^-	1.62_{max} 2 0.614_{av} 8	12 2	0.16	2.4	0.323

[a]Auger and X-ray intensities in ^{132}Xe are negligible compared with those in ^{132}I

Decay Characteristics continued

Radiations continued

Type	Energy MeV	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β_9^-	1.78_{max} 2 0.686_{av} 8	2 2	0.03	0.45	0.364
β_{10}^-	2.14_{max} 2 0.850_{av} 8	21 2	0.38	5.7	0.455
All β's	0.283_{av} 4	200	1.21	18.0	0.33
X_L[a]	0.00394	11 2	0.0009	0.013	0.029
X_K	0.02921	71 7	0.044	0.66	9.0
γ_1	0.04972 1	13.9 10	0.015	0.22	19
γ_2	0.11176 8	1.8 2	0.0043	0.064	31
γ_3	0.11630 8	1.9 2	0.0047	0.070	32
γ_4	0.1472 1	0.24 2	0.00075	0.011	34
[x]γ_5	0.1833 3	0.16 3	0.0006	0.009	35
γ_6	0.22816 6	85 5	0.41	6.1	37
γ_7	0.2548 2	0.19 3	0.0010	0.015	38
γ_8	0.2627 1	1.48 9	0.0083	0.12	38
γ_9	0.2848 1	0.81 7	0.0049	0.073	38
γ_{10}	0.3066 4	0.11 4	0.0007	0.010	39
[x]γ_{11}	0.3165 4	0.16 4	0.0011	0.016	39
γ_{12}	0.3635 4	0.5 1	0.004	0.060	40
γ_{13}	0.3878 4	0.17 3	0.0014	0.021	41
[x]γ_{14}	0.4168 4	0.48 9	0.0043	0.064	42
γ_{15}	0.4319 4	0.47 9	0.0043	0.064	42
[x]γ_{16}	0.4460 4	0.69 8	0.0066	0.098	42
γ_{17}	0.4734 7	0.27 5	0.0027	0.040	43
γ_{18}	0.4875 7	0.18 5	0.0019	0.028	43

continued on next page

[b]Energy of L_1-line given
[c]Energy of M_1-line given
[x]Not shown on decay scheme since placement not determined

$\left({}^{132}_{52}\mathrm{Te}_{80}-{}^{132}_{53}\mathrm{I}_{79}\right)$-3

Decay Characteristics continued

Radiations continued

Type	Energy MeV	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
γ_{19}	0.50590 *13*	5.2 *2*	0.056	0.83	44
γ_{20}	0.52265 *9*	16.5 *6*	0.184	2.7	44
$^{x}\gamma_{21}$	0.5355 *4*	0.54 *8*	0.0062	0.092	44
γ_{22}	0.5471 *2*	1.29 *9*	0.015	0.22	44
γ_{23}	0.6210 *2*	2.0 *1*	0.026	0.39	46
γ_{24}	0.63022 *9*	14.1 *6*	0.189	2.8	46
γ_{25}	0.6506 *2*	2.7 *2*	0.037	0.55	47
γ_{26}	0.66769 *8*	101.3 *1*	1.441	21.5	47
γ_{27}	0.6698 *3*	5.1 *8*	0.073	1.1	47
γ_{28}	0.6716 *3*	5.4 *4*	0.077	1.1	47
γ_{29}	0.7271 *2*	6.7 *3*	0.104	1.5	48
γ_{30}	0.77261 *8*	78 *2*	1.28	19.1	49
γ_{31}	0.7802 *3*	1.27 *6*	0.021	0.31	49
$^{x}\gamma_{32}$	0.7845 *4*	0.44 *5*	0.0074	0.11	49
γ_{33}	0.8098 *2*	2.9 *3*	0.050	0.74	50
γ_{34}	0.8122 *2*	5.8 *5*	0.100	1.5	50
$^{x}\gamma_{35}$	0.8633 *2*	0.61 *5*	0.011	0.16	51
γ_{36}	0.8768 *2*	1.10 *5*	0.020	0.30	51
γ_{37}	0.9103 *2*	0.94 *5*	0.0182	0.27	51
γ_{38}	0.9276 *3*	0.46 *8*	0.009	0.13	52
γ_{39}	0.95455 *9*	18.5 *6*	0.38	5.7	52
γ_{40}	0.9845 *2*	0.58 *6*	0.0122	0.18	53
γ_{41}	1.0347 *2*	0.59 *5*	0.013	0.19	54
γ_{42}	1.13603 *12*	3.0 *2*	0.073	1.1	55
γ_{43}	1.1434 *2*	1.4 *1*	0.034	0.51	56
γ_{44}	1.1482 *7*	0.21 *5*	0.005	0.074	56
γ_{45}	1.1732 *2*	1.1 *1*	0.027	0.40	56
$^{x}\gamma_{46}$	1.2727 *4*	0.15 *3*	0.004	0.06	58

Decay Characteristics continued

Radiations continued

Type	Energy MeV	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
γ_{47}	1.2907 *3*	1.16 *6*	0.032	0.48	58
γ_{48}	1.2953 *3*	2.0 *1*	0.055	0.82	58
γ_{49}	1.2982 *5*	0.9 *1*	0.025	0.37	58
$^{x}\gamma_{50}$	1.3171 *7*	0.12 *2*	0.0034	0.051	58
γ_{51}	1.37207 *13*	2.5 *1*	0.073	1.1	59
$^{x}\gamma_{52}$	1.392 *2*	0.24 *15*	0.007	0.10	59
γ_{53}	1.39857 *10*	7.3 *3*	0.217	3.2	59
γ_{54}	1.44256 *10*	1.46 *6*	0.045	0.67	60
γ_{55}	1.4768 *2*	0.14 *2*	0.0044	0.066	61
γ_{56}	1.7575 *2*	0.38 *3*	0.014	0.21	65
γ_{57}	1.92108 *12*	1.22 *9*	0.050	0.74	67
γ_{58}	2.00230 *12*	1.1 *1*	0.047	0.70	68
γ_{59}	2.0868 *2*	0.25 *4*	0.011	0.16	69
γ_{60}	2.1727 *2*	0.19 *3*	0.009	0.13	70
γ_{61}	2.2232 *2*	0.12 *2*	0.006	0.089	71
$^{x}\gamma_{62}$	2.3905 *2*	0.17 *2*	0.009	0.13	73

Basic Data, Sources for Adopted Values

Decay Scheme

^{132}Te Q^{-} = **0.493** *4* — $E(\beta_1^-) + E(0.27788\ \text{level})$

No ground-state β-group — 58C28, 65Iv01

The γ-placements are determined by the γ-energies and $\beta\gamma$-, $X\gamma$-delayed coincidence data (66Go23, 69Ha26).

Intensities per 100 ^{132}Te decays are obtained from the relative γ-intensities, relative ce-intensities, ce_1/γ_1, and the requirement that $I(\gamma_1 + ce_1) = 100$.

continued on next page

^{x}Not shown on decay scheme since placement not determined

Basic Data, Sources for Adopted Values cont.

Decay Scheme continued

^{132}I $Q^- = 3.58$ 2 $E(\beta^-_{10})+E(1.4403$ level)

No ground-state β (<0.008%) 65Jo13

The γ-placements are determined by the γ-energies and $\gamma\gamma$-coincidence measurements (67Ar12, 68Ha45).

Intensities per 100 ^{132}Te decays are obtained from the relative γ-intensities, ce_{26}/γ_{26}, and the requirement that $I(\gamma_{26}+ce_{26}+\gamma_{49}) = 102.6$ *1*.[a]

Decay Modes

Type	Energy MeV	Intensity %	
ce_{1K}		73 *7*	$I(\gamma_1)$, ce_{1K}/γ_1, ce_{1K}/ce_{1L}, ce_{1MN}/ce_{1L}, and $I(\gamma_1+ce_1)=100$
ce_{1L}		10.1 *10*	
ce_{1MN}		3.0 *3*	
ce_{26K}		0.36 *1*	ce_{26K}/γ_{26}, γ_{49}/γ_{26}, and $I(\gamma_{26}+ce_{26}+\gamma_{49}+ce_{49}) = 102.6$[a]
$ce_{2K}\cdots ce_{6MN}$, ce_{30K}			I(ce) are obtained from $I(\gamma)$, ce_K/γ, ce_K/ce_L, and ce_{MN}/ce_L
β^-_1	0.215 *4*		65Iv01
		100	Decay scheme
β^-_2	*0.74 *2*		$Q^- - E(\approx 2.84$ level)
	0.80 *4*	21	61De17
		*17 *1*	γ-intensities
β^-_3	0.83 2		$Q^- - E(2.7545$ level)
		0.25 *4*	γ-intensities
β^-_4	0.91 2		$Q^- - E(2.6700$ level)
		3.6 *2*	γ-intensities
β^-_5	*1.00 2		$Q^- - E(\approx 2.59$ level)
	1.04 *4*	15	61De17
		*14 2	γ-intensities
β^-_6	*1.19 *2*		$Q^- - E(\approx 2.39$ level)
	1.218 *25*	24	61De17
		*22 *1*	γ-intensities
β^-_7	1.47 2		$Q^- - E(2.111$ level)
		9 2	γ-intensities
β^-_8	*1.62 2		$Q^- - E(1.9629$ level)
	1.609 *25*	21	61De17
		*12 2	γ-intensities
β^-_9	1.78 2		$Q^- - E(1.8038$ level)
		2 2	γ-intensities

Basic Data, Sources for Adopted Values cont.

Decay Modes continued

Type	Energy MeV	Intensity %	
β^-_{10}	[w]2.14 2		61De17, 65Jo13
		18	61De17
		*21 2	γ-intensities

$\gamma_1\cdots\gamma_3$, γ_6 — $E(\gamma)$ and $I(\gamma)$ are data of 66Fr02. The authors' relative γ-intensities are normalized as described above under ce_1

γ_4, γ_5, $\gamma_8\cdots\gamma_{62}$ — $E(\gamma)$ and $I(\gamma)$ are weighted averages of data of 66Ar15, 67He03, 67Yt01, and 69Ca05. The relative γ-intensities of each author are normalized as described under ce_{26K} above.

Auxiliary Data

$\gamma_{49}/\gamma_{26} = 0.009$ *1*	66Ar15, 67He03, 67Yt01, 69Ca05
$ce_{1K}/\gamma_1 =$ [w]5.3 *2*	58C28, 61Go19, 66Fr02
$ce_{1K}/ce_{1L} =$ [w]7.3 *5*	65Iv01, 66Fr02
$ce_{1MN}/ce_{1L} = 0.3$	Theory
$\therefore ce_1/\gamma_1 = 6.2$ *2*	
$ce_{2K}/\gamma_2 = 0.49$ *7*	66Fr02
$ce_{2K}/ce_{2L} = 3.6$ *4*	66Fr02
$ce_{3K}/\gamma_3 = 0.46$ *7*	66Fr02
$ce_{3K}/ce_{3L} = 4.7$ *4*	66Fr02
$ce_{6K}/\gamma_6 =$ [w]0.075 *9*	61Go19, 66Fr02
$ce_{6K}/ce_{6L} =$ [w]5.4 *8*	65Iv01, 66Fr02
$ce_{6MN}/ce_{6L} = 0.3$	Theory
$ce_{26K}/\gamma_{26} =$ [w]0.0036 *3*	65Iv03, 69Ca05
*0.00360	E2 Theory
$ce_{30K}/\gamma_{30} =$ [w]0.0026 *3*	65Iv03, 69Ca05
*0.00250	E2 Theory
$\omega_K = 0.875$, $\omega_L = 0.130$, $n_{KL} = 0.92$ (I)	Appendix III
$\omega_K = 0.880$, $\omega_L = 0.138$, $n_{KL} = 0.91$ (Xe)	Appendix III

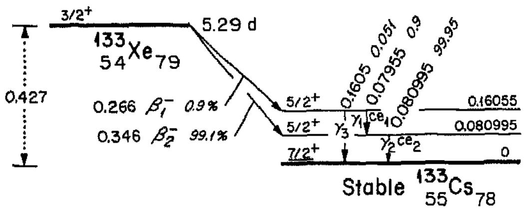
[a] In a ^{132}Te-^{132}I equilibrium mixture, the ratio of ^{132}I activity to that of ^{132}Te is 1.026 *1*. See first "Note" under ^{132}Te-^{132}I decay scheme drawing

[w] Weighted average

*Value adopted by compilers from possibilities shown

$^{133}_{54}Xe_{79}$

Decay Characteristics



$T_{1/2}$ **5.29 d** *1* Appendix I

Note

Weak γ's of energy 0.221 (0.0002%), 0.302 (0.005%), and 0.382 (<0.01%) which de-excite a level at 0.382 MeV have not been included because of their low intensities (58S110, 59J17, 61Er4, and 68A116).

Note

2.26-d ^{133m}Xe is present (initial abundance ≈4%) in a fission-produced ^{133}Xe source. The ^{133m}Xe activity [13% γ (0.233 MeV), 60% ce_K (0.198 MeV), and 27% ce_{LM} (0.227 MeV)] is ≈1% of the ^{133}Xe activity after 10 days and ≈0.4% after 15 days.

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00355**	48 *2*	0.0036	0.85	<0.0001
e_{AK}	**0.02546**	6.0 *2*	0.0033	0.78	0.00097
ce_{1K}	**0.04357** *5*	0.30 *8*	0.00028	0.066	0.0025
ce_{2K}	**0.045010** *5*	52 *2*	0.050	11.8	0.0027
ce_{1L}	**0.07384**[a] *5*	0.18 *10*	0.00028	0.066	0.0063
ce_{2L}	**0.075281** *5*	8.7 *5*	0.014	3.3	0.0066
ce_{1MN}	**0.07833**[b] *5*	0.06 *3*	0.00010	0.024	0.0071
ce_{2MN}	**0.79778** *5*	2.4 *2*	0.041	9.7	0.0072
β_1^-	**0.266**$_{max}$ *3* **0.0751**$_{av}$ *9*	0.9 *2*	0.0014	0.33	0.0221
β_2^-	**0.346**$_{max}$ *3* **0.1007**$_{av}$ *9*	99.1 *2*	0.213	50.5	0.0342
All β's	**0.1005**$_{av}$ *9*	100	0.214	50.7	0.0341
X_L	**0.00429**	8.0 *3*	0.00073	0.17	0.038
X_K	**0.03164**	46 *2*	0.031	7.3	10
γ_1	**0.07955** *5*	0.4 *2*	0.0007	0.17	27
γ_2	**0.080995** *5*	36.6 *8*	0.063	14.9	28
γ_3	**0.1605** *5*	0.051 *8*	0.00017	0.040	34

Basic Data, Sources for Adopted Values

Decay Scheme

Q^- = **0.427** *3* E(β_2^-)+E(0.080995 level)

No ground-state β 52B55

Intensities per 100 ^{133}Xe decays are obtained from ce_2/γ_2, γ_3/γ_2, and the requirement that $I(\gamma_2+ce_2+\gamma_3)=100$.

Decay Modes

Type	Energy MeV	Intensity %	
ce_{1K}		0.30 *8*	ce_{1K}/ce_{2K} 61Er4
ce_{1L}		0.18 *10*	$I(ce_{1K})$, ce_{1K}/ce_{1L},
ce_{1M}		0.06 *3*	and ce_{1L}/ce_{1M}
ce_{2K}		52 *2*	$I(ce_2)$, ce_{2K}/ce_{2L},
ce_{2L}		8.7 *5*	and ce_{2L}/ce_{2MN}
ce_{2MN}		2.4 *2*	
ce_2		63 *2*	See $I(\gamma_2)$
β_1^-	**0.266** *3*	0.9 *2*	Q^--E(0.16055 level) (γ+ce)-intensities
β_2^-	[W]**0.346** *3*	99.1 *2*	52B55, 61Er4 (γ+ce)-intensities
γ_1	**0.07955** *5*	[U]0.4 *2*	61Er4 γ_1/γ_2 61Er4, 68A116
γ_2	[W]**0.080995** *5*	36.6 *8*	64Ma27, 64Si21 ce_2/γ_2, γ_3/γ_2 and $I(\gamma_2+ce_2+\gamma_3)=100$
γ_3	**0.1605** *5*[c]	[W]0.051 *8*	61Er4 See $I(\gamma_2)$

Auxiliary Data

α_K = 0.885, α_L = 0.143, n_{KL} = 0.91 — Appendix III

γ_3/γ_2 = [U]0.0014 *3* — 61Er4, 68A116

ce_{2K}/γ_2 = [W]1.43 *5* — 54B36, 61Er4

ce_{2K}/ce_{2L} = [W]6.0 *2* — 61Br9, 61Er4, 64Si21

ce_{2L}/ce_{2MN} = [W]3.7 *2* — 61Er4, 64Si21

$\therefore ce_2/\gamma_2$ = 1.73 *6*

ce_{1K}/ce_{1L} = 1.7 *8* — 61Er4

ce_{1L}/ce_{1M} = 4.6 — M1 Theory

[a] Energy of L_1-line given

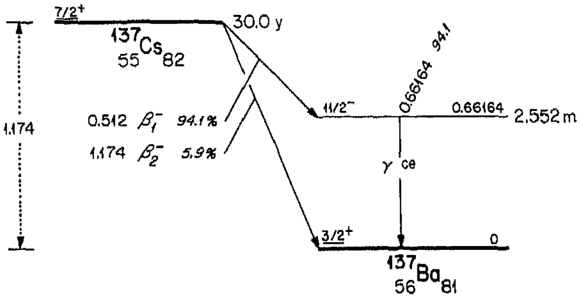
[b] Energy of M_1-line given

[c] Uncertainty assigned by compilers

[U],[W] Unweighted average, weighted average

$^{137}_{55}Cs_{82}$ - $^{137m}_{56}Ba_{81}$

Decay Characteristics



$T_{½}$	30.0 y *5*	(^{137}Cs)	Appendix I
	2.552 m *2*	(^{137m}Ba)	

Radiations

Type	Energy MeV	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00367**	7.10 *4*	0.00056	0.032	<0.0001
e_{AK}	**0.02642**	0.85 *1*	0.00048	0.028	0.0010
ce_K	**0.62420** *8*	7.78 *4*	0.1034	6.0	0.18
ce_L	**0.65565** *8*	1.44 *3*	0.0201	1.2	0.19
ce_{MN}	**0.66035** *8*	0.30 *6*	0.0042	0.24	0.19
β_1^-	**0.512**$_{max}$ *1* **0.1740**$_{av}$ *4*	94.1 *4*	0.349	20.2	0.070
β_2^-	**1.174**$_{max}$ *1* **0.4182**$_{av}$ *4*	5.9 *4*	0.053	3.1	0.212
All β's	**0.1884**$_{av}$ *4*	100	0.401	23.2	0.087
X_L	**0.00447**	1.25 *1*	0.00012	0.007	0.042
X_K	**0.03288**	6.88 *4*	0.00482	0.28	11
γ	**0.66164** *8*	84.6 *4*	1.192	69.0	47

Note

The half-life of ^{137m}Ba is so short, compared with that of its parent, ^{137}Cs, that the enhancement of I(γ) and I(ce) due to the presence of ^{137m}Ba in an equilibrium ^{137}Cs-^{137m}Ba mixture can be neglected.

Basic Data, Sources for Adopted Values

Decay Scheme

Q^- = 1.174 *1* E(β_1^-) + E(0.66164 level)

No γ other than 0.66164 γ 48T02

Intensities per 100 ^{137}Cs decays are obtained from I(β_1^-) and the requirement that I(β_1^-+β_2^-) = 100.

Decay Modes

Type	Energy MeV	Equilibrium Intensity %	
ce_K		7.78 *4*	ce_K/γ, ce_K/ce_{LMN}; ce_K/ce_L and I(γ+ce) = I(β_1^-)
ce_L		1.44 *3*	
ce_{MN}		0.30 *6*	
β_1^-	^{W}**0.512** *1*		66Hs02, 68Wo02
		^{W}94.1 *4*	57R41, 58Y01, 62Da5, 66Hs02, 69Ha05
β_2^-	***1.174** *1*		Q^-
	1.20		57B17
		5.9 *4*	I(β_1^-) and I(β_1^-+β_2^-) = 100
γ	**0.661635** *76*		60Gr38[a]
		85.7 *9*	$\gamma/\Sigma\beta^-$ 65Me03
		*84.6 *4*	ce_K/γ, ce_K/ce_{LMN}, and I(γ+ce) = I(β_1^-)

Auxiliary Data

α_K = 0.890	Appendix III
α_L = 0.150	
n_{KL} = 0.90	
ce_K/γ = ^{W}0.0914 *5*	63Le20, 65Me03[b], 69Ha05
*0.092	M4 Theory
ce_K/ce_{LMN} = ^{W}4.47 *5*	52K02, 53M14, 62Da5, 65Ge06, 69Ha05
ce_K/ce_L = *5.41	M4 Theory
^{U}5.55 *10*	53D31, 53K69, 54V09, 54W14, 56A51, 58Y01, 66Ve01, 62Ge9, 64Ge05, 67Ka24

[a] Authors' value recalculated by 68JBMa using a more recent energy value for calibration standard of 60Gr38

[b] Author measured ce/γ. Compilers obtain ce_K/γ from authors' data and the adopted value of ce_K/ce_{LMN}

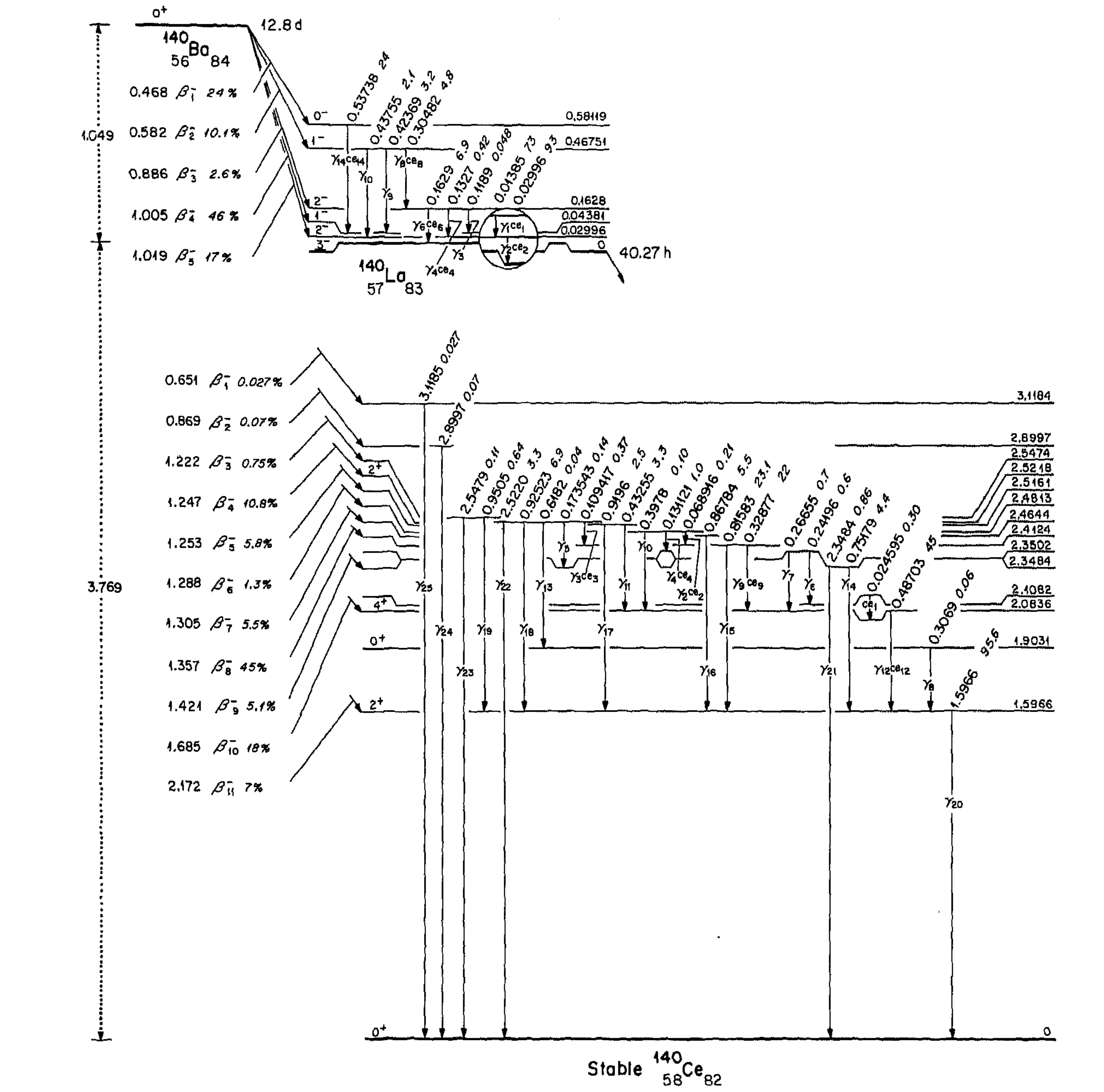
[U] Unweighted average

[W] Weighted average

*Value adopted by compilers from possibilities shown

$\left({}^{140}_{56}Ba_{84}-{}^{140}_{57}La_{83}\right)$-1

Decay Characteristics



$T_{1/2}$	12.8 d *1*	(^{140}Ba)	Appendix I
	40.27 h *5*	(^{140}La)	

Note

Because of the large number of electrons present due to the β-continuum, low-intensity conversion-electron transitions can be neglected here. Only ce-transitions with intensity $\geq$0.1% have been included.

Decay Characteristics continued

Note

The ratio of ^{140}La activity to that of its parent, ^{140}Ba, is given as a function of time, t, by

$$\frac{T_A}{T_A-T_B}\left[1-\exp\left(0.6931\frac{(T_A-T_B)t}{T_AT_B}\right)\right] = 1.153\left[1-\exp 0.516t\right]$$

where $T_A = T_{1/2}(^{140}Ba)$, $T_B = T_{1/2}(^{140}La)$, t is in days, and the ^{140}La activity is taken to be zero at t = 0 (i.e., the ^{140}Ba source is initially pure).

Radiations (^{140}Ba)

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00380**	98 *3*	0.0079	0.73	<0.0001
ce_{1L}	**0.00758**[a] *5*	55 2	0.0089	0.82	≈ 0.00011
ce_{1M}	**0.01249**[b] *5*	11.2 *4*	0.0030	0.28	0.00027
ce_{1N}	**0.01358**[c] *5*	≈ 6	≈ 0.002	≈ 0.2	0.00032
ce_{2L}	**0.02369**[a] *5*	60.2 *8*	0.0304	2.8	0.00086
e_{AK}	**0.02739**	0.14 *1*	0.00008	0.007	0.0011
ce_{2M}	**0.02860**[b] *5*	12.6 2	0.0077	0.71	0.0012
ce_{2N}	**0.02969**[c] *5*	6.3 *12*	0.0040	0.37	0.0013
ce_{4K}	**0.0938** *1*	0.25 *5*	0.00050	0.046	0.0097
ce_{6K}	**0.1240** *1*	0.63 *6*	0.0017	0.16	0.015
ce_{6LM}	**0.1566**[a] *1*	0.10 *1*	0.00033	0.030	0.022
ce_{8K}	**0.26590** *3*	0.25 *5*	0.0014	0.13	0.051
ce_{14K}	**0.49846** *3*	0.25 *5*	0.0027	0.25	0.13
β^-_1	**0.468**$_{max}$ *16* **0.141**$_{av}$ *5*	24 2	0.072	6.6	0.056
β^-_2	**0.582**$_{max}$ *16* **0.182**$_{av}$ *5*	10.1 *4*	0.039	3.6	0.078
β^-_3	**0.886**$_{max}$ *16* **0.311**$_{av}$ *6*	2.6 *4*	0.017	1.6	0.154
β^-_4	**1.005**$_{max}$ *16* **0.346**$_{av}$ *6*	46 2	0.339	31.2	0.172
β^-_5	**1.019**$_{max}$ *16* **0.363**$_{av}$ *6*	17 2	0.13	12.0	0.186
All β's	**0.282**$_{av}$ *6*	100	0.601	55.4	0.165

Decay Characteristics continued

Radiations (^{140}Ba) continued

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
X_L	**0.00465**	18.0 *5*	0.00178	0.16	0.047
γ_1	**0.01385** *5*	1.29 *4*	0.00038	0.035	1.3
γ_2	**0.02996** *5*	14.0 2	0.0089	0.82	9.6
X_K	**0.03415**	1.24 *9*	0.00090	0.083	12
γ_3	**0.1189** *1*	0.048 *5*	0.00012	0.011	32
γ_4	**0.1327** *1*	0.17 *3*	0.00048	0.044	33
$^x\gamma_5$	**0.144** *5*	0.04 *1*	0.00012	0.011	34
γ_6	**0.1629** *1*	6.2 *3*	0.022	2.0	35
$^x\gamma_7$	**0.177** *5*	0.19 *5*	0.00072	0.066	35
γ_8	**0.30482** *3*	4.5 *3*	0.029	2.7	39
γ_9	**0.42369** *4*	3.2 2	0.029	2.7	42
γ_{10}	**0.43755** *5*	2.1 2	0.020	1.8	42
$^x\gamma_{11}$	**0.466** *5*	0.21 *7*	0.0021	0.19	43
$^x\gamma_{12}$	**0.498** *5*	0.4 2	0.0042	0.39	43
$^x\gamma_{13}$	**0.512** *5*	0.26 *7*	0.0028	0.26	44
γ_{14}	**0.53738** *3*	23.8 *12*	0.27	24.9	44
$^x\gamma_{15}$	**0.602** *5*	0.6 2	0.0077	0.71	46
$^x\gamma_{16}$	**0.637** *5*	0.3 *1*	0.0041	0.38	46
$^x\gamma_{17}$	**0.661** *5*	0.7 2	0.010	0.92	47

Radiations (^{140}La)

See next page

[a] Energy of L_1-line given
[b] Energy of M_1-line given
[c] Energy of N_1-line given
[x] Not shown on decay scheme since placement not determined

$\left({}^{140}_{56}\mathrm{Ba}_{84}-{}^{140}_{57}\mathrm{La}_{83}\right)$-3

Decay Characteristics continued

Radiations (^{140}La)

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	0.00394	1.45 6	0.00012	0.002	<0.0001
ce_{1LMN}	0.018046[a] 4	0.32 4	0.00012	0.002	0.00053
e_{AK}	0.02839	0.170 4	0.00010	0.002	0.0012
ce_{2K}	0.028473 6	0.16 3	0.00010	0.002	0.0012
ce_{3K}	0.068974 5	0.15 1	0.00022	0.004	0.0056
ce_{4K}	0.090678 6	0.21 1	0.00040	0.007	0.0091
ce_{9K}	0.288325 12	0.73 1	0.0045	0.074	0.058
ce_{12K}	0.44659 2	0.43 2	0.0041	0.068	0.11
β_1^-	0.651_{max} 5 0.207_{av} 2	0.027 3	0.00012	0.002	0.092
β_2^-	0.869_{max} 5 0.292_{av} 2	0.07 1	0.00043	0.007	0.140
β_3^-	1.222_{max} 5 0.437_{av} 2	0.75 6	0.0070	0.12	0.223
β_4^-	1.247_{max} 5 0.447_{av} 2	10.8 4	0.103	1.7	0.229
β_5^-	1.253_{max} 5 0.450_{av} 2	5.8 3	0.056	0.92	0.231
β_6^-	1.288_{max} 5 0.465_{av} 2	1.3 2	0.013	0.21	0.239
β_7^-	1.305_{max} 5 0.472_{av} 2	5.5 3	0.055	0.91	0.244
β_8^-	1.357_{max} 5 0.495_{av} 2	45 2	0.47	7.8	0.256
β_9^-	1.421_{max} 5 0.522_{av} 2	5.1 1	0.057	0.94	0.272
β_{10}^-	1.685_{max} 5 0.638_{av} 2	18 2	0.24	4.0	0.338
β_{11}^-	2.172_{max} 5 0.839_{av} 2	7 1	0.12	2.0	0.451
All β's	0.536_{av} 2	100	1.14	18.8	0.297

[a]Energy of L_1-line given

Decay Characteristics continued

Radiations (^{140}La) continued

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
X_L	0.00484	0.27 1	0.000028	≈0	0.054
γ_1	0.024595 4	<0.01	<0.000005	≈0	6.2
X_K	0.03547	1.51 4	0.0011	0.018	13
γ_2	0.068916 6	0.06 1	0.000088	≈0	25
γ_3	0.109417 5	0.23 2	0.00054	0.009	31
γ_4	0.131121 6	0.8 2	0.0022	0.036	33
γ_5	0.173543 8	0.14 4	0.00052	0.009	35
γ_6	0.24196 1	0.6 1	0.0031	0.051	37
γ_7	0.26655 1	0.7 1	0.0040	0.066	38
γ_8	0.3069 2	0.06 4	0.0004	0.007	39
γ_9	0.32877 2	21 2	0.15	2.5	40
γ_{10}	0.3978 1	0.10 3	0.0008	0.013	41
γ_{11}	0.43255 3	3.3 2	0.030	0.50	42
γ_{12}	0.48703 2	45 2	0.467	7.7	43
γ_{13}	0.6182 7	0.04 2	0.0005	0.008	46
γ_{14}	0.75179 6	4.4 1	0.070	1.2	49
γ_{15}	0.81583 6	23.1 4	0.401	6.6	50
γ_{16}	0.86784 10	5.5 3	0.102	1.7	51
γ_{17}	0.9196 2	2.5 2	0.049	0.81	52
γ_{18}	0.92523 8	6.9 3	0.136	2.2	52
γ_{19}	0.9505 3	0.64 6	0.013	0.21	52
γ_{20}	1.5966 2	95.6 3	3.25	53.7	62
γ_{21}	2.3484 5	0.86 4	0.043	0.71	72
γ_{22}	2.5220 4	3.3 2	0.18	3.0	74
γ_{23}	2.5479 8	0.11 1	0.0060	0.10	75
γ_{24}	2.8997 5	0.07 1	0.0043	0.071	≈80
γ_{25}	3.1185 3	0.027 3	0.0018	0.030	≈80

Basic Data, Sources for Adopted Values

Decay Scheme

^{140}Ba $Q^- = \mathbf{1.049}$ *16* $E(\beta_1^-)+E(0.58119 \text{ level})$
The γ-placements are determined by the γ-energies and $\gamma\gamma$-, $ce\gamma$-coincidence measurements (65Bu07).
Intensities per 100 ^{140}Ba decays are obtained from the relative γ-intensities, relative ce-intensities, $\gamma_{14}/\Sigma\beta^-$, and ce_{14K}/γ_{14}.

^{140}La $Q^- = 3.769$ *5* $E(\beta_{11}^-)+E(1.5966 \text{ level})$
Ground-state β-group negligible (0.0006%) 60Dz5
The γ-placements are determined by the γ-energies and $\gamma\gamma$-coincidence measurements (68Ba18).
Intensities per 100 ^{140}La decays are obtained from the relative γ-intensities and the requirement that $I(\gamma_{20}+\ldots\gamma_{25}) = 100$.

Decay Modes (^{140}Ba)

Type	Energy MeV	Intensity %	
ce_{1L}		55 *2*	$I(\gamma_1)$, ce_{1L}/γ_1, ce_{1M}/ce_{1L}, and ce_{1N}/ce_{1M}
ce_{1M}		11.2 *4*	
ce_{1N}		≈6	
ce_{2L}		60.2 *8*	ce_2/γ_2, ce_{2M}/ce_{2L}, ce_{2N}/ce_{2M}, and the requirement that $I(\gamma_2+ce_2+\gamma_6+ce_6) = 100$
ce_{2M}		12.6 *2*	
ce_{2N}		6.3 *12*	

$ce_3\ldots ce_{14}$ $I(ce_K)$ are data of 51C39. The authors' relative values have been normalized so that $ce_{14K}/\gamma_{14} = 0.0105$. Uncertainties have been assigned by the compilers.

Type	Energy MeV	Intensity %	Source
β_1^-	W**0.468** *16*		49L14, 59B161, 65Bu07
		24 *2*	γ-intensities
β_2^-	***0.582** *16*		Q^--E(0.46751 level)
	U**0.59**		57P20, 59B161, 65Bu07
		*10.1 *4*	γ-intensities
		U15	56S128, 57P20, 65Bu07
β_3^-	***0.886** *16*		Q^--E(0.1678 level)
	U**0.85**		59B161, 65Bu07
		*2.6 *4*	γ-intensities
		U3.8	56S128, 65Bu07
β_4^-	**1.005** *16*		Q^--E(0.04381 level)
		46 *2*	γ-intensities
β_5^-	**1.019** *16*		Q^--E(0.02996 level)
		17 *2*	γ-intensities

U Unweighted average
W Weighted average
*Value adopted by compilers from possibilities shown

Basic Data, Sources for Adopted Values cont.

Decay Modes (^{140}Ba) continued

Type	Energy MeV	Intensity %

$\gamma_1\ldots\gamma_{17}$ $E(\gamma)$ are weighted averages of data of 61Ge1 and 66Mo16 except for γ_5, γ_7, $\gamma_{11}\ldots\gamma_{13}$, and $\gamma_{15}\ldots\gamma_{17}$ which have been reported only by 66Vr01.
$I(\gamma_1)$ is obtained from γ_1/γ_2; $I(\gamma_2)$ is obtained from ce_2/γ_2 and the requirement $I(\gamma_2+ce_2+\gamma_6+ce_6) = 100$. The other $I(\gamma)$ are weighted averages of data of 66Ke15 and 66Vr01. The relative values of each author are normalized to $I(\gamma_{14}) = 23.8$ *12*.

Decay Modes (^{140}La)

Type	Energy MeV	Intensity %

$ce_1\ldots ce_{12}$ $I(ce)$ are data of 67Ka12. The authors' relative values are normalized so that $ce_{12K}/\gamma_{12} = 0.0096$.

$\beta_1^-\ldots\beta_7^-$, β_9^- $E(\beta^-)$ are obtained from $Q^-(^{140}La)$ and the ^{140}Ce level energies. $I(\beta^-)$ are obtained from the $(\gamma+ce)$-intensities.

Type	Energy MeV	Intensity %	Source
β_8^-	***1.357** *5*		Q^--E(2.4124 level)
	W**1.356** *12*		54B63, 67Ka12
		*45 *2*	$(\gamma+ce)$-intensities
		42 *6*	67Ka12
β_{10}^-	***1.685** *5*		Q^--E(2.0836 level)
	W**1.676** *8*		60La4, 67Ka12
		19 *2*	$(\gamma+ce)$-intensities
		17 *2*	67Ka12
		*18 *2*	
β_{11}^-	W**2.172** *5*		60La4, 67Ka12
		7 *1*	$(\gamma+ce)$-intensities
		7 *1*	67Ka12

$\gamma_1\ldots\gamma_{25}$ $E(\gamma)$ are weighted averages of data of 66Ba36 and 67Ka12.
$I(\gamma)$ are weighted averages of data of 66Hu18, 66Vr01, 67Ka12 and 68Ba18. The relative values of each author are normalized so that $I(\gamma_{20}+\ldots\gamma_{25}) = 100$.

Auxiliary Data

See next page

$\left({}^{140}_{56}Ba_{84}-{}^{140}_{57}La_{83}\right)$-5

Basic Data, Sources for Adopted Values

Auxiliary Data (^{140}Ba)

$ce_{1L}/\gamma_1 = 42.5$		M1[a] Theory
$ce_{1M}/ce_{1L} = 0.205$		M1[a] Theory
$ce_{1N}/ce_{1M} = 0.5$	from $ce_N/ce_M = 0.5$ for ce_2	
$ce_{2L}/\gamma_2 = 4.30$		M1[a] Theory
$ce_{2M}/ce_{2L} = 0.210$		M1[a] Theory
$ce_{2N}/ce_{2M} = 0.5$ *1*[b]		51C39
$\therefore ce_2/\gamma_2 = 5.65$ *8*		
$ce_{6LM}/ce_{6K} = 0.162$		M1[c] Theory
$ce_{14K}/\gamma_{14} = $ *0.0105		M1 Theory
0.006 *2*		55R17
$\gamma_1/\gamma_2 = 0.092$ *2*		65Bu07
$\gamma_{14}/\Sigma\beta^- = 0.238$ *12*		63Mc12
$\omega_K = 0.895$	(La)	Appendix III
$\omega_L = 0.155$	(La)	Appendix III
$n_{KL} = 0.89$	(La)	Appendix III

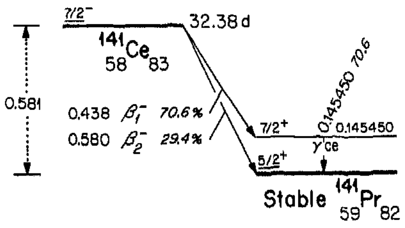
[a]E2 admixture <0.1% (61Ge1)
[b]Uncertainty assigned by compilers
[c]E2 admixture <2% (61Ge1)
*Value adopted by compilers from possibilities shown

Basic Data, Sources for Adopted Values cont.

Auxiliary Data (^{140}La)

$ce_{12K}/\gamma_{12} = 0.0096$		E2 Theory
$\omega_K = 0.899$	(Ce)	Appendix III
$\omega_L = 0.161$	(Ce)	Appendix III
$n_{KL} = 0.89$	(Ce)	Appendix III

Decay Characteristics



$T_{1/2}$	**32.38 d** *2*	Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00408**	15.7 *5*	0.0014	0.26	<0.0001
e_{AK}	**0.02942**	1.80 *5*	0.0011	0.21	0.0012
ce_K	**0.103459** *5*	18.4 *5*	0.040	7.6	0.011
ce_L	**0.138615**[a] *5*	2.5 *1*	0.0074	1.4	0.018
ce_{MN}	**0.143939**[b] *5*	0.68 *3*	0.0021	0.40	0.019
β_1^-	**0.438**$_{max}$ *3* **0.1312**$_{av}$	70.6 *11*	0.197	37.3	0.0499
β_2^-	**0.580**$_{max}$ *2* **0.1814**$_{av}$	29.4 *11*	0.114	21.6	0.077
All β's	**0.1459**$_{av}$	100	0.311	58.8	0.060
X_L	**0.00503**	3.2 *1*	0.00034	0.064	0.059
X_K	**0.03671**	16.6 *5*	0.0130	2.5	13
γ	**0.145450** *5*	49.0 *10*	0.152	28.8	34

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^- = {}^W$**0.581** *2* — $E(\beta_2^-)$, $E(\beta_1^-)$+E (0.145450 level)

No γ other than 0.145450γ — 52J23, 55J02

Intensities per 100 ^{141}Ce decays are obtained from $\gamma/(\beta_1^-+\beta_2^-)$, ce_K/γ, ce_K/ce_{MN}, and the requirement that $I(\beta_1^-+\beta_2^-) = 100$.

Basic Data, Sources for Adopted Values cont

Decay Modes

Type	Energy MeV	Intensity %	
ce_K		18.4 *5*	$I(\gamma)$, ce_K/γ, ce_K/ce_L and ce_K/ce_{LMN}
ce_L		2.5 *1*	
ce_{MN}		0.68 *3*	
β_1^-	^{W}**0.438** *3*		50F58, 52K27, 55J02, 68Be06
		*70.6 *11*	$I(\gamma+ce)$
		^{U}70 *3*	50F58, 52K27, 55J02, 57Z03, 58J22, 58L69
β_2^-	^{W}**0.580** *2*		50F58, 52K27, 55J02, 58J22
		*29.4 *11*	$I(\beta_1^-)$ and $I(\beta_1^-+\beta_2^-) = 100$
		^{U}30 *3*	50F58, 52K27, 55J02, 57Z03, 58J22
γ	^{W}**0.145450** *5*		65Ge04, 67B103, 67Wh01, 68Le03, 69Ba12
		^{W}49.0 *10*	$\gamma/(\beta_1^-+\beta_2^-)$

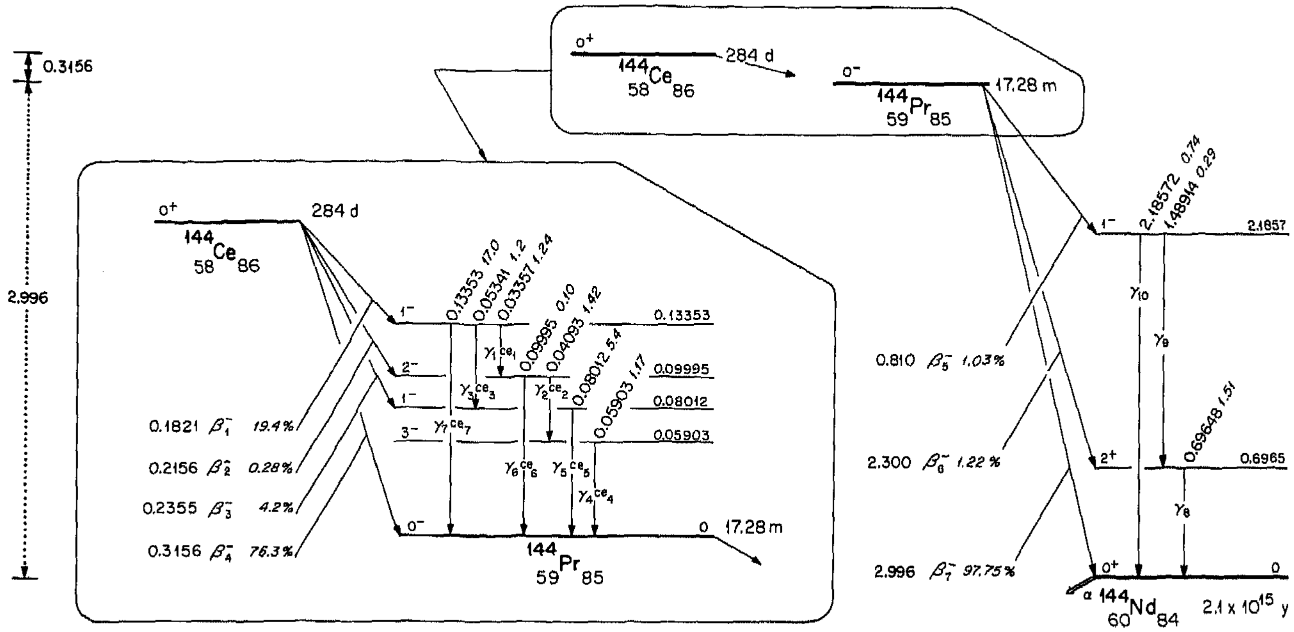
Auxiliary Data

$\omega_K = 0.903$ $\omega_L = 0.167$ $n_{KL} = 0.88$	Appendix III
$ce_K/\gamma = {}^W0.375$ *5*	61Ne12, 66Di02, 66Pa09
$ce_K/ce_L = 7.4$ *3*	65Ge04
$ce_K/ce_{LMN} = {}^W5.8$ *2*	64Cr03, 65Ge04
$\gamma/(\beta_1^-+\beta_2^-) = {}^W0.490$ *10*	64Cr03, 66El02

[a] Energy of L_1-line given
[b] Energy of M_1-line given
^{U} Unweighted average
^{W} Weighted average
*Value adopted by compilers from possibilities shown

$\left({}^{144}_{58}Ce_{86} - {}^{144}_{59}Pr_{85}\right)$-1

Decay Characteristics



$T_{1/2}$		
	284 d *1* (^{144}Ce)	Appendix I
	17.28 m *6* (^{144}Pr)	
	2.1×10^{15}y (^{144}Nd)	For data see S. Raman, Nuclear Data B2-1-67 (1967)

Note

Weak γ's of energy 0.626, 0.675, 0.814, 0.864, 1.388, and 2.114 MeV (^{144}Pr decay) have not been included here because of their low intensities (<0.01%). Data on these γ's are summarized by S. Raman, Nuclear Data B2-1-47 (1967). See also 69Fa09.

Note

Since the half-life of ^{144}Pr is much shorter than that of its parent, ^{144}Ce, the ratio of ^{144}Pr activity to that of ^{144}Ce in an initially pure ^{144}Ce source will increase at first and then approach the constant value $T_A/(T_A-T_B)^a = 1.000$ after $\approx 10T_B$ ($\approx$ 3h). When the ratio of activities has reached this constant value, the parent and daughter are in equilibrium and the total activity is equal to 1 + 1.000 = 2.000 times the ^{144}Ce activity.

Since the half-life of ^{144}Nd is so long the activity of ^{144}Nd in a ^{144}Ce source is negligible. We can thus treat ^{144}Nd as a stable nucleus and ignore its α-decay to ^{140}Ce.

[a] $T_A = T_{1/2}$ (^{144}Ce), $T_B = T_{1/2}$ (^{144}Pr)
[b] Energy of L_1-line given
[c] Energy of M_1-line given

Radiations

Type	Energy MeV	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00408**	10.3 *3*	0.00090	0.032	<0.0001
e_{AK}	**0.02942**	0.95 *3*	0.00060	0.021	0.0012
ce_{3K}	**0.01142** *5*	0.92 *14*	0.00023	0.008	0.00024
ce_{4K}	**0.01704** *3*	0.40 *3*	0.00014	0.005	0.00048
ce_{1L}	**0.02673**[b] *3*	0.85 *7*	0.00048	0.017	0.0011
ce_{1MN}	**0.03206**[c] *3*	0.17 *2*	0.00012	0.004	0.0015
ce_{2L}	**0.03409**[b] *3*	0.83 *7*	0.00060	0.021	0.0016
ce_{5K}	**0.03813** *3*	3.3 *1*	0.0027	0.096	0.0020
ce_{2MN}	**0.03942**[c] *3*	0.20 *3*	0.00017	0.006	0.0021
ce_{3L}	**0.04657**[b] *5*	0.13 *2*	0.00013	0.005	0.0028
ce_{3M}	**0.05190**[c] *5*	0.03 *1*	0.00003	0.001	0.0034
ce_{4L}	**0.05219**[b] *3*	0.61 *5*	0.00068	0.024	0.0035
ce_{4MN}	**0.05752**[c] *3*	0.16 *2*	0.00020	0.007	0.0041
ce_{6K}	**0.05796** *5*	0.06 *1*	0.00007	0.002	0.0041

Decay Characteristics continued

Radiations continued

Type	Energy MeV	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
ce_{5L}	**0.07328**[a] *3*	0.46 *2*	0.00072	0.026	0.0063
ce_{5MN}	**0.07861**[b] *3*	0.13 *3*	0.00022	0.008	0.0071
ce_{7K}	**0.09154** *3*	5.3 *2*	0.0103	0.37	0.0092
ce_{7L}	**0.12669**[a] *3*	0.74 *3*	0.0020	0.071	0.016
ce_{7MN}	**0.13202**[b] *3*	0.19 *2*	0.00053	0.019	0.017
β_1^-	**0.1821**$_{max}$ *15* **0.0495**$_{av}$ *5*	19.4 *7*	0.0205	0.73	0.0116
β_2^-	**0.2156**$_{max}$ *15* **0.0595**$_{av}$ *5*	0.28 *12*	0.0004	0.014	0.0158
β_3^-	**0.2355**$_{max}$ *15* **0.0655**$_{av}$ *5*	4.2 *3*	0.0059	0.21	0.0181
β_4^-	**0.3156**$_{max}$ *15* **0.0905**$_{av}$ *5*	76.3 *7*	0.147	5.2	0.0295
β_5^-	**0.810**$_{max}$ *3* **0.268**$_{av}$ *1*	1.03 *4*	0.0059	0.21	0.126
β_6^-	**2.300**$_{max}$ *3* **0.899**$_{av}$ *1*	1.22 *6*	0.0234	0.83	0.52
β_7^-	**2.996**$_{max}$ *3* **1.240**$_{av}$ *1*	97.75 *6*	2.582	91.7	0.67
All β's	**0.654**$_{av}$ *3*	200	2.786	98.9	0.66
X_L	**0.00503**	2.10 *5*	0.00022	0.008	0.059
γ_1	**0.03357** *3*	0.22 *2*	0.00016	0.006	12
X_K	**0.03671**	9.0 *3*	0.0070	0.25	13
γ_2	**0.04093** *3*	0.39 *3*	0.00034	0.012	16
γ_3	**0.05341** *5*	0.14 *2*	0.00016	0.006	21
γ_4	**0.05903** *3*	≈ 0	-	-	-
γ_5	**0.08012** *3*	1.54 *15*	0.0026	0.092	27
γ_6	**0.09995** *5*	0.038 *4*	0.00008	0.003	30
γ_7	**0.13353** *3*	10.8 *5*	0.0307	1.1	33
γ_8	**0.69648** *9*	1.51 *5*	0.0224	0.77	47
γ_9	**1.48914** *7*	0.29 *2*	0.0092	0.32	61
γ_{10}	**2.18572** *5*	0.74 *3*	0.0344	1.2	71

[a]Energy of L_1-line given
[b]Energy of M_1-line given
[c]Measured values

Basic Data, Sources for Adopted Values

Decay Scheme

^{144}Ce Q^- = **0.3156** *15* $E(\beta_4^-)$

The γ-placements are determined by the γ-energies, $\gamma\gamma$- and $\beta\gamma$-coincidence measurements (56P24, 57P51, 58H76, 59F54, 60Sa22, 61Ge9, 62Fo4, 63Fu16), and the observed β-groups.

Intensities per 100 ^{144}Ce decays are obtained from the relative γ-intensities, relative ce-intensities, $ce_{7K}/(\beta_1^-+\cdots\beta_4^-)$, $\gamma_7/(\beta_1^-+\cdots\beta_4^-)$, and the requirement $I(\beta_1^-+\cdots\beta_4^-)$ = 100%.

^{144}Pr Q^- = [w]**2.996** *3* $E(\beta_7^-)$[c], $E(\beta_5^-)$[c]+E(2.1857 level)

The γ-placements are determined by the γ-energies, the observed $\gamma_8\gamma_9$-coincidence (52A19, 57F50, 61Su4), and the observed β-groups.

Intensities per 100 ^{144}Ce decays are obtained from relative γ-intensities, $(\gamma_8+\gamma_{10})/(\beta_5^-+\beta_6^-+\beta_7^-)$ and the requirement $I(\beta_5^-+\beta_6^-+\beta_7^-)$ = 100%.

Decay Modes

Type	Energy MeV	Intensity %	
$ce_1\cdots ce_6$		$I(ce_{1L}\cdots ce_{4L})$ and $I(ce_{5K}, ce_{6K})$ are weighted averages of data of 60Ge5 and 62Fo4. The relative values of each author are normalized to 5.3% for $I(ce_{7K})$. The other I(ce) are obtained from the above by use of K/L and MN/L values	
ce_{7K}		5.3 *2*	$ce_{7K}/(\beta_1^-+\cdots\beta_4^-)$
ce_{7L}		0.74 *3*	$I(ce_{7K})$, ce_{7K}/ce_{7L},
ce_{7MN}		0.19 *2*	and ce_{7L}/ce_{7MN}

continued on next page

$\left({}^{144}_{58}Ce_{86}-{}^{144}_{59}Pr_{85}\right)$-3

Basic Data, Sources for Adopted Values cont.

Decay Modes continued

Type	Energy MeV	Intensity %	
β_1^-	*0.1821 15		Q^--E(1.3353 level)
	^{W}0.182 3		56P24, 57P51, 59F54, 59S57, 60Sa22, 63Fu16
		*19.4 7	(γ+ce)-intensities
		19.7 5	66Da04
β_2^-	0.2156 15		Q^--E(0.09995 level)
		0.28 12	(γ+ce)-intensities
β_3^-	0.2355 15		Q^--E(0.08012 level)
	^{W}0.239 4		54C60, 57P51, 58H76, 59F54, 59S57, 62Fo4, 63Fu16
		*4.2 3	(γ+ce)-intensities
		4.6 3	66Da04
β_4^-	0.3156 15		66Da04
		*76.3 7	(γ+ce)-intensities
		75.7 8	66Da04
β_5^-	*0.810 3		Q^--E(2.1857 level)
	^{W}0.806 5		58G99, 59P77
		*1.03 4	(γ+ce)-intensities
		^{U}1.9 4	54C60, 54E09, 58H76
β_6^-	*2.300 3		Q^--E(0.6965 level)
	^{W}2.296 11		58G99, 59P77
		*1.22 6	(γ+ce)-intensities
		^{U}2.3 7	54E09, 58H76
β_7^-	*2.996 3		Q^-
	^{W}2.998 3		59P77, 66Da04, 67Na15
		*97.75 6	(γ+ce)-intensities
		^{U}96.3 10	54C60, 54E09, 58H76
$\gamma_1\cdots\gamma_6$	E(γ) are data of 60Ge5. I($\gamma_1\cdots\gamma_4$) are obtained from I(ce_L) and ce_L/γ. I(γ_5,γ_6) are data of 69Fa09 normalized so that I(γ_7) = 10.8%.		
γ_7	0.13353 3		60Ge5
		10.8 5	$\gamma_7/(\beta_1^-+\cdots\beta_4^-)$
γ_8	0.69648 9		68Sa05
		^{W}1.51 5	$\gamma_8/(\gamma_8+\gamma_{10})$ 58G99, 61Mo9, 68Ra01, 68Sa05, 69Fa09
γ_9	1.48914 7		68Sa05
		^{W}0.29 2	γ_9/γ_8 58G99, 61Mo9, 68Ra01, 68Sa05, 69Fa09
γ_{10}	2.18572 5		68Sa05
		^{W}0.74 3	$\gamma_{10}/(\gamma_8+\gamma_{10})$ 58G99, 61Mo9, 68Ra01, 68Sa05, 69Fa09
$\gamma_8+\gamma_{10}$		2.26 10	$(\gamma_8+\gamma_{10})/(\beta_5^-+\beta_6^-+\beta_7^-)$ and $I(\beta_5^-+\beta_6^-+\beta_7^-)$=100

Basic Data, Sources for Adopted Values cont.

Auxiliary Data

ce_{1L}/γ_1	= 3.80	M1 Theory
ce_{1MN}/ce_{1L}	= 0.20 3	60Ge5
ce_{2L}/γ_2	= 2.08	M1 Theory
ce_{2MN}/ce_{2L}	= 0.24 3	60Ge5
ce_{3L}/γ_3	= 0.95	M1 Theory
ce_{3K}/ce_{3L}	= 7.1	M1 Theory
ce_{3M}/ce_{3L}	= 0.22 7	60Ge5
	*0.21	M1 Theory
ce_{4L}/γ_4	= 0.71	M1 Theory
ce_{4K}/ce_{4L}	= 0.66	M1 Theory
ce_{4MN}/ce_{4L}	= 0.26 2	60Ge5
ce_{5K}/γ_5	= *2.02	M1 Theory
	^{W}1.3 3	56P24, 58H76
ce_{5K}/ce_{5L}	= *7.1	M1 Theory
	^{W}7.3 4	60Ge5, 62Fo4
ce_{5MN}/ce_{5L}	= 0.28 6	60Ge5
$ce_{7K}/(\beta_1^-+\cdots\beta_4^-)$	= 0.053 2	60Ge5
$\gamma_7/(\beta_1^-+\cdots\beta_4^-)$	= ^{W}0.108 5	58L69, 59P77, 61Si7
ce_{7K}/ce_{7L}	= *7.2	M1 Theory
	^{W}7.2 2	60Ge5, 62Fo4
ce_{7MN}/ce_{7L}	= 0.26 3	60Ge5
$\gamma_8/(\beta_5^-+\beta_6^-+\beta_7^-)$	= 0.0149 7	59P77
$\gamma_{10}/(\beta_5^-+\beta_6^-+\beta_7^-)$	= 0.0077 4	64Mc23
$\therefore(\gamma_8+\gamma_{10})/(\beta_5^-+\beta_6^-+\beta_7^-)$	= 0.0226 10	
ω_K	= 0.903	(Pr) Appendix III
ω_L	= 0.167	(Pr) Appendix III
n_{KL}	= 0.88	(Pr) Appendix III

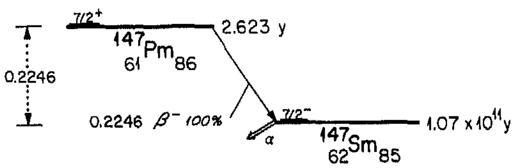
Comparison of Additional Experimental Results with Values Calculated from the Adopted Decay Scheme

$I(X_K+\gamma_1+\gamma_2+\gamma_3)$	= 9.8% 3	From adopted values
	^{W}10.0% 1	59F54, 61Si7, 63Zu02
$I(e_{AK})$	= 0.95 3	From adopted values
	^{U}0.94 7	54E09, 56P24, 62Fo4

^{U}Unweighted average
^{W}Weighted average
*Value adopted by compilers from possibilities shown

$^{147}_{61}Pm_{86}$

Decay Characteristics	Basic Data, Sources for Adopted Values



$T_{1/2}$ 2.623 y *1* (^{147}Pm) Appendix I
1.07×10^{11}y (^{147}Sm) For data see W.B. Ewbank et al., Nuclear Data B2-4-58 (1967)

Note

A weak (γ+ce)-transition of energy 0.121 MeV and intensity 0.008% (56L17, 57S105, 66Pr11) de-exciting a level at 0.121 MeV and the β-group required to feed this level (0.103 MeV, 0.008%) have not been included here because of their low intensities.

Note

Since the half-life of ^{147}Sm is so long, the activity of ^{147}Sm in a ^{147}Pm source is negligible. We can thus treat ^{147}Sm as a stable nucleus and ignore its α-decay to ^{143}Nd.

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β^-	**0.2246**$_{max}$ *6*				
	0.0621$_{av}$ *2*	100	0.132	100	0.0166

Decay Scheme

Q^- = **0.2246** *6* E(β^-)
No γ other than 0.121γ (56L17) (see first ''Note'' under decay scheme drawing)
$\therefore$ I(β^-) = 100%

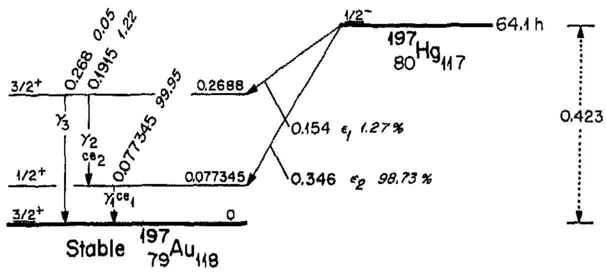
Decay Modes

Type	Energy MeV	Intensity %	
β^-	^{W}**0.2246** *6*		49L23, 50A01, 50L04, 58H32, 66Hs01
		100	Decay scheme

^{W}Weighted average

$^{197}_{80}Hg_{117}$-1

Decay Characteristics



$T_{1/2}$ 64.1 h *1* Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00742**	90.1 *7*	0.0142	5.0	≈0.0001
e_{AK}	**0.05239**	3.15 *2*	0.00351	1.2	0.0035
ce_{1L}	**0.062992**[a] *4*	61.8 *6*	0.0829	29.0	0.0048
ce_{1MN}	**0.073920**[b] *4*	19 *1*	0.030	10.5	0.0063
ce_{2K}	**0.1108** *2*	0.53 *5*	0.0012	0.42	0.012
ce_{2LMN}	**0.1771**[a] *2*	0.13 *1*	0.00049	0.17	0.027
X_L	**0.00971**	51.8 *4*	0.0107	3.7	0.44
X_K	**0.07042**	71.8 *3*	0.1077	37.7	26
γ_1	**0.077345** *8*	19.5 *2*	0.0321	11.2	27
γ_2	**0.1915** *2*	0.56 *4*	0.0023	0.81	36
γ_3	**0.268** *1*	0.05 *2*	0.00023	0.081	38

[a]Energy of L_1-line given

[b]Energy of M_1-line given

[c]The compilers assume there is no ground-state ϵ-branch. This assumption is based on the following observations.
1) 67Ba44 has measured $X_K/\gamma_1 = 3.2$ *8*. From the calculated X_K intensity of 71.8% [71.3% of $I(X_K)$ comes from ϵ-processes and is thus independent of the amount of g.s. capture] the minimum value of $I(\gamma_1)$ is 18%. Thus, $I(\gamma_1 + ce_1) > 92\%$ and ϵ(g.s.) $< 8\%$
2) For a first-forbidden transition, log ft is expected to be > 5.8. For $Q^+ = 0.423$ MeV and $T_{1/2}(^{197}Hg)$ = 64.1 h, this log ft value yields ϵ(g.s.) $< 1\%$

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^+ = 0.423$ *13* $E_{\epsilon_1} + E(0.2688 \text{ level})$

The γ-placements are determined by the γ-energies, the observed $\gamma_1\gamma_2$-coincidence (55J22), and the known 0.077-MeV level [seen in (p,p') by 57E11].

Intensities per 100 ^{197}Hg decays are obtained from the relative ce-intensities, $ce_1/\gamma_1, \gamma_3/\gamma_1$, and the requirement that $I(\gamma_1 + ce_1 + \gamma_3) = 100$[c].

Decay Modes

Type	Energy MeV	Intensity %	
ϵ_{1K}		0.68 *6*	ϵ_{1K}/ϵ_1
ϵ_{1L}		0.43 *7*	$\epsilon_{1L}/\epsilon_{1K}$
ϵ_{1MNO}		0.15 *3*	$\epsilon_{1MNO}/\epsilon_{1L}$
ϵ_1		1.27 *7*	(γ+ce)-intensities
ϵ_{2K}		73.7 *3*	$I(\epsilon_2)$, $\epsilon_{2L}/\epsilon_{2K}$ and $\epsilon_{2MNO}/\epsilon_{2L}$
ϵ_{2L}		18.9 *3*	
ϵ_{2MNO}		6.2 *1*	
ϵ_2		98.73 *7*	$I(\epsilon_1)$ and $I(\epsilon_1 + \epsilon_2) = 100$
ce_{1L}		61.8 *6*	ce_{1L}/γ_1, ce_{1MN}/ce_{1L}, γ_3/γ_1, and $I(\gamma_1 + ce_1 + \gamma_3) = 100$
ce_{1MN}		19 *1*	
ce_{2K}		[w]0.53 *5*	ce_{2K}/ce_{1L} 55J22, 61Ju5
ce_{2LMN}		0.13 *1*	$I(ce_{2K})$ and ce_{2LMN}/ce_{2K}
γ_1	**0.077345** *8*		63Ma08
		19.5 *2*	See $I(ce_1)$
γ_2	**0.1915** *2*		61Ju5
		0.56 *4*	$I(ce_{2K})$ and ce_{2K}/γ_2
γ_3	[u]**0.268** *1*		65Ha15, 65He04
		0.05 *2*	See $I(ce_1)$

Auxiliary Data

$\epsilon_{1K}/\epsilon_1 = 0.54$ *6* 65De20

$\epsilon_{1MNO}/\epsilon_{1L} = 0.306(q^2_{M_1}/q^2_{L_1})^d$ Theory

$\epsilon_{1L}/\epsilon_{1K} = 0.163(q^2_{L_1}/q^2_K)^d$ Theory

$\therefore$ from $(\epsilon_{1K}/\epsilon_1)^{-1} = 1 + (\epsilon_{1L}/\epsilon_{1K})(1 + \epsilon_{1MNO}/\epsilon_{1L})$ one obtains

$E_{\epsilon_1} = 0.154$ *13*

$\epsilon_{1L}/\epsilon_{1K} = 0.63$ *11*

$\epsilon_{1MNO}/\epsilon_{1L} = 0.355$ *4*

continued on next page

[d]The q's are neutrino energies defined by $q_i = E_\epsilon - E_i$ where E_i is the electron binding energy in the i-shell. See Appendix III

[u]Unweighted average

Basic Data, Sources for Adopted Values cont.

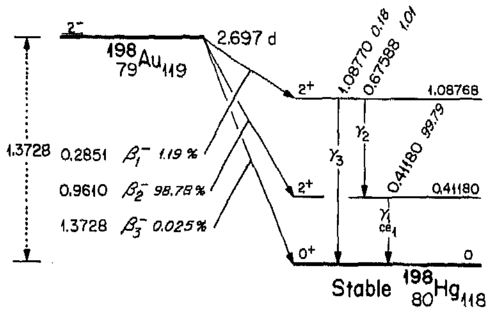
Auxiliary Data continued

$\epsilon_{2L}/\epsilon_{2K}$	= 0.256 5[a]	Theory
$\epsilon_{2MNO}/\epsilon_{2L}$	= 0.326	Theory
ce_{1L}/γ_1	= 3.17	Theory[b]
ce_{1MN}/ce_{1L}	= [W]0.30 2	55J22, 61Ju5, 67Bu22
$\therefore ce_1/\gamma_1$	= 4.12 7	
ce_{2K}/γ_2	= *0.94	Theory[c]
	0.7 to 2.5	55J22, 56P05, 60Fe3, 60Jo17, 65Ha15, 65He04, 67Ba44
ce_{2LMN}/ce_{2K}	= [W]0.25 1	55J22, 65He04, 67Ba44
γ_3/γ_1	= 0.0026 8	67Bu22
ω_K	= 0.958	Appendix III
ω_L	= 0.365	Appendix III
n_{KL}	= 0.81	Appendix III

[a]Uncertainty is that resulting from uncertainty in Q^+
[b]M1 + 1.2% E2 from L-subshell ratios of 67Ba44
[c]M1 + 5% E2 from L-subshell ratios of 67Ba44
[W]Weighted average
*Value adopted by compilers from possibilities shown

$^{198}_{79}Au_{119}$

Decay Characteristics



$T_{1/2}$	2.697 d *5*	Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00760**	2.12 *3*	0.000343	0.022	≈ 0.0001
e_{AK}	**0.05380**	0.118 *1*	0.000135	0.009	0.0036
ce_{1K}	**0.32869** *1*	2.87 *3*	0.0201	1.29	0.070
ce_{1L}	**0.39696**[a] *1*	1.07 *3*	0.0090	0.58	0.093
ce_{1MN}	**0.40823**[b] *1*	0.32 *4*	0.0028	0.18	0.097
β_1^-	**0.2851**$_{max}$ *4* **0.0799**$_{av}$ *2*	1.19 *8*	0.00203	0.13	0.0246
β_2^-	**0.9610**$_{max}$ *4* **0.3183**$_{av}$ *2*	98.78 *3*	0.6697	42.9	0.159
β_3^-	**1.3728**$_{max}$ *4* **0.4671**$_{av}$ *2*	0.025 *5*	0.00025	0.016	0.267
All β's	**0.3159**$_{av}$ *2*	100	0.6729	43.1	0.159
X_L	**0.00999**	1.27 *2*	0.000270	0.017	0.47
X_K	**0.07249**	2.75 *3*	0.00425	0.27	26
γ_1	**0.41180** *1*	95.53 *5*	0.8379	53.6	42
γ_2	**0.67588** *2*	1.01 *8*	0.0145	0.93	47
γ_3	**1.08770** *3*	0.18 *2*	0.0042	0.27	55

[a] Energy of L_1-line given
[b] Energy of M_1-line given
[W] Weighted average
*Value adopted by compilers from possibilities shown

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^- = 1.3728$ *4* — $E(\beta_2^-) + E(0.41180$ level$)$

The γ-placements are determined by the γ-energies and the observed $\gamma_1\gamma_2$-coincidence (51B52, 51C24).

Intensities per 100 ^{198}Au decays are obtained from the relative γ-intensities, ce_1/γ_1, $I(\beta_3^-)$, and the requirement that $I(\beta_3+\gamma_1+ce_1+\gamma_3) = 100$.

Decay Modes

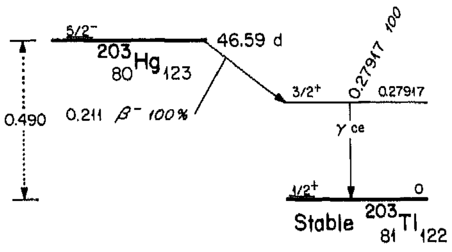
Type	Energy MeV	Intensity %	
$ce_{1K} \cdots ce_{1MN}$			$I(ce_1)$, ce_{1K}/ce_{1L}, and ce_{1K}/ce_{1LMN}
ce_1		4.26 *4*	See $I(\gamma_1)$
β_1^-	*0.2851 *4*		$Q^- - E(1.08768$ level$)$
	0.290 *15*		51B52
		1.19 *8*	γ-intensities
β_2^-	[W]0.9610 *4*		54E04, 56P28, 58W08, 60De17, 61De3, 62Ha25, 63Le11, 64Bl10, 64Le09, 65Be24, 65Ke04, 65Pa08, 67Na15
		98.78 *3*	γ-intensities
β_3^-	*1.3728 *4*		Q^-
	1.371 *4*	0.025 *5*	55E11
γ_1	0.411795 *9*		65Mu03
		95.53 *5*	γ_3/γ_1, ce_1/γ_1 $I(\beta_3^-)$ and $(\beta_3^-+\gamma_1+ce_1+\gamma_3) = 100$
γ_2	[W]0.67588 *2*		64Ka17, 65Re17
		1.01 *8*	γ_2/γ_1 51C24, 51H18, 54E04, 54M19, 55D41, 56V20, 58W08
γ_3	[W]1.08770 *3*		64Ka17, 65Re17
		0.18 *2*	See $I(\gamma_1)$

Auxiliary Data

γ_3/γ_1 = [W]0.0019 *2*	51C24, 51H18, 54E04, 54M19, 55D41, 56V20
ce_{1K}/γ_1 = 0.0300	E2 Theory
*[W]0.0300 *2*	61Pe7, 62Ha25, 63Le11, 64Be33, 65Be07, 65Ke04, 65Ne11, 65Pa08, 66Le02, 66Pa01, 67Bo44
ce_{1K}/ce_{1L} = 2.86	E2 Theory
*[W]2.69 *8*	59K20, 60De17, 64He19, 66Pa01, 68Bo38
ce_{1K}/ce_{1LMN} = [W]2.05 *4*	63Ku09, 66Pa01, 67Bo44
∴ ce_1/γ_1 = 0.0446 *4*	
ω_K = 0.959	Appendix III
ω_L = 0.375	Appendix III
n_{KL} = 0.81	Appendix III

$^{203}_{80}Hg_{123}$

Decay Characteristics	Basic Data, Sources for Adopted Values



$T_{½}$ **46.59 d** *5* Appendix I

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00778**	9.0 *1*	0.00149	0.21	≈0.0001
e_{AK}	**0.05522**	0.53 *1*	0.00062	0.086	0.0038
ce_K	**0.19364** *2*	13.3 *2*	0.0548	7.62	0.031
ce_L	**0.26382**[a] *2*	3.98 *8*	0.0224	3.12	0.050
ce_{MN}	**0.27547**[b] *2*	1.24 *4*	0.00728	1.01	0.054
β^-	**0.211**$_{max}$ *1* **0.0592**$_{av}$ *6*	100	0.126	17.5	0.0148
X_L	**0.01027**	5.63 *8*	0.00123	0.17	0.53
X_K	**0.07460**	12.8 *2*	0.0203	2.82	26
γ	**0.27917** *2*	81.5 *2*	0.485	67.5	38

[a]Energy of L_1-line given
[b]Energy of M_1-line given
[W]Weighted average

Decay Scheme

$Q^- =$ **0.490** *1*	$E(\beta^-) + E(\gamma)$
No γ other than 0.27917γ	52C01
No g.s. β-group (<4×10^{-3}%)	55M40
∴ $I(\beta) = I(\gamma+ce) = 100$	

Decay Modes

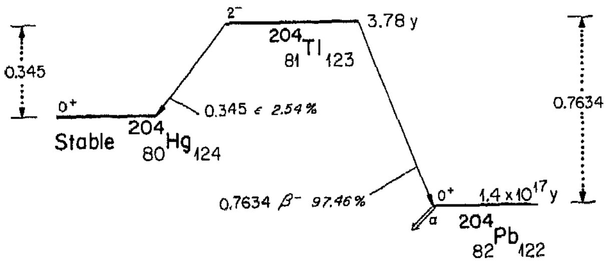
Type	Energy MeV	Intensity %	
ce_K		13.3 *2*	I(ce), ce_K/ce_L, and ce_L/ce_{MN}
ce_L		3.98 *8*	
ce_{MN}		1.24 *4*	
ce		18.5 *2*	See I(γ)
β^-	[W]**0.211** *1*		51W22, 54T17, 55M40, 58N28, 65Pa17
		100	Decay scheme
γ	[W]**0.27917** *2*		58E19, 64He19
		81.5 *2*	ce/γ and I(γ+ce) = 100

Auxiliary Data

$ce_K/\gamma =$ [W]0.163 *1*	53B97, 54M108, 56N26, 58N28, 61Su10, 63Bu09, 63Cr14, 65Pa17, 67Sa08
$ce_K/ce_L =$ [W]3.34 *4*	56N26, 58N28, 62He9, 65Pa17
$ce_L/ce_{MN} =$ [W]3.21 *6*	58N28, 62He9, 65Pa17
∴ $ce/\gamma = 0.227$ *2*	
$\omega_K = 0.960$	Appendix III
$\omega_L = 0.386$	
$n_{KL} = 0.80$	

$^{204}_{81}Tl_{123}$

Decay Characteristics



$T_{1/2}$	3.78 y *2*	(^{204}Tl)	Appendix I
	1.4×10^{17}y	(^{204}Pb)	

Note
Since the half-life of ^{204}Pb is so long, the activity of ^{204}Pb in a ^{204}Tl source is negligible. We can thus treat ^{204}Pb as a stable nucleus and ignore its α-decay to ^{200}Hg.

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00760**	1.27 *3*	0.00021	0.041	≈ 0.0001
e_{AK}	**0.05380**	0.063 *2*	0.00007	0.014	0.0036
β^-	**0.7634**$_{max}$ *2* **0.2433**$_{av}$ *1*	97.46 *5*	0.505	99.5	0.121
X_L	**0.00999**	0.76 *2*	0.00016	0.032	0.47
X_K	**0.07249**	1.47 *3*	0.00227	0.45	26

[a] Uncertainty is that due to uncertainty in Q^+
[U] Unweighted average
[W] Weighted average
* Value adopted by compilers from possibilities shown

Basic Data, Sources for Adopted Values

Decay Scheme

$Q^+ = 0.345$ *7*	65MTW1
$Q^- = 0.7634$ *2*	$E(\beta^-)$
No γ (<0.01%)	52D22, 55Y02
∴ $I(\beta^-+\epsilon) = 100$	

Decay Modes

Type	Energy MeV	Intensity %	
ϵ_K		1.53 *3*	$I(\epsilon)$, ϵ_L/ϵ_K, and $\epsilon_{MNOP}/\epsilon_L$
ϵ_L		0.79 *2*	
ϵ_{MNOP}		0.23 *1*	
ϵ		2.54 *5*	ϵ/β^- and $I(\beta^-+\epsilon) = 100$
β^-	[W]**0.7634** *2*		67Pa08, 68Wo02
		97.46 *5*	ϵ/β^- and $I(\beta^-+\epsilon) = 100$

Auxiliary Data

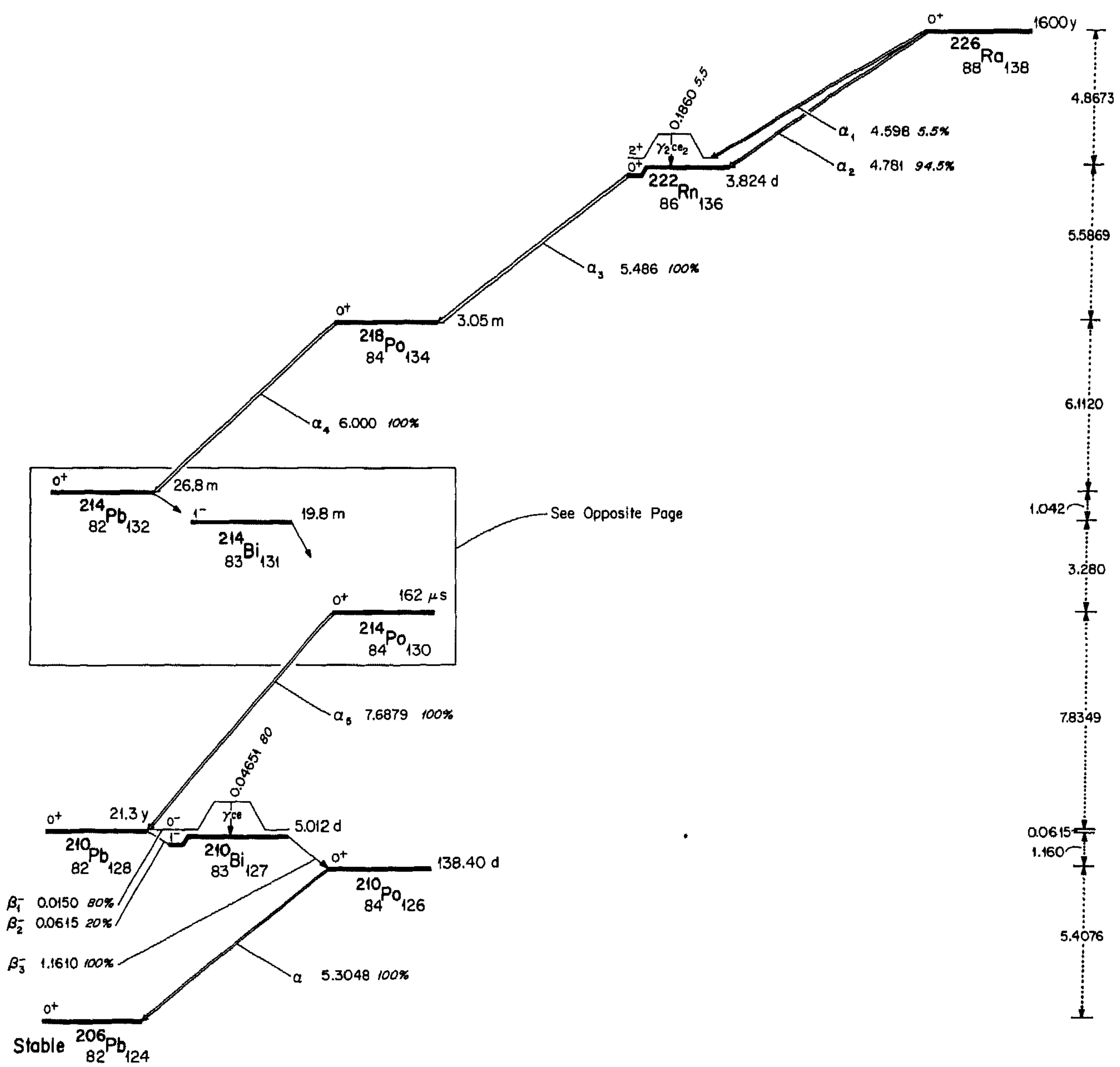
$\epsilon_L/\epsilon_K = $ *0.514 *14*[a]	Theory
[U]0.51 *4*	61Jo12, 63Ro32, 64Ch17, 66Kl02
$\epsilon_{MNOP}/\epsilon_L = 0.294$ *1*[a]	Theory
$\epsilon_K/\beta^- = $ [W]0.0156 *3*	61Jo12, 62Le5, 64Ch17, 66Kl02, 67Ha39
$(\epsilon_K+\epsilon_L)/\beta^- = 0.0229$ *6*	66Kl02
$\epsilon/\beta^- = 0.0260$ *6*	ϵ_K/β^-, ϵ_L/ϵ_K and $\epsilon_{MNO}/\epsilon_L$
0.0263 *6*	$(\epsilon_K+\epsilon_L)/\beta^-$, ϵ_L/ϵ_K and $\epsilon_{MNO}/\epsilon_L$
*0.0261 *5*	
$\omega_K = 0.959$, $\omega_L = 0.375$, $n_{KL} = 0.81$ (Hg)	Appendix III

Comparison of Additional Experimental Results with Values Calculated from the Adopted Decay Scheme

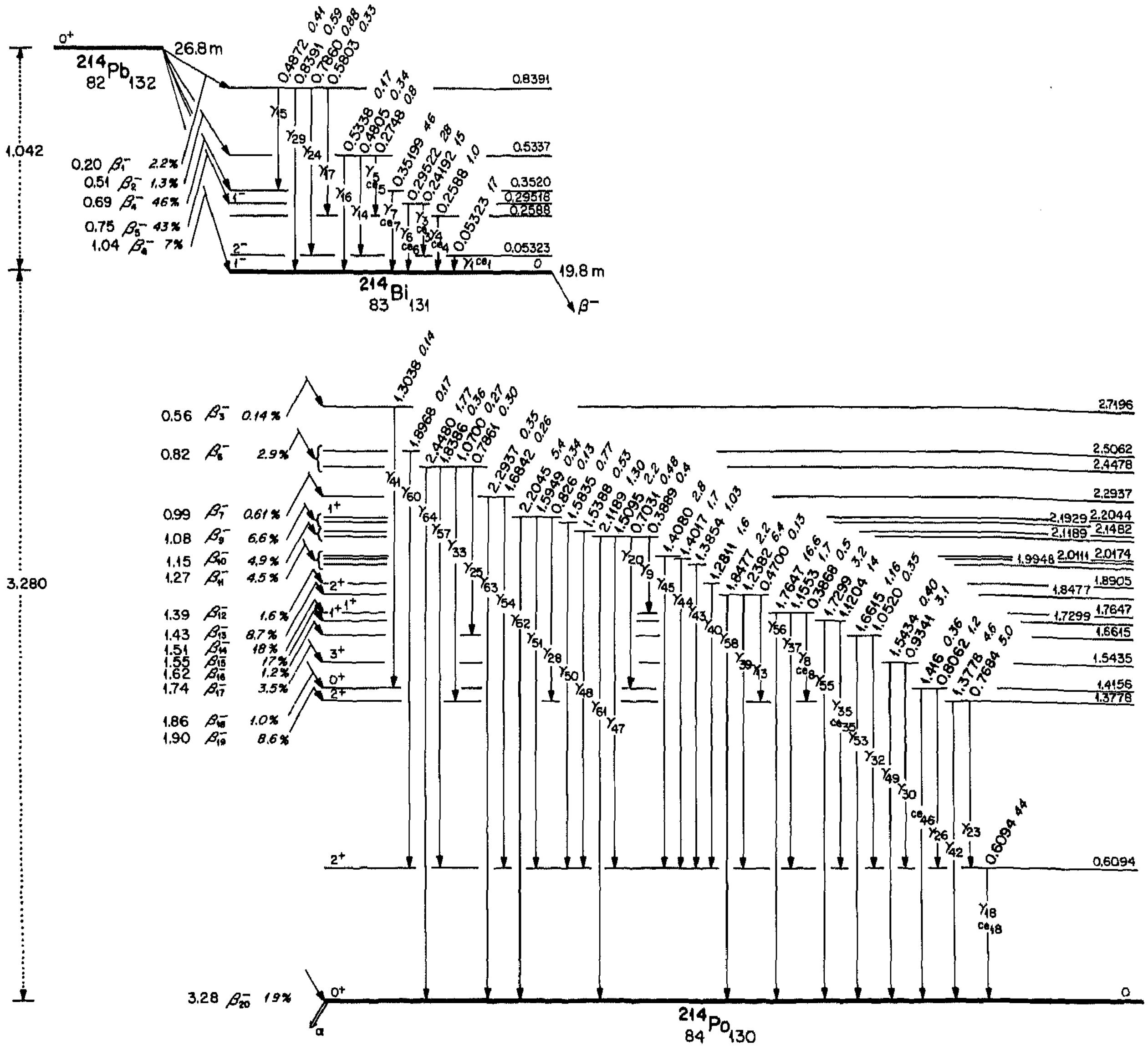
$I(X_L)/I(X_K) = 0.52$ *2*	65Ra04
0.52 *2*	From adopted values

$\left({}^{226}_{88}Ra_{138} + \text{chain of daughters}\right)$ -1

Decay Characteristics



Decay Characteristics continued



$\left({}^{226}_{88}\mathrm{Ra}_{138} + \text{chain of daughters}\right)$ -3

Decay Characteristics

$T_{1/2}$	**1600 y** *7*	(^{226}Ra)	Appendix I
	3.824 d *2*	(^{222}Rn)	A.H.Wapstra, N.B.Gove, Nuclear Data Sheets for 213≤A≤228, Nuclear Data B1-5 (1966)
	3.05 m	(^{218}Po)	
	26.8 m	(^{214}Pb)	
	19.8 m	(^{214}Bi)	
	162 μs *2*	(^{214}Po)	
	21.3[a]y *5*	(^{210}Pb)	Nuclear Data Sheets, 1959-1965, Reprint by Academic Press, N.Y. (1966)
	5.012 d *9*	(^{210}Bi)	
	138.40 d *1*	(^{210}Po)	

Note

The half-lives of the daughter nuclei ^{222}Rn, ^{218}Po, ^{214}Pb, ^{214}Bi, and ^{214}Po are negligibly small compared with that of ^{226}Ra. A radium source from which the ^{222}Rn (radon gas) does not escape reaches equilibrium with the above daughter products in $\approx 10T_{1/2}(^{222}\mathrm{Rn})$ (≈38d).

The half-life of ^{210}Pb is long, but still much shorter than that of ^{226}Ra. The ratio of ^{210}Pb activity to that of ^{226}Ra in an initially pure ^{226}Ra source is given as a function of time by

$$\frac{T_A}{T_A-T_B}\left[1-\exp\left(-0.693\,\frac{T_A-T_B}{T_AT_B}\,t\right)\right]=1.014\left[1-\exp(-0.0310t)\right]$$

where $T_A=T_{1/2}(^{226}\mathrm{Ra})$, $T_B=T_{1/2}(^{210}\mathrm{Pb})$, and t is in years.

Since the half-life of ^{210}Bi is much shorter than that of ^{210}Pb, the ^{210}Bi and ^{210}Pb activities in a ^{226}Ra source will be in equilibrium.

The ratio of ^{210}Po activity to that of ^{226}Ra in an initially pure ^{226}Ra source is given as a function of time by

$$1.014\left[1-1.017\times\exp(-0.0310t)+0.0176\times\exp(-1.83t)\right]$$

where t is in years.

Note

Only radiations with equilibrium intensities >0.1 per 100 decays of ^{226}Ra are included here.

[a]Values of 64Ra12 and 67Vo04 have been included in addition to those given in the Nuclear Data Sheets Reprint Issue

[b]Transition in Bi

[c]Transition in Po

[d]Transition in Rn

[e]Energy of L_1-line given

[f]Uncertainty assigned by compilers

[g]Energy of M_1-line given

Decay Characteristics continued

Radiations (^{226}Ra+$\cdots$^{214}Po)

Type	Energy Me	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00815[b]**	20 *2*	0.0038	0.007	≈0.00013
	0.00833[c]	0.72 *3*			
	0.00871[d]	1.1 *1*			
ce_{1L}	**0.03684[e]** *2*	10 *2*[f]	0.008	0.014	0.0019
ce_{1MN}	**0.04923[g]** *2*	4.8 *10*[f]	0.0050	0.009	0.0031
e_{AK}	**0.05816[b]**	0.90 *2*	0.00111	0.002	0.0042
ce_{2K}	**0.0955** *1*	0.64 *3*	0.0013	0.003	0.010
ce_{3K}	**0.15139** *3*	6.2 *5*	0.020	0.035	0.021
ce_{4K}	**0.1683** *1*	0.45 *5*	0.0016	0.003	0.025
ce_{2L}	**0.1696[e]** *1*	1.2 *1*	0.0043	0.009	0.025
ce_{2M}	**0.1820[f]** *1*	0.33 *1*	0.0013	0.003	0.028
ce_{5K}	**0.1843** *1*	0.28 *3*	0.0011	0.002	0.029
ce_{6K}	**0.20469** *4*	7.7 *2*	0.034	0.060	0.034
ce_{3L}	**0.22553[e]** *3*	1.1 *2*	0.0053	0.009	0.040
ce_{3M}	**0.23792[f]** *3*	0.3 *1*	0.0015	0.003	0.043
ce_{7K}	**0.26146** *6*	8.6 *2*	0.048	0.084	0.050
ce_{6L}	**0.27883[e]** *4*	1.3 *1*	0.0077	0.014	0.055
ce_{6M}	**0.29122[f]** *4*	0.3 *1*	0.0019	0.003	0.059
ce_{8K}	**0.2937** *7*	0.15 *2*	0.00094	0.002	0.059
ce_{7L}	**0.33560[e]** *6*	1.6 *1*	0.011	0.020	0.073
ce_{7M}	**0.34799[f]** *6*	0.5 *1*	0.0037	0.007	0.076
ce_{18K}	**0.5163** *2*	0.63 *3*	0.0069	0.012	0.14
ce_{18L}	**0.5925[e]** *2*	0.18 *1*	0.0023	0.004	0.17
ce_{35K}	**1.0273** *2*	0.18 *1*	0.0039	0.007	0.34
ce_{46K}	**1.323** *1*	0.35 *1*	0.0099	0.017	0.46

continued on next page

Decay Characteristics continued

Radiations (^{226}Ra+...^{214}Po) continued

Type	Energy MeV	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R^{a}_{90} (cm) in Water
α_1	4.598 1	5.5 1	0.54	0.95	0.0030[a]
α_2	4.781 1	94.5 1	9.62	16.9	0.0031[a]
α_3	5.486 1	100	11.69	20.5	0.0038[a]
α_4	6.000 1	100	12.78	22.5	0.0044[a]
α_5	7.6879 7	100	16.38	28.8	0.0066[a]
β^-_1	0.20_{max} 2 0.056_{av} 6	2.2 2	0.0026	0.005	0.0148
β^-_2	0.51_{max} 2 0.152_{av} 6	1.3 1	0.0042	0.007	0.062
β^-_3	0.56_{max} 2 0.169_{av} 6	0.14 4	0.0005	0.001	0.072
β^-_4	0.69_{max} 2 0.215_{av} 6	46 3	0.21	0.37	0.098
β^-_5	0.75_{max} 2 0.236_{av} 6	43 2	0.22	0.39	0.110
β^-_6	0.82_{max} 2 0.264_{av} 6	2.9 2	0.016	0.028	0.129
β^-_7	0.99_{max} 2 0.326_{av} 7	0.61 5	0.0042	0.008	0.163
β^-_8	1.04_{max} 2 0.348_{av} 7	7 4	0.05	0.09	0.177
β^-_9	1.08_{max} 2 0.362_{av} 7	6.6 5	0.051	0.086	0.184
β^-_{10}	1.15_{max} 2 0.391_{av} 8	4.9 3	0.041	0.070	0.205
β^-_{11}	1.27_{max} 2 0.438_{av} 8	4.5 4	0.042	0.081	0.231
β^-_{12}	1.39_{max} 2 0.487_{av} 8	1.6 2	0.017	0.030	0.260
β^-_{13}	1.43_{max} 2 0.504_{av} 8	8.7 7	0.093	0.16	0.270
β^-_{14}	1.51_{max} 2 0.537_{av} 8	18 1	0.21	0.39	0.289
β^-_{15}	1.55_{max} 2 0.554_{av} 8	17 1	0.20	0.35	0.299

Decay Characteristics continued

Radiations (^{226}Ra+...^{214}Po) continued

Type	Energy MeV	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β^-_{16}	1.62_{max} 2 0.583_{av} 8	1.2 1	0.014	0.025	0.316
β^-_{17}	1.74_{max} 2 0.600_{av} 8	3.5 3	0.045	0.079	0.357
β^-_{18}	1.86_{max} 2 0.686_{av} 8	1.0 2	0.014	0.023	0.376
β^-_{19}	1.90_{max} 2 0.702_{av} 8	8.6 7	0.13	0.23	0.386
β^-_{20}	3.28_{max} 2 1.317_{av} 9	19 2	0.53	0.93	0.73
All β's	0.450_{av} 8	200	1.92	2.5	0.367
X_L	0.01084[b] 0.01113[c] 0.01173[d]	14 1 0.51 2 0.85 8	0.0035	0.006	0.62
γ_1	0.05323 2	2.2 4	0.0025	0.004	21
X_K	0.07892[b] 0.08117[c] 0.08578[d]	22.3 6 1.26 4 0.73 8	0.0410	0.072	28
γ_2	0.1860 1	3.3 1	0.015	0.026	35
γ_3	0.24192 3	7.4 6	0.038	0.067	37
γ_4	0.2588 1	0.56 9	0.0031	0.005	38
γ_5	0.2748 1	0.48 9	0.0028	0.005	38
γ_6	0.29522 4	18 1	0.113	0.20	39
γ_7	0.35199 6	35 3	0.26	0.46	40
γ_8	0.3868 7	0.37 10	0.0030	0.005	41
γ_9	0.3889 7	0.40 10	0.0033	0.006	41
[x]γ_{10}	0.4059 4	0.15 4	0.0013	0.002	41
[x]γ_{11}	0.4550 3	0.29 5	0.0028	0.005	43

[a]Value for α's is mean range. See Appendix IV
[b]Transition in Bi
[c]Transition in Po
[d]Transition in Rn
[x]Not shown on decay scheme since placement not determined

$\left({}^{226}_{88}Ra_{138} + \text{chain of daughters}\right)$ -5

Decay Characteristics continued

Radiations (^{226}Ra+...^{214}Po) continued

Type	Energy MeV	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90}(cm) in Water
$^{x}\gamma_{12}$	0.4621 2	0.21 5	0.0021	0.004	43
γ_{13}	0.4700 3	0.13 4	0.0013	0.002	43
γ_{14}	0.4805 2	0.34 7	0.0035	0.006	43
γ_{15}	0.4872 2	0.41 8	0.0043	0.008	43
γ_{16}	0.5338 2	0.17 4	0.0019	0.003	44
γ_{17}	0.5803 2	0.33 6	0.0041	0.007	45
γ_{18}	0.6094 2	43 3	0.56	0.98	46
$^{x}\gamma_{19}$	0.6656 2	1.5 2	0.021	0.037	47
γ_{20}	0.7031 2	0.48 6	0.0072	0.013	48
$^{x}\gamma_{21}$	0.7199 2	0.42 5	0.0064	0.011	48
$^{x}\gamma_{22}$	0.7530 3	0.11 3	0.0018	0.003	48
γ_{23}	0.7684 2	5.0 5	0.082	0.14	49
γ_{24}	0.7860 2	0.88 9	0.015	0.026	49
γ_{25}	0.7861 4	0.30 8	0.0050	0.009	49
γ_{26}	0.8062 2	1.2 2	0.021	0.037	50
$^{x}\gamma_{27}$	0.8212 3	0.16 4	0.0028	0.004	50
$^{x}\gamma_{28}$	0.826 1	0.13 6	0.0023	0.004	50
γ_{29}	0.8391 2	0.59 8	0.010	0.018	50
γ_{30}	0.9341 2	3.1 3	0.062	0.11	52
$^{x}\gamma_{31}$	0.9642 3	0.39 5	0.0080	0.014	53
γ_{32}	1.0520 3	0.35 4	0.0078	0.014	54
γ_{33}	1.0700 3	0.27 4	0.0062	0.011	55
$^{x}\gamma_{34}$	1.1040 4	0.16 3	0.0038	0.007	55
γ_{35}	1.1204 2	14.0 8	0.33	0.58	55
$^{x}\gamma_{36}$	1.1338 3	0.25 5	0.0060	0.011	56
γ_{37}	1.1553 2	1.7 2	0.042	0.074	56
$^{x}\gamma_{38}$	1.2077 3	0.52 6	0.013	0.023	57
γ_{39}	1.2382	6.4 6	0.17	0.30	57

Decay Characteristics continued

Radiations (^{226}Ra+...^{214}Po) continued

Type	Energy MeV	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
γ_{40}	1.2811 2	1.6 2	0.044	0.077	58
γ_{41}	1.3038 4	0.14 3	0.0039	0.007	58
γ_{42}	1.3778 2	4.6 4	0.13	0.23	59
γ_{43}	1.3854 2	1.03 8	0.030	0.053	59
γ_{44}	1.4017 3	1.7 3	0.051	0.090	60
γ_{45}	1.4080 2	2.8 3	0.084	0.15	60
γ_{46}	1.416 1	0[a]	0	0	60
γ_{47}	1.5095 3	2.2 2	0.071	0.12	61
γ_{48}	1.5388 3	0.53 4	0.017	0.030	62
γ_{49}	1.5434 4	0.40 4	0.013	0.023	62
γ_{50}	1.5835 3	0.77 6	0.026	0.046	62
γ_{51}	1.5949 4	0.34 3	0.012	0.021	63
$^{x}\gamma_{52}$	1.5996 4	0.40 7	0.014	0.025	63
γ_{53}	1.6615 2	1.16 7	0.041	0.072	64
γ_{54}	1.6842 3	0.26 2	0.0093	0.016	64
γ_{55}	1.7299 2	3.2 2	0.118	0.21	64
γ_{56}	1.7647 2	16.6 8	0.62	1.1	65
γ_{57}	1.8386 3	0.36 3	0.014	0.025	66
γ_{58}	1.8477 3	2.2 2	0.087	0.15	66
$^{x}\gamma_{59}$	1.8736 3	0.23 2	0.0092	0.016	67
γ_{60}	1.8968 4	0.17 3	0.007	0.013	67
γ_{61}	2.1189 3	1.30 9	0.059	0.10	70
γ_{62}	2.2045 3	5.4 5	0.25	0.44	71
γ_{63}	2.2937 3	0.35 3	0.017	0.030	72
γ_{64}	2.4480 3	1.77 9	0.092	0.16	74

[a] No photons are emitted in a transition between states with spin 0 and the same parity

[x] Not shown on decay scheme since placement not determined

Decay Characteristics continued

Radiations (^{210}Pb+^{210}Bi)

Type	Energy MeV	Equilibrium Intensity %	$\bar{\Delta}\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	**0.00815**[a]	34.5 *8*	0.0060	0.65	≈0.00013
ce_L	**0.03012**[b] *2*	57.9 *12*	0.0371	4.0	0.0013
ce_M	**0.04251**[c] *2*	13.8 *7*	0.0125	1.3	0.0024
ce_{NOP}	**0.04557**[d] *2*	4.4 *3*	0.0043	0.46	0.0027
β_1^-	**0.0150**$_{max}$ *8* **0.0038**$_{av}$ *2*	80 2	0.0065	0.70	0.00013
β_2^-	**0.0615**$_{max}$ *8* **0.0158**$_{av}$ *3*	20 2	0.0067	0.73	0.00169
β_3^-	**1.1610**$_{max}$ *11* **0.3945**$_{av}$ *4*	100	0.840	91.1	0.205
All β's	**0.2004**$_{av}$ *4*	200	0.854	92.6	0.202
X_L	**0.01084**[a]	23.4 *5*	0.0054	0.59	0.62
γ	**0.04651** *2*	4.05 *8*	0.00401	0.43	18

Radiations (^{210}Po)

Type	Energy MeV	Intensity %	$\bar{\Delta}\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
α	**5.3048** *4*	100	11.3	100	0.0037

Basic Data, Sources for Adopted Values

Decay Scheme

^{226}Ra Q_α = **4.8673** *15* — 67WaKu
Only two α-groups (α_1,α_2) observed with $I(\alpha) > 0.1\%$ (63Ba62). ∴ $I(\alpha_1+\alpha_2) = 100\%$

^{222}Rn Q_α = **5.5869** *15* — 67WaKu
Only one α-group (α_3) observed with $I(\alpha) > 0.1\%$ (58W16). ∴ $I(\alpha_3) = 100\%$

^{218}Po Q_α = **6.1120** *15* — 67WaKu
β^--branch to ^{218}At is negligible (0.02%) — 58W16
Only one α-group (α_4) observed with $I(\alpha) > 0.1\%$ (58W16). ∴ $I(\alpha_4) = 100\%$

[a]Transition in Bi
[b,c,d]Energy of L_1-, M_1-, N_1-line given

Basic Data, Sources for Adopted Values cont.

Decay Scheme continued

^{214}Pb Q^- = **1.042** *14* — 67WaKu
The γ-placements are determined by the γ-energies, $\gamma\gamma$- and $\beta\gamma$-coincidence measurements (52B78, 53K40, 57N11), and the observed β-groups.
Intensities per 100 ^{226}Ra decays are obtained as described below under ^{214}Bi.

^{214}Bi Q^- = **3.280** *13* — 67WaKu
The γ-placements are determined by the γ-energies, $\gamma\gamma$- and $\beta\gamma$-coincidence measurements (52W33, 55J28, 55R26, 57N10, 58B87), the observed β-groups, and the observed long-range α-groups to known levels in ^{210}Pb (65Le08).
Intensities per 100 ^{226}Ra decays are obtained from the relative γ-intensities in a ^{226}Ra source, ce_{18K}/γ_{18}, $I(\beta_{20})$, and the requirement that the intensity sum for all transitions feeding the ^{214}Po ground state be 100%.

^{214}Po Q_α = **7.8349** *7* — 67WaKu
Only one α-group (α_5) observed with $I(\alpha) > 0.1\%$ (58W16). ∴ $I(\alpha_5) = 100\%$

^{210}Pb Q^- = ^{W}**0.0615** *8* — $E(\beta_1^-)^e$+E(0.04651 level), $E(\beta_2^-)^e$
No γ other than 0.04651γ — 52E17, 53K15, 56F22
∴ $I(\beta_1^-+\beta_2^-) = 100\%$

^{210}Bi Q^- = **1.1610** *11* — $E(\beta_3^-)$
No γ — 53M20, 53W04, 55L02, 56F22
∴ $I(\beta_3^-) = 100\%$

^{210}Po Q_α = **5.4076** *6* — 65MTW1
Only one α-group observed with $I(\alpha) > 0.1\%$ (58B45). ∴ $I(\alpha) = 100\%$

Decay Modes (^{226}Ra+...^{214}Po)

Type	Energy MeV	Intensity %

$ce_1 \ldots ce_{46}$ except ce_2, ce_{6K}, ce_{7K} and ce_{18} — I(ce) are unweighted averages of data of 51K32, 54M77, and 57N11. The relative values of each author are normalized so that $I(ce_{6K}+ce_{7K}) = 16.3$ *9*.

ce_{2K}, ce_{2L}, ce_{2M} — I(ce) are obtained from $I(\alpha_1)$, ce_{2K}/γ_2, ce_{2K}/ce_{2L}, ce_{2L}/ce_{2M}, and $I(\gamma_1 + \bar{ce}_1) = I(\alpha_1)$.

ce_{6K}, ce_{7K} — $I(ce_K)$ are obtained from $I(\gamma)$ and ce_K/γ for each transition.

ce_{18K}, ce_{18L} — See $I(\gamma_1 \ldots \gamma_{64})$

[e]Measured values

$\left({}^{226}_{88}Ra_{138} + \text{chain of daughters}\right)$ -7

Basic Data, Sources for Adopted Values cont.

Decay Modes (^{226}Ra+...^{214}Po) continued

Type	Energy MeV	Intensity %	
α_1	^{W}4.598 *1*		58W16, 63Ba62
		^{U}5.5 *1*	52A39, 58W16, 63Ba62
α_2	4.781 *1*		63Ba62
		94.5 *1*	I(α_1) and I(α_1+α_2) = 100

α_3, α_4 E(α) are data of 63Ba62. I(α) are 100% from decay scheme.

Type	Energy MeV	Intensity %	
α_5	^{W}7.6879 *7*		64Wa19, 65Le08
		100	Decay scheme

β_1^-...β_3^-, β_6^-, β_7^-, β_9^-...β_{18}^-: E(β^-) are calculated from the Q$^-$-values and the ^{214}Bi and ^{214}Po level energies. I(β^-) are calculated from the γ-intensities.

Type	Energy MeV	Intensity %	
β_4^-	*0.69 *2*		Q$^-$(^{214}Pb)-E(0.3520 level)
	^{U}0.63 *4*		52B78, 53K40
		*46 *3*	γ-intensities
		^{U}40 *11*	52B78, 53K40
β_5^-	*0.75 *2*		Q$^-$(^{214}Pb)-E(0.29518 level)
	^{U}0.69 *4*		52B78, 53K40
		*43 *2*	γ-intensities
		^{U}60 *11*	52B78, 53K40
β_8^-	*1.04 *2*		Q$^-$(^{214}Pb)
	1.03 *6*		56D28
		*7 *4*	γ-intensities
		6	56D28
β_{19}^-	*1.90 *2*		Q$^-$(^{214}Bi)-E(1.3778 level)
	1.88 *8*		56D06
		*8.6 *7*	γ-intensities
		9	56D06
β_{20}^-	*3.28 *2*		Q$^-$(^{214}Bi)
	^{W}3.27 *2*		56D06, 60Lu7
		^{U}19 *2*	41C04, 52W33, 55R54, 56D06

γ_1...γ_{64} E(γ_1, γ_3, γ_6, γ_7 and γ_{18}) are data of 52M45. The other E(γ)'s are weighted averages of data of 67Ma40, 67Ma51, and 69Li10. I(γ), except I(γ_2), are weighted averages of data of 64Ew04, 67Ma40, 67Ma51, 69La03, and 69Li10. The relative values of each author are normalized so that, in conjunction with I(β_{20}^-), ce$_{18K}$/γ_{18}, and ce$_{18K}$/ce$_{18L}$, the intensity sum for all transitions feeding the ^{214}Po ground state is 100%. I(γ_2) is obtained from ce$_2$/γ_2, I(α_1), and I(ce$_2$+γ_2) = I(α_1).

^{U}Unweighted average
^{W}Weighted average
*Value adopted by compilers from possibilities shown

Basic Data, Sources for Adopted Values cont.

Decay Modes (^{210}Pb+^{210}Bi)

Type	Energy MeV	Intensity %	
ce$_L$		*57.9 *12*	I(γ) and ce$_L$/γ
		^{U}54 *5*	50C01, 51B37, 53B80, 53W28, 58T10
ce$_M$		13.8 *7*	I(ce$_L$), ce$_L$/ce$_M$, ce$_M$/ce$_{NOP}$
ce$_{NOP}$		4.4 *3*	I(ce$_L$), ce$_L$/ce$_M$, ce$_M$/ce$_{NOP}$
ce		76 *2*	I(ce$_L$+ ce$_M$+ ce$_{NOP}$)
β_1^-	*0.0150 *8*		Q$^-$-E(0.04651 level)
	0.0152 *10*		53J02
		80 *2*	I(β_2^-) and I(β_1^-+β_2^-) = 100
β_2^-	*0.0615 *8*		Q$^-$
	0.0610 *13*		63Ro31
		19 *2*	58T10, 63Ro31
		*20 *2*	(γ+ce)-intensities
β_3^-	^{W}1.1610 *11*		62Da3, 67Hs01
		100	Decay scheme
γ	^{W}0.04651 *2*		52E17, 57F29
		^{W}4.05 *8*	$\gamma/\Sigma\beta^-$ 54D23, 57F06, 58K71

Decay Modes (^{210}Po)

Type	Energy MeV	Intensity %	
α	^{W}5.3048 *4*		33R03, 53C64, 58W09, 61Be13, 61Ry2, 61Ry5
		100	Decay scheme

Auxiliary Data (^{226}Ra+...^{214}Po)

	(Bi)	(Po)	(Rn)	
ω_K =	0.961	0.962	0.962	Appendix III
ω_L =	0.405	0.412	0.427	Appendix III
n_{KL} =	0.80	0.80	0.79	Appendix III

ce$_{2K}$/γ_2 = 0.22	55J14	
*0.194	E2 Theory	
ce$_{2K}$/ce$_{2L}$ = 0.527	E2 Theory	
ce$_{2L}$/ce$_{2M}$ = 3.7	E2 Theory	
∴ ce$_2$/γ_2 = *0.66	E2 Theory	
ce$_2$/γ_2 = 0.64 *5*	63Go21	

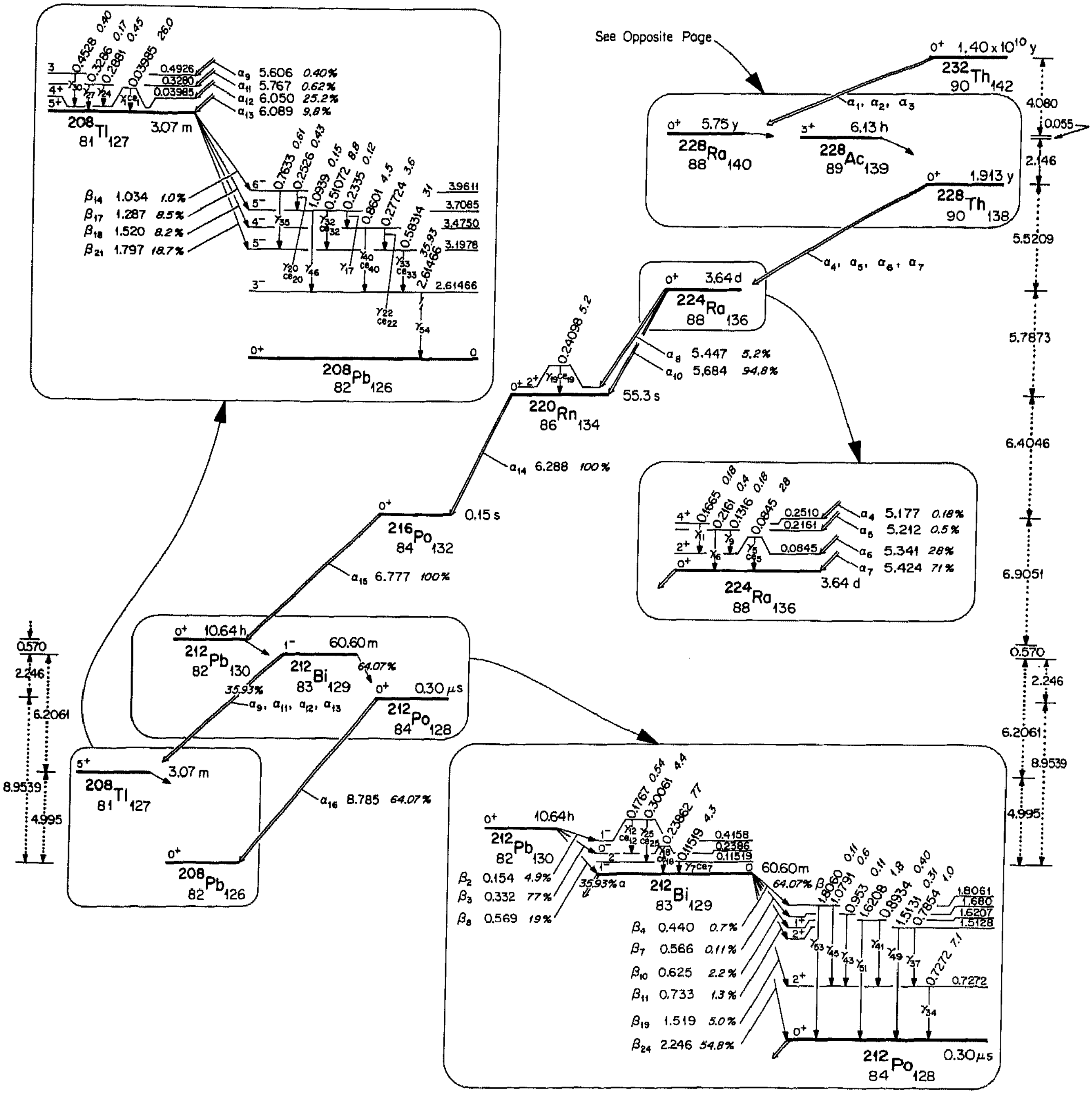
ce$_{6K}$/γ_6 = 0.408	M1 Theory	
ce$_{7K}$/γ_7 = 0.255	M1 Theory	
ce$_{18K}$/γ_{18} = 0.0150	E2 Theory	
ce$_{18K}$/ce$_{18L}$ = *3.53	E2 Theory	
3.43 *10*	60Ma5	

Auxiliary Data (^{210}Pb+^{210}Bi)

ce$_L$/γ = *14.3	M1 Theory
14.4 *5*	66Ve01
ce$_L$/ce$_M$ = *4.24	M1 Theory
^{W}4.2 *2*	50C01, 53B80, 53W28, 66Ve01
ce$_M$/ce$_{NOP}$ = 3.1 *2*	66Ve01

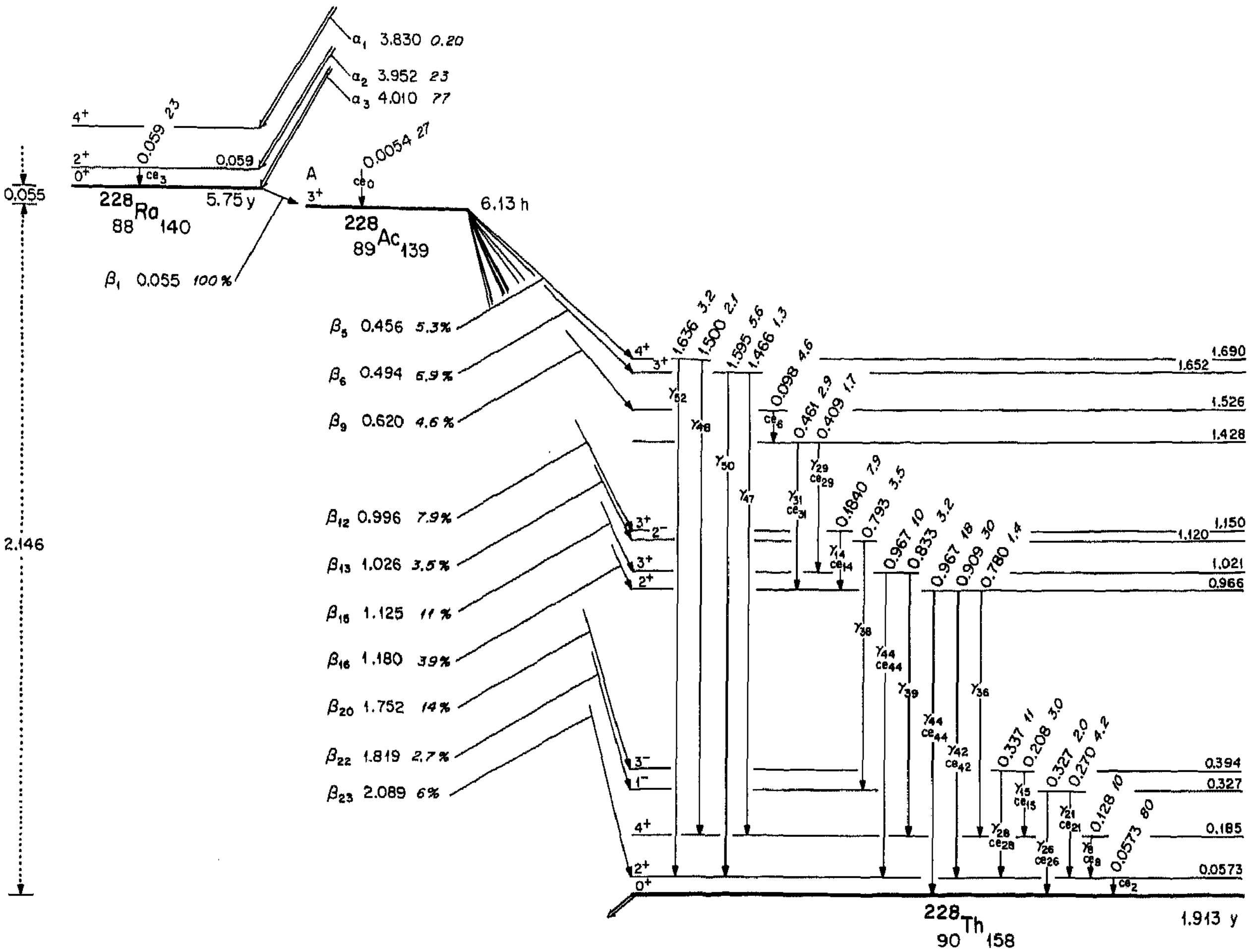
$\left({}^{232}_{90}\mathrm{Th}_{142} + \text{chain of daughters}\right) - 1$

Decay Characteristics



$\left({}^{232}_{90}\mathrm{Th}_{142} + \text{chain of daughters}\right)$ -2

Decay Characteristics continued



$T_{½}$	1.40×10^{10}y *2*	(^{232}Th)		Appendix I
	5.75 y *3*	(^{228}Ra)	A.H. Wapstra, N.B. Gove, Nuclear Data Sheets for 213 ≤ A ≤ 228, Nuclear Data B1-5 (1966)	
	6.13 h	(^{228}Ac)		
	1.913 y *1*	(^{228}Th)		
	3.64 d *2*	(^{224}Ra)		
	55.3 s *3*	(^{220}Rn)		
	0.15 s *1*	(^{216}Po)		
	10.64 h *2*	(^{212}Pb)	Nuclear Data Sheets, 1959-1965, Reprint by Academic Press, N.Y. (1966)	
	60.60 m *4*	(^{212}Bi)		
	0.30 μs *1*	(^{212}Po)		
	3.07[a]m *2*	(^{208}Tl)		

[A]See ^{228}Ra ''Decay Scheme'' discussion

[a]Value of 67La20 has been included in addition to those given in the Nuclear Data Sheets Reprint Issue

Note

Only radiations with equilibrium intensities > 0.1 per 100 decays of ^{232}Th are included here.

Note

The intensities in the table are given for a natural Th source in which ^{232}Th is in equilibrium with all its daughter products. If a purified Th source is used, the specific activity of the source will be strongly dependent on the time elapsed since purification. See 64Hy02, page 491, for a discussion of this point.

$\left({}^{232}_{90}\mathrm{Th}_{142} + \text{chain of daughters}\right)$-3

Decay Characteristics continued

Radiations (^{232}Th+...^{208}Tl)

Type	Energy MeV	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
ce_{0}	0.0054	27 3	0.0031	0.004	<0.0001
e_{AL}	0.00778^{a}	12.0 8	0.018	0.022	≈0.001
	0.00797^{b}	1.42 4			
	0.00815^{c}	20 1			
	0.00871^{d}	0.49 2			
	0.00909^{e}	21 2			
	0.00948^{f}	40 2			
ce_{8K}	0.018 1	0.44 4	0.00017	≈0	0.00053
ce_{1L}	0.02450^{g} 1	19.6 11	0.012	0.014	0.00091
ce_{7K}	0.02467 3	3.2 6			
ce_{1M}	0.03615^{h} 1	4.6 3	0.050	0.059	0.0019
ce_{2L}	0.0368^{g} 3	59 3			
ce_{1NO}	0.03900^{i} 1	0.7 5	0.016	0.019	0.0021
ce_{3L}	0.040^{g} 1	18 2			
ce_{2MN}	0.0521^{h} 3	21 1	0.029	0.034	0.0034
ce_{3M}	0.054^{h} 1	5 1			
$^{x}ce_{4L}$	0.0576^{g} 1	≈0.2	0.0020	0.002	0.0041
e_{AK}	0.05816^{c}	1.4 1			
ce_{5L}	0.0653^{g} 1	20 2	0.028	0.033	0.0051
e_{AK}	0.06916^{f}	0.24 2			
ce_{14K}	0.0743 2	4.6 5	0.022	0.026	0.0070
ce_{6L}	0.078^{g} 1	3.4 4			
ce_{5M}	0.0797^{h} 1	5.3 5			
ce_{5NO}	0.0833^{i} 1	2.0 2	0.0042	0.005	0.0080
ce_{12K}	0.0862 1	0.34 5			
ce_{6M}	0.093^{h} 1	1.2 2	0.0024	0.003	0.0095
ce_{7L}	0.09880^{g} 3	0.57 8	0.0018	0.002	0.010
ce_{15K}	0.098 1	0.29 3			
ce_{8L}	0.108^{g} 1	6.1 6	0.014	0.017	0.012
ce_{8MN}	0.123^{h} 1	1.9 2	0.0050	0.006	0.015
ce_{19K}	0.14258 3	0.46 2	0.096	0.11	0.020
ce_{18K}	0.14810 1	30 1			
$^{x}ce_{13L}$	0.1581^{g} 4	0.17 2	0.0066	0.008	0.023
ce_{21K}	0.159 1	0.17 2			
ce_{14L}	0.1635^{g} 2	1.4 2			
ce_{20K}	0.1646 3	0.16 4			
$^{x}ce_{23K}$	0.172 1	0.12 2	0.0016	0.002	0.026
ce_{14M}	0.1788^{h} 2	0.3 1			

Decay Characteristics continued

Radiations (^{232}Th+...^{208}Tl) continued

Type	Energy MeV	Equilibrium Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R^{j}_{90} (cm) in Water
ce_{22K}	0.18924 4	1.0 1	0.0040	0.005	0.030
ce_{25K}	0.21009 3	1.2 1	0.0059	0.007	0.036
ce_{26K}	0.217 1	0.12 2			
ce_{18L}	0.22223^{g} 1	5.3 2	0.027	0.032	0.039
ce_{19L}	0.22293^{g} 3	0.50 2			
ce_{28K}	0.227 1	0.32 3	0.011	0.013	0.042
ce_{18M}	0.23462^{h} 1	1.3 1			
ce_{19M}	0.23650^{h} 3	0.14 1			
ce_{18NO}	0.23768^{i} 1	0.5 1			
ce_{22L}	0.26138^{g} 4	0.17 2	0.0009	0.001	0.049
ce_{25L}	0.28422^{g} 3	0.20 2	0.0012	0.001	0.056
ce_{29K}	0.299 1	0.14 2	0.0009	0.001	0.061
ce_{31K}	0.351 2	0.18 2	0.0013	0.002	0.078
ce_{32K}	0.42272 2	0.66 3	0.0059	0.007	0.10
ce_{32L}	0.49486^{g} 2	0.13 2	0.0061	0.007	0.13
ce_{33K}	0.49514 3	0.45 1			
ce_{33L}	0.56728^{g} 3	0.12 2	0.0014	0.002	0.16
ce_{40K}	0.7721 4	0.11 2	0.0018	0.002	0.24
ce_{42K}	0.799 1	0.35 4	0.0060	0.007	0.25
ce_{44K}	0.857 1	0.22 2	0.0040	0.005	0.27
α_{1}	3.830 5	0.20 8	0.016	0.019	0.0023^{j}
α_{2}	3.952 5	23 2	1.9	2.2	0.0024^{j}
α_{3}	4.010 5	77 2	6.6	7.8	0.0025^{j}
α_{4}	5.177 2	0.18 7	0.020	0.024	0.0035^{j}
α_{5}	5.212 2	0.5 1	0.06	0.07	0.0036^{j}
α_{6}	5.341 2	28 3	3.2	3.8	0.0037^{j}

[a-f] Transitions in Tl, Pb, Bi, Rn, Ra, and Th, respectively
[g] Energy of L_1 line given
[h] Energy of M_1 line given
[i] Energy of N_1 line given
[j] Value for α's is mean range. See Appendix IV
[x] Not shown on level scheme since placement not determined

Decay Characteristics continued

Radiations (^{232}Th+...^{208}Tl) continued

Type	Energy MeV	Equilibrium Intensity %	$\Delta \left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R^{a}_{90} (cm) in Water
α_7	5.424 2	71 3	8.2	9.7	0.0038[a]
α_8	5.447 2	5.2 2	0.60	0.71	0.0038[a]
α_9	5.606 2	0.40 1	0.048	0.057	0.0040[a]
α_{10}	5.684 2	94.8 2	11.48	13.6	0.0041[a]
α_{11}	5.767 1	0.62 1	0.076	0.09	0.0042[a]
α_{12}	6.050 1	25.2 1	3.25	3.8	0.0045[a]
α_{13}	6.089 1	9.8 1	1.27	1.5	0.0045[a]
α_{14}	6.288 2	100	13.39	15.8	0.0048[a]
α_{15}	6.777 2	100	14.44	17.1	0.0054[a]
α_{16}	8.785 1	64.07 6	11.99	14.2	0.0083[a]
β^-_1	0.055_{max} 3 0.0141_{av} 9	100	0.030	0.035	0.0012
β^-_2	0.154_{max} 3 0.0410_{av} 8	4.9 7	0.0043	0.005	0.0087
β^-_3	0.332_{max} 3 0.0938_{av} 9	77 2	0.154	0.18	0.0315
β^-_4	0.440_{max} 4 0.128_{av} 2	0.7 2	0.0019	0.002	0.050
β^-_5	0.456_{max} 13 0.132_{av} 4	5.3 5	0.015	0.018	0.052
β^-_6	0.494_{max} 12 0.145_{av} 4	6.9 6	0.021	0.025	0.059
β^-_7	0.566_{max} 4 0.170_{av} 2	0.11 3	0.0004	0.0005	0.073
β^-_8	0.569_{max} 3 0.171_{av} 10	19 3	0.069	0.082	0.074
β^-_9	0.620_{max} 12 0.187_{av} 4	4.6 5	0.018	0.021	0.084
β^-_{10}	0.625_{max} 4 0.190_{av} 2	2.2 1	0.009	0.011	0.085
β^-_{11}	0.733_{max} 4 0.228_{av} 2	1.3 2	0.0063	0.007	0.108
β^-_{12}	0.996_{max} 12 0.321_{av} 4	7.9 7	0.054	0.064	0.165

Decay Characteristics continued

Radiations (^{232}Th+...^{208}Tl) continued

Type	Energy MeV	Equilibrium Intensity %	$\Delta \left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β^-_{13}	1.026_{max} 12 0.332_{av} 4	3.5 4	0.025	0.030	0.172
β^-_{14}	1.034_{max} 5 0.341_{av} 2	1.0 1	0.0073	0.009	0.173
β^-_{15}	1.125_{max} 12 0.370_{av} 4	11 2	0.087	0.10	0.195
β^-_{16}	1.180_{max} 12 0.390_{av} 4	39 5	0.32	0.38	0.208
β^-_{17}	1.287_{max} 5 0.440_{av} 2	8.5 3	0.080	0.094	0.236
β^-_{18}	1.520_{max} 5 0.533_{av} 2	8.2 3	0.093	0.11	0.292
β^-_{19}	1.519_{max} 4 0.530_{av} 2	5.0 5	0.056	0.066	0.292
β^-_{20}	1.752_{max} 12 0.615_{av} 5	14 2	0.18	0.21	0.347
β^-_{21}	1.797_{max} 5 0.647_{av} 2	18.7 4	0.26	0.31	0.361
β^-_{22}	1.819_{max} 12 0.649_{av} 5	2.7 5	0.037	0.044	0.365
β^-_{23}	2.089_{max} 12 0.756_{av} 5	6 5	0.10	0.12	0.430
β^-_{24}	2.246_{max} 4 0.831_{av} 2	54.8 4	0.97	1.1	0.473
All β's	0.305_{av} 2	400	2.60	3.1	0.323
X_L	0.01027[b] 0.01055[c] 0.01084[d]	7.5 5 0.93 3 13.8 4	0.0050	0.006	0.60
	0.01173[e] 0.01234[f] 0.01297[g]	0.37 1 17 2 33 2	0.0137	0.016	1.0
γ_1	0.03985 1	1.06 6	0.00090	0.001	15
γ_2	0.0573 3	<0.1	–	–	–
γ_3	0.059 1	<0.1	–	–	–

[a]Value for α's is mean range. See Appendix IV

[b-g]Transitions in Tl, Pb, Bi, Rn, Ra, and Th, respectively

$\left({}^{232}_{90}Th_{142} + \text{chain of daughters}\right)$-5

Decay Characteristics continued

Radiations (^{232}Th+...^{208}Tl) continued

Type	Energy MeV	Equilibrium Intensity %	$\Delta \left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
X_K	0.07674[a]	2.3 *1*			
[x]γ_4	0.0781 *1*	<0.1			
X_K	0.07892[b]	34 *1*			
γ_5	0.0845 *1*	1.2 *1*	0.157	0.19	28
X_K	0.08578[c]	44 2			
	0.09557[d]	6.3 5			
γ_6	0.098 *1*	<0.1			
γ_7	0.11519 *3*	0.57 *8*	0.0014	0.002	32
γ_8	0.128 *1*	1.6 2	0.004	0.005	33
γ_9	0.1316 *8*	0.18 *3*	0.0005	0.001	33
[x]γ_{10}	0.151 2	0.8 *1*	0.0026	0.003	34
γ_{11}	0.1665 *8*	0.18 7	0.0006	0.001	35
γ_{12}	0.1767 *1*	0.20 *4*	0.0008	0.001	35
[x]γ_{13}	0.1786 *4*	<0.1	–	–	-
γ_{14}	0.1840 2	1.6 2	0.0063	0.007	35
γ_{15}	0.208 *1*	2.7 *3*	0.012	0.014	36
γ_{16}	0.2161 *6*	0.4 2	0.0018	0.002	36
γ_{17}	0.2335 *8*	0.12 *6*	0.0006	0.001	37
γ_{18}	0.23862 *1*	40 *1*	0.20	0.24	37
γ_{19}	0.24098 *3*	4.1 2	0.021	0.025	37
γ_{20}	0.2526 *3*	0.27 *4*	0.0015	0.002	38
γ_{21}	0.270 2	4.0 *4*	0.023	0.027	38
γ_{22}	0.27724 *4*	2.4 2	0.014	0.017	38
[x]γ_{23}	0.282 *1*	0.3 *1*	0.002	0.002	38
γ_{24}	0.2881 *6*	0.45 5	0.0028	0.003	39
γ_{25}	0.30061 *3*	3.0 *1*	0.019	0.022	39
γ_{26}	0.327 *1*	1.9 2	0.013	0.015	39
γ_{27}	0.3286 *15*	0.17 2	0.0012	0.001	40
γ_{28}	0.337 *1*	11 2	0.079	0.09	40
γ_{29}	0.409 *1*	1.6 2	0.014	0.017	41

Decay Characteristics continued

Radiations (^{232}Th+...^{208}Tl) continued

Type	Energy MeV	Equilibrium Intensity %	$\Delta \left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
γ_{30}	0.4528 *10*	0.40 *1*	0.0039	0.005	43
γ_{31}	0.461 2	2.7 *3*	0.027	0.032	43
γ_{32}	0.51072 *2*	8.0 *3*	0.087	0.10	44
γ_{33}	0.58314 *3*	30 *2*	0.37	0.44	45
γ_{34}	0.7272 *4*	7.1 *4*	0.110	0.13	48
γ_{35}	0.7633 *3*	0.61 *3*	0.0099	0.012	49
γ_{36}	0.780 *1*	1.4 2	0.023	0.027	49
γ_{37}	0.7854 *6*	1.0 2	0.017	0.020	49
γ_{38}	0.793 *1*	3.5 *4*	0.059	0.070	49
γ_{39}	0.833 *1*	3.2 *4*	0.057	0.067	50
γ_{40}	0.8601 *4*	4.4 *2*	0.081	0.096	51
γ_{41}	0.8934 *8*	0.40 *3*	0.0076	0.009	51
γ_{42}	0.909 *1*	30 *4*	0.58	0.68	51
γ_{43}	0.9530 *20*	0.11 *3*	0.0022	0.003	52
γ_{44}	0.967 *1*	27 *3*	0.56	0.66	53
γ_{45}	1.0791 *10*	0.6 *2*	0.014	0.017	55
γ_{46}	1.0939 *3*	0.15 *3*	0.0035	0.004	55
γ_{47}	1.466 *3*	1.3 2	0.041	0.048	61
γ_{48}	1.500 *3*	2.1 *3*	0.067	0.079	61
γ_{49}	1.5131 *10*	0.31 *4*	0.010	0.012	62
γ_{50}	1.595 5	5.6 *6*	0.19	0.22	62
γ_{51}	1.6208 *8*	1.8 *1*	0.062	0.073	63
γ_{52}	1.636 *4*	3.2 *3*	0.112	0.13	63
γ_{53}	1.8060 *10*	0.11 *2*	0.0042	0.005	66
γ_{54}	2.61466 *10*	35.93 *6*	2.00	2.36	≈ 80

[a-d]Transitions in Pb, Bi, Rn, and Th, respectively
[x]Not shown on level scheme since placement not determined

Basic Data, Sources for Adopted Values

Decay Scheme

^{232}Th $Q_\alpha = 4.080$ *5* 67WaKu

Only three α-groups ($\alpha_1, \alpha_2, \alpha_3$) observed with $I(\alpha) > 0.1\%$ (59K58, 61Ko11) $\therefore I(\alpha_1 + \alpha_2 + \alpha_3) = 100\%$.

No ce or γ other than ce$_3$ (52D12, 55P41, 56A30)

$\alpha_2$ce$_3$-coincidence observed (52D12, 56A30)

Transitions per 100 ^{232}Th decays are obtained from the α-intensities and the requirement $I(ce_3)^a = I(\alpha_2)$.

^{228}Ra $Q^- = 0.055$ *3* 67WaKu

The decay scheme of ^{228}Ra is not definitely establishea. 60Go6 reported a single β-group with E_{max} corresponding to a ground-state to ground-state transition. 61To10 reported two possible β-groups and low-energy conversion lines (≈ 0.005 MeV) with intensity 27 per 100 ^{228}Ra decays. Because of the uncertainty in the placement of these transitions and the resulting uncertaintly in β-endpoint energy, the ^{228}Ra decay is treated as consisting of a single β-group with $E_{max} = Q^-$, and a single ce-transition with E(ce) = 0.0054 MeV and intensity 27% *3*^{b}.

^{228}Ac $Q^- = 2.146$ *12* 67WaKu

The γ-placements are determined by the γ-energies, $\beta\gamma$- and $\gamma\gamma$-coincidence measurements in ^{228}Ac decay (53K19, 54B68, 57B156), and ceγ-coincidence measurements in ^{228}Pa decay (60Ar6).

Intensities per 100 ^{232}Th decays are obtained from the measured absolute ce-intensities (ce per 100 dis), relative γ-intensities, and ce$_{44K}/\gamma_{44}$.

^{228}Th $Q_\alpha = 5.5209$ *20* 67WaKu

Only 4 α-groups ($\alpha_4, \alpha_5, \alpha_6, \alpha_7$) are observed with $I(\alpha) > 0.1\%$ (53A31, 57S92). $\therefore I(\alpha_4 + \ldots \alpha_7) = 100\%$.

The γ-placements are determined by the γ-energies, $\gamma\gamma$-coincidence measurements (57S92), and αce-coincidence measurements (65Ne03).

Intensities per 100 ^{232}Th decays are obtained from γ-intensities measured relative to γ_{54} (in ^{208}Pb), the adopted intensity of γ_{54}, ce$_5/\gamma_5$, $I(\alpha_6)$, and the requirement that $I(\gamma_5 + ce_5)^c = I(\alpha_6)$.

$^a I(\gamma_3) < 0.1\%$

^{b}Uncertainty assigned by compilers

$^c I(\gamma_9)$ and $I(\gamma_{11})$ are negligible here

$^d \Sigma\alpha\,(^{212}Bi) = 35.93\%$ *6*, $\Sigma\beta^-\,(^{212}Bi) = 64.07\%$ *6*, $\therefore I(\gamma_{54}) = 35.93$ *6* from decay scheme

^{w}Weighted average

Basic Data, Sources for Adopted Values cont.

Decay Scheme continued

^{224}Ra $Q_\alpha = 5.7873$ *16* 67WaKu

Only two α-groups (α_8, α_{10}) are observed with $I(\alpha) > 0.1\%$ (62Wa28) $\therefore I(\alpha_8 + \alpha_{10}) = 100\%$.

No γ other than 0.24098γ with $I(\gamma) > 0.1\%$ 60St20

Transitions per 100 ^{232}Th decays are obtained from the α-intensities, ce$_{19}/\gamma_{19}$, and the requirement that $I(\gamma_{19} + ce_{19}) = I(\alpha_8)$.

^{220}Rn $Q_\alpha = 6.4046$ *22* 67WaKu

Only one α-group (α_{14}) observed with $I(\alpha) > 0.1\%$ (62Wa28) $\therefore I(\alpha_{14}) = 100\%$.

No γ with $I(\gamma) > 0.1\%$ (60St20)

^{216}Po $Q_\alpha = 6.9051$ *16* 67WaKu

Only one α-group (α_{15}) observed with $I(\alpha) > 0.1\%$ (62Wa28) $\therefore I(\alpha_{15}) = 100\%$.

^{212}Pb $Q^- = {}^w0.570$ *3* $E(\beta_8^-)$, $E(\beta_3^-)$+E(0.2386 level)

The γ-placements are determined by the γ-energies, $\gamma\gamma$- and $\beta\gamma$-coincidence measurements (49G26, 57N11, 58D25, 58S171, 60Ro16, 61Gi2), and the observed α-groups from ^{216}At (64Mc21, 65Br11).

Intensities per 100 ^{232}Th decays are obtained from the relative γ-intensities, ce$_{18K}/\Sigma\beta^-$, and ce$_{25K}/\gamma_{25}$.

^{212}Bi $Q^- = 2.246$ *4* 67WaKu

$Q_\alpha = 6.2061$ *8* 67WaKu

Only 4 α-groups ($\alpha_9, \alpha_{11}, \alpha_{12}, \alpha_{13}$) observed with $I(\alpha) > 0.1\%$ (53R29, 60Wa14) $\therefore I(\alpha_9 + \alpha_{11} + \alpha_{12} + \alpha_{13}) = 35.93\%^d$

The γ-placements in ^{208}Tl are determined by the γ-energies, $\gamma\gamma$-coincidence measurements (58D25), and the observed α-groups.

The γ-placements in ^{212}Po are determined by the γ-energies, $\gamma\gamma$- and $\beta\gamma$-coincidence measurements (60Ga15, 60Sc7, 62Be9), and the observed β-groups.

Intensities in ^{208}Tl per 100 ^{232}Th decays are obtained from the relative γ-intensities, ce$_1/\gamma_1$ $I(\gamma_1)$/dis, and the adopted α-intensities.

Intensities in ^{212}Po per 100 ^{232}Th decays are obtained from relative γ-intensities, $I(\gamma_{34})/\Sigma(\alpha + \beta^-)$, and $I(\gamma_{54})$ (in ^{208}Pb).

^{212}Po $Q_\alpha = 8.9539$ *9* 67WaKu

Only one α-group (α_{16}) observed (62Be9) $\therefore I(\alpha_{16}) = 64.07^d$ per 100 ^{232}Th decays.

^{208}Tl $Q^- = 4.995$ *5* 65MTW1

The levels in ^{208}Pb are well known (see e.g. 67Sa11, 68Bj01). The ^{208}Tl γ's, on the basis of their energies and coincidence relations (54E24, 60Sc7), can be uniquely placed among these levels.

Intensities per 100 ^{232}Th decays are obtained from relative γ-intensities, relative ce-intensities, ce$_{32K}/\gamma_{32}$, and the requirement that $I(\gamma_{54}) = 35.93.^d$

$\left({}^{232}_{90}\mathrm{Th}_{142} + \text{chain of daughters}\right)$ -7

Basic Data, Sources for Adopted Values cont.

Decay Modes (^{232}Th...^{208}Tl)

Type	Energy MeV	Intensity %	
^{232}Th			
ce_{3L}		18 *2*	I(ce_3) and ce_{3M}/ce_{3L}
ce_{3M}		5 *1*	
ce_3		^{W}23 *2*	I(α_2)
α_1	^{U}**3.830** *5*		59K58, 61Ko11
		0.20 *8*	59K58
α_2	***3.952** *5*		Q_α-E(0.059 level)-E_R^a
	3.951		61Ko11
		^{W}23 *2*	52D12, 56A30, 59K58
α_3	***4.010** *5*		Q_α-E_R^a
	^{W}**4.011**^{b} *5*		57H08, 62Ko12
		77 *2*	I(α_2) and I($\alpha_2+\alpha_3$)^c= 100
^{228}Ra			
ce_0	**0.0054**	27 *3*^{d}	61To10
β_1	**0.055** *3*		Q^-
		100	Decay scheme
^{228}Ac			
ce_{2L}		^{U}45	$ce_{2L}/(ce_{6L}+ce_{14K})$ 54B11, 60Ar6
		*59 *3*	I(ce_2) and ce_{2L}/ce_{2MN}
ce_{2MN}		21 *1*	
ce_2		80 *3*	I($\gamma_{26}+ce_{26}$), I($\gamma_{44}+ce_{44}$)^e, and I($ce_2+\gamma_{26}+ce_{26}+\gamma_{44}^e+ce_{44}^e$) = 100

ce_4, ce_6, ce_8, $ce_{13}\ldots ce_{15}$, ce_{21}, ce_{23}, ce_{26}, ce_{28}, ce_{29}, ce_{31}, ce_{42}, ce_{44}: I(ce_K), except ce_L for $\gamma_4, \gamma_6, \gamma_8$, are unweighted averages of relative data of 60Ar6 and absolute values^f of 54B11. The relative values of 60Ar6 are normalized to the value I($ce_{6L}+ce_{14K}$) = 8.0 of 54B11. Uncertainties have been assigned by the compilers. The other ce-intensities are calculated from the above ce_L- and ce_K-values and ce_L/ce_K, ce_L/ce_{MN}, etc., ratios.

^{a}Recoil energy carried off by daughter nucleus
^{b}Authors' value increased by 0.003 MeV because of a change in calibration energy
^{c}I(α_1) is negligible here
^{d}Uncertainty assigned by compilers
^{e}Note that γ_{44} is placed twice. Include here only that part of γ_{44} which feeds the ground state
^{f}ce's per 100 ^{228}Ac decays
^{g}I(γ_9) and I(γ_{11}) are negligible here
^{U,W}Unweighted average, weighted average
*Value adopted by compilers from possibilities shown

Basic Data, Sources for Adopted Values cont.

Decay Modes (^{232}Th...^{208}Tl) continued

^{228}Ac continued

$\beta_5, \beta_6, \beta_{12}, \beta_{13}, \beta_{15}, \beta_{16}, \beta_{20}, \beta_{22}$: E($\beta$) are calculated from Q^- and the ^{228}Th level energies. I(β) are calculated from the (γ+ce)-intensities.

Type	Energy MeV	Intensity %	
β_9	***0.620** *12*		E(1.526 level)
	0.62	7.6	53K19
		*4.6 *5*	(γ+ce)-intensities
β_{23}	***2.089** *12*		Q^--E(0.0573 level)
	^{U}**2.14** *4*		53K19, 57B156
		10.1	53K19
		*6 *5*	(γ+ce)-intensities

γ_2, γ_4, γ_6, γ_8, γ_{10}, γ_{13}, γ_{14}, γ_{15}, γ_{21}, γ_{23}, γ_{26}, γ_{28}, γ_{29}, γ_{31}, γ_{36}, γ_{38}, γ_{39}, γ_{42}, γ_{44}, γ_{47}, γ_{48}, γ_{50}, γ_{52}: E(γ) are unweighted averages of data of 53K19, 54B11, 60Ar6, and 67Bh01. Uncertainties have been assigned by the compilers. I(γ), except γ_{36}, are data of 67Bh01. The author's relative values are normalized so that ce_{44K}/γ_{44} = 0.0082. I(γ_{36}) is calculated from I(ce_{36K}) = 0.017% (60Ar6) and ce_{36K}/γ_{36}.

Type	Energy MeV	Intensity %	
^{228}Th			
ce_{5L}		20 *2*	ce_{5L}/ce_{5M}, ce_{5L}/ce_{5MNO}
ce_{5M}		5.3 *5*	
ce_{5NO}		2.0 *2*	
ce_5		27 *2*	See I(γ_5)
α_4	***5.177** *2*		Q_α-E(0.2510 level)-E_R^a
	5.176	0.2	53A31
		*0.18 *7*	γ-intensities
α_5	***5.212** *2*		Q_α-E(0.2161 level)-E_R^a
	5.211	0.4	53A31
		0.6 *2*	γ-intensities
		*0.5 *1*	
α_6	***5.341** *2*		Q_α-E(0.0845 level)-E_R^a
	^{U}**5.341**	^{U}28 *3*^{d}	49R02, 53A31
α_7	***5.424** *2*		Q_α-E_R^a
	^{U}**5.425**		49R02, 53A31
		71 *3*	I(α_4), I(α_5), I(α_6) and I($\alpha_4+\alpha_5+\alpha_6+\alpha_7$) = 100
γ_5	^{U}**0.0845**		52R21, 53R23, 54N01, 54R10
		1.2 *1*	ce_5/γ_5, I(α_6), and I(γ_5+ce_5) = I(α_6)^g

γ_9, γ_{11}, γ_{16}: E(γ) and I(γ) are data of 68Da21. The authors' relative intensities are normalized to I(γ_{54}) (^{208}Pb) = 35.93.

Basic Data, Sources for Adopted Values cont.

Decay Modes (^{232}Th...^{208}Tl) continued

Type	Energy MeV	Intensity %	
^{224}Ra			
ce_{19K}		0.46 *2*	I(ce_{19}), ce_{19K}/ce_{19L}, and ce_{19L}/ce_{19M}
ce_{19L}		0.50 *2*	
ce_{19M}		0.14 *1*	
ce_{19}		1.10 *4*	See I(γ_{19})
α_9	*5.447 *2*		Q_α-E(0.24098 level)-E_R^a
	^{U}5.447		49R09, 53A31, 62Ba19, 62Wa28
		^{U}5.2 2^b	49R09, 53A31, 62Wa28
α_{10}	*5.684 *2*		Q_α-E_R^a
	5.6840 *16*^{c}		62Ba19
		94.8 2	I(α_8) and I(α_8+α_{10}) = 100
γ_{19}	0.240984 *33*		52M45
		4.1 2	ce_{19}/γ_{19}, I(α_8), and I(γ_{19}+ce_{19})=I(α_8)
^{220}Rn			
α_{14}	*6.288 2		Q_α-E_R^a
	6.2884 22^c		62Ba19
		100	Decay scheme
^{216}Po			
α_{15}	*6.777 2		Q_α-E_R^a
	6.7772 *16*^{c}		62Ba19
		100	Decay scheme
^{212}Pb			
ce_7, ce_{12}, ce_{25}			I(ce) are calculated from I(γ), ce_K/γ, and ce_K/ce_L values
ce_{18K}		^{U}30 *1*^{b}	$ce_{18K}/\Sigma\beta^-$
$ce_{18L,M,NO}$			I(ce_{18K}), ce_{18K}/ce_{18L}, ce_{18L}/ce_{18M}, and ce_{18M}/ce_{18NO}
β_2	0.154 *3*		Q-E(0.4158 level)
		4.9 7	γ-intensities
β_3	^{W}0.332 *3*		48M30, 58S171
		77 2	γ-intensities
β_8	0.569 *3*		48M30
		*19 *3*	γ-intensities
		12 2	48M30

^{a}Recoil energy carried off by daughter nucleus
^{b}Uncertainty assigned by compilers
^{c}Uncertainty as adopted by 64Wa19
$^d\gamma_{18}$ only

Basic Data, Sources for Adopted Values cont.

Decay Modes (^{232}Th...^{208}Tl) continued

Type	Energy MeV	Intensity %	
^{212}Pb continued			
γ_7, γ_{12}, γ_{18}, γ_{25}			E(γ) are weighted averages of data of 52M45^d, 60Bell1^d, 68An08, and 68Da21. I(γ) are weighted averages of data of 60Ro16, 61Gi2, 68An08, and 68Da21. The relative values of each author are normalized so that ce_{18K}/γ_{18} = 0.74.
^{212}Bi (to ^{212}Po)			
β_4	*0.440 *4*		Q^--E(1.8061 level)
	0.45 *4*	5.4^e	57B134
		*0.7 *2*	γ-intensities
β_7	0.566 *4*		Q^--E(1.680 level)
		0.11 *3*	γ-intensities
β_{10}	*0.625 *4*		Q^--E(1.6207 level)
	0.67 5	3.8^e	57B134
		*2.2 *1*	γ-intensities
β_{11}	0.733 *4*		Q^--E(1.5128 level)
		1.3 *2*	γ-intensities
β_{19}	*1.519 *4*		Q^--E(0.7272 level)
	1.55	6.4^e	57B134
		*5.0 *5*	γ-intensities
β_{24}	*2.246 *4*		Q^-
	2.2505 *25*		48M30
		40^e	57B134
		*54.8 *4*	γ-intensities
γ_{34}, γ_{37}, γ_{41}, γ_{43}, γ_{45}, γ_{49}, γ_{51}, γ_{53}			E(γ_{34}, γ_{37}, γ_{41}, γ_{43}, γ_{45}) are data of 68Da21. E(γ_{49}, γ_{51}, γ_{53}) are data of 68Yt01. I(γ), except γ_{34} and γ_{37}, are weighted averages of data of 60Ga15, 60Sc7, 62Be9, 68Da21, and 68Yt01. The relative values of 68Da21 and 68Yt01 are normalized to the adopted value for I(γ_{54}) (in ^{208}Pb). The relative values of 60Sc7 are normalized to that author's absolute^f value for I(γ_{34}). The relative values of the other authors are normalized to the adopted value for I(γ_{34}+γ_{37}) (from 60Sc7 and 68Da21).

^{e}From authors' value per 100 ^{212}Bi β's and adopted value of I($\Sigma\beta$) = 64.07 for ^{212}Bi decay
$^f\gamma$'s per ^{212}Bi disintegrations
^{U}Unweighted average
^{W}Weighted average
*Value adopted by compilers from possibilities shown

$\left({}^{232}_{90}Th_{142} + \text{chain of daughters} \right)$ -9

Basic Data, Sources for Adopted Values cont.

Decay Modes (${}^{232}Th \ldots {}^{208}Tl$) continued

Type	Energy MeV	Intensity %	
${}^{212}Bi$ (to ${}^{208}Tl$)			
ce_{1L}		19.6 *11*	I(γ_1), ce_{1L}/γ_1, ce_{1L}/ce_{1M} and the requirement of an intensity balance at the 0.03985 level
ce_{1M}		4.6 *3*	
ce_{1NO}		0.7 *5*	
α_9	*5.606 *2*		Q_α-E(0.4926 level)-E_R^a
	W5.605 *2*		53R29, 54B107
		U0.40[b] *1*	53R29, 54B107, 60Wa14
α_{11}	*5.767 *1*		Q_α-E(0.3280 level)-E_R^a
	W5.767 *3*		53R29, 54B107
		U0.62[b] *1*	53R29, 54B107, 60Wa14, 62Be9
α_{12}	*6.050 *1*		Q_α-E(0.03985 level)-E_R^a
	W6.051 *1*		53R29, 54B107, 61Ry2
		U25.2[b] *1*	53R29, 54B107, 60Wa14, 61Ry2
α_{13}	*6.089 *1*		Q_α-E_R^a
	W6.090 *1*		53R29, 54B107, 60Ry1
		9.8[b] *1*	53R29, 54B107, 60Wa14, 62Be9
γ_1	0.03985 *1*		65Gr05
		1.06 *6*	$\gamma_1/\Sigma\alpha$
γ_{24}	0.2881 *6*		68Da21
		U0.40 *10*	γ_{24}/γ_{54} 62Be9, 68Da21
		*0.45 *5*	I(α_{11}), γ_{24}/γ_{27} and I(γ_{24}+γ_{27}) = I(α_{11})
γ_{27}	0.3286 *15*		68Da21
		0.11 *2*	γ_{27}/γ_{54} 62Be9
		*0.17 *2*	I(α_{11}), γ_{24}/γ_{27} and I(γ_{24}+γ_{27}) = I(α_{11})
γ_{30}	0.4528 *10*		68Da21
		0.36 *10*	γ_{30}/γ_{54} 68Da21
		*0.40 *1*	I(α_9)
${}^{212}Po$			
α_{16}	8.785 *1*		Q_α-E_R^a
		64.07 *6*	$\Sigma\beta^-({}^{212}Bi)$ = 64.07%

Basic Data, Sources for Adopted Values cont.

Decay Modes (${}^{232}Th \ldots {}^{208}Tl$) continued

Type	Energy MeV	Intensity %	
${}^{208}Tl$			
ce_{20}, ce_{22}, ce_{32}, ce_{33}, ce_{40}			I(ce_K) are unweighted averages of data of 32E01, 39A06, 39F04, 48M30, 57K56, 61Wo1, and 63Da11. The relative values of each author are normalized so that ce_{32K}/γ_{32} = 0.082. I(ce_L) are calculated from I(ce_K) and ce_K/ce_L values.
β_{14}	*1.034 *5*		Q^--E(3.9611 level)
	1.04		54E24
		*1.0 *1*	(γ+ce)-intensities
		1.7 *1*	60Sc7
β_{17}	*1.287 *5*		Q^--E(3.7085 level)
	U1.27		54E24, 56D21
		8.7 *3*	(γ+ce)-intensities
		8.1 *4*	60Sc7
		*8.5 *3*	
β_{18}	*1.520 *5*		Q^--E(3.4750 level)
	U1.52		54E24, 56D21
		8.0 *4*	(γ+ce)-intensities
		8.3 *4*	60Sc7
		*8.2 *3*	
β_{21}	*1.797 *5*		Q^--E(3.1978 level)
	W1.795 *5*		34H02, 48F09, 48M29, 54E24
		18 *2*	(γ+ce)-intensities
		*W18.7 *4*	60Sc7, 67Os01
γ_{17}, γ_{20}, γ_{22}, γ_{32}, γ_{33}, γ_{35}, γ_{40}, γ_{46}, γ_{54}			E(γ_{22}) is a weighted average of data of 52M45, 60Ka9, and 68An08. E(γ_{32}) is a weighted average of data of 52L18, 60De14, 61Wo1, and 65Gr05. E(γ_{54}) is a weighted average of data of 65Gr05 and 68Gu05. The other E(γ) are weighted averages of data of 68Da21 and 69Pa02. I(γ) are weighted averages of data of 60Em1, 60Sc7, 68Da21, and 69Pa02. The relative values of each author are normalized to the value 35.93[c]% for γ_{54}.

[a] Recoil energy carried off by the daughter nucleus
[b] From relative I(α) and $\Sigma\alpha({}^{212}Bi)$ = 35.93%
[c] $\Sigma\alpha$ (${}^{212}Bi$) = 35.93% *6* ∴ I(γ_{54}) = 35.93 *6* from decay scheme
U Unweighted average
W Weighted average
* Value adopted by compilers from possibilities shown

Basic Data, Sources for Adopted Values cont.

Auxiliary Data

$\gamma_1/\Sigma\alpha = 1.06$ *6*	58K66
$ce_{1L}/\gamma_1 = 18.5$	M1 Theory[a]
$ce_{1L}/ce_{1M} = 4.3$	M1 Theory[a]
$\therefore ce_1/\gamma_1 = 22.8$	
$ce_{2L}/ce_{2MN} = {}^{U}0.35$ *4*[b]	24B01, 54B11
$ce_{3M}/ce_{3L} = 0.273$	E2 Theory
$ce_{5L}/\gamma_5 = 15.7$	E2 Theory
$ce_{5L}/ce_{5M} = 3.7$	E2 Theory
$ce_{5L}/ce_{5MNO} = 2.7$ *3*[b]	52R21
$\therefore ce_5/\gamma_5 = 21.5$	
$ce_{6L}/ce_{6M} = 2.8$	60Ar6
$ce_{7K}/\gamma_7 = 5.7$	M1 Theory[c]
$ce_{7K}/ce_{7L} = 5$ *1*	57N11
$*5.7$	M1 Theory[c]
$ce_{8K}/ce_{8L} = *0.072$	E2 Theory
0.039	54B11
$ce_{8L}/ce_{8MN} = {}^{U}3.2$ *3*	54B11, 60Ar6
$ce_{12K}/\gamma_{12} = 1.68$	M1 Theory
$ce_{14K}/ce_{14L} = 3.2$ *4*	60Ar6
$ce_{14L}/ce_{14M} = 4.0$ *4*	60Ar6
$ce_{18K}/\Sigma\beta^- = 30$ *1*[b]	48F09, 48M30, 55N19, 57K49
$ce_{18K}/\gamma_{18} = *0.74$	M1 Theory
0.74 *7*	60Ro16
$ce_{18K}/ce_{18L} = *5.7$	M1 Theory
5.4 *2*	65Da07
$ce_{18L}/ce_{18M} = *4.1$	M1 Theory
${}^{W}4.4$ *1*	63Da11, 69Kr06
$ce_{18M}/ce_{18NO} = {}^{W}3.1$ *2*	63Da11, 69Kr06
$ce_{19K}/\gamma_{19} = 0.113$	E2 Theory
$ce_{19K}/ce_{19L} = 0.79$	54R10
$*0.92$	E2 Theory
$ce_{19L}/ce_{19M} = 3.6$	E2 Theory
$\therefore ce_{19}/\gamma_{19} = 0.269$	
$ce_{22K}/ce_{22L} = 5.9$	63Da11
$ce_{25K}/\gamma_{25} = *0.39$	M1 Theory[d]
0.45 *7*	61Gi2
$ce_{25K}/ce_{25L} = 5.8$	M1 Theory
$ce_{32K}/\gamma_{32} = 0.082$	M1,E2 Theory[e]
$ce_{32K}/ce_{32L} = 5.2$ *5*	61Wo1
$ce_{33K}/ce_{33L} = 3.8$	E2 Theory

Basic Data, Sources for Adopted Values cont.

Auxiliary Data continued

$\gamma_{34}/\Sigma(\alpha+\beta^-) = 0.071$ *4*	60Sc7
$ce_{36K}/\gamma_{36} = 0.012$	E2 Theory
$ce_{44K}/\gamma_{44} = 0.0082$	E2 Theory
$\gamma_{24}/\gamma_{27} = 2.6$ *3*	62Be9

$\Sigma\alpha({}^{212}\mathrm{Bi})$ per 100 ${}^{212}\mathrm{Bi}$ disintegrations $= {}^{W}35.93$ *6* — 60Sc7, 62Be9, 65Wa09

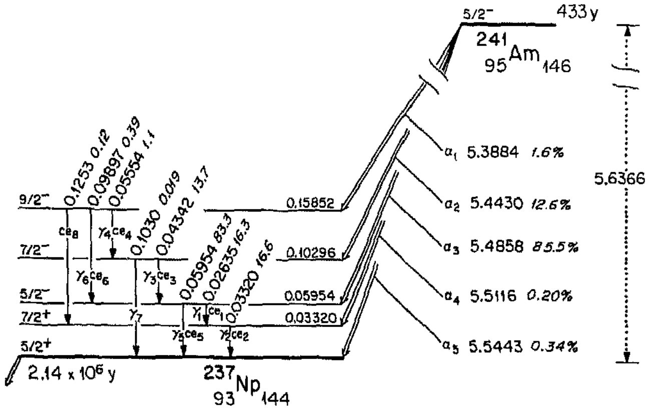
$\therefore \Sigma\beta^-({}^{212}\mathrm{Bi})$ per 100 ${}^{212}\mathrm{Bi}$ disintegrations $= 64.07$ *6* — $I(\Sigma\alpha+\Sigma\beta^-) = 100$

		Source
(Tl)	$\omega_L = 0.386$	Appendix III
(Pb)	$\omega_K = 0.960$, $\omega_L = 0.396$, $n_{KL} = 0.80$	Appendix III
(Bi)	$\omega_K = 0.961$, $\omega_L = 0.405$, $n_{KL} = 0.80$	Appendix III
(Rn)	$\omega_K = 0.962$, $\omega_L = 0.427$, $n_{KL} = 0.79$	Appendix III
(Ra)	$\omega_L = 0.438$	Appendix III
(Th)	$\omega_K = 0.963$, $\omega_L = 0.446$, $n_{KL} = 0.78$	Appendix III

[a] M1 multipolarity from L-subshell ratios (57Z05, 60Pe5)
[b] Uncertainty assigned by compilers
[c] M1 multipolarity from L-subshell ratios (57K49, 59S59)
[d] M1 multipolarity from comparison of theoretical ce_K/γ
[e] M1+9.8% E2 from L-subshell ratios (61Wo1)
[U] Unweighted average
[W] Weighted average
*Value adopted by compilers from possibilities shown

$^{241}_{95}Am_{146}$-1

Decay Characteristics



$T_{½}$	433 y 2	Appendix I
	2.14×10^{6}y 1	60Br12

Note
Since the half-life of ^{237}Np is so long, the activity of ^{237}Np in a ^{241}Am source is negligible. We can thus treat ^{237}Np as a stable nucleus and ignore its α-decay to ^{233}Pa.

Note
Many weak α-, γ- and ce-transitions present in ^{241}Am decay are not included here because of their low intensities (<0.01%). See 67LeHo for a list of these radiations.

Radiations

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
ce_{1L}	0.00475[a] 1	8.7 7	0.00088	0.007	<0.0001
ce_{8K}	0.0066 3	0.12 2	0.000017	≈0	<0.0001
e_{AL}	0.01009	36 1	0.0077	0.065	0.00019
ce_{2L}	0.01160 1	11.4 8	0.0028	0.024	0.00024
ce_{1M}	0.02063[b] 1	4.0 2	0.0018	0.015	0.00066
ce_{3L}	0.02182 2	10.2 5	0.0048	0.041	0.00074
ce_{1N}	0.02485[c] 1	1.1 1	0.00058	0.005	0.00093
ce_{2M}	0.02748 1	3.7 4	0.0022	0.019	0.0011
ce_{2NO}	0.03170 1	1.4 2	0.0010	0.008	0.0014

Decay Characteristics continued

Radiations continued

Type	Energy MeV	Intensity %	$\Delta\left(\frac{\text{gm-rad}}{\mu\text{Ci-h}}\right)$	$\Delta/\Sigma\Delta$ %	R_{90}[d] (cm) in Water
ce_{4L}	0.03394 2	0.9 1	0.00065	0.0055	0.0016
ce_{3M}	0.03770 2	2.7 3	0.0022	0.019	0.0019
ce_{5L}	0.037936 2	34.0 9	0.0275	0.23	0.0020
ce_{3NO}	0.04192 2	0.7 1	0.00063	0.005	0.0023
ce_{4M}	0.04982 2	0.20 2	0.00021	0.0018	0.0032
ce_{5M}	0.053813 4	10.3 5	0.0118	0.10	0.0036
ce_{5NOP}	0.058035 2	3.7 3	0.0046	0.039	0.0042
ce_{6L}	0.07737 3	0.27 3	0.00044	0.004	0.0069
ce_{6MNO}	0.09325 3	0.10 1	0.00020	0.002	0.0095
α_1	5.3884 10	1.6 1	0.184	1.6	0.0037[d]
α_2	5.4430 10	12.6 4	1.46	12.3	0.0038[d]
α_3	5.4858 10	85.5 5	9.99	84.5	0.0038[d]
α_4	5.5116 10	0.20 3	0.023	0.19	0.0039[d]
α_5	5.5443 10	0.34 4	0.040	0.34	0.0039[d]
X_L	0.01394	29 1	0.0086	0.073	1.3
γ_1	0.02635 1	2.5 2	0.0014	0.012	7.2
γ_2	0.03320 1	0.14 4	0.00010	≈0	12
γ_3	0.04342 2	0.073 7	0.000068	≈0	17
γ_4	0.05554 2	0.020 2	0.000024	≈0	22
γ_5	0.059536 1	35.3 5	0.0448	0.38	23
γ_6	0.09897 3	0.021 2	0.000044	≈0	30
γ_7	0.1030 1	0.019 2	0.000042	≈0	30
X_K	0.10348	0.08 2	0.00018	0.002	30
γ_8	0.1253 3	<0.01	<0.00003	≈0	32

[a]Energy of L_2-line given
[b]Energy of M_1-line given
[c]Energy of N_1-line given
[d]Value given for α's is mean range. See Appendix IV

Basic Data, Sources for Adopted Values

Decay Scheme

$Q_\alpha = {}^{U}5.6366\ 10$ E(α_2)+E^a_R+E(0.10296 level), E(α_3)+E^a_R+E(0.05954 level)

The γ-placements are determined by the γ-energies, $\alpha\gamma$-coincidence measurements (65Mi06, 68Ka09), and the observed α-groups.

Intensities per 100 ^{241}Am decays are obtained from the absolute[b] γ- and α-intensities, ce_L/ce_M, etc., values, and the requirement of an intensity balance at each level.

Decay Modes

Type	Energy MeV	Intensity %	
ce_{1L}		8.7 *7*	I(γ_1), ce_{1L_3}/γ_1, and ce_{1L}/ce_{1L_3}
ce_{1M}		4.0 *2*	I(ce_{1L_3}) and ce_{1L_3}/ce_{1M}
ce_{1N}		1.1 *1*	I(ce_{1M}) and ce_N/ce_M
ce_{2L}		11.4 *8*	I(ce_2), ce_{2L}/ce_{2M}, and ce_{2M}/ce_{2NO}
ce_{2M}		3.7 *4*	
ce_{2NO}		1.4 *2*	
ce_2		16.5 *10*	I(γ_2), I(γ_1+ce_1), I(ce^c_{8K}), I(α_4), and intensity balance at the 0.03320 level
ce_{3L}		10.2 *5*	I(ce_3), ce_{3L}/ce_{3M}, and ce_{3M}/ce_{3NO}
ce_{3M}		2.7 *3*	
ce_{3NO}		0.7 *1*	
ce_3		13.6 *5*	I(γ_3), I(γ_4+ce_4), I(γ_7), I(α_2), and intensity balance at the 0.10296 level
ce_{4L}		0.9 *1*	I(ce^c_{8K}), I(γ_6+ce_6), I(α_1), ce_{4L}/γ_4, ce_{4L}/ce_{4M}, and intensity balance at the 0.15852 level
ce_{4M}		0.20 *2*	
ce_{5L}		34.0 *9*	I(ce_5), ce_{5L}/ce_{5M}, and ce_{5M}/ce_{5NOP}
ce_{5M}		10.3 *6*	
ce_{5NOP}		3.7 *3*	
ce_5		48.0 *12*	I(γ_5), I(γ_1+ce_1), I(α_3), I(γ_3+ce_3), I(γ_6+ce_6), and intensity balance at the 0.05954 level
ce_{6L}		0.27 *3*	I(γ_6) and ce_{6L}/γ_6
ce_{6MNO}		0.10 *1*	I(ce_{6L}) and ce_{6L}/ce_{6MNO}
ce_{8K}		0.12 *2*[d]	ce_{8K}/ce_{5L} 59S10

[a]Recoil energy carried off by the residual nucleus
[b]Transitions per 100 ^{241}Am decays
[c]Conversion in higher shells is negligible here
[d]Uncertainty assigned by compilers
[e]M1 + 11% E2 from ce_{4L}/ce_{4L_2} of 59S10, 64Wo03, and 66Ko06
U, W Unweighted average, weighted average

Basic Data, Sources for Adopted Values cont.

Decay Modes continued

Type	Energy MeV	Intensity %		
$\alpha_1 \ldots \alpha_5$				E(α_2, α_3) are data of 68Ba25. The other E(α) are obtained from Q_α, E^a_R, and the ^{237}Np level energies. I(α) are unweighted averages of data of 55G57, 57R20, 64Ba24, and 65Mi06.
γ_1	^{W}**0.02635** *1*			55D02, 55J01, 64Wo03, 66Ko06, 66Ya05
		2.5 *2*	$\gamma_1/\Sigma\alpha$	57M17
γ_2	^{W}**0.03320** *1*			55D02, 64Wo03, 66Ko06, 66Ya05
		^{U}0.14 *4*	$\gamma_2/\Sigma\alpha$	55D02, 57M17
γ_3	^{W}**0.04342** *2*			55D02, 64Wo03, 66Ko06, 66Ya05
		0.073 *7*	$\gamma_3/\Sigma\alpha$	57M17
γ_4	^{W}**0.05554** *2*			64Wo03, 66Ko06
		0.020 *2*		See I(ce_4)
γ_5	**0.059536** *1*			68Je01
		^{W}35.3 *5*	$\gamma_5/\Sigma\alpha$	57M17, 65Mc12
γ_6	^{W}**0.09897** *3*			66Ko06, 66Mi05, 67Gu08
		^{W}0.021 *2*	$\gamma_6/\Sigma\alpha$	66Le13, 66Mi05, 67Gu08
γ_7	^{W}**0.1030** *1*			66Ko06, 66Le13, 66Mi05, 67Gu08
		^{W}0.019 *2*	$\gamma_7/\Sigma\alpha$	66Le13, 66Mi05, 67Gu08
γ_8	^{W}**0.1253** *3*			66Mi05, 67Gu08, 68Ka09
		<0.01		66Le13, 66Mi05, 67Gu08

Auxiliary Data

ce_{1L_3}/γ_1 = 1.50	E1 Theory	ce_{5L}/ce_{5M} = ^{W}3.3 *2*	64Wo03, 66Ya05
ce_{1L}/ce_{1L_3} = 2.3 *3*[d]	59S10	ce_{5M}/ce_{5NOP} = 2.8 *2*	64Wo03
ce_{1L_3}/ce_{1M} = 0.94 *5*	66Ya05		
ce_{1N}/ce_{1M} = 3.6 *2*	66Ya05	ce_{6L}/γ_6 = 12.6	E2 Theory
ce_{2L}/ce_{2M} = ^{U}3.0 *3*	59S10, 66Ya05	ce_{6L}/ce_{6MNO} = ^{U}0.37 *4*[d]	59S10, 66Ko06
ce_{2M}/ce_{2NO} = 2.6 *3*[d]	66Ko06		
ce_{3L}/ce_{3M} = 3.8 *4*[d]	64Wo03	ω_K = 0.963	Appendix III
ce_{3M}/ce_{3NO} = 4.0 *4*	59S10, 64Wo03, 66Ko06	ω_L = 0.450	
		n_{KL} = 0.78	

ce_{4L}/γ_4 = 44 *5*, ce_{4L}/ce_{4M} = 4.4 *5* Theory[e]

Appendix I

Basic Half-Life Data with Recommended Values

The following table gives the experimental data from which the half-lives for the nuclides included in this compilation were adopted. Many of the recommended values were selected at a two-day meeting held at the Oak Ridge National Laboratory in Dec. 1967. Attending this meeting were S. B. Garfinkel, of the National Bureau of Standards, and G. I. Gleason, of the Oak Ridge Associated Universities, along with S. A. Reynolds, B. H. Ketelle, and J. E. Bigelow, of the Oak Ridge National Laboratory, and members of the Nuclear Data Group.

Explanation of Table

$T_{1/2}$ — Experimental value with uncertainty. Units are given only with the first entry and with the adopted value. The entry 1.03 m *2* is to be read as 1.03 ±0.02 m. Similarly, 3.462 d *12* is to be read as 3.462 ± 0.012 d.

No. $T_{1/2}$ Followed — Number of half-lives over which the decay was followed.

Produced by — Method of production used by the author. The methods fall into two main categories, production by nuclear reaction and production by separation from a radioactive parent.
In those cases where a nuclear reaction has been used, the target element and the reaction are shown. A mass number given with the target indicates either that the target was enriched in that isotope or that the isotope shown has a natural abundance of 100%. The abbreviation ''chem'' indicates that the element of interest was chemically separated from the reaction products. The abbreviation ''ms'' indicates that the isotope with a given mass number has been separated with a mass spectrometer from the reaction products. A combination of ''chem'' and ''ms'' uniquely separates out a given isotope of a given element.
For those cases where the method of production is by separation from a radioactive parent, the parent isotope and its mode of decay are shown.

Method — Method used by the author to determine the half-life. The methods fall into two groups depending upon the length of the half-life being determined. For an isotope with half-life less than a few years, the half-life is usually determined from the observation of the disintegration rate as a function of time. In these cases, the type of counter used to follow the decay is given. For an isotope with half-life longer than a few years, the specific activity method is usually employed. In these cases, the methods used to obtain the number of disintegrations per sec, λN, and the number of radioactive atoms in the source, N, are given.

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
^{3}H				
12.1 y 5	0.044		^{3}He growth	47N01
12.46 10			λN ^{3}He diffusion;	50J60
			N gas density	50J60
12.41 20			λN GM; N ms	51J15
12.262 4			^{3}He growth	55J20
12.58 18			^{3}H decay cal	58P64
12.346 2			^{3}H decay cal	67Jo09
12.25 8			^{3}He growth	67Jo10
A 12.35 y 1 U 12.34 6 W 12.329 14				
^{7}Be				
52.93 d 22	2.3	Li(d,n) chem	ic	49S20
53.61 17		Li(p,n) chem	ic	53K16
53.0 4	1.6	C(p,3pn) chem	ic	56B36
53.5 2	3.5	Li(p,n) chem	ic	57W37
53.1 3		C(^{3}He,^{7}Be)	scinγ	65En01
A 53.3 d 2 U 53.23 14 W 53.34 14				
^{11}C				
20.50 m 6	4		GM	41S01
20.35 8	5	B(d,n) chem	electroscope	41S11
20.0 4		B(d,n)	GM	44S30
20.0 1	6	C(p,pn)	scinγ±	51D12
20.74 10	15	C(^{3}He,α)		53K08
20.26 10	3.5	C(γ,n)	scinγ±	55B163
20.8 2		C(p,pn)	pc	57P53
20.11 13		B(p,γ)	scinγ±	58A115
20.34 4	16	C(p,pn)	scinγ±	64Ka31
20.8 4		^{10}B(^{3}He,d)	scinγ±	65Pa10
A 20.4 m 3 U 20.39 10 W 20.39 7				
^{13}N				
10.05 m 3		C(p,γ)	GM	53C34
10.08 4		C(d,n)	scinγ±	55W43
10.07 6		^{9}Be(^{6}Li,2n)	scinγ±	57N17
9.96 3	5	C(p,γ)	scinγ±	58A115
9.96 3	12	C(d,n)	scinβ+	58D09
9.965 4	13		scinβ+	60Ja12
9.93 5	8	N(γ,n)	pc scinγ±γ±	60Ki2
9.96 2$	10	C(d,n)	scinγ±γ±	65Eb01
10.05 5		N(n,2n)	well scinγ±	65Bo42
A 9.97 m 2 U 10.003 19 W 9.968 6				

$ 95% confidence level

A Adopted value
U Unweighted average
W Weighted average

For explanation of other symbols and definition of U and W, see SYMBOLS AND DEFINITIONS.

Appendix I

Basic Half-Life Data with Recommended Values continued

^{14}C

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
4700 y 400			λN GM; N ms	46R10
5100 200			λN GM; N ms	48N02
7200 500			λN GM; N ms	48Y02
6360 200			λN GM; N ms	49H52
5589 75			λN GM; N ms	49J07
5580 90			λN GM; N ms	50E59
6360 190			λN GM; N ms	50M10
5513 165			λN pc; N ms	50M10
5370 200			λN GM; N ms	51M30
6100 85			E*λN cal;	52J11
			N gas density	52J11
5900 250			E*λN ic; N ms	54C41
5780 65			λN pc; N ms	61Wa16
5680 40			λN pc; N ms	62D14
5745 50			λN pc GM; N ms	64Hu09
5660 30			λN pc; N ms	68Be47
5736 56			λN liquid scin; N ms	68Re13

A 5730$ y 40$ U 5773 141 W 5706 41

* E is the average β^--energy. Value used is 0.0493 MeV

$ Value adopted at Fifth Radiocarbon Dating Conference, Cambridge, 1962. See 62Go33, also 65Jo18

^{15}O

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
124.0 s 5		^{16}O(α,αn)	scinβ^+	57P12
124.1 5		C(α,n)	scinβ^+	59K99
122.1 1		C(α,n)	scinβ^+	60Ja12
122.6 10		C(α,n)	scin$\gamma^\pm$	63Ne05

A 123 s 1 U 123.2 5 W 122.2 3

^{18}F

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
109.8 m 12	13	^{19}F(γ,n) chem	GM	58B74
109.7 5	5	^{18}O(p,n)	well scin	59C01
110.2 2		^{19}F(p,d) chem	pc	60Yu2
109.9 2				62We17
109.6 6	11	O(t,n) chem	pc	63Be47
110.5 6	8	O(t,n)	scin$\gamma^\pm$	64Ho28
109.72 6	10	O(t,n) chem	pc	64Ma12
		O(α,d) chem		64Ma12
109.87 11		^{19}F(n,2n)	scin$\gamma^\pm\gamma^\pm$	65Eb01

A 109.8 m 2 U 109.91 11 W 109.79

^{22}Na

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
2.58 y 3	1.0		pc	57M47
2.62 2	1.5	Mg(n,α) chem	ic	61Wy1
2.602 2	2.6	Mg(p,2pn) chem	ic	65An07
2.600 2	1.2	Mg(p,2pn) chem	ic	68An01

A 2.60 y 1 U 2.600 8 W 2.6010 14

^{24}Na

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
15.10 h 4		^{23}Na(n,γ) chem	ic	50C69
15.04 6	13	^{23}Na(n,γ) chem	pc	50S55
15.06 4				51S14
14.97 2	5	^{23}Na(n,γ)	electroscope	53L09
14.90 5	0.7	^{23}Na(n,γ)	ic	55T07
15.01 6		V(p,s) chem	GM	56R45
14.98 2			ic	57K65
14.959 10	7	^{23}Na(n,γ) chem	pc	58C20
15.00 6		^{27}Al(n,α)	pc	59P64
14.953 13	4	^{23}Na(n,γ)	pcβγ	60Wo7
15.05 3	6	^{23}Na(n,γ)	liquid scin	61Jo26
15.05 2	3.1	^{23}Na(n,γ)	ic	61Wy1
15.05 5		^{23}Na(n,γ)	scinγ	62Mo21
15.01 5		^{23}Na(n,γ) chem	scin γ	66L109
15.00 2		^{23}Na(n,γ)	ic pc scinγ	68La10

A 15.00 h 4 U 15.009 13 W 14.978 10

^{28}Mg

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
21.8 h 3	7	Mg(t,p) chem	GM	53I01
22.1 3	7	Si(p,3p) chem	GM	53J07
21.2 2	13	Cl(p,s) chem	GM	53L21
20.8 5		S(p,s) chem	GM	53M23
		K(p,s) chem		53M23
21.4 6		Mg(α,2p)		53W22
21.3 2	9	Mg(α,2p)	GM	54S28
21.22 8	12	^{26}Mg(t,p) chem	pc	61Ne15
20.88 5	14	^{26}Mg(t,p) chem	pc well scin	63We19

A 21.1 h 1 U 21.34 16 W 21.07 10

^{28}Al

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
2.30 m 3		^{27}Al(n,γ)	GM	43E07
2.27 2	6	^{27}Al(n,γ)	electroscope	53B48
2.31 6		Si(n,p)	GM	56C11
2.305 5	11	^{27}Al(n,γ)	scinγ	59E41
2.26 1	22	^{28}Mg(β^-) chem	well scin	61Ne15
2.28 6	5	^{27}Al(d,p)	GM	62F14
2.312 11		^{27}Al(n,γ)	scinγ	62Ma38
2.238 6	3	^{28}Mg(β^-) chem	scinβ^- scinγ	63We19
2.243 2	15	^{27}Al(n,γ)	scinγ	69Em01
		Si(n,p)		69Em01
2.240 7		^{27}Al(n,γ)	pc scinγ	69Wy01

A 2.24 m 1 U 2.276 9 W 2.250 6

^{32}P

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
14.30 d 3		^{31}P(d,p) chem	ic	38C01
14.35 5	2	S(n,p)	GM	48K28
14.59 3	3		electroscope	51S25
14.50 4	5	^{31}P(n,γ)	electroscope	53L09
14.223 15	11	S(d,α) chem	pc	57A03
14.55 6		S(n,p)	ic	59R51
14.282 10	11	S(n,p) chem	GM	61Ma46
14.30 8			cal	61Oz1
14.290 14		S(n,p) chem	pc	66Go16
		^{31}P(n,γ) chem		66Go16
14.32 1		S(n,p)	GM	69Pe04

A 14.29 d 3 U 14.37 4 W 14.30 3

^{35}S

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
87.1 d 12			GM	47H06
87.16 10			pc	58S49
88.8 10		S(n,γ) chem		59C12
86.35 17	6.2		pc	59C56
87.1 9			cal	61Oz1
89.0 5	4.0	Cl(n,p) chem	pc	61Wy1
87.9 3	8	chem	pc	65F102
87.39 10	3	chem	pc	68Wo06

A 88.0 d 10 U 87.6 3 W 87.21 17

Appendix I

Basic Half-Life Data with Recommended Values continued

^{36}Cl

T1/2(β−)

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
4.4x10^{5}y 5			λN GM; N mic	49W15
3.08 3		Cl(n,γ) chem	λN pc; N ms	55B93
2.6 4			λN GM;	57W37
			N Cl(n,γ) yield	57W37
2.5 4		Cl(n,γ)	λN GM; N mic	57W37
3.10 4			λN pc; N ms	66Go07
3.06 2			λN liquid scin; N ms	66Go07

A 3.07x10^{5}y 3 U 3.12 28 W 3.071 23

therefore T1/2=3.01x10^{5}y 3 if I(β−)=98.1%

^{38}Cl

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
37.0 m 3	10	Cl(d,p)	ic	36V01
37.3 3	4	Cl(d,p) chem		39W05
38.5 5	4	Cl(d,p)	GM	46H02
37.29 4		Cl(n,γ) chem	ic	50C69
37.12 18	5	Cl(n,γ)	scinγ	62Mo21
37.0* 1		A(d,α)		63Wi11
37.4 2	2	Cl(n,γ) chem	scinγ	69Ba14

A 37.3 m 1 U 37.4 3 W 37.28 5

* probably contains trace of 32-m ^{34}Cl therefore not included in U or W 63Wi11

^{40}K

β/s-gm K

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
28.3 10			4π cell counter	50S52
27.1 6			KI scin, area under	51G29
			β spectrum	51G29
29.2 10			KI scin, area under	55K21
			β spectrum	55K21
29.6 7			a, ^{32}P calibration	55S38
27.50 25			pc, cyl. geometry	56M20
			backscattering corr.	56M20
27.2 5			KI scin, integral counts	59K26
28.8 9			GM, UX_2 calibration	60Sa3
28.2 3			KOH in liquid scin	61G17
27.17 8			K_2SO_4 in liquid scin	62F15
29.2 5			KCl in liquid scin	65Br25
28.26 5			KI scin, integral counts	65Le15
27.9 3			KCl in liquid scin	66Fe09

A 28.0 2 U 28.2 3 W 27.95 15

therefore λ(β−)=0.486x10^{-9}y^{-1} 4 if abundance of ^{40}K=0.0118%

γ/s-gm K

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
3.4 1			pc, E(γ)=4.9 MeV/s-gm K	48E09
			^{60}Co calibration	48E09
3.50 14			scin, ^{59}Fe ^{60}Co	55B125
			^{142}Pr calibration	55B125
3.39 12			scin, ^{24}Na ^{60}Co	57W43
			calibration	57W43
3.22 15			scin, ^{60}Co calibration	60Sa3
3.20 8			well crystal, efficiency	65Le15
			calculated from theory	65Le15
3.36 12			KI scin, integral counts	65Le15
3.25 6			well crystal, 5 nuclei	66De04
			used for calibration	66De04

A 3.30 4 U 3.33 4 W 3.30 4

therefore λ(γ)=0.0570x10^{-9}y^{-1} 7 if abundance of ^{40}K=0.0118%

therefore T1/2=0.693x[λ(β−)+λ(γ)]$^{-1}$=1.28x10^{9}y 1

^{42}K

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
12.44 h 10	5	K(d,p) chem		47S08
12.516* 7		K(n,γ)	ic	53B58
12.44 8	7	K(n,γ) chem	ic	53K26
12.46 7	4	K(n,γ) chem	pc, ic	57W37
12.37 9	30	chem	pc	59M27
12.358 7	10	K(n,γ) chem	pc	62Me6
12.47 7		K(n,γ)	scinγ	62Mo21
12.361 9	6.5	K(n,γ) chem	pc	67Go21

A 12.35 h 1 U 12.414 19 W 12.361 6

* contains 15.00-h ^{24}Na impurity therefore not included in U or W 53B58

^{45}Ca

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
164 d 4	1.2	Ca(n,γ)	GM	53D01
153 2	0.7	^{45}Sc(n,p) chem	GM	57T11
167 3		^{44}Ca(n,γ) chem	pc	59C12
165.1 7	3.5	^{44}Ca(n,γ) chem	pc	61Wy1
162.63 11	5.8	Ca(n,γ)	pc	65An07

A 164 d 1 U 162.3 24 W 162.67 23

^{47}Ca

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
4.51 d 2	5	^{48}Ca(γ,n)	pc	61Fo12
4.53 1	4.4	^{46}Ca(n,γ) chem	well scin	61Wy1
4.71 3				63Fu09
4.52 5	1	Ca(n,γ) chem	scinγ	64B120
4.535 4	9	^{48}Ca(γ,n)	scinγ	64G104
4.56 2	2		scinγ	67G105
4.50 3	7	Ca(n,γ)	well scin	67Sm02
4.530 4	3.3	^{46}Ca(n,γ)	ic	68Re04

A 4.53 d 1 U 4.549 24 W 4.535 6

^{47}Sc

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
3.43 d 3	7	^{49}Ti(d,α) chem	ic	49K12
3.40 5		^{47}Ca(β−) chem		53C44
3.44 5	7	Cr(p,s) chem	GM	53M64
3.45 10	6	Ca(p,2n) chem	well scin	55L34
			GM scinγ	55L34
3.3 1		^{47}Ca(β−) chem	GM	56L38
3.45 6		^{47}Ti(n,p) chem	pc	59P64
3.38 9	4.5	V(p,s) chem	scinγ	63Ho17
3.34 2	20	^{47}Ca(β−) chem	scinγ	67Me09

A 3.40 d 5 U 3.399 20 W 3.381 18

^{49}Ca

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
8.9 m 2		^{48}Ca(n,γ)	scinγ	56M27
8.75 20	4	^{48}Ca(n,γ)	scinγ	56D02

A 8.8 m 2 U 8.82 8 W 8.82 14

^{49}Sc

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
57.2 m 7		^{49}Ca(β−) chem	pc	56D02
57.5 1		^{49}Ca(β−) chem	scinβ	61Re5
57.5 1		^{49}Ca(β−) chem		66Co30

A 57.5 m 2 U 57.40 10 W 57.50 7

Appendix I

Basic Half-Life Data with Recommended Values continued

^{51}Cr

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
27.75 d 30	5	Cr(n,γ) chem	ic GM	52L17
27.9 2	4	^{50}Cr(d,p) chem	well scin	56K33
		^{52}Cr(d,t) chem		56K33
27.8 1	10	Cr(n,γ) chem	pc	56S87
27.81 20			ic	57K65
27.82 20	4	^{51}V(p,n) chem	scinγ	63Ho17
27.701 6	6	Cr(n,γ)	well scin	64Ma56
27.76 15	2		scinγ	67G105
27.7 2		Cr(n,γ)	ic pc scinγ	67La21
27.780 13	4	Cr(n,γ)	ic	68An01

A 27.72 d 3 U 27.780 21 W 27.715 11

^{52}Mn

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
5.60 d 1		Cr(d,2n) chem	pc	54B58
5.72 2	18	Cr(d,2n) chem	well scin	55B10
5.69 3	4	Cr(d,2n) chem	well scin	56K33

A 5.67 d 9 U 5.67 4 W 5.63 3

^{54}Mn

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
313.5 d 7	2.0	Fe(n,p) chem	ic	61Wy1
311.9 2	1.5	Fe(n,p) chem	ic	65An07
312.4 6		chem	ic	65Ta10
312.1 3	2.4	Fe(n,p) chem	ic	68An01
312.2 9		Cr(d,n) chem	ic pc scinγ	68La10
312.99 10	6.2	^{54}Fe(n,p)	scinγ	68Z101

A 312.5 d 5 U 312.52 26 W 312.72 21

^{55}Fe

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
2.94 y 3	0.5	Fe(d,p)	ic	50B76
2.60 2	1.8	^{54}Fe(n,γ)	pc	56S87
2.79 3	4.5		GM	67RG01
2.685 10	3.2	Fe(n,γ)	pc	68An01

A 2.7 y 1 U 2.75 7 W 2.70 5

^{56}Ni

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
5.4 d 1		^{54}Fe(α,2n) chem	scinγ	52S30
6.0 5	2	Fe(α,2n) chem	scinγ	52W15
5.8 6		Fe(α,2n) chem	scinγ	61Mo10
6.10 2	3	Fe(α,2n) chem	scinγ	63We06

A 6.1 d 1 U 6.08 13 W 6.11 4

^{56}Co

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
77.2 d 8		Fe(d,2n) chem	pc	54B58
77.3 3	3	Fe(p,n) chem	ic	57W37

A 77.3 d 3 U 77.25 5 W 77.3 3

^{57}Co

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
271.65 d 13	2.1	Ni(p,2p) chem	ic	65An07
269.8 4	5.9	Ni(p,2p) chem	ic	67Re05

A 270 d 2 U 270.7 9 W 271.5 5

^{58}Co

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
72 d 4	2	Co(γ,n) chem	GM	52H58
71.3 2	7	Ni(n,p) chem	pc	56S87
71.5 8	1	Ni(n,p)	scin$\gamma^{\pm}\gamma^{\pm}$	68De08
		^{59}Co(n,2n) ^{59}Co(γ,n)		68De08

A 71.3 d 2 U 71.6 2 W 71.3 2

^{59}Fe

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
45.1 d 2	8	Fe(d,p)	pc	51S56
45.0 2	0.3	Fe(n,γ) chem	ic	55T27
44.3 4	5.4	^{58}Fe(n,γ) chem	ic	57W37
44.56 3	4		ic	58K26
43.7 6			scin$\beta\gamma$	60Fu3
44.50 20	2	chem	scinγ	67G105

A 44.6 d 4 U 44.53 20 W 44.58 5

^{60}Co

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
5.27 y 7	0.02		ic	51T25
5.21 4			ic	53K21
5.28 3	1.0		ic	56E18
5.20 3			electroscope	56L31
5.25 4	1.2		ic	56P52
5.24 3	1.2	^{59}Co(n,γ)	ic	57G07
5.29 3	0.2			58B192
5.33 4	0.23	^{59}Co(n,γ)	ic	58K26
5.29 2		^{59}Co(n,γ)	electroscope	58L61
5.26 3				58S53
5.263 3	0.61		ic	63Go03
5.259 3	1.0	^{59}Co(n,γ)	ic	68An01
5.27 2		^{59}Co(n,γ)	ic pc scinγ	68La10

A 5.26 y 1 U 5.262 9 W 5.2613 22

^{63}Ni

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
85 y 20				51B05
125 6			λN 4$\pi\beta$; N ms	56M95
91.6 31$		^{62}Ni(n,γ) chem	λN liquid scin;	62Ho5
			N ms	62Ho5

A 92 y 3 U 100 12 W S8 10

$ 95% confidence level

^{64}Cu

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
12.80 h 4	9	Cu(n,γ)	ppl	50R62
12.74 7		Cu(n,γ)	pc	51S56
12.88 3	12	Cu(n,γ)	ic	51S91
12.80 3	1	Cu(n,γ)	ic	55T07
12.90 6		^{75}As(p,s) chem	GM	56R45
12.87 5	5	Cu(n,γ)	ic	57W37
12.85 5	>1	Cu(n,2n)	pc	59P64
12.70 3	10	^{66}Zn(d,α) chem		61Wi19
		^{67}Zn(d,αn) chem		61Wi19
12.86 3	>1	Cu(n,2n)	scin$\gamma^{\pm}$	65Pa18
12.701 11		^{63}Cu(n,γ)	scin$\gamma^{\pm}$	68He20

A 12.8 h 1 U 12.810 24 W 12.751 24

^{65}Zn

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
245.0 d 8	0.25	Zn(n,γ) chem	ic	53T17
243.5 8	1.9	Zn(n,γ)	ic	57G07
244.6 6			ic	57K65
246.4 22	1.0	Zn(n,γ) chem	ic	57W37
245.7 11			ic	60Ea2
249.7 14	1.2		scinγ	61Ag2
243.7 4	3	Zn(n,γ)	ic	65An07
243.62 12	2.8	Zn(n,γ)	ic	68An01

A 243.8 d 7 U 245.3 7 W 243.75 22

Appendix I

Basic Half-Life Data with Recommended Values continued

^{75}Se

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
115 d 5	1.6	Se(n,γ) chem	GM	47F08
		^{75}As(d,2n)		47F08
127 2	7.9	^{75}As(d,2n) chem	ic	48C07
125 5	1.6	Se(n,γ) chem	GM	50G20
119.9 6	2.2	Se(n,γ) chem	ic	57W37
120.4 2			ic	60Ea2

A 120 d 1 U 121.5 21 W 120.4 4

^{76}As

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
26.3 h 3	8	^{75}As(n,γ)	GM	40M04
26.75 15	5	^{75}As(n,γ) chem	GM	42W01
26.9 3	3.7	^{75}As(n,γ)	electroscope	43M11
26.1 3	3	^{75}As(n,γ) chem	electroscope	48P08
25.6 4		^{75}As(n,γ)	scinβ	53H40
26.4 2		^{75}As(n,γ) chem		53H47
26.5 2			ic	55D48
26.16 5	4.3	^{75}As(n,γ) chem	ic	69Re01

A 26.3 h 3 U 26.34 14 W 26.25 8

^{79}Kr

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
34.5 h 10		Br(p,n) chem	electroscope	40C06
36 1		Kr(n,γ) ms	GM	52B55
34.5 2	6	Br(d,2n) chem	ic	52R13
34.92 5	3	Br(d,2n) ms	scinγ	64Bo25

A 34.9 h 2 U 35.0 4 W 34.90 7

^{82}Br

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
36.0 h 1	4	Br(n,γ)	GM	50B10
35.87 5		Br(n,γ) chem	ic	50C69
35.7 3	5			51S25
35.1 1	8			51W09
35.55 15	5	Br(n,γ) chem	ic	61Wyl
35.344 13		^{81}Br(n,γ) chem	pc	62Me6
35.34 3	3	^{81}Br(n,γ)	scinγ	68Re04

A 35.4 h 1 U 35.56 12 W 35.38 6

^{85}Kr

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
10.57 y 14	0.07		scinβ	53T22
10.27 18	0.68	U(n,f) chem	ms	53W17
10.76 2	1.0	U(n,f) chem ms	pc	63Le07
10.75 3	0.59	U(n,f) chem	ic	65An07
10.701 23	0.77	U(n,f) chem	ic	68An01

A 10.73 y 6 U 10.61 9 W 10.734 23

^{85}Sr

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
65.0 d 7		U(n,f) chem		56H77
64.0 2	3.3	^{84}Sr(n,γ) chem	scinγ	57W37
63.90 27	4	^{84}Sr(n,γ)	scinγ	62Sa12
65.19 13	1.4	Sr(n,γ)	ic	65An07
64.93 22	2		scinγ	67G105

A 64.5 d 5 U 64.60 27 W 64.75 27

^{86}Rb

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
18.66 d 3	4	Rb(n,γ) chem		55E20
18.64 4	9	fission product chem		55N09
18.68 7	5	Rb(n,γ) chem	GM	57W37
18.82 11	2		scinγ	67G105

A 18.66 d 2 U 18.70 4 W 18.66 2

^{87}Rb

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
4.70×10^{10}y 10			λN liquid scin; N weighing	59F40
4.72 8			λN 4π gas; N weighing	60Ra11
5.53 10			λN NaI+RbI scin; N weighing	61Be41
5.25 10			λN 4π pc; N weighing	61Mc7
5.82 10			λN NaI+RbI scin; N weighing	62Le6
4.77 10			λN liquid scin; N ms	64Ko11
4.87 35			λN liquid scin; N weighing	65Br25
5.21 15			λN liquid scin; N weighing	66Br25
4.72 4		^{87}Rb decay	ms	66Mc12

A 4.7×10^{10}y 1 U 5.07 14 W 4.92 12

^{87}Y

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
80 h 3		Sr(p,n) chem	ic	40D05
80 1		Sr(d,n) chem	GM	51M46
80.7 15				67S106

A 80 h 1 U 80.2 2 W 80.2 8

^{87}Sr metastable state

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
2.80 h 3	10	Nb(p,s) chem	GM	51H24
2.80 5	9	^{87}Y(ec) chem	GM	51M46
2.88 3		^{87}Y(ec) chem		52G14
2.90 8		U(n,f) chem		56H77
2.83 2		Sr(n,2n)	well scin	65Bo42
2.805 3	5	^{87}Y(ec) chem	ic	68Go30

A 2.81 h 1 U 2.836 18 W 2.806 4

^{88}Y

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
108.1 d 3	3.1	Sr(p,n) chem	ic	61Wyl
106.52 3	2.6	Sr(p,n) chem	ic	65An07
106.61 2	4.3	Sr(p,n) chem	ic	68An01

A 107 d 1 U 107.1 5 W 106.59 7

^{89}Sr

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
50.5 d 2	8	U(n,f) chem		55H81
50.5 2		^{88}Sr(n,γ)		55H81
		Y(n,p) Sr(n,γ)		55H81
51 1	4	U(n,f) chem		56K07
50.36 18	2.6	^{88}Sr(n,γ) chem	GM	59D37
50.52 3	5.1	^{88}Sr(n,γ)	pc	65An07

A 50.5 d 1 U 50.58 11 W 50.515 29

^{90}Sr

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
27.7 y 4		U(n,f) chem	λN pc; N ms	55W15
28.82 14	0.39	U(n,f) chem	^{90}Sr decay pc	65An07
28.0 4	0.36	U(n,f) chem	^{90}Sr decay pc	65F101
28.5 9		U(n,f) chem	λN pc; N ms	65F101

A 28.5 y 8 U 28.26 25 W 28.63 22

^{90}Y

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
64.6 h 4	10	^{90}Sr(β^-) chem	GM	54C05
64.2 2	7.5	^{90}Sr(β^-) chem	GM	55S23
64.029 24		^{90}Sr(β^-) chem	pc	55S113
64.24 30	8	^{90}Sr(β^-) chem	GM	55V03
64.8 2		^{90}Sr(β^-) chem		56H77
63.97 10	10	^{90}Sr(β^-) chem	pc	57P09
64.4 4	2	^{90}Sr(β^-) chem	GM	57W37
64.3 4	2.6	Y(n,γ)	cal	59R61
64.05 11		^{90}Sr(β^-) chem	scinβ	66R101
64.6 8	16	^{90}Sr(β^-) chem	scinβ	67Bi02
64.21 8		^{90}Sr(β^-) chem	ic pc scinγ	68La10

A 64.0 h 1 U 64.33 8 W 64.06 4

Appendix I

Basic Half-Life Data with Recommended Values continued

^{91}Y

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
58.5 d 10	1	U(n,f) chem	scinγ	54B38
58.3 8		U(n,f) chem		56H77
59.1 2	2	U(n,f) chem	pc	61Wy1
58.8 2	6.6	U(n,f) chem	pc	63Ho15
59.0 6		Pu(n,f) chem	pc	65Ma52

A 58.9 d 4 U 58.74 15 W 58.93 13

^{95}Zr

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
65.2 d 10	5	^{94}Zr(n,γ)		53C23
		U(n,f)		53C23
65.5 d 2	7	chem	pc	65F102

A 65.5 d 5 U 65.35 15 W 65.49 20

^{95}Nb metastable state

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
3.50 d 9	10	^{95}Zr(β−) chem	GM	53S14
3.75 9		^{95}Zr(β−) chem	GM	55D43
3.608 33	3.5	^{95}Zr(β−) chem		69Fo01

A 3.61 d 4 U 3.62 7 W 3.61 4

^{95}Nb

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
35.0 d 5		^{95}Zr(β−) chem	scinγ	53C23
35.3 2	5	U(n,f) chem	GM	58S117
35.58 42	1	^{95}Zr(β−) chem	ic	59P43
35.0 1	5	U(n,f) chem	ic	61Wy1
35.8 5	13	chem	pc	65F102
35.04 4	4	^{95}Zr(β−) chem	ic	68An01
35.1 2		U(n,f) chem	ic pc scinγ	68La10
35.15 3	3	^{95}Zr(β−) chem	ic	68Re04

A 35.1 d 1 U 35.23 11 W 35.108 23

^{99}Mo

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
66.0 h 1	8	U(n,f) chem	ic	47S25
66.00 15	8	U(n,f) chem	pc	57G62
		Mo(n,γ) chem		57G62
67.2 2		U(n,f) chem	GM	58P71
65.6 2	11	U(n,f) chem	pc	61Ne15
66.7 1	11	^{98}Mo(n,γ) chem	well scin	65Cr03
65.93 24	8	Mo(n,γ)	pc	67Ba37
65.95 4	9	Mo(n,γ)	scinγ	67Ba37
66.69 6	4	U(n,f) chem	ic	68Re04

A 66.2 h 5 U 66.26 19 W 66.20 14

^{99}Tc

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
2.12×10^{5} y	4	U(n,f) chem	λN pcβγ;	51F05
		^{99}Mo(β−) chem	N chem	51F05
2.15	5	U(n,f) chem	λN pc;	60Bo8
		^{99}Mo(β−) chem	N chem	60Bo8
2.14	5	U(n,f) chem	λN liquid scin;	66Go10
			N chem	66Go10

A 2.13×10^{5}y 8 U 2.137 9 W 2.134 26

^{99}Tc metastable state

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
6.04 h 3		^{99}Mo(β−) chem	ic	53B41
5.996 11	12	^{99}Mo(β−) chem	ic	58B92
5.98 1	25	^{99}Mo(β−) chem	well scin	61Ne15
6.007 2	5	^{99}Mo(β−) chem	ic	66Go22
6.049 3	2		scinγ	67G105
6.06 5	7.8	^{99}Mo(β−) chem	scinγ	67K104
6.02 1	11	^{99}Mo(β−) chem	well scin ic	68Re08

A 6.02 h 3 U 6.022 11 W 6.018 8

^{103}Ru

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
39.8 d 4	3	Ru(n,γ) chem	GM	52K27
39.5 5	15	Ru(n,γ) chem	ic	54B104
39.7 6	3.4	U(n,f) chem	ic	57W37
39.4 4	2-6	^{102}Ru(n,γ) chem	pc	59C12
39.5 3	4.7		pc	65F102

A 39.6 d 5 U 39.58 7 W 39.56 18

^{103}Rh metastable state

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
57.5 m 5		^{103}Rh(n,nγ)	scinX	57J19
56 1		^{103}Rh(γ,γ)	scinX	67Ab07

A 57 m 1 U 56.8 8 W 57.2 6

^{106}Ru

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
366.6 d 9	5	U(n,f) chem	pc	56S87
373 4	5	Ru(2n,γ) chem	pc	57M47
365.8 17			ic	60Ea2
371 1	3.2	U(n,f) chem	ic	61Wy1
368.0 18	4	chem	pc	65F102

A 369 d 2 U 368.9 14 W 368.3 11

^{106}Rh

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
30.35 s 15		^{106}Ru(β−)	scin	67Mi11

A 30.4 s 5

^{111}Ag

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
7.5 d 1	6	^{111}Pd(β−) chem		50J53
7.45 1	8	chem	scinγ	60Ba49

A 7.45 d 1 U 7.48 3 W 7.45 1

^{113}Sn

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
112 d 2	4	^{112}Sn(n,γ) chem		50N52
118 2	2	^{112}Sn(n,γ)		51C34
119 3	1		pc	56A28
115.2 8	2	chem	scinγ	67G105

A 115 d 1 U 116.0 16 W 115.3 10

^{113}In metastable state

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
1.73 h 4	5	Cd(d,n) chem	sce	40L07
1.71 3	5	^{113}Sn(ec) chem	scinγ	58G06
1.75 4	8	^{113}Sn(ec) chem	scinγ	59R64
1.663 3	2		scinγ	67G105
1.655 3	13	^{113}Sn(ec) chem	well scin	67Ok02
1.65 1	6	^{113}Sn(ec)	scinγ	69Va04

A 1.66 h 1 U 1.694 17 W 1.659 4

^{123}Te

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
1.24×10^{13}y 10			λN pc; N weighing	62Wa15

A 1.2×10^{13}y 2

^{123}Te metastable state

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
117 d 6		La(p,s) chem ms	scinγ	65An05
120 1	1.9	Te(n,γ)	scinγ	69G101
120 1	3.2	^{122}Te(n,γ) chem	scinγ	69Re03

A 120 d 1 U 119 1 W 120 1

Appendix I

Basic Half-Life Data with Recommended Values continued

^{123}I

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
13.0 h 5		Sb(α,n) chem	GM	49M35
13.30 5		La(p,s) chem ms	scinγ	65An05
13.31 3	4	^{123}Xe(β^+) chem	scinγ	68An01
13.02 2	13	^{123}Te(p,n) chem	scinγ	68Hu01

A 13.2 h 1 U 13.16 9 W 13.13 8

^{124}Sb

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
60.4 d 2		Sb–Be source	BF_3	57M50
59.9 5		Sb–Be source	BF_3	58J01
60.1 3	2–6	Sb(n,γ) chem	pc	59C12
60.200 12	3	Sb(n,γ)	cal	66F101
60.3 2	2.5	Sb(n,γ)	ic	68Re04

A 60.20 d 2 U 60.18 9 W 60.201 12

^{124}I

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
4.0 d 3	6	Sb(α,n) chem	electroscope	38L05
4.24 5	5	Sb(α,n) chem	scinγ	58D88
4.1 1	5	Sb(α,n) chem	scinγ	59G59
4.2 2		^{121}Sb(α,n) chem	scinγ	59M122
4.15 3		La(p,s) chem ms	scinγ	65An05
4.1 2	2.5	I(γ,3n)	semiγ	68Jo02

A 4.17 d 7 U 4.14 4 W 4.169 25

^{125}Sb

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
2.78 y 4	1	^{125}Sn(β^-) chem	ic	61Wy1
2.71 2	3	chem	pc	65F102
2.81 5	2	^{125}Sn(β^-) chem	pc	66La13

A 2.77 y 4 2.77 3 W 2.73 3

^{125}Te metastable state

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
58 d 4		^{125}Sb(β^-)		49H27
58 1		La(p,s) chem ms	scinγ	65An05

A 58 d 1 U 58 W 58 1

^{131}I

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
8.02 d 3	8		ic GM	51S96
8.05 1	6	U(n,f) chem	pc	53B10
8.06 2	6		electroscope	53L09
8.02 4	4	U(n,f) chem	GM	53P25
8.075 22	5		electroscope	53S28
8.054 10	6		scinγ	58B214
8.067 7	10		ic	58K26
8.048 16	2		scinγ	67G105
8.073 8		^{131}Te(β) chem	ic pc scinγ	68La10
8.070 9	4	U(n,f) chem	ic	68Re04

A 8.06 d 1 U 8.054 6 W 8.053 4

^{131}Xe metastable state

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
12.0 d 3	2	^{131}I(β^-) chem ms	scin	52B55
11.8 1		La(p,s) chem ms	scin	65An05
		U(n,f) chem ms		65An05
11.94 4		^{131}I(β^-) chem	scin	66Kn03

A 11.9 d 1 U 11.91 6 W 11.92 4

^{132}Te

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
77.7 h 5	6	U(n,f) chem	GM	53P25
75 3	2	U(n,f) chem	^{132}Xe growth ms	56F15
78.2 8		U(n,f) chem ms	scinγ	65An05
		La(p,s) chem ms		65An05

A 78 h 1 U 77.0 10 W 77.8 4

^{132}I

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
2.259 h 8	3.5	U(n,f) chem	ic	54E27
2.30 5	5	U(n,f) chem	scinγ	55W35
2.292 7	3	U(n,f) chem	ic	58K26
2.33 1	32	U(n,f) chem	pc	61Ne15
2.34 2		U(n,f) chem ms	scinγ	65An05
		La(p,s) chem ms		65An05
2.2846 4	6	^{132}Te(β^-) chem	well scin	66Ma56

A 2.28 h 2 U 2.301 12 W 2.285 11

^{133}Xe

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
5.270*d 2	0.7	U(n,f) chem	^{133}Xe decay ms	50M15
5.31 3	2.6	U(n,f) chem ms	scinγ	68Al16
5.29 1	4.5	U(n,f) chem	ic	69Re01

A 5.29 d 1 U 5.30 1 W 5.29 1

*Not included in U or W. Value is low because of the presence of ^{133}Xe metastable state in author's ms sources. This isomer was unknown at time of experiment

^{137}Cs

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
30.0 y 4		U(n,f) chem	λN pc; N ms	55B106
30.4 4	0.005	U(n,f) chem	^{137}Ba growth ms	61Fa3
30.1 7			λN liquid scin; N ms	62F19
29.68 5	0.10		^{137}Cs decay ic	63Go03
29.2 3	0.09	U(n,f) chem	^{137}Ba growth ms	63Ri02
29.40 18	0.17	U(n,f) chem	^{137}Cs decay ms	64Co35
30.9 7		U(n,f) chem	λN pc; N ms	65F101
29.9 5	0.10	U(n,f) chem	^{137}Cs decay pc	65F101
30.72 10			λN well scin; N ms	65Le25
29.78 14			^{137}Ba growth ms	65Le25
30.25 7	0.19		^{137}Cs decay ms	67Di06
29.76 13	0.13	U(n,f) chem	^{137}Cs decay ic	68An01
30.23 16	0.26	U(n,f) chem	^{137}Cs decay ic	68Re04
30.64 43	0.33	U(n,f) chem	^{137}Cs decay pc	69Ha29

A 30.0 y 5 U 30.02 14 W 29.95 11

^{137}Ba metastable state

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
2.554 m 3		^{137}Cs(β^-) chem	pc ic	65Me03
2.5513 7	3	^{137}Cs(β^-) chem	well scin	66Ma28
2.5577 32		^{137}Cs(β^-) chem	well scin	67Mi11

A 2.552 m 2 U 2.5543 19 W 2.5517 10

^{140}Ba

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
12.80 d 5	12	^{239}Pu(n,f) chem		50e09

A 12.8 d 1

^{140}La

T1/2	No. T1/2 Followed	Produced by	Method	Ref. Key
40.22 h 2	14	^{140}Ba(β^-) chem	pc	54K08
40.31 6	13	La(n,γ)	pc	54Y02
40.27 5		U(n,f) chem	pc	57P09
40.2 2	2	^{140}Ba(β^-) chem	ic	68Re04

A 40.27 h 5 U 40.250 25 W 40.234 18

Appendix I

Basic Half-Life Data with Recommended Values continued

^{141}Ce

T1/2	No.	T1/2 Followed	Produced by	Method	Ref. Key
32.55 d	1	5	^{140}Ce(n,γ)	ic	65An07
32.38	2	8	^{139}La(n,γ)(n,γβ$^-$)	well scin	67Ob01
			^{139}La(n,γ)(β$^-$)(n,γ)		67Ob01

A 32.38 d 2 U 32.47 9 W 32.52 7

^{144}Ce

T1/2	No.	T1/2 Followed	Produced by	Method	Ref. Key
284.5 d	10	8	U(n,f) chem	pc	56S87
284.3	5		U(n,f) chem	ic	57K26
283.8	6	4.6		pc	65F102
284.8	10		U(n,f) chem	ic pc scinγ	68La10
284.9	8	3.1	U(n,f) chem	pc	68Re04

A 284 d 1 U 284.5 2 W 284.3 3

^{144}Pr

T1/2	No.	T1/2 Followed	Produced by	Method	Ref. Key
17.27 m	4		U(n,f) chem	pc	57P09
17.30	5	20	U(n,f) chem	pc	63Ho15
17.3	1	4	U(n,f) chem	semiγ	68Ra01

A 17.28 m 6 U 17.29 1 W 17.28 3

^{147}Pm

T1/2	No.	T1/2 Followed	Produced by	Method	Ref. Key
2.66 y	2	4.8	U(n,f) chem	pc	56S87
2.64	2	4		pc	57M47
2.618	7	1.3		pc	65An07
2.60	2	4.6		pc	65F102
2.620	5	1.1	U(n,f) chem	cal	65Wh04
2.6234	4$	1.4	U(n,f) chem	cal	67Jo07
2.62	1	1.9	U(n,f) chem	pc	68Re04

A 2.623 y 1 U 2.6204 11 W 2.6234 4

$ 95% confidence level

^{197}Hg

T1/2	No.	T1/2 Followed	Produced by	Method	Ref. Key
64.09 h	8		^{197}Au(p,n)	well scin scinγ	66E109
64.19	20		^{196}Hg(n,γ)	well scin	66E109
64.14	11		^{197}Tl(ec) chem	well scin	66E109

64.1 h 1 U 64.14 3 W 64.12 6

^{198}Au

T1/2	No.	T1/2 Followed	Produced by	Method	Ref. Key
2.697 d	3	3.7	^{197}Au(n,γ)	electroscope	53L09
2.699	3	10	^{197}Au(n,γ)	electroscope	54B61
2.686	5	1	^{197}Au(n,γ)	ic	55T07
2.697	5	2.6	^{197}Au(n,γ)	scinγ	56J24
2.694	6	9	^{197}Au(n,γ)	GM	56S75
2.704	4	11		ic	58K26
2.696	9	6	^{197}Au(n,γ)	GM	59G109
2.699	4	1.9	^{197}Au(n,γ)	cal	60Ro22
2.687	5				63St20
2.695	7	7	^{197}Au(n,γ) chem	ic	68Go22
2.697	5		^{197}Au(n,γ)	ic pc scinγ	68La10
2.693	5	3.2	^{197}Au(n,γ)	GM	68Re04

A 2.697 d 5 U 2.6954 16 W 2.6965 15

^{203}Hg

T1/2	No.	T1/2 Followed	Produced by	Method	Ref. Key
45.9 d	5	2	Hg(n,γ)	pc	51W22
47.9	2	>1	^{202}Hg(n,γ)		52C01
46.91	14	5	Hg(n,γ)	ic	56E14
47.1	2	3	Hg(n,γ)	GM	57T11
45.4	5	4	Hg(n,γ) chem	ic	57W37
47.2	7	2–6	Hg(n,γ)	pc	59C12
46.8	2	2	^{202}Hg(n,γ)	(scinγ)(pcβ)	62Ta6
46.577	8	5	Hg(n,γ) chem	ic	65An07
46.64	27	2		scinγ	67G105
46.600	10	3	Hg(n,γ) chem	ic	68An01
47.0	1		Hg(n,γ)	ic pc scinγ	68La10

A 46.59 d 5 U 46.73 20 W 46.590 1

^{204}Tl

T1/2	No.	T1/2 Followed	Produced by	Method	Ref. Key
3.78 y	4	0.36	Tl(n,γ) chem	pc	59F27
			Tl(d,p) chem		59F27
3.91	2	0.79		GM	59W13
3.81	4	0.58	Tl(n,γ)	scin	62Le5
3.91	9	0.79	Tl(n,γ)	GM	62Ni1
3.80	2	3.2		pc	63Ha17
3.754	4	1.9		pc	65An07
3.68	5	0.71		pc	65F102
3.825	3		^{203}Tl(n,γ) ^{203}Tl(d,p)	pc	68Ho07
			^{205}Tl(n,2n) ^{205}Tl(d,t)		68Ho07
3.85	4		Tl(n,γ)	ic pc scinγ	68La10
3.774	5	0.53	Tl(n,γ)	cal	69Bo24
3.793	5	5.1	Tl(n,γ) chem	pc	69Ha29
3.7730	13	1.6		cal	69Jo02

A 3.78 y 2 U 3.805 19 W 3.780 7

^{204}Pb

T1/2	No.	T1/2 Followed	Produced by	Method	Ref. Key
1.4×10^{17}y				λN ppl; N weighing	58R23

A 1.4×10^{17}y

^{226}Ra

T1/2	No.	T1/2 Followed	Produced by	Method	Ref. Key
1622 y	13			λN ic; N weighing	49K01
1617	11			λN scinα;	56S110
				N scinγ Ra standard	56S110
1577	9			E*λN cal; N weighing	59G80
1602	8			E*λN cal; N weighing	59M12
1599	7			E*λN cal; N weighing	66Ra13

A 1600 y 7 U 1603 8 W 1600 7

* E is the average energy emitted per ^{226}Ra decay

^{232}Th

T1/2	No.	T1/2 Followed	Produced by	Method	Ref. Key
1.45×10^{10}y	5			λN ic; N weighing	56M43
1.39	3			λN ppl; N weighing	56P42
1.42	7			λN scin(^{208}Tl γ);	56S117
				N weighing	56S117
1.41	1			λN ic; N chem	60Fa7
1.401	7			λN liquid scin; N chem	63Le21

A 1.40×10^{10}y 2 U 1.414 10 W 1.404 6

^{241}Am

T1/2	No.	T1/2 Followed	Produced by	Method	Ref. Key
458.1 y	5			λN pc; N weighing	57H10
457.7	18			λN pc; N weighing	58W69
432.7	7			E*λN cal; N weighing	67Oe01
436.6	3			λN pc; N weighing	68St02

A 433 y 2 U 446 7 W 450 7

* E is the average energy emitted per ^{241}Am decay.
Value used is 5.635 MeV

Appendix II

Common Methods of Bulk Production

The following table gives the method or methods by which the nuclides included in this compilation can be produced in bulk. The methods given are taken from the Isotopes Users Guide F. E. McKinney, S. A. Reynolds, P. S. Baker, ORNL-IIC-19 (1969).

Explanation of Table

Abund. (%) — Natural relative isotopic abundance of target from 59Full.

Reaction — Reaction used for bulk production

σ(b) — Reaction cross section for energy of incident particle given in column 6
Neutron cross sections are taken from the Second Supplement to BNL-325
References for charged-particle cross sections are given in footnotes

E(MeV) — Energy of incident particle for which cross section in column 5 is given. For neutron cross sections, ''thermal'' denotes neutrons with velocity 2200 meter/s

Product	Target	Abund. (%)	Reaction	σ(b)	E(MeV)
^{3}H	^{6}Li	7.42	(n,α)	950	thermal
^{7}Be	^{7}Li	92.58	(p,n)	0.58[a]	2.25
^{11}C	^{11}B	80.39	(p,n)	0.43[b]	6.0
^{13}N	^{12}C	98.89	(d,n)	0.12[c]	5.0
^{14}C	^{14}N	99.63	(n,p)	1.8	thermal
^{15}O	^{14}N	99.63	(d,n)	0.024[d]	2.27
^{18}F	^{19}F	100	(p,pn)	0.12[e]	20
^{22}Na	^{25}Mg	10.13	(p,α)	0.115[f]	15
	^{26}Mg	11.17	(p,αn)	0.043[f]	30
^{24}Na	^{23}Na	100	(n,γ)	0.53	thermal
	^{27}Al	100	(n,α)	0.13	13
^{28}Mg-^{28}Al	^{26}Mg	11.17	(t,p)	–[g]	
^{32}P	^{32}S	95.0	(n,p)	0.35	9.0
	^{35}Cl	75.53	(n,α)	0.19	14.5
	^{31}P	100	(n,γ)	0.19	thermal
^{35}S	^{35}Cl	75.53	(n,p)	0.4	thermal
	^{34}S	4.22	(n,γ)	0.27	thermal
^{36}Cl	^{35}Cl	75.53	(n,γ)	44	thermal
^{38}Cl	^{37}Cl	24.47	(n,γ)	0.43	thermal
^{40}K	Occurs naturally		(0.0118%)		
^{42}K	^{41}K	6.88	(n,γ)	1.1	thermal
^{45}Ca	^{44}Ca	2.06	(n,γ)	0.7	thermal
^{47}Ca-^{47}Sc	^{46}Ca	0.0033	(n,γ)	0.3	thermal
^{49}Ca-^{49}Sc	^{48}Ca	0.18	(n,γ)	1.1	thermal
^{51}Cr	^{51}V	99.76	(p,n)	0.52[h]	9
	^{50}Cr	4.31	(n,γ)	17.0	thermal
^{52}Mn	^{52}Cr	83.76	(p,n)	0.45[i]	10
^{54}Mn	^{54}Cr	2.38	(p,n)	0.25[j]	5.5
	^{54}Fe	5.82	(n,p)	0.55	8.0
^{55}Fe	^{55}Mn	100	(p,n)	0.35[j]	5.6
	^{54}Fe	5.82	(n,γ)	2.9	thermal
	^{58}Ni	67.88	(n,α)	≈0.11	14.6
^{56}Co	^{56}Fe	91.66	(p,n)	0.45[h]	13
^{56}Ni	^{54}Fe	5.82	(α,2n)	0.010[k]	30
^{57}Co	^{60}Ni	26.23	(p,α)	0.040[l]	13
^{58}Co	^{58}Ni	67.88	(n,p)	0.65	8
	^{55}Mn	100	(α,n)	0.18[m]	14
^{59}Fe	^{58}Fe	0.33	(n,γ)	1.2	thermal
	^{59}Co	100	(n,p)	0.07	14
^{60}Co	^{59}Co	100	(n,γ)	37	thermal
	^{60}Ni	26.23	(n,p)	≈0.13	13
^{63}Ni	^{62}Ni	3.66	(n,γ)	2	thermal
^{64}Cu	^{63}Cu	69.09	(n,γ)	4.5	thermal
^{65}Zn	^{64}Zn	48.89	(n,γ)	0.46	thermal
^{75}Se	^{74}Se	0.87	(n,γ)	30	thermal
^{76}As	^{75}As	100	(n,γ)	4.5	thermal
^{79}Kr	^{78}Kr	0.35	(n,γ)	2	thermal
^{82}Br	^{81}Br	49.46	(n,γ)	3.2	thermal
^{85}Kr	Fission product				
^{85}Sr	^{84}Sr	0.56	(n,γ)	1.3	thermal
^{86}Rb	^{85}Rb	72.15	(n,γ)	1.0	thermal
^{87}Y	^{87}Sr	7.02	(p,n)	0.5[n]	7
^{88}Y	^{88}Sr	82.56	(p,n)	0.2[n]	7
^{89}Sr	Fission product				
^{90}Sr-^{90}Y	Fission product				
^{91}Y	Fission product				
^{95}Zr	Fission product				
^{99}Mo	^{98}Mo	23.78	(n,γ)	0.51	thermal
	Fission product				
^{103}Ru	Fission product				
	^{102}Ru	31.61	(n,γ)	1.23	thermal
^{106}Ru-^{106}Rh	Fission product				
^{111}Ag	^{110}Pd	11.81	(n,$\gamma\beta^-$)	0.2	thermal
^{113}Sn	^{112}Sn	0.96	(n,γ)	1.3	thermal
^{123}I	^{123}Te	0.87	(p,n)	–[g]	
^{123m}Te	^{122}Te	2.46	(n,γ)	1	thermal
^{124}Sb	^{123}Sb	42.75	(n,γ)	3.3	thermal
^{124}I	^{121}Sb	57.25	(α,n)	–[g]	
^{125}Sb	^{124}Sn	5.94	(n,$\gamma\beta^-$)	0.1	thermal
^{125m}Te	^{124}Te	4.61	(n,γ)	5	thermal
^{131}I	Fission product				
	^{130}Te	34.48	(n,$\gamma\beta^-$)	0.23	thermal
^{132}Te-^{132}I	Fission product				
^{133}Xe	Fission product				
^{137}Cs	Fission product				
^{140}Ba-^{140}La	Fission product				
^{141}Ce	Fission product				
	^{139}La	99.911	(n,γ)(n,$\gamma\beta^-$)		thermal
^{144}Ce-^{144}Pr	Fission product				
^{147}Pm	Fission product				
^{197}Hg	^{196}Hg	0.146	(n,γ)	904	thermal
^{198}Au	^{197}Au	100	(n,γ)	98.8	thermal
^{203}Hg	^{202}Hg	29.80	(n,γ)	4	thermal
^{204}Tl	^{203}Tl	29.50	(n,γ)	11	thermal
^{226}Ra	Decay product of ^{238}U				
^{232}Th	Occurs naturally				
^{241}Am	^{238}U Multiple n-capture to ^{241}Pu(β^-)				

See next page for footnotes

Appendix II

Common Methods of Bulk Production

[a] J. H. Gibbons, R. L. Macklin, Phys. Rev. *114*, 571 (1959)
[b] G. J. F. Legge, I. F. Bubb, Nucl. Phys. *26*, 613 (1961)
[c] O. D. Brill, L. V. Sumin, At. Energ. USSR *7*, 377 (1959); Soviet J. At. Energy *7*, 856 (1959)
[d] T. Retz-Schmidt, J. L. Weil, Phys. Rev. *119*, 1079 (1960)
[e] A. B. Whitehead, J. S. Foster, Can. J. Phys. *36*, 1276 (1958)
[f] J. W. Meadows, R. B. Holt, Phys. Rev. *83*, 1257 (1951)
[g] Not determined
[h] S. Tanaka, M. Furakawa, J. Phys. Soc. Japan *14*, 1269 (1959)
[i] J. Wing, J. R. Huizenga, Phys. Rev. *128*, 280 (1962)
[j] C. H. Johnson, A. Galonsky, C. N. Inskeep, ORNL-2910 (1960)
[k] F. Houck, J. M. Miller, Phys. Rev. *123*, 231 (1961)
[l] S. Kaufman, Phys. Rev. *117*, 1532 (1960)
[m] T. Matsuo, J. M. Matuszek, Jr., N. D. Dudley, T. T. Sugihara, Phys. Rev. *139*, B886 (1965)
[n] J. P. Blaser, F. Boehm, P. Marmier, P. Scherrer, Helv. Phys. Acta *24*, 441 (1951)

Appendix III

A. Fluorescence Yields, L-Shell Vacancies per K-Shell Vacancy

Values of K-shell fluorescence yield (ω_K), L-shell fluorescence yield (ω_L), and number of L-shell vacancies created by a K-shell vacancy (n_{KL}).* Parentheses enclose extrapolated values.

Z	ω_K	ω_L	n_{KL}	Z	ω_K	ω_L	n_{KL}
1				51	0.862	0.120	0.93
2				52	0.868	0.125	0.93
3				53	0.874	0.131	0.92
4				54	0.880	0.137	0.91
5	0			55	0.885	0.143	0.91
6	(0.003)			56	0.890	0.150	0.90
7	(0.007)			57	0.895	0.155	0.89
8	(0.012)			58	0.899	0.161	0.89
9	(0.018)			59	0.903	0.167	0.88
10	(0.025)		(1.84)	60	0.906	0.174	0.88
11	(0.033)		(1.82)	61	0.911	0.180	0.88
12	(0.044)		(1.81)	62	0.915	0.186	0.87
13	(0.055)		(1.79)	63	0.918	0.192	0.87
14	(0.068)		(1.78)	64	0.922	0.198	0.86
15	(0.082)		(1.76)	65	0.925	0.204	0.86
16	0.098		(1.74)	66	0.928	0.210	0.86
17	0.115		(1.72)	67	0.931	0.216	0.85
18	0.135		(1.70)	68	0.935	0.222	0.85
19	0.154		(1.68)	69	0.937	0.227	0.84
20	0.175		1.66	70	0.940	0.233	0.84
21	0.195		1.64	71	0.942	0.250	0.84
22	0.217		1.62	72	0.945	0.268	0.83
23	0.240		1.59	73	0.947	0.284	0.83
24	0.265		1.56	74	0.950	0.300	0.83
25	0.290		1.54	75	0.952	0.314	0.82
26	0.316		1.51	76	0.953	0.327	0.82
27	0.343		1.48	77	0.955	0.340	0.82
28	0.374		1.45	78	0.956	0.353	0.81
29	0.405		1.42	79	0.958	0.365	0.81
30	0.438		1.39	80	0.959	0.375	0.81
31	0.472	0	1.35	81	0.960	0.386	0.80
32	0.508	(0.005)	1.31	82	0.960	0.396	0.80
33	0.548	(0.010)	1.27	83	0.961	0.405	0.80
34	0.590	(0.018)	1.23	84	0.962	0.412	0.80
35	0.625	(0.024)	1.19	85	0.962	0.420	0.79
36	0.655	(0.029)	1.16	86	0.962	0.427	0.79
37	0.680	(0.035)	1.13	87	0.962	0.433	0.79
38	0.702	(0.041)	1.11	88	0.963	0.438	0.79
39	0.722	(0.048)	1.09	89	0.963	0.442	0.78
40	0.740	0.053	1.07	90	0.963	0.446	0.78
41	0.755	0.060	1.05	91	0.963	0.448	0.78
42	0.770	0.065	1.04	92	0.963	0.450	0.78
43	0.785	0.071	1.02	93	0.963	0.450	0.78
44	0.798	0.077	1.01				
45	0.810	0.083	0.99				
46	0.820	0.090	0.98				
47	0.830	0.096	0.97				
48	0.840	0.101	0.96				
49	0.850	0.107	0.95				
50	0.856	0.113	0.94				

*Values of ω_K and ω_L were taken from Figs. 8 and 13, respectively, of 66F108

Values of n_{KL} were calculated as described under "*X*-Rays" in "Review of Radiation Processes"

Appendix III

B. Electron Capture. Calculation of ϵ_K/β^+, ϵ_L/ϵ_K, $\epsilon_{MN...}/\epsilon_L$, ϵ/β^+

In the electron-capture process, a nucleus with atomic number Z captures one of its bound electrons and transforms to the isobar of atomic number Z-1. The capture is accompanied by the emission of a monoenergetic neutrino.

In order for electron capture leading to a vacancy in, say, the K-shell to occur, the atomic mass difference between initial and final states, $E\epsilon$, must be greater than the binding energy of a K-shell electron in the daughter atom, E_K (63Ba21, 63Ba72). For a transition from the ground state of the parent to a given level in the daughter nucleus, $E_\epsilon = Q^+ - E(\text{level})$. The energy carried off by the neutrino is then given by

$$q_K = E_\epsilon - E_K.$$

If the energy requirement $E_\epsilon > E_K$ is satisfied, electron capture from the K-shell is more probable than that from any other shell because of the greater density at the nucleus of the K-shell electrons.

K-shell electron capture consists of all capture processes which result in the production of a K-shell vacancy in the daughter atom. The dominant process is capture of a K-shell electron with the resulting vacancy appearing in the K-shell of the final atom. However, as emphasized by Bahcall (63Ba21, 63Ba72), other processes can also contribute. If one considers only the three lowest s-shells (K, L_1, M_1), then as pointed out by Bahcall, a K-shell vacancy can be produced in three experimentally indistinguishable processes:

(a) Capture of a K-shell electron

(b) Capture of an L_1-shell electron with the initial K-shell electron making a transition to the final L_1-shell. The initial L_1-shell vacancy is thus observed as a vacancy in the K-shell of the daughter atom

(c) Capture of an M_1-shell electron with the initial K-shell electron making a transition to the final M_1-shell. The initial M_1-shell vacancy is thus observed as a vacancy in the K-shell of the daughter atom.

The dominant contribution comes from process (a). We denote this contribution by ϵ_K^0. The total K-shell capture rate can then be expressed in terms of ϵ_K^0 as

$$\epsilon_K = \epsilon_K^0 B_K \tag{1}$$

where B_K is the "exchange" correction factor for the K-shell introduced by Bahcall to take account of processes (b) and (c). The values of B_K (and also of B_{L_i} and B_{M_1} to be introduced below) as obtained by use of the ORNL atomic wavefunction program described below are given in Table 1. For $Z > 20$, the values of B_K differ from those of Bahcall (63Ba72) by less than 2%, the values of B_{L_i} by less than 3%, and the values of B_{M_1} by less than 20%. As calculated by both groups, B_K includes not only the "exchange" effects of processes (b) and (c) but also the effect of imperfect atomic overlap arising in all three processes as a result of the different nuclear charge seen by the initial and final atomic states.

An expression for ϵ_K^0 which is valid for allowed transitions ($\Delta J = 0$, 1, no parity change) can be written (60Bo38)

$$\epsilon_K^0 = \frac{g^2|M_{0,1}|^2}{4\pi^2} q_K^2 g_K^2. \tag{2}$$

For unique forbidden transitions [$\Delta J \geq 2$, $\Delta\pi = (-1)^{\Delta J-1}$], ϵ_K^0 can be written (60Bo38)

$$\epsilon_K^0 = \frac{g^2|M_{\Delta J}|^2}{4\pi^2} \frac{(q_K r_0)^{2(\Delta J-1)}}{[(2\Delta J-1)\,!!]^2} q_K^2 g_K^2. \tag{3}$$

In these expressions g^2 is a constant (with dimension of time^{-1}); the M's are specific combinations of nuclear matrix elements which are in general unknown; g_K is the large component of the bound-state radial wavefunction of the captured K-shell electron (evaluated at the nuclear surface, r_0); q_K is the neutrino energy (defined above) in units of mc^2 (0.511 MeV); and r_0 is the nuclear radius in units of $\hbar/mc$ (3.8612×10^{-11} cm). The common notations for the large and small components of the electron radial wavefunctions are f and g, respectively. For the L_2-, M_2-, . . . shells, f is the large component. For all other shells of interest here, g is the large component.

K-Shell Capture-to-Positron Ratio (ϵ_K/β^+)

For an allowed or unique forbidden transition, the combination of nuclear matrix elements appearing in Eqs. (2) and (3) is the same as that appearing in the expression for the rate of positron emission Eqs. (10) and (11). The ratio ϵ_K/β^+ is thus independent of these matrix elements. We obtain

$$\epsilon_K/\beta^+ = \frac{\pi}{2}\frac{q_K^2 g_K^2 B_K}{f} \quad \text{allowed} \tag{4}$$

$$= \frac{\pi}{2}\frac{q_K^{2\Delta J} g_K^2 B_K}{f_{\Delta J-1}} \quad \text{unique forbidden.} \tag{5}$$

In these expressions f and $f_{\Delta J-1}$ are the statistical rate functions for allowed and unique forbidden β^+-decay, respectively. See Part C of this Appendix for a definition of these quantities and a description of the method by which they were calculated.

In the case of nonunique forbidden transitions, ϵ_K/β^+ is not independent of the unknown nuclear matrix elements. Not enough experimental data are available to ascertain whether or not any deviation from the "allowed" values should be expected. The only available results are on transitions of the type $2^- \rightarrow 2^+$ where deviations of +20% to +50% from the "allowed" values have been observed (62Va10). For transitions of this type ($2^- \rightarrow 2^+$), Konijn et al. (60Ko6) have calculated correction factors for ϵ_K/β^+-ratios (relative to the "allowed" values) which lead to good agreement with the experimental data (62Va10). Values of ϵ_K/β^+ for the $2^- \rightarrow 2^+$ transitions appearing in this compilation include the correction factors from Fig. 2a of (60Ko6).

L-Shell to K-Shell Electron-Capture Ratio (ϵ_L/ϵ_K)

L-shell electron capture consists of all those capture processes which result in the production of an L-shell vacancy in the daughter atom. The dominant process is capture of an L-shell electron with the resulting vacancy appearing in the L-shell of the final atom. However, just as in K-shell capture, exchange effects contribute to the total L-shell capture rate. In analogy with Eq. (1), we define

$$\epsilon_{L_i} = \epsilon^0_{L_i} B_{L_i} \quad (i = 1, 2, 3),$$

where L_i denotes a particular L-subshell.

For allowed transitions, expressions for $\epsilon^0_{L_1}$ and $\epsilon^0_{L_2}$ can be obtained from Eq. (2) by the replacement of q_K, g_K by q_{L_1}, g_{L_1} and q_{L_2}, f_{L_2}, respectively. Compared with L_1- and L_2-shell capture, L_3-capture is always negligible in allowed transitions. The L/K-capture ratio can then be written

$$\frac{\epsilon_L}{\epsilon_K} = \frac{\epsilon_{L_1}}{\epsilon_K}\left[1 + \frac{\epsilon_{L_2}}{\epsilon_{L_1}}\right] \quad \text{allowed} \tag{6a}$$

$$= \frac{g^2_{L_1} q^2_{L_1} B_{L_1}}{g^2_K q^2_K B_K}\left[1 + \frac{f^2_{L_2} B_{L_2}}{g^2_{L_1} B_{L_1}}\right]. \tag{6b}$$

For unique forbidden transitions, expressions for $\epsilon^0_{L_1}$ and $\epsilon^0_{L_2}$ can be obtained from Eq. (3) by making the changes described above for the allowed case. In addition, the contribution from L_3-capture must now be included (60Bo38). The expression for L- to K-shell capture then becomes

$$\frac{\epsilon_L}{\epsilon_K} = \frac{\epsilon_{L_1}}{\epsilon_K}\left[1 + \frac{\epsilon_{L_2} + \epsilon_{L_3}}{\epsilon_{L_1}}\right] \quad \text{unique forbidden} \tag{7a}$$

$$= \frac{g^2_{L_1} q^{2\Delta J}_{L_1} B_{L_1}}{g^2_K q^{2\Delta J}_K B_K}\left[1 + \frac{f^2_{L_2} B_{L_2}}{g^2_{L_1} B_{L_1}} + \frac{3(\Delta J - 1)(2\Delta J - 1)}{(q_{L_1} r_0)^2}\,\frac{g^2_{L_3} B_{L_3}}{g^2_{L_1} B_{L_1}}\right]. \tag{7b}$$

In Eqs. (6b) and (7b), the differences in binding energy among the L-subshells have been neglected. These differences are usually negligible with respect to the transition energy. In cases where the binding energy difference cannot be neglected, the expressions for ϵ_L/ϵ_K should be modified by multiplying the second term in square brackets of (6b) by $q^2_{L_2}/q^2_{L_1}$, the second term in square brackets of (7b) by $(q_{L_2})^{2\Delta J}/(q_{L_1})^{2\Delta J}$, and by replacing $1/q^2_{L_1}$ in the third term of (7b) by $(q_{L_3})^{2\Delta J-2}/(q_{L_1})^{2\Delta J}$.

Electron Capture from the M-, N- . . . Shells ($\epsilon_{MN...}/\epsilon_L$)

Electron capture from the M-, N-, and higher shells is defined in a manner analogous to that for the K- and L-shells. For allowed transitions only the s-shells and $p_{1/2}$-subshells give non-negligible contributions to the total capture rate. The largest contribution comes from M_1-shell capture. Relative to L_1-shell capture, it is convenient to express the higher shell capture rate in the form

$$\frac{\epsilon_{MN...}}{\epsilon_{L_1}} = \frac{\epsilon_{M_1}}{\epsilon_{L_1}}\left[1 + \frac{\epsilon_{M_2} + \epsilon_{N_1} + \epsilon_{N_2} + \cdots}{\epsilon_{M_1}}\right] \tag{8a}$$

$$= \frac{g^2_{M_1} q^2_{M_1}}{g^2_{L_1} q^2_{L_1}}\left[1 + \frac{f^2_{M_2} + g^2_{N_1} + f^2_{N_2} + \cdots}{g^2_{M_1}}\right]. \tag{8b}$$

Relative to total L-shell capture, the higher shell capture rate is thus given by

$$\frac{\epsilon_{MN...}}{\epsilon_L} = \left(\frac{\epsilon_{MN...}}{\epsilon_{L_1}}\right)\left(\frac{\epsilon_{L_1}}{\epsilon_L}\right)$$

where $(\epsilon_{L_1}/\epsilon_L)^{-1}$ is given by the term in square brackets in Eq. (6) or Eq. (7).

In analogy with the L-to-K capture ratio, the M_1-to-L_1 capture ratio can be written

$$\frac{\epsilon_{M_1}}{\epsilon_{L_1}} = \frac{\epsilon^0_{M_1} B_{M_1}}{\epsilon^0_{L_1} B_{L_1}},$$

where B_{M_1} and B_{L_1} are the "exchange" corrections appropriate to the M_1- and L_1-shells. These "exchange" corrections, as well as values for $\epsilon^0_{M_1}/\epsilon^0_{L_1}$ have been calculated by Bahcall (63Ba74). A comparison (69Fi05) of the available experimental data on M_1/L_1-capture ratios with the theoretical values of Bahcall shows that better agreement is obtained if exchange corrections are neglected, i.e., if B_{M_1} is set equal to B_{L_1}. The use of $\epsilon^0_{M_1}/\epsilon^0_{L_1}$ and B_{M_1}/B_{L_1} values given by the ORNL code does not change the conclusion of (69Fi05).

In Eq. (8b) all exchange corrections for the M-, N-, . . . subshells have been set equal to that for the L_1-subshell. Also, the differences in binding energy between the M-, N-, . . . subshells have been neglected.

For most transitions, the differences between M_1- and L_1-shells can also be neglected. In Table 3 are given values of $\epsilon_{MN...}/\epsilon_{L_1}$ calculated from Eq. (8) with q_{M_1} set equal to q_{L_1}.

In the case of unique forbidden transitions, contributions from subshells other than those included in Eq. (8) become important for small transition energies. In particular, for first-forbidden unique transitions a term (65Hu15)

$$9g_{M_3}^2/(q_{L_1}^2 r_0^2 g_{L_1}^2)$$

should be added within the square brackets to Eq. (8b). This term becomes important for $q_{L_1} \leq 100$ keV. In this compilation, except for the case of ^{40}K-decay for which $9g_{M_3}^2/(g_{L_1}^2 r_0^2) = 0.00109$, the contributions to $\epsilon_{MN...}/\epsilon_{L_1}$ of "unique" terms can be neglected. For a general discussion of these contributions see (65Hu15).

Total Capture-to-Positron Ratio (ϵ/β^+)

The expressions for the capture ratios given in Eqs. (6), (7), and (8) can be combined to give the following relation for the ratio of total electron capture to that in the K-shell,

$$\frac{\epsilon}{\epsilon_K} = 1 + \frac{\epsilon_{L_1}}{\epsilon_K}\left[1 + \frac{\epsilon_{L_2} + \epsilon_{L_3} + \epsilon_{MN...}}{\epsilon_{L_1}}\right].$$

The total capture-to-positron ratio can then be found from

$$\frac{\epsilon}{\beta^+} = \left(\frac{\epsilon_K}{\beta^+}\right)\left(\frac{\epsilon}{\epsilon_K}\right),$$

where ϵ_K/β^+ is given by Eq. (4) or Eq. (5).

Bound-State Electron Radial Wavefunctions ($g_K, g_{L_1} \ldots$)

Table 2 contains the electron radial densities (g_K^2, $g_{L_1}^2/g_{K_1}^2$ . . .) at the nuclear surface (r_0) needed in the calculation of capture ratios and capture-to-positron ratios. These densities have been obtained by use of the relativistic self-consistent-field computer code developed at the Oak Ridge National Laboratory (66Ne10, 68Tu03, 69Tu02). The wavefunctions calculated by this code are solutions of the Dirac equation with a Hartree self-consistent potential. Electron exchange is included in the Slater approximation (51S97). The nuclear potential used is that appropriate to a finite nucleus with charge distribution

$$\rho(r) = \rho_0 \left(1 + \exp\frac{r - r_0}{a}\right)^{-1}.$$

In this expression, r_0 is the "half-density" radius defined as the radius at which the nuclear density has fallen to one-half its maximum value, and $a = s/4(\ln 3)$, where s is the surface thickness defined as the distance over which the density falls from 90% to 10% of its maximum value. The parameters r_0 and s, as taken from Elton (61E13), are given by

$$\begin{aligned} r_0 &= (0.002908\ A^{1/3} - 0.002437\ A^{-1/3})\,\hbar/mc \\ &= (1.123\ A^{1/3} - 0.941\ A^{-1/3}) \times 10^{-13}\ \text{cm} \end{aligned}$$

and

$$\begin{aligned} s &= 0.0065\ \hbar/mc = 2.5 \times 10^{-13}\ \text{cm} \quad \text{for } A \geq 16 \\ &= 0.0049\ h/mc = 1.9 \times 10^{-13}\ \text{cm} \quad \text{for } A < 16. \end{aligned}$$

Several other calculations of electron radial wavefunctions have become available recently. Suslov (68Su08) has obtained K- and L-shell densities based on calculations with the nonrelativistic self-consistent-field potential of Herman and Skillman (63He12) (for $Z < 72$) and a similar relativistic potential of Liberman et al. (65Li14) ($72 \leq Z \leq 98$). Electron exchange is included in the Slater approximation (51S97). Suslov incorporates finite nuclear-size effects by treating the nucleus as a uniformly charged sphere with a sharp surface.

Behrens and Janecke (69Be42) have calculated K-, L-, and M-shell densities by solving the Dirac equation for the bound electrons with Hartree-Fock potentials ($Z \leq 36$) and Thomas-Fermi-Dirac potentials ($Z > 36$). Electron exchange and finite nuclear-size effects are included in the same manner as by Suslov.

The ratio of L_1-shell to K-shell densities has been calculated by Winter (68Wi07) on the basis of analytical Hartree-Fock wavefunctions obtained as solutions of the nonrelativistic Schrodinger equation for a point nucleus. The relativistic correction was obtained from a comparison of the relativistic and nonrelativistic hydrogen-like wavefunctions. Finite nuclear size affects the L_1- and K-wavefunctions in a similar manner, so that the use of the point-nucleus approximation is not expected to affect the L_1/K-density ratio.

Prior to 1968, the most widely used tabulations of electron densities were those of Band et al. (56B168, 58B11) and of Brysk and Rose (55B43, 58B13).

The calculations of Band et al. were based on point-nucleus wavefunctions for the Thomas-Fermi-Dirac statistical atomic model with screening constants taken from Metropolis, Reitz, and Thomas (51M79, 54T40). The calculations of Brysk and Rose were based on relativistic point-nucleus Coulomb radial wavefunctions corrected for screening on the basis of the statistical atomic model. In both these calculations, corrections were made for the effects of finite nuclear size.

Table 1. Exchange Corrections

Values of exchange corrections for the K-, L_1-, L_2-, L_3-, and M_1-shells.* Parentheses enclose extrapolated values.

Z	B_K	B_{L_1}	B_{L_2}, B_{L_3}	B_{M_1}
1				
2				
3				
4				
5				
6	0.938			
7	0.948	1.475		
8	0.958	1.405		
9	0.964	1.360		
10	0.969	1.309		
11	0.973	1.283		
12	0.974	1.248		
13	0.975	1.212		1.628
14	0.976	1.186	0.921	1.510
15	0.977	1.169	0.929	1.434
16	0.978	1.154	0.935	1.388
17	0.979	1.143	0.940	1.358
18	0.980	1.132	0.944	1.328
19	0.981	1.120	0.946	1.285
20	0.982	1.113	0.948	1.255
21	0.982	1.101	0.947	1.253
22	0.982	1.096	0.950	1.248
23	0.983	1.091	0.953	1.240
24	0.984	1.088	0.956	1.234
25	0.985	1.085	0.958	1.226
26	0.985	1.080	0.960	1.220
27	0.986	1.078	0.962	1.213
28	0.986	1.076	0.964	1.206
29	0.986	1.072	0.965	1.198
30	0.987	1.070	0.967	1.190
31	0.987	1.069	0.968	1.182
32	0.988	1.067	0.969	1.175
33	0.988	1.064	0.970	1.168
34	0.988	1.062	0.971	1.155
35	0.989	1.060	0.971	1.150
36	0.989	1.059	0.972	1.144
37	0.989	1.057	0.973	1.136
38	0.990	1.053	0.973	1.130
39		1.051	0.974	1.125
40		1.050	0.974	1.121
41		1.048	0.975	1.118
42		1.046	0.975	1.116
43		1.045	0.976	1.113
44		1.043	0.976	1.110
45	0.991	1.042	0.976	1.107
46		1.041	0.977	1.104
47		1.040	0.977	1.101
48		1.039	0.977	1.099
49		1.038	0.978	1.096
50		1.037	0.978	1.093
51	0.991	1.036	0.978	1.091
52		1.035	0.979	1.088
53		1.034		1.086
54		1.033		1.084
55	0.992	1.032		1.081
56		1.032	0.980	1.079
57		1.031		1.077
58		1.030		1.075
59		1.030		1.072
60		1.029		1.070
61		1.028		1.068
62		1.028		1.066
63		1.028		1.065
64		1.027		1.065
65		1.027	0.981	1.064
66		1.027		1.064
67		1.026		1.063
68		1.026		1.063
69		1.026		1.062
70		1.025		1.062
71		1.025		1.061
72		1.024		1.061
73		1.024		1.060
74		1.024	0.982	1.060
75	0.992	1.024		1.059
76		1.024		1.058
77		1.023		1.058
78		1.023		1.057
79		1.022		1.057
80				1.056
81				1.055
82				1.055
83				1.055
84				1.054
85		1.021		1.054
86				1.053
87				1.053
88				1.052
89				1.052
90				1.051

*Values for these correction factors were calculated by N. B. Gove and one of the authors (M.J.M.) using the ORNL atomic wavefunction code described in the text

Table 2. Electron Radial Densities

Values at the nuclear surface (r_0) of the electron radial density g_K^2 and density ratios $g_{L_1}^2/g_K^2$, $f_{L_2}^2/g_{L_1}^2$, $9g_{L_3}^2/r_0^2g_{L_1}^2$, and $\epsilon_{MN\cdots}/\epsilon_{L_1} = (g_{M_1}^2 + f_{M_2}^2 + g_{N_1}^2 + f_{N_2}^2 + \ldots)/g_{L_1}^2$ *

Z	g_K^2	$g_{L_1}^2/g_K^2$	$f_{L_2}^2/g_{L_1}^2$	$9g_{L_3}^2/r_0^2g_{L_1}^2$	$\epsilon_{MN\cdots}/\epsilon_{L_1}$
5	0.000177	0.0405	0.00008		
6	0.000311	0.0493	0.00018		
7	0.000501	0.0541	0.00024	0.00024	
8	0.000757	0.0564	0.00032	0.00063	
9	0.001091	0.0577	0.00041	0.00122	
10	0.00151	0.0584	0.00053	0.00207	
11	0.00204	0.0627	0.00069	0.00268	0.018
12	0.00268	0.0666	0.00088	0.00339	0.037
13	0.00344	0.0699	0.00108	0.00417	0.048
14	0.00435	0.0729	0.00131	0.00498	0.063
15	0.00541	0.0756	0.00155	0.00586	0.079
16	0.00664	0.0781	0.00181	0.00682	0.093
17	0.00807	0.0804	0.00209	0.00784	0.103
18	0.00970	0.0824	0.00240	0.00891	0.110
19	0.01156	0.0844	0.00272	0.0100	0.128
20	0.01367	0.0862	0.00306	0.0112	0.144
21	0.0160	0.0879	0.00343	0.0125	0.148
22	0.0187	0.0896	0.00382	0.0138	0.150
23	0.0217	0.0910	0.00424	0.0151	0.152
24	0.0250	0.0924	0.00467	0.0165	0.147
25	0.0287	0.0938	0.00512	0.0180	0.154
26	0.0328	0.0950	0.00560	0.0194	0.155
27	0.0373	0.0962	0.00610	0.0210	0.156
28	0.0423	0.0974	0.00663	0.0225	0.156
29	0.0477	0.0985	0.00717	0.0241	0.152
30	0.0538	0.0995	0.00774	0.0258	0.158
31	0.0604	0.1006	0.00834	0.0274	0.162
32	0.0676	0.1015	0.00895	0.0291	0.166
33	0.0755	0.1026	0.00958	0.0308	0.172
34	0.0841	0.1035	0.0102	0.0325	0.177
35	0.0935	0.1043	0.0109	0.0343	0.182
36	0.1037	0.1053	0.0116	0.0361	0.187
37	0.1149	0.1063	0.0124	0.0379	0.193
38	0.1269	0.1071	0.0131	0.0396	0.199
39	0.1402	0.1080	0.0139	0.0414	0.206
40	0.154	0.1089	0.0147	0.0432	0.210
41	0.170	0.1098	0.0156	0.0450	0.213
42	0.186	0.1107	0.0164	0.0469	0.216
43	0.205	0.1115	0.0173	0.0487	0.219
44	0.224	0.1124	0.0183	0.0505	0.222
45	0.245	0.1133	0.0192	0.0523	0.225
46	0.268	0.1142	0.0202	0.0540	0.228
47	0.293	0.1150	0.0212	0.0588	0.233
48	0.319	0.1159	0.0222	0.0576	0.238
49	0.348	0.1168	0.0233	0.0593	0.241
50	0.379	0.1178	0.0244	0.0610	0.246
51	0.413	0.1187	0.0255	0.0627	0.249
52	0.449	0.1196	0.0267	0.0644	0.253
53	0.488	0.1205	0.0278	0.0661	0.257
54	0.529	0.1215	0.0291	0.0679	0.261
55	0.574	0.1224	0.0303	0.0693	0.266
56	0.623	0.1234	0.0316	0.0708	0.271
57	0.675	0.1244	0.0329	0.0722	0.274
58	0.732	0.1254	0.0343	0.0739	0.277
59	0.793	0.1264	0.0357	0.0752	0.279
60	0.857	0.1275	0.0371	0.0767	0.281
61	0.927	0.1285	0.0386	0.0780	0.284
62	1.002	0.1296	0.0401	0.0794	0.286
63	1.084	0.1306	0.0417	0.0807	0.288
64	1.171	0.1317	0.0433	0.0819	0.290
65	1.266	0.1328	0.0449	0.0831	0.292
66	1.367	0.1340	0.0466	0.0842	0.294
67	1.474	0.1351	0.0483	0.0853	0.296
68	1.59	0.1362	0.0501	0.0864	0.298
69	1.72	0.1374	0.0519	0.0871	0.300
70	1.85	0.1386	0.0538	0.0883	0.303
71	2.00	0.1398	0.0557	0.0892	0.305
72	2.15	0.1410	0.0577	0.0900	0.308
73	2.32	0.1423	0.0597	0.0908	0.310
74	2.50	0.1436	0.0618	0.0916	0.313
75	2.69	0.1448	0.0639	0.0922	0.315
76	2.90	0.1462	0.0661	0.0929	0.318
77	3.13	0.1475	0.0684	0.0934	0.320
78	3.37	0.1489	0.0707	0.0939	0.323
79	3.62	0.1502	0.0730	0.0943	0.326
80	3.90	0.1517	0.0755	0.0948	0.329
81	4.21	0.1531	0.0780	0.0954	0.331
82	4.53	0.1546	0.0806	0.0954	0.334
83	4.88	0.1561	0.0833	0.0956	0.337
84	5.25	0.1576	0.0860	0.0958	0.341
85	5.66	0.1591	0.0888	0.0959	0.344
86	6.09	0.1607	0.0917	0.0960	0.347
87	6.55	0.1623	0.0947	0.0959	0.350
88	7.06	0.1639	0.0978	0.0955	0.353
89	7.61	0.1656	0.1010	0.0954	0.356
90	8.19	0.1673	0.1042	0.0954	0.359
91	8.83	0.1690	0.1076	0.0953	0.361
92	9.51	0.1708	0.1111	0.0952	0.364
93	10.25	0.1726	0.1147	0.0946	0.367
94	11.05	0.1744	0.1184	0.0941	0.370
95	11.92	0.1763	0.1222	0.0936	0.374
96	12.86	0.1782	0.1262	0.0931	0.377
97	13.88	0.1802	0.1303	0.0924	0.380
98	14.98	0.1829	0.1345	0.0917	0.384

*Values for these densities and density ratios were calculated by N. B. Gove and one of the authors (M.J.M.) using the ORNL atomic wavefunction code described in the text

C. Spectral Shape in β-Decay

Knowledge of the function N(E), giving the probability per unit time of the emission of β-particles with energy E, is needed in three applications in the present compilation. First, the average energy of a β-group with maximum energy E_{max} is given by

$$E_{av} = \int_0^{E_{max}} E \times N(E)dE \Big/ \int_0^{E_{max}} N(E)dE.$$

Second, the total β-decay rate needed for the evaluation of capture-to-positron ratios is given by

$$\lambda = \int_0^{E_{max}} N(E)dE.$$

Third, the calculation of the 90% absorbed-dose range for a given β-group requires knowing N(E) for that group. The following discussion describes the procedure used by the compilers to obtain the quantity N(E) and its energy-integrated spectra.

β-spectra are usually discussed in terms of "shape factors," S(Z, W). These factors are defined in such a way that the β-decay rate can be written

$$\begin{aligned}\lambda &= \int_1^{W_0} N(W)dW \\ &= \frac{g^2}{2\pi^3}\int_1^{W_0} W(W^2-1)^{1/2}(W_0-W)^2 \\ &\qquad \times F(Z, W)\, S_n(Z, W)dW,\end{aligned} \tag{9}$$

where g^2 is a constant (with dimensions of time^{-1}); W is the total β-energy in units of mc^2 (0.511 MeV); W_0 is the maximum β-energy; N(W) is the number of β-particles emitted per unit time with energy W; F(Z, W) is the Fermi function (66Sc35, p. 41); and $S_n(Z, W)$ is the shape factor for an n^{th}-forbidden transition. The Fermi function takes into account the distortion of the electron wavefunction by the nuclear charge. The shape factors are combinations of nuclear matrix elements which are in general unknown.

For allowed transitions ($\Delta J = 0$, 1, no parity change), the shape factor is independent of energy. Eq. (9) can then be written

$$\begin{aligned}\lambda &= \frac{g^2 S_0}{2\pi^3}\int_1^{W_0} W(W^2-1)^{1/2}(W_0-W)^2 F(Z, W)dW \\ &= \frac{g^2 S_0}{2\pi^3} f(Z, W_0),\end{aligned} \tag{10}$$

where $f(Z, W_0)$ is the statistical rate function for allowed β-decay. The shape factor S_0 is identical to the matrix element $|M_{0,1}|^2$ appearing in the expression for allowed electron-capture decay [Eq. (2)].

Unique n^{th}-forbidden transitions [$\Delta J \geq 2$, $\Delta\pi = (-1)^{\Delta J - 1}$, $n = \Delta J - 1$] depend on a single nuclear matrix element so that it is possible to factor out this unknown matrix element from the shape factor. Equation (9) can then be written (66Sc35, p. 278)

$$\lambda = \frac{g^2|M_{\Delta J}|^2}{2\pi^3}\int_1^{W_0} W(W^2-1)^{1/2}(W_0-W)^2 \times F(Z, W)\, C_{\Delta J-1}(Z, W)dW \tag{11a}$$

$$= \frac{g^2|M_{\Delta J}|^2}{2\pi^3} f_{\Delta J-1}(Z, W_0) \times \frac{(r_0)^{2(\Delta J-1)}}{[(2\Delta J-1)!!]^2}, \tag{11b}$$

where $f_{\Delta J-1}(Z, W_0)$ is the statistical rate function for n^{th}-forbidden unique β-decay and $C_{\Delta J-1}(Z, W) = S_n(Z, W)/|M_{\Delta J}|^2$ is the known (51D33) energy-dependent part of the shape factor. The matrix element $|M_{\Delta J}|^2$ is the same as that appearing in the expression for unique forbidden electron-capture decay [Eq. (3)].

In the case of nonunique forbidden transitions, several unknown matrix elements contribute to the shape factor so that Eq. (9) cannot be evaluated. However, for nonunique first-forbidden transitions, experimental measurements of spectral shapes indicate that nearly all such transitions have the same shape as that for allowed transitions (66Wu03). For the calculation of average energies and R_{90}-values, nonunique first-forbidden transitions are assumed to have the "allowed" shape.

If the degree of forbiddenness of a particular β-group is not known (i.e., spin or parity of initial or final state not known), the transition is assumed to be allowed for the purpose of calculating the average energy and the R_{90}-value.

The Fermi function, F(Z, W); the shape factors, $C_{\Delta J-1}$ (Z, W); and the statistical rate functions, f and $f_{\Delta J-1}$, have been obtained from a computer program developed by N. B. Gove of the Oak Ridge National Laboratory. The Fermi function calculated by this program is corrected for electron screening, finite de Broglie wavelength, and finite nuclear size. The screening correction is obtained from Matese and Johnson (66Ma57) and is incorporated by use of a method described by Rose, Perry, and Dismuke (53R37). The finite de Broglie wavelength correction was taken from Morita (59M127). The finite nuclear-size correction was taken from Rose and Holmes (51R33) and Rose, Holmes, and Dismuke (57R21).

Appendix IV

90% Absorbed-Dose Ranges in Water

For an isotropic, monoenergetic point source of radiation in an unbounded, homogeneous medium, the absorbed-dose rate at a distance r from the source, D(r), can be written (68Lo14)

$$D(r) = A\Delta f(r) \quad \text{rad/sec.}$$

In this expression A is the source activity; Δ is the equilibrium absorbed-dose constant (see SYMBOLS AND DEFINITIONS); and f(r) is the point-isotropic specific absorbed fraction, i.e., the fraction of the emitted energy absorbed per gram at a distance r from an isotropic point source.

The fraction of the energy emitted by this source that is deposited in a sphere of radius R around the source, $\varphi(R)$, is then given by (68Be62)

$$\varphi(R) = \int_0^R 4\pi r^2 D(r)dr \Big/ \int_0^\infty 4\pi r^2 D(r)dr$$
$$= \int_0^R r^2 f(r)dr \Big/ \int_0^\infty r^2 f(r)dr.$$

By evaluating $\varphi(R)$ for a large number of radii, one can obtain by inverse interpolation the value of R for which $\varphi(R)$ has a specific value. In particular, the 90% absorbed-dose range, R_{90}, is the value of R for which $\varphi(R)$ is 90%.

The 90% absorbed-dose ranges in water for monoenergetic photon and electron sources are given in Figs. 1 and 2, respectively. The R_{90}-values for the β-groups are given in the TABLE OF RADIATION DATA. The β-group values depend on the shapes as well as on the maximum energy and intensity of the β-spectra and must be calculated separately for each individual case. The photon R_{90}-data were taken from Table 8 of Berger (68Be62). The electron and β-group R_{90}-values were calculated by Berger (69Be44). A full discussion of the method by which the electron and β-group R_{90}-data were obtained will appear in an MIRD pamphlet (69Be43).

The maximum energies and intensities of the β-groups needed as input data for calculation of the β-range values are described in Part C of Appendix III.

In the case of alpha particles, R_{90}-values are not available. We give instead the mean range. Values of mean range in water as a function of alpha-particle energy, given in Fig. 3, were provided by L. C. Northcliffe (70NoSc).

Since alpha particles travel through matter in an approximately straight path, dissipating their energies gradually, the mean range of an alpha particle will not be greatly different from its R_{90}-range. Moreover, for the alpha-particle energies encountered in this compilation, the ranges in water are so short ($\approx$ 0.004 cm) that this difference should be of negligible importance.

Thanks are due Drs. Berger and Northcliffe for making their data available prior to publication. Their important contributions to the dose information contained in the present compilation is greatly appreciated.

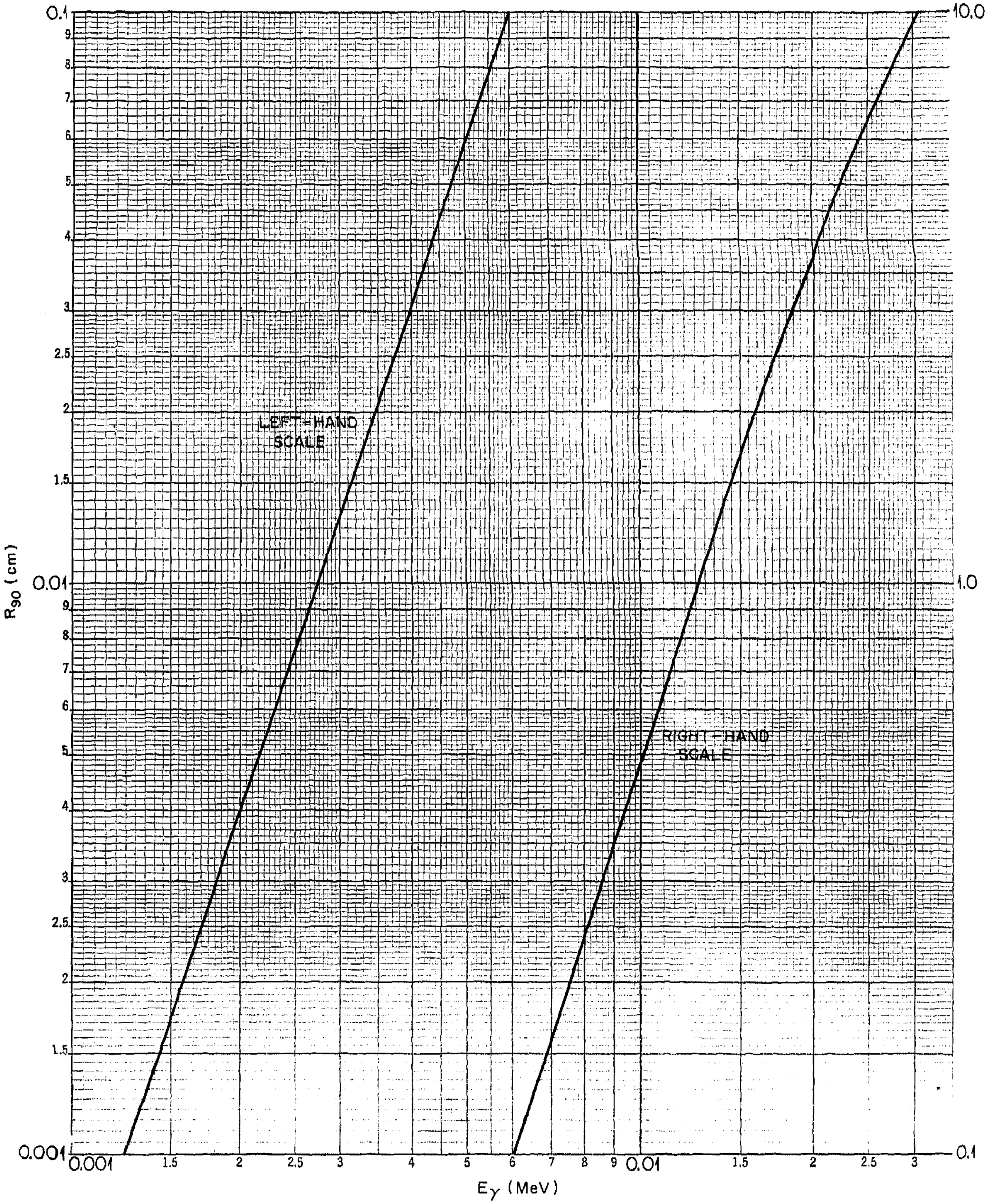


Fig. 1a. 90% absorbed-dose range in water for photons as a function of photon energy

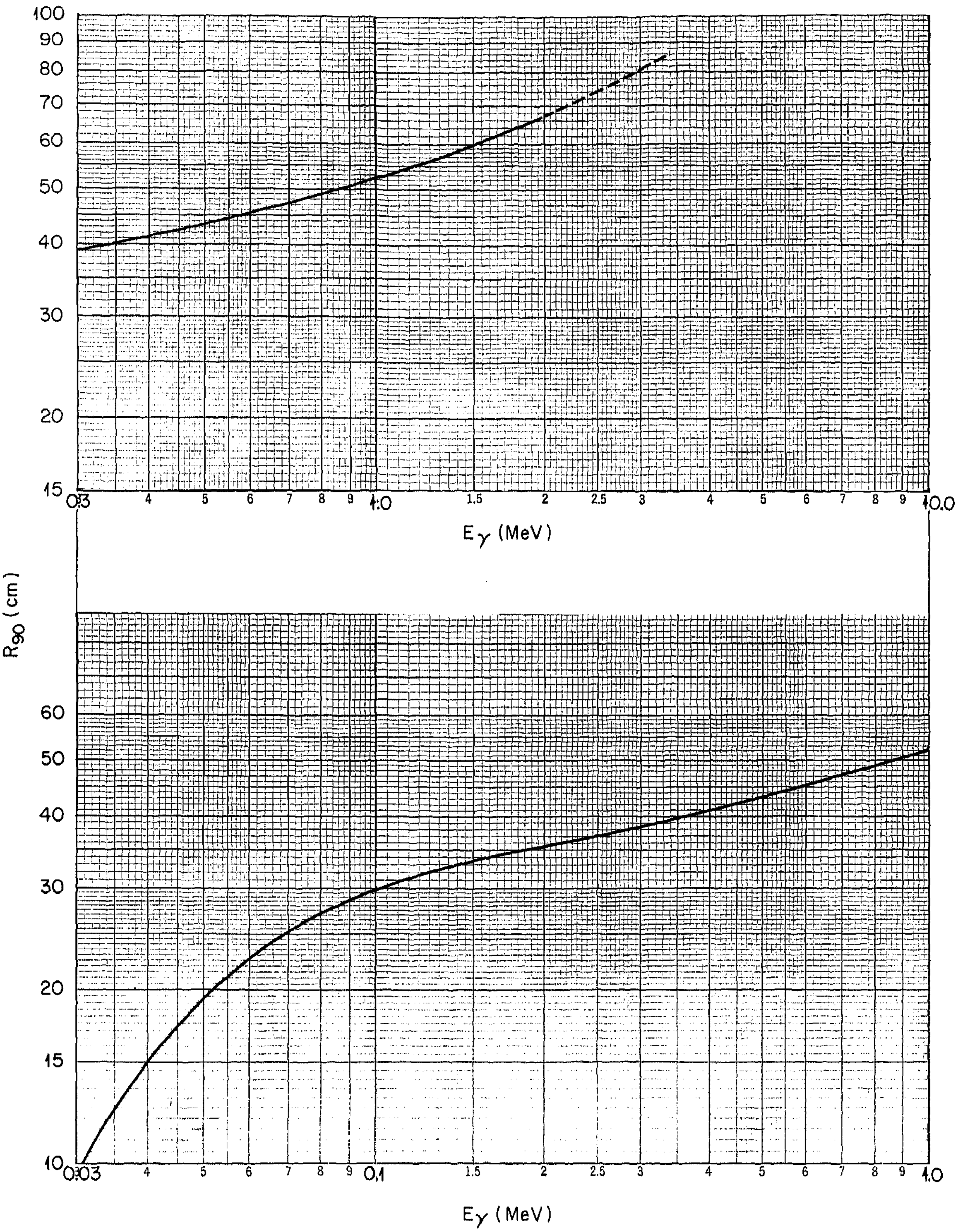


Fig. 1b. 90% absorbed-dose range in water
for photons as a function of photon energy

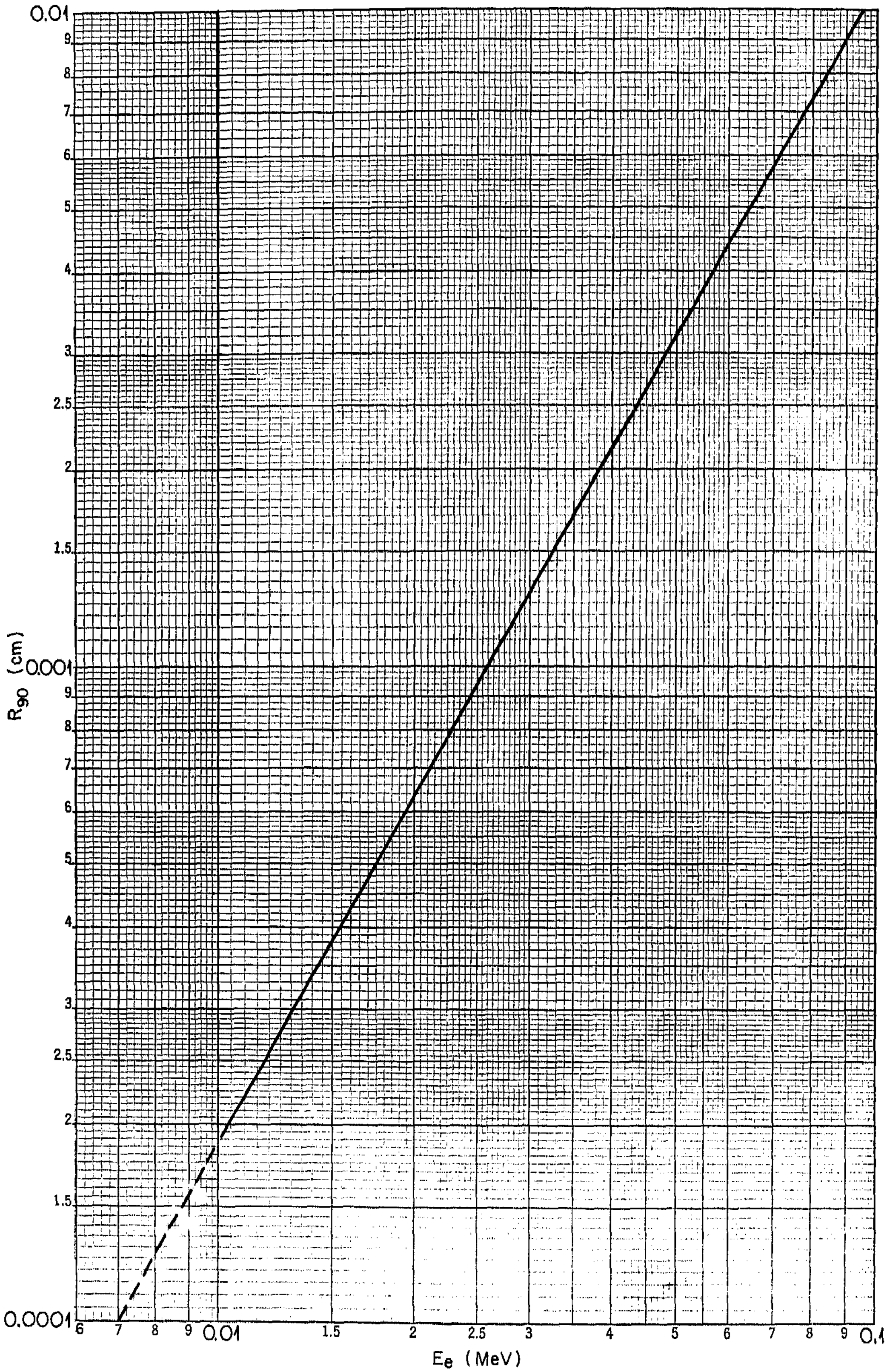


Fig. 2a. 90% absorbed-dose range in water
for electrons as a function of electron energy

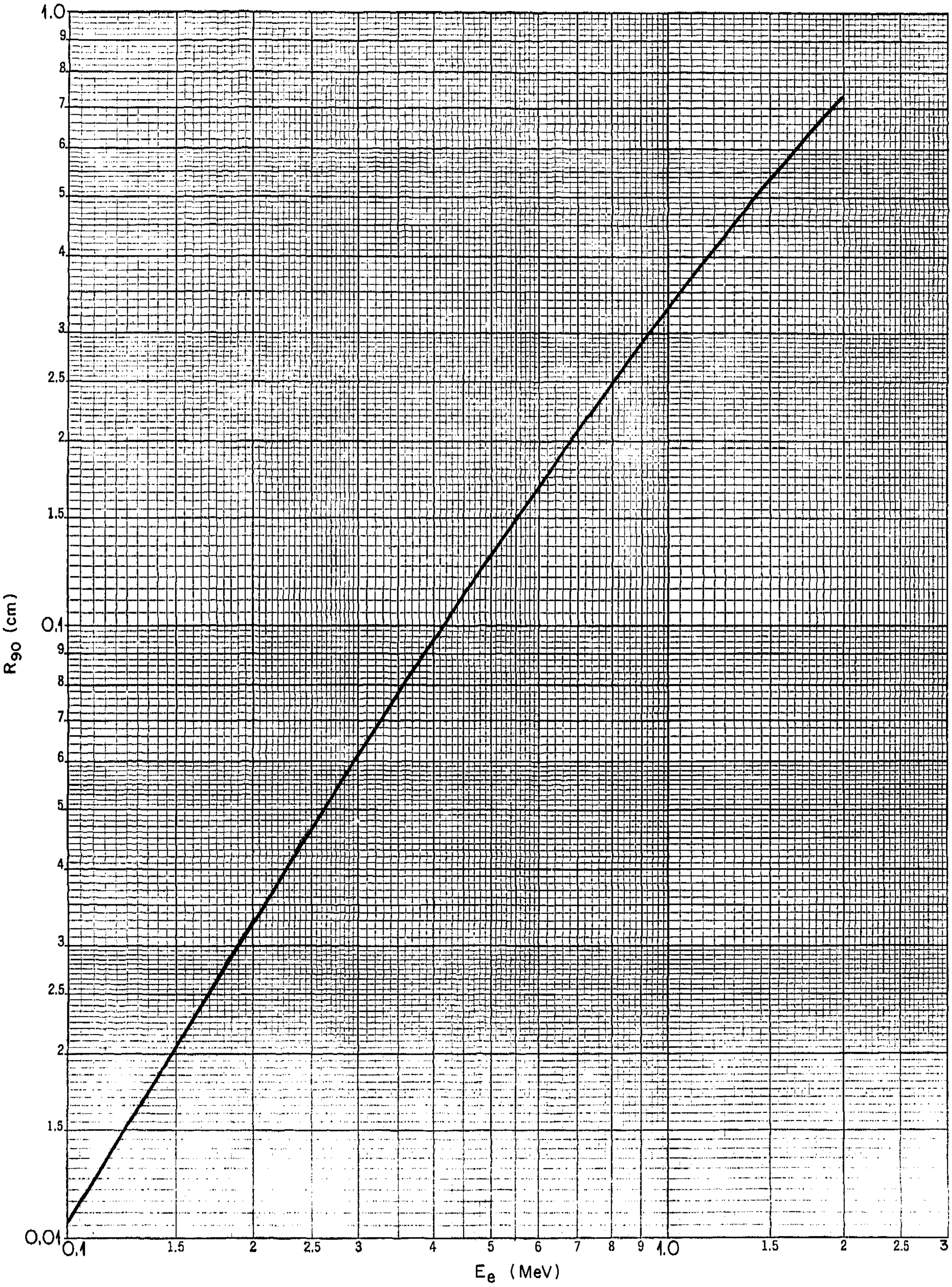


Fig. 2b. 90% absorbed-dose range in water for electrons as a function of electron energy

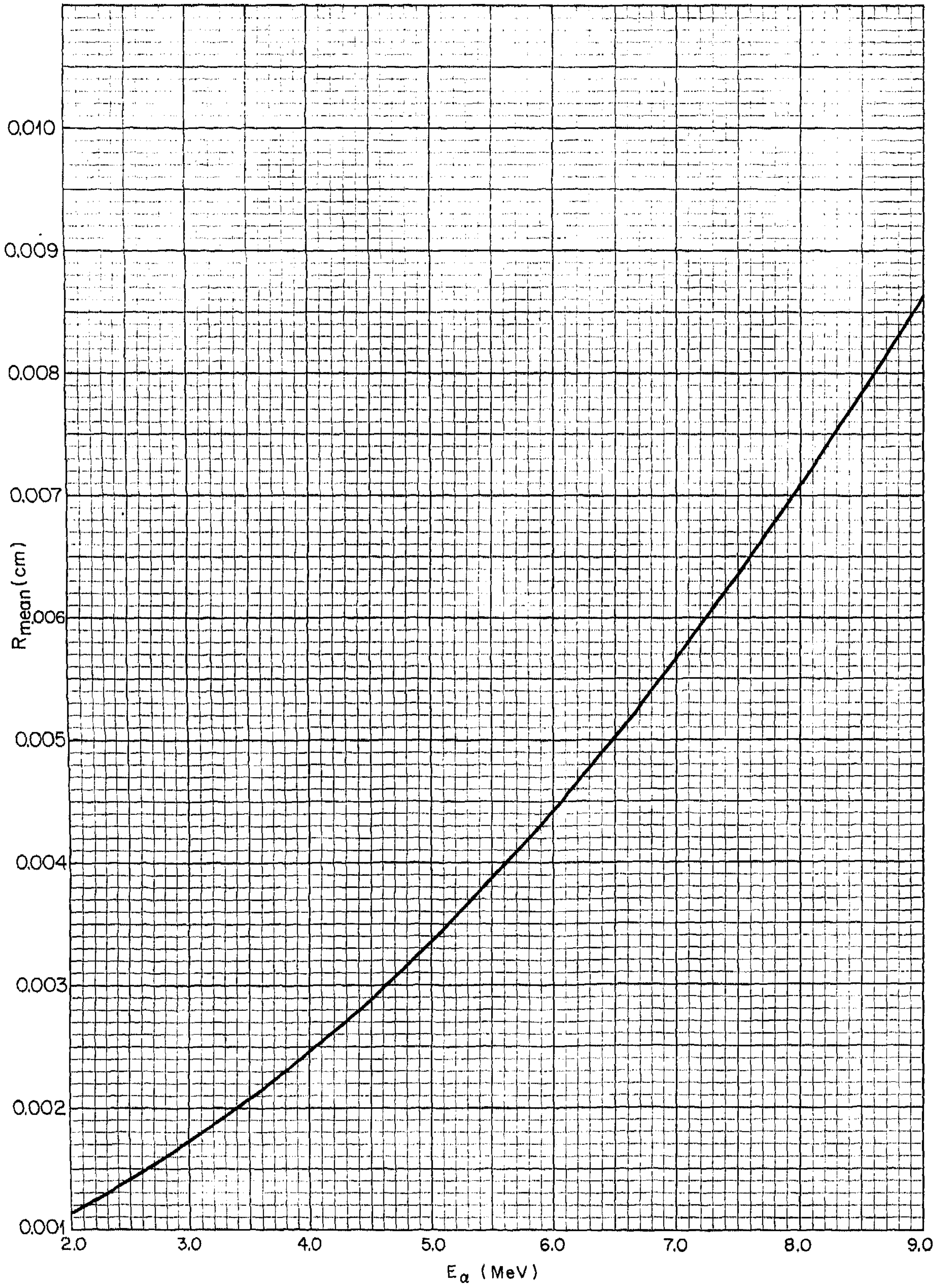


Fig. 3. Mean range in water for alpha particles as a function of alpha-particle energy

24B01 D.H.Black - Proc.Roy.Soc.(London) 106A, 632(1924)
32E01 C.D.Ellis - Proc.Roy.Soc.(London) 138A, 318(1932)
33R03 S.Rosenblum, G.Dupouy - J.phys.radium 4, 262(1933)
34H02 W.J.Henderson - Proc.Roy.Soc.(London) 147A, 572(1934)
36V01 S.N.Van Voorhis - Phys.Rev. 49, 889(1936)
38C01 B.N.Cacciapuoti - Nuovo cimento 15, 213(1938)
38L05 J.J.Livingood, G.T.Seaborg - Phys.Rev. 54, 775(1938)
39A06 R.Arnoult - Ann.phys. 12, 241(1939)
39F04 A.Flammersfeld - Z.Physik 114, 227(1939)
39L15 E.R.Lyman - Phys.Rev. 55, 234 (1939)
39O01 F.Oppenheimer, E.P.Tomlinson - Phys.Rev. 56, 858A (1939)
39T01 A.W.Tyler - Phys.Rev. 56, 125 (1939)
39W05 Y.Watase, Z.Itoh - Proc.Phys.Math.Soc.Japan 21, 626(1939)
40C06 E.C.Creutz, L.A.Delsasso, R.B.Sutton, M.G.White, W.H.Barkas - Phys.Rev. 58, 481(1940)
40D05 L.A.DuBridge, J.Marshall - Phys.Rev. 58, 7(1940)
40L07 J.L.Lawson, J.M.Cork - Phys.Rev. 57, 982(1940)
40M04 A.C.G.Mitchell, L.M.Langer, P.W.McDaniel - Phys.Rev. 57, 1107(1940)
41C04 A.A.Constantinov, G.D.Latyshev - J.Phys.USSR 5, 249(1941)
Internal Conversion of γ-Rays from RaC
41I01 Z.Itoh - Proc.Phys.Math.Soc.Japan 23, 405 (1941)
41R05 S.Ruben, M.D.Kamen - Phys.Rev. 59, 349 (1941)
41S01 A.K.Solomon - Phys.Rev. 60, 279(1941)
41S11 J.H.C.Smith, D.B.Cowie - J.Appl.Phys. 12, 78(1941)
41T01 A.A.Townsend - Proc.Roy.Soc.(London) 177A, 357 (1941)
β-Ray Spectra of Light Elements
41W03 Y.Watase - Proc.Phys.Math.Soc.Japan 23, 618 (1941)
42W01 G.L.Weil - Phys.Rev. 62, 229(1942)
43E07 S.Eklund, N.Hole - Arkiv Mat.Astron.Fysik 29A, No.26(1943)
43M11 C.E.Mandeville - Phys.Rev. 63, 91(1943)
Gamma-Rays from As^{76}
44D01 M.Deutsch, L.G.Elliott - Phys.Rev. 65, 211 (1944)
44S30 K.Siegbahn - Arkiv Mat.Astron.Fysik 30A, No.20(1944)
45D01 M.Deutsch, L.G.Elliott, A.Roberts - Phys.Rev. 68, 192 (1945)
46G01 W.M.Good, D.Peaslee, M.Deutsch - Phys.Rev. 69, 313 (1946)
46H02 N.Hole, K.Siegbahn - Arkiv Mat.Astron.Fysik 33A, No.9(1946)
46H07 O.Hirzel, H.Waffler - Helv.Phys.Acta 19, 216 (1946)
46R10 A.F.Reid, J.R.Dunning - Phys.Rev. 70, 431(1946)
46S09 K.Siegbahn - Phys.Rev. 70, 127 (1946)
46S12 K.Siegbahn, S.E.Petersson - Arkiv Mat.Astron.Fysik 32B, No.5 (1946)
47D07 M.Deutsch - Phys.Rev. 72, 729 (1947)
47F08 H.N.Friedlander, L.Seren, S.H.Turkel - Phys.Rev. 72, 23(1947)
47G07 E.Gleditsch, T.Graf - Phys.Rev. 72, 640 (1947)
47H06 D.J.Hughes, D.Hall, C.Eggler, E.Goldfarb - Phys.Rev. 72, 646(1947)
47L04 L.M.Langer, C.S.Cook, M.B.Sampson - Phys.Rev. 71, 906 (1947)
47L08 P.W.Levy - Phys.Rev. 72, 248 (1947)
47N01 A.Novick - Phys.Rev. 72, 972(1947)
47P07 W.L.Peacock - Phys.Rev. 72, 1049 (1947)
47P10 W.C.Peacock, J.W.Jones, R.T.Overman - MonN-432, p.56 (1947)
Decay Schemes: Summary of All Spectrometer Data to Date
47S08 K.Siegbahn - Arkiv Mat.Astron.Fysik 34B, No.4 (1947)
47S25 J.A.Seiler - ANL-4000, p.119(1947)
47S26 A.K.Solomon, R.G.Gould, C.B.Anfinsen - Phys.Rev. 72, 1097 (1947)
48B21 J.L.Berggren, R.K.Osborne - Phys.Rev. 74, 1240A (1948)
48C02 C.S.Cook, L.M.Langer - Phys.Rev. 73, 601 (1948)
48C07 W.S.Cowart, M.L.Pool, D.A.McCown, L.L.Woodward - Phys.Rev. 73, 1454(1948)
48C10 C.S.Cook, L.M.Langer, H.C.Price,Jr. - Phys.Rev. 74, 548 (1948)
48C27 W.W.Chupp, E.M.McMillan - Phys.Rev. 74, 1217 (1948)
48E09 R.D.Evans, R.O.Evans - Revs.Mod.Phys. 20, 305(1948)
48F09 N.Feather, J.Kyles, R.W.Pringle - Proc.Phys.Soc.(London) 61A, 466 (1948)
48K13 W.J.Knox - Phys.Rev. 74, 1192 (1948)
48K28 E.D.Klema, A.O.Hanson - Phys.Rev. 73, 106(1948)
48M28 F.Metzger, M.Deutsch - Phys.Rev. 74, 1640 (1948)
48M29 D.G.E.Martin, H.O.W.Richardson, Y.K.Hsu - Proc.Phys.Soc.(London) 60, 466 (1948)
48M30 D.G.E.Martin, H.O.W.Richardson - Proc.Roy.Soc.(London) 195A, 287 (1948)
48N02 L.D.Norris, M.G.Inghram - Phys.Rev. 73, 350(1948)
48P08 K.Philipp, F.Rehbein - Z.Physik 124, 225(1948)
48T02 J.Townsend, G.E.Owen, M.Cleland, A.L.Hughes - Phys.Rev. 74, 99 (1948)
48Y02 L.Yaffe, J.M.Grunlund - Phys.Rev. 74, 696(1948)
48Z02 D.J.Zaffarano, B.D.Kern, A.C.G.Mitchell - Phys.Rev. 74, 682 (1948)
49A03 J.Angus, A.L.Cockroft, S.C.Curran - Phil.Mag. 40, 522 (1949)

49B16 R.Bouchez, G.Kayas - J.phys.radium 10, 110 (1949)
49B26 J.P.Blaser, F.Boehm, P.Marmier - Phys.Rev. 75, 1953 (1949)
49C08 S.C.Curran, J.Angus, A.L.Cockroft - Phil.Mag. 40, 53 (1949); Addendum Phys.Rev. 76, 853 (1949)
Investigation of Soft Radiations - II. The Beta Spectrum of Tritium
49F02 L.Feldman, C.S.Wu - Phys.Rev. 75, 1286A (1949)
49G26 L.V.Groshev, L.Y.Shavtvalov - Doklady Akad.Nauk SSSR 68, 257(1949); Nucl.Sci.Abstr. 4, 282, Abstr.1767 (1950)
Measurement of the Partial β Spectrum of the ThB by the Method of Coincidences in a Double β Spectrometer
49H01 G.C.Hanna, B.Pontecorvo - Phys.Rev. 75, 983 (1949)
49H21 O.Huber, R.Ruetschi, P.Scherrer - Helv.Phys.Acta 22, 375 (1949)
49H27 R.D.Hill, G.Scharff-Goldhaber, G.Friedlander - Phys.Rev. 75, 324(1949)
49H52 R.C.Hawkings, R.F.Hunter, W.B.Mann, W.H.Stephens - Can.J.Res. 27B, 545(1949)
Half-Life of Carbon 14
49J07 W.M.Jones - Phys.Rev. 76, 885(1949)
49K01 B.H.Ketelle - ORNL-229, p.35(1949)
49K12 N.L.Krisberg, M.L.Pool - Phys.Rev. 75, 1693(1949)
49K14 B.D.Kern, A.C.G.Mitchell, D.J.Zaffarano - Phys.Rev. 76, 94 (1949)
49L06 L.M.Langer, H.C.Price,Jr. - Phys.Rev. 76, 641 (1949)
49L14 W.S.Lyon - ORNL-286, p.216 (1949)
49L23 L.Lidofsky, P.Macklin, C.S.Wu - Phys.Rev. 76, 1888 (1949)
49M35 A.C.G.Mitchell, J.Y.Mei, F.C.Maienschein, C.L.Peacock - Phys.Rev. 76, 1450(1949)
49M57 K.C.Mann, D.Rankin, P.N.Kaykin - Phys.Rev. 76, 1719 (1949)
49R02 S.Rosenblum, M.Valadares, M.Perey - Compt.rend. 228, 385(1949)
49R09 S.Rosenblum, M.Valadares, M.Perey, J.Vial - Compt.rend. 229, 1009(1949)
49S20 E.Segre, C.E.Wiegand - Phys.Rev. 75, 39(1949); Erratum Phys.Rev. 81, 284(1951)
49S30 K.Siegbahn, A.Hedgran, M.Deutsch - Phys.Rev. 76, 1263 (1949)
49W10 H.M.Wilson, S.C.Curran - Phil.Mag. 40, 631 (1949)
49W15 C.S.Wu, C.H.Townes, L.Feldman - Phys.Rev. 76, 692(1949)
50A01 H.M.Agnew - Phys.Rev. 77, 655 (1950)
50A07 D.E.Alburger - Phys.Rev. 78, 629 (1950)
50B08 P.R.Bell, B.Weaver, J.M.Cassidy - Phys.Rev. 77, 399 (1950)
50B10 E.Berne - Phys.Rev. 77, 568(1950)
50B76 G.L.Brownell, C.J.Maletskos - Phys.Rev. 80, 1102 (1950)
Half-Life of Fe^{55} and Co^{60}
50B91 M.E.Bunker, R.Canada - Phys.Rev. 80, 961 (1950)
50C01 L.Cranberg - Phys.Rev. 77, 155(1950)
50C69 J.W.Cobble, R.W.Atteberry - Phys.Rev. 80, 917(1950)
50D06 M.Deutsch, W.E.Wright - Phys.Rev. 77, 139 (1950)
Lifetimes of Excited States of Au^{197}, Fe^{57}, Cd^{111}, Hg^{198}, and Tl^{203}
50e09 D.W.Engelkemeir, M.S.Freedman, L.E.Glendenin, R.P.Metcalf - NNES 9,1104(1950)
50E59 A.G.Engelkemeir, W.F.Libby - Rev.Sci.Inst. 21, 550(1950)
50F58 M.S.Freedman, D.W.Engelkemeir - Phys.Rev. 79, 897 (1950)
50F60 G.Friedlander, M.L.Perlman, G.Scharff-Goldhaber - Phys.Rev. 80, 1103 (1950)
50g03 L.E.Glendenin, C.D.Coryell - NNES 9, 687 (1950)
Further Studies on Sr^{90} and Y^{90}
50G20 F.E.Geiger,Jr. - Phys.Rev. 79, 212A(1950)
50H01 W.F.Hornyak, T.Lauritsen - Phys.Rev. 77, 160 (1950)
50J53 S.Johansson - Phys.Rev. 79, 896 (1950)
50J60 G.H.Jenks, F.H.Sweeton, J.A.Ghormley - Phys.Rev. 80, 990 (1950)
50K04 R.Katz, R.D.Hill, M.Goldhaber - Phys.Rev. 78, 9 (1950)
50K51 H.E.Kubitschek - Phys.Rev. 79, 23 (1950)
50K60 B.H.Ketelle - Phys.Rev. 80, 758 (1950)
50L02 L.M.Langer - Phys.Rev. 77, 50 (1950)
50L04 L.M.Langer, J.W.Motz, H.C.Price,Jr. - Phys.Rev. 77, 798 (1950)
50L51 L.M.Langer, R.D.Moffat, H.C.Price,Jr. - Phys.Rev. 79, 808 (1950)
50M03 P.Macklin, L.Feldman, L.Lidofsky, C.S.Wu - Phys.Rev. 77, 137 (1950)
50M10 W.W.Miller, R.Ballentine, W.Bernstein, L.Friedman, A.O.Nier, R.D.Evans - Phys.Rev. 77, 714(1950)
50M15 J.Macnamara, C.B.Collins, H.G.Thode - Phys.Rev. 78, 129(1950)
50M26 J.Y.Mei, C.M.Huddleston, A.C.G.Mitchell - Phys.Rev. 79, 429 (1950)
50M82 W.Mims, H.Halban, R.Wilson - Nature 166, 1027 (1950)
50N52 C.M.Nelson, B.H.Ketelle, G.E.Boyd - ORNL-828 (1950)
Studies on the Nuclear Chemistry of Tin
50R03 B.E.Robertson, W.E.Scott, M.L.Pool - Phys.Rev. 78, 318A (1950)
50R51 J.H.Reynolds - Phys.Rev. 79, 789 (1950)
50R59 H.T.Richards, R.V.Smith, C.P.Browne - Phys.Rev. 80, 524 (1950)
50R62 E.Rabinowicz - Proc.Phys.Soc.(London) 63A, 1040(1950)
50S19 K.Siegbahn, W.Forsling - Arkiv Fysik 1, 505 (1950)

50S52 G.A.Sawyer, M.L.Wiedenbeck - Phys.Rev. 79, 490(1950)
50S55 A.K.Solomon - Phys.Rev. 79, 403(1950)
50S60 A.Storruste - Phys.Rev. 79, 193 (1950)
50W62 S.D.Warshaw - Phys.Rev. 80, 111 (1950)
50Z51 H.Zeldes, B.H.Ketelle, A.R.Brosi - Phys.Rev. 79, 901 (1950)
51B05 A.R.Brosi, C.J.Borkowski, E.E.Conn, J.C.Griess, Jr. - Phys.Rev. 81, 391(1951)
51B17 P.R.Bell, J.M.Cassidy, G.G.Kelley - Phys.Rev. 82, 103 (1951)
51B37 D.K.Butt, W.D.Brodie - Proc.Phys.Soc.(London) 64A, 791(1951)
51B52 A.R.Brosi, B.H.Ketelle, H.Zeldes, E.Fairstein - Phys.Rev. 84, 586 (1951)
51B57 J.P.Blaser, F.Boehm, P.Marmier, P.Scherrer - Helv.Phys.Acta 24, 441 (1951)
51C24 P.E.Cavanagh - Phys.Rev. 82, 791 (1951)
51C34 J.M.Cork, A.E.Stoddard, C.E.Branyan, W.J.Childs, D.W.Martin, J.M.LeBlanc - Phys.Rev. 84, 596(1951)
51C39 J.M.Cork, J.M.Le Blanc, A.E.Stoddard, D.W.Martin, C.E.Branyan, W.J.Childs - Phys.Rev. 83, 856 (1951)
51C50 M.R.Cleland, J.Townsend, A.L.Hughes - Phys.Rev. 84, 298 (1951)
51D12 J.M.Dickson, T.C.Randle - Proc.Phys.Soc.(London) 64A, 902(1951)
51D33 J.P.Davidson, Jr. - Phys.Rev. 82, 48(1951)
The First Forbidden Shape Factor and the f(n)t Products for Beta-Decay
51E09 D.Engelkemeir - Phys.Rev. 82, 552 (1951)
51E21 E.W.Emery - Phys.Rev. 83, 679 (1951)
51F05 S.Fried, A.H.Jaffey, N.F.Hall, L.E.Glendenin - Phys.Rev. 81, 741(1951)
51G29 M.L.Good - Phys.Rev. 83, 1054 (1951)
51H18 P.Hubert - Compt.rend. 232, 2201 (1951)
51H24 E.K.Hyde, G.D.O'Kelley - Phys.Rev. 82, 944 (1951)
51H33 D.R.Hamilton, W.P.Alford, L.Gross - Phys.Rev. 83, 215A (1951)
51H40 B.Hamermesh, V.Hummel - Phys.Rev. 84, 381 (1951)
51H88 G.W.Hinman - Thesis, Carnegie Inst.Tech. (1951); NYO-91 (1951)
Design of Double Focusing β-Ray Spectroscope and Application to Internal Conversion in Cu^{64}
51J15 W.M.Jones - Phys.Rev. 83, 537(1951)
The Half-Life of Tritium by Absolute Counting
51K29 B.H.Ketelle, H.Zeldes, A.R.Brosi, R.A.Dandl - Phys.Rev. 84, 585 (1951)
51K32 S.Kageyama - J.Phys.Soc.Japan 6, 285(1951)
51M30 G.G.Manov, L.F.Curtiss - J.Research Natl.Bur.Standards 46, 328(1951)
51M46 L.G.Mann, P.Axel - Phys.Rev. 84, 221(1951) L.G.Mann, P.Axel - Phys.Rev. 84, 221 (1951)
51M79 N.Metropolis, J.R.Reitz - J.Chem.Phys. 19, 555 (1951)
Solutions of the Fermi-Thomas-Dirac Equation
51P17 E.Plassmann, F.R.Scott - Phys.Rev. 84, 156 (1951)
51R24 L.Ruby, J.R.Richardson - Phys.Rev. 83, 698 (1951)
51R33 M.E.Rose, D.K.Holmes - Phys.Rev. 83, 190 (1951)
The Effect of Finite Nuclear Size in Beta-Decay
51S14 J.H.Sreb - Phys.Rev. 81, 469(1951)
51S25 W.K.Sinclair, A.F.Holloway - Nature 167, 365(1951)
51S56 R.P.Schuman, A.Camilli - Phys.Rev. 84, 158(1951)
51S91 L.M.Silver - Can.J.Phys. 29, 59(1951)
51S96 W.K.Sinclair, E.W.Emery - British J.Radiology 23, 576(1951)
The Half-Life of Iodine-131 and the Anomalous Decay of Exposed Sodium Iodine Sources
51S97 J.C.Slater - Phys.Rev. 81, 385 (1951)
A Simplification of the Hartree-Fock Method
51T12 J.F.Turner, P.E.Cavanagh - Phil.Mag. 42, 636 (1951)
51T25 J.Tobailem - Compt.rend. 233, 1360(1951)
51V05 N.F.Verster, G.J.Nijgh, R.van Lieshout, C.J.Bakker - Physica 17, 637 (1951)
51W09 F.P.W.Winteringham - Nature 167, 155(1951)
51W14 H.W.Wilson - Phys.Rev. 82, 548 (1951)
51W22 H.W.Wilson, S.C.Curran - Phil.Mag. 42, 762 (1951)
51Z01 H.Zeldes, A.R.Brosi, B.H.Ketelle - Phys.Rev. 81, 642 (1951)
52A06 D.E.Alburger - Phys.Rev. 85, 734A (1952)
52A19 D.E.Alburger, J.J.Kraushaar - Phys.Rev. 87, 448 (1952)
52A39 F.Asaro, I.Perlman - Phys.Rev. 88, 129(1952)
52B16 J.C.Bowe, P.Axel - Phys.Rev. 85, 858 (1952)
52B26 R.E.Bell, R.L.Graham, H.E.Petch - Can.J.Phys. 30, 35 (1952)
52B53 S.D.Bloom - Phys.Rev. 88, 312 (1952)
52B55 I.Bergstrom - Arkiv Fysik 5, 191 (1952)
52B78 E.E.Berlovich - Izvest.Akad.Nauk SSSR, Ser.Fiz. 16, 314 (1952)
52B95 R.E.Bell, R.L.Graham - Phys.Rev. 86, 212 (1952)
52C01 J.M.Cork, D.W.Martin, J.M.LeBlanc, C.E.Branyan - Phys.Rev. 85, 386 (1952)
52C10 R.S.Caswell - Phys.Rev. 86, 82 (1952)
52C17 P.E.Cavanagh - Phil.Mag. 43, 648 (1952)
52C31 L.S.Cheng, J.L.Dick, J.D.Kurbatov - Phys.Rev. 88, 887 (1952)

52D12 D.C.Dunlavey, G.T.Seaborg - Phys.Rev. 87, 165(1952)
52D22 E.Der Mateosian - Phys.Rev. 88, 1186 (1952)
52E02 W.S.Emmerich, J.D.Kurbatov - Phys.Rev. 85, 149 (1952)
52E17 G.T.Ewan, M.A.S.Ross - Nature 170, 760(1952)
52F14 C.Y.Fan - Phys.Rev. 87, 252 (1952)
52F16 L.Feldman, C.S.Wu - Phys.Rev. 87, 1091 (1952)
52G14 G.A.Graves, L.M.Langer, R.D.Moffat - Phys.Rev. 88, 344 (1952)
52H58 D.C.Hoffman, D.S.Martin, Jr. - J.Phys.Chem. 56, 1097(1952)
52J11 G.H.Jenks, F.H.Sweeton - Phys.Rev. 86, 803(1952)
52J23 S.A.E.Johansson - Arkiv Fysik 3, 533 (1952)
52K02 W.C.Kelly - Phys.Rev. 85, 101 (1952)
52K27 E.Kondaiah - Arkiv Fysik 4, 81 (1952)
52L17 W.S.Lyon - Phys.Rev. 87, 1126(1952)
52L18 G.Lindstrom - Arkiv Fysik 4, 1 (1952)
52L19 L.M.Langer, R.D.Moffat - Phys.Rev. 88, 689 (1952)
52M03 F.K.McGowan - Phys.Rev. 85, 142 (1952)
52M21 F.R.Metzger - Phys.Rev. 86, 435 (1952)
52M22 H.T.Motz, D.E.Alburger - Phys.Rev. 86, 165 (1952)
52M45 D.E.Muller, H.C.Hoyt, D.J.Klein, J.W.M.DuMond - Phys.Rev. 88, 775 (1952)
52M53 F.R.Metzger - Phys.Rev. 88, 1360 (1952)
52R13 P.Radvanyi - Compt.rend. 234, 1275(1952)
52R16 D.Rose, G.Hinman, L.G.Lang - Phys.Rev. 86, 863 (1952)
52R21 S.Rosenblum, M.Valadares, M.Guillot - Compt.rend. 235, 238(1952)
52S29 A.W.Sunyar, J.W.Mihelich, G.Scharff-Goldhaber, M.Goldhaber, N.S.Wall, M.Deutsch - Phys.Rev. 86, 1023 (1952)
52S30 R.K.Sheline, R.W.Stoughton - Phys.Rev. 87, 1 (1952)
The Nuclide Ni^{56}
52S52 H.Slatis, K.Siegbahn - Arkiv Fysik 4, 485 (1952)
Determination of Multipole Orders from Internal Pair Formation
52T18 E.P.Tomlinson, S.L.Ridgway - Phys.Rev. 88, 170A (1952); Oral Report
52V03 H.T.Vlaar, A.H.W.Aten,Jr. - Physica 18, 275 (1952)
52W15 W.J.Worthington,Jr. - Phys.Rev. 87, 158 (1952)
Nickel 56
52W33 A.H.Wapstra - Physica 18, 1247(1952)
53A31 F.Asaro, F.Stephens,Jr., I.Perlman - Phys.Rev. 92, 1495(1953)
53B10 R.M.Bartholomew, F.Brown, R.C.Hawkings, W.F.Merritt, L.Yaffe - Can.J.Chem. 31, 120(1953)
53B15 J.M.Brabant, L.W.Cochran, R.S.Caswell - Phys.Rev. 91, 210A (1953)
53B41 K.T.Bainbridge, M.Goldhaber, E.Wilson - Phys.Rev. 90, 430(1953)
53B48 R.M.Bartholomew, F.Brown, W.D.Howell, W.R.J.Shorey, L.Yaffe - Can.J.Phys. 31, 714 (1953)
The Design of an Automatic Recording Electroscope and its Use to Determine Half-Lives in Radioactive Decay
53B58 P.R.J.Burch - Nature 172, 361(1953)
53B80 A.A.Bashilov,B.S.Dzhelepov, L.S.Chervenskaya - Izvest.Akad.Nauk SSSR, Ser.Fiz. 17, 428(1953); Chem.Abstr. 48, No.2490i (1954)
53B82 A.A.Bashilov, N.M.Antoneva, D.C.Broder, B.S.Dzhelepov - Izvest.Akad.Nauk.SSSR, Ser.Fiz. 17, 468 (1953); Chem.Abstr. 48, No. 2488h (1954)
53B97 A.O.Burford - Thesis, Vanderbilt University (1953); TID-15684 (1953)
The Electron Spectrum of Mercury-203 from 50 keV to 300 keV
53B99 P.Benoist-Gueutal - Ann.phys. 8, 593 (1953)
Contribution a l'Etude Theorique de la Radioactivite β et de la Capture e: Intervention du Cortege Electronique
53C16 L.S.Cheng, M.L.Pool - Phys.Rev. 90, 886 (1953)
53C23 J.M.Cork, J.M.LeBlanc, D.W.Martin, W.H.Nester, M.K.Brice - Phys.Rev. 90, 579 (1953)
53C34 J.L.W.Churchill, W.M.Jones, S.E.Hunt - Nature 172, 460(1953)
53C44 J.M.Cork, J.M.LeBlanc, M.K.Brice, W.H.Nester - Phys.Rev. 92, 367 (1953)
53C64 E.R.Collins, C.D.McKenzie, C.A.Ramm - Proc.Roy.Soc.(London) 216A, 219 (1953)
53D01 C.F.G.Delaney, J.H.J.Poole - Phys.Rev. 89, 529(1953)
53D29 B.S.Dzhelepov, N.N.Zhukovskii, A.A.Karamyan, S.S.Shestopalova - Izvest.Akad.Nauk SSSR, Ser.Fiz. 17, 518 (1953)
53D30 B.S.Dzhelepov, N.N.Zukovskii, V.P.Prikhodtseva, Y.V.Kholnov - Izvest.Akad.Nauk SSSR, Ser.Fiz. 17, 511 (1953); Chem.Abstr. 48, No.2488d (1954)
53D31 V.M.Dolishnyuk, G.M.Drabkin, V.I.Orlov, L.I.Rusinov - Doklady Akad.Nauk SSSR 92, 1141 (1953); NSF-tr-229 (1954)
53G07 R.L.Graham, R.E.Bell - Can.J.Phys. 31, 377 (1953)
53G22 M.Goodrich, J.S.Levinger, W.Payne - Phys.Rev. 91, 1225 (1953)
53H28 H.C.Hoyt, J.W.M.DuMond - Phys.Rev. 91, 1027 (1953)
53H40 D.R.Hamilton, A.Lemonick, F.M.Pipkin - Phys.Rev. 92, 1191(1953)
53H47 P.Hubert - Ann.phys. 8, 662 (1953)

53H55 D.R.Hamilton, W.P.Alford, L.Gross - Phys.Rev. 92, 1521 (1953)
53I01 E.Iweran, W.S.Koski, F.Rasetti - Phys.Rev. 91, 1229 (1953)
53J02 A.A.Jaffe, S.G.Cohen - Phys.Rev. 89, 454(1953)
53J07 J.W.Jones, T.P.Kohman - Phys.Rev. 90, 495(1953)
53K08 D.N.Kundu, T.W.Donaven, M.L.Pool, J.K.Long - Phys.Rev. 89, 1200(1953)
53K15 Y.Kobayashi, G.Miyamota - J.Phys.Soc.Japan 8, 135(1953)
53K16 J.J.Kraushaar, E.D.Wilson, K.T.Bainbridge - Phys.Rev. 90, 610(1953)
53K19 J.Kyles, C.G.Campbell, W.J.Henderson - Proc.Phys.Soc.(London) 66A, 519(1953)
53K21 J.Kastner, G.N.Whyte - Phys.Rev. 91, 332(1953)
53K26 B.Kahn, W.S.Lyon - Phys.Rev. 91, 1212(1953)
53K40 S.Kageyama - J.Phys.Soc.Japan 8, 689(1953)
53K47 B.Kahn, W.S.Lyon - Phys.Rev. 92, 902 (1953)
53K69 W.E.Kinney - Thesis, Rensselaer Polytechnic Inst. (1953); AECU-2921 (1953)
Investigations on Cs^{137}
53L09 E.E.Lockett, R.H.Thomas - Nucleonics 11, No.3, 14 (1953)
The Half-Lives of Several Radioactive Radioisotopes
53L21 M.Lindner - Phys.Rev. 91, 642(1953)
53L35 L.M.Langer, N.H.Lazar, R.J.D.Moffat - Phys.Rev. 91, 338 (1953)
53M12 A.Michalowicz - J.Phys.Radium 14, 214 (1953)
Sur le Rayonnement de Freinage Interne du ^{55}Fe
53M14 R.E.Maerker, R.D.Birkhoff - Phys.Rev. 89, 1159 (1953)
53M20 D.G.E.Martin, G.Parry - Phil.Mag. 44, 344(1953)
53M23 L.Marquez - Phys.Rev. 90, 330 (1953)
53M64 L.Marquez - Phys.Rev. 92, 1511(1953)
53P02 F.T.Porter, H.P.Hotz - Phys.Rev. 89, 938 (1953)
An Upper Limit for Atomic Orbital Electron Ejection Accompanying K-Capture in Fe^{55}
53P14 J.F.Perkins, S.K.Haynes - Phys.Rev. 92, 687 (1953)
53P25 A.C.Pappas - MIT Technical Report 63 (1953); AECU-2806 (1953)
A Radiochemical Study of Fission Yields in the Region of Shell Perturbations and the Effect of Closed Shells in Fission
53R23 M.Riou - Ann.phys. 8, 535(1953)
53R29 A.Rytz - J.recherches centre natl.recherche sci., Labs.Bellevue (Paris) No.25, 254(1953)
53R37 M.E.Rose, C.L.Perry, N.M.Dismuke - ORNL-1459 (1953)
Tables for the Analysis of Allowed and Forbidden Beta Transitions
53S14 H.Slatis, L.Zappa - Arkiv Fysik 6, 81(1953)
53S26 M.Sakai, P.Hubert - Compt.rend. 236, 1249 (1953)
53S28 H.H.Seliger, L.Cavallo, S.V.Culpepper - Phys.Rev. 90, 443(1953)
53T05 E.P.Tomlinson, S.L.Ridgway, K.Gopalakrishman - Phys.Rev. 91, 484A (1953); Oral Report
53T17 J.Tobailem - J.phys.radium 14, 553(1953)
53T22 J.F.Turner - AERE-N/R 1254 (1953)
53W04 C.S.Wu, F.Boehm, E.Nagel - Phys.Rev. 90, 388A(1953); Oral Report
53W13 B.T.Wright - Phys.Rev. 90, 159 (1953)
53W17 R.K.Wanless, H.G.Thode - Can.J.Phys. 31, 517(1953)
53W22 A.H.Wapstra, A.D.Veenendaal - Phys.Rev. 91, 426(1953)
53W28 C.S.Wu, F.Boehm, E.Nagel - Phys.Rev. 91, 319(1953)
53Y04 T.Yuasa - Compt.rend. 237, 1077 (1953)
54A06 D.E.Alburger, M.A.Grace - Proc.Phys.Soc.(London) 67A, 280 (1954)
The Disintegration of Cobalt 57
54B11 W.D.Brodie - Proc.Phys.Soc.(London) 67A, 265(1954)
54B36 I.Bergstrom, S.Thulin, A.H.Wapstra, B.Astrom - Arkiv Fysik 7, 255 (1954)
54B38 M.E.Bunker, J.P.Mize, J.W.Starner - Phys.Rev. 94, 1694 (1954)
54B58 W.H.Burgus, G.A.Cowan, J.W.Hadley, W.Hess, T.Shull, M.L.Stevenson, H.F.York - Phys.Rev. 95, 750 (1954)
Cross Sections for the Reactions $Ti^{48}(d,2n)V^{48}$; $Cr^{52}(d,2n)Mn^{52}$; and $Fe^{56}(d,2n)Co^{56}$
54B61 R.E.Bell, L.Yaffe - Can.J.Phys. 32, 416(1954)
54B63 A.A.Bashilov, B.S.Dzhelepov, L.S.Chervinskaia - Izvest.Akad.Nauk SSSR, Ser.Fiz. 18, 88 (1954)
54B68 H.C.Box, G.S.Klaiber - Phys.Rev. 95, 1247(1954)
54B104 G.E.Boyd, Q.V.Larson - ORNL-1755, p.35 (1954)
Observations on the Nuclear Chemistry of Ruthenium and Rhodium
54B107 G.H.Briggs - Revs.Modern Phys. 26, 1(1954)
54C05 A.Chetham-Strode, Jr., E.M.Kinderman - Phys.Rev. 93, 1029(1954)
54C41 R.S.Caswell, J.M.Brabant, A.Schwebel - J.Research Natl.Bur.Standards 53, 27(1954)
54C60 J.M.Cork, M.K.Brice, L.C.Schmid - Phys.Rev. 96, 1295 (1954)
54D23 P.E.Damon, F.R.Edwards - Phys.Rev. 95, 1698(1954)
54E04 L.G.Elliott, M.A.Preston, J.L.Wolfson - Can.J.Phys. 32, 153 (1954)
54E09 W.S.Emmerich, W.J.Auth, J.D.Kurbatov - Phys.Rev. 94, 110 (1954)
54E24 L.G.Elliott, R.L.Graham, J.Walker, J.L.Wolfson - Proc.Roy.Soc.(Canada) 48, 12A (1954)
54E27 E.W.Emery, N.Veall - Nature 174, 889(1954)

54G66 T.Grabowski, L.Natanson - Bull.Acad.Polon.Sci., Cl.III, 2, 379 (1954)
54K08 H.W.Kirby, M.L.Salutsky - Phys.Rev. 93, 1051(1954)
54M19 D.Maeder, R.Muller, V.Wintersteiger - Helv.Phys.Acta 27, 3 (1954)
54M28 P.S.Mittelman - Phys.Rev. 94, 99 (1954)
54M30 L.Madansky, F.Rasetti - Phys.Rev. 94, 407 (1954)
Radiative Electron Capture in Fe^{55}
54M43 J.Moreau - Arkiv Fysik 7, 391 (1954)
54M77 M.Mladjenovic, H.Slatis - Arkiv Fysik 8, 65(1954)
54M83 J.Moreau - Compt.rend. 239, 800 (1954)
54M108 F.R.Metzger - Quoted by 54V04
54N01 J.O.Newton, B.Rose - Phil.Mag. 45, 58(1954)
54N09 G.J.Nijgh, L.T.M.Ornstein, N.Grobben - Physica 20, 243 (1954)
54O03 J.L.Olsen, G.D.O'Kelley - Phys.Rev. 93, 1125 (1954)
54R10 S.Rosenblum, M.Valadares, M.Guillot - J.phys.radium 15, 129(1954)
54S08 E.F.Sturcken, Z.O'Friel, A.H.Weber - Phys.Rev. 93, 1053 (1954)
54S18 S.E.Singer, W.S.Emmerich, J.D.Kurbatov - Phys.Rev. 94, 779A (1954)
Radiative Electron Capture in Fe^{55}, A^{37}, and Ni^{59}
54S28 R.K.Sheline, N.R.Johnson, P.R.Bell, R.C.Davis, F.K.McGowan - Phys.Rev. 94, 1642 (1954)
54S51 R.Sehr - Z.Physik 137, 523 (1954)
54T17 S.Thulin, K.Nybo - Arkiv Fysik 7, 289 (1954)
54T39 S.Thulin, J.Moreau, *H.Atterling - Arkiv Fysik 8, 229 (1954)*
The Decay of Kr^{79}
54T40 L.H.Thomas - *J.Chem.Phys. 22, 1758 (1954)*
Tables of Statistical Electron Distributions for Atoms with Degree of Ionization Zero to Four and of the Corresponding Electrostatic Potentials
54V04 J.Varma - Phys.Rev. 94, 795A (1954); Oral Report
54V09 J.Verhaeghe, J.Demuynck - Compt.rend. 239, 1374 (1954)
54W14 A.H.Wapstra - Arkiv Fysik 7, 275 (1954)
54Y02 L.Yaffe, H.G.Thode, W.F.Merritt, R.C.Hawkings, F.Brown, R.M.Bartholomew - Can.J.Chem. 32, 1017(1954)
54Z05 P.P.Zarubin - Izvest.Akad.Nauk SSSR, Ser.Fiz. 18, 563 (1954)
55A29 T.Azuma - J.Phys.Soc.Japan 10, 167 (1955)
55B01 M.E.Bunker, J.W.Starner - Phys.Rev. 97, 1272 (1955)
55B10 E.W.Backofen, R.H.Herber - Phys.Rev. 97, 743(1955)
55B43 H.Brysk, M.E.Rose - ORNL-1830 (1955)
Theoretical Results on Orbital Capture
55B93 R.M.Bartholomew, A.W.Boyd, F.Brown, R.C.Hawkings, M.Lounsbury, W.F.Merritt - Can.J.Phys. 33, 43(1955)
55B106 F.Brown, G.R.Hall, A.J.Walter - J.Inorg.Nuclear Chem. 1, 241(1955)
55B125 G.Backenstoss, K.Goebel - Z.Naturforsch. 10a, 920(1955)
55B129 A.Bisi, E.Germagnoli, L.Zappa - Nuovo cimento 2, 1052 (1955)
55B163 W.C.Barber, W.D.George, D.D.Reagan - Phys.Rev. 98, 73(1955)
55C31 J.M.Cork, M.K.Brice, L.C.Schmid - Phys. 99, 703 (1955)
55D02 R.B.Day - Phys.Rev. 97, 689(1955)
55D09 B.De Raad, W.C.Middelkoop, B.van Nooyen, P.M.Endt - Physica 20, 1278 (1955)
55D35 R.W.P.Drever, A.Moljk - Phil.Mag. 46, 1337 (1955)
55D41 B.S.Dzhelepov, N.N.Zhukovskii, V.P.Prikhodtseva, Y.V.Kholnov - Izvest.Akad.Nauk SSSR, Ser.Fiz. 19, 271 (1955); Columbia Tech.Transl. 19, 247 (1956)
55D43 G.M.Drabkin, V.I.Orlov, L.I.Rusinov - Izvest.Akad.Nauk SSSR, Ser.Fiz. 19, 324 (1955); Columbia Tech.Transl. 19, 294 (1956)
55D48 B.S.Dzhelepov, O.E.Kraft - Vestnik Leningrad Univ. 10, No.8, Ser.Mat.Fiz.I Khim. No.3, 97(1955); Chem.Abstr. 50, No.12675e(1956)
55E11 L.G.Elliott, M.A.Preston, J.L.Wolfson - Can.J.Phys. 33, 607 (1955)
55E20 E.W.Emery, J.E.S.Bradley, N.Veall - Nature 175, 34(1955)
55E23 R.D.Evans - The Atomic Nucleus, McGraw-Hill Book Co., Inc., New York (1955)
55F03 H.H.Forster, A.Rosen - Phys.Rev. 98, 1172A (1955)
55F40 L.W.Fagg, E.A.Wolicki, R.O.Bondelid, K.L.Dunning, S.Snyder - Phys.Rev. 100, 1299 (1955)
55G57 L.L.Goldin, G.I.Novikova, E.F.Tretyakov - Conf.Acad.Sci.USSR Peaceful Uses of Atomic Energy, Session Div.Phys.Math.Sci., Moscow, p.226(1955); Consultants Bureau Transl. p.167(1956)
α-Spectra of Heavy Elements
55H81 G.Herrmann, F.Strassman - Z.Naturforsch. 10a, 146(1955)
55J01 H.Jaffe, T.O.Passell, C.I.Browne, I.Perlman - Phys.Rev. 97, 142(1955)
55J02 J.T.Jones,Jr., E.N.Jensen - Phys.Rev. 97, 1031 (1955)
55J14 M.K.Juric, D.M.Stanojevic - Bull.Inst.Nuclear Sci.'Boris Kidrich' 5, 15(1955)
55J20 W.M.Jones - Phys.Rev. 100, 124(1955)
55J22 R.Joly, J.Brunner, J.Halter, O.Huber - Helv.Phys.Acta 28, 403 (1955)
55J28 S.A.E.Johansson - Arkiv Fysik 9, 561(1955)
The RaC-RaC' Decay
55K10 J.D.Kurbatov, B.B.Murray, M.Sakai - Phys.Rev. 98, 674 (1955)

55K12 B.Kahn, W.S.Lyon - Phys.Rev. 98, 58 (1955)
55K21 S.Kono - J.Phys.Soc.Japan 10, 495 (1955)
55L02 L.Lidofsky, N.Benczer, P.Macklin, C.S.Wu - Phys.Rev. 98, 1186A(1955)
55L30 H.R.Lemmer, O.J.A.Segaert, M.A.Grace - Proc.Phys.Soc.(London) 68A, 701 (1955)
The Decay of Cobalt 57
55L34 W.S.Lyon, B.Kahn - Phys.Rev. 99, 728 (1955)
55L46 W.S.Lyon, R.R.Rickard - Phys.Rev. 100, 112 (1955)
55L55 H.H.Landon - Phys.Rev. 100, 1414 (1955)
55M40 N.Marty - Compt.rend. 240, 291 (1955)
55M87 W.C.Middelkoop, A.Heyligers, L.H.T.Rietjens, H.J.van den Bold, P.M.Endt - Physica 21, 897 (1955)
Radioactive Decay of ^{57}Co
55N09 J.B.Niday - Phys.Rev. 98, 42(1955)
55N15 R.T.Nichols, E.N.Jensen - Phys.Rev. 100, 1407 (1955)
55N19 O.B.Nielsen - Kgl.Danske Videnskab.Selskab, Mat.-fys.Medd. 30, No.11(1955)
55P04 A.V.Pohm, R.C.Waddell, J.P.Powers, E.N.Jensen - Phys.Rev. 97, 432 (1955)
55P41 S.W.Peat, M.A.S.Ross - Proc.Phys.Soc.(London) 68A, 923(1955)
55R17 R.C.Rohr, R.D.Birkhoff - Phys.Rev. 98, 1266 (1955)
55R26 R.E.Rowland - Phys.Rev. 99, 757(1955)
55R54 R.A.Ricci, G.Trivero - Nuovo cimento 2, 745(1955)
55R64 P.Radvanyi - Ann.phys. 10, 584 (1955)
55S05 B.Saraf, J.Varma, C.E.Mandeville - Phys.Rev. 98, 1206A (1955)
55S16 B.Saraf - Phys.Rev. 97, 715 (1955)
55S23 P.Schmeling - Z.Naturforsch. 10a, 79(1955)
55S38 A.D.Suttle, Jr., W.F.Libby - Anal.Chem. 27, 921(1955)
55S113 M.L.Salutsky, H.W.Kirby - Anal.Chem. 27, 567(1955)
55T01 S.Thulin - Arkiv Fysik 9, 137 (1955)
55T07 J.Tobailem - J.phys.radium 16, 48(1955)
55T27 J.Tobailem - Ann.phys. 10, 783(1955)
55V03 H.L.Volchok, J.L.Kulp - Phys.Rev. 97, 102(1955)
55W15 D.M.Wiles, R.H.Tomlinson - Can.J.Phys. 33, 133(1955)
55W35 A.C.Wahl - Phys.Rev. 99, 730(1955)
55W43 D.H.Wilkinson - Phys.Rev. 100, 32(1955)
55Y02 T.Yuasa, J.Laberrigue-Frolow, L.Feuvrais - J.phys.radium 16, 39 (1955)
56A28 P.Avignon - Ann.phys. 1, 10 (1956)
Etudes sur Quelques Captures Orbitales
56A30 G.Albouy - Ann.phys. 1, 99(1956)
56A51 I.A.Antonova - Izvest.Akad.Nauk SSSR, Ser.Fiz. 20, 896 (1956); Columbia Tech.Transl. 20, 814 (1957)
56B36 P.Bouchez, J.Tobailem, J.Robert, R.Muxart, R.Mellet, P.Daudel - J.phys.radium 17, 363(1956)
56B147 E.E.Berlovich, D.M.Khai, A.V.Savateev - Izvest.Akad.Nauk SSSR, Ser.Fiz. 20, 275 (1956); Columbia Tech.Transl. 20, 259 (1957)
56B168 I.M.Band, L.N.Zyrianova, T.Chen-Zhui - Izvest.Akad.Nauk SSSR, Ser.Fiz. 20. 1387 (1956); Columbia Tech.Transl. 20, 1269 (1957)
Numerical Values of the K-Electron Functions Determining the Probability of Allowed and Forbidden K-Capture
56C11 A.V.Cohen, P.H.White - Nuclear Phys. 1, 73(1956)
56D06 H.Daniel, R.Nierhaus - Z.Naturforsch. 11a, 212 (1956)
56D21 F.Demichelis, L.A.Radicati - Nuovo cimento 3, 377(1956)
56D28 H.Daniel - Z.Naturforsch. 11a, 759(1956)
56D38 R.W.B.Drever, A.Moljk, J.Scobie - Phil.Mag. 1, 942 (1956)
56D59 B.S.Dzhelepov, V.P.Prikhodtseva, A.I.Feoktistov, I.V.Kholnov - Izvest.Akad.Nauk SSSR, Ser.Fiz. 20, 1361 (1956); Columbia Tech.Transl. 20, 1243 (1957)
56E14 G.G.Eichholz, J.V.Krzyzewski - Can.J.Phys. 34, 1167(1956)
56E18 R.D.Evans - Priv.Comm. (1956)
56F15 W.H.Fleming, H.G.Thode - Can.J.Chem. 34, 408(1956)
56F22 R.W.Fink, G.W.Warren, R.R.Edwards, P.E.Damon - Phys.Rev. 103, 651(1956)
56G12 W.E.Graves, S.K.Suri - Phys.Rev. 101, 1368 (1956)
56H77 G.Herrmann, F.Strassmann - Z.Naturforsch. 11a, 946(1956)
56J11 R.G.Johnson, O.E.Johnson, L.M.Langer - Phys.Rev. 102, 1142 (1956)
56J24 K.E.Johansson - Arkiv Fysik 10, 247 (1956)
56K07 A.Kjelberg, A.C.Pappas - Nuclear Phys. 1, 322(1956)
56K33 P.Kafalas, J.W.Irvine, Jr. - Phys.Rev. 104, 703(1956)
56L17 H.Langevin-Joliot - J.phys.radium 17, 497 (1956)
56L31 E.E.Lockett, R.H.Thomas - Nucleonics 14, No.11, 127(1956)
56L38 L.J.Lidofsky, V.K.Fischer - Phys.Rev. 104, 759 (1956)
56M18 H.Mark, C.Goodman - Phys.Rev. 101, 768 (1956)
56M20 A.McNair, R.N.Glover, H.W.Wilson - Phil.Mag. 1, 199 (1956)
56M27 D.W.Martin, J.M.Cork, S.B.Burson - Phys.Rev. 102, 457 (1956)

56M43 R.L.Macklin, H.S.Pomerance - J.Nuclear Energy 2, 243(1956)
56M95 C.C.McMullen, B.D.Pate, R.H.Tomlinson, L.Yaffe - Can.J.Chem. 34, 1742(1956)
56N21 T.D.Nainan, H.G.Devare, A.Mukerji - Proc.Indian Acad.Sci. 44A, 111 (1956)
56N26 C.Nordling, K.Siegbahn, E.Sokolowski, A.H.Wapstra - Nuclear Phys. 1, 326 (1956)
56O02 G.D.O'Kelley, N.H.Lazar, E.Eichler - Phys.Rev. 101, 1059 (1956)
56P05 V.R.Potnis, C.E.Mandeville, J.S.Burlew - Phys.Rev. 101, 753 (1956)
56P07 A.V.Pohm, R.C.Waddell, E.N.Jensen - Phys.Rev. 101, 1315 (1956)
56P24 I.Pullman, P.Axel - Phys.Rev. 102, 1366 (1956)
56P28 F.T.Porter, M.S.Freedman, T.B.Novey, F.Wagner,Jr. - Phys.Rev. 103, 921 (1956)
56P42 E.Picciotto, S.Wilgain - Nuovo cimento 4, 1525(1956)
56P52 W.E.Perry, J.W.Dale - Quoted by 56L31
56R45 G.Rudstam - Thesis, University of Uppsala (1956)
Spallation of Medium Weight Elements
56S75 C.Sastre, G.Price - Nuclear Sci.And Eng. 1, 325(1956)
56S87 R.P.Schuman, M.E.Jones, A.C.Mewherter - J.Inorg.Nuclear Chem. 3, 160 (1956)
56S110 W.Sebaoun - Ann.phys. 1, 680(1956)
56S117 F.E.Senftle, T.A.Farley, N.Lazar - Phys.Rev. 104, 1629(1956)
56S119 V.S.Shpinel, G.A.Kuznetsova - Zhur.Eksptl.i Teoret.Fiz. 30, 231 (1956); Soviet Phys.JETP 3, 216 (1956)
56S128 M.Setterwall, K.M.Low, K.E.Edvarson - Priv.Comm. (June 1956)
56S137 N.S.Shimanskaia - Zhur.Eksptl.i Teoret.Fiz. 29, 486 (1956); Soviet Phys.JETP 4, 355 (1957)
56V20 J.Volpe, G.Hinman - Phys.Rev. 104, 753 (1956)
56W24 R.G.Waddell, E.N.Jensen - Phys.Rev. 102, 816 (1956)
56Z06 A.V.Zolotavin, E.P.Grigoriev, M.A.Abrovian - Izvest.Akad.Nauk SSSR, Ser.Fiz. 20, 28 (1956); Columbia Tech.Transl. 20, 271 (1957)
57A03 O.U.Anders, W.W.Meinke - Nucleonics 15, No.12, 68(1957)
57B17 G.Backstrom - Quoted by 57B60
57B45 J.B.Bellicard, A.Moussa - J.phys.radium 18, 115 (1957)
Etude des Electrons Auger-K et des Electrons de Conversion du ^{57}Co
57B60 I.Bergstrom, G.Andersson - Arkiv Fysik 12, 415 (1957)
57B134 J.Burde, B.Rozner - Phys.Rev. 107, 531(1957)
57B156 A.Bjornholm, O.Nathan, O.B.Nielsen, R.K.Sheline - Nuclear Phys. 4, 313 (1957)
57C62 R.D.Conner, I.L.Fairweather - Proc.Phys.Soc.(London) 70A, 769 (1957)
57D37 J.W.M.DuMond - Ann.Phys.(N.Y.) 2, 283 (1957)
57E11 B.Elbek, C.K.Bockelman - Phys.Rev. 105, 657 (1957)
57F06 R.W.Fink - Phys.Rev. 106, 266(1957)
57F29 M.Frilley, M.Valadares - J.phys.radium 18, 468(1957)
57F35 M.S.Freedman, F.T.Porter, F.Wagner,Jr., P.P.Day - Phys.Rev. 108, 836 (1957)
57F50 E.I.Firsov, A.A.Bashilov - Izvest.Akad.Nauk SSSR, Ser.Fiz. 21, 1633 (1957); Columbi Tech.Transl. 21, 1619 (1958)
57G07 K.W.Geiger - Phys.Rev. 105, 1539(1957)
57G54 E.P.Grigorev, L.N.Evtikheev, A.V.Zolotavin - Vestnik Leningrad Univ. 12, No.4, Ser.Fiz.i Khim. No.1, 57 (1957); Chem.Abstr. 51, No.11114f (1957)
57G62 S.R.Gunn, H.G.Hicks, H.B.Levy, P.C.Stevenson - Phys.Rev. 107, 1642(1957)
57G76 E.P.Grigorev, L.V.Gustova, A.V.Zolotavin, B.Kratsik, T.V.Poleshchuk, O.V.Chubinskii Vestnik Leningrad Univ. 12, No.10, Ser.Fiz.i Khim. No.2, 37 (1957); Chem.Abstr. 5 No.4346f (1958)
Arsenic-76 Radiation
57H08 B.G.Harvey, H.G.Jackson, T.A.Eastwood, G.C.Hanna - Can.J.Phys.35, 258 (1957)
57H10 G.R.Hall, T.L.Markin - J.Inorg.Nuclear Chem. 4, 137(1957)
57H83 S.Hultberg, A.Hedgran - Arkiv Fysik 11, 369 (1957)
57J19 G.A.Jones, W.R.Phillips - Proc.Roy.Soc.(London) 239A, 487(1957)
57K22 O.G.Kistner, A.Schwarzschild, B.M.Rustad, D.E.Alburger - Phys.Rev. 105, 1339 (1957)
57K26 B.H.Ketelle, A.R.Brosi - Priv.Comm. (October 1957)
57K49 E.M.Krisyouk, A.G.Sergeev, G.D.Latyshev, V.D.Vorobyov - Nuclear Phys. 4, 579(1957)
57K56 E.M.Krisiuk, A.G.Sergeev, G.D.Latyshev, K.I.Ilin, V.I.Fadeev - Zhur.Eksptl.i Teoret.Fiz. 33, 1144(1957); Soviet Phys.JETP 6, 880(1958)
57K65 G.M.Karavaev, S.A.Rusinova - Trudy Vsesoyuz.Nauch.-Issledovatel.Inst.Metrol. 30, 132(1957)
Precise Measurements of Half Lives
57M17 L.B.Magnusson - Phys.Rev. 107, 161(1957)
57M47 W.F.Merritt, P.J.Campion, R.C.Hawkings - Can.J.Phys. 35, 16(1957)
57M50 R.L.Macklin - Nuclear Instr. 1, 335(1957)
57N10 R.Nierhaus, H.Daniel - Z.Naturforsch. 12a, 1(1957)
57N11 K.O.Nielsen, O.B.Nielsen, M.A.Waggoner - Nuclear Phys. 2, 476(1957)
57N17 E.Norbeck, Jr., C.S.Littlejohn - Phys.Rev. 108, 754(1957)
57P09 D.F.Peppard, G.W.Mason, S.W.Moline - J.Inorg.Nuclear Chem. 5, 141(1957)
57P12 J.R.Penning, F.H.Schmidt - Phys.Rev. 105, 647(1957)
57P20 C.L.Peacock - NP-6325 (1957)
Study of Nuclear Disintegrations

57P36 F.T.Porter, F.Wagner,Jr., M.S.Freedman - Phys.Rev. 107, 135 (1957)
57P51 V.Parfenova, N.V.Forafontov, V.S.Shpinel - Izvest.Akad.Nauk SSSR, Ser.Fiz. 21, 1061 (1957); Columbia Tech.Transl. 21, 1590 (1958)
57P53 I.D.Prokoshkin, A.A.Tiapkin - Zhur.Eksptl.i Teoret.Fiz. 32, 177(1957); Soviet Phys.JETP 5, 148(1957)
57R20 S.Rosenblum, M.Valadares, J.Milsted - J.phys.radium 18, 609(1957)
57R21 M.E.Rose, D.K.Holmes - ORNL-1022 (1957)
The Effect of the Finite Size of the Nucleus in Beta-Decay
57R41 R.A.Ricci - Physica 23, 693 (1957)
57S23 J.Scobie - Nuclear Phys. 3, 465 (1957)
57S92 F.S.Stephens,Jr., F.Asaro, I.Perlman - Phys.Rev. 107, 1091(1957)
57S105 N.Starfelt, J.Cederlund - Phys.Rev. 105, 241 (1957)
57T11 H.Thiry - Bull.soc.roy.sci.Liege 26, 29(1957)
57W37 H.W.Wright, E.I.Wyatt, S.A.Reynolds, W.S.Lyon, T.H.Handley - Nuclear Sci.And Eng. 2, 427(1957)
Half-Lives of Radionuclides. I
57W43 G.W.Wetherill - Science 126, 545(1957)
57Y06 T.Yuasa, J.Laberrigue-Frolow, L.Feuvrais - J.phys.radium 18, 498 (1957)
57Z03 G.B.Zorzoli - Nuovo cimento 5, 289 (1957)
57Z05 A.I.Zhernovoi, E.M.Krisiuk, G.D.Latyshev, A.S.Remennyi, A.G.Sergeev, V.I.Fadeev - Zhur.Eksptl.i Teoret.Fiz. 32, 682(1957); Soviet Phys.JETP 5, 563(1957)
58A115 S.E.Arnell, J.Dubois, O.Almen - Nuclear Phys. 6, 196(1958)
58B11 I.M.Band, L.N.Zyrianova, I.P.Suslov - Izvest.Akad.Nauk SSSR, Ser.Fiz. 22, 952(1958); Columbia Tech.Transl. 22, 943 (1959)
Tables of Functions Needed for Determining the Probability of Allowed and Forbidden L-Capture
58B13 H.Brysk, M.E.Rose - Revs.Modern Phys. 30, 1169 (1958)
Theoretical Results on Orbital Capture
58B45 G.Bastin-Scoffier, R.J.Walen - Compt.rend. 247, 2333(1958)
58B74 W.L.Bendel, J.McElhinney, R.A.Tobin - Phys.Rev. 111, 1297(1958)
58B81 N.Benczer-Koller - Thesis, Columbia University (1958); CU-177 (1958)
The Beta and Gamma Radiations of Br^{82} and Rb^{82} and the Energy Levels of Kr^{82}
58B87 G.R.Bishop - Nuclear Phys. 5, 358(1958)
58B92 D.H.Beyers, R.Stump - Phys.Rev. 112, 77(1958)
58B192 A.R.Brosi, B.H.Ketelle - Priv.Comm. (1958)
58B214 L.Burkinshaw - Phys.In Med.Biol. 2, 255(1958)
58C08 E.L.Chupp, J.W.M.Dumond, F.J.Gordon, R.C.Jopson, H.Mark - Phys.Rev. 109, 2036 (1958)
Precision Determination of Some Energy Levels in Fe^{57}, Zn^{67}, and Tc^{99}
58C20 P.J.Campion, J.S.Merritt - Can.J.Phys. 36, 983(1958)
58C28 G.D.Cheever, W.S.Koski, D.R.Tilley, L.Madansky - Phys.Rev. 110, 922 (1958)
58D03 H.Daniel - Z.Physik 150, 144 (1958)
58D09 H.Daniel, U.Schmidt-Rohr - Nuclear Phys. 7, 516(1958)
58D10 H.Daniel - Nuclear Phys. 8, 191 (1958)
58D25 F.Demichelis, B.Chinaglia, G.Trivero - Nuovo cimento 8, 369(1958)
58D88 N.A.Dyson, P.R.Francois - Phys.In Med.Biol. 3, 111(1958)
58E19 K.Edvarson, K.Siegbahn, A.H.Wapstra - Quoted by 58N28
58E44 A.J.Elwyn, H.H.Landon, S.Oleksa, G.N.Glasoe - Phys.Rev. 112, 1200 (1958)
Study of Some (p,n) Reactions by Neutron Time-of-Flight
58G06 R.K.Girgis, R.van Lieshout - Physica 24, 672(1958)
58G93 D.P.Gregory, D.A.Landsman - Phys.Rev. 109, 2091 (1958)
58G99 R.L.Graham, J.S.Geiger, T.A.Eastwood - Can.J.Phys. 36, 1084 (1958)
58G107 E.P.Grigorev, A.V.Zolotavin, I.I.Kuzmin, E.D.Pavlitskaia - Izvest.Akad.Nauk SSSR, Ser.Fiz. 22, 194 (1958); Columbia Tech.Transl. 22, 191 (1959)
58H32 J.H.Hamilton, L.M.Langer, W.G.Smith - Phys.Rev. 112, 2010 (1958)
58H76 R.L.Hickok, W.A.McKinley, S.C.Fultz - Phys.Rev. 109, 113 (1958)
58H109 Y.C.Hsu, L.S.Cheng - Wu Li Hsueh Pao 14, 114 (1958)
58J01 C.H.Johnson, A.Galonsky, J.P.Ulrich - Phys.Rev. 109, 1243(1958)
58J22 M.C.Joshi, B.N.Subba Rao, B.V.Thosar - Nuovo cimento 9, 600 (1958)
58K13 K.Kamada, T.Teranishi, Y.Yoshizawa - J.Phys.Soc.Japan 13, 763 (1958)
58K26 J.P.Keene, L.A.Mackenzie, C.W.Gilbert - Phys.In Med.Biol. 2, 360(1958)
58K34 T.Katoh, M.Nozawa, Y.Yoshizawa, Y.Koh - J.Phys.Soc.Japan 13, 1419 (1958)
58K57 J.Konijn, B.van Nooijen, H.L.Hagedoorn - Physica 24, 377 (1958)
58K64 J.Konijn, H.L.Hagedoorn, H.Van Krugten, J.Slobben - Physica 24, 931 (1958)
58K66 I.Y.Krause - Z.Physik 151, 210 (1958)
58K71 I.Y.Krause - Z.Physik 152, 586(1958)
58L61 T.P.Loftus, R.M.Lee - Priv.Comm. (January 1958)
58L69 W.S.Lyon - Nuclear Sci. and Eng. 4, 709 (1958)
58M02 F.K.McGowan, P.H.Stelson - Phys.Rev. 109, 901 (1958)
58N28 G.J.Nijgh, A.H.Wapstra, L.T.M.Ornstein, N.Salomons-Grobben, J.R.Huizenga, O.Almen - Nuclear Phys. 9, 528 (1958)

58P64 M.M.Popov, Yu.V.Gagarinskii, M.D.Senin, T.P.Mikhalenko, Yu.M.Morozov - Atomnaya Energ. 4, 296(1958); J.Nuclear Energy 9, 190(1959)
58P71 A.N.Protopopov, G.M.Tolmacher, V.N.Ushatski, R.V.Venediktova, I.T.Krisuk, L.P.Rodionova, G.V.Iakovleva - Atomnaya Energ. 5, 130(1958); J.Nuclear Energy 10A, 80(1959)
58R07 R.L.Robinson, L.M.Langer - Phys.Rev. 109, 1255 (1958)
58R23 W.Riezler, G.Kauw - Z.Naturforsch. 13a, 904 (1958)
58R62 R.L.Robinson, L.M.Langer - Phys.Rev. 112, 481 (1958)
58S49 H.H.Seliger, W.B.Mann, L.M.Cavallo - J.Research Natl.Bur.Standards 60, 447(1958)
58S53 H.H.Seliger, L.M.Cavallo - Priv.Comm. (January 1958)
58S110 A.H.Snell, F.Pleasonton - Phys.Rev. 111, 1338 (1958)
58S117 A.Speecke, J.Hoste - Bull.soc.chim.Belges 67, 131(1958)
58S171 V.A.Sergienko - Izvest.Akad.Nauk SSSR, Ser.Fiz. 22, 198 (1958); Columbia Tech.Transl. 22, 195 (1959)
58T10 J.Tousset, A.Moussa - J.phys.radium 19, 39(1958)
58V31 S.S.Vasilev, L.Y.Shavtvalov - Izvest.Akad.Nauk SSSR, Ser.Fiz. 22, 788 (1958); Columbia Tech.Transl. 22, 782 (1959)
β-Spectra of the Short-Lived Isotopes Al^{28} and F^{17}
58W08 A.H.Wapstra, G.J.Nijgh, N.Salomons-Grobben, L.T.M.Ornstein - Nuclear Phys. 9, 538 (1958)
58W09 F.A.White, F.M.Rourke, J.C.Sheffield, R.P.Schuman, J.R.Huizenga - Phys.Rev. 109, 437 (1958)
Absolute Measurement of Alpha Particles from Po^{210}
58W16 R.J.Walen, G.Bastin - Compt.Rend.Congr.Intern.Phys.Nucl., Paris (1958),P.Gugenberger, Ed., Dunod, Paris, p.910(1959)
Quelques Structures Fines dans la Famille du Radium
58W69 J.C.Wallmann, P.Graf, L.Goda - J.Inorg.Nucl.Chem. 7, 199 (1958)
The Specific Activities and Half Lives of Americium-241 and Americium-243
58Y01 Y.Yoshizawa - Nuclear Phys. 5, 122 (1958)
59B30 A.A.Bashilov, V.V.Ilin - Izvest.Akad.Nauk SSSR, Ser.Fiz. 23, 154 (1959); Columbia Tech.Transl. 23, 149 (1960)
59B161 P.Boskma, H.de Waard - Nuclear Phys. 14, 145 (1959)
59B188 V.E.Bunakov, B.S.Dzhelepov, I.Zvolskii, V.A.Sergienko - Izvest.Akad.Nauk SSSR, Ser.Fiz. 23, 859 (1959); Columbia Tech.Transl. 23, 851 (1960)
59B208 S.B.Burson, H.A.Grench, L.C.Schmid - Phys.Rev. 115, 188 (1959)
59C01 C.H.Carlson, L.Singer, D.H.Service, W.D.Armstrong - Intern.J.Appl.Radiation and Isotopes 4, 210(1959)
59C12 J.P.Cali, L.F.Lowe - Nucleonics 17, No.10, 86(1959)
59C56 R.D.Cooper, E.S.Cotton - Science 129, 1360(1959)
59C77 D.C.Conway, W.H.Johnston - Phys.Rev. 116, 1544 (1959)
59D103 B.S.Dzhelepov, V.A.Eliseev, V.P.Prikhodtseva, Y.V.Kholnov - Izvest.Akad.Nauk SSSR, Ser.Fiz. 23, 207 (1959); Columbia Tech.Transl. 23, 199 (1960)
59E41 J.O.Elliot, F.C.Young - Nuclear Sci.And Eng. 5, 55(1959)
59F18 J.M.Ferguson - Nuclear Phys. 12, 579 (1959)
59F27 R.W.Fink, B.L.Robinson - Nuclear Phys. 10, 82(1959)
59F40 K.F.Flynn, L.E.Glendenin - Phys.Rev. 116, 744 (1959)
59F54 N.J.Freeman - Proc.Phys.Soc.(London) 74, 449 (1959)
59G45 R.K.Girgis, R.A.Ricci, R.van Lieshout - Nuclear Phys. 13, 461 (1959)
59G55 G.I.Gleason - Phys.Rev. 113, 287 (1959)
59G59 R.K.Girgis, R.van Lieshout - Physica 25, 133(1959)
59G80 G.V.Gorshkov, Z.G.Gretchenko, T.A.Ilyunskaya, B.S.Kuznetsov, N.S.Shimanskaya - Atomnaya Energ. 7, 445(1959); Atomic Energy (USSR)(English Translation) 7, 912(1959)
59G109 L.Grigorescu, P.Sandru - Acad.rep.populare Romine, Inst.fiz.Studii cercetari fiz. 10, 366(1959); Nuclear Sci.Abstr. 14, 390, Abstr.2971(1960)
59H27 D.S.Harmer, M.L.Perlman - Phys.Rev. 114, 1133 (1959)
59J17 S.Jha, H.G.Devare, M.N.Rao, R.M.Singru - Nuovo cimento 11, 788 (1959)
59K20 V.M.Kelman, R.Y.Metskhvarishvili - Zhur.Eksptl.i Teoret.Fiz. 36, 694 (1959); Soviet Phys.JETP 9, 486 (1959)
59K26 W.H.Kelly, G.B.Beard, R.A.Peters - Nuclear Phys. 11, 492(1959)
59K58 G.E.Kocharov, A.P.Komar, G.A.Korolev - Zhur.Eksptl.i Teoret.Fiz. 36, 68(1959); Soviet Phys.JETP 9, 48(1959)
59K99 O.C.Kistner, E.M.Rustad - Phys.Rev. 114, 1329(1959)
Ratio of the Gamow-Teller and Fermi Coupling Constants Determined from ft Values
59L30 R.D.Leamer - Phys.Rev. 114, 1590 (1959)
59M12 G.R.Martin, D.G.Tuck - Intern.J.Appl.Radiation and Isotopes 5, 141(1959)
59M27 J.Mackin, D.Love - J.Inorg.Nuclear Chem. 10, 17(1959)
59M76 F.R.Metzger, W.B.Todd - Nuclear Phys. 10, 220 (1959)
59M117 H.Morinaga, N.Matsuro, M.Sugawara - Phys.Rev. 114, 1146 (1959)
59M122 A.C.G.Mitchell, J.O.Juliano, C.B.Creager, C.W.Kocher - Phys.Rev. 113, 628(1959)
59M127 M.Morita - Phys.Rev. 113, 1584 (1959)
Higher Order Corrections to the Allowed Beta Decay

59N06 R.S.Narcisi - Thesis, Harvard University (1959); AECU-4336 (1959)
The Radioactivity of Sb^{125} and Te^{125m}
59O37 R.G.Osmond, M.J.Owers - J.Inorg.Nuclear Chem. 9, 96(1959)
59P43 A.Pierroux, G.Gueben, J.Gobaerts - Bull.soc.roy.sci.Liege 28, 180(1959)
59P64 A.Poularikas, R.W.Fink - Phys.Rev. 115, 989(1959)
59P77 F.T.Porter, P.P.Day - Phys.Rev. 114, 1286 (1959)
59P78 F.T.Porter - Phys.Rev. 115, 450 (1959)
59R51 J.Robert - Ann.phys. 4, 89(1959)
59R61 J.Robert - J.phys.radium 20, 830(1959)
59R64 V.N.Rybakov, I.I.Stronskii - Atomnaya Energ. 6, 208(1959); Atomic Energy (USSR)(English Translation) 6, 125(1959)
Production of Sb^{125} and In^{113m} without Carriers
59S10 P.S.Samoilov - Izvest.Akad.Nauk SSSR, Ser.Fiz. 23, 1416(1959); Columbia Tech.Transl. 23, 1401(1960)
59S27 W.Schmidt-Ott - Z.Physik 154, 286 (1959)
59S32 J.Scobie, R.B.Moler, R.W.Fink - Phys.Rev. 116, 657 (1959)
59S57 A.K.Sen Gupta, R.Bhattacharyya, J.Lahiri, P.N.Mukherjee - Indian J.Phys. 33, 388 (1959)
59S59 A.G.Sergeyev, V.D.Vorolyev, A.S.Remenny, T.J.Kolchenskaya, G.D.Latyshev, Y.S.Yegorov - Nuclear Phys. 9, 498(1959)
59W11 A.H.Wapstra, G.J.Nijgh, R.van Lieshout - Nuclear Spectroscopy Tables, North Holland Publishing Co., Amsterdam, and Interscience Publishers, Inc., New York (1959)
59W13 A.C.Wahl - J.Inorg.Nuclear Chem. 10, 1(1959)
60Ar6 E.Arbman, S.Bjornholm, O.B.Nielsen - Nuclear Phys. 21, 406(1960)
60Ar10 K.P.Artamonova, L.V.Gustova, Y.N.Podkopaev, O.V.Chubinskii - Zh.Eksperim.i Teor.Fiz. 39, 1593 (1960); Soviet Phys.JETP 12, 1109 (1961)
The Gamma Spectrum of Na^{24} in the 2.5-5.5 MeV Energy Range
60Ba13 G.Backstrom, I.Marklund - Arkiv Fysik 17, 393 (1960)
60Ba49 A.P.Baerg, R.M.Bartholomew, R.H.Betts - Can.J.Chem. 38, 2147(1960)
60Be6 D.Berenyi, G.Mathe, T.Scharbert - Nuclear Phys. 14, 459 (1960)
60Be11 P.Bergvall - Arkiv Fysik 17, 125 (1960)
60Bo8 G.E.Boyd, Q.V.Larson, E.E.Motta - J.Am.Chem.Soc. 82, 809(1960)
60Bo25 H.E.Bosch, D.J.Horen - UCRL-9385 (1960)
Search for a 0^+, 2^+, 4^+ Triplet in the Vicinity of 1.140 MeV in Pd^{106}
60Bo38 R.Bouchez, P.Depommier - Repts.Progr.In Phys. 23, 395 (1960)
Orbital Electron Capture by the Nucleus
60Ca18 P.J.Campion, J.G.V.Taylor, J.S.Merritt - Intern.J.Appl. Radiation and Isotopes 8, 8 (1960)
60De6 M.de Croes, G.Backstrom - Arkiv Fysik 16, 567 (1960)
60De14 C.de Vries - Nuclear Phys. 18, 428(1960)
60De17 C.de Vries, E.J.Bleeker, N.Salomons-Grobben - Nuclear Phys. 18, 454 (1960)
60Dz5 B.S.Dzhelepov, E.A.Emelyanov, K.P.Kupriyanova, Y.N.Podkopaev - Izvest.Akad.Nauk SSSR, Ser.Fiz. 24, 288 (1960); Columbia Tech.Transl. 24, 275 (1961)
60Ea2 H.T.Easterday, R.L.Smith - Nuclear Phys. 20, 155(1960)
60Em1 G.T.Emery, W.R.Kane - Phys.Rev. 118, 755(1960)
60Ew4 G.T.Ewan, R.L.Graham, J.S.Geiger - Nuclear Phys. 19, 221 (1960)
M1/E2 Mixing Ratio in the Fe^{57} 14.41 keV γ-Transition
60Fa7 T.A.Farley - Can.J.Phys. 38, 1059(1960)
60Fe3 L.Feuvrais - Ann.phys. 5, 181 (1960)
Les Noyaux de Nombre de Masse A et de Nombre de Charge Z Impairs de la Region Ou A Est Voisin de 190
60Fu3 E.Fuschini, G.Giacometti, C.Maroni, P.Varonesi - Nuovo cimento 16, 886(1960)
60Ga15 Y.N.Gangrskii, G.M.Gusinskii, I.K.Lemberg - Izvest.Akad.Nauk SSSR, Ser.Fiz. 24, 1449(1960); Columbia Tech.Transl. 24, 1443(1961)
60Ge5 J.S.Geiger, R.L.Graham, G.T.Ewan - Nuclear Phys. 16, 1 (1960)
60Go6 G.Goetze - Z.Physik 158, 347 (1960)
60Gr3 E.P.Grigoriev, A.V.Zolotavin - Nuclear Phys. 14, 443 (1960)
60Gr38 R.L.Graham, G.T.Ewan, J.S.Geiger - Nuclear Instr.and Methods 9, 245 (1960)
A One-Meter-Radius Iron-Free Double-Focusing $\pi\sqrt{2}$ Spectrometer for Beta-Ray Spectroscopy with a Precision of $1:10^5$
60Ja12 J.Janecke - Z.Naturforsch. 15a, 593(1960)
60Jo7 O.E.Johnson, W.G.Smith - Phys.Rev. 118, 1315 (1960)
60Jo17 M.C.Joshi, B.V.Thosar - Proc.Intern.Conf.Nucl.Struct., Kingston, Canada, D.A.Bromley, E.W.Vogt, Ed., Univ.Toronto Press p.623 (1960)
60Ka9 E.Karlsson, K.Siegbahn - Nuclear Instr.And Methods 7, 113(1960)
60Ka20 T.Katoh, M.Nozawa, Y.Yoshizawa, Y.Koh - J.Phys.Soc. Japan 15, 2140 (1960)
60Ki2 J.D.King, R.N.H.Haslam, R.W.Parsons - Can.J.Phys. 38, 231(1960)
60Ko6 J.Konijn, B.van Nooijen, A.H.Wapstra - Nuclear Phys. 16, 683 (1960)
60La4 L.M.Langer, D.R.Smith - Phys.Rev. 119, 1308 (1960)
60Lu7 G.Luhrs, C.Mayer-Boricke - Z.Naturforsch. 15a, 939 (1960)
60Ma5 C.Mayer-Boricke, G.Luhrs - Z.Naturforsch. 15a, 103(1960)

60Pe5 N.Perrin - Ann.phys. 5, 71 (1960)
Contribution a l'Etude de la Spectroscopie Nucleaire par la Methode des Coincidences. Application a la Desintegration des Rh 101 et 102, a l'Evaluation des Rapports Capture K sur Capture L et a la Determination des Coefficients de Conversion
60Pe23 R.W.Peelle - ORNL-3016, p.110 (1960); Nucl.Sci.Abstr. 15, 872, Abstr. 6770 (1961)
Gamma-Ray Intensity Ratios in the Decay of 105-Day Y^{88}
60Ra11 W.Rausch, W.Schmidt - Physik.Verhandl. 11, 66(1960)
60Ri6 R.A.Ricci, G.Chilosi, G.Varcaccio, G.B.Vingiani, R.van Lieshout - Nuovo cimento 17, 523 (1960)
60Ro16 P.G.Roetling, W.P.Ganley, G.S.Klaiber - Nuclear Phys. 20, 347(1960)
60Po22 J.Robert - J.phys.radium 21, 808(1960)
60Ry1 A.Rytz - Compt.rend. 250, 3156(1960)
60Sa3 Y.Saji - J.Phys.Soc.Japan 15, 367(1960)
60Sa22 H.J.Sathoff, T.Azuma - TID-6080, App.8 (1960)
Decay of Cerium-144
60Sc7 G.Schupp, H.Daniel, G.W.Eakins, E.N.Jensen - Phys.Rev. 120, 189(1960)
60Sc16 T.Scharbert, D.Berenyi, G.Mathe - Acta Phys.Acad.Sci.Hung. 12, 305 (1960); Nucl.Sci.Abstr. 15, 2956, Abstr.22937 (1961)
60Se5 O.J.Segaert, J.Demuynck, A.M.Hoogenboom, H.van den Bold - Nuclear Phys. 16, 138 (1960)
60St20 F.S.Stephens, F.Asaro, I.Perlman - Phys.Rev. 119, 796(1960)
60Su6 A.W.Sunyar, M.Goldhaber - Phys.Rev. 120, 871 (1960)
60Su10 B.N.Subba Rao - Proc.Indian Acad.Sci. 8A, 130 (1960)
60Wa14 R.J.Walen, G.Bastin-Scoffier - Nuclear Phys. 16, 246(1960)
60Wo7 G.Wolf - Nukleonik 2, 255(1960); Nuclear Sci.Abstr. 15, 1945, Abstr.15078(1961)
60Yu2 H.P.Yule, A.Turkevich - Phys.Rev. 118, 1591(1960)
61Ag2 I.I.Agirbiceanu, V.Tatu - Compt.rend. 252, 3979(1961)
61Be13 E.H.Beckner, R.L.Bramblett, G.C.Phillips, T.A.Eastwood - Phys.Rev. 123, 2100 (1961)
61Be41 G.B.Beard, W.H.Kelly - Nuclear Phys. 28, 570(1961)
61Bi10 E.I.Biryukov, B.S.Kuznetsov, N.S.Shimanskaya - Zhur.Eksptl.i Teoret.Fiz. 41, 22 (1961); Soviet Phys.JETP 14, 16 (1962)
61Br9 F.Brown, R.L.Graham, G.T.Ewan, J.Uhler - Can.J.Phys. 39, 779 (1961)
61Ca5 D.C.Camp, L.M.Langer, D.R.Smith - Phys.Rev. 123, 241 (1961)
61De3 P.Depommier, M.Chabre - Compt.rend. 252, 1587 (1961)
Forme Precise Due Spectre β de ^{198}Au
61De17 H.G.Devare - Nuclear Phys. 28, 148 (1961)
On the Decay of I^{132}
61De25 P.Depommier, M.Chabre - J.phys.radium 22, 656 (1961)
61De26 J.P.Deutsch, L.Grenacs, J.Lehmann, P.Lipnik - J.phys.radium 22, 659 (1961)
61Du8 M.Duquesne - Ann.phys. 6, 643 (1961); Nuclear Sci.Abstr. 15, 3667, Abstr.28465 (1961)
Etude de l'Emission d'Electrons Negatifs Accompagnant les Radioactivites β^- et α par la Technique des Coincidences
61Ed2 W.F.Edwards, C.J.Gallagher,Jr. - Nuclear Phys. 26, 649 (1961)
61El3 L.R.B.Elton - Nuclear Sizes, Oxford Univ.Press, London (1961)
61Er4 P.Erman, Z.Sujkowski - Arkiv Fysik 20, 209 (1961)
61Fa3 H.Farrar, A.K.Dasgupta, R.H.Tomlinson - Can.J.Chem. 39, 681(1961)
61Fo12 M.S.Foster, D.L.Weaver, A.F.Voigt - Intern.J.Appl.Radiation and Isotopes 12, 60(1961)
Photoproduction of Calcium-47
61Ge1 J.S.Geiger, R.L.Graham, G.T.Ewan - Bull.Am.Phys.Soc. 6, No.1, 71, XA2 (1961)
61Ge9 J.S.Geiger, R.L.Graham, G.T.Ewan - Nuclear Phys. 28, 387 (1961)
61Gi2 M.Giannini, D.Prosperi, S.Sciuti - Nuovo cimento 21, 430(1961)
61Gl7 L.E.Glendenin - Ann.N.Y.Acad.Sci. 91, 166(1961)
Present Status of the Decay Constants
61Go19 S.Gorodetzky, N.Schulz, R.Manquenouille, R.Richert, A.C.Knipper - Priv.Comm. (October 1961); See Also 61Go24
61Go24 S.Gorodetzky, R.Manquenouille, R.Richert, A.C.Knipper - Proc.Conf. Electromagnetic Lifetimes and Properties Nuclear States, Gatlinburg, Tennessee (October 1961); NAS-NRC Publ.974, p.79 (1962)
Measurements of Nuclear Lifetimes with a Time-to-Height Converter
61Hu12 S.Hultberg, D.J.Horen, J.M.Hollander - Nuclear Phys. 28, 471 (1961)
61Jo12 B.R.Joshi - Proc.Phys.Soc.(London) 77, 1205 (1961)
61Jo22 B.R.Joshi, G.M.Lewis - Proc.Phys.Soc. (London) 78, 1056 (1961)
61Jo26 E.T.Jozefowicz - Nukleonika 6, 379(1961); Phys.Abstr. 65, 579, Abstr.5850(1962)
61Ju5 B.Jung, J.Svedberg - Arkiv Fysik 19, 429 (1961)
61Ko11 G.E.Kocharov, G.A.Korolev - Izvest.Akad.Nauk SSSR, Ser.Fiz. 25, 237 (1961); Columbia Tech.Transl. 25, 227 (1962)
61Kr4 V.A.Krutov, V.G.Gorshkov - Gamma Rays, USSR Acad.Sci., Moscow-Leningrad, p.508 (1961)
61Li16 M.A.Listengarten - Izvest.Akad.Nauk SSSR, Ser.Fiz. 25, 792 (1961); Columbia Tech.Transl. 25, 803 (1962)
Calculation of the Probability of the Auger Effect
61Ma46 P.G.Marais, J.Deist - S.African J.Agr.Sci. 4, 627(1961)
Half-Life of ^{32}P

61Mc3 J.D.McCullen, J.J.Kraushaar - Phys.Rev. 122, 555 (1961)
61Mc7 A.McNair, H.W.Wilson - Phil.Mag. 6, 563(1961)
61Mo9 J.E.Monahan, S.Raboy, C.C.Trail - Phys.Rev. 123, 1373 (1961)
61Mo10 S.Monaro, R.A.Ricci, R.van Lieshout - Nuovo cimento, Suppl. 19, 329(1961)
61Ne12 L.Nemet - Izvest.Akad.Nauk SSSR, Ser.Fiz. 25, 68 (1961); Columbia Tech.Transl. 25, 68 (1962)
61Ne15 R.D.Newman - Priv.Comm. (December 1961)
Half-Lives of I-132, Mg-28, Tc-99m, Mo-99, and Al-28
61Ni2 R.T.Nichols, R.E.McAdams, E.N.Jensen - Phys.Rev. 122, 172 (1961)
61Ni11 R.T.Nichols, R.E.McAdams, E.N.Jensen - IS-252 (1961); Nucl.Sci.Abstr. 16, 4084, Abstr.30164 (1962)
Small Order Shape Factor in Na^{22}
61Oz1 Y.Ozias, H.Roux, P.Boivinet, E.Calvet - Compt.rend. 253, 2944(1961)
Determination Microcalorimetrique des Caracteristiques d'Un Element Radioactif
61Pe7 B.G.Pettersson, J.E.Thun, T.R.Gerholm - Nuclear Phys. 24, 243(1961)
61Pi1 W.L.Pillinger, J.J.Hentges, J.A.Blair - Phys.Rev. 121, 232 (1961)
61Ra4 J.Ravier, P.Marguin, A.Moussa - J.phys.radium 22, 249 (1961)
61Re6 I.Rezanka, J.Frana, M.Vobecky, A.Mastalka - J.Inorg.Nuclear Chem. 18, 13(1961)
61Ry2 A.Rytz - Helv.Phys.Acta 34, 240(1961)
61Ry5 A.Rytz, H.H.Staub, H.Winkler - Helv.Phys.Acta 34, 960 (1961)
61Si7 A.N.Silantev, B.S.Kuznetsov - Izvest.Akad.Nauk SSSR, Ser.Fiz. 25, 1186 (1961); Columbia Tech.Transl. 25, 1191 (1962)
61Su4 K.Sugiyama, A.Furusawa, S.Hayashibe, M.Kimura - J.Phys.Soc.Japan 16, 1538 (1961)
61Su10 Z.Sujkowski - Arkiv Fysik 20, 243 (1961)
61To10 J.Tousset, A.Moussa - J.phys.radium 22, 683(1961)
61Wa16 D.E.Watt, D.Ramsden, H.W.Wilson - Intern.J.Appl.Radiation and Isotopes 11, 68(1961); Nuclear Sci.Abstr. 15, No.24A, 4221, Abstr.32740(1961)
61Wi19 D.C.Williams, J.W.Irvine, Jr. - MIT-LNS Progr.Report, p.33 (November 1961); NYO-2668
A Study of (d,He^3) Nuclear Excitation Functions
61Wo1 J.L.Wolfson - Can.J.Phys. 39, 468(1961)
61Wy1 E.I.Wyatt, S.A.Reynolds, T.H.Handley, W.S.Lyon, H.A.Parker - Nuclear Sci.And Eng. 11, 74(1961)
62Am3 S.Y.Ambiye, R.P.Sharma - Nuclear Phys. 29, 657 (1962)
62Ba19 G.Bastin-Scoffier - Compt.rend. 254, 3854 (1962)
62Be9 G.Bertolini, F.Capellani, G.Restelli, A.Rota - Nuclear Phys. 30, 599(1962)
62Be29 D.Berenyi - Phys.Letters 2, 332 (1962)
62Br15 H.W.Brandhorst, Jr., J.W.Cobble - Phys.Rev. 125, 1323 (1962)
62Ca32 E.J.Callan - Bull.Am.Phys.Soc. 7, No.6, 416, V1 (1962)
K-Level Widths for Atoms of $16<Z<83$
62Ch15 C.J.Ching, L.S.Novikov - Zhur.Eksptl.i Teoret.Fiz. 42, 364 (1962); Soviet Phys.JETP 15, 252 (1962)
62Da3 H.Daniel - Nuclear Phys. 31, 293 (1962)
62Da5 H.Daniel, H.Schmitt - Z.Physik 168, 292 (1962)
62Do7 P.W.Dougan, K.W.D.Ledingham, R.W.P.Drever - Phil.Mag. 7, 1223 (1962)
62En1 D.W.Engelkemeir, K.F.Flynn, L.E.Glendenin - Phys.Rev. 126, 1818 (1962)
62En6 J.Engelmann - Thesis, Univ.Paris (1962); CEA-2036 (1962)
Mesure de l'Activite des Emetteurs Gamma par Chambres d'Ionisation. Determination du Coefficient Specifique d'Emission Gamma de Quelques Radioelements
62Fl4 J.M.Flores - Phys.Rev. 127, 1246(1962)
62Fl5 D.G.Fleishman, V.V.Glazunov - At.Energ.USSR 12, 320(1962); Soviet J.At.Energy 12, 338(1962)
Determination of the β-Decay Constant of K^{40}
62Fl9 D.G.Fleishman, I.V.Burovina, V.P.Nesterov - At.Energ.USSR 13,592(1962); Soviet J.At.Energy 13, 1224(1962)
Half-Life of Cs^{137}
62Fo4 N.V.Forafontov, V.S.Shpinel, Ts.Vasilev - Nuclear Phys. 35, 260 (1962)
62Fr13 W.F.Frey, J.H.Hamilton, S.Hultberg - Arkiv Fysik 21, 383 (1962)
62Ge9 J.S.Geiger, R.L.Graham, F.Brown - Can.J.Phys. 40, 1258 (1962)
62Go33 H.Godwin - Nature 195, 984(1962)
Half-Life of Radiocarbon
62Ha25 J.H.Hamilton, R.V.Stockendal, D.C.Camp, L.M.Langer, D.R.Smith - Nuclear Phys. 36, 567 (1962)
62He9 C.J.Herrlander, R.L.Graham - Bull.Am.Phys.Soc. 7, No.7, 491, QA5 (1962)
62Ho5 D.L.Horrocks, A.L.Harkness - Phys.Rev. 125, 1619(1962)
62Hu7 W.Hunzinger, P.Huber - Helv.Phys.Acta 35, 351 (1962)
62Ka25 M.Kantola, V.Sutela - Ann.Acad.Sci.Fennicae, Ser. A VI, No.107 (1962)
Decay Scheme of Fe^{59}
62Ko12 G.A.Korolev, G.E.Kocharov - Izvest.Akad.Nauk SSSR, Ser.Fiz. 26, 235(1962); Columbia Tech.Transl. 26, 233(1963)
62Kr1 P.Kramer, E.C.Bos, A.de Beer, J.Blok - Physica 28, 569 (1962)
Measurements on Electron Capture Branching Ratios in the Decay of the Nuclides ^{54}Mn, ^{65}Zn and ^{57}Co

62Kr2 P.Kramer, A.De Beer, J.Blok - Physica 28, 587 (1962)
62Le5 H.Leutz, K.Ziegler - Z.Physik 166, 582(1962)
62Le6 Y.K.Lee, C.S.Wu - CU(PNPL)-218, p.47(1962)
62Li19 M.A.Listengarten - Izvest.Akad.Nauk SSSR, Ser.Fiz. 26, 182 (1962); Columbia Tech.Transl. 26, 182 (1963)
Calculations of the Auger Effect Probability for Heavy Elements
62Ma26 C.Manduchi, G.Zannoni - Nuclear Phys. 36, 497 (1962)
Measurement of the L/K and M/L Capture Ratios in ^{71}Ge Decay
62Ma33 D.MacArthur, R.Goodman, A.Artna, M.W.Johns - Nuclear Phys. 38, 106 (1962)
62Ma38 S.Malmskog, J.Konijn - Nuclear Phys. 38, 196(1962)
62Me6 J.S.Merritt, J.G.V.Taylor - Can.J.Phys. 40, 1044(1962)
62Mo9 J.E.Monahan, S.Raboy, C.C.Trail - Nuclear Phys. 33, 633 (1962)
62Mo21 J.E.Monahan, S.Raboy, C.C.Trail - Nuclear Instr.Methods 17, 225(1962)
Measurements of Lifetimes of Radioactive Sources
62Ni1 R.Nilsson - Nuclear Phys. 29, 66(1962)
62Oc2 A.G.S.Ocampo, D.C.Conway - Phys.Rev. 128, 258 (1962)
62Ol4 I.U.Olsson, I.Karlen, A.H.Turnbull, N.J.D.Prosser - Arkiv Fysik 22, 237(1962)
A Determination of the Half-Life of C-14 with a Proportional Counter
62Pe19 B.Persson - Acta Radiol. 58, 192 (1962); Nuclear Sci.Abstr. 16, 3670, Abstr.28041 (1962)
62Ra3 M.K.Ramaswamy, B.A.Bishara, P.S.Jastram - Bull.Am.Phys.Soc. 7, No.4, 341, UA8 (1962)
62Sa12 A.R.Sattler - Phys.Rev. 127, 854(1962)
62Sa14 A.R.Sattler - Nuclear Phys. 36, 648 (1962)
62Ta6 J.G.V.Taylor - Can.J.Phys. 40, 383(1962)
62Ta11 J.G.V.Taylor, J.S.Merritt - Can.J.Phys. 40, 926 (1962)
62Va10 B.van Nooijen, H.van Krugten, W.J.Wiesehahn, A.H.Wapstra - Nuclear Phys. 31, 406 (1962)
62Wa15 D.E.Watt, R.N.Glover - Phil.Mag 7, 105 (1962)
62Wa28 R.J.Walen - Compt.rend. 255, 1604 (1962)
62We17 A.Weiss, M.Hillman - BNL-731, p.54(1962)
Counting Techniques
62Wi8 R.R.Wilson, A.A.Bartlett, J.J.Kraushaar, J.D.McCullen, R.A.Ristinen - Phys.Rev. 125, 1655 (1962)
62Wo9 J.L.Wolfson, J.J.H.Park, L.Yaffe - Nuclear Phys. 39, 613 (1962)
63Ba21 J.N.Bahcall - Phys.Rev. 129, 2683 (1963)
Overlap and Exchange Effects in Beta Decay
63Ba30 N.B.Badalov, S.S.Vasilenko, M.G.Kaganskii, D.L.Kaminskii - Izv.Akad.Nauk SSSR, Ser.Fiz. 27, 260 (1963); Bull.Acad.Sci.USSR, Phys.Ser. 27, 270 (1964)
Internal Pair Conversion in the Decay of As^{76}
63Ba62 G.Bastin-Scoffier, C.F.Leang, R.J.Walen - J.Phys. 24, 854 (1963)
Spectrographie α de ^{226}Ra et Niveaux des Rn de A Pair
63Ba72 J.N.Bahcall - Phys.Rev. 132, 362 (1963)
Exchange and Overlap Effects in Electron Capture and in Related Phenomena
63Ba74 J.N.Bahcall - Phys.Rev. 131, 1756 (1963)
Effect of Exchange on M/L Electron Capture Ratios
63Be47 K.Beg, F.Brown - Intern.J.Appl.Radiation Isotopes 14, 137(1963)
Production of Carrier-Free Radio-Fluorine-18 and Determination of its Half-Life
63Bo31 H.E.Bosch, T.Urstein - Nucl.Instr.Methods 24, 109 (1963)
Nuclear Studies by Means of Beta Spectroscopy with Scintillation Counters
63Bo43 P.Boivinet, E.Calvet, Y.Ozias - Compt.Rend. 256, 1103(1963)
Determination Microcalorimetrique des Caracteristiques de l'Yttrium 90 et de la Perte d'Energie Due au Freinage des β
63Bu09 R.Burmeister, H.Graber, J.Schintlmeister, R.Weibrecht - Nucl.Phys. 42, 56 (1963)
Bestimmung des K-Konversionskoeffizienten des 279 Kev-Ubergangs in Tl^{203}
63Ch13 G.Chandra, V.R.Pandharipande - Nucl.Phys. 46, 119 (1963)
Energy Levels of Te^{125}
63Cr14 W.L.Croft, B.-G.Pettersson, J.H.Hamilton - Nucl.Phys. 48, 267 (1963)
The K-Conversion Coefficient of the 279 keV Transition in Tl^{203} by a Coincidence Technique and Establishment as a Standard
63Da10 R.A.Damerow, R.R.Ries, W.H.Johnson, Jr. - Phys.Rev.132, 1673 (1963)
Atomic Masses from Ruthenium to Xenon
63Da11 H.Daniel, G.Luhrs - Z.Physik 176, 30(1963)
$\pi\sqrt{2}$-Spektrometers und Untersuchung des Konversionslinienspektrums von In-114m und ThB mit Folgeprodukten
63Dr04 R.W.P.Drever, A.Moljk - Quoted by 63Mo12
63Fu09 E.Fuschini, V.Gadjokov, C.Maroni, P.Veronesi - Nuovo Cimento 29, 311(1963)
On the Decay Scheme of Ca-47
63Fu16 M.Fujishiro, T.Azuma - Ann.Rept.Radiation Center Osaka Prefect. 4, 86 (1963)
Beta-Spectra of Ce-144
63Go03 S.G.Gorbics, W.E.Kunz, A.E.Nash - Nucleonics 21, No.1, 63(1963)
New Values for Half-Lives of Cs^{137} and Co^{60} Nuclides

63Go21 M.T.Goncalves - Compt.Rend. 257, 887(1963)
Spectre d'Electrons de Conversion Associes a la Transmutation du Radium 226 en Radon 222

63Gr41 K.Y.Gromov, A.S.Danagulyan, A.T.Strigachev, M.-L.Chou - JINR-P-1510 (1963)
Conversion Electrons of Yttrium Isotopes

63Ha08 C.K.Hargrove, K.W.Geiger, A.Chatterjee - Nucl.Phys. 40, 566 (1963)
The Decay of ^{131}I

63Ha17 G.Harbottle - Nucl.Phys. 41, 604(1963)
The Half-Lives of Tl^{204}, Au^{195}, Ir^{192} and its Long-Lived Isomer $Ir^{192}m_2$

63Ha41 J.W.Harpster, D.L.Bennett, K.J.Casper - Nucl.Phys. 47, 443 (1963)
Energy of the First Excited State of Sr^{86}

63He12 F.Herman, S.Skillman - Atomic Structure Calculations, Prentice-Hall, Inc. (1963)

63Ho15 D.C.Hoffman - J.Inorg.Nucl.Chem. 25, 1196(1963)
Half-Lives of Some Rare Earth Nuclides

63Ho17 S.Hontzeas, L.Yaffe - Can.J.Chem. 41, 2194(1963)
Interaction of Vanadium with Protons of Energies up to 84 MeV

63Ju02 H.Jungclaussen, J.Schintlmeister, H.Sodan - Nucl.Phys. 43, 650 (1963)
Messungen Zum Zerfallsschema des J^{131}

63Ke13 T.J.Kennett, G.L.Keech - Nucl.Instr.Methods 24, 142 (1963)
An Anti-Coincidence β-Ray Scintillation Spectrometer

63Ku09 T.J.Kurey,Jr., R.R.Roy - Nucl.Phys. 44, 670 (1963)
K/(L+M) Conversion Ratios in the Decay $Pm^{148} \to Sm^{148}$

63La06 L.M.Langer, D.E.Wortman - Phys.Rev. 132, 324 (1963); Erratum Phys.Rev. 133, 12 (1964)
Radioactive Decay of Nb-95

63La13 L.M.Langer, E.H.Spejewski, D.E.Wortman - Phys.Rev. 132, 2616 (1963)
Beta Spectrum of Ca^{47}

63Le07 J.Lerner - J.Inorg.Nucl.Chem. 25, 749(1963)
Half-Life of Kr-85

63Le11 W.H.G.Lewin, B.Van Nooijen, C.W.E.Van Eijk, A.H.Wapstra - Nucl.Phys. 48, 159 (1963)
The K-Conversion Coefficient of the 412 keV E2 Transition in ^{198}Hg

63Le20 B.C.Levrat - Thesis, Univ.Michigan (1963)
Internal Conversion Coefficients in the Decay of Hg^{203}, Cs^{137}, Au^{198}, Sn^{113} and Hf^{180m}

63Le21 L.J.LeRoux, L.E.Glendenin - Natl.Conf.Nucl.Energy, Application of Isotopes and Radiation, Pretoria, South Africa, F.L.Warren, Ed., Atomic Energy Board, Pelindaba, South Africa, p.83(1963)
Half-Life of Thorium-232

63Le22 K.W.D.Ledingham, J.A.Payne, R.W.P.Drever - Proc.Intern.Conf.Role At.Electrons in Nucl.Transformations, Warsaw, Vol.II, p.359 (1963); CONF-233 (1963)
The Ratio of K-Capture to Positron Emission in the Decay of Nitrogen 13

63Ma07 G.Manduchi, G.Zannoni - Nuovo Cimento 27, 251 (1963)
Experimental Results on Orbital-Electron Capture

63Ma08 I.Marklund, B.Lindstrom - Nucl.Phys. 40, 329 (1963)
Precision Determination of Gamma Energies of Nuclei with A = 152-197

63Mc12 L.D.McIsaac - IDO-16898, p.27 (1963)
Gamma Ray Branching Ratios for Ba^{140} and La^{140}

63Me10 W.Mehlhorn, R.G.Albridge - Z.Physik 175, 506 (1963)
Die KLL-Auger-Spektron von Eisen und Vanadium

63Mo12 R.B.Moler, R.W.Fink - Phys.Rev.131, 821 (1963)
L/K Capture Ratio in Mn^{54}, Fe^{55}, Co^{57}, and Co^{58}

63Ne05 J.W.Nelson, E.B.Carter, G.E.Mitchell, R.H.Davis - Phys.Rev. 129, 1723(1963)
Thresholds Observed in the $C^{12}(\alpha,n)O^{15}$, $Si^{28}(\alpha,n)S^{31}$, $S^{32}(\alpha,n)Ar^{35}$, $S^{34}(\alpha,n)Ar^{37}$, and $Cl^{35}(p,n)Ar^{35}$ Reactions

63Ne18 J.M.Neill, N.C.Rasmussen, T.J.Thompson - MITNE-37 (August 1963)
Measurement of Gamma-Ray Spectra from Thermal-Neutron Capture

63Ok01 K.Okano, K.Nishimira - J.Phys.Soc.Japan 18, 1563 (1963)
(p,n) Threshold Measurements on Na, Al, Cu, Ga, Ge, Se, Y, and Sn

63Pa20 H.Paul, F.P.Viehbock, P.Skarek, H.Baier, I.Hofmann, H.Wotke - Acta Phys.Austriaca 16, 278 (1963)
Messung des Betaspektrums von Na^{24}

63Rh01 J.I.Rhode, O.E.Johnson, W.G.Smith - Phys.Rev. 129, 815 (1963)
Positron Decay of Y^{88}

63Rh02 J.I.Rhode, O.E.Johnson - Phys.Rev.131, 1227 (1963)
Positron Decay of Co^{58}

63Ri02 B.F.Rider, J.P.Peterson, Jr., C.P.Ruiz - Nucl.Sci.Eng. 15, 284(1963)
The Mass Spectrometric Determination of the Cs^{137} Half-Life

63Ro31 I.M.Rogachev, V.P.Chechev, G.C.Katykhin - Vestn.Leningr.Univ., No.22, Ser.Fiz.i Khim., No.4, 92(1963); Nucl.Sci.Abstr. 18, 2284, Abstr.17094 (1964)
β_0 Component in Pb^{210} Decay

63Ro32 B.L.Robinson - Quoted by 66Kl02

63Sa25 H.J.Sathoff, T.Hayashi, J.R.Comerford, Jr., M.H.Kurbatov, J.D.Kurbatov - TID-18567, App.1 (1963)
Decay of Arsenic-76

63St20 S.V.Starodubtsev, R.B.Begzhanov, S.L.Rakovitskii - Izv.Akad.Nauk Uz.SSR, Ser.Fiz.-Mat.Nauk 7, No.2, 44(1963)
Investigation of Conversion Electrons from ^{198}Hg with a $\pi\sqrt{2}$ Beta Spectrometer

63Ta04 J.G.V.Taylor, J.S.Merritt - Phys.Canada 19, No.3, 17, Abstr.4.5 (1963)
K/β^{+} Ratio in the Decay of Zn^{65}

63We06 D.O.Wells, S.L.Blatt, W.E.Meyerhof - Phys.Rev. 130, 1961(1963)
Decay of Ni-56

63We19 A.J.Weiss, M.Hillman - Intern.J.Appl.Radiation Isotopes 14, 628(1963)
The Magnesium-28-Aluminum-28 System; an Aluminum-28 Generator

63Wi11 D.C.Williams, J.W.Irvine, Jr. - Phys.Rev. 130, 259(1963)
Nuclear Excitation Functions: Ar^{40}, Zn^{68}(d,He^{3})

63Wo01 D.E.Wortman, L.M.Langer - Phys.Rev. 131, 325 (1963)
Beta Decay of Fe^{59}

63Zu02 W.Zuk, S.Gustafsson - Arkiv Fysik 24, 69(1963)
Gamma-Gamma Angular Correlation and Intensity Measurements on Low Energy Gamma Rays in the Decay of Ce-144

64An05 S.Andre, P.Depommier - Compt. Rend. 259, 1102 (1964)
Mesure du Spectre β de la Transition $2^{-}\to2^{+}$ du ^{42}K

64An12 S.Andre, P.Depommier - J. Phys. (Paris) 25, 673 (1964)
Facteurs de Forme des Spectres β de ^{114}In et ^{90}Y

64Ba24 J.E.E.Baglin, B.M.Spicer - Nucl. Phys. 54, 549 (1964)
Photodisintegration of Ca^{40}

64Be33 K.-E.Bergkvist, S.Hultberg - Arkiv Fysik 26, 239 (1964)
Precision Determination of the K-Conversion Coefficient of the 412 keV Transition in Hg^{198} by the External-Internal Conversion Method

64Bj01 J.H.Bjerregaard, P.F.Dahl, O.Hansen, G.Sidenius - Nucl. Phys. 51, 641 (1964)
Energy Levels from (p,p'), (d,p) and (d,α) Reactions on the Stable Isotopes Between Sc^{45} and Ni^{58}

64Bl10 P.H.Blichert-Toft, P.Kugler - Arkiv Fysik 25, 317 (1964)
An Improved Experimental Method for Internal Conversion Coefficient Measurements

64Bl20 W.W.Black - IDO-17042, p. 39 (1964)
Decay of Ca-47

64Bo25 E.C.O.Bonacalza - Arkiv Fysik 26, 141 (1964)
Search for Vibrational Levels in Br^{79}

64By02 W.Bygrave, D.Eccleshall, M.J.L.Yates - Nucl. Phys. 53, 385 (1964)
The Coulomb Excitation of Se^{76} and Se^{78} Using Oxygen Ions

64Ch08 Y.Y.Chu, O.C.Kistner, A.C.Li, S.Monaro, M.L.Perlman - Phys. Rev. 133, B1361 (1964)
E2/M1 Ratios in the Isomeric Transitions of Te^{121} and Te^{123}, and the Decay of the Te^{121} Isomers to Sb^{121}

64Ch17 P.Christmas - Nucl. Phys. 55, 577 (1964); Erratum Nucl. Phys. 61, 352 (1965)
Electron Capture in Tl^{204}

64Ch18 Y.Y.Chu, M.L.Perlman - Phys. Rev. 135, B319 (1964)
Empirical Screening Correction for M-Subshell Internal Conversion Coefficients

64Co34 W.Collin, H.Daniel, O.Mehling, H.Schmitt, G.Spannagel, K.S.Subudhi - Z. Physik 180, 143 (1964)
Spins und γ-Multipolordnungen beim Zerfall Fe$^{59}\to$Co^{59}

64Co35 H.D.Cook, C.J.Rettger, W.J.Sewalk - WAPD-BT-30, p. 31 (1964)
Investigations of Burnup Determinations on Highly Irradiated Fuels by Mass Spectrometric Methods

64Cr03 D.F.Crouch, L.D.McIsaac - IDO-16977, p. 39 (1964)
Branching Ratios and Internal Conversion Coefficients for the 145-keV Transition Associated with the Decay of Ce-141

64Da16 H.Daniel, G.T.Kaschl, H.Schmitt, K.Springer - Phys.Rev. 136, B1240(1964)
Shapes of Allowed and Unique First-Forbidden β-Ray Spectra: In^{114}, K^{42}, Rb^{86}, Sr^{90}, and Y^{90}

64Da19 H.Daniel, O.Mehling, P.Schmidlin, D.Schotte, E.Thummernicht - Z.Physik 179, 62(1964)
Zerfallsschemata, β-Matrixelemente und γ-Multipolordnungen fur die Ubergange Co$^{56}\to$ Fe^{56} und J$^{131}\to$ Xe^{131}

64Ea01 T.A.Eastwood, F.Brown, R.D.Werner - Can.J.Phys. 42, 218(1964)
The Gamma Branching Ratio of Kr^{85}

64Er09 P.Erman, J.Rossi, E.C.O.Bonacalza, J.Miskel - Arkiv Fysik 26, 135 (1964)
The K Auger Group Intensities in Cl^{37}

64Ew04 G.T.Ewan, A.J.Tavendale - Can.J.Phys. 42, 2286(1964)
High-Resolution Studies of Gamma-Ray Spectra Using Lithium-Drift Germanium Gamma-Ray Spectrometers

64Ew05 G.T.Ewan, A.J.Tavendale - Nucl.Instr.Methods 26, 183(1964)
Application of High Resolution Lithium-Drift Germanium Gamma-Ray Spectrometers to High Energy Gamma-Rays

64Ge05 H.V.Gersch, E.Hentschel, P.Gippner, W.Rudolph - Nucl.Instr. Methods 25, 314(1964)
$\pi\sqrt{2}$-β-Spektrometer mit Doppeltem Umlauf

64Gi04 C.Gil-Montalbo - Radiochim.Acta 3, 115(1964)
Half-Life of Calcium 47

64He19 C.J.Herrlander, R.L.Graham - Nucl.Phys. 58, 544(1964)
Penetration Effects in the K and L Internal Conversion Coefficients of the 279 keV Transition in Tl^{203}

64Ho27 V.Hovi, L.Niemela, J.Varonen - Ann.Acad.Sci.Fennicae, Ser. A VI, No.150(1964)
On the Mean Beta Disintegration Energies of Pr^{143}, S^{35}, and Pm^{147}

64Ho28 I.Hofmann - Acta Phys.Austriaca 18, 309(1964)
Das Positronen-Spektrum des F^{18}

64Hu09 E.E.Hughes, W.B.Mann - Intern.J.Appl.Radiation Isotopes 15, 97(1964); Nucl.Sci.Abstr. 18, 2271, Abstr.16961(1964)
The Half-Life of Carbon-14: Comments on the Mass-Spectrometric Method

64Hy02 E.K.Hyde, I.Perlman, G.T.Seaborg - The Nuclear Properties of the Heavy Elements, Vol.II, Prentice-Hall, Inc., Englewood Cliffs, N.J.(1964)

64Je03 R.C.Jenkins, W.E.Meyerhof - Nucl.Phys. 58, 417(1964)
Internal Conversion Coefficients of Ni^{56}

64Jo11 C.H.Johnson, C.C.Trail, A.Galonsky - Phys.Rev. 136, B1719(1964)
Thresholds for (p,n) Reactions on 26 Intermediate-Weight Nuclei

64Jo12 R.K.Jolly - Phys.Rev. 136, B683(1964)
Nuclear Structure Studies in Tellurium Isotopes with (d,p) and (d,t) Reactions

64Ka17 G.Kaye, R.L.Graham - Can.J.Phys. 42, 1865(1964)
A Precision Measurement of the Energies of Transitions in Hg^{198} and Hg^{199}

64Ka23 S.E.Karlsson, O.Bergman, W.Scheuer - Arkiv Fysik 27, 61(1964)
The Decay of Rh^{105}

64Ka31 T.M.Kavanagh, J.K.P.Lee, W.T.Link - Can.J.Phys. 42, 1429(1964)
A Precise Measurement of the C^{11} Production Cross Section for 98-MeV Protons on Carbon

64Ke10 T.J.Kennett, I.B.Webster, W.V.Prestwich - Nucl.Phys. 58, 56(1964)
The Decay of Br^{82}

64Ke11 E.S.Kenney - Thesis, Pennsylvania State Univ. (1964); Dissertation Abstr. 25, 6706(1965)
The Decay of ^{82}Br

64Ko11 A.Kovach - Acta Phys.Acad.Sci.Hung. 17, 341(1964)
A Re-Determination of the Half-Life of Rubidium-87

64La13 L.M.Langer, E.H.Spejewski, D.E.Wortman - Phys.Rev. 135, B581(1964)
Precise Shape Measurements of Beta Spectra of Y^{90} and Y^{91}

64Le09 J.Lehmann - J.Phys.(Paris)25, 326(1964); Erratum J.Phys.(Paris)25, 767(1964)
Forme de Spectre pour la Transition Beta de 965 keV dans ^{198}Au

64Ma05 K.W.Marlow - Nucl.Phys. 51, 684(1964)
Determination of Some Energy Levels in Light and Medium Weight Nuclei with a Precision Gamma Ray Scintillation Spectrometer

64Ma09 S.Malmskog - Nucl.Phys. 51, 690(1964)
The Decay of the Second 2+ Level in Fe^{58}

64Ma12 J.D.Mahoney, S.S.Markowitz - J.Inorg.Nucl.Chem. 26, 907(1964)
The Half-Life of Fluorine-18

64Ma27 B.P.Maier - Thesis, Technische Hochschule Munchen (1964)
Niederenergetische Gammalinien vom Neutroneneinfang in U 238, Lu 175, and Lu 176

64Ma30 K.C.Mann, F.A.Payne, R.P.Chaturvedi - Can.J.Phys. 42, 1700(1964)
The Decay of Sb^{125}

64Ma56 P.G.Marais, F.J.Haasbroek, J.H.M.Karsten - S.African J.Agr.Sci. 7, 881(1964)
Half-Life of ^{51}Cr

64Mc21 J.D.McCoy - Soc.Sci.Fennica, Commentationes Phy.Math. 30, No.4(1964)
Alpha Decay Studies of Pa-230, Pa-228, Pa-226, and Their Descendants

64Mc23 L.D.McIsaac - IDO-17042, p.43(1964)
Branching Ratio of 2.18-MeV Gamma Ray in Decay of Pr-144

64Mi07 S.C.Misra, U.C.Gupta, N.P.S.Sidhu - Nucl.Phys. 51, 174(1964)
Decay of ^{47}Sc

64Na06 S.J.Nassiff, P.Diodati, I.L.De Torriani - NP-14606(1964)
Coeficiente de Ramificacion en El Y^{87}

64Na07 S.J.Nassiff, P.Diodati, I.L.De Torriani - ORNL-Tr-1796(1964); See Also 64Na06
The Branching Ratio of ^{87}Y

64Ra12 H.Ramthun - Z.Naturforsch. 19a, 1064(1964)
Kolarimetrische Neubestimmung der Halbwertszeit von RaD (^{210}Pb)

64Re09 J.J.Reidy - TID-21826(1964)
The Precision Energy Measurements of Gamma Rays in the Energy Region of 90-2500 keV

64Sa21 V.V.G.Sastry, V.Lakshminarayana, S.Jnanananda - Nucl.Phys. 56, 140(1964)
The Radioactive Decay of Ag^{111}

64Sh16 S.Shastry, R.Bhattacharyya - Nucl.Phys. 55, 397(1964)
Decay of Y^{88} to the 3.22 and 3.52 MeV Levels of Sr^{88}

64Si13 L.Simons, S.Bergstrom, A.Anttila - Soc.Sci.Fennica, Commentationes Phy.Math. 29, No.1(1964)
Investigations of Gamma Rays Following the Beta Decay of Br^{82}

64Si21 K.Siegbahn, C.Nordling, S.-E.Karlsson, S.Hagstrom, A.Fahlman, I.Andersson - Nucl.Instr.Methods 27, 173(1964)
A 50-CM Double Focusing Beta Spectrometer of the Current Sheet Type
64Sn01 R.E.Snyder, G.B.Beard - Nucl.Instr.Methods 26, 31(1964)
A 4π Beta Spectrometer
64Sp03 A.Sperduto, W.W.Buechner - Phys.Rev. 134, B142(1964)
Reaction Energies and Energy Levels from Proton and Deuteron Bombardment of the Iron Isotopes
64Vi03 V.D.Vitman, N.A.Voinova, B.S.Dzhelepov - Izv.Akad.Nauk SSSR, Ser.Fiz. 28, 222(1964); Bull.Acad.Sci.USSR, Phys.Ser. 28, 139(1965)
Gamma-Radiation from As^{76}
64Wa19 A.H.Wapstra - Nucl.Phys. 57, 48(1964)
Recalibration of Alpha Particle Energies
64Wi04 A.Williams - Nucl.Phys. 52, 324(1964)
Measurement of the Ratio of Electron Capture to Positon Emission in the Decay of Na-22
64Wo03 J.L.Wolfson, J.J.H.Park - Can.J.Phys. 42, 1387(1964)
Low-Energy Gamma-Ray Transitions in Np^{237} Following α Decay of Am^{241}
65An05 G.Andersson, G.Rudstam, G.Sorensen - Arkiv Fysik 28, 37 (1965)
Decay Data on Some Xe, I, and Te Isotopes
65An07 S.C.Anspach, L.M.Cavallo, S.B.Garfinkel, J.M.R.Hutchinson, C.N.Smith - NP-15663 (1965)
Half Lives of Materials Used in the Preparation of Standard Reference Materials of Nineteen Radioactive Nuclides Issued by the National Bureau of Standards
65Be07 K.-E.Bergkvist, S.Hultberg - Arkiv Fysik 27, 321 (1965)
A Precision Measurement of $\alpha_2(k)$ of the 412 keV Transition in Hg^{198} By the Internal-External Conversion Method and a High Resolution Study Of the 412 keV Angular Distribution of Gold K-Shell Photoelectrons
65Be24 H.Beekhuis, H.De Waard - Nucl.Phys. 74, 459 (1965)
Shape of the 962 keV Beta Spectrum of ^{198}Au
65Be35 J.Beyea, L.Mo, A.R.Sayres, L.J.Lidofsky - Bull.Am. Phys.Soc. 10, No.5, 610, FC2 (1965)
^{40}Ar-^{40}K Mass Difference
65Be37 I.Bergstrom, C.Nordling, A.H.Snell, R.Wilson, B.G.Pettersson - Alpha-, Beta- and Gamma-Ray Spectroscopy, Vol.2, K.Siegbahn, Ed., North-Holland Publishing Co., Amsterdam, p.1523 (1965)
Some 'Internal' Effects in Nuclear Decay
65Bo42 M.Bormann, E.Fretwurst, P.Schehka, G.Wrege, H.Buttner, A.Lindner, H.Meldner - Nucl.Phys. 63, 438 (1965)
Some Excitation Functions of Neutron Induced Reactions in the Energy Range 12.6-19.6 MeV
65Br11 J.-P.Briand, P.Chevallier - Compt.Rend. 260, 5251 (1965)
Etude des Niveaux Nucleaires du Bismuth 212 (ThC) Excites dans la Desintegration α de l'Astate 216
65Br25 G.A.Brinkman, A.H.W.Aten, Jr., J.T.Veenboer - Physica 31, 1305 (1965)
Natural Radioactivity of K-40, Rb-87 and Lu-176
65Br37 D.Brune, J.Dubois, S.Hellstrom - Nukleonik 7, 484(1965)
Improvements in Applied Gamma-Ray Spectrometry by Germanium Semi-Conductor Detector
65Bu07 J.Burde, M.Rakavy, G.Adam - Nucl.Phys. 68, 561 (1965)
The Excited States of the Odd Nucleus La^{140} Populated by the Beta Decay of Ba^{140}
65Ca11 J.L.Campbell, W.Leper, K.W.D.Ledingham - Quoted by 68Fi02
65Ch04 G.Chilosi, G.D.O'Kelley, E.Eichler - Bull.Am.Phys.Soc. 10, No.1, 92, HC2 (1965)
Low-Energy States in ^{49}Sc Populated in the Decay of ^{49}Ca
65Cr02 T.Cretzu, K.Hohmuth - Nucl.Phys. 66, 391 (1965)
Zum Zerfall des Mo^{99}
65Cr03 P.Crowther, J.S.Eldridge - Nucl.Phys. 66, 472 (1965)
Decay of 99-Mo--99m-Tc
65Da07 H.Daniel, P.Jahn, G.Spannagel - Z.Physik 188, 252 (1965)
Konversion der 238,6 Kev-γ-Linie des ThB und Vergleich mit Den Tabbellen von Sliv und von Rose
65De20 S.A.De Wit, A.H.Wapstra - Nucl.Phys. 73, 49 (1965)
The Decay Energies of ^{197}Hg and ^{195}Au
65Dh01 K.C.Dhingra, U.C.Gupta, N.P.S.Sidhu - Current Sci.(India) 34, 504 (1965)
Decay of ^{51}Cr
65Eb01 T.G.Ebrey, P.R.Gray - Nucl.Phys. 61, 479 (1965)
Precision Half-Life Measurements of Fourteen Positon-Emitting Nuclei
65En01 J.B.A.England, B.L.Reece - Nucl.Phys. 72, 449 (1965)
A Study of the (^3He,^7Be) Reaction in ^{12}C
65Fl01 K.F.Flynn, L.E.Glendenin, A.L.Harkness, E.P.Steinberg - J.Inorg.Nucl.Chem. 27, 21 (1965)
Half-Lives of ^{90}Sr and ^{137}Cs
65Fl02 K.F.Flynn, L.E.Glendenin, E.P.Steinberg - Nucl.Sci.Eng. 22, 416 (1965)
Half-Life Determinations by Direct Decay

65Fr12 M.S.Freedman, F.T.Porter, F.Wagner, Jr. - Phys.Rev. 140, B563 (1965)
Low-Intensity First-Forbidden Beta-Decay Branch in Ca^{45}

65Ge04 J.S.Geiger, R.L.Graham, I.Bergstrom, F.Brown - Nucl.Phys. 68, 352 (1965)
Measurements of M1 and E2 Transition Probabilities in Te^{125}, I^{127}, Xe^{129}, Cs^{133}, La^{139} and Pr^{141}

65Ge06 J.S.Geiger - Quoted by 65Me03

65Gf02 H.Gfirtner, W.Reiser, H.Schneider - Z.Naturforsch. 20a, 1727 (1965)
Das γ-Spektrum von Krypton-82

65Gr05 R.L.Graham, G.Murray, J.S.Geiger - Can.J.Phys. 43, 171 (1965)
Precision Measurement of the Momenta of Conversion Electron Lines from Sources of ^{212}Pb (ThB)

65Gu06 U.C.Gupta, P.K.Srivastava, G.D.Khera - Nucl.Phys. 73, 413 (1965)
Decay of ^{86}Rb

65Ha15 A.J.Haverfield, H.T.Easterday, J.M.Hollander - Nucl.Phys. 64, 379 (1965)
Note on the Pt and Hg Mass-197 Isomers

65He04 R.G.Helmer, L.D.McIsaac - Phys.Rev. 137, B223 (1965)
Level Structure in Au^{197} from the Decay of Hg^{197m}, Hg^{197}, and Pt^{197}

65He08 Z.He-Sung, N.S.Maltseva, V.N.Mekhedov, V.N.Rybakov - Yadern.Fiz. 1, 189(1965); Soviet J.Nucl.Phys. 1, 132 (1965)
The K-Capture Fraction of Ge^{66}, Ge^{69}, and As^{72}

65Hi12 M.W.Hill - BNWL-SA-315 (1965)
Gamma-Ray Transitions in Fe^{58}

65Hs02 S.T.Hsue, L.M.Langer, S.M.Tang, D.A.Zollman - Nucl.Phys. 73, 379 (1965)
^{124}Sb Spectrum Shape

65Hu15 W.M.Hubbard - Phys.Rev. 137,B245 (1965)
M-Shell Electron Contribution to Orbital Electron Capture

65Iv01 Y.F.Ivanov, I.A.Rumer, A.Y.Bukach - Izv.Akad.Nauk SSSR, Ser.Fiz. 29, 157 (1965); Bull.Acad.Sci.USSR, Phys.Ser. 29, 154 (1966)
Internal Conversion Electrons of Te^{132}

65Iv03 Y.F.Ivanov, I.A.Rumer - Yadern.Fiz. 2, 974 (1965); Soviet J.Nucl.Phys. 2, 694 (1966)
Internal Conversion Coefficients for Certain Nuclear Transitions in Xe^{132}

65Jo13 N.R.Johnson, K.Wilsky, P.G.Hansen, H.L.Nielsen - Nucl.Phys. 72, 617 (1965)
High-Energy Transitions in the Decay of ^{132}I

65Jo18 F.Johnson - Science 149, 1326 (1965)
Half-Life of Radiocarbon

65Ke04 W.J.Keeler, R.D.Connor - Nucl.Phys. 61, 513(1965)
The Decay of Au^{198}

65Ki03 O.C.Kistner, A.W.Sunyar - Phys.Rev. 139, B295(1965)
Excited States of Fe^{57} Populated in Co^{57} Decay

65Le08 C.-F.Leang - Compt.Rend. 260, 3037(1965)
Spectres α de Long Parcours des Poloniums 214 (RaC') et 212 (ThC')

65Le15 H.Leutz, G.Schulz, H.Wenninger - Z.Physik 187, 151(1965)
The Decay of Potassium-40

65Le24 J.Legrand - CEA-R-2813(1965)
Contribution a la Mesure Absolue de l'Activite des Isotopes Se Desintegrant par Capture Electronique Determination du Rendement de Fluorescence de Quelques Elements

65Le25 R.E.Lewis, R.E.McHenry, T.A.Butler - Trans.Am.Nucl.Soc. 8, 79(1965)
Half-Life of Cs-137

65Li14 D.Liberman, J.T.Waber, D.T.Cromer - Phys.Rev. 137, A27 (1965)
Self-Consistent-Field Dirac-Slater Wave Functions for Atoms and Ions. I. Comparison with Previous Calculations

65Ma09 K.W.Marlow - Nucl.Phys. 61, 13(1965)
Further Precision Gamma Ray Measurements with a Scintillation Spectrometer

65Ma38 J.M.Mathiesen, J.P.Hurley - Nucl.Phys. 72, 475(1965)
Energy Levels in ^{57}Fe

65Ma52 D.A.Marsden, L.Yaffe - Can.J.Chem. 43, 249(1965)
Mass Distribution in Thermal Neutron Fission of ^{239}Pu

65Mc12 L.D.McIsaac - IDO-17052, p.31(1965)
Branching Ratio for the 59.6-keV Transition in the Decay of Am-241

65Me03 J.S.Merritt, J.G.V.Taylor - Anal.Chem. 37, 351(1965)
Decay of Cesium-137 Determined by Absolute Counting Methods

65Mi06 W.Michaelis - Z.Physik 186, 42(1965)
A Study of the Radiation from Am^{241}

65Mi09 K.Miyano - J.Phys.Soc.Japan 20, 2094(1965)
Non Existence of the Reported 0.58 MeV Gamma Ray in the Decay of ^{42}K

65Mo03 L.Mo, F.Hsu, C.S.Wu - Bull.Am.Phys.Soc. 10, No.1, 81, GC1(1965)
Energy Levels of Kr^{82}

65Mo22 G.Moreau, G.Ambrosino - Compt.Rend. 261, 5438(1965)
Contribution a l'Etude du Cobalt 57

65MTW1 J.H.E.Mattauch, W.Thiele, A.H.Wapstra - Nucl.Phys. 67, 1(1965); See Also 66Wa03
1964 Atomic Mass Table

65Mu03 G.Murray, R.L.Graham, J.S.Geiger - Nucl.Phys. 63, 353(1965)
The Precision Determination of Some γ-Ray Energies Using a β-Spectrometer

65Mu09 A.Mukerji, D.N.McNelis, J.W.Kane, Jr. - Nucl.Phys. 67, 466(1965)
Decay of ^{103}Ru

65Ne03 W.R.Neal, H.W.Kraner - Phys.Rev. 137, B1164(1965)
Mean Lives of Excited Rotational States of Heavy Even-Even Nuclei

65Ne11 W.B.Newbolt, J.H.Hamilton - Bull.Am.Phys.Soc. 10, No.2, 244, A4(1965)
K Conversion Coefficient of the 412-keV Transition in Hg^{198} by the Peak-to-Beta-Spectrum Method

65Ni01 E.B.Nieschmidt, C.E.Mandeville, L.D.Ellsworth - Bull.Am.Phys.Soc. 10, No.1, 129, SP1(1965)
Radiations of Br^{82} and Cd^{115m}

65Oh01 H.Ohnuma, Y.Hashimoto, I.Tomita - Nucl.Phys. 66, 337(1965)
Nuclear Levels of ^{56}Co from the Decay of ^{56}Ni

65Pa08 H.Paul - Nucl.Phys. 72, 326(1965)
The Spectrum of the Main Beta Transition of ^{198}Au and the K Conversion Coefficient of the 412 keV Gamma Transition

65Pa10 J.R.Patterson, J.M.Poate, E.W.Titterton, B.A.Robson - Proc.Phys.Soc.(London) 86, 1297(1965)
A Study of the Reaction ^{10}B(^{3}He,d)^{11}C Between 3.5 and 10 MeV

65Pa17 D.Parsignault - Thesis, Univ.Paris (1965); CEA-R-2631(1965)
Etude et Realisation d'un spectrometre β a Champ Magnetique Axial Uniforme, Muni d'un selecteur de Coincidence β-γ. Etude des Spectres β du ^{32}P, ^{203}Hg, ^{198}Au. Mesure des Coefficients de Conversion du ^{203}Tl et du ^{198}Hg

65Pa18 V.A.Paulsen, H.Liskien - Nukleonik 7, 117(1965); Phys.Abstr. 69, 106, Abstr.1093(1966)
Excitation Functions for the Reactions Ni^{58}(n,2n)Ni^{57}, Cu^{65}(n,2n)Cu^{64} and Zn^{64}(n,2n)Zn^{63} in the Energy Range 12.6 to 19.6 MeV

65Pe18 H.Pettersson, O.Bergman, C.Bergman - Arkiv Fysik 29, 423(1965)
The Decay of Co^{56}

65Ra04 P.V.Rao, B.Crasemann - Phys.Rev. 137, B64(1965)
L/K X-Ray Intensity Ratio in the Decay of Tl^{204} and L-Shell Fluorescence Yields of Hg

65Re14 J.J.Reidy, M.L.Wiedenbeck - Nucl.Phys. 70, 518(1965)
Precision Measurements of Gamma-Ray Energies up to 2 MeV Using a 2m curved-Crystal Monochromator

65Re16 J.J.Reidy, M.L.Wiedenbeck - Bull.Am.Phys.Soc. 10, No.8, 1131, SP3(1965)
Curved-Crystal Spectrometer Measurements on the Gamma-Rays Following the Decay of Br^{82}, Tb^{160}, and Dy^{165}

65Re17 J.J.Reidy, M.L.Wiedenbeck - Bull.Am.Phys.Soc. 10, No.8, 1131, SP2(1965)
Precision Energy Measurements on the Gamma-Rays Following the Decay of Na^{24}, Co^{60}, Au^{198}, and Au^{199} Using a 2-m Curved Crystal Spectrometer

65Ro09 R.L.Robinson, P.H.Stelson, F.K.McGowan, J.L.C.Ford, Jr., W.T.Milner - Nucl.Phys. 74, 281(1965)
Gamma Ray Energies Determined with a Lithium-Drifted Germanium Detector

65Se08 S.K.Sen, I.C.Durosinmi-Etti - Phys.Letters 18, 144(1965)
Measurement of α(K), α(Total) and K/(L + M) for Electron Capture Transitions in 113m-In and 109m-Ag with a Solid State Detector

65Sm06 R.K.Smither, A.I.Namenson - Quoted by 67Ma01, p.10

65Sp06 G.D.Sprouse, S.S.Hanna - Nucl.Phys. 74, 177(1965)
Gamma Ray Transitions in ^{57}Fe

65Sp08 E.Spring - Phys.Letters 18, 132(1965)
Internal Pair Formation in ^{60}Ni and ^{24}Mg Measured by the Detection of Annihilation Radiation

65Ta10 J.G.V.Taylor, J.S.Merritt - AECL-2501, p.26(1965)
Half-Life of ^{54}Mn

65Th07 R.H.Thomspon, K.J.Casper - Nucl.Phys. 72, 106(1965)
Beta Decay of ^{86}Rb

65Wa09 J.Walker, T.Salgir - Proc.Phys.Soc.(London) 86, 423(1965)
The Branching Ratio of ^{212}Bi(ThC)

65Wh01 D.H.White, B.G.Saunders - Bull.Am.Phys.Soc. 10, No.1, 13, AD9(1965)
γ Emission Following Neutron Capture in As^{75}

65Wh04 E.J.Wheelwright, D.M.Fleming, F.P.Roberts - J.Phys.Chem. 69, 1220(1965)
Calorimetric Determination of the Mean β-Energy and Half-Life of Promethium-147

65Wi13 G.Winter - ZfK-PhA-17 (1965)
The Decay of ^{79}Kr

66An10 S.Andre, P.Depommier - Compt.Rend. 262B, 214(1966)
Spectres β du ^{86}Rb

66Ar15 G.Ardisson, F.-X.Petit - Compt. Rend. 263B, 1408(1966)
Sur le Rayonnement γ de l'Iode 132

66Ba36 H.W.Baer, J.J.Reidy, M.L.Wiedenbeck - Nucl.Phys. 86, 332(1966)
The Level Structure of the Nucleus ^{140}Ce

66Bi13 E.I.Biryukov, E.G.Zaletskii, N.S.Shimanskaya - Izv.Akad.Nauk SSSR, Ser.Fiz. 30, 504(1966); Bull.Acad.Sci.USSR, Phys.Ser. 30, 514(1967)
Values of the K/β+ Ratio for the Allowed $4^+ \to 4^+$ Transition in V^{48} and the $2^+ \to 2^+$ Transition in Co^{58}

66Ca10 M.J.Canty, W.F.Davidson, R.D.Connor - Nucl.Phys. 85, 317(1966)
Beta Spectra in the Decay of ^{32}P and ^{124}Sb

66Ch09 L.B.Church, A.Gaigalas, R.B.Sutton, R.E.Cote, S.Raboy, C.C.Trail - Phys.Rev. 142, 690(1966)
Gamma Rays from the Decay of 35-Day Nb^{95}

66Co30 J.T.Corless - NYO-3369-6(1966)
Isotopic Abundance Studies by Neutron Activation Analysis

66Da04 H.Daniel, G.T.Kaschl - Nucl.Phys. 76, 97(1966)
Spektralformen von $(0 \to 0)$-β-Ubergangen mit Paritatswechsel: ^{144}Ce, ^{144}Pr und ^{166}Ho

66De04 A.W.De Ruyter, A.H.W.Aten, Jr., A.Van Dulmen, C.Krol-Koning, E.Zuidema - Physica 32, 991(1966)
Specific Gamma Emission of Natural Potassium and Lanthanum

66Di02 R.S.Dingus, W.L.Talbert, Jr., M.G.Stewart - Nucl.Phys. 83, 545(1966)
Measurements of Conversion Coefficients for Transitions in ^{154}Gd, ^{160}Dy, ^{170}Yb, ^{171}Yb and ^{141}Pr

66Do07 K.W.Dolan, D.K.McDaniels, D.O.Wells - Phys.Rev. 148, 1151(1966)
Energy Levels of ^{56}Fe

66El02 J.S.Eldridge, P.Crowther, W.S.Lyon - Nucleonics 24, No.3, 62(1966)
Gamma-Ray Branching Ratios for In^{116}, Nd^{147} and Ce^{141}

66El09 J.S.Eldridge, W.S.Lyon - ORNL-3889, p.49(1966)
Nuclear Properties of Radionuclides: ^{197}Hg

66Et01 R.C.Etherton, W.H.Kelly - Nucl.Phys. 84, 129(1966)
Excited States in ^{82}Kr Populated by the Decay of 35 h ^{82}Br

66Fe09 I.Feuerhake, A.Hinzpeter - Naturwissenschaften 53, 272(1966)
Die Betaaktivitat von ^{40}K im Naturlichen Isotopengemisch

66Fi08 R.W.Fink, R.C.Jopson, H.Mark, C.D.Swift - Rev.Mod.Phys. 38, 513(1966)
Atomic Fluorescence Yields

66Fl01 D.M.Fleming, I.T.Myers - Intern.J.Appl.Radiation Isotopes 17, 251(1966)
Calorimetric Determination of the Half-Life of Antimony-124

66Fr02 K.Fransson, C.E.Bemis,Jr. - Nucl.Phys. 78, 207(1966)
The Decay of ^{132}Te and Levels in Odd ^{132}I

66Fr05 M.S.Freedman, F.Wagner,Jr., F.T.Porter, H.H.Bolotin - Phys.Rev. 146, 791(1966)
Level Structure in Cr^{52} Populated in 5.7-Day Mn^{52} Decay

66Fr14 M.S.Freedman, F.T.Porter, F.Wagner - Phys.Rev. 152, 1005(1966)
Evidence for Hindered First-Forbidden Unique Beta Branch in Ca^{47} Decay

66Ga13 M.Gasior, H.Niewodniczanski, A.Potempa - Priv.Comm.(1966); IFJ Rept.492/PL(1966)
Excited States of ^{75}As Following the Decay of ^{75}Se

66Go07 G.Goldstein - J.Inorg.Nucl.Chem. 28, 937(1966)
Partial Half-Life for β-Decay of ^{36}Cl

66Go10 G.Goldstein, J.A.Dean - J.Inorg.Nucl.Chem. 28, 285(1966)
Half-Life and Specific Activity of ^{99}Tc

66Go16 I.W.Goodier, D.H.Pritchard - Intern.J.Appl.Radiation Isotopes 17, 121(1966)
The Half Life of ^{32}P

66Go22 I.W.Goodier, A.Williams - Nature 210, 614(1966)
Measurement of the Absolute Disintegration Rate of Technetium-99m

66Go23 S.Gorodetzky, N.Schulz, J.Chevallier, A.C.Knipper - J.Phys.(Paris) 27, 521(1966)
Periodes de Niveaux Excites du Calcium 40 et de l'Iode 132

66Ha03 E.N.Hatch, G.W.Eakins, G.C.Nelson, R.E.McAdams - Proc.Intern.Conf.Internal Conversion Process, Nashville, Tenn. (1965), J.H.Hamilton, Ed., Academic Press, Inc., New York,p.183(1966)
Method for Measuring Internal Conversion Coefficients Using a Bent-Crystal Gamma-Ray Monochromator and a Magnetic Electron Spectromèter

66Ha07 J.H.Hamilton, S.R.Amtey, B.van Nooijen, A.V.Ramayya, J.J.Pinajian - Phys.Letters 19, 682(1966)
Total and K Conversion Coefficient Measurements in ^{54}Cr, ^{65}Cu and ^{88}Sr For Use as Standards

66Ha15 P.G.Hansen, H.L.Nielsen, K.Wilsky, Y.K.Agarwal, C.V.K.Baba, S.K.Bhattacherjee - Nucl.Phys. 76, 257(1966)
Spectral Shapes and a Beta-Gamma Directional Correlation in the Beta Decay of ^{172}Tm ($J\pi$=2-)

66Ha41 A.Hashizume - Thesis, Univ.Paris(1966); CEA-R-2839
Development of a Junction Beta Spectrometer. Application to Study of the Spectra of ^{14}C and ^{35}S

66He07 W.Heuer - Z.Physik 194, 224(1966)
Das L/K-Einfangverhaltnis von ^{51}Chrom

66He11 R.L.Heath, J.E.Cline - IDO-17188(June 1966)
Gamma-Ray Spectrometry of Neutron-Deficient Isotopes

66Hs01 S.T.Hsue, L.M.Langer, E.H.Spejewski, S.M.Tang - Nucl.Phys. 80, 657(1966)
Search for Post-End-Point Electrons and for Evidence of Neutrino Degeneracy
66Hs02 S.T.Hsue, L.M.Langer, S.M.Tang - Nucl.Phys. 86, 47(1966)
Precise Determination of the Shape of the Twice Forbidden Beta Spectrum of ^{137}Cs
66Hu17 M.Huguet, H.Forest, C.Ythier - Compt.Rend. 263B, 1342(1966)
Sur la Desintegration du Cobalt 56
66Hu18 M.Huguet, H.Forest, C.Ythier - Compt.Rend. 263B, 79(1966)
Sur l'Etude du Rayonnement γ de Haute Energie au Moyen d'un spectrometre a Paires a Haute Resolution
66Ka04 A.A.Katsanos, J.R.Huizenga, H.K.Vonach - Phys.Rev. 141, 1053(1966)
Nuclear Energy Levels of Fe^{56} and Co^{59}
66Ke15 J.Kern, G.Mauron, O.Huber - Helv.Phys.Acta 39, 212 (1966)
Sur la Desintegration du ^{140}Ba
66Kl02 H.Klein, H.Leutz - Nucl.Phys. 79, 27(1966)
P(L)/P(K) Electron Capture Ratio in the Decay of ^{204}Tl
66Kn03 K.Knauf, H.Sommer, H.Klewe-Nebenius - Z.Physik 197, 101(1966)
Suche nach Zweiquantenprozessen beim Zerfall von Xe^{131m}
66Ko06 L.N.Kondratev, E.F.Tretyakov - Izv.Akad.Nauk SSSR, Ser.Fiz. 30, 386(1966); Bull.Acad.Sci.USSR, Phys.Ser. 30, 393(1967)
Conversion Electrons Accompanying Alpha Decay of Am^{241} and the Level Diagram of Np^{237}
66Ko20 V.O.Kostroun, P.V.Rao, B.Crasemann - Phys.Rev. 152, 1010(1966)
Beta Feeding of the $d_3/_2$ Hole State in ^{47}Sc
66La06 H.Langhoff, L.Frevert, W.Schott, A.Flammersfeld - Nucl.Phys. 79, 145(1966)
The Excited Levels of ^{79}Br
66La13 F.O.Lawrence, W.R.Daniels, D.C.Hoffman - J.Inorg.Nucl.Chem. 28, 2477(1966)
Radiochemical Purification of Tin and the Half-Lives of ^{121}Sn, ^{123}Sn, ^{125}Sn and ^{125}Sb
66Le02 W.H.G.Lewin - Proc.Intern.Conf.Internal Conversion Process, Nashville, Tenn.(1965), J.H.Hamilton, Ed., Academic Press, Inc., New York, p.163(1966)
Recent Determinations of Conversion Coefficients of E2 Transitions Obtained from Coincidence Techniques and the Peak-to-Beta Spectrum Method
66Le13 C.M.Lederer, J.K.Poggenburg, F.Asaro, J.O.Rasmussen, I.Perlman - Nucl.Phys. 84, 481(1966)
Energy Levels of ^{237}Np (I). The Alpha Decay of ^{241}Am
66Li09 H.Liskien, A.Paulsen - Proc.Intern.Conf.Radiat.Meas.Nucl.Power, Berkeley, Engl., D.J.Littler, Ch., Editorial Panel, Inst.Phys.And the Phys.Soc., London, Conf.Series No.2, p.352 (1966)
Compilation and Measurement of Differential Cross-Sections for Neutron Induced Threshold Reactions
66Ma28 P.G.Marais, F.J.Haasbroek, E.van der S.Lotz, J.van R.Smit - J.S.African Chem.Inst. 19, 1(1966)
Half Life of ^{137}Ba
66Ma49 E.P.Mazets, Y.V.Sergeenkov - Izv.Akad.Nauk SSSR, Ser.Fiz. 30, 1185(1966); Bull.Acad.Sci.USSR, Phys.Ser. 30, 1237(1967)
Decay of Sb^{125}
66Ma56 P.G.Marais, F.J.Haasbroek, C.F.G.Heyns, J.H.M.Karsten - S.African J.Agr.Sci. 9, 259 (1966)
Half-Life of ^{132}I
66Ma57 J.J.Matese, W.R.Johnson - Phys.Rev. 150, 846(1966)
Screening Corrections to the Fermi Function for Allowed β Decay
66Mc12 C.C.McMullen, K.Fritze, R.H.Tomlinson - Can.J.Phys. 44, 3033(1966)
The Half-Life of Rubidium-87
66Mi05 W.Michaelis - Z.Physik 194, 395(1966)
Prazisionsmessung des Am^{241}-Gammaspektrums
66Mo10 G.A.Moss, D.O.Wells, D.K.McDaniels - Nucl.Phys. 82, 289(1966)
An Investigation of the Levels of ^{131}Xe
66Mo12 J.Morgenstern - Priv.Comm. (1966)
66Mo16 G.A.Moss, D.K.McDaniels - Nucl.Phys. 85, 513(1966)
The Decay of ^{140}Ba
66Ne10 C.W.Nestor, T.C.Tucker, T.A.Carlson, L.D.Roberts, F.B.Malik, C.Froese - ORNL-4027 (1966)
Relativistic and Non-Relativistic scf Wave Functions for Atoms and Ions from Z = 2 to 80, Together with Calculations of Binding Energies, Mean Radii, Screening Constants, Charge Distributions, and Electron Shake-Off Probabilities
66Ov01 V.V.Ovechkin, T.K.Ragimov, D.F.Rau - Yadern.Fiz. 4, 683(1966); Soviet J.Nucl.Phys. 4, 484(1967)
The γ Spectrum of Rh^{106}
66Pa01 D.Parsignault - Proc.Intern.Conf.Internal Conversion Process, Nashville, Tenn. (1965), J.H.Hamilton, Ed., Academic Press, Inc., New York, p.173(1966)
The Beta Spectrum of Au^{198}, and the Conversion Coefficients of the 412-keV Line in Hg^{198}

66Pa09 S.C.Pancholi - Nucl.Phys. 81, 417(1966)
K-Shell Internal Conversion Coefficient Measurement for the 145 keV Transition in ^{141}Pr

66Pa18 P.B.Parks, P.M.Beard, E.G.Bilpuch, H.W.Newson - Nucl.Phys. 85, 504(1966)
A Precision Measurement of Reaction Thresholds

66Pi01 C.J.Piluso, D.O.Wells, D.K.McDaniels - Nucl.Phys. 77, 193(1966)
The Decay of ^{56}Ni and ^{57}Ni

66Pr11 R.S.Pressly, M.E.Pruitt - Priv.Comm. (December 1966)

66Ra09 P.V.Rao, D.K.McDaniels, B.Crasemann - Nucl.Phys. 81, 296(1966); Erratum Nucl.Phys. A95, 705(1967)
Decay of ^{75}Se

66Ra13 H.Ramthun - Nukleonik 8, 244(1966)
Halbwertszeit und Spezifische Aktivitat von Radium-226

66Ra21 P.S.Rao - Current Sci.(India) 35, 384(1966)
Intensity of 1.114 MeV Gamma Transition in the Decay of Zn^{65} to Cu^{65}

66Ra22 R.V.Rama Mohan, K.V.Reddy, B.B.V.Raju, S.Jnanananda - Indian J.Pure Appl.Phys. 4, 420(1966)
Angular Correlation Studies and Level Schemes of Iron-58

66Ri01 P.Riehs - Nucl.Phys. 75, 381(1966)
Messung des Betaspektrums von ^{90}Y

66Ri07 C.Ribordy, O.Huber, P.Siffert, L.Stab - Helv.Phys.Acta 39, 262(1966)
Note sur la Desintegration du ^{51}Cr

66Sa08 M.Sakai, T.Yamazaki, J.M.Hollander - Nucl.Phys. 84, 302(1966)
New Weak Beta Transition from ^{88}Y

66Sa16 M.Sakai, T.Yamazaki, J.M.Hollander - UCRL-16580, p.92(1966)
Internal-Conversion Coefficients of the 381-keV and 389-keV M4 Transitions from Y-87m and Sr-87m

66Sc01 R.Schoneberg, M.Schumacher, A.Flammersfeld - Z.Physik 192, 305(1966)
Der Zerfall des Co^{56}

66Sc35 H.F.Schopper - Weak Interactions and Nucl.Beta Decay, North-Holland Publ.Co., Amsterdam (1966)

66St14 J.Steyn, A.S.M.De Jesus - NP-15912(1966)
Coincidence Measurements on Nuclides Decaying by Electron Capture

66Ts01 R.Tsaletka, Y.Vrzal - JINR-P-2739(1966)
Measurement of ^{95}Zr and Nb^{95} Mixture by Ge(Li) Detectors

66Va16 N.A.Vartanov, P.S.Samoilov, Y.S.Tsaturov - Yadern.Fiz. 3, 598(1966); Soviet J.Nucl.Phys. 3, 436(1966)
γ Radiation of Sr^{85}

66Ve01 L.J.Velinsky, M.A.Velinsky, S.K.Haynes - Proc.Intern.Conf.Internal Conversion Process Nashville, Tenn. (1965), J.H.Hamilton, Ed., Academic Press, Inc., New York, p.393(1966)
Relative Intensities of Internal Conversion Lines in 137m-Ba and 210-Bi

66Vo08 N.A.Voinova, B.S.Dzhelepov, Y.V.Kalinichev, D.M.Kaminker, A.G.Sergeev - Yadern.Fiz. 3, 593(1966); Soviet J.Nucl.Phys. 3, 429(1966)
The γ Spectrum of Mn^{56}

66Vr01 Y.Vrzal, E.P.Grigorev, A.V.Zolotavin, Y.Liptak, Y.Urbanets - JINR-P6-2986(1966)
Intensity of γ-Rays 75-Se, 106-Rh, 110m-Ag, 124-Sb, 140-Ba, 140-La and 154-Eu

66Wa03 A.H.Wapstra - Z.Naturforsch. 21a, 68(1966)
A Correction to the 1964 Mass Table

66Wi01 H.H.Williams, E.K.Warburton, K.W.Jones, J.W.Olness - Phys.Rev. 144, 801(1966)
Excitation Energies of Bound States of O^{17} and B^{12}

66Wu03 C.S.Wu, S.A.Moszkowski - Beta Decay, Interscience Publishers, New York (1966)

66Ya05 T.Yamazaki, J.M.Hollander - Nucl.Phys. 84, 505(1966)
Energy Levels of ^{237}Np (II). High Resolution Study of Transitions in the Decay of ^{237}U

66Yo02 T.Young, F.Gabbard, J.D.Brandenberger, J.D.Reber, J.J.Egan - Bull.Am.Phys.Soc. 11, No.4, 510, A13(1966)
$Ar^{40}(p,n)K^{40}$ Reaction, 2.3 - 5.0 MeV

67Ab07 I.A.Abrams, L.L.Pelekis - Program and Theses, Proc. 17th All-Union Conf. Nucl. Spectroscopy and Struct. At. Nuclei, Kharkov, p. 30 (1967)
Excitation of Metastable Levels in Nuclei by the γ-Rays of 116m-In

67Ar12 G.Ardisson - Compt.Rend. 264C, 1999(1967)
Sur la Desintegration de l'Iode 132

67Au01 R.L.Auble, W.C.McHarris, W.H.Kelly - Nucl.Phys. A91, 225(1967)
The Decay Schemes of ^{56}Co and ^{56}Mn and Their Use as Calibration Standards

67Ba37 M.N.Baldwin - Nucl.Sci.Eng. 30, 144(1967)
Molybdenum-99 Half-Life Determination

67Ba44 A.A.Bartlett, D.Bulthaup, K.Mohan - Bull.Am.Phys.Soc. 12, No.1, 37, BG15(1967)
Measurements on the Decay of Hg^{197}

67Ba60 P.H.Barker, R.D.Connor - Bull.Am.Phys.Soc. 12, No.5, 696, EE2 (1967)
Use of Gamma Rays in Fe^{56} as Calibration Standards

67Ba61 L.E.Bailey, J.B.Swedlund - Phys.Rev. 158, 6(1967)
X-Ray Fluorescence Yields of Al, Cl, Ar, Sc, Ti, V, Mn, Fe, Co, Y, and Ag
67BeBu J.A.Bearden, A.F.Burr - Rev.Mod.Phys. 39, 125(1967)
Reevaluation of X-Ray Atomic Energy Levels
67Be60 R.Beraud, I.Berkes, J.Daniere, M.Levy, G.Marest, R.Rougny - Compt.Rend.265B, 1354(1967)
Decroissance du Fer-59 et Niveaux Excites du Cobalt-59
67Bh01 S.K.Bhattacherjee, S.K.Mitra, H.C.Jain, H.C.Padhi, K.S.Bhatki, D.C.Ephraim - Nucl.Phys. A90, 696(1967)
The Spin of ^{228}Ac from Beta-Decay Experiments
67Bi02 J.K.Bienlein, G.Graf, W.Kreische, W.Lampert, G.Loos - Nucl.Phys. A92, 549(1967)
Das Spektrum der Inneren Bremsstrahlung beim β-Zerfall von ^{90}Y und ^{90}Sr
67Bl03 W.W.Black, R.L.Heath - Nucl.Phys. A90, 650(1967)
Measurement of Some Gamma-Ray Energies Suitable for Routine Energy Calibration
67Bo18 H.E.Bosch, M.C.Simon, E.Szichman, L.Gatto, S.M.Abecasis - Phys.Rev. 159, 1029(1967)
Disintegration of Sn^{113}
67Bo44 H.E.Bosch, E.Szichman - Bull.Am.Phys.Soc. 12, No.4, 598, KH13 (1967)
Determination of the Three Conversion Coefficients in the Decay of Au^{198} with Semiconductor Counters
67Br21 L.Broman, S.Boreving - Arkiv Fysik 34, 259(1967)
An Investigation of the Decay $^{95}Zr \to ^{95}Nb \to ^{95}Mo$
67Bu22 V.R.Burmistrov, Y.A.Andreev, A.D.Vongai, S.P.Karetskaya, A.F.Novgorodov - Izv.Akad.Nauk SSSR, Ser.Fiz. 31, 1676 (1967); Bull.Acad.Sci.USSR, Phys.Ser. 31, 1716 (1968)
Investigation of the Gamma Radiation from 197-Hg and 197m-Hg
67Ca09 J.L.Campbell, W.Leiper, K.W.D.Ledingham, R.W.P.Drever - Nucl.Phys. A96,279(1967)
The Ratio of K-Capture to Positon Emission in the Decay of ^{11}C
67Ch08 C.Chasman, R.A.Ristinen - Quoted by 66Wi01
67Ch20 C.Chasman, R.A.Ristinen - Phys.Rev. 159, 915(1967)
Beta Decay of Mn^{56} and Co^{56}
67De05 B.Denecke, E.De Roost, A.Spernol, R.Vaninbroukx - Nucl.Sci.Eng. 28, 305(1967)
The Gamma-Ray Branching of Krypton-85
67Di06 L.A.Dietz, C.F.Pachucki - Priv.Comm. (1967)
Interim Values for the Half Lives of Cesium-137 and Cesium-134 as Measured by Mass Spectrometry
67Do01 L.Dorikens-Vanpraet, E.Jacobs, K.Heyde, J.Demuynck, D.De Frenne - J.Phys.(Paris) 28, 1 (1967)
Le Schema de Desintegration de ^{99}Mo
67EnVa P.M.Endt, C.Van der Leun - Nucl.Phys. A105, 1(1967)
Energy Levels of Z=11-21 Nuclei (IV)
67Fi12 H.J.Fischbeck, J.J.Reidy - Priv.Comm. (March 1967)
Gamma Ray Transition Energies in the Decay of I^{131}
67Fo09 H.Forest, M.Huguet, C.Ythier - Compt.Rend. 264B, 1614(1967)
Sur le Rayonnement γ de Haute Energie du Rhodium 106
67Gl05 G.I.Gleason - Priv.Comm. (December 1967)
Half-Life Measurements by Gamma-Ray Spectroscopy
67Go21 I.W.Goodier - Intern.J.Appl.Radiation Isotopes 18, 334(1967)
The Half-Life of K^{42}
67Go30 N.B.Gove - Proc.Intern.Conf.Atomic Masses, 3rd, Winnipeg, Canada, R.C.Barber, Ed., Univ.Manitoba Press, p.119(1967)
Beta Decay Energy Systematics
67Gr05 G.Graeffe, W.B.Walters - Phys.Rev. 153, 1321(1967)
Decay of ^{129}Cs and ^{131}I to the Levels in ^{129}Xe and ^{131}Xe
67Gu08 C.Gunther, L.R.Parsignault - Nucl.Phys. A104, 588(1967)
The Nuclear g-Factors of the 5/2$^-$[523] States in ^{237}Np and ^{239}Np and the Level Structure of ^{237}Np
67Ha06 D.C.Hall, R.G.Albridge - Nucl.Phys. A91, 495(1967)
Internal Conversion Coefficients in the Decay of ^{57}Co
67Ha39 F.Hareux - Thesis, Centre d'Etudes Nucleaires de Saclay (1967); CEA-R 3315
Contribution a la Spectrometrie des Emetteurs β a l'Aide de Detecteurs a Jonction - Etude des Spectres du ^{35}S, ^{45}Ca, ^{204}Tl, ^{36}Cl
67He03 R.Henck, L.Stab, P.Siffert, A.Coche - Nucl.Phys. A93, 597(1967)
Etude Experimentale des Niveaux Excites de ^{132}Xe
67He08 R.L.Heath - Priv.Comm.(1967)
67Hn01 D.H.Hnatowich, C.D.Coryell - MIT-905-108, p.3 (1967)
The Decay of 7.5-day ^{111}Ag
67Hs01 S.T.Hsue, M.U.Kim, S.M.Tang - Nucl.Phys. A94, 146(1967)
End Point of the RaE Beta Spectrum
67Hs03 S.T.Hsue, M.U.Kim, L.M.Langer, E.H.Spejewski, J.B.Willett - Nucl.Phys. A101, 688(1967)
Decay of ^{47}Ca

67Jo02 R.E.Johnston, J.H.Douglas, R.G.Albridge - Nucl.Phys. A91, 505(1967)
The K-Auger Spectrum of Arsenic
67Jo05 A.S.Johnston, G.M.Julian - Priv.Comm. (1967)
67Jo07 K.C.Jordan - MLM-1399, p.16(1967)
Half-Life of Promethium-147
67Jo09 K.C.Jordan, B.C.Blanke, W.A.Dudley - J.Inorg.Nucl.Chem. 29, 2129(1967)
Half-Life of Tritium
67Jo10 P.M.S.Jones - J.Nucl.Mater. 21, 239(1967)
The Half Life of Tritium
67Ka12 S.-E.Karlsson, B.Svahn, H.Pettersson, G.Malmsten, E.Y.De Aisenberg - Nucl.Phys. A100, 113(1967)
The Decay of ^{140}La
67Ka24 V.M.Kartashov, O.V.Stakhov, A.G.Troitskaya, G.A.Shevelev - Yadern.Fiz. 6, 901 (1967);Soviet J.Nucl.Phys. 6, 656 (1968)
Multipolarity of the 661.59-keV Transition in Ba^{137}
67Ki10 J.D.King, N.Neff, H.W.Taylor - Nucl.Instr.Methods 52, 349(1967)
The Energy of the ^{40}K Gamma Ray and its Use as a Calibration Standard
67Kl04 D.Klockow - Talanta 14, 817 (1967)
Radiochemische Trennungen mit Hilfe der Ringofenmethode--II
67Ko01 J.Konijn, E.W.A.Lingeman, S.A.De Wit - Nucl.Phys. A90, 558(1967)
The Decay of ^{48}Sc and ^{48}V
67Ko10 J.Konijn, W.H.G.Lewin, B.van Nooijen, H.F.van Beek, S.A.De Wit, E.W.A.Lingeman - Nucl.Phys. A102, 129(1967)
Allowed K-Capture to Positon Emission Ratios in the Decays of ^{48}V and ^{52}Mn
67La20 N.O.Lassen, N.Hornstrup - Kgl.Danske Videnskab.Selskab., Mat.-Fys.Medd. 36, No.4 (1967)
Half-Life of ^{208}Tl(ThC'')
67La21 *F.Lagoutine, Y.Le gallic, J.Legrand - Proc.Symp.Standardization of radionuclides, Vienna, Austria(1966), Intern.At.Energy Agency, Vienna, p.603(1967); CONF-661012*
Determination Precise de Quelques Periodes Radioactives
67LeHo C.M.Lederer, J.M.Hollander, I.Perlman - Table of Isotopes, Sixth Edition, John Wiley and Sons, Inc., New York (1967)
67Le06 J.Lehmann - Nucl.Phys. A98, 273(1967)
Spectrum Shape Measurement of Two Beta Transitions in ^{111}Ag
67Le07 H.Leutz, H.Wenninger - Nucl.Phys. A99, 55(1967)
Electron-Capture to Positon-Emission Ratio in the Decay of ^{22}Na
67Ma40 H.Maria, G.Ardisson - Compt.Rend. 265B, 789(1967)
Sur le Rayonnement γ de Haute Energie du Bismuth 214 (Radium C)
67Ma51 H.Maria - Compt.Rend. 265B, 1138(1967)
Sur le Rayonnement γ de Basse Energie du Radium 226 et de Ses Derives, Et le Caractere Multipolaire de Quelques Transitions γ du Polonium 214
67Mc10 M.F.McCann, G.M.Lewis, K.M.Smith - Nucl.Phys. A98, 577(1967)
The Electron Capture Decay of ^{40}K
67Me09 J.W.T.Meadows, V.A.Mode - Priv.Comm. (February 1967)
Experimental Parameters of the Sc^{47} Half-Life Measurements
67Me18 W.Menti - Helv.Phys.Acta 40, 981(1967)
Innere Konversion und Multipolstrahlung Zwischen Angeregten Zustanden von Einigen Mittelschweren Kernen
67Mi11 V.Middelboe - Kgl.Danske Videnskab.Selskab, Mat.-Fys.Medd. 35, No.8(1966)
Some Accurate Half-Life Determinations
67Mi13 K.Miyano - J.Phys.Soc.Japan 23, 1191(1967)
Beta Decay of Yttrium-87 Isomer
67Mu10 J.Murray, T.A.McMath, J.A.Cameron - Can.J.Phys. 45, 1821(1967)
Nuclear *g* Factors of the First Excited States of ^{76}Se and ^{122}Te
67Mu15 A.Mukerji, J.B.McCough, Jr., *G.D.Cole - Nucl.Phys. A100, 81(1967)*
Orbital Electron Captures in ^{51}Cr and *^{65}Zn and the K-Fluorescence Yields of V and Cu*
67Mu20 A.Mukerji, W.W.Walker, O.B.*Dickins, Jr. - Nuovo Cimento 52B, 225(1967)*
K-Shell Internal-Conversion *Coefficients of the 122 and 136.4 keV Gamma Transitions of* ^{57}Co
67Na15 T.Nagarajan, M.Ravindranath, *K.Venkata Reddy, S.Jnanananda - BARC-305, p.34(1967)*
Determination *of End-Point Energies of Beta Transitions with Siegbahn-Slatis* Spectrometer
67Ob01 H.A.O'Brien, Jr., J.S.Eldridge - *Nucleonics 25, No.2, 41(1967)*
A New Way to Make Pure Ce^{141}
67Oe01 F.L.Oetting, S.R.Gunn - *J.Inorg.Nucl.Chem. 29, 2659(1967)*
A Calorimetric Determination *of the Specific Power and Half-Life of Americium-241*
67Ok02 H.Okamura, M.Ogawa, A.Mito - *J.Inorg.Nucl.Chem. 29, 1185(1967)*
The Half-Life of Indium-113m
67Os01 H.Ostertag, K.H.Lauterjung - Z.Physik 199, 25(1967)
Der β-Zerfall des ^{208}Tl

67Pa08 J.J.H.Park, P.Christmas - Can.J.Phys. 45, 2621(1967)
Electron Spectra in the Decay of Thallium-204
67Pa14 S.C.Pancholi, N.R.Johnson - ORNL-4164, p.12(1967)
Levels in ^{75}As Populated in the Decay of 120-Day ^{75}Se
67Pa22 A.Pakkanen - Ann. Acad. Sci. Fennicae, Ser. A VI, No. 253 (1967)
Excited States of 52-Cr Populated in the Decay of 52m,g-Mn and 52-V
67Pi03 W.R.Pierson, K.Rengan - Phys.Rev. 159, 939(1967)
Positron Emission from ^{105}Ag and Related Aspects of ^{105}Ag Decay
67Pi04 W.R.Pierson - Phys.Rev. 159, 951(1967)
Positron Emission from ^{36}Cl
67Ra01 S.Raman - Nucl.Phys. A90, 508(1967)
Energy Levels of ^{82}Kr Populated by ^{82}Br Decay
67Ra03 A.V.Ramayya, J.H.Hamilton, S.M.Brahmavar, J.J.Pinajian - Phys.Letters 24B, 49(1967)
Precision Gamma-Ray Energy Measurements
67Ra11 P.V.Rao, R.W.Fink - Nucl.Phys. A103, 385(1967)
Levels in ^{106}Pd from Decay of 8.5-d ^{106}Ag, 24-min ^{106}Ag and 30-sec ^{106}Rh
67Ra29 H.Ramthun - Proc.Symp.Standardization of Radionuclides, Vienna, Austria(1966), Intern.At.Energy Agency, Vienna, p.589(1967); CONF-661012
Microcalorimetric Determination of the Mean β-Energy of ^{90}Sr + ^{90}Y
67Re05 S.A.Reynolds, E.Wyatt - Priv.Comm. (1967)
67Rg01 Research Group, Tracerlab Richmond Radiochemistry and Radiomeasurements Group - Priv.Comm. (1967)
67Ro03 R.L.Robinson, F.K.McGowan, P.H.Stelson, W.T.Milner - Nucl.Phys. A96, 6(1967)
Low-Lying Levels of ^{79}Br
67Ru04 J.-Z.Ruan, H.Inoue - J.Phys.Soc.Japan 23, 481(1967)
Decay of ^{124}I
67Sa08 H.S.Sahota, B.S.Sood - Current Sci.(India) 36, 601(1967)
On the Determination of K-Conversion Coefficients
67Sa11 J.Saudinos, G.Vallois, O.Beer - Nucl.Sci.Appl. 3, No.2, 22(1967)
Spectroscopy of $Pb^{206,207,208}$ by Inelastic Scattering of 24.5 MeV Protons
67Se05 H.Sergolle, G.Albouy, J.Bouloumie, J.M.Lagrange, L.Marcus, M.Pautrat - J.Phys.(Paris) 28, 383(1967)
Contribution a l'Etude de la Desintegration de ^{123}I
67Sl06 S.H.Slivinsky, R.G.Winter - Bull.Am.Phys.Soc. 12, No.7, 1042, BD11(1967)
Isomeric Cross-Section Ratios for $Sr^{87}(p,n)Y^{87,87*}$
67Sm02 R.H.Smith, W.F.Bethard - Nucleonics 25, No.4, 7(1967)
GA Data on Ca^{47}
67Sp06 E.H.Spejewski, J.B.Willett - Nucl.Phys. A99, 625(1967)
The Negaton Spectrum of ^{36}Cl
67St05 P.H.Stelson - Phys.Rev. 157, 1098(1967)
Decay of ^{124}Sb to ^{124}Te
67Te02 R.G.Tee, A.Aspinall - Nucl.Phys. A98, 417(1967)
Measurements of the Energy Level Structure of Ni Isotopes Using (d,p) and (p,p') Reactions
67To04 D.Totzek, K.-W.Hoffmann - Z.Physik 205, 137(1967)
L/K-Einfangverhaltnis von ^{65}Zn
67Vo04 H.R.Von Gunten, A.Wyttenbach, H.Dulakas - J.Inorg.Nucl.Chem. 29, 2826(1967)
Half-Life of ^{210}Pb (RaD)
67Vo07 T.Von Ledebur, F.C.Roehmer - Helv.Phys.Acta 40, 340(1967)
γ-Ray Spectroscopy of the Decay ^{38}Cl → ^{38}A
67Vr05 J.Vrzal, E.P.Grigorev, A.V.Zolotavin, J.Liptak, V.O.Sergeev, J.Urbanets - Izv.Akad.Nauk SSSR, Ser.Fiz. 31, 696(1967); Bull.Acad.Sci.USSR, Phys.Ser. 31, 692(1968)
Decay of ^{106}Rh
67WaKu A.H.Wapstra, C.Kurzeck, A.Anisimoff - Proc. Intern. Conf. Atomic Masses, 3rd, Winnipeg, Canada, R.C.Barber, Ed., Univ. Manitoba Press, p. 153 (1967)
New Masses for Nuclides with A > 212
67Wh01 D.H.White, D.J.Groves - Nucl.Phys. A91, 453(1967)
Precision Measurements of Standard Gamma-Ray Energies
67Wi17 G.Winter, K.Hohmuth, R.Ross, H.Kastner, J.Schintlmeister - Z.Phys.Chem. 234, 305(1967)
Messung des Elektroneneinfangverhaltnisses P(L)/P(K) von ^{56}Ni und ^{57}Ni Unter Verwendung von Dicyclopentadienyl-Nickel
67Yt01 C.Ythier, G.Ardisson, M.Lefort - Compt.Rend. 264B, 84(1967)
Study of the High Energy Gamma Radiation of ^{132}I Using a Pair Spectrometer
67Yt02 C.Ythier, G.Ardisson - Compt.Rend. 264C, 944(1967)
Sur le Rayonnement γ de l'Iode 131
67Ze04 H.Zemann, D.Semrad - SGAE-PH-58/1967 (1967)
Precision Measurement of Continuous Beta Spectra
68Al16 P.Alexander, J.P.Lau - Nucl.Phys. A121, 612 (1968)
Nuclear Structure in ^{133,135}Xe and ^{133,135}Cs

68An01 S.C.Anspach, L.M.Cavallo, S.B.Garfinkel, J.M.R.Hutchinson, C.N.Smith - Priv.Comm. (January 1968)

68An08 M.Anthony - J.Sci.Instr. 1, 573 (1968)
The Energy of the E, G, H and I(a) Conversion Lines of the Th B β Spectrum

68Ba10 S.A.Baranov, V.M.Kulakov, V.M.Shatinskii - Program and Theses, Proc.18th Ann.Conf.Nucl.Spectroscopy and Struct.of at.Nuclei, Riga, p.167(1968)
Relative Determination of Energies of the Most Intense Groups of α-Particles of Isotopes of Heavy Elements with $T_1/_2$ > 50 Years

68Ba18 H.W.Baer, J.J.Reidy, M.L.Wiedenbeck - Nucl.Phys. A113, 33(1968)
The Decay of ^{140}La to Levels in ^{140}Ce

68Ba25 S.A.Baranov, V.M.Kulakov, V.M.Shatinskii - Yadern.Fiz. 7, 727(1968); Soviet J.Nucl.Phys. 7, 442(1968); See Also 68Ba10
Relative Determination of the Energy of the Most Intense Groups of α Particles of Certain Isotopes ($T_1/_2$> 50 Years) of Heavy Elements

68Ba49 W.Bambynek, E.De Roost, E.Funck - Proc.Conf.Electron Capture and Higher Order Processes in Nucl.Decays, Debrecen, Hungary, D.Berenyi, Ed., Eotvos Lorand Phys.Soc., Budapest, p.253 (1968)
On the Decay of ^{58}Co

68Ba60 J.Barrette, S.Monaro - Nucl.Instr.Methods 63, 235 (1968)
Note on the Energies of the Gamma-Transitions in ^{113}Sn Decay

68Be01 D.Berenyi, D.Varga, B.Vasvari, E.Brucher - Nucl.Phys. A106, 248 (1968)
An Upper Limit for the Positon Decay of ^{54}Mn

68Be06 H.Beekhuis, R.J.Van Duinen - Nucl.Phys. A108, 382(1968)
Matrix Element Cancellation in the Beta Decay of ^{141}Ce and ^{199}Au

68Be10 T.A.Belote, W.E.Dorenbusch, J.Rapaport - Nucl.Phys. A109, 666(1968)
Excitation of ^{56}Co by Two-Particle Transfer Reactions

68Be35 E.Beck, H.Daniel - Z.Physik 216, 229 (1968)
Das Positronenspektrum von ^{22}Na und die Ruhemasse des Neutrinos Aus Dem β^+ -Zerfall

68Be47 F.Bella, M.Alessio, P.Fratelli - Nuovo Cimento 58B, 232 (1968)
A Determination of the Half-Life of ^{14}C

68Be62 M.J.Berger - J.Nucl.Med., Suppl.No.1, 15 (1968)
Energy Deposition in Water by Photons from Point Isotropic Sources

68Bj01 J.H.Bjerregaard, O.Hansen, O.Nathan, R.Chapman, S.Hinds - Nucl.Phys. A107, 241 (1968)
The Reaction ^{209}Bi(t,α)^{208}Pb

68Bl15 P.H.Blichert-Toft - NP-17944 (1968)
Radioatoms in Nuclear Medicine

68Bo38 M.Bogdanovic, M.Mladjenovic, R.Stepic - Z.Physik 216, 267 (1968)
Measurement of Internal Conversion K/L_3 and K/L Ratios for E2 Transitions

68Ca22 H.K.Carter, J.H.Hamilton, S.R.Amtey, J.C.Manthuruthil, J.J.Pinajian - Bull.Am.Phys.Soc. 13, No.11, 1466, FE2(1968)
Conversion-Electron Measurements in the Decay of ^{132}I

68Da12 H.Daniel, W.Collin, M.Kuntze, S.Margulies, B.Martin, O.Mehling, P.Schmidlin, H.Schmitt - Nucl.Phys. A118, 689(1968)
Kernspektroskopische Untersuchungen an ^{8}Li, ^{42}K, ^{86}Rb, ^{141}Ce, ^{144}Ce, ^{144}Pr und ^{203}Hg

68Da21 J.Dalmasso, C.Marsol - Compt.Rend. 267B, 1366(1968)
Sur le Rayonnement Yg de Basse Energie du Thorium 228 et de Ses Derives Et le Caractere Multipolaire des Transitions de 212 Po

68De08 P.Decowski, W.Grochulski, A.Marcinkowski, K.Siwek, I.Sledzinska, Z.Wilhelmi - Nucl.Phys. A112, 513(1968)
Isomeric Cross-Section Ratios and Total Cross Sections for the Co^{59}(n,2n)Co^{58}g,m, Ni^{58}(n,p)Co^{58}g,μ and Co^{59}(γ,n)Co^{58}g,μ Reactions

68En01 G.A.P.Engelbertink, H.Lindeman, M.J.N.Jacobs - Nucl.Phys. A107, 305 (1968)
Investigation of J $\rightarrow$ J M1 Transitions in ^{38}Ar

68Fi02 R.W.Fink - Nucl.Phys. A110, 379(1968)
Comparison with theory of Experimental Values of L/K Orbital Electron Capture Ratios for Allowed and First-Forbidden Transitions

68Fi04 H.J.Fischbeck - Phys.Rev. 173, 1078 (1968)
Intensities of Inner Beta Groups in Ca^{47} and Shapes of Nonstatistical Allowed Outer Groups in Ca^{47} and P^{32}

68Fo07 B.Fogelberg, A.Backlin - NP-17722 (LF-23) (1968)
Precision Measurements in the Decay of ^{113}Sn

68Ga14 C.Gatrousis, R.A.Meyer - Bull.Am.Phys.Soc. 13, No.11, 1426, DD7(1968)
Levels of ^{59}Co Populated in the Decay of ^{59}Fe

68Go22 I.W.Goodier - Intern.J.Appl.Radiation Isotopes 19, 823 (1968)
The Half-Lives of ^{56}Mn and ^{198}Au

68Go30 I.W.Goodier, F.H.Hughes, M.J.Woods - Intern.J.Appl.Radiation Isotopes 19, 795 (1968)
The Calibration of the 1383A Ionisation Chamber for Sr^{87}m

68Gu05 R.Gunnink, R.A.Meyer, J.B.Niday, R.P.Anderson - Nucl.Instr.Methods 65, 26 (1968)
Precise Determinations of High-Energy Gamma Rays and Errors in the Pair-Peak Method

68HaSe R.S.Hager, E.C.Seltzer - Nucl.Data A4, 1 (1968)
Internal Conversion Tables. Part 1: K-, L-, M-Shell Conversion Coefficients for Z = 30 to Z = 103

68Ha35 J.Hattula, E.Liukkonen - Ann.Acad.Sci.Fennicae, Ser.A VI, No.274 (1968)
On the Decay of 30s 106g-Rh

68Ha45 J.H.Hamilton, H.K.Carter, J.J.Pinajian - Bull.Am.Phys.Soc. 13, No.11, 1466, FE3(1968); Priv.Comm.(1969)
Levels in ^{132}Xe Populated by ^{132}I

68Ha47 J.W.Hammer - Z.Physik 216, 355(1968)
Experimentelle Untersuchungen am Elektroneneinfang des Mangan 54 und Zink 65

68He20 F.Heinrich, G.Philippin - Helv.Phys.Acta 41, 431 (1968)
Prazisionsmessung der Halbwertszeit von Cu^{64}

68He21 R.L.Heath - Priv.Comm. (1968)

68Hi11 J.E.Hiscott - AERE-R-5342(1968)
Gamma-Ray Branching Ratio in the Decay of Zr^{95}

68Hi12 P.F.Hinrichsen - Nucl.Phys. A118, 538(1968)
Decay of 78.4 h ^{89}Zr

68Ho07 D.L.Horrocks - Nucl.Phys. A110, 238(1968)
Search for Short-Lived Isomer of ^{204}Tl

68Hu01 H.B.Hupf, J.S.Eldridge, J.E.Beaver - Intern.J.Appl.Radiation Isotopes 19, 345(1968)
Production of Iodine-123 for Medical Applications

68In01 T.Inamura - J.Phys.Soc.Japan 24, 1(1968)
Beta and Gamma Spectroscopic Studies of ^{125}Sb

68Ja03 P.Jahn, W.Todt, O.Dragoun - Z.Physik 210, 245(1968)
Energie- und Intensitatsmessungen an Konversionselektronen des Zerfalls ^{75}Se→^{75}As

68JBMa J.B.Marion - Nucl.Data A4, 301(1968)
Gamma-Ray Calibration Energies

68Je01 R.W.Jewell, W.John, R.Massey, B.G.Saunders - Nucl.Instr.Methods 62, 68(1968)
Bent Crystal Spectrometer for Use with a Germanium Detector

68Jo02 G.G.Jonsson, B.Forkman - Nucl.Phys. A107, 52 (1968)
(γ,xn) Reactions in ^{127}I

68Ka09 R.Kamoun, R.Ballini, S.Bergstrom-Rohlin, J.-M.Kuchly, P.Siffert - Compt.Rend. 266B, 1241 (1968)
Niveaux Excites du Noyau du Neptunium 237 Obtenus par Radioactivite α De l'Americium 241

68Ka20 R.A.Kalinauskas, K.V.Makaryunas, K.Makaryunene, R.I.Davidonis - Izv.Akad.Nauk SSSR, Ser.Fiz. 32, 207(1968); Bull.Acad.Sci.USSR, Phys.Ser. 32, 187(1969)
Investigation of the Radiation Accompanying the Isomeric Transitions in 123m-Te and 127m-Te

68La07 R.E.Larson, C.M.Gordon - Priv.Comm. (April 1968)
Gamma Rays from ^{47}Ca, ^{49}Ca, ^{38}K, ^{42}K and ^{43}K

68La10 F.Lagoutine, Y.Le Gallic, J.Legrand - Intern.J.Appl.Radiation Isotopes 19, 475(1968)
Determination Precise de Quelques Periodes Radioactives

68La21 J.-M.Lagrange - Compt.Rend. 267B, 1354 (1968)
Etude du Schema de Desintegration de l'Iode-124

68Le03 J.Legrand, J.P.Boulanger, J.P.Brethon - Nucl.Phys. A107, 177 (1968)
Determination de l'Energie de Quelques Transitions γ

68Le16 M.Lepri, W.S.Lyon - Priv.Comm. (1968)

68Lo14 R.Loevinger, M.Berman- J.Nucl.Med., Suppl.No. 1,7 (1968)
A Schema for Absorbed-Dose Calculations for Biologically-Distributed Radionuclides

68Ma08 J.C.Manthuruthil, H.J.Hennecke, C.R.Cothern - Phys.Rev. 165, 1363(1968)
Internal-Conversion-Electron Study of the Decay of Ru^{103}

68Mc04 J.McDonald, D.Porter - Nucl.Phys. A109, 529(1968)
Excited States in ^{111}Cd

68Mc13 M.F.McCann, K.M.Smith - Nucl.Phys. A121, 233 (1968)
The L/K Electron Capture Ratio in the Decay of ^{65}Zn on the 1.114 MeV Excited State of ^{65}Cu

68Na10 T.S.Nagpal - Nucl.Phys. A121, 176 (1968)
Gamma Rays Following the Decay of ^{75}Se

68Ni05 E.B.Nieschmidt - Quoted by 68Ma08

68No02 J.A.Nolen, Jr., H.T.Fortune, P.Kienle, G.C.Morrison - Bull.Am.Phys.Soc. 13, No.4, 584, BF15 (1968)
Energy Levels of ^{103}Ru and ^{105}Ru from the ^{102,104}Ru(d,p) Reaction

68Pe01 H.Pettersson. S.Antman, Y.Grunditz - Nucl.Phys. A108, 124(1968)
The Decay of ^{90}Nb

68Ra01 S.Raman - Nucl.Phys. A107, 402 (1968)
Decay of ^{144}Pr to Levels in ^{144}Nd

68Ra11 R.C.Ragaini, W.B.Walters, G.E.Gordon, P.A.Baedecker - Nucl.Phys. A115, 611(1968)
Decay Scheme of 13.3 h ^{123}I

68Ra16 R.C.Ragaini, W.B.Walters, R.A.Meyer - Priv.Comm. (December 1968)
Levels of ^{124}Te from the Decay of 4.2-d ^{124}I

68Re04 S.A.Reynolds, J.F.Emery, E.I.Wyatt - Nucl.Sci.Eng. 32, 46(1968)
Half-Lives of Radionuclides - III

68Re08 S.A.Reynolds - Priv.Comm. (May 1968)
Half-Life of Tc-99m

68Re13 S.A.Reynolds - ORNL-4343, p.76(1968)
Quality Control

68Ri03 J.C.Ritter, R.E.Larson, J.I.Hoover - Nucl.Phys. A110, 463(1968)
$(\gamma,2n)$, $(\gamma,\alpha n)$ and $(\gamma,\alpha 2n)$ Reactions on ^{63}Cu and the Decay of ^{58}Co

68Ru04 W.Rubinson, K.P.Gopinathan - Phys.Rev. 170, 969(1968)
Conversion Coefficients of the Fe^{57} 14.4-keV Transition, the K-Capture Fraction in Co^{57} e^- Capture, and the K-Fluorescence Yield of Fe

68Sa05 A.R.Sayres, C.C.Trail - Nucl.Phys. A113, 521(1968)
Precision Measurement of the Energies of the Gamma Rays from ^{144}Nd

68Sc01 I.G.Schroder, M.McKeown, G.Scharff-Goldhaber - Phys.Rev. 165, 1184(1968)
Mass Difference of K^{40} and Ar^{40}

68Sh07 A.H.Sher, B.D.Pate - Nucl.Phys.A112, 85(1968)
The Decay of ^{56}Co and ^{56}Mn

68St02 R.E.Stone, E.K.Hulet - J.Inorg.Nucl.Chem. 30, 2003 (1968)
Radiochemical Determination of the Alpha Half-Life of ^{241}Am

68St05 P.H.Stelson - Nucl.Phys. A111, 331(1968)
Decay of ^{65}Zn

68Su08 Y.P.Suslov - Proc.Conf.Electron Capture and Higher Order Processes in Nucl.Decays, Debrecen, Hungary, D.Berenyi, Ed., Eotvos Lorand Phys.Soc.,Budapest, p.51 (1968)
Functions for the Analysis of K, L-Electron Capture

68Ta06 W.D.Tajibnapis, M.K.Ramaswamy - Nuovo Cimento 55B, 591 (1968)
On the K-Conversion Coefficient of the 393 keV Transition in ^{113}In

68Tu03 T.C.Tucker, L.D.Roberts, C.W.Nestor, Jr., T.A.Carlson, F.B.Malik - Phys.Rev. 174, 118 (1968)
Calculation of the Electron Binding Energies and X-Ray Energies for the Superheavy Elements 114, 126, and 140 Using Relativistic Self-Consistent-Field Atomic Wave Functions

68Va06 J.van Klinken, F.Pleiter, H.T.Dijkstra - Nucl.Phys. A112, 372(1968)
Beta- and Gamma-Ray Measurements on the Decay of ^{38}Cl

68Va13 E.Vatai, D.Varga, J.Uchrin - Nucl.Phys. A116, 637(1968)
Measurement of the $E/\beta+$ Ratio in the Decay of ^{22}Na and ^{74}As

68Va14 C.W.E.van Eijk, B.van Nooijen, F.Schutte, S.M.Brahmavar, J.H.Hamilton, J.J.Pinajian - Nucl.Phys. A121, 440(1968)
The Decay of ^{99}Mo

68We02 H.Wenninger, J.Stiewe, H.Leutz - Nucl.Phys. A109, 561(1968)
The ^{22}Na Positon Spectrum

68Wh03 D.H.White, D.J.Groves, R.E.Birkett - Nucl.Instr.Methods 66, 70 (1968)
Precision Measurements of Gamma Rays from ^{60}Co, ^{41}Ar and $^{53}Cr(n,\gamma)^{54}Cr$

68Wi07 G.Winter - Nucl.Phys. A113, 617(1968)
The L_1/K Orbital Electron Capture Ratio of Low-Z Elements

68Wo02 J.L.Wolfson, A.J.Collier - Nucl.Phys. A112, 156(1968)
Precision Measurement of Beta-Ray End-Point Energies: ^{60}Co, ^{137}Cs, and ^{204}Tl

68Wo04 K.Wolcken - Z.Naturforsch. 23a, 788(1968)
Energieniveaus in Te^{125}

68Wo06 E.J.Woodhouse, T.H.Norris - J.Inorg.Nucl.Chem. 30, 1373(1968)
Half-Life of Sulphur-35

68Yt01 C.Ythier, H.Maria, G.Ardisson - Compt.Rend. 267B, 1109(1968)
Sur le Rayonnement γ de Haute Energie Accompagnant la Desintegration du Bismuth 214

68Zi01 W.H.Zimmer, R.E.Dahl - Nucl.Sci.Eng. 32, 132(1968)
Half-Life of ^{54}Mn

68Zi04 J.P.Zirnheld, R.Henck - J.Phys.(Paris) 29, 144(1968)
Etude du Schema de Desintegration de ^{124}Sb

69Au01 I.P.Auer, J.J.Reidy, M.L.Wiedenbeck - Nucl.Phys. A124, 199(1969)
The Decay of ^{124}Sb to the Levels of ^{124}Te

69Ba12 H.W.Baer, J.Bardwick - Nucl.Phys. A129, 1 (1969)
Study of N=82 Nuclei in the Reaction $^{142}Nd(d,^3He)^{141}Pr$

69Ba14 H.E.Banta, G.I.Gleason - Priv.Comm.(June 1969)
Radioactivity of ^{38}Cl

69Be42 H.Behrens, J.Janecke - Numerical Data and Functional Relationships in Sci.Technol., Landolt-Bornstein, New Ser., H.Schopper, Ed., Springer-Verlag, Berlin, Group 1: Nucl.Phys.Technol., Vol.4 (1969)
Numerical Tables for Beta-Decay and Electron Capture

69Be43 M.J.Berger - J.Nucl.Med., Suppl.No.5, Pamphlet 8 to Be Published (1969)

69Be44 M.J.Berger - Priv.Comm. (1969)

69Bo24 B.Bortels - Intern.J.Appl.Radiation Isotopes 20, 612 (1969)
An Accurate Calorimetric Determination of the Half-Life of Thallium-204

69Ca05 H.K.Carter, J.H.Hamilton, J.C.Manthuruthil, S.R.Amtey, J.J.Pinajian, E.F.Zganjar - Priv.Comm.(April 1969); See Also 68Ca22
Conversion Coefficient Measurements in ^{132}Xe from High Resolution Electron and Gamma-Ray Studies

69Ch06 St.Charalambus, H.Daniel, H.Koch, G.Poelz, H.Schmitt, L.Tauscher, G.Backenstoss - Nucl.Phys. A126, 428(1969)
Energies and Intensities of ^{125}Sb Gamma Rays
69Em01 J.F.Emery - Priv.Comm. (February 1969)
69Fa09 J.L.Fasching, W.B.Walters, C.D.Coryell - Priv.Comm. (September 1969)
Decay of 284-Day ^{144}Ce, 17.3 min ^{144}Pr and a New Isomer, 7.2 min 144m-Pr
69Fi05 R.W.Fink - Phys.Rev. 180, 1220 (1969)
M/L Orbital-Electron Capture Ratios in Cd^{109} Decay
69Fo01 C.Foin, J.Oms, J.Blachot, J.Crancon - Nucl.Phys. A123, 513(1969)
Etude de la Desintegration ^{95}Zr → ^{95}Nb
69FuCo G.H.Fuller, V.W.Cohen - Nucl.Data Tables A5, 433(1969)
Nuclear Spins and Moments
69Ha05 H.H.Hansen, G.Lowenthal, A.Spernol, W.van der Eijk, R.Vaninbroukx - Z.Physik 218, 25(1969)
The Beta Branching Ratio and Conversion Coefficients in the ^{137}Cs Decay
69Ha09 R.Hardell, S.O.Idetjarn, H.Ahlgren - Nucl.Phys. A126, 392(1969)
Thermal-Neutron Capture Gamma Rays from the ^{27}Al(n,γ)^{28}Al Reaction
69Ha26 J.H.Hamilton, H.K.Carter, J.J.Pinajian - Priv.Comm. (September 1969)
Gamma-Gamma Coincidence Measurements and the Level Structure of ^{132}Xe
69Ha29 G.Harbottle - Priv.Comm. (August 1969); BNL-13901 (1969)
The Half-Lives of Two Long-Lived Nuclear Isomers, 108m-Ag and 192m$_2$-Ir, And of 137-Cs and 204-Tl
69Hu04 E.Huster, O.Krafft - Z.Naturforsch. 24a, 285(1969)
Das L/K-Einfangverhaltnis von Zink 65
69Jo02 K.C.Jordon, J.H.Birden, B.C.Blanke - J.Inorg.Nucl.Chem. 31, 2641 (1969)
Determination of the Half-Life Value of Thallium-204
69Kl01 A.F.Kluk, D.Krmpotic, J.H.Hamilton - Z.Physik 227, 78 (1969)
Search for Weakly Populated States in the Decay of ^{51}Cr
69Kr06 D.Krpic, R.Stepic, M.Bogdanovic, M.Mladenovic - Fizika 1, 171(1969)
K/L$_3$, M/L and (n+O+...)/M Ratios for 239 keV M1 Transitions in ^{212}Bi
69La03 W.Lauppe, G.Luhrs - Z.Physik 219, 169(1969)
Messungen am Po^{214} γ-Spektrum mit einem Ge(Li)-Paar-Spektrometer
69Li10 E.W.A.Lingeman, J.Konijn, P.Polak, A.H.Wapstra - Nucl.Phys. A133, 630 (1969)
The Decay of ^{214}Pb and Other ^{226}Ra Daughters
69Mc05 M.McDonnell, M.K.Ramaswamy - Nucl.Phys. A127, 531 (1969)
Direct Measurement of the Decay Energy of ^{85}Sr from Inner Bremsstrahlung Spectrum and Bahcall Exchange Correction
69Me04 R.A.Meyer, W.B.Walters, R.C.Ragaini - Nucl.Phys. A127, 595 (1969)
Decay of the ^{124}Sb Isomers to Levels of ^{124}Te
69Pa02 A.Pakkanen, J.Kantele, P.Suominen - Z.Physik 218, 273(1969)
Levels in ^{208}Pb Populated in the Decay of ^{208}Tl(ThC'')
69Pa05 T.Paradellis, S.Hontzeas - Nucl.Phys. A131, 378 (1969)
Gamma Decay of ^{75}Se
69Pe04 D.W.Pernaa - Intern.J.Appl.Radiation Isotopes 20, 613(1969)
The Half-Life of ^{32}P
69Ra01 N.RanaKumar, R.W.Fink, P.V.Rao - Nucl.Phys. A127, 683 (1969)
K-Shell Conversion Coefficient of the 40.58 keV Transition in ^{99}Mo Decay
69Ra05 R.C.Ragaini, J.D.Knight - Nucl.Phys. A125, 97(1969)
Levels of ^{88}Sr from the Decay of ^{88}Rb
69Ra12 D.E.Raeside, M.A.Ludington, J.J.Reidy, M.L.Wiedenbeck - Nucl.Phys. A130, 677 (1969)
The Decay of ^{75}Se
69Re01 S.A.Reynolds - Priv.Comm. (January 1969)
69Re03 S.A.Reynolds, W.T.Mullins - Priv.Comm.(March 1969)
69St03 K.-D.Strutz, H.-J.Strutz, A.Flammersfeld - Z.Physik 221, 231 (1969)
Der Zerfall des Rh^{106}g
69Tu02 T.C.Tucker, L.D.Roberts, C.W.Nestor, Jr., T.A.Carlson, F.B.Malik - Phys.Rev. 178, 998 (1969)
Relativistic Self-Consistent-Field Calculation of the Wave Functions, Eigenvalues, Isotope Shifts, and the ^{6}S Hyperfine-Structure Coupling Constant as a Function of Pressure for Metallic Gold in the Wigner-Seitz Model
69Va04 H.van den Berg, M.McDonnell, M.K.Ramaswamy - Can.J.Phys. 47, 594(1969)
Precision Measurement of the Half-Life of 133m-In
69Wo02 R.E.Wood, J.M.Palms, P.Venugopala Rao - Nucl.Phys. A126, 300(1969)
Note on the Gamma Ray Spectrum from the ^{47}Ca Decay
69Wy01 A.Wyttenbach, H.Dulakas - J.Radioanal.Chem. 2, 287(1969)
The Half-Life of ^{28}Al
70NoSc L.C.Northcliffe, R.F.Schilling - Nucl.Data Tables A7, 233 (1970)
Range and Stopping-Power Tables for Heavy Ions