ORNL-4923

RADIOACTIVE ATOMS — SUPPLEMENT I

M. J. Martin

MAST

BLANK PAGE

Printed in the United States of America. Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road, Springfield, Virginia 22151
Price: Printed Copy \$4.00, Microfiche \$1.45

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

Contract No. W-7405-eng-26

NUCLEAR DATA PROJECT

RADIOACTIVE ATOMS - SUPPLEMENT I

M. J. Martin

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

NOVEMBER 1973

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37830
operated by
UNION CARBIDE CORPORATION
for the
U.S. ATOMIC ENERGY COMMISSION

MARTIN

RADIOACTIVE ATOMS SUPPLEMENT I

M. J. Martin

Nuclear Data Project

Abstract: Decay schemes and decay data are presented for 15 radioactive atomic species of special importance in the monitoring of reactor effluents. In addition to the nuclear radiations required for this purpose, are listed the atomic radiations of additional importance to workers in the fields of nuclear medicine and health physics. 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 species. The basic data from which the "best" values were chosen, along with literature references, are also given.

Cutoff Date: All data received before August 1, 1973, have been included.

Acknowledgments: The compilers would like to thank M.J. Berger, R.L. Bunting, G.H. Carlson, R.J. Gehlke, J.K. Halbig, R.A. Meyer, L.G. Multhauf, R.C. Ragani, and W.B. Walters for communicating their results to the compiler prior to publication.

CONTENTS

INTRODUCTION	2
EXPLANATION OF TABLE OF RADIATION DATA. POLICIES FOLLOWED	2
TABLE OF ATOMIC CONSTANTS	3
SYMBOLS AND DEFINITIONS	3
TABLE OF RADIATION DATA	5
^{83}Kr ^{133}Xe ^{85}Kr ^{87}Kr ^{133}Xe ^{135}Xe ^{90}Kr ^{135}Xe ^{135}Xe ^{90}Kr ^{91}Rb ^{135}Xe ^{137}Cs ^{135}Xe ^{137}Cs	
REFERENCES	6

BLANK PAGE

M. J. MARTIN

INTRODUCTION

The present work is a supplement to the publication, "Radioactive Atoms: Auger-Electron, α -, β -, γ -, and X-Ray Data" by M.J. Martin and P.H. Blichert-Toft, published in *Nuclear Data Tables* 8, Numbers 1-2, October 1970, hereafter referred to as (70MaBl). The reader is referred to this publication for a fuller discussion of the decay processes and policies. Much of the following descriptive material was selected directly from this reference.

EXPLANATION OF TABLE OF RADIATION DATA.
POLICIES FOLLOWED

The material for each nucleus is arranged in two main sections, the first headed **Decay Characteristics** and the second headed **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 - and ce-emission. The energy of the transition is 2.253 MeV and the intensity (γ +ce) is 32 transitions per 100 decays of the parent. Absence of the symbol ce (or γ) indicates that the ce- (or γ -) 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.

$1/2^-$, $3/2^+$, etc.

Spin and parity values for levels.

$T_{1/2}$

Half-lives are given for ground-state and long-lived metastable-state decays.

Radiations

This table contains data on atomic and nuclear radiations of the type $e_A(e_{AK}e_{AL})$, $X(X_KX_L)$, β^- , γ , and ce (ce_Kce_L ...) emitted with intensity >0.01 per 100 disintegrations of the parent nucleus (i.e., $>0.01\%$). Note, however, that low-intensity ($\leq 0.01\%$) γ - or ce-transitions have been taken into account wherever (γ +ce)-intensity imbalances have been used to deduce β -intensities. In those

cases where weak radiations ($\leq 0.01\%$) 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 ^{87}Kr , ^{88}Kr - ^{88}Rb , and ^{136}Xe - ^{136}Cs 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 ^{199}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 has not been measured. However, theoretical estimates of some of these quantities are available for limited Z-regions. For ^{136}Kr , based on theoretical values of the required atomic constants given in 72BaCr, the compiler estimates a yield of $\approx 300\%$ M-shell Auger transitions (with energy ≈ 0.0002 MeV).

The radiations are listed in the first column by type. For an explanation of the notation employed see **SYMBOLS AND DEFINITIONS**. Particle radiations (e_A , ce, 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, Δ , the value of energy emitted per disintegration is presented in units of $\text{gm-rad}/\mu\text{Ci-h}$. For an infinite, homogeneous medium in which a source is uniformly dispersed with a concentration of $1 \mu\text{Ci-h/gm}$, Δ gives the absorbed dose in rads. See also **SYMBOLS AND DEFINITIONS**.

Column 6 contains the 90% absorbed-dose range, $R_{90}(\text{cm})$, 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. R_{90} values for photons were taken from Fig. 1 of 70MaBl, drawn from data provided by M.J. Berger (68Be62). The R_{90} values for internal conversion and Auger electrons were taken from unpublished data of Berger. The values are 5-8% higher than those of Fig. 2 of 70MaBl, drawn from data of Berger (71Be81). R_{90} values for the β -groups are not available at this time.

Basic Data, Sources for Adopted Values

Decay Scheme

The Q-values adopted for this compilation have been taken from the 1971 mass adjustment (71WaGo) except in those cases where more precise values were available from recent β -endpoint measurements. Following the Q-value is a statement, or statements, given 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**. Only experimental data which are quoted with uncertainties were considered.

INTRODUCTION

The present work is a supplement to the publication, "Radioactive Atoms: Auger-Electron, α -, β -, γ -, and X-Ray Data" by M.J. Martin and P.H. Blichert-Toft, published in *Nuclear Data Tables* 8, Numbers 1-2, October 1970, hereafter referred to as (70MaBl). The reader is referred to this publication for a fuller discussion of the decay processes and policies. Much of the following descriptive material was selected directly from this reference.

EXPLANATION OF TABLE OF RADIATION DATA, POLICIES FOLLOWED

The material for each nucleus is arranged in two main sections, the first headed Decay Characteristics and, the second headed 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 - and ce-emission. The energy of the transition is 2.253 MeV and the intensity (γ +ce) is 32 transitions per 100 decays of the parent. Absence of the symbol ce (or γ) indicates that the ce- (or γ -) 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.

$1/2^-$, $3/2^+$, etc.

Spin and parity values for levels.

$T_{1/2}$

Half-lives are given for ground-state and long-lived metastable-state decays.

Radiations

This table contains data on atomic and nuclear radiations of the type $e_A(e_{AK}, e_{AL})$, $X(X_K, X_L)$, β^- , γ , and ce ($ce_K, ce_L, \dots$) emitted with intensity >0.01 per 100 disintegrations of the parent nucleus (i.e., $>0.01\%$). Note, however, that low-intensity ($\leq 0.01\%$) γ - or ce-transitions have been taken into account wherever (γ +ce)-intensity imbalances have been used to deduce β -intensities. In those

cases where weak radiations ($\leq 0.01\%$) 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 ^{87}Kr , ^{88}Kr - ^{88}Rb , and ^{138}Xe - ^{138}Cs 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 has not been measured. However, theoretical estimates of some of these quantities are available for limited Z-regions. For ^{87}Kr , based on theoretical values of the required atomic constants given in 72BaCr, the compiler estimates a yield of $\approx 300\%$ M-shell Auger transitions (with energy ≈ 0.0002 MeV).

The radiations are listed in the first column by type. For an explanation of the notation employed see SYMBOLS AND DEFINITIONS. Particle radiations (e_A , ce, 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, Δ , the value of energy emitted per disintegration is presented in units of $\text{gm-rad}/\mu\text{Ci-h}$. For an infinite, homogeneous medium in which a source is uniformly dispersed with a concentration of $1\mu\text{Ci-h/gm}$, Δ gives the absorbed dose in rads. See also SYMBOLS AND DEFINITIONS.

Column 6 contains the 90% absorbed-dose range, $R_{90}(\text{cm})$, 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. R_{90} values for photons were taken from Fig. 1 of 70MaBl, drawn from data provided by M.J. Berger (68Be62). The R_{90} values for internal conversion and Auger electrons were taken from unpublished data of Berger. The values are 5-8% higher than those of Fig. 2 of 70MaBl, drawn from data of Berger (71Be81). R_{90} values for the β -groups are not available at this time.

Basic Data, Sources for Adopted Values

Decay Scheme

The Q-values adopted for this compilation have been taken from the 1971 mass adjustment (71WaGo) except in those cases where more precise values were available from recent β -endpoint measurements. Following the Q-value is a statement, or statements, given 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. Only experimental data which are quoted with uncertainties were considered.

Directly measured energies and intensities are given as weighted or unweighted averages of all the comparably precise experimental determinations. For each energy and intensity value, references for the experimental data used in the average are given in the right half of the column.

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^- -average energies, the values are calculated from the theoretical spectrum shape. The method of calculation is described in Part C of Appendix III of 70MaBI.

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.), as well as any other ratios (e.g., γ/β , X/β , X/γ , etc.) required for the intensity normalization condition given under Decay Scheme. Fluorescence yields, L-shell vacancies per K-shell vacancy, and relative X-ray data are given in the Table of Atomic Constants. If the multipolarity of a transition is known, theoretical values of conversion coefficients are given with the experimental data. A recent survey of M4 and E3 conversion coefficients (73Ra14) shows that the theoretical α_K - and α -values for these multipolarities are 2-3% higher than the experimental values. In the present work, in those cases where theoretical values for E3 or M4 transitions are required, values of 68HaSe lowered by 3% are adopted. Uncertainties of 3% have been applied by the compiler to all adopted theoretical conversion coefficients.

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 from Dragoun et al. (71DrPI). Where experimental or theoretical values are not available, the approximate relation $ce_{MNO}.../ce_L = 1.3$ was used.

TABLE OF ATOMIC CONSTANTS

Atomic Constant	Z				
	36	37	54	55	56
$KX_{K\alpha_1}\%$	0.5671 42	0.5642 42	0.5281 42	0.5254 42	0.5230 43
$KX_{K\alpha_2}\%$	0.2920 40	0.2912 39	0.2836 38	0.2837 38	0.2835 39
$KX_{K\beta}\%$	0.1409 24	0.1446 25	0.1883 31	0.1909 31	0.1935 31
ω_K^*	0.646 30	0.669 8	0.889 20	0.895 12	0.901 26
$\bar{\omega}_L^*$	0.013 5	0.015 5	0.10 3	0.10 3	0.10 3
n_{KL}^*	1.15	1.13	0.40	0.89	0.89

*Intensity of indicated X-ray component relative to total K-shell X-ray intensity. Values have been calculated by the compiler from $K\alpha_1/K\alpha_2$ and $K\alpha_2/K\alpha_1$ intensity ratios given by 70Ne22.

*K-shell fluorescence yield (ω_K), average L-shell fluorescence yield ($\bar{\omega}_L$), and L-vacancies per K-shell vacancy (n_{KL}) from 72Ho1's ω_K -values are "fitted values" from Table III-V. $\bar{\omega}_L$ -values with uncertainties have been estimated by the compiler from fig. 4-34. n_{KL} -values are from Table IV-VI.

SYMBOLS AND DEFINITIONS

$\bar{x}$	Average
ce_{1K} , ce_{2L} , etc.	K-shell conversion electron for transition 1, L-shell conversion electron for transition 2, etc.
Ci	Curie
d	Day
dis	Disintegration
e_{AK} , e_{AL}	K-shell Auger electron, L-shell Auger electron
f	Statistical rate function for allowed β -decay
f^{10}	Statistical rate function for first-forbidden unique β -decay
h	Hour
J	Total angular-momentum quantum number
m	Minute
max	Maximum
n	Neutron
n_{KL}	Number of L-shell vacancies created by a K-shell vacancy.
p	Proton
Q^-	Total disintegration energy in β^- -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	Second
U	Unweighted average. See below
W	Weighted average. See below
X_K , X_L	K X-ray, L X-ray
y	Year
β_1 , β_2 , ...	Beta particle corresponding to transition 1, 2, etc.
γ_1 , γ_2 , ...	Gamma ray corresponding to transition 1, 2, etc.
Δ	Equilibrium absorbed-dose constant. See below
$\mu Ci-h$	Microcurie-hour

M. J. MARTIN

π	Parity
ω_K, ω_L	K-, L-shell fluorescence yield
3.624 /2	3.624 ± 0.012
3.6 /2	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 of 70MaBl contains a discussion of the method by which the R_{90} -values given in this compilation were obtained.

Unweighted and Weighted Averages. If $x_1 \pm \Delta x_1, x_2 \pm \Delta x_2, \dots, x_n \pm \Delta x_n$ 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

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

and $\Delta \bar{x}$ is the larger of $(W)^{1/2}$ and

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

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

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

Equilibrium Dose Constant (Δ_i). 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 (68Lo14)

$$D_{eq} = C \sum \Delta_i \text{ rad.}$$

where the cumulated concentration C ($\mu\text{Ci-h gm}$) is constant, and $\Delta_i = 2.13 I_i E_i$ gm-rad $\mu\text{Ci-h}$ 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 $\mu\text{Ci-h}$. (1 MeV disintegration = $3.7 \times 10^4 \times 3.6 \times 10^3 \times 6.25 \times 10^7 = 2.13$ gm-rad $\mu\text{Ci-h}$.)

RADIOACTIVE ATOMS SUPPLEMENT I

^{83m}Kr
36 4⁺^{83m}Kr
36 4⁺

Decay Characteristics						Basic Data Sources for Adopted Values
Decay Scheme		
$T_{1/2}$ 1.86 h /						$\gamma_1 \gamma_2$ -coincidence observed No γ other than γ_1, γ_2 observed $I(\gamma_1 + ce_1) = I(\gamma_2 + ce_2) = 100$		
$T_{1/2}$ 1.86 h /						γ_1 ^w 0.00940 /		
Radiations						γ_2 ^w 0.05216 2		
Type	Energy MeV	Intensity %	$\Delta \left(\frac{\text{gm-rad}}{\mu\text{Ci-h}} \right)$	$\Delta \Sigma \Delta$ %	R ₉₀ (cm) in Water	Type	Energy MeV	Intensity %
e _{AL}	0.0015	158.3	0.0050	6.0	8.4 × 10 ⁻⁶	ce _{1L}	69.4	$\left. \begin{array}{l} ce_{1L}/\gamma_1, ce_{1L}/ce_{1M}, \\ ce_{1N}/ce_{1L}, \text{ and} \\ I(\gamma_1 + ce_1) = 100 \end{array} \right\}$
ce _{1L}	0.00748 /	69.4	0.0110	13.1	0.00012	ce _{1M}	11.4 /	
ce _{1M}	0.00911 /	11.4 /	0.0022	2.6	0.00018	ce _{1N}	1.9 /	
ce _{1N}	0.00938 /	1.9 /	0.0004	0.5	0.00019	ce _{2K}	23.2 5	$\left. \begin{array}{l} ce_{2K}/\gamma_2, ce_{2L}/ce_{2K}, \\ ce_{2M}/ce_{2L}, ce_{2N}/ce_{2M} \\ \text{and } I(\gamma_2 + ce_2) = 100 \end{array} \right\}$
e _{AK}	0.0108	7.9 /	0.0018	2.1	0.00024	ce _{2L}	64.2	
ce _{2K}	0.01783 2	23.2 5	0.0088	10.5	0.00056	ce _{2M}	11.5 4	
ce _{2L}	0.03024 2	64.2	0.041	48.8	0.0014	ce _{2N}	1.0 /	
ce _{2MN}	0.03187 2	12.5 4	0.0085	10.1	0.0015	γ_1 ^w 0.00940 /		
X _L	0.0016	2.1 2	0.00007	0.08	0.0021	γ_2 ^w 0.05216 2		
γ_1	0.00940 /	4.8 2	0.0010	1.2	0.40	69Ph03.71Ru17 71Va38.72Ko35 See I(ce ₁)		
X _{Ka₂}	0.01260	4.5 2	0.0012	1.4	1.0	71Ru17.71Va38.72Ko35 See I(ce ₂)		
X _{Ka₁}	0.01265	8.7 3	0.0023	2.7	1.0	Auxiliary Data		
X _{Kβ}	0.0142	2.2 /	0.0007	0.8	1.4	ce ₁ /γ ₁ = 19.6 /		
γ_2	0.03216 2	0.051 2	0.00003	0.04	11.0	ce _{1L} /γ ₁ = 14.3 /		
						ce _{1M} /ce _{1L} = 0.164		
						ce _{1N} /ce _{1M} = 0.163 24		
						ce _{2K} /γ ₂ = *454 /5		
						= 495		
						ce _{2K} /ce _{2L} = *0.36 /		
						= 0.39		
						ce _{2L} /ce _{2M} = *5.6 /		
						= 5.9		
						ce _{2N} /ce _{2M} = 0.087 6		
						ce ₂ /γ ₂ = *1961 80		
						= 2084		
						72Ko35 M1+E2 Theory ^a M1+E2 Theory ^a 72Ko35		
						71Ru17 E3 Theory 72Ko35 E3 Theory 72Ko35 E3 Theory 72Ko35 E3 Theory		
						^a 0.00022 5 from 72Ko35		
						^w Weighted average		
						[*] Value adopted by compilers from alternatives shown		

M. J. MARTIN

 ^{85m}Kr
36 49 -1 ^{85m}Kr
36 49 -1

Decay Characteristics

$T_{1/2}$ 4.48 h / (^{85m}Kr)
10.73 y / (^{85}Kr)

Note

Transitions of energy 0.12985, 0.15118, and 0.36281, reported by $^{72}\text{Ra}35$ in the decay of ^{85}Kr , have not been included because of their low intensities ($<10^{-5}\%$).

Radiations (^{85m}Kr)

Type	Energy MeV	Intensity %	$\Delta/(\text{gm-rad})$ $(\mu\text{Ci-h})$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
ϵ_{Al}	0.0015	11.8 ^a 6	0.0004	0.04	8.4×10^{-6}
ϵ_{AK}	0.0111	3.1 ^a 2	0.0007	0.08	0.00025
$\epsilon_{2\text{K}}$	0.13598 1	2.98 7	0.008 5	1.0	0.019
$\epsilon_{2\text{L}}$	0.14912 1	0.34 2	0.0012	0.13	0.022
$\epsilon_{2\text{MN}}$	0.15086 1	0.08 1	0.0003	0.03	0.022
$\epsilon_{3\text{K}}$	0.29054 2	6.3 4	0.0390	4.4	0.062
$\epsilon_{3\text{L}}$	0.30295 2	0.93 6	0.0060	0.68	0.067
$\epsilon_{3\text{MN}}$	0.30458 2	0.19 2	0.0012	0.14	0.067

Decay Characteristics continued

Radiations (^{85m}Kr) continued

Type	Energy MeV	Intensity %	$\Delta/(\text{gm-rad})$ $(\mu\text{Ci-h})$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β_1^-	0.260 _{max} ² 0.0746 _{av} 6	0.021 5	0.00003	0.003	
β_2^-	0.711 _{max} ² 0.2383 _{av} 7	0.29 1	0.0015	0.17	
β_3^-	0.841 _{max} ² 0.2904 _{av} 7	77.7 8	0.481	54.8	
All β 's	0.2898 _{av} 7	78.0 8	0.481	54.8	
X_{L}	0.0016	0.17 ^a 1	≈ 0		0.0021
$X_{\text{Ka}2}$	0.01260 ^b	1.2 1	0.0003	0.03	1.0
$X_{\text{Ka}1}$	0.01265 ^b	2.4 2	0.0006	0.07	1.0
$X_{\text{Ka}2}$	0.01334 ^c	0.58 2	0.0002	0.02	1.2
$X_{\text{Ka}1}$	0.01340 ^c	1.12 3	0.0003	0.03	1.2
$X_{\text{K}\beta}$	0.0142 ^b	0.59 4	0.0002	0.02	1.4
$X_{\text{K}\beta}$	0.0150 ^c	0.29 1	0.0001	0.01	1.7
γ_1	0.12985 2	0.30 1	0.0008	0.09	32
γ_2	0.15118 1	74.6 8	0.240	27.3	34
γ_3	0.30487 2	14.6 6	0.095	10.8	39
γ_4	0.4510 1	0.011 4	0.0001	0.01	42
γ_5	0.7316 3	0.010 3	0.0002	0.02	48

Radiations (^{85}Kr)

Type	Energy MeV	Intensity %	$\Delta/(\text{gm-rad})$ $(\mu\text{Ci-h})$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β_1^-	0.173 _{max} ² 0.0475 _{av} 6	0.43 1	0.0004	0.07	
β_2^-	0.687 _{max} ² 0.2514 _{av} 8	99.57 1	0.533	99.0	
All β 's	0.2506 _{av} 8	100	0.534	99.2	
γ_5	0.513 ^a 1	0.43 1	0.0047	0.87	44

^aSum of intensities for transitions in Kr and Rb

^{b,c}Transition in Kr , Rb

RADIOACTIVE ATOMS SUPPLEMENT I

 $^{85\text{m},85}_{36}\text{Kr}^{-2}$
 36 49

 $^{85\text{m},85}_{36}\text{Kr}^{-2}$
 36 49

Basic Data. Sources for Adopted Values				Basic Data. Sources for Adopted Values continued			
Decay Scheme				Decay Modes (^{85}Kr)			
$^{85\text{m}}\text{Kr}$ The decay scheme is that of $^{72}\text{Ra}35$. Transitions per 100 $^{85\text{m}}\text{Kr}$ decays are obtained from γ_3 , γ_2 , ce_3 , γ_3 , ce_2/γ_2 , and the requirement that $I(\gamma_3+ce_3)+I(\gamma_2+ce_2)=100^a$.				Type	Energy MeV	Intensity %	
				β_1^-	0.173 _{max} 2	0.43 1	$Q^- - E(0.51399 \text{ level})$
^{85}Kr $Q^- = 0.687 \pm 0.002 \text{ MeV}$ $E(0.15118 \text{ level}) = 0.30487 \text{ level}$ Transitions per 100 ^{85}Kr decays are obtained from γ_5 , $(\beta_1+\beta_3)$ and the requirement $I(\beta_1+\beta_3)=100$.				β_3^-	0.687 _{max} 2	99.57 1	Q^- $100 - I(\gamma_5)$
$T_{1/2}$ 4.480 h 8 ($^{85\text{m}}\text{Kr}$) 70Wo08 10.73 h 6 (^{85}Kr) 70MaBl				γ_5	0.51399 1	0.43 1	67Bl03, 68Le03 71He27, 72Ra35 $\gamma_5 / (\beta_1 + \beta_3)$
Decay Modes ($^{85\text{m}}\text{Kr}$)				Auxiliary Data ($^{85\text{m}}\text{Kr}$)			
Type	Energy MeV	Intensity %		$\gamma_2/\gamma_3 = {}^w 5.13 \pm 22$ 70Wo08, 72Mc24, 72Ra35			
ce_{2K}		2.98 7	ce_{2K}/γ , ce_{2L}/γ and ce_{2MN}/γ for γ_2 , γ_3 , γ_2/γ_3 and $I(\gamma_2+ce_2)+I(\gamma_3+ce_3)=100^a$ $ce_{2K}+ce_{2L}+ce_{2MN}$	$ce_{2K}/\gamma_2 = 0.0400 \pm 8$			
ce_{2L}		0.34 2		$ce_{2L}/\gamma_2 = 0.0045 \pm 2$			
ce_{2MN}		0.08 1		$ce_{2MN}/\gamma_2 = 0.0010 \pm 1$			
ce_2		3.40 8		$\therefore ce_2/\gamma_2 = 0.0455 \pm 9$			
ce_{3K}		6.3 4	See ce_2 above $ce_{3K}+ce_{3L}+ce_{3MN}$	$ce_{3K}/\gamma_3 = {}^w 0.432 \pm 20$			
ce_{3L}		0.93 6		$= 0.436$			
ce_{3MN}		0.19 2		$ce_{3L}/\gamma_3 = {}^w 0.064 \pm 3$			
ce_3		7.4 4		$= 0.066$			
β_2^-	0.260 _{max} 2	0.021 5	$(Q^-)^b - E(0.7318 \text{ level})$ $I(\gamma_4)+I(\gamma_5)$	$ce_{3MN}/\gamma_3 = 0.013 \pm 1$			
β_4^-	0.711 _{max} 2	0.29 1	$(Q^-)^b - E(0.28103 \text{ level})$ $I(\gamma_1)-I(\gamma_4)$	$\therefore ce_3/\gamma_3 = 0.509 \pm 24$			
β_5^-	0.841 _{max} 2	77.7 8	70Wo08 $I(\gamma_2+ce_2)-I(\gamma_1)$	Auxiliary Data (^{85}Kr)			
γ_1	0.12985 2	0.30 1	72Ra35 γ_1/γ_2 72Ra35	$\gamma_5 / (\beta_1 + \beta_3) = {}^w 0.00434 \pm 11$ 64Ea01, 67De05			
γ_2	${}^w 0.15118 \pm 1$	74.6 8	72Mc24, 72Ra35 See ce_2 above				
γ_3	${}^w 0.30487 \pm 2$	14.6 6	72Mc24, 72Ra35 See ce_2 above				
γ_4	0.4510 1	0.011 4	72Ra35 γ_4/γ_2 72Ra35				
γ_6	0.7316 3	0.010 3	72Ra35 γ_6/γ_2 72Ra35				

^a $I(\gamma_6)$ is negligible here^b $Q^- = Q^-(^{85}\text{Kr}) - E(0.30487 \text{ level})$ ^c Authors' value increased by 1 keV based on comparison of authors' $E(\gamma_5)$ with adopted $E(\gamma_5)$ ^w Weighted average^{*} Value adopted by compilers from alternatives shown

M. J. MARTIN

 $^{87}_{36}\text{Kr}^{-1}$ $^{87}_{36}\text{Kr}^{-1}$

Decay Characteristics

$T_{1/2}$ 76.3 M (^{87}Kr)
 4.88×10^{10} Y (^{87}Rb)

Note

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

Note

Because of the large number of low-intensity γ -rays and the resulting complexity of the ^{87}Kr decay scheme, only radiations with intensity $>0.1\%$ are included here. The total intensity of the 14 γ 's not included is $\approx 0.7\%$. For a list of these γ 's, see 71Sh01.73Ge03.

Radiations

Type	Energy MeV	Intensity %	$\Delta(\text{gm-rad})$ $(\mu\text{Ci-h})$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
ϵ_{AL}	0.0017	0.23	1	≈ 0	0.00001
ce_{IK}	0.38738	2	0.18	1	0.0615
β_1^-	0.580 _{max} 0.188 _{av}	0.47	4	0.0019	0.04
β_2^-	0.928 _{max} 0.326 _{av}	4.3	4	0.030	0.66
β_3^-	1.077 _{max} 0.389 _{av}	0.58	6	0.0048	0.11

Radiations continued

Type	Energy MeV	Intensity %	$\Delta(\text{gm-rad})$ $(\mu\text{Ci-h})$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β_4^-	1.334 _{max} 0.500 _{av}	9.7	7	0.103	2.3
β_5^-	1.474 _{max} 0.562 _{av}	5.7	3	0.068	1.5
β_6^-	1.511 _{max} 0.579 _{av}	0.36	6	0.004	0.09
β_7^-	2.148 _{max} 0.870 _{av}	0.6	2	0.011	0.24
β_8^-	2.311 _{max} 0.946 _{av}	0.2	1	0.004	0.09
β_9^-	3.043 _{max} 1.294 _{av}	7.1	5	0.20	4.4
β_{10}^-	3.485 _{max} 1.501 _{av}	40.4	18	1.29	28.6
β_{11}^-	3.888 _{max} 1.694 _{av}	30.5	22	1.10	24.4
All β 's	1.323 _{av}	100		2.818	62.4

M. J. MARTIN

⁸⁷Kr -1
36 51

⁸⁷Kr -1
36 51

Decay Characteristics

$T_{1/2}$ 76.3 m β^- (⁸⁷Kr)
4.88x10¹⁰ y β^- (⁸⁷Rb)

Note

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

Note

Because of the large number of low-intensity γ -rays and the resulting complexity of the ⁸⁷Kr decay scheme, only radiations with intensity >0.1% are included here. The total intensity of the 14 γ 's not included is $\approx$ 0.7%. For a list of these γ 's, see 71Sh01.73Ge03.

Radiations

Type	Energy MeV	Intensity %	$\Delta/(\text{gm-rad})$ $(\mu\text{Ci-h})$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	0.0017	0.23 1	$\approx$ 0		0.00001
α_{IK}	0.38738 2	0.18 1	0.0015	0.03	0.095
β_1^-	0.580 _{max} 7 0.188 _{av} 3	0.47 4	0.0019	0.04	
β_2^-	0.928 _{max} 7 0.326 _{av} 3	4.3 4	0.030	0.66	
β_3^-	1.077 _{max} 7 0.389 _{av} 3	0.58 6	0.0048	0.11	

Radiations continued

Type	Energy MeV	Intensity %	$\Delta/(\text{gm-rad})$ $(\mu\text{Ci-h})$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β_4^-	1.334 _{max} 7 0.500 _{av} 3	9.7 7	0.103	2.3	
β_5^-	1.474 _{max} 7 0.562 _{av} 3	5.7 3	0.068	1.5	
β_6^-	1.511 _{max} 7 0.579 _{av} 3	0.36 6	0.004	0.09	
β_7^-	2.148 _{max} 7 0.870 _{av} 3	0.6 2	0.011	0.24	
β_8^-	2.311 _{max} 7 0.946 _{av} 3	0.2 1	0.004	0.09	
β_{10}^-	3.485 _{max} 7 1.501 _{av} 3	40.4 18	1.29	28.6	
β_{11}^-	3.888 _{max} 7 1.694 _{av} 3	30.5 22	1.10	24.4	
All β 's	1.323 _{av} 3	100	2.818	62.4	

RADIOACTIVE ATOMS SUPPLEMENT I

⁸⁷Kr -2
36 51⁸⁷Kr -2
36 51

Decay Characteristics continued						Basic Data, Sources for Adopted Values	
Radiations continued						Decay Scheme	
Type	Energy MeV	Intensity %	Δ (gm-rad / μ Ci-h)	$\Delta \Sigma \Delta$ %	R ₉₀ (cm) in Water	$Q^- = 3.888^-$ $E(\beta_{11})$ The decay scheme is that of 71Sh01. Intensities per 100 ⁸⁷ Kr decays are obtained from the relative photon intensities, ce_{1K}/γ_1^c , $k(\beta_{11})$, and the requirement that $k(\gamma \text{ to g.s.} + ce_{1K}^c) + k(\beta_{11}) = 100$.	
X_K^a	0.01340	0.12 1	0.00003	0.0007	1.2	$T_{1/2} = 76.3 \pm 5$ (⁸⁷ Kr) 1.88×10^{10} y (⁸⁷ Rb) 64Cl01.72Eb02 72Ne19	
γ_1	0.40258 2	49.4 17	0.424	9.4	41	Decay Modes	
γ_2	0.67387 4	1.9 2	0.027	0.60	47	Type	Energy MeV
γ_3	0.81425 8	0.17 2	0.0029	0.064	49	Intensity %	
γ_4	0.83640 5	0.76 5	0.014	0.31	50	ce_{1K}	0.18 1 ce_{1K}/γ_1 and normalization condition given above
γ_5	0.84545 4	7.5 5	0.135	3.0	50	$\beta_{11} \dots \beta_{10}$	$E(\beta)$ are obtained from Q^- and the level energies. $k(\beta)$ are obtained from the γ -ray intensity imbalances at each level.
γ_6	0.9468 2	0.13 1	0.0026	0.05	51	β_{11}	3.888 $^-$ 30.5 22 73Wo01
γ_7	1.17540 8	1.15 7	0.029	0.64	55	$\gamma_1 \dots \gamma_{19}$	$E(\gamma)$ are data of 73Ge02 except γ_{11} which is the value of 72Sh01. $k(\gamma)$ are weighted averages of data of 72Sh01 and 73Ge02. The $k(\gamma)$ are normalized so that $k(\gamma \text{ to g.s.} + ce_{1K}^c) + k(\beta_{11}) = 100$.
γ_8	1.33796 8	0.68 4	0.019	0.42	57	Auxiliary Data	
γ_9	1.38253 7	0.29 2	0.0085	0.19	58	$ce_{1K}/\gamma_1 = 0.0036$ /	M1+E2 Theory with $\delta^2 = 0.059_{-4}^{+3}$ 64Al28
γ_{10}^b	1.3899 2	0.12 1	0.0036	0.08	58		
γ_{11}	1.5312 4	0.36 6	0.012	0.27	60		
γ_{12}	1.5780 2	0.12 1	0.0040	0.09	61		
γ_{13}	1.74052 8	2.1 2	0.078	1.73	64		
γ_{14}	2.0118 2	3.0 2	0.129	2.9	67		
γ_{15}	2.4088 3	0.24 5	0.012	0.27	≈73		
γ_{16}	2.5549 2	9.5 7	0.52	11.5	≈75		
γ_{17}	2.5583 3	4.0 4	0.22	4.9	≈75		
γ_{18}	2.8112 2	0.34 3	0.020	0.44	≈78		
γ_{19}	3.3084 2	0.47 4	0.033	0.73	≈85		

^aSince the X_K -intensity is so weak, the compilers have not separated it into its components. The energy given is that for $K_{\alpha 1}$.

^bNot shown on decay scheme since placement not determined.

^cConversion in higher shells is negligible.

^wWeighted average.

^aSince the X_K -intensity is so weak, the compilers have not separated it into its components. The energy given is that for $K_{\alpha 1}$.

^bNot shown on decay scheme since placement not determined.

^cConversion in higher shells is negligible.

^wWeighted average.

M. J. MARTIN

$^{88}_{36}\text{Kr}$ $^{88}_{51}\text{Rb}$ 1-1

$^{88}_{36}\text{Kr}$ $^{88}_{51}\text{Rb}$ 1-1

Decay Characteristics

M. J. MARTIN

 $^{88}\text{Kr} - ^{88}\text{Rb} \rightarrow 3$
 $36 \quad 52 \quad 37 \quad 51$
 $^{88}\text{Kr} - ^{88}\text{Rb} \rightarrow 3$
 $36 \quad 52 \quad 37 \quad 51$

Decay Characteristics continued

Radiations (^{88}Kr) continued

Type	Energy MeV	Intensity %	Δ (cm-rad) $\mu\text{Ci-h}$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
γ_{14}	0.78823 4	0.53 4	0.0084	0.18	49
γ_{15}^a	0.79027 12	0.11 2	0.0014	0.038	49
γ_{16}	0.83482 2	12.8 8	0.228	4.6	50
γ_{17}	0.85031 6	0.19 2	0.0034	0.07	50
γ_{18}	0.86232 3	0.67 4	0.0123	0.25	50
γ_{19}	0.94491 4	0.31 3	0.0062	0.13	51
γ_{20}	0.98577 2	1.29 9	0.027	0.54	52
γ_{21}	0.99007 14	0.15 2	0.0032	0.06	52
γ_{22}	1.03967 5	0.46 3	0.0102	0.21	53
γ_{23}	1.04955 11	0.12 1	0.0027	0.05	53
γ_{24}	1.14143 3	1.28 8	0.031	0.63	55
γ_{25}	1.17959 4	0.98 6	0.025	0.50	55
γ_{26}	1.18496 5	0.66 5	0.017	0.34	55
γ_{27}	1.20978 6	0.11 3	0.0028	0.06	55
γ_{28}	1.21287 14	0.15 2	0.0039	0.08	55
γ_{29}	1.24523 4	0.39 3	0.0103	0.21	56
γ_{30}	1.25068 4	1.12 7	0.030	0.60	56
γ_{31}	1.35234 10	0.18 2	0.0052	0.10	58
γ_{32}	1.36995 3	1.76 14	0.051	1.03	58
γ_{33}	1.40697 8	0.21 2	0.0063	0.13	59
γ_{34}	1.51841 4	2.04 15	0.066	1.33	60
γ_{35}	1.5248 4	0.14 7	0.0045	0.09	60
γ_{36}	1.52975 3	10.9 7	0.36	7.3	60
γ_{37}	1.60379 7	0.45 4	0.015	0.30	62
γ_{38}	1.68534 7	0.67 7	0.024	0.48	62
γ_{39}^a	1.8927 2	0.15 2	0.0060	0.12	66
γ_{40}	1.9087 2	0.12 2	0.0049	0.10	66
γ_{41}	2.02983 3	4.6 3	0.20	4.0	67

Decay Characteristics continued

Radiations (^{88}Kr) continued

Type	Energy MeV	Intensity %	Δ (cm-rad) $\mu\text{Ci-h}$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
γ_{42}	2.03541 2	3.7 3	0.16	3.2	67
γ_{43}	2.1860 3	0.42 7	0.020	0.40	≈ 70
γ_{44}	2.19568 2	13.1 8	0.61	12.3	≈ 70
γ_{45}	2.23162 3	3.4 2	0.16	3.2	≈ 70
γ_{46}	2.35194 3	0.74 5	0.037	0.75	≈ 72
γ_{47}	2.39198 3	35.1 17	1.79	36.1	≈ 72
γ_{48}	2.40880 13	0.11 1	0.0056	0.11	≈ 73
γ_{49}	2.54835 5	0.65 4	0.035	6.71	≈ 74
γ_{50}	2.77098 11	0.16 2	0.0094	0.19	≈ 78

Radiations (^{88}Rb)

See next page

^aNot shown on drawing. Placement not established

RADIOACTIVE ATOMS SUPPLEMENT I

 $^{88}_{36}\text{Kr} - ^{88}_{37}\text{Rb} \quad 1-4$
 $^{88}_{36}\text{Kr} - ^{88}_{37}\text{Rb} \quad 1-4$

Decay Characteristics continued						Basic Data. Sources for Adopted Values	
Radiations (^{88}Rb)						Decay Scheme	
Type	Energy MeV	Intensity %	$\Delta(\mu\text{m-rad})$ $\mu\text{Ci-h}$	$\Delta\Sigma\Delta$ %	R_{90} (cm) in Water	^{88}Kr $Q^- = 2.93 \text{ J}$	73Cr02
β_1	0.485 $_{m,11}^{+4}$ 0.1519 $_{s,11}$	0.74 8	0.0024	0.04		The decay scheme is that of $^{72}\text{Bu}37$. Intensities per 100 ^{88}Kr decays are obtained from $I(\beta_1)$, the relative photon intensities, α/γ -values, and the requirement that $I(\gamma + \alpha \text{ to g.s.}) + I(\beta_1) = 100$.	
β_2	0.493 $_{m,11}^{+4}$ 0.1548 $_{s,11}$	0.42 5	0.0014	0.03		^{88}Rb $Q^- = 5.388 \text{ J}$	73Ha03
β_3	0.595 $_{m,11}^{+4}$ 0.1978 $_{s,11}$	0.17 3	0.0007	0.01		The decay scheme is that of $^{72}\text{Bu}37$. Intensities per 100 ^{88}Rb decays are obtained from γ , $\Sigma\beta$ and the relative photon intensities.	
β_4	0.834 $_{m,11}^{+4}$ 0.2829 $_{s,11}$	2.4 3	0.014	0.24		$T_{1/2}$ ^{88}Kr 2.80 h ^{88}Rb 17.78 m	
β_5	0.924 $_{m,11}^{+4}$ 0.3239 $_{s,11}$	0.25 3	0.0017	0.03		49Ko13, 64Cr01, 72Eb02 51Ba02, 69Ra05	
β_6	2.120 $_{m,11}^{+4}$ 0.8554 $_{s,11}$	1.06 13	0.019	0.33		Decay Modes (^{88}Kr)	
β_7	2.604 $_{m,11}^{+4}$ 1.0814 $_{s,11}$	14 2	0.32	5.5		Type	Energy MeV
β_8	3.502 $_{m,11}^{+4}$ 1.5075 $_{s,11}$	4 4	0.13	2.2			Intensity %
β_9	5.338 $_{m,11}^{+4}$ 2.3835 $_{s,11}$	76 4	3.86	66.5		α_{1K}	10.3 6
All β 's	2.0617 $_{s,11}^{+4}$	100	4.39	75.6		α_{1L}	1.19 7
γ_1	0.298022 11	15 2	0.29	5.0	51	α_{1M}	0.20 1
γ_2	1.36661 10	0.10 2	0.0029	0.05	58	α_{3K} 0.21 3 α_{3K}/α_{4K}	
γ_3	1.38243 4	0.79 12	0.023	0.40	58	α_{4K}	1.16 12
γ_4	1.77985 7	0.24 4	0.009	0.15	64	α_{4L}	0.14 2
γ_5	1.83602 3	23 3	0.90	15.5	65	$\beta_1 \dots \beta_{10}$ $E(\beta)$ are obtained from Q^- and the level energies. $I(\beta)$ are obtained from the $(\gamma + \alpha)$ -intensity imbalances at each level.	
γ_6	2.11139 11	0.14 2	0.0063	0.11	69	β_{11}	2.93 3
γ_7	2.11892 6	0.46 7	0.021	0.36	69	γ_1 0.027511 15 1.90 17 $^{73}\text{Me}13$ Sec $I(\alpha_1)$	
γ_8	2.57778 7	0.22 3	0.012	0.21	≈ 75	$\gamma_2 \dots \gamma_{50}$ $E(\gamma)$ and $I(\gamma)$ are weighted averages of data of $^{73}\text{Me}13$, $^{73}\text{Ge}02$, and $^{72}\text{Bu}37$. The $I(\gamma)$ are normalized so that $I(\gamma + \alpha \text{ to g.s.}) + I(\beta_{11}) = 100$.	
γ_9	2.67791 4	2.2 3	0.125	2.15	≈ 76	^{88}Kr $Q^- = 2.93 \text{ J}$ 14 4 From $\log f^{11}_{11} = 9.23 + 9.50^b$	
γ_{10}	2.73402 3	0.11 2	0.0064	0.11	≈ 77		
γ_{11}	3.00950 6	0.28 4	0.018	0.31	≈ 81		
γ_{12}	3.21856 7	0.25 4	0.017	0.29	≈ 84		
γ_{13}	3.48653 9	0.15 3	0.011	0.19	≈ 87		
γ_{14}	4.7427 2	0.17 3	0.017	0.29	≈ 100		

^aDirect β -feeding of the 0.02751 level is expected to be negligible. For a second-forbidden unique β -transition, $\log f^{21}_{11}$ is expected to be ≥ 12.8 ($^{73}\text{Ra}60$) $\therefore I(\beta) < 0.1\%$.

^bThis is the range of $\log f^{11}_{11}$ values obtained for seven $0^+ \rightarrow 2^-$ transitions in Rb, Sr, Y and Zr nuclei. Values of $I(\beta)$ based on equilibrium ^{88}Kr - ^{88}Rb sources and the assumption that $I_\gamma(1.836 \text{ J in } ^{88}\text{Sr}) = 23 \text{ J}$ are 9.9 ($^{73}\text{Ha}03$) and 19.12 ($^{73}\text{Ge}02$).

^wWeighted average

M. J. MARTIN

 $^{88}_{36}\text{Kr} - ^{88}_{51}\text{Rb} \quad 1-5$
 $^{88}_{36}\text{Kr} - ^{88}_{51}\text{Rb} \quad 1-5$

Basic Data. Sources for Adopted Values cont

Decay Modes (^{88}Rb)

Type	Energy MeV	Intensity %
------	---------------	----------------

β_1, β_2 $E(\beta)$ are obtained from Q^β and the level energies. $I(\beta)$ are obtained from the γ -intensity imbalances at each level.

$\gamma_1, \dots, \gamma_4$ $E(\gamma)$ and $I(\gamma)$ are weighted averages of data of $^{72}\text{Bu}37$ and $^{73}\text{Ge}02$.

γ_1 $^{W}0.898022 \pm 11$ $^{W}15.2$ γ_1, γ_2 $^{73}\text{Ge}02, ^{73}\text{Mu}07$
 $^{72}\text{Bu}37, ^{73}\text{Ge}02$

γ_3 $^{W}1.836016 \pm 23$ $^{W}23.3$ $\gamma_3, \Sigma\beta^-$ $^{73}\text{Ge}02, ^{73}\text{Mu}07$
 $^{56}\text{La}03.69\text{Ra}05$

Auxiliary Data (^{88}Kr)

$\alpha_1/\gamma_1 = 6.36$ From intensity balance at 0.02751 level

$^{*}5.93$ M1 Theory
 $\alpha_{1K}/\alpha_{1LM} = 8$ 55Th01
 $^{*}7.45$ M1 Theory
 $\alpha_{1K}/\gamma_1 = 5.20$
 $\alpha_{2K}/\alpha_{1L} = 8.69$ } M1 Theory
 $\alpha_{1M}/\alpha_{1L} = 0.17$

$\alpha_{4K}/\gamma_4 = 0.044 \pm 4$ $^{73}\text{Ha}25$
 $\alpha_{4K}/\alpha_{4L} = 8.44 \pm 50$ $^{73}\text{Ha}25$

$\alpha_{4K}/\alpha_{3K} = 5.49 \pm 16$ $^{73}\text{Ha}25$

Auxiliary Data (^{88}Rb)

$\gamma_3/\Sigma\beta^- = ^{W}0.232 \pm 32$ $^{56}\text{La}03.69\text{Ra}05$

^WWeighted average

*Value adopted by comparison from alternatives shown

RADIOACTIVE ATOMS SUPPLEMENT 1

 ^{131m}Xe ^{131m}Xe
54 77

Decay Characteristics						Basic Data. Sources for Adopted Values
Decay Scheme No γ other than 0.163930 γ observed $I(\gamma+ce) = 100$	
$T_{1/2}$ 11.9 d $\pm$ 1						$T_{1/2}$ 11.9 d $\pm$ 1 65Am05.66Am03.72Em01	
Radiations						Decay Modes	
Type	Energy MeV	Intensity %	Δ (gm-rad) $\mu\text{Ci-h}$	Δ $\Sigma\Delta$ %	R_{rel} (cm) in Water	Type	Energy MeV
ce_K	0.0034	76.4	0.0055	1.6	0.000033	ce_K	0.163930 $\pm$
ce_K	0.02456	6.8 $\pm$ 1.3	0.0036	1.0	0.0010		
ce_K	0.129369 $\pm$	61.2	0.168	48.6	0.017		
ce_L^a	0.15848 $\pm$	30.2	0.101	29.2	0.024		
ce_M^b	0.16279 $\pm$	5.9 $\pm$ 1.0	0.020	5.8	0.025		
$ce_{N_1}^c$	0.16372 $\pm$	1.5 $\pm$ 0.4	0.0052	1.5	0.025		
X_L	0.0041	8.3	0.0007	0.2	0.033		
$X_{K\alpha_2}$	0.02946	15.3 $\pm$ 6	0.0096	2.8	9.7		
$X_{K\alpha_1}$	0.02978	28.6 $\pm$ 11	0.0181	5.2	9.4		
$X_{K\beta}$	0.0336	10.2 $\pm$ 4	0.0073	2.1	12		
γ	0.163930 $\pm$	2.0 $\pm$ 1	0.0070	2.0	34		
						Auxiliary Data	
						$ce_K/\gamma = 31.1 \pm 1.0$ 66Kn03.66Mi01 32.1 M4 Theory $K/L = 2.05 \pm 1.3$ 52Be55.62Ge09.62Wo09 2.14 M4 Theory $M/L = 0.20 \pm 0.23$ 62Wo09.72Pi01 $NO/M = 0.25 \pm 0.21$ M4 Theory $ce_{N_1}/ce_M = 50.1 \pm 51.5$ 72Pi01 M4 Theory	
						$73Wa07$ See α above	

^aEnergy of L_1 -line given^bEnergy of M_1 -line given^cEnergy of N_1 -line given¹Unweighted average²Value adopted by compilers from alternatives shown

M. J. MARTIN

 $^{133m}_{54}\text{Xe}^{-1}$ $^{133m}_{54}\text{Xe}^{-1}$

Decay Characteristics

$T_{1/2}$ 2.25 d 3 (^{133m}Xe)
5.29 d 1 (^{133}Xe)

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 (see, for example, 61Er04, 68Al16).

Radiations (^{133m}Xe)

Type	Energy MeV	Intensity %	Δ (gm-rad) $\mu\text{Ci-h}$	$\Delta \Sigma \Delta$ %	R_{90} (cm) in Water
ϵ_{AL}	0.0034	70.3	0.0051	1.03	0.000033
ϵ_{AK}	0.02456	7.2	0.0037	0.75	0.0010
ϵ_{4K}	0.1983 3	63.7 8	0.269	54.5	0.034
ϵ_{4L}^a	0.2274 3	20.8 7	0.101	20.5	0.042
ϵ_{4M}^b	0.2318 3	4.2 7	0.021	4.3	0.044
ϵ_{4NO}^c	0.2327 3	1.0 5	0.0050	1.0	0.045
X_L	0.0041	8.3	0.0007	0.14	0.033
$Y_{K\alpha 2}$	0.02946	16.1 5	0.0101	2.05	9.2
$X_{K\alpha 1}$	0.02978	29.9 9	0.0190	3.85	9.4
$X_{K\beta}$	0.0336	10.7 4	0.0077	1.56	12
γ_4	0.2329 3	10.3 3	0.0511	10.4	37

^aEnergy of L_1 -line given^bEnergy of M_1 -line given^cEnergy of N_1 -line given

Decay Characteristics continued

Radiations (^{133}Xe)

Type	Energy MeV	Intensity %	Δ (gm-rad) $\mu\text{Ci-h}$	$\Delta \Sigma \Delta$ %	R_{90} (cm) in Water
ϵ_{AL}	0.0034	50.2	0.0038	0.99	0.000036
ϵ_{AK}	0.02546	5.5 7	0.0030	0.78	0.0011
ϵ_{4L}	0.04363 1	0.30 8	0.00028	0.07	0.0027
ϵ_{2K}	0.045006 5	52.0 3	0.0499	13.0	0.0029
ϵ_{2L}^a	0.07390 1	0.047 10	0.00007	0.018	0.0066
ϵ_{2L}^b	0.075279 5	8.5 2	0.0136	3.53	0.0069
ϵ_{4MNO}^c	0.07840 1	0.016 4	0.00003	0.008	0.0074
ϵ_{2M}^b	0.079776 5	2.0 2	0.0034	0.88	0.0077
ϵ_{2NO}^c	0.080762 5	0.35 5	0.00060	0.16	0.0078
ϵ_{3K}	0.12466 7	0.012 4	0.00003	0.008	0.017
β_1^-	0.266 _{max} 3 0.0749 _{av} 8	0.66 10	0.0010	0.26	
β_2^-	0.346 _{max} 3 0.1005 _{av} 9	99.34 10	0.213	55.3	
All β 's	0.1005 _{av} 9	100	0.214	55.5	
X_L	0.0043	6.2	0.0005	0.13	0.038
$X_{K\alpha 2}$	0.03062	13.3 3	0.0087	2.26	10
$X_{K\alpha 1}$	0.03097	24.6 4	0.0162	4.20	10
$X_{K\beta}$	0.0350	8.9 2	0.0066	1.71	12
γ_1	0.079621 11	0.22 6	0.00037	0.10	27
γ_2	0.080997 5	37.1 4	0.064	16.6	27
γ_3	0.16063 4	0.06 2	0.00021	0.05	34

RADIOACTIVE ATOMS SUPPLEMENT I

 $^{133m,133}_{54}\text{Xe}^{-2}$ $^{133m,133}_{54}\text{Xe}^{-2}$

Basic Data. Sources for Adopted values			Basic Data. Sources for Adopted Values cont.		
Decay Scheme			Decay Modes (^{133}Xe) continued		
^{133m}Xe No γ other than γ_4 . $\therefore I(\gamma_4 + \alpha_4) = 100$			Type	Energy MeV	Intensity %
^{133}Xe $Q^- = 0.427 \beta$ $E(\beta_2) + E(0.080997^* \text{ level})$ No ground state β observed. ^a 52Be55 Intensities per 100 ^{133}Xe decays are obtained from α_2/γ_2 , α_3/γ_3 , γ_3/γ_2 and the requirement that $I(\gamma_2 + \alpha_2 + \gamma_3 + \alpha_3K^b) = 100$			γ_2	$^{*}0.080997 \pm 5$	37.1 ± 4 64Si21, 70Gr13 α_2/γ_2 , α_3K/γ_3 , γ_3/γ_2 and the requirement that $I(\gamma_2 + \alpha_2 + \gamma_3 + \alpha_3K^b) = 100$
$T_{1/2}$ $^{*}2.25 \text{ d } \beta$ (^{133m}Xe) 51Be11, 61Er04, 68Al16 $^{*}5.29 \text{ d } I$ (^{133}Xe) 68Al16, 72Em01			γ_3	$^{*}0.16063 \pm 4$	0.06 ± 2 66Th09, 67He09, 68Bo04 See $I(\gamma_2)$
Decay Modes (^{133m}Xe)			Auxiliary Data (^{133m}Xe)		
Type	Energy MeV	Intensity %	$\alpha_4K/\gamma_4 = 6.2 \pm 2$ M4 Theory ^c $\alpha_4K/\alpha_4L = 2.9 \pm 2$ 52Be55 $^{*}3.95$ M4 Theory $\alpha_4M/\alpha_4L = 0.30 \pm 4$ 52Be55 0.22 M4 Theory $^{*}0.20 \pm 3$ From 0.164 M4 γ in $^{131m}\text{Xe}^d$ $\alpha_4NO/\alpha_4M = 0.25 \pm 4$ From 0.164 M4 γ in ^{131m}Xe $\therefore \alpha_4/\gamma_4 = 8.7 \pm 4$		
α_4K		63.7 ± 8	α_4K/γ_4 , α_4K/α_4L , α_4M/α_4L , α_4NO/α_4M and the requirement that $I(\gamma_4 + \alpha_4) = 100$		
α_4L		20.8 ± 7			
α_4M		4.2 ± 7			
α_4NO		1.0 ± 5			
γ_4	$^{*}0.2329 \pm 3$	10.3 ± 3	52Be55, 72A:02 See α_4 above		
Decay Modes (^{133}Xe)			Auxiliary Data (^{133}Xe)		
Type	Energy MeV	Intensity %	$\alpha_{1K}/\gamma_1 = 1.40^{*} \pm 4$ 66Th09 $\alpha_{1K}/\alpha_{1L} = 6.4 \pm 2$ 67He09 $\alpha_{1MNO}/\alpha_{1L} = 0.33$ Theory $\therefore \alpha_1/\gamma_1 = 1.69 \pm 8$		
α_{1K}		0.30 ± 8	$\alpha_2K/\gamma_2 = ^{*}1.40 \pm 2$ 54Be36 ^f , 61Er04 ^f , 64Ni04, 66Ra16 ^g , 66Th09 ^f , 68Bo04, 70Av01 ^f $\alpha_{2L}/\alpha_{2K} = ^{*}0.163 \pm 3$ 61Br09, 61Er04, 64Si21, 69Fr04 $\alpha_{2M}/\alpha_{2L} = 0.233 \pm 4$ 64Si21 $\alpha_{2NO}/\alpha_{2M} = 0.18 \pm 2$ 61Er04 ^h $\therefore \alpha_2/\gamma_2 = 1.69 \pm 3$		
α_{1L}		0.047 ± 10			
α_{1MNO}		0.016 ± 4			
α_{2K}		52.0 ± 3	$\alpha_3K/\gamma_3 = ^{*}0.20 \pm 1$ 68Bo04, 69To12, 70Av01, 72Sc08 $\alpha_{1K}/\alpha_{2K} = 0.0058 \pm 5$ 61Er04 $\therefore \gamma_1/\gamma_2 = 0.0058 \pm 5$ using adopted α_2/γ_2 $\gamma_1/\gamma_3 = ^{*}0.29 \pm 2$ 68Bo04, 72Sc08 $\therefore \gamma_1/\gamma_2 = 0.0017 \pm 5$		
α_{2L}		8.5 ± 2			
α_{2M}		2.0 ± 2			
α_{2NO}		0.35 ± 5			
α_2		62.8 ± 4	See $I(\gamma_2)$		
α_3K		0.012 ± 4	See $I(\gamma_2)$		
β_1^-	$^{*}0.206 \pm 3$	0.66 ± 10	$Q^- - E(0.160618 \text{ level})$ $(\gamma + \alpha) - \text{intensities}$		
β_2^-	$^{*}0.346 \pm 3$	99.34 ± 10	52Be55, 61Er04 $(\gamma + \alpha) - \text{intensities}$		
γ_1	$^{*}0.079621 \pm 11$	0.22 ± 6	67He09, 69Fr14 α_{1K}/γ_1		

^{c,w} Unweighted average, weighted average^aIf $\log(f) > 11.0$ as expected for a 2- $\text{No } 2$ transition, then $I(\gamma_3) < 0.0008\%$ ^bHigher β - β conversion is negligible here^cThe M4 theory value of 6.40 has been reduced by 15% as explained in the text^dIn ^{131m}Xe , 52Be55 reports 0.34 ± 2 and M4 theory gives 0.23 compared with 0.19 ± 2 (72Ho11) and 0.21 ± 4 (62W009)^eFrom $(\alpha_{1K}/\gamma_1)/(\alpha_{2K}/\gamma_2) = 0.997 \pm 5$ and adopted α_{2K}/γ_2 ^fAuthors' value corrected by compilers to reflect adopted α_K ^gFrom $\alpha_2/\gamma_2 = 1.76 \pm 2$ and $\alpha_{1MNO}/\alpha_{2K} = 0.208 \pm 5$ ^hFrom authors' $\text{No } M_{12} = 0.199 \pm 2$ and $M_1/M_{12} = 0.11 \pm 2$ of 64Si21ⁱValue adopted by compilers from alternatives shown

135m.135
Xe -1
54 81

Decay Characteristics

Decay Characteristics continued

Energy level diagram for ^{135m}Xe showing transitions from 15.65 m to 9.15 h. The diagram includes levels for ^{135}Xe , ^{135m}Xe , and ^{135}I . Transitions are labeled with gamma rays (γ_1 to γ_{11}), internal conversion (ce_K , ce_L , ce_M , ce_N), and electron capture (ec_K , ec_L , ec_M , ec_N).

$T_{1/2}$ 15.65 m (^{135m}Xe)
9.15 h (^{135}Xe)

Radiations (^{135m}Xe)

Type	Energy MeV	Intensity %	Δ (gm-rad) ($\mu\text{Ci-h}$)	Δ $\Sigma\Delta$ %	R_{90} (cm) in Water
ce_{AL}	0.0034	14.9 6	0.0011	0.10	0.000033
ce_{AK}	0.02456	1.7 3	0.0007	0.08	0.0010
ce_{LK}	0.49206 3	15.2 4	0.159	14.2	0.13
ce_{LL}^a	0.52117 3	2.9 1	0.032	2.9	0.15
ce_{LM}^b	0.52548 3	0.60 2	0.0067	0.60	0.15
ce_{LN}^c	0.52642 3	0.20 1	0.0022	0.20	0.15
γ_{L}	0.0041	1.7 5	0.00015	0.01	0.033
$X_{\text{Ka}2}$	0.02946	2.4 2	0.0024	0.21	9.2
$X_{\text{Ka}1}$	0.02978	2.1 3	0.0045	0.40	9.4
$X_{\text{K}\beta}$	0.0356	2.5 1	0.0018	0.16	12
γ_{H}	0.52662 3	81.2 5	0.911	81.3	44

^aEnergy of L_1 -line given

^bEnergy of M_1 -line given

^cEnergy of N_1 -line given

Radiations (^{135m}Xe)^d

Type	Energy MeV	Intensity %	Δ (gm-rad) ($\mu\text{Ci-h}$)	Δ $\Sigma\Delta$ %	R_{90} (cm) in Water
ce_{AL}	0.0036	5.1 4	0.00039	0.03	0.000036
ce_{AK}	0.02546	0.6 1	0.00033	0.03	0.0011
ce_{LK}	0.21376 1	5.5 4	0.025	2.1	0.039
ce_{LL}^a	0.244 _{av} 1	0.72 5	0.0037	0.31	0.048
ce_{LM}^b	0.2495 _{av} 1	0.14 1	0.0007	0.06	0.049
β_1^-	0.094 _{max} ⁹ 0.025 _{av} ⁹	0.082 7	0.00004	0.003	
β_2^-	0.175 _{max} ⁹ 0.047 _{av} ⁹	0.056 10	0.00006	0.005	
β_3^-	0.548 _{max} ⁹ 0.170 _{av} ⁹	2.8 2	0.0101	0.84	
β_4^-	0.74 _{max} ⁹ 0.215 _{av} ⁹	0.50 1	0.0026	0.22	
β_5^-	0.907 _{max} ⁹ 0.307 _{av} ⁹	96.6 2	0.632	52.6	
All β 's	0.302 _{av} ⁹	100	0.643	53.6	
γ_{L}	0.0043	0.6 2	0.00005	0.004	0.038
$X_{\text{Ka}2}$	0.03062	1.41 2	0.00092	0.08	10
$X_{\text{Ka}1}$	0.03097	2.61 4	0.00172	0.14	10
$X_{\text{K}\beta}$	0.0350	0.95 2	0.00071	0.06	12
γ_1	0.1582 2	0.23 2	0.00078	0.06	34
γ_2	0.1999 7	≈ 0.02	≈ 0.00009	≈ 0.007	35
γ_3	0.249741 10	90.6 5	0.482	40.1	37
γ_4	0.3583 3	0.20 2	0.0015	0.12	40
γ_5	0.3731 10	≈ 0.011	≈ 0.00009	≈ 0.007	40
γ_6	0.4079 3	0.32 2	0.0028	0.23	41
γ_8	0.60807 4	2.58 14	0.033	2.8	46
γ_9	0.6546 4	0.032 4	0.00045	0.04	46
γ_{10}	0.7319 4	0.045 5	0.00070	0.06	48
γ_{11}	0.8126 4	0.050 6	0.00087	0.07	49

^d $I(\text{ce}_{\text{LN}}) = 0.05$, $I(\text{ce}_{\text{LM}}) = 0.02$. These intensities are negligible relative to β_5^- . $I(\text{ce}_{\text{LK}}) \leq 0.06$ if γ_1 is E1, M1 or E2

RADIOACTIVE ATOMS SUPPLEMENT 1

 $^{135m}_{54}\text{Xe}^{-2}_{81}$ $^{135}_{54}\text{Xe}^{-2}_{81}$

Basic Data, Sources for Adopted Values				Basic Data, Sources for Adopted Values cont.			
Decay Scheme				Decay Modes (¹³⁵ Xe) continued			
^{135m} Xe No γ other than γ ₇ , ∴ I(γ ₇ +ce ₇) = 100				Type	Energy MeV	Intensity %	
¹³³ Xe Q ⁻ = 1.157 v No ground state β observed. ^a Intensities per 100 ¹³⁵ Xe decays are obtained from ce ₃ γ ₃ , γ ₆ γ ₃ , γ ₈ γ ₃ and the requirement that I(γ ₃ +ce ₃ +γ ₆ +γ ₈) ^b = 100.				γ ₈	0.60807 4	^w 2.58 ^d 14	72Mc24 68Al16,68Op02 72Ac02,72Mc24
$T_{1/2}$ 15.65 m 10 (^{135m} Xe) 60Ko02 ^w 9.15 h 2 (¹³⁵ Xe) 53Br11,64Cl01, 65An05,68Al16				γ ₉	0.6546 4	0.032 4	} 68Al16
				γ ₁₀	0.7319 4	0.045 5	
				γ ₁₁	0.8126 4	0.050 6	
Decay Modes (^{135m} Xe)				Auxiliary Data (^{135m} Xe)			
Type	Energy MeV	Intensity %		ce _{7K} /γ ₇ = 0.198 12			72Ac02
ce _{7K}		15.2 4	} ce _{7K} /γ ₇ , ce _{7K} /ce _{7L} , ce _{7M} /ce _{7L} , ce _{7NO} /ce _{7M} and the requirement that I(γ ₇ +ce ₇) = 100	*0.187 6			M4 Theory ^e
ce _{7L}		2.88 8		ce _{7L} /ce _{7K} = 0.190			M4 Theory
ce _{7M}		0.60 2		ce _{7M} /ce _{7L} = 0.21			M4 Theory
ce _{7NO}		0.20 1		ce _{7NO} /ce _{7M} = 0.33			Theory
γ ₇	0.526620 30	81.2 5	See I(ce ₇) above	∴ ce ₇ /γ ₇ = 0.232 7			
Decay Modes (¹³⁵ Xe)				Auxiliary Data (¹³⁵ Xe)			
Type	Energy MeV	Intensity %		ce _{3K} γ ₃ = *0.061 4			72Ac02
ce _{3K}		5.5 4	} ce _{3K} /γ ₃ , ce _{3K} /ce _{3L} , ce _{3M} /ce _{3L} , ce _{3NO} /ce _{3M} , γ ₆ /γ ₃ , γ ₈ /γ ₃ and the requirement that I(γ ₃ +ce ₃ +γ ₆ +γ ₈) ^b = 100	0.063			M1 Theory
ce _{3L}		0.72 5		ce _{3K} /ce _{3L} = 7.68			M1 Theory
ce _{3M}		0.144 10		ce _{3M} /ce _{3L} = 0.20			M1 Theory
ce _{3NO}		0.048 ^c 4		ce _{3NO} /ce _{3M} = 0.33			Theory
ce _{8K}		0.022 ^c 8	ce _{8K} /γ ₈	ce _{3K} /ce _{3LM} = *6.4			M1 Theory
β ₁ ⁻ to β ₅ ⁻ E(β) are from Q ⁻ and the level energies. I(β) are from the (γ+ce)-intensities.				6.5			52Be55
γ ₁	0.1582 2	^w 0.23 ^d 2	68Al16,68Op02	∴ ce ₃ /γ ₃ = 0.071 5			
γ ₂	0.1999 7	≈0.02 ^d	68Al16	ce _{8K} /γ ₈ = 0.0084 22			72Ac02
γ ₃	0.249741 10	90.6 5	72Mc24 See I(ce ₃) above				
γ ₄	0.3583 3	^w 0.20 ^d 2	68Al16,68Op02,72Ac02				
γ ₅	0.3731 10	≈0.011 ^d	68Al16				
γ ₆	0.4079 3	^w 0.32 ^d 2	68Al16,68Op02,72Ac02				
				*If log ft > 11.0 as expected for a 2-No β-transition, then I(g.s.) < 0.002%			
				^b I(ce ₈) is negligible here			
				^c This intensity is negligible relative to the β ₅ continuum			
				^d From I(γ)/I(γ ₃)			
				^e The M4 theory value of 0.193 has been reduced by 3% as explained in the text			
				^w Weighted average			
				*Value adopted by compilers from alternatives shown			

^aIf $\log ft > 11.0$ as expected for a 2-No β -transition, then $I(\beta_{gs}) < 0.002\%$ ^b $I(\text{ce}_8)$ is negligible here^cThis intensity is negligible relative to the β_5 continuum^dFrom $I(\gamma)/I(\gamma_3)$ ^eThe M4 theory value of 0.193 has been reduced by 3% as explained in the text^wWeighted average^{*}Value adopted by compilers from alternatives shown

M. J. MARTIN

Decay Characteristics

$T_{1/2}$ 3.83 m ^{137}Xe
30.0 y ^{137}Cs
2.552 m $^{137\text{m}}\text{Ba}$

Note
14 weak transitions ($\leq 0.04\%$) tentatively assigned to ^{137}Xe by 68Ho22 are not included here.

Note
The half-life of $^{137\text{m}}\text{Ba}$ is so short, compared with that of ^{137}Cs , that the enhancement of $^{137\text{m}}\text{Ba}$ activity in a ^{137}Cs - $^{137\text{m}}\text{Ba}$ mixture can be neglected.

Radiations (^{137}Xe)

Type	Energy MeV	Intensity %	$\Delta(\text{gm-rad})/\mu\text{Ci-h}$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
e_{AL}	0.0036	0.31 5	0.00002	≈ 0	0.000036
e_{AK}	0.02546	0.03 1	0.00002	≈ 0	0.0011
ce_{2K}	0.4194 1	0.33 7	0.0029	0.07	0.11
ce_{2L}	0.4497 1	0.050 11	0.00048	0.01	0.12
ce_{2MNO}	0.4542 1	0.014 3	0.00014	0.004	0.12

Radiations (^{137}Xe) continued

Type	Energy MeV	Intensity %	$\Delta(\text{gm-rad})/\mu\text{Ci-h}$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
β_3^-	1.21 _{max} ⁶ 0.43 _{av} ³	0.87 10	0.0080	0.21	
β_4^-	1.99 _{max} ⁶ 0.77 _{av} ³	0.17 4	0.0028	0.07	
β_5^-	2.14 _{max} ⁶ 0.84 _{av} ³	0.05 4	0.009	0.02	
β_6^-	2.28 _{max} ⁶ 0.90 _{av} ³	0.43 11	0.0082	0.21	
β_7^-	2.49 _{max} ⁶ 1.00 _{av} ³	0.21 5	0.0045	0.12	
β_8^-	3.08 _{max} ⁶ 1.27 _{av} ³	0.14 7	0.0038	0.10	
β_9^-	3.21 _{max} ⁶ 1.33 _{av} ³	0.9 2	0.025	0.64	
β_{10}^-	3.60 _{max} ⁶ 1.51 _{av} ³	31 3	1.00	25.7	

RADIOACTIVE ATOMS SUPPLEMENT I

Decay Characteristics continued						Decay Characteristics continued					
Radiations (^{137}Xe) continued						Radiations (^{137}Cs)					
Type	Energy MeV	Intensity %	$\Delta/\text{gm-rad} \backslash \mu\text{Ci-h}$	$\Delta \Sigma \Delta$	R_{90} (cm) in Water	Type	Energy MeV	Intensity %	$\Delta/\text{gm-rad} \backslash \mu\text{Ci-h}$	$\Delta \Sigma \Delta$ %	R_{90} (cm) in Water
β_{11}^-	4.06 _{max} 6 1.73 _{av} 3	66 3	2.43	62.4		ϵ_{AL}	0.0037	7.5 3	0.0006	0.03	0.000038
All β 's	1.64 _{av} 3	100	3.49	89.5		ϵ_{AK}	0.0264	0.8 2	0.0004	0.02	0.0011
X_L	0.0043	0.03 1	0.000003	≈ 0	0.038	ϵ_K	0.624204 9	7.80 6	0.1037	5.99	0.19
$X_{K\alpha 2}$	0.03062	0.09 1	0.00006	≈ 0	10	ϵ_L	0.655656 9	1.42 3	0.0198	1.14	0.20
$X_{K\alpha 1}$	0.03097	0.16 2	0.00011	0.003	10	ϵ_{MNO}	0.660352 9	0.32 8	0.0045	0.26	0.20
$X_{K\beta}$	0.0350	0.06 1	0.00004	≈ 0	12	β_1^-	0.514 _{max} 1 0.1743 _{av} 4	94.6 3	0.351	20.3	
γ_1	0.394 1	0.18 4	0.0015	0.04	41	β_2^-	1.176 _{max} 1 0.4164 _{av} 4	5.4 3	0.048	2.8	
γ_2	0.45538 10	32 7	0.31	8.0	43	All β 's	0.1874 _{av}	100	0.399	23.0	
γ_3	0.595 1	0.09 2	0.0011	0.03	45	X_L	0.0045	0.8 3	0.00008	≈ 0	0.043
γ_4	0.849 1	0.69 15	0.012	0.31	50	$X_{K\alpha 2}$	0.03182	1.99 6	0.00135	0.08	11
γ_5	0.934 1	0.07 2	0.0014	0.04	51	$X_{K\alpha 1}$	0.03219	3.67 11	0.00252	0.15	11
γ_6	0.982 1	0.23 5	0.0048	0.12	52	$X_{K\beta}$	0.0363	1.36 4	0.00105	0.06	13
γ_7	1.068 1	2.08 2	0.0018	0.05	54	γ	0.661645 9	85.1 4	1.199	69.2	47
γ_8^a	1.107 1	0.07 2	0.0017	0.04	54	Basic Data, Sources for Adopted Values					
γ_9	1.117 1	0.21 5	0.0050	0.13	54	Decay Scheme					
γ_{10}	1.185 1	0.08 2	0.0020	0.05	55	^{137}Xe $Q^- = 4.06$ 6 $E(\beta_{11})$					
γ_{11}^a	1.197 1	0.07 2	0.0017	0.05	55	The decay scheme is that of 68Ho22.					
γ_{12}	1.275 1	0.26 6	0.0071	0.18	57	Intensities per 100 ^{137}Xe decays are obtained from $I(\beta_{11}^-)$, the relative photon intensities, ϵ_2/γ_2 , and the requirement that $I(\gamma + \text{ce to g.s.}) + I(\beta_{11}^-) = 100$					
γ_{13}	1.576 1	0.18 4	0.0060	0.15	61	^{137}Cs $Q^- = 1.176$ 1 $E(\beta_1) + E(\gamma)$					
γ_{14}	1.615 1	0.17 4	0.0058	0.15	62	No γ other than 0.661645 γ observed.					
γ_{15}	1.668 1	0.08 2	0.0028	0.07	62	Intensities per 100 ^{137}Cs decays are obtained from $I(\beta_1^-)$ and the requirement that $I(\beta_1^- + \beta_2^-) = 100$.					
γ_{16}	1.784 1	0.51 11	0.019	0.49	64	$T_{1/2}$ $^{w}3.83$ m 1 (^{137}Xe) 66Ar08.68Ho22.					
γ_{17}	1.918 1	0.12 3	0.0049	0.13	66	$^{w}30.0$ y 2 (^{137}Cs) 69To20.69Ca03.72Eh02					
γ_{18}	2.396 1	0.11 3	0.0056	0.14	72	2.552 m 2 (^{137m}Cs) 70MaB1.70Wa19.					
γ_{19}	2.852 1	0.27 6	0.016	0.41	79	72Em01.73Di01					
^a Not shown on Drawing. Placement not established						70MaB1					
^w Weighted average											

M. J. MARTIN

 $^{137}_{54}\text{Xe} - ^{137}_{82}\text{Cs}$ 1-3 $^{137}_{54}\text{Xe} - ^{137}_{83}\text{Cs}$ 1-3

Basic Data, Sources for Adopted Values cont.

Basic Data, Sources for Adopted Values cont.

Decay Modes (^{137}Xe)

Type	Energy	Intensity
α_{2K}		0.33 %
α_{2L}		0.050 11
α_{2MNO}		0.014 3

α_{2K}/γ_2 , α_{2K}/α_{2L} ,
 $\alpha_{2MNO}/\alpha_{2L}$ and the re-
 quirement that $I(\gamma+ce) =$
 $I(\beta_1) + I(\beta_2) = 100$

$\beta_1 \rightarrow \beta_{10}$	$E(\beta)$ are from Q(^{137}Xe) and the level energies. $I(\beta)$, except β_{10} , are from the γ -imbalances at each level.	
$\beta_{10} \rightarrow \beta_{11}$	$E(\beta_{11}) = 4.06$ 6 (64On03) 64On03 measured $I(\beta_{11}) = 65$ 6 and $I(\beta_{10}) = 32$ 4, 30 12. From these data, and $\Sigma I(\beta_1 \rightarrow \beta_9)/I(\beta_{10})$ from the $(\gamma+ce)$ -intensities, the compilers obtain $I(\beta_{11}) = 66$ 3.	
$\gamma_1 \rightarrow \gamma_{19}$	$E(\gamma)$, except γ_2 , are data of 68Ho22. $E(\gamma_2)$ is the value of 73Ge02. $I(\gamma)$ are relative intensities of 68Ho22 normalized as described under α_2 above. Uncertainties of 20% have been assigned by the compilers to author's relative I_γ .	

Decay Modes (^{137}Cs)

Type	Energy MeV	Intensity %
α_K		7.80 6
α_L		1.42 3
α_{MNO}		0.32 8
β_1	^W 0.514 1	94.6 3
β_2	1.176 1	5.4 3
γ	0.661645 9	85.1 4

$I(\gamma)$, α_K/γ , α_K/α_L ,
 α_L/γ and the require-
 ment that $I(\gamma+ce) = I(\beta_1)$

62Da05, 66Hs02, 68Wo02^a
 $I(\beta_1 + \beta_2) = 100$

$E(\beta_1) + E(\gamma)$
 Recommended by 69Ha05

73Mu07
 Recommended by 69Ha05

Auxiliary Data (^{137}Xe)

$\alpha_{2K}/\gamma_2 = 0.0090$ 11	72Ac02
^a 0.0103 3	E2 Theory
$\alpha_{2K}/\alpha_{2L} = 6.6$	E2 Theory
$\alpha_{2M}/\alpha_{2L} = 0.21$	E2 Theory
$\alpha_{2NO}/\alpha_{2M} = 0.33$	Theory
$\alpha_{2K}/\gamma_2 = 0.0123$ 3	

Auxiliary Data (^{137}Cs)

$\alpha_K/\gamma = 0.0916$ 5
$\alpha_L/\gamma = 0.1121$ 5
$\alpha_K/\alpha_L = 5.50$ 10

Recommended by 69Ha05

^aValue of 0.51163 84 quoted by authors raised to 0.51167 84 by compilers
 due to more recent value for calibration energy used by authors

^WWeighted average

^aValue adopted by compilers from alternatives shown

RADIOACTIVE ATOMS SUPPLEMENT I

Decay Characteristics

For ^{138}Cs Decay Scheme
see next page

$T_{1/2}$ 14.17 m ^{138}Xe
32.2 m ^{138}Cs

Note

Because of the larger number of low-intensity γ -rays observed in both ^{138}Xe and ^{138}Cs decays, and the resulting complexity of the decay schemes, only radiations with intensity $>0.1\%$ are included here. In ^{138}Xe decay, the intensity of the 54 γ 's omitted is 2.2%. In ^{138}Cs decay, 39 γ 's are omitted with total intensity 1.8%. Neglect of these γ 's leads to the neglect, in ^{138}Xe , of 9 possible weak β 's with total intensity $<1\%$, and in ^{138}Cs , of 9 possible weak β 's with total intensity $<0.9\%$.

Note

The ratio of ^{138}Cs activity to that of ^{138}Xe in an initially pure ^{138}Xe source is given, as a function of time, t , by

$$\frac{T_A}{T_B - T_A} \left[\exp\left(\frac{0.6931}{T_A T_B} (T_B - T_A)t\right) - 1 \right] = 0.787 \left[\exp(0.0273t) - 1 \right]$$

where $T_A = T_{1/2}(^{138}\text{Xe})$, $T_B = T_{1/2}(^{138}\text{Cs})$, and t is in minutes.

M. J. MARTIN

 $^{138}_{54}\text{Xe} - ^{138}_{55}\text{Cs} \quad 1-2$
 $^{138}_{54}\text{Xe} - ^{138}_{55}\text{Cs} \quad 1-2$

Decay Characteristics continued

 $^{138}_{55}\text{Cs} \quad 32.2 \text{ h}$

RADIOACTIVE ATOMS SUPPLEMENT 1

$^{138}_{54}\text{Xe} - ^{138}_{55}\text{Cs} \text{ } \beta\text{-}$

$^{138}_{54}\text{Xe} - ^{138}_{55}\text{Cs} \text{ } \beta\text{-}$

Decay Characteristics						Decay Characteristics continued					
Radiations (^{138}Xe)						Radiations (^{138}Xe) continued					
Type	Energy MeV	Intensity %	Δ (gm-rad) $\mu\text{Ci-h}$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water	Type	Energy MeV	Intensity %	Δ (gm-rad) $\mu\text{Ci-h}$	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
$\epsilon_{\text{AL}} + \epsilon_{\text{LM}}^{\text{a}}$	0.00363 5	85 7	0.0066	0.17	3.6×10^{-5}	X_{L}	0.0043	6 2	0.0005	0.01	0.038
$\epsilon_{\text{INO}}^{\text{b}}$	0.00462 5	10.2 13	0.00100	0.03	5.4×10^{-5}	γ_1	0.00485 5	0.20 3	0.00002	≈ 0	0.054
$\epsilon_{\text{2L}}^{\text{c}}$	0.00514 5	53 2	0.0058	0.15	6.5×10^{-5}	γ_2	0.01085 5	0.72 2	0.00017	0.004	0.54
$\epsilon_{\text{2M}}^{\text{d}}$	0.00963 5	10.6 4	0.00217	0.06	0.00019	$X_{\text{K}\alpha_2}$	0.03062	0.94 6	0.00061	0.02	10.0
$\epsilon_{\text{2NO}}^{\text{e}}$	0.01062 5	3.3 1	0.00075	0.02	0.00023	$X_{\text{K}\alpha_1}$	0.03097	1.7 1	0.00112	0.03	10.0
						$X_{\text{K}\beta}$	0.0350	0.63 4	0.00047	0.01	12.5
ϵ_{AK}	0.02546	0.38 6	0.00021	0.005	0.0011	γ_3	0.15375 3	5.0 4	0.016	0.42	34
ϵ_{3K}	0.11777 3	1.15 14	0.0029	0.11	0.015	γ_4	0.24256 5	3.3 3	0.017	0.44	37
$\epsilon_{\text{3L}}^{\text{f}}$	0.14804 3	0.15 2	0.00047	0.01	0.021	γ_5	0.25831 5	29 2	0.160	4.2	37
ϵ_{4K}	0.20658 5	0.23 2	0.0010	0.03	0.037	γ_6	0.28251 6	0.41 3	0.0025	0.07	38
ϵ_{5K}	0.22233 5	1.68 14	0.0080	0.21	0.042	γ_7	0.37144 5	0.47 3	0.0037	0.10	40
$\epsilon_{\text{5L}}^{\text{g}}$	0.25260 5	0.27 5	0.0015	0.04	0.051	γ_8	0.39643 5	6.1 4	0.052	1.4	41
ϵ_{6K}	0.36945 5	0.12 1	0.00092	0.02	0.086	γ_9	0.40136 5	2.1 2	0.018	0.47	41
ϵ_{10K}	0.39851 5	0.29 2	0.0025	0.065	0.10	γ_{10}	0.43449 6	19.4 13	0.180	4.7	42
$\beta_1^{\text{h}} + \beta_2^{\text{i}}$	0.26 _{max} 5 0.073 _{av} 14	0.78 6	0.0012	0.03		γ_{11}	0.50022 6	0.35 3	0.0037	0.10	43
β_3^{j}	0.41 _{max} 5 0.122 _{av} 15	3.5 2	0.0091	0.24		γ_{12}	0.53007 7	0.25 2	0.0028	0.07	44
β_4^{k}	0.49 _{max} 5 0.149 _{av} 15	11 1	0.035	0.91		γ_{13}^{l}	0.53776 13	0.11 2	0.0013	0.03	44
$\beta_5^{\text{m}} + \beta_6^{\text{n}}$	0.72 _{max} 5 0.24 _{av} 2	36 2	0.18	4.7		γ_{14}^{o}	0.55595 9	0.12 1	0.0014	0.04	44
β_7^{p}	0.96 _{max} 5 0.33 _{av} 2	0.23 2	0.0016	0.04		γ_{15}	0.56853 6	0.31 2	0.0038	0.10	45
β_8^{q}	1.80 _{max} 5 0.69 _{av} 2	0.28 4	0.0041	0.11		γ_{16}	0.58884 8	0.12 1	0.0015	0.04	45
$\beta_9^{\text{r}} + \beta_{10}^{\text{s}}$	2.32 _{max} 5 0.92 _{av} 2	31 2	0.61	15.9		γ_{17}	0.65408 8	0.14 1	0.0020	0.05	46
$\beta_{11}^{\text{t}} + \beta_{12}^{\text{u}}$	2.74 _{max} 5 1.11 _{av} 2	18 3	0.43	11.2		γ_{18}	0.86582 7	0.30 3	0.0055	0.14	50
All β 's	0.59 _{av} 2	100	1.27	33.2		γ_{19}	0.86935 6	0.61 5	0.0113	0.30	50
						γ_{20}	0.89687 12	0.14 2	0.0027	0.07	50
						γ_{21}	0.91251 7	0.36 3	0.0070	0.18	51
						γ_{22}	0.91713 6	0.99 7	0.0193	0.50	51
						γ_{23}	0.93636 11	0.14 2	0.0028	0.07	51
						γ_{24}	0.94125 8	0.24 2	0.0048	0.13	51

^{a-c}Energy of M_1^{a} -, N_1^{b} -, L_1^{c} -line given

^dNot shown on drawing. This β -group feeds a level which is de-excited by several weak γ 's ($<0.1\%$)

^eNot shown on drawing. Placement not definitely established

M. J. MARTIN

$$^{138}_{54}\text{Xe} \rightarrow ^{138}_{55}\text{Cs} + \beta^-$$

$$^{138}_{54}\text{Xe} \rightarrow ^{138}_{55}\text{Cs} + \beta^-$$

Decay Characteristics continued						Decay Characteristics continued					
Radiations (^{138}Xe) continued						Radiations (^{138}Cs)					
Type	Energy MeV	Intensity %	Δ gm-rad $\mu\text{Ci-h}$	Δ S.S. %	R_{90} (cm) in Water	Type	Energy MeV	Intensity %	Δ gm-rad $\mu\text{Ci-h}$	Δ S.S. %	R_{90} (cm) in Water
γ_{25}	1.09387 9	0.44 3	0.0103	0.27	54	ϵ_{AL}	0.0037	0.66 7	0.000052	≈ 0	3.8×10^{-5}
γ_{26}	1.09677 11	0.23 2	0.0054	0.14	54	α_{1K}	0.10066 6	0.45 7	0.00096	0.01	0.011
γ_{27}	1.1022 2	0.12 2	0.0028	0.07	54	α_{5K}	0.19032 6	0.11 1	0.00045	0.006	0.033
γ_{28}	1.11429 10	1.7 2	0.040	1.0	54	α_{11K}	0.42535 7	0.27 2	0.0024	0.03	0.11
γ_{29}	1.14164 9	0.55 4	0.0134	0.35	54	$\beta_1^- + \beta_2^-$	0.71 _{max} 7 0.23 _{av} 3	0.45 3	0.0022	0.03	
γ_{30}	1.1454 2	0.14 2	0.0034	0.09	54	β_3^-	1.21 _{max} 7 0.43 _{av} 3	0.19 2	0.0017	0.02	
γ_{31}	1.5718 2	0.29 3	0.0097	0.25	61	$\beta_4^- + \beta_5^-$	1.36 _{max} 7 0.49 _{av} 3	0.68 7	0.0071	0.09	
γ_{32}	1.6146 2	0.26 3	0.0089	0.23	62	$\beta_6^- + \beta_7^-$	1.62 _{max} 7 0.61 _{av} 3	0.70 9	0.0091	0.12	
γ_{33}	1.76826 13	18.6 12	0.70	18.3	64	$\beta_8^- + \beta_9^-$	1.93 _{max} 7 0.74 _{av} 3	0.48 3	0.0118	0.16	
γ_{34}	1.8125 2	0.20 2	0.0077	0.20	64	$\beta_{10}^- + \beta_{11}^-$	2.09 _{max} 8 0.82 _{av} 3	0.59 4	0.0103	0.14	
γ_{35}	1.85086 13	1.49 10	0.059	1.54	65	$\beta_{12}^- + \beta_{13}^-$	2.31 _{max} 8 0.92 _{av} 3	0.81 4	0.0159	0.21	
γ_{36}	1.92536 14	0.64 5	0.026	0.68	66	$\beta_{14}^- + \beta_{15}^-$	2.42 _{max} 8 0.97 _{av} 3	0.6 2	0.012	0.16	
γ_{37}	2.00475 14	6.1 4	0.26	6.8	67	β_{16}^-	2.51 _{max} 7 1.01 _{av} 3	1.6 1	0.034	0.45	
γ_{38}	2.01582 14	13.7 9	0.59	15.4	≈ 68	$\beta_{17}^- + \beta_{18}^-$	2.66 _{max} 8 1.08 _{av} 3	10.8 5	0.248	3.3	
γ_{39}	2.07917 14	1.63 11	0.072	1.9	≈ 68	$\beta_{19}^- + \beta_{20}^-$	2.84 _{max} 8 1.16 _{av} 3	42 2	1.04	13.8	
γ_{40}	2.2523 2	2.6 2	0.125	3.3	≈ 71	β_{21}^-	2.98 _{max} 7 1.22 _{av} 3	6.7 4	0.174	2.3	
γ_{41}	2.3219 2	0.73 5	0.036	0.94	≈ 72	β_{22}^-	3.07 _{max} 7 1.26 _{av} 3	14.0 8	0.38	5.1	
γ_{42}	2.4753 2	0.36 3	0.019	0.50	≈ 74	β_{23}^-	3.39 _{max} 7 1.41 _{av} 3	12 2	0.36	4.8	
γ_{43}^a	2.4976 2	0.20 2	0.0106	0.28	≈ 74	β_{24}^-	3.85 _{max} 7 1.63 _{av} 3	9 5	0.31	4.1	
						All β 's	1.22 _{av} 3	100	2.60	34.6	

^a Not shown on drawing. Placement not definitely established

^b Not shown on drawing. This β -group feeds a level which is de-excited by several weak γ 's ($< 0.1\%$)

RADIOACTIVE ATOMS SUPPLEMENT I

$$\begin{matrix} 138 & 138 \\ \text{Xe} & - & \text{Cs} \\ 54 & 84 & 55 & 83 \end{matrix} \rightarrow \text{S}$$

$$\begin{matrix} 138 & 138 \\ \text{Xe} & - & \text{Cs} \\ 54 & 84 & 55 & 83 \end{matrix} \rightarrow \text{S}$$

Decay Characteristics continued						Decay Characteristics continued					
Radiations (^{138}Cs) continued						Radiations (^{138}Cs) continued					
Type	Energy MeV	Intensity %	Δ (gm-rad) ($\mu\text{Ci-h}$)	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water	Type	Energy MeV	Intensity %	Δ (gm-rad) ($\mu\text{Ci-h}$)	$\Delta/\Sigma\Delta$ %	R_{90} (cm) in Water
$X_{K\alpha_2}$	0.03182	0.21 3	0.00014	0.002	10.5	γ_{27}	1.43586 9	75 5	2.29	30.5	59
$X_{K\alpha_1}$	0.03219	0.39 4	0.00027	0.004	10.5	γ_{28}	1.4450 3	1.0 2	0.031	0.41	59
$X_{K\beta}$	0.0364	0.15 2	0.00012	0.002	13.0	γ_{29}	1.4956 3	0.18 4	0.0057	0.08	60
γ_1	0.13810 6	1.15 7	0.0034	0.04	33	γ_{30}	1.55531 10	0.36 2	0.012	0.16	60
γ_2	0.19196 6	0.43 3	0.0018	0.02	35	γ_{31}^a	1.6141 2	0.14 3	0.0048	0.06	61
γ_3	0.19389 8	0.29 2	0.0012	0.02	35	γ_{32}	1.7277 2	0.11 2	0.0040	0.05	63
γ_4	0.21232 8	0.15 2	0.00068	0.009	36	γ_{33}	1.7783 3	0.14 2	0.0053	0.07	64
γ_5	0.22776 6	1.29 7	0.0063	0.08	36	γ_{34}	2.0239 2	0.12 2	0.0052	0.07	≈ 68
γ_6	0.32490 8	0.26 2	0.0018	0.02	39	γ_{35}	2.0623 2	0.12 2	0.0053	0.07	≈ 68
γ_7	0.36393 8	0.25 2	0.0019	0.03	40	γ_{36}	2.2107 4	0.22 7	0.010	0.13	≈ 70
γ_8	0.36529 13	0.13 2	0.0010	0.01	40	γ_{37}	2.21800 10	16.0 8	0.76	10.1	≈ 70
γ_9	0.40898 6	4.0 2	0.035	0.47	41	γ_{38}	2.4994 3	0.19 5	0.010	0.13	≈ 74
γ_{10}	0.42159 7	0.37 2	0.0033	0.04	42	γ_{39}	2.58315 13	0.26 2	0.014	0.19	≈ 75
γ_{11}	0.46279 7	26.8 15	0.264	3.5	43	γ_{40}	2.63959 13	8.1 5	0.46	6.1	≈ 76
γ_{12}	0.51674 12	0.37 5	0.0041	0.05	44	γ_{41}	2.73112 15	0.13 1	0.0076	0.10	≈ 77
γ_{13}	0.54694 7	9.5 5	0.111	1.5	44	γ_{42}^a	2.8066 2	0.11 1	0.0066	0.09	≈ 78
γ_{14}	0.76610 12	0.13 2	0.0021	0.03	48	γ_{43}	3.3390 3	0.18 2	0.013	0.17	≈ 85
γ_{15}	0.77331 10	0.21 2	0.0035	0.05	49	γ_{44}	3.3670 3	0.27 2	0.019	0.25	≈ 85
γ_{16}	0.78208 9	0.32 2	0.0053	0.07	49						
γ_{17}	0.87180 8	4.7 3	0.087	1.2	50						
γ_{18}	0.93503 12	0.17 2	0.0034	0.05	51						
γ_{19}	1.00978 8	28.4 15	0.61	8.1	52						
γ_{20}	1.05432 15	0.15 2	0.0034	0.05	53						
γ_{21}	1.14722 9	1.19 7	0.021	0.28	54						
γ_{22}	1.1992 3	0.17 2	0.0043	0.06	55						
γ_{23}	1.20369 13	0.38 4	0.0097	0.13	55						
γ_{24}	1.2649 2	0.13 2	0.0035	0.05	57						
γ_{25}	1.34359 9	1.11 6	0.032	0.43	57						
γ_{26}	1.41568 13	0.36 3	0.0109	0.15	58						

^aNot shown on drawing since placement not definitely established

Basic Data. Sources for Adopted Values

Basic Data. Sources for Adopted Values cont

Decay Scheme

^{138}Xe The decay scheme is that of ^{138}Xe .
 $Q^- = 2.755$ $^{138}\text{Xe} \rightarrow ^{138}\text{Cs}$
 Intensities per 100 decays of ^{138}Xe are obtained from the relative photon intensities, the ratio $\Sigma I_{\gamma}(^{138}\text{Xe})/\Sigma I_{\gamma}(^{138}\text{Cs})^b$ measured under equilibrium conditions, and the requirement that $\Sigma I_{\gamma}(^{138}\text{Cs})^b = 100^c$.

^{138}Cs The decay scheme is that of ^{138}Cs .
 $Q^- = 5.29^d$ $^{138}\text{Cs} \rightarrow ^{138}\text{Ba}$
 Intensities per 100 decays of ^{138}Cs are obtained from the relative photon intensities and the requirement that $\Sigma I_{\gamma}(^{138}\text{Cs})^b = 100^c$.

$T_{1/2}$ ^{138}Xe 14.17 m ^{138}Xe 64Cl01.65Pa14.
 ^{138}Cs 32.2 m ^{138}Cs 40G105.56Ba66.56Bu01.
 60Wi10.69Ca03

Decay Modes (^{138}Xe)

Type	Energy MeV	Intensity %	
α_{1M}		34.6	$I(\alpha_1), \alpha_{1M}/\alpha_1,$ $\alpha_{1N}/\alpha_{1M}, \alpha_{1O}/\alpha_{1N}$
α_{1N}		8.2 13	
α_{1O}		2.0 3	
α_1		44.7	
			$I(\alpha_1)^e = 44^f.7$
α_{2L}		53.2	$I(\alpha_2), \alpha_{2L}/\alpha_2,$ $\alpha_{2M}/\alpha_{2L}, \alpha_{2N}/\alpha_{2M},$ α_{2O}/α_{2N}
α_{2M}		10.6 4	
α_{2N}		2.5 1	
α_{2O}		0.8 1	
α_2		67.2	α_2/γ_2 and $I(\gamma_2 + \alpha_2) = 68^g.2$

Other α

$I(\gamma), \alpha_K/\gamma, \alpha_K/\alpha_L$

$\beta_{1-10}, \beta_{11-12}$ $\left\{ \begin{array}{l} E(\beta) \text{ are from } Q^-(^{138}\text{Xe}) \text{ and the } ^{138}\text{Cs} \\ \text{level energies.} \\ I(\beta) \text{ are from the } (\gamma + \alpha) \text{-intensity imbalances} \\ \text{at each level.} \end{array} \right.$

β_{12} 16.3 From $I_{1M}(\gamma_1)/I_L(\gamma_2), I_L(\gamma_2),$
 α_{1M}/α_1 and intensity balance at the 0.01085 level
 <10 From expected $\log f^{10}t > 8.5$
 $^{*5.5}$

γ_1 0.00485 5 $^{72}\text{Mo}33$
 0.20 3 α_{1M}/γ_1 and $I(\alpha_{1M})$

γ_2 0.01085 5 $^{72}\text{Mo}33$
 0.72 2 See $I(\alpha_2)$

$\gamma_3 \cdots \gamma_{43}$ $E(\gamma)$ and $I(\gamma)$ are data of $^{72}\text{Ca}28$. $I(\gamma)$ per 100 ^{138}Xe decays are obtained as explained above under "Decay Scheme."

Decay Modes (^{138}Cs)

Type	Energy MeV	Intensity %
α_K		$I(\gamma), \alpha_K/\gamma$
β_{1-12}		$E(\beta)$ are taken from $Q^-(^{138}\text{Cs})$ and the ^{138}Ba level energies $I(\beta)$ are from the $(\gamma + \alpha)$ -intensity imbalances at each level
$\gamma_1 \cdots \gamma_{44}$		$E(\gamma)$ and $I(\gamma)$ are data of $^{72}\text{Ca}28$. $I(\gamma)$ per 100 ^{138}Cs decays are obtained from the requirement that $\Sigma I_{\gamma}(^{138}\text{Cs})^b = 100^c$.

Auxiliary Data (^{138}Xe)

$\alpha_{1M}/\alpha_{2L} = 0.414$ $^{72}\text{Mo}33$ $= 0.5710$ From adopted values	$\alpha_{3K}/\gamma_3 = 0.23$ $\alpha_{3K}/\alpha_{3L} = 7.6$	M1 ^h Theory
$\alpha_{1M}/\alpha_{1M} = 0.89$ $\alpha_{1M}/\alpha_1 = 0.77$ $\alpha_{1N}/\alpha_{1M} = 0.24$ $\alpha_{1O}/\alpha_{1N} = 0.24$ $\alpha_{1M}/\gamma_1 = 148$	$\alpha_{4K}/\gamma_4 = 0.069$ ¹ $\alpha_{5K}/\gamma_5 = 0.057$ ² $\alpha_{5K}/\alpha_{5L} = 6.5$ ²	
$\alpha_2/\gamma_2 = 93$ $\alpha_{2M}/\alpha_{2L} = 0.20$ $\alpha_{2N}/\alpha_{2M} = 0.24$ $\alpha_{2O}/\alpha_{2N} = 0.20$	$\alpha_{6K}/\gamma_6 = 0.017$ ² $\alpha_{10K}/\gamma_{10} = 0.013$ ²	M1 ^h Theory

Auxiliary Data (^{138}Cs)

$\alpha_{1K}/\gamma_1 = 0.39$ ⁵ $\alpha_{5K}/\gamma_5 = 0.087$ ¹	M1 ^h E2 Theory	$\alpha_{11K}/\gamma_{11} = 0.0122$ E2 ^k Theory
---	------------------------------	--

^aFrom $\beta\gamma$ -experiments

^b $\Sigma I_{\gamma}(^{138}\text{Xe})$ = sum of photon intensities feeding the ground state + 0.01085 level + 0.01570 level in ^{138}Cs

$\Sigma I_{\gamma}(^{138}\text{Cs})$ = sum of photon intensities feeding the ground state of ^{138}Ba

^cNegligible β -feeding of the ^{138}Cs ground state is expected ($I < 0.001\%$ for the expected $\log ft > 12.8$)

^dRevised from 5.28 given in $^{72}\text{Ca}28$ (priv. comm. from authors)

^e $I(\gamma_1)$ is negligible here

^fFrom intensity balance at 0.01085 level with $I_{\beta} = 5\%$

^gFrom intensity balance at ground state. Negligible β -feeding of the ^{138}Cs ground state is expected ($I < 0.00003\%$ for the expected $\log ft > 12.8$)

^hSee $^{72}\text{Ca}28$ for multipolarity assignment

ⁱUncertainty covers spread in M1, E2 theory values

^kMultipolarity assignment based on decay scheme

^lWeighted average

^mValue adopted by compilers from alternatives shown

RADIOACTIVE ATOMS SUPPLEMENT I

REFERENCE LIST

-
- 40Gl05 G.M.Glasoe, J.Steigmar - Phys.Rev. 58, 1 (1940)
Radioactive Products from Gases Produced in Uranium Fission
- 49Ko13 J.Koch, O.Kofoed-Hansen, P.Kristensen, W.Drost-Hansen - Phys.Rev. 76, 279 (1949)
Measurements on Radioactive Krypton Isotopes from Fission after Mass-Spectrographic Separation
- 51Be11 I.Bergstrom - Phys.Rev. 81, 638 (1951)
On the Isomerism of Kr^{83} and Xe^{133}
- 51Bu02 M.E.Bunker, L.M.Langer, P.J.D.Moffat - Phys.Rev. 81, 30 (1951)
The Disintegration of Pb^{208}
- 52Ba20 P.T.Barrett - Proc.Phys.Soc.(London) 65A, 450 (1952)
 Kr^{85} - an Investigation of the Radiations Succeeding the Metastable State
- 52Be55 I.Bergstrom - Arkiv Fysik 5, 191 (1952)
The Isomers of Krypton and Xenon
- 52De25 H.deWaard - Physica 18, 1151 (1952)
A High Resolution Coincidence Instrument with Scintillation Counters. Delayed and Prompt Coincidences in the Decay of ^{181}Hf
- 53Br11 F.Brown, L.Yaffe - Can.J.Chem. 31, 242 (1953)
The Independent Yield of Xe^{135} Produced in the Fission of Natural Uranium by Pile Neutrons
- 54Be36 I.Bergstrom, S.Thulin, A.H.Wapstra, B.Astrom - Arkiv Fysik 7, 255 (1954)
K-Conversion Coefficients of γ -Transitions Occurring in the Decay of Kr^{85m} , Xe^{129m} , Xe^{131m} , Xe^{133} , and Xe^{133m}
- 55Th01 S.Thulin - Arkiv Fysik 9, 137 (1955)
Studies in Nuclear Spectroscopy with Electromagnetically Separated Gaseous Isotopes II - Disintegration of Some Krypton and Xenon Isotopes
- 56Ba66 P.M.Bartholomew, A.P.Perg - Can.J.Chem. 34, 201 (1956)
The Yield of Cs^{138} in Thermal Neutron Fission of U^{235}
- 56Bu01 M.E.Bunker, R.B.Duffield, J.P.Wize, J.W.Starner - Phys.Rev. 103, 1417 (1956)
Disintegration of Cs^{138}
- 56La03 N.H.Lazar, E.Eichler, G.D.O'Kelley - Phys.Rev. 101, 727 (1956)
Nuclear Levels in Sr^{88} from the Disintegration of Rb^{88} and Y^{88}
- 60Ko02 K.Kotajima, H.Morinaga - Nuclear Phys. 16, 231 (1960)
Isomerism in $N = 81$ Nuclei
- 60Wi10 R.G.Wille, P.W.Fink - Phys.Rev. 118, 242 (1960)
Activation Cross Sections for 14.8 MeV Neutrons and Some New Radioactive Nuclides in the Rare Earth Region
- 61Br09 F.Brown, P.L.Graham, G.T.Ewan, J.Uhler - Can.J.Phys. 39, 779 (1961)
The Conversion Electron Spectrum from a Mass-Separated Source of Xe^{133}
- 61Er04 P.Erman, Z.Sujkowski - Arkiv Fysik 20, 209 (1961)
Gamma Transition Probabilities and the Auger Effect in the β -Decay of Xe^{133}
- 62Da05 H.Daniel, H.Schmitt - Z.Physik 168, 292 (1962)
Das β -Spektrum des Cs^{137}
- 62Ge09 J.S.Geiger, R.L.Graham, F.Brown - Can.J.Phys. 40, 1258 (1962)
The Conversion Line Intensity Ratios for M4 Transitions in Xe and Ba
- 62Wo09 J.L.Wolfson, J.J.H.Park, L.Yaffe - Nuclear Phys. 39, 613 (1962)
Internal Conversion Spectrum of I^{131} (8.06 d)
- 63Ru03 S.L.Ruby, Y.Hazoni, M.Pasternak - Phys.Rev. 129, 826 (1963)
Lifetimes of the Low-Energy M1 Transitions in La^{137} and Kr^{83}
- 64Al28 D.G.Akhazov, V.D.Vasilev, G.M.Gusinski, I.K.Lemberg, V.A.Nabichvishvili - Izv.Akad.Nauk SSSR, Ser.Fiz. 28, 1683 (1964); Bull.Acad.Sci.USSR, Phys.Ser. 28, 1575 (1965)
Angular Distribution of Gamma Radiation Emitted in Coulomb Excitation of Odd-A Nuclei
- 64Cl01 W.B.Clark, H.G.Thode - Can. J. Phys. 42, 213 (1964)
Mass Spectrometric Measurements of the Half-Lives of Kr^{87} , Kr^{88} , Xe^{135} , Xe^{138}
- 64Ea01 T.A.Eastwood, F.Brown, R.D.Werner - Can.J.Phys. 42, 218 (1964)
The Gamma Branching Ratio of Kr^{85}
- 64Ni04 F.B.Nieschmidt, C.E.Mandeville, L.D.Ellsworth, D.D.Bornemeier - Phys.Rev. 136, B557 (1964)
Nuclear Transitions in Cs^{133}
- 64On03 R.J.Onega, W.W.Pratt - Phys.Rev. 136, B365 (1964)
Decay of Xe^{137}
-

M. J. MARTIN

REFERENCE LIST

-
- 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
- 65An05 G.Andersson, G.Rudstam, G.Sorensen - Arkiv Fysik 28, 37 (1965)
Decay Data on Some Xe, I, and Te Isotopes
- 65Pa14 P.Patzelt, G.Herrmann - Proc.Symp.on Phys.and Chem.of Fission, Vol.II, Salzburg, Austria, IAEA, Vienna, p.243(1965)
Indirect Determination of Half-Lives of Short-Lived Fission Gases Using a Gas Flow Method
- 66Ar07 E.A.Arutyunyan, B.S.Dzhelelov, Y.V.Kholnov - Program and Theses, Proc 16th All-Union Conf.Nucl.Spectroscopy and Struct.of at.Nuclei, Moscow, p.33(1966)
On the γ -Spectra of ^{133}Ce
- 66Ar08 N.P.Archer, G.L.Keech - Can.J.Phys. 44, 1823(1966)
Direct Measurements of the Half-Lives of Some Short-Lived Xenon and Cesium Isotopes
- 66Ge01 J.S.Gelger - Proc.Intern.Conf.Internal Conversion Process, Nashville, Tenn. (1965), J.H.Hamilton, Ed., Academic Press, Inc., New York, p.379(1966)
The Internal Conversion of High Multipole Order γ -Transitions
- 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
- 66Kn03 K.Knauf, H.Sommer, H.Klewe-Nebenius - Z.Physik 197, 101(1966)
Suche nach Zweiquantenprozessen beim Zerfall von $\text{Xe}^{131\text{m}}$
- 66Mi01 S.C.Misra, J.S.Merritt, J.G.V.Taylor - Quoted by 66Ge01
- 66Ra16 B.N.S.Rao - Nucl.Phys. 86, 443(1966)
Internal Conversion Coefficient of the 81 keV Transition in ^{133}Cs
- 66Th09 J.E.Thun, S.Tornkvist, K.B.Nielsen, H.Snellman, F.Falk, A.Mocoroa - Nucl.Phys. 88, 289(1966)
Levels and Transitions in ^{133}Cs
- 67De05 R.Denecke, E.De Roost, A.Spernol, P.Vaninbrouckx - Nucl.Sci.Eng. 28, 305(1967)
The Gamma-Ray Branching of Krypton-85
- 67He09 H.J.Hennecke, J.C.Manthuruthil, O.Bergman, C.R.Cothern - Phys.Rev. 159, 955(1967)
Internal-Conversion-Electron Study of the Decay of Ba^{133} to Cs^{133}
- 68Al16 P.Alexander, J.P.Lau - Nucl.Phys. A121, 612 (1968)
Nuclear Structure in $^{133,135}\text{Xe}$ and $^{133,135}\text{Cs}$
- 68Be62 M.J.Berger - J.Nucl.Med., Suppl.No.1, 15 (1968)
Energy Deposition in Water by Photons from Point Isotropic Sources
- 68Bo04 H.E.Bosch, A.J.Haverfield, F.Szichman, S.M.Abecasis - Nucl.Phys. A108, 209(1968)
High-Resolution Studies in the Decay of ^{133}Ba with Semiconductor Counters
- 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 $Z = 103$
- 68Ho22 G.Holm - Arkiv Fysik 37, 1(1968)
Energy Levels in the Single Closed Shell Nucleus ^{137}Cs Populated in the Decay of 4π in ^{137}Xe
- 68Le03 J.Legrand, J.P.Boulanger, J.P.Brethon - Nucl.Phys. A107, 177 (1968)
Determination de l'Energie de Quelques Transitions γ
- 68Lo14 R.Loewinger, M.Berman - J.Nucl.Med., Suppl.No. 1,7 (1968)
A Schema for Absorbed-Dose Calculations for Biologically-Distributed Radionuclides
- 68Op02 J.P.Op de Beeck, W.B.Walters - J.Inorg.Nucl.Chem. 30, 2881 (1968)
Decay of $9.2\text{-h } ^{135}\text{Xe}$
- 68To20 K.Tomura, N.Miyaji - Radiochim.Acta 10, 173 (1968)
Gamma-Rays of Short-Lived Xenon Isotopes
- 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
- 69Ca03 G.C.Carlson, W.C.Schick, Jr., W.L.Talbert, Jr., F.K.Wohn - Nucl.Phys. A125, 267(1969)
Half-Lives of Some Short-Lived Mass-Separated Gaseous Fission Products And Their Daughters
-

RADIOACTIVE ATOMS - SUPPLEMENT I

REFERENCE LIST

-
- 69Fr04 K.Fransson, P.Erman - Arkiv Fysik 39, 7 (1969)
The M4 Transitions in ^{131}Xe and ^{133}Xe
- 69Ha05 H.H.Hansen, G.Lowenthal, A.Spernol, W.van der Eijk, R.Vaninbrouckx - Z.Physik 218, 25(1969)
The Beta Branching Ratio and Conversion Coefficients in the ^{137}Cs Decay
- 69Ph03 A.Philippe, C.Ballaux, R.Dams, F.Adams - Radiochem.Radioanal.Letters 1, 351 (1969)
The Decay of ^{80}Br - $^{83\text{m}}\text{Kr}$
- 69Pa05 R.C.Ragaini, J.D.Knight - Nucl.Phys. A125, 97(1969)
Levels of ^{88}Sr from the Decay of ^{88}Rb
- 69To12 S.Tornkvist, L.Hasselgren, S.Strom, J.-E.Thun, S.Antman - UIIP-612 (1969)
Internal Conversion Studies of Transitions Populating and Depopulating The 161 keV Level in ^{133}Cs
- 70Av01 F.T.Avignone, III, G.D.Frey, L.D.Hendrick - Phys.Rev. C1, 635 (1970)
Internal-Conversion Penetration Effects in M1 Transitions of ^{133}Cs
- 70Gr13 R.C.Greenwood, R.G.Helmer, P.J.Gehrke - Nucl.Instrum.Methods 77, 141 (1970)
Precise Comparison and Measurement of Gamma-Ray Energies with a Ge(Li) Detector I. 50-420 keV
- 70MaB1 M.J.Martin, P.H.Blichert-Toft - Nucl.Data Tables A8, Nos.1-2 (1970)
Radioactive Atoms. Auger Electron, α -, β -, γ -, and X-Ray Data
- 70Ne22 G.C.Nelson, B.G.Saunders, S.I.Salem - At.Data 1, 377 (1970)
K X-Ray Transition Probabilities
- 70Wa19 K.F.Walz, H.M.Weiss - Z.Naturforsch. 25a, 921 (1970)
Messung der Halbwertszeiten von ^{60}Co , ^{137}Cs and ^{133}Ba
- 70Wo08 F.K.Wohn, W.L.Talbert, Jr., J.K.Halbig - Nucl.Phys. A152, 561 (1970)
The Decay of $^{85\text{m}}\text{Kr}$
- 71Be81 M.J.Berger - J.Nucl.Med., Suppl.No.5, 5 (1971)
Distribution of Absorbed Dose Around Point Sources of Electrons and Beta Particles in Water and Other Media
- 71DrP1 O.Dragoun, Z.Plajner, F.Schmutzler - Nucl.Data Tables A9, 119 (1971)
Contribution of Outer Atomic Shells to Total Internal Conversion Coefficients
- 71He27 R.G.Helmer, R.C.Greenwood, P.J.Gehrke - ANCR-1016, p.408 (1971)
Precise Comparison and Measurement of Gamma-Ray Energies with a Ge(Li) Detector II: 400 to 1300 keV
- 71Ru17 S.L.Ruby, R.G.Clark, L.E.Glendenin - Phys.Lett. 36A, 321 (1971)
Internal-Conversion Coefficients in the Decay of $^{83}\text{Kr-m}$
- 71Sh01 A.Shihab-Eldin, S.G.Prussin, F.M.Berenthal, J.O.Rasmussen - Nucl.Phys. A160, 33 (1971)
Levels in ^{87}Rb Populated in the Decay of ^{87}Kr
- 71Va38 S.Vaisala, G.Graeffe, J.Heinonen - Tampere Univ.Tech.Res.Rept. No.4 (1971)
The Levels of ^{83}Kr Obtained in the Decay of ^{83}Rb and ^{83}Br
- 71WaGo A.H.Wapstra, N.B.Gove - Nuclear Data Tables A9, Nos.4-5, 265 (1971)
The 1971 Atomic Mass Evaluation in Five Parts
- 72Ac02 E.Achterberg, F.C.Iglesias, A.E.Jech, J.A.Moragues, D.Otero, M.L.Perez, A.N.Proto, J.J.Rossi, W.Scheuer, J.F.Suarez - Phys.Rev. C5, 1759 (1972)
Conversion-Coefficient Measurements and Spin-Parity Assignments for Excited Levels in $^{133,135,136}\text{Xe}$, $^{135,137,139}\text{Cs}$, and ^{138}Ba
- 72BaCr W.Bambynek, B.Crasemann, R.W.Fink, H.-U.Freund, H.Mark, C.D.Swift, R.E.Price, P.Venugopala Rao - Rev.Mod.Phys. 44, 716 (1972)
X-Ray Fluorescence Yields, Auger, and Coster-Kronig Transition Probabilities
- 72Bu37 R.L.Bunting - Thesis, Iowa State Univ. (1972)
The Decays of ^{88}Kr and ^{88}Rb
- 72Ca28 G.H.Carlson - Thesis, Iowa State Univ. (1972); IS-T-549 (1972)
The Decays of ^{138}Xe and ^{138}Cs
- 72Eh02 B.Ehrenberg, S.Amiel - Phys.Rev. C6, 618 (1972)
Independent Yields of Krypton and Xenon Isotopes in Thermal-Neutron Fission of ^{235}U . Observation of an Odd-Even Effect in the Element Yield Distribution
- 72Em01 J.F.Emery, S.A.Reynolds, E.I.Wyatt, G.I.Gleason - Nucl.Sci.Eng. 48, 319 (1972)
Half-Lives of Radionuclides - IV
- 72Il01 F.Illes, C.Ujhelyi, S.Juhasz - Proc.Int.Conf.Radioactivity in Nucl.Spectrosc., Nashville, Tenn. (1969), J.H.Hamilton, J.C.Manthuruthil, Eds., Gordon and Breach, New York, Vol.2, p.1349 (1972)
Internal Conversion Ratios for the Higher Shells in the Decay of $\text{Xe}^{131\text{m}}$
-

M. J. MARTIN

REFERENCE LIST

-
- 72Ko35 B.Kolk, F.Pleiter, W.Heeringa - Nucl.Phys. A194, 614 (1972)
Internal Conversion Measurements on ^{83m}Kr
- 72Mc24 L.D.McIsaac, R.J.Gehrke, J.E.Cline, R.L.Heath - ANCR-1088, p.387 (1972)
Measurement of Gamma-Ray Energies and Relative Intensities of Fission Product
Gases and their Daughters
- 72Mo33 E.Monnand, P.Brisson, L.C.Carras, J.Crancon, C.Ristori, F.Schussler, A.Moussa -
Nucl.Phys. A195, 192 (1972)
Desintegration de ^{138}Xe
- 72Ne19 W.Neumann, E.Huster - Z.Naturforsch. 27a, 862 (1972)
Neubestimmung der Halbwertszeit des ^{87}Rb durch Vergleich von Messungen
an den getrennten Isotopen ^{87}Rb und ^{85}Rb
- 72Ra35 R.C.Ragaini - Priv.Comm. (Nov.1972)
- 72Sc08 W.-D.Schmidt-Ott, R.W.Fink - Z.Phys. 249, 286 (1972)
The Determination by an Independent Method of P(K) Electron Capture
Probabilities in ^{133}Ba and ^{139}Ce Decays. Gamma Decay of ^{133}Ba
- 72Sh01 D.A.Shirley - Priv.Comm. (January 1972)
- 73Cl02 J.R.Clifford, W.L.Talbert, Jr., F.K.Wohn, J.P.Adams, J.R.McConnell - Phys.Rev.
C7, 2535 (1973)
Decay Energies of Gaseous Fission Products and their Daughters for A=88 to 93
- 73Di01 L.A.Dietz, C.F.Pachucki - J.Inorg.Nucl.Chem. 35, 1769 (1973)
 ^{137}Cs and ^{134}Cs Half-Lives Determined by Mass Spectrometry
- 73Ge02 R.J.Gehrke, L.D.McIsaac, R.L.Heath - ANCR-1129 (1973)
 γ -Ray Energy and Relative Intensity Measurements of Several Fission Product
Radionuclides
- 73Ge03 R.J.Gehrke, J.R.Berthel - Priv.Comm. (March 1973)
- 73Ha03 J.K.Halbig, F.K.Wohn - Priv.Comm. (March 1973)
- 73Ha25 J.K.Halbig - Priv.Comm. (March 1973)
- 73Me13 R.A.Meyer - Priv.Comm. (March 1973)
- 73Mu07 L.G.Multhaupt - Priv.Comm. (July 1973)
- 73Ra10 S.Raman, N.E.Gove - Phys.Rev. C7, 1995 (1973)
Rules for Spin and Parity Assignments Based on Log ft Values
- 73Ra14 S.Raman, T.A.Walkiewicz, R.Gunnink, B.Martin - Phys.Rev. C7, 2531 (1973)
How Good Are the Theoretical Internal-Conversion Coefficients (Question)
- 73Wa07 W.B.Walters, R.A.Meyer - Bull.Amer.Phys.Soc. 18, No.1, p.99, HH14 (1973);
Priv.Comm. (January 1973)
Levels of ^{131}Xe Populated in the Decay of ^{131}I
-