Monographie BIPM-5

Table of Radionuclides (Vol. 2 - A = 151 to 242)

M.-M. Bé, V. Chisté, C. Dulieu
E. Browne
V. Chechev, N. Kuzmenko
R. Helmer
A. Nichols
E. Schönfeld, R. Dersch



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Preface

This monograph is one of several published in a series by the Bureau International des Poids et Mesures (BIPM) on behalf of the *Comité Consultatif des Rayonnements Ionisants* (CCRI), previously known as the *Comité Consultatif pour les Etalons de Mesure des Rayonnements Ionisants* (CCEMRI). The aim of this series of publications is to review topics that are of importance for the measurement of ionizing radiation and especially of radioactivity, in particular those techniques normally used by participants in international comparisons. It is hoped that these publications will prove to be useful reference volumes both for those who are already engaged in this field and for those who are approaching such measurements for the first time.

The purpose of this monograph, number 5 in the series, is to present the recommended values of nuclear and decay data for a set of sixty-eight radionuclides. Activity measurements for thirty-two of these radionuclides have already been the subject of comparisons under the auspices of Section II of the CCRI. The material for this monograph will be covered in two volumes. Volume 1 contains the primary recommended data relating to half-lives, decay modes, x-rays, gamma-rays, electron emissions; alpha- and beta-particle transitions and emissions, and their uncertainties for radionuclides with mass number up to and including 150; Volume 2 contains the equivalent data for radionuclides with mass number over 150. The data have been collated and evaluated by an international working group (Decay Data Evaluation Project) led by the BNM-LNHB. The evaluators have agreed on the methodologies to be used and the CD-ROM included with this monograph contains the evaluators' comments for each radionuclide in addition to the data tables included in the monograph.

The work involved in evaluating nuclear data is on-going and the recommended values are updated on the LNHB website at http://www.nucleide.org/DDEP_WG/DDEPdata.htm. The publication of further volumes of Monographie 5 is envisaged as and when necessary to add new radionuclide data or re-evaluations in a more permanent format that can be referenced easily.

Although other data sets may still be used when evaluating radionuclide activity, use of this common, recommended data set should help to reduce the uncertainties in activity evaluations and lead to more coherent results for comparisons.

G. Moscati
President of the CCRI

A.J. Wallard
Director of the BIPM

Note: Following Resolution 10 of the 22nd CGPM in 2003, a decimal point has been used as the decimal marker in the English text but in the data tables, which were edited in French, a decimal comma has been used. There should be no ambiguity in use.

Monographie BIPM-5 - Table of Radionuclides, Vol. 2 (A = 151 to 242)

Marie-Martine Bé, Vanessa Chisté, Christophe Dulieu, Laboratoire National Henri Becquerel (LNHB), France;
Edgardo Browne, Lawrence Berkeley National Laboratory (LBNL), USA;
Valery Chechev, Nikolay Kuzmenko, Khlopin Radium Institute (KRI), Russia;
Richard Helmer, Idaho National Engineering and Environmental Laboratory (INEEL), USA;
Alan Nichols, International Atomic Energy Agency (IAEA), Austria;
Eckart Schönfeld, Rainer Dersch, Physikalisch-Technische Bundesanstalt (PTB), Germany.

"TABLE DE RADIONUCLÉIDES"

Sommaire - Ce volume regroupe l'évaluation des radionucléides suivants :

^{7}Be, ^{11}C, ^{13}N, ^{15}O, ^{18}F, ^{24}Na, ^{32}P, ^{33}P, ^{44}Sc, ^{44}Ti, ^{46}Sc, ^{51}Cr, ^{54}Mn, ^{56}Mn, ^{57}Co, ^{57}Ni, ^{59}Fe, ^{64}Cu, ^{66}Ga, ^{67}Ga, ^{85}Kr, ^{85}Sr, ^{88}Y, ^{89}Sr, ^{93}Nb^{m}, ^{99}Mo, ^{99}Tc^{m}, ^{109}Cd, ^{110}Ag, ^{110}Ag^{m}, ^{123}I, ^{123}Te^{m}, ^{125}Sb, ^{129}I, ^{131}I, ^{131}Xe^{m}, ^{133}Ba, ^{140}Ba, ^{140}La, ^{152}Eu, ^{153}Gd, ^{153}Sm, ^{154}Eu, ^{155}Eu, ^{166}Ho, ^{166}Ho^{m}, ^{169}Yb, ^{170}Tm, ^{177}Lu, ^{186}Re, ^{198}Au, ^{201}Tl, ^{203}Hg, ^{204}Tl, ^{208}Tl, ^{212}Bi, ^{212}Pb, ^{212}Po, ^{216}Po, ^{220}Rn, ^{224}Ra, ^{226}Ra, ^{227}Th, ^{228}Th, ^{238}Pu, ^{240}Pu, ^{241}Am, ^{242}Pu.

Les valeurs recommandées et les incertitudes associées comprennent : la période radioactive, les modes de décroissance, les émissions α, β, γ, X et électroniques ainsi que les caractéristiques des transitions correspondantes.

"TABLE OF RADIONUCLIDES"

Summary - This volume includes the evaluation of the following radionuclides :

^{7}Be, ^{11}C, ^{13}N, ^{15}O, ^{18}F, ^{24}Na, ^{32}P, ^{33}P, ^{44}Sc, ^{44}Ti, ^{46}Sc, ^{51}Cr, ^{54}Mn, ^{56}Mn, ^{57}Co, ^{57}Ni, ^{59}Fe, ^{64}Cu, ^{66}Ga, ^{67}Ga, ^{85}Kr, ^{85}Sr, ^{88}Y, ^{89}Sr, ^{93}Nb^{m}, ^{99}Mo, ^{99}Tc^{m}, ^{109}Cd, ^{110}Ag, ^{110}Ag^{m}, ^{123}I, ^{123}Te^{m}, ^{125}Sb, ^{129}I, ^{131}I, ^{131}Xe^{m}, ^{133}Ba, ^{140}Ba, ^{140}La, ^{152}Eu, ^{153}Gd, ^{153}Sm, ^{154}Eu, ^{155}Eu, ^{166}Ho, ^{166}Ho^{m}, ^{169}Yb, ^{170}Tm, ^{177}Lu, ^{186}Re, ^{198}Au, ^{201}Tl, ^{203}Hg, ^{204}Tl, ^{208}Tl, ^{212}Bi, ^{212}Pb, ^{212}Po, ^{216}Po, ^{220}Rn, ^{224}Ra, ^{226}Ra, ^{227}Th, ^{228}Th, ^{238}Pu, ^{240}Pu, ^{241}Am, ^{242}Pu.

Primary recommended data comprise half-lives, decay modes, X-rays, gamma-rays, electron emissions, alpha- and beta-particle transitions and emissions, and their uncertainties.

"TABELLE DER RADIONUKLIDE"

Zusammenfassung

^{7}Be, ^{11}C, ^{13}N, ^{15}O, ^{18}F, ^{24}Na, ^{32}P, ^{33}P, ^{44}Sc, ^{44}Ti, ^{46}Sc, ^{51}Cr, ^{54}Mn, ^{56}Mn, ^{57}Co, ^{57}Ni, ^{59}Fe, ^{64}Cu, ^{66}Ga, ^{67}Ga, ^{85}Kr, ^{85}Sr, ^{88}Y, ^{89}Sr, ^{93}Nb^{m}, ^{99}Mo, ^{99}Tc^{m}, ^{109}Cd, ^{110}Ag, ^{110}Ag^{m}, ^{123}I, ^{123}Te^{m}, ^{125}Sb, ^{129}I, ^{131}I, ^{131}Xe^{m}, ^{133}Ba, ^{140}Ba, ^{140}La, ^{152}Eu, ^{153}Gd, ^{153}Sm, ^{154}Eu, ^{155}Eu, ^{166}Ho, ^{166}Ho^{m}, ^{169}Yb, ^{170}Tm, ^{177}Lu, ^{186}Re, ^{198}Au, ^{201}Tl, ^{203}Hg, ^{204}Tl, ^{208}Tl, ^{212}Bi, ^{212}Pb, ^{212}Po, ^{216}Po, ^{220}Rn, ^{224}Ra, ^{226}Ra, ^{227}Th, ^{228}Th, ^{238}Pu, ^{240}Pu, ^{241}Am, ^{242}Pu.

In diesem Bericht sind evaluierte Werte der Halbwertszeiten, Übergangs-wahrscheinlichkeiten und Übergangsenergien von α, β^{-}-, β^{+}-, EC- und Gammaübergängen, Konversionskoeffizienten von Gammaübergängen, Emissions-wahrscheinlichkeiten von Röntgen- und Gammaquanten, Auger- und Konversions-elektronen.

“TABLA DE RADIONUCLEIDOS”

Prólogo – Este volúmen agrupa la evaluación de los radionucleidos siguientes :

^{7}Be, ^{11}C, ^{13}N, ^{15}O, ^{18}F, ^{24}Na, ^{32}P, ^{33}P, ^{44}Sc, ^{44}Ti, ^{46}Sc, ^{51}Cr, ^{54}Mn, ^{56}Mn, ^{57}Co, ^{57}Ni, ^{59}Fe, ^{64}Cu, ^{66}Ga, ^{67}Ga, ^{85}Kr, ^{85}Sr, ^{88}Y, ^{89}Sr, ^{93}Nb^{m}, ^{99}Mo, ^{99}Tc^{m}, ^{109}Cd, ^{110}Ag, ^{110}Ag^{m}, ^{123}I, ^{123}Te^{m}, ^{125}Sb, ^{129}I, ^{131}I, ^{131}Xe^{m}, ^{133}Ba, ^{140}Ba, ^{140}La, ^{152}Eu, ^{153}Gd, ^{153}Sm, ^{154}Eu, ^{155}Eu, ^{166}Ho, ^{166}Ho^{m}, ^{169}Yb, ^{170}Tm, ^{177}Lu, ^{186}Re, ^{198}Au, ^{201}Tl, ^{203}Hg, ^{204}Tl, ^{208}Tl, ^{212}Bi, ^{212}Pb, ^{212}Po, ^{216}Po, ^{220}Rn, ^{224}Ra, ^{226}Ra, ^{227}Th, ^{228}Th, ^{238}Pu, ^{240}Pu, ^{241}Am, ^{242}Pu.

Los valores recomendados y las incertidumbres asociadas comprenden : el período radioactivo, los modos de desintegración, las emisiones α, β, γ, X y electrónicas incluyendo las características de las transiciones correspondientes.

TABLE DE RADIONUCLÉIDES
TABLE OF RADIONUCLIDES
TABELLE DER RADIONUKLIDE
ТАБЛИЦА РАДИОНУКЛИДОВ
TABLA DE RADIONUCLEIDOS

Marie-Martine Bé, Vanessa Chisté, Christophe Dulieu, Laboratoire National Henri Becquerel (BNM-LNHB/CEA) ;
Edgardo Browne, Shiu-Chin Wu, Lawrence Berkeley National Laboratory (LBNL) ;
Valery Chechev, Nikolay Kuzmenko, Khlopin Radium Institute (KRI) ;
Richard Helmer, Idaho National Engineering and Environmental Laboratory (INEEL) ;
Alan L. Nichols, IAEA Nuclear Data Section ;
Eckart Schönfeld, Rainer Dersch, Physikalisch-Technische Bundesanstalt (PTB).

TABLE DE RADIONUCLÉIDES

INTRODUCTION

Le Laboratoire National Henri Becquerel (LNHB) a commencé l'étude des données nucléaires et atomiques qui caractérisent la décroissance des radionucléides en 1974. Ces évaluations ont fait l'objet de la publication des quatre volumes de la Table de Radionucléides [87Ta, 99Be]. Ce nouveau volume s'inscrit dans la continuation du travail précédent.

D'autre part, pour des raisons évidentes, telles la facilité de mise à jour des données ou la commodité de consultation pour les utilisateurs, le LNHB a créé une base de données informatisée. Le logiciel NUCLEIDE est la forme informatisée de cette table, il permet un accès aisé aux différentes informations à l'aide de menus déroulants atteints par un simple « clic » sur un « bouton ».

Le propos de la Table est d'étudier un nombre limité de radionucléides utiles dans le domaine de la métrologie ou dans des domaines variés d'applications (médecine nucléaire, environnement, cycle du combustible, etc.) et d'en présenter une étude complète.

Les données recommandées comprennent : la période radioactive, les modes de décroissance, les émissions α, β, γ, X et électroniques ainsi que les caractéristiques des transitions associées.

Dans le but de mettre à jour et d'ajouter de nouvelles évaluations plus rapidement le Laboratoire National Henri Becquerel (LNHB, France) et le Physikalisch - Technische Bundesanstalt (PTB, Allemagne) ont établi un accord de coopération. Ils ont ensuite été rejoints par Idaho National Engineering and Environmental Laboratory (INEEL, États-Unis), Lawrence Berkeley National Laboratory (LBNL, États-Unis) et Khlopin Radium Institute (KRI, Russie). Le premier travail de cette collaboration internationale a été d'établir une méthode et des règles communes d'évaluation. Les évaluations proposent des valeurs recommandées et leurs incertitudes. Ces valeurs ont été évaluées à partir des données expérimentales disponibles. A défaut, elles sont issues de calculs théoriques. Toutes les références utilisées pour l'évaluation d'un radionucléide sont listées à la fin de chaque chapitre.

VALEURS RECOMMANDÉES ET INCERTITUDES

Les principales étapes pour l'évaluation des données et leurs incertitudes sont :
- une analyse critique de toutes les publications disponibles afin de retenir ou non une valeur et son incertitude, ramenée à l'incertitude-type composée ;
- la détermination d'une valeur recommandée qui est, selon les cas, une moyenne simple ou pondérée des valeurs issues des publications, ceci est décidé après examen du chi carré réduit. Dans le cas d'une moyenne pondérée, le poids relatif de chaque valeur est limité à 50 %. L'incertitude, notée *uc*, est la plus grande des valeurs des incertitudes interne ou externe ; dans le cas de valeurs incompatibles elle peut être étendue pour recouvrir la valeur la plus précise.

Pour certaines applications il est nécessaire de définir une incertitude élargie, notée *U*, telle que :
$U(y) = k \, . \, uc(y)$ où k est le facteur d'élargissement.
La valeur de k retenue pour cette publication est : $k = 1$.

Les valeurs d'incertitude indiquées portent sur les derniers chiffres significatifs, ainsi :
9,230 (11) signifie $9{,}230 \pm 0{,}011$ et
9,2 (11) $9{,}2 \pm 1{,}1$

Si une valeur est donnée sans incertitude, cela signifie qu'elle est considérée comme douteuse. Elle est indiquée à titre indicatif et souvent a été estimée en fonction du schéma de désintégration comme étant « de l'ordre de ».

Des précisions concernant les techniques d'évaluation peuvent être obtenues dans les références [85Zi], [96He], [99In] (voir rubrique Références) ou directement auprès des auteurs.

La description physique des données évaluées est disponible dans la référence [99In].

NUMÉROTAGE

Les niveaux d'un noyau sont numérotés, arbitrairement, de 0 pour le niveau fondamental à *n* pour le énième niveau excité. Les diverses transitions sont ainsi repérées par leur niveau de départ et leur niveau d'arrivée.
Dans le cas de transition de faible probabilité qu'il n'est pas possible de situer sur le schéma de désintégration, les niveaux de départ et d'arrivée sont notés (-1, *n*).
Dans le cas de l'émission gamma de 511 keV qui suit une désintégration bêta plus, la notation adoptée est : (-1, -1).

UNITÉS

Les valeurs recommandées sont exprimées :
- pour les périodes

	Symbole
. en secondes pour $T_{1/2}$ <= 60 secondes	s
. en minutes pour $T_{1/2}$ > 60 secondes	min
. en heures pour $T_{1/2}$ > 60 minutes	h
. en jours pour $T_{1/2}$ > 24 heures	d
. en années pour $T_{1/2}$ > 365 jours	a

1 année = 365,242 198 jours = 31 556 926 secondes ;

- pour les probabilités de transition et nombre de particules émises, les valeurs sont données pour 100 désintégrations ;

- les énergies sont exprimées en keV.

AVERTISSEMENT

Ce document a été imprimé en 2004, pour toutes les nouvelles évaluations et mises à jour ultérieures le lecteur se référera aux documents accessibles sur :
http://www.nucleide.org/NucData.htm

TABLE OF RADIONUCLIDES

INTRODUCTION

The evaluation of decay data for the "Table de Radionucléides" by BNM – LNHB/CEA began in 1974, continued to 1987 and four volumes were published [87Ta] and then, in 1999, the fifth volume was published containing the revised evaluations for 30 selected radionuclides [99Be].
Moreover, LNHB developed a software (NUCLEIDE) with the objectives of making it easier to update and add data and, obviously, to offer easy access to the nuclear and atomic decay data to the user by "click on the button" facilities.
The aim of this Table is to provide recommended data for nuclides of special interest for metrology or practical applications like nuclear medicine, monitoring and reactor shielding, etc.
Primary recommended data comprise half-lives, decay modes, X-rays, gamma-rays, electron emissions, alpha- and beta-particle transitions and emissions, and their uncertainties. All the references used for the evaluations are given.
In order to update the data of the nuclides already present and to add new evaluations, the Laboratoire National Henri Becquerel (LNHB, France) and the Physikalisch-Technische Bundesanstalt (PTB, Germany) established a cooperative agreement ; they were then joined by the Idaho National Engineering and Environmental Laboratory (INEEL, USA), the Lawrence Berkeley National Laboratory (LBNL, USA) and the Khlopin Radium Institute (KRI, Russia). This international collaboration is based on an informal agreement, the initial work of this group was to discuss and to agree on a methodology to be used in these evaluations. The data and associated uncertainties were evaluated from all available experiments and taking into account theoretical considerations.

RECOMMENDED VALUES AND UNCERTAINTIES

The main steps for the evaluation of the data and their uncertainties are :
- a critical analysis of all available original publications in order to accept or not each value and its uncertainty reduced to the combined standard uncertainty ;
- the determination of the best value which is either the weighted or the unweighted average of the retained values, this is decided after examination of the reduced χ^2 value. With a weighted average, each weight is limited to 50 %. The uncertainty, designated *uc*, is the greatest of the internal or external uncertainty values. For a discrepant set of data, it may be expanded to cover the most precise input value.

For some applications it may be necessary to define an expanded uncertainty, designated *U*, as :
$U(y) = k.uc(y)$ where k is the coverage factor.
For this publication the expanded uncertainty is computed with $k = 1$.

The value of the uncertainty, in parentheses, referred to the corresponding last digits, i.e. :
9.230 (11) means 9.230 ± 0.011 and
9.2 (11) 9.2 ± 1.1

If a value is given without an uncertainty, this means that this value is considered as questionable. It is provided for information and was often estimated from the decay scheme as to be "in the order of".

Information about evaluation procedures can be obtained from references [85Zi, 96He, 99In] or directly from the authors.
Information about meaning of physical data can be obtained from reference [99In].

NUMBERING

The nuclear levels are arbitrarily numbered from 0 for the ground state level to *n* for the *n*th excited level. All the transitions are designated by their initial and final level.
For transitions with weak probabilities which are not shown by an arrow in the decay scheme, the initial and final levels are noted (-1, *n*).
For the 511 keV gamma emission which follows the beta plus disintegration, the adopted numbering is (-1, -1).

UNITS

The recommended values are expressed :
- for half-lives :

	Symbol
. in seconds for $T_{1/2}$ <= 60 seconds	s
. in minutes for $T_{1/2}$ > 60 seconds	min
. in hours for $T_{1/2}$ > 60 minutes	h
. in days for $T_{1/2}$ > 24 hours	d
. in years for $T_{1/2}$ > 365 days	a

1 year = 365.242 198 days = 31 556 926 seconds

- for transition probabilities and number of emitted particles, the values are given for 100 disintegrations ;

- for energies the values are expressed in keV.

CAUTION

This report was printed in 2004, new evaluations and updated issues will be available on :
http://www.nucleide.org/NucData.htm

TABELLE DER RADIONUKLIDE

EINLEITUNG

Die Evaluation der Zerfallsdaten für die Table de Radionucléides durch das BNM-LNHB/CEA begann im Jahre 1974, diese Arbeit wurde bis 1987 fortgesetzt, und es wurden vier Bände veröffentlicht [87Ta, 99Be]. Dieser neue Bericht kommt hinzu dem vorhergehend Arbeit.
Übrigens wurde ein Computerform der Table de Radionucléides im LNHB entwickelt. Diese Software erleichtert die Aktualisierung und die Einbeziehung weiterer Daten und ermöglicht den Zugang zu den Kern- und Atomdaten für den Anwender auf „Tastendruck".
Der Zweck dieser Tabelle ist es, empfohlene Daten einer begrenzten Anzahl von Radionukliden für metrologische und praktische Anwendungen wie etwa in der Nuklearmedizin, der Umgebungsüberwachung, der Reaktorabschirmung usw. zur Verfügung zu stellen.
Die Datenbank umfaßt empfohlene Daten und ihre Unsicherheiten, die aus den verfügbaren Daten oder theoretischen Berechnungen gewonnen worden sind. Alle für die Evaluation benutzten Referenzen werden angegeben.
Um die schon vorliegenden Daten zu aktualisieren und neue Evaluationen schneller einbeziehen zu können, vereinbarten das Laboratoire National Henri Becquerel (LNHB, Frankreich) und die Physikalisch-Technische Bundesanstalt (PTB, Deutschland) einen Vertrag zur Zusammenarbeit. Es schlossen sich das Idaho National Engineering and Environmental Laboratory (INEEL, USA), das Lawrence Berkeley National Laboratory (LBNL, USA) und das Khlopin Radium Institut (KRI, Rußland) an. Eine der ersten Arbeiten dieser Gruppe war es, die in diesen Evaluationen benutzte Methodologie zu diskutieren und festzulegen.

EMPFOHLENE WERTE UND UNSICHERHEITEN

Die Hauptschritte für die Evaluation der Daten und Unsicherheiten sind:
- Eine kritische Analyse aller verfügbaren Veröffentlichungen, um einen Wert und seine Unsicherheit - auf die kombinierte Standardunsicherheit zurückgeführt - zu berücksichtigen.
- Die Bestimmung eines empfohlenen Wertes, der entweder das gewichtete oder das ungewichtete Mittel der veröffentlichten Werte ist. Die Entscheidung wird nach der Prüfung des reduzierten Chi-Quadrat-Werts getroffen. Im Falle des gewichteten Mittels wird ein Gewicht, das größer ist als 50 %, auf 50 % reduziert. Die Unsicherheit, als *uc* bezeichnet, ist der größere Wert der inneren oder äußeren Unsicherheit. Für einen diskrepanten Datensatz ist sie so zu vergrößern, daß der genaueste Einzelwert in der Unsicherheit mit eingeschlossen ist.

Für einige Anwendungen ist es notwendig, eine vergrößerte Unsicherheit, als *U* bezeichnet, wie folgt zu definieren:
$U(y) = k \, . \, uc(y)$ wo k der Erweiterungsfaktor ist.
Für die vorliegende Veröffentlichung ist die erweitere Unsicherheit mit $k = 1$ berechnet.
Die Werte der Unsicherheit beziehen sich auf die letzten Stellen, d. h.:
9,230(11) bedeutet $9{,}230 \pm 0{,}011$ und
9,2(11) bedeutet $9{,}2 \pm 1{,}1$

Wenn ein Wert ohne Unsicherheit angegeben ist, bedeutet das, daß dieser Wert als fragwürdig zu betrachten ist. Er wird zur Information mitgeteilt und ist oft abgeschätzt aus dem Zerfallsschema im Sinne „in der Größenordnung von".

Informationen über die Evaluationsprozedur können aus den Referenzen [85Zi, 96He, 99In] oder direkt von den Autoren bezogen werden.

NUMERIERUNG

Die Kernniveaus werden willkürlich numeriert von 0 für den Grundzustand bis zu *n* für das *n*-te angeregte Niveau. Alle Übergänge werden durch ihr Ausgangs- und Endniveau gekennzeichnet. Für Übergänge mit geringen Wahrscheinlichkeiten, die nicht durch einen Pfeil im Zerfallsschema gezeigt sind, werden das Ausgangs- und Endniveau notiert. (-1, *n*)

Für die 511 keV-Gamma-Emission, die dem Beta Plus-Zerfall folgt, ist die angenommene Numerierung (-1, -1).

EINHEITEN

Die empfohlenen Werte sind ausgedrückt:
- für Halbwertszeiten:

	Symbol
. in Sekunden für $T_{1/2} \leq 60$ Sekunden	s
. in Minuten für $T_{1/2} > 60$ Sekunden	min
. in Stunden für $T_{1/2} > 60$ Minuten	h
. in Tagen für $T_{1/2} > 24$ Stunden	d
. in Jahren für $T_{1/2} > 365$ Tage	a

1 a = 365,242 198 d = 31 556 926 s

- für Übergangswahrscheinlichkeiten und die Anzahl der emittierten Teilchen werden Werte angegeben, die sich auf 100 Zerfälle beziehen.

- die Werte der Energien sind in keV ausgedrückt.

HINWEIS

Dieses Dokument wurde im Jahre 2004 erstellt. Alle späteren Fassungen oder neueren Evaluationen können vom Leser unter
http://www.nucleide.org/NucData.htm
abgerufen werden.

ТАБЛИЦА РАДИОНУКЛИДОВ

ВВЕДЕНИЕ

Оценка данных распада для Table de Radionucléides, BNM – LNHB/CEA была начата в 1974 г. и продолжалась до 1987 г. К тому времени были опубликованы четыре тома [87Ta] и затем, в 1999 г., был опубликован пятый том, содержащий ревизованные оценки для 30 выбранных радионуклидов [99Be]. Новое издание находится в русле предыдущей работы.
В дополнение в LNHB была развита компьютерная форма Table de Radionucléides (программа NUCLEIDE) с тем, чтобы обеспечить более простое обновление и дополнение данных и, очевидно, также с целью предложить пользователю более легкий доступ к ядерным и атомным данным распада путем "нажатия кнопки".
Цель настоящего издания - дать рекомендованные данные для нуклидов, представляющих специфический интерес для метрологии или практических приложений, таких как ядерная медицина, мониторинг, реакторная защита и др.
Первичные рекомендованные данные включают периоды полураспада, виды распада, характеристики X- и гамма-излучений, электронных излучений, альфа- и бета-переходов и излучений и погрешности величин этих характеристик. В книге дан полный список литературы, использованной для оценок.
Для того чтобы обновить данные по нуклидам, уже имеющимся в Table de Radionucléides, и добавить новые оценки, Национальная лаборатория им. Анри Беккереля (LNHB, Франция) и Физико-Технический Институт (PTB, Германия) заключили кооперативное соглашение. К ним затем присоединились Национальная лаборатория прикладных и экологических исследований Айдахо (INEEL, США), Лоуренсовская Национальная Лаборатория Беркли (LBNL, США) и Радиевый институт им. В.Г. Хлопина (KRI, Россия). Это международное сотрудничество основано на неформальном соглашении. Первоначальная работа состояла в обсуждении и принятии согласованной методологии, которая должна быть использована в этих оценках. Данные и связанные с ними погрешности были оценены с использованием всех имеющихся в распоряжении результатов экспериментов и с учетом теоретических рассмотрений.

РЕКОМЕНДОВАННЫЕ ЗНАЧЕНИЯ И ПОГРЕШНОСТИ

Основные шаги для оценки данных и их погрешностей следующие:

- критический анализ всех имеющихся оригинальных публикаций, чтобы принять или отвергнуть данное значение и его погрешность, приведенную к комбинированному стандартному отклонению;

- определение лучшего значения, которое является взвешенным или невзвешенным средним сохраненных величин; выбор взвешенного или невзвешенного среднего определяется анализом величины χ^2. В случае среднего взвешенного вес каждого оригинального результата ограничивается 50 %. В качестве итоговой погрешности (*uc*) принимается большая из двух погрешностей среднего взвешенного: внутренней и внешней. Для расходящегося набора данных она может быть расширена, чтобы перекрыть самое точное входное значение.

Для некоторых применений может оказаться необходимым расширенная погрешность (U), выраженная как: $U(y)=k.uc(y)$, где k - коэффициент перекрытия. Для этой публикации принято $k=1$.
Значение погрешности, в скобках, приводится в единицах последней значащей цифры, т.е.:

9,230(11) означает 9,230 ± 0,011 и
9,2(11) 9,2 ± 1,1

Если значение величины дается без погрешности, она считается сомнительной и приводится для информации. Такие величины часто оценивались из схемы распада под рубрикой "порядка".

Информацию о процедурах оценки можно получить из публикаций [85Zi, 96He, 99In] или непосредственно от авторов.
Информация о смысле физических величин может быть получена из [99In].

НУМЕРАЦИЯ

Ядерные уровни произвольно пронумерованы от 0 для основного состояния до *n* для *n*-ого возбужденного уровня. Все переходы обозначаются по их начальному и конечному уровням.
Для слабых переходов, не показанных стрелкой в схеме распада, начальный и конечный уровни обозначаются как (-1, *n*).
Для гамма-излучения с энергией 511 кэВ, которое следует за бета-плюс распадом, принято обозначение (-1, -1).

ЕДИНИЦЫ

Рекомендованные значения выражены:

- для периодов полураспада:
  - в секундах для $T_{1/2} \leq 60$ секунд s
  - в минутах для $T_{1/2} > 60$ секунд min
  - в часах для $T_{1/2} > 60$ минут h
  - в сутках для $T_{1/2} > 24$ часов d
  - в годах для $T_{1/2} > 365$ суток a

1 год = 365,242 198 суток = 31 556 926 секунд

- для вероятностей переходов и числа испускаемых частиц значения даны на 100 распадов;

- для энергий значения выражены в килоэлектронвольтах (keV).

ПРИМЕЧАНИЕ

Этот отчет подготовлен в 2004 г. Новые оценки и обновленные результаты можно найти на сайте:
http://www.nucleide.org/NucData.htm

TABLA DE RADIONUCLEIDOS

INTRODUCCION

El Laboratoire National Henri Becquerel (LNHB) comenzó el estudio de datos nucleares y atómicos que caracterizan la desintegración de radionucleidos en 1974. Esas evaluaciones han permitido la publicación de cuatro volúmenes de la Tabla de radionucleidos [^{87}Ta,^{99}Be]. Este nuevo volúmen es el siguiente en la continuación del estudio precedente.

Con la idea de facilitar, la corrección de nuevos datos y la comodidad de consulta para los utilisadores, el LNHB a creado una base de datos en computadora. El programa NUCLEIDE es el contenido de la Tabla en computadora, que permite el fácil acceso a diferentes informaciones, con la ayuda de menues en cascada accesibles con un simple « clic » sobre una « tecla ».

El objetivo de la Tabla es estudiar un número limitado de radionucleidos útiles en el campo de la metrología u otros campos de aplicación (medicina nuclear, medio ambiente, ciclo del combustible, etc.) y presentar un estudio completo.

Los datos recomendados comprenden : el período radioactivo, los modos de desintegración, las emisiones α, β, γ, X y electrónicas con las características de transiciones asociadas.

Con el propósito de actualizar y agregar nuevas evaluaciones rapidamente el *Laboratoire National Henri Becquerel* (LNHB, Francia) y el *Physikalisch-Technische Bundesanstalt* (PTB , Alemania) establecieron un acuerdo de colaboración. Luego se unieron a este acuerdo el *Idaho National Engineering and Environmental Laboratory* (INEEL, USA), *Lawrence Berkeley National Laboratory* LBNL, USA) y *Khlopin Radium Institute* (KRI, Rusia). El primer trabajo de esta colaboración internacional ha sido de establecer un méthodo y reglas comunes de evaluación. Las evaluaciones proponen valores recomendados e incertidumbres asociadas. Esos valores han sido evaluados a partir de datos experimentales disponibles. En ausencia de éstos últimos, esos valores han sido obtenidos por cálculos teóricos. Todas las referencias utilizadas para la evaluación de un radionucleido son listadas al final de cada capítulo.

VALORES RECOMENDADOS E INCERTIDUMBRES

Las principales etapas para evaluar datos con sus incertidumbres son :

- Un análisis crítico de todas las publicaciones disponibles con el fin de obtenir o no un valor con su incertidumbre, considerada como incertidumbre tipo compuesta.
- La determinación de un valor recomendado que es, según el caso, una media simple o ponderada de valores obtenidos de publicaciones, ésto es decidido luego de examinar el chi al cuadrado reducido. En el caso de una media ponderada, el peso relativo de cada valor es limitado a 50 %. La incertidumbre, llamada *uc*, es el mayor de los valores de incertidumbres interna o externa ; en el caso de valores incompatibles, este valor puede ser extendido con el fin de recubrir el valor más preciso.

Par ciertas aplicaciones, es necesario definir una incertidumbre extendida, llamada *U*, la cual es :
$U(y) = k \, . \, uc(y)$ donde k es el factor de extensión.
El valor de k retenido en esta publicación es : $k = 1$.

Los valores de incertidumbres indicados entre paréntesis corresponden a las últimas cifras significativas,
por ejemplo :

9,230 (11)	significa	9,230 ± 0,011 y
9,2 (11)	significa	9,2 ± 1,1

Si un valor es dado sin incertidumbre, significa que ésta es considerada dudosa (es indicada aproximativamente y ha sido estimada a partir del esquema de desintegración).

NUMERACION

Los niveles de un núcleo son numerados de manera arbitraria, de 0 para el nivel fundamental, a *n* para el enésimo nivel excitado. Las diversas transiciones son así señaladas desde el nivel de partida al nivel de llegada.
En el caso de una transición de probabilidad pequeña que es imposible de indicar en el esquema de desintegración, los niveles de partida y de llegada son notificados : (-1, *n*).
En el caso de una emisión γ de 511 keV que sigue a una desintegración β^+, la notación adoptada es : (-1, -1).

UNIDADES

Los valores recomendados son expresados :
- para los períodos :

	Símbolo
. en segundos para $T_{1/2} \leq 60$ segundos	s
. en minutos para $T_{1/2} > 60$ segundos	min
. en horas para $T_{1/2} > 60$ minutos	h
. en días para $T_{1/2} > 24$ horas	d
. en años para $T_{1/2} > 365$ días	a

1 año = 365,242 198 días = 31 556 926 segundos ;

- para las probabilidades de transición y número de partículas emitidas, les valores son dados por 100 desintegraciones ;

- para las energías los valores son expresados en keV.

ADVERTENCIA

Este documento ha sido imprimido en 2004, para obtener todas las nuevas evaluaciones actualizadas ulteriormente, el lector deberá referirse a los documentos disponibles en :
http://www.nucleide.org/NucData.htm

RÉFÉRENCES
REFERENCES
REFERENZEN
REFERENCIAS

[87Ta] Table de Radionucléides, F. Lagoutine, N. Coursol, J. Legrand. ISBN 2 7272 0078 1 (LMRI, 1982-1987).
[85Zi] W.L. Zijp, Netherland Energy Research Foundation, ECN, Petten, The Netherlands, Rep. ECN-179.
[96He] R.G. Helmer, Proceedings of the Int. Symp. "Advances in alpha-, beta- and gamma-ray Spectrometry", St. Petersburg, September 1996, p. 71.
[96Be] M.-M. Bé, B. Duchemin and J. Lamé. Nucl. Instrum. Methods A369 (1996) 523 and Bulletin du Bureau National de Métrologie 110 (1998).
[99In] Table de Radionucléides. Introduction, nouvelle version. Introduction, revised version. Einleitung, überarbeitete Fassung. ISBN 2 7272 0201 6, BNM-CEA/LNHB BP 52, 91191 Gif-sur-Yvette Cedex, France.
[99Be] M.-M. Bé, E. Browne, V. Chechev, R.G. Helmer, E. Schönfeld. Table de Radionucléides, ISBN 2 7272 0200 8 and ISBN 2 7272 0211 3 (LHNB, 1988-1999).

AUTEURS POUR CORRESPONDANCE
AUTHOR'S MAIL ADDRESSES
ADRESSEN DER AUTOREN
AUTORES PARA CORRESPONDENCIA

Toutes demandes de renseignements concernant les données recommandées et la façon dont elles ont été établies doivent être adressées directement aux auteurs des évaluations.

Information on the data and the evaluation procedures is available from the authors listed below.

Informationen über die Daten und Evaluationsprozeduren können bei den im folgenden zusammengestellten Autoren angefordert werden.

Todos los pedidos de información relativos a datos recomendados y la manera de establecerlos deben dirigirse directamente a los autores de las evaluaciones.

Dr. Marie-Martine Bé
CEA/LNHB
91191 Gif-sur-Yvette, CEDEX, France
Tel : 33-1-69-08-46-41
Fax : 33-1-69-08-26-19
E-mail : mmbe@cea.fr

Dr. Edgardo Browne
Lawrence Berkeley National Laboratory
MS 50A-1148, Berkeley, California 94720, USA
Tel : (510) 486-7647
Fax : (510) 486-5757
E-mail : ebrowne@lbl.gov

Dr. Valery P. Chechev
V.G. Khlopin Radium Institute
28, 2nd Murinsky Ave., 194021 St. Petersburg, Russia
Tel : 007 (812) 2473706
Fax : 007 (812) 2478095
E-mail : chechev@atom.nw.ru

Dr. Vanessa Chisté
CEA/LNHB
91191 Gif-sur-Yvette, CEDEX, France
Tel : 33-1-69-08-63-07
Fax : 33-1-69-08-26-19
E-mail : vanessa.chiste@cea.fr

Dr. Rainer Dersch
Physikalisch-Technische Bundesanstalt
Bundesallee 100, 38116 Braunschweig, Germany
Fax : 49-0531-592-6015
E-mail : rainer.dersch@ptb.de

Dr. Richard G. Helmer
Idaho National Engineering and Environmental Laboratory
P.O. Box 1625 MS 2114, Idaho Falls, Idaho 83415, USA
Tel : (208) 526-4157
Fax : (208) 526-9267
E-mail : HelmerR@pcif.net

Dr. Filip Kondev
Nuclear Applications and Nuclear Data Program, Technology Development Division
Argonne National Laboratory
9700 South Cass Ave. Argonne, ILL 60439, USA
Tel : 1-(630) 252-4484
Fax : 1-(630) 252-5287
E-mail : kondev@anl.gov

Dr. T. Desmond MacMahon
NPL, Centre for Ionising Radiation Metrology
Teddington,
Middlesex, TW11 0LW, United Kingdom
Te 44 20 8943 8573
Fax : 44 20 8943 6161
E-mail : desmond.macmahon@npl.co.uk

Dr. Alan L. Nichols
IAEA Nuclear Data Section
Wagramerstrasse 5, A-1400 Vienna
Tel : 43 1 260021709
Fax : 43 1 26007
E-mail : a.nichols@iaea.org

Dr. Eckart Schönfeld
Physikalisch-Technische Bundesanstalt
Bundesallee 100, 38116 Braunschweig, Germany
Tel : 49-0531-592-6110
Fax : 49-0531-592-6015

Dr. Vito Vanin
Dr. Rui M. Castro
Instituto de Fisica University of Sao Paulo
Caixa Postal 66318
05315-970 Sao Paulo, SP , Brazil
Tel : 55-11-3091-6853
Fax : 55-11-3091-6832
E-mail : Vanin@if.usp

Dr. Shiu-Chin Wu
Physics Department
Tsing Hua University
Taiwan
E-mail : scwu@phys.nthu.edu.tw

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$^{152}_{63}\mathrm{Eu}_{89}$

1 Decay Scheme

Eu-152 disintegrates 72.1% by electron-capture and about 0.027% by emission of positrons to Sm-152 and by beta minus emission (27.9%) to Gd-152.
L'europium 152 se désintègre par capture électronique (72,1%) et par émission de positron (environ 0,027%) vers le samarium 152 et par émission bêta moins (27,9%) vers le gadolinium 152.

2 Nuclear Data

$T_{1/2}(^{152}\mathrm{Eu})$	:	13,522	(16)	a
$Q^-(^{152}\mathrm{Eu})$	:	1818,8	(11)	keV
$Q^+(^{152}\mathrm{Eu})$	:	1874,3	(7)	keV

2.1 Electron Capture Transitions

	Energy keV	Probability × 100	Nature	lg ft	P_K	P_L	P_M
$\epsilon_{0,19}$	105,2 (7)	0,068 (5)	1st Forbidden	10,3	0,6586 (33)	0,2591 (24)	0,0657 (12)
$\epsilon_{0,18}$	117,1 (7)	0,041 (3)	1st Forbidden	10,7	0,6903 (28)	0,2358 (20)	0,0591 (11)
$\epsilon_{0,17}$	144,1 (7)	0,0422 (12)	(Allowed)	10,9	0,7339 (23)	0,2036 (16)	0,0499 (9)
$\epsilon_{0,16}$	224,4 (7)	0,889 (14)	Allowed	10,1	0,7859 (19)	0,1651 (13)	0,0392 (7)
$\epsilon_{0,15}$	261,4 (7)	0,0208 (14)		11,9	0,7966 (18)	0,1571 (13)	0,0370 (7)
$\epsilon_{0,14}$	294,9 (7)	2,068 (12)	Allowed	10	0,8036 (17)	0,1519 (12)	0,0356 (7)
$\epsilon_{0,13}$	344,5 (7)	24,72 (11)	Allowed	9,1	0,8109 (17)	0,1465 (12)	0,0341 (7)
$\epsilon_{0,12}$	502,6 (7)	0,869 (24)	1st Forbidden	10,9	0,8236 (16)	0,1370 (11)	0,0316 (6)
$\epsilon_{0,11}$	581,5 (7)	0,644 (10)	(1st Forbidden)	11,2	0,8271 (16)	0,1344 (11)	0,0309 (6)
$\epsilon_{0,10}$	640,4 (7)	17,16 (8)	1st Forbidden	9,8	0,8291 (16)	0,1329 (11)	0,0305 (6)
$\epsilon_{0,9}$	788,5 (7)	21,35 (11)	1st Forbidden	9,9	0,8327 (15)	0,1302 (11)	0,0297 (6)
$\epsilon_{0,8}$	833,2 (7)	0,086 (7)	Allowed	12,4	0,8335 (15)	0,1296 (11)	0,0296 (6)
$\epsilon_{0,7}$	851,3 (7)	0,238 (5)	1st Forbidden	11,9	0,8338 (15)	0,1294 (11)	0,0295 (6)
$\epsilon_{0,5}$	1063,9 (7)	1,28 (3)	1st Forbidden	11,4	0,8366 (15)	0,1273 (11)	0,0290 (6)
$\epsilon_{0,2}$	1507,8 (7)	0,77 (5)	1st Forbidden	12	0,8398 (15)	0,1249 (11)	0,0283 (5)
$\epsilon_{0,1}$	1752,5 (7)	1,7 (10)	1st Forbidden	11,8	0,8408 (15)	0,1241 (10)	0,0281 (5)

USP, LBNL /V.R. Vanin,
R.M. de Castro, E. Browne

2.2 β^+ Transitions

	Energy keV	Probability × 100	Nature	lg ft
$\beta^+_{0,2}$	485,8 (7)	0,0024 (2)	1st Forbidden	
$\beta^+_{0,1}$	730,5 (7)	0,025 (15)	1st Forbidden	

2.3 β^- Transitions

	Energy keV	Probability × 100	Nature	lg ft
$\beta^-_{0,15}$	126,4 (11)	0,0203 (11)	1st Forbidden	11,1
$\beta^-_{0,14}$	175,4 (11)	1,826 (21)	Allowed	9,6
$\beta^-_{0,13}$	213,5 (11)	0,101 (3)	1st Forbidden	11,1
$\beta^-_{0,12}$	268,6 (11)	0,0536 (18)	1st Forbidden	11,7
$\beta^-_{0,11}$	384,8 (11)	2,44 (3)	1st Forbidden	10,5
$\beta^-_{0,10}$	500,3 (11)	0,0267 (17)	1st Forbidden	12,9
$\beta^-_{0,9}$	504,1 (11)	0,0048 (7)	2nd Forbidden	13,6
$\beta^-_{0,8}$	536,5 (11)	0,037 (8)	1st Forbidden	12,8
$\beta^-_{0,7}$	695,6 (11)	13,80 (15)	Allowed	10,6
$\beta^-_{0,6}$	709,7 (11)	0,245 (8)	1st Forbidden	12,4
$\beta^-_{0,4}$	888,2 (11)	0,303 (7)	1st Forbidden	12,7
$\beta^-_{0,3}$	1063,4 (11)	0,904 (14)	1st Forbidden	12,5
$\beta^-_{0,1}$	1474,5 (11)	8,17 (11)	1st Forbidden	12,1

2.4 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L (10^{-3})	α_M (10^{-3})	α_T
$\gamma_{1,0}$(Sm)	121,7818 (3)	61,5 (10)	E2	0,676 (20)	378 (11)	87,5 (26)	1,165 (35)
$\gamma_{5,3}$(Sm)	125,69 (13)	0,038 (13)	(E2)	0,616 (18)	329 (10)	76,0 (23)	1,042 (31)
$\gamma_{10,9}$(Sm)	148,010 (17)	0,055 (8)	(M1+50%E2)	0,430 (13)	115,0 (34)	26,0 (8)	0,578 (17)
$\gamma_{7,4}$(Gd)	192,6 (4)	0,00714 (22)	(E1)	0,0426 (13)	6,09 (18)	1,32 (4)	0,0504 (15)
$\gamma_{14,12}$(Sm)	207,6 (3)	0,0062 (4)	(E1)	0,0327 (10)	4,55 (14)	0,975 (29)	0,0385 (12)
$\gamma_{14,11}$(Gd)	209,41 (13)	0,0058 (5)	(E1)	0,0342 (10)	4,86 (15)	1,050 (32)	0,0404 (12)
$\gamma_{7,5}$(Sm)	212,568 (15)	0,0229 (8)	E2	0,1244 (37)	36,4 (11)	8,25 (25)	0,171 (5)
$\gamma_{(-1,0)}$(Sm)	237,3 (1)	0,0026 (9)	(E1)	0,0231 (7)	3,18 (10)	0,681 (20)	0,0272 (8)
$\gamma_{19,13}$(Sm)	239,42 (17)	0,008 (3)	(E1)	0,0225 (7)	3,11 (9)	0,665 (20)	0,0265 (8)
$\gamma_{2,1}$(Sm)	244,6976 (8)	8,37 (5)	E2	0,0809 (24)	21,1 (6)	4,75 (14)	0,1080 (32)
$\gamma_{11,8}$(Sm)	251,633 (7)	0,0687 (15)	(E1)	0,0198 (6)	2,72 (8)	0,583 (17)	0,0233 (7)
$\gamma_{11,7}$(Sm)	269,86 (6)	0,006 (3)	(E2)	0,0602 (18)	14,60 (44)	3,27 (10)	0,0789 (24)
$\gamma_{2,1}$(Gd)	271,131 (8)	0,084 (3)	E2	0,0621 (19)	16,20 (49)	3,70 (11)	0,0831 (25)
$\gamma_{9,5}$(Sm)	275,449 (15)	0,0357 (19)	(M1)	0,0887 (27)	12,30 (37)	2,65 (8)	0,1044 (31)
$\gamma_{12,9}$(Sm)	285,98 (3)	0,0107 (7)	(E2)	0,0506 (15)	11,80 (35)	2,63 (8)	0,0657 (20)

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L (10^{-3})	α_M (10^{-3})	α_T
$\gamma_{13,10}$(Sm)	295,9390 (17)	0,449 (3)	E1	0,01310 (39)	1,78 (5)	0,381 (11)	0,01530 (46)
$\gamma_{4,2}$(Gd)	315,174 (17)	0,052 (2)	(E2)	0,0400 (12)	9,38 (28)	2,12 (6)	0,0521 (16)
$\gamma_{7,4}$(Sm)	316,2 (2)	0,0032 (10)	(E2)	0,0376 (11)	8,19 (25)	1,83 (5)	0,0481 (14)
$\gamma_{(-1,1)}$(Sm)	320,03 (15)	0,0017 (6)					
$\gamma_{11,6}$(Gd)	324,83 (3)	0,0785 (16)	M1+50%E2	0,0521 (16)	8,97 (27)	1,99 (6)	0,0636 (19)
$\gamma_{11,6}$(Sm)	329,425 (21)	0,131 (6)	(E1)	0,0100 (3)	1,360 (41)	0,290 (9)	0,01170 (35)
$\gamma_{12,8}$(Sm)	330,54 (10)	0,0061 (17)	(E1)	0,0099 (3)	1,34 (4)	0,288 (9)	0,01160 (35)
$\gamma_{4,2}$(Sm)	340,40 (14)	0,033 (3)	E2	0,0304 (9)	6,32 (19)	1,410 (42)	0,0385 (12)
$\gamma_{1,0}$(Gd)	344,2789 (12)	27,65 (13)	E2	0,0311 (9)	6,87 (21)	1,550 (46)	0,0399 (12)
$\gamma_{8,4}$(Gd)	351,66 (4)	0,0145 (24)	E2	0,0293 (9)	6,39 (19)	1,440 (43)	0,0375 (11)
$\gamma_{16,11}$(Sm)	357,26 (5)	0,0041 (5)	(E1)	0,00820 (25)	1,110 (33)	0,237 (7)	0,00960 (29)
$\gamma_{7,3}$(Gd)	367,7896 (20)	0,870 (5)	E1	0,00830 (25)	1,130 (34)	0,245 (7)	0,00970 (29)
$\gamma_{(-1,2)}$(Sm)	379,37 (6)	0,00083 (21)					
$\gamma_{18,12}$(Sm)	385,69 (20)	0,0052 (7)	(M1+50%E2)	0,0290 (9)	4,59 (14)	0,999 (30)	0,0348 (10)
$\gamma_{10,4}$(Gd)	387,90 (8)	0,00429 (45)	(M1+E2+E0)	0,38 (9)			0,45 (11)
$\gamma_{(-1,3)}$(Sm)	391,32 (14)	0,00125 (22)					
$\gamma_{(-1,4)}$(Sm)	406,74 (15)	0,00083 (21)					
$\gamma_{3,1}$(Gd)	411,1171 (12)	2,292 (11)	E2	0,0190 (6)	3,79 (11)	0,849 (25)	0,0239 (7)
$\gamma_{16,10}$(Sm)	416,049 (8)	0,1097 (17)	(E1)	0,00570 (17)	0,762 (23)	0,1630 (49)	0,0067 (2)
$\gamma_{10,5}$(Sm)	423,45 (4)	0,0033 (5)	(M1+50%E2)	0,0226 (7)	3,5 (1)	0,761 (23)	0,0271 (8)
$\gamma_{12,6}$(Gd)	440,86 (10)	0,0136 (11)	(E2)	0,01580 (47)	3,03 (9)	0,677 (20)	0,0197 (6)
$\gamma_{5,2}$(Sm)	443,966 (3)	0,325 (18)	(E2)	0,01450 (44)	2,63 (8)	0,579 (17)	0,0178 (5)
$\gamma_{13,9}$(Sm)	443,966 (3)	2,821 (22)	E1(+M2)	0,00520 (16)	0,635 (19)	0,1390 (42)	0,00600 (18)
$\gamma_{13,7}$(Gd)	482,31 (3)	0,0014 (6)	(E1)	0,00440 (13)	0,594 (18)	0,1280 (38)	0,00510 (15)
$\gamma_{11,5}$(Sm)	482,31 (3)	0,0285 (16)	(M1+50%E2)	0,01610 (48)	2,43 (7)	0,526 (16)	0,0192 (6)
$\gamma_{13,8}$(Sm)	488,680 (2)	0,4197 (24)	M1+E2	0,01150 (34)	1,96 (6)	0,429 (13)	0,01400 (42)
$\gamma_{14,9}$(Sm)	493,508 (20)	0,028 (3)	(E1)	0,00380 (11)	0,509 (15)	0,1090 (33)	0,00450 (14)
$\gamma_{6,2}$(Gd)	493,509 (20)	0,0093 (21)	(E2)	0,01180 (35)	2,14 (6)	0,476 (14)	0,01450 (44)
$\gamma_{13,6}$(Gd)	496,39 (3)	0,00461 (44)	M1+E2+E0	0,082 (9)			0,097 (11)
$\gamma_{17,10}$(Sm)	496,39 (3)	0,0049 (8)	(E1)	0,00380 (11)	0,502 (15)	0,1070 (32)	0,00440 (13)
$\gamma_{11,4}$(Gd)	503,475 (5)	0,1554 (18)	(E2)	0,01120 (34)	2,02 (6)	0,448 (13)	0,01380 (41)
$\gamma_{14,7}$(Gd)	520,228 (5)	0,0545 (12)	(M1+50%E2)	0,01520 (46)	2,30 (7)	0,504 (15)	0,0181 (5)
$\gamma_{18,10}$(Sm)	523,13 (5)	0,0114 (21)	(M1+50%E2)	0,01310 (39)	1,94 (6)	0,421 (13)	0,01560 (47)
$\gamma_{8,3}$(Gd)	526,882 (20)	0,0141 (7)	M1+E2+E0	0,084 (9)			0,094 (8)
$\gamma_{14,6}$(Gd)	534,246 (7)	0,0369 (19)	(E1)	0,0035 (1)	0,470 (14)	0,101 (3)	0,00410 (12)
$\gamma_{(-1,5)}$(Sm)	535,4 (4)	0,0060 (16)	(M1+50%E2)	0,01240 (37)	1,83 (5)	0,395 (12)	0,01470 (44)
$\gamma_{14,8}$(Sm)	538,29 (6)	0,0042 (6)	(M1+50%E2)	0,01220 (37)	1,80 (5)	0,389 (12)	0,01450 (44)
$\gamma_{14,7}$(Sm)	556,56 (3)	0,0178 (11)	(E1)	0,00290 (9)	0,387 (12)	0,0826 (25)	0,0034 (1)
$\gamma_{13,5}$(Gd)	557,91 (17)	0,0044 (7)	(E2)	0,00870 (26)	1,490 (45)	0,331 (10)	0,01060 (32)
$\gamma_{12,5}$(Sm)	561,2 (5)	0,00109 (21)	(E2)	0,00790 (24)	1,300 (39)	0,285 (9)	0,00960 (29)
$\gamma_{3,1}$(Sm)	562,93 (2)	0,038 (13)	E2	0,00780 (23)	1,290 (39)	0,282 (8)	0,00950 (28)
$\gamma_{16,9}$(Sm)	563,991 (7)	0,458 (14)	E1	0,00280 (8)	0,376 (11)	0,0802 (24)	0,0033 (1)
$\gamma_{13,6}$(Sm)	566,442 (5)	0,133 (4)	M1+35,4%E2	0,01170 (35)	1,66 (5)	0,357 (11)	0,01380 (41)
$\gamma_{15,8}$(Sm)	571,83 (8)	0,0048 (8)					
$\gamma_{4,1}$(Gd)	586,266 (3)	0,4732 (41)	E2+4%M1+E0	0,0202 (16)			0,0243 (9)
$\gamma_{(-1,6)}$(Sm)	595,61 (1)	0,0031 (17)					
$\gamma_{14,6}$(Sm)	616,05 (3)	0,0092 (6)	(E2)	0,00630 (19)	1,00 (3)	0,219 (7)	0,00760 (23)
$\gamma_{17,9}$(Sm)	644,37 (5)	0,0063 (6)	(E1)	0,00210 (6)	0,280 (8)	0,0598 (18)	0,00250 (8)
$\gamma_{7,2}$(Sm)	656,490 (5)	0,1519 (19)	E2+18%M1+E0	0,0497 (16)			0,0568 (20)
$\gamma_{12,4}$(Sm)	664,78 (5)	0,010 (3)	(E2)	0,00520 (16)	0,818 (25)	0,178 (5)	0,00630 (19)
$\gamma_{18,9}$(Sm)	671,157 (17)	0,0196 (13)	M1+1,9%E2	0,00900 (27)	1,220 (37)	0,260 (8)	0,01050 (32)
$\gamma_{13,4}$(Gd)	674,677 (7)	0,0172 (18)	E2+17%M1	0,00630 (19)	0,980 (29)	0,215 (6)	0,00760 (23)
$\gamma_{8,2}$(Sm)	674,677 (3)	0,170 (4)	E1	0,00190 (6)	0,254 (8)	0,0542 (16)	0,00230 (7)
$\gamma_{11,3}$(Gd)	678,625 (5)	0,473 (4)	E2+6%M1	0,00570 (17)	0,900 (27)	0,198 (6)	0,00690 (21)
$\gamma_{(-1,7)}$(Sm)	683,32 (11)	0,0031 (8)					
$\gamma_{16,6}$(Sm)	686,61 (5)	0,0201 (17)	(M1+50%E2)	0,0067 (2)	0,954 (29)	0,205 (6)	0,00790 (24)
$\gamma_{5,1}$(Sm)	688,672 (5)	0,877 (6)	E2+M1+E0	0,0359 (13)			0,0434 (13)
$\gamma_{(-1,8)}$(Sm)	696,87 (19)	0,0029 (10)					
$\gamma_{5,1}$(Gd)	703,25 (6)	0,0018 (9)	(E2)	0,00500 (15)	0,796 (24)	0,175 (5)	0,00600 (18)

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L (10^{-3})	α_M (10^{-3})	α_T
$\gamma_{10,2}$(Gd)	703,25 (6)	0,0035 (9)	(E2)	0,00500 (15)	0,796 (24)	0,175 (5)	0,00600 (18)
$\gamma_{14,4}$(Gd)	712,845 (6)	0,0963 (19)	(E1)	0,00190 (6)	0,251 (8)	0,0541 (16)	0,00220 (7)
$\gamma_{13,5}$(Sm)	719,351 (4)	0,059 (7)	(E1)	0,00170 (5)	0,222 (7)	0,0473 (14)	0,00200 (6)
$\gamma_{9,2}$(Sm)	719,351 (4)	0,270 (13)	(E2)	0,00440 (13)	0,666 (20)	0,1440 (43)	0,00520 (16)
$\gamma_{19,8}$(Sm)	727,99 (14)	0,0106 (13)	(E1)	0,00166 (5)	0,216 (6)	0,0461 (14)	0,00193 (6)
$\gamma_{(-1,9)}$(Sm)	735,4 (1)	0,0058 (10)					
$\gamma_{(-1,10)}$(Sm)	756,12 (9)	0,0054 (8)					
$\gamma_{6,1}$(Gd)	764,902 (9)	0,191 (4)	E2+6,5%M1	0,00440 (13)	0,669 (20)	0,1460 (44)	0,00520 (16)
$\gamma_{14,5}$(Sm)	768,946 (9)	0,089 (3)	(E1)	0,001500 (45)	0,193 (6)	0,0412 (12)	0,00170 (5)
$\gamma_{7,1}$(Gd)	778,9066 (24)	12,99 (6)	E1	0,001600 (48)	0,209 (6)	0,0450 (14)	0,00190 (6)
$\gamma_{12,3}$(Gd)	794,81 (3)	0,0265 (11)	M1(+13,8%E2)	0,0065 (2)	0,905 (27)	0,196 (6)	0,00770 (23)
$\gamma_{19,6}$(Sm)	805,70 (7)	0,0125 (8)	(E1)	0,001400 (42)	0,176 (5)	0,0374 (11)	0,001600 (48)
$\gamma_{5,0}$(Sm)	810,453 (5)	0,318 (3)	(E2)	0,0033 (1)	0,493 (15)	0,1070 (32)	0,00400 (12)
$\gamma_{16,5}$(Sm)	839,36 (4)	0,0161 (8)	(E1)	0,001200 (36)	0,1620 (49)	0,0345 (10)	0,001500 (45)
$\gamma_{6,1}$(Sm)	841,576 (5)	0,163 (2)	E1	0,001200 (36)	0,1610 (48)	0,0343 (10)	0,001500 (45)
$\gamma_{10,2}$(Sm)	867,383 (3)	4,258 (23)	E2+2%M1	0,00290 (9)	0,423 (13)	0,0913 (27)	0,0035 (1)
$\gamma_{(-1,11)}$(Sm)	896,58 (9)	0,0669 (21)					
$\gamma_{7,1}$(Sm)	901,184 (11)	0,084 (3)	E2	0,00260 (8)	0,382 (11)	0,0824 (25)	0,00310 (9)
$\gamma_{15,4}$(Sm)	906,01 (6)	0,016 (1)					
$\gamma_{8,1}$(Sm)	919,340 (4)	0,430 (4)	E1	0,00100 (3)	0,135 (4)	0,0288 (9)	0,001200 (36)
$\gamma_{11,2}$(Sm)	926,320 (15)	0,274 (4)	(E2)	0,00250 (8)	0,358 (11)	0,0772 (23)	0,00290 (9)
$\gamma_{4,0}$(Gd)	930,58 (15)	0,0731 (19)	(E2)	0,00270 (8)	0,400 (12)	0,0872 (26)	0,0032 (1)
$\gamma_{15,3}$(Gd)	937,053 (15)	0,0027 (6)	(M1+50%E2)	0,00370 (11)	0,516 (15)	0,1120 (34)	0,00430 (13)
$\gamma_{19,5}$(Sm)	958,63 (5)	0,0211 (19)	(M1+E2)	0,00310 (9)			0,00360 (11)
$\gamma_{6,0}$(Sm)	963,393 (12)	0,1342 (20)	E1	0,00100 (3)	0,1230 (37)	0,0263 (8)	0,001100 (33)
$\gamma_{9,1}$(Sm)	964,082 (18)	14,54 (7)	E2(+M1)	0,00230 (7)	0,327 (10)	0,0703 (21)	0,00270 (8)
$\gamma_{10,1}$(Gd)	974,09 (4)	0,0139 (8)	M1+50%E2+E0	0,0048 (5)			0,0056 (6)
$\gamma_{13,2}$(Gd)	990,19 (3)	0,0315 (13)	(E2)	0,00240 (7)	0,347 (10)	0,0755 (23)	0,00300 (9)
$\gamma_{(-1,12)}$(Sm)	1001,1 (3)	0,0046 (10)					
$\gamma_{12,2}$(Sm)	1005,276 (17)	0,667 (23)		0,00220 (7)	0,311 (9)	0,0669 (20)	0,00260 (8)
$\gamma_{(-1,15)}$(Sm)	1084 (1)	0,244 (8)					
$\gamma_{9,0}$(Sm)	1085,841 (10)	10,15 (6)	E2	0,00180 (5)	0,250 (8)	0,0536 (16)	0,00210 (6)
$\gamma_{11,1}$(Gd)	1089,741 (5)	1,735 (10)	(M1)+E2	0,00200 (6)			0,00230 (7)
$\gamma_{6,0}$(Gd)	1109,178 (12)	0,186 (4)	E2	0,00190 (6)	0,269 (8)	0,0584 (18)	0,00220 (7)
$\gamma_{10,1}$(Sm)	1112,080 (3)	13,44 (6)	E2(+1%M1)	0,00170 (5)	0,238 (7)	0,0511 (15)	0,00200 (6)
$\gamma_{(-1,13)}$(Sm)	1139 (1)	0,0013 (3)					
$\gamma_{11,1}$(Sm)	1170,93 (11)	0,0366 (13)	(M1+50%E2)	0,00200 (6)	0,265 (8)	0,0567 (17)	0,00230 (7)
$\gamma_{12,1}$(Gd)	1206,11 (15)	0,0138 (8)	(E2)	0,001600 (48)	0,225 (7)	0,0487 (15)	0,00190 (6)
$\gamma_{14,2}$(Sm)	1212,953 (11)	1,417 (9)	E1	0,000600 (18)	0,0802 (24)	0,0170 (5)	0,000700 (21)
$\gamma_{12,1}$(Sm)	1249,944 (13)	0,187 (3)	E2	0,001400 (42)	0,184 (6)	0,0395 (12)	0,001600 (48)
$\gamma_{13,1}$(Gd)	1261,349 (23)	0,0337 (11)	M1	0,00230 (7)	0,313 (9)	0,0676 (20)	0,00270 (8)
$\gamma_{11,0}$(Sm)	1292,784 (19)	0,104 (3)	(E2)	0,001300 (39)	0,172 (5)	0,0368 (11)	0,001500 (45)
$\gamma_{14,1}$(Gd)	1299,148 (8)	1,634 (9)	E1(+0,2%M2)	0,000600 (18)	0,0803 (24)	0,0172 (5)	0,000700 (21)
$\gamma_{9,0}$(Gd)	1314,7 (2)	0,0048 (6)	E1	0,000600 (18)	0,0773 (23)	0,0166 (5)	0,000700 (21)
$\gamma_{15,1}$(Gd)	1348,10 (7)	0,0175 (8)	E2+(0,6%M1)	0,001300 (39)	0,179 (5)	0,0387 (12)	0,001600 (48)
$\gamma_{17,2}$(Sm)	1363,77 (5)	0,0257 (8)	M1(+E2)	0,00170 (5)	0,222 (7)	0,0474 (14)	0,00200 (6)
$\gamma_{18,2}$(Sm)	1390,36 (16)	0,0048 (6)	(M1+50%E2)	0,001400 (42)	0,180 (5)	0,0385 (12)	0,001600 (48)
$\gamma_{13,1}$(Sm)	1408,013 (3)	20,86 (9)	E1(+M2)	0,000500 (15)	0,0615 (18)	0,01310 (39)	0,000600 (18)
$\gamma_{14,1}$(Sm)	1457,651 (11)	0,498 (4)	E1	0,000500 (15)	0,0580 (17)	0,01230 (37)	0,000500 (15)
$\gamma_{16,1}$(Sm)	1528,111 (18)	0,281 (5)	E1	0,000400 (12)			0,000500 (15)
$\gamma_{13,0}$(Gd)	1605,61 (7)	0,0081 (4)	(E2)	0,000900 (27)			0,000900 (27)
$\gamma_{17,1}$(Sm)	1608,36 (8)	0,0053 (3)	(E1)	0,000400 (12)			0,000400 (12)
$\gamma_{18,1}$(Sm)	1635,2 (5)	0,00015 (5)	(M1+50%E2)	0,00100 (3)			0,00100 (3)
$\gamma_{14,0}$(Gd)	1643,6 (1)	0,0015 (4)	(M2)	0,00280 (8)			0,0032 (1)
$\gamma_{19,1}$(Sm)	1647,41 (14)	0,0064 (4)	(E2)	0,000800 (24)			0,000800 (24)
$\gamma_{(-1,14)}$(Sm)	1674,30 (6)	0,0060 (8)					
$\gamma_{19,0}$(Sm)	1769,09 (5)	0,0092 (3)	(E2)	0,000700 (21)			0,000700 (21)

3 Atomic Data

3.1 Sm

ω_K : 0,926 (4)
$\bar{\omega}_L$: 0,158 (6)
n_{KL} : 0,857 (4)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	39,5229		55,25
	$K\alpha_1$	40,1186		100
	$K\beta_3$	45,289	}	
	$K\beta_1$	45,413	}	
	$K\beta_5''$	45,731	}	31,23
	$K\beta_2$	46,575	}	
	$K\beta_4$	46,705	}	8,06
	$KO_{2,3}$	46,813	}	
X_L				
	$L\alpha$	5,61 – 5,64		
	$L\gamma$	– 7,18		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	31,190 – 33,218	100
KLX	37,302 – 40,097	50,7
KXY	43,39 – 46,79	6,42
Auger L	0,08 – 7,69	1815

3.2 Gd

ω_K : 0,932 (4)
$\bar{\omega}_L$: 0,176 (6)
n_{KL} : 0,850 (4)

3.2.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	42,3093		55,59
	$K\alpha_1$	42,9967		100
	$K\beta_3$	48,556	}	
	$K\beta_1$	48,697	}	
	$K\beta_5''$	49,053	}	31,6
	$K\beta_2$	49,961	}	
	$K\beta_4$	50,099	}	8,31
	$KO_{2,3}$	50,219	}	
X_L				
	$L\alpha$	6,025 – 6,057		
	$L\gamma$	– 7,78		

3.2.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	33,310 – 35,562	100
KLX	39,907 – 42,976	51,3
KXY	46,48 – 50,20	6,58
Auger L	0,07 – 8,33	

4 Electron Emissions

		Energy keV		Electrons per 100 disint.
e_{AL}	(Sm)	0,08	- 7,69	67,7 (7)
e_{AK}	(Sm)			5,9 (4)
	KLL	31,190	- 33,218 }	
	KLX	37,302	- 40,097 }	
	KXY	43,39	- 46,79 }	
e_{AL}	(Gd)	0,07	- 8,33	0,800 (14)
e_{AK}	(Gd)			0,062 (4)
	KLL	33,310	- 35,562 }	
	KLX	39,907	- 42,976 }	
	KXY	46,48	- 50,20 }	
$ec_{1,0\ K}$	(Sm)	74,9475	(20)	19,2 (6)
$ec_{1,0\ L}$	(Sm)	114,045	- 115,066	10,7 (3)
$ec_{1,0\ M}$	(Sm)	120,059	- 120,702	2,48 (7)
$ec_{1,0\ N}$	(Sm)	121,436	- 121,776	0,57 (2)
$ec_{2,1\ K}$	(Sm)	197,8632	(20)	0,611 (19)
$ec_{2,1\ L}$	(Sm)	236,961	- 237,981	0,159 (5)
$ec_{1,0\ K}$	(Gd)	294,0394	(20)	0,86 (3)
$ec_{1,0\ L}$	(Gd)	335,903	- 337,036	0,190 (6)
$\beta^+_{0,1}$	max:	730,5	(7)	0,025 (15)
$\beta^+_{0,1}$	avg:	338,1	(3)	
$\beta^+_{0,2}$	max:	485,8	(7)	0,0024 (2)
$\beta^+_{0,2}$	avg:	230,7	(3)	
$\beta^-_{0,15}$	max:	126,4	(11)	0,0203 (11)
$\beta^-_{0,15}$	avg:	33,4	(3)	
$\beta^-_{0,14}$	max:	175,4	(11)	1,826 (21)
$\beta^-_{0,14}$	avg:	47,4	(4)	
$\beta^-_{0,13}$	max:	213,5	(11)	0,101 (3)
$\beta^-_{0,13}$	avg:	58,6	(4)	
$\beta^-_{0,12}$	max:	268,6	(11)	0,0536 (18)
$\beta^-_{0,12}$	avg:	75,2	(4)	
$\beta^-_{0,11}$	max:	384,8	(11)	2,44 (3)
$\beta^-_{0,11}$	avg:	112,3	(4)	
$\beta^-_{0,10}$	max:	500,3	(11)	0,0267 (17)
$\beta^-_{0,10}$	avg:	151,4	(4)	
$\beta^-_{0,9}$	max:	504,1	(11)	0,0048 (7)
$\beta^-_{0,9}$	avg:	152,7	(4)	
$\beta^-_{0,8}$	max:	536,5	(11)	0,037 (8)
$\beta^-_{0,8}$	avg:	164,1	(4)	

		Energy keV		Electrons per 100 disint.
$\beta^-_{0,7}$	max:	695,6	(11)	13,80 (15)
$\beta^-_{0,7}$	avg:	221,7	(4)	
$\beta^-_{0,6}$	max:	709,7	(11)	0,245 (8)
$\beta^-_{0,6}$	avg:	226,9	(5)	
$\beta^-_{0,4}$	max:	888,2	(11)	0,303 (7)
$\beta^-_{0,4}$	avg:	295,1	(5)	
$\beta^-_{0,3}$	max:	1063,4	(11)	0,904 (14)
$\beta^-_{0,3}$	avg:	364,6	(5)	
$\beta^-_{0,1}$	max:	1474,5	(11)	8,17 (11)
$\beta^-_{0,1}$	avg:	535,4	(5)	

5 Photon Emissions

5.1 X-Ray Emissions

		Energy keV		Photons per 100 disint.	
XL	(Sm)	5,61 — 7,18		13,0 (4)	
XKα_2	(Sm)	39,5229		20,8 (3)	} Kα
XKα_1	(Sm)	40,1186		37,7 (5)	}
XKβ_3	(Sm)	45,289	}		
XKβ_1	(Sm)	45,413	}	11,78 (19)	K$'\beta_1$
XKβ''_5	(Sm)	45,731	}		
XKβ_2	(Sm)	46,575	}		
XKβ_4	(Sm)	46,705	}	3,04 (8)	K$'\beta_2$
XKO$_{2,3}$	(Sm)	46,813	}		
XL	(Gd)	6,025 — 7,78		0,177 (5)	
XKα_2	(Gd)	42,3093		0,243 (7)	} Kα
XKα_1	(Gd)	42,9967		0,437 (12)	}
XKβ_3	(Gd)	48,556	}		
XKβ_1	(Gd)	48,697	}	0,138 (4)	K$'\beta_1$
XKβ''_5	(Gd)	49,053	}		
XKβ_2	(Gd)	49,961	}		
XKβ_4	(Gd)	50,099	}	0,0363 (13)	K$'\beta_2$
XKO$_{2,3}$	(Gd)	50,219	}		

5.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{1,0}$(Sm)	121,7817 (3)	28,41 (13)
$\gamma_{5,3}$(Sm)	125,69 (13)	0,019 (6)
$\gamma_{10,9}$(Sm)	148,010 (17)	0,035 (5)
$\gamma_{7,4}$(Gd)	192,6 (4)	0,0068 (2)
$\gamma_{14,12}$(Sm)	207,6 (3)	0,0059 (4)
$\gamma_{14,11}$(Gd)	209,41 (13)	0,0055 (5)
$\gamma_{7,5}$(Sm)	212,568 (15)	0,0196 (6)
$\gamma_{(-1,0)}$(Sm)	237,31 (5)	0,0025 (8)
$\gamma_{19,13}$(Sm)	239,42 (17)	0,008 (3)
$\gamma_{2,1}$(Sm)	244,6974 (8)	7,55 (4)
$\gamma_{11,8}$(Sm)	251,633 (10)	0,0671 (15)
$\gamma_{11,7}$(Sm)	269,86 (6)	0,0060 (24)
$\gamma_{2,1}$(Gd)	271,131 (8)	0,078 (3)
$\gamma_{9,5}$(Sm)	275,449 (15)	0,0323 (17)
$\gamma_{12,9}$(Sm)	285,98 (3)	0,0100 (6)
$\gamma_{13,10}$(Sm)	295,9387 (17)	0,442 (3)
$\gamma_{4,2}$(Gd)	315,174 (17)	0,0496 (17)
$\gamma_{7,4}$(Sm)	316,2 (2)	0,0031 (10)
$\gamma_{(-1,1)}$(Sm)	320,03 (15)	0,0017 (6)
$\gamma_{11,6}$(Gd)	324,83 (3)	0,0738 (15)
$\gamma_{11,6}$(Sm)	329,425 (21)	0,129 (6)
$\gamma_{12,8}$(Sm)	330,54 (10)	0,0060 (17)
$\gamma_{4,2}$(Sm)	340,40 (14)	0,031 (3)
$\gamma_{1,0}$(Gd)	344,2785 (12)	26,59 (12)
$\gamma_{8,4}$(Gd)	351,66 (4)	0,0140 (22)
$\gamma_{16,11}$(Sm)	357,26 (5)	0,0040 (5)
$\gamma_{7,3}$(Gd)	367,7891 (20)	0,862 (5)
$\gamma_{(-1,2)}$(Sm)	379,37 (6)	0,00083 (21)
$\gamma_{18,12}$(Sm)	385,69 (20)	0,0050 (6)
$\gamma_{10,4}$(Gd)	387,90 (8)	0,00296 (21)
$\gamma_{(-1,3)}$(Sm)	391,32 (14)	0,00125 (21)
$\gamma_{(-1,4)}$(Sm)	406,74 (15)	0,00083 (21)
$\gamma_{3,1}$(Gd)	411,1165 (12)	2,238 (10)
$\gamma_{16,10}$(Sm)	416,048 (8)	0,1090 (17)
$\gamma_{10,5}$(Sm)	423,45 (4)	0,0032 (5)
$\gamma_{12,6}$(Gd)	440,86 (10)	0,0133 (10)
$\gamma_{5,2}$(Sm)	443,965 (3)	0,32 (2)
$\gamma_{13,9}$(Sm)	443,965 (3)	2,80 (2)
$\gamma_{13,7}$(Gd)	482,31 (3)	0,00139 (6)
$\gamma_{11,5}$(Sm)	482,31 (3)	0,0279 (16)
$\gamma_{13,8}$(Sm)	488,6792 (20)	0,4139 (24)
$\gamma_{6,2}$(Gd)	493,508 (20)	0,009 (2)
$\gamma_{14,9}$(Sm)	493,508 (20)	0,0278 (30)
$\gamma_{13,6}$(Gd)	496,39 (3)	0,0042 (4)
$\gamma_{17,10}$(Sm)	496,39 (3)	0,0049 (5)

	Energy keV	Photons per 100 disint.
$\gamma_{11,4}$(Gd)	503,474 (5)	0,1533 (18)
$\gamma^{\pm}$	511	0,054 (30)
$\gamma_{14,7}$(Gd)	520,227 (5)	0,0536 (13)
$\gamma_{18,10}$(Sm)	523,13 (5)	0,0113 (21)
$\gamma_{8,3}$(Gd)	526,881 (20)	0,0129 (6)
$\gamma_{14,6}$(Gd)	534,245 (7)	0,0368 (19)
$\gamma_{(-1,5)}$(Sm)	535,4 (4)	0,0060 (16)
$\gamma_{14,8}$(Sm)	538,29 (6)	0,0042 (6)
$\gamma_{14,7}$(Sm)	556,56 (3)	0,0177 (11)
$\gamma_{13,5}$(Gd)	557,91 (17)	0,0044 (7)
$\gamma_{12,5}$(Sm)	561,2 (5)	0,00108 (21)
$\gamma_{3,1}$(Sm)	562,93 (2)	0,038 (13)
$\gamma_{16,9}$(Sm)	563,990 (7)	0,457 (13)
$\gamma_{13,6}$(Sm)	566,442 (5)	0,131 (4)
$\gamma_{15,8}$(Sm)	571,83 (8)	0,0048 (8)
$\gamma_{4,1}$(Gd)	586,265 (3)	0,462 (4)
$\gamma_{(-1,6)}$(Sm)	595,61 (1)	0,0031 (17)
$\gamma_{14,6}$(Sm)	616,05 (3)	0,0092 (6)
$\gamma_{17,9}$(Sm)	644,37 (5)	0,0063 (6)
$\gamma_{7,2}$(Sm)	656,489 (5)	0,1437 (18)
$\gamma_{12,4}$(Sm)	664,78 (5)	0,010 (3)
$\gamma_{18,9}$(Sm)	671,155 (17)	0,0194 (13)
$\gamma_{8,2}$(Sm)	674,675 (3)	0,170 (4)
$\gamma_{13,4}$(Gd)	674,677 (3)	0,0171 (18)
$\gamma_{11,3}$(Gd)	678,623 (5)	0,470 (4)
$\gamma_{(-1,7)}$(Sm)	683,32 (11)	0,0031 (8)
$\gamma_{16,6}$(Sm)	686,61 (5)	0,0200 (17)
$\gamma_{5,1}$(Sm)	688,670 (5)	0,841 (6)
$\gamma_{(-1,8)}$(Sm)	696,87 (19)	0,0029 (10)
$\gamma_{10,2}$(Gd)	703,25 (6)	0,0035 (9)
$\gamma_{5,1}$(Gd)	703,25 (6)	0,0018 (9)
$\gamma_{14,4}$(Gd)	712,843 (6)	0,0961 (19)
$\gamma_{13,5}$(Sm)	719,349 (4)	0,059 (7)
$\gamma_{9,2}$(Sm)	719,349 (4)	0,268 (13)
$\gamma_{19,8}$(Sm)	727,99 (14)	0,0106 (13)
$\gamma_{(-1,9)}$(Sm)	735,4 (1)	0,0058 (10)
$\gamma_{(-1,10)}$(Sm)	756,12 (9)	0,0054 (8)
$\gamma_{6,1}$(Gd)	764,900 (9)	0,190 (4)
$\gamma_{14,5}$(Sm)	768,944 (9)	0,088 (3)
$\gamma_{7,1}$(Gd)	778,9045 (24)	12,97 (6)
$\gamma_{12,3}$(Gd)	794,81 (3)	0,0263 (10)
$\gamma_{19,6}$(Sm)	805,70 (7)	0,0125 (8)
$\gamma_{5,0}$(Sm)	810,451 (5)	0,317 (3)
$\gamma_{16,5}$(Sm)	839,36 (4)	0,0160 (8)
$\gamma_{6,1}$(Sm)	841,574 (5)	0,163 (2)
$\gamma_{10,2}$(Sm)	867,380 (3)	4,243 (23)
$\gamma_{(-1,11)}$(Sm)	896,58 (9)	0,0669 (21)

	Energy keV	Photons per 100 disint.
$\gamma_{7,1}$(Sm)	901,181 (11)	0,084 (3)
$\gamma_{15,4}$(Sm)	906,01 (6)	0,016 (1)
$\gamma_{8,1}$(Sm)	919,337 (4)	0,429 (5)
$\gamma_{11,2}$(Sm)	926,317 (15)	0,273 (4)
$\gamma_{4,0}$(Gd)	930,58 (15)	0,0729 (19)
$\gamma_{15,3}$(Gd)	937,050 (15)	0,0027 (6)
$\gamma_{19,5}$(Sm)	958,63 (5)	0,0210 (19)
$\gamma_{6,0}$(Sm)	963,390 (12)	0,1341 (20)
$\gamma_{9,1}$(Sm)	964,079 (18)	14,50 (6)
$\gamma_{10,1}$(Gd)	974,09 (4)	0,0138 (8)
$\gamma_{13,2}$(Gd)	990,19 (3)	0,0315 (13)
$\gamma_{(-1,12)}$(Sm)	1001,1 (3)	0,0046 (10)
$\gamma_{12,2}$(Sm)	1005,272 (17)	0,665 (23)
$\gamma_{(-1,15)}$(Sm)	1084 (1)	0,244 (8)
$\gamma_{9,0}$(Sm)	1085,837 (10)	10,13 (6)
$\gamma_{11,1}$(Gd)	1089,737 (5)	1,73 (1)
$\gamma_{6,0}$(Gd)	1109,174 (12)	0,186 (4)
$\gamma_{10,1}$(Sm)	1112,076 (3)	13,41 (6)
$\gamma_{(-1,13)}$(Sm)	1139 (1)	0,0013 (3)
$\gamma_{11,1}$(Sm)	1170,93 (11)	0,0365 (13)
$\gamma_{12,1}$(Gd)	1206,11 (15)	0,0135 (8)
$\gamma_{14,2}$(Sm)	1212,948 (11)	1,416 (9)
$\gamma_{12,1}$(Sm)	1249,938 (13)	0,186 (3)
$\gamma_{13,1}$(Gd)	1261,343 (23)	0,0336 (11)
$\gamma_{11,0}$(Sm)	1292,778 (19)	0,104 (3)
$\gamma_{14,1}$(Gd)	1299,142 (8)	1,633 (9)
$\gamma_{9,0}$(Gd)	1314,7 (2)	0,0048 (6)
$\gamma_{15,1}$(Gd)	1348,10 (7)	0,0175 (8)
$\gamma_{17,2}$(Sm)	1363,77 (5)	0,0256 (8)
$\gamma_{18,2}$(Sm)	1390,36 (16)	0,0048 (6)
$\gamma_{13,1}$(Sm)	1408,013 (3)	20,85 (8)
$\gamma_{14,1}$(Sm)	1457,643 (11)	0,498 (4)
$\gamma_{16,1}$(Sm)	1528,103 (18)	0,281 (5)
$\gamma_{13,0}$(Gd)	1605,61 (7)	0,0081 (4)
$\gamma_{17,1}$(Sm)	1608,36 (8)	0,0053 (3)
$\gamma_{18,1}$(Sm)	1635,2 (5)	0,00015 (5)
$\gamma_{14,0}$(Gd)	1643,6 (1)	0,0015 (4)
$\gamma_{19,1}$(Sm)	1647,41 (14)	0,0064 (4)
$\gamma_{(-1,14)}$(Sm)	1674,30 (6)	0,0060 (8)
$\gamma_{19,0}$(Sm)	1769,09 (5)	0,0092 (3)

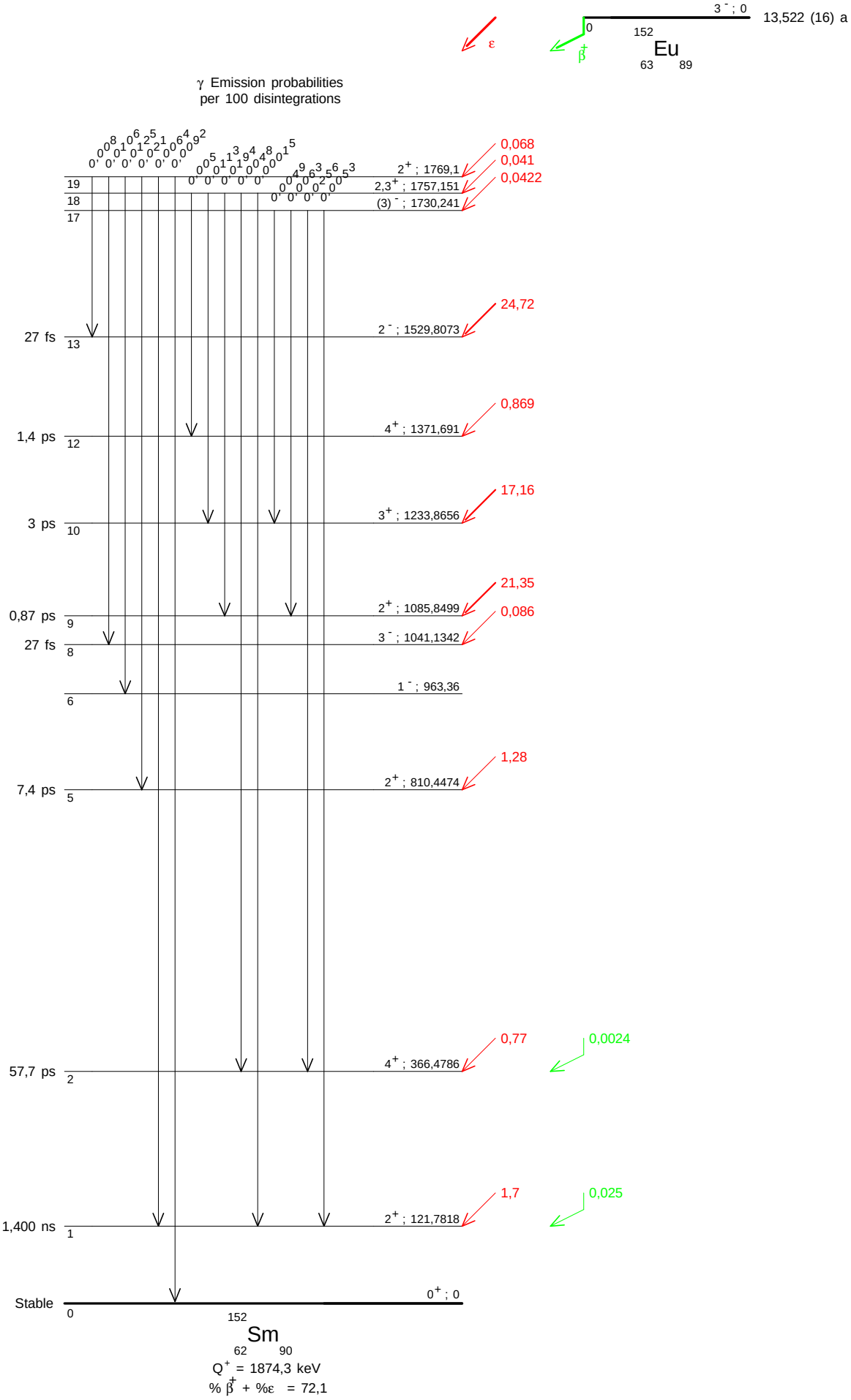
6 Main Production Modes

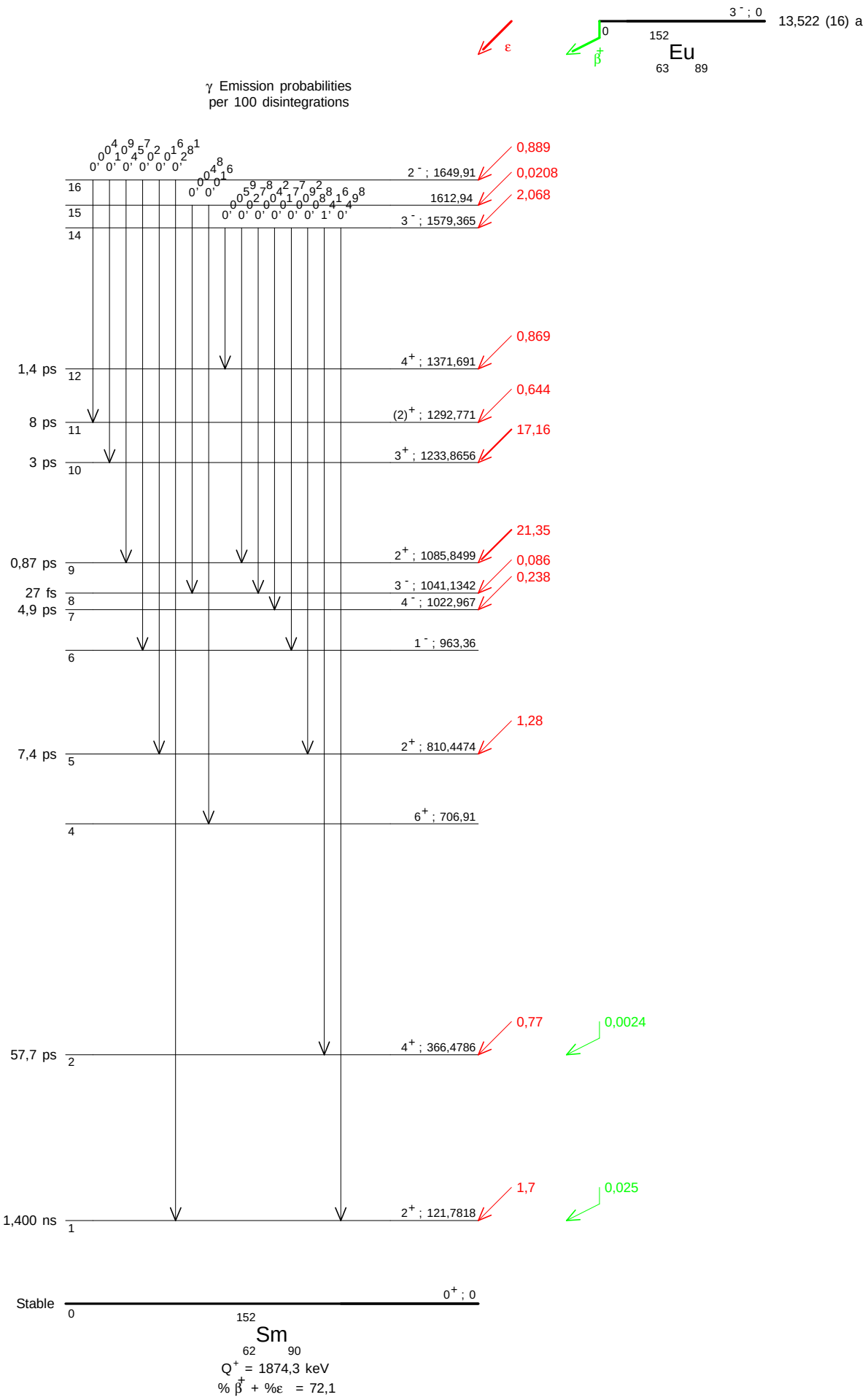
Eu − 151(n,γ)Eu − 152

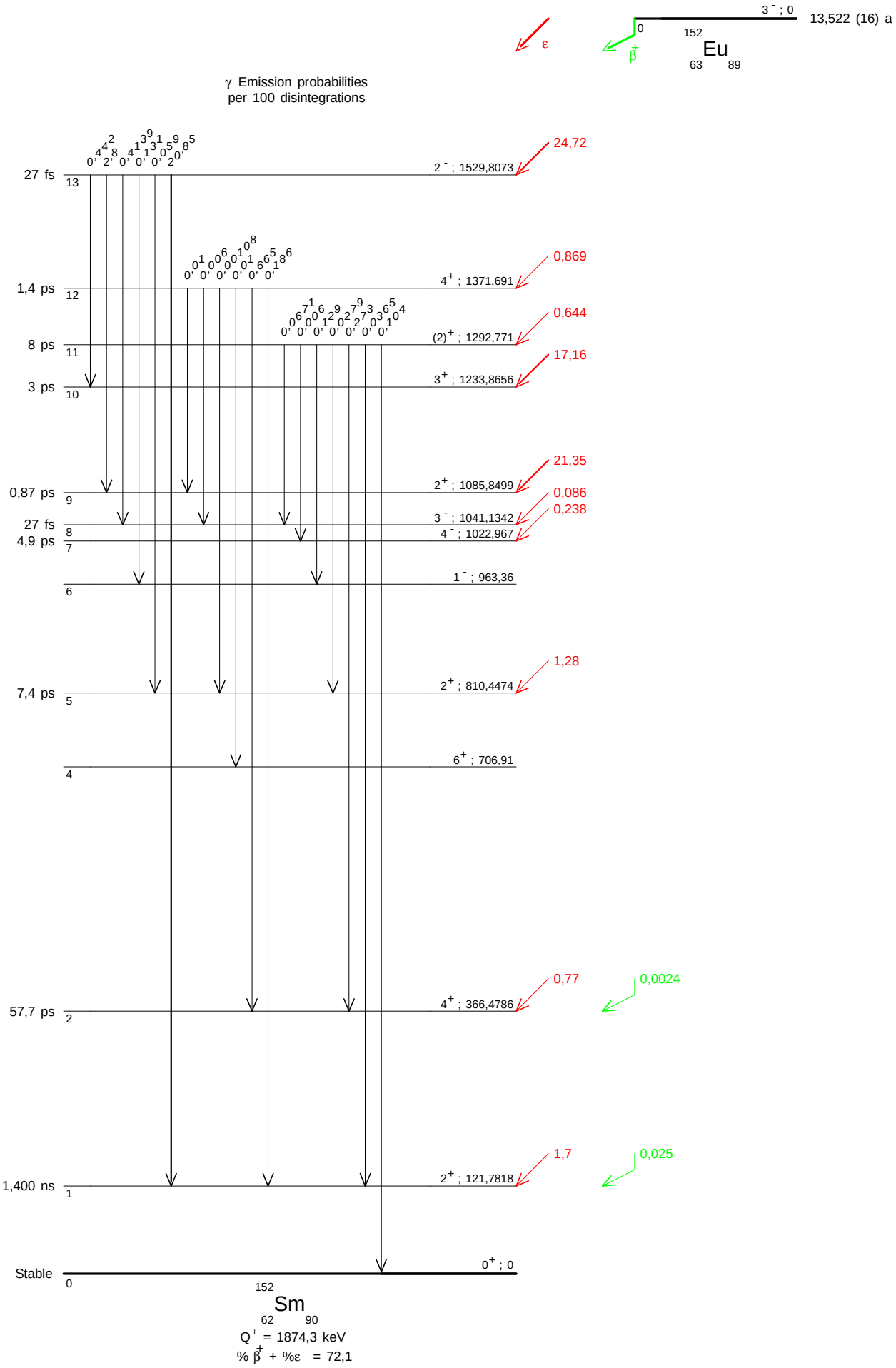
7 References

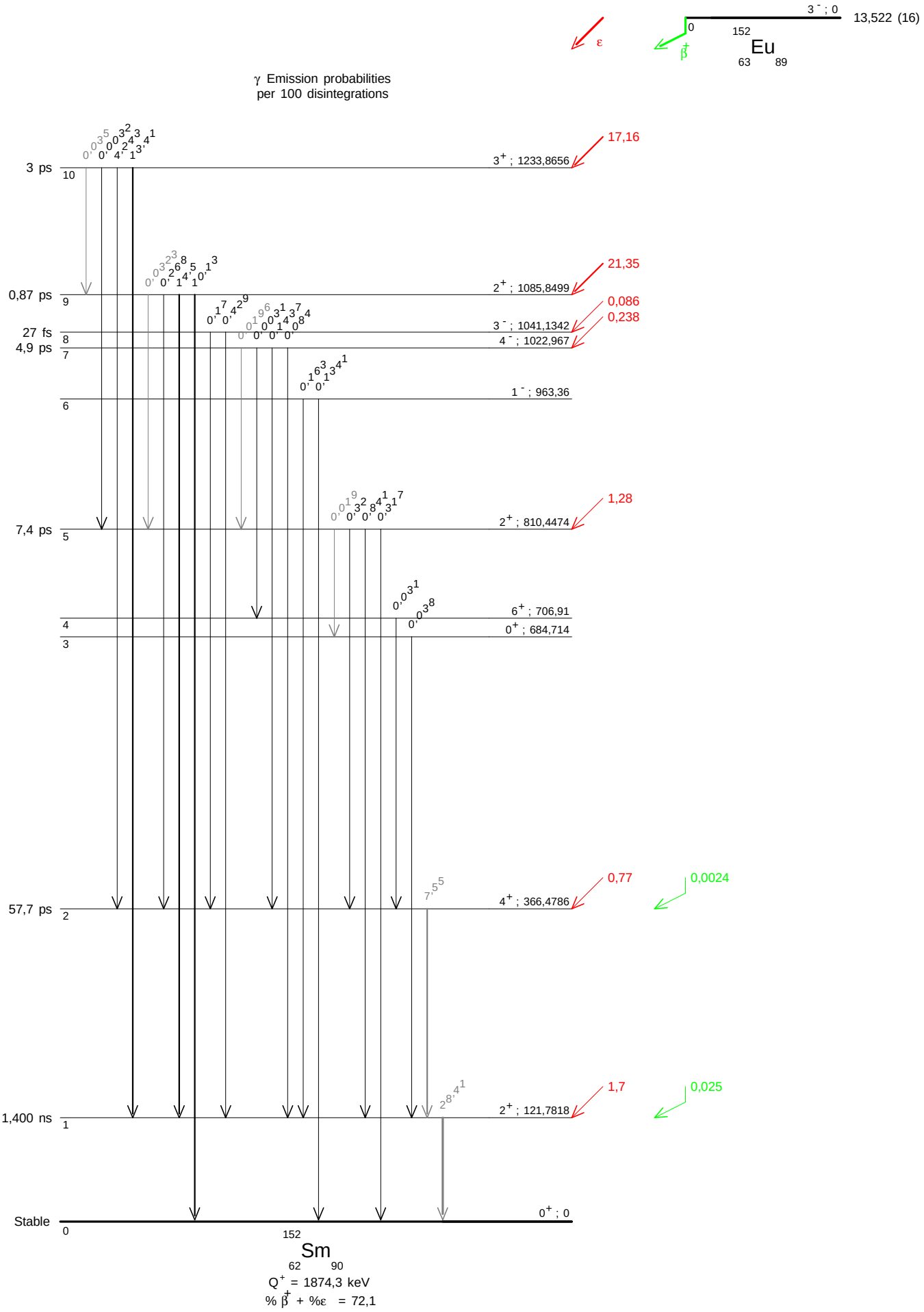
- P. F. Zweifel. Phys. Rev. 107 (1957) 329
  (Electron Capture/Beta plus ratio)
- A. Notea, E. Elias. Nucl. Instrum. Methods 86 (1970) 269
  (Gamma-ray emission probabilities)
- L. L. Riedinger, N. R. Johnson, J. H. Hamilton. Phys. Rev. C2 (1970) 2358
  (Gamma-ray emission probabilities)
- J. Barrette, M. Barrette, A.Boutard, G. Lamoureux, S.Monaro, S. Markiza. Can. J. Phys. 49 (1971) 2462
  (Gamma-ray emission probabilities)
- K. R. Baker, J. H. Hamilton, A. V. Ramayya. Z. Physik 256 (1972) 387
  (Gamma-ray emission probabilities)
- J. F. Emery, S. A. Reynolds, E. I. Wyatt, G. I. Gleason. Nucl. Sci. Eng. 48 (1972) 319
  (Half-life)
- F. B. Larkins. At. Data Nucl. Data Tables 20 (1977) 313
  (Atomic Electron Binding Energies.)
- R. J. Gherke, R. G. Helmer, R. C. Greenwood. Nucl. Instrum. Methods 147 (1977) 405
  (Gamma-ray emission probabilities)
- F. Lagoutine, J. Legrand, C. Bac. Int. J. Appl. Radiat. Isotop. 29 (1978) 269
  (Half-life)
- F. Rösel, H. M. Friess, K. Alder, H. C. Pauli. At. Data Nucl. Data Tables 21 (1978) 92
  (Theoretical ICC)
- K. Debertin. Report PTB-Ra-7 (1978)
  (Gamma-ray emission probabilities)
- K. Debertin. Nucl. Instrum. Methods 158 (1979) 479
  (Gamma-ray emission probabilities)
- A. K. Sharma, R. Kaur, H. R. Verma, P. N Treahan. J. Phys. Soc. Jpn 48 (1980) 1407
  (Gamma-ray emission probabilities)
- A. R. Rutledge, L. V. Smith, J. S. Merritt. NBS Special Publication 626 (1982) 5
  (Half-life)
- S. Baba, K. Ichikawa, K. Gunji, T. Sekine, H. Baba, T. Komori. Int. J. Appl. Radiat. Isotop. 34 (1983) 891
  (Half-life)
- K. Walz, K. Debertin, H. Schrader. Int. J. Appl. Radiat. Isotop. 34 (1983) 1191
  (Half-life)
- Y. Iwata, M. Yasuhara, K. Maeda, Y. Yoshizawa. Nucl. Instrum. Methods 219 (1984) 123
  (Gamma-ray emission probabilities)
- W. L. Zijp. Report FYS/RASA-85 19 (1985)
  (Limitation of Relative Statistical Weights)
- D. Mehta, M. L. Garg, J. Singh, N. Singh, T. S. Cheema, P. N. Trehan. Nucl. Instrum. Methods A219 (1986) 447
  (Gamma-ray emission probabilities)
- M. J. Woods, S. E. M. Lucas. Int. J. Appl. Radiat. Isotop. 37 (1986) 1157
  (Half-life)
- E. R. Cohen, B. N. Taylor. Rev. Mod. Phys. 59 (1987) 1121
  (Fundamental Constants)
- T. W. Burrows. Report BNL-NCS-52142 (1988)
  (The program RADLST.)
- V. N. Danilenko, N. P. Gromova, A. A. Konstantinov, N. V. Kurenkov, A. B. Malinin, S. V. Matveev, T. E. Sazonova, E. K.Stepanov, S. V. Sepman, I. N. Tronova. Appl. Rad. Isotopes 40 (1989) 711
  (Gamma-ray emission probabilities)
- N. M. Stewart, E. Eid, M. S. S. El-Daghmah, J. K. Jabber. Z. Physik A335 (1990) 13
  (Gamma-ray emission probabilities)

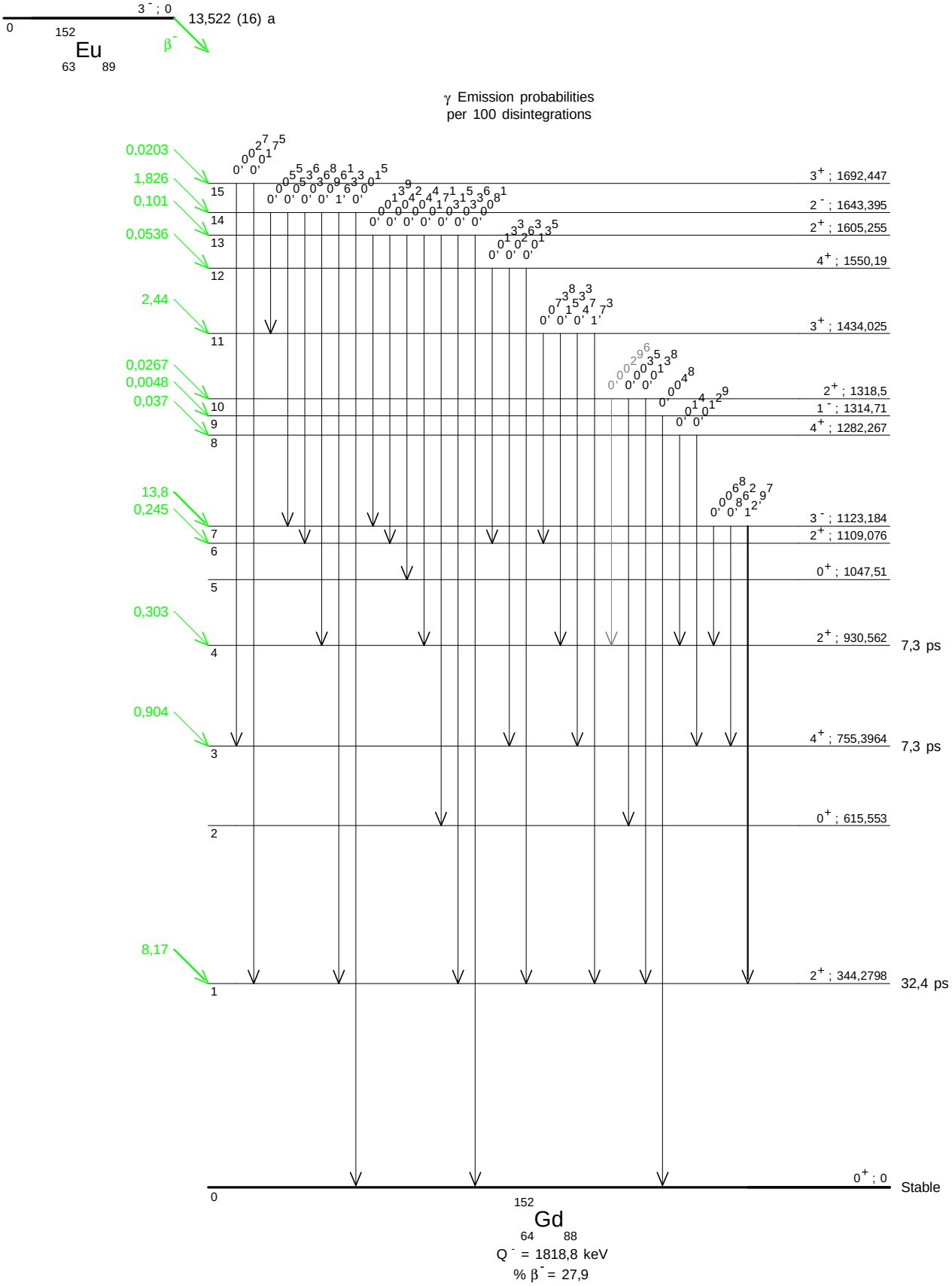
- R. A. Meyer. Fizika 22 (1990) 153
  (Gamma-ray emission probabilities)
- W. Bambynek, T. Barta, R. Jedlovsky, P. Christmas, N. Coursol, K. Debertin, R. G. Helmer, A. L. Nichols, F. J. Schima, Y. Yoshizawa. Report IAEA-TECDOC 619 (1991)
  (Gamma-ray emission probabilities)
- M. P. Unterweger, D. D. Hoppes, F. J. Schima. Nucl. Instrum. Methods A312 (1992) 349
  (Half-life)
- Y. Yan, H. Sun, D. Hu, J. Huo, Y.Liu. Z. Physik A344 (1992) 25
  (Gamma-ray emission probabilities)
- M. U. Rajput, T. D. Mac Mahon. Nucl. Instrum. Methods A312 (1992) 289
  (Limitation of Relative Statistical Weights)
- Kawaldeep, V. Kumar, K. S. Dhillon, K. Singh. J. Phys. Soc. Jpn 62 (1993) 901
  (Gamma-ray emission probabilities)
- G. Audi, A. H. Wapstra. Nucl. Phys. A595 (1995) 409
  (Q)
- A. Artna-Cohen. Nucl. Data Sheets 79 (1996) 1
  (Gamma ray energies, Gamma-ray emission probabilities, Multipolarities)
- E. Schönfeld, H. Janssen. Nucl. Instrum. Methods A369 (1996) 527
  (K fluorescence yield)
- R. H. Martin, K. I. W. Burns, J. G. V. Taylor. Nucl. Instrum. Methods A390 (1997) 267
  (Half-life)
- H. Y. Hwang, T. S. Park, J. M. Lee. Appl. Rad. Isotopes 49 (1998) 1201
  (Gamma-ray emission probabilities)
- E. Schönfeld, G. Rodloff. Report PTB-6.11-98-1 (1998)
  (K X-ray emission probabilities, K fluorescence yield.)
- E. Yakusev, N. Coursol. Note CEA/LPRI 98/002 (1998)
  (ICC, a computer program to interpolate theoretical conversion coefficients.)
- H. Janssen, E. Schönfeld. (1998)
  (EMISSION, a computer program to calculate X-ray and Auger-electron emission probabilities.)
- E. Schönfeld, F. Y. Chu, E. Browne. (1998)
  (EC-CAPTURE, a computer program to calculate EC probabilities to atomic sub-shells.)
- E. Schönfeld. Appl. Rad. Isotopes 49 (1998) 1353
  (PK,PL,PM)
- H. Siegert, H. Schrader, U. Schötzig. Appl. Rad. Isotopes 49 (1998) 1397
  (Half-life)
- E. Schönfeld, G. Rodloff. Report PTB-6.11-1999-1 (1999)
  (K X-ray energies, K Auger electron energies)
- R.G. Helmer, C. van der Leun. Nucl. Instrum. Methods A450 (2000) 35
  (Gamma ray energies)
- H.Schrader. Appl. Rad. Isotopes 60,2-3 (2004) 317
  (Half-life)

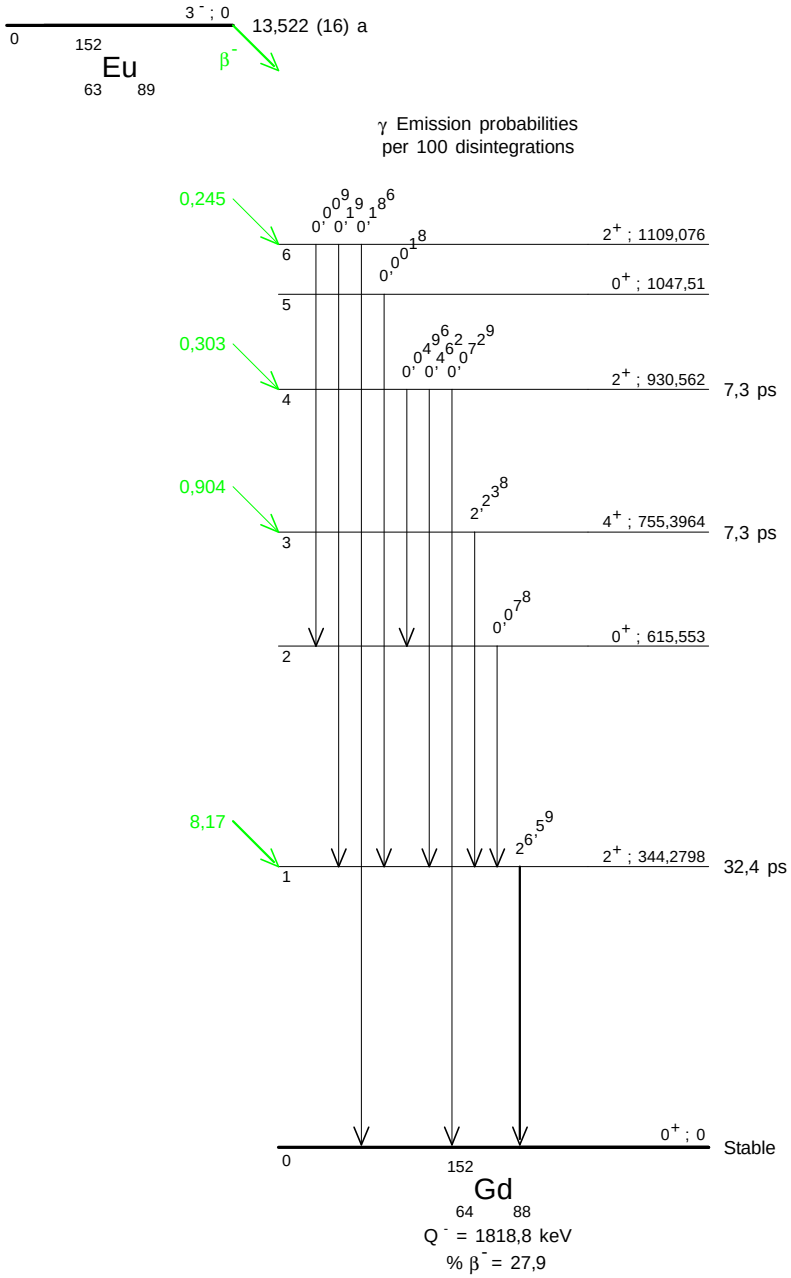

3 - ; 0
13,522 (16) a
ε
β+
0
152
Eu
63
89
γ Emission probabilities
per 100 disintegrations
2+ ; 1769,1
2,3+ ; 1757,151
(3) - ; 1730,241
0,068
0,041
0,0422
19
18
17
24,72
27 fs
2 - ; 1529,8073
13
0,869
1,4 ps
4+ ; 1371,691
12
17,16
3 ps
3+ ; 1233,8656
10
21,35
0,87 ps
2+ ; 1085,8499
9
0,086
27 fs
3 - ; 1041,1342
8
1 - ; 963,36
6
1,28
7,4 ps
2+ ; 810,4474
5
0,77
0,0024
57,7 ps
4+ ; 366,4786
2
1,7
0,025
1,400 ns
2+ ; 121,7818
1
Stable
0+ ; 0
0
152
Sm
62
90
Q+ = 1874,3 keV
% β+ + %ε = 72,1


3 - ; 0
13,522 (16) a
ε
β+
0
152
Eu
63 89
γ Emission probabilities
per 100 disintegrations
2 - ; 1649,91
1612,94
3 - ; 1579,365
4+ ; 1371,691
(2)+ ; 1292,771
3+ ; 1233,8656
2+ ; 1085,8499
3 - ; 1041,1342
4 - ; 1022,967
1 - ; 963,36
2+ ; 810,4474
6+ ; 706,91
4+ ; 366,4786
2+ ; 121,7818
0+ ; 0
0,889
0,0208
2,068
0,869
0,644
17,16
21,35
0,086
0,238
1,28
0,77
0,0024
1,7
0,025
16
15
14
12
11
10
9
8
7
6
5
4
2
1
1,4 ps
8 ps
3 ps
0,87 ps
27 fs
4,9 ps
7,4 ps
57,7 ps
1,400 ns
Stable
0
152
Sm
62 90
Q+ = 1874,3 keV
% β+ + %ε = 72,1


3⁻ ; 0
13,522 (16) a
ε
β+
0
152
Eu
63
89
γ Emission probabilities
per 100 disintegrations
24,72
2⁻ ; 1529,8073
27 fs
13
0,869
4+ ; 1371,691
1,4 ps
12
0,644
(2)+ ; 1292,771
8 ps
11
17,16
3+ ; 1233,8656
3 ps
10
21,35
2+ ; 1085,8499
0,87 ps
9
0,086
3⁻ ; 1041,1342
27 fs
8
0,238
4⁻ ; 1022,967
4,9 ps
7
1⁻ ; 963,36
6
1,28
2+ ; 810,4474
7,4 ps
5
6+ ; 706,91
4
0,77
0,0024
4+ ; 366,4786
57,7 ps
2
1,7
0,025
2+ ; 121,7818
1,400 ns
1
0+ ; 0
Stable
0
152
Sm
62
90
Q+ = 1874,3 keV
% β+ + %ε = 72,1


3 - ; 0
13,522 (16)
0
152
Eu
63 89
ε
β+
γ Emission probabilities
per 100 disintegrations
17,16
3+ ; 1233,8656
3 ps
10
21,35
2+ ; 1085,8499
0,87 ps
9
0,086
3 - ; 1041,1342
27 fs
8
0,238
4 - ; 1022,967
4,9 ps
7
1 - ; 963,36
6
1,28
2+ ; 810,4474
7,4 ps
5
6+ ; 706,91
4
0+ ; 684,714
3
0,77
0,0024
4+ ; 366,4786
57,7 ps
2
1,7
0,025
2+ ; 121,7818
1,400 ns
1
Stable
0+ ; 0
0
152
Sm
62 90
Q+ = 1874,3 keV
% β+ + %ε = 72,1


3⁻ ; 0
13,522 (16) a
β⁻
0
152
Eu
63 89
γ Emission probabilities
per 100 disintegrations
0,0203
1,826
0,101
0,0536
2,44
0,0267
0,0048
0,037
13,8
0,245
0,303
0,904
8,17
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
3⁺ ; 1692,447
2⁻ ; 1643,395
2⁺ ; 1605,255
4⁺ ; 1550,19
3⁺ ; 1434,025
2⁺ ; 1318,5
1⁻ ; 1314,71
4⁺ ; 1282,267
3⁻ ; 1123,184
2⁺ ; 1109,076
0⁺ ; 1047,51
2⁺ ; 930,562
7,3 ps
4⁺ ; 755,3964
7,3 ps
0⁺ ; 615,553
2⁺ ; 344,2798
32,4 ps
0⁺ ; 0
Stable
152
Gd
64 88
Q⁻ = 1818,8 keV
% β⁻ = 27,9


3⁻ ; 0
13,522 (16) a
0
152
Eu
63 89
β⁻
γ Emission probabilities
per 100 disintegrations
0,245
0,303
0,904
8,17
2⁺ ; 1109,076
0⁺ ; 1047,51
2⁺ ; 930,562
7,3 ps
4⁺ ; 755,3964
7,3 ps
0⁺ ; 615,553
2⁺ ; 344,2798
32,4 ps
0⁺ ; 0
Stable
152
Gd
64 88
Q⁻ = 1818,8 keV
% β⁻ = 27,9

$^{153}_{64}\mathrm{Gd}_{89}$

1 Decay Scheme

Gd-153 disintegrates by 100% electron capture to levels in Eu-153.
Le gadolinium 153 se désintègre à 100% par capture électronique vers des niveaux exités de l'europium 153.

2 Nuclear Data

$T_{1/2}(^{153}\mathrm{Gd}\ )$: 240,4 (10) d
$Q^{+}(^{153}\mathrm{Gd}\ )$: 484,4 (11) keV

2.1 Electron Capture Transitions

	Energy keV	Probability × 100	Nature	lg ft	P_K	P_L	P_M
$\epsilon_{0,4}$	311,5 (11)	15,9 (6)	1st forbidden	7,9	0,8019 (19)	0,1519 (4)	0,0359 (9)
$\epsilon_{0,3}$	381,2 (11)	42,4 (18)	1st forbidden	7,7	0,8111 (18)	0,1452 (16)	0,0341 (8)
$\epsilon_{0,2}$	387,0 (11)	38,0 (11)	Allowed	7,7	0,8116 (18)	0,1448 (16)	0,034 (8)
$\epsilon_{0,1}$	401,0 (11)	0,08 (7)	1st forbidden				
$\epsilon_{0,0}$	484,4 (11)	4 (3)	1st forbidden	8,9	0,8192 (17)	0,1392 (15)	0,0324 (8)

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{2,1}$(Eu)	14,06383 (20)	0,244 (61)	E1		8,70 (26)	1,92 (6)	11,2 (3)
$\gamma_{3,1}$(Eu)	19,81296 (19)	0,39 (1)	E2		2523 (76)	579 (17)	3290 (99)
$\gamma_{4,3}$(Eu)	69,67302 (13)	2,42 (7)	M1+1,8%E2	4,48 (14)	0,730 (23)	0,204 (6)	5,41 (16)
$\gamma_{4,2}$(Eu)	75,42215 (21)	0,138 (3)	E1+0,3%M2	0,63 (5)	0,113 (15)	0,032 (4)	0,77 (7)
$\gamma_{1,0}$(Eu)	83,36719 (17)	0,950 (7)	M1+65,6%E2	2,37 (7)	1,13 (5)	0,329 (12)	3,82 (12)
$\gamma_{4,1}$(Eu)	89,48598 (21)	0,252 (5)	M1+6,2%E2	2,15 (6)	0,39 (7)	0,110 (17)	2,65 (6)
$\gamma_{2,0}$(Eu)	97,43103 (17)	37,9 (8)	E1	0,258 (8)	0,0384 (12)	0,0105 (3)	0,307 (9)
$\gamma_{3,0}$(Eu)	103,18016 (13)	57,4 (6)	M1+1,4%E2	1,45 (5)	0,216 (7)	0,0603 (18)	1,72 (5)
$\gamma_{4,0}$(Eu)	172,85317 (13)	0,050 (2)	M1+65,6%E2	0,300 (5)	0,064 (2)	0,0184	0,382 (6)

3 Atomic Data

3.1 Eu

ω_K : 0,929 (4)
$\bar{\omega}_L$: 0,168 (7)
n_{KL} : 0,853 (4)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	40,9024		55,42
	$K\alpha_1$	41,5427		100
	$K\beta_3$	46,9004	}	
	$K\beta_1$	47,0384	}	
	$K\beta_5''$	47,373	}	31,5
	$K\beta_2$	48,2566	}	
	$K\beta_4$	48,386	}	8,1
	$KO_{2,3}$	48,4979	}	
X_L				
	$L\alpha$	5,85 –		
	$L\gamma$	– 8,03		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	32,25 – 34,38	100
KLX	38,59 – 41,27	51
KXY	44,9 – 48,2	6,5
Auger L	3,4 – 7,8	18,9

4 Electron Emissions

		Energy keV	Electrons per 100 disint.
e_{AL}	(Eu)	3,4 - 7,8	111,5 (25)
e_{AK}	(Eu)		9,3 (6)
	KLL	32,25 - 34,38	}
	KLX	38,59 - 41,27	}
	KXY	44,9 - 48,2	}
$ec_{2,1\ L}$	(Eu)	6,012 - 7,097	0,174 (24)
$ec_{3,1\ L}$	(Eu)	11,761 - 12,836	0,30 (8)
$ec_{4,3\ K}$	(Eu)	21,1540 (5)	10,8 (5)
$ec_{1,0\ K}$	(Eu)	34,8482 (5)	0,47 (2)
$ec_{2,0\ K}$	(Eu)	48,9120 (5)	7,5 (3)
$ec_{3,0\ K}$	(Eu)	54,6611 (5)	30,6 (11)
$ec_{4,3\ L}$	(Eu)	61,621 - 62,896	1,77 (8)
$ec_{4,3\ M}$	(Eu)	67,873 - 68,742	0,49 (2)
$ec_{1,0\ L}$	(Eu)	75,315 - 76,390	0,22 (2)
$ec_{2,0\ L}$	(Eu)	89,379 - 90,454	1,10 (5)
$ec_{3,0\ L}$	(Eu)	95,128 - 96,203	4,6 (2)
$ec_{2,0\ M}$	(Eu)	95,631 - 96,300	0,30 (1)
$ec_{3,0\ M}$	(Eu)	101,38 - 102,10	1,30 (5)

5 Photon Emissions

5.1 X-Ray Emissions

		Energy keV	Photons per 100 disint.	
XL	(Eu)	5,85 — 8,03	22,5 (11)	
$XK\alpha_2$	(Eu)	40,9024	34,5 (9)	} $K\alpha$
$XK\alpha_1$	(Eu)	41,5427	62,2 (15)	}
$XK\beta_3$	(Eu)	46,9004 }		
$XK\beta_1$	(Eu)	47,0384 }	19,6 (6)	$K'\beta_1$
$XK\beta_5''$	(Eu)	47,373 }		
$XK\beta_2$	(Eu)	48,2566 }		
$XK\beta_4$	(Eu)	48,386 }	5,05 (17)	$K'\beta_2$
$XKO_{2,3}$	(Eu)	48,4979 }		

5.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{2,1}$(Eu)	14,06383 (20)	0,020 (5)
$\gamma_{3,1}$(Eu)	19,81296 (19)	0,00012
$\gamma_{4,3}$(Eu)	69,67302 (13)	2,42 (7)
$\gamma_{4,2}$(Eu)	75,42213 (23)	0,078 (3)
$\gamma_{1,0}$(Eu)	83,36717 (21)	0,197 (7)
$\gamma_{4,1}$(Eu)	89,48595 (22)	0,069 (5)
$\gamma_{2,0}$(Eu)	97,43100 (21)	29,0 (8)
$\gamma_{3,0}$(Eu)	103,18012 (17)	21,1 (6)
$\gamma_{4,0}$(Eu)	172,85307 (21)	0,036 (2)

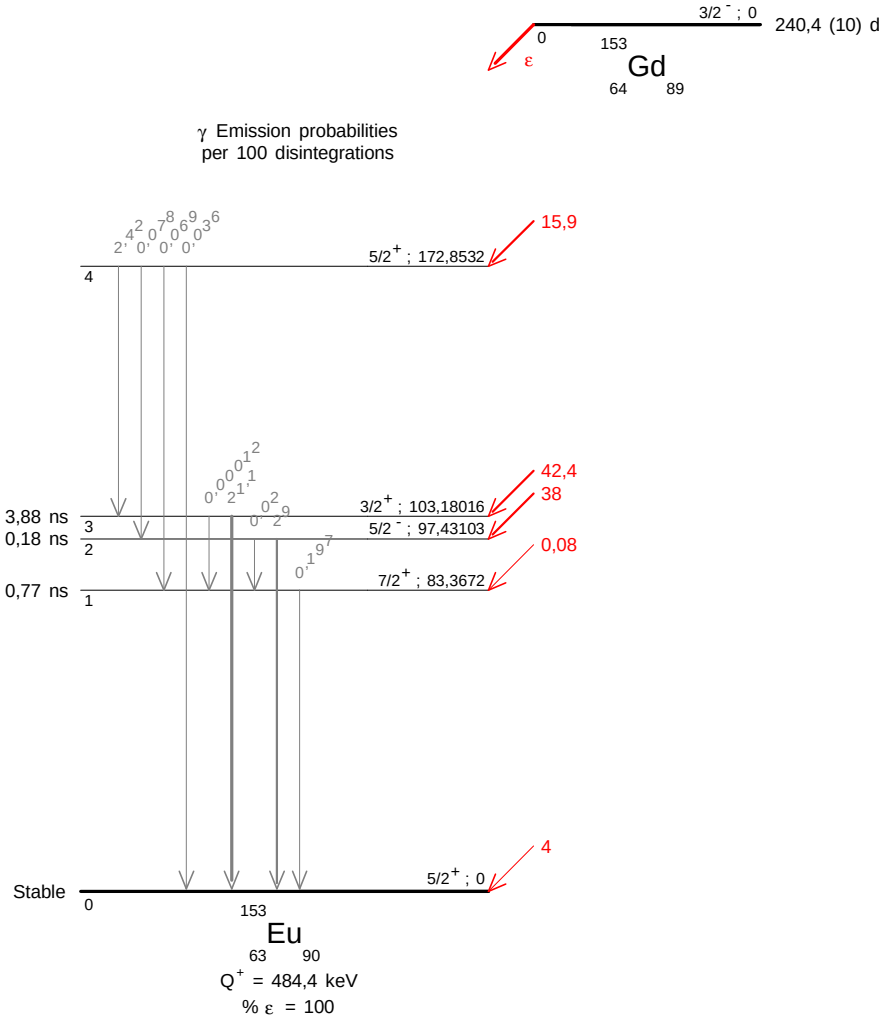
6 Main Production Modes

$\mathrm{Gd-152(n,\gamma)Gd-153}$
$\mathrm{Eu-153(d,2n)Gd-153}$

7 References

- R.E.Hein, A.F.Voigt. Phys.Rev. 79 (1950) 783
  (Half-life)
- D.C.Hoffman. J. Inorg. Nucl. Chem. 25 (1963) 1196
  (Half-life)
- K.Mühlbauer. Z.Phys. 230 (1970) 18
  (Gamma-ray energies)
- J.F.Emery, S.A.Reynolds, E.I.Wyatt, K.I. Gleason. Nucl.Sci.Eng. 48 (1972) 319
  (Half-life)
- V.A.Sergienko, V.M.Lebedev. Bull. Ac.Sc. URSS Phys.Ser.38 4 (1974) 122
  (Gamma-ray emmission probabilities)
- K.Singh, H.S.Sahota. Indian J. Phys. 59A (1985) 95
  (Gamma-ray emmission probabilities)
- E.Browne, R.B.Firestone. Table of Radioactive Isotopes, Appendix C, Table 7a (John Wiley and Sons, New York) C (1986) 7a
  (P Xrel)
- B.M.Coursey, D.D.Hoppes, F.J.Shima, M.P.Unterweger. Appl. Rad. Isotopes 38 (1987) 31
  (Gamma-ray emmission probabilities)
- S.Subrahmanyeswara Rao, K.Bhaskara Rao, V.Seshagiri Rao, H.C.Padhi. J.Phys.G.Nucl.Phys 14 (1988) 1259
  (Gamma-ray emmission probabilities)
- N.Venkateswara Rao, G.S.Sri Krishna, S. Bhuloka Reddy, C.V.Raghavaiah, G.Satyanarayana, D.L.Sastry. Nuovo Cim. 99A (1988) 303
  (Gamma-ray emmission probabilities)
- Yu.S.Popov, N.Yu.Nezgovorov, G.A.Timofeev. Sov. J. Radiochem. 31 (1989) 1
  (Half-life)
- B.Chand, J.Goswamy, D.Metha, N.Singh, P.N.Trehan. Appl. Rad. Isotopes 43 (1992) 997
  (Gamma-ray emmission probabilities)
- V.P.Chechev, A.G.Egorov. Nucl. Instrum. Methods Phys. Res. A 312 (1992) 378
  (Gamma-ray emmission probabilities)

- M.P.Unterweger, D.D.Hoppes, F.J.Shima. Nucl. Instrum. Methods Phys. Res. A 312 (1992) 349
(Half-life)
- A.G.Egorov, V.P.Chechev, G.E.Shchukin. Bull. Acad. Sci. URSS, Phys. 57 5 (1993) 911
(Gamma-ray emmission probabilities)
- E. Schönfeld. Report PTB 6.33-95-2 (1995)
(Elec. capt. probabilities in atomic shells)
- V.Kumar, Kawaldeep, K.Singh. J.Radioanal.Nucl.Chem. 189 (1995) 3
(Gamma-ray emmission probabilities)
- G. Audi, A.H.Wapstra. Nucl.Phys. A595 (1995) 409
(Q)
- E. Schönfeld, H.Janssen. Nucl. Instrum. Methods Phys. Res. A 369 (1996) 572
(Atomic Data)
- R.G.Helmer. Nuclear Data Sheets 83 (1998) 285
(Multipolarities)
- R.G.Helmer, C.van der Leun. Nucl. Instrum. Methods Phys. Res. A450 (2000) 35
(Gamma-ray energies)


3/2 - ; 0
240,4 (10) d
0
ε
153
Gd
64
89
γ Emission probabilities
per 100 disintegrations
15,9
5/2+ ; 172,8532
4
42,4
38
3,88 ns
0,18 ns
3
3/2+ ; 103,18016
5/2 - ; 97,43103
2
0,08
7/2+ ; 83,3672
0,77 ns
1
4
Stable
5/2+ ; 0
0
153
Eu
63
90
Q+ = 484,4 keV
% ε = 100

$^{153}_{62}\mathrm{Sm}_{91}$

1 Decay Scheme

Sm-153 disintegrates via 3 main branches and at least 10 others very weak branches by 100% beta-emission to levels in Eu-153.
Le samarium 153 se désintègre vers 3 branches principales et vers au moins 10 autres branches plus faibles de l'europium 153 par émission bêta moins.

2 Nuclear Data

$T_{1/2}(^{153}\mathrm{Sm}\ )$: 1,92849 (11) d
$Q^-(^{153}\mathrm{Sm}\ )$: 808,2 (8) keV

2.1 β^- Transitions

	Energy keV	Probability × 100	Nature	lg ft
$\beta^-_{0,18}$	44,4 (8)	0,000025 (25)		8,9
$\beta^-_{0,17}$	47,8 (8)	0,00063 (7)		7,9
$\beta^-_{0,16}$	89,5 (8)	0,00134 (15)	Allowed	8,4
$\beta^-_{0,15}$	95,1 (8)	0,0135 (8)		7,4
$\beta^-_{0,14}$	101,6 (8)	0,0237 (8)	Allowed	7,3
$\beta^-_{0,13}$	106,7 (8)	0,00076 (15)		8,8
$\beta^-_{0,12}$	114,0 (8)	0,0242 (10)	Allowed	7,4
$\beta^-_{0,11}$	126,3 (8)	0,0102 (4)	1st forbidden	7,9
$\beta^-_{0,10}$	150,5 (8)	0,0005 (5)		9,3
$\beta^-_{0,9}$	171,7 (8)	0,0665 (13)	1st forbidden	7,5
$\beta^-_{0,8}$	173,5 (8)	0,0568 (11)	Allowed	7,6
$\beta^-_{0,7}$	223,2 (8)	0,00228 (6)		9,4
$\beta^-_{0,6}$	538,4 (8)	0,0012 (12)	2nd forbidden	11
$\beta^-_{0,5}$	635,3 (8)	31,1 (10)	Allowed	6,7
$\beta^-_{0,4}$	656,6 (8)	0,034 (12)	Unique 1st forbidden	10
$\beta^-_{0,3}$	705,0 (8)	49,6 (19)	Allowed	6,7

	Energy keV	Probability × 100	Nature	lg ft
$\beta^-_{0,2}$	710,8 (8)	0,59 (6)	1st forbidden	8,6
$\beta^-_{0,0}$	808,2 (8)	18,4 (18)	Allowed	7,3

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{2,1}$(Eu)	14,06383 (24)		E1		8,7 (3)	1,92 (6)	11,2 (4)
$\gamma_{3,1}$(Eu)	19,81296 (21)	0,28	E2		2523 (76)	579 (18)	3290 (99)
$\gamma_{4,2}$(Eu)	54,1936 (12)	0,0304 (4)	M1+E2	7,9 (15)	5 (4)	1,5 (8)	15 (5)
$\gamma_{4,1}$(Eu)	68,2557 (12)	0,0023 (4)	E1	0,664 (20)	0,105 (3)	0,0285 (9)	0,797 (24)
$\gamma_{5,3}$(Eu)	69,67300 (13)	30,32 (3)	M1+1,82%E2	4,48 (13)	0,731 (23)	0,204 (6)	5,41 (16)
$\gamma_{5,2}$(Eu)	75,42213 (21)	0,342 (26)	E1+0,3%M2	0,63 (5)	0,113 (14)	0,032 (4)	0,77 (7)
$\gamma_{1,0}$(Eu)	83,36717 (17)	0,927 (7)	M1+40%E2	2,37 (8)	1,13 (6)	0,329 (12)	3,83 (12)
$\gamma_{5,1}$(Eu)	89,48595 (21)	0,577 (55)	M1+5,8%E2	2,15 (7)	0,39 (7)	0,111 (17)	2,65 (10)
$\gamma_{6,5}$(Eu)	96,8825 (7)	0,024	M1+E2	1,52 (23)	0,7 (5)	0,16 (9)	2,4 (4)
$\gamma_{2,0}$(Eu)	97,43100 (21)	1,009 (18)	E1	0,258 (8)	0,0384 (12)	0,0105 (3)	0,307 (9)
$\gamma_{3,0}$(Eu)	103,18012 (17)	79,7 (3)	M1+1,4%E2	1,45 (4)	0,216 (6)	0,061 (2)	1,72 (5)
$\gamma_{6,4}$(Eu)	118,1105 (10)	0,00027 (6)	[E1]	0,153 (5)	0,0223 (7)	0,0061 (2)	0,181 (5)
$\gamma_{4,0}$(Eu)	151,6245 (12)	0,0116 (4)	E1	0,0782 (23)	0,0111 (3)	0,00315 (9)	0,092 (3)
$\gamma_{6,3}$(Eu)	166,5548 (15)	0,00086 (6)	[E2]	0,268 (9)	0,104 (3)	0,0304 (9)	0,403 (12)
$\gamma_{6,2}$(Eu)	172,3035 (13)	0,0004	[E1]	0,0555 (16)	0,0078 (2)	0,00214 (6)	0,0655 (20)
$\gamma_{5,0}$(Eu)	172,85307 (21)	0,1019 (20)	M1+40%E2	0,301 (10)	0,064 (3)	0,0184 (8)	0,382 (11)
$\gamma_{7,5}$(Eu)	412,17 (10)	0,00192 (5)					
$\gamma_{12,6}$(Eu)	424,45 (11)	0,00189 (5)					
$\gamma_{14,6}$(Eu)	436,89 (9)	0,00170 (15)					
$\gamma_{15,6}$(Eu)	443,38 (20)	0,000088 (15)					
$\gamma_{8,5}$(Eu)	461,81 (12)	0,00158 (26)					
$\gamma_{9,5}$(Eu)	463,62 (10)	0,0136 (6)					
$\gamma_{10,5}$(Eu)	484,82 (14)	0,00038 (3)					
$\gamma_{7,2}$(Eu)	487,59 (15)	0,00036					
$\gamma_{11,5}$(Eu)	509,06 (10)	0,00199 (18)					
$\gamma_{12,5}$(Eu)	521,34 (11)	0,0069 (3)					
$\gamma_{8,3}$(Eu)	531,47 (12)	0,0547 (9)					
$\gamma_{9,3}$(Eu)	533,29 (10)	0,0299 (6)					
$\gamma_{9,2}$(Eu)	539,04 (10)	0,0211 (6)					
$\gamma_{12,4}$(Eu)	542,56 (11)	0,0032 (9)					
$\gamma_{16,5}$(Eu)	545,84 (14)	0,00076 (3)					
$\gamma_{14,4}$(Eu)	555,01 (9)	0,00474 (9)					
$\gamma_{10,1}$(Eu)	574,31 (14)	0,00016 (5)					
$\gamma_{11,3}$(Eu)	578,73 (10)	0,00328 (9)					
$\gamma_{11,2}$(Eu)	584,48 (10)	0,00106 (3)					
$\gamma_{17,5}$(Eu)	587,54 (17)	0,00050 (5)					
$\gamma_{12,3}$(Eu)	591,01 (11)	0,00118 (5)					
$\gamma_{12,2}$(Eu)	596,76 (11)	0,0109 (3)					
$\gamma_{13,3}$(Eu)	598,28 (24)	0,0018 (3)					
$\gamma_{11,1}$(Eu)	598,54 (10)	0,0018 (3)					
$\gamma_{14,3}$(Eu)	603,45 (9)	0,00448 (12)					
$\gamma_{13,2}$(Eu)	604,03 (24)	0,00448 (12)					
$\gamma_{14,2}$(Eu)	609,20 (9)	0,0128 (7)					
$\gamma_{15,3}$(Eu)	609,95 (20)	0,0128 (7)					
$\gamma_{16,3}$(Eu)	615,51 (14)	0,00056 (15)					
$\gamma_{15,2}$(Eu)	615,69 (20)	0,00056 (15)					
$\gamma_{13,1}$(Eu)	618,09 (24)	0,00073 (15)					

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{15,1}$(Eu)	629,75 (20)	0,000099 (15)					
$\gamma_{8,0}$(Eu)	634,66 (12)	0,00052 (6)					
$\gamma_{9,0}$(Eu)	636,47 (10)	0,00193 (12)					
$\gamma_{17,3}$(Eu)	657,21 (7)	0,00040 (2)					
$\gamma_{10,0}$(Eu)	657,67 (25)	0,00040 (2)					
$\gamma_{17,2}$(Eu)	662,96 (17)	0,00005 (4)					
$\gamma_{17,1}$(Eu)	677,02 (17)	0,000044 (15)					
$\gamma_{11,0}$(Eu)	681,91 (10)	0,00015 (12)					
$\gamma_{12,0}$(Eu)	694,19 (11)	0,000020 (6)					
$\gamma_{13,0}$(Eu)	701,46 (24)	0,000029 (6)					
$\gamma_{14,0}$(Eu)	706,63 (9)	0,000023 (12)					
$\gamma_{15,0}$(Eu)	713,12	0,000231 (20)					
$\gamma_{16,0}$(Eu)	718,69 (14)	0,000025 (5)					
$\gamma_{17,0}$(Eu)	760,39 (17)	0,000032 (5)					
$\gamma_{18,0}$(Eu)	763,8 (8)	0,000044 (12)					

3 Atomic Data

3.1 Eu

ω_K : 0,929 (4)
$\bar{\omega}_L$: 0,168 (7)
n_{KL} : 0,853 (4)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	40,9024		55,42
	$K\alpha_1$	41,5427		100
	$K\beta_3$	46,904	}	
	$K\beta_1$	47,0384	}	
	$K\beta_5''$	47,373	}	31,5
	$K\beta_2$	48,266	}	
	$K\beta_4$	48,386	}	8,13
	$KO_{2,3}$	48,499	}	
X_L				
	$L\alpha$	5,18 – 8,03		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	32,24 – 34,38	100
KLX	38,59 – 41,52	51
KXY	44,9 – 48,5	6,5
Auger L	3,4 – 7,8	1870

4 Electron Emissions

		Energy keV	Electrons per 100 disint.
e_{AL}	(Eu)	3,4 - 7,8	56,1 (16)
e_{AK}	(Eu)		4,7 (3)
	KLL	32,24 - 34,38 }	
	KLX	38,59 - 41,52 }	
	KXY	44,9 - 48,5 }	
$ec_{3,1\ L}$	(Eu)	11,760 - 12,836	0,214
$ec_{5,3\ T}$	(Eu)	21,154 - 68,542	25,6 (11)
$ec_{5,3\ K}$	(Eu)	21,1541 (5)	21 (1)
$ec_{5,2\ K}$	(Eu)	26,9031 (5)	0,122 (17)
$ec_{1,0\ K}$	(Eu)	34,8482 (5)	0,46 (3)
$ec_{5,1\ K}$	(Eu)	40,9669 (5)	0,34 (3)
$ec_{2,0\ K}$	(Eu)	48,9121 (5)	0,199 (6)
$ec_{3,0\ T}$	(Eu)	54,661 - 102,049	50,3 (15)
$ec_{3,0\ K}$	(Eu)	54,6611 (5)	42,4 (13)
$ec_{5,3\ L}$	(Eu)	61,621 - 62,696	3,46 (17)
$ec_{5,3\ M}$	(Eu)	67,873 - 68,542	0,96 (5)
$ec_{1,0\ L}$	(Eu)	75,315 - 76,390	0,22 (1)
$ec_{5,1\ L}$	(Eu)	81,434 - 82,509	0,062 (6)
$ec_{1,0\ M}$	(Eu)	81,567 - 82,236	0,063 (3)
$ec_{3,0\ L}$	(Eu)	95,128 - 96,203	6,3 (2)
$ec_{3,0\ M}$	(Eu)	101,380 - 102,049	1,78 (6)
$\beta^-_{0,18}$	max:	44,4 (8)	0,000025 (25)
$\beta^-_{0,18}$	avg:	11,3 (3)	
$\beta^-_{0,17}$	max:	47,8 (8)	0,00063 (7)
$\beta^-_{0,17}$	avg:	12,19 (22)	
$\beta^-_{0,16}$	max:	89,5 (8)	0,00134 (15)
$\beta^-_{0,16}$	avg:	23,29 (22)	

		Energy keV		Electrons per 100 disint.
$\beta^-_{0,15}$	max:	95,1	(8)	0,0135 (8)
$\beta^-_{0,15}$	avg:	24,80	(23)	
$\beta^-_{0,14}$	max:	101,6	(8)	0,0237 (8)
$\beta^-_{0,14}$	avg:	26,57	(22)	
$\beta^-_{0,13}$	max:	106,7	(8)	0,00076 (15)
$\beta^-_{0,13}$	avg:	27,99	(25)	
$\beta^-_{0,12}$	max:	114,0	(8)	0,0242 (10)
$\beta^-_{0,12}$	avg:	29,99	(23)	
$\beta^-_{0,11}$	max:	126,3	(8)	0,0102 (4)
$\beta^-_{0,11}$	avg:	33,41	(23)	
$\beta^-_{0,10}$	max:	150,5	(8)	0,0005 (5)
$\beta^-_{0,10}$	avg:	40,24	(24)	
$\beta^-_{0,9}$	max:	171,7	(8)	0,0665 (13)
$\beta^-_{0,9}$	avg:	46,32	(24)	
$\beta^-_{0,8}$	max:	173,5	(8)	0,0568 (11)
$\beta^-_{0,8}$	avg:	46,84	(24)	
$\beta^-_{0,7}$	max:	223,2	(8)	0,00228 (6)
$\beta^-_{0,7}$	avg:	61,5	(3)	
$\beta^-_{0,6}$	max:	538,4	(8)	0,0012 (12)
$\beta^-_{0,6}$	avg:	164,9	(3)	
$\beta^-_{0,5}$	max:	635,3	(8)	31,1 (10)
$\beta^-_{0,5}$	avg:	199,7	(3)	
$\beta^-_{0,4}$	max:	656,6	(8)	0,034 (12)
$\beta^-_{0,4}$	avg:	221,2	(3)	
$\beta^-_{0,3}$	max:	705,0	(8)	49,6 (19)
$\beta^-_{0,3}$	avg:	225,3	(3)	
$\beta^-_{0,2}$	max:	710,8	(8)	0,59 (6)
$\beta^-_{0,2}$	avg:	227,6	(3)	
$\beta^-_{0,0}$	max:	808,2	(8)	18,4 (18)
$\beta^-_{0,0}$	avg:	264,5	(3)	

5 Photon Emissions

5.1 X-Ray Emissions

		Energy keV	Photons per 100 disint.	
XL	(Eu)	5,18 — 8,03	10,04 (15)	
XKα_2	(Eu)	40,9024	16,3 (3)	} Kα
XKα_1	(Eu)	41,5427	29,3 (4)	}

		Energy keV		Photons per 100 disint.	
$XK\beta_3$	(Eu)	46,904	}		
$XK\beta_1$	(Eu)	47,0384	}	9,20 (14)	$K'\beta_1$
$XK\beta_5''$	(Eu)	47,373	}		
$XK\beta_2$	(Eu)	48,266	}		
$XK\beta_4$	(Eu)	48,386	}	2,36 (11)	$K'\beta_2$
$XKO_{2,3}$	(Eu)	48,499	}		

5.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{3,1}$(Eu)	19,81296 (21)	0,000085
$\gamma_{4,2}$(Eu)	54,1936 (12)	0,0019 (4)
$\gamma_{4,1}$(Eu)	68,2574 (12)	0,0013 (4)
$\gamma_{5,3}$(Eu)	69,67300 (13)	4,73 (3)
$\gamma_{5,2}$(Eu)	75,42213 (23)	0,193 (26)
$\gamma_{1,0}$(Eu)	83,36717 (21)	0,192 (7)
$\gamma_{5,1}$(Eu)	89,48595 (22)	0,158 (15)
$\gamma_{6,5}$(Eu)	96,8824 (7)	0,007
$\gamma_{2,0}$(Eu)	97,43100 (21)	0,772 (18)
$\gamma_{3,0}$(Eu)	103,18012 (17)	29,26 (32)
$\gamma_{6,4}$(Eu)	118,1105 (10)	0,00023 (6)
$\gamma_{4,0}$(Eu)	151,6244 (12)	0,0106 (4)
$\gamma_{6,3}$(Eu)	166,5546 (15)	0,00061 (6)
$\gamma_{6,2}$(Eu)	172,3032 (13)	0,0004
$\gamma_{5,0}$(Eu)	172,85307 (21)	0,0737 (20)
$\gamma_{7,5}$(Eu)	412,05 (20)	0,00192 (5)
$\gamma_{12,6}$(Eu)	424,4 (3)	0,00189 (5)
$\gamma_{14,6}$(Eu)	436,9 (3)	0,00170 (15)
$\gamma_{15,6}$(Eu)	443,2 (5)	0,000088 (15)
$\gamma_{8,5}$(Eu)	462,0 (3)	0,00158 (26)
$\gamma_{9,5}$(Eu)	463,6 (2)	0,0136 (6)
$\gamma_{10,5}$(Eu)	485,0 (2)	0,00038 (3)
$\gamma_{7,2}$(Eu)	487,75 (23)	0,00036
$\gamma_{11,5}$(Eu)	509,15 (20)	0,00199 (18)
$\gamma_{12,5}$(Eu)	521,30 (25)	0,0069 (3)
$\gamma_{8,3}$(Eu)	531,40 (15)	0,0547 (9)
$\gamma_{9,3}$(Eu)	533,2 (2)	0,0299 (6)
$\gamma_{9,2}$(Eu)	539,1 (2)	0,0211 (6)
$\gamma_{12,4}$(Eu)	542,7 (2)	0,0032 (9)
$\gamma_{16,5}$(Eu)	545,75 (15)	0,00076 (3)
$\gamma_{14,4}$(Eu)	554,94 (10)	0,00474 (9)
$\gamma_{10,1}$(Eu)	574,1 (3)	0,00016 (5)
$\gamma_{11,3}$(Eu)	578,75 (20)	0,00328 (9)

	Energy keV	Photons per 100 disint.
$\gamma_{11,2}$(Eu)	584,55 (20)	0,00106 (3)
$\gamma_{17,5}$(Eu)	587,60 (25)	0,00050 (5)
$\gamma_{12,3}$(Eu)	590,96 (20)	0,00118 (5)
$\gamma_{12,2}$(Eu)	596,7 (2)	0,0109 (3)
$\gamma_{13,3}$(Eu)	598,3 (3)	0,0018 (3)
$\gamma_{11,1}$(Eu)	598,54 (10)	0,0018 (3)
$\gamma_{14,3}$(Eu)	603,6 (4)	0,00448 (12)
$\gamma_{13,2}$(Eu)	604,03 (24)	0,00448 (12)
$\gamma_{14,2}$(Eu)	609,5 (3)	0,0128 (7)
$\gamma_{15,3}$(Eu)	609,95 (20)	0,0128 (7)
$\gamma_{16,3}$(Eu)	615,51 (14)	0,00056 (15)
$\gamma_{15,2}$(Eu)	615,8 (4)	0,00056 (15)
$\gamma_{13,1}$(Eu)	617,9 (3)	0,00073 (15)
$\gamma_{15,1}$(Eu)	630,5 (4)	0,000099 (15)
$\gamma_{8,0}$(Eu)	634,8 (3)	0,00052 (6)
$\gamma_{9,0}$(Eu)	636,5 (2)	0,00193 (12)
$\gamma_{17,3}$(Eu)	657,21 (7)	0,00040 (2)
$\gamma_{10,0}$(Eu)	657,55 (25)	0,00040 (2)
$\gamma_{17,2}$(Eu)	662,4 (6)	0,00005 (4)
$\gamma_{17,1}$(Eu)	677,0 (3)	0,000044 (15)
$\gamma_{11,0}$(Eu)	682,0 (6)	0,00015 (12)
$\gamma_{12,0}$(Eu)	694,1 (3)	0,000020 (6)
$\gamma_{13,0}$(Eu)	701,8 (4)	0,000029 (6)
$\gamma_{14,0}$(Eu)	706,8 (5)	0,000023 (12)
$\gamma_{15,0}$(Eu)	713,9 (3)	0,000231 (20)
$\gamma_{16,0}$(Eu)	719,0 (4)	0,000025 (5)
$\gamma_{17,0}$(Eu)	760,5 (4)	0,000032 (5)
$\gamma_{18,0}$(Eu)	763,8 (6)	0,000044 (12)

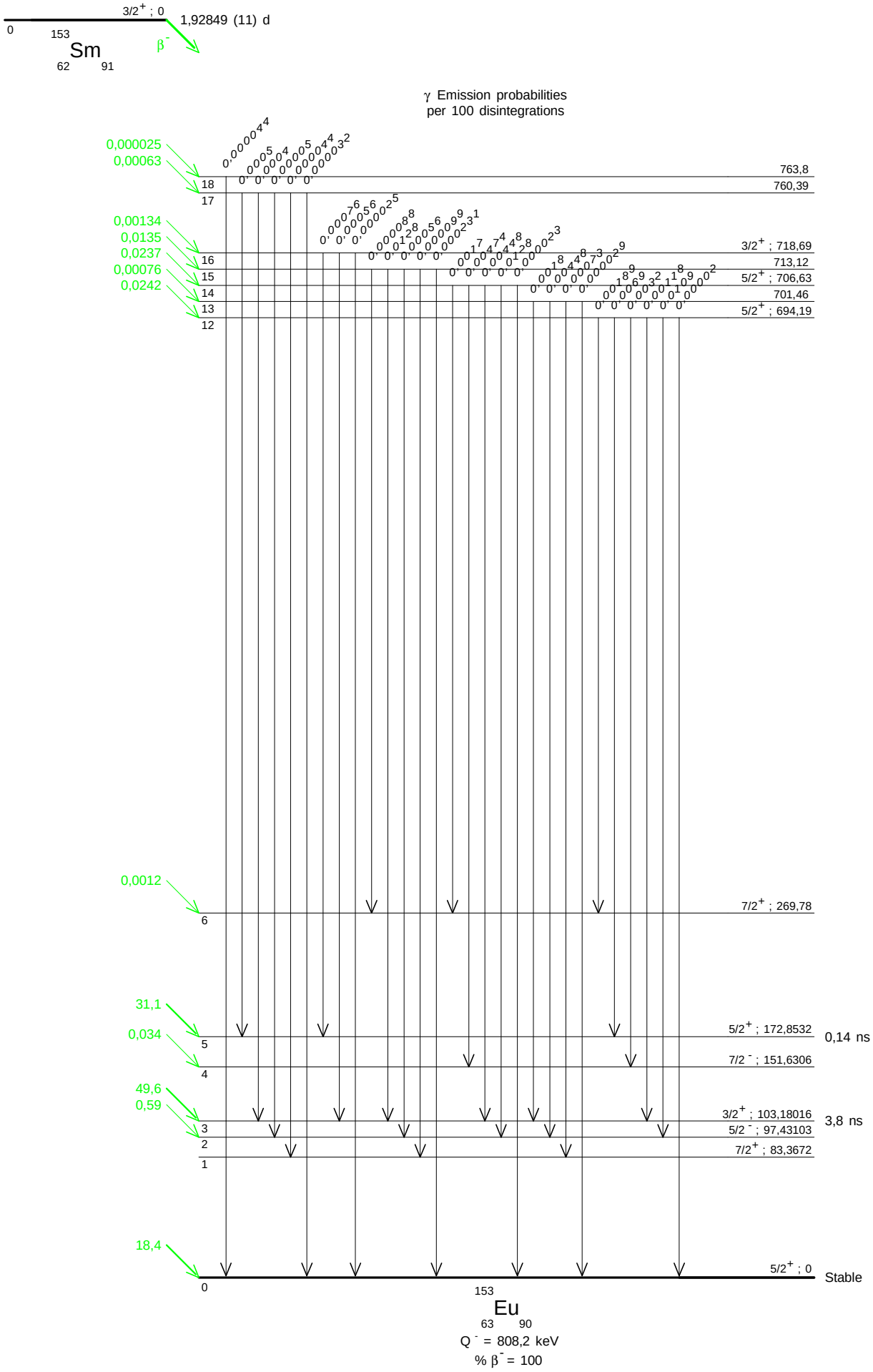
6 Main Production Modes

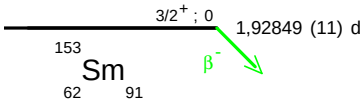
$\mathrm{Sm-152(n,\gamma)Sm-153}$
$\mathrm{Nd-150(\alpha,n)Sm-153}$

7 References

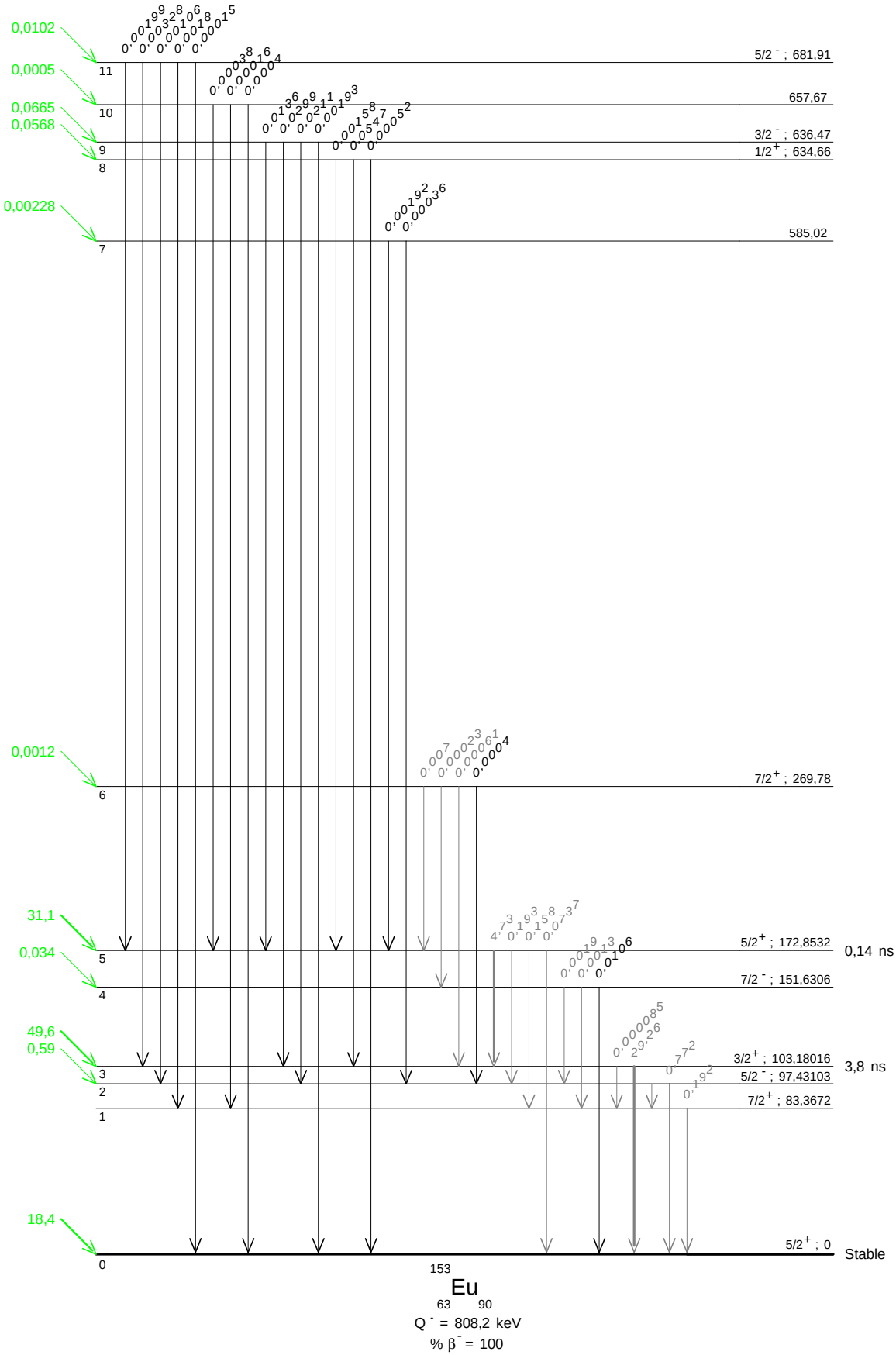
- M. E. Lee, R. Katz. Phys. Rev. 93 (1954) 155
  (Half-life)
- J. M. Cork, M. K. Brice, R. G. Helmer, R. M. Woods. Phys. Rev. 110 (1958) 526
  (Half-life)
- E. Monnand, A. Moussa. Nucl. Phys. 25 (1961) 292
  (L1/L2/L3, eA, KXY/KLX/KLL, E2/M1 for 70/83, Conv. Elec.)
- R. E. Green, W. H. Walker. Can. J. Phys. 39 (1961) 1216
  (Half-life)
- E. I. Wyatt, S. A. Reynolds, T. H. Handley, W. S. Lyon, H. A. Parker. Nucl. Sci. Eng. 11 (1961) 74
  (Half-life)

- M. J. Cabell. J. Inorg. Nucl. Chem. 24 (1961) 749
(Half-life)
- T. Suter, P. Reyes-Suter, S. Gustafson, I. Marklund. Nucl. Phys. 29 (1962) 33
(Gamma emission probabilities, mixing ratios, Gamma ray energies, Conv. Elec. emission energies, Conv. Elec. emission probabilities, K ICC)
- D. C. Hoffman. J. Inorg. Nucl. Chem. 25 (1963) 1196
(Half-life)
- P. Alexander. Phys. Rev. 134 (1964) B499
(Gamma emission probabilities)
- P. H. Blichert-Toft, E. G. Funk, J. W. Mihelich. Nucl. Phys. 79 (1966) 12
(Gamma emission probabilities)
- R. Smither, E. Bieber, T. von Egidy, W. Kaiser, K. Wien. Phys. Rev. 187 (1969) 1632
(Gamma emission probabilities)
- J. Ungrin, M. W. Johns. Nucl. Phys. A127 (1969) 353
(Gamma emission probabilities, Gamma ray energies)
- Y. Patin. Compt. Rend. 268B (1969) 574
(Gamma emission probabilities, Gamma ray energies)
- K. Muhlbauer. Z. Phys. 230 (1970) 18
(Gamma ray energies)
- Y. Y. Chu, E. M. Franz, G. Friedlander. Phys. Rev. C1 (1970) 1826
(Half-life)
- S. Baba, H. Baba, H. Natsume. J. Inorg. Nucl. Chem. 33 (1971) 589
(Half-life)
- S. Abdel-Malak, S. M. Darwish, M. Abou-Leila, N. Walley El-Din, A. M. Hassan. Z. Phys. A322 (1985) 163
(Gamma emission probabilities and energies)
- E. Browne, R. B. Firestone. Table of Radioact. Isot., Ann. C, Table 7a (John Wiley & Sons, New York) (1986)
(PX)
- B. M. Coursey, D. D. Hoppes, F. J. Schima, M. P. Unterweger. Appl. Rad. Isotopes 38 (1987) 31
(Gamma emission probabilities)
- R. G. Helmer. Nucl. Data Sheets 83 (1988) 285
(Multipolarities)
- M. P. Unterweger, D. D. Hoppes, F. J. Schima. Nucl. Instrum. Methods Phys. Res. A312 (1992) 349
(Half-life)
- B. Chand, J. Goswamy, D. Mehta, N. Sing, P. N. Trehan. Appl. Rad. Isotopes 43 (1992) 997
(Gamma emission probabilities)
- B. M. Coursey, J. M. Calhoun, J. Cessna, D. B. Golas, F. J. Schima, M. P. Unterweger. Nucl. Instrum. Methods Phys. Res. A339 (1994) 26
(Half-life)
- G. Audi, A. H. Wapstra. Nucl. Phys. A595 (1995) 409
(Q)
- E. Schönfeld, H. Janssen. Nucl. Instrum. Methods Phys. Res. A369 (1996) 572
(P(KBeta)/P(KAlpha), P(KLX)/P(KLL), P(KXY)P(KLL), n)
- N. E. Bowles, S. A. Woods, D. H. Woods, S. M. Jerome, M. J. Woods, P. de Lavison, S. Lineham, J. Keightley, J. Poupaki. Appl. J. Rad. Isotopes (1997)
(Half-life)
- R. G. Helmer, C. van der Leun. Nucl. Instrum. Methods Phys. Res. A450 (2000) 35
(Gamma ray energies)


3/2+ ; 0
1,92849 (11) d
0
153
Sm
62
91
β-
γ Emission probabilities
per 100 disintegrations
0,000025
0,00063
0,00134
0,0135
0,0237
0,00076
0,0242
0,0012
31,1
0,034
49,6
0,59
18,4
763,8
760,39
713,12
3/2+ ; 718,69
5/2+ ; 706,63
701,46
5/2+ ; 694,19
7/2+ ; 269,78
5/2+ ; 172,8532
0,14 ns
7/2 - ; 151,6306
3/2+ ; 103,18016
3,8 ns
5/2 - ; 97,43103
7/2+ ; 83,3672
5/2+ ; 0
Stable
18
17
16
15
14
13
12
6
5
4
3
2
1
0
153
Eu
63
90
Q - = 808,2 keV
% β- = 100



γ Emission probabilities
per 100 disintegrations



153
Eu
63 90
Q - = 808,2 keV
% β- = 100

$^{154}_{63}\mathrm{Eu}_{91}$

1 Decay Scheme

Eu-154 disintegrates by 99.982 % beta decay via excited levels of Gd-154 and by 0.018 % electron capture via excited levels of Sm-154. Transitions to the ground states of Gd-154 and Sm-154 have not been observed.
L'europium 154 se désintègre par émission bêta vers les niveaux excités de gadolinium 154 (99,982%) et par capture électronique vers les niveaux excités de samarium 154 (0,02%). Des transitions vers les niveaux fondamentaux du gadolinium 154 et du samarium 154 n'ont pas été observées.

2 Nuclear Data

$T_{1/2}(^{154}\mathrm{Eu})$	:	8,601	(4)	a
$Q^+(^{154}\mathrm{Eu})$	:	717,3	(11)	keV
$Q^-(^{154}\mathrm{Eu})$	:	1968,4	(11)	keV

2.1 Electron Capture Transitions

	Energy keV	Probability × 100	Nature	lg ft	P_K	P_L	P_M
$\epsilon_{0,2}$	450,6 (11)	0,0047 (8)	1st forbidden	12,9	0,8205 (16)	0,1393 (11)	0,0322 (6)
$\epsilon_{0,1}$	635,3 (11)	0,013 (13)	1st forbidden	12,7	0,8289 (16)	0,1330 (11)	0,0305 (6)

2.2 β^- Transitions

	Energy keV	Probability × 100	Nature	lg ft
$\beta^-_{0,33}$	73,7 (11)	0,0035 (6)	1 st forbidden	10,92
$\beta^-_{0,32}$	89,4 (11)	0,0042 (3)		
$\beta^-_{0,31}$	107,2 (11)	0,034 (3)	allowed	10,44
$\beta^-_{0,30}$	130,1 (12)	0,017 (5)	1 st forbidden	10,99
$\beta^-_{0,29}$	171,7 (12)	0,060 (6)	allowed	10,8

	Energy keV	Probability × 100	Nature	lg ft
$\beta^-_{0,28}$	178,1 (11)	0,022 (1)	1 st forbidden	11,31
$\beta^-_{0,27}$	197,9 (11)	0,0022 (4)	1 st forbidden	12,46
$\beta^-_{0,26}$	248,8 (11)	28,32 (22)	allowed	8,66
$\beta^-_{0,25}$	270,2 (11)	0,0100 (4)	(1 st forbidden)	12,33
$\beta^-_{0,24}$	307,5 (11)	0,849 (9)	1 st forbidden	10,48
$\beta^-_{0,23}$	322,6 (11)	0,148 (4)	1 st forbidden	11,31
$\beta^-_{0,22}$	351,3 (11)	1,78 (3)	allowed	10,34
$\beta^-_{0,21}$	408,8 (12)	0,100 (4)	allowed	11,81
$\beta^-_{0,20}$	437,1 (11)	0,330 (13)	1 st forbidden	11,39
$\beta^-_{0,19}$	458,3 (11)	0,021 (2)	(2nd forbidden)	12,66
$\beta^-_{0,18}$	550,0 (11)	0,075 (2)	1 st forbidden	12,23
$\beta^-_{0,16}$	570,9 (11)	36,06 (35)	allowed	9,74
$\beta^-_{0,13}$	704,6 (11)	0,707 (7)	1 st forbidden	11,76
$\beta^-_{0,12}$	716,8 (11)	0,289 (6)	allowed	12,18
$\beta^-_{0,8}$	840,6 (11)	17,33 (18)	1 st forbidden	10,64
$\beta^-_{0,7}$	920,8 (11)	0,108 (18)	1 st forbidden	13
$\beta^-_{0,6}$	972,1 (11)	2,82 (18)	1 st forbidden	11,66
$\beta^-_{0,5}$	1152,9 (11)	0,33 (3)	1 st forbidden	12,8
$\beta^-_{0,2}$	1597,4 (11)	0,31 (7)	1 st forbidden	13,43
$\beta^-_{0,1}$	1845,3 (11)	10,3 (5)	1 st forbidden	12,4

2.3 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{26,24}$(Gd)	58,4	0,0087 (9)	(E1)				1,23 (3)
$\gamma_{8,7}$(Gd)	80,4	0,016 (13)	(M1,E2)				4,8 (10)
$\gamma_{1,0}$(Sm)	81,99 (2)	0,018 (13)	E2	1,98 (4)	2,28 (5)	0,532 (11)	4,93 (10)
$\gamma_{1,0}$(Gd)	123,0707 (9)	88,8 (13)	E2	0,653 (13)	0,418 (9)	0,096 (2)	1,197 (19)
$\gamma_{18,15}$(Gd)	125,39 (5)	0,007 (2)					
$\gamma_{24,20}$(Gd)	129,5	0,028 (4)	(M1,E2)				0,99 (3)
$\gamma_{8,6}$(Gd)	131,58 (5)	0,0216 (11)	M1+E2				0,95 (4)
$\gamma_{5,3}$(Gd)	134,84	0,0134 (8)	E2				0,868 (18)
$\gamma_{16,12}$(Gd)	146,05 (5)	0,044 (2)	(M1,E2)				0,68 (2)
$\gamma_{16,11}$(Gd)	156,2	0,0152 (6)	(M1,E2)				0,55 (3)
$\gamma_{(-1,1)}$(Gd)	159,9	0,0010 (5)					
$\gamma_{21,16}$(Gd)	162,09 (5)	0,0016 (6)	(E2)				0,457 (9)
$\gamma_{15,8}$(Gd)	165,90 (21)	0,0025 (5)					
$\gamma_{6,5}$(Gd)	180,7	0,0054 (7)	(M1,E2)				0,35 (4)
$\gamma_{2,1}$(Sm)	184,72	0,0047 (8)	E2	0,193 (4)	0,0642 (13)	0,0146 (3)	0,275 (6)
$\gamma_{26,20}$(Gd)	188,24 (2)	0,252 (6)	E1	0,0453 (90)	0,0065 (2)		0,0536 (11)
$\gamma_{(-1,2)}$(Gd)	195,5 (5)	0,002 (1)					
$\gamma_{(-1,3)}$(Gd)	197	0,0016 (2)					
$\gamma_{22,17}$(Gd)	202,50 (16)	0,03 (1)					
$\gamma_{26,19}$(Gd)	209,4 (4)	0,0025 (6)					

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{22,16}$(Gd)	219,4	0,0028 (6)	(M1,E2)				0,20 (4)
$\gamma_{14,7}$(Gd)	229,01 (13)	0,0024 (8)					
$\gamma_{7,5}$(Gd)	232,01 (5)	0,0270 (11)	E2				0,137 (3)
$\gamma_{20,15}$(Gd)	237	0,006 (3)					0,018 (7)
$\gamma_{2,1}$(Gd)	247,9290 (7)	7,65 (8)	E2	0,0810 (16)	0,0228 (5)		0,110 (2)
$\gamma_{16,9}$(Gd)	260,9	0,0022 (7)					
$\gamma_{20,13}$(Gd)	267,44	0,0148 (8)	(E2)				0,087 (2)
$\gamma_{(-1,4)}$(Gd)	269,8	0,0071 (11)	(E1)				0,0209 (4)
$\gamma_{(-1,5)}$(Gd)	274,0 (5)	0,0039 (2)					
$\gamma_{20,12}$(Gd)	279,9	0,0030 (2)	(E1)				0,0190 (4)
$\gamma_{20,11}$(Gd)	290	0,0033 (2)	(E1)				0,0174 (3)
$\gamma_{21,13}$(Gd)	295,7	0,0024 (2)	(E1)				0,0166 (3)
$\gamma_{16,8}$(Gd)	296 (1)	0,0014 (9)	(E1)				0,0166 (3)
$\gamma_{26,18}$(Gd)	301,25	0,0102 (4)	(E2)				0,0158 (3)
$\gamma_{26,17}$(Gd)	305,1	0,0187 (8)	(M1,E2)				0,075 (18)
$\gamma_{(-1,6)}$(Gd)	308,2	0,0024 (6)					
$\gamma_{8,5}$(Gd)	312,3	0,019 (2)	(M1,E2)				0,07 (2)
$\gamma_{6,3}$(Gd)	315,4	0,007 (2)	(E2)				0,052 (1)
$\gamma_{(-1,7)}$(Gd)	320 (1)	0,0010 (7)					
$\gamma_{26,16}$(Gd)	322,02 (5)	0,070 (3)	(M1,E2)				0,065 (17)
$\gamma_{7,4}$(Gd)	329,9 (7)	0,0095 (5)	E2				0,0454 (9)
$\gamma_{4,2}$(Gd)	346,72 (5)	0,030 (1)	E2				0,0391 (8)
$\gamma_{23,14}$(Gd)	368,21	0,0030 (2)					
$\gamma_{18,7}$(Gd)	370,71	0,0058 (14)	E2				0,0321 (7)
$\gamma_{22,11}$(Gd)	375,2 (5)	0,0021 (8)	(E2)				0,0310 (6)
$\gamma_{23,13}$(Gd)	382,00 (5)	0,0100 (4)	(E2,M1)				0,034 (11)
$\gamma_{24,13}$(Gd)	397,1	0,030 (1)	(M1,E2)				0,036 (10)
$\gamma_{16,6}$(Gd)	401,260 (14)	0,202 (4)	(E1,M2,E3)				0,07 (2)
$\gamma_{20,8}$(Gd)	403,55 (5)	0,027 (1)	(M1,E2)				0,035 (10)
$\gamma_{(-1,8)}$(Gd)	414,3	0,0049 (6)					
$\gamma_{24,11}$(Gd)	419,4	0,0039 (23)	M2				0,140 (3)
$\gamma_{(-1,9)}$(Gd)	422,1	0,0022 (9)					
$\gamma_{(-1,10)}$(Gd)	435,9	0,0038 (10)					
$\gamma_{5,2}$(Gd)	444,4931 (19)	0,570 (6)	E2	0,0154 (3)	0,00295 (6)		0,0192 (4)
$\gamma_{32,17}$(Gd)	463,9	0,0042 (3)					
$\gamma_{26,12}$(Gd)	467,84 (5)	0,0618 (24)	(M1,E2)				0,024 (7)
$\gamma_{26,11}$(Gd)	478,27 (5)	0,230 (2)	M1	0,0245 (5)	0,00341 (7)		0,0287 (6)
$\gamma_{22,9}$(Gd)	480,61	0,0048 (3)					
$\gamma_{20,7}$(Gd)	483,74	0,0051 (3)	(E2)				0,0153 (3)
$\gamma_{(-1,11)}$(Gd)	484,64	0,0039 (2)					
$\gamma_{22,8}$(Gd)	488,26	0,007 (3)	(E1)				0,00498 (10)
$\gamma_{27,13}$(Gd)	506,4	0,0064 (14)	E2				0,0136 (3)
$\gamma_{(-1,12)}$(Gd)	510	0,059 (7)					
$\gamma_{(-1,13)}$(Gd)	512	0,032 (7)					
$\gamma_{23,8}$(Gd)	518,00 (5)	0,047 (2)	(E2,M1)				0,013 (1)
$\gamma_{24,8}$(Gd)	533,1	0,007 (2)					
$\gamma_{29,13}$(Gd)	533,1	0,004 (3)	E1				0,00412 (8)
$\gamma_{13,4}$(Gd)	545,6	0,014 (2)	(E2)				0,0112 (2)
$\gamma_{3,1}$(Gd)	557,58 (5)	0,270 (5)	E2	0,0087 (2)	0,0015 (3)		0,0106 (2)
$\gamma_{21,6}$(Gd)	563,4	0,0030 (7)	(M2)				0,058 (1)
$\gamma_{22,7}$(Gd)	569,23	0,0100 (8)	(E1)				0,0036 (1)
$\gamma_{16,5}$(Gd)	582,01 (5)	0,889 (11)	E1	0,00288 (6)	0,000385 (8)		0,00339 (7)
$\gamma_{26,8}$(Gd)	591,755 (3)	4,97 (5)	E1+(M2)	0,0028 (6)	0,000374 (8)		0,00329 (10)
$\gamma_{31,13}$(Gd)	597,5	0,0055 (3)	(E1)				0,00321 (7)
$\gamma_{23,7}$(Gd)	598,3	0,0062 (7)	M1+2,8%E2				0,014 (1)
$\gamma_{17,5}$(Gd)	600,0 (5)	0,006 (4)	(E1)				0,00318 (7)
$\gamma_{18,5}$(Gd)	602,81 (5)	0,0035 (2)	E0+M1+E2				0,048 (6)
$\gamma_{24,7}$(Gd)	613,26 (5)	0,094 (4)	(E2,M1)				0,012 (4)
$\gamma_{22,6}$(Gd)	620,52	0,091 (5)	(E1)				0,00296 (6)

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{6,2}$(Gd)	625,2570 (24)	0,319 (5)	E2	0,00658 (13)	0,00109 (2)		0,00797 (16)
$\gamma_{27,8}$(Gd)	642,4	0,0044 (17)	(M1,E2)				0,011 (4)
$\gamma_{23,6}$(Gd)	649,44 (5)	0,079 (3)	E2				0,0073 (2)
$\gamma_{25,7}$(Gd)	650,6	0,0100 (4)	(E0,M1,E2)				0,026 (8)
$\gamma_{24,6}$(Gd)	664,68 (5)	0,029 (1)	(M1,E2)				0,010 (3)
$\gamma_{29,8}$(Gd)	668,9	0,013 (2)	E1				0,00253 (5)
$\gamma_{7,2}$(Gd)	676,598 (12)	0,166 (11)	E0+M1+E2	0,049 (5)	0,0080 (8)		0,059 (6)
$\gamma_{3,0}$(Gd)	680,72 (10)	0,0052 (7)	E0				
$\gamma_{5,1}$(Gd)	692,4222 (18)	1,88 (3)	E0+M1+E2	0,040 (4)	0,0070 (7)		0,049 (6)
$\gamma_{20,5}$(Gd)	715,77 (3)	0,19 (1)	(E0,M1,E2)				0,013 (4)
$\gamma_{26,6}$(Gd)	723,3032 (22)	20,09 (21)	E1+0,05%M2	0,00184 (4)	0,000244 (5)		0,00215 (5)
$\gamma_{(-1,14)}$(Gd)	737,6	0,0063 (24)					
$\gamma_{8,2}$(Gd)	756,8040 (23)	4,55 (5)	E1+2,8%M2	0,00431 (9)	0,00067 (2)		0,0051 (12)
$\gamma_{27,6}$(Gd)	774,4	0,008 (4)	(M3)				0,053 (2)
$\gamma_{30,7}$(Gd)	790,2	0,010 (3)	(E2)				0,00462 (9)
$\gamma_{29,6}$(Gd)	800,2	0,032 (5)	E1				0,00175 (4)
$\gamma_{22,5}$(Gd)	801,21 (4)	0,012 (3)	(E1)				0,00175 (4)
$\gamma_{5,0}$(Gd)	815,53 (5)	0,514 (7)	E2	0,00360 (7)	0,000548 (11)		0,00430 (9)
$\gamma_{(-1,15)}$(Gd)	830,3	0,008 (3)					
$\gamma_{24,5}$(Gd)	845,418 (7)	0,588 (9)	E2	0,00333 (7)	0,000502 (10)		0,00397 (8)
$\gamma_{20,3}$(Gd)	850,64 (3)	0,242 (4)	E2				0,00392 (8)
$\gamma_{6,1}$(Gd)	873,1860 (23)	12,22 (12)	E2+1,55%M1+E0	0,00313 (6)	0,00047 (1)		0,00373 (8)
$\gamma_{12,2}$(Gd)	880,60 (3)	0,081 (4)	E1+0,05%M2				0,00153 (8)
$\gamma_{13,2}$(Gd)	892,778 (6)	0,516 (7)	E0+E2+M1				0,00369 (8)
$\gamma_{33,6}$(Gd)	898,36	0,0020 (5)	(M1,E2)				0,0048 (13)
$\gamma_{26,5}$(Gd)	904,067 (3)	0,891 (11)	E1(+M2)	0,00118 (4)	0,000156 (3)		0,00138 (3)
$\gamma_{14,2}$(Gd)	906,1	0,0118 (6)					
$\gamma_{(-1,16)}$(Gd)	919,24	0,012 (1)					
$\gamma_{7,1}$(Gd)	924,63 (5)	0,062 (2)	E2				0,00327 (7)
$\gamma_{(-1,17)}$(Gd)	928,4	0,0045 (21)					
$\gamma_{29,5}$(Gd)	981,3 (5)	0,0084 (17)	(E1)				0,00118 (3)
$\gamma_{(-1,18)}$(Gd)	984,5	0,0094 (21)					
$\gamma_{6,0}$(Gd)	996,25 (5)	10,53 (10)	E2	0,00236 (5)	0,000342 (7)		0,00279 (6)
$\gamma_{8,1}$(Gd)	1004,722 (7)	17,91 (18)	E1+1,35%M2	0,00232 (5)	0,000336 (7)		0,00276 (6)
$\gamma_{9,1}$(Gd)	1012,8 (2)	0,003 (1)					
$\gamma_{30,5}$(Gd)	1023 (1)	0,0066 (25)	(M1,E2)				
$\gamma_{(-1,19)}$(Gd)	1033,4	0,0117 (8)					
$\gamma_{18,2}$(Gd)	1047,4 (1)	0,049 (3)	E2				0,00251 (5)
$\gamma_{(-1,20)}$(Gd)	1049,4 (1)	0,0172 (8)					
$\gamma_{(-1,21)}$(Gd)	1072,2	0,0035 (14)					
$\gamma_{10,1}$(Gd)	1110	0,003 (2)					
$\gamma_{11,1}$(Gd)	1118,53 (6)	0,108 (14)	E1	0,000798 (16)	0,000103 (20)		0,00093 (2)
$\gamma_{(-1,22)}$(Gd)	1124,2	0,0069 (10)					
$\gamma_{12,1}$(Gd)	1128,556 (7)	0,317 (5)	E1	0,000785 (16)	0,000101 (2)		0,000915 (18)
$\gamma_{9,0}$(Gd)	1136,1	0,007 (1)					
$\gamma_{13,1}$(Gd)	1140,707 (6)	0,235 (4)	E2				0,00211 (4)
$\gamma_{(-1,23)}$(Gd)	1153,1 (5)	0,011 (4)					
$\gamma_{20,2}$(Gd)	1160,37 (8)	0,0437 (21)	(E2)				0,00204 (4)
$\gamma_{15,1}$(Gd)	1170,7 (5)	0,0036 (10)					
$\gamma_{21,2}$(Gd)	1188,35 (17)	0,093 (7)	(E1)				0,00083 (2)
$\gamma_{(-1,25)}$(Gd)	1216,8	0,0035 (10)					
$\gamma_{(-1,24)}$(Gd)	1232,1 (5)	0,008 (5)					
$\gamma_{11,0}$(Gd)	1241,44 (10)	0,133 (6)	E1+(M2)	0,000662 (13)			0,000771 (15)
$\gamma_{22,2}$(Gd)	1246,126 (4)	0,863 (11)	E1	0,000658 (13)			0,000766 (15)
$\gamma_{16,1}$(Gd)	1274,435 (4)	34,9 (3)	E1+0,1%M2	0,000632 (13)			0,000737 (15)
$\gamma_{24,2}$(Gd)	1290,51 (10)	0,025 (3)	(M1,E2)				0,0021 (5)
$\gamma_{17,1}$(Gd)	1292,0 (2)	0,0127 (5)	E1				0,00072 (2)
$\gamma_{18,1}$(Gd)	1295,5 (2)	0,0091 (10)					
$\gamma_{(-1,26)}$(Gd)	1316,4 (3)	0,017 (4)					

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{19,1}$(Gd)	1387,0 (5)	0,019 (2)	(E1)				0,00063 (2)
$\gamma_{27,2}$(Gd)	1397,35 (5)	0,0031 (8)	(M1,E2)				0,0018 (4)
$\gamma_{20,1}$(Gd)	1408,5 (2)	0,023 (3)	(E0,M1,E2)				0,0037 (14)
$\gamma_{17,0}$(Gd)	1415,0 (5)	0,040 (2)	E1				0,00061 (1)
$\gamma_{18,0}$(Gd)	1418,6 (2)	0,011 (2)	E2				0,00138 (3)
$\gamma_{28,2}$(Gd)	1419,0 (2)	0,0020 (1)	(M1,E2)				0,0017 (4)
$\gamma_{29,2}$(Gd)	1425,9 (5)	0,0012 (7)	(E1)				0,00060 (1)
$\gamma_{31,2}$(Gd)	1489,6 (2)	0,0029 (4)	(E1)				0,00056 (1)
$\gamma_{22,1}$(Gd)	1494,056 (4)	0,699 (9)	E1	0,000481 (10)			0,00056 (1)
$\gamma_{19,0}$(Gd)	1510,0 (5)	0,0048 (10)	(E1)				0,00047 (1)
$\gamma_{33,2}$(Gd)	1522 (1)	0,0006 (3)	(E2)				0,00102 (2)
$\gamma_{20,0}$(Gd)	1531,5 (2)	0,0060 (4)	(E2)				0,00101 (2)
$\gamma_{24,1}$(Gd)	1537,82 (4)	0,053 (2)	(M1,E2)				0,0012 (3)
$\gamma_{(-1,27)}$(Gd)	1554	0,0011 (5)					
$\gamma_{26,1}$(Gd)	1596,4892 (28)	1,784 (17)	E1(+M2)	0,000430 (9)			0,00049 (1)
$\gamma_{28,1}$(Gd)	1667,3 (2)	0,0019 (3)	(E2)				
$\gamma_{29,1}$(Gd)	1674,0 (5)	0,0017 (4)	(E1)				
$\gamma_{30,1}$(Gd)	1716,9 (5)	0,0006 (3)	(M1,E2)				
$\gamma_{33,1}$(Gd)	1773 (1)	0,00035 (21)	(M1,E2)				
$\gamma_{30,0}$(Gd)	1838,0 (5)	0,0008 (2)	(E2)				
$\gamma_{33,0}$(Gd)	1895 (1)	0,0006 (2)	(E2)				

3 Atomic Data

3.1 Sm

ω_K : 0,926 (4)
$\bar{\omega}_L$: 0,158 (6)
n_{KL} : 0,857 (4)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	39,5229		55,25
	$K\alpha_1$	40,1186		100
	$K\beta_3$	45,289	}	
	$K\beta_1$	45,413	}	
	$K\beta_5''$	45,731	}	31,26
	$K\beta_2$	46,575	}	
	$K\beta_4$	46,705	}	8,06
	$KO_{2,3}$	46,813	}	
X_L				
	$L\ell$	4,99		
	$L\gamma$	– 7,49		

3.1.2 Auger Electrons

	Energy keV	Relative probability
KLL	31,19 – 33,22	100
KLX	37,30 – 40,18	50,7
KXY	45,30 – 46,23	6,42
Auger L	3,2 – 7,6	2277

3.2 Gd

ω_K : 0,932 (4)
$\bar{\omega}_L$: 0,176 (6)
n_{KL} : 0,850 (4)

3.2.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	42,3093		55,59
	$K\alpha_1$	42,9967		100
	$K\beta_3$	48,556	}	
	$K\beta_1$	48,697	}	
	$K\beta_5''$	49,053	}	31,66
	$K\beta_2$	49,961	}	
	$K\beta_4$	50,099	}	8,32
	$KO_{2,3}$	50,219	}	
X_L				
	$L\ell$	5,36		
	$L\gamma$	– 8,1		

3.2.2 Auger Electrons

	Energy keV	Relative probability
KLL	33,32 – 35,58	100
KLX	39,98 – 42,86	51,3
KXY	47,98 – 48,91	6,58
Auger L	3,4 – 8,3	2814

4 Electron Emissions

		Energy keV		Electrons per 100 disint.
e_{AL}	(Sm)	3,2	- 7,6	0,023 (13)
e_{AK}	(Sm)			0,0016 (13)
	KLL	31,19	- 33,22 }	
	KLX	37,30	- 40,18 }	
	KXY	45,30	- 46,23 }	
e_{AL}	(Gd)	3,4	- 8,3	33,2 (6)
e_{AK}	(Gd)			1,86 (12)
	KLL	33,32	- 35,58 }	
	KLX	39,98	- 42,86 }	
	KXY	47,98	- 48,91 }	
$ec_{1,0\ K}$	(Gd)	72,832	(1)	26,4 (4)
$ec_{1,0\ L}$	(Gd)	114,70	- 115,83	16,9 (4)
$ec_{1,0\ M}$	(Gd)	121,19	- 121,89	3,88 (9)
$ec_{2,1\ K}$	(Gd)	197,6898	(7)	0,558 (12)
$ec_{2,1\ L}$	(Gd)	239,56	- 240,69	0,157 (4)
$ec_{5,1\ K}$	(Gd)	642,180	(2)	0,072 (7)
$\beta^-_{0,33}$	max:	73,7	(11)	0,0035 (6)
$\beta^-_{0,33}$	avg:	19,0	(3)	
$\beta^-_{0,32}$	max:	89,4	(11)	0,0042 (3)
$\beta^-_{0,32}$	avg:	23,3	(3)	
$\beta^-_{0,31}$	max:	107,2	(11)	0,034 (3)
$\beta^-_{0,31}$	avg:	28,1	(3)	
$\beta^-_{0,30}$	max:	130,1	(12)	0,017 (5)
$\beta^-_{0,30}$	avg:	34,5	(3)	
$\beta^-_{0,29}$	max:	171,7	(12)	0,060 (6)
$\beta^-_{0,29}$	avg:	46,3	(3)	
$\beta^-_{0,28}$	max:	178,1	(11)	0,022 (1)
$\beta^-_{0,28}$	avg:	48,1	(3)	
$\beta^-_{0,27}$	max:	197,9	(11)	0,0022 (4)
$\beta^-_{0,27}$	avg:	53,9	(3)	
$\beta^-_{0,26}$	max:	248,8	(11)	28,32 (22)
$\beta^-_{0,26}$	avg:	69,2	(3)	
$\beta^-_{0,25}$	max:	270,2	(11)	0,0100 (4)
$\beta^-_{0,25}$	avg:	75,7	(3)	
$\beta^-_{0,24}$	max:	307,5	(11)	0,849 (9)
$\beta^-_{0,24}$	avg:	87,4	(3)	
$\beta^-_{0,23}$	max:	322,6	(11)	0,148 (4)
$\beta^-_{0,23}$	avg:	92,2	(4)	

		Energy keV		Electrons per 100 disint.
$\beta^-_{0,22}$	max:	351,3	(11)	1,78 (3)
$\beta^-_{0,22}$	avg:	101,4	(4)	
$\beta^-_{0,21}$	max:	408,8	(12)	0,100 (4)
$\beta^-_{0,21}$	avg:	120,3	(4)	
$\beta^-_{0,20}$	max:	437,1	(11)	0,330 (13)
$\beta^-_{0,20}$	avg:	129,8	(4)	
$\beta^-_{0,19}$	max:	458,3	(11)	0,021 (2)
$\beta^-_{0,19}$	avg:	136,9	(4)	
$\beta^-_{0,18}$	max:	550,0	(11)	0,075 (2)
$\beta^-_{0,18}$	avg:	168,8	(4)	
$\beta^-_{0,16}$	max:	570,9	(11)	36,06 (35)
$\beta^-_{0,16}$	avg:	176,2	(4)	
$\beta^-_{0,13}$	max:	704,6	(11)	0,707 (7)
$\beta^-_{0,13}$	avg:	225,0	(4)	
$\beta^-_{0,12}$	max:	716,8	(11)	0,289 (6)
$\beta^-_{0,12}$	avg:	229,5	(4)	
$\beta^-_{0,8}$	max:	840,6	(11)	17,33 (18)
$\beta^-_{0,8}$	avg:	276,6	(4)	
$\beta^-_{0,7}$	max:	920,8	(11)	0,108 (18)
$\beta^-_{0,7}$	avg:	307,8	(4)	
$\beta^-_{0,6}$	max:	972,1	(11)	2,82 (18)
$\beta^-_{0,6}$	avg:	328,1	(4)	
$\beta^-_{0,5}$	max:	1152,9	(11)	0,33 (3)
$\beta^-_{0,5}$	avg:	401,0	(5)	
$\beta^-_{0,2}$	max:	1597,4	(11)	0,31 (7)
$\beta^-_{0,2}$	avg:	588,0	(5)	
$\beta^-_{0,1}$	max:	1845,3	(11)	10,3 (5)
$\beta^-_{0,1}$	avg:	695,6	(5)	

5 Photon Emissions

5.1 X-Ray Emissions

		Energy keV		Photons per 100 disint.	
XL	(Sm)	4,99 — 7,49		0,0044 (20)	
XKα_2	(Sm)	39,5229		0,006 (4)	} Kα
XKα_1	(Sm)	40,1186		0,010 (8)	}
XKβ_3	(Sm)	45,289	}		
XKβ_1	(Sm)	45,413	}	0,003 (2)	K$'\beta_1$
XKβ''_5	(Sm)	45,731	}		
XKβ_2	(Sm)	46,575	}		
XKβ_4	(Sm)	46,705	}	0,001	K$'\beta_2$
XKO$_{2,3}$	(Sm)	46,813	}		
XL	(Gd)	5,36 — 8,1		7,1 (3)	
XKα_2	(Gd)	42,3093		7,2 (2)	} Kα
XKα_1	(Gd)	42,9967		13,0 (3)	}
XKβ_3	(Gd)	48,556	}		
XKβ_1	(Gd)	48,697	}	4,1 (1)	K$'\beta_1$
XKβ''_5	(Gd)	49,053	}		
XKβ_2	(Gd)	49,961	}		
XKβ_4	(Gd)	50,099	}	1,08 (3)	K$'\beta_2$
XKO$_{2,3}$	(Gd)	50,219	}		

5.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{26,24}$(Gd)	58,4	0,0039 (4)
$\gamma_{8,7}$(Gd)	80,4	0,0028 (14)
$\gamma_{1,0}$(Sm)	81,99 (2)	0,0031 (21)
$\gamma_{1,0}$(Gd)	123,0706 (9)	40,4 (5)
$\gamma_{18,15}$(Gd)	125,39 (5)	0,007 (2)
$\gamma_{24,20}$(Gd)	129,5	0,014 (2)
$\gamma_{8,6}$(Gd)	131,58 (5)	0,0111 (5)
$\gamma_{5,3}$(Gd)	134,84	0,0072 (4)
$\gamma_{16,12}$(Gd)	146,05 (5)	0,026 (1)
$\gamma_{16,11}$(Gd)	156,2	0,0098 (4)
$\gamma_{(-1,1)}$(Gd)	159,9	0,0010 (5)

	Energy keV	Photons per 100 disint.
$\gamma_{21,16}$(Gd)	162,09 (5)	0,0011 (4)
$\gamma_{15,8}$(Gd)	165,90 (21)	0,0025 (5)
$\gamma_{6,5}$(Gd)	180,7	0,0040 (5)
$\gamma_{2,1}$(Sm)	184,72	0,0037 (7)
$\gamma_{26,20}$(Gd)	188,24 (2)	0,239 (6)
$\gamma_{(-1,2)}$(Gd)	195,5 (5)	0,002 (1)
$\gamma_{(-1,3)}$(Gd)	197	0,0016 (2)
$\gamma_{22,17}$(Gd)	202,50 (16)	0,03 (1)
$\gamma_{26,19}$(Gd)	209,4 (4)	0,0025 (6)
$\gamma_{22,16}$(Gd)	219,4	0,0023 (5)
$\gamma_{14,7}$(Gd)	229,01 (13)	0,0024 (8)
$\gamma_{7,5}$(Gd)	232,01 (5)	0,024 (1)
$\gamma_{20,15}$(Gd)	237	0,006 (3)
$\gamma_{2,1}$(Gd)	247,9288 (7)	6,89 (7)
$\gamma_{16,9}$(Gd)	260,9	0,0022 (7)
$\gamma_{20,13}$(Gd)	267,44	0,0136 (7)
$\gamma_{(-1,4)}$(Gd)	269,8	0,0070 (11)
$\gamma_{(-1,5)}$(Gd)	274,0 (5)	0,0039 (2)
$\gamma_{20,12}$(Gd)	279,9	0,0030 (2)
$\gamma_{20,11}$(Gd)	290	0,0033 (2)
$\gamma_{21,13}$(Gd)	295,7	0,0024 (2)
$\gamma_{16,8}$(Gd)	296 (1)	0,0014 (9)
$\gamma_{26,18}$(Gd)	301,25	0,0102 (4)
$\gamma_{26,17}$(Gd)	305,1	0,0174 (7)
$\gamma_{(-1,6)}$(Gd)	308,2	0,0024 (6)
$\gamma_{8,5}$(Gd)	312,3	0,018 (2)
$\gamma_{6,3}$(Gd)	315,4	0,007 (2)
$\gamma_{(-1,7)}$(Gd)	320 (1)	0,0010 (7)
$\gamma_{26,16}$(Gd)	322,02 (5)	0,066 (3)
$\gamma_{7,4}$(Gd)	329,9 (7)	0,0091 (5)
$\gamma_{4,2}$(Gd)	346,72 (5)	0,029 (1)
$\gamma_{23,14}$(Gd)	368,21	0,0030 (2)
$\gamma_{18,7}$(Gd)	370,71	0,0056 (14)
$\gamma_{22,11}$(Gd)	375,2 (5)	0,0020 (8)
$\gamma_{23,13}$(Gd)	382,00 (5)	0,0099 (4)
$\gamma_{24,13}$(Gd)	397,1	0,029 (1)
$\gamma_{16,6}$(Gd)	401,259 (14)	0,189 (3)
$\gamma_{20,8}$(Gd)	403,55 (5)	0,026 (1)
$\gamma_{(-1,8)}$(Gd)	414,3	0,0049 (6)
$\gamma_{24,11}$(Gd)	419,4	0,0034 (20)
$\gamma_{(-1,9)}$(Gd)	422,1	0,0022 (9)
$\gamma_{(-1,10)}$(Gd)	435,9	0,0038 (10)
$\gamma_{5,2}$(Gd)	444,4924 (19)	0,560 (8)
$\gamma_{32,17}$(Gd)	463,9	0,0042 (3)
$\gamma_{26,12}$(Gd)	467,84 (5)	0,0604 (24)
$\gamma_{26,11}$(Gd)	478,27 (5)	0,224 (3)
$\gamma_{22,9}$(Gd)	480,61	0,0048 (3)

	Energy keV	Photons per 100 disint.
$\gamma_{20,7}$(Gd)	483,74	0,0050 (3)
$\gamma_{(-1,11)}$(Gd)	484,64	0,0039 (2)
$\gamma_{22,8}$(Gd)	488,26	0,007 (3)
$\gamma_{27,13}$(Gd)	506,4	0,0063 (14)
$\gamma_{(-1,12)}$(Gd)	510	0,059 (7)
$\gamma^{\pm}$	511	
$\gamma_{(-1,13)}$(Gd)	512	0,032 (7)
$\gamma_{23,8}$(Gd)	518,00 (5)	0,047 (2)
$\gamma_{24,8}$(Gd)	533,1	0,007 (2)
$\gamma_{29,13}$(Gd)	533,1	0,004 (3)
$\gamma_{13,4}$(Gd)	545,6	0,014 (2)
$\gamma_{3,1}$(Gd)	557,58 (5)	0,267 (5)
$\gamma_{21,6}$(Gd)	563,4	0,0028 (7)
$\gamma_{22,7}$(Gd)	569,23	0,0100 (8)
$\gamma_{16,5}$(Gd)	582,01 (5)	0,886 (11)
$\gamma_{26,8}$(Gd)	591,755 (3)	4,95 (5)
$\gamma_{31,13}$(Gd)	597,5	0,0055 (3)
$\gamma_{23,7}$(Gd)	598,3	0,0062 (7)
$\gamma_{17,5}$(Gd)	600	0,006 (4)
$\gamma_{18,5}$(Gd)	602,81 (5)	0,0033 (2)
$\gamma_{24,7}$(Gd)	613,26 (5)	0,093 (4)
$\gamma_{22,6}$(Gd)	620,52	0,091 (5)
$\gamma_{6,2}$(Gd)	625,2556 (24)	0,317 (5)
$\gamma_{27,8}$(Gd)	642,4	0,0044 (17)
$\gamma_{23,6}$(Gd)	649,44 (5)	0,078 (3)
$\gamma_{25,7}$(Gd)	650,6	0,0098 (4)
$\gamma_{24,6}$(Gd)	664,68 (5)	0,029 (1)
$\gamma_{29,8}$(Gd)	668,9	0,013 (2)
$\gamma_{7,2}$(Gd)	676,596 (12)	0,157 (11)
$\gamma_{5,1}$(Gd)	692,4205 (18)	1,79 (3)
$\gamma_{20,5}$(Gd)	715,77 (3)	0,19 (1)
$\gamma_{26,6}$(Gd)	723,3014 (22)	20,05 (21)
$\gamma_{(-1,14)}$(Gd)	737,6	0,0063 (24)
$\gamma_{8,2}$(Gd)	756,8020 (23)	4,53 (5)
$\gamma_{27,6}$(Gd)	774,4	0,008 (4)
$\gamma_{30,7}$(Gd)	790,2	0,010 (3)
$\gamma_{29,6}$(Gd)	800,2	0,032 (5)
$\gamma_{22,5}$(Gd)	801,21 (4)	0,012 (3)
$\gamma_{5,0}$(Gd)	815,53 (5)	0,512 (7)
$\gamma_{(-1,15)}$(Gd)	830,3	0,008 (3)
$\gamma_{24,5}$(Gd)	845,416 (7)	0,586 (9)
$\gamma_{20,3}$(Gd)	850,64 (3)	0,241 (4)
$\gamma_{6,1}$(Gd)	873,1834 (23)	12,17 (12)
$\gamma_{12,2}$(Gd)	880,60 (3)	0,081 (4)
$\gamma_{13,2}$(Gd)	892,775 (6)	0,514 (7)
$\gamma_{33,6}$(Gd)	898,36	0,0020 (5)
$\gamma_{26,5}$(Gd)	904,064 (3)	0,890 (11)

	Energy keV	Photons per 100 disint.
$\gamma_{14,2}$(Gd)	906,1	0,0118 (6)
$\gamma_{(-1,16)}$(Gd)	919,24	0,012 (1)
$\gamma_{7,1}$(Gd)	924,63 (5)	0,062 (2)
$\gamma_{(-1,17)}$(Gd)	928,4	0,0045 (21)
$\gamma_{29,5}$(Gd)	981,3 (5)	0,0084 (17)
$\gamma_{(-1,18)}$(Gd)	984,5	0,0094 (21)
$\gamma_{6,0}$(Gd)	996,25 (5)	10,5 (1)
$\gamma_{8,1}$(Gd)	1004,718 (7)	17,86 (18)
$\gamma_{9,1}$(Gd)	1012,8 (2)	0,003 (1)
$\gamma_{30,5}$(Gd)	1023 (1)	0,0066 (25)
$\gamma_{(-1,19)}$(Gd)	1033,4	0,0119 (7)
$\gamma_{18,2}$(Gd)	1047,4 (1)	0,049 (3)
$\gamma_{(-1,20)}$(Gd)	1049,4 (1)	0,0172 (8)
$\gamma_{(-1,21)}$(Gd)	1072,2	0,0035 (14)
$\gamma_{10,1}$(Gd)	1110	0,003 (2)
$\gamma_{11,1}$(Gd)	1118,52 (6)	0,108 (14)
$\gamma_{(-1,22)}$(Gd)	1124,2	0,0069 (10)
$\gamma_{12,1}$(Gd)	1128,552 (7)	0,317 (5)
$\gamma_{9,0}$(Gd)	1136,1	0,007 (1)
$\gamma_{13,1}$(Gd)	1140,702 (6)	0,235 (4)
$\gamma_{(-1,23)}$(Gd)	1153,1 (5)	0,011 (4)
$\gamma_{20,2}$(Gd)	1160,36 (8)	0,0436 (21)
$\gamma_{15,1}$(Gd)	1170,7 (5)	0,0036 (10)
$\gamma_{21,2}$(Gd)	1188,34 (17)	0,093 (7)
$\gamma_{(-1,25)}$(Gd)	1216,8	0,0033 (10)
$\gamma_{(-1,24)}$(Gd)	1232,1 (5)	0,008 (5)
$\gamma_{11,0}$(Gd)	1241,43 (10)	0,133 (6)
$\gamma_{22,2}$(Gd)	1246,121 (4)	0,862 (11)
$\gamma_{16,1}$(Gd)	1274,429 (4)	34,9 (3)
$\gamma_{24,2}$(Gd)	1290,5 (1)	0,025 (3)
$\gamma_{17,1}$(Gd)	1292,0 (2)	0,0127 (5)
$\gamma_{18,1}$(Gd)	1295,5 (2)	0,0091 (10)
$\gamma_{(-1,26)}$(Gd)	1316,4 (3)	0,017 (4)
$\gamma_{19,1}$(Gd)	1387,0 (5)	0,019 (2)
$\gamma_{27,2}$(Gd)	1397,34 (5)	0,0031 (8)
$\gamma_{20,1}$(Gd)	1408,5 (2)	0,023 (3)
$\gamma_{17,0}$(Gd)	1415,0 (5)	0,040 (2)
$\gamma_{18,0}$(Gd)	1418,6 (2)	0,011 (2)
$\gamma_{28,2}$(Gd)	1419,0 (2)	0,0020 (1)
$\gamma_{29,2}$(Gd)	1425,9 (5)	0,0012 (7)
$\gamma_{31,2}$(Gd)	1489,6 (2)	0,0029 (4)
$\gamma_{22,1}$(Gd)	1494,048 (4)	0,698 (9)
$\gamma_{19,0}$(Gd)	1510,0 (5)	0,0048 (10)
$\gamma_{33,2}$(Gd)	1522 (1)	0,0006 (3)
$\gamma_{20,0}$(Gd)	1531,4 (2)	0,0060 (4)
$\gamma_{24,1}$(Gd)	1537,81 (4)	0,053 (2)
$\gamma_{(-1,27)}$(Gd)	1554	0,0011 (5)

	Energy keV	Photons per 100 disint.
$\gamma_{26,1}$(Gd)	1596,4804 (28)	1,783 (17)
$\gamma_{28,1}$(Gd)	1667,3 (2)	0,0019 (3)
$\gamma_{29,1}$(Gd)	1674,0 (5)	0,0017 (4)
$\gamma_{30,1}$(Gd)	1716,9 (5)	0,0006 (3)
$\gamma_{33,1}$(Gd)	1773 (1)	0,00035 (21)
$\gamma_{30,0}$(Gd)	1838,0 (5)	0,0008 (2)
$\gamma_{33,0}$(Gd)	1895 (1)	0,0006 (2)

6 Main Production Modes

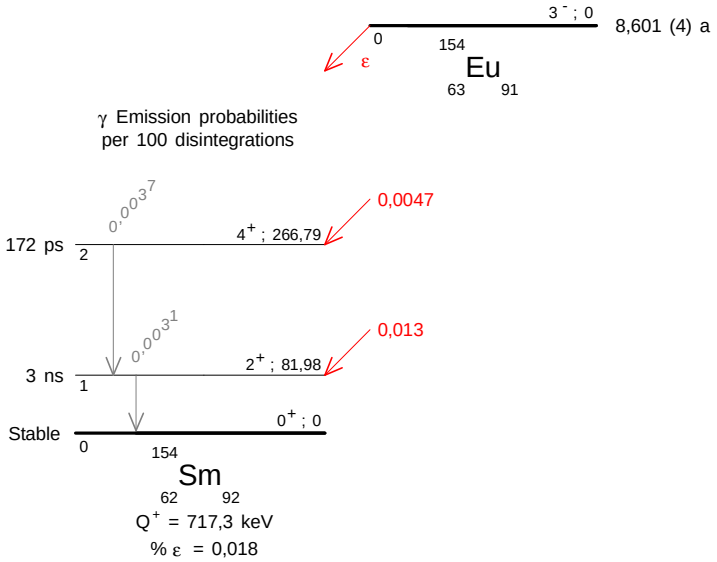
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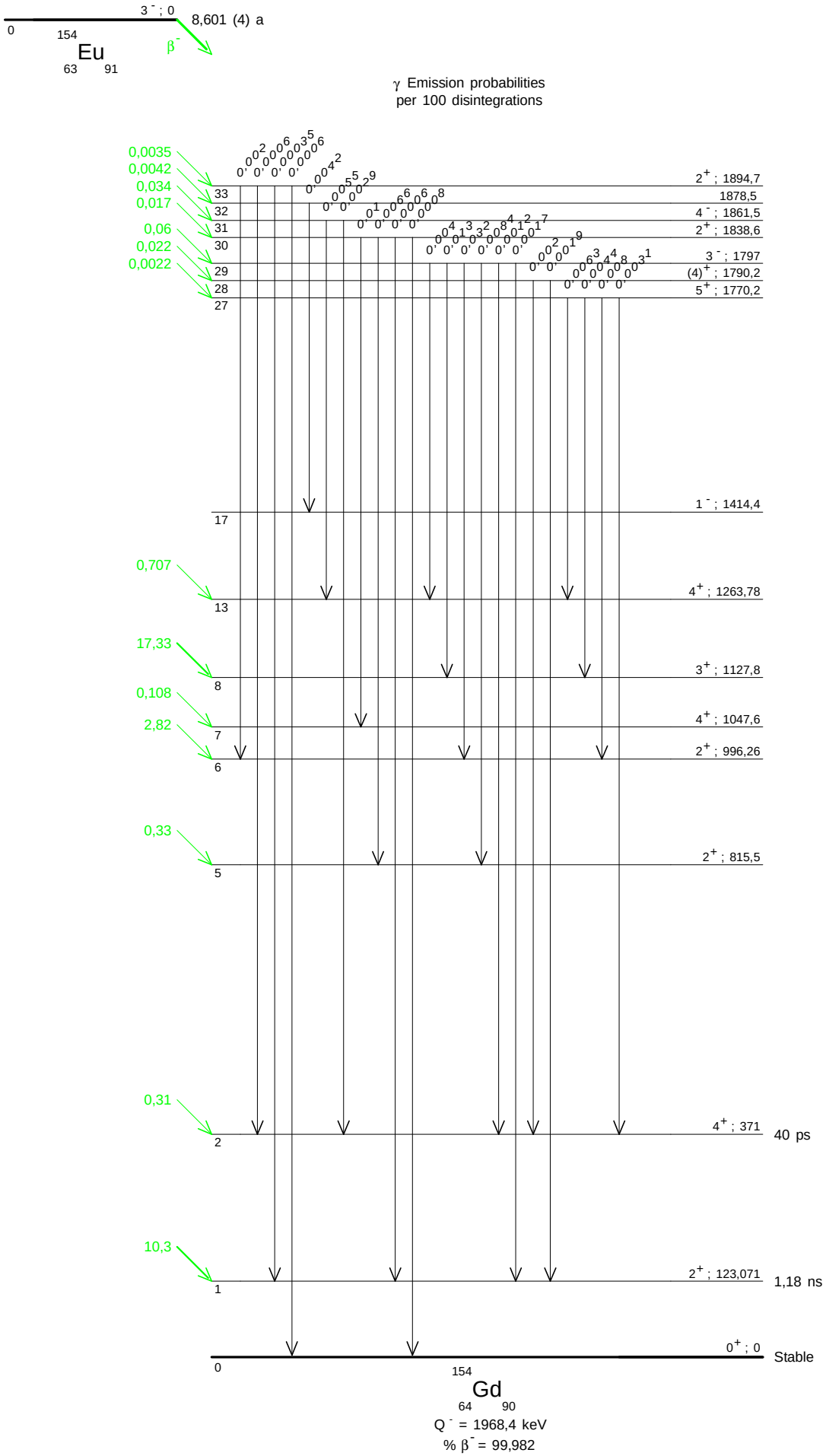
7 References

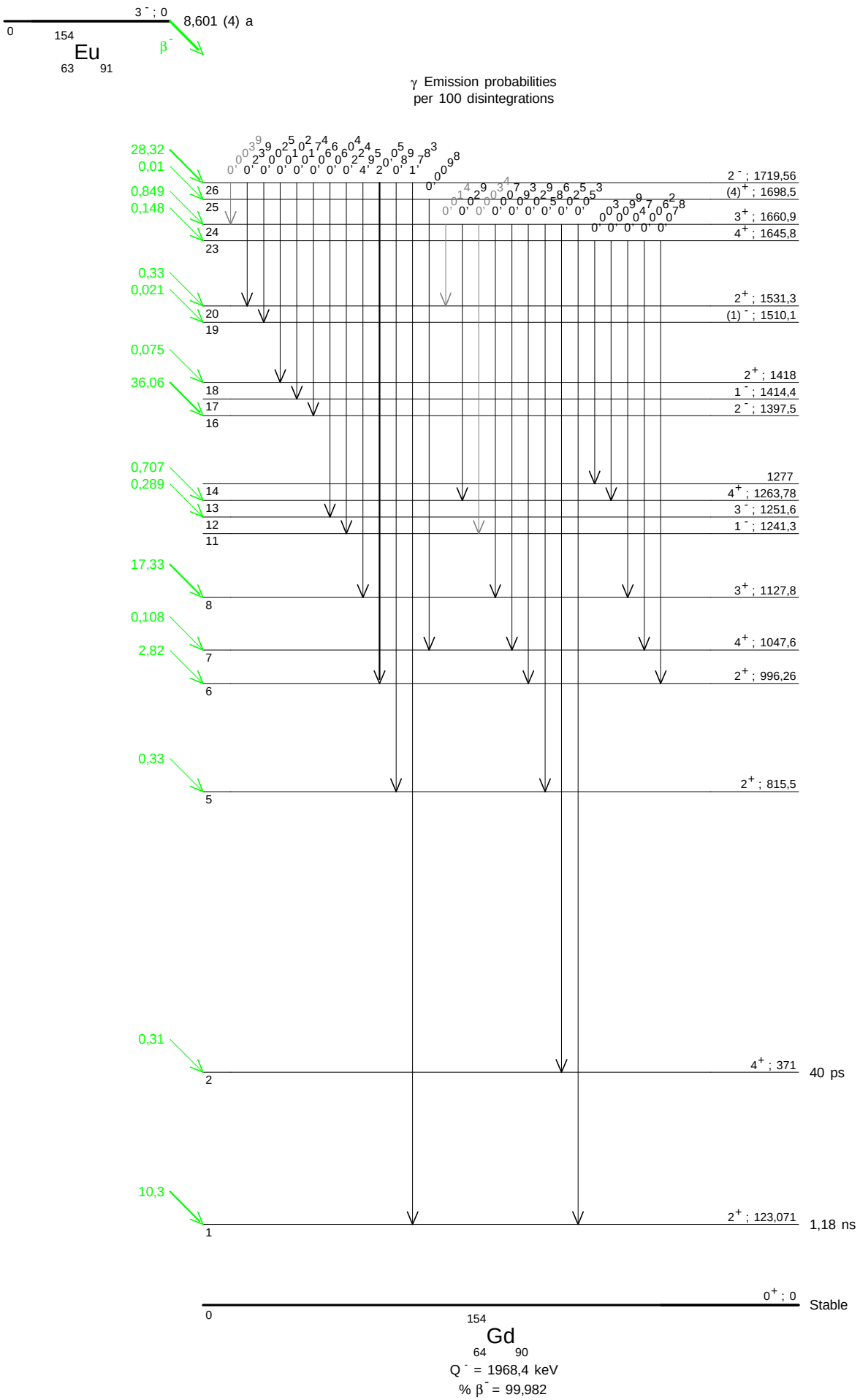
- R. J. Hayden, J. H. Reynolds, M. G. Inghram. Phys. Rev. 75 (1949) 1500
  (Half-life.)
- D. G. Karraker, R. J. Hayden, M. G. Inghram. Phys. Rev. 87 (1952) 901
  (Half-life.)
- V. M. Kelman, V. A. Romanov, R. Y. Metskhvarishvili, V. A. Kolyunov. Nucl. Phys. 2 (1957) 395
  (Gamma Multipolarities.)
- E. L. Chupp, J. W. M. DuMond, F. J. Gordon, R. C. Jopson, H. Mark. Phys. Rev. 112 (1958) 518
  (Gamma-ray energies.)
- D. S. Lu, R. S. Dingus. Phys. Lett. 3 (1962) 44
  (Gamma-ray energies, experimental internal conversion electrons.)
- P. C. Hansen, H. L. Nielsen, K. Wilsky. Nucl. Phys. 89 (1966) 571
  (Beta transition probabilities.)
- J. S. W. Jansen, J. H. Hamilton, E. F. Zganjar. Proc. Intern. Conf. Internal Conversion Process, Nashville (1966) 257
  (Experimental ICC, gamma multipolarities.)
- J. A. Bearden. Rev. Mod. Phys. 39 (1967) 78
  (X-ray energies.)
- R. A. Meyer. Phys. Rev. 174 (1968) 1478
  (Gamma-ray energies, relative emission probabilities.)
- L. K. Ng, K. S. Mann, T. G. Walton. Nucl. Phys. A116 (1968) 433
  (Beta transition probabilities.)
- G. I. Anderson, G. T. Evans. Nucl. Phys. Ä123 (1969) 609
  (Gamma multipolarities.)
- L. Varnell, J. D. Bowman, J. Trischuk. Nucl. Phys. A127 (1969) 270
  (Gamma-ray emission probabilities.)
- L. L. Riedinger, E. Eichler, J. Fuglsang. Proc. Intern. Conf. Nucl. Reactors Induced By Heavy ions, Heidelberg (1970) 442
  (Gamma-ray relative emission probabilities.)
- L. L. Riedinger, N. R. Johnson, J. H. Hamilton. Phys. Rev. C2 (1970) 2358
  (Gamma-ray energies)
- J. F. Emery, S. A. Reynolds, E. I. Wyatt, G. I. Gleason. Nucl. Sci. Eng. 48 (1972) 319
  (Half-life.)
- T. S. Nagpal, R. E. Caucher. Can. J. Phys. 50 (1972) 2688
  (Gamma multipolarities.)
- R. L. Heath. Gamma-ray Spectrum Catalogue In.: ANCR 1000 2 (1974)
  (Gamma-ray energies.)

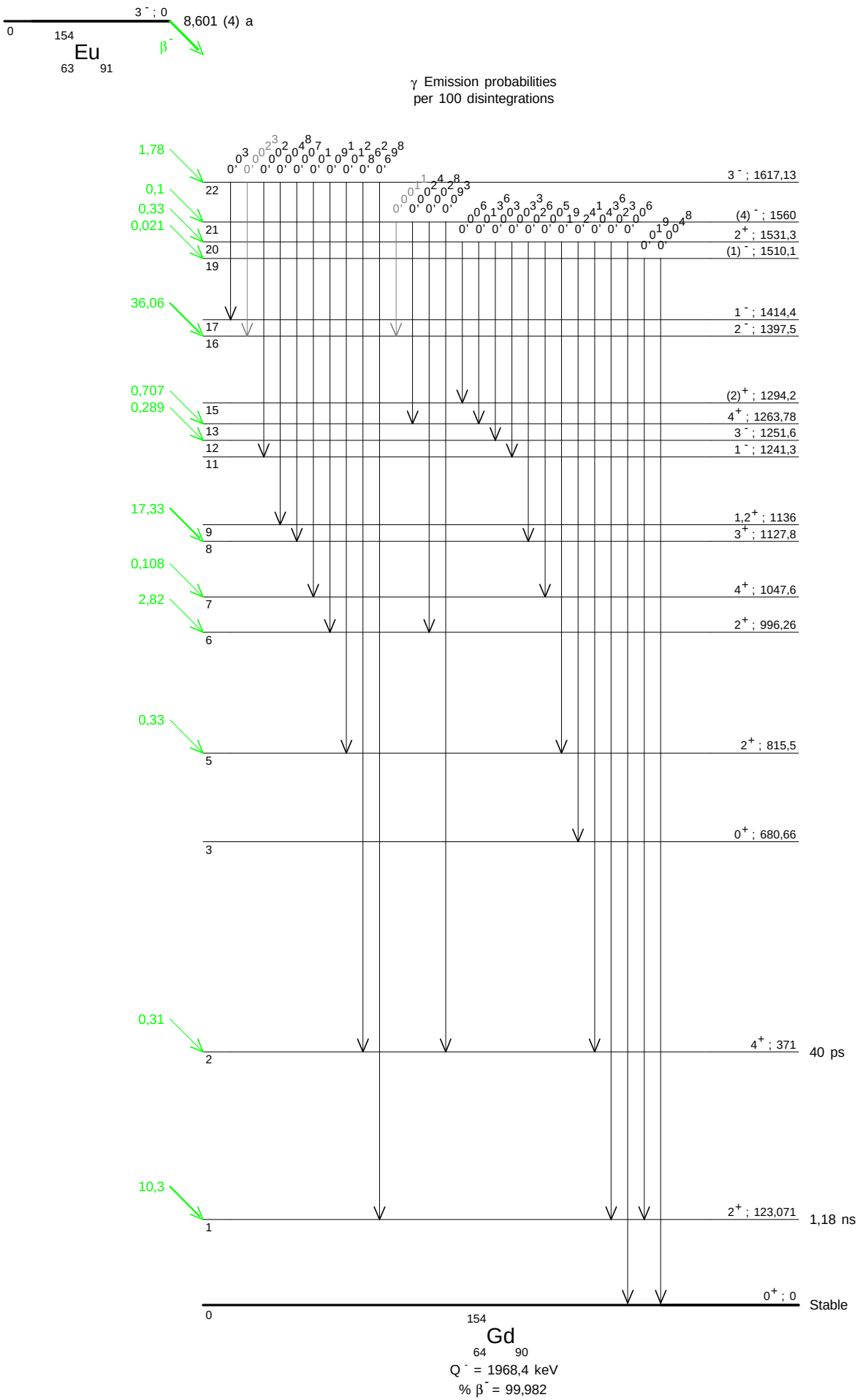
- F. P. Larkins. At. Data Nucl. Data Tables 20 (1977) 313
  (Auger electrons energies.)
- H. Yamada, H. Kawakami, M. Koike, K. Komura. J. Phys. Soc. Jpn 42 (1977) 1448
  (Gamma multipolarities.)
- F. Rosel, H. M. Friess, K. Alder, H. C. Pauli. At. Data Nucl. Data Tables 21 (1978) 92
  (Theoretical ICC.)
- W. N. Roney Jr, W. A. Seale. Nucl. Instrum. Methods 171 (1980) 389
  (Gamma-ray relative emission probabilities.)
- A. K. Sharma, R. Kaur, H. R. Verma, P. N. Trehan. J. Phys. Soc. Jpn 48 (1980) 1407
  (Gamma-ray relative emission probabilities.)
- D. D. Hopes, J. M. R. Hutchinson, F. J. Schima, M. P. Unterweger. NBS-SP 626 (1982) 85
  (Half-life.)
- K. F. Walz, K. Debertin, H. Schrader. Int. J. Appl. Radiat. Isotop. 34 (1983) 1191
  (Half-life.)
- J. Iwata, M. Yasuhara, K. Maeda, Y. Yoshizawa. Nucl. Instrum. Methods 219 (1984) 123
  (Gamma-ray relative emission probabilities.)
- W. Xinlin, L. Xiaodi, D. Hongshan. Chin. J. Nucl. Phys. 8 (1986) 371
  (Gamma-ray relative emission probabilities.)
- M. J. Woods, S. F. M. Lucas. Int. J. Appl. Radiat. Isotop. 37 (1986) 1157
  (Half-life.)
- F. Lagoutine, N. Coursol, J. Legrand. Table de Radionucleides, ISBN 2-7272-0078-1 (1987)
  (Energy of Auger electrons.)
- M. U. Rajput, T. D. MacMahon. ZFK - 732 (1988) 313
  (Half-life.)
- L. L. Kiang, G. C. Kiang, P. K. Teng et al.. Z. Physik A333 (1989) 19
  (Gamma-ray relative emission probabilities.)
- F. J. Schima. IAEA-CPR informal report GS/59 IAEA-TECDOC-619 (1989)
  (Gamma-ray relative emission probabilities.)
- R. A. Meyer. Fizika (Zagreb) 22 (1990) 153
  (Gamma-ray energies and relative emission probabilities.)
- R. C. Helmer. Appl. Rad. Isotopes Phys. Rev. 41 (1990) 75
  (Gamma-ray relative emission probabilities.)
- A. V. Zanevsky, G. A. Isaakyan, N. V. Kurenkov et al.. Proc. 41st. Ann. Conf. Nucl. Spectr. At Nuclei (1991) 477
  (123-keV gamma-ray absolute emission probability.)
- S. U. El-Kameesy, M. S. Abdel-Wahab, L. Al-Houty, H. Abou-Leila. Act. Phys. Acad. Sci. Hung. 71 (1992) 161
  (Gamma-ray relative emission probabilities.)
- M. A. Hammed, I. M. Lowies, T. D. MacMahon. Nucl. Instrum. Methods Phys. Res. A312 (1992) 308
  (Gamma-ray relative emission probabilities and 1274-keV gamma-ray absolute emission probability.)
- T. E. Sazonova, G. A. Isaakyan, N. I. Karmalitsyn, S. V. Sepman, A. V. Zanevsky. Nucl. Instrum. Methods Phys. Res. A312 (1992) 372
  (Gamma-ray relative emission probabilities.)
- U. Schotzig, H. Schrader, K. Debertin. Proc. Intern. Conf. Nucl. Data for Science and Techn. (1992) 562
  (Half-life.)
- D. Smith, D. H. Woods, S. A. Woods et al.. Nucl. Instrum. Methods Phys. Res. A312 (1992) 353
  (Gamma-ray energies and emission probabilities.)
- M. P. Unterweger, D. D. Hopes, F. J. Schima. Nucl. Instrum. Methods Phys. Res. A312 (1992) 349
  (Half-life.)
- J. L. Thompson, A. R. Cartwright. Appl. Rad. Isotopes 44 (1993) 707
  (Half-life.)
- B. M. Coursey, J. M. Calhoun, J. Cessna, D. B. Golas, F. J. Schima, M. P. Unterweger. Nucl. Instrum. Methods Phys. Res. A339 (1994) 26
  (1274-keV gamma-ray absolute emission probability.)
- G. Audi, A. H. Wapstra. Nucl. Phys. A595 (1995) 409
  (Q-value)
- N. Mach, B. Fogerberg. Phys. Rev. C51 (1995) 509
  (Experimental internal conversion electrons.)
- I. Alfter, E. Bodenstedt, W. Knichel, J. Schuth. Z. Physik A355 (1996) 277
  (Experimental gamma multipolarities.)

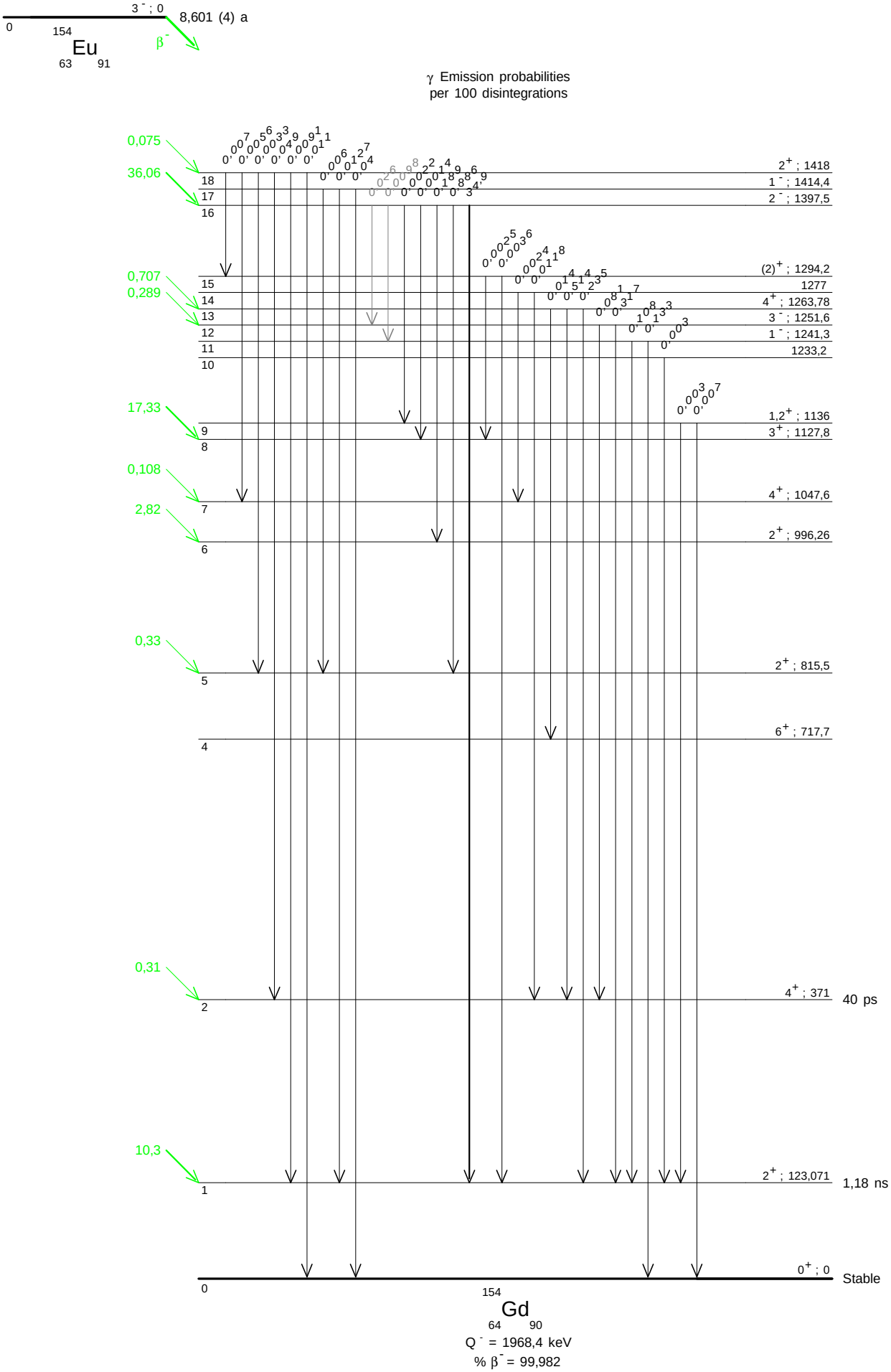
- E. Schonfeld, H. Jansen. Nucl. Instrum. Methods Phys. Res. A369 (1996) 527
(Atomic Data.)
- S. I. Kafala, T. D. MacMahon, S. V. Borzakov. J. Radioanal. Nucl. Chem. 215 (1997) 193
(248 and 996-keV gamma-ray absolute emission probabilities.)
- H. Siegert, H. Schrader, U. Schotzig. Appl. Rad. Isotopes 49 (1998) 1397
(Half-life.)
- E. Schonfeld. Appl. Rad. Isotopes 49 (1998) 1353
(Fractional electron capture probabilities Pk, Pl, Pm.)
- C. W. Reich, R. G. Helmer. Nucl. Data Sheets 85 (1998) 171
(Level scheme, multipolarities, total ICC.)
- E. Schonfeld, G. Rodloff. PTB- 6.11-1999-1999-1 (1999)
(KX-ray energies and relative emission probabilities.)
- V. P. Chechev, A. G. Egorov. Appl. Rad. Isotopes 52 (2000) 601
(Evaluation technique.)
- R. G. Helmer, C. van der Leun. Nucl. Instrum. Methods Phys. Res. A450 (2000) 35
(Gamma-ray energies.)
- M. P. Unterweger. Appl. Rad. Isotopes 56 (2002) 125
(Half-life.)

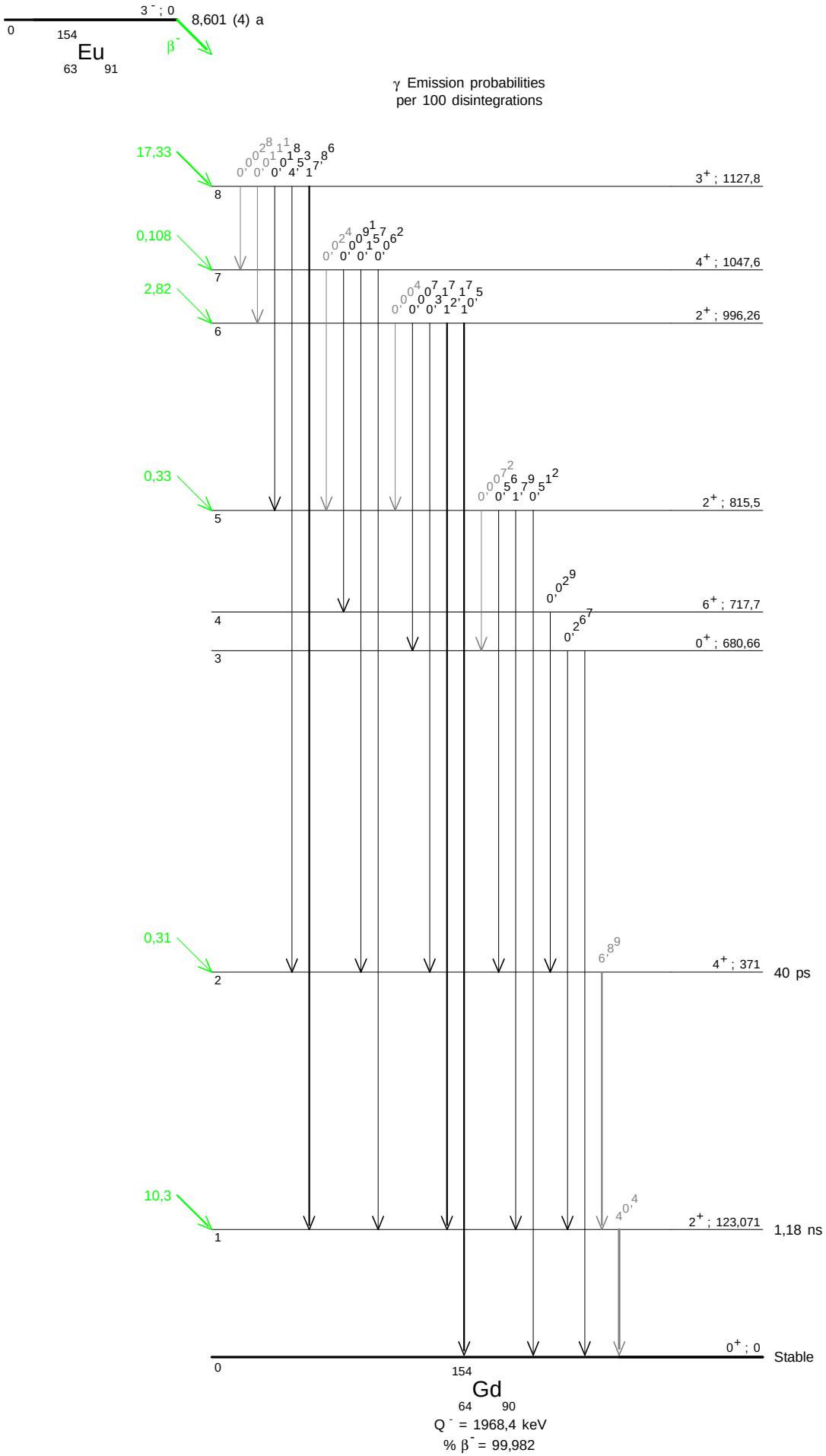

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0
154
ε
Eu
63
91
γ Emission probabilities
per 100 disintegrations
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0,0047
172 ps
4+ ; 266,79
2
0,0031
0,013
3 ns
2+ ; 81,98
1
Stable
0+ ; 0
0
154
Sm
62
92
Q+ = 717,3 keV
% ε = 0,018


3⁻ ; 0
8,601 (4) a
β⁻
0
154
Eu
63
91
γ Emission probabilities
per 100 disintegrations
0,0035
0,0042
0,034
0,017
0,06
0,022
0,0022
33
32
31
30
29
28
27
2⁺ ; 1894,7
1878,5
4⁻ ; 1861,5
2⁺ ; 1838,6
3⁻ ; 1797
(4)⁺ ; 1790,2
5⁺ ; 1770,2
1⁻ ; 1414,4
17
0,707
13
4⁺ ; 1263,78
17,33
8
3⁺ ; 1127,8
0,108
7
4⁺ ; 1047,6
2,82
6
2⁺ ; 996,26
0,33
5
2⁺ ; 815,5
0,31
2
4⁺ ; 371
40 ps
10,3
1
2⁺ ; 123,071
1,18 ns
0
0⁺ ; 0
Stable
154
Gd
64
90
Q⁻ = 1968,4 keV
% β⁻ = 99,982


3 - ; 0
8,601 (4) a
β -
0
154
Eu
63 91
γ Emission probabilities
per 100 disintegrations
28,32
0,01
0,849
0,148
0,33
0,021
0,075
36,06
0,707
0,289
17,33
0,108
2,82
0,33
0,31
10,3
2 - ; 1719,56
(4) + ; 1698,5
3 + ; 1660,9
4 + ; 1645,8
2 + ; 1531,3
(1) - ; 1510,1
2 + ; 1418
1 - ; 1414,4
2 - ; 1397,5
1277
4 + ; 1263,78
3 - ; 1251,6
1 - ; 1241,3
3 + ; 1127,8
4 + ; 1047,6
2 + ; 996,26
2 + ; 815,5
4 + ; 371
40 ps
2 + ; 123,071
1,18 ns
0 + ; 0
Stable
26
25
24
23
20
19
18
17
16
14
13
12
11
8
7
6
5
2
1
0
154
Gd
64 90
Q - = 1968,4 keV
% β - = 99,982


3 - ; 0
8,601 (4) a
β -
0
154
Eu
63 91
γ Emission probabilities
per 100 disintegrations
1,78
0,1
0,33
0,021
36,06
0,707
0,289
17,33
0,108
2,82
0,33
0,31
10,3
3 - ; 1617,13
(4) - ; 1560
2+ ; 1531,3
(1) - ; 1510,1
1 - ; 1414,4
2 - ; 1397,5
(2)+ ; 1294,2
4+ ; 1263,78
3 - ; 1251,6
1 - ; 1241,3
1,2+ ; 1136
3+ ; 1127,8
4+ ; 1047,6
2+ ; 996,26
2+ ; 815,5
0+ ; 680,66
4+ ; 371
40 ps
2+ ; 123,071
1,18 ns
0+ ; 0
Stable
22
21
20
19
17
16
15
13
12
11
9
8
7
6
5
3
2
1
0
154
Gd
64 90
Q - = 1968,4 keV
% β - = 99,982


3 - ; 0
8,601 (4) a
0
154
Eu
63 91
β -
γ Emission probabilities
per 100 disintegrations
0,075
36,06
0,707
0,289
17,33
0,108
2,82
0,33
0,31
10,3
2+ ; 1418
1 - ; 1414,4
2 - ; 1397,5
(2)+ ; 1294,2
1277
4+ ; 1263,78
3 - ; 1251,6
1 - ; 1241,3
1233,2
1,2+ ; 1136
3+ ; 1127,8
4+ ; 1047,6
2+ ; 996,26
2+ ; 815,5
6+ ; 717,7
4+ ; 371
40 ps
2+ ; 123,071
1,18 ns
0+ ; 0
Stable
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
2
1
0
154
Gd
64 90
Q - = 1968,4 keV
% β - = 99,982


3⁻ ; 0
8,601 (4) a
β⁻
0
154
Eu
63
91
γ Emission probabilities
per 100 disintegrations
17,33
0,108
2,82
0,33
0,31
10,3
8
7
6
5
4
3
2
1
0
3⁺ ; 1127,8
4⁺ ; 1047,6
2⁺ ; 996,26
2⁺ ; 815,5
6⁺ ; 717,7
0⁺ ; 680,66
4⁺ ; 371
40 ps
2⁺ ; 123,071
1,18 ns
0⁺ ; 0
Stable
154
Gd
64
90
Q⁻ = 1968,4 keV
% β⁻ = 99,982

$^{155}_{63}\mathrm{Eu}_{92}$

1 Decay Scheme

Eu-155 disintegrates 100 % via beta minus disintegration to excited levels and to the ground state in Gd-155.
L'europium 155 se désintègre par émission bêta moins vers des niveaux excités et le niveau fondamental de gadolinium 155.

2 Nuclear Data

$T_{1/2}(^{155}\mathrm{Eu}\ )$: 4,753 (14) a
$Q^-(^{155}\mathrm{Eu}\ )$: 252,1 (11) keV

2.1 β^- Transitions

	Energy keV	Probability × 100	Nature	lg ft
$\beta^-_{0,6}$	106,1 (11)	0,73 (7)	1st Forbidden	8,83
$\beta^-_{0,5}$	134,2 (11)	1,85 (23)	Allowed	8,75
$\beta^-_{0,4}$	144,6 (11)	<0,01	2nd Forbidden	>11,1
$\beta^-_{0,3}$	146,9 (11)	46,1 (29)	Allowed	7,47
$\beta^-_{0,2}$	165,7 (11)	25,5 (29)	Allowed	7,89
$\beta^-_{0,1}$	192,2 (11)	9,2 (4)	1st Forbidden	8,54
$\beta^-_{0,0}$	252,2 (11)	16,6 (11)	Allowed	8,65

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{5,4}$(Gd)	10,4183 (13)	1,2 (1)	M1+0,11%E2		265 (22)	59 (5)	340 (23)
$\gamma_{3,2}$(Gd)	18,763 (2)	17,7 (28)	M1+7,1%E2		284 (22)	65,9 (30)	367 (22)

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{4,2}$(Gd)	21,035 (4)	1,2 (1)	E2		2013 (60)	471 (14)	2600 (70)
$\gamma_{2,1}$(Gd)	26,531 (21)	0,94 (7)	E1		1,55 (5)	0,342 (11)	1,98 (6)
$\gamma_{5,2}$(Gd)	31,444 (7)	0,50 (15)	M1+17%E2		53 (13)	12,5 (30)	69 (14)
$\gamma_{3,1}$(Gd)	45,299 (1)	1,89 (7)	E1		0,347 (10)	0,0758 (23)	0,443 (11)
$\gamma_{5,1}$(Gd)	57,989 (1)	0,150 (14)	E1	1,021 (10)	0,173 (5)	0,0377 (11)	1,243 (11)
$\gamma_{1,0}$(Gd)	60,0086 (10)	12,8 (6)	M1+4,1%E2	7,48 (9)	1,55 (6)	0,347 (14)	9,48 (11)
$\gamma_{6,1}$(Gd)	86,0591 (10)	0,65 (7)	M1+3,0%E2	2,66 (3)	0,443 (17)	0,098 (4)	3,23 (4)
$\gamma_{2,0}$(Gd)	86,5479 (10)	44,0 (5)	E1	0,360 (4)	0,0561 (17)	0,0122 (4)	0,432 (7)
$\gamma_{3,0}$(Gd)	105,3083 (10)	26,5 (8)	E1	0,214 (2)	0,0323 (10)	0,00701 (21)	0,255 (3)
$\gamma_{6,0}$(Gd)	146,071 (1)	0,084 (7)	E2	0,397 (4)	0,198 (6)	0,0462 (14)	0,653 (8)

3 Atomic Data

3.1 Gd

ω_K : 0,932 (4)
$\bar{\omega}_L$: 0,176 (6)
n_{KL} : 0,850 (4)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	42,3093		55,59
	$K\alpha_1$	42,9967		100
	$K\beta_3$	48,556	}	
	$K\beta_1$	48,697	}	
	$K\beta_5''$	49,053	}	31,8
	$K\beta_2$	49,961	}	
	$K\beta_4$	50,099	}	8,1
	$KO_{2,3}$	50,219	}	
X_L				
	$L\ell$	5,36		
	$L\gamma$	– 8,35		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	33,49 – 35,75	100
KLX	39,98 – 42,86	51,3
KXY	47,98 – 48,95	6,58
Auger L	3,4 – 8,3	

4 Electron Emissions

		Energy keV	Electrons per 100 disint.
e_{AL}	(Gd)	3,4 - 8,3	35,1 (20)
e_{AK}	(Gd)		1,71 (11)
	KLL	33,49 - 35,75 }	
	KLX	39,98 - 42,86 }	
	KXY	47,98 - 48,95 }	
$ec_{5,4\ L}$	(Gd)	2,043 - 3,175	0,93 (13)
$ec_{5,1\ K}$	(Gd)	7,75 (3)	0,068 (7)
$ec_{5,4\ M}$	(Gd)	8,538 - 9,233	0,21 (3)
$ec_{1,0\ K}$	(Gd)	9,770 (3)	9,1 (4)
$ec_{3,2\ L}$	(Gd)	10,387 - 11,520	13,6 (23)
$ec_{4,2\ L}$	(Gd)	12,659 - 13,792	0,93 (18)
$ec_{3,2\ M}$	(Gd)	16,882 - 17,578	3,2 (5)
$ec_{2,1\ L}$	(Gd)	18,155 - 19,288	0,49 (4)
$ec_{4,2\ M}$	(Gd)	19,154 - 19,850	0,22 (4)
$ec_{5,2\ L}$	(Gd)	23,068 - 24,201	0,38 (4)
$ec_{2,1\ M}$	(Gd)	24,650 - 25,346	0,108 (8)
$ec_{5,2\ M}$	(Gd)	29,563 - 30,259	0,09 (3)
$ec_{6,1\ K}$	(Gd)	35,820 (3)	0,41 (5)
$ec_{2,0\ K}$	(Gd)	36,309 (3)	11,05 (16)
$ec_{3,1\ L}$	(Gd)	36,923 - 38,056	0,45 (2)
$ec_{3,1\ M}$	(Gd)	43,418 - 44,114	0,100 (5)
$ec_{5,1\ L}$	(Gd)	49,613 - 50,746	0,012 (1)
$ec_{1,0\ L}$	(Gd)	51,633 - 52,766	1,89 (11)
$ec_{3,0\ K}$	(Gd)	55,069 (3)	4,52 (14)
$ec_{5,1\ M}$	(Gd)	56,108 - 56,804	0,0030 (3)
$ec_{1,0\ M}$	(Gd)	58,128 - 58,823	0,42 (3)
$ec_{6,1\ L}$	(Gd)	77,683 - 78,816	0,068 (8)
$ec_{2,0\ L}$	(Gd)	78,172 - 79,305	1,72 (5)
$ec_{6,1\ M}$	(Gd)	84,178 - 84,874	0,015 (2)
$ec_{2,0\ M}$	(Gd)	84,667 - 85,363	0,375 (13)

		Energy keV		Electrons per 100 disint.
$ec_{6,0\ K}$	(Gd)	95,832	(3)	0,0202 (16)
$ec_{3,0\ L}$	(Gd)	96,933 - 98,066		0,68 (3)
$ec_{3,0\ M}$	(Gd)	103,428 - 104,123		0,148 (8)
$ec_{6,0\ L}$	(Gd)	137,696 - 138,829		0,0101 (8)
$ec_{6,0\ M}$	(Gd)	144,190 - 144,886		0,0024 (2)
$\beta^-_{0,6}$	max:	106,1	(11)	0,73 (7)
$\beta^-_{0,6}$	avg:	27,8	(3)	
$\beta^-_{0,5}$	max:	134,2	(11)	1,85 (23)
$\beta^-_{0,5}$	avg:	35,6	(3)	
$\beta^-_{0,4}$	max:	144,6	(11)	0,01
$\beta^-_{0,4}$	avg:			
$\beta^-_{0,3}$	max:	146,9	(11)	46,1 (29)
$\beta^-_{0,3}$	avg:	39,2	(3)	
$\beta^-_{0,2}$	max:	165,7	(11)	25,5 (29)
$\beta^-_{0,2}$	avg:	44,6	(3)	
$\beta^-_{0,1}$	max:	192,2	(11)	9,2 (4)
$\beta^-_{0,1}$	avg:	52,3	(3)	
$\beta^-_{0,0}$	max:	252,2	(11)	16,6 (11)
$\beta^-_{0,0}$	avg:	70,2	(3)	

5 Photon Emissions

5.1 X-Ray Emissions

		Energy keV		Photons per 100 disint.	
XL	(Gd)	5,36 — 8,35		7,5 (5)	
$XK\alpha_2$	(Gd)	42,3093		6,70 (13)	} Kα
$XK\alpha_1$	(Gd)	42,9967		12,05 (23)	}
$XK\beta_3$	(Gd)	48,556	}		
$XK\beta_1$	(Gd)	48,697	}	3,84 (11)	$K'\beta_1$
$XK\beta''_5$	(Gd)	49,053	}		
$XK\beta_2$	(Gd)	49,961	}		
$XK\beta_4$	(Gd)	50,099	}	0,977 (26)	$K'\beta_2$
$XKO_{2,3}$	(Gd)	50,219	}		

5.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{5,4}$(Gd)	10,4183 (13)	0,0035 (4)
$\gamma_{3,2}$(Gd)	18,763 (2)	0,048 (7)
$\gamma_{4,2}$(Gd)	21,035 (4)	0,00046 (3)
$\gamma_{2,1}$(Gd)	26,531 (21)	0,316 (22)
$\gamma_{5,2}$(Gd)	31,444 (7)	0,0071 (15)
$\gamma_{3,1}$(Gd)	45,299 (1)	1,31 (5)
$\gamma_{5,1}$(Gd)	57,989 (1)	0,067 (6)
$\gamma_{1,0}$(Gd)	60,0086 (10)	1,22 (5)
$\gamma_{6,1}$(Gd)	86,0591 (10)	0,154 (17)
$\gamma_{2,0}$(Gd)	86,5479 (10)	30,7 (3)
$\gamma_{3,0}$(Gd)	105,3083 (10)	21,1 (6)
$\gamma_{6,0}$(Gd)	146,071 (1)	0,051 (4)

6 Main Production Modes

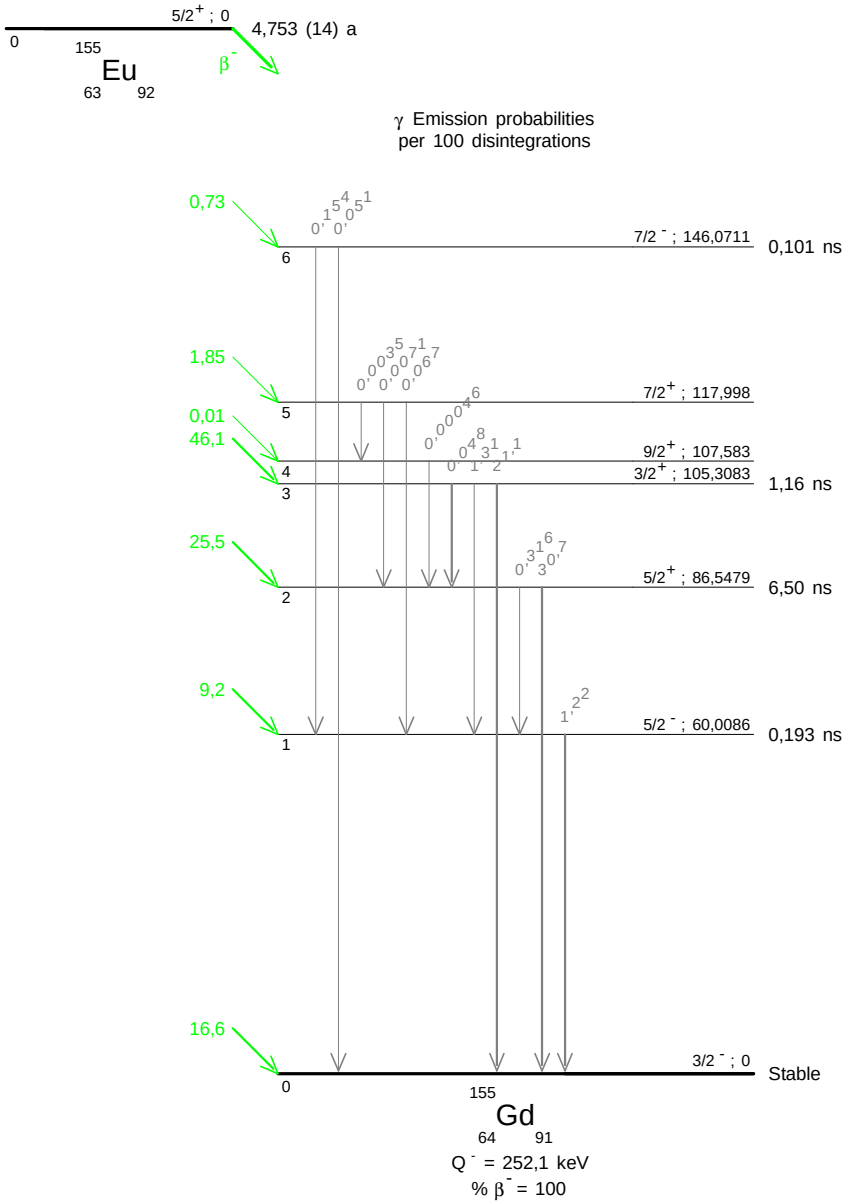
$\left\{ \begin{array}{l} \mathrm{Sm-154(n,\gamma)Sm-155} \\ \text{Possible impurities : } \mathrm{Eu-152,\ Eu-154} \end{array} \right.$

7 References

- J.A.Marinsky, L.E.Glendenin, F.Metzger. MIT-LNS Progr Report NP-1272 (1949) 67
  (Beta emission energies and probabilities)
- M.R.Lee, R.Katz. Phys.Rev. 93 (1954) 155
  (Beta emission energies and probabilities)
- V.S.Dubey, C.E.Mandeville, M.A.Rothman. Phys.Rev. 103 (1956) 1430
  (Beta emission energies and probabilities)
- M.C. Joshi, B.V.Thosar. Proc. Indian Acad. Sci. 50A (1959) 342
  (Beta emission energies and probabilities)
- J. de Boer, M.Martin, P.Marmier. Helv. Phys. Acta 32 (1959) 658
  (Multipolarity mixing ratios)
- E.N.Hatch, F.Boehm. Z. Physik 155 (1959) 609
  (Gamma ray energies and relative emission probabilities)
- B.N. Subba Rao. Nuovo Cim. 16 (1960) 283
  (Beta emission energies and probabilities)
- B.N. Subba Rao. Nucl.Phys. 28 (1961) 503
  (Multipolarity mixing ratios)
- B. Harmatz, T.H. Handley, J.W. Mihelich. Phys.Rev. 128 (1962) 1176
  (Multipolarity mixing ratios)
- D.Ashery, A.E.Blaugrund, R.Kalish. Nucl.Phys. 76 (1966) 336
  (Multipolarity mixing ratios)
- C.Foin, J.Oms, J-L.Barat. J.Phys.(Paris) 28 (1967) 861
  (G-energies, P(KX), Pce, multipolarity mixing ratios)
- J.Kormicki, H.Niewodniczanski, Z.Stachura, K.Zuber, A.Budziak. Nucl.Phys. A102 (1967) 253
  (Multipolarity mixing ratios)

- P.H.Blichert-Toft, E.G.Funk, J.W.Mihelich,. Nucl.Phys. A96 (1967) 190
  (KX-ray emission probabilities)
- R.E.Berg, J.L.Snelgrove, E.Kashy. Phys.Rev. 153 (1967) 1165
  (Gamma ray relative emission probabilities)
- R.S.Hager, E.C.Seltzer. Nucl. Data Tables A4 (1968) 1
  (Theoretical ICC)
- J.Oms, C.Foin, A.Baudry. Comp. Rend. Acad. Sci. (Paris) 266B (1968) 1292
  (KX ray emission probabilities)
- P.Alexander. Nucl.Phys. A108 (1968) 145
  (Gamma ray relative emission probabilities)
- R.A.Meyer, J.W.T.Meadows. Nucl.Phys. A132 (1969) 177
  (Gamma and KX ray energies and emission probabilities)
- R.S Mowatt. Can J.Phys. 48 (1970) 1933
  (Half-life)
- D.E.Raeside. Nucl. Instrum. Methods 87 (1970) 7
  (Gamma ray energies)
- J.D.Reierson, G.C.Nelson, E.N.Hatch. Nucl.Phys. A153 (1970) 109
  (Gamma ray energies and relative emission probabilities)
- R.J.Gehrke, R.A.Lokken. Nucl. Instrum. Methods 97 (1971) 219
  (Gamma ray relative emission probabilities)
- J.F.Emery, S.A.Reynolds, E.I.Wyatt, G.I.Gleason. Nucl.Sci.Eng. 48 (1972) 319
  (Half-life)
- B.N. Subba Rao. Current Sci. (India) 41 (1972) 692
  (Half-life)
- S.I.Salem, S.L.Panossian, R.A.Krause. At.Data.Nuc.Data.Tables 14 (1974) 91
  (KX ray relative emission probabilities)
- W.R.Daniels, D.W Barr, G.F.Grisham, F.O.Lawrence. J. Inorg. Nucl. Chem. 36 (1974) 3874
  (Half-life)
- R.L.Heath. Report Ancr 1000-2 (1974)
  (Gamma ray relative emission probabilities)
- P.Christmas, P.Cross. J.Phys.(London) G1 (1975) 113
  (Gamma ray energies, multipolarity mixing ratios)
- H. J. Krell, S. Hofmann. Z. Physik A272 (1975) 257
  (Egamma, P'gamma, multipolarity mixing ratios)
- R.A.Meyer, R.Gunnink, C.M.Lederer, E.Browne. Phys.Rev. C13 (1976) 2466
  (Gamma ray energies)
- F.P.Larkins. At.Data.Nuc.Data.Tables 20 (1977) 313
  (Auger electron energies)
- I.M.Band, M.B.Trzhaskovskaya. Special report of Leningrad nuclear physics institute (1978)
  (Theoretical ICC)
- F.Rösel, H.M.Friess, K.Alder, H.C.Pauli. At.Data.Nuc.Data.Tables 21 (1978) 92
  (Theoretical ICC)
- B.M.Coursey, D.D.Hoppes, F.J. Schima. Nucl. Instrum. Methods 193 (1982) 1
  (Gamma ray relative emission probabilities)
- K.F.Walz, K.Debertin, H.Schrader. Int. J. Appl. Radiat. Isotop. 34 (1983) 1191
  (Half-life)
- H.H.Schmidt, W.Stoffl, T.Egidy, P.Hungerford, H.J. Scheerer, K. Schreckenbach, H.G.Borner, D.D.Warner, R.E.Chrien, R.C.Greenwood, C.W. Reich. J.Phys.(London) G12 (1986) 411
  (Gamma ray and level energies, multipolarity mixing ratios)
- F. Lagoutine, Coursol N., Legrand J. Table de Radionucleides, ISBN-2-7272-0078-1. (LMRI, 1982-1987) (1987)
  (Energy of Auger electrons)
- R.A.Meyer. Fizika (Zagreb) 22 (1990) 153
  (Gamma ray energies and relative emission probabilities)
- V.M. Gorozhankin, A.Kovalik, L.E.Ir, M.A. Makhmud, Ya.Novak, A.F. Novgorodov. Program and Thesis, Proc 40th Ann Conf Nucl Spectrosc Struct At Nuclei, Leningrad (1990) 97
  (Gamma ray energies, multipolarity mixing ratios)
- T.E.Sazonova, G.A.Isaakyan, N.I.Karmalitsyn, S.V. Sepman, A.V. Zanevsky. Nucl. Instrum. Methods Phys. Res. A312 (1992) 372
  (105,31 keV gamma ray absolute emission probability)

- M.P.Unterweger, D.D.Hoppes, F.J.Schima. Nucl. Instrum. Methods Phys. Res. A312 (1992) 349
(Half-life)
- I.M.Band, M.B.Trzhaskovskaya. At.Data.Nuc.Data.Tables 55 (1993) 43
(Theoretical ICC)
- J.L.Thompson, and A.R.Cartwright. Appl. Rad. Isotopes 44 (1993) 707
(Half-life)
- B.M.Coursey, J.M.Calhoun, J.Cessna, D.B.Golas, F.J.Schima, M.P. Unterweger. Nucl. Inst. Meth. Phys. Res. A339 (1994) 26
(86,55 keV gamma ray absolute emission probability)
- A.G.Egorov, V.P.Chechev. Nucl. Instrum. Methods Phys. Res. A339 (1994) 248
(Gamma and KX ray absolute emission probabilities)
- C.W.Reich. Nucl.Data Sheets 71 (1994) 709
(Decay scheme and level energies)
- G. Audi, A.H Wapstra. Nucl.Phys. A595 (1995) 409
(Q value)
- V.P.Chechev, A.G.Egorov, G.E.Shchukin. Appl. Rad. Isotopes 47 (1996) 329
(Gamma ray relative emission probabilities)
- E.Schönfeld, H.Janssen. Nucl. Instrum. Methods Phys. Res. A369 (1996) 527
(Atomic data)
- H.Siegert, H.Schrader, U.Schotzig. Appl. Rad. Isotopes 49 (1998) 1397
(Half-life)
- E.Schönfeld, G.Rodloff. Report PTB-6.11, Braunschweig 1999-1 (1999)
(KX ray energies and relative emission probabilities)
- V.P.Chechev, A.G.Egorov. Appl. Rad. Isotopes 52 (2000) 601
(Evaluation of half-life)
- M.P.Unterweger. Appl. Rad. Isotopes 56 (2002) 125
(Half-life)


5/2+ ; 0
4,753 (14) a
0
155
Eu
63 92
β-
γ Emission probabilities
per 100 disintegrations
0,73
7/2- ; 146,0711
0,101 ns
6
1,85
7/2+ ; 117,998
5
0,01
46,1
9/2+ ; 107,583
3/2+ ; 105,3083
1,16 ns
4
3
25,5
5/2+ ; 86,5479
6,50 ns
2
9,2
5/2- ; 60,0086
0,193 ns
1
16,6
3/2- ; 0
Stable
0
155
Gd
64 91
Q- = 252,1 keV
% β- = 100

$^{166}_{67}\mathrm{Ho}_{99}$

1 Decay Scheme

Ho-166 decays by beta minus emission to excited states of Er-166.
L'holmium 166 se désintègre uniquement par émission bêta moins vers les états excités d'erbium 166.

2 Nuclear Data

$T_{1/2}(^{166}\mathrm{Ho}\ )$: 26,795 (29) h
$Q^-(^{166}\mathrm{Ho}\ )$: 1854,5 (9) keV

2.1 β^- Transitions

	Energy keV	Probability × 100	Nature	lg ft
$\beta^-_{0,8}$	24,1 (9)	0,0353 (11)		5
$\beta^-_{0,7}$	41,7 (9)	0,00010 (3)	1st forbidden	12,1
$\beta^-_{0,6}$	192,0 (9)	0,304 (7)	Allowed	6,9
$\beta^-_{0,5}$	326,2 (9)	0,00276 (22)	Unique 1st forbidden	9,5
$\beta^-_{0,4}$	394,5 (9)	0,955 (16)	1st forbidden	7,4
$\beta^-_{0,3}$	1068,6 (9)	0,0072 (21)	Unique 1st forbidden	11,6
$\beta^-_{0,1}$	1773,9 (9)	50,5 (15)	Unique 1st forbidden	9
$\beta^-_{0,0}$	1854,5 (9)	48,2 (15)	1st forbidden	8,1

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L (10^{-2})	α_M (10^{-2})	α_T
$\gamma_{1,0}$(Er)	80,5725 (13)	51,7 (11)	E2	1,65 (5)	401 (8)	97,8 (20)	6,90 (14)
$\gamma_{2,1}$(Er)	184,4107 (21)	0,0020 (9)	E2	0,205 (6)	9,84 (30)	2,36 (7)	0,333 (10)
$\gamma_{3,2}$(Er)	520,80 (7)	0,00036 (2)	E2	0,01192 (36)	0,234 (7)	0,0535 (16)	0,0149 (5)
$\gamma_{4,3}$(Er)	674,25 (7)	0,0200 (17)	E2	0,00653 (20)	0,1138 (34)	0,0257 (8)	0,00799 (24)

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L (10^{-2})	α_M (10^{-2})	α_T
$\gamma_{3,1}$(Er)	705,21 (7)	0,0147 (12)	E2+M1	0,00591 (18)	0,1012 (30)	0,0228 (7)	0,00721 (22)
$\gamma_{3,0}$(Er)	785,78 (7)	0,0121 (3)	E2	0,00467 (14)	0,0769 (23)	0,0173 (5)	0,00566 (17)
$\gamma_{5,2}$(Er)	1263,25 (15)	0,0155 (9)	E2(+M3)	0,0018 (2)	0,03 (1)	0,0058 (2)	0,0021 (2)
$\gamma_{4,1}$(Er)	1379,452 (10)	0,935 (35)	E2	0,00151 (5)	0,022 (1)	0,0048 (2)	0,00179 (5)
$\gamma_{5,1}$(Er)	1447,66 (15)	0,00105 (10)	E2(+E0)	0,00138 (4)	0,0198 (6)	0,0044 (2)	0,00163 (5)
$\gamma_{4,0}$(Er)	1460,025 (10)	0,0003	E0	0,3			
$\gamma_{5,0}$(Er)	1528,23 (15)	0,00014 (5)	E2	0,00125 (4)	0,0178 (5)		0,00147 (4)
$\gamma_{6,1}$(Er)	1581,860 (15)	0,186 (4)	E1+(M2)	0,0006 (1)			
$\gamma_{6,0}$(Er)	1662,433 (15)	0,118 (5)	E1	0,000484 (15)			
$\gamma_{7,1}$(Er)	1732,2 (5)	0,000046 (20)	M1(+E2)	0,0015 (2)			
$\gamma_{8,1}$(Er)	1749,846 (24)	0,0272 (10)	E1(+M2)	0,0005 (2)			
$\gamma_{7,0}$(Er)	1812,8 (5)	0,000056 (19)	E1(+M2)	0,0004 (2)			
$\gamma_{8,0}$(Er)	1830,419 (24)	0,0081 (2)	E1	0,000413 (12)			

3 Atomic Data

3.1 Er

ω_K : 0,942 (4)
$\bar{\omega}_L$: 0,216 (9)
n_{KL} : 0,838 (4)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	Kα_2	48,2215		56,34
	Kα_1	49,1282		100
	Kβ_3	55,495	}	
	Kβ_1	55,682	}	
	Kβ_5''	56,04	}	32,5
	Kβ_2	57,21	}	
	Kβ_4	57,313	}	8,45
	$KO_{2,3}$	57,456	}	
X_L				
	Lℓ	6,14		
	Lα	6,9 – 6,95		
	Lη	7,05		
	Lβ	7,75 – 8,34		
	Lγ	8,81 – 9,43		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	37,78 – 40,55	100
KLX	45,52 – 49,10	52,4
KXY	53,07 – 57,84	6,86
Auger L	3,9 – 7,6	

4 Electron Emissions

		Energy keV	Electrons per 100 disint.
e_{AL}	(Er)	3,9 - 7,6	28,0 (6)
e_{AK}	(Er)		0,63 (5)
	KLL	37,78 - 40,55 }	
	KLX	45,52 - 49,10 }	
	KXY	53,07 - 57,84 }	
$ec_{1,0\ T}$	(Er)	23,09 - 80,54	45,2 (15)
$ec_{1,0\ K}$	(Er)	23,090 (2)	10,81 (35)
$ec_{1,0\ L}$	(Er)	70,82 - 72,22	26,3 (8)
$ec_{1,0\ M}$	(Er)	78,37 - 79,16	6,41 (21)
$ec_{1,0\ N}$	(Er)	80,12 - 80,57	1,493 (49)
$\beta^-_{0,8}$	max:	24,1 (9)	0,0353 (11)
$\beta^-_{0,8}$	avg:	7,1 (10)	
$\beta^-_{0,7}$	max:	41,7 (9)	0,00010 (3)
$\beta^-_{0,7}$	avg:	13 (2)	
$\beta^-_{0,6}$	max:	192,0 (9)	0,304 (7)
$\beta^-_{0,6}$	avg:	52 (1)	
$\beta^-_{0,5}$	max:	326,2 (9)	0,00276 (22)
$\beta^-_{0,5}$	avg:	93 (3)	
$\beta^-_{0,4}$	max:	394,5 (9)	0,955 (16)
$\beta^-_{0,4}$	avg:	115 (3)	
$\beta^-_{0,3}$	max:	1068,6 (9)	0,0072 (21)
$\beta^-_{0,3}$	avg:	356 (9)	
$\beta^-_{0,1}$	max:	1773,9 (9)	50,5 (15)
$\beta^-_{0,1}$	avg:	651,1 (6)	
$\beta^-_{0,0}$	max:	1854,5 (9)	48,2 (15)
$\beta^-_{0,0}$	avg:	693,8 (6)	

5 Photon Emissions

5.1 X-Ray Emissions

		Energy keV		Photons per 100 disint.	
XL	(Er)	6,14 — 9,43		7,91 (18)	
XKα_2	(Er)	48,2215		2,91 (10)	} Kα
XKα_1	(Er)	49,1282		5,16 (17)	}
XKβ_3	(Er)	55,495	}		
XKβ_1	(Er)	55,682	}	1,68 (6)	K$'\beta_1$
XKβ''_5	(Er)	56,04	}		
XKβ_2	(Er)	57,21	}		
XKβ_4	(Er)	57,313	}	0,436 (18)	K$'\beta_2$
XKO$_{2,3}$	(Er)	57,456	}		

5.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{1,0}$(Er)	80,5725 (13)	6,55 (8)
$\gamma_{2,1}$(Er)	184,4107 (11)	0,0015 (7)
$\gamma_{3,2}$(Er)	520,80 (7)	0,00035 (2)
$\gamma_{4,3}$(Er)	674,24 (7)	0,0198 (17)
$\gamma_{3,1}$(Er)	705,21 (7)	0,0146 (12)
$\gamma_{3,0}$(Er)	785,78 (7)	0,0120 (3)
$\gamma_{5,2}$(Er)	1263,24 (15)	0,0155 (9)
$\gamma_{4,1}$(Er)	1379,446 (10)	0,933 (35)
$\gamma_{5,1}$(Er)	1447,66 (15)	0,00105 (10)
$\gamma_{4,0}$(Er)	1460,018 (10)	0,0002
$\gamma_{5,0}$(Er)	1528,23 (15)	0,00014 (5)
$\gamma_{6,1}$(Er)	1581,852 (15)	0,186 (4)
$\gamma_{6,0}$(Er)	1662,424 (15)	0,118 (5)
$\gamma_{7,1}$(Er)	1732,2 (5)	0,000046 (20)
$\gamma_{8,1}$(Er)	1749,837 (14)	0,0272 (10)
$\gamma_{7,0}$(Er)	1812,8 (5)	0,000056 (19)
$\gamma_{8,0}$(Er)	1830,408 (24)	0,0081 (2)

6 Main Production Modes

Ho − 165 (E = thermal)(n,γ)Ho − 166

Ho − 165(d,p)Ho − 166

Ho − 165(d,pg)Ho − 166

Er − 167(t)Ho − 166

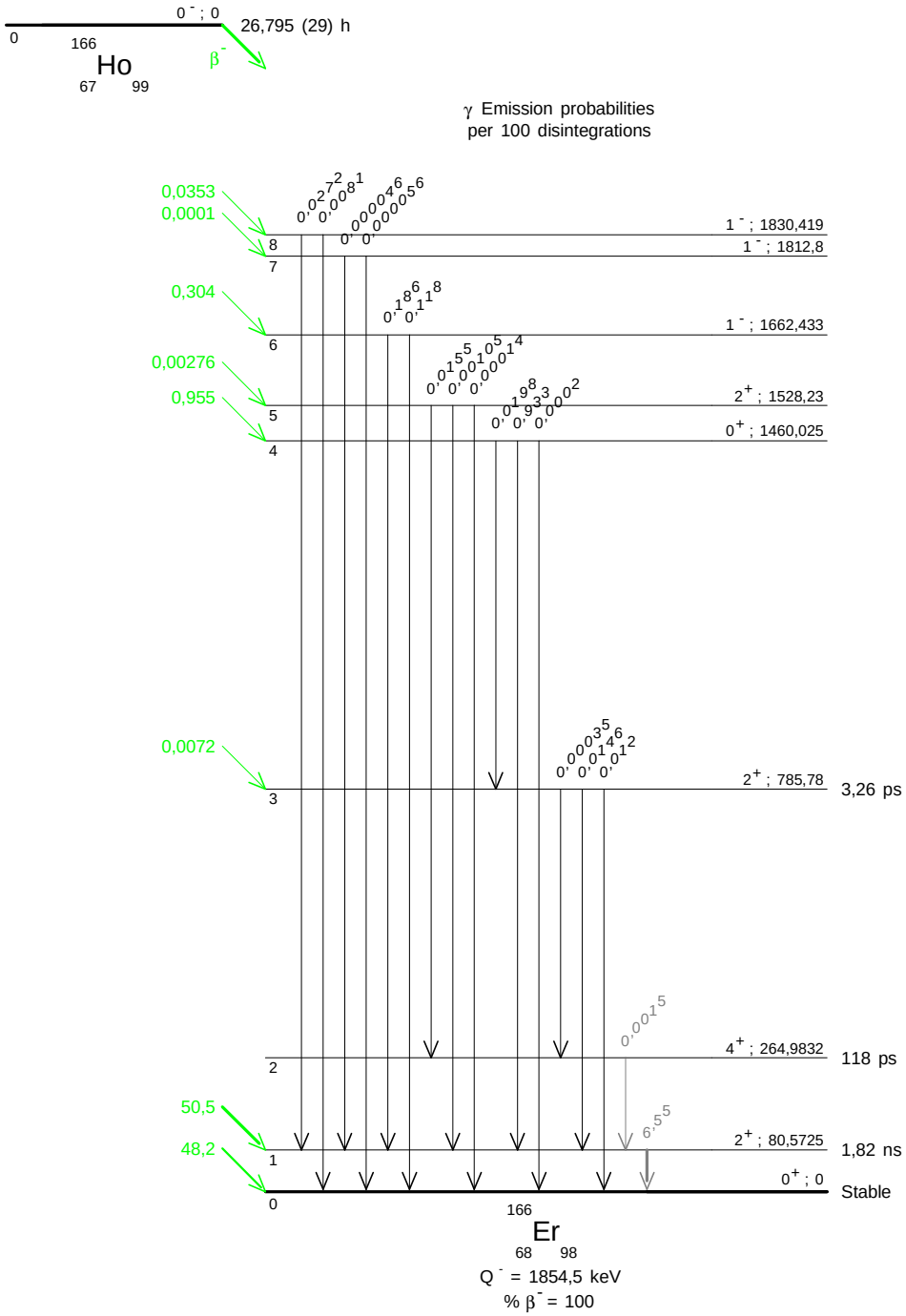
Dy − 166 decay, $T_{1/2}$ = 81,6 h

7 References

- M.G.Inghram, R.J.Hayden. Phys. Rev. 71 (1947) 130
  (Half-life)
- P.J.Grant, J.M.Hill. Nature 163 (1949) 524
  (Half-life)
- M.Antoneva, A.A.Bashilov, B.S.Dzhelepov. Izv. Acad. Nauk. SSSR 14 (1950) 299
  (Half-life)
- A.Sunyar. Phys. Rev. 93 (1954) 1345
  (Beta transitions)
- R.L.Graham, J.L.Wolfson, M.A.Clark. Phys. Rev. 98 (1955) 1173a
  (Beta emission probabilities)
- J.M.Cork, M.K.Brice, R.G.Helmer, R.M.Woods Jr. Phys. Rev. 110 (1958) 526
  (Half-life, Beta plus transitions)
- J.E Cline, E.C.Yates, E.H.Turk. Nucl. Phys. 30 (1962) 154
  (Beta transitions)
- D.C.Hoffman. J. Inorg. Nucl. Chem. 25 (1963) 1196
  (Half-life)
- M.K.Ramaswamy, S.M.Brahmavar. Curr. Sci. India 32 (1963) 451
  (Conv. Elec. emission probabilities)
- L.Funke, K.Hohmut, H.Jungclausen, K.Kann, G.Mueller, H.Sodan, L.Werner. Kernenergie 6 (1963) 152
  (Beta emission energies)
- W.Gelletly, J.S.Geiger, R.L.Graham. Bull. Amer. Phys. Soc. 11 (1966) 352
  (K X-ray emission probabilities, K X-ray energies)
- H.A.Neumann. Z. Naturforsch. 21a (1966) 1328
  (Gamma-ray emission probabilities)
- P.Erman, G.T.Emery, M.L.Perlman. Phys. Rev. 147 (1966) 858
  (K X-ray emission probabilities, K X-ray energies)
- W.H.Brantley, A.R.Polderman, W.H.G.Lewin. Bull. Amer. Phys. Soc. 11 (1966) 824
  (Conv. Elec. emission probabilities)
- H.Daniel, G.Th.Kaschl. Nucl. Phys. 76 (1966) 97-117
  (Half-life, Beta emission probabilities, Conv. Elec. emission probabilities)
- J.Zylicz, M.H.Jorgensen, O.B.Nielsen, O.Skilbreid. Nucl. Phys. 81 (1966) 88
  (Conv. Elec. emission probabilities)
- S.E.Karlsson, I.Andersson, O.Nilsson, G.Malmsten, C.Nordling, K.Siegbahn. Nucl. Phys. 89 (1966) 513
  (K X-ray emission probabilities, K X-ray energies)
- J.A.Bearden. Rev. Mod. Phys. 39 (1967) 78
  (K X-ray energies)
- C.Gunther, L.D.Parsignault. Phys. Rev. 153 (1967) 1297
  (Gamma-ray emission probabilities)
- S.B.Burson. Phys. Rev. 158 (1967) 1161
  (Gamma-ray emission probabilities)
- W.Gelletly, J.S.Geiger, R.L.Graham. Phys. Rev. 157 (1967) 1043
  (L X-ray ratio)
- M.Arnoux, A.Gizon. Compt. Rend. Acad. Sci. Paris 264 (1967) 1518
  (L/M ratio)
- S.Hoegberg, J.E.Bergmark, G.Malmsten, O.Nilsson. Nucl. Phys. A120 (1968) 569
  (K X-ray emission probabilities, K X-ray energies)
- M.Bogdanovic, M.Mladjenovic, R.Stepic. Nucl. Phys. A106 (1968) 209
  (Conv. Elec. emission probabilities)
- O.Nilsson, I.Thoren, G.Malmsten, S.Hoegberg. Nucl. Phys. A120 (1968) 561
  (K/L ratio)

- E.Falkstroem, S.Nilsson, S.Boreving. Arkiv Pysik 39 (1968) 1
  (Conv. Elec. emission energies)
- M.Bogdanovic, M.Mladjenovic, R.Stepic. Z. Physik 216 (1968) 267
  (K/L ratio)
- G.C.Nelson, E.N.Hatch. Nucl. Phys. A127 (1969) 560
  (Conv. Elec. emission energies)
- O.Nilsson, I.Thorein, G.Malmsten, S.Hogberg. Nucl. Phys. A139 (1969) 712
  (ICC)
- C.W.Reich, J.E.Cline.. Phys. Rev. A159 (1970) 181-201
  (Gamma ray energies, Gamma-ray emission probabilities)
- J.L.Campbell, H.J.Smith, I.K.Mac Kenzie. Nucl. Instrum. Methods 92 (1971) 237
  (Conv. Elec. emission energies)
- O.Dragoun, B.Martin, D.Merkert, M.Vinduska. Nucl. Phys. A183 (1972) 390
  (K X-ray emission probabilities, K X-ray energies)
- J.L.Campbell, R.J.Goble, J.J.Smith, J.H.Amilton, J.C.Manthuruthil. Radioactivity in Nuc. Spec. (1972) 1387
  (Conv. Elec. emission energies)
- E.P.Gregoriev, A.V.Zolotavin, S.V.Kamynov. Bull. Acad. Sci. USSR, Fyz. Ser. 38 (1974) 30
  (Beta emission probabilities)
- E.P.Gregoriev, A.V.Zolotavin, S.V.Kamynov. Izv. Akad. Nauk. SSSR, Ser. Fiz. 38 (1974) 2499
  (Beta emission probabilities)
- K.VenkataRamaniah, V.Lakshminarayana, K.VenkataReddy. Curr. Science (India) 45 (1976) 473
  (Beta emission probabilities, Gamma-ray emission probabilities)
- F.P.Larkins. At. Data. Nucl. Data Tables 20 (1977) 313
  (Auger electron energies)
- M.Allab, F.Azgui, G.Ardisson. Radiochem. Radioanal. Letters 30 (1977) 253
  (Gamma-ray emission probabilities, Gamma ray energies)
- V.M.Kartashov, A.G.Troizkaya, G.A.Shevilev. Probl. Yad. Fiz. Kosm. Luchei 7 (1977) 3
  (Conv. Elec. emission probabilities)
- F.Rösel, W.M.Fries, K.Adler, H.C.Pauli. At. Data. Nucl. Data Tables 21 (1978) 92
  (Conv. Elec. emission probabilities)
- Srinivasa Rao, S.Lakshminarayana, V.Seshagiri Rao, D.L.Sastry. Current Science 48 (1979) 811
  (angular corr.)
- V.V.Bulgakov, V.I.Gavrilyuk, A.A.Klyuchnikov, A.P.Lasko, P.N.Muzalev, N.V.Strelchuk, A.I.Feokistov, Y.E.Frantsev. Summaries of the 30th Conf. Nucl. Spectr. and Struct. Samarkand (1981) 293
  (L/M/N)
- T.Sekine, H.Baba. J. Inorg. Nucl. Chem. 43 (1981) 1107
  (Gamma-ray emission probabilities)
- M.Srinivasa Rao, S.Lakshminarayana, D.G.S.Nagarayana, L.Raghavendra Rao, V.Seshagiri Rao, D.L.Sastry. Indian J. of Pure and Applied Physics 22 (1984) 10
  (Gamma ray energies)
- A.E.Ignatochkin, E.N.Shurshikov, Yu.F.Jaborov. Nucl. Data Sheets 52 (1987) 365
  (Spin and Parity, Half-life, excited levels, Gamma ray energies)
- B.Chand, J.Goswamy, D.Mehta, N.Singh, P.N.Trehan. Proc. Phys. Soc. (1988)
  (X-ray emission probabilities)
- M.K.Balodis, A.V.Afanasev, P.T.Prokofev, Yu.Ja.Tamberg. Izvestiya Akademii Nauk. SSSR, Seriya Fizicheskaya 52 (1988) 2117
  (level scheme)
- A.Abzouzi, M.S.Antony, V.B.Ndocko Ndongue. J. Radioanal. Nucl. Chem. 135 (1989) 1
  (Half-life)
- B.Chand, J. GOSWAMY, D. MEHTA, N.Singh, P.N TREHAN. Nucl. Instrum. Methods Phys. Res. A284 (1989) 393
  (Gamma-ray emission probabilities)
- J.M.Calhoun, J.T.Cessna, B.M.Coursey, D.D.Hoppes, F.J.Schima, M.P.Unterweger. Radioactivity and Radiochemistry 2 (1991) 38-45
  (Half-life, Gamma-ray emission probabilities)
- C.Ardisson, V.Barci, J.Dalmasso, A.Hachem, G.Ardisson. Il Nuovo Cimento 105A (1992) 215-232
  (Gamma ray energies, Gamma-ray emission probabilities)
- M.P.Unterweger, D.D.Hoppes, F.J.Schima. Nucl. Instrum. Methods Phys. Res. A312 (1992) 349-352
  (Half-life)

- J.M.Domingos, G.D.Symow, A.C.Douglas. Nucl. Phys. A180 (1992) 600
(mixing ratios)
- B.M.Coursey, J.M.Calhoun, J.Cessna, D.B.Golas, F.J.Schima, M.P.Unterweger. Nucl. Instrum. Methods Phys. Res. A339 (1994) 26-30
(Gamma-ray emission probabilities)
- G.Audi, A.H.Wapstra. Nucl. Phys. A595 (1995) 409
(Q)
- E.Schönfeld, H.Janssen. Nucl. Instrum. Methods Phys. Res. A369 (1996) 527
(K fluorescence yield, L vacancies)
- R.B.Firestone, V.S.Shirley. Table of Isotopes, Wiley NewYork (1996)
(Production modes)
- R.G.Helmer, C. van der Leun. Nucl. Instrum. Methods Phys. Res. A450 (2000) 35
(Gamma ray energies)


0 - ; 0
26,795 (29) h
0
166
Ho
67
99
β-
γ Emission probabilities
per 100 disintegrations
0,0353
0,0001
0,304
0,00276
0,955
0,0072
50,5
48,2
1 - ; 1830,419
1 - ; 1812,8
1 - ; 1662,433
2+ ; 1528,23
0+ ; 1460,025
2+ ; 785,78
3,26 ps
4+ ; 264,9832
118 ps
2+ ; 80,5725
1,82 ns
0+ ; 0
Stable
8
7
6
5
4
3
2
1
0
166
Er
68
98
Q - = 1854,5 keV
% β- = 100

$^{166}_{67}\mathrm{Ho}^{m}_{99}$

1 Decay Scheme

Ho-166m disintegrates by β^- emission mainly to the 1827 keV and to the 1786 keV levels of Er-166.
L'holmium 166 métastable se désintègre par émission bêta moins, principalement vers les deux niveaux de 1827 keV et 1786 keV de l'erbium 166.

2 Nuclear Data

$T_{1/2}(^{166}\mathrm{Ho}^{m})$	:	1200	(180)	a
$Q^-(^{166}\mathrm{Ho}^{m})$	:	1860,5	(9)	keV

2.1 β^- Transitions

	Energy keV	Probability × 100	Nature	lg ft
$\beta^-_{0,17}$	32,9 (9)	17,2 (4)	Allowed	8,4
$\beta^-_{0,16}$	73,5 (9)	74,8 (12)	Allowed	8,8
$\beta^-_{0,11}$	304,6 (9)	0,394 (5)	1st forbidden	12,9
$\beta^-_{0,10}$	484,5 (9)	0,81 (26)	1st forbidden	13
$\beta^-_{0,9}$	644,5 (9)	2,31 (29)	1st forbidden	13,4
$\beta^-_{0,6}$	949,3 (9)	1,12 (6)	1st forbidden	14,2
$\beta^-_{0,3}$	1315,1 (9)	3,4 (6)	1st forbidden	14,3

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce} \times 100$	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{5,4}$(Er)	73,62 (7)	0,212 (14)	M1+E2	5,98 (18)	0,902 (27)	0,201 (6)	7,14 (21)
$\gamma_{1,0}$(Er)	80,580 (3)	99,981 (4)	E2	1,65 (3)	4,01 (8)	0,978 (29)	6,90 (14)
$\gamma_{16,15}$(Er)	94,675 (14)	0,650 (23)	M1+E2	2,89 (9)	0,435 (13)	0,0967 (29)	3,45 (10)
$\gamma_{8,7}$(Er)	119,033 (9)	0,452 (11)	E2+M1	0,888 (27)	0,556 (17)	0,1339 (40)	1,614 (48)
$\gamma_{16,14}$(Er)	121,176 (31)	0,593 (20)	E2	0,663 (20)	0,610 (18)	0,1480 (44)	1,460 (44)
$\gamma_{17,15}$(Er)	135,260 (14)	0,194 (4)	E2	0,493 (15)	0,373 (11)	0,0904 (27)	0,981 (29)
$\gamma_{9,8}$(Er)	140,703 (7)	0,0829 (44)	M1+E2	0,604 (18)	0,256 (8)	0,0611 (18)	0,938 (28)
$\gamma_{10,9}$(Er)	160,039 (7)	0,157 (8)	M1+E2	0,417 (13)	0,1530 (46)	0,0363 (11)	0,616 (18)
$\gamma_{17,14}$(Er)	161,76 (3)	0,166 (6)	E2 (+M1)	0,299 (9)	0,171 (5)	0,0412 (12)	0,522 (16)
$\gamma_{2,1}$(Er)	184,4107 (11)	96,7 (7)	E2	0,205 (6)	0,0984 (30)	0,0236 (7)	0,334 (7)
$\gamma_{16,13}$(Er)	190,86 (7)	0,279 (7)	E2	0,186 (6)	0,0853 (26)	0,0204 (6)	0,297 (9)
$\gamma_{16,12}$(Er)	214,75 (6)	0,534 (13)	E2	0,1318 (40)	0,0526 (16)	0,01254 (38)	0,200 (4)
$\gamma_{8,5}$(Er)	215,869 (8)	3,18 (20)	E2	0,1299 (26)	0,0516 (10)	0,01229 (37)	0,197 (4)
$\gamma_{17,13}$(Er)	231,45 (7)	0,253 (7)	E2	0,1062 (21)	0,0391 (8)	0,00928 (28)	0,157 (3)
$\gamma_{9,7}$(Er)	259,736 (9)	1,195 (11)	E2	0,0762 (15)	0,0249 (5)	0,00589 (18)	0,1087 (22)
$\gamma_{3,2}$(Er)	280,4630 (34)	32,07 (28)	E2	0,0613 (12)	0,0187 (4)	0,00439 (13)	0,0855 (17)
$\gamma_{10,8}$(Er)	300,742 (7)	3,99 (4)	E2	0,0503 (10)	0,0144 (3)	0,00338 (10)	0,0691 (14)
$\gamma_{9,6}$(Er)	304,758 (9)	0,0195 (13)	E2	0,0485 (10)	0,0137 (3)	0,00322 (10)	0,0662 (13)
$\gamma_{11,9}$(Er)	339,75 (5)	0,1694 (24)	E2	0,0359 (7)	0,00930 (19)	0,00217 (7)	0,048 (1)
$\gamma_{6,3}$(Er)	365,768 (8)	2,56 (4)	E2	0,0294 (6)	0,00721 (15)	0,00167 (5)	0,0388 (8)
$\gamma_{16,10}$(Er)	410,955 (9)	11,45 (18)	E1(+M2)	0,00743 (22)	0,001055 (32)	0,000233 (7)	0,00878 (26)
$\gamma_{17,10}$(Er)	451,540 (9)	2,936 (14)	E1(+M2)	0,00599 (18)	0,000846 (25)	0,000187 (6)	0,00707 (21)
$\gamma_{10,6}$(Er)	464,797 (9)	1,28 (4)	M1+E2	0,01579 (47)	0,0033 (1)	0,000758 (23)	0,0201 (6)
$\gamma_{15,9}$(Er)	476,319 (13)	0,0365 (13)	E1	0,00531 (16)	0,000748 (22)	0,000165 (5)	0,00627 (19)
$\gamma_{12,8}$(Er)	496,95 (6)	0,126 (3)	E1(+M2)	0,00483 (15)	0,000679 (20)	0,0001497 (45)	0,00571 (17)
$\gamma_{4,2}$(Er)	520,80 (7)	0,155 (6)	E2	0,01192 (36)	0,00234 (7)	0,000535 (16)	0,0149 (3)
$\gamma_{8,3}$(Er)	529,823 (6)	9,5 (4)	M1+E2	0,01145 (26)	0,00223 (5)	0,000508 (15)	0,0144 (3)
$\gamma_{16,9}$(Er)	570,994 (9)	5,45 (20)	E1(+M2)	0,00358 (11)	0,000498 (15)	0,0001097 (33)	0,00421 (13)
$\gamma_{5,2}$(Er)	594,417 (6)	0,59 (6)	E2+M1	0,00881 (26)	0,001613 (48)	0,000366 (11)	0,01089 (33)
$\gamma_{17,9}$(Er)	611,579 (9)	1,31 (21)	E1(+M2)	0,00309 (9)	0,000429 (13)	0,0000944 (28)	0,00364 (11)
$\gamma_{12,7}$(Er)	615,98 (6)	0,100 (31)	E4	0,0444 (13)	0,0185 (6)	0,00449 (13)	0,0687 (21)
$\gamma_{13,7}$(Er)	639,86 (7)	0,0946 (7)	E1	0,00282 (8)	0,000389 (12)	0,0000857 (26)	0,00331 (10)
$\gamma_{11,6}$(Er)	644,51 (5)	0,145 (4)	E2+M1	0,00810 (24)	0,001384 (42)	0,000312 (9)	0,00989 (30)
$\gamma_{9,3}$(Er)	670,526 (6)	5,38 (21)	E2+M1	0,00666 (20)	0,001161 (35)	0,000262 (8)	0,00816 (24)
$\gamma_{7,2}$(Er)	691,253 (8)	1,33 (7)	E2+M1	0,00620 (19)	0,001069 (32)	0,000241 (7)	0,00758 (23)
$\gamma_{4,1}$(Er)	705,21 (7)	0,014 (7)	E2(+M1)	0,00591 (18)	0,001012 (30)	0,000228 (7)	0,00721 (22)
$\gamma_{16,8}$(Er)	711,697 (9)	55,0 (9)	E1(+M2)	0,00227 (7)	0,000311 (9)	0,0000685 (21)	0,00266 (8)
$\gamma_{13,5}$(Er)	736,70 (7)	0,374 (6)	E1	0,00211 (6)	0,000290 (9)	0,0000637 (19)	0,00249 (7)
$\gamma_{17,8}$(Er)	752,282 (9)	12,2 (3)	E1(+M2)	0,00203 (6)	0,000278 (8)	0,0000611 (18)	0,00238 (7)
$\gamma_{5,1}$(Er)	778,828 (6)	3,03 (8)	E2+M1	0,00477 (14)	0,000788 (24)	0,000177 (5)	0,00579 (17)
$\gamma_{4,0}$(Er)	785,78 (7)	0,019 (4)	E2	0,00467 (14)	0,000769 (23)	0,000173 (5)	0,00566 (17)
$\gamma_{8,2}$(Er)	810,286 (5)	57,6 (11)	E2+M1	0,00438 (9)	0,00071 (2)	0,0001603 (48)	0,0053 (1)
$\gamma_{10,3}$(Er)	830,565 (6)	9,77 (18)	E2+M1	0,00416 (12)	0,000673 (20)	0,0001509 (45)	0,00503 (15)
$\gamma_{7,1}$(Er)	875,664 (8)	0,724 (9)	E2	0,00371 (11)	0,000592 (18)	0,0001324 (40)	0,00447 (13)
$\gamma_{9,2}$(Er)	950,989 (5)	2,754 (19)	E2	0,00313 (9)	0,000488 (15)	0,0001089 (33)	0,00376 (11)
$\gamma_{11,3}$(Er)	1010,27 (5)	0,0797 (16)	E2	0,00277 (8)	0,000425 (13)	0,0000947 (28)	0,00332 (10)
$\gamma_{14,3}$(Er)	1120,344 (30)	0,199 (4)	E1	0,000956 (29)	0,0001283 (38)	0,0000281 (8)	0,001121 (34)
$\gamma_{15,3}$(Er)	1146,845 (12)	0,2061 (26)	E1	0,000918 (28)	0,0001230 (37)	0,0000270 (8)	0,001075 (32)
$\gamma_{16,3}$(Er)	1241,520 (8)	0,85 (3)	E1(+M2)	0,000796 (24)	0,0001063 (32)	0,0000233 (7)	0,000932 (28)
$\gamma_{17,3}$(Er)	1282,105 (8)	0,183 (7)	E1(+M2)	0,000752 (23)	0,0001004 (30)	0,0000220 (7)	0,000881 (26)
$\gamma_{12,2}$(Er)	1307,24 (6)	0,0055 (11)	E1	0,000727 (22)	0,0000970 (29)	0,0000213 (6)	0,000852 (26)
$\gamma_{13,2}$(Er)	1331,12 (7)	0,0043 (12)	E1	0,000705 (21)	0,0000939 (28)	0,0000206 (6)	0,000825 (25)
$\gamma_{14,2}$(Er)	1400,79 (2)	0,508 (6)	E1	0,000645 (19)	0,0000859 (26)	0,0000188 (6)	0,000755 (23)
$\gamma_{15,2}$(Er)	1427,24 (2)	0,498 (6)	E1	0,000625 (19)	0,0000831 (25)	0,0000182 (5)	0,000732 (22)

3 Atomic Data

3.1 Er

ω_K : 0,942 (4)
$\bar{\omega}_L$: 0,216 (9)
n_{KL} : 0,836 (4)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	48,2211		56,4
	$K\alpha_1$	49,1277		100
	$K\beta_3$	55,494	}	
	$K\beta_1$	55,681	}	
	$K\beta_5''$	56,04	}	31,9
	$K\beta_2$	57,21	}	
	$K\beta_4$	57,313	}	8,8
	$KO_{2,3}$	57,45	}	
X_L				
	$L\ell$	6,14		
	$L\alpha$	6,9 – 6,95		
	$L\eta$	7,05		
	$L\beta$	7,75 – 8,34		
	$L\gamma$	8,81 – 9,43		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	37,78 – 40,55	100
KLX	45,52 – 49,10	52,2
KXY	53,07 – 56,84	7,84
Auger L	3,9 – 7,6	

4 Electron Emissions

		Energy keV	Electrons per 100 disint.
e_{AL}	(Er)	3,9 - 7,6	72,0 (7)
e_{AK}	(Er)		2,33 (17)
	KLL	37,78 - 40,55	}
	KLX	45,52 - 49,10	}
	KXY	53,07 - 56,84	}
$ec_{5,4\ K}$	(Er)	16,13 (7)	0,15 (10)
$ec_{1,0\ T}$	(Er)	23,095 - 80,550	87,4 (31)
$ec_{1,0\ K}$	(Er)	23,095 (3)	20,9 (7)
$ec_{16,15\ K}$	(Er)	37,189 (14)	0,422 (18)
$ec_{8,7\ K}$	(Er)	61,548 (9)	0,154 (5)
$ec_{16,14\ K}$	(Er)	63,69 (3)	0,160 (7)
$ec_{1,0\ L}$	(Er)	70,828 - 72,222	50,8 (18)
$ec_{1,0\ M}$	(Er)	78,374 - 79,171	12,38 (43)
$ec_{1,0\ N}$	(Er)	80,131 - 80,576	2,89 (10)
$ec_{16,15\ L}$	(Er)	84,924 - 86,317	0,0635 (26)
$ec_{10,9\ K}$	(Er)	102,554 (7)	0,0524 (31)
$ec_{8,7\ L}$	(Er)	109,282 - 110,675	0,0962 (34)
$ec_{16,14\ L}$	(Er)	111,424 - 112,818	0,147 (6)
$ec_{2,1\ T}$	(Er)	126,925 - 184,381	24,1 (7)
$ec_{2,1\ K}$	(Er)	126,925 (1)	14,86 (44)
$ec_{16,12\ K}$	(Er)	157,26 (6)	0,0587 (23)
$ec_{8,5\ K}$	(Er)	158,384 (8)	0,346 (24)
$ec_{2,1\ L}$	(Er)	174,659 - 176,053	7,13 (22)
$ec_{2,1\ M}$	(Er)	182,204 - 183,001	1,71 (5)
$ec_{2,1\ N}$	(Er)	183,962 - 184,406	0,402 (12)
$ec_{9,7\ K}$	(Er)	202,251 (9)	0,0821 (26)
$ec_{8,5\ L}$	(Er)	206,118 - 207,511	0,137 (10)
$ec_{3,2\ T}$	(Er)	222,978 - 280,433	2,5 (16)
$ec_{3,2\ K}$	(Er)	222,978 (4)	1,8 (12)
$ec_{10,8\ K}$	(Er)	243,257 (7)	0,188 (6)
$ec_{3,2\ L}$	(Er)	270,711 - 272,105	0,55 (36)
$ec_{3,2\ M}$	(Er)	278,256 - 279,053	0,13 (8)
$ec_{10,8\ L}$	(Er)	290,991 - 292,384	0,0537 (17)
$ec_{6,3\ K}$	(Er)	308,282 (8)	0,0723 (25)
$ec_{16,10\ K}$	(Er)	353,469 (9)	0,0843 (28)
$ec_{8,3\ K}$	(Er)	472,338 (6)	0,108 (6)
$ec_{16,8\ K}$	(Er)	654,211 (9)	0,1246 (47)
$ec_{8,2\ K}$	(Er)	752,80 (5)	0,251 (9)
$\beta^-_{0,17}$	max:	32,9 (9)	17,2 (4)
$\beta^-_{0,17}$	avg:	8,2 (2)	
$\beta^-_{0,16}$	max:	73,5 (9)	74,8 (12)
$\beta^-_{0,16}$	avg:	18,6 (4)	

		Energy keV		Electrons per 100 disint.
$\beta^-_{0,11}$	max:	304,6	(9)	0,394 (5)
$\beta^-_{0,11}$	avg:			
$\beta^-_{0,10}$	max:	484,5	(9)	0,81 (26)
$\beta^-_{0,10}$	avg:			
$\beta^-_{0,9}$	max:	644,5	(9)	2,31 (29)
$\beta^-_{0,9}$	avg:	201,2	(9)	
$\beta^-_{0,6}$	max:	949,3	(9)	1,12 (6)
$\beta^-_{0,6}$	avg:	294,3	(9)	
$\beta^-_{0,3}$	max:	1315,1	(9)	3,4 (6)
$\beta^-_{0,3}$	avg:	674,6	(9)	

5 Photon Emissions

5.1 X-Ray Emissions

		Energy keV		Photons per 100 disint.	
XL	(Er)	6,14 — 9,43		20,8 (4)	
XKα_2	(Er)	48,2211		10,81 (21)	} Kα
XKα_1	(Er)	49,1277		19,2 (4)	}
XKβ_3	(Er)	55,494	}		
XKβ_1	(Er)	55,681	}	6,24 (14)	K$'\beta_1$
XKβ''_5	(Er)	56,04	}		
XKβ_2	(Er)	57,21	}		
XKβ_4	(Er)	57,313	}	1,62 (5)	K$'\beta_2$
XKO$_{2,3}$	(Er)	57,45	}		

5.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{5,4}$(Er)	73,62 (7)	0,0260 (16)
$\gamma_{1,0}$(Er)	80,5725 (13)	12,66 (23)
$\gamma_{16,15}$(Er)	94,675 (14)	0,146 (4)
$\gamma_{8,7}$(Er)	119,033 (10)	0,173 (3)
$\gamma_{16,14}$(Er)	121,175 (10)	0,241 (7)
$\gamma_{17,15}$(Er)	135,260 (14)	0,0979 (19)
$\gamma_{9,8}$(Er)	140,703 (7)	0,0428 (22)
$\gamma_{10,9}$(Er)	160,039 (7)	0,097 (5)

	Energy keV	Photons per 100 disint.
$\gamma_{17,14}$(Er)	161,76 (3)	0,109 (4)
$\gamma_{2,1}$(Er)	184,4107 (11)	72,5 (3)
$\gamma_{16,13}$(Er)	190,86 (7)	0,215 (5)
$\gamma_{16,12}$(Er)	214,79 (3)	0,445 (11)
$\gamma_{8,5}$(Er)	215,871 (7)	2,66 (17)
$\gamma_{17,13}$(Er)	231,45 (7)	0,219 (6)
$\gamma_{9,7}$(Er)	259,736 (10)	1,078 (10)
$\gamma_{3,2}$(Er)	280,4630 (23)	29,54 (25)
$\gamma_{10,8}$(Er)	300,741 (3)	3,73 (3)
$\gamma_{9,6}$(Er)	304,758 (9)	0,0183 (12)
$\gamma_{11,9}$(Er)	339,75 (5)	0,1616 (23)
$\gamma_{6,3}$(Er)	365,768 (6)	2,46 (4)
$\gamma_{16,10}$(Er)	410,956 (3)	11,35 (17)
$\gamma_{17,10}$(Er)	451,540 (4)	2,915 (14)
$\gamma_{10,6}$(Er)	464,798 (6)	1,25 (4)
$\gamma_{15,9}$(Er)	476,25 (4)	0,0363 (13)
$\gamma_{12,8}$(Er)	496,90 (6)	0,125 (3)
$\gamma_{4,2}$(Er)	520,80 (7)	0,153 (6)
$\gamma_{8,3}$(Er)	529,825 (4)	9,4 (4)
$\gamma_{16,9}$(Er)	570,995 (5)	5,43 (20)
$\gamma_{5,2}$(Er)	594,417 (6)	0,58 (6)
$\gamma_{17,9}$(Er)	611,579 (6)	1,31 (21)
$\gamma_{12,7}$(Er)	615,93 (6)	0,094 (29)
$\gamma_{13,7}$(Er)	639,86 (6)	0,0943 (7)
$\gamma_{11,6}$(Er)	644,51 (7)	0,144 (4)
$\gamma_{9,3}$(Er)	670,526 (4)	5,34 (21)
$\gamma_{7,2}$(Er)	691,253 (7)	1,32 (7)
$\gamma_{4,1}$(Er)	705,21 (7)	0,014 (7)
$\gamma_{16,8}$(Er)	711,697 (3)	54,9 (9)
$\gamma_{13,5}$(Er)	736,70 (7)	0,373 (6)
$\gamma_{17,8}$(Er)	752,280 (4)	12,2 (3)
$\gamma_{5,1}$(Er)	778,827 (6)	3,01 (8)
$\gamma_{4,0}$(Er)	785,78 (7)	0,019 (4)
$\gamma_{8,2}$(Er)	810,286 (4)	57,3 (11)
$\gamma_{10,3}$(Er)	830,565 (4)	9,72 (18)
$\gamma_{7,1}$(Er)	875,663 (7)	0,721 (9)
$\gamma_{9,2}$(Er)	950,988 (4)	2,744 (19)
$\gamma_{11,3}$(Er)	1010,27 (6)	0,0794 (16)
$\gamma_{14,3}$(Er)	1120,32 (3)	0,199 (4)
$\gamma_{15,3}$(Er)	1146,77 (3)	0,2059 (26)
$\gamma_{16,3}$(Er)	1241,519 (4)	0,85 (3)
$\gamma_{17,3}$(Er)	1282,102 (5)	0,183 (7)
$\gamma_{12,2}$(Er)	1307,19 (6)	0,0055 (11)
$\gamma_{13,2}$(Er)	1331,12 (7)	0,0043 (12)
$\gamma_{14,2}$(Er)	1400,79 (2)	0,508 (6)
$\gamma_{15,2}$(Er)	1427,24 (2)	0,498 (6)

6 Main Production Modes

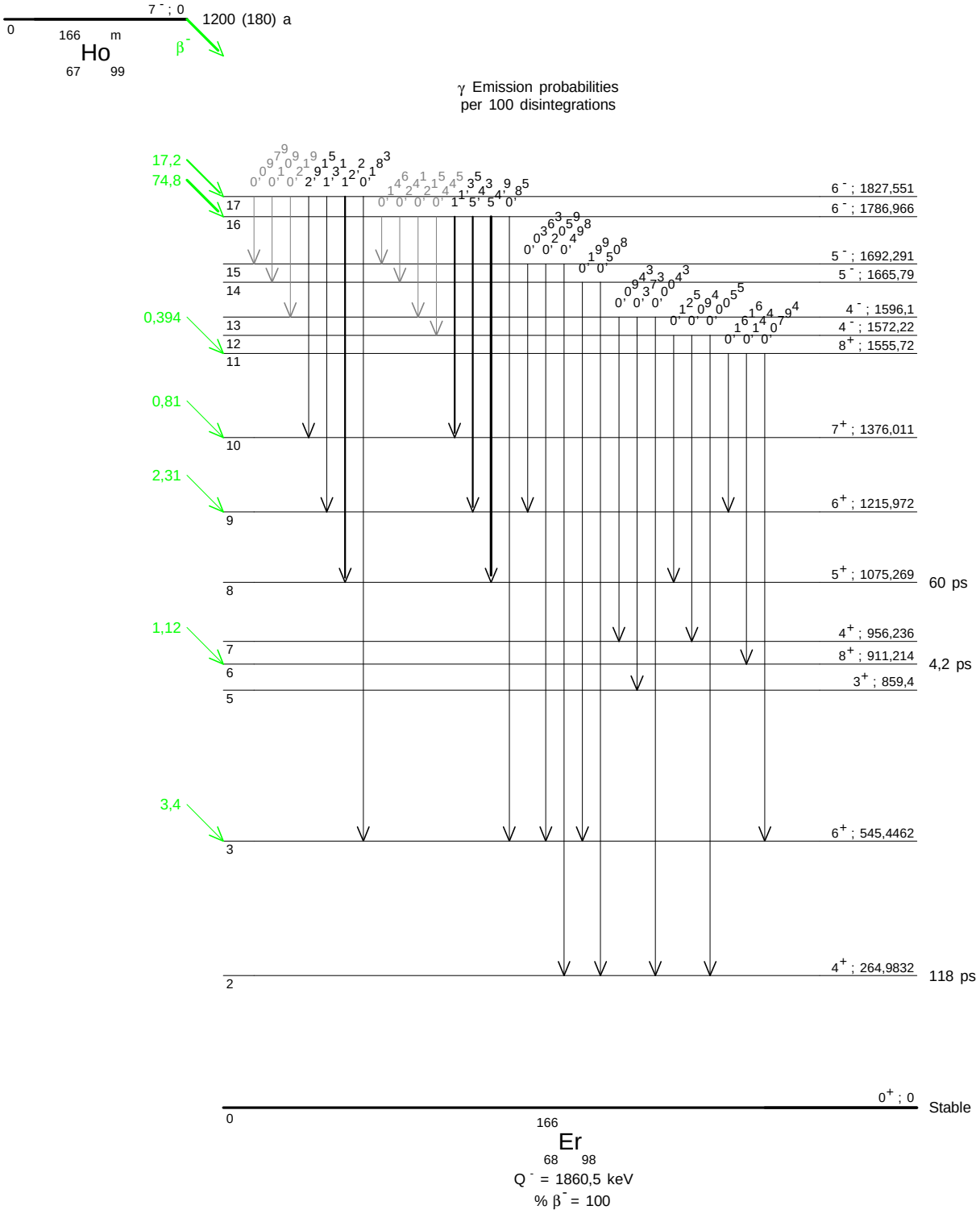
$\begin{cases} \mathrm{Ho-165(n,\gamma)Ho-166m} & \sigma : 1 \text{ barns} \\ \text{Possible impurities : Ho} - 166 \end{cases}$

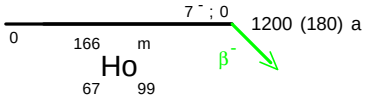
7 References

- I.Marklund, B.V.vanNooijen, Z.Grabowski. Nucl. Phys. 15 (1960) 533
  (Conv. Elec. emission probabilities)
- R.Hardell, S.Nilsson. Nucl. Phys. 39 (1962) 286
  (Gamma ray energies)
- E.Gerdau, W.Krull, L.Mayer, J.Braunsfurth, J.Heisenberg, P.Steiner, E.Bodenstedt. Z. Phys. 174 (1963) 389
  (anagular correlation)
- C.W.Reich, J.E.Cline. Phys. Rev. 137 (1965) B1424
  (Gamma-ray emission probabilities, Delta)
- K.T.Faler, J.Inorg.. Nucl. Chem. 27 (1965) 25
  (Half-life)
- S.B.Burson, P.F.A.Goudsmit, J.Konijn. Phys. Rev. 158 (1967) 1161
  (levels)
- C.Gunther, D.W.Parsignault. Phys. Rev. 153 (1967) 1297
  (Gamma rays)
- J.A.Bearden. Rev. Mod. Phys. (1967) 78
  (x-ray energie)
- E.C.Nelson, E.N.Hatch. Nucl. Phys. A127 (1969) 560
  (Conv. Elec. emission probabilities)
- C.W.Reich, J.E.Cline. Nucl. Phys. A159 (1970) 181
  (Normalization factor)
- J.L.Campbell, H.J.Smith, I.K.Mackenzie. Nucl. Instrum. Methods 92 (1971) 237
  (Conv. Elec. emission probabilities)
- T.Miyokawa, I.Katayama, S.Morinobu, H.Ikegami. Int. Conf. Nucl. Moments and Nucl. Structure, Osaka, Japan 34 (1972) 247
  (Delta)
- J.M.Domingos, G.D.Symons, A.C.Douglas. Nucl. Phys. A180 (1972) 600
  (Normalization factor, Delta)
- N.Lavi. Nucl. Instrum. Methods 109 (1973) 265
  (Gamma rays)
- E.W.A.Lingeman, F.W.N.deBoer, B.J.Meijer. Nucl. Instrum. Methods 118 (1974) 609
  (Gamma rays)
- K.R.Baker, J.H.Hamilton, J.Lange, A.V.Ramayya, L.Varnell, V.Marun-Rezwani, T. Mori, H.Ionue, Y.Yoszizawa. J. Phys. Soc. Jap. 38 (1975) 611,14
  (Gamma ray energies)
- J.J.Pinajin, J.A.Maruhn. Phys. Lett. 57B (1975) 441
  (mixing ratios)
- K.R.Baker, J.H.Hamilton, J.Lange, A.V.Ramayya, L.Varnell, V.Maruhn-Rezwani, J.J.Pinajian, J.A.Marahn. Phys. Lett. 57B (1975) 441
  (Delta)
- Tsuneo Morii, HikaruInoue, YasukazuYoshizawa. J. Phys. Soc. Japan 38 (1975) 611
  (Gamma ray energies)
- J.H.Hamilton. Bull. Akad. Sci. USSR, Phys. Ser. 40 (1976) 14
  (mixing ratios)
- J.H. HAMILTON. Bull. Acad. Sci. URSS 40 (1976) 14
  (Mixing ratio)
- R.L.West, E.G.Funk, A.Visvanathan, J.P.Adams, J.W.Mihelich. Nucl. Phys. A270 (1976) 300
  (mixing ratios, Delta)
- R.J.Gehrke, R.G.Helmer, R.C.Greenwood. Nucl. Instrum. Methods 147 (1977) 405
  (Gamma rays)

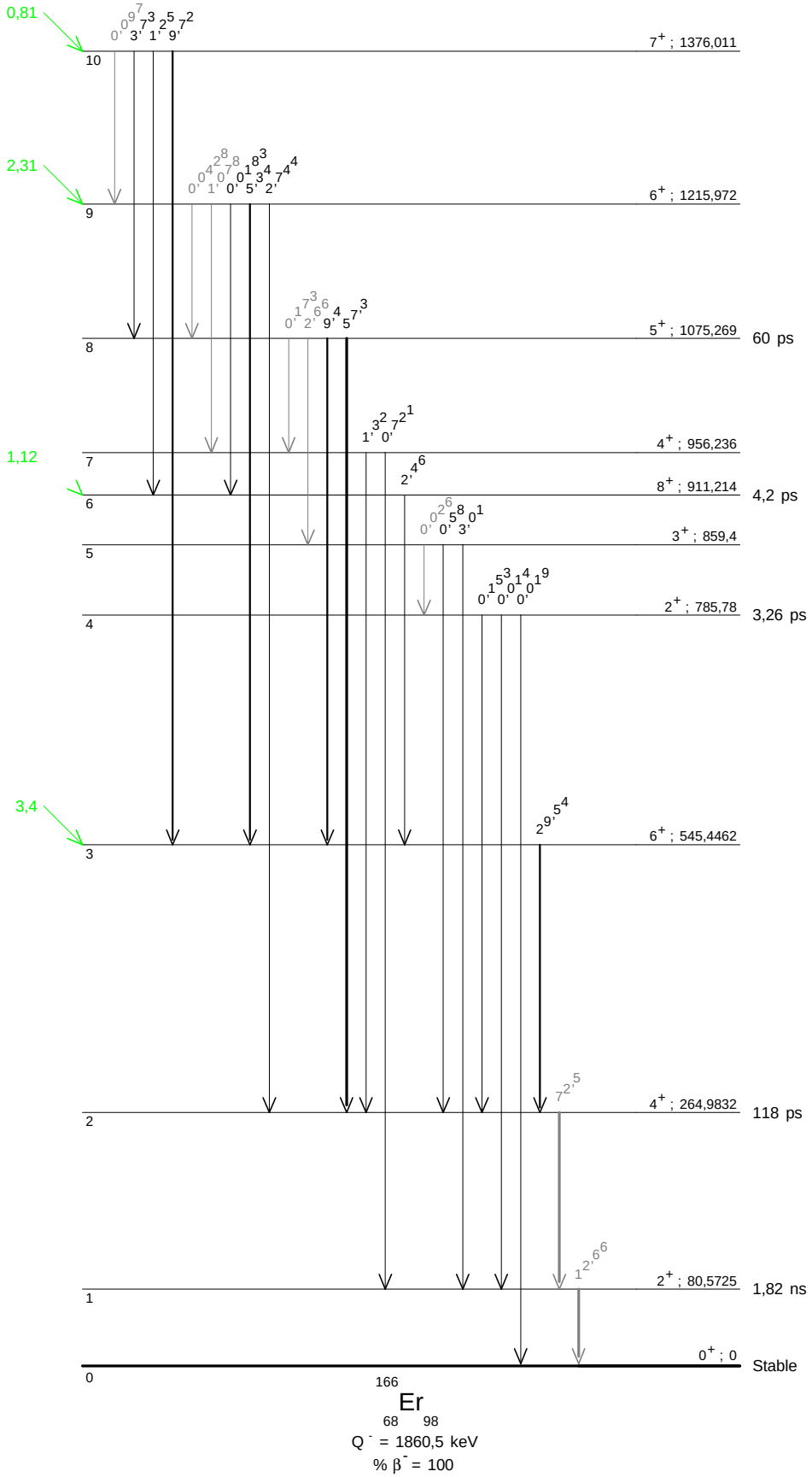
- F.,H.M.Fries, K.Alder, H.C.Pauli. At. Data. Nucl. Data Tables 21 (1978) 92
  (Conv. Elec. emission probabilities)
- F.K.McGowan, W.T.Milner, R.L.Robinson, P.H.Stelson, Z.W.Grabowski. Nucl. Phys. (1978) 51
  (Delta)
- T.E.Sampson. Nucl. Instrum. Methods 150 (1978)
  (Gamma rays)
- F.K.McGowan, W.T.Milner, R.L.Robinson, P.H.Stelson, Z.W.Grabowski. Nucl. Phys. A297 (1978) 51
  (Gamma rays, Delta)
- J.Adam, J.Frana, E.P.Grigoriev, K.Ya.Gromov, M.Honusek, T.A.Islamov, V.O.Sergeev. Czech. J. Phys. B29 (1979) 997
  (Gamma ray energies)
- J.Lange, K.R.Baker, J.H.Hamilton, A.V.Ramayya, L.Varnell, J.J.Pinajian, V.Maruhn-Rezwani. Z. Phys. A303 (1981) 321
  (mixing ratios, Delta)
- K.S.Krane, J.D.Moses. Phys. Rev. C24 (1981) 654
  (mixing ratios, Delta)
- J.Lange, K.R.Baker, J.H.Hamilton, A.V.Ramayya, L.Varnell, J.J.Pinajian, V.Maruhn Rezwani. Z. Phys. A303 (1981) 321
  (mixing ratios, delta)
- A.Rytz. NBS-SP-626 (1982) 140
  (Gamma-ray emission probabilities)
- S.S.Sooch, Ravinder Kaur, Nirmal Singh, P.N.Trehan. Nucl. Instrum. Methods 203 (1982) 339
  (Gamma ray energies, Gamma-ray emission probabilities)
- N.Blagojevic, N.R.Wood. Int. J. Appl. Radiat. Isotop. 33 (1982) 153
  (Gamma rays)
- A.Alzner, E.Bodenstedt, B.Gemünden, J.van den Hoff, H.Reif. Z. Phys. A322 (1985) 467
  (mixing ratios, Delta)
- T.Ogandaga, J.Dalmasso, G.Ardisson. J. Radioanal. Nucl. Chem. 107 (1986) 59
  (Gamma ray energies)
- P.O.Lipas, P.Toivonen,E.Hammaren. Nucl. Phys. A469 (1987) 348
  (mixing ratios)
- J.Adam, W.Wagner, W.Zwolska, J.Zwolski, B.Kracik, M.Fischer. Izvestiya Akademii Nauk SSSR, Seriya Fizicheskaya 52 (1988) 18
  (Gamma ray energies, Gamma-ray emission probabilities)
- B.Chand, J.Goswamy, D.Mehta, S.Singh, M.L.Garg, N.Singh, P.N.Trehan. Nucl. Instrum. Methods A273 (1988) 310
  (K X-ray emission probabilities, Gamma-ray emission probabilities, K X-ray energies)
- J.Adam, M.Fiser, B.Kracik, V.Wagner, V.Zvolska, J.Zvolsky. UJF02/88 (1988)
  (Gamma rays)
- V.N.Danilenko, N.P.Gromova, A.A.Konstantinov, N.V.Kurenkov, A.B.Malinin, A.V.Mamelin, S.V.Matveev, T.E.Sazonova, E.K.Stepanov, S.V.Sepman, Yu.G.Toporov, I.N.Tronova. Appl. Rad. Isotopes 40 (1989) 789
  ()
- V.Vagner. 41th Int. Conf. Nucl. Structure, Minsk (1991) 97
  (Gamma-ray emission probabilities)
- C.Ardisson, V.Barci, J.Dalmasso, A.Hachem, G.Ardisson. ll Nuovo Cimento 105 (1992) 215
  (Gamma ray energies, Gamma-ray emission probabilities)
- C.Wesselborg, D.E.Alburger. Verh. Der Deutschen Phys. Gesellschaft 27 (1992) 136
  (Gamma ray energies)
- W.Wagner. Bull. Russ. Acad. Sci. 56 (1992) 675
  (Gamma-ray emission probabilities, mixing ratios, Delta)
- Wang Xin Lin, Yang Jing Xia. Nucl. Instrum. Methods A312 (1992) 385
  (Gamma-ray emission probabilities)
- E.N.Shursikow, N.V.Timofeeva. Nucl. Data Sheets 67 (1992) 45-152
  (Half-life, excited levels, Gamma ray energies, Gamma-ray emission probabilities)
- Hiroshi Miyahara, Hiroki Matumoto, Chizuo Mori, NorioTakeuchi, Tsuguo Genka. Nucl. Instrum. Methods A339 (1994) 203
  (Gamma-ray emission probabilities)
- J.Morel, M.Etcheverry, J.Plagnard. Appl. Radiat. Isot. 47 (1996) 529
  (Gamma-ray emission probabilities)

- R.B.Firestone, V.S.Shirley. Table of Isotopes, Wiley, New York (1996)
(Production modes)
- E.Schönfeld, H.Janssen. Nucl. Instrum. Methods A369 (1996) 572
(K X-ray emission probabilities)
- Y.Hino, S.Matui, T.Yamada, N.Takeuchi, K.Onoma, S.Iwamoto, H.Kogure. Appl. Rad. Isotopes 52 (2000) 545
(Gamma-ray emission probabilities)
- R.G.Helmer, C.van der Leun. Nucl. Instrum. Meth. A450 (2000) 35
(Gamma ray energies)


7 - ; 0
1200 (180) a
0
166 m
Ho
67 99
β -
γ Emission probabilities
per 100 disintegrations
17,2
74,8
0,394
0,81
2,31
1,12
3,4
6 - ; 1827,551
6 - ; 1786,966
5 - ; 1692,291
5 - ; 1665,79
4 - ; 1596,1
4 - ; 1572,22
8+ ; 1555,72
7+ ; 1376,011
6+ ; 1215,972
5+ ; 1075,269
60 ps
4+ ; 956,236
8+ ; 911,214
4,2 ps
3+ ; 859,4
6+ ; 545,4462
4+ ; 264,9832
118 ps
0+ ; 0
Stable
0
166
Er
68 98
Q - = 1860,5 keV
% β - = 100



γ Emission probabilities
per 100 disintegrations



$^{169}_{70}\mathrm{Yb}_{99}$

1 Decay Scheme

The Yb-169 disintegrates 100 % by electron capture to excited levels of Tm-169.
L'ytterbium 169 se désintègre à 100 % par capture électronique vers des niveaux excités du thulium 169.

2 Nuclear Data

$T_{1/2}(^{169}\mathrm{Yb}\ )$: 32,018 (5) d
$Q^{+}(^{169}\mathrm{Yb}\ )$: 909 (5) keV

2.1 Electron Capture Transitions

	Energy keV	Probability × 100	Nature	lg ft	P_K	P_L	P_M
$\epsilon_{0,19}$	31 (5)	0,000004 (1)	Allowed	10,8			
$\epsilon_{0,18}$	77 (5)	0,0000175 (5)	Allowed	11,2			
$\epsilon_{0,17}$	127 (5)	0,0045 (3)	Allowed	10,5	0,623 (15)	0,280 (11)	0,0743 (32)
$\epsilon_{0,16}$	190 (5)	0,0037 (2)	Allowed	10,3	0,725 (5)	0,2073 (35)	0,0526 (13)
$\epsilon_{0,15}$	262 (5)	0,00013 (7)	1st forbidden	12			
$\epsilon_{0,14}$	276 (5)	0,0109 (4)	Allowed	10,3	0,7692 (25)	0,1750 (18)	0,0432 (9)
$\epsilon_{0,13}$	338 (5)	0,00030 (6)	(2nd Forbidden)	12			
$\epsilon_{0,12}$	434 (5)	0,000344 (7)	Unique 1st forbidden	12			
$\epsilon_{0,11}$	436 (5)	12,6 (3)	1st forbidden	7,6	0,7980 (19)	0,1540 (13)	0,0372 (7)
$\epsilon_{0,10}$	474 (5)	0,121 (14)	Allowed	9,9	0,8017 (18)	0,1513 (13)	0,0365 (7)
$\epsilon_{0,9}$	479 (5)	0,0044 (1)	1st forbidden	11,2	0,8020 (18)	0,1511 (13)	0,0364 (7)
$\epsilon_{0,8}$	530 (5)	82,2 (18)	1st forbidden	7	0,8057 (18)	0,1484 (12)	0,0356 (7)
$\epsilon_{0,6}$	564 (5)	0,0138 (13)	1st forbidden	11	0,8078 (18)	0,1469 (12)	0,0352 (7)
$\epsilon_{0,5}$	577 (5)	0,0142 (16)	Allowed	10,9	0,8085 (18)	0,1463 (12)	0,0350 (7)
$\epsilon_{0,4}$	593 (5)	5,1 (19)	Allowed	8,33	0,8093 (17)	0,1457 (12)	0,0349 (7)

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{1,0}$(Tm)	8,41016 (15)	95,1 (8)	M1+0,108%E2			218 (11)	273 (13)
$\gamma_{3,2}$(Tm)	20,74370 (21)	11,2 (4)	M1+0,085%E2		44,5 (13)	10,0 (3)	57,3 (17)
$\gamma_{7,4}$(Tm)	51,51 (40)	0,1686 (1)	E2		37,1 (15)	9,1 (4)	48,6 (22)
$\gamma_{8,4}$(Tm)	63,12044 (4)	92,9 (18)	E1+0,01%M2	0,899 (27)	0,163 (6)	0,0366 (12)	1,11 (4)
$\gamma_{11,8}$(Tm)	93,61450 (8)	12,6 (3)	M1+3,25%E2	3,18 (10)	0,55 (2)	0,124 (4)	3,89 (12)
$\gamma_{11,7}$(Tm)	105,19 (10)	0,0034 (10)	[E1]	0,24 (1)	0,039 (3)		0,293 (15)
$\gamma_{2,1}$(Tm)	109,77928 (4)	59,9 (7)	M1+2,17%E2	2,03 (3)	0,327 (5)	0,0730 (11)	2,45 (4)
$\gamma_{10,4}$(Tm)	117,377 (18)	0,121 (14)	(M1+E2)	1,70 (17)	0,257 (26)	0,057 (6)	2,03 (20)
$\gamma_{2,0}$(Tm)	118,18944 (14)	4,97 (9)	E2	0,697 (21)	0,734 (22)	0,179 (6)	1,66 (5)
$\gamma_{3,1}$(Tm)	130,52293 (6)	24,5 (5)	E2	0,538 (17)	0,470 (15)	0,115 (4)	1,15 (4)
$\gamma_{11,4}$(Tm)	156,73495 (9)	0,0109 (3)	(E1)	0,0853 (26)	0,0132 (4)	0,0029 (1)	0,102 (3)
$\gamma_{4,3}$(Tm)	177,21317 (6)	35,49 (26)	M1+15,8%E2	0,484 (7)	0,0868 (13)	0,0197 (3)	0,590 (9)
$\gamma_{5,3}$(Tm)	193,15 (5)	0,0111 (16)	M1+1,1%E2	0,42 (2)	0,063 (5)		0,50 (3)
$\gamma_{4,2}$(Tm)	197,95687 (7)	52,03 (31)	M1+9%E2	0,370 (6)	0,0603 (9)	0,0136 (2)	0,448 (7)
$\gamma_{6,3}$(Tm)	205,99 (6)	0,0036 (8)	(E1)	0,042 (2)	0,0020 (2)		0,050 (2)
$\gamma_{5,2}$(Tm)	213,936 (17)	0,0035 (3)	E2	0,135 (7)	0,072 (6)		0,21 (1)
$\gamma_{6,2}$(Tm)	226,3 (7)	0,00025 (18)					
$\gamma_{8,3}$(Tm)	240,33362 (12)	0,120 (6)	E1+0,9%M2	0,037 (4)	0,0065 (7)	0,0009 (1)	0,045 (5)
$\gamma_{8,2}$(Tm)	261,07734 (9)	1,735 (9)	E1+0,1%M2	0,0237 (7)	0,00355 (11)	0,00079 (3)	0,0283 (9)
$\gamma_{9,3}$(Tm)	291,1909	0,0044 (1)	[E1]	0,018 (1)	0,0026 (2)		0,021 (2)
$\gamma_{10,3}$(Tm)	294,54 (11)	0,0011 (5)					
$\gamma_{4,1}$(Tm)	307,73616 (9)	10,72 (5)	E2	0,0482 (15)	0,0141 (4)	0,00333 (10)	0,0666 (20)
$\gamma_{4,0}$(Tm)	316,1463	0,0033 (3)	M3+E4				
$\gamma_{(-1,20)}$(Tm)	328 (2)	0,00672 (43)					
$\gamma_{11,3}$(Tm)	333,94777 (27)	0,00174 (9)	E1	0,0126 (13)	0,00182 (19)	0,00040 (4)	0,0149 (15)
$\gamma_{6,1}$(Tm)	336,621 (3)	0,0099 (9)	(E1)	0,0123 (13)	0,00179 (18)	0,00040 (4)	0,0146 (15)
$\gamma_{12,2}$(Tm)	356,74 (5)	0,000141 (6)					
$\gamma_{8,1}$(Tm)	370,85660 (29)	0,00111 (15)	[M2]	0,249 (8)	0,0460 (14)	0,0106 (3)	0,308 (9)
$\gamma_{8,0}$(Tm)	379,26676 (25)	0,00034 (14)	[E3]	0,0757 (23)	0,0401 (12)	0,0098 (3)	0,128 (4)
$\gamma_{16,5}$(Tm)	386,673 (13)	0,00038 (4)	[M1,E2]				
$\gamma_{10,1}$(Tm)	425,1138	0,00162 (29)					
$\gamma_{13,2}$(Tm)	452,62 (8)	0,000035 (19)	(M1+E2)				
$\gamma_{17,4}$(Tm)	465,657 (6)	0,000231 (24)					
$\gamma_{12,0}$(Tm)	474,973 (9)	0,000203 (9)					
$\gamma_{14,3}$(Tm)	494,360 (8)	0,00157 (12)					
$\gamma_{18,5}$(Tm)	500,35 (10)	0,0000088 (8)					
$\gamma_{15,3}$(Tm)	507,8 (3)	0,0000015 (8)					
$\gamma_{14,2}$(Tm)	515,108 (6)	0,00437 (16)	(M1)	0,0306 (30)	0,0045 (5)	0,00099 (10)	0,036 (4)
$\gamma_{15,2}$(Tm)	528,573 (10)	0,00013 (6)					
$\gamma_{19,5}$(Tm)	546,16 (22)	0,0000015 (4)					
$\gamma_{13,1}$(Tm)	562,414 (12)	0,00014 (4)	(M1+E2)				
$\gamma_{13,0}$(Tm)	570,89 (3)	0,000127 (26)	(M1+E2)				
$\gamma_{16,3}$(Tm)	579,855 (5)	0,00210 (17)	(M1)	0,023 (1)	0,0033 (3)		0,027 (2)
$\gamma_{16,2}$(Tm)	600,608 (8)	0,00114 (7)	(M1)				
$\gamma_{(-1,33)}$(Tm)	614,1 (5)	0,000097 (14)					
$\gamma_{14,1}$(Tm)	624,887 (4)	0,00495 (27)	(M1)	0,0187 (19)	0,0027 (3)	0,00060 (6)	0,0222 (22)
$\gamma_{14,0}$(Tm)	633,32 (10)	0,0000070 (5)					
$\gamma_{17,3}$(Tm)	642,878 (9)	0,000081 (5)					
$\gamma_{17,2}$(Tm)	663,604 (7)	0,00203 (15)					
$\gamma_{18,3}$(Tm)	693,46 (8)	0,0000087 (4)					
$\gamma_{16,1}$(Tm)	710,360 (15)	0,0000313 (22)					
$\gamma_{19,3}$(Tm)	739,42 (11)	0,00000183 (22)					
$\gamma_{19,2}$(Tm)	760,24 (24)	0,00000083 (22)					
$\gamma_{17,1}$(Tm)	773,390 (14)	0,00219 (11)					
$\gamma_{17,0}$(Tm)	781,64 (8)	0,0000030 (3)					

3 Atomic Data

3.1 Tm

ω_K : 0,945 (4)
$\bar{\omega}_L$: 0,227 (9)
n_{KL} : 0,835 (4)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	49,7731		56,64
	$K\alpha_1$	50,7417		100
	$K\beta_3$	57,304	}	
	$K\beta_1$	57,516	}	
	$K\beta_5''$	57,925	}	32,7
	$K\beta_2$	59,1	}	
	$K\beta_4$	59,21	}	8,5
	$KO_{2,3}$	59,357	}	
X_L				
	$L\ell$	6,34		
	$L\alpha$	7,13 – 7,18		
	$L\eta$	7,31		
	$L\beta$	8,18 – 8,64		
	$L\gamma$	9,15 – 9,78		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	38,96 – 41,88	100
KLX	46,88 – 50,71	52,6
KXY	54,78 – 59,32	6,92
Auger L	3,85 – 7,18	2450

4 Electron Emissions

		Energy keV			Electrons per 100 disint.
e_{AL}	(Tm)	3,85	-	7,18	168,2 (18)
e_{AK}	(Tm)				10,8 (8)
	KLL	38,96	-	41,88	}
	KLX	46,88	-	50,71	}
	KXY	54,78	-	59,32	}
$ec_{8,4\ T}$	(Tm)	3,7308	-	63,0881	48,9 (18)
$ec_{8,4\ K}$	(Tm)	3,7308		(4)	39,6 (12)
$ec_{1,0\ T}$	(Tm)	6,10	-	8,38	95 (6)
$ec_{1,0\ M}$	(Tm)	6,103	-	6,942	76 (5)
$ec_{3,2\ T}$	(Tm)	10,628	-	20,711	11,0 (4)
$ec_{3,2\ L}$	(Tm)	10,628	-	12,096	8,6 (3)
$ec_{3,2\ M}$	(Tm)	18,437	-	19,276	1,93 (7)
$ec_{11,8\ K}$	(Tm)	34,2249		(8)	8,18 (27)
$ec_{11,8\ T}$	(Tm)	34,225	-	93,582	10,0 (3)
$ec_{2,1\ K}$	(Tm)	50,3897		(4)	35,2 (6)
$ec_{2,1\ T}$	(Tm)	50,3897	-	109,7470	42,5 (7)
$ec_{8,4\ L}$	(Tm)	53,0047	-	54,4720	7,18 (27)
$ec_{10,4\ K}$	(Tm)	57,987		(18)	0,068 (9)
$ec_{2,0\ T}$	(Tm)	58,79	-	118,16	3,1 (1)
$ec_{2,0\ K}$	(Tm)	58,7998		(2)	1,30 (4)
$ec_{8,4\ M}$	(Tm)	60,8136	-	61,6527	1,61 (5)
$ec_{3,1\ T}$	(Tm)	71,133	-	130,491	13,1 (5)
$ec_{3,1\ K}$	(Tm)	71,1333		(1)	6,1 (2)
$ec_{11,8\ L}$	(Tm)	83,499	-	84,967	1,4 (5)
$ec_{11,8\ M}$	(Tm)	91,308	-	92,147	0,32 (1)
$ec_{2,1\ L}$	(Tm)	99,6636	-	101,1310	5,68 (9)
$ec_{2,1\ M}$	(Tm)	107,4725	-	108,3116	1,267 (20)
$ec_{2,0\ L}$	(Tm)	108,074	-	109,541	1,37 (4)
$ec_{2,0\ M}$	(Tm)	115,883	-	116,723	0,33 (1)
$ec_{4,3\ T}$	(Tm)	117,823	-	177,181	13,2 (2)
$ec_{4,3\ K}$	(Tm)	117,8235		(1)	10,8 (2)
$ec_{3,1\ L}$	(Tm)	120,407	-	121,875	5,3 (2)
$ec_{3,1\ M}$	(Tm)	128,216	-	129,055	1,31 (5)
$ec_{4,2\ T}$	(Tm)	138,567	-	197,924	16,1 (3)
$ec_{4,2\ K}$	(Tm)	138,5671		(1)	13,29 (22)
$ec_{4,3\ L}$	(Tm)	167,097	-	168,565	1,94 (3)
$ec_{4,3\ M}$	(Tm)	174,906	-	175,745	0,44 (1)
$ec_{4,2\ L}$	(Tm)	187,841	-	189,308	2,17 (3)
$ec_{4,2\ M}$	(Tm)	195,649	-	196,489	0,49 (1)
$ec_{4,1\ K}$	(Tm)	248,3479		(1)	0,484 (15)
$ec_{4,1\ L}$	(Tm)	297,621	-	299,089	0,142 (4)

5 Photon Emissions

5.1 X-Ray Emissions

		Energy keV		Photons per 100 disint.	
XL	(Tm)	6,34 — 9,78		49,4 (8)	
XKα_2	(Tm)	49,7731		52,9 (8)	} Kα
XKα_1	(Tm)	50,7417		93,5 (13)	}
XKβ_3	(Tm)	57,304	}		
XKβ_1	(Tm)	57,516	}	30,6 (6)	Kβ'_1
XKβ''_5	(Tm)	57,925	}		
XKβ_2	(Tm)	59,1	}		
XKβ_4	(Tm)	59,21	}	7,95 (21)	Kβ'_2
XKO$_{2,3}$	(Tm)	59,357	}		

5.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{1,0}$(Tm)	8,41016 (15)	0,347 (17)
$\gamma_{3,2}$(Tm)	20,74370 (21)	0,1925 (43)
$\gamma_{7,4}$(Tm)	51,51 (40)	0,0034 (1)
$\gamma_{8,4}$(Tm)	63,12044 (4)	44,05 (24)
$\gamma_{11,8}$(Tm)	93,61447 (8)	2,571 (17)
$\gamma_{11,7}$(Tm)	105,19 (10)	0,0026 (8)
$\gamma_{2,1}$(Tm)	109,77924 (4)	17,36 (9)
$\gamma_{10,4}$(Tm)	117,377 (18)	0,0398 (36)
$\gamma_{2,0}$(Tm)	118,18940 (14)	1,87 (1)
$\gamma_{3,1}$(Tm)	130,52293 (6)	11,38 (5)
$\gamma_{11,4}$(Tm)	156,73487 (9)	0,00990 (25)
$\gamma_{4,3}$(Tm)	177,21307 (6)	22,32 (10)
$\gamma_{5,3}$(Tm)	193,15 (5)	0,0074 (10)
$\gamma_{4,2}$(Tm)	197,95675 (7)	35,93 (12)
$\gamma_{6,3}$(Tm)	205,99 (6)	0,0034 (8)
$\gamma_{5,2}$(Tm)	213,936 (17)	0,00291 (22)
$\gamma_{6,2}$(Tm)	226,3 (7)	0,00025 (18)
$\gamma_{8,3}$(Tm)	240,33344 (12)	0,115 (5)
$\gamma_{8,2}$(Tm)	261,07712 (9)	1,687 (8)
$\gamma_{9,3}$(Tm)	291,190 (11)	0,00431 (14)
$\gamma_{10,3}$(Tm)	294,54 (11)	0,0011 (5)
$\gamma_{4,1}$(Tm)	307,73757 (9)	10,046 (45)
$\gamma_{4,0}$(Tm)	316,2 (7)	0,0033 (3)

	Energy keV	Photons per 100 disint.
$\gamma_{(-1,20)}$(Tm)	328 (2)	0,00672 (43)
$\gamma_{11,3}$(Tm)	333,94777 (27)	0,00171 (9)
$\gamma_{6,1}$(Tm)	336,621 (3)	0,0098 (9)
$\gamma_{12,2}$(Tm)	356,74 (5)	0,000141 (6)
$\gamma_{8,1}$(Tm)	370,85616 (29)	0,00085 (11)
$\gamma_{8,0}$(Tm)	379,26630 (25)	0,00030 (12)
$\gamma_{16,5}$(Tm)	386,673 (13)	0,00038 (4)
$\gamma_{10,1}$(Tm)	425,0 (2)	0,00162 (29)
$\gamma_{13,2}$(Tm)	452,62 (8)	0,000035 (19)
$\gamma_{17,4}$(Tm)	465,657 (6)	0,000231 (24)
$\gamma_{12,0}$(Tm)	474,973 (9)	0,000203 (9)
$\gamma_{14,3}$(Tm)	494,360 (8)	0,00157 (12)
$\gamma_{18,5}$(Tm)	500,35 (10)	0,0000088 (8)
$\gamma_{15,3}$(Tm)	507,8 (3)	0,0000015 (8)
$\gamma_{14,2}$(Tm)	515,107 (6)	0,00422 (16)
$\gamma_{15,2}$(Tm)	528,572 (10)	0,00013 (6)
$\gamma_{19,5}$(Tm)	546,16 (22)	0,0000015 (4)
$\gamma_{13,1}$(Tm)	562,413 (12)	0,00014 (4)
$\gamma_{13,0}$(Tm)	570,89 (3)	0,000127 (26)
$\gamma_{16,3}$(Tm)	579,854 (5)	0,00204 (16)
$\gamma_{16,2}$(Tm)	600,607 (8)	0,00114 (7)
$\gamma_{(-1,33)}$(Tm)	614,1 (5)	0,000097 (14)
$\gamma_{14,1}$(Tm)	624,886 (4)	0,00484 (27)
$\gamma_{14,0}$(Tm)	633,32 (10)	0,0000070 (5)
$\gamma_{17,3}$(Tm)	642,877 (9)	0,000081 (5)
$\gamma_{17,2}$(Tm)	663,603 (7)	0,00203 (15)
$\gamma_{18,3}$(Tm)	693,46 (8)	0,0000087 (4)
$\gamma_{16,1}$(Tm)	710,358 (15)	0,0000313 (22)
$\gamma_{19,3}$(Tm)	739,42 (11)	0,00000183 (22)
$\gamma_{19,2}$(Tm)	760,24 (24)	0,00000083 (22)
$\gamma_{17,1}$(Tm)	773,390 (14)	0,00219 (11)
$\gamma_{17,0}$(Tm)	781,64 (8)	0,0000030 (3)

6 Main Production Modes

$\left\{ \begin{array}{l} \mathrm{Yb-169m(I.T.)Yb-169} \\ T_{1/2} = 46\ s \end{array} \right.$

$\left\{ \begin{array}{l} \mathrm{Lu-169(E.C.,)Yb-169} \\ T_{1/2} = 34{,}06\ h \end{array} \right.$

$\mathrm{Er-167}(\alpha,2\mathrm{n}\gamma)\mathrm{Yb-169}$

$\mathrm{Yb-168(n,}\gamma\mathrm{)Yb-169}$

$\mathrm{Yb-168(d,p)Yb-169}$

$\mathrm{Yb-170(d,t)Yb-169}$

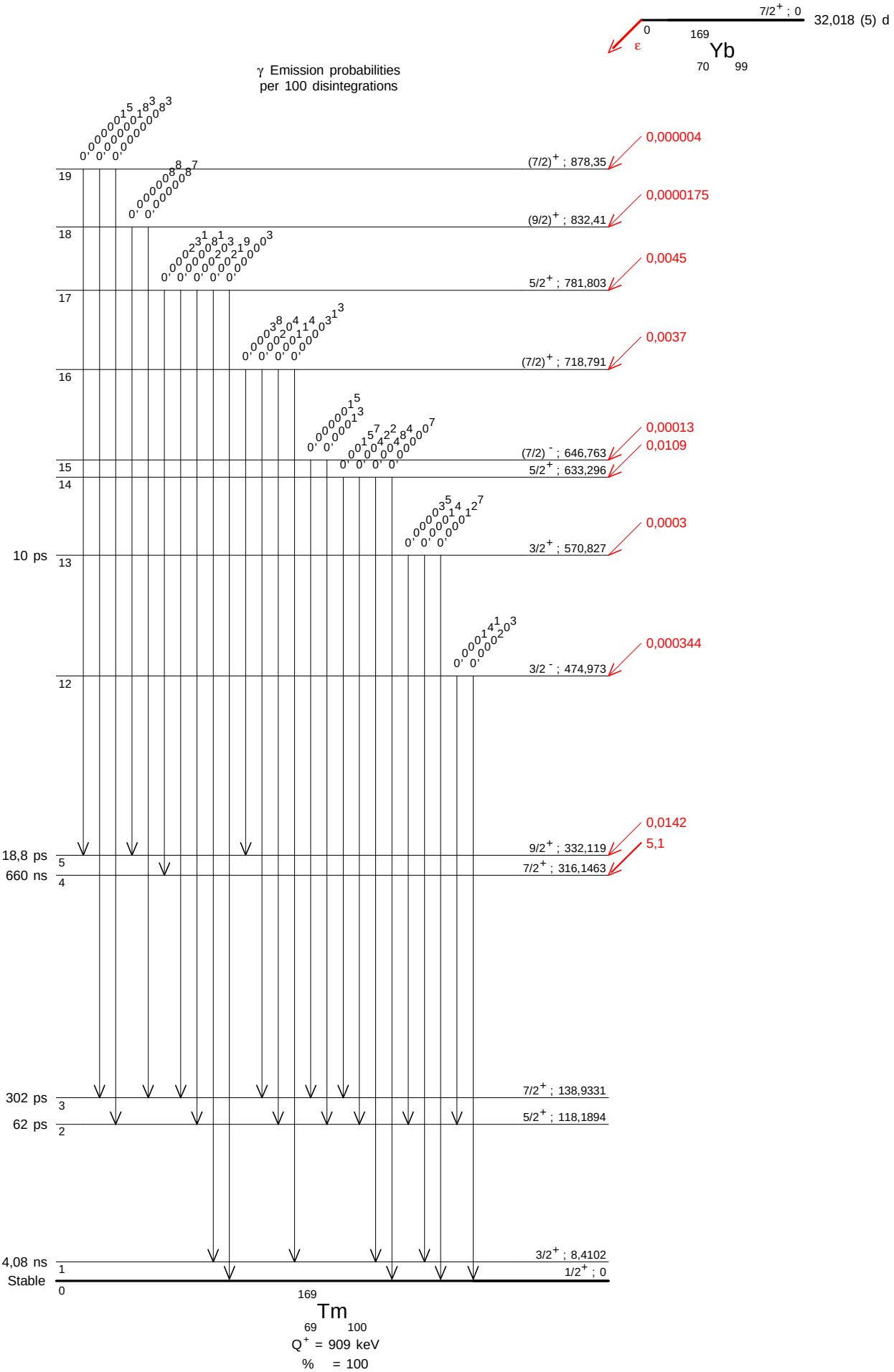
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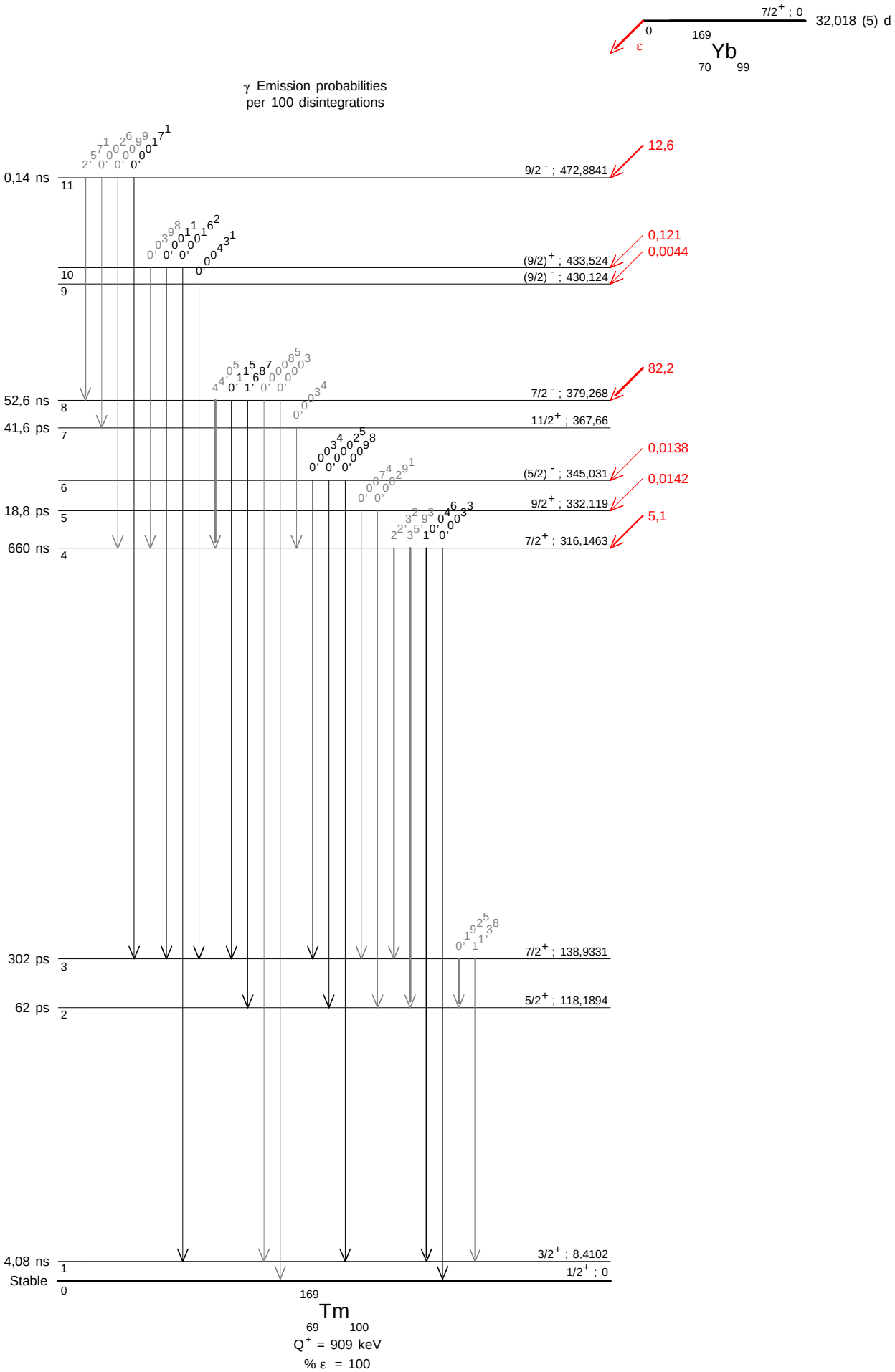
7 References

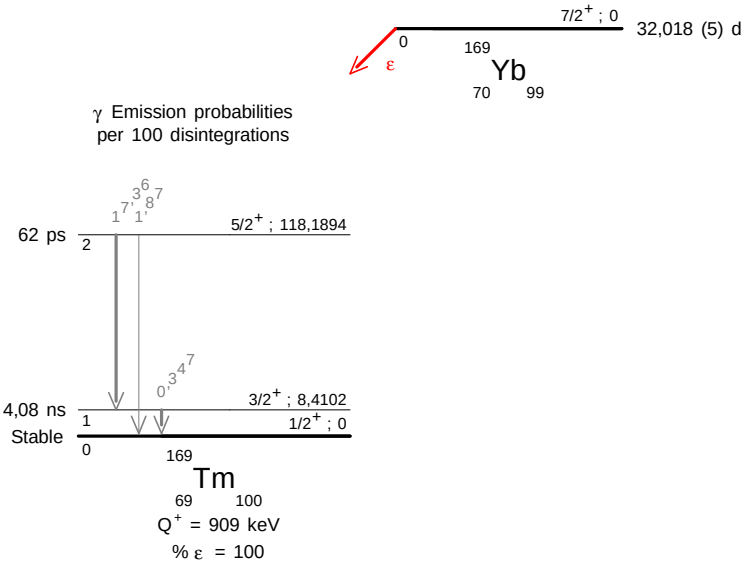
- D. Walker. Proc. Phys. Soc., London 62A (1949) 799
  (Half-life)
- G. Charpak, F. Suzor. J. Phys. Radium 20 (1959) 513
  (ICC)
- Z. Grabowski, J. E. Thun, B. Lindström. Z. Physik 169 (1962) 303
  (ICC)
- P. Alexander, F. Boehm. Nucl. Phys. 46 (1963) 108
  (Gamma-ray emission probabilities)
- J. E. Brown, E. N. Hatch. Nucl. Instrum. Methods 47 (1967) 185
  (Gamma-ray emission probabilities)
- T. A. Carlson, P. Erman, F. Franson. Nucl. Phys. A111 (1968) 371
  (ICC)
- C. Günther, H. Hübel, A. Kluge, K. Krien, H. Toschinski. Nucl. Phys. A123 (1969) 386
  (Multipolarity)
- V. S. Aleksandrov, V. A. Balalaev, B. S. Dzhelepov, V. E. Ter-Nersesyants. Bull. Acad. Sci. URSS, Phys. Ser. 34 (1970) 42
  (Gamma-ray emission probabilities)
- N. B. Gove, M. J. Martin. Nuclear Data Tables 10 (1971) 206
  (lg ft)
- S. K. Sen, D. L. Salie, E. Tomchuk. Can. J. Phys. 50 (1972) 2348
  (Gamma-ray emission probabilities)
- V. A. Balalaev, B. S. Dzhelepov. Izv. Akad. Nauk SSSR, Ser.Fiz. 36,10 (1972) 2089
  (Gamma-ray emission probabilities)
- V. R. Potnis, G. P. Agin, C. E. Mandeville, R. Rogow. Bull. Amer. Phys. Soc. 17 (1972) 28
  (Gamma-ray emission probabilities)
- K. S. Krane, C. E. Olsen, W. A. Steyert. Nucl. Phys. A197 (1972) 352
  (Multipolarity. Erratum Nucl.Phys. A224 (1974) 596)
- A. P. Agnihotry, K. P. Gopinathan, H. C. Jain, C. V. K. Baba. Phys. Rev. C 6,1 (1972) 321
  (Gamma-ray emission probabilities, ICC, multipolarity)
- V. S. Aleksandrov, Ts. Vylov, T. M. Muminov, B. Osipenko. Joint Nuclear Research Institute, Dubna, Preprint P6-7308 (1973)
  (Gamma-ray emission probabilities)
- N. Lavi. Nucl. Instrum. Methods 107 (1973) 197
  (Gamma-ray emission probabilities)
- F. Lagoutine, J. Legrand, C. Bac. Int. J. Appl. Rad. Isot. 26 (1975) 131
  (Half-life)
- G. L.B orchert, W. Scheck, K. P. Wieder. Z. Naturforsch. 30a (1975) 274
  (Gamma-ray energies)
- K. P. Artomonova, A. A. Voronkov, E. P. Grigoriev, A. V. Zolotavin, V. O. Sergeev. Bull. Acad. Sci. USSR, Phys. Ser. 40, 1 (1976) 30
  (Gamma-ray emission probabilities and Internal Conversion Coefficients)
- H. R. Verma, A. K. Sharma, N. Singh, P. Trehan. J. Phys. Soc. Japan 45 (1976) 374
  (Gamma-ray emission probabilities)
- M. K. Georgieva, G. Ch. Tumbev. Comp. Rend. de l'Academia Bulgare des Sciences 29 (1976) 639
  (Gamma-ray emission probabilities)
- R. J. Gehrke, R. G. Helmer, R. C. Greenwood. Nucl. Instrum. Methods 147 (1977) 405
  (Gamma-ray emission probabilities)
- F. Rösel, H. M. Fries, K. Alder, H. C. Pauli. At. Data. Nucl. Data Tables 21 (1978) 292
  (Theoretical Internal Conversion Coefficients)
- E. G. Kessler Jr, L. Jacobs, W. Schwitz, R. D. Deslattes. Nucl. Instrum. Methods 160 (1979) 435
  (Gamma-ray energies)
- A. R. Rutledge, L. V. Smith, J. S. Merritt. Report AECL 6692 (1980)
  (Half-life)
- H. Houtermans, O. Milosevic, F. Reichel. Int. J. Appl. Rad. Isot. 31 (1980) 153
  (Half-life)
- E. Funck, U. Schötzig, K. F. Walz. Int. J. Appl. Radiat. Isotop. 34,8 (1983) 1215
  (Gamma-ray emission probabilities)

- K. M. Akhmetov, W. I. Balaschow, B. V. Bobykin. 35 Conf. on nuclear spectroscopy and nuclear structure.Summaries of reports. Yadernoj Fiziki (1985) 127
  (Multipolarity)
- E. Garcia Torano, A. Grau Malonda. Comp. Phys. Commun. 36 (1985) 307
  (Gamma-ray emission probabilities)
- V. V. Bulgakov, V. I. Gavrilyuk, A. P. Lashko, N. V. Stril'chuk, A. I. Feoktistov, Yu. E. Frantsev, V. B. Kharlanov. Izv. Akad. Nauk SSSR, Ser. Fiz 49, 11 (1985) 2107
  (Gamma-ray emission probabilities)
- I. Adam, W. Wagner, M. Gonusek, B. Krazik. 35 Conf. on nuclear spectroscopy and nuclear structure.Summaries of reports. Yadernoj Fiziki (1985) 126
  (Gamma-ray emission probabilities)
- I. Adam, W. Wagner, M. Gonusek, B. Kracik. Izv. Akad. Nauk SSSR, Ser.Fiz. 50,5 (1986) 855
  (Gamma-ray energy and emission probabilities)
- D. Mehta, M. L. Garg, J. Singh, N. Singh, T. S. Cheema, P. N. Trehan. Nucl. Instrum. Methods A245 (1986) 447
  (Gamma-ray emission probabilities)
- S. Davaa, T. I. Kracikova, M. Finger, V. M. Tsupko-Sitnikov, V. N. Pavlov. Sov. J. Nucl. Phys. 45 ,3 (1987) 397
  (Multipolarity)
- T. I. Kracikova, S. Davaa, M. Finger, V. N. Pavlov, V. M. Tsupko-Sitnikov. Hyperfine Interactions 34 (1987) 127
  (Multipolarity)
- H. S. Sahota, T. Iwashita, B. S. Grewal. J. Phys. Soc. Japan 56, 11 (1987) 3881
  (Elec. Capt. Probabilities)
- J. Kits, M. Choc, F. Latal. Jaderna energie 34 (1988) 231
  (Half-life)
- W. Wagner, I. Adam, S. Batsev, B. Kratsik, M. Fisher, D. Srnka. Izv. Akad. Nauk SSSR, Ser.Fiz. 54, 9 (1990) 1811
  (Gamma-ray emission probabilities)
- J. L. Parker. Nucl. Instrum. Methods A286 (1990) 502
  (Half-life)
- I. Adam, S. Bazev, W. Wagner, B. Krazik, M. Fischer. Nuclear Spectroscopy and Nuclear Structure.Nuclear Spectroscopy and Nuclear Shape.Summaries of repo AN SSSR (1990) 106
  (Gamma-ray energy and emission probabilities)
- V. S. Shirley. Nuclear Data Sheets 64 (1991) 505
  (Level energies, spin and parity)
- W. A. Volkert, W. F. Goeckeler, G. J. Ehrhardt, A. R. Ketring. J. Nucl. Med. 32 (1991) 174
  (Gamma-ray emission probabilities)
- M. P. Unterweger, D. O. Hoppes, F. J. Schima. Nucl. Instrum. Methods Phys. Res. A312 (1992) 349
  (Half-life)
- I. M. Band, M. B. Trzhaskovskaya. At. Data. Nucl. Data Tables 55,1 (1993) 43
  (Theoretical ICC)
- M. A. Baratova, T. A. Islamov, A. X. Kholmatov, M. S. Hhodzaev, Yu. Zainutdinov, R. A. Niyazov. Ann. Conf. Nucl. Spectrosc. At. Nuclei, Dubna (1993) 98
  (ICC)
- B. M. Coursey, J. M. Calhoun, J. Cessna, D. B. Golas, F. J. Schima. Nucl. Instrum. Methods Phys. Res. A339 (1994) 26
  (Half-life)
- V. A. Zhezltonozhsky, N. V. Strilchuk, V. P. Khomenkov. Bull. Acad. Sci. URSS 59,1 (1995) 15
  (ICC)
- G. Audi, A. H. Wapstra. Nucl. Phys. A595 (1995) 409
  (Q)
- S. Bhattacharya, D. Bandyopadhyay, S. K. Saha, S. K. Basu. Nucl. Instrum. Methods Phys. Res. A378 (1996) 515
  (Gamma-ray emission probabilities)
- E. Schönfeld, H. Janssen. Nucl. Instrum. Methods A369 (1996) 527
  (Atomic Data)
- R. B. Firestone, V. S. Shirley. Table of Isotopes, Wiley, New York, (1996)
  (Production modes)
- C. C. Dey, B. K. Sinha, K. S. Basu. Phys. Rev. C55 ,3 (1997) 1197
  (Multipolarity)

- E. Schönfeld. Appl. Rad. Isotopes 49,9 (1998) 1353
(Elec. Capt. Probabilities)
- H. Miyahara, H. Nagata, T. Furusawa, N. Murakami, C. Mori, N. Takeuchi,T. Genka. Nucl. Instrum. Methods Phys. Res. A420 (1999) 155
(Gamma-ray emission probabilities)
- E. Schönfeld, U. Schötzig, R. Klein. Appl. Rad. Isotopes 50 (1999) 753
(Gamma-ray emission probabilities)
- J. Morel, M. Etcheverry, J. Plagnard *et al.* Euromet 410 - Report CEA N-2842 (1999)
(Gamma-ray emission probabilities)
- R. G. Helmer, C. van der Leun. Nucl. Instrum. Methods Phys. Res. A450 (2000) 35
(Gamma ray energies)
- A. Iwahara, J. U. Delgado, R. Poledna, C. J. da Silva, R. T. Lopes. Nucl. Instrum. Methods Phys. Res. A455 (2000) 607
(Half-life)
- J. Morel, M. Etcheverry, J. Plagnard. Appl. Rad. Isotopes 52 (2000) 455
(Gamma-ray emission probabilities)
- T. E. Sazonova, S. V. Sepman *et al.* Appl. Rad. Isotopes 52 (2000) 455
(Gamma-ray emission probabilities)


7/2+ ; 0
32,018 (5) d
0
169
ε
Yb
70
99
γ Emission probabilities
per 100 disintegrations
0,000004
(7/2)+ ; 878,35
19
0,0000175
(9/2)+ ; 832,41
18
0,0045
5/2+ ; 781,803
17
0,0037
(7/2)+ ; 718,791
16
0,00013
0,0109
(7/2) - ; 646,763
5/2+ ; 633,296
15
14
0,0003
3/2+ ; 570,827
10 ps
13
0,000344
3/2 - ; 474,973
12
0,0142
5,1
9/2+ ; 332,119
18,8 ps
5
7/2+ ; 316,1463
660 ns
4
7/2+ ; 138,9331
302 ps
3
5/2+ ; 118,1894
62 ps
2
3/2+ ; 8,4102
4,08 ns
1
1/2+ ; 0
Stable
0
169
Tm
69
100
Q+ = 909 keV
% = 100


7/2+ ; 0
32,018 (5) d
0
ε
169
Yb
70 99
γ Emission probabilities
per 100 disintegrations
12,6
9/2 - ; 472,8841
0,14 ns
11
0,121
0,0044
(9/2)+ ; 433,524
(9/2) - ; 430,124
10
9
82,2
7/2 - ; 379,268
52,6 ns
8
41,6 ps
11/2+ ; 367,66
7
0,0138
(5/2) - ; 345,031
6
0,0142
9/2+ ; 332,119
18,8 ps
5
5,1
7/2+ ; 316,1463
660 ns
4
302 ps
7/2+ ; 138,9331
3
62 ps
5/2+ ; 118,1894
2
4,08 ns
3/2+ ; 8,4102
1
Stable
1/2+ ; 0
0
169
Tm
69 100
Q+ = 909 keV
% ε = 100


7/2+ ; 0
32,018 (5) d
0
169
Yb
70
99
ε
γ Emission probabilities
per 100 disintegrations
62 ps
5/2+ ; 118,1894
2
4,08 ns
Stable
3/2+ ; 8,4102
1/2+ ; 0
1
0
169
Tm
69
100
Q+ = 909 keV
% ε = 100

$^{170}_{69}\mathrm{Tm}_{101}$

1 Decay Scheme

Tm-170 disintegrates by both beta minus decay and electron capture, respectively, to the first excited level of 84.25 keV (18.3 %) and the ground state (81 %) in Yb-170, and to the first excited level of 78.6 keV (0.03 %) and the ground state (0.12 %) in Er-170.
Le thulium 170 se désintègre par émission bêta moins et par capture électronique vers le premier niveau à 84,25 keV (18,3%), le niveau fondamental (81,6 %) de l'ytterbium 170, et le premier niveau à 78,6 keV (0,03 %) et le niveau fondamental (0,12 %) de l'erbium 170.

2 Nuclear Data

$T_{1/2}(^{170}\mathrm{Tm})$	:	127,8	(6)	d
$Q^-(^{170}\mathrm{Tm})$	:	968,0	(8)	keV
$Q^+(^{170}\mathrm{Tm})$	:	314,4	(18)	keV

2.1 β^- Transitions

	Energy keV	Probability × 100	Nature	lg ft
$\beta^-_{0,1}$	883,7 (8)	18,3 (7)	1st forbidden	8,924
$\beta^-_{0,0}$	968,0 (8)	81,6 (7)	1st forbidden	9,432

2.2 Electron Capture Transitions

	Energy keV	Probability × 100	Nature	lg ft	P_K	P_L	P_M
$\epsilon_{0,1}$	235,8 (18)	0,029 (3)	1st forbidden	10,21	0,7595 (22)	0,1822 (15)	0,0451 (9)
$\epsilon_{0,0}$	314,4 (18)	0,118 (7)	1st forbidden	9,906	0,7838 (19)	0,1645 (13)	0,0401 (8)

2.3 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce} \times 100$	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{(-1,0)}$(Er)							
$\gamma_{1,0}$(Er)	78,59 (2)	0,029 (3)	E2	1,72 (11)	4,51 (30)	1,10 (7)	7,62 (50)
$\gamma_{1,0}$(Yb)	84,25474 (8)	18,3 (7)	E2	1,39 (2)	3,81 (6)	0,94 (1)	6,39 (10)

3 Atomic Data

3.1 Er

ω_K : 0,942 (4)
$\bar{\omega}_L$: 0,216 (9)
n_{KL} : 0,838 (4)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	48,2212		56,34
	$K\alpha_1$	49,1276		100
	$K\beta_3$	55,4797	}	
	$K\beta_1$	55,6737	}	
	$K\beta_5''$	56,0322	}	32,5
	$K\beta_5'$	56,0762	}	
	$K\beta_2$	57,142	}	
	$K\beta_4$	57,313	}	8,45
	$KO_{2,3}$	57,456	}	
X_L				
	$L\ell$	6,15		
	$L\gamma$	– 9,43		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	37,79 – 40,56	100
KLX	45,47 – 49,10	52,4
KXY	53,02 – 57,43	6,9

3.2 Yb

ω_K : 0,947 (4)
$\bar{\omega}_L$: 0,238 (10)
n_{KL} : 0,833 (4)

3.2.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	51,3541		56,73
	$K\alpha_1$	52,3887		100
	$K\beta_3$	59,1593	}	
	$K\beta_1$	59,3825	}	
	$K\beta''_5$	59,756	}	32,83
	$K\beta'_5$	59,8045	}	
	$K\beta_2$	60,962	}	
	$K\beta_4$	61,141	}	8,57
	$KO_{2,3}$	61,309	}	
X_L				
	$L\ell$	6,548		
	$L\alpha$	7,369 – 7,416		
	$L\eta$	7,583		
	$L\beta$	8,026 – 8,756		
	$L\gamma$	9,736 – 10,142		

3.2.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	40,16 – 43,23	100
KLX	48,36 – 52,36	52,8
KXY	56,48 – 61,29	7

4 Electron Emissions

		Energy keV	Electrons per 100 disint.
e_{AK}	(Er)		0,0072 (6)
	KLL	37,79 - 40,56	}
	KLX	45,47 - 49,10	}
	KXY	53,02 - 57,43	}
e_{AK}	(Yb)		0,182 (14)
	KLL	40,16 - 43,23	}
	KLX	48,36 - 52,36	}
	KXY	56,48 - 61,29	}
$ec_{1,0\ K}$	(Er)	21,10 (2)	0,0058 (5)
$ec_{1,0\ K}$	(Yb)	22,9224 (1)	3,45 (13)
$ec_{1,0\ L}$	(Er)	68,84 - 70,23	0,015 (1)
$ec_{1,0\ L}$	(Yb)	73,77 - 75,31	9,4 (4)
$ec_{1,0\ M}$	(Er)	76,38 - 77,18	0,0037 (3)
$ec_{1,0\ M}$	(Yb)	81,86 - 82,73	2,3 (1)
$\beta^-_{0,1}$	max:	883,7 (8)	18,3 (7)
$\beta^-_{0,1}$	avg:	290,5 (3)	
$\beta^-_{0,0}$	max:	968,0 (8)	81,6 (7)
$\beta^-_{0,0}$	avg:	323,1 (3)	

5 Photon Emissions

5.1 X-Ray Emissions

		Energy keV	Photons per 100 disint.	
XL	(Er)	6,15 — 9,43	0,0306 (19)	
$XK\alpha_2$	(Er)	48,2212	0,332 (16)	} $K\alpha$
$XK\alpha_1$	(Er)	49,1276	0,0590 (24)	}
$XK\beta_3$	(Er)	55,4797	}	
$XK\beta_1$	(Er)	55,6737	} 0,0191 (10)	$K'\beta_1$
$XK\beta''_5$	(Er)	56,0322	}	
$XK\beta'_5$	(Er)	56,0762	}	
$XK\beta_2$	(Er)	57,142	}	
$XK\beta_4$	(Er)	57,313	} 0,0050 (3)	$K'\beta_2$
$XKO_{2,3}$	(Er)	57,456	}	

		Energy keV		Photons per 100 disint.	
XL	(Yb)	6,548 — 10,142		3,22 (13)	
XKα_2	(Yb)	51,3541		0,95 (4)	} Kα
XKα_1	(Yb)	52,3887		1,67 (7)	}
XKβ_3	(Yb)	59,1593	}		
XKβ_1	(Yb)	59,3825	}	0,55 (3)	K$'\beta_1$
XKβ_5''	(Yb)	59,756	}		
XKβ_5'	(Yb)	59,8045	}		
XKβ_2	(Yb)	60,962	}		
XKβ_4	(Yb)	61,141	}	0,144 (7)	K$'\beta_2$
XKO$_{2,3}$	(Yb)	61,309	}		

5.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{1,0}$(Er)	78,59 (2)	0,0034 (3)
$\gamma_{1,0}$(Yb)	84,25474 (8)	2,48 (9)

6 Main Production Modes

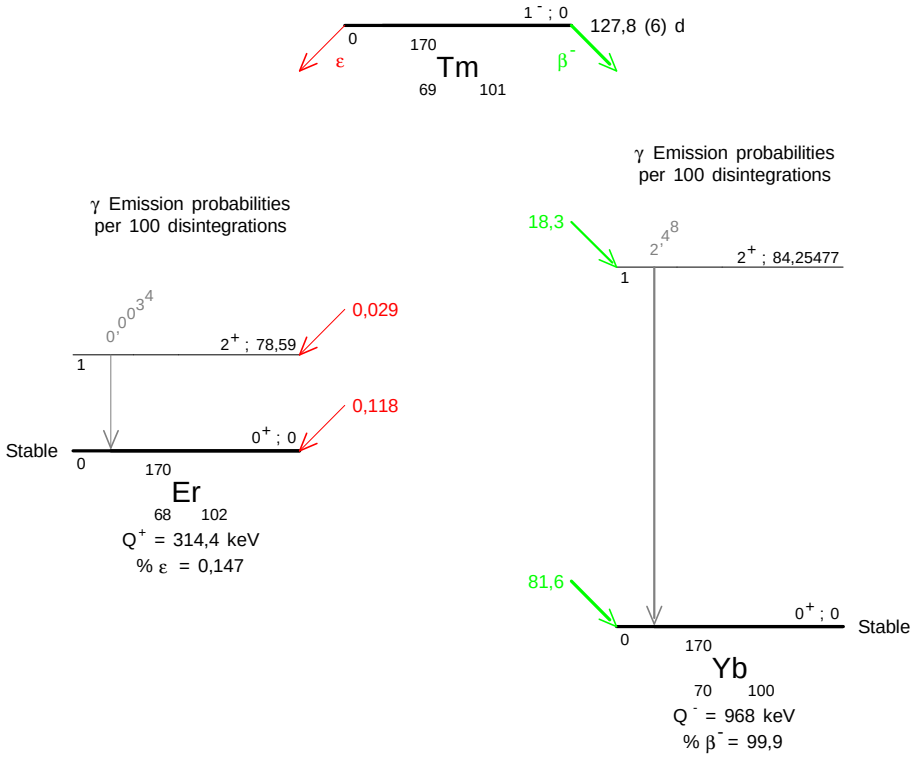
Tm − 169(n,γ)Tm − 170

{ Er − 170(p,n)Tm − 170
{ Possible impurities : Tm − 168

7 References

- E. L. Chupp *et al.* Phys. Rev. 112 (1958) 518
  (gamma ray energy)
- Bonner *et al.* Phys. Rev. 127 (1962) 217
  (Half-life)
- K. F. Flynn *et al.* Nucl. Sci. Eng. 22 (1965) 416
  (Half-life)
- R. S. Dingus *et al.* Nucl. Phys. 83 (1966) 545
  (ICC K, g-84)
- J. A. Bearden. Rev. Mod. Phys. 39 (1967) 78
  (X-ray energies)
- W. I. Kerrigan. J. Inorg. Nucl. Chem. 29 (1967) 2657
  (Half-life)

- O. Nilsson *et al.* Nucl. Phys. A120 (1968) 561
  (ICC M / ICC NO)
- S. A. Reynolds, *et al.* Nucl. Sci. Eng. 32 (1968) 46
  (Half-life)
- H. H. Hansen, S. Hellstrom. Z. Phys. 223 (1969) 139
  (Energy of g-79)
- F. Lagoutine *et al.* Int. J. Appl. Radiat. Isotop. 20 (1969) 868
  (Half-life)
- G. C. Nelson, E. N. Hatch. Nucl. Phys. A127 (1969) 560
  (ICC K, g-84)
- S. Mohan. Phys. Rev. C1 (1970) 254
  (ICC K(g84), energy and relative probability of g-79)
- J. L. Campbell. Nucl. Instrum. Methods 92 (1971) 237
  (ICC K(g84))
- J. Plch *et al.* Czech. J. Phys. 23 (1973) 1181
  (ICC K(g84), absolute g-84 emission probability)
- F. P. Larkins. At. Data Nuc. Data Tables 20 (1977) 313
  (Auger electron energies)
- F. Rösel *et al.* At. Data Nuc. Data Tables 21 (1978) 293
  (Internal conversion coefficients)
- D. Mehta *et al.* Nucl. Instrum. Methods A242 (1985) 149
  (ICC K(g84), PX/Pg(84), Pg(79)/Pg(84))
- Rao N. Venkateswara, *et al.* J. Phys. (London) G12 (1986) 45
  (ICC K(g84), Pg(79)/Pg(84))
- Rao N. Venkateswara, *et al.* Indian J. Phys. 60A (1986) 162
  (PX/Pg(84))
- A.M. Geidelman *et al.* Conf. on Nucl. Spectr. and Atomic Nucl. Structure, Yurmala, 14-17 April, LO Nauka, Leningrad, 1987 (1987) 133
  (Absolute g(84) emission probability)
- N.K. Kuzmenko *et al.* Izmeritelnay Tekhnika N9 (1988) 47
  (1988 decay data evaluation, absolute g(84) emission probability)
- A.M. Geidelman *et al.* Proc. Intern. Conf. Nuclear data for Science and Technology, Mito, Japan, 1988 (1988) 909
  (Absolute g(84) emission probability)
- A.G. Egorov *et al.* Program. and Thesis, Proc.39th Ann. Conf. Nucl. Spectrosc. Struct. At Nuclei, Leningrad, 1989 (1989) 505
  (Yb XK-ray emission probabilities)
- T. Kempisty *et al.* Nucl. Instrum. Methods A286 (1990) 535
  (Absolute g(84) emission probability, ICC K(g84))
- A.G. Egorov *et al.* Program and Thesis, Proc. 40th Ann. Conf. Nucl. Spectrosc. Struct. At Nuclei, Leningrad,1990 (1990) 486
  (Er XK-ray emission probabilities)
- G. Audi, A. H. Wapstra. Nucl. Phys. A595 (1995) 409
  (Q values)
- C. M. Baglin. Nucl. Data Sheets 77 (1996) 125
  (Decay scheme)
- E. Schönfeld, H. Janssen. Nucl. Instrum. Methods A369 (1996) 527
  (Atomic data)
- B. Singh *et al.* Nucl. Data Sheets 84 (1998) 487
  (lg ft)
- E. Schönfeld. Appl. Rad. Isotopes 49 (1998) 1353
  (gamma-ray energies)
- R. G. Helmer, C. van der Leun. Nucl. Instrum. Methods A450 (2000) 35
  (gamma-ray energies)
- R.D.Deslattes, *et al.* Rev. Mod. Phys. 75 (2003) 35
  (L X-ray energies)


1⁻ ; 0
127,8 (6) d
0
170
ε
Tm
69
101
β⁻
γ Emission probabilities
per 100 disintegrations
0,029
0,118
2⁺ ; 78,59
1
0⁺ ; 0
Stable
0
170
Er
68
102
Q⁺ = 314,4 keV
% ε = 0,147
γ Emission probabilities
per 100 disintegrations
18,3
2⁺ ; 84,25477
1
81,6
0⁺ ; 0
Stable
0
170
Yb
70
100
Q⁻ = 968 keV
% β⁻ = 99,9

$^{177}_{71}\mathrm{Lu}_{106}$

1 Decay Scheme

The Lu-177 ground state (JPI=7/2+) disintegrates by beta- emission (PB-=100%) to the ground state (JPI=7/2-) and to three excited levels (JPI=9/2-,11/2- and 9/2+) of Hf-177.
Le lutécium 177 se désintègre par émission bêta moins vers le niveau fondamental d' hafnium 177 via trois niveaux excités.

2 Nuclear Data

$T_{1/2}(^{177}\mathrm{Lu}\ )$: 6,647 (4) d
$Q^{-}(^{177}\mathrm{Lu}\ )$: 498,3 (8) keV

2.1 β^- Transitions

	Energy keV	Probability × 100	Nature	lg ft
$\beta^-_{0,3}$	177,0 (8)	11,64 (10)	Allowed	6,1
$\beta^-_{0,2}$	248,6 (8)	0,012 (8)	1st forbidden Unique	9,2
$\beta^-_{0,1}$	385,4 (8)	9,1 (5)	1st Forbidden	7,3
$\beta^-_{0,0}$	498,3 (8)	79,3 (5)	1st Forbidden	6,7

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{3,2}$(Hf)	71,6418 (6)	0,327 (6)	E1+M2	0,715 (14)	0,138 (6)	0,0317 (14)	0,894 (22)
$\gamma_{1,0}$(Hf)	112,9498 (4)	20,29 (7)	M1+95,1%E2	0,817 (12)	1,104 (6)	0,2755 (14)	2,272 (5)
$\gamma_{2,1}$(Hf)	136,7245 (5)	0,1014 (7)	M1+90%E2	0,559 (21)	0,456 (7)	0,1129 (21)	1,158 (18)
$\gamma_{3,1}$(Hf)	208,3662 (4)	11,09 (7)	E1+0,54%M2	0,055 (4)	0,0094 (10)	0,00216 (24)	0,068 (5)
$\gamma_{2,0}$(Hf)	249,6742 (6)	0,2296 (21)	E2	0,091	0,038	0,009	0,141
$\gamma_{3,0}$(Hf)	321,3159 (6)	0,233 (8)	E1+M2	0,06 (5)	0,012 (10)	0,0028 (22)	0,08 (6)

3 Atomic Data

3.1 Hf

ω_K : 0,951 (4)
$\bar{\omega}_L$: 0,26 (1)
n_{KL} : 0,829 (4)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	54,612		57,2
	$K\alpha_1$	55,7909		100
	$K\beta_3$	62,985	}	
	$K\beta_1$	63,234	}	
	$K\beta_5''$	63,662	}	33
	$K\beta_2$	64,942	}	
	$K\beta_4$	65,132	}	8,8
	$KO_{2,3}$	65,316	}	
X_L				
	$L\ell$	6,96		
	$L\alpha$	7,844 – 7,899		
	$L\eta$	8,139		
	$L\beta$	8,905 – 9,342		
	$L\gamma$	10,516 – 10,89		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	42,601 – 46,007	100
KLX	51,391 – 55,784	53,4
KXY	60,15 – 65,34	7,08
Auger L	4,3 – 11,2	

4 Electron Emissions

		Energy keV	Electrons per 100 disint.
e_{AL}	(Hf)	4,3 - 11,2	8,75 (20)
e_{AK}	(Hf)		0,283 (90)
	KLL	42,601 - 46,007	}
	KLX	51,391 - 55,784	}
	KXY	60,15 - 65,34	}
$ec_{3,2\ K}$	(Hf)	6,2910 (9)	0,123 (5)
$ec_{1,0\ K}$	(Hf)	47,5990 (8)	5,07 (18)
$ec_{1,0\ L}$	(Hf)	101,678 - 101,679	6,84 (23)
$ec_{1,0\ M}$	(Hf)	110,348 - 110,349	1,71 (6)
$ec_{3,1\ K}$	(Hf)	143,0154 (8)	0,57 (5)
$ec_{3,1\ L}$	(Hf)	197,094 - 197,096	0,098 (11)
$\beta^-_{0,3}$	max:	177,0 (8)	11,64 (10)
$\beta^-_{0,3}$	avg:	47,66 (23)	
$\beta^-_{0,2}$	max:	248,6 (8)	0,012 (8)
$\beta^-_{0,2}$	avg:	78,6 (3)	
$\beta^-_{0,1}$	max:	385,4 (8)	9,1 (5)
$\beta^-_{0,1}$	avg:	111,7 (3)	
$\beta^-_{0,0}$	max:	498,3 (8)	79,3 (5)
$\beta^-_{0,0}$	avg:	149,4 (3)	

5 Photon Emissions

5.1 X-Ray Emissions

		Energy keV	Photons per 100 disint.	
XL	(Hf)	6,96 — 10,89	3,18 (6)	
$XK\alpha_2$	(Hf)	54,612	1,59 (3)	} Kα
$XK\alpha_1$	(Hf)	55,7909	2,78 (6)	}
$XK\beta_3$	(Hf)	62,985 }		
$XK\beta_1$	(Hf)	63,234 }	0,917 (23)	$K'\beta_1$
$XK\beta''_5$	(Hf)	63,662 }		
$XK\beta_2$	(Hf)	64,942 }		
$XK\beta_4$	(Hf)	65,132 }	0,245 (8)	$K'\beta_2$
$XKO_{2,3}$	(Hf)	65,316 }		

5.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{3,2}$(Hf)	71,6418 (6)	0,1726 (23)
$\gamma_{1,0}$(Hf)	112,9498 (4)	6,20 (7)
$\gamma_{2,1}$(Hf)	136,7245 (5)	0,0470 (7)
$\gamma_{3,1}$(Hf)	208,3662 (4)	10,38 (7)
$\gamma_{2,0}$(Hf)	249,6742 (6)	0,2012 (21)
$\gamma_{3,0}$(Hf)	321,3159 (6)	0,216 (8)

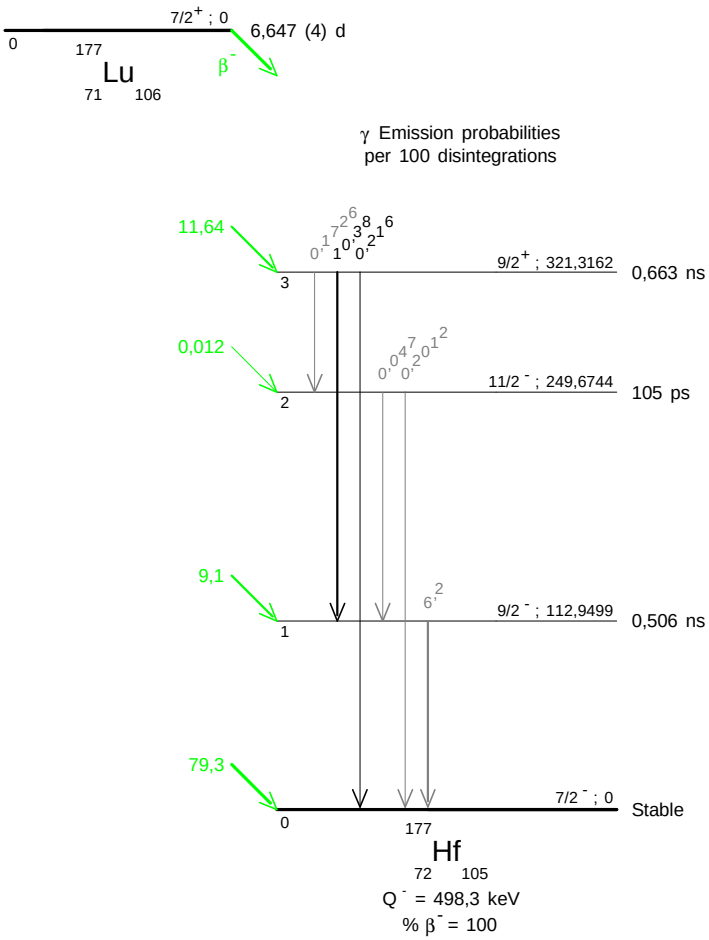
6 Main Production Modes

$Lu - 176(n,\gamma)Lu - 177$ $\quad$ σ : 1778 (75) barns

7 References

- D. G. Douglas. Phys. Rev. 75 (1949) 1960
  (Beta minus emission probability)
- P. Marmier, F. Boehm. Phys. Rev. 97 (1955) 103
  (Beta minus emission probability,Gamma ray energies,Gamma-ray emission probabilities)
- T. Wiedling. Thesis, Univ. of Stockholm (1956)
  (Beta minus emission probability)
- R. H. BETTS, O. F. Dahlinger, D. M. Munro. Can. J. Phys. 36 (1958) 73
  (Half-life)
- L. C. Schmid, W. P. Stinson. Nucl. Sci. Eng. 7 (1960) 477
  (Half-life)
- H. I. WEST Jr, L .G. Mann, R. J. Nagle. Phys. Rev. 124 (1961) 527
  (Gamma ray energies,Gamma-ray emission probabilities,Mixing ratio,K ICC,L ICC)
- M. S. EL-NESR, E. BASHANDY. Nucl. Phys. 31 (1962) 128
  (Beta minus emission probability)
- P. Alexander, F. BOEHM, E. Kankeleit. Phys. Rev. 133 (1964) B284
  (Beta minus emission probability,Gamma ray energies,Gamma-ray emission probabilities)
- D. F. Crouch, L. D. McIsaac. Report IDO-16932 (1964) 26
  (Gamma-ray emission probabilities)
- B. P. MAIER. Z. Physik 184 (1965) 153
  (Gamma ray energies)
- A. J. HAVERFIELD, F. M. Bernthal, J. M. Hollander. Nucl. Phys. A94 (1967) 337
  (Beta minus emission probability,Gamma ray energies,Gamma-ray emission probabilities)
- B. Hrastnik, I. Basar, M. Diksic, K. Ilakovac, V. Kos, A. Ljubcic. Z. Physik 239 (1970) 25
  (Mixing ratio)
- J. F. Emery, S. A. REYNOLDS, E. I. Watt, G. I. Gleason. Nucl. Sci. Eng. 48 (1972) 319
  (Half-life)
- S. Hogberg, R. Jadrny, S.-E. Karlsson, G. Malmsten, O. Nilsson. Z. Physik 254 (1972) 89
  (Mixing ratio)
- L. HOLMBERG, V. Stefansson, J. Becker, C. Bargholtz, L. Gidefeldt. Phys. Scr. 6 (1972) 177
  (Mixing ratio)
- V. N. Grigoriev, D. M. Kaminker, Y. V. Sergeenkov. Bull. Acad. Sci. URSS 36 (1973) 762
  (K ICC,L ICC)
- B. D. Jeltema, F. M. Bernthal. Phys. Rev. C10 (1974) 778
  (K ICC,L ICC)

- K. S.Krane, C. E. Olsen, W. A. Steyert. Phys. Rev. C10 (1974) 825
(Mixing ratio)
- A. P. Agnihotry, K. P. Gopinathan, H. C. Jain. Phys. Rev. C9 (1974) 336
(Gamma-ray emission probabilities,Mixing ratio,K ICC,L ICC)
- H. E. Keus, W. J. Huiskamp. Physica 85B (1977) 137
(Mixing ratio)
- F. Rösel, H. M. Fries, K. Alder, H. C. Pauli. At. Data Nucl. Data Tables 21 (1978) 92
(Theoretical ICC)
- V. Hnatowicz. Czech. J. Phys. B31 (1981) 260
(Gamma ray energies,Gamma-ray emission probabilities)
- F. LAGOUTINE, J. Legrand. Int. J. Appl. Radiat. Isotop. 33 (1982) 711
(Half-life)
- D. Mehta, B. Chand, S. Singh, M. L. Garg, N. Singh, T. S. Cheema, T. N. Trehan. Nucl. Instrum. Methods Phys. Res. A260 (1987) 157
(Gamma-ray emission probabilities)
- S. Matsui, H. Inoue, Y. Yoshizawa. Nucl. Instrum. Methods Phys. Res. A281 (1989) 568
(Gamma-ray energy)
- A. Abzouzi, M. S. Antony, A. Hachem, V. B. Ndocko Ndongue. J. Radioanal. Nucl. Chem. 144 (1990) 359
(Half-life)
- C. C. Dey, B. K. Sinha, R. Bhattacharya. Nuovo Cim. 105A (1992) 1307
(Mixing ratio)
- E. Browne. Nucl. Data Sheets 68 (1993) 747
(Nuclear Data)
- G. Audi, A. Wapstra. Nucl. Phys. A595 (1995) 409
(Q)
- E. Schönfeld, H. Janssen. Nucl. Instrum. Methods Phys. Res. A369 (1996) 527
(Atomic Data)
- E. Schönfeld, G. Rodloff. Report PTB-6.11-98-1 (1998)
(X-ray energies)
- B. E. Zimmerman, M. P. Unterweger, J. W. Brodack. Appl. Rad. Isotopes 54 (2001) 623
(Half-life)
- E. Schönfeld, U. Schötzig. Appl. Rad. Isotopes 54 (2001) 785
(X-ray emission probabilities)
- U. Schötzig, H. Schrader, E. Schönfeld, E. Gunther, R. Klein. Appl. Rad. Isotopes 55 (2001) 89
(Beta minus emission probability, Half-life, Gamma-ray emission probabilities)


7/2+ ; 0
6,647 (4) d
0
177
Lu
71
106
β-
γ Emission probabilities
per 100 disintegrations
11,64
9/2+ ; 321,3162
0,663 ns
3
0,012
11/2- ; 249,6744
105 ps
2
9,1
9/2- ; 112,9499
0,506 ns
1
79,3
7/2- ; 0
Stable
0
177
Hf
72
105
Q- = 498,3 keV
% β- = 100

$^{186}_{75}\mathrm{Re}_{111}$

1 Decay Scheme

Re-186 decays by beta minus emissions mainly to the fundamental and the 137 keV excited levels of Os-186 and by electron capture to the W-186.
Le rhénium 186 se désintègre par émission bêta moins principalement vers le niveau fondamental et le niveau excité de 137 keV de l'osmium 186 ; et par capture électronique vers le niveau fondamental et vers le niveau excité de 122 keV du tungstène 186.

2 Nuclear Data

$T_{1/2}(^{186}\mathrm{Re})$	:	3,7186	(17)	d
$Q^-(^{186}\mathrm{Re})$	:	1069,5	(9)	keV
$Q^+(^{186}\mathrm{Re})$	:	581,6	(17)	keV

2.1 Electron Capture Transitions

	Energy keV	Probability × 100	Nature	lg ft	P_K	P_L	P_M
$\epsilon_{0,1}$	459,3 (17)	1,69 (3)	1st Forbidden	7,8	0,7836 (19)	0,1638 (13)	0,0404 (8)
$\epsilon_{0,0}$	581,6 (17)	5,84 (12)	1st Forbidden	7,5	0,7943 (18)	0,1560 (12)	0,0382 (7)

2.2 β^- Transitions

	Energy keV	Probability × 100	Nature	lg ft
$\beta^-_{0,4}$	159,0 (9)	0,000027 (9)	unique 1st forbidden	10,9
$\beta^-_{0,3}$	302,0 (9)	0,0627 (9)	1st Forbidden	8,9
$\beta^-_{0,1}$	932,3 (9)	21,5 (3)	1st Forbidden	8
$\beta^-_{0,0}$	1069,5 (9)	70,9 (3)	1st Forbidden	7,7

2.3 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{1,0}$(W)	122,33 (10)	1,694 (29)	E2	0,585 (12)	0,927 (19)	0,234 (7)	1,81 (4)
$\gamma_{1,0}$(Os)	137,157 (8)	21,57 (39)	E2	0,433 (13)	0,645 (19)	0,1648 (49)	1,290 (39)
$\gamma_{4,3}$(Os)	143,000 (42)	0,0000021 (7)	M1+E2	1,39 (8)	0,35 (2)	0,0842 (25)	1,85 (11)
$\gamma_{2,1}$(Os)	296,933 (31)	0,000058 (16)	E2	0,0609 (12)	0,0260 (6)	0,00645 (19)	0,095 (2)
$\gamma_{3,2}$(Os)	333,390 (42)	0,000066 (16)	[E2]	0,0454 (14)	0,0170 (5)	0,00418 (13)	0,0678 (20)
$\gamma_{4,2}$(Os)	476,390 (42)	0,0000015 (5)	E2+M1	0,0193 (6)	0,00512 (15)	0,001235 (37)	0,0259 (8)
$\gamma_{3,1}$(Os)	630,323 (31)	0,0297 (6)	M1+E2	0,0105 (6)	0,0023 (2)	0,000538 (16)	0,0134 (1)
$\gamma_{3,0}$(Os)	767,48 (3)	0,0330 (6)	E2	0,00690 (21)	0,001342 (40)	0,000315 (9)	0,00865 (26)
$\gamma_{4,1}$(Os)	773,323 (31)	0,000023 (7)	E2+M1	0,0189 (6)	0,00291 (9)		0,0266 (7)

3 Atomic Data

3.1 W

ω_K : 0,954 (4)
$\bar{\omega}_L$: 0,283 (11)
n_{KL} : 0,825 (4)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	57,9823		57,57
	$K\alpha_1$	59,3189		100
	$K\beta_3$	66,952	}	
	$K\beta_1$	67,2451	}	
	$K\beta''_5$	67,664	}	33,15
	$K\beta_2$	69,033	}	
	$K\beta_4$	69,295	}	9,08
	$KO_{2,3}$	69,484	}	
X_L				
	$L\ell$	7,38		
	$L\gamma$	– 12,07		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	45,109 – 48,882	100
KLX	54,514 – 59,312	53,7
KXY	63,89 – 69,51	7,18
Auger L	4,5 – 12,1	27,6

3.2 Os

ω_K : 0,957 (4)
$\bar{\omega}_L$: 0,308 (12)
n_{KL} : 0,821 (4)

3.2.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	61,4873		58,03
	$K\alpha_1$	63,0011		100
	$K\beta_3$	71,078	}	
	$K\beta_1$	71,414	}	
	$K\beta_5''$	71,855	}	33,46
	$K\beta_2$	73,319	}	
	$K\beta_4$	73,615	}	9,37
	$KO_{2,3}$	73,819	}	
X_L				
	$L\ell$	7,82		
	$L\gamma$	– 12,92		

3.2.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	47,710 – 51,892	100
KLX	57,759 – 62,955	54,2
KXY	67,77 – 73,78	7,34
Auger L	4,7 – 12,9	60

4 Electron Emissions

		Energy keV	Electrons per 100 disint.
e_{AL}	(W)	4,5 - 12,1	4,11 (4)
e_{AK}	(W)		0,291 (26)
	KLL	45,109 - 48,882 }	
	KLX	54,514 - 59,312 }	
	KXY	63,89 - 69,51 }	
e_{AL}	(Os)	4,7 - 12,9	6,43 (8)
e_{AK}	(Os)		0,175 (18)
	KLL	47,710 - 51,892 }	
	KLX	57,759 - 62,955 }	
	KXY	67,77 - 73,78 }	
$ec_{1,0\ K}$	(W)	52,8 (1)	0,353 (8)
$ec_{1,0\ T}$	(Os)	63,29 - 137,11	12,15 (38)
$ec_{1,0\ K}$	(Os)	63,29 (1)	4,08 (13)
$ec_{1,0\ L}$	(W)	110,23 - 112,12	0,559 (13)
$ec_{1,0\ M}$	(W)	119,51 - 120,52	0,1411 (44)
$ec_{1,0\ L}$	(Os)	124,19 - 126,29	6,08 (18)
$ec_{1,0\ M}$	(Os)	134,11 - 135,20	1,552 (47)
$ec_{1,0\ N}$	(Os)	136,5 - 137,1	0,381 (12)
$\beta^-_{0,4}$	max:	159,0 (9)	0,000027 (9)
$\beta^-_{0,4}$	avg:	42,6 (7)	
$\beta^-_{0,3}$	max:	302,0 (9)	0,0627 (9)
$\beta^-_{0,3}$	avg:	84,7 (7)	
$\beta^-_{0,1}$	max:	932,3 (9)	21,5 (3)
$\beta^-_{0,1}$	avg:	306,7 (7)	
$\beta^-_{0,0}$	max:	1069,5 (9)	70,9 (3)
$\beta^-_{0,0}$	avg:	359,6 (7)	

5 Photon Emissions

5.1 X-Ray Emissions

		Energy keV		Photons per 100 disint.	
XL	(W)	7,38 — 12,07		1,66 (4)	
XKα_2	(W)	57,9823		1,736 (30)	} Kα
XKα_1	(W)	59,3189		3,02 (5)	}
XKβ_3	(W)	66,952	}		
XKβ_1	(W)	67,2451	}	1,000 (23)	K$'\beta_1$
XKβ''_5	(W)	67,664	}		
XKβ_2	(W)	69,033	}		
XKβ_4	(W)	69,295	}	0,274 (8)	K$'\beta_2$
XKO$_{2,3}$	(W)	69,484	}		
XL	(Os)	7,82 — 12,92		2,99 (7)	
XKα_2	(Os)	61,4873		1,13 (4)	} Kα
XKα_1	(Os)	63,0011		1,94 (6)	}
XKβ_3	(Os)	71,078	}		
XKβ_1	(Os)	71,414	}	0,650 (23)	K$'\beta_1$
XKβ''_5	(Os)	71,855	}		
XKβ_2	(Os)	73,319	}		
XKβ_4	(Os)	73,615	}	0,182 (8)	K$'\beta_2$
XKO$_{2,3}$	(Os)	73,819	}		

5.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{1,0}$(W)	122,33 (10)	0,603 (6)
$\gamma_{1,0}$(Os)	137,157 (8)	9,42 (6)
$\gamma_{4,3}$(Os)	143,00 (4)	0,00000074 (25)
$\gamma_{2,1}$(Os)	296,93 (3)	0,000053 (15)
$\gamma_{3,2}$(Os)	333,39 (4)	0,000062 (15)
$\gamma_{4,2}$(Os)	476,39 (4)	0,0000015 (5)
$\gamma_{3,1}$(Os)	630,32 (3)	0,0293 (6)
$\gamma_{3,0}$(Os)	767,478 (30)	0,0327 (6)
$\gamma_{4,1}$(Os)	773,32 (3)	0,000022 (7)

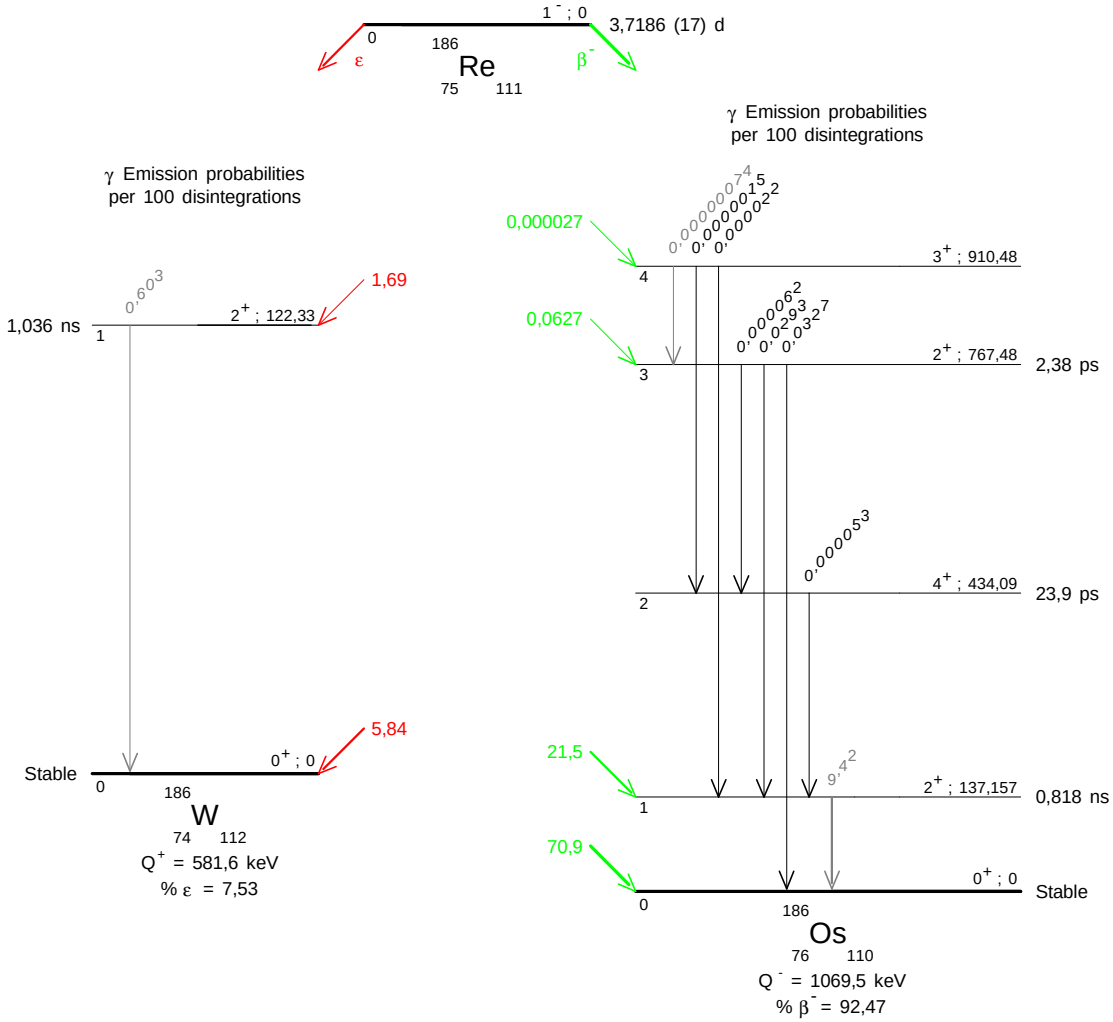
6 Main Production Modes

$\begin{cases} \mathrm{Re-185(n,\gamma)Re-186} \qquad \sigma : 112\ (3)\ \text{barns} \\ \text{Possible impurities :}\ \ \mathrm{Re-186m,\ Re-188,\ Re-188m} \end{cases}$

7 References

- K.Sinma, H.Yamasaki. Phys. Rev. 55 (1939) 320
  (Half-life)
- K.Fajans, W.H.Sullivan. Phys. Rev. 58 (1940) 276
  (Half-life)
- J.M.Cork, R.G.Shreffer, C.M.Fowler. Phys. Rev. 74 (1940) 1657
  (Half-life)
- H.Yamasaki, K.Sinma. Sci. Pap. Inst. Phys. Chem. Res. 37 (1940) 10
  (Half-life)
- P.J.Grant, R.Richmond. Proc. Phys. Soc. 62A (1945) 573
  (Half-life)
- L.J.Goodman, M.L.Pool. Phys. Rev. 71 (1947) 288
  (Half-life)
- A.T.Dybvig, M.L.Pool. Phys. Rev. 80 (1950) 126
  (Half-life)
- T.C.Chu. Phys. Rev. 79 (1950) 582
  (Half-life)
- D.Guss, L.Killion, F.T.Porter. Phys. Rev. 95 (1954) 627
  (Gamma ray energies, lg ft)
- F.T.Porter, M.S.Freedman, T.B.Novey, F.Wagner Jr. Phys. Rev. 103 (1956) 921
  (Gamma ray energies,Beta emission probabilities)
- T.B.Novey, M.S.Freedman, F.T.Porter, F.Wagner Jr. Phys. Rev. 103 (1956) 942
  (Beta emission probabilities, Gamma ray energies,angular correlation)
- M.W.Johns, C.C.MacMullen, I.R.Williams, S.V.Nablo. Can. J. Phys. 34 (1956) 69
  (Beta emission probabilities)
- E.L.Chupp, A.F.Clark, J.W.M.Dumond, F.J.Gordon, H.Mark. Phys. Rev. 107 (1957) 745
  (Gamma ray energies)
- G.Gueben, J.Govaerts. Monographie Nr.2, Inst. Inter univ. Sciences Nucleaires (1958)
  (Half-life)
- G.T.Emery, W.R.Kane, M.MacKeown, M.L.Perlman, G.Scharff-Goldhaber. Phys. Rev. 129 (1963) 2597
  (Gamma ray energies, Gamma-ray emission probabilities)
- I.Marklund, B.Lindström. Nucl. Phys. 40 (1963) 329
  (Gamma ray energies)
- L.Maly, Z.Plajner, J.Jursik, M.Finger. Czech. J. Phys. B14 (1964) 240
  (Gamma-ray emission probabilities, Gamma ray energies, Beta emission energies, Beta emission probabilities, Conv. Elec. emission probabilities)
- B.Harmatz, T.H.Handley. Nucl. Phys. 56 (1964) 1
  (Gamma ray energies)
- J.D.Kurfess, R.P.Scharenberg. Phys. Rev. 161 (1967) 1185
  (Half-life, of the 122 keV level)
- J.O.Newton, F.S.Stephens, R.M.Diamond, K.Kotajima, E.Matthias. Nucl. Phys. A95 (1967) 357
  (Gamma ray energies)
- J.A.Bearden. Rev. Mod. Phys. 39 (1967) 78
  (Gamma ray energies)
- K.V.R.Rao, P.Jagam, A.R., D.L.Sastry. Nuclear Physics and Solid StatePhysics Symposium (1969)
  (anagular correlation, decay scheme)
- S.Andre, P.Liaud. Comp. Rend. Acad. Sci. (Paris) 268 (1969) 270
  (Beta emission energies)
- S.Andre, P.Liaud. J. Phys. 31 (1970) 155
  (Beta emission energies)

- M.Trudel, E.E.Habib, H.Ogata. Phys. Rev. C1 (1970) 643
  (Beta emission energies)
- R.Michel, U.Herpers. Radiochim. Acta 16 (1971) 115
  (Half-life)
- K.V.Ramana Rao, V.Lakshminarayana. Current Science-Bangalore, India 40 (1971) 1
  (K X-ray emission probabilities, K X-ray energies, angular correlation)
- D.W.Seegmiller, M.Lindner, R.A.Meyer. Nucl. Phys. A185 (1972) 94
  (Gamma-ray emission probabilities, Conv. Elec. emission probabilities)
- B.Fogelberg. Nucl. Phys. A197 (1972) 497
  (Gamma ray energies, Gamma-ray emission probabilities)
- B.N.Subba Rao. Proceedings of the Nuclear Physics and Solid State Symposium, Bombay (1972) 1344
  (Conv. Elec. emission probabilities)
- H.Karwowski, S.Majewski, B.Pietrzyk, L.Wencel, J.Jastrzebski. J. Phys. 36 (1975) 471
  (Half-life, of the 122 keV level)
- D.Bogdan, Tr.Cretu, H.Fuia, G.Macarie, D.G.Popescu. Bul. Inst. Politehnic Gheorghe Gheorghiu-Dej Bucuresti Seria Electrtehnika (1977) 18
  (Betta decay)
- F.Rösel, H.M.Fries, K.Alder, H.C.Pauli. At. Data. Nucl. Data Tables 21 (1978) 92
  (Conv. Elec. emission probabilities)
- D.Oertel, W.D.Brewer. Phys. Rev. C23 (1981) 2751
  (Betta branches)
- R.B.Firestone. Nucl. Data Sheets 55 (1988) 583
  (levels)
- A.Abzouzi, MS.Antony, V.B.NdockoNdongue. J. Radioanal. Nucl. Chem. 137 (1989) 381
  (Half-life)
- J.Goswami, B.Chand, D.Mehta, N.Singh, P.N.Trehan. Appl. Rad. Isotopes 42 (1991) 1033
  (Gamma-ray emission probabilities)
- B.M.Coursey, J.Cessna, E.Garcia-Torano, D.B.Golas, A.GrauMalonda, D.H.Gray, D.D.Hoppes, J.M.LosArcos, M.T.Martin-Casallo, F.J.Schima, M.P.Unterweger. Appl. Rad. Isotopes 42 (1991) 865
  (Half-life)
- M.P.Unterweger, D.D.Hoppes, F.J.Schima. Nucl. Instrum. Methods Phys. Res. A312 (1992) 349
  (Half-life)
- E.Schönfeld, H.Janssen, U.Schötzig, E.Günther, H.Schrader. Nucl. Instrum. Methods Phys. Res. A339 (1994) 174
  (Gamma-ray emission probabilities, Half-life, Conv. Elec. emission probabilities)
- G.Audi, A.H.Wapstra. Nucl. Phys. A595 (1995) 409
  (Q)
- E.Schönfeld, H.Janssen. Nucl. Instrum. Methods Phys. Res. A369 (1996) 527
  (K fluorescence yield, K X-ray emission probabilities, L vacancies)
- C.M.Baglin. Nucl. Data Sheets 82 (1997) 1
  (Spin and Parity, Half-life, excited levels)
- E.Schönfeld. Appl. Rad. Isotopes 49 (1998) 1353
  (X-ray emission probabilities)
- H.Miyahara, G. Wurdiyanto, H. Nagata, A. Yoshida, K. Yanagida, C. Mori. Appl. Rad. Isotopes 52 (2000) 573
  (Gamma-ray emission probabilities)
- D.H.Woods, M. Ciocanel, L. J. Husband, J. D. Keightley, P. de Lavison, S. Lineham, M. J. Woods, S. A. Woods. Appl. Rad. Isotopes 52 (2000) 581
  (Gamma-ray emission probabilities)
- H.Schrader. Appl. Rad. Isotopes 60, 2-3 (2004) 317
  (Half-life)


1 - ; 0
3,7186 (17) d
0
186
Re
75 111
ε
β -
γ Emission probabilities
per 100 disintegrations
γ Emission probabilities
per 100 disintegrations
0,000027
0,0627
1,69
5,84
21,5
70,9
1,036 ns
Stable
3+ ; 910,48
2+ ; 767,48
2,38 ps
4+ ; 434,09
23,9 ps
2+ ; 137,157
0,818 ns
2+ ; 122,33
0+ ; 0
0+ ; 0
Stable
W
74 112
Q+ = 581,6 keV
% ε = 7,53
Os
76 110
Q - = 1069,5 keV
% β- = 92,47

$^{198}_{79}\mathrm{Au}_{119}$

1 Decay Scheme

The Au-198 disintegrates following three beta minus transitions, the main one is to the 411 keV level of Hg-198.
L'or 198 se désintègre selon trois transitions bêta moins, la principale vers le niveau de 411 keV du mercure 198, les deux autres de plus faible intensité vers le niveau de 1087 keV et le niveau fondamental.

2 Nuclear Data

$T_{1/2}(^{198}\mathrm{Au}) : 2{,}6944 \quad (8) \quad \mathrm{d}$
$Q^-(^{198}\mathrm{Au}) : 1372{,}2 \quad (10) \quad \mathrm{keV}$

2.1 β^- Transitions

	Energy keV	Probability × 100	Nature	lg ft
$\beta^-_{0,2}$	284,5 (10)	0,989 (8)	1st Forbidden	7,6
$\beta^-_{0,1}$	960,4 (10)	98,986 (10)	1st Forbidden	7,36
$\beta^-_{0,0}$	1372,2 (10)	0,025 (5)	Unique 1st Forbidden	12,27

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{1,0}$(Hg)	411,80250 (17)	99,81 (9)	E2	0,0301 (2)	0,01091 (25)	0,0027 (2)	0,0447 (5)
$\gamma_{2,1}$(Hg)	675,8849 (7)	0,827 (7)	M1+56(5)%E2	0,0211 (15)	0,00380 (26)	0,00090 (7)	0,0261 (18)
$\gamma_{2,0}$(Hg)	1087,6874 (7)	0,1598 (30)	E2	0,00419 (13)	0,000761 (23)	0,000179 (5)	0,00519 (16)

3 Atomic Data

3.1 Hg

ω_K : 0,962 (4)
$\bar{\omega}_L$: 0,355 (14)
n_{KL} : 0,813 (4)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	68,895		59
	$K\alpha_1$	70,819		100
	$K\beta_3$	79,822	}	
	$K\beta_1$	80,253	}	
	$K\beta_5''$	80,75	}	33,9
	$K\beta_2$	82,435	}	
	$K\beta_4$	82,776	}	9,94
	$KO_{2,3}$	83,028	}	
X_L				
	$L\ell$	8,721		
	$L\alpha$	9,898 – 9,989		
	$L\eta$	10,651		
	$L\beta$	11,358 – 12,56		
	$L\gamma$	13,41 – 14,474		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	53,17 – 58,28	100
KLX	64,59 – 70,81	55,2
KXY	75,92 – 83,08	7,62
Auger L	5,1 – 14,8	32

4 Electron Emissions

		Energy keV	Electrons per 100 disint.
e_{AL}	(Hg)	5,1 - 14,8	2,170 (24)
e_{AK}	(Hg)		0,110 (12)
	KLL	53,17 - 58,28	}
	KLX	64,59 - 70,81	}
	KXY	75,92 - 83,08	}
$ec_{1,0\ K}$	(Hg)	328,7002 (5)	2,876 (19)
$ec_{1,0\ L}$	(Hg)	396,963 - 399,519	1,042 (24)
$ec_{1,0\ M}$	(Hg)	408,241 - 409,508	0,258 (19)
$\beta^-_{0,2}$	max:	284,5 (10)	0,989 (8)
$\beta^-_{0,2}$	avg:	79,4 (3)	
$\beta^-_{0,1}$	max:	960,4 (10)	98,986 (10)
$\beta^-_{0,1}$	avg:	314,5 (3)	
$\beta^-_{0,0}$	max:	1372,2 (10)	0,025 (5)
$\beta^-_{0,0}$	avg:	466 (1)	

5 Photon Emissions

5.1 X-Ray Emissions

		Energy keV	Photons per 100 disint.	
XL	(Hg)	8,721 — 14,474	1,21 (2)	
$XK\alpha_2$	(Hg)	68,895	0,809 (8)	} Kα
$XK\alpha_1$	(Hg)	70,819	1,372 (12)	}
$XK\beta_3$	(Hg)	79,822	}	
$XK\beta_1$	(Hg)	80,253	} 0,466 (8)	K$'\beta_1$
$XK\beta''_5$	(Hg)	80,75	}	
$XK\beta_2$	(Hg)	82,435	}	
$XK\beta_4$	(Hg)	82,776	} 0,136 (4)	K$'\beta_2$
$XKO_{2,3}$	(Hg)	83,028	}	

5.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{1,0}$(Hg)	411,80205 (17)	95,54 (7)
$\gamma_{2,1}$(Hg)	675,8836 (7)	0,806 (7)
$\gamma_{2,0}$(Hg)	1087,6842 (7)	0,159 (3)

6 Main Production Modes

$\left\{ \begin{array}{l} \mathrm{Au-197(n,\gamma)Au-198} \qquad \sigma : 98{,}8\ (3)\ \mathrm{barns} \\ \mathrm{Possible\ impurities:\ Au-199} \end{array} \right.$

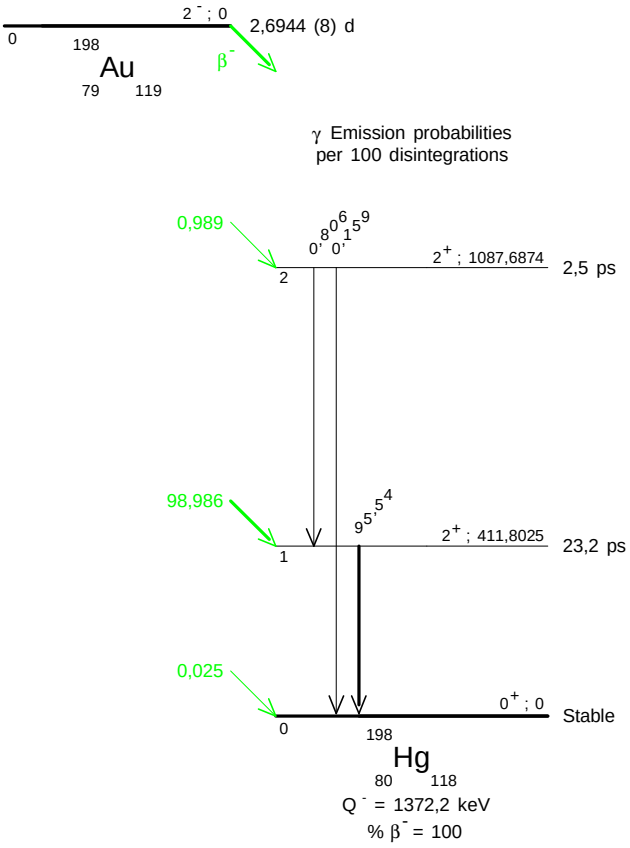
7 References

- E.McMillan, M.Kamen, S.Ruben. Phys. Rev. 52 (1937) 531
  (Half-life)
- C.Diemer, H.Groendijk. Physica 11 (1946) 396
  (Half-life)
- L.M.Silver. Phys. Rev. 76 (1949) 589
  (Half-life)
- D.Saxon, R.Heller. Phys. Rev. 75 (1949) 909
  (Half-life)
- L.M.Silver. Can. J. Phys. 29 (1950) 59
  (Half-life)
- M.Hubert. Comp. Rend. Acad. Sci. (Paris) 232 (1951) 2201
  (Gamma-ray emission probabilities)
- A.Brosi, B.Ketelle, H.Zeldes, E.Fairstein. Phys. Rev. 84 (1951) 586
  (Gamma-ray emission probabilities)
- W.K.Sinclair, A.F.Holloway. Nature 167 (1951) 365
  (Half-life)
- P.E.Cavanagh, J.F.Turner, D.V.Booker, H.J.Dunster. Proc. Phys. Soc. London 64A (1951) 13
  (Half-life, Gamma-ray emission probabilities)
- D.Schiff, F.R.Metzger. Phys. Rev. 90 (1953) 849
  (Multipolarities 676 keV)
- E.E.Lockett, R.H.Thomas. Nucleonics 11 (1953) 14
  (Half-life)
- C.D.Schrader, E.B.Nelson, J.A.Jacobs. Phys. Rev. 90 (1953) 159
  (Multipolarities 676 keV)
- R.E.Bell, L.Yaffe. Can. J. Phys. 32 (1954) 416
  (Half-life)
- L.G.Elliott, M.A.Preston, J.L.Wolfson. Can. J. Phys. 32 (1954) 153
  (Beta emission probabilities, Conv. Elec. emission probabilities)
- D.Maeder, R.Mueller, V.Wintersteiger. Helv. Phys. Acta 27 (1954) 3
  (Gamma-ray emission probabilities)
- J.Tobailem. J. Phys. Rad. 16 (1955) 48
  (Half-life)
- B.S.Dzhelepov, N.N.Zhukovski, V.P.Prikhodtseva, Iu.V.Kholnov. Bull. Acad. Sci. USSR 19 (1955) 247
  (Gamma-ray emission probabilities)

- C.Sastre, G.Price. Nucl. Sci. Eng. 1 (1956) 325
  (Half-life)
- K.-E.Johansson. Arkiv Fysik 10 (1956) 247
  (Half-life)
- F.T.Porter, M.S.Friedman, T.B.Novey, F.Wagner Jr.. Phys. Rev. 103 (1956) 921
  (Beta emission probabilities)
- J.Volpe, G.Hinmann. Phys. Rev. 104 (1956) 753
  (Multipolarities 676 keV)
- J.P.Keene, L.A.Mackenzie, C.W.Gilbert. Phys. Med. Biol. 2 (1958) 360
  (Half-life)
- V.M.Kelman, R.Ya.Metskhvarishvili. Soviet. Phys. JETP 36 (1959) 486
  (Conv. Coeff. Ratios K/L/M)
- J.Robert. J. Phys. Rad. 21 (1960) 808
  (Half-life)
- P.Depommier, M.Chabre. Comp. Rend. Acad. Sci. (Paris) 252 (1961) 1587
  (Beta emission probabilities)
- P.Depommier, M.Chabre. J. Phys. Rad. 22 (1961) 674
  (Beta emission probabilities)
- R.L.Graham. Privat. Comm. quoted by Depommier and Chabre (1961)
  (Beta emission probabilities)
- R.P.Sharma, S.H.Devare, B.Saraf. Phys. Rev. 125 (1962) 2071
  (Beta emission probability)
- J.H.Hamilton et al.. Nucl. Phys. 36 (1962) 567
  (Beta emission probability)
- T.J.Kurey Jr., P.R.Roy. Nucl. Phys. 44 (1963) 670
  (Conv. Coeff. Ratios K/LM)
- V.Starodubtsev et al.. Izv. Akad. Nauk. USSR, Ser. Fiz.- Mat. Nauk. 2 (1963) 44
  (Half-life)
- W.H.G.Lewin, B.vanNooyen, C.W.E.vanEijk, A.H.Wapstra. Nucl. Phys. 48 (1963) 159
  (Beta emission probabilities)
- J.Lehmann. J. Phys. 25 (1964) 326
  (Beta emission probabilities)
- C.J.Herrlander, R.L.Graham. Nucl. Phys. 58 (1964) 544
  (Conv. Coeff. Ratios K/L)
- M.Sakai, M.Nozawa, H.I.Kegami, T.Yamazaki. Nucl. Phys. 53 (1964) 529
  (Multipolarities)
- V.Starodubtsev et al.. Nucl. Sci. Abstr. 18 (1964) 9348
  (Half-life)
- H.Beekhuis, H.deWaard. Nucl. Phys. 74 (1965) 459-46
  (Beta emission probabilities)
- K.E.Bergkvist. Arkiv Physik 27 (1965) 351
  (Conv. Elec. emission probabilities)
- H.Paul. Nucl. Phys. 72 (1965) 326
  (Beta emission probabilities)
- W.J.Keeler, R.D.Connor. Nucl. Phys. 61 (1965) 513
  (Conv. Elec. emission probabilities, Beta emission probabilities)
- S.C.Anspach, L.M.Cavallo, S.B.Garfinkel, J.M.R.Hutchinson. NBS Misc.Publ. 260-9 (1965) NP-15663
  (Half-life)
- W.H.G.Lewin. thesis, Delft (1965)
  (Beta emission probabilities)
- D.Parsignault. Internal Conversion Processes, J. H. Hamilton, ed. Acad. Press, New York (1966) 173
  (Conv. Coeff. Ratios K/L and K/LMN)
- S.A.Reynolds, J.F.Emery, E.I.Wyatt. Nucl. Sci. Eng. 32 (1966) 46
  (Half-life)
- M.Uhl, H.Warhanek. Oesterr. Akad. Wiss. Sitzber. Math-Nat.Kl., Abt.II 175 (1966) 77
  (Multipolarities 676 keV)
- J.Koch, F.Münnich, U.Schötzig. Nucl. Phys. A103 (1967) 300
  (Multipolarities 676 keV)
- H.E.Bosch, E.Szichman. Bull. Am. Phys. Soc. 12 (1967) 598
  (Conv. Elec. emission probabilities)

- J.A.Bearden. Rev. Mod. Phys. 39 (1967) 78
  (X-ray energies)
- F.Lagoutine, Y.leGallic, J.Legrand. Int. J. Appl. Radiat. Isotop. 19 (1968) 475
  (Half-life)
- I.W.Goodier. Int. J. Appl. Radiat. Isotop. 19 (1968) 823
  (Half-life)
- S.A.Reynolds, J.F.Emery, E.I.Wyatt. Nucl. Sci. Eng. 32 (1968) 46
  (Half-life)
- M.Bogdanovich, M.Mladjenovich, R.Stepich. Nucl. Phys. A106 (1968) 209
  (Conv. Coeff. Ratios K/L)
- R.Beraud, I.Berkes, J.Daniere, R.Haroutunian, M.Levy, G.Marest, R.Rougny. Phys. Rev. 188 (1969) 1958
  (Multipolarities 676 keV)
- A.Vuorinen, E.Kaloinen. Ann. Acad. Sci. Fennicae Ser. Avi 310 (1969)
  (Half-life)
- M.J.Cabell, M.Wilkins. J.Inorg.Nucl.Chem. 32 (1970) 1409
  (Half-life)
- M.M.CostaPaiva, E.Martinho. Int. J. Appl. Radiat. Isotop. 21 (1970) 40
  (Half-life)
- A.Pakkanen. Nucl. Phys. A172 (1971) 193
  (Multipolarities 676 keV)
- K.Debertin. Atomkernenergie 17 (1971) 97
  (Half-life)
- O.Dragoun, B.Martin, D.Merkert, M.Vinduska. Nucl. Phys. A183 (1972) 390
  (Conv. Elec. emission probabilities)
- K.Venkata Ramana Rao, V.Lakshminarayana. Nuovo Cimento 8A (1972) 298
  (Multipolarities 676 keV)
- T.Nagarajan, M.Ravindranath, K.VenkataReddy. J. Phys. A (Gen.Phys.) 5 (1972) 1395
  (Conv. Elec. emission probabilities, Beta emission probabilities)
- M.S.El-Nesr, M.G.Mousa. Atomkernenergie 21 (1973) 207
  (Conv. Elec. emission energies)
- P.Nyikos, H.B.Bier, P.Huberit, H.R.Kobel, H.Leuenberger. Helv. Phys. Acta 46 (1973) 444
  (Half-life)
- M.Kawamura, T.Tomiyama. J. Phys. Soc. Japan 36 (1974) 27
  (Multipolarities 676 keV)
- C.N.Rao, B.M.Rao,P.M.Rao,K.V.Reddy. Phys. Rev. 11C (1975) 1735
  (Conv. Elec. emission probabilities)
- J.L.Campbell, LA.McNelles. Nucl. Instrum. Methods 125 (1975) 205
  (X/γ- ratio)
- T.S.Reddy. thesis Andhra Univ., Waltair,India (1976)
  (Conv. Elec. emission probabilities)
- J.S.Merritt, F.H.Gibson. Report AECL-5802 (1977) p.43
  (Half-life)
- F.Rösel, H.M.Fries, K.Alder, H.C.Pauli. At. Data. Nucl. Data Tables 21 (1978)
  (Conv. Elec. emission probabilities)
- Y.Iwata, Y.Yoshizawa. Nucl. Instrum. Methods 175 (1980) 525
  (Gamma-ray emission probabilities)
- R.G.Deslattes, E.G.Kessler, W.C.Sauder, A.Henins. Ann. Phys. 129 (1980) 378
  (Gamma ray energies)
- A.R.Rutledge, L.V.Smith, J.S.Merritt. report AECL-6692 (1980)
  (Half-life)
- D.D.Hoppes, J.M.R.Hutchinson, F.J.Schima, M.P.Unterweger. Report NBS-SP 626 (1982) 85
  (Half-life)
- H.Hansen. European Applied Research Reports 6 (1985) 777
  (Conv. Elec. emission probabilities)
- R.B.Begzhanov, D.A.Gladyshev, L.D.Magrupov, Sch.A.Mirachmedov, M.Narsikulov, P.A.Abdulachatov, S.Ch.Salimov. 37th All-Union conference on Nuclear Spectroscopy and Nuclear Structure,Yirmala,USSR (1987) p.260
  (L X-rays)

- B.Chand, J.Goswamy, D.Mehta, N.Singh, P.N.Trehan. Nucl. Instrum. Methods A284 (1989) 393
(Gamma-ray emission probabilities, X-ray emission probabilities)
- A.Abzouzi, M.S.Antony, A.Hachem, V.B.NdockoNdongue. J. Radioanal. Nucl. Chem.Lett. 144 (1990) 359
(Half-life)
- M.P.Unterweger, D.D.Hoppes, F.J.Schima. Nucl. Instrum. Methods A312 (1992) 349-35
(Half-life)
- E.P.Mignonsin. Appl. Radiat. Isotopes 45 (1994) 17
(Half-life)
- Zhou Chunmei. Nuclear Data Sheets 74 (1995) 259
(Production modes)
- E.Schönfeld, H.Janssen. Nucl. Instrum. Methods A369 (1996) 527
(fluorescence yield; KB/KA ratio, Auger electron)
- R.G.Helmer, C.Van der Leun. Nucl. Instrum. Methods A450 (2000) 35
(Gamma energies)


2 - ; 0
2,6944 (8) d
0
198
Au
79
119
β -
γ Emission probabilities
per 100 disintegrations
0,989
8 0 6 5 9
0' 0' 1
2 + ; 1087,6874
2,5 ps
2
98,986
9 5, 5 4
2 + ; 411,8025
23,2 ps
1
0,025
0 + ; 0
Stable
0
198
Hg
80
118
Q - = 1372,2 keV
% β - = 100

$^{201}_{81}\mathrm{Tl}_{120}$

1 Decay Scheme

Tl-201 decays by electron capture to the Hg-201.
Le thallium 201 se désintègre par capture électronique vers le mercure 201.

2 Nuclear Data

$T_{1/2}(^{201}\mathrm{Tl}\ )$: 3,0421 (17) d
$Q^{+}(^{201}\mathrm{Tl}\ )$: 483 (15) keV

2.1 Electron Capture Transitions

	Energy keV	Probability × 100	Nature	lg ft	P_K	P_L	P_M
$\epsilon_{0,4}$	316 (15)	40,9 (9)	1st Forbidden	6,1	0,724 (7)	0,206 (7)	0,054 (2)
$\epsilon_{0,3}$	451 (15)	13,0 (5)	1st Forbidden	6,9	0,758 (3)	0,181 (3)	0,0461 (12)
$\epsilon_{0,2}$	457 (15)	0,23	Unique 1st Forbidden	8,5			
$\epsilon_{0,1}$	482 (15)	25 (22)	1st Forbidden	6,5	0,763 (3)	0,178 (3)	0,0451 (12)
$\epsilon_{0,0}$	483 (15)	21 (21)	1st Forbidden	6,5	0,763 (3)	0,178 (3)	0,0451 (12)

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{1,0}$(Hg)	1,565 (6)	38 (22)	M1+E2				4,7 (7) 10^4
$\gamma_{3,2}$(Hg)	5,869 (26)	0,52 (14)	[M1+E2]				
$\gamma_{2,0}$(Hg)	26,269 (7)	0,64 (7)	M1(+E2)		58,8 (18)	13,74 (41)	76,9 (23)
$\gamma_{3,1}$(Hg)	30,573 (17)	12,77 (25)	M1+E2		36,9 (4)	8,79 (26)	48,5 (2)
$\gamma_{3,0}$(Hg)	32,138 (16)	11,28 (22)	M1+E2		32,0 (4)	7,62 (23)	41,9 (2)
$\gamma_{4,3}$(Hg)	135,312 (34)	11,59 (28)	M1+E2	2,83 (3)	0,48 (5)	0,1138 (34)	3,45 (10)

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{4,2}$(Hg)	141,18 (4)	< 0,02	[E2]	0,372 (11)	0,774 (23)	0,202 (6)	1,41 (4)
$\gamma_{4,1}$(Hg)	165,885 (31)	0,420 (13)	M1(+E2)	1,57 (3)	0,270 (5)	0,0634 (19)	1,86 (8)
$\gamma_{4,0}$(Hg)	167,45 (3)	28,9 (9)	M1+E2	1,55 (3)	0,262 (5)	0,0620 (19)	1,89 (8)

3 Atomic Data

3.1 Hg

ω_K : 0,962 (4)
$\bar{\omega}_L$: 0,355 (14)
n_{KL} : 0,813 (4)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	68,895		58,99
	$K\alpha_1$	70,82		100
	$K\beta_3$	79,823	}	
	$K\beta_1$	80,254	}	
	$K\beta_5''$	80,762	}	33,94
	$K\beta_2$	82,435	}	
	$K\beta_4$	82,776	}	10
	$KO_{2,3}$	83,028	}	
X_L				
	$L\ell$	8,72		
	$L\alpha$	9,898 – 9,989		
	$L\eta$	10,651		
	$L\beta$	11,563 – 12,56		
	$L\gamma$	13,41 – 14,85		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	53,178 – 58,277	100
KLX	64,594 – 68,430	55,2
KXY	75,98 – 83,09	7,62
Auger L	5,1 – 14,8	34

4 Electron Emissions

		Energy keV	Electrons per 100 disint.
e_{AL}	(Hg)	5,1 - 14,8	57,7 (7)
e_{AK}	(Hg)		3,7 (4)
	KLL	53,178 - 58,277 }	
	KLX	64,594 - 68,430 }	
	KXY	75,98 - 83,09 }	
$ec_{2,0\ L}$	(Hg)	11,429 - 13,985	0,48 (5)
$ec_{3,1\ L}$	(Hg)	15,734 - 18,289	9,70 (34)
$ec_{3,0\ L}$	(Hg)	17,299 - 19,854	8,57 (31)
$ec_{2,0\ M}$	(Hg)	22,707 - 23,974	0,113 (13)
$ec_{3,1\ M}$	(Hg)	27,011 - 28,278	2,27 (8)
$ec_{3,0\ M}$	(Hg)	28,576 - 29,843	2,00 (7)
$ec_{3,1\ N}$	(Hg)	29,770 - 30,473	0,583 (21)
$ec_{3,0\ N}$	(Hg)	31,334 - 32,038	0,515 (19)
$ec_{4,3\ K}$	(Hg)	52,210 (34)	7,45 (24)
$ec_{4,1\ K}$	(Hg)	82,783 (31)	0,237 (8)
$ec_{4,0\ K}$	(Hg)	84,348 (30)	15,6 (5)
$ec_{4,3\ L}$	(Hg)	120,473 - 123,028	1,268 (41)
$ec_{4,3\ M}$	(Hg)	131,750 - 133,017	0,296 (9)
$ec_{4,3\ N}$	(Hg)	134,509 - 135,212	0,0760 (24)
$ec_{4,0\ L}$	(Hg)	152,611 - 155,166	2,65 (8)
$ec_{4,0\ M}$	(Hg)	163,888 - 165,155	0,62 (2)
$ec_{4,0\ N}$	(Hg)	166,647 - 167,350	0,159 (5)

5 Photon Emissions

5.1 X-Ray Emissions

		Energy keV		Photons per 100 disint.	
XL	(Hg)	8,72 — 14,85		42,7 (18)	
XKα_2	(Hg)	68,895		27,3 (5)	} Kα
XKα_1	(Hg)	70,82		46,4 (7)	}
XKβ_3	(Hg)	79,823	}		
XKβ_1	(Hg)	80,254	}	15,7 (4)	K$'\beta_1$
XKβ''_5	(Hg)	80,762	}		
XKβ_2	(Hg)	82,435	}		
XKβ_4	(Hg)	82,776	}	4,61 (13)	K$'\beta_2$
XKO$_{2,3}$	(Hg)	83,028	}		

5.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{1,0}$(Hg)	1,565 (6)	0,00081 (47)
$\gamma_{3,2}$(Hg)	5,869 (26)	0,5
$\gamma_{2,0}$(Hg)	26,269 (7)	0,0082 (9)
$\gamma_{3,1}$(Hg)	30,573 (17)	0,258 (5)
$\gamma_{3,0}$(Hg)	32,138 (16)	0,263 (5)
$\gamma_{4,3}$(Hg)	135,312 (34)	2,604 (22)
$\gamma_{4,2}$(Hg)	141,18 (4)	< 0,008
$\gamma_{4,1}$(Hg)	165,885 (31)	0,147 (2)
$\gamma_{4,0}$(Hg)	167,45 (3)	10,0 (1)

6 Main Production Modes

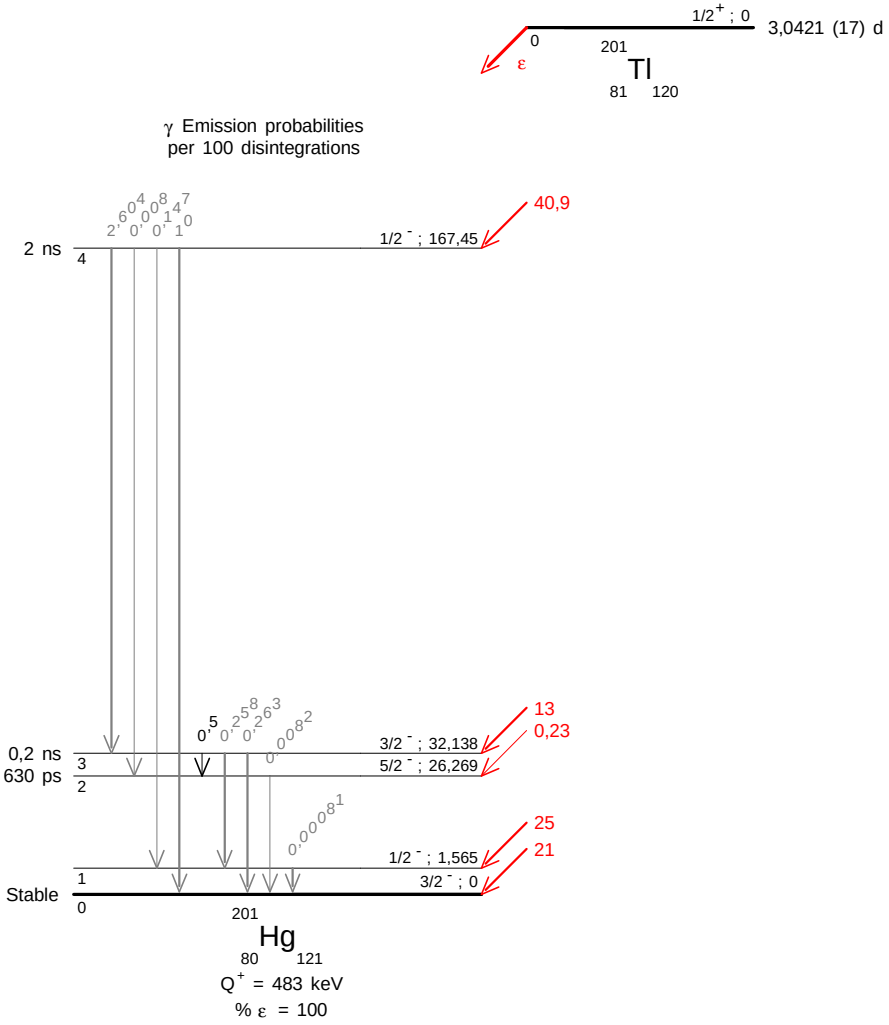
$\left\{ \begin{array}{l} \mathrm{Tl-203(p,3n)Pb-201} \\ \text{Possible impurities : } \mathrm{Pb-200,\ Pb-202m,\ Pb-203,\ Pb-204m,\ Tl-200} \end{array} \right.$

$\left\{ \begin{array}{l} \mathrm{Tl-205(p,5n)Pb-201} \\ \text{Possible impurities : } \mathrm{Pb-200,\ Pb-202m,\ Pb-204m,\ Tl-200,\ Tl-202} \end{array} \right.$

$\left\{ \begin{array}{l} \mathrm{Tl-203(d,4n)Pb-201} \\ \text{Possible impurities : } \mathrm{Pb-200,\ Pb-202m,\ Pb-203,\ Pb-204m,\ Tl-200,\ Tl-202} \end{array} \right.$

7 References

- H.M.Neumann, I.Perlman. Phys. Rev. 78 (1950) 191
  (Half-life)
- R.K.Gupta. Arkiv Fysik 17 (1960) 337
  (Relative emission probabilities of KLL Auger lines)
- C.J.Herrlander, R.Stockendal, R.K.Gupta. Arkiv Fysik 17 (1960) 315
  (Gamma ray energies,, Conv. Elec. emission probabilities)
- D.Reyes-Suter, T.Suter. Arkiv Fysik 20 (1961) 415
  (Half-life 32 keV level in HG201)
- D.J.Horen, J.Arvienx, M.Buenerd, J.Cole, G.Perrin, P.de Saintiguon. Phys. Rev. C11 (1975) 1247
  (Multipolarities)
- S.Hofmann, D.Walcher. Z. Physik A272 (1975) 351
  (Multipolarities, Spin and Parity)
- H.W.Nass. J. Nucl. Med. 18 (1977) 1047
  (Gamma-ray emission probabilities)
- E.F.Novak, A.P.Arya, R.L.Martz. Phys. Rev. C18 (1978) 1045
  (Multipolarities)
- K.Debertin, W.Pessara, U.Schötzig, K.F.Walz. Int. J. Appl. Radiat. Isotop. 30 (1979) 551
  (Half-life)
- F.Lagoutine, J.Legrand. Int. J. Appl. Radiat. Isotop. 33 (1982) 711
  (Half-life)
- P.Schuler, K.Hardt, C.Gunther, K.Freitag, P.Herzog, N.Niederwestbery, H.Reif, E.B.Shera, M.V.Hoehn. Z. Physik A313 (1983) 305
  (Gamma ray energies, Gamma-ray emission probabilities, Multipolarities)
- N.Dragoun, V.Brabec, M.Rysavy, A.Spalek, K.Freitag. Z. Physik A326 (1987) 279
  (Conv. Elec. emission probabilities)
- E.Funck. Appl. Rad. Isotopes 38 (1987) 771
  (Gamma-ray emission probabilities)
- H.Schrader. Appl. Rad. Isotopes 40 (1989) 381
  (Half-life)
- J.Plch, P.Kovar, P.Dryak. Appl. Rad. Isotopes 40,513 (1989)
  (Gamma-ray emission probabilities)
- Yu.S.Kalashnikova, I.M.Narodetschin, V.P.Yurov. Nucl. Phys. A508 (1990) 239c
  (Gamma-ray emission probabilities)
- B.M.Coursey, D.D.Hoppes, A.T.Hirschfeld, S.M.Judge, D.H.Woods, M.J.Woods, E.Funck, H.Schrader, A.G.Tuck. Appl. Rad. Isotopes 41 (1990) 289
  (Gamma-ray emission probabilities)
- Y.Kawada, Y.Hino, W.Gatot. Nucl. Instrum. Methods Phys. Res. A286 (1990) 539
  (Gamma-ray emission probabilities)
- M.P.Unterweger, D.D.Hoppes, F.J.Schima. Nucl. Instrum. Methods Phys. Res. A312 (1992) 349
  (Gamma-ray emission probabilities)
- S.Rab. Nucl. Data Sheets 71 (1994) 421
  (Level Half-lives, Spin and Parity, Conv. Elec. emission probabilities, Multipolarities)
- B.R.S.Simpson, B.R.Meyer. Appl. Rad. Isotopes 45 (1994) 669
  (Half-life)
- K.De Souza, *et al.*. Appl. Rad. Isotopes 60, 2-3 (2004) 317
  (Half-life)
- H.Schrader. Appl. Rad. Isotopes 60, 2-3 (2004) 317
  (Half-life)


1/2+ ; 0
3,0421 (17) d
0
ε
201
Tl
81
120
γ Emission probabilities
per 100 disintegrations
40,9
2 ns
4
1/2 - ; 167,45
13
0,23
0,2 ns
630 ps
3
2
3/2 - ; 32,138
5/2 - ; 26,269
25
21
1/2 - ; 1,565
Stable
1
0
3/2 - ; 0
201
Hg
80
121
Q+ = 483 keV
% ε = 100

$^{203}_{80}\mathrm{Hg}_{123}$

1 Decay Scheme

The simple and consistent decay scheme is dominated by beta decay to the first excited state of Tl-203, followed by a single gamma transition to the ground state.
Le mercure 203 se désintègre par émission bêta moins vers le niveau excités de 279 keV du thallium 203.

2 Nuclear Data

$T_{1/2}(^{203}\mathrm{Hg}\ )$: 46,594 (12) d
$Q^{-}(^{203}\mathrm{Hg}\ )$: 491,8 (12) keV

2.1 β^{-} Transitions

	Energy keV	Probability × 100	Nature	lg ft
$\beta^{-}_{0,1}$	212,6 (12)	99,99 (1)	Allowed	6,455
$\beta^{-}_{0,0}$	491,8 (12)	0,01 (1)	1st Forbidden Unique	11,6

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{1,0}$(Tl)	279,1969 (12)	99,99 (1)	M1+75%E2	0,1640 (10)	0,0476 (2)	0,0155 (2)	0,2271 (12)

3 Atomic Data

3.1 Tl

ω_K : 0,963 (4)
$\bar{\omega}_L$: 0,367 (15)
n_{KL} : 0,812 (5)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	70,8325		59,24
	$K\alpha_1$	72,8725		100
	$K\beta_3$	82,118	}	
	$K\beta_1$	82,577	}	
	$K\beta_5''$	83,115	}	34
	$K\beta_2$	84,838	}	
	$K\beta_4$	85,134	}	10,1
	$KO_{2,3}$	85,444	}	
X_L				
	$L\ell$	8,953		
	$L\alpha$	10,172 – 10,268		
	$L\eta$	10,994		
	$L\beta$	11,812 – 12,643		
	$L\gamma$	14,291 – 14,738		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	54,587 – 59,954	100
KLX	66,37 – 72,86	56
KXY	78,12 – 85,50	7,7
Auger L	5,18 – 10,13	3370

4 Electron Emissions

		Energy keV	Electrons per 100 disint.
e_{AL}	(Tl)	5,18 - 10,13	10,1 (1)
e_{AK}	(Tl)		0,49 (6)
	KLL	54,587 - 59,954	
	KLX	66,37 - 72,86	
	KXY	78,12 - 85,50	
$ec_{1,0\ T}$	(Tl)	193,66 - 279,18	18,5 (1)
$ec_{1,0\ K}$	(Tl)	193,66 (1)	13,37 (6)
$ec_{1,0\ L}$	(Tl)	263,85 - 266,54	3,88 (2)
$ec_{1,0\ M}$	(Tl)	275,49 - 279,18	1,26 (1)
$\beta^-_{0,1}$	max:	212,6 (12)	99,99 (1)
$\beta^-_{0,1}$	avg:	57,8 (4)	
$\beta^-_{0,0}$	max:	491,8 (12)	0,01 (1)
$\beta^-_{0,0}$	avg:	154,4 (4)	

5 Photon Emissions

5.1 X-Ray Emissions

		Energy keV	Photons per 100 disint.	
XL	(Tl)	8,953 — 14,738	5,43 (9)	
$XK\alpha_2$	(Tl)	70,8325	3,75 (4)	} Kα
$XK\alpha_1$	(Tl)	72,8725	6,33 (6)	}
$XK\beta_3$	(Tl)	82,118	}	
$XK\beta_1$	(Tl)	82,577	} 2,15 (4)	$K'\beta_1$
$XK\beta''_5$	(Tl)	83,115	}	
$XK\beta_2$	(Tl)	84,838	}	
$XK\beta_4$	(Tl)	85,134	} 0,639 (16)	$K'\beta_2$
$XKO_{2,3}$	(Tl)	85,444	}	

5.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{1,0}$(Tl)	279,1952 (10)	81,48 (8)

6 Main Production Modes

Au – 203(β^-)Hg – 203

Tl – 204(γ,p)Hg – 203

Hg – 202(n,γ)Hg – 203

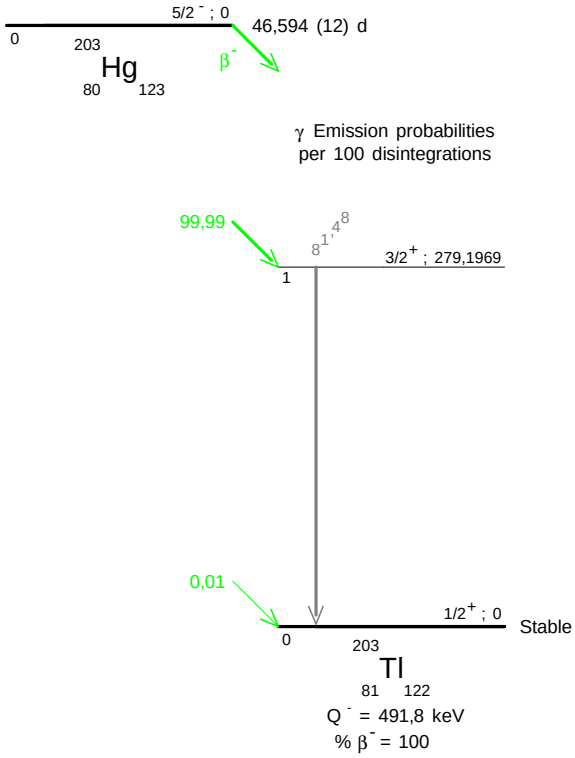
Hg – 202(d,p)Hg – 203

Hg – 204(d,t)Hg – 203

7 References

- N. Marty. Comp. Rend. Acad. Sci. (Paris) 240B (1955) 291-294
  (Beta-particle emission probabilities)
- A. H. Wapstra, G. J. Nijgh. Nucl. Phys. 1 (1956) 245-258
  (Internal conversion coefficients)
- J. L. Wolfson. Can. J. Phys. 34 (1956) 256-264
  (Beta-particle emission probabilities, transition type)
- G.J. Nijgh, A. H. Wapstra, L. Th. M. Ornstein, N. Salomons-Grobben, J. R. Huizenga, O. Almen. Nucl. Phys. 9 (1958) 528-537
  (Internal conversion coefficients)
- R. W. Peelle. ORNL Report ORNL-3016 (1960) 116-125
  (Internal conversion coefficients)
- Z. Sujkowski. Ark. Fysik 20, No. 16 (1961) 243-267
  (Internal conversion coefficients)
- J. G. V. Taylor. Can. J. Phys. 40 (1962) 383-392
  (Internal conversion coefficients)
- R. Burmeister, H. Graber, J. Schintlmeister, R. Weibrecht. Nucl. Phys. 42 (1963) 56-61
  (Internal conversion coefficients)
- W. L. Croft, B. G. Pettersson, J. H. Hamilton. Nucl. Phys. 48 (1963) 267-272
  (Internal conversion coefficients)
- C. J. Herrlander, R. L. Graham. Nucl. Phys. 58 (1964) 544-560
  (Internal conversion coefficients)
- F. Lagoutine, Y. Le Gallic, J. Legrand. Int. J. Appl. Radiat. Isot. 19 (1968) 475-482
  (Half-life)
- J. F. Emery, S. A. Reynolds, E. I. Wyatt, G. I. Gleason. Nucl. Sci. Eng. 48 (1972) 319-323
  (Half-life)
- K. F. Walz, H. M. Weiss, E. Funck. PTB Jahresbericht (1972) 150-151
  (Internal conversion coefficients)
- H. S. Sahota. Indian J. Phys. 46 (1972) 86-92
  (Internal conversion coefficients)
- H. H. Hansen, D. Mouchel. Z. Phys. 267 (1974) 371-377
  (Internal conversion coefficients)
- F. Rösel, H. M. Fries, K. Alder, H. C. Pauli. At. Data. Nucl. Data Tables 21 (1978) 291-514
  (Internal conversion coefficients)

- H. Houtermans, O. Milosevic, F. Reichel. Int. J. Appl. Radiat. Isotop. 31 (1980) 153
(Half-life)
- A. R. Rutledge, L. V. Smith, J. S. Merritt. AECL Report AECL-6692 (1980)
(Half-life)
- K. F. Walz, K. Debertin, H. Schrader. Int. J. Appl. Radiat. Isotop. 34 (1983) 1191
(Half-life)
- M. R. Schmorak. Nucl. Data Sheets 46 (1985) 287
(Nuclear structure, energies)
- H. H. Hansen. European Appl. Res. Rept. - Nucl. Sci. Technol. 6, No. 4 (1985) 777-816
(Internal conversion coefficients)
- M. P. Unterweger, D. D. Hoppes, F. J. Schima. Nucl. Instrum. Methods A312 (1992) 349-352
(Half-life)
- S. Rab. Nucl. Data Sheets 70 (1993) 173
(Nuclear structure, energies)
- G. Audi, A. H. Wapstra. Nucl. Phys. A595 (1995) 409
(Q value)
- E. Schönfeld, H. Janssen. Nucl. Instrum. Methods A369 (1996) 527-533
(K X-ray, L X-ray, Auger electrons)
- E. Schönfeld, G. Rodloff. PTB Report PTB-6.11-98-1 (1998)
(Auger electrons)
- E. Schönfeld, G. Rodloff. PTB Report PTB-6.11-1999-1 (1999)
(K X-ray)
- R. G. Helmer, C. van der Leun. Nucl. Instrum. Methods A450 (2000) 35-70
(Gamma-ray energies)
- E. Schönfeld, H. Janssen, R. Klein. Appl. Rad. Isotopes 52 (2000) 955-956
(Internal conversion coefficients)
- M.J. Woods. IAEA TECDOC (2004)
(Half-life evaluation)


5/2 - ; 0
46,594 (12) d
0
203
Hg
80
123
β -
γ Emission probabilities
per 100 disintegrations
99,99
8 1' 4 8
3/2 + ; 279,1969
1
0,01
1/2 + ; 0
Stable
0
203
Tl
81
122
Q - = 491,8 keV
% β - = 100

$^{\mathbf{204}}_{81}\mathrm{Tl}_{123}$

1 Decay Scheme

Le Tl-204 se désintègre par capture électronique (2,92 %) vers le niveau fondamental de Hg-204 et par émission bêta moins (97,08 %) vers le niveau fondamental de Pb-204.
Tl-204 disintegrates 97.08 (13)% by beta minus emission and 2.92 (13)% by electron capture transition to the ground states of Pb-204 and Hg-204, respectively.

2 Nuclear Data

$T_{1/2}(^{204}\mathrm{Tl})$	:	3,788	(15)	a
$Q^-(^{204}\mathrm{Tl})$	:	763,72	(18)	keV
$Q^+(^{204}\mathrm{Tl})$	:	345,0	(13)	keV

2.1 β^- Transitions

	Energy keV	Probability × 100	Nature	lg ft
$\beta^-_{0,0}$	763,7 (2)	97,08 (13)	Unique 1st Forbidden	10,1

2.2 Electron Capture Transitions

	Energy keV	Probability × 100	Nature	lg ft	P_K	P_L	P_{M+}
$\epsilon_{0,0}$	347,5 (15)	2,92 (13)	Unique 1st Forbidden	9,6	0,5843 (14)	0,3024 (10)	0,1133 (5)

3 Atomic Data

3.1 Hg

ω_K	:	0,962	(4)
$\bar{\omega}_L$	:	0,355	(14)
$\bar{\omega}_M$	:	0,026	(3)
n_{KL}	:	0,815	(4)
$\bar{n}_{LM}$	:	1,34	(4)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	68,895		58,99
	$K\alpha_1$	70,82		100
	$K\beta_3$	79,823	}	
	$K\beta_1$	80,254	}	
	$K\beta_5''$	80,762	}	34,3
	$K\beta_2$	82,435	}	
	$K\beta_4$	82,776	}	10,04
	$KO_{2,3}$	83,028	}	
X_L				
	$L\ell$	8,721		
	$L\alpha$	9,898 – 9,989		
	$L\eta$	10,647		
	$L\beta$	11,924 – 11,822		
	$L\gamma$	– 14,847		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	53,17 – 58,28	100
KLX	64,59 – 70,81	55,2
KXY	75,92 – 83,08	7,62
Auger L	5,1 – 14,8	

3.2 Pb

ω_K : 0,963 (4)
$\bar{\omega}_L$: 0,379 (15)
n_{KL} : 0,811 (5)

3.2.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	72,8049		59,5
	$K\alpha_1$	74,97		100
	$K\beta_3$	84,451	}	
	$K\beta_1$	84,937	}	
	$K\beta_5''$	85,47	}	34,2
	$K\beta_2$	87,238	}	
	$K\beta_4$	87,58	}	10,3
	$KO_{2,3}$	87,911	}	

4 Electron Emissions

		Energy keV		Electrons per 100 disint.
e_{AL}	(Hg)	5,1 - 14,8		1,48 (3)
e_{AK}	(Hg)			0,065 (8)
	KLL	53,17 - 58,28	}	
	KLX	64,59 - 70,81	}	
	KXY	75,92 - 83,08	}	
$\beta^-_{0,0}$	max:	763,7 (2)		97,08 (13)
$\beta^-_{0,0}$	avg:	243,9 (1)		

5 Photon Emissions

5.1 X-Ray Emissions

		Energy keV		Photons per 100 disint.	
XL	(Hg)	8,721 — 14,847		0,787 (20)	
XKα_2	(Hg)	68,895		0,474 (20)	} Kα
XKα_1	(Hg)	70,82		0,812 (34)	}
XKβ_3	(Hg)	79,823	}		
XKβ_1	(Hg)	80,254	}	0,273 (10)	K$'\beta_1$
XKβ''_5	(Hg)	80,762	}		
XKβ_2	(Hg)	82,435	}		
XKβ_4	(Hg)	82,776	}	0,081 (3)	K$'\beta_2$
XKO$_{2,3}$	(Hg)	83,028	}		
XKα_2	(Pb)	72,8049		0,0044 (3)	} Kα
XKα_1	(Pb)	74,97		0,0061 (3)	}
XKβ_3	(Pb)	84,451	}		
XKβ_1	(Pb)	84,937	}	0,0027 (2)	K$'\beta_1$
XKβ''_5	(Pb)	85,47	}		
XKβ_2	(Pb)	87,238	}		
XKβ_4	(Pb)	87,58	}	0,00073 (2)	K$'\beta_2$
XKO$_{2,3}$	(Pb)	87,911	}		

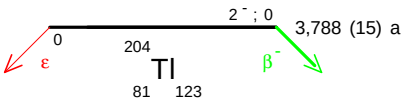
6 Main Production Modes

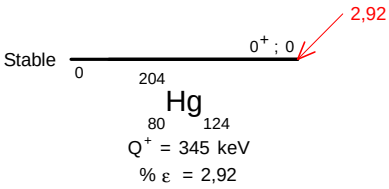
$\mathrm{Tl-203(n,\gamma)Tl-204}$ $\quad \sigma$: 11,0 (5) barns
Possible impurities : None

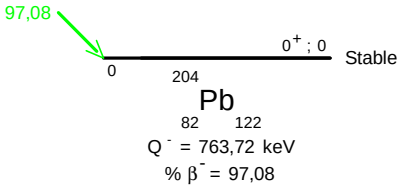
7 References

- M.H.Biavati, S.J.Nassiff, C.S.Wu. Phys. Rev. 125,4 (1961) 1364
  (Q)
- B.R.JOSHI. Proc. Phys.Soc. 77 (1961) 1205
  (PL/PK ratio)
- H.LEUTZ, K.ZIEGLER. Z. Phys. 166 (1962) 582
  (Half-life)
- P.CHRISTMAS. Nucl. Phys. 55 (1964) 577
  (Beta emission energies X-ray emission probabilities)
- S.C.Anspach, *et al.*. Report NBS 260-9 (1965)
  (Half-life)
- H.KLEIN, H. LEUTZ. Nucl. Phys. 79 (1966) 27
  (Q)
- D.L.HORROCKS. Nucl. Phys. A110 (1968) 238
  (Half-life)

- J.J.H.Park, P.Christmas. Can. J. Phys. 45 (1968) 2621
(K Auger/B-)
- G.BORTELS. Int. J. Appl. Radiat. Isotop. 20 (1969) 613
(Half-life)
- K.C.JORDAN, J.H BIRDEN, B.C BLANKE. J. Inorg. Nucl. Chem. 31 (1969) 2641
(Half-life)
- G.HARBOTTLE. Radiochim. Acta 13 (1970) 132
(Half-life)
- H.Lancman, A.Bond. Phys. Rev. C 7, 6 (1973) 2600
(Q)
- A.ZIDE, H.LANCMAN. Phys. Rev. C19 (1979) 1053
(Q)
- U.Schötzig. Nucl. Instrum. Methods A286 (1990) 523
(X-ray emission intensities)
- M.R.Schmorak. Nucl. Data Sheets 72,3 (1994) 409
(Spin and Parity)
- G. Audi, A. H. Wapstra. Nucl. Phys. A 595 (1995) 409
(Q)
- E.Schönfeld, H.Janssen. Nucl. Instrum. Methods A369 (1996) 527
(Atomic Data)
- I.Bergström, *et al.* Nucl. Instrum. Methods A487 (2002) 618
(Atomic mass)


2⁻ ; 0
3,788 (15) a
0
204
ε
Tl
β⁻
81
123


2,92
Stable
0⁺ ; 0
0
204
Hg
80
124
Q⁺ = 345 keV
% ε = 2,92


97,08
0⁺ ; 0
Stable
0
204
Pb
82
122
Q⁻ = 763,72 keV
% β⁻ = 97,08

$^{208}_{81}\mathrm{Tl}_{127}$

1 Decay Scheme

Tl-208 decays by beta minus emission to the Pb-208 excited levels.
Le thallium 208 se désintègre par émission bêta moins vers les niveaux excités du plomb 208.

2 Nuclear Data

$T_{1/2}(^{208}\mathrm{Tl}\ )$: 3,060 (8) min
$Q^{-}(^{208}\mathrm{Tl}\ )$: 5001 (2) keV

2.1 β^{-} Transitions

	Energy keV	Probability × 100	Nature	lg ft
$\beta^{-}_{0,18}$	521 (2)	0,053 (5)	1st Forbidden	6,67
$\beta^{-}_{0,17}$	618 (2)	0,017 (5)	1st Forbidden	7,4
$\beta^{-}_{0,16}$	643 (2)	0,045 (7)	1st Forbidden	7,05
$\beta^{-}_{0,15}$	678 (2)	0,005 (2)	1st Forbidden	8,1
$\beta^{-}_{0,14}$	690 (2)	0,076 (11)	1st Forbidden	6,93
$\beta^{-}_{0,13}$	705 (2)	0,048 (6)	1st Forbidden	7,16
$\beta^{-}_{0,12}$	718 (2)	0,030 (7)	1st Forbidden	7,4
$\beta^{-}_{0,11}$	739 (2)	0,002 (1)	1st Forbidden	8,6
$\beta^{-}_{0,10}$	821 (2)	0,231 (9)	1st Forbidden	6,71
$\beta^{-}_{0,9}$	876 (2)	0,18 (2)	1st Forbidden	6,91
$\beta^{-}_{0,8}$	1005 (3)	0,007 (3)	1st Forbidden	8,5
$\beta^{-}_{0,7}$	1040 (2)	3,26 (7)	1st Forbidden	5,92
$\beta^{-}_{0,6}$	1055 (2)	0,048 (3)	1st Forbidden	7,77
$\beta^{-}_{0,5}$	1081 (2)	0,64 (6)	1st Forbidden	6,69
$\beta^{-}_{0,4}$	1293 (2)	24,1 (3)	1st Forbidden	5,39
$\beta^{-}_{0,3}$	1526 (2)	22,2 (7)	1st Forbidden	5,69
$\beta^{-}_{0,2}$	1803 (2)	49,0 (9)	1st Forbidden	5,62

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M+	α_T
$\gamma_{5,4}$(Pb)	211,4 (2)	0,39 (2)	[M1+2%E2]	0,952 (29)	0,166 (5)	0,052 (2)	1,17 (4)
$\gamma_{4,3}$(Pb)	233,3 (1)	0,59 (2)	[M1+2%E2]	0,724 (22)	0,125 (4)	0,039 (1)	0,888 (27)
$\gamma_{7,4}$(Pb)	252,5 (2)	1,34 (4)	[M1+2%E2]	0,582 (17)	0,100 (3)	0,0310 (9)	0,713 (21)
$\gamma_{3,2}$(Pb)	277,37 (3)	10,3 (5)	[M1]	0,457 (14)	0,078 (2)	0,0240 (7)	0,559 (17)
$\gamma_{7,3}$(Pb)	485,8 (1)	0,055 (4)	[M1]	0,101 (3)	0,0170 (5)	0,0050 (2)	0,123 (4)
$\gamma_{4,2}$(Pb)	510,7 (1)	25,0 (2)	[M1+0,27%E2]	0,089 (3)	0,0156 (5)	0,0040 (1)	0,108 (3)
$\gamma_{2,1}$(Pb)	583,187 (2)	86,8 (1)	E2	0,0152 (5)	0,0042 (1)	0,00130 (4)	0,0207 (6)
$\gamma_{13,4}$(Pb)	587,8 (2)	0,060 (21)	[M1]	0,0614 (18)	0,0102 (3)	0,0032 (1)	0,0748 (22)
$\gamma_{9,3}$(Pb)	650,2 (2)	0,05 (2)	[M1]	0,0472 (14)	0,0078 (2)	0,00250 (8)	0,0575 (17)
$\gamma_{10,3}$(Pb)	705,3 (2)	0,023 (4)	[M1]	0,0382 (11)	0,0063 (2)	0,00200 (6)	0,0465 (14)
$\gamma_{5,2}$(Pb)	722,0 (1)	0,25 (4)	[M1+8,8%E2]	0,0337 (10)	0,0056 (2)	0,00180 (5)	0,0411 (10)
$\gamma_{6,2}$(Pb)	748,7 (2)	0,0480 (31)	[M1]	0,0328 (10)	0,0054 (2)	0,00170 (5)	0,0399 (12)
$\gamma_{7,2}$(Pb)	763,2 (1)	1,86 (3)	[M1+0,01%E2]	0,0312 (10)	0,0052 (2)	0,00150 (5)	0,0379 (11)
$\gamma_{12,3}$(Pb)	808,3 (2)	0,030 (7)					
$\gamma_{13,3}$(Pb)	821,1 (2)	0,042 (4)	[M1]	0,0258 (8)	0,0043 (1)	0,00130 (4)	0,0314 (9)
$\gamma_{14,3}$(Pb)	835,9 (2)	0,076 (11)					
$\gamma_{3,1}$(Pb)	860,56 (3)	12,8 (1)	[M1+33,5%E2]	0,0176 (5)	0,0030 (1)	0,00100 (3)	0,0216 (6)
$\gamma_{16,3}$(Pb)	883,4 (2)	0,032 (3)	[M1]	0,0214 (7)	0,0035 (1)	0,00120 (4)	0,0261 (8)
$\gamma_{9,2}$(Pb)	927,6 (2)	0,128 (1)	[M1]	0,0189 (6)	0,0031 (1)	0,00100 (3)	0,0230 (7)
$\gamma_{10,2}$(Pb)	982,7 (2)	0,209 (8)	[M1]	0,0163 (5)	0,00270 (8)	0,00080 (2)	0,0198 (6)
$\gamma_{4,1}$(Pb)	1093,9 (1)	0,43 (2)	E2	0,00455 (14)	0,00084 (3)	0,000270 (8)	0,00566 (17)
$\gamma_{15,2}$(Pb)	1125,7 (4)	0,005 (2)					
$\gamma_{16,2}$(Pb)	1160,8 (2)	0,011 (3)	[M1]	0,0107 (3)	0,00160 (5)	0,00060 (2)	0,0129 (4)
$\gamma_{17,2}$(Pb)	1185,2 (3)	0,017 (5)	[M1]	0,0101 (3)	0,00160 (5)	0,00060 (2)	0,0123 (4)
$\gamma_{18,2}$(Pb)	1282,8 (3)	0,053 (5)	[M1]	0,00830 (25)	0,00127 (4)	0,00049 (2)	0,01006 (30)
$\gamma_{8,1}$(Pb)	1381,1 (5)	0,007 (3)	[E2]	0,00297 (9)	0,00051 (2)	0,000160 (5)	0,00364 (11)
$\gamma_{11,1}$(Pb)	1647,5 (7)	0,002 (1)					
$\gamma_{16,1}$(Pb)	1743,9 (2)	0,002 (1)	[M1]	0,00382 (11)	0,00057 (2)	0,000160 (5)	0,00455 (14)
$\gamma_{1,0}$(Pb)	2614,511 (10)	100,00 (1)	E3	0,00173 (5)	0,000290 (9)	0,000080 (2)	0,00210 (6)

3 Atomic Data

3.1 Pb

ω_K : 0,963 (4)
$\bar{\omega}_L$: 0,379 (15)
n_{KL} : 0,811 (5)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	72,8049		59,6
	$K\alpha_1$	74,97		100
	$K\beta_3$	84,451	}	
	$K\beta_1$	84,937	}	
	$K\beta_5''$	85,47	}	34,1

		Energy keV		Relative probability
	$K\beta_2$	87,238	}	
	$K\beta_4$	87,58	}	10,3
	$KO_{2,3}$	87,911	}	
X_L				
	$L\ell$	9,184		
	$L\alpha$	10,45 – 10,551		
	$L\eta$	11,349		
	$L\beta$	12,142 – 13,015		
	$L\gamma$	14,765 – 15,216		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	56,03 – 61,67	100
KLX	68,18 – 74,97	56
KXY	80,3 – 88,0	7,8
Auger L	5,26 – 10,40	3020

4 Electron Emissions

		Energy keV		Electrons per 100 disint.
e_{AL}	(Pb)	5,26 - 10,40		5,23 (9)
e_{AK}	(Pb)			0,28 (4)
	KLL	56,03 - 61,67	}	
	KLX	68,18 - 74,97	}	
	KXY	80,3 - 88,0	}	
$ec_{3,2\ K}$	(Pb)	189,37 (3)		3,01 (9)
$ec_{3,2\ L}$	(Pb)	261,51 - 264,33		0,51 (2)
$ec_{3,2\ M}$	(Pb)	273,52 - 277,23		0,16 (1)
$ec_{4,2\ K}$	(Pb)	422,7 (1)		2,0 (1)
$ec_{4,2\ L}$	(Pb)	494,8 - 497,7		0,3
$ec_{2,1\ K}$	(Pb)	495,19 (3)		1,3 (1)
$ec_{4,2\ M}$	(Pb)	506,8 - 510,6		0,09
$ec_{2,1\ L}$	(Pb)	567,33 - 570,15		0,4
$ec_{2,1\ M}$	(Pb)	579,34 - 583,05		0,1

		Energy keV		Electrons per 100 disint.
$\beta^-_{0,18}$	max:	521	(2)	0,053 (5)
$\beta^-_{0,18}$	avg:	155,1	(7)	
$\beta^-_{0,17}$	max:	618	(2)	0,017 (5)
$\beta^-_{0,17}$	avg:	188,6	(7)	
$\beta^-_{0,16}$	max:	643	(2)	0,045 (7)
$\beta^-_{0,16}$	avg:	197,1	(7)	
$\beta^-_{0,15}$	max:	678	(2)	0,005 (2)
$\beta^-_{0,15}$	avg:	209,5	(7)	
$\beta^-_{0,14}$	max:	690	(2)	0,076 (11)
$\beta^-_{0,14}$	avg:	213,9	(7)	
$\beta^-_{0,13}$	max:	705	(2)	0,048 (6)
$\beta^-_{0,13}$	avg:	219,2	(7)	
$\beta^-_{0,12}$	max:	718	(2)	0,030 (7)
$\beta^-_{0,12}$	avg:	223,8	(7)	
$\beta^-_{0,11}$	max:	739	(2)	0,002 (1)
$\beta^-_{0,11}$	avg:	231,4	(8)	
$\beta^-_{0,10}$	max:	821	(2)	0,231 (9)
$\beta^-_{0,10}$	avg:	261,2	(7)	
$\beta^-_{0,9}$	max:	876	(2)	0,18 (2)
$\beta^-_{0,9}$	avg:	281,5	(7)	
$\beta^-_{0,8}$	max:	1005	(3)	0,007 (3)
$\beta^-_{0,8}$	avg:	330,4	(8)	
$\beta^-_{0,7}$	max:	1040	(2)	3,26 (7)
$\beta^-_{0,7}$	avg:	343,6	(8)	
$\beta^-_{0,6}$	max:	1055	(2)	0,048 (3)
$\beta^-_{0,6}$	avg:	349,2	(8)	
$\beta^-_{0,5}$	max:	1081	(2)	0,64 (6)
$\beta^-_{0,5}$	avg:	359,5	(8)	
$\beta^-_{0,4}$	max:	1293	(2)	24,1 (3)
$\beta^-_{0,4}$	avg:	442,3	(8)	
$\beta^-_{0,3}$	max:	1526	(2)	22,2 (7)
$\beta^-_{0,3}$	avg:	536,2	(8)	
$\beta^-_{0,2}$	max:	1803	(2)	49,0 (9)
$\beta^-_{0,2}$	avg:	650,3	(8)	

5 Photon Emissions

5.1 X-Ray Emissions

		Energy keV		Photons per 100 disint.	
XL	(Pb)	9,184 — 15,216		2,89 (6)	
XKα_2	(Pb)	72,8049		2,15 (6)	} Kα
XKα_1	(Pb)	74,97		3,61 (9)	}
XKβ_3	(Pb)	84,451	}		
XKβ_1	(Pb)	84,937	}	1,23 (4)	K$'\beta_1$
XKβ_5''	(Pb)	85,47	}		
XKβ_2	(Pb)	87,238	}		
XKβ_4	(Pb)	87,58	}	0,373 (13)	K$'\beta_2$
XKO$_{2,3}$	(Pb)	87,911	}		

5.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{5,4}$(Pb)	211,4 (2)	0,18 (1)
$\gamma_{4,3}$(Pb)	233,3 (1)	0,31 (1)
$\gamma_{7,4}$(Pb)	252,5 (2)	0,78 (2)
$\gamma_{3,2}$(Pb)	277,37 (3)	6,6 (3)
$\gamma_{7,3}$(Pb)	485,8 (1)	0,049 (4)
$\gamma_{4,2}$(Pb)	510,7 (1)	22,6 (2)
$\gamma_{2,1}$(Pb)	583,187 (2)	85,0 (3)
$\gamma_{13,4}$(Pb)	587,8 (2)	0,06 (2)
$\gamma_{9,3}$(Pb)	650,2 (2)	0,05 (2)
$\gamma_{10,3}$(Pb)	705,3 (2)	0,022 (4)
$\gamma_{5,2}$(Pb)	722,0 (1)	0,24 (4)
$\gamma_{6,2}$(Pb)	748,7 (2)	0,046 (3)
$\gamma_{7,2}$(Pb)	763,2 (1)	1,79 (3)
$\gamma_{12,3}$(Pb)	808,3 (2)	0,030 (7)
$\gamma_{13,3}$(Pb)	821,1 (2)	0,041 (4)
$\gamma_{14,3}$(Pb)	835,9 (2)	0,076 (11)
$\gamma_{3,1}$(Pb)	860,56 (3)	12,5 (1)
$\gamma_{16,3}$(Pb)	883,4 (2)	0,031 (3)
$\gamma_{9,2}$(Pb)	927,6 (2)	0,125 (1)
$\gamma_{10,2}$(Pb)	982,7 (2)	0,205 (8)
$\gamma_{4,1}$(Pb)	1093,9 (1)	0,43 (2)
$\gamma_{15,2}$(Pb)	1125,7 (4)	0,005 (2)
$\gamma_{16,2}$(Pb)	1160,8 (2)	0,011 (3)
$\gamma_{17,2}$(Pb)	1185,2 (3)	0,017 (5)
$\gamma_{18,2}$(Pb)	1282,8 (3)	0,052 (5)

	Energy keV	Photons per 100 disint.
$\gamma_{8,1}$(Pb)	1381,1 (5)	0,007 (3)
$\gamma_{11,1}$(Pb)	1647,5 (7)	0,002 (1)
$\gamma_{16,1}$(Pb)	1743,9 (2)	0,002 (1)
$\gamma_{1,0}$(Pb)	2614,511 (10)	99,79 (1)

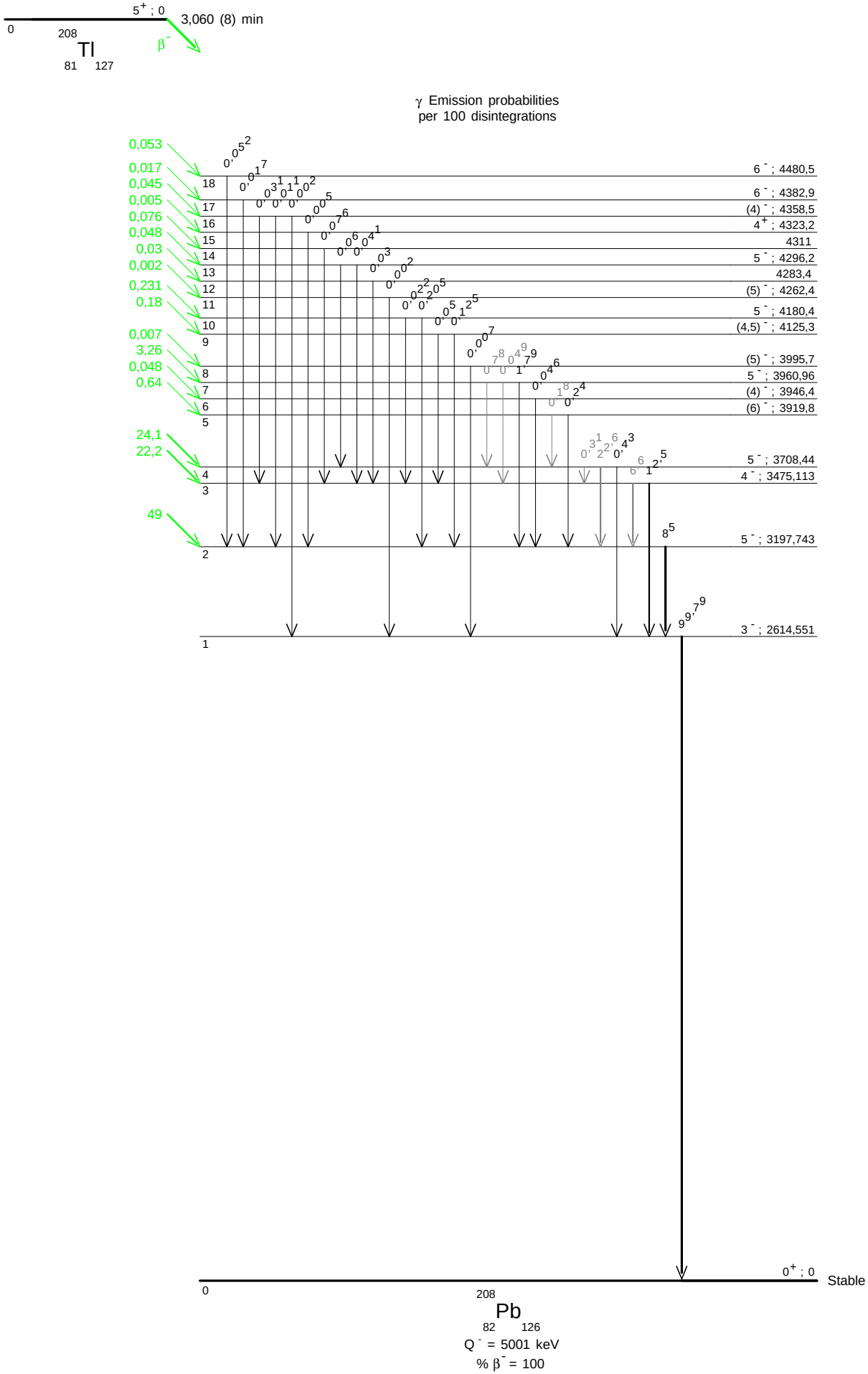
6 Main Production Modes

Bi – 212 α decay

7 References

- D.L. BAULCH, H.A. DAVID, J.F. DUNCAN. Australian J. Chem. 10 (1957) 85
  (Half-life)
- G. SCHUPP, H. DANIEL, G.W. EAKINS, E.N. JENSEN. Phys. Rev. 120 (1960) 189
  (Beta-ray emission probabilites, gamma-ray emission probabilities)
- G.T. EMERY, W.R. KANE. Phys. Rev. 118 (1960) 755
  (Beta-ray emission probabilites, gamma-ray emission probabilities)
- L. SIMONS, M. BRENNER, L. KÄLD, K-E. NYSTEN, E. SPRING. Soc. Sci. Fennica Comm. Phys. Math. 26 (1961) part 6
  (Gamma-ray emission probabilities)
- H. OSTERTAG, K.H. LAUTERJUNG. Z. Phys. 199 (1967) 25
  (Beta-ray emission probabilities)
- N.O. LASSEN, N. HORNSTRUP. Mat. Fys. Medd. Dan. Vit Selsk 36 (1967) No. 4
  (Half-life)
- J.S. LARSEN, B.C. JORGENSEN. Z. Phys. 227 (1969) 65
  (Gamma-ray emission probabilities)
- S.M. BRAHMAVAR, J.H. HAMILTON. Nucl. Instrum. Methods 69 (1969) 353
  (Gamma-ray energies)
- A. PAKKANEN, J. KANTELE, P. SUOMINEN. Z. Phys. 218 (1969) 273
  (Gamma-ray emission probabilities)
- G. AUBIN, J. BARRETTE, G. LAMOUREUX, S. MONARO. Nucl. Instrum. Methods 76 (1969) 85
  (Gamma-ray emission probabilities)
- V.H. MUNDSCHENK. Radiochim. Acta 14 (1970) 72
  (Half-life)
- R. ACKERHALT, P. ELLERBE, G. HARBOTTLE. Radiochem. Radioanal. Letters 8 (1971) 75
  (Half-life)
- J. DALMASSO. FRNC-TH-441 (1972)
  (Gamma-ray emission probabilities)
- P. JAGAM, D.S. MURTY. Nucl. Phys. A197 (1972) 540
  (Gamma-ray emission probabilities, multipolarity)
- J. DALMASSO, H. MARIA, C. YTHIER. Comp. Rend. Acad. Sci. (Paris) 277B (1973) 467
  (Gamma-ray emission probabilities)
- M. KORTELAHTI, A. PAKKENAN, J. KANTELE. Nucl. Phys. A240 (1975) 87
  (Gamma-ray emission probabilities, multipolarity)
- W. KURCEWICZ, E. RUCHOWSKA, N. KAFFRELL, N. TRAUTMANN. Nucl. Instrum. Methods 146 (1977) 613
  (Gamma-ray energies)
- R.J. GEHRKE, R.G. HELMER, R.C. GREENWOOD. Nucl. Instrum. Methods 147 (1977) 405
  (Gamma-ray emission probabilities)

- F. RÖSEL, H.M. FRIES, K. ALDER, H.C. PAULI. At. Data. Nucl. Data Tables 21 (1978) 291
(Internal conversion coefficients)
- F.T. AVIGNONE, A.G. SCHMIDT. Phys. Rev. C17 (1978) 380
(Gamma-ray emission probabilities)
- R.G. HELMER. Nucl. Instrum. Methods 164 (1979) 355
(Gamma-ray energies)
- S. SADASIVAN, V.M. RAGHUNATH. Nucl. Instrum. Methods 196 (1982) 561
(Gamma-ray emission probabilities)
- U. SCHÖTZIG, K. DEBERTIN. Int. J. Appl. Radiat. Isot. 34 (1983) 533
(Gamma-ray emission probabilities)
- R. VANINBROUKX, H.H. HANSEN. Int. J. Appl. Radiat. Isot. 34 (1983) 1395
(Gamma-ray emission probabilities)
- R.J. GEHRKE, V.J. NOVICK, J.D. BAKER. Int. J. Appl. Radiat. Isot. 35 (1984) 581
(Gamma-ray emission probabilities)
- M.J. MARTIN. Nucl. Data Sheets 47 (1986) 797
(Nuclear structure, energies)
- W-J. LIN, G. HARBOTTLE. J. Radioanal. Nucl. Chem. 157 (1992) 367
(Gamma-ray emission probabilities)
- O. EL SAMAD, J. DALMASSO, G. BARCI-FUNEL, G. ARDISSON. Radiochim. Acta 62 (1993) 65
(Gamma-ray emission probabilities)
- G. AUDI, A.H. WAPSTRA. Nucl. Phys. A595 (1995) 409
(Q value)
- E. SCHÖNFELD, H. JANssEN. Nucl. Instrum. Methods A369 (1996) 527
(K-x ray, L-x ray, Auger electrons)
- E. SCHÖNFELD, G. RODLOFF. Report PTB-6.11-98-1 (1998)
(Auger electrons)
- E. SCHÖNFELD, G. RODLOFF. Report PTB-6.11-1999-1 (1999)
(K-x ray)
- R.G. HELMER, C. VAN DER LEUN. Nucl. Instrum. Methods A450 (2000) 35
(Gamma energy)


5+ ; 0
3,060 (8) min
0
208
Tl
81 127
β-
γ Emission probabilities
per 100 disintegrations
0,053
0,017
0,045
0,005
0,076
0,048
0,03
0,002
0,231
0,18
0,007
3,26
0,048
0,64
24,1
22,2
49
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
6 - ; 4480,5
6 - ; 4382,9
(4) - ; 4358,5
4+ ; 4323,2
4311
5 - ; 4296,2
4283,4
(5) - ; 4262,4
5 - ; 4180,4
(4,5) - ; 4125,3
(5) - ; 3995,7
5 - ; 3960,96
(4) - ; 3946,4
(6) - ; 3919,8
5 - ; 3708,44
4 - ; 3475,113
5 - ; 3197,743
3 - ; 2614,551
0+ ; 0
Stable
0
208
Pb
82 126
Q - = 5001 keV
% β- = 100

$^{212}_{83}\mathrm{Bi}_{129}$

1 Decay Scheme

Bi-212 undergoes β^- decay to Po-212 (64.07(7)%), and α decay to Tl-208 (35.93(7)%).
Le bismuth 212 se désintègre à 64,07(7)% par émission β^- vers le polonium 212 et à 35,93(7)% par émission α vers le thallium 208.

2 Nuclear Data

$T_{1/2}(^{212}\mathrm{Bi})$	:	60,54	(6)	min
$T_{1/2}(^{212}\mathrm{Po})$	:	300	(2)	10^{-9} s
$T_{1/2}(^{208}\mathrm{Tl})$	:	3,060	(8)	min
$Q^-(^{212}\mathrm{Bi})$	:	2254	(2)	keV
$Q^\alpha(^{212}\mathrm{Bi})$	:	6207,14	(4)	keV

2.1 α Transitions

	Energy keV	Probability × 100	F
$\alpha_{0,7}$	5400 (1)	0,000039 (4)	20800
$\alpha_{0,6}$	5448 (1)	0,00036 (18)	3810
$\alpha_{0,5}$	5586,7 (3)	0,0050 (7)	1370
$\alpha_{0,4}$	5714,45 (14)	0,43 (4)	66,9
$\alpha_{0,3}$	5733,6 (2)	0,06 (1)	594
$\alpha_{0,2}$	5879,2 (1)	0,63 (3)	269
$\alpha_{0,1}$	6167,28 (4)	25,1 (1)	126
$\alpha_{0,0}$	6207,14 (4)	9,7 (1)	480
$^*\alpha_{1,0}$	9681,46 (12)	0,0024 (2)	
$^*\alpha_{4,0}$	10633,58 (13)	0,0010 (1)	
$^*\alpha_{5,0}$	10755,0 (3)	0,0106 (8)	

* Transitions α of long range.

2.2 β^- Transitions

	Energy keV	Probability × 100	Nature	lg ft
$\beta^-_{0,6}$	448 (2)	0,68 (5)	1st Forbidden non-unique	6,69
$\beta^-_{0,5}$	453 (2)	0,029 (1)	1st Forbidden non-unique	8,08
$\beta^-_{0,4}$	575 (2)	0,21 (5)	1st Forbidden non-unique	7,56
$\beta^-_{0,3}$	633 (2)	1,90 (4)	1st Forbidden non-unique	6,74
$\beta^-_{0,2}$	741 (2)	1,45 (2)	1st Forbidden non-unique	7,1
$\beta^-_{0,1}$	1527 (2)	4,58 (21)	1st Forbidden non-unique	7,71
$\beta^-_{0,0}$	2254 (2)	55,23 (21)	1st Forbidden non-unique	7,269

2.3 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M+	α_T
$\gamma_{1,0}$(Tl)	39,858 (4)	26 (1)	[M1]		18,6 (5)	6,00 (18)	24,6 (7)
$\gamma_{5,3}$(Po)	180,2 (2)	0,010 (3)	M1	1,79 (5)	0,32 (1)	0,100 (3)	2,21 (7)
$\gamma_{2,1}$(Tl)	288,08 (6)	0,47 (3)	[M1+E2]	0,378 (11)	0,064 (2)	0,0190 (6)	0,461 (14)
$\gamma_{2,0}$(Tl)	327,94 (6)	0,160 (4)	[M1]	0,267 (8)	0,0450 (13)	0,0130 (4)	0,325 (10)
$\gamma_{3,1}$(Tl)	433,7 (2)	0,011 (2)	[M1]	0,126 (4)	0,0210 (6)	0,0060 (2)	0,153 (5)
$\gamma_{4,1}$(Tl)	452,8 (1)	0,39 (3)	[M1]	0,112 (3)	0,0190 (6)	0,0060 (2)	0,137 (4)
$\gamma_{3,0}$(Tl)	473,6 (2)	0,049 (3)	[M1]	0,100 (3)	0,0160 (5)	0,00500 (15)	0,121 (4)
$\gamma_{4,0}$(Tl)	492,7 (1)	0,04 (1)	[M1]	0,090 (3)	0,0150 (5)	0,00400 (12)	0,109 (3)
$\gamma_{5,1}$(Tl)	580,5 (3)	0,0010 (2)	[E2]	0,0148 (5)	0,0039 (1)	0,00130 (4)	0,0200 (6)
$\gamma_{5,0}$(Tl)	620,4 (3)	0,0040 (6)	[M1]	0,0492 (15)	0,0081 (2)	0,00250 (8)	0,0598 (18)
$\gamma_{1,0}$(Po)	727,33 (1)	6,84 (12)	E2	0,0106 (3)	0,00260 (8)	0,00090 (3)	0,0141 (4)
$\gamma_{6,0}$(Tl)	759 (1)	0,00036 (18)					
$\gamma_{2,1}$(Po)	785,37 (9)	1,16 (1)	[M1+E2]	0,0338 (10)	0,0057 (2)	0,00180 (5)	0,0413 (12)
$\gamma_{7,0}$(Tl)	807 (1)	0,000039 (4)					
$\gamma_{3,1}$(Po)	893,41 (2)	0,39 (1)	[M1+E2]	0,0243 (7)	0,0041 (1)	0,00130 (4)	0,0297 (9)
$\gamma_{4,1}$(Po)	952,12 (2)	0,14 (4)	[M1+E2]	0,0164 (5)	0,00280 (8)	0,00100 (3)	0,0202 (6)
$\gamma_{5,1}$(Po)	1073,6 (2)	0,015 (5)	E2	0,00516 (15)	0,00100 (3)	0,00033 (1)	0,00649 (20)
$\gamma_{6,1}$(Po)	1078,63 (11)	0,56 (2)	[M1+E2]	0,0149 (4)	0,00230 (7)	0,00090 (3)	0,0181 (5)
$\gamma_{2,0}$(Po)	1512,70 (8)	0,29 (1)	E2	0,00278 (8)	0,00048 (2)	0,000160 (5)	0,00342 (10)
$\gamma_{3,0}$(Po)	1620,74 (1)	1,52 (3)	[M1+E2]	0,00504 (15)	0,00078 (2)	0,000030 (1)	0,00585 (18)
$\gamma_{4,0}$(Po)	1679,45 (1)	0,07 (1)	E2	0,00230 (7)	0,00039 (1)	0,000130 (4)	0,00282 (8)
$\gamma_{5,0}$(Po)	1800,9 (2)	0,004 (2)	E0				
$\gamma_{6,0}$(Po)	1805,96 (10)	0,12 (3)	E2	0,00202 (6)	0,00034 (1)	0,000110 (3)	0,00247 (7)

3 Atomic Data

3.1 Po

ω_K : 0,965 (4)
$\bar{\omega}_L$: 0,403 (16)
n_{KL} : 0,807 (5)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	76,864		60,1
	$K\alpha_1$	79,293		100
	$K\beta_3$	89,256	}	
	$K\beta_1$	89,63	}	
	$K\beta_5''$	90,363	}	34,4
	$K\beta_2$	92,45	}	
	$K\beta_4$	92,62	}	10,7
	$KO_{2,3}$	92,98	}	
X_L				
	$L\ell$	9,66		
	$L\alpha$	11,016 – 11,13		
	$L\eta$	12,085		
	$L\beta$	12,823 – 13,778		
	$L\gamma$	15,742 – 16,21		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	58,98 – 65,21	100
KLX	71,90 – 79,29	57
KXY	84,8 – 93,1	8,1
Auger L	5,43 – 10,93	3190

3.2 Tl

ω_K : 0,963 (4)
$\bar{\omega}_L$: 0,367 (15)
n_{KL} : 0,812 (5)

3.2.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	70,833		59
	$K\alpha_1$	72,873		100
	$K\beta_3$	82,118	}	
	$K\beta_1$	82,43	}	
	$K\beta''_5$	83,115	}	34
	$K\beta_2$	84,838	}	
	$K\beta_4$	85,134	}	10,1
	$KO_{2,3}$	85,444	}	
X_L				
	$L\ell$	8,953		
	$L\alpha$	10,172 – 10,268		
	$L\eta$	10,994		
	$L\beta$	11,812 – 12,643		
	$L\gamma$	14,291 – 14,738		

3.2.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	54,59 – 59,95	100
KLX	66,37 – 72,86	55
KXY	78,12 – 85,50	7,6
Auger L	5,18 – 10,13	363000

4 α Emissions

	Energy keV	Probability × 100
$\alpha_{0,7}$	5298 (1)	0,000039 (4)
$\alpha_{0,6}$	5345 (1)	0,00036 (18)
$\alpha_{0,5}$	5481,3 (3)	0,0050 (7)
$\alpha_{0,4}$	5606,63 (14)	0,43 (4)
$\alpha_{0,3}$	5625,4 (2)	0,06 (1)
$\alpha_{0,2}$	5768,27 (10)	0,63 (3)
$\alpha_{0,1}$	6050,92 (4)	25,1 (1)
$\alpha_{0,0}$	6090,02 (4)	9,7 (1)
$^{*}\alpha_{1,0}$	9498,79 (12)	0,0024 (2)
$^{*}\alpha_{4,0}$	10432,95 (13)	0,0010 (1)
$^{*}\alpha_{5,0}$	10552,1 (3)	0,0106 (8)

* α of long range.

5 Electron Emissions

		Energy keV	Electrons per 100 disint.
e_{AL}	(Po)	5,43 - 10,93	0,0958 (16)
e_{AK}	(Po)		0,0050 (6)
	KLL	58,98 - 65,21	}
	KLX	71,90 - 79,29	}
	KXY	84,8 - 93,1	}
e_{AL}	(Tl)	5,18 - 10,13	16,7 (7)
e_{AK}	(Tl)		0,0074 (9)
	KLL	54,59 - 59,95	}
	KLX	66,37 - 72,86	}
	KXY	78,12 - 85,50	}
$ec_{1,0\ L}$	(Tl)	24,51 - 27,20	19 (1)
$ec_{1,0\ M}$	(Tl)	36,15 - 39,85	6,1 (2)
$\beta^{-}_{0,6}$	max:	448 (2)	0,68 (5)
$\beta^{-}_{0,6}$	avg:	130,7 (7)	
$\beta^{-}_{0,5}$	max:	453 (2)	0,029 (1)
$\beta^{-}_{0,5}$	avg:	132,3 (7)	
$\beta^{-}_{0,4}$	max:	575 (2)	0,21 (5)
$\beta^{-}_{0,4}$	avg:	173,0 (7)	

		Energy keV		Electrons per 100 disint.
$\beta^-_{0,3}$	max:	633	(2)	1,90 (4)
$\beta^-_{0,3}$	avg:	193,3	(7)	
$\beta^-_{0,2}$	max:	741	(2)	1,45 (2)
$\beta^-_{0,2}$	avg:	231,5	(8)	
$\beta^-_{0,1}$	max:	1527	(2)	4,58 (21)
$\beta^-_{0,1}$	avg:	533,9	(8)	
$\beta^-_{0,0}$	max:	2254	(2)	55,23 (21)
$\beta^-_{0,0}$	avg:	835,0	(9)	

6 Photon Emissions

6.1 X-Ray Emissions

		Energy keV		Photons per 100 disint.	
XL	(Po)	9,66 — 16,21		0,0581 (12)	
XKα_2	(Po)	76,864		0,0404 (10)	} Kα
XKα_1	(Po)	79,293		0,0672 (17)	}
XKβ_3	(Po)	89,256	}		
XKβ_1	(Po)	89,63	}	0,0231 (7)	K$'\beta_1$
XKβ''_5	(Po)	90,363	}		
XKβ_2	(Po)	92,45	}		
XKβ_4	(Po)	92,62	}	0,00720 (24)	K$'\beta_2$
XKO$_{2,3}$	(Po)	92,98	}		
XL	(Tl)	8,953 — 14,738		6,73 (22)	
XKα_2	(Tl)	70,833		0,0563 (27)	} Kα
XKα_1	(Tl)	72,873		0,095 (5)	}
XKβ_3	(Tl)	82,118	}		
XKβ_1	(Tl)	82,43	}	0,0323 (16)	K$'\beta_1$
XKβ''_5	(Tl)	83,115	}		
XKβ_2	(Tl)	84,838	}		
XKβ_4	(Tl)	85,134	}	0,0096 (5)	K$'\beta_2$
XKO$_{2,3}$	(Tl)	85,444	}		

6.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{1,0}$(Tl)	39,858 (4)	1,01 (3)
$\gamma_{5,3}$(Po)	180,2 (2)	0,003 (1)
$\gamma_{2,1}$(Tl)	288,08 (6)	0,32 (2)
$\gamma_{2,0}$(Tl)	327,94 (6)	0,121 (3)
$\gamma_{3,1}$(Tl)	433,7 (2)	0,0095 (20)
$\gamma_{4,1}$(Tl)	452,8 (1)	0,34 (3)
$\gamma_{3,0}$(Tl)	473,6 (2)	0,044 (3)
$\gamma_{4,0}$(Tl)	492,7 (1)	0,04 (1)
$\gamma_{5,1}$(Tl)	580,5 (3)	0,0010 (2)
$\gamma_{5,0}$(Tl)	620,4 (3)	0,0038 (6)
$\gamma_{1,0}$(Po)	727,33 (1)	6,74 (12)
$\gamma_{6,0}$(Tl)	759 (1)	0,00036 (18)
$\gamma_{2,1}$(Po)	785,37 (9)	1,11 (1)
$\gamma_{7,0}$(Tl)	807 (1)	0,000039 (4)
$\gamma_{3,1}$(Po)	893,41 (2)	0,38 (1)
$\gamma_{4,1}$(Po)	952,12 (2)	0,14 (4)
$\gamma_{5,1}$(Po)	1073,6 (2)	0,015 (5)
$\gamma_{6,1}$(Po)	1078,63 (11)	0,55 (2)
$\gamma_{2,0}$(Po)	1512,70 (8)	0,29 (1)
$\gamma_{3,0}$(Po)	1620,74 (1)	1,51 (3)
$\gamma_{4,0}$(Po)	1679,45 (1)	0,07 (1)
$\gamma_{5,0}$(Po)	1800,9 (2)	0,004 (2)
$\gamma_{6,0}$(Po)	1805,96 (10)	0,12 (3)

7 Main Production Modes

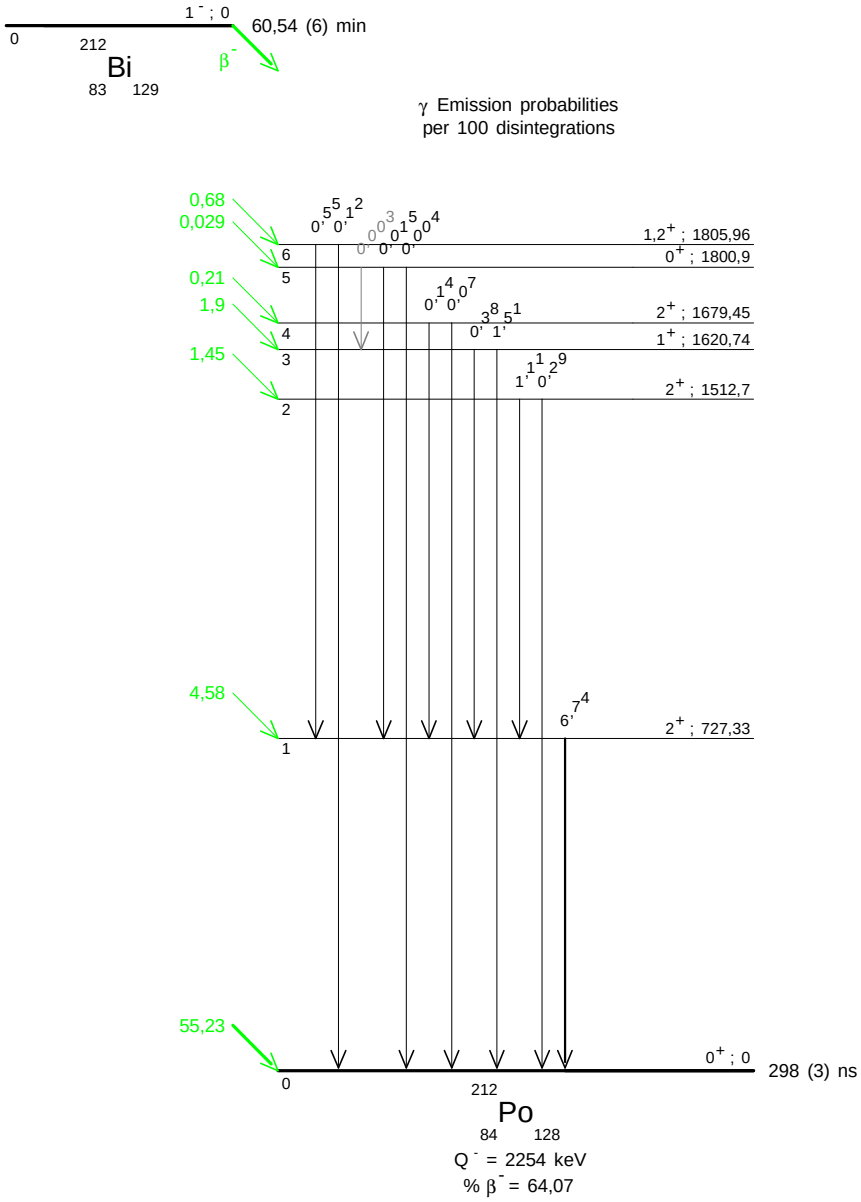
Pb – 212 β^- decay

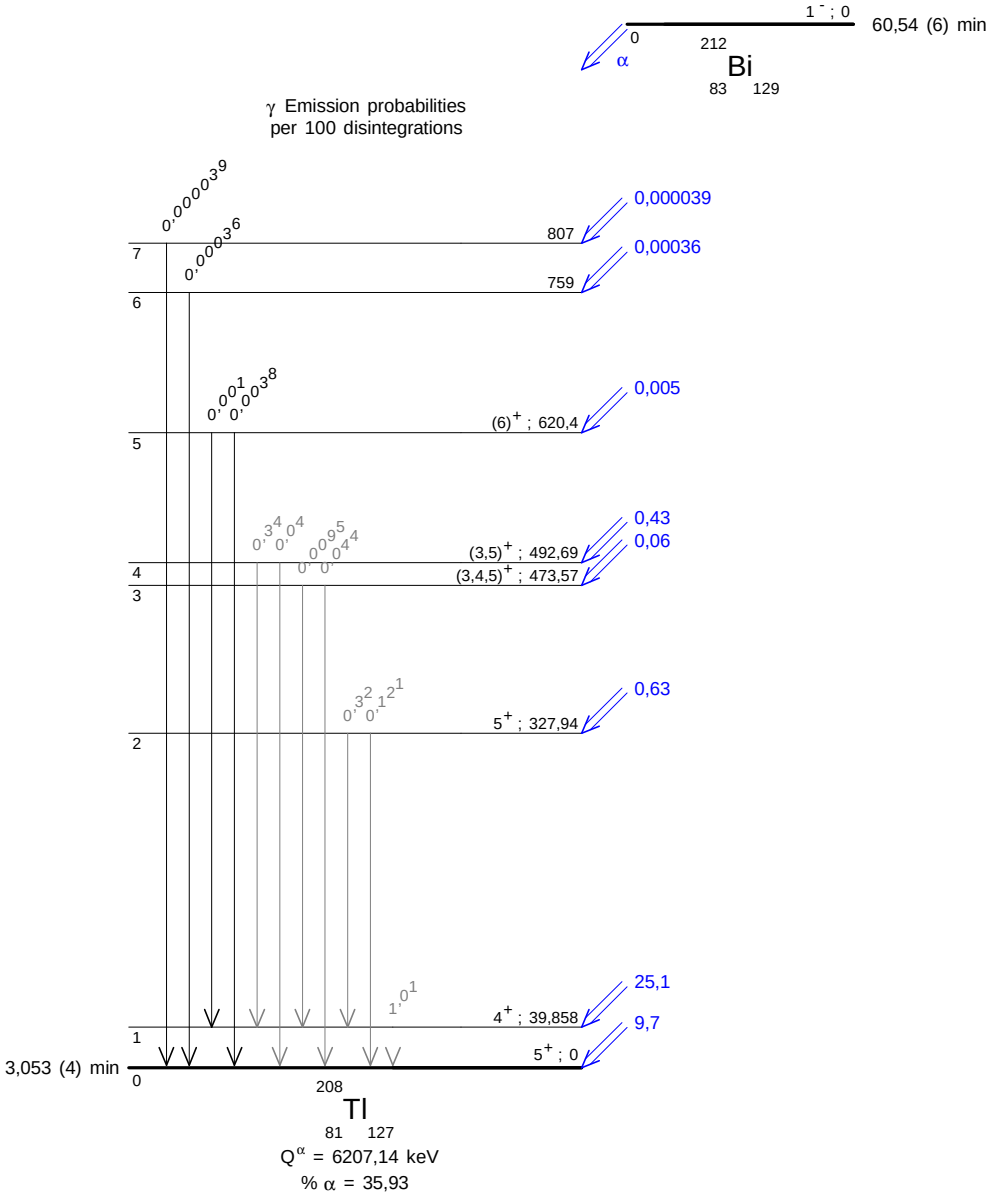
8 References

- F.V. LERCH. Sitzber. Akad. Wiss. Wien, Wath-naturw. Kl. Abt. IIa 123 (1914) 699
  (Half-life)
- W.B. LEWIS, B.V. BOWDEN. Proc. Roy. Soc. (London) A145 (1934) 235
  (Alpha emission energies, Alpha emission probabilities)
- D.E. BUNYAN, A. LUNDBY, W. WALKER. Proc. Phys. Soc. (London) 62A (1949) 253
  (Half-life)
- A. RYTZ. Comp. Rend. Acad. Sci. (Paris) 233 (1951) 790
  (Alpha emission energies, Alpha emission probabilities)
- K. SIEGBAHN, K. EDVARSON. Nucl. Phys. 1 (1956) 137
  (Gamma-ray energies)
- J. BURDE, B. ROZNER. Phys. Rev. 107 (1957) 531
  (Beta-ray emission probabilities)
- R.J. WALEN, G. BASTIN-SCOFFIER. Nucl. Phys. 16 (1960) 246
  (Alpha emission energies, Alpha emission probabilities)

- G. SCHUPP, H. DANIEL, G.W. EAKINS, E.N. JENSEN. Phys. Rev. 120 (1960) 189
(Gamma-ray emission probabilities)
- G.T. EMERY, W.R. KANE. Phys. Rev. 118 (1960) 755
(Gamma-ray emission probabilities, high-energy alpha)
- K.P. APPLEGATE, E.M. MORIMOTO, M. KAHR, J.D. KNIGHT. J. Inorg. Nucl. Chem. 19 (1961) 375
(Half-life)
- F.C. FLACK, J.E. JOHNSON. Proc. Phys. Soc. 79 (1962) 10
(Gamma-ray emission probabilities, branching fraction)
- G. BERTOLINI, F. CAPELLANI, G. RESTELLI, A. ROTA. Nucl. Phys. 30 (1962) 599
(Alpha emission probabilities)
- G. ASTNER, I. BERGSTROM, L. ERIKSSON, U. FAGERQUIST, G. HOLM, A. PERSSON. Nucl. Phys. 45 (1963) 49
(Half-life)
- H. DANIEL, G. LUHRS. Z. Phys. 176 (1963) 30
(Gamma-ray emission probabilities)
- J.L. WININGER. J. Phys. (Paris) 25 (1964) 897
(Gamma-ray energies)
- J. WALKER, T. SALGIR. Proc. Phys. Soc. 86 (1965) 423
(Branching fraction)
- C.F. LEANG. Comp. Rend. Acad. Sci. (Paris) 260 (1965) 3037
(Alpha emission energies, Alpha emission probabilities)
- S.S. KLEIN. NP-16835 (1965)
(Gamma-ray energies)
- N.O. LASSEN, N. HORNSTRUP. Mat. Fys. Medd. Dan. Vit. Selsk. 36, No.4 (1967)
(Half-life)
- R. BENOIT, G. BERTOLINI, F. CAPPELLANI, G. RESTELLI. Nuovo Cim. 49B (1967) 125
(Gamma-ray emission probabilities)
- J. DALMASSO, C. MARSOL. Comp. Rend. Acad. Sci. (Paris) 267B (1968) 1366
(Gamma-ray emission probabilities)
- C. YTHIER, H. FOREST, G. ARDISSON, H. MARIA. Comp. Rend. Acad. Sci. (Paris) 267 (1968) 1362
(Gamma-ray energies, Gamma-ray emission probabilities)
- B. GRENNBERG, A. RYTZ. Comp. Rend. Acad. Sci. (Paris) 269B (1969) 652
(Alpha emission probabilities, Alpha emission energies)
- S.M. BRAHMAVAR, J.H. HAMILTON. Nucl. Instrum. Methods 69 (1969) 353
(Gamma-ray energies)
- R. ACKERHALT, P. ELLERBE, G. HARBOTTLE. Radiochem. Radioanal. Lett. 8 (1971) 75
(Half-life)
- J. DALMASSO. FRNC-TH-441 (1972)
(Gamma-ray emission probabilities)
- J. DALMASSO, H. MARIA, C. YTHIER. Comp. Rend. Acad. Sci. (Paris) 277B (1973) 467
(Gamma-ray emission probabilities)
- A.G.da SILVA, L.T. AULER, G.L. AULER, G.L.de ALMEIDA, R.H. TOPKE. INIS Atomindex-mf-1222 (1974)
(Gamma-ray energies, Gamma-ray emission probabilities)
- S. SANYAL, R.K. GARG, S.D. CHAUHAN, S.I. GUPTA, S.C. PANCHOLI. Phys. Rev. C12 (1975) 318
(Half-life)
- F.T. AVIGNONE, A.G. SCHMIDT. Phys. Rev. C17 (1978) 380
(Gamma-ray emission probabilities)
- F. RÖSEL, H.M. FRIES, K. ALDER, H.C. PAULI. At. Data Nucl. Data Tables 21 (1978) 291
(Internal convesion coefficients)
- R.G. HELMER. Nucl. Instrum. Methods 164 (1979) 355
(Gamma-ray energies)
- A. RYTZ. At. Data. Nucl. Data Tables 23 (1979) 507
(Alpha emission energies, Alpha emission probabilities)
- S. SADASIVAN, V.M. RAGHUNATH. Nucl. Instrum. Methods 196 (1982) 561
(Gamma-ray emission probabilities)
- B. BENGTSON, H.L. NIELSEN, N. RUD, K. WILSKY. Nucl. Phys. A378 (1982) 1
(Multipolarity)
- R. VANINBROUKX, H.H. HANSEN. Int. J. Appl. Radiat. Isotop. 34 (1983) 1395
(Gamma-ray emission probabilities)

- U. SCHÖTZIG, K. DEBERTIN. Int. J. Appl. Radiat. Isotop. 34 (1983) 533
(Gamma-ray emission probabilities)
- R.J. GEHRKE, V.J. NOVICK, J.D. BAKER. Int. J. Appl. Radiat. Isotop. 35 (1984) 581
(Gamma-ray emission probabilities)
- A.H. WAPSTRA, G. AUDI. Nucl. Phys. A432 (1985) 1
(Q values)
- M.J. MARTIN. Nucl. Data Sheets 47 (1986) 797
(Nuclear structure, energies)
- A. ARTNA-COHEN. Nucl. Data Sheets 66 (1992) 171
(Nuclear structure, energies)
- W-J. LIN, G. HARBOTTLE. J. Radioanal. Nucl. Chem. 157 (1992) 367
(Gamma-ray emission probabilities)
- G. AUDI, A.H. WAPSTRA. Nucl. Phys. A595 (1995) 409
(Q values)
- E. SCHÖNFELD, H. JANSSEN. Nucl. Instrum. Methods A369 (1996) 527
(K-x ray, L-x ray, Auger electrons)
- E. SCHÖNFELD, G. RODLOFF. Report PTB-6.11-98-1 (1998)
(Auger electrons)
- E. SCHÖNFELD, G. RODLOFF. Report PTB-6.11-1999-1 (1999)
(K-x ray)


1⁻ ; 0
60,54 (6) min
0
212
Bi
83 129
β⁻
γ Emission probabilities
per 100 disintegrations
0,68
0,029
0,21
1,9
1,45
4,58
55,23
1,2⁺ ; 1805,96
0⁺ ; 1800,9
2⁺ ; 1679,45
1⁺ ; 1620,74
2⁺ ; 1512,7
2⁺ ; 727,33
0⁺ ; 0
298 (3) ns
6
5
4
3
2
1
0
212
Po
84 128
Q⁻ = 2254 keV
% β⁻ = 64,07


1⁻ ; 0
60,54 (6) min
0
α
212
Bi
83 129
γ Emission probabilities
per 100 disintegrations
0,000039
807
0,00036
759
0,005
(6)⁺ ; 620,4
0,43
(3,5)⁺ ; 492,69
0,06
(3,4,5)⁺ ; 473,57
0,63
5⁺ ; 327,94
25,1
4⁺ ; 39,858
9,7
5⁺ ; 0
7
6
5
4
3
2
1
0
3,053 (4) min
208
Tl
81 127
Q^α = 6207,14 keV
% α = 35,93

$^{212}_{82}\mathrm{Pb}_{130}$

1 Decay Scheme

Pb-212 disintegrates by beta minus emission to excited and fundamental levels of Bi-212.
Le plomb 212 se désintègre par émission bêta moins vers des niveaux excités et fondamental du bismuth 212.

2 Nuclear Data

$T_{1/2}(^{212}\mathrm{Pb}\ )$: 10,64 (1) h
$T_{1/2}(^{212}\mathrm{Bi}\ )$: 60,54 (6) min
$Q^{-}(^{212}\mathrm{Pb}\ )$: 574 (2) keV

2.1 β^- Transitions

	Energy keV	Probability × 100	Nature	lg ft
$\beta^-_{0,3}$	159 (2)	5,1 (2)	1st Forbidden	5,38
$\beta^-_{0,2}$	335 (2)	84,0 (14)	1st Forbidden	5,19
$\beta^-_{0,0}$	574 (2)	10,9 (14)	1st Forbidden	6,84

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M+	α_T
$\gamma_{1,0}$(Bi)	115,183 (5)	5,12 (21)	[M1]	5,87 (18)	1,027 (30)	0,323 (10)	7,22 (22)
$\gamma_{2,1}$(Bi)	123,45 (1)	0,37 (1)	[E2]	0,418 (8)	1,802 (36)	0,630 (13)	2,85 (6)
$\gamma_{3,2}$(Bi)	176,64 (1)	0,16 (2)	[M1]	1,742 (50)	0,303 (10)	0,095 (3)	2,14 (6)
$\gamma_{2,0}$(Bi)	238,632 (2)	83,8 (11)	[M1]	0,753 (23)	0,130 (4)	0,040 (1)	0,923 (30)
$\gamma_{3,1}$(Bi)	300,09 (1)	4,74 (20)	[M1]	0,401 (12)	0,069 (2)	0,0210 (6)	0,491 (15)
$\gamma_{3,0}$(Bi)	415,27 (1)	0,17 (3)	[M1]	0,167 (5)	0,028 (1)	0,0090 (3)	0,204 (6)

3 Atomic Data

3.1 Bi

ω_K : 0,964 (4)
$\bar{\omega}_L$: 0,391 (16)
n_{KL} : 0,809 (5)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	74,8157		59,8
	$K\alpha_1$	77,1088		100
	$K\beta_3$	86,835	}	
	$K\beta_1$	87,344	}	
	$K\beta_5''$	87,862	}	34,2
	$K\beta_2$	89,91	}	
	$K\beta_4$	90,074	}	10,4
	$KO_{2,3}$	90,421	}	
X_L				
	$L\ell$	9,42		
	$L\alpha$	10,731 – 10,839		
	$L\eta$	11,712		
	$L\beta$	12,48 – 13,393		
	$L\gamma$	15,248 – 15,709		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	57,49 – 63,42	100
KLX	70,03 – 77,11	57
KXY	82,53 – 90,52	7,8
Auger L	5,35 – 10,66	3040

4 Electron Emissions

		Energy keV	Electrons per 100 disint.
e_{AL}	(Bi)	5,35 - 10,66	25,2 (5)
e_{AK}	(Bi)		1,37 (16)
	KLL	57,49 - 63,42	}
	KLX	70,03 - 77,11	}
	KXY	82,53 - 90,52	}
$ec_{1,0\ K}$	(Bi)	24,657 (5)	3,66 (13)
$ec_{1,0\ L}$	(Bi)	98,80 - 101,76	0,64 (2)
$ec_{1,0\ M}$	(Bi)	111,18 - 115,03	0,20 (1)
$ec_{2,0\ K}$	(Bi)	148,106 (2)	33 (1)
$ec_{3,1\ K}$	(Bi)	209,56 (2)	1,27 (4)
$ec_{2,0\ L}$	(Bi)	222,24 - 225,21	5,7 (2)
$ec_{2,0\ M}$	(Bi)	234,63 - 238,47	1,7 (1)
$ec_{3,1\ L}$	(Bi)	283,70 - 286,67	0,22 (1)
$ec_{3,1\ M}$	(Bi)	296,09 - 299,93	0,07
$\beta^-_{0,3}$	max:	159 (2)	5,1 (2)
$\beta^-_{0,3}$	avg:	42,3 (6)	
$\beta^-_{0,2}$	max:	335 (2)	84,0 (14)
$\beta^-_{0,2}$	avg:	94,8 (7)	
$\beta^-_{0,0}$	max:	574 (2)	10,9 (14)
$\beta^-_{0,0}$	avg:	173,1 (7)	

5 Photon Emissions

5.1 X-Ray Emissions

		Energy keV	Photons per 100 disint.	
XL	(Bi)	9,42 — 15,709	14,5 (4)	
$XK\alpha_2$	(Bi)	74,8157	10,7 (3)	} $K\alpha$
$XK\alpha_1$	(Bi)	77,1088	17,9 (5)	}
$XK\beta_3$	(Bi)	86,835	}	
$XK\beta_1$	(Bi)	87,344	} 6,12 (20)	$K'\beta_1$
$XK\beta''_5$	(Bi)	87,862	}	
$XK\beta_2$	(Bi)	89,91	}	
$XK\beta_4$	(Bi)	90,074	} 1,87 (7)	$K'\beta_2$
$XKO_{2,3}$	(Bi)	90,421	}	

5.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{1,0}$(Bi)	115,183 (5)	0,623 (22)
$\gamma_{2,1}$(Bi)	123,45 (1)	0,096 (4)
$\gamma_{3,2}$(Bi)	176,64 (1)	0,052 (4)
$\gamma_{2,0}$(Bi)	238,632 (2)	43,6 (3)
$\gamma_{3,1}$(Bi)	300,09 (1)	3,18 (13)
$\gamma_{3,0}$(Bi)	415,27 (1)	0,144 (22)

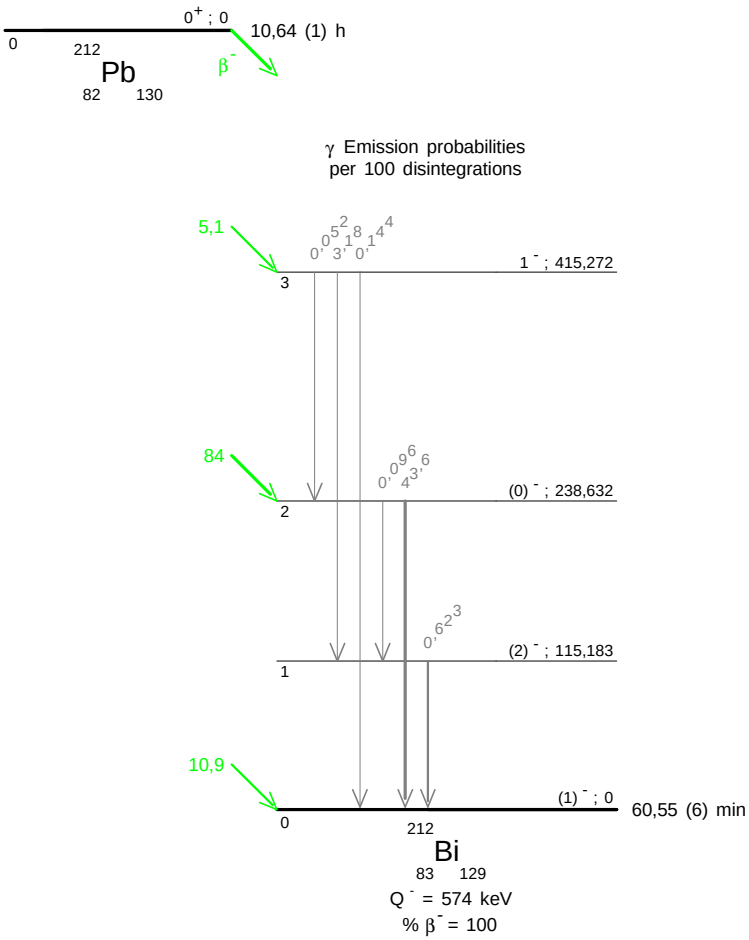
6 Main Production Modes

Po − 210(t,p)Pb − 212
Po − 216 α decay

7 References

- D.G.E. MARTIN, H.O.W. RICHARDSON. Proc. Phys. Soc. 195A (1948) 287
  (Beta-ray emission probabilities)
- H.von BUTTLAR. Naturwissenschaften 39 (1952) 575
  (Half-life)
- P. MARIN, G.R. BISHOP, H. HALBAN. Proc. Phys. Soc. (London) 66A (1953) 608
  (Half-life)
- J. TOBAILEM, J. ROBERT. J. Phys. Radium 16 (1955) 115
  (Half-life)
- E.M. KRISYOUK, A.G. SERVEYEV, G.D. LATYSHEV, V.D. VOROBYOV. Nucl. Phys. 4 (1957) 579
  (Conversion-electron emission probabilities, multipolarity)
- K.O. NIELSEN, O.B. NIELSEN, M.A. WAGGONER. Nucl. Phys. 2 (1957) 476
  (Conversion-electron emission probabilities, multipolarity)
- A.G. SERGEYEV, V.D. VOROLYEV, A.S. REMENNYI, T.J. KOLCHENSKAYA, G.D. LATYSHEV, Y.S. YEGOROV. Nucl. Phys. 9 (1959) 498
  (Mixing Ratio)
- P.G. ROETLING, W.P. GANLEY, G.S. KLAIBER. Nucl. Phys. 20 (1960) 347
  (Gamma-ray emission probabilities, multipolarity)
- M. GIANNINI, D. PROSPERI, S. SCIUTI. Nuovo Cim. 21 (1961) 430
  (Gamma-ray emission probabilities)
- H. DANIEL, G. LÜHRS. Z. Phys. 176 (1963) 30
  (Conversion-electron emission probabilities, multipolarity)
- D. KRPIC, R. STEPIC, M. BOGDANOVIC, M. MLADENOVIC. Fizika 1 (1969) 171
  (Mixing Ratio)
- J. DALMASSO. Report FRNC-TH-441 (1972)
  (Gamma-ray emission probabilities)
- J. DALMASSO, H. MARIA, C. YTHIER. Comp. Rend. Acad. Sci. (Paris) 277B (1973) 467
  (Gamma-ray emission probabilities)
- F. RÖSEL, H.M. FRIES, K. ALDER, H.C. PAULI. At. Data. Nucl. Data Tables 21 (1978) 291
  (Internal conversion coefficients)
- F.T. AVIGNONE, A.G. SCHMIDT. Phys. Rev. C17 (1978) 380
  (Gamma-ray emission probabilities)
- S. SADASIVAN, V.M. RAGHUNATH. Nucl. Instrum. Methods 196 (1982) 561
  (Gamma-ray emission probabilities)

- R. VANINBROUKX, H.H. HANSEN. Int. J. Appl. Radiat. Isot. 34 (1983) 1395
  (Gamma-ray emission probabilities)
- U. SCHÖTZIG, K. DEBERTIN. Int. J. Appl. Radiat. Isot. 34 (1983) 533
  (Gamma-ray emission probabilities)
- R.J. GEHRKE, V.J. NOVICK, J.D. BAKER. Int. J. Appl. Radiat. Isot. 35 (1984) 581
  (Gamma-ray emission probabilities)
- A. ARTNA-COHEN. Nucl. Data Sheets 66 (1992) 171
  (Nuclear structure, energies)
- W-J. LIN, G. HARBOTTLE. J. Radioanal. Nucl. Chem. 157 (1992) 367
  (Gamma-ray emission probabilities)
- G. AUDI, A.H. WAPSTRA. Nucl. Phys. A595 (1995) 409
  (Q value)
- E. SCHÖNFELD, H. JANSSEN. Nucl. Instrum. Methods Phys. Res. A369 (1996) 527
  (K-x ray, L-x ray, Auger electrons)
- E. SCHÖNFELD, G. RODLOFF. Report PTB-6.11-98-1 (1998)
  (Auger electrons)
- E. SCHÖNFELD, G. RODLOFF. Report PTB-6.11-1999-1 (1999)
  (K-x ray)


0+ ; 0
10,64 (1) h
0
212
Pb
82 130
β-
γ Emission probabilities
per 100 disintegrations
5,1
0,52 1,8 1,44
0,03 0,0
1- ; 415,272
3
84
0,096 0,436
(0)- ; 238,632
2
0,623
(2)- ; 115,183
1
10,9
(1)- ; 0
60,55 (6) min
0
212
Bi
83 129
Q- = 574 keV
% β- = 100

$^{212}_{84}\mathrm{Po}_{128}$

1 Decay Scheme

Po-212 is an extremely short-lived radionuclide populated via the beta decay of Bi-212 and the alpha decay of Rn-216. Alpha decay of Po-212 occurs directly to the ground state of Pb-208.
Le polonium 212 se désintègre par émission alpha vers le niveau fondamental du plomb 208.

2 Nuclear Data

$T_{1/2}(^{212}\mathrm{Po})$	:	300	(2)	10^{-9} s
$Q^{\alpha}(^{212}\mathrm{Po})$	:	8954,13	(11)	keV

2.1 α Transitions

	Energy keV	Probability × 100	F
$\alpha_{0,0}$	8954,13 (11)	100	1

3 α Emissions

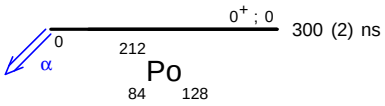
	Energy keV	Probability × 100
$\alpha_{0,0}$	8785,18 (11)	100

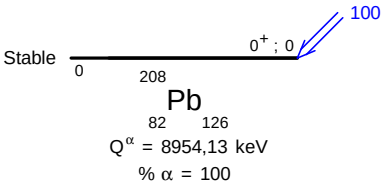
4 Main Production Modes

$\mathrm{Bi} - 212(\beta^-)\mathrm{Po} - 212$
$\mathrm{Rn} - 216(\alpha)\mathrm{Po} - 212$
$\mathrm{Bi} - 209(\alpha,\mathrm{p})\mathrm{Po} - 212$
$\mathrm{Pb} - 210(\alpha,2\mathrm{n}\gamma)\mathrm{Po} - 212$

5 References

- D.E. BUNYAN, A. LUNDLY, W. WALKER. Proc. Phys. Soc. (London) 62A (1949) 253
  (Half-life)
- F.C. FLACK, J.E. JOHNSON. Proc. Phys. Soc. 79 (1962) 10
  (Half-life)
- G. ASTNER, I. BERGSTROM, L. ERIKSSON, U. FAGERGUIST, G. HOLM, A. PERSSON. Nucl. Phys. 45 (1963) 49
  (Half-life)
- A. RYTZ, B. GRENNBERG, D.J. GORMAN. Proc. 4th Int. Conf. Atomic Masses and Fund. Constants, Teddington, England, Eds Plenum Press (1971) 1
  (Alpha emission energies)
- H. DEL CASTILLO, R. ROOS, A. TEJERA, F. ALBA. Rev. Mex. Fis. 20 (1971) 17
  (Alpha emission energies)
- G.W. MCBETH, R.A. WINYARD. Int. J. Appl. Radiat. Isotop. 23 (1972) 527
  (Half-life)
- E. HUENGES, H. VONACH, J. LABETZKI. Nucl. Instrum. Methods 121 (1974) 307
  (Alpha emission energies)
- S. SANYAL, R.K. GARG, S.D. CHAUHAN, S.L. GUPTA, S.C. PANCHOLI. Phys. Rev. C12 (1975) 318
  (Half-life)
- A. RYTZ. At. Data Nucl. Data Tables 23 (1979) 507
  (Alpha emission energies)
- G. AUDI, A.H. WAPSTRA. Nucl. Phys. A595 (1995) 409
  (Q value)


0+ ; 0
300 (2) ns
0
α
212
Po
84
128


100
Stable
0+ ; 0
0
208
Pb
82
126
Qα = 8954,13 keV
% α = 100

$^{216}_{84}\mathrm{Po}_{132}$

1 Decay Scheme

Po-216 decays (100%) by alpha emission to the Pb-212 fundamental level.
Le polonium 216 se désintègre (100%) par émission alpha vers le niveau fondamental de plomb 212.

2 Nuclear Data

$T_{1/2}(^{216}\mathrm{Po})$	:	0,150	(5)	s
$T_{1/2}(^{212}\mathrm{Pb})$	:	10,64	(1)	h
$Q^{\alpha}(^{216}\mathrm{Po})$	:	6906,52	(51)	keV

2.1 α Transitions

	Energy keV	Probability × 100	F
$\alpha_{0,1}$	6101,6 (10)	0,0019 (3)	34,7
$\alpha_{0,0}$	6906,52 (50)	99,9981 (3)	1

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M+	α_T
$\gamma_{1,0}$(Pb)	804,9 (5)	0,0019 (3)	[E2]	0,0081 (2)	0,00180 (4)	0,00050 (1)	0,0104 (2)

3 Atomic Data

3.1 Pb

ω_K	:	0,963	(4)
$\bar{\omega}_L$	:	0,379	(15)
n_{KL}	:	0,811	(5)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	72,8049		59
	$K\alpha_1$	74,97		100
	$K\beta_3$	84,451	}	
	$K\beta_1$	84,937	}	
	$K\beta_5''$	85,47	}	34
	$K\beta_2$	87,238	}	
	$K\beta_4$	87,58	}	10,3
	$KO_{2,3}$	87,911	}	
X_L				
	$L\ell$	9,184		
	$L\alpha$	10,45 – 10,551		
	$L\eta$	11,349		
	$L\beta$	12,142 – 13,015		
	$L\gamma$	14,765 – 15,216		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	56,03 – 61,67	100
KLX	68,18 – 74,97	54
KXY	80,3 – 88,0	7,7
Auger L	5,26 – 10,40	3060

4 α Emissions

	Energy keV	Probability × 100
$\alpha_{0,1}$	5988,6 (10)	0,0019 (3)
$\alpha_{0,0}$	6778,6 (5)	99,9981 (3)

5 Electron Emissions

		Energy keV	Electrons per 100 disint.
e_{AL}	(Pb)	5,26 - 10,40	0,0000107 (10)
e_{AK}	(Pb)		0,00000057 (11)
	KLL	56,03 - 61,67	}
	KLX	68,18 - 74,97	}
	KXY	80,3 - 88,0	}

6 Photon Emissions

6.1 X-Ray Emissions

		Energy keV	Photons per 100 disint.	
XL	(Pb)	9,184 — 15,216	0,0000060 (6)	
$XK\alpha_2$	(Pb)	72,8049	0,0000043 (7)	} Kα
$XK\alpha_1$	(Pb)	74,97	0,0000073 (12)	}
$XK\beta_3$	(Pb)	84,451	}	
$XK\beta_1$	(Pb)	84,937	} 0,0000025 (4)	K$'\beta_1$
$XK\beta_5''$	(Pb)	85,47	}	
$XK\beta_2$	(Pb)	87,238	}	
$XK\beta_4$	(Pb)	87,58	} 0,00000075 (13)	K$'\beta_2$
$XKO_{2,3}$	(Pb)	87,911	}	

6.2 Gamma Emissions

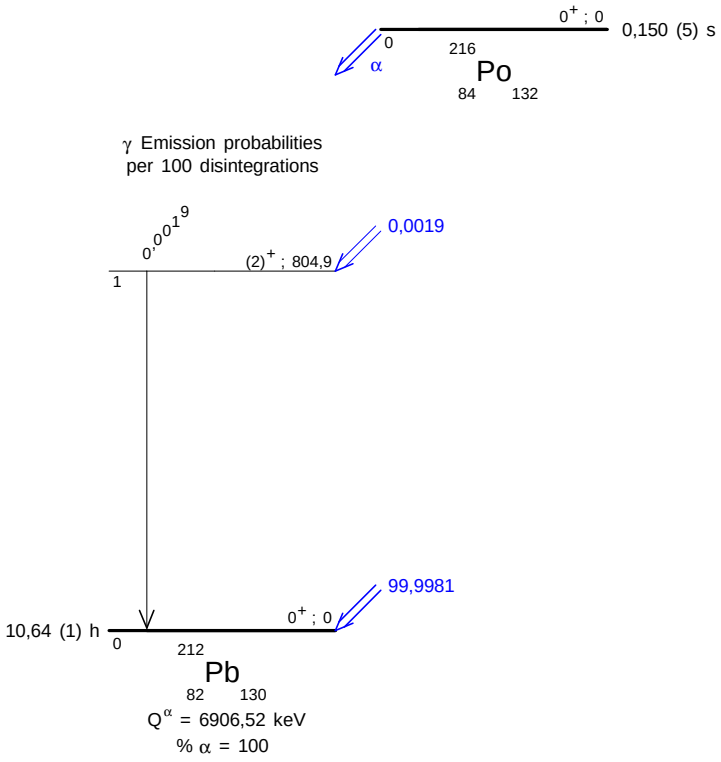
	Energy keV	Photons per 100 disint.
$\gamma_{1,0}$(Pb)	804,9 (5)	0,0019 (3)

7 Main Production Modes

$\mathrm{Bi} - 216(\beta^-)\mathrm{Po} - 216$
$\mathrm{Th} - 228$ α decays

8 References

- H.G.J. MOSELEY, K. FAJANS. Phil. Mag. 22 (1911) 629
  (Half-life)
- A.G. WARD. Proc. Roy. Soc. (London) 181A (1942) 183
  (Half-life)
- H.V. BUTTLAR. Naturwissenschaften 39 (1952) 575
  (Half-life)
- P. MARIN, G.R. BISHOP, H. HALBAN. Proc. Phys. Soc. (London) 66A (1953) 608
  (Half-life)
- J. TOBAILEM, J. ROBERT. J. Phys. Radium 16 (1955) 115
  (Half-life)
- R.J. WALEN. Comp. Rend. Acad. Sci. (Paris) 255 (1962) 1604
  (Alpha emission energies, Alpha emission probabilities)
- H. DIAMOND, J.E. GINDLER. J. Inorg. Nucl. Chem. 25 (1963) 143
  (Half-life)
- W. KURCEWICZ, N. KAFFRELL, N. TRAUTMANN, A. PLOCHOCKI, J. ZYLICZ, M. MATUL, K. STRYCZNIEWICZ. Nucl. Phys. A289 (1977) 1
  (Gamma-ray energies, Gamma-ray emission probabilities)
- F. RÖSEL, H.M. FRIES, K. ALDER, H.C. PAULI. At. Data Nucl. Data Tables 21 (1978) 291
  (Internal conversion coefficients)
- A. ARTNA-COHEN. Nucl. Data Sheets 66 (1992) 171
  (Nuclear structure, energies)
- G. AUDI, A.H. WAPSTRA. Nucl. Phys. A595 (1995) 409
  (Q value)
- E. SCHÖNFELD, H. JANSSEN. Nucl. Instrum. Methods Phys. Res. A369 (1996) 527
  (K-x ray, L-x ray, Auger electrons)
- E. SCHÖNFELD, G. RODLOFF. Report PTB-6.11-98-1 (1998)
  (Auger electrons)
- E. SCHÖNFELD, G. RODLOFF. Report PTB-6.11-1999 (1999)
  (K-x ray)


0+ ; 0
0,150 (5) s
0
α
216
Po
84
132
γ Emission probabilities
per 100 disintegrations
0,0019
(2)+ ; 804,9
1
99,9981
0+ ; 0
10,64 (1) h
0
212
Pb
82
130
Q α = 6906,52 keV
% α = 100

$^{220}_{86}\mathrm{Rn}_{134}$

1 Decay Scheme

Rn-220 mainly decays by alpha emission to the Po-216 fundamental level.
Le radon 220 se désintègre par émission alpha principalement vers le niveau fondamental du polonium 216.

2 Nuclear Data

$T_{1/2}(^{220}\mathrm{Rn})$	:	55,8	(3)	s
$T_{1/2}(^{216}\mathrm{Po})$	:	0,150	(5)	s
$Q^{\alpha}(^{220}\mathrm{Rn})$	:	6404,67	(10)	keV

2.1 α Transitions

	Energy keV	Probability × 100	F
$\alpha_{0,1}$	5854,91 (14)	0,118 (15)	3,08
$\alpha_{0,0}$	6404,67 (10)	99,882 (15)	1

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M+	α_T
$\gamma_{1,0}$(Po)	549,76 (4)	0,118 (15)	E2	0,0184 (6)	0,0057 (2)	0,00190 (6)	0,0260 (8)

3 Atomic Data

3.1 Po

ω_K	:	0,965	(4)
$\bar{\omega}_L$	:	0,403	(16)
n_{KL}	:	0,807	(5)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	76,864		60
	$K\alpha_1$	79,293		100
	$K\beta_3$	89,256	}	
	$K\beta_1$	89,807	}	
	$K\beta_5''$	90,363	}	34,43
	$K\beta_2$	92,263	}	
	$K\beta_4$	92,618	}	10,71
	$KO_{2,3}$	92,983	}	
X_L				
	$L\ell$	9,658		
	$L\alpha$	11,016 – 11,13		
	$L\eta$	12,085		
	$L\beta$	12,823 – 13,778		
	$L\gamma$	15,742 – 16,213		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	58,98 – 65,21	100
KLX	71,90 – 79,29	55
KXY	84,8 – 93,1	8
Auger L	5,43 – 10,93	3400

4 α Emissions

	Energy keV	Probability × 100
$\alpha_{0,1}$	5748,46 (14)	0,118 (15)
$\alpha_{0,0}$	6288,22 (10)	99,882 (15)

5 Electron Emissions

		Energy keV	Electrons per 100 disint.
e_{AL}	(Po)	5,43 - 10,93	0,00155 (12)
e_{AK}	(Po)		0,000074 (13)
	KLL	58,98 - 65,21	}
	KLX	71,90 - 79,29	}
	KXY	84,8 - 93,1	}

6 Photon Emissions

6.1 X-Ray Emissions

		Energy keV	Photons per 100 disint.	
XL	(Po)	9,658 — 16,213	0,00096 (7)	
$XK\alpha_2$	(Po)	76,864	0,00060 (8)	} $K\alpha$
$XK\alpha_1$	(Po)	79,293	0,00100 (14)	}
$XK\beta_3$	(Po)	89,256	}	
$XK\beta_1$	(Po)	89,807	} 0,00034 (5)	$K'\beta_1$
$XK\beta_5''$	(Po)	90,363	}	
$XK\beta_2$	(Po)	92,263	}	
$XK\beta_4$	(Po)	92,618	} 0,000107 (15)	$K'\beta_2$
$XKO_{2,3}$	(Po)	92,983	}	

6.2 Gamma Emissions

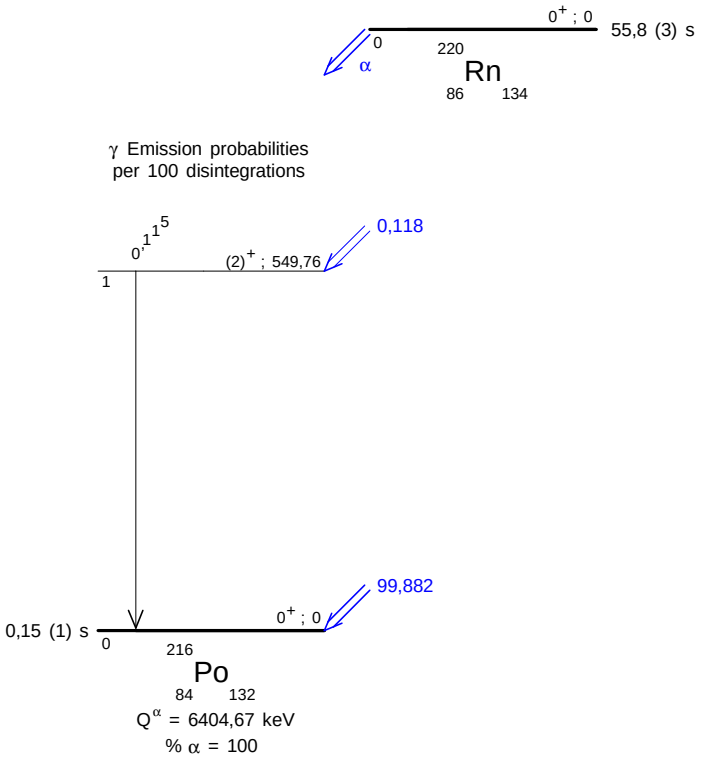
	Energy keV	Photons per 100 disint.
$\gamma_{1,0}$(Po)	549,76 (4)	0,115 (15)

7 Main Production Modes

Th – 228 α decays()

8 References

- A.G. WARD. Proc. Roy. Soc. (London) 181A (1942) 183
  (Half-life)
- H. SCHMIED, R.W. FINK, B.L. ROBINSON. J. Inorg. Nucl. Chem. 1 (1955) 342
  (Half-life)
- L. MADANSKY, F. RASETTI. Phys. Rev. 102 (1956) 464
  (Gamma-ray emission probabilities)
- H. RODENBUSCH, G. HERRMANN. Z. Naturforsch. 16a (1961) 577
  (Half-life)
- R.J. WALEN. Compt. Rend. Ac. Sci. (Paris) 255 (1962) 1604
  (Alpha emission energies, Alpha emission probabilities)
- J.E. GINDLER, D.W. ENGELKEMEIR. Radiochim. Acta 2 (1963) 58
  (Half-life)
- H. DIAMOND, J.E. GINDLER. J. Inorg. Nucl. Chem. 25 (1963) 143
  (Half-life)
- J.B. HURSH. J. Inorg. Nucl. Chem. 28 (1966) 2771
  (Half-life)
- J. DALMASSO. Report FRNC-TH-441 (1972)
  (Gamma-ray emission probabilities)
- J. DALMASSO. Comp. Rend. Acad. Sci. (Paris) 277B (1973) 467
  (Gamma-ray emission probabilities)
- W. KURCEWICZ, N. KAFFRELL, N. TRAUTMANN, A. PLOCHOCKI, J. ZYLICZ, A. MATUL, K. STRYCZNIEWICZ. Nucl. Phys. A289 (1977) 1
  (Gamma-ray emission probabilities)
- F. RÖSEL, H.M. FRIES, K. ALDER, H.C. PAULI. At. Data. Nucl. Data Tables 21 (1978) 291
  (Internal conversion coefficients)
- R.J. GEHRKE, V.J. NOVICK, J.D. BAKER. Int. J. Appl. Radiat. Isotop. 35 (1984) 581
  (Gamma-ray emission probabilities)
- G. AUDI, A.H. WAPSTRA. Nucl. Phys. A595 (1995) 409
  (Q value)
- E. SCHÖNFELD, H . JANSSEN. Nucl. Instrum. Methods Phys. Res. A369 (1996) 527
  (K-x ray, L-x ray, Auger electrons)
- A. ARTNA-COHEN. Nucl. Data Sheets 80 (1997) 157
  (Nuclear structure, energies)
- E. SCHÖNFELD, G. RODLOFF. PTB Report 6.11-98-1 (1998)
  (Auger electrons)
- E. SCHÖNFELD, G. RODLOFF. PTB Report 6.11-1999-1 (1999)
  (K-x ray)


0+ ; 0
55,8 (3) s
0
α
220
Rn
86
134
γ Emission probabilities
per 100 disintegrations
0,118
0+
1
5
1
1
(2)+ ; 549,76
1
99,882
0+ ; 0
0,15 (1) s
0
216
Po
84
132
Q α = 6404,67 keV
% α = 100

$^{224}_{88}\mathrm{Ra}_{136}$

1 Decay Scheme

Ra-224 mainly decays by alpha emission to the fundamental and the 241 keV levels of Rn-220.
Le radium 224 se désintègre par émission alpha principalement vers le niveau fondamental et le niveau excité de 241 keV du radon 220.

2 Nuclear Data

$T_{1/2}(^{224}\mathrm{Ra})$	:	3,627	(7)	d
$T_{1/2}(^{220}\mathrm{Rn})$	:	55,8	(3)	s
$Q^{\alpha}(^{224}\mathrm{Ra})$	:	5788,87	(15)	keV

2.1 α Transitions

	Energy keV	Probability × 100	F
$\alpha_{0,4}$	5125,84 (25)	0,0030 (5)	7,42
$\alpha_{0,3}$	5143,43 (24)	0,0076 (14)	3,73
$\alpha_{0,2}$	5255,18 (25)	0,0074 (8)	17,4
$\alpha_{0,1}$	5547,88 (16)	5,26 (7)	1,03
$\alpha_{0,0}$	5788,87 (15)	94,72 (7)	1

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M+	α_T
$\gamma_{1,0}$(Rn)	240,986 (6)	5,27 (7)	E2	0,111 (2)	0,124 (3)	0,045 (1)	0,280 (6)
$\gamma_{2,1}$(Rn)	292,70 (11)	0,0073 (8)	E2	0,0730 (15)	0,057 (1)	0,0210 (4)	0,151 (3)
$\gamma_{3,1}$(Rn)	404,5 (1)	0,0022 (5)	E1	0,0141 (3)	0,00240 (5)	0,00080 (2)	0,0173 (4)
$\gamma_{4,1}$(Rn)	422,04 (11)	0,0030 (5)	[E1]	0,0129 (3)	0,00220 (4)	0,00070 (1)	0,0158 (3)
$\gamma_{3,0}$(Rn)	645,44 (9)	0,0054 (9)	E1	0,0055 (1)	0,00090 (2)	0,00030 (1)	0,0067 (1)

3 Atomic Data

3.1 Rn

ω_K : 0,967 (4)
$\bar{\omega}_L$: 0,428 (17)
n_{KL} : 0,804 (5)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	81,07		60,5
	$K\alpha_1$	83,78		100
	$K\beta_3$	94,247	}	
	$K\beta_1$	94,868	}	
	$K\beta_5''$	95,449	}	34,68
	$K\beta_2$	97,48	}	
	$K\beta_4$	97,853	}	11
	$KO_{2,3}$	98,357	}	
X_L				
	$L\ell$	10,137		
	$L\alpha$	11,598 – 11,726		
	$L\eta$	12,855		
	$L\beta$	14,565 – 13,52		
	$L\gamma$	16,77 – 17,28		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	62,02 – 68,89	100
KLX	75,74 – 83,79	56
KXY	89,45 – 98,39	8
Auger L	5,58 – 11,48	5840

4 α Emissions

	Energy keV	Probability × 100
$\alpha_{0,4}$	5034,31 (25)	0,0030 (5)
$\alpha_{0,3}$	5051,58 (24)	0,0076 (14)
$\alpha_{0,2}$	5161,34 (25)	0,0074 (8)
$\alpha_{0,1}$	5448,81 (16)	5,26 (7)
$\alpha_{0,0}$	5685,50 (15)	94,72 (7)

5 Electron Emissions

		Energy keV	Electrons per 100 disint.
e_{AL}	(Rn)	5,58 - 11,48	0,537 (9)
e_{AK}	(Rn)		0,0151 (19)
	KLL	62,02 - 68,89	}
	KLX	75,74 - 83,79	}
	KXY	89,45 - 98,39	}
$ec_{1,0\ K}$	(Rn)	142,590 (12)	0,46 (2)
$ec_{1,0\ L}$	(Rn)	222,94 - 226,38	0,51 (2)
$ec_{1,0\ M}$	(Rn)	236,51 - 240,76	0,18 (1)

6 Photon Emissions

6.1 X-Ray Emissions

		Energy keV		Photons per 100 disint.	
XL	(Rn)	10,137 — 17,28		0,387 (8)	
$XK\alpha_2$	(Rn)	81,07		0,130 (4)	} $K\alpha$
$XK\alpha_1$	(Rn)	83,78		0,215 (7)	}
$XK\beta_3$	(Rn)	94,247	}		
$XK\beta_1$	(Rn)	94,868	}	0,0744 (24)	$K'\beta_1$
$XK\beta_5''$	(Rn)	95,449	}		
$XK\beta_2$	(Rn)	97,48	}		
$XK\beta_4$	(Rn)	97,853	}	0,0238 (9)	$K'\beta_2$
$XKO_{2,3}$	(Rn)	98,357	}		

6.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{1,0}$(Rn)	240,986 (6)	4,12 (4)
$\gamma_{2,1}$(Rn)	292,70 (11)	0,0063 (7)
$\gamma_{3,1}$(Rn)	404,5 (1)	0,0022 (5)
$\gamma_{4,1}$(Rn)	422,04 (11)	0,0030 (5)
$\gamma_{3,0}$(Rn)	645,44 (9)	0,0054 (9)

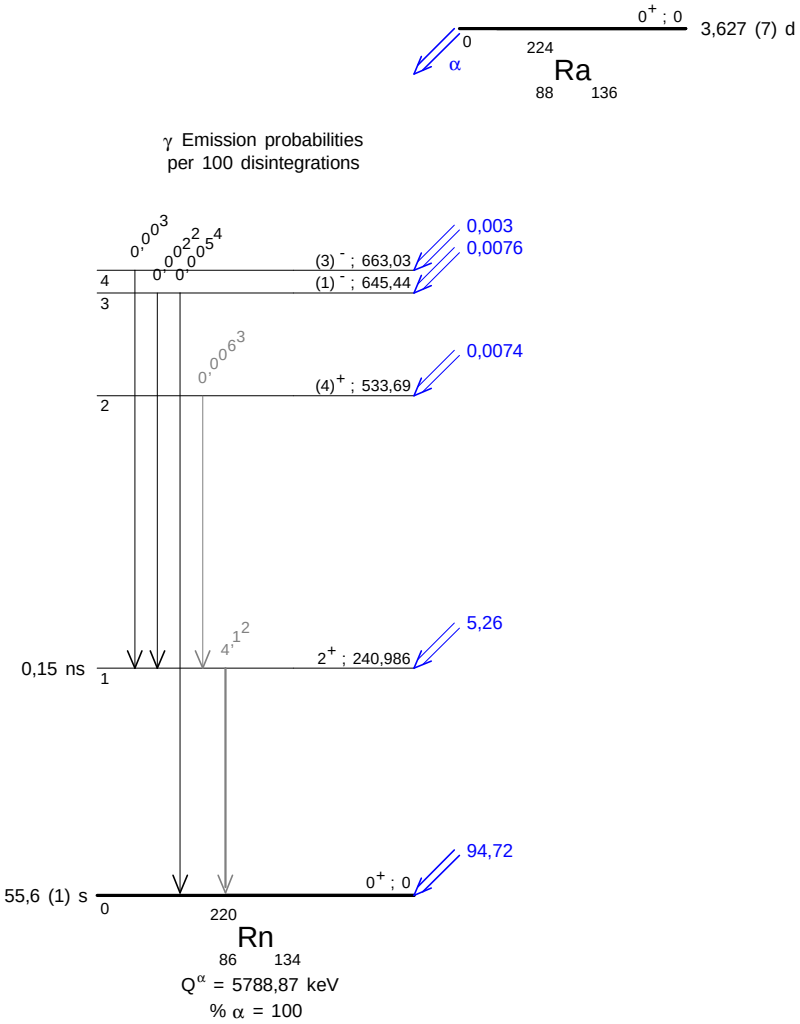
7 Main Production Modes

Ra – 226(p,t)Ra – 224
Th – 228 α decays

8 References

- F. ASARO, F. STEPHENS, I. PERLMAN. Phys. Rev. 92 (1953) 1495
  (Alpha-particle emission probabilities)
- R.D. LLOYD, C.W. MAYS, D.R. ATHERTON, D.O. CLARK. Report COO-225 (1962) 88
  (Half-life)
- R.J. WALEN. Comp. Rend. Acad. Sci. (Paris) 255 (1962) 1604
  (Alpha emission energies)
- J.B. HURSH. J. Inorg. Nucl. Chem. 28 (1966) 2771
  (Half-life)
- A. PEGHAIRE. Nucl. Instrum. Methods 75 (1969) 66
  (Gamma-ray emission probabilities)
- J.C. SOARES, J.P. RIBEIRO, A. GONCALVES, F.B. GIL, J.G. FERREIRA. Comp. Rend. Acad. Sci. (Paris) 273B (1971) 985
  (Alpha-particle emission probabilities)
- K.C. JORDAN, G.W. OTTO, R.P. RATAY. J. Inorg. Nucl. Chem. 33 (1971) 1215
  (Half-life)
- J. DALMASSO. FRNC-TH-441 (1972)
  (Gamma-ray emission probabilities)
- J. DALMASSO, H. MARIA, C. YTHIER. Comp. Rend. Acad. Sci. (Paris) 277B (1973) 467
  (Gamma-ray emission probabilities)
- W. KURCEWICZ, N. KAFFRELL, N. TRAUTMANN, A. PLOCHOCKI, J. ZYLICZ, M. MATUL, K. STRYCZNIEWICZ K.STRYCZNIEWICZ. Nucl. Phys. A289 (1977) 1
  (Gamma-ray energies, Gamma-ray emission probabilities)
- W. KURCEWICZ, E. RUCHOWSKA, N. KAFFRELL, N. TRAUTMANN. Nucl. Instrum. Methods 146 (1977) 613
  (Gamma-ray energies)
- F. RÖSEL, H.M. FRIES, K. ALDER, H.C. PAULI. At. Data Nucl. Data Tables 21 (1978) 291
  (Internal conversion coefficients)
- S. SADASIVAN, V.M. RAGHUNATH. Nucl. Instrum. Methods 196 (1982) 561
  (Gamma-ray emission probabilities)
- R. VANINBROUKX, H.H. HANSEN. Int. J. Appl. Radiat. Isot. 34 (1983) 1395
  (Gamma-ray emission probabilities)
- U. SCHÖTZIG, K. DEBERTIN. Int. J. Appl. Radiat. Isot. 34 (1983) 533
  (Gamma-ray emission probabilities)

- R.J. GEHRKE, V.J. NOVICK, J.D. BAKER. Int. J. Appl. Radiat. Isot. 35 (1984) 581
(Gamma-ray emission probabilities)
- G. BORTELS, D. REHER, R. VANINBROUKX. Int. J. Appl. Radiat. Isot. 35 (1984) 305
(Gamma-ray emission probabilities)
- P.B. PRICE, J.D. STEVENSON, S.W. BARWICK, H.L. RAVN. Phys. Lett. 54 (1985) 297
(Cluster decay)
- E. HOURANI, L. ROSIER, G. BERRIER-RONSIN, A. ELAYI, A.C. MUELLER, G. RAPPENECKER, G. ROTBARD, G. RENOU, A. LIEBE, L. STAB, H.L. RAVN. Phys. Lett. C44 (1991) 1424
(Cluster decay)
- W-J. LIN, G. HARBOTTLE. J. Radioanal. Nucl. Chem. 157 (1992) 367
(Gamma-ray emission probabilities)
- T. BABELIOWSKY, G. BORTELS. Appl. Rad. Isotopes 44 (1993) 1349
(Alpha-particle emission probabilities)
- G. AUDI, A.H. WAPSTRA. Nucl. Phys. A595 (1995) 409
(Q value)
- G. ARDISSON, M. HUSSONNOIS. Radiochim. Acta 70/71 (1995) 123
(Cluster decay)
- E. SCHÖNFELD, H. JANSSEN. Nucl. Instrum. Methods Phys. Res. A369 (1996) 527
(K-x ray, L-x ray, Auger electrons)
- A. ARTNA-COHEN. Nucl. Data Sheets 80 (1997) 157
(Nuclear structure, energies)
- S.P. TRETYAKOVA, V.L. MIKHEEV. Nuovo Cim. 110 (1997) 1043
(Cluster decay)
- E. SCHÖNFELD, G. RODLOFF. PTB Report 6.11-98-1 (1998)
(Auger electrons)
- E. SCHÖNFELD, G. RODLOFF. PTB Report 6.11-1999-1 (1999)
(K-x ray)
- H. SCHRADER. Appl. Rad. Isotopes 60 (2004) 317
(Half-life)


0+ ; 0
3,627 (7) d
0
224
α
Ra
88
136
γ Emission probabilities
per 100 disintegrations
0,003
0,0076
(3)- ; 663,03
(1)- ; 645,44
4
3
0,0074
(4)+ ; 533,69
2
5,26
0,15 ns
2+ ; 240,986
1
94,72
55,6 (1) s
0+ ; 0
0
220
Rn
86
134
Qα = 5788,87 keV
% α = 100

$^{226}_{88}\mathrm{Ra}_{138}$

1 Decay Scheme

Le Ra-226 se désintègre par émission alpha principalement vers le niveau excité de 186 keV et le niveau fondamental de Rn-222.
Ra-226 disintegrates by alpha emission mainly to the 186 keV level and to the ground state level of Rn-222.

2 Nuclear Data

$T_{1/2}(^{226}\mathrm{Ra})$	:	1600	(7)	a
$T_{1/2}(^{222}\mathrm{Rn})$	:	3,8235	(4)	d
$Q^{\alpha}(^{226}\mathrm{Ra})$	:	4870,63	(25)	keV

2.1 α Transitions

	Energy keV	Probability × 100	F
$\alpha_{0,4}$	4235 (2)	0,0002	8,65
$\alpha_{0,3}$	4270 (2)	0,0008	4,5
$\alpha_{0,2}$	4422 (1)	0,0065 (16)	10,4
$\alpha_{0,1}$	4684 (1)	5,96 (8)	0,96
$\alpha_{0,0}$	4870,54 (25)	94,03 (8)	1

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{1,0}$(Rn)	186,211 (13)	5,97 (8)	E2	0,190 (6)	0,367 (11)	0,0986 (30)	0,689 (21)
$\gamma_{2,1}$(Rn)	262,27 (5)	0,0065 (16)	(E2)				0,212 (2)
$\gamma_{3,1}$(Rn)	414,60 (5)	0,0003	(E1)				0,0165 (3)
$\gamma_{4,1}$(Rn)	449,37 (10)	0,0002	[E1]				
$\gamma_{3,0}$(Rn)	600,66 (5)	0,0005	(E1)				0,0077 (2)

BNM/LNHB, INEEL /MM. Bé,
V. Chisté, R.G. Helmer

3 Atomic Data

3.1 Rn

ω_K : 0,967 (4)
$\bar{\omega}_L$: 0,428 (17)
n_{KL} : 0,804 (5)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	81,07		60,62
	$K\alpha_1$	83,78		100
	$K\beta_3$	94,247	}	
	$K\beta_1$	94,868	}	
	$K\beta_5''$	95,449	}	34,68
	$K\beta_2$	97,48	}	
	$K\beta_4$	97,853	}	11,1
	$KO_{2,3}$	98,357	}	
X_L				
	$L\ell$	10,137		
	$L\alpha$	11,59 – 11,72		
	$L\eta$	12,855		
	$L\beta$	14,31 – 14,51		
	$L\gamma$	16,24 – 17,2		

4 α Emissions

	Energy keV	Probability × 100
$\alpha_{0,4}$	4160 (2)	0,0002
$\alpha_{0,3}$	4191 (2)	0,0008
$\alpha_{0,2}$	4340 (1)	0,0065 (16)
$\alpha_{0,1}$	4601 (1)	5,96 (8)
$\alpha_{0,0}$	4784,34 (25)	94,03 (8)

5 Electron Emissions

		Energy keV	Electrons per 100 disint.
$ec_{1,0\ T}$	(Rn)	87,814 - 186,168	2,43 (7)
$ec_{1,0\ K}$	(Rn)	87,814 (13)	0,67 (2)
$ec_{1,0\ L}$	(Rn)	168,163 - 171,601	1,30 (4)
$ec_{1,0\ M}$	(Rn)	181,738 - 183,327	0,35 (1)
$ec_{1,0\ N}$	(Rn)	185,121 - 185,989	0,092 (3)

6 Photon Emissions

6.1 X-Ray Emissions

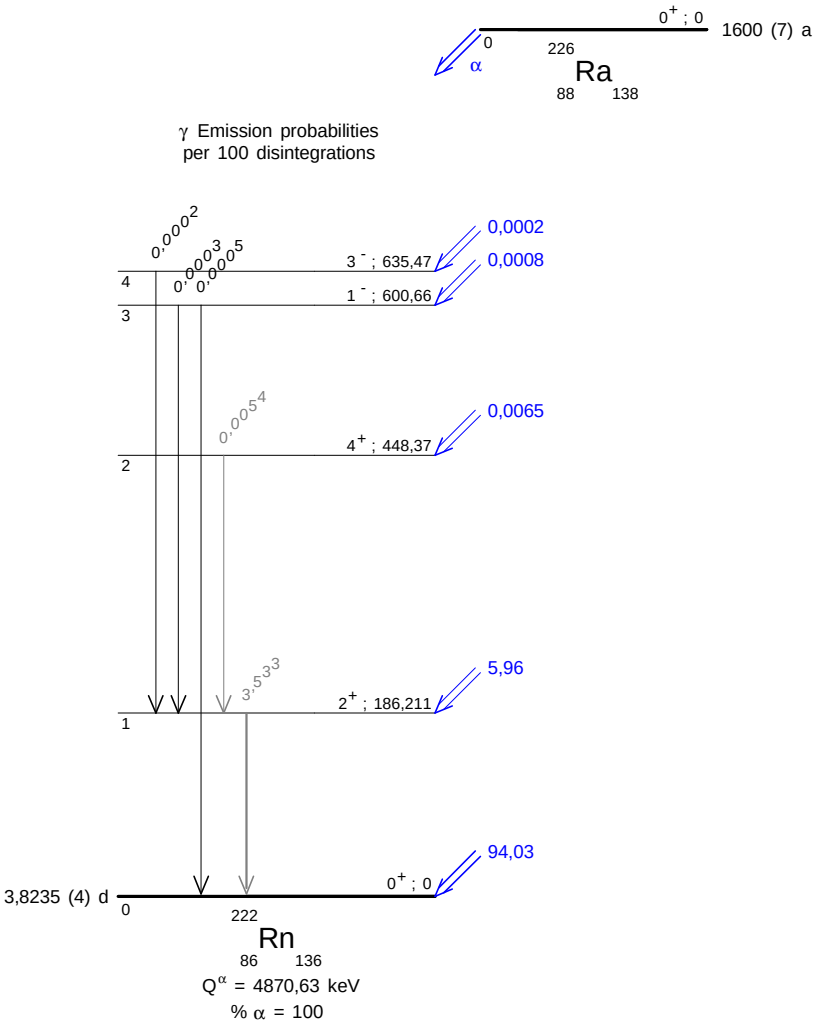
		Energy keV		Photons per 100 disint.	
XL	(Rn)	10,137 — 17,2		0,813 (17)	
$XK\alpha_2$	(Rn)	81,07		0,191 (7)	} $K\alpha$
$XK\alpha_1$	(Rn)	83,78		0,315 (11)	}
$XK\beta_3$	(Rn)	94,247	}		
$XK\beta_1$	(Rn)	94,868	}	0,109 (4)	$K'\beta_1$
$XK\beta_5''$	(Rn)	95,449	}		
$XK\beta_2$	(Rn)	97,48	}		
$XK\beta_4$	(Rn)	97,853	}	0,0349 (14)	$K'\beta_2$
$XKO_{2,3}$	(Rn)	98,357	}		

6.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{1,0}$(Rn)	186,211 (13)	3,533 (21)
$\gamma_{2,1}$(Rn)	262,27 (5)	0,0054 (13)
$\gamma_{3,1}$(Rn)	414,60 (5)	0,0003
$\gamma_{4,1}$(Rn)	449,37 (10)	0,0002
$\gamma_{3,0}$(Rn)	600,66 (5)	0,0005

7 References

- T.P.Kohman, D.P.Ames, J.Sedlet. NNES 14B (1949) 1675
  (Half-life)
- W.Sebaoun. Ann. Phys. 1 (1956) 680
  (Half-life)
- G.R.Martin, D.G.Tuck. Int. J. Appl. Radiat. Isotop. 5 (1959) 141
  (Half-life)
- G.V.Gorshkov, et al.. Atomnaya Energ., Atomic Energy (USSR) 7 (1959) 912
  (Half-life)
- F.S.STEPHENS, F.ASARO, I.PERLMAN. Phys. Rev. 119 (1960) 796
  (Gamma-ray emission probabilities)
- G.BASTIN-SCOFFIER, C.F LEANG, R.J WALEN. J. Phys. (Paris) 24 (1963) 854
  (Alpha emission energies Alpha emission probabilities)
- H.RAMTHUN. Nucleonics 8 (1966) 244
  (Half-life)
- E.W.A.Lingeman, J.Konijn, P.Polak, A.H.Wapstra. Nucl. Phys. A133 (1969) 630
  (Gamma-ray emission intensities)
- W.LOURENS, A.H.WAPSTRA. Z. Phys. 247 (1971) 147
  (Gamma-ray energies Gamma-ray emission probabilities)
- A.G. de Pinho, M.Weksler. Z. Naturforsch. 28a (1973) 1635
  (X-ray emission intensities)
- A.Hachem. Comp. Rend. Acad. Sci. (Paris) 281 Serie B (1975) 45
  (Gamma-ray emission intensities)
- F.Rösel, H.M.Friess, K.Alder, H.C.Pauli. At. Data. Nucl. Data Tables 21 (1978) 92
  (Theoretical internal conversion coefficients)
- H.Akçay, G.Mouze, D.Maillard, C.Ythier. Radiochem. Radioanal. Lett. 51 (1982) 1
  (Gamma-ray emission intensities)
- D.G.Olson. Nucl. Instrum. Methods 206 (1983) 313
  (Gamma-ray emission intensities)
- U.Schötzig, K.Debertin. Int. J. Appl. Radiat. Isotop. 34,2 (1983) 533
  (Gamma-ray emission intensities, X-ray emission intensities)
- G.MOUZE, C.Ythier, J.F.Comanducci. Rev. Roumaine Phys. 35 (1990) 337
  (Gamma-ray emission intensities)
- W.J.Lin, G.Harbottle. J. Radioanal. Nucl. Chem. Lett. 153 (1991) 137
  (Gamma-ray emission intensities)
- A.RYTZ. At. Data. Nucl. Data Tables 47 (1991) 205
  (Alpha emission energies Alpha emission probabilities)
- O.Diallo, G.Mouze, C.Ythier, J.F.Comanducci. Nuovo Cim. 106A,10 (1993) 1321
  (Gamma-ray emission intensities)
- G.Audi, A.H.Wapstra. Nucl. Phys. A595 (1995) 409
  (Q)
- Y.A.Akovali. Nucl. Data Sheets 77 (1996) 271
  (Spin and Parity)
- J.Morel, M.Etcheverry, J.L.Picolo. Appl. Rad. Isotopes 49 (1998) 1387
  (Gamma-ray emission intensities)
- D.Sardari, T.D.MacMahon. J. Radioanal. Nucl. Chem. 244,2 (2000) 463
  (Gamma-ray emission intensities)
- J.U.Delgado, J.Morel, M.Etcheverry. Appl. Rad. Isotopes 56 (2002) 137
  (Gamma-ray emission intensities, X-ray emission intensities)
- G.L.Molnar, ZS.Révay, T.Belgya. Proc.11th Int. Symp. On Capture gamma-ray Spectroscopy, 2-6 Sep 2002, Pruhonice, Ed. J.Kvasil, P.Cejnar, M.Krticka (2003) 522
  (Gamma-ray emission intensities)
- R.G.Helmer. IAEA - CRP Report To be published (2004)
  (186-keV gamma ray intensity)


0+ ; 0
1600 (7) a
0
α
226
Ra
88
138
γ Emission probabilities
per 100 disintegrations
0,0002
0,0008
3 - ; 635,47
1 - ; 600,66
4
3
0,0065
4+ ; 448,37
2
5,96
2+ ; 186,211
1
94,03
0+ ; 0
3,8235 (4) d
0
222
Rn
86
136
Q$^{\alpha}$ = 4870,63 keV
% α = 100

$^{227}_{90}\mathrm{Th}_{137}$

1 Decay Scheme

Th-227 is member of the natural U-235 radioactive decay chain. Th-227 disintegrates entirely by alpha decay to Ra-223.
Le thorium 227 appartient à la chaine naturelle de l'uranium 235, il se désintègre à 100 % par émission alpha vers le radium 223.

2 Nuclear Data

$T_{1/2}(^{227}\mathrm{Th})$	:	18,718	(5)	d
$T_{1/2}(^{223}\mathrm{Ra})$	:	11,43	(5)	d
$Q^{\alpha}(^{227}\mathrm{Th})$	:	6146,43	(15)	keV

2.1 α Transitions

	Energy keV	Probability × 100	F
$\alpha_{0,56}$	5123,8 (40)	0,00031 (2)	30
$\alpha_{0,53}$	5146,8 (40)	0,00023 (2)	58
$\alpha_{0,52}$	5174,7 (40)	0,000150 (15)	133
$\alpha_{0,51}$	5202,2 (40)	0,00028 (2)	106
$\alpha_{0,50}$	5220,7 (30)	0,00062 (5)	60
$\alpha_{0,49}$	5238,8 (20)	0,00410 (8)	12
$\alpha_{0,46}$	5264 (3)	0,00170 (17)	39
$\alpha_{0,45}$	5273,5 (40)	0,00120 (24)	60
$\alpha_{0,43}$	5286,9 (25)	0,0038 (3)	25
$\alpha_{0,42}$	5303,7 (20)	0,0070 (3)	17
$\alpha_{0,40}$	5323 (2)	0,0098 (3)	16
$\alpha_{0,38}$	5342,4 (20)	0,00320 (16)	61
$\alpha_{0,36}$	5358,7 (20)	0,0026 (2)	94
$\alpha_{0,34}$	5417,3 (40)	0,00024 (10)	2190
$\alpha_{0,33}$	5431,6 (50)	0,0002 (1)	3240
$\alpha_{0,32}$	5461,0 (25)	0,00066 (3)	1410
$\alpha_{0,31}$	5505,7 (30)	0,00044 (7)	3700
$\alpha_{0,30}$	5556,5 (20)	0,00270 (5)	1140
$\alpha_{0,29}$	5578,7 (22)	0,0012 (1)	3400
$\alpha_{0,28}$	5608,7 (20)	0,0166 (3)	362
$\alpha_{0,27}$	5630,9 (18)	0,021 (2)	377

	Energy keV	Probability × 100	F
$\alpha_{0,26}$	5686,1 (16)	0,176 (6)	87
$\alpha_{0,25}$	5701,1 (18)	0,170 (17)	108
$\alpha_{0,23}$	5714,0 (16)	0,216 (8)	99
$\alpha_{0,22}$	5723,0 (17)	0,0070 (4)	3380
$\alpha_{0,21}$	5741,4 (15)	0,0179 (15)	1660
$\alpha_{0,20}$	5770,0 (15)	2,06 (12)	20
$\alpha_{0,19}$	5776,1 (16)	0,057 (4)	791
$\alpha_{0,18}$	5795,0 (16)	1,5 (1)	38
$\alpha_{0,16}$	5803,1 (16)	3,63 (20)	17
$\alpha_{0,15}$	5811,2 (16)	8,3 (3)	8,2
$\alpha_{0,14}$	5815,7 (16)	4,89 (20)	15
$\alpha_{0,13}$	5830,8 (16)	0,0342 (25)	2490
$\alpha_{0,12}$	5860,13 (15)	20,4 (9)	5,9
$\alpha_{0,11}$	5865,7 (15)	0,228 (10)	561
$\alpha_{0,10}$	5899,5 (15)	0,311 (5)	599
$\alpha_{0,9}$	5911,7 (15)	1,27 (2)	169
$\alpha_{0,7}$	5971,8	2,42 (10)	175
$\alpha_{0,6}$	6015,9 (15)	0,174 (8)	4000
$\alpha_{0,5}$	6022,0 (15)	0,775 (30)	963
$\alpha_{0,4}$	6066,6 (15)	3,00 (15)	404
$\alpha_{0,3}$	6084,94 (10)	23,5 (9)	63
$\alpha_{0,2}$	6096,8 (20)	<0,005	835000
$\alpha_{0,1}$	6116,6 (15)	2,90 (15)	717
$\alpha_{0,0}$	6146,32 (15)	24,2 (9)	118

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{6,5}$(Ra)	6,5 (3)	3,7 (11)	[E1]				41,2 (12)
$\gamma_{17,16}$(Ra)	8,15 (20)	0,008 (3)					
$\gamma_{2,1}$(Ra)	20,25 (5)	1,90 (23)	[E1]		2,83 (8)	1,51 (5)	7,2 (2)
$\gamma_{25,22}$(Ra)	20,94 (5)	0,006 (3)					
$\gamma_{(-1,1)}$(Ra)	22,0 (2)	0,009 (9)					
$\gamma_{(-1,2)}$(Ra)	24,13 (5)	0,086 (8)					
$\gamma_{(-1,3)}$(Ra)	27,41 (9)	0,029 (5)					
$\gamma_{4,2}$(Ra)	29,60 (3)	13,0 (7)	[M1+62,8%E2]		1653 (50)	444 (13)	2246 (67)
$\gamma_{1,0}$(Ra)	29,86 (1)	43 (6)	M1+14,4%E2		429 (13)	113 (3)	581 (17)
$\gamma_{3,1}$(Ra)	31,58 (1)	19 (3)	M1+7,3%E2		205 (6)	53,2 (16)	276 (8)
$\gamma_{20,17}$(Ra)	33,39 (8)	0,023 (8)	[E1]		1,57 (5)	0,395 (12)	2,09 (6)
$\gamma_{25,21}$(Ra)	40,20 (3)	0,015 (4)					
$\gamma_{20,15}$(Ra)	41,93 (5)	0,06 (3)	[E1]		0,86 (3)	0,214 (6)	1,14 (3)
$\gamma_{14,12}$(Ra)	43,77 (5)	0,42 (3)	E1		0,767 (23)	0,191 (6)	1,02 (3)
$\gamma_{(-1,4)}$(Ra)	43,8 (5)	0,054 (22)					
$\gamma_{5,4}$(Ra)	44,22 (12)	6,9 (17)	M1+21,3%E2		98 (3)	25,8 (8)	132 (4)
$\gamma_{8,6}$(Ra)	44,40 (5)	0,6 (4)	M1		27,1 (8)	6,55 (20)	35,8 (11)
$\gamma_{15,12}$(Ra)	48,30 (3)	4,4 (16)	E2		232 (7)	63,1 (19)	317 (10)
$\gamma_{4,1}$(Ra)	49,82 (5)	0,72 (16)	E1		0,542 (16)	0,133 (4)	0,72 (2)
$\gamma_{2,0}$(Ra)	50,13 (1)	14,0 (9)	E1		0,533 (16)	0,131 (4)	0,708 (21)
$\gamma_{7,5}$(Ra)	50,85 (5)	0,8 (4)	M1+13,8%E2		40,6 (12)	10,5 (3)	54,7 (16)
$\gamma_{15,11}$(Ra)	54,19 (4)	0,13 (3)	(M1)		15,0 (5)	3,60 (11)	19,9 (6)
$\gamma_{23,20}$(Ra)	56,00 (6)	0,091 (5)	M1		13,6 (4)	3,27 (10)	18,1 (5)
$\gamma_{16,12}$(Ra)	56,42 (7)	0,4 (3)	M1+18,1%E2		30,7 (9)	8,00 (24)	41,5 (12)

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{(-1,8)}$(Ra)	59,6 (5)	0,010 (4)					
$\gamma_{3,0}$(Ra)	61,44 (2)	8,8 (11)	E2		72,4 (22)	19,7 (6)	99 (3)
$\gamma_{17,11}$(Ra)	62,45 (5)	4,0 (6)	M1+7,8%E2		14,4 (4)	3,61 (11)	19,2 (6)
$\gamma_{21,17}$(Ra)	62,68 (3)	0,010 (4)	[E1]		0,294 (9)	0,0719 (22)	0,39 (1)
$\gamma_{18,12}$(Ra)	64,35 (10)	0,034 (5)	[E1]		0,274 (8)	0,067 (2)	0,363 (11)
$\gamma_{(-1,9)}$(Ra)	66,2 (5)	0,006 (4)					
$\gamma_{(-1,10)}$(Ra)	66,4 (5)	0,008 (4)					
$\gamma_{(-1,11)}$(Ra)	68,7 (1)	0,202 (11)	M1+50%E2		24,9 (7)	6,7 (2)	33,8 (10)
$\gamma_{6,3}$(Ra)	68,74 (3)	1,07 (20)	M1+16,8%E2		13,3 (4)	3,43 (10)	17,9 (5)
$\gamma_{(-1,12)}$(Ra)	69,8 (3)	0,010 (4)					
$\gamma_{10,7}$(Ra)	72,85 (5)	0,024 (19)					
$\gamma_{5,2}$(Ra)	73,63 (5)	0,59 (22)	E2		30,4 (9)	8,29 (25)	41,5 (12)
$\gamma_{(-1,0)}$(Ra)	75,01 (5)	0,026 (10)					
$\gamma_{(-1,13)}$(Ra)	77,4 (4)	0,0101 (5)					
$\gamma_{4,0}$(Ra)	79,69 (2)	2,30 (13)	E1		0,155 (5)	0,0377 (11)	0,205 (6)
$\gamma_{23,17}$(Ra)	89,6 (4)	0,0038 (13)					
$\gamma_{5,1}$(Ra)	93,88 (5)	1,67 (9)	E1		0,100 (3)	0,0243 (7)	0,133 (4)
$\gamma_{7,4}$(Ra)	94,97 (5)	0,32 (19)	E2		9,1 (3)	2,48 (7)	12,4 (4)
$\gamma_{20,11}$(Ra)	96,03 (5)	0,077 (15)	(E1)		0,094 (3)	0,0229 (7)	0,125 (4)
$\gamma_{15,9}$(Ra)	99,58 (10)	0,025 (6)					
$\gamma_{24,17}$(Ra)	99,6 (2)	0,0126 (6)					
$\gamma_{6,1}$(Ra)	100,27 (3)	0,87 (17)	E2		7,06 (21)	1,93 (6)	9,6 (3)
$\gamma_{23,14}$(Ra)	102,5 (1)	0,00113 (5)					
$\gamma_{11,7}$(Ra)	105,2 (1)	0,0097 (5)					
$\gamma_{16,9}$(Ra)	107,76 (7)	0,09 (3)	(M1), [E2]	5,6 (2)	3,53 (11)	0,93 (3)	10,4 (3)
$\gamma_{22,1}$(Ra)	109,2 (4)	0,0052 (15)					
$\gamma_{25,15}$(Ra)	110,65 (5)	0,023 (15)	E2	0,286 (9)	4,46 (13)	1,22 (4)	6,38 (19)
$\gamma_{(-1,14)}$(Ra)	112,6 (5)	0,009 (4)					
$\gamma_{8,3}$(Ra)	113,11 (5)	0,75 (14)	E1	0,279 (8)	0,0613 (18)	0,0148 (4)	0,360 (11)
$\gamma_{7,3}$(Ra)	113,11	1,3 (6)	E2	0,294 (9)	4,03 (12)	1,10 (3)	5,80 (17)
$\gamma_{10,6}$(Ra)	117,20 (5)	0,258 (22)	E1	0,256 (8)	0,0558 (17)	0,0135 (4)	0,33 (1)
$\gamma_{(-1,61)}$(Ra)	117,5 (5)	0,012 (4)					
$\gamma_{10,5}$(Ra)	123,58 (10)	0,014 (5)					
$\gamma_{21,11}$(Ra)	124,44 (20)	0,0040 (22)					
$\gamma_{(-1,15)}$(Ra)	128,02 (2)	0,0032 (5)					
$\gamma_{(-1,19)}$(Ra)	129,4 (2)	0,0013 (6)					
$\gamma_{19,9}$(Ra)	134,6 (1)	0,040 (8)	[E1]	0,185 (6)	0,0389 (12)	0,0094 (3)	0,236 (7)
$\gamma_{(-1,23)}$(Ra)	138,4 (1)	0,014 (3)					
$\gamma_{(-1,24)}$(Ra)	140,6 (3)	0,021 (3)					
$\gamma_{20,9}$(Ra)	141,42 (5)	0,140 (28)	E1	0,164 (5)	0,0342 (10)	0,00820 (25)	0,210 (6)
$\gamma_{11,6}$(Ra)	150,14 (20)	0,011 (3)					
$\gamma_{24,11}$(Ra)	162,19 (10)	0,008 (3)					
$\gamma_{(-1,25)}$(Ra)	164,52 (10)	0,014 (3)					
$\gamma_{17,7}$(Ra)	168,36 (10)	0,014 (3)					
$\gamma_{21,9}$(Ra)	169,95 (10)	0,0054 (22)					
$\gamma_{(-1,27)}$(Ra)	171,5 (2)	0,0038 (13)					
$\gamma_{9,3}$(Ra)	173,45 (3)	0,055 (1)	M1,E2	1,51 (5)	0,553 (17)	0,142 (4)	2,26 (7)
$\gamma_{(-1,30)}$(Ra)	175,8 (3)	0,020 (5)					
$\gamma_{(-1,33)}$(Ra)	181,1 (3)	0,0025 (13)					
$\gamma_{(-1,35)}$(Ra)	182,3 (2)	0,0038 (13)					
$\gamma_{9,2}$(Ra)	184,65 (5)	0,039 (5)	E1	0,0874 (30)	0,0172 (5)	0,00410 (12)	0,110 (3)
$\gamma_{25,10}$(Ra)	197,56 (10)	0,013 (4)					
$\gamma_{11,4}$(Ra)	200,5 (1)	0,013 (9)					
$\gamma_{20,7}$(Ra)	201,64 (10)	0,048 (6)	M1+71,7%E2	0,636 (20)	0,316 (9)	0,0825 (25)	1,06 (3)
$\gamma_{(-1,37)}$(Ra)	202,5 (5)	0,006 (3)					
$\gamma_{15,6}$(Ra)	204,14 (10)	0,340 (47)	E2	0,156 (5)	0,291 (9)	0,0787 (24)	0,552 (17)
$\gamma_{9,1}$(Ra)	204,98 (10)	0,51 (8)	M1+1,4%E2	1,74 (5)	0,322 (10)	0,0774 (23)	2,17 (7)
$\gamma_{14,5}$(Ra)	206,08 (5)	0,38 (4)	E2	0,153 (5)	0,280 (8)	0,0756 (23)	0,534 (16)
$\gamma_{15,5}$(Ra)	210,62 (5)	1,32 (11)	E1	0,0642 (19)	0,0124 (4)	0,00297 (9)	0,0805 (24)

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{17,6}$(Ra)	212,70 (4)	0,21 (3)	M1+13,8%E2	1,39 (4)	0,285 (9)	0,0692 (21)	1,77 (5)
$\gamma_{26,10}$(Ra)	212,7 (3)	0,019 (5)					
$\gamma_{(-1,40)}$(Ra)	216,0 (1)	0,00025 (13)					
$\gamma_{11,3}$(Ra)	218,90 (5)	0,30 (3)	M1	1,47 (4)	0,268 (8)	0,0643 (19)	1,82 (5)
$\gamma_{(-1,43)}$(Ra)	219,0 (2)	0,049 (12)					
$\gamma_{(-1,45)}$(Ra)	223,2 (4)	0,0050 (13)					
$\gamma_{26,9}$(Ra)	225,5 (3)	0,009 (3)					
$\gamma_{21,7}$(Ra)	229,9 (5)	0,0038 (13)					
$\gamma_{9,0}$(Ra)	234,76 (10)	1,10 (14)	M1(+0,5%E2)	1,20 (4)	0,220 (7)	0,0528 (16)	1,49 (4)
$\gamma_{12,2}$(Ra)	235,96 (2)	13,4 (6)	E1	0,0493 (15)	0,0093 (3)	0,00224 (7)	0,0617 (19)
$\gamma_{20,6}$(Ra)	246,12 (10)	0,0120 (22)					
$\gamma_{(-1,63)}$(Ra)	248,1 (1)	0,024 (5)					
$\gamma_{22,8}$(Ra)	249,6 (5)	0,0076 (25)					
$\gamma_{11,1}$(Ra)	250,15 (5)	0,020 (4)	M1	1,01 (3)	0,185 (6)	0,0443 (13)	1,26 (4)
$\gamma_{14,4}$(Ra)	250,27 (8)	0,64 (6)	M1+81,5%E2	0,271 (8)	0,136 (4)	0,0355 (11)	0,455 (14)
$\gamma_{20,5}$(Ra)	252,50 (5)	0,24 (4)	M1	0,99 (3)	0,180 (5)	0,0431 (13)	1,22 (4)
$\gamma_{15,4}$(Ra)	254,63 (3)	0,73 (14)	E1	0,041 (1)	0,00776 (23)	0,00186 (6)	0,0517 (16)
$\gamma_{12,1}$(Ra)	256,23 (2)	8,5 (4)	E2	0,099 (3)	0,114 (3)	0,0305 (9)	0,253 (8)
$\gamma_{(-1,47)}$(Ra)	260,6 (2)	0,0051 (13)					
$\gamma_{16,4}$(Ra)	262,87 (5)	0,110 (9)	E1	0,0385 (10)	0,00719 (22)	0,00172 (5)	0,0480 (14)
$\gamma_{(-1,50)}$(Ra)	265,3 (2)	0,0050 (13)					
$\gamma_{27,10}$(Ra)	267,05 (20)	0,010 (3)					
$\gamma_{24,8}$(Ra)	267,86 (20)	0,0069 (25)					
$\gamma_{25,7}$(Ra)	270,56 (20)	0,028 (9)					
$\gamma_{15,3}$(Ra)	272,91 (5)	0,80 (6)	M1+50%E2	0,441 (13)	0,117 (4)	0,0292 (9)	0,597 (18)
$\gamma_{14,2}$(Ra)	279,80 (5)	0,101 (25)	M1+1,4%E2	0,773 (23)	0,135 (4)	0,0323 (10)	0,91 (3)
$\gamma_{21,5}$(Ra)	280,7 (3)	0,0025 (13)					
$\gamma_{17,3}$(Ra)	281,42 (5)	0,304 (25)	M1+21,9%E2	0,588 (18)	0,121 (4)	0,0294 (9)	0,749 (22)
$\gamma_{15,10}$(Ra)	284,24 (10)	0,039 (13)					
$\gamma_{26,7}$(Ra)	285,52 (10)	0,066 (18)	M1+50%E2	0,390 (12)	0,101 (3)	0,0252 (8)	0,526 (16)
$\gamma_{12,0}$(Ra)	286,09 (2)	2,6 (3)	M1+50%E2	0,390 (12)	0,101 (3)	0,0252 (8)	0,526 (16)
$\gamma_{19,4}$(Ra)	289,59 (10)	1,9 (4)					
$\gamma_{28,10}$(Ra)	289,77 (10)	0,019 (4)					
$\gamma_{16,2}$(Ra)	292,41 (5)	0,066 (8)	E1	0,0303 (10)	0,00557 (17)	0,00133 (4)	0,0377 (11)
$\gamma_{20,4}$(Ra)	296,50 (5)	0,76 (8)	M1+1,7%E2	0,624 (19)	0,114 (3)	0,0274 (8)	0,775 (23)
$\gamma_{14,1}$(Ra)	299,98 (3)	2,24 (12)	E1	0,0286 (10)	0,00525 (16)	0,00125 (4)	0,0356 (11)
$\gamma_{18,2}$(Ra)	300,50 (16)	0,0200 (44)	(M1+50%E2)	0,34 (1)	0,086 (3)	0,0214 (6)	0,455 (14)
$\gamma_{15,1}$(Ra)	304,50 (2)	2,4 (3)	M1+6,3%E2(+E0)	0,95 (12)	0,161 (22)	0,024 (8)	1,1 (1)
$\gamma_{(-1,53)}$(Ra)	306,1 (3)	0,010 (4)					
$\gamma_{23,5}$(Ra)	308,40 (3)	0,024 (4)	M1+50%E2	0,318 (10)	0,0792 (24)	0,0197 (6)	0,424 (13)
$\gamma_{16,1}$(Ra)	312,69 (3)	0,83 (8)	M1+2,5%E2	0,535 (16)	0,098 (3)	0,0236 (7)	0,665 (20)
$\gamma_{(-1,55)}$(Ra)	314,75 (10)	0,034 (2)					
$\gamma_{20,3}$(Ra)	314,85 (48)	0,48 (4)	E1 or M1				
$\gamma_{24,5}$(Ra)	318,46 (20)	0,0066 (22)					
$\gamma_{19,2}$(Ra)	319,24 (5)	0,050 (11)	M1+3,1%E2	0,503 (15)	0,093 (3)	0,0222 (7)	0,626 (19)
$\gamma_{21,4}$(Ra)	324,88 (20)	0,014 (4)	M1+50%E2	0,277 (8)	0,0674 (20)	0,0167 (5)	0,367 (11)
$\gamma_{20,2}$(Ra)	325,99 (18)	0,006 (3)					
$\gamma_{14,0}$(Ra)	329,85 (2)	3,0 (2)	(E1)	0,0232 (10)	0,0042 (1)	0,00100 (3)	0,0288 (9)
$\gamma_{(-1,57)}$(Ra)	332,2 (2)	0,0016 (5)					
$\gamma_{15,0}$(Ra)	334,37 (2)	1,60 (13)	M1+27,1%E2	0,348 (10)	0,0714 (21)	0,0174 (5)	0,442 (13)
$\gamma_{27,8}$(Ra)	339,76 (10)	0,0038 (13)					
$\gamma_{16,0}$(Ra)	342,55 (4)	0,43 (11)	M1+62,5%E2	0,194 (6)	0,0523 (16)	0,0131 (4)	0,264 (8)
$\gamma_{20,1}$(Ra)	346,45 (1)	0,0117 (14)					
$\gamma_{(-1,60)}$(Ra)	348,5 (5)	0,0066 (22)					
$\gamma_{18,0}$(Ra)	350,54 (7)	0,110 (19)	E1	0,0204 (10)	0,00366 (11)	0,00090 (3)	0,0252 (8)
$\gamma_{23,4}$(Ra)	352,61 (10)	0,013 (3)	M1+50%E2	0,223 (7)	0,0525 (16)	0,0130 (4)	0,293 (9)
$\gamma_{22,3}$(Ra)	362,63 (10)	0,050 (3)					
$\gamma_{19,0}$(Ra)	369,35 (5)	0,0060 (13)					
$\gamma_{23,3}$(Ra)	370,93 (8)	0,004 (3)					

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{21,1}$(Ra)	374,8 (2)	0,00151 (7)					
$\gamma_{20,0}$(Ra)	376,27 (10)	0,0050 (13)					
$\gamma_{(-1,62)}$(Ra)	379,4 (1)	0,010 (3)					
$\gamma_{23,2}$(Ra)	382,2 (3)	0,0063 (13)					
$\gamma_{25,3}$(Ra)	383,51 (4)	0,03 (3)	M1+17,5%E2	0,267 (8)	0,0512 (15)	0,0124 (4)	0,335 (10)
$\gamma_{(-1,64)}$(Ra)	392,4 (5)	0,0098 (22)					
$\gamma_{26,3}$(Ra)	398,6 (3)	0,0014 (4)					
$\gamma_{23,1}$(Ra)	402,2 (3)	0,008 (5)					
$\gamma_{25,1}$(Ra)	415,11 (10)	0,0014 (6)					
$\gamma_{23,0}$(Ra)	432,33 (10)	0,0040 (5)					
$\gamma_{(-1,66)}$(Ra)	442,5 (10)	0,000058 (3)					
$\gamma_{(-1,68)}$(Ra)	445	0,0005 (5)					
$\gamma_{49,26}$(Ra)	448,0 (6)	0,000139 (8)					
$\gamma_{36,15}$(Ra)	452,9 (3)	0,001					
$\gamma_{36,14}$(Ra)	457,5 (1)	0,000068 (3)					
$\gamma_{(-1,70)}$(Ra)	462 (1)	0,000048 (2)					
$\gamma_{30,5}$(Ra)	466,8 (2)	0,0005 (3)					
$\gamma_{(-1,72)}$(Ra)	469,0 (2)	0,0009 (3)					
$\gamma_{40,17}$(Ra)	480 (1)	0,00029 (9)					
$\gamma_{43,20}$(Ra)	482 (1)	0,00014 (4)					
$\gamma_{40,14}$(Ra)	493,1 (2)	0,00053 (8)					
$\gamma_{42,15}$(Ra)	507,5 (1)	0,00064 (25)					
$\gamma_{43,16}$(Ra)	516,6 (3)	0,00028 (10)					
$\gamma_{(-1,74)}$(Ra)	521,8 (3)	0,00038 (13)					
$\gamma_{43,15}$(Ra)	524,5 (4)	0,00019 (4)					
$\gamma_{48,19}$(Ra)	534,6 (4)	0,00010 (3)					
$\gamma_{40,12}$(Ra)	536,9 (1)	0,00107 (17)					
$\gamma_{(-1,78)}$(Ra)	540,2 (3)	0,00025 (13)					
$\gamma_{36,9}$(Ra)	552,4 (5)	0,00023 (5)					
$\gamma_{42,12}$(Ra)	556,1 (2)	0,00037 (15)					
$\gamma_{(-1,80)}$(Ra)	565,4 (1)	0,0014 (3)					
$\gamma_{38,9}$(Ra)	569,1 (3)	0,00058 (9)					
$\gamma_{50,18}$(Ra)	576,0 (2)	0,00032 (19)					
$\gamma_{43,11}$(Ra)	579,0 (2)	0,0004 (3)					
$\gamma_{(-1,82)}$(Ra)	585,8 (1)	0,0009 (3)					
$\gamma_{40,9}$(Ra)	589,0 (6)	0,000058 (15)					
$\gamma_{50,14}$(Ra)	596 (1)	0,0000101 (5)					
$\gamma_{(-1,84)}$(Ra)	598,9 (2)	0,00063 (13)					
$\gamma_{42,9}$(Ra)	607,7 (3)	0,00018 (4)					
$\gamma_{49,12}$(Ra)	621,4 (5)	0,000058 (15)					
$\gamma_{53,20}$(Ra)	623,8 (5)	0,00016 (4)					
$\gamma_{33,4}$(Ra)	632,3 (7)	0,00014 (3)					
$\gamma_{52,14}$(Ra)	641,0 (5)	0,000019 (6)					
$\gamma_{45,9}$(Ra)	644,3 (3)	0,00009 (4)					
$\gamma_{(-1,86)}$(Ra)	648,5 (5)	0,000019 (6)					
$\gamma_{33,2}$(Ra)	662,8 (4)	0,000058 (18)					
$\gamma_{50,9}$(Ra)	692,0 (7)	0,000039 (11)					
$\gamma_{45,8}$(Ra)	704,3 (5)	0,000078 (16)					
$\gamma_{36,4}$(Ra)	707,2 (7)	0,000039 (11)					
$\gamma_{42,5}$(Ra)	718,5 (10)	0,000029 (11)					
$\gamma_{35,3}$(Ra)	722,1 (6)	0,00037 (12)					
$\gamma_{38,4}$(Ra)	723,5 (1)	0,00027 (10)					
$\gamma_{35,2}$(Ra)	734,4 (5)	0,00010 (4)					
$\gamma_{43,5}$(Ra)	735,4 (2)	0,00016 (5)					
$\gamma_{36,2}$(Ra)	738,4 (10)	0,000068 (17)					
$\gamma_{41,4}$(Ra)	746,4 (7)	0,00010 (4)					
$\gamma_{45,6}$(Ra)	748,8 (4)	0,00040 (12)					
$\gamma_{35,1}$(Ra)	754,1 (2)	0,00024 (14)					
$\gamma_{36,1}$(Ra)	756,9 (2)	0,00019 (5)					

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{(-1,88)}$(Ra)	757,3 (4)	0,00102 (24)					
$\gamma_{42,4}$(Ra)	762,6 (5)	0,00026 (5)					
$\gamma_{41,3}$(Ra)	766,3 (5)	0,00029 (6)					
$\gamma_{40,2}$(Ra)	773,4 (4)	0,00015 (4)					
$\gamma_{41,2}$(Ra)	775,8 (5)	0,00151 (15)					
$\gamma_{42,3}$(Ra)	781,0 (5)	0,00032 (6)					
$\gamma_{35,0}$(Ra)	784,2 (5)	0,000097 (24)					
$\gamma_{36,0}$(Ra)	787,4 (5)	0,000039 (10)					
$\gamma_{(-1,95)}$(Ra)	787,6 (5)	0,00011 (3)					
$\gamma_{40,1}$(Ra)	792,6 (6)	0,000029 (8)					
$\gamma_{37,0}$(Ra)	792,6 (6)	0,000039 (10)					
$\gamma_{43,3}$(Ra)	797,3 (5)	0,00090 (12)					
$\gamma_{38,0}$(Ra)	803,9 (4)	0,00063 (6)					
$\gamma_{43,2}$(Ra)	808,6 (4)	0,000076 (25)					
$\gamma_{42,1}$(Ra)	812,6 (4)	0,0017 (3)					
$\gamma_{(-1,92)}$(Ra)	818 (1)	0,000029 (11)					
$\gamma_{45,3}$(Ra)	818,1 (2)	0,00017 (8)					
$\gamma_{40,0}$(Ra)	823,4 (4)	0,0025 (3)					
$\gamma_{41,0}$(Ra)	826,7 (5)	0,00016 (5)					
$\gamma_{43,1}$(Ra)	828,5 (5)	0,00019 (5)					
$\gamma_{(-1,94)}$(Ra)	828,9 (2)	0,00076 (4)					
$\gamma_{44,1}$(Ra)	837,8 (5)	0,00052 (12)					
$\gamma_{42,0}$(Ra)	842,5 (3)	0,00087 (13)					
$\gamma_{50,4}$(Ra)	846,7 (5)	0,00015 (3)					
$\gamma_{45,1}$(Ra)	848,3 (6)	0,00027 (11)					
$\gamma_{46,1}$(Ra)	854,3 (5)	0,000068 (14)					
$\gamma_{49,2}$(Ra)	857,3 (7)	0,000058 (18)					
$\gamma_{43,0}$(Ra)	858,9 (2)	0,00025 (4)					
$\gamma_{51,4}$(Ra)	863 (1)	0,000019 (8)					
$\gamma_{44,0}$(Ra)	867,3 (5)	0,00029 (22)					
$\gamma_{50,2}$(Ra)	876,3 (4)	0,00023 (8)					
$\gamma_{49,1}$(Ra)	878,2 (4)	0,00014 (4)					
$\gamma_{47,0}$(Ra)	891 (1)	0,000019 (6)					
$\gamma_{51,2}$(Ra)	893 (1)	0,000013 (4)					
$\gamma_{50,1}$(Ra)	896,1 (5)	0,00011 (3)					
$\gamma_{49,0}$(Ra)	908,6 (4)	0,0023 (3)					
$\gamma_{52,3}$(Ra)	910 (1)	0,000015 (6)					
$\gamma_{53,4}$(Ra)	920,0 (5)	0,000011 (3)					
$\gamma_{50,0}$(Ra)	927 (1)	0,000006 (3)					
$\gamma_{53,3}$(Ra)	938,0 (8)	0,000010 (4)					
$\gamma_{52,1}$(Ra)	941,6 (3)	0,000069 (11)					
$\gamma_{55,3}$(Ra)	958,7 (3)	0,000061 (13)					
$\gamma_{53,1}$(Ra)	970,2 (2)	0,00014 (11)					
$\gamma_{52,0}$(Ra)	971,7 (10)	0,000010 (5)					
$\gamma_{55,1}$(Ra)	990,0 (7)	0,000034 (9)					
$\gamma_{56,1}$(Ra)	995 (1)	0,000006 (4)					
$\gamma_{53,0}$(Ra)	999,8 (5)	0,000029 (8)					
$\gamma_{54,0}$(Ra)	1015,2 (7)	0,000015 (4)					
$\gamma_{55,0}$(Ra)	1020 (1)	0,000019 (6)					
$\gamma_{56,0}$(Ra)	1025 (1)	0,000015 (4)					

3 Atomic Data

3.1 Ra

ω_K : 0,968 (4)
$\bar{\omega}_L$: 0,452 (18)
n_{KL} : 0,801 (5)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	85,43		61,15
	$K\alpha_1$	88,47		100
	$K\beta_3$	99,432	}	
	$K\beta_1$	100,13	}	
	$K\beta_5''$	100,738	}	35,13
	$K\beta_2$	102,89	}	
	$K\beta_4$	103,295	}	11,49
	$KO_{2,3}$	103,74	}	
X_L				
	$L\ell$	10,662		
	$L\alpha$	12,196 – 12,339		
	$L\eta$	13,662		
	$L\beta$	14,236 – 15,447		
	$L\gamma$	17,848 – 18,412		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	65,149 – 72,729	100
KLX	79,721 – 88,466	58,2
KXY	94,27 – 103,91	8,36
Auger L	5,71 – 12,04	

4 α Emissions

	Energy keV	Probability × 100
$\alpha_{0,56}$	5033,5 (40)	0,00031 (2)
$\alpha_{0,53}$	5056,1 (40)	0,00023 (2)
$\alpha_{0,52}$	5083,5 (40)	0,000150 (15)

	Energy keV	Probability × 100
$\alpha_{0,51}$	5110,5 (40)	0,00028 (2)
$\alpha_{0,50}$	5128,7 (30)	0,00062 (5)
$\alpha_{0,49}$	5146,5 (20)	0,00410 (8)
$\alpha_{0,46}$	5171 (3)	0,00170 (17)
$\alpha_{0,45}$	5180,6 (40)	0,00120 (24)
$\alpha_{0,43}$	5193,7 (25)	0,0038 (3)
$\alpha_{0,42}$	5210,2 (20)	0,0070 (3)
$\alpha_{0,40}$	5229,2 (20)	0,0098 (3)
$\alpha_{0,38}$	5248,3 (20)	0,00320 (16)
$\alpha_{0,36}$	5264,3 (20)	0,0026 (2)
$\alpha_{0,34}$	5321,8 (40)	0,00024 (10)
$\alpha_{0,33}$	5335,9 (50)	0,0002 (1)
$\alpha_{0,32}$	5365,0 (25)	0,00066 (3)
$\alpha_{0,31}$	5408,7 (30)	0,00044 (7)
$\alpha_{0,30}$	5458,6 (20)	0,00270 (5)
$\alpha_{0,29}$	5480,4 (22)	0,0012 (1)
$\alpha_{0,28}$	5509,9 (20)	0,0166 (3)
$\alpha_{0,27}$	5531,7 (18)	0,021 (2)
$\alpha_{0,26}$	5585,9 (16)	0,176 (6)
$\alpha_{0,25}$	5600,6 (18)	0,170 (17)
$\alpha_{0,23}$	5613,3 (16)	0,216 (8)
$\alpha_{0,22}$	5622,0 (17)	0,0070 (4)
$\alpha_{0,21}$	5640,2 (15)	0,0179 (15)
$\alpha_{0,20}$	5668,0 (15)	2,06 (12)
$\alpha_{0,19}$	5674,3 (16)	0,057 (4)
$\alpha_{0,18}$	5693,0 (16)	1,5 (1)
$\alpha_{0,16}$	5700,8 (16)	3,63 (20)
$\alpha_{0,15}$	5708,8 (16)	8,3 (3)
$\alpha_{0,14}$	5713,2 (16)	4,89 (20)
$\alpha_{0,13}$	5728,1 (16)	0,0342 (25)
$\alpha_{0,12}$	5756,87 (15)	20,4 (9)
$\alpha_{0,11}$	5762,3 (15)	0,228 (10)
$\alpha_{0,10}$	5795,5 (15)	0,311 (5)
$\alpha_{0,9}$	5807,5 (15)	1,27 (2)
$\alpha_{0,7}$	5866,6	2,42 (10)
$\alpha_{0,6}$	5909,9 (15)	0,174 (8)
$\alpha_{0,5}$	5916,0 (15)	0,775 (30)
$\alpha_{0,4}$	5959,7 (15)	3,00 (15)
$\alpha_{0,3}$	5977,72 (10)	23,5 (9)
$\alpha_{0,2}$	5989,4 (20)	<0,005
$\alpha_{0,1}$	6008,8 (15)	2,90 (15)
$\alpha_{0,0}$	6038,01 (15)	24,2 (9)

5 Electron Emissions

		Energy keV	Electrons per 100 disint.
e_{AL}	(Ra)	5,71 - 12,04	55,9 (22)
e_{AK}	(Ra)		0,20 (3)
	KLL	65,149 - 72,729 }	
	KLX	79,721 - 88,466 }	
	KXY	94,27 - 103,91 }	

		Energy keV	Electrons per 100 disint.
$ec_{2,1\ L}$	(Ra)	1,018 - 4,806	0,65 (9)
$ec_{7,3\ K}$	(Ra)	9,195	0,06 (3)
$ec_{4,2\ L}$	(Ra)	10,368 - 14,156	9,6 (9)
$ec_{1,0\ L}$	(Ra)	10,628 - 14,416	32 (5)
$ec_{3,1\ L}$	(Ra)	12,348 - 16,136	13,7 (25)
$ec_{2,1\ M}$	(Ra)	15,428 - 17,145	0,35 (5)
$ec_{2,1\ N}$	(Ra)	19,042 - 19,971	0,66 (9)
$ec_{4,2\ M}$	(Ra)	24,778 - 26,495	2,58 (23)
$ec_{5,4\ L}$	(Ra)	24,988 - 28,776	5,1 (13)
$ec_{1,0\ M}$	(Ra)	25,038 - 26,755	8,5 (14)
$ec_{3,1\ M}$	(Ra)	26,758 - 28,475	3,6 (6)
$ec_{4,2\ N}$	(Ra)	28,392 - 29,321	0,86 (8)
$ec_{1,0\ N}$	(Ra)	28,652 - 29,581	2,9 (5)
$ec_{15,12\ L}$	(Ra)	29,068 - 32,856	3,2 (12)
$ec_{3,1\ N}$	(Ra)	30,372 - 31,301	1,19 (22)
$ec_{2,0\ L}$	(Ra)	30,898 - 34,686	4,4 (4)
$ec_{5,4\ M}$	(Ra)	39,398 - 41,115	1,3 (3)
$ec_{3,0\ L}$	(Ra)	42,208 - 46,000	6,4 (9)
$ec_{5,4\ N}$	(Ra)	43,012 - 43,941	0,44 (11)
$ec_{17,11\ L}$	(Ra)	43,218 - 47,010	2,9 (4)
$ec_{15,12\ M}$	(Ra)	43,478 - 45,195	0,9 (3)
$ec_{2,0\ M}$	(Ra)	45,308 - 47,025	1,10 (11)
$ec_{15,12\ N}$	(Ra)	47,092 - 48,021	0,31 (11)
$ec_{2,0\ N}$	(Ra)	48,922 - 49,851	0,40 (4)
$ec_{6,3\ L}$	(Ra)	49,508 - 53,296	0,76 (15)
$ec_{3,0\ M}$	(Ra)	56,618 - 58,335	1,7 (3)
$ec_{17,11\ M}$	(Ra)	57,628 - 59,345	0,72 (11)
$ec_{3,0\ N}$	(Ra)	60,232 - 61,161	0,60 (9)
$ec_{17,11\ N}$	(Ra)	61,242 - 62,171	0,24 (4)
$ec_{6,3\ M}$	(Ra)	63,918 - 65,635	0,20 (4)
$ec_{6,3\ N}$	(Ra)	67,532 - 68,461	0,067 (13)
$ec_{7,3\ L}$	(Ra)	93,878 - 97,666	0,8 (4)
$ec_{7,3\ M}$	(Ra)	108,288 - 110,005	0,2 (1)
$ec_{7,3\ N}$	(Ra)	111,902 - 112,831	0,07 (3)
$ec_{20,5\ K}$	(Ra)	148,585 (50)	0,107 (16)
$ec_{12,1\ K}$	(Ra)	152,315 (20)	0,673 (45)
$ec_{15,3\ K}$	(Ra)	168,995 (50)	0,220 (15)
$ec_{12,0\ K}$	(Ra)	182,175 (20)	0,66 (7)
$ec_{20,4\ K}$	(Ra)	192,585 (50)	0,268 (26)
$ec_{14,1\ K}$	(Ra)	196,065 (30)	0,0618 (41)
$ec_{15,1\ K}$	(Ra)	200,585 (20)	1,06 (19)
$ec_{16,1\ K}$	(Ra)	208,775 (30)	0,268 (23)
$ec_{14,0\ K}$	(Ra)	225,935 (20)	0,067 (5)
$ec_{15,0\ K}$	(Ra)	230,455 (20)	0,386 (33)
$ec_{12,1\ L}$	(Ra)	236,998 - 240,786	0,78 (5)
$ec_{12,1\ M}$	(Ra)	251,408 - 253,125	0,207 (14)
$ec_{15,3\ L}$	(Ra)	253,678 - 257,466	0,0585 (40)
$ec_{12,0\ L}$	(Ra)	266,858 - 270,646	0,172 (18)
$ec_{15,1\ L}$	(Ra)	285,268 - 289,056	0,180 (33)
$ec_{15,0\ L}$	(Ra)	315,138 - 318,926	0,079 (7)

6 Photon Emissions

6.1 X-Ray Emissions

		Energy keV		Photons per 100 disint.	
XL	(Ra)	10,662 — 18,412		41,3 (17)	
XKα_2	(Ra)	85,43		1,81 (6)	} Kα
XKα_1	(Ra)	88,47		2,96 (10)	}
XKβ_3	(Ra)	99,432	}		
XKβ_1	(Ra)	100,13	}	1,04 (4)	K$'\beta_1$
XKβ_5''	(Ra)	100,738	}		
XKβ_2	(Ra)	102,89	}		
XKβ_4	(Ra)	103,295	}	0,340 (13)	K$'\beta_2$
XKO$_{2,3}$	(Ra)	103,74	}		

6.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{6,5}$(Ra)	6,5 (3)	0,09 (3)
$\gamma_{17,16}$(Ra)	8,15 (20)	0,008 (3)
$\gamma_{2,1}$(Ra)	20,25 (5)	0,23 (3)
$\gamma_{25,22}$(Ra)	20,94 (5)	0,006 (3)
$\gamma_{(-1,1)}$(Ra)	22,0 (2)	0,009 (9)
$\gamma_{(-1,2)}$(Ra)	24,13 (5)	0,086 (8)
$\gamma_{(-1,3)}$(Ra)	27,41 (9)	0,029 (5)
$\gamma_{4,2}$(Ra)	29,60 (3)	0,0058 (3)
$\gamma_{1,0}$(Ra)	29,86 (1)	0,074 (11)
$\gamma_{3,1}$(Ra)	31,58 (1)	0,067 (11)
$\gamma_{20,17}$(Ra)	33,39 (8)	0,008 (3)
$\gamma_{25,21}$(Ra)	40,20 (3)	0,015 (4)
$\gamma_{20,15}$(Ra)	41,93 (5)	0,028 (13)
$\gamma_{14,12}$(Ra)	43,77 (5)	0,208 (16)
$\gamma_{(-1,4)}$(Ra)	43,8 (5)	0,054 (22)
$\gamma_{5,4}$(Ra)	44,22 (12)	0,052 (13)
$\gamma_{8,6}$(Ra)	44,40 (5)	0,016 (10)
$\gamma_{15,12}$(Ra)	48,30 (3)	0,014 (5)
$\gamma_{4,1}$(Ra)	49,82 (5)	0,42 (9)
$\gamma_{2,0}$(Ra)	50,13 (1)	8,2 (5)
$\gamma_{7,5}$(Ra)	50,85 (5)	0,015 (6)
$\gamma_{15,11}$(Ra)	54,19 (4)	0,0063 (13)
$\gamma_{23,20}$(Ra)	56,00 (6)	0,0048 (2)
$\gamma_{16,12}$(Ra)	56,42 (7)	0,009 (8)
$\gamma_{(-1,8)}$(Ra)	59,6 (5)	0,010 (4)
$\gamma_{3,0}$(Ra)	61,44 (2)	0,088 (11)
$\gamma_{17,11}$(Ra)	62,45 (5)	0,20 (3)
$\gamma_{21,17}$(Ra)	62,68 (3)	0,007 (3)
$\gamma_{18,12}$(Ra)	64,35 (10)	0,025 (4)
$\gamma_{(-1,9)}$(Ra)	66,2 (5)	0,006 (4)
$\gamma_{(-1,10)}$(Ra)	66,4 (5)	0,008 (4)
$\gamma_{(-1,11)}$(Ra)	68,7 (1)	0,0058 (3)
$\gamma_{6,3}$(Ra)	68,74 (3)	0,057 (10)
$\gamma_{(-1,12)}$(Ra)	69,8 (3)	0,010 (4)

	Energy keV	Photons per 100 disint.
$\gamma_{10,7}$(Ra)	72,85 (5)	0,024 (19)
$\gamma_{5,2}$(Ra)	73,63 (5)	0,014 (5)
$\gamma_{(-1,0)}$(Ra)	75,01 (5)	0,026 (10)
$\gamma_{(-1,13)}$(Ra)	77,4 (4)	0,0101 (5)
$\gamma_{4,0}$(Ra)	79,69 (2)	1,90 (11)
$\gamma_{23,17}$(Ra)	89,6 (4)	0,0038 (13)
$\gamma_{5,1}$(Ra)	93,88 (5)	1,48 (8)
$\gamma_{7,4}$(Ra)	94,97 (5)	0,024 (14)
$\gamma_{20,11}$(Ra)	96,03 (5)	0,068 (13)
$\gamma_{15,9}$(Ra)	99,58 (10)	0,025 (6)
$\gamma_{24,17}$(Ra)	99,6 (2)	0,013 (1)
$\gamma_{6,1}$(Ra)	100,27 (3)	0,082 (16)
$\gamma_{23,14}$(Ra)	102,5 (1)	0,00113 (5)
$\gamma_{11,7}$(Ra)	105,2 (1)	0,0097 (5)
$\gamma_{16,9}$(Ra)	107,76 (7)	0,0076 (25)
$\gamma_{22,1}$(Ra)	109,2 (4)	0,0052 (15)
$\gamma_{25,15}$(Ra)	110,65 (5)	0,0032 (20)
$\gamma_{(-1,14)}$(Ra)	112,6 (5)	0,009 (4)
$\gamma_{7,3}$(Ra)	113,11	0,19 (9)
$\gamma_{8,3}$(Ra)	113,11 (5)	0,55 (10)
$\gamma_{10,6}$(Ra)	117,20 (5)	0,194 (17)
$\gamma_{(-1,61)}$(Ra)	117,5 (5)	0,012 (4)
$\gamma_{10,5}$(Ra)	123,58 (10)	0,014 (5)
$\gamma_{21,11}$(Ra)	124,44 (20)	0,0040 (22)
$\gamma_{(-1,15)}$(Ra)	128,02 (2)	0,0032 (5)
$\gamma_{(-1,19)}$(Ra)	129,4 (2)	0,0013 (6)
$\gamma_{19,9}$(Ra)	134,6 (1)	0,033 (7)
$\gamma_{(-1,23)}$(Ra)	138,4 (1)	0,014 (3)
$\gamma_{(-1,24)}$(Ra)	140,6 (3)	0,021 (3)
$\gamma_{20,9}$(Ra)	141,42 (5)	0,116 (23)
$\gamma_{11,6}$(Ra)	150,14 (20)	0,011 (3)
$\gamma_{24,11}$(Ra)	162,19 (10)	0,008 (3)
$\gamma_{(-1,25)}$(Ra)	164,52 (10)	0,014 (3)
$\gamma_{17,7}$(Ra)	168,36 (10)	0,014 (3)
$\gamma_{21,9}$(Ra)	169,95 (10)	0,0054 (22)
$\gamma_{(-1,27)}$(Ra)	171,5 (2)	0,0038 (13)
$\gamma_{9,3}$(Ra)	173,45 (3)	0,017 (3)
$\gamma_{(-1,30)}$(Ra)	175,8 (3)	0,020 (5)
$\gamma_{(-1,33)}$(Ra)	181,1 (3)	0,0025 (13)
$\gamma_{(-1,35)}$(Ra)	182,3 (2)	0,0038 (13)
$\gamma_{9,2}$(Ra)	184,65 (5)	0,035 (4)
$\gamma_{25,10}$(Ra)	197,56 (10)	0,013 (4)
$\gamma_{11,4}$(Ra)	200,5 (1)	0,013 (9)
$\gamma_{20,7}$(Ra)	201,64 (10)	0,023 (3)
$\gamma_{(-1,37)}$(Ra)	202,5 (5)	0,006 (3)
$\gamma_{15,6}$(Ra)	204,14 (10)	0,22 (3)
$\gamma_{9,1}$(Ra)	204,98 (10)	0,16 (3)
$\gamma_{14,5}$(Ra)	206,08 (5)	0,25 (3)
$\gamma_{15,5}$(Ra)	210,62 (5)	1,22 (11)
$\gamma_{17,6}$(Ra)	212,70 (4)	0,077 (10)
$\gamma_{26,10}$(Ra)	212,7 (3)	0,019 (5)
$\gamma_{(-1,40)}$(Ra)	216,0 (1)	0,00025 (13)
$\gamma_{11,3}$(Ra)	218,90 (5)	0,107 (11)
$\gamma_{(-1,43)}$(Ra)	219,0 (2)	0,049 (12)
$\gamma_{(-1,45)}$(Ra)	223,2 (4)	0,0050 (13)
$\gamma_{26,9}$(Ra)	225,5 (3)	0,009 (3)
$\gamma_{21,7}$(Ra)	229,9 (5)	0,0038 (13)
$\gamma_{9,0}$(Ra)	234,76 (10)	0,44 (5)
$\gamma_{12,2}$(Ra)	235,96 (2)	12,6 (6)

	Energy keV	Photons per 100 disint.
$\gamma_{20,6}$(Ra)	246,12 (10)	0,0120 (22)
$\gamma_{(-1,63)}$(Ra)	248,1 (1)	0,024 (5)
$\gamma_{22,8}$(Ra)	249,6 (5)	0,0076 (25)
$\gamma_{11,1}$(Ra)	250,15 (5)	0,0087 (17)
$\gamma_{14,4}$(Ra)	250,27 (8)	0,44 (4)
$\gamma_{20,5}$(Ra)	252,50 (5)	0,108 (16)
$\gamma_{15,4}$(Ra)	254,63 (3)	0,69 (13)
$\gamma_{12,1}$(Ra)	256,23 (2)	6,8 (4)
$\gamma_{(-1,47)}$(Ra)	260,6 (2)	0,0051 (13)
$\gamma_{16,4}$(Ra)	262,87 (5)	0,105 (9)
$\gamma_{(-1,50)}$(Ra)	265,3 (2)	0,0050 (13)
$\gamma_{27,10}$(Ra)	267,05 (20)	0,010 (3)
$\gamma_{24,8}$(Ra)	267,86 (20)	0,0069 (25)
$\gamma_{25,7}$(Ra)	270,56 (20)	0,028 (9)
$\gamma_{15,3}$(Ra)	272,91 (5)	0,50 (3)
$\gamma_{14,2}$(Ra)	279,80 (5)	0,053 (13)
$\gamma_{21,5}$(Ra)	280,7 (3)	0,0025 (13)
$\gamma_{17,3}$(Ra)	281,42 (5)	0,174 (14)
$\gamma_{15,10}$(Ra)	284,24 (10)	0,039 (13)
$\gamma_{26,7}$(Ra)	285,52 (10)	0,043 (12)
$\gamma_{12,0}$(Ra)	286,09 (2)	1,70 (17)
$\gamma_{19,4}$(Ra)	289,59 (10)	1,9 (4)
$\gamma_{28,10}$(Ra)	289,77 (10)	0,019 (4)
$\gamma_{16,2}$(Ra)	292,41 (5)	0,064 (8)
$\gamma_{20,4}$(Ra)	296,50 (5)	0,43 (4)
$\gamma_{14,1}$(Ra)	299,98 (3)	2,16 (12)
$\gamma_{18,2}$(Ra)	300,50 (16)	0,014 (3)
$\gamma_{15,1}$(Ra)	304,50 (2)	1,12 (14)
$\gamma_{(-1,53)}$(Ra)	306,1 (3)	0,010 (4)
$\gamma_{23,5}$(Ra)	308,40 (3)	0,017 (3)
$\gamma_{16,1}$(Ra)	312,69 (3)	0,50 (4)
$\gamma_{(-1,55)}$(Ra)	314,75 (10)	0,034 (2)
$\gamma_{20,3}$(Ra)	314,85 (4)	0,48 (4)
$\gamma_{24,5}$(Ra)	318,46 (20)	0,0066 (22)
$\gamma_{19,2}$(Ra)	319,24 (5)	0,031 (7)
$\gamma_{21,4}$(Ra)	324,88 (20)	0,010 (3)
$\gamma_{20,2}$(Ra)	325,99 (18)	0,0062 (25)
$\gamma_{14,0}$(Ra)	329,85 (2)	2,9 (2)
$\gamma_{(-1,57)}$(Ra)	332,2 (2)	0,0016 (5)
$\gamma_{15,0}$(Ra)	334,37 (2)	1,11 (9)
$\gamma_{27,8}$(Ra)	339,76 (10)	0,0038 (13)
$\gamma_{16,0}$(Ra)	342,55 (4)	0,34 (9)
$\gamma_{20,1}$(Ra)	346,45 (1)	0,0117 (14)
$\gamma_{(-1,60)}$(Ra)	348,5 (5)	0,0066 (22)
$\gamma_{18,0}$(Ra)	350,54 (7)	0,107 (18)
$\gamma_{23,4}$(Ra)	352,61 (10)	0,0098 (22)
$\gamma_{22,3}$(Ra)	362,63 (10)	0,050 (3)
$\gamma_{19,0}$(Ra)	369,35 (5)	0,0060 (13)
$\gamma_{23,3}$(Ra)	370,93 (8)	0,004 (3)
$\gamma_{21,1}$(Ra)	374,8 (2)	0,00151 (7)
$\gamma_{20,0}$(Ra)	376,27 (10)	0,0050 (13)
$\gamma_{(-1,62)}$(Ra)	379,4 (1)	0,010 (3)
$\gamma_{23,2}$(Ra)	382,2 (3)	0,0063 (13)
$\gamma_{25,3}$(Ra)	383,51 (4)	0,024 (23)
$\gamma_{(-1,64)}$(Ra)	392,4 (5)	0,0098 (22)
$\gamma_{26,3}$(Ra)	398,6 (3)	0,0014 (4)
$\gamma_{23,1}$(Ra)	402,2 (3)	0,008 (5)
$\gamma_{25,1}$(Ra)	415,11 (10)	0,0014 (6)
$\gamma_{23,0}$(Ra)	432,33 (10)	0,0040 (5)

	Energy keV	Photons per 100 disint.
$\gamma_{(-1,66)}$(Ra)	442,5 (10)	0,000058 (3)
$\gamma_{(-1,68)}$(Ra)	445	0,0005 (5)
$\gamma_{49,26}$(Ra)	448,0 (6)	0,000139 (7)
$\gamma_{36,15}$(Ra)	452,9 (3)	0,001
$\gamma_{36,14}$(Ra)	457,5 (1)	0,000068 (3)
$\gamma_{(-1,70)}$(Ra)	462 (1)	0,000048 (2)
$\gamma_{30,5}$(Ra)	466,8 (2)	0,0005 (3)
$\gamma_{(-1,72)}$(Ra)	469,0 (2)	0,0009 (3)
$\gamma_{40,17}$(Ra)	480 (1)	0,00029 (9)
$\gamma_{43,20}$(Ra)	482 (1)	0,00014 (4)
$\gamma_{40,14}$(Ra)	493,1 (2)	0,00053 (8)
$\gamma_{42,15}$(Ra)	507,5 (1)	0,00064 (25)
$\gamma_{43,16}$(Ra)	516,6 (3)	0,00028 (10)
$\gamma_{(-1,74)}$(Ra)	521,8 (3)	0,00038 (13)
$\gamma_{43,15}$(Ra)	524,5 (4)	0,00019 (4)
$\gamma_{48,19}$(Ra)	534,6 (4)	0,00010 (3)
$\gamma_{40,12}$(Ra)	536,9 (1)	0,00107 (17)
$\gamma_{(-1,78)}$(Ra)	540,2 (3)	0,00025 (13)
$\gamma_{36,9}$(Ra)	552,4 (5)	0,00023 (5)
$\gamma_{42,12}$(Ra)	556,1 (2)	0,00037 (15)
$\gamma_{(-1,80)}$(Ra)	565,4 (1)	0,0014 (3)
$\gamma_{38,9}$(Ra)	569,1 (3)	0,00058 (9)
$\gamma_{50,18}$(Ra)	576,0 (2)	0,00032 (19)
$\gamma_{43,11}$(Ra)	579,0 (2)	0,0004 (3)
$\gamma_{(-1,82)}$(Ra)	585,8 (1)	0,0009 (3)
$\gamma_{40,9}$(Ra)	589,0 (6)	0,000058 (15)
$\gamma_{50,14}$(Ra)	596 (1)	0,0000101 (5)
$\gamma_{(-1,84)}$(Ra)	598,9 (2)	0,00063 (13)
$\gamma_{42,9}$(Ra)	607,7 (3)	0,00018 (4)
$\gamma_{49,12}$(Ra)	621,4 (5)	0,000058 (15)
$\gamma_{53,20}$(Ra)	623,8 (5)	0,00016 (4)
$\gamma_{33,4}$(Ra)	632,3 (7)	0,00014 (3)
$\gamma_{52,14}$(Ra)	641,0 (5)	0,000019 (6)
$\gamma_{45,9}$(Ra)	644,3 (3)	0,00009 (4)
$\gamma_{(-1,86)}$(Ra)	648,5 (5)	0,000019 (6)
$\gamma_{33,2}$(Ra)	662,8 (4)	0,000058 (18)
$\gamma_{50,9}$(Ra)	692,0 (7)	0,000039 (11)
$\gamma_{45,8}$(Ra)	704,3 (5)	0,000078 (16)
$\gamma_{36,4}$(Ra)	707,2 (7)	0,000039 (11)
$\gamma_{42,5}$(Ra)	718,5 (10)	0,000029 (11)
$\gamma_{35,3}$(Ra)	722,1 (6)	0,00037 (12)
$\gamma_{38,4}$(Ra)	723,5 (1)	0,00027 (10)
$\gamma_{35,2}$(Ra)	734,4 (5)	0,00010 (4)
$\gamma_{43,5}$(Ra)	735,4 (2)	0,00016 (5)
$\gamma_{36,2}$(Ra)	738,4 (10)	0,000068 (17)
$\gamma_{41,4}$(Ra)	746,4 (7)	0,00010 (4)
$\gamma_{45,6}$(Ra)	748,8 (4)	0,00040 (12)
$\gamma_{35,1}$(Ra)	754,1 (2)	0,00024 (14)
$\gamma_{36,1}$(Ra)	756,9 (2)	0,00019 (5)
$\gamma_{(-1,88)}$(Ra)	757,3 (4)	0,00102 (24)
$\gamma_{42,4}$(Ra)	762,6 (5)	0,00026 (5)
$\gamma_{41,3}$(Ra)	766,3 (5)	0,00029 (6)
$\gamma_{40,2}$(Ra)	773,4 (4)	0,00015 (4)
$\gamma_{41,2}$(Ra)	775,8 (5)	0,00151 (15)
$\gamma_{42,3}$(Ra)	781,0 (5)	0,00032 (6)
$\gamma_{35,0}$(Ra)	784,2 (5)	0,000097 (24)
$\gamma_{36,0}$(Ra)	787,4 (5)	0,000039 (10)
$\gamma_{(-1,95)}$(Ra)	787,6 (5)	0,00011 (3)
$\gamma_{40,1}$(Ra)	792,6 (6)	0,000029 (8)

	Energy keV	Photons per 100 disint.
$\gamma_{37,0}$(Ra)	792,6 (6)	0,000039 (10)
$\gamma_{43,3}$(Ra)	797,3 (5)	0,00090 (12)
$\gamma_{38,0}$(Ra)	803,9 (4)	0,00063 (6)
$\gamma_{43,2}$(Ra)	808,6 (4)	0,000076 (25)
$\gamma_{42,1}$(Ra)	812,6 (4)	0,0017 (3)
$\gamma_{(-1,92)}$(Ra)	818 (1)	0,000029 (11)
$\gamma_{45,3}$(Ra)	818,1 (2)	0,00017 (8)
$\gamma_{40,0}$(Ra)	823,4 (4)	0,0025 (3)
$\gamma_{41,0}$(Ra)	826,7 (5)	0,00016 (5)
$\gamma_{43,1}$(Ra)	828,5 (5)	0,00019 (5)
$\gamma_{(-1,94)}$(Ra)	828,9 (2)	0,00076 (4)
$\gamma_{44,1}$(Ra)	837,8 (5)	0,00052 (12)
$\gamma_{42,0}$(Ra)	842,5 (3)	0,00087 (13)
$\gamma_{50,4}$(Ra)	846,7 (5)	0,00015 (3)
$\gamma_{45,1}$(Ra)	848,3 (6)	0,00027 (11)
$\gamma_{46,1}$(Ra)	854,3 (5)	0,000068 (14)
$\gamma_{49,2}$(Ra)	857,3 (7)	0,000058 (18)
$\gamma_{43,0}$(Ra)	858,9 (2)	0,00025 (4)
$\gamma_{51,4}$(Ra)	863 (1)	0,000019 (8)
$\gamma_{44,0}$(Ra)	867,3 (5)	0,00029 (22)
$\gamma_{50,2}$(Ra)	876,3 (4)	0,00023 (8)
$\gamma_{49,1}$(Ra)	878,2 (4)	0,00014 (4)
$\gamma_{47,0}$(Ra)	891 (1)	0,000019 (6)
$\gamma_{51,2}$(Ra)	893 (1)	0,000013 (4)
$\gamma_{50,1}$(Ra)	896,1 (5)	0,00011 (3)
$\gamma_{49,0}$(Ra)	908,6 (4)	0,0023 (3)
$\gamma_{52,3}$(Ra)	910 (1)	0,000015 (6)
$\gamma_{53,4}$(Ra)	920,0 (5)	0,000011 (3)
$\gamma_{50,0}$(Ra)	927 (1)	0,000006 (3)
$\gamma_{53,3}$(Ra)	938,0 (8)	0,000010 (4)
$\gamma_{52,1}$(Ra)	941,6 (3)	0,000069 (11)
$\gamma_{55,3}$(Ra)	958,7 (3)	0,000061 (13)
$\gamma_{53,1}$(Ra)	970,2 (2)	0,00014 (11)
$\gamma_{52,0}$(Ra)	971,7 (10)	0,000010 (5)
$\gamma_{55,1}$(Ra)	990,0 (7)	0,000034 (9)
$\gamma_{56,1}$(Ra)	995 (1)	0,000006 (4)
$\gamma_{53,0}$(Ra)	999,8 (5)	0,000029 (8)
$\gamma_{54,0}$(Ra)	1015,2 (7)	0,000015 (4)
$\gamma_{55,0}$(Ra)	1020 (1)	0,000019 (6)
$\gamma_{56,0}$(Ra)	1025 (1)	0,000015 (4)

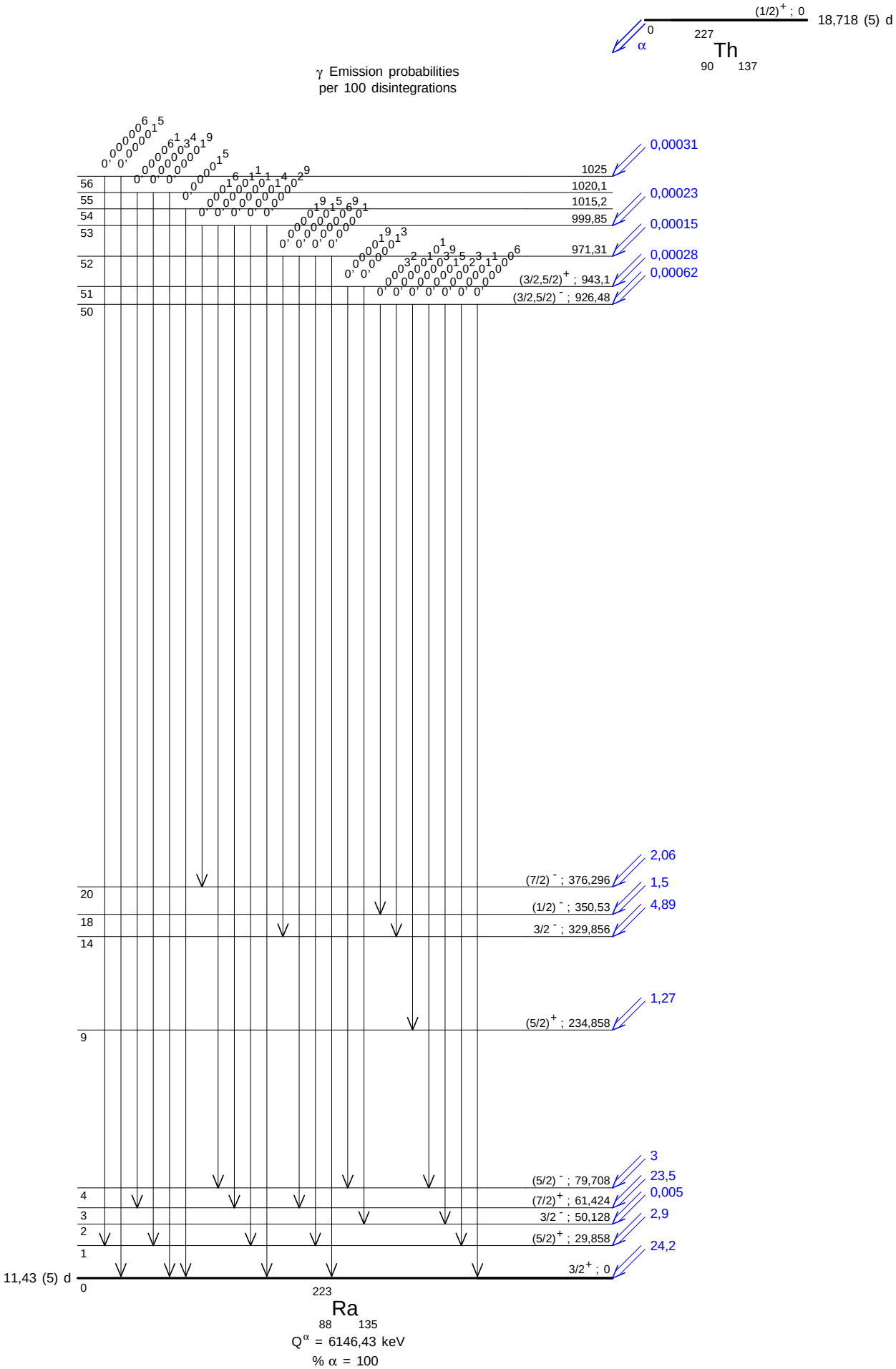
7 Main Production Modes

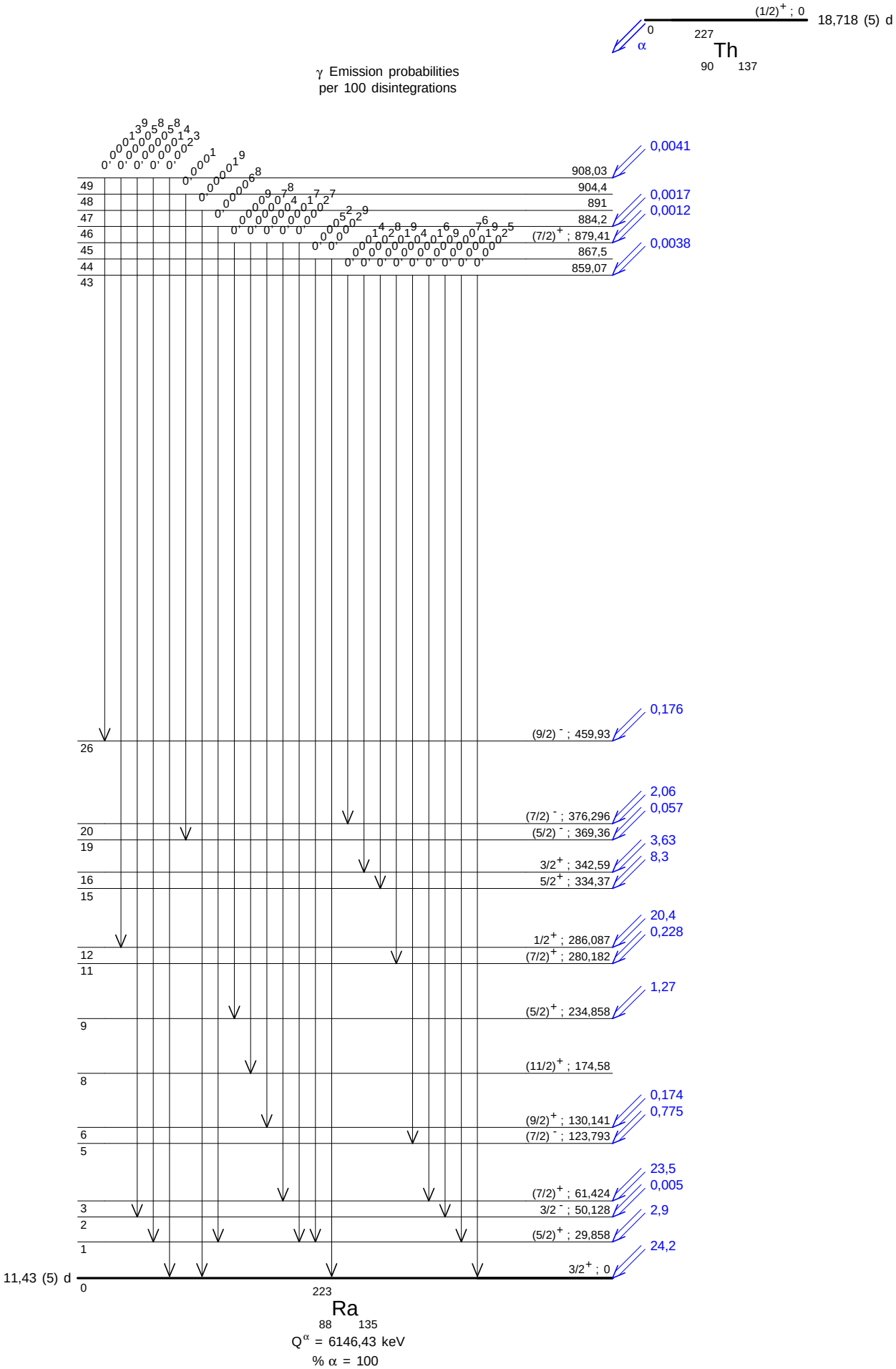
$\mathrm{Ra-226(n,\gamma)Ra-227}$
$\mathrm{Ra-227}(\beta^-)\mathrm{Ac-227}$
$\mathrm{Ac-227}(\beta^-)\mathrm{Th-227}$

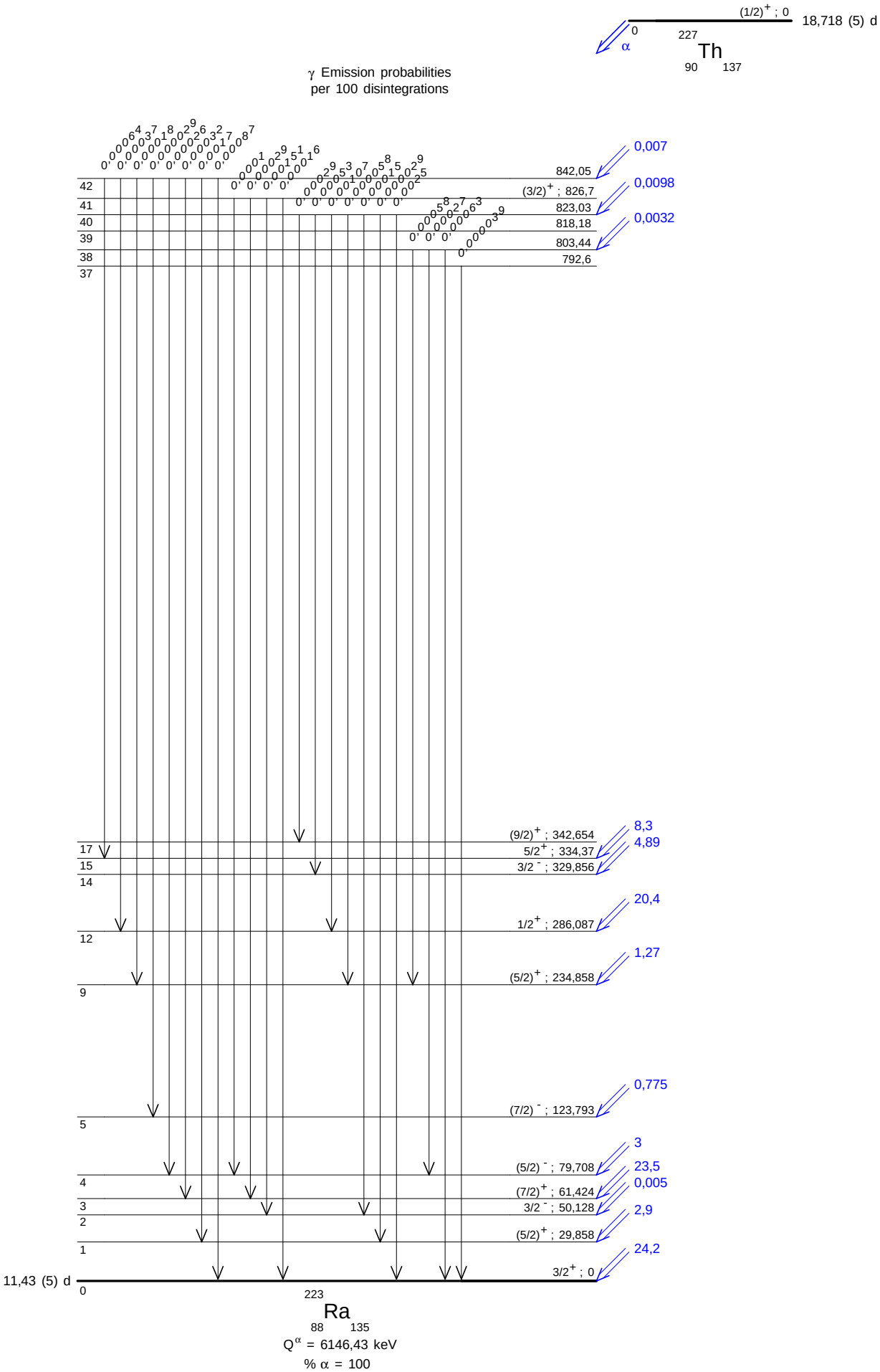
8 References

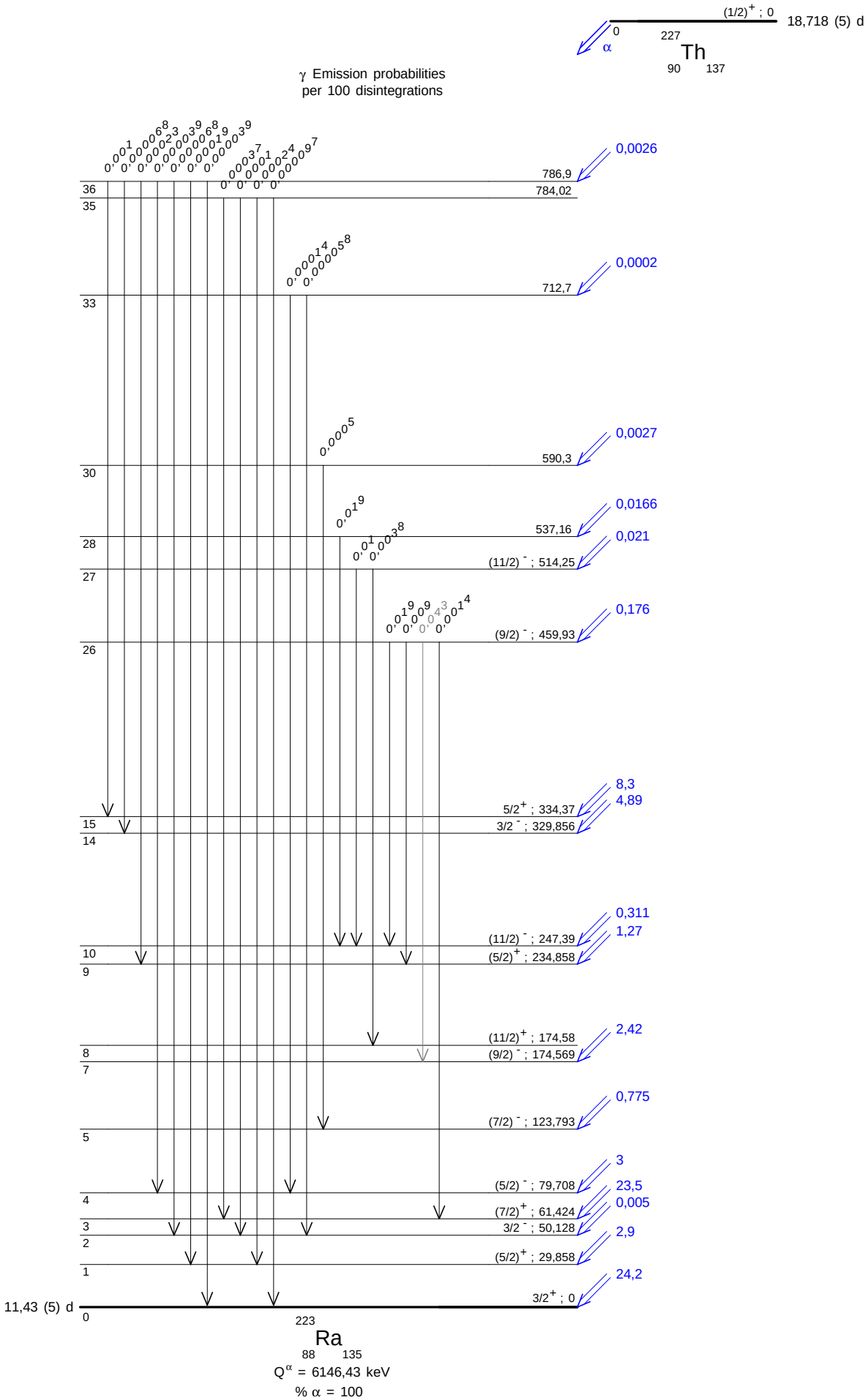
- K. C. Jordan, B.C.Blanke. Int. At. Energy (Viena) (567) 1967
  (Half-life)
- G.R.Hagee, M.L.Curtis, G.R.Grove,. Phys. Rev. 96 (1954) 817A
  (Half-life)
- J.F.EICHELBERGER, G.R.Grove, L.V. Jones, E.A.Rembold. Report MLM 1155 (1963) 12
  (Half-life)
- A.PEGHAIRE. Nucl. Instrum. Methods 75 (1969) 66
  (Absolute gamma-ray emission probabilities)

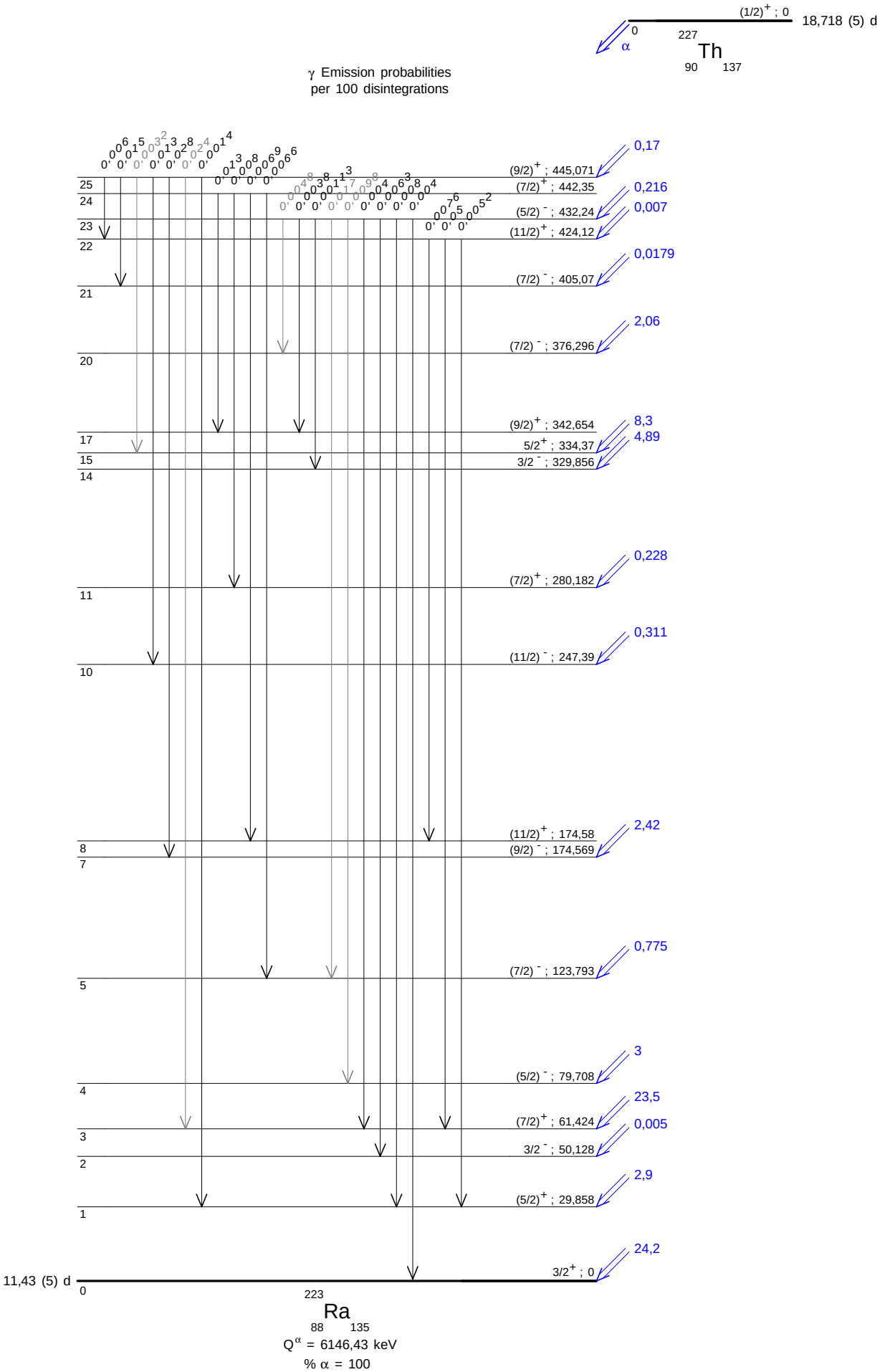
- C.Briancon, R.Walen. J. Phys. (Paris) 30 (1969) 753
  (Gamma ray energies,Gamma-ray emission probabilities)
- B.Grennberg, A.Rytz. Metrologia 7 (1971) 65
  (Alpha emission energies)
- W.H.A.Hessenlink, A.H.Wapstra, J.G.Kromme, E.J.Haighton, M.Van Kampen, W.Hutjes, K.E.M.Dijkman. Nucl. Phys. A191 (1972) 283
  (Gamma ray energies,Gamma-ray emission probabilities)
- F.P.Larkins. At. Data. Nucl. Data Tables 20 (1977) 311
  (Atomic electron binding energies)
- F.Rosel, H.M.Fries, K.Alder, H.C.Pauli. At. Data. Nucl. Data Tables 21 (1978) 92
  (Theoretical ICC)
- W.L.Zijp. Report ECN FYS/RASA 85/19 (1985)
  (Discrepant data. Limited Relative Statistical Weight method.)
- G.J.Miller, J.C.McGeorge, I.Anthony, R.O.Owens. Phys. Rev. C36 (1987) 420
  (Half-life)
- Ch.Briancon, S.Cwiok, S.A.Eid, V.Gree, W.D.Hamilton, C.F.Liang, R.J.Walen. J. Phys. (London) G16 (1990) 1735
  (Gamma ray energies)
- K.Komura, M.Yamamoto, K.Ueno. Nucl. Instrum. Methods A295 (1990) 461
  (Atomic Data,Auger electron emission probabilities,X-ray emission probabilities)
- A.Rytz. At. Data. Nucl. Data Tables 47 (1991) 205
  (Alpha emission energies)
- A.Abdul-Hadi, V.Barci, B.Weiss, H.Maria, G.Ardisson, M.Hussonnois, O.Constantinescu. Phys. Rev. C47 (1993) 94
  (Gamma ray energies,Gamma-ray emission probabilities)
- G. Audi, A.H.Wapstra. Nucl. Phys. A595 (1995) 409
  (The 1995 Update to the Atomic Mass Evaluation. Q-alpha.)
- E.Schönfeld, H.Janssen. Nucl. Instrum. Methods A369 (1996) 527
  (Atomic Data,X-ray emission probabilities,K Auger electron emission probabilities)
- Y.A.Akovali. Nucl. Data Sheets 84 (1998) 1
  (Alpha decay. Radius parameter of even-even nuclei.)
- E.Schönfeld, G. Rodloff. Report PTB-6.11-98-1 Braunschweig (1998)
  (Auger electron energies)
- E.Schönfeld, H. Janssen. Appl. Rad. Isotopes 52 (2000) 595
  (X-ray and Auger electron emission probabilities.)
- E.Browne. Nucl. Data Sheets 93 (2001) 763
  (Evaluated data (ENSDF) for nuclei with A=227. Adjusted alpha-particle energies.)

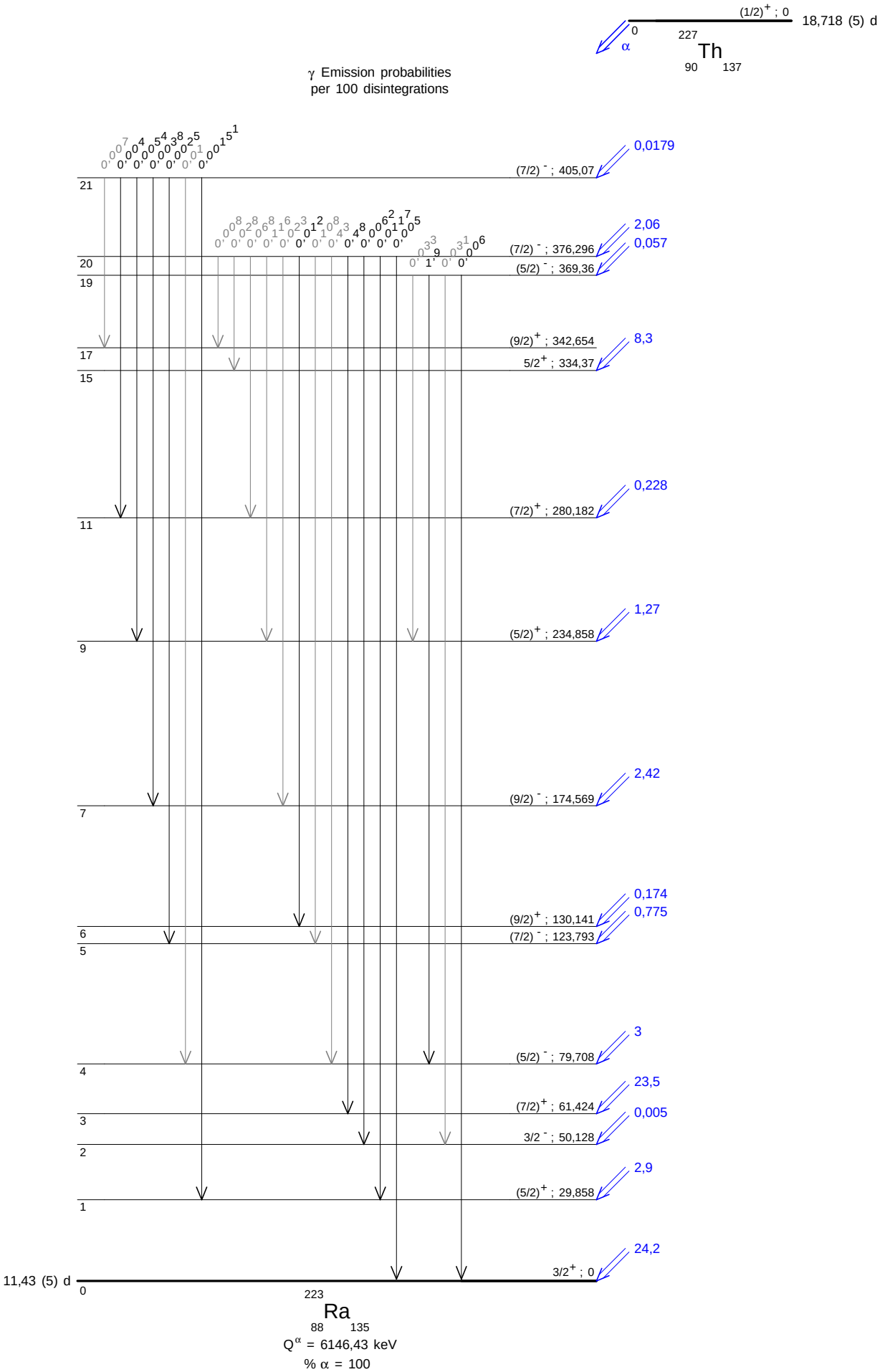

(1/2)+ ; 0
18,718 (5) d
0
α
227
Th
90
137
γ Emission probabilities
per 100 disintegrations
1025
1020,1
1015,2
999,85
971,31
(3/2,5/2)+ ; 943,1
(3/2,5/2) - ; 926,48
(7/2) - ; 376,296
(1/2) - ; 350,53
3/2 - ; 329,856
(5/2)+ ; 234,858
(5/2) - ; 79,708
(7/2)+ ; 61,424
3/2 - ; 50,128
(5/2)+ ; 29,858
3/2+ ; 0
0,00031
0,00023
0,00015
0,00028
0,00062
2,06
1,5
4,89
1,27
3
23,5
0,005
2,9
24,2
56
55
54
53
52
51
50
20
18
14
9
4
3
2
1
0
11,43 (5) d
223
Ra
88
135
Q^α = 6146,43 keV
% α = 100

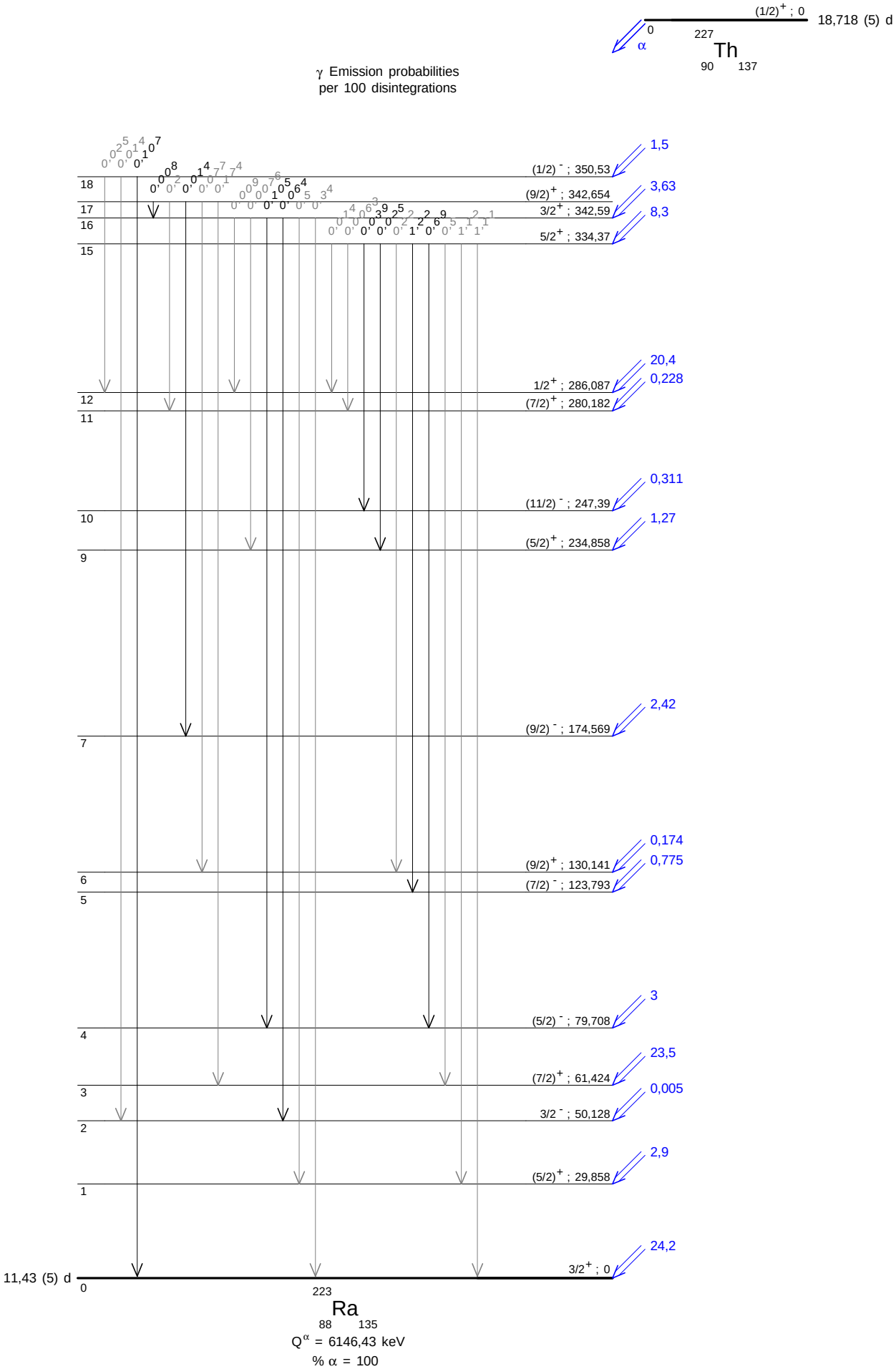

(1/2)+ ; 0
18,718 (5) d
0
α
227
Th
90
137
γ Emission probabilities
per 100 disintegrations
908,03
904,4
891
884,2
(7/2)+ ; 879,41
867,5
859,07
0,0041
0,0017
0,0012
0,0038
49
48
47
46
45
44
43
(9/2) - ; 459,93
(7/2) - ; 376,296
(5/2) - ; 369,36
3/2+ ; 342,59
5/2+ ; 334,37
1/2+ ; 286,087
(7/2)+ ; 280,182
(5/2)+ ; 234,858
(11/2)+ ; 174,58
(9/2)+ ; 130,141
(7/2) - ; 123,793
(7/2)+ ; 61,424
3/2 - ; 50,128
(5/2)+ ; 29,858
3/2+ ; 0
0,176
2,06
0,057
3,63
8,3
20,4
0,228
1,27
0,174
0,775
23,5
0,005
2,9
24,2
26
20
19
16
15
12
11
9
8
6
5
3
2
1
0
11,43 (5) d
223
Ra
88
135
Q^α = 6146,43 keV
% α = 100

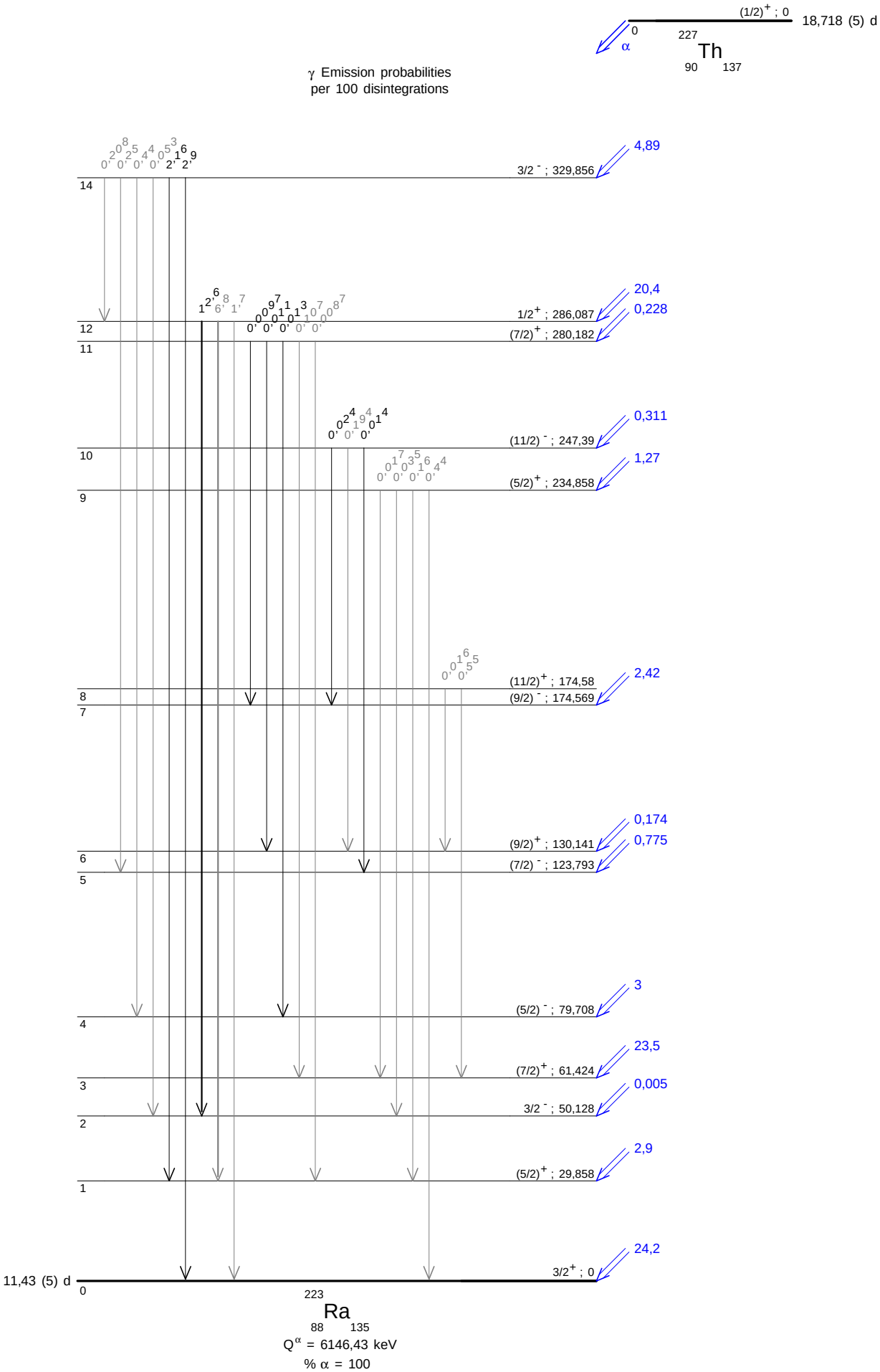

(1/2)+ ; 0
18,718 (5) d
0
α
227
Th
90 137
γ Emission probabilities
per 100 disintegrations
842,05
(3/2)+ ; 826,7
823,03
818,18
803,44
792,6
0,007
0,0098
0,0032
42
41
40
39
38
37
(9/2)+ ; 342,654
5/2+ ; 334,37
3/2 - ; 329,856
1/2+ ; 286,087
(5/2)+ ; 234,858
(7/2) - ; 123,793
(5/2) - ; 79,708
(7/2)+ ; 61,424
3/2 - ; 50,128
(5/2)+ ; 29,858
3/2+ ; 0
8,3
4,89
20,4
1,27
0,775
3
23,5
0,005
2,9
24,2
17
15
14
12
9
5
4
3
2
1
0
11,43 (5) d
223
Ra
88 135
Q^α = 6146,43 keV
% α = 100

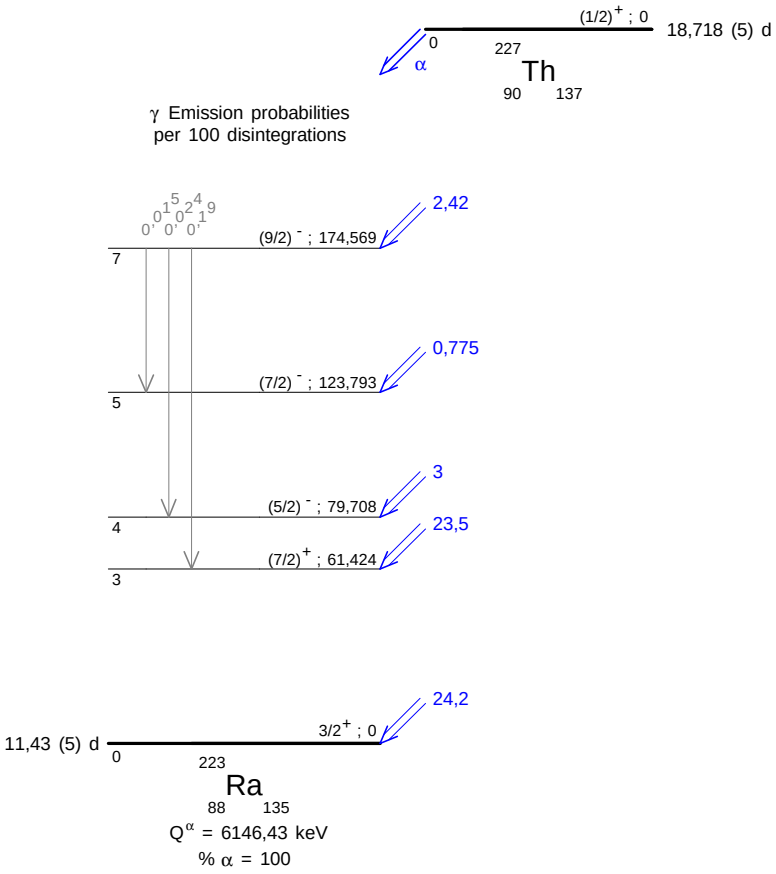

(1/2)+ ; 0
18,718 (5) d
0
α
227
Th
90 137
γ Emission probabilities
per 100 disintegrations
786,9
784,02
0,0026
712,7
0,0002
590,3
0,0027
537,16
0,0166
(11/2) - ; 514,25
0,021
(9/2) - ; 459,93
0,176
5/2+ ; 334,37
8,3
3/2 - ; 329,856
4,89
(11/2) - ; 247,39
0,311
(5/2)+ ; 234,858
1,27
(11/2)+ ; 174,58
2,42
(9/2) - ; 174,569
(7/2) - ; 123,793
0,775
(5/2) - ; 79,708
3
(7/2)+ ; 61,424
23,5
3/2 - ; 50,128
0,005
(5/2)+ ; 29,858
2,9
3/2+ ; 0
24,2
11,43 (5) d
223
Ra
88 135
Q α = 6146,43 keV
% α = 100

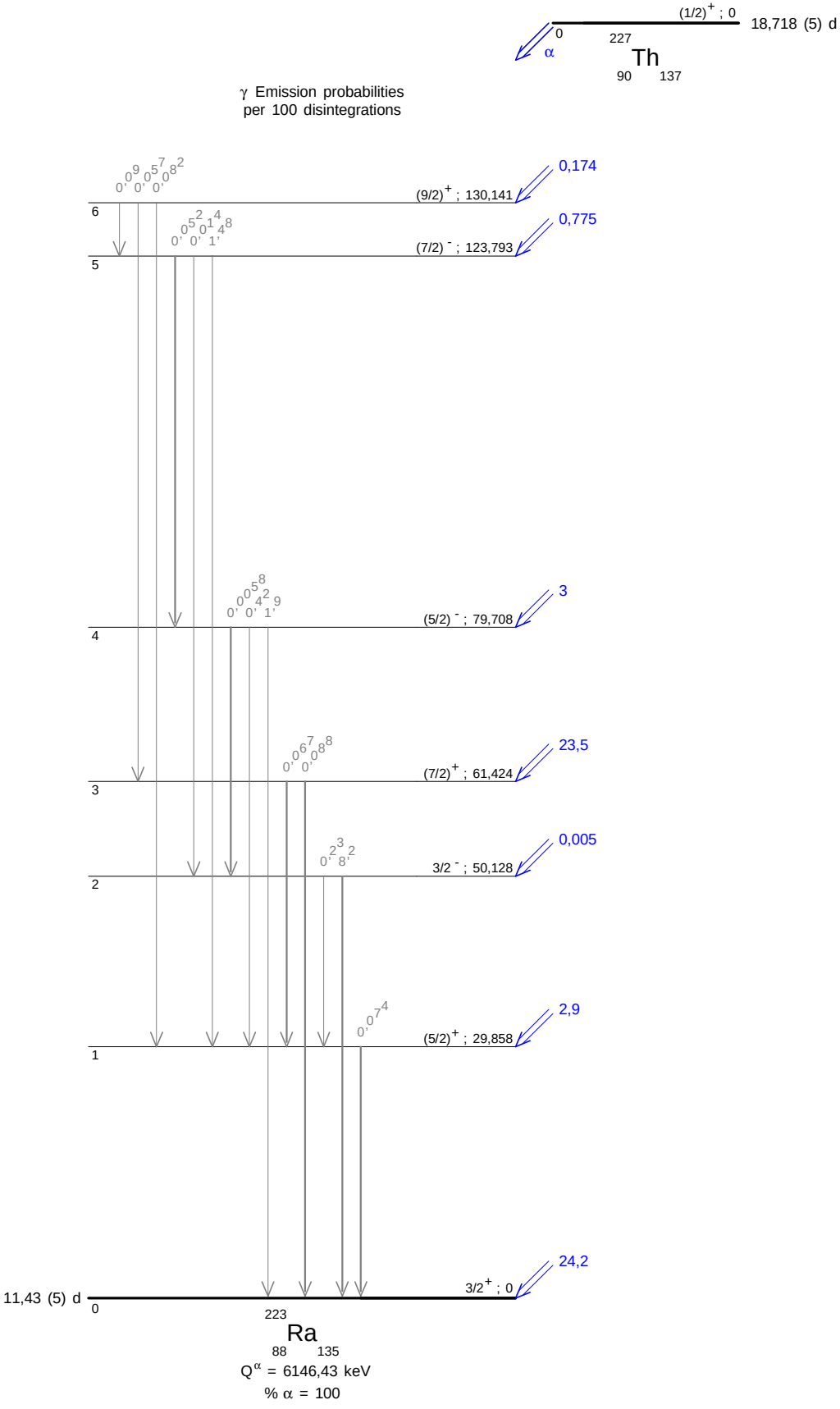

(1/2)+ ; 0
18,718 (5) d
0
α
227
Th
90
137
γ Emission probabilities
per 100 disintegrations
(9/2)+ ; 445,071
(7/2)+ ; 442,35
(5/2)- ; 432,24
(11/2)+ ; 424,12
(7/2)- ; 405,07
(7/2)- ; 376,296
(9/2)+ ; 342,654
5/2+ ; 334,37
3/2- ; 329,856
(7/2)+ ; 280,182
(11/2)- ; 247,39
(11/2)+ ; 174,58
(9/2)- ; 174,569
(7/2)- ; 123,793
(5/2)- ; 79,708
(7/2)+ ; 61,424
3/2- ; 50,128
(5/2)+ ; 29,858
3/2+ ; 0
0,17
0,216
0,007
0,0179
2,06
8,3
4,89
0,228
0,311
2,42
0,775
3
23,5
0,005
2,9
24,2
11,43 (5) d
223
Ra
88
135
Q^α = 6146,43 keV
% α = 100


(1/2)+ ; 0
18,718 (5) d
0
α
227
Th
90
137
γ Emission probabilities
per 100 disintegrations
0,0179
(7/2) - ; 405,07
21
2,06
0,057
(7/2) - ; 376,296
(5/2) - ; 369,36
20
19
8,3
(9/2)+ ; 342,654
5/2+ ; 334,37
17
15
0,228
(7/2)+ ; 280,182
11
1,27
(5/2)+ ; 234,858
9
2,42
(9/2) - ; 174,569
7
0,174
0,775
(9/2)+ ; 130,141
(7/2) - ; 123,793
6
5
3
(5/2) - ; 79,708
4
23,5
(7/2)+ ; 61,424
0,005
3/2 - ; 50,128
3
2
2,9
(5/2)+ ; 29,858
1
24,2
3/2+ ; 0
11,43 (5) d
0
223
Ra
88
135
Q^α = 6146,43 keV
% α = 100


(1/2)+ ; 0
18,718 (5) d
0
α
227
Th
90
137
γ Emission probabilities
per 100 disintegrations
(1/2) - ; 350,53
1,5
(9/2)+ ; 342,654
3,63
3/2+ ; 342,59
8,3
5/2+ ; 334,37
1/2+ ; 286,087
20,4
(7/2)+ ; 280,182
0,228
(11/2) - ; 247,39
0,311
(5/2)+ ; 234,858
1,27
(9/2) - ; 174,569
2,42
(9/2)+ ; 130,141
0,174
(7/2) - ; 123,793
0,775
(5/2) - ; 79,708
3
(7/2)+ ; 61,424
23,5
3/2 - ; 50,128
0,005
(5/2)+ ; 29,858
2,9
3/2+ ; 0
24,2
11,43 (5) d
0
223
Ra
88
135
Qα = 6146,43 keV
% α = 100


(1/2)+ ; 0
18,718 (5) d
0
α
227
Th
90
137
γ Emission probabilities
per 100 disintegrations
4,89
3/2 - ; 329,856
14
20,4
0,228
1/2+ ; 286,087
(7/2)+ ; 280,182
12
11
0,311
(11/2) - ; 247,39
10
1,27
(5/2)+ ; 234,858
9
2,42
(11/2)+ ; 174,58
(9/2) - ; 174,569
8
7
0,174
0,775
(9/2)+ ; 130,141
(7/2) - ; 123,793
6
5
3
(5/2) - ; 79,708
4
23,5
(7/2)+ ; 61,424
3
0,005
3/2 - ; 50,128
2
2,9
(5/2)+ ; 29,858
1
24,2
3/2+ ; 0
11,43 (5) d
0
223
Ra
88
135
Qα = 6146,43 keV
% α = 100


(1/2)+ ; 0
18,718 (5) d
0
α
227
Th
90
137
γ Emission probabilities
per 100 disintegrations
2,42
(9/2) - ; 174,569
7
0,775
(7/2) - ; 123,793
5
3
(5/2) - ; 79,708
4
23,5
(7/2)+ ; 61,424
3
24,2
11,43 (5) d
3/2+ ; 0
0
223
Ra
88
135
Q α = 6146,43 keV
% α = 100


(1/2)+ ; 0
18,718 (5) d
0
227
α
Th
90
137
γ Emission probabilities
per 100 disintegrations
0,174
(9/2)+ ; 130,141
0,775
(7/2) - ; 123,793
6
5
3
(5/2) - ; 79,708
4
23,5
(7/2)+ ; 61,424
3
0,005
3/2 - ; 50,128
2
2,9
(5/2)+ ; 29,858
1
24,2
3/2+ ; 0
11,43 (5) d
0
223
Ra
88
135
Q^α = 6146,43 keV
% α = 100

$^{228}_{90}\mathrm{Th}_{138}$

1 Decay Scheme

Th-228 decays 100% by alpha-particle emission to various excited levels and the ground state of Ra-224.
Le thorium 228 se désintègre par émission alpha principalement vers le niveau fondamental et le niveau excité de 84,4 keV de radium 224.

2 Nuclear Data

$T_{1/2}(^{228}\mathrm{Th})$	:	698,60	(23)	d
$T_{1/2}(^{224}\mathrm{Ra})$	:	3,627	(7)	d
$Q^{\alpha}(^{228}\mathrm{Th})$	:	5520,12	(22)	keV

2.1 α Transitions

	Energy keV	Probability × 100	F
$\alpha_{0,8}$	4527,5 (3)	0,0000044 (12)	7,37
$\alpha_{0,7}$	4603,8 (3)	0,000017 (3)	6,96
$\alpha_{0,6}$	5040,9 (4)	0,000025 (5)	4370
$\alpha_{0,5}$	5087,1 (3)	0,000010 (3)	21300
$\alpha_{0,4}$	5229,76 (26)	0,036 (7)	44,1
$\alpha_{0,3}$	5269,34 (23)	0,20 (2)	13,6
$\alpha_{0,2}$	5304,14 (22)	0,38 (3)	11,5
$\alpha_{0,1}$	5435,75 (22)	26,2 (2)	0,948
$\alpha_{0,0}$	5520,12 (22)	73,2 (2)	1

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M+	α_T
$\gamma_{4,2}$(Ra)	74,4 (1)	0,016 (6)	[E2]		28,9 (8)	7,89 (16)	39,5 (8)
$\gamma_{1,0}$(Ra)	84,373 (3)	26,6 (14)	E2		15,9 (3)	5,8 (1)	21,7 (4)
$\gamma_{2,1}$(Ra)	131,612 (4)	0,155 (8)	E1	0,195 (4)	0,041 (1)	0,013 (1)	0,249 (6)
$\gamma_{5,4}$(Ra)	142,7 (1)	0,0000041 (13)	[E2]	0,280 (6)	1,396 (28)	0,50 (1)	2,18 (4)
$\gamma_{3,1}$(Ra)	166,410 (4)	0,205 (16)	E2	0,225 (5)	0,704 (14)	0,256 (5)	1,185 (24)
$\gamma_{5,3}$(Ra)	182,3 (1)	0,0000056 (20)	[E1]	0,090 (2)	0,0178 (3)	0,0060 (1)	0,114 (2)
$\gamma_{4,1}$(Ra)	205,99 (4)	0,0201 (11)	[E1]	0,0676 (14)	0,0131 (3)	0,0042 (1)	0,0849 (17)
$\gamma_{2,0}$(Ra)	215,985 (4)	0,243 (22)	E1	0,0605 (12)	0,01160 (25)	0,0038 (1)	0,0759 (15)
$\gamma_{6,3}$(Ra)	228,4 (2)	0,000025 (5)	[E2]	0,125 (2)	0,182 (4)	0,065 (1)	0,372 (7)
$\gamma_{7,2}$(Ra)	700,4 (1)	0,0000029 (9)	E1	0,00508 (10)	0,00084 (2)	0,000270 (5)	0,00619 (12)
$\gamma_{8,3}$(Ra)	741,87 (1)	0,0000014 (4)	[E2]	0,0121 (2)	0,00330 (6)	0,00110 (2)	0,0165 (3)
$\gamma_{7,1}$(Ra)	832,0 (1)	0,000014 (2)	E2+M3	0,0098 (2)	0,00240 (5)	0,00090 (2)	0,0131 (3)
$\gamma_{8,1}$(Ra)	908,28 (1)	0,0000016 (5)	[M1+50%E2]	0,0203 (20)	0,0038 (4)	0,0012 (1)	0,0253 (25)
$\gamma_{8,0}$(Ra)	992,65 (6)	0,0000014 (4)	[E2]	0,00720 (15)	0,00160 (3)	0,00050 (1)	0,0093 (2)

3 Atomic Data

3.1 Ra

ω_K : 0,968 (4)
$\bar{\omega}_L$: 0,452 (18)
n_{KL} : 0,801 (5)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	85,43		61,22
	$K\alpha_1$	88,47		100
	$K\beta_3$	99,432	}	
	$K\beta_1$	100,13	}	
	$K\beta_5''$	100,738	}	34,9
	$K\beta_2$	102,89	}	
	$K\beta_4$	103,295	}	11,51
	$KO_{2,3}$	103,74	}	
X_L				
	$L\ell$	10,622		
	$L\alpha$	12,196 – 12,339		
	$L\eta$	13,662		
	$L\beta$	14,236 – 15,447		
	$L\gamma$	17,848 – 18,412		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	65,15 – 72,73	100
KLX	79,72 – 88,47	58
KXY	94,27 – 103,91	8,4
Auger L	5,71 – 12,04	9050

4 α Emissions

	Energy keV	Probability × 100
$\alpha_{0,8}$	4448,0 (3)	0,0000044 (12)
$\alpha_{0,7}$	4523,0 (3)	0,000017 (3)
$\alpha_{0,6}$	4952,5 (4)	0,000025 (5)
$\alpha_{0,5}$	4997,8 (3)	0,000010 (3)
$\alpha_{0,4}$	5138,01 (26)	0,036 (7)
$\alpha_{0,3}$	5176,89 (23)	0,20 (2)
$\alpha_{0,2}$	5211,08 (22)	0,38 (3)
$\alpha_{0,1}$	5340,38 (22)	26,2 (2)
$\alpha_{0,0}$	5423,28 (22)	73,2 (2)

5 Electron Emissions

		Energy keV	Electrons per 100 disint.
e_{AL}	(Ra)	5,71 - 12,04	10,5 (4)
e_{AK}	(Ra)		0,00193 (26)
	KLL	65,15 - 72,73 }	
	KLX	79,72 - 88,47 }	
	KXY	94,27 - 103,91 }	
$ec_{1,0\ T}$	(Ra)	65,14 - 84,09	25,4 (8)
$ec_{1,0\ L}$	(Ra)	65,14 - 68,93	18,6 (6)
$ec_{1,0\ M}$	(Ra)	79,55 - 84,09	6,8 (2)
$ec_{2,0\ K}$	(Ra)	112,067 (5)	0,180 (6)
$ec_{3,1\ L}$	(Ra)	147,17 - 150,97	0,066 (2)

6 Photon Emissions

6.1 X-Ray Emissions

		Energy keV		Photons per 100 disint.	
XL	(Ra)	10,622 — 18,412		8,8 (4)	
XKα_2	(Ra)	85,43		0,0172 (8)	} Kα
XKα_1	(Ra)	88,47		0,0281 (12)	}
XKβ_3	(Ra)	99,432	}		
XKβ_1	(Ra)	100,13	}	0,0098 (5)	K$'\beta_1$
XKβ''_5	(Ra)	100,738	}		
XKβ_2	(Ra)	102,89	}		
XKβ_4	(Ra)	103,295	}	0,00323 (16)	K$'\beta_2$
XKO$_{2,3}$	(Ra)	103,74	}		

6.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{4,2}$(Ra)	74,4 (1)	0,00039 (14)
$\gamma_{1,0}$(Ra)	84,373 (3)	1,17 (5)
$\gamma_{2,1}$(Ra)	131,612 (4)	0,124 (6)
$\gamma_{5,4}$(Ra)	142,7 (1)	0,0000013 (4)
$\gamma_{3,1}$(Ra)	166,410 (4)	0,094 (7)
$\gamma_{5,3}$(Ra)	182,3 (1)	0,0000050 (18)
$\gamma_{4,1}$(Ra)	205,99 (4)	0,0185 (10)
$\gamma_{2,0}$(Ra)	215,985 (4)	0,226 (20)
$\gamma_{6,3}$(Ra)	228,4 (2)	0,000018 (4)
$\gamma_{7,2}$(Ra)	700,4 (1)	0,0000029 (9)
$\gamma_{8,3}$(Ra)	741,87 (1)	0,0000014 (4)
$\gamma_{7,1}$(Ra)	832,0 (1)	0,000014 (2)
$\gamma_{8,1}$(Ra)	908,28 (1)	0,0000016 (5)
$\gamma_{8,0}$(Ra)	992,65 (6)	0,0000014 (4)

7 Main Production Modes

Th − 230(p,t)Th − 228

Th − 230(α,α2nγ)Th − 228

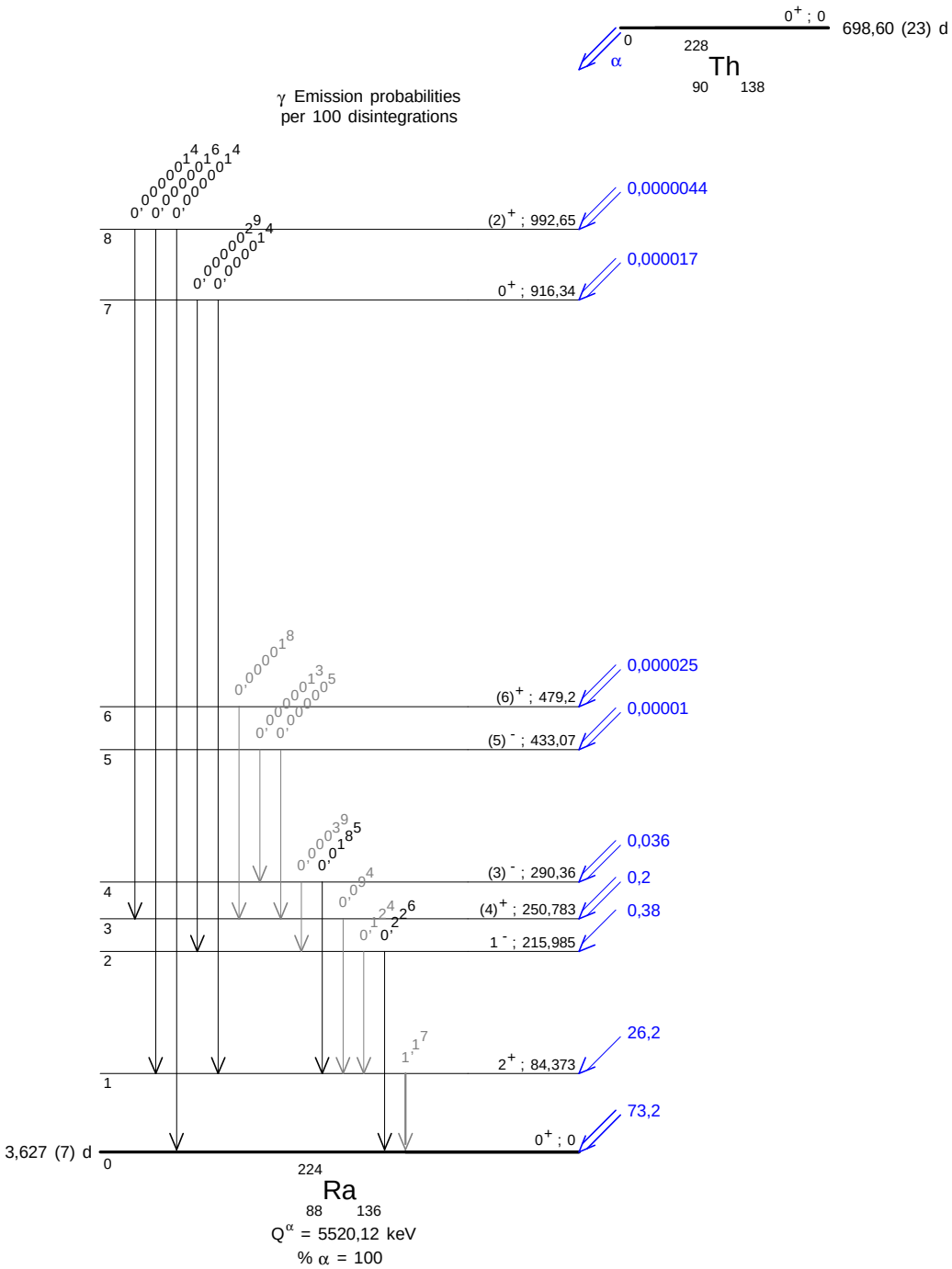
Ra − 226(α,2nγ)Th − 228

U − 232 alpha decay

8 References

- F. ASARO, F. STEPHENS, I. PERLMAN. Phys. Rev. 92 (1953) 1495
  (Alpha-particle emission probabilities, gamma-ray emission probabilities, internal conversion coefficients)
- H.W. KIRBY, G.R. GROVE, D.L. TIMMA. Phys. Rev. 102 (1956) 1140
  (Half-life)
- M.O. COSTA, M.R.S. GRADE. Port. Phys. 4 (1966) 267
  (Conversion electrons, internal conversion coefficients)
- C.L. DUKE, W.L. TALBERT. Phys. Rev. 173 (1968) 1125
  (Internal conversion coefficients)
- A. PEGHAIRE. Nucl. Instrum. Methods 75 (1969) 66
  (Gamma-ray emission probabilities)
- S.A. BARANOV, V.M. SHATINSKII, V.M. KULAKOV, Y.F. RODIONOV. Sov. J. Nucl. Phys. 11 (1970) 515
  (Gamma-ray emission probabilities)
- K.C. JORDAN, G.W. OTTO, R.P. RATAY. J. Inorg. Nucl. Chem. 33 (1971) 1215
  (Half-life)
- J. DALMASSO. Report FRNC-TH-441 (1972)
  (Gamma-ray energies)
- R.L. HEATH. Report ANCR-1000-2 (1974)
  (Gamma-ray energies)
- S.A. BARANOV, A.G. ZELENKOV, V.M. KULAKOV. IAEA-186 III (1976) 249
  (Alpha-particle emission probabilities)
- W. KURCEWICZ, N. KAFFRELL, N. TRAUTMANN, A. PLOCHOCKI, J. ZYLICZ, M. MATUL, K. STRYCZNIEWICZ. Nucl. Phys. A289 (1977) 1
  (Gamma-ray energies Gamma-ray emission probabilities)
- W. KURCEWICZ, E. RUCHOWSKA, N. KAFFRELL, N. TRAUTMANN. Nucl. Instrum. Methods 146 (1977) 613
  (Gamma-ray energies)
- F. Rösel, H.M. FRIES, K. ALDER, H.C. PAULI. At. Data Nucl. Data Tables 21 (1978) 291
  (Internal conversion coefficients)
- A. RYTZ. At. Data Nucl. Data Tables 23 (1979) 507
  (Alpha emission energies)
- W. KURCEWICZ, E. RUCHOWSKA, N. KAFFRELL, T. BJOERNSTAD, G. NYMAN. Nucl. Phys. A356 (1981) 15
  (908.28 keV gamma-ray emission probabilities)
- S. SADASIVAN, V.M. RAGHUNATH. Nucl. Instrum. Methods 196 (1982) 561
  (Gamma-ray emission probabilities)
- R.J. GEHRKE, V.J. NOVICK, J.D. BAKER. Int. J. Appl. Radiat. Isotop. 35 (1984) 581
  (Gamma-ray emission probabilities)
- M.P. UNTERWEGER, D.D. HOPPES, F.J. SCHIMA. Nucl. Instrum. Methods A312 (1992) 349
  (Half-life)
- T. BABELIOWSKY, G. BORTELS. Appl. Rad. Isotopes 44 (1993) 1349
  (Alpha-particle emission probabilities)
- G. AUDI, A.H. WAPSTRA. Nucl. Phys. A595 (1995) 409
  (Q value)
- G. ARDISSON, M. HUSSONNOIS. Radiochim. Acta 70/71 (1995) 123
  (Cluster decay)
- E. SCHÖNFELD, H. Janssen. Nucl. Instrum. Methods A369 (1996) 527
  (K-x ray, L-x ray, Auger electrons)
- A. ARTNA-COHEN. Nucl. Data Sheets 80 (1997) 227
  (Nuclear structure, energies)

- S.P. TRETYAKOVA, V.L. MIKHEEV. Nuovo Cim. 110 (1997) 1043
(Cluster decay)
- E. SCHÖNFELD, G. RODLOFF. Report PTB-6.11-98-1 (1998)
(Auger electrons)
- E. SCHÖNFELD, G. RODLOFF. Report PTB-6.11-1999-1 (1999)
(X-ray emission probabilities)


0+ ; 0
698,60 (23) d
0
α
228
Th
90
138
γ Emission probabilities
per 100 disintegrations
0,0000044
(2)+ ; 992,65
0,000017
0+ ; 916,34
0,000025
(6)+ ; 479,2
0,00001
(5)- ; 433,07
0,036
(3)- ; 290,36
0,2
(4)+ ; 250,783
0,38
1- ; 215,985
26,2
2+ ; 84,373
73,2
0+ ; 0
3,627 (7) d
224
Ra
88
136
Qα = 5520,12 keV
% α = 100

$^{238}_{94}\mathrm{Pu}_{144}$

1 Decay Scheme

Pu-238 decays by alpha transitions to U-234. Most of the alpha decay populates the U-234 ground state (71.04%) and the U-234 first excited level with energy of 43.5 keV (28.85%). Branching of Pu-238 decay by spontaneous fission is $1.85(5)\,10^{-7}$ %.
Le plutonium 238 se désintègre par émission alpha vers le niveau fondamental de l'uranium 234 (71,04%) et vers l'état excité de 43,5 keV. Le nombre de désintégrations par fission spontanée est de $1{,}85(5)\,10^{-7}$ *%.*

2 Nuclear Data

$T_{1/2}(^{238}\mathrm{Pu})$	:	87,74	(3)	a
$T_{1/2}(^{234}\mathrm{U})$	:	245,5	(6)	10^3 a
$Q^{\alpha}(^{238}\mathrm{Pu})$	:	5593,20	(19)	keV

2.1 α Transitions

	Energy keV	Probability × 100	F
$\alpha_{0,14}$	4507,90 (24)	$\sim 1{,}2\ 10^{-6}$	3,5
$\alpha_{0,13}$	4548,67 (20)	$1{,}17\ (7)\,10^{-6}$	7,5
$\alpha_{0,12}$	4569,5 (3)	$\sim 2{,}0\ 10^{-7}$	64
$\alpha_{0,11}$	4603,75 (20)	$1{,}52\ (16)\,10^{-7}$	152,9
$\alpha_{0,10}$	4645,35 (24)	$1{,}7\ (4)\,10^{-7}$	28
$\alpha_{0,9}$	4666,46 (20)	$1{,}30\ (5)\,10^{-6}$	53
$\alpha_{0,8}$	4741,50 (24)	$8{,}2\ (17)\,10^{-6}$	30,1
$\alpha_{0,7}$	4743,9 (2)	$7{,}4\ (22)\,10^{-8}$	3470
$\alpha_{0,6}$	4783,32 (20)	$1{,}0\ (4)\,10^{-4}$	5
$\alpha_{0,5}$	4806,91 (20)	$8{,}21\ (16)\,10^{-6}$	89,04
$\alpha_{0,4}$	5096,16 (20)	$6{,}85\ (23)\,10^{-6}$	10000
$\alpha_{0,3}$	5297,13 (19)	0,00297 (4)	432
$\alpha_{0,2}$	5449,85 (19)	0,105 (3)	101
$\alpha_{0,1}$	5549,70 (19)	28,85 (6)	1,394
$\alpha_{0,0}$	5593,20 (19)	71,04 (6)	1

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce} \times 100$	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{8,6}$(U)	41,82 (11)	2,7 (14) 10^{-6}	(E2)		645 (13)	178 (4)	885 (18)
$\gamma_{1,0}$(U)	43,498 (1)	29,1 (8)	E2		532 (11)	147 (3)	731 (15)
$\gamma_{11,9}$(U)	62,70 (1)	1,6 (3) 10^{-8}	E1		0,325 (7)	0,0807 (16)	0,434 (9)
$\gamma_{2,1}$(U)	99,852 (3)	0,108 (2)	E2		9,97 (20)	2,78 (6)	13,7 (3)
$\gamma_{11,7}$(U)	140,15 (2)	2,2 (7) 10^{-8}	M1 + 63% E2	2,9 (8)	1,8 (5)	0,49 (14)	5,4 (15)
$\gamma_{3,2}$(U)	152,719 (2)	2,97 (4) 10^{-3}	E2	0,217 (5)	1,43 (3)	0,397 (8)	2,19 (5)
$\gamma_{13,8}$(U)	192,91 (7)	1,2 (4) 10^{-9}	(E2)	0,164 (3)	0,515 (10)	0,142 (3)	0,872 (18)
$\gamma_{4,3}$(U)	200,97 (3)	6,85 (23) 10^{-6}	E2	0,150 (3)	0,432 (9)	0,119 (3)	0,748 (15)
$\gamma_{11,5}$(U)	203,12 (3)	2,2 (5) 10^{-8}	M1+66% E2	0,88 (17)	0,44 (9)	0,116 (23)	1,56 (30)
$\gamma_{14,8}$(U)	233,6 (2)	4,1 10^{-7}	(E0+E2)				
$\gamma_{13,6}$(U)	234,6 (2)	0,1 10^{-6}	E0				
$\gamma_{14,7}$(U)	235,9 (3)	1,0 (5) 10^{-8}	(E1)	0,0537 (11)	0,0108 (2)	0,00262 (5)	0,0681 (14)
$\gamma_{13,5}$(U)	258,227 (3)	7,4 (12) 10^{-8}	(E1)	0,0439 (9)	0,0087 (2)	0,00211 (4)	0,0554 (11)
$\gamma_{14,5}$(U)	299,2 (2)	4,6 (3) 10^{-8}	(E1)	0,0318 (7)	0,00616 (13)	0,00149 (3)	0,0400 (8)
$\gamma_{7,2}$(U)	705,9 (3)	5,0 (13) 10^{-8}	(E1)	0,00577 (12)	0,00100 (2)	0,000239 (5)	0,00709 (14)
$\gamma_{8,2}$(U)	708,4 (2)	5,0 (3) 10^{-7}	(E2)	0,0156 (3)	0,00497 (10)	0,00127 (3)	0,0223 (5)
$\gamma_{12,3}$(U)	727,8 (2)	2,7 (3) 10^{-9}	(E2)	0,0149 (3)	0,00462 (9)	0,00118 (3)	0,0211 (4)
$\gamma_{5,1}$(U)	742,814 (5)	5,13 (13) 10^{-6}	E1	0,00526 (11)	0,00091 (2)	0,000216 (5)	0,00646 (13)
$\gamma_{6,1}$(U)	766,39 (10)	2,23 (5) 10^{-5}	E2	0,0136 (3)	0,00403 (8)	0,00103 (2)	0,0190 (4)
$\gamma_{9,2}$(U)	783,4 (1)	2,3 (3) 10^{-8}	(E2)	0,0130 (3)	0,00380 (8)	0,00097 (2)	0,0181 (4)
$\gamma_{5,0}$(U)	786,3 (1)	3,22 (9) 10^{-6}	E1	0,00474 (9)	0,000814 (17)	0,000194 (4)	0,00583 (12)
$\gamma_{10,2}$(U)	804,4 (4)	1,1 (3) 10^{-7}	E0+E2				0,57
$\gamma_{7,1}$(U)	805,6 (3)	5,6 (15) 10^{-8}	(E1)	0,00455 (9)	0,000778 (16)	0,000185 (4)	0,00558 (11)
$\gamma_{8,1}$(U)	808,25 (15)	4,1 10^{-6}	E0+17% E2	3,31	0,94		4,3
$\gamma_{6,0}$(U)	809,88 (3)	7,7 10^{-6}	E0	>60			
$\gamma_{8,0}$(U)	851,7 (1)	1,29 (4) 10^{-6}	(E2)	0,0112 (2)	0,00308 (6)	0,000775 (16)	0,0155 (3)
$\gamma_{12,2}$(U)	880,5 (3)	> 1,5 (4) 10^{-7}	(E0+E2)				
$\gamma_{9,1}$(U)	883,23 (10)	7,3 (4) 10^{-7}	E2	0,0105 (2)	0,00280 (6)	0,000705 (14)	0,0144 (3)
$\gamma_{10,1}$(U)	904,3 (2)	6,2 (11) 10^{-8}	(E2)	0,0102 (2)	0,00264 (5)	0,000664 (13)	0,0137 (3)
$\gamma_{9,0}$(U)	926,72 (15)	5,65 (25) 10^{-7}	(E2)	0,00974 (20)	0,00249 (5)	0,000625 (13)	0,0131 (3)
$\gamma_{14,2}$(U)	941,9 (2)	4,72 (23) 10^{-7}	(E2)	0,00946 (20)	0,00240 (5)	0,000601 (12)	0,0127 (3)
$\gamma_{11,1}$(U)	946,0 (3)	9,2 (13) 10^{-8}	(E1)	0,00342 (7)	0,000579 (12)	0,000137 (3)	0,00419 (9)
$\gamma_{12,1}$(U)	980,3 (1)	4,2 10^{-8}	(E2)	0,00882 (18)	0,00218 (5)	0,000544 (11)	0,0117 (3)
$\gamma_{13,1}$(U)	1001,03 (15)	9,9 (4) 10^{-7}	E2	0,00850 (17)	0,00207 (4)	0,000517 (11)	0,0113 (3)
$\gamma_{14,1}$(U)	1041,8 (3)	0,20 (2) 10^{-6}	(E0+E2)				
$\gamma_{14,0}$(U)	1085,4 (3)	7,8 (9) 10^{-8}	(E2)				

3 Atomic Data

3.1 U

ω_K : 0,970 (4)
$\bar{\omega}_L$: 0,500 (19)
n_{KL} : 0,794 (5)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	94,666		62,47
	$K\alpha_1$	98,44		100
	$K\beta_3$	110,421	}	
	$K\beta_1$	111,298	}	
	$K\beta_5''$	111,964	}	36,08
	$K\beta_5'$	111,964	}	
	$K\beta_2$	114,46	}	
	$K\beta_4$	115,01	}	12,34
	$KO_{2,3}$	115,377	}	
X_L				
	$L\ell$	11,62		
	$L\alpha$	13,44 – 13,62		
	$L\eta$	15,4		
	$L\beta$	15,74 – 18,16		
	$L\gamma$	19,5 – 21,75		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	71,78 – 80,95	100
KLX	88,15 – 98,34	59,6
KXY	104,42 – 115,40	8,88
Auger L	5,9 – 21,6	

4 α Emissions

	Energy keV	Probability × 100
$\alpha_{0,14}$	4432,00 (25)	$\sim 1{,}2\ 10^{-6}$
$\alpha_{0,13}$	4472,09 (21)	$1{,}17\ (7)\ 10^{-6}$
$\alpha_{0,12}$	4492,6 (3)	$\sim 2{,}0\ 10^{-7}$

	Energy keV	Probability × 100
$\alpha_{0,11}$	4526,24 (21)	1,52 (16) 10^{-7}
$\alpha_{0,10}$	4567,14 (25)	1,7 (4) 10^{-7}
$\alpha_{0,9}$	4587,89 (21)	1,30 (5) 10^{-6}
$\alpha_{0,8}$	4661,67 (23)	8,2 (17) 10^{-6}
$\alpha_{0,7}$	4664,03 (21)	7,4 (22) 10^{-8}
$\alpha_{0,6}$	4702,79 (21)	1,0 (4) 10^{-4}
$\alpha_{0,5}$	4725,98 (21)	8,21 (16) 10^{-6}
$\alpha_{0,4}$	5010,36 (21)	6,85 (23) 10^{-6}
$\alpha_{0,3}$	5207,94 (20)	0,00297 (4)
$\alpha_{0,2}$	5358,09 (20)	0,105 (3)
$\alpha_{0,1}$	5456,26 (20)	28,85 (6)
$\alpha_{0,0}$	5499,03 (20)	71,04 (6)

5 Electron Emissions

		Energy keV	Electrons per 100 disint.
e_{AL}	(U)	5,9 - 21,6	10,6 (9)
e_{AK}	(U)		0,000011 (1)
	KLL	71,78 - 80,95 }	
	KLX	88,15 - 98,34 }	
	KXY	104,42 - 115,40 }	
$ec_{1,0\ L}$	(U)	21,74 - 26,33	21,1 (6)
$ec_{3,2\ K}$	(U)	37,117 (2)	2,01 (5) 10^{-4}
$ec_{1,0\ M}$	(U)	37,950 - 39,948	5,83 (17)
$ec_{2,1\ L}$	(U)	78,094 - 82,684	0,0733 (17)
$ec_{4,3\ K}$	(U)	85,37 (3)	5,88 (23) 10^{-7}
$ec_{2,1\ M}$	(U)	94,304 - 96,302	0,0204 (5)
$ec_{3,2\ L}$	(U)	130,960 - 135,551	1,33 (3) 10^{-3}
$ec_{3,2\ M}$	(U)	147,171 - 149,169	3,69 (8) 10^{-4}
$ec_{4,3\ L}$	(U)	179,21 - 183,80	1,69 (7) 10^{-6}
$ec_{4,3\ M}$	(U)	195,42 - 197,42	4,7 (2) 10^{-7}
$ec_{6,1\ K}$	(U)	650,78 (2)	3,0 (1) 10^{-7}
$ec_{8,1\ K}$	(U)	692,6 (1)	2,6 10^{-5}
$ec_{6,1\ L}$	(U)	744,62 - 749,21	8,8 (3) 10^{-8}
$ec_{6,1\ M}$	(U)	760,83 - 762,83	2,26 (7) 10^{-8}
$ec_{8,1\ L}$	(U)	786,44 - 791,03	7,0 10^{-7}
$ec_{6,0\ K}$	(U)	894,28 (3)	6,0 10^{-5}

6 Photon Emissions

6.1 X-Ray Emissions

		Energy keV		Photons per 100 disint.	
XL	(U)	11,62 — 21,75		10,63 (8)	
XKα_2	(U)	94,666		0,000106 (3)	} Kα
XKα_1	(U)	98,44		0,000169 (5)	}
XKβ_3	(U)	110,421	}		
XKβ_1	(U)	111,298	}	0,0000609 (16)	K$'\beta_1$
XKβ''_5	(U)	111,964	}		
XKβ'_5	(U)	111,964	}		
XKβ_2	(U)	114,46	}		
XKβ_4	(U)	115,01	}	0,0000202 (6)	K$'\beta_2$
XKO$_{2,3}$	(U)	115,377	}		

6.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{8,6}$(U)	41,82 (11)	3,0 (16) 10^{-9}
$\gamma_{1,0}$(U)	43,498 (1)	3,97 (8) 10^{-2}
$\gamma_{11,9}$(U)	62,70 (1)	1,1 (3) 10^{-8}
$\gamma_{2,1}$(U)	99,852 (3)	7,35 (8) 10^{-3}
$\gamma_{11,7}$(U)	140,15 (2)	3,5 (7) 10^{-8}
$\gamma_{3,2}$(U)	152,719 (2)	9,30 (7) 10^{-4}
$\gamma_{13,8}$(U)	192,91 (7)	6,6 (20) 10^{-10}
$\gamma_{4,3}$(U)	200,97 (3)	3,92 (13) 10^{-6}
$\gamma_{11,5}$(U)	203,12 (3)	8,5 (15) 10^{-9}
$\gamma_{14,7}$(U)	235,9 (3)	9 (5) 10^{-9}
$\gamma_{13,5}$(U)	258,227 (3)	7,0 (11) 10^{-8}
$\gamma_{14,5}$(U)	299,2 (2)	4,4 (3) 10^{-8}
$\gamma_{7,2}$(U)	705,9 (1)	5,0 (13) 10^{-8}
$\gamma_{8,2}$(U)	708,4 (2)	4,9 (3) 10^{-7}
$\gamma_{12,3}$(U)	727,8 (2)	2,7 (3) 10^{-9}
$\gamma_{5,1}$(U)	742,813 (5)	5,10 (13) 10^{-6}
$\gamma_{6,1}$(U)	766,38 (2)	2,19 (5) 10^{-4}
$\gamma_{9,2}$(U)	783,4 (1)	2,2 (3) 10^{-8}
$\gamma_{5,0}$(U)	786,27 (3)	3,20 (9) 10^{-6}
$\gamma_{10,2}$(U)	804,4 (3)	7,1 (17) 10^{-8}
$\gamma_{7,1}$(U)	805,80 (5)	5,6 (15) 10^{-8}
$\gamma_{8,1}$(U)	808,2 (1)	7,67 (25) 10^{-7}

	Energy keV	Photons per 100 disint.
$\gamma_{8,0}$(U)	851,7 (1)	1,27 (4) 10^{-6}
$\gamma_{12,2}$(U)	880,5 (1)	1,5 (4) 10^{-7}
$\gamma_{9,1}$(U)	883,24 (4)	7,2 (4) 10^{-7}
$\gamma_{10,1}$(U)	904,3 (2)	6,1 (11) 10^{-8}
$\gamma_{9,0}$(U)	926,74 (5)	5,58 (25) 10^{-7}
$\gamma_{14,2}$(U)	941,94 (10)	4,66 (23) 10^{-7}
$\gamma_{11,1}$(U)	946,00 (3)	9,2 (13) 10^{-8}
$\gamma_{12,1}$(U)	980,3 (1)	4,2 10^{-8}
$\gamma_{13,1}$(U)	1001,03 (3)	9,8 (4) 10^{-7}
$\gamma_{14,1}$(U)	1041,7 (2)	1,97 (16) 10^{-7}
$\gamma_{14,0}$(U)	1085,4 (2)	7,7 (9) 10^{-8}

7 Main Production Modes

$\mathrm{Np} - 238(\beta^-)\mathrm{Pu} - 238$

$\mathrm{Cm} - 242(\alpha)\mathrm{Pu} - 238$

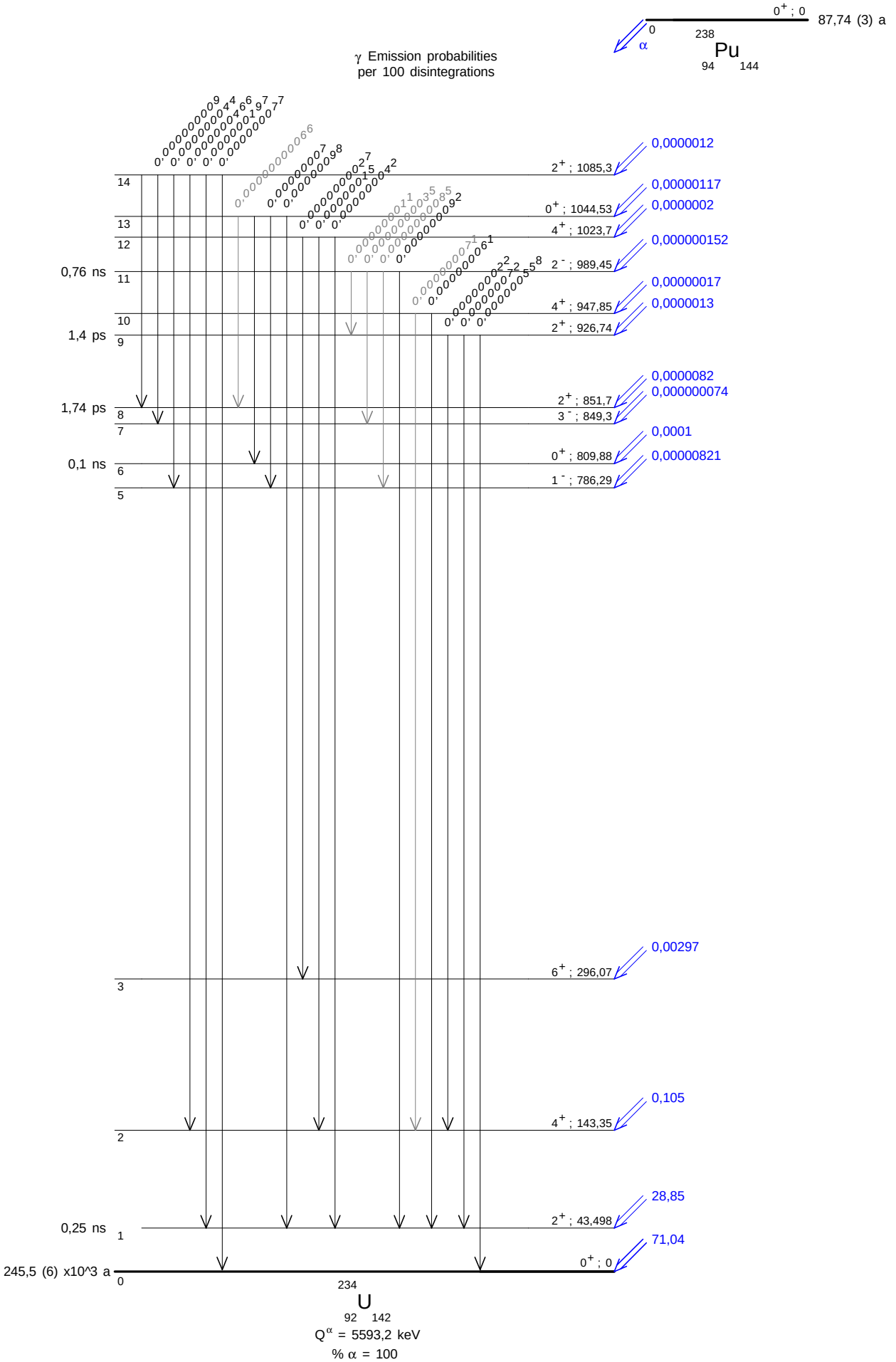
8 References

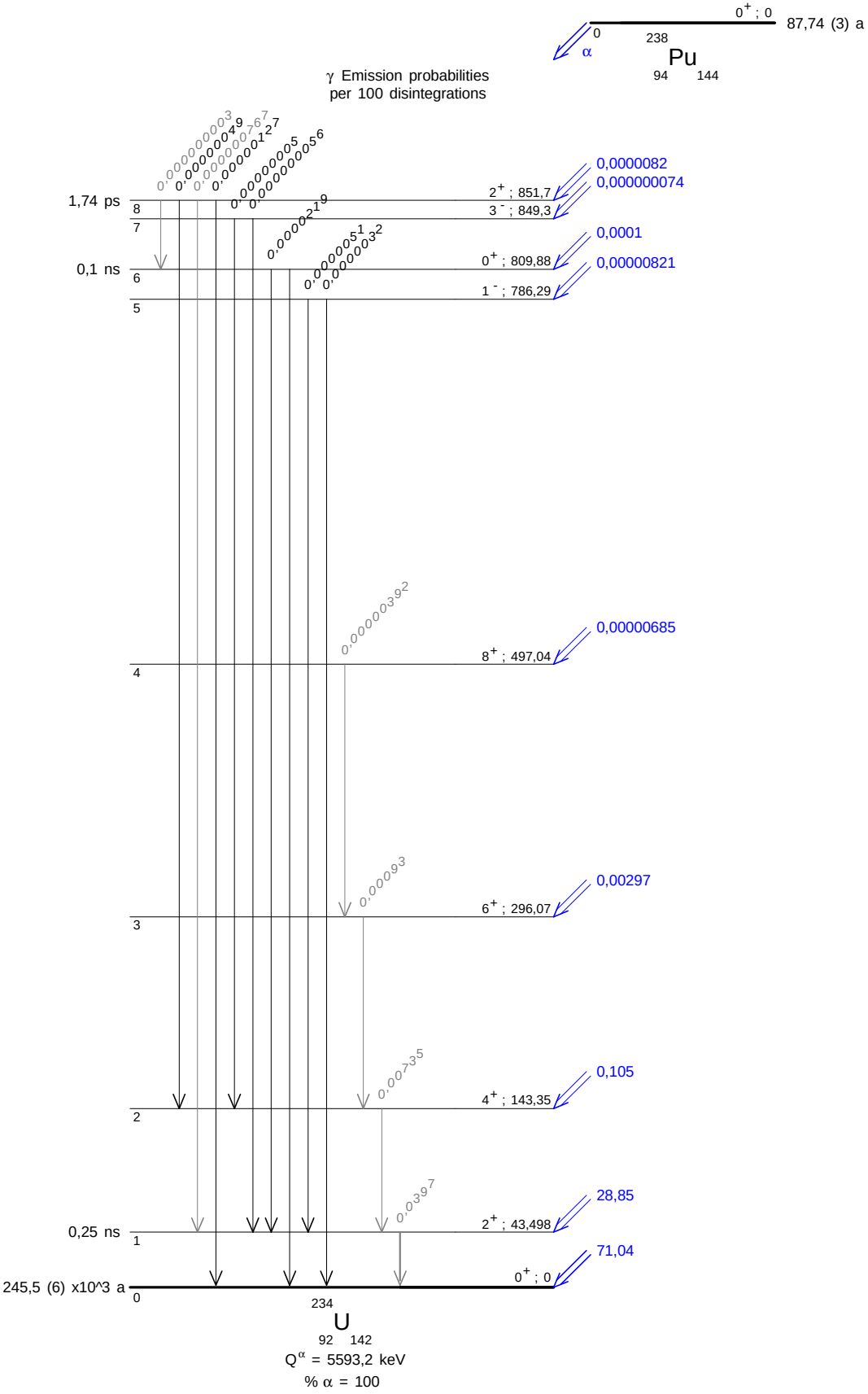
- A. H. Jaffey, A. Hirsch. Report ANL-4286 (1949)
  (Spontaneous fission half-life)
- A. H. Jaffey, J. Lerner. Report ANL-4411 (1950)
  (Half-life)
- A. H. Jaffey, L. B. Magnusson. Paper No. 14.2. National Nuclear Energy Plutonium Project Record Div. IV .McGraw-Hill, New York. 14B (1951) 978
  (Half-life)
- A. H. Jaffey. Paper No. 2.2. National Nuclear Energy Plutonium Project Record Div. IV. McGraw-Hill, New York. 14B (1951) 89
  (Half-life)
- G. T. Seaborg, R. A. James and A. Giorso. Paper No. 14.2. National Nuclear Energy Series, Plutonium Project Record, Div. IV. McGraw-Hill, New York. 14B (1951) 978
  (Half-life)
- G. T. Seaborg, J.Katz and W. M. Manning. Paper No. 14.2. National Nuclear Energy Series, Plutonium Project Record, Div. IV. McGraw-Hill, New York. 14B (1951) 978
  (Half-life)
- E. Segre. Phys. Rev. 86 (1952) 21
  (Spontaneous fission half-life)
- F. Asaro, I. Perlman. Phys. Rev. 94 (1954) 381
  (Alpha-particle energies and emission probabilities)
- K. W. Jones, R. A. Douglas, M. T. McEllistrem and H. T. Richards. Phys. Rev. 94 (1954) 947
  (Half-life)
- E. L. Church, A. W. Sunyar. Phys. Rev 98 (1955) 1186A
  (Gamma-ray energies)
- J. O. Newton, B. Rose and J. Milsted. Phil. Mag. 1 (1956) 981
  (Gamma-ray energies)

- D. C. Hoffman, G. P. Ford and F. O. Lawrence, J. Inorg.. Nucl. Chem. 5 (1957) 6
  (Half-life)
- L. N. Kondratev, G. I. Novikova, V. B. Dedov and L. L. Goldin. Izv. Akad. Nauk SSSR, Ser Fiz 21 (1957) 907
  (Alpha-particle energies and emission probabilities)
- V. A. Druin, V. P. Perelygin and G. I. Khlebnikov. Soviet Phys. JETP 13 (1961) 913; Zhurn. Eksptl. i Teoret. Fiz. 40 (1961)
  (Spontaneous fission half-life)
- C. F. Leang. Compt. Rend. 255 (1962) 3155
  (Alpha-particle energies and emission probabilities)
- S. Bjornholm, C. M. Lederer, F. Asaro and I. Perlman. Phys. Rev. 130 (1963) 2000
  (Alpha transition probabilities)
- J. W. Halley, D. Engelkemeir. Phys. Rev. 134 (1964) A24
  (L X-ray emission probabilities)
- F. Les. Acta. Phys. Polon. 26 (1964) 951
  (E0+E2 transition probabilities)
- C. M. Lederer. Priv Comm, quoted by 67Le24, unpublished (1964)
  (E0+E2 transition probabilities)
- J. F. Eichelberger, G. R. Grove and L. V. Jones. MLM-1238 (1965)
  (Half-life)
- K. C. Jordan. Report No. MLM-1443, July-September (1967) 11
  (Half-life)
- J. A. Bearden. Rev. Mod. Phys. 39 (1967) 78
  (X-ray energies)
- J. Byrne, W. Gelletly, M. A. S. Ross and F. Shaikh. Phys. Rev. 170 (1968) 80
  (L X-ray emission probabilities)
- L. Salgueiro et al.. C. R. Acad. Sci. 267B (1968) 1293
  (L X-ray emission probabilities)
- K. L. Swinth, P. Polishuk. N.Y. Plenum Press, 1968, (1968) 279
  (L X-ray emission probabilities)
- S. A. Baranov, V. M. Kulakov and V. M. Shatinskii. Nucl. Phys.Yadern. Fiz. 7 (1968) 442, 727.
  (Alpha-particle energies and emission probabilities)
- S. R. Amtey, J. H. Hamilton, A. V. Ramayya. Nucl. Phys. A126 (1969) 201
  (Conversion electron relative intensities)
- D. Benson. Priv. Comm. (1969)
  (Half-life)
- C. M. Lederer, F. Asaro and I. Perlman. UCRL-18667 (1969) 3
  (Gamma-ray energies and emission probabilities)
- S. A. Baranov, V. M. Kulakov, V. M. Shatinskii and Z. S. Gladkikh. Yad. Fiz. 12 (1970) 1105.
  (Alpha-particle energies and emission probabilities)
- J. E. Cline. IN-1448 Rev. (1971)
  (Gamma-ray energies and emission probabilities)
- K. L. Swinth. IEEE Transactions Nuclear Science, part 1 18 (1971) 125
  (L X-ray emission probabilities)
- J. C. Soares, J. P. Ribeiro, A. Goncalves, F. B. Gil and J. C. Ferreira. Compt. Rend. 273B (1971) 985
  (Alpha-particle energies and emission probabilities)
- A. I. Makarenko, L. A. Ostretsov and N. V. Forafontov. Izv. Akad. Nauk SSSR, Ser. Fiz. 35 (1971) 2335; Bull. Acad. Sci. USSR, Phys. Ser. 35 (1972) 2118. ()
  (Gamma-ray energies and emission probabilities)
- B. Grennberg, A. Rytz. Metrologia. 7 (1971) 65
  (Alpha-particle energies)
- S. A. Baranov, V. M. Kulakov, V. M. Shatinskii and Z. S. Gladkikh. Soviet J. Nucl. Phys. 12 (1971) 604
  (Alpha-particle energies and emission probabilities)
- R. Gunnink, R. J. Morrow. UCRL-51087 (1971)
  (Gamma-ray energies and emission probabilities)
- J. D. Hastings, W. W. Strohm. J. Inorg. Nucl. Chem. 34 (1972) 25
  (Spontaneous fission half-life)
- M. Schmorak, C. E. Bemis, Jr., M. J. Zender, N. B. Gove and P. F. Dittner. Nucl. Phys. A178 (1972) 410
  (Gamma-ray energies)

- W. W. Strohm, K. C. Jordan. Nucl. Soc. 18 (1974) 185
  (Half-life)
- R. R. Gay, R. Sher. Bull. Am. Phys. Soc. 20(2) (1975) 160,GB13
  (Spontaneous fission half-life)
- N. R. Gunnink, J. E. Evans and A. L. Prindle. UCRL-52139 (1976)
  (Gamma-ray energies and emission probabilities)
- D. G. Vasilik, R. W. Martin. Nucl. Instrum. Methods 135 (1976) 405
  (L X-ray emission probabilities)
- V. G. Polyukhov, G. A. Timofeev, P. A. Privalova, V. Y. Gabeskiriya and A. P. Chetverikov. Soviet. J. At. Energy 40 (1976) 66; At. Energ. 40 (1976) 61 ()
  (Half-life)
- H. Umezawa, T. Suzuki and S. Ichikawa. J. Nucl. Sci. Technol. 13 (1976) 327
  (Gamma-ray and emission probabilities)
- C. E. Bemis Jr., L. Tubbs. Report ORNL-5297 (1977) 93
  (L X-ray emission probabilities)
- H. Diamond, W. C. Bentley, A. H. Jaffey and K. F. Flynn. Phys. Rev. 15 (1977) 1034
  (Half-life)
- F. P. Larkins. Atomic Data and Nuclear Data Tables 20 (1977) 313
  (Auger electron energies)
- F. Rosel, H. M. Friess, K. Alder and H. C. Pauli. At. Data Nucl. Data Tables. 21 (1978) 92
  (Theoretical ICC)
- R. Vaninbroukx, G Grosse and W. Zehner. Report CBNM/RN/45/79 (1979)
  (Gamma-ray emission probabilities)
- A. Cesana, G. Sandrelli, V. Sangiust and M. Terrani. Energia Nucl. (Milan) 26 (1979) 526
  (Gamma-ray energies and emission probabilities)
- S. K. Aggarwal, A. V. Jadhav, S. A. Chitambar, K. Raghuraman, S. N. Acharya, A. R. Parab, C. K. Sivaramakrishnan and H. C. Jain. Radiochem. Radioanal. Lett. 46 (1981) 69
  (Half-life)
- V. D. Sevastyanov, V. P. Jarina. Voprosi Atomnoi Nauki i Tekhniki, seriya Jadernie Konstanti. 5(44) (1981) 21
  (Half-life)
- A. M. Geidelman, Yu. S. Egorov, V. G. Nedovesov. Conf. Nucl. Spectrosc. Struct. At. Nuclei, (1982) Kiev (1982) 511
  (L X-ray emission probabilities)
- G. Barreau, H. G. Borner, T. von Egidy, R. W. Hoff. Z. Phys. A308 (1982) 209
  (K X-ray energies)
- I. Ahmad, J. Hines, J. E. Gindler. Phys. Rev. C27 (1983) 2239
  (K X-ray energies)
- V. V. Ovechkin, V. M. Chesalin and I. A. Shkabura. Izv. Akad. Nauk SSSR, Ser. Fiz. 48 (1984) 1029
  (Gamma-ray energies and emission probabilities)
- I. Ahmad. Nucl. Instrum. Meth. 223 (1984) 319
  (Alpha-particle energies and emission probabilities)
- L. M. Bak, P. Dryak, V. G. Nedovesov, S. A. Sidorenko, G. E. Shukin, K. P. Yakovlev. Conf. Nucl. Spectrosc. At. Nuclei, Alma-Ata (1984) 541
  (L X-ray emission probabilities)
- G. Bortels, B. Denecke, R. Valninbroukx. Nucl. Instrum. Meth. 223 (1984) 329
  (Alpha-particle, gamma-ray and L X-ray energies and emission probabilities)
- P. Dryak, Yu. S. Egorov, V. G. Nedovesov, I. Plkh, G. E. Shukin. Conf. Nucl. Spectrosc. At. Nuclei, Alma-Ata (1984) 540
  (L X-ray emission probabilities)
- R. G. Helmer, C. W. Reich. J. Appl. Radiat. Isotop. 35 (1984) 1067
  (Gamma-ray energies and emission probabilities)
- P. A. Burns, P. N. Johnston and J. R. Moroney, A. Lorenz. IAEA Tech. Report, Ser. 261 (1986) 147
  (Alpha-particle energies and emission probabilities)
- F. Lagoutine, N. Coursol and J. Legrand. ISBN-2-7272-0078-1 (LMRI, 1982-1987)
  (Energy of Auger electrons)
- G. Bortels, P.Collaers. Appl. Radiat. Isot. 38 (1987) 831
  (Alpha-particle energies and emission probabilities)
- Yu. A. Selitsky, V. B. Funshtein, V. A. Yakovlev. Proc. 38th Ann. Conf. Nucl. Spectrosc. Struct. At. Nuclei, Baku (1988) 131
  (Spontaneous fission half-life)

- I. Ahmad, R. R. Betts, T. Happ, D. J. Henderson, F. L. H. Wolfs and A. H. Wuosmaa. Nucl. Instrum. Meth. Phys. Res. A299 (1990) 201
(Alpha-particle energies)
- Yu. S. Popov, I. B. Makarov, D. Kh. Srurov, E. A. Erin. Sov. Radiochem. 32 (1990) 425
(M X-ray emission probability)
- P. N. Johnston, J. R. Moroney and P. A. Burns. Appl. Radiat. Isot. 42 (1991) 245
(Alpha-particle energies)
- A. Rytz, G. Barci-Funel. At. Data Nucl. Data Tables. 47 (1991) 205
(Alpha-particle energies)
- G. Barci-Funel, J. Dalmasso and G. Ardisson. Appl. Radiat. Isot. 43 (1992) 37
(L X-ray emission probabilities)
- M. C. Lepy, B. Duchemin, J. Morel. Nucl. Instrum. Methods Phys. Res. A339 (1994) 218
(L X-ray energies and emission probabilities)
- M. C. Lepy, B. Duchemin, J. Morel. Nucl. Instrum. Methods Phys. Res. A353 (1994) 10
(L X-ray energies and emission probabilities)
- S. I. Kafala, T. D. MacMahon, P. W. Gray. Nucl. Instrum. Methods Phys. Res. A339 (1994) 151
(Evaluation technique)
- D. T. Baran. Appl. Radiat. Isot. 45 (1994) 1177
(Gamma-ray emission probabilities)
- Y. A. Akovali. Nuclear Data Sheets 71 (1994) 181
(Level energies and data from Pa-234 and Np-234 decays)
- P. N. Johnston, P. A. Burns. Nucl. Instrum. Meth. Phys. Res. A361 (1995) 229
(L X-ray energies and emission probabilities)
- G. Audi, A. H. Wapstra. Nucl. Phys. A595 (1995) 409
(Decay energy)
- E. Schonfeld, H. Janssen. Nucl. Instrum. Meth. Phys. Res. A369 (1996) 527
(Atomic data)
- J. Yang, J. Ni. Nucl. Instrum. Meth. Phys. Res. A413 (1998) 239
(Alpha-particle energies and emission probabilities)
- E. Schönfeld, G. Rodloff. PTB-6.11-1999-1999-1 (1999)
(K X-ray energies and relative emission probabilities)
- E. Schönfeld, H.Janssen. Appl. Rad. Isot. 52 (2000) 595
(L X-ray and Auger electron emission probabilities)
- V. P. Chechev, A. G. Egorov. Appl. Rad. Isot. 52 (2000) 601
(Evaluation technique)
- R. G. Helmer, C. van der Leun. Nucl. Instrum. Meth. Phys. Res. A450 (2000) 35
(Gamma-ray energies)
- N. E. Holden, D. C. Hoffman. Pure Appl. Chem. 72 (2000) 1525
(Spontaneous fission half-life)
- Y. Nir-El. Radiochim. Acta 88 (2000) 83
(Gamma-ray energies)


0+ ; 0
87,74 (3) a
0
α
238
Pu
94
144
γ Emission probabilities
per 100 disintegrations
0,0000012
2+ ; 1085,3
0,00000117
0+ ; 1044,53
0,0000002
4+ ; 1023,7
0,000000152
2- ; 989,45
0,76 ns
0,00000017
4+ ; 947,85
0,0000013
2+ ; 926,74
1,4 ps
0,0000082
2+ ; 851,7
0,000000074
3- ; 849,3
1,74 ps
0,0001
0+ ; 809,88
0,00000821
1- ; 786,29
0,1 ns
0,00297
6+ ; 296,07
0,105
4+ ; 143,35
28,85
2+ ; 43,498
0,25 ns
71,04
0+ ; 0
245,5 (6) x10^3 a
234
U
92
142
Qα = 5593,2 keV
% α = 100


0+ ; 0
87,74 (3) a
0
α
238
Pu
94 144
γ Emission probabilities
per 100 disintegrations
1,74 ps
0,1 ns
0,25 ns
245,5 (6) x10^3 a
2+ ; 851,7
3- ; 849,3
0+ ; 809,88
1- ; 786,29
8+ ; 497,04
6+ ; 296,07
4+ ; 143,35
2+ ; 43,498
0+ ; 0
0,0000082
0,000000074
0,0001
0,00000821
0,00000685
0,00297
0,105
28,85
71,04
234
U
92 142
Q^α = 5593,2 keV
% α = 100

$^{240}_{94}\mathrm{Pu}_{146}$

1 Decay Scheme

Pu-240 decays 100 % by alpha transitions to U-236 and by spontaneous fission with branching fraction of $5.7(2)\,10^{-6}$ %. Most of the alpha decay populates the U-236 ground state (72.7 %) and the U-236 first excited level with energy of 45.24 keV (27.2 %).
Le plutonium 240 décroit à 100 % par émission alpha vers l'uranium 236, et pour une faible proportion par fission spontanée (5,7 (2)10^{-6} *%). Les branchements alpha principaux se font vers le niveau fondamental (72,7 %) et le niveau excité de 45,24 keV (27,2 %).*

2 Nuclear Data

$T_{1/2}(^{240}\mathrm{Pu})$	:	6561	(7)	a
$T_{1/2}(^{236}\mathrm{U})$	:	23,42	(4)	10^6 a
$Q^{\alpha}(^{240}\mathrm{Pu})$	:	5255,78	(15)	keV

2.1 α Transitions

	Energy keV	Probability × 100	F
$\alpha_{0,10}$	4289,15 (18)	$< 1{,}0\ 10^{-7}$	> 70
$\alpha_{0,9}$	4295,5 (4)	$< 1{,}3\ 10^{-7}$	> 61
$\alpha_{0,8}$	4297,79 (23)	$< 1{,}7\ 10^{-7}$	> 49
$\alpha_{0,7}$	4336,57 (23)	$\approx 6{,}5\ 10^{-7}$	≈ 27
$\alpha_{0,5}$	4568,18 (16)	$1{,}93\ (4)\,10^{-5}$	66
$\alpha_{0,4}$	4733,54 (16)	$4{,}7\ (5)\,10^{-5}$	471
$\alpha_{0,3}$	4946,00 (15)	$1{,}082\ (18)\,10^{-3}$	648
$\alpha_{0,2}$	5106,30 (15)	0,0863 (18)	94,7
$\alpha_{0,1}$	5210,54 (15)	27,16 (11)	1,4
$\alpha_{0,0}$	5255,78 (15)	72,74 (11)	1

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{1,0}$(U)	45,242 (3)	27,2 (8)	E2		439 (9)	121,5 (24)	604 (12)
$\gamma_{6,5}$(U)	56,6 (5)		(E2)		148 (3)	41,1 (8)	204 (4)
$\gamma_{2,1}$(U)	104,234 (6)	0,0874 (18)	E2		8,16 (16)	2,27 (5)	11,24 (22)
$\gamma_{3,2}$(U)	160,307 (3)	$1{,}129\ (17)\ 10^{-4}$	E2	0,208 (4)	1,154 (23)	0,320 (7)	1,79 (4)
$\gamma_{4,3}$(U)	212,46 (5)	$4{,}7\ (5)\ 10^{-5}$	E2	0,141 (3)	0,341 (7)	0,0941 (19)	0,610 (12)
$\gamma_{10,6}$(U)	222,4 (1)						
$\gamma_{10,5}$(U)	279,0 (1)		(M1+E2)				
$\gamma_{5,2}$(U)	538,11 (10)	$1{,}68\ (14)\ 10^{-7}$	E3	0,0631 (13)	0,0599 (12)	0,0164 (4)	0,145 (3)
$\gamma_{6,2}$(U)	594,5 (3)						
$\gamma_{5,1}$(U)	642,35 (9)	$1{,}45\ (4)\ 10^{-5}$	E1+(M2+E3)	0,112 (10)	0,031 (3)		0,15 (2)
$\gamma_{5,0}$(U)	687,60 (5)	$4{,}66\ (22)\ 10^{-6}$	E1	0,219 (12)	0,068 (6)		0,31 (2)
$\gamma_{6,1}$(U)	698,1	$< 2{,}5\ 10^{-8}$					
$\gamma_{9,2}$(U)	≈ 810,9						
$\gamma_{7,1}$(U)	873,92 (15)	$5{,}9\ (6)\ 10^{-7}$	(E2)	0,01079 (22)	0,00288 (6)	0,000725 (15)	0,0147 (3)
$\gamma_{8,1}$(U)	≈ 912,7		(M1)	0,0440 (9)	0,00813 (16)	0,00196 (4)	0,0548 (11)
$\gamma_{9,1}$(U)	915,1 (3)		(M1+E0)				
$\gamma_{7,0}$(U)	918,9 (3)	$\approx 6{,}0\ 10^{-8}$	(E0)				
$\gamma_{10,1}$(U)	921,2 (2)		E1	0,00359 (7)	0,000607 (12)	0,000145 (3)	0,00439 (8)
$\gamma_{8,0}$(U)	958,0 (2)	$< 1{,}0\ 10^{-7}$					
$\gamma_{9,0}$(U)	≈ 959,9	$< 5{,}0\ 10^{-8}$					
$\gamma_{10,0}$(U)	966,9 (2)	$< 5{,}0\ 10^{-8}$	E1	0,00330 (6)	0,000556 (11)	0,000132 (3)	0,00404 (8)

3 Atomic Data

3.1 U

ω_K : 0,970 (4)
$\bar{\omega}_L$: 0,500 (19)
n_{KL} : 0,794 (5)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	94,666		62,47
	$K\alpha_1$	98,44		100
	$K\beta_3$	110,421	}	
	$K\beta_1$	111,298	}	
	$K\beta_5''$	111,964	}	36,06
	$K\beta_2$	114,407	}	
	$K\beta_4$	115,012	}	12,33
	$KO_{2,3}$	115,377	}	

		Energy keV	Relative probability
X_L			
	Lℓ	11,62	
	Lα	13,44 – 13,62	
	Lη	15,407	
	Lβ	15,74 – 18,16	
	Lγ	19,5 – 21,75	

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	71,78 – 80,95	100
KLX	88,15 – 98,43	59,6
KXY	104,51 – 115,59	8,88
Auger L	5,9 – 21,6	

4 α Emissions

	Energy keV	Probability × 100
$\alpha_{0,10}$	4217,62 (18)	$< 1{,}0\ 10^{-7}$
$\alpha_{0,9}$	4223,8 (4)	$< 1{,}3\ 10^{-7}$
$\alpha_{0,8}$	4226,12 (23)	$< 1{,}7\ 10^{-7}$
$\alpha_{0,7}$	4264,25 (23)	$\approx 6{,}5\ 10^{-7}$
$\alpha_{0,5}$	4492,00 (16)	$1{,}93\ (4)\ 10^{-5}$
$\alpha_{0,4}$	4654,60 (16)	$4{,}7\ (5)\ 10^{-5}$
$\alpha_{0,3}$	4863,51 (15)	$1{,}082\ (18)\ 10^{-3}$
$\alpha_{0,2}$	5021,15 (15)	0,0863 (18)
$\alpha_{0,1}$	5123,64 (15)	27,16 (11)
$\alpha_{0,0}$	5168,13 (15)	72,74 (11)

5 Electron Emissions

		Energy keV	Electrons per 100 disint.
e_{AL}	(U)	5,9 - 21,6	10,3 (8)
e_{AK}	(U)		0,0000027 (4)
	KLL	71,78 - 80,95	}
	KLX	88,15 - 98,43	}
	KXY	104,51 - 115,59	}
$ec_{1,0\ T}$	(U)	23,48 - 45,24	27,2 (8)
$ec_{1,0\ L}$	(U)	23,484 - 28,074	19,8 (6)
$ec_{1,0\ M}$	(U)	39,694 - 41,692	5,47 (15)
$ec_{2,1\ L}$	(U)	82,476 - 87,066	0,0583 (13)
$ec_{2,1\ M}$	(U)	98,686 - 100,684	0,0162 (4)

6 Photon Emissions

6.1 X-Ray Emissions

		Energy keV		Photons per 100 disint.	
XL	(U)	11,62 — 21,75		10,34 (15)	
$XK\alpha_2$	(U)	94,666		0,0000260 (8)	} $K\alpha$
$XK\alpha_1$	(U)	98,44		0,0000416 (12)	}
$XK\beta_3$	(U)	110,421	}		
$XK\beta_1$	(U)	111,298	}	0,0000152 (5)	$K'\beta_1$
$XK\beta_5''$	(U)	111,964	}		
$XK\beta_2$	(U)	114,407	}		
$XK\beta_4$	(U)	115,012	}	0,0000049 (2)	$K'\beta_2$
$XKO_{2,3}$	(U)	115,377	}		

6.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{1,0}$(U)	45,242 (3)	0,0450 (9)
$\gamma_{6,5}$(U)	56,6 (5)	
$\gamma_{2,1}$(U)	104,234 (6)	0,00714 (7)
$\gamma_{3,2}$(U)	160,307 (3)	4,045 (22) 10^{-4}

	Energy keV	Photons per 100 disint.
$\gamma_{4,3}$(U)	212,46 (5)	2,9 (3) 10^{-5}
$\gamma_{10,6}$(U)	222,4 (1)	
$\gamma_{10,5}$(U)	279,0 (1)	
$\gamma_{5,2}$(U)	538,11 (10)	1,47 (12) 10^{-7}
$\gamma_{6,2}$(U)	594,5 (3)	
$\gamma_{5,1}$(U)	642,35 (9)	1,26 (3) 10^{-5}
$\gamma_{5,0}$(U)	687,60 (5)	3,56 (16) 10^{-6}
$\gamma_{6,1}$(U)	698,1	$< 2,5\ 10^{-8}$
$\gamma_{9,2}$(U)	$\approx$ 810,9	
$\gamma_{7,1}$(U)	873,92 (15)	5,8 (6) 10^{-7}
$\gamma_{8,1}$(U)	$\approx$ 912,7	
$\gamma_{9,1}$(U)	915,1 (3)	
$\gamma_{7,0}$(U)	918,9 (3)	
$\gamma_{10,1}$(U)	921,2 (2)	
$\gamma_{8,0}$(U)	958,0 (2)	$< 1,0\ 10^{-7}$
$\gamma_{9,0}$(U)	$\approx$ 959,9	$< 5,0\ 10^{-8}$
$\gamma_{10,0}$(U)	966,9 (2)	$< 5,0\ 10^{-8}$

7 Main Production Modes

U − 238(n,γ)Np − 240
U − 238(α,2n)Pu − 240
U − 238(α,pn)Np − 240

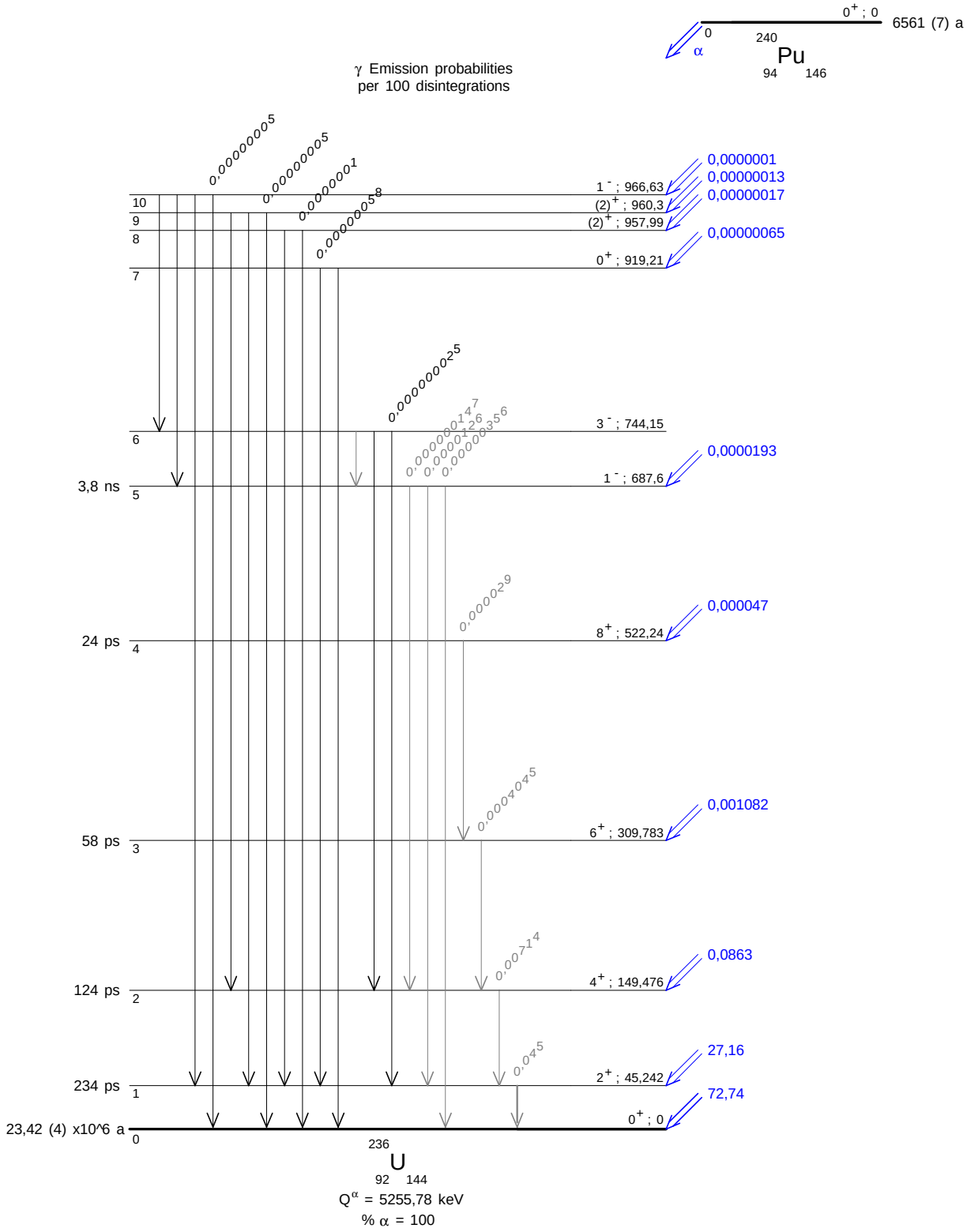
8 References

- M. G. Inghram, D. C. Hess, P. R. Fields, G. L. Pyle. Phys. Rev. 83 (1951) 1250
  (Half-life)
- E. F. Westrum. Phys. Rev. 83 (1951) 1249
  (Half-life)
- F. Asaro, I. Perlman. Phys. Rev. 88 (1952) 828
  (Alpha emission energies, Alpha emission probabilities)
- E. M. Kinderman. Hanford Lab. Report HW 27660 (1953)
  (SF Half-life)
- F. R. Barclay, W. Galbraith, K. M. Glover, G. R. Hall, W. J. Whitehouse. Proc. Phys. Soc. (London) 67A (1954) 646
  (SF Half-life)
- O. Chamberlain, G. W. Farwell, E. Segre. Phys. Rev. 94 (1954) 156
  (SF Half-life)
- G. Farwell, J. E. Roberts, A. C. Wahl. Phys. Rev. 94 (1954) 363
  (Half-life)
- J. P. Butler, T. A. Eastwood, T. L. Collins, M. E. Jones, F. M. Rourke, R. P. Schuman. Phys. Rev. 103 (1956) 634
  (Half-life)
- L. L. Goldin, G. I. Novikova, E. F. Tretyakov. Phys. Rev. 103 (1956) 1004
  (Alpha emission energies, Alpha emission probabilities)
- L. M. Kondratev, G. I. Novikova, Y. P. Sobolev, L. L. Goldin. Zh. Eksp. Teor. Fiz. 31 (1956) 771
  (Alpha emission energies, Alpha emission probabilities)

- F. Asaro, S. G. Thompson, F. S. Stephens, Jr. I. Perlman. Priv. Comm. 1957, cited in1964Hy02 (1957)
  (Alpha emission energies, Alpha emission probabilities)
- P. S. Samoilov. Atomnaya Energ. 4 (1958) 81
  (Gamma ray energies)
- Ya. P. Dokuchaev. Atomnaya Energ. 6 (1959) 74
  (Half-life)
- V. L. Mikheev, N. K. Skobelev, V. A. Druin, G. N. Flerov. Zhur. Eksptl. i Teoret. Fiz. 37 (1959) 859
  (Half-life)
- E. F. Tretyakov, L. N. Kondratev, G. I. Khlebnikov, L. L. Goldin. Zh. Eksp. Teor. Fiz. 36 (1959) 362
  (Gamma ray energies)
- D. E. Watt, F. J. Bannister, J. B. Laidler, F. Brown. Phys. Rev. 126 (1962) 264
  (SF Half-life)
- C. F. Leang. Compt. Rend. 255 (1962) 3155
  (Alpha emission energies)
- L. Z. Malkin, I. D. Alkhazov, A. S. Krivokhatsky, K. A. Petrzhak. At. Energ. USSR 15 (1963) 158
  (SF Half-life)
- 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)
  (Alpha emission energies, Alpha emission probabilities)
- J. A. Bearden. Rev. Mod. Phys. 39 (1967) 78
  (X-ray energies)
- P. Fieldhouse, D. S. Mather, E. R. Culliford. J. Nucl. Energy 21 (1967) 749
  (SF Half-life)
- P. H. White. Priv. Comm., cited in 2000Ho27 (1967)
  (SF Half-life)
- F. L. Oetting. Proc. Symp. Thermodyn. Nucl. Mater. With Emphasis on Solution Syst., Vienna, Austria (1967), IAEA, Vienna (1968) 55
  (Half-life)
- C. M. Lederer, J. M. Jaklevic, S. G. Prussin. Nucl. Phys. A135 (1969) 36
  (Alpha emission energies, Alpha emission probabilities)
- K. L. Swinth. IEEE Nuclear Science Symp. 4 (1970) 125
  (LX-ray emission probabilities)
- R. Gunnink, R. J. Morrow. UCRL 51087 (1971)
  (Gamma ray energies, Gamma-ray emission probabilities)
- M. Schmorak, C. E. Bemis Jr, M. J. Zender, N. B. Gove, P. F. Dittner. Nucl. Phys. A178 (1972) 410
  (Gamma ray energies, Gamma-ray emission probabilities)
- J. E. Cline, R. J. Gehrke, L. D. McIsaac. ANCR 1069 (1972)
  (Gamma ray energies)
- D. J. Gorman, A. Rytz, H. V. Michel. Compt. Rend. B275 (1972) 291
  (Alpha emission energies)
- R. L. Heath. Gamma-Ray Spectrum Catalogue. In: ANCR 1000 2 (1974)
  (Gamma ray energies)
- T. Dragnev, K. Scharf. Intern. J. Appl. Radiat. Isotop. 26 (1975) 125
  (Gamma-ray emission probabilities)
- H. Ottmar. Proc. Int. Symp. Neutron Capt. G- Ray Spectr. and Related Topics, 2nd, Petten, Netherlands, K. Abrahams et al., Eds., Reactor Centrum (1975) 658
  (Gamma-ray energies and emission probabilities)
- R. Gunnink, J. E. Evans, A. L. Prindle. UCRL-52139 (1976)
  (Gamma-ray energies and emission probabilities)
- H. Umezawa, T. Suzuki, S. Ichikawa. J. Nucl. Sci. Technol 13 (1976) 327
  (Gamma-ray emission probabilities)
- F. P. Larkins. Atomic Data and Nuclear Data Tables 20 (1977) 313
  (Auger electron energies)
- S. A. Baranov, V. M. Shatinskii. Yad. Fiz. 26 (1977) 461
  (Alpha emission energies, Alpha emission probabilities)
- F. Rosel, H. M. Friess, K. Alder, H. C. Pauli. At. Data Nucl. Data Tables. 21 (1978) 92
  (Theoretical ICC)
- A. H. Jaffey, H. Diamond, W. C. Bentley, D. G. Graczyk, K. P. Flynn. Phys. Rev. C18 (1978) 969
  (Half-life)

- C. Budtz-Jorgensen, H.-H. Knitter. NEANDC(E) 202U Vol III (1979) p 9
  (SF Half-life)
- R. G. Helmer, C. W. Reich. Intern. J. Appl.Radiat. Isotop. 32 (1981) 829
  (Gamma-ray energies and emission probabilities)
- J. Morel. LMRI, Saclay, private communication, 1981 Cited in IAEA, Vienna, Tec. Rep. 261, 1986 (1981)
  (Gamma-ray emission probabilities)
- G. Barreau, H. G. Borner, T. von Egidy, R. W. Hoff. Z. Phys. A308 (1982) 209
  (K X-ray energies)
- I. Ahmad, J. Hines, J. E. Gindler. Phys. Rev. C27 (1983) 2239
  (K X-ray energies)
- I. Ahmad. Nucl. Instrum. Methods 223 (1984) 319
  (Alpha emission probabilities)
- F. J. Steinkruger, G. M. Matlack, R. J. Beckman. Intern. J. Appl. Radiat. Isotop. 35 (1984) 171
  (Half-life)
- C. R. Rudy, K. C. Jordan, R. Tsugawa. Intern. J. Appl. Radiat. Isotop. 35 (1984) 177
  (Half-life)
- S. Mirzadeh, Y. Y. Chu, S. Katcoff, L. K. Peker. Phys. Rev. C29 (1984) 985
  (Gamma ray energies)
- L. L. Lucas, J. R. Noyce. Intern. J. Appl. Radiat. Isotop. 35 (1984) 173
  (Half-life)
- G. Bortels, B. Denecke, R. Vaninbroukx. Nucl. Instrum. Methods 223 (1984) 329
  (L X-ray energies)
- A. A. Androsenko, P. A. Androsenko, Yu. V. Ivanov, A. E. Konyaev, V. F. Kositsyn, E. M. Tsenter, V. T. Shchebolev. At. Energ. 57 (1984) 357
  (SF Half-life)
- R. J. Beckman, S. F. Marsh, R. M. Abernathey, J. E. Rein. Intern. J. Appl. Radiat. Isotop. 35 (1984) 163
  (Half-life)
- IAEA. Decay Data of the Transactinium Nuclides, IAEA, Vienna, Tec. Rep. Ser. 261, 1986. (1986)
  (Gamma-ray emission probabilities)
- F. Lagoutine, N. Coursol, J. Legrand. ISBN-2-7272-0078-1 (LMRI, 1982-1987) (1987)
  (Energy of Auger electrons)
- Yu. A. Selitsky, V. B. Funshtein, V. A. Yakovlev. Program and Theses, Proc. 38th Ann. Conf. Nucl. Spectrosc. Struct. At. Nuclei, Baku, (1988) 131 (1988)
  (SF Half-life)
- N. Dytlewski, M. G. Hines, J. W. Boldeman. Nucl. Sci. Eng. 102 (1989) 423
  (SF Half-life)
- S. V. Anichenkov, Yu. S. Popov. Radiokhimiya 32 (1990) 109
  (Alpha emission probabilities)
- Yu. V. Ivanov, A. E. Konyaev, V. F. Kositsyn, E. A. Kholnova, V. T. Shchebolev, M. F. Yudin. At. Energ. 70 (1991) 396
  (SF Half-life)
- A. Rytz. At. Data Nucl. Data Tables. 47 (1991) 205
  (Alpha-particle energies)
- M. R. Schmorak. Nucl.Data Sheets 63 (1991) 139
  (Decay scheme, 236U level energies, gamma-ray multipolarities)
- C. J. Bland, J.Truffy. Appl. Radiat. Isot. 43 (1992) 1241
  (Alpha emission probabilities)
- G. Barci-Funel, J. Dalmasso, G. Ardisson. Appl. Rad. Isotopes 43 (1992) 37
  (X-ray energies)
- M. Sanchez, F. V. Tome, J. D. Bejarano. Nucl. Instrum. Methods A340 (1994) 509
  (Alpha emission probabilities)
- M. C. Lépy, B. Duchemin, J. Morel. Nucl. Instrum. Methods A339 (1994) 218
  (L X-ray energies and emission probabilities)
- D. T. Baran. Appl. Radiat. Isot. 45 (1994) 1177
  (Alpha emission probabilities)
- W. Raab, J. L. Parus. Nucl. Instrum. Methods A339 (1994) 116
  (Alpha emission probabilities)
- M. C. Lépy, B.Duchemin, J.Morel. Nucl. Instrum. Methods A353 (1994) 10
  (L X-ray energies and emission probabilities)

- G. Audi, A. H. Wapstra. Nucl. Phys. A595 (1995) 409
(Decay energy)
- P. N. Johnston, P. A. Burns. Nucl. Instrum. Methods A361 (1995) 229
(L X-ray energies and emission probabilities)
- R. B. Firestone, V. S. Shirley, C. M. Baglin, S. Y. F. Chu, J. Zipkin. Table of Isotopes, Eighth Edition, Volume II: A=151-272, 2800-2801 (1996)
(Decay scheme, 236U level energies, gamma ray multipolarities)
- L. L. Vintro, P. I. Mitchell, O. M. Condren, M. Moran, J. Vives i Batlle, J. A. Sanchez-Cabeza. Nucl. Instrum. Methods Phys. Res. A369 (1996) 597
(Alpha emission probabilities)
- E. Schönfeld, G. Rodloff. PTB-6.11-1999-1999-1, Braunschweig, February 1999 (1999)
(K X-ray energies and relative emission probabilities)
- V. P. Chechev, A. G. Egorov. Appl. Rad. Isotopes 52 (2000) 601
(Evaluation technique)
- N. E. Holden, D. C. Hoffman. Pure Appl. Chem. 72 (2000) 1525
(Spontaneous fission half-life)
- G. Sibbens, S.Pommé. Appl. Rad. Isotopes 60, 2-3 (2004) 155
(Alpha emission energies, Alpha emission probabilities)


0+ ; 0
6561 (7) a
0
α
240
Pu
94 146
γ Emission probabilities
per 100 disintegrations
0,0000001
0,00000013
0,00000017
0,00000065
1 - ; 966,63
(2)+ ; 960,3
(2)+ ; 957,99
0+ ; 919,21
10
9
8
7
6
3 - ; 744,15
0,0000193
1 - ; 687,6
3,8 ns
5
0,000047
8+ ; 522,24
24 ps
4
0,001082
6+ ; 309,783
58 ps
3
0,0863
4+ ; 149,476
124 ps
2
27,16
2+ ; 45,242
234 ps
1
72,74
0+ ; 0
23,42 (4) x10^6 a
0
236
U
92 144
Qα = 5255,78 keV
% α = 100

$^{241}_{95}\mathrm{Am}_{146}$

1 Decay Scheme

Am-241 decays 100 % by alpha transitions to Np-237. Most of the decay (84.6 %) populate the excited level of Np-237 with energy of 59.54 keV. Branching of Am-241 decay by spontaneous fission is 4.3(18) 10^{-10}%.
L'américium 241 décroit à 100 % par émission alpha vers le neptunium 237. Le branchement principal (84,6%) se fait vers le niveau excité de 59 keV. Un faible branchement (4,3(18) 10^{-10} %) par fission spontanée existe.

2 Nuclear Data

$T_{1/2}(^{241}\mathrm{Am})$	:	432,6	(6)	a
$T_{1/2}(^{237}\mathrm{Np})$	:	2,14	(1)	10^6 a
$Q^{\alpha}(^{241}\mathrm{Am})$	:	5637,81	(12)	keV

2.1 α Transitions

	Energy keV	Probability × 100	F
$\alpha_{0,36}$	4837,81 (16)	0,00004 (3)	47
$\alpha_{0,34}$	4881,81 (16)	0,000086	44
$\alpha_{0,33}$	4915,86 (13)	0,0007	9,5
$\alpha_{0,32}$	4971,6 (2)		
$\alpha_{0,30}$	5039,8 (3)		
$\alpha_{0,29}$	5044,8 (11)		
$\alpha_{0,28}$	5047,53 (20)		
$\alpha_{0,27}$	5092,22 (20)	0,0001	1000
$\alpha_{0,25}$	5140,79 (14)		
$\alpha_{0,24}$	5151,85 (17)	0,00011	2300
$\alpha_{0,23}$	5178,17 (13)	∼0,0004	∼1000
$\alpha_{0,22}$	5185,28 (13)	∼0,0004	∼1000
$\alpha_{0,21}$	5193,03 (16)		
$\alpha_{0,20}$	5203,69 (20)	0,0004	1400
$\alpha_{0,19}$	5220 (4)		

	Energy keV	Probability × 100	F
$\alpha_{0,18}$	5242,29 (13)	0,0007	1400
$\alpha_{0,17}$	5266,88 (13)	0,0003	4600
$\alpha_{0,16}$	5269,22 (13)	0,0009	1600
$\alpha_{0,15}$	5278,1 (2)	0,0006	2700
$\alpha_{0,14}$	5305,45 (13)		
$\alpha_{0,13}$	5313,39 (13)	0,0013	2100
$\alpha_{0,12}$	5321,0 (3)		
$\alpha_{0,11}$	5332,75 (13)	0,0022 (3)	1600
$\alpha_{0,9}$	5370,27 (14)	0,0005	12000
$\alpha_{0,8}$	5411,85 (13)	0,014 (3)	770
$\alpha_{0,6}$	5479,32 (13)	1,66 (3)	16,4
$\alpha_{0,5}$	5507,81 (13)	0,01	4000
$\alpha_{0,4}$	5534,85 (12)	13,23 (10)	4,3
$\alpha_{0,3}$	5561,91 (12)	0,04	2000
$\alpha_{0,2}$	5578,27 (12)	84,45 (10)	1,3
$\alpha_{0,1}$	5604,61 (12)	0,23 (1)	600
$\alpha_{0,0}$	5637,81 (12)	0,38 (1)	6100

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{10,9}$(Np)	13,81 (2)						
$\gamma_{2,1}$(Np)	26,3446 (2)	22,56 (70)	E1		6,12 (20)	1,6 (2)	8,4 (3)
$\gamma_{4,3}$(Np)	27,06						
$\gamma_{27,26}$(Np)	31,4						
$\gamma_{(-1,1)}$(Np)	32,183						
$\gamma_{1,0}$(Np)	33,1963 (3)	23,3 (6)	M1+1,7%E2		143 (5)	35 (5)	192 (5)
$\gamma_{(-1,2)}$(Np)	38,54 (3)						
$\gamma_{3,1}$(Np)	42,704 (5)	2,2 (5)	(M1+42%E2)		296 (30)	81 (8)	400 (4)
$\gamma_{4,2}$(Np)	43,420 (3)	12,9 (10)	M1+17%E2		136 (4)	36,5 (12)	186 (5)
$\gamma_{14,10}$(Np)	51,01 (3)	0,000046 (12)	(E1)		0,573 (12)	0,144 (3)	0,77 (2)
$\gamma_{5,3}$(Np)	54,1						
$\gamma_{6,4}$(Np)	55,55 (2)	1,2 (2)	M1+17%E2		49 (4)	13,1 (12)	67 (6)
$\gamma_{13,9}$(Np)	56,8						
$\gamma_{(-1,3)}$(Np)	57,85 (5)						
$\gamma_{2,0}$(Np)	59,5409 (1)	78,0 (11)	E1+0,01%M2		0,875 (18)	0,226 (7)	1,18 (3)
$\gamma_{7,5}$(Np)	61,44						
$\gamma_{14,9}$(Np)	64,83 (2)	0,00020 (3)	E1		0,305 (6)	0,076 (2)	0,41 (1)
$\gamma_{8,6}$(Np)	67,46 (5)	0,013 (4)	M1+17%E2		23 (5)	6,0 (13)	31 (8)
$\gamma_{4,1}$(Np)	69,76 (3)	0,0039 (5)	E1		0,252 (5)	0,0625 (13)	0,336 (7)
$\gamma_{3,0}$(Np)	75,8 (2)	0,0335	E2		39,6 (8)	11,1 (2)	54,8 (11)
$\gamma_{36,33}$(Np)	78,1						
$\gamma_{11,8}$(Np)	79,1						
$\gamma_{15,9}$(Np)	92,1						
$\gamma_{5,1}$(Np)	96,7 (2)	0,00099 (4)	E2		13,7 (3)	3,82 (4)	18,8 (4)
$\gamma_{6,2}$(Np)	98,95 (1)	0,337 (10)	E2		11,3 (3)	3,16 (7)	15,6 (3)
$\gamma_{4,0}$(Np)	102,97 (1)	0,0219 (5)	E1		0,091 (2)	0,0224 (5)	0,121 (3)

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{(-1,4)}$(Np)	106,42 (5)						
$\gamma_{20,13}$(Np)	109,70 (7)	0,0000524	if E2				9,7
$\gamma_{7,3}$(Np)	115,54						
$\gamma_{21,13}$(Np)	120,36 (8)						
$\gamma_{8,4}$(Np)	123,02 (2)	0,0069 (2)	E2	0,187 (4)	4,13 (8)	1,15 (2)	5,90 (12)
$\gamma_{6,1}$(Np)	125,29 (1)	0,0054 (3)	(E1)	0,239 (5)	0,0546 (11)	0,0134 (3)	0,306 (6)
$\gamma_{(-1,5)}$(Np)	128,05						
$\gamma_{20,11}$(Np)	129,2						
$\gamma_{22,13}$(Np)	135,3						
$\gamma_{(-1,6)}$(Np)	136,7						
$\gamma_{30,23}$(Np)	138,5						
$\gamma_{29,22}$(Np)	139,46 (8)	0,000023 (5)	if E2				3,4
$\gamma_{11,6}$(Np)	146,57 (1)	0,00175 (4)	E2	0,210 (4)	1,87 (4)	0,522 (11)	2,80 (6)
$\gamma_{8,3}$(Np)	150,08 (3)	0,000088 (5)	(E1)	0,153 (3)	0,0344 (7)	0,0084 (2)	0,199 (4)
$\gamma_{26,15}$(Np)	154,27 (20)	0,0000042	if M1				7,5
$\gamma_{(-1,7)}$(Np)	156,4 (3)						
$\gamma_{29,20}$(Np)	159,16 (20)	0,0000016 (5)	if E1				0,17
$\gamma_{24,13}$(Np)	161,54 (10)	0,0000114	if M1				6,6
$\gamma_{9,4}$(Np)	164,59 (1)	0,000180 (8)	E2	0,195 (4)	1,12 (2)	0,311 (6)	1,73 (4)
$\gamma_{13,6}$(Np)	165,91 (4)						
$\gamma_{18,8}$(Np)	169,55 (2)	0,00043 (3)		0,190 (4)	0,98 (2)	0,273 (6)	1,55 (3)
$\gamma_{11,5}$(Np)	175,08 (3)	0,000042 (3)	(E2)	0,183 (4)	0,85 (2)	0,237 (5)	1,36 (3)
$\gamma_{(-1,8)}$(Np)	190,4						
$\gamma_{25,11}$(Np)	191,90 (1)	0,0000419 (20)	E2	0,163 (4)	0,57 (1)	0,159 (4)	0,95 (2)
$\gamma_{29,18}$(Np)	197,0 (2)	0,00000054	if E1				0,1
$\gamma_{(-1,9)}$(Np)	201,70 (14)						
$\gamma_{18,7}$(Np)	204,06 (6)						
$\gamma_{9,2}$(Np)	208,00 (2)	0,00329 (10)	M1+2,4%E2	2,56 (6)	0,507 (11)	0,124 (3)	3,19 (7)
$\gamma_{13,4}$(Np)	221,45 (3)						
$\gamma_{26,10}$(Np)	232,81 (5)						
$\gamma_{9,1}$(Np)	234,33	0,0000084	if M2				8,6
$\gamma_{26,9}$(Np)	246,7 (1)						
$\gamma_{13,3}$(Np)	248,58 (8)	0,00000155 (8)	if E1				0,061
$\gamma_{21,7}$(Np)	260,9 (1)						
$\gamma_{13,2}$(Np)	264,87 (5)						
$\gamma_{9,0}$(Np)	267,54 (3)	0,000036 (2)	E1+5,4%M2	0,25 (1)	0,076 (3)	0,20 (1)	0,35 (3)
$\gamma_{(-1,10)}$(Np)	270,63						
$\gamma_{(-1,51)}$(Np)	271,54						
$\gamma_{20,6}$(Np)	275,73 (8)						
$\gamma_{27,9}$(Np)	278,18	0,0000032	if M1				1,4
$\gamma_{13,1}$(Np)	291,26 (20)						
$\gamma_{16,3}$(Np)	292,78 (4)	0,000017 (1)	E2	0,080 (2)	0,101 (2)	0,0276 (6)	0,219 (5)
$\gamma_{15,2}$(Np)	300,13 (6)						
$\gamma_{20,5}$(Np)	304,2 (2)	0,00000093 (2)					
$\gamma_{16,2}$(Np)	309,1 (3)	0,000002	if E1				0,038
$\gamma_{12,0}$(Np)	316,8 (2)						
$\gamma_{21,5}$(Np)	322,53 (3)	0,000264 (8)	(M1+26,5%E2)	0,59 (9)	0,13 (2)	0,032 (5)	0,75 (12)
$\gamma_{(-1,52)}$(Np)	324,69	0,0000018 (3)					
$\gamma_{(-1,53)}$(Np)	329,69	0,0000011 (2)					
$\gamma_{14,0}$(Np)	332,36 (2)	0,0001720 (8)	E2	0,0638 (13)	0,062 (13)	0,0169 (4)	0,150 (3)
$\gamma_{16,1}$(Np)	335,40 (3)	0,00084 (4)	M1+17,3%E2	0,59 (8)	0,12 (2)	0,030 (4)	0,75 (12)
$\gamma_{17,1}$(Np)	337,7 (2)	0,00000488 (7)					
$\gamma_{(-1,11)}$(Np)	350,71	0,00000139 (5)					
$\gamma_{20,3}$(Np)	358,3 (2)	0,00000129 (5)					
$\gamma_{16,0}$(Np)	368,63 (3)	0,00036 (2)	M1	0,538 (11)	0,103 (2)	0,0251 (5)	0,667 (14)
$\gamma_{17,0}$(Np)	370,94 (3)	0,000082 (6)	M1+16%E2	0,45 (5)	0,092 (9)	0,023 (2)	0,57 (6)
$\gamma_{(-1,54)}$(Np)	374,83	0,00000313 (5)					
$\gamma_{21,3}$(Np)	376,66 (3)	0,000225 (9)	M1	0,507 (11)	0,098 (2)	0,0237 (5)	0,629 (13)
$\gamma_{22,3}$(Np)	383,80 (3)	0,000045	if M1				0,6

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{(-1,12)}$(Np)	389,0 (3)	0,0000005					
$\gamma_{(-1,13)}$(Np)	390,61 (5)	0,00000573 (8)					
$\gamma_{32,9}$(Np)	398,6 (2)						
$\gamma_{29,7}$(Np)	401,68	0,00000018 (4)	M1+E2				0,31 (22)
$\gamma_{30,7}$(Np)	406,4 (2)	0,0000021	if M1				0,51
$\gamma_{(-1,14)}$(Np)	411,27	0,00000018 (4)					
$\gamma_{21,1}$(Np)	419,32 (4)	0,000036 (7)	M1+E2				0,27 (20)
$\gamma_{22,1}$(Np)	426,47 (4)	0,000031 (6)	M1+E2				0,27 (18)
$\gamma_{(-1,15)}$(Np)	429,9 (1)	0,00000109 (5)					
$\gamma_{(-1,55)}$(Np)	440,63	0,00000056 (3)					
$\gamma_{(-1,16)}$(Np)	442,81 (7)	0,00000331 (7)					
$\gamma_{35,13}$(Np)	446,68	0,00000011 (2)					
$\gamma_{21,0}$(Np)	452,5 (3)	0,0000025	if E2				0,063
$\gamma_{26,2}$(Np)	454,66 (8)	0,0000131 (4)	M1+E2				0,376
$\gamma_{22,0}$(Np)	459,68 (10)	0,0000043 (8)	M1+E2				0,21 (15)
$\gamma_{29,5}$(Np)	463,22 (20)	0,000001	if E2				0,059
$\gamma_{30,5}$(Np)	468,06 (15)	0,0000035 (2)	if M1				0,31
$\gamma_{(-1,17)}$(Np)	486,05	0,00000105 (6)					
$\gamma_{28,4}$(Np)	487,64	0,00000081 (7)	if M1				0,31
$\gamma_{(-1,56)}$(Np)	494,39	0,00000010 (2)					
$\gamma_{(-1,57)}$(Np)	501,39	0,00000014 (2)					
$\gamma_{27,1}$(Np)	512,4 (3)	0,0000021	if E1				0,013
$\gamma_{26,0}$(Np)	514,2 (2)	0,0000039 (2)	if E1				0,013
$\gamma_{30,3}$(Np)	522,11	0,00000125	if M1				0,26
$\gamma_{(-1,58)}$(Np)	525,14	0,00000016 (3)					
$\gamma_{38,13}$(Np)	528,87	0,00000072 (5)	if E2				0,043
$\gamma_{(-1,59)}$(Np)	532,44	0,00000008 (2)					
$\gamma_{27,0}$(Np)	545,7	0,00000025 (3)	if E1				0,011
$\gamma_{(-1,60)}$(Np)	548,15	0,00000005 (2)					
$\gamma_{(-1,61)}$(Np)	555,25	0,00000009 (2)					
$\gamma_{33,6}$(Np)	563,48	0,00000046 (2)	if E2				0,038
$\gamma_{36,8}$(Np)	573,94 (20)	0,00000154 (8)	if M1				0,2
$\gamma_{(-1,18)}$(Np)	582,89	0,00000101 (6)					
$\gamma_{31,2}$(Np)	586,5 (2)	0,00000148 (6)	if M1				0,19
$\gamma_{28,0}$(Np)	590,28 (15)	0,00000333 (6)	if M1				0,19
$\gamma_{34,6}$(Np)	597,44 (8)	0,0000086 (2)	if M1				0,18
$\gamma_{(-1,62)}$(Np)	600,26	0,00000022 (3)					
$\gamma_{33,4}$(Np)	619,01 (2)	0,000070 (3)	if M1				0,16
$\gamma_{38,8}$(Np)	627,2 (2)	0,00000059 (3)	if M1				0,16
$\gamma_{32,1}$(Np)	632,93 (15)	0,00000124 (5)					
$\gamma_{(-1,63)}$(Np)	636,9	0,00000021 (3)					
$\gamma_{36,6}$(Np)	641,46 (5)	0,0000081 (1)	if M1				0,15
$\gamma_{34,4}$(Np)	652,98 (4)	0,000043 (1)	if M1				0,14
$\gamma_{33,2}$(Np)	662,41 (2)	0,00045 (10)	E0+M1+E2	0,18 (4)			0,23 (5)
$\gamma_{32,0}$(Np)	666,2 (3)	0,00000095 (7)					
$\gamma_{36,5}$(Np)	669,9 (2)	0,00000051 (7)	if E1				0,008
$\gamma_{37,5}$(Np)	675,8 (3)	0,00000085 (5)					
$\gamma_{34,3}$(Np)	680,1 (1)	0,00000334 (7)	if E1				0,0078
$\gamma_{33,1}$(Np)	688,76 (4)	0,0000325 (5)	if E1				0,0076
$\gamma_{(-1,19)}$(Np)	693,46	0,00000354 (7)					
$\gamma_{34,2}$(Np)	696,48	0,0000058 (2)	if M1				0,12
$\gamma_{(-1,20)}$(Np)	709,42 (5)	0,00000641 (18)					
$\gamma_{(-1,64)}$(Np)	712,5	0,00000020 (3)					
$\gamma_{33,0}$(Np)	721,98 (3)	0,000196 (4)	if E1				0,007
$\gamma_{37,3}$(Np)	729,52 (15)	0,00000137 (5)					
$\gamma_{(-1,21)}$(Np)	731,44	0,00000046 (4)					
$\gamma_{(-1,65)}$(Np)	736,68	0,00000128 (5)					
$\gamma_{35,1}$(Np)	737,34 (5)	0,00000794 (8)					
$\gamma_{(-1,66)}$(Np)	740,51	0,00000019 (3)					

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{(-1,22)}$(Np)	742,9 (3)	0,00000035					
$\gamma_{(-1,67)}$(Np)	745,02	0,00000009 (2)					
$\gamma_{(-1,85)}$(Np)	750,39	0,000000006 (2)					
$\gamma_{34,0}$(Np)	755,91 (5)	0,0000079 (1)	if E1				0,0064
$\gamma_{(-1,23)}$(Np)	759,5 (1)	0,00000181 (5)					
$\gamma_{(-1,24)}$(Np)	763,31	0,00000023 (2)					
$\gamma_{36,1}$(Np)	767,0 (1)	0,00000502 (3)	if E1				0,0063
$\gamma_{35,0}$(Np)	770,6 (1)	0,00000481 (5)					
$\gamma_{37,1}$(Np)	772,17	0,00000305 (6)	if M1				0,092
$\gamma_{(-1,69)}$(Np)	774,67	0,00000011 (2)					
$\gamma_{(-1,25)}$(Np)	777,39	0,00000015 (2)					
$\gamma_{(-1,26)}$(Np)	780,53	0,00000031 (2)					
$\gamma_{(-1,27)}$(Np)	782,2 (5)	0,00000015					
$\gamma_{39,3}$(Np)	786,00 (15)	0,00000062					
$\gamma_{(-1,28)}$(Np)	789,0 (3)	0,00000042 (6)					
$\gamma_{(-1,70)}$(Np)	792,6	0,00000003 (1)					
$\gamma_{(-1,29)}$(Np)	794,92 (20)	0,00000094					
$\gamma_{39,2}$(Np)	801,94 (20)	0,00000123 (7)					
$\gamma_{(-1,71)}$(Np)	803,19	0,00000016 (3)					
$\gamma_{37,0}$(Np)	806,26 (30)	0,00000031					
$\gamma_{(-1,30)}$(Np)	811,9 (3)	0,00000063 (6)					
$\gamma_{(-1,31)}$(Np)	819,33	0,00000043 (6)					
$\gamma_{(-1,32)}$(Np)	822,21	0,00000024 (6)					
$\gamma_{39,1}$(Np)	828,54	0,00000021 (4)					
$\gamma_{(-1,33)}$(Np)	835,21	0,00000003					
$\gamma_{(-1,72)}$(Np)	838,88	0,00000004 (1)					
$\gamma_{(-1,34)}$(Np)	841,14	0,00000010 (3)					
$\gamma_{(-1,73)}$(Np)	843,7	0,00000097 (8)					
$\gamma_{(-1,74)}$(Np)	846,86	0,00000016 (3)					
$\gamma_{(-1,35)}$(Np)	847,4 (5)	0,0000003					
$\gamma_{(-1,36)}$(Np)	851,6 (10)	0,00000041 (6)					
$\gamma_{(-1,37)}$(Np)	854,95	0,00000023 (4)					
$\gamma_{(-1,75)}$(Np)	856,26	0,00000010 (3)					
$\gamma_{40,2}$(Np)	860,7	0,00000008					
$\gamma_{39,0}$(Np)	862,7 (5)	0,00000061 (6)					
$\gamma_{(-1,38)}$(Np)	870,63	0,00000150 (3)					
$\gamma_{(-1,76)}$(Np)	882	0,00000004 (1)					
$\gamma_{(-1,77)}$(Np)	886,53	0,00000015 (3)					
$\gamma_{40,1}$(Np)	887,73	0,00000033 (6)					
$\gamma_{(-1,78)}$(Np)	890,38	0,00000032 (5)					
$\gamma_{(-1,79)}$(Np)	894,47	0,00000003 (1)					
$\gamma_{(-1,39)}$(Np)	898,17	0,00000006 (2)					
$\gamma_{(-1,40)}$(Np)	902,61	0,00000033 (3)					
$\gamma_{(-1,80)}$(Np)	909,95	0,00000005 (1)					
$\gamma_{(-1,41)}$(Np)	912,4	0,00000028 (3)					
$\gamma_{40,0}$(Np)	922,19	0,00000019 (3)					
$\gamma_{(-1,42)}$(Np)	928,95	0,00000009 (2)					
$\gamma_{(-1,81)}$(Np)	939,2	0,00000005 (1)					
$\gamma_{41,0}$(Np)	946,06	0,00000010 (3)					
$\gamma_{(-1,82)}$(Np)	952,72	0,00000003 (1)					
$\gamma_{(-1,44)}$(Np)	955,91	0,00000060 (5)					
$\gamma_{42,0}$(Np)	962,19	0,00000004 (1)					
$\gamma_{(-1,83)}$(Np)	969,09	0,00000003 (1)					
$\gamma_{(-1,84)}$(Np)	980,84	0,00000003 (1)					
$\gamma_{43,0}$(Np)	1014,33	0,0000010 (2)					

3 Atomic Data

3.1 Np

ω_K : 0,971 (4)
$\bar{\omega}_L$: 0,511 (20)
$\bar{\omega}_M$: 0,0528
n_{KL} : 0,791 (5)
$\bar{n}_{LM}$: 1,163

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	97,069		62,82
	$K\alpha_1$	101,059		100
	$K\beta_3$	113,303	}	
	$K\beta_1$	114,234	}	
	$K\beta_5''$	114,912	}	36,21
	$K\beta_2$	117,463	}	
	$K\beta_4$	117,876	}	12,47
	$KO_{2,3}$	118,429	}	
X_L				
	$L\ell$	11,89		
	$L\alpha$	13,76 – 13,944		
	$L\eta$	15,876		
	$L\beta$	16,13 – 17,99		
	$L\gamma$	20,12 – 22,2		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	73,50 – 83,13	100
KLX	90,36 – 97,28	60,2
KXY	107,10 – 114,58	9,06
Auger L	6,04 – 13,52	55000000

4 α Emissions

	Energy keV	Probability × 100
$\alpha_{0,36}$	4757,41 (16)	0,00004 (3)
$\alpha_{0,34}$	4800,68 (16)	0,000086
$\alpha_{0,33}$	4834,16 (13)	0,0007
$\alpha_{0,32}$	4889,0 (2)	
$\alpha_{0,30}$	4956,1 (3)	
$\alpha_{0,29}$	4961,7 (11)	
$\alpha_{0,28}$	4963,64 (20)	
$\alpha_{0,27}$	5007,59 (20)	0,0001
$\alpha_{0,25}$	5055,35 (14)	
$\alpha_{0,24}$	5066,23 (17)	0,00011
$\alpha_{0,23}$	5092,06 (13)	0,0004
$\alpha_{0,22}$	5099,10 (13)	0,0004
$\alpha_{0,21}$	5106,72 (16)	
$\alpha_{0,20}$	5117,21 (20)	0,0004
$\alpha_{0,19}$	5133 (4)	
$\alpha_{0,18}$	5155,16 (13)	0,0007
$\alpha_{0,17}$	5179,35 (13)	0,0003
$\alpha_{0,16}$	5181,65 (13)	0,0009
$\alpha_{0,15}$	5190,4 (2)	0,0006
$\alpha_{0,14}$	5217,28 (13)	
$\alpha_{0,13}$	5225,08 (13)	0,0013
$\alpha_{0,12}$	5232,6 (3)	
$\alpha_{0,11}$	5244,12 (13)	0,0022 (3)
$\alpha_{0,9}$	5281,02 (14)	0,0005
$\alpha_{0,8}$	5321,91 (13)	0,014 (3)
$\alpha_{0,6}$	5388,26 (13)	1,66 (3)
$\alpha_{0,5}$	5416,27 (13)	0,01
$\alpha_{0,4}$	5442,86 (12)	13,23 (10)
$\alpha_{0,3}$	5469,47 (12)	0,04
$\alpha_{0,2}$	5485,56 (12)	84,45 (10)
$\alpha_{0,1}$	5511,47 (12)	0,23 (1)
$\alpha_{0,0}$	5544,11 (12)	0,38 (1)

5 Electron Emissions

		Energy keV	Electrons per 100 disint.
e_{AL}	(Np)	6,04 - 13,52	36,0 (14)
e_{AK}	(Np)		0,000115 (16)
	KLL	73,50 - 83,13	}
	KLX	90,36 - 97,28	}
	KXY	107,10 - 114,58	}
$ec_{2,1\ L}$	(Np)	3,92 - 8,73	14,7 (5)
$ec_{1,0\ L}$	(Np)	10,77 - 15,58	17,3 (3)
$ec_{3,1\ L}$	(Np)	20,31 - 25,12	1,6 (4)
$ec_{2,1\ M}$	(Np)	20,61 - 22,67	3,8 (5)
$ec_{4,2\ L}$	(Np)	20,99 - 25,81	8,6 (9)
$ec_{1,0\ M}$	(Np)	27,47 - 29,53	4,3 (6)
$ec_{6,4\ L}$	(Np)	33,13 - 37,94	0,89 (12)
$ec_{3,1\ M}$	(Np)	37,01 - 39,07	0,5 (1)
$ec_{2,0\ L}$	(Np)	37,11 - 37,93	31,3 (5)
$ec_{4,2\ M}$	(Np)	37,70 - 39,75	2,3 (4)
$ec_{6,4\ M}$	(Np)	49,83 - 51,89	0,24 (3)
$ec_{2,0\ M}$	(Np)	53,80 - 55,88	8,09 (25)
$ec_{6,2\ L}$	(Np)	76,52 - 81,34	0,229 (8)
$ec_{6,2\ M}$	(Np)	93,21 - 95,29	0,064 (2)

6 Photon Emissions

6.1 X-Ray Emissions

		Energy keV	Photons per 100 disint.	
XL	(Np)	11,89 — 22,2	37,6 (3)	
$XK\alpha_2$	(Np)	97,069	0,00116 (2)	} $K\alpha$
$XK\alpha_1$	(Np)	101,059	0,00185 (4)	}
$XK\beta_3$	(Np)	113,303	}	
$XK\beta_1$	(Np)	114,234	} 0,000670 (14)	$K'\beta_1$
$XK\beta_5''$	(Np)	114,912	}	
$XK\beta_2$	(Np)	117,463	}	
$XK\beta_4$	(Np)	117,876	} 0,000231 (5)	$K'\beta_2$
$XKO_{2,3}$	(Np)	118,429	}	

6.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{2,1}$(Np)	26,3446 (2)	2,40 (3)
$\gamma_{1,0}$(Np)	33,1963 (3)	0,121 (3)
$\gamma_{3,1}$(Np)	42,704 (5)	0,0055 (11)
$\gamma_{4,2}$(Np)	43,420 (3)	0,069 (5)
$\gamma_{14,10}$(Np)	51,01 (3)	0,000026 (12)
$\gamma_{6,4}$(Np)	55,55 (2)	0,0181 (18)
$\gamma_{(-1,3)}$(Np)	57,85 (5)	0,0052 (15)
$\gamma_{2,0}$(Np)	59,5409 (1)	35,78 (9)
$\gamma_{14,9}$(Np)	64,83 (2)	0,00014 (3)
$\gamma_{8,6}$(Np)	67,46 (5)	0,00042 (10)
$\gamma_{4,1}$(Np)	69,76 (3)	0,0029 (4)
$\gamma_{3,0}$(Np)	75,8 (2)	0,0006
$\gamma_{5,1}$(Np)	96,7 (2)	0,00005 (2)
$\gamma_{6,2}$(Np)	98,95 (1)	0,0203 (4)
$\gamma_{4,0}$(Np)	102,97 (1)	0,0195 (4)
$\gamma_{(-1,4)}$(Np)	106,42 (5)	0,000015
$\gamma_{20,13}$(Np)	109,70 (7)	0,0000049
$\gamma_{21,13}$(Np)	120,36 (8)	0,0000045
$\gamma_{8,4}$(Np)	123,02 (2)	0,00100 (4)
$\gamma_{6,1}$(Np)	125,29 (1)	0,0041 (2)
$\gamma_{29,22}$(Np)	139,46 (8)	0,0000053 (11)
$\gamma_{11,6}$(Np)	146,57 (1)	0,00046 (1)
$\gamma_{8,3}$(Np)	150,08 (3)	0,000073 (5)
$\gamma_{26,15}$(Np)	154,27 (20)	0,0000005
$\gamma_{29,20}$(Np)	159,16 (20)	0,0000014 (5)
$\gamma_{24,13}$(Np)	161,54 (10)	0,0000015
$\gamma_{9,4}$(Np)	164,59 (1)	0,000066 (3)
$\gamma_{13,6}$(Np)	165,91 (4)	0,000023 (1)
$\gamma_{18,8}$(Np)	169,55 (2)	0,00017 (1)
$\gamma_{11,5}$(Np)	175,08 (3)	0,000018 (3)
$\gamma_{(-1,8)}$(Np)	190,4	0,0000022 (5)
$\gamma_{25,11}$(Np)	191,90 (1)	0,0000215 (10)
$\gamma_{29,18}$(Np)	197,0 (2)	0,00000049
$\gamma_{(-1,9)}$(Np)	201,70 (14)	0,0000008
$\gamma_{18,7}$(Np)	204,06 (6)	0,0000206 (5)
$\gamma_{9,2}$(Np)	208,00 (2)	0,000786 (5)
$\gamma_{13,4}$(Np)	221,45 (3)	0,0000434 (6)
$\gamma_{26,10}$(Np)	232,81 (5)	0,00000482 (8)
$\gamma_{9,1}$(Np)	234,33	0,00000087 (7)
$\gamma_{26,9}$(Np)	246,7 (1)	0,00000244 (6)
$\gamma_{13,3}$(Np)	248,58 (8)	0,00000146 (3)
$\gamma_{21,7}$(Np)	260,9 (1)	0,00000129 (6)
$\gamma_{13,2}$(Np)	264,87 (5)	0,00000943 (7)
$\gamma_{9,0}$(Np)	267,54 (3)	0,0000268 (5)
$\gamma_{(-1,10)}$(Np)	270,63 (15)	0,0000005 (2)

	Energy keV	Photons per 100 disint.
$\gamma_{(-1,51)}$(Np)	271,54	0,00000144 (5)
$\gamma_{20,6}$(Np)	275,73 (8)	0,00000632 (8)
$\gamma_{27,9}$(Np)	278,18	0,00000115
$\gamma_{13,1}$(Np)	291,26 (20)	0,00000305 (7)
$\gamma_{16,3}$(Np)	292,78 (4)	0,0000142 (2)
$\gamma_{20,5}$(Np)	304,2 (2)	0,00000093 (2)
$\gamma_{16,2}$(Np)	309,1 (3)	0,0000019 (3)
$\gamma_{21,5}$(Np)	322,53 (3)	0,000151 (3)
$\gamma_{(-1,52)}$(Np)	324,69	0,0000018 (3)
$\gamma_{(-1,53)}$(Np)	329,69	0,0000011 (2)
$\gamma_{14,0}$(Np)	332,36 (2)	0,000150 (3)
$\gamma_{16,1}$(Np)	335,40 (3)	0,000496 (5)
$\gamma_{17,1}$(Np)	337,7 (2)	0,00000488 (7)
$\gamma_{(-1,11)}$(Np)	350,71	0,00000139 (5)
$\gamma_{20,3}$(Np)	358,3 (2)	0,00000129 (5)
$\gamma_{16,0}$(Np)	368,63 (3)	0,000214 (4)
$\gamma_{17,0}$(Np)	370,94 (3)	0,0000520 (6)
$\gamma_{(-1,54)}$(Np)	374,83	0,00000313 (5)
$\gamma_{21,3}$(Np)	376,66 (3)	0,000137 (3)
$\gamma_{22,3}$(Np)	383,80 (3)	0,0000281 (5)
$\gamma_{(-1,12)}$(Np)	389,0 (3)	0,00000049
$\gamma_{(-1,13)}$(Np)	390,61 (5)	0,00000573 (8)
$\gamma_{29,7}$(Np)	401,68	0,00000014 (3)
$\gamma_{30,7}$(Np)	406,4 (2)	0,00000137 (5)
$\gamma_{(-1,14)}$(Np)	411,27	0,00000018 (4)
$\gamma_{21,1}$(Np)	419,32 (4)	0,0000284 (3)
$\gamma_{22,1}$(Np)	426,47 (4)	0,0000243 (7)
$\gamma_{(-1,15)}$(Np)	429,9 (1)	0,00000109 (5)
$\gamma_{(-1,55)}$(Np)	440,63	0,00000056 (3)
$\gamma_{(-1,16)}$(Np)	442,81 (7)	0,00000331 (7)
$\gamma_{35,13}$(Np)	446,68	0,00000011 (2)
$\gamma_{21,0}$(Np)	452,5 (3)	0,00000236 (6)
$\gamma_{26,2}$(Np)	454,66 (8)	0,00000953 (7)
$\gamma_{22,0}$(Np)	459,68 (10)	0,00000355 (6)
$\gamma_{29,5}$(Np)	463,22 (20)	0,000001
$\gamma_{30,5}$(Np)	468,06 (15)	0,00000269 (5)
$\gamma_{(-1,17)}$(Np)	486,05	0,00000105 (6)
$\gamma_{28,4}$(Np)	487,64	0,00000062 (5)
$\gamma_{(-1,56)}$(Np)	494,39	0,00000010 (2)
$\gamma_{(-1,57)}$(Np)	501,39	0,00000014 (2)
$\gamma_{27,1}$(Np)	512,4 (3)	0,0000021 (4)
$\gamma_{26,0}$(Np)	514,2 (2)	0,0000038 (2)
$\gamma_{30,3}$(Np)	522,11	0,00000099 (5)
$\gamma_{(-1,58)}$(Np)	525,14	0,00000016 (3)
$\gamma_{38,13}$(Np)	528,87	0,00000069 (5)
$\gamma_{(-1,59)}$(Np)	532,44	0,00000008 (2)
$\gamma_{27,0}$(Np)	545,7	0,00000025 (3)

	Energy keV	Photons per 100 disint.
$\gamma_{(-1,60)}$(Np)	548,15	0,00000005 (2)
$\gamma_{(-1,61)}$(Np)	555,25	0,00000009 (2)
$\gamma_{33,6}$(Np)	563,48	0,00000044 (2)
$\gamma_{36,8}$(Np)	573,94 (20)	0,00000128 (5)
$\gamma_{(-1,18)}$(Np)	582,89	0,00000101 (6)
$\gamma_{31,2}$(Np)	586,5 (2)	0,00000124 (5)
$\gamma_{28,0}$(Np)	590,28 (15)	0,00000280 (5)
$\gamma_{34,6}$(Np)	597,44 (8)	0,00000729 (8)
$\gamma_{(-1,62)}$(Np)	600,26	0,00000022 (3)
$\gamma_{33,4}$(Np)	619,01 (2)	0,000060 (2)
$\gamma_{38,8}$(Np)	627,2 (2)	0,00000051 (2)
$\gamma_{32,1}$(Np)	632,93 (15)	0,00000124 (5)
$\gamma_{(-1,63)}$(Np)	636,9	0,00000021 (3)
$\gamma_{36,6}$(Np)	641,46 (5)	0,00000704 (7)
$\gamma_{34,4}$(Np)	652,98 (4)	0,0000376 (8)
$\gamma_{33,2}$(Np)	662,41 (2)	0,000367 (5)
$\gamma_{32,0}$(Np)	666,2 (3)	0,00000095 (7)
$\gamma_{36,5}$(Np)	669,9 (2)	0,00000051 (7)
$\gamma_{37,5}$(Np)	675,8 (3)	0,00000085 (5)
$\gamma_{34,3}$(Np)	680,1 (1)	0,00000331 (7)
$\gamma_{33,1}$(Np)	688,76 (4)	0,0000323 (5)
$\gamma_{(-1,19)}$(Np)	693,46	0,00000354 (7)
$\gamma_{34,2}$(Np)	696,48	0,00000517 (6)
$\gamma_{(-1,20)}$(Np)	709,42 (5)	0,00000641 (18)
$\gamma_{(-1,64)}$(Np)	712,5	0,00000020 (3)
$\gamma_{33,0}$(Np)	721,98 (3)	0,000196 (4)
$\gamma_{37,3}$(Np)	729,52	0,00000137 (5)
$\gamma_{(-1,21)}$(Np)	731,44	0,00000046 (4)
$\gamma_{(-1,65)}$(Np)	736,68	0,00000128 (5)
$\gamma_{35,1}$(Np)	737,34 (5)	0,00000794 (8)
$\gamma_{(-1,66)}$(Np)	740,51	0,00000019 (3)
$\gamma_{(-1,22)}$(Np)	742,9 (3)	0,00000035
$\gamma_{(-1,67)}$(Np)	745,02	0,00000009 (2)
$\gamma_{(-1,85)}$(Np)	750,39	0,000000006 (2)
$\gamma_{34,0}$(Np)	755,91 (5)	0,00000784 (8)
$\gamma_{(-1,23)}$(Np)	759,5 (1)	0,00000181 (5)
$\gamma_{(-1,24)}$(Np)	763,31	0,00000023 (2)
$\gamma_{36,1}$(Np)	767,0 (1)	0,00000501 (3)
$\gamma_{35,0}$(Np)	770,6 (1)	0,00000481 (5)
$\gamma_{37,1}$(Np)	772,17	0,00000279 (3)
$\gamma_{(-1,69)}$(Np)	774,67	0,00000011 (2)
$\gamma_{(-1,25)}$(Np)	777,39	0,00000015 (2)
$\gamma_{(-1,26)}$(Np)	780,53	0,00000031 (2)
$\gamma_{(-1,27)}$(Np)	782,2 (5)	0,00000015
$\gamma_{39,3}$(Np)	786,00 (15)	0,00000062
$\gamma_{(-1,28)}$(Np)	789,0 (3)	0,00000042 (6)
$\gamma_{(-1,70)}$(Np)	792,6	0,00000003 (1)

	Energy keV	Photons per 100 disint.
$\gamma_{(-1,29)}$(Np)	794,92 (20)	0,00000094
$\gamma_{39,2}$(Np)	801,94 (20)	0,00000123 (7)
$\gamma_{(-1,71)}$(Np)	803,19	0,00000016 (3)
$\gamma_{37,0}$(Np)	806,26 (30)	0,00000031
$\gamma_{(-1,30)}$(Np)	811,9 (3)	0,00000063 (6)
$\gamma_{(-1,31)}$(Np)	819,33	0,00000043 (6)
$\gamma_{(-1,32)}$(Np)	822,21	0,00000024 (6)
$\gamma_{39,1}$(Np)	828,54	0,00000021 (4)
$\gamma_{(-1,33)}$(Np)	835,21	0,00000003
$\gamma_{(-1,72)}$(Np)	838,88	0,00000004 (1)
$\gamma_{(-1,34)}$(Np)	841,14	0,00000010 (3)
$\gamma_{(-1,73)}$(Np)	843,7	0,00000097 (8)
$\gamma_{(-1,74)}$(Np)	846,86	0,00000016 (3)
$\gamma_{(-1,35)}$(Np)	847,4 (5)	0,00000027 (3)
$\gamma_{(-1,36)}$(Np)	851,6 (10)	0,00000041 (6)
$\gamma_{(-1,37)}$(Np)	854,95	0,00000023 (4)
$\gamma_{(-1,75)}$(Np)	856,26	0,00000010 (3)
$\gamma_{40,2}$(Np)	860,7	0,00000008 (3)
$\gamma_{39,0}$(Np)	862,7 (5)	0,00000061 (6)
$\gamma_{(-1,38)}$(Np)	870,63	0,00000150 (3)
$\gamma_{(-1,76)}$(Np)	882	0,00000004 (1)
$\gamma_{(-1,77)}$(Np)	886,53	0,00000015 (3)
$\gamma_{40,1}$(Np)	887,73	0,00000033 (6)
$\gamma_{(-1,78)}$(Np)	890,38	0,00000032 (5)
$\gamma_{(-1,79)}$(Np)	894,47	0,00000003 (1)
$\gamma_{(-1,39)}$(Np)	898,17	0,00000006 (2)
$\gamma_{(-1,40)}$(Np)	902,61	0,00000033 (3)
$\gamma_{(-1,80)}$(Np)	909,95	0,00000005 (1)
$\gamma_{(-1,41)}$(Np)	912,4	0,00000028 (3)
$\gamma_{40,0}$(Np)	922,19	0,00000019 (3)
$\gamma_{(-1,42)}$(Np)	928,95	0,00000009 (2)
$\gamma_{(-1,81)}$(Np)	939,2	0,00000005 (1)
$\gamma_{41,0}$(Np)	946,06	0,000000010 (2)
$\gamma_{(-1,82)}$(Np)	952,72	0,00000003 (1)
$\gamma_{(-1,44)}$(Np)	955,91	0,00000060 (5)
$\gamma_{42,0}$(Np)	962,19	0,00000004 (1)
$\gamma_{(-1,83)}$(Np)	969,09	0,00000003 (1)
$\gamma_{(-1,84)}$(Np)	980,84	0,00000003 (1)
$\gamma_{43,0}$(Np)	1014,33	0,0000010 (2)

7 Remarks

7.1 Gamma Transitions and Conversion Electron Coefficients

Transitions (-1,x) are not placed in the decay scheme.
Transitions without uncertainty on the energy value or without transition probability are questionnable.

7.2 X Radiations

Intensity of M X-rays = 6,3 (6) %

8 Main Production Modes

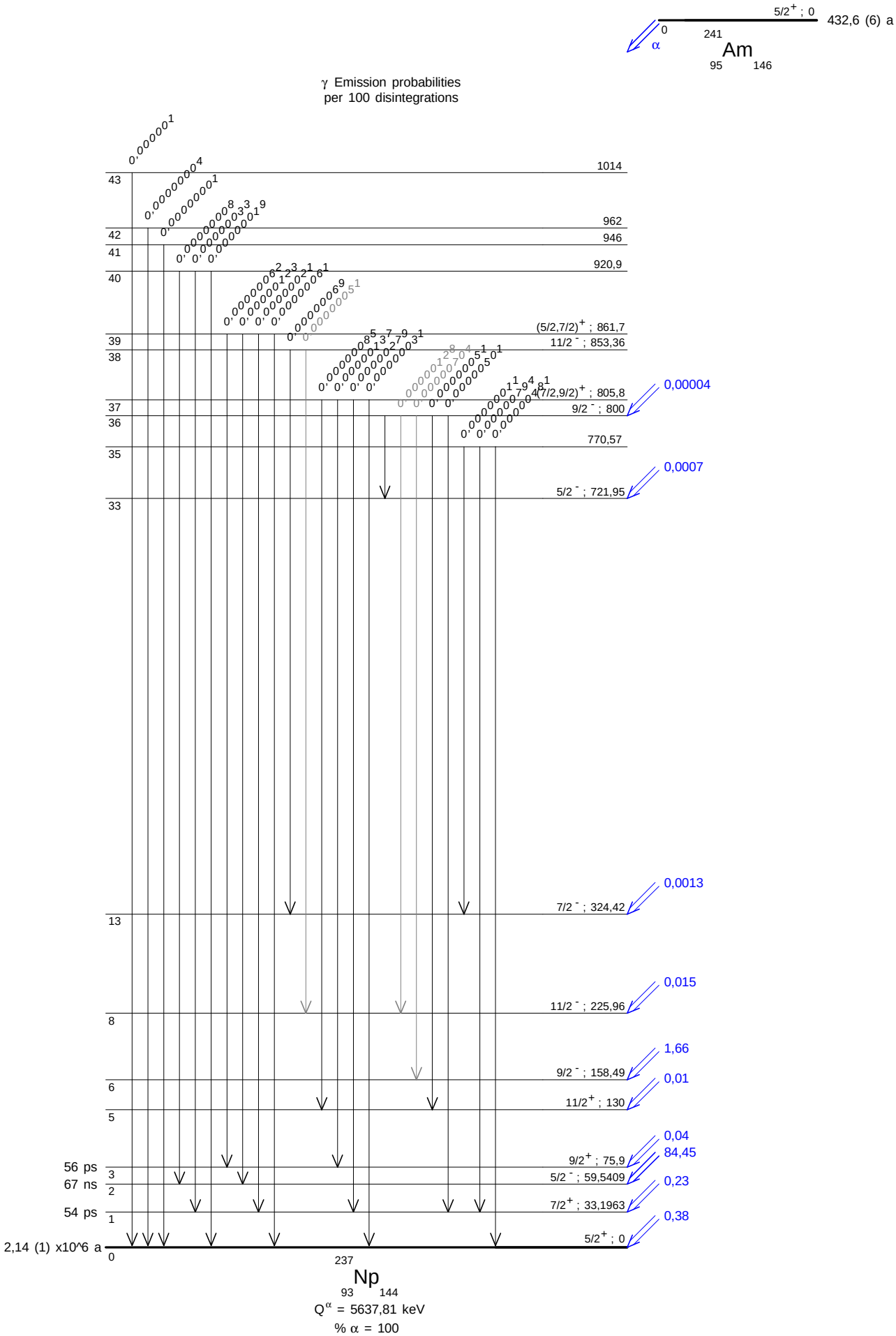
Daughter of Pu – 241

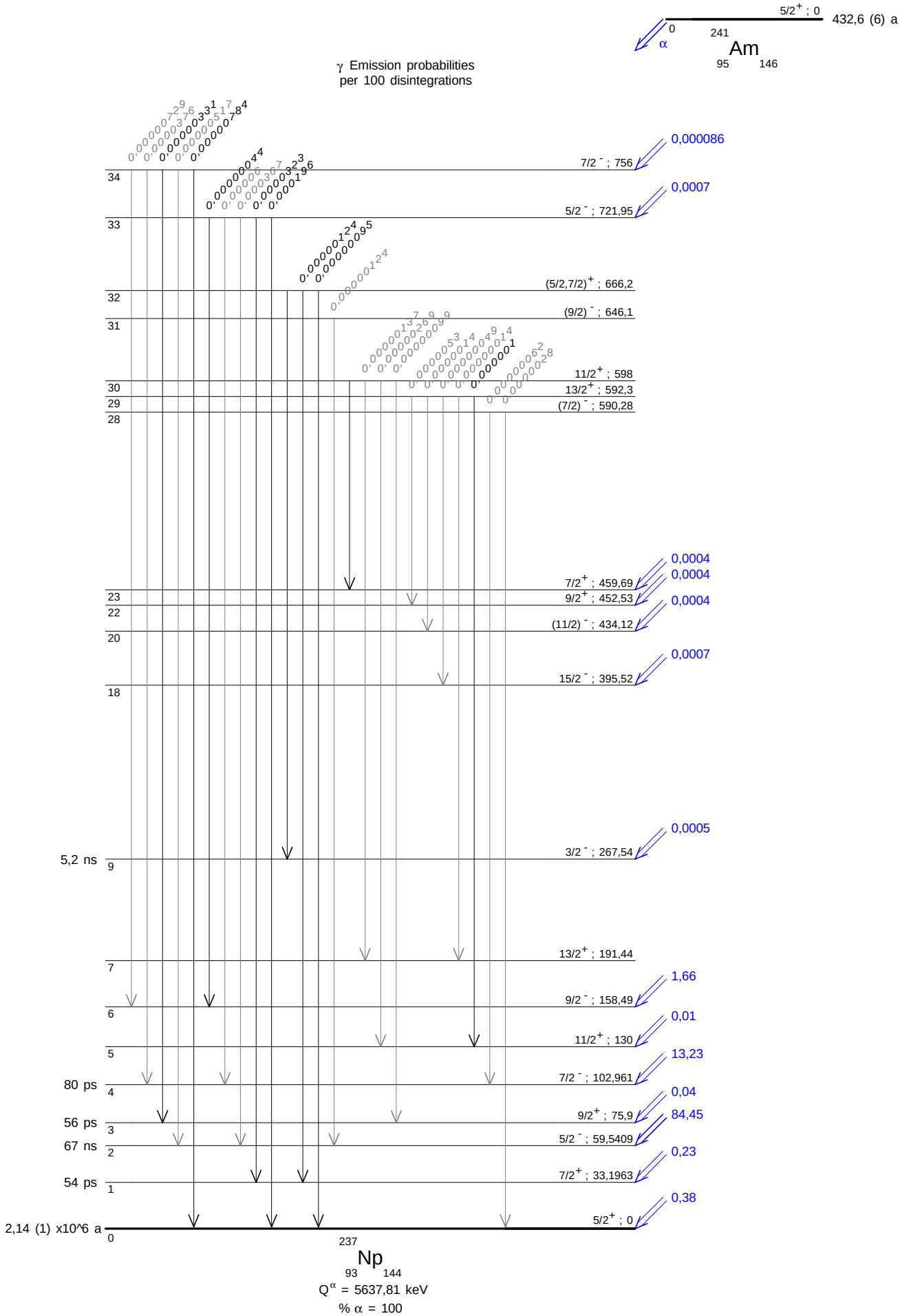
9 References

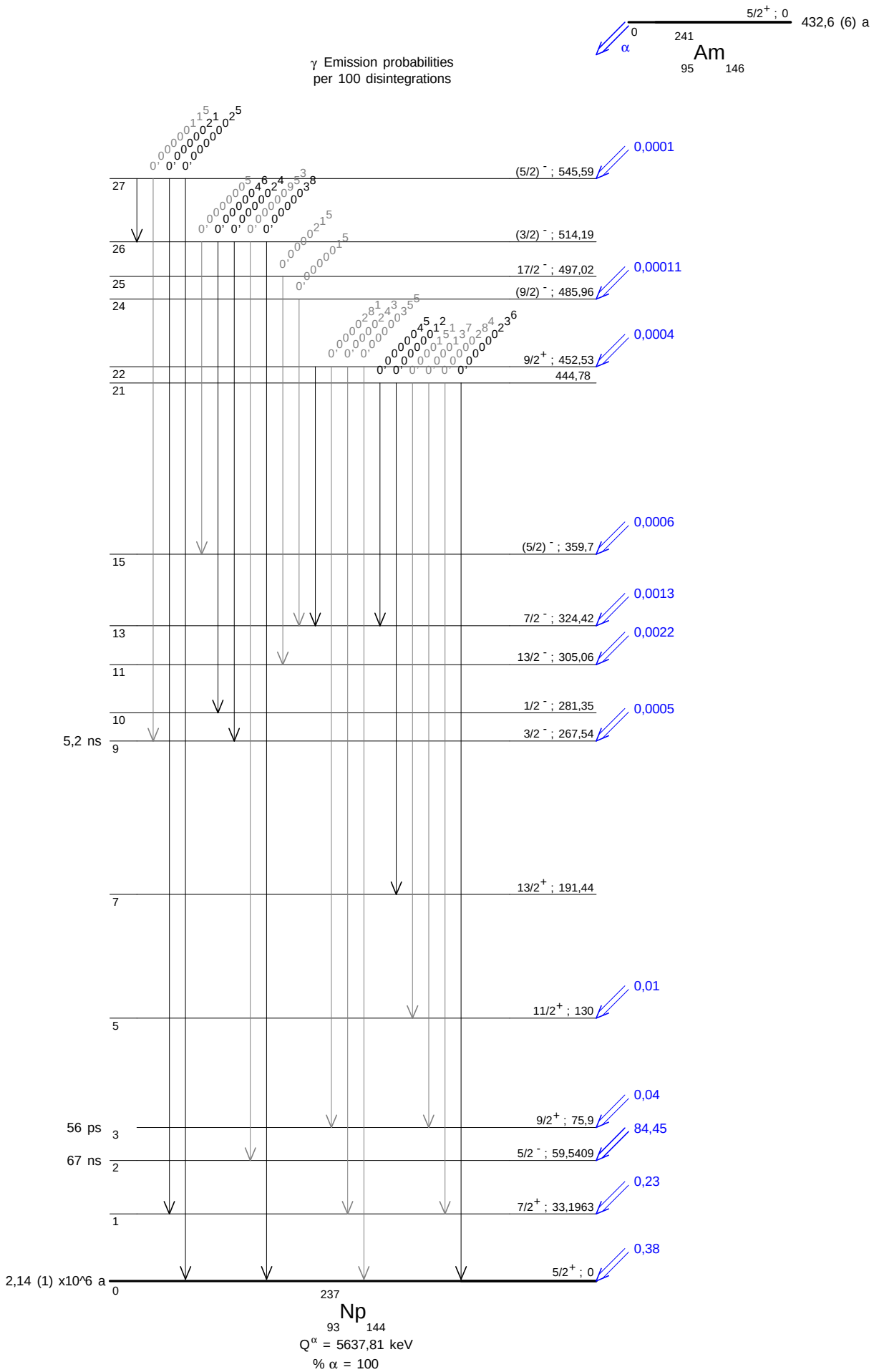
- R.B.Day. Phys.Rev. 97 (1955) 689
  (gamma-ray emission probabilities)
- LL.Goldin, G.I. Novikova, E.F.Tretyakov. Conf. Acad. Sci. USSR Moscow (1956) 226
  (energies of alpha-particles, alpha-particle emission probabilities)
- L.B.Magnusson. Phys.Rev. 107 (1957) 161
  (gamma-ray energies and emission probabilities)
- S.Rosenblum, M.Valadares, J.Milsted. J.Phys.Radium 18 (1957) 609
  (energies of alpha-particles)
- P.S.Samoilov. Columbia Tech. Transl. (Izv.Akad.Nauk SSSR, ser.fiz. 23 (1959) 1416) 23 (1960) 1401
  (gamma-ray energy, gamma transition probabilities and multipolarities)
- C.F.Leang. Comp. Rend. Acad. Sci. (Paris) 255 (1962) 3155
  (energies of alpha-particles)
- S.A.Baranov, V.M.Kulakov, V.M.Shatinsky. Nucl.Phys. 56 (1964) 252
  (alpha-particle energies and emission probabilities)
- J.L.Wolfson, J.H.Park. Can. J.Phys. (also Erratum Can.J.Phys. 48 (1970) 2782) 42 (1964) 1387
  (gamma-ray energies and multipolarities)
- L.D.McIsaac. Report IDO-17052 (1965) 31
  (gamma-ray emission probabilities)
- W.Michaelis. Z.Phys. 186 (1965) 42
  (alpha particle energies and emission probabilities)
- W.Yamazaki, J.M.Hollander. Nucl.Phys. 84 (1966) 505
  (internal conversion probabilities)
- C.M.Lederer, J.K.Poggenburg, F.Asaro, J.O.Rasmussen, I.Perlman. Nucl.Phys. 84 (1966) 481
  (internal conversion coefficients)
- F.L.Oetting, S.R.Gunn. J. Inorg. Nucl. Chem. 29 (1967) 2659
  (half-life)
- L.N.Kondratev, E.F.Tretyakov. Bull. Acad. Sci. URSS, Phys. Ser. (IzV.Akad. Nauk SSSR, Ser. Fiz. 30 (1966) 386) 30 (1967) 393
  (internal conversion probabilities)
- R.Kamoun, R.Ballini, S.Bergstrom-Rohlin, J-M.Kuchly, P.Siffert. Comp. Rend. Acad. Sci. (Paris) 266 (1968) 1241
  (energies of alpha-particles)
- R.W.Jewell, W.John, R.Massey, B.G.Saunders. Nucl. Instrum. Methods 62 (1968) 68
  (gamma-ray energies)
- L.C.Brown, R.C.Propst. J. Inorg. Nucl. Chem. 30 (1968) 2591
  (half-life)
- R.E.Stone, E.K.Hulet. J. Inorg. Nucl. Chem. 30 (1968) 2003
  (half-life)

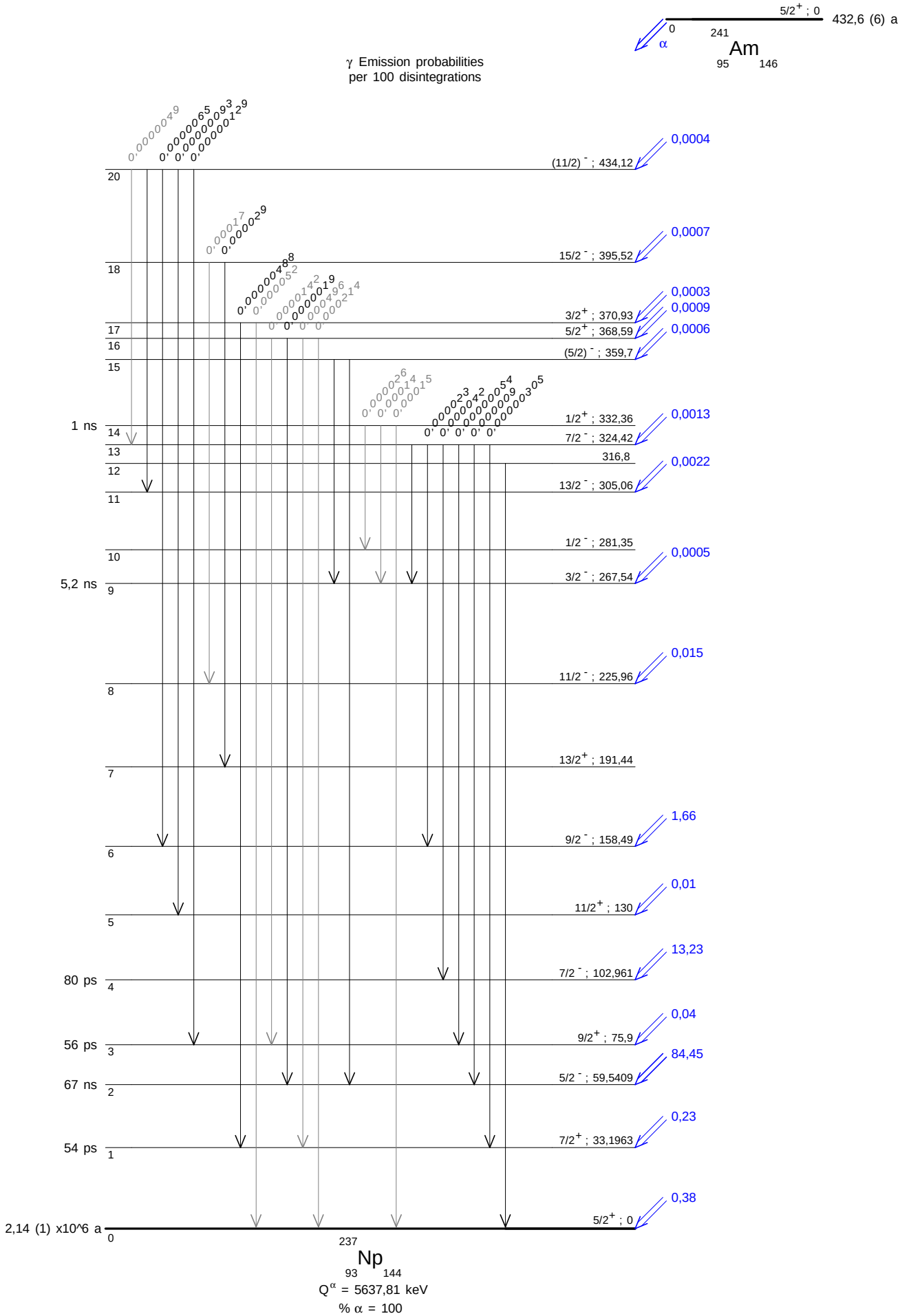
- S.A.Baranov, V.M.Kulakov, V.M.Shatinskii. Sov.J.Nucl.Phys. 7 (1968) 442.
  (energies of alpha-particles)
- R.E.Stone, E.K.Hulet. J. Inorg. Nucl. Chem. 30 (1968) 2003
  (half-life)
- G.C.Nelson, B.G.Saunders. Nucl. Instrum. Methods 84 (1970) 90
  (gamma-ray energies)
- E.Karttunen, H.U.Freund, R.W.Fink. Phys.Rev. 4 (1971) 1695
  (MX-ray emission probability)
- R.L.Watson, T.K.Li. Nucl.Phys. A178 (1971) 201
  (LX-ray emission probabilities)
- B.Grennberg, A.Rytz. Métrologia 7 (1971) 65
  (energies of alpha-particle)
- R.J.Gehrke, R.A.Lokken. Nucl. Instrum. Methods 97 (1971) 219
  (XL- and gamma -ray emission probabilities)
- J.Jove, R.Robert. Radiochem. Radioanal. Letters 10 (1972) 139
  (half-life)
- J.L.Campbell, L.A.McNelles. Nucl. Instrum. Methods 117 (1974) 519
  (LX- and gamma - ray emission probabilities)
- W.J.Gallagher, S.J.Cipolla. Nucl. Instrum. Methods 122 (1974) 405
  (LX- ray emission probabilities)
- R.L.Heath. Report ANCR 1000 (1974) 2
  (gamma - ray energies and emission probabilities)
- V.G.Polyukhov, G.A.Timofeev, P.A.Privalova, P.F.Baklanova. Soviet J. At. Energy 36 (1974) 402
  (half-life)
- W.W.Strohm, K.C.Jordan. Nucl. Soc. 18 (1974) 185
  (half-life)
- J.Legrand, J.P.Perolat, C. Bac, J.Gorry. Int. J. Appl. Radiat. Isotop. 26 (1975) 179
  (gamma - ray emission probabilities)
- H.Ramthun, W.Muller. Int. J. Appl. Radiat. Isotop. 26 (1975) 589
  (half-life)
- J.Plch, J.Zderadicka, L.Kokta. J.Phys. 26B (1976) 1344
  (gamma-ray emission probability)
- R.Gunnink, J.E.Evans, A.L.Prindle. Report UCRL-52139 (1976)
  (LX-, KX- and gamma-ray emission probabilities)
- F.P.Larkins. At. Data. Nucl. Data Tables 20 (1977) 313
  (Auger electron energies)
- A.Genoux-Lubain, G.Ardisson. Radiochem. Radioanal. Letters 33 (1978) 59
  (gamma-ray energies and emission probabilities)
- V.V.Ovechkin. Bull. Acad. Sci. URSS, Ser. Phys. (Izv.Akad. Nauk SSSR, Ser Fiz. 42(1978) 101) 42(1) (1978) 82
  (gamma-ray energies and emission probabilities)
- F.Rösel, H.M.Fries, K.Alder, H.C.Pauli. At. Data. Nucl. Data Tables 21 (1978) 91
  (internal conversion coefficients)
- A.Genoux-Lubain, G.Ardisson. Comp. Rend. Acad. Sci. (Paris) B287 (1978) 13
  (Gamma-ray emission energies and intensities)
- C.Ardisson, A.Genoux-Lubain, V.Barci, G.Ardisson. Radiochem. Radioanal. Letters 40 (1979) 207
  (gamma-ray energies)
- A.Rytz. At. Data. Nucl. Data Tables 23 (1979) 507
  (energies of alpha-particles)
- D.D.Cohen. Nucl. Instrum. Methods 178 (1980) 481
  (LX-ray emission probabilities)
- G.Barreau, H.G.Borner, T.Egidy, von. R.W.Hoff. Z.Phys. 308 (1982) 209
  (KX-ray energies)
- JM.R.Hutchinson, P.A.Mullen. Int. J. Appl. Radiat. Isotop. 34 (1983) 543
  (gamma-ray emission probabilities)
- I.Ahmad, J.Hines, J.E.Gindler. Phys.Rev. C27 (1983) 2239
  (LX-, KX-ray energies and KX-, gamma-ray emission probabilities)
- K.Debertin, W.Pessara. Int. J. Appl. Radiat. Isotop. 34 (1983) 515
  (gamma-ray emission probabilities)
- I.Ahmad. Nucl. Instrum. Methods 223 (1984) 319
  (alpha-particle emission probabilities)

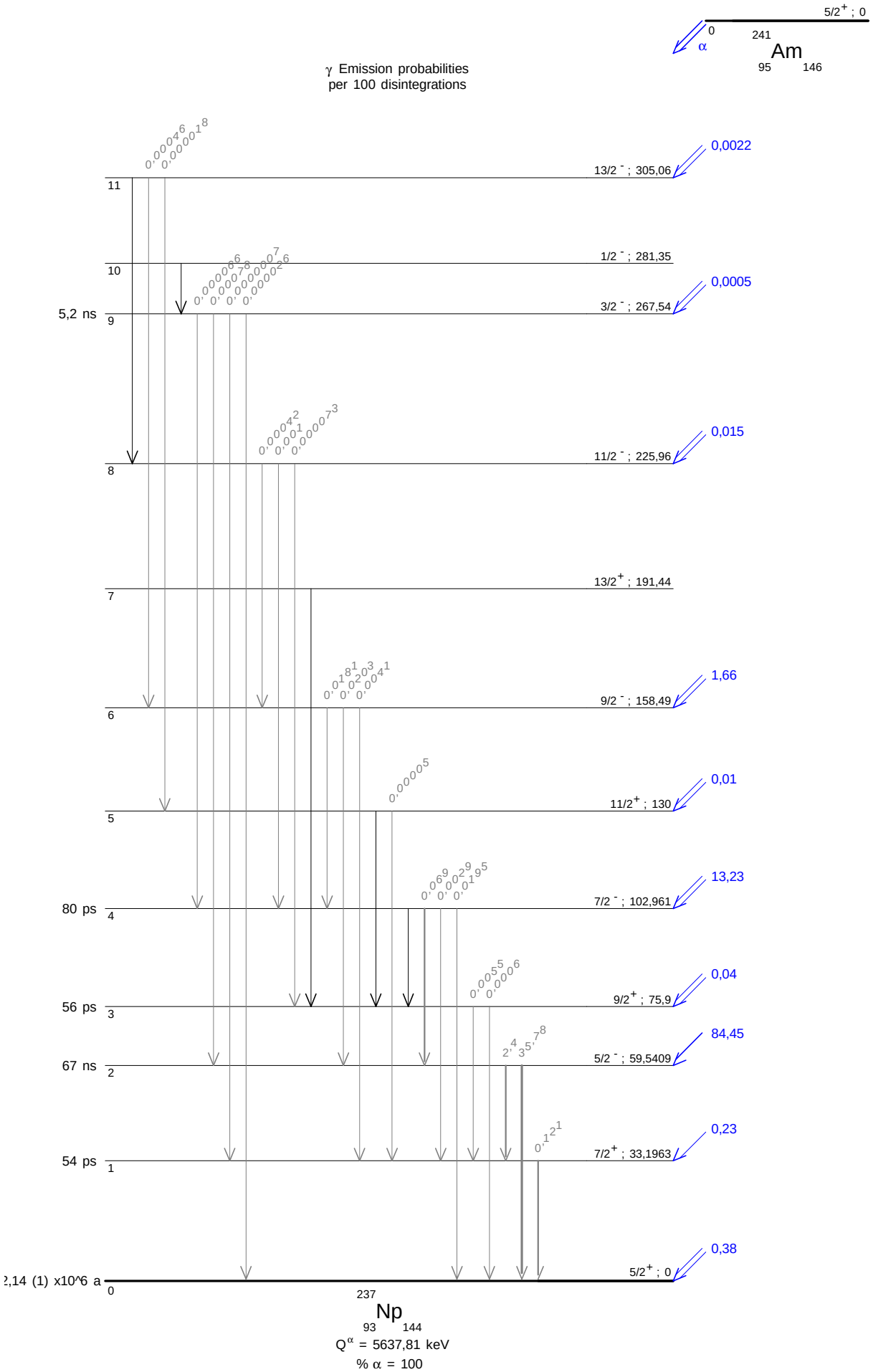
- V.V.Ovechkin, A.E.Khokhlov. Izv.Akad.Nauk SSSR 48 (1984) 1032
(gamma-ray energies and emission probabilities)
- G.Bortels, P.Collaers. Appl. Rad. Isotopes 38 (1987) 831
(alpha-particle emission probabilities)
- V.P.Chechev, N.K.Kuzmenko, V.O.Sergeev, K.P.Artamonova. Evaluated decay data, Energoatomizdat Ed. Moscow (1988)
(gamma-ray energies)
- D.D.Cohen. Nucl. Instrum. Methods A267 (1988) 492
(LX-ray emission probabilities)
- J.H.Hubbell. Report NIST 89-4144 (1989)
(M fluorescence yield)
- A.Rytz. At. Data Nucl. Data Tables 47 (1991) 205
(Alpha emission energies and intensities)
- C.J.Bland, J.Morel, E.Etcheverry, M.C.Lépy. Nucl. Instrum. Methods A312 (1992) 323
(LX-ray emission probabilities)
- I.Ahmad. Private communication quoted in 1994Bland (1993)
(alpha-particle emission probabilities)
- M.C.Lépy, K. Debertin, H. Janssen, U. Schötzig. Report PTB- Ra-31 (1993)
(L X-ray emission intensities)
- C.J.Bland. Nucl. Instrum. Methods A339 (1994) 180
(alpha-particle emission probabilities)
- M.C.Lépy, B.Duchemin, J.Morel. Nucl. Instrum. Methods A353 (1994) 10
(LX-ray emission probabilities)
- G.Audi, A.H.Wapstra. Nucl.Phys. A595 (1995) 409
(Q)
- Y.A.Akovali. Nucl. Data Sheets 74 (1995) 461
(Decay scheme)
- P.N.Johnson. Nucl. Instrum. Methods A369 (1996) 107
(evaluated gamma-ray emission probabilities and internal conversion coefficients)
- A.M.Sanchez, P.R.Montero, F.V.Tome. Nucl. Instrum. Methods A369 (1996) 593
(alpha-particle emission probabilities)
- E.Schönfeld, H.Janssen. Nucl. Instrum. Methods A369 (1996) 527
(Atomic data)
- C.C.Bueno, J.A.C.Goncalves, M.D.S.Santos. Nucl. Instrum. Methods A371 (1996) 460
(alpha-particle emission probabilities)
- A.Abdul-Hadi. J.Radional.Nucl.Chem 231 (1998) 147
(Gamma-ray emission energies and intensities)
- A.Kovalik, E.A. Yakushev, V.M. Gorozhankin, M. Novgorodov, M.Rysavy. J. Phys. (London) G24 (1998) 2247
(Conv. Elec. emission energies and intensities)
- Y.Jang, J.Ni. Nucl. Instrum. Methods A413 (1998) 239
(Alpha emission intensities)
- E.Schönfeld, G.Rodloff. Report PTB 6.11-1, Braunscheig (1999)
(XK-ray energies and emission probabilities)
- R.G.Helmer, van der C.Leun. Nucl. Instrum. Methods A450 (2000) 35
(gamma-ray energies)
- E.Schönfeld, U. Schötzig. Appl. Rad. Isotopes 54 (2001) 785
(L X-ray emission energies and intensities)


5/2+ ; 0
432,6 (6) a
0
α
241
Am
95
146
γ Emission probabilities
per 100 disintegrations
1014
962
946
920,9
(5/2,7/2)+ ; 861,7
11/2 - ; 853,36
(7/2,9/2)+ ; 805,8
9/2 - ; 800
770,57
5/2 - ; 721,95
7/2 - ; 324,42
11/2 - ; 225,96
9/2 - ; 158,49
11/2+ ; 130
9/2+ ; 75,9
5/2 - ; 59,5409
7/2+ ; 33,1963
5/2+ ; 0
0,00004
0,0007
0,0013
0,015
1,66
0,01
0,04
84,45
0,23
0,38
43
42
41
40
39
38
37
36
35
33
13
8
6
5
3
2
1
0
56 ps
67 ns
54 ps
2,14 (1) x10^6 a
237
Np
93
144
Q^α = 5637,81 keV
% α = 100


5/2+ ; 0
432,6 (6) a
α
241
Am
95
146
γ Emission probabilities
per 100 disintegrations
0,000086
7/2 - ; 756
0,0007
5/2 - ; 721,95
(5/2,7/2)+ ; 666,2
(9/2) - ; 646,1
11/2+ ; 598
13/2+ ; 592,3
(7/2) - ; 590,28
0,0004
7/2+ ; 459,69
0,0004
9/2+ ; 452,53
0,0004
(11/2) - ; 434,12
0,0007
15/2 - ; 395,52
0,0005
3/2 - ; 267,54
5,2 ns
13/2+ ; 191,44
1,66
9/2 - ; 158,49
0,01
11/2+ ; 130
13,23
7/2 - ; 102,961
80 ps
0,04
9/2+ ; 75,9
56 ps
84,45
5/2 - ; 59,5409
67 ns
0,23
7/2+ ; 33,1963
54 ps
0,38
5/2+ ; 0
2,14 (1) x10^6 a
237
Np
93
144
Qα = 5637,81 keV
% α = 100


5/2+ ; 0
432,6 (6) a
0
α
241
Am
95
146
γ Emission probabilities
per 100 disintegrations
(5/2) - ; 545,59
0,0001
(3/2) - ; 514,19
17/2 - ; 497,02
0,00011
(9/2) - ; 485,96
9/2+ ; 452,53
0,0004
444,78
(5/2) - ; 359,7
0,0006
7/2 - ; 324,42
0,0013
13/2 - ; 305,06
0,0022
1/2 - ; 281,35
3/2 - ; 267,54
0,0005
5,2 ns
13/2+ ; 191,44
11/2+ ; 130
0,01
56 ps
9/2+ ; 75,9
0,04
67 ns
5/2 - ; 59,5409
84,45
7/2+ ; 33,1963
0,23
2,14 (1) x10^6 a
5/2+ ; 0
0,38
237
Np
93
144
Q^α = 5637,81 keV
% α = 100


5/2+ ; 0
432,6 (6) a
α
241
Am
95
146
γ Emission probabilities
per 100 disintegrations
(11/2) - ; 434,12
0,0004
15/2 - ; 395,52
0,0007
3/2+ ; 370,93
0,0003
5/2+ ; 368,59
0,0009
(5/2) - ; 359,7
0,0006
1/2+ ; 332,36
0,0013
7/2 - ; 324,42
316,8
13/2 - ; 305,06
0,0022
1/2 - ; 281,35
3/2 - ; 267,54
0,0005
11/2 - ; 225,96
0,015
13/2+ ; 191,44
9/2 - ; 158,49
1,66
11/2+ ; 130
0,01
7/2 - ; 102,961
13,23
9/2+ ; 75,9
0,04
5/2 - ; 59,5409
84,45
7/2+ ; 33,1963
0,23
5/2+ ; 0
0,38
1 ns
5,2 ns
80 ps
56 ps
67 ns
54 ps
2,14 (1) x10^6 a
237
Np
93
144
Q^α = 5637,81 keV
% α = 100


5/2+ ; 0
0
α
241
Am
95
146
γ Emission probabilities
per 100 disintegrations
0,0022
13/2 - ; 305,06
11
1/2 - ; 281,35
10
0,0005
5,2 ns
3/2 - ; 267,54
9
0,015
11/2 - ; 225,96
8
13/2+ ; 191,44
7
1,66
9/2 - ; 158,49
6
0,01
11/2+ ; 130
5
13,23
80 ps
7/2 - ; 102,961
4
0,04
56 ps
9/2+ ; 75,9
3
84,45
67 ps
5/2 - ; 59,5409
2
0,23
54 ps
7/2+ ; 33,1963
1
0,38
2,14 (1) x10^6 a
5/2+ ; 0
0
237
Np
93
144
Q^α = 5637,81 keV
% α = 100

$^{242}_{94}\mathrm{Pu}_{148}$

1 Decay Scheme

Pu-242 decays 100% by alpha transitions to U-238 and by spontaneous fission with branching fraction of 5.49(9)10^{-4} %. Most of the alpha decay populates the U-238 ground state (76.5 %) and the U-238 first excited level with energy of 44.9 keV (23.5 %).
Le plutonium 242 se désintègre par émission alpha et par fission spontanée dans une proportion de 5,49(9) 10^{-4} %. L' émission alpha a lieu principalement vers le niveau excité de 44,9 keV (23,5 %) et le niveau fondamental (76,5 %) de l'uranium 238.

2 Nuclear Data

$T_{1/2}(^{242}\mathrm{Pu})$	:	3,73	(3)	10^5 a
$T_{1/2}(^{238}\mathrm{U})$	:	4,47	(2)	10^9 a
$Q^{\alpha}(^{242}\mathrm{Pu})$	:	4984,4	(9)	keV

2.1 α Transitions

	Energy keV	Probability × 100	F
$\alpha_{0,3}$	4677,2 (9)	0,00085 (6)	602
$\alpha_{0,2}$	4836,0 (9)	0,0308 (13)	234
$\alpha_{0,1}$	4939,5 (9)	23,49 (18)	1,62
$\alpha_{0,0}$	4984,4 (9)	76,48 (18)	1

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{1,0}$(U)	44,915 (13)	23,52 (18)	E2		455 (9)	126 (3)	625 (13)
$\gamma_{2,1}$(U)	103,50 (4)	0,0316 (13)	E2		8,43 (17)	2,35 (5)	11,61 (23)
$\gamma_{3,2}$(U)	158,80 (8)	0,00085 (6)	E2	0,210 (4)	1,203 (24)	0,334 (7)	1,86 (4)

3 Atomic Data

3.1 U

ω_K : 0,970 (4)
$\bar{\omega}_L$: 0,500 (19)
n_{KL} : 0,794 (5)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	94,666		62,47
	$K\alpha_1$	98,44		100
	$K\beta_3$	110,421	}	
	$K\beta_1$	111,298	}	
	$K\beta_5''$	111,964	}	36,06
	$K\beta_2$	114,407	}	
	$K\beta_4$	115,012	}	12,33
	$KO_{2,3}$	115,377	}	
X_L				
	$L\ell$	11,62		
	$L\alpha$	13,44 – 13,62		
	$L\eta$	15,4		
	$L\beta$	15,73 – 18,21		
	$L\gamma$	19,51 – 21,73		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	71,776 – 80,954	100
KLX	88,153 – 98,429	59,6
KXY	104,51 – 115,59	8,88
Auger L	0,10 – 21,65	

4 α Emissions

	Energy keV	Probability × 100
$\alpha_{0,3}$	4600,0 (9)	0,00085 (6)
$\alpha_{0,2}$	4756,1 (9)	0,0308 (13)
$\alpha_{0,1}$	4858,1 (9)	23,49 (18)
$\alpha_{0,0}$	4902,2 (9)	76,48 (18)

5 Electron Emissions

		Energy keV	Electrons per 100 disint.
e_{AL}	(U)	0,10 - 21,65	8,6 (5)
e_{AK}	(U)		0,0000019 (3)
	KLL	71,776 - 80,954	}
	KLX	88,153 - 98,429	}
	KXY	104,51 - 115,59	}
$ec_{1,0\ L}$	(U)	23,157 - 27,747	17,1 (5)
$ec_{1,0\ M}$	(U)	39,367 - 41,365	4,74 (15)

6 Photon Emissions

6.1 X-Ray Emissions

		Energy keV		Photons per 100 disint.	
XL	(U)	11,62 — 21,73		8,56 (40)	
$XK\alpha_2$	(U)	94,666		0,0000180 (15)	} Kα
$XK\alpha_1$	(U)	98,44		0,0000288 (24)	}
$XK\beta_3$	(U)	110,421	}		
$XK\beta_1$	(U)	111,298	}	0,0000104 (10)	K$'\beta_1$
$XK\beta_5''$	(U)	111,964	}		
$XK\beta_2$	(U)	114,407	}		
$XK\beta_4$	(U)	115,012	}	0,0000032 (3)	K$'\beta_2$
$XKO_{2,3}$	(U)	115,377	}		

6.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{1,0}$(U)	44,915 (13)	0,0376 (8)
$\gamma_{2,1}$(U)	103,50 (4)	0,00251 (11)
$\gamma_{3,2}$(U)	158,80 (8)	0,000298 (20)

7 Main Production Modes

Multiple n – capture from U – 238, Pu – 238

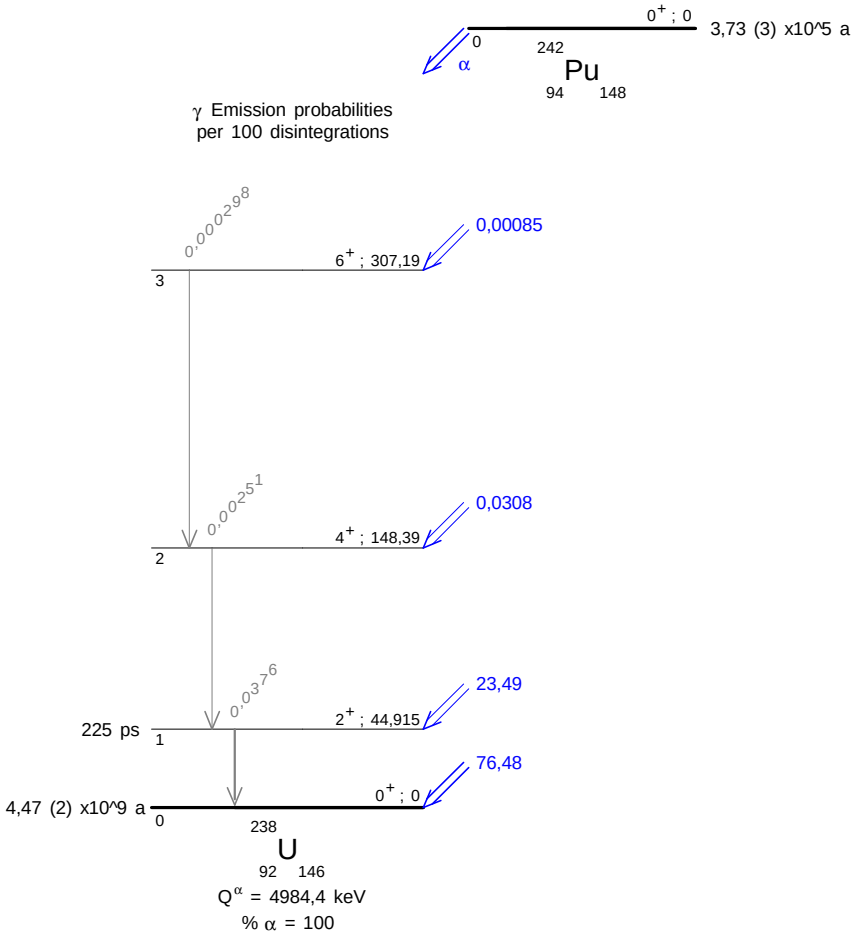
- Pu – 241(n,γ)Pu – 242
- Possible impurities : Pu – 238, Pu – 239, Pu – 240, Pu – 241, Am – 241

- Am – 241(n,γ)Am – 242
- Possible impurities : Am – 241, Cm – 242

8 References

- F. Asaro. PhD Thesis, Univ. of California, Livermore, CA, Report UCRL-2180 (1953)
  (Alpha-particle energies and emission probabilities)
- J.P. Butler, M. Lounsbury, J. Merritt. Can. J. Chem. 34 (1956) 253
  (Half-life)
- J.P. Butler, T.A. Eastwood, T.L. Collins, M.E. Jones, F.M. Rourke, R.P. Schuman. Phys. Rev. 103 (1956) 634
  (Half-life, SF half-life)
- J.P. Hummel. Report UCRL-3456 (1956)
  (Alpha-particle energies and emission probabilities)
- L.M. Kondratev, G.I. Novikova, Y.P. Sobolev, L.L. Goldin. Zh. Eksp. Teor. Fiz. 31 (1956) 771
  (Alpha-particle energies and emission probabilities)
- J.F. Mech, H. Diamond, M.H. Studier, P.R. Fields, A. Hirsch, C.M. Stephens, R.F. Barnes, D.J. Henderson, J.R. Huizenga. Phys. Rev. 103 (1956) 340
  (Half-life, SF half-life)
- M.H. Studier, A. Hirch. Private Comm. - Quoted in 1956Me37 (1956)
  (SF Half-life)
- V.A. Druin, V.P. Perelygin, G.I. Khlebnikov. Soviet Phys. JETP 13 (1961) 913
  (SF half-life)
- L.Z. Malkin, I.D. Alkhazov, A.S. Krivokhatsky, K.A. Petrzhak. At. Energ. USSR 15 (1963) 158
  (SF half-life)
- J.A. Bearden. Rev. Mod. Phys. 39 (1967) 78
  (X-ray energies)
- S.A. Baranov, V.M. Kulakov, V.M. Shatinskii. Nucl. Phys. 7 (1968) 442
  (Alpha-particle energies)
- C.E. Bemis Jr., J. Halperin, R. Eby. J. Inorg. Nucl. Chem. 31 (1969) 599
  (Half-life)
- R.W. Durham, F. Molson. Can. J. Phys. 48 (1970) 716
  (Half-life)
- M. Schmorak, C.E. Bemis Jr., M.J. Zender, N.B. Gove, P.F. Dittner. Nucl. Phys. A178 (1972) 410
  (Gamma-ray energies and emission probabilities)

- D.W. Osborne, H.E. Flotow. Phys. Rev. C14 (1976) 1174
  (Half-life)
- S.A. Baranov, A.G. Zelenkov; V.M. Kulakov. Sov. At. Energy 41 (1976) 987
  (Alpha-emission probabilities)
- L.S. Bulyanitsa, A.M. Geidelman, Y.S. Egorov, L.M. Krizhanskii, A.A. Lipovskii, L.D. Preobrazhenskaya, A.V. Lovtsyus, Y.V. Kholnov. Bull. Akad. Sci. USSR, Phys. Ser. 40 (1976) 42
  (Half-life)
- F.P. Larkins. At. Data Nucl. Data Tables 20 (1977) 313
  (Auger electron energies)
- J.W. Meadows. Report BNL-NCS-24273(1978) (1978) 10
  (Half-life, SF half-life)
- F. Rösel, H.M. Friess, K. Alder, H.C. Pauli. At. Data Nucl. Data Tables. 21 (1978) 92
  (Theoretical ICC)
- S.K. Aggarwal, S.N. Acharya, A.R. Parab, H.C. Jain. Phys.Rev. C20 (1979) 1135
  (Half-Life)
- N.A. Khan, H.A. Khan, K. Gul, M. Anwar, G. Hussain, R.A. Akbar, A. Waheed, M.S. Shaikh. Nucl. Instrum. Methods 173 (1980) 163
  (SF Half-life)
- A. Lorenz. IAEA Tech Rept Ser, No 261 (1986)
  (Evaluated decay data)
- R. Vaninbroukx, G. Bortels, B. Denecke. Int. J. Appl. Radiat. Isotop. 37 (1986) 1167
  (Alpha-, gamma-ray emission probabilities)
- F. Lagoutine, N. Coursol, J. Legrand. Table de radionucléides, ISBN-2-7272-0078-1 (1987)
  (Auger electron energies)
- Yu.A. Selitsky, V.B. Funshtein, V.A. Yakovlev. Program and Theses, Proc. 38th Ann. Conf. Nucl. Spectrosc. Struct. (1988) 131
  (SF half-life)
- Yu.S. Popov, I.B. Makarov, D.Kh. Srurov, E.A. Erin. Radiokhimiya 32 (1990) 2
  (MX-, LX- ray relative emission probabilities)
- A. Rytz. At. Data Nucl. Data Tables. 47 (1991) 205
  (Alpha-emission energies)
- M.C. Lepy, B. Duchemin, J. Morel. Nucl. Instrum. Methods Phys. Res. A353 (1994) 10
  (LX ray energies and emission probabilities)
- G. Audi, A.H. Wapstra. Nucl. Phys. A595 (1995) 409
  (Decay energy)
- P.N. Johnston, P.A. Burns. Nucl. Instrum. Methods Phys. Res. A361 (1995) 229
  (LX-ray energies and emission probabilities)
- E. Schönfeld, H. Janssen. Nucl. Instrum. Methods Phys. Res. A369 (1996) 527
  (Atomic data)
- E. Schönfeld, G. Rodloff. Report PTB-6.11 (1999)
  (KX-ray energies and relative emission probabilities)
- F.E.Chukreev, V.E.Makarenko, M.J.Martin. Nucl. Data Sheets 97 (2002) 129
  (Decay Scheme)
- Y.A. Akovali. Nucl. Data Sheets 96 (2002) 177
  (Decay Scheme)


0+ ; 0
3,73 (3) x10^5 a
0
α
242
Pu
94
148
γ Emission probabilities
per 100 disintegrations
0,00029^8
6+ ; 307,19
0,00085
3
0,00025^1
4+ ; 148,39
0,0308
2
0,0037^6
225 ps
2+ ; 44,915
23,49
1
0+ ; 0
76,48
4,47 (2) x10^9 a
0
238
U
92
146
Q^α = 4984,4 keV
% α = 100

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