

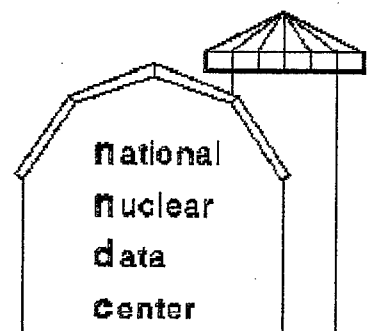
EVALUATED NUCLEAR STRUCTURE DATA FILE

A Manual for Preparation
of Data Sets

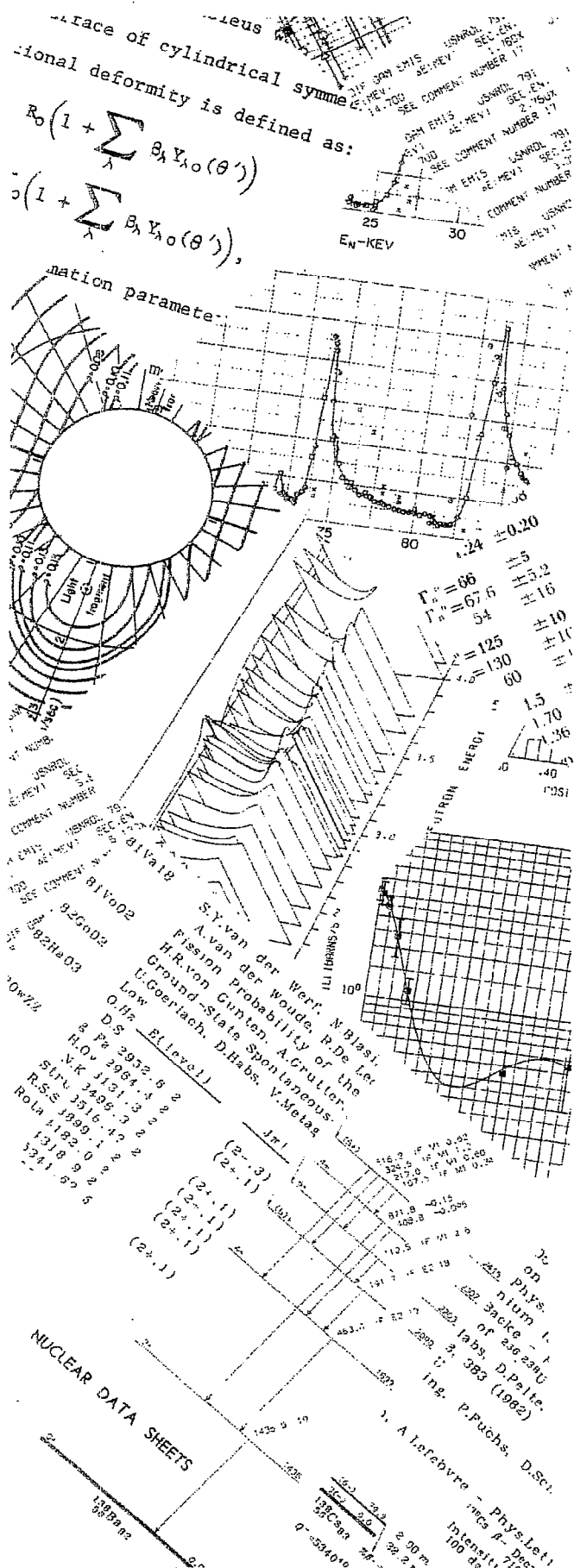
Jagdish K. Tuli

February 2001

National Nuclear Data Center
Brookhaven National Laboratory
P.O. Box 5000
Upton, Long Island, New York 11973



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Formal Report

Evaluated Nuclear Structure Data File

**A Manual for Preparation
of Data Sets**

Jagdish K. Tuli

February, 2001

**National Nuclear Data Center
Brookhaven National Laboratory
P.O. Box 5000
Upton, New York 11973-5000**

Abstract

The structure and the format for the Evaluated Nuclear Structure Data FILE (ENSDF) is described. ENSDF is used to store nuclear structure properties of nuclides and the results of various experiments to derive those properties.

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Chapter I

Introduction

This manual¹ describes the organization and structure of the Evaluated Nuclear Structure Data File (ENSDF). This computer-based file is maintained by the National Nuclear Data Center (NNDC) at Brookhaven National Laboratory for the international Nuclear Structure and Decay Data Network.²

For every mass number (presently, $A \leq 293$), the Evaluated Nuclear Structure Data File (ENSDF) contains evaluated structure information. For masses $A \geq 44$, this information is published in the *Nuclear Data Sheets*; for $A < 44$, ENSDF is based on compilations published in the journal *Nuclear Physics*. The information in ENSDF is updated by mass chain or by nuclide with a varying cycle time dependent on the availability of new information.

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¹The format for ENSDF was first designed by W. B. Ewbank and M. R. Schmorak at the Nuclear Data Project, Oak Ridge National Laboratory, and was described in the Rept ORNL-5054/R1 (February 1978). The present report describes the current format and supersedes both the ORNL report and the reports BNL-NCS 51655 (March 1983) and BNL-NCS-51655-Rev.87 (April 1987) both by J. K. Tuli.

²Coordinated by the International Atomic Energy Agency, Vienna - see any issue of the *Nuclear Data Sheets* for list of evaluation data centers.

Chapter II

GENERAL ORGANIZATION AND STRUCTURE OF THE DATA FILE

A General Organization

The Evaluated Nuclear Structure Data File (ENSDF) is made up of a collection of 'data sets' which present one of the following kinds of information:

1. The summary information for a mass chain giving information, *e.g.*, evaluators' names and affiliations, cutoff date, evaluators' remarks, and publication details, *etc.*
2. The references used in all the data sets for the given mass number. This data set is based upon reference codes (key numbers) used in various data sets for a given mass number and is added to the file by the NNDC.
3. The adopted level and gamma-ray properties for each nuclide.
4. The evaluated results of a single type of experiment, *e.g.*, a radioactive decay or a nuclear reaction for a given nuclide.
5. The combined evaluated results of a number of experiments of the same kind, *e.g.*, (Heavy ion, $xn\gamma$), Coulomb excitation, *etc.* for a given nuclide.

The data sets in ENSDF are organized by their mass number. Within a mass number the data sets are of two kinds:

- Data sets which contain information pertaining to the complete mass chain. These data sets contain information of the type (1) and (2) given above.
- Data sets belonging to a given nuclide (Z-value).

Latter data sets, *i.e.* for a given nuclide (Z-value), consist of the following:

- A Comments data set which gives abstract information for the nuclide. This data set contains summary information as described in (1) above. This data set exists only if the nuclide was evaluated or updated beyond the whole mass chain was evaluated.
- Adopted data set (only one per Z-value) giving adopted properties of the levels and gamma rays seen in that nuclide.
- Data sets giving information of the type (4) or (5) above.

If there is more than one data set of type (4) or (5) for a given nuclide, then an adopted data set is *required* for that nuclide. If there is only one data set for a given nuclide and no gamma-rays have been seen, then that data set is assumed also to present the adopted properties for that nuclide. If, however, there is gamma information known for the nuclide then a separate Adopted Levels, Gammas data set must be given even if all the information comes from only one experiment (data set).

The general organization of ENSDF is shown schematically in Fig. II.1.

B Data Set Structure

A data set is composed of 80-character records. A data set has at least two records, the beginning (DSCID) and the endrecord. Data set structure is shown in Fig. II.2 and is described below:

A data set *must* begin with an IDENTIFICATION record and *must* end with an END record (a blank record). Between these two records, there can be as many additional records as are needed to describe fully the experimental or the evaluated information.

Immediately following the IDENTIFICATION record is a group of records which contain information about the entire data set (#1 and #2 in Fig. II.2). The History (H), general COMMENT (C), NORMALIZATION (N), Q-VALUE (Q), PARENT (P), and CROSS-REFERENCE (X) records are of this type. Not all of these records are included in every data set. For example, Q-VALUE (Q) and CROSS-REFERENCE (X) records normally appear only in adopted data sets while the PARENT (P) record is given only in radioactive decay data sets.

The body of a data set (#3 and #4 in Fig. II.2) is composed of numeric data records which describe the measured or deduced properties of levels, γ rays, α particles, etc. These records are associated with the level which decays (for GAMMA, records) or the level which is populated (for BETA, EC, ALPHA, PARTICLE, or DELAYED- PARTICLE records). Thus, each LEVEL record is followed by a group of records describing β , ϵ , or (delayed-) particle decay into the level and γ -ray out of the level (#4 in Fig. II.2). The LEVEL records, and the corresponding radiation records, are placed in the data set in the order of increasing energy.

If a GAMMA, ALPHA, EC, BETA, or (DELAYED-)PARTICLE record properly belongs in a data set but cannot be associated with any particular level, then the record should be placed in the data set *before any* LEVEL records (#3 in fig. II.2).

The placement of COMMENT records is described in III.B.5.

C File Storage and Transmittal

The data sets sent to NNDC for inclusion in ENSDF can be in any order, as the file is currently maintained using a data base management system which rearranges various data sets in their predetermined order. Copies of the file are transmitted in the form of a sequential file via various mass media. Unless requested otherwise the data sets in the sequential file are arranged by mass numbers in increasing numerical order. For a given mass number the data sets are organized as given in Fig. II.1, ordering them from left to right. Decay data sets are placed under the daughter nuclide and are ordered by A, Z and then the excitation energy of the parent nuclide. The reaction data sets are given under the residual nuclide and ordered by the A, Z of the target

EVALUATED NUCLEAR STRUCTURE DATA FILE

Organization Chart

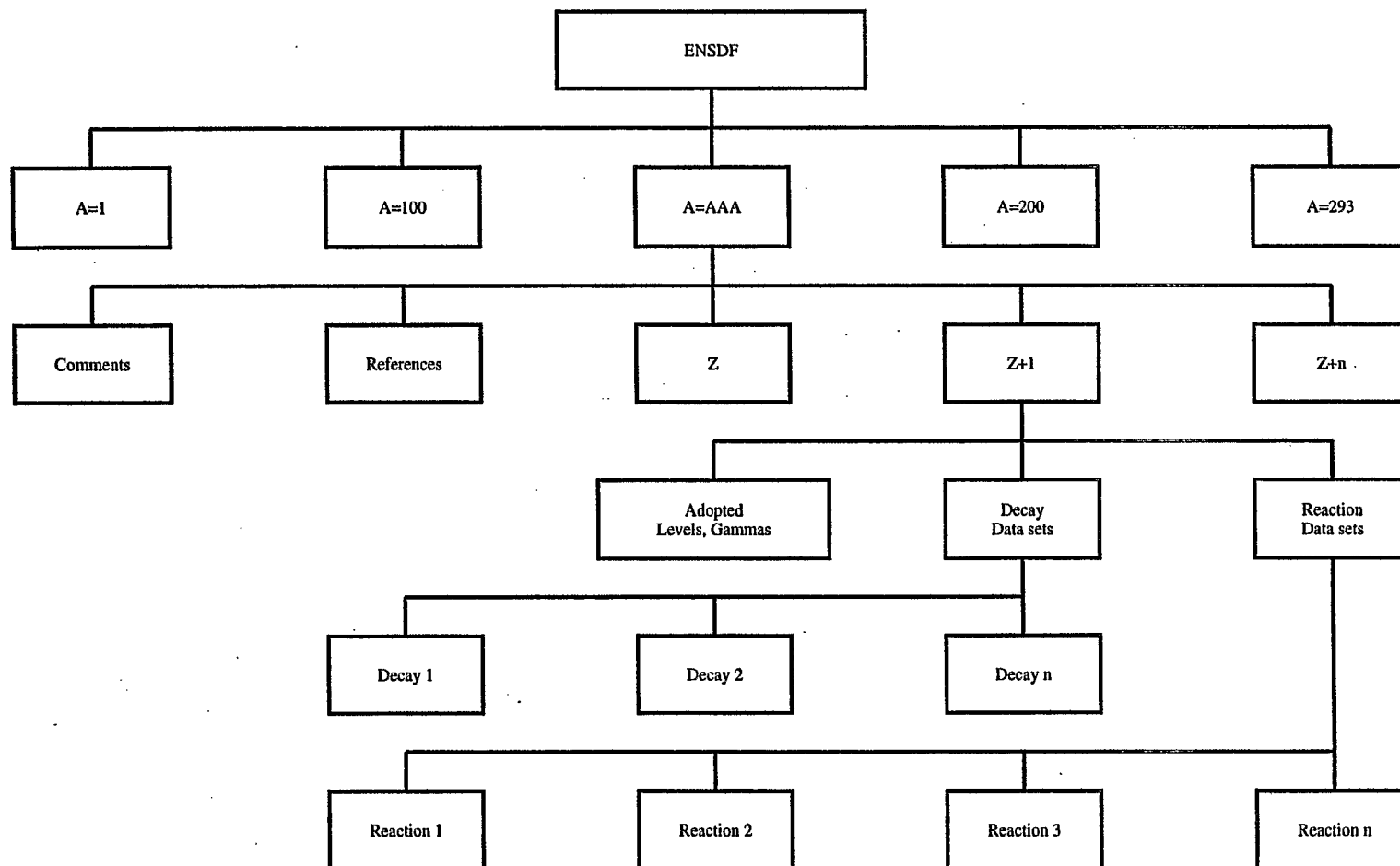


Figure II.1: ENSDF Organization

nuclide followed by the A, Z of the incident particle and then by the energy of the incident particle. These are followed by other data sets, *e.g.*, Coulomb Excitation, (HI,XNG), etc.

Data Set Structure

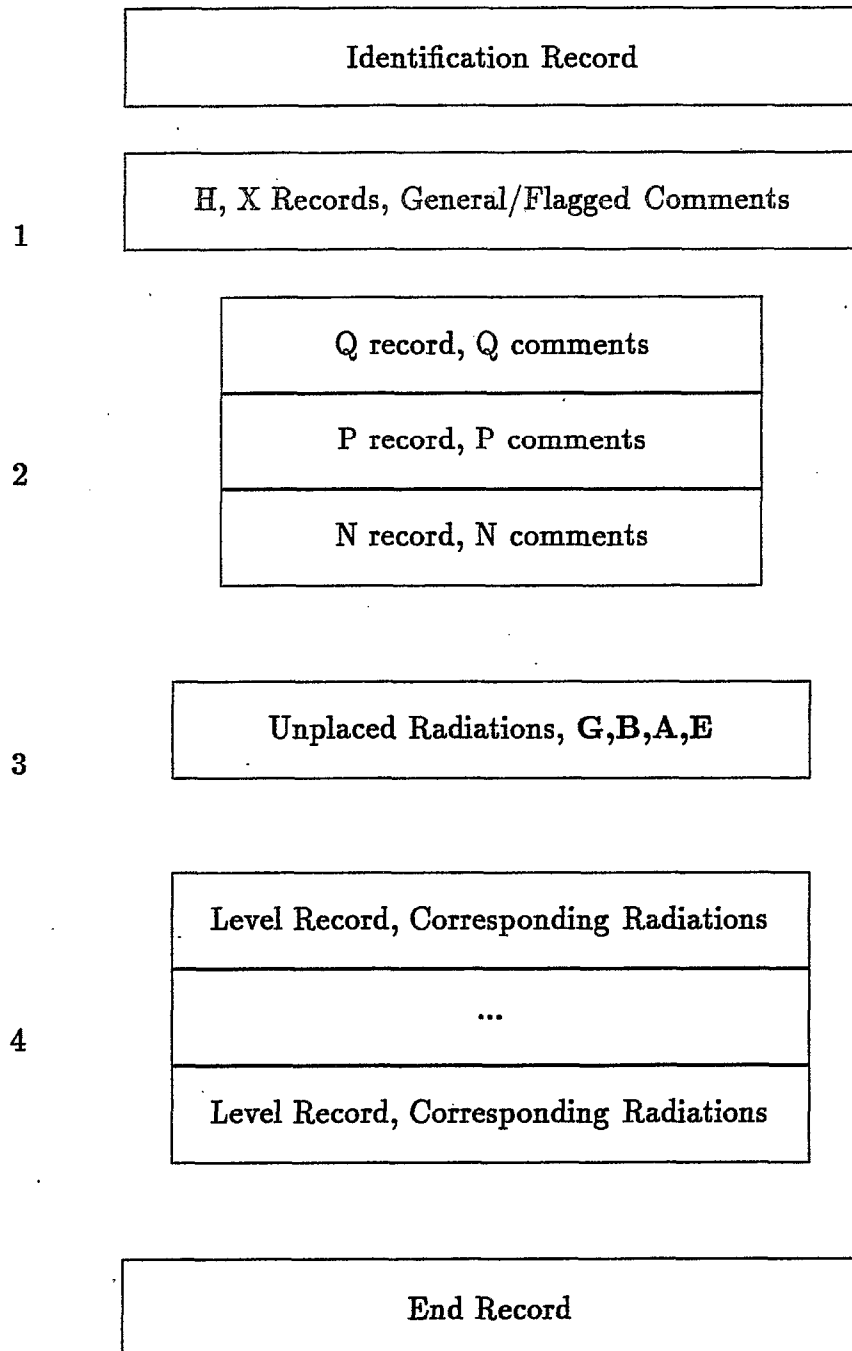


Fig. II.2

Chapter III

STANDARD ONE-CARD RECORD FORMATS

A Introduction

In most cases, all information for a record can be placed on a single 80-column (byte) card (record)¹. A 'standard' format has been defined for each one-card record, such that the most commonly used quantities can be placed on a single card. The standard formats are described in this section for each record. If a needed quantity is not included in the standard format or if a value will not fit within the field defined for the value by the standard format, or if a record cannot be contained on a single card, then additional cards can be prepared as described in Chapter IV (for examples, see Appendix C and D). Note that many of the analysis programs may not process standard fields when placed on the continuation records.

B The Standard One-Card Record Formats

Record formats are given below in the same order in which they would normally be encountered in a data set. Conditions under which each record may appear or be required are given in parentheses. The format descriptions give the fields (in inclusive card-column numbers), the field names (the formal 'name' of the quantity that goes into the field), and a brief field description. Card columns not explicitly included in the fields are expected to be blank. A detailed description of each field can be found in the reference section noted. (Any numerical field left blank usually implies that the numerical information is lacking. Numbers will usually be assumed to be positive unless stated otherwise.) Numbers can be entered anywhere in the appropriate field (i.e., there is no need to left-adjust or right-adjust, unless stated otherwise.)

¹Throughput this manual an 80-byte record is referred to as a card of 80 columns. Column number refers to the byte number on the record, starting from the left.

1 The Identification Record

*Required for all data sets.
Must precede all other records.*

Field (Col.)	Name	Description	Reference
1-5	NUCID	Nuclide Identification	V.1
6-9		Must be blank	
10-39	DSID	Data set identification	V.2
40-65	DSREF	References to main supporting publications and analyses	V.3
66-74	PUB	Publication Information	V.4
75-80	DATE	The date (year/month) when the data set was placed in ENSDF (entered automatically by computer)	V.5

Note: In the rare case when DSID field is insufficient for dataset identification it may be continued on a second identification record with col 1-39 defined as above except that col. 6 will contain an alphanumeric character and columns 40-80 will be blank. If there is a continuation record, the DSID field on the first IDENTIFICATION record *must* end with a ',' (comma).

2 The History Record

The history records follow the Identification record and should appear in reverse-chronological order, most recent being the first

Field (Col.)	Name	Description	Reference
1-5	NUCID	Nuclide identification	V.1
6		Blank	
		Any alphanumeric character other than '1' for continuation records	
7		Must be blank	
8	H	Letter 'H' is required	
9		Must be blank	
10-80	History	Dataset history consisting of various field descriptors and their values in cols 10-80 continued on any number of continuation records. Field descriptor is followed by an '=' (without spaces before or after '=') and the value and a terminator '\$' ('\$' is not needed for the last field descriptor).	V.25

3 The Q-value Record

Required for adopted data sets.

If there is only one data set for the nuclide then the Q-value record should be given in that data set.

Must precede L, G, B, E, A, DP records.

If signs are not given, they will be assumed to be +.

Field (Col.)	Name	Description	Reference
1-5	NUCID	Nuclide identification	V.1
6		Blank	
7		Must be blank	
8	Q	Letter 'Q' is required	
9		Must be blank	
10-19	Q ⁻	Total energy (keV) available for β^- decay of the ground state. (Q ⁻ > 0 if β^- decay is energetically possible. Q ⁻ < 0 represents the Q_ϵ energy of the Z+1 (Z = proton number) isobar.)	V.10
20-21	DQ ⁻	Standard uncertainty in Q ⁻	V.11
22-29	SN	Neutron separation energy in keV	V.10
30-31	DSN	Standard uncertainty in SN	V.11
32-39	SP	Proton separation energy in keV	V.10
40-41	DSP	Standard uncertainty in SP	V.11
42-49	QA	Total energy (keV) available for α decay of the ground state	V.10
50-55	DQA	Standard uncertainty in QA	V.12
56-80	QREF	Reference citation(s) for the Q-values	V.3

4 The Cross-Reference Record

*Given only in adopted data sets.
Must precede L, G, B, E, A, DP records.*

Field (Col.)	Name	Description	Reference
1-5	NUCID	Nuclide identification	V.1
6		Blank	
7		Must be blank	
8	X	Letter 'X' is required	
9	DSSYM	Any ASCII character that uniquely identifies the data set whose DSID is given in col. 10-39.	
10-39	DSID	<i>Must exactly match one of the DSID's used</i>	V.2
40-80		Blank	

NOTES:

1. In the *Nuclear Data Sheets* the DSID on the first 'X' record in the data set will be identified with character 'A' and second DSID with 'B' and so on irrespective of DSSYM on the X card. Only the first 14 DSID's on 'X' records are given different symbols. All the rest are given the symbol 'O' (for others). By merely reshuffling the X-records, evaluators can ascertain the DSID's that will be identified individually. This has no effect on the file and affects only the published output.
2. If the DSID for the data set is continued on to a second card, the DSID on XREF record must match the DSID on the the first card, including the terminating ',' which will be translated into ellipses in the cross-reference table in the output.
3. There must be a data set corresponding every given X-record.

5 The Comment Record

General Comments

Must precede all L, G, B, E, A, DP records.

Field (Col.)	Name	Description	Reference
1-5	NUCID	Nuclide identification	V.1
6		Blank	
		Any alphanumeric character other than '1' for continuation records	
7	C	Letter 'C', 'D', or 'T' is required <i>See notes 3 - 5 below</i>	
8	RTYPE	Blank or record type of records to which the comment pertains	V.6
9	PSYM	Blank , or symbol for a (delayed-)particle, <i>e.g., N, P, etc.</i>	
10-80	CTEXT	Text of the comment. [See ENSDF Translation Dictionary (Appendix F)]	V.7

NOTES:

1. The comment refers only to records of specified **RTYPE** given in that data set. The comment will normally appear only in the table for that **RTYPE** in the output. For example, if the comment is on levels ('L' in col. 8) it will appear only in the level properties table.
2. If col. 8 and 9 are blank then the comment refers to the whole data set. These general comments precede formatted level or the radiation records. See Appendix B for use of comment records in COMMENTS data set.
3. Letter 'T' in place of 'C' in col. 7 of a comment record indicates to the output programs that this record should be reproduced 'as is' and the blanks in the record should not be squeezed out.
4. Letter 'D' in place of 'C' in col. 7 of a comment record indicates to the output programs that this is a documentation record and can be ignored. This record will also be ignored by the various analysis programs.
5. Lower case letters 'c' and 't' in col. 7 of a comment record indicate to the output programs that CTEXT in these records should not be translated. These will appear as written in the *Nuclear Data Sheets*. In this mode one must write special characters directly, for example, '[g]' for γ , '[+238]Pu' for ^{238}Pu . See Appendix A for list of special characters.

Record Comments

Must follow the record to which the comment pertains.

Field (Col.)	Name	Description	Reference
1-5	NUCID	Nuclide identification	V.1
6		Blank	
		Any alphanumeric character other than '1' for continuation records	
7	C	Letter 'C' or 'D' is required	
		<i>See notes 4 and 5 on General Comments</i>	
8	RTYPE	Record type being commented upon	V.6
		It can be blank for Particle records	
9	PSYM	Blank , or symbol for a particle, <i>e.g.</i> , N, P, <i>etc.</i>	
10-80	SYM\$ or SYM,SYM,...,\$	SYM = type of data being commented upon Specified SYMs must be followed by a '\$' except as in note 1 below.	V.8
10-80	CTEXT	Text of comment follows the '\$' On continuation comment records, CTEXT may start in col. 10, and SYM or SYMs are <i>not</i> repeated. [See ENSDF Translation Dictionary, Appendix F]	V.7

NOTES:

1. The old format, where SYM were specified in col. 10-19, will be accepted without the '\$' delimiter as long as col. 19 is a blank. In this case comment text begins in col. 20.
2. Record comments placed following a record of the same **RTYPE** refer only to that one record. (For example, a comment record with 'CL' in cols. 7-8 and 'T\$' in col. 10-11 placed following the level record for the second-excited state refers to the half-life of *only* the second-excited state.)

Footnote Comments
Must precede L, G, B, E, A, DP records

Field (Col.)	Name	Description	Reference
1-9		same as in ii (Record Comments)	
10-80	SYM\$ or SYM,SYM,...,\$ or SYM(FLAG)\$ or SYM(FLAG), SYM(FLAG),...,\$	SYM = see note 1 below FLAG = any ASCII alphanumeric character or string of alphanumeric characters <i>Field must end with a '\$'</i> <i>-See note 1 on Record comments for exception</i>	V.8
10-80	CTEXT	Text of comment follows '\$' On continuation comment records SYM or SYM(FLAG) are <i>not</i> repeated. [See ENSDF Translation Dictionary (Appendix F)]	V.7

NOTES:

1. SYM can only be one of the following:

- The fields defined in formatted L, G, B, E, A, DP records.
- BAND. This SYM *must* be accompanied with a FLAG. Note also that text following '\$' delimiter, or in col. 20-80 in old format, will appear as the band label in some of the drawings. Any other information on that band should, therefore, be given on continuation records.

2. Footnote without FLAG

- This refers to all records of the specified RTYPE in the data set.
- The footnote will normally appear only in the table for that RTYPE in the output. For example, if the footnote is on levels ('L' in col. 8) it will appear only in the level properties table.
- Footnote with FLAG
 - Only those records are footnoted for which footnote flags are given, see note 4 below.
 - Only those data values of data types specified by SYM which is associated with a given FLAG are footnoted.

3. Footnote **FLAG** must be either a single character placed in col. 77 of the formatted record or a string of characters assigned to a special data type called **FLAG** on the following continuation record.

Examples of flags on a continuation record:

```
152EU2 G FLAG=ABCD$  
156GD2 L FLAG=KMP$
```

4. No footnotes are allowed for records of **RTYPE**: N, P, or Q.
5. To change the standard label heading of a formatted field, *e.g.*, S to C^2S for L records, **CTEXT** should have the form **LABEL=name**, where 'name' is the new label desired. The new label should be kept as short as possible. Note that **FLAG** can not be specified with relabeling; also any other comment on the relabelled field must appear on a different record.

Examples of field relabel:

```
156GD CL S$LABEL=C2S  
156GD CL S$LABEL=DSIGMA/DOMEGA (45 DEG)
```


6 The Parent Record

*Required for all decay data sets.
Must precede L, G, B, E, A, DP records.*

Field (Col.)	Name	Description	Reference
1-5	NUCID	Parent Nuclide identification	V.1
6		Must be blank	
7		Must be blank	
8	P	Letter 'P' is required	
9		Blank or an integer in case of multiple P records in the data set	
10-19	E	Energy of the decaying level in keV (0.0 for g.s.)	V.18
20-21	DE	Standard uncertainty in E	V.11
22-39	J	Spin and parity	V.20
40-49	T	Half-life; units <i>must</i> be given	V.14
50-55	DT	Standard uncertainty in T	V.12
56-64		Must be blank	
65-74	QP	Ground-state Q-value in keV (total energy available for <u>g.s. → g.s.</u> transition); it will always be a positive number. Not needed for IT and SF decay.	V.9
75-76	DQP	Standard uncertainty in QP	V.11
77-80	ION	Ionization State (for Ionized Atom decay), blank otherwise	

NOTES:

1. More than one parent card is allowed in a data set. If the decay scheme is due to more than one parent then separate P records should be given for each parent level.
2. Currently, publication program allows maximum of two parent cards.
3. Parent information, *namely*, E, J, T, QP must be identical to their values given in its Adopted Levels data set.

7 The Normalization Record

*Must precede L, G, B, E, A, DP records.
Required if an absolute normalization is possible;
used mainly with decay and (n, γ) reaction data sets.*

Field (Col.)	Name	Description	Reference
1-5	NUCID	Nuclide (Daughter/Product) identification	V.1
6		Must be blank	
7		Must be blank	
8	N	Letter 'N' is required	
9		Blank or an integer in case of multiple P records in the data set. It should correspond to the designator on the P record.	
10-19	NR	Multiplier for converting relative <i>photon</i> intensity (RI in the GAMMA record) to <i>photons</i> per 100 decays of the parent through the decay branch or to <i>photons</i> per 100 neutron captures in an (n, γ) reaction. <i>Required</i> if the absolute photon intensity can be calculated.	V.9
20-21	DNR	Standard uncertainty in NR	V.11
22-29	NT	Multiplier for converting relative <i>transition</i> intensity (including conversion electrons) [TI in the GAMMA record] to <i>transitions</i> per 100 decays of the parent through this decay branch or per 100 neutron captures in an (n, γ) reaction. <i>Required</i> if TI are given in the GAMMA record and the normalization is known.	V.9
30-31	DNT	standard uncertainty in NT	V.11
32-39	BR	Branching ratio multiplier for converting intensity per 100 decays through this decay branch to intensity per 100 decays of the parent nuclide. <i>Required if known.</i>	V.9
40-41	DBR	Standard uncertainty in BR	V.11
42-49	NB	Multiplier for converting relative β^- and ϵ intensities (IB in the B- record; IB, IE, TI in the EC record) to intensities per 100 decays through this decay branch. <i>Required if known.</i>	V.9

Field (Col.)	Name	Description	Reference
50-55	DNB	Standard uncertainty in NB	V.11
56-62	NP	Multiplier for converting per hundred delayed-transition intensities to per hundred decays of precursor	V.9
63-64	DNP	standard uncertainty in NP	V.11
65-80		Must be blank	

Note: Normally β^- and ϵ intensities are given as per 100 parent decays. One should remember that the multiplier for conversion to per 100 decays is $NB \times BR$ and, therefore, $NB = 1/BR$. Also, the uncertainties in $I(\beta^-)$ will be calculated from addition of three quantities $\Delta(I(\beta^-))$, DBR and DNB in quadrature. Unless the uncertainties are precisely known it is recommended that NB be given without uncertainty. See PN record.

If more than one P records exist in the data set then there should be corresponding N records giving the respective branching ratios.

8 The Production Normalization Record

Must follow N record, if N record present.

It should be given when G records with intensities are present.

Field	Name	Description
1-5	NUCID	Nuclide (Daughter/Product) identification
6		Blank
7	P	Letter 'P' (for production) is required
8	N	Letter 'N' is required
9		Must be blank
10-19	NR×BR	Multiplier for converting relative <i>photon</i> intensity (RI in the GAMMA record) to <i>photons</i> per 100 decays of the parent. (Normally NR×BR). If left blank (NR DNR)×(BR DBR) from N record will be used for normalization.
20-21	UNC ¹	Standard uncertainty in NR×BR
22-29	NT×BR	Multiplier for converting relative <i>transition</i> intensity (including conversion electrons) [TI in the GAMMA record] to <i>transitions</i> per 100 decays of the parent. (Normally NT×BR) If left blank (NT DNT)×(BR DBR) from N record will be used for normalization.
30-31	UNC ¹	standard uncertainty in NT×BR
42-49	NB×BR	Multiplier for converting relative β^- and ϵ intensities (IB in the B- record; IB, IE, TI in the EC record) to intensities per 100 decays. If left blank (NB DNB)×(BR DBR) from N record will be used for normalization.
50-55	UNC ¹	Standard uncertainty in (NB DNT)×(BR DBR)
56-62	NP	Same as in 'N' record
63-64	UNC ¹	standard uncertainty in NP
77	COM	Blank or 'C' (for comment) If blank, comment associated with the intensity option will appear in the drawing in the <i>Nuclear Data Sheets</i> . If letter 'C' is given, the desired comment to appear in the drawing should be given on the continuation ('nPN') record(s), col. 10-80.

¹If left blank no uncertainty will appear in the publication.

Field Name Description

78 OPT Intensity Option. Option as to what intensity to display in the drawings in the *Nuclear Data Sheets*. The available options are given below (default option 3).

<u>Option</u>	<u>Intensity displayed</u>	<u>Comment in drawing</u>
1	TI or $RI(1 + \alpha)$	Relative $I(\gamma + ce)$
2	$TI \times NT$ or $RI \times NR \times (1 + \alpha)$	$I(\gamma + ce)$ per 100 (mode) decays
3	$TI \times NT \times BR$ or $RI \times BR \times NR \times (1 + \alpha)$	$I(\gamma + ce)$ per 100 parent decays
4	$RI \times NT \times BR$	$I(\gamma)$ per 100 parent decays
5	RI	Relative $I(\gamma)$
6	RI	Relative photon branching from each level
7	RI	% photon branching from each level

9 The Level Record

Optional, although a data set usually has at least one.

Field (Col.)	Name	Description	Reference
1-5	NUCID	Nuclide identification	V.1
6		Blank	
		Any alphanumeric character other than '1' for continuation records	
7		Must be blank	
8	L	Letter 'L' is required	
9		Must be blank	
10-19	E	Level energy in keV - <i>Must not be blank</i>	V.18
20-21	DE	Standard uncertainty in E	V.11
22-39	J	Spin and parity	V.20
40-49	T	Half-life of the level; units <i>must</i> be given. Mean-life expressed as the width of a level, in units of energy, may also be used	V.14
50-55	DT	Standard uncertainty in T	V.12
56-64	L	Angular momentum transfer in the reaction determining the data set. (Whether it is L_n , L_p , ΔL , <i>etc.</i> , is determined from the DSID field of the IDENTIFICATION record.)	V.22
65-74	S	Spectroscopic strength for this level as deter- mined from the reaction in the IDENTI- FICATION record. (Spectroscopic factor for particle-exchange reactions; β for inelastic scattering.) Note: If a quantity other than spectroscopic factor is given in this field, a footnote relabelling the field is required.	V.21
75-76	DS	Standard uncertainty in S	V.11
77	C	Comment FLAG used to refer to a particular comment record	V.8
78-79	MS	Metastable state is denoted by 'M ' or 'M1' for the first (lowest energy) isomer; 'M2', for the second isomer, <i>etc.</i> For Ionized Atom Decay field gives the atomic electron shell or subshell in which β^- particle is captured	V.17

Field (Col.)	Name	Description	Reference
80	Q	The character '?' denotes an uncertain or questionable level Letter 'S' denotes neutron, proton, alpha separation energy or a level expected but not observed	

10 The Beta (β^-) Record

Must follow the LEVEL record for the level which is fed by the β^- .

Field (Col.)	Name	Description	Reference
1-5	NUCID	Nuclide identification	V.1
6		Blank	
		Any alphanumeric character other than '1' for continuation records	
7		Must be blank	
8	B	Letter 'B' is required	
9		Must be blank	
10-19	E	Endpoint energy of the β^- in keV <i>Given only if measured</i>	V.18
20-21	DE	Standard uncertainty in E	V.11
22-29	IB	Intensity of the β^- -decay branch ¹	V.13
30-31	DIB	Standard uncertainty in IB	V.11
42-49	LOGFT	The log <i>ft</i> for the β^- transition for uniqueness given in col. 78-79	V.9
50-55	DFT	Standard uncertainty in LOGFT	V.12
56-76		Must be blank	
77	C	Comment FLAG (Letter 'C' denotes coincidence with a following radiation. A '?' denotes probable coincidence with a following radiation.)	V.8
78-79	UN	Forbiddenness classification for the β^- decay, <i>e.g.</i> , '1U', '2U' for first-, second-unique forbidden. (A blank field signifies an allowed transition. Nonunique forbiddenness can be indicated in col 78, with col 79 blank)	V.16
80	Q	The character '?' denotes an uncertain or questionable β^- decay Letter 'S' denotes an expected or predicted transition	

¹The intensity units are defined by the NORMALIZATION record.

11 The EC (or EC + β^+) Record

Must follow the LEVEL record for the level being populated in the decay.

Field (Col.)	Name	Description	Reference
1-5	NUCID	Nuclide identification	V.1
6		Blank	
		Any alphanumeric character other than '1' for continuation records	
7		Must be blank	
8	E	Letter 'E' is required	
9		Must be blank	
10-19	E	Energy for <i>electron capture</i> to the level Given only if measured or deduced from measured β^+ end-point energy	V.18
20-21	DE	Standard uncertainty in E	V.11
22-29	IB	Intensity of β^+ -decay branch ¹	V.13
30-31	DIB	Standard uncertainty in IB	V.11
32-39	IE	Intensity of electron capture branch ¹	V.13
40-41	DIE	Standard uncertainty in IE	V.11
42-49	LOGFT	The log <i>ft</i> for ($\epsilon + \beta^+$) transition for uniqueness given in col. 78-79	V.9
50-55	DFT	Standard uncertainty in LOGFT	V.12
65-74	TI	Total ($\epsilon + \beta^+$) decay intensity ¹	V.13
75-76	DTI	Standard uncertainty in TI	V.11
77	C	Comment FLAG (Letter 'C' denotes coincidence with a following radiation. A '?' denotes probable coincidence with a following radiation.)	V.8
78-79	UN	Forbiddenness classification for ϵ, β^+ decay, <i>e.g.</i> , '1U', '2U' for first, second unique forbidden. (A blank signifies an allowed or a nonunique forbidden transition. Nonunique forbiddenness can be indicated in col 78, with col 79 blank)	V.16
80	Q	The character '?' denotes an uncertain or questionable ϵ, β^+ branch Letter 'S' denotes an expected or predicted transition	

¹IE, IB and TI must be in the same units (see also NB in NORMALIZATION record).

12 The Alpha Record

Must follow the LEVEL record for the level being populated in the decay.

Field (Col.)	Name	Description	Reference
1-5	NUCID	Nuclide identification	V.1
6		Blank	
7		Must be blank	
8	A	Letter 'A' is required	
9		Must be blank	
10-19	E	Alpha energy in keV	V.18
20-21	DE	Standard uncertainty in E	V.11
22-29	IA	Intensity of α -decay branch in <i>percent</i> of the total α decay	V.13
30-31	DIA	Standard uncertainty in IA	V.11
32-39	HF	Hindrance factor for α decay	V.9
40-41	DHF	Standard uncertainty in HF	V.11
42-76		Must be blank	
77	C	Comment FLAG (Letter 'C' denotes coincidence with a following radiation. A '?' denotes probable coincidence with a following radiation.)	V.8
78-79		Must be blank	
80	Q	The character '?' denotes uncertain or questionable α branch Letter 'S' denotes an expected or predicted α branch	

13 The (Delayed-) Particle Record

*Must follow the LEVEL record for the level which is fed by the particle.
Records for particles which are unassigned in a level scheme should precede the first level of the data set.*

Field (Col.)	Name	Description	Reference
1-5	NUCID	Nuclide identification	V.1
6		Blank	
		Any alphanumeric character other than '1' for continuation records	
7		Must be blank	
8	D	Blank for prompt-, Letter 'D' for delayed-particle emission	
9	Particle	The symbol for the (delayed) particle (N=neutron, P=proton, A=alpha particle) is required)	
10-19	E	Energy of the particle in keV	V.18
20-21	DE	Standard uncertainty in E	V.11
22-29	IP	Intensity of (delayed) particles in percent of the total (delayed-) particle emissions	V.13
30-31	DIP	Standard uncertainty in IP	V.11
32-39	EI	Energy of the level in the 'intermediate' (mass=A+1 for n, p; A+4 for α) nuclide in case of delayed particle	V.13
40-49	T	Width of the transition in keV	V.14
50-55	DT	Uncertainty in T	V.12
56-64	L	Angular-momentum transfer of the emitted particle	V.22
65-76	Blank		
77	C	Comment FLAG used to refer to a particular comment record.	V.8
78	COIN	Letter 'C' denotes placement confirmed by coincidence. Symbol '?' denotes probable coincidence.	V.15
79		Blank	
80	Q	The character '?' denotes an uncertain placement of the transition in the level scheme Letter 'S' denotes an expected, but as yet unobserved, transition.	

Notes:

1. The delayed-particle record will appear in a delayed-particle data set (*e.g.*, B-N DECAY, ECP DECAY, *etc.*) which should be given under the A-chain for the final nuclide. For example, '95RB B-N DECAY' should be given as data set for ^{94}Sr .
2. The intensity units are defined by the NORMALIZATION record.

14 The Gamma Record

*Must follow the LEVEL record for the level from which the γ ray decays.
Records for γ rays which are unassigned in a level scheme should precede the first level of the data set.*

Field (Col.)	Name	Description	Reference
1-5	NUCID	Nuclide identification	V.1
6		Blank	
		Any alphanumeric character other than '1' for continuation records	
7		Must be blank	
8	G	Letter 'G' is required	
9		Must be blank	
10-19	E	Energy of the γ -ray in keV - <i>Must not be blank</i>	V.18
20-21	DE	Standard uncertainty in E	V.11
22-29	RI	Relative <i>photon</i> intensity ¹	V.13
30-31	DRI	Standard uncertainty in RI	V.11
32-41	M	Multipolarity of transition	V.19
42-49	MR	Mixing ratio, δ . (Sign must be shown explicitly if known. If no sign is given, it will be assumed to be unknown.)	V.10
50-55	DMR	Standard uncertainty in MR	V.12
56-62	CC	Total conversion coefficient	V.9
63-64	DCC	Standard uncertainty in CC	V.11
65-74	TI	Relative total transition intensity ¹	V.13
75-76	DTI	Standard uncertainty in TI	V.11
77	C	Comment FLAG used to refer to a particular comment record. The sym- bol '*' denotes a multiply-placed γ ray. The symbol '&' denotes a multiply-placed transition with intensity <u>not</u> divided. The symbol '@' denotes a multiply-placed transition with intensity suitably divided. The symbol '%' denotes that the intensity given as RI is the % branching in the Super Deformed Band.	V.8
78	COIN	Letter 'C' denotes placement confirmed by coincidence. Symbol '?' denotes questionable coincidence.	V.15

¹The intensity units are defined by the NORMALIZATION record.

Field (Col.)	Name	Description	Reference
79		Blank	
80	Q	The character '?' denotes an uncertain placement of the transition in the level scheme Letter 'S' denotes an expected, but as yet unobserved, transition	

15 The Reference Record

*Record can occur only in Reference data set.
The NNDC provides the Reference data set.*

Field (Col.)	Name	Description	Reference
1-3	MASS	Mass Number	
4-7		Must be blank	
8	R	Letter 'R' is required	
9		Must be blank	
10-17	KEYNUM	Reference key number	V.3
18-80	REFERENCE	Abbreviated reference (from NSR file)	

16 The End Record

*Required for all data sets.
Must be the last record in a data set.*

Field (Col.)	Description
1-80	All columns are blank

C Summary

The following two pages summarize the standard one-card formats for all allowed record types.

SUMMARY of STANDARD ONE-CARD RECORD FORMAT

Col No.	Record TYPE											Particle
R	I	X	C/D	Q	N	P	L	G	B	E	A	
1-3	<-----Mass----->											
4-5	<-----Element symbol----->											
6	#	#		#	#	#	#	#	#	#	#	#
7			C/D									
8	R		@	Q	N	P	L	G	B	E	A	D(delayed)
9	#											P/N/A
10-39	ID	ID										
10-19	key#		SYM	Q-	NR				E			
20-21				DQ-	DNR				DE			
20-80	Ref		Com									
22-39						J	J					
22-29				SN	NT			RI	IB	IB	IA	IP
30-31				DSN	DNT			DRI	DIB	DIB	DIB	DIP
32-41								M				
32-39				SP	BR					IE	HF	ED
40-41				DSP	DBR					DIE	DHF	
40-49						T	T					T
40-65	Ref											
42-49				QA	NB			MR	<-LOGFT->			
50-55				DQA	DNB	DT	DT	DMR	<--DFT-->			
56-62								CC				
56-64							L					L
56-80				QRef								
63-64								DCC				
65-74						QP	S	TI		TI		
66-74	PUB											
75-76						DQP	DS	DTI		DTI		
75-80	Date											
77							C	a	C	C	C	C
78-79							MS	C/?	UN	UN		
80							Q	Q	Q	Q	Q	Q

Any ASCII Character

@ L,G,B,A,E,N,Q,P for record comments following the respective record
a * denotes multiply placed.

@ denotes multiply placed, intensity suitably divided.

& denotes multiply placed, undivided intensity given.

% denotes that the intensity given is % branching in SD band

ENSDF Standard 80-character Formated Records

31

Notes:

blank

These fields must be blank.

& Primary record must have a blank or "1" in this field. Continuation records should have any printable ASCII character except for blank or "1" (one).

! Unique alphanumeric character identifying the source data set.

† Allowed characters for this field are C, c, D, d, T, and t.

Character identifying the record being commented on. Allowed characters for this field are N, P, Q, L, G, B, E, A, D, and blank.

† Must be blank except for: 1) Particle code for a (delayed-)particle record. 2) Sequence number for normalization and parent records.

§ Must be blank except when there are multiple parent records then this field should contain an integer relating the parent record to the related normalization record.

Byte 8 must either be blank for a prompt particle radiation or D for a delayed particle radiation. Byte 9 identifies the particle (N, P, D, or T).

Chapter IV

RECORDS CONTAINING MORE THAN ONE CARD

A Card Enumeration

Certain record types, namely, the Identification, History, Parent, Normalization records can have multiple occurrence of records with qualifications as indicated in the descriptions of these record types. For other record types if all the information cannot be contained on a single card, it is possible to use additional cards to describe the record fully. The first card of a record will have a blank in col. 6 and subsequent cards will have an ASCII character different from blank or 1 (usually running numbers: 2 to 9 or letters A to Z).

B Format for Continuation Cards

THE CONTINUATION RECORD

Must follow the record of the same RTYPE.

<u>Field</u>	<u>Name</u>	<u>Description</u>
1-5	NUCID	Nuclide identification
6		Any alphanumeric character other than 1. Note: 'S' is reserved for computer-produced records which will usually be suppressed in the <i>Nuclear Data Sheets</i>
7		Must be blank
8	RTYPE	Letter corresponding to the record type L, B, E, G or H
9		Must be blank
10-80	Data	< quant > < op > < value > [<i>< op > < value ></i>][<i>< ref ></i>] \$...

In the description of **Data** above the following abbreviations have been used:

- < *quant* >: Standard symbol for a quantity as defined in IV.C below.
Notes: 1. Ratios of more than two quantities should be indicated by colons and not by slashes (*e.g.*, K:L1:L2:L3 and not K/L1/L2/L3).
2. See V.24 for description of < *value* > when < *quant* >=XREF
3. See V.25 for description of items for H record
- < *op* >: =, <, >, <=, >=, EQ, AP, LT, LE, GT, GE
Note: For the last 6 operators blanks before and after them are required.
- < *value* >: Numeric value with units as needed and optional uncertainty.
Uncertainty is as defined in Sections V.11 and V.12.
Note: For ranges, uncertainties should not be included.
To specify a bounded range of values a second operator (note that =, EQ, AP are not valid) and value are required.
See examples below.
- [...]: Optional.
- < *ref* >: 8 character key numbers, KEYNUM (see V.3), separated by commas and enclosed within parentheses, *e.g.*, (1976TU01,1981BO01).
- \$: Delimiter (end of record is also a delimiter; thus '\$' is not needed for the last item on a record)

Examples:

126TE 2 G BE2W=25.3 7(1970LAZM)
126I 2 L %EC+%B+=56.3 20 (1977JA04)\$%B- EQ 43.7 20 (1977JA04)
126SN S B EAV=2030 60
126TE 2 L G LE 0.19 GT 0.1 (1981SH15)\$MOME2 AP -0.20\$BE2=0.478 12

C Allowed Data Types on Continuation Records

Each record type is permitted to contain only a limited (but extendable) set of data types. For example, a **GAMMA** record is not allowed to contain information of data type **DTYPE = J** (nuclear spin), similarly a **LEVEL** record is not allowed to contain **LOGFT** information.

For **A** and **DP** records only **FLAG** in addition to the quantities on the formatted records, can be given on a continuation record. The allowed data types for **LEVEL**, **GAMMA**, **B-**, and **EC** records are described below.

1 The Level Record

Allowed data types E, DE, J, T, DT, L, S, DS, C, MS, Q, are described with the standard formats in Section III.B.9. Additional allowed data types are:

<u>TYPE</u>	<u>Description</u>
%EC,%B+,%EC+%B+, %B-,%IT,%SF, %A,%P,%N,...; %B-N; %B-XN; ...	Percent decay of the level by ϵ , β^+ , $\epsilon + \beta^+$, β^- , isomeric transition, spontaneous fission, α , proton, or neutron decay, ... Percent delayed decay through n, xn emission,... Similarly, for other particle emissions, e.g., p, xp, α , x α , etc., following β^- , β^+ , or ϵ decays. <i>Note: Decay modes must be given on '2 L' card in adopted set and on an 'S L' card in decay and (n,γ) data sets</i>
ION	Ionization State (used in Ionized Atom Decay)
CONF	Nuclear configuration of the level
BE1, BE2, ...	Reduced electric transition probability (<i>upward</i>) given in units $e^2 \times (\text{barns})^L$, where $L = 1, 2, \dots$ for the transition from the ground state to this level
B2, B3, ...	$2^L - \text{pole}$ ($L=2,3,\dots$) nuclear deformation parameter
FLAG	Additional footnote symbols
G	g-factor of the level
ISPIN	Isobaric spin
ISPINZ	Z-component of Isobaric Spin
MOME1, MOME2, ...	Electric moments: dipole, quadrupole, ...
MOMM1, MOMM2, ...	Magnetic moments: dipole, quadrupole, ...
WIDTH,WIDTHG, WIDTHG0,WIDTHN, WIDTHP, WIDTHA	Level width, Γ , Partial- γ , $-\gamma_0$, -n, -p, - α widths, $\Gamma(\gamma)$, $\Gamma(\gamma_0)$, $\Gamma(n)$, $\Gamma(p)$, $\Gamma(\alpha)$, respectively
XREF	Cross-reference to other data sets for that nuclide, this is generally given only in the adopted set.

2 The Gamma Record

Allowed data types, E, DE, RI, DRI, M, MR, DMR, CC, DCC, TI, DTI, C, COIN, Q, are described with the standard formats in Section III.B.14. Additional allowed data types are:

<u>DTYPE</u>	<u>Description</u>
BE1, BE2, ...	Reduced electric transition probability (<i>downward</i>) given in units of $e^2 \times (\text{barns})^L$, where $L = 1, 2, \dots$
BE1W, BE2W, ...	Reduced electric transition probability (<i>downward</i>) given in single-particle (Weisskopf) units
BM1, BM2, ...	Reduced magnetic transition probability (<i>downward</i>) given in units of $\mu_N^2 \times (\text{barns})^{L-1}$, where $L = 1, 2, \dots$
BM1W, BM2W, ...	Reduced magnetic transition probability (<i>downward</i>) given in single-particle (Weisskopf) units
CE	Total conversion electron intensity
CEK, CEL, ...	Conversion-electron (ce) intensity for K, L, ...
CEL1, ...	L_1, \dots conversion
ECC	Measured total conversion coefficient
EKC, ELC, EL1C, ...	Measured K-, L-, L_1 -, ... conversion coefficient
FL	Final level energy. It must be either <i>identical</i> to a level energy in the data set optionally followed by a '?' (latter expresses uncertain placement) or a '?' (if the final level is not known)
FLAG	Additional footnote symbols
KC, LC, L1C, ...	Theoretical K-, L-, L_1 -, ... conversion coefficient
K:L, M:L, L1:L2, ...	Conversion-electron intensity ratios
K:T, L:T, ...	Ratio of K, L, ... ce-intensity to total ($\gamma + \text{ce}$) intensity

3 The Beta (β^-) Record

Allowed data types E, DE, IB, DIB, LOGFT, DFT, C, UN, Q, are described with the standard formats in Section III.B.10. Additional allowed data types are:

<u>DTYPE</u>	<u>Description</u>
EAV	Average energy of the β^- spectrum
FLAG	Additional footnote symbols (Note: 'C' and '?' may not be used - see III.B.10 for their special meaning)

4 The EC Record

Allowed data types, E, DE, IB, DIB, IE, DIE, LOGFT, DFT, TI, DTI, C, UN, Q, are described with the standard formats in Section III.B.11. Additional allowed data types are:

<u>DTYPE</u>	<u>Description</u>
EAV	Average energy of the β^+ spectrum
CK,CL,CM, ...,CL+	Calculated fraction of decay by electron capture from the K, L, M, ..., L+M+...shells
ECK,ECL,ECM, ..., ECL+	Measured fraction of decay by electron capture from the K, L, M, ..., L+M+...shells
CK/T,CL/T, ...	Ratio of K, L, ... ϵ -intensity to total ϵ intensity
FLAG	Additional footnote symbols (Note: 'C' and '?' may not be used - see III.B.11 for their special meaning)

Chapter V

DETAILED FIELD DESCRIPTIONS

1 NUCID

The standard nuclide identification consists of two parts - mass number in cols. (1-3), right justified and element name (or $Z - 100$ for $Z > 109$) in (col. 4-5), left justified. The nuclide identification must be contained *within* the field defined for it (cols. 1-5). The nuclide identification *must* be included on every card of a data set except the END record. Comments and reference data sets pertaining to the whole A-(mass) chain evaluation contain only the A-value in the NUCID field.

2 DSID

Data Set ID for an ENSDF data set serves as a unique, computer recognizable identification for the data set. There can *not* be two data sets with identical DSID and NUCID. In the rare circumstance two data sets with same DSID for a given NUCID can be accommodated by ending DSID with a colon (:) and following it with a unique identifier which will then be different for the various data sets with that DSID.

The following rules for DSID should be strictly observed for ENSDF entries. Single blanks have meaning and should be used according to the formats below. In the description below the *optional fields are given in italics*. General categories are given in upper and lower cases and further defined. DSID must be confined to the 30 spaces allowed. The field may, however, be continued on to the DSID field on the second ID record as explained in Chapter III in which case the DSID on the first record must end with a ‘,’.

GENERAL ID'S

REFERENCES

COMMENTS (see Appendix B for format for this data set)

ADOPTED LEVELS

ADOPTED LEVELS, GAMMAS

DECAY DATA SET ID'S

Parent Mode Decay (*Half-life*)

Parent should be the parent nuclide symbol, *e.g.*, 52CR

For SF decay more than one parent can be given separated by commas

For Ionized Atom Decay parent nuclide symbol is followed by ionization state in square brackets, *e.g.*, 187RE[+75]

Mode may be one of B+, B-, EC, IT, A, P, B-N, ECP, SF, , ...

List of decay modes may be expanded.

Half-life can be of the form T defined in V.14.1

MUONIC ATOM

REACTION DATA SET ID'S

Target(Reaction), (*Reaction*), *Target*(*Reaction*) *E=Energy Qualifier*

COULOMB EXCITATION

(HI,XNG)

Target should be the target (nuclide or element) symbol

Reaction should be given as (*in,out*), *e.g.*, (N,P)

in is the incident particle, *out* are the outgoing particles

Energy may be one of the following

NUM, *NUM* Units (for definition of NUM see V.9.)

NUM-NUM Units

TH (for thermal)

RES (for resonance)

Qualifier may be one of the following

RES

IAR

IAS

EXAMPLES:

187RE B- DECAY

187RE[+75] B- DECAY

190PT A DECAY (6E11 Y)

186OS(N,G) E=THERMAL

RE(N,N'):TOF

186W(N,G) E=RES: AVG

187OS(D,D') E=12, 17 MEV

187RE(D,2NG), 187RE(P,NG)

PB(238U,FXG)

187OS IT DECAY (231 US)

187AU P DECAY:?

95RB B-N DECAY

186W(N,G) E=TH: SECONDARY

238U(N,FG) E=TH

189OS(P,T) E=19 MEV

185RE(A,2NG) E=23-42.8 MEV

44CA(P,G) E=856, 906 KEV IAR

PB(238U,XG)

3 DSREF, KEYNUM, QREF

The DSREF and QREF fields may include up to three key numbers (KEYNUM) each of which refers to a particular publication. Additional key numbers may be placed in COMMENT records. *Key numbers must be left-justified and separated by commas with no blanks between the comma and the reference.* A reference key number must be of the form YYYYAA BB where YYYY is a four digit integer, AA are two alphabetic characters and BB is either a two digit integer or consists of two alphabetic characters. Examples: 1981TU01, 1981TUXY, etc.

4 PUB

Publication information generally consists of the year of the A-chain publication denoted by two digit year indicator followed by three-character code NDS for Nuclear Data Sheets and two-letter code NP for Nuclear Physics-A. This may optionally be followed by a comma and other updating information, *e.g.*, the initials of the person modifying the data set after its publication. Example: 78NDS,TWB or 81NDS.

5 DATE

This field is of the form YYYYMM where YYYY and MM are four and two digit integers, respectively, within the following ranges:

$YY \geq 1900$ and $01 \leq MM \leq 12$

6 RTYPE

RTYPE is a two-letter code in col. 8-9 that gives a name to the RECORD type. Note that col. 9 is blank for most of the RTYPE

<u>RTYPE</u>	<u>Description</u>
blank	May be IDENTIFICATION, general COMMENT, or END record
H	HISTORY record
N	NORMALIZATION record
	Production Normalization record has 'P' in col 7.
P	PARENT record
Q	Q-VALUE record
L	LEVEL record
G	GAMMA record
B	BETA (β^-) record

E **EC** (for ϵ, β^+ or $\epsilon + \beta^+$) record
A **ALPHA** record
R **REFERENCE** record
X **CROSS-REFERENCE** record
DP **DELAYED PARTICLE** record, or
 PARTICLE (col.8=blank) record
 Particle symbol (*e.g.*, 'P' for proton) is given in col. 9.

7 CTEXT

This field consists of free text. The various expressions used in **CTEXT** can be translated via dictionary lookup. The translation dictionary is given in Appendix F. The unit expression used in translation is the string of characters between adjacent 'delimiters'. The characters presently used as 'delimiters' are:

b(blank) ,(comma) .b(period followed by a blank) ; : () - =
 + < > / and \$

In some cases the dictionary lookup programs look beyond the next delimiter for proper translation.

8 SYM(FLAG)

The **SYM(FLAG)** field (with **FLAG** given) is valid only for records with **RTYPE**: L, G, B, E, A, DP. However, **SYM** (without **FLAG**) may additionally be used for record types N, P, and Q.

FLAG can be a string of characters *optionally* separated by commas. Any character other than a comma and parentheses can be used as a **FLAG** symbol. For B and E records 'C' can not be used for a **FLAG** as 'C' in column 77 of B, E, and A records denotes coincidence. Similarly '*', '@', '%', and '&' for G records are reserved with special meaning (III.B.14). See notes on **SYM** and **FLAG** under description of **COMMENT** record. **FLAG** can be used only with **SYMs** which are valid data types on a formatted card or with **BAND**. In fact, for **BAND** **FLAG** *must* be given.

Allowed symbols to be used as **SYM** for various **RTYPE** are currently limited to the fields allowed on the formatted records.

9 BR,CC,HF,LOGFT,NB,NP,NR,NT,QP

These fields consist of either a blank or a single unsigned number (NUM) in one of the following forms:

1. An integer (*e.g.*, 345)
2. A real number (*e.g.*, 345.23)
3. An integer followed by an integer exponent (*e.g.*, 345E-4, 4E+5)
4. A real number followed by an integer exponent (*e.g.*, 345.E-4)

Note: It is desirable to write a number as '0.345' rather than '345'.

10 MR,Q-,QA,SN,SP

These fields have the same form as the quantities in V.9. above with the difference that they are allowed to have signature (positive or negative).

11 DBR,DCC,DE,DHF,DIA,DIB,DIE,DIP,DNB

Includes DNR,DNP,DNT,DQP,DQ-,DS,DSP,DTI

These two character fields, represent uncertainty in the 'standard' form in the given quantity. The 'standard' numeric uncertainty denotes an uncertainty in the last significant figure(s), for example, NR=0.873, DNR=11 represent a normalization factor of 0.873 ± 0.011 , similarly QP=2.3E6, DQP=10 stand for a Q-value of $(2.3 \pm 1.0) \times 10^6$ (see also General Policies given in Appendix H). The non-numeric uncertainty, *e.g.*, <, >, or \geq , *etc.* is denoted by expressions LT, GT, and GE, *etc.* The allowed forms for these fields are summarized below:

1. Blank
2. An integer < 99, preferably < 25, (left or right justified)
3. One of the following expressions:
LT, GT, LE, GE, AP, CA, SY
for <, >, \leq , \geq , \approx , calculated, and from systematics, respectively.

12 DFT,DMR,DT,DNB,DQA

These fields allow for the specification of 'standard' asymmetric uncertainty. For example, $T=4.2$ S, $DT=+8-10$, represent a half-life= $4.2_{-1}^{+0.8}$ s, similarly $MR=-3$, $DMR=+1-4$ represent mixing ratio= -3_{-4}^{+1} meaning a range from -7 to -2. (Note: asymmetric uncertainties add algebraically.) When the $+/-$ construction is missing from this field, the digits or the expressions given in this field represent either the numeric 'standard' symmetric or the non-numeric uncertainty as described in V.11 above.

To summarize this field, there are two cases:

1. Symmetric uncertainty - the field consists of an integer number or an expression of the type described in V.11 above.
2. Asymmetric uncertainty - the field is of the form $+x - y$, where x and y are integers.

13 IA, IB, IE, IP, RI, TI

The following numbers/expressions are valid for these fields:

1. NUM (number as defined in V.9 above)
2. (NUM)

Note: Parentheses denote that the number given has been deduced (not directly measured) or taken from other experiment(s).

14 T

The field for half-life T must have one of the following forms:

1. NUM-Blank-Units (*i.e.*, number as defined in V.9 above followed by a blank and its units)
Valid symbols for units are: Y, D, H, M, S, MS, US, NS, PS, FS, AS, EV, KEV, and MEV, for year, day, hour, minute, second(s), 10^{-3} s, 10^{-6} s, 10^{-9} s, 10^{-12} s, 10^{-15} s, 10^{-18} s, eV, 10^3 eV, and 10^6 eV, respectively.
2. Word 'STABLE'

Note: A question mark following half-life denotes that the assignment to that level is not certain. A comment should be given to explain the exact meaning intended.

15 COIN

This one character field can either be blank or have character 'C' or '?'. The character 'C' denotes coincidence while '?' denotes questionable coincidence.

16 UN

This two character field can either be blank for allowed transitions or have an integer between 1 and 9 indicating order of forbiddenness followed by a blank for 'non-unique' or a 'U' for unique transition.

17 MS

This two character field can either be blank or have character 'M' followed by a blank or a digit between 1 and 9.

18 E

An energy field, E, can have only one of the following forms:

1. NUM (as defined in V.9 above)
2. NUM+A or A+NUM, where A=X, Y, Z, U, V, W, A, B,...used in this order; *i.e.*, for the first occurrence an 'X' is used, for its second occurrence a 'Y' is used, and so on.
3. SN+NUM, SP+NUM. Resonance energies should be given in center-of-mass system, as far as possible.
4. A (as defined in 2. above)

Note: Parentheses are allowed for this field. They denote that the number given has been deduced (not directly measured) or taken from other experiment(s). Explanation as to what is intended should be given.

19 M

The multipolarity field can be one of the following:

1. Mult

2. Mult+Mult
3. Mult,Mult
4. NOT Mult

MULT

Where Mult = E_L or $M_{L'}$
 (where L, L' are single digits - $L \geq 0, L' \geq 1$)
 $M_{L'} + E_L$ or
 $E_L + M_{L'}$ or
 D or Q

Note: Parentheses in the multipolarity field denote that the assignment is probable and not definite. Square brackets indicate assumed or derived assignment.

20 J

The spin-parity field can have only one of the following forms:

1. JPI (it can be J, π , or $J\pi$)
2. JPI OR JPI (',' (comma) can be used in place of 'OR')
3. JPI AND JPI ('&' (ampersand) can be used in place of 'AND')
4. OP JPI (where OP is AP, LE, or GE)
 Note: This will be interpreted as $\pi=PI$ and J is OP J
 Example: $\leq 5+$ means $\pi = +$ and $J \leq 5$
5. NOT JPI
6. JPI TO JPI (':' (colon) can be used in place of 'TO')
 Note: If parity is given in the range it will be interpreted as follows:
 - (a) J to $J'PI$ means $J \leq J \leq J'$ and $\pi = PI$
 - (b) JPI to $J'PI'$ means $JPI, J=J+1 PI = \pm, \dots, J = J' - 1PI = \pm, J'PI'$
 - (c) JPI to J' means $JPI, J = J + 1PI = \pm, \dots, J = J' - 1PI = \pm, J'PI = \pm$

Examples:

- (a) 3 to 6- means $J\pi = 3-, 4-, 5-, 6-$
- (b) 3+ to 6- means $J\pi = 3+, 4\pm, 5\pm, 6-$
- (c) 3+ to 6 means $J\pi = 3+, 4\pm, 5\pm, 6\pm$

7. NATURAL/UNNATURAL

8. A or A+JPI (where A is one of the characters, J, K, L, M, N, O, P,...)

In the above $J=N$ or $N/2$ (N is a positive integer or zero)

$PI(\pi)=+$ or $-$

$JPI=J$ or PI or J followed by PI

Note:

1. Parentheses in the J^π field indicate that the parenthesised value(s) is (are) based upon weak arguments. See 'Bases for Spin and Parity Assignments' in Appendix H. Note that $JPI=(3,4)-$ is interpreted as $J=(3)$ or (4) and $\pi=-$.
2. As far as possible do not give more than three JPI values.
3. The ranges such as 3- to 5+ are better written as 3-,4,5+.
4. Square brackets around J^π value indicate assumed value.

21 S

This field may contain no more than three S-values, in the form of NUM defined in V.9, separated by a '+' or a comma, for corresponding L-values given in the L-field (col. 65-74). Parentheses are allowed and will be interpreted to mean probable values.

22 L

This field may contain no more than three integer numbers optionally preceded by LE or GE and separated by a '+' or a comma. Parentheses are allowed and will be interpreted to mean probable values. Square brackets indicate assumed or derived values.

For certain reactions the L value may be accompanied by its electric or magnetic character in the form similar to multipolarity (V.19).

23 ION

This field is either blank or a signed integer, left justified, denoting order of ionization of the atom, *e.g.*, +75. It is used in Ionized Atom Decay data sets.

24 Cross Reference

The cross referencing of a record (currently allowed only for the 'L' record in an ADOPTED data set) is done through specification on the continuation record and it takes the following forms:

1. NUCID 2 L XREF=ABC\$

Above record indicates that the adopted level (specified by preceding 'L' record) has been seen in data sets 'A', 'B', and 'C' and that the corresponding levels are unambiguous.

2. NUCID 2 L XREF=A(E1)B(E2)C(E3)\$

This record indicates that the adopted level is the same as the E1 level in data set 'A', the E2 level in data set 'B', *etc.*

3. NUCID 2 L XREF=A(E1,E2)B(E3)\$

This record indicates that the adopted level is either the E1 or the E2 level in data set 'A', the E3 level in data set 'B'.

4. NUCID 2 L XREF=A(*E1)B(E2)\$

This record indicates that a level with energy E1 in data set 'A' is associated with more than one adopted level. An '*' must appear on all occurrences of a multiply assigned level. Alternatively, the notation A(*) may be used if the energy is apparent.

5. NUCID 2 L XREF=+\$

This record indicates that the adopted level has been seen in all data sets.

6. NUCID 2 L XREF=-(AB)\$

This record indicates that the adopted level has been seen in all data sets except the data sets 'A' and 'B'.

Note: The symbols A, B, C relating to specific data sets must be defined through Cross-Reference records (see III.B.4).

25 History record

1. In all individual data sets in ENSDF (excepting the REFERENCE and COMMENTS data sets) the following information will be presented (the information is required, unless indicated optional) on an H record every time changes are made to the data set (see III.B.2 for description of H record):
 - TYP Type of change/evaluation (required)
 - AUT Author's name (the person who makes or is responsible for the change not necessarily the evaluator of the data set) (required)
 - DAT Date of change (optional, if cutoff date given)
 - CUT Literature cutoff date (optional when changes do not involve fresh evaluation)
 - CIT Citation (optional, if not published)
 - COM Comments (optional)
2. Current list of evaluation types (can be expanded) are
 - FUL Complete revision of the nuclide based on all information to the cutoff date indicated. Cutoff date required
 - FMT Some format changes done
 - ERR Errata (Fix error(s) in the dataset, should be accompanied with COM)
 - MOD Modified dataset for partial update of nuclide. Kind of modification done should be indicated as comment. Cutoff date is optional.
 - UPD Update due to scan of new literature. Cutoff date is required.
 - EXP Experimental (not evaluated) data set.

There can be only one type specification per history record given.
3. Date and Cutoff date must be given as DD-MMM-YYYY (e.g., 31-MAY-1996)
4. Citation (optional) gives the reference where the evaluation is published. CIT=ENSDF means included in ENSDF but not published.
5. Comments (optional) may give general remarks about evaluation/update.
6. The fields can be in any order on an 'H' record.

Note that history records indicate various revisions. These are wiped out at the next FULL evaluation.

For FULL evaluation NNDC will introduce 'H' records based on the COMMENTS data set.

Examples:

156DY H TYP=MOD\$AUT=B. Singh\$DAT=31-DEC-1995\$
156DY2H COM=Updated SDB data only\$
156DY H TYP=UPD\$AUT=R. Helmer\$CUT=15-DEC-1994\$
156DY2H COM=Updated data set since last full evaluation\$
156DY H TYP=FMT\$AUT=J. Tuli\$DAT=1-DEC-1994\$COM=FIXED T1/2\$
156DY H TYP=FUL\$AUT=R. Helmer\$CUT=01-May-1991\$
156DY2H CIT=NDS 65, 65 (1992)\$

Appendix A

Character Set

The base character set is the standard 7-bit ASCII character set up to octal 173. Characters with octal values of 173 and greater are used as control characters. An alternate character set consists primarily of the Greek alphabet and some special symbols. The backslash character (octal 134) is interpreted as a backspace command. An alternate character in the input file consists of two characters, a control character and the standard character equivalent of the alternate character. All available alternate characters and their standard equivalents are given in the table on the following page.

There are four control characters, | (octal 176), ~ (octal 176), { (octal 173), and } (octal 175). The vertical bar and the tilde are used to shift the next character into the first and second alternate character sets, respectively. The entire string of characters may also be modified from their standard form. In this case the string to be modified is enclosed by the open and close brace control characters. The character immediately following the open brace is interpreted as a control character. The available control character values and their meanings are given below. The modified character strings may be nested. The control characters may be in either upper or lower case.

Examples

|g	will be displayed as	γ
{B{+238}Pu}	will be displayed as	²³⁸ Bu

String Control Characters

|	first alternate character
~	second alternate character
+	superscript
-	subscript (Note: + and - are mutually exclusive)
I	italic
B	bold
U	underline

Note: The symbol ^ (caret) may be used before a character or a word to preserve its case, e.g., ^A for A (and not a).

Alternate Character sets

Standard	1st alt.	2nd alt.	Standard	1st alt.	2nd alt.
!	©	!	N	N	N
"	—	"	O	O	Ö
#	§	⊗	P	Π	P
\$	e	\$	Q	Θ	Ô
%	√	%	R	Ρ	R
&	≡	&	S	Σ	S
'	°	Å	T	T	T
(	←	(	U	Υ	Û
)	→	)	V	V	V
*	×	.	W	Ω	W
+	±	+	X	Ξ	X
,	½	,	Y	Ψ	Y
-	≠	-	Z	Z	Z
.	∞	.	[{	[
/	÷	/]	}]
0	(	0	^	↑	^
1	)	1	—	↓	—
2	[	2	,	,	,
3	]	3	a	α	ä
4	<	4	b	β	b
5	>	5	c	γ	c
6	√	6	d	δ	d
7	∫	7	e	ε	é
8	Π	8	f	φ	f
9	Σ	9	g	γ	g
:	†	:	h	χ	h
;	‡	;	i	ι	i
<	≤	<	j	ε	j
=	≠	=	k	κ	k
>	≥	>	l	λ	λ
?	≈	?	m	μ	m
@	∞	•	n	ν	n
A	Α	Ä	o	ο	ö
B	B	B	p	π	p
C	H	C	q	θ	ō
D	Δ	D	r	ρ	r
E	E	É	s	σ	s
F	Φ	F	t	τ	t
G	Γ	G	u	υ	ü
H	X	H	v	?	v
I	I	I	w	ω	w
J	~	J	x	ξ	x
K	K	K	y	ψ	y
L	Λ	L	z	ζ	z
M	M	M			

Appendix B

Format For Comments Data Set

This data set consists only of general comment records (defined in III.B(4)). The format of the comment records is similar to general comments in other data sets except that the NUCID field will contain only the mass number, AAA, and that a SYM field is required as in a flagged comment. As in the flagged comments, the SYM field will either occupy columns 10 to 19 with column 19 being blank or the SYM will be followed by a '\$'. Continuation records for a given comment are allowed with the additional feature that a new line will be started if the continuation character in column 6 is a '#' and that a new paragraph will be started if the character is a '@'. This feature is intended to facilitate the entry of information into the COMM comments.

<u>SYM</u>	<u>Meaning</u>
TITLE	Title of evaluation. Required if the evaluation spans several masses.
AUTH	Authors, a list of authors from the institution given in the following INST comment. A letter or number in parenthesis following an authors last name will signal a permanent address which is different from the institution. (See PERM)
INST	Institution, name and address of the authors' institution. INST comment must follow the appropriate AUTH comment. The # continuation character is used so the address does not run together into one line. More than one set of AUTH and INST comments can be given if more than one institution is involved.
ABST	Abstract, should be terse and to the point. Additional details should be given under COMM comments.
CUT	Cutoff data and associated comments.
COMM	General comments on techniques used in the evaluation or on other information common to many of the isotopes.
ACKN	Acknowledgments.
PERM(a)	Permanent address of an author. The letter or number 'a' within the parenthesis corresponds to the letter

or number within the parenthesis which follows the authors last name in the AUTH comment.

FUND Funding, an acknowledgment of funding which will result in a footnote being added to the title.

CIT Citation. To be added by the NDS production staff so that the publication can be correctly cited by persons using a retrieval of the A chain. The authors may leave it out.

EXAMPLE of a COMMENTS data set

```

156      COMMENTS
156  C  TITL$ Nuclear Data Sheets for A=156
156  C  AUTH$R. G. Helmer
156  C  INST$Idaho National Engineering Laboratory
156  #C      EG&G Idaho, Inc.
156  #C      Idaho Falls, Idaho 83415 USA
156  C  ABST$The experimental results from the various reaction and decay
156  2C studies leading to nuclides in the A=156 mass chain, and ALPHA decays
156  3C from it, have been reviewed. These data are summarized and presented,
156  4C together with adopted levels schemes and properties.
156  C  CUT$Data available prior to May 1991 have been evaluated.
156  C  ACKN$The evaluator wishes to thank C. W. Reich, the reviewer, and the
156  2C editors for many helpful discussions.
156  C  FUND$Research sponsored by the U. S. Department of Energy.
156  C  CIT$R. G. Helmer, NDS 65, 65 (1992)
156  C  COMM$General Comments: In this evaluation, the following expression
156  2C was used to define the rotational-band parameters a and B:
156  C   $E(J) = E\{-0\} + a[J(J+1) - K\{+2\}] + B[J(J+1) - K\{+2\}]\{+2\}.$ 
156  C  with the following terms sometimes added for K=1 and 2 bands
156  C   $+ (-1)\{+J+1\}a\{-2\}J(J+1)$  for K=1
156  C  and
156  C   $+ (-1)\{+J\}a\{-4\}(J-1)J(J+1)(J+2)$  for K=2.
156  C  In the determination of the values of these parameters, the energy
156  2C spacings of only the lowest levels, and minimum number of levels, were
156  3C used.
156  C  The ENSDF file (the computer data base from which these Data Sheets
156  3C are produced), contains some information that is not printed in these
156  4C Data Sheets. This includes the theoretical internal-conversion
156  6C coefficients for each shell, where the values are significant, for
156  8C each |g for which a multipolarity is given in the Data Sheets. Also, a
156  9C short comment is made about the experimental methods for each
156  BC reference. This information would be available if a copy of the ENSDF
156  DC file were obtained.

```

Output for above COMMENTS data set is shown on the following page

Nuclear Data Sheets for A = 156*

R. G. Helmer

Idaho National Engineering Laboratory

EG&G Idaho, Inc.

Idaho Falls, Idaho 83415 USA

(Received June 24, 1991; Revised August 20, 1991)

Abstract: The experimental results from the various reaction and decay studies leading to nuclides in the A=156 mass chain, and α decays from it, have been reviewed. These data are summarized and presented, together with adopted levels schemes and properties.

Cutoff Date: Data available prior to May 1991 have been evaluated.

General Policies and Organization of Material: See the January issue of Nuclear Data Sheets.

Acknowledgments: The evaluator wishes to thank C. W. Reich, the reviewer, and the editors for many helpful discussions.

General Comments: In this evaluation, the following expression was used to define the rotational-band parameters A and B:

$$E(J) = E_0 + A[J(J+1) - K^2] + B[J(J+1) - K^2]^2.$$

with the following terms sometimes added for K=1 and 2 bands

$$+ (-1)^{J+1} A_2 J(J+1) \text{ for } K=1$$

and

$$+ (-1)^J A_4 (J-1)J(J+1)(J+2) \text{ for } K=2.$$

In the determination of the values of these parameters, the energy spacings of only the lowest levels, and minimum number of levels, were used.

The ENSDF file (the computer data base from which these Data Sheets are produced), contains some information that is not printed in these Data Sheets. This includes the theoretical internal-conversion coefficients for each shell, where the values are significant, for each γ for which a multipolarity is given in the Data Sheets. Also, a short comment is made about the experimental methods for each reference. This information would be available if a copy of the ENSDF file were obtained.

* Research sponsored by the U. S. Department of Energy.

Appendix C

Example of an adopted data set

Example of an ADOPTED LEVELS, GAMMAS data set

```

162TB      ADOPTED LEVELS, GAMMAS                                99NDS      199909
162TB H TYP=FUL$AUT=R. G. Helmer and C. W. Reich$CIT=NDS 87, 317 (1999)$
162TB2 H CUT=1-Jan-1999$
162TB Q 2506      36 6284      36 7457      36 -895      85      1995AU04
162TB C Data are from 162GD B- decay (1982Ge07,1970Ch02) and 163DY(T,A)
162TB2C reaction (1989BuZW,1988BuZP).
162TB CL E      Other levels up to 1600 keV are indicated by the 163DY(T,A)
162TB2CL spectrum in 1988BuZP.
162TB CL J      For the levels reported from the 163DY(T,A) reaction, the
162TB2CL JPI values are based on L=2 transfers and intensity patterns
162TB3CL within bands that indicate pickup of a 3/2[411] proton.
162TB CL BAND(A) KPI = 1- band.
162TB2CL CONF=((P,3/2(411))(N,5/2(523))).
162TB0CL ^A=9.78
162TB DL      Levels: 1- (0), 2- (39), 3- (97), 4- (176), 5- (267).
162TB CL BAND(B) KPI = 4- band.
162TB2CL CONF=((P,3/2(411))(N,5/2(523))).
162TB0CL ^A AP 10
162TB CL BAND(C) Bandhead of KPI = 1+ band.
162TB2CL CONF=((P,7/2(523))(N,5/2(523)))
162TB XY162GD B- DECAY
162TB XZ163DY(T,A)
162TB PN
162TB L 0      1-      7.60 M 15
162TB2 L %B=-100 $ XREF=+
162TB CL T      Unweighted average of 7.43 MIN 4 (1965Sc24) and 7.76 MIN 10
162TB2CL (1977Ka08). Others: 7.48 M 3 (1965Sc24), 8.0 M 5 (1966Fu08),
162TB3CL 7.75 M 31 (1966Sc24), 7.5 M 10 (1967Gu03), and 7.6 M 2 (1968Ka10).
162TB4CL See 1951Bu25, 1960Wi10, and 1962Ta12 for half-life measurements
162TB5CL related to nuclide identification.
162TB CL J      Configuration is assigned as

```

162TB2CL CONF=((P,3/2(411))(N,5/2(523))) based on the ground-state
 162TB3CL assignments of CONF=(P,3/2(411)) for 161TB and
 162TB4CL CONF=(N,5/2(523)) for 161GD and 163DY.
 162TB CL J LOGFT=4.95 of the B- transition to the 2- level at 1148 keV
 162TB2CL in 162DY indicates an allowed-unhindered B transition, which
 162TB3CL must be CONF=(N,5/2(523)) to CONF=(P,7/2(523)). This confirms
 162TB4CL the configuration assignment to this ground state as well as
 162TB5CL helping establish the configuration assignment to the 1148-keV
 162TB6CL level in 162DY as CONF=((P,3/2(411))(P,7/2(523))). See 162DY
 162TB6CL Adopted Levels and 1995Be02 for further discussion.
 162TB L 39.10 9 2- A
 162TB2 L XREF=+
 162TB CL J From M1 component in G to 1- ground state, expected energy
 162TB2CL spacing in rotational band, and (T,A) reaction results.
 162TB G 39.0 2 100 M1+(E2)
 162TB CG M From intensity balance at 39 level in 162GD B- decay,
 162TB2CG transition is primarily M1 (1970Ch02); x/G intensity ratio and
 162TB3CG γ -L x-ray energy are consistent with this.
 162TB L 97 1 3- A
 162TB2 L XREF=Z
 162TB L 176 1 4- A
 162TB2 L XREF=Z
 162TB L 216 1 4- B
 162TB2 L XREF=Z
 162TB CL J Configuration is assigned as that of the ground state,
 162TB2CL namely, (PI 3/2[411])(NU 5/2[523]) recoupled. The systematics
 162TB3CL of 1998Ja07 suggest a "theoretical" Gallagher-Moszkowski splitting
 162TB4CL of 82 keV compared to the observed 216 keV, if this assignment
 162TB5CL is correct.
 162TB L 267 2 5- A
 162TB2 L XREF=Z
 162TB L 310 1 5- B
 162TB2 L XREF=Z
 162TB L 341.41 9 (0-,1)
 162TB2 L XREF=Y
 162TB CL J From LOGFT=5.9 in B- decay from 0+ 162GD.
 162TB G 302.30 15 58 9
 162TB G 341.42 10 100 9
 162TB L 442.11 8 1+ C
 162TB2 L XREF=Y
 162TB CL J From allowed-unhindered (LOGFT=4.4) B- transition from the
 162TB2CL 162GD ground state (0+). This also uniquely establishes the
 162TB3CL configuration of this level as CONF=((N,5/2(523))(P,7/2(523))).
 162TB G 403.00 8 85 4
 162TB G 442.12 8 100

Output for above data set is shown in the following pages

Adopted Levels, Gammas

Q(β^-)=2506 36; S(n)=6284 36; S(p)=7457 36; Q(α)=-395 85 1995Au04.

Data are from ^{162}Gd β^- decay (1982Ge07,1970Ch02) and $^{163}\text{Dy}(t,\alpha)$ reaction (1989BuZW,1988BuZP).

 ^{162}Tb Levels

Cross Reference (XREF) Flags

A ^{162}Gd β^- Decay
B $^{163}\text{Dy}(t,\alpha)$

E(level) [†]	J π^{\ddagger}	XREF	T _{1/2}	Comments
0.0 [‡]	1-	AB	7.60 min 15	<p>%β^-=100. T_{1/2}: Unweighted average of 7.43 min 4 (1965Sc24) and 7.76 min 10 (1977Ka08). Others: 7.48 min 3 (1965Sc24), 8.0 min 5 (1966Fu08), 7.75 min 31 (1966Sc24), 7.5 min 10 (1967Gu03), and 7.6 min 2 (1968Ka10). See 1951Bu25, 1960Wi10, and 1962Ta12 for half-life measurements related to nuclide identification. Jx: Configuration is assigned as configuration=((π 3/2[411])(ν 5/2[523])) based on the ground-state assignments of configuration=((π 3/2[411]) for ^{161}Tb and configuration=((ν 5/2[523]) for ^{161}Gd and ^{163}Dy. Jx: log ft=4.95 of the β^- transition to the 2- level at 1148 keV in ^{162}Dy indicates an allowed-unhindered β transition, which must be configuration=((ν 5/2[523]) to configuration=((π 7/2[523])). This confirms the configuration assignment to this ground state as well as helping establish the configuration assignment to the 1148-keV level in ^{162}Dy as configuration=((π 3/2[411])(π 7/2[523])). See ^{162}Dy Adopted Levels and 1995Be02 for further discussion. Jx: From M1 component in γ to 1- ground state, expected energy spacing in rotational band, and (t,α) reaction results.</p>
39.10 [‡] 9	2-	AB		
97 [‡] 1	3-	B		
176 [‡] 1	4-	B		
216 [‡] 1	4-	B		<p>Jx: Configuration is assigned as that of the ground state, namely, (π 3/2[411])(ν 5/2[523]) recoupled. The systematics of 1998Ja07 suggest a "theoretical" Gallagher-Moszkowski splitting of 82 keV compared to the observed 216 keV, if this assignment is correct.</p>
267 [‡] 2	5-	B		
310 [‡] 1	5-	B		
341.41 9	(0-,1)	A		<p>Jx: From log ft=5.9 in β^- decay from 0+ ^{162}Gd.</p>
442.11 [Ⓢ] 8	1+	A		<p>Jx: From allowed-unhindered (log ft=4.4) β^- transition from the ^{162}Gd ground state (0+). This also uniquely establishes the configuration of this level as configuration=((ν 5/2[523])(π 7/2[523])).</p>

[†] Other levels up to 1600 keV are indicated by the $^{163}\text{Dy}(t,\alpha)$ spectrum in 1988BuZP.

[‡] For the levels reported from the $^{163}\text{Dy}(t,\alpha)$ reaction, the Jx values are based on L=2 transfers and intensity patterns within
bands that indicate pickup of a 3/2[411] proton.

[‡] (A): K π =1- band. Configuration=((π 3/2[411])(ν 5/2[523])). A=9.78.

[‡] (B): K π =4- band. Configuration=((π 3/2[411])(ν 5/2[523])). A=10.

[Ⓢ] (C): Bandhead of K π =1+ band. Configuration=((π 7/2[523])(ν 5/2[523])).

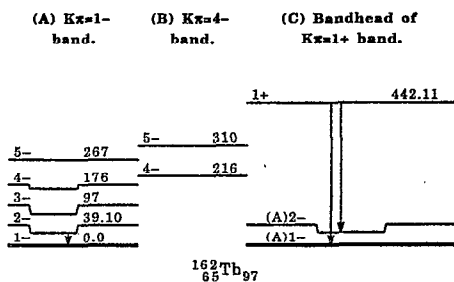
 $\gamma(^{162}\text{Tb})$

E(level)	E γ	I γ	Mult.	Comments
39.10	39.0 2	100	M1+(E2)	<p>Mult.: From intensity balance at 39 level in ^{162}Gd β^- decay, transition is primarily M1 (1970Ch02); x/y intensity ratio and L x-ray energy are consistent with this.</p>
341.41	302.30 15	58 9		
	341.42 10	100 9		
442.11	403.00 8	85 4		
	442.12 8	100		

$^{162}\text{Tb}_{97}-2$
 $^{65}\text{Tb}_{97}$

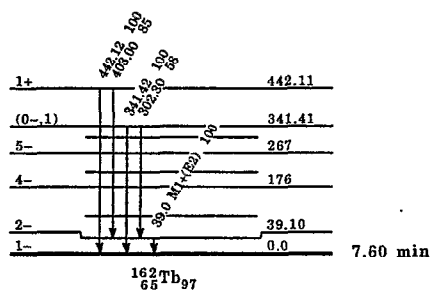
$^{162}\text{Tb}_{97}-2$
 $^{65}\text{Tb}_{97}$

Adopted Levels, Gammas (continued)



Level Scheme

Intensities: relative photon
branching from each level



Appendix D

Example of a decay data set

Example of a DECAY data set

162TB 162GD B- DECAY 1982GE07,1970CH02 99NDS 199909
162TB H TYP=FUL\$AUT=R. G. Helmer and C. W. Reich\$CIT=NDS 87, 317 (1999)\$
162TB2 H CUT=1-Jan-1999\$
162TB C 162GD has been produced by double-neutron capture in enriched 160GD
162TB2C with radiochemistry (1967Wa05,1970Ch02) and from spontaneous fission
162TB3C of 252CF with radiochemistry (1982Ge07). Measurements include
162TB4C G singles and GG, GX, and GB coincidences.
162TB CL Decay scheme is from 1982Ge07, and is similar to those of
162TB2CL 1970Ch02 and 1967Wa05.
162TB CL The consistency of the scheme is supported
162TB2CL by the fact that the sum of the energies of the radiations is
162TB3CL 1395 keV 56 which agrees with the Q value of 1400 100.
162TB CL E From least-squares fit to G energies.
162TB CL J From 162TB Adopted Levels. Rotational band and Nilsson
162TB CG Data are from 1982Ge07, unless otherwise noted. Others:
162TB2CG 1970Ch02, 1967Wa05.
162TB CB E From 1970Ch02.
162TB CB IB From evaluators' assumption that 100% of the decays
162TB2CB depopulate the levels at 341 and 442 keV (that is, no B-
162TB3CB feeding of the ground state and 39 level) and no G feeding of
162TB4CB the 341-keV level. From LOGFT GE 5.9 for 0+ to 1- ground state
162TB5CB (1973Ra10), IB-(0) LE 13% and from LOGF1T GE 8.5 for 0+ to 2- at
162TB6CB 39 keV (1973Ra10), IB-(39) LE 0.15%.
162TB2CL configuration assignments are given there.
162TB D Experimental methods:
162TB D 1967Wa05: 162GD from double-neutron capture in enriched (94%) 160GD
162TB2D with radiochemistry. G's measured with NAI(TL) detectors.
162TB D 1970Ch02: 162GD from double-neutron capture in enriched (94.8%) 160GD
162TB2D with radiochemistry. G's measured with Ge and Si(Li) detectors
162TB3D and B's with Si(Li) detector. GX and GB coincidences measured.
162TB D 1982Ge07: 162GD from 252CF spontaneous fission with radiochemistry.

162TB2D G's measured with Ge detector.

162GD	P	0	0+	8.4 M	2	14E2	1
162TB	N	0.51	2	1.0	1.0		

162TB CN NR Based on evaluators' assumption that 100% of the decays
162TB2CN depopulate the levels at 341 and 442 keV.

162TB	PN						3
162TB	L	0	1-	7.60 M	15		

162TB CL T From 162TB Adopted Levels and based on 7.43 M 4 (1965Sc24)
162TB2CL and 7.76 M 10 (1977Ka08).

162TB	L	39.10	9	2-			
162TB	G	39.0	2	10	2	M1+(E2)	8 2 C

162TBS G LC=6 2\$ MC=1.4 3

162TB CG E Average of 39.1 2 (1982Ge07) and 38.8 2 (1970Ch02).
162TB CG RI Average of 9 2 (1982Ge07) and 14 3 (1970Ch02).
162TB CG M,CC CC value deduced by evaluators from intensity balance at 39
162TB2CG level for current decay scheme; added G's feeding 39 level will
162TB3CG increase CC value. From CC(M1)=5.58 and CC(E2)=135, G is
162TB4CG primarily M1 with some E2 probable. Measured x/G intensity
162TB5CG ratio and L x-ray energy are consistent with this (1970Ch02).

162TB	L	341.41	9	(0-,1)			
162TB	B		4.5	5	5.9	2	

162TBS B EAV=362 14

162TB	G	302.30	15	3.1	5		
162TB	G	341.42	10	5.3	5		
162TB	L	442.11	8	1+			
162TB	B	10E2	1	95.5	5	4.4	2 C

162TBS B EAV=322 40

162TB	G	403.00	8	85	4	[E1]	0.008 C
162TBS	G	KC=0.0069\$	LC=0.0010\$	MC=0.0002			
162TB	G	442.12	8	100		[E1]	0.007 C
162TBS	G	KC=0.0056\$	LC=0.00076\$	MC=0.0002			

Output for above data set is shown in the following pages.

¹⁶²Tb₉₇
⁶⁵

¹⁶²Tb₉₇
⁶⁵

¹⁶²Gd β^- Decay 1982Ge07,1970Ch02

Parent ¹⁶²Gd: E=0; J π =0+; T_{1/2}=8.4 min 2; Q(g.s.)=14 \times 10² I; % β^- decay=100.

¹⁶²Gd has been produced by double-neutron capture in enriched ¹⁶⁰Gd with radiochemistry (1967Wa05,1970Ch02) and from spontaneous fission of ²⁵²Cf with radiochemistry (1982Ge07). Measurements include γ singles and $\gamma\gamma$, γ X, and $\gamma\beta$ coincidences.

¹⁶²Tb Levels

Decay scheme is from 1982Ge07, and is similar to those of 1970Ch02 and 1967Wa05.

The consistency of the scheme is supported by the fact that the sum of the energies of the radiations is 1395 keV 56 which agrees with the Q value of 1400 100.

E(level) [†]	J π [‡]	T _{1/2}	Comments
0.0	1-	7.60 min 15	T _{1/2} : From ¹⁶² Tb Adopted Levels and based on 7.43 min 4 (1965Sc24) and 7.76 min 10 (1977Ka08).
39.10 9	2-		
341.41 9	(0-,1)		
442.11 8	1+		

[†] From least-squares fit to γ energies.

[‡] From ¹⁶²Tb Adopted Levels. Rotational band and Nilsson.

β^- radiations

EP [†]	E(level)	IP [‡]	Log f _t	Comments
1000 100	442.11	95.5 5	4.4 2	av EP=322 40.
(1060 100)	341.41	4.5 5	5.9 2	av EP=362 14.

[†] From 1970Ch02.

[‡] From evaluators' assumption that 100% of the decays depopulate the levels at 341 and 442 keV (that is, no β^- feeding of the ground state and 39 level) and no γ feeding of the 341-keV level. From log f_t25.9 for 0+ to 1- ground state (1973Ra10),

IP⁻(0) \leq 13% and from log f_t28.5 for 0+ to 2- at 39 keV (1973Ra10), IP⁻(39) \leq 0.15%. configuration assignments are given there.

[§] For β^- intensity per 100 decays, multiply by 1.0.

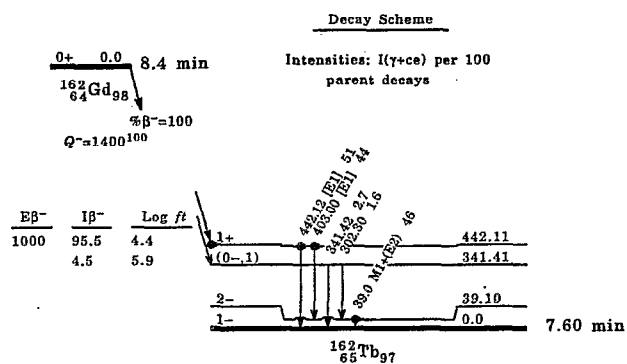
γ (¹⁶²Tb)

Data are from 1982Ge07, unless otherwise noted. Others: 1970Ch02, 1967Wa05.

I γ normalization: Based on evaluators' assumption that 100% of the decays depopulate the levels at 341 and 442 keV.

E γ	E(level)	I γ [†]	Mult.	α	Comments
39.0 2	39.10	10 2	M1+(E2)	8 2	α (L)=6 2; α (M)=1.4 3. E γ : Average of 39.1 2 (1982Ge07) and 38.8 2 (1970Ch02). I γ : Average of 9 2 (1982Ge07) and 14 3 (1970Ch02). Mult., α : α value deduced by evaluators from intensity balance at 39 level for current decay scheme; added γ 's feeding 39 level will increase α value. From α (M1)=5.58 and α (E2)=135, γ is primarily M1 with some E2 probable. Measured x/ γ intensity ratio and L x-ray energy are consistent with this (1970Ch02).
302.30 15	341.41	3.1 5			
341.42 10	341.41	5.3 5			
403.00 8	442.11	85 4	[E1]	0.008	α (K)=0.0069; α (L)=0.0010; α (M)=0.0002.
442.12 8	442.11	100	[E1]	0.007	α (K)=0.0056; α (L)=0.00076; α (M)=0.0002.

[†] For absolute intensity per 100 decays, multiply by 0.51 2.

$^{162}\text{Gd} \beta^-$ Decay 1982Ge07,1970Ch02 (continued)


Appendix E

ENSDF coding for Ionized Atom decay

Decay Data Set

1. ID record

The ionization state of the atom would be in square brackets following the nuclide symbol in the DSID field.

2. Parent record

- Energy field: level energy of the parent nucleus
- Half-life field: half-life for the decay of the ionized atom
- Q-value field: nuclear ground-state to ground-state value
- New field (77-80): ionization state

3. Level records

- Energy field: level energy of the daughter nucleus
- MS field: atomic electron shell or subshell in which the emitted beta-particle is captured.
- A new quantity, "ION", giving the ionization state would be required on an "S L" record following the level record.

4. Daughter Adopted Levels, Gammas

The adopted levels would be cross-referenced to the observed states in the ionized atom decay dataset.

5. Parent Adopted Levels, Gammas

The half-life and decay branching of the ionized atom decay would be given as comments (analogous to the current practice for half-lives which differ due to chemical effects). This should be regarded as an interim solution; after more experience is gained, methods of giving this data on level continuation records should be derived.

Examples:

187Re

1870S 187RE[+75] B- DECAY 96B037
 1870S C BOUND STATE B- DECAY OF BARE 187RE (75+ CHARGE STATE)
 1870S C 96B037 (ALSO 97N007,97KLO6,97WE08): DECAY OF FULLY IONIZED 187RE
 1870S2C NUCLEI CIRCULATING IN A STORAGE RING.
 1870S C T1/2 OF 187RE ION (75+ CHARGE STATE)=32.9 Y 20
 187RE P 0 5/2+ 32.9 Y 20 2.663 19+75
 1870S N 1.0
 1870S L 0 1/2- K
 1870SS L ION=+75
 1870S B WEAK 11 AP 1U?
 1870S L 9.75 3/2- K
 1870SS L ION=+75
 1870S B 100 7.87 3
 1870S G 9.75 S
 1870S L 0 1/2- L1
 1870SS L ION=+75
 1870S B ?

187RE ADOPTED LEVELS, GAMMAS

187RE CL BAND(A)\$5/2[402]?
 187RE L 0.0 5/2+ 4.35E10 Y 13 A
 187RE2 L %B=-100%A LT 0.0001
 187RE CL %B-({+187}Re{++75})=100; T1/2({+187}Re{++75})=32.9 20 Y

1870S ADOPTED LEVELS, GAMMAS

1870S CL BAND(A)\$1/2[501] BAND
 1870S CL BAND(B)\$3/2[512] BAND
 1870S XA187RE B- DECAY
 1870S XB187IR EC DECAY
 1870S XC1860S(N,G) E=THERMAL
 1870S XD187RE(D,2NG), 187RE(P,NG)
 1870S XE COULOMB EXCITATION
 1870S XF1890S(P,T)
 1870S XG1860S(D,P)
 1870S XH1870S(D,D')
 1870S XI1880S(D,T),(T,A)
 1870S XJ187RE[+75] B- DECAY
 1870S L 0.0 1/2- STABLE A
 1870SX L XREF=ABCDEFGH IJ
 1870S L 9.746 24 3/2- 2.38 NS 18 B
 1870SX L XREF=BCDFJ

163Dy

163HO C BOUND STATE B- DECAY OF $\{+163\}\text{Dy}\{+66+\}$ ION
 163HO C 92JU01: T1/2 MEASURED BY STORING BARE 163DY 66+ IONS IN A HEAVY-ION
 163HO2C STORAGE RING.
 163HO C T1/2($\{+163\}\text{Dy}\{+66+\}$)=47 +5-4 D
 163DY P 0+Y 5/2- 47 D +5-4 -2.565 14+66
 163HO N 1.0
 163HO L 0 7/2- K
 163HOS L ION=+66
 163HO B 100

 163DY ADOPTED LEVELS, GAMMAS
 163DY L 0.0 5/2- STABLE
 163DY CL $\%B-(\{+163\}\text{Dy}\{+66+\})=100$; T1/2($\{+163\}\text{Dy}\{+66+\}$)=47 +5-4 D
 163HO XA163HO IT DECAY (1.09 S)
 163HO XB163ER EC DECAY
 163HO XC162DY(P,P) IAR
 163HO XD162DY(3HE,D),(A,T)
 163HO XE163DY(D,2NG),(P,NG)
 163HO XG164ER(POL T,A)
 163HO XI165HO(P,T)
 163HO XJ163DY[+66] B- DECAY
 163HO CL BAND(A) 7/2(523). A=11.12, B=-0.313 EV
 163HO L 0.0 7/2- 4570 Y 25
 163HO2 L %EC=100
 163HO3 L FLAG=A\$XREF=-(C)

Appendix F

ENSDF Dictionary - Translation into true-type character set

ENSDF	Translation	ENSDF	TRANSLATION
-----	-----	-----	-----
"A"	"A"	(UP)	(|~)
%12C	%{+12}C	*	\|*\
%14C	%{+14}C	**(J+1/2)	{+(J+|,.)}
%2B-	%2|b{+-}	** -1	{+-1}
%A	%|a	** -3	{+-3}
%B+A	%|b{++}|a	** -4	{+-4}
%B+N	%|b{++}n	**1/2	{+1/2}
%B+P	%|b{++}p	**1/3	{+1/3}
%B+_	%|b{++}	**2	{+2}
%B-2N	%|b{+-}2n	**3	{+3}
%B-N	%|b{+-}n	**L	{+L}
%B-P	%|b{+-}p	*A**(1/3)	|*|A{+1/3}
%B-_	%|b{+-}	*DS/DW	d|s/d|W
%BEC	%|b{++}|e	*E	|*E
%EO	%EO	*EG	E|g
%E2	%E2	*EKC	|a(K)exp
%EC	%|e	*G*WIDTHGO**2	g|G{+2}\{-|g0}
%ECA	%|e|a	*G2	g{-2}
%ECF	%|eF	*IB-	|*I|b{+-}
%ECK	%|ek	*IE	|*I|e
%ECP	%|ep	*Q	|*Q
%EWSR	%EWSR	*R	R
%G	%|g	*RI	I|g
%I	%I	*SIGMA	|*|s
%IB	%I|b	*SUMOF	|S
%IG	%I|g	*T1/2	|*T{-1/2}
%IT	%IT	*TAU	|t
%M1	%M1	*WIDTH	|G
%N	%n	*WIDTHP	|G{-p}
%P	%p	2B-	2|b{+-}
%RI	%I|g	2J	2J
%SF	%SF	2N*SIGMA	2N|s
(A)	(|a)	4PI	4|p
(B)	(|b)	4PIB	4|p|b
(COUL.)	(Coul.)	4PIBG	4|p|b|g
(CV)	(CV)	4PIG	4|p|g
(DOWN)	(|_)	A DECAY	|a decay
(H,T)	(H,T)	A DECAYS	|a decays
(IT)	(IT)	A SYST	|a syst
(T)	(t)	A'	|a'
(THETA,H)	(|q,H)	A(THETA)	A(|q)
(THETA,H,T,T)	(|q,H,t,T)	A**1/3	A{+1/3}
(THETA,T,H)	(|q,T,H)	A**2/3	A{+2/3}

ENSDF	TRANSLATION
-----	-----
A-DECAY	|a-decay
A-N	A-N
A-SYST	|a-syst
A0	A{-0}
A1	A{-1}
A11	A{-11}
A2	A{-2}
A2/A0	A{-2}/A{-0}
A22	A{-22}
A2P2	A{-2}P{-2}
A3	A{-3}
A4	A{-4}
A44	A{-44}
A5	A{-5}
A6	A{-6}
A7	A{-7}
A=	A=
AA	|a|a
AA0	Aa{-0}
AAS	AAS
AB	AB
ACE	(|a)(ce)
AG	|a|g
AJ	AJ
ALAGA	Alaga
ALPHA	|a
ALPHA0	|a{-0}
ALPHA1	|a{-1}
ALPHA2	|a{-2}
ALPHA3	|a{-3}
ALPHAS	|a's
AP	|?
APRIL	April
AUGER	Auger
AUGUST	August
AVRSQ	{ <r{+2}>}
AXK	(|a)(K x ray)
AY	Ay
B	|b
B(E0	B(E0
B(E1	B(E1
B(E2	B(E2
B(E3	B(E3

ENSDF	TRANSLATION
-----	-----
B(E4	B(E4
B(IS	|b(IS
B(J	B(J
B*R	|bR
B*RHO	B|*|r
B+	|b{++}
B-2N	|b{+-}2n
B-N	|b{+-}n
B-VIBRATIONAL	|b-vibrational
B-	|b{+-}
B/A	B/A
B0	|b{-0}
B00	|b{-00}
B02	|b{-02}
B03	|b{-03}
B04	|b{-04}
B1	|b{-1}
B12	|b{-12}
B2	|b{-2}
B2*R	|b{-2}R
B20	|b{-20}
B22	|b{-22}
B24	|b{-24}
B3	|b{-3}
B3*R	|b{-3}R
B30	|b{-30}
B4	|b{-4}
B4*R	|b{-4}R
B42	|b{-42}
B4C	B{-4}C
B5	|b{-5}
B5*R	|b{-5}R
B6	|b{-6}
B6*R	|b{-6}R
B7	|b{-7}
B=	B=
BA	|b|a
BAVRSQ	{ < b{+2}>{+1/2}}
BB	|b|b
BC	|bc
BCE	|bce
BCS	BCS
BE(L)	BE(L)

ENSDF	TRANSLATION	ENSDF	TRANSLATION
-----	-----	-----	-----
BE-	|be{+-}	BL**2	|b{-L}{+2}
BEO	B(E0)	BL*R	|b{-L}R
BEOW	B(E0)(W.u.)	BL*R*A**(1/3)	|b{-L}RA{+1/3}
BE1	B(E1)	BLAIR	Blair
BE1UP	B(E1)|^	BM(L)	BM(L)
BE1W	B(E1)(W.u.)	BM1	B(M1)
BE2	B(E2)	BM1UP	B(M1)|^
BE2DWN	B(E2)|_	BM1W	B(M1)(W.u.)
BE2UP	B(E2)|^	BM2	B(M2)
BE2W	B(E2)(W.u.)	BM2UP	B(M2)|^
BE3	B(E3)	BM2W	B(M2)(W.u.)
BE3UP	B(E3)|^	BM3	B(M3)
BE3W	B(E3)(W.u.)	BM3W	B(M3)(W.u.)
BE3WUP	B(E3)(W.u.)|^	BM4	B(M4)
BE4	B(E4)	BM4W	B(M4)(W.u.)
BE4UP	B(E4)|^	BM5W	B(M5)(W.u.)
BE4W	B(E4)(W.u.)	BM8UP	B(M8)|^
BE5	B(E5)	BML	B(ML)
BE5W	B(E5)(W.u.)	BMLW	B(ML)(W.u.)
BE6	B(E6)	BN	|bn
BE6UP	B(E6)|^	BOHR	Bohr
BE6W	B(E6)(W.u.)	BORN	Born
BE7	B(E7)	BP	|bp
BE7W	B(E7)(W.u.)	BR	Branching
BE8	B(E8)	BREIT	Breit
BEC DECAY	|b{++}|e Decay	BRINK	Brink
BEL	B(EL)	Be	Be
BELW	B(EL)(W.u.)	C	C
BERKELEY	Berkeley	C.M.	c.m.
BESSEL	Bessel	C12G	{+12}C|g
BETA	|b	C2S	C{+2}S
BETA*R	|bR	CA(OH)	Ca(OH)
BETAS	|b's	CC	|a
BETHE	Bethe	CCBA	CCBA
BF3	BF{-3}	CCC	CCC
BG	|b|g	CE	ce
BGG	|b|g|g	CEB	ce|b
BGN	|b|gn	CEG	ce|g
BGO	BGO	CEK	ce(K)
BGT	|b(GT)	CEL	ce(L)
BIEDENHARN	Biedenharn	CEL1	ce(L1)
BJ**2	BJ{+2}	CEL12	ce(L12)
BL	|b{-L}	CEL2	ce(L2)

ENSDF	TRANSLATION	ENSDF	TRANSLATION
-----	-----	-----	-----
CEL23	ce(L23)	CURIE	Curie
CEL3	ce(L3)	Cm	Cm
CEM	ce(M)	D)	D)
CEM1	ce(M1)	D+(Q)	D+(Q)
CEM2	ce(M2)	D+Q	D+Q
CEM23	ce(M23)	D3HE	d{+3}He
CEM3	ce(M3)	DA	|DA
CEM4	ce(M4)	DA2	|DA{-2}
CEM45	ce(M45)	DA4	|DA{-4}
CEM5	ce(M5)	DAVRSQ	{ |D<r{+2}>}
CEN	ce(N)	DAVRSQ4	{ |D<r{+4}>}
CEN1	ce(N1)	DAVRSQ6	{ |D<r{+6}>}
CEN2	ce(N2)	DAVYDOV	Davydov
CEN3	ce(N3)	DBR	branching uncertainty
CEN4	ce(N4)	DCC	|D|a
CEN45	ce(N45)	DCO	DCO
CEN5	ce(N5)	DCOQ	DCOQ
CEO	ce(O)	DE	|DE
CEO+CEP	ce(O)+ce(P)	DE/DX	dE/dx
CEO1	ce(O1)	DECEMBER	December
CERENKOV	Cerenkov	DEG	\|'
CERN	CERN	DELTA	|D\
CHI	|h	DFT	|D(log ft)
CHI**2	|h{+2}	DG	d|g
CK	|eK	DHF	|D(HF)
CL	|eL	DIA	|DI|a
CLEBSCH	Clebsch	DIB	|DI|b
CM	|eM	DIE	|DI|e
CM2	cm{+2}	DISPIN	|DT
CM3	cm{+3}	DJ	|DJ
CN	|eN	DJPI	|DJ|p
CO	Co	DK	|DK
COMPTON	Compton	DL	|DL
CONF	configuration	DMR	|D|d
CONF=	configuration=	DN	|DN
CORIOLIS	Coriolis	DNB	|D(|b-normalization)
COS2TH	cos{+2}|q	DNR	|D(|g-normalization)
COSTER	Coster	DNT	|D(|g+ce-normalization)
COUL	Coul	DOMEGA	d|W
COULOMB	Coulomb	DOPPLER	Doppler
CP	CP	DPAC	DPAC
CRC	CRC	DPAD	DPAD
CSI	CsI	DPI	|D|p

ENSDF	TRANSLATION	ENSDF	TRANSLATION
DQ+	|DQ(|e)	E7	E7
DQ-	|DQ(|b{+-})	E8	E8
DQA	|DQ(|a)	E9	E9
DRI	|DI|g	EA	E|a
DS	|DS	EAV	av E|b
DS/DW	d|s/d|W	EB	E|b
DSA	DSA	EB-	E|b{+-}
DSAM	DSAM	EBE2UP	|eB(E2)|~
DSIGMA	d|s	EBE3UP	|eB(E3)|~
DSN	|DS(n)	EB_	E|b
DSP	|DS(p)	EC	|e
DT	|DT{-1/2}	EC2P	|e2p
DT1/2	|DT{-1/2}	ECA	|e|a
DTI	|DI(|g+ce)	ECC	|a(exp)
DUBNA	Dubna	ECE	E(ce)
DWBA	DWBA	ECK	|eK(exp)
DWIA	DWIA	ECL	|eL(exp)
DWUCK	DWUCK	ECL1	|eL1(exp)
E	E	ECL2	|eL2(exp)
E' (THETA)	e'(|q)	ECL3	|eL3(exp)
E(A)	E(|a)	ECM	|jM(exp)
E(D)	E(d)	ECN	|jN(exp)
E(E)	E(e)	ECP	|ep
E(N)	E(n)	ED	E(d)
E(P)	E(p)	EDE	E|DE
E(P1)	E(p{-1})	EE	Ee
E(P2)	E(p{-2})	EEC	E|e
E(T)	E(t)	EG	E|g
E**1/2	E{+1/2}	EG**3	E|g{+3}
E**2	E{+2}	EG**5	E|g{+5}
E+	e{++}	EKC	|a(K)exp
E+-	e{+|+}	EL	EL
E-E	E-E	EL12C	|a(L12)exp
E.G.	{|e.g.}	EL1C	|a(L1)exp
E/DE	E/|DE	EL23C	|a(L23)exp
E0	E0	EL2C	|a(L2)exp
E1	E1	EL3C	|a(L3)exp
E10	E10	ELC	|a(L)exp
E2	E2	EM1C	|a(M1)exp
E3	E3	EM2C	|a(M2)exp
E4	E4	EM3C	|a(M3)exp
E5	E5	EM4C	|a(M4)exp
E6	E6	EM5C	|a(M5)exp

ENSDF	TRANSLATION
EMC	|a(M)exp
EN	E(n)
EN1C	|a(N1)exp
EN23C	|a(N23)exp
EN2C	|a(N2)exp
EN3C	|a(N3)exp
EN4C	|a(N4)exp
ENC	|a(N)exp
ENDF/B-V	ENDF/B-V
ENDF/B_	ENDF/B
ENDOR	ENDOR
ENGE	Enge
EP	E(p)
EPR	EPR
EPSILON	|e
EPSILONB	|eB
ESR	ESR
ET	E(t)
EV	eV
EVEN-A	even-A
EWSR	EWSR
EX.	ex.
E{	E{
F+B	F+B
F-K	F-K
F/B	F/B
FEBRUARY	February
FERMI	Fermi
FESHBACH	Feshbach
FG	(fragment)|g
FM	fm
FM**-1	fm{+-1}
FM**2	fm{+2}
FM**4	fm{+4}
FM-1	fm{+-1}
FOCK	Fock
FOURIER	Fourier
FWHM	FWHM
G FACTOR	g factor
G FACTORS	g factors
G(2+	g(2+
G*T	gT
G*W*WIDTHGO	gw|G{-|g0}

ENSDF	TRANSLATION
G*W*WIDTHGO**2	gw|G{-0}\{+2}
G*WIDTH	g|G
G*WIDTHGO	g|G{-|g0}
G*WIDTHGO**2	g|G{+2}\{-|g0}
G*WIDTHN	g|G{-n}
G+-	|g{+|+}
G-FACTOR	g-factor
G-FACTORS	g-factors
G-M	G-M
G/A	|g/|a
GO	|g{-0}
G1	g{-1}
G1*WIDTH	g{-1}|G
G2	g{-2}
G2*WIDTH	g{-2}|G
G=	g=
GA	|?>
GA2	g{-A}\{+2}
GALLAGHER	Gallagher
GAMMA	|g
GAMOW	Gamow
GARVEY	Garvey
GAUSSIAN	Gaussian
GB	|g|b
GB-	|g|b{+-}
GCE	|gce
GDR	GDR
GE	|>
GE(LI)	Ge(Li)
GE-	|ge{+-}
GEIGER	Geiger
GEIGER-MULLER	Geiger-Muller
GELI	Ge(Li)
GEV	GeV
GG	|g|g
GGG	|g|g|g
GGN	|g|gn
GGT	|g|g|t
GM	GM
GMR	GMR
GN	|gn
GP	|gp
GP'	|gp'

ENSDF	TRANSLATION	ENSDF	TRANSLATION
-----	-----	-----	-----
GP(T)	|gp(t)	IMPAC	IMPAC
GQR	GQR	IN(	In(
GS	g.s.	INFNT	|@
GSI	GSI	IPAC	IPAC
GT	>	IS D	is D
GT1/2	gT{-1/2}	ISOLDE	ISOLDE
GTOL	GTOL	ISPIN	T
GWIDTHWIDTHG	g|G{-0}|G|g	ISPINZ	T{-z}
GX	|gX	IT BRANCHING	IT branching
G_	|g	IT DECAY	IT decay
H(	H(	IT DECAYS	IT decays
H**2	h{+2}	IT TRANSITION	IT transition
H,	H,	IT-	IT-
H=	H=	IT=	IT=
HAGER	Hager	IX	I(x ray)
HARTREE	Hartree	J	J
HAUSER	Hauser	J**2	J{+2}
HERA	HERA	J0	J{-0}
HF	HF	J1	J{-1}
HI	HI	J2	J{-2}
HOMEGA	h\|'|w	JANUARY	January
HP	HP	JF	J{-f}
HPGE	HPGE	JI	J{-i}
I	I	JKP	JK|p
I.E.	{Ii.e.}	JMAX	Jmax
IA	I|a	JMIN	Jmin
IAR	IAR	JOSEF	JOSEF
IAS	IAS	JPI	J|p
IB	I|b	JULIE	JULIE
IB+	I|b{++}	JULY	July
IB-	I|b{+-}	JUNE	June
IBA	IBA	K	K
IBM	IBM	K/L+M	K/L+M
IBS	IBS	K/LM	K/LM
ICC	|a	K/T	ce(K)/(|g+ce)
ICE	Ice	KAPPA	|k
ICE(K)	Ice(K)	KC	|a(K)
ICE(N)	Ice(N)	KELSON	Kelson
IE	I|e	KEV	keV
IEC	I|e	KEVIN	Kelvin
IG	I|g	KG	kG
IG*EG	I|gE|g	KL1L1	KL{-1}L{-1}
IGISOL	IGISOL	KL1L2	KL{-1}L{-2}

ENSDF	TRANSLATION	ENSDF	TRANSLATION
KL1L3	$KL\{-1\}L\{-3\}$	LARMOR	Larmor
KL1M1	$KL\{-1\}M\{-1\}$	LASER	LASER
KL1M2	$KL\{-1\}M\{-2\}$	LBL	LBL
KL1M3	$KL\{-1\}M\{-3\}$	LC	$|a(L)$
KL2L2	$KL\{-2\}L\{-2\}$	LE	$|<$
KL2L3	$KL\{-2\}L\{-3\}$	LEGENDRE	Legendre
KL2M1	$KL\{-2\}M\{-1\}$	LI	Li
KL2M3	$KL\{-2\}M\{-3\}$	LITHERLAND	Litherland
KL2M4	$KL\{-2\}M\{-4\}$	LM	LM
KL3L3	$KL\{-3\}L\{-3\}$	LMN	LMN
KL3LM1	$KL\{-3\}LM\{-1\}$	LN	$L(n)$
KL3M2	$KL\{-3\}M\{-2\}$	LOGF1T	$\log| \{If\{+1\}t\}$
KL3M3	$KL\{-3\}M\{-3\}$	LOGF1UT	$\log| \{If\{+1u\}t\}$
KL3N	$KL\{-3\}N$	LOGF2UT	$\log| \{If\{+2u\}t\}$
KLL	KLL	LOGF3UT	$\log| \{If\{+3u\}t\}$
KLM	KLM	LOGFT	$\log| \{If\}t\}$
KM2M3	$KM\{-2\}M\{-3\}$	LOHENGRIN	LOHENGRIN
KM2N2	$KM\{-2\}N\{-2\}$	LORENTZIAN	Lorentzian
KM3M3	$KM\{-3\}M\{-3\}$	LP	$L(p)$
KNIGHT	Knight	LT	$<$
KOE	kOe	M	M
KPI	$K|p$	$M+/T$	$ce(M+)/(|g+ce)$
KRANE	Krane	$M+=$	$M+=$
KRONIG	Kronig	M-SHELL	M-shell
KUO-BROWN	Kuo-Brown	M-SUBSHELL	M-subshell
KURIE	Kurie	M/CE	M/total ce
KXY	KXY	M/T	$ce(M)/(|g+ce)$
L	L	M1	M1
$L+/T$	$ce(L+)/(|g+ce)$	M12	M12
L/T	$ce(L)/(|g+ce)$	M1C	$|a(M1)$
L1	L1	M2	M2
L12	L12	M23	M23
L12C	$|a(L12)$	M2C	$|a(M2)$
L1C	$|a(L1)$	M3	M3
L2	L2	M3C	$|a(M3)$
L23	L23	M4	M4
L23C	$|a(L23)$	M45	M45
L2C	$|a(L2)$	M4C	$|a(M4)$
L3	L3	M5	M5
L3C	$|a(L3)$	M5C	$|a(M5)$
LA	$|?<$	M6	M6
LAMBDA	$|1$	M8	M8
LAMPF	LAMPF	MARCH	March

ENSDF	TRANSLATION	ENSDF	TRANSLATION
-----	-----	-----	-----
MB	mb	N4C	|a(N4)
MB/SR	mb/sr	N5	N5
MC	|a(M)	N5C	|a(N5)
MC+	|a(M+...)	N6C	|a(N6)
MEDLIST	MEDLIST	N<	N<
MEV	MeV	N=	N=
MEV**-4	MeV{E4-4}	NAI	NaI
MG/CM2	mg/cm{+2}	NB	I|b normalization
MHZ	MHZ	NB/SR	nb/sr
MILLI-EV	meV	NBS	NBS
MIT	MIT	NC	|a(N)
ML	M+L	NC+	|a(N+...)
MNO	M+N+O	NC2S	NC{+2}\$
MOME2	Q	NDS	Nuclear Data Sheets
MOME3	Octupole mom(el)	NE	|=
MOMM1	|m	NE213	NE213
MOMM3	Octupole mom(mag)	NG	n|g
MOMM5	2{+5} mom(mag)	NGG	n|g|g
MOMM7	2{+7} mom(mag)	NILSSON	Nilsson
MOSSBAUER	Mossbauer	NMR	NMR
MOSZKOWSKI	Moszkowski	NOTE:	Note:
MR	|d	NOVEMBER	November
MR**2	|d{+2}	NP	Particle normalization
MS	ms	NQR	NQR
MU	|m	NR	I|g normalization
MU-	|m{+-}	NS*SIGMA	NS|s
N*SIGMA	N|*|s	NT	I(|g+ce) normalization
N+/T	ce(N+)/(|g+ce)	NU	|n
N-SHELL	N-shell	NX	NX
N-SUBSHELL	N-subshell	Ne	Ne
N-Z	N-Z	O	O
N/T	ce(N)/(|g+ce)	O/Q	O/Q
N1	N1	O/T	ce(O)/(|g+ce)
N12	N12	O1	O1
N123	N123	O123	O123
N1C	|a(N1)	O1C	|a(O1)
N2	N2	O2	O2
N23	N23	O2C	|a(O2)
N2C	|a(N2)	O3	O3
N3	N3	O3C	|a(O3)
N3C	|a(N3)	O4C	|a(O4)
N4	N4	OCTOBER	October
N45	N45	ODD-A	odd-A

ENSDF	TRANSLATION	ENSDF	TRANSLATION
-----	-----	-----	-----
OMEGA	|w	QA	Q(|a)
OMEGA**2*TAU	|w{+2}|t	QDD	QDD
OMEGA*T	|w|t	QDDM	QDDM
ORNL	ORNL	QDMDQ	QDMDQ
OSIRIS	OSIRIS	QMG	QMG
P DECAY	p decay	QP	Q(g.s.)
P(THETA)	p(|q)	QQSP	QQSP
P+/T	ce(P+)/(|g+ce)	QS	Q{-s}
P-WIDTH	p-width	QSD	QSD
PO	P{-0}	R	R
P1	P1	R(DCO)	R(DCO)
P1/2	p1/2	R**2	r{+2}
P1C	|a(P1)	R**4	r{+4}
P2NG	p2n|g	R**6	r{+6}
PAC	PAC	RO	r{-0}
PAD	PAD	RDDS	RDDS
PALPHA	p|a	RDM	RDM
PG	p|g	RHO	|r
PGG	p|g|g	RHO**2	|r{+2}
PHI	|F	RI	I|g
PHI(P1)	|F(p{-1})	RITZ	Ritz
PHI(P2)	|F(p{-2})	ROSE	Rose
PI	|p	RPA	RPA
PI-	|p{+-}	RUL	RUL
PIB	|p|b	RUTHERFORD	Rutherford
PIBG	|p|b|g	RYTZ	Rytz
PIG	|p|g	S VALUE	S value
PN	P{-n}	S VALUES	S values
PNG	pn|g	S'	S'
PRI	|DI|g(%)	S(2N)	S(2n)
PSI	|Y	S(2P)	S(2p)
PWBA	PWBA	S(CE)	s(ce)
PWIA	PWIA	S-1	s{+-1}
Q	Q	S-FACTOR	S-factor
Q(	Q(	S-FACTORS	S-factors
Q+0	Q+0	S-VALUE	S-value
Q+_	Q(|e)	S-VALUES	S-values
Q-	Q(|b{+-})	S-WAVE	s-wave
Q/D	Q/D	S/	S/
Q22	Q{-22}	S=	S=
Q2D	Q2D	SA	S(|a)
Q2DM	Q2DM	SAXON	Saxon
Q3D	Q3D	SCHMIDT	Schmidt

ENSDF	TRANSLATION
SD	SD
SDB	SDB
SE(LI)	Se(Li)
SELTZER	Seltzer
SEPTEMBER	September
SF	SF
SI(LI)	Si(Li)
SIGMA	|s
SIGMA(O)	|s{-0}
SIGMA*DE	|s|*|DE
SIGMAG	|s{-|g}
SIGMAN	|s{-n}
SIGMANU	|s|n
SIGNA	|s(n|a)
SINGG	|s(n|g)
SILI	Si(Li)
SIO	SiO
SLIV-BAND	Sliv-Band
SN	S(n)
SOREQ	SOREQ
SP	S(p)
STEFFEN	Steffen
STOCKHOLM	Stockholm
SUMOF	|S\
SY	syst
Sn	Sn
T	T{-1/2}
T)	t)
T,	t,
T/	T/
T1/2	T{-1/2}
T20	T20
T21	T21
T22	T22
TAU	|t
TDPAD	TDPAD
TELLER	Teller
TEMP	T
TG	t|g
TH	th
THETA	|q
THETA**2	|q{+2}
THETA1	|q{-1}

ENSDF	TRANSLATION
THETA2	|q{-2}
THETAA	|q|a
THETAA**2	|q|a{+2}
THETAG	|q|g
THETAP1**2	|q{-p1}{+2}
THETAP2**2	|q{-p2}{+2}
TI	I(|g+ce)
TOF	tof
TPAD	TPAD
TRISTAN	TRISTAN
TRIUMPH	TRIUMPH
Ti	Ti
U	U
U2A2	U{-2}A{-2}
UB	|mb
UB*MEV	|mb|*MeV
UB/SR	|mb/sr
UG	|mg
UG/CM	|mg/cm
UK	UK
UNISOR	UNISOR
UNIV	Univ
UNIVERSITY	University
US	|ms
USA	USA
USSR	USSR
V	V
VAP	VAP
W	W
W(THETA)*G*WIDTH	w(|q)g|G{-|g0}
W.U.	W.u.
WEISSKOPF	Weisskopf
WIDTH	|G
WIDTH**2	|G{+2}
WIDTHA	|G|a
WIDTHA0	|G{-|a0}
WIDTHA1	|G{-|a1}
WIDTHA2	|G{-|a2}
WIDTHA3	|G{-|a3}
WIDTHA4	|G{-|a4}
WIDTHG	|G{-|g}
WIDTHGO	|G{-|g0}
WIDTHGO**2	|G{+2}\{-|g0}

ENSDF	TRANSLATION	ENSDF	TRANSLATION
WIDTHG1	|G{-|g1}	XLB15	L|b{-15}| x ray
WIDTHN	|G{-n}	XLB2	L|b{-2}| x ray
WIDTHNO	|G{-n0}	XLB215	L|b{-215}| x ray
WIDTHP	|G{-p}	XLB3	L|b{-3}| x ray
WIDTHP'	|G{-p'}	XLB4	L|b{-4}| x ray
WIDTHPO	|G{-p0}	XLB5	L|b{-5}| x ray
WIDTHP1	|G{-p1}	XLB6	L|b{-6}| x ray
WIDTHP2	|G{-p2}	XLB9	L|b{-9}| x ray
WIGNER	Wigner	XLC	L{-|c} x ray
WINTHER	Winther	XLG	L{-|g} x ray
X(	X(	XLG1	L|g{-1}| x ray
X-RAY	x-ray	XLG2	L|g{-2}| x ray
X-RAYS	x-rays	XLG3	L|g{-3}| x ray
XG	X|g	XLG4	L|g{-4}| x ray
XK	K| x ray	XLG5	L|g{-5}| x ray
XKA	K|a| x ray	XLG6	L|g{-6}| x ray
XKA1	K|a{-1}| x ray	XLL	L{-{S1}} x ray
XKA2	K|a{-2}| x ray	XM	M x ray
XKB	K|b| x ray	XPYNG	xpyn|g
XKB1	K|b{-1} x ray	XX	XX
XKB13	K|b{-13} x ray	YTTRIUM	Y
XKB1P	K|b{-1}'| x ray	Z	Z
XKB2	K|b{-2} x ray	Z>N	Z>N
XKB2P	K|b{-2}'| x ray	[E2]	[E2]
XKB3	K|b{-3} x ray	[RI	[I|g
XKB4	K|b{-4} x ray	a0	a{-0}
XKB5	K|b{-5} x ray	|D	|D
XKB5I	K|b{-5}\{+I} x ray		
XKB5II	K|b{-5}\{+II} x ray		
XKG	(K| x ray)|g		
XK02	K-0{-2} x ray		
XK023	K-0{-23} x ray		
XK03	K-0{-3} x ray		
XL	L| x ray		
XL1	L{-1} x ray		
XL2	L{-2} x ray		
XL3	L{-3} x ray		
XLA	L{-|a} x ray		
XLA1	L|a{-1}| x ray		
XLA2	L|a{-2}| x ray		
XLB	L{-|b} x ray		
XLB1	L|b{-1}| x ray		
XLB10	L|b{-10}| x ray		

Appendix G

ENSDF Dictionary - ordered by output

ENSDF Dictionary - ordered by output

<u>Translation</u>	<u>ENSDF</u>	<u>Translation</u>	<u>ENSDF</u>
(α)(ce)	ACE	B(E0)	BE0
(β)	(B)	B(E0)(W.u.)	BE0W
(θ ,H,t,T)	(THETA,H,T,T)	B(E1)	B(E1
(θ ,H)	(THETA,H)	B(E1)(W.u.)	BE1W
(θ ,T,H)	(THETA,T,H)	B(E1) \uparrow	BE1UP
2J	2J	B(E1)	BE1
2N σ	2N*SIGMA	B(E2)	B(E2
2 ⁵ mom(mag)	MOMM5	B(E2)	BE2
2 ⁷ mom(mag)	MOMM7	B(E2) \uparrow	BE2UP
2 β^-	2B-	B(E2) \downarrow	BE2DWN
4 π	4PI	B(E2)(W.u.)	BE2W
4 $\pi\beta\gamma$	4PIBG	B(E3)	B(E3
4 $\pi\beta$	4PIB	B(E3) \uparrow	BE3UP
4 $\pi\gamma$	4PIG	B(E3)(W.u.) \uparrow	BE3WUP
<	LT	B(E3)	BE3
>	GT	B(E3)(W.u.)	BE3W
A(θ)	A(THETA)	B(E4)	B(E4
A-N	A-N	B(E4) \uparrow	BE4UP
A=	A=	B(E4)(W.u.)	BE4W
AAS	AAS	B(E4)	BE4
AB	AB	B(E5)	BE5
AJ	AJ	B(E5)(W.u.)	BE5W
Aa ₀	AA0	B(E6)(W.u.)	BE6W
Alaga	ALAGA	B(E6) \uparrow	BE6UP
April	APRIL	B(E6)	BE6
Auger	AUGER	B(E7)(W.u.)	BE7W
August	AUGUST	B(E7)	BE7
Ay	AY	B(E8)	BE8
A ^{1/3}	A**1/3	B(EL)(W.u.)	BELW
A ^{2/3}	A**2/3	B(EL)	BEL
A ₀	A0	B(J)	B(J
A ₁₁	A11	B(M1)	BM1
A ₁	A1	B(M1) \uparrow	BM1UP
A ₂₂	A22	B(M1)(W.u.)	BM1W
A ₂ /A ₀	A2/A0	B(M2)	BM2
A ₂	A2	B(M2) \uparrow	BM2UP
A ₂ P ₂	A2P2	B(M2)(W.u.)	BM2W
A ₃	A3	B(M3)(W.u.)	BM3W
A ₄₄	A44	B(M3)	BM3
A ₄	A4	B(M4)	BM4
A ₅	A5	B(M4)(W.u.)	BM4W
A ₆	A6	B(M5)(W.u.)	BM5W
A ₇	A7	B(M8) \uparrow	BM8UP
B(E0)	B(E0	B(ML)	BML

ENSDF Dictionary - ordered by output

<u>Translation</u>	<u>ENSDF</u>	<u>Translation</u>	<u>ENSDF</u>
B(ML)(W.u.)	BMLW	DCO	DCO
B/A	B/A	DCOQ	DCOQ
B=	B=	DPAC	DPAC
BCS	BCS	DPAD	DPAD
BE(L)	BE(L)	DSA	DSA
BF ₃	BF3	DSAM	DSAM
BGO	BGO	DWBA	DWBA
BJ ²	BJ**2	DWIA	DWIA
BM(L)	BM(L)	DWUCK	DWUCK
Be	Be	Davydov	DAVYDOV
Berkeley	BERKELEY	December	DECEMBER
Bessel	BESSEL	Doppler	DOPPLER
Bethe	BETHE	Dubna	DUBNA
Biedenharn	BIEDENHARN	E	E
Blair	BLAIR	E(ce)	ECE
Bohr	BOHR	E(d)	ED
Born	BORN	E(d)	E(D)
Branching	BR	E(e)	E(E)
Breit	BREIT	E(n)	E(N)
Brink	BRINK	E(n)	EN
B ₄ C	B4C	E(p)	EP
Bxp	B*RHO	E(p)	E(P)
C	C	E(p ₂)	E(P2)
CCBA	CCBA	E(p ₁)	E(P1)
CCC	CCC	E(t)	ET
CERN	CERN	E(t)	E(T)
CP	CP	E(α)	E(A)
CRC	CRC	E-E	E-E
Ca(OH)	CA(OH)	E/ΔE	E/DE
Cerenkov	CERENKOV	E0	E0
Clebsch	CLEBSCH	E1	E1
Cm	Cm	E10	E10
Co	CO	E2	E2
Compton	COMPTON	E3	E3
Coriolis	CORIOIS	E4	E4
Coster	COSTER	E5	E5
Coul	COUL	E6	E6
Coulomb	COULOMB	E7	E7
CsI	CSI	E8	E8
Curie	CURIE	E9	E9
C ² S	C2S	EL	EL
D)	D)	ENDF/B-V	ENDF/B-V
D+(Q)	D+(Q)	ENDF/B	ENDF/B_
D+Q	D+Q	ENDOR	ENDOR

ENSDF Dictionary - ordered by output

<u>Translation</u>	<u>ENSDF</u>	<u>Translation</u>	<u>ENSDF</u>
EPR	EPR	H,	H,
ESR	ESR	H=	H=
EWSR	EWSR	HERA	HERA
Ee	EE	HF	HF
Enge	ENGE	HI	HI
E	E	HP	HP
E ^{1/2}	E**1/2	HPGE	HPGE
E ²	E**2	Hager	HAGER
EΔE	EDE	Hartree	HARTREE
Eα	EA	Hauser	HAUSER
Eβ	EB	I	I
Eβ	EB_	I(x ray)	IX
Eβ ⁻	EB-	I(γ+ce)	TI
Eε	EEC	I(γ+ce) normalization	NT
Eγ	*EG	IAR	IAR
Eγ	EG	IAS	IAS
Eγ ³	EG**3	IBA	IBA
Eγ ⁵	EG**5	IBM	IBM
F+B	F+B	IBS	IBS
F-K	F-K	IGISOL	IGISOL
F/B	F/B	IMPAC	IMPAC
FWHM	FWHM	IPAC	IPAC
February	FEBRUARY	ISOLDE	ISOLDE
Fermi	FERMI	IT branching	IT BRANCHING
Feshbach	FESHBACH	IT decay	IT DECAY
Fock	FOCK	IT decays	IT DECAYS
Fourier	FOURIER	IT=	IT=
G-M	G-M	Ice	ICE
GDR	GDR	Ice(K)	ICE(K)
GM	GM	Ice(N)	ICE(N)
GMR	GMR	In(	IN(
GQR	GQR	Iα	IA
GSI	GSI	Iβ	IB
GTOL	GTOL	Iβ normalization	NB
Gallagher	GALLAGHER	Iβ ⁻	IB-
Gamow	GAMOW	Iβ ⁺	IB+
Garvey	GARVEY	Ie	IE
Gaussian	GAUSSIAN	Ie	IEC
Ge(Li)	GE(LI)	Iγ	IG
Ge(Li)	GELI	Iγ	*RI
GeV	GEV	Iγ	RI
Geiger-Muller	GEIGER-MULLER	Iγ normalization	NR
Geiger	GEIGER	IγEγ	IG*EG
H(	H(	J	J

ENSDF Dictionary - ordered by output

<u>Translation</u>	<u>ENSDF</u>	<u>Translation</u>	<u>ENSDF</u>
JK π	JKP	Kelvin	KEVIN
JOSEF	JOSEF	Knight	KNIGHT
JULIE	JULIE	Krane	KRANE
January	JANUARY	Kronig	KRONIG
J _{max}	JMAX	Kuo-Brown	KUO-BROWN
J _{min}	JMIN	Kurie	KURIE
July	JULY	K x ray	XK
June	JUNE	K α_2 x ray	XKA2
J ²	J**2	K α_1 x ray	XKA1
J ₀	J0	K α x ray	XKA
J ₁	J1	K β_2 x ray	XKB2
J ₂	J2	K β_2' x ray	XKB2P
J _f	JF	K β_4 x ray	XKB4
J _i	JI	K β_3 x ray	XKB3
J π	JPI	K β_1 x ray	XKB1
K	K	K β_1' x ray	XKB1P
K-O ₂ x ray	XK02	K β_5^I x	XKB5I
K-O ₃ x ray	XK03	K β_5^{II} x	XKB5II
K-O ₂₃ x ray	XK023	K β_{13} x ray	XKB13
K/L+M	K/L+M	K β_5 x ray	XKB5
K/LM	K/LM	K β x ray	XKB
KLL	KLL	K π	KPI
KLM	KLM	L	L
KL ₁ L ₁	KL1L1	L(n)	LN
KL ₁ M ₂	KL1M2	L(p)	LP
KL ₁ L ₃	KL1L3	L1	L1
KL ₁ M ₃	KL1M3	L12	L12
KL ₁ M ₁	KL1M1	L2	L2
KL ₁ L ₂	KL1L2	L23	L23
KL ₂ M ₁	KL2M1	L3	L3
KL ₂ L ₂	KL2L2	LAMPF	LAMPF
KL ₂ L ₃	KL2L3	LASER	LASER
KL ₂ M ₃	KL2M3	LBL	LBL
KL ₂ M ₄	KL2M4	LM	LM
KL ₃ L ₃	KL3L3	LMN	LMN
KL ₃ LM ₁	KL3LM1	LOHENGRIN	LOHENGRIN
KL ₃ N	KL3N	Larmor	LARMOR
KL ₃ M ₃	KL3M3	Legendre	LEGENDRE
KL ₃ M ₂	KL3M2	Li	LI
KM ₂ M ₃	KM2M3	Litherland	LITHERLAND
KM ₂ N ₂	KM2N2	Lorentzian	LORENTZIAN
KM ₃ M ₃	KM3M3	L ₁ x ray	XL1
KXY	KXY	L ₂ x ray	XL2
Kelson	KELSON	L ₃ x ray	XL3

ENSDF Dictionary - ordered by output

<u>Translation</u>	<u>ENSDF</u>	<u>Translation</u>	<u>ENSDF</u>
L ₁ x ray	XLL	MIT	MIT
L _α x ray	XLA	March	MARCH
L _β x ray	XLB	MeV	MEV
L _η x ray	XLC	MeV ⁻⁴	MEV**-4
L _γ x ray	XLG	Mossbauer	MOSSBAUER
L x ray	XL	Moszkowski	MOSZKOWSKI
Lα ₁ x ray	XLA1	N-Z	N-Z
Lα ₂ x ray	XLA2	N-shell	N-SHELL
Lβ ₃ x ray	XLB3	N-subshell	N-SUBSHELL
Lβ ₄ x ray	XLB4	N1	N1
Lβ ₁ x ray	XLB1	N12	N12
Lβ ₅ x ray	XLB5	N123	N123
Lβ ₂ x ray	XLB2	N2	N2
Lβ ₂₁₅ x ray	XLB215	N23	N23
Lβ ₉ x ray	XLB9	N3	N3
Lβ ₁₅ x ray	XLB15	N4	N4
Lβ ₆ x ray	XLB6	N45	N45
Lβ ₁₀ x ray	XLB10	N5	N5
Lγ ₃ x ray	XLG3	N<	N<
Lγ ₄ x ray	XLG4	N=	N=
Lγ ₆ x ray	XLG6	NBS	NBS
Lγ ₅ x ray	XLG5	NC ² S	NC2S
Lγ ₂ x ray	XLG2	NE213	NE213
Lγ ₁ x ray	XLG1	NMR	NMR
M	M	NQR	NQR
M x ray	XM	NSσ	NS*SIGMA
M+=	M+=	NX	NX
M+L	ML	NaI	NAI
M+N+O	MNO	Ne	Ne
M-shell	M-SHELL	Nilsson	NILSSON
M-subshell	M-SUBSHELL	Note:	NOTE:
M/total ce	M/CE	November	NOVEMBER
M1	M1	Nuclear Data Sheets	NDS
M12	M12	N×σ	N*SIGMA
M2	M2	O	O
M23	M23	O/Q	O/Q
M3	M3	O1	O1
M4	M4	O123	O123
M45	M45	O2	O2
M5	M5	O3	O3
M6	M6	ORNL	ORNL
M8	M8	OSIRIS	OSIRIS
MEDLIST	MEDLIST	October	OCTOBER
MHZ	MHZ	Octupole mom(mag)	MOMM3

ENSDF Dictionary - ordered by output

<u>Translation</u>	<u>ENSDF</u>	<u>Translation</u>	<u>ENSDF</u>
Octupole mom(el)	MOME3	S(2p)	S(2P)
P1	P1	S(n)	SN
PAC	PAC	S(p)	SP
PAD	PAD	S(α)	SA
PWBA	PWBA	S-factors	S-FACTORS
PWIA	PWIA	S-factor	S-FACTOR
Particle normalization	NP	S-value	S-VALUE
P ₀	P0	S-values	S-VALUES
P _n	PN	S/	S/
Q	MOME2	S=	S=
Q	Q	SD	SD
Q(	Q(	SDB	SDB
Q(g.s.)	QP	SF	SF
Q(α)	QA	SOREQ	SOREQ
Q(β^-)	Q-	Saxon	SAXON
Q(ϵ)	Q+ ₋	Schmidt	SCHMIDT
Q+O	Q+O	Se(Li)	SE(LI)
Q/D	Q/D	Seltzer	SELTZER
Q2D	Q2D	September	SEPTEMBER
Q2DM	Q2DM	Si(Li)	SI(LI)
Q3D	Q3D	Si(Li)	SILI
QDD	QDD	SiO	SIO
QDDM	QDDM	Sliv-Band	SLIV-BAND
QDMDQ	QDMDQ	Sn	Sn
QMG	QMG	Steffen	STEFFEN
QQSP	QQSP	Stockholm	STOCKHOLM
QSD	QSD	T	TEMP
Q ₂₂	Q22	T	ISPIN
Q _s	QS	T/	T/
R	*R	T20	T20
R	R	T21	T21
R(DCO)	R(DCO)	T22	T22
RDDS	RDDS	TDPAD	TDPAD
RDM	RDM	TPAD	TPAD
RPA	RPA	TRISTAN	TRISTAN
RUL	RUL	TRIUMPH	TRIUMPH
Ritz	RITZ	Teller	TELLER
Rose	ROSE	Ti	Ti
Rutherford	RUTHERFORD	T _{1/2}	T1/2
Rytz	RYTZ	T _{1/2}	T
S values	S VALUES	T _z	ISPINZ
S value	S VALUE	U	U
S'	S'	UK	UK
S(2n)	S(2N)	UNISOR	UNISOR

ENSDF Dictionary - ordered by output

<u>Translation</u>	<u>ENSDF</u>	<u>Translation</u>	<u>ENSDF</u>
USA	USA	ce(M45)	CEM45
USSR	USSR	ce(M4)	CEM4
Univ	UNIV	ce(M5)	CEM5
University	UNIVERSITY	ce(N)/(γ+ce)	N/T
U ₂ A ₂	U2A2	ce(N)	CEN
V	V	ce(N+)/(γ+ce)	N+/T
VAP	VAP	ce(N1)	CEN1
W	W	ce(N2)	CEN2
W.u.	W.U.	ce(N3)	CEN3
Weisskopf	WEISSKOPF	ce(N45)	CEN45
Wigner	WIGNER	ce(N4)	CEN4
Winther	WINTHER	ce(N5)	CEN5
X(	X(	ce(O)	CEO
XX	XX	ce(O)/(γ+ce)	O/T
Xγ	XG	ce(O)+ce(P)	CEO+CEP
Y	YTTRIUM	ce(O1)	CEO1
Z	Z	ce(P+)/(γ+ce)	P+/T
Z>N	Z>N	ceβ	CEB
[E2]	[E2]	ceγ	CEG
[Iγ	[RI	cm ²	CM2
°	DEG	cm ³	CM3
x	*	configuration=	CONF=
av Eβ	EAV	configuration	CONF
a ₀	a0	cos ² θ	COS2TH
branching uncertainty	DBR	dE/dx	DE/DX
c.m.	C.M.	d ³ He	D3HE
ce	CE	dΩ	DOMEGA
ce(K)/(γ+ce)	K/T	dγ	DG
ce(K)	CEK	dσ	DSIGMA
ce(L)/(γ+ce)	L/T	dσ/dΩ	DS/DW
ce(L)	CEL	dσ/dΩ	*DS/DW
ce(L+)/(γ+ce)	L+/T	e'(θ)	E'(THETA)
ce(L1)	CEL1	eV	EV
ce(L12)	CEL12	even-A	EVEN-A
ce(L23)	CEL23	ex.	EX.
ce(L2)	CEL2	e ⁺	E+
ce(L3)	CEL3	e [±]	E+-
ce(M)/(γ+ce)	M/T	fm	FM
ce(M)	CEM	fm ⁻¹	FM-1
ce(M+)/(γ+ce)	M+/T	fm ⁻¹	FM**-1
ce(M1)	CEM1	fm ²	FM**2
ce(M2)	CEM2	fm ⁴	FM**4
ce(M23)	CEM23	g factor	G FACTOR
ce(M3)	CEM3	g factors	G FACTORS

ENSDF Dictionary - ordered by output

Translation	ENSDF	Translation	ENSDF
g(2+	G(2+	p1/2	P1/2
g-factors	G-FACTORS	p2n γ	P2NG
g-factor	G-FACTOR	pn γ	PNG
g.s.	GS	p α	PALPHA
g=	G=	p γ	PG
gT	G*T	p $\gamma\gamma$	PGG
gT _{1/2}	GT1/2	r ²	R**2
gW Γ_0^2	G*W*WIDTHG0**2	r ⁴	R**4
gw $\Gamma_{\gamma 0}$	G*W*WIDTHG0	r ⁶	R**6
g ₁ Γ	G1*WIDTH	r ₀	R0
g ₁	G1	s(ce)	S(CE)
g ₂ Γ	G2*WIDTH	s-wave	S-WAVE
g ₂	*G2	syst	SY
g ₂ ²	G2	s-1	S-1
g _A ²	GA2	t)	T)
g Γ	G*WIDTH	t,	T,
g $\Gamma_{\gamma 0}^2$	*G*WIDTHG0**2	th	TH
g $\Gamma_{\gamma 0}^2$	G*WIDTHG0**2	tof	TOF
g Γ_n	G*WIDTHN	ty	TG
g $\Gamma_{\gamma 0}$	G*WIDTHG0	w(θ)g $\Gamma_{\gamma 0}$	W(THETA)*G*WID
g $\Gamma_0\Gamma\gamma$	GWIDTH0WIDTHG	x-ray	X-RAY
k ω	HOMEGA	x-rays	X-RAYS
h ²	H**2	xpyn γ	XPYNG
is D	IS D	<r ² >	AVRSQ
kG	KG	< β^2 > ^{1/2}	BAVRSQ
kOe	KOE	Δ <r ⁴ >	DAVRSQ4
keV	KEV	Δ <r ² >	DAVRSQ
log f ^{1u} t	LOGF1UT	Δ <r ⁶ >	DAVRSQ6
log f ^{3u} t	LOGF3UT	(J+ $\frac{1}{2}$)	** (J+1/2)
log f ^{2u} t	LOGF2UT	-1	** -1
log f ^{1t}	LOGF1T	-3	** -3
log ft	LOGFT	-4	** -4
mb	MB	1/2	** 1/2
mb/sr	MB/SR	1/3	** 1/3
meV	MILLI-EV	¹² C γ	C12G
mg/cm ²	MG/CM2	2	**2
ms	MS	3	**3
nb/sr	NB/SR	L	**L
n γ	NG	e.g.	E.G.
n $\gamma\gamma$	NGG	i.e.	I.E.
odd-A	ODD-A	$\times E$	*E
p decay	P DECAF	$\times I\beta^-$	*IB-
p(θ)	P(THETA)	$\times Ie$	*IE
p-width	P-WIDTH	$\times Q$	*Q

ENSDF Dictionary - ordered by output

Translation	ENSDF	Translation	ENSDF
$\times T_{1/2}$	*T1/2	Φ	PHI
$\times A^{1/3}$	*A**(1/3)	$\Phi(p_2)$	PHI(P2)
$\times \sigma$	*SIGMA	$\Phi(p_1)$	PHI(P1)
\leq	LE	Γ	*WIDTH
\neq	NE	Γ	WIDTH
\geq	GE	$\Gamma_{\gamma 0}^2$	WIDTHG0**2
\approx	AP	Γ^2	WIDTH**2
$\approx <$	LA	Γ_n	WIDTHN
$\approx >$	GA	Γ_{n0}	WIDTHN0
∞	INFNT	Γ_{p0}	WIDTHP0
Δ	Δ	Γ_{p1}	WIDTHP1
$\Delta(\text{HF})$	DHF	Γ_p	*WIDTHP
$\Delta(\log ft)$	DFT	$\Gamma_{p'}$	WIDTHP'
$\Delta(\beta\text{-normalization})$	DNB	Γ_{p2}	WIDTHP2
$\Delta(\gamma\text{-normalization})$	DNR	Γ_p	WIDTHP
$\Delta(\gamma+ce\text{-normalization})$	DNT	$\Gamma_{\alpha 4}$	WIDTHA4
ΔA	DA	$\Gamma_{\alpha 1}$	WIDTHA1
ΔA_2	DA2	Γ_{γ}	WIDTHG
ΔA_4	DA4	$\Gamma_{\gamma 1}$	WIDTHG1
ΔE	DE	$\Gamma_{\alpha 2}$	WIDTHA2
$\Delta I(\gamma+ce)$	DTI	$\Gamma_{\alpha 0}$	WIDTHA0
$\Delta I\alpha$	DIA	$\Gamma_{\gamma 0}$	WIDTHG0
$\Delta I\beta$	DIB	$\Gamma_{\alpha 3}$	WIDTHA3
$\Delta I\epsilon$	DIE	Γ_{α}	WIDTHA
$\Delta I\gamma$	DRI	Σ	*SUMOF
$\Delta I\gamma(\%)$	PRI	Σ	SUMOF
ΔJ	DJ	Ψ	PSI
$\Delta J\pi$	DJPI	α	ICC
ΔK	DK	α	ALPHA
ΔL	DL	α	CC
ΔN	DN	α decay	A DECAY
$\Delta Q(\epsilon)$	DQ+	α decays	A DECAYS
$\Delta Q(\beta^-)$	DQ-	α syst	A SYST
$\Delta Q(\alpha)$	DQA	α'	A'
ΔS	DS	$\alpha's$	ALPHAS
$\Delta S(n)$	DSN	$\alpha(K)\text{exp}$	*EKC
$\Delta S(p)$	DSP	$\alpha(K)\text{exp}$	EKC
ΔT	DISPIN	$\alpha(K)$	KC
$\Delta T_{1/2}$	DT	$\alpha(L)\text{exp}$	ELC
$\Delta T_{1/2}$	DT1/2	$\alpha(L)$	LC
Δ	DELTA	$\alpha(L12)\text{exp}$	EL12C
$\Delta\alpha$	DCC	$\alpha(L12)$	L12C
$\Delta\delta$	DMR	$\alpha(L1)\text{exp}$	EL1C
$\Delta\pi$	DPI	$\alpha(L1)$	L1C

ENSDF Dictionary - ordered by output

<u>Translation</u>	<u>ENSDF</u>	<u>Translation</u>	<u>ENSDF</u>
$\alpha(L2)$	L2C	α_3	ALPHA3
$\alpha(L23)exp$	EL23C	$\alpha\alpha$	AA
$\alpha(L23)$	L23C	$\alpha\gamma$	AG
$\alpha(L2)exp$	EL2C	β	BETA
$\alpha(L3)exp$	EL3C	β	B
$\alpha(L3)$	L3C	$\beta's$	BETAS
$\alpha(M)exp$	EMC	$\beta(GT)$	BGT
$\alpha(M)$	MC	$\beta(IS)$	B(IS)
$\alpha(M+..)$	MC+	β -vibrational	B-VIBRATIONAL
$\alpha(M1)$	M1C	βR	B*R
$\alpha(M1)exp$	EM1C	βR	BETA*R
$\alpha(M2)$	M2C	βc	BC
$\alpha(M2)exp$	EM2C	βce	BCE
$\alpha(M3)$	M3C	βe^-	BE-
$\alpha(M3)exp$	EM3C	βn	BN
$\alpha(M4)$	M4C	βp	BP
$\alpha(M4)exp$	EM4C	β^+	B+
$\alpha(M5)$	M5C	$\beta^+ \epsilon$ Decay	BEC DECAY
$\alpha(M5)exp$	EM5C	β^{-2n}	B-2N
$\alpha(N)exp$	ENC	β^-	B-
$\alpha(N)$	NC	$\beta^- n$	B-N
$\alpha(N+..)$	NC+	β_0	B0
$\alpha(N1)exp$	EN1C	β_{04}	B04
$\alpha(N1)$	N1C	β_{03}	B03
$\alpha(N2)exp$	EN2C	β_{02}	B02
$\alpha(N2)$	N2C	β_{00}	B00
$\alpha(N23)exp$	EN23C	β_{12}	B12
$\alpha(N3)$	N3C	β_1	B1
$\alpha(N3)exp$	EN3C	β_{20}	B20
$\alpha(N4)exp$	EN4C	β_{24}	B24
$\alpha(N4)$	N4C	β_{22}	B22
$\alpha(N5)$	N5C	$\beta_2 R$	B2*R
$\alpha(N6)$	N6C	β_2	B2
$\alpha(O1)$	O1C	β_3	B3
$\alpha(O2)$	O2C	$\beta_3 R$	B3*R
$\alpha(O3)$	O3C	β_{30}	B30
$\alpha(O4)$	O4C	β_4	B4
$\alpha(P1)$	P1C	β_{42}	B42
$\alpha(exp)$	ECC	$\beta_4 R$	B4*R
α -decay	A-DECAY	β_5	B5
α -syst	A-SYST	$\beta_5 R$	B5*R
α_0	ALPHA0	β_6	B6
α_1	ALPHA1	$\beta_6 R$	B6*R
α_2	ALPHA2	β_7	B7

ENSDF Dictionary - ordered by output

Translation	ENSDF	Translation	ENSDF
β_L	BL	$\gamma\gamma\tau$	GGT
$\beta_L R A^{1/3}$	BL*R*A**(1/3)	$\gamma\gamma\gamma$	GGG
β_L^2	BL**2	χ	CHI
$\beta_L R$	BL*R	χ^2	CHI**2
$\beta\alpha$	BA	$\in M(\text{exp})$	ECM
$\beta\beta$	BB	$\in N(\text{exp})$	ECN
$\beta\gamma$	BG	κ	KAPPA
$\beta\gamma n$	BGN	λ	LAMBDA
$\beta\gamma\gamma$	BGG	μ	MOMM1
δ	MR	μ	MU
δ^2	MR**2	μb	UB
ϵ	EPSILON	$\mu b/sr$	UB/SR
ϵ	EC	$\mu b \times \text{MeV}$	UB*MEV
$\epsilon 2p$	EC2P	μg	UG
ϵB	EPSILONB	$\mu g/cm$	UG/CM
$\epsilon B(E2)\uparrow$	EBE2UP	μs	US
$\epsilon B(E3)\uparrow$	EBE3UP	μ^-	MU-
ϵK	CK	ν	NU
$\epsilon K(\text{exp})$	ECK	π	PI
ϵL	CL	π^-	PI-
$\epsilon L(\text{exp})$	ECL	$\pi\beta$	PIB
$\epsilon L1(\text{exp})$	ECL1	$\pi\beta\gamma$	PIBG
$\epsilon L2(\text{exp})$	ECL2	$\pi\gamma$	PIG
$\epsilon L3(\text{exp})$	ECL3	θ	THETA
ϵM	CM	θ^2	THETA**2
ϵN	CN	θ_1	THETA1
ϵp	ECP	θ_2	THETA2
$\epsilon\alpha$	ECA	θ_{p1}^2	THETAP1**2
γ	GAMMA	θ_{p2}^2	THETAP2**2
γ	G_	$\theta\alpha$	THETA A
γ/α	G/A	$\theta\alpha^2$	THETA A**2
γX	GX	$\theta\gamma$	THETA G
γce	GCE	ρ	RHO
γe^-	GE-	ρ^2	RHO**2
γn	GN	σ	SIGMA
γp	GP	$\sigma(n\gamma)$	SIGNG
$\gamma p'$	GP'	$\sigma(n\alpha)$	SIGNA
$\gamma p(t)$	GP(T)	σ_0	SIGMA(0)
γ^\pm	G+-	σ_n	SIGMAN
γ_0	G0	σ_γ	SIGMAG
$\gamma\beta$	GB	$\sigma \times \Delta E$	SIGMA*DE
$\gamma\beta^-$	GB-	σv	SIGMANU
$\gamma\gamma$	GG	τ	*TAU
$\gamma\gamma n$	GGN	τ	TAU

ENSDF Dictionary - ordered by output.

Translation

ENSDF

ω	OMEGA
$\omega^2\tau$	OMEGA**2*TAU
$\omega\tau$	OMEGA*T

Appendix H

ENSDF Policies

GENERAL POLICIES - Presentation of Data

The Nuclear Data Sheets are prepared from the Evaluated Nuclear Structure Data File (ENSDF), a computer file maintained by the National Nuclear Data Center on behalf of the International Network for Nuclear Structure and Decay Data Evaluations. See page iii for a list of the members of this network and their evaluation responsibilities. The presentation of material in the Nuclear Data Sheets reflects the organization of ENSDF, which is a collection of "data sets". For each nuclear species, these data sets present the following types of information:

- The adopted properties of the nucleus.
- The evaluated results of a single type of experiment, such as a radioactive decay, a single nuclear reaction, or the combined results of a number of similar types of experiments, such as (HI,xny) reactions. The data given in ENSDF are primarily derived from experimental information.

The general policies and conventions followed in the preparation of these data sets and in the presentation of material in the Nuclear Data Sheets (NDS) are discussed below.

General

The following policies apply to the adoption or presentation of data. Deviations from these policies will be noted by the evaluator.

1. The excitation energies of levels connected by γ transitions are from a least-squares fit to the adopted γ energies.
2. Dominant decay branches (i.e., for the decay of ground states and isomeric states) are rounded off to 100 when the competing branches total less than approximately 0.001%. When only one branch has been observed and no estimate can be made for expected competing branches, the observed branch is given as ≤ 100 and the competing branch(es) as "%branching=?".
3. Total internal-conversion coefficients (α) for each transition are theoretical values corresponding to the listed radiation character (i.e., multipolarity) and mixing ratio (δ). For a transition of mixed character (two or more multipolarities) and unknown mixing ratio, α is the average of the possible extremes and the uncertainty overlaps the full range of values.
In all calculations by the evaluator involving internal-conversion coefficients, a 3% uncertainty is assumed for the theoretical coefficients.
4. The cross reference flags (XREF), defined in the Adopted Levels table are given for each adopted level. When a level in an individual reaction or decay data set may correspond to more than one adopted level, the flag for that data set is given in lower case. In case of ambiguity, the energy from a particular data set is given as a comment.

Adopted Levels, Gammas data set

The Adopted Levels and γ radiations tables in the NDS are generated from an Adopted Levels, Gammas data set in ENSDF. This data set represents the best values for the level and γ properties as determined by the evaluator on the basis of all the available information.

The following information is included in an Adopted Levels, Gammas data set.

For the nuclide:

1. $Q(\beta^-)$: β^- decay energy [always presented as $Q(\beta^-) = M(A, Z) - M(A, Z+1)$] and α decay energy [$Q(\alpha)$] for the ground state.
2. $S(n)$ and $S(p)$: Neutron and proton separation energies.
3. **XREF**: Cross-reference symbol assignments for the various experimental data sets.

For each level:

1. **E(lev)**: Excitation energy (relative to the ground state).
2. **J π** : Spin and parity with arguments supporting the assignment.
3. **T $_{1/2}$** or **Γ** : Half-life or total width in center of mass.
4. **Decay branching** for the ground state and isomers (an isomer is defined as a nuclear level with $T_{1/2} \geq 0.1$ s or one for which a separate decay data set is given in ENSDF).
5. **Q $_{\mu}$** : Static electric and magnetic moments.
6. **XREF Flags** to indicate in which reaction and/or decay data sets the level is seen.
7. **Configuration assignments** (e.g., Nilsson orbitals in deformed nuclei, shell-model assignments in spherical nuclei).
8. **Band assignments** and possibly band parameters (e.g., rotational bands in deformed regions).
9. **Isomer and isotope shifts** (usually only a literature reference is given).
10. **Charge distribution of ground states** (usually only a literature reference is given).
11. **Deformation parameters**.
12. **B(E2) \uparrow , B(M1) \uparrow , ...**: Electric or magnetic excitation probabilities when the level half-life or the ground-state branching is not known.

For γ -ray and E0 transitions:

1. **Placement** in level scheme.
2. **E γ** : Measured γ -ray or E0 transition energy.
3. **I γ** : Relative photon intensity from each level.
4. **Mult, δ** : Electric or magnetic multipole character, the mixing ratio, and nuclear penetration parameter.
5. **CC**: Total internal-conversion coefficient (when significant).
6. **B(EL)(W.u), B(M1)(W.u), ...**: Reduced transition probabilities in Weisskopf units.

GENERAL POLICIES - Presentation of Data (cont.)

Reaction and decay data sets

These data sets include information about different types of experiments and may include data sets for β decay, α decay, isomeric transition (IT) decay, Coulomb excitation, charged-particle reactions [such as (d,p) and (t,p)], heavy-ion reactions [such as ($^{40}\text{Ar}, \text{xn}\gamma$)], (γ, γ), and mesonic atoms.

The following policies apply to the presentation of data in reaction and decay data sets. Any deviation from these policies will be noted by the evaluator.

1. The J^π values in the decay data sets and reaction data sets with gammas are taken from the associated Adopted Levels, Gammas data set. For other reaction data sets the J^π values are from the reaction data. The J^π value to the capture state in thermal-neutron capture is assigned assuming s-wave capture.
2. The character of a γ ray and its mixing ratio are from the associated Adopted γ radiation table.
3. The term "absolute intensity" has the same meaning as the term "emission probability", and the term "relative intensity" is equivalent to "relative emission probability" or "relative emission rate." The former are given as intensities per 100 decays.
4. Beta and electron-capture intensities are per 100 decays of the parent and are usually deduced from γ intensity imbalance for the levels fed. The separation of $I(e+\beta^+)$ into $I(e)$ and $I(\beta^+)$ is based on theoretical s/β^+ ratios. The log f values for nonunique transitions are calculated as for allowed transitions.
5. Particle transition intensities (other than β 's) are per 100 particle decays. The total particle branching is given both in the drawings and in the tables.
6. Tabular γ -ray intensities are relative values. The normalization factor to convert them to absolute intensities [photons per 100 decays of the parent for decay data sets, or photons per 100 neutron captures for (n, γ) data sets, etc.] is given in a footnote.
7. Radiations from the decay of neutron or proton resonances are not presented. The energies and other level properties for bound levels deduced from resonance experiments are included. Primary as well as secondary γ 's following thermal-neutron capture are generally included.
8. $BE\lambda$, $BM\lambda$ for the excitation of levels are generally given.
9. Up to three references that make major contributions to the information in a specific data set are given in the data set heading. These major references also appear in the drawings.

Organization of material

Within each A chain, information is presented by nuclides which are arranged in order of increasing Z. There is an index for each evaluation which is followed by an isobaric diagram. A table of properties for the ground state and isomeric levels for all nuclides of the A chain is given following or with the isobaric diagram.

For each nuclide, A_Z , the arrangement of material and conventions for inclusion in tables are described below.

1. Adopted levels in A_Z - All adopted level properties are shown for each level, together with explanatory comments.
2. Adopted γ radiations in A_Z .
3. Band structure is shown where known.
4. Levels and radiations in A_Z from radioactive decays - Decays are ordered by increasing A, Z, and excitation energy of the parent.
 - a. Table of levels deduced from the decay.
 - b. Tables of radiations observed in the decay.
 - c. Decay Scheme
5. Levels and γ rays in A_Z from nuclear reactions - Reactions are ordered by increasing A, Z of the target, then by increasing A, Z of the incident nucleus. A heading is given for each reaction.
 - a. Table of levels deduced from the reaction.
 - b. Table of γ rays observed in the reaction, if any.
 - c. Level Scheme, if γ rays were observed and placed.

GENERAL POLICIES - "THEORY"

A reference "Theory 1967Xy01" indicates theoretical predictions computed by the authors of 1967Xy01. A reference "Theory" alone indicates a determination by the evaluator of theoretical predictions described below.

Internal Conversion Coefficients

Theoretical conversion coefficients are obtained by spline interpolation (1968Ha53) from tables of Hager and Seltzer (1968Ha53) for the K-, L₁...₃-, M₁...₅-shells and of Dragoun, Plajner, and Schmutzler (1971Dr11) for the (N+O+...) -shells. For the N₁...₅-subshells, values are obtained by graphical interpolation from tables of Dragoun, Pauli, and Schmutzler (1969Dr09). For K-, L₁...₃-shells, conversion coefficients for transitions outside the E_γ, A, or Z ranges of Hager and Seltzer are obtained as follows: for E_γ < 6000 keV and for Z=3,6,10 and 14 ≤ Z ≤ 30 interpolation from tables of Band, *et al.* (1976Ba63); for E_γ > 2600 keV, by graphical interpolation from tables of Trusov (1972Tr09). For E0 transitions, K/L₁ and L₁/L₂ ratios are obtained by graphical interpolation from tables of Hager and Seltzer (1968Ha61).

Angular Distribution and Correlation Coefficients

The coefficients required for analysis of directional correlation, polarization correlation, directional distribution, and polarization distribution data are obtained as described by Steffen (1971St47, 1971St48). In particular, we adopt the phase convention for the mixing ratio, δ, defined by Krane and Steffen (1970Kr03). Particle parameters required for the analysis of correlation and distribution data involving conversion electrons are obtained by graphical interpolation from tables of Hager and Seltzer (1968Ha54). The expression for the deorientation coefficient required to account for intermediate unobserved mixed radiations is given by Anicin (1972An20).*

A tabulation of gamma-gamma directional-correlation coefficients is given by Taylor, *et al.* (1971Ta32). These authors use the Steffen phase convention.

Penetration Parameters

Penetration parameters required for the analysis of internal conversion data and angular correlation or distribution data involving electrons are obtained by graphical interpolation from tables of Hager and Seltzer (1968Ha61).

Internal Pair Conversion Coefficients

Theoretical internal pair conversion coefficients for Λ=E1, M1, E2 are obtained by graphical interpolation in Z, E from tables of Lombard, *et al.* (1968Lo16).

* As pointed out by these authors, most earlier references which discuss this coefficient define it incorrectly.

β-Decay Rate Probabilities

Log ft values, capture-to-positron ratios, and electron-capture ratios for allowed, first-forbidden unique, and second-forbidden unique transitions are obtained as described by Gove and Martin (1971Go40). This reference also contains a tabulation of log ft values and total capture-to-positron ratios for allowed and first-forbidden unique transitions.

Atomic Processes

X-ray fluorescence yields are obtained from Bambynek, *et al.* (1972Bb16) for Z ≤ 92 and from Ahmad (1979Ah01) for Z > 92.

Electron binding energies for Z < 84 are taken from Bearden and Burr (1967Be73) and from Porter and Freedman (1978Po08) for Z > 84.

α-Decay Hindrance Factors

The α-hindrance factors (the ratio of the measured partial half-life for α-emission to the theoretical half-life) are obtained from the spin-independent equations of Preston (1947Pr17). The nuclear radius for each even-even nucleus is determined by defining, for the g.s. to g.s. α-transition, the hindrance factor (HF)=1. For odd-A and odd-odd nuclei, the radius parameters are chosen to be the average of the radii for the adjacent even-even nuclei (1998Ak04). In cases where only one adjacent even-even radius is known, the extrapolated/interpolated value for the unknown radius is used in the calculation. A survey of the dependence of α-hindrance factors on asymptotic quantum numbers and the variation of α-hindrance factors within rotational bands is given for A > 229 in 1972El21.

Electromagnetic Transition Rates

The Weisskopf single-particle estimates for the half-lives of electric and magnetic multipole radiation of energy E_γ are (1952B197)

$$T_{1/2W}(EL) = 0.190 \left(\frac{L}{L+1} \right) \left(\frac{3+L}{3} \right)^2 \frac{[(2L+1)!!]^2}{A^{2L/3}} \left(\frac{164.44}{E_\gamma (\text{MeV})} \right)^{2L+1} \times 10^{-21} \text{ s}$$

$$T_{1/2W}(ML) = 3.255 A^{2/3} T_{1/2W}(EL)$$

for a nuclear radius of $1.2 A^{1/3} \times 10^{-13}$ cm.

Unweighted and Weighted Averages

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

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

and $\Delta \bar{x}$ is the larger of

$$(W)^{1/2} \\ \text{and } [W \sum (\Delta x_i)^{-2} (\bar{x} - x_i)^2 / (n-1)]^{1/2}.$$

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

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

SUMMARY OF BASES FOR SPIN AND PARITY ASSIGNMENTS

PROPOSITIONS ON WHICH STRONG ARGUMENTS ARE BASED

Ground States

1. The ground state of an even-even nucleus has $J^\pi = 0^+$.
2. Spin determinations by such techniques as atomic-beam resonance, paramagnetic resonance, electron-spin resonance, and optical spectroscopy give correct values.

Gamma Transitions

3. The agreement of the measured value of a single conversion coefficient with the theoretical value for a multipolarity which is well separated from the value for any other multipolarity determines the transition multipolarity.
4. In all other cases if there is no other evidence for multipolarity, agreement of two or more measured conversion coefficients or ratios with theoretical values is necessary in order to establish the multiplicities of a transition and its mixing ratio.
5. Since an E0 transition can proceed only by conversion or pair production, pure E0 is ruled out if photons are observed.
6. Recommended upper limits for γ -ray strengths (Γ_γ/Γ_w , Γ_w -Weisskopf estimate) for various A values are given below.

Character*	Γ_γ/Γ_w (Upper Limit)		
	A=6-44 ^{a,b}	A=45-150 ^{b,c}	A>150 ^d
E1 (IV)	0.3 ^a	0.01	0.01
E2 (IS)*	100	300	1000
E3	100	100	100
E4	100	100 ^b	
M1 (IV)	10	3	2
M2 (IV)	3	1	1
M3 (IV)	10	10	10
M4		30	10

* 'IV' and 'IS' stand for isovector and isoscalar

^a Γ_γ/Γ_w (Upper Limit)=30 for A=90-150

^b Γ_γ/Γ_w (Upper Limit)=0.1 for A=21-44

^c Γ_γ/Γ_w (Upper Limit)=0.003 for E1 (IS), 10 for E2 (IV), 0.03 for M1 (IS), 0.1 for M2 (IS)

^d From 1979En05

^e From 1979En04

^f From 1981En06

^g Deduced from ENSDF by M. J. Martin

^h In super-deformed bands the E2 transitions can have $\Gamma_\gamma/\Gamma_w > 1000$.

Beta Transitions

7. If $\log ft < 5.9$, the transition is allowed: $\Delta J=0$ or 1, $\Delta\pi=\text{no}$ (no change in parity). Superallowed ($\Delta T=0$) $0^+ \rightarrow 0^+$ transitions have $\log ft$ in the range 3.48 to 3.50. Isospin forbidden ($\Delta T=1$) $0^+ \rightarrow 0^+$ transitions have $\log ft > 6.4$. If $3.6 < \log ft < 6.4$, the transition is not $0^+ \rightarrow 0^+$.
8. If $\log f^{1u} < 8.5$ ($\log f^t < 7.4$), $\Delta J=0,1$; $\Delta\pi=\text{yes}$ or no .
9. If $\log ft < 11.0$, $\Delta J=0,1$; $\Delta\pi=\text{yes}$ or no or $\Delta J=2$, $\Delta\pi=\text{yes}$.
10. If $\log ft < 12.8$, $\Delta J=0,1,2$; $\Delta\pi=\text{yes}$ or no .
11. If $\log f^{1u} \geq 8.5$ ($\log f^t \geq 7.4$) and if the Fermi plot has the curvature corresponding to a shape factor (p^2+q^2), then the transition is first-forbidden unique ($\Delta J=2$, $\Delta\pi=\text{yes}$).

See "β-Decay Rate Probabilities" on page vii.

Note that $\log f^{1u} = \log f^t + 1.079$.

Note: For nuclei at, or very near to, closed shells values may be smaller. For example, in the mass region around Z=82, the upper limit of 5.9 given in #7 above could be 5.1.

† See 1973Ra10

$\gamma\gamma$ Directional Correlation

$$W(\theta) = \sum_{k=\text{even}} A_k P_k(\cos \theta)$$

12. If a gamma-gamma directional-correlation experiment yields $A_2 \approx +0.36$ and $A_4 \approx +1.1$, then the spin sequence is $0 \rightarrow 2 \rightarrow 0$.

13. Results of $\gamma\gamma(\theta)$ are strong evidence for excluding spin sequences for which the theoretical A_2 or A_4 falls well outside the experimental range.

$\beta\gamma$ Directional Correlation

$$W(\theta) = \sum_{k=\text{even}} A_k(\beta) A_k(\gamma) P_k(\cos \theta)$$

14. If $|A_2(\beta)| \geq 0.1$ ($A_2=0$), the transition is not allowed. The converse is not true.

15. If $A_4(\beta) \neq 0$, the transition is neither allowed nor first forbidden.

16. If $A_4(\beta)=0$, the transition is allowed or first forbidden.

$\beta\gamma$ Polarization Correlation

$$P(\theta) = \frac{\sum_{k=\text{odd}} A_k(\beta) A_k(\gamma) P_k(\cos \theta)}{W(\theta)}$$

17. In allowed transitions,

$$\begin{array}{ll} \beta^- & A_1(\beta) < 0 \text{ if } J_i = J_f \\ \beta^+ & A_1(\beta) > 0 \text{ if } J_i = J_f \\ & A_1(\beta) \geq 0 \text{ if } J_i = J_f + 1 \\ & A_1(\beta) < 0 \text{ if } J_i = J_f - 1 \\ \beta^- & A_1(\beta) \leq 0 \text{ if } J_i = J_f + 1 \\ \beta^+ & A_1(\beta) > 0 \text{ if } J_i = J_f - 1 \end{array}$$

18. If $A_3(\beta) \neq 0$, the β -transition is not allowed. The converse is not always true.

γ Angular Distribution

19. In the angular distribution of gamma rays from deexcitation of states populated in high-spin reactions (for a typical value of $\sigma/J=0.3$, where σ is the magnetic substate population parameter):

- a. If $A_2 \approx +0.3$ and $A_4 \approx -0.1$, the transition is generally $\Delta J=2$ (stretched quadrupole). (The same A_2 and A_4 values are possible for $\Delta J=0$, D+Q transitions also, but such transitions are less common. $A_4=0$ for $\Delta J=0$, dipole transition).
- b. If $A_2 \approx -0.2$ and $A_4=0$, the transition is generally $\Delta J=1$ (stretched dipole).
- c. If $A_4 > 0$ ($A_2 \approx +0.5$ to -0.8), the transition is $\Delta J=1$, D+Q.

γ DCO Ratio

In the angular correlation (DCO) of gamma rays from deexcitation of states populated in high-spin reactions (for a typical value of $\sigma/J=0.3$, where σ is the magnetic substate population parameter):

20. For $\Delta J=2$, stretched quadrupole as a gating transition:
 - a. $R(\text{DCO}) \approx 1.0$, the transition is generally $\Delta J=2$ (stretched quadrupole). (The same value is possible for $\Delta J=0$, dipole but such transitions are less common).
 - b. If $R(\text{DCO}) \approx 0.5$, the transition is generally $\Delta J=1$ (stretched dipole).
 - c. If $R(\text{DCO})$ differs significantly from ≈ 0.5 or ≈ 1.0 , the transition is $\Delta J=1$ (or 0), D+Q.

SUMMARY OF BASES FOR SPIN AND PARITY ASSIGNMENTS - continued

PROPOSITIONS ON WHICH STRONG ARGUMENTS ARE BASED continued

γ DCO Ratio continued

21. For $\Delta J=1$, stretched dipole as a gating transition:
 - a. If $R(\text{DCO}) \approx 2.0$, the transition is generally $\Delta J=2$ (stretched quadrupole). (The same value is possible for $\Delta J=0$, dipole transitions, but such transitions are less common).
 - b. If $R(\text{DCO}) \approx 1.0$, the transition is generally $\Delta J=1$ (stretched dipole).
 - c. If $R(\text{DCO})$ differs significantly from ≈ 2.0 or ≈ 1.0 , the transition is $\Delta J=1$ (or 0), D+Q.

Reactions

22. Low-energy Coulomb excitation is predominantly E2 excitation.
23. Coulomb excitation determines J^π if the excitation probability agrees with the calculated values of Alder (60Al23).
24. The spin of the compound nuclear state resulting from thermal-neutron capture is equal to the spin of the target nucleus plus or minus $1/2$.
25. Primary γ 's from neutron capture are E1, M1, E2, or M1+E2.
26. If the angular distribution in a single-nucleon transfer reaction can be fitted with a unique L value, the spin of the final state J_f is related to the spin of the initial state J_i by

$$\vec{J}_f = \vec{J}_i + \vec{L} + \vec{M}$$

with parity change if L is odd.

27. If the vector analyzing power for a single-nucleon transfer reaction shows a clear preference between $J=L+1/2$ and $J=L-1/2$ and if the L value is known, then the J value is determined.

28. Generally for the states populated in high-spin reactions, spins increase with increasing excitation energy. This is a result of the fact that these reactions tend to populate yrast or near yrast states.

29. If the angular distribution can be fitted with a unique L-value the J^π of the final state is related to the J^π of the initial state by $\vec{J}_f = \vec{J}_i + \vec{L}$, $\pi_f \pi_i = (-1)^L$, for the following cases

- a. A strong group observed in (p,t), (t,p), and ($^3\text{He,n}$) reactions (strong groups are assumed to result from two identical nucleons transferred in a relative s state)
- b. A strong group observed in the α -particle transfer reaction ($^6\text{Li,d}$).
- c. (e,e') and (α,α') inelastic scattering.
30. In reactions with $J^\pi=0^+$ target, projectile, and ejectile, if the yield of a group at 0° or 180° is
 - a. non-zero, the parity of the final state is $(-1)^{J_f}$
 - b. zero at several uncorrelated energies, the parity of the final state is $(-1)^{J_f+1}$
31. In reactions with a polarized $J^\pi=1$ projectile in the $m=0$ substate, with $J^\pi=0^+$ ejectile and target, if the yield of a group at 0° or 180° is
 - a. non-zero, the parity of the final state is $(-1)^{J_f+1}$
 - b. zero at several uncorrelated energies, the parity of the final state is $(-1)^{J_f}$

Regions of Strong Nuclear Deformation

The systematic occurrence of rotational-band structure in the strongly deformed nuclides can be a considerable help in making J^π assignments, since one can also use the level energy as one of the considerations. This frequently makes it possible to assign a J^π value to a level with confidence from data which, absent such structure, might yield an ambiguous assignment.

32. Level-energy considerations. If the couplings among the states are not too strong, the energies of the lower members of a band can be expressed by the relatively simple relation (see, e.g., 1971Bu16 and references therein):

$$E(J,K) = AX + BX^2 + CX^3 + \dots + (-1)^{J+K} \prod_{i=1-K}^K (J+i) \{A_{2K} + B_{2K}X + \dots\} \quad (1)$$

where $X = J(J+1) - K^2$

The inertial parameter, A, exhibits a systematic behavior in the various regions of strongly deformed nuclei, which can be helpful in assigning levels to rotational bands. In some instances (e.g., strong Coriolis coupling) where the A values depart significantly from systematic trends, this observation can itself be useful, since it can help establish the presence of such effects and, hence, provide evidence for the relevant nucleonic configurations.

For the case of $K=1/2$ bands, the decoupling parameter, a, which is characteristic for each such band, is given by the ratio A_1/A in (1). Establishing a value for the decoupling parameter of a proposed band can be useful in assigning a nucleonic configuration to it - and vice-versa.

33. Allowed-unhindered beta transitions. In this region, beta transitions having $\log ft$ values < 5.0 are classified as "allowed unhindered" (au). Such transitions take place between one-quasiparticle orbitals having the same asymptotic quantum numbers. In the "rare-earth" region ($90 \leq N \leq 112$, $60 \leq Z \leq 76$), four such orbital pairs are known: [532], near the beginning of this region; [523], near the middle of this region; [514], above the middle of this region; and, at the high end, [505]. Observation of an au transition is definitive evidence for the presence of the particular pair of orbitals.

34. Coulomb excitation. If a sequence of levels having "rotational-like" energy spacings is found to be excited with enhanced probabilities, this is evidence that this sequence (at least below the first "backband") forms the ground-state rotational band for the nuclide involved. If the E2 transition probabilities involved are large (tens of Weisskopf units or larger) and comparable to each other, then this is definitive evidence for both a band structure and the sequence of J^π values, assuming one of the spins is known.

35. Alpha decay. Observation of a "favored" α transition (HF < 4) indicates that the two states involved have the same nucleonic configuration. If a sequence of levels having "rotational-like" energy spacings is associated with the level fed by this favored transition and these levels have HF's that vary according to the established trend within rotational bands (1972El21), then this sequence can be considered to form a rotational band whose nucleonic configuration is the same as that of the alpha-decaying state. If the J^π value of this latter state and its configuration are known, then the corresponding quantities can be considered to be known for the band in the daughter nuclide or vice versa.

36. Single-nucleon-transfer reactions (light-ion-induced). For a single-nucleon transfer reaction induced by light ions (^4He and lighter), the characteristic pattern of cross sections among rotational-band members ("fingerprint") can be used to assign a set of levels as specific J^π members of a band based on a particular Nilsson configuration, if the fingerprint agrees well with that predicted by the Nilsson-model wavefunctions and is distinct from those expected for other configurations in the mass region. (This method is even stronger if angular distributions giving unique L values, or vector analyzing powers, support the assignments for one or more of the levels.)

SUMMARY OF BASES FOR SPIN AND PARITY ASSIGNMENTS - continued

PROPOSITIONS ON WHICH STRONG ARGUMENTS ARE BASED continued

High-spin states

In the decay of high-spin states, commonly produced in heavy-ion induced compound nuclear reactions or in highly excited nuclides created as products of nuclear fission or in Coulomb excitation, the multipolarities of the deexciting γ transitions and the relative spins and parities of the levels are generally determined from angular distributions, angular correlations (DCO ratios), linear polarizations and internal-conversion coefficients. In addition, relative energy-level spacings and the increase of γ intensity with decreasing excitation energy are important clues.

37. For a well-deformed nucleus when a regular sequence of $\Delta J=2$ (stretched quadrupole) transitions is observed at high spins as a cascade, the sequence may be assigned to a common band with E2 multipolarity for all the transitions in the cascade. A similar but somewhat weaker argument holds for less deformed nuclei where a common sequence of levels is connected by a regular sequence of $\Delta J=2$ (stretched quadrupole) transitions in a cascade.

38. For near-spherical nuclei, when a regular sequence of $\Delta J=1$ (stretched dipole) transitions is observed at high spins as a cascade, then the sequence may be assigned to a common band with (M1) multipolarity for all the transitions in the cascade. (Cascades of $\Delta J=1$, E1 transitions occur in rare cases of nuclides which show alternating-parity bands or reflection asymmetry.)

39. In the absence of angular distribution/correlation data, a regular sequence of transitions in a cascade may be assigned to a common structure or a band if (a) the low-lying levels of this structure have well established spin and parity assignments and (b) there is good evidence that, at higher energies and spins, the band has not changed in its internal structure due to band crossings or other perturbations.

Alpha Decay

40. The hindrance factor for an α transition from the ground state of an even-even nucleus to the ground state of the daughter nucleus is 1.0 by definition. For odd-A and odd-odd nuclei, hindrance factors ≤ 4 identify favored α transitions, and these connect states having the same spin, parity and configuration.

41. For α -decay between two states, one of which has $J=0$, the parity change is given by $\Delta\pi=(-1)^{J_0}$.

PROPOSITIONS ON WHICH WEAK ARGUMENTS ARE BASED

1. In cases where gammas of one multipolarity "cluster" in one time region in the half-life vs. energy plot, as is true for M4's, other γ 's whose half-lives fall in this cluster may be assigned the corresponding multipolarity.

2. In cases where a cluster of two multipolarities, e.g. M1 and E2 occupies one time region, a new gamma of which the half-life falls in this region may be assigned one of the two multipolarities or a mixture of the two.

3. Whenever $\Delta J \geq 2$, an appreciable part of the gamma transition proceeds by the lowest possible multipole order.

This statement is based on the scarcity of counter-examples and the observation that few E2 γ 's are as slow as M3's, few M2's as slow as E3's, etc.

4. The spin and parity of a parent state may be inferred from the measured properties of its assumed isobaric analog resonance, and *vice versa*.

5. Low-lying states of odd-A nuclei have shell-model spins and parities, except in the regions where deformations appear. This argument is much stronger when supported by expected cross-section strengths (C^2S) in single-nucleon transfer reactions.

It is recognized that some shell-model predictions are stronger than others. For example, the shell model would mildly deny that the ground-state J^π of the 39th proton be $3/2^+$, but emphatically deny its being $3/2^-$. However, we have not included this distinction here and consider all shell-model arguments to be weak.

6a. For low-lying states of odd-odd spherical nuclei, the Nordheim rules (1950No10):

$$J = j_p + j_n, \text{ if } j_p = 1/2 \text{ and } j_n = 1/2; \\ J = |j_p - j_n|, \text{ if } j_p = 1/2 \text{ and } j_n = 1/2.$$

may be helpful in obtaining the ground-state spins and parities, if there is supporting evidence.

6b. For excited states of strongly deformed odd-odd nuclei, the Gallagher-Moszkowski rules (1958Ga27) may be helpful in deducing the relative positions of the two two-quasiparticle states formed by the two different couplings of the quasiparticle constituents, if there is supporting evidence. Here, the state corresponding to the parallel alignment ($\Sigma=1$) of the projections ($=1/2$) of the intrinsic spins of the two odd particles is expected to lie lower than that produced by the antiparallel ($\Sigma=0$) alignment. This can be particularly useful in establishing the ground state J^π values and nucleonic configurations for odd-odd nuclei.

(In the strongly deformed even-even nuclei, the opposite is expected to obtain, i.e., the $\Sigma=0$ coupling should lie lower than that with $\Sigma=1$. In these nuclei, however, the experimental situation is less clear since the two-quasiparticle excitations occur at or above the pairing gap, where the level densities are high and couplings to vibrational excitations can affect the two two-quasiparticle states differently.)

7. Statements similar to 5 and 6 based on other models.

8. Statements based on interpolation or extrapolation of regional trends, such as shown in 1971Bu16, 1972El21, 1977Ch27, 1990Ja11 and 1998Ja07 for the rare-earth and heavy-mass regions.

9. All statements connected with the nonobservation of expected transitions.

10. Rules extracted in the survey by 1972El21 for unfavored α transitions can be used to deduce the configuration of the parent or the daughter level, if the configuration of the other is known.

11. For magnetic moments, the extreme rarity of pure single-particle states and observation of large deviations from free-nucleon g -factors in nuclei means that comparison between the experiment and the 'Schmidt Limit' estimates (based on such pure states) is not a sound basis for spin or parity assignment. The magnetic moments or g -factors, however, can give supporting evidence for assignments where predictions for possible alternatives, using g -factors based on local systematics of measured moments, differ widely.

For excited states, the 'collective' aspects of the state frequently make substantial contribution to the magnetic moment. The correct g -factor for this contribution is a matter of detailed theory and any assignment based on assumed $g(\text{collective})=Z/A$ must be viewed with caution.

CONVENTIONS USED IN NUCLEAR DATA SHEETS

Units

Energies	keV
Cross Sections	barns
Magnetic dipole moments	nuclear magnetons (μ_N)
Electric quadrupole moments	barns
B(EL)	$e^2 b^L$
B(ML)	$\mu_N^2 b^{L-1}$

Uncertainties ("Errors") The uncertainty in any number is given one space after the number itself:

4.623 3	means 4.623 \pm 0.003
4.6 h 12	means 4.6 \pm 1.2 h
5.4×10^3 2	means 5400 \pm 200
4.2 +8-10	means 4.2 $^{+0.8}_{-1.0}$
-4.2 +8-10	means $-(4.2 +10-8) = -4.2^{+0.8}_{-1.0}$

? Question Mark given after a quantity often indicates doubt as to the existence or the value of the quantity. For example, a "?" given after the $T_{1/2}$ value indicates that the assignment of that half-life to the associated level is not certain.

() Parentheses have the following interpretation for different quantities in the tabular data:

Quantity	Meaning of parentheses
J^π	J^π based upon weak arguments. See SUMMARY OF BASES FOR SPIN AND PARITY ASSIGNMENTS.
L transfer or Mult.	Possible value but not definitely established experimentally.
Other	Value deduced (i.e., is not directly measured) or taken from other sources.

Examples:

$$J^\pi = (1/2, 3/2)^-$$

Weak arguments limit the spin to 1/2 or 3/2. Strong arguments indicate negative parity.

$$J^\pi = 4^{(+)}$$

Strong arguments show the spin is 4; weak arguments suggest positive parity.

$$L = (3)$$

L value tentatively established as 3.

$$\text{Mult.} = (M1)$$

Radiation character tentatively established as M1.

$$\text{Mult.} = M1(+E2)$$

Radiation character includes E2 with a mixing ratio, $|\delta|$, that may be >0 .

[] Brackets

$7/2^- [514]$ Nilsson asymptotic quantum numbers, $K^\pi [N n_z A]$

Assumed quantity, e.g., $[M1+E2]$

References

- 1947Pr17 M. A. Preston - Phys. Rev. 71, 865 (1947); The Theory of Alpha-Radioactivity
- 1950No10 L. W. Nordheim, Phys. Rev. 78, 294 (1950) Beta-Decay and the Nuclear Shell Model
- 1952B197 J. M. Blatt, V. F. Weisskopf - Theoretical Nuclear Physics, John Wiley and Sons, Inc., New York, p. 627 (1952)
- 1958Ga27 C. J. Gallagher and S.A. Moszkowski, Phys. Rev. 111, 1282 (1958); Coupling of Angular Momenta in Odd-Odd Nuclei
- 1958Ro60 M. E. Rose - Internal Conversion Coefficients, North-Holland Publishing Co., Amsterdam (1958)
- 1960Al23 K. Alder, A. Winther, Kgl. Danske Videnskab, Selskab, Mat.-Fys. Medd. 32, No. 8 (1960); On the Theory of Multiple Coulomb Excitation with Heavy Ions
- 1967Be73 J. A. Bearden, A.F. Burr - Rev. Mod. Phys. 39, 125 (1967); Reevaluation of X-Ray Atomic Energy Levels
- 1968Ha53 R. S. Hager, E. C. Seltzer - Nucl. Data A4, 1 (1968); Internal Conversion Tables. Part I: K-, L-, M-Shell Conversion Coefficients for Z=30 to Z=103
- 1968Ha54 R. S. Hager, E. C. Seltzer - Nucl. Data A4, 397 (1968); Internal Conversion Tables. Part II: Directional and Polarization Particle Parameters for Z=30 to Z=103
- 1968Lo16 R. J. Lombard, C. F. Perdriat, J. H. Brunner - Nucl. Phys. A110, 41 (1968); Internal Pair Formation and Multipolarity of Nuclear Transitions
- 1969Dr09 O. Dragoun, H. C. Pauli, F. Schmutzler - Nucl. Data Tables A6, 235 (1969); Tables of Internal Conversion Coefficients for N-Subshell Electrons
- 1969Ha61 R. S. Hager, E. C. Seltzer - Nucl. Data Tables A6, 1 (1969); Internal Conversion Tables. Part III: Coefficients for the Analysis of Penetration Effects in Internal Conversion and E0 Internal Conversion
- 1970Kr03 K. S. Krane, R. M. Steffen - Phys. Rev. C2, 724 (1970); Determination of the E2/M1 Multipole Mixing Ratios of the Gamma Transitions in ^{110}Cd
- 1971Bu16 M.E. Bunker and C. W. Reich, Revs. Mod. Phys. 43, 348 (1971) A Survey of Nonrotational States of Odd-A Nuclei ($150 < A < 190$)
- 1971Dr11 O. Dragoun, Z. Plajner, F. Schmutzler, Nucl. Data Tables A9, 119 (1971); Contribution of Outer Atomic Shells to Total Internal Conversion Coefficients
- 1971Go40 N. B. Gove, M. J. Martin - Nucl. Data Tables A10, 205 (1971); Log-f Tables for Beta Decay
- 1971St47 R. M. Steffen - Report LA-4565-MS, Los Alamos Scientific Laboratory (1971); Angular Distributions and Correlations of Radiation Emitted from Oriented Nuclei
- 1971St48 R. M. Steffen - Proc. Int. Conf. Angular Correlations in Nuclear Disintegration, Delft, Netherlands (1970), H. van Krugten, B. van Nooijen, Eds., Wolters-Noordhoff Publ., Groningen, p. 1 (1971); Angular Distributions and Correlations of Nuclear Radiations in Nuclear Spectroscopy
- 1971Ta32 H. W. Taylor, B. Singh, F. S. Prato, R. McPherson - Nucl. Data Tables A9, No. 1, 1 (1971); A Tabulation of Gamma-Gamma Directional-Correlation Coefficients
- 1972An20 I. V. Anicin, R. B. Vukanovic, A. H. Kukoc - Nucl. Instrum. Methods 103, 395 (1972); The New Feature of 1-3 Directional Correlations with Mixed Unobserved Transitions
- 1972Bb16 W. Bambynek, B. Crasemann, R. W. Fink, H.-U. Freund, H. Mark, C. D. Swift, R. E. Price, P. Venugopala Rao - Rev. Mod. Phys. 44, 716 (1972); X-Ray Fluorescence Yields, Auger, and Coster-Kronig Transition Probabilities
- 1972E121 Y. A. Ellis, M. R. Schmorak - Nucl. Data Sheets B8, 345 (1972); Survey of Nuclear Structure Systematics for A \geq 229
- 1972Tr09 V. F. Trusov - Nucl. Data Tables 10, 477 (1972); Internal Conversion Coefficients for High-Energy Transitions
- 1973Ra10 S. Raman, N. B. Gove - Phys. Rev. C7, 1995 (1973) Rules for Spin and Parity Assignments Based on log ft values
- 1976Ba63 I. M. Band, M. B. Trzhaskovskaya, M. A. Listengarten At. Nucl. Data Tables 18, 433 (1976); Internal Conversion Coefficients for Atomic Numbers Z \leq 30
- 1977Ch27 R. R. Chasman, I. Ahmad, A. M. Friedman and J. R. Erskine, Revs. Modern Phys. 49, 833 (1977) Survey of Single-Particle States in Mass Region A $>$ 228
- 1978Po08 F. T. Porter and M. S. Freedman - J. Phys. Chem. Ref. Data 7, 1267 (1978) Recommended Atomic Electron Binding Energies, 1s to 6p $_{3/2}$, for Heavy Elements, Z=84 to 103
- 1979Ah01 I. Ahmad - Z. Phys. A290, 1 (1979) Precision Measurement of K-Shell Fluorescence Yields in Actinide Elements
- 1979En04 P. M. Endt, At. Data Nucl. Data Tables 23, 547 (1979) Strengths of Gamma-Ray Transitions in A=45-90 Nuclei
- 1979En05 P. M. Endt, At. Data Nucl. Data Tables 23, 3 (1979) Strengths of Gamma-Ray Transitions in A=6-44 Nuclei (III)
- 1981En06 P. M. Endt, At. Data Nucl. Data Tables 26, 47 (1981) Strengths of Gamma-Ray Transitions in A=91-150 Nuclei
- 1990Ja11 A. K. Jain, R. K. Sheline, P. C. Sood and K. Jain, Revs. Modern Phys. 62, 393 (1990) Intrinsic States of Deformed Odd-A Nuclei in Mass Regions ($151 \leq A \leq 193$) and A \geq 221
- 1998Ak04 Y. A. Akovali - Nucl. Data Sheets 84, 1 (1998) Review of Alpha-Decay Data from Double-Even Nuclei
- 1998Ja07 A. K. Jain, R. K. Sheline, D. M. Headly, P.C. Sood, D.G. Burke, I. Hrivnacova, J. Kvasil, D. Nosek, R. W. Hoff, Revs. Modern Phys. 70, 843 (1998) Nuclear Structure in Odd-Odd Nuclei, $144 \leq A \leq 194$

Nuclear Data Sheets Symbols and Abbreviations

<p>A A₂, A₄ av B(EL), B(ML) calc. CA CCBA ce chem circ c.m. coef coin Coul. ex. CP cryst C^{2s}, C^{2g} d D DSA DWBA DWIA E E(e) E1, E2, EL excit expt F F-K FWHM g GDR GQR g.s. h H HF hfs HI Y IAR IAS IBS IMPAC inel ion chem IT J K K, L, M K/L L L(n), L(p) min M+ M1, M2, ML mag spect max Moss ms mult N NMR, NQR norm PAC pc P.γ(θ) P.γ(t) pol</p>	<p>mass number*, A=Z+N coefficients of Legendre polynomials in angular-correlation or angular-distribution measurement average reduced EL, ML transition probability in $e^2(\text{ebarn})^2$, $\mu_N^2(\text{ebarn})^{1/2}$ calculated, calculation coupled-channel Born approximation conversion electron chemical separation circular center of mass coefficient coincidence Coulomb excitation circular polarization crystal-diffraction spectrometer one-nucleon spectroscopic strength for pickup, stripping reactions day dipole Doppler shift attenuation distorted-wave Born approximation distorted-wave impulse approximation energy energy of electron-capture transition (endpoint of γ-continuum + K-electron separation energy of daughter) electric dipole, quadrupole, 2^h-pole excitation function experiment, experimental fission Fermi-Kurie (plot) energy resolution, full width at half maximum gyromagnetic ratio giant dipole resonance giant quadrupole resonance ground state hour magnetic field hindrance factor hyperfine structure heavy ion intensity isobaric analog resonance isobaric analog state internal bremsstrahlung spectrum ion implantation perturbed angular correlation technique inelastic chemical separation by ion exchange isomeric transition total angular momentum quantum number* projection of nuclear angular momentum J on nuclear symmetry axis K-, L-, M-shell internal conversion K-, L-conversion electron ratio (1)orbital angular momentum quantum number*, (2)multipolarity L-transfer in neutron, proton transfer reaction minutes M+N+O+... magnetic dipole, quadrupole, 2^h-pole magnetic spectrometer maximum Mössbauer effect (1)mass spectrometer, (2)millisecond multipolarity/character neutron number*, N=A-Z nuclear magnetic, quadrupole resonance normalization perturbed angular correlation proportional counter angular distribution of γ-rays with respect to a proton beam time distribution of photons with respect to a pulsed proton beam polarized, polarisation</p>	<p>priv comm PWBA Q Q(d) Q(p-) Q(α) R RDM RUL rel res s S S' S(n) or S_n S(p) or S_p scatt scin semi SF spall sr syst. SY t T T₂ T_{1/2} th thresh tof vib W.u. y Z α α(K), α(L) α_γ, β_γ, π α_γ(θ,H,t), β_γ(θ,H,t), γ_γ(θ,H,t) β₂, β₃, β_L β_γ(pol), γ_γ(pol) Γ, Γ_γ, Γ(n) γ(θ,H,T) γ[±] δ ε εK, εL, εM ε(γ)B(E2), ε(ce)B(E2) θ λ μ ν π σ Σ(γ) α(K), α(L) %α %β- %β+ %ε %IT %SF ⟨r²⟩</p>	<p>private communication plane-wave Born approximation (1)reaction energy*, (2)disintegration energy*, (3)quadrupole moment*, in units of barns, (4)quadrupole total disintegration energy in τ decay total disintegration energy in β- decay total disintegration energy in α decay, E(α) + E(recoil) r_nA^{1/3}, nuclear radius* recoil distance measurement recommended upper limit for γ-ray strength relative resonance second spectroscopic factor [(2J_f+1)/(2J_i+1)]S energy necessary to separate a neutron, proton from nucleus scattering scintillation counter semiconductor detector spontaneous fission spallation steradian systematics triton (1)isobaric spin, (2)temperature Z-Component of isobaric spin. (N-Z)/2 half-life* thermal threshold time-of-flight measurement vibrational Weisskopf single-particle transition speed year atomic number*, Z=A-N total γ-ray internal conversion coefficient N(ce)/N(γ)* γ-ray internal conversion coefficient for electrons ejected from the K-, L-shell coincidences of α's and γ's, β's and γ's, γ's and γ's α_γ, β_γ, γ-γ-coincidences as function of angle, magnetic field, time quadrupole, octupole, 2^h-pole nuclear deformation parameter polarisation correlation of γ's in coincidence with β's, γ's level width*, partial width for γ-, n-emission γ-intensity as function of angle, magnetic field, temperature annihilation radiation ratio of reduced matrix elements of (L+1)- to L-pole radiation with sign convention of Krane and Steffen, Phys.Rev. C2, 724 (1970) electron capture electron capture from K-, L-, M-shell partial B(E2) for photon, conversion electron detection indicates angular dependence (1)projection of particle angular momentum on nuclear symmetry axis, (2)radiation type, e.g., M1, M2... magnetic moment of particle*, given in nuclear magnetons (μ_N) neutron shell-model configuration parity, proton shell-model configuration cross section* coincidence summing of γ-rays K, average-L fluorescence yield percent α branching from level percent β- branching from level percent β+ branching from level percent ε branching from level percent (γce) branching from level percent spontaneous fission from level root-mean-square of nuclear radius</p>
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Prefixes*

T	tera	(=10 ¹²)	m	milli	(=10 ⁻³)
G	giga	(=10 ⁹)	μ	micro	(=10 ⁻⁶)
M	mega	(=10 ⁶)	n	nano	(=10 ⁻⁹)
k	kilo	(=10 ³)	p	pico	(=10 ⁻¹²)
c	centi	(=10 ⁻²)	f	femto	(=10 ⁻¹⁵)
			a	atto	(=10 ⁻¹⁸)

Symbols for Particles and Quanta*

n	neutron	π	pion
p	proton	μ	muon
d	deuteron	e	electron
t	triton	ν	neutrino
α	α-particle	γ	photon

* Recommended by Commission on Symbols, Units, and Nomenclature of
International Union of Pure and Applied Physics