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EVALUATED NUCLEAR STRUCTURE DATA FILE

A Manual for Preparation of Data Sets

J.K. Tuli

April 1987

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EVALUATED NUCLEAR STRUCTURE DATA FILE¹

A Manual for Preparation of Data Sets

J. K. Tuli

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, $A \leq 263$), the Evaluated Nuclear Structure Data File (ENSDF) contains evaluated structure information. For masses $A \geq 45$, this information is documented in the *Nuclear Data Sheets*; for $A < 45$, ENSDF is based on compilations published in the journal *Nuclear Physics*. The information in ENSDF is updated by mass chains with a present cycle time of approximately six years.

The author gratefully acknowledges many suggestions and comments received during the revision of this manual. Special thanks are due to M. J. Martin (ORNL), R. B. Firestone (LBL), and the following colleagues at NNDC: S. Pearlstein, M. R. Bhat, T. W. Burrows, and R. R. Kinsey. This research was supported by the Office of Basic Energy Sciences, U. S. Department of Energy.

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 RI (February 1978). The present report describes the current format and supersedes both the ORNL report and the Rept. BNL-NCS 51655 (March 1983) by J. K. Tuli.

²Coordinated by the International Atomic Energy Agency, Vienna - see Appendix E for list of evaluation centers.

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 evaluated results of a single experiment, e.g., a radioactive decay or a nuclear reaction
- 2 The combined evaluated results of a number of experiments of the same kind, e.g., (Heavy ion xn γ), Coulomb excitation, etc.
- 3 The adopted properties of the nucleus
- 4 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 NNDC
- 5 The summary information for a mass chain giving information, e.g., evaluator's name and affiliations, cutoff date, Nuclear Data Sheets publication details, etc.

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

- i Data sets which contain information pertaining to the complete mass chain. These data sets contain information of the type (4) and (5) given above
- ii Data sets belonging to a given nucleus (Z-value).

Data sets (ii), i.e. for a given nucleus (Z-value), consist of the following:

- a. Adopted data set (only one per Z-value) giving adopted properties of the levels and radiations seen in that nucleus.
- b. Data sets giving information of the type (1) or (2) above.

If there is more than one data set of type (1) or (2) for a given nucleus, then an adopted data set is *required* for that nucleus. If there is only one data set for a given nucleus, then that set is assumed also to present the adopted properties for that nucleus.

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

Evaluated Nuclear Structure Data File

Organization Chart

Fig. 1

II. General Organization

B. Data Set Structure

A data set is composed of records; each record is made up of one or more 80-column card images. Data set structure is given in Fig. 2 and is described below.

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

Immediately following the **IDENTIFICATION** record is a group of records which contain information about the entire data set (#1 and #2 in Fig. 2). The 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. 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**, 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. 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**, or **BETA** 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. 2).

The placement of **COMMENT** records is described in Chapter III.

C. File Storage and Transmittal

The data sets sent to NNDC for inclusion in ENSDF can be in any order, as the file is stored in a direct access mode (by data sets) using a data base management system. Copies of the file are transmitted in the form of a sequential file on magnetic tape. 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. 1, ordering them from left to right. Decay data sets are placed under the daughter nucleus and are ordered by A, Z and then the excitation energy of the parent nucleus. The reaction data sets are given under the residual nucleus and are ordered by the A, Z of the target nucleus followed by the A, Z of the incident particle and then by the energy of the incident particle.

II. General Organization

Data Set Structure

Fig. 2

III. STANDARD ONE-CARD RECORD FORMATS

A. Introduction

In most cases, all information for a record can be placed on a single 80-column card. 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). Note that many of the analysis programs, at present, do not process standard fields when placed on the continuation cards.

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.)

III Standard One-Card Record Formats

1. THE IDENTIFICATION RECORD

(Required for all data sets Must precede all other records)

<u>Field (Col.)</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
1-5	NUCID	Nucleus Identification	V.1
6-9		Must be blank	
10-39	DSID	Data set identification	V.2
40-64	DSREF	References to main supporting publications and analyses	V.3
65-74	PUB	Publication Information	V.4
75-80	DATE	The date (year/month/day) 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.

2. 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 +.)

<u>Field (Col.)</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
1-5	NUCID	Nucleus 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_c 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.11
56-80	QREF	Reference citation(s) for the Q-values	V.3

III. Standard One-Card Record Formats

3. THE CROSS-REFERENCE RECORD

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

<u>Field (Col.)</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
1-5	NUCID	Nucleus 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	Must exactly match one of the DSID's used	V.2
40-80		Blank	

Note: 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.

4. THE COMMENT RECORD

i. General Comments

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

<u>Field (Col.)</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
1-5	NUCID	Nucleus identification	V.1
6		Blank	
		Any alphanumeric character other than 'I' 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		Blank, or symbol for a particle, e.g., N, P, etc.	
10-80	CTEXT	Text of the comment. [See ENSDF Translation Dictionary (Appendix D)]	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 is blank then the comment refers to the whole data set. In the case that **NUCID** contains only the mass number (cols. 4-9 blank) the comment refers to the whole mass-chain A.

III. Standard One-Card Record Formats

THE COMMENT RECORD (cont.)

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. *See examples in Appendix C.*
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 should 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 can write special characters directly, for example, "[g" for γ , "[+238}Pu" for ^{238}Pu . See Appendix A for list of special characters.

ii. Record Comments

(Must follow the record to which the comment pertains)

<u>Field (Col.)</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
1-5	NUCID	Nucleus identification	V.1
6		Blank	
		Any alphanumeric character other than 'I' 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
9	PSYM	Blank, or symbol for a particle, e.g., N, P, etc.	
10-80	SYM\$ or SYM,SYM,...\$	SYM = type of data being commented upon <i>Specified SYMs must be followed by a "\$" except as in note 1 below.</i>	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 not repeated. [See ENSDF Translation Dictionary (Appendix D)]	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 only to the half-life of the second-excited state.)

III. Standard One-Card Record Formats

THE COMMENT RECORD (cont.)

iii. Footnote Comments

(Must precede *L, G, B, E, A, DP* records)

<u>Field</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
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 D)]	V.7

NOTES:

- SYM** can only be one of the following:
 - The fields defined in formatted *L, G, B, E, A, DP* records.
 - TITLE see note 2 below. **FLAG** with this **SYM** is not allowed
 - 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 the drawing. Any other information on that band should, therefore, be given on continuation records.
 - CONF. Same as BAND except that **FLAG** is optional. Without **FLAG** the given configuration comment will apply to all levels.
- 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.
 - If the word "TITLE" was used as **SYM** the footnote will apply to the table heading.
- 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.
- 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$
```
- No footnotes are allowed for records of **RTYPE: N, P, or Q.**

III. Standard One-Card Record Formats

NOTES (cont.):

6. To change the standard label heading of a formatted field, e.g. S to C²S 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/OMEGA (45 DEG)

5. THE PARENT RECORD

(Required for all decay data sets, except IT and SF decays.

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

<u>Field (Col.)</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
1-5	NUCID	Parent Nucleus identification	V.1
6		Blank	
7		Must be blank	
8	P	Letter "P" is required	
9		Must be blank	
10-19	E	Energy of the decaying level in keV (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	V.9
75-76	DQP	Standard uncertainty in QP	V.11
77-80		Must be blank	

Note: More than one parent card is allowed in a data set. If the decay scheme is due to more than one parent level then separate P records should be given for each parent level.

III. Standard One-Card Record Formats

6. THE NORMALIZATION RECORD

(Must precede L, C, B, E, A, DP records.

Required if an absolute normalization is possible; used mainly with decay and (n, γ) reaction data sets.)

<u>Field (Col.)</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
1-5	NUCID	Nucleus (Daughter/Product) identification	V.1
6		Blank	
7		Must be blank	
8	N	Letter "N" is required	
9		Must be blank	
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. Required 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. Required 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	ER	Branching ratio multiplier for converting intensity per 100 decays through this decay branch to intensity per 100 decays of the parent nucleus. Required if known.	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. Required if known.	V.9
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 and therefore NB=1.0. If a value other than 1.0 is given it should be remembered that the multiplier for conversion to per 100 decays is NB $\times$ BR. Also, the uncertainties in I(β^-) 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.

III. Standard One-Card Record Formats

7. THE LEVEL RECORD

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

<u>Field (Col.)</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
1-5	NUCID	Nucleus 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 , etc., 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, etc.	V.17
80	Q	The character "?" denotes an uncertain or questionable level Letter "S" denotes neutron or proton separation energy or a level expected but not observed	

III. Standard One-Card Record Formats

8. THE BETA (β^-) RECORD

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

<u>Field (Col.)</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
1-5	NUCID	Nucleus 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 [†]	V.13
30-31	DIB	Standard uncertainty in IE	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	Uniqueness classification for the β^- decay, e.g., "1U", "2U". (A blank signifies an allowed or a nonunique forbidden tran- sition.)	V.16
80	Q	The character "?" denotes an uncertain or questionable β^- decay Letter "S" denotes an expected or predicted transition	

[†]The intensity units are defined by the **NORMALIZATION** record.

9. THE EC (or EC + β^+) RECORD

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

<u>Field (Col.)</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
1-5	NUCID	Nucleus identification	V.1
6		Blank	
		Any alphanumeric character other than 'I' 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 <i>Given only if measured</i>	V.18
20-21	DE	Standard uncertainty in E	V.11
22-29	IB	Intensity of β^+ -decay branch [†]	V.13
30-31	DIB	Standard uncertainty in IB	V.11
32-39	IE	Intensity of electron capture branch [†]	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 [†]	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	Uniqueness classification for ϵ , β^+ decay, e.g., "1U", "2U". (A blank signifies an allowed or a nonunique forbidden transition.)	V.16
80	Q	The character "?" denotes an uncertain or questionable ϵ , β^+ branch Letter "S" denotes an expected or predicted transition	

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

III. Standard One-Card Record Formats

10. THE ALPHA RECORD

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

<u>Field (Col.)</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
1-5	NUCID	Nucleus 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.12
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	

III. Standard One-Card Record Formats

11. 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.)

<u>Field (Col.)</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
1-5	NUCID	Nucleus identification	V.1
6		Blank Any alphanumeric character other than 'I' 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 <i>percent</i> 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) nucleus 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.10
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	

*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-chian
for the final nucleus. For example, "95RB B-N DECAY" should be given as
data set for ⁹⁴Sr.

†The intensity units are defined by the **NORMALIZATION** record.

III. Standard One-Card Record Formats

12. 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.)

<u>Field (Col.)</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
1-5	NUCID	Nucleus identification	V.1
6		Blank	
		Any alphanumeric character other than 'I' 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 - Must not be blank	V.18
20-21	DE	Standard uncertainty in E	V.11
22-29	RI	Relative <i>photon</i> intensity†	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†	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.	V.8
78	COIN	Letter "C" denotes placement confirmed by coincidence. Symbol "?" denotes questionable 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	

†The intensity units are defined by the **NORMALIZATION** record.

III. Standard One-Card Record Formats

13. THE REFERENCE RECORD

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

<u>Field (Col.)</u>	<u>Name</u>	<u>Description</u>	<u>Reference</u>
1-3	MASS	Mass Number	
4-7		Must be blank	
8	R	Letter "R" is required	
9		Must be blank	
10-15	KEYNUM	Reference key number	V.3
16-80	REFERENCE	Abbreviated reference (from NSR file)	

14. THE END RECORD

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

<u>Field (Col.)</u>	<u>Description</u>
1-80	All columns are blank

C. Summary

The following figure (Fig. 3) summarizes the standard one-card formats for all allowed record types.

[illegible]

* = RTYPE

§ = COLUMN 6 IS BLANK OR 1 FOR THE FIRST CARD RECORD, ANY OTHER CHARACTER FOR CONTINUATION

$t = c$ OR ? FOR COINCIDENCE

‡ = PARTICLE SYMBOL

+ = "C" OR "D" OR "T"

AAA= MASS NUMBER

@ = ANY CHARACTER

fig. 3

IV. RECORDS CONTAINING MORE THAN ONE CARD

A. Card Enumeration

If all the information for a given record type 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. Subsequent cards will have characters 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 (Col.)</u>	<u>Name</u>	<u>Description</u>
1-5	NUCID	Nucleus 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 , or G
9		Must be blank
10-80	Data	<quant><op><value>[<op><value>][<ref>]\$...

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

- <quant>: Standard symbol for a quantity as defined in **IV.3** 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.23** for description of <value> when <quant>=XREF
- <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>: 6 character key numbers, **KEYNUM** (see **V.3**), separated by commas and enclosed within parentheses, e.g., (76TU01,81B001).
- \$: Delimiter (end of record is also a delimiter; thus '\$' should not be the last character in a record)

Examples:

```
126TE2 G BE2W=25.3 7(70LAZM)
126I 2 L %EC+%B+=56.3 20 (77JA04)$%B- EQ 43.7 20 (77JA04)
126SN2 B EAV=2030 60
126TE2 L G LE 0.19 GT 0.1 (81SH15)$MOME2 AP -0.20$BE2=0.478 12
```


IV. Continuation Records

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). Neither may a **LEVEL** record contain **LOGFT** information.

No continuations are allowed for **Q**, **N**, and **P** records. For **A** and **DP** records only data type **FLAG** is allowed on the continuation records. For special format for the continuation of **IDENTIFICATION** record see III.B-1. The allowed record 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.6. Additional allowed data types are:

<u>TYPE</u>	<u>Description</u>
%EC, %B+, %EC+%B+, %B-, %IT, %SF, %A, %P, %N	Percent decay of the level by ϵ , β^+ , $\epsilon+\beta^+$, β^- , isomeric transition, spontaneous fission, α , proton, or neutron decay.
%B-N; %B-xN; ...	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</i>	
G	g-factor of the level
MOME1, MOME2, ...	Electric moments: dipole, quadrupole, ...
MOMM1, MOMM2, ...	Magnetic moments: dipole, quadrupole, ...
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 -pole ($L=2,3,\dots$) nuclear deformation parameter
ISPIN	Isobaric spin
ISPINZ	Z-component of Isobaric Spin
WIDTH, WIDTHG, WIDTHG0, WIDTHN, WIDTHP, WIDTHA	Level width, Γ , Partial- γ , $-\gamma_0$, $-n$, $-p$, $-\alpha$ widths, $\Gamma(\gamma)$, $\Gamma(\gamma_0)$, $\Gamma(n)$, $\Gamma(p)$, $\Gamma(\alpha)$, respectively
XREF	Cross-reference to other data sets for that nuclide
FLAG	Additional footnote symbols

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.7. 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

IV. Continuation Records

GAMMA Record (continued)

<u>DTYPE</u>	<u>Description</u>
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
CEK, CEL, CEL1, ...	Conversion-electron (ce) intensity for K, L, $L_1, \dots$ conversion
ECC	Measured total conversion coefficient
KC, LC, L1C, ...	Theoretical K-, L-, $L_1, \dots$ conversion coefficient
EKC, ELC, EL1C, ...	Measured K-, L-, $L_1, \dots$ 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
CE	Total conversion electron intensity
FL	Final level energy
FLAG	Additional footnote symbols

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.8. 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.8 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.9. 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 (K, L, M, ..., L+ are also acceptable as DTYPE and have the same meaning.)
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.9 for their special meaning)

V. DETAILED FIELD DESCRIPTIONS

1. NUCID

The standard nucleus identification consists of two parts - mass number in cols. (1-3), right justified and element name (or Z-100 for Z>103) in (col. 4-5), left justified. The nucleus identification must be contained *within* the field defined for it (cols. 1-5). The nucleus identification *must* be included on every **IDENTIFICATION** record. It must also 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

The Data Set **ID** for an ENSDF data set must serve as a unique, computer recognizable identification for the data set. For that purpose, the following rules should be strictly observed for ENSDF entries. Single blanks have meaning and should be used according to the formats below. A colon may be used to define a sub-topic. All characters must be confined to the 30 spaces allowed. *Optional fields are given in italics.* General categories are given in upper and lower cases and further defined.

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 isotope symbol (e.g.) 52CR.

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

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 (*Reaction*)

INELASTIC SCATTERING

(H1,XNG)

Target should be the target (isotope or element) symbol

Reaction should be a reaction symbol (e.g.) N,P.

V. Detailed Field Descriptions

REACTION DATA SET ID'S (CONT.)

Energy may be one of the following

NUM, *NUM* Units (for definition of NUM see V.9.)
NUM-NUM Units
THERMAL or TH
RESONANCE or RES

Qualifier may be one of the following

RES
IAR
IAS

EXAMPLES:

187RE B- DECAY	187OS IT DECAY (231 US)
187AU P DECAY:?	190PT A DECAY (6E11 Y)
95RB B-N DECAY	186OS(N,G) E=THERMAL
186W(N,G) E=TH: SECONDARY G'S	RE(N,N'):TOF
186W(N,G) E=RES: AVG	189OS(P,T) E=19 MEV
187OS(D,D') E=12, 17 MEV	185RE(A,2NG) E=23-42.8 MEV
187RE(D,2NG), 187RE(P,NG)	44CA(P,G) E=856, 906 KEV IAR

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 **YYAABB** where **YY** is a two digit integer, **AA** are two alphabetic characters and **BB** is either a two digit integer or consists of two alphabetic characters. Examples: **81TU01**, **81TUXY**, etc.

4. PUB

Publication information consists of the year of the **A-chain** publication in Nuclear Data Sheets denoted by two digit year indicator followed by three-character code **NDS**. 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 **YYMMDD** where **YY**, **MM** and **DD** are two digit integers within the following ranges $00 \leq YY \leq 99$, $01 \leq MM \leq 12$ and $01 \leq DD \leq 31$.

6. RTYPE

RTYPE is a one-letter code in col. 8 that gives a name to the **RECORD** type.

<u>RTYPE</u>	<u>Description</u>
blank	May be IDENTIFICATION , general COMMENT , or END record
N	NORMALIZATION record
P	PARENT record
Q	Q-VALUE record
L	LEVEL record
G	GAMMA record
B	BETA (B^-) record
E	EC (or EC + B^+) record
A	ALPHA record
R	REFERENCE record
X	CROSS-REFERNCE 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 D. 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 ?? of **B**, **E** AND **A** records denotes coincidence. Similarly "*" and "&" for **G** records are reserved to denote multiple placement in the level/decay scheme. See notes on **SYM** and **FLAG** on page 9. Note also that **FLAG** can be used only with **BAND** and **CONF** in addition to those **SYMs** which are valid data types on a formatted card. *In fact, for BAND FLAG must be given.*

V. Detailed Field Descriptions

8. SYM(FLAG) (CONT.)

Allowed symbols to be used as **SYM** for various **RTYPE** are given below:

<u>RTYPE</u>	<u>Allowed SYM</u>
L	E, DE, J, T, DT, L, S, DS, BAND, CONF, BE1, BE2, ..., B2, B3, ..., G, ISPIN, ISPINZ, MOME1, MOME2, ..., MOMM1, MOMM2, ..., %EC+%B+, %X (X=B-, B+, EC, IT, SF, A, P, or N), %XY (X=B-, B+, or EC; Y=N, P, A, ..., or KN, KP, KA, ... where K=2,3, ..., or 9), WIDTH, WIDTHG, WIDTHG0, WIDTHN, TITLE
G	E, DE, RI, DRI, M, MR, DMR, CC, DCC, TI, DTI, BE1, BE2, ..., BE1W, BE2W, ..., BM1, BM2, ..., BM1W, BM2W, ..., CC, CEK, CEL, CEL1, ..., KC, LC, LIC, ..., CE, EKC, ELC, ELIC, ..., K/L, M/L, L1/L2, ..., K/T, L/T, ..., TITLE
B	E, DE, IB, DIB, LOGFT, DFT, EAV, TITLE
E	E, DE, IB, DIB, IE, DIE, LOGFT, DFT, TI, DTI, EAV, CK, CL, CM, CN+ECK, ECL, ECM, ECN+, CK/T, CL/T, TITLE
A	E, DE, IA, DIA, HF, DHF, TITLE
N	NR, DNR, NT, DNT, BR, DBR, NB, DNB
P	E, DE, J, T, DT, QP, DQP
Q	Q-, DQ-, SN, DSN, SP, DSP, QA, DQA
DP	E, DE, IP, DIP, EL, T, DT, L

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

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'. However, even if the leading '0' were omitted, presumably to save space, it will appear with a leading '0' in the *Nuclear Data Sheets*.

V. Detailed Field Descriptions

10. Q-, SN, SP, QA, MR

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) and R can be within parentheses).

11. DNR, DNT, DBR, DNB, DQP, DQ-, DSN, DSP, DQA, DE, DRI, DTI, DIB, DIE, DCC, DIA, DS, DHF

These one or 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 $(2.3 \pm 1.0) \cdot 10^6$ (see also Appendix F-1). 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 less than, greater than, less than or equal to, greater than or equal to, approximately equal to, calculated, and from systematics, respectively.

12. DFT, DMR, DT

These fields allow for the specification of "standard" asymmetric uncertainty. For example, T=4.2 S DT=+8-10, represent a half-life= $4.2^{+0.8}_{-1.0}$ s, similarly MR=-3 DMR=+1-4 represent mixing ratio= -3^{+1}_{-4} 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 K. above.
2. Asymmetric uncertainty - the field is of the form
+x-y, where x and y are integers.

13. RI, TI, IE, IE, IA

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 or have an integer between 1 and 9 followed by character "U".

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.

V. Detailed Field Descriptions

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, or W 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, SN+A, or SP+A (where A is as defined in 2. above)
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
5. IF Mult or [MULT]

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

V. Detailed Field Descriptions

20. J

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

1. JPI
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: LE 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 $JPI, J=J+1 \ PI=\pm, \dots, J=J'-1 \ PI=\pm, J'PI'$
- c. JPI to J' means $JPI, J=J+1 \ PI=\pm, \dots, J=J'-1 \ PI=\pm, J' \ PI=]I:0.5$

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

In the above J = N or N/2 (N is a positive integer or zero)
PI = + or -
JPI = J or PI or J followed by PI,

- Note:
1. Parentheses in the Jⁿ field indicate that the parenthesised value(s) is (are) based upon weak arguments. See "Bases for Spin and Parity Assignments" - Appendix F-4.
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 Jⁿ 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.

V. Detailed Field Descriptions

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

23. 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 two adopted levels. 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.3).

APPENDIX A

CHARACTER SET

The character set available includes all characters currently used at the NNDC and provides for future expansion. 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 is defined which consists primarily of the Greek alphabet and 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 Table IV.

There are four control characters, "|" (octal 174), "~" (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. Entire strings 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 in Table V. Modified character strings may be nested, but one may not terminate a string without terminating all strings nested within that string. The control character may be either upper or lower case.

EXAMPLES

g	will be displayed	
{B{+238}Pu}	will be displayed	γ ²³⁸ Pu

Special compound characters can be generated as follows:

D	from	n"backslash character" "
h	from	h"backslash character" "
X	from	l"backslash character" "

TABLE A-1

STRING CONTROL CHARACTERS

1 OR !	-	first alternate character set
2 OR ~	-	second alternate character set
+	-	superscript
-	-	subscript
I	-	italic
S	-	script
B	-	boldface
U	-	underline
O	-	overscore
E	-	elevate characters
R	-	raise base line

Note: + and - are mutually exclusive as are I and S.

APPENDIX A (cont.)

TABLE A-2
AVAILABLE CHARACTERS

<u>OCTAL</u>	<u>STANDARD</u>	<u>ALTERNATE</u>	<u>OCTAL</u>	<u>STANDARD</u>	<u>ALTERNATE</u>
40	(blank)	(blank)*	116	N	N
41	!	©	117	O	O
42	"	—	120	P	Π
43	#	§	121	Q	Θ
44	\$	e	122	R	P
45	%	√	123	S	Σ
46	&	≡	124	T	T
47	'	°	125	U	↑
50	(	←	126	V	∇
51	)	→	127	W	Ω
52	*	•	130	X	Ξ
53	+	±	131	Y	Ψ
54	,	½	132	Z	Z
55	-	≠	133	[	{
56	.	α	134		
57	/	÷	135	]	}
60	0	(	136	^	↑
61	1	)	137	_	↓
62	2	[	140	`	˘
63	3	]	141	a	α
64	4	<	142	b	β
65	5	>	143	c	γ
66	6	∫	144	d	δ
67	7	∫	145	e	ε
70	8	Π	146	f	φ
71	9	Σ	147	g	γ
72	:	†	150	h	χ
73	;	‡	151	i	ι
74	<	≤	152	j	ε
75	=	≠	153	k	κ
76	>	≥	154	l	λ
77	?	≈	155	m	μ
100	@	∞ •	156	n	ν
101	A	A	157	o	ο
102	B	B	160	p	π
103	C	H	161	q	θ
104	D	Δ	162	r	ρ
105	E	E	163	s	σ
106	F	Φ	164	t	τ
107	G	Γ	165	u	υ
110	H	X	166	v	θ
111	I	I	167	w	ω
112	J	~	170	x	ξ
113	K	K	171	y	ψ
114	L	Λ	172	z	ζ
115	M	M			

* The first ALTERNATE blank is an invariant character, one half the width of the STANDARD blank and the second ALTERNATE blank is one quarter the width of a STANDARD blank.

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>
TITL	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 date 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.

APPENDIX C

EXAMPLES OF INPUT/OUTPUT IN ENSDF/Nuclear Data Sheets

Appendix C-1 EXAMPLE - COMMENTS DATA SET

Appendix C-2 EXAMPLE - ADOPTED LEVELS

Appendix C-3 EXAMPLE - DECAY DATA SET

APPENDIX C-1

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$IDAHO NATIONAL ENGINEERING LABORATORY
156 #C    EG&G IDAHO, INC.
156 #C    IDAHO FALLS, IDAHO 83415  USA
156 C    ABST      THE EXPERIMENTAL RESULTS FROM THE VARIOUS REACTION AND
156 2C    DECAY STUDIES LEADING TO NUCLIDES IN THE A=156 MASS CHAIN, AND
156 3C    ALPHA DECAYS FROM IT, HAVE BEEN REVIEWED.  THESE DATA ARE
156 4C    SUMMARIZED AND PRESENTED, TOGETHER WITH ADOPTED LEVEL SCHEMES
156 5C    AND PROPERTIES.
156 C    CUT      DATA AVAILABLE PRIOR TO JUNE 1985 HAVE BEEN EVALUATED.
156 C    ACKN      THE EVALUATOR WISHES TO THANK M. A. LEE AND C. W.
156 2C    REICH FOR MANY HELPFUL DISCUSSIONS AND A. L. FREEMAN FOR THE DATA
156 3C    ENTRY AND PROCESSING.
156 C    FUND      RESEARCH SPONSORED BY THE U. S. DEPARTMENT OF ENERGY.
156 c    COMM$In this evaluation, the following expression was used to define
156 2c    the rotational-band parameters A and B:
156 #c
156 #c      
$$E(J) = E\{-0\} + AJ(J+1) + B[J(J+1)]\{+2\}.$$

156 #c
156 #c    For the levels in  $\{+156\}$ Gd the parameters  $A\{-2\}$  and  $A\{-4\}$  representing
156 7c    the shift between the odd- and even-spin levels have also been
156 8c    calculated for some bands from the expressions
156 #c
156 #c      
$$E(J) = E\{-0\} + AJ(J+1) - (-1)\{+J\}A\{-2\}J(J+1) \quad \text{for } K|p = 1+$$

156 #c    and
156 #c      
$$E(J) = E\{-0\} + A[J(J+1)-K\{+2\}] + B[J(J+1)-K\{+2\}]\{+2\} +$$

156 Dc    
$$(-1)\{+J\}A\{-4\}(J-1)J(J+1)(J+2) \quad \text{for } K|p = 2+.$$

156 #c
156 #c    In the determination of the values of these parameters, the energy
156 Gc    spacings of only the lowest levels, and minimum number of levels, were
156 Hc    used.
156 @c    The term "half-life" is used to refer to a ground state or an isomer
156 2c    for which there is a separate data set. The term "lifetime" is used to
156 3c    refer to the same quantity for any other level.
156 @c    In each group of data sets for a given element, the following customs
156 Bc    are usually maintained. All of the information concerning the
156 Cc    gamma-ray multiplicities are considered and summarized in the Adopted
156 Dc    data set, and these adopted values are also quoted in all the other
156 Ec    data sets. For level lifetimes, the data in the individual data sets
156 Fc    included only values from that type of experiment. The values which
156 Gc    summarize all of the measurements are only given in the Adopted data
156 Hc    set. The  $J|p$  values for the levels are also treated in the latter
156 Ic    way, except in so far as the authors of the experimental papers have
156 Jc    already considered the results of other experiments. Since a  $B(E2)$ 
156 Kc    value to a  $2+$  excited state from  $0+$  g.s. is equivalent to the
156 Lc    lifetime of  $E2$  G in the opposite direction, a  $T\{-1/2\}$  value can be
156 Mc    computed from  $B(E2)$  value. This has not been done. All  $T\{-1/2\}$  values
156 Nc    come only from experiments measuring this quantity.
156 @c    The ENSDF file (the computer data base from which these Data Sheets
156 9c    are produced), contains some information that is not printed in these
156 9c    Data Sheets. This includes the theoretical internal-conversion
156 9c    coefficients for each shell, where the values are significant, for
156 9c    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 9c    reference. This information would be available if a copy of the ENSDF
156 9c    file were obtained.
156 C    CLT      NDS 49.383 1986

```


APPENDIX C-1 (cont.)

Output example for Comments Data Set

Nuclear Data Sheets for A = 156*

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(Received October 10, 1985, Revised March 27, 1986)

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 level schemes and properties.

Cutoff Date: Data available prior to June 1985 have been evaluated.

Organization of Material: See page v.

Acknowledgements: The evaluator wishes to thank M. A. Lee and C. W. Reich for many helpful discussions and A. L. Freeman for the data entry and processing.

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

$$E(J) = E_0 + AJ(J+1) + B[J(J+1)]^2.$$

For the levels in ^{156}Gd the parameters A_2 and A_4 representing the shift between the odd- and even-spin levels have also been calculated for some bands from the expressions

$$E(J) = E_0 + AJ(J+1) - (-1)^J A_2 J(J+1) \quad \text{for } K\pi = 1+$$

and

$$E(J) = E_0 + A[J(J+1)-K^2] + B[J(J+1)-K^2]^2 + (-1)^J A_4 (J-1)J(J+1)(J+2) \quad \text{for } K\pi = 2+.$$

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 term "half-life" is used to refer to a ground state or an isomer for which there is a separate data set. The term "lifetime" is used to refer to the same quantity for any other level.

In each group of data sets for a given element, the following customs are usually maintained. All of the information concerning the gamma-ray multiplicities are considered and summarized in the Adopted data set, and these adopted values are also quoted in all the other data sets. For level lifetimes, the data in the individual data sets included only values from that type of experiment. The values which summarize all of the measurements are only given in the Adopted data set. The $J\pi$ values for the levels are also treated in the latter way, except in so far as the authors of the experimental papers have already considered the results of other experiments. Since a $B(E2)$ value to a $2+$ excited state from $0+$ g.s. is equivalent to the lifetime of $E2$ G in the opposite direction, a $T_{1/2}$ value can be computed from $B(E2)$ value. This has not been done. All $T_{1/2}$ values come only from experiments measuring this quantity.

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-2

Example of an Adopted Levels Data Set

154SM ADOPTED LEVELS 870129

154SM Q -717.0 21 7967.9 10 9086 16 -1197.2 25 85WA02

154SM D Other reactions: 154SM(P,P'G), 154SM(D,D'), and 152SM(t,p).

154SM T Summary of Adopted T Values

154SM T

E(level)	Adopted	Comments
0.0	Stable	
81.9	3.02 NS 4	Weighted average of 3.03 NS 5 (67W006) and 3.00 NS 6 (68R109). Other: 2.74 NS 24 (59B110).
266.7	172 PS 4	Weighted average of 173 PS 5 (72D106) and 169 PS 10 (80J008).
543.9	22.7 PS 6	Weighted average of 23.3 PS 7 (72D106) and 22.7 PS 6 (average of two values in 80J008).
902.8	5.93 PS 25	Weighted average of 6.2 PS 6(72D106), 6.0 PS 4 (77KE06), and 5.8 PS 4 (80J008).
921.5	26 FS 4	Calculated from level width of 0.0176 eV 24

154SM T Summary of JPI Assignments

E(level)	Adopted	β^- decay	(n,n' γ)	Coulomb excit
0.0	0+	0+	0+	0+
81.9	2+	2+	2+	2+
266.7	4+	4+	4+	4+
543.9	6+	6+		6+

154SM T

154SM C The data on the level energies and JPI values are

154SM2C primarily from the 154PM B- DECAY.

154SM CL E From least-squares fit to G energies.

154SM CL BAND(A) KPI=0+ ground-state band. A= 13.81, B= -0.0234

154SM CL BAND(B) Octupole-vibrational band. A= 10.58, B= -0.0413

154SM XR154PM B- DECAY (1.73 MIN)

154SM XS154PM B- DECAY (2.68 MIN)

154SM XT154PM(3HE,3H)

154SM XU154SM(N,N'G)

154SM XVCOULOMB EXCITATION

154SM XWINELASTIC SCATTERING

154SM XX154SM(G,G')

154SM XY152SM(T,P)

154SM XZ154EU EC DECAY

154SM L 0.0 0+ STABLE A

154SM L 81.99 2 2+ 3.02 NS 4 A

154SM2 L MOME2= -1.87 4 \$ BE2= 4.32 2 \$ MOMM1= +0.70 5 \$

154SM CL J From E2 Coulomb excitation from 0+ ground state.

154SM L 266.74 7 4+ 172 PS 4 A

154SM2 L MOMM1= +1.35 15 \$ MOME2= -2.2 8 \$ BE4= 0.305 18 \$ XREF= -(TX) \$

154SM CL J From multiple Coulomb excitation and expected 0+ band

154SM2CL structure.

154SM L 543.9 5 6+ 22.7 PS 6 A

154SM2 L MOMM1= +1.90 28 \$ XREF= SVWY

154SM CL J From multiple Coulomb excitation and expected 0+ band

154SM2CL structure.

154SM CL MOMM1 From 72KU10 and given as g-factor of 0.317 46. (Also given

154SM2CL by 76FU06 and 78LEZA.)

154SM L 902.8 8 8+ 5.93 PS 25 A

154SM2 L XREF= V

154SM CL J From multiple Coulomb excitation and expected 0+ band

154SM2CL structure.

154SM L 921.57 11 1- 26 FS 4 B

154SM2 L XREF= RSUWX

154SM CL J From E1 excitation by (G,G') reaction.

154SM2CL partial-width data (76ME17) from (G,G') experiment.

154SM L 1012.62 12 3- B

154SM2 L BE3= 0.10 2 \$ XREF= SUVW

154SM CL J From E3 Coulomb excitation.

154SM CL BE3 Weighted average of 0.11 3 (68KE04) and 0.09 2 (68VE01).

154SM2CL Other: 66SE06.

APPENDIX C-2 (cont.)

Example Output for the Adopted Levels Data Set

¹⁵⁴Sm Adopted Levels

Q(β^-)=-717.0 2f; S(n)=7967.9 10; S(p)=9086 16; Q(α)=-1197.2 25 85Wa02.

Summary of Adopted $T_{1/2}$ Values

E(level)	Adopted	Comments
0.0	Stable	
81.9	3.02 ns 4	Weighted average of 3.03 ns 5 (67Wo06) and 3.00 ns 6 (68Ri09). Other: 2.74 ns 24 (59Bi10).
266.7	172 ps 4	Weighted average of 173 ps 5 (72Di06) and 169 ps 10 (80Jo08).
543.9	22.7 ps 6	Weighted average of 23.3 ps 7 (72Di06) and 22.7 ps 6 (average of two values in 80Jo08).
902.8	5.93 ps 25	Weighted average of 6.2 ps 6 (72Di06), 6.0 ps 4 (77Ke06), and 5.8 ps 4 (80Jo08).
921.5	26 fs 4	Calculated from level width of 0.0176 eV 24

Summary of $J\pi$ Assignments

E(level)	Adopted	β^- decay	(n,n' γ)	Coulomb excit
0.0	0+	0+	0+	0+
81.9	2+	2+	2+	2+
266.7	4+	4+	4+	4+
543.9	6+	6+		6+

The data on the level energies and $J\pi$ values are primarily from the ¹⁵⁴Pm β^- decay.

Cross Reference (XREF) Flags

A ¹⁵⁴ Pm β^- Decay (1.73 min)	F Inelastic Scattering
B ¹⁵⁴ Pm β^- Decay (2.68 min)	G ¹⁵⁴ Sm(γ,γ')
C ¹⁵⁴ Pm(³ He, ³ H)	H ¹⁵² Sm(t,p)
D ¹⁵⁴ Sm(n,n' γ)	I ¹⁵⁴ Eu ϵ Decay
E Coulomb Excitation	

E(level) [†]	$J\pi$	XREF	$T_{1/2}$	Comments
0.0 [‡]	0+		stable	
81.99 [‡] 2	2+		3.02 ns 4	Q=-1.87 4; B(E2)=4.32 2; μ =+0.70 5. J π : From E2 Coulomb excitation from 0+ ground state. μ =+1.35 15; Q=-2.2 8; B(E4)=0.305 18. J π : From multiple Coulomb excitation and expected 0+ band structure.
266.74 [‡] 7	4+	C G	172 ps 4	μ =+1.9D 2E J π : From multiple Coulomb excitation and expected 0+ band structure. μ : From 72Ku10 and given as g-factor of 0.317 46. (Also given by 76Fu06 and 78LeZA.).
543.9 [‡] 5	6+	B EF H	22.7 ps 6	J π : From multiple Coulomb excitation and expected 0+ band structure. μ : From 72Ku10 and given as g-factor of 0.317 46. (Also given by 76Fu06 and 78LeZA.).
902.8 [‡] 8	8+	E	5.93 ps 25	J π : From multiple Coulomb excitation and expected 0+ band structure.
921.57 [§] 11	1-	AB D FG	26 fs 4	J π : From E1 excitation by (γ,γ') reaction. partial-width data (76Me17) from (γ,γ') experiment. B(E3)=0.10 2. J π : From E3 Coulomb excitation.
1012.62 [§] 12	3-	B DEF		B(E3): Weighted average of 0.11 3 (68Ke04) and 0.09 2 (68Ve01). Other: 66Se06.

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

[‡] K π =0+ ground-state band. A=13.81, B=-0.0234.

[§] Octupole-vibrational band. A=10.58, B=-0.0413.

APPENDIX C-3

Example of a Decay Data Set

```

154SM 154PM B- DECAY (1.7 M) 74YA07,72TA13,71DA28 87NDS 870101
154PM P (0.1) 1.7 M 2 4.0E+3 1
154SM N 0.194 30 1.0
154SM CN NR I(G+CE)=100 TO G.S. IF IT-DECAY OF PARENT=0
154SM C OTHERS: 68DEZZ,72H008,73PRO5,74BU09.
154SM CG F,R,I$FROM 74YA07 UNLESS OTHERWISE STATED.
154SM CG RI(B)$DATA NOT GIVEN; DEDUCED FROM G-BRANCHING RATIOS VIA 2.7-MIN
154SM CB MEASURED BETAS: 71DA28,74YA07. OTHERS: 73PRO5,72TA13,58WI42
154SM G 414.8 2 5.9 9
154SM L 0.0 0+ STABLE
154SM L 81.98 10 2+
154SM G 81.98 10 65 10 E2 4.93 C
154SMS G KC= 2.021 $LC= 2.250 $MC= 0.519 $NC+= 0.1402 $
154SM L 266.7 2 4+
154SM G 184.76 10 25 5 E2 0.27 C
154SMS G KC= 0.1925 $LC= 0.0633 $MC=0.01428 $NC+=0.00389 $
154SM CG E FROM 71DA28. OTHER: 184.6 1 (74YA07)
154SM L 921.6 2 1-
154SM B 12 2 6.5 C
154SM2 B EAV= 1250 50$
154SM CB EB=3.0 2 MEV (74YA07,71DA28) SC1N, F-K
154SM G 839.6 2 66.3 38 C
154SM G 921.6 2 44.3 27 C
154SM L 1099.7 3 0+
154SM B 5 1 6.8
154SM2 B EAV= 1170 50$
154SM G 1017.6 2 53.1 32 C
154SM L 1178.2 3 2+
154SM B 3.5 12 6.9
154SM2 B EAV= 1140 50$
154SM G 911.1 3 24.1 25 C
154SM G 1096.2 3 29.9 22 C
154SM G 1177.8 8 19.0 19 C
154SM L 1440.4 4 2+
154SM G 1173.7 100.08 5 B
154SM G 1358.6 2 1.3 4 B
154SM G 1440.3 2 1.1 4 B
154SM L 1476.1 3 (1-)
154SM B 11 2 6.2 C
154SM2 B EAV= 1000 50$
154SM G 1394.0 2 65 10 C
154SM L 1890.9 3
154SM B 3.0 5 6.5
154SM2 B EAV= 820 50$
154SM G 1808.8 3 8.4 13
154SM G 1891.0 4 7.0 14
154SM L 2069.8 3
154SM B 25 2 5.4 C
154SM2 B EAV= 740 50$
154SM G 891.5 2 35.6 23
154SM G 970.0 2 26.9 20
154SM G 1148.1 2 48.2 30 C
154SM G 1988.0 3 6.7 10
154SM G 2070.2 3 9.6 10
154SM L 2140.9 2
154SM B 36 3 5.2 C
154SM2 B EAV= 700 50$
154SM G 664.6 2 7.2 14
154SM G 700.4 6 2.5 8
154SM G 962.5 2 19.1 16 C
154SM G 1218.0 10
154SM G 2058.9 2 100 C
154SM G 2140.9 2 56.7 34 C
154SM L 2347.7 3
154SM B 1.8 2 6.3
154SM2 B EAV= 610 50$
154SM G 2347.7 3 9.2 9
154SM L 2592.3 3
154SM B 1.8 2 6.0
154SM2 B EAV= 510 50$
154SM G 2510.6 2 7.0 8
154SM G 2592.0 3 2.2 5
154SM L 2618.2 5
154SM B 1.0 3 6.2
154SM2 B EAV= 500 50$
154SM G 2535.9 3 3.3 8
154SM G 2618.8 5 2.0 8

```

APPENDIX C-3 (cont.)

Example for Radiation Tables

β^- radiations from ^{154}Pm β^- Decay (1.7 min) 74Ya07,72Ta13,71Da28

Others: 68De22,72Ho08,73Pr05,74Bu09.

Measured β 's: 71Da28,74Ya07. Others: 73Pr05,72Ta13,58W142.

$E\beta^-$	E(level)	$I\beta^-^\dagger$	Log $f t$	Comments
(1380 100)	2618.2	1.0 3	6.2	av $E\beta=500$ 50.
(1410 100)	2592.3	1.8 2	6.0	av $E\beta=510$ 50.
(1650 100)	2347.7	1.8 2	6.3	av $E\beta=610$ 50.
(1860 100)	2140.9	36 3	5.2	av $E\beta=700$ 50.
(1930 100)	2069.8	25 2	5.4	av $E\beta=740$ 50.
(2110 100)	1890.9	3.0 5	6.5	av $E\beta=820$ 50.
(2520 100)	1476.1	11 2	6.2	av $E\beta=1000$ 50.
(2820 100)	1178.2	3.5 12	6.9	av $E\beta=1140$ 50.
(2900 100)	1099.7	5 1	6.8	av $E\beta=1170$ 50.
(3080 100)	921.6	12 2	6.5	av $E\beta=1250$ 50.
$E\beta=3.0$ 2 MeV (74Ya07,71Da28) scin. F-K.				

† For β^- intensity per 100 decays, multiply by 100.

$\gamma(^{154}\text{Sm})$ from ^{154}Pm β^- Decay (1.7 min) 74Ya07,72Ta13,71Da28

By normalization: $I(\gamma)=100$ to g.s. If IT-decay of parent=0.

$E\gamma^\ddagger$	E(level)	$I\gamma^{\dagger\dagger}$	Mult.	α	Comments
81.98 10	81.98	65 10	E2	4.93	$\alpha(K)=2.021$; $\alpha(L)=2.250$; $\alpha(M)=0.519$; $\alpha(N+...)=0.1402$.
184.76 10	266.7	25 5	E2	0.27	$\alpha(K)=0.1925$; $\alpha(L)=0.0633$; $\alpha(M)=0.01428$; $\alpha(N+...)=0.00389$.
					$E\gamma$: from 71Da28. Other: 184.6 1 (74Ya07).
*414.8 2		5.9 9			
664.6 2	2140.9	7.2 14			
700.4 6	2140.9	2.5 8			
839.6 2	921.6	66.3 38			
891.5 2	2069.8	35.6 23			
911.1 3	1178.2	24.1 25			
921.6 2	921.6	44.3 27			
962.5 2	2140.9	19.1 16			
970.0 2	2069.8	26.9 20			
1017.6 2	1099.7	53.1 32			
1096.2 3	1178.2	29.9 22			
1148.1 2	2069.8	48.2 30			
1173.7 10	1440.4	0.08 § 5			
1177.8 8	1178.2	19.0 19			
1218.0 10	2140.9				
1358.6 2	1440.4	1.3 § 4			
1394.0 2	1476.1	65 10			
1440.3 2	1440.4	1.1 § 4			
1808.8 3	1890.9	8.4 13			
1891.0 4	1890.9	7.0 14			
1988.0 3	2069.8	6.7 10			
2058.9 2	2140.9	100			
2070.2 3	2069.8	9.6 10			
2140.9 2	2140.9	56.7 34			
2347.7 3	2347.7	9.2 9			
2510.6 2	2592.3	7.0 8			
2535.9 3	2618.2	3.3 8			
2592.0 3	2592.3	2.2 5			
2618.8 5	2618.2	2.0 8			

‡ From 74Ya07 unless otherwise noted.

† For absolute intensity per 100 decays, multiply by 0.19 3.

§ Data not given; deduced from γ -branching ratios via 2.7-min.

* γ ray not placed in level scheme.

APPENDIX C-3 (cont.)

Example of Plot output

APPENDIX D

ENSDF TRANSLATION DICTIONARY

The publication programs translate the text of comments (**CTEXT** in Section **III.B**) from the computer-readable **ENSDF** input into printed output for *Nuclear Data Sheets*.

The translation dictionary, as of January, 1987, is given below. It is given sorted by the output (translation) (Appendix D-I) and by the ENSDF input (Appendix D-II). The dictionary is constantly enlarged and improved as new needs are encountered.

ENSDF DICTIONARY - ordered by output

Translation	ENSDF	Translation	ENSDF
A	$\sim A$	CCBA	CCBA
av $E\beta$	EAV	ce	CE
Ay	AY	CERN	CERN
A(θ)	A(THETA)	ce(K)	CEK
A-N	A-N	ce(K)/(γ +ce)	K/T
A ^{1/3}	A**1/3	ce(L)	CEL
A ^{2/3}	A**2/3	ce(L)/(γ +ce)	L/T
A ₀	A0	ce(L1)	CEL1
a ₀	a0	ce(L2)	CEL2
A ₁	A1	ce(L3)	CEL3
A ₂	A22	ce(M)	CEM
A ₂	A2	ce(M)/(γ +ce)	M/T
A ₂ P ₂	A2P2	ce(M+)/(γ +ce)	M+/T
A ₂ /A ₀	A2/A0	ce(M1)	CEM1
A ₃	A3	ce(M2)	CEM2
A ₄	A4	ce(M3)	CEM3
B	$\sim B$	ce(M4)	CEM4
Be	Be	ce(M5)	CEM5
BE(L)	BE(L)	ce(N)	CEN
BF ₃	BF3	ce(N+)/(γ +ce)	N+/T
BG0	BG0	ce(N1)	CEN1
BJ ²	BJ**2	ce(N2)	CEN2
BM(L)	BM(L)	ce(N3)	CEN3
Branching	BR	ce(N4)	CEN4
branching uncertainty	DBR	ce(N5)	CEN5
B(EL)	BEL	ce(0)	CE0
B(EL)(W.u.)	BELW	ce(0)+ce(P)	CE0+CEP
B(E0)	B(E0)	ce β	CEB
B(E0)	BE0	ce γ	CEG
B(E0)(W.u.)	BE0W	Cm	Cm
B(E1)	B(E1)	cm ²	CM2
B(E1)(W.u.)	BE1W	cm ³	CM3
B(E2)	B(E2)	Co	CO
B(E2)(W.u.)	BE2W	configuration	CONF
B(E2) [†]	BE2UP	configuration=	CONF=
B(E3)	B(E3)	cos ² θ	COS2TH
B(E3)(W.u.)	BE3W	Coul	COUL
B(E3) [†]	BE3UP	CP	CP
B(E4)	B(E4)	CsI	CSI
B(E4)(W.u.)	BE4W	c.m.	C.M.
B(E4) [†]	BE4UP	C ² S	C2S
B(E5)	BE5	D	$\sim D$
B(E5)(W.u.)	BE5W	DCO	DCO
B(E6)	BE6	DCOQ	DCOQ
B(E6)(W.u.)	BE6W	dE/dx	DE/DX
B(E7)	BE7	DPAC	DPAC
B(E8)	BE8	DPAD	DPAD
B(J)	B(J)	DSA	DSA
B(ML)	BML	DSAM	DSAM
B(ML)(W.u.)	BMLW	DWBA	DWBA
B(M1)	BM1	DWIA	DWIA
B(M1)(W.u.)	BM1W	DWUCK	DWUCK
B(M2)	BM2	D+Q	D+Q
B(M2)(W.u.)	BM2W	D+(Q)	D+(Q)
B(M3)	BM3	d ³ He	D3HE
B(M3)(W.u.)	BM3W	d γ	DG
B(M4)	BM4	d σ	DSIGMA
B(M4)(W.u.)	BM4W	d σ /d Ω	DS/DW
B(M5)(W.u.)	BM5W	d Ω	DOMEGA
B $\cdot$ ρ	B $\cdot$ RHO	E	E
C	C	Ee	EE
		EL	EL
		ENDOR	ENDOR
		ENSDF	ENSDF
		EPR	EPR

ENSDF DICTIONARY - ordered by output

Translation	ENSDF	Translation	ENSDF
ESR	ESR	IAR	IAR
eV	EV	IAS	IAS
even-A	EVEN-A	IBA	IBA
EWSR	EWSR	IBS	IBS
$e'(\theta)$	$E'(\text{THETA})$	Ice	ICE
$E(\text{ce})$	ECE	IMPAC	IMPAC
$E(d)$	$E(D)$	IPAC	IPAC
$E(e)$	$E(E)$	ISOLDE	ISOLDE
$E(n)$	EN	IT decay	IT DECAY
$E(n)$	$E(N)$	$I(\gamma+\text{ce})$	TI
$E(p)$	EP	$I\alpha$	IA
$E(p)$	$E(P)$	$I\beta$	IB
$E(t)$	$E(T)$	$I\beta$ normalization	NB
$E(\alpha)$	$E(A)$	$I\beta^+$	IB+
E-E	E-E	$I\beta^-$	IB-
$E/\Delta E$	E/DE	$I\varepsilon$	IE
E0	E0	$I\gamma$	IG
E1	E1	$I\gamma$	RI
E2	E2	$I\gamma$ normalization	NR
E3	E3	$I\gamma E\gamma$	IG*EG
E4	E4	J	J
E5	E5	JK π	JKP
E6	E6	J_{max}	JMAX
E7	E7	J_{min}	JMIN
E8	E8	JOSEF	JOSEF
E9	E9	JULIE	JULIE
e^+	E^+	J_f	JF
$E^{1/2}$	$E^{**1/2}$	J_i	J1
E^2	E^{**2}	J_0	J0
$E\alpha$	EA	J_1	J1
$E\beta$	EB	J_2	J2
$E\Delta E$	EDE	$J\pi$	JPI
$E\varepsilon$	EEC	K	K
$E\gamma$	EG	keV	KEV
$E\gamma^5$	EG^{**5}	kG	KG
f _m	FM	KLL	KLL
f_m^{-1}	FM^{*-1}	kOe	KOE
f_m^{-1}	FM-1	K-O ₂₃ x ray	XK023
f_m^2	FM^{**2}	K-O ₂ x ray	XK02
f_m^4	FM^{**4}	K-O ₃ x ray	XK03
FWHM	FWHM	K/L+M	K/L+M
F-K	F-K	K x ray	KK
GDR	GDR	K α_1 x ray	XKA1
Geiger	GEIGER	K α_2 x ray	XKA2
GeV	GEV	K α x ray	XKA
Ge(Li)	GELI	K β_1 x ray	XKB1
GM	GM	K β_1' x ray	XKB1P
GMR	GMR	K β_2 x ray	XKB2
GQR	GQR	K β_2' x ray	XKB2P
gT	G*T	K β_3 x ray	XKB3
GTOL	GTOL	K β_4 x ray	XKB4
$gT_{1/2}$	$GT_{1/2}$	K β_5 x ray	XKB5
$g\omega\Gamma_{\gamma 0}$	G*W*WIDTHGO	K β_5^1 x ray	XKB51
g-factor	G-FACTOR	K β_5^{11} x ray	XKB511
g.s.	GS	K β x ray	XKB
$g\Gamma$	G*WIDTH	K π	KPI
$g\Gamma_{\gamma 0}^2$	G*WIDTHGO**2	L	L
$g\Gamma_{\gamma 0}^2$	*G*WIDTHGO**2	LAMPF	LAMPF
$g\Gamma_{\gamma 0}$	G*WIDTHGO	Larmor	LARMOR
HF	HF	Li	LI
HI	HI	log $f t$	LOGFT
HPGE	HPGE	log $f' t$	LOGF1T
$\hbar\omega$	HOMEGA	log $f' u t$	LOGF1UT
$\hbar^2$	H^{**2}	L(n)	LN
I	I	L(p)	LP

ENSDF DICTIONARY - ordered by output

Translation	ENSDF	Translation	ENSDF
L1	L1	Q+0	Q+0
L2	L2	Q3D	Q3D
L3	L3	R	R
L ₁ x ray	XL1	RPA	RPA
L ₂ x ray	XL2	RUL	RUL
L ₃ x ray	XL3	r ²	R**2
L _i x ray	XLL	r ₀	RO
L _a x ray	XLA	S	~S
L _β x ray	XLB	S value	S VALUE
L _γ x ray	XLG	SF	SF
L x ray	XL	Si(Li)	SILI
Lα ₁ x ray	XLA1	Sn	Sn
Lα ₂ x ray	XLA2	SOREQ	SOREQ
Lβ ₁ x ray	XLB1	syst	SY
Lβ ₂ x ray	XLB2	S'	S'
Lγ ₁ x ray	XLG1	S(n)	SN
Lγ ₂ x ray	XLG2	S(p)	SP
M	M	S(α)	SA
M x ray	XM	S-factor	S-FACTOR
mb	MB	S-value	S-VALUE
mb/sr	MB/SR	s-wave	S-WAVE
MEDLIST	MEDLIST	s ⁻¹	S-I
MeV	MEV	T	ISPIN
meV	MILLI-EV	T	TEMP
mg/cm ²	MG/CM2	T	~T
ms	MS	th	TH
M1	M1	Ti	Ti
M2	M2	tof	TOF
M3	M3	TPAD	TPAD
M4	M4	TRISTAN	TRISTAN
M5	M5	TRIUMPH	TRIUMPH
N	~N	T20	T20
NaI	NAI	T21	T21
NBS	NBS	T22	T22
nb/sr	NB/SR	T _z	ISPINZ
NC ² S	NC2S	T _{1/2}	T
Ne	Ne	tγ	TG
NMR	NMR	U	U
Note:	NOTE:	UNISOR	UNISOR
NQR	NQR	V	V
NSσ	NS*SIGMA	W	W
NX	NX	w(θ)gΓ _{γ0}	W(THETA)*G*WIDTHGO
N-Z	N-Z	W.u.	W.U.
nγ	NG	X	~X
nγγ	NGG	XX	XX
N·σ	N*SIGMA	x-ray	X-RAY
O	O	Xγ	XG
odd-A	ODD-A	Y	YTTRIUM
OSIRIS	OSIRIS	Y	~Y
P	~P	Z	Z
PAC	PAC	%EWSR	%EWSR
PAD	PAD	%E0	%E0
PWBA	PWBA	%E2	%E2
PWIA	PWIA	%IT	%IT
p(θ)	P(THETA)	%Iβ	%IB
p-width	P-WIDTH	%Iγ	%RI
pa	PALPHA	%M1	%M1
pγ	PG	%SF	%SF
pγγ	PGG	%2β ⁻	%2B-
Q	MOME2	% ¹² C	%12C
Q	Q	% ¹⁴ C	%14C
Q(g.s.)	QP	%α	%A
Q(α)	QA	%β ⁺	%B+
Q(β ⁻)	Q-	%β ⁺ n	%B+N
Q(ε)	Q+ ₋	%β ⁺ p	%B+P

APPENDIX D-1 (cont.)

ENSDF DICTIONARY - ordered by output

Translation	ENSDF	Translation	ENSDF
$\% \beta^+ \alpha$	%B+A	$\alpha(N)$	NC
$\% \beta^-$	%B-	$\alpha(N) \exp$	ENC
$\% \beta^- n$	%B-N	$\alpha(N+...)$	NC+
$\% \beta^- p$	%B-P	$\alpha(N+...)\exp$	ENC+
$\% \epsilon$	%EC	$\alpha(N1)$	N1C
$\% \epsilon p$	%ECP	$\alpha(N2)$	N2C
$\% \gamma$	%G	$\alpha(N2)\exp$	EN2C
(fragment) γ	FG	$\alpha(N3)$	N3C
(H,t)	(H,T)	$\alpha(N3)\exp$	EN3C
(K x ray) γ	XKG	α -syst	A-SYST
(t)	(T)	$\alpha\alpha$	AA
(α)	(A)	$\alpha\gamma$	AG
(α)(ce)	ACE	β	B
(α)(K x ray)	AXK	β	BETA
(β)	(B)	βc	BC
(θ, H)	(THETA, H)	βce	BCE
(t)	(UP)	βe^-	BE-
(d)	(DOWN)	βn	BN
2J	2J	βp	BP
$2\beta^-$	2B-	βR	B*R
4 π	4PI	β -vibrational	B-VIBRATIONAL
4 $\pi\beta$	4PIB	β^+	B+
4 $\pi\beta\gamma$	4PIBG	β^-	B-
4 $\pi\gamma$	4PIG	β_L	BL
<	LT	$\beta_L R$	BL*R
>	GT	$\beta_L R A^{1/3}$	BL*R*A**(1/3)
°	DEG	β_0	B0
$\langle r^2 \rangle$	AVRSQ	β_{12}	B12
$\Delta \langle r^2 \rangle$	DAVRSQ	β_1	B1
e g	E.G.	β_{20}	B20
i.e	I.E.	β_{22}	B22
L	**L	β_2	B2
-1	** -1	β_{2R}	B2*R
-3	** -3	β_{30}	B30
-4	** -4	β_3	B3
1/3	** 1/3	β_{3R}	B3*R
$1^2 C \gamma$	C12G	β_{42}	B42
α	ALPHA	β_4	B4
α	CC	β_{4R}	B4*R
α decay	A DECAY	β_5	B5
α syst	A SYST	β_6	B6
$\alpha(\exp)$	ECC	β_7	B7
$\alpha(K)$	KC	$\beta\alpha$	BA
$\alpha(K)\exp$	EKC	$\beta\beta$	BB
$\alpha(L)$	LC	$\beta\gamma$	BG
$\alpha(L)\exp$	ELC	$\beta\gamma n$	BGN
$\alpha(L+...)\exp$	ELC+	$\beta\gamma\gamma$	BGG
$\alpha(L1)$	L1C	δ	MR
$\alpha(L1)\exp$	EL1C	ΔA	DA
$\alpha(L2)$	L2C	ΔA_2	DA2
$\alpha(L2)\exp$	EL2C	ΔA_4	DA4
$\alpha(L3)$	L3C	ΔE	DE
$\alpha(L3)\exp$	EL3C	$\Delta I(\gamma+ce)$	DTI
$\alpha(M)$	MC	$\Delta I\alpha$	DIA
$\alpha(M)\exp$	EMC	$\Delta I\beta$	DIB
$\alpha(M+...)$	MC+	$\Delta I\epsilon$	DIE
$\alpha(M+...)\exp$	EMC+	$\Delta I\gamma$	DRI
$\alpha(M1)$	M1C	$\Delta I\gamma(\%)$	PRJ
$\alpha(M1)\exp$	EM1C	ΔJ	DJ
$\alpha(M2)$	M2C	$\Delta J\pi$	DJP1
$\alpha(M2)\exp$	EM2C	ΔK	DK
$\alpha(M3)$	M3C	ΔL	DL
$\alpha(M3)\exp$	EM3C	$\Delta Q(\alpha)$	DQA
$\alpha(M4)$	M4C	$\Delta Q(\epsilon)$	DQ+
$\alpha(M5)$	M5C	ΔS	DS

ENSDF DICTIONARY - ordered by output

Translation	ENSDF	Translation	ENSDF
ΔS_n	DSN	$\gamma\gamma$	GG
$\Delta S(p)$	DSP	$\gamma\gamma\gamma$	GGG
ΔT	DISPIN	$\gamma\gamma\tau$	GGT
$\Delta T_{1/2}$	DT	χ	CHI
$\Delta(HF)$	DHF	χ^2	CHI**2
$\Delta(\log ft)$	DFT	$\epsilon M(\exp)$	ECM
$\Delta(\beta\text{-normalization})$	DNB	$\epsilon N(\exp)$	ECN
$\Delta(\gamma\text{-normalization})$	ONR	κ	KAPPA
Δ	DELTA	λ	LAMBDA
δ^2	MR**2	μ	MOMM1
$\Delta\alpha$	DCC	μ	MU
$\Delta\delta$	DMR	μb	UB
$\Delta\pi$	DPI	$\mu b/sr$	UB/SR
ϵ	EC	$\mu b \cdot MeV$	UB*MEV
ϵ	EPSILON	μg	UG
ϵB	EPSILONB	$\mu g/cm$	UG/CM
$\epsilon B(E2)^\dagger$	EBE2UP	μs	US
$\epsilon B(E3)^\dagger$	EBE3UP	μ^-	MU-
ϵK	CK	ν	NU
$\epsilon K(\exp)$	ECK	π	PI
ϵL	CL	π^-	PI-
$\epsilon L(\exp)$	ECL	$\pi\beta$	PIB
ϵM	CM	$\pi\beta\gamma$	PIBG
ϵN	CN	$\pi\gamma$	PIG
ϕ	PHI	θ	THETA
γ	G	θ_1	THETA1
γ	GAMMA	θ_2	THETA2
Γ	WIDTH	$\theta\gamma$	THETAG
γce	GCE	ρ	RHO
γe^-	GE-	ρ^2	RHO**2
γn	GN	σ	SIGMA
$\gamma p'$	GP'	Σ	SUMOF
γX	GX	σ_n	SIGMAN
γ/α	G/A	σ_0	SIGMA(0)
Γ^2	WIDTH**2	σ_γ	SIGMAG
$\Gamma_{\gamma 0}^2$	WIDTHG0**2	$\sigma\nu$	SIGMANU
γ^2	G+-	$\sigma \cdot \Delta E$	SIGMA*DE
Γ_{n0}	WIDTHN0	τ	TAU
Γ_n	WIDTHN	ω	OMEGA
$\Gamma_{p'}$	WIDTHP'	$\omega^2\tau$	OMEGA**2*TAU
Γ_{p0}	WIDTHP0	$\omega\tau$	OMEGA*T
Γ_{p1}	WIDTHP1	ψ	PSI
Γ_{p2}	WIDTHP2	*	*
Γ_p	WIDTHP	$\leq$	LE
Γ_p	*WIDTHP	$\neq$	NE
$\Gamma_{\gamma 0}$	WIDTHG0	$\approx$	GE
Γ_γ	WIDTHG	∞	AP
$\Gamma\alpha$	WIDTHA		INFNT
$\gamma\beta$	GB		

ENSDF

$11/2(505)$
 $CONF=(N,NLJ)$
 $CONF=((P,7/2(633))(P,3/2(521))(N,3/2(621)))$
 $CONF=(N,NLJ,-1)$
 $CONF=(N,1G9/2)$
 $CONF=(N,3G9/2,+3,23/2-)$
 $CONF=(N,3P1/2,-1)$
 $CONF=((208Pb\ 3-)(P,1H9/2))15/2+$
 $CONF=(P,1G9/2)$
 $CONF=((P,1H9/2,+2,8+)(N,2F5/2,-3,11/2-))45/2-$
 $CONF=(P,3G9/2,+3,23/2-)$

TRANSLATION

$11/2[505]$
 $configuration=(\nu nlj)$
 $configuration=((\pi 7/2[633])(\pi 3/2[521])(\nu 3/2[621]))$
 $configuration=(\nu nlj)^{-1}$
 $configuration=(\nu 1g_{9/2})$
 $configuration=(\nu 3g_{9/2})^{+3}23/2-$
 $configuration=(\nu 3p_{1/2})^{-1}$
 $configuration=((^{208}Pb\ 3-)(\pi 1h_{9/2}))15/2+$
 $configuration=(\pi 1g_{9/2})$
 $configuration=((\pi 1h_{9/2}^2 8+(\nu 2f_{5/2})^{-3}11/2-))25/2-$
 $configuration=(\pi 3g_{9/2})^{+3}23/2-$

APPENDIX D-II

ENSDF DICTIONARY - ordered by input

ENSDF	Translation	ENSDF	Translation
A DECAY	α decay	BM(L)	BM(L)
A SYST	α syst	BM1	B(M1)
AA	$\alpha\alpha$	BM1W	B(M1)(W.u.)
ACE	$(\alpha)(ce)$	BM2	B(M2)
AG	$\alpha\gamma$	BM2W	B(M2)(W.u.)
ALPHA	α	BM3	B(M3)
AP	$\approx$	BM3W	B(M3)(W.u.)
AVRSQ	$\langle r^2 \rangle$	BM4	B(M4)
AXK	$(\alpha)(K \text{ x ray})$	BM4W	B(M4)(W.u.)
AY	Ay	BM5W	B(M5)(W.u.)
A(THETA)	A(θ)	BN	β_n
A**1/3	A ^{1/3}	BP	β_p
A**2/3	A ^{2/3}	BR	Branching
A-N	A-N	B(E0)	B(E0)
A-SYST	α -syst	B(E1)	B(E1)
A0	A ₀	B(E2)	B(E2)
a0	a ₀	B(E3)	B(E3)
A1	A ₁	B(E4)	B(E4)
A2	A ₂	B(J)	B(J)
A2P2	A ₂ P ₂	B*R	β_R
A2/A0	A ₂ /A ₀	B*RHO	B· ρ
A22	A ₂₂	B+	β^+
A3	A ₃	B-VIBRATIONAL	β -vibrational
A4	A ₄	B-	β^-
B	β	B0	β_0
BA	$\beta\alpha$	B1	β_1
BB	$\beta\beta$	B12	β_{12}
BC	βc	B2	β_2
BCE	βce	B2*R	β_2R
Be	Be	B20	β_{20}
BEL	B(EL)	B22	β_{22}
BELW	B(EL)(W.u.)	B3	β_3
BETA	β	B3*R	β_3R
BE(L)	BE(L)	B30	β_{30}
BE-	βe^-	B4	β_4
BE0	B(E0)	B4*R	β_4R
BE0W	B(E0)(W.u.)	B42	β_{42}
BE1	B(E1)	B5	β_5
BE1W	B(E1)(W.u.)	B6	β_6
BE2	B(E2)	B7	β_7
BE2UP	B(E2)†	C	C
BE2W	B(E2)(W.u.)	CC	α
BE3	B(E3)	CCBA	CCBA
BE3UP	B(E3)†	CE	ce
BE3W	B(E3)(W.u.)	CEB	ce β
BE4	B(E4)	CEG	ce γ
BE4UP	B(E4)†	CEK	ce(K)
BE4W	B(E4)(W.u.)	CEL	ce(L)
BE5	B(E5)	CEL1	ce(L1)
BE5W	B(E5)(W.u.)	CEL2	ce(L2)
BE6	B(E6)	CEL3	ce(L3)
BE6W	B(E6)(W.u.)	CEM	ce(M)
BE7	B(E7)	CEM1	ce(M1)
BE8	B(E8)	CEM2	ce(M2)
BF3	BF ₃	CEM3	ce(M3)
BG	$\beta\gamma$	CEM4	ce(M4)
BGG	$\beta\gamma\gamma$	CEM5	ce(M5)
BGN	$\beta\gamma n$	CEN	ce(N)
BG0	BG0	CEN1	ce(N1)
BJ**2	BJ ²	CEN2	ce(N2)
BL	β_L	CEN3	ce(N3)
BL*R	β_{LR}	CEN4	ce(N4)
BL*R*A**(1/3)	$\beta_{LR}A^{1/3}$	CEN5	ce(N5)
BML	B(ML)	CE0	ce(0)
BMLW	B(ML)(W.u.)	CE0+CEP	ce(0)+ce(P)

ENSDF DICTIONARY - ordered by input

ENSDF	Translation	ENSDF	Translation
CERN	CERN	D+Q	D+Q
CHI	χ	D+(Q)	D+(Q)
CHI**2	χ^2	D3HE	$d^3\text{He}$
CK	ϵK	E	E
CL	ϵL	EA	E α
Cm	Cm	EAV	$\alpha \nu$ E β
CM	ϵM	EB	E β
CM2	cm^2	EBE2UP	$\epsilon B(E2)^\dagger$
CM3	cm^3	EBE3UP	$\epsilon B(E3)^\dagger$
CN	ϵN	EC	ϵ
CO	Co	ECC	$\alpha(\text{exp})$
CONF	configuration	ECE	E(ce)
CONF=	configuration=	ECK	$\epsilon K(\text{exp})$
COS2TH	$\cos^2\theta$	ECL	$\epsilon L(\text{exp})$
COUL	Coul	ECM	$\epsilon M(\text{exp})$
CP	CP	ECN	$\epsilon N(\text{exp})$
CS1	CsI	EDE	E ΔE
C.M.	c.m.	EE	Ee
C12G	$^{12}\text{C}\gamma$	EEC	E ϵ
C2S	C^2S	EG	E γ
DA	ΔA	EG**5	E γ^5
DAVRSQ	$\Delta < r^2 >$	EKC	$\alpha(K)\text{exp}$
DA2	ΔA_2	EL	EL
DA4	ΔA_4	ELC	$\alpha(L)\text{exp}$
DBR	branching uncertainty	ELC+	$\alpha(L+\dots)\text{exp}$
DCC	$\Delta\alpha$	EL1C	$\alpha(L1)\text{exp}$
DCO	DCO	EL2C	$\alpha(L2)\text{exp}$
DCOQ	DCOQ	EL3C	$\alpha(L3)\text{exp}$
DE	ΔE	EMC	$\alpha(M)\text{exp}$
DEG		EMC+	$\alpha(M+\dots)\text{exp}$
DELTA	Δ	EM1C	$\alpha(M1)\text{exp}$
DE/DX	dE/dx	EM2C	$\alpha(M2)\text{exp}$
DFT	$\Delta(\log ft)$	EM3C	$\alpha(M3)\text{exp}$
DG	d γ	EN	E(n)
DHF	$\Delta(\text{HF})$	ENC	$\alpha(N)\text{exp}$
DIA	$\Delta I\alpha$	ENC+	$\alpha(N+\dots)\text{exp}$
DIB	$\Delta I\beta$	ENDOR	ENDOR
DIE	$\Delta I\epsilon$	ENSDF	ENSDF
DISPIN	ΔT	EN2C	$\alpha(N2)\text{exp}$
DJ	ΔJ	EN3C	$\alpha(N3)\text{exp}$
DJPI	$\Delta J\pi$	EP	E(p)
DK	ΔK	EPR	EPR
DL	ΔL	EPSILON	ϵ
DMR	$\Delta\delta$	EPSILONB	ϵB
DNB	$\Delta(\beta\text{-normalization})$	ESR	ESR
DNR	$\Delta(\gamma\text{-normalization})$	EV	eV
DOMEGA	d Ω	EVEN-A	even-A
DPAC	DPAC	EWSR	EWSR
DPAD	DPAD	E'(THETA)	e'(θ)
DPI	$\Delta\pi$	E(A)	E(α)
DQA	$\Delta Q(\alpha)$	E(D)	E(d)
DQ+	$\Delta Q(\epsilon)$	E(E)	E(e)
DRI	$\Delta I\gamma$	E(N)	E(n)
DS	ΔS	E(P)	E(p)
DSA	DSA	E(T)	E(t)
DSAM	DSAM	E**1/2	E $^{1/2}$
DSIGMA	d σ	E**2	E 2
DSN	ΔS_n	E+	e+
DSP	$\Delta S(p)$	E-E	E-E
DS/DW	d $\sigma/d\Omega$	E.G.	e.g.
DT	$\Delta T_{1/2}$	E/DE	E/ ΔE
DTI	$\Delta I(\gamma+ce)$	E0	E0
DWBA	DWBA	E1	E1
DWIA	DWIA	E2	E2
DWUCK	DWUCK	E3	E3

ENSDF DICTIONARY - ordered by input

ENSDF	Translation	ENSDF	Translation
E4	E4	IPAC	IPAC
E5	E5	ISOLDE	ISOLDE
E6	E6	ISPIN	T
E7	E7	ISPINZ	T _z
E8	E8	IT DECAY	IT decay
E9	E9	I.E.	i.e.
FG	(fragment) γ	J	J
FM	f _m	JF	J _f
FM**1	f _m ⁻¹	J1	J ₁
FM**2	f _m ²	JKP	JK π
FM**4	f _m ⁴	JMAX	J _{max}
FM-1	f _m ⁻¹	JMIN	J _{min}
FWHM	FWHM	JOSEF	JOSEF
F-K	F-K	JPI	J π
G	γ	JULIE	JULIE
GAMMA	γ	J0	J ₀
GB	$\gamma\beta$	J1	J ₁
GCE	γce	J2	J ₂
GDR	GDR	K	K
GE	$\geq$	KAPPA	κ
GEIGER	Geiger	KC	$\alpha(K)$
GELI	Ge(Li)	KEV	keV
GEV	GeV	KG	kG
GE-	γe^-	KLL	KLL
GG	$\gamma\gamma$	KOE	kOe
GGG	$\gamma\gamma\gamma$	KPI	K π
GGT	$\gamma\gamma\tau$	K/L+M	K/L+M
GM	GM	K/T	ce(K)/($\gamma+ce$)
GMR	GMR	L	L
GN	γn	LAMBDA	λ
GP'	$\gamma p'$	LAMPF	LAMPF
GQR	GQR	LARMOR	Larmor
GS	g.s.	LC	$\alpha(L)$
GT	$>$	LE	$\leq$
GTOL	GTOL	LI	Li
GT1/2	$gT_{1/2}$	LN	L(n)
GX	γX	LOGFT	log f _t
G*T	gT	LOGFIT	log f' _t
G*WIDTH	g Γ	LOGFITUT	log f' _{ut}
G*WIDTHGO	g $\Gamma_{\gamma 0}$	LP	L(p)
G*WIDTHGO**2	g $\Gamma_{\gamma 0}^2$	LT	$<$
G*WIDTHGO	g $\omega\Gamma_{\gamma 0}$	L/T	ce(L)/($\gamma+ce$)
G+-	γ^+	L1	L1
G-FACTOR	g-factor	L1C	$\alpha(L1)$
G/A	γ/α	L2	L2
HF	HF	L2C	$\alpha(L2)$
HI	HI	L3	L3
HOMEGA	$\hbar\omega$	L3C	$\alpha(L3)$
HPGE	HPGE	M	M
H**2	h ²	MB	mb
I	I	MB/SR	mb/sr
IA	I α	MC	$\alpha(M)$
IAR	IAR	MC+	$\alpha(M+...)$
IAS	IAS	MEDLIST	MEDLIST
IB	I β	MEV	MeV
IBA	IBA	MG/CM2	mg/cm ²
IBS	IBS	MILLI-EV	meV
IB+	I β^+	MOME2	Q
IB-	I β^-	MOMM1	μ
ICE	Ice	MR	δ
IE	I ϵ	MR**2	δ^2
IG	I γ	MS	ms
IG*EG	I $\gamma E\gamma$	MU	μ
IMPAC	IMPAC	MU-	μ^-
INFNT	∞	M+/T	ce(M+)/($\gamma+ce$)

ENSDF DICTIONARY - ordered by input

ENSDF	Translation	ENSDF	Translation
M/T	$ce(M)/(\gamma+ce)$	R	R
M1	M1	RHO	ρ
M1C	$\alpha(M1)$	RHO**2	ρ^2
M2	M2	RI	$I\gamma$
M2C	$\alpha(M2)$	RPA	RPA
M3	M3	RUL	RUL
M3C	$\alpha(M3)$	R**2	r^2
M4	M4	RO	r_0
M4C	$\alpha(M4)$	S VALUE	S value
M5	M5	SA	$S(\alpha)$
M5C	$\alpha(M5)$	SF	SF
NAI	NaI	SIGMA	σ
NB	$I\beta$ normalization	SIGMAG	σ_γ
NBS	NBS	SIGMAN	σ_n
NB/SR	nb/sr	SIGMANU	σ_ν
NC	$\alpha(N)$	SIGMA(O)	σ_0
NC+	$\alpha(N+...)$	SIGMA*DE	$\sigma \cdot \Delta E$
NC2S	NC ² S	SILI	Si(Li)
Ne	Ne	Sn	Sn
NE	$\neq$	SN	S(n)
NG	$n\gamma$	SOREQ	SOREQ
NGG	$n\gamma\gamma$	SP	S(p)
NMR	NMR	SUMOF	Σ
NOTE:	Note:	SY	syst
NQR	NQR	S'	S'
NR	$I\gamma$ normalization	S-FACTOR	S-factor
NS*SIGMA	NS σ	S-VALUE	S-value
NU	ν	S-WAVE	s-wave
NX	NX	S-1	s^{-1}
N*SIGMA	$N \cdot \sigma$	T	$T_{1/2}$
N+/T	$ce(N+)/(\gamma+ce)$	TAU	τ
N-Z	N-Z	TEMP	T
N1C	$\alpha(N1)$	TG	$t\gamma$
N2C	$\alpha(N2)$	TH	th
N3C	$\alpha(N3)$	THETA	θ
O	0	THETAG	$\theta\gamma$
ODD-A	odd-A	THETA1	θ_1
OMEGA	ω	THETA2	θ_2
OMEGA*T	$\omega\tau$	TI	$I(\gamma+ce)$
OMEGA**2*TAU	$\omega^2\tau$	Ti	Ti
OSIRIS	OSIRIS	TOF	tof
PAC	PAC	TPAD	TPAD
PAD	PAD	TRISTAN	TRISTAN
PALPHA	$p\alpha$	TRIUMPH	TRIUMPH
PG	$p\gamma$	T20	T20
PGG	$p\gamma\gamma$	T21	T21
PHI	ϕ	T22	T22
PI	π	U	U
PIB	$\pi\beta$	UB	μb
PIBG	$\pi\beta\gamma$	UB*MEV	$\mu b \cdot MeV$
PIG	$\pi\gamma$	UB/SR	$\mu b/sr$
PI-	π^-	UG	μg
PRI	$\Delta I\gamma(\%)$	UG/CM	$\mu g/cm$
PSI	ψ	UNISOR	UNISOR
PWBA	PWBA	US	μs
PWIA	PWIA	V	V
P(THETA)	$p(\theta)$	W	W
P-WIDTH	p-width	WIDTH	Γ
Q	Q	WIDTHA	Γ_α
QA	$Q(\alpha)$	WIDTHG	Γ_γ
QP	$Q(g.s.)$	WIDTHG0	$\Gamma_{\gamma 0}$
Q+0	Q+0	WIDTHG0**2	$\Gamma_{\gamma 0}^2$
Q+-	$Q(\epsilon)$	WIDTHN	Γ_n
Q-	$Q(\beta^-)$	WIDTHNO	Γ_{n0}
Q3D	Q3D	WIDTHP	Γ_p

APPENDIX D-II

ENSDF DICTIONARY - ordered by input

ENSDF	Translation	ENSDF	Translation
WIDTHP	Γ_p	%B+	$\% \beta^+$
WIDTHP0	Γ_{p0}	%B-N	$\% \beta^- n$
WIDTHP1	Γ_{p1}	%B-P	$\% \beta^- p$
WIDTHP2	Γ_{p2}	%B-	$\% \beta^-$
WIDTH**2	Γ^2	%EC	$\% \epsilon$
W(THETA)*G*WIDTHG0	$w(\theta) g \Gamma_{\gamma 0}$	%ECP	$\% \epsilon p$
W.U.	W.u.	%EWSR	$\% EWSR$
XG	X_γ	%E0	$\% E0$
XK	K x ray	%E2	$\% E2$
XKA	K α x ray	%G	$\% \gamma$
XKA1	K α_1 x ray	%IB	$\% I \beta$
XKA2	K α_2 x ray	%IT	$\% I T$
XKB	K β x ray	%M1	$\% M1$
XKB1	K β_1 x ray	%R1	$\% I \gamma$
XKB1P	K β_1 x ray	%SF	$\% SF$
XKB2	K β_2 x ray	%12C	$\%^{12}C$
XKB2P	K β_2 x ray	%14C	$\%^{14}C$
XKB3	K β_3 x ray	%2B-	$\% 2 \beta^-$
XKB4	K β_4 x ray	(A)	(α)
XKB5	K β_5 x ray	(B)	(β)
XKB51	K β_5^1 x ray	(DOWN)	($\downarrow$)
XKB511	K β_5^{11} x ray	(H,T)	(H,t)
XKG	(K x ray) γ	(THETA,H)	(θ, H)
XK02	K-0 ₂ x ray	(T)	(t)
XK023	K-0 ₂₃ x ray	(UP)	($\uparrow$)
XK03	K-0 ₃ x ray	*	*
XL	L x ray	*G*WIDTHG0**2	$g \Gamma_{\gamma 0}^2$
XLA	L α x ray	*WIDTHP	Γ_p
XLA1	L α_1 x ray	**L	L
XLA2	L α_2 x ray	** -1	-1
XLB	L β x ray	** -3	-3
XLB1	L β_1 x ray	** -4	-4
XLB2	L β_2 x ray	** 1/3	1/3
XLG	L γ x ray	2B-	$2 \beta^-$
XLG1	L γ_1 x ray	2J	2J
XLG2	L γ_2 x ray	4PI	4 π
XLL	L _t x ray	4PIB	4 $\pi \beta$
XL1	L ₁ x ray	4PIBG	4 $\pi \beta \gamma$
XL2	L ₂ x ray	4PIG	4 $\pi \gamma$
XL3	L ₃ x ray	-A	A
XM	M x ray	-B	B
XX	XX	-D	D
X-RAY	x-ray	-N	N
YTTRIUM	Y	-P	P
Z	Z	-S	S
%A	$\% \alpha$	-T	T
%B+A	$\% \beta^+ \alpha$	-X	X
%B+N	$\% \beta^+ n$	-Y	Y
%B+P	$\% \beta^+ p$		

ENSDF

11/2(505)
 CONF=(N,NLJ)
 CONF=((P,7/2(633))(P,3/2(521))(N,3/2(621))
 CONF=(N,NLJ,-1)
 CONF=(N,1G9/2)
 CONF=(N,3G9/2,+3,23/2-)
 CONF=(N,3P1/2,-1)
 CONF=((208PB 3-)(P,1H9/2))15/2+
 CONF=(P,1G9/2)
 CONF=((P,1H9/2,+2,8+)(N,2F5/2,-3,11/2-))25/2-
 CONF=(P,3G9/2,+3,23/2-)

TRANSLATION

11/2[505]
 configuration=(ν nlj)
 configuration=((π 7/2[633])(π 3/2[521])(ν 3/2[621]))
 configuration=(ν nlj)⁻¹
 configuration=(ν 1g_{9/2})
 configuration=(ν 3g_{9/2})⁺³23/2-
 configuration=(ν 3p_{1/2})⁻¹
 configuration=((²⁰⁸Pb 3-)(π 1h_{9/2}))15/2+
 configuration=(π 1g_{9/2})
 configuration=((π 1h_{9/2})²₈₊(ν 2f_{5/2})⁻³_{11/2-})25/2-
 configuration=(π 3g_{9/2})⁺³23/2-

APPENDIX E

DATA EVALUATION CENTERS

<p>a. National Nuclear Data Center
Brookhaven National Laboratory
Upton, NY 11973, U.S.A.
Contact: J. K. Tuli</p> <p>b. Nuclear Data Project
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Contact: M. J. Martin</p> <p>c. Isotopes Project
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Contact: E. Browne/R. B. Firestone</p> <p>d. Idaho National Engineering
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Contact: C. W. Reich</p> <p>e. Physics Department
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Contact: F. Ajzenberg-Selove</p> <p>f. Center for Nuclear Structure
and Reaction Data of the U.S.S.R.
State Committee on the Utilization
of Atomic Energy U.S.S.R.
46 Ulitsa Kurchatova
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Contact: F. E. Chukreev</p> <p>g. Data Centre
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Contact: D. De Frenne</p> <p>o. Tandem Accelerator Laboratory
McMaster University
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Contact: J. A. Kuehner</p> <p>p. Institute of Atomic Energy
P.O. Box 275 (41), Beijing,
People's Republic of China
Contact: C. Dunjiu</p> |
|---|---|

EVALUATION RESPONSIBILITY

<u>A-Range</u>	<u>Center</u>	<u>A-Range</u>	<u>Center</u>	<u>A-Range</u>	<u>Center</u>	<u>A-Range</u>	<u>Center</u>
1-4	f	65-73	a	136-148	a	195-198	p
5-20	e	74-80	m	149, 151	o	199-237	b
21-44	h	81-100	i	150, 152	a	238-244 (even)	f
45-50	a	101-110	j	153-162	d	239-243 (odd)	b
51-56	p	111-117	n	163, 165	a	245-263	b
57, 58	a	118-129	k	164, 166	f		
59-64	l	130-135	g	167-194	c		

APPENDIX F

Conventions, Policies and Symbols in Nuclear Data Sheets

Appendix F-1	Language Style in Nuclear Data Sheets
Appendix F-2	General Policies - Theory
Appendix F-3	Bases For Spin And Parity Assignments
Appendix F-4	Conventions
Appendix F-5	Symbols and Abbreviations

LANGUAGE STYLE IN NUCLEAR DATA SHEETS

The *Nuclear Data Sheets* generally follow the language guidelines as contained in the American Institute of Physics, Style Manual (AIP Publ. R-283, 1978). Some specific suggestions on punctuation, abbreviations, spelling, and grammar, as well as a discussion of some common problems follows:

a. Abbreviations: Use the standard abbreviations given in Appendix F-5 and the inside back cover of the journal. For example, use "excit" instead of "exc," "exp" instead of "expt," etc. Use periods with abbreviations only if given on the list. Abbreviations such as av, calc, norm, pol, rel, res, etc. should not be used in the regular text. They are intended for use in tables, equations, parenthetical expressions, reactions, etc. to conserve space.

b. Keynumbers: Keynumbers should be treated as plural subjects since, for example, "81Aa99 are continuing ..." is the same as "The authors of 81Aa99 are continuing..." Keynumbers in series should be in either descending (preferred) or ascending chronological, alphabetical, and numerical order. This should be consistent throughout an evaluation.

c. Tense: Past-tense verbs should be used for events which have already taken place and are not ongoing. For example "81Aa99 measured..." instead of "81Aa99 measure..." However, "81Ba12 cite..."

d. Spelling: When there are two or more correct spellings of a word, use the short or American spelling. For example, "analog" instead of "analogue," "behavior" instead of "behaviour," "polarization" instead of "polarisation." However, "thru," "tho," and other simplified spellings, slang, or jargon should not be used. Under I(vi) below, there is a list of some words that are always spelled solid and others that are always hyphenated. Use standard rules for hyphenating compound modifiers. Appendix B of the AIP Style Manual contains additional examples of the preferred spellings of words which occur frequently. Webster's Instant Word Guide is a very useful source for both the spelling and the hyphenation of words.

e. Commas. A comma precedes the conjunction before the final item in a series, unless the conjunction joins combinations. This rule would also apply to the semi-colon when used in a series. In comments listing level energy and $J\pi$, set off the $J\pi$ with commas as an appositive. For example:

1981.3, (1-, 2-), is given
1993.5, 1, is given.

In a series, use semicolons after all but the last $J\pi$ (comma before conjunction). For example, 1981.3, (1-, 2-); 1992.4, 3-, 5-; and 1993.5, 1, are given.

Key numbers in comments are separated by commas immediately followed by a space. However, key numbers on formatted or continuation records or key numbers enclosed in parentheses are separated by a comma without a following blank.

f. Person: Smooth transitions between first and third person are acceptable.

g. Units: With the exception of the four standard units for energy, cross section, and electric and magnetic moments as given under the "Conventions used in Nuclear Data Sheets," appropriate units, as defined in Appendix F-5 should be given for all quantities. In general, the unit should appear between the value and associated uncertainty. For example, $T_{1/2} = 13.3 \text{ min } 5$. There are a few exceptions where the unit is associated with the quantity measured or deduced. For example, $B(E2)(W.u.)=1.0$ 1, instead of $B(E2)=1.0$ W.u. 1.

h. Mathematical operators and equations: The following operators are allowed within the text: +, -, =, <, >, LT, GT, LE, NE, AP

The production programs will remove the leading and trailing blanks around the operators, thus compacting an equation.

APPENDIX F-1

LANGUAGE STYLE IN NUCLEAR DATA SHEETS (cont.)

The representation of complex equations often causes problems. The evaluator can code these in comments using the special characters as defined in Appendix A-1. If you are not sure of the proper use of special characters write down the formula in a note to NNDC and the production staff will try to code it for you.

i. Miscellaneous:

- (i) Use "spin and parity" instead of "spin-parity."
- (ii) Use "uncertainty" instead of "error" unless "error" means "mistake."
- (iii) If a number contains a decimal point, there must be a number before the decimal point ("0.99" instead of ".99").
- (iv) Use the form "0.99 9" instead of "0.99±9" or "0.99±0.09" for uncertainties.
- (v) When foreign words are used, the appropriate number should be reflected in the verb and modifiers. One of the most widely used word in this category is the Latin singular word "datum," whose plural is "data." Singular "This datum is ..." would have the plural "These data are..."
- (vi) Some single words:

antianalog	depopulation	nonstatistical
antiparallel	endpoint	nonuniform
bandhead	lifetime	nonunique
backbending	lineshape	overall
backscatter	nonaligned	photopeak
crossover	nonelastic	pickup (adj.)
cutoff (adj.)	nonlocal	subshell
deadline	nonresonant	wavelength
deexcitation	nonrotational	

Some hyphenated words (Modifiers made up of two or more words are usually hyphenated)

di-pion	1-no shape
half-life	2-yes shape
half-width	96-keV level
mean-life	s-wave capture
non-negative	shell-model calculations
non-Fermi	x-ray intensity
quasi-free-electron	
self-consistent	
semi-infinite	
up-spin	

The following are spelled as two words

cross section
shell model
wave function
x ray
α particle
γ ray

GENERAL POLICIES - "THEORY"

A reference "Theory 67Xy01" indicates theoretical predictions computed by the authors of 67Xy01. A reference "Theory" alone indicates a determination by the compiler of theoretical predictions described below.

Internal Conversion Coefficients

Theoretical conversion coefficients are obtained by spline interpolation (68Ha53) from tables of Hager and Seltzer (68Ha53) for the K -, $L_{1,2,3}$ -, $M_{1,2,3}$ -shells and of Dragoun, Plajner, and Schmutzler (71Dr11) for the $(N+O+...)$ -shells. For the $N_{1,2,3}$ -subshells, values are obtained by graphical interpolation from tables of Dragoun, Pauli, and Schmutzler (69Dr09). For K -, $L_{1,2,3}$ -shells, conversion coefficients for transitions outside the E_γ , A -, or Z -ranges of Hager and Seltzer are obtained as follows: for $E_\gamma \leq 6000$ keV and for $Z=3, 6, 10$ and $14 \leq Z \leq 30$ interpolation from tables of Band et al. (76Ba63); for $E_\gamma > 2600$ keV, by graphical interpolation from tables of Trusov (72Tr09). For $E0$ -transitions, K/L_1 and L_1/L_2 ratios are obtained by graphical interpolation from tables of Hager and Seltzer (69Ha61).

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 (71St47, 71St48). In particular, we adopt the phase convention for the mixing ratio, δ , defined by the authors (70Kr03). 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 (68Ha54). The expression for the deorientation coefficient required to account for intermediate unobserved mixed radiations is given by Anicin (72An20).

A tabulation of gamma-gamma directional coefficients is given by Taylor, et al. (71Ta32). 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 (69Ha61).

Internal Pair Conversion Coefficients

Theoretical internal pair conversion coefficients for $A=E1, M1, E2$ are obtained by graphical interpolation in Z, E from tables of Lombard, et al. (68Lo16).

* 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 (71Go40). This reference also contains a tabulation of log f 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. (72Bb16) for $Z \leq 92$ and from Ahmad (79Ah01) for $Z > 92$.

Electron binding energies for $Z < 84$ are taken from Bearden and Burr (67Be73) and from Porter and Freedman (78Po08) 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 (47Pr17). The nuclear radius for each even-even nucleus was determined by defining, for the g.s. to g.s. α -transition hindrance factor, $HF \approx 1$. For odd- A and odd-odd nuclei, the radius was chosen to be the average of the radii for the adjacent even-even nuclei (72El21). In the few cases where only one adjacent even-even radius was known, that value was corrected for the $A^{1/3}$ mass dependence and used in the calculation.

Electromagnetic Transition Rates

The Weisskopf single-particle estimates for the half-lives of electric and magnetic multipole radiation of energy E_γ are (52B197)

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

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

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

Unweighted and Weighted Averages

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

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

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

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

APPENDIX F-2 (cont.)

GENERAL POLICIES - "THEORY" continued

References

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ORGANIZATION OF MATERIAL

Within each A chain, information is collected by isotope and arranged in order of increasing Z. For each isotope, ^AZ, the arrangement of material and conventions for inclusion in tables are described below. Uncertainties are shown whenever available.

1. Adopted levels in ^AZ - All adopted level properties are shown for each level, together with explanatory comments.
2. Adopted γ radiations in ^AZ.
3. Radiations from ^AZ decay - All adopted radiation properties are shown for each mode of decay of the ^AZ ground state. Properties of α , β^- , AND $\epsilon + \beta^+$ radiations precede γ -radiation properties.
4. Radiations from ^AZ isomeric-state decay - Decay of each isomeric state is presented according to the same conventions as for the ground-state decay.

5. Levels and γ rays in ^AZ from decay[†] - Decays are ordered by A, Z of the parent.
 - a) Table of levels deduced from the decay.
 - b) Table of γ rays observed in the decay unless given under its respective parent according to 3 or 4 above.
6. Levels and γ rays in ^AZ from nuclear reactions[†] - Reactions are ordered by A, Z of the target, then by 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.

[†] The detailed results are tabulated only when the information is not adequately summarized on the drawings.

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 multipolarities of a transition and its mixing ratio.
5. Since 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 ^{a,b}	A>150 ^c
E1 (IV)	0.3 ^a	0.01	0.01
E2 (IS)	100	300	1000
E3	100	100	100
E4	100	100 [†]	
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).

^d 10 for E2 (IV), 0.03 for M1 (IS), 0.1 for M2 (IS)

^e From 79En04

^f From 81En06

^g Deduced from ENSDF by M. J. Martin

Beta Transitions[§]

- 7a. If $3.6 < \log ft < 5.9$, the transition is allowed: $\Delta J=0$ or 1, $\Delta\pi=+$ (no change in parity). For the mass region around Z=82, the upper limit should be lowered to 5.1.
- 7b. If $3.6 < \log ft < 6.4$, the transition is not $0^+ \rightarrow 0^+$. Superaligned ($\Delta T=0$) $0^+ \rightarrow 0^+$ transitions have $\log ft$ in the range 3.48 to 3.50. Isospin forbidden ($\Delta T=1$) $0^+ \rightarrow 0^+$ transitions have $\log ft > 6.4$.
8. If $\log f^{int} < 8.5$, $\Delta J=0,1$; $\Delta\pi=+$.
9. If $\log ft < 11.0$, $\Delta J=0,1$; $\Delta\pi=+$ or $\Delta J=2$, $\Delta\pi=-$.
10. If $\log ft < 12.8$, $\Delta J=0,1,2$; $\Delta\pi=+$.
11. If $\log f^{int} \geq 8.5$ and if the Fermi plot has the curvature corresponding to a shape factor (p^2+q^2), then the transition is first-forbidden unique ($\Delta J=2$, $\Delta\pi=-$).

See "β-Decay Rate Probabilities" on page App-F-iv.
Note that $\log f^{int} = \log ft + 10.79$.

* ($\log ft < 7.4$)

† ($\log ft < 7.4$)

 $\gamma\gamma$ 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 $|A_2(\beta)| \geq 0.1$ ($A_4=0$), 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,

$$\begin{aligned} \beta^- & A_1(\beta) < 0 \text{ if } J_i = J_f, \\ \beta^+ & A_1(\beta) > 0 \text{ if } J_i = J_f, \end{aligned}$$

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

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

18. If $A_2(\beta) \neq 0$, the β -transition is not allowed. The converse is not always true.

Reactions

19. Low-energy Coulomb excitation is predominantly E2 excitation.

20. Coulomb excitation determines J^π if the excitation probability agrees with the calculated values of Alder et al., Kgl. Danske Videnskab. Selskab, Mat.-Fys. Medd. 32, No. 8 (1960).

21. The spin of the compound nuclear state resulting from thermal-neutron capture is equal to the spin of the target nucleus plus or minus $\frac{1}{2}$.

22. Primary γ 's from neutron capture are E1, M1, E2, or M1+E2.

23. 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

$$\vec{J}_f = \vec{J}_i + \vec{l} + \vec{s}$$

with parity change if l is odd.

24. For $Z < 50$ and $Z \approx 82$, 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.

The limitation in the regions of applicability results from a lack of measurements in other regions rather than an expected or observed violation.

§ See 73Ra10

SUMMARY OF BASES FOR SPIN AND PARITY ASSIGNMENTS - continued

PROPOSITIONS ON WHICH STRONG ARGUMENTS
ARE BASED continued

25. 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 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)
- A strong group observed in the α -particle reaction ($^6\text{Li,d}$).
- (e,e') and (α,α') inelastic scattering.

26. In reactions with $J^\pi=0^+$ target, projectile, and ejectile, if the yield of a group at 0° or 180° is

- non-zero, the parity of the final state is $(-1)^{J_f}$
- zero at several uncorrelated energies, the parity of the final state is $(-1)^{J_f+1}$

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

- non-zero, the parity of the final state is $(-1)^{J_f+1}$
- zero at several uncorrelated energies, the parity of the final state is $(-1)^{J_f}$

Magnetic Moments

27. In nonrotational regions, if the known spin and magnetic moment of a level lead to an expected shell-model state by use of the Schmidt diagram, the level parity is determined.

28. In rotational regions, if the known spin and magnetic moment of a level agree with theoretical values for only one expected Nilsson level, the level parity is determined.

Deformed Region - Band Structure

Symbol	Evidence
D	Data from β - or γ -transitions suggest $J^\pi = 2^+$
x	The level is Coulomb excited
y	The level energy is given by the rotational level-energy formula
z,z'	The inertial parameter, decoupling parameters, fits the local trend

In terms of the above types of evidence, the following rules can be stated for nuclei in the rotational regions. $90 \leq N \leq 112$, and $Z \geq 87$.

29. For the first excited state in an even-even nucleus, x or Dz is sufficient to assign a spin and parity of 2^+ .

30. A level may be assigned to the ground-state rotational band on evidence of type xz or yz, provided the ground-state spin is well known.

31. A level may be assigned to a rotational band on evidence of type yz, provided at least one member of the band has well-known spin.

32. For $K=1/2$ bands, yz' is sufficient evidence to assign spins to the levels.

Alpha Decay

33. In odd-A nuclei, levels connected by α -transitions have the same spin and parity if the hindrance factor is less than 4.

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

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 multiplicities occupy one time region e.g. M1 and E2, a new gamma of which the half-life falls in this region may be assigned one of the two multiplicities 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. 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 that all shell-model arguments are weak.

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

6. In regions of nuclear deformation, the Nilsson model can be used to limit the possible spins and parities.

7. Statements similar to 4 and 6 based on other models.

8. Statements based on interpolation or extrapolation of regional trends.

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

REFERENCES

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- 79En04 P. M. Endt, At.Data Nucl.Data Tables 23, 547 (1979); Strengths of Gamma-Ray Transitions in $A = 45-90$ Nuclei
- 81En06 P. M. Endt, At.Data Nucl.Data Tables 26, 47 (1981); Strengths of Gamma-Ray Transitions in $A = 91-150$ Nuclei

CONVENTIONS USED IN NUCLEAR DATA SHEETS

Units

Energies keV
 Cross Sections barns
 Magnetic dipole moments nuclear magnetons
 Electric quadrupole moments barns

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

4.623 3 means 4.623 ± 0.003
 4.6 12 means 4.6 ± 1.2
 $5.4 \cdot 10^3$ 2 means 5400 ± 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 Marks** given after the energy value of a level or a radiation represent doubt as to the existence of that level or the radiation. A "?" given after the $T_{1/2}$ value indicates that the assignment of that half-life to given 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
L, Mult.	Probable but not definite
Other	Value deduced (not directly measured) or taken from other experiment(s).

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.

Mult. = M1(+E2)

Multipolarity is M1 with possible admixture of E2.

[] **Brackets**

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

Assumed quantity, e.g., [M1+E2], [$7/2^+$]

XREF (Cross Reference)

The cross reference symbols (characters 'A' to 'O') for the various experiments in which a level is seen are sometimes given in the adopted-levels table. When an adopted level may correspond to more than one level in a given experiment the flag for that experiment is given in lower case. In cases of ambiguity the energy for the corresponding level is given as a comment.

Level Scheme Symbols

----- Level of which the existence is not well-established

..... Adopted position of neutron- or proton-separation energy

_____ Well-established level

===== Ground-state or long-lived isomeric level

↓ Radiation of which the position on the level scheme is not well-established

⋮ An expected strong transition that has not been observed

Beta, gamma, and alpha ray placement is consistent with coincidence measurements

4380 0.4 7.5

4380-keV α -transition with intensity 0.4% and hindrance factor (HF) = 7.5

Decay modes of a level

404 4 8.5

β^- -transition with endpoint energy, 404 keV measured directly; intensity, 4% of decays, usually found indirectly (from γ -intensities, a more accurate method if there are several β -groups); $\log ft = 8.5$

119 80 6.3

ϵ -transition with energy determined directly from endpoint of γ -continuum (to which is added K-shell electron binding energy) or from L-, K-capture ratio; with intensity 80%, usually determined indirectly (from γ -intensities); $\log ft = 6.3$

665 25

γ -transition with energy 665 keV and intensity 25 in the units specified in the drawing

%

Number per 100 disintegrations of a nuclear level

APPENDIX F-5

Nuclear Data Sheets Symbols and Abbreviations

A	mass number*, $A=Z+N$	priv comm	private communication
A_2, A_4	coefficients of Legendre polynomials in angular-correlation or angular-distribution measurement	PWBA	plane-wave Born approximation
av	average	Q	(1)reaction energy*, (2)disintegration energy*, (3)quadrupole moment*, in units of barns, (4)quadrupole
B(EL), B(ML)	reduced EL, ML transition probability in $e^2 \cdot (\text{barn})^L$, $\mu_N^2 \cdot (\text{barn})^{L-1}$	Q(ϵ)	total disintegration energy in ϵ decay
calc, CA	calculated, calculation	Q(β^-)	total disintegration energy in β^- decay
CCBA	coupled-channel Born approximation	Q(α)	total disintegration energy in α decay, $E(\alpha) + E(\text{recoil})$
ce	conversion electron	R	$r_0 A^{1/3}$, nuclear radius*
chem	chemical separation	RDM	recoil distance measurement
circ	circular	RUL	recommended upper limit for γ -ray strength
c.m.	center of mass	rel	relative
coef	coefficient	res	resonance
coin	coincidence	s	second
Coul. ex.	Coulomb excitation	S	spectroscopic factor
CP	circular polarization	S'	$[(2J_i+1)/(2J_f+1)]S$
cryst	crystal-diffraction spectrometer	S(n) or S_n	energy necessary to separate a
C^2S, C^2S'	one-nucleon spectroscopic strength for pickup, stripping reactions	S(p) or S_p	neutron, proton from nucleus
d	day	scatt	scattering
D	dipole	scin	scintillation counter
DSA	Doppler shift attenuation	semi	semiconductor detector
DWBA	distorted-wave Born approximation	SF	spontaneous fission
DWIA	distorted-wave impulse approximation	spall	spallation
E	energy	sr	steradian
$E(\epsilon)$	energy of electron-capture transition (endpoint of γ -continuum + K-electron separation energy of daughter)	syst, SY	systematics
E1, E2, EL	electric dipole, quadrupole, 2^L -pole	t	triton
excit	excitation function	T	(1)isobaric spin, (2)temperature
expt	experiment, experimental	Tz	Z-Component of isobaric spin, $(N-Z)/2$
F	fission	$T_{1/2}$	half-life*
F-K	Fermi-Kurie (plot)	th	thermal
FWHM	energy resolution, full width at half maximum	thresh	threshold
g	gyromagnetic ratio*	tof	time-of-flight measurement
GDR	giant dipole resonance	vib	vibrational
GQR	giant quadrupole resonance	W.u.	Weisskopf single-particle transition speed
g.s.	ground state	y	year
h	hour	Z	atomic number*, $Z=A-N$
H	magnetic field	α	total γ -ray internal conversion coefficient $N(\text{ce})/N(\gamma)$ *
HF	hindrance factor	$\alpha(K), \alpha(L)$	γ -ray internal conversion coefficient for electrons ejected from the K-, L-shell
hfs	hyperfine structure	$\alpha\gamma, \beta\gamma, \gamma\gamma$	coincidences of α 's and γ 's, β 's and γ 's, γ 's and γ 's
HI	heavy ion	$\alpha\gamma(\theta, H, t)$, $\beta\gamma(\theta, H, t)$, $\gamma\gamma(\theta, H, t)$	$\alpha\gamma$ -, $\beta\gamma$ -, $\gamma\gamma$ -coincidences as function of angle, magnetic field, time
I	intensity	$\beta_2, \beta_3, \beta_L$	quadrupole, octupole, 2^L -pole nuclear deformation parameter
IAR	isobaric analog resonance	$\beta\gamma(\text{pol})$, $\gamma\gamma(\text{pol})$	polarization correlation of γ 's in coincidence with β 's, γ 's
IAS	isobaric analog state	$\Gamma, \Gamma(\gamma), \Gamma(n)$	level width*, partial width for γ -, n-emission
IBS	internal bremsstrahlung spectrum	$\gamma(\theta, H, T)$	γ -intensity as function of angle, magnetic field, temperature
IMPAC	ion implantation perturbed angular correlation technique	γ^+	annihilation radiation
inel	inelastic	δ	ratio of reduced matrix elements of $(L+1)$ - to L -pole radiation with sign convention of Krane and Steffen, Phys.Rev. C2, 724 (1970)
ion chem	chemical separation by ion exchange	ϵ	electron capture
IT	isomeric transition	$\epsilon K, \epsilon L, \epsilon M$	electron capture from K-, L-, M-shell
J	total angular momentum quantum number*	$\epsilon(\gamma)B(E2)$	partial B(E2) for photon
K	projection of nuclear angular momentum J on nuclear symmetry axis	$\epsilon(\text{ce})B(E2)$	conversion electron detection
K, L, M	K-, L-, M-shell internal conversion	θ	indicates angular dependence
K/L	K-, L-conversion electron ratio	λ	(1)projection of particle angular momentum on nuclear symmetry axis, (2)radiation type, e.g., M1, M2...
L	(1)orbital angular momentum quantum number*, (2)multipolarity	μ	magnetic moment of particle*, given in nuclear magnetons (μ_N)
L(n), L(p)	L-transfer in neutron, proton transfer reaction	ν	neutron shell-model configuration
min	minute	π	parity, proton shell-model configuration
M+	$M+N+O+\dots$	σ	cross section*
M1, M2, ML	magnetic dipole, quadrupole, 2^L -pole	$\Sigma(\gamma\gamma)$	coincidence summing of γ -rays
mag spect	magnetic spectrometer	$\omega(K), \omega(L)$	K, average-L fluorescence yield
max	maximum	$\% \alpha$	percent α branching from level
Moss	Mossbauer effect	$\% \beta^-$	percent β^- branching from level
ms	(1)mass spectrometer, (2)millisecond	$\% \beta^+$	percent β^+ branching from level
mult	multipolarity/character	$\% \epsilon$	percent ϵ branching from level
N	neutron number, $N=A-Z$	$\% IT$	percent (γ +ce) branching from level
NMR, NQR	nuclear magnetic, quadrupole resonance	$\% SF$	percent spontaneous fission from level
norm	normalization	$\langle r^2 \rangle$	root-mean-square of nuclear radius
PAC	perturbed angular correlation		
pc	proportional counter		
p, γ (θ)	angular distribution of γ -rays with respect to a proton beam		
p, γ (t)	time distribution of photons with respect to a pulsed proton beam		
pol	polarized, polarization		

Prefixes*				Symbols for Particles and Quanta*					
T	tera	($=10^{12}$)	m	milli	($=10^{-3}$)	n	neutron	π	pion
G	giga	($=10^9$)	μ	micro	($=10^{-6}$)	p	proton	μ	muon
M	mega	($=10^6$)	n	nano	($=10^{-9}$)	d	deuteron	e	electron
k	kilo	($=10^3$)	p	pico	($=10^{-12}$)	t	triton	ν	neutrino
c	centi	($=10^{-2}$)	f	femto	($=10^{-15}$)	α	α -particle	γ	photon
			a	atto	($=10^{-18}$)				

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

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