MEMO 4-C 2/112

To Distribution

From P.D. Johnston

Subject EXFOR Coding of Fission Product Yields

16 July 1980

The implementation of a computational format for Fission Product yields has shown a number of inconsistencies and errors in EXFOR coding of Fission Product yield data. There are in particular two areas where care is needed; the specification of isomeric states of products, and heading and units for fractional and relative yields.

Isomeric states

From my reading of the manuals there are three valid ways of coding isomeric states for fission products.

a) For a unique product, the Reaction code, SF4 should contain, where appropriate -M.

b) For a table of various product yields where Decay Data is available, the -M extension should be used in Field one of the DECAY-DATA code.

c) Where no Decay Data is available the ISOMER column heading, with value 1. or 2. may be used following the ELEMENT and MASS column headings.

Fractional Yields

These should always be coded as explicit ratios of the independant or cumulative yields over the chain yield. The column heading should be RATIO, units NO-DIM, and the values may only be in the range from zero to unity. (i.e. not percentage).

Relative yields (arbitarily normalised to a particular product yield of unity) should be coded with REL in SF8 of the Reaction code, with column heading DATA and units ARB-UNITS.

None of these rules are new, but having reviewed the data in EXFOR, I felt that an explicit reminder would help to clarify the situation.

I also include a proposal replacement and extension of the LEXFOR manual entry for coding Fission Product yields, including a definition of a new branchcode, CHG, (Reaction SF5) for charge yields, used in EXFOR works 21549 and 21550.

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Fission Yields

Definition Scission of a heavy nucleus into two, or occasionally three, fragments produces nuclei which undergo a sequence of de-excitations. The yield of a nucleus of specified Z and A is usually measured as a percentage yield per fission of the heavy target nucleus fissions.

Primary Fission Fragment yields

The percentage yield per fission of nuclei of specified Z and mass, or specified mass, before prompt neutron-emission: Usually within 4 X 10 - 14 secs of fission.

ISO - QUANT	REACTION
NF, YLD, PRE	(N,F) ELEM/MASS, PRE, FY

Secondary Fission Fragment Yields

The percentage yield per fission of nuclei of specified mass, after prompt neutron emission, but before beta decay or delayed neutron emission.

ISO - QUANT	REACTION
NF, YLD, SEC	(N,F) MASS, SEC, FY

Independent Fission Product Yields

The percentage yield of nuclei of specified Z and mass after prompt neutron emission, but before beta decay or delayed neutron emission.

ISO - QUANT	REACTION
NF, YLD, IND	(N,F)ELEM/MASS, IND, FY

Cumulative fission Product Yields

The cumulative yield of nuclei of specified Z and Mass , including the independant yield plus the additional yield from beta decay and delayed neutron emission of neighboring nuclei.

ISO-QUANT	REACTION
NF, YLD, CUM	(N,F) ELEM/MASS, CUM, FY

Total Chain Yield

The sum of the cumulative yields of all fission products having a specified mass

ISO-QUANT	REACTION
NF, YLD, CHN	(N,F) MASS, CHN, FY

Fractional Yields

Fractional independant or cumulative yields relative to the chain yield for a specified mass.

ISO-QUANT	REACTION
(NF,YLD,IND)/(NF,YLD,CHN)	(N,F)ELEM/MASS,IND,FY)/(N,F)MASS,CHN,FY)

NB: HEADING RATIO; UNITS NO-DIM

Most Probably Charge ZP

The arithmetic mean of the Primary fission fragment or independant product charge distributions for a specified mass chain often empirically approximated by a Gaussian distribution.

ISO-QUANT	REACTION
NF, ZP	(N,F), ZP

Charge Yields

The summed yields for a specified product Z, before beta decay processes.

ISO-QUANT	REACTION
NF,CHG	(N,F), CHG,FY

EXFOR Retransmissions Requested

10722.002	Fractional independant yields. The column heading should be RATIO and numerical volumes X 1/100.
10723.004 005	Unique masses should be coded under MASS, not MASS-MIN. Cumulative yields should have a specified Z, are these really Chain yields?
10821.004	Fractional independant yields - heading should be RATIO.
10864. Many	Relative yields - use ARB-UNITS.
10890.	Illegal valves coded under ISOMER heading.
30267.002	Product isomeric state should be coded with ISOMER heading.
30508.Many	Preferable to code MXW/REL together with ARB-UNITS.
30509.003	Inconsistent coding for product change Reaction to (N,F)2-HE-4,TER,FY)
40019.002 003	Should units be PC/FIS?

Computational Format for Fission Product Yields

Variable	FORTRAN Format	COBOL PL/I Format	Cols.	Description
DATA				
Z-TAR	I 3	9(3)	1-3	Z-number of target
A-TAR	A 3	X(3)	4-6	A-number of target
N-SPEC	A	X	7	Code for incident neutron spectrum (see A below)
N-ENER	E9.2	X(9)	8-16	Neutron energy (eV)
Z-PRO	I 3	9(3)	17-19	Z-number of product
A-PRO	A 3	X(3)	20-22	A-number of product
ISOM	A	X	23	Isomer state (m)
YIE-TYP	A 2	X(2)	24-25	Yield type (see B below)
YIELD	E10.3	X(10)	26-35	Yield (" " ")
YIE-ERR	E10.3	X(10)	36-45	Yield error(" " ")
DEC-PAR	A 2	X(2)	46-47	Decay particle (see C below)
HAL-LIF	A 8	X(8)	48-55	Half-life & units (free format)
DEC-EN	A 6	X(6)	56-61	Decay energy (keV)
BRA-RAT	A 4	X(4)	62-65	Branch ratio
NORMALISATION				
N-Z-TAR	I 3	9(3)	66-68	Z-number of target
N-A-TAR	A 3	X(3)	69-71	A-number of targe
N-N-SPEC	A	X	72	Code for incident neutron spectrum (see A below)
N-N-ENER	E9.2	X(9)	73-81	Neutron energy (ev)
N-Z-PRO	I 3	9(3)	82-84	Z-number of product
N-A-PRO	A 3	X(3)	85-87	A-number of product
N-ISOM	A	X	88	Isomer state (m)
N-YIE-TYP	A 2	X(2)	89-90	Yield type (see B below)
N-YIELD	E10.3	X(10)	91-100	Yield (" " ")
N-DEC-PAR *	A 2	X(2)	101-102	Decay particle (see C below)
N-HAL-LIF *	A 8	X(8)	103-110	Half-life & units (free format)
N-DEC-EN *	A 6	X(6)	111-116	Decay energy (keV)
N-BRA-RAT *	A 4	X(4)	117-120	Branch ratio
INDEX				
LAB	A 3	X(3)	121-123	Laboratory (as in CINDA dictionary)
ACCESS	I 5	9(5)	124-128	EXFOR accession number
SUB-ACCESS	I 3	9(3)	129-131	EXFOR sub-accession number
FILLER	A	X	132	Blanks

* Not currently implemented.

Explanations

A.	N-SPEC =	M	-Thermal Maxwellian average
		F	-Fission spectra average
		S	-Unspecified spectrum average
B.	YIE-TYP =	PR	-Primary fragment
		SE	-Secondary fragment
		IN	-Independent product yields (direct formation only)
		CU	-Cumulative product yields via direct formation and radioactive decay
		CH	-Total chain
		FI	-Independent ratio (YIE YIE-ERR are ratios)
		FC	-Cumulative ratio (" " " ")
C.	DEC-PAR =	XR	-X-rays
		DG	-Decay gammas
		AR	-Annihilation radiation
		B-	-Beta - decay
		B	-Beta - or + decay
		B+	-Beta + decay
		IC	-Internal conversion
		E	-Electrons e.g. Auger, Compton
		EC	-Electron capture
		RC	-Recoil nucleus
		RS	-Residual nucleus
		PN	-Prompt neutrons
		DN	-Delayed neutrons
		SF	-Spontaneous fission fragments