Memo CP-D/211

11 December 1990

To: Distribution

From: O. Schwerer

Subject: Dictionary Additions - Reply to memo CP-M/13
(Note: Memo CP-M/13 is appended to the present memo)
in particular:
1. Legendre coefficients for double differential data (including remarks on entries M0283 and 22084) and proposed Lexfor update
2. Codes LG,LN,LGR,LNR for dict. 34
3. Report code SFMN

Appendices:
A. Memo CP-M/13
B. Proposed Lexfor pages

This memo contains our reply to the proposed dictionary additions of CP-M/13 which was brought to the November 1990 NRDC Meeting.

1. Legendre coefficients for double-differential data

- We appreciate the clarification given in CP-M/13, in particular the formula on p. 3 of that memo.

- At the November NRDC meeting it turned out that this type of double-differential Legendre data is actually the same representation as the one used recently for neutron data in entry 22084 (transmitted on TRANS 2127, coded there as ,DA/DE,,LEG with free text explanation).

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During the discussions at the meeting, we proposed to use the existing modifier RS (rather than introducing a new one, RDE).

This solution would require only a new entry in dictionary 36, but no new code in dict. 34.

After the meeting, we checked the recently received TRANS tape M009 for double-differential Legendre coefficients. (Note: There were reading problems with this tape as received at NDS and retransmission was requested at the NRDC meeting.) As far as the tape could be read, only one entry containing such data was found (M0283). In this entry (subentries 13-21) the data are coded ,DA,DE,,LEG/RS,DERIV which corresponds to the solution we proposed at the meeting (before seeing this entry) but not to the coding proposed in CP-M/13 (= introduction of a new modifier RDE).

In order to better understand the quantities given, we checked the original references of the two works concerned:

(a) Y. Birenbaum et al., NP/A 369, 483, 81: Pb(γ,n) (entry M0283)
(b) Fischer, Uhl, Vonach, PR/C 37, 578, 88: Nb, Ag, In (n,xp) (entry 22084)

and we now believe, that for these 2 works no new codes at all are needed (see the following for details).

(a) Birenbaum et al. (M0283)

- In the article I found no explicit mentioning of double-differential data or $d^2\sigma/d\Omega dE'$. The coefficients represent the angular distribution of (γ,n) neutrons leading to the ground state of the residual nucleus, designated "(γ,n_0)" in the article. In my opinion this should be coded as

  PAR,DA,,LEG/RS
  (this code is already included in dict. 36).

Other remarks on entry M0283:

- Subentry 1 contains the secondary energy E = 262. KEV in the COMMON section. Is this really valid for all subentries? (The entry contains data for the two reactions 82-PB-208(G,N) and 82-PB-207(G,N), in both cases leading to the ground state of PB-207 and PB-206, respectively.)

- E-LVL=0. should also be given in the subentries containing the Legendre coefficients, (with entry under EN-SEC, as in the other subentries).

(b) Fischer, Uhl, Vonach (22084)

In this article, the Legendre coefficients are meant, explicitly, to represent the double-differential cross section. The information on page

580 of the article shows, however, that the energy and angular dependences are described separately; therefore, also here the coding PAR,DA,,LEG/RS is applicable.

The text describing the data of Table II (both on p. 580) defines

$$\frac{d^2\sigma}{dE'd\Omega} = \sum_{\ell=o}^{2} a_\ell P_\ell\ (\cos\Theta),$$

with Table II giving the ratios a_1/a_o and a_2/a_o (called "reduced" Legendre coefficients).

In our working paper for the NRDC meeting, we have shown that these reduced coefficients correspond to the representation

$$\frac{d^2\sigma(E,E',\Theta)}{dE'd\Omega} = \frac{1}{4\pi}\frac{d\sigma}{dE'}\ [1 + \sum_{\ell=1}^{n} W_\ell(E,E')P_\ell(\cos\Theta)] \qquad (1)$$

with $W_\ell = a_\ell/a_o$ (which is the same as the formula given on page 3 of CP-M/13).

Single-differential data, with the PAR modifier referring to a specific energy-group of outgoing particles, are described by

$$\frac{d\sigma_{par}(E,E',\Theta)}{d\Omega} = \frac{\sigma_{par}}{4\pi}\ [1 + \sum_{\ell=1}^{n} W_\ell(E,E')P_\ell(\cos\Theta)] \qquad (2)$$

corresponding to the code PAR,DA,,LEG/RS.

The Legendre expansion part of (1) and (2) is the same; the only difference between (1) and (2) is the dimension and an associated scaling factor, both represented by the factors $\sigma/4\pi$ or $\frac{1}{4\pi}\frac{d\sigma}{dE'}$ respectively, which are, however, not included in the Exfor quantity to be compiled. The Exfor quantity means only the "naked" reduced Legendre coefficients, which can be used to calculate either the partial single-differential (cross section or the double-differential cross section, whatever data the user is interested in.

Page 580 of Fischer et al. illustrates this nicely:

- Table II gives the reduced Legendre coefficients $a_\ell/a_o = W_\ell$;
- Table I gives $d\sigma/dE'$ (Note that the heading of Table I says erroneously $d\sigma/d\Omega$; the units are correctly given as mb/MeV);

- The partial cross sections can also be taken from Table I, by taking into account the energy intervals used in Tables I and II and the appropriate dimensions, e.g.:
  σ_{par} (for E_p = 4-6 MeV) = 3.97 + 6.27 mb = 10.24 mb

To calculate the double-differential cross sections, one takes the W_ℓ from table II and $d\sigma/dE'$ from table I and uses formula (1) above.

To calculate $d\sigma/d\Omega$, one takes W_ℓ from table II and the partial cross section as described, using formula (2) above.

We therefore propose to use the coding PAR,DA,,LEG/RS for the corresponding subentries of entry 22084. Besides the REACTION code, no other changes need be made to those subentries.

See Appendix B for a summary of the above to be added to Lexfor. We include also the codes DA,,LEG/RSO and DA,,LEG/RSD whcih are missing in Lexfor page F.16.

2. Codes LG,LN,LGR,LNR for dictionary 34

These codes need further explanations of their usage and in particular an accompanying Lexfor entry before they can be introduced.

3. Proposed code SFMN: change to journal code AANL

We found the corresponding publication in the INIS list of journals with short abbreviation AANLA. To be as consistent as possible with INIS, we propose to add the code AANL to dictionary 5 (journals):

AANL (ATTI ACCAD.NAZ.LINCEI,REND.,CL.SCI.FIS.,MAT,NAT.) 2ITY

Memo CP-M/13

Date:	01.11.90
From:	CDFE
Subject:	Dictionary Additions 1990 Technical NRDC Meeting Materials
Reference:	Memo CP-M/11, Memo CP-D/193, Memo CP-D/194, Memo CP-D/201, Memo CP-D/207
To:	Distribution

We agree with most of useful remarks and comments of O.Schwerer about our Dictionary Additions which we have proposed in our Memo CP-M/11.

In accordance with Memos CP-D/193, 194, 201, and 207 we support information for introduction of new quantity code for Legendre coefficients for double - differential data (DA/DE,,LEG/RDE) and some new Dictionary Additions.

Attachments: Dictionary Additions - page 2
LEXFOR page on "FITTING COEFFICIENTS" - page 3

CLEARANCE: V.V.Varlamov

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Dictionary	Code	Comment
6	SFMN	(REND. ACCAD. NAZ. LINCEI, CLASSE DI FIZ. MAT. E NAT.)
7	NRLMEN	(NUCL. REACTIONS AT LOW AND MIDDLE ENERGIES, MOSCOW 1958) (YADERNYE REAKCII PRI NIZKIKH I SREDNIKH ENERGIYAKH = NUCL. REACTIONS AT LOW AND MIDDLE ENERGIES, IN RUSSIAN, MOSCOW 1958)
34 (beginning of Dict.)	LG	COMMON LOGARITHMIC SCALE
	LN	NATURAL LOGARITHMIC SCALE
	LGR	COMMON LOGARITHM OF RATIO {(1/E)*(D-SIG/D-ENERGY)}
	LNR	NATURAL LOGARITHM OF RATIO {(1/E)*(D-SIG/D-ENERGY)}
34	RDE	MODIFIER FOR LEGENDRE COEFFICIENTS OF THE FORM (4PI/(D-SIG/D-ENERGY)* (D(D-SIG/D-ENERGY/D-OMEGA) = 1+SUM(C(L)*P(L)))
36	,DA/DE,,LEG/RDE	(DOUBLE-DIFF. CROSS SECTION * 4PI/(D-SIG/D-ENERGY), LEGENDRE COEFFICIENTS OF THE FORM (4PI/(D-SIG/D-ENERGY))* (D(D-SIG/D-ENERGY)/D-OMEGA)= 1 + SUM(S(L)*P(L))

FITTING COEFFICIENTS

Legendre Coefficients

Representation:

DA/DE,,LEG/RDE = C_l (units NO-DIM), where

$$\frac{d^2 \sigma(E,\theta)}{dE\, d\Omega} = \frac{1}{4\pi} \frac{d\sigma}{dE} \{ 1 + \sum_{l=1}^{n} C_l(E) P_l(\cos\theta) \}$$

Proposed addition to Lexfor page P.16

Add at bottom of page:

DA,,LEG/RSO = a_ℓ (no dimension) where:

$$\frac{d\sigma}{d\Theta}(E,\Theta) = \frac{d\sigma}{d\Theta}(E,0^\circ) \sum_{\ell=0}^{n} a_\ell(E)\, P_\ell\,(\cos\Theta)$$

DA,,LEG/RSD = a_ℓ (no dimension) where:

$$\frac{d\sigma}{d\Theta}(E,\Theta) = \frac{d\sigma}{d\Theta}(E,90^\circ)\left[1 + \sum_{\ell=1}^{n} a_\ell(E)\, P_\ell\,(\cos\Theta)\right]$$

Proposed Lexfor page

Legendre coefficients for double-differential data

Also double-differential cross sections may be represented by Legendre coefficients:

$$\frac{d^2\sigma(E,E',\Theta)}{dE'd\Omega} = \sum_{\ell=o}^{n} a_\ell(E,E')P_\ell(\cos\Theta)$$

Up to now, no special coding for double-differential Legendre coefficients was required because in the works compiled in Exfor so far,

- reduced Legendre coefficients were given ($W_\ell = a_\ell/a_o$ with no dimension)
- the secondary energy E' was given as an energy group (e.g. intervals of 1 MeV width) but not as a continuous point-variable.

In these cases the Legendre coefficients may be compiled as PAR,DA,,LEG/RS, as can be seen from the following:

The above Legendre expansion can be rewritten as

$$\sum_{\ell=0}^{n} a_\ell(E,E')P_\ell(\cos\Theta) = a_o(E,E')\ [1 + \sum_{\ell=1}^{n} \frac{a_\ell(E,E')}{a_o(E,E')}\ P_\ell\ (\cos\Theta)] =$$

$$= \frac{1}{4\pi}\frac{d\sigma}{dE'}\ [1 + \sum_{\ell=1}^{n} W_\ell\ (E,E')\ P_\ell\ (\cos\Theta)] \qquad (1)$$

with $W_\ell = a_\ell/a_o$, in the same way as in the single-differential case for ,DA,,LEG/RS.

The single-differential cross section, with the PAR modifier referring to a specific energy-group E'of outgoing particles, is described by

$$\frac{d\sigma_{par}(E,E'\Theta)}{d\Omega} = \frac{\sigma_{par(E,E')}}{4\pi}\ [1 + \sum_{\ell=1}^{n} W_\ell(E,E')P_\ell(\cos\Theta)] \qquad (2)$$

where W_ℓ coresponds to the code PAR,DA,,LEG/RS (with no dimension).

The Legendre expansion part of (1) and (2) is the same; the only difference between (1) and (2) is the dimension and an associated scaling factor, both represented by the factors $\sigma/4\pi$ or $\frac{1}{4\pi}\frac{d\sigma}{dE'}$ respectively, which are, however, not included in the Exfor quantity to be compiled.

Therefore, this type of coefficients should be compiled as PAR,DA,,LEG/RS, even when labelled "double-differential" in the original reference. The coefficients of type W_ℓ are usually called "reduced Legendre coefficients" or explicitly defined as ratios a_ℓ/a_0 (this is also true for the normal single-differential case DA,,LEG/RS).

Should other types of double-differential Legendre coefficients occur in the literature, new codes could be needed in the future.