International Atomic Energy Agency

Technical Remarks on Compilation

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List of Remarks

1. ***News 1***: Post WPEC SG30 activity – new report from Koning
2. ***News 2***: Recent comment on our digitization published in PRC
3. DECAY-DATA - $T_{1/2}$ vs isomeric flag
4. Excitation energies of heavy-ion reaction data
5. Coding of alternative results
6. Keywords of deleted entries
7. Free text
8. ERR-ANALYSIS
9. HISTORY

To reduce redundancy in EXFOR Master

10. Expression of digitized data (reminder)
11. Status of updated manuals (Formats, LEXFOR, Dictionary)

New Verification of EXFOR Data by Koning

Now available!
http://www.oecd-nea.org/databank/docs/2014/db-doc2014-3.pdf

Arjan Koning evaluated a deviation factor (Michel's f-factor) for neutron-induced threshold reaction cross sections in EXFOR from those in various libraries (CENDL-3.1, EAF-2010, ENDF/B-VII.1, IRDFF-1.0, JEFF-3.2, JENDL-4.0, TENDL-2013 as well as TALYS calculation when necessary).

New Verification of EXFOR Data by Koning (cont)

Work done by Arjan (from the report)

"All (n,n'), (n,2n), (n,p), (n,α) cross sections, plus other less measured (n,x) cross sections like (n,d), (n,t), (n,h), (n,np) and (n,nα) etc, i.e. about **10000** subentries out of a total of about 25000, have been covered in more detail than just automatic comparison."

"Put differently, the only reaction classes *not reviewed* are (n,tot), (n,el), (n,non), (n,f) and (n,γ). "

New Verification of EXFOR Data by Koning (cont)

Important conclusions for us (from the report)

"In most cases, it turned out that the reported quantity was indeed correctly compiled into EXFOR."

"However, for about 30 cases, the EXFOR compilation was wrong, for either the numerical value or the reported quantity, and appropriate actions have in the mean time been taken by NRDC to correct this."

"More important than these errors is the confirmation that many experiments for the various reactions have indeed been correctly compiled."

New Verification of EXFOR Data by Koning (cont)

Important conclusions for us (from the report)

It is recommended that at least the status symbol of each data set, i.e. T, R, N or E, is recorded in EXFOR or a related database.

T: Subentries which are automatically compared with data libraries

R: The subentry contains certainly the reaction and data measured by the author, since the associated publication has been checked by the reviewer.

N: Automatic score T1, T2 or T3 but pdf of paper not available for checking.

E: Subentries which contain errors and require specified action

(For each symbol, 1: small deviations. / 2: questionable deviations /3: strong deviations, e.g., T1, T2, T3, R1, R2, R3,…)

The final score must be T1, N1, N2, N3, R1, R2 or R3 for verified subentries. Keep R (checked against the article) in the EXFOR Master? (~3000 data sets)

Digitization – Comment on X4 in a PRC article

Influence of uncertainties in various input on the prediction from the standard solar model (A. Serenelli et al., PRD87(2013)043001)

TABLE III. Estimated 1σ uncertainties in solar (from Bahcall, Serenelli, and Basu [14] and nuclear physics (from Adelberger *et al.* [5]) uncertainties, and their influence on flux predictions, computed from the partial derivatives of Table I.

β_j	Value	$\frac{\Delta\beta_j}{\beta_j}$ (%)	$\frac{\Delta\phi(^8\mathrm{B})}{\phi(^8\mathrm{B})}$ (%)	$\frac{\Delta\phi(^7\mathrm{Be})}{\phi(^7\mathrm{Be})}$ (%)	$\frac{\Delta\phi(^{13}\mathrm{N})}{\phi(^{13}\mathrm{N})}$ (%)	$\frac{\Delta\phi(^{15}\mathrm{O})}{\phi(^{15}\mathrm{O})}$ (%)
$L_\odot$	3.842×1033 ergs/s	0.4	2.8	1.4	1.8	2.4
Opacity	1.0	2.5	6.5	3.0	3.7	5.1
Age	4.57 Gyr	0.44	0.59	0.33	0.41	0.60
Diffusion	1.0	15.0	4.0	1.9	5.1	5.7
p + p	$(4.01 \pm 0.04) \times 10^{-25}$ MeV b	1.0	2.6	1.0	2.2	2.9
^{3}He + ^{3}He	(5.21 ± 0.27) MeV b	5.2	2.1	2.2	0.16	0.12
^{3}He + ^{4}He	(0.56 ± 0.03) MeV b	5.4	4.3	4.6	0.33	0.28
p + ^{7}Be	(20.8 ± 1.6) eV b	7.7	7.7	0.0	0.0	0.0
e + ^{7}Be		2.0	2.0	0.0	0.0	0.0
p + ^{14}N	(1.66 ± 0.12) keV b	7.5	0.05	0.0	5.6	7.5

Accurate determination of the S(0)-factor for ^{3}He+^{4}He→^{7}Be is desired.

Digitization – Comment on X4 in a PRC article (cont)

R-matrix analysis by R.J.deBoer et al. (PRC90(2014)035804

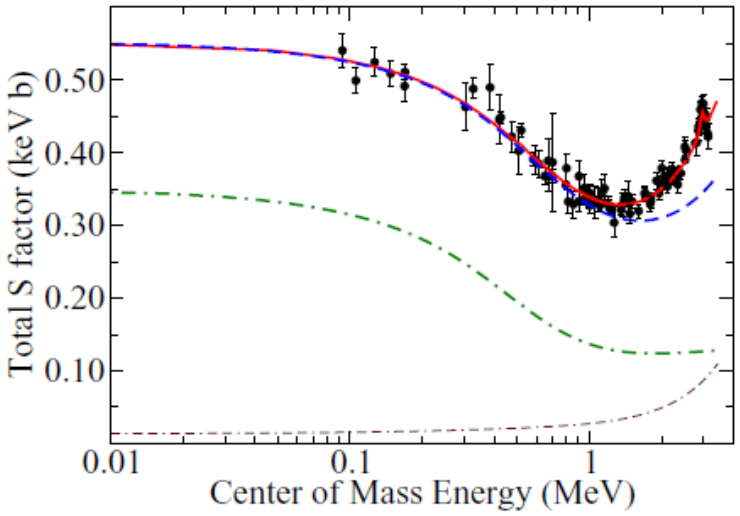


FIG. 4. (Color online) Different R-matrix components used for the fit to the ^{3}He$(\alpha,\gamma)^7$Be cross section. The data points are all recent

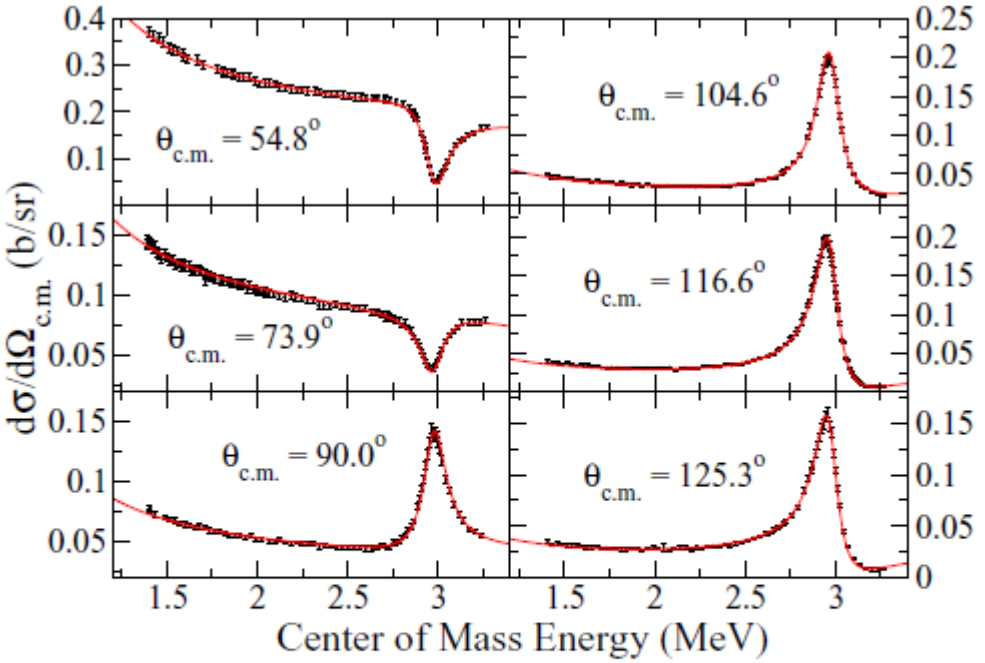


FIG. 8. (Color online) Example excitation curves representative of the fit to the ^{3}He$(\alpha,\alpha)^3$He data of Ref. [34] performed simultaneously with the capture data. The data have been digitized from Fig. 2 of that work by the authors.

[2]A digitization of this data was also available on EXFOR [53]. It was found that this digitization had a significant offset in the energy scale of several of the excitation curves. !!

[53] V. Zerkin, http://www-nds.iaea.org/exfor/exfor.htm

Digitization – Comment on X4 in a PRC article (cont)

Digitized values in EXFOR on the original figure

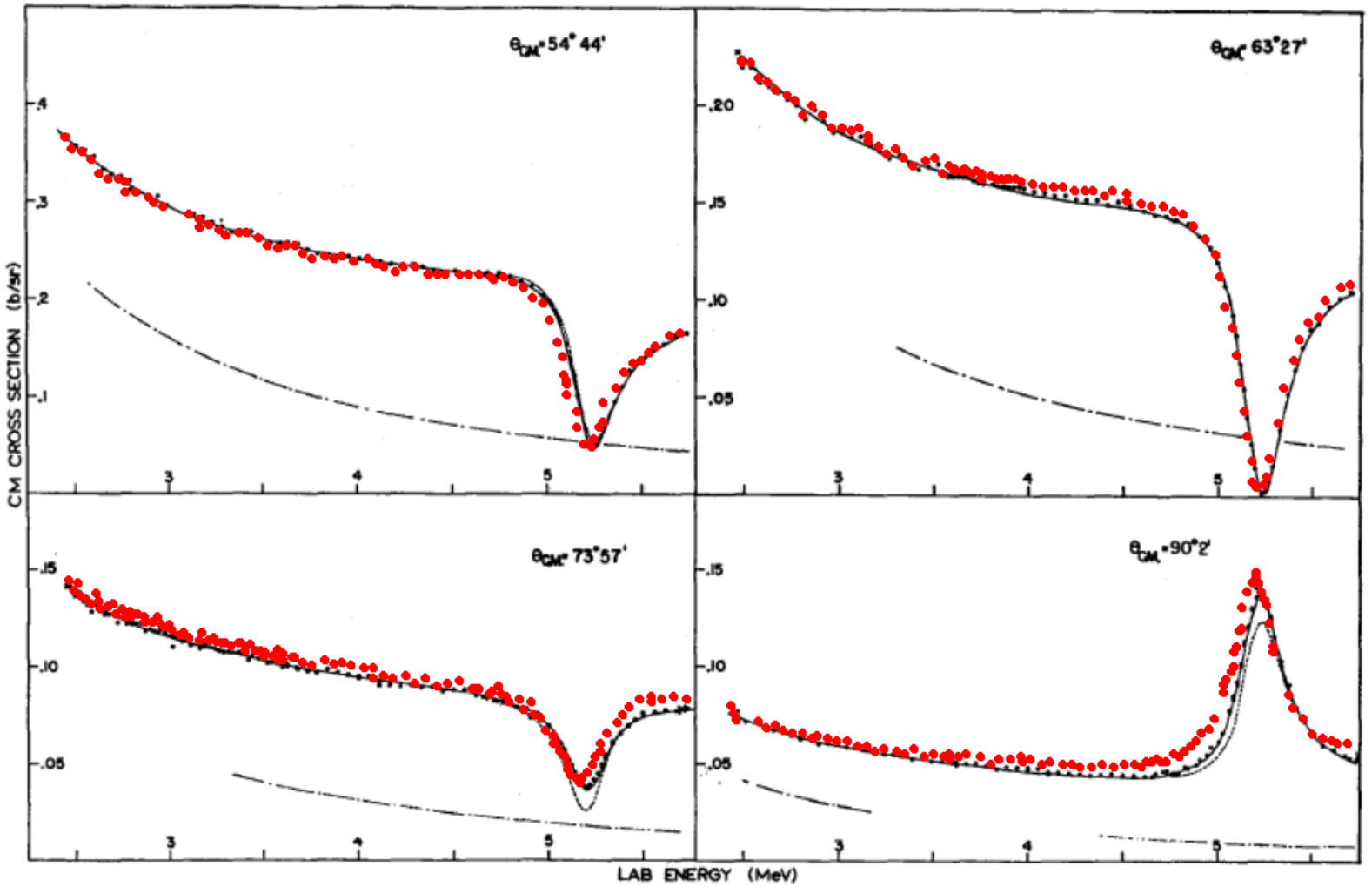
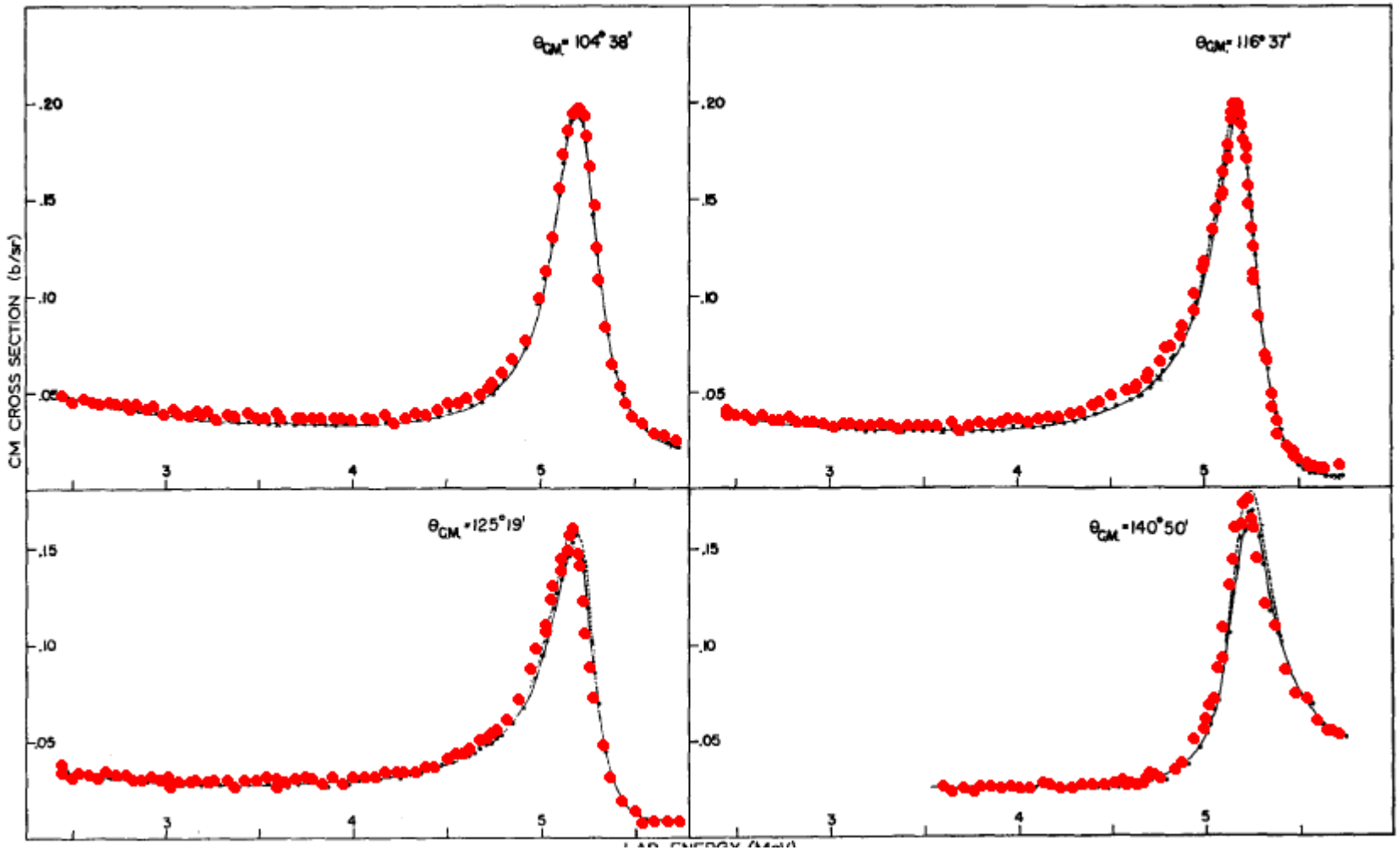


Fig. 2(a).

Digitization – Comment on X4 in a PRC article (cont)

Digitized values in EXFOR on the original figure (cont)



DECAY-DATA - $T_{1/2}$ vs Isomeric Flag

- ~1200 strange relations between the nuclide code and $T_{1/2}$ were detected by my tool (More than 50% deviation in T1/2 from wallet cards.)

- Initial checking: Sveta Babykina checked each case against the original article, and made a proposal of correction. (completed)

- Second checking: Then currently I am checking her comment one by one. I have finished it for ~800 cases.

DECAY-DATA - $T_{1/2}$ vs Isomeric Flag (cont)

***Examples* of straightforward correction**

- Trivial mistake by compiler (*e.g.*, "53.5 day" in article but "53.5HR" by compiler) .
- Change in the level order (*e.g.*, 5 hr g.s. and 70 min m.s. of **^{110}In**. See also F.Tarkanyi et al., NIMB245(2006)379 about the history).

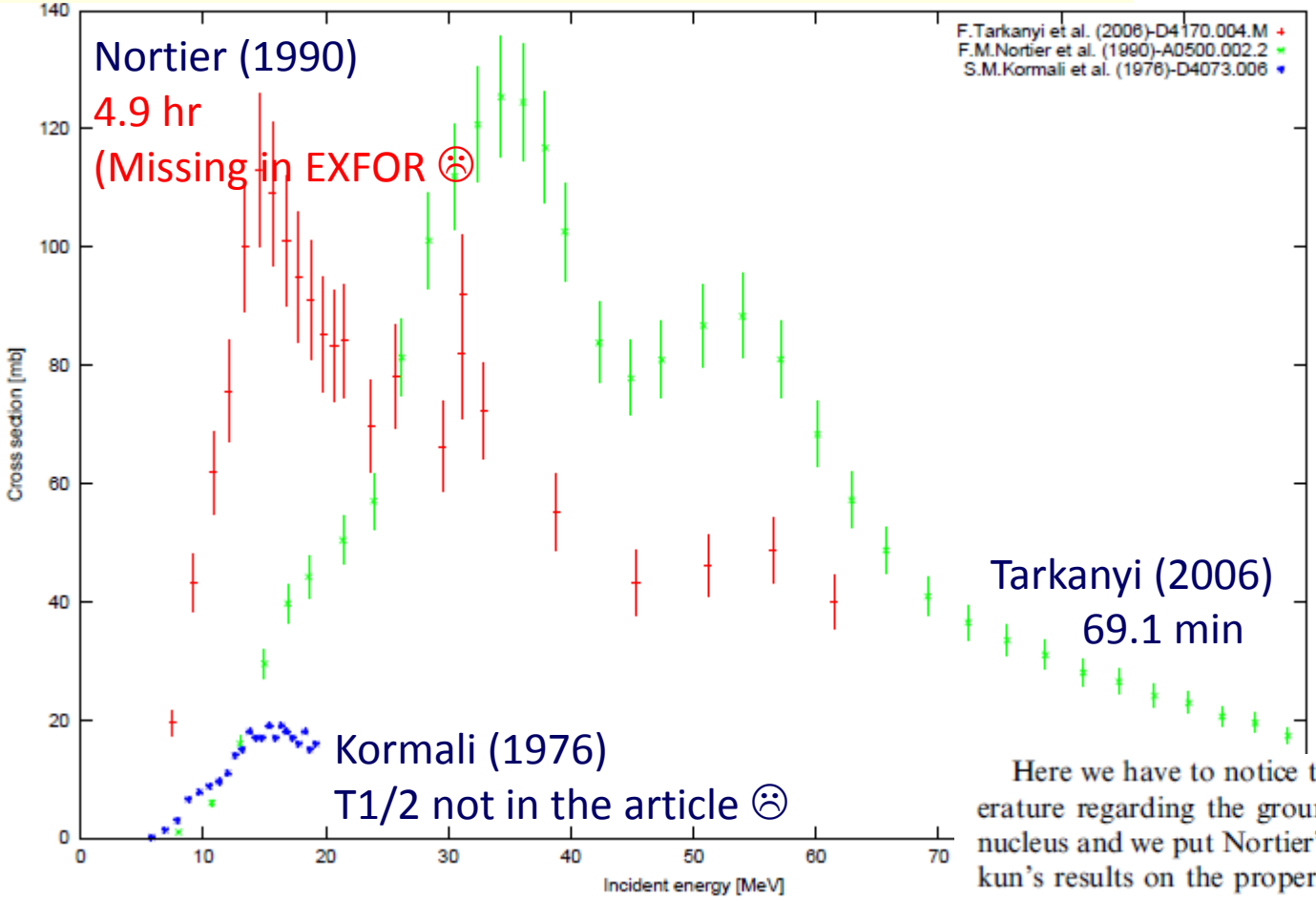
***Examples* of non-straightforward correction**

- Strange $T_{1/2}$ in the original article without detailed decay radiation information.
- Assignment of isomeric flag when level ordering of g.s. and m.s. uncertain (*e.g.*, 17 sec and 6 min state of **^{108}Rh**).

  What should be used? **-A? –B? –X?**

DECAY-DATA - $T_{1/2}$ vs Isomeric Flag (cont)

(48-CD-0(P,X)49-IN-110-M,,SIG) in EXFOR



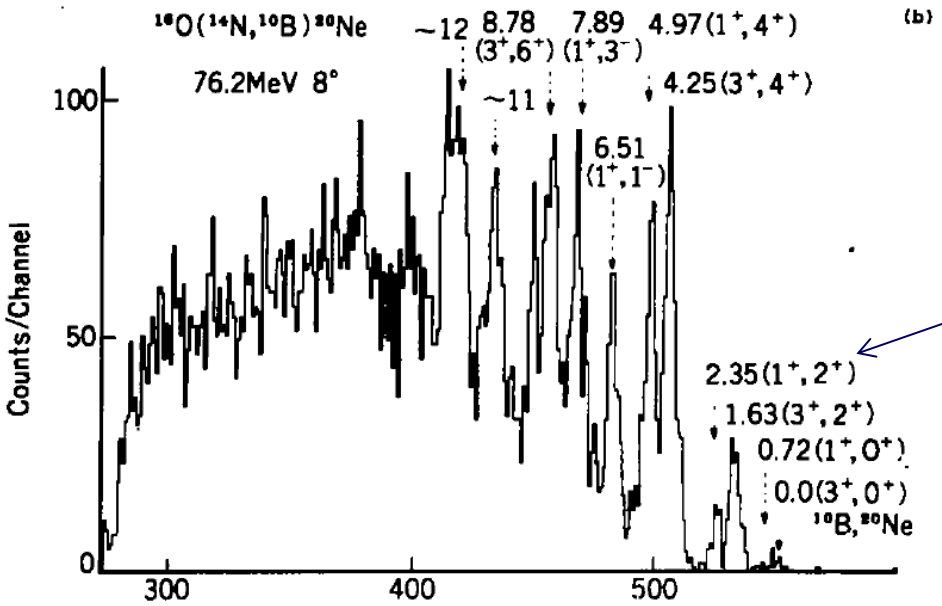
My program does *not* detect this case because the compiler did not give DECAY-DATA. (D. Steyn informed me.)

Here we have to notice that there is confusion in the literature regarding the ground and metastable state of this nucleus and we put Nortier's, Kormali's, Otozai's and Skakun's results on the proper category if it was necessary.

F.Tarkanyi et al., NIMB245(2006)379

Level Energies in Heavy-Ion Binary Reactions

$^{16}O(^{14}B,^{10}B)^{20}Ne$ energy spectrum (T. Motobayashi et al., NPA331(1979)193)



"2.35 MeV ($^{10}B,^{20}Ne$)=($1^+,2^+$)"
→E_x=(0.72 MeV, 1.63 MeV).

The two body kinematics gives us the sum of excitation energies of two nuclides in the exit channel.

E-LVL1 and E-LVL2 are expected when partial data are given for a heavy-ion binary reaction.

Alternative (Interdependent) Results

Interdependent Data

Different results for the same quantity obtained in the same experiment by two different methods of analysis may be coded in the same subentry.

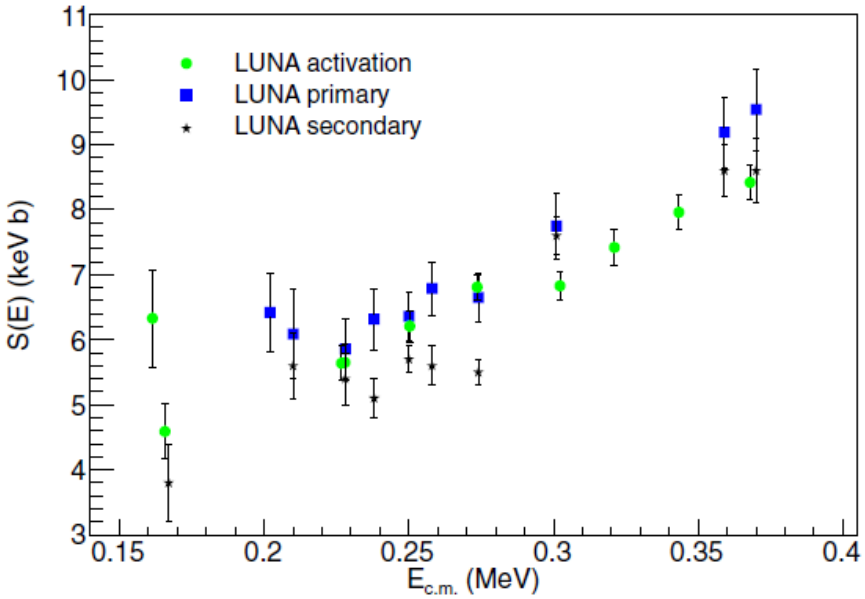
Such data may also be entered in separate subentries, in which case, the subentries should be linked to each other using STATUS code **COREL**. (LEXFOR S.21).

Examples:

- Two data sets obtained by off- and on-line analysis.
- Two data sets from two flight paths.
- 0^{th} order (cross section) and higher order fitting coefficients (an example of different but interdependent quantities)

Alternative (Interdependent) Results (cont)

$^{17}O(p,\gamma)^{18}F$ S-factor from off-line (green) and on-line (blue, black) analysis (A. Di Leva et al., PRC89(2013)015803)



These 3 data sets may be compiled in

- the same subentry by the multiple reaction formalism,

or

- different subentries linked by STATUS=COREL each other.

Do *not* distinguish these data sets by FLAG!

Each data set must be differentiated by free text (e.g., “activation”, “prompt gamma”) otherwise it looks like duplication.

Alternative (Interdependent) Results (cont)

Two data sets reported in the same article and compiled in two separate entries are *not* always interdependent.

Example:

Neutron data and photonuclear data compiled in two entries reported in the same article are not always interdependent (i.e., linked not by STAUTS=COREL but by REL-REF=O).

Compilation in separate entries

If separate experiments from different service areas with clearly separated results are reported in the same paper, the results should be compiled in separate entries. This applies also if the data were measured at one laboratory, and, subsequently, analyzed at another laboratory and the laboratories are in different areas. The entries may be linked using the STATUS code COREL; see **Status** (Interdependent Data).

The separation is obligatory if data for different projectile types (neutron, charged particle, photon) are reported in the same publication.

In all such cases cross references to the other entry must be given.

This must be done by REL-REF=O.

Keywords of Deleted Entries

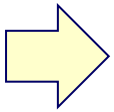
Deletion of entries

… Not all keywords must be retained; in general, the following information-identifier keywords must be included (left) in the BIB section: **REFERENCE**, **TITLE**, **AUTHOR**, **INSTITUTE**, and **HISTORY**. (EXFOR Formats 8.2)

Namely, decision on the rest of the keywords is up to the compiler. It could be however better to delete unnecessary keywords to avoid future updates (due to mistakes, new rules, new dictionaries etc.).

Keywords of Deleted Entries (cont)

```
SUBENT        O0143001   20120521
BIB                15         40
TITLE      Isospin dependence of the 65 MeV proton optical
           potential in f-p shell nuclei.
AUTHOR     (T.Noro,H.Sakaguchi,M.Nakamura,K.Hatanaka,F.Ohtani,
           H.Sakamoto,S.Kobayashi)
INSTITUTE  (2JPNKTO)
           (2JPNOSA)
REFERENCE  (J,NP/A,366,189,1981)
PART-DET   (P)
DETECTOR   (HPGE) Elastically scattered protons were detected by
…
FACILITY   (CYCLO,2JPNOSA)
METHOD     (SITA,EXTB,BCINT). The 65 MeV polarized proton beam.
…
REL-REF    (I,E0243001,S.Kato+,J,NIM,169,589,1980)
…
INC-SPECT   EN-RSL . the overall FHWM energy resolution.
ERR-ANALYS (DATA-ERR) The sum of the statistical errors and
…
           (ANG-ERR-D). Data point reader uncertainty.
           (ERR-DIG). Data point reader uncertainty.
…
ADD-RES    (COMP).Optical model using 'MAGALI' code.
…
STATUS     (CURVE) by CAJaD from fig.1 (a,b) of NP/A,366,189,1981
…
ENDBIB              40          0
COMMON               5          3
EN          EN-RSL     ANG-RSL    DATA-ERR   ANG-ERR-D
MEV         MEV        ADEG       PER-CENT   ADEG
        65.        0.2       0.05        1.8   0.19
```



```
SUBENT        O0143001   20120521
BIB                15         40
TITLE      Isospin dependence of the 65 MeV proton optical
           potential in f-p shell nuclei.
AUTHOR     (T.Noro,H.Sakaguchi,M.Nakamura,K.Hatanaka,F.Ohtani,
           H.Sakamoto,S.Kobayashi)
INSTITUTE  (2JPNKTO,2JPNOSA)
REFERENCE  (J,NP/A,366,189,1981)
FACILITY   (CYCLO,2JPNOSA)
STATUS     (CURVE) by CAJaD from fig.1 (a,b) of NP/A,366,189,1981
HISTORY    (19950625C)
           (19950628U)
           (20120521D) SD: Entry deleted. Duplication with E0249.
           Updated to new date formats,lower case; corrected
           according to last EXFOR rules and Dict.
           Year of ref. corrected.
ENDBIB              40          0
NOCOMMON
```

Here FACILITY and STATUS are kept
In addition to the minimum keywords required in LEXFOR.

Free Text – *Be short and precise*!

Free Text
(See also EXFOR Formats Manual Chapter 3).

Be short and precise!

Lengthy free text information may hide essential free text information. The compiler should not do “copy and paste” and should identify key information to be kept as free text.

Free Text – *Be short and precise*! (cont)

How to make free text more visible?

- **Enter the free text under the keyword and code to which it pertains.** (from LEXFOR, underlined part is addition proposed by NO)

- **Do not expand coded information by free text in general.**

  "In general, the contents of the coded information should not be repeated in free text, since the coded information is either self-explanatory, as in the case of AUTHOR, or the codes are designed for machine processing. " (from LEXFOR).

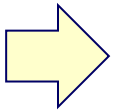
  N.B. This may contradict with the "Expansions of these codes may be used, at the compiler's discretion, embedded in free text." (EXFOR Formats 3.3).

- **Use coded information instead of free text when possible.**

Free Text – *Be short and precise*! (cont)

(ACTIV,EXTB,STTA,GSPEC,MOSEP)

Excitation function was measured via the activation technique using stacked foil targets. Six stacks were irradiated at 16.0, 20.7 And 26.6 MeV. Irradiation time were between 0.5 and 2 hours, the beam current was 100 to 200 Na. The beam energy was measured directly by measuring the time between the beam bounches in Juelich, and was determined from the extraction radius and the cyclotron frequency in Debrecen. For monitoring the beam Ti and Cu foils were used.



(ACTIV) Irradiated for 0.5 to 2 hours with the beam current was 100 to 200 nA.

The beam energy was measured directly by measuring the time between the beam bounches in juelich, and was determined from the extraction radius and the cyclotron frequency in Debrecen.

(MOSEP) Ti and Cu foils used for monitoring the beam.

(STTA) Six stacks were irradiated at 16.0, 20.7 and 26.6 MeV.

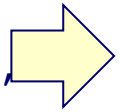
(EXTB,GSPEC)

Free Text – *Be short and precise*! (cont)

(2ITYBAU) Istituto Nazionale di Fisica Nucleare (INFN), Bari, Italy. G.Tagliente, corresponding author, Email = guiseppe.tagliente@ba.infn.it; N.Colonna, S.Marrone, R.Terlizzi

(2ITYTRI) Istituto Nazionale di Fisica Nucleare (INFN), Trieste, Italy. K.Fujii, P.M.Milazzo, U.Abbondanno, F.Belloni, C.Moreau

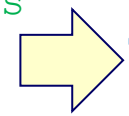
(2FR SAC) CEA/Saclay-DSM/DAPNIA, Gif-sur-Yvette, France. G.Aerts, S.Andriamonje, E.Berthoumieux, W.Dridi, F.Gunsing, J.Pancin, L.Perrot, A.Plukis



(2ITYBAU,2ITYTRI,2FR SAC)

Free Text – *Be short and precise*! (cont)

Nuclear data were taken from E. Browne, R.B.Firestone, Table of radioactive isotopes, ed. V.S.Shirley, Wiley, 1986, New York. To calculate the particles energies in the foils Ziegler's stopping table was used. (J.F.Ziegler, the stopping and ranges of ions in matter, vol 3. Pergamon, New York, 1977)



(R,,J.F.Ziegler,B,ANDERSEN,3,1977)
Stopping power given

(R,,E.Browne+,B,BROWNE,,1986)
Decay data given

ERR-ANALYS – source to be described

The Formats Manual introduces

> "ERR-ANALYS. Explains the sources of uncertainties and the values given in the COMMON or DATA sections under data headings of the type ERR- or -ERR."

where sources does NOT mean where the compiler found the uncertainties BUT what types of error sources are considered (e.g., counting statistics, normalization).

ERR-ANALYS – source to be described (cont)

Example ("source" is misunderstood by the compiler):

ERR-ANALYS	**(DATA-ERR) The uncertainty is reported by authors on figure**

must be

ERR-ANALYS	**(DATA-ERR) No information on source of uncertainties**

when there is no information.

ERR-ANALYS – Should we explain ERR-DIG?

Example (three error fields are given):

ERR-ANALYS	**(EN-ERR-DIG)Digitization error of EN (ERR-DIG) Digitization error of DATA (DATA-ERR) Not specified. Error bars digitized.**

could be simplified to

ERR-ANALYS	**(DATA-ERR) No information on source of uncertainties**

and leave further explanation to output systems, e.g., on X4+:

```
COMMON              2          1          12
            #Legend: 2 x 1 x 12 : data columns * lines * column width
            | #EN-ERR-DIG | Digitizing error of incident particle energy | PER-CENT | per-cent |
            | #ERR-DIG    | Digitizing error (of DATA)                   | PER-CENT | per-cent |
            #/Legend
EN-ERR-DIG  ERR-DIG
PER-CENT    PER-CENT
2.19        .95
ENDCOMMON
```

HISTORY

NRDC2014 C28:

All important alterations must be described in each affected data subentry in addition to a short summary (e.g., subentry numbers) in the common (001) subentry.

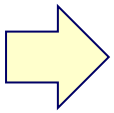
NRDC2014 A12 (to me):

Delete the following footnote in the LEXFOR entry "History":
Compilers are urged to document all changes under HISTORY.

Make important alterations more visible!

HISTORY (cont)

```
ENTRY            X1216   20130208
SUBENT         X1216001   20130208
BIB                   9         17
...
HISTORY     (19970404T)  + +  Converted and updated at DKE  + +
            (20130208A) N.N. Upper -> lower case correction.
            Dates were corrected for 4-digits year.
            REACTION SF4 in Subent 002 was corrected
             95-AM-240-M -> 95-AM-240-L according to the comment of
            N.Otsuka (NDS, IAEA) .
             DATA 2, DATA 3 were added.
ENDBIB                17          0
NOCOMMON               0          0
ENDSUBENT             20          0
SUBENT         41216002   20130208
BIB                   5         10
REACTION   1(95-AM-241(N,2N)95-AM-240-L,,SIG)
           2(95-AM-241(N,2N)95-AM-240-G,,SIG)
           3(95-AM-241(N,2N)95-AM-240-L/G,,SIG/RAT)
DECAY-DATA    Are not given in the article.
            Supposed as :  95-AM-240-L,0.9MSEC
REFERENCE   (W,PLEVE,1966)Private communication of V.P.Zommer,1966
             to A.A.Pleve,S.M.Polikanov+ .
STATUS      (TABLE) Table 1 of J,YF,6,488,1967 .
            (APRVD) Private communication to V.P.Zommer,1966.
HISTORY     (19970404T)  + +  Converted from SUBENT 80342002 + +
ENDBIB
```



```
ENTRY            X1216   20130208
SUBENT         X1216001   20130208
BIB                   9         17
...
HISTORY     (19970404T)  + +  Converted and updated at DKE  + +
            (20130208A) N.N. Major revision in 002.
ENDBIB                17          0
NOCOMMON               0          0
ENDSUBENT             20          0
SUBENT         41216002   20130208
BIB                   5         10
REACTION   1(95-AM-241(N,2N)95-AM-240-L,,SIG)
           2(95-AM-241(N,2N)95-AM-240-G,,SIG)
           3(95-AM-241(N,2N)95-AM-240-L/G,,SIG/RAT)
DECAY-DATA    Are not given in the article.
            Supposed as :  95-AM-240-L,0.9MSEC
REFERENCE   (W,PLEVE,1966)Private communication of V.P.Zommer,1966
             to A.A.Pleve,S.M.Polikanov+ .
STATUS      (TABLE) Table 1 of J,YF,6,488,1967 .
            (APRVD) Private communication to V.P.Zommer,1966.
HISTORY     (19970404T)  + +  Converted from SUBENT 80342002 + +
            (20130208A) N.N. REACITON(SF4): -M -> -L also g.s.
             production and isomeric ratio data added.
ENDBIB
```

I personally do not want to see " 4 digits year", "upper -> lower" especially when more important alteration is done.

Digitization – Guideline of Expression

Keep consistency for the number of digits between the digitized values and uncertainties.

Example:

```
DATA
EN            DATA          DATA-ERR
MEV           MB            MB
 14.1          12.34          2.34
 14.3          12.3           2.3
 14.5           1.234E+01     0.234E+01
 14.6           1.23 E+01     0.23 E+01
```

…

Digitization – Guideline of Expression (cont)

Use the fixed and floating decimal point expression for the numbers digitized from linear and logarithmic scale, respectively.

Example:

`12.345` (a value digitized from linear scale)

`1.2345E+02` (a value digitized from logarithmic scale)

Digitization – Guideline of Expression (cont)

Digitization accuracy may be given in the absolute unit (e.g., ADEG) or relative unit (e.g., PER-CENT) for the numbers digitized from linear and logarithmic scale, respectively.

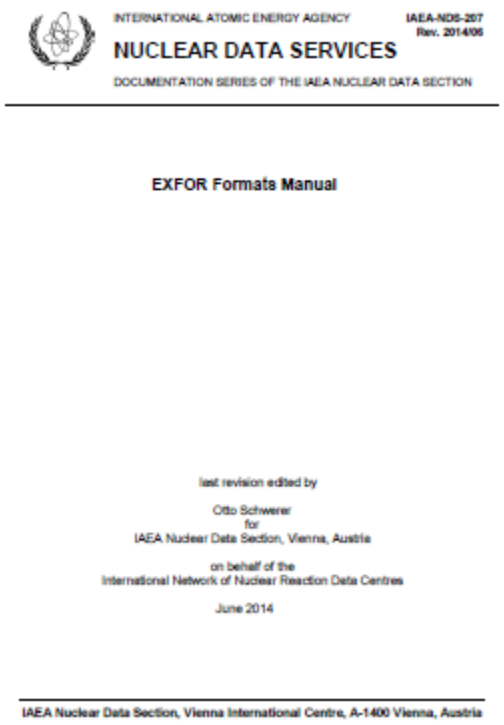
Example:

```
COMMON
ANG-ERR-D   ERR-DIG
ADEG        PER-CENT
 0.12        1.2
ENDCOMMON
DATA
ANG-CM      DATA          DATA-ERR
ADEG        MB            MB
  5.67        3.456E+02   0.234E+02
 12.31        2.345E+02   0.123E+02
...
```

This example also emphasizes consistency for the number of digits between digitization uncertainty and digitized value for ANG.

Updated manuals (Formats, LEXFOR, Dictionary)

- Revised manuals (Formats, LEXFOR and Dictionary) have been drafted by Otto in June 2014. It now waits my reviews ☹


INTERNATIONAL ATOMIC ENERGY AGENCY
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EXFOR Formats Manual

last revision edited by
Otto Schwerer
for
IAEA Nuclear Data Section, Vienna, Austria
on behalf of the
International Network of Nuclear Reaction Data Centres
June 2014

IAEA Nuclear Data Section, Vienna International Centre, A-1400 Vienna, Austria

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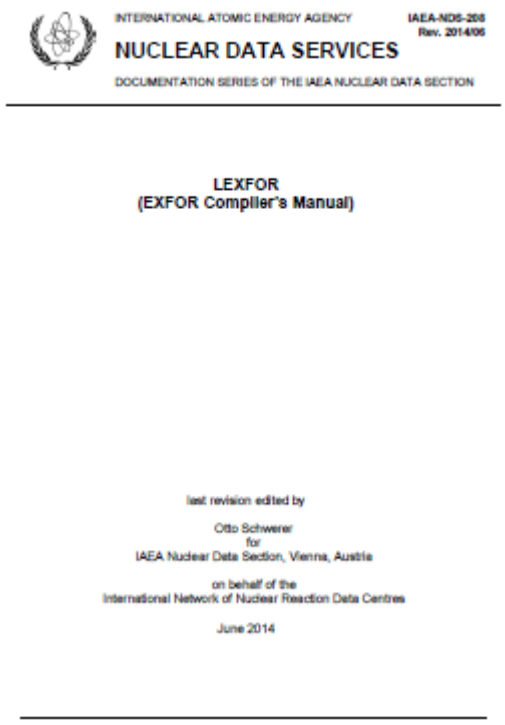
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LEXFOR
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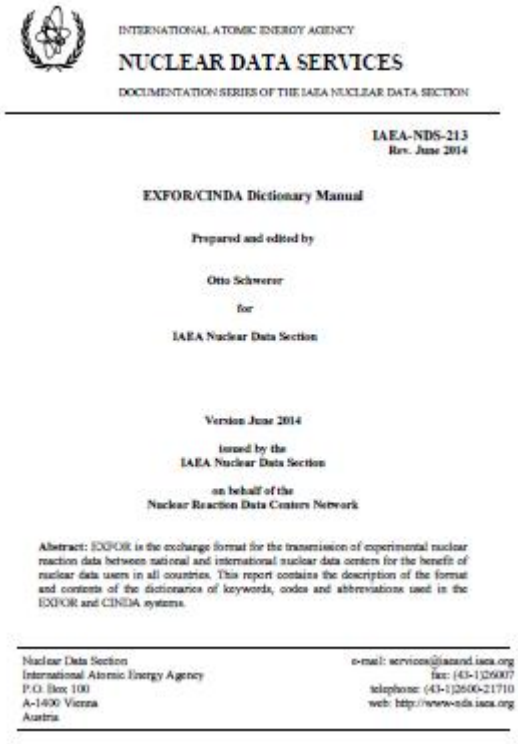
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EXFOR/CINDA Dictionary Manual

Prepared and edited by

Otto Schwerer

for

IAEA Nuclear Data Section

Version June 2014

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Nuclear Reaction Data Centers Network

Abstract: EXFOR is the exchange format for the transmission of experimental nuclear reaction data between national and international nuclear data centers for the benefit of nuclear data users in all countries. This report contains the description of the format and contents of the dictionaries of keywords, codes and abbreviations used in the EXFOR and CINDA systems.

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