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Update of RIPL discrete levels

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November 2012

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1. INTRODUCTION

The first update of the Reference Input Parameter Library Phase II (RIPL-2) Discrete Level Scheme Library (DLSL) was performed in October 2005 by T. Belgya under a Contract Agreement with the IAEA [1]. The second update followed in 2007 with the setup of easy-to-use programs which can use the original ENSDF files to create the DLSL in the format that was defined in RIPL-2 [2]. The description in APPENDIX 4 of Ref. [1] serves as a guide to any user who wants to run the program(s). The results of the update were also reported. The current work represents a new update of the database, addressing and amending the problems which have occurred and were reported during the last 5 years. The updated version of RIPL-2, RIPL-3 was published in December 2009 [3].

The purpose of this report is to document the changes in the new DLSL.

2. PROBLEMS OF THE DISCRETE LEVEL SCHEME LIBRARY (DLSL) REPORTED BY USERS

It was noted that there are many zero branching ratios which make calculations difficult, even for well-known nuclei. In point 1) and 2) below, we consider the reasons and offer possible solutions.

1. Some branching ratios are set to zero for example in case of ^{27}Al or ^{15}N:

For some light elements the branching ratios are given in the ENSDF files as a maximum limit. Those were kept zero because it would be a mistake to set them to the limiting quoted value and there is no indication to set them to a smaller value.

2. It is surprising that even for the well-known ^{12}C the gamma branching ratios are zero:

For many light mass nuclei evaluators give no branching ratios for the gamma-rays, instead decay widths in eV are indicated in the comment lines. In every such case, the reading of these comment lines was implemented and the branching ratios were calculated. It is also typical for these cases that the decay modes of the corresponding levels are not known with certainty. Thus the isomer transition values are noted with question marks (%IT=?) as well as the competing neutron decay (%N) or other modes which are also noted with question marks. In all of these cases the earlier software version set the isomer transition percentage (%IT) values to zero, which were used in the branching ratio calculation as multiplication factor, thus the branching ratios were calculated to be equal to zero. This situation is now avoided by setting %IT artificially to 100%, which does not reflect the truth, but if the user calculates the %IT from his or her model, then the branching ratio can be used to distribute the gamma decays to their final states correctly. A typical example for this case is the ^{12}C decay scheme for which the original ENSDF data set can be studied for better understanding.

The next two problems were identified during the evaluation of this update.

3. Level energies given within parentheses in the previous update:

The parentheses caused run-time error when the level energy was read in. Now it is fixed in such a way that the parentheses are removed from the level energy field (Elev) and the field value is read in without parentheses.

4. A misprint was found during the run of the converter programs and was fixed:

The transcript is given below:

```
ENSDF.055
55CO  L    10580.0 5   25/2-
55COX L XREF=I
55CO  G       880  1     10  3                                                G
55CO  G    1889.5  6    100  7M1+E2     -0.6      2
55CO2 G FLAG=GH
55COF G FL=8789.7
```

FL=8789.7 is a misprint in the last line. It should point to

```
55CO  L     8689.7 4     23/2-
```

The final spin assigned is correct for this transition.

5. Other problems:

Arjan Koning listed two cases that cause runtime error in TALYS. One of them occurs in the ^{59}Mn decay scheme in which only 4 levels are known. The 3rd excited level is coming from the ^{59}Co(π^-,π^+) reaction for which the double GDR energy was given at 27.2 MeV. The other is coming from the ^{230}Th(^{3}He,t)^{230}Pa reaction as the first known excited state in ^{230}Pa is at 17763 keV. The only way to eliminate them is to delete these lines from the corresponding ZXXX.dat files.

3. COMPARISON TO THE EARLIER VERSION OF DLSL

The comparison was made in the EXCEL file called parall_comparison_2012.xls which also contained results for the 2007 update. In the comparison sheet the contents of both worksheets were copied into one table. This table can be sorted by mass and charge numbers, and by the creation time (old, new). This way the results of the old and the new evaluations of the same nucleus appear next to each other. A macro named *changes* creates a comparison of the two data sets in the worksheet *changes*. The sorting by time can help to create three distinct categories, the completely new data, the old, which are not presented in the new, and a comparison. In the latter, the differences in the cumulative level number, the maximum number of levels (up to which the scheme is considered to be complete) between the new and the old data sets were calculated.

As a result of analyses it was found that 183 new data sets of nuclei have appeared in the new ENSDF evaluation (dated Sept. 2011). Most of them are just having a ground state and are (thus) not important for the DLSL library. There were 14 cases which disappeared from the new evaluation. They are listed in Table 1. Changes in number of levels (N_lev), in number of N_max and U_max are shown in Fig 1-3, **positive change means increase** of number of levels, N_max and U_max relative to 2007 data.

Table 1. Nuclei having no levels in the 2011 evaluation.

Z	A	year
8	25	2007
16	49	2007
18	52	2007
27	49	2007
29	52	2007
33	62	2007
34	66	2007
37	72	2007
112	277	2007
112	282	2007
112	283	2007
112	284	2007
112	285	2007

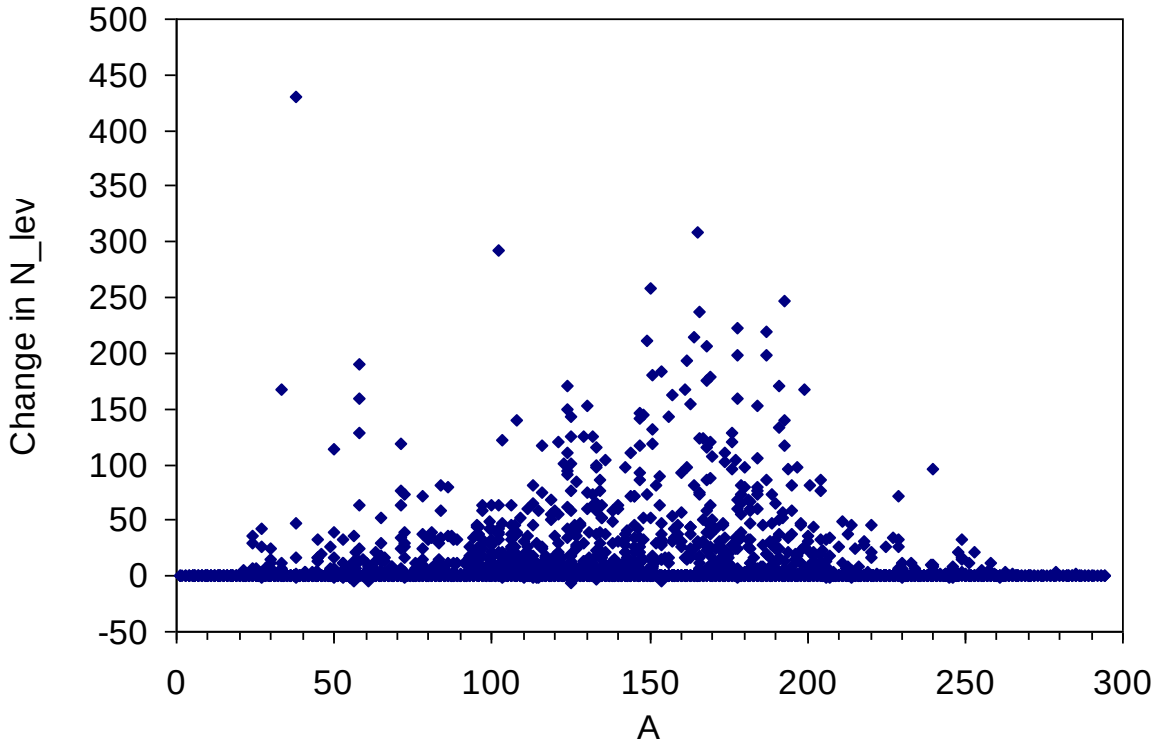

Fig. 1. Changes in the number of levels in the 2011 evaluation compared to the 2007 evaluation.

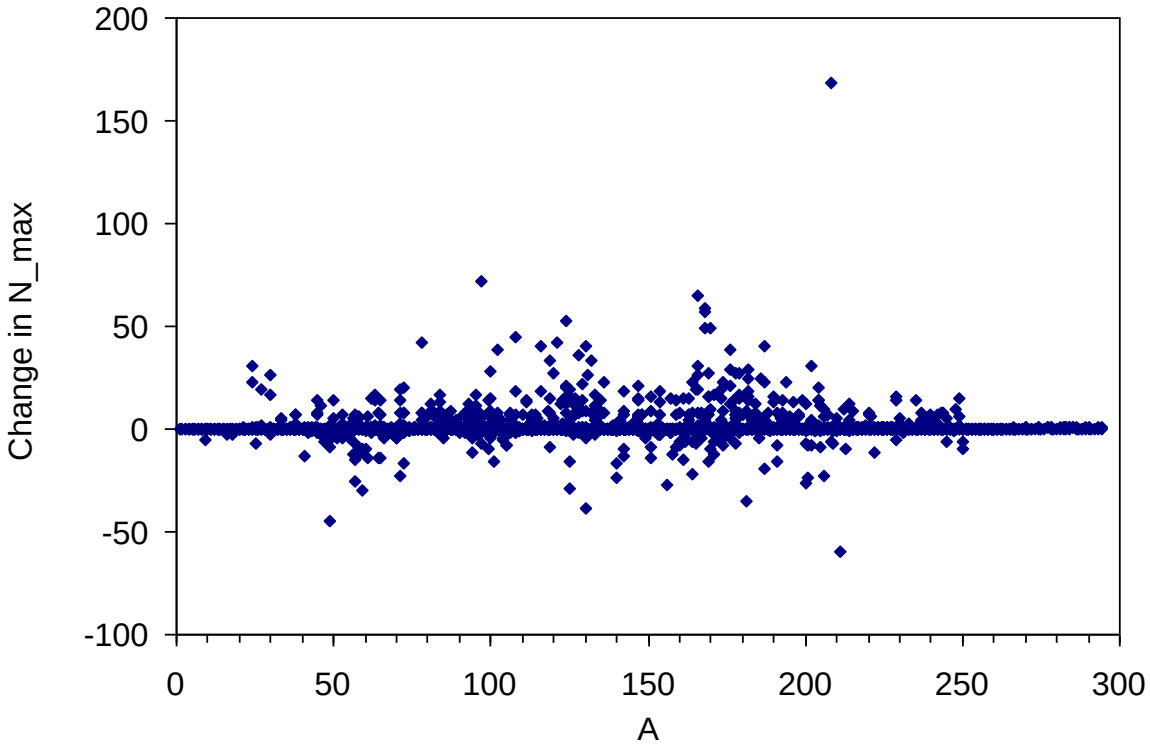

Fig. 2. Changes in the maximum number of levels up to which the scheme is considered to be complete in the 2011 evaluation compared to the 2007 evaluation.

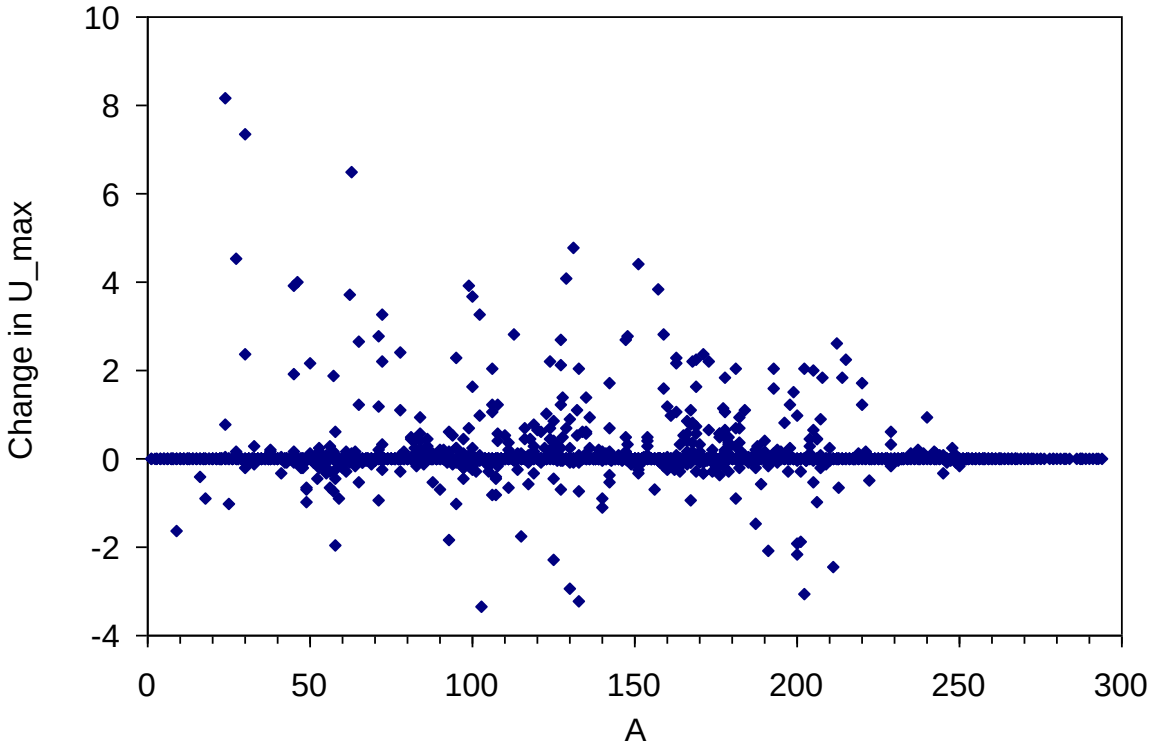

Fig. 3. Changes in the maximum energy of levels up to which the scheme is considered to be complete in the 2011 evaluation compared to the 2007 evaluation.

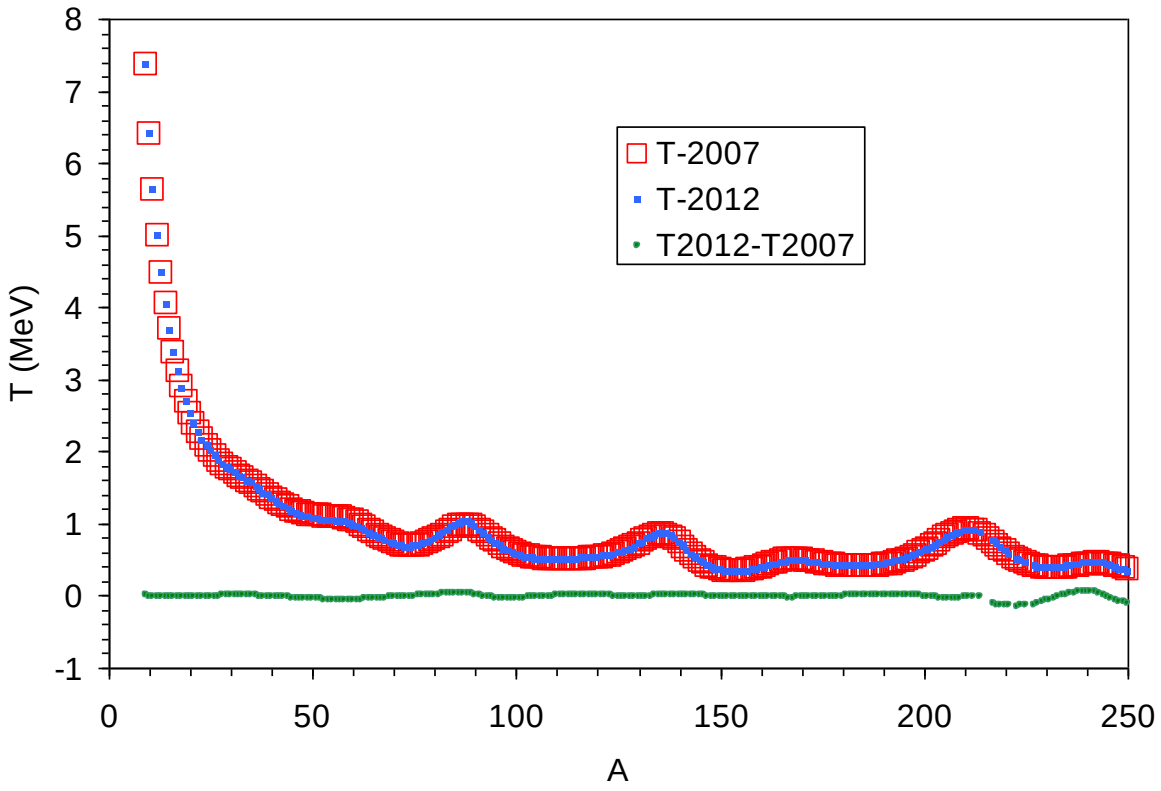

Fig. 4. Comparison of temperature of constant temperature model fits to the 2011 evaluation and to the 2007 evaluation. Difference is also shown (green dots). The temperature fitted to the cumulative number of level data as a function of mass number *A* is shown in this Figure together with the 2007 fit, as well as their difference which shows negligible change, except for actinides.

4. STATISTICS FOR THE NEW CONVERSION

Table 2. Statistics of updates of ENSDF conversion to RIPL-2 format.

	2005	**2007**	**2012**
Number of nuclei processed		3020	3117
Number of records read in		2113877	2443294
Number of levels processed	138595	135406	164794
Number of gammas processed	200944	203449	248169
Number of unique spins	68858	63339	76768
Number of unique spins with parenthesis	38912	32507	43489
Number of spins inferred from gamma transitions	3581	4441	4663
Number of spins inferred from spin distributions	3516	3678	3760
Number of spins chosen from list by spin distributions	6058	6779	7041
Number of known ICC	23184	24945	32610
Number of newly determined ICC	117675	124328	145908

5. ACKNOWLEDGEMENTS

This work was carried out under an IAEA Contractual Service Agreement and the author should like to thank the Project Officer, R. Capote Noy, for his help to perform this task.

6. REFERENCES

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