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Second Meeting of the Coordinated Research Project on the Intercomparison of Evaluations of Actinide Neutron Nuclear Data

Aix-en-Provence, 30 April - 1 May 1979

SUMMARY REPORT

Prepared by H. D. Lemmel
Nuclear Data Section
International Atomic Energy Agency

July 1979

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Abstract

The second meeting of the participants in the IAEA Coordinated research programme for the intercomparison of evaluations of actinide neutron nuclear data, was convened by the IAEA Nuclear Data Section on 30 April-1 May 1979, at Aix-en-Provence in France.

The meeting participants reviewed the status of actinide neutron data evaluations and intercomparisons, presented progress reports of their work, exchanged views and experiences about data evaluation and nuclear model calculations, and laid plans for future work.

Contents

Meeting of the Coordinated Research Project
on the Intercomparison of Evaluations of
Actinide Neutron Nuclear Data

Aix-en-Provence, 30 April, 1 May 1979

Meeting Participants

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* The CRP participants resp. their alternates are markes with an asterisk.

Meeting of the coordinated research project on the
"Intercomparison of Evaluations of Actinide Neutron Nuclear Data"

Aix-en-Provence, Hotel "Le Roy René", 30 April-1 May 1979

Agenda

Monday, 30 April, ca 9:00 hrs

1. Opening, Election of Chairman, Adoption of Agenda, etc

2. Brief reports by participants:

   - activities completed and being done
   - special problems encountered
   - plans for the future

3. Definition of specific items to be discussed either in plenary or in subgroups

4. Discussion of specific items as defined under 3.

   Subgroups on Am-241 (243)
   Pu-242
   Cm-244 (and other isotopes)

Tuesday, 1 May

4. continued

5. Conclusions, actions, recommendations

Summary of the Meeting

The second meeting of the participants in the IAEA Coordinated Research Programme (CRP) on the Intercomparison of Evaluations of Actinide Neutron Nuclear Data, was convened by the IAEA Nuclear Data Section on 30 April-1 May 1979 at Aix-en-Provence in France. The meeting was chaired by Dr. B.H. Patrick, U.K.

The main purpose of the meeting was to give the CRP participants an opportunity to exchange views and experiences about their work, to discuss specific problems encountered, and to plan the future work of the CRP.

The participants presented progress reports of their work. Several evaluations which had been finished and circulated among participants prior to the meeting, were reviewed. Questions relating to nuclear model calculations and their applications were discussed. Scope and time schedule for the continuation of the work were projected.

The conclusions and recommendations are given on the following pages.

CONCLUSIONS AND RECOMMENDATIONS

1. Evaluation

The Meeting discussed the working programs of the participants. These include, according to present plans, evaluations for the neutron data of 31 actinides, mostly planned to be finished by the end of 1980, some being envisaged for 1981/82. See Tables 1 and 2 on pages 10 and 11. These include partial or full evaluations. Note that the lists are subject to modifications.

The evaluations produced by members of the CRP will be compiled in an IAEA file with two parts, one for complete evaluations, the other for partial evaluations.

A "complete evaluation" is to include all cross-sections, $\bar{\nu}$ and μ in the full energy range from 10^{-3} eV up to 15 MeV at least.

Evaluations may have the formats of ENDF/B, UKNDL or KEDAK.

If possible, UKNDL and KEDAK formatted evaluations should also be issued in, or converted to ENDF/B format.

The meeting appreciates the announcement that the USSR participants use the ENDF/B format for their evaluations.

The Japanese actinide evaluations of 1977 included in JENDL-1 can be included in the IAEA file.

For the Israel evaluations of Np-237 and Pu-238 Karlsruhe should be consulted before including them, as these isotopes were evaluated in cooperation with Karlsruhe.

Evaluations should be accompanied not only by a detailed report but also by a summary documentation for the convenience of data users. This should include:

- lists of experimental data used for different quantities and energy ranges
- a summary of evaluation methods used for the different quantities and energy ranges
- standards used
- thermal values adopted
- parameters of the models used
- etc.

The summary documentation may be included at the beginning of the file or as a few-page paper to be sent to data users together with the tape.

NDS should check whether all essential items were included in the documentation and, where necessary, should check back with the authors.

Evaluations should be accompanied by an (at least rough) estimate of uncertainties for the different quantities and energy ranges.

2. Intercomparison

For intercomparisons the methodology given in the paper by S. Yiftah should be adopted. This includes four levels:

1. Comparison of data input: a) experimental data
   b) models and parameters used
   c) systematics, etc

2. graphical comparison and definition of differences

3. analysis and importance of differences encountered

4. sensitivity analysis.

See S. Yiftah, M. Caner, Y. Gur: On the methodology of the intercomparison of TND evaluations. Advisory Group Meeting on Transactinide Nuclear Data, Cadarache, 2-5 May 1979.

Each author should compare the results of his evaluation with other available evaluations. The progress achieved compared to previous evaluations and the differences encountered, should be discussed.

If the comparison with another evaluation within the CRP indicates significant differences, the authors are encouraged to contact each other for clarification of the differences.

The IAEA file will include different evaluations for the same nuclide.

If evaluations are revised, NDS will send the revised version to everyone to whom it had sent the earlier version.

The Meeting welcomes the announced release of the ENDF/B-5 actinides file and asks the participants, to include these evaluations in their intercomparison.

After receipt of the ENDF/B-5 file NDS should see that participants receive from NEA-DB or NDS selective retrievals covering their interest.

NDS should take initiative to stimulate the intercomparison of the ENDF/B-5 evaluations with the evaluations already finished within the CRP.

Feedback to evaluators, experimenters and interested committees is encouraged.

3. Standards:

Recommendations no. 4 of the 1978 CRP-Meeting was endorsed, which reads:

The current ENDF/B Library of "7 Standards" which is available to everybody, is recommended for convenience. However, when necessary (e.g. for consistency within JENDL, KEDAK or UKNDL) other standard values will

also be accepted, if they are properly documented. It is noted that the accuracy of most actinide data is such that different standard values will not significantly influence the results.

It was recommended that participants should change over to ENDF/B-5 standards as soon as these become available.

The only important standards not available in the ENDF/B Library of "7 Standards" are the U-238 fission and capture cross-sections. NDS should try to obtain these two reactions from the ENDF/B-5 Library for use as standards within the CRP.

The standards actually used should be well documented. NDS should check whether the standards used as well as other essential information is included in the documentation of the evaluations.

Those experimental cross-section data which depend on the knowledge of half-lives should, as far as possible, be corrected to the half-life values recommended by the CRP on actinide decay-data. NDS should distribute these values to the participants.

4. Distribution of evaluation work

It was discussed, how far evaluators should specialize themselves and rely for certain data types on the work of other specialized evaluators.

For $\bar{\nu}$ the evaluation by F. Manero and V.A. Konshin [At. En. Rev. 10, 637, 1972] was widely used and it was questioned whether this could be updated. For nuclides with insufficient experimental data the recipes by R.J. Howerton [Nucl. Sci. and Eng. 62, 438, 1977] and by R. Bois, J. Fréhaut [CEA-R-4791, 1976] should be considered.

If an evaluator does not evaluate angular (or energy) distributions, it may be advisable that he takes over (with appropriate caution!) such data from other evaluations, as this may be useful for future benchmark computations.

5. Nuclear models

Several participants (Mehta, Menapace, Salvy) tested the differences obtained when using the spherical or deformed optical model on several nuclides and in different energy ranges.

Dr. Salvy is asked to prepare a survey with the goal of specifying the numerical differences obtained from spherical and deformed optical model computations and advising participants, as far as possible, which model should be used for which actinide in which energy range.

Dr. Mehta agreed to investigate the various semi-empirical statistical models and pre-compound contributions to calculate (n,2n) and (n,3n) cross-sections and to report to the 1980 CRP Meeting.

6. Testing of data

Participants and NDS are asked to inquire with appropriate institutes in participating countries whether sufficient details about irradiation or burnup experiments and their spectra can be released for the purpose of benchmark computations.

NDS should compile such information and distribute it to participants for possible data testing before the 1980 CRP Meeting.

In the thermal range differential data should be compared with experimental resonance-integrals if such data are available.

7. Specific intercomparisons

A number of specific intercomparisons of actinide evaluations are included in the reports of the participants on their evaluations.

The Meeting split into subgroups dealing with those nuclides which had been considered by two or more participants, in particular

Am-241 (243) - Fort, Igarasi, Menapace, Patrick, Budtz-Jorgensen, Knitter, Sandberg
Pu-242 - Bobkov, Menapace, Salvy
Cm-244 (and other isotopes) - Igarasi, Yiftah.

Th-232 will be treated by correspondence between Drs. Mehta and Vasiliu.

Preliminary conclusions include the following observations:

For Am-241 the evaluations (Fort, Menapace, Patrick) seem to agree within the uncertainty of experimental data with the exception of the fission resonance-integral, where the experimental values are significantly larger (ca factor of 2) than the values calculated from the evaluated differential data.

Some Geel measurements seem to be discrepant.

New experiments for differential inelastic scattering data are desirable for more reliable adjusting of optical model parameters.

For a comparison with ENDF/B-5 evaluation of Am-241, Igarasi's paper submitted to the AG-Meeting is referred to.

Intercomparisons on Am-241 are to be continued by correspondence to include also the Karlsruhe and Obninsk evaluations being in progress.

For Pu-242 a preliminary comparison was performed. Whereas Menapace's and Salvy's evaluations for the resonance and high energy regions respectively rather complement each other, the Pu-242 paper by Konshin which was not available prior to the meeting, requires further studies.

8. Summary report

The Meeting reviewed the summary report on the CRP by S. Yiftah *) and approved it after some amendments. In particular the meeting endorsed the recommendations on pages 10 and 11.

9. Next meeting

The 1980 Meeting of the CRP is envisaged to be held in Vienna in June preceding the INDC Meeting.

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*) S. Yiftah: Coordinated Research Programme on the intercomparison of evaluations of actinide neutron nuclear data. Invited paper, Second Advisory Group Meeting on Transactinium Isotope Nuclear Data, Cadarache, France, 2-5 May 1979, IAEA report, to be published.

Table 1 - Programme by Country

Tentative! Subject to modifications!

	Finished		In Progress	Planned	
	1977	1978/79	1979	by 1980	after 1980
France Bruyère-le-Châtel Cadarache		(Pu-242) Am-241	Th-232, U-237,239 Np-237	Pu-241, 242 Np-239, Cm-243$^{\Delta}$	U-233, 234, Pu-237
Germany, Fed. Rep.			Pu-242, Am-241, 242, 243 Cm-244	Pu-240, 241, 242* Cm-243$^{\Delta}$	
India			Th-232	Th-233	Pa-231, 232 U-232, 233, 234
Israel	Np-237, Pu-238	Cm-244	Cm-246	Pu-240, 241, 242*	Cm-248
Italy		(Pu-241, 242) (Am-241, Cm-242)	Pu-241, 242 Am-241, 243 Cm-242, 245	Cm-243$^{\Delta}$ Cm-246, 247, 248	
Japan	Th-232, Pa-233, U-234, Np-239, Pu-240, 241, Am-241	Am-243, Cm-244 (Cm-245)	Cm-242, 245	Np-237 Pu-236, 238, 242 Am-242, 242m U-233, 236	
Romania		Th-233	U-233	Pa-231,(232),233	
U.K.		Am-241	Am-243	Np-239, Am-242m Cm-242,(243),244	Cm-245-248
U.S.S.R. Obninsk Minsk		Pu-241, 242	Am-241		

( ) = partial or preliminary.

*, Δ = cooperations

( ) = uncertain

Table 2 - List of Nuclides Covered by the Present Programme

Tentative! Subject to modifications!

	Finished 1977	Finished 1978/79	In Progress	Planned by 1980	Planned after 1980
90-Th-231					In
232	J	R	In (F)		
233				In	
91-Pa-231				R	In
232				[R]	In
233	J			In R	
92-U-232					In
233			R	J	F In
234	J				F In
236				J	
237			F		
239			F		
93-Np-237	Is		F_c	J	
239	J			F_c U	
94-Pu-236				J	
237					F
238	Is			J	
240	J			Is+G	
241	J	C (It)	(It)	F Is+G	
242		(F)(It)C	G (It)	F J Is+G	
95-Am-241	J	U (It)F_c	G (It)C		
242			G	J	
242m				U J	
243		J	G U (It)		
96-Cm-242		(It)	J (It)	U	
243				It+F_c+G [U]	
244		J Is	G	U	
245		(J)	J (It)		U
246			Is	(It)	U
247				(It)	U
248				(It)	U Is

(It) = res. region (F) = partial [U] = uncertain

(J) (F) = preliminary

C = USSR (CCCP)
F = France, Bruyère-le-Châtel
F_c = France, Cadarache
G = Germany, Fed. Rep.
In = India
Is = Israel
It = Italy
J = Japan
R = Romania
U = UK

COMPUTER PROGRAMS

To enable CRP participants to exchange experiences with theoretical model calculations, programs used by some of the participants are listed in the following:

France

Optical model codes:

JUPITOR1	(version improved at BRC) deformed optical model
SOMC2	spherical optical model with automatic research of parameters based on SPRT method (to be published)
ECIS, ECIS"H"	deformed optical model (from RAYNAL, Saclay)

Statistical model codes:

MSPQ	published (version 1)
NCNR, HELMAG	not published

India

Operational on BESM-6

a) used for evaluation:

SPLINE

ADAPE

ABACU-2 (home-made, semi-empirical, for statistical model, preequilibrium fission)

b) operational but not yet used:

ELISSE

JUPITOR

Israel

Fast energy range:

ABACUS-NEARREX	combination of optical model (ABACUS) and statistical (NEARREX)
SIGMA	(n,2n) (n,3n) $\bar{\mu}_L$

Average resonance parameter:

STARA	maximum likelihood estimate of $\langle \Gamma_n^o \rangle$ and $\langle D \rangle$

See details and references in IA-1353 (Cm-244 evaluation)

Italy

CRESO:	Resolved and unresolved region calculations from parameters in ENDF/B format
DIME:	Dyson-Metka statistical analysis of resonance and Bollinger-Thomas test for l-quantum number assignment
HAUSER:	(by Mann and Shenter) Hauser-Feshbach statistical model calculations (including compound elastic and inelastic, captures fission, n-particle reactions)
PLUME:	Multilevel BW calculations with analytical Doppler broadening
STAFAN:	(by M. Stefanon) D_0 l-s, S_0, S_1 determination from resonance parameters by "maximum likelihood" method
VENUS:	resonance generation according to Porter-Thomas and Wigner distributions
JUPITOR:	(by Tamura) coupled-channel O.M. calculations
ADAPE:	same, adiabatic approximation
PRODE:	pre-compound calculations for "knock-on" (n,n') and (n,p) reactions

JAERI

RESEND-J	resonance cross section calculations with resonance parameters single-level, multilevel formula
TOTAL	total cross section and s-wave strength function calculation with spherical optical model
CASTHY	capture, total, elastic scattering, inelastic scattering cross section calculations with spherical optical and Hauser-Feshbach with fluctuation correction and Brink-Axil E1 giant resonance formula
(FISCAL)	(fission cross section calculation program, not yet completed, this will be included in CASTHY)

U.K.

AVXC	
FISRA	
EVAPF	statistical model code