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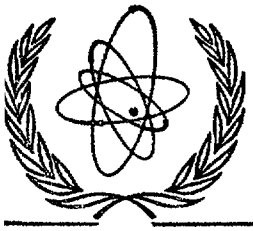

International Atomic Energy Agency

~~INDC/222~~
May 1968
G-distribution

Status Report
on the
Review of the 2200 m/sec Fission Constants

INTRODUCTION (W.M. Good)

The monitoring of the 2200 m/sec constants of the fissile nuclides has been a continuing activity of the IAEA. From the long-range point of view, such an activity should consist of occasional reviews to assure that the data and analytical methods are in fact the best that are currently available according to expert opinion.

Such a review has just been concluded, by a group augmented in size from the first one of several years ago, to include representative members from USA and USSR. Because the meeting proper have so recently taken place and because of certain handicaps suffered from underestimating the magnitude of such a revision, no very complete written report is available at INDC meeting time. In order that the committee might reflect on the relative importance of this Agency activity at this time, Dr. Carl Westcott who coordinated the work has given permission to submit his unedited comments on the present status of the recent review.

Status Report as of May 3rd 1968 (C.H. Westcott*)

(with tables completed by H.D. Lemmel to follow at a later date)

1. The present review was timed to begin from the status of Nuclear Data revealed at the Washington, D.C., Conference on Neutron Cross-Sections and Technology of 4-7 March 1968. Some preparations took place in 1967 in the IAEA and serious work began in Chalk River late in 1967; extensive correspondence, particularly with Dr. B.R. Leonard (the U.S.-nominated participant), was then carried on. Two groups met, viz., one (a) in Chalk River, March 18-21, and the other (b) in Vienna, April 23-25, 1968; those present were

(a) Dr. B.R. Leonard, USA
Mr. J. Story, UK
Dr. C.H. Westcott, Canada
Mr. G.C. Hanna, Canada
Dr. H.D. Lemmel, IAEA

(b) Dr. P.P. Blagovolin, USSR
Dr. N.J. Pattenden, UK
Dr. K. Ekberg, Sweden (former IAEA)
As well as Drs. Westcott and Lemmel and
(part-time) Mrs. P.M. Attree, IAEA

2. It has now become clear that the work cannot be completed as rapidly as had originally been hoped. On several points, somewhat specialized discussions have become necessary, and in some cases this has only recently begun by correspondence. The kinds of information leading to particular difficulties are discussed in sections 6-12 below. In addition, there have been delays of various kinds, both in technical matters (including the pressure of other work) and in supporting services, but mainly it has been a question of underestimating the work to be done, in addition to certain problems being posed at a late date in correspondence or documents.

3. In future it would appear preferable (if more expensive) to convene a single group in one location for this type of work, although

* Typed after the author left Vienna

some specialized topics (e.g., σ_s) could be dealt with on separate occasions if the specialists concerned could meet. It is also now seen to be desirable to arrange such a meeting in the middle of the interval between INDC meetings, rather than to start seriously only 2-3 months before an INDC meeting, if a report of substance to the INDC is desired.

4. For this revision a 16-parameter fit has been used, giving a better representation of g-factor effects than the former 10-parameter fit, and this has caused little difficulty. A more open question is the accuracy which may be attributed to g-factors. Work on this point is still in process at Chalk River - an extensive study of curve shapes (e.g., of $\sigma\sqrt{E}$ vs E) has been made, to obtain the g-factors for U-233, U-235 and Pu-239 now used, but their accuracy is not yet well substantiated.

5. As work is still proceeding, the exact state of the input tables at the time of the INDC meeting will be presented verbally. The main points described below will also be supplemented at this time by a mention of more minor difficulties still outstanding (e.g., cross sections for Au, B, Co, Na, etc.).

6. The discrepancy in $\bar{\nu}$ measurements persists. New data have not changed the picture substantially (for this reason the correction of $\bar{\nu}$ inputs for minor factors, including effects of fast neutron spectrum differences, is being left until last - these will not seriously change the general picture). A manuscript by De Volpi*, recently received, makes some suggestions for measurements to improve the situation - these, we feel, should be considered (possibly on a "standards-panel report" agenda item) by the INDC, with a view to facilitating any action agreed to be desirable.

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* Compare INDC-229, Supplement 1

7. Scattering cross-sections (used to deduce σ_a from σ_T) also are in question. This is a specialized problem and the results of correspondence, arising from the discussion in Vienna of the Chalk River meeting's recommendations, are awaited.

8. Half-lives have recently been called into question, and for U-233 there is a direct effect on our work (Pu-241 is also in doubt according to Cabell, as well as U-234). It will take a little time to decide how best to deal with this point. Further experimental data (CBMN Spernol et al.) is believed to be almost ready for release.

9. Additional data which remains provisional, or is expected shortly, is also in question for several types of data (σ_a and η of Pu-241, J.R. Smith; σ_f, Deruytter; the manuscript of De Volpi as mentioned before, etc.). It is now the intention to try to set a revised deadline of 4th June (at Chalk River) for additional results; Mrs. Attree will be visiting Canada soon after this date and perhaps correspondence on outstanding matters will be reasonably complete by then; a later deadline may have to be agreed if the outstanding problems cannot be settled soon.

10. A major problem has been the use of reactor-spectrum measurements of η, α, etc. A recently-arrived manuscript by B.R. Leonard Jr* (work done since the Chalk River meeting) raises serious questions which we have not yet had time to explore at all, since some correspondence appears essential. The presently used inputs are based on concepts pre-dating this document.

11. Even apart from the main point of the preceding paragraph, there are problems of interpretation of work such as the η-ratios by Fast and Aber (IN-1060), which are only in process of resolution.

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* Compare INDC-229 Supplement 2

12. Care is also being taken to deal as fully as possible with error- (or weight-) adjustments needed when several inputs to the least-squares process are correlated. This work is in hand but not yet complete. In particular (new to the 16-parameter method) the ratio of δ and σ_{2200} values (or $\hat{a}$ or $\hat{\eta}$ and the 2200 m/sec analogues) is now used as a supplementary input on g-factor data, with suitable weights. Only for integral measurements where spectral problems seem perhaps quite significant (i.e., generally for Pu fuels) is this procedure sometimes rejected (cf. section 10 above).

13. It is now our best estimate that a complete manuscript can be ready some time between August and October of 1968, although if the problems are not resolved reasonably soon, some further travel may be desirable. The completion date should not be allowed to "slip" too far or a number of new results or documents may enter the picture and perhaps appreciably complicate the situation.

14. If any one difficulty (e.g., $\bar{\nu}$, as discussed in (6) above) is rather rapidly cleared up after this work has gone to press, the Nuclear Data Unit may be able to clarify the matter by correspondence and (with the now-tested 16-parameter method) arrange a suitable up-date of our results.

15. A general revision on the present scale, with preferably a less tight travel-budget, appeared to the meetings held to be an activity which should be planned to begin soon after the 1970 INDC meeting, so that the results should be available by mid-1971. However, the rate of production of new data is somewhat unpredictable, so this can be considered only a general guide-line.

16. In a future up-date, the extent to which results from integral types of measurement can be used, may become more important than at present. If monokinetic measurements (or those in well-known simple spectra) are adequate, this step may not be needed, but the reliability of the interpretation of integral studies is an important point. In the current revision we have attempted to be rather more demanding

on this point than we were in 1965, and the addition to the team of a U.S. participant is partly, but only to a limited extent, responsible for this development of philosophy.

17. The cooperation of many persons in connection with this work in various ways is gratefully acknowledged.

18. Tables of input data and preliminary results of the fit will be distributed by H.D. Lemmel to the INDC as a supplement to this document.

Supplement 1
May 1968

Discrepancies in the spontaneous fission neutron yield ν of CF-252

A manuscript by A. De Volpi and K.G. Porges, Argonne, reports on the

> Resolution of the worldwide discrepancy in $\nu(^{252}Cf)$ measurements.

From this manuscript, the introductory "Note to the Reader" is extracted:

For a number of years it has become apparent that there exists a reproducible <u>systematic</u> discrepancy in measurements of the spontaneous fission neutron yield $\nu(^{252}Cf)$, a standard upon which other values of $\nu(^{235}U$ and $^{239}Pu)$ can be based. Measurements from three independent laboratories have provided values around 3.80 ± 0.02 while three other experiments have been reported with $\nu(^{252}Cf)$ at 3.70 ± 0.02. Based on our own independent measurements, plus our calibrations of three national standard neutron sources, a thesis can be developed which resolves the discrepancy (to a large extent). We obtain a preliminary value of $\nu(^{252}Cf) = 3.808 \pm 0.030$ (total yield). This memorandum is being widely circulated prior to publication in order to elicit comments and in order to propose certain cooperative experiments which could provide final resolution of the problem.

Disclosure of this information is being made somewhat prematurely with partial documentation because of the imminent IAEA re-evaluation of fundamental fission parameters.

Supplement 2

May 1968

Uncertainties in 2200 m/s constants due to the neutron spectra in integral experiments

A manuscript by B.R. Leonard, R.C. Liikala, U.P. Jenquin describes the

> Thermalization Analysis of an Integral Measurement of Alpha.

From this manuscript, some passages are extracted which illustrate the serious implications on the 2200 m/s review:

In the 1965 IAEA review ... the input values were determined almost exclusively by the results of integral measurements. The derivation of 2200 m/s values from these integral experiments has been done in almost every case by using the Westcott (g + rs) convention. In some cases, an assigment of effective neutron temperature, T_n, has been made from auxiliary experiments involving spectral index detectors such as lutetium. In others, the physical temperature has been used and in still others, the assigment is completely obscure. While the reviewers have attempted to assign reasonable and consistent uncertainty limits to the values of T_n, g, r, and s used in the derivation, it is not clear that the basic spectra assumed in the convention is a valid interpretation of most of the experiments. For most of the integral measurements no calculations of neutron spectra have been presented to substantiate the validity or define the possible errors of the spectra assumed in the interpretation.

Because of the obvious importance of these integral experiments in the derivation of the 2200 m/s constants, we have made a study of an irradiation experiment which has an important bearing on several of these constants ... The object of the study was to compare the results of an analysis of the irradiation using the spectra calculated by slowing down and thermalization codes with the results obtained from an analysis using the (g + rs) convention. By using an identical set of microscopic cross sections in both analyses the differences due only to neutron spectra could be defined ... The implications of these

results with respect to the derivation of 2200 m/s constants from other integral experiments are quite serious. The only other experimental values of alpha of comparable stated precision which were used in the 1965 review and the revision for ^{241}Pu in 1966 were based on irradiations in much harder spectra than the NRU irradiation than that of Durham, et al which we have studied. It would appear that the uncertainties in those results due to spectral uncertainties must be significantly larger than the uncertainties derived here. Similar considerations apply to all of the values of σ_c derived from integral measurements which were used in the IAEA review ... On the basis of the calculations presented here and many other calculations of H_2O and D_2O neutron spectra it would appear to us that the derivation of fundamental nuclear constants from integral measurements must necessarily be substantiated by a reasonable analysis of the neutron spectra.