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INTERNATIONAL NUCLEAR DATA COMMITTEE

Report on Australian Activities

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1. Data Compilation

We have continued to build up our master library tape of data which has been partially evaluated by us after selection of material from the literature and by direct contact with workers producing experimental information.

Recently, the work has been greatly aided by the supply of data by the Nuclear Data Unit from the DASTAR and other collections. The first tape arrived at the beginning of May from Vienna. We are at present trying to have it transferred from 7 to 9 track tape because of the recent acquisition of our IBM 360-50H. The problems involved in the conversion have been annoying and I would like to hear the technical problems discussed in due course.

For our part, we have contributed to the CINDA compilation and used it extensively also - a fact which our staff have asked me to note with thanks. We have contributed our recent results and those of some of our University colleagues to DASTAR, including:

1. $\bar{\nu}$ measurements for thermal fission of Pu 239, Pu 241, U233 and U235 relative to Cf.252 plus our estimated errors on all component parts of the measurements.

2. $\bar{\nu}$ measurements for spontaneous fission of Pu 240 and Pu 242 relative to Cf.252.

3. some (n,p) cross section measurements above threshold (from Melbourne University).

2. Evaluation of Nuclear Data at the A.A.E.C.

Most of our evaluation work is oriented towards satisfying the needs peculiar to our own reactor physics codes such as GYMEA. This uses a single level symmetric resonance theory and necessitates the development of programmes which can use theories readily reducible to the single level approximation. In particular, single and multilevel fits have been carried out for U233. The multilevel formulae used are approximations to the Lane and Thomas version although this leads to little error in the resulting parameters. Significantly better fits to experiment are obtained with the multilevel version. New data on resonance scattering is currently being analysed.

The fission product cross sections are being evaluated on an individual isotope basis. Compound nucleus theory is used together with average resonance parameters to estimate unknown resonance cross sections. These will shortly be checked using high energy information from ABACUS 2. The cross sections are to be checked by comparing yields of each isotope against the results of mass spectograph measurements on a sample irradiated in HIFAR.

Sundry evaluations have been completed on C12, the chromium and zirconium isotopes, and we will shortly be undertaking evaluations of all fission cross sections in a new updating of our GYMEA library.

Emphasis has been placed upon obtaining data which can be related to our reactor physics programme. Up until recently it was essential that we cover quite a wide range of isotopes and the evaluation could not be classed as extensive. With access to the evaluations of others, we hope to concentrate on some of the data and give it treatment in depth. Some discussion of the areas being covered by other groups would be most valuable to us. We are particularly grateful for access to evaluations sent to us through the Nuclear Data Unit.

3. Measurement Programme

(a) Fission Physics - Nubar for Thermal Fission

The work on relative nubar measurements for thermal fission has been reported and the results entered in DASTAR. Every effort was made to reduce the errors to a minimum and a complete coverage of the error considerations has been presented. In our evaluation of the final results in relation to those of others we would make the following points:

(i) the measurements for U235 and U233 seem to be in excellent agreement;

(ii) although few measurements exist for Pu 241, the situation appears reasonable and for the present, the results are adequate;

(iii) our consideration of the results for Pu 239 leads us to believe some further measurement is necessary in view of the spread in results when taken relative to Cf 252 prompt nubar = 3.784.

Hopkins & Diven	2.841 ± 0.028
Colvin & Sowerby	2.874 ± 0.019
Boldeman & Dalton	2.904 ± 0.008
Mather et al.	2.932 ± 0.034

We do not consider that we can do more at present ourselves. Taken in conjunction with recent eta results it appears likely that the final result is close to 2.90.

(b) Fission Physics - Spontaneous Fission Nubar

(i) Relative measurements of spontaneous fission nubar have been completed for Pu 240 and Pu 242 and the results have been entered in DASTAR. The values for prompt nubar are:

Pu 240	2.168 ± 0.009
Pu 242	2.157 ± 0.009

relative to that for Cf 252 = 3.784.

(ii) We have been giving further consideration to an absolute measurement of prompt nubar for Cf 252. The search has been for an independent method of measurement. We may have more to report at the next meeting as the investigations are now reaching the stage where a decision to proceed or stop will be necessary.

In the analysis of the existing information, we cannot see any worthwhile progress being made unless the measurements can achieve a genuine accuracy to better than ± 0.5%. The existing errors in the liquid scintillator measurements are as follows:

(a) dead time corrections for Cf are unlikely to be very much less than one per cent. We must therefore look for an accuracy in the correction to better than 30%;

(b) the uncertainty in the Cf 252 fission spectrum produces, typically 0.12% uncertainty innubar for a two per cent error in average E;

(c) although little real data exists, it is probable that delayed gamma rays warrant a correction of 0.2 per cent under usual experimental conditions;

(d) the efficiency calibration of the liquid scintillator tank as a function of energy may need consideration.

(c) <u>Fission Physics - Nubar versus Neutron Energy</u>

At the moment we are concerned with nubar versus En for Pu 241 where we are looking for precision in the measurement and at the same time seeking for fine structure. We received EANDC(OR)67A just before the meeting and note that to the accuracy sought (5%) the requirement is fulfilled. Nevertheless we are continuing to improve the accuracy.

It should be possible in due course to extend the measurements to include Pu 239 and possibly Pu 240.

(d) <u>Neutron Capture Studies</u>

Two experiments utilising different techniques and applicable to different mass regions are active at Lucas Heights:

(i) Averaged partial widths of nuclei with 10 - 100 eV resonance spacing are determined using broad (60 nsec) pulsing and a Ge(Li) detector system.

Time-of-flight and gamma ray data are stored and analysed by a PDP-7 computer, programmed to set up digital windows on the time-of-flight spectrum and to take simultaneously up to six gamma ray spectra of 1024 channels.

Preliminary spectra obtained with a 5 kg natural mercury target required several days to resolve gamma ray peaks from the background. This background is due to thermal capture in the Ge(Li) diode and is time independent. The poor yield rate requires the selection of future targets which give strong high energy gamma rays on neutron capture.

(ii) Resonances of light nuclei can be resolved using a ten nanosecond pulsed beam and a large NaI crystal. Two parameter analysis with the PDP-7 allows the observation of gamma ray spectra from each resonance, to provide data on spins and parities and the spin dependence of resonance spacing. Natural iron and Fe56 are currently under investigation.

(iii) We also have studies being carried out in association with Australian Universities (Melbourne and Townsville). Thermal neutron beams from our high flux reactor HIFAR are being used to obtain spectra using a germanium detector. An angular correlation rig is under development.

(iv) Using the Betatron at Melbourne University, measurements are under way to determine Γ_γ for the 132 eV resonance of cobalt. A Moxon-Rae detector is being used and is presently under test.

(v) Another group at the same University is conducting a comparison of (γ,n) and (n,y) reactions. The project has just begun and an effort will be made to find low energy neutrons from the (γ,n) reaction and to carry out a detailed comparison with the inverse reaction using the same neutron energies.

To date the efforts in each of these projects have largely concentrated on detector technique development. Enough runs have been done on (i) and (ii) to show that we have a promising programme but work is far from complete. Emphasis has been on gamma ray spectra but interest exists in cross section work. The need is for some improvements in facilities to make increased work worthwhile.

(e) ORNL keV Capture Spectra and Compilation

The group at ORNL carried out measurement of spectra for more than 20 elements and separated isotopes. Dr. Bird of our laboratory was in ORNL at that time. Less than half the results have been reported and the results show many interesting features which differ from the thermal capture data. They should be finalized, published and eventually should be placed into a compilation of "Resonance Capture Spectra".

At present there seems to be difficulty in the compilation of thermal capture spectra, in part perhaps because the advent of the germanium detector has produced a great burst of activity in this field. We are already contributing to "Slow Neutron Capture Gamma Ray Newsletter" and consider it valuable. We believe it might be possible to arrange compilation on a similar basis, each participating group treating a few nuclei. If such a scheme can be put into effect we would be willing to consider active participation through our group.

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