

INTERNATIONAL NUCLEAR DATA COMMITTEE

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Report on Australian Activities, May 1969-May 19701. Data Sources for A.A.E.C. Library

CINDA continues to be used by experimental and theoretical teams as a starting point in the search for information to be used in planning and analysis of experiments and in the assessment of theoretical models for use in evaluation work. The rate at which its revisions and supplements are produced is accepted as reasonable. Earlier requests to the Nuclear Data Section for cross section information have now been met as the data files became available.

2. Evaluation of Nuclear Data(a) Fission Product Data Compilation

The capture and total cross sections for 190 fission products have been evaluated using resolved data where available, statistical theory and the optical model, the evaluation covering the energy range from .001 e.V. to 15 M.e.V. The results are being prepared in the format of the U.K.A.E.A. Nuclear Data File and will be transmitted to the I.A.E.A. Nuclear Data Section. About 15,000 data points are involved. In an attempt to assess the reliability of the estimates of unmeasured data, the theoretical predictions were compared with experiments where they were available and the maximum deviations were found not to exceed 20%.

It is planned to use the data for carrying out an assessment of fission product chain poisoning in fast as well as thermal reactor systems. From the results pseudo fission product data will be prepared in multi-group form for use in reactor codes.

(b) Fission Physics

Monte Carlo calculations of the energy and angular distributions of the light nuclei emitted in spontaneous ternary fission of ^{252}Cf have been performed. Classical mechanics and a three point charge model of the scissioning nucleus are used. For α -particle emission, excellent agreement with measured energy and angular distributions was obtained with initial conditions at the instant of α -particle release given by

velocity of heavy fragment = 3.75×10^8 cm/sec.

average energy of α -particle = 2.75 MeV

distance between heavy fragments = 23.7 fermi.

Calculations have been made of the energy required to release various light nuclei in ternary fission of ^{252}Cf , averaging over the mass distribution.

The trend is for the amount of energy required to vary reciprocally as the relative frequency of occurrence of the particular mode and work is proceeding in an attempt to establish a simple relationship between the two variables.

(c) Multilevel Analysis

A multilevel scattering formalism incorporating resonance-resonance interference has been developed which differs in some respects from the Adler-Adler theory. Satisfactory agreement with experimental information is achieved for ^{23}Na , ^{197}Au and ^{235}U . A report on the formalism is in preparation.

(d) Analysis of (n,2n) Cross Sections

The statistical model has been used to derive an expression for the (n,2n) excitation function above the (n,3n) threshold, taking into account mutual competition between the two processes. The resulting agreement with experiment supports the suggestion of Menlove et al. (1967, Phys. Rev. 163, 1308) for improving Pearlstein's (1965, Nucl. Sci. & Engr., 23, 238) analytical treatment of the competition.

3. Measurement Programme(a) Fission Measurements

Measurements of prompt nuubar for ^{233}U and ^{235}U have been completed for neutron energies ranging from 0 to 2 M.e.V. and for ^{239}Pu up to 1 M.e.V. For all isotopes the energy dependence is found to be linear with a change of slope at the pairing energy. Evaluation of data taken at A.A.E.C. together with data reported elsewhere gives the following expressions (all relative to $\bar{\nu} = 3.782$ for ^{252}Cf)

$$\begin{aligned}
 ^{233}\text{U} \quad \bar{\nu}_p &= (2.491 \pm 0.007) + (0.035 \pm 0.026) E_n & E_n < 0.44 \text{ M.e.V.} \\
 &= (2.453 \pm 0.008) + (0.122 \pm 0.007) E_n & 0.44 < E_n < 5 \text{ M.e.V.} \\
 ^{235}\text{U} \quad \bar{\nu}_p &= (2.416 \pm 0.004) + (0.107 \pm 0.004) E_n & E_n < 1.95 \text{ M.e.V.} \\
 &= (2.373 \pm 0.014) + (0.129 \pm 0.004) E_n & 1.95 < E_n < 5 \text{ M.e.V.} \\
 ^{239}\text{Pu} \quad \bar{\nu}_p &= (2.890 \pm 0.005) + (0.115 \pm 0.016) E_n & E_n < 1.19 \text{ M.e.V.} \\
 &= (2.847 \pm 0.023) + (0.151 \pm 0.006) E_n & 1.19 < E_n < 5 \text{ M.e.V.}
 \end{aligned}$$

These data are in qualitative agreement with expectation from the double humped fission barrier model.

Measurements have been completed of ν as a function of fission fragment mass and total fragment kinetic energies for thermal fission in ^{235}U . The results obtained are in agreement with the earlier (1967) results of Maslin et al. A series of experiments which will include the dependence on nuclear charge of the fission fragments is beginning.

A Ge(Li) detector has been used to measure gamma rays in delayed coincidence with ^{252}Cf fission fragments. A search was made for gamma rays associated with the half lives of tens of microseconds reported for thermal fissions of ^{235}U and ^{239}Pu . These were not observed above the background but half lives of several microseconds were observed. Analysis of the experiment is continuing.

(b) Neutron Capture Gamma Ray Studies

Following completion of a compilation of k.e.V. neutron capture results for A=40-70 (Bird, Allen and Kenny (1969, B.A.P.S. 14, 1237) work has continued on analysis and interpretation of these results.

For Calcium the transitions observed give evidence for at least five resonances in ^{40}Ca and one each in ^{42}Ca and ^{44}Ca in the neutron energy range 10-100 k.e.V. Since many of these resonances are not observed in transmission measurements they must have small neutron widths and it is likely that both p and d wave resonances are present. Contributions from p and d waves are also suggested from the measurements for Zinc which have been repeated with improved resolution and background.

Preliminary measurements have been carried out for capture in Barium, Strontium, Yttrium and Zirconium, but analysis of these is not complete.

The thermal capture facility has been modified and transferred to a beam line viewing the graphite reflector of the A.A.E.C. HIFAR reactor. In association with the University of Townsville the facility is being used for angular correlation measurements of cascade gamma rays in copper and zinc.

Proton capture reactions can be useful in establishing the performance of gamma ray detectors, and measurements of this type in association with the Universities of Melbourne and N.S.W. have been extended to provide an improved understanding of the reactions involved. A yield curve has been measured for the reaction $^{27}\text{Al}(p,\gamma)^{28}\text{Si}$ over the proton energy range from 2.45 to 2.9 M.e.V. and angular distributions measured for cascade gamma rays from some of the resonances in that range.

(c) Additional Measurement Facilities

Civil engineering construction work has begun on a split table critical facility which should be in operation towards the end of 1971. After commissioning it is proposed that the facility will initially be used for a series of clean critical experiments covering a wide range of Plutonium Graphite ratios. These should serve as a set of benchmark experiments with which Plutonium data can be assessed.