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REPORT TO THE DOE NUCLEAR DATA COMMITTEE,
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MASTER

A. NUCLEAR DATA APPLICATIONS-MEASUREMENTS1. Branching Ratio in the Decay of ^7Be (Mathews, Haight, Lanier and White)

Recently it has been suggested¹ that the ^7Be electron-capture branch to the ^7Li first excited state may be considerably larger than the presently adopted value of $10.4 \pm 0.1\%$. This would imply lower cross sections for reactions producing ^7Be which have been determined by the 478-keV gamma rays from this decay. Particularly important is the $^3\text{He}(\alpha, \gamma)^7\text{Be}$ reaction, a critical link in the p-p chain leading to the production of solar neutrinos. We have measured this branching ratio by implanting a ^7Be beam² into a silicon surface-barrier detector telescope and counting the subsequent gamma decays. We obtain a preliminary value of $10.7 \pm 0.4\%$ consistent with the adopted value.

2. Kerma Factor for Carbon at $E_n = 14.1$ MeV (Haight, Grimes,* Johnson,** and Barschall***)

The kerma factor (kinetic energy of charged particles per neutron/cm²) for carbon has been determined at $E_n = 14.1$ MeV by measuring the $G(n, \alpha)$ cross section and the angular distribution of the alpha-particle emission spectra with a magnetic quadrupole charged-particle spectrometer. By combining these results with evaluated cross sections for elastic and discrete inelastic scattering, we infer the kerma factor to be $1.9 \pm 0.1 \cdot 10^{-11}$ Gy cm². This value is less than that in a recent compilation³ by 15%.

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¹ C. Rolfs, BAPS, 27, 748 (1982).

² R. C. Haight, G. J. Mathews, R. M. White, L. A. Aviles, and S. E. Woodard, Nucl. Instrum. and Methods (in press).

³ R.S. Caswell, J. J. Coyne, and M. L. Randolph, Radiation Research 83, 217 (1980).

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3. Photoneutron Cross Sections with Monoenergetic Photons (Berman, Woodworth, Jury,* McNeill,** Pywell,*** Thompson****)

We have completed the analysis of our 1980 measurements at the LLNL Electron-Positron Linear Accelerator. The $^{15}\text{N}(\gamma, n)$ data (cross section and average photoneutron energy) are presented in Ref. 4, the $^{16}\text{O}(\gamma, n)$ data in Ref. 5, and the $^{28}\text{Si}(\gamma, n)$, $^{29}\text{Si}(\gamma, n)$, $^{30}\text{Si}(\gamma, n)$, and $^{30}\text{Si}(\gamma, 2n)$ data in Ref. 6. Data have been obtained for ^{14}C in 1982, on a 35-Ci sample of elemental ^{14}C , in the giant-resonance region; and measurements are scheduled in early 1983 for the pygmy-resonance region on a combined sample of the above and a 50-Ci sample of $\text{Ca}^{14}\text{CO}_3$. This experiment will complete the series of total photoneutron cross-section measurements on the carbon, nitrogen, and oxygen isotopes performed at LLNL^{4,5,7}.

4. Neutron Differential Scattering Measurements in the Energy Range $14 < E < 38$ MeV (Hansen, Pohl, Wong, Poppe)

Elastic and inelastic differential cross sections have been measured for ^{93}Nb , ^{115}In , ^{140}Ce and ^{197}Au at 14.6 MeV. The purpose of these measurements is to fill wide gaps that exist in the data base of elastic neutron scattering. Together with our previously reported data,⁸ these measurements will allow us to obtain a more complete comparison between measurements and calculations in the region $9 < A < 238$.

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⁴ J. W. Jury et al., Phys. Rev. C 26, 777 (1982).

⁵ B. L. Berman et al., Phys. Rev. C 27, 1 (1983).

⁶ R. E. Pywell et al., Phys. Rev. C (in press).

⁷ J. T. Caldwell et al., Phys. Rev. Lett. 15, 976 (1965)--(160); S. C. Fultz et al., Phys. Rev. 143, 790 (1966)--(12C); B. L. Berman et al., Phys. Rev. C 2, 2318 (1970)--(14N); J. G. Woodworth et al., Phys. Rev. C 19, 1667 (1979)--(18O); J. W. Jury et al., Phys. Rev. C 19, 1684 (1979)--(13C); and J. W. Jury et al., Phys. Rev. C 21, 503 (1980)--(17O).

⁸ Hansen, Pohl, Poppe, Wong, Dietrich, BAPS 27, 721 (1982).

We have also started a program of high energy neutron elastic differential cross sections using the $^3\text{H}(d,n)^4\text{He}$ reaction and deuterons with energies $3 < E_d < 20$ MeV from the LLNL Cyclograaff facility. Preliminary measurements have been carried out for C, Fe and U at 26 and 29.5 MeV.

5. The Half-life of ^{77}Kr (Momyer, Fontanilla, Nagle, Prindle)

We produced about 8×10^5 Bq of ^{77}Kr for a half-life determination by irradiating enriched ^{78}Kr (99.1%) with 14 MeV neutrons at the Livermore ICT Facility. The decay of ^{77}Kr was followed in portions of the sample using thin-window, proportional counters for gross beta activity, Ge(Li) detectors for individual gamma rays (principally the 130-keV gamma), and a sodium iodide (NaI) detector for integral gamma count.

Useful data were obtained through more than ten half-lives and were analyzed for the ^{77}Kr half-life using an iterative least-squares program called Peanuts. The results are in Table A-1.

TABLE A-1. Peanuts' results for ^{77}Kr half-life

Sample	Counter	Half-life (minutes)	Error Estimate (%)
1	Beta # 1	71.219	.09
2	Beta # 1	71.245	.08
3	Beta # 2	71.129	.08
4	Beta # 2	71.128	.10
5	Ge(Li) #1	70.827	.10
6	Ge(Li) #2	71.158	.08
7	NaI	71.003	.10
Average		71.101 $\pm$ 0.20%	

The error attached to the average is the standard deviation of a measurement estimated from the results. Our best value for the half-life of ^{77}Kr is 71.10 ± 0.14 minutes. The present literature value is 74.7 ± 0.7 minutes.⁹

6. Stellar Neutron Capture Rates for $^{86,87,88}\text{Sr}$ (Mathews, Becker, Howe)

Neutron capture cross sections from 1 to 200 keV have been measured for $^{86,87}\text{Sr}$ (and are underway for ^{88}Sr) using the Livermore electron linac as a neutron source. These cross sections are being utilized to study the s-process branching through ^{85}Kr as a monitor of the neutron capture rate during the s-process, and also to study the ^{87}Rb , ^{87}Sr chronometric pair as an independent measure of the age of

⁹ I. Borchert, Zeit. Phys. 244, 338 (1971).

the galaxy. Preliminary analysis indicates a neutron-capture lifetime of 15 years for a 30 keV s-process, and a galactic age consistent with other chronometers.

7. Neutron Total Cross Sections from 2.5 to 60 MeV (Phillips, White, and Camarda*)

Precision neutron total cross sections have been measured over a wide energy range for investigations of the optical model. We have completed measurements on four nuclei near mass-140, ^{139}La , ^{140}Ce , ^{142}Ce , and ^{141}Pr , and begun a study of the isotopes of calcium.

The first step in our analysis of these data was to obtain phenomenological optical model potentials which reproduce the energy dependence of the cross sections. We have also begun calculations of the optical potentials from a microscopic viewpoint using a folding model to infer the nuclear matter distributions from the data. We use two approaches to determine the effect of the nuclear medium on the force between nucleons: that suggested by Brieva and Rook,¹⁰ which produces a density dependent interaction and that proposed by Jeukenne, Lejeune, and Mahaux,¹¹ which directly gives the optical potential. Preliminarily, we find better agreement with the second approach.

8. $^{142},^{143},^{144}\text{Nd}$ Neutron Capture Nucleosynthesis and the Origin of Meteoritic Isotopic Anomalies (Mathews, Käppeler**)

In order to better understand the origin of meteoritic abundance anomalies and the neutron capture nucleosynthesis of Nd isotopes, neutron capture cross sections have been measured for $^{142},^{143},^{144}\text{Nd}$ using the Kernforschungszentrum-Karlsruhe pulsed Van de Graaff proton beam to generate neutrons of 1-250 keV from the $^7\text{Li}(p,n)$ reaction. Stellar synthesis, 30-keV Maxwellian-averaged capture cross sections of 62 ± 6 , 298 ± 28 , and 154 ± 8 mb have been derived for ^{142}Nd , ^{143}Nd , and ^{144}Nd respectively.

These new cross sections indicate the following: For ^{142}Nd , the cross section indicates an enhanced N_0 value for this nucleus in the s-process, which may result from alpha-particle recycling. The new higher ^{144}Nd cross section is more consistent than previous values with the expected mix of s- and r-process material for this isotope. The new cross sections tend to confirm the origin of Nd meteoritic anomalies to be due to a unique r-process-like event.

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¹⁰ F. A. Brieva and J. R. Rook, Nucl. Phys. A291, 317 (1977).

¹¹ J. P. Jeukenne, A. Lejeune, and C. Mahaux, Phys. Rev. C 16, 80 (1977).

9. Measurement of the Half-life of ^{163}Ho (Baisden, Sisson, Niemeyer, Hudson, Bennett,* Naumann*)

In a continuing effort to explore the electron-capture (EC) decay properties of ^{163}Ho as a probe of neutrino mass, we have measured a half-life of 4570 ± 50 years (95% confidence level) for ^{163}Ho using isotope dilution mass spectrometry. This holmium isotope is of interest because its electron-capture Q-value ($Q_{\text{EC}} = 2.6 \pm 2.1$ keV), though quite uncertain, is unusually small.¹² As a result, only EC from M (2.05 keV) or higher electron shells is energetically feasible, thus leaving only about 600 eV of energy for the emerging neutrino.

From the measured value of the half-life we infer an EC Q-value of 2.65 keV using known atomic physics factors and an estimate of the nuclear matrix element based on the systematics of EC ft values for the $7/2[523]$ to $5/2[523]$ electron capture transition of other Ho isotopes. The estimate of the nuclear matrix element is the dominant source of uncertainty in Q_{EC} and an uncertainty of $\pm 30\%$ in the matrix element corresponds to a Q_{EC} range of 2.45 to 2.90 keV.

10. Properties of Thermal-Neutron Fission of Long-Lived ^{236}Np (Lindner, Seegmiller**)

Approximately four nanograms of ^{236}Np ($^{237}\text{Np}/^{236}\text{Np}$ atom ratio = 0.272) and 60 nanograms of ^{235}U were irradiated in a stacked-foil arrangement for about seven hours in the core of the Livermore Pool-Type Reactor (LPTR). Following irradiation, no chemical separations were made; instead, the gamma-ray spectra were followed frequently for about six months, and the resultant gamma-ray photopeaks of all spectra were analyzed with the GAMANAL peak-shape fitting program.¹³

Thirty-seven fission products were identified from the decay of the observed photopeaks. The fission-product mass-yield curve was constructed by two independent methods: a) by comparison of the ^{235}U and ^{236}Np fission product photopeak intensities together with the published

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¹² C. M. Lederer and V. S. Shirley, Eds., Table of Isotopes, 7th ed., Wiley, New York (1978).

¹³ R. Gunnink and J. B. Miday, Lawrence Livermore National Laboratory, Livermore, CA, UCRL-51061 (1971).

Fig. A-1. Fission-product yield vs. mass for long-lived ^{236}Np .

fission yields¹⁴ of ^{235}U (R-value method); and b) from interpretation of the absolute intensities of the photopeak decay data. The agreement was generally good. The mass-yield curve for ^{236}Np fission obtained by method (a) is shown in Fig. A-1. It appears to show little, if any, of the "fine structure" characteristic of ^{235}U . The shape more closely approximates that of ^{239}Pu thermal fission than that of ^{235}U .

¹⁴ B. F. Rider, NEDO-12154-3C ENDF322 (1981).

We have carefully examined the data for independent yields in the isobaric pairs $^{92}\text{Sr} - ^{92}\text{Y}$, $^{105}\text{Ru} - ^{105}\text{Rh}$, $^{131}\text{Sb} - ^{131}\text{Te}$, $^{133}\text{I} - ^{133}\text{Xe}$, $^{135}\text{I} - ^{135}\text{Xe}$, and $^{140}\text{Ba} - ^{140}\text{La}$. No evidence for independent yields of ^{92}Y , ^{105}Rh , ^{135}Xe , or ^{140}La could be found within the calculated uncertainties of the data.

Independent yields of ^{131}Te and ^{133}Xe were a larger fraction of the chain yield for ^{236}Np than for ^{235}U . These yields, together with a 20-fold higher fission yield for the shielded nuclide ^{136}Ce found in ^{236}Np fission, indicate that, in some modes at least, neutron evaporation--and hence nuclear excitation--is more pronounced in ^{236}Np thermal fission than in ^{235}U .

We have also calculated the thermal fission cross section of ^{236}Np by two methods: a) by comparison with ^{235}U fissions and the known fission cross section of that nucleus, and b) by comparison with the known $^{237}\text{Np}(n,\gamma)$ cross section, the observed ^{238}Np , and the known isotope ratio $^{237}\text{Np}/^{236}\text{Np}$ of the sample. These results are shown in Table A-1.

TABLE A-1. Thermal Fission Cross Section

Comparison Method	Cross Section (b)
$^{235}\text{U}(n,f)$	$1.90 \cdot 10^3 (\pm 7.6\%)$
$^{237}\text{Np}(n,\gamma)^{238}\text{Np}$	$1.74 \cdot 10^3 (\pm 2.9\%)$

Our values may be compared to that of Gindler, et al.,¹⁵ who reported a thermal fission cross section of $(2.54 \pm 0.46) \cdot 10^3$ barns. The cross sections used for $^{235}\text{U}(n,f)$ and $^{237}\text{Np}(n,\gamma)$ are valid only for a truly thermalized neutron spectrum. The extent to which the spectrum in the core of the LPTR differed from an ideal thermal spectrum introduces uncertainties not reflected in the above estimates. Thus the agreement among the three reported values seems generally satisfactory.

¹⁵ Gindler, Glendenin, Krapp, Fernandez, Flynn, and Henderson, J. Inorg. Nucl. Chem. 43, 445 (1981).

11. Revised Branching Ratios in ^{237}U and ^{238}Pu Decays (Ruhter, Camp)

The gamma-ray branching intensity value used for the ^{238}Pu , 152.68-keV gamma ray is reported to be $(9.56 \pm 0.20) \times 10^{-6}$.¹⁶ We have remeasured¹⁷ this value to be $(9.32 \pm 0.08) \times 10^{-6}$. Several other references^{18,19} also report a reduction in this branching intensity.

The gamma-ray branching intensity value used for the ^{237}U , 164.58-keV gamma-ray is reported to be $(4.53 \pm 0.10) \times 10^{-7}$.¹⁶ This value has been remeasured and determined to be $(4.67 \pm 0.04) \times 10^{-7}$.^{19,20}

¹⁶ R. Gunnink, J. Evans and A. Prindle, "A Reevaluation of the Gamma-Ray Energies and Absolute Branching Intensities of ^{237}U , $^{238,239,240,241}\text{Pu}$, and ^{241}Am ," UCRL 52139 (1976).

¹⁷ W. Ruhter and D. Camp, "A Portable Computer to Reduce Gamma-Ray Spectra for Plutonium Isotopic Ratios," UCRL 53145 (ISPU-134) (1981).

¹⁸ J. Fleissner, J. Lemming, and J. Jarvis, "Study of a Two-Detector Method for Measuring Plutonium Isotopics," Proceedings of the ANS Conference, Analytical Methods for Safeguards and Accountability Measurements of Special Nuclear Materials, NBS 528 (1978).

¹⁹ H. Ottmar, "Results from an Interlaboratory Exercise on the Determination of Plutonium Isotopic Ratios by Gamma Spectrometry," KfK 3149, ESARDA 1/81 (1981).

²⁰ W. Ruhter, to be published.

12. Levels of ^{244}Cm Populated by the Beta Decay of 10-hour ^{244}Am and 26-minute $^{244\text{m}}\text{Am}$ (Hoff, von Egidy,* Lougheed, White** Börner,*** Schreckenbach,*** Warner,**** Barreau*****)

We have measured gamma ray and conversion-electron spectra for the ^{244}Am beta decay isomers in ^{243}Am targets undergoing neutron capture in the High Flux Reactor of the Institut Laue-Langevin at Grenoble. Six new gamma transitions are assigned to the beta decay of 26-min $^{244\text{m}}\text{Am}$, including a prominent E0 transition (984.92 keV) that depopulates an excited 0^+ state in ^{244}Cm . This is the first observation of an excited 0^+ state in ^{244}Cm . The experimental observations for this transition are four electron peaks from conversion in the K, L_I , M_I , and N_I shells of curium. The observed ratio of L_I/K conversion = 0.21 ± 0.03 agrees well with theoretical values of 0.184²¹ and 0.195.²² Consistent with the placement of this E0 transition is the observation of a 941.95-keV gamma ray that is assigned as an E2 transition populating the 43-keV 2^+ level. Four other transitions, all with energies above 1 MeV, are assigned to the de-excitation of new levels in ^{244}Cm at 1084 and 1106-keV (see Fig. A-2).

The experimental value for the ratio of reduced transition probabilities from the 984.91-keV level, $X \equiv B(E0; 0_2^+ \rightarrow 0_1^+)/B(E2; 0_2^+ \rightarrow 2_1^+) = 2.1 \pm 0.7$, is larger than other experimental X values for 0_2^+ states in the actinide region, the average of which is 0.25. Rasmussen²³ has demonstrated that for collective vibrations of deformed nuclei (beta vibrations), one expects values of $X = 0.2$. On the other hand, larger values of X have been determined experimentally and produced in calculations for more highly excited 0^+ states in the actinides. The 984.91-keV level in ^{244}Cm is apparently the first excited 0^+ state in ^{244}Cm since we can set limits of no more than 10-15% of the observed beta decay to lower-lying 0^+ states (except the ground state). This level is distinctive because of its large X value relative to other 0_2^+ states in the actinide region. A more detailed description of its nature will require additional experimental and theoretical treatment.

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²¹ D. A. Bell, C. E. Avelledo, M. G. Davidson, and J. P. Davidson, Can. J. Phys. 48, 2542 (1970).

²² R. S. Hager and E. C. Seltzer, Nucl. Data Tables A6, 1 (1969).

²³ J. O. Rasmussen, Nucl. Phys. 19, 85 (1960).

Fig. A-2.

Levels of ^{244}Cm from gamma transitions accompanying beta decay of ^{244}Am isomers. Transition intensities ($I_{\gamma} + I_{ce}$) per 100 neutron captures are listed following gamma-ray energies and multiplicities.

B. NUCLEAR DATA APPLICATIONS-CALCULATIONS

1. Systematic Test of Microscopic Optical Models for Nucleon Scattering in the Range 7-60 MeV (Dietrich, Hansen, Phillips, Pohl, Poppe, Wong, Petrovich,* Mellema,** Finlay**)

In order to improve our ability to calculate elastic neutron scattering on targets for which direct measurements are difficult or impossible, we have undertaken a systematic study of microscopic optical models that relate nucleon scattering to the nuclear density and a realistic nucleon-nucleon interaction. The two principal models that have been tested in the range 7-60 MeV are those of Brieda and Rook¹ (BR), and Jeukenne, Lejeune, and Mahaux² (JLM). In both of these models, the results of nucleon-scattering calculations in nuclear matter at various densities are applied to finite nuclei by making a local-density approximation. The models have been tested against 14-MeV neutron angular distributions and total cross sections over a wide mass range and also neutron data on ⁵⁴Fe, ⁵⁶Fe, and ²⁰⁸Pb in the range 7-26 MeV; new angular distributions in the range 20-26 MeV were measured on ²⁰⁸Pb and the Fe isotopes in collaboration with Ohio University. The isospin properties of the models have been tested by including proton-scattering data in the analysis. Total neutron cross sections in the range 5-60 MeV for ¹⁴⁰Ce have also been calculated and compared with experiment (see Sec. A.7).

When the strengths of the calculated real and imaginary potentials are adjusted with normalizing parameters, it is found that both models yield reasonable comparisons with the shapes of the angular distribution data. In nearly all cases, the normalizing parameters lie in the ranges 1.0 ± 0.1 and 1.0 ± 0.3 for the real and imaginary potentials, respectively. The energy- and mass-dependence of the imaginary normalizing parameter is much weaker for the JLM than the BR model. Total neutron cross sections are reproduced more accurately by the JLM than the BR model; however, this is partly due to an extra parameter in the JLM model that adjusts the r.m.s. radius of the potentials. The comparison of neutron and proton scattering on ²⁰⁸Pb shows that, when Coulomb effects are treated properly, the BR model is isospin consistent; i.e., at each energy the same normalizing parameters apply to scattering of both projectiles. Figure B-1 shows a comparison of the calculated and measured³ elastic scattering cross sections at 14.6 MeV.

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¹ F. A. Brieda and J. R. Rook, Nucl. Phys. A291, 299,317 (1977).

² J. P. Jeukenne, A. Lejeune, and C. Mahaux, Phys. Rev. C 16, 80 (1977).

³ L. F. Hansen, B. Pohl, and C. Wong, Lawrence Livermore National Laboratory report UCID-15987 (1982).

Fig. B-1. Comparison between the 14.6 MeV neutron elastic scattering measurements and calculations carried out with the JLM, and BR microscopic optical potentials.

2. Lanczos Method Shell-Model Calculations of Gamow-Teller Strength Functions (Bloom, Mathews, Aron, Fuller,* Hausman**)

A method has been developed for calculating the Gamow-Teller (GT) strength function for complex nuclei based on the Livermore system of vector method codes. The essence of the technique is to construct a collective GT state vector, $|CGT\rangle$, by applying the GT operator to the parent ground state. A basis of daughter states is then constructed by applying a suitable two-body operator (e.g. double isospin flip, spin flip or J^2) to the $|CGT\rangle$. Finally this basis is diagonalized via a suitable number of Lanczos iterations with a Hamiltonian which includes a realistic finite-range nucleon-nucleon force. The GT strength function is then projected out of these daughter states.

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We have calculated the GT strength function for ^{90}Zr . In this calculation ground-state correlations were introduced via a pairing Hamiltonian, and the basis of daughter states (12,535 uncoupled Slater determinants) was generated by successive operations with the T^2 and J^2 operators. The experimental structure and widths are well reproduced for excitation energies < 16 MeV. In addition there is evidence for strength at high energies (16-25 MeV) which may have been observed experimentally but, at the moment, is tentatively assigned to $L = 1$. Similar calculations have also been done which allow for 2-particle, 2-hole excitations in ^{56}Fe and ^{54}Fe .

Calculations have also been done for nuclei of interest in astrophysics. For example, the GT electron-capture rates for nuclei near ^{58}Fe have been calculated. The new rates significantly decrease the rate of neutronization during gravitational collapse of a massive star. This has led to successful computations⁴ of core-bounce supernovae scenarios. Efforts have also been underway to calculate the GT beta-decay rates of very neutron-rich heavy nuclei such as ^{95}Rb and ^{130}Cd which are of interest in r-process nucleosynthesis.

3. Explosive Nucleosynthesis and Direct Radiative Capture Rates (Mathews, Dietrich, Mengonni,* Thielemann,** and Fowler***)

In explosive astrophysical environments involving rapid neutron (r-process) or proton (rp-process) capture, the capture reactions may involve low Q values (< 1 MeV), and few (or no) compound nuclear resonances. In this case, the nuclear statistical-model assumptions usually applied are not valid and the reaction rates may be more appropriately described by a direct radiative capture (DRC) mechanism. We have made global calculations of DRC rates for neutron and proton reactions with nuclei far from the line of beta stability. One such comparison is shown in Fig. B-2 which shows DRC Maxwellian averaged neutron capture cross sections compared with two different Hauser-Feshbach estimates. The calculations include nuclei near beta stability, out to, and beyond the r-process peak at $A = 130$, $N = 82$. Near the r-process path the DRC cross sections become comparable to or greater than the statistical-model estimates and hence should be included in network calculations. Since the DRC rates can also be taken as a lower limit, we utilize this limit to infer a critical neutron density of $\rho_n > 1.5 \times 10^{-20} \text{ cm}^{-3}$ above which $(n, \gamma) \rightleftharpoons (\gamma, n)$ equilibrium is guaranteed in the r-process at any temperature.

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⁴ T. A. Weaver, S. E. Woosley, and G. M. Fuller, *BAAS* **14**, 957 (1983).

Fig. B-2. Maxwellian-averaged neutron-capture cross sections for cadmium isotopes calculated with the direct radiative capture model and two Hauser-Feshbach, statistical models.

4. Calculation of Fission Cross Sections (White)

We have completed a computer code, FISCAL, employing Hauser-Feshbach theory, to calculate the fission cross sections over the energy region of the fission neutron spectrum, from ~ 100 keV to ~ 5 MeV. In this energy region many of the fissile actinides have 'macroscopic' structure as seen, for example, in the $^{235}\text{U}(n,f)$ and $^{245}\text{Cm}(n,f)$ cross sections around 1 MeV neutron energy. We have applied the code to these two nuclei to investigate this structure around 1 MeV as well as the general shape and magnitude of the fission cross section in the energy range from 100 keV to 5 MeV. The code allows flexible input of neutron transmission coefficients, discrete levels and level density representations of both the residual and compound nuclei. Also included are

discrete levels and level density representations of fission transition states at both barriers of a double-humped fission barrier. Results and conclusions of our calculations of the $^{235}\text{U}(n,f)$ and $^{245}\text{Cm}(n,f)$ cross sections have been reported.⁵

C. NUCLEAR DATA APPLICATIONS-EVALUATIONS

1. Evaluated Data Libraries (Howerton)

During the past year ENDL82, ACTL82, and ECPL82 were prepared and distributed. ENDL82 is the 1982 version of the LLNL Evaluated Neutron Data Library. ACTL82 is the 1982 version of the LLNL Evaluated Neutron Activation Data Library. ECPL82 is the 1982 version of the LLNL Charged Particle Data Library.

Considerable modifications are made to all these data files. Complete evaluations for six new materials were added to ENDL ($^{74,75}\text{As}$, $^{88,89}\text{Y}$, ^{233}Pa , ^{237}Pu); over two hundred activation cross sections were added to ACTL; six new reactions and Maxwell-averaged average energies for residuals and reacting particles were added to ECPL. Since ENDL now contains explicit energy distributions for all secondary particles ($Z \leq 2$, $A \leq 4$), it is possible to check for total energy imbalances. A code (GAMCHK) was written to do the checking and total photon production cross sections were assumed to be the source of any imbalance. The photon production cross section was modified to insure total energy balance within 10% if the imbalance was greater than 100 keV. If the imbalance was less than 100 keV, it was ignored.

Documentation of the code (OMEGA) is in the final stages and will be published before mid-1983. OMEGA controls nine codes that update, plot, list in convenient form, make calculational constants for S_n , Diffusion and Monte Carlo codes and produce standard data files of the calculational constants using the appropriate evaluated data file.

⁵ R. M. White and J. C. Browne, Proc. Int. Conf. on Nuclear Data for Science and Technology, Antwerp, Belgium (1982) (to be published).