IFC-S1

STATUS REPORT TO THE NEANSC WORKING GROUP ON INTERNATIONAL EVALUATION COOPERATION

from

Subgroup II: Comparison of the Resonance Regions for ^{52}Cr, ^{56}Fe and ^{58}Ni

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PROGRESS SUMMARY

This subgroup was formed at the last meeting of the Working Group as an extension of Subgroup I. It is charged with the task of comparing resonance regions of ^{52}Cr, ^{56}Fe and ^{58}Ni, and understanding reasons for any significant differences. To date, subgroup membership has been established, and activities have begun to understand the basis for each resolved resonance region evaluation, including data used, analysis methods, etc.

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CURRENT ACTIVITIES

The initial investigation was initiated on ^{52}Cr, as significant differences among evaluations of the total cross section in the resonance region for this isotope were illustrated in the invited paper of M. Salvatores at the Juelich Nuclear Data Conference. We start by outlining the resonance region evaluations for ^{52}Cr as presently exist in JEF-2, JENDL-3 and ENDF/B-VI.

1. JEF-2/EFF-2

Documentation for EFF-2 indicates this file is the same as found in JEF-2, so the following comments are taken from the JEF-2 evaluation, obtained from the NNDC at Brookhaven National Laboratory. The file was prepared at ENEA-Bologna by F. Fabbri, G. Maino, E. Menapace, A. Mengoni and G. C. Panini, and completed in February 1989. A note is given that the "resonance param. changed to Reich-Moore formalism" on July 16, 1991. File 1 notes also report that resonance parameters are used in computing the total, elastic and capture cross sections up to 637 keV, and a bound level has been added to reproduce the thermal cross section values. The thermal values given are in exact agreement with Mughabghab, i.e., 2.96b (elastic) and 0.76b (capture), with a resonance integral of 0.47b. Resonance parameters from AL77, BR85 and ST71 were used in the evaluation.

Inspection of File 2-151 shows that the resonance region covers the energy range from 1.e-5 eV to 637 keV. A radius of 5.2 fm is used, and fifteen s-wave resonances are given.

From File 3-1 we find that the total cross section is zero up to 637 keV, where it matches on to the upper limit of the resonance region. No background file is used to supplement the cross section obtained from the resonance parameters.

2. JENDL-3

Documentation of the ^{52}Cr evaluation is given in Report JAERI-1319, which documents the JENDL-3 library. The evaluation for ^{52}Cr was done by T. Asami from NEDAC, and completed in March 1987. The resonance parameters are given as MLBW parameters, and cover the energy range from 1.e-5 to 300 keV. The radius was 5.2 fm, as used in JEF-2, also with fifteen s-wave resonances given. The evaluation used data of ST71, BE75, AL77, KE77, AG84 and BR85. The thermal cross sections are 2.96b (elastic), 0.76b (capture), and 3.72b (total), with a resonance integral of 0.46b, in excellent agreement with JEF-2.

From File 3-1 we find that no background cross section is used from 1.e-5 to 300 keV; the total cross section is obtained from the resonance parameters alone.

3. ENDF/B-VI

Documentation of the ^{52}Cr evaluation is given in BNL-NCS-17541, Summary Documentation for ENDF/B-VI, and in File 1 of the evaluation. Much work was put into obtaining resonance parameters for the chromium isotopes, with less than satisfactory results. We also utilized the resonance parameter results of BR85 and AG84. However, these studies were both primarily done to study statistical properties of resonance parameters, and not to obtain a set of resonance parameters which faithfully reproduces the experimental cross section over a wide energy range. In particular, one region of the data was analyzed, using a set of dummy resonances and a particular value of the radius. When the next energy region was analyzed, the values of the dummy resonances and scattering radius were not kept fixed, but allowed to vary to provide the best fit for that energy region. Thus, when one attempts to use the published "set" of resonance parameters in an evaluation, it is not clear what values of the radius and dummy resonance parameters should be used. For example, RO89 (based on BR85 data) lists the radius used in the analysis as 5.5 ± 0.5 fm.

For ENDF/B-VI evaluation work we did not have the experimental data of BR85, which has higher energy resolution than any other data presently available. Thus, we obtained the $^{52}Cr_2O_3$ ORELA data used in the AG84 analysis, which had lower resolution. As a check on these data, which exist for each chromium isotope, we reduced the Cr_2O_3 transmission data for each isotope to total cross section data (including removal of the oxygen cross section), weighted them by their isotopic abundance, and combined them to obtain "natural" chromium data. These "natural" data were then compared with ORELA 200-m high resolution data taken with a natural chromium sample. As these two sets of data differed by as much as 10%, we compared our 200-m natural Cr data with another 80-m natural Cr ORELA measurement (which used a different Cr sample) covering the energy range from 2-80 MeV. The 200-m and 80-m natural chromium data agreed to better than 2% at overlapping energies, indicating that our 200-m natural chromium data were correct, and the isotopic data used in the AG84 analysis were not. We then renormalized the isotopic 80-m ^{52}Cr ORELA data, and used the BR85 resonance parameters as starting parameters for a SAMMY (Bayesian multilevel R-matrix code with Reich-Moore approximation) analysis, adjusting the s-waves and the radius for a best fit. This work was carried on, together with similar work on the other ORELA Cr_2O_3 isotopic data, in an attempt to get a good fit. With time running out for this part of the evaluation work, we combined the SAMMY fits to the ORELA isotopic data into a natural chromium result, and compared with our 200-m natural chromium data. Figure 1 shows the results from 20 - 100 keV, the primary region of difficulty shown in Salvatores paper. The resulting fit is not comparable in quality to other resonance analysis work done at ORELA on ^{56}Fe and ^{58}Ni. Thermal values are 2.96b (elastic) and 0.75b (capture). Thirty four s-waves are included to represent the data to 980 keV.

To attempt to provide the "best" results for ENDF/B-VI, we chose to obtain a "difference file" between the SAMMY fit and the ORELA ^{52}Cr 80-m data. This difference file was put in File 3-1, and covers the energy range from 20 - 980 keV. From 980 keV to 20 MeV, results of the 200-m natural chromium measurement were used. This insures that above the energy range where deep minima occur, combining the results from the four isotopes will give the correct result for natural chromium.

FUTURE WORK

Further R-matrix analysis work for the chromium isotopes with the existing data base may not be warranted. Availability of the high resolution data used in the BR85 and RO89 analyses would be helpful, but looking at Figure 1 in RO89, the counting statistics may not be adequate for a detailed analysis. At ORELA we are planning on doing a high resolution transmission measurement on a $^{52}Cr_2O_3$ sample from 40 eV to 20 MeV in August. Particular attention will be paid to remove water from the sample, and compensate for the oxygen. Differential elastic scattering data have been taken for ^{52}Cr at six angles, to help determine the spin and parity of resonances. Results of these measurements will be used in a new SAMMY resonance parameter analysis for ^{52}Cr.

Comparison work on the resonance regions of ^{56}Fe and ^{58}Ni from JEF-2, JENDL-3 and ENDF/B-VI will be initiated this summer.

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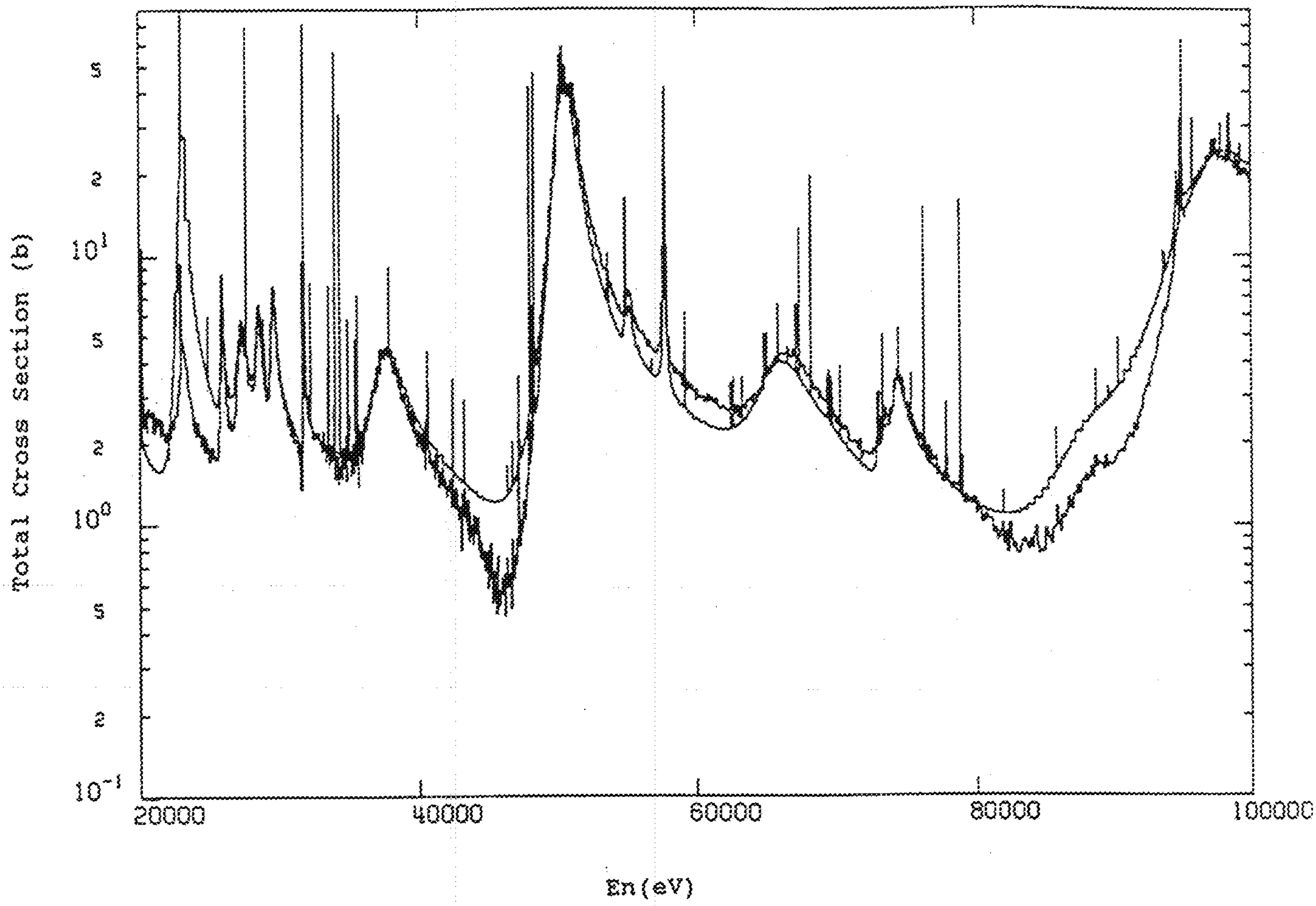

Figure 1. Comparison of ORELA 200-m natural chromium data with SAMMY fit obtained from combining fits to ORELA isotopic data from AG84.