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Evaluation of the resonance region for ^{58}Fe

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Abstract

An evaluation of the resonance parameters for neutrons incident on ^{58}Fe has been carried out in the energy region of resolved resonances. The recommended parameters given in this report reproduce the measured differential cross section and the recommended thermal capture cross section to within the published errors and more closely than the present JEF-2.2 evaluated file.

The spins of the resonances with neutron widths greater than the radiation widths could be derived from the observed capture areas by assuming that the average radiation width of 0.2446 eV did not vary greatly with spin or momentum. Spins and momentum of the remaining resonances were allocated in a random fashion to make up the expected $2J + 1$ spacing distribution and the strength functions. The expected $1/v$ dependence of the capture cross section below the first positive resonance is accomplished by the addition of several negative energy resonances. The radiation width of the first bound level was adjusted to reproduce the evaluated thermal capture cross section of 1.3143 barns and its neutron width adjusted to fit the measured total cross section in the region above ~ 50 eV.

These recommended parameters should only be used to calculate cross sections up to 155 keV.

Between 155 keV and 2 MeV the averaged cross section given in Appendix 2 could be used, and above 2 MeV the recommended values given in the present JEF-2.2 file could be adopted.

One of the problems with this evaluation and previous ones is that $\sim 45\%$ of the calculated value of the total resonance integral of 1.2817 ± 0.0277 barns comes from the first two resonances for which there is effectively only one transmission measurement by Garg et al [Gar-78a] and some preliminary capture measurements by Borella [Bo-04]. New measurements on enriched or natural iron are needed to solve this problem. Another is that there is a correlation between the radiation widths and the neutron widths. This correlation may be genuine or may be due to the detection of scattered neutrons in the γ -ray detectors, and needs investigating.

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Introduction

The present set of resonance parameters in the JEF-2.2 evaluated data file give a thermal capture cross section of 1.2736 barns and a scattering cross section of 2.180 barns of which the positive energy resonances contribution is only 0.1964 barns and 0.1298 barns respectively, the main contributions coming from the two bound resonances at -210 eV and -169680 eV. Adjustment of the bound resonance parameters is required to get agreement with the latest evaluated capture cross section at 0.0253 eV of 1.3143 barns [Ref. Mo-02] and the recommended coherent scattering length of 15 ± 7 fm (a scattering cross section of between 8 and 66 barns). As can be seen in Figure 1 there is also some disagreement with measured total cross section up to energy of a few tens of keV.

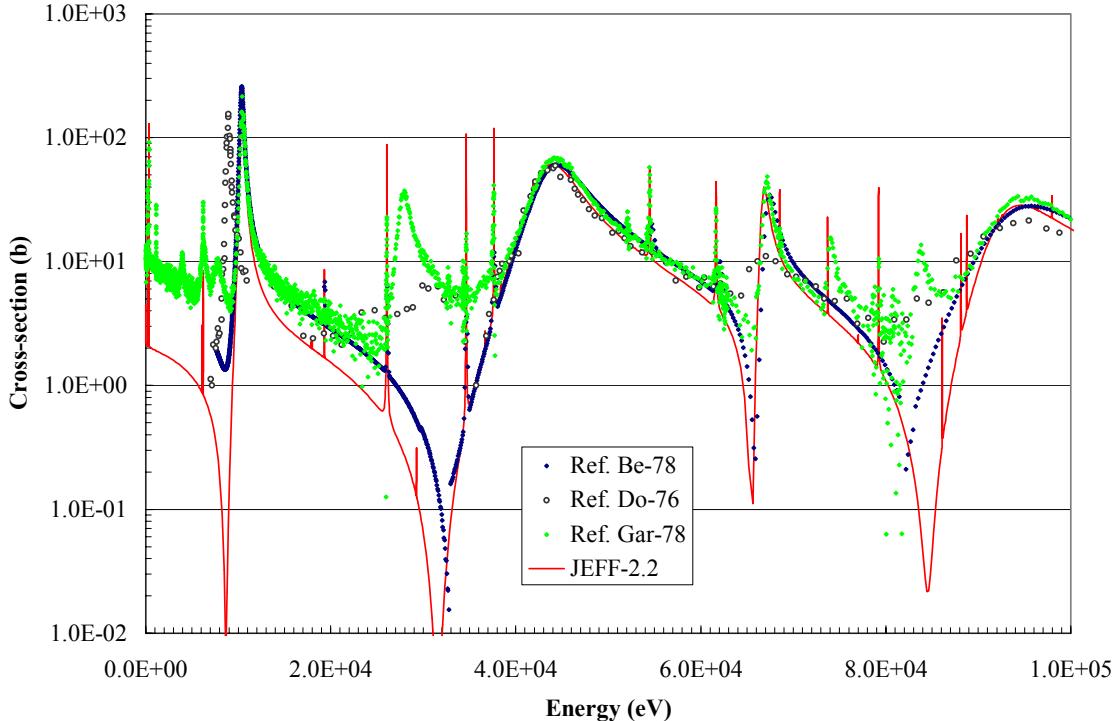


Figure 1: A comparison of the measured total cross section of ^{58}Fe and one calculated using the JEF-2.2 evaluation. A cross section of 5.6415 barns has been subtracted from the data of reference [Gar-78] to account for the oxygen content. The low broad peaks below 10 keV are s-wave resonances in ^{54}Fe and ^{57}Fe . The peaks at 27 keV, 74 keV and 84 keV are due to the s-wave resonances in ^{56}Fe . The cross section from reference [Be-78] appears to have been calculated from the resonance parameters and is not the measured data.

The capture cross section in the energy range below the first positive energy s-wave resonance is expected to follow a $1/v$ dependence. That calculated using the JEF-2.2 evaluation multiplied by the square-root of the neutron energy dips below the constant value expected from a $1/v$ dependence (Figure 2). In reactor calculations using the JEF-2.2 evaluation will give a lower $1/v$ contribution to both the capture cross section and the resonance integral. The comparison of the calculation using the JEF-2.2 resonance parameters with the measured data indicates that a re-evaluation of at least the resonance parameters within a few tens keV either side of zero energy is required.

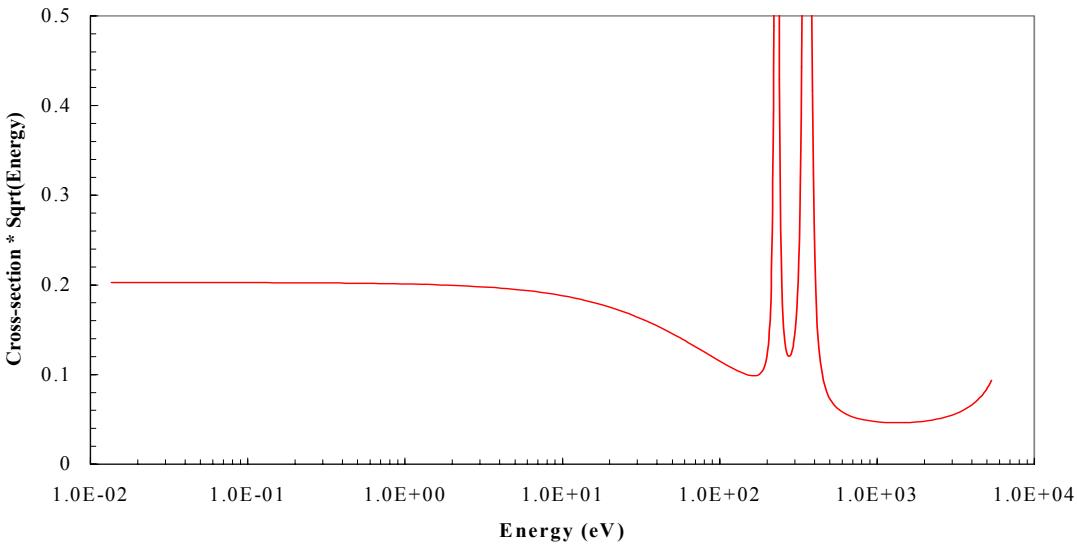


Figure 2: Calculated capture cross section multiplied by the square root of the neutron energy

Available data

Hockenbury et al [Ho-69] state in their paper that the data for ^{58}Fe came only from the natural sample. From the ratio of A_γ to $g\Gamma_n\Gamma_\gamma/\Gamma_t$, given in their Table VII, the natural abundance of ^{58}Fe used in the their analysis was found to be 0.33%, in agreement with the abundance evaluation during 1965 to 1977. The present accepted value for the natural abundance of ^{58}Fe is 0.282%, the correction for the change in abundance is a factor of 1.1702.

230 eV capture area $g\Gamma_n\Gamma_\gamma/\Gamma_t = 6.5 \pm 1.4$ meV, corrected 7.606 ± 1.64 meV

358 eV capture area $g\Gamma_n\Gamma_\gamma/\Gamma_t = 17.0 \pm 5.0$ meV, corrected 20.0 ± 5.9 meV

Allen and Macklin [Al-80] capture measurements used a sample enriched to 82.12% ^{58}Fe and obtained the resonance capture areas from fits to the data. They also carried out some shape analysis where the natural width of the resonances exceeded about five times the resolution width. Only the resonance energies are given for the resonances at 230 and 358 eV. The corrections to the measured capture area for the detection of scattered neutrons for the s-wave resonances are given in their Table II and vary from 21% to 89%. The quoted mean radiation width of 0.36 eV for $J > 0$ is possibly too large as it assumes all the narrower resonances are p-wave ($\langle g \rangle$ equals 1.67). The observed s-wave spacing below ~ 200 keV is ~ 25 keV. Assuming that the resonance spacing follows the $2J + 1$ law, there should be at least ~ 8 s-wave $J = 0.5$, ~ 8 p-wave $J = 0.5$ and ~ 16 p-wave $J = 1.5$, that is a total number of resonances of ~ 32 . Below 200 keV a total of 69 resonances have been observed, seven are known to be s-wave. The difference between the observed and the calculated s- and p-wave contribution is 37. This is slightly lower than the expected number of d-wave of ~ 40 calculated for the d-wave spins of $J = 1.5$ and $J = 2.5$ as several small p- and d-wave resonances will not have been observed. If it is assumed that the radiation width can be determined from the capture area for the same fraction of d-wave resonances as p-wave then the $\langle g \rangle$ is 2.25 and the average radiation width is ~ 0.27 eV.

Kappler et al [Ka-83] capture measurements were carried out using a 3 MeV pulsed Van de Graaff with a 60 cm flight path over the neutron energy range 10 to 100 keV. Two aluminium canned C_6D_6 liquid scintillators were used to detect the capture γ -rays from the samples. Measurements were carried out on a sample enriched to 73.26% ^{58}Fe and a sample of natural iron. The incident neutron flux was measured relative to the gold capture cross section given in ENDF/B-IV, using a 1mm thick gold sample.

The program FANAC was used to determine the capture areas and some of the individual resonance parameters. The radiation widths for the larger resonances tend to be smaller than other published data, possibly due to the relatively large distance between the sample and the detectors enabling them to separate the detection of the scattered neutron from the capture events in the sample.

Hong et al [Ho-77] carried out capture and transmission measurements using a 3 MeV pulsed Van de Graaff. The transmission was carried out on a 4.991 m flight path using as a neutron detector a 13 mm thick ⁶Li glass scintillator. The prompt neutron capture γ -rays were detected in a 800 litre liquid scintillator at a flight path of 1.93 m. The measurements were carried out on a sample enriched to 65.09% ⁵⁸Fe and a sample of natural iron. The capture measurements were relative to that of a gold sample.

The shape fitting code FANAL-II was used to analyse the transmission data and the Monte-Carlo program TACASI was used to determine the radiation widths of some of the individual resonances. The radiation widths for the larger resonances tend to be the largest of the published data. This is possibly due to the detections of the γ -rays from the capture of the scattered neutron in the surroundings of the sample and the γ -ray detector.

The parameters given in the report by Beer et al [Be-78] appear to be identical to those given in the Hong et al's paper and are not included in the evaluation but are included in the table in Appendix 4. The smooth cross section given in the EXFOR file is thought to be a calculation using their fitted parameters and not the experimental values.

The EXFOR file lists the total cross section measurements of E.Ja. Doil'nitsyn et al [Do-76], it also includes the observed widths of the first two s-wave resonances. I have been unable to obtain the reference or any other information about this measurement. It is excluded from this evaluation.

Gayther et al [Gay-77] only gave the natural capture area for the resonance at

$$358 \text{ eV} = (3.51 \pm 0.25) \times 10^{-5} / 0.00282 = 12.45 \pm 0.89 \text{ meV}$$

and a shape fit to the data gave

$$g\Gamma_n = 11.9 \pm 0.8 \text{ meV} \text{ and } \Gamma_\gamma = 250 \pm 140 \text{ meV}$$

assuming an abundance of 0.31% for ⁵⁸Fe in natural iron and $J = 0.5$, i.e. $g = 1.0$. The change in abundance from 0.31% down to 0.282% changes only Γ_n to 13.08 ± 0.98 meV, as it comes mainly from the area under the curve. The change in abundance is assumed to have only a minor effect on the value of Γ_γ as, to a first order, this comes from the total width minus the neutron width i.e. $\Gamma_\gamma = 250 + 11.9 - 13.08 = 248.8 \pm 140$ meV. The time of flight data in the region of the 358 eV was typed in from a Harwell computer output. This data was then used in the final fit for the parameters of this resonance.

Some neutron capture measurements have recently been carried out at Geel by Borella [Bo-04] to investigate the effects of gamma-ray attenuation on the capture detector weighting function. One of the samples consisted of four discs of metallic gold interleaved between five discs of metallic iron. Borella sent the raw capture yield for the composite sample and the results of measurements on two gold samples. The normalization determined from the 4.9 eV ¹⁹⁷Au and the 1.1 keV ⁵⁶Fe resonance were in good agreement. The normalized data was then incorporated into a least square fit with the Garg et al [Gar-78a] transmission data for the region around the 359 eV and 230 eV resonances of ⁵⁷Fe. In the case of the resonance at 359 eV the Harwell [Gay-77] capture data was also included.

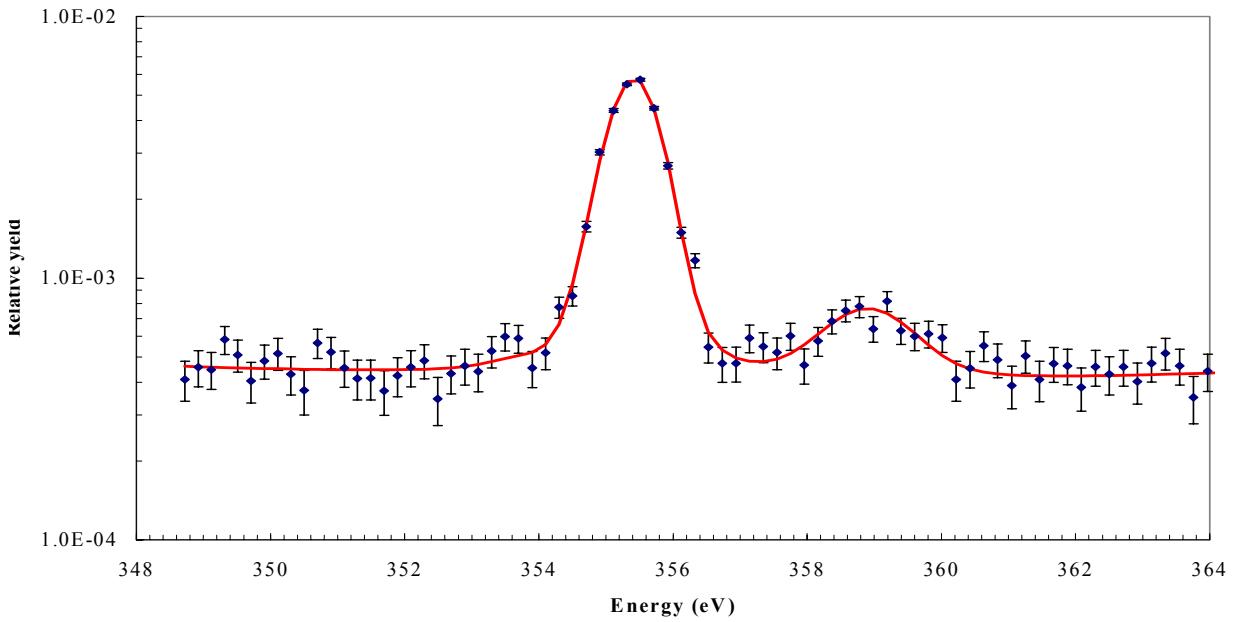


Figure 3: A fit to the Geel natural gold/iron capture data [Bo-04]. The 358.9 eV ^{58}Fe resonance is the high energy part of the smaller peak centred at ~ 358.4 eV, the lower part coming from multiple scattering into the gold resonance at 355.4 eV.

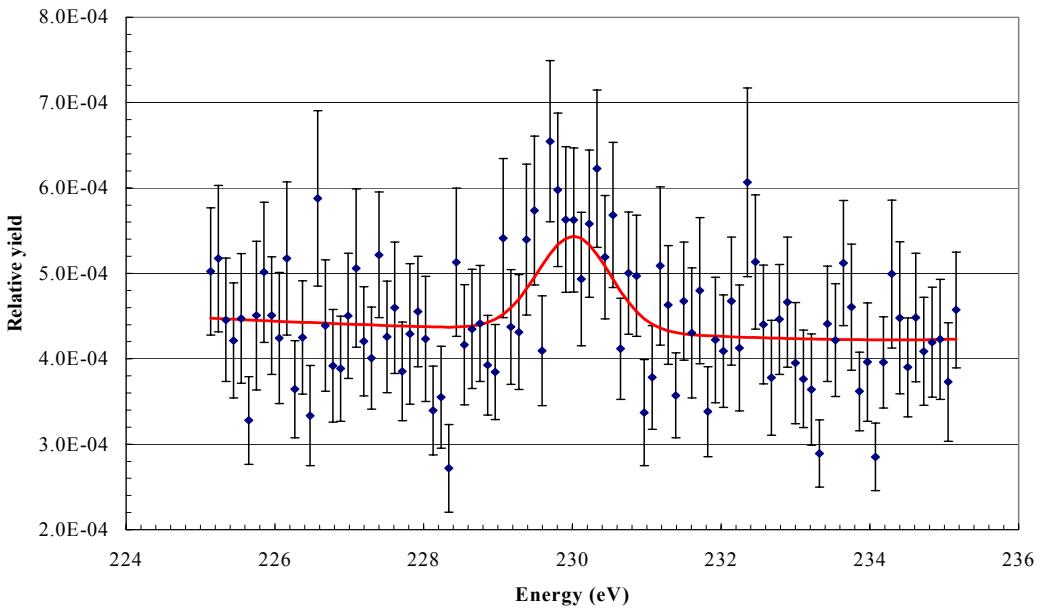


Figure 4: The fit to the Geel capture data for natural iron plus gold sample in the region of the 230 eV ^{58}Fe resonance

Garg et al [Gar-78] carried out transmission measurements on a sample ^{58}Fe enriched to 73.26%. Two measurements were carried out, one using a Li-glass scintillator, and the other using a NE-110 plastic scintillator. The data from the Li-glass scintillator is the only one listed in the EXFOR file. Harvey sent a copy of the raw transmission data for the Li-glass scintillator measurements but was unable to recover the data from the plastic scintillator measurement. Their original determination of the resonance parameters was carried out using both area and shape analysis. A constant radiation width of 0.5 eV appears to have been used in both the area and shape analysis.

After comparing calculations of the total cross section carried out using the resonance parameters in the ENDF/B and JEF-2.2 with Garg et al's [Gar-78] data, it was decided to carry out a re-analysis of

data. The initial fits to the data were poor with chi-square per degree of freedom ~ 2.0 , the worst part of the fit being in the regions around the peaks of the wide s-wave resonances. Although the adjustment of the background gave some improvement, its magnitude and time dependence was unrealistic. Prior to the final fit to the ^{58}Fe data, a fit was carried out on the ^{57}Fe transmission data of Rohr et al [Ro-66], details of the fit are given in Appendix 5. The best fit to Garg et al [Gar-78a] data was obtained by adjusting the sample thickness, the isotopic abundances of the isotopes ^{54}Fe , ^{56}Fe and ^{57}Fe as well as the main resonance parameters, the normalization, and background. The abundance of the ^{58}Fe was adjusted so that the sum of the abundances of all the iron isotopes equalled unity. In the region from ~ 30 eV to 155 KeV a chi-square per degree of freedom of 1.0690 was obtained.

Table I: Changes to the isotopic abundance

Isotope	Ref. Values	Fitted values	Ratio
Fe-58	73.26 ± 0.08	73.5696	1.0042
Fe-54	1.14 ± 0.02	1.0916 ± 0.0222	0.9576 ± 0.0247
Fe-56	23.74 ± 0.06	23.4688 ± 0.163	0.9885 ± 0.0074
Fe-57	1.86 ± 0.03	1.8730 ± 0.0287	1.0070 ± 0.0222
Sum	100.0	100.0 ± 0.167	
O-16	150.0	150.0	

The sample thickness increased from 0.05147 ± 0.00103 a/b to 0.055421 ± 0.000193 a/b an increase of $7.67 \pm 2.0\%$ which is just under four times the quoted error on the thickness. The correlation matrix indicates that there is little correlation between the fitted abundance of the isotopes. The highest correlations in the abundance of the isotopes are between the neutron widths of the main resonances.

Table II: Additional background required in the fit to Garg et al [Gar-78a] transmission data

Energy (eV)	Time (μ-sec.)	Background d
50	1032.8	0.00840
100	565.7	0.00466
1000	178.9	0.00479
10000	56.57	0.00216
100000	17.89	0.00049

The adjustment to the background is small and comes mainly from the resonances where the transmission minima is less than ~ 0.1 (0.358 keV, 10.4 keV and 43.7 keV) and the resonances with transmission minima between 0.1 and 0.2 contributing a smaller amount. All the background parameters are highly correlated hence a change in one will have to be accompanied by a related change in the others.

The fitted normalization of 1.0251 ± 0.0020 being not equal to unity may be due to errors in the nuclear radius of the iron isotopes 54, or 56 or 57 or oxygen used in the calculation. It could also be due to the presence of an unknown impurity such as absorbed water.

The neutron width of the negative energy resonances at -3612.8 eV is derived from the shape of the observed cross section, thus has a large correlation between the resonance parameters, the background and the normalization. The radiation width is adjusted to get agreement with the observed thermal activation cross section of 1.3143 barns.

In these fits the effective temperature was kept fixed at a value of 293 K.

The fitted flight path length of 78.2122 ± 0.021 m and zero time of 11.6972 ± 0.0082 μ -seconds were adjusted by fixing the resonance energies of the ^{56}Fe at 27.791, 74.029, 83.628, 123.651, 129.770 and the 140.480 keV to the values given in the JEF-2.2 file. The fitted flight path length is in reasonable agreement with the quoted value of 78.203 m. The definition of the flight path length in REFIT is the distance between the emitting face of the neutron source and the incident face of the detector. The mean and spread of the distances the neutron travels in the source and detector are energy dependent and are effectively included in the resolution function.

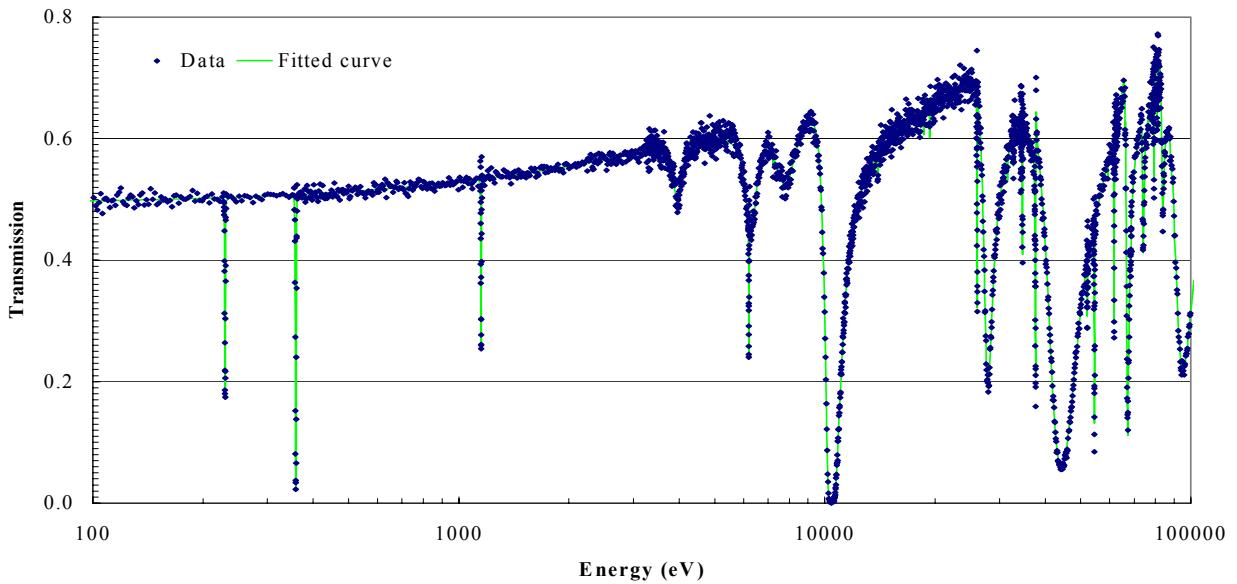


Figure 5: The least square fit to the transmission data of Garg et al [Gar-78a]

The resonance parameters below ~ 200 keV determined from the fit are shown in Tables III and IV and compared with the original analysis of Garg et al [Gar-78] for the ^{58}Fe and the other isotopes with values in the JEF-2.2 evaluated data files. The resonance parameters up to 150 keV given in the table below were used in this evaluation rather than those obtained by Garg et al [Gar-78]. The differences are thought to be due to only being able to access the data from the Li-glass measurements.

Table III: The resonance parameters from a fit to the transmission data of Garg et al [Gar-78a]. The original results of Garg et al [Gar-78] are in the rows marked with a G in the first column. The parameters for resonances marked \$ in the first column were not given in reference [Gar-78]. The fit to the resonances at 230 and 359 eV, marked with #, included capture data from Geel [Bo-04] and Harwell [Gay-76].

Fe-58					
	Energy (eV)	J	L	Radiation width (eV)	Neutron width (eV)
\$	-3612.8 fixed	0.5	0	0.74169±0.0393	271.55±13.38
#	230.038±0.020	-0.5	1	0.14567±0.04131	(2.0414±0.0961)E-03
G	229.8±0.2				(2.0±0.10)E-03
#	358.918±0.020	-1.5	1	0.29895±0.0371	(6.8714±0.355)E-03
G	358.6±0.2				(10.5±1.0)E-03
\$	1152.733±0.321	-0.5	1	0.2446	(2.127±0.546)E-03
\$	6193.801±4.880	-05	1	0.2446	(20.340±19.36)E-03
\$	6201.048±1.148	1.5	2	0.2446	(85.396±27.08)E-03
	6206.046±1.525	-1.5	1	0.2446	(41.145±24.92)E-03
G	6199.0±2.0				2.0±0.5
	10426.319±1.110	0.5	0	0.8900	328.20±2.086
G	10380.0±5.0				249.0±25.0
\$	19325.262±3.571	-1.5	1	0.1696	0.2088±0.0539
	26083.360±1.175	-0.5	1	0.2123	8.0199±0.432
G	26070.0±10.0				30.0±5.0
	34665.880±2.494	-1.5	1	0.2019	3.288±0.394
G	34646.0±10.0				12.5±2.5
	37665.880±1.898	0.5	0	0.2382	48.124±1.398
G	37663.0±10.0				50.0±10.0
	43822.692±11.520	0.5	0	1.1929	5532.7±33.42
G	43150.0±30.0				4320.0±430
\$	45849.212±7.804	2.5	2	0.2446	4.475±1.179
	54530.412±2.859	-1.5	1	0.3470	51.905±1.738
G	54500±40.0				35.0±10.0
	61712.207±3.820	-1.5	1	0.2044	27.891±1.372
G	61700.0±40.0				40.0±10.0
	67057.403±6.292	0.5	0	0.3996	915.06±10.63
G	66900.0±10.0				810.0±80.0
	79337.910±11.36	-0.5	1	0.1502	24.045±3.08
G	79340.0±40.0				25.0±5.0
	93650.321±30.48	0.5	0	1.0059	9240.4±72.98
G	92500.0±64.0				7430.0±740.0
	109321.933±22.25	-0.5	1	0.3360	41.207±6.873
G	109260.0±40.0				40.0±15.0
\$	114326.331±116.3	-0.5	1	0.2446	1.7752±2.960
	121187.166±19.68	0.5	0	1.0502E+00	2254.6±38.68
G	121000.0±46.0				1810.0±180.0

	123462.644±21.17	-1.5	1	0.2446	49.798±7.439
G	123420.0±40.0				30.0±10.0
	130109.301±13.64	-1.5	1	0.3365	88.097±9.518
G	130080.0±50.0				135.9±20.0
\$	13126.474±66.62	-0.5	1	1.8062	20.762±7.660
	135708/297±63.77	-1.5	1	0.3564	9.154±3.841
G	135590.0±50.0				12.5±5.0
\$	138184.126±126.4	2.5	2	0.3920	3.533±2.632
	144040.629±27.92	2.5	2	0.3741	24.447±3.724
G	144000.0±60.0				33.33±10.0
\$	151441.911±39.75	-0.5	1	0.2446	47.77±10.78
	152016.674±11.16	-1.5	1	1.1242	182.54±9.606
G	151980.0±60.0				182.5±25.0
\$	152430.297±39.13	0.5	0	0.3467	30.32±7.09
	159252.05±71.33	-0.5	1	0.2446	37.45±20.18
G	159420.0±60.0				70.0±14
	166234.171±16.88	2.5	2	0.2899	57.333±4.314
G	166220.0±60.0				60.0±12.0
	178828.80±199.0	0.5	0	0.8821	2243.1±44.60
G	178500.0±84.0				2750.0±280.0

A high value of chi-square per data point of 1.9 was found in the energy region of the resonance at 1.15 keV in ^{56}Fe . Assuming the parameters of the ^{56}Fe at 1.15 keV are correct, the addition of a resonance allocated to ^{58}Fe at an energy of 1152.722 ± 0.343 eV, with a neutron width of 2.127 ± 0.55 meV, assuming a radiation width of 0.2446 eV reduce chi-square per degree of freedom to 1.34. The presence of this resonance would not have been suspected in the earlier analysis.

In Garg et al's [Gar-78a] data there are several regions that have a similar shape to shallow broad resonance dips, these cannot be allocated to any of the iron isotopes and do not correspond to resonances in other isotopes. The clearest ones are at 32.76 keV and 135.7 keV.

The dip at 32.76 keV was temporarily allocated to ^{57}Fe as a good fit to the region could be obtained assuming it to be a p-wave with $J = 2$, the fitted neutron width being 41 ± 19 eV. But as there is no sign of such a resonance in the published data on ^{57}Fe or any other isotope, the region around the dip was not used in the final fit to the data.

The suggested interference in the shape of the dip at ~135 keV indicates the presence of an s-wave resonance with a width of ~500 eV and an abundance times the spin weighting factor ~0.06. There are several isotopes with resonances in this energy region but all have resonances at lower energies. These isotopes can be eliminated as the lower energy resonances were not observed. As there was no satisfactory explanation for the dip, the region from 134 keV to 137 keV has been left out of the final fit to Garg et al's [Gar-78a] data.

Table IV: The resonance parameters for ^{54}Fe , ^{56}Fe and ^{57}Fe obtained from the analysis of the transmission data of Garg et al [Gar-78a]. The JEF-2.2 parameters are listed in the rows marked with a J in the first column. The energy of the s-wave ^{56}Fe resonances were not adjusted in the fit and used to adjust the effective flight path length and zero time of the measurement. The value of 1020 eV for the neutron width of the 3964 eV resonance in ^{57}Fe listed in the JEF-2.2 File is now known to be in error.

	Energy (eV)	J	L	Radiation Width (eV)	Neutron width (eV)
Fe-54					
	7775.508±1057	0.5	0	1.7800	973.76±37.20
J	7720.0			1.7800	1040.0
FE-56					
	1151.0 Fixed	-0.5	1	0.57278	0.06170 Fixed
J	1151.0			0.572782	0.06170
	27791.0 Fixed	0.5	0	1.5324	1442.1±13.48
J	27791.0				1409.3
	74029.0 Fixed	0.5	0	0.69561	667.82±27.02
J	74029.0				611.5
	83628.0 Fixed	0.5	0	0.52883	1305.6±49.89
J	83628.0				1215.1
	123651.0 Fixed	-1.5	1	0.28397	8.588±18.62
J	122801.0				619.0
	129770.0 Fixed	0.5	0	0.6200	273.8±84.73
J	129861.0				588.0
	140480.0 Fixed	0.5	0	1.6100	2879.8±84.72
J	140479.0				2735.0
	169222.491±16.88	0.5	0	0.94000	722.55±74.25
J	169275.0			0.9400	962.0
	187680.649±79.26	0.5	0	1.0500	3880.2±187.3
J	187737.0			1.0500	3620.0
FE-57					
	3953.980±4.213	0.0	0	0.740	233.99±9.39
J	3964.0			0.740	1020.0
	6254.906±4.289	1.0	0	1.1500	506.75±12.91
J	6217.0			1.1500	381.0

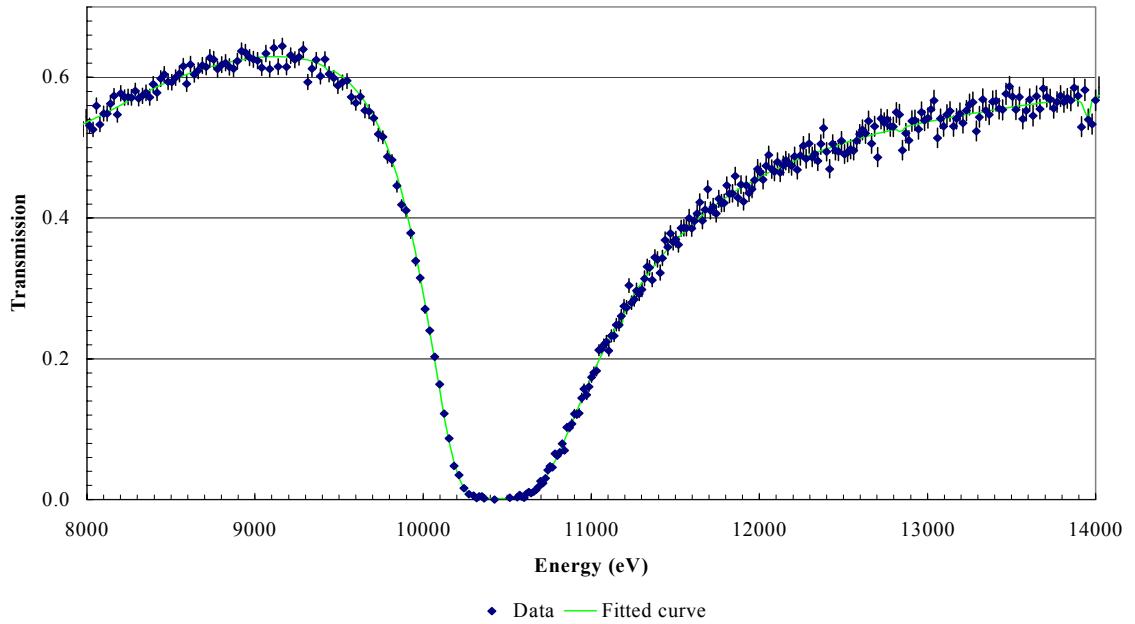


Figure 6: A comparison of the Garg et al's [Gar-78a] measured data and the fitted curve in the region of the 10 keV resonance of ^{58}Fe

The fitted curve on the low energy side of the 10 keV ^{58}Fe s-wave resonance is above the measured data points in the region from ~ 9 to ~ 10 keV ^{58}Fe (Figure 6) and again may be interpreted as a resonance dip due to an unknown isotope. The poor fit may indicate that fitted value of the neutron width of the ^{58}Fe at 10 keV may be larger than the true value.

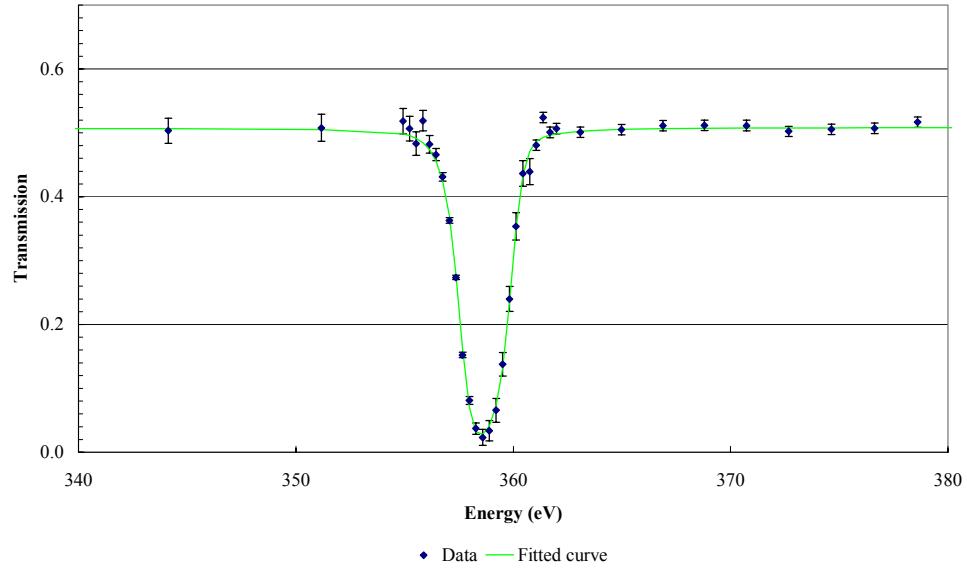


Figure 7: Garg et al's [Gar-78a] data in the region of the ^{58}Fe resonance at 359 eV and the fit to the data

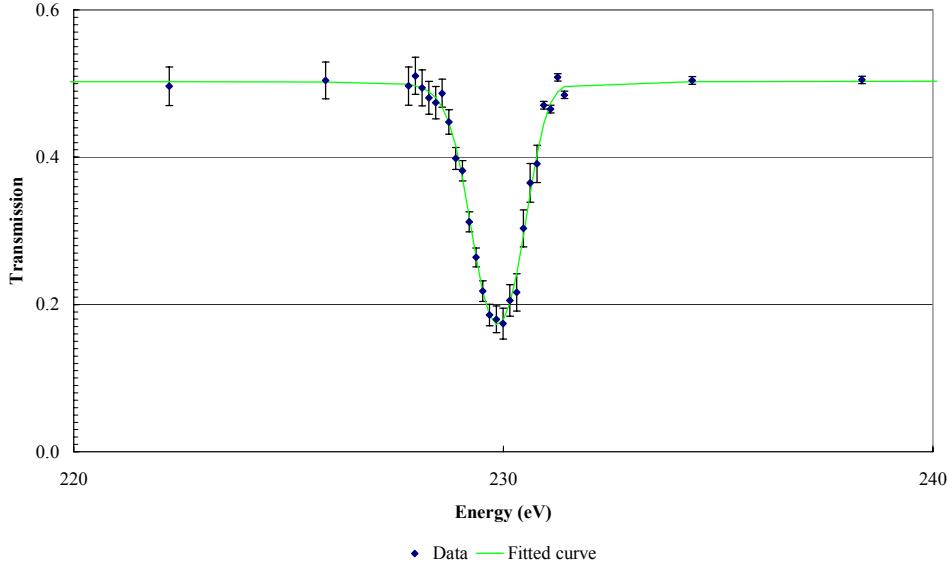


Figure 8: Garg et al's data [Gar-78a] in the region of the ^{58}Fe resonance at 230 eV and the fit to the data

Evaluation of the resonance parameters

Resonance energy

The resonance energies determined in the re-analysis of Garg et al's [Gar-78a] transmission data were chosen as the standard energy scale. A least square fit was then used to adjust the flight path length and the zero time to get agreement in the energy with the standard. The zero time for all the publications is assumed to be zero. The fitted flight path lengths and zero times are all close to the values given in the publications. The larger uncertainties are due to the fact that there may be only a few resonances in the data over-lapping with the standard set. The recommended resonance energies are obtained from the weighted mean of the values calculated from the adjusted flight path lengths and zero times.

Table V: Adjustment of the time of flight and zero time to get agreement with the reference chosen as the standard

Ref.	Length m	Fitted Length m	Zero time ($\mu\text{-sec.}$)
Ho-69	25.44	25.433 ± 0.127	-0.044 ± 0.149
Al-80	40.0	40.1949 ± 0.199	0.082 ± 0.570
Ka-83	100.0	100.256 ± 4.909	-0.041 ± 1.921
Ho-77, s-wave	45.0	45.326 ± 0.762	0.087 ± 0.240
Ho-77, p-wave	45.0	45.023 ± 0.493	0.020 ± 0.162
Gar-78, >187 keV	78.203	78.299 ± 1.277	0.153 ± 0.334
Gar-78, <187 keV Standard (See this paper)	78.203	78.212	-
Gay-76	100.0	100.0	-0.199 ± 0.055
Be-78	10.0	10.421 ± 0.034	0.013 ± 0.011
Mo-80	45.0	45.0	-0.081 ± 0.492

Spins, neutron and radiation width of the resonances

The s-wave resonances in the region below 200 keV are easily recognized by their minima due to interference between the resonances and potential components of the total cross section. A much better fit to Garg et al's [Gar-78a] data is obtained in the region of the resonance at 37.659 keV by allocating the resonance to be an s-wave spin $J = +0.5$ and on close examination Beer et al's [Be-78] data in Figure 4 of the report show a similar interference effect. The interference minimum is on the higher energy side of the resonance because of resonance-resonance interference effects. The spins of other smaller resonances are not easily determined from the available total and capture data.

The observed s-wave spacing below ~200 keV is ~25 keV. Assuming that the resonance spacing follows the $2J + 1$ law, there should be ~8 p-wave resonances with $J = -0.5$ and ~16 with $J = -1.5$, a total number of resonances of ~32. Below 200 keV a total of 69 resonances have been observed, of which seven are known to be s-wave. The difference between the observed and the calculated s- and p-wave contribution is 37, close to the predicted number of 40 for d-wave resonances with spins of $J = +1.5$ and $J = +2.5$. It is expected that several of the smaller p- and d-wave resonances will have been missed as well as some of the larger e- and f-wave ones may be observed. If it is assumed that the radiation width can be determined from the capture area for the same fraction of d-wave resonances as p-wave then the $\langle g \rangle$ is 2.25 and the average radiation width is ~0.27 eV.

Assuming that the average radiation does not vary greatly with momentum and spin then the capture areas for resonances with the larger neutron widths will be approximately multiples of 0.27 eV i.e., 0.27, 0.54 and 0.81 eV. In Allen and Macklin's [Al-80] list there are eight with areas of 0.25 ± 0.06 eV, ten with areas of 0.54 ± 0.12 eV and fourteen with areas larger than 0.8 eV. If then it is assumed that these groups of resonances have spin weighting factors of 1, 2 and 3, the weight average radiation width is equal to 0.245 eV. Using this lower value of the radiation width the spins of several other resonances were allocated as well as some of the previous ones reallocated to high spins. The peaks with capture areas greater than 1.0 eV are allocated as d-wave with $J = +2.5$, and have been omitted from the average as they can be assumed to be due to two or more resonances. The spin of the resonances with neutron widths less than ~0.5 eV were allocated in a random fashion to give approximately the calculated number of resonances for each spin. The resonances with spin $J = 1.5$, were at first all allocated to be p-waves but later randomly allocated in equal numbers as p- and d-wave resonances. These assumptions should make little difference to the calculated total and capture cross sections, but may cause some error in the calculation of the angular distribution of the scattered neutrons.

Table VI: The weighted average radiation width as a function of the assumed spin

J	Radiation width (eV)	Chi-square.	Number
+0.5	0.2631 ± 0.0094	202.1	7
-0.5	0.2312 ± 0.0062	158.5	14
1.5	0.2237 ± 0.0058	107.4	13
2.5	0.3156 ± 0.0107	231.4	10

The low value of 0.2630 eV for the s-wave resonances comes mainly from the smaller s-wave resonances as the correction for the detection of scattered neutrons is smaller and may indicate that the detection of the scattered neutrons in the region of the resonances with the large neutron widths has been underestimated.

A weighted average of all the "measured" radiation widths, assuming the allocated spins and momentum are correct, equals 0.2446 ± 0.0037 eV. A least square fit to all the radiation widths

assuming the observed width is a constant plus a term dependent on the scattering area of the resonance

$$\Gamma_\gamma = 0.2441 \pm 0.0157 + (9.047 \pm 2.350) g \Gamma_n \Gamma_n / [E_r (\Gamma_n + \Gamma_\gamma)],$$

either indicates that there is a dependence of the radiation width on the neutron width or the detection of the scattered neutrons is much greater than the experimentalist thought. The high value of chi-square can be interpreted as a natural spread in the observed values of the radiation width of $\sim 26\%$.

After the selection of the spin for each resonance, the recommended parameters are obtained from a weighted mean of the accepted published data. The recommended parameters in ENDFB format are given in the table in Appendix 1 and the various constants calculated from the parameters are given in Appendix 2. The table in Appendix 4 includes the recommended parameters together with all the published parameters. No adjustment has been made to the neutron or radiation width for the changes in the published resonance energies.

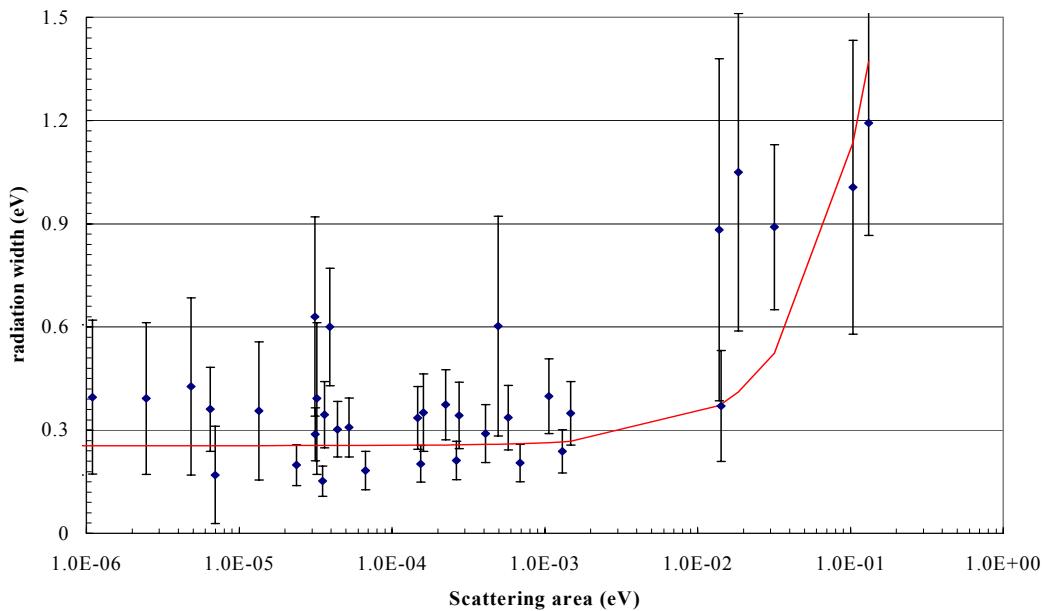


Figure 9: The fit to the “observed” radiation width and the scattering area of the resonance

A calculation of the cross sections, (total, elastic scattering, inelastic scattering to the levels at 0.8108 and 1.6747 MeV and the capture) in the region above 100 keV was carried out using the program AVEFIT. The program AVEFIT uses the R-matrix formalism in the calculation of the cross sections. The calculated unresolved capture cross section in the neutron energy region indicates that a radiation width of ~ 0.24 eV gives a better fit to the measured capture data of Allen et al [Al-80]. There are only six measured data points in the energy range from ~ 500 keV to ~ 2 MeV. There are five of the points measured by Trofimou [Tr-85 and Tr-87] and one at 450 keV by Garliea et al [Iga-80]. These measured points are all larger than the calculated values but as the thermal capture cross section is about 1000 times greater than the MeV cross section, the higher measured capture cross section could be explained by a very small contribution from thermalised fast neutrons. The calculated cross sections are given in Appendix 3.

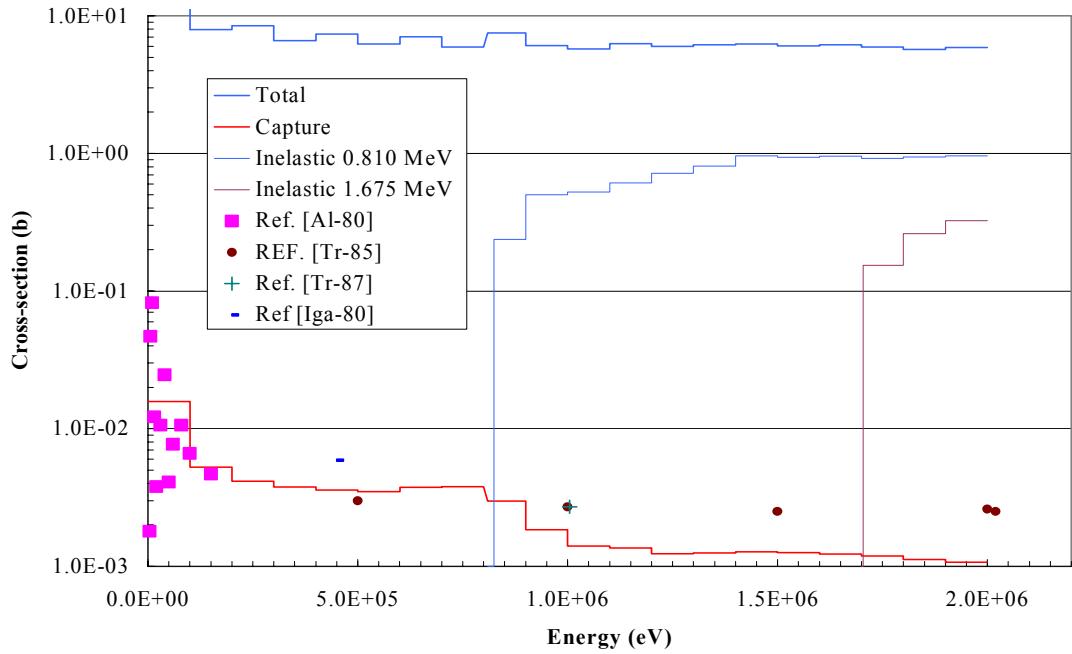


Figure 10: The calculated cross sections averaged in 100 keV intervals, compared to the measured values given in the EXFOR files. The scatter in the calculated values is due to the finite number of resonances that have been used in the calculation.

Table VII: Average resonance parameters used in the AVEFIT calculations

Nuclear radius = $1.35 \times 58^{1/3}$ fm	5.226 fm
Resonance spacing	21.03 keV
Strength function l – even	3.4600×10^{-4}
Strength function l – odd	0.6200×10^{-4}
Average radiation width For all spins and parities	0.2446 eV
Level spin = 0^+	0.0 MeV
Level spin = 2^+	0.81076 MeV
Level spin = 2^+	1.6747 MeV
Level spin = 4^+	2.0765 MeV

Conclusion

The recommended parameters given in this report reproduce the measured differential cross section and the recommended thermal capture cross section more closely than the present JEF-2.2 evaluated file over the neutron energy range up to ~ 150 keV.

These parameters should only be used to calculate the cross sections up to 155 keV.

Between 155 keV and 2 MeV the cross section given in Appendix 2 could be used and above 2 MeV the recommended values given in the present JEF-2.2 could be adopted. As there are no measurements for ^{58}Fe of the cross sections above a few hundred keV, the values in the JEF-2.2 file come from those recommended for ^{56}Fe . The calculated capture cross section below the first resonance is made to follow the expected $1/v$ shape by the inclusion of several negative energy s-wave resonances (Figure 11).

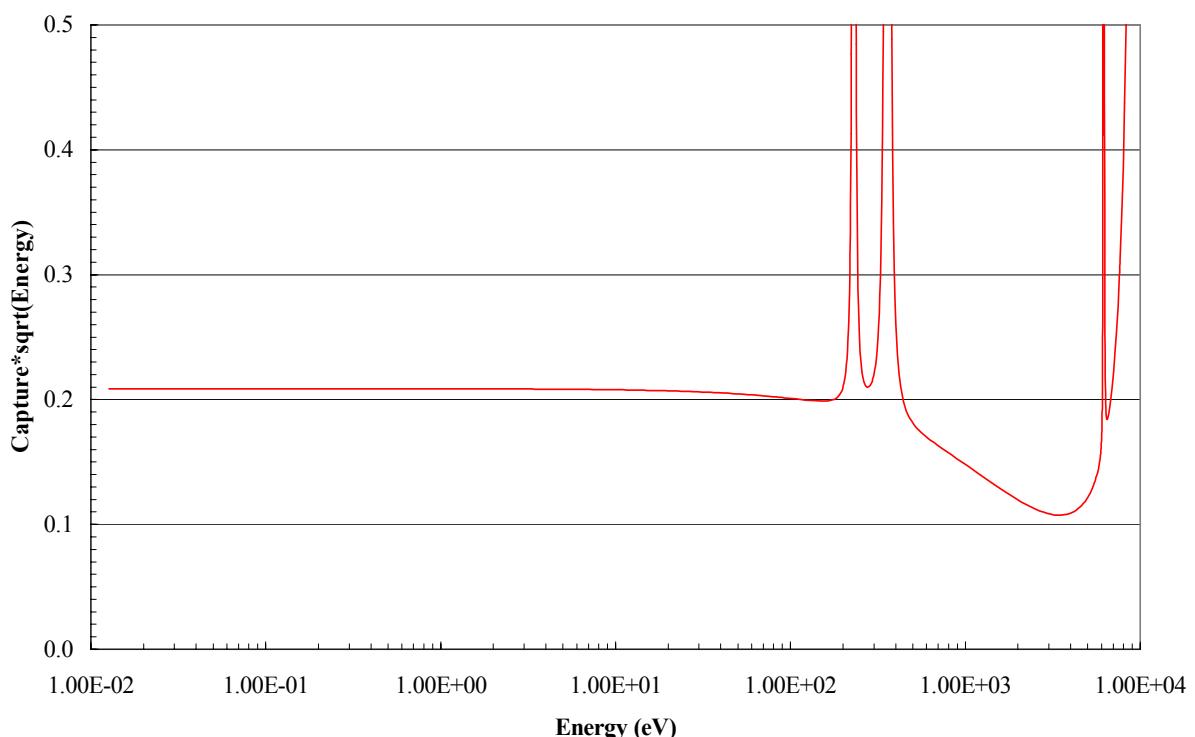


Figure 11: Calculated capture cross section using the recommended parameters times the square root of the neutron energy

Capture yields calculated using the recommended parameters are in general agreement with the figures given in the paper by Allen and Macklin [Al-80] and with the figure on page 241 in the paper by Kappler et al [Ka-83].

One of the problems with this evaluation and previous ones is that $\sim 45\%$ of the calculated value of the total resonance integral of 1.2817 ± 0.0278 barns comes from the first two resonances for which there is effectively only one transmission measurement by Garg et al [Gar-78a] and some preliminary capture measurements carried out at Geel by Borella [Bo-04]. New measurements on enriched or natural iron are needed to solve this problem. Another is the correlation between the radiation width and the neutron width. This effect has been observed in capture measurements in many other isotopes. This correlation may be genuine or it may be due to the detection of scattered neutrons in the γ -ray detectors and needs investigating.

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Appendix 1

THESE RESONANCE PARAMETERS SHOULD ONLY BE USED TO CALCULATE THE CROSS SECTION IN THE ENERGY RANGE 0 eV TO 155 keV.

From \sim 155 keV to \sim 350 KeV the parameters reproduce the gross structure in the total cross section as seen in the transmission data but will not reproduce the capture cross section due to the fact that many of the p-wave and higher orbital angular momentum resonances are not included in the list.

YOU REQUIRE ALL THE PARAMETERS TO REPRODUCE THE OBSERVED DIFFERENTIAL DATA

NUCLEAR MASS = 57.933280458 amu, NEUTRON MASS = 1.008664923 amu

ENDF mass = $57.933280458 / 1.008664923 = 57.435605$

Nuclear radius for all spins = 0.5226 in units of 10**-12

Practical radius from cm^{-3} to m^{-3} in units of 10^{-12}
 0.0 5.226000-1
 5.743561+1 0.0 0
 -5.524500 5 5.000000-1 6.986000 3 2.446000-1 0.000000 0 0.000000 0
 -5.243075 5 5.000000-1 6.805700 3 2.446000-1 0.000000 0 0.000000 0
 -4.961650 5 5.000000-1 6.620500 3 2.446000-1 0.000000 0 0.000000 0
 -4.680225 5 5.000000-1 6.430000 3 2.446000-1 0.000000 0 0.000000 0
 -4.398800 5 5.000000-1 6.233700 3 2.446000-1 0.000000 0 0.000000 0
 -4.117375 5 5.000000-1 6.031000 3 2.446000-1 0.000000 0 0.000000 0
 -3.835950 5 5.000000-1 5.821200 3 2.446000-1 0.000000 0 0.000000 0
 -3.554525 5 5.000000-1 5.603600 3 2.446000-1 0.000000 0 0.000000 0
 -3.273100 5 5.000000-1 5.377200 3 2.446000-1 0.000000 0 0.000000 0
 -2.991675 5 5.000000-1 5.140900 3 2.446000-1 0.000000 0 0.000000 0
 -2.966100 5 5.000000-1 5.582000 3 2.446000-1 0.000000 0 0.000000 0
 -2.659090 5 5.000000-1 5.286000 3 2.446000-1 0.000000 0 0.000000 0
 -2.352080 5 5.000000-1 4.971000 3 2.446000-1 0.000000 0 0.000000 0
 -2.045070 5 5.000000-1 4.635000 3 2.446000-1 0.000000 0 0.000000 0
 -1.738060 5 5.000000-1 4.273000 3 2.446000-1 0.000000 0 0.000000 0
 -1.431050 5 5.000000-1 3.877000 3 2.446000-1 0.000000 0 0.000000 0
 -1.124040 5 5.000000-1 3.436000 3 2.446000-1 0.000000 0 0.000000 0
 -8.170300 4 5.000000-1 2.930000 3 2.446000-1 0.000000 0 0.000000 0
 -5.618000 4 5.000000-1 3.529000 3 2.446000-1 0.000000 0 0.000000 0
 -3.060000 4 5.000000-1 1.793000 3 2.446000-1 0.000000 0 0.000000 0
 -3.612800 3 5.000000-1 2.715500 2 7.416900-1 0.000000 0 0.000000 0
 1.042621 4 5.000000-1 3.412200 2 8.927600-1 0.000000 0 0.000000 0
 3.766585 4 5.000000-1 4.750000 1 2.383300-1 0.000000 0 0.000000 0
 4.381800 4 5.000000-1 5.553400 3 1.198000 0 0.000000 0 0.000000 0
 6.705694 4 5.000000-1 9.188400 2 3.544400-1 0.000000 0 0.000000 0
 9.364229 4 5.000000-1 9.266300 3 1.029300 0 0.000000 0 0.000000 0
 1.211862 5 5.000000-1 2.268200 3 1.074200 0 0.000000 0 0.000000 0
 1.602447 5 5.000000-1 1.332600 0 2.446000-1 0.000000 0 0.000000 0
 1.788285 5 5.000000-1 2.243600 3 8.821000-1 0.000000 0 0.000000 0
 2.399875 5 5.000000-1 1.040200 4 2.446000-1 0.000000 0 0.000000 0
 2.658000 5 5.000000-1 5.000000 2 2.446000-1 0.000000 0 0.000000 0
 3.101937 5 5.000000-1 2.955100 3 2.446000-1 0.000000 0 0.000000 0
 3.202941 5 5.000000-1 1.356600 3 2.446000-1 0.000000 0 0.000000 0
 3.481050 5 5.000000-1 2.000000 3 2.446000-1 0.000000 0 0.000000 0
 5.743561+1 5.226000-1 1
 2.300379 2-5.000000-1 2.042400-3 1.456700-1 0.000000 0 0.000000 0
 3.589448 2-1.500000 0 6.898000-3 2.989500-1 0.000000 0 0.000000 0
 1.152733 3-5.000000-1 2.127300-3 2.446000-1 0.000000 0 0.000000 0
 6.189454 3-5.000000-1 2.247400-2 2.446000-1 0.000000 0 0.000000 0
 6.201009 3-5.000000-1 5.608200-2 2.446000-1 0.000000 0 0.000000 0
 6.206012 3-1.500000 0 3.944500-2 2.446000-1 0.000000 0 0.000000 0
 1.782729 4-1.500000 0 2.525800-3 2.446000-1 0.000000 0 0.000000 0
 1.794685 4-5.000000-1 1.151800-2 2.446000-1 0.000000 0 0.000000 0
 1.932513 4-1.500000 0 2.121300-1 1.695700-1 0.000000 0 0.000000 0
 2.608359 4-5.000000-1 8.000500 0 2.114100-1 0.000000 0 0.000000 0
 2.922199 4-5.000000-1 1.491100-2 2.446000-1 0.000000 0 0.000000 0
 3.467054 4-1.500000 0 3.101500-1 2.016900-1 0.000000 0 0.000000 0
 3.655448 4-1.500000 0 5.365100-2 2.446000-1 0.000000 0 0.000000 0
 3.824567 4-1.500000 0 8.852400-2 2.446000-1 0.000000 0 0.000000 0
 3.921055 4-1.500000 0 3.162000-2 2.446000-1 0.000000 0 0.000000 0
 4.181140 4-1.500000 0 9.738800-1 3.048700-1 0.000000 0 0.000000 0
 5.453038 4-5.000000-1 5.205500 1 3.491300-1 0.000000 0 0.000000 0
 6.171216 4-1.500000 0 2.688000 1 2.054800-1 0.000000 0 0.000000 0
 7.338734 4-1.500000 0 8.704000-1 6.359500-1 0.000000 0 0.000000 0
 7.933744 4-5.000000-1 2.409400 1 1.472300-1 0.000000 0 0.000000 0
 8.574455 4-1.500000 0 1.358000 0 2.446000-1 0.000000 0 0.000000 0
 8.765328 4-5.000000-1 5.000000 0 3.078600-1 0.000000 0 0.000000 0
 9.218762 4-5.000000-1 2.413800 0 1.984800-1 0.000000 0 0.000000 0

9.586608	4-1.500000	0	2.187500	0	2.446000-1	0.000000	0	0.000000	0
9.750585	4-1.500000	0	1.528900	0	2.446000-1	0.000000	0	0.000000	0
1.093205	5-5.000000-1	4.108000	1	3.423000-1	0.000000	0	0.000000	0	
1.112952	5-1.500000	010.000000-1	3.605700-1	0.000000	0	0.000000	0		
1.139799	5-5.000000-1	1.044600	0	2.446000-1	0.000000	0	0.000000	0	
1.234633	5-5.000000-1	4.823000	1	3.256800-1	0.000000	0	0.000000	0	
1.301090	5-1.500000	0	5.573000	1	3.355700-1	0.000000	0	0.000000	0
1.312598	5-5.000000-1	4.013900	1	1.806200	0	0.000000	0	0.000000	0
1.356926	5-1.500000	0	1.892400	0	3.564000-1	0.000000	0	0.000000	0
1.390663	5-1.500000	0	3.091600	0	2.446000-1	0.000000	0	0.000000	0
1.411453	5-5.000000-1	9.616300-1	2	2.446000-1	0.000000	0	0.000000	0	
1.440406	5-1.500000	0	1.929200	1	1.827300-1	0.000000	0	0.000000	0
1.514419	5-1.500000	0	4.776600	1	2.446000-1	0.000000	0	0.000000	0
1.520165	5-1.500000	0	1.681900	2	5.979400-1	0.000000	0	0.000000	0
1.524414	5-5.000000-1	8.676600	0	6.970000-1	0.000000	0	0.000000	0	
1.715204	5-1.500000	0	3.488100	0	2.446000-1	0.000000	0	0.000000	0
1.775522	5-1.500000	0	1.484600	0	2.446000-1	0.000000	0	0.000000	0
1.910948	5-1.500000	0	1.484600	0	2.446000-1	0.000000	0	0.000000	0
2.060300	5-1.500000	0	4.750000	1	2.446000-1	0.000000	0	0.000000	0
2.069000	5-5.000000-1	1.500000	2	2.446000-1	0.000000	0	0.000000	0	
2.102000	5-1.500000	0	5.000000	1	2.446000-1	0.000000	0	0.000000	0
2.217300	5-1.500000	0	5.000000	1	2.446000-1	0.000000	0	0.000000	0
2.286400	5-5.000000-1	1.000000	2	2.446000-1	0.000000	0	0.000000	0	
2.397900	5-1.500000	0	1.500000	2	2.446000-1	0.000000	0	0.000000	0
2.430000	5-1.500000	0	4.000000	1	2.446000-1	0.000000	0	0.000000	0
2.555600	5-5.000000-1	5.000000	1	2.446000-1	0.000000	0	0.000000	0	
2.649958	5-5.000000-1	7.463500	3	2.446000-1	0.000000	0	0.000000	0	
2.710600	5-1.500000	0	4.250000	1	2.446000-1	0.000000	0	0.000000	0
2.756000	5-1.500000	0	7.000000	1	2.446000-1	0.000000	0	0.000000	0
2.774000	5-5.000000-1	8.000000	1	2.446000-1	0.000000	0	0.000000	0	
2.821300	5-1.500000	0	1.600000	2	2.446000-1	0.000000	0	0.000000	0
2.893800	5-5.000000-1	6.500000	1	2.446000-1	0.000000	0	0.000000	0	
3.119000	5-1.500000	0	1.850000	2	2.446000-1	0.000000	0	0.000000	0
3.186000	5-1.500000	0	1.500000	2	2.446000-1	0.000000	0	0.000000	0
3.338000	5-5.000000-1	4.000000	2	2.446000-1	0.000000	0	0.000000	0	
3.397500	5-1.500000	0	2.000000	2	2.446000-1	0.000000	0	0.000000	0
3.422300	5-1.500000	0	1.500000	2	2.446000-1	0.000000	0	0.000000	0
3.449200	5-5.000000-1	1.500000	2	2.446000-1	0.000000	0	0.000000	0	
5.743561+1	5.2226000-1	2				23			
1.870825	4	2.500000	0	1.116700-1	2.446000-1	0.000000	0	0.000000	0
3.141204	4	2.500000	0	4.626000-1	2.446000-1	0.000000	0	0.000000	0
3.893203	4	2.500000	0	2.138600-2	2.446000-1	0.000000	0	0.000000	0
4.584883	4	2.500000	0	1.692700	0	2.304100-1	0.000000	0	0.000000
5.333915	4	1.500000	0	5.994500-2	2.446000-1	0.000000	0	0.000000	0
6.825184	4	2.500000	0	3.333300	0	3.026800-1	0.000000	0	0.000000
7.661868	4	1.500000	0	7.095500-2	2.446000-1	0.000000	0	0.000000	0
8.786474	4	2.500000	0	3.333300	0	6.302000-1	0.000000	0	0.000000
8.838280	4	2.500000	0	4.229900	0	2.446000-1	0.000000	0	0.000000
9.155319	4	2.500000	0	1.076200	0	4.271400-1	0.000000	0	0.000000
1.024029	5	2.500000	0	2.821800-1	3.530100-1	0.000000	0	0.000000	0
1.035009	5	2.500000	0	5.766900-2	2.446000-1	0.000000	0	0.000000	0
1.193699	5	2.500000	0	3.853300	0	2.446000-1	0.000000	0	0.000000
1.297586	5	2.500000	0	2.000000	1	3.355400-1	0.000000	0	0.000000
1.381401	5	2.500000	0	1.277400	0	5.180100-1	0.000000	0	0.000000
1.429583	5	2.500000	0	3.333300	1	3.741000-1	0.000000	0	0.000000
1.662337	5	2.500000	0	5.052400	1	2.878500-1	0.000000	0	0.000000
1.674656	5	2.500000	0	1.559000	0	2.446000-1	0.000000	0	0.000000
1.740915	5	2.500000	0	2.931100-1	2.446000-1	0.000000	0	0.000000	0
1.793318	5	2.500000	0	1.276200	1	2.446000-1	0.000000	0	0.000000
1.855598	5	2.500000	0	4.666700	0	6.064000-1	0.000000	0	0.000000
1.956958	5	2.500000	0	1.333300	1	2.446000-1	0.000000	0	0.000000
2.183200	5	2.500000	0	3.000000	1	2.446000-1	0.000000	0	0.000000

Appendix 2

Summary of the reactor constants for ^{58}Fe calculated from the recommended parameters

Maxwellian average

Temperature	= 0.0253 eV
Total cross section	= 9.3888 b
Capture cross section	= 1.1694 b
Scattering cross section	= 8.2188 b
Capture cross section $\times 2/\sqrt{\pi}$	= 1.3143 b

Incident neutron energy

Incident neutron energy	= 0.0253 eV
Total cross section	= 9.5384 b
Capture cross section	= 1.3143 b
Scattering cross section	= 8.2188 b
Capture/ \sqrt{E}	= 0.209054

Energy range 1.0 eV to 155 keV

$$\text{Resonance integral capture} = 0.68585 \pm 0.025 \text{ b}$$

The contribution of the two resonances at 230 and 359 eV is 0.585 b (~87%)

The known resonance contribution from 155 keV to 2 MeV = 0.00159 ± 0.002 b

Estimate of missed resonance contribution from AVEFIT calculations = 0.003 ± 0.0015 b

Thermal capture cross section = 1.3143 ± 0.264 b

$$\begin{aligned} 1/v \text{ contribution above 0.5 eV,} \\ &= 2 \times 1.3143 \times \sqrt{0.0253}/\sqrt{0.5} \\ &= 0.5913 \pm 0.0118 \text{ b} \end{aligned}$$

This may be an overestimate as in the region above the positive resonances it dies away faster than $1/v$

$$\text{Estimate of integral above 2 MeV} = 0.002 \pm 0.001 \text{ b}$$

$$\textbf{Total resonance capture integral} = \mathbf{1.2817 \pm 0.0278 \text{ b}}$$

Appendix 3

The calculated cross section averaged over 100 keV.

Column 1 Mean neutron energy (eV)

Column 2 Total cross section (b)

Column 3 Elastic scattering cross section (b)

Column 4 Capture cross section (b)

Column 5 Inelastic cross section (b), for the level at 810.76 keV

Column 6 Inelastic cross section (b), for the level at 1674.7 keV

1	2	3	4	5	6
50100	18.53115	18.51543	1.57E-02	0	0
150100	7.96316	7.957895	5.26E-03	0	0
250100	8.465101	8.460937	4.16E-03	0	0
350100	6.583507	6.579727	3.78E-03	0	0
450100	7.35681	7.353232	3.58E-03	0	0
550100	6.253419	6.249928	3.49E-03	0	0
650100	7.047603	7.043844	3.76E-03	0	0
750100	5.942594	5.938786	3.81E-03	0	0
850100	7.500503	7.259623	2.99E-03	0.237893	0
950100	6.090503	5.588901	1.84E-03	0.499761	0
1050100	5.743285	5.21737	1.40E-03	0.524511	0
1150100	6.277817	5.664474	1.36E-03	0.611982	0
1250100	6.00406	5.287382	1.23E-03	0.715445	0
1350100	6.141485	5.330994	1.25E-03	0.809244	0
1450100	6.248916	5.285605	1.27E-03	0.962041	0
1550100	6.039197	5.102718	1.26E-03	0.935223	0
1650100	6.159591	5.202213	1.22E-03	0.956155	0
1750100	5.907557	4.835096	1.19E-03	0.917632	0.153638
1850100	5.700753	4.49769	1.12E-03	0.939947	0.261998
1950100	5.870881	4.582131	1.07E-03	0.962784	0.324891

Appendix 4

Lines starting with Rec. in Column 1,

Column 2 resonance identification number

Column 3, 4, 5 and 6 recommended parameters, (table headings)

Lines starting with Chi/DF in column 1 Chi-square per degree of freedom = chi-square/number of data points

Remaining lines are the parameters derived from the published data.

Column 2 is the reference number, those with a negative sign have not been used in the averaging

Column 3, 4, 5, 6 and 7 Parameters (table headings)

The numbers given in the column 2 of the table refer to the following references:-

- 1 [Ho-69]
- 2 [Al-80]
- 3 [Ka-83]
- 4 [Ho-77] s-wave resonances
- 5 [Ho-77] resonances with L>0
- 6 [Gar-78] resonances <188 keV
- 7 [Gar-78] resonances >188 keV
- 8 [Gay-77]
- 9 See present paper
- 10 [Be-78]
- 11 [Mo-80]

References J are the present values in the JEF-2.2 evaluation file.

References E are the present values in the ENDF/B-VI evaluation file.

- J The recommended spin of the resonance and as given by the authors
- L The recommended angular momentum and as given by the authors

Where no value is given for the radiation width it is recommended that a value of 0.2446 eV is used for p-wave and above.

		Energy (eV)	Neutron width (eV)	Radiation width (eV)	J	L
Rec.	10	230.038± 2.029E-02	2.0424E-03± 9.604E-05	1.4567E-01± 4.131E-02	0.50	1
Chi/DF		0.070	6.5949E-01	0.000		
	1	230.168± 1.310E+00	0.7850E-02± 7.152E-03			
	2	229.738± 8.300E-01				
	-6	229.715± 2.000E-01	0.2000E-02± 1.000E-04			>0
	9	230.038± 2.030E-02	0.2041E-02± 9.605E-05	0.1457± 4.131E-02	0.50	1
	J	229.800	0.2000E-02	0.4000	0.50	1
	E	230.000	0.1000E-02	0.4000	1.50	1
---	---	-----	-----	-----	---	--
Rec.	20	358.945± 7.195E-02	6.8980E-03± 3.519E-04	2.9895E-01± 3.710E-02	1.50	1
Chi/DF		13.670	1.6092E-01	0.000		
	1	359.327± 2.049E+00	0.1043E-01± 7.593E-03			
	2	358.478± 1.296E+00				
	-6	358.435± 2.000E-01	0.1050E-01± 1.000E-03			>0
	8	359.714± 1.060E-01	0.7456E-02± 3.405E-03		1.50	1
	9	358.918± 1.980E-02	0.6871E-02± 3.552E-04	0.2989± 3.710E-02	1.50	1
	11	359.342± 2.060E+00	0.9205E-02± 4.765E-03			>0
	J	358.600	0.1000E-01	0.4000	1.50	1
	E	359.000	0.1100E-01	0.4000	1.50	1
---	---	-----	-----	-----	---	--
	22					
	9	1152.733± 3.214E-01	0.2127E-02± 5.459E-04	0.2446± 1.223E-01	0.50	1
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Rec.	30	2827.209± 1.673E+01				
Chi/DF		0.000			2.50	2
	1	2827.209± 1.673E+01				
	E	2820.000	0.2000E-02	0.4000	0.50	1
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	40					
	1	4976.826± 3.036E+01				
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Rec.	50	6189.454± 1.382E+01	2.2474E-02± 8.421E-03	2.4460E-01± 1.223E-01	0.50	1
Chi/DF		8.525	1.4984E-02	0.000		
	1	6183.294± 3.834E+01				
	2	6098.460± 2.259E+01	0.2297E-01± 9.352E-03			
	9	6193.801± 4.880E+00	0.2034E-01± 1.936E-02	0.2446± 1.223E-01	0.50	1
	J	6107.000	0.1000E-01	0.4000	1.50	1
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Rec.	54	6201.009± 1.146E+00	5.6082E-02± 1.913E-02	2.4460E-01± 1.223E-01	0.50	1
Chi/DF		0.472	1.6706E+00	0.000		
	2	6185.277± 2.292E+01	0.4359E-01± 1.768E-02			
	-6	6187.148± 2.000E+00	0.4000E+01± 1.000E+00			>0
	9	6201.048± 1.148E+00	0.8540E-01± 2.708E-02	0.2446± 1.223E-01	0.50	1
	J	6194.000	0.3900E-01	0.4000	0.50	1
	E	6199.000	0.1000E+01	0.1000	1.50	1
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Rec.	56	6206.012± 1.522E+00	3.9445E-02± 1.294E-02	2.4460E-01± 1.223E-01	1.50	1
Chi/DF		0.115	6.3782E-03	0.000		
	2	6198.249± 2.297E+01	0.3882E-01± 1.515E-02			
	9	6206.046± 1.525E+00	0.4115E-01± 2.492E-02	0.2446± 1.223E-01	1.50	1
	J	6207.000	0.3500E-01	0.4000	1.50	1
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	60					
	1	9333.170± 6.026E+01				
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Rec.	70	10426.213± 1.566E+00	3.4122E+02± 1.557E+01	8.9276E-01± 6.297E-02	0.50	0
Chi/DF		1.995	6.5689E+01	0.497		
	1	10451.144± 6.840E+01				
	2	10400.973± 3.919E+01	0.3400E+03± 3.000E+01	0.9728± 8.780E-02		
	3	10412.054± 4.650E+01	0.3400E+03± 1.700E+02	0.7966± 9.368E-02	0.50	0
	4	10283.174± 4.700E+01	0.4160E+03± 5.000E+00	1.6000± 5.000E+01	0.50	0
	-6	10354.331± 5.000E+00	0.2490E+03± 2.500E+01			>0
	8	10408.151± 7.050E+01	0.4116E+03± 2.058E+02	1.0658± 5.388E-01	0.50	0
	9	10426.319± 1.110E+00	0.3282E+03± 2.086E+00	0.8901± 4.450E-01	0.50	0
	-10	10300.149± 4.700E+01	0.4160E+03± 3.200E+01		0.50	0
	J	10400.000	0.3100E+03	0.8700	0.50	0
	E	10380.000	0.2482E+03	1.2464	0.50	0
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Rec.	80	17827.285± 6.908E+01	2.5258E-03± 2.547E-03		1.50	1
Chi/DF		0.000	0.000			
	2	17827.285± 6.908E+01	0.2526E-02± 2.547E-03			
	J	17870.000	0.5000E-02	0.4000	1.50	1
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Rec.	90	17946.854± 6.958E+01	1.1518E-02± 7.160E-03		0.50	1
Chi/DF		0.000	0.000			
	2	17946.854± 6.958E+01	0.1152E-01± 7.160E-03			
	J	17990.000	0.1100E-01	0.4000	0.50	1
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Rec.	95	18708.251± 8.000E+01	1.1167E-01± 5.232E-01		2.50	2
Chi/DF		0.000	0.000			
	5	18708.251± 8.000E+01	0.1117E+00± 5.232E-01			
	E	18740.000	0.1602E+00	0.2000	1.50	1
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Rec.	100	19325.130± 3.563E+00	2.1213E-01± 4.984E-02	1.6957E-01± 7.174E-02	1.50	1
Chi/DF		0.174	9.5805E-01	0.000		
	2	19271.986± 7.508E+01	0.2356E+00± 1.591E-01			
	3	19330.484± 1.147E+02	0.2337E+00± 2.427E-01			
	5	19312.699± 9.500E+01	0.1300E+01± 6.500E-01	0.1696± 1.346E-01		
	9	19325.263± 3.571E+00	0.2009E+00± 5.394E-02	0.1696± 8.478E-02	0.50	1
	J	19320.000	0.1710E+00	0.2500	1.50	1
	E	19350.000	0.2817E+00	0.1696	1.50	1
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Rec.	110	26083.594± 1.175E+00	8.0005E+00± 4.234E-01	2.1141E-01± 8.166E-03	0.50	1
Chi/DF		0.313	4.2230E-02	0.549		
	2	25994.761± 1.037E+02	0.8000E+01± 4.000E+00	0.2157± 9.324E-03		
	3	26147.949± 1.790E+02	0.8000E+01± 4.000E+00	0.1957± 1.721E-02		
	5	26047.828± 1.300E+02	0.6800E+01± 3.400E+00	0.3579± 1.886E-01		
	-6	25967.941± 1.000E+01	0.3000E+02± 5.000E+00			>0
	9	26083.606± 1.175E+00	0.8020E+01± 4.317E-01	0.2123± 1.062E-01	0.50	1
	-10	25944.431± 1.300E+02	0.6800E+01± 6.800E+00			
	J	26070.000	0.2000E+02	0.2000	0.50	1
	E	26070.000	0.5609E+01	0.2000	0.50	1
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Rec.	120	29221.989± 1.029E+02	1.4911E-02± 1.215E-02		0.50	1
Chi/DF		0.529	0.258			
	2	29180.503± 1.177E+02	0.1485E-01± 1.215E-02			
	3	29357.036± 2.124E+02	0.6404E+00± 1.231E+00			
	J	29270.000	0.1700E-01	0.4000	0.50	1
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Rec.	130	31412.045± 9.976E+01	4.6260E-01± 2.546E+00		2.50	2
Chi/DF		0.023	0.000			
	2	31400.091± 1.276E+02				
	5	31430.837± 1.600E+02	0.4626E+00± 2.546E+00			

	E	31500.000	0.6000E+00	0.2000	1.50	1
---	---	-----	-----	-----	---	--
Rec.	140	34670.536± 2.493E+00	3.1015E-01± 7.224E-01	2.0169E-01± 1.149E-02	1.50	1
Chi/DF		0.618	3.6625E+00	1.804		
	2	34524.800± 1.418E+02	0.3500E+01± 1.750E+00	0.2009± 8.595E-03		
	5	34590.144± 1.900E+02	0.3950E+01± 1.975E+00	0.5399± 1.783E-01		
	-6	34489.712± 1.000E+01	0.1250E+02± 2.500E+00		>0	
	9	34670.595± 2.494E+00	0.3288E-02± 3.942E-01	0.2019± 1.010E-01	1.50	1
	-10	34431.990± 1.900E+02	0.3950E+01± 3.950E+00			
	J	34640.000	0.1250E+02	0.3300	1.50	1
	E	34650.000	0.1674E+02	0.2000	0.50	1
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Rec.	150	36554.484± 1.511E+02	5.3651E-02± 3.252E-02		1.50	1
Chi/DF		0.000	0.000			
	2	36554.484± 1.511E+02	0.5365E-01± 3.252E-02			
	J	36680.000	0.4200E-01	0.4000	1.50	1
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Rec.	160	37665.850± 1.898E+00	4.7500E+01± 2.061E+00	2.3833E-01± 1.392E-02	0.50	0
Chi/DF		0.408	2.2554E+00	2.106		
	2	37509.529± 1.555E+02	0.4800E+02± 2.400E+01	0.2311± 1.162E-02		
	3	37682.931± 3.074E+02	0.4750E+02± 2.375E+01	0.2513± 1.719E-02		
	5	37569.601± 2.100E+02	0.2700E+02± 8.000E+00	0.8032± 2.440E-01		
	-6	37485.885± 1.000E+01	0.5000E+02± 1.000E+01		>0	
	9	37665.880± 1.898E+00	0.4812E+02± 1.398E+00	0.2382± 1.191E-01	0.50	0
	-10	37390.604± 2.100E+02	0.2700E+02± 8.000E+00			
	J	37640.000	0.2000E+02	0.2400	1.50	1
	E	37660.000	0.2831E+02	0.4000	0.50	1
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Rec.	170	38245.666± 1.589E+02	8.8524E-02± 5.305E-02		1.50	1
Chi/DF		0.000	0.000			
	2	38245.666± 1.589E+02	0.8852E-01± 5.305E-02			
	J	38380.000	0.7800E-01	0.4000	1.50	1
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Rec.	180	38932.030± 1.622E+02	2.1386E-02± 2.144E-02		2.50	2
Chi/DF		0.000	0.000			
	2	38932.030± 1.622E+02	0.2139E-01± 2.144E-02			
	J	39070.000	0.2000E-01	0.4000	2.50	2
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Rec.	190	39210.546± 1.635E+02	3.1620E-02± 3.300E-02		1.50	1
Chi/DF		0.000	0.000			
	2	39210.546± 1.635E+02	0.3162E-01± 3.300E-02			
	J	39350.000	0.2900E-01	0.4000	1.50	1
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Rec.	200	41811.403± 1.334E+02	9.7388E-01± 6.042E-01	3.0487E-01± 3.103E-02	1.50	1
Chi/DF		0.254	2.6098E+00	2.187		
	2	41736.840± 1.754E+02	0.2500E+01± 1.250E+00	0.3027± 2.280E-02		
	3	41997.565± 3.610E+02	0.7850E+00± 3.925E-01	0.2811± 5.629E-02		
	5	41873.619± 2.500E+02	0.1500E+02± 7.500E+00	0.6631± 1.751E-01		
	J	41890.000	0.5700E+00	0.4000	1.50	1
	E	41980.000	0.1740E+01	1.0000	1.50	1
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Rec.	210	43818.002± 3.263E+01	5.5534E+03± 7.499E+01	1.1980E+00± 1.023E-01	0.50	0
Chi/DF		8.080	5.1682E+00	0.013		
	2	43139.050± 1.821E+02	0.5550E+04± 1.000E+03	1.0002± 1.000E+00		
	3	43402.499± 3.791E+02	0.5553E+04± 2.777E+03	1.2003± 1.044E-01	0.50	0
	4	43069.434± 2.500E+02	0.6370E+04± 2.100E+02	2.1700± 5.000E+01	0.50	0
	-6	42932.856± 3.000E+01	0.4320E+04± 4.300E+02		>0	
	9	43822.693± 1.152E+01	0.5533E+04± 3.342E+01	1.1929± 5.965E-01	0.50	0
	-10	43215.130± 2.500E+02	0.6370E+04± 2.100E+02		0.50	0
	J	43300.000	0.5800E+04	1.1000	0.50	0
	E	43550.000	0.6130E+04	2.2000	0.50	0
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Rec.	220	45848.835± 7.793E+00	1.6927E+00± 7.448E-01	2.3041E-01± 3.048E-02	2.50	2
Chi/DF		0.497	2.2580E+00	0.005		
	2	45614.983± 1.940E+02	0.2660E+01± 1.390E+01			
	3	45911.508± 4.121E+02	0.1093E+01± 5.467E-01	0.2295± 3.148E-02		
	5	45818.228± 2.900E+02	0.1276E+02± 9.201E+02			
	9	45849.213± 7.804E+00	0.4475E+01± 1.179E+00	0.2446± 1.223E-01	0.50	1
	J	45790.000	0.9700E+00	0.4000	2.50	2
	E	45940.000	0.1300E+00	1.0000	1.50	1
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Rec.	230	53339.152± 2.117E+02	5.9945E-02± 5.756E-02		1.50	2
Chi/DF		0.405	0.736			
	2	53279.019± 2.318E+02	0.1424E+00± 1.120E-01			
	3	53640.800± 5.193E+02	0.3035E-01± 6.710E-02			
	J	53500.000	0.7000E-01	0.4000	1.50	1
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Rec.	240	54530.376± 2.859E+00	5.2055E+01± 1.705E+00	3.4913E-01± 1.996E-02	0.50	1
Chi/DF		0.510	8.3994E-02	1.333		
	2	54242.989± 2.367E+02	0.5210E+02± 2.605E+01	0.3726± 2.256E-02		
	3	54644.769± 5.338E+02	0.5210E+02± 2.605E+01	0.3149± 2.724E-02		
	5	54561.729± 3.300E+02	0.5700E+02± 1.000E+01			

-6	54191.917	$\pm 4.000E+01$	0.7000E+02	$\pm 2.000E+01$		>0	
9	54530.412	$\pm 2.859E+00$	0.5191E+02	$\pm 1.738E+00$	0.3470	$\pm 1.735E-01$	
-10	54248.686	$\pm 3.300E+02$	0.5700E+02	$\pm 1.000E+01$	0.50	1	
J	54470.000		0.6400E+02		0.3400	0.50	
E	54900.000		0.5037E+02		0.4000	0.50	
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Rec.	250	61712.160	$\pm 3.819E+00$	2.6880E+01	$\pm 2.037E+00$	2.0548E-01	$\pm 1.496E-02$
Chi/DF		0.564		2.4558E+00		2.222	
2	61376.710	$\pm 2.733E+02$	0.1400E+02	$\pm 7.000E+00$	0.1926	$\pm 1.179E-02$	
3	61874.407	$\pm 6.422E+02$	0.1395E+02	$\pm 6.975E+00$	0.2406	$\pm 1.946E-02$	
5	61848.958	$\pm 3.900E+02$	0.2650E+02	$\pm 7.000E+00$			
-6	61328.993	$\pm 4.000E+01$	0.4000E+02	$\pm 1.000E+01$		>0	
9	61712.207	$\pm 3.820E+00$	0.2789E+02	$\pm 1.373E+00$	0.2044	$\pm 1.022E-01$	
-10	61471.256	$\pm 3.900E+02$	0.2650E+02	$\pm 7.000E+00$	0.50	1	
J	61650.000		0.6700E+02		0.4300	0.50	
E	62000.000		0.2262E+02		1.0000	0.50	
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Rec.	260	67056.935	$\pm 1.042E+01$	9.1884E+02	$\pm 1.038E+01$	3.5444E-01	$\pm 1.238E-01$
Chi/DF		2.746		9.1465E-01		0.052	
2	66392.493	$\pm 2.998E+02$	0.1000E+04	$\pm 3.000E+02$	0.3001	$\pm 2.001E-01$	
3	66896.048	$\pm 7.213E+02$	0.9190E+03	$\pm 4.595E+02$	0.4360	$\pm 3.003E-01$	
4	66261.118	$\pm 4.400E+02$	0.9970E+03	$\pm 4.900E+01$	1.0000	$\pm 2.800E+01$	
-6	66481.194	$\pm 1.000E+01$	0.8100E+03	$\pm 8.000E+01$		>0	
9	67057.403	$\pm 6.292E+00$	0.9151E+03	$\pm 1.063E+01$	0.3699	$\pm 1.850E-01$	
-10	66539.310	$\pm 4.400E+02$	0.9970E+03	$\pm 4.900E+01$	0.50	0	
J	66700.000		0.9000E+03		0.4300	0.50	
E	67200.000		0.8649E+03		0.3000	0.50	
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Rec.	270	68251.842	$\pm 2.517E+02$	3.3333E+00	$\pm 9.623E-01$	3.0268E-01	$\pm 3.680E-02$
Chi/DF		0.205		1.0650E-31		5.583	
2	68199.836	$\pm 3.094E+02$	0.3333E+01	$\pm 1.667E+00$	0.3622	$\pm 2.540E-02$	
3	68704.043	$\pm 7.505E+02$	0.3333E+01	$\pm 1.667E+00$	0.2640	$\pm 1.980E-02$	
5	68178.866	$\pm 5.300E+02$	0.3333E+01	$\pm 1.667E+00$	0.5975	$\pm 2.154E-01$	
-6	68145.345	$\pm 4.000E+01$	0.3333E+01	$\pm 1.667E+00$		>0	
J	68520.000		0.3330E+01		0.3050	2.50	
E	68400.000		0.3178E+01		0.3000	1.50	
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Rec.	280	73387.343	$\pm 2.765E+02$	8.7040E-01	$\pm 4.312E-01$	6.3595E-01	$\pm 2.499E-01$
Chi/DF		0.265		1.2782E-02		0.000	
2	73362.754	$\pm 3.375E+02$	0.1729E+01	$\pm 5.467E+00$			
3	73927.732	$\pm 8.370E+02$	0.8650E+00	$\pm 4.325E-01$	0.6360	$\pm 2.499E-01$	
5	73194.002	$\pm 5.900E+02$	0.5988E+01	$\pm 1.884E+02$			
J	73720.000		0.4170E+01		0.4000	1.50	
E	73440.000		0.2390E+01		0.3000	1.50	
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Rec.	290	76618.679	$\pm 3.554E+02$	7.0955E-02	$\pm 3.118E-02$		
Chi/DF		0.000		0.000		1.50	2
2	76618.679	$\pm 3.554E+02$	0.7095E-01	$\pm 3.118E-02$			
J	77000.000		0.6400E-01		0.4000	1.50	
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Rec.	300	79337.435	$\pm 1.135E+01$	2.4094E+01	$\pm 2.903E+00$	1.4723E-01	$\pm 1.959E-02$
Chi/DF		0.991		2.7838E-03		0.50	1
2	78822.091	$\pm 3.677E+02$	0.2400E+02	$\pm 1.200E+01$	0.1408	$\pm 1.842E-02$	
3	79453.715	$\pm 9.319E+02$	0.2500E+02	$\pm 1.250E+01$	0.2770	$\pm 8.405E-02$	
-6	78799.333	$\pm 4.000E+01$	0.2500E+02	$\pm 5.000E+00$		>0	
9	79337.910	$\pm 1.136E+01$	0.2405E+02	$\pm 3.081E+00$	0.1502	$\pm 7.509E-02$	
J	79220.000		0.1250E+02		0.2700	1.50	
E	79340.000		0.1375E+02		0.2000	0.50	
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Rec.	310	85744.552	$\pm 3.793E+02$	1.3580E+00	$\pm 3.731E+00$		
Chi/DF		0.426		0.010		1.50	1
2	85649.218	$\pm 4.065E+02$	0.2187E+01	$\pm 9.018E+00$			
3	86387.613	$\pm 1.056E+03$	0.1187E+01	$\pm 4.098E+00$	0.4000	1.50	
J	86100.000		0.7400E+00				
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Rec.	320	87653.283	$\pm 4.180E+02$	5.0000E+00	$\pm 2.500E+00$	3.0786E-01	$\pm 3.090E-02$
Chi/DF		0.000		0.0000E+00		0.000	
2	87653.283	$\pm 4.180E+02$	0.5000E+01	$\pm 2.500E+00$	0.3079	$\pm 3.090E-02$	
-6	87596.137	$\pm 4.000E+01$	0.1000E+02	$\pm 5.000E+00$		>0	
J	88120.000		0.1000E+02		0.2900	0.50	
E	88485.000		0.1034E+02		0.2000	0.50	
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Rec.	330	87864.738	$\pm 3.681E+02$	3.3333E+00	$\pm 1.667E+00$	6.3020E-01	$\pm 2.385E-01$
Chi/DF		0.027		0.0000E+00		0.000	
2	87831.854	$\pm 4.191E+02$	0.3333E+01	$\pm 1.667E+00$	0.6302	$\pm 2.385E-01$	
5	87975.759	$\pm 7.700E+02$	0.3600E+01		0.4000	2.50	
J	88750.000		0.4288E+01				
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Rec.	340	88382.797	$\pm 3.940E+02$	4.2299E+00	$\pm 2.301E+01$		
Chi/DF		0.484		0.000		2.50	2
2	88278.275	$\pm 4.217E+02$	0.4191E+01	$\pm 2.978E+01$			
3	89101.259	$\pm 1.105E+03$	0.4288E+01	$\pm 3.626E+01$			

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Rec.	350	91553.189± 3.884E+02	1.0762E+00± 5.878E-01	4.2714E-01± 2.327E-01	2.50	2
Chi/DF		0.053	9.9918E-01	0.000		
	2	91601.353± 4.410E+02	0.4916E+00± 8.291E-01			
	5	91386.702± 8.200E+02	0.1667E+01± 8.333E-01	0.4271± 2.327E-01		
	J	92100.000	0.7900E+00	0.4000	1.50	1
	E	91730.000	0.1040E+01	0.3000	1.50	1
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Rec.	360	92187.620± 4.153E+02	2.4138E+00± 1.034E+00	1.9848E-01± 1.355E-01	0.50	1
Chi/DF		0.331	1.2414E+00	22.006		
	2	92097.293± 4.440E+02	0.2000E+01± 1.000E+00	0.1739± 2.935E-02		
	3	92820.299± 1.175E+03	0.5000E+01± 2.500E+00	0.9453± 1.618E-01		
	J	92600.000	0.3300E+00	0.4000	0.50	1
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Rec.	370	93642.290± 5.568E+01	9.2663E+03± 1.599E+02	1.0293E+00± 3.451E-01	0.50	0
Chi/DF		3.362	4.8543E+00	0.035		
	2	92494.036± 4.463E+02	0.9260E+04± 1.500E+03	1.5002± 1.500E+00		
	3	93322.902± 1.184E+03	0.9260E+04± 4.630E+03	1.0001± 5.001E-01	0.50	0
	4	92384.399± 6.900E+02	0.1223E+05± 7.800E+02	7.7400± 1.780E+02	0.50	0
	-6	91819.658± 6.400E+01	0.7430E+04± 7.400E+02		>0	
	9	93650.312± 3.048E+01	0.9240E+04± 7.298E+01	1.0059± 5.030E-01	0.50	0
	-10	92842.648± 6.900E+02	0.1223E+05± 7.800E+02		0.50	0
	J	93000.000	0.8500E+04	1.0000	0.50	0
	E	91499.000	0.9096E+04	7.7400	0.50	0
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Rec.	380	95866.077± 4.663E+02	2.1875E+00± 1.081E+01		1.50	1
Chi/DF		0.000	0.000			
	2	95866.077± 4.663E+02	0.2187E+01± 1.081E+01			
	J	96400.000	0.7900E+00	0.4000	1.50	1
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Rec.	390	97505.850± 4.457E+02	1.5289E+00± 1.313E+01		1.50	1
Chi/DF		0.384	0.000			
	2	97403.167± 4.755E+02	0.4699E+02± 4.244E+03			
	3	98248.778± 1.279E+03	0.1528E+01± 1.313E+01			
	J	97950.000	0.3600E+01	0.4000	1.50	1
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Rec.	400	102402.863± 4.480E+02	2.8218E-01± 1.992E-01	3.5301E-01± 4.239E-01	2.50	2
Chi/DF		0.154	1.6254E+00	0.000		
	2	102311.257± 5.051E+02	0.1692E+00± 1.797E-01			
	5	102740.707± 9.700E+02	0.6333E+00± 3.167E-01	0.3530± 4.239E-01		
	J	102900.000	0.2300E+00	0.4000	1.50	1
	E	103150.000	0.2270E+01	0.4000	1.50	1
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Rec.	410	103500.943± 5.124E+02	5.7669E-02± 7.387E-02		2.50	2
Chi/DF		0.000	0.000			
	2	103500.943± 5.124E+02	0.5767E-01± 7.387E-02			
	J	104100.000	0.5300E-01	0.4000	2.50	2
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Rec.	420	109320.483± 3.538E+01	4.1080E+01± 6.5000E+00	3.4230E-01± 3.710E-02	0.50	1
Chi/DF		2.532	3.2574E-03	0.005		
	2	108457.335± 5.429E+02	0.4000E+02± 2.000E+01	0.3429± 3.807E-02		
	-6	108387.032± 4.000E+01	0.4000E+02± 1.500E+01		>0	
	9	109321.933± 2.225E+01	0.4121E+02± 6.873E+00	0.3307± 1.653E-01	0.50	1
	J	109180.000	0.4000E+02	0.3300	0.50	1
	E	109260.000	0.9952E+00	0.4000	0.50	1
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Rec.	430	111295.186± 4.992E+02	1.0000E+00± 3.536E-01	3.6057E-01± 7.857E-02	1.50	1
Chi/DF		0.061	0.0000E+00	0.031		
	2	111232.474± 5.602E+02	0.1000E+01± 5.000E-01	0.3605± 7.857E-02		
	5	111536.977± 1.100E+03	0.1000E+01± 5.000E-01	8.0909± 4.368E+01		
	J	111900.000	0.7000E+00	0.4000	1.50	1
	E	112000.000	0.8036E+01	1.0000	1.50	1
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Rec.	440	113979.936± 8.635E+02	1.0446E+00± 1.569E+00	2.4460E-01± 1.223E-01	0.50	1
Chi/DF		16.918	8.4715E-02	0.000		
	2	111827.106± 5.639E+02	0.7592E+00± 1.850E+00			
	9	114326.300± 2.262E+02	0.1775E+01± 2.960E+00	0.2446± 1.223E-01	0.50	1
	J	112500.000	0.3300E+00	0.4000	1.50	1
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Rec.	450	119369.929± 5.351E+02	3.8533E+00± 3.359E+01		2.50	2
Chi/DF		0.085	0.000			
	2	119456.966± 6.124E+02	0.3853E+01± 3.409E+01			
	5	119089.110± 1.100E+03	0.3853E+01± 1.963E+02			
	J	119600.000	0.5400E+00	0.4000	2.50	2
	E	119600.000	0.3488E+01	0.4000	1.50	1
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Rec.	460	121186.203± 2.565E+01	2.2682E+03± 5.227E+01	1.0742E+00± 3.800E-01	0.50	0
Chi/DF		1.701	1.8922E+00	0.004		
	2	120943.035± 6.220E+02	0.2270E+04± 8.000E+02	1.1005± 5.505E-01		
	4	119438.313± 9.700E+02	0.2670E+04± 2.100E+02		0.50	0
	-6	119982.936± 4.600E+01	0.1810E+04± 1.800E+02		>0	
	9	121187.166± 1.968E+01	0.2255E+04± 3.868E+01	1.0502± 5.251E-01	0.50	0

	-10	120112.283± 9.700E+02	0.2670E+04± 2.100E+02		0.50	0
	J	121500.000	0.2300E+04	1.0600	0.50	0
	E	121210.000	0.2399E+04	2.3000	0.50	0
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Rec.	470	123463.349± 2.141E+01	4.8230E+01± 6.927E+00	3.2568E-01± 6.161E-02	0.50	1
Chi/DF		1.024	3.3433E-01	0.589		
	2	124113.032± 6.425E+02	0.3800E+02± 1.900E+01	0.3533± 7.133E-02		>0
	-6	122372.338± 4.000E+01	0.6000E+02± 2.000E+01			
	9	123462.644± 2.117E+01	0.4980E+02± 7.439E+00	0.2446± 1.223E-01	0.50	1
	J	124900.000	0.6000E+02	0.3400	0.50	1
	E	123420.000	0.9976E-02	0.4000	1.50	1
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Rec.	480	130109.006± 1.757E+01	5.5730E+01± 3.401E+01	3.3557E-01± 3.355E-02	1.50	1
Chi/DF		2.391	2.4331E+01	0.000		
	2	129065.385± 6.750E+02	0.2000E+02± 1.000E+01	0.3355± 3.423E-02		
	9	130109.302± 1.136E+01	0.8810E+02± 9.518E+00	0.3365± 1.682E-01	1.50	1
	J	129900.000	0.6750E+02	0.3200	1.50	1
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Rec.	490	129758.640± 6.796E+02	2.0000E+01± 1.000E+01	3.3554E-01± 2.744E-02	2.50	2
Chi/DF		0.000	0.0000E+00	0.000		
	2	129758.640± 6.796E+02	0.2000E+02± 1.000E+01	0.3355± 2.744E-02		>0
	-6	128946.596± 5.000E+01	0.4500E+02± 6.667E+00			
	-10	129387.764± 1.100E+03	0.6667E+02± 7.333E+00			
	E	130880.000	0.7365E+02	1.8000	1.50	2
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Rec.	500	131259.806± 6.619E+01	4.0139E+01± 5.566E+01	1.8062E+00± 6.130E-01	0.50	1
Chi/DF		0.832	5.9201E+01	0.000		
	2	130451.878± 6.842E+02				
	5	130712.427± 1.100E+03	0.2000E+03± 2.200E+01	1.8062± 8.349E-01		
	9	131269.474± 6.662E+01	0.2076E+02± 7.660E+00	1.8062± 9.031E-01	1.50	1
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Rec.	510	135692.565± 1.579E+02	1.8924E+00± 5.947E+00	3.5640E-01± 1.782E-01	1.50	1
Chi/DF		3.293	7.4628E-02	0.000		
	2	134412.893± 7.106E+02	0.1559E+01± 6.071E+00			
	-6	134383.990± 5.000E+01	0.1250E+02± 5.000E+00			>0
	9	135712.040± 8.766E+01	0.9809E+01± 2.959E+01	0.3564± 1.782E-01	1.50	1
	J	135300.000	0.1250E+02	0.3600	1.50	1
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Rec.	520	135652.623± 6.480E+02			2.50	2
Chi/DF		0.028				
	2	135601.084± 7.185E+02				
	5	135877.220± 1.500E+03				
	J	137600.000	0.2360E+02	0.4000	2.50	2
	E	135590.000	0.1247E+02	0.4000	1.50	2
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Rec.	530	138140.135± 2.525E+02	1.2774E+00± 5.695E-01	5.1801E-01± 1.326E-01	2.50	2
Chi/DF		4.111	7.6998E-01	0.762		
	2	136690.215± 7.259E+02	0.1167E+01± 5.833E-01	0.6243± 1.800E-01		
	9	138184.100± 1.264E+02	0.3533E+01± 2.632E+00	0.3920± 1.960E-01	2.50	2
	J	140000.000	0.1890E+01	0.4000	1.50	1
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Rec.	540	139066.349± 7.420E+02	3.0916E+00± 2.227E+01		1.50	1
Chi/DF		0.000	0.000			
	2	139066.349± 7.420E+02	0.3092E+01± 2.227E+01			
	J	143800.000	0.3300E+02	0.3600	2.50	2
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Rec.	550	141145.299± 7.561E+02	9.6163E-01± 3.657E+00		0.50	1
Chi/DF		0.000	0.000			
	2	141145.299± 7.561E+02	0.9616E+00± 3.657E+00			
	E	144000.000	0.1802E+02	0.4000	1.50	1
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Rec.	560	142958.319± 6.921E+02	3.3333E+01± 1.179E+01	3.7410E-01± 4.160E-02	2.50	2
Chi/DF		0.154	0.0000E+00	1.928		
	2	142828.145± 7.676E+02	0.3333E+02± 1.667E+01	0.3707± 3.006E-02		
	5	143523.851± 1.600E+03	0.3333E+02± 1.667E+01	0.8898± 3.726E-01		
	-6	142680.332± 6.000E+01	0.3333E+02± 1.000E+01			>0
	J	145000.000	0.2000E+02	0.3500	0.50	1
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Rec.	570	144040.615± 2.790E+01	1.9292E+01± 6.921E+00	1.8273E-01± 2.972E-02	1.50	1
Chi/DF		0.025	7.3861E+00	1.072		
	2	144015.975± 7.758E+02	0.1000E+02± 5.000E+00	0.1781± 2.905E-02		
	-6	143923.014± 6.000E+01	0.1000E+02± 2.500E+00			>0
	9	144040.615± 2.792E+01	0.2445E+02± 3.724E+00	0.3741± 1.870E-01	2.50	2
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	575					
	9	151441.911± 3.975E+01	0.4777E+02± 1.078E+01	0.2446± 1.223E-01	1.50	1
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Rec.	580	152016.529± 1.116E+01	1.6819E+02± 1.709E+01	5.9794E-01± 5.379E-02	1.50	1
Chi/DF		0.442	4.5468E+00	1.300		
	2	151240.871± 8.260E+02	0.8350E+02± 4.175E+01	0.5891± 4.751E-02		
	5	151963.269± 1.400E+03	0.1425E+03± 1.550E+01	1.3527± 5.809E-01		
	-6	150549.398± 6.000E+01	0.1825E+03± 2.500E+01			>0

	9	152016.674± 1.116E+01	0.1825E+03± 9.606E+00	1.1242± 5.621E-01	1.50	1
	-10	150512.393± 1.400E+03	0.1425E+03± 1.550E+01			
	E	152650.000	0.1936E+03	2.7000	1.50	1
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Rec.	590	152441.390± 2.476E+02	8.6766E+00± 5.974E+00	6.9700E-01± 3.922E-01	0.50	1
Chi/DF		40.130	1.3454E+00	23.969		
	2	157969.282± 8.735E+02	0.1500E+02± 7.500E+00	1.0371± 1.060E-01		>0
	-6	157883.335± 6.000E+01	0.7000E+02± 1.500E+01			
	9	152430.297± 3.913E+01	0.3032E+01± 7.086E+00	0.2446± 1.223E-01	2.50	2
	J	159100.000	0.2330E+02	0.3300	2.50	2
	E	159420.000	0.3335E+02	0.4000	1.50	1
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Rec.	600	160244.719± 8.898E+02	1.3326E+00± 9.575E+00		0.50	0
Chi/DF		0.000	0.000			
	2	160244.719± 8.898E+02	0.1333E+01± 9.575E+00			
	J	161400.000	0.1200E+01	0.4000	0.50	0
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Rec.	610	166233.689± 2.632E+01	5.0524E+01± 1.473E+01	2.8785E-01± 3.680E-02	2.50	2
Chi/DF		2.433	1.4141E+01	0.000		
	2	164795.071± 9.225E+02	0.1867E+02± 9.333E+00	0.2877± 3.804E-02		>0
	-6	164584.225± 6.000E+01	0.6000E+02± 1.167E+01			
	9	166234.171± 1.688E+01	0.5733E+02± 4.315E+00	0.2899± 1.450E-01	1.50	1
	J	166220.000	0.9000E+02	0.4100	1.50	1
	E	166220.000	0.1000E+02	0.4000	0.50	1
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Rec.	620	167465.609± 9.419E+02	1.5590E+00± 7.620E+00		2.50	2
Chi/DF		0.000	0.000			
	2	167465.609± 9.419E+02	0.1559E+01± 7.620E+00			
	J	168700.000	0.3160E+01	0.4000	1.50	1
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Rec.	630	171520.422± 9.716E+02	3.4881E+00± 3.160E+01		1.50	1
Chi/DF		0.000	0.000			
	2	171520.422± 9.716E+02	0.3488E+01± 3.160E+01			
	J	172800.000	0.1030E+02	0.4000	1.50	1
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Rec.	640	174091.488± 9.906E+02	2.9311E-01± 6.430E-01		2.50	2
Chi/DF		0.000	0.000			
	2	174091.488± 9.906E+02	0.2931E+00± 6.430E-01			
	J	178900.000	0.4200E+00	0.4000	1.50	1
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	650					
	2	177552.203± 1.016E+03	0.1485E+01± 1.334E+01			
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Rec.	660	178828.512± 1.990E+01	2.2436E+03± 1.457E+01	8.8210E-01± 4.410E-01	0.50	0
Chi/DF		0.335	3.4410E-01	0.000		
	2	178145.430± 1.021E+03				
	4	175512.782± 7.036E+03	0.2390E+04± 2.500E+02		0.50	0
	-6	176680.134± 8.400E+01	0.2750E+04± 2.800E+02			>0
	9	178828.798± 1.990E+01	0.2243E+04± 1.460E+01	0.8821± 4.410E-01	0.50	0
	-10	176714.432± 1.700E+03	0.2390E+04± 2.500E+02		0.50	0
	J	178500.000	0.2570E+04	0.9000	0.50	0
	E	178690.000	0.2677E+04	3.0000	0.50	0
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Rec.	670	179331.849± 1.030E+03	1.2762E+01± 4.261E+02		2.50	2
Chi/DF		0.000	0.000			
	2	179331.849± 1.030E+03	0.1276E+02± 4.261E+02			
	J	180700.000	0.1380E+01	0.4000	2.50	2
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Rec.	680	185559.821± 1.077E+03	4.6667E+00± 2.333E+00	6.0640E-01± 7.318E-02	2.50	2
Chi/DF		0.000	0.0000E+00	0.000		
	2	185559.821± 1.077E+03	0.4667E+01± 2.333E+00			
	-6	185442.713± 6.000E+01	0.1667E+02± 5.000E+00			>0
	J	187400.000	0.1670E+02	0.5300	2.50	2
	E	187400.000	0.2410E+02	0.4000	1.50	1
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Rec.	690	191094.776± 1.119E+03	1.4846E+00± 1.088E+01		1.50	1
Chi/DF		0.000	0.000			
	2	191094.776± 1.119E+03	0.1485E+01± 1.088E+01			
	J	192600.000	0.4200E+00	0.4000	1.50	1
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Rec.	700	195695.760± 8.074E+01	1.3333E+01± 5.000E+00		2.50	2
Chi/DF		1.816	0.000			
	2	194158.362± 1.142E+03				
	7	195700.000± 6.000E+01	0.1333E+02± 5.000E+00			>0
	J	195700.000	0.1330E+02	0.4000	2.50	2
	E	195700.000	0.8830E+01	0.4000	1.50	1
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Rec.	710	206030.000± 7.000E+01	4.7500E+01± 1.000E+01		1.50	1
Chi/DF		0.000	0.000			
	7	206030.000± 7.000E+01	0.4750E+02± 1.000E+01			>0
	J	205030.000	0.4750E+02	0.7500	1.50	1
	E	206030.000	0.2268E+02	0.4000	0.50	1

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Rec.	720	206900.000± 7.000E+01	1.5000E+02± 3.000E+01	0.50	1		
Chi/DF	0.000	0.000					
J	7	206900.000± 7.000E+01	0.1500E+03± 3.000E+01	0.7500		>0	
E	206900.000	0.1500E+03	0.2119E+02	0.4000	1	0.50	1
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Rec.	730	210200.000± 7.000E+01	5.0000E+01± 1.500E+01	1.50	1		
Chi/DF	0.000	0.000					
J	7	210200.000± 7.000E+01	0.5000E+02± 1.500E+01	0.7500	1	>0	
E	210200.000	0.5000E+02	0.3393E+01	0.4000	1	1.50	1
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Rec.	740	218320.000± 7.000E+01	3.0000E+01± 1.000E+01	2.50	2		
Chi/DF	0.000	0.000					
J	7	218320.000± 7.000E+01	0.3000E+02± 1.000E+01	0.7500	2	>0	
E	218320.000	0.3000E+02	0.4220E+02	0.4000	2	2.50	2
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Rec.	750	221730.000± 7.000E+01	5.0000E+01± 1.500E+01	1.50	1		
Chi/DF	0.000	0.000					
J	7	221730.000± 7.000E+01	0.5000E+02± 1.500E+01	0.7500	1	>0	
E	221730.000	0.5000E+02	0.4492E+02	0.4000	2	1.50	2
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Rec.	760	228640.000± 7.000E+01	1.0000E+02± 3.000E+01	0.50	1		
Chi/DF	0.000	0.000					
J	7	228640.000± 7.000E+01	0.1000E+03± 3.000E+01	0.7500	1	>0	
E	228640.000	0.1000E+03	0.3285E+02	0.4000	1	0.50	1
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Rec.	770	239790.000± 7.000E+01	1.5000E+02± 2.500E+01	1.50	1		
Chi/DF	0.000	0.000					
J	7	239790.000± 7.000E+01	0.1500E+03± 2.500E+01	0.7500	1	>0	
E	238790.000	0.1500E+03	0.1149E+03	0.4000	1	0.50	1
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Rec.	800	239987.546± 2.491E+02	1.0402E+04± 8.244E+02	0.50	0		
Chi/DF	3.680	0.124					
J	4	235005.813± 2.600E+03	0.1080E+05± 1.400E+03	0.50	0		
E	7	240000.000± 1.300E+02	0.1019E+05± 1.020E+03			>0	
J	-10	236869.114± 2.600E+03	0.1080E+05± 1.400E+03			0.50	0
E	240000.000	0.1020E+05	0.9000			0.50	0
J	241430.000	0.1475E+05	3.0000			0.50	0
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Rec.	830	243000.000± 7.000E+01	4.0000E+01± 1.000E+01	1.50	1		
Chi/DF	0.000	0.000					
J	7	243000.000± 7.000E+01	0.4000E+02± 1.000E+01	0.7500	1	>0	
E	243000.000	0.4000E+02	0.3968E+02	0.4000	1	1.50	1
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Rec.	860	255560.000± 7.000E+01	5.0000E+01± 1.000E+01	0.50	1		
Chi/DF	0.000	0.000					
J	7	255560.000± 7.000E+01	0.5000E+02± 1.000E+01	0.7500	1	>0	
E	255570.000	0.5000E+02	0.2538E+02	0.4000	1	1.50	1
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Rec.	900	264995.768± 1.615E+02	7.4635E+03± 9.350E+02	0.50	1		
Chi/DF	4.519	2.302					
J	4	258833.293± 2.900E+03	0.9200E+04± 1.300E+03	0.50	0		
E	7	265000.000± 7.600E+01	0.6960E+04± 7.000E+02			>0	
J	-10	260987.676± 2.900E+03	0.9200E+04± 1.300E+03			0.50	0
E	265800.000	0.1997E+02	0.4000			1.50	2
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Rec.	910	265800.000± 8.000E+01	5.0000E+02± 8.000E+01	0.50	0		
Chi/DF	0.000	0.000					
J	7	265800.000± 8.000E+01	0.5000E+03± 8.000E+01	0.7500	1	>0	
E	265000.000	0.5000E+03	1.2000			0.50	1
J	265800.000	0.1095E+05	3.0000			0.50	0
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Rec.	920	271060.000± 8.000E+01	4.2500E+01± 5.000E+00	1.50	1		
Chi/DF	0.000	0.000					
J	7	271060.000± 8.000E+01	0.4250E+02± 5.000E+00	0.7500	1	>0	
E	271060.000	0.4250E+02	0.4241E+02	0.4000	1	1.50	2
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Rec.	930	275600.000± 8.000E+01	7.0000E+01± 1.250E+01	1.50	1		
Chi/DF	0.000	0.000					
J	7	275600.000± 8.000E+01	0.7000E+02± 1.250E+01	0.7500	1	>0	
E	275600.000	0.7000E+02	0.1365E+03	0.4000	1	1.50	1
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Rec.	940	277400.000± 8.000E+01	8.0000E+01± 2.000E+01		0.50	1
Chi/DF		0.000	0.000			
	7	277400.000± 8.000E+01	0.8000E+02± 2.000E+01			>0
	J	277400.000	0.8000E+02	1.2000	0.50	1
	E	277400.000	0.3941E+02	0.4000	1.50	1
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Rec.	950	282130.000± 8.000E+01	1.6000E+02± 2.500E+01		1.50	1
Chi/DF		0.000	0.000			
	7	282130.000± 8.000E+01	0.1600E+03± 2.500E+01			>0
	J	282130.000	0.1600E+03	1.2000	1.50	1
	E	282130.000	0.1000E+02	0.4000	1.50	1
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Rec.	960	289380.000± 8.000E+01	6.5000E+01± 3.500E+01		0.50	1
Chi/DF		0.000	0.000			
	7	289380.000± 8.000E+01	0.6500E+02± 3.500E+01			>0
	J	289380.000	0.6500E+02	1.2000	0.50	1
	E	289380.000	0.3232E+02	0.4000	1.50	2
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Rec.	1000	310193.745± 2.411E+02	2.9551E+03± 2.468E+02		0.50	0
Chi/DF		6.310	0.131			
	4	300902.325± 3.700E+03	0.3100E+04± 4.700E+02		0.50	0
	7	310200.000± 9.600E+01	0.2900E+04± 2.900E+02			>0
	-10	303604.060± 3.700E+03	0.3100E+04± 4.700E+02		0.50	0
	J	310200.000	0.2900E+04	0.9000	0.50	0
	E	310200.000	0.4499E+04	3.0000	0.50	0
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Rec.	1030	311900.000± 9.000E+01	1.8500E+02± 5.000E+01		1.50	1
Chi/DF		0.000	0.000			
	7	311900.000± 9.000E+01	0.1850E+03± 5.000E+01			>0
	J	311900.000	0.1850E+03	1.2000	1.50	1
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	1060					
	7	318600.000± 9.000E+01	0.1500E+03± 5.000E+01			>0
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Rec.	1100	320294.114± 2.273E+02	1.3566E+03± 3.674E+02		0.50	0
Chi/DF		5.067	9.441			
	4	311518.287± 3.900E+03	0.1030E+04± 1.600E+02		0.50	0
	7	320300.000± 1.010E+02	0.1770E+04± 1.800E+02			>0
	-10	314364.587± 3.900E+03	0.1030E+04± 1.600E+02		0.50	0
	J	318600.000	0.1500E+03	1.2000	1.50	1
	E	311900.000	0.3650E+03	3.0000	0.50	0
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Rec.	1110	333800.000± 1.000E+02	4.0000E+02± 1.000E+02		0.50	1
Chi/DF		0.000	0.000			
	7	333800.000± 1.000E+02	0.4000E+03± 1.000E+02			>0
	J	333800.000	0.4000E+03	1.2000	0.50	1
	E	333800.000	0.2000E+03	0.4000	1.50	2
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Rec.	1120	339750.000± 1.000E+02	2.0000E+02± 5.000E+01		1.50	1
Chi/DF		0.000	0.000			
	7	339750.000± 1.000E+02	0.2000E+03± 5.000E+01			>0
	J	339750.000	0.2000E+03	1.2000	1.50	1
	E	339750.000	0.2000E+03	0.4000	1.50	1
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Rec.	1130	342230.000± 1.000E+02	1.5000E+02± 5.000E+01		1.50	1
Chi/DF		0.000	0.000			
	7	342230.000± 1.000E+02	0.1500E+03± 5.000E+01			>0
	E	342230.000	0.3000E+03	0.4000	0.50	1
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Rec.	1140	344920.000± 1.000E+02	1.5000E+02± 5.000E+01		0.50	1
Chi/DF		0.000	0.000			
	7	344920.000± 1.000E+02	0.1500E+03± 5.000E+01			>0
	J	342230.000	0.1500E+03	1.2000	1.50	1
	E	344920.000	0.7500E+02	0.4000	1.50	1
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Rec.	1150	348105.000± 1.150E+02	2.0000E+03± 3.000E+02		0.50	0
Chi/DF		0.000	0.000			
	7	348105.000± 1.150E+02	0.2000E+04± 3.000E+02			>0
	J	344920.000	0.1500E+03	1.2000	0.50	1
	E	348110.000	0.4292E+04	3.0000	0.50	0
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Appendix 5

The ^{57}Fe data

The resonance parameters given in the JEF-2.2 file for ^{57}Fe did not reproduce the measurement of the ^{57}Fe total cross section measured by Rohr et al [Ro-66] covering the energy range from ~ 20 keV to ~ 200 keV. The data was converted to time of flight transmission and a least square fit was then carried out using the program REFIT to determine the resonance energy, the elastic neutron and inelastic neutron widths of the most prominent resonances. The resultant fitted parameters are given in the Table VIII and the fit to the data shown in Figure 11. The parameters for the resonances at 3951 eV and 6250 eV are taken from the fit to Garg et al's [Gar-78a] data. The parameters of first negative energy were included in the fit, the radiation width was adjusted to fit a thermal capture cross section of 2.48 ± 0.3 barns and its neutron width coming from the resonance-resonance interference effects the data. The parameters listed in Table VIII reproduce the observed ^{57}Fe transmission in the neutron energy region up to ~ 200 keV but may not be a true representation of the total cross section, but as ^{57}Fe is present to only 1.873 % any error should introduce only a minor error in the ^{58}Fe resonance parameters.

Table VIII: Fitted ^{57}Fe resonance parameters

Energy (eV)	Spin J	l	Radiation Width (eV)	Neutron Width (eV)	Inelastic Width (eV)
-5681.9 (fixed)	1.0	0	0.9832 ± 0.1850	$1.0770\text{E}03 \pm 1.878\text{E}+02$	$0.0000\text{e} 00$
3951.6 \pm 4.2	0.0	0	0.7400	$2.4203\text{E}+02 \pm 9.7840\text{E}+00$	$0.0000\text{E}+00$
6250.8 \pm 4.3	1.0	0	1.1500	$5.1152\text{E}+02 \pm 1.3202\text{E}+01$	$0.0000\text{E}+00$
29250.0 \pm 14.2	1.0	0	0.9832	$3.4939\text{E}+03 \pm 1.9078\text{E}+01$	$7.5906\text{E}+02 \pm 2.180\text{E}+01$
41279.3 \pm 58.2	1.0	0	0.9832	$6.0313\text{E}+02 \pm 5.7278\text{E}+01$	$1.8907\text{E}+03 \pm 1.614\text{E}+02$
41935.9 \pm 71.3	0.0	1	1.1902	$2.9533\text{E}+01 \pm 1.7800\text{E}+01$	$0.0000\text{E}+00$
47044.3 \pm 10.0	1.0	0	0.9832	$4.5977\text{E}+02 \pm 2.5276\text{E}+01$	$-4.1242\text{E}+00 \pm 3.590\text{E}+01$
45795.5 \pm 855.0	0.0	0	1.1902	$2.2685\text{E}+03 \pm 3.8096\text{E}+02$	$6.3881\text{E}+03 \pm 2.825\text{E}+03$
52637.0 \pm 76.1	1.0	1	1.1902	$2.6498\text{E}+01 \pm 1.1073\text{E}+01$	$0.0000\text{E}+00$
55371.5 \pm 226.9	0.0	0	1.1902	$1.2516\text{E}+04 \pm 6.1822\text{E}+02$	$0.0000\text{E}+00$
61239.9 \pm 50.5	1.0	0	0.9832	$4.3108\text{E}+03 \pm 1.0298\text{E}+02$	$2.6760\text{E}+02 \pm 1.670\text{E}+02$
77176.6 \pm 48.3	1.0	0	0.9832	$2.0778\text{E}+03 \pm 6.9377\text{E}+01$	$7.8490\text{E}+02 \pm 1.018\text{E}+02$
93929.2 \pm 126.6	1.0	0	0.9832	$1.0682\text{E}+02 \pm 2.1348\text{E}+01$	$-1.5193\text{E}+02 \pm 1.825\text{E}+02$
109776.0 \pm 80.8	1.0	1	1.1902	$7.9219\text{E}+02 \pm 1.6307\text{E}+02$	$6.6760\text{E}+02 \pm 2.208\text{E}+02$
110020.1 \pm 153.1	1.0	0	0.9832	$3.3592\text{E}+03 \pm 1.2182\text{E}+02$	$1.6244\text{E}+03 \pm 2.323\text{E}+02$
123998.2 \pm 13.3	1.0	0	0.7700	$1.2817\text{E}+03 \pm 3.5776\text{E}+02$	$3.5469\text{E}+03 \pm 9.569\text{E}+02$
125388.7 \pm 285.4	1.0	0	1.000	$4.4868\text{E}+02 \pm 2.1437\text{E}+02$	$-1.9898\text{E}+03 \pm 3.584\text{E}+03$
132084 \pm 1293.0	1.0	0	1.240	$8.4033\text{E}+03 \pm 2.2499\text{E}+03$	$3.3746\text{E}+03 \pm 4.354\text{E}+03$
134036.5 \pm 296.9	1.0	0	3.900	$1.3574\text{E}+03 \pm 8.1949\text{E}+02$	$2.5231\text{E}+03 \pm 1.174\text{E}+03$
140905.4 \pm 75.4	1.0	0	2.900	$1.6774\text{E}+02 \pm 4.5451\text{E}+01$	$-2.1517\text{E}+01 \pm 7.426\text{E}+01$
166943.1 \pm 223.3	1.0	0	1.330	$1.1145\text{E}+03 \pm 2.7150\text{E}+02$	$-1.9500\text{E}+03 \pm 4.703\text{E}+02$
170010.7 \pm 109.4	1.0	0	0.8000	$1.1143\text{E}+03 \pm 2.2503\text{E}+02$	$7.4731\text{E}+02 \pm 2.909\text{E}+02$
175712.3 \pm 499.8	1.0	0	1.240	$9.4973\text{E}+02 \pm 2.1510\text{E}+02$	$4.0547\text{E}+03 \pm 1.119\text{E}+04$
185109.7 \pm 170.0	1.0	0	1.900	$3.9144\text{E}+03 \pm 3.833\text{E}+02$	$5.4908\text{E}+02 \pm 1.780\text{E}+02$
188781.9 \pm 349.8	0.0	0	1.240	$3.2991\text{E}+03 \pm 1.167\text{E}+03$	$-1.4910\text{E}+02 \pm 9.545\text{E}+02$
200119.1 \pm 185.3	1.0	0	0.5000	$4.4896\text{E}+02 \pm 4.7216\text{E}+01$	$3.5333\text{E}+03 \pm 2.340\text{E}+03$
200459.7 \pm 185.3	0.0	0	0.5000	$2.5719\text{E}+034.6494\text{E}+02$	$1.7993\text{E}+02 \pm 5.812\text{E}+02$
215509.1 \pm 8302.0	0.0	0	0.5	$2.6793\text{E}+03 \pm 2.2293\text{E}+03$	$-3.3746\text{E}+03 \pm 4.163\text{E}+04$

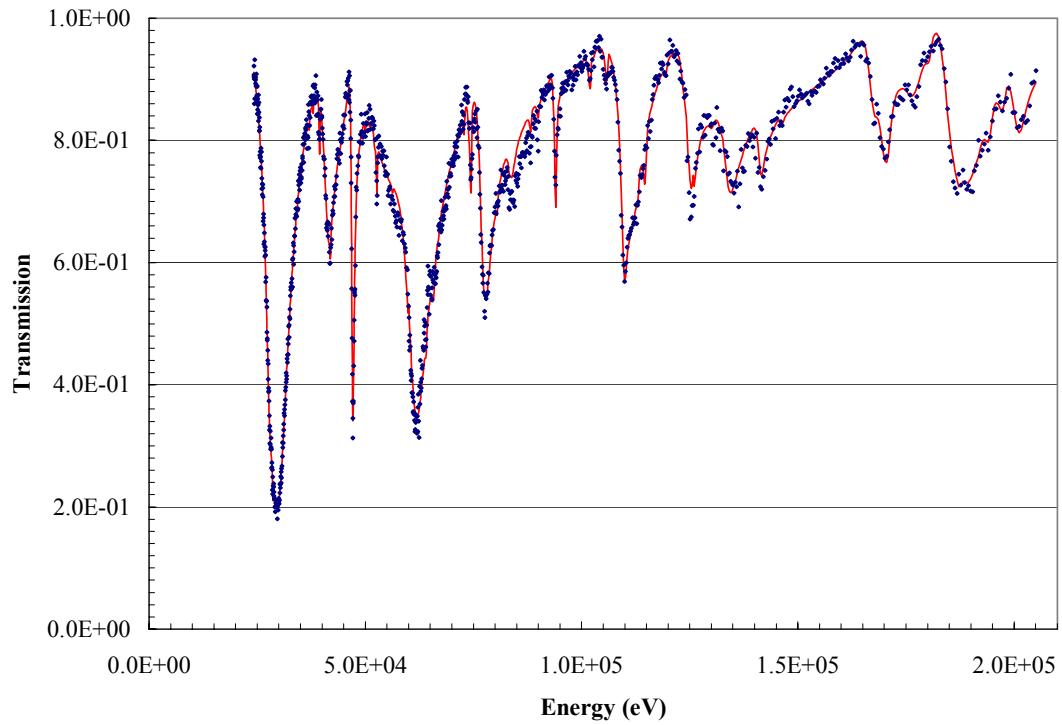


Figure 11: The fit to the transmission data of Rohr et al [Ro-66] using the parameters given in Table VIII

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