

Concise Covariance Matrix Format Proposal for ENDF

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Attached is a proposal for a new “Concise Covariance Matrix” format for the resolved-resonance region, ENDF File 32 (LRU = 1, LRF = 1,2,3,7, LRX = 10 + LRF).

Please send your comments (both positive and negative) and your suggestions for improvements (both to the format itself and to the ENDF-102 pages) to me as soon as possible. Comments can be e-mailed to LarsonNM@ornl.gov. Also feel free to forward this note to any of your colleagues who might be interested.

It is my intention to formally submit this format to CSEWG during the November 2002 meeting.

The format has already been implemented into SAMMY: that is, SAMMY can create files in this format. In addition, the format has been partially implemented into the ORNL processing code system AMPX; multigroup cross sections and associated covariance matrix can be calculated for LRF = 1 or 2 nuclides (single- or multilevel Breit Wigner). A more general implementation will be accomplished as time permits.

General features of the format:

1. The covariance matrix is stored as uncertainties plus correlation matrix.
2. Off-diagonal elements of the correlation matrix are mapped to two-digit integers (thus dropping 2% of the information in the “exact” correlation matrix).
3. Only non-zero off-diagonal elements are listed in the ENDF file, in order to conserve space.
4. The entire correlation matrix is given; unlike the original File 32 format, this format is not limited to correlations between parameters of one resonance. Instead, the format permits reporting of all correlation coefficients greater than 2% in absolute value.

Description of the format

Drafts of pages of the ENDF-102 manual for this format are attached.¹ The description in the draft pages includes an algorithm (and FORTRAN coding) for reconstructing the approximate correlation matrix from the mapped correlation coefficients. Sections 32.4 through 32.5 provide details for this format, including explicit listing of the mapping.

¹ An early draft of this document included a new type of record designed specifically for storage of the mapped correlation coefficients. However, Maurice Greene convinced me that it would be more acceptable to use an existing record type (the TEXT record), albeit in a somewhat unconventional manner, to accomplish the same purpose: (1) CSEWG would look more favorably on a proposal that did not propose a new record type, and (2) a TEXT record would require significantly less space in the binary version of the ENDF files than would an integer-based format.

A brief verbal description of the format is given here. For technical details, please see the manual pages.

1. The usual ENDF conventions are used for reading/writing the uncertainties: HEAD, CONT, and LIST records. As with other File 32 options, the resonance parameter values are given on one line (or more if needed for LRF=7), followed on the next line(s) by the uncertainties on those parameters. [Author's note: re-listing the parameter values here was done for consistency with other File 32 options, and because this eased the process of implementing this format into AMPX. Nevertheless, this is not necessarily an optimal choice: there is really no need to redundantly list the parameter values, as they are already available in File 2.]
2. File 32 begins with the same lines as in the other File 32 formats, with LRU = 1 and with a new parameter LRX set equal to 10 + LRF (to distinguish from the original File 32 options). [Authors' note: Is there a better way to do this?]
3. Following the final set of resonances and uncertainties, the correlation coefficients (mapped to two-digit integers) are given in a TEXT record (which can be read as alphanumeric text, but could be read directly as integers).

Examples and Comments

Two examples of File 32 are provided on the attached pages. The first is ^{152}Gd using the multilevel Breit Wigner (LRF = 2) approximation. The second is ^{233}U using the Reich-Moore format (LRF = 3). In each case, only a representative portion of the file is shown.

The files listed here are “annotated”, which means they are identical to the “real” files but also include comment cards (which begin with #####). The comments are designed to make it easier to understand and remember what the numbers mean. (NOTE: Annotated files will not be used within ENDF but instead are used only for illustrative purposes.)

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My thanks to Maurice Greene for advice on preparation of the format and of the manual pages, to Mike Dunn for assistance in understanding AMPX enough to prepare one application of the concise covariance matrix in that code, to Luiz Leal and Herve Derrien for providing examples, and to Luiz, Herve, Mike, Maurice, and Royce Sayer for careful and insightful reviews of this proposal.

0.7.4 TEXT Records

Draft September 3, 2002

This record is used either (1) as the first entry on an ENDF tape (TPID), (2) to give comments in File 1, or (3) to store correlation coefficient information for resonance parameters in File 32. It is indicated by the following shorthand notation:

```
[MAT, MF, MT / HL ] TEXT
```

where HL is 66 characters of text information. The TEXT record can be read with the following FORTRAN statements:

```
READ (LIB,10) HL, MAT, MF, MT, NS  
10 FORMAT (A66, I4, I2, I3, I5)
```

where NS is the sequence number.¹³ For a TPID record, MAT contains the tape number NTAPE, and MF and MT are both zero. For a TEXT record in File 1, MF = 1 and MT = 451. For a TEXT record containing correlation coefficient information in File 32, MF = 32 and MT=151; in this case, the TEXT record can be read as integers:

```
READ (LIB,20) I, J, (K(N),N=1,27), MAT, MF, MT, NS  
20 FORMAT (I5, I5, 1X, 27I2, 1X, I4, I2, I3, I5)
```

Detailed information on this use of TEXT record is presented in Section 32.

32. FILE32, COVARIANCES OF RESONANCE PARAMETERS

DRAFT September 10, 2002

Two options are now provided for reporting the covariances for resonance parameters. The first is described in Sections 32.1 through 32.3. The second is discussed in Sections 32.4 and 32.5.

32.1 through 32.3 remain as is.

32.4. General Description of Concise Covariance Matrix.

This format was developed in order to provide a means of communicating the actual resonance-parameter covariance matrix (as determined during the data-analysis process) in a compact, legible, and accurate form. The covariance matrix is specified as uncertainties plus correlation matrix, since that is the form in which the meaning is most apparent (and mistakes are most obvious). The correlation coefficients are presented in a compact representation which contains 98% of the information in the un-compact covariance matrix.

If the covariance matrix element connecting parameter number i with parameter number j is denoted by V_{ij} , the uncertainty on parameter i by D_i , and the correlation coefficient by C_{ij} , then these quantities are related by

$$D_i^2 = V_{ii} \quad V_{ij} = D_i C_{ij} D_j$$

Values for C_{ij} range from -1 to +1; values for D_i are always positive. Note that the diagonal elements of C_{ij} , those for which $i=j$, are always exactly 1.0 and therefore are never specified explicitly. Compacting the off-diagonal correlation coefficients is accomplished as follows: (1) Drop (set to zero) all values of C_{ij} between -0.02 and +0.02. (2) Map the remaining values C_{ij} onto two-digit positive integers K_{ij} , using the relationships :

$$\begin{aligned} K_{ij} &= C_{ij} / 0.02 + 50 && \text{rounded down to next integer for positive } C_{ij}, \\ K_{ij} &= C_{ij} / 0.02 + 50 && \text{rounded up to the next integer for negative } C_{ij}. \end{aligned}$$

Those off-diagonal correlation coefficients which are exactly equal to 1 are mapped to $K=99$, and coefficients exactly equal to -1 are mapped to $K=1$. The complete mapping is given explicitly in the Table 32.4.1. The reverse mapping takes the two-digit integer to the center of the range given in Table 32.4.1. Explicitly, if c_{ij} represents the reconstructed (approximate) correlation coefficient, then

$$\begin{aligned} c_{ij} &= (K_{ij} - 50) \times 0.02 + 0.01 && \text{for } K_{ij} > 50; \\ c_{ij} &= (K_{ij} - 50) \times 0.02 - 0.01 && \text{for } K_{ij} < 50. \end{aligned}$$

Table 32.4.1. Mapping from correlation coefficient to two-digit integer.

$C_{min} < C < C_{max}$	K	c	$C_{min} < C < C_{max}$	K	c	$C_{min} < C < C_{max}$	K	c	
-1.0	-.98	1	-.99	-.34	-.32	.34	.36	.67	.35
-.98	-.96	2	-.97	-.32	-.30	.35	.36	.68	.37
-.96	-.94	3	-.95	-.30	-.28	.36	.38	.69	.39
-.94	-.92	4	-.93	-.28	-.26	.37	.40	.70	.41
-.92	-.90	5	-.91	-.26	-.24	.38	.42	.71	.43
-.90	-.88	6	-.89	-.24	-.22	.39	.44	.72	.45
-.88	-.86	7	-.87	-.22	-.20	.40	.46	.73	.47
-.86	-.84	8	-.85	-.20	-.18	.41	.48	.74	.49
-.84	-.82	9	-.83	-.18	-.16	.42	.50	.75	.51
-.82	-.80	10	-.81	-.16	-.14	.43	.52	.76	.53
-.80	-.78	11	-.79	-.14	-.12	.44	.54	.77	.55
-.78	-.76	12	-.77	-.12	-.10	.45	.56	.78	.57
-.76	-.74	13	-.75	-.10	-.08	.46	.58	.79	.59
-.74	-.72	14	-.73	-.08	-.06	.47	.60	.80	.61
-.72	-.70	15	-.71	-.06	-.04	.48	.62	.81	.63
-.70	-.68	16	-.69	-.04	-.02	.49	.64	.82	.65
-.68	-.66	17	-.67	-.02	0.00	0	.66	.83	.67
-.66	-.64	18	-.65	.00	.02	0	.68	.84	.69
-.64	-.62	19	-.63	.02	.04	.51	.70	.85	.71
-.62	-.60	20	-.61	.04	.06	.52	.72	.86	.73
-.60	-.58	21	-.59	.06	.08	.53	.74	.87	.75
-.58	-.56	22	-.57	.08	.10	.54	.76	.88	.77
-.56	-.54	23	-.55	.10	.12	.55	.78	.89	.79
-.54	-.52	24	-.53	.12	.14	.56	.80	.90	.81
-.52	-.50	25	-.51	.14	.16	.57	.82	.91	.83
-.50	-.48	26	-.49	.16	.18	.58	.84	.92	.85
-.48	-.46	27	-.47	.18	.20	.59	.86	.93	.87
-.46	-.44	28	-.45	.20	.22	.60	.88	.94	.89
-.44	-.42	29	-.43	.22	.24	.61	.90	.95	.91
-.42	-.40	30	-.41	.24	.26	.62	.92	.96	.93
-.40	-.38	31	-.39	.26	.28	.63	.94	.97	.95
-.38	-.36	32	-.37	.28	.30	.64	.96	.98	.97
-.36	-.34	33	-.35	.30	.32	.65	.99	1.0	.99
				.32	.34	.66	.99		

Two types of records are used to read the mapped correlation coefficients. A CONT record defines NM, the number of lines of TEXT records that follow.

```
[MAT, 32, 151 / 0.0, 0.0, 0, NNN, NM, 0] CONT
[MAT, MF, MT / HL ] TEXT
[MAT, MF, MT / HL ] TEXT
```

< Continue until a total of NM TEXT records are read >

The information stored in the TEXT records may be summarized as follows: Let i and j represent two of the parameters in the numbering scheme defined above. Only those correlation coefficients mapped to non-zero integers K_{ij} (see Section 32.4) are printed in File 32. Each line of the file begins by specifying the location (i.e., by specifying i and j), with $i > j$; other K 's on the same line correspond to $(i, j+1), (i, j+2), \dots (i, j+26)$ [so long as $j + 26 < i$]. If there are more non-zero K 's for the same i , they are given on another line, again beginning with the next non-zero K .

Though these records can be read as alphanumeric text, and the integer values extracted from the text, alternatively the integer values can be read directly from the ASCII ENDF file. The following FORTRAN can be used to read the mapped correlation coefficients and reconstruct the correlation matrix:

```
DIMENSION K(27), CORR(n,n)
READ (LIB,10) NNN, NM, NX, MAT, MF, MT, NS
10 FORMAT (33X, 3I11, I4, I2, I3, I5)
C   The CONT record: NNN is dimension of CORR(NNN,NNN), and
C   NM is the number of lines to follow in the file
      DO I=1,NNN
        DO J=1,I-1
          CORR(J,I) = 0.0
        END DO
        CORR(I,I) = 1.0
      END DO
      DO M=1,NM
        READ (LIB,20) I, J, (K(N),N=1,27), MAT, MF, MT, NS
20    FORMAT (I5, I5, 1X, 27I2, 1X, I4, I2, I3, I5)
C   This is the TEXT record
      JP = J - 1
      DO N=1,27
        JP = JP + 1
        IF (JP.GE.I) GO TO 30
        IF (K(N).NE.0) THEN
          IF (K(N).GT.50) THEN
            CORR(JP,I) = (K(N)-50)*0.02 + 0.01
          ELSE
            CORR(JP,I) = (K(N)-50)*0.02 - 0.01
          END IF
        END IF
      END DO
      CONTINUE
30    END DO
```

Note that only the lower-triangular portion of the correlation matrix [CORR(J,I) for J < I or J = I] is defined by this procedure. The upper-triangular portion can be found by invoking symmetry [CORR(I,J) = CORR(J,I)].

32.5 Formats for Concise Covariance Matrix

The concise format for covariances uses File 32, MT=151, with LRX = 10 + LRF (with LRF = 1, 2, 3, and 7) for LRU=1 (resolved-resonance parameters). The format parallels the format for File 2, MT = 151, with parameter uncertainties specified along with parameter values. Correlation coefficients are given separately.

The general structure of File 32 is as given in Section 32.2, with the substitution of LRX for LRF. (The flag LRX is set to 10 + LRF, indicating that this is the Concise Covariance Matrix format.)

```
[MAT, 32, 151 / ZA, AWR,    0,    0, NIS,    0] HEAD
[MAT, 32, 151 / ZAI, AWR,    0,    0, LFW,   NER] CONT      (isotope)
[MAT, 32, 151 / EL, EH, LRU, LRX, NIS, NAPS] CONT      (range)
<subsection for the first energy range for the first isotope>
[MAT, 32, 151 / EL, EH, LRU, LRX, NIS, NAPS] CONT      (range)
<subsection for the second energy range for the first isotope>
-----
-----
[MAT, 32, 151 / EL, EH, LRU, LRX, NIS, NAPS] CONT      (range)
<subsection for the last energy range for the first isotope>
-----
-----
[MAT, 32, 151 / ZAI, AWR,    0,    0, LFW,   NER] CONT      (isotope)
[MAT, 32, 151 / EL, EH, LRU, LRX, NIS, NAPS] CONT      (range)
<subsection for the first energy range for the last isotope>
-----
-----
[MAT, 32, 151 / EL, EH, LRU, LRX, NIS, NAPS] CONT      (range)
<subsection for the last energy range for the last isotope>
-----
-----
[MAT, 32, 0 / 0.0, 0.0,    0,    0,    0,    0] SEND
[MAT, 0, 0 / 0.0, 0.0,    0,    0,    0,    0] FEND
```

Formats for the individual subsections differ depending on the value of LRX, and are discussed in Sections 32.5.1.

32.5.1 Concise covariance matrix formats for subsections of a particular energy range and isotope

In the format descriptions to follow, the notation is as defined in Section 2. Uncertainties are denoted by parameters whose names begin with “D” but are otherwise identical to the parameter of Section 2. For example, ER represents the resonance energy in the laboratory system, in units of eV. DER therefore represents the uncertainty (square root of the variance) associated with the resonance energy; DER has the same units as ER.

Parameters which are not variables (that is, which are not searchable parameters in the analysis process) do not have uncertainties associated with them. For example, the total spin of a resonance, denoted by parameter AJ, has no associated uncertainty DAJ. In File 32, the value 0.0 is given instead of DAJ (for LRF = 1,2,3).

For LRF = 1 and 2, the redundant parameter GT (which is equal to GN + GG + GF) has no corresponding uncertainty DGT specified explicitly. Instead, if needed, DGT may be calculated using values for DGN, DGG, and DGF, and the correlation matrix.

During the evaluation process, not all potential variables are treated as searchable parameters. For example, if no capture cross section data were available, the evaluator might choose to set all capture widths GG to a constant value. The associated uncertainty DGG is then specified in File 32 as -1.0, indicating that this parameter’s uncertainty is not known. (The proper procedure to be used in evaluating the effect of these unvaried parameters on the final covariance matrix remains an open question, and is not addressed in this document.)

In order to express the correlation matrix as concisely as possible, the resonance parameters (those which may be varied during the evaluation process) are implicitly numbered, in the order in which they occur in the listing of File 2. For LRF = 1, 2, or 3, the non-searchable parameter AJ is included in the list but is NOT included in this numbering, nor (for LRF=1 or 2) is the redundant parameter GT. Parameters whose value is given but whose uncertainty is unknown (as described in the previous paragraph) are included in the numerical ordering. For non-fissile nuclides, fission widths are not included in the numbering scheme; likewise, for fissile nuclides for which the evaluator chose to use only one fission width, the second fission width (for LRF = 3) would not be counted.

32.5.1.2 SLBW and MLBW (LRU=1, LRF=1 or 2)

The structure of the *subsection* (assuming NRO = 0) is:

```
[MAT, 32, 151 / SPI, AP,      0,      0,      NLS,      0] CONT
[MAT, 32, 151 /AWRI, QX,      L,      LRX, 12*NRS, NRS /
  ER1, AJ1,   GT1,   GN1,   GG1,   GF1,
  DER1, 0.0 , 0.0 , DGN1, DGG1, DGF1,
  ER2, AJ2,   GT2,   GN2,   GG2,   GF2,
  DER2, 0.0 , 0.0 , DGN2, DGG2, DGF2,
-----
```

```

ERNRS, AJNRS, GTNRS, GNNRS, GGNRS, GFNRS
DERNRS, 0.0, 0.0, DGNNRS, DGGNRS, DGNRS] CONT
[MAT, 32, 151 / 0.0, 0.0, 0, NNN, NM, 0 ] CONT
[MAT, 32, 151 / HL ] TEXT
[MAT, 32, 151 / HL ] TEXT
< Continue until a total of NM TEXT records are read >

```

Note that NNN is the total number of unique resonance parameters included in this listing, not including AJ or GT. For fissile nuclides, NNN = NRS × 4; for non-fissile nuclides, NNN = NRS × 3.

32.5.1.3 Reich Moore (LRU=1, LRF=3)

The structure of the *subsection* (assuming NRO = 0) is:

```

[MAT, 32, 151 / SPI, AP, LAD, 0, NLS, NLSC] CONT
[MAT, 32, 151 / AWRI, QX, L, LRX, 12*NRS, NRS /
    ER1, AJ1, GN1, GG1, GFA1, GFB1,
    DER1, 0.0, DGN1, DGG1, DGFA1, DGFB1,
    ER2, AJ2, GN2, GG2, GFA2, GFB2,
    DER2, 0.0, DGN2, DGG2, DGFA2, DGFB2,
    -----
    ERNRS, AJNRS, GNNRS, GGNRS, GFANRS, GFBNRS,
    DERNRS, 0.0, DGNNRS, DGGNRS, DGFANRS, DGFBNRS] CONT
[MAT, 32, 151 / 0.0, 0.0, 0, NNN, NM, 0 ] CONT
[MAT, 32, 151 / HL ] TEXT
[MAT, 32, 151 / HL ] TEXT
< Continue until a total of NM TEXT records are read >

```

Note that NNN is the total number of resonance parameters in this listing (again not including AJ). For non-fissile nuclides, NNN = NRS × 3. For fissile nuclides, NNN = NRS × 4 if only one fission channel is used, and NNN = NRS × 5 if both are used.

32.5.1.3 Complete Reich Moore (LRU=1, LRF=7)

The structure of the *subsection* is

```

[MAT, 32, 151 / 0.0, 0.0, 0, 0, NJS, 0 ] CONT
[MAT, 32, 151 / 0.0, 0.0, NPP, 0, 12*NPP, 2*NPP/
    MA1, MB1, ZA1, ZB1, IA1, IB1,
    Q1, PNT1, SHF1, MT1, PA1, PB1,
    MA2, MB2, ZA2, ZB2, IA2, IB1,
    Q2, PNT2, SHF2, MT2, PA2, PB1,
    -----
    MANPP, MBNPP, ZANPP, ZBNPP, IANPP, IBNPP,
    QNPP, PNTNPP, SHFNPP, MTNPP, PANPP, PBNPP] LIST
[MAT, 32, 151 / AJ, PJ, 0, 0, 6*NCH, NCH/
    IPP1, L1, SCH1, BND1, APE1, APT1,
    IPP2, L2, SCH2, BND2, APE2, APT2,
    -----

```

```

IPPNCH, LNCH, SCHNCH, BNDNCH, APENCH, APTNCH] LIST

[MAT, 32, 151/0.0, 0.0, 0, NRS, 12*NX, NX/
ER1, GAM1,1, GAM2,1, GAM3,1, GAM4,1, GAM5,1,
GAM6,1, ..., GAMNCH,1,
DER1, DGAM1,1, DGAM2,1, DGAM3,1, DGAM4,1, DGAM5,1,
DGAM6,1, ..., DGAMNCH,1,
ER2, GAM1,2, GAM2,2, GAM3,2, GAM4,2, GAM5,2,
GAM6,2, ..., GAMNCH,2,
DER2, DGAM1,2, DGAM2,2, DGAM3,2, DGAM4,2, DGAM5,2,
DGAM6,2, ..., DGAMNCH,2,
-----
ERNRS, GAM1,NRS, GAM2,NRS, GAM3,NRS, GAM4,NRS, GAM5,NRS,
GAM6,NRS, ..., GAMNCH,NRS,
DERNRS, DGAM1,NRS, DGAM2,NRS, DGAM3,NRS, DGAM4,NRS, DGAM5,NRS,
DGAM6,NRS, ..., DGAMNCH,NRS] LIST
<The above two list records are repeated until each of
the NJS J $\pi$  states has been specified.>
[MAT, 32, 151 / HL] TEXT
[MAT, 32, 151 / HL] TEXT
< Continue until a total of NM TEXT records are read >

```

For LRF = 7 (unlike other formats), the number of channels may vary from one spin group to another. The number of resonance parameters NNN is therefore given by the sum (from 1 to NJS) of (NCH \times NRS).

64152.0	1.506147+2	0	0	1	0642532151	1
####						
#### Z_A	Abundance					
64152.0	1.000000+0	0	0	1	0642532151	2
####						
#### Emin	Emax	Lru=1 => Resolved Resonance Region				
####		Lrf=2 => ML Breit Wigner				
1.000000-5	2.660000+3	1	12	0	1642532151	3
0.0	8.200000-1	0	0	1	0642532151	4
####						
#### Weight	Radius	L=0	Number of resonances=	129		
1.506147+2		0	0	774	129642532151	5
####						
#### E_res	+/-J	Gamma_Tot	Gamma_n	Gamma_gam		
-1.00100981	0.5	6.316225-2	4.523852-3	5.863839-2	642532151	6
0.003023984	0.0		1.354056-5	2.196643-4	642532151	7
12.35000664	0.5	6.327033-2	4.650997-3	5.861933-2	642532151	8
0.000179657	0.0		3.676864-6	1.319601-4	642532151	9
36.85999851	0.5	1.400852-1	8.400213-2	5.608309-2	642532151	10
0.000357685	0.0		4.054777-5	1.539299-4	642532151	11
39.30000663	0.5	9.501525-2	3.900195-2	5.601331-2	642532151	12
0.000294763	0.0		4.307561-5	1.965066-4	642532151	13
42.73000127	0.5	5.907443-2	3.059938-3	5.601449-2	642532151	14
0.000374788	0.0		9.728247-6	3.480504-4	642532151	15
74.34000064	0.5	1.104264-1	6.000203-2	5.042432-2	642532151	16
0.000377151	0.0		3.100845-5	1.310129-4	642532151	17
85.55000491	0.5	6.373410-2	5.110534-3	5.862357-2	642532151	18
0.000358178	0.0		9.203606-6	2.273932-4	642532151	19
92.39999827	0.5	2.006264-1	1.420045-1	5.862195-2	642532151	20
0.000529818	0.0		6.129688-5	1.481593-4	642532151	21
139.9999945	0.5	1.374267-1	7.880433-2	5.862237-2	642532151	22
0.000514057	0.0		4.928948-5	1.529997-4	642532151	23
160.0000040	0.5	6.145485-2	2.830510-3	5.862434-2	642532151	24
0.000541073	0.0		7.739500-6	2.981764-4	642532151	25
173.8000132	0.5	1.161207-1	8.600537-2	3.011530-2	642532151	26
0.000490337	0.0		5.925938-5	9.077078-5	642532151	27
185.7000056	0.5	1.365230-1	8.400423-2	5.251872-2	642532151	28
0.000513284	0.0		6.611917-5	1.514341-4	642532151	29
203.0999890	0.5	1.558316-1	9.700983-2	5.882179-2	642532151	30
0.000572913	0.0		6.670159-5	1.777026-4	642532151	31
207.7000083	0.5	6.385150-2	5.230673-3	5.862082-2	642532151	32
0.000666089	0.0		1.536168-5	4.211907-4	642532151	33
223.3000017	0.5	3.652309-1	3.009976-1	6.423329-2	642532151	34
0.000933075	0.0		1.528411-4	1.948988-4	642532151	35
231.4000054	0.5	1.080114-1	4.599855-2	6.201281-2	642532151	36
0.000510096	0.0		7.906451-5	2.602832-4	642532151	37
237.9999890	0.5	3.236312-1	2.236010-1	1.000302-1	642532151	38
0.000866547	0.0		1.722881-4	2.940136-4	642532151	39
252.3999909	0.5	1.794183-1	1.270055-1	5.241278-2	642532151	40
0.000633405	0.0		1.371040-4	1.589780-4	642532151	41
282.5999913	0.5	1.941284-1	1.450111-1	4.911732-2	642532151	42
0.000709893	0.0		1.123160-4	1.623240-4	642532151	43
293.3999703	0.5	4.230320-1	3.520120-1	7.102007-2	642532151	44
0.001012331	0.0		2.055647-4	1.973983-4	642532151	45
303.1000000	0.5	7.531747-2	1.670220-2	5.861527-2	642532151	46
0.000788243	0.0		5.186884-5	3.608763-4	642532151	47
309.5000118	0.5	6.682989-2	8.210998-3	5.861889-2	642532151	48
0.000853512	0.0		3.082312-5	4.772109-4	642532151	49
318.2999905	0.5	1.192151-1	6.059874-2	5.861638-2	642532151	50
0.000595853	0.0		1.176547-4	2.057848-4	642532151	51
333.7000002	0.5	9.041829-2	3.180421-2	5.861408-2	642532151	52
0.000673439	0.0		7.167226-5	2.231625-4	642532151	53
379.2000037	0.5	3.765506-1	3.170283-1	5.952231-2	642532151	54
0.001015486	0.0		2.100488-4	1.834682-4	642532151	55

[Lines 56 through 247 are deliberately omitted here.]

2351.000022	0.5	8.447024-2	2.582571-2	5.864453-2	642532151	248
0.003187827	0.0		2.040631-4	8.830323-4	642532151	249
2377.400009	0.5	8.836202-2	2.972347-2	5.863855-2	642532151	250
0.003031003	0.0		1.854241-4	7.107122-4	642532151	251
2396.900040	0.5	2.886377-1	2.300254-1	5.861232-2	642532151	252
0.001947182	0.0		6.626058-4	2.976004-4	642532151	253
2410.699857	0.5	1.422218+0	1.350002+0	7.221561-2	642532151	254
0.003161164	0.0		1.889452-3	2.519936-4	642532151	255
2474.800072	0.5	2.705771-1	2.119739-1	5.860328-2	642532151	256
0.002455846	0.0		8.661019-4	3.006068-4	642532151	257
2538.499988	0.5	3.646130-1	2.446145-1	1.199986-1	642532151	258
0.002529746	0.0		8.684387-4	5.651132-4	642532151	259
2651.100823	0.5	3.472188-1	2.886965-1	5.852224-2	642532151	260
0.002402010	0.0		9.482976-4	2.888681-4	642532151	261
2657.778530	0.5	1.207077-1	5.630786-2	6.439981-2	642532151	262
0.004835547	0.0		4.264667-4	8.209001-4	642532151	263
####						
# #### Concise Correlation Matrix follows						
# #### Number of resonance parameters = 387						
# #### Number of lines to follow this one = 325						
0.0	0.0	0	387	325	325642532151	264
####						
# #### Corr(J,I) = (K(J,I)*0.02 +/- 0.01)						
# #### I J K(J,I) thru K(J+26,I)						
2	1 9				642532151	265
3	1 1368				642532151	266
5	1 33725667				642532151	267
6	1 5841454938				642532151	268
8	1 337157516146				642532151	269
9	1 554547 47 5242				642532151	270
10	8 3852				642532151	271
11	1 465651 52 55175466				642532151	272
12	1 5148 4856354841				642532151	273
14	8 46 47 51				642532151	274
15	8 5148 464536				642532151	275
16	8 49				642532151	276
17	1 435852 5349 52	61			642532151	277
18	1 5149	41			642532151	278
19	17 49				642532151	279
20	8 49 46 60				642532151	280
21	19 4454				642532151	281
22	8 49 48				642532151	282
23	1 435953 5349 51	5249 5460 63			642532151	283
24	1 5148	47 4443 41			642532151	284
25	23 49				642532151	285
26	1 485351 51	64			642532151	286
27	26 40				642532151	287
29	26 49 53				642532151	288
30	27 49 37				642532151	289
32	1 4852 51	51	51	642532151	290	
32	29 52 61			642532151	291	
33	29 49495140			642532151	292	
34	32 47			642532151	293	
35	1 4952			642532151	294	
35	29 51 5248 65			642532151	295	
36	31 49 47 38			642532151	296	
37	32 49 48			642532151	297	
38	1 4952			642532151	298	
38	31 51 51 61			642532151	299	
39	36 495140			642532151	300	
40	39 51			642532151	301	

[Lines 302 through 537 deliberately omitted here]

320	290	49			51	51	59	642532151	538	
320	317	355373						642532151	539	
321	315	4945	374942					642532151	540	
323	317	49	4947	51				642532151	541	
324	320	51464828						642532151	542	
326	325	87						642532151	543	
327	325	6863						642532151	544	
328	325	687163						642532151	545	
329	325	29194131						642532151	546	
330	325	3939322952						642532151	547	
332	331	62						642532151	548	
333	328	5149485243						642532151	549	
335	329	49	49	49				642532151	550	
336	332	51474819						642532151	551	
338	332	49		4951				642532151	552	
339	333	49		484828				642532151	553	
341	340	55						642532151	554	
342	341	36						642532151	555	
345	343	4940						642532151	556	
346	344	5149						642532151	557	
347	344	544769						642532151	558	
348	344	49494939						642532151	559	
349	344	5149	49					642532151	560	
350	329	51			51	51	53485556	80	642532151	561
351	342	49	49494948475146					642532151	562	
352	350	49						642532151	563	
353	350	45	64					642532151	564	
354	349	49	48	39				642532151	565	
356	349	4947		47	52			642532151	566	
357	350	51		5148	29			642532151	567	
359	350	47			534756			642532151	568	
360	356	4949	34					642532151	569	
362	350	49			55			642532151	570	
363	360	49	35					642532151	571	
365	350	49			49	52		642532151	572	
366	363	494919						642532151	573	
368	350	49				51		642532151	574	
369	367	4926						642532151	575	
371	350	49			51		524857		642532151	576
372	370	5142						642532151	577	
373	350	49			5149	52485151		642532151	578	
374	349	5149		51		5249	544753584982		642532151	579
375	368	4949484545	41						642532151	580
377	374	48	54						642532151	581
378	375	494930							642532151	582
380	379	54							642532151	583
381	379	4726							642532151	584
383	382	59							642532151	585
384	382	5437							642532151	586
385	382	515152							642532151	587
386	382	4946	53						642532151	588
387	383	51465333							642532151	589

92233.0	2.290533+2	0	0	1	0922232151	1
####						
#### Z_A	Abundance					
92233.0	1.000000+0	0	1	1	0922232151	2
####						
#### Emin	Emax	Lru=1 => Resolved Resonance Region				
####		Lrf=3 => Reich-Moore format				
1.000000-5	1.500000+2	1	13	0	1922232151	3
####						
#### Spin	Radius	Number of L values = 1				
2.5	9.620000-1	1	0	1	4922232151	4
####						
#### Weight	Radius	L=0	Number of resonances=	770		
2.290533+2	9.620000-1	0	0	4620	770922232151	5
####						
#### E_res	+/-J	Gamma_n	Gamma_gam	Gamma_f1	Gamma_f2	
-1060.00000	3.0	1.523900+0	4.000000-2	2.600000-1	2.370000-1922232151	6
-1.000000000	0.0	-1.000000+0-1.000000+0-1.000000+0-1.000000+0922232151				7
-800.000000	-2.0	1.315100+0	4.000000-2	3.120000-1-2.250000-1922232151		8
-1.000000000	0.0	-1.000000+0-1.000000+0-1.000000+0-1.000000+0922232151				9
-575.000000	3.0	8.079100-1	4.000000-2-2.550000-1	2.400000-1922232151		10
-1.000000000	0.0	-1.000000+0-1.000000+0-1.000000+0-1.000000+0922232151				11
-387.500000	-2.0	5.887700-1	4.000000-2	2.825000-1-2.420000-1922232151		12
-1.000000000	0.0	-1.000000+0-1.000000+0-1.000000+0-1.000000+0922232151				13
-237.500000	3.0	3.885200-1	4.000000-2-2.850000-1-2.300000-1922232151			14
-1.000000000	0.0	-1.000000+0-1.000000+0-1.000000+0-1.000000+0922232151				15
-137.500000	-2.0	1.954500-1	4.000000-2	3.120000-1	2.150000-1922232151	16
-1.000000000	0.0	-1.000000+0-1.000000+0-1.000000+0-1.000000+0922232151				17
-77.5000000	3.0	1.105800-1	4.000000-2-3.340000-1	2.480000-1922232151		18
-1.000000000	0.0	-1.000000+0-1.000000+0-1.000000+0-1.000000+0922232151				19
-40.0000000	-2.0	4.305600-2	4.000000-2-2.530000-1-3.520000-1922232151			20
-1.000000000	0.0	-1.000000+0-1.000000+0-1.000000+0-1.000000+0922232151				21
-17.9130000	3.0	5.345500-3	4.000000-2	3.400000-1-2.040000-1922232151		22
-1.000000000	0.0	-1.000000+0-1.000000+0-1.000000+0-1.000000+0922232151				23
-7.79660000	-2.0	2.958100-4	4.000000-2-1.870000-1	1.180000-1922232151		24
-1.000000000	0.0	-1.000000+0-1.000000+0-1.000000+0-1.000000+0922232151				25
-4.53180000	-2.0	1.765500-5	4.000000-2-2.251500+0	1.624500-3922232151		26
-1.000000000	0.0	-1.000000+0-1.000000+0-1.000000+0-1.000000+0922232151				27
-3.32780000	-2.0	2.629523-5	4.471000-2	1.777848+0	1.325959-3922232151	28
-1.000000000	0.0	2.605765-6-1.000000+0	1.616154-1	1.326810-4922232151		29
-3.05440000	3.0	8.976641-4	7.607500-2-2.034293-1	1.428462+0922232151		30
-1.000000000	0.0	4.729018-5-1.000000+0	1.955152-2	8.949895-2922232151		31
-2.45840000	3.0	1.937439-4	8.530100-2	1.064770-2	5.636812-5922232151	32
-1.000000000	0.0	1.787800-5-1.000000+0	1.064196-3	5.636736-6922232151		33
-1.75650000	3.0	1.897976-4	3.763200-2	1.981943+0	8.586006-5922232151	34
-1.000000000	0.0	1.121293-5-1.000000+0	1.423510-1	8.587307-6922232151		35
-0.99317000	-2.0	1.287307-7	2.849600-2	4.359686-2-1.462515+0922232151		36
-1.000000000	0.0	1.283272-8-1.000000+0	4.211877-3	1.012372-1922232151		37
0.167370983	3.0	1.092339-7	8.571931-2	1.973494-2-2.621687-4922232151		38
0.001339122	0.0	7.070430-9	3.232506-3	1.527696-3	2.616484-5922232151	39
0.236397665	-2.0	3.254845-8	4.876550-2	1.408055-3	6.496068-4922232151	40
0.007441612	0.0	3.006132-9	4.665944-3	1.393843-4	6.491480-5922232151	41
0.558655963	-2.0	6.153748-7	2.518800-2	3.297604-1	3.339129-2922232151	42
0.014881406	0.0	5.512755-8-1.000000+0	2.552269-2	3.071276-3922232151		43
1.457125269	-2.0	2.134125-4	3.678507-2	3.920237-4-5.859796-1922232151		44
0.010563956	0.0	7.597958-6	2.991831-3	3.924710-5	1.890550-2922232151	45
1.768572735	3.0	2.422066-4	3.929131-2-1.392659-1	6.344544-2922232151		46
0.003106020	0.0	6.265952-6	2.873595-3	5.878464-3	4.263439-3922232151	47
2.303997013	3.0	1.503628-4	4.034157-2	5.668310-2	6.919863-6922232151	48
0.001621586	0.0	8.121118-6	2.885512-3	3.357210-3	6.909328-7922232151	49
3.527713130	-2.0	1.854515-4	4.100700-2	6.138131-1	4.432676-4922232151	50
0.010640834	0.0	5.997129-6-1.000000+0	2.534844-2	4.431135-5922232151		51
3.631905276	3.0	5.254121-5	3.837181-2	8.318507-2	2.592728-5922232151	52
0.004631352	0.0	3.712008-6	3.423368-3	7.657404-3	2.593190-6922232151	53

4.439024805	-2.0	3.491466-4	3.645915-2-7.002754-5-1.134445+0922232151	54
0.011280673	0.0	7.096285-6	3.626917-3 7.004060-6 2.561568-2922232151	55
5.812053445	3.0	9.397782-5	4.100000-2 3.316257-1-1.853276-4922232151	56
0.005936999	0.0	4.213754-6-1.000000+0	1.706887-2 1.853782-5922232151	57
6.615987848	-2.0	3.872524-4	4.100000-2 8.466131-6 6.383480-1922232151	58
0.022123786	0.0	2.088117-5-1.000000+0	8.466902-7 3.777151-2922232151	59
6.824278639	3.0	6.654547-4	3.738362-2-1.090544-1-9.942402-3922232151	60
0.002324825	0.0	2.666562-5	3.366820-3 5.937994-3 9.906580-4922232151	61
7.479099251	3.0	3.656046-5	4.100000-2 4.220367-2 1.544343-1922232151	62
0.007933990	0.0	1.930041-6-1.000000+0	4.090940-3 1.266157-2922232151	63
8.690077293	-2.0	2.142330-5	4.100000-2 1.674090-1 7.718288-4922232151	64
0.010750240	0.0	1.609904-6-1.000000+0	1.577891-2 7.662748-5922232151	65
8.807467099	-2.0	3.444035-4	4.100000-2-4.516863-3-1.617669+0922232151	66
0.039751177	0.0	1.580901-5-1.000000+0	4.483340-4 7.284313-2922232151	67
9.162676633	3.0	6.957581-5	5.373228-2 2.250022-1 1.180740-2922232151	68
0.005288264	0.0	4.130419-6	5.019702-3 1.463339-2 1.160485-3922232151	69
10.37690743	3.0	1.385579-3	5.016042-2-2.677024-1 1.655829-5922232151	70
0.002837367	0.0	2.949574-5	4.809164-3 7.103204-3 1.656271-6922232151	71
11.27541678	3.0	2.682686-4	4.100000-2-4.485145-2-4.410695-1922232151	72
0.009834420	0.0	1.063651-5-1.000000+0	4.005817-3 2.527395-2922232151	73
11.69904777	-2.0	1.138775-4	4.100000-2-5.238642-1-3.438234-2922232151	74
0.021201875	0.0	6.912180-6-1.000000+0	3.827892-2 3.437323-3922232151	75
12.78507854	3.0	1.321903-3	4.282490-2 5.125982-2-2.596436-1922232151	76
0.003222575	0.0	2.356414-5	4.144805-3 4.114893-3 8.849818-3922232151	77
13.43539584	3.0	1.277661-4	4.100000-2 2.606664-1 5.107212-4922232151	78
0.016657514	0.0	8.150567-6-1.000000+0	2.185941-2 5.110688-5922232151	79
13.67596768	-2.0	3.436229-4	3.586469-2-2.262109-1 5.483402-2922232151	80
0.006780223	0.0	1.189924-5	3.481925-3 1.000367-2 5.248946-3922232151	81
15.32828270	3.0	6.501700-4	4.377100-2-4.197700-4-1.533700-1922232151	82
-1.000000000	0.0	-1.000000+0-1.000000+0-1.000000+0-1.000000+0922232151	83	
15.49745445	3.0	6.659400-5	4.100000-2 1.404600-2-5.924100-3922232151	84
-1.000000000	0.0	-1.000000+0-1.000000+0-1.000000+0-1.000000+0922232151	85	
16.20449518	3.0	7.152300-4	4.100000-2 3.364900-1 8.093500-2922232151	86
-1.000000000	0.0	-1.000000+0-1.000000+0-1.000000+0-1.000000+0922232151	87	
16.57316072	3.0	5.659100-4	3.483800-2-2.676800-2 1.499400-1922232151	88
-1.000000000	0.0	-1.000000+0-1.000000+0-1.000000+0-1.000000+0922232151	89	

(Lines 90 through 1539 deliberately omitted here)

1175.000000	3.0	1.272100+0	4.000000-2-2.550000-1-2.400000-1922232151	1540		
-1.000000000	0.0	-1.000000+0-1.000000+0-1.000000+0-1.000000+0922232151	1541			
1400.000000	-2.0	1.899900+0	4.000000-2 3.120000-1 2.250000-1922232151	1542		
-1.000000000	0.0	-1.000000+0-1.000000+0-1.000000+0-1.000000+0922232151	1543			
1660.000000	3.0	2.133800+0	4.000000-2 2.600000-1 2.370000-1922232151	1544		
-1.000000000	0.0	-1.000000+0-1.000000+0-1.000000+0-1.000000+0922232151	1545			
####						
#### Concise Correlation Matrix follows						
#### Number of resonance parameters =	2310					
#### Number of lines for correlation coefficients =	251					
0.0	0.0	0	2310	251	251922232151 1546	
####						
#### Corr(J,I) = (K(J,I)*0.02 +/- 0.01)						
#### I J K(J,I) thru K(J+26,I)						
234 232 51					922232151 1547	
237 232 51 52					922232151 1548	
239 237 44					922232151 1549	
240 232 54 54	27	54			922232151 1550	
242 237 31 60					922232151 1551	
247 232 49 52	36	6549	38 49		922232151 1552	
249 234 53 62	5835	54	49 24		922232151 1553	
252 240 51					922232151 1554	
254 232 51 46		52		51 52	922232151 1555	
255 232 48		4972	45	53 58	922232151 1556	
256 234 47 44	59	48		51 47	53	922232151 1557

257	234	47	59	5543		30	80	494977	922232151	1558			
258	237	31	4755	48	63	47	537770	922232151	1559				
259	234	45	60	5361	48	31	45	4844595335	922232151	1560			
260	237	49	49		54		51	534852	922232151	1561			
261	234	49	49	52		53	46	605753	922232151	1562			
262	237	52	49		49	53	5339434349	47	922232151	1563			
263	255	4852	5251	54					922232151	1564			
264	237	49					53	5151	922232151	1565			
265	237	51					48	49	922232151	1566			
266	232	44	49	47	46		49		922232151	1567			
266	259	51	51						922232151	1568			
267	232	52	41				53	4554	4951	922232151	1569		
267	259	47	51	44					922232151	1570			
269	234	57	42	45			52	52465148	53	922232151	1571		
269	266	7256							922232151	1572			
270	232	48	52	52			49	48	5340	51	922232151	1573	
270	266	2355							922232151	1574			
271	234	46	45	60	47		56	53	4976524949	922232151	1575		
271	262	5249	4748	4644					922232151	1576			
272	232	53	48	44	5242		53	41	4524494741	922232151	1577		
272	259	6348	4951	5443	57	65			922232151	1578			
273	234	49	43	53	48		48	49	922232151	1579			
273	266	5149	51	5461					922232151	1580			
274	266	51							922232151	1581			
275	232	53	49	47	5229	54		43	51	4810464848	922232151	1582	
275	259	52	4851	5744	6149277244				922232151	1583			
276	237	45	6045	54	44	76		56	65	46	4852	922232151	1584
276	267	49	5148736251	42						922232151	1585		
277	232	49	51	47	53		45	58	5256	5157	922232151	1586	
277	259	4051		4854	5151281726	44			922232151	1587			
278	234	48	43	51	48		49		484947		922232151	1588	
278	261	49		49	52	4915	605476			922232151	1589		
279	234	52	55	48	51		45		51585148554551	922232151	1590		
279	261	51		5251	49	432762	43375233			922232151	1591		
280	237	49	47		55		49	4148	5143		922232151	1592	
280	266	4853	54	405654516345	4336					922232151	1593		
281	234	51	59	5549		37	61		53	564951	922232151	1594	
281	271	4232		485165487743						922232151	1595		

(Lines 1596 through 1784 deliberately omitted here)

362	232	51	51	51	51		49			922232151	1785		
362	279	5149		5251			48	48	49	49	922232151	1786	
362	315	49	51	51	51	4848	47		51	52	922232151	1787	
362	342	46	52445243	41	51	57432526	46	37			922232151	1788	
363	356	51		5574							922232151	1789	
364	232	52	45								922232151	1790	
364	267	51	48	51		49	49		5152		922232151	1791	
364	300	49						51			922232151	1792	
364	327	48	4949	51	51	47	51	5449	51475931	25	4956	922232151	1793
364	354	57	46	59	203936							922232151	1794
365	296	4949	51									922232151	1795
365	326	4851					48	494952	52	47	922232151	1796	
365	355	474939	52	52604944							922232151	1797	