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EUROPEAN ATOMIC ENERGY COMMUNITY - EURATOM

RDMM - A CODE FOR FAST NEUTRON SPECTRA DETERMINATION BY ACTIVATION ANALYSIS

by

G. DI COLA and A. ROTA

1966

Joint Nuclear Research Center
Ispra Establishment - Italy

Scientific Information Processing Center - CETIS
and
Chemistry Department
Nuclear Chemistry

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CONTENTS

SUMMARY

RDMM (Relative Deviation Minimization Method) is the name of the FORTRAN Code here described. It allows the automatic interpretation of the activation data for the in-pile fast neutron spectra determination.

1. STATEMENT OF THE PROBLEM

Measurements of in-pile fast neutron spectra are often obtained by threshold detector irradiations. The threshold detector technique give data usually expressed as normalized activation rates, that is:

$$A_i = \int \sigma_i(E) \varphi(E)\, dE \qquad (1)$$

where A_i indicates the reaction probability per second for a nucleus of the i'th isotope, having $\sigma_i(E)$ as differential cross-section, when immersed in the unknown neutron flux $\varphi(E)$ n/(cm^{2}sec MeV).

The code, here described in the following, allows the φ (E) determination, on the hypothesis that the neutron flux shape can be approximated by an expression of the type:

$$\varphi(E) \approx \varphi^t(E) = W(E) \sum_{i}^{t}{}_k\, a_k \Psi_k(E) \qquad (2)$$

where:

n = number of the threshold detectors used in the experiment of activation.

W(E)= weighting function, chosen in agreement with the kind of the treated problem.

Ψ_k(E)= complete set of arbitrary functions.

a_k = coefficients of the expansion, that will be determined by the calculation.

t = cut-off number.

Experimental and theoretical support of the proposed code can be found in detail in a paper by Di Cola and Rota [(1)].

(1) G.DI COLA and A.ROTA - Nucl. Sci. and Eng. 23,344,(1965)

Manuscript received on April 28, 1966.

2. OUTLINE OF THE CODE

The Relative Deviation Minimization Method (R D M M) suggests to choose, as solution of the problem, the flux that minimize the quadratic form

$$Q(t,a_1,\ldots\ldots a_t) = \sum_1^n {}_i \left[\frac{A_i - \int \sigma_i(E)\varphi^t(E)\ dE}{A_i} \right]^2$$

with the condition $t \leq n$.

A second feature of the code is the determination of the standard deviation on the resulting flux, as function of the standard deviation on the activation rates and on the data of cross-sections. A limitation is that the standard deviation on the cross-sections can be expressed only in the form:

$$\sigma_i(E) \pm \alpha_i \sigma_i(E)$$

with α_i = cost.

Care should be taken to read correctly the output data in order to choose, as solution of the problem under study, the best approximation.

3. SOME REMARKS ON THE USE OF THE CODE

A correct running of the code requires the knowledge of the limitations described in the following:

3.1 Sets of the ψ functions

The $\psi(E)$ functions must belong to a class that can be described by the general formula:

$$\psi_k(E) = \sum_1^k {}_j\ b_{j-1}\ E^{j-1}$$

This class includes, for instance, the Laguerre polynomials, the Chebyshew polynomials, the Legendre polynomials, and so on. The use of trigonometric functions is not allowed without a suitable change in a part of the code.

The functions ψ must belong to a set of complete functions and it is better if they are normalized. This last condition is not strictly necessary.

3.2 Activation rates and scale factors

According to their definition, the activation rates are usually very small numbers. (e.g. $A_{Np} = 4.10^{-13}$ for a fast flux, above 0.5 MeV, of 5.10^{10} n/(cm^2 sec))

Numerical reasons require that these numbers are in the range (order of magnitude) $10^{-3} \div 10^{3}$. It is then necessary to work with the A_i reduced by a suitable scale factor, that must be recalled when the results are read.

The cross-sections are given in mb and it follows that the flux is actually expressed in n/(10^{-27} cm^2 sec MeV). If a scale factor of 10^{+c} is used for the activation rates, the scale factor 10^{27-c} must be applied to the results in order to obtain differential flux values in the usual unity, n/(cm^{2}sec MeV), and integral flux values in n/(cm^{2}sec).

4. DESCRIPTION OF THE FORTRAN PROGRAM

4.1 General information

RDMM has been written in FORTRAN IV or MAP language. It consists of a MAIN program and 10 subroutines.

Data transfer to and from subroutines is obtained both through COMMON and explicite arguments, as the case requires.

4.2 Subroutines

1 INPUT reads the input data and transforms them in the

way required for the processing. It writes the data of the problem.

2 PESI defines the W(E) in the form e^{-E}. If the use of a different weighting function is required, this subroutine must be suitably changed.

3 MTRIX calculates the elements of the matrices S and $R^T R$ defined in formulas (3) and (11) of reference (1).

4 ABC performs an approximate evaluation of an integral of the form

$$\int_a^b f(x)\, dx$$

by the n-point Newton-Cotes integration formulas, with n variable from 2 to 7.

5 SIMH calculates the inverse of a given matrix.

6 FLXCAL calculates the differential and integral neutron fluxes as in formula (5) or reference (1).

7 RNG performs a transformation of random numbers to obtain statistically independent parameters.

8 CAS computes a random number by using a congruential method.

9 AVERAG calculates the mean and the standard deviation of a given frequency distribution.

10 CØE reads, normalized and prints the coefficients b_j (see 3.1). This routine now refers to Laguerre polynominals.

4.3 Input description

The following table contains the list of the input cards.

Data Cards.

Order of cards	Names	Description	Format
1	RCRD1	Titles	12A6
2	RCRD2	Titles	12A6
3	NS,NP,NPP	NS = number of detectors: n NP = number of points in which the σ(E) are tabulated NPP= step of the print-out results.	10I6
4	MIN, MAX	MIN = minimum t MAX = maximum t ($\leq$n)	10I6
5	NHIS (I)	Number of Montecarlo hystories for each approximation order. If NHIS (I) = 0 no error evaluation is performed for t=I	10I6
6	E(1), H	E(1)= the first energy value in which the σ_i(E) are tabulated (MeV). H = step of the energy tabulation (MeV).	3E10.6
7	NS blocks of data cards, for I = 1, NS as follows		
	SIGNME(I)	Name of detector (6 characters) Cross sections of the detector I expressed in mbarn for J=1, NP.	12A6 5F10.3
8	NS data cards, for I = 1, NS, as follows:		
	A(I),SA(I), SV(I)	A= Activation rate SA= Relative standard error on the A SV= Relative standard error on the SIGMA.	3E10.6
9	MAX cards, for I = 1, MAX, as follows:		
	CF(J,I)	CF = coefficients of the polynomial forms (J=1,I)	

4.4 Output description

The first page contains:

- The title of the problem.
- The coefficients b_i of the functions ω_k (see 3.1)
- The activation rates, its relative standard deviations and the cross-section relative standard deviations.
- The "cut-off" numbers of the series expansion and the number of the Monte-Carlo hystories required.

In the pages that follow the results of the computation are listed. For each cut-off number one or two pages are printed. The first one contains:

- The list of the numbers:

$$\frac{\int \sigma_i \varphi^k \, dE}{A_i} \qquad \begin{array}{l} i = 1, \ldots\ldots n \\ k = \text{cut-off number} \end{array}$$

These numbers tend to 1 as φ^k tends to φ.

- The value of the quadratic form Q (see form (1)
- The value of $\Phi^* = \int_{0.5} \varphi^k(E) \, dE$
- The table of the actual values of $\varphi^k(E)$

A second page is printed only if a statistical analysis on the results is required. This page contains all the information concerning this analysis on integral and differential neutron fluxes.

```
      DIMENSION V(10)
      DIMENSION AV(141),SD(141)
      DIMENSION A(10),E(141),NHIS(10),SA(10),SIGNME(10),SV(10),TN(10),VV
     1(10),W(141)
      DIMENSION CA(10,141),CF(10,10),S(10,10),SIGMA(10,141),T(10,10),TI(
     110,10)
      COMMON MIN,MAX,NG,NS,NP,NPP,H
      COMMON A,E,NHIS,SA,SIGNME,SV,TN,VV,W
      COMMON CA,CF,S,SIGMA,T,TI
      DIMENSION FI(141),FXT(150),FLX(150,30)                          MAIN
  100 FORMAT (1H1,30X,26HAPPROXIMATION  NUMBER  ***,I2,4H ***,////,1H ,1
     10X,5HCHECK,//)
  101 FORMAT (14X,3HQ =,E10.3,33H  -  INTEGRAL FLUX ABOVE .5 MEV =,E10.3
     1,//,1H ,4X,1HE,7X,2HFI,8X,1HE,7X,2HFI,8X,1HE,7X,2HFI,8X,1HE,7X,2HF
     2I,8X,1HE,7X,2HFI,//)
  102 FORMAT ((1H ,5(F7.2,E11.3)))
  103 FORMAT (1H1 ,28X,22HSTATISTICAL ANALISYS (,I3,11H HISTORIES),//)
  104 FORMAT (1H ,8H INT.FLX,E10.3,7H    MEAN,E10.3,4H +0-,E10.3,6H   O/O
     1,F6.2,4H   (,E10.3,2H -,E10.3,1H))
  105 FORMAT (//,1H ,64H   E /      NEUTRON FLUX        STANDARD DEVIAT.
     1      68 PER CENT,//,67H  (MEV)   CALCUL.  MONTECARLO   ABSOLUTE  R
     2ELAT.    CONFIDENCE INT.,//)
  106 FORMAT (1H ,F6.2,3E11.3,F8.3,2E11.3)
  107 FORMAT (1H0,10X,A6,F8.3)
  108 FORMAT (///)

      CALL INPUT                                                   ,1
      KP=NP/NPP+1                                                  ,2
      CALL MTRIX                                                   ,3
      DO 1 K=1,KP                                                  ,4
      L=K*NPP-(NPP-1)                                              ,5
      E(K)=E(L)                                                    ,6
    1 CONTINUE                                                     ,7     ,8
      DO 12 NG=MIN,MAX                                             ,9
      WRITE (6,100) NG                                             ,10    ,11    ,12
      CALL SIMH(T,TI,NG,1)                                         ,13
      CALL FLXCAL(FI,FLXINT,V)                                     ,14
      Q=0                                                          ,15
      DO 3 K=1,NS                                                  ,16
      C=0                                                          ,17
      DO 2 L=1,NG                                                  ,18
    2 C=C+S(K,L)*V(L)                                              ,19    ,20
      WRITE (6,107)SIGNME(K),C                                     ,21    ,22    ,23
    3 Q=Q+(1.-C)**2                                                ,24    ,25
      WRITE (6,108)                                                ,26    ,27
      WRITE (6,101) Q,FLXINT                                       ,28    ,29    ,30
      WRITE (6,102) (E(I),FI(I),I=1,KP)                            ,31    ,32    ,33    ,34    ,35
      NHS=NHIS(NG)                                                 ,36
      IF(NHS)4,4,5                                                 ,37
    4 GO TO 12                                                     ,38
    5 CONTINUE                                                     ,39
      DO 8 NN=1,NHS                                                ,40
      CALL RNG(A,SA,NS)                                            ,41
      CALL RNG(VV,SV,NS)                                           ,42
      DO 6 I=1,NS                                                  ,43
```

```
       EXTERNAL FORMULA NUMBER    -    SOURCE STATEMENT    -    INTERNAL FORMULA NUMBER(S)

     A(I)=A(I)/VV(I)                                                   ,44
  6  CONTINUE                                                          ,45     ,46
     CALL  FLXCAL(W,WW,V)                                              ,47
     DO 7  K=1,KP                                                      ,48
     FLX(NN,K)=W(K)                                                    ,49
  7  CONTINUE                                                          ,50     ,51
     FXT(NN)=WW                                                        ,52
  8  CONTINUE                                                          ,53     ,54
     DO 9  K=1,KP                                                      ,55
     CALL  AVERAG(FLX(1,K),NHS,AV(K),SD(K))                            ,56
  9  CONTINUE                                                          ,57     ,58
     CALL  AVERAG(FXT,NHS,TFM,SDIF)                                    ,59
     WRITE (6,103) NHS                                                 ,60     ,61     ,62
     S1=SDIF/TFM                                                       ,63
     S2=TFM-SDIF                                                       ,64
     S3=TFM+SDIF                                                       ,65
     WRITE (6,104) FLXINT,TFM,SDIF,S1,S2,S3                            ,66     ,67     ,68
     WRITE (6,105)                                                     ,69     ,70
     DO 10  K=1,KP                                                     ,71
     S1=SD(K)/AV(K)                                                    ,72
     S2=AV(K)-SD(K)                                                    ,73
     S3=AV(K)+SD(K)                                                    ,74
     WRITE (6,106) E(K),FI(K),AV(K),SD(K),S1,S2,S3                     ,75     ,76     ,77
 10  CONTINUE                                                          ,78     ,79
     DO 11  I=1,NS                                                     ,80
     A(I)=1.                                                           ,81
 11  CONTINUE                                                          ,82     ,83
 12  CONTINUE                                                          ,84     ,85
     STOP                                                              ,86
     END
                                                                       ,87
```

EXTERNAL FORMULA NUMBER - SOURCE STATEMENT - INTERNAL FORMULA NUMBER(S)

```
      SUBROUTINE INPUT
      DIMENSION A(10),E(141),NHIS(10),SA(10),SIGNME(10),SV(10),TN(10),VV
     1(10),W(141)
      DIMENSION CA(10,141),CF(10,10),S(10,10),SIGMA(10,141),T(10,10),TI(
     110,10)
      COMMON MIN,MAX,NG,NS,NP,NPP,H
      COMMON A,E,NHIS,SA,SIGNME,SV,TN,VV,W
      COMMON CA,CF,S,SIGMA,T,TI
      DIMENSION RCRD1(12),RCRD2(12)                                INPUT
    1 FORMAT (12A6)
    2 FORMAT (1H1,20X,12A6,////,1H ,20X,12A6,/////)
    3 FORMAT (10I6)
    4 FORMAT (3E10.6)
    5 FORMAT (5F10.3)
    7 FORMAT (1H ///
     1       1H ,6X,4HDATA//1H0,13X,41HDETECTOR  ACTIV.RATE   0/0 A
     10/0 SIGMA)
    8 FORMAT (1H0,13X,A6,E13.4,F8.3,F11.3)
    9 FORMAT (////,1H )
   10 FORMAT (10X,10HPOL. ORDER,I3,15H  NUMB. OF HIS.,I4)
      READ (5,1) RCRD1,RCRD2                              ,1   ,2   ,3
      WRITE (6,2) RCRD1,RCRD2                             ,4   ,5   ,6
      READ (5,3) NS,NP,NPP                                ,7   ,8   ,9   ,10  ,11
      READ (5,3) MIN,MAX                                  ,12  ,13  ,14  ,15
      READ (5,3) (NHIS(I),I=MIN,MAX)                      ,16  ,17  ,18  ,19  ,20
      READ (5,4) E(1),H                                   ,21  ,22  ,23
      DO 11 K=2,NP                                        ,24
   11 E(K)=E(K-1)+H                                       ,25  ,26
      DO 12 I=1,NS                                        ,27
      READ (5,1) SIGNME(I)                                ,28  ,29  ,30
   12 READ (5,5) (SIGMA(I,J),J=1,NP)                      ,31  ,32  ,33  ,34  ,35  ,36
      READ (5,4) ((A(I),SA(I),SV(I)),I=1,NS)              ,37  ,38  ,39  ,40  ,41
      DO 13 I=1,NS                                        ,42
      DO 13 J=1,NP                                        ,43
   13 SIGMA(I,J)=SIGMA(I,J)/A(I)                          ,44  ,45  ,46
      CALL COE(MAX,CF)                                    ,47
      CALL PESI(W,E,NP)                                   ,48
      WRITE (6,7)                                         ,49  ,50
      WRITE (6,8) ((SIGNME(I),A(I),SA(I),SV(I)),I=1,NS)   ,51  ,52  ,53  ,54  ,55
      WRITE (6,9)                                         ,56  ,57
      WRITE (6,10) (K,NHIS(K),K=MIN,MAX)                  ,58  ,59  ,60  ,61  ,62
      DO116 I=1,NS                                        ,63
  116 A(I)=1.                                             ,64  ,65
      RETURN                                              ,66
      END
                                                          ,67
```

```
      SUBROUTINE PESI(W,E,NP)
C     OPTIONAL SUBROUTINE
C     TO BE MODIFIED ACCORDING TO THE NECESSITIES
      DIMENSION W(1),E(1)
      DO 1 K=1,NP                                              ,1
      W(K)=EXP(-E(K))                                          ,2
    1 CONTINUE                                                 ,3      ,4
      RETURN                                                   ,5
      END
                                                               ,6
```

```
     EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT   -   INTERNAL FORMULA NUMBER(S)

      SUBROUTINE MTRIX
      DIMENSION A(10),E(141),NHIS(10),SA(10),SIGNME(10),SV(10),TN(10),VV
     1(10),W(141)
      DIMENSION CA(10,141),CF(10,10),S(10,10),SIGMA(10,141),T(10,10),TI(
     110,10)
      COMMON MIN,MAX,NG,NS,NP,NPP,H
      COMMON A,E,NHIS,SA,SIGNME,SV,TN,VV,W
      COMMON CA,CF,S,SIGMA,T,TI
      DIMENSION V(141)                                        MTRIX
      NG=MAX                                                           ,1
      DO 2  I=1,NG                                                     ,2
      DO 2  J=1,NP                                                     ,3
      POL=0.                                                           ,4
      DO 1  K=1,I                                                      ,5
      K1=I-K+1                                                         ,6
    1 POL=POL*E(J)+CF(K1,I)                                            ,7    ,8
    2 CA(I,J)=POL*W(J)
C                                                                      ,9    ,10   ,11
      DO 5  K=1,NG                                                     ,12
      DO 5  I=1,NS                                                     ,13
      DO 3  J=1,NP                                                     ,14
    3 V(J)=SIGMA(I,J)*CA(K,J)                                          ,15   ,16
    5 S(I,K)=ABC(NP,5,H,V)                                             ,17   ,18   ,19
      DO 6  J=1,NG                                                     ,20
      DO 6  K=1,NG                                                     ,21
      T(J,K)=0                                                         ,22
      DO 6  L=1,NS                                                     ,23
    6 T(J,K)=T(J,K)+S(L,J)*S(L,K)                                      ,24   ,25   ,26   ,27
      RETURN                                                           ,28
      END
                                                                       ,29
```

```
      FUNCTION ABC(NP,MP,H,Y)
      DIMENSION S(7,7),D(7),Y(3000)
C
      DATA((S(I,J),J=1,7),I=2,7)/1.,1.,0.,0.,0.,0.,0.,
     111.,4.,1.,0.,0.,0.,0.,
     221.,3.,3.,1.,0.,0.,0.,
     337.,32.,12.,32.,7.,0.,0.,
     4419.,75.,50.,50.,75.,19.,0.,
     5541.,216.,27.,272.,27.,216.,41./
      DATA (D(I),I=2,7)/.5,.33333333,.375,.04444444,.01736111,.00714286/
      NI=NP-1                                                   ,1
      MI=MP-1                                                   ,2
      M=NI/MI                                                   ,3
      K=NI-MI*M                                                 ,4
C
      Z=0                                                       ,5
      MM=0                                                      ,6
      DO 1  I=1,M                                               ,7
      W=0                                                       ,8
      DO 2  J=1,MP                                              ,9
      JM=MM+J                                                   ,10
    2 W=W+S(MP,J)*Y(JM)                                         ,11    ,12
      Z=Z+W                                                     ,13
    1 MM=JM-1                                                   ,14    ,15
      Z=Z*D(MP)                                                 ,16
C
      IF(K)3,3,4                                                ,17
    4 KP=K+1                                                    ,18
      W=0                                                       ,19
      DO 5  J=1,KP                                              ,20
      JM=MM+J                                                   ,21
    5 W=W+S(KP,J)*Y(JM)                                         ,22    ,23
      Z=Z+W*D(KP)                                               ,24
C
    3 ABC=Z*H                                                   ,25
      RETURN                                                    ,26
      END                                                       ,27
```

```
      SUBROUTINE SIMH(A,AT,N,ITER)
      DIMENSION A(10,10),AT(10,10)
    1 DO 2 I=1,N                                         ,1
      DO 2 J=1,N                                         ,2
    2 AT(I,J)=A(J,I)                                     ,3     ,4     ,5
      DET=1.                                             ,6
      DO 80 IL=1,ITER                                    ,7
      DO 80 I=1,N                                        ,8
      C=0.                                               ,9
      DO 10 K=1,N                                        ,10
   10 C=C+A(I,K)*AT(K,I)                                 ,11    ,12
      IF(C)20,555,20                                     ,13
   20 DET=DET*C                                          ,14
      DO 30 J=1,N                                        ,15
   30 AT(J,I)=AT(J,I)/C                                  ,16    ,17
      DO 70 J=1,N                                        ,18
      IF(J-I)40,70,40                                    ,19
   40 H=0.                                               ,20
      DO 50 K=1,N                                        ,21
   50 H=H+A(I,K)*AT(K,J)                                 ,22    ,23
      DO 60 K=1,N                                        ,24
   60 AT(K,J)=AT(K,J)-H*AT(K,I)                          ,25    ,26
   70 CONTINUE                                           ,27    ,28
   80 CONTINUE                                           ,29    ,30    ,31
      RETURN                                             ,32
  555 CONTINUE                                           ,33
      WRITE (6,90)                                       ,34    ,35
   90 FORMAT (1H0,22HILL-CONDITIONED MATRIX)
      STOP                                               ,36
      END                                       FICM0065
                                                         ,37
```

```
   SUBROUTINE FLXCAL(FI,FLXINT,V)
   DIMENSION A(10),E(141),NHIS(10),SA(10),SIGNME(10),SV(10),TN(10),VV
  1(10),W(141)
   DIMENSION CA(10,141),CF(10,10),S(10,10),SIGMA(10,141),T(10,10),TI(
  110,10)
   COMMON MIN,MAX,NG,NS,NP,NPP,H
   COMMON A,E,NHIS,SA,SIGNME,SV,TN,VV,W
   COMMON CA,CF,S,SIGMA,T,TI
   DIMENSION FI(141),V(10)                                   FLXCAL
   DO 1  J=1,NG                                                         ,1
   TN(J)=0.                                                             ,2
   DO 1  K=1,NS                                                         ,3
 1 TN(J)=TN(J)+S(K,J)*A(K)                                              ,4    ,5    ,6
   DO 2  K=1,NG                                                         ,7
   V(K)=0.                                                              ,8
   DO 2  I=1,NG                                                         ,9
 2 V(K)=V(K)+TI(K,I)*TN(I)                                              ,10   ,11   ,12
   DO 3  I=1,NP                                                         ,13
   FI(I)=0.                                                             ,14
   DO 3  L=1,NG                                                         ,15
 3 FI(I)=FI(I)+CA(L,I)*V(L)                                             ,16   ,17   ,18
   FLXINT=ABC(NP-5,5,H,FI(6))                                           ,19
   K=0                                                                  ,20
   DO 4  I=1,NP,NPP                                                     ,21
   K=K+1                                                                ,22
 4 FI(K)=FI(I)                                                          ,23   ,24
   RETURN                                                               ,25
   END
                                                                        ,26
```

```
      SUBROUTINE RNG(PAR,SPAR,N)
C     RANDOM NUMBER GENERATION
      DIMENSION PAR(10),TAB(2,30),SPAR(10)
      DATA ((TAB(J,K),J=1,2),K=1,29)/-4.,0.,-2.33,.01,-2.06,.02,-1.89,.0
     13,-1.76,.04,-1.65,.05,-1.29,.1,-1.04,.15,-.85,.2,-.68,.25,-.53,.3,
     2-.39,.35,-.26,.4,-.13,.45,.0,.5,.13,.55,.26,.60,.39,.65,.53,.70,.6
     38,.75,.85,.80,1.04,.85,1.29,.9,1.65,.95,1.76,.96,1.89,.97,2.06,.98
     4,2.33,.99,4.,1./
      DO 3 K=1,N                                                   ,1
      CALL CAS(RN)                                                 ,2
      DO 1 I=1,29                                                  ,3
      IF(TAB(2,I)-RN)1,1,2                                         ,4
    1 CONTINUE                                                     ,5    ,6
    2 CONTINUE                                                     ,7
      PAR(K)=TAB(1,I)-((TAB(2,I)-RN)/(TAB(2,I)-TAB(2,I-1))*(TAB(1,I)-TAB
     1(1,I-1)))                                                    ,8
      PAR(K)=1.+SPAR(K)*PAR(K)                                     ,9
    3 CONTINUE                                                     ,10   ,11
      RETURN                                                       ,12
      END
                                                                   ,13
```

```
RDMM   CAS                                                                08/15/65
    ASSEMBLED TEXT.
            $TEXT  CAS                                                                      CAS 0001
                                                 ENTRY   CAS

BINARY CARD ID. CAS 0002
       00000  1 00000 0 00003  10001   CAS   SAVE
       00001  0774 00 4 00000  10000
       00002  0020 00 4 00001  10000
       00003  0634 00 4 04000  10011
       00004  0634 00 4 00020  10001
       00005  0634 00 4 00000  10011
              1 00000 7 00001  10001
       00006  0560 00 0 00016  10001         LDQ     U
       00007  0200 00 0 00017  10001         MPY     X
       00010  4600 00 0 00016  10001         STQ     U
       00011  0500 00 0 00022  10001         CLA     =0200
       00012  0763 00 0 00033  10000         LLS     27
       00013  0300 00 0 00023  10001         FAD     =0200000000000
       00014  0601 60 4 00003  10000         STO*    3,4
                        00015                RETURN  CAS
       00016  000000000335     10000   U     OCT     000000000335
       00017  000000037035     10000   X     OCT     000000037035
       00020  000000000000     10000         *LDIR
       00021  232162606060     10000

BINARY CARD ID. CAS 0003
       00022  000000000200     10000         *LORG
       00023  200000000000     10000
                        00000  01111         END
```

EXTERNAL FORMULA NUMBER - SOURCE STATEMENT - INTERNAL FORMULA NUMBER(S)

```
      SUBROUTINE AVERAG(X,NX,AV,SD)
      DIMENSION X(2)
      CNX=NX                                              ,1
      VQM=0                                               ,2
      AV=0                                                ,3
      DO 1 I=1,NX                                         ,4
    1 AV=AV+X(I)                                          ,5     ,6
      AV=AV/CNX                                           ,7
      DO 2 I=1,NX                                         ,8
    2 VQM=VQM+(X(I)-AV)**2                                ,9     ,10
      SD=SQRT(VQM/(CNX-1.))                               ,11
      RETURN                                              ,12
      END                                                 ,13
```

```
      SUBROUTINE COE(MAX,CF)
      DIMENSION CF(10,10)
    6 FORMAT (10E7.4)
   16 FORMAT (1H0,1P8E15.4)
      CN=1                                    ,1
      DO 14 I=1,MAX                           ,2
      READ (5,6) (CF(J,I),J=1,I)              ,3    ,4    ,5    ,6    ,7
      DO 15 J=1,I                             ,8
   15 CF(J,I)=CF(J,I)/CN                      ,9    ,10
      CN=CN*FLOAT(I)**2                       ,11
      WRITE (6,16) (CF(J,I),J=1,I)            ,12   ,13   ,14   ,15   ,16
   14 CONTINUE                                ,17   ,18
      RETURN                                  ,19
      END                                     ,20
```

SAMPLE PROBLEM *** EXP. DATA ISPRA 1 REACTOR 3.7 MW

LAGUERRE POLYNOMIALS 8 DETECTORS

1.0000E 00							
1.0000E 00	-1.0000E 00						
5.0000E-01	-1.0000E 00	2.5000E-01					
1.6667E-01	-5.0000E-01	2.5000E-01	-2.7778E-02				
4.1667E-02	-1.6667E-01	1.2500E-01	-2.7778E-02	1.7361E-03			
8.3333E-03	-4.1667E-02	4.1667E-02	-1.3889E-02	1.7361E-03	-6.9444E-05		
1.3889E-03	-8.3333E-03	1.0417E-02	-4.6296E-03	8.6806E-04	-6.9444E-05	1.9290E-06	
1.9841E-04	-1.3889E-03	2.0833E-03	-1.1574E-03	2.8935E-04	-3.4722E-05	1.9290E-06	-3.9368E-08

DATA

DETECTOR	ACTIV.RATE	0/0 A	0/0 SIGMA
NI-NEW	0.6150E 02	0.050	0.050
NEPT.	0.4170E 04	0.050	0.050
AL-N.P	0.2540E 01	0.050	0.050
URANIO	0.3390E 03	0.050	0.050
FERRO	0.7630E 00	0.050	0.050
TORIO	0.9210E 02	0.050	0.050
AL-ALF	0.5280E 00	0.050	0.050
ZOLFO	0.4070E 02	0.050	0.050

POL. ORDER 4 NUMB. OF HIS. 150
POL. ORDER 5 NUMB. OF HIS. 150
POL. ORDER 6 NUMB. OF HIS. 150
POL. ORDER 7 NUMB. OF HIS. 150
POL. ORDER 8 NUMB. OF HIS. 150

APPROXIMATION NUMBER *** 4 ***

CHECK

NI-NEW	1.082
NEPT.	0.996
AL-N.P	0.970
URANIC	1.079
FERRO	1.042
TORIC	0.888
AL-ALF	0.975
ZOLFO	0.937

Q = 0.328E-01 - INTEGRAL FLUX ABOVE .5 MEV = 0.355E 01

E	FI	E	FI	E	FI	E	FI	E	FI
0.	0.140E 02	0.50	0.619E 01	1.00	0.262E 01	1.50	0.105E 01	2.00	0.401E-00
2.50	0.146E-00	3.00	0.557E-01	3.50	0.284E-01	4.00	0.219E-01	4.50	0.203E-01
5.00	0.187E-01	5.50	0.164E-01	6.00	0.136E-01	6.50	0.107E-01	7.00	0.809E-02
7.50	0.592E-02	8.00	0.422E-02	8.50	0.293E-02	9.00	0.199E-02	9.50	0.133E-02
10.00	0.873E-03	10.50	0.563E-03	11.00	0.357E-03	11.50	0.223E-03	12.00	0.137E-03
12.50	0.821E-04	13.00	0.483E-04	13.50	0.276E-04	14.00	0.153E-04		

STATISTICAL ANALISYS (150 HISTORIES)

INT.FLX 0.355E 01   MEAN 0.356E 01 +0- 0.238E-00   0/0 0.07   (0.332E 01 - 0.380E 01)

E	NEUTRON FLUX		STANDARD DEVIAT.		68 PER CENT	
(MEV)	CALCUL.	MONTECARLO	ABSOLUTE	RELAT.	CONFIDENCE INT.	
0.	0.140E 02	0.141E 02	0.158E 01	0.113	0.125E 02	0.156E 02
0.50	0.619E 01	0.621E 01	0.590E 00	0.095	0.562E 01	0.680E 01
1.00	0.262E 01	0.263E 01	0.196E-00	0.074	0.243E 01	0.282E 01
1.50	0.105E 01	0.106E 01	0.582E-01	0.055	0.999E 00	0.112E 01
2.00	0.401E-00	0.402E-00	0.247E-01	0.061	0.377E-00	0.426E-00
2.50	0.146E-00	0.146E-00	0.166E-01	0.114	0.129E-00	0.163E-00
3.00	0.557E-01	0.559E-01	0.995E-02	0.178	0.460E-01	0.658E-01
3.50	0.284E-01	0.286E-01	0.518E-02	0.181	0.234E-01	0.338E-01
4.00	0.219E-01	0.220E-01	0.317E-02	0.144	0.188E-01	0.252E-01
4.50	0.203E-01	0.204E-01	0.277E-02	0.136	0.176E-01	0.231E-01
5.00	0.187E-01	0.188E-01	0.246E-02	0.131	0.164E-01	0.213E-01
5.50	0.164E-01	0.165E-01	0.197E-02	0.119	0.145E-01	0.184E-01
6.00	0.136E-01	0.136E-01	0.142E-02	0.105	0.122E-01	0.150E-01
6.50	0.107E-01	0.107E-01	0.943E-03	0.088	0.978E-02	0.117E-01
7.00	0.809E-02	0.811E-02	0.574E-03	0.071	0.754E-02	0.868E-02
7.50	0.592E-02	0.593E-02	0.328E-03	0.055	0.561E-02	0.626E-02
8.00	0.422E-02	0.422E-02	0.195E-03	0.046	0.403E-02	0.442E-02
8.50	0.293E-02	0.293E-02	0.151E-03	0.052	0.278E-02	0.308E-02
9.00	0.199E-02	0.199E-02	0.143E-03	0.072	0.185E-02	0.214E-02
9.50	0.133E-02	0.133E-02	0.135E-03	0.102	0.119E-02	0.146E-02
10.00	0.873E-03	0.871E-03	0.121E-03	0.139	0.750E-03	0.993E-03
10.50	0.563E-03	0.562E-03	0.104E-03	0.185	0.458E-03	0.665E-03
11.00	0.357E-03	0.356E-03	0.853E-04	0.240	0.270E-03	0.441E-03
11.50	0.223E-03	0.222E-03	0.679E-04	0.306	0.154E-03	0.290E-03
12.00	0.137E-03	0.136E-03	0.527E-04	0.388	0.829E-04	0.188E-03
12.50	0.821E-04	0.813E-04	0.400E-04	0.492	0.413E-04	0.121E-03
13.00	0.483E-04	0.476E-04	0.298E-04	0.626	0.178E-04	0.775E-04
13.50	0.276E-04	0.271E-04	0.219E-04	0.808	0.520E-05	0.491E-04
14.00	0.153E-04	0.149E-04	0.159E-04	1.068	-0.102E-05	0.308E-04

APPROXIMATION NUMBER *** 5 ***

CHECK

NI-NEW	1.088
NEPT.	1.035
AL-N.P	0.964
URANIC	1.059
FERRC	1.026
TCRIC	0.873
AL-ALF	0.991
ZCLFC	0.951

Q = 0.330E-01 - INTEGRAL FLUX ABOVE .5 MEV = 0.371E 01

E	FI	E	FI	E	FI	E	FI	E	FI
0.	0.162E 02	0.50	0.680E 01	1.00	0.273E 01	1.50	0.104E 01	2.00	0.380E-00
2.50	0.138E-00	3.00	0.568E-01	3.50	0.329E-01	4.00	0.261E-01	4.50	0.229E-01
5.00	0.198E-01	5.50	0.163E-01	6.00	0.129E-01	6.50	0.983E-02	7.00	0.729E-02
7.50	0.530E-02	8.00	0.380E-02	8.50	0.271E-02	9.00	0.191E-02	9.50	0.135E-02
10.00	0.956E-03	10.50	0.677E-03	11.00	0.480E-03	11.50	0.342E-03	12.00	0.243E-03
12.50	0.174E-03	13.00	0.124E-03	13.50	0.889E-04	14.00	0.635E-04		

STATISTICAL ANALISYS (150 HISTORIES)

INT.FLX 0.371E 01   MEAN 0.372E 01 +0- 0.407E-00   0/0 0.11   (0.332E 01 - 0.413E 01)

E	NEUTRON FLUX		STANDARD DEVIAT.		68 PER CENT	
(MEV)	CALCUL.	MONTECARLO	ABSOLUTE	RELAT.	CONFIDENCE INT.	
0.	0.162E 02	0.161E 02	0.495E 01	0.307	0.112E 02	0.211E 02
0.50	0.680E 01	0.680E 01	0.142E 01	0.208	0.538E 01	0.821E 01
1.00	0.273E 01	0.274E 01	0.299E-00	0.109	0.244E 01	0.304E 01
1.50	0.104E 01	0.105E 01	0.699E-01	0.066	0.985E 00	0.112E 01
2.00	0.380E-00	0.386E-00	0.530E-01	0.137	0.333E-00	0.439E-00
2.50	0.138E-00	0.139E-00	0.244E-01	0.175	0.115E-00	0.164E-00
3.00	0.568E-01	0.568E-01	0.101E-01	0.178	0.467E-01	0.669E-01
3.50	0.329E-01	0.323E-01	0.114E-01	0.353	0.209E-01	0.437E-01
4.00	0.261E-01	0.254E-01	0.101E-01	0.398	0.153E-01	0.356E-01
4.50	0.229E-01	0.224E-01	0.671E-02	0.299	0.157E-01	0.291E-01
5.00	0.198E-01	0.195E-01	0.358E-02	0.184	0.159E-01	0.231E-01
5.50	0.163E-01	0.162E-01	0.214E-02	0.132	0.141E-01	0.183E-01
6.00	0.129E-01	0.129E-01	0.215E-02	0.167	0.107E-01	0.150E-01
6.50	0.983E-02	0.985E-02	0.217E-02	0.221	0.767E-02	0.120E-01
7.00	0.729E-02	0.733E-02	0.188E-02	0.257	0.545E-02	0.921E-02
7.50	0.530E-02	0.535E-02	0.142E-02	0.266	0.392E-02	0.677E-02
8.00	0.380E-02	0.384E-02	0.934E-03	0.243	0.291E-02	0.477E-02
8.50	0.271E-02	0.273E-02	0.518E-03	0.190	0.221E-02	0.325E-02
9.00	0.191E-02	0.193E-02	0.224E-03	0.116	0.171E-02	0.216E-02
9.50	0.135E-02	0.136E-02	0.146E-03	0.107	0.122E-02	0.151E-02
10.00	0.956E-03	0.959E-03	0.223E-03	0.233	0.736E-03	0.118E-02
10.50	0.677E-03	0.676E-03	0.275E-03	0.406	0.401E-03	0.950E-03
11.00	0.480E-03	0.477E-03	0.287E-03	0.602	0.190E-03	0.764E-03
11.50	0.342E-03	0.337E-03	0.273E-03	0.809	0.646E-04	0.610E-03
12.00	0.243E-03	0.239E-03	0.243E-03	1.018	-0.436E-05	0.482E-03
12.50	0.174E-03	0.170E-03	0.208E-03	1.224	-0.381E-04	0.377E-03
13.00	0.124E-03	0.121E-03	0.171E-03	1.421	-0.508E-04	0.292E-03
13.50	0.889E-04	0.857E-04	0.138E-03	1.606	-0.519E-04	0.223E-03
14.00	0.635E-04	0.609E-04	0.108E-03	1.775	-0.472E-04	0.169E-03

APPROXIMATION NUMBER *** 6 ***

CHECK

NI-NEW	1.087
NEPT.	1.013
AL-N.P	0.963
URANIC	1.065
FERRO	1.031
TORIC	0.877
AL-ALF	0.988
ZOLFO	0.948

Q = 0.321E-01 - INTEGRAL FLUX ABOVE .5 MEV = 0.362E 01

E	FI	E	FI	E	FI	E	FI	E	FI
0.	0.152E 02	0.50	0.651E 01	1.00	0.267E 01	1.50	0.104E 01	2.00	0.388E-00
2.50	0.142E-00	3.00	0.573E-01	3.50	0.318E-01	4.00	0.247E-01	4.50	0.219E-01
5.00	0.193E-01	5.50	0.162E-01	6.00	0.130E-01	6.50	0.101E-01	7.00	0.753E-02
7.50	0.550E-02	8.00	0.394E-02	8.50	0.279E-02	9.00	0.195E-02	9.50	0.135E-02
10.00	0.935E-03	10.50	0.645E-03	11.00	0.444E-03	11.50	0.305E-03	12.00	0.210E-03
12.50	0.145E-03	13.00	1.000E-04	13.50	0.691E-04	14.00	0.479E-04		

STATISTICAL ANALISYS (150 HISTORIES)

INT.FLX 0.362E 01   MEAN 0.362E 01 +0- 0.345E-00   0/0 0.10   (0.328E 01 - 0.397E 01)

E	NEUTRON FLUX		STANDARD DEVIAT.		68 PER CENT	
(MEV)	CALCUL.	MONTECARLO	ABSOLUTE	RELAT.	CONFIDENCE INT.	
0.	0.152E 02	0.152E 02	0.374E 01	0.246	0.114E 02	0.189E 02
0.50	0.651E 01	0.649E 01	0.111E 01	0.170	0.539E 01	0.760E 01
1.00	0.267E 01	0.267E 01	0.264E-00	0.099	0.240E 01	0.293E 01
1.50	0.104E 01	0.104E 01	0.693E-01	0.066	0.975E 00	0.111E 01
2.00	0.388E-00	0.389E-00	0.421E-01	0.108	0.347E-00	0.431E-00
2.50	0.142E-00	0.143E-00	0.222E-01	0.156	0.120E-00	0.165E-00
3.00	0.573E-01	0.577E-01	0.121E-01	0.210	0.455E-01	0.698E-01
3.50	0.318E-01	0.319E-01	0.982E-02	0.308	0.220E-01	0.417E-01
4.00	0.247E-01	0.247E-01	0.770E-02	0.312	0.170E-01	0.324E-01
4.50	0.219E-01	0.219E-01	0.515E-02	0.235	0.167E-01	0.270E-01
5.00	0.193E-01	0.193E-01	0.327E-02	0.170	0.160E-01	0.226E-01
5.50	0.162E-01	0.163E-01	0.250E-02	0.154	0.137E-01	0.188E-01
6.00	0.130E-01	0.131E-01	0.226E-02	0.173	0.108E-01	0.153E-01
6.50	0.101E-01	0.101E-01	0.198E-02	0.196	0.812E-02	0.121E-01
7.00	0.753E-02	0.757E-02	0.158E-02	0.208	0.60[illegible]E-02	0.915E-02
7.50	0.550E-02	0.554E-02	0.112E-02	0.202	0.442E-02	0.666E-02
8.00	0.394E-02	0.398E-02	0.706E-03	0.177	0.327E-02	0.468E-02
8.50	0.279E-02	0.281E-02	0.380E-03	0.135	0.243E-02	0.319E-02
9.00	0.195E-02	0.197E-02	0.187E-03	0.095	0.178E-02	0.216E-02
9.50	0.135E-02	0.137E-02	0.171E-03	0.125	0.120E-02	0.154E-02
10.00	0.935E-03	0.945E-03	0.220E-03	0.233	0.726E-03	0.117E-02
10.50	0.645E-03	0.651E-03	0.246E-03	0.377	0.406E-03	0.897E-03
11.00	0.444E-03	0.448E-03	0.245E-03	0.546	0.203E-03	0.693E-03
11.50	0.305E-03	0.308E-03	0.226E-03	0.733	0.822E-04	0.534E-03
12.00	0.210E-03	0.212E-03	0.198E-03	0.933	0.142E-04	0.409E-03
12.50	0.145E-03	0.146E-03	0.166E-03	1.141	-0.205E-04	0.312E-03
13.00	1.000E-04	0.100E-03	0.136E-03	1.350	-0.352E-04	0.236E-03
13.50	0.691E-04	0.693E-04	0.108E-03	1.558	-0.387E-04	0.177E-03
14.00	0.479E-04	0.479E-04	0.842E-04	1.759	-0.363E-04	0.132E-03

APPROXIMATION NUMBER *** 7 ***

CHECK

NI-NEW	1.088
NEPT.	1.022
AL-N.P	0.963
URANIO	1.064
FERRO	1.030
TORIO	0.876
AL-ALF	0.989
ZOLFO	0.951

Q = 0.324E-01 - INTEGRAL FLUX ABOVE .5 MEV = 0.366E 01

E	FI	E	FI	E	FI	E	FI	E	FI
0.	0.157E 02	0.50	0.663E 01	1.00	0.269E 01	1.50	0.104E 01	2.00	0.385E-00
2.50	0.141E-00	3.00	0.575E-01	3.50	0.324E-01	4.00	0.252E-01	4.50	0.222E-01
5.00	0.194E-01	5.50	0.162E-01	6.00	0.129E-01	6.50	0.998E-02	7.00	0.746E-02
7.50	0.546E-02	8.00	0.392E-02	8.50	0.278E-02	9.00	0.196E-02	9.50	0.136E-02
10.00	0.947E-03	10.50	0.655E-03	11.00	0.452E-03	11.50	0.311E-03	12.00	0.214E-03
12.50	0.147E-03	13.00	0.101E-03	13.50	0.697E-04	14.00	0.479E-04		

STATISTICAL ANALISYS (150 HISTORIES)

INT.FLX 0.356E 01 MEAN 0.359E 01 +0- 0.383E-00 0/0 0.11 (0.320E 01 - 0.397E 01)

E	NELTRON FLUX		STANDARD DEVIAT.		68 PER CENT	
(MEV)	CALCUL.	MCNTECARLO	ABSOLUTE	RELAT.	CONFIDENCE INT.	
0.	0.167E 02	0.165E 02	0.713E 01	0.433	0.933E 01	0.236E 02
0.50	0.661E 01	0.662E 01	0.116E 01	0.175	0.546E 01	0.778E 01
1.00	0.257E 01	0.260E 01	0.433E-00	0.166	0.217E 01	0.304E 01
1.50	0.991E 00	0.100E 01	0.191E-00	0.190	0.813E 00	0.119E 01
2.00	0.384E-00	0.383E-00	0.427E-01	0.111	0.341E-00	0.426E-00
2.50	0.153E-00	0.150E-00	0.590E-01	0.393	0.910E-01	0.209E-00
3.00	0.670E-01	0.649E-01	0.418E-01	0.645	0.230E-01	0.107E-00
3.50	0.348E-01	0.347E-01	0.142E-01	0.410	0.205E-01	0.490E-01
4.00	0.228E-01	0.240E-01	0.128E-01	0.532	0.112E-01	0.368E-01
4.50	0.181E-01	0.196E-01	0.184E-01	0.939	0.119E-02	0.380E-01
5.00	0.157E-01	0.169E-01	0.162E-01	0.955	0.757E-03	0.331E-01
5.50	0.139E-01	0.146E-01	0.103E-01	0.701	0.438E-02	0.249E-01
6.00	0.121E-01	0.124E-01	0.429E-02	0.347	0.809E-02	0.167E-01
6.50	0.102E-01	0.102E-01	0.190E-02	0.188	0.825E-02	0.121E-01
7.00	0.830E-02	0.807E-02	0.381E-02	0.473	0.425E-02	0.119E-01
7.50	0.652E-02	0.621E-02	0.462E-02	0.745	0.158E-02	0.108E-01
8.00	0.492E-02	0.463E-02	0.433E-02	0.935	0.302E-03	0.895E-02
8.50	0.357E-02	0.334E-02	0.340E-02	1.020	-0.673E-04	0.674E-02
9.00	0.248E-02	0.232E-02	0.227E-02	0.977	0.527E-04	0.459E-02
9.50	0.164E-02	0.155E-02	0.119E-02	0.768	0.360E-03	0.275E-02
10.00	0.101E-02	0.990E-03	0.349E-03	0.352	0.641E-03	0.134E-02
10.50	0.569E-03	0.591E-03	0.417E-03	0.706	0.174E-03	0.101E-02
11.00	0.270E-03	0.320E-03	0.808E-03	2.526	-0.488E-03	0.113E-02
11.50	0.774E-04	0.143E-03	0.102E-02	7.160	-0.881E-03	0.117E-02
12.00	-0.372E-04	0.338E-04	0.110E-02	32.413	-0.106E-02	0.113E-02
12.50	-0.983E-04	-0.286E-04	0.107E-02	-37.345	-0.110E-02	0.104E-02
13.00	-0.124E-03	-0.602E-04	0.981E-03	-16.311	-0.104E-02	0.921E-03
13.50	-0.128E-03	-0.721E-04	0.861E-03	-11.945	-0.934E-03	0.789E-03
14.00	-0.120E-03	-0.724E-04	0.731E-03	-10.089	-0.803E-03	0.658E-03

383 LINES CLTPUT THIS JOB.

APPROXIMATION NUMBER *** 8 ***

CHECK

NI-NEW	1.084
NEPT.	0.996
AL-N.P	0.954
URANIC	1.057
FERRC	1.041
TORIC	0.871
AL-ALF	0.983
ZCLFC	0.957

Q = 0.330E-01 - INTEGRAL FLUX ABOVE .5 MEV = 0.356E 01

E	FI	E	FI	E	FI	E	FI	E	FI
0.	0.167E 02	0.50	0.661E 01	1.00	0.257E 01	1.50	0.991E 00	2.00	0.384E-00
2.50	0.153E-00	3.00	0.670E-01	3.50	0.348E-01	4.00	0.228E-01	4.50	0.181E-01
5.00	0.157E-01	5.50	0.139E-01	6.00	0.121E-01	6.50	0.102E-01	7.00	0.830E-02
7.50	0.652E-02	8.00	0.492E-02	8.50	0.357E-02	9.00	0.248E-02	9.50	0.164E-02
10.00	0.101E-02	10.50	0.569E-03	11.00	0.270E-03	11.50	0.774E-04	12.00	-0.372E-04
12.50	-0.983E-04	13.00	-0.124E-03	13.50	-0.128E-03	14.00	-0.120E-03		

STATISTICAL ANALISYS (150 HISTORIES)

INT.FLX 0.366E 01   MEAN 0.364E 01 +0- 0.287E-00   0/0 0.08   (0.335E 01 - 0.393E 01)

E	NELTRON FLUX		STANDARD DEVIAT.		68 PER CENT	
(MEV)	CALCUL.	MONTECARLO	ABSOLUTE	RELAT.	CONFIDENCE INT.	
0.	0.157E 02	0.154E 02	0.304E 01	0.197	0.124E 02	0.185E 02
0.50	0.663E 01	0.656E 01	0.900E 00	0.137	0.566E 01	0.746E 01
1.00	0.269E 01	0.268E 01	0.223E-00	0.083	0.245E 01	0.290E 01
1.50	0.104E 01	0.104E 01	0.707E-01	0.068	0.974E 00	0.112E 01
2.00	0.385E-00	0.389E-00	0.401E-01	0.103	0.349E-00	0.429E-00
2.50	0.141E-00	0.143E-00	0.196E-01	0.137	0.123E-00	0.163E-00
3.00	0.575E-01	0.583E-01	0.109E-01	0.186	0.475E-01	0.692E-01
3.50	0.324E-01	0.324E-01	0.932E-02	0.288	0.231E-01	0.417E-01
4.00	0.252E-01	0.250E-01	0.742E-02	0.297	0.176E-01	0.324E-01
4.50	0.222E-01	0.220E-01	0.494E-02	0.225	0.170E-01	0.269E-01
5.00	0.194E-01	0.192E-01	0.300E-02	0.156	0.163E-01	0.222E-01
5.50	0.162E-01	0.162E-01	0.210E-02	0.130	0.141E-01	0.183E-01
6.00	0.129E-01	0.130E-01	0.186E-02	0.143	0.111E-01	0.149E-01
6.50	0.998E-02	0.101E-01	0.167E-02	0.166	0.839E-02	0.117E-01
7.00	0.746E-02	0.755E-02	0.136E-02	0.181	0.619E-02	0.892E-02
7.50	0.546E-02	0.554E-02	0.100E-02	0.181	0.454E-02	0.654E-02
8.00	0.392E-02	0.399E-02	0.658E-03	0.165	0.333E-02	0.464E-02
8.50	0.278E-02	0.283E-02	0.380E-03	0.135	0.245E-02	0.321E-02
9.00	0.196E-02	0.198E-02	0.201E-03	0.102	0.178E-02	0.218E-02
9.50	0.136E-02	0.138E-02	0.152E-03	0.110	0.122E-02	0.153E-02
10.00	0.947E-03	0.951E-03	0.178E-03	0.188	0.772E-03	0.113E-02
10.50	0.655E-03	0.653E-03	0.200E-03	0.306	0.453E-03	0.852E-03
11.00	0.452E-03	0.447E-03	0.201E-03	0.451	0.245E-03	0.648E-03
11.50	0.311E-03	0.305E-03	0.188E-03	0.617	0.117E-03	0.492E-03
12.00	0.214E-03	0.207E-03	0.166E-03	0.802	0.410E-04	0.373E-03
12.50	0.147E-03	0.141E-03	0.141E-03	1.002	-0.321E-06	0.282E-03
13.00	0.101E-03	0.954E-04	0.116E-03	1.216	-0.206E-04	0.211E-03
13.50	0.697E-04	0.646E-04	0.930E-04	1.439	-0.284E-04	0.158E-03
14.00	0.479E-04	0.437E-04	0.730E-04	1.671	-0.293E-04	0.117E-03

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Alfred Nobel

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