

C FIGCSM : Fit the parameters for the Generalised Coherent State Model
C LINK GCSM+CLRAC

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CC CU ACEST COD trateaza benzile g,b,ga + benzile chirale in 138Nd

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IMPLICIT REAL*8(A-H,O-Z)
COMMON/FACT/FACLOG(800)
COMMON/CRAC/IIJA,IIJB,IIJC,IIJD,IIJE,IIJF,RAC
REAL RAC
COMMON/OVERL2/AI20(20),AI20D(20),AI20DD(20),AIR(4,40),AIRD(4,40),
&AIRDD(4,40),FAN(11),SL(21,21),AN2(21)
COMMON/CNORME/GMNOT(40),GRGRNO(20,30),GNO(21),GMNO(40),GRNOT(10),
&GRNO(30)
COMMON/DIPANDPC/ANO1PL(20,20,30),ANOPC(20,20,7,30),
&ANPCGR(20,20,7,20)
COMMON/CNOR/GGGNO(20,21),ANOGR(20,20,21)
COMMON/ANORPC0/ANOPC0(20,20,7,30)
COMMON/OVERL/AN0(21),AN1(21)
COMMON/FMAT/F(20,20,23,3),BTILD(20,20),BPLUS(20,20),BPLB(20,20)
&,BPLBGRGR(20,20)
COMMON/HAMIL/HAH(7,30)
COMMON/HAMCHIR/HAH0(7,30),HAH1(7,30),HAH2(7,30)
COMMON/AVPC0/AVPRPC0(20,20,7,20),AVNEPC0(20,20,7,20),
&AVJPPC0(20,20,7,20)
COMMON/AMAT/AMAJPN(20,20,7,20,20),AMAJF(20,20,7,20,20)
COMMON/TRANS/BM1(20,20,7,20,20)
COMMON/TRANSPC0/BM1PC0(20,20,7,20,20)
COMMON/AMATPC0/AMAPNPC0(20,20,7,20,20),AMAJFPC0(20,20,7,20,20)
COMMON/ENE1/EGRESSO(20,20),EEGR(20,21)
COMMON/INDDE/IASCO
DIMENSION ANG(20),ACCOS(20),AVJPR2(20),
&UNghi(20,20,20),TEST(20,20,20),AVGRJPR(20,20,21),
&AVGRJNE(20,20,21),ACCOSGR(21),UNGHIGR(20,20,21),AVJPGR(20,20,21)
&,ANGPC(20,20,7,20),ANGPC0(20,20,7,20)
DIMENSION CIF(10,12)
DIMENSION GNO3(20),EX3(20),MATR(6)
DATA MATR/3,1,2,3,1,4/
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C ACEASTA VERSIUNE FOLOSESTE ZQP IN ORBITALUL h11/2

C IN REST ESTE IDENTIC CU FIGCSM1

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AMC2=938.85
HC=197.8
PI=3.141592
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```
OPEN(UNIT=10,FILE='Nd138.DAT',STATUS='OLD')
OPEN(UNIT=20,FILE='CHIR.OUT',STATUS='NEW')
OPEN(UNIT=21,FILE='TRANSIT.OUT',STATUS='NEW')
OPEN(UNIT=27,FILE='FFFACT.OUT',STATUS='NEW')
WRITE(20,217)
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217 format(/,10x,'Here I am')
```

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CALL LOGAFACTO
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C WRITE(20,218)
C 218 format(/,10x,'One step more')
```

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C ATENTIE! AICI DE ARE SEMNIFICATIA DE RHO
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```
DO 50 IJKL=1,20
CALL ABCNORM(IJKL)
50 CONTINUE
IIII=8
IASCO=IIII
CALL FFACT(IASCO)
CALL ENERGIES
IIII=8
WRITE(20,34)(EEGR(IIII,IJ),IJ=1,11)
34 FORMAT(/,10X,'GS BAND ENERGIES'/,
& 10X,'*****',/,
& 10X,5(F10.5,2X))
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```
CALL AM1CHIR
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c ABM1=BM1(1,1,2,4,3)
c ABM2=BM1(1,12,2,4,3)
c WRITE(20,807)ABM1,ABM2
c807 FORMAT(/,10X,'ABM1 ABM2 =',2(F10.5,2X))
c963 FORMAT(/,5X,F5.3,2X,F5.3,2X,I2,F10.5)

C
C
C

WRITE(20,1016)
1016 FORMAT(/,1X,'INAINTE DE CALL HAMI')
C WRITE(20,1015)
1015 FORMAT(/,1X,'INAINTE DE CALL HAMIGR')
C CALL HAMIGR
CALL HAMI

C
C
C
C

IJ=6
J=2*IJ-2
KMIN=J+1
DO 8014 K=KMIN,20
WRITE(20,8012)J,HAH0(IJ,K),HAH1(IJ,K),HAH2(IJ,K)
8014 CONTINUE
8013 continue
c 8007 CONTINUE

8012 FORMAT(/,10X,'J HAH0 HAH1 HAH2 =',I3,1X,3(F8.5,2X))
CLOSE(UNIT=20)
CLOSE(UNIT=21)
STOP
END

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C

SUBROUTINE ENERGIES
IMPLICIT REAL*8(A-H,0-Z)
COMMON/FACT/FACLOG(800)
COMMON/CRAC/IIJA,IIJB,IIJC,IIJD,IIJE,IIJF,RAC
REAL RAC
COMMON/OVERL2/AI20(20),AI20D(20),AI20DD(20),AIR(4,40),AIRD(4,40),
&AIRDD(4,40),FAN(11),SL(21,21),AN2(21)
COMMON/CNORME/GMNOT(40),GRGRNO(20,30),GNO(21),GMNO(40),GRNOT(10),

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&GRNO(30)
COMMON/CNOR/GGGNO(20,21), ANOGR(20,20,21)
COMMON/ANORPC0/ANOPC0(20,20,7,30)
COMMON/DIPANDPC/ANO1PL(20,20,30), ANOPC(20,20,7,30),
&ANPCGR(20,20,7,20)
COMMON/OVERL/AN0(21), AN1(21)
COMMON/AVJ/AVJPRO2(20,20,20), AVJNEU2(20,20,20)
COMMON/TRANS/BM1(20,20,7,20,20)
COMMON/TRANSPC0/BM1PC0(20,20,7,20,20)
COMMON/AMATPC0/AMAPNPC0(20,20,7,20,20), AMAJFPC0(20,20,7,20,20)
COMMON/ENE1/EGRESSO(20,20), EEGR(20,21)
COMMON/FIT1/EXPGR(10), EXPBE(10), EXPGA(10)
COMMON/FIT2/NEXPGR, NEXPBE, NEXPGA
COMMON/COEF/AAA1, AAA2, AAA3, AAA4, IND
COMMON/GIR/GPA, GNA
COMMON/ENERGG0/EGAM1(40)
common/INDDE/IASCO
REAL EXPGR, EXPBE, EXPGA
DIMENSION HGG(21), HBB(21), EXB1(21), EBTA1(21),
1EGRT1(20), EGRT2(20), EGRTE(20), EGRET(20),
1HGMGM(20), HGGM(10), ARAC(4), EB1(11), EB2(11),
1EGAM3(20), EB3(11),
1BEM1(9), BMM(9), GIRO(6), BE1G(2,3),
1EXG(21), EXGA(40), EXB(21), EBTA(21), YGSQ(21),
1EGR(21), EGRES(20), EGAM(40), EGAM2(40), ERES(20)
DIMENSION EGAMT1(40), EGAMT2(40), EGAMT3(40), EGAMT(40),
1EXGAT(40), BGATI(20), DDD(20),
1EGRE1(20), EGRE2(20), EXGRE(20)
C
C TEST THE CLEBSCH-GORDAN AND RACAHA COEFFICIENTS
C
C1=CLB(5,4,3,3,-2,1)
C2=-SQRT(189./1430.)
W1=SJS(6,4,4,6,2,2)
W2=1./105.
WRITE(*,2000)C1,C2,W1,W2
WRITE(20,2000)C1,C2,W1,W2
2000 FORMAT(/' ***CLB=',2F10.5,' ***SJS=',2F10.5)
C
C
C
C
C READ INPUT DATA
C
READ(10,7999)LIS
READ(10,7000)ZET, AMASS, BE2, DEI, DEF, DDDE
READ(10,7000)(EXPGR(I), I=1,5)
READ(10,7000)(EXPBE(I), I=1,2)
READ(10,7000)(EXPGA(I), I=1,5)
CLOSE(UNIT=10)

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WRITE(20,7100)ZET,AMASS,BE2,DEI,DEF,DDD
7000 FORMAT(8F10.5)
7100 FORMAT(/'   ZET      AMASS      BE2  ',
*          '   DEI      DEF      DDD  '/8F10.4)
7103 FORMAT(/10X,'GROUND STATE ENERGIES'/8F10.4)
7104 FORMAT(/10X,' BETA  STATE ENERGIES'/8F10.4)
7106 FORMAT(/10X,' GAMMA STATE ENERGIES'/8F10.4)
7999 FORMAT(I5)
WRITE(20,7103)(EXPGR(I),I=1,5)
WRITE(20,7104)(EXPBE(I),I=1,2)
WRITE(20,7106)(EXPGA(I),I=1,5)
NEXPGR=5
NEXPBE=2
NEXPGA=5
LIS=1
DO 1111 IIII=1,20
DE=IIII*0.2
CALL ABCNORM(IIII)
DO 800 J=1,20
JJ=2*(J/2)
IF(JJ.NE.J) GO TO 801
J2MIN=J-2
J2MAX=J+2
GO TO 892
801 CONTINUE
J2MIN=J-1
J2MAX=J+1
892 CONTINUE
J2MAX=MIN0(J2MAX,40)
SUM1=0.
SUM2=0.
DO 802 J2=J2MIN,J2MAX,2
IJ2=(J2+2)/2
A1=CLB(J,2,J2,1,-1,0)
SUM1=SUM1+A1**2*AN0(IJ2)
SUM2=SUM2+A1**2*AN1(IJ2)*DE**2
802 CONTINUE
SUM1=22.4*(2*J+1.)*DX*SUM1
EGRT1(J)=(22.4*(2*J+1.)*DX*SUM2*GRNOT(J)**2)
ERES(J)=(2*J+1.)*DX*SUM2*GRNOT(J)**2
800 CONTINUE
DO 206 J=2,40
A1=29.*AIR(2,J)+28.*AIR(3,J)+6.*AIR(4,J)+
1(98.+29*DE**2)*AIRD(2,J)+28.*(DE**2)*AIRD(3,J)+
16.*(DE**2)*AIRD(4,J)
A2=(2*J+1.)*DX*(DE*GMNOT(J))**2
A3=AIR(2,J)
EGAMT1(J)=A2*A1/49
EGAMT3(J)=-16*A2*A3/35.
A4=29.*AIR(2,J)+28.*AIR(3,J)+6.*AIR(4,J)

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EGAMT2(J)=A2*A4/49.
206 CONTINUE
ACL=(DE*CLB(2,2,1,0,1,1))**2
DO 100 J=1,20
JJ=2*(J/2)
IF(JJ.NE.J) GO TO 101
J2MIN=J
J2MAX=J
GO TO 192
101 CONTINUE
J2MIN=J-1
J2MAX=J+1
192 CONTINUE

SU1=0.
SU3=0.
DO 102 J2=J2MIN,J2MAX,2
IJ2=(J2+2)/2
A1=CLB(J,1,J2,1,-1,0)

SU3=SU3+A1**2*AN0(IJ2)
SU1=SU1+A1**2*AN1(IJ2)*DE**2
SUM2=0.
SU2=0.
DO 103 JP=1,3
JJP=2*JP
A2=CLB(J,JP,J2,1,-1,0)*CLB(1,2,JP,1,0,1)
A3=SJS(4,2,2,4,4,JJP)*A2**2

SU2=SU2+A3*3*DE**2*(DE**2*AN1(IJ2)+AN0(IJ2))
103 CONTINUE

SU1=SU1+SU2
102 CONTINUE

EGRE1(J)=SU1*(2*J+1.)*DX*GRNO(J)**2
EGRE1(J)=EGRE1(J)+SU3*(2*J+1.)*DX*
1ACL*GRNO(J)**2
100 CONTINUE
DO 106 J=2,40
A2=(2*J+1.)*DX*(DE*GMNO(J))**2
EGAM1(J)=A2*AIRD(2,J)
106 CONTINUE

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C   URMEAZA SUBRUTINA DE FIT A PARAMETRILOR
C

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C
C PRIMA METODA: THE LEAST SQUARE METHOD
C
C
C

C CALL FILEAST(DE)
C go to 1555

C
C
C
C FIT PER ENERGIES. PARAMETRII FITATI SUNT:AAA1=A1+A2 I SUNT FIXATE
ENERGIILE PENTRU 2⁺ SI 6⁺ I DIN BANDA
C AAA4=A4
FUNDAMENTALA
C AAA2=A1-A2 I ESTE FITATA EN
STARII 2⁺ DIN GAMMA
C AAA3=A3 I ESTE FITATA EN
PENTRU 0⁺ DIN BETA

C
C
C A DOUA METODA: FIXAREA ENERGIILE DE EXCITATIE ENTRU 4 NIVELE DIN
BENZILE,GROUND, BETA SI GAMMA
C
C

DE2=DE**2
A101=AN1(1)/AN0(1)
A102=AN1(2)/AN0(2)
A104=AN1(5)/AN0(5)
A11=DE2*(A102-A101)
A12=6.
A21=DE2*(A104-A101)
A22=72.
B1=EXPGR(2)
B2=EXPGR(5)
DET = A11*A22-A21*A12
AAA1=(B1 *A22-B2 *A12)/DET
AAA4=(A11*B2 -A21*B1)/DET
EZERO=AAA1*(DE2)*AN1(1)/AN0(1)
AAA2=EXPGA(1)+EZERO-(AAA1*EGAM1(2))+6.*AAA4)

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C22=2*AAA2+AAA1*(DE2)*AN1(2)/AN0(2)+6.*AAA4-EZERO-EXPBE(2)
C33=0.16*(DE2)*AN1(2)/AN0(2)
AAA3=C22/C33
1555 continue
C
C
C
C ENERGIILE CELOR 6 BENZI SUNT NOTATE ASTFEL:
C
C EGR(J) ENERGIILE IN GROUND BAND
C EGAM(J) " " GAMMA BAND
C EBTA1(I)" " BETA BAND
C EGRES(I)" " 1^+ BAND
C EGRTE(J)" " \tilde{1}^+ BAND
C EGAMT(J)" " \tilde{\gamma} BAND
C
C enrgiile de excitatie in cele 6 benzi sunt notate:
C EXG(I) = EGR(I)-EZERO
C EXB1(I) = EBTA1(I)-EZERO
C EXGA(J) =EGAM(J)-EZERO
C EXGRE(J) =EGRES(J)-EZERO
C EGRET(J) =EGRTE(J)-EZERO
C EXGAT(J) =EGAMT(J)-EZERO
C EZERO =EGR(1)
C
C
C
2005 continue
C
C
C REZULTATE PENTRU ENERGII
C
C
C
DE2=DE**2
DO 105 I=1,21
J=2*I-2
EGR(I)=AAA1*(DE2)*AN1(I)/AN0(I)+AAA4*J*(J+1.)
EEGR(IIII,I)=EGR(I)
EBTA1(I)=2*AAA2+(AAA1-0.16*AAA3)*(DE2)*AN1(I)/AN0(I)
1+AAA4*J*(J+1.)
EXG(I)=EGR(I)-EGR(1)
EXB1(I)=EBTA1(I)-EGR(1)
105 CONTINUE
ezero=EGR(1)
DO 107 J=2,40
EGAM(J)=AAA1*EGAM1(J)+AAA4*J*(J+1.)+AAA2
EXGA(J)=EGAM(J)-EZERO
107 CONTINUE
DO 1077 J=2,40

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      EGAMT(J)=AAA1+AAA2+AAA1*EGAMT1(J)+(AAA1-AAA2)*EGAMT2(J)+
&AAA3*EGAMT3(J)+AAA4*J*(J+1)
      EXGAT(J)=EGAMT(J)-EZERO
1077 CONTINUE
      ACL=(DE*CLB(2,2,1,0,1,1))**2
      DO 120 J=1,20
      SUM1=0.
      DO 121 J1=1,4
      JJ1=2*(J1/2)
      IPH=1
      IF(JJ1.NE.J1)IPH=-1.
      A1=0.
      IF(J1.EQ.2)A1=-2.
      A2=A1-2*IPH*(DE*CLB(2,2,J1,1,0,1))**2
      K1=IABS(J-J1)
      K2=J1+J
      KK1=2*(K1/2)
      J2MIN=K1
      IF(KK1.NE.K1)J2MIN=K1+1
      DO 122 JP=J2MIN,K2,2
      IJ2=(JP+2)/2
      A3=(CLB(J,J1,JP,1,-1,0))**2*AN0(IJ2)
      SUM1=SUM1+A2*A3
122 CONTINUE
121 CONTINUE
      EGRE2(J)=0.2*ACL*(GRNO(J)**2)*SUM1*(2*J+1.)*DX
120 CONTINUE
      K=IIII
      DO 125 J=1,20
      EGRES(J)=AAA1*EGRE1(J)+AAA3*EGRE2(J)+AAA4*J*(J+1.)
1+AAA1+AAA2
      EGRESSO(K,J)=EGRES(J)
      EXGRE(J)=EGRES(J)-EZERO
      WRITE(20,8024)K, J,EGRESSO(K,J),EZERO
125 CONTINUE
8024 FORMAT(/,10X,'K J EGRESSO EZERO =',2I3,2X,2(F15.10))
      DO 881 J=1,20
      EGRT2(J)=-2.56*ERES(J)
881 CONTINUE
      DO 882 J=1,20
      EGRTE(J)=AAA1*EGRT1(J)+AAA3*EGRT2(J)+AAA4*
1J*(J+1.)+3.*AAA2
      EGRET(J)=EGRTE(J)-EZERO
882 CONTINUE

C
C
C
C   CALCULUL r.m.s.
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C
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C
    SUM=0.
    DO 1850 I=1,NEXPGR
    SUM=SUM+(EXG(I)-EXPGR(I))**2
1850 CONTINUE
    DO 1851 I=1,NEXPBE
    IF(I.EQ.1)GO TO 1851
    SUM=SUM+(EXB1(I)-EXPBE(I))**2
1851 CONTINUE
    DO 1852 I=1,NEXPGA
    J=I+1
    SUM=SUM+(EXGA(J)-EXPGA(I))**2
1852 CONTINUE
    NTOT=NEXPGR+NEXPBE+NEXPGA
    RMS=DSQRT(SUM/(NTOT+0.D0))
    WRITE(20,1853)DE,RMS
C    if(iiii.eq.11)go to 1235
C    go to 1234
C 1235 continue
    1853 FORMAT(/,10X,'DE RMS =', 2(F10.5,2X),/)

    WRITE(20,172)AAA1,AAA2,AAA3,AAA4,DE
    WRITE(20,173)
    WRITE(20,170)(EXPGR(I),I=1,5)
    WRITE(20,170)(EXG(I),I=1,11)
    WRITE(20,174)
    WRITE(20,170)(EXPBE(I),I=1,2)
    WRITE(20,170)(EXB1(I),I=1,11)
    WRITE(20,175)
    WRITE(20,170)(EXPGA(I),I=1,5)
    WRITE(20,170)(EXGA(I),I=2,20)
    WRITE(20,170)(EXGAT(I),I=2,20)
    WRITE(20,176)
    WRITE(20,170)(EXGRE(I),I=1,20)
    WRITE(20,170)(EGRET(I),I=1,20)
1234 continue
    GO TO 1111

C
C  CALCULUL LUI BM1 PRIN MAI MULTE METODE
C
C
    AMC2=938.85
    HC=197.8
    PI=3.141592
    AMASS=138
    R0=1.2*AMASS**(1./3.)
    ZET=60

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```

BE2=0.194
C
C Expresia lui SBM1 este data de Eq. 3 din PLB 300 (1993) 195-198
C
C
A1=GRNO(1)*GNO(1)*DX*DE**2
A2=2*AN0(1)+AN0(2)
A3=0.9/12.56
SBM1=(A3*(A1*A2)**2)/4.
C WRITE(*,171)SBM1
C
C DE = BE2 * KP**2
C
AA1=0.5*(AAA1+AAA2)
AA2=0.5*(AAA1-AAA2)
AA3=AAA3
AA4=AAA4
AKP2=3.*AMASS*AMC2*(R0/HC)**2*(AA1+6.*AA4+0.2*AA3)/(16.*PI)
AKP=SQRT(AKP2)
DEE=BE2*AKP

C
C
C BE0; BKP2 este dat de Eq. 4.28 si 4.31 din NPA 491 (1989) 24-44
C
C
BE02=PI*HC**2/
*(3.24*AMC2*AMASS**2*(5./3.)*(AAA1/(6.*DE**2)+AAA4))
BE0=SQRT(BE02)
BKP=DE/BE0
BKP2=BKP**2

C
C
C DKP este dat de Eq. 3.20 din NPA 491 (1989) 24-44
C
C
DKP=BE0/BE2
DKP2=DKP**2

C
C BE1
C
BE1=BE0*AMASS/SQRT(ZET*(AMASS-ZET))
BE12=BE1**2
CKP2=DE**2/BE12
CKP=SQRT(CKP2)

C
C B(M1:0--->1)
C

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C
C
C Expresia lui SBM1 este data de Eq. 3 din PLB 300 (1993) 195-198
C
C

A1=GRNO(1)*GNO(1)*DX*DE**2
A2=2*AN0(1)+AN0(2)
A3=0.9/12.56
SBM1=(A3*(A1*A2)**2)/4.

C WRITE(*,171)SBM1

C
C REDM reprezinta e.m <0+||Jp||1+>
C
C

REDM=SQRT(1.2)*0.5*DE2*GNO(1)*GRNO(1)*
* (1./GNO(1)**2+0.1/GNO(2)**2)
FAC=3.*ZET*AMC2*(R0/HC)**2/(8.*PI)

C
C Gp si Gn sunt dati de Eq. 4.12 din NPA 491 (1989) 24-44
C
C

GRP=FAC*(AA1+6.*AA4)
GRN=FAC*AA3/5.
GPA=GRP/AKP2
GNA=GRN/AKP2
GGA=GPA-GNA
BM1A=(0.75/PI)*(GGA*REDM)**2
WRITE(20,1112)GPA,GNA

1112 FORMAT(/,10X,'Gp Gn',/,
& 10X,'*****',/,
& 10X,2(F10.5,2X))

C
C GPB=GRP/BKP2
C GNB=GRN/BKP2
C GGB=GPB-GNB
C BM1B=(0.75/PI)*(GGB*REDM)**2

C
C GPD=GRP/DKP2
C GND=GRN/DKP2
C GGD=GPD-GND
C BM1D=(0.75/PI)*(GGD*REDM)**2

C
C GPC=GRP/CKP2
C GNC=GRN/CKP2
C GGC=GPC-GNC
C BM1C=(0.75/PI)*(GGC*REDM)**2

C

```

c      GPF=0.666
c      GNF=0.133
C      GPF=0.5
C      GNF=-0.1
      GPF=GPA
      GNF=GNA
      GGF=GPF-GNF
      BM1F=(0.75/PI)*(GGF*REDM)**2
      SBM1=(SBM1*GGF**2)/3.D0
C
C
C      Calculul lui BM1 pentru tranzitia 1+--->2+
C
C
      J=1
      JP=2
      JJ=2*J
      JJP=2*JP
      DEP=DE/SQRT(2.D0)
      FAC1=3.*DSQRT(10.D0*(2*JP+1.D0))*DEP**2*GNO(2)*GRNO(1)

      SUM=0.
      DO 901 I3=1,2
      J3=2*I3-2
      JJ3=2*J3
      JSMI=IABS(JP-J3)
      JSMA=JP+J3
      ISMI=(JSMI+2)/2
      ISMA=(JSMA+2)/2
      DO 902 IS=ISMI, ISMA
      JS=(2*IS-2)/2
      JJS=2*JS
      A=DSQRT(2*JS+1.D0)*CLB(2,2,JS,0,0,0)*CLB(J3,JS,JP,0,0,0)*
&CLB(J3,1,J,0,-1,-1)
      B=SJS(2,4,2,4,4,JJS)*SJS(JJP,2,JJ3,2,JJ,JJS)/(GNO(I3)**2)
      SUM=SUM+A*B
902  CONTINUE
901  CONTINUE
      SUM=FAC1*SUM
      BM12=0.75D0/PI*(GGF*SUM)**2
      BM10=BM1F/3.D0
C
C WRITE OUTPUT DATA
C
      WRITE(20,172)AAA1,AAA2,AAA3,AAA4,DE,DEE
      WRITE(20,182)BE2,AKP,GGA,BM1A
      WRITE(20,183)BE0,BKP,GGB,BM1B
      WRITE(20,185)BE2,DKP,GGD,BM1D
      WRITE(20,184)BE1,CKP,GGC,BM1C
      write(20,186)SBM1,BM10,BM12,GGF,DE

```

```

C      IF(LIS.LT.1) GO TO 8000

170 FORMAT(8F10.4)
171 FORMAT(/' BM1 =' ,F10.4)
172 FORMAT(/' *** AAA1 *** AAA2 *** AAA3 *** AAA4 ',
*          '*** DE *** DEE '/8F10.4)
182 FORMAT( ' BE2 AKP GGA BM1A =' ,4F10.4)
183 FORMAT( ' BE0 BKP GGB BM1B =' ,4F10.4)
184 FORMAT( ' BE1 CKP GGC BM1C =' ,4F10.4)
185 FORMAT( ' BE2 DKP GGD BM1D =' ,4F10.4)
186 FORMAT( ' SBM1 BM1F BM12 GGF DE =' ,5F10.4)
173 FORMAT(/20X,'THE ENERGIES OF THE GROUND STATES')
174 FORMAT(/20X,'THE ENERGIES OF THE BETA STATES')
175 FORMAT(/20X,'THE ENERGIES OF THE GAMMA STATES')
176 FORMAT(/20X,'THE ENERGIES OF THE M1 STATES')
177 FORMAT(/20X,'THE ENERGIES OF THE M1 TILD STATES')
178 FORMAT(/20X,'THE ENERGIES OF THE GAMMA TILD STATES')
179 FORMAT(/20X,'BGATI')
1111 continue
      RETURN
      END

C
C
C
C
C
      SUBROUTINE UNGHIURI
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/AVPC0/AVPRPC0(20,20,7,20),AVNEPC0(20,20,7,20),
&AVJPPC0(20,20,7,20)
      COMMON/DIPANDPC/AN01PL(20,20,30),ANOPC(20,20,7,30),
&ANPCGR(20,20,7,20)
      COMMON/AVJ/AVJPRO2(20,20,20),AVJNEU2(20,20,20)
      COMMON/ANORPC0/ANOPC0(20,20,7,30)
      COMMON/CNOR/GGGNO(20,21),ANOGR(20,20,21)
      DIMENSION ANG(20),ACCOS(20),AVJPR2(20),
&UNGHI(20,20,20),TEST(20,20,20),AVGRJPR(20,20,21),
&AVGRJNE(20,20,21),ACCOSGR(21),UNGHIGR(20,20,21),AVJPGR(20,20,21)
&,ANGPC(20,20,7,20),ANGPC0(20,20,7,20)
      dimension DDD(20)

C
C
C
C
C
      WRITE(20,5554)
5554 FORMAT(/,10X,'COMPOZITIA JP, JN, IN STARILE J DIN GRAUND BAND',/,
&          10X,'*****',/)
C

```

```

C      AVP=<Jp>,  AVN=<Jn>
C
C
C
C
      DO 930 I1=1,20
      DO 931 I2=1,20
      DO 932 IJ=1,21
      J=2*IJ-2
      sum1=0.
      sum2=0.
      DO 933 IJPR=1,41,2

      JPR=IJPR-1
      IPR=(JPR+2)/2
      JNEMI=IABS(J-JPR)
      JNEMA=J+JPR
      JNEMA=MIN0(JNEMA,40)
      DO 934 IJNE=JNEMI+1,JNEMA+1,2
      JNE=IJNE-1
      INE=(JNE+2)/2
      A1=1.D0/(GGGNO(I1,IPR)*GGGNO(I2,INE))**2
      A2=CLB(JPR,JNE,J,0,0,0)**2
      sum1=sum1+JPR*(JPR+1.)*A1*A2
      SUM2=SUM2+JNE*(JNE+1.)*A1*A2
934  CONTINUE
933  CONTINUE
      AVGRJPR(I1,I2,IJ)=SUM1*ANOGR(I1,I2,IJ)**2
      AVGRJNE(I1,I2,IJ)=SUM2*ANOGR(I1,I2,IJ)**2
      AVP=DSQRT(AVGRJPR(I1,I2,IJ))
      AVN=DSQRT(AVGRJNE(I1,I2,IJ))
      AVP=0.5*(-1.+DSQRT(1.D0+4.*AVP**2))
      AVN=0.5*(-1.+DSQRT(1.D0+4.*AVN**2))
932  CONTINUE
931  CONTINUE
930  CONTINUE
C
C
C
C
C  UNGHIUL INTRE Jp SI J_n INTR-0 STARE J A BENZII FUNDAMENTALE
C                                     =UNGHIGR(I1,I2,J)
C  AICI ROTONII SI NEUTRONII AU DEFORMARI DIFERITE SPECIFICATE
C  DE INDICII I1 SI I2
C
C
C
C
      DO 750 I1=1,20
      DO 751 I2=1,20

```

```

DO 752 IJ=1,21
J=2*IJ-2
ACCOSGR(IJ)=(J*(J+1.D0)-AVGRJPR(I1,I2,IJ)-AVGRJNE(I1,I2,IJ))/
&(2.D0*DSQRT(AVGRJPR(I1,I2,IJ)*AVGRJNE(I1,I2,IJ)))
UNGHIGR(I1,I2,IJ) =DACOS(ACCOSGR(IJ))*180/PI
752 CONTINUE
751 CONTINUE
750 CONTINUE
WRITE(20,764)
764 FORMAT(/,10X,'DEPRO DENE JGR UNGHIGR',/,
&      10X,'*****')
DO 9660 I1=1,15
DEPR=DDD(I1)
DO 9661 I2=1,15
DENE=DDD(I2)

WRITE(20,963)DEPR,DENE,J,UNGHIGR(I1,I2,IJ)
9662 CONTINUE
9661 CONTINUE
9660 CONTINUE

C
C
C
C
C
C
WRITE(20,5556)
5556 FORMAT(/,10X,'COMP JP, JN, IN STARILE J DIN BANDA 1+ pur FEN',/,
&      10X,'*****',/)
C
C
C AVP2=<Jp> AVN2=<Jn>
C
C
C
C
DO 940 I1=1,20
DO 941 I2=1,20
DO 942 J=1,20
IF(J.EQ.2*(J/2))JPMI=J
IF(J.EQ.2*(J/2))JPMA=J
IF(J.NE.2*(J/2))JPMI=J-1
IF(J.NE.2*(J/2))JPMA=J+1
JPMA=MIN0(JPMA,20)
C write(20,971)J,JPMI,JPMA
SUM1=0.
SUM2=0.
sum3=0.
DO 948 IJP=JPMI+1,JPMA+1,2

```



```

JP=IJP-1
IIJP=(JP+2)/2
sum5=0.
DO 943 IJPR=1,20,2
JPR=IJPR-1
IPR=(JPR+2)/2
JNEMI=IABS(JP-JPR)

IF(JNEMI.NE.2*(JNEMI/2))JNEMI=JNEMI+1
JNEMA=JP+JPR
JNEMA=MIN0(JNEMA,20)
DO 944 IJNE=JNEMI+1,JNEMA+1,2
JNE=IJNE-1
INE=(JNE+2)/2
A1=1.D0/(GGGNO(I1,IPR)*GGGNO(I2,INE))**2
A2=CLB(JPR,JNE,JP,0,0,0)**2
A3=CLB(JP,1,J,0,1,1)**2
SUM1=SUM1+A1*A2*A3*(JPR*(JPR+1.)+6.)
SUM2=SUM2+A1*A2*A3*(JNE*(JNE+1.)+6.)
sum3=sum3+A1*A2*A3
SUM5=SUM5+A1*A2
944 CONTINUE
943 CONTINUE
C TEST2=SUM5*ANOGR(I1,I2,IIJP)**2
C WRITE(20,974)I1,I2,J,JP,TEST2
948 CONTINUE
AVJPRO2(I1,I2,J)=SUM1*ANO1PL(I1,I2,J)**2
AVJNEU2(I1,I2,J)=SUM2*ANO1PL(I1,I2,J)**2
AVP2=DSQRT(AVJPRO2(I1,I2,J))
AVN2=DSQRT(AVJNEU2(I1,I2,J))
AVP2=0.5*(-1.+DSQRT(1.D0+4.*AVP2**2))
AVN2=0.5*(-1.+DSQRT(1.D0+4.*AVN2**2))
C WRITE(20,5557)I1,I2,J,AVP2,AVN2
TEST(I1,I2,J)=SUM3*ANO1PL(I1,I2,J)**2
942 CONTINUE
941 CONTINUE
940 CONTINUE
5557 FORMAT(/,10X,'Dp Dn IJ AVP2 AVN2 =',3(I3,2X),2(F10.5,2X))
974 FORMAT(/,10X,'I1,I2,JP,TEST2 =',4(I3,2X),F10.5)
WRITE(20,5558)
5558 FORMAT(/,10X,'COMP (JP+JN)^2, IN STARILE J DIN BANDA 1+ pur FEN',/,
& 10X,'*****',/)
C
C
C AVJPGR=<(Jp+Jn)^2>
C
C
C

```

```

DO 740 I1=1,20
DO 741 I2=1,20
DO 742 J=1,20
IF(J.EQ.2*(J/2))JPMI=J
IF(J.EQ.2*(J/2))JPMA=J
IF(J.NE.2*(J/2))JPMI=J-1
IF(J.NE.2*(J/2))JPMA=J+1
JPMA=MIN0(JPMA,20)
C   write(20,971)J,JPMI,JPMA
SUM=0.
DO 748 IJP=JPMI+1,JPMA+1,2
JP=IJP-1
IIJP=(JP+2)/2
SUM=SUM+(1./(ANOGRI(I1,I2,IIJP)**2))*(JP*(JP+1.)+12.)
&*(CLB(JP,1,J,0,1,1)**2)
748 CONTINUE
AVJPGR(I1,I2,J)=SUM*ANO1PL(I1,I2,J)**2
742 CONTINUE
741 CONTINUE
740 CONTINUE

C
C
C
C
C   UNGHIUL INTRE Jp SI J_n INTR-0 STARE DIPOLARA PURA (1^+)_J
C                                     =UNGHI(I1,I2,J)
C   AICI ROTONII SI NEUTRONII AU DEFORMARI DIFERITE SPECIFICATE
C   DE INDICII i1 SI i2
C
C
C
C

DO 950 I1=1,20
DO 951 I2=1,20
DO 952 J=1,20
ACCOS(J)=(AVJPGR(I1,I2,J)-AVJPRO2(I1,I2,J)-AVJNEU2(I1,I2,J))/
&(2.D0*DSQRT(AVJPRO2(I1,I2,J)*AVJNEU2(I1,I2,J)))
UNGHI(I1,I2,J) =DACOS(ACCOS(J))*180/PI
952 CONTINUE
951 CONTINUE
950 CONTINUE
WRITE(20,964)
964 FORMAT(/,10X,'DEPRO DENE J UNGHI',/,
&      10X,'*****')
971 format(/,10x,'J JPMI JPMA =',3(I3,2X))
DO 960 I1=1,15
DEPRO=DDD(I1)

```

```

        DO 961 I2=1,15
        DENE=DDD(I2)
961    CONTINUE
960    CONTINUE
C
C
C    2QP CUPLATE LA BANDA FUNDAMENTALA
C
C
        WRITE(20,1018)
1018   FORMAT(/,1X,'2QP COUPLING TO THE GROUND BAND')

C
CC
CCC
CCC VOM CONSIDERA ACUM FUNCTIA DE UNDA PARTICLE-CORE: 2 CVASIPARTICULE
CUPLATE LA 0 STARE DIPOLARA
CCC
CCC
CC
C
        WRITE(20,1017)
1017   FORMAT(/,1X,'2QP COUPLING TO THE DIPOLE BAND',/)

C

C
C
C
C
        WRITE(20,5598)
5598   FORMAT(/,10X,'COMP JP, JN, IN STARILE J DIN 1^+ CU 2QP INCLUS',/,
&      10X,'*****',/)
C
C
C
C

C    GO TO 8011
DO 514 I1=1,20
DO 513 I2=1,20
DO 510 IJ=1,6

```

```

J=2*IJ-2
DO 511 I=J+1,20
JPMI=IABS(I-J)
JPMI=MAX0(1,JPMI)
JPMA=I+J
JPMA=MIN0(20,JPMA)
SUM=0.
SUM1=0.
SUM2=0.
DO 512 JP=JPMI,JPMA
SUM=SUM+2.*(CLB(J,JP,I,J,1,J+1)**2)/(ANO1PL(I1,I2,JP)**2)
&*AVJPRO2(I1,I2,JP)
SUM1=SUM1+2.*(CLB(J,JP,I,J,1,J+1)**2)/(ANO1PL(I1,I2,JP)**2)
&*AVJNEU2(I1,I2,JP)
SUM2=SUM2+2.*(CLB(J,JP,I,J,1,J+1)**2)/(ANO1PL(I1,I2,JP)**2)
&*AVJPGR(I1,I2,JP)
512 CONTINUE
SUM=SUM*ANOPC(I1,I2,IJ,I)**2
SUM1=SUM1*ANOPC(I1,I2,IJ,I)**2
SUM2=SUM2*ANOPC(I1,I2,IJ,I)**2
C WRITE(20,5559)I1,I2,IJ,I,SUM,SUM1,SUM2
ANGPC(I1,I2,IJ,I)=DACOS((SUM2-SUM-SUM1)/(2.*DSQRT(SUM*SUM1)))
&*180/PI
C AVP4=DSQRT(SUM)
C AVN5=DSQRT(SUM1)
C AVP4=0.5*(-1.+DSQRT(1.D0+4.*AVP4**2))
C AVN5=0.5*(-1.+DSQRT(1.D0+4.*AVN5**2))
511 CONTINUE
510 CONTINUE
513 CONTINUE
514 CONTINUE
5559 FORMAT(/,10X,'Dp Dn IJ I SUM SUM1 SUM2 =',4(I3,2X),3(F10.5,2X))
WRITE(20,525)
C WRITE(20,524)DEPR,DENE,J,I,ANGPC(I1,I2,IJ,I)
525 FORMAT(10X,'DEPR DENE J I ANGPC',/,
& 10X,'*****')
524 FORMAT(/,10X,2(F5.3,2X),2(I2,1X),F10.5)

C
C
C
C
WRITE(20,8031)
8031 FORMAT(/,10X,'AM TERMINAT CU MEDIILE PE (2QP_CORE)_1')
C
C
C
C

```

```

C
C
CC
CCC  Cazul (a^+a^+)_J0}
CC
C
C
C
C
C
C
C  UNGHIUL INTRE Jp SI J_n INTR-O STARE DIPOLARA (2QPX1)_J0
C                                     =ANGPC0(I1,I2,J)

C  AICI ROTONII SI NEUTRONII AU DEFORMARI DIFERITE SPECIFICATE
C  DE INDICII i1 SI i2
C
C
C
C

```

```

DO 614 I1=1,20
DO 613 I2=1,20
DO 610 IJ=1,6
J=2*IJ-2
DO 611 I=1,20

```

```

JPMI=IABS(I-J)

```

```

JPMI=MAX0(1,JPMI)
JPMA=I+J
JPMA=MIN0(20,JPMA)
SUM=0.
SUM1=0.
SUM2=0.
DO 612 JP=JPMI,JPMA
SUM=SUM+2.*(CLB(J,JP,I,0,1,1)**2)/(AN01PL(I1,I2,JP)**2)
&*AVJPRO2(I1,I2,JP)
SUM1=SUM1+2.*(CLB(J,JP,I,0,1,1)**2)/(AN01PL(I1,I2,JP)**2)
&*AVJNEU2(I1,I2,JP)
SUM2=SUM2+2.*(CLB(J,JP,I,0,1,1)**2)/(AN01PL(I1,I2,JP)**2)
&*AVJPGR(I1,I2,JP)

```

```

612 CONTINUE
SUM=SUM*ANOPC0(I1,I2,IJ,I)**2
SUM1=SUM1*ANOPC0(I1,I2,IJ,I)**2
SUM2=SUM2*ANOPC0(I1,I2,IJ,I)**2
AVPRPC0(I1,I2,IJ,I)=SUM

AVNEPC0(I1,I2,IJ,I)=SUM1
AVJPPC0(I1,I2,IJ,I)=SUM2
ANGPC0(I1,I2,IJ,I)=DACOS((SUM2-SUM-SUM1)/(2.*DSQRT(SUM*SUM1)))
&*180/PI
611 CONTINUE
610 CONTINUE
613 CONTINUE
614 CONTINUE

```

```

WRITE(20,9664)
9664 FORMAT(/,10X,'DEPRO DENE J ANGPC0',/,
& 10X,'*****')

```

```

C
CC
CC
CC
C

```

```

WRITE(20,625)
DO 620 I1=1,20
DEPR=DDD(I1)
DO 621 I2=1,20
DENE=DDD(I2)
DO 622 IJ=1,6
J=2*IJ-2
DO 623 I=1,20
WRITE(20,624)DEPR,DENE,J,I,ANGPC0(I1,I2,IJ,I)
623 CONTINUE
622 CONTINUE
621 CONTINUE
620 CONTINUE
625 FORMAT(10X,'DEPR DENE J I ANGPC0',/,
& 10X,'*****')
624 FORMAT(/,10X,2(F5.3,2X),2(I2,1X),F10.5)

```

```

C
CC
CC
CC
C

```

```

963  FORMAT(/,10X, 2(F5.3,2X),I2,F10.5)
965  FORMAT(/,10X,'I1 I2 J, AVJPR AVJN',3(I3,2x),2(F8.3,2x))

967  FORMAT(/,10X,'TEST(I1,I2,J)=' ,F10.5)
      RETURN
      END

```

```

      SUBROUTINE LOGAFACTO
      IMPLICIT REAL*8(A-H,0-Z)
      COMMON/FACT/FACLOG(800)

C
C
C   FACLOG(I+1)=ln(I!)
C
C
      FACLOG(1)=0.0D0
      FACLOG(2)=0.0D0
      ADD=1.0D0
      DO 999 J=3,800
      ADD=ADD+1.0D0
      ADDLOG=DLOG(ADD)
      FACLOG(J)=FACLOG(J-1)+ADDLOG
999  CONTINUE
      RETURN
      END

```

```

C
C
C
C
C

```

```

      SUBROUTINE ABCNORM(IIII)
      IMPLICIT REAL*8(A-H,0-Z)
      COMMON/FACT/FACLOG(800)
      COMMON/CNOR/GGGNO(20,21),ANOGR(20,20,21)
      COMMON/DIPANDPC/AN01PL(20,20,30),ANOPC(20,20,7,30),
&ANPCGR(20,20,7,20)
      COMMON/AVJ/AVJPRO2(20,20,20),AVJNEU2(20,20,20)
      COMMON/ANORPC0/ANOPC0(20,20,7,30)
      COMMON/OVERL/AN0(21),AN1(21)
      COMMON/OVERL2/AI20(20),AI20D(20),AI20DD(20),AIR(4,40),AIRD(4,40),

```

```

&AIRDD(4,40),FAN(11),SL(21,21),AN2(21)
COMMON/CNORME/GMNOT(40),GRGRNO(20,30),GNO(21),GMNO(40),GRNOT(10),
&GRNO(30)
dimension DDD(20)

C      DO 1111 IIII=1,20
      DE=0.2D0*(IIII+0.D0)
      EXFA=DEXP(-DE**2)
C
C
C
C OVERLAP INTEGRALS: I^{(0)}_J SI I^{(1)}_J
C
C
C
      write(20,216)
216  FORMAT(/,10X,'NORMS STEP 0 OVER')
      DO 5 J1=1,21
      J=2*J1-2
      DO 1 L1=1,3
      L=L1-1
      SL(J1,L1)=0.0
      K=L
      ACON=1000.0D0
2    CONTINUE
      J10=J/2
      IF(K.LT.J10) GO TO 200
      I1=2*K+1
      I2=K+J/2+1
      I3=K-L+1
      I4=K-J/2+1
      I5=2*K+J+2
      L2=2*(K-L)
      ANUM=K*DLOG(3.D0)+FACLOG(I1)+FACLOG(I2)
      ANUM=ANUM+L2*DLOG(DE)
      ANUMI=(K-J)*DLOG(2.D0)+FACLOG(I3)+FACLOG(I4)+FACLOG(I5)
      FR=ANUM-ANUMI
      FR1=DEXP(FR)
      DEC=DEXP(-0.5*DE**2)
      SL(J1,L1)=SL(J1,L1)+FR1*DEC
      ER=DABS(SL(J1,L1)/ACON-1.0)
      IF(ER.LT.1.0D-7) GO TO 1
      ACON=SL(J1,L1)
200  CONTINUE

      K=K+1
      GO TO 2
1    CONTINUE
5    CONTINUE
      DO 6 J1=1,21

```



```

AN0(J1)=SL(J1,1)
AN1(J1)=-0.5*SL(J1,1)+SL(J1,2)
AN2(J1)=0.25*SL(J1,1)-SL(J1,2)+SL(J1,3)
6 CONTINUE
write(20,215)
215 FORMAT(/,10X,'NORMS STEP 1 OVER')
C
C THE NORM FUNCTIONS
C
X=DE**2
DO 11 J1=1,20
J=2*J1
JP=J1+1
SUM=J*(J+1.D0)*2
SUM1=(J-1.D0)*(J+2.)*3
SUM=SUM/SUM1
SUM=DSQRT(SUM)
AI20(J1)=SUM*((1-X)*AN0(JP)/X+AN1(JP))
AI20D(J1)=SUM*(-0.5*(1+X)*AN1(JP)/X+0.25*(J*(J+1.)+2*X**2-4)*
1AN0(JP)/(X**2))
Z=(2+X)*AN0(JP)/(3*X)+2*AN1(JP)/3.D0
ZP=(2*X-1.)*AN1(JP)/(3*X)+(J*(J+1.)+2*X**2-4)*AN0(JP)/(6*X**2)

YR=(2*(1+X)/(3*X)+2*(1-X)/(X*(J-1.)*(J+2.)))*AN0(JP)+(1./3.+2./
1((J-1.)*(J+2.)))*AN1(JP)
YD=((1+5*X)/(6*X)-(X+1.)/(X*(J-1.)*(J+2.)))*AN1(JP)+((X**2-1)/
1(X**2*(J-1.)*(J+2.))+2*(X**2-1)+J*(J+1.))/(12*X**2))*AN0(JP)
ADD=(2*(5*X**3+X**2-3*X+1)+(5*X-3)*J*(J+1.))/(24*X**3)
PRO=-(X**3+X**2+X-3)
PRO=PRO/(2*X**3*(J-1)*(J+2.))
YDD=(ADD+PRO)*AN0(JP)
ADD=(7*(X**2-2*X-1)+J*(J+1.))/(12*X**2)
PRO=(X**2+2*X+3)/(2*X**2*(J-1)*(J+2.))
YDD=YDD+(ADD+PRO)*AN1(JP)
ZPP=AN1(JP)*(J*(J+1.)/(6*X)+(2*X**3+2*X**2-11*X+5.)/
1(6*X**2))+AN0(JP)*(-J*(J+1.)/(12*X**3)
1+(4*X**2-X+4.)/(6*X**2))
AIR(2,J)=YR
AIR(3,J)=-2*YR+3*Z
AIR(4,J)=10.*YR/3.+14*YD/3.-7.*Z

AIRD(2,J)=YD
AIRD(3,J)=-2*YD+3.*ZP
AIRD(4,J)=10.*YD/3.+14.*YDD/3.-7.*ZP
AIRDD(2,J)=YDD
AIRDD(3,J)=3*ZPP-2*YDD
TE1=-2*X**2+12*X-6.+(9-10*X)*J*(J+1)
TE1=TE1/(24*X**4)
TE2=X**2+2*X-9

```

```

TE3=2*(J-1.)*(J+2.)*X**4
TE2=TE2/TE3
TU1=10*X**3+2*X**2-26*X+6.+(5*X-7.)*J*(J+1.)
TU2=24*X**3
TU1=TU1/TU2
TU3=X**3+X**2+5*X+9.
TU4=2*(J-1.)*(J+2.)*X**3
TU3=-TU3/TU4
SP1=7*(X**2-2*X-1.)+J*(J+1.)
SP2=12*X**2
SP1=SP1/SP2
SP3=X**2+2*X+3
SP4=2*(J-1.)*(J+2.)*X**2
SP3=SP3/SP4
YDDD=(TE1+TE2)*AN0(JP)+(TU1+TU3)*AN1(JP)+(SP1+SP3)*AN2(JP)
AIRDD(4, J)=14*YDDD/3.+10*YDD/3.-7*ZPP

```

11 CONTINUE

```

DO 22 J=3,40,2
JM1=(J+1)/2
ADD=(J+(J+1.)*(J+2.)/(6*X))/(2*J+1.)
JP1=(J+3)/2
PRO=(J+1.-J*(J-1.)/(6*X))/(2*J+1.)
Z=ADD*AN0(JM1)+PRO*AN0(JP1)
YR=(J-1.D0)*AN0(JP1)/(2*J+1.)+(J+2.D0)*AN0(JM1)/(2*J+1.)

ZP=(J+(J+1.D0)*(J+2.)/(6*X))*AN1(JM1)+(J+1.-
1J*(J-1.D0)/
1(6*X))*AN1(JP1)-(J+1.)*(J+2.)/(6*X**2)*AN0(JM1)+
1J*(J-1.D0)/
1(6*X**2)*AN0(JP1)
ZP=ZP/(2*J+1.)
YD=((J-1.D0)*AN1(JP1)+(J+2.)*AN1(JM1))/(2*J+1.)
YDD=((J-1.)/(2*J+1.D0))*((X-3)*AN1(JP1)/(2*X)+(2*X**2+(J+1.D0)
1*(J+2.D0))*AN0(JP1)/(4*X**2))+((J+2.D0)/(2*J+1.D0))*((X-3.)*
1AN1(JM1)/(2*X)+(2*X**2+J*(J-1.))*AN0(JM1)/(4*X**2))
SU1=(J+1.)*(J+2.)/(6*X**3)+(J+(J+1.)*(J+2.)/(6*X))*
1(2*X**2+J*(J-1))/(4*X**2)
SU1=SU1/(2*J+1.)
SU2=-J*(J-1.)/(6*X**3)+(J+1.-J*(J-1.)/(6*X))*
1(2*X**2+(J+1.)*(J+2.))/(4*X**2)
SU2=SU2/(2*J+1.)
SU3=-(J+1.)*(J+2.)/(3*X**2)+(J+(J+1.)*(J+2.)/(6*X))*(X-3)/(2*X)
SU3=SU3/(2*J+1.)
SU4=J*(J-1.)/(3*X**2)+(J+1.-J*(J-1.)/(6*X))*(X-3)/(2*X)
SU4=SU4/(2*J+1.)
ZPP=SU1*AN0(JM1)+SU2*AN0(JP1)+SU3*AN1(JM1)+SU4*AN1(JP1)
AIR(2, J)=YR
AIR(3, J)=-2*YR+3.*Z
AIR(4, J)=10.*YR/3.+14.*YD/3.-7.*Z
AIRD(2, J)=YD

```

```

AIRDD(3, J)=-2.*YD+3.*ZP
AIRD(4, J)=10.*YD/3.+14.*YDD/3.-7.*ZP
AIRDD(2, J)=YDD
AIRDD(3, J)=3*ZPP-2*YDD
TE1=(6+2*X**2+(J+1.)*(J+2.))*(J-1)
TE2=4*(X**2)*(2*J+1.)
TE1=TE1/TE2
TE2=(X-3.)*(J-1.)
TE3=2*X*(2*J+1.)
TE2=TE2/TE3
TE3=-2*(J+1.)*(J+2.)*(J-1.)
TU1=4*(2*J+1.)*X**3
TE3=TE3/TU1
TU1=(6+2*X**2+J*(J-1))*(J+2.)
TU2=4*X**2*(2*J+1.)
TU1=TU1/TU2
TU2=(X-3.)*(J+2.)
TU3=2*X*(2*J+1.)
TU2=TU2/TU3
TU3=-2*J*(J-1.)*(J+2.)
SP1=4*(X**3)*(2*J+1.)
TU3=TU3/SP1
YDDD=TE1*AN1(JP1)+TE2*AN2(JP1)+TE3*AN0(JP1)+TU1*AN1(JM1)
1+TU2*AN2(JM1)+TU3*AN0(JM1)
AIRDD(4, J)=14*YDDD/3.+10*YDD/3.-7*ZPP

```

22 CONTINUE

C
C

C

C THE NORMS AND OVERLAP INTEGRALS = NG,NB,NGM,NGB,NGGM,NBGM
C GNO(I) norma starii J=2*I-2 din banda fundamentala
C GMNO(J) norma starii J din banda gamma
C GMNOT(J) norma starii J din banda \tilde{\gamma}
C GRNO(J) norma starii J din banda 1^+
C GRNOT(J) norma starii J din banda \tilde{1}^+

C
C

C

```

DO 890 J=1,21
J1=2*J-2
GNO(J)=1/AN0(J)
GNO(J)=DSQRT(GNO(J))

```

```

      GNO(J)=GNO(J)/DSQRT(2*J1+1.0D0)
      GNO(J)=GNO(J)*DEXP(0.5*DE**2)
890 CONTINUE
C      WRITE(20,7970)
C 7990 FORMAT(8F10.4)
C      WRITE(20,7990)GNO
      DO 40 J=2,40
      GMNO(J)=(2*J+1.)*AIR(2,J)*DEXP(-DE**2)
      GMNO(J)=1/SQRT(GMNO(J))
40 CONTINUE
      DX=DEXP(-DE**2)
      DO 800 J=1,20
      JJ=2*(J/2)
      IF(JJ.NE.J) GO TO 801
      J2MIN=J-2
      J2MAX=J+2
      GO TO 892
801 CONTINUE
      J2MIN=J-1
      J2MAX=J+1
892 CONTINUE
      J2MAX=MIN0(J2MAX,40)
      SUM1=0.
      SUM2=0.
      DO 802 J2=J2MIN,J2MAX,2
      IJ2=(J2+2)/2
      A1=CLB(J,2,J2,1,-1,0)
      SUM1=SUM1+A1**2*AN0(IJ2)
      SUM2=SUM2+A1**2*AN1(IJ2)*DE**2
802 CONTINUE
      SUM1=22.4*(2*J+1.)*DX*SUM1
      GRNOT(J)=1./SQRT(SUM1)
800 CONTINUE
      DO 400 J=2,40
      GMNOT(J)=(2*J+1.)*((98.+29*DE**2)*AIR(2,J)+28.*DE**2*
1AIR(3,J)+6 *DE**2*AIR(4,J))*(DEXP(-DE**2))/49.
      GMNOT(J)=1/SQRT(GMNOT(J))
400 CONTINUE
      ACL=(DE*CLB(2,2,1,0,1,1))**2
      DO 100 J=1,30
      JJ=2*(J/2)
      IF(JJ.NE.J) GO TO 101
      J2MIN=J
      J2MAX=J
      GO TO 192
101 CONTINUE
      J2MIN=J-1
      J2MAX=J+1
192 CONTINUE
      SUM1=0.

```

```

DO 102 J2=J2MIN,J2MAX,2
IJ2=(J2+2)/2
A1=CLB(J,1,J2,1,-1,0)
SUM1=SUM1+A1**2*AN0(IJ2)

SUM2=0.

DO 103 JP=1,3
JJP=2*JP
A2=CLB(J,JP,J2,1,-1,0)*CLB(1,2,JP,1,0,1)
A3=SJS(4,2,2,4,4,JJP)*A2**2
SUM2=SUM2+A3*3*DE**2*AN0(IJ2)
103 CONTINUE
SUM1=SUM1+SUM2
102 CONTINUE
SUM1=SUM1*(2*J+1.)*DX
GRNO(J)=1./SQRT(SUM1)
100 CONTINUE
DDD(IIII)=DE
DO 925 J=1,21
GGGNO(IIII,J)=GNO(J)
925 CONTINUE
DO 926 J=1,20
GRGRNO(IIII,J)=GRNO(J)
926 continue
IF(IIII.LT.20)GO TO 1112
1111 CONTINUE
DO 9300 I1=1,20
DO 9311 I2=1,20
DO 9322 IJ=1,21
J=2*IJ-2
SUM=0.D0
DO 9333 IJPR=1,41,2
JPR=IJPR-1
IPR=(JPR+2)/2
JNEMI=IABS(J-JPR)
JNEMA=J+JPR
JNEMA=MIN0(JNEMA,40)
DO 9344 IJNE=JNEMI+1,JNEMA+1,2
JNE=IJNE-1
INE=(JNE+2)/2
A1=1.D0/(GGGNO(I1,IPR)*GGGNO(I2,INE))**2
A2=CLB(JPR,JNE,J,0,0,0)**2
SUM=SUM+A1*A2
9344 CONTINUE
9333 CONTINUE
ANOGR(I1,I2,IJ)=1.D0/DSQRT(SUM)
C WRITE(20,5555)I1,I2,IJ,SUM,ANOGR(I1,I2,IJ)
9322 CONTINUE

```

```

9311 CONTINUE
9300 CONTINUE
5555 FORMAT(/,10X,'I1 I2 IJ SUM ANOGR(I1,I2,IJ)=' ,3(I3,2X),2(F10.5,2X))
WRITE(20,2225)((GGGNO(7,J)),J=1,11)
write(20,2250)((ANOGR(7,7,J)),J=1,11)
2225 FORMAT(/,2X,'GGGNO =' ,6(F10.5,2X))
2250 FORMAT(/,2X,'ANOGR =' ,6(F10.5,2X))
DO 935 I1=1,20
DO 936 I2=1,20
DO 937 J=1,30
IF(J.EQ.2*(J/2))JPMI=J
IF(J.EQ.2*(J/2))JPMA=J
IF(J.NE.2*(J/2))JPMI=J-1
IF(J.NE.2*(J/2))JPMA=J+1
C   JPMA=MIN0(JPMA,20)
SUM=0.
DO 938 IJP=JPMI+1,JPMA+1,2
JP=IJP-1
IIJP=(JP+2)/2
SUM=SUM+(CLB(JP,1,J,0,1,1)**2)/(ANOGR(I1,I2,IIJP)**2)
938 CONTINUE
AN01PL(I1,I2,J)=1.D0/DSQRT(SUM)
c   write(20,972)I1,I2,J,AN01PL(I1,I2,J)
937 CONTINUE
936 CONTINUE
935 CONTINUE
DO 504 I1=1,20
DO 503 I2=1,20

DO 500 IJ=1,6
J=2*IJ-2
DO 501 I=J+1,30
JPMI=IABS(I-J)
JPMI=MAX0(1,JPMI)
JPMA=I+J
JPMA=MIN0(30,JPMA)
SUM=0.
DO 502 JP=JPMI,JPMA
SUM=SUM+2.*(CLB(J,JP,I,J,1,J+1)**2)/(AN01PL(I1,I2,JP)**2)
502 CONTINUE
ANOPC(I1,I2,IJ,I)=1./DSQRT(SUM)
c   write(20,530)I1,I2,IJ,I,ANOPC(I1,I2,IJ,I)
501 CONTINUE
500 CONTINUE
503 CONTINUE
504 CONTINUE
530 FORMAT(/5X,'ANOPC I1 I2 IJ I = ' ,4(i2,2x),F10.5)
DO 5014 I1=1,20
DO 5013 I2=1,20
DO 5010 IJ=1,6

```

```

J=2*IJ-2
DO 5011 I=J,20
JPMI=IABS(I-J)
IF(JPMI.NE.2*(JPMI/2))JPMI=JPMI+1

JPMA=I+J

JPMA=MIN0(20,JPMA)

SUM=0.
DO 5012 JP=JPMI,JPMA,2
IJP=(JP+2)/2

SUM=SUM+2.*(CLB(J,JP,I,J,0,J)**2)/(ANOGR(I1,I2,IJP)**2)
5012 CONTINUE
ANPCGR(I1,I2,IJ,I)=1./DSQRT(SUM)
c write(20,530)I1,I2,IJ,I,ANOPC(I1,I2,IJ,I)
5011 CONTINUE
5010 CONTINUE
5013 CONTINUE
5014 CONTINUE
DO 604 I1=1,20
DO 603 I2=1,20
DO 600 IJ=1,6
J=2*IJ-2
DO 601 I=1,30
JPMI=IABS(I-J)
JPMI=MAX0(1,JPMI)
JPMA=I+J
JPMA=MIN0(20,JPMA)
SUM=0.
DO 602 JP=JPMI,JPMA
SUM=SUM+2.*(CLB(J,JP,I,0,1,1)**2)/(AN01PL(I1,I2,JP)**2)
602 CONTINUE
ANOPC0(I1,I2,IJ,I)=1./DSQRT(SUM)
C write(20,530)I1,I2,IJ,I,ANOPC(I1,I2,IJ,I)
601 CONTINUE
600 CONTINUE
603 CONTINUE
604 CONTINUE
1112 CONTINUE
RETURN
END

```

C

c Aceasta este o subrutina corecta de dreij trimisa de Oliver Haug

c la Madrid in Februarie 2000.
c Este bine de pus intotdeauna un exemplu de test inainte de a folosirea
c functiilor CLB si CLEB
c

```

Double precision FUNCTION DREIJ(AJ,BJ,CJ,AM,BM,CM)
IMPLICIT REAL*8(A-H,O-Z)
COMMON/BINOCO/ Q(250,250),KH(300),IORD
DATA IORD/0/
DATA ZERO,EIN,EINE, EPS/0.0D0,1.0D0,1.01D0,1.0D-2/
DREIJ=ZERO
JA=AJ+AM+EINE
MA=AJ-AM+EINE
JB=BJ+BM+EINE
MB=BJ-BM+EINE
JC=CJ+CM+EINE
MC=CJ-CM+EINE
LA=BJ+CJ-AJ+EINE
LB=CJ+AJ-BJ+EINE
LC=AJ+BJ-CJ+EINE

LT=AJ+BJ+CJ+EINE
IF(IORD-10) 1,15,1
1 IORD=10
DO 10 L=1,250

Q(L,1)=EIN
10 Q(L,L)=EIN
DO 11 L=2,249
DO 12 K=2,L
12 Q(L+1,K)=Q(L,K-1)+Q(L,K)
11 CONTINUE
15 D=DABS(AM+BM+CM)-EPS
IF(D) 5,5,21
5 LD=MIN0(JA,JB,JC,MA,MB,MC,LA,LB,LC)
IF(LD) 21,21,6
6 JA2=AJ+AJ+AM+AM
JB2=BJ+BJ+BM+BM
JC2=CJ+CJ+CM+CM
I=JA2+JB2+JC2-JA2/2*2-JB2/2*2-JC2/2*2
IF(I) 21,7,21
7 FN=Q(JA+MA-1,LC)*Q(JB+MB-1,LC)/(Q(LT,JC+MC-1)*Q(LT+1,2)
1 *Q(JA+MA-1,JA)*Q(JB+MB-1,JB)*Q(JC+MC-1,JC))
K0=MAX0(0,LC-JA,LC-MB)+1
K1=MIN0(LC,MA,JB)
X=ZERO
DO 20 K=K0,K1
20 X=-X-Q(LC,K)*Q(LB,MA-K+1)*Q(LA,JB-K+1)
IP=K1+LB+JC

```



```

P=1-2*(IP-IP/2*2)
DREIJ=P*X*DSQRT(FN)
21 RETURN
END

```

```

DOUBLE PRECISION
1FUNCTION CLEB(RJ1,RJ2,RJ3,RM1,RM2,RM3)
C

```

```

C CLEBSCH-GORDAN COEFFICIENT FOR SINGLE REAL ARGUMENTS
C

```

```

DOUBLE PRECISION DREIJ
IPH=1
K1=ABS(RJ1-RJ2+RM3)+0.1
IF(K1.NE.(2*(K1/2))) IPH=-1
RM4=-RM3
CLEB=IPH*
&DREIJ(RJ1+0.d0,RJ2+0.d0,RJ3+0.d0,RM1+0.d0,RM2+0.d0,RM4+0.d0)
& *DSQRT(2*RJ3+1.D0)
RETURN
END

```

```

DOUBLE PRECISION
1FUNCTION CLB(J1,J,L,K1,K,KK1)
C
C CLEBSCH-GORDAN COEFFICIENT FOR SINGLE INTEGER ARGUMENTS
C

```

```

DOUBLE PRECISION CLEB
AJ1=J1+0.
AJ=J+0.
AL=L+0.
AK1=K1+0.
AK=K+0.
AKK1=KK1+0.
CLB=CLEB(AJ1,AJ,AL,AK1,AK,AKK1)
RETURN
END

```

```

DOUBLE PRECISION
1FUNCTION CLB2(JJ1,JJ,LL,KK1,KK)
C
C

```

```

C CLEBSH GORDAN FOR DOUBLED INDICES
C
C

```

```

DOUBLE PRECISION CLEB
AJ1=JJ1/2+0.
AJ =JJ/2+0.
AL =LL/2+0.

```

```
AKK1=KK1/2+0.  
AKK=KK/2+0.  
AKKK=AKK1+AKK  
CLB2=CLEB(AJ1,AJ,AL,AKK1,AKK,AKKK)  
RETURN  
END
```

```
SUBROUTINE RAC7
```

```
C
```

```
C RACAH COEFFICIENT FOR DOUBLE ARGUMENTS
```

```
C
```

```
COMMON/FACT/FACLOG(800)  
COMMON/CRAC/IIJA,IIJB,IIJC,IIJD,IIJE,IIJF,RAC  
DOUBLE PRECISION FACLOG  
DIMENSION LT(6)  
IA=IIJA  
IB=IIJB  
IC=IIJC  
ID=IIJD  
IE=IIJE  
IF=IIJF  
K1=IA+IB-IE  
K3=IC+ID-IE  
K5=IA+IC-IF  
K7=IB+ID-IF  
K2=IE-IABS(IA-IB)  
K4=IE-IABS(IC-ID)  
K6=IF-IABS(IA-IC)  
K8=IF-IABS(IB-ID)  
K9=MIN0(K1,K2,K3,K4,K5,K6,K7,K8)  
RAC=0.0  
IF (K9) 4000,20,20  
20 K2=K1-2*(K1/2)  
K4=K3-2*(K3/2)  
K6=K5-2*(K5/2)  
K8=K7-2*(K7/2)  
  
IF(MAX0(K2,K4,K6,K8)) 4000,25,4000  
25 LTMIN=MIN0(IA,IB,IC,ID,IE,IF)  
IF(LTMIN) 4000,30,150  
30 LT(1)=IA  
LT(2)=IB  
LT(3)=IC  
LT(4)=ID  
LT(5)=IE  
LT(6)=IF  
LTMIN=LT(1)  
KMIN=1  
DO 40 N=2,6  
IF(LT(N)-LTMIN)35,40,40
```

```

35 LTMIN=LT(N)
   KMIN=N
40 CONTINUE
   S1=1.0
   F1=IE

   F2=IF

   GO TO (55,55,55,55,45,50),KMIN

45 F1=IA

   F2=IC

   S1=(-1.0)**(K5/2)

   GO TO 55

50 F1=IA
   F2=IB
   S1=(-1.0)**(K1/2)
55 RAC=S1/SQRT((F1+1.)*(F2+1.))
   GO TO 4000
150 IABEP=(IA+IB+IE)/2+1
   ICDEP=(IC+ID+IE)/2+1
   IACFP=(IA+IC+IF)/2+1
   IBDFP=(IB+ID+IF)/2+1
   IABE=IABEP-IE
   IEAB=IABEP-IB
   IBEA=IABEP-IA
   ICDE=ICDEP-IE
   IECD=ICDEP-ID
   IDEC=ICDEP-IC
   IACF=IACFP-IF
   IFAC=IACFP-IC
   ICFA=IACFP-IA
   IBDF=IBDFP-IF
   IFBD=IBDFP-ID
   IDFB=IBDFP-IB

   NZMAX=MIN0(IABE, ICDE, IACF, IBDF)
   IABCD1=(IA+IB+IC+ID+4)/2
   IEFMBC=(IE+IF-IB-IC)/2
   IEFMAD=(IE+IF-IA-ID)/2
   NZMI1=-IEFMAD

```

```

NZMI2=- IEFMBC
NZMIN=MAX(0,NZMI1,NZMI2)+1
SQLOG=0.5*(FACLOG(IABE)+FACLOG(IEAB)+FACLOG(IBEA)+FACLOG(ICDE)
1      +FACLOG(IECD)+FACLOG(IDECD)+FACLOG(IACF)+FACLOG(IFAC)
2      +FACLOG(ICFA)+FACLOG(IBDF)+FACLOG(IFBD)+FACLOG(IDFB)
3-FACLOG(IABEP+1)-FACLOG(ICDEP+1)-FACLOG(IACFP+1)-FACLOG(IBDFP+1))
DO 200 NZ=NZMIN,NZMAX
NZM1=NZ-1
K1=IABCD1-NZM1
K2=IABE-NZM1
K3=ICDE-NZM1
K4=IACF-NZM1
K5=IBDF-NZM1
K6=NZ
K7=IEFMAD+NZ
K8=IEFMBC+NZ
SSLOG=SQLOG+FACLOG(K1)-FACLOG(K2)-FACLOG(K3)-FACLOG(K4)
1      -FACLOG(K5)-FACLOG(K6)-FACLOG(K7)-FACLOG(K8)
SSTERM=((-1.0)**NZM1)*EXP(SSLOG)
RAC=RAC+SSTERM
200 CONTINUE
IF(ABS(RAC).LT.1.0E-10 ) RAC=0.0
4000 RETURN
END

```

```

DOUBLE PRECISION
1FUNCTION SJS(I1,I2,I3,L1,L2,L3)
COMMON/CRAC/IIJA,IIJB,IIJC,IIJD,IIJE,IIJF,RAC

```

```

C
C RACAH COEFFICIENT FOR DOUBLE ARGUMENTS
C

```

```

IIJA=I1
IIJB=I2
IIJC=I3
IIJD=L1
IIJE=L2
IIJF=L3
CALL RAC7
SJS=RAC
RETURN
END

```

```

SUBROUTINE AM1CHIR
COMMON/AMAT/AMAJPN(20,20,7,20,20),AMAJF(20,20,7,20,20)
COMMON/DIPANDPC/ANO1PL(20,20,30),ANOPC(20,20,7,30),
&ANPCGR(20,20,7,20)
COMMON/AVJ/AVJPRO2(20,20,20),AVJNEU2(20,20,20)
DOUBLE PRECISION ANO1PL,AVJPRO2,AVJNEU2,ANOPC,ANPCGR,CLB

```

```
COMMON/TRANS/BM1(20,20,7,20,20)
COMMON/GIR/GPA,GNA
DOUBLE PRECISION AMAJPJN,AMAJF,SJS,
```

```
&BM1,GPA,GNA
```

```
C
CC
CCC ELEMENTELE DE MATRICE ALE OPERATORULUI DE TRANZITIE M1
CC
C
```

```
WRITE(20,17)
17 FORMAT(/,10X,'SUM=AMPL. M1 PENTRU COMP. FERMIONICA',/,
```

```
& 10X,'*****',/,
& 10X,'SUM1=AMPL. M1 PENTRU COMP. MIEZULUI',/,
& 10X,'*****',/,
& 10X,'AAA=BM1 PENTRU TRANZITIA I+1-->I,I=11,20',/,
& 10X,'*****',/)
```

```
C GIRF=1.4169
GIRF=1.2899
c GIRF=-0.2943

C GIRF=-0.348
c GIRP=0.666
c GIRN=0.1333
C GIRP=1.2
C GIRN=-0.4
PI=3.141592

C
C
C GIRP=0.7915
```

```

C      GIRN=0.0086
      GIRP=GPA
      GIRN=GNA
      DO 5 I1=1,20
      DO 6 I2=1,20

      DO 1 IJ=1,6
      J=2*IJ-2
      JJ=2*J
      DO 2 I=J+2,20
      II=2*I
      DO 3 IP=J+1,20
      IF(1.LT.IABS(I-IP).OR.1.GT.(I+IP))GO TO 3
      IF(J.EQ.0.AND.I.NE.IP)GO TO 3
      IIP=2*IP
      SUM=0.
      SUM1=0.
      J1MIN=IABS(I-J)
      J1MAX=I+J
      J1MAX=MIN0(J1MAX,20)
      DO 4 J1=J1MIN,J1MAX
      JJ1=2*J1
      SUM=SUM+CLB(J,J1,I,J,1,J+1)*CLB(J,J1,IP,J,1,J+1)*
&1./(AN01PL(I1,I2,J1)**2)*SJS(JJ,JJ1,II,2,IIP,JJ1)*
&(GIRP*SQRT(AVJPRO2(I1,I2,J1))+
&GIRN*SQRT(AVJNEU2(I1,I2,J1)))
      SUM1=SUM1+CLB(J,J1,I,J,1,J+1)*CLB(J,J1,IP,J,1,J+1)*
&1./(AN01PL(I1,I2,J1)**2)*SJS(IIP,JJ1,2,JJ,JJ,II)
4     CONTINUE
C      WRITE(20,15)SUM,SUM1
15    FORMAT(/10X,'SUM SUM1 =',2(F10.5))
      SUM=SUM*2.*SQRT(3.*(2*IP+1.))*
&ANOPC(I1,I2,IJ,I)*ANOPC(I1,I2,IJ,IP)
      SUM1=SUM1*2.*SQRT(J*(J+1.)*(2*IP+1.)*(2*J+1.))*ANOPC(I1,I2,IJ,I)*
&ANOPC(I1,I2,IJ,IP)*GIRF
      AMAJPJN(I1,I2,IJ,I,IP)=SUM
      AMAJF(I1,I2,IJ,I,IP)=SUM1
      AAA=
&(AMAJPJN(I1,I2,IJ,I,IP)+AMAJF(I1,I2,IJ,I,IP))**2
&*3./(4.*PI)
      BM1(I1,I2,IJ,I,IP)=AAA
      IF(I1.NE.5.OR.I2.NE.5)GO TO 3
      write(21,16)I1,I2,IJ,I,SUM,SUM1,AAA
c      WRITE(20,15)SUM,SUM1
3     CONTINUE
2     CONTINUE
1     CONTINUE
6     CONTINUE
5     CONTINUE
      ABM1=BM1(1,1,2,4,3)

```

```

      ABM2=BM1(1,12,2,4,3)
      WRITE(20,887)ABM1,ABM2
887  FORMAT(/,10X,'AMB1 =',2(F10.5,2X))
16   format(/,2x,'I1 I2 IJ I SUM SUM1 AAA =',4(I2,2X),3(F10.5,2X))
      RETURN
      END

```

```

      SUBROUTINE AM1PC0CHIR
      DOUBLE PRECISION AMAPNPC0,AMAJFPC0,
&BM1PC0,AVPRPC0,AVNEPC0,AVJPPC0,SJS,AMAJPJN,AMAJF,GPA,GNA
      COMMON/AMAT/AMAJPJN(20,20,7,20,20),AMAJF(20,20,7,20,20)
      COMMON/AMATPC0/AMAPNPC0(20,20,7,20,20),AMAJFPC0(20,20,7,20,20)
      COMMON/DIPANDPC/ANO1PL(20,20,30),ANOPC(20,20,7,30),
&ANPCGR(20,20,7,20)
      COMMON/AVJ/AVJPRO2(20,20,20),AVJNEU2(20,20,20)
      DOUBLE PRECISION ANO1PL,AVJPRO2,AVJNEU2,ANOPC,ANPCGR
      COMMON/ANORPC0/ANOPC0(20,20,7,30)
      COMMON/AVPC0/AVPRPC0(20,20,7,20),AVNEPC0(20,20,7,20),
&AVJPPC0(20,20,7,20)
      COMMON/TRANSPC0/BM1PC0(20,20,7,20,20)
      COMMON/GIR/GPA,GNA
      DOUBLE PRECISION A,B,F,BTILD,BPLUS,BPLB
&GGGNO,ANOGR,DP,DN,CLEB,BPLBGRGR,ANOPC0,CLB

```

```

C
CC
CCC ELEMENTELE DE MATRICE ALE OPERATORULUI DE TRANZTIE M1
CC
C

```

```

      WRITE(20,22)GPA,GNA
22  FORMAT(/10X,'REZULTATE PENTRU DIPOLE (2QP)_{J0};',//
&      10X,'g_F=1.3527;g_p=',F10.5,2X,'g_n=',F10.5)

```

```

      GIRF=1.4169
C      GIRF=1.2453
c      GIRF=-0.2943

```

```

C      GIRP=1.2
C      GIRN=-0.4
      PI=3.141592
      GIRP=GPA
      GIRN=GNA

```

```

C
C

```

```

      DO 5 I1=1,20
      DO 6 I2=1,20
      DO 1 IJ=1,6
      J=2*IJ-2

```

```

JJ=2*J
DO 2 I=J+2,20
II=2*I
DO 3 IP=J+1,20
IF(1.LT.IABS(I-IP).OR.1.GT.(I+IP))GO TO 3
IF(J.EQ.0.AND.I.NE.IP)GO TO 3
IIP=2*IP
SUM=0.
SUM1=0.
J1MIN=IABS(I-J)
J1MAX=I+J
J1MAX=MIN0(J1MAX,20)
DO 4 J1=J1MIN,J1MAX
JJ1=2*J1
SUM=SUM+CLB(J,J1,I,0,1,1)*CLB(J,J1,IP,0,1,1)*
&1./(AN01PL(I1,I2,J1)**2)*SJS(JJ,JJ1,II,2,IIP,JJ1)*
&(GIRP*SQRT(AVJPRO2(I1,I2,J1))+
&GIRN*SQRT(AVJNEU2(I1,I2,J1)))
SUM1=SUM1+CLB(J,J1,I,0,1,1)*CLB(J,J1,IP,0,1,1)*
&1./(AN01PL(I1,I2,J1)**2)*SJS(IIP,JJ1,2,JJ,JJ,II)
4 CONTINUE
C WRITE(20,15)SUM,SUM1
15 FORMAT(/10X,'SUM SUM1 =',2(F10.5))
SUM=SUM*2.*SQRT(3.*(2*IP+1.))*
&ANOPC0(I1,I2,IJ,I)*ANOPC0(I1,I2,IJ,IP)
SUM1=SUM1*2.*SQRT(J*(J+1.)*(2*IP+1.)*(2*J+1.))*ANOPC0(I1,I2,IJ,I)*
&ANOPC0(I1,I2,IJ,IP)*GIRF
AMAPNPC0(I1,I2,IJ,I,IP)=SUM
AMAJFPC0(I1,I2,IJ,I,IP)=SUM1
AAA=
&(AMAPNPC0(I1,I2,IJ,I,IP)+AMAJFPC0(I1,I2,IJ,I,IP))**2
&*3./(4.*PI)
BM1PC0(I1,I2,IJ,I,IP)=AAA
IF(I1.NE.5.OR.I2.NE.5)GO TO 3
write(20,16)I1,I2,IJ,I,SUM,SUM1,AAA
C WRITE(20,15)SUM,SUM1
3 CONTINUE
2 CONTINUE
1 CONTINUE
6 CONTINUE
5 CONTINUE
ABM1=BM1PC0(1,1,2,4,3)
ABM2=BM1PC0(1,12,2,4,3)
WRITE(20,807)ABM1,ABM2
807 FORMAT(/,10X,'AMB1 =',2(F10.5,2X))
16 format(/,2x,'I1 I2 IJ I SUM SUM1 AAA =',4(I2,2X),3(F10.5,2X))
RETURN
END

```



```

SUBROUTINE FFACT(IASCO)
COMMON/FMAT/F(20,20,23,3),BTILD(20,20),BPLUS(20,20),BPLB(20,20)
&,BPLBGRGR(20,20)
COMMON/DIPANDPC/ANO1PL(20,20,30),ANOPC(20,20,7,30),
&ANPCGR(20,20,7,20)
COMMON/AVJ/AVJPRO2(20,20,20),AVJNEU2(20,20,20)
DOUBLE PRECISION ANO1PL,AVJPRO2,AVJNEU2,ANOPC,ANPCGR
COMMON/CNOR/GGGNO(20,21),ANOGR(20,20,21)
DOUBLE PRECISION GGGNO,ANOGR
common/defo/DP, DN
COMMON/BB4GRGR/BBGRGR(20,20)
COMMON/PARA/X00, UU0, UU2, UU4, XPC, XSS, E2QP
C common/INDDE/IASCO
DOUBLE PRECISION SJS,A,B,F,BTILD,BPLUS,BPLB,BBGRGR,
&DP, DN, CLEB, BPLBGRGR, X00, UU0, UU2, UU4, XPC, XSS, E2QP, CLB
WRITE(20,26)
26 FORMAT(/, 'SUNT IN FFACT')
IIII=IASCO
X00=1.D0
UU0=-0.00D0
UU2=0.D0
UU4=0.D0
XPC=0.2D0
XSS=0.D0
C UU2=-0.4D0
C UU2=-0.D0
C UU4=0.44D0
C XPC=0.2D0
C XSS=0.02D0
E2QP=4.050D0
write(27,2255)X00,UU0,UU2,UU4,XPC,XSS,E2QP
2255 FORMAT(1X,'X00 UU0 UU2 UU4 XPC XSS E2QP =',/,
&7(F8.5,2X))
RO=IIII*0.2
DP=RO/DSQRT(2.D0)
DN=DP
WRITE(27,62)IIII,DP
WRITE(27,25)((GGGNO(7,J)),J=1,11)
write(27,225)((ANOGR(7,7,J)),J=1,11)
WRITE(27,226)( ANO1PL(7,7,J),J=1,20)
226 FORMAT(' ANO1PL =',/(8F10.5))
25 FORMAT(/,2X,'GGGNO =',6(F10.5,2X))
225 FORMAT(/,2X,'ANOGR =',6(F10.5,2X))
62 FORMAT(/,10X,'IIII DP =',I4,2X,F8.5)
C
C
C DP -DEFORMAREA PROTONICA
C DN -DEFORMAREA NEUTRONICA
C

```

C

```
DO 1 IP=1,20
IIP=2*IP
DO 2 I=1,20
II=2*I
IF(IABS(I-IP).GT.2.OR.(I+IP).LT.2) GO TO 2
DO 3 I2=1,3
II2=2*I2
I1MIN1=IABS(IP-I2)
I1MIN2=IABS(IP-1)
IMIN=MAX0(I1MIN1,I1MIN2)
I1MAX1=IP+I2
I1MAX2=IP+1
I1MAX=MIN0(I1MAX1,I1MAX2)
IF(I1MIN.NE.2*(I1MIN/2))I1MIN=I1MIN+1
IF(I1MAX.NE.2*(I1MAX/2))I1MAX=I1MAX-1
```

C

```
I1MAX=MIN0(I1MAX,10)
DO 4 J1=I1MIN+1,I1MAX+1,2
I1=J1-1
II1=2*I1
A=DSQRT(2*I2+1.D0)*CLB(2,1,I2,0,1,1)*CLB(I1,I2,IP,0,1,1)
B=SJS(4,4,II2,4,2,2)*SJS(IIP,4,II1,II2,II,2)
F(IP,I,I1,I2)=A*B
```

4 CONTINUE

3 CONTINUE

2 CONTINUE

1 CONTINUE

C

```
K1=DP/0.2
```

C

```
K2=DN/0.2
```

C

```
K1=DP*DSQRT(2.D0)/0.2D0
```

C

```
K2=DN*DSQRT(2.D0)/0.2D0
```

```
K1=IIII
```

```
K2=K1
```

```
DO 5 IP=1,20
```

```
DO 6 I=1,20
```

```
BTILD(IP,I)=0.D0
```

```
IF(IABS(I-IP).GT.2.OR.(I+IP).LT.2) GO TO 6
```

```
A=DP*(2*I+1.D0)/(2*IP+1.D0)*CLB(I,2,IP,1,0,1)*ANO1PL(K1,K2,I)/
&ANO1PL(K1,K2,IP)
```

```
B=3.D0*DSQRT(2*I+1.D0)*ANO1PL(K1,K2,I)*ANO1PL(K1,K2,IP)
```

```
SUM1=0.
```

```
DO 7 I2=1,3
```

```
II2=2*I2
```

```
I1MIN=IABS(IP-1)
```

```
I1MAX=IP+1
```

```
IF(I1MIN.NE.2*(I1MIN/2))I1MIN=I1MIN+1
```

```
IF(I1MAX.NE.2*(I1MAX/2))I1MAX=I1MAX-1
```

C

```
I1MAX=MIN0(I1MAX,10)
```

```
DO 8 I1=I1MIN,I1MAX,2
```

```

      JL1=(I1+2)/2
      C=DP*F(IP,I,I1,I2)*CLB(I1,1,IP,0,1,1)/(ANOGR(K1,K2,JL1)**2)
      SUM1=SUM1+C
8  CONTINUE
7  CONTINUE
   BTILD(IP,I)=A+B*SUM1
6  CONTINUE
5  CONTINUE
   DO 9 I=1,20
   DO 10 IP=1,20
   BPLUS(I,IP)=0.
   IF(IABS(I-IP).GT.2.OR.(I+IP).LT.2) GO TO 10
   IMIP=IABS(I-IP)
   IPH=1
   IF(IMIP.NE.2*(IMIP/2)) IPH=-1
   BPLUS(I,IP)=DSQRT((2*IP+1.D0)/(2*I+1.D0))*IPH*BTILD(IP,I)
10 CONTINUE
9  CONTINUE
   DO 11 I=1,20
   DO 12 IP=1,20
   BPLB(I,IP)=BPLUS(I,IP)+BTILD(I,IP)
12 CONTINUE
11 CONTINUE
   DO 14 I =1,20
   J=2*I-2
   DO 15 IP =1,20
   JP=2*IP-2
   BPLBGRGR(I,IP)=0.0
   IF(J.LT.IABS(JP-2).OR.J.GT.(JP+2))GO TO 15
   A=DP*CLB(JP,2,J,0,0,0)
   B=((2*JP+1.)/(2*J+1.))*GGGNO(IIII,IP)/GGGNO(IIII,I))
   C=(GGGNO(IIII,I)/GGGNO(IIII,IP))
   BPLBGRGR(I,IP)=A*(B+C)
   BBGRGR(I,IP)=B+C
   WRITE(27,52)DP,A,B,C,BPLBGRGR(I,IP)
15 CONTINUE
14 CONTINUE
   WRITE(27,42)((BPLBGRGR(I,J),J=1,20),I=1,20)
42  FORMAT(/1X,'BPLBGRGR=',8(F8.5,1X))
52  FORMAT(1X,'DP A B C BPLBGRGR =',5(F10.5,2X))
   CLOSE(UNIT=27)
   RETURN
   END

SUBROUTINE HAMI
COMMON/FMAT/F(20,20,23,3),BTILD(20,20),BPLUS(20,20),BPLB(20,20)
&,BPLBGRGR(20,20)
COMMON/DIPANDPC/ANO1PL(20,20,30),ANOPC(20,20,7,30),

```

```

&ANPCGR(20,20,7,20)
COMMON/AVJ/AVJPRO2(20,20,20),AVJNEU2(20,20,20)
DOUBLE PRECISION ANO1PL,AVJPRO2,AVJNEU2,ANOPC,ANPCGR
COMMON/CNOR/GGGNO(20,21),ANOGR(20,20,21)
DOUBLE PRECISION GGGNO,ANOGR
COMMON/HAMIL/HAH(7,30)
COMMON/HAMCHIR/HAH0(7,30),HAH1(7,30),HAH2(7,30)
common/defo/DP, DN
COMMON/ENE1/EGRESSO(20,20),EEGR(20,21)
COMMON/MONOPOLE/T00(6,20)
COMMON/QUADRUP/T22(6,20)
COMMON/HEX/T44(6,20)
COMMON/PARA/X00,UU0,UU2,UU4,XPC,XSS,E2QP
common/INDDE/IASCO
DOUBLE PRECISION SJS,A,B,F,BTILD,BPLUS,BPLB,
&HAH,CLEB,ETA,QMAT,GGNO,CLB,EGRESSO,EEGR,
&DP, DN,T00,X00,T22,T44,BPLBGRGR,XPC,XSS,E2QP,UU0,UU2,UU4
&,HAH0,HAH1,HAH2

```

C

C

C FORMAREA MATRICII CARE DETERMINA ENERGIILE BENZILOR MAGNETICE

C

C ATENTIE! EGRESSO ESTE CALCULAT CU \RHO PE CAND AICI SE LUCREAZA CU DP
SI DN

C DE ACEEA ESTE NEVOIE SA SE FACA LEGATURA INTRE CELE DOUA REPREZENTARI

C

C

C

C

```

      IIII=IASCO
      E1ZERO=EEGR(IIII,1)
      WRITE(20,8023)E1ZERO
8023  format(/,10x,' ezero =',f15.10)

```

```

      RO=IIII*0.2
      DP=RO/DSQRT(2.D0)
      DN=DP
      EZERO=EEGR(IIII,1)

```

C WRITE(20,22)

22 FORMAT(/,10X,'AM INTRAT IN HAMI')

340 FORMAT(/,10X,'ANOPC SJS =' 2(F15.8))

C CALL FFACT

CALL AMONOP(IIII)

CALL QUAD2(IIII)

CALL HEXAD(IIII)

WRITE(20,51)(T00(6,I),I=11,20)

WRITE(20,52)(T22(6,I),I=11,20)

```

WRITE(20,53)(T44(6,I),I=11,20)
51  FORMAT(1X,'T00=',(8F8.5,1X))

52  FORMAT(1X,'T22=',(8F8.5,1X))
53  FORMAT(1X,'T44=',(8F8.5,1X))
    AMASS=138
    AJMIC=5.5
    JMIC2=2*AJMIC
8026 FORMAT(/,10X,'PC STRENGTH =', F15.10)
C
C
C
C
C THE CASE OF Nd138 ISOTOPE
C
C
C
C

    NPR=10
    AMC2=938.85
    HC=197.8
    PI=3.141592
    HOM=41./(AMASS**0.33330)
    HPMOM=HC**2/(AMC2*HOM)
    ATES=CLEB(5.5,2.,5.5,0.5,0.,0.5)
    QMAT=6.5D0*DSQRT(5.D0/(4.*PI))*HPMOM*CLEB(5.5,2.,5.5,0.5,0.,0.5)
    V2=(NPR+0.D0)/(2*AJMIC+1.D0)
    U2=1.D0-V2
    ETA=0.5D0*QMAT*(U2-V2)
    STR =XPC*ETA

C
C
C
C

    I1=DP*DSQRT(2.D0)/0.2
    I2=DN*DSQRT(2.D0)/0.2
    K1=DP*DSQRT(2.D0)/0.2
    K2=DN*DSQRT(2.D0)/0.2
C    WRITE(20,3339) QMAT, ETA,DP, DN,ATES
3339 FORMAT(/,10X,'QMAT  ETA  DP  DN  ATES=', 5(F10.5,2X))
    21  FORMAT(/,10X,'J  I  H1  SUM  H1*SUM =', 2(I3,2X),3(F10.5,2X))
        DO 1  IJ=1,6
            J=2*IJ-2
            JJ=2*J
            DO 2  I=J+1,20
                II=2*I
                H1=4.*(2*J+1.)*DSQRT(5.D0)*XPC*ANOPC(I1,I2,IJ,I)**2*ETA*
                &SJS(JJ,JMIC2,JJ,JMIC2,JMIC2,4)
C        write(20,340) ANOPC(I1,I2,IJ,I), SJS(JJ,JMIC2,JJ,JMIC2,JMIC2,4)

```

```

SUM=0.
JPMIN=IABS(I-J)
JPMAX=I+J
C   JPMAX=MIN0(20, JPMAX)
DO 3 JP=JPMIN, JPMAX
  JJP=2*JP
  A=DSQRT(2*JP+1.D0)*CLB(J, JP, I, J, 1, J+1)
  DO 4 JS=JPMIN, JPMAX
    JJS=2*JS
    B=SJS(JJ, 4, II, JJP, JJ, JJS)*CLB(J, JS, I, J, 1, J+1)*BPLB(JP, JS)
    SUM=SUM+A*B/(ANO1PL(K1, K2, JP)*ANO1PL(K1, K2, JS))
4  CONTINUE
3  CONTINUE

C
C   ATENTIE! IN VERSIUNEA VECHЕ LIPSEA NUMITORUL (ANO1PL(K1, K2, JP)*ANO1PL
C   (K1, K2, JS))
C

K1=DP*DSQRT(2.D0)/0.2
K2=DN*DSQRT(2.D0)/0.2
C   write(20, 21)J, I, H1, SUM, H1*SUM
HAH(IJ, I)=H1*SUM
H2=I*(I+1.)-J*(J+1.)
JPMIN=IABS(I-J)
JPMAX=I+J
C   JPMAX=MIN0(20, JPMAX)
SUM2=0.
SUM3=0.

DO 14 JP=JPMIN, JPMAX
  SUM2=SUM2+2.*JP*(JP+1.D0)*CLB(J, JP, I, J, 1, J+1)**2/
&(ANO1PL(K1, K2, JP)**2)
  SUM3=SUM3+2.*EGRESSO(IIII, JP)*CLB(J, JP, I, J, 1, J+1)**2/
&(ANO1PL(K1, K2, JP)**2)
14 CONTINUE
  H3=-ANOPC(K1, K2, IJ, I)**2*SUM2
  H4= ANOPC(K1, K2, IJ, I)**2*SUM3
  HAH0(IJ, I)=HAH(IJ, I)-0.5*XSS*(H2+H3)+H4+E2QP-EZERO
&-X00*(UU0*T00(IJ, I)+UU2*T22(IJ, I)+UU4*T44(IJ, I))
  HAH1(IJ, I)=HAH(IJ, I)+0.5*XSS*(H2+H3)+H4+E2QP-EZERO
&-X00*(UU0*T00(IJ, I)+UU2*T22(IJ, I)+UU4*T44(IJ, I))
  HAH2(IJ, I)=HAH(IJ, I)+H4+E2QP-EZERO
&-X00*(UU0*T00(IJ, I)+UU2*T22(IJ, I)+UU4*T44(IJ, I))
C   write(20, 8016)J, I, H2, H3, H4
2  CONTINUE
1  CONTINUE
  WRITE(20, 34)(EGRESSO(IIII, IJ), IJ=1, 20)
34  FORMAT(/, 10X, '1+ BAND ENERGIES' /,
&      10X, '*****' /, /,

```

```

&          10X,5(F10.5,2X))
  IJ=6
  J=2*IJ-2
  KMIN=J+1
  do 8014 K=KMIN,20
    WRITE(20,8012)J,HAH0(IJ,K),HAH1(IJ,K),HAH2(IJ,K)
8014 CONTINUE
8013 continue
  WRITE(20,8026)STR
8012 FORMAT(/,10X,'J HAH0 HAH1 HAH2 DIP =',I3,1X,3(F8.5,2X))
8016 format(/,10x,'J I H2 H3 H4 =',2(I4),3(F12.8,1x))
  RETURN
  END
C
C
C
C
  SUBROUTINE HAMIGR
  COMMON/FMAT/F(20,20,23,3),BTILD(20,20),BPLUS(20,20),BPLB(20,20)
&,BPLBGRGR(20,20)
  COMMON/DIPANDPC/ANO1PL(20,20,30),ANOPC(20,20,7,30),
&ANPCGR(20,20,7,20)
  COMMON/AVJ/AVJPRO2(20,20,20),AVJNEU2(20,20,20)
  DOUBLE PRECISION ANO1PL,AVJPRO2,AVJNEU2,ANOPC,ANPCGR
  COMMON/CNOR/GGGNO(20,21),ANOGR(20,20,21)
  DOUBLE PRECISION GGGNO,ANOGR
  COMMON/HAMIL/HAH(7,30)
  COMMON/HAMGR/HPCGR(7,30)
  COMMON/HAMCHIR/HAH0(7,30),HAH1(7,30),HAH2(7,30)
  common/defo/DP, DN
  COMMON/ENE1/EGRESSO(20,20),EEGR(20,21)
  COMMON/MONOPOLE/T00(6,20)
  COMMON/MONOPGR/T0GR(6,20)
  COMMON/QUADRUP/T22(6,20)
  COMMON/QADGR/T2GR(6,20)
  COMMON/HEX/T44(6,20)
  COMMON/HXGR/T4GR(6,20)
  COMMON/PARA/X00,UU0,UU2,UU4,XPC,XSS,E2QP
  common/INDDE/IASCO
  DOUBLE PRECISION SJS,A,B,F,BTILD,BPLUS,BPLB,
&HAH,CLEB,ETA,QMAT,GGNO,CLB,EGRESSO,EEGR,
&DP, DN,T00,X00,T22,T44,T0GR,T2GR,T4GR,BPLBGRGR
&,UU0,UU2,UU4,XPC,XSS,E2QP,HPCGR
&,HAH0,HAH1,HAH2
C    WRITE(20,41)X00,UU0,UU2,UU4,XPC,XSS,E2QP,IIII,ID
41  FORMAT(1X,'X00 U0 U2 U4 XPC XSS E2QP IIII ID=',7(F8.5,1X),2(I3))
C
C
C  FORMAREA MATRICII CARE DETERMINA ENERGIILE BENZILOR MAGNETICE
C

```

```

C   ATENTIE! EGRESSO ESTE CALCULAT CU \RHO PE CAND AICI SE LUCREAZA CU DP
SI DN
C   DE ACEEA ESTE NEVOIE SA SE FACI LEGATURA INTRE CELE DOUA REPREZENTARI
C
C
C
C
C   OPEN(UNIT=28,FILE='HGR.OUT',STATUS='NEW')
WRITE(20,22)
22  FORMAT(/,10X,'AM INTRAT IN HAMIGR')
    IIII=IASCO
    EZERO=EEGR(IIII,1)
    write(20,8023) EZERO
8023 format(/,10x,'EZERO =',f15.10)
    RO=IIII*0.2
    DP=RO/DSQRT(2.D0)
    DN=DP
340  FORMAT(/,10X,'ANOPC SJS =',2(F15.8))
C   CALL FFACT
    CALL AMONGR(IIII)
    CALL QUADGR(IIII)
    CALL HEXGR(IIII)
    WRITE(20,51)(T0GR(6,I),I=10,20)
    WRITE(20,52)(T2GR(6,I),I=10,20)
    WRITE(20,53)(T4GR(6,I),I=10,20)
51  FORMAT(1X,'T0GR=',(8F8.5,1X))
52  FORMAT(1X,'T2GR=',(8F8.5,1X))
53  FORMAT(1X,'T4GR=',(8F8.5,1X))
    AMASS=138
    AJMIC=5.5
    JMIC2=2*AJMIC

8026 FORMAT(/,10X,'PC STRENGTH =',F15.10)
C
C THE CASE OF Nd138 ISOTOPE
C
    NPR=10
    AMC2=938.85
    HC=197.8
    PI=3.141592
    AMASS=138.
    HOM=41./(AMASS**0.33330)
    HPMOM=HC**2/(AMC2*HOM)
    ATES=CLEB(5.5,2.,5.5,0.5,0.,0.5)
    QMAT=6.5D0*DSQRT(5.D0/(4.*PI))*HPMOM*CLEB(5.5,2.,5.5,0.5,0.,0.5)
    V2=(NPR+0.D0)/(2*AJMIC+1.D0)
    U2=1.D0-V2
    ETA=0.5D0*QMAT*(U2-V2)
    STR =XPC*ETA
C   WRITE(20,8026)STR

```



```

I1=DP*DSQRT(2.D0)/0.2
I2=DN*DSQRT(2.D0)/0.2
K1=DP*DSQRT(2.D0)/0.2
K2=DN*DSQRT(2.D0)/0.2
WRITE(20,3339) QMAT, ETA, DP, DN, ATES
3339 FORMAT(/,10X,'QMAT  ETA  DP  DN  ATES=', 5(F10.5,2X))
21  FORMAT(/,10X,'J  I  H1GRGR  SUM  H1GRGR*SUM  =', 2(I3,2X),3(F15.5,2X))
C
DO 1 IJ=1,6
J=2*IJ-2
JJ=2*J
C
DO 2 I=J,20
II=2*I
H1GRGR=4.*(2*J+1.)*DSQRT(5.D0)*XPC*ANPCGR(I1,I2,IJ,I)**2*ETA*
&SJS(JJ,JMIC2,JJ,JMIC2,JMIC2,4)
SUM=0.
JPMIN=IABS(I-J)
JPMAX=I+J
C
JPMAX=MIN0(10,JPMAX)
IF(JPMIN.NE.2*(JPMIN/2))JPMIN=JPMIN+1
C
DO 3 JP=JPMIN,JPMAX,2
IJP=(JP+2)/2
JJP=2*JP
A=DSQRT(2*JP+1.D0)*CLB(J,JP,I,J,0,J)
DO 4 JS=JPMIN,JPMAX,2
IJS=(JS+2)/2
JJS=2*JS
B=SJS(JJ,4,II,JJP,JJ,JJS)*CLB(J,JS,I,J,0,J)*BPLBGRGR(IJP,IJS)
SUM=SUM+A*B/(ANOGGR(K1,K2,IJP)*ANOGGR(K1,K2,IJS))
4 CONTINUE
3 CONTINUE
C
C
C
K1=DP*DSQRT(2.D0)/0.2
K2=DN*DSQRT(2.D0)/0.2
write(20,21)J,I,H1GRGR,SUM,H1GRGR*SUM
HPCGR(IJ,I)=H1GRGR*SUM
H2=I*(I+1.)-J*(J+1.)
JPMIN=IABS(I-J)
IF(JPMIN.NE.2*(JPMIN/2))JPMIN=JPMIN+1
JPMAX=I+J
C
JPMAX=MIN0(10,JPMAX)
SUM2=0.
SUM3=0.
DO 14 JP=JPMIN,JPMAX,2

```

```

      IJP=(JP+2)/2
      SUM2=SUM2+2.*JP*(JP+1.D0)*CLB(J,JP,I,J,0,J)**2/
&(ANOGGR(K1,K2,IJP)**2)
      SUM3=SUM3+2.*EEGR(IIII,IJP)*CLB(J,JP,I,J,0,J)**2/
&(ANOGGR(K1,K2,IJP)**2)
14 CONTINUE
      H3=-ANPCGR(K1,K2,IJ,I)**2*SUM2
      H4= ANPCGR(K1,K2,IJ,I)**2*SUM3
      HAH0(IJ,I)=HPCGR(IJ,I)-0.5*XSS*(H2+H3)+H4+E2QP-EZERO
&-X00*(UU0*T0GR(IJ,I)+UU2*T2GR(IJ,I)+UU4*T4GR(IJ,I))
      HAH1(IJ,I)=HPCGR(IJ,I)+0.5*XSS*(H2+H3)+H4+E2QP-EZERO
&-X00*(UU0*T0GR(IJ,I)+UU2*T2GR(IJ,I)+UU4*T4GR(IJ,I))
      HAH2(IJ,I)=HPCGR(IJ,I)+H4+E2QP-EZERO
&-X00*(UU0*T0GR(IJ,I)+UU2*T2GR(IJ,I)+UU4*T4GR(IJ,I))
      write(20,8016)J,I,H2,H3,H4,HPCGR(IJ,I),E2QP,EZERO
2 CONTINUE
1 CONTINUE
      WRITE(20,42)((BPLBGRGR(I,J),J=1,11),I=1,11)
42 FORMAT(/1X,'BPLBGRGR=',8(F8.5,1X))
      WRITE(20,34)(EEGR(IIII,IJ),IJ=1,11)
34 FORMAT(/,10X,'GS BAND ENERGIES'/,
&          10X,'*****',/,
&          10X,5(F10.5,2X))
      IJ=6
      J=2*IJ-2
      KMIN=J
      do 8014 K=KMIN,20
      WRITE(20,8012)J,HAH0(IJ,K),HAH1(IJ,K),HAH2(IJ,K)
8014 CONTINUE
8013 continue
      WRITE(20,8026)STR
8012 FORMAT(/,10X,'J HAH0 HAH1 HAH2 GR =',I3,1X,3(F8.5,2X))
8016 format(/,10x,'J I H2 H3 H4 HPCGR E2QP,EZERO =',2(I4),/,
&6(F12.5,1x))
c      CLOSE(UNIT=28)
      RETURN

      END

C
C
C
      SUBROUTINE AMONOP(ID)
      COMMON/DIPANDPC/ANO1PL(20,20,30),ANOPC(20,20,7,30),
&ANPCGR(20,20,7,20)

```

```

COMMON/AVJ/AVJPRO2(20,20,20),AVJNEU2(20,20,20)
DOUBLE PRECISION ANO1PL,AVJPRO2,AVJNEU2,ANOPC,ANPCGR
COMMON/QUADRUP/T22(6,20)
COMMON/HEX/T44(6,20)
COMMON/CNOR/GGNO(20,21),ANOGR(20,20,21)
DOUBLE PRECISION GGGNO,ANOGR
COMMON/MONOPOLE/T00(6,20)
DOUBLE PRECISION SJS,F1,F,F3,BTILD,BPLUS,BPLB,

```

```
&HAH,CLEB,V2,U2,ETA,GGNO,CLB,
```

```
&DP,DN,T00,X00,SUM,SUM1,T22,T44
```

```
AJMIC=5.5
```

```
PI=3.141592
```

```
RO=ID*0.2
```

```
DP=RO/DSQRT(2.D0)
```

```
DN=DP
```

```
DE=DP
```

```
K1=DP*DSQRT(2.D0)/0.2
```

```
K2=DN*DSQRT(2.D0)/0.2
```

```
NPR=10
```

```
V2=(NPR+0.D0)/(2*AJMIC+1.D0)
```

```
c V2=0.8512
```

```
U2=1.D0-V2
```

```
ETA=0.5D0*(U2-V2)
```

```
DO 1 IJ=1,6
```

```
J=2*IJ-2
```

```
IMIN = J+1
```

```
DO 2 I=IMIN,20
```

```
F3=ANOPC(K1,K2,IJ,I)
```

```
F1=(ANOPC(K1,K2,IJ,I)**2)*ETA*(4.*DE**2)/(DSQRT(5.D0*PI))
```

```
JPMIN=IABS(I-J)
```

```
JPMAX=I+J
```

```
JPMAX=MIN0(JPMAX,20)
```

```
SUM=0.
```

```
SUM1=0.
```

```
DO 3 JP=JPMIN,JPMAX
```

```
SUM=SUM+(CLB(J,JP,I,J,1,J+1)/ANO1PL(K1,K2,JP))**2
```

```
DO 4 IJS =1, 11
```

```
JS = 2*IJS-2
```

```
SUM1=SUM1+(CLB(J,JP,I,J,1,J+1)*CLB(JS,1,JP,0,1,1)/
```

```
&GGGNO(ID,IJS))**2
```

```
4 CONTINUE
```

```
3 CONTINUE
```

```
T00(IJ,I)=F1*(SUM+SUM1*CLB(2,2,1,1,0,1)**2)
```

```
write(20,15)F3,f1,sum,sum1,t00(ij,i)
```

```
2 CONTINUE
```

```
1 CONTINUE
```

```
15 FORMAT(/,10X,'F3 F1,SUM,SUM1,T00 = ',5(F10.5,2X))
```

```

RETURN
END
C
C
C
C
    SUBROUTINE AMONGR(ID)
    COMMON/DIPANDPC/ANO1PL(20,20,30),ANOPC(20,20,7,30),
&ANPCGR(20,20,7,20)
    COMMON/AVJ/AVJPRO2(20,20,20),AVJNEU2(20,20,20)
    DOUBLE PRECISION ANO1PL,AVJPRO2,AVJNEU2,ANOPC,ANPCGR
    COMMON/QUADRUP/T22(6,20)
    COMMON/QADGR/T2GR(6,20)
    COMMON/HEX/T44(6,20)
    COMMON/HXGR/T4GR(6,20)
    COMMON/CNOR/GGGNO(20,21),ANOGR(20,20,21)
    DOUBLE PRECISION GGGNO,ANOGR

    COMMON/MONOPOLE/T00(6,20)
    COMMON/MONOPGR/T0GR(6,20)
    DOUBLE PRECISION SJS,F1,F,F3,BTILD,BPLUS,BPLB,
&HAH,CLEB,U0,U2,U4,ETA,GGNO,CLB,
&DP,DN,T00,X00,SUM,SUM1,T22,T44,T0GR,T4GR,T2GR
    AJMIC=5.5
    PI=3.141592
    RO=ID*0.2
    DP=RO/DSQRT(2.D0)
    DN=DP
    DE=DP
    K1=DP*DSQRT(2.D0)/0.2
    K2=DN*DSQRT(2.D0)/0.2
    NPR=10
    V2=(NPR+0.D0)/(2*AJMIC+1.D0)
c    V2=0.8512
    U2=1.D0-V2
    ETA=0.5D0*(U2-V2)
    DO 1 IJ=1,6
    J=2*IJ-2
    IMIN = J
    DO 2 I=IMIN,20
    T0GR(IJ,I)=(2*DE**2)/DSQRT(5.D0*PI)*ETA
2    CONTINUE
1    CONTINUE
15  FORMAT(/,10X,'F3 F1,SUM,SUM1,T00 = ',5(F10.5,2X))
    RETURN
    END

C
C
C

```

C

```
DOUBLE PRECISION FUNCTION QQQJ2J(J)
DOUBLE PRECISION SJS
AJSM=5.5
JMIC2=2*AJSM
JJ=2*J
QQQJ2J=4.*DSQRT(5.D0*(2*J+1.D0))*SJS(4,JMIC2,JJ,JMIC2,JMIC2,JJ)
RETURN
END
```

C

C

C

C

```
DOUBLE PRECISION FUNCTION BPBJPJS(ID,JP,JS)
COMMON/DIPANDPC/ANO1PL(20,20,30),ANOPC(20,20,7,30),
&ANPCGR(20,20,7,20)
COMMON/AVJ/AVJPRO2(20,20,20),AVJNEU2(20,20,20)
DOUBLE PRECISION ANO1PL,AVJPRO2,AVJNEU2,ANOPC,ANPCGR
COMMON/CNOR/GGGNO(20,21),ANOGR(20,20,21)
DOUBLE PRECISION GGGNO,ANOGR
DOUBLE PRECISION SJS,C1,C2,C3,C4,CLB,
&CLEB,V2,U2,ETA,
&DP,DN,SUM,DE
JJP=2*JP
JJS=2*JS
RO=ID*0.2
DP=RO/DSQRT(2.D0)
DN=DP
DE=DP
C2=(4.*DE**2)*DSQRT(15.D0*(2*JS+1.D0))
C1=0.0D0
IF(JP.EQ.JS)C1=(2.*DE**2)*CLB(JP,2,JP,1,0,1)*CLB(2,2,2,0,0,0)
SM=0.D0
DO 1 JF1=1,3
JJF1=2*JF1
C3=DSQRT(2.D0*JF1+1.D0)*CLB(2,JF1,1,0,-1,-1)*SJS(4,4,2,JJF1,4,4)
JFMI=IABS(JF1-2)
JFMIN=MAX0(1,JFMI)
JFMAX=JF1+2
DO 2 JF=JFMIN,JFMAX
JJF=2*JF
C4=(2*JF+1.D0)*CLB(2,JF,JF1,0,1,1)*SJS(4,4,JJF,4,2,JJF1)
J2MI1=IABS(JP-1)
J2MA1=JP+1
J2MI2=IABS(JS-JF)
J2MA2=JS+JF
J2MI3=MAX0(J2MI1,J2MI2)
J2MA3=MIN0(J2MA1,J2MA2)
IF(J2MI3.NE.2*(J2MI3/2))J2MIN=J2MI3+1
J2MAX=MIN0(J2MA3,10)
```

C

```

DO 3 J2=J2MIN,J2MAX,2
IJ2=(J2+2)/2
JJ2=2*J2
SUM=SUM+C2*C3*C4*CLB(J2,1,JP,0,-1,-1)*CLB(J2,JF,JS,0,-1,-1)*
&SJS(JJS,4, JJ2,2, JJP, JJF)/(GGGNO(ID, IJ2)**2)
3 CONTINUE
2 CONTINUE
1 CONTINUE
BPBPJPJS=C1+SUM
RETURN
END

```

C
C
C
C

```

SUBROUTINE QUAD2(ID)
COMMON/QUADRUPT/T22(6,20)
COMMON/DIPANDPC/ANO1PL(20,20,30),ANOPC(20,20,7,30),
&ANPCGR(20,20,7,20)
COMMON/AVJ/AVJPRO2(20,20,20),AVJNEU2(20,20,20)
DOUBLE PRECISION ANO1PL,AVJPRO2,AVJNEU2,ANOPC,ANPCGR
COMMON/CNOR/GGGNO(20,21),ANOGR(20,20,21)
DOUBLE PRECISION GGGNO,ANOGR
DOUBLE PRECISION SJS,CLB,
&CLEB,V2,U2,ETA,QMAT,GGNO,T22,
&DP, DN, SUM, DE, QQQJ2J, BPBPJPJS
AJMIC=5.5
NPR=10
AMC2=938.85
HC=197.8
PI=3.141592
AMASS=138
HOM=41./(AMASS**0.33330)
HPMOM=HC**2/(AMC2*HOM)
ATES=CLEB(5.5,2.,5.5,0.5,0.,0.5)
QMAT=6.5D0*DSQRT(5.D0/(4.*PI))*HPMOM*CLEB(5.5,2.,5.5,0.5,0.,0.5)
V2=(NPR+0.D0)/(2*AJMIC+1.D0)

```

c

```

V2=0.8512
U2=1.D0-V2
ETA=0.5D0*QMAT*(U2-V2)
DO 1 IJ=1,6
J=2*IJ-2
JJ=2*J
DO 2 I=J+1,20
II=2*I
C1=(ANOPC(ID, ID, IJ, I)**2)*ETA*QQQJ2J(J)
JPMI=IABS(I-J)
JPMIN=MAX0(JPMI,1)
JPMAX=J+I
JPMAX=MIN0(JPMA,20)

```

```

SUM=0.D0
DO 3 JP=JPMIN,JPMAX
JJP=2*JP
DO 4 JS=JPMIN,JPMAX
JJS=2*JS
SUM=SUM+DSQRT((2.*J+1.D0)*(2.*JP+1.D0))*CLB(JP,J,I,1,J,J+1)*
&CLB(JS,J,I,1,J,J+1)*SJS(JJ,4,II,JJS,JJ,JJP)*BPBPJPJS(ID,JP,JS)
4 CONTINUE
3 CONTINUE
T22(IJ,I)=C1*SUM
write(20,15)IJ,I,QQQJ2J(J),C1,SUM,T22(ij,i)
2 continue
1 continue
15 FORMAT(/,10X,'IJ I QQQJ2J C1 SUM T22 = ',2(I2,1X),4(F10.5,2X))
RETURN
END

```

C
C
C
C

```

SUBROUTINE QUADGR(ID)
COMMON/QUADRUP/T22(6,20)
COMMON/QADGR/T2GR(6,20)
COMMON/DIPANDPC/AN01PL(20,20,30),ANOPC(20,20,7,30),
&ANPCGR(20,20,7,20)
COMMON/AVJ/AVJPRO2(20,20,20),AVJNEU2(20,20,20)
DOUBLE PRECISION AN01PL,AVJPRO2,AVJNEU2,ANOPC,ANPCGR
COMMON/CNOR/GGNO(20,21),ANOG(20,20,21)
DOUBLE PRECISION GGNO,ANOG
COMMON/FMAT/F(20,20,23,3),BTILD(20,20),BPLUS(20,20),BPLB(20,20)
&,BPLBGRGR(20,20)
DOUBLE PRECISION SJS,CLB,
&CLEB,V2,U2,ETA,QMAT,GGNO,T22,
&DP,DN,SUM,DE,QQQJ2J,BPBPJPJS,T2GR,
&F,BTILD,BPLUS,BPLB,BPLBGRGR
AJMIC=5.5
NPR=10
AMC2=938.85
HC=197.8
PI=3.141592
AMASS=138.
HOM=41./(AMASS**0.33330)
HPMOM=HC**2/(AMC2*HOM)
ATES=CLEB(5.5,2.,5.5,0.5,0.,0.5)
QMAT=6.5D0*DSQRT(5.D0/(4.*PI))*HPMOM*CLEB(5.5,2.,5.5,0.5,0.,0.5)
V2=(NPR+0.D0)/(2*AJMIC+1.D0)
U2=1.D0-V2
ETA=0.5D0*QMAT*(U2-V2)
DO 1 IJ=1,6

```

```

J=2*IJ-2

JJ=2*J
DO 2 I=J,20
II=2*I
C1=(ANPCGR(ID, ID, IJ, I)**2)*ETA*QQQJ2J(J)
JPMI=IABS(I-J)
JPMA=J+I
C   JPMAX=MIN0(JPMA,10)
   if(JPMI.ne.2*(JPMI/2))JPMI=JPMI+1
SUM=0.D0
DO 3 JP=JPMI,JPMA,2
IJP=(JP+2)/2
JJP=2*JP
DO 4 JS=JPMI,JPMA,2
IJS=(JS+2)/2
JJS=2*JS
SUM=SUM+DSQRT((2.*J+1.D0)*(2.*JP+1.D0))*CLB(JP,J,I,0,J,J)*
&CLB(JS,J,I,0,J,J)*SJS(JJ,4,II,JJS,JJ,JJP)*BPLBGRGR(IJP,IJS)
&*(-DE*DSQRT(2.D0/7.D0)/(ANOGGR(ID, ID, IJP)*ANOGGR(ID, ID, IJS)))
4   CONTINUE
3   CONTINUE
T2GR(IJ,I)=C1*SUM
C   write(20,15)IJ,I,QQQJ2J(J),C1,SUM,T22(ij,i)
2   continue
1   continue
15  FORMAT(/,10X,'IJ I QQQJ2J C1 SUM T22 = ',2(I2,1X),4(F10.5,2X))
RETURN
END

```

```

C
C
C
C

```

```

DOUBLE PRECISION FUNCTION QQQJ4J(J)
DOUBLE PRECISION SJS
AJSM=5.5
JMIC2=2*AJSM
JJ=2*J
QQQJ4J=12.*DSQRT(2*J+1.D0)*SJS(8,JMIC2,JJ,JMIC2,JMIC2,JJ)
RETURN
END

```

```

C
C
C
C

```

```

DOUBLE PRECISION FUNCTION BPBP4JPJS(ID,JP,JS)

```



```

COMMON/DIPANDPC/ANO1PL(20,20,30),ANOPC(20,20,7,30),
&ANPCGR(20,20,7,20)
COMMON/AVJ/AVJPRO2(20,20,20),AVJNEU2(20,20,20)
DOUBLE PRECISION ANO1PL,AVJPRO2,AVJNEU2,ANOPC,ANPCGR
COMMON/CNOR/GGGNO(20,21),ANOGR(20,20,21)
DOUBLE PRECISION GGGNO,ANOGR

DOUBLE PRECISION SJS,C1,C2,C3,C4,CLB,
&CLEB,V2,U2,ETA,
&DP, DN, SUM, DE
BPBP4JPJS=0.d0
IF(4.LT.IABS(JS-JP).OR.4.GT.(JP+JS))GO TO 27
JJP=2*JP
JJS=2*JS
RO=ID*0.2
DP=RO/DSQRT(2.D0)
DN=DP
DE=DP
C2=(12.*DE**2)*DSQRT(3.D0*(2*JS+1.D0))
C1=0.0D0
IF(JP.EQ.JS)C1=(2.*DE**2)*CLB(JP,4,JP,1,0,1)*CLB(2,2,4,0,0,0)
SM=0.D0
DO 1 JF1=1,3
JJF1=2*JF1
C3=DSQRT(2.D0*JF1+1.D0)*CLB(2,JF1,1,0,-1,-1)*SJS(4,8,2,JJF1,4,4)
JFMI=IABS(JF1-2)
JFMIN=MAX0(1,JFMI)
JFMAX=JF1+2
DO 2 JF=JFMIN,JFMAX
JJF=2*JF
C4=(2*JF+1.D0)*CLB(2,JF,JF1,0,1,1)*SJS(4,4,JJF,8,2,JJF1)
J2MI1=IABS(JP-1)
J2MA1=JP+1
J2MI2=IABS(JS-JF)
J2MA2=JS+JF
J2MI3=MAX0(J2MI1,J2MI2)
J2MA3=MIN0(J2MA1,J2MA2)
J2MIN=J2MI3
IF(J2MI3.NE.2*(J2MI3/2))J2MIN=J2MI3+1
C   J2MAX=MIN0(J2MA3,10)
IF(J2MAX.NE.2*(J2MAX/2))J2MAX=J2MAX-1
DO 3 J2=J2MIN,J2MA3,2
IJ2=(J2+2)/2
JJ2=2*J2
SUM=SUM+C2*C3*C4*CLB(J2,1,JP,0,-1,-1)*CLB(J2,JF,JS,0,-1,-1)*
&SJS(JJS,8,JJ2,2,JJP,JJF)/(GGGNO(ID,IJ2)**2)

C   WRITE(20,15)JF1,JF,J2,C1,C2,C3,C4,SUM
3   CONTINUE
2   CONTINUE

```

```

1 CONTINUE

BPBP4JPJS=C1+SUM
15 FORMAT(/,10X,'JF1 JF J2 C1 C2 C3 C4 SUM =',3(I2,2X),5(F10.5,2X))
27 CONTINUE
RETURN
END

C
C
C
C

SUBROUTINE HEXAD(ID)
COMMON/HEX/T44(6,20)
COMMON/HXGR/T4GR(6,20)
COMMON/DIPANDPC/ANO1PL(20,20,30),ANOPC(20,20,7,30),
&ANPCGR(20,20,7,20)
COMMON/AVJ/AVJPRO2(20,20,20),AVJNEU2(20,20,20)
DOUBLE PRECISION ANO1PL,AVJPRO2,AVJNEU2,ANOPC,ANPCGR
COMMON/CNOR/GGGNO(20,21),ANOGR(20,20,21)
DOUBLE PRECISION GGGNO,ANOGR

COMMON/FMAT/F(20,20,23,3),BTILD(20,20),BPLUS(20,20),BPLB(20,20)
&,BPLBGRGR(20,20)
DOUBLE PRECISION SJS,CLB,
&CLEB,V2,U2,ETA,QMAT,GGNO,T44,
&DP, DN, SUM, DE,QQQJ4J,BPBP4JPJS,T4GR
&,F,BTILD,BPLUS,BPLB,BPLBGRGR
AJMIC=5.5
NPR=10
AMC2=938.85
HC=197.8
PI=3.141592
AMSS=138.
HOM=41./(AMASS**0.33330)
HPMOM=HC**2/(AMC2*HOM)
ATES=CLEB(5.5,2.,5.5,0.5,0.,0.5)
HEXMAT=(13.D0*15.D0*25.D0/8.D0)*DSQRT((2*AJMIC+1.D0)/(4.*PI))*
&(HPMOM**2)*CLEB(5.5,4.,5.5,0.5,0.,0.5)
V2=(NPR+0.D0)/(2*AJMIC+1.D0)
c V2=0.8512
U2=1.D0-V2
ETA=0.5D0*HEXMAT*(U2-V2)

DO 1 IJ=1,6
J=2*IJ-2
JJ=2*J

DO 2 I=J,20

II=2*I

```

```

C1=(ANOPC(ID, ID, IJ, I)**2)*ETA*QQQJ4J(J)
JPMI=IABS(I-J)
JPMA=J+I
JPMAX=MIN0(JPMA, 20)
JPMIN=MAX0(JPMI, 1)
SUM=0.D0
DO 3 JP=JPMIN, JPMAX
  JJP=2*JP
DO 4 JS=JPMIN, JPMAX
  IF(4.LT.IABS(JS-JP).OR.4.GT.(JP+JS))GO TO 4
  JJS=2*JS
  SUM=SUM+DSQRT((2.*J+1.D0)*(2.*JP+1.D0))*CLB(JP, J, I, 1, J, J+1)*
&CLB(JS, J, I, 1, J, J+1)*SJS(JJ, 8, II, JJS, JJ, JJP)*BPBP4JPJS(ID, JP, JS)
4 CONTINUE
3 CONTINUE
T44(IJ, I)=C1*SUM
write(20, 15)IJ, I, QQQJ4J(J), C1, SUM, T44(ij, i)
2 continue
1 continue
15 FORMAT(/, 10X, 'IJ I QQQJ4J C1 SUM T44 = ', 2(I2, 1X), 4(F10.5, 2X))
16 FORMAT(/, 10X, 'ID, JP, JS, C8= ', 3(I2, 2X), F15.9)
RETURN
END

```

C
C
C
C

```

SUBROUTINE HEXGR(ID)
COMMON/HEX/T44(6, 20)
COMMON/HXGR/T4GR(6, 20)
COMMON/DIPANDPC/ANO1PL(20, 20, 30), ANOPC(20, 20, 7, 30),
&ANPCGR(20, 20, 7, 20)
COMMON/AVJ/AVJPRO2(20, 20, 20), AVJNEU2(20, 20, 20)
DOUBLE PRECISION ANO1PL, AVJPRO2, AVJNEU2, ANOPC, ANPCGR
COMMON/CNOR/GGGNO(20, 21), ANOGR(20, 20, 21)
DOUBLE PRECISION GGGNO, ANOGR
COMMON/FMAT/F(20, 20, 23, 3), BTILD(20, 20), BPLUS(20, 20), BPLB(20, 20)
&, BPLBGRGR(20, 20)
COMMON/BB4GRGR/BBGRGR(20, 20)
DOUBLE PRECISION SJS, F, BTILD, BPLUS, BPLB, CLB,
&CLEB, U0, U2, U4, ETA, QMAT, GGNO, T44,
&DP, DN, SUM, DE, QQQJ4J, BPBP4JPJS, T4GR, BPLBGRGR, BBGRGR
write(20, 25)
25 FORMAT(/, 10X, 'AM INTRAT IN HEXGR'/)
32 FORMAT(/, 10X, 'J I ANPCGR ETA QQQJ4J= ', 2(I2, 1X), 3(F15.5, 2X))
AJMIC=5.5
NPR=10
AMC2=938.85
HC=197.8

```

```

PI=3.141592
AMASS=138.
HOM=41./(AMASS**0.33330)
HPMOM=HC**2/(AMC2*HOM)
ATES=CLEB(5.5,2.,5.5,0.5,0.,0.5)
HEXMAT=(13.D0*15.D0*25.D0/8.D0)*DSQRT((2*AJMIC+1.D0)/(4.*PI))*
&(HPMOM**2)*CLEB(5.5,4.,5.5,0.5,0.,0.5)
V2=(NPR+0.D0)/(2*AJMIC+1.D0)
U2=1.D0-V2
ETA=0.5D0*HEXMAT*(U2-V2)
DO 1 IJ=1,6
J=2*IJ-2
JJ=2*J
DO 2 I=J,20
II=2*I
C1=(ANPCGR(ID, ID, IJ, I)**2)*ETA*QQQJ4J(J)
WRITE(20,32)J, I, ANPCGR(ID, ID, IJ, I), ETA, QQQJ4J(J)
JPMI=IABS(I-J)
JPMA=J+I
C
  JPMA=MIN0(JPMA,10)
  SUM=0.D0
  IF(JPMI.NE.2*(JPMI/2))JPMI=JPMI+1
  DO 3 JP=JPMI,JPMA,2
  IJP=(JP+2)/2
  JJP=2*JP
  DO 4 JS=JPMI,JPMA,2
  IJS=(JS+2)/2
  IF(4.LT.IABS(JS-JP).OR.4.GT.(JP+JS))GO TO 4
  JJS=2*JS
  CC=CLB(JS,4,JP,0,0,0)
  SUM=SUM+DSQRT((2.*J+1.D0)*(2.*JP+1.D0))*CLB(JP,J,I,0,J,J)*
&CLB(JS,J,I,0,J,J)*SJS(JJ,8,II,JJS,JJ,JJP)*BBGRGR(IJP,IJS)
&*CC*(DE**2*CLB(2,2,4,0,0,0))/(ANOGGR(ID, ID, IJP)*ANOGGR(ID, ID, IJS))
4  CONTINUE
3  CONTINUE
  T4GR(IJ, I)=C1*SUM
  WRITE(20,15)IJ, J, QQQJ4J(J), C1, SUM, T4GR(IJ, I)
2  continue
1  continue
15 FORMAT(/,10X, 'IJ I QQQJ4J C1 SUM T44 = ',2(I2,1X),4(F10.5,2X))
16 FORMAT(/,10X, 'ID, JP, JS, C8=' ,3(I2,2X), F15.9)
  RETURN
  END

```

```

SUBROUTINE FILEAST(DE)
DOUBLE PRECISION DE, AN0, AN1, EGAM1, A, B, X, AAA1, AAA2, AAA3, AAA4
COMMON/FIT1/EXPGR(10), EXPBE(10), EXPGA(10)
COMMON/FIT2/NEXPGR, NEXPBE, NEXPGA
COMMON/ENERGGO/EGAM1(40)

```

```

COMMON/OVERL/AN0(21),AN1(21)
COMMON/COEF/AAA1,AAA2,AAA3,AAA4,IND
REAL EXPGR,EXPBE,EXPGA
dimension A(4,4),B(4),X(4),ENERG1(21),ENERG2(21),ENERG3(21)

```

C

C Atentie! pentru Os190, aceasta subrutina a fost modificata deoarece in banda

C gamma lipsesc date experimentale pentru energiile starilor 7+ si 9+

C

C

```

WRITE(20,1234)
1234 FORMAT(/,10X,'SUNT IN FILEAST',/)
WRITE(20,8106)NEXPGR,NEXPBE,NEXPGA,DE
WRITE(20,8103)(EXPGR(I),I=1,NEXPGR)
WRITE(20,8104)(EXPBE(I),I=1,NEXPBE)
WRITE(20,8105)(EXPGA(I),I=1,NEXPGA)
8103 FORMAT(/10X,'GROUND STATE ENERGIES'/5F10.4)
8104 FORMAT(/10X,' BETA STATE ENERGIES'/5F10.4)
8105 FORMAT(/10X,'GAMMA STATE ENERGIES'/8F10.4)
8106 FORMAT(/,10X,'NEXPGR NEXPBE NEXPGA DE =',3(I2,2X),F8.5)
NEXPGR=5
NEXBE=2
NEXPGA=5
SUMGR=0.
SUMBE=0.
SUMGA=0.
DE2=DE**2
DO 1 I=1,NEXPGR
SUMGR=SUMGR+EXPGR(I)*DE2*(AN1(I)/AN0(I)-AN1(1)/AN0(1))
1 CONTINUE
DO 2 I=1,NEXPBE
IF(I.EQ.1) GO TO 2
SUMBE=SUMBE+EXPBE(I)*DE2*(AN1(I)/AN0(I)-AN1(1)/AN0(1))
2 CONTINUE
DO 3 I=1,NEXPGA
II=I+1
SUMGA=SUMGA+EXPGA(I)*(EGAM1(II)-DE2*AN1(1)/AN0(1))
3 CONTINUE

SU2BE=0.
SU2GA=0.
DO 4 I=1,NEXPBE
IF(I.EQ.1) GO TO 4
SU2BE=SU2BE+EXPBE(I)*2
4 CONTINUE
DO 5 I=1,NEXPGA
SU2GA=SU2GA+EXPGA(I)
5 CONTINUE

```

```

SU3BE=0
DO 6 I=1,NEXPBE
IF (I.EQ.1) GO TO 6
SU3BE=SU3BE+EXPBE(I)*(-0.16*DE2*AN1(I)/AN0(I))
6 CONTINUE
SU4GR=0.
SU4BE=0.
SU4GA=0.

DO 7 I=1,NEXPGR
J=2*I-2

SU4GR=SU4GR+EXPGR(I)*J*(J+1.)
7 CONTINUE
DO 8 I=1,NEXPBE
IF(I.EQ.1) GO TO 8
J=2*I-2
SU4BE=SU4BE+EXPBE(I)*J*(J+1.)
8 CONTINUE
DO 9 I=1,NEXPGA
II=I+1
J=II
SU4GA=SU4GA+EXPGA(I)*J*(J+1.)
9 CONTINUE
B(1)=SUMGR+SUMBE+SUMGA
B(2)=SU2BE+SU2GA
B(3)=SU3BE
B(4)=SU4GR+SU4BE+SU4GA
write(20,1811)(B(I),I=1,4)
1811 format(/,10x,'B(1) B(2) B(3) B(4) =',4(f10.5,2x))
WRITE(20,337)
337 FORMAT(/,1X,'STEP 1 OVER')

S1GR=0.

S1BE=0.

S1GA=0.
DO 10 I=1,NEXPGR
S1GR=S1GR+(DE2*(AN1(I)/AN0(I)-AN1(1)/AN0(1)))**2
10 CONTINUE
DO 11 I=1,NEXPBE
IF(I.EQ.1) GO TO 11
S1BE=S1BE+(DE2*(AN1(I)/AN0(I)-AN1(1)/AN0(1)))**2
11 CONTINUE
DO 12 I=1,NEXPGA
J=I+1
S1GA=S1GA+(EGAM1(J)-DE2*AN1(1)/AN0(1)))**2
12 CONTINUE
A(1,1)=S1GR+S1BE+S1GA

```

```

write(20,1812)S1GR,S1BE,S1GA,A(1,1)
1812 format(/,10x,'S1GR S1BE S1GA A(1,1) =',4(f10.5,2x))

WRITE(20,338)

338  FORMAT(/,1X,'STEP 2 OVER')
      SU2GR=0.
      SU2BE=0.
      SU2GA=0.
      DO 13 I=1,NEXPBE
      IF(I.EQ.1) GO TO 13
      SU2BE=SU2BE+2*DE2*(AN1(I)/AN0(I)-AN1(1)/AN0(1))
13  CONTINUE
      DO 14 I=1,NEXPGA
      J=I+1
      SU2GA=SU2GA+(EGAM1(J)-DE2*AN1(1)/AN0(1))
14  CONTINUE
      A(1,2)=SU2GR+SU2BE+SU2GA
      write(20,1813)SU2GR,SU2BE,SU2GA,A(1,2)
1813 format(/,10x,'SU2GR SU2BE SU2GA A(1,2) =',4(f10.5,2x))
      WRITE(20,39)
39  FORMAT(/,1X,'STEP 3 OVER')
      SU3BE=0.0
      DO 15 I=1,NEXPBE
      IF(I.EQ.1) GO TO 15
      SU3BE=SU3BE-0.16*(DE2*AN1(I)/AN0(I))*
&(DE2*AN1(I)/AN0(I)-DE2*AN1(1)/AN0(1))
15  CONTINUE
      A(1,3)=SU3BE
      write(20,1815)SU3BE,A(1,3)
1815 format(/,10x,'SU3BE A(1,3) =',2(f10.5,2x))
      SU4GR=0.
      SU4BE=0.
      SU4GA=0.
      DO 16 I=1,NEXPGR

      J=2*I-2
      SU4GR=SU4GR+J*(J+1.)*DE2*
&(AN1(I)/AN0(I)-AN1(1)/AN0(1))
16  CONTINUE
      DO 17 I=1,NEXPBE
      IF(I.EQ.1) GO TO 17
      J=2*I-2
      SU4BE=SU4BE+J*(J+1.)*DE2*(AN1(I)/AN0(I)-AN1(1)/AN0(1))
17  CONTINUE
      DO 18 I=1,NEXPGA
      J=I+1
      SU4GA=SU4GA+J*(J+1.)*(EGAM1(J)-DE2*AN1(1)/AN0(1))
18  CONTINUE

```

```

A(1,4)=SU4GR+SU4BE+SU4GA
write(20,1816)SU4GR,SU4BE,SU4GA,A(1,4)
1816 format(/,10x,'SU4GR SU4BE SU4GA A(1,4) =',4(f10.5,2x))
WRITE(20,400)
400  FORMAT(/,1X,'STEP 4 OVER')
S2GR=0.
S2BE=0.
S2GA=0.
DO 19 I=1,NEXPBE
IF(I.EQ.1) GO TO 19
S2BE=S2BE+2.*DE2*(AN1(I)/AN0(I)-AN1(1)/AN0(1))
19  CONTINUE
DO 20 I=1,NEXPGA
J=I+1
S2GA=S2GA+(EGAM1(J)-DE2*AN1(1)/AN0(1))
20  CONTINUE
A(2,1)=S2GR+S2BE+S2GA
write(20,1817)S2GR,S2BE,S2GA,A(2,1)
1817 format(/,10x,'S2GR S2BE S2GA A(2,1) =',4(f10.5,2x))
WRITE(20,441)
441  FORMAT(/,1X,'STEP 5 OVER')
S22GR=0.
S22BE=0.
S22GA=0.
S22BE=4.
DO 21 I=1,NEXPBE
IF(I.EQ.1)GO TO 21
S22BE=S22BE+4.
21  CONTINUE
DO 22 I=1,NEXPGA
J=I+1
S22GA=S22GA+1.
22  CONTINUE
C    S22GA=5.
A(2,2)=S22GR+S22BE+S22GA
write(20,1818)S22GR,S22BE,S22GA,A(2,2)
1818 format(/,10x,'S22GR S22BE S22GA A(2,2) =',4(f10.5,2x))
WRITE(20,442)
442  FORMAT(/,1X,'STEP 6 OVER')
S23GR=0.
S23BE=0.
S23GA=0.
DO 23 I=1,NEXPBE
IF(I.EQ.1) GO TO 23
S23BE=S23BE-0.32*DE2*AN1(I)/AN0(I)
23  CONTINUE
A(2,3)=S23GR+S23BE+S23GA
write(20,1819)S23GR,S23BE,S23GA,A(2,3)
1819 format(/,10x,'S23GR S23BE S23GA A(2,3) =',4(f10.5,2x))
WRITE(20,43)

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43  FORMAT(/,1X,'STEP 7 OVER')
    S24GR=0.
    S24BE=0.
    S24GA=0.
    DO 24 I=1,NEXPBE
    IF(I.EQ.1) GO TO 24
    J=2*I-2
    S24BE=S24BE+2.*J*(J+1.)
24  CONTINUE
    DO 25 I=1,NEXPGA
    J=I+1
    S24GA=S24GA+J*(J+1.)
25  CONTINUE
    A(2,4)=S24GR+S24BE+S24GA
    write(20,1820)S24GR,S24BE,S24GA,A(2,4)
1820 format(/,10x,'S24GR S24BE S24GA A(2,4) =',4(f10.5,2x))
    WRITE(20,44)
44  FORMAT(/,1X,'STEP 8 OVER')
    S31GR=0.
    S31BE=0.
    S31GA=0.
    DO 26 I=1,NEXPBE
    IF(I.EQ.1) GO TO 26
    J=2*I-2
    S31BE=S31BE-0.16*(DE2*AN1(I)/AN0(I))*
&(DE2*AN1(I)/AN0(I)-DE2*AN1(1)/AN0(1))
26  CONTINUE
    A(3,1)=S31GR+S31BE+S31GA
    write(20,1821)S31GR,S31BE,S31GA,A(3,1)
1821 format(/,10x,'S31GR S31BE S31GA A(3,1) =',4(f10.5,2x))
    WRITE(20,45)
45  FORMAT(/,1X,'STEP 9 OVER')
    S32GR=0.
    S32BE=0.
    S32GA=0.
    DO 27 I=1,NEXPBE
    J=2*I-2
    IF(I.EQ.1) GO TO 27
    S32BE=S32BE-0.32*DE2*AN1(I)/AN0(I)
27  CONTINUE
    A(3,2)=S32GR+S32BE+S32GA
    write(20,1822)S32GR,S32BE,S32GA,A(3,2)
1822 format(/,10x,'S32GR S32BE S32GA A(3,2) =',4(f10.5,2x))
    WRITE(20,46)
46  FORMAT(/,1X,'STEP 10 OVER')
    S33GR=0.
    S33BE=0.
    S33GA=0.
    DO 28 I=1,NEXPBE
    IF(I.EQ.1) GO TO 28

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```

      J=2*I-2
      S33BE=S33BE+(-0.16*DE2*AN1(I)/AN0(I))**2
28  CONTINUE
      A(3,3)=S33GR+S33BE+S33GA
      write(20,1823)S33GR,S33BE,S33GA,A(3,3)
1823 format(/,10x,'S33GR S33BE S33GA A(3,3) =',4(f10.5,2x))
      WRITE(20,47)
47  FORMAT(/,1X,'STEP 11 OVER')
      S34GR=0.
      S34BE=0.
      S34GA=0.
      DO 29 I=1,NEXPBE
      IF(I.EQ.1) GO TO 29
      J=2*I-2
      S34BE=S34BE+J*(J+1.)*(-0.16*DE2*AN1(I)/AN0(I))
29  CONTINUE
      A(3,4)=S34GR+S34BE+S34GA
      write(20,1824)S34GR,S34BE,S34GA,A(3,4)
1824 format(/,10x,'S34GR S34BE S34GA A(3,4) =',4(f10.5,2x))
      WRITE(20,48)
48  FORMAT(/,1X,'STEP 12 OVER')
      S41GR=0.
      S41BE=0.
      S41GA=0.
      DO 30 I=1,NEXPGR
      J=2*I-2
      S41GR=S41GR+J*(J+1.)*DE2*
&(AN1(I)/AN0(I)-AN1(1)/AN0(1))
30  CONTINUE
      DO 31 I=1,NEXPBE
      IF(I.EQ.1) GO TO 31
      J=2*I-2
      S41BE=S41BE+J*(J+1.)*DE2*
&(AN1(I)/AN0(I)-AN1(1)/AN0(1))
31  CONTINUE
      DO 32 I=1,NEXPGA
      J=I+1
      S41GA=S41GA+J*(J+1.)*(EGAM1(J)-DE2*AN1(1)/AN0(1))
32  CONTINUE
      A(4,1)=S41GR+S41BE+S41GA
      write(20,1825)S41GR,S41BE,S41GA,A(4,1)
1825 format(/,10x,'S41GR S41BE S41GA A(4,1) =',4(f10.5,2x))
      S42GR=0.
      S42BE=0.
      S42GA=0.
      DO 33 I=1,NEXPBE
      IF(I.EQ.1) GO TO 33
      J=2*I-2
      S42BE=S42BE+2.*J*(J+1.)
33  CONTINUE

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```

DO 34 I=1,NEXPGA
  J=I+1
  S42GA=S42GA+J*(J+1.)
34 CONTINUE
  A(4,2)=S42GR+S42BE+S42GA
  write(20,1826)S42GR,S42BE,S42GA,A(4,2)
1826 format(/,10x,'S42GR S42BE S42GA A(4,2) =',4(f10.5,2x))
  S43GR=0.
  S43BE=0.
  S43GA=0.
  DO 35 I=1,NEXPBE
  IF(I.EQ.1) GO TO 35
  J=2*I-2
  S43BE=S43BE-J*(J+1.)*0.16*DE2*AN1(I)/AN0(I)
35 CONTINUE
  A(4,3)=S43GR+S43BE+S43GA
C   write(20,1827)S43GR,S43BE,S43GA,A(4,3)
1827 format(/,10x,'S43GR S43BE S43GA A(4,3) =',4(f10.5,2x))
  S44GR=0.
  S44BE=0.
  S44GA=0.
  DO 36 I=1,NEXPGR
  J=2*I-2
  S44GR=S44GR+(J*(J+1.))**2
36 CONTINUE
  DO 37 I=1,NEXPBE
  IF(I.EQ.1) GO TO 37
  J=2*I-2
  S44BE=S44BE+(J*(J+1.))**2
37 CONTINUE
  DO 38 I=1,NEXPGA
  J=I+1
  S44GA=S44GA+(J*(J+1.))**2
38 CONTINUE
  A(4,4)=S44GR+S44BE+S44GA
  write(20,1828)S44GR,S44BE,S44GA,A(4,4)
1828 format(/,10x,'S44GR S44BE S44GA A(4,4) =',4(f15.5,2x))
  WRITE(20,49)
49  FORMAT(/,1X,'STEP 13 OVER')
  CALL GAUSS(4,A,B,X,IND)
  AAA1=X(1)
  AAA2=X(2)
  AAA3=X(3)
  AAA4=X(4)
  write(20,1861)aaa1,aaa2,aaa3,aaa4,de,IND
1861 FORMAT(/,2X,'AAA1 AAA2 AAA3 AAA4, IND =', 5(F10.5,2X),I2)
  DO 40 I=1,11
  J=2*I-2
  ENERG1(I)=AAA1*DE2*(AN1(I)/AN0(I)-AN1(1)/AN0(1))+AAA4*J*(J+1.)
40 CONTINUE

```

```

WRITE(20,1862)(ENERG1(I),I=1,11)
1862 FORMAT(/,10X,'GR BAND ENERGIES =',5(F10.5,2X))
DO 41 I=1,11
J=2*I-2
ENERG2(I)=AAA1*DE2*(AN1(I)/AN0(I)-AN1(1)/AN0(1))+2.*AAA2-
&0.16*AAA3*DE2*AN1(I)/AN0(I)+AAA4*J*(J+1.)
41 CONTINUE
WRITE(20,1863)(ENERG2(I),I=1,11)
1863 FORMAT(/,10X,'BETA BAND ENERGIES =',5(F10.5,2X))
DO 42 I=1,19
J=I+1
ENERG3(J)=AAA1*(EGAM1(J)-DE2*AN1(1)/AN0(1))+AAA2+AAA4*J*(J+1.)
42 CONTINUE
WRITE(20,1864)(ENERG3(I),I=2,20)

1864 FORMAT(/,10X,'GAMMA BAND ENERGIES =',5(F10.5,2X))
RETURN
END

```

```

subroutine gauss(n,a,b,x,ind)
c
c solve a system of linear equations using Gauss method
c
c n : order of the matrix
c a : matrix of the coefficients
c b : free terms vector
c x : solution vector
c ind = 0 : compatible system
c
c 1 : incompatible system
c
c implicit double precision (a-h,o-z)

double precision A,B,X
DIMENSION A(n,n),B(n),X(n)
ind=0
im=n-1
do 1 i=1,im
m1=i
do 2 m2=i,n
if(abs(a(m1,i)).lt.abs(a(m2,i))) m1=m2
2 continue
if(a(m1,i).eq.0) ind=1

if(a(m1,i).eq.0) go to 90

```

```

    if(m1.eq.i) go to 25
    do 3 j=1,n
      y=a(i,j)
      a(i,j)=a(m1,j)

      a(m1,j)=y
3    continue
    y=b(i)

    b(i)=b(m1)

    b(m1)=y

25  y=a(i,i)
    if(y.eq.0) ind=1
    if(y.eq.0) go to 90
    do 4 j=i,n
      a(i,j)=a(i,j)/y
4    continue
    b(i)=b(i)/y
    jm=i+1
    do 5 j=jm,n
      if(a(j,i).eq.0) go to 40
      y=a(j,i)

      do 6 k=i,n
        a(j,k)=a(j,k)-a(i,k)*y

6      continue
      b(j)=b(j)-b(i)*y
40     continue
5     continue
1     continue
    if(a(n,n).eq.0) ind=1
    if(a(n,n).eq.0) go to 90
    x(n)=b(n)/a(n,n)
    nm=n-1
    do 7 i=1,nm
      x(n-i)=b(n-i)
      do 8 k=1,i
        x(n-i)=x(n-i)-a(n-i,n-i+k)*x(n-i+k)
8      continue
7     continue
90    continue
    return

```

end