```
*==> fap.f <==
      FUNCTION FAP(I,II,J,S,A1,A2,A3,YT,YB,YL,G1,G2,G3,AMU,HM3
     #,AT,AB,AL,Q3,Q2,Q1
     #,U3,U2,U1,D3,D2,D1,SL3,SL2,SL1,E3,E2,E1,HM1,HM2,VS1,VS2)
      IMPLICIT DOUBLE PRECISION (A-H, O-Z)
      PARAMETER(LO=10)
      COMMON/SCALE/AMGUT,SUSY,AMZ,AMW
C----------------------------------------------------
C  Unused Commons
C     COMMON/TTT/TIN,TFIN
C     COMMON/YYY/Y(33)
C     COMMON/APAR/VIMA
C     COMMON/NIT/AGUT,AMOO,AMO,AM1,AM2,AM3,AO
C----------------------------------------------------
C   S = parameter t defined as 2log(Mgut/m)
C----------------------------------------------------
      V=(AMGUT**2)*DEXP(-S)
      AG1=G1**2
      AG2=G2**2
      AG3=G3**2
      UM=AMU**2
      AAT=AT**2
      AAB=AB**2
      AAL=AL**2
C------------------------------------------------
C The thresholds ofthe various particles below
C------------------------------------------------
      LH=I
      LHX=II
C----------------------------------------------------------
C     Below the thetas relevant to MASSES
C     LH=1 no thresholds , LH=2 yes to thresholds
C----------------------------------------------------------
      TG1=T(LH,AG1,V)
      TG2=T(LH,AG2,V)
      TG3=T(LH,AG3,V)
      TH1=T(LH,HM1,V)
      TH2=T(LH,HM2,V)
      TN1=T(LH,UM,V)
      TN2=T(LH,UM,V)
      TQ3=T(LH,Q3,V)
      TQ2=T(LH,Q2,V)
      TQ1=T(LH,Q1,V)
      TU3=T(LH,U3,V)
      TU2=T(LH,U2,V)
      TU1=T(LH,U1,V)
      TD3=T(LH,D3,V)
      TD2=T(LH,D2,V)
      TD1=T(LH,D1,V)
      TL3=T(LH,SL3,V)
      TL2=T(LH,SL2,V)
      TL1=T(LH,SL1,V)
      TE3=T(LH,E3,V)
      TE2=T(LH,E2,V)
      TE1=T(LH,E1,V)
C------------------------------------------------------
C   Below the thetas relevant to GAUGE couplings
C   LHX=1 no thresholds , LHX=2 yes to thresholds
C------------------------------------------------------
      TG1X=T(LHX,AG1,V)
      TG2X=T(LHX,AG2,V)
      TG3X=T(LHX,AG3,V)
```



```
      TH1X=T(LHX,HM1,V)
      TH2X=T(LHX,HM2,V)
      TN1X=T(LHX,UM,V)
      TN2X=T(LHX,UM,V)
      TQ3X=T(LHX,Q3,V)
      TQ2X=T(LHX,Q2,V)
      TQ1X=T(LHX,Q1,V)
      TU3X=T(LHX,U3,V)
      TU2X=T(LHX,U2,V)
      TU1X=T(LHX,U1,V)
      TD3X=T(LHX,D3,V)
      TD2X=T(LHX,D2,V)
      TD1X=T(LHX,D1,V)
      TL3X=T(LHX,SL3,V)
      TL2X=T(LHX,SL2,V)
      TL1X=T(LHX,SL1,V)
      TE3X=T(LHX,E3,V)
      TE2X=T(LHX,E2,V)
      TE1X=T(LHX,E1,V)
C----------------------------------------------------
C  Below the thetas relevant to YUKAWA couplings
C----------------------------------------------------
      PHX=DBLE(LHX-1)
      DHX=DBLE(2-LHX)
CC
      TG1Y=PHX*TG1X+DHX*TG1
      TG2Y=PHX*TG2X+DHX*TG2
      TG3Y=PHX*TG3X+DHX*TG3
      TH1Y=PHX*TH1X+DHX*TH1
      TH2Y=PHX*TH2X+DHX*TH2
      TN1Y=PHX*TN1X+DHX*TN1
      TN2Y=PHX*TN2X+DHX*TN2
      TQ1Y=PHX*TQ1X+DHX*TQ1
      TQ2Y=PHX*TQ2X+DHX*TQ2
      TQ3Y=PHX*TQ3X+DHX*TQ3
      TU1Y=PHX*TU1X+DHX*TU1
      TU2Y=PHX*TU2X+DHX*TU2
      TU3Y=PHX*TU3X+DHX*TU3
      TD1Y=PHX*TD1X+DHX*TD1
      TD2Y=PHX*TD2X+DHX*TD2
      TD3Y=PHX*TD3X+DHX*TD3
      TL1Y=PHX*TL1X+DHX*TL1
      TL2Y=PHX*TL2X+DHX*TL2
      TL3Y=PHX*TL3X+DHX*TL3
      TE1Y=PHX*TE1X+DHX*TE1
      TE2Y=PHX*TE2X+DHX*TE2
      TE3Y=PHX*TE3X+DHX*TE3
C -----------------------------------------------------------------
C
C  The possible combinations of the switches are as follows :
C
C
C [ I=1 , II=1 ]   corresponding to   LH=1 , LHX=1 :
C
C   TG1=T(1,...)   etc -----> No thresholds to masses + No freeze out
C   TG1X=T(1,...)  etc -----> No thresholds to gauge
C   TG1Y=T(1,...)  etc -----> No thresholds to Yukawas
C
C
C [ I=1 , II=2 ]   corresponding to   LH=1 , LHX=2 :
C
C   TG1=T(1,...)  etc -----> No thresholds to masses + Yes to freeze out
```

```
C   TG1X=T(2,...)  etc -----> Yes  to gauge
C   TG1Y=T(2,...)  etc -----> Yes to Yukawas
C
C
C [ I=2 , II=2 ]   corresponding to   LH=2 , LHX=2 :
C
C   TG1=T(2,...)   etc -----> Yes to masses + Yes to freeze out
C   TG1X=T(2,...)  etc -----> Yes  to gauge
C   TG1Y=T(2,...)  etc -----> Yes to Yukawas
C
C
C [ I=2 , II=1 ]   corresponding to   LH=2 , LHX=1 :
C
C   TG1=T(2,...)   etc -----> Yes to masses + Yes to freeze out
C   TG1X=T(1,...)  etc -----> No  to gauge
C   TG1Y=T(2,...)  etc -----> Yes to Yukawas
C   If we use TG1X instead of TG1Y bellow ---> No Thres.to Yukawas
C   Actually, in the version> susy5b we use pole masses for the
C   quarks and leptons and we set TG1X on the formulae for the
C   Yukawa thresholds below.
C ---------------------------------------------------------------
CC
C----------------------------------
C    # of generations
C----------------------------------
      XGEN=3.D0
CC
      SERUT=(279.D0/800.D0+XGEN*1803.D0/1600.D0)*(A1**2)+
     #(207.D0/32.D0+XGEN*357.D0/64.D0)*(A2**2)+
     #(27.D0/80.D0+XGEN*9.D0/80.D0)*A1*A2
CC
      SOMM=Q1*TQ1+Q2*TQ2+Q3*TQ3+(D1*TD1+D2*TD2+D3*TD3)-
     #2.D0*(U1*TU1+U2*TU2+U3*TU3)-(SL1*TL1+SL2*TL2+SL3*TL3)+
     #(E1*TE1+E2*TE2+E3*TE3)-HM1*TH1+HM2*TH2
CC
      SSMM=(3.D0/5.D0)*A1*SOMM
CC
      SPMM=-(3.D0*(HM2-UM)+Q3)*YT+4.D0*YT*U3+
     #(3.D0*(HM1-UM)-Q3)*YB-2.D0*YB*D3+((HM1-UM)+SL3)*YL-
     #2.D0*YL*E3+(3.D0*A2/2.D0+3.D0*A1/10.D0)*
     #(HM2-HM1-SL1-SL2-SL3)+(8.D0*A3/3.D0+3.D0*A2/2.D0+
     #1.D0*A1/30.D0)*(Q1+Q2+Q3)-(16.D0*A3/3.D0+16.D0*A1/15.D0)
     #*(U1+U2+U3)+(8.D0*A3/3.D0+2.D0*A1/15.D0)*(D1+D2+D3)
     #+6.D0*A1*(E1+E2+E3)/5.D0
CC
      SPMM1=A1*(3.D0*(HM1+HM2-2.D0*UM)+
     #Q1+Q2+Q3+3.D0*(SL1+SL2+SL3)+8.D0*(U1+U2+U3)+
     #2.D0*(D1+D2+D3)+6.D0*(E1+E2+E3))/5.D0
CC
      SPMM2=A2*(HM1+HM2-2.D0*UM+3.D0*(Q1+Q2+Q3)+
     #SL1+SL2+SL3)
CC
      SPMM3=A3*(2.D0*(Q1+Q2+Q3)+(U1+U2+U3)+(D1+D2+D3))
      SM1=HM1-UM
      SM2=HM2-UM
C-------------------------------------------------------------
C Yukawa Thresholds
C If we use TG1X all T11,T22,.... are equal to 1(No thresholds)
C If we use TG1Y --->yes thresholds at yukawas
C
C  Thresholds functions for the top yukawa
C-------------------------------------------------------------
```



```
       T33=(6.D0-TG3X*(TQ3X+TU3X))/4.D0
       T32=(1.D0/4.D0)*(-1.D0+4.D0*TH2X-2.D0*TN2X*TG2X-TQ3X*TG2X
      #+4.D0*TN2X*TQ3X*TG2X)
CC
       T31=(18.D0/13.D0)*(15.D0/72.D0-TG1X*TN2X/4.D0+TH2X/2.D0
      #-TG1X*TQ3X/72.D0-TG1X*TN2X*TQ3X/6.D0-2.D0*TG1X*TU3X/9.D0
      #+2.D0*TG1X*TN2X*TU3X/3.D0)
CC
       T3T=-(-6.D0-3.D0*TH2X-2.D0*TN2X*TQ3X-TN2X*TU3X)/12.D0
       T3B=(TH1X+TN2X*TD3X)/2.D0
C-------------------------------------------------
C  Thresholds functions for the bottom yukawa
C-------------------------------------------------
       T23=(6.D0-TG3X*(TQ3X+TD3X))/4.D0
       T22=(1.D0/4.D0)*(-1.D0+4.D0*TH1X-2.D0*TN1X*TG2X-TQ3X*TG2X
      #+4.D0*TN1X*TQ3X*TG2X)
CC
       T21=(-18.D0/7.D0)*(7.D0/24.D0+TG1X*TD3X/18.D0+TG1X*TN1X/4.D0
      #-TG1X*TD3X*TN1X/3.D0-TH1X/2.D0+TG1X*TQ3X/72.D0-
      #TG1X*TN1X*TQ3X/6.D0)
CC
       T2T=(TH2X+TN2X*TU3X)/2.D0
       T2B=(6.D0+TD3X*TN1X+3.D0*TH1X+2.D0*TQ3X*TN1X)/12.D0
       T2L=1.D0
C------------------------------------------------
C  Thresholds functions for the lepton yukawa
C------------------------------------------------
       T12=(1.D0/4.D0)*(-1.D0+4.D0*TH1X-2.D0*TN1X*TG2X-TL3X*TG2X
      #+4.D0*TN1X*TL3X*TG2X)
CC
       T11=-(-11.D0+4.D0*TG1X*TE3X+2.D0*TG1X*TN1X-8.D0*TG1X*TE3X*TN1X
      #-4.D0*TH1X+TG1X*TL3X+4.D0*TG1X*TL3X*TN1X)/12.D0
CC
       T1L=(2.D0+TE3X*TN1X+3.D0*TH1X+2.D0*TN1X*TL3X)/8.D0
       T1B=1.D0
C----------------------------------------
C  Thresholds for the Gaugino masses
C----------------------------------------
       XV3=3.D0*TG3-(2.D0*(TQ1+TQ2+TQ3)+TU1+TU2+TU3+TD1+TD2+TD3)/6.D0
       XV2=-6.D0*TG2+(TH1*TN1+TH2*TN2)/2.D0+3.D0*(TQ1+TQ2+TQ3)/2.D0+
      #(TL1+TL2+TL3)/2.D0
CC
       XV1=((TQ1+TQ2+TQ3)/6.D0+(TU1+TU2+TU3)*(4.D0/3.D0)+
      #(TD1+TD2+TD3)/3.D0+(TL1+TL2+TL3)/2.D0+(TE1+TE2+TE3)+
      #(TH1*TN1+TH2*TN2)/2.D0)/11.D0
C-------------------------------------
C  Thresholds for the Beta parameter
C-------------------------------------
       TB2=TN1+TN2+TH1*TG2+TH2*TG2+4.D0*TH1*TH2-2.D0*TN1*TG2-
      #2.D0*TN2*TG2+2.D0*(TH1+TH2)-8.D0*TN1*TN2
CC
       TB1=TN1+TN2+TH1*TG2+TH2*TG2+4.D0*TH1*TH2-2.D0*TN1*TG1-
      #2.D0*TN2*TG1+2.D0*(TH1+TH2)-8.D0*TN1*TN2
C---------------------------------------------
C  Thresholds for the trilinear couplings...
C
C  For AT
C---------------------------------------------
       TAT3=4.D0*(6.D0+4.D0*TG3-2.D0*TQ3-TQ3*TG3-2.D0*TU3-TG3*TU3-
      #4.D0*TQ3*TU3)/3.D0
CC
        TAT2=(-3.D0+6.D0*TH2-6.D0*TQ3-12.D0*TQ3*TH2+6.D0*TG2
```

```
     #-3.D0*TQ3*TG2+12.D0*TN2*TQ3*TG2)/4.D0
CC
       TAT1=(15.D0+34.D0*TG1+18.D0*TH2-2.D0*TQ3-TG1*TQ3
     #-12.D0*TG1*TQ3*TN2+12.D0*TH2*TQ3-32.D0*TU3-16.D0*TG1*TU3
     #+48.D0*TG1*TU3*TN2-48.D0*TH2*TU3-16.D0*TQ3*TU3)/60.D0
CC
      TATT=.5D0*(6.D0*TN2-3.D0*TH2-2.D0*TQ3*TN2+8.D0*TQ3*TH2-TU3*TN2
     #+4.D0*TU3*TH2+12.D0*TQ3*TU3)
CC
      TATB=.5D0*(2.D0*TN1-TN1*TD3-TH1)
C----------------
C    For AB
C----------------
       TAB3=4.D0*(6.D0+4.D0*TG3-2.D0*TD3-TD3*TG3-2.D0*TQ3-TG3*TQ3-
     #4.D0*TQ3*TD3)/3.D0
CC
       TAB2=(-3.D0+6.D0*TH1-6.D0*TQ3-12.D0*TQ3*TH1+6.D0*TG2
     #-3.D0*TQ3*TG2+12.D0*TN1*TQ3*TG2)/4.D0
CC
       TAB1=(-21.D0+10.D0*TG1+18.D0*TH1-8.D0*TD3-4.D0*TG1*TD3
     #+24.D0*TG1*TD3*TN1-24.D0*TH1*TD3-2.D0*TQ3-TG1*TQ3
     #+12.D0*TG1*TQ3*TN1-12.D0*TH1*TQ3+8.D0*TQ3*TD3)/60.D0
CC
      TABB=.5D0*(6.D0*TN1-3.D0*TH1-TD3*TN1+8.D0*TQ3*TH1-2.D0*TQ3*TN1
     #+4.D0*TD3*TH1+12.D0*TQ3*TD3)
CC
      TABT=.5D0*(2.D0*TN2-TN2*TU3-TH2)
C-----------------
C    For AL
C-----------------
      TAL1=(3.D0/20.D0)*(11.D0+10.D0*TG1-8.D0*TE3-4.D0*TG1*TE3+
     #8.D0*TG1*TE3*TN1+2.D0*TH1-8.D0*TE3*TH1-2.D0*TL3-TG1*TL3
     #-8.D0*TE3*TL3-4.D0*TG1*TN1*TL3+4.D0*TH1*TL3)
CC
      TAL2=(-3.D0+6.D0*TH1-6.D0*TL3-12.D0*TH1*TL3+6.D0*TG2-
     #3.D0*TL3*TG2+12.D0*TN1*TL3*TG2)/4.D0
CC
      TALL=.5D0*(6.D0*TN1-TN1*TE3-3.D0*TH1+4.D0*TH1*TE3+4.D0*TE3*TL3
     #-2.D0*TN1*TL3+8.D0*TH1*TL3)
CC
CC
CC
      RGEMU=(1.5D0*A2*(8.D0*TN1*TN2-TN1-TN2-TH1*TG2-TH2*TG2)/4.D0+
     #(3.D0/10.D0)*A1*(8.D0*TN1*TN2-TN1-TN2-TH1*TG1-TH2*TG1)/4.D0-
     #1.5D0*YB*(TQ3+TD3)/2.D0-1.5D0*YT*(TQ3+TU3)/2.D0-
     #.5D0*YL*(TL3+TE3)/2.D0)*AMU+
     #(.5D0*AMU*(3.D0*(3.D0*(YT**2)+3.D0*(YB**2)
     #+2.D0*YB*YT+(YL**2))-
     #YT*(16.D0*A3+4.D0*A1/5.D0)-YB*(16.D0*A3-2.D0*A1/5.D0)-
     #6.D0*A1*YL/5.D0-15.D0*(A2**2)/2.D0-9.D0*A1*A2/5.D0-
     #207.D0*(A1**2)/50))
CC
C-------------------------------------------------
C  J=1  for A1=(g1/4Pi)**2  , dA1/dt=F(1,...)
C-------------------------------------------------
      IF(J.EQ.1) THEN
      FAP=-(1.D0/5.D0)*(A1**2.D0)*(20.D0+(TN1X+TN2X)+(TH1X+TH2X)/2.D0+
     #(TL1X+TL2X+TL3X)/2.D0+(TE1X+TE2X+TE3X)+(TQ1X+TQ2X+TQ3X)/6.D0+
     #4.D0*(TU1X+TU2X+TU3X)/3.D0+(TD1X+TD2X+TD3X)/3.D0)-
     #(A1**2.D0)*HET(1,V)-
     #(A1**2.D0)*(199.D0*A1/25.D0+27.D0*A2/5.D0+
     #88.D0*A3/5.D0-26.D0*YT/5.D0-
```



```
     #14.D0*YB/5.D0-18.D0*YL/5.D0)
C-------------------------------------------------
C  J=2  for A2=(g2/4Pi)**2  , dA2/dt=F(2,...)
C-------------------------------------------------
      ELSE IF(J.EQ.2) THEN
      FAP=-(A2**2.D0)*(-10.D0/3.D0+4.D0*TG2X/3.D0+(TN1X+TN2X)/3.D0+
     #(TH1X+TH2X)/6.D0 +(TQ1X+TQ2X+TQ3X)/2.D0+(TL1X+TL2X+TL3X)/6.D0)-
     #(A2**2.D0)*HET(2,V)-
     #(A2**2.D0)*(9.D0*A1/5.D0+25.D0*A2+24.D0*A3-
     #6.D0*YT-6.D0*YB-2.D0*YL)
C-------------------------------------------------
C  J=3  for A3=(g3/4Pi)**2  , dA3/dt=F(3,...)
C-------------------------------------------------
      ELSE IF(J.EQ.3) THEN
      FAP=3.D0*(A3**2.D0)*(7.D0/3.D0-
     #2.D0*TG3X/3.D0-(TQ1X+TQ2X+TQ3X)/9.D0
     #-(TD1X+TD2X+TD3X)/18.D0-(TU1X+TU2X+TU3X)/18.D0)-
     #(A3**2.D0)*HET(3,V)-
     #(A3**2.D0)*(11.D0*A1/5.D0+9.D0*A2+14.D0*A3-
     #4.D0*YT-4.D0*YB)
C-------------------------------------------------
C  J=4  for Yt=(ht/4Pi)**2  , dYt/dt=F(4,...)
C-------------------------------------------------
      ELSE IF(J.EQ.4) THEN
      FAP=(16.D0*A3*T33/3.D0+3.D0*A2*T32+13.D0*A1*T31/15.D0
     #-YB*T3B-6.D0*YT*T3T)*YT+
     #YT*(22.D0*(YT**2)+5.D0*(YB**2)+5.D0*YB*YT+YB*YL-
     #YT*(16.D0*A3+6.D0*A2+6.D0*A1/5.D0)-2.D0*A1*YB/5.D0+
     #16.D0*(A3**2)/9.D0-8.D0*A3*A2-136.D0*A3*A1/45.D0-
     #15.D0*(A2**2)/2.D0-A2*A1-2743.D0*(A1**2)/450.D0)
C-------------------------------------------------
C  J=5  for Yb=(hb/4Pi)**2  , dYb/dt=F(5,...)
C-------------------------------------------------
      ELSE IF(J.EQ.5) THEN
      FAP=(16.D0*A3*T23/3.D0+3.D0*A2*T22+7.D0*A1*T21/15.D0
     #-6.D0*YB*T2B-YT*T2T-YL)*YB+
     #YB*(22.D0*(YB**2)+5.D0*(YT**2)+3.D0*(YL**2)+
     #5.D0*YB*YT+3.D0*YB*YL-YB*(16.D0*A3+2.D0*A1/5.D0+
     #6.D0*A2)-6.D0*A1*YL/5.D0-4.D0*A1*YT/5.D0+
     #16.D0*(A3**2)/9.D0-8.D0*A3*A2-8.D0*A3*A1/9.D0-
     #15.D0*(A2**2)/2.D0-A2*A1-287.D0*(A1**2)/90.D0)
C-------------------------------------------------
C  J=6  for YL=(hL/4Pi)**2  , dYL/dt=F(6,...)
C-------------------------------------------------
      ELSE IF(J.EQ.6) THEN
      FAP=(3.D0*A2*T12+9.D0*A1*T11/5.D0-3.D0*YB*T1B-4.D0*YL*T1L)*YL
     #+YL*(10.D0*(YL**2)+9.D0*(YB**2)+3.D0*YT*YB+9.D0*YL*YB-
     #YB*(16.D0*A3-2.D0*A1/5.D0)-(6.D0*A1/5.D0+6.D0*A2)*YL-
     #15.D0*(A2**2)/2.D0-9.D0*A2*A1/5.D0-27.D0*(A1**2)/2.D0)
C-----------------------------------------------------------------
C  J=7,8,9  gaugino masses M1,M2,M3 which we denote by G1,G2,G3.
C  In the following we define F(7,..),F(8,...),F(9,...) such that
C  dM1/dt=F(7,...)  , dM2/dt=F(8,...) , dM3/dt=F(9,...)
C-----------------------------------------------------------------
      ELSE IF(J.EQ.7) THEN
      FAP=-(33.D0/5.D0)*A1*G1*XV1*TG1Y-
     #A1*(199.D0*A1*2.D0*G1/25.D0+27.D0*A2*(G1+G2)/5.D0+
     #88.D0*A3*(G1+G3)/5.D0)+A1*(26.D0*(AT*YT+G1*YT)/5.D0+14.D0*
     #(AB*YB+G1*YB)/5.D0+18.D0*(AL*YL+G1*YL)/5.D0)*TG1Y
CC
      ELSE IF(J.EQ.8) THEN
      FAP=-A2*G2*XV2*TG2Y-
```

```
     #A2*(9.D0*A1*(G2+G1)/5.D0+25.D0*A2*2.D0*G2+24.D0*A3*(G2+G3))
     #+A2*(6.D0*(AT*YT+G2*YT)+6.D0*(AB*YB+G2*YB)+2.D0*
     #(AL*YL+G2*YL))*TG2Y
CC
      ELSE IF(J.EQ.9) THEN
      FAP=3.D0*A3*G3*XV3*TG3Y-
     #A3*(11.D0*A1*(G1+G3)/5.D0+9.D0*A2*(G2+G3)+14.D0*A3*2.D0*G3)
     #+A3*(4.D0*(AT*YT+G3*YT)+4.D0*(AB*YB+G3*YB))*TG3Y
C-----------------------------------------------------------------
C  The Higgsino and Higgs mixing parameters below, J=10 for "mu"
C  and J=11 for "m3^2"
C-----------------------------------------------------------------
      ELSE IF(J.EQ.10) THEN
      FAP=TN1Y*TN2Y*RGEMU
CC
      ELSE IF(J.EQ.11) THEN
      FAP=TH1Y*TH2Y*((HM3*(1.5D0*A2*(TH1+TH2-(TN1+TN2)*TG2
     #+2.D0*TH1*TH2)/2.D0
     #+(3.D0/10.D0)*A1*(TH1+TH2-(TN1+TN2)*TG1+2.D0*TH1*TH2)/2.D0
     #-1.5D0*YT-1.5D0*YB-.5D0*YL)
     #+3.D0*A2*AMU*G2*TG2*TN1*TN2+(3.D0/5.D0)*A1*AMU*G1*TG1*TN1*TN2
     #-AMU*(3.D0*AT*YT*TQ3*TU3+3.D0*AB*YB*TQ3*TD3+AL*YL*TL3*TE3))
     #-(.5D0*HM3*(-9.D0*(YT**2)-9.D0*(YB**2)-6.D0*YB*YT-
     #3.D0*(YL**2)+(16.D0*A3+4.D0*A1/5.D0)*YT+
     #(16.D0*A3-2.D0*A1/5.D0)*YB
     #+6.D0*A1*YL/5.D0+15.D0*(A2**2)/2.D0+
     #9.D0*A1*A2/5.D0+207.D0*(A1**2)/50.D0)+
     #.5D0*AMU*(-36.D0*AT*(YT**2)-36.D0*AB*(YB**2)-
     #12.D0*AT*YT*YB-12.D0*AB*YT*YB-12.D0*AL*(YL**2)+
     #AT*YT*(32.D0*A3+8.D0*A1/5.D0)+AB*YB*(32.D0*A3-4.D0*A1/5.D0)
     #+12.D0*A1*AL*YL/5.D0+(32.D0*A3*G3+8.D0*A1*G1/5.D0)*YT+
     #(32.D0*A3*G3-4.D0*A1*G1/5.D0)*YB+12.D0*A1*G1*YL/5.D0+
     #30.D0*(A2**2)*G2+18.D0*A1*A2*(G1+G2)/5.D0+
     #414.D0*(A1**2)*G1/25.D0)))
C-----------------------------------------------------
C  The trilinear couplings... AT,AB,AL  for J=12,13,14
C-----------------------------------------------------
      ELSE IF(J.EQ.12) THEN
      FAP=TH2Y*TQ3Y*TU3Y*((16.D0*A3*G3*TG3/3.D0+
     #(13.D0/15.D0)*A1*G1*
     #(4.D0+9.D0*TN2)*TG1/13.D0+3.D0*A2*G2*TG2*TN2
     #-YB*AB*TH1*TD3-
     #.5D0*AT*(A3*TAT3+A2*TAT2+A1*TAT1+YB*TATB+YT*TATT))-
     #(.5D0*AT*(-30.D0*(YT**2)-5.D0*(YB**2)-7.D0*YB*YT-
     #YL*YB+(16.D0*A3+4.D0*A1/5.D0+12.D0*A2)*YT+
     #2.D0*A1*YB/5.D0-16.D0*(A3**2)/9.D0+8.D0*A3*A2+
     #136.D0*A3*A1/45.D0+15.D0*(A2**2)/2.D0+A2*A1+
     #2743.D0*(A1**2)/450.D0)+
     #.5D0*(-80.D0*AT*(YT**2)-8.D0*AT*YT*YB-10.D0*AB*YB*YT-
     #2.D0*AL*YL*YB-20.D0*AB*(YB**2)-2.D0*AB*YL*YB+
     #AT*YT*(32.D0*A3+14.D0*A1/5.D0+6.D0*A2)+
     #4.D0*A1*AB*YB/5.D0
     #+(32.D0*A3*G3+12.D0*A1*G1/5.D0+12.D0*A2*G2)*YT+
     #4.D0*A1*G1*YB/5.D0-64.D0*(A3**2)*G3/9.D0+
     #16.D0*A3*A2*(G3+G2)+272.D0*A3*A1*(G3+G1)/45.D0+
     #30.D0*(A2**2)*G2+2.D0*A2*A1*(G1+G2)+
     #5486.D0*(A1**2)*G1/225.D0)
     #-AT*(.5D0)*(-22.D0*(YT**2)-5.D0*(YB**2)-5.D0*YB*YT-YB*YL+
     #YT*(16.D0*A3+6.D0*A2+6.D0*A1/5.D0)+2.D0*A1*YB/5.D0-
     #16.D0*(A3**2)/9.D0+8.D0*A3*A2+136.D0*A3*A1/45.D0+
     #15.D0*(A2**2)/2.D0+A2*A1+
     #2743.D0*(A1**2)/450.D0)))
```



```
CC
       ELSE IF(J.EQ.13) THEN
       FAP=TH1Y*TQ3Y*TD3Y*((16.D0*A3*G3*TG3/3.D0+(7.D0/15.D0)*A1*G1*
      #(-4.D0+18.D0*TN1)*TG1/14.D0+3.D0*A2*G2*TG2*TN1-YL*AL*TE3*TL3
      #-YT*AT*TH2*TU3-.5D0*AB*(A3*TAB3+A2*TAB2+A1*TAB1+YB*TABB+YT*TABT))-
      #(.5D0*AB*(-30.D0*(YB**2)-7.D0*YB*YT-3.D0*(YL**2)-5.D0*(YT**2)
      #-5.D0*YB*YL+(16.D0*A3+12.D0*A2+4.D0*A1/5.D0)*YB+
      #6.D0*A1*YL/5.D0+4.D0*A1*YT/5.D0-16.D0*(A3**2)/9.D0+
      #8.D0*A3*A2+8.D0*A3*A1/9.D0+15.D0*(A2**2)/2.D0
      #+A2*A1+287.D0*(A1**2)/90.D0)
      #+.5D0*(-10.D0*AT*YT*YB-8.D0*AB*YB*YT-12*AL*(YL**2)-
      #20*AT*(YT**2)-6.D0*AL*YL*YB-4.D0*AB*YB*YL-80.D0*AB*(YB**2)
      #+(32.D0*A3+2.D0*A1/5.D0+6.D0*A2)*AB*YB+
      #12.D0*A1*AL*YL/5.D0+8.D0*A1*AT*YT/5.D0+
      #(32.D0*A3*G3-4.D0*A1*G1/5.D0)*YB+12.D0*A1*G1*YL/5.D0+
      #(12.D0*A2*G2+8.D0*A1*G1/5.D0)*YB+8.D0*A1*G1*YT/5.D0-
      #64.D0*(A3**2)*G3/9.D0+16.D0*A3*A2*(G3+G2)+
      #16.D0*A3*A1*(G3+G1)/9.D0+30.D0*(A2**2)*G2+
      #2.D0*A2*A1*(G2+G1)+574.D0*(A1**2)*G1/45.D0)-
      #AB*.5D0*(-22.D0*(YB**2)-5.D0*(YT**2)-3.D0*(YL**2)-
      #5.D0*YB*YT-3.D0*YB*YL+YB*(16.D0*A3+2.D0*A1/5.D0+6.D0*A2)
      #+6.D0*A1*YL/5.D0+4.D0*A1*YT/5.D0-16.D0*(A3**2)/9.D0+
      #8.D0*A3*A2+8.D0*A3*A1/9.D0+15.D0*(A2**2)/2.D0+
      #A2*A1+287.D0*(A1**2)/90.D0)))
CC
       ELSE IF(J.EQ.14) THEN
       FAP=TH1Y*TL3Y*TE3Y*(((9.D0/5.D0)*A1*G1*
      #(2.D0+TN1)*TG1/3.D0+3.D0*A2*G2*TG2*TN1
      #-3.D0*YB*AB*TD3*TQ3-.5D0*AL*(A2*TAL2+A1*TAL1+YL*TALL))-
      #(.5D0*AL*(-9.D0*(YB**2)-3.D0*YB*YT-
      #14.D0*(YL**2)-15.D0*YL*YB+(16.D0*A3-2.D0*A1/5.D0)*YB
      #+12.D0*A2*YL+15.D0*(A2**2)/2.D0+9.D0*A1*A2/5.D0
      #+27.D0*(A1**2)/2.D0)+
      #.5D0*(-36.D0*AB*(YB**2)-6.D0*AT*YT*YB
      #-6*AB*YB*YT-36.D0*AL*(YL**2)-12.D0*AL*YL*YB-
      #18.D0*AB*YB*YL+AB*YB*(32.D0*A3-4.D0*A1/5.D0)+
      #AL*YL*(18.D0*A1/5.D0+6.D0*A2)+
      #(32.D0*A3*G2-4.D0*A1*G1/5.D0)*YB+12.D0*A1*G1*YL/5.D0
      #+12.D0*A2*G2*YL+30.D0*(A2**2)*G2+18.D0*A2*A1*(G1+G2)/5.D0
      #+54.D0*(A1**2)*G1)-
      #AL*.5D0*(-10.D0*(YL**2)-9.D0*(YB**2)-3.D0*YT*YB-
      #9.D0*YL*YB+YB*(16.D0*A3-2.D0*A1/5.D0)+
      #(6.D0*A1/5.D0+6.D0*A2)*YL+15.D0*(A2**2)/2.D0+
      #9.D0*A2*A1/5.D0+27.D0*(A1**2)/2.D0)))
C------------------------
C   Masses are below:
C
C   J=15 for mQ3
C------------------------
       ELSE IF(J.EQ.15) THEN
       FAP=TQ3Y*(((8.D0*A3*(TQ3-TG3)/3.D0+3.D0*A2*(TQ3-TG2)/2.D0+
      #A1*(TQ3-TG1)/30.D0)*Q3-SSMM/6.D0
      #+16.D0*A3*AG3*TG3/3.D0+3.D0*A2*AG2*TG2+A1*AG1*TG1/15.D0
      #-YT*(Q3*TN2+U3*TU3+HM2*TH2+AAT*TH2*TU3+
      #UM*(TH1*TU3-2.D0*TN2))
      #-YB*(Q3*TN1+D3*TD3+HM1*TH1+AAB*TH1*TD3+
      #UM*(TH2*TD3-2.D0*TN1)))-
      #.5D0*(-(2.D0*Q3+8.D0*SM2)*(YT**2)-8.D0*U3*(YT**2)-
      #6.D0*Q3*(YT**2)-(2.D0*Q3+8.D0*SM1)*(YB**2)-
      #8.D0*D3*(YB**2)-6.D0*Q3*(YB**2)-3.D0*YT*((Q3+4.D0*SM2)*YT+
      #2.D0*U3*YT+Q3*YT)-(3.D0*YB+YL)*((Q3+4.D0*SM1)+2.D0*D3+
      #Q3)*YB-6.D0*YT*(Q3+U3)*YT-YB*(6.D0*Q3*YB+6.D0*D3*YB+
```

```
     #2.D0*SL3*YL+2.D0*E3*YL)-40.D0*(YT**2)*AAT-40.D0*(YB**2)*
     #AAB-2.D0*AAB*YB*YL-2.D0*AAL*YB*YL-4.D0*AB*AL*YB*YL+
     #2.D0*A1*((2.D0*Q3+4.D0*SM2)*YT+4.D0*YT*U3+2.D0*YT*Q3+
     #4.D0*YT*AAT+8.D0*G1*AT*YT+8.D0*AG1*YT+(Q3+2.D0*SM1)*YB
     #+2.D0*YB*D3+YB*Q3+2.D0*AAB*YB+4.D0*G1*AB*YB
     #+4.D0*AG1*YB)/5.D0
     #+2.D0*A1*SPMM/5.D0-128.D0*(A3**2)*AG3/3.D0+
     #32.D0*A3*A2*(AG3+AG2+G2*G3)+32.D0*A3*A1*(AG3+AG1+G1*G3)/45.D0
     #+33*(A2**2)*AG2+2.D0*A2*A1*(AG2+AG1+G1*G2)/5.D0
     #+199.D0*(A1**2)*AG1/75.D0+16.D0*A3*SPMM3/3.D0+3.D0*A2*SPMM2+
     #A1*SPMM1/15.D0))
C-------------------
C   J=16 for mQ2
C-------------------
      ELSE IF(J.EQ.16) THEN
      FAP=TQ2Y*(((8.D0*A3*(TQ2-TG3)/3.D0+3.D0*A2*(TQ2-TG2)/2.D0+
     #A1*(TQ2-TG1)/30.D0)*Q2-SSMM/6.D0
     #+16.D0*A3*AG3*TG3/3.D0+3.D0*A2*AG2*TG2+A1*AG1*TG1/15.D0)
     #-0.5D0*(2.D0*A1*SPMM/5.D0-128.D0*(A3**2)*AG3/3.D0+
     #32.D0*A3*A2*(AG3+AG2+G2*G3)+
     #32.D0*A3*A1*(AG3+AG1+G1*G3)/45.D0+33.D0*(A2**2)*AG2+2.D0*
     #A2*A1*(AG2+AG1+G1*G2)/5.D0+199.D0*(A1**2)*AG1/75.D0+
     #16.D0*A3*SPMM3/3.D0+3.D0*A2*SPMM2+A1*SPMM1/15.D0))
C------------------
C   J=17 for mQ1
C------------------
      ELSE IF(J.EQ.17) THEN
      FAP=TQ1Y*(((8.D0*A3*(TQ1-TG3)/3.D0+3.D0*A2*(TQ1-TG2)/2.D0+
     #A1*(TQ1-TG1)/30.D0)*Q1-SSMM/6.D0
     #+16.D0*A3*AG3*TG3/3.D0+3.D0*A2*AG2*TG2+A1*AG1*TG1/15.D0)
     #-0.5D0*(2.D0*A1*SPMM/5.D0-128.D0*(A3**2)*AG3/3.D0+
     #32.D0*A3*A2*(AG3+AG2+G2*G3)+
     #32.D0*A3*A1*(AG3+AG1+G1*G3)/45.D0+
     #33.D0*(A2**2)*AG2+2.D0*A2*A1*(AG2+AG1+G1*G2)/5.D0+
     #199.D0*(A1**2)*AG1/75.D0+16.D0*A3*SPMM3/3.D0+
     #3.D0*A2*SPMM2+A1*SPMM1/15.D0))
C------------------
C   J=18 for mU3
C------------------
      ELSE IF(J.EQ.18) THEN
      FAP=TU3Y*(((8.D0*A3*(TU3-TG3)/3.D0+8.D0*A1*(TU3-TG1)/15.D0)*U3
     #+2.D0*SSMM/3.D0
     #+16.D0*A3*AG3*TG3/3.D0+16.D0*A1*AG1*TG1/15.D0
     #-2.D0*YT*(U3*TN2+Q3*TQ3+HM2*TH2+AAT*TH2*TQ3+
     #UM*(TH1*TQ3-2.D0*TN2)))-
     #.5D0*(-(2.D0*U3+8.D0*SM2)*(YT**2)-8.D0*Q3*(YT**2)-
     #6.D0*U3*(YT**2)-(2.D0*U3+4.D0*SM2+4.D0*SM1)*YT*YB-
     #8.D0*Q3*YT*YB-4.D0*D3*YB*YT-2.D0*U3*YB*YT-
     #6.D0*YT*((U3+4.D0*SM2)*YT+2.D0*Q3*YT+U3*YT)
     #-12.D0*YT*(Q3+U3)*YT-8.D0*AB*AT*YB*YT-
     #4.D0*AAB*YB*YT-4.D0*AAT*YB*YT-64.D0*AAT*(YT**2)+
     #(6.D0*A2-2.D0*A1/5.D0)*((U3+2.D0*SM2)*YT+
     #2.D0*YT*Q3+U3*YT+2.D0*AAT*YT)+12.D0*A2*(2.D0*AG2*YT+
     #2.D0*G2*AT*YT)-4.D0*A1*(2.D0*AG1*YT+2.D0*G1*AT*YT)/5.D0
     #-8.D0*A1*SPMM/5.D0-128*(A3**2)*AG3/3.D0+512.D0*A3*A1*
     #(AG3+AG1+G1*G3)/45.D0+3424.D0*(A1**2)*AG1/75.D0+
     #16.D0*A3*SPMM3/3.D0+16.D0*A1*SPMM1/15.D0))
C-------------------
C   J=19 for mU2
C-------------------
      ELSE IF(J.EQ.19) THEN
      FAP=TU2Y*(((8.D0*A3*(TU2-TG3)/3.D0+8.D0*A1*(TU2-TG1)/15.D0)*U2
```



```
     #+2.D0*SSMM/3.D0
     #+16.D0*A3*AG3*TG3/3.D0+16.D0*A1*AG1*TG1/15.D0)-
     #.5D0*(-8.D0*A1*SPMM/5.D0-128*(A3**2)*AG3/3.D0+
     #512.D0*A3*A1*(AG3+AG1+G1*G3)/45.D0+3424.D0*(A1**2)*AG1/75.D0
     #+16.D0*A3*SPMM3/3.D0+16.D0*A1*SPMM1/15.D0))
C------------------
C   J=20 for mU1
C------------------
      ELSE IF(J.EQ.20) THEN
      FAP=TU1Y*(((8.D0*A3*(TU1-TG3)/3.D0+8.D0*A1*(TU1-TG1)/15.D0)*U1
     #+2.D0*SSMM/3.D0
     #+16.D0*A3*AG3*TG3/3.D0+16.D0*A1*AG1*TG1/15.D0)-
     #.5D0*(-8.D0*A1*SPMM/5.D0-128.D0*(A3**2)*AG3/3.D0+
     #512.D0*A3*A1*(AG3+AG1+G1*G3)/45.D0+3424.D0*(A1**2)*AG1/75.D0+
     #16.D0*A3*SPMM3/3.D0+16.D0*A1*SPMM1/15.D0))
C------------------
C   J=21 for mD3
C------------------
      ELSE IF(J.EQ.21) THEN
      FAP=TD3Y*(((8.D0*A3*(TD3-TG3)/3.D0+2.D0*A1*
     #(TD3-TG1)/15.D0)*D3
     #-SSMM/3.D0
     #+16.D0*A3*AG3*TG3/3.D0+4.D0*A1*AG1*TG1/15.D0
     #-2.D0*YB*(D3*TN1+Q3*TQ3+HM1*TH1+AAB*TH1*TQ3+
     #UM*(TH2*TQ3-2.D0*TN1)))-
     #.5D0*(-(2.D0*D3+8.D0*SM1)*(YB**2)-8.D0*Q3*(YB**2)-
     #6.D0*D3*(YB**2)-(2.D0*D3+4.D0*SM2+4.D0*SM1)*YB*YT-
     #8.D0*Q3*YB*YT-4.D0*U3*YB*YT-2.D0*D3*YB*YT-
     #(2.D0*D3+4.D0*SM1+2.D0*Q3)*YB*(6.D0*YB+2.D0*YL)-
     #4.D0*YB*(3.D0*Q3*YB+3.D0*D3*YB+SL3*YL+E3*YL)-
     #16.D0*AAB*(YB**2)-8.D0*AB*AT*YB*YT-4.D0*AAB*YB*YT-
     #4.D0*AAT*YB*YT-4.D0*AAB*YB*(3.D0*YB+YL)-
     #4.D0*YB*(3.D0*AAB*YB+AAL*YL)-8.D0*AB*YB*
     #(3.D0*AB*YB+AL*YL)+(6.D0*A2+2.D0*A1/5.D0)*
     #(2.D0*D3*YB+2.D0*SM1*YB+2.D0*Q3*YB+2.D0*AAB*YB)+
     #12.D0*A2*(2.D0*AG2+2.D0*G2*AB)*YB+
     #4.D0*A1*(2.D0*AG1+2.D0*G1*AB)*YB/5.D0+
     #4.D0*A1*SPMM/5.D0-128.D0*(A3**2)*AG3/3.D0+128.D0*
     #A3*A1*(AG3+AG1+G3*G1)/45.D0+808.D0*(A1**2)*AG1/75.D0+
     #16.D0*A3*SPMM3/3.D0+4.D0*A1*SPMM1/15.D0))
C--------------------
C   J=22 for mD2
C--------------------
      ELSE IF(J.EQ.22) THEN
      FAP=TD2Y*(((8.D0*A3*(TD2-TG3)/3.D0+2.D0*A1*(TD2-TG1)/15.D0)*D2
     #-SSMM/3.D0
     #+16.D0*A3*AG3*TG3/3.D0+4.D0*A1*AG1*TG1/15.D0)-
     #.5D0*(-128.D0*(A3**2)*AG3/3.D0+128.D0*A3*A1*
     #(AG3+AG1+G3*G1)/45.D0+4.D0*A1*SPMM/5.D0+
     #808.D0*(A1**2)*AG1/75.D0+16.D0*A3*SPMM3/3.D0+
     #4.D0*A1*SPMM1/15.D0))
C--------------------
C   J=23 for mD1
C--------------------
      ELSE IF(J.EQ.23) THEN
      FAP=TD1Y*(((8.D0*A3*(TD1-TG3)/3.D0+2.D0*A1*(TD1-TG1)/15.D0)*D1
     #-SSMM/3.D0
     #+16.D0*A3*AG3*TG3/3.D0+4.D0*A1*AG1*TG1/15.D0)-
     #.5D0*(4.D0*A1*SPMM/5.D0-128.D0*(A3**2)*AG3/3.D0+
     #128.D0*A3*A1*(AG3+AG1+G3*G1)/45.D0+808.D0*(A1**2)*AG1/75.D0
     #+16.D0*A3*SPMM3/3.D0+4.D0*A1*SPMM1/15.D0))
C--------------------
```

```
C    J=24 for mL3
C--------------------
       ELSE IF(J.EQ.24) THEN
       FAP=TL3Y*(((3.D0*A2*(TL3-TG2)/2.D0+3.D0*A1*(TL3-TG1)/10.D0)*SL3
      #+SSMM/2.D0
      #+3.D0*A2*AG2*TG2+3.D0*A1*AG1*TG1/5.D0
      #-YL*(SL3*TN1+E3*TE3+HM1*TH1+AAL*TH1*TE3+
      #UM*(TH2*TE3-2.D0*TN1)))-
      #.5D0*(-(2.D0*SL3+8.D0*SM1)*(YL**2)-8.D0*E3*(YL**2)-
      #6.D0*SL3*(YL**2)-(3.D0*YB+YL)*((SL3+4.D0*SM1)*YL+
      #2.D0*E3*YL+SL3*YL)-YL*(6.D0*Q3*YB+6.D0*D3*YB+
      #2.D0*SL3*YL+2.D0*E3*YL)-24.D0*AAL*(YL**2)-
      #6.D0*AAL*YB*YL-6.D0*AAB*YB*YL-12.D0*AB*AL*YB*YL+
      #6.D0*A1*((SL3+2.D0*SM1)*YL+2.D0*E3*YL+SL3*YL+
      #2.D0*AAL*YL+4.D0*G1*AL*YL+4.D0*AG1*YL)/5.D0
      #-6.D0*A1*SPMM/5.D0+33.D0*(A2**2)*AG2+
      #18.D0*A2*A1*(AG2+AG1+G1*G2)/5.D0+621.D0*(A1**2)*AG1/25.D0+
      #3.D0*A2*SPMM2+3.D0*A1*SPMM1/5.D0))
C--------------------
C    J=25 for mL2
C--------------------
       ELSE IF(J.EQ.25) THEN
       FAP=TL2Y*(((3.D0*A2*(TL2-TG2)/2.D0+3.D0*A1*(TL2-TG1)/10.D0)*SL2
      #+SSMM/2.D0
      #+3.D0*A2*AG2*TG2+3.D0*A1*AG1*TG1/5.D0)-
      #.5D0*(-6.D0*A1*SPMM/5.D0+33.D0*(A2**2)*AG2+
      #18.D0*A2*A1*(AG2+AG1+G1*G2)/5.D0+621.D0*(A1**2)*AG1/25.D0
      #+3.D0*A2*SPMM2+3.D0*A1*SPMM1/5.D0))
C--------------------
C    J=26 for mL1
C--------------------
       ELSE IF(J.EQ.26) THEN
       FAP=TL1Y*(((3.D0*A2*(TL1-TG2)/2.D0+3.D0*A1*(TL1-TG1)/10.D0)*SL1
      #+SSMM/2.D0
      #+3.D0*A2*AG2*TG2+3.D0*A1*AG1*TG1/5.D0)-
      #.5D0*(-6.D0*A1*SPMM/5.D0+33.D0*(A2**2)*AG2+18.D0*A2*A1*
      #(AG2+AG1+G1*G2)/5.D0+621.D0*(A1**2)*AG1/25.D0+
      #3.D0*A2*SPMM2+3.D0*A1*SPMM1/5.D0))
C--------------------
C    J=27 for mE3
C--------------------
       ELSE IF(J.EQ.27) THEN
       FAP=TE3Y*(((6.D0*A1*(TE3-TG1)/5.D0)*E3-SSMM
      #+12.D0*A1*AG1*TG1/5.D0
      #-2.D0*YL*(E3*TN1+SL3*TL3+HM1*TH1+AAL*TH1*TL3+
      #UM*(TH2*TL3-2.D0*TN1)))-
      #.5D0*(-(2.D0*E3+8.D0*SM1)*(YL**2)-8.D0*SL3*(YL**2)-
      #6.D0*E3*(YL**2)-(6.D0*YB+2.D0*YL)*(4.D0*SM1*YL+
      #2.D0*SL3*YL+2.D0*E3*YL)-4.D0*YL*(3.D0*Q3*YB+
      #3.D0*D3*YB+SL3*YL+E3*YL)-
      #16.D0*AAL*(YL**2)-4.D0*AAL*YL*(3.D0*YB+YL)-
      #4.D0*YL*(3.D0*AAB*YB+AAL*YL)-8.D0*AL*YL*
      #(3.D0*AB*YB+AL*YL)+(6.D0*A2-6.D0*A1/5.D0)*
      #((2.D0*E3+2.D0*SM1)*YL+2.D0*YL*SL3+2.D0*YL*AAL)+
      #12.D0*A2*(2.D0*AG2+2.D0*G2*AL)*YL-
      #12.D0*A1*(2.D0*AG1+2.D0*G1*AL)*YL/5.D0+
      #12.D0*A1*SPMM/5.D0+2808.D0*(A1**2)*AG1/25.D0+
      #12.D0*A1*SPMM1/5.D0))
C--------------------
C    J=28 for mE2
C--------------------
       ELSE IF(J.EQ.28) THEN
```



```
       FAP=TE2Y*(((6.D0*A1*(TE2-TG1)/5.D0)*E2-SSMM
      #+12.D0*A1*AG1*TG1/5.D0)-
      #.5D0*(12.D0*A1*SPMM/5.D0+2808.D0*(A1**2)*AG1/25.D0+
      #12.D0*A1*SPMM1/5.D0))
C--------------------
C    J=29 for mE1
C--------------------
       ELSE IF(J.EQ.29) THEN
       FAP=TE1Y*(((6.D0*A1*(TE1-TG1)/5.D0)*E1-SSMM
      #+12.D0*A1*AG1*TG1/5.D0)-
      #.5D0*(12.D0*A1*SPMM/5.D0+2808.D0*(A1**2)*AG1/25.D0+
      #12.D0*A1*SPMM1/5.D0))
C-------------------------------------------
C    J=30   Higgs mass m1^2 (=mH1^2+mu^2)
C-------------------------------------------
       ELSE IF(J.EQ.30) THEN
CC
       FAP=TH1Y*(((1.5D0*A2*(TH1-TN1*TG2)
      #+3.D0*A1*(TH1-TN1*TG1)/10.D0)*HM1
      #+3.D0*A2*(AG2+UM)*TN1*TG2
      #+3.D0*A1*(AG1+UM)*TN1*TG1/5.D0+SSMM/2.D0
      #-YL*(HM1+SL3*TL3+E3*TE3+AAL*TL3*TE3)
      #-3.D0*YB*(HM1+Q3*TQ3+D3*TD3+AAB*TQ3*TD3)
      #-3.D0*YT*UM*TQ3*TU3)-
      #(.5D0*(-36.D0*SM1*(YB**2)-36.D0*Q3*(YB**2)-36.D0*D3*(YB**2)
      #-6.D0*((SM1+SM2+Q3)*YT*YB+U3*YT*YB+Q3*YB*YT+D3*YT*YB+
      #2.D0*(SM1+SL3)*
      #(YL**2)+2.D0*E3*(YL**2)+12.D0*AAB*(YB**2)+AAT*YT*YB+
      #AAB*YT*YB+2.D0*AB*AT*YB*YT+4.D0*AAL*(YL**2))
      #+(32.D0*A3-4.D0*A1/5.D0)*((SM1+Q3)*YB+YB*D3+AAB*YB)+
      #32.D0*A3*(2.D0*AG3*YB+2.D0*G3*YB*AB)-
      #4.D0*A1*(2.D0*AG1*YB+2.D0*G1*AB*YB)/5.D0+
      #12.D0*A1*((SM1+SL3)*YL+YL*E3+AAL*YL+2.D0*AG1*YL
      #+2.D0*G1*AL*YL)/5.D0
      #-6.D0*A1*SPMM/5.D0+33.D0*(A2**2)*AG2+18.D0*A2*A1*
      #(AG2+AG1+G1*G2)/5.D0+621.D0*(A1**2)*AG1/25.D0+
      #3.D0*A2*SPMM2+3.D0*A1*SPMM1/5.D0)+
      #UM*(-3.D0*(3.D0*(YT**2)+3.D0*(YB**2)+2.D0*YB*YT+(YL**2))
      #+YT*(16.D0*A3+4.D0*A1/5.D0)+YB*(16.D0*A3-2.D0*A1/5.D0)
      #+6.D0*A1*YL/5.D0+15.D0*(A2**2)/2.D0+9.D0*A1*A2/5.D0+
      #207.D0*(A1**2)/50.D0)))
C-------------------------------------------
C    J=31   Higgs mass m2^2  (=mH2^2+mu^2)
C-------------------------------------------
       ELSE IF(J.EQ.31) THEN
       FAP=TH2Y*(((1.5D0*A2*(TH2-TN2*TG2)
      #+3.D0*A1*(TH2-TN2*TG1)/10.D0)*HM2
      #+3.D0*A2*(AG2+UM)*TN2*TG2
      #+3.D0*A1*(AG1+UM)*TN2*TG1/5.D0-SSMM/2.D0
      #-YL*UM*TE3*TL3
      #-3.D0*YT*(HM2+Q3*TQ3+U3*TU3+AAT*TQ3*TU3)
      #-3.D0*YB*UM*TQ3*TD3)-
      #(.5D0*(-36.D0*SM2*(YT**2)-36.D0*Q3*(YT**2)-36.D0*U3*(YT**2)
      #-6.D0*(SM1+SM2+Q3)*YT*YB-6.D0*U3*YT*YB-6.D0*Q3*YT*YB
      #-6.D0*D3*YT*YB-72.D0*AAT*(YT**2)
      #-6.D0*AAB*YB*YT-6.D0*AAT*YT*YB-
      #12.D0*AB*AT*YB*YT+(32.D0*A3+8.D0*A1/5.D0)*
      #(SM2*YT+Q3*YT+U3*YT+AAT*YT)+32.D0*A3*(2.D0*AG3*YT+
      #2.D0*G3*AT*YT)+8.D0*A1*(2.D0*AG1*YT+2.D0*G1*AT*YT)/5.D0
      #+6.D0*A1*SPMM/5.D0+33.D0*(A2**2)*AG2+
      #18.D0*A2*A1*(AG2+AG1+G1*G2)/5.D0+621.D0*(A1**2)*AG1/25.D0
      #+3.D0*A2*SPMM2+3.D0*A1*SPMM1/5.D0)+
```

```
     #UM*(-3.D0*(3.D0*(YT**2)+3.D0*(YB**2)+2.D0*YB*YT+(YL**2))
     #+YT*(16.D0*A3+4.D0*A1/5.D0)+YB*(16.D0*A3-2.D0*A1/5.D0)
     #+6.D0*A1*YL/5.D0+15.D0*(A2**2)/2.D0+9.D0*A1*A2/5.D0+
     #207.D0*(A1**2)/50.D0)))
C-----------------------------
C   J=32   vev for the H1
C-----------------------------
      ELSE IF(J.EQ.32) THEN
      GIH1=YL+3.D0*YB-3.D0*A2/2.D0-3.D0*A1/10.D0
      GIIH1=-9.D0*YB**2-3.D0*YB*YT-3.D0*YL**2
     #+(16.D0*A3-2.D0*A1/5.D0)*YB+6.D0*A1*YL/5.D0
     #+15.D0*A2**2/4.D0+9.D0*A1*A2/10.D0+207.D0*A1**2/100.D0
      FAP=VS1*(GIH1+GIIH1)/2.D0
C----------------------------
C   J=33  vev for the H2
C----------------------------
      ELSE IF(J.EQ.33) THEN
      GIH2=3.D0*YT-3.D0*A2/2.D0-3.D0*A1/10.D0
      GIIH2=-9.D0*YT**2-3.D0*YB*YT+(16.D0*A3+4.D0*A1/5.D0)*YT
     #+15.D0*A2**2/4.D0+9.D0*A1*A2/10.D0+207.D0*A1**2/100.D0
      FAP=VS2*(GIH2+GIIH2)/2.D0
C----------------------------
C   J=34  vev for the AU1
C----------------------------
      ELSE IF(J.EQ.34) THEN
      BTU1=-3.D0*AT*YT+16.D0*A3*G3/3.D0+3.D0*A2*G2
     #+13.D0*A1*G1/15.D0
      BTU2=-36.D0*AT*YT**2-6.D0*AT*YT*YB-6.D0*AB*YT*YB
     #+(32.D0*A3+8.D0*A1/5.D0)*AT*YT
     #+(32.D0*A3*G3+8.D0*A1*G1/5.D0)*YT-64.D0*A3**2*G3/9.D0
     #+16.D0*A3*A2*(G3+G2)+272.D0*A3*A1*(G3+G1)/45.D0
     #+30.D0*A2**2*G2+2.D0*A2*A1*(G1+G2)+5486.D0*A1**2*G1/225.D0
      FAP=BTU1-BTU2/2.D0
C----------------------------
C   J=35  vev for the AU2
C----------------------------
      ELSE IF(J.EQ.35) THEN
      BETU1=-3.D0*AT*YT+16.D0*A3*G3/3.D0+3.D0*A2*G2
     #+13.D0*A1*G1/15.D0
      BETU2=-36.D0*AT*YT**2-6.D0*AT*YT*YB-6.D0*AB*YT*YB
     #+(32.D0*A3+8.D0*A1/5.D0)*AT*YT
     #+(32.D0*A3*G3+8.D0*A1*G1/5.D0)*YT-64.D0*A3**2*G3/9.D0
     #+16.D0*A3*A2*(G3+G2)+272.D0*A3*A1*(G3+G1)/45.D0
     #+30.D0*A2**2*G2+2.D0*A2*A1*(G1+G2)+5486.D0*A1**2*G1/225.D0
      FAP=BETU1-BETU2/2.D0
C----------------------------
C   J=36  vev for the AD1
C----------------------------
      ELSE IF(J.EQ.36) THEN
      BTD1=-3.D0*AB*YB-AL*YL+16.D0*A3*G3/3.D0+3.D0*A2*G2
     #+7.D0*A1*G1/15.D0
      BTD2=-36.D0*AB*YB**2-6.D0*AT*YT*YB-6.D0*AB*YT*YB
     #-12.D0*AL*YL**2+(32.D0*A3-4.D0*A1/5.D0)*AB*YB
     #+12.D0*A1*AL*YL/5.D0+(32.D0*A3*G3-4.D0*A1*G1/5.D0)*YB
     #+12.D0*A1*G1*YL/5.D0-64.D0*A3**2*G3/9.D0+16.D0*A3*A2*(G2+G3)
     #+16.D0*A3*A1*(G3+G1)/9.D0+30.D0*A2**2*G2+2.D0*A2*A1*(G2+G1)
     #+574.D0*A1**2*G1/45.D0
      FAP=BTD1-BTD2/2.D0
C----------------------------
C   J=37  vev for the AD2
C----------------------------
      ELSE IF(J.EQ.37) THEN
```



```
      BETD1=-3.D0*AB*YB-AL*YL+16.D0*A3*G3/3.D0+3.D0*A2*G2
     #+7.D0*A1*G1/15.D0
      BETD2=-36.D0*AB*YB**2-6.D0*AT*YT*YB-6.D0*AB*YT*YB
     #-12.D0*AL*YL**2+(32.D0*A3-4.D0*A1/5.D0)*AB*YB
     #+12.D0*A1*AL*YL/5.D0+(32.D0*A3*G3-4.D0*A1*G1/5.D0)*YB
     #+12.D0*A1*G1*YL/5.D0-64.D0*A3**2*G3/9.D0+16.D0*A3*A2*(G2+G3)
     #+16.D0*A3*A1*(G3+G1)/9.D0+30.D0*A2**2*G2+2.D0*A2*A1*(G2+G1)
     #+574.D0*A1**2*G1/45.D0
      FAP=BETD1-BETD2/2.D0
C-----------------------------
C   J=38  vev for the AL1
C-----------------------------
      ELSE IF(J.EQ.38) THEN
      BTE1=-3.D0*AB*YB-AL*YL+3.D0*A2*G2+9.D0*A1*G1/5.D0
      BTE2=-36.D0*AB*YB**2-6.D0*AT*YT*YB-6.D0*AB*YB*YT
     #-12.D0*AL*YL**2+(32.D0*A3-4.D0*A1/5.D0)*AB*YB
     #+12.D0*A1*AL*YL/5.D0+(32.D0*A3*G3-4.D0*A1*G1/5.D0)*YB
     #+12.D0*A1*G1*YL/5.D0+30.D0*A2**2*G2+18.D0*A2*A1*(G1+G2)/5.D0
     #+54.D0*A1**2*G1
      FAP=BTE1-BTE2/2.D0
C-----------------------------
C   J=39  vev for the AL2
C-----------------------------
      ELSE IF(J.EQ.39) THEN
      BETE1=-3.D0*AB*YB-AL*YL+3.D0*A2*G2+9.D0*A1*G1/5.D0
      BETE2=-36.D0*AB*YB**2-6.D0*AT*YT*YB-6.D0*AB*YB*YT
     #-12.D0*AL*YL**2+(32.D0*A3-4.D0*A1/5.D0)*AB*YB
     #+12.D0*A1*AL*YL/5.D0+(32.D0*A3*G3-4.D0*A1*G1/5.D0)*YB
     #+12.D0*A1*G1*YL/5.D0+30.D0*A2**2*G2+18.D0*A2*A1*(G1+G2)/5.D0
     #+54.D0*A1**2*G1
      FAP=BETE1-BETE2/2.D0
CC
      ENDIF
      RETURN
      END

*==> fon.f <==
      SUBROUTINE FON(T,Y,YPRIME)
      IMPLICIT DOUBLE PRECISION (A-H, O-Z)
      DOUBLE PRECISION Y(NUU), YPRIME(NUU)
      COMMON/IZO/IZF,IZR
      COMMON/NUEQ/NUU
CC
      LR=IZF
      LRX=IZR
      DO   J=1,NUU
         YPRIME(J)=
     #   FAP(LR,LRX,J,T,Y(1),Y(2),Y(3),Y(4),Y(5),Y(6),Y(7),Y(8),Y(9),
     #   Y(10),Y(11),Y(12),Y(13),Y(14),Y(15),Y(16),Y(17),Y(18),Y(19),
     #   Y(20),Y(21),Y(22),Y(23),Y(24),Y(25),Y(26),Y(27),Y(28),Y(29),
     #   Y(30),Y(31),Y(32),Y(33))
      ENDDO
CC
      RETURN
       END

*==> gf.f <==
      SUBROUTINE GF(TQ,CY,CYPRIME)
      IMPLICIT DOUBLE PRECISION (A-H, O-Z)
      COMMON/MUU/MUU
      DOUBLE PRECISION CY(MUU),CYPRIME(MUU)
C-----------------------------------------------------------
```

```
C   CY(1)=a3/(4pi^2), CY(2)=aem/(4pi^2), CY(3)=mb, CY(4)=mtau
C-------------------------------------------------------------
      CYPRIME(1)=(23.D0/3.D0)*(CY(1)**2)+(116.D0/3.D0)*(CY(1)**3)
     #-(22.D0/9.D0)*CY(2)*(CY(1)**2)+9769.D0*(CY(1)**4)/54.D0
CC
      CYPRIME(2)=-(80.D0/9.D0)*(CY(2)**2)-(464.D0/27.D0)*(CY(2)**3)
     #-(176.D0/9.D0)*CY(1)*(CY(2)**2)
CC
      CYPRIME(3)=-.5D0*CY(3)*(-2.D0*CY(2)/3.D0-8.D0*CY(1)+
     #(397.D0/81.D0)*(CY(2)**2)-(1012.D0/9.D0)*(CY(1)**2)
     #-8.D0*CY(1)*CY(2)/9.D0-949.7424D0*(CY(1)**3))
CC
      CYPRIME(4)=-.5D0*CY(4)*(-6.D0*CY(2)+(373.D0/9.D0)*(CY(2)**2))
CC
      RETURN
      END

*==> rk4.f <==
      SUBROUTINE RK4(L,LL,TORL,TI,TF,P1,P2,P3,P4,P5,P6,P7,P8,P9,P10
     #,P11,P12
     #,P13,P14,P15,P16,P17,P18,P19,P20,P21,P22,P23,P24,P25,P26,P27,P28
     #,P29,P30,P31,P32,P33,P34,P35,P36,P37,P38,P39)
      IMPLICIT DOUBLE PRECISION (A-H, O-Z)
      PARAMETER (NU=39)
      DOUBLE PRECISION Y(NU)
      COMMON/YYY/Y
      COMMON/OSS/TS,TEND,TOL
      COMMON/IZO/IZF,IZR
CC
      IZF=L
      IZR=LL
CC
      TOL=TORL
      TS=TI
      TEND=TF
CC
      Y(1)=P1
      Y(2)=P2
      Y(3)=P3
      Y(4)=P4
      Y(5)=P5
      Y(6)=P6
      Y(7)=P7
      Y(8)=P8
      Y(9)=P9
      Y(10)=P10
      Y(11)=P11
      Y(12)=P12
      Y(13)=P13
      Y(14)=P14
      Y(15)=P15
      Y(16)=P16
      Y(17)=P17
      Y(18)=P18
      Y(19)=P19
      Y(20)=P20
      Y(21)=P21
      Y(22)=P22
      Y(23)=P23
      Y(24)=P24
      Y(25)=P25
      Y(26)=P26
```



```
      Y(27)=P27
      Y(28)=P28
      Y(29)=P29
      Y(30)=P30
      Y(31)=P31
      Y(32)=P32
      Y(33)=P33
      Y(34)=P34
      Y(35)=P35
      Y(36)=P36
      Y(37)=P37
      Y(38)=P38
      Y(39)=P39
CC
      RETURN
      END

*==> t.f <==
      FUNCTION T(I,X,Y)
      IMPLICIT DOUBLE PRECISION (A-H, O-Z)
      IF(I.EQ.1) THEN
        T=1.D0
      ELSE IF(I.EQ.2.AND.X.GE.Y) THEN
        T=0.D0
      ELSE
        T=1.D0
      ENDIF
      RETURN
      END

*==> divprk.f <==
      SUBROUTINE DIVPRK(IDS,N,FCN,X,XEND,EPS,WPARAM,Y)
      IMPLICIT DOUBLE PRECISION(A-H, O-Z)
      DIMENSION Y(N)
      DIMENSION WPARAM(23+21*N)
      EXTERNAL FCN
CC
      IDSF=IDS
      CALL D02CAF(X,XEND,N,Y,EPS,FCN,WPARAM,IDSF)
      X=XEND
      RETURN
      END
```