# SuSeFLAV: Supersymmetric particle spectrum and lepton flavor violation calculator

Technical Manual

April 27, 2011

## Contents

# 1 SuSeFLAV/bsg.f

*[ Functions ]*

**NAME:**

```
subroutine bsg
```

**SYNOPSIS:**

```
Main routine for running SuSeFLAV.
```

**FUNCTION:**

```
This subroutine calculates the b->s,gamma rate
The functions follow from that of Bertolini-Borzumati-Masiero
And A. Bartl et. al (PRD 64 076009 (2001) ).
The SM NLO Contibutions and MSSM LO Contributions are added.
The functions are combinations of various functions presented
in the papers above.
```

**INPUTS:**

```
tanbeta  -   ratio of vevs
mT       -   top quark mass
mB       -   bottom quark mass
Ceg      -   (1x2) Chargino eigen values
SUeg     -   (1x6) up-type squark eigenvalue
USU      -   (6x6) squark mixing matrix
OCL,OCR  -   (2 X 2) orthogonal matrices such that
             MChar = Transpose[OCR].Diag[MChar].OCL
mHchar   -   mass of charged higgs
```

**RESULT:**

```
Bbsg     - b->s gamma decay rate
```

**EXAMPLE:**

```
subroutine bsg(tanbeta,mT,mB,Ceg,SUeg,USU,OCL,OCR,mHchar,Bbsg)
```

**NOTES:**

```
mHchar = Mass of the Charged Higgs Boson (NOT Squared !!)
```

**BUGS:**

```
---
```

**SEE ALSO:**

```
-----
```

## 2 SuSeFLAV/ewsbiterate.f/coratmz

*[ Functions ]*

**NAME:**

```
SUBROUTINE coratmz
```

**SYNOPSIS:**

```
One loop correction to all standard model inputs at MZ.
```

**FUNCTION:**

```
Calculates one-loop threshold corrections to $M_t, M_b, M_tau, \alpha_{em},
\alpha_s and \sin^2 \theta_w$ at MZ.
We closely follow BPMZ [hep-ph/9606211].
```

**INPUTS:**

```
 MW         - Mass of W boson.
 MZ         - Mass of Z boson.
tanbeta     - the ratio of the vevs of the two Higgs doublet fields.
alphaDR     - \overbar{DR} Electromagnetic coupling constant.
```

**RESULT:**

```
 MWc_mz     - One loop corrected mass of W boson.
 MZc_mz     - One loop corrected mass of Z boson.
 MTc_mz     - One loop corrected top quark mass. (Expand on correction parameters)
 mBc_mz     - One loop corrected bottom quark mass.
 mTauc_mz   - One loop corrected tau lepton mass.
 alphas1    - One loop corrected strong coupling constant.
 alphaem    - One loop corrected electromagnetic coupling constant.
 delalphaem - One loop correction to electromagnetic coupling constant.
 delalphas  - One loop correction to strong coupling constant.
 sinsqtheff - Corrected effective weak mixing angle.
```

**EXAMPLE:**

```
      SUBROUTINE coratMZ(MW,MZ,tanbeta,alphaDR,MWc_mz, MZc_mz,MTc_mz,
     $     mBc_mz,mTauc_mz,alphas1,alphaem,delalphas, delalphem,
     $     sinsqtheff,newvev,mbdrbar,itcount)
```

**NOTES:**

Common blocks used in this routine

```
  common/rgeopt_mz/mt_mz, mb_mz, mtau_mz
  common/sminputs/ mbpole, mtaupole, Mtpole
  common/higgsmixmz/ alphatree
  common/sinsq_mz/sinsqthw_mz
  common/mu_mz/ murgemz
  common/qcd_cor/mbmzdrbar
  common/softout_mat_mz/mSQRGz,mSURGz,mSDRGz,AURGz,ADRGz,
 $     AERGz,ANURGz,mSLRGz,mSERGz, mSNURGz,ONz,OCLz,OCRz,
 $     MCharz, MNeutz
  common/rgeoutput_MZ/ mh1mzz,mh2mzz,M1tmz,M2tmz,M3tmz,
 $     alph1MZ,alph2MZ,alph3MZ,vev1mz,vev2mz,yumz,ydmz,yemz
  common/sparticles_MZ/SUeggz,SDeggz,SLeggz,SNeggz,Negz,Cegz,
 $     mh0sqz,mhu0sqz,mhpmsqz,mA0sqz
```

External Subroutines used in this routine

```
  EXTERNAL topcor, bottomcor, taucor,pizz, piww
  EXTERNAL strongcoupling, emcoupling, vevewsb, S2ThetaW,
 $     pizgamma,S2ThetaEff
```

**BUGS:**

---

**SEE ALSO:**

---

# 3 SuSeFLAV/ewsbiterate.f/RECURSIVE SUBROUTINE ITERATE

*[ Functions ]*

**NAME:**

```
Subroutine Iterate
```

**SYNOPSIS:**

```
Recursive subroutine for \mu parameter minimization
```

**FUNCTION:**

```
This suborutine minimizes \mu parameter using iterative methods
and incorporates REWSB at msusy. Also, it checks for D-flat conditions and
whether the determinant is negative.
```

**INPUTS:**

```
scale       - Scale at which minimization is done(ex. msusy or MZ)
mt          - One-loop corrected mass of top quark(GeV).
murge       - \mu at tree level
msusy       - scale at which susy is broken.
newtbeta    - the ratio of the vevs of the twoHiggs doublet fields at msusy.
```

**RESULT:**

```
bmur        - b_{\mu} obtained from converged value of \mu
muflag      - flags unphysical \mu. muflag = 2 for \mu^2 <0 and if
              iteration count exceeds the limit.
try1        - Counter for iteration.
muold       - Converged/Minimized value of |\mu|.
itcount     - Counter for RGE iteration.
flags       - Saves the error encountered in a character string.
mursq       - value of \mu^2
```

**EXAMPLE:**

```
 RECURSIVE SUBROUTINE ITERATE (scale,mt,murge,bmur,newtbeta,
$     msusy,muflag,try1,muold,itcount,flags, mursq)
```

**NOTES:**

```
Common Blocks used:
 common/mssminputs/ m0, m12, m10, m20, sgnmu, tanbeta, a0
 common/softout_mat/mSQRG,mSURG,mSDRG,AURG,ADRG,
$     AERG,ANURG,mSLRG,mSERG, mSNURG,ON,OCL,OCR,MChar, MNeut
 common/rgeoutput_susy/ mh1mz,mh2mz,M1tz,M2tz,M3tz,
$     alph1,alph2,alph3,vev1,vev2,yuRG,ydRG,yeRG
```

```
      common/sparticles_susy/SUegg,SDegg,SLegg,SNegg,Neg,Ceg,
     $     mh0sq,mhu0sq,mhpmsq,mA0sq
      common/sminputs/ mbpole, mtaupole, Mtpole
      common/sinsq_susy/sinsqthw_susy
      common/hzV/ delta1,delta2

     External routines used in this routine:
     EXTERNAL pizz,tadpole1,piww
     EXTERNAL tadpole2,pis1s1,pis1s2,pis2s2
```

**BUGS:**

```
---
```

**SEE ALSO:**

```
-----
```

# 4 SuSeFLAV/ewsbiterate.f/REWSBCOR

*[ Functions ]*

**NAME:**

```
Subroutine REWSBCOR
```

**SYNOPSIS:**

```
One loop correction to all MSSM paramters at msusy.
```

**FUNCTION:**

```
Calculates complete one-loop threshold corrections to all MSSM particles.
We closely follow BPMZ [hep-ph/9606211].
```

**INPUTS:**

```
 mur       -  Converged value of \mu parameter.
 bmur      -  Converged calue of b_{\mu} parameter.
 sgnmu     -  Sign of \mu parameter.
 newtbeta  -  \tan\beta at msusy scale.
 MT        -  One-loop corrected mass of top quark (GeV).
 msusy     -  Susy breaking scale (GeV).
```

**RESULT:**

```
Corrected sfermions, gauginos and higgs masses.
  M3t       - One-loop corrected gluino mass(GeV).
  mAm3      - One-loop corrected psuedo scalar higgs mass(GeV).
  STeg      - (1 X 2) One-loop corrected (s)top masses, contains mixed state of L and R.
  SCeg      - (1 X 2) One-loop corrected (s)charm masses, L and R components.
  SUqeg     - (1 X 2) One-loop corrected (s)up masses, L and R components.
  SBeg      - (1 X 2) One-loop corrected (s)bottom masses, contains mixed state of L and R.
  SSTeg     - (1 X 2) One-loop corrected (s)strange masses, L and R components.
  SDneg     - (1 X 2) One-loop corrected (s)down masses, L and R components.
  STaueg    - (1 X 2) One-loop corrected (s)tau masses, contains mixed state of L and R.
  SMUeg     - (1 X 2) One-loop corrected (s)mu masses, L and R components.
  SEeg      - (1 X 2) One-loop corrected (s)electron masses, L and R components.
  tsnu      - One-loop corrected tau (s)neutrino mass.
  musnu     - One-loop corrected mu (s)neutrino mass.
  elsnu     - One-loop corrected electron (s)neutrino mass.
  newmA0sq  | one loop corrected higgs masses.
  newmh0sq  | Currently we use compact analytical expression at two-loop level for the lightest
  newmhpmsq | Heinenmeyer, Hollik and Weiglein [hep-ph/ 9903404]
  newmHu0sq |
  Cegm      - (1 X 2) One-loop corrected chargino masses.
  negm      - (1 X 4) One-loop corrected neutralino masses.
```

**EXAMPLE:**

```
      SUBROUTINE  REWSBCOR(mur,bmur,sgnmu,newtbeta,MT,
     $     msusy,msnew,M3t,mAm3,
     $     STeg,SCeg,SUqeg,SBeg,SSTeg,SDneg,STaueg,SMUeg,SEeg,
     $     tsnu,musnu,elsnu, newmA0sq, newmh0sq, newmhpmsq,
     $     newmHu0sq,Cegm,negm,itcount)
```

**NOTES:**

```
Common blocks used in this routine:

  common/sminputs/ mbpole, mtaupole, Mtpole
  common/softout_mat/mSQRG,mSURG,mSDRG,AURG,ADRG,
 $     AERG,ANURG,mSLRG,mSERG, mSNURG,ON,OCL,OCR,MChar, MNeut
  common/rgeoutput_susy/ mh1mz,mh2mz,M1tz,M2tz,M3tz,
 $     alph1,alph2,alph3,vev1,vev2,yuRG,ydRG,yeRG
  common/sparticles_susy/SUegg,SDegg,SLegg,SNegg,Neg,Ceg,
 $     mh0sq,mhu0sq,mhpmsq,mA0sq
  common/sinsq_susy/sinsqthw_susy
  common/opt_mixing/OCRm, OCLTm,ONew, alpha
```

```
  common/vev_ewsb/ vev1n,vev2n

External subroutines in this routine:

  EXTERNAL pizz,tadpole1,piww
  EXTERNAL tadpole2,piaa,vevewsb,pis1s1,pis1s2,pis2s2,pihphm,pistop
  EXTERNAL pisbottom,pischarm,pisupq,pistaul
  EXTERNAL pisdown,pistausnu,higgs_analytical
```

**BUGS:**

```
---
```

**SEE ALSO:**

```
-----
```

# 5 SuSeFLAV/oneloopchargino.f

*[ Functions ]*

**NAME:**

```
subroutine chargino
```

**SYNOPSIS:**

```
One loop correction to chargino.
```

**FUNCTION:**

```
 Computes 1loop correction to charginos at a given energy scale and
 external momenta
```

**INPUTS:**

```
 p                              - External momentum
 q                              - Energy scale
 g,gp,g3                        - Gauge couplings(g = em, gp = weak,
                                  g3 = strong)
 mt,mb,mtau                     - pole masses of top, bottom and tau
 mSQRG,mSDRG,mSURG,mSLRG,mSERG  - (3 X 3) mass matrix definition
 yuRG,ydRG,yeRG                 - (3 X 3)Yukawas
```

```
AURG,ADRG,AERG                - (3 X 3)Trilinear couplings
pizzT,piwwT                   - self energy of W and Z bosons at M_z
mh0sq,mhu0sq,mhpmsq,mA0sq     - physicsal higgs mass squared
modmu                         - modulus of the \mu paramter
vev1,vev2                     - vacuum expectation values of the two
                                higgs doublet fields
M3t                           - Gaugino mass at msusy
tanbeta                       - the ratio of the vevs of the
                                two Higgs doublet fields.
SUegg   =  6 eigenvalues of UP-Squark mass matrix.
SDegg   =  6 eigenvalues of Down-Squark mass matrix.
Slegg   =  6 eigenvalues of slepton mass matrix.
SNegg   =  3 eigenvalues of sneutrino mass matrix.
ON      =  (4 X 4) orthogonal matrix such that
           ON.MNeut.Transpose[ON] = Diag[MNeut]
Neg     =  4 singular values (descending order) of the
           Neutralino mass matrix.

OCR, OCL =  (2 X 2) orthogonal matrices such that
            MChar = Transpose[OCR].Diag[MChar].OCL
Ceg     =   2 singular values of the chargino Mass Matrix
```

**RESULT:**

```
Cegm        =  2 eigenvalues of the 1-loop corrected chargino mass matrix.
OCRm, OCLTm =  (2 X 2) orthogonal matrices such that
            MChar = Transpose[OCRm].Diag[MChar].OCLTm
charmasstot = (2x2) corrected chargino mass matrix
```

**EXAMPLE:**

```
subroutine chargino(p,q,g,gp,mt,mb,mtau,tanbeta,mSQRG,mSDRG,mSURG,
$     mSLRG,mSERG,AURG,ADRG,AERG,yuRG,ydRG,yeRG,SUegg,SDegg,SLegg,
$     SNegg,Neg,Ceg,MChar,ON,OCL,OCR,modmu,mh0sq,mhu0sq,mHpmsq,
$     mA0sq,vev1,vev2,charmasstot,OCRm,OCLTm,Cegm)
```

**NOTES:**

1. q, the energy scale at which the corrections are added = msusy.
2. Conventions and notations followed are that of BPMZ.
3. p = msusy

**BUGS:**

---

**SEE ALSO:**

# 6 SuSeFLAV/oneloopfermion.f

*[ Functions ]*

**NAME:**

```
Subroutine topcor, bottomcor and taucor
```

**SYNOPSIS:**

```
One loop correction to fermions.
```

**FUNCTION:**

```
Computes self energy for third generation fermions at a given energy scale and external momenta
```

**INPUTS:**

```
p                              - External momentum
q                              - Energy scale
g,gp,g3                        - Gauge couplings(g = em, gp = weak, g3 = strong)
mt,mb,mtau                     - pole masses of top, bottom and tau
mSQRG,mSDRG,mSURG,mSLRG,mSERG  - (2 X 2) mass matrix definition
yuRG,ydRG,yeRG                 - Yukawas
AURG,ADRG,AERG                 - Trilinear couplings
pizzT,piwwT                    - self energy of W and Z bosons at M_z
mh0sq,mhu0sq,mhpmsq,mA0sq      - physicsal higgs mass squared
modmu                          - modulus of the \mu paramter
M3t,M2t                        - Gaugino mass at msusy
tanbeta                        - the ratio of the vevs of the twoHiggs doublet fields.
SUegg   =  6 eigenvalues (ascending order) of UP-Squark mass matrix.
SDegg   =  6 eigenvalues (ascending order) of Down-Squark mass matrix.
Slegg   =  6 eigenvalues (ascending order) of slepton mass matrix.
SNegg   =  3 eigenvalues (ascending order) of sneutrino mass matrix.
ON      =  (4 X 4) orthogonal matrix such that
           ON.MNeut.Transpose[ON] = Diag[MNeut]
Neg     =  4 singular values (descending order) of the Neutralino mass matrix.

OCR, OCL =  (2 X 2) orthogonal matrices such that
            MChar = Transpose[OCR].Diag[MChar].OCL
Ceg     =   2 singular values of the Neutralino Mass Matrix
```

**RESULT:**

```
S_eg     =  2 eigenvalues of the corrected mass matrix( L and R components).
```

**EXAMPLE:**

```
      SUBROUTINE topcor(p,q,g,g3,M3t,mt,mb,mtau,tanbeta,mSQRG,mSDRG,
     $     mSURG,mSlRG,mSERG,AURG,ADRG,AERG,yuRG,ydRG,yeRG,SUegg,SDegg,
     $     SLegg,SNegg,Neg,Ceg,mh0sq,mhu0sq,mhpmsq,mA0sq,modmu,ON,OCL,
     $     OCR,correction)

      SUBROUTINE bottomcor(p,q,g,g3,M3t,mt,mb,mtau,tanbeta,mSQRG,mSDRG,
     $     mSURG,mSlRG,mSERG,AURG,ADRG,AERG,yuRG,ydRG,yeRG,SUegg,SDegg,
     $     SLegg,SNegg,Neg,Ceg,mh0sq,mhu0sq,mhpmsq,mA0sq,modmu,ON,OCL,
     $     OCR,hb,ht,htau,M2tz,mbcor)

      SUBROUTINE taucor(p,q,g,g3,M3t,mt,mb,mtau,tanbeta,mSQRG,mSDRG,
     $     mSURG,mSlRG,mSERG,AURG,ADRG,AERG,yuRG,ydRG,yeRG,SUegg,SDegg,
     $     SLegg,SNegg,Neg,Ceg,mh0sq,mhu0sq,mhpmsq,mA0sq,modmu,ON,OCL,
     $     OCR,M2tz,mtaucor)
```

**NOTES:**

1. q, the energy scale at which the corrections are added = MZ
2. Conventions and notations followed are that of BPMZ.

**BUGS:**

---

**SEE ALSO:**

---

# 7 SuSeFLAV/oneloophiggs.f/higgs_analytical

*[ Functions ]*

**NAME:**

subroutine higgs_analytical

**SYNOPSIS:**

Computes One loop correction(analytical) to cp even higgs boson and light higgs.

**FUNCTION:**

```
The routine calcultes one loop correction to cp even higgs boson.
hep-ph/ 9903404, hep-ph/0002213  - analytical expression for light higgs and
CP- even higgs
```

**INPUTS:**

```
alph3                          -  g3/(16 * pi^2)
mt                             -  running masses of top, bottom and tau
yuRG,ydRG,yeRG                 - (3 X 3) Yukawas
AURG                           - (3 X 3) Trilinear couplings
pizzT,piwwT                    - self energy of W and Z bosons at M_z
modmu                          - modulus of the \mu paramter
vev1,vev2                      - vacuum expectation values of the two
                                 higgs doublet fields
M3t                            - Gaugino mass at msusy
tanbeta                        - the ratio of the vevs of the
                                 two Higgs doublet fields.
SUegg   =  6 eigenvalues of UP-Squark mass matrix.
```

**RESULT:**

```
sigphi1,sigphi2,
sigphi12,sig2phi2
sig2phi2yuk         - elements of One loop corrections.
```

**EXAMPLE:**

```
SUBROUTINE higgs_analytical(MT,tanbeta,SUegg,AURG,sgnmu,modmu,
$     pizzT,piwwT,alph3,sigphi1,sigphi2,
$     sigphi12,sig2phi2,sig2phi2yuk)
```

**NOTES:**

1. q, the energy scale at which the corrections are added = msusy.
2. Conventions and notations followed are that of BPMZ.

**BUGS:**

```
---
```

**SEE ALSO:**

# 8 SuSeFLAV/oneloophiggs.f/pisisj

*[ Functions ]*

**NAME:**

```
subroutine pis1s1,pis1s2,pis2s2
```

**SYNOPSIS:**

```
Computes One loop correction to cp even higgs boson.
```

**FUNCTION:**

```
The routine calcultes one loop correction to cp even higgs boson.
From hep-ph/9606211's appendix.
```

**INPUTS:**

```
p                              - External momentum
q                              - Energy scale
g,gp,g3                        - Gauge couplings(g = em, gp = weak,
                                 g3 = strong)
mt,mb,mtau                     - pole masses of top, bottom and tau
mSQRG,mSDRG,mSURG,mSLRG,mSERG  - (3 X 3) mass matrix definition
yuRG,ydRG,yeRG                 - (3 X 3) Yukawas
AURG,ADRG,AERG                 - (3 X 3) Trilinear couplings
pizzT,piwwT                    - self energy of W and Z bosons at M_z
mh0sq,mhu0sq,mhpmsq,mA0sq      - physical higgs mass squared
modmu                          - modulus of the \mu paramter
vev1,vev2                      - vacuum expectation values of the two
                                 higgs doublet fields
M3t                            - Gaugino mass at msusy
tanbeta                        - the ratio of the vevs of the
                                 two Higgs doublet fields.
SUegg   =  6 eigenvalues of UP-Squark mass matrix.
SDegg   =  6 eigenvalues of Down-Squark mass matrix.
Slegg   =  6 eigenvalues of slepton mass matrix.
SNegg   =  3 eigenvalues of sneutrino mass matrix.
ON      =  (4 X 4) orthogonal matrix such that
           ON.MNeut.Transpose[ON] = Diag[MNeut]
Neg     =  4 singular values (descending order) of the
           Neutralino mass matrix.

OCR, OCL =  (2 X 2) orthogonal matrices such that
            MChar = Transpose[OCR].Diag[MChar].OCL
Ceg      =   2 singular values of the chargino Mass Matrix
```

**RESULT:**

```
pis1s1,pis1s2,pis2s2   =  one loop correction at a given
                          scale(generally msusy).
```

**EXAMPLE:**

```
subroutine pis1s1(p,q,g,gp,mt,mb,mtau,tanbeta,mSQRG,mSDRG,mSURG,
$     mSLRG,mSERG,AURG,ADRG,AERG,yuRG,ydRG,yeRg,SUegg,SDegg,SLegg,
$     SNegg,Neg,Ceg,ON,OCL,OCR,sgnmu,modmu,mh0sq,mhu0sq,mHpmsq,
$     mA0sq,vev1,vev2,pis1s1ans)

subroutine pis1s2(p,q,g,gp,mt,mb,mtau,tanbeta,mSQRG,mSDRG,mSURG,
$     mSLRG,mSERG,AURG,ADRG,AERG,yuRG,ydRG,yeRg,SUegg,SDegg,SLegg,
$     SNegg,Neg,Ceg,ON,OCL,OCR,sgnmu,modmu,mh0sq,mhu0sq,
$     mHpmsq,mA0sq,vev1,vev2,pis1s2ans)

subroutine pis2s2(p,q,g,gp,mt,mb,mtau,tanbeta,mSQRG,mSDRG,mSURG,
$     mSLRG,mSERG,AURG,ADRG,AERG,yuRG,ydRG,yeRg,SUegg,SDegg,SLegg,
$     SNegg,Neg,Ceg,ON,OCL,OCR,sgnmu,modmu,mh0sq,mhu0sq,mHpmsq,
$     mA0sq,vev1,vev2,pis2s2ans)
```

**NOTES:**

1. q, the energy scale at which the corrections are added = msusy.
2. Conventions and notations followed are that of BPMZ.

**BUGS:**

---

**SEE ALSO:**

# 9 SuSeFLAV/oneloopneutralino.f

*[ Functions ]*

**NAME:**

subroutine neutralino

**SYNOPSIS:**

One loop correction to neutralino.

**FUNCTION:**

```
Computes 1-loop correction to neutralinos at a given energy scale and
external momenta
```

**INPUTS:**

```
p                              - External momentum
q                              - Energy scale
g,gp,g3                        - Gauge couplings(g = em, gp = weak,
                                 g3 = strong)
mt,mb,mtau                     - pole masses of top, bottom and tau
mSQRG,mSDRG,mSURG,mSLRG,mSERG  - (3 X 3) mass matrix definition
yuRG,ydRG,yeRG                 - (3 X 3) Yukawas
AURG,ADRG,AERG                 - (3 X 3) Trilinear couplings
pizzT,piwwT                    - self energy of W and Z bosons at M_z
mh0sq,mhu0sq,mhpmsq,mA0sq      - physical higgs mass squared
modmu                          - modulus of the \mu paramter
vev1,vev2                      - vacuum expectation values of the two
                                 higgs doublet fields
M3t                            - Gaugino mass at msusy
tanbeta                        - the ratio of the vevs of the
                                 two Higgs doublet fields.
SUegg   =  6 eigenvalues of UP-Squark mass matrix.
SDegg   =  6 eigenvalues of Down-Squark mass matrix.
Slegg   =  6 eigenvalues of slepton mass matrix.
SNegg   =  3 eigenvalues of sneutrino mass matrix.
ON      =  (4 X 4) orthogonal matrix such that
           ON.MNeut.Transpose[ON] = Diag[MNeut]
Neg     =  4 singular values (descending order) of the
           Neutralino mass matrix.

OCR, OCL =  (2 X 2) orthogonal matrices such that
            MChar = Transpose[OCR].Diag[MChar].OCL
Ceg     =   2 singular values of the chargino Mass Matrix
```

**RESULT:**

```
Negm            =   4 eigenvalues of the 1-loop corrected neutralino
                        mass matrix.
ONew            =   (4 X 4) corrected orthogonal matrix such that
                  MChar = Transpose[Onew].Diag[MNeut].ONew
neutmassmasstot = (4x4) corrected neutralino mass matrix
```

**EXAMPLE:**

```
subroutine neutralino(p,q,g,gp,mt,mb,mtau,tanbeta,mSQRG,mSDRG,
```

```
$     mSURG,mSLRG,mSERG,AURG,ADRG,AERG,yuRG,ydRG,yeRG,SUegg,SDegg,
$     SLegg,SNegg, MNeut1,Neg,Ceg,ON,OCL,OCR,modmu,mh0sq,mhu0sq,
$     mHpmsq,mA0sq,vev1,vev2,ONew,Negm,neutmasstot)
```

**NOTES:**

```
1. q, the energy scale at which the corrections are added = msusy.
2. Conventions and notations followed are that of BPMZ.
3. p = msusy
```

**BUGS:**

```
---
```

**SEE ALSO:**

## 10 SuSeFLAV/oneloopselfenergy.f

*[ Functions ]*

**NAME:**

```
oneloopselfenergy
```

**SYNOPSIS:**

```
One loop correction to Z,W,hA,Hpm.
```

**FUNCTION:**

```
 Computes self energy for W,Z,hA and Hpm, given, energy scale and external momenta
```

**INPUTS:**

```
p                              - External momentum
q                              - Energy scale
g,gp,g3                        - Gauge couplings(g = em, gp = weak, g3 = strong)
mt,mb,mtau                     - pole masses of top, bottom and tau
mSQRG,mSDRG,mSURG,mSLRG,mSERG  - (2 X 2) mass matrix definition
AURG,ADRG,AERG                 - Trilinear couplings
mh0sq,mhu0sq,mhpmsq,mA0sq      - physical higgs mass squared
modmu                          - modulus of the \mu paramter
tanbeta                        - the ratio of the vevs of the two Higgs doublet fields.
```

```
SUegg    =  6 eigenvalues (ascending order) of UP-Squark mass matrix.
SDegg    =  6 eigenvalues (ascending order) of Down-Squark mass matrix.
Slegg    =  6 eigenvalues (ascending order) of slepton mass matrix.
SNegg    =  3 eigenvalues (ascending order) of sneutrino mass matrix.
ON       =  (4 X 4) orthogonal matrix such that
            ON.MNeut.Transpose[ON] = Diag[MNeut]
Neg      =  4 singular values (descending order) of the Neutralino mass matrix.

OCR, OCL =  (2 X 2) orthogonal matrices such that
            MChar = Transpose[OCR].Diag[MChar].OCL
Ceg      =   2 singular values of the Neutralino Mass Matrix
```

**RESULT:**

```
pizzT      - Z boson self energy
piwwT      - W boson self energy
piaaT      - Higgs boson A self energy
piHpHm     - Charged higgs H+ self energy
```

**EXAMPLE:**

```
      SUBROUTINE pizz(p,q,g,mt,mb,mtau,tanbeta,mSQRG,mSDRG,mSURG,mSLRG,
     $     mSERG,AURG,ADRG,AERG,SUegg,SDegg,SLegg,SNegg,Neg,Ceg,mh0sq,
     $     mhu0sq,mhpmsq,mA0sq,modmu,ON,OCL,OCR,pizzT)

       SUBROUTINE piww(p,q,g,mt,mb,mtau,tanbeta,mSQRG,mSDRG,mSURG,mSLRG,
     $     mSERG,AURG,ADRG,AERG,SUegg,SDegg,SLegg,SNegg,Neg,Ceg,mh0sq,
     $     mhu0sq,mhpmsq,mA0sq,modmu,ON,OCL,OCR,piwwT)

       SUBROUTINE piaa(p,q,g,gp,mt,mb,mtau,tanbeta,mSQRG,mSDRG,mSURG,
     $     mSLRG,mSERG,yuRG,ydRG,yeRG,AURG,ADRG,AERG,SUegg,SDegg,SLegg,
     $     SNegg,Neg,Ceg,mh0sq,mhu0sq,mhpmsq,mA0sq,modmu,ON,OCL,OCR,
     $     piaaT)

      SUBROUTINE pihphm(p,q,g,gp,mt,mb,mtau,tanbeta,mSQRG,mSDRG,mSURG,
     $     mSLRG,mSERG,AURG,ADRG,AERG,SUegg,SDegg,SLegg,SNegg,Neg,Ceg,
     $     yuRG,yeRG,ydRG,mh0sq,mhu0sq,mhpmsq,mA0sq,modmu,ON,OCL,OCR,
     $     pihphmT)
```

**NOTES:**

1. q, the energy scale at which the corrections are added = MZ for W and Z bosons.
2. Running values of gauge couplings( Rge output) are used.
3. Pole masses: DRbar scheme is followed.
4. Conventions followed are that of BPMZ.

**BUGS:**

```
---
```

**SEE ALSO:**

```
----
```

# 11 SuSeFLAV/oneloopsfermion.f

*[ Functions ]*

**NAME:**

```
oneloopsfermion
```

**SYNOPSIS:**

```
One loop correction to sfermions.
```

**FUNCTION:**

```
 Computes self energy for all sfermions at a given energy scale and external momenta
```

**INPUTS:**

```
p                              - External momentum
q                              - Energy scale
g,gp,g3                        - Gauge couplings(g = em, gp = weak,
                                 g3 = strong)
mt,mb,mtau                     - pole masses of top, bottom and tau
mSQRG,mSDRG,mSURG,mSLRG,mSERG  - (3 X 3) mass matrix definition
yuRG,ydRG,yeRG                 - (3 X 3)Yukawas
AURG,ADRG,AERG                 - (3 X 3)Trilinear couplings
pizzT,piwwT                    - self energy of W and Z bosons at M_z
mh0sq,mhu0sq,mhpmsq,mA0sq      - physicsal higgs mass squared
modmu                          - modulus of the \mu paramter
vev1,vev2                      - vacuum expectation values of the two higgs
                                 doublet fields
M3t                            - Gaugino mass at msusy
tanbeta                        - the ratio of the vevs of the twoHiggs
                                 doublet fields.
SUegg   =  6 eigenvalues of UP-Squark mass matrix.
SDegg   =  6 eigenvalues of Down-Squark mass matrix.
```

```
Slegg   =  6 eigenvalues of slepton mass matrix.
SNegg   =  3 eigenvalues of sneutrino mass matrix.
ON      =  (4 X 4) orthogonal matrix such that
           ON.MNeut.Transpose[ON] = Diag[MNeut]
Neg     =  4 singular values (descending order) of the
            Neutralino mass matrix.

OCR, OCL =  (2 X 2) orthogonal matrices such that
            MChar = Transpose[OCR].Diag[MChar].OCL
Ceg     =   2 singular values of the chargino Mass Matrix
```

**RESULT:**

```
S_eg     =  2 eigenvalues of the corrected mass matrix( L and R components).
```

**EXAMPLE:**

```
      SUBROUTINE pistop(p,q,g,gp,g3,mt,mb,mtau,tanbeta,mSQRG,mSDRG,
$     mSURG,mSLRG,mSERG,yuRG,ydRG,yeRG,AURG,ADRG,AERG,SUegg,SDegg,
$     SLegg,SNegg,Neg,Ceg,pizzT,piwwT,mh0sq,mhu0sq,mhpmsq,mA0sq,
$     modmu,ON,OCL,OCR,vev1,vev2,M3t,STeg)

      SUBROUTINE pisbottom(p,q,g,gp,g3,mt,mb,mtau,tanbeta,mSQRG,mSDRG,
$     mSURG,mSLRG,mSERG,yuRG,ydRG,yeRG,AURG,ADRG,AERG,SUegg,SDegg,
$     SLegg,SNegg,Neg,Ceg,pizzT,piwwT,mh0sq,mhu0sq,mhpmsq,mA0sq,
$     modmu,ON,OCL,OCR,vev1,vev2,M3t,SBeg)

      SUBROUTINE pisstrange(p,q,g,gp,g3,mt,mb,mtau,tanbeta,mSQRG,mSDRG,
$     mSURG,mSLRG,mSERG,yuRG,ydRG,yeRG,AURG,ADRG,AERG,SUegg,SDegg,
$     SLegg,SNegg,Neg,Ceg,pizzT,piwwT,mh0sq,mhu0sq,mhpmsq,mA0sq,
$     modmu,ON,OCL,OCR,vev1,vev2,M3t,SSTeg)

      SUBROUTINE pisdown(p,q,g,gp,g3,mt,mb,mtau,tanbeta,mSQRG,mSDRG,
$     mSURG,mSLRG,mSERG,yuRG,ydRG,yeRG,AURG,ADRG,AERG,SUegg,SDegg,
$     SLegg,SNegg,Neg,Ceg,pizzT,piwwT,mh0sq,mhu0sq,mhpmsq,mA0sq,
$     modmu,ON,OCL,OCR,vev1,vev2,M3t,SDeg)

      SUBROUTINE pischarm(p,q,g,gp,g3,mt,mb,mtau,tanbeta,mSQRG,mSDRG,
$     mSURG,mSLRG,mSERG,yuRG,ydRG,yeRG,AURG,ADRG,AERG,SUegg,SDegg,
$     SLegg,SNegg,Neg,Ceg,pizzT,piwwT,mh0sq,mhu0sq,mhpmsq,mA0sq,
$     modmu,ON,OCL,OCR,vev1,vev2,M3t,SCeg)

      SUBROUTINE pisupq(p,q,g,gp,g3,mt,mb,mtau,tanbeta,mSQRG,mSDRG,
$     mSURG,mSLRG,mSERG,yuRG,ydRG,yeRG,AURG,ADRG,AERG,SUegg,SDegg,
$     SLegg,SNegg,Neg,Ceg,pizzT,piwwT,mh0sq,mhu0sq,mhpmsq,mA0sq,
$     modmu,ON,OCL,OCR,vev1,vev2,M3t,SUeg)
```

```
      SUBROUTINE pistaul(p,q,g,gp,g3,mt,mb,mtau,tanbeta,mSQRG,mSDRG,
     $     mSURG,mSLRG,mSERG,yuRG,ydRG,yeRG,AURG,ADRG,AERG,SUegg,SDegg,
     $     SLegg,SNegg,Neg,Ceg,pizzT,piwwT,mh0sq,mhu0sq,mhpmsq,mA0sq,
     $     modmu,ON,OCL,OCR,vev1,vev2,M3t,STaueg)

      SUBROUTINE pisMUl(p,q,g,gp,g3,mt,mb,mtau,tanbeta,mSQRG,mSDRG,
     $     mSURG,mSLRG,mSERG,yuRG,ydRG,yeRG,AURG,ADRG,AERG,SUegg,SDegg,
     $     SLegg,SNegg,Neg,Ceg,pizzT,piwwT,mh0sq,mhu0sq,mhpmsq,mA0sq,
     $     modmu,ON,OCL,OCR,vev1,vev2,M3t,SMueg)

      SUBROUTINE pitausnu(p,q,g,gp,g3,mt,mb,mtau,tanbeta,mSQRG,mSDRG,
     $     mSURG,mSLRG,mSERG,yuRG,ydRG,yeRG,AURG,ADRG,AERG,SUegg,SDegg,
     $     SLegg,SNegg,Neg,Ceg,pizzT,piwwT,mh0sq,mhu0sq,mhpmsq,mA0sq,
     $     modmu,ON,OCL,OCR,vev1,vev2,M3t,tsnu)

      SUBROUTINE pimulsnu(p,q,g,gp,g3,mt,mb,mtau,tanbeta,mSQRG,mSDRG,
     $     mSURG,mSLRG,mSERG,yuRG,ydRG,yeRG,AURG,ADRG,AERG,SUegg,SDegg,
     $     SLegg,SNegg,Neg,Ceg,pizzT,piwwT,mh0sq,mhu0sq,mhpmsq,mA0sq,
     $     modmu,ON,OCL,OCR,vev1,vev2,M3t,musnu)

      SUBROUTINE pielsnu(p,q,g,gp,g3,mt,mb,mtau,tanbeta,mSQRG,mSDRG,
     $     mSURG,mSLRG,mSERG,yuRG,ydRG,yeRG,AURG,ADRG,AERG,SUegg,SDegg,
     $     SLegg,SNegg,Neg,Ceg,pizzT,piwwT,mh0sq,mhu0sq,mhpmsq,mA0sq,
     $     modmu,ON,OCL,OCR,vev1,vev2,M3t,elsnu)
```

**NOTES:**

1. q, the energy scale at which the corrections are added = msusy.
2. Running values of gauge couplings( Rge output) are used.
3. Pole masses: DRbar scheme is followed.
4. Conventions and notations followed are that of BPMZ.

**BUGS:**

---

**SEE ALSO:**

DSYEV - Diagonalizing Routine.
LAPACK

# 12 SuSeFLAV/onelooptadpole.f

*[ Functions ]*

**NAME:**

```
subroutine tadpole1,tadpole2
```

**SYNOPSIS:**

```
Computes One loop tadpoles.
```

**FUNCTION:**

```
The routine calcultes one loop tadpoles
From hep-ph/9606211's appendix. It should be done at MSusy to minimize the
1-loop contributions.
```

**INPUTS:**

```
p                              - External momentum
q                              - Energy scale
g,gp,g3                        - Gauge couplings(g = em, gp = weak,
                                 g3 = strong)
mt,mb,mtau                     - pole masses of top, bottom and tau
mSQRG,mSDRG,mSURG,mSLRG,mSERG  - (3 X 3) mass matrix definition
yuRG,ydRG,yeRG                 - (3 X 3) Yukawas
AURG,ADRG,AERG                 - (3 X 3) Trilinear couplings
pizzT,piwwT                    - self energy of W and Z bosons at M_z
mh0sq,mhu0sq,mhpmsq,mA0sq      - physical higgs mass squared
modmu                          - modulus of the \mu paramter
vev1,vev2                      - vacuum expectation values of the two
                                 higgs doublet fields
M3t                            - Gaugino mass at msusy
tanbeta                        - the ratio of the vevs of the
                                 two Higgs doublet fields.
SUegg   =  6 eigenvalues of UP-Squark mass matrix.
SDegg   =  6 eigenvalues of Down-Squark mass matrix.
Slegg   =  6 eigenvalues of slepton mass matrix.
SNegg   =  3 eigenvalues of sneutrino mass matrix.
ON      =  (4 X 4) orthogonal matrix such that
           ON.MNeut.Transpose[ON] = Diag[MNeut]
Neg     =  4 singular values (descending order) of the
           Neutralino mass matrix.

OCR, OCL =  (2 X 2) orthogonal matrices such that
            MChar = Transpose[OCR].Diag[MChar].OCL
Ceg      =   2 singular values of the chargino Mass Matrix
```

**RESULT:**

```
 delta1,delta2   =  tadpoles at a given scale(generally msusy).
```

**EXAMPLE:**

```
      subroutine tadpole1(q,g,mt,mb,mtau,tanbeta,mSQRG,mSDRG,mSURG,
     $     mSLRG,mSERG,AURG,ADRG,AERG,yuRG,ydRG,yeRG,SUegg,SDegg,SLegg,
     $     SNegg,Neg,Ceg,ON,OCL,OCR,sgnmu,modmu,mh0sq,mhu0sq,mHpmsq,
     $     mA0sq,vev1,vev2,pizzT,piwwT,delta1)

      subroutine tadpole2(q,g,mt,mb,mtau,tanbeta,mSQRG,mSDRG,mSURG,
     $     mSLRG,mSERG,AURG,ADRG,AERG,yuRG,ydRG,yeRG,SUegg,SDegg,SLegg,
     $     SNegg,Neg,Ceg,ON,OCL,OCR,sgnmu,modmu,mh0sq,mhu0sq,mHpmsq,
     $     mA0sq,vev1,vev2,pizzT,piwwT,delta2)
```

**NOTES:**

```
1. q, the energy scale at which the corrections are added = msusy.
2. Conventions and notations followed are that of BPMZ.
```

**BUGS:**

```
---
```

**SEE ALSO:**

# 13 SuSeFLAV/rgeiterate.f

*[ Functions ]*

**NAME:**

```
RECURSIVE Subroutine rgeiterate
```

**SYNOPSIS:**

```
Run mssm and sm  RGEs, computes tree level physical masses
and the corresponding one loop correction
for MSSM parameters.
```

**FUNCTION:**

```
This suborutine integrates MSSM RGEs and computes low
energy spectrum at msusy.
```

**INPUTS:**

```
MW          - Mass of W boson
MZ          - Mass of Z boson
MT          - top quark mass in \overline{DR} scheme
mb          - bottom quark  mass in \overline{DR} scheme
mtau        - \tau lepton  mass in \overline{DR} scheme
msusyold    - Initial guess value of msusy = sqrt(m0^2 + 4 m12^2)
vevsc       - scaled vev. vev/root2
vevin       - vev at MZ
yuin        - (3x3) up type yukawa matrix
ydin        - (3x3) down type yukawa matrix
yein        - (3x3) matrix yukawa for leptons
alphaDR     - alpha_{\overline{DR}}
alph1in     -  g1^2/(16 pi^2) at MZ
alph2in     -  g2^2/(16 pi^2) at MZ
alph3in     -  g3^2/(16 pi^2) at MZ
mur         -  \mu at mz
bmur        -  \bmu at mz
msusy       - susy breaking scale
prnstat     - Print control
itcount     - Rge iteration count
```

**RESULT:**

```
MTc_mz      -  one loop correction to top quark
mBc_mz      -  one loop correction to bottom  quark
mtauc_mz    -  one loop correction to tau lepton
delalphem   -  one loop correction to em coupling
delalphas   -  one loop correction to strong coupling
murge       -  RGE output: \mu at M_{susy} scale
bmurge      -  RGE output: b_\mu at M_{susy} scale
newtbeta    -  Ratio of vev at msusy from rge running.
msusynew    -  geometric mean of stop1 and stop2
flags       -  flags problem with rge running, if any.
itcount     - iteration count
stopratu
stopratd    - variables used to check for global convergence of \mu
sinsqtheff - one loop corrected effective sinsqthw

Calculated tree level and 1-loop masses are stored in
common blocks
```

**EXAMPLE:**

```
RECURSIVE SUBROUTINE rgeit(MW,MZ,MT,MTc_mz,mB,mBc_mz,mTau,
```

```
$     mtauc_mz,msusyold,vevsc,vevin,vev1in,vev2in,yuin,
$     ydin,yein,alphaDR,alph1in,alph2in,delalphem,
$     alph3in,delalphas,mur,bmur,murge,bmurge,prnstat,check,
$     newtbeta, MTatMZ,msusynew,mursq,try,newmh0sq,cheg,
$     flags,runum,itcount,stopratu,stopratd,sinsqtheff)
```

**NOTES:**

```
Common Blocks used:
 common/mascorr/ MT_qcd_corr
 common/sminputs/ mbpole, mtaupole, Mtpole
 common/loops/ lopt,rhn
 common/mssminputs/ m0, m12, m10, m20, sgnmu, tanbeta, a0
 common/mssmrhn/ MR1,MR2,MR3,ue3, Ynui
 common/charinputs/case, model
 common/rgeinput_high/ MX, M1X,M2X,M3X,mh10,mh20,
$     mQ0,mU0,mD0,mE0,mL0,mNU0
 common/softout_mat/mSQRG,mSURG,mSDRG,AURG,ADRG,
$     AERG,ANURG,mSLRG,mSERG, mSNURG,ON,OCL,OCR,MChar, MNeut
 common/softout_mat_mz/mSQRGz,mSURGz,mSDRGz,AURGz,ADRGz,
$     AERGz,ANURGz,mSLRGz,mSERGz, mSNURGz,ONz,OCLz,OCRz,
$     MCharz, MNeutz
 common/rgeoutput_susy/ mh1mz,mh2mz,M1tz,M2tz,M3tz,
$     alph1,alph2,alph3,vev1,vev2,yuRG,ydRG,yeRG
 common/rgeoutput_MZ/ mh1mzz,mh2mzz,M1tmz,M2tmz,M3tmz,
$     alph1MZ,alph2MZ,alph3MZ,vev1mz,vev2mz,yumz,ydmz,yemz
 common/sparticles_susy/SUegg,SDegg,SLegg,SNegg,Neg,Ceg,
$     mh0sq,mhu0sq,mhpmsq,mA0sq
 common/sparticles_MZ/SUeggz,SDeggz,SLeggz,SNeggz,Negz,Cegz,
$     mh0sqz,mhu0sqz,mhpmsqz,mA0sqz
 common/soft_mat_susy/ mSL1, SLeg, USL, SNeg, USN, SUeg, USU,
$     SDeg, USD
 common/soft_mat_mz/ mSL1z, SLegz, USLz, SNegz, USNz, SUegz, USUz,
$     SDegz, USDz
 common/sfmixing_susy/thetat,thetab,thetatau,thetac,thetas,thetamu,
$     thetau,thetad,thetae
 common/mu_mz/ murgemz
 common/rgeopt_mz/mt_mz, mb_mz, mtau_mz
 common/runningew/MWsq_mz,MZsq_mz
 common/hzV/ delta1,delta2
 common/mu_rge/mufrge
 common/runningmass_susy/MT_susy, MB_susy, Mtau_susy
 common/mAflag/flag_bmu

External Routines used:
 EXTERNAL completerun, runtomz,iterate,rewsbcor, coratmz, lhaout
```

**BUGS:**

---

**SEE ALSO:**

-----

## 14 SuSeFLAV/softspectrum.f

*[ Functions ]*

**NAME:**

softspectrum

**SYNOPSIS:**

Subroutine to generate Susy spectrum.

**FUNCTION:**

```
THIS PROGRAM CALCULATES THE MASSES AND MIXINGS IN THE SOFT
SECTOR FOR A GIVEN SPARTICLE MASSES AT LOW ENERGIES. THIS
PARAMETERS CAN BE EITHER OUTPUT FROM RGE OR DIRECT INPUTS.
AT PRESENT, IT HAS MAINLY SLEPTONIC AND SNEUTRINO PART ALONG
WITH CHARGINO AND NEUTRALINO PARTS IN THE BASIS WHERE CHARGED
LEPTONS ARE CONSIDERED DIAGONAL.
Higgs Spectrum added. Last Modified : 26/01/10.
```

**INPUTS:**

```
tanbeta  = value of the tanbeta being used.
mSLRG    = (3 X 3) real mass matrix of left-handed sleptons (L)
mSERG    = (3 X 3) real mass matrix of right-handed sleptons (E^c)
AERG     = (3 X 3) real mass matrix of leptonic A-parameters.
M1tz     = low-energy (~M_Z) value of parameter M1
M2tz     = low-energy (~M_Z) value of parameter M2
mur      =  low-energy value of the mu-parameter either through REWSB
       or as a free parameter.
```

**RESULT:**

```
SUegg = 6 eigenvalues (lr-stop,lr-scharm,lr-sups) of UP-Squark mass matrix.
USU = (6 X 6) real orthogonal matrix such that,
       USU*MSU*Transpose[USU] = Diag[MSU].
SUeg = 6 singular values (descending order) of UP-Squark mass
       mass matrix. All positive.

SDegg = 6 eigenvalues (lr,lr,lr) of Down-Squark mass matrix.
USD = (6 X 6) real orthogonal matrix such that,
       USD*MSD*Transpose[USD] = Diag[MSD].
SDeg = 6 singular values (descending order) of Down-Squark mass
       mass matrix. All positive.

Slegg = 6 eigenvalues (lr,lr,lr) of slepton mass matrix.
USL = (6 X 6) real orthogonal matrix such that,
       USL*MSL*Transpose[USL] = Diag[MSL].
SLeg = 6 singular values (descending order) of slepton mass
       mass matrix. All positive.

SNegg = 3 eigenvalues (ascending order) of sneutrino mass matrix.
USN = (3 X 3) real orthogonal matrix such that
        USN*mSN*Transpose[USN] = Diag[MSN].
SNeg = 3 singular values (descending order) of sneutrino mass matrix.

ON = (4 X 4) orthogonal matrix such that
      ON.MNeut.Transpose[ON] = Diag[MNeut]
Neg = 4 singular values (descending order) of the Neutralino mass matrix.

OCR, OCL = (2 X 2) orthogonal matrices such that
           MChar = Transpose[OCR].Diag[MChar].OCL
Ceg = 2 singular values of the Neutralino Mass Matrix

AOK = Tells us whether all the diagonalising routines have run alright
      or not. Without the Higgs spectrum, AOK should be 10 on output,
      if everything goes well.
```

**EXAMPLE:**

```
 subroutine softspectrum(tanbeta,mSQRG,mSDRG,mSURG,AURG,ADRG,vev1,
$     vev2,mSLRG,mSERG,AERG,yuRG,yeRG,ydRG,M1tz,M2tz,mur,SUegg,USU,
$     SUeg,SDegg,USD,SDeg,SLegg,USL,SLeg,SNegg,USN,SNeg,ON,Neg,OCR,
$     OCL,Ceg,AOK,MT_susy,MB_susy,Mtau_susy,mh1mz,mh2mz,mh0sq,
$     mhu0sq,mhpmsq,mA0sq,Neuevi,ONL,ONR)
```

**NOTES:**

```
ALL Masses and Parameters are in GeV.
```

```
Lapack is required.
Note that Lapack returns singular values as A = U Diag [A] Transpose[V]
or Transpose[U] A V = Diag[A]  which is transpose of the conventions of
Mathematica as well as our conventions. (See notes). Our conventions
coincide with that of HN.  Also compare with that of Haber-Kane.
```

**BUGS:**

```
Possibly there are no bugs in this subroutine.
```

**SEE ALSO:**

```
-----
```

# 15 SuSeFLAV/spectrumtl.f/completerun

*[ Functions ]*

**NAME:**

```
Subroutine completerun
```

**SYNOPSIS:**

```
Runs RGEs and computes tree level physical masses
for MSSM parameters.
```

**FUNCTION:**

```
This suborutine integrates MSSM RGEs and computes low
energy spectrum at msusy.
```

**INPUTS:**

```
vevin      - vev at MZ
yuin       - (3x3) up type yukawa matrix
ydin       - (3x3) down type yukawa matrix
yein       - (3x3) matrix yukawa for leptons
alph1in    -  g1^2/(16 pi^2) at MZ
alph2in    -  g2^2/(16 pi^2) at MZ
alph3in    -  g3^2/(16 pi^2) at MZ
mur        -  \mu at mz
bmur       -  \bmu at mz
msusy      - susy breaking scale
prnstat    - Print control
itcount    - Rge iteration count
```

**RESULT:**

```
     murge    -  RGE output: \mu at M_{susy} scale
     bmurge   -  RGE output: b_\mu at M_{susy} scale
     newtbeta -  Ratio of vev at msusy from rge running.
     flags    -  flags problem with rge running, if any.

    Calculated tree level masses are stored in common blocks
      common/softout_mat/mSQRG,mSURG,mSDRG,AURG,ADRG,
     $     AERG,ANURG,mSLRG,mSERG, mSNURG,ON,OCL,OCR,MChar, MNeut
      common/rgeoutput_susy/ mh1mz,mh2mz,M1tz,M2tz,M3tz,
     $     alph1,alph2,alph3,vev1,vev2,yuRG,ydRG,yeRG
      common/sparticles_susy/SUegg,SDegg,SLegg,SNegg,Neg,Ceg,
     $     mh0sq,mhu0sq,mhpmsq,mA0sq
```

**EXAMPLE:**

```
   subroutine completerun(msusyold,vevin,yuin,ydin,yein,
     $     alph1in,alph2in,alph3in,mur,bmur,murge,bmurge,prnstat,
     $     check,newtbeta,msusynew,mursq,try,flags,runum,itcount)
```

**NOTES:**

```
     Common Blocks used:
      common/mu_rge/mufrge
      common/loops/ lopt,rhn
      common/sminputs/ mbpole, mtaupole, Mtpole
      common/mssminputs/ m0, m12, m10, m20, sgnmu, tanbeta, a0
      common/mssmrhn/ MR1,MR2,MR3,ue3, Ynui
      common/charinputs/case, model
      common/rgeinput_high/ MX, M1X,M2X,M3X,mh10,mh20,
     $     mQ0,mU0,mD0,mE0,mL0,mNU0
      common/softout_mat/mSQRG,mSURG,mSDRG,AURG,ADRG,
     $     AERG,ANURG,mSLRG,mSERG, mSNURG,ON,OCL,OCR,MChar, MNeut
      common/rgeoutput_susy/ mh1mz,mh2mz,M1tz,M2tz,M3tz,
     $     alph1,alph2,alph3,vev1,vev2,yuRG,ydRG,yeRG
      common/sparticles_susy/SUegg,SDegg,SLegg,SNegg,Neg,Ceg,
     $     mh0sq,mhu0sq,mhpmsq,mA0sq
      common/soft_mat_susy/ mSL1, SLeg, USL, SNeg, USN, SUeg, USU,
     $     SDeg, USD
      common/runningmass_susy/MT_susy, MB_susy, Mtau_susy

     External Routine used:
      EXTERNAL MSSMRUN,mutreelevel,softspectrum
```

**BUGS:**

---

**SEE ALSO:**

---

# 16 SuSeFLAV/spectrumtl.f/runtomz

*[ Functions ]*

**NAME:**

```
Subroutine runtomz
```

**SYNOPSIS:**

```
Runs RGEs from msusy to MZ and computes tree level
physical masses for MSSM parameters.
```

**FUNCTION:**

```
This suborutine integrates MSSM RGEs from msusy to MZ and
computes low energy spectrum at msusy.

*  INPUTS
    MX          -  Reference scale, 10^19(GeV)
    msusy       -  susy breaking scale.
    mu_conv     -  Converged value of \mu at msusy.
    bmur_conv   -  Converged value of b_\mu at msusy.
```

**RESULT:**

```
    murgemz     -  RGE output: \mu at M_z scale
    bmurgemz    -  RGE output: b_\mu at M_z scale
    newtbetamz  -  Ratio of vev at MZ from rge running.
    flags       - flags any problem with the running

   Calculated tree level masses at MZ are stored in common blocks
     common/rgeoutput_MZ/ mh1mzz,mh2mzz,M1tmz,M2tmz,M3tmz,
    $     alph1MZ,alph2MZ,alph3MZ,vev1mz,vev2mz,yumz,ydmz,yemz
     common/sparticles_MZ/SUeggz,SDeggz,SLeggz,SNeggz,Negz,Cegz,
    $     mh0sqz,mhu0sqz,mhpmsqz,mA0sqz
     common/softout_mat_mz/mSQRGz,mSURGz,mSDRGz,AURGz,ADRGz,
    $     AERGz,ANURGz,mSLRGz,mSERGz, mSNURGz,ONz,OCLz,OCRz,
```

```
$     MCharz, MNeutz
 common/soft_mat_mz/ mSL1z, SLegz, USLz, SNegz, USNz, SUegz, USUz,
$     SDegz, USDz
 common/rgeopt_mz/mt_mz, mb_mz, mtau_mz
```

**EXAMPLE:**

```
 SUBROUTINE runtomz(try,MX,msusy,mu_conv,bmur_conv,
$     murgemz,bmurgemz,newtbetamz,flags)
```

**NOTES:**

```
Common Blocks used:
 common/mssminputs/ m0, m12, m10, m20, sgnmu, tanbeta, a0
 common/rgeoutput_MZ/ mh1mzz,mh2mzz,M1tmz,M2tmz,M3tmz,
$     alph1MZ,alph2MZ,alph3MZ,vev1mz,vev2mz,yumz,ydmz,yemz
 common/sparticles_MZ/SUeggz,SDeggz,SLeggz,SNeggz,Negz,Cegz,
$     mh0sqz,mhu0sqz,mhpmsqz,mA0sqz
 common/softout_mat_mz/mSQRGz,mSURGz,mSDRGz,AURGz,ADRGz,
$     AERGz,ANURGz,mSLRGz,mSERGz, mSNURGz,ONz,OCLz,OCRz,
$     MCharz, MNeutz
 common/soft_mat_mz/ mSL1z, SLegz, USLz, SNegz, USNz, SUegz, USUz,
$     SDegz, USDz
 common/rgeopt_mz/mt_mz, mb_mz, mtau_mz
 common/runningew/MWsq_mz,MZsq_mz

External routines used:
  EXTERNAL MSSM_MZ, softspectrum
```

**BUGS:**

```
---
```

**SEE ALSO:**

```
-----
```

# 17 SuSeFLAV/SuSemain.f

*[ Functions ]*

**NAME:**

```
subroutine SuSemain
```

**SYNOPSIS:**

```
Main routine for running SuSeFLAV.
```

**FUNCTION:**

```
Computes 1-loop corrected Supersymmetric particle spectrum for a given
set of mSUGRA/NUHM/CNUM inputs. Also, the routine computes branching
ratios and decay rates for rare lfv processes.
```

**INPUTS:**

```
prnstat    -    Print Control. 1= print statements
Mg1        -    high energy input for bino
Mg2        -    high energy input for  wino
Mg3        -     high energy input for gluino

Other relevant input parameters are stored in common block
  common/sminputs/ mbpole, mtaupole, Mtpole
  common/loops/ lopt,rhn
  common/mssminputs/ m0, m12, m10, m20, sgnmu, tanbeta, a0
  common/mssmrhn/ MR1,MR2,MR3,ue3, Ynui
  common/charinputs/case, model
```

**RESULT:**

```
 errge      - if any error is encountered errge =1 else =0.
Output is written in slha.out
```

**EXAMPLE:**

```
SUBROUTINE SuSeFLAV(prnstat,mq20, mq30, mu20, mu30, md20, md30,
 $     ml20,ml30, me20,me30, mnu20,mnu30,Mg1,Mg2,Mg3,errge)
```

**NOTES:**

```
Common blocks used:
 common/sminputs/ mbpole, mtaupole, Mtpole
 common/loops/ lopt,rhn
 common/mssminputs/ m0, m12, m10, m20, sgnmu, tanbeta, a0
 common/mssmrhn/ MR1,MR2,MR3,ue3, Ynui
 common/charinputs/case, model
 common/rgeinput_high/ MX, M1X,M2X,M3X,mh10,mh20,
$     mQ0,mU0,mD0,mE0,mL0,mNU0
 common/softout_mat/mSQRG,mSURG,mSDRG,AURG,ADRG,
```

```
$     AERG,ANURG,mSLRG,mSERG, mSNURG,ON,OCL,OCR,MChar, MNeut
 common/rgeoutput_susy/ mh1mz,mh2mz,M1tz,M2tz,M3tz,
$     alph1,alph2,alph3,vev1,vev2,yuRG,ydRG,yeRG
 common/rgeoutput_MZ/ mh1mzz,mh2mzz,M1tmz,M2tmz,M3tmz,
$     alph1MZ,alph2MZ,alph3MZ,vev1mz,vev2mz,yumz,ydmz,yemz
 common/sparticles_susy/SUegg,SDegg,SLegg,SNegg,Neg,Ceg,
$     mh0sq,mhu0sq,mhpmsq,mA0sq
 common/soft_mat_susy/ mSL1, SLeg, USL, SNeg, USN, SUeg, USU,
$     SDeg, USD
 common/qcd_cor/mbmzdrbar,mbMZmsbar
 common/sparticles_MZ/SUeggz,SDeggz,SLeggz,SNeggz,Negz,Cegz,
$     mh0sqz,mhu0sqz,mhpmsqz,mA0sqz
 common/soft_mat_mz/ mSL1z, SLegz, USLz, SNegz, USNz, SUegz, USUz,
$     SDegz, USDz
 common/softout_mat_mz/mSQRGz,mSURGz,mSDRGz,AURGz,ADRGz,
$     AERGz,ANURGz,mSLRGz,mSERGz, mSNURGz,ONz,OCLz,OCRz,
$     MCharz, MNeutz
 common/rgeopt_mz/mt_mz, mb_mz, mtau_mz
 common/lfvindex/delta
 common/mutaup/rrstaumu,USLsrt,USLTsrt
 common/gauge/alph,Gf,alphas

External routines:
 external  rgeit
```

**BUGS:**

---

**SEE ALSO:**

---

# 18 susyflav/mssmrge.f

*[ Functions ]*

**NAME:**

mssmrge

**SYNOPSIS:**

In this subroutine we write all the mssm renormalization group equations, including the flavor mixing in the squark and slepton sector.

**FUNCTION:**

```
Computes the numerical values of all the mssm rge at a given energy scale
```

**INPUTS:**

```
yy(126)    - Initial values for all RGEs
t          - energy scale
```

**RESULT:**

```
yy(126)    - RGE output at a scale t
```

**EXAMPLE:**

```
subroutine mssmrge(t,yy,dydx)
```

**NOTES:**

```
The notation we use closely follows that
of Martin and Vaughn PRD50(1994)2282 and
Ibarra and Simonetto JHEP04(2008)102.
Note that alpha1, alpha2, alpha3 in the following are
further normalised by a "4 pi " factor.
Remember all the yukawa matrices are also normalised by this "4 pi x 2"
factor. thus : yu(i,j) = [ 1/(4 pi x 2) ] (yu(i,j) ); where yu = yukawa
in the lagrangian and yu == yukawa in the program.
Also remember that all the A-parameters and the soft breaking masses
are also scaled/normalised by the "4 pi x 2" factor.

  dydx(1)-dydx(3) : yu(1,1) - yu(1,3)
  dydx(4)-dydx(6) : yu(2,1) - yu(2,3)
  dydx(7)-dydx(9) : yu(3,1) - yu(3,3)

  dydx(10)-dydx(12) : yd(1,1) - yd(1,3)
  dydx(13)-dydx(15) : yd(2,1) - yd(2,3)
  dydx(16)-dydx(18) : yd(3,1) - yd(3,3)

  dydx(19)-dydx(21) : ye(1,1) - ye(1,3)
  dydx(22)-dydx(24) : ye(2,1) - ye(2,3)
  dydx(25)-dydx(27) : ye(3,1) - ye(3,3)
  dydx(28)-dydx(30) : ynu(1,1) - ynu(1,3)
  dydx(31)-dydx(33) : ynu(2,1) - ynu(2,3)
  dydx(34)-dydx(36) : ynu(3,1) - ynu(3,3)
```

```
dydx(37)-dydx(39) : au(1,1) - au(1,3)
dydx(40)-dydx(42) : au(2,1) - au(2,3)
dydx(43)-dydx(45) : au(3,1) - au(3,3)

dydx(46)-dydx(48) : ad(1,1) - ad(1,3)
dydx(49)-dydx(51) : ad(2,1) - ad(2,3)
dydx(52)-dydx(54) : ad(3,1) - ad(3,3)

dydx(55)-dydx(57) : ae(1,1) - ae(1,3)
dydx(58)-dydx(60) : ae(2,1) - ae(2,3)
dydx(61)-dydx(63) : ae(3,1) - ae(3,3)
dydx(64)-dydx(66) : anu(1,1) - anu(1,3)
dydx(67)-dydx(69) : anu(2,1) - anu(2,3)
dydx(70)-dydx(72) : anu(3,1) - anu(3,3)
dydx(73)-dydx(75) : mq(1,1) - mq(1,3)
dydx(76)-dydx(77) : mq(2,2) - mq(2,3)
dydx(78)          : mq(3,3)

dydx(79)-dydx(81) : mu(1,1) - mu(1,3)
dydx(82)-dydx(83) : mu(2,2) - mu(2,3)
dydx(84)          : mu(3,3)

dydx(85)-dydx(87) : md(1,1) - md(1,3)
dydx(88)-dydx(89) : md(2,2) - md(2,3)
dydx(90)          : md(3,3)

dydx(91)-dydx(93) : ml(1,1) - ml(1,3)
dydx(94)-dydx(95) : ml(2,2) - ml(2,3)
dydx(96)          : ml(3,3)

dydx(97)-dydx(99)   : me(1,1) - me(1,3)
dydx(100)-dydx(101) : me(2,2) - me(2,3)
dydx(102)           : me(3,3)
dydx(103)-dydx(105) : mnu(1,1) - mnu(1,3)
dydx(106)-dydx(107) : mnu(2,2) - mnu(2,3)
dydx(108)           : mnu(3,3)


dydx(109)          : mh1
dydx(110)          : mh2
dydx(111)          : mu
dydx(112)          : b_mu

dydx(113)-dydx(118) : m_neutrino(3x3)_symmetric
dydx(119)-dydx(121) : aplh3-alph1
dydx(122)-dydx(124) : m1t-m3t
```

**BUGS:**

```
---
```

**SEE ALSO:**

```
smrge, odeint
```

# 19 susyflav/smrge.f

*[ Functions ]*

**NAME:**

```
Subroutine smrge, smrgemt
```

**SYNOPSIS:**

```
In this subroutine we write all the standard model renormalization
group.
```

**FUNCTION:**

```
Computes the numerical values of all the sm rge at a given energy scale
```

**INPUTS:**

```
yy(31)    - Initial values for all RGEs
t          - energy scale
```

**RESULT:**

```
yy(31)    - RGE output at a scale t
```

**EXAMPLE:**

```
subroutine smrge(t,yy,dydx)
subroutine smrgemt(t,yy,dydx) - SM rge running without top
```

**NOTES:**

```
The notation we use closely follows that
of Arason, castano et al, PRD46(1192)3945.
```

```
Note that alpha1, alpha2, alpha3 in the following are
further normalised by a "4 pi " factor.
Remember all the yukawa matrices are also normalised by this "4 pi x 2"
factor. thus : yu(i,j) = [ 1/(4 pi x 2) ] (yu(i,j) ); where yu = yukawa
in the lagrangian and yu == yukawa in the program.
Also remember that all the A-parameters and the soft breaking masses
are also scaled/normalised by the "4 pi x 2" factor.

  dydx(1)-dydx(3) : yu(1,1) - yu(1,3)
  dydx(4)-dydx(6) : yu(2,1) - yu(2,3)
  dydx(7)-dydx(9) : yu(3,1) - yu(3,3)

  dydx(10)-dydx(12) : yd(1,1) - yd(1,3)
  dydx(13)-dydx(15) : yd(2,1) - yd(2,3)
  dydx(16)-dydx(18) : yd(3,1) - yd(3,3)

  dydx(19)-dydx(21) : ye(1,1) - ye(1,3)
  dydx(22)-dydx(24) : ye(2,1) - ye(2,3)
  dydx(25)-dydx(27) : ye(3,1) - ye(3,3)
  dydx(28)          : alph3
  dydx(39)          : alph2
  dydx(30)          : alph1
  dydx(31)          : vev
```

**BUGS:**

```
---
```

**SEE ALSO:**

```
smrge, odeint
```