In[211]:=
```
TH1M = THiggs1Mod /. {σn[3] → 0, σv[i_] → 0};
TH2M = THiggs2Mod /. {σn[3] → 0, σv[i_] → 0};
TSM = TSingletMod /. {σn[3] → 0, σv[i_] → 0};
TL1M = TLeft1Mod /. {σn[3] → 0, σv[i_] → 0};
TL2M = TLeft2Mod /. {σn[3] → 0, σv[i_] → 0};
TL3M = TLeft3Mod /. {σn[3] → 0, σv[i_] → 0}; TR3M = TRight3Mod /. {σn[3] → 0, σv[i_] → 0};
```

In[217]:=
```
Vac3 = Flatten[{Solve[TH1M == 0, mH1][[1]],
    Solve[TH2M == 0, mH2][[1]],
    Solve[TSM == 0, MS][[1]], {σn[3] → 0, σv[i_] → 0}}];
```

In[219]:=
```
TE3 = Mneut[[Range[1, 7], Range[1, 7]]] /. Vac3 // Simplify;
TO3 = Mneut[[Range[8, 14], Range[8, 14]]] /. Vac3 // Simplify;
TC3 = Mchar /. Vac3 // Simplify;
Mcχ = Mchχ /. Vac3 // Simplify;
McχT = MchχT /. Vac3 // Simplify;
Mnχ = Mneχ /. Vac3 // Simplify;
```

In[226]:=
```
prec = 50;
$MinPrecision = prec;
TeV = 10^12; GeV = 10^9; MeV = 10^6;
vSq = SetPrecision[(174 GeV)^2, prec];
vSqHiggs = (vSq - σv[1]^2 - σv[2]^2 - σv[3]^2) /. {σn[3] → 0, σv[i_] → 0};
mW = SetPrecision[80.403 GeV, prec];
mZ = SetPrecision[91.1876 GeV, prec];
αew = SetPrecision[1 / 127.908957, prec];
θw = SetPrecision[ArcSin[Sqrt[0.23124]], prec]; mtPole = SetPrecision[180 GeV, prec];
αstrong = SetPrecision[0.102, prec];
mup = SetPrecision[1.5 MeV, prec];
mcharm = SetPrecision[1.1 GeV, prec];
mtop = SetPrecision[mtPole / (1 + 4 * αstrong / (3 Pi)), prec];
mdown = SetPrecision[3 MeV, prec];
mstrange = SetPrecision[60 MeV, prec];
mbottom = SetPrecision[4.1 GeV, prec];
melectron = SetPrecision[0.511 MeV, prec];
mmuon = SetPrecision[105.66 MeV, prec];
mtau = SetPrecision[1.777 GeV, prec];
(*Yup=SetPrecision[mup /v2,prec];
Ycrm=SetPrecision[mcharm /v2,prec];*)
Ytop = SetPrecision[mtop / v2, prec];
(*Ydwn=SetPrecision[mdown /v1,prec];
Ystg=SetPrecision[mstrange /v1,prec];*)
Ybtm = SetPrecision[mbottom / v1, prec];
(*Yϵ=SetPrecision[melectron /v1,prec];
Yμ=SetPrecision[mmuon /v1,prec];*)
Yτ = SetPrecision[mtau / v1, prec];
```

In[248]:=
```
β = SetPrecision[ArcTan[30], prec];
g1 := SetPrecision[Sqrt[(2 * Tan[θw]^2 * mW^2) / vSq], prec];
g2 := SetPrecision[mW * Sqrt[2 / vSq], prec];
v1 = Sqrt[vSqHiggs / (1 + Tan[β]^2)];
v2 = v1 * Tan[β];
```

In[252]:=
```
varA = Union[Variables[TE3], Variables[TO3]]
```

Out[252]=
```
{A0, A2, A3, κ0, κ2, κ3, σS, A1[1], A1[2], A1[3], ML[1, 1], ML[1, 2],
 ML[1, 3], ML[2, 2], ML[2, 3], ML[3, 3], MN[3, 3], κ1[1], κ1[2], κ1[3]}
```

In[253]:=
```
varB = Complement[Variables[TC3], Union[Variables[TE3], Variables[TO3]]]
```

Out[253]=
```
{Aτ, ME[3, 3]}
```

In[255]:=
```
varC = Union[Variables[Mcχ], Variables[Mnχ]]
```

Out[255]=
```
{M1, M2, κ0, κ2, κ3, σS, κ1[1], κ1[2], κ1[3]}
```

In[256]:=
```
Union[varA, varB, varC]
```

Out[256]=
```
{A0, A2, A3, Aτ, M1, M2, κ0, κ2, κ3, σS, A1[1], A1[2], A1[3], ME[3, 3], ML[1, 1],
 ML[1, 2], ML[1, 3], ML[2, 2], ML[2, 3], ML[3, 3], MN[3, 3], κ1[1], κ1[2], κ1[3]}
```

In[384]:=
```
Block[{A0, A1, A2, A3, Aτ, M1, M2, κ0, κ1, κ2, κ3, σS, ME, ML, MN},
 $MinPrecision = prec;
 A0 = SetPrecision[TeV, prec];
 A1[i_] := SetPrecision[TeV, prec];
 A2 = SetPrecision[TeV, prec];
 A3 = -SetPrecision[300 GeV, prec];
 Aτ = SetPrecision[TeV, prec];
 κ0 = SetPrecision[0.4, prec];
 κ1[i_] := SetPrecision[10^-5, prec];
 κ2 = SetPrecision[0.5, prec];
 κ3 = SetPrecision[0.6, prec];
 M1 = SetPrecision[350 GeV, prec];
 M2 = SetPrecision[500 GeV, prec];
 σS = SetPrecision[TeV, prec];
 ME[3, 3] = SetPrecision[TeV, prec];
 MN[3, 3] = SetPrecision[TeV, prec];
 ML[1, 1] = ML[2, 2] = ML[3, 3] = SetPrecision[TeV, prec];
 ML[1, 2] = ML[1, 3] = ML[2, 3] = SetPrecision[500 GeV, prec];
 {valSNe, vecSNe} = Eigensystem[TE3];
 {valSNo, vecSNo} = Eigensystem[TO3];
 {valSC, vecSC} = Eigensystem[TC3];
 valFN = Sqrt[Eigenvalues[Mnχ.Transpose[Conjugate[Mnχ]]]];
 vecFN = Inverse[Transpose[Eigenvectors[Mnχ.Transpose[Conjugate[Mnχ]]]]];
 valFC = Sqrt[Eigenvalues[Conjugate[McχT].Mcχ]];
 vecFCu = Conjugate[Inverse[Transpose[Eigenvectors[Mcχ.Conjugate[McχT]]]]];
 vecFCv = Inverse[Transpose[Eigenvectors[Conjugate[McχT].Mcχ]]];
 $MinPrecision = 0;
 Im[{N[Sqrt[valSNe] * 10^-9, 4], N[Sqrt[valSNo] * 10^-9, 4]}] // Chop
]
```

Out[384]=
```
{{0, 0, 0, 0, 0, 0, 0}, {0, 0, 0, 0, 0, 0, 0}}
```

In[385]:=
```
Chop[N[vecSNe^2, 2], 0.01] // MatrixForm
```

Out[385]//MatrixForm=

1.0	0	0	0	0	0	0
0	0	0	0.028	0.028	0.028	0.92
0	0	0	0.31	0.31	0.31	0.084
0	0	0	0	0.50	0.50	0
0	0	0	0.67	0.17	0.17	0
0	0.037	0.96	0	0	0	0
0	0.96	0.037	0	0	0	0

In[386]:=
```
N[Sqrt[valSNe] * 10^-9, 4] // Chop
```

Out[386]=
```
{5800., 1578., 1185., 863.6, 863.6, 466.7, 15.59}
```

In[387]:=
```
Chop[N[vecSNo^2, 2], 0.01] // MatrixForm
```

Out[387]//MatrixForm=

1.0	0	0	0	0	0	0
0	0	0	0.32	0.32	0.32	0.041
0	0	0	0	0.50	0.50	0
0	0	0	0.67	0.17	0.17	0
0	0	1.0	0	0	0	0
0	0	0	0.014	0.014	0.014	0.96
0	1.0	0	0	0	0	0

In[388]:=
```
N[Sqrt[valSNo] * 10^-9, 4] // Chop
```

Out[388]=
```
{5800., 1248., 863.6, 863.6, 671.5, 194.9, 0}
```

In[389]:= **Chop[N[vecSC^2, 2], 0.01] // MatrixForm**

Out[389]//MatrixForm=

$$\begin{pmatrix} 1.0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.33 & 0.33 & 0.33 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1.0 \\ 0 & 0 & 0.50 & 0.50 & 0 & 0 \\ 0 & 0 & 0.17 & 0.17 & 0.67 & 0 \\ 0 & 1.0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

In[390]:= **N[Sqrt[valSC] * 10^-9, 4] // Chop**

Out[390]= {5800., 1226., 1001., 867.3, 867.0, 0}

In[392]:= **N[valFC * 10^-9, 4] // Chop**

Out[392]= {530.5, 376.2, 1.777, 0, 0}

In[393]:= **N[valFN * 10^-9, 4] // Chop**

Out[393]= $\{614.4, 527.7, 500.0, 407.1, 387.0, 328.1, 1.815 \times 10^{-8}, 0, 0\}$