In[212]:=
```
Vac = Flatten[{Solve[THiggs1Mod == 0, mH1][[1]],
    Solve[THiggs2Mod == 0, mH2][[1]],
    Solve[TSingletMod == 0, MS][[1]],
    Solve[TRight3Mod == 0, MN[3, 3]][[1]],
    Solve[TLeft1Mod == 0, ML[1, 1]][[1]],
    Solve[TLeft2Mod == 0, ML[2, 2]][[1]],
    Solve[TLeft3Mod == 0, ML[3, 3]][[1]]}];
```

In[213]:=
```
TE = Mneut[[Range[1, 7], Range[1, 7]]] /. Vac // Simplify;
TO = Mneut[[Range[8, 14], Range[8, 14]]] /. Vac // Simplify;
TC = Mchar /. Vac // Simplify;
```

In[216]:=
```
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;
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[236]:=
```
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[240]:=
```
varA = Union[Variables[TE], Variables[TO]]
```

Out[240]=
```
{A0, A2, A3, κ0, κ2, κ3, σS, A1[1], A1[2], A1[3], ML[1, 2],
 ML[1, 3], ML[2, 3], κ1[1], κ1[2], κ1[3], σn[3], σv[1], σv[2], σv[3]}
```

In[241]:=
```
varB = Complement[Variables[TC], Union[Variables[TE], Variables[TO]]]
```

Out[241]=
```
{Aτ, ME[3, 3]}
```

In[242]:=
```
varC = Union[Variables[Mchχ], Variables[Mneχ]]
```

Out[242]=
```
{M1, M2, κ0, κ2, κ3, σS, κ1[1], κ1[2], κ1[3], σn[3], σv[1], σv[2], σv[3]}
```

In[243]:=
```
Union[varA, varB, varC]
```

Out[243]=
```
{A0, A2, A3, Aτ, M1, M2, κ0, κ2, κ3, σS, A1[1], A1[2], A1[3], ME[3, 3],
 ML[1, 2], ML[1, 3], ML[2, 3], κ1[1], κ1[2], κ1[3], σn[3], σv[1], σv[2], σv[3]}
```

In[244]:=
```
Block[{A0, A1, A2, A3, Aτ, κ0, κ1, κ2, κ3, M1, M2, ME, ML, σS, σn, σν},
 $MinPrecision = prec;
 A0 = SetPrecision[TeV, prec];
 A2 = -SetPrecision[TeV, prec];
 A3 = -SetPrecision[TeV, prec];
 Aτ = SetPrecision[TeV, prec];
 A1[i_] := -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];
 σn[3] = SetPrecision[TeV, prec];
 σν[1] = SetPrecision[0.19 MeV, prec];
 σν[2] = SetPrecision[0.14 MeV, prec];
 σν[3] = SetPrecision[0.15 MeV, prec];
 ME[3, 3] = ML[1, 2] = ML[1, 3] = ML[2, 3] = SetPrecision[TeV, prec];
 {valSNe, vecSNe} = Eigensystem[TE];
 {valSNo, vecSNo} = Eigensystem[TO];
 {valSC, vecSC} = Eigensystem[TC];
 valFN = Sqrt[Eigenvalues[Mneχ.Transpose[Conjugate[Mneχ]]]];
 vecFN = Inverse[Transpose[Eigenvectors[Mneχ.Transpose[Conjugate[Mneχ]]]]];
 valFC = Sqrt[Eigenvalues[Conjugate[MchχT].Mchχ]];
 vecFCu = Conjugate[Inverse[Transpose[Eigenvectors[Mchχ.Conjugate[MchχT]]]]];
 vecFCv = Inverse[Transpose[Eigenvectors[Conjugate[MchχT].Mchχ]]];
 $MinPrecision = 0;
 Im[{N[Sqrt[valSNe] * 10^-9, 4], N[Sqrt[valSNo] * 10^-9, 4]}] // Chop
]
```

Out[244]=
```
{{0, 0, 0, 0, 0, 0, 0}, {0, 0, 0, 0, 0, 0, 0}}
```

In[245]:=
```
Chop[N[vecSNe^2, 2], 0.01] // MatrixForm
```

Out[245]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 & 0 & 1.0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1.0 & 0 \\ 0 & 0 & 0 & 1.0 & 0 & 0 & 0 \\ 1.0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.63 & 0 & 0 & 0 & 0.36 \\ 0 & 0.054 & 0.33 & 0 & 0 & 0 & 0.62 \\ 0 & 0.94 & 0.037 & 0 & 0 & 0 & 0.021 \end{pmatrix}$$

In[246]:=
```
N[Sqrt[valSNe] * 10^-9, 4] // Chop
```

Out[246]=
```
{1.115 × 10^6, 1.077 × 10^6, 9.567 × 10^5, 6053., 717.5, 320.6, 23.08}
```

In[247]:=
```
Chop[N[vecSNo^2, 2], 0.01] // MatrixForm
```

Out[247]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 & 0 & 1.0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1.0 & 0 \\ 0 & 0 & 0 & 1.0 & 0 & 0 & 0 \\ 1.0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.50 & 0 & 0 & 0 & 0.50 \\ 0 & 0 & 0.50 & 0 & 0 & 0 & 0.50 \\ 0 & 1.0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

In[248]:=
```
N[Sqrt[valSNo] * 10^-9, 4] // Chop
```

Out[248]=
```
{1.115 × 10^6, 1.077 × 10^6, 9.567 × 10^5, 6053., 1732., 632.9, 0}
```

In[249]:=
```
Chop[N[vecSC^2, 2], 0.01] // MatrixForm
```

Out[249]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 & 1.0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1.0 & 0 \\ 0 & 0 & 1.0 & 0 & 0 & 0 \\ 1.0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1. \\ 0 & 1.0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

In[250]:=
```
N[Sqrt[valSC] * 10^-9, 4] // Chop
```

Out[250]= $\{1.115 \times 10^6, 1.077 \times 10^6, 9.567 \times 10^5, 6053., 1001., 0\}$

In[251]:=
```
N[valFC * 10^-9, 4] // Chop
```

Out[251]= $\{530.5, 376.2, 1.777, 0, 0\}$

In[252]:=
```
N[valFN * 10^-9, 4] // Chop
```

Out[252]= $\{1055., 531.0, 408.0, 393.0, 331.7, 46.93, 1.726 \times 10^{-10}, 0, 0\}$