Automatic Generation of the Lagrangian Beyond SM (BETA Version !!!)

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!! Disclaimer !!

ἓν οἶδα ὅτι οὐδὲν οἶδα *hèn oîda hóti oudèn oîda*

 - Σωκράτης

"The only thing that I know is that I don't know anything"

 - Socrates

Outline

- It's FREE. Doesn't depend on Mathematica !!!
- Algebra Package (Tested)
- Compact Lie Algebra Package (Tested)
- Zn (Discrete Group) Package (Tested)
- Model package (Tested ?!??!?)
- GUI (In progress …)
- Package Mentality (everything's library based)
- Automated Comprehensive Testing !!!
- Future Work
- Live Demo ☺ ☺ ☺ (Sneak Preview)

Algebra Package

- Fraction (no rounding error of floating points)
  - Numerator, Root and Denominator
- Fraction Sum
- Fraction Sum Vector
- Fraction Sum Matrix
- Automated Testing for all fraction operations

Compact Lie Algebra

- All Reps implemented(as long as enough memory) of Compact Lie Algebra
- Exact Reps, no rounding error using Fraction Sum class !!!
- Generator Matrices
- Singlet generation of product of Reps
- Automated Testing

Zn (Discrete Group)

- Defining reps only for now and only Zn
- Automated Testing

Model Package

- Gauge groups (local and global)
- Discrete group (now only Zn)
- CompField class (container class including SUSY)
- Interaction class (container for Lagrangian terms)
- Automated Lagrangian generation
- Automated Testing ??!!?!??
  - MSSM
  - SM 1 and 2 Higgs (up to Dim 6) and QED

QED

QED

$$\overline{\Psi_L}\gamma^\mu D_\mu \Psi_L + \overline{\Psi_R}\gamma^\mu D_\mu \Psi_R + F_{\mu\nu}F^{\mu\nu}$$

$$m_0 \overline{\Psi_R}\Psi_L + m_0^* \overline{\Psi_L}\Psi_R$$

MSSM

MSSM up to Dimension 4

$$\int d^2\theta d^2\bar{\theta}\Phi_q^\dagger \exp[g_0 G_C + g_1 W_L + g_2 B_Y]\Phi_q + \int d^2\theta d^2\bar{\theta}\Phi_u^\dagger \exp[g_0 G_C + g_2 B_Y]\Phi_u + \int d^2\theta d^2\bar{\theta}$$

$$\Phi_d^\dagger \exp[g_0 G_C + g_2 B_Y]\Phi_d + \int d^2\theta d^2\bar{\theta}\Phi_l^\dagger \exp[g_1 W_L + g_2 B_Y]\Phi_l + \int d^2\theta d^2\bar{\theta}\Phi_e^\dagger \exp[g_2 B_Y]\Phi_e + \int d^2\theta d^2\bar{\theta}$$

$$\Phi_{H1}^\dagger \exp[g_1 W_L + g_2 B_Y]\Phi_{H1} + \int d^2\theta d^2\bar{\theta}\Phi_{H2}^\dagger \exp[g_1 W_L + g_2 B_Y]\Phi_{H2} + \int d^2\theta G_C G_C + \int d^2\bar{\theta}G_C^\dagger G_C^\dagger +$$

$$\int d^2\theta W_L W_L + \int d^2\bar{\theta}W_L^\dagger W_L^\dagger + \int d^2\theta B_Y B_Y + \int d^2\bar{\theta}B_Y^\dagger B_Y^\dagger$$

$$\mu_0 \int d^2\theta \Phi_{H2}\Phi_{H1} + \mu_0^* \int d^2\bar{\theta}\Phi_{H1}^\dagger \Phi_{H2}^\dagger$$

$$y_1 \int d^2\theta \Phi_{H2}\Phi_u \Phi_q + y_1^* \int d^2\bar{\theta}\Phi_q^\dagger \Phi_u^\dagger \Phi_{H2}^\dagger + y_2 \int d^2\theta \Phi_{H1}\Phi_d \Phi_q + y_2^* \int d^2\bar{\theta}\Phi_q^\dagger \Phi_d^\dagger \Phi_{H1}^\dagger + y_3 \int d^2\theta \Phi_{H1}\Phi_e \Phi_l$$

$$+ y_3^* \int d^2\bar{\theta}\Phi_l^\dagger \Phi_e^\dagger \Phi_{H1}^\dagger$$

SM 1 Higgs (Dim 4)

SM with 1 Higgs up to Dimension 4

$$\overline{Q_l}\gamma^\mu D_\mu Q_l + \overline{U_r}\gamma^\mu D_\mu U_r + \overline{D_r}\gamma^\mu D_\mu D_r + \overline{L_l}\gamma^\mu D_\mu L_l + \overline{E_r}\gamma^\mu D_\mu E_r + D_\mu \Phi^* D^\mu \Phi + G_{C\mu\nu}G_C^{\mu\nu} + \theta_0 \varepsilon_{\alpha\beta\gamma\delta}G_C^{\alpha\beta}G_C^{\gamma\delta}$$

$$+ W_{L\mu\nu}W_L^{\mu\nu} + \theta_1 \varepsilon_{\alpha\beta\gamma\delta}W_L^{\alpha\beta}W_L^{\gamma\delta} + B_{Y\mu\nu}B_Y^{\mu\nu}$$

$$\mu_{r0}\Phi\Phi^*$$

$$\lambda_{r1}\Phi\Phi\Phi^*\Phi^*$$

$$y_2\Phi\overline{U_r}Q_l + y_2^*\Phi^*\overline{Q_l}U_r + y_3\Phi^*\overline{D_r}Q_l + y_3^*\Phi\overline{Q_l}D_r + y_4\Phi^*\overline{E_r}L_l + y_4^*\Phi\overline{L_l}E_r$$

SM 1 Higgs (Dim 6)

$$\overline{Q_l}\gamma^\mu D_\mu Q_l + \overline{U_r}\gamma^\mu D_\mu U_r + \overline{D_r}\gamma^\mu D_\mu D_r + \overline{L_l}\gamma^\mu D_\mu L_l + \overline{E_r}\gamma^\mu D_\mu E_r + D_\mu\Phi^* D^\mu\Phi + G_{C\mu\nu}G_C^{\mu\nu} + \theta_0\varepsilon_{\alpha\beta\gamma\delta}G_C^{\alpha\beta}G_C^{\gamma\delta} + W_{L\mu\nu}W_L^{\mu\nu} +$$

$$\theta_1\varepsilon_{\alpha\beta\gamma\delta}W_L^{\alpha\beta}W_L^{\gamma\delta} + B_{Y\mu\nu}B_Y^{\mu\nu}$$

$$\mu_{r0}\Phi\Phi^*$$

$$\lambda_{r1}\Phi\Phi\Phi^*\Phi^*$$

$$y_2\Phi\overline{U_r}Q_l + y_2^*\Phi^*\overline{Q_l}U_r + y_3\Phi^*\overline{D_r}Q_l + y_3^*\Phi\overline{Q_l}D_r + y_4\Phi^*\overline{E_r}L_l + y_4^*\Phi\overline{L_l}E_r +$$

$$y_5\Phi\Phi\overline{L_l}L_l^c + y_5^*\Phi^*\Phi^*\overline{L_l^c}L_l +$$

$$y_6\Phi^*\Phi\Phi\overline{U_r}Q_l + y_6^*\Phi\Phi^*\Phi^*\overline{Q_l}U_r + y_7\Phi^*\Phi^*\Phi\overline{D_r}Q_l + y_7^*\Phi\Phi\Phi^*\overline{Q_l}D_r + y_8\Phi^*\Phi^*\Phi\overline{E_r}L_l + y_8^*\Phi\Phi\Phi^*\overline{L_l}E_r$$

$$
\begin{aligned}
&g_{r9}\overline{Q}_l\gamma_\mu Q_l\overline{Q}_l\gamma^\mu Q_l + g_{r10}\overline{Q}_l^c\sigma_{\mu\nu}Q_l\overline{Q}_l\sigma^{\mu\nu}Q_l^c + g_{r11}\overline{Q}_l^c Q_l\overline{Q}_l Q_l^c + g_{r12}\overline{Q}_l\gamma_\mu Q_l\overline{U}_r\gamma^\mu U_r + g_{r13}\overline{Q}_l^c\gamma_\mu U_r\overline{U}_r\gamma^\mu Q_l^c + g_{r14}\overline{Q}_l\sigma_{\mu\nu}U_r\overline{U}_r \\
&\sigma^{\mu\nu}Q_l + g_{r15}\overline{Q}_l U_r\overline{U}_r Q_l + g_{r16}\overline{Q}_l\gamma_\mu Q_l\overline{D}_r\gamma^\mu D_r + g_{r17}\overline{Q}_l^c\gamma_\mu D_r\overline{D}_r\gamma^\mu Q_l^c + g_{r18}\overline{Q}_l\sigma_{\mu\nu}D_r\overline{D}_r\sigma^{\mu\nu}Q_l + g_{r19}\overline{Q}_l D_r\overline{D}_r Q_l + g_{r20}\overline{Q}_l\gamma_\mu L_l \\
&\overline{L}_l\gamma^\mu Q_l + g_{r21}\overline{Q}_l\gamma_\mu Q_l\overline{L}_l\gamma^\mu L_l + g_{r22}\overline{Q}_l^c\sigma_{\mu\nu}L_l\overline{L}_l\sigma^{\mu\nu}Q_l^c + g_{r23}\overline{Q}_l^c L_l\overline{L}_l Q_l^c + g_{r24}\overline{Q}_l\gamma_\mu Q_l\overline{E}_r\gamma^\mu E_r + g_{r25}\overline{Q}_l^c\gamma_\mu E_r\overline{E}_r\gamma^\mu Q_l^c + g_{r26}\overline{Q}_l \\
&\sigma_{\mu\nu}E_r\overline{E}_r\sigma^{\mu\nu}Q_l + g_{r27}\overline{Q}_l E_r\overline{E}_r Q_l + g_{28}\overline{Q}_l\sigma_{\mu\nu}Q_l^c\overline{L}_l\sigma^{\mu\nu}Q_l^c + g_{28}^*\overline{Q}_l^c\sigma_{\mu\nu}Q_l\overline{Q}_l^c\sigma^{\mu\nu}L_l + g_{29}\overline{Q}_l Q_l^c\overline{L}_l Q_l^c + g_{29}^*\overline{Q}_l^c Q_l\overline{Q}_l^c L_l + g_{30}\overline{D}_r \\
&\sigma_{\mu\nu}Q_l\overline{U}_r\sigma^{\mu\nu}Q_l + g_{30}^*\overline{Q}_l\sigma_{\mu\nu}D_r\overline{Q}_l\sigma^{\mu\nu}U_r + g_{31}\overline{D}_r Q_l\overline{U}_r Q_l + g_{31}^*\overline{Q}_l D_r\overline{Q}_l U_r + g_{32}\overline{U}_r\sigma_{\mu\nu}Q_l\overline{D}_r\sigma^{\mu\nu}Q_l + g_{32}^*\overline{Q}_l\sigma_{\mu\nu}U_r\overline{Q}_l\sigma^{\mu\nu}D_r + \\
&g_{33}\overline{U}_r Q_l\overline{D}_r Q_l + g_{33}^*\overline{Q}_l U_r\overline{Q}_l D_r + g_{34}\overline{Q}_l\sigma_{\mu\nu}Q_l^c\overline{U}_r^c\sigma^{\mu\nu}D_r + g_{34}^*\overline{Q}_l^c\sigma_{\mu\nu}Q_l\overline{D}_r\sigma^{\mu\nu}U_r^c + g_{35}\overline{Q}_l Q_l^c\overline{U}_r^c D_r + g_{35}^*\overline{Q}_l^c Q_l\overline{D}_r U_r^c + g_{36}\overline{E}_r \\
&\gamma_\mu Q_l^c\overline{U}_r\gamma^\mu Q_l^c + g_{36}^*\overline{Q}_l^c\gamma_\mu E_r\overline{Q}_l^c\gamma^\mu U_r + g_{37}\overline{U}_r\gamma_\mu Q_l^c\overline{E}_r\gamma^\mu Q_l^c + g_{37}^*\overline{Q}_l^c\gamma_\mu U_r\overline{Q}_l^c\gamma^\mu E_r + g_{38}\overline{Q}_l\sigma_{\mu\nu}Q_l^c\overline{E}_r\sigma^{\mu\nu}U_r^c + g_{38}^*\overline{Q}_l^c\sigma_{\mu\nu}Q_l \\
&\overline{U}_r^c\sigma^{\mu\nu}E_r + g_{39}\overline{Q}_l Q_l^c\overline{E}_r U_r^c + g_{39}^*\overline{Q}_l^c Q_l\overline{U}_r^c E_r + g_{40}\overline{E}_r\sigma_{\mu\nu}Q_l\overline{U}_r\sigma^{\mu\nu}L_l + g_{40}^*\overline{Q}_l\sigma_{\mu\nu}E_r\overline{L}_l\sigma^{\mu\nu}U_r + g_{41}\overline{E}_r Q_l\overline{U}_r L_l + g_{41}^*\overline{Q}_l E_r\overline{L}_l U_r \\
&+ g_{42}\overline{U}_r\sigma_{\mu\nu}Q_l\overline{E}_r\sigma^{\mu\nu}L_l + g_{42}^*\overline{Q}_l\sigma_{\mu\nu}U_r\overline{L}_l\sigma^{\mu\nu}E_r + g_{43}\overline{U}_r Q_l\overline{E}_r L_l + g_{43}^*\overline{Q}_l U_r\overline{L}_l E_r + g_{44}\overline{L}_l\sigma_{\mu\nu}Q_l^c\overline{U}_r^c\sigma^{\mu\nu}E_r + g_{44}^*\overline{Q}_l^c\sigma_{\mu\nu}L_l\overline{E}_r\sigma^{\mu\nu} \\
&U_r^c + g_{45}\overline{L}_l Q_l^c\overline{U}_r^c E_r + g_{45}^*\overline{Q}_l^c L_l\overline{E}_r U_r^c + g_{46}\overline{D}_r\gamma_\mu Q_l^c\overline{L}_l\gamma^\mu U_r^c + g_{46}^*\overline{Q}_l^c\gamma_\mu D_r\overline{U}_r^c\gamma^\mu L_l + g_{47}\overline{U}_r\gamma_\mu Q_l^c\overline{L}_l\gamma^\mu D_r^c + g_{47}^*\overline{Q}_l^c\gamma_\mu U_r\overline{D}_r^c\gamma^\mu L_l \\
&+ g_{48}\overline{L}_l\sigma_{\mu\nu}Q_l^c\overline{D}_r\sigma^{\mu\nu}U_r^c + g_{48}^*\overline{Q}_l^c\sigma_{\mu\nu}L_l\overline{U}_r^c\sigma^{\mu\nu}D_r + g_{49}\overline{L}_l Q_l^c\overline{D}_r U_r^c + g_{49}^*\overline{Q}_l^c L_l\overline{U}_r^c D_r + g_{50}\overline{L}_l\gamma_\mu Q_l\overline{D}_r\gamma^\mu E_r + g_{50}^*\overline{Q}_l\gamma_\mu L_l\overline{E}_r\gamma^\mu D_r \\
&+ g_{51}\overline{E}_r\gamma_\mu Q_l^c\overline{D}_r^c\gamma^\mu L_l + g_{51}^*\overline{Q}_l^c\gamma_\mu E_r\overline{L}_l\gamma^\mu D_r^c + g_{52}\overline{D}_r\sigma_{\mu\nu}Q_l\overline{L}_l\sigma^{\mu\nu}E_r + g_{52}^*\overline{Q}_l\sigma_{\mu\nu}D_r\overline{E}_r\sigma^{\mu\nu}L_l + g_{53}\overline{D}_r Q_l\overline{L}_l E_r + g_{53}^*\overline{Q}_l D_r\overline{E}_r L_l + \\
&g_{r54}\overline{U}_r\gamma_\mu U_r\overline{U}_r\gamma^\mu U_r + g_{r55}\overline{U}_r^c\sigma_{\mu\nu}U_r\overline{U}_r\sigma^{\mu\nu}U_r^c + g_{r56}\overline{U}_r^c U_r\overline{U}_r U_r^c + g_{r57}\overline{U}_r\gamma_\mu D_r\overline{D}_r\gamma^\mu U_r + g_{r58}\overline{U}_r\gamma_\mu U_r\overline{D}_r\gamma^\mu D_r + g_{r59} \\
&\overline{U}_r^c\sigma_{\mu\nu}D_r\overline{D}_r\sigma^{\mu\nu}U_r^c + g_{r60}\overline{U}_r^c D_r\overline{D}_r U_r^c + g_{r61}\overline{U}_r\gamma_\mu U_r\overline{L}_l\gamma^\mu L_l + g_{r62}\overline{U}_r^c\gamma_\mu L_l\overline{L}_l\gamma^\mu U_r^c + g_{r63}\overline{U}_r\sigma_{\mu\nu}L_l\overline{L}_l\sigma^{\mu\nu}U_r + g_{r64}\overline{U}_r L_l\overline{L}_l U_r + \\
&g_{r65}\overline{U}_r\gamma_\mu E_r\overline{E}_r\gamma^\mu U_r + g_{r66}\overline{U}_r\gamma_\mu U_r\overline{E}_r\gamma^\mu E_r + g_{r67}\overline{U}_r^c\sigma_{\mu\nu}E_r\overline{E}_r\sigma^{\mu\nu}U_r^c + g_{r68}\overline{U}_r^c E_r\overline{E}_r U_r^c + g_{69}\overline{E}_r\sigma_{\mu\nu}U_r^c\overline{D}_r\sigma^{\mu\nu}U_r^c + g_{69}^*\overline{U}_r^c\sigma_{\mu\nu}E_r \\
&\overline{U}_r^c\sigma^{\mu\nu}D_r + g_{70}\overline{E}_r U_r^c\overline{D}_r U_r^c + g_{70}^*\overline{U}_r^c E_r\overline{U}_r^c D_r + g_{71}\overline{D}_r\sigma_{\mu\nu}U_r^c\overline{E}_r\sigma^{\mu\nu}U_r^c + g_{71}^*\overline{U}_r^c\sigma_{\mu\nu}D_r\overline{U}_r^c\sigma^{\mu\nu}E_r + g_{72}\overline{D}_r U_r^c\overline{E}_r U_r^c + g_{72}^*\overline{U}_r^c D_r \\
&\overline{U}_r^c E_r + g_{73}\overline{U}_r\sigma_{\mu\nu}U_r^c\overline{E}_r\sigma^{\mu\nu}D_r^c + g_{73}^*\overline{U}_r^c\sigma_{\mu\nu}U_r\overline{D}_r^c\sigma^{\mu\nu}E_r + g_{74}\overline{U}_r U_r^c\overline{E}_r D_r^c + g_{74}^*\overline{U}_r^c U_r\overline{D}_r^c E_r + g_{r75}\overline{D}_r\gamma_\mu D_r\overline{D}_r\gamma^\mu D_r + g_{r76} \\
&\overline{D}_r^c\sigma_{\mu\nu}D_r\overline{D}_r\sigma^{\mu\nu}D_r^c + g_{r77}\overline{D}_r^c D_r\overline{D}_r D_r^c + g_{r78}\overline{D}_r\gamma_\mu D_r\overline{L}_l\gamma^\mu L_l + g_{r79}\overline{D}_r^c\gamma_\mu L_l\overline{L}_l\gamma^\mu D_r^c + g_{r80}\overline{D}_r\sigma_{\mu\nu}L_l\overline{L}_l\sigma^{\mu\nu}D_r + g_{r81}\overline{D}_r L_l\overline{L}_l D_r + \\
&g_{r82}\overline{D}_r\gamma_\mu E_r\overline{E}_r\gamma^\mu D_r + g_{r83}\overline{D}_r\gamma_\mu D_r\overline{E}_r\gamma^\mu E_r + g_{r84}\overline{D}_r^c\sigma_{\mu\nu}E_r\overline{E}_r\sigma^{\mu\nu}D_r^c + g_{r85}\overline{D}_r^c E_r\overline{E}_r D_r^c + g_{r86}\overline{L}_l\gamma_\mu L_l\overline{L}_l\gamma^\mu L_l + g_{r87}\overline{L}_l^c\sigma_{\mu\nu}L_l\overline{L}_l\sigma^{\mu\nu} \\
&L_l^c + g_{r88}\overline{L}_l^c L_l\overline{L}_l L_l^c + g_{r89}\overline{L}_l\gamma_\mu L_l\overline{E}_r\gamma^\mu E_r + g_{r90}\overline{L}_l^c\gamma_\mu E_r\overline{E}_r\gamma^\mu L_l^c + g_{r91}\overline{L}_l\sigma_{\mu\nu}E_r\overline{E}_r\sigma^{\mu\nu}L_l + g_{r92}\overline{L}_l E_r\overline{E}_r L_l + g_{r93}\overline{E}_r\gamma_\mu E_r\overline{E}_r\gamma^\mu E_r + \\
&g_{r94}\overline{E}_r^c\sigma_{\mu\nu}E_r\overline{E}_r\sigma^{\mu\nu}E_r^c + g_{r95}\overline{E}_r^c E_r\overline{E}_r E_r^c + g_{r96}\Phi\Phi\Phi\Phi^*\Phi^*\Phi^*
\end{aligned}
$$

SM 2 Higgs (Dim 4)

SM with 2 Higgs up to Dimension 4

$$\overline{Q_l}\gamma^\mu D_\mu Q_l + \overline{U_r}\gamma^\mu D_\mu U_r + \overline{D_r}\gamma^\mu D_\mu D_r + \overline{L_l}\gamma^\mu D_\mu L_l + \overline{E_r}\gamma^\mu D_\mu E_r + D_\mu \Phi_1^* D^\mu \Phi_1 + D_\mu \Phi_2^* D^\mu \Phi_2 + G_{C\mu\nu} G_C^{\mu\nu}$$

$$+ \theta_0 \varepsilon_{\alpha\beta\gamma\delta} G_C^{\alpha\beta} G_C^{\gamma\delta} + W_{L\mu\nu} W_L^{\mu\nu} + \theta_1 \varepsilon_{\alpha\beta\gamma\delta} W_L^{\alpha\beta} W_L^{\gamma\delta} + B_{Y\mu\nu} B_Y^{\mu\nu}$$

$$\mu_{r0}\Phi_1\Phi_1^* + \mu_1\Phi_2\Phi_1 + \mu_1^*\Phi_1^*\Phi_2^* + \mu_{r2}\Phi_2\Phi_2^*$$

$$\lambda_{r3}\Phi_1\Phi_1\Phi_1^*\Phi_1^* + \lambda_4\Phi_2\Phi_1\Phi_1\Phi_1^* + \lambda_4^*\Phi_1\Phi_1^*\Phi_1^*\Phi_2^* + \lambda_{r5}\Phi_1\Phi_2\Phi_1^*\Phi_2^* + \lambda_6\Phi_2\Phi_2\Phi_1\Phi_1 + \lambda_6^*\Phi_1^*\Phi_1^*\Phi_2^*\Phi_2^*$$

$$+ \lambda_7\Phi_2\Phi_2\Phi_1\Phi_2^* + \lambda_7^*\Phi_2\Phi_1^*\Phi_2^*\Phi_2^* + \lambda_{r8}\Phi_2\Phi_2\Phi_2^*\Phi_2^*$$

$$y_9\Phi_1\overline{U_r}Q_l + y_9^*\Phi_1^*\overline{Q_l}U_r + y_{10}\Phi_2^*\overline{U_r}Q_l + y_{10}^*\Phi_2\overline{Q_l}U_r + y_{11}\Phi_1^*\overline{D_r}Q_l + y_{11}^*\Phi_1\overline{Q_l}D_r + y_{12}\Phi_2\overline{D_r}Q_l + y_{12}^*\Phi_2^*$$

$$\overline{Q_l}D_r + y_{13}\Phi_1^*\overline{E_r}L_l + y_{13}^*\Phi_1\overline{L_l}E_r + y_{14}\Phi_2\overline{E_r}L_l + y_{14}^*\Phi_2^*\overline{L_l}E_r$$

SM 2 Higgs (Dim 6)

$$\overline{Q}_l\gamma^\mu D_\mu Q_l + \overline{U}_r\gamma^\mu D_\mu U_r + \overline{D}_r\gamma^\mu D_\mu D_r + \overline{L}_l\gamma^\mu D_\mu L_l + \overline{E}_r\gamma^\mu D_\mu E_r + D_\mu\Phi_1^* D^\mu\Phi_1 + D_\mu\Phi_2^* D^\mu\Phi_2 + G_{C\mu\nu}G_C^{\mu\nu} + \theta_0\varepsilon_{\alpha\beta\gamma\delta}G_C^{\alpha\beta}G_C^{\gamma\delta} +$$

$$W_{L\mu\nu}W_L^{\mu\nu} + \theta_1\varepsilon_{\alpha\beta\gamma\delta}W_L^{\alpha\beta}W_L^{\gamma\delta} + B_{Y\mu\nu}B_Y^{\mu\nu}$$

$$\mu_{r0}\Phi_1\Phi_1^* + \mu_1\Phi_2\Phi_1 + \mu_1^*\Phi_1^*\Phi_2^* + \mu_{r2}\Phi_2\Phi_2^*$$

$$\lambda_{r3}\Phi_1\Phi_1\Phi_1^*\Phi_1^* + \lambda_4\Phi_2\Phi_1\Phi_1\Phi_1^* + \lambda_4^*\Phi_1\Phi_1^*\Phi_1^*\Phi_2^* + \lambda_{r5}\Phi_1\Phi_2\Phi_1^*\Phi_2^* + \lambda_6\Phi_2\Phi_2\Phi_1\Phi_1 + \lambda_6^*\Phi_1^*\Phi_1^*\Phi_2^*\Phi_2^* + \lambda_7\Phi_2\Phi_2\Phi_1\Phi_2^*$$

$$+ \lambda_7^*\Phi_2\Phi_1^*\Phi_2^*\Phi_2^* + \lambda_{r8}\Phi_2\Phi_2\Phi_2^*\Phi_2^*$$

$$y_9\Phi_1\overline{U}_rQ_l + y_9^*\Phi_1^*\overline{Q}_lU_r + y_{10}\Phi_2^*\overline{U}_rQ_l + y_{10}^*\Phi_2\overline{Q}_lU_r + y_{11}\Phi_1^*\overline{D}_rQ_l + y_{11}^*\Phi_1\overline{Q}_lD_r + y_{12}\Phi_2\overline{D}_rQ_l + y_{12}^*\Phi_2^*\overline{Q}_lD_r + y_{13}\Phi_1^*\overline{E}_rL_l$$

$$+ y_{13}^*\Phi_1\overline{L}_lE_r + y_{14}\Phi_2\overline{E}_rL_l + y_{14}^*\Phi_2^*\overline{L}_lE_r +$$

$$y_{15}\Phi_1\Phi_1\overline{L}_lL_l^c + y_{15}^*\Phi_1^*\Phi_1^*\overline{L}_l^cL_l + y_{16}\Phi_2^*\Phi_1\overline{L}_lL_l^c + y_{16}^*\Phi_2\Phi_1^*\overline{L}_l^cL_l + y_{17}\Phi_2^*\Phi_2^*\overline{L}_lL_l^c + y_{17}^*\Phi_2\Phi_2\overline{L}_l^cL_l +$$

$$y_{18}\Phi_1^*\Phi_1\Phi_1\overline{U_r}Q_l + y_{18}^*\Phi_1\Phi_1^*\Phi_1^*\overline{Q_l}U_r + y_{19}\Phi_1^*\Phi_2^*\Phi_1\overline{U_r}Q_l + y_{19}^*\Phi_1\Phi_2\Phi_1^*\overline{Q_l}U_r + y_{20}\Phi_1^*\Phi_2^*\Phi_2^*\overline{U_r}Q_l + y_{20}^*\Phi_1\Phi_2\Phi_2\overline{Q_l}U_r +$$

$$y_{21}\Phi_1\Phi_1\Phi_2\overline{U_r}Q_l + y_{21}^*\Phi_1^*\Phi_1^*\Phi_2^*\overline{Q_l}U_r + y_{22}\Phi_2^*\Phi_1\Phi_2\overline{U_r}Q_l + y_{22}^*\Phi_2\Phi_1^*\Phi_2^*\overline{Q_l}U_r + y_{23}\Phi_2^*\Phi_2^*\Phi_2\overline{U_r}Q_l + y_{23}^*\Phi_2\Phi_2\Phi_2^*\overline{Q_l}U_r +$$

$$y_{24}\Phi_1^*\Phi_1^*\Phi_1\overline{D_r}Q_l + y_{24}^*\Phi_1\Phi_1\Phi_1^*\overline{Q_l}D_r + y_{25}\Phi_1^*\Phi_1^*\Phi_2^*\overline{D_r}Q_l + y_{25}^*\Phi_1\Phi_1\Phi_2\overline{Q_l}D_r + y_{26}\Phi_1^*\Phi_1\Phi_2\overline{D_r}Q_l + y_{26}^*\Phi_1\Phi_1^*\Phi_2^*\overline{Q_l}D_r +$$

$$y_{27}\Phi_1^*\Phi_2^*\Phi_2\overline{D_r}Q_l + y_{27}^*\Phi_1\Phi_2\Phi_2^*\overline{Q_l}D_r + y_{28}\Phi_1\Phi_2\Phi_2\overline{D_r}Q_l + y_{28}^*\Phi_1^*\Phi_2^*\Phi_2^*\overline{Q_l}D_r + y_{29}\Phi_2^*\Phi_2\Phi_2\overline{D_r}Q_l + y_{29}^*\Phi_2\Phi_2^*\Phi_2^*\overline{Q_l}D_r +$$

$$y_{30}\Phi_1^*\Phi_1^*\Phi_1\overline{E_r}L_l + y_{30}^*\Phi_1\Phi_1\Phi_1^*\overline{L_l}E_r + y_{31}\Phi_1^*\Phi_1^*\Phi_2^*\overline{E_r}L_l + y_{31}^*\Phi_1\Phi_1\Phi_2\overline{L_l}E_r + y_{32}\Phi_1^*\Phi_1\Phi_2\overline{E_r}L_l + y_{32}^*\Phi_1\Phi_1^*\Phi_2^*\overline{L_l}E_r + y_{33}$$

$$\Phi_1^*\Phi_2^*\Phi_2\overline{E_r}L_l + y_{33}^*\Phi_1\Phi_2\Phi_2^*\overline{L_l}E_r + y_{34}\Phi_1\Phi_2\Phi_2\overline{E_r}L_l + y_{34}^*\Phi_1^*\Phi_2^*\Phi_2^*\overline{L_l}E_r + y_{35}\Phi_2^*\Phi_2\Phi_2\overline{E_r}L_l + y_{35}^*\Phi_2\Phi_2^*\Phi_2^*\overline{L_l}E_r$$

$$g_{r36}\overline{Q_l}\gamma_\mu Q_l\overline{Q_l}\gamma^\mu Q_l + g_{r37}\overline{Q_l^c}\sigma_{\mu\nu}Q_l\overline{Q_l}\sigma^{\mu\nu}Q_l^c + g_{r38}\overline{Q_l^c}Q_l\overline{Q_l}Q_l^c + g_{r39}\overline{Q_l}\gamma_\mu Q_l\overline{U_r}\gamma^\mu U_r + g_{r40}\overline{Q_l^c}\gamma_\mu U_r\overline{U_r}\gamma^\mu Q_l^c + g_{r41}\overline{Q_l}\sigma_{\mu\nu}U_r\overline{U_r}\sigma^{\mu\nu}$$

$$Q_l + g_{r42}\overline{Q_l}U_r\overline{U_r}Q_l + g_{r43}\overline{Q_l}\gamma_\mu Q_l\overline{D_r}\gamma^\mu D_r + g_{r44}\overline{Q_l^c}\gamma_\mu D_r\overline{D_r}\gamma^\mu Q_l^c + g_{r45}\overline{Q_l}\sigma_{\mu\nu}D_r\overline{D_r}\sigma^{\mu\nu}Q_l + g_{r46}\overline{Q_l}D_r\overline{D_r}Q_l + g_{r47}\overline{Q_l}\gamma_\mu L_l\overline{L_l}\gamma^\mu Q_l$$

$$+ g_{r48}\overline{Q_l}\gamma_\mu Q_l\overline{L_l}\gamma^\mu L_l + g_{r49}\overline{Q_l^c}\sigma_{\mu\nu}L_l\overline{L_l}\sigma^{\mu\nu}Q_l^c + g_{r50}\overline{Q_l^c}L_l\overline{L_l}Q_l^c + g_{r51}\overline{Q_l}\gamma_\mu Q_l\overline{E_r}\gamma^\mu E_r + g_{r52}\overline{Q_l^c}\gamma_\mu E_r\overline{E_r}\gamma^\mu Q_l^c + g_{r53}\overline{Q_l}\sigma_{\mu\nu}E_r\overline{E_r}\sigma^{\mu\nu}Q_l$$

$$+ g_{r54}\overline{Q_l}E_r\overline{E_r}Q_l + g_{55}\overline{Q_l}\sigma_{\mu\nu}Q_l^c\overline{L_l}\sigma^{\mu\nu}Q_l^c + g_{55}^*\overline{Q_l^c}\sigma_{\mu\nu}Q_l\overline{Q_l^c}\sigma^{\mu\nu}L_l + g_{56}\overline{Q_l}Q_l^c\overline{L_l}Q_l^c + g_{56}^*\overline{Q_l^c}Q_l\overline{Q_l^c}L_l + g_{57}\overline{D_r}\sigma_{\mu\nu}Q_l\overline{U_r}\sigma^{\mu\nu}Q_l + g_{57}^*$$

$$\overline{Q_l}\sigma_{\mu\nu}D_r\overline{Q_l}\sigma^{\mu\nu}U_r + g_{58}\overline{D_r}Q_l\overline{U_r}Q_l + g_{58}^*\overline{Q_l}D_r\overline{Q_l}U_r + g_{59}\overline{U_r}\sigma_{\mu\nu}Q_l\overline{D_r}\sigma^{\mu\nu}Q_l + g_{59}^*\overline{Q_l}\sigma_{\mu\nu}U_r\overline{Q_l}\sigma^{\mu\nu}D_r + g_{60}\overline{U_r}Q_l\overline{D_r}Q_l + g_{60}^*\overline{Q_l}U_r$$

$$\overline{Q_l}D_r + g_{61}\overline{Q_l}\sigma_{\mu\nu}Q_l^c\overline{U_r^c}\sigma^{\mu\nu}D_r + g_{61}^*\overline{Q_l^c}\sigma_{\mu\nu}Q_l\overline{D_r}\sigma^{\mu\nu}U_r^c + g_{62}\overline{Q_l}Q_l^c\overline{U_r^c}D_r + g_{62}^*\overline{Q_l^c}Q_l\overline{D_r}U_r^c + g_{63}\overline{E_r}\gamma_\mu Q_l^c\overline{U_r}\gamma^\mu Q_l^c + g_{63}^*\overline{Q_l^c}\gamma_\mu E_r$$

$$\overline{Q_l^c}\gamma^\mu U_r + g_{64}\overline{U_r}\gamma_\mu Q_l^c\overline{E_r}\gamma^\mu Q_l^c + g_{64}^*\overline{Q_l^c}\gamma_\mu U_r\overline{Q_l^c}\gamma^\mu E_r + g_{65}\overline{Q_l}\sigma_{\mu\nu}Q_l^c\overline{E_r}\sigma^{\mu\nu}U_r^c + g_{65}^*\overline{Q_l^c}\sigma_{\mu\nu}Q_l\overline{U_r^c}\sigma^{\mu\nu}E_r + g_{66}\overline{Q_l}Q_l^c\overline{E_r}U_r^c + g_{66}^*$$

$$\overline{Q_l^c}Q_l\overline{U_r^c}E_r + g_{67}\overline{E_r}\sigma_{\mu\nu}Q_l\overline{U_r}\sigma^{\mu\nu}L_l + g_{67}^*\overline{Q_l}\sigma_{\mu\nu}E_r\overline{L_l}\sigma^{\mu\nu}U_r + g_{68}\overline{E_r}Q_l\overline{U_r}L_l + g_{68}^*\overline{Q_l}E_r\overline{L_l}U_r + g_{69}\overline{U_r}\sigma_{\mu\nu}Q_l\overline{E_r}\sigma^{\mu\nu}L_l + g_{69}^*\overline{Q_l}\sigma_{\mu\nu}U_r\overline{L_l}$$

$$\sigma^{\mu\nu}E_r + g_{70}\overline{U_r}Q_l\overline{E_r}L_l + g_{70}^*\overline{Q_l}U_r\overline{L_l}E_r + g_{71}\overline{L_l}\sigma_{\mu\nu}Q_l^c\overline{U_r^c}\sigma^{\mu\nu}E_r + g_{71}^*\overline{Q_l^c}\sigma_{\mu\nu}L_l\overline{E_r}\sigma^{\mu\nu}U_r^c + g_{72}\overline{L_l}Q_l^c\overline{U_r^c}E_r + g_{72}^*\overline{Q_l^c}L_l\overline{E_r}U_r^c + g_{73}\overline{D_r}$$

$$\gamma_\mu Q_l^c\overline{L_l}\gamma^\mu U_r^c + g_{73}^*\overline{Q_l^c}\gamma_\mu D_r\overline{U_r^c}\gamma^\mu L_l + g_{74}\overline{U_r}\gamma_\mu Q_l^c\overline{L_l}\gamma^\mu D_r^c + g_{74}^*\overline{Q_l^c}\gamma_\mu U_r\overline{D_r^c}\gamma^\mu L_l + g_{75}\overline{L_l}\sigma_{\mu\nu}Q_l^c\overline{D_r}\sigma^{\mu\nu}U_r^c + g_{75}^*\overline{Q_l^c}\sigma_{\mu\nu}L_l\overline{U_r^c}\sigma^{\mu\nu}D_r +$$

$$g_{76}\overline{L_l}Q_l^c\overline{D_r}U_r^c + g_{76}^*\overline{Q_l^c}L_l\overline{U_r^c}D_r + g_{77}\overline{L_l}\gamma_\mu Q_l\overline{D_r}\gamma^\mu E_r + g_{77}^*\overline{Q_l}\gamma_\mu L_l\overline{E_r}\gamma^\mu D_r + g_{78}\overline{E_r}\gamma_\mu Q_l^c\overline{D_r^c}\gamma^\mu L_l + g_{78}^*\overline{Q_l^c}\gamma_\mu E_r\overline{L_l}\gamma^\mu D_r^c + g_{79}\overline{D_r}\sigma_{\mu\nu}$$

$$Q_l\overline{L_l}\sigma^{\mu\nu}E_r + g_{79}^*\overline{Q_l}\sigma_{\mu\nu}D_r\overline{E_r}\sigma^{\mu\nu}L_l + g_{80}\overline{D_r}Q_l\overline{L_l}E_r + g_{80}^*\overline{Q_l}D_r\overline{E_r}L_l + g_{r81}\overline{U_r}\gamma_\mu U_r\overline{U_r}\gamma^\mu U_r + g_{r82}\overline{U_r^c}\sigma_{\mu\nu}U_r\overline{U_r}\sigma^{\mu\nu}U_r^c + g_{r83}\overline{U_r^c}U_r\overline{U_r}$$

$$U_r^c + g_{r84}\overline{U_r}\gamma_\mu D_r\overline{D_r}\gamma^\mu U_r + g_{r85}\overline{U_r}\gamma_\mu U_r\overline{D_r}\gamma^\mu D_r + g_{r86}\overline{U_r^c}\sigma_{\mu\nu}D_r\overline{D_r}\sigma^{\mu\nu}U_r^c + g_{r87}\overline{U_r^c}D_r\overline{D_r}U_r^c + g_{r88}\overline{U_r}\gamma_\mu U_r\overline{L_l}\gamma^\mu L_l + g_{r89}\overline{U_r^c}\gamma_\mu L_l$$

$$\overline{L_l}\gamma^\mu U_r^c + g_{r90}\overline{U_r}\sigma_{\mu\nu}L_l\overline{L_l}\sigma^{\mu\nu}U_r + g_{r91}\overline{U_r}L_l\overline{L_l}U_r + g_{r92}\overline{U_r}\gamma_\mu E_r\overline{E_r}\gamma^\mu U_r + g_{r93}\overline{U_r}\gamma_\mu U_r\overline{E_r}\gamma^\mu E_r + g_{r94}\overline{U_r^c}\sigma_{\mu\nu}E_r\overline{E_r}\sigma^{\mu\nu}U_r^c + g_{r95}\overline{U_r^c}E_r$$

$$\overline{E_r}U_r^c + g_{96}\overline{E_r}\sigma_{\mu\nu}U_r^c\overline{D_r}\sigma^{\mu\nu}U_r^c + g_{96}^*\overline{U_r^c}\sigma_{\mu\nu}E_r\overline{U_r^c}\sigma^{\mu\nu}D_r + g_{97}\overline{E_r}U_r^c\overline{D_r}U_r^c + g_{97}^*\overline{U_r^c}E_r\overline{U_r^c}D_r + g_{98}\overline{D_r}\sigma_{\mu\nu}U_r^c\overline{E_r}\sigma^{\mu\nu}U_r^c + g_{98}^*$$

$$\overline{U_r^c}\sigma_{\mu\nu}D_r\overline{U_r^c}\sigma^{\mu\nu}E_r + g_{99}\overline{D_r}U_r^c\overline{E_r}U_r^c + g_{99}^*\overline{U_r^c}D_r\overline{U_r^c}E_r + g_{100}\overline{U_r}\sigma_{\mu\nu}U_r^c\overline{E_r}\sigma^{\mu\nu}D_r^c + g_{100}^*\overline{U_r^c}\sigma_{\mu\nu}U_r\overline{D_r^c}\sigma^{\mu\nu}E_r + g_{101}\overline{U_r}U_r^c\overline{E_r}D_r^c +$$

$$g_{101}^*\overline{U_r^c}U_r\overline{D_r^c}E_r + g_{r102}\overline{D_r}\gamma_\mu D_r\overline{D_r}\gamma^\mu D_r + g_{r103}\overline{D_r^c}\sigma_{\mu\nu}D_r\overline{D_r}\sigma^{\mu\nu}D_r^c + g_{r104}\overline{D_r^c}D_r\overline{D_r}D_r^c + g_{r105}\overline{D_r}\gamma_\mu D_r\overline{L_l}\gamma^\mu L_l + g_{r106}\overline{D_r^c}\gamma_\mu L_l\overline{L_l}\gamma^\mu$$

$$D_r^c + g_{r107}\overline{D_r}\sigma_{\mu\nu}L_l\overline{L_l}\sigma^{\mu\nu}D_r + g_{r108}\overline{D_r}L_l\overline{L_l}D_r + g_{r109}\overline{D_r}\gamma_\mu E_r\overline{E_r}\gamma^\mu D_r + g_{r110}\overline{D_r}\gamma_\mu D_r\overline{E_r}\gamma^\mu E_r + g_{r111}\overline{D_r^c}\sigma_{\mu\nu}E_r\overline{E_r}\sigma^{\mu\nu}D_r^c + g_{r112}$$

$$\overline{D_r^c}E_r\overline{E_r}D_r^c + g_{r113}\overline{L_l}\gamma_\mu L_l\overline{L_l}\gamma^\mu L_l + g_{r114}\overline{L_l^c}\sigma_{\mu\nu}L_l\overline{L_l}\sigma^{\mu\nu}L_l^c + g_{r115}\overline{L_l^c}L_l\overline{L_l}L_l^c + g_{r116}\overline{L_l}\gamma_\mu L_l\overline{E_r}\gamma^\mu E_r + g_{r117}\overline{L_l^c}\gamma_\mu E_r\overline{E_r}\gamma^\mu L_l^c + g_{r118}\overline{L_l}$$

$$\sigma_{\mu\nu}E_r\overline{E_r}\sigma^{\mu\nu}L_l + g_{r119}\overline{L_l}E_r\overline{E_r}L_l + g_{r120}\overline{E_r}\gamma_\mu E_r\overline{E_r}\gamma^\mu E_r + g_{r121}\overline{E_r^c}\sigma_{\mu\nu}E_r\overline{E_r}\sigma^{\mu\nu}E_r^c + g_{r122}\overline{E_r^c}E_r\overline{E_r}E_r^c + g_{r123}\Phi_1\Phi_1\Phi_1\Phi_1^*\Phi_1^*\Phi_1^* +$$

$$g_{124}\Phi_2\Phi_1\Phi_1\Phi_1\Phi_1^*\Phi_1^* + g_{124}^*\Phi_1\Phi_1\Phi_1^*\Phi_1^*\Phi_1^*\Phi_2^* + g_{r125}\Phi_1\Phi_1\Phi_2\Phi_1^*\Phi_1^*\Phi_2^* + g_{126}\Phi_2\Phi_2\Phi_1\Phi_1\Phi_1\Phi_1^* + g_{126}^*\Phi_1\Phi_1^*\Phi_1^*\Phi_1^*\Phi_2^*$$

$$\Phi_2^* + g_{127}\Phi_2\Phi_2\Phi_1\Phi_1\Phi_2^*\Phi_1^* + g_{127}^*\Phi_1\Phi_2\Phi_1^*\Phi_1^*\Phi_2^*\Phi_2^* + g_{r128}\Phi_1\Phi_2\Phi_2\Phi_1^*\Phi_2^*\Phi_2^* + g_{129}\Phi_2\Phi_2\Phi_2\Phi_1\Phi_1\Phi_1 + g_{129}^*\Phi_1^*\Phi_1^*\Phi_1^*$$

$$\Phi_2^*\Phi_2^*\Phi_2^* + g_{130}\Phi_2\Phi_2\Phi_2\Phi_1\Phi_1\Phi_2^* + g_{130}^*\Phi_2\Phi_1^*\Phi_1^*\Phi_2^*\Phi_2^*\Phi_2^* + g_{131}\Phi_2\Phi_2\Phi_2\Phi_1\Phi_2^*\Phi_2^* + g_{131}^*\Phi_2\Phi_2\Phi_1^*\Phi_2^*\Phi_2^*\Phi_2^* + g_{r132}\Phi_2$$

$$\Phi_2\Phi_2\Phi_2^*\Phi_2^*\Phi_2^*$$

GUI

- For now done through web browser using Wt
- In the future, can be installed on a local server
- Can also be run on a stand alone computer
- Output is in MathML, (should) work on any mobile device

Future Work

- Symmetry Breaking
- Read/Write model from/to a file
- Connect to FeynRules
- GUI of Dynkin Diagram of Reps
- Discrete Groups other than Zn