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Fermion Masses and Mixing from Double Cover and Metaplectic Cover of A_5 Modular Symmetry Group

Supplementary Material

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Wee provide more details about the A'_5 modular models in this supplementary file. We focus on the models with small number of free parameters. In the following, we will systematically classify the lepton and quark models based on A'_5 modular symmetry, and quark-lepton unification would be also studied.

1 Lepton sector

1.1 Charged lepton sector

In the charged lepton sector, we consider six possible combinations of representation assignments of L and E^c, which are named $C^{i}, \cdots, C^{vi}$ respectively. As shown in table 1, lepton doublet L can be triplet representations $\mathbf{3}$ or $\mathbf{3'}$, while right-handed E^c can be $\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1}$, $\mathbf{2}\oplus\mathbf{1}$ or $\mathbf{2'}\oplus\mathbf{1}$. For a given representation, different weight assignments correspond to different models. The weights of the fields, the superpotential, and the mass matrix of the charged leptons will be shown one by one below.

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	C^{i}	C^{ii}	C^{iii}	C^{iv}	C^{v}	C^{vi}	C^{vii}	C^{viii}	C^{ix}	C^{x}
ρ_L	$\mathbf{3}$	$\mathbf{3'}$	$\mathbf{3}$	$\mathbf{3}$	$\mathbf{3'}$	$\mathbf{3'}$	$\mathbf{3}$	$\mathbf{3}$	$\mathbf{3'}$	$\mathbf{3'}$
$\rho_{E_i^c}$	$\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1}$	$\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1}$	$\mathbf{2}\oplus\mathbf{1}$	$\mathbf{2'}\oplus\mathbf{1}$	$\mathbf{2}\oplus\mathbf{1}$	$\mathbf{2'}\oplus\mathbf{1}$	$\mathbf{3}$	$\mathbf{3'}$	$\mathbf{3}$	$\mathbf{3'}$
# of models (total number)	1 (1)	1 (1)	6 (6)	8 (9)	8 (9)	6 (6)	2 (3)	3 (3)	3 (3)	2 (3)

Table 1: The number (in bracket) of possible charged lepton models for different representation assignment of L and $E^c_{1,2,3}$ under the finite modular group A'_5 up to weight 6 modular forms. We don't count the cases which give degenerate charged lepton masses. We also list the number (without bracket) of models which contain up to four independent terms in the charged lepton superpotential $\mathcal{W}_e$.

C^{i}_1: $k_{E^c_{1,2,3}}+k_L=2,4,6$

$$\mathcal{W}_e=\alpha\left(Y^{(2)}_{\mathbf{3}}E^c_1LH_d\right)_{\mathbf{1}}+\beta\left(Y^{(4)}_{\mathbf{3}}E^c_2LH_d\right)_{\mathbf{1}}+\gamma\left(Y^{(6)}_{\mathbf{3}I}E^c_3LH_d\right)_{\mathbf{1}}+\delta\left(Y^{(6)}_{\mathbf{3}II}E^c_3LH_d\right)_{\mathbf{1}}$$

$$M_e=\begin{pmatrix}\alpha Y^{(2)}_{\mathbf{3},1} & \alpha Y^{(2)}_{\mathbf{3},3} & \alpha Y^{(2)}_{\mathbf{3},2}\\ \beta Y^{(4)}_{\mathbf{3},1} & \beta Y^{(4)}_{\mathbf{3},3} & \beta Y^{(4)}_{\mathbf{3},2}\\ \gamma Y^{(6)}_{\mathbf{3}I,1}+\delta Y^{(6)}_{\mathbf{3}II,1} & \gamma Y^{(6)}_{\mathbf{3}I,3}+\delta Y^{(6)}_{\mathbf{3}II,3} & \gamma Y^{(6)}_{\mathbf{3}I,2}+\delta Y^{(6)}_{\mathbf{3}II,2}\end{pmatrix}v_d$$

C^{ii}_1: $k_{E^c_{1,2,3}}+k_L=2,4,6$

$$\mathcal{W}_e=\alpha\left(Y^{(2)}_{\mathbf{3'}}E^c_1LH_d\right)_{\mathbf{1}}+\beta\left(Y^{(4)}_{\mathbf{3'}}E^c_2LH_d\right)_{\mathbf{1}}+\gamma\left(Y^{(6)}_{\mathbf{3'}I}E^c_3LH_d\right)_{\mathbf{1}}+\delta\left(Y^{(6)}_{\mathbf{3'}II}E^c_3LH_d\right)_{\mathbf{1}}$$

$$M_e=\begin{pmatrix}\alpha Y^{(2)}_{\mathbf{3'},1} & \alpha Y^{(2)}_{\mathbf{3'},3} & \alpha Y^{(2)}_{\mathbf{3'},2}\\ \beta Y^{(4)}_{\mathbf{3'},1} & \beta Y^{(4)}_{\mathbf{3'},3} & \beta Y^{(4)}_{\mathbf{3'},2}\\ \gamma Y^{(6)}_{\mathbf{3'}I,1}+\delta Y^{(6)}_{\mathbf{3'}II,1} & \gamma Y^{(6)}_{\mathbf{3'}I,3}+\delta Y^{(6)}_{\mathbf{3'}II,3} & \gamma Y^{(6)}_{\mathbf{3'}I,2}+\delta Y^{(6)}_{\mathbf{3'}II,2}\end{pmatrix}v_d$$

C^{iii}_1: $k_{E^c_{D,3}}+k_L=2,3$

$$W_e=\alpha\left(Y^{(3)}_{\mathbf{4'}}E^c_DLH_d\right)_{\mathbf{1}}+\beta\left(Y^{(2)}_{\mathbf{3}}E^c_3LH_d\right)_{\mathbf{1}}$$

$$M_e=\begin{pmatrix}-\sqrt{2}\alpha Y^{(3)}_{\mathbf{4'},3} & \alpha Y^{(3)}_{\mathbf{4'},2} & \sqrt{3}\alpha Y^{(3)}_{\mathbf{4'},4}\\ -\sqrt{2}\alpha Y^{(3)}_{\mathbf{4'},2} & \sqrt{3}\alpha Y^{(3)}_{\mathbf{4'},1} & -\alpha Y^{(3)}_{\mathbf{4'},3}\\ \beta Y^{(2)}_{\mathbf{3},1} & \beta Y^{(2)}_{\mathbf{3},3} & \beta Y^{(2)}_{\mathbf{3},2}\end{pmatrix}v_d$$

C_2^{iii}: $k_{E^c_{D,3}} + k_L = 3, 4$

$$W_e = \alpha \left(Y^{(3)}_{\mathbf{4'}} E^c_D L H_d \right)_{\mathbf{1}} + \beta \left(Y^{(4)}_{\mathbf{3}} E^c_3 L H_d \right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} -\sqrt{2}\alpha Y^{(3)}_{\mathbf{4'},3} & \alpha Y^{(3)}_{\mathbf{4'},2} & \sqrt{3}\alpha Y^{(3)}_{\mathbf{4'},4} \\ -\sqrt{2}\alpha Y^{(3)}_{\mathbf{4'},2} & \sqrt{3}\alpha Y^{(3)}_{\mathbf{4'},1} & -\alpha Y^{(3)}_{\mathbf{4'},3} \\ \beta Y^{(4)}_{\mathbf{3},1} & \beta Y^{(4)}_{\mathbf{3},3} & \beta Y^{(4)}_{\mathbf{3},2} \end{pmatrix} v_d$$

C_3^{iii}: $k_{E^c_{D,3}} + k_L = 5, 2$

$$\mathcal{W}_e = \alpha \left(Y^{(5)}_{\mathbf{2}} E^c_D L H_d \right)_{\mathbf{1}} + \beta \left(Y^{(5)}_{\mathbf{4'}} E^c_D L H_d \right)_{\mathbf{1}} + \gamma \left(Y^{(2)}_{\mathbf{3}} E^c_3 L H_d \right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} \alpha Y^{(5)}_{\mathbf{2},2} - \sqrt{2}\beta Y^{(5)}_{\mathbf{4'},3} & \sqrt{2}\alpha Y^{(5)}_{\mathbf{2},1} + \beta Y^{(5)}_{\mathbf{4'},2} & \sqrt{3}\beta Y^{(5)}_{\mathbf{4'},4} \\ \alpha Y^{(5)}_{\mathbf{2},1} - \sqrt{2}\beta Y^{(5)}_{\mathbf{4'},2} & \sqrt{3}\beta Y^{(5)}_{\mathbf{4'},1} & -\sqrt{2}\alpha Y^{(5)}_{\mathbf{2},2} - \beta Y^{(5)}_{\mathbf{4'},3} \\ \gamma Y^{(2)}_{\mathbf{3},1} & \gamma Y^{(2)}_{\mathbf{3},3} & \gamma Y^{(2)}_{\mathbf{3},2} \end{pmatrix} v_d$$

C_4^{iii}: $k_{E^c_{D,3}} + k_L = 5, 4$

$$\mathcal{W}_e = \alpha \left(Y^{(5)}_{\mathbf{2}} E^c_D L H_d \right)_{\mathbf{1}} + \beta \left(Y^{(5)}_{\mathbf{4'}} E^c_D L H_d \right)_{\mathbf{1}} + \gamma \left(Y^{(4)}_{\mathbf{3}} E^c_3 L H_d \right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} \alpha Y^{(5)}_{\mathbf{2},2} - \sqrt{2}\beta Y^{(5)}_{\mathbf{4'},3} & \sqrt{2}\alpha Y^{(5)}_{\mathbf{2},1} + \beta Y^{(5)}_{\mathbf{4'},2} & \sqrt{3}\beta Y^{(5)}_{\mathbf{4'},4} \\ \alpha Y^{(5)}_{\mathbf{2},1} - \sqrt{2}\beta Y^{(5)}_{\mathbf{4'},2} & \sqrt{3}\beta Y^{(5)}_{\mathbf{4'},1} & -\sqrt{2}\alpha Y^{(5)}_{\mathbf{2},2} - \beta Y^{(5)}_{\mathbf{4'},3} \\ \gamma Y^{(4)}_{\mathbf{3},1} & \gamma Y^{(4)}_{\mathbf{3},3} & \gamma Y^{(4)}_{\mathbf{3},2} \end{pmatrix} v_d$$

C_5^{iii}: $k_{E^c_{D,3}} + k_L = 3, 6$

$$\mathcal{W}_e = \alpha \left(Y^{(3)}_{\mathbf{4'}} E^c_D L H_d \right)_{\mathbf{1}} + \beta \left(Y^{(6)}_{\mathbf{3}I} E^c_3 L H_d \right)_{\mathbf{1}} + \gamma \left(Y^{(6)}_{\mathbf{3}II} E^c_3 L H_d \right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} -\sqrt{2}\alpha Y^{(3)}_{\mathbf{4'},3} & \alpha Y^{(3)}_{\mathbf{4'},2} & \sqrt{3}\alpha Y^{(3)}_{\mathbf{4'},4} \\ -\sqrt{2}\alpha Y^{(3)}_{\mathbf{4'},2} & \sqrt{3}\alpha Y^{(3)}_{\mathbf{4'},1} & -\alpha Y^{(3)}_{\mathbf{4'},3} \\ \beta Y^{(6)}_{\mathbf{3}I,1} + \gamma Y^{(6)}_{\mathbf{3}II,1} & \beta Y^{(6)}_{\mathbf{3}I,3} + \gamma Y^{(6)}_{\mathbf{3}II,3} & \beta Y^{(6)}_{\mathbf{3}I,2} + \gamma Y^{(6)}_{\mathbf{3}II,2} \end{pmatrix} v_d$$

C_6^{iii}: $k_{E^c_{D,3}} + k_L = 5, 6$

$$W_e = \alpha \left(Y^{(5)}_{\mathbf{2}} E^c_D L H_d \right)_{\mathbf{1}} + \beta \left(Y^{(5)}_{\mathbf{4'}} E^c_D L H_d \right)_{\mathbf{1}} + \gamma \left(Y^{(6)}_{\mathbf{3}I} E^c_3 L H_d \right)_{\mathbf{1}} + \delta \left(Y^{(6)}_{\mathbf{3}II} E^c_3 L H_d \right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} \alpha Y^{(5)}_{\mathbf{2},2} - \sqrt{2}\beta Y^{(5)}_{\mathbf{4'},3} & \sqrt{2}\alpha Y^{(5)}_{\mathbf{2},1} + \beta Y^{(5)}_{\mathbf{4'},2} & \sqrt{3}\beta Y^{(5)}_{\mathbf{4'},4} \\ \alpha Y^{(5)}_{\mathbf{2},1} - \sqrt{2}\beta Y^{(5)}_{\mathbf{4'},2} & \sqrt{3}\beta Y^{(5)}_{\mathbf{4'},1} & -\sqrt{2}\alpha Y^{(5)}_{\mathbf{2},2} - \beta Y^{(5)}_{\mathbf{4'},3} \\ \gamma Y^{(6)}_{\mathbf{3}I,1} + \delta Y^{(6)}_{\mathbf{3}II,1} & \gamma Y^{(6)}_{\mathbf{3}I,3} + \delta Y^{(6)}_{\mathbf{3}II,3} & \gamma Y^{(6)}_{\mathbf{3}I,2} + \delta Y^{(6)}_{\mathbf{3}II,2} \end{pmatrix} v_d$$

C_1^{iv}: $k_{E^c_{D,3}} + k_L = 1, 2$

$$W_e = \alpha \left(Y_{\mathbf{6}}^{(1)} E_D^c L H_d \right)_{\mathbf{1}} + \beta \left(Y_{\mathbf{3}}^{(2)} E_3^c L H_d \right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} \sqrt{2}\alpha Y_6 & \sqrt{2}\alpha Y_5 & \alpha\left(Y_1 + Y_2\right) \\ \sqrt{2}\alpha Y_3 & \alpha\left(Y_1 - Y_2\right) & \sqrt{2}\alpha Y_4 \\ \beta Y_{\mathbf{3},1}^{(2)} & \beta Y_{\mathbf{3},3}^{(2)} & \beta Y_{\mathbf{3},2}^{(2)} \end{pmatrix} v_d$$

C_2^{iv}: $k_{E^c_{D,3}} + k_L = 1, 4$

$$W_e = \alpha \left(Y_{\mathbf{6}}^{(1)} E_D^c L H_d \right)_{\mathbf{1}} + \beta \left(Y_{\mathbf{3}}^{(4)} E_3^c L H_d \right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} \sqrt{2}\alpha Y_6 & \sqrt{2}\alpha Y_5 & \alpha\left(Y_1 + Y_2\right) \\ \sqrt{2}\alpha Y_3 & \alpha\left(Y_1 - Y_2\right) & \sqrt{2}\alpha Y_4 \\ \beta Y_{\mathbf{3},1}^{(4)} & \beta Y_{\mathbf{3},3}^{(4)} & \beta Y_{\mathbf{3},2}^{(4)} \end{pmatrix} v_d$$

C_3^{iv}: $k_{E^c_{D,3}} + k_L = 3, 2$

$$\mathcal{W}_e = \alpha \left(Y_{\mathbf{6}I}^{(3)} E_D^c L H_d \right)_{\mathbf{1}} + \beta \left(Y_{\mathbf{6}II}^{(3)} E_D^c L H_d \right)_{\mathbf{1}} + \gamma \left(Y_{\mathbf{3}}^{(2)} E_3^c L H_d \right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} \sqrt{2}\left(\alpha Y_{\mathbf{6}I,6}^{(3)} + \beta Y_{\mathbf{6}II,6}^{(3)}\right) & \sqrt{2}\left(\alpha Y_{\mathbf{6}I,5}^{(3)} + \beta Y_{\mathbf{6}II,5}^{(3)}\right) & \begin{array}{c} \alpha\left(Y_{\mathbf{6}I,1}^{(3)} + Y_{\mathbf{6}I,2}^{(3)}\right) \\ +\beta\left(Y_{\mathbf{6}II,1}^{(3)} + Y_{\mathbf{6}II,2}^{(3)}\right) \end{array} \\ \sqrt{2}\left(\alpha Y_{\mathbf{6}I,3}^{(3)} + \beta Y_{\mathbf{6}II,3}^{(3)}\right) & \begin{array}{c} \alpha Y_{\mathbf{6}I,1}^{(3)} - \alpha Y_{\mathbf{6}I,2}^{(3)} \\ +\beta\left(Y_{\mathbf{6}II,1}^{(3)} - Y_{\mathbf{6}II,2}^{(3)}\right) \end{array} & \sqrt{2}\left(\alpha Y_{\mathbf{6}I,4}^{(3)} + \beta Y_{\mathbf{6}II,4}^{(3)}\right) \\ \gamma Y_{\mathbf{3},1}^{(2)} & \gamma Y_{\mathbf{3},3}^{(2)} & \gamma Y_{\mathbf{3},2}^{(2)} \end{pmatrix} v_d$$

C_4^{iv}: $k_{E^c_{D,3}} + k_L = 3, 4$

$$\mathcal{W}_e = \alpha \left(Y_{\mathbf{6}I}^{(3)} E_D^c L H_d \right)_{\mathbf{1}} + \beta \left(Y_{\mathbf{6}II}^{(3)} E_D^c L H_d \right)_{\mathbf{1}} + \gamma \left(Y_{\mathbf{3}}^{(4)} E_3^c L H_d \right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} \sqrt{2}\left(\alpha Y_{\mathbf{6}I,6}^{(3)} + \beta Y_{\mathbf{6}II,6}^{(3)}\right) & \sqrt{2}\left(\alpha Y_{\mathbf{6}I,5}^{(3)} + \beta Y_{\mathbf{6}II,5}^{(3)}\right) & \begin{array}{c} \alpha\left(Y_{\mathbf{6}I,1}^{(3)} + Y_{\mathbf{6}I,2}^{(3)}\right) \\ +\beta\left(Y_{\mathbf{6}II,1}^{(3)} + Y_{\mathbf{6}II,2}^{(3)}\right) \end{array} \\ \sqrt{2}\left(\alpha Y_{\mathbf{6}I,3}^{(3)} + \beta Y_{\mathbf{6}II,3}^{(3)}\right) & \begin{array}{c} \alpha Y_{\mathbf{6}I,1}^{(3)} - \alpha Y_{\mathbf{6}I,2}^{(3)} \\ +\beta\left(Y_{\mathbf{6}II,1}^{(3)} - Y_{\mathbf{6}II,2}^{(3)}\right) \end{array} & \sqrt{2}\left(\alpha Y_{\mathbf{6}I,4}^{(3)} + \beta Y_{\mathbf{6}II,4}^{(3)}\right) \\ \gamma Y_{\mathbf{3},1}^{(4)} & \gamma Y_{\mathbf{3},3}^{(4)} & \gamma Y_{\mathbf{3},2}^{(4)} \end{pmatrix} v_d$$

C_5^{iv}: $k_{E^c_{D,3}} + k_L = 1, 6$

$$\mathcal{W}_e = \alpha \left(Y_{\mathbf{6}}^{(1)} E^c_D L H_d\right)_{\mathbf{1}} + \beta \left(Y_{\mathbf{3}I}^{(6)} E^c_3 L H_d\right)_{\mathbf{1}} + \gamma \left(Y_{\mathbf{3}II}^{(6)} E^c_3 L H_d\right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} \sqrt{2}\alpha Y_6 & \sqrt{2}\alpha Y_5 & \alpha\left(Y_1 + Y_2\right) \\ \sqrt{2}\alpha Y_3 & \alpha\left(Y_1 - Y_2\right) & \sqrt{2}\alpha Y_4 \\ \beta Y^{(6)}_{\mathbf{3}I,1} + \gamma Y^{(6)}_{\mathbf{3}II,1} & \beta Y^{(6)}_{\mathbf{3}I,3} + \gamma Y^{(6)}_{\mathbf{3}II,3} & \beta Y^{(6)}_{\mathbf{3}I,2} + \gamma Y^{(6)}_{\mathbf{3}II,2} \end{pmatrix} v_d$$

C_6^{iv}: $k_{E^c_{D,3}} + k_L = 5, 2$

$$W_e = \alpha \left(Y_{\mathbf{6}I}^{(5)} E^c_D L H_d\right)_{\mathbf{1}} + \beta \left(Y_{\mathbf{6}II}^{(5)} E^c_D L H_d\right)_{\mathbf{1}} + \gamma \left(Y_{\mathbf{6}III}^{(5)} E^c_D L H_d\right)_{\mathbf{1}} + \delta \left(Y_{\mathbf{3}}^{(2)} E^c_3 L H_d\right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} \sqrt{2}\left(\alpha Y^{(5)}_{\mathbf{6}I,6} + \beta Y^{(5)}_{\mathbf{6}II,6} + \gamma Y^{(5)}_{\mathbf{6}III,6}\right) & \sqrt{2}\left(\alpha Y^{(5)}_{\mathbf{6}I,5} + \beta Y^{(5)}_{\mathbf{6}II,5} + \gamma Y^{(5)}_{\mathbf{6}III,5}\right) & \begin{array}{c} \alpha\left(Y^{(5)}_{\mathbf{6}I,1} + Y^{(5)}_{\mathbf{6}I,2}\right) + \beta\left(Y^{(5)}_{\mathbf{6}II,1} + Y^{(5)}_{\mathbf{6}II,2}\right) \\ +\gamma\left(Y^{(5)}_{\mathbf{6}III,1} + Y^{(5)}_{\mathbf{6}III,2}\right) \end{array} \\ \sqrt{2}\left(\alpha Y^{(5)}_{\mathbf{6}I,3} + \beta Y^{(5)}_{\mathbf{6}II,3} + \gamma Y^{(5)}_{\mathbf{6}III,3}\right) & \begin{array}{c} \alpha\left(Y^{(5)}_{\mathbf{6}I,1} - Y^{(5)}_{\mathbf{6}I,2}\right) + \beta\left(Y^{(5)}_{\mathbf{6}II,1} - Y^{(5)}_{\mathbf{6}II,2}\right) \\ +\gamma\left(Y^{(5)}_{\mathbf{6}III,1} - Y^{(5)}_{\mathbf{6}III,2}\right) \end{array} & \sqrt{2}\left(\alpha Y^{(5)}_{\mathbf{6}I,4} + \beta Y^{(5)}_{\mathbf{6}II,4} + \gamma Y^{(5)}_{\mathbf{6}III,4}\right) \\ \delta Y^{(2)}_{\mathbf{3},1} & \delta Y^{(2)}_{\mathbf{3},3} & \delta Y^{(2)}_{\mathbf{3},2} \end{pmatrix} v_d$$

C_7^{iv}: $k_{E^c_{D,3}} + k_L = 3, 6$

$$W_e = \alpha \left(Y_{\mathbf{6}I}^{(3)} E^c_D L H_d\right)_{\mathbf{1}} + \beta \left(Y_{\mathbf{6}II}^{(3)} E^c_D L H_d\right)_{\mathbf{1}} + \gamma \left(Y_{\mathbf{3}II}^{(6)} E^c_3 L H_d\right)_{\mathbf{1}} + \delta \left(Y_{\mathbf{3}I}^{(6)} E^c_3 L H_d\right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} \sqrt{2}\left(\alpha Y^{(3)}_{\mathbf{6}I,6} + \beta Y^{(3)}_{\mathbf{6}II,6}\right) & \sqrt{2}\left(\alpha Y^{(3)}_{\mathbf{6}I,5} + \beta Y^{(3)}_{\mathbf{6}II,5}\right) & \begin{array}{c} \alpha\left(Y^{(3)}_{\mathbf{6}I,1} + Y^{(3)}_{\mathbf{6}I,2}\right) \\ +\beta\left(Y^{(3)}_{\mathbf{6}II,1} + Y^{(3)}_{\mathbf{6}II,2}\right) \end{array} \\ \sqrt{2}\left(\alpha Y^{(3)}_{\mathbf{6}I,3} + \beta Y^{(3)}_{\mathbf{6}II,3}\right) & \begin{array}{c} \alpha\left(Y^{(3)}_{\mathbf{6}I,1} - Y^{(3)}_{\mathbf{6}I,2}\right) \\ +\beta\left(Y^{(3)}_{\mathbf{6}II,1} - Y^{(3)}_{\mathbf{6}II,2}\right) \end{array} & \sqrt{2}\left(\alpha Y^{(3)}_{\mathbf{6}I,4} + \beta Y^{(3)}_{\mathbf{6}II,4}\right) \\ \delta Y^{(6)}_{\mathbf{3}I,1} + \gamma Y^{(6)}_{\mathbf{3}II,1} & \delta Y^{(6)}_{\mathbf{3}I,3} + \gamma Y^{(6)}_{\mathbf{3}II,3} & \delta Y^{(6)}_{\mathbf{3}I,2} + \gamma Y^{(6)}_{\mathbf{3}II,2} \end{pmatrix} v_d$$

C_8^{iv}: $k_{E^c_{D,3}} + k_L = 5, 4$

$$W_e = \alpha \left(Y_{\mathbf{6}I}^{(5)} E^c_D L H_d\right)_{\mathbf{1}} + \beta \left(Y_{\mathbf{6}II}^{(5)} E^c_D L H_d\right)_{\mathbf{1}} + \gamma \left(Y_{\mathbf{6}III}^{(5)} E^c_D L H_d\right)_{\mathbf{1}} + \delta \left(Y_{\mathbf{3}}^{(4)} E^c_3 L H_d\right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} \sqrt{2}\left(\alpha Y^{(5)}_{\mathbf{6}I,6} + \beta Y^{(5)}_{\mathbf{6}II,6} + \gamma Y^{(5)}_{\mathbf{6}III,6}\right) & \sqrt{2}\left(\alpha Y^{(5)}_{\mathbf{6}I,5} + \beta Y^{(5)}_{\mathbf{6}II,5} + \gamma Y^{(5)}_{\mathbf{6}III,5}\right) & \begin{array}{c} \alpha\left(Y^{(5)}_{\mathbf{6}I,1} + Y^{(5)}_{\mathbf{6}I,2}\right) + \beta\left(Y^{(5)}_{\mathbf{6}II,1} + Y^{(5)}_{\mathbf{6}II,2}\right) \\ +\gamma\left(Y^{(5)}_{\mathbf{6}III,1} + Y^{(5)}_{\mathbf{6}III,2}\right) \end{array} \\ \sqrt{2}\left(\alpha Y^{(5)}_{\mathbf{6}I,3} + \beta Y^{(5)}_{\mathbf{6}II,3} + \gamma Y^{(5)}_{\mathbf{6}III,3}\right) & \begin{array}{c} \alpha\left(Y^{(5)}_{\mathbf{6}I,1} - Y^{(5)}_{\mathbf{6}I,2}\right) + \beta\left(Y^{(5)}_{\mathbf{6}II,1} - Y^{(5)}_{\mathbf{6}II,2}\right) \\ +\gamma\left(Y^{(5)}_{\mathbf{6}III,1} - Y^{(5)}_{\mathbf{6}III,2}\right) \end{array} & \sqrt{2}\left(\alpha Y^{(5)}_{\mathbf{6}I,4} + \beta Y^{(5)}_{\mathbf{6}II,4} + \gamma Y^{(5)}_{\mathbf{6}III,4}\right) \\ \delta Y^{(4)}_{\mathbf{3},1} & \delta Y^{(4)}_{\mathbf{3},3} & \delta Y^{(4)}_{\mathbf{3},2} \end{pmatrix} v_d$$

C_1^v: $k_{E^c_{D,3}} + k_L = 2, 1$

$$W_e = \alpha \left(Y_{\mathbf{6}}^{(1)} E_D^c L H_d\right)_{\mathbf{1}} + \beta \left(Y_{\mathbf{3'}}^{(2)} E_3^c L H_d\right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} \alpha Y_5 & -\alpha Y_3 & \alpha Y_2 \\ -\alpha Y_4 & -\alpha Y_1 & -\alpha Y_6 \\ \beta Y_{\mathbf{3'},1}^{(2)} & \beta Y_{\mathbf{3'},3}^{(2)} & \beta Y_{\mathbf{3'},2}^{(2)} \end{pmatrix} v_d$$

C_2^v: $k_{E^c_{D,3}} + k_L = 4, 1$

$$W_e = \alpha \left(Y_{\mathbf{6}}^{(1)} E_D^c L H_d\right)_{\mathbf{1}} + \beta \left(Y_{\mathbf{3'}}^{(4)} E_3^c L H_d\right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} \alpha Y_5 & -\alpha Y_3 & \alpha Y_2 \\ -\alpha Y_4 & -\alpha Y_1 & -\alpha Y_6 \\ \beta Y_{\mathbf{3'},1}^{(4)} & \beta Y_{\mathbf{3'},3}^{(4)} & \beta Y_{\mathbf{3'},2}^{(4)} \end{pmatrix} v_d$$

C_3^v: $k_{E^c_{D,3}} + k_L = 3, 2$

$$\mathcal{W}_e = \alpha \left(Y_{\mathbf{6}I}^{(3)} E_D^c L H_d\right)_{\mathbf{1}} + \beta \left(Y_{\mathbf{6}II}^{(3)} E_D^c L H_d\right)_{\mathbf{1}} + \gamma \left(Y_{\mathbf{3'}}^{(2)} E_3^c L H_d\right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} \alpha Y_{\mathbf{6}I,5}^{(3)} + \beta Y_{\mathbf{6}II,5}^{(3)} & -\alpha Y_{\mathbf{6}I,3}^{(3)} - \beta Y_{\mathbf{6}II,3}^{(3)} & \alpha Y_{\mathbf{6}I,2}^{(3)} + \beta Y_{\mathbf{6}II,2}^{(3)} \\ -\alpha Y_{\mathbf{6}I,4}^{(3)} - \beta Y_{\mathbf{6}II,4}^{(3)} & -\alpha Y_{\mathbf{6}I,1}^{(3)} - \beta Y_{\mathbf{6}II,1}^{(3)} & -\alpha Y_{\mathbf{6}I,6}^{(3)} - \beta Y_{\mathbf{6}II,6}^{(3)} \\ \gamma Y_{\mathbf{3'},1}^{(2)} & \gamma Y_{\mathbf{3'},3}^{(2)} & \gamma Y_{\mathbf{3'},2}^{(2)} \end{pmatrix} v_d$$

C_4^v: $k_{E^c_{D,3}} + k_L = 3, 4$

$$\mathcal{W}_e = \alpha \left(Y_{\mathbf{6}I}^{(3)} E_D^c L H_d\right)_{\mathbf{1}} + \beta \left(Y_{\mathbf{6}II}^{(3)} E_D^c L H_d\right)_{\mathbf{1}} + \gamma \left(Y_{\mathbf{3'}}^{(4)} E_3^c L H_d\right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} \alpha Y_{\mathbf{6}I,5}^{(3)} + \beta Y_{\mathbf{6}II,5}^{(3)} & -\alpha Y_{\mathbf{6}I,3}^{(3)} - \beta Y_{\mathbf{6}II,3}^{(3)} & \alpha Y_{\mathbf{6}I,2}^{(3)} + \beta Y_{\mathbf{6}II,2}^{(3)} \\ -\alpha Y_{\mathbf{6}I,4}^{(3)} - \beta Y_{\mathbf{6}II,4}^{(3)} & -\alpha Y_{\mathbf{6}I,1}^{(3)} - \beta Y_{\mathbf{6}II,1}^{(3)} & -\alpha Y_{\mathbf{6}I,6}^{(3)} - \beta Y_{\mathbf{6}II,6}^{(3)} \\ \gamma Y_{\mathbf{3'},1}^{(4)} & \gamma Y_{\mathbf{3'},3}^{(4)} & \gamma Y_{\mathbf{3'},2}^{(4)} \end{pmatrix} v_d$$

C_5^v: $k_{E^c_{D,3}} + k_L = 1, 6$

$$\mathcal{W}_e = \alpha \left(Y_{\mathbf{6}}^{(1)} E_D^c L H_d\right)_{\mathbf{1}} + \beta \left(Y_{\mathbf{3'}I}^{(6)} E_3^c L H_d\right)_{\mathbf{1}} + \gamma \left(Y_{\mathbf{3'}II}^{(6)} E_3^c L H_d\right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} \alpha Y_5 & -\alpha Y_3 & \alpha Y_2 \\ -\alpha Y_4 & -\alpha Y_1 & -\alpha Y_6 \\ \beta Y_{\mathbf{3'}I,1}^{(6)} + \gamma Y_{\mathbf{3'}II,1}^{(6)} & \beta Y_{\mathbf{3'}I,3}^{(6)} + \gamma Y_{\mathbf{3'}II,3}^{(6)} & \beta Y_{\mathbf{3'}I,2}^{(6)} + \gamma Y_{\mathbf{3'}II,2}^{(6)} \end{pmatrix} v_d$$

C_6^v: $k_{E^c_{D,3}}+k_L=5,2$

$$W_e=\alpha\left(Y^{(5)}_{\mathbf{6}I}E^c_DLH_d\right)_{\mathbf{1}}+\beta\left(Y^{(5)}_{\mathbf{6}II}E^c_DLH_d\right)_{\mathbf{1}}+\gamma\left(Y^{(5)}_{\mathbf{6}III}E^c_DLH_d\right)_{\mathbf{1}}+\delta\left(Y^{(2)}_{\mathbf{3'}}E^c_3LH_d\right)_{\mathbf{1}}$$

$$M_e=\begin{pmatrix}\alpha Y^{(5)}_{\mathbf{6}I,5}+\beta Y^{(5)}_{\mathbf{6}II,5}+\gamma Y^{(5)}_{\mathbf{6}III,5} & -\alpha Y^{(5)}_{\mathbf{6}I,3}-\beta Y^{(5)}_{\mathbf{6}II,3}-\gamma Y^{(5)}_{\mathbf{6}III,3} & \alpha Y^{(5)}_{\mathbf{6}I,2}+\beta Y^{(5)}_{\mathbf{6}II,2}+\gamma Y^{(5)}_{\mathbf{6}III,2}\\ -\alpha Y^{(5)}_{\mathbf{6}I,4}-\beta Y^{(5)}_{\mathbf{6}II,4}-\gamma Y^{(5)}_{\mathbf{6}III,4} & -\alpha Y^{(5)}_{\mathbf{6}I,1}-\beta Y^{(5)}_{\mathbf{6}II,1}-\gamma Y^{(5)}_{\mathbf{6}III,1} & -\alpha Y^{(5)}_{\mathbf{6}I,6}-\beta Y^{(5)}_{\mathbf{6}II,6}-\gamma Y^{(5)}_{\mathbf{6}III,6}\\ \delta Y^{(2)}_{\mathbf{3'},1} & \delta Y^{(2)}_{\mathbf{3'},3} & \delta Y^{(2)}_{\mathbf{3'},2}\end{pmatrix}v_d$$

C_7^v: $k_{E^c_{D,3}}+k_L=3,6$

$$W_e=\alpha\left(Y^{(3)}_{\mathbf{6}I}E^c_DLH_d\right)_{\mathbf{1}}+\beta\left(Y^{(3)}_{\mathbf{6}II}E^c_DLH_d\right)_{\mathbf{1}}+\gamma\left(Y^{(6)}_{\mathbf{3'},II}E^c_3LH_d\right)_{\mathbf{1}}+\delta\left(Y^{(6)}_{\mathbf{3'},I}E^c_3LH_d\right)_{\mathbf{1}}$$

$$M_e=\begin{pmatrix}\alpha Y^{(3)}_{\mathbf{6}I,5}+\beta Y^{(3)}_{\mathbf{6}II,5} & -\alpha Y^{(3)}_{\mathbf{6}I,3}-\beta Y^{(3)}_{\mathbf{6}II,3} & \alpha Y^{(3)}_{\mathbf{6}I,2}+\beta Y^{(3)}_{\mathbf{6}II,2}\\ -\alpha Y^{(3)}_{\mathbf{6}I,4}-\beta Y^{(3)}_{\mathbf{6}II,4} & -\alpha Y^{(3)}_{\mathbf{6}I,1}-\beta Y^{(3)}_{\mathbf{6}II,1} & -\alpha Y^{(3)}_{\mathbf{6}I,6}-\beta Y^{(3)}_{\mathbf{6}II,6}\\ \delta Y^{(6)}_{\mathbf{3'}I,1}+\gamma Y^{(6)}_{\mathbf{3'}II,1} & \delta Y^{(6)}_{\mathbf{3'}I,3}+\gamma Y^{(6)}_{\mathbf{3'}II,3} & \delta Y^{(6)}_{\mathbf{3'}I,2}+\gamma Y^{(6)}_{\mathbf{3'}II,2}\end{pmatrix}v_d$$

C_8^v: $k_{E^c_{D,3}}+k_L=5,4$

$$W_e=\alpha\left(Y^{(5)}_{\mathbf{6}I}E^c_DLH_d\right)_{\mathbf{1}}+\beta\left(Y^{(5)}_{\mathbf{6}II}E^c_DLH_d\right)_{\mathbf{1}}+\gamma\left(Y^{(5)}_{\mathbf{6}III}E^c_DLH_d\right)_{\mathbf{1}}+\delta\left(Y^{(4)}_{\mathbf{3'}}E^c_3LH_d\right)_{\mathbf{1}}$$

$$M_e=\begin{pmatrix}\alpha Y^{(5)}_{\mathbf{6}I,5}+\beta Y^{(5)}_{\mathbf{6}II,5}+\gamma Y^{(5)}_{\mathbf{6}III,5} & -\alpha Y^{(5)}_{\mathbf{6}I,3}-\beta Y^{(5)}_{\mathbf{6}II,3}-\gamma Y^{(5)}_{\mathbf{6}III,3} & \alpha Y^{(5)}_{\mathbf{6}I,2}+\beta Y^{(5)}_{\mathbf{6}II,2}+\gamma Y^{(5)}_{\mathbf{6}III,2}\\ -\alpha Y^{(5)}_{\mathbf{6}I,4}-\beta Y^{(5)}_{\mathbf{6}II,4}-\gamma Y^{(5)}_{\mathbf{6}III,4} & -\alpha Y^{(5)}_{\mathbf{6}I,1}-\beta Y^{(5)}_{\mathbf{6}II,1}-\gamma Y^{(5)}_{\mathbf{6}III,1} & -\alpha Y^{(5)}_{\mathbf{6}I,6}-\beta Y^{(5)}_{\mathbf{6}II,6}-\gamma Y^{(5)}_{\mathbf{6}III,6}\\ \delta Y^{(4)}_{\mathbf{3'},1} & \delta Y^{(4)}_{\mathbf{3'},3} & \delta Y^{(4)}_{\mathbf{3'},2}\end{pmatrix}v_d$$

C_1^{vi}: $k_{E^c_{D,3}}+k_L=3,2$

$$W_e=\alpha\left(Y^{(3)}_{\mathbf{4'}}E^c_DLH_d\right)_{\mathbf{1}}+\beta\left(Y^{(2)}_{\mathbf{3'}}E^c_3LH_d\right)_{\mathbf{1}}$$

$$M_e=\begin{pmatrix}-\sqrt{2}\alpha Y^{(3)}_{\mathbf{4'},4} & -\sqrt{3}\alpha Y^{(3)}_{\mathbf{4'},2} & \alpha Y^{(3)}_{\mathbf{4'},1}\\ \sqrt{2}\alpha Y^{(3)}_{\mathbf{4'},1} & \alpha Y^{(3)}_{\mathbf{4'},4} & -\sqrt{3}\alpha Y^{(3)}_{\mathbf{4'},3}\\ \beta Y^{(2)}_{\mathbf{3'},1} & \beta Y^{(2)}_{\mathbf{3'},3} & \beta Y^{(2)}_{\mathbf{3'},2}\end{pmatrix}v_d$$

C_2^{vi}: $k_{E^c_{D,3}}+k_L=3,4$

$$W_e=\alpha\left(Y^{(3)}_{\mathbf{4'}}E^c_DLH_d\right)_{\mathbf{1}}+\beta\left(Y^{(4)}_{\mathbf{3'}}E^c_3LH_d\right)_{\mathbf{1}}$$

$$M_e=\begin{pmatrix}-\sqrt{2}\alpha Y^{(3)}_{\mathbf{4'},4} & -\sqrt{3}\alpha Y^{(3)}_{\mathbf{4'},2} & \alpha Y^{(3)}_{\mathbf{4'},1}\\ \sqrt{2}\alpha Y^{(3)}_{\mathbf{4'},1} & \alpha Y^{(3)}_{\mathbf{4'},4} & -\sqrt{3}\alpha Y^{(3)}_{\mathbf{4'},3}\\ \beta Y^{(4)}_{\mathbf{3'},1} & \beta Y^{(4)}_{\mathbf{3'},3} & \beta Y^{(4)}_{\mathbf{3'},2}\end{pmatrix}v_d$$

C_3^{vi}: $k_{E^c_{D,3}} + k_L = 5, 2$

$$\mathcal{W}_e = \alpha\left(Y^{(5)}_{\mathbf{2'}} E^c_D L H_d\right)_{\mathbf{1}} + \beta\left(Y^{(5)}_{\mathbf{4'}} E^c_D L H_d\right)_{\mathbf{1}} + \gamma\left(Y^{(2)}_{\mathbf{3'}} E^c_3 L H_d\right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} -\alpha Y^{(5)}_{\mathbf{2'},2} - \sqrt{2}\beta Y^{(5)}_{\mathbf{4'},4} & -\sqrt{3}\beta Y^{(5)}_{\mathbf{4'},2} & \sqrt{2}\alpha Y^{(5)}_{\mathbf{2'},1} + \beta Y^{(5)}_{\mathbf{4'},1} \\ \sqrt{2}\beta Y^{(5)}_{\mathbf{4'},1} - \alpha Y^{(5)}_{\mathbf{2'},1} & \beta Y^{(5)}_{\mathbf{4'},4} - \sqrt{2}\alpha Y^{(5)}_{\mathbf{2'},2} & -\sqrt{3}\beta Y^{(5)}_{\mathbf{4'},3} \\ \gamma Y^{(2)}_{\mathbf{3'},1} & \gamma Y^{(2)}_{\mathbf{3'},3} & \gamma Y^{(2)}_{\mathbf{3'},2} \end{pmatrix} v_d$$

C_4^{vi}: $k_{E^c_{D,3}} + k_L = 5, 4$

$$\mathcal{W}_e = \alpha\left(Y^{(5)}_{\mathbf{2'}} E^c_D L H_d\right)_{\mathbf{1}} + \beta\left(Y^{(5)}_{\mathbf{4'}} E^c_D L H_d\right)_{\mathbf{1}} + \gamma\left(Y^{(4)}_{\mathbf{3'}} E^c_3 L H_d\right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} -\alpha Y^{(5)}_{\mathbf{2'},2} - \sqrt{2}\beta Y^{(5)}_{\mathbf{4'},4} & -\sqrt{3}\beta Y^{(5)}_{\mathbf{4'},2} & \sqrt{2}\alpha Y^{(5)}_{\mathbf{2'},1} + \beta Y^{(5)}_{\mathbf{4'},1} \\ \sqrt{2}\beta Y^{(5)}_{\mathbf{4'},1} - \alpha Y^{(5)}_{\mathbf{2'},1} & \beta Y^{(5)}_{\mathbf{4'},4} - \sqrt{2}\alpha Y^{(5)}_{\mathbf{2'},2} & -\sqrt{3}\beta Y^{(5)}_{\mathbf{4'},3} \\ \gamma Y^{(4)}_{\mathbf{3'},1} & \gamma Y^{(4)}_{\mathbf{3'},3} & \gamma Y^{(4)}_{\mathbf{3'},2} \end{pmatrix} v_d$$

C_5^{vi}: $k_{E^c_{D,3}} + k_L = 3, 6$

$$\mathcal{W}_e = \alpha\left(Y^{(3)}_{\mathbf{4'}} E^c_D L H_d\right)_{\mathbf{1}} + \beta\left(Y^{(6)}_{\mathbf{3'}I} E^c_3 L H_d\right)_{\mathbf{1}} + \gamma\left(Y^{(6)}_{\mathbf{3'}II} E^c_3 L H_d\right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} -\sqrt{2}\alpha Y^{(3)}_{\mathbf{4'},4} & -\sqrt{3}\alpha Y^{(3)}_{\mathbf{4'},2} & \alpha Y^{(3)}_{\mathbf{4'},1} \\ \sqrt{2}\alpha Y^{(3)}_{\mathbf{4'},1} & \alpha Y^{(3)}_{\mathbf{4'},4} & -\sqrt{3}\alpha Y^{(3)}_{\mathbf{4'},3} \\ \beta Y^{(6)}_{\mathbf{3'}I,1} + \gamma Y^{(6)}_{\mathbf{3'}II,1} & \beta Y^{(6)}_{\mathbf{3'}I,3} + \gamma Y^{(6)}_{\mathbf{3'}II,3} & \beta Y^{(6)}_{\mathbf{3'}I,2} + \gamma Y^{(6)}_{\mathbf{3'}II,2} \end{pmatrix} v_d$$

C_6^{vi}: $k_{E^c_{D,3}} + k_L = 5, 6$

$$W_e = \alpha\left(Y^{(5)}_{\mathbf{2'}} E^c_D L H_d\right)_{\mathbf{1}} + \beta\left(Y^{(5)}_{\mathbf{4'}} E^c_D L H_d\right)_{\mathbf{1}} + \gamma\left(Y^{(6)}_{\mathbf{3'},I} E^c_3 L H_d\right)_{\mathbf{1}} + \delta\left(Y^{(6)}_{\mathbf{3'},II} E^c_3 L H_d\right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} -\alpha Y^{(5)}_{\mathbf{2'},2} - \sqrt{2}\beta Y^{(5)}_{\mathbf{4'},4} & -\sqrt{3}\beta Y^{(5)}_{\mathbf{4'},2} & \sqrt{2}\alpha Y^{(5)}_{\mathbf{2'},1} + \beta Y^{(5)}_{\mathbf{4'},1} \\ \sqrt{2}\beta Y^{(5)}_{\mathbf{4'},1} - \alpha Y^{(5)}_{\mathbf{2'},1} & \beta Y^{(5)}_{\mathbf{4'},4} - \sqrt{2}\alpha Y^{(5)}_{\mathbf{2'},2} & -\sqrt{3}\beta Y^{(5)}_{\mathbf{4'},3} \\ \gamma Y^{(6)}_{\mathbf{3'}I,1} + \delta Y^{(6)}_{\mathbf{3'}II,1} & \gamma Y^{(6)}_{\mathbf{3'}I,3} + \delta Y^{(6)}_{\mathbf{3'}II,3} & \gamma Y^{(6)}_{\mathbf{3'}I,2} + \delta Y^{(6)}_{\mathbf{3'}II,2} \end{pmatrix} v_d$$

C_1^{vii}: $k_{E^c} + k_L = 2$

$$W_e = \alpha\left(Y^{(2)}_{\mathbf{3}} E^c L H_d\right)_{\mathbf{1}} + \beta\left(Y^{(2)}_{\mathbf{5}} E^c L H_d\right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} 2\beta Y^{(2)}_{\mathbf{5},1} & \alpha Y^{(2)}_{\mathbf{3},3} - \sqrt{3}\beta Y^{(2)}_{\mathbf{5},5} & -\alpha Y^{(2)}_{\mathbf{3},2} - \sqrt{3}\beta Y^{(2)}_{\mathbf{5},2} \\ -\alpha Y^{(2)}_{\mathbf{3},3} - \sqrt{3}\beta Y^{(2)}_{\mathbf{5},5} & \sqrt{6}\beta Y^{(2)}_{\mathbf{5},4} & \alpha Y^{(2)}_{\mathbf{3},1} - \beta Y^{(2)}_{\mathbf{5},1} \\ \alpha Y^{(2)}_{\mathbf{3},2} - \sqrt{3}\beta Y^{(2)}_{\mathbf{5},2} & -\alpha Y^{(2)}_{\mathbf{3},1} - \beta Y^{(2)}_{\mathbf{5},1} & \sqrt{6}\beta Y^{(2)}_{\mathbf{5},3} \end{pmatrix} v_d$$

C_2^{vii}: $k_{E^c} + k_L = 4$

$$W_e = \alpha \left(Y_{\mathbf{1}}^{(4)} E^c L H_d\right)_{\mathbf{1}} + \beta \left(Y_{\mathbf{3}}^{(4)} E^c L H_d\right)_{\mathbf{1}} + \gamma \left(Y_{\mathbf{5}I}^{(4)} E^c L H_d\right)_{\mathbf{1}} + \delta \left(Y_{\mathbf{5}II}^{(4)} E^c L H_d\right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} \alpha Y_{\mathbf{1},1}^{(4)} + 2\gamma Y_{\mathbf{5}I,1}^{(4)} + 2\delta Y_{\mathbf{5}II,1}^{(4)} & \beta Y_{\mathbf{3},3}^{(4)} - \sqrt{3}\left(\gamma Y_{\mathbf{5}I,5}^{(4)} + \delta Y_{\mathbf{5}II,5}^{(4)}\right) & -\beta Y_{\mathbf{3},2}^{(4)} - \sqrt{3}\left(\gamma Y_{\mathbf{5}I,2}^{(4)} + \delta Y_{\mathbf{5}II,2}^{(4)}\right) \\ -\beta Y_{\mathbf{3},3}^{(4)} - \sqrt{3}\left(\gamma Y_{\mathbf{5}I,5}^{(4)} + \delta Y_{\mathbf{5}II,5}^{(4)}\right) & \sqrt{6}\left(\gamma Y_{\mathbf{5}I,4}^{(4)} + \delta Y_{\mathbf{5}II,4}^{(4)}\right) & \alpha Y_{\mathbf{1},1}^{(4)} + \beta Y_{\mathbf{3},1}^{(4)} - \gamma Y_{\mathbf{5}I,1}^{(4)} - \delta Y_{\mathbf{5}II,1}^{(4)} \\ \beta Y_{\mathbf{3},2}^{(4)} - \sqrt{3}\left(\gamma Y_{\mathbf{5}I,2}^{(4)} + \delta Y_{\mathbf{5}II,2}^{(4)}\right) & \alpha Y_{\mathbf{1},1}^{(4)} - \beta Y_{\mathbf{3},1}^{(4)} - \gamma Y_{\mathbf{5}I,1}^{(4)} - \delta Y_{\mathbf{5}II,1}^{(4)} & \sqrt{6}\left(\gamma Y_{\mathbf{5}I,3}^{(4)} + \delta Y_{\mathbf{5}II,3}^{(4)}\right) \end{pmatrix} v_d$$

C_1^{viii}: $k_{E^c} + k_L = 2$

$$W_e = \alpha \left(Y_{\mathbf{5}}^{(2)} E^c L H_d\right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} \sqrt{3} Y_{\mathbf{5},1}^{(2)} & Y_{\mathbf{5},5}^{(2)} & Y_{\mathbf{5},2}^{(2)} \\ Y_{\mathbf{5},4}^{(2)} & -\sqrt{2} Y_{\mathbf{5},3}^{(2)} & -\sqrt{2} Y_{\mathbf{5},5}^{(2)} \\ Y_{\mathbf{5},3}^{(2)} & -\sqrt{2} Y_{\mathbf{5},2}^{(2)} & -\sqrt{2} Y_{\mathbf{5},4}^{(2)} \end{pmatrix} (\alpha v_d)$$

C_2^{viii}: $k_{E^c} + k_L = 4$

$$W_e = \alpha \left(Y_{\mathbf{4}}^{(4)} E^c L H_d\right)_{\mathbf{1}} + \beta \left(Y_{\mathbf{5}I}^{(4)} E^c L H_d\right)_{\mathbf{1}} + \gamma \left(Y_{\mathbf{5}II}^{(4)} E^c L H_d\right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} \sqrt{3}\left(\beta Y_{\mathbf{5}I,1}^{(4)} + \gamma Y_{\mathbf{5}II,1}^{(4)}\right) & \sqrt{2}\alpha Y_{\mathbf{4},4}^{(4)} + \beta Y_{\mathbf{5}I,5}^{(4)} + \gamma Y_{\mathbf{5}II,5}^{(4)} & \sqrt{2}\alpha Y_{\mathbf{4},1}^{(4)} + \beta Y_{\mathbf{5}I,2}^{(4)} + \gamma Y_{\mathbf{5}II,2}^{(4)} \\ -\sqrt{2}\alpha Y_{\mathbf{4},3}^{(4)} + \beta Y_{\mathbf{5}I,4}^{(4)} + \gamma Y_{\mathbf{5}II,4}^{(4)} & -\alpha Y_{\mathbf{4},2}^{(4)} - \sqrt{2}\left(\beta Y_{\mathbf{5}I,3}^{(4)} + \gamma Y_{\mathbf{5}II,3}^{(4)}\right) & \alpha Y_{\mathbf{4},4}^{(4)} - \sqrt{2}\left(\beta Y_{\mathbf{5}I,5}^{(4)} + \gamma Y_{\mathbf{5}II,5}^{(4)}\right) \\ -\sqrt{2}\alpha Y_{\mathbf{4},2}^{(4)} + \beta Y_{\mathbf{5}I,3}^{(4)} + \gamma Y_{\mathbf{5}II,3}^{(4)} & \alpha Y_{\mathbf{4},1}^{(4)} - \sqrt{2}\left(\beta Y_{\mathbf{5}I,2}^{(4)} + \gamma Y_{\mathbf{5}II,2}^{(4)}\right) & -\alpha Y_{\mathbf{4},3}^{(4)} - \sqrt{2}\left(\beta Y_{\mathbf{5}I,4}^{(4)} + \gamma Y_{\mathbf{5}II,4}^{(4)}\right) \end{pmatrix} v_d$$

C_3^{viii}: $k_{E^c} + k_L = 6$

$$W_e = \alpha \left(Y_{\mathbf{4}I}^{(6)} E^c L H_d\right)_{\mathbf{1}} + \beta \left(Y_{\mathbf{4}II}^{(6)} E^c L H_d\right)_{\mathbf{1}} + \gamma \left(Y_{\mathbf{5}I}^{(6)} E^c L H_d\right)_{\mathbf{1}} + \delta \left(Y_{\mathbf{5}II}^{(6)} E^c L H_d\right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} \sqrt{3}\left(\gamma Y_{\mathbf{5}I,1}^{(6)} + \delta Y_{\mathbf{5}II,1}^{(6)}\right) & \begin{array}{c}\sqrt{2}\alpha Y_{\mathbf{4}I,4}^{(6)} + \sqrt{2}\beta Y_{\mathbf{4}II,4}^{(6)} \\ +\gamma Y_{\mathbf{5}I,5}^{(6)} + \delta Y_{\mathbf{5}II,5}^{(6)}\end{array} & \begin{array}{c}\sqrt{2}\alpha Y_{\mathbf{4}I,1}^{(6)} + \sqrt{2}\beta Y_{\mathbf{4}II,1}^{(6)} \\ +\gamma Y_{\mathbf{5}I,2}^{(6)} + \delta Y_{\mathbf{5}II,2}^{(6)}\end{array} \\ \begin{array}{c}-\sqrt{2}\alpha Y_{\mathbf{4}I,3}^{(6)} - \sqrt{2}\beta Y_{\mathbf{4}II,3}^{(6)} \\ +\gamma Y_{\mathbf{5}I,4}^{(6)} + \delta Y_{\mathbf{5}II,4}^{(6)}\end{array} & \begin{array}{c}-\alpha Y_{\mathbf{4}I,2}^{(6)} - \beta Y_{\mathbf{4}II,2}^{(6)} \\ -\sqrt{2}\left(\gamma Y_{\mathbf{5}I,3}^{(6)} + \delta Y_{\mathbf{5}II,3}^{(6)}\right)\end{array} & \begin{array}{c}\alpha Y_{\mathbf{4}I,4}^{(6)} + \beta Y_{\mathbf{4}II,4}^{(6)} \\ -\sqrt{2}\left(\gamma Y_{\mathbf{5}I,5}^{(6)} + \delta Y_{\mathbf{5}II,5}^{(6)}\right)\end{array} \\ \begin{array}{c}-\sqrt{2}\alpha Y_{\mathbf{4}I,2}^{(6)} - \sqrt{2}\beta Y_{\mathbf{4}II,2}^{(6)} \\ +\gamma Y_{\mathbf{5}I,3}^{(6)} + \delta Y_{\mathbf{5}II,3}^{(6)}\end{array} & \begin{array}{c}\alpha Y_{\mathbf{4}I,1}^{(6)} + \beta Y_{\mathbf{4}II,1}^{(6)} \\ -\sqrt{2}\left(\gamma Y_{\mathbf{5}I,2}^{(6)} + \delta Y_{\mathbf{5}II,2}^{(6)}\right)\end{array} & \begin{array}{c}-\alpha Y_{\mathbf{4}I,3}^{(6)} - \beta Y_{\mathbf{4}II,3}^{(6)} \\ -\sqrt{2}\left(\gamma Y_{\mathbf{5}I,4}^{(6)} + \delta Y_{\mathbf{5}II,4}^{(6)}\right)\end{array} \end{pmatrix} v_d$$

C_1^{ix}: $k_{E^c} + k_L = 2$

$$W_e = \alpha \left(Y_{\mathbf{5}}^{(2)} E^c L H_d\right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} \sqrt{3}Y_{\mathbf{5},1}^{(2)} & Y_{\mathbf{5},4}^{(2)} & Y_{\mathbf{5},3}^{(2)} \\ Y_{\mathbf{5},5}^{(2)} & -\sqrt{2}Y_{\mathbf{5},3}^{(2)} & -\sqrt{2}Y_{\mathbf{5},2}^{(2)} \\ Y_{\mathbf{5},2}^{(2)} & -\sqrt{2}Y_{\mathbf{5},5}^{(2)} & -\sqrt{2}Y_{\mathbf{5},4}^{(2)} \end{pmatrix} (\alpha v_d)$$

C_2^{ix}: $k_{E^c} + k_L = 4$

$$W_e = \alpha \left(Y_{\mathbf{4}}^{(4)} E^c L H_d\right)_{\mathbf{1}} + \beta \left(Y_{\mathbf{5}I}^{(4)} E^c L H_d\right)_{\mathbf{1}} + \gamma \left(Y_{\mathbf{5}II}^{(4)} E^c L H_d\right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} \sqrt{3}\left(\beta Y_{\mathbf{5}I,1}^{(4)} + \gamma Y_{\mathbf{5}II,1}^{(4)}\right) & -\sqrt{2}\alpha Y_{\mathbf{4},3}^{(4)} + \beta Y_{\mathbf{5}I,4}^{(4)} + \gamma Y_{\mathbf{5}II,4}^{(4)} & -\sqrt{2}\alpha Y_{\mathbf{4},2}^{(4)} + \beta Y_{\mathbf{5}I,3}^{(4)} + \gamma Y_{\mathbf{5}II,3}^{(4)} \\ \sqrt{2}\alpha Y_{\mathbf{4},4}^{(4)} + \beta Y_{\mathbf{5}I,5}^{(4)} + \gamma Y_{\mathbf{5}II,5}^{(4)} & -\alpha Y_{\mathbf{4},2}^{(4)} - \sqrt{2}\left(\beta Y_{\mathbf{5}I,3}^{(4)} + \gamma Y_{\mathbf{5}II,3}^{(4)}\right) & \alpha Y_{\mathbf{4},1}^{(4)} - \sqrt{2}\left(\beta Y_{\mathbf{5}I,2}^{(4)} + \gamma Y_{\mathbf{5}II,2}^{(4)}\right) \\ \sqrt{2}\alpha Y_{\mathbf{4},1}^{(4)} + \beta Y_{\mathbf{5}I,2}^{(4)} + \gamma Y_{\mathbf{5}II,2}^{(4)} & \alpha Y_{\mathbf{4},4}^{(4)} - \sqrt{2}\left(\beta Y_{\mathbf{5}I,5}^{(4)} + \gamma Y_{\mathbf{5}II,5}^{(4)}\right) & -\alpha Y_{\mathbf{4},3}^{(4)} - \sqrt{2}\left(\beta Y_{\mathbf{5}I,4}^{(4)} + \gamma Y_{\mathbf{5}II,4}^{(4)}\right) \end{pmatrix} v_d$$

C_3^{ix}: $k_{E^c} + k_L = 6$

$$W_e = \alpha \left(Y_{\mathbf{4}I}^{(6)} E^c L H_d\right)_{\mathbf{1}} + \beta \left(Y_{\mathbf{4}II}^{(6)} E^c L H_d\right)_{\mathbf{1}} + \gamma \left(Y_{\mathbf{5}I}^{(6)} E^c L H_d\right)_{\mathbf{1}} + \delta \left(Y_{\mathbf{5}II}^{(6)} E^c L H_d\right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} \sqrt{3}\left(\gamma Y_{\mathbf{5}I,1}^{(6)} + \delta Y_{\mathbf{5}II,1}^{(6)}\right) & \begin{matrix} -\sqrt{2}\alpha Y_{\mathbf{4}I,3}^{(6)} - \sqrt{2}\beta Y_{\mathbf{4}II,3}^{(6)} \\ +\gamma Y_{\mathbf{5}I,4}^{(6)} + \delta Y_{\mathbf{5}II,4}^{(6)} \end{matrix} & \begin{matrix} -\sqrt{2}\alpha Y_{\mathbf{4}I,2}^{(6)} - \sqrt{2}\beta Y_{\mathbf{4}II,2}^{(6)} \\ +\gamma Y_{\mathbf{5}I,3}^{(6)} + \delta Y_{\mathbf{5}II,3}^{(6)} \end{matrix} \\ \begin{matrix} \sqrt{2}\alpha Y_{\mathbf{4}I,4}^{(6)} + \sqrt{2}\beta Y_{\mathbf{4}II,4}^{(6)} \\ +\gamma Y_{\mathbf{5}I,5}^{(6)} + \delta Y_{\mathbf{5}II,5}^{(6)} \end{matrix} & \begin{matrix} -\alpha Y_{\mathbf{4}I,2}^{(6)} - \beta Y_{\mathbf{4}II,2}^{(6)} \\ -\sqrt{2}\left(\gamma Y_{\mathbf{5}I,3}^{(6)} + \delta Y_{\mathbf{5}II,3}^{(6)}\right) \end{matrix} & \begin{matrix} \alpha Y_{\mathbf{4}I,1}^{(6)} + \beta Y_{\mathbf{4}II,1}^{(6)} \\ -\sqrt{2}\left(\gamma Y_{\mathbf{5}I,2}^{(6)} + \delta Y_{\mathbf{5}II,2}^{(6)}\right) \end{matrix} \\ \begin{matrix} \sqrt{2}\alpha Y_{\mathbf{4}I,1}^{(6)} + \sqrt{2}\beta Y_{\mathbf{4}II,1}^{(6)} \\ +\gamma Y_{\mathbf{5}I,2}^{(6)} + \delta Y_{\mathbf{5}II,2}^{(6)} \end{matrix} & \begin{matrix} \alpha Y_{\mathbf{4}I,4}^{(6)} + \beta Y_{\mathbf{4}II,4}^{(6)} \\ -\sqrt{2}\left(\gamma Y_{\mathbf{5}I,5}^{(6)} + \delta Y_{\mathbf{5}II,5}^{(6)}\right) \end{matrix} & \begin{matrix} -\alpha Y_{\mathbf{4}I,3}^{(6)} - \beta Y_{\mathbf{4}II,3}^{(6)} \\ -\sqrt{2}\left(\gamma Y_{\mathbf{5}I,4}^{(6)} + \delta Y_{\mathbf{5}II,4}^{(6)}\right) \end{matrix} \end{pmatrix} v_d$$

C_1^{x}: $k_{E^c} + k_L = 2$

$$W_e = \alpha \left(Y_{\mathbf{3'}}^{(2)} E^c L H_d\right)_{\mathbf{1}} + \beta \left(Y_{\mathbf{5}}^{(2)} E^c L H_d\right)_{\mathbf{1}}$$

$$M_e = \begin{pmatrix} 2\beta Y_{\mathbf{5},1}^{(2)} & \alpha Y_{\mathbf{3'},3}^{(2)} - \sqrt{3}\beta Y_{\mathbf{5},4}^{(2)} & -\alpha Y_{\mathbf{3'},2}^{(2)} - \sqrt{3}\beta Y_{\mathbf{5},3}^{(2)} \\ -\alpha Y_{\mathbf{3'},3}^{(2)} - \sqrt{3}\beta Y_{\mathbf{5},4}^{(2)} & \sqrt{6}\beta Y_{\mathbf{5},2}^{(2)} & \alpha Y_{\mathbf{3'},1}^{(2)} - \beta Y_{\mathbf{5},1}^{(2)} \\ \alpha Y_{\mathbf{3'},2}^{(2)} - \sqrt{3}\beta Y_{\mathbf{5},3}^{(2)} & -\alpha Y_{\mathbf{3'},1}^{(2)} - \beta Y_{\mathbf{5},1}^{(2)} & \sqrt{6}\beta Y_{\mathbf{5},5}^{(2)} \end{pmatrix} v_d$$

C_2^x: $k_{E^c}+k_L=4$

$$W_e=\alpha\left(Y_{\mathbf{1}}^{(4)}E^cLH_d\right)_{\mathbf{1}}+\beta\left(Y_{\mathbf{3'}}^{(4)}E^cLH_d\right)_{\mathbf{1}}+\gamma\left(Y_{\mathbf{5}I}^{(4)}E^cLH_d\right)_{\mathbf{1}}+\delta\left(Y_{\mathbf{5}II}^{(4)}E^cLH_d\right)_{\mathbf{1}}$$

$$M_e=\begin{pmatrix}\alpha Y_{\mathbf{1},1}^{(4)}+2\gamma Y_{\mathbf{5}I,1}^{(4)}+2\delta Y_{\mathbf{5}II,1}^{(4)} & \beta Y_{\mathbf{3'},3}^{(4)}-\sqrt{3}\left(\gamma Y_{\mathbf{5}I,4}^{(4)}+\delta Y_{\mathbf{5}II,4}^{(4)}\right) & -\beta Y_{\mathbf{3'},2}^{(4)}-\sqrt{3}\left(\gamma Y_{\mathbf{5}I,3}^{(4)}+\delta Y_{\mathbf{5}II,3}^{(4)}\right)\\ -\beta Y_{\mathbf{3'},3}^{(4)}-\sqrt{3}\left(\gamma Y_{\mathbf{5}I,4}^{(4)}+\delta Y_{\mathbf{5}II,4}^{(4)}\right) & \sqrt{6}\left(\gamma Y_{\mathbf{5}I,2}^{(4)}+\delta Y_{\mathbf{5}II,2}^{(4)}\right) & \alpha Y_{\mathbf{1},1}^{(4)}+\beta Y_{\mathbf{3'},1}^{(4)}-\gamma Y_{\mathbf{5}I,1}^{(4)}-\delta Y_{\mathbf{5}II,1}^{(4)}\\ \beta Y_{\mathbf{3'},2}^{(4)}-\sqrt{3}\left(\gamma Y_{\mathbf{5}I,3}^{(4)}+\delta Y_{\mathbf{5}II,3}^{(4)}\right) & \alpha Y_{\mathbf{1},1}^{(4)}-\beta Y_{\mathbf{3'},1}^{(4)}-\gamma Y_{\mathbf{5}I,1}^{(4)}-\delta Y_{\mathbf{5}II,1}^{(4)} & \sqrt{6}\left(\gamma Y_{\mathbf{5}I,5}^{(4)}+\delta Y_{\mathbf{5}II,5}^{(4)}\right)\end{pmatrix}v_d$$

1.2 Neutrino sector

Under the theoretical framework of Seesaw mechanism, the neutrino sector is rich in content. Heavy neutrinos can be three or two generations or be absent. The neutrino mass matrices corresponding to these three scenarios will be very different, and the corresponding models will be given in Sec. 1.2.1, Sec. 1.2.2 and Sec. 1.2.3.

In table 2, we give the representation assignments of L and N^c in these three scenarios. For heavy neutrino with three (two) generations or be absent, they are named $S^{i,\cdots,iv}$ ($T^{i,\cdots,iv}$) or $W^{i,ii}$ respectively. In the following subsections, we will give the corresponding models in turn, including weight assignments, superpotentials, mass matrices M_D, M_N and M_ν. The mass matrices of light neutrinos in the type-I seesaw can be obtained by the so-called seesaw formula $M_\nu=-M_D^TM_N^{-1}M_D$.

	S^i	S^{ii}	S^{iii}	S^{iv}	T^i	T^{ii}	T^{iii}	T^{iv}	W^i	W^{ii}
ρ_L	$\mathbf{3}$	$\mathbf{3}$	$\mathbf{3'}$	$\mathbf{3'}$	$\mathbf{3}$	$\mathbf{3}$	$\mathbf{3'}$	$\mathbf{3'}$	$\mathbf{3}$	$\mathbf{3'}$
ρ_{N^c}	$\mathbf{3}$	$\mathbf{3'}$	$\mathbf{3}$	$\mathbf{3'}$	$\mathbf{2}$	$\mathbf{2'}$	$\mathbf{2}$	$\mathbf{2'}$	$-$	$-$
# of models (total number)	3 (15)	2 (12)	2 (12)	3 (15)	5 (6)	5 (9)	5 (9)	5 (6)	3 (3)	3 (3)

Table 2: The number (in bracket) of possible neutrino models for different representation assignments of L and N^c under the finite modular group A_5' up to weight 6 modular forms, where the case without modular forms is not counted. We also list the number (without bracket) of models which contain up to three independent terms in the neutrino superpotential $\mathcal{W}_\nu$.

1.2.1 Type-I seesaw with three right-handed neutrinos

S_1^i: $k_{N^c}=1, k_L=-1$

$$\mathcal{W}_\nu=g\left(N^cLH_u\right)_{\mathbf{1}}+\Lambda\left(Y_{\mathbf{5}}^{(2)}N^cN^c\right)_{\mathbf{1}}$$

$$M_D=\begin{pmatrix}1&0&0\\0&0&1\\0&1&0\end{pmatrix}gv_u\qquad M_N=\begin{pmatrix}2Y_{\mathbf{5},1}^{(2)} & -\sqrt{3}Y_{\mathbf{5},5}^{(2)} & -\sqrt{3}Y_{\mathbf{5},2}^{(2)}\\ -\sqrt{3}Y_{\mathbf{5},5}^{(2)} & \sqrt{6}Y_{\mathbf{5},4}^{(2)} & -Y_{\mathbf{5},1}^{(2)}\\ -\sqrt{3}Y_{\mathbf{5},2}^{(2)} & -Y_{\mathbf{5},1}^{(2)} & \sqrt{6}Y_{\mathbf{5},3}^{(2)}\end{pmatrix}\Lambda$$

S^i_2: $k_{N^c}=0, k_L=2$

$$\mathcal{W}_\nu = g_1\left(Y^{(2)}_{\mathbf{3}} N^c L H_u\right)_{\mathbf{1}} + g_2\left(Y^{(2)}_{\mathbf{5}} N^c L H_u\right)_{\mathbf{1}} + \Lambda\left(N^c N^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} 2g_2Y^{(2)}_{\mathbf{5},1} & g_1Y^{(2)}_{\mathbf{3},3}-\sqrt{3}g_2Y^{(2)}_{\mathbf{5},5} & -g_1Y^{(2)}_{\mathbf{3},2}-\sqrt{3}g_2Y^{(2)}_{\mathbf{5},2} \\ -g_1Y^{(2)}_{\mathbf{3},3}-\sqrt{3}g_2Y^{(2)}_{\mathbf{5},5} & \sqrt{6}g_2Y^{(2)}_{\mathbf{5},4} & g_1Y^{(2)}_{\mathbf{3},1}-g_2Y^{(2)}_{\mathbf{5},1} \\ g_1Y^{(2)}_{\mathbf{3},2}-\sqrt{3}g_2Y^{(2)}_{\mathbf{5},2} & -g_1Y^{(2)}_{\mathbf{3},1}-g_2Y^{(2)}_{\mathbf{5},1} & \sqrt{6}g_2Y^{(2)}_{\mathbf{5},3} \end{pmatrix} v_u$$

$$M_N = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}\Lambda$$

S^i_3: $k_{N^c}=1, k_L=1$

$$\mathcal{W}_\nu = g_1\left(Y^{(2)}_{\mathbf{3}} N^c L H_u\right)_{\mathbf{1}} + g_2\left(Y^{(2)}_{\mathbf{5}} N^c L H_u\right)_{\mathbf{1}} + \Lambda\left(Y^{(2)}_{\mathbf{5}} N^c N^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} 2g_2Y^{(2)}_{\mathbf{5},1} & g_1Y^{(2)}_{\mathbf{3},3}-\sqrt{3}g_2Y^{(2)}_{\mathbf{5},5} & -g_1Y^{(2)}_{\mathbf{3},2}-\sqrt{3}g_2Y^{(2)}_{\mathbf{5},2} \\ -g_1Y^{(2)}_{\mathbf{3},3}-\sqrt{3}g_2Y^{(2)}_{\mathbf{5},5} & \sqrt{6}g_2Y^{(2)}_{\mathbf{5},4} & g_1Y^{(2)}_{\mathbf{3},1}-g_2Y^{(2)}_{\mathbf{5},1} \\ g_1Y^{(2)}_{\mathbf{3},2}-\sqrt{3}g_2Y^{(2)}_{\mathbf{5},2} & -g_1Y^{(2)}_{\mathbf{3},1}-g_2Y^{(2)}_{\mathbf{5},1} & \sqrt{6}g_2Y^{(2)}_{\mathbf{5},3} \end{pmatrix} v_u$$

$$M_N = \begin{pmatrix} 2Y^{(2)}_{\mathbf{5},1} & -\sqrt{3}Y^{(2)}_{\mathbf{5},5} & -\sqrt{3}Y^{(2)}_{\mathbf{5},2} \\ -\sqrt{3}Y^{(2)}_{\mathbf{5},5} & \sqrt{6}Y^{(2)}_{\mathbf{5},4} & -Y^{(2)}_{\mathbf{5},1} \\ -\sqrt{3}Y^{(2)}_{\mathbf{5},2} & -Y^{(2)}_{\mathbf{5},1} & \sqrt{6}Y^{(2)}_{\mathbf{5},3} \end{pmatrix}\Lambda$$

S^{ii}_1: $k_{N^c}=0, k_L=2$

$$\mathcal{W}_\nu = g\left(Y^{(2)}_{\mathbf{5}} N^c L H_u\right)_{\mathbf{1}} + \Lambda\left(N^c N^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} \sqrt{3}Y^{(2)}_{\mathbf{5},1} & Y^{(2)}_{\mathbf{5},5} & Y^{(2)}_{\mathbf{5},2} \\ Y^{(2)}_{\mathbf{5},4} & -\sqrt{2}Y^{(2)}_{\mathbf{5},3} & -\sqrt{2}Y^{(2)}_{\mathbf{5},5} \\ Y^{(2)}_{\mathbf{5},3} & -\sqrt{2}Y^{(2)}_{\mathbf{5},2} & -\sqrt{2}Y^{(2)}_{\mathbf{5},4} \end{pmatrix} g v_u \qquad M_N = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}\Lambda$$

S_2^{ii}: $k_{N^c}=1, k_L=1$

$$\mathcal{W}_\nu = g\left(Y_{\mathbf{5}}^{(2)} N^c L H_u\right)_{\mathbf{1}} + \Lambda\left(Y_{\mathbf{5}}^{(2)} N^c N^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} \sqrt{3}Y^{(2)}_{\mathbf{5},1} & Y^{(2)}_{\mathbf{5},5} & Y^{(2)}_{\mathbf{5},2} \\ Y^{(2)}_{\mathbf{5},4} & -\sqrt{2}Y^{(2)}_{\mathbf{5},3} & -\sqrt{2}Y^{(2)}_{\mathbf{5},5} \\ Y^{(2)}_{\mathbf{5},3} & -\sqrt{2}Y^{(2)}_{\mathbf{5},2} & -\sqrt{2}Y^{(2)}_{\mathbf{5},4} \end{pmatrix} g v_u$$

$$M_N = \begin{pmatrix} 2Y^{(2)}_{\mathbf{5},1} & -\sqrt{3}Y^{(2)}_{\mathbf{5},4} & -\sqrt{3}Y^{(2)}_{\mathbf{5},3} \\ -\sqrt{3}Y^{(2)}_{\mathbf{5},4} & \sqrt{6}Y^{(2)}_{\mathbf{5},2} & -Y^{(2)}_{\mathbf{5},1} \\ -\sqrt{3}Y^{(2)}_{\mathbf{5},3} & -Y^{(2)}_{\mathbf{5},1} & \sqrt{6}Y^{(2)}_{\mathbf{5},5} \end{pmatrix} \Lambda$$

S_1^{iii}: $k_{N^c}=0, k_L=2$

$$\mathcal{W}_\nu = g\left(Y_{\mathbf{5}}^{(2)} N^c L H_u\right)_{\mathbf{1}} + \Lambda\left(N^c N^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} \sqrt{3}Y^{(2)}_{\mathbf{5},1} & Y^{(2)}_{\mathbf{5},4} & Y^{(2)}_{\mathbf{5},3} \\ Y^{(2)}_{\mathbf{5},5} & -\sqrt{2}Y^{(2)}_{\mathbf{5},3} & -\sqrt{2}Y^{(2)}_{\mathbf{5},2} \\ Y^{(2)}_{\mathbf{5},2} & -\sqrt{2}Y^{(2)}_{\mathbf{5},5} & -\sqrt{2}Y^{(2)}_{\mathbf{5},4} \end{pmatrix} g v_u \qquad M_N = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix} \Lambda$$

S_2^{iii}: $k_{N^c}=1, k_L=1$

$$\mathcal{W}_\nu = g\left(Y_{\mathbf{5}}^{(2)} N^c L H_u\right)_{\mathbf{1}} + \Lambda\left(Y_{\mathbf{5}}^{(2)} N^c N^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} \sqrt{3}Y^{(2)}_{\mathbf{5},1} & Y^{(2)}_{\mathbf{5},4} & Y^{(2)}_{\mathbf{5},3} \\ Y^{(2)}_{\mathbf{5},5} & -\sqrt{2}Y^{(2)}_{\mathbf{5},3} & -\sqrt{2}Y^{(2)}_{\mathbf{5},2} \\ Y^{(2)}_{\mathbf{5},2} & -\sqrt{2}Y^{(2)}_{\mathbf{5},5} & -\sqrt{2}Y^{(2)}_{\mathbf{5},4} \end{pmatrix} g v_u$$

$$M_N = \begin{pmatrix} 2Y^{(2)}_{\mathbf{5},1} & -\sqrt{3}Y^{(2)}_{\mathbf{5},5} & -\sqrt{3}Y^{(2)}_{\mathbf{5},2} \\ -\sqrt{3}Y^{(2)}_{\mathbf{5},5} & \sqrt{6}Y^{(2)}_{\mathbf{5},4} & -Y^{(2)}_{\mathbf{5},1} \\ -\sqrt{3}Y^{(2)}_{\mathbf{5},2} & -Y^{(2)}_{\mathbf{5},1} & \sqrt{6}Y^{(2)}_{\mathbf{5},3} \end{pmatrix} \Lambda$$

S_1^{iv}: $k_{N^c}=1, k_L=-1$

$$\mathcal{W}_\nu = g\left(N^c L H_u\right)_{\mathbf{1}} + \Lambda\left(Y_{\mathbf{5}}^{(2)} N^c N^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix} g v_u \qquad M_N = \begin{pmatrix} 2Y^{(2)}_{\mathbf{5},1} & -\sqrt{3}Y^{(2)}_{\mathbf{5},4} & -\sqrt{3}Y^{(2)}_{\mathbf{5},3} \\ -\sqrt{3}Y^{(2)}_{\mathbf{5},4} & \sqrt{6}Y^{(2)}_{\mathbf{5},2} & -Y^{(2)}_{\mathbf{5},1} \\ -\sqrt{3}Y^{(2)}_{\mathbf{5},3} & -Y^{(2)}_{\mathbf{5},1} & \sqrt{6}Y^{(2)}_{\mathbf{5},5} \end{pmatrix} \Lambda$$

S_2^{iv}: $k_{N^c}=0, k_L=2$

$$\mathcal{W}_\nu = g_1\left(Y^{(2)}_{\mathbf{3'}}N^cLH_u\right)_{\mathbf{1}} + g_2\left(Y^{(2)}_{\mathbf{5}}N^cLH_u\right)_{\mathbf{1}} + \Lambda\left(N^cN^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} 2g_2Y^{(2)}_{\mathbf{5},1} & g_1Y^{(2)}_{\mathbf{3'},3}-\sqrt{3}g_2Y^{(2)}_{\mathbf{5},4} & -g_1Y^{(2)}_{\mathbf{3'},2}-\sqrt{3}g_2Y^{(2)}_{\mathbf{5},3} \\ -g_1Y^{(2)}_{\mathbf{3'},3}-\sqrt{3}g_2Y^{(2)}_{\mathbf{5},4} & \sqrt{6}g_2Y^{(2)}_{\mathbf{5},2} & g_1Y^{(2)}_{\mathbf{3'},1}-g_2Y^{(2)}_{\mathbf{5},1} \\ g_1Y^{(2)}_{\mathbf{3'},2}-\sqrt{3}g_2Y^{(2)}_{\mathbf{5},3} & -g_1Y^{(2)}_{\mathbf{3'},1}-g_2Y^{(2)}_{\mathbf{5},1} & \sqrt{6}g_2Y^{(2)}_{\mathbf{5},5} \end{pmatrix} v_u$$

$$M_N = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}\Lambda$$

S_3^{iv}: $k_{N^c}=1, k_L=1$

$$\mathcal{W}_\nu = g_1\left(Y^{(2)}_{\mathbf{3'}}N^cLH_u\right)_{\mathbf{1}} + g_2\left(Y^{(2)}_{\mathbf{5}}N^cLH_u\right)_{\mathbf{1}} + \Lambda\left(Y^{(2)}_{\mathbf{5}}N^cN^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} 2g_2Y^{(2)}_{\mathbf{5},1} & g_1Y^{(2)}_{\mathbf{3'},3}-\sqrt{3}g_2Y^{(2)}_{\mathbf{5},4} & -g_1Y^{(2)}_{\mathbf{3'},2}-\sqrt{3}g_2Y^{(2)}_{\mathbf{5},3} \\ -g_1Y^{(2)}_{\mathbf{3'},3}-\sqrt{3}g_2Y^{(2)}_{\mathbf{5},4} & \sqrt{6}g_2Y^{(2)}_{\mathbf{5},2} & g_1Y^{(2)}_{\mathbf{3'},1}-g_2Y^{(2)}_{\mathbf{5},1} \\ g_1Y^{(2)}_{\mathbf{3'},2}-\sqrt{3}g_2Y^{(2)}_{\mathbf{5},3} & -g_1Y^{(2)}_{\mathbf{3'},1}-g_2Y^{(2)}_{\mathbf{5},1} & \sqrt{6}g_2Y^{(2)}_{\mathbf{5},5} \end{pmatrix} v_u$$

$$M_N = \begin{pmatrix} 2Y^{(2)}_{\mathbf{5},1} & -\sqrt{3}Y^{(2)}_{\mathbf{5},4} & -\sqrt{3}Y^{(2)}_{\mathbf{5},3} \\ -\sqrt{3}Y^{(2)}_{\mathbf{5},4} & \sqrt{6}Y^{(2)}_{\mathbf{5},2} & -Y^{(2)}_{\mathbf{5},1} \\ -\sqrt{3}Y^{(2)}_{\mathbf{5},3} & -Y^{(2)}_{\mathbf{5},1} & \sqrt{6}Y^{(2)}_{\mathbf{5},5} \end{pmatrix}\Lambda$$

1.2.2 Type-I seesaw with two right-handed neutrinos

T_1^{i}: $k_{N^c}=1, k_L=2$

$$\mathcal{W}_\nu = g\left(Y^{(3)}_{\mathbf{4'}}N^cLH_u\right)_{\mathbf{1}} + \Lambda\left(Y^{(2)}_{\mathbf{3}}N^cN^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} -\sqrt{2}Y^{(3)}_{\mathbf{4'},3} & Y^{(3)}_{\mathbf{4'},2} & \sqrt{3}Y^{(3)}_{\mathbf{4'},4} \\ -\sqrt{2}Y^{(3)}_{\mathbf{4'},2} & \sqrt{3}Y^{(3)}_{\mathbf{4'},1} & -Y^{(3)}_{\mathbf{4'},3} \end{pmatrix} gv_u \qquad M_N = \begin{pmatrix} -\sqrt{2}Y^{(2)}_{\mathbf{3},2} & -Y^{(2)}_{\mathbf{3},1} \\ -Y^{(2)}_{\mathbf{3},1} & \sqrt{2}Y^{(2)}_{\mathbf{3},3} \end{pmatrix}\Lambda$$

T_2^{i}: $k_{N^c}=2, k_L=1$

$$\mathcal{W}_\nu = g\left(Y^{(3)}_{\mathbf{4'}}N^cLH_u\right)_{\mathbf{1}} + \Lambda\left(Y^{(4)}_{\mathbf{3}}N^cN^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} -\sqrt{2}Y^{(3)}_{\mathbf{4'},3} & Y^{(3)}_{\mathbf{4'},2} & \sqrt{3}Y^{(3)}_{\mathbf{4'},4} \\ -\sqrt{2}Y^{(3)}_{\mathbf{4'},2} & \sqrt{3}Y^{(3)}_{\mathbf{4'},1} & -Y^{(3)}_{\mathbf{4'},3} \end{pmatrix} gv_u \qquad M_N = \begin{pmatrix} -\sqrt{2}Y^{(4)}_{\mathbf{3},2} & -Y^{(4)}_{\mathbf{3},1} \\ -Y^{(4)}_{\mathbf{3},1} & \sqrt{2}Y^{(4)}_{\mathbf{3},3} \end{pmatrix}\Lambda$$

T_3^i: $k_{N^c}=1, k_L=4$

$$\mathcal{W}_\nu = g_1\left(Y_{\mathbf{2}}^{(5)}N^cLH_u\right)_{\mathbf{1}} + g_2\left(Y_{\mathbf{4'}}^{(5)}N^cLH_u\right)_{\mathbf{1}} + \Lambda\left(Y_{\mathbf{3}}^{(2)}N^cN^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} g_1Y_{\mathbf{2},2}^{(5)} - \sqrt{2}g_2Y_{\mathbf{4'},3}^{(5)} & \sqrt{2}g_1Y_{\mathbf{2},1}^{(5)} + g_2Y_{\mathbf{4'},2}^{(5)} & \sqrt{3}g_2Y_{\mathbf{4'},4}^{(5)} \\ g_1Y_{\mathbf{2},1}^{(5)} - \sqrt{2}g_2Y_{\mathbf{4'},2}^{(5)} & \sqrt{3}g_2Y_{\mathbf{4'},1}^{(5)} & -\sqrt{2}g_1Y_{\mathbf{2},2}^{(5)} - g_2Y_{\mathbf{4'},3}^{(5)} \end{pmatrix} v_u$$

$$M_N = \begin{pmatrix} -\sqrt{2}Y_{\mathbf{3},2}^{(2)} & -Y_{\mathbf{3},1}^{(2)} \\ -Y_{\mathbf{3},1}^{(2)} & \sqrt{2}Y_{\mathbf{3},3}^{(2)} \end{pmatrix} \Lambda$$

T_4^i: $k_{N^c}=2, k_L=3$

$$\mathcal{W}_\nu = g_1\left(Y_{\mathbf{2}}^{(5)}N^cLH_u\right)_{\mathbf{1}} + g_2\left(Y_{\mathbf{4'}}^{(5)}N^cLH_u\right)_{\mathbf{1}} + \Lambda\left(Y_{\mathbf{3}}^{(4)}N^cN^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} g_1Y_{\mathbf{2},2}^{(5)} - \sqrt{2}g_2Y_{\mathbf{4'},3}^{(5)} & \sqrt{2}g_1Y_{\mathbf{2},1}^{(5)} + g_2Y_{\mathbf{4'},2}^{(5)} & \sqrt{3}g_2Y_{\mathbf{4'},4}^{(5)} \\ g_1Y_{\mathbf{2},1}^{(5)} - \sqrt{2}g_2Y_{\mathbf{4'},2}^{(5)} & \sqrt{3}g_2Y_{\mathbf{4'},1}^{(5)} & -\sqrt{2}g_1Y_{\mathbf{2},2}^{(5)} - g_2Y_{\mathbf{4'},3}^{(5)} \end{pmatrix} v_u$$

$$M_N = \begin{pmatrix} -\sqrt{2}Y_{\mathbf{3},2}^{(4)} & -Y_{\mathbf{3},1}^{(4)} \\ -Y_{\mathbf{3},1}^{(4)} & \sqrt{2}Y_{\mathbf{3},3}^{(4)} \end{pmatrix} \Lambda$$

T_5^i: $k_{N^c}=3, k_L=0$

$$\mathcal{W}_\nu = g\left(Y_{\mathbf{4'}}^{(3)}N^cLH_u\right)_{\mathbf{1}} + \Lambda_1\left(Y_{\mathbf{3}I}^{(6)}N^cN^c\right)_{\mathbf{1}} + \Lambda_2\left(Y_{\mathbf{3}II}^{(6)}N^cN^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} -\sqrt{2}Y_{\mathbf{4'},3}^{(3)} & Y_{\mathbf{4'},2}^{(3)} & \sqrt{3}Y_{\mathbf{4'},4}^{(3)} \\ -\sqrt{2}Y_{\mathbf{4'},2}^{(3)} & \sqrt{3}Y_{\mathbf{4'},1}^{(3)} & -Y_{\mathbf{4'},3}^{(3)} \end{pmatrix} g v_u$$

$$M_N = \begin{pmatrix} -\sqrt{2}\left(\Lambda_1Y_{\mathbf{3}I,2}^{(6)} + \Lambda_2Y_{\mathbf{3}II,2}^{(6)}\right) & -\Lambda_1Y_{\mathbf{3}I,1}^{(6)} - \Lambda_2Y_{\mathbf{3}II,1}^{(6)} \\ -\Lambda_1Y_{\mathbf{3}I,1}^{(6)} - \Lambda_2Y_{\mathbf{3}II,1}^{(6)} & \sqrt{2}\left(\Lambda_1Y_{\mathbf{3}I,3}^{(6)} + \Lambda_2Y_{\mathbf{3}II,3}^{(6)}\right) \end{pmatrix}$$

T_1^{ii}: $k_{N^c}=1, k_L=0$

$$\mathcal{W}_\nu = g\left(Y_{\mathbf{6}}^{(1)}N^cLH_u\right)_{\mathbf{1}} + \Lambda\left(Y_{\mathbf{3'}}^{(2)}N^cN^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} \sqrt{2}Y_6 & \sqrt{2}Y_5 & Y_1+Y_2 \\ \sqrt{2}Y_3 & Y_1-Y_2 & \sqrt{2}Y_4 \end{pmatrix} g v_u \qquad M_N = \begin{pmatrix} -\sqrt{2}Y_{\mathbf{3'},3}^{(2)} & Y_{\mathbf{3'},1}^{(2)} \\ Y_{\mathbf{3'},1}^{(2)} & \sqrt{2}Y_{\mathbf{3'},2}^{(2)} \end{pmatrix} \Lambda$$

T_2^{ii}: $k_{N^c} = 2, k_L = -1$

$$\mathcal{W}_\nu = g\left(Y_{\mathbf{6}}^{(1)} N^c L H_u\right)_{\mathbf{1}} + \Lambda\left(Y_{\mathbf{3'}}^{(4)} N^c N^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} \sqrt{2}Y_6 & \sqrt{2}Y_5 & Y_1+Y_2 \\ \sqrt{2}Y_3 & Y_1-Y_2 & \sqrt{2}Y_4 \end{pmatrix} g v_u \qquad M_N = \begin{pmatrix} -\sqrt{2}Y_{\mathbf{3'},3}^{(4)} & Y_{\mathbf{3'},1}^{(4)} \\ Y_{\mathbf{3'},1}^{(4)} & \sqrt{2}Y_{\mathbf{3'},2}^{(4)} \end{pmatrix} \Lambda$$

T_3^{ii}: $k_{N^c} = 1, k_L = 2$

$$\mathcal{W}_\nu = g_1\left(Y_{\mathbf{6}I}^{(3)} N^c L H_u\right)_{\mathbf{1}} + g_2\left(Y_{\mathbf{6}II}^{(3)} N^c L H_u\right)_{\mathbf{1}} + \Lambda\left(Y_{\mathbf{3'}}^{(2)} N^c N^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} \sqrt{2}\left(g_1 Y_{\mathbf{6}I,6}^{(3)} + g_2 Y_{\mathbf{6}II,6}^{(3)}\right) & \sqrt{2}\left(g_1 Y_{\mathbf{6}I,5}^{(3)} + g_2 Y_{\mathbf{6}II,5}^{(3)}\right) & \begin{matrix} g_1\left(Y_{\mathbf{6}I,1}^{(3)} + Y_{\mathbf{6}I,2}^{(3)}\right) \\ +g_2\left(Y_{\mathbf{6}II,1}^{(3)} + Y_{\mathbf{6}II,2}^{(3)}\right) \end{matrix} \\ \sqrt{2}\left(g_1 Y_{\mathbf{6}I,3}^{(3)} + g_2 Y_{\mathbf{6}II,3}^{(3)}\right) & \begin{matrix} g_1\left(Y_{\mathbf{6}I,1}^{(3)} - Y_{\mathbf{6}I,2}^{(3)}\right) \\ +g_2\left(Y_{\mathbf{6}II,1}^{(3)} - Y_{\mathbf{6}II,2}^{(3)}\right) \end{matrix} & \sqrt{2}\left(g_1 Y_{\mathbf{6}I,4}^{(3)} + g_2 Y_{\mathbf{6}II,4}^{(3)}\right) \end{pmatrix} v_u$$

$$M_N = \begin{pmatrix} -\sqrt{2}Y_{\mathbf{3'},3}^{(2)} & Y_{\mathbf{3'},1}^{(2)} \\ Y_{\mathbf{3'},1}^{(2)} & \sqrt{2}Y_{\mathbf{3'},2}^{(2)} \end{pmatrix} \Lambda$$

T_4^{ii}: $k_{N^c} = 2, k_L = 1$

$$\mathcal{W}_\nu = g_1\left(Y_{\mathbf{6}I}^{(3)} N^c L H_u\right)_{\mathbf{1}} + g_2\left(Y_{\mathbf{6}II}^{(3)} N^c L H_u\right)_{\mathbf{1}} + \Lambda\left(Y_{\mathbf{3'}}^{(4)} N^c N^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} \sqrt{2}\left(g_1 Y_{\mathbf{6}I,6}^{(3)} + g_2 Y_{\mathbf{6}II,6}^{(3)}\right) & \sqrt{2}\left(g_1 Y_{\mathbf{6}I,5}^{(3)} + g_2 Y_{\mathbf{6}II,5}^{(3)}\right) & \begin{matrix} g_1\left(Y_{\mathbf{6}I,1}^{(3)} + Y_{\mathbf{6}I,2}^{(3)}\right) \\ +g_2\left(Y_{\mathbf{6}II,1}^{(3)} + Y_{\mathbf{6}II,2}^{(3)}\right) \end{matrix} \\ \sqrt{2}\left(g_1 Y_{\mathbf{6}I,3}^{(3)} + g_2 Y_{\mathbf{6}II,3}^{(3)}\right) & \begin{matrix} g_1\left(Y_{\mathbf{6}I,1}^{(3)} - Y_{\mathbf{6}I,2}^{(3)}\right) \\ +g_2\left(Y_{\mathbf{6}II,1}^{(3)} - Y_{\mathbf{6}II,2}^{(3)}\right) \end{matrix} & \sqrt{2}\left(g_1 Y_{\mathbf{6}I,4}^{(3)} + g_2 Y_{\mathbf{6}II,4}^{(3)}\right) \end{pmatrix} v_u$$

$$M_N = \begin{pmatrix} -\sqrt{2}Y_{\mathbf{3'},3}^{(4)} & Y_{\mathbf{3'},1}^{(4)} \\ Y_{\mathbf{3'},1}^{(4)} & \sqrt{2}Y_{\mathbf{3'},2}^{(4)} \end{pmatrix} \Lambda$$

T_5^{ii}: $k_{N^c}=3, k_L=-2$

$$\mathcal{W}_\nu = g\left(Y_{\mathbf{6}}^{(1)}N^cLH_u\right)_{\mathbf{1}} + \Lambda_1\left(Y_{\mathbf{3'}I}^{(6)}N^cN^c\right)_{\mathbf{1}} + \Lambda_2\left(Y_{\mathbf{3'}II}^{(6)}N^cN^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} \sqrt{2}Y_6 & \sqrt{2}Y_5 & Y_1+Y_2 \\ \sqrt{2}Y_3 & Y_1-Y_2 & \sqrt{2}Y_4 \end{pmatrix} g v_u$$

$$M_N = \begin{pmatrix} -\sqrt{2}\left(\Lambda_1 Y_{\mathbf{3'}I,3}^{(6)} + \Lambda_2 Y_{\mathbf{3'}II,3}^{(6)}\right) & \Lambda_1 Y_{\mathbf{3'}I,1}^{(6)} + \Lambda_2 Y_{\mathbf{3'}II,1}^{(6)} \\ \Lambda_1 Y_{\mathbf{3'}I,1}^{(6)} + \Lambda_2 Y_{\mathbf{3'}II,1}^{(6)} & \sqrt{2}\left(\Lambda_1 Y_{\mathbf{3'}I,2}^{(6)} + \Lambda_2 Y_{\mathbf{3'}II,2}^{(6)}\right) \end{pmatrix}$$

T_1^{iii}: $k_{N^c}=1, k_L=0$

$$\mathcal{W}_\nu = g\left(Y_{\mathbf{6}}^{(1)}N^cLH_u\right)_{\mathbf{1}} + \Lambda\left(Y_{\mathbf{3}}^{(2)}N^cN^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} Y_5 & -Y_3 & Y_2 \\ -Y_4 & -Y_1 & -Y_6 \end{pmatrix} g v_u \qquad M_N = \begin{pmatrix} -\sqrt{2}Y_{\mathbf{3},2}^{(2)} & -Y_{\mathbf{3},1}^{(2)} \\ -Y_{\mathbf{3},1}^{(2)} & \sqrt{2}Y_{\mathbf{3},3}^{(2)} \end{pmatrix}\Lambda$$

T_2^{iii}: $k_{N^c}=2, k_L=-1$

$$\mathcal{W}_\nu = g\left(Y_{\mathbf{6}}^{(1)}N^cLH_u\right)_{\mathbf{1}} + \Lambda\left(Y_{\mathbf{3}}^{(4)}N^cN^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} Y_5 & -Y_3 & Y_2 \\ -Y_4 & -Y_1 & -Y_6 \end{pmatrix} g v_u \qquad M_N = \begin{pmatrix} -\sqrt{2}Y_{\mathbf{3},2}^{(4)} & -Y_{\mathbf{3},1}^{(4)} \\ -Y_{\mathbf{3},1}^{(4)} & \sqrt{2}Y_{\mathbf{3},3}^{(4)} \end{pmatrix}\Lambda$$

T_3^{iii}: $k_{N^c}=1, k_L=2$

$$\mathcal{W}_\nu = g_1\left(Y_{\mathbf{6}I}^{(3)}N^cLH_u\right)_{\mathbf{1}} + g_2\left(Y_{\mathbf{6}II}^{(3)}N^cLH_u\right)_{\mathbf{1}} + \Lambda\left(Y_{\mathbf{3}}^{(2)}N^cN^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} g_1 Y_{\mathbf{6}I,5}^{(3)} + g_2 Y_{\mathbf{6}II,5}^{(3)} & -g_1 Y_{\mathbf{6}I,3}^{(3)} - g_2 Y_{\mathbf{6}II,3}^{(3)} & g_1 Y_{\mathbf{6}I,2}^{(3)} + g_2 Y_{\mathbf{6}II,2}^{(3)} \\ -g_1 Y_{\mathbf{6}I,4}^{(3)} - g_2 Y_{\mathbf{6}II,4}^{(3)} & -g_1 Y_{\mathbf{6}I,1}^{(3)} - g_2 Y_{\mathbf{6}II,1}^{(3)} & -g_1 Y_{\mathbf{6}I,6}^{(3)} - g_2 Y_{\mathbf{6}II,6}^{(3)} \end{pmatrix} v_u$$

$$M_N = \begin{pmatrix} -\sqrt{2}Y_{\mathbf{3},2}^{(2)} & -Y_{\mathbf{3},1}^{(2)} \\ -Y_{\mathbf{3},1}^{(2)} & \sqrt{2}Y_{\mathbf{3},3}^{(2)} \end{pmatrix}\Lambda$$

T_4^{iii}: $k_{N^c}=2, k_L=1$

$$\mathcal{W}_\nu = g_1\left(Y^{(3)}_{\mathbf{6}I}N^cLH_u\right)_{\mathbf{1}} + g_2\left(Y^{(3)}_{\mathbf{6}II}N^cLH_u\right)_{\mathbf{1}} + \Lambda\left(Y^{(4)}_{\mathbf{3}}N^cN^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} g_1Y^{(3)}_{\mathbf{6}I,5}+g_2Y^{(3)}_{\mathbf{6}II,5} & -g_1Y^{(3)}_{\mathbf{6}I,3}-g_2Y^{(3)}_{\mathbf{6}II,3} & g_1Y^{(3)}_{\mathbf{6}I,2}+g_2Y^{(3)}_{\mathbf{6}II,2} \\ -g_1Y^{(3)}_{\mathbf{6}I,4}-g_2Y^{(3)}_{\mathbf{6}II,4} & -g_1Y^{(3)}_{\mathbf{6}I,1}-g_2Y^{(3)}_{\mathbf{6}II,1} & -g_1Y^{(3)}_{\mathbf{6}I,6}-g_2Y^{(3)}_{\mathbf{6}II,6} \end{pmatrix} v_u$$

$$M_N = \begin{pmatrix} -\sqrt{2}Y^{(4)}_{\mathbf{3},2} & -Y^{(4)}_{\mathbf{3},1} \\ -Y^{(4)}_{\mathbf{3},1} & \sqrt{2}Y^{(4)}_{\mathbf{3},3} \end{pmatrix}\Lambda$$

T_5^{iii}: $k_{N^c}=3, k_L=-2$

$$\mathcal{W}_\nu = g\left(Y^{(1)}_{\mathbf{6}}N^cLH_u\right)_{\mathbf{1}} + \Lambda_1\left(Y^{(6)}_{\mathbf{3}I}N^cN^c\right)_{\mathbf{1}} + \Lambda_2\left(Y^{(6)}_{\mathbf{3}II}N^cN^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} Y_5 & -Y_3 & Y_2 \\ -Y_4 & -Y_1 & -Y_6 \end{pmatrix} g v_u$$

$$M_N = \begin{pmatrix} -\sqrt{2}\left(\Lambda_1Y^{(6)}_{\mathbf{3}I,2}+\Lambda_2Y^{(6)}_{\mathbf{3}II,2}\right) & -\Lambda_1Y^{(6)}_{\mathbf{3}I,1}-\Lambda_2Y^{(6)}_{\mathbf{3}II,1} \\ -\Lambda_1Y^{(6)}_{\mathbf{3}I,1}-\Lambda_2Y^{(6)}_{\mathbf{3}II,1} & \sqrt{2}\left(\Lambda_1Y^{(6)}_{\mathbf{3}I,3}+\Lambda_2Y^{(6)}_{\mathbf{3}II,3}\right) \end{pmatrix}$$

T_1^{iv}: $k_{N^c}=1, k_L=2$

$$\mathcal{W}_\nu = g\left(Y^{(3)}_{\mathbf{4}'}N^cLH_u\right)_{\mathbf{1}} + \Lambda\left(Y^{(2)}_{\mathbf{3}'}N^cN^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} -\sqrt{2}Y^{(3)}_{\mathbf{4}',4} & -\sqrt{3}Y^{(3)}_{\mathbf{4}',2} & Y^{(3)}_{\mathbf{4}',1} \\ \sqrt{2}Y^{(3)}_{\mathbf{4}',1} & Y^{(3)}_{\mathbf{4}',4} & -\sqrt{3}Y^{(3)}_{\mathbf{4}',3} \end{pmatrix} g v_u \qquad M_N = \begin{pmatrix} -\sqrt{2}Y^{(2)}_{\mathbf{3}',3} & Y^{(2)}_{\mathbf{3}',1} \\ Y^{(2)}_{\mathbf{3}',1} & \sqrt{2}Y^{(2)}_{\mathbf{3}',2} \end{pmatrix}\Lambda$$

T_2^{iv}: $k_{N^c}=2, k_L=1$

$$\mathcal{W}_\nu = g\left(Y^{(3)}_{\mathbf{4}'}N^cLH_u\right)_{\mathbf{1}} + \Lambda\left(Y^{(4)}_{\mathbf{3}'}N^cN^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} -\sqrt{2}Y^{(3)}_{\mathbf{4}',4} & -\sqrt{3}Y^{(3)}_{\mathbf{4}',2} & Y^{(3)}_{\mathbf{4}',1} \\ \sqrt{2}Y^{(3)}_{\mathbf{4}',1} & Y^{(3)}_{\mathbf{4}',4} & -\sqrt{3}Y^{(3)}_{\mathbf{4}',3} \end{pmatrix} g v_u \qquad M_N = \begin{pmatrix} -\sqrt{2}Y^{(4)}_{\mathbf{3}',3} & Y^{(4)}_{\mathbf{3}',1} \\ Y^{(4)}_{\mathbf{3}',1} & \sqrt{2}Y^{(4)}_{\mathbf{3}',2} \end{pmatrix}\Lambda$$

T_3^{iv}: $k_{N^c}=1, k_L=4$

$$\mathcal{W}_\nu = g_1\left(Y^{(5)}_{\mathbf{2'}}N^cLH_u\right)_{\mathbf{1}} + g_2\left(Y^{(5)}_{\mathbf{4'}}N^cLH_u\right)_{\mathbf{1}} + \Lambda\left(Y^{(2)}_{\mathbf{3'}}N^cN^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} -g_1Y^{(5)}_{\mathbf{2'},2} - \sqrt{2}g_2Y^{(5)}_{\mathbf{4'},4} & -\sqrt{3}g_2Y^{(5)}_{\mathbf{4'},2} & \sqrt{2}g_1Y^{(5)}_{\mathbf{2'},1} + g_2Y^{(5)}_{\mathbf{4'},1} \\ \sqrt{2}g_2Y^{(5)}_{\mathbf{4'},1} - g_1Y^{(5)}_{\mathbf{2'},1} & g_2Y^{(5)}_{\mathbf{4'},4} - \sqrt{2}g_1Y^{(5)}_{\mathbf{2'},2} & -\sqrt{3}g_2Y^{(5)}_{\mathbf{4'},3} \end{pmatrix} v_u$$

$$M_N = \begin{pmatrix} -\sqrt{2}Y^{(2)}_{\mathbf{3'},3} & Y^{(2)}_{\mathbf{3'},1} \\ Y^{(2)}_{\mathbf{3'},1} & \sqrt{2}Y^{(2)}_{\mathbf{3'},2} \end{pmatrix} \Lambda$$

T_4^{iv}: $k_{N^c}=2, k_L=3$

$$\mathcal{W}_\nu = g_1\left(Y^{(5)}_{\mathbf{2'}}N^cLH_u\right)_{\mathbf{1}} + g_2\left(Y^{(5)}_{\mathbf{4'}}N^cLH_u\right)_{\mathbf{1}} + \Lambda\left(Y^{(4)}_{\mathbf{3'}}N^cN^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} -g_1Y^{(5)}_{\mathbf{2'},2} - \sqrt{2}g_2Y^{(5)}_{\mathbf{4'},4} & -\sqrt{3}g_2Y^{(5)}_{\mathbf{4'},2} & \sqrt{2}g_1Y^{(5)}_{\mathbf{2'},1} + g_2Y^{(5)}_{\mathbf{4'},1} \\ \sqrt{2}g_2Y^{(5)}_{\mathbf{4'},1} - g_1Y^{(5)}_{\mathbf{2'},1} & g_2Y^{(5)}_{\mathbf{4'},4} - \sqrt{2}g_1Y^{(5)}_{\mathbf{2'},2} & -\sqrt{3}g_2Y^{(5)}_{\mathbf{4'},3} \end{pmatrix} v_u$$

$$M_N = \begin{pmatrix} -\sqrt{2}Y^{(4)}_{\mathbf{3'},3} & Y^{(4)}_{\mathbf{3'},1} \\ Y^{(4)}_{\mathbf{3'},1} & \sqrt{2}Y^{(4)}_{\mathbf{3'},2} \end{pmatrix} \Lambda$$

T_5^{iv}: $k_{N^c}=3, k_L=0$

$$\mathcal{W}_\nu = g\left(Y^{(3)}_{\mathbf{4'}}N^cLH_u\right)_{\mathbf{1}} + \Lambda_1\left(Y^{(6)}_{\mathbf{3'}I}N^cN^c\right)_{\mathbf{1}} + \Lambda_2\left(Y^{(6)}_{\mathbf{3'}II}N^cN^c\right)_{\mathbf{1}}$$

$$M_D = \begin{pmatrix} -\sqrt{2}Y^{(3)}_{\mathbf{4'},4} & -\sqrt{3}Y^{(3)}_{\mathbf{4'},2} & Y^{(3)}_{\mathbf{4'},1} \\ \sqrt{2}Y^{(3)}_{\mathbf{4'},1} & Y^{(3)}_{\mathbf{4'},4} & -\sqrt{3}Y^{(3)}_{\mathbf{4'},3} \end{pmatrix} g v_u$$

$$M_N = \begin{pmatrix} -\sqrt{2}\left(\Lambda_1Y^{(6)}_{\mathbf{3'}I,3} + \Lambda_2Y^{(6)}_{\mathbf{3'}II,3}\right) & \Lambda_1Y^{(6)}_{\mathbf{3'}I,1} + \Lambda_2Y^{(6)}_{\mathbf{3'}II,1} \\ \Lambda_1Y^{(6)}_{\mathbf{3'}I,1} + \Lambda_2Y^{(6)}_{\mathbf{3'}II,1} & \sqrt{2}\left(\Lambda_1Y^{(6)}_{\mathbf{3'}I,2} + \Lambda_2Y^{(6)}_{\mathbf{3'}II,2}\right) \end{pmatrix}$$

1.2.3 Models without right-handed neutrino

W_1^{i}: $k_L=1$

$$W_\nu = \tfrac{1}{\Lambda_1}\left(Y^{(2)}_{\mathbf{5}}L^2H_u^2\right)_{\mathbf{1}}$$

$$M_\nu = \begin{pmatrix} 2Y^{(2)}_{\mathbf{5},1} & -\sqrt{3}Y^{(2)}_{\mathbf{5},5} & -\sqrt{3}Y^{(2)}_{\mathbf{5},2} \\ -\sqrt{3}Y^{(2)}_{\mathbf{5},5} & \sqrt{6}Y^{(2)}_{\mathbf{5},4} & -Y^{(2)}_{\mathbf{5},1} \\ -\sqrt{3}Y^{(2)}_{\mathbf{5},2} & -Y^{(2)}_{\mathbf{5},1} & \sqrt{6}Y^{(2)}_{\mathbf{5},3} \end{pmatrix} \frac{v_u^2}{\Lambda_1}$$

W_2^i: $k_L = 2$

$$W_\nu = \frac{1}{\Lambda_1}\left(Y_{\mathbf{1}}^{(4)} L^2 H_u^2\right)_{\mathbf{1}} + \frac{1}{\Lambda_2}\left(Y_{\mathbf{5}I}^{(4)} L^2 H_u^2\right)_{\mathbf{1}} + \frac{1}{\Lambda_3}\left(Y_{\mathbf{5}II}^{(4)} L^2 H_u^2\right)_{\mathbf{1}}$$

$$M_\nu = \begin{pmatrix} \frac{Y_{\mathbf{1},1}^{(4)}}{\Lambda_1} + \frac{2Y_{\mathbf{5}I,1}^{(4)}}{\Lambda_2} + \frac{2Y_{\mathbf{5}II,1}^{(4)}}{\Lambda_3} & -\frac{\sqrt{3}\left(\Lambda_3 Y_{\mathbf{5}I,5}^{(4)}+\Lambda_2 Y_{\mathbf{5}II,5}^{(4)}\right)}{\Lambda_2\Lambda_3} & -\frac{\sqrt{3}\left(\Lambda_3 Y_{\mathbf{5}I,2}^{(4)}+\Lambda_2 Y_{\mathbf{5}II,2}^{(4)}\right)}{\Lambda_2\Lambda_3} \\ -\frac{\sqrt{3}\left(\Lambda_3 Y_{\mathbf{5}I,5}^{(4)}+\Lambda_2 Y_{\mathbf{5}II,5}^{(4)}\right)}{\Lambda_2\Lambda_3} & \sqrt{6}\left(\frac{Y_{\mathbf{5}I,4}^{(4)}}{\Lambda_2} + \frac{Y_{\mathbf{5}II,4}^{(4)}}{\Lambda_3}\right) & \frac{Y_{\mathbf{1},1}^{(4)}}{\Lambda_1} - \frac{Y_{\mathbf{5}I,1}^{(4)}}{\Lambda_2} - \frac{Y_{\mathbf{5}II,1}^{(4)}}{\Lambda_3} \\ -\frac{\sqrt{3}\left(\Lambda_3 Y_{\mathbf{5}I,2}^{(4)}+\Lambda_2 Y_{\mathbf{5}II,2}^{(4)}\right)}{\Lambda_2\Lambda_3} & \frac{Y_{\mathbf{1},1}^{(4)}}{\Lambda_1} - \frac{Y_{\mathbf{5}I,1}^{(4)}}{\Lambda_2} - \frac{Y_{\mathbf{5}II,1}^{(4)}}{\Lambda_3} & \sqrt{6}\left(\frac{Y_{\mathbf{5}I,3}^{(4)}}{\Lambda_2} + \frac{Y_{\mathbf{5}II,3}^{(4)}}{\Lambda_3}\right) \end{pmatrix} v_u^2$$

W_3^i: $k_L = 3$

$$W_\nu = \frac{1}{\Lambda_1}\left(Y_{\mathbf{1}}^{(6)} L^2 H_u^2\right)_{\mathbf{1}} + \frac{1}{\Lambda_2}\left(Y_{\mathbf{5}I}^{(6)} L^2 H_u^2\right)_{\mathbf{1}} + \frac{1}{\Lambda_3}\left(Y_{\mathbf{5}II}^{(6)} L^2 H_u^2\right)_{\mathbf{1}}$$

$$M_\nu = \begin{pmatrix} \frac{Y_{\mathbf{1},1}^{(6)}}{\Lambda_1} + \frac{2Y_{\mathbf{5}I,1}^{(6)}}{\Lambda_2} + \frac{2Y_{\mathbf{5}II,1}^{(6)}}{\Lambda_3} & -\frac{\sqrt{3}\left(\Lambda_3 Y_{\mathbf{5}I,5}^{(6)}+\Lambda_2 Y_{\mathbf{5}II,5}^{(6)}\right)}{\Lambda_2\Lambda_3} & -\frac{\sqrt{3}\left(\Lambda_3 Y_{\mathbf{5}I,2}^{(6)}+\Lambda_2 Y_{\mathbf{5}II,2}^{(6)}\right)}{\Lambda_2\Lambda_3} \\ -\frac{\sqrt{3}\left(\Lambda_3 Y_{\mathbf{5}I,5}^{(6)}+\Lambda_2 Y_{\mathbf{5}II,5}^{(6)}\right)}{\Lambda_2\Lambda_3} & \sqrt{6}\left(\frac{Y_{\mathbf{5}I,4}^{(6)}}{\Lambda_2} + \frac{Y_{\mathbf{5}II,4}^{(6)}}{\Lambda_3}\right) & \frac{Y_{\mathbf{1},1}^{(6)}}{\Lambda_1} - \frac{Y_{\mathbf{5}I,1}^{(6)}}{\Lambda_2} - \frac{Y_{\mathbf{5}II,1}^{(6)}}{\Lambda_3} \\ -\frac{\sqrt{3}\left(\Lambda_3 Y_{\mathbf{5}I,2}^{(6)}+\Lambda_2 Y_{\mathbf{5}II,2}^{(6)}\right)}{\Lambda_2\Lambda_3} & \frac{Y_{\mathbf{1},1}^{(6)}}{\Lambda_1} - \frac{Y_{\mathbf{5}I,1}^{(6)}}{\Lambda_2} - \frac{Y_{\mathbf{5}II,1}^{(6)}}{\Lambda_3} & \sqrt{6}\left(\frac{Y_{\mathbf{5}I,3}^{(6)}}{\Lambda_2} + \frac{Y_{\mathbf{5}II,3}^{(6)}}{\Lambda_3}\right) \end{pmatrix} v_u^2$$

W_1^{ii}: $k_L = 1$

$$W_\nu = \frac{1}{\Lambda_0}\left(Y_{\mathbf{5}}^{(2)} L^2 H_u^2\right)_{\mathbf{1}}$$

$$M_\nu = \begin{pmatrix} 2Y_{\mathbf{5},1}^{(2)} & -\sqrt{3}Y_{\mathbf{5},4}^{(2)} & -\sqrt{3}Y_{\mathbf{5},3}^{(2)} \\ -\sqrt{3}Y_{\mathbf{5},4}^{(2)} & \sqrt{6}Y_{\mathbf{5},2}^{(2)} & -Y_{\mathbf{5},1}^{(2)} \\ -\sqrt{3}Y_{\mathbf{5},3}^{(2)} & -Y_{\mathbf{5},1}^{(2)} & \sqrt{6}Y_{\mathbf{5},5}^{(2)} \end{pmatrix} \frac{v_u^2}{\Lambda_0}$$

W_2^{ii}: $k_L = 2$

$$W_\nu = \frac{1}{\Lambda_1}\left(Y_{\mathbf{1}}^{(4)} L^2 H_u^2\right)_{\mathbf{1}} + \frac{1}{\Lambda_2}\left(Y_{\mathbf{5}I}^{(4)} L^2 H_u^2\right)_{\mathbf{1}} + \frac{1}{\Lambda_3}\left(Y_{\mathbf{5}II}^{(4)} L^2 H_u^2\right)_{\mathbf{1}}$$

$$M_\nu = \begin{pmatrix} \frac{Y_{\mathbf{1},1}^{(4)}}{\Lambda_1} + \frac{2Y_{\mathbf{5}I,1}^{(4)}}{\Lambda_2} + \frac{2Y_{\mathbf{5}II,1}^{(4)}}{\Lambda_3} & -\frac{\sqrt{3}\left(\Lambda_3 Y_{\mathbf{5}I,4}^{(4)}+\Lambda_2 Y_{\mathbf{5}II,4}^{(4)}\right)}{\Lambda_2\Lambda_3} & -\frac{\sqrt{3}\left(\Lambda_3 Y_{\mathbf{5}I,3}^{(4)}+\Lambda_2 Y_{\mathbf{5}II,3}^{(4)}\right)}{\Lambda_2\Lambda_3} \\ -\frac{\sqrt{3}\left(\Lambda_3 Y_{\mathbf{5}I,4}^{(4)}+\Lambda_2 Y_{\mathbf{5}II,4}^{(4)}\right)}{\Lambda_2\Lambda_3} & \sqrt{6}\left(\frac{Y_{\mathbf{5}I,2}^{(4)}}{\Lambda_2} + \frac{Y_{\mathbf{5}II,2}^{(4)}}{\Lambda_3}\right) & \frac{Y_{\mathbf{1},1}^{(4)}}{\Lambda_1} - \frac{Y_{\mathbf{5}I,1}^{(4)}}{\Lambda_2} - \frac{Y_{\mathbf{5}II,1}^{(4)}}{\Lambda_3} \\ -\frac{\sqrt{3}\left(\Lambda_3 Y_{\mathbf{5}I,3}^{(4)}+\Lambda_2 Y_{\mathbf{5}II,3}^{(4)}\right)}{\Lambda_2\Lambda_3} & \frac{Y_{\mathbf{1},1}^{(4)}}{\Lambda_1} - \frac{Y_{\mathbf{5}I,1}^{(4)}}{\Lambda_2} - \frac{Y_{\mathbf{5}II,1}^{(4)}}{\Lambda_3} & \sqrt{6}\left(\frac{Y_{\mathbf{5}I,5}^{(4)}}{\Lambda_2} + \frac{Y_{\mathbf{5}II,5}^{(4)}}{\Lambda_3}\right) \end{pmatrix} v_u^2$$

W_3^{ii}: $k_L = 3$

$$W_\nu = \frac{1}{\Lambda_1}\left(Y_{\mathbf{1}}^{(6)} L^2 H_u^2\right)_{\mathbf{1}} + \frac{1}{\Lambda_2}\left(Y_{\mathbf{5}I}^{(6)} L^2 H_u^2\right)_{\mathbf{1}} + \frac{1}{\Lambda_3}\left(Y_{\mathbf{5}II}^{(6)} L^2 H_u^2\right)_{\mathbf{1}}$$

$$M_\nu = \begin{pmatrix} \frac{Y_{\mathbf{1},1}^{(6)}}{\Lambda_1} + \frac{2Y_{\mathbf{5}I,1}^{(6)}}{\Lambda_2} + \frac{2Y_{\mathbf{5}II,1}^{(6)}}{\Lambda_3} & -\frac{\sqrt{3}\left(\Lambda_3 Y_{\mathbf{5}I,4}^{(6)} + \Lambda_2 Y_{\mathbf{5}II,4}^{(6)}\right)}{\Lambda_2\Lambda_3} & -\frac{\sqrt{3}\left(\Lambda_3 Y_{\mathbf{5}I,3}^{(6)} + \Lambda_2 Y_{\mathbf{5}II,3}^{(6)}\right)}{\Lambda_2\Lambda_3} \\ -\frac{\sqrt{3}\left(\Lambda_3 Y_{\mathbf{5}I,4}^{(6)} + \Lambda_2 Y_{\mathbf{5}II,4}^{(6)}\right)}{\Lambda_2\Lambda_3} & \sqrt{6}\left(\frac{Y_{\mathbf{5}I,2}^{(6)}}{\Lambda_2} + \frac{Y_{\mathbf{5}II,2}^{(6)}}{\Lambda_3}\right) & \frac{Y_{\mathbf{1},1}^{(6)}}{\Lambda_1} - \frac{Y_{\mathbf{5}I,1}^{(6)}}{\Lambda_2} - \frac{Y_{\mathbf{5}II,1}^{(6)}}{\Lambda_3} \\ -\frac{\sqrt{3}\left(\Lambda_3 Y_{\mathbf{5}I,3}^{(6)} + \Lambda_2 Y_{\mathbf{5}II,3}^{(6)}\right)}{\Lambda_2\Lambda_3} & \frac{Y_{\mathbf{1},1}^{(6)}}{\Lambda_1} - \frac{Y_{\mathbf{5}I,1}^{(6)}}{\Lambda_2} - \frac{Y_{\mathbf{5}II,1}^{(6)}}{\Lambda_3} & \sqrt{6}\left(\frac{Y_{\mathbf{5}I,5}^{(6)}}{\Lambda_2} + \frac{Y_{\mathbf{5}II,5}^{(6)}}{\Lambda_3}\right) \end{pmatrix} v_u^2$$

1.3 Lepton Models

In this chapter, we will give all possible models through combinations based on the results of charged lepton sector and neutrino sector. In the combination, we only need to require the lepton doublet L in both sectors to have the same representation $\mathbf{3}$ or $\mathbf{3}'$ under A'_5 group.

In table 3, We present 720 possible models, they are named $\mathcal{L}_1 \cdots \mathcal{L}_{720}$, their representation assignments and weights, as well as the $\chi^2_{\min}$ of normal ordering(NO) and inverted ordering(IO) neutrino models are also shown. We find that 25(49) of the 720 models with 9 or 10 parameters can give the best fit results within the experimental 3σ limit for NO(IO) models. There are also some models with $\chi^2_{\min} < 50$, but the best fit values of the observables slightly deviate from the 3σ limit. We have marked them in the table with ★ and ☆ respectively. We have selected some models that can accommodate the experimental data for detailed discussion in the article.

Models	#P	Combinations	$(\rho_{E^c}, \rho_L, \rho_{N^c})$	k_{E^c}	k_L	k_{N^c}	χ^2 (NO)	χ^2 (IO)
$\mathcal{L}_1$	8	$C_1^{i},\ S_1^{i}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	3, 5, 7	−1	1	1571.8	18886.
$\mathcal{L}_2$	10	$C_1^{i},\ S_2^{i}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	0, 2, 4	2	0	2.6459×10^{-8} ★	2.8006×10^{-6} ★
$\mathcal{L}_3$	10	$C_1^{i},\ S_3^{i}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	1, 3, 5	1	1	3.9239×10^{-8} ★	1.1577×10^{-6} ★
$\mathcal{L}_4$	8	$C_1^{i},\ S_1^{ii}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	0, 2, 4	2	0	1610.	554.1
$\mathcal{L}_5$	8	$C_1^{i},\ S_2^{ii}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	1, 3, 5	1	1	2379.1	4580.
$\mathcal{L}_6$	8	$C_1^{ii},\ S_1^{iii}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3})$	0, 2, 4	2	0	1138.5	775460.
$\mathcal{L}_7$	8	$C_1^{ii},\ S_2^{iii}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3})$	1, 3, 5	1	1	1318.6	6957.4
$\mathcal{L}_8$	8	$C_1^{ii},\ S_1^{iv}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	3, 5, 7	−1	1	251.77	560.64
$\mathcal{L}_9$	10	$C_1^{ii},\ S_2^{iv}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	0, 2, 4	2	0	2.1424×10^{-8} ★	2.7143×10^{-6} ★
$\mathcal{L}_{10}$	10	$C_1^{ii},\ S_3^{iv}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	1, 3, 5	1	1	4.5697×10^{-8} ★	8.5578×10^{-8} ★
$\mathcal{L}_{11}$	5	$C_1^{iii},\ S_1^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	4, 3	−1	1	14413.	279190.
$\mathcal{L}_{12}$	7	$C_1^{iii},\ S_2^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	1, 0	2	0	14515.	14636.
$\mathcal{L}_{13}$	7	$C_1^{iii},\ S_3^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	2, 1	1	1	14801.	14807.
$\mathcal{L}_{14}$	5	$C_1^{iii},\ S_1^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	1, 0	2	0	15793.	593320.
$\mathcal{L}_{15}$	5	$C_1^{iii},\ S_2^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	2, 1	1	1	16415.	72912.
$\mathcal{L}_{16}$	5	$C_2^{iii},\ S_1^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	4, 5	−1	1	1.0806×10^{6}	594180.
$\mathcal{L}_{17}$	7	$C_2^{iii},\ S_2^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	1, 2	2	0	14569.	14629.
$\mathcal{L}_{18}$	7	$C_2^{iii},\ S_3^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	2, 3	1	1	14235.	266840.
$\mathcal{L}_{19}$	5	$C_2^{iii},\ S_1^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	1, 2	2	0	16175.	17733.
$\mathcal{L}_{20}$	5	$C_2^{iii},\ S_2^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	2, 3	1	1	16431.	1.2156×10^{6}
$\mathcal{L}_{21}$	7	$C_3^{iii},\ S_1^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	6, 3	−1	1	516.84	260830.
$\mathcal{L}_{22}$	9	$C_3^{iii},\ S_2^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	3, 0	2	0	8.7252 ★	379.05
$\mathcal{L}_{23}$	9	$C_3^{iii},\ S_3^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	4, 1	1	1	479.19	390.79
$\mathcal{L}_{24}$	7	$C_3^{iii},\ S_1^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	3, 0	2	0	1910.2	1958.
$\mathcal{L}_{25}$	7	$C_3^{iii},\ S_2^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	4, 1	1	1	1826.3	8857.9
$\mathcal{L}_{26}$	7	$C_4^{iii},\ S_1^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	6, 5	−1	1	1.0804×10^{6}	594180.
$\mathcal{L}_{27}$	9	$C_4^{iii},\ S_2^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	3, 2	2	0	14579.	14298.
$\mathcal{L}_{28}$	9	$C_4^{iii},\ S_3^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	4, 3	1	1	14502.	254740.
$\mathcal{L}_{29}$	7	$C_4^{iii},\ S_1^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	3, 2	2	0	16583.	15851.
$\mathcal{L}_{30}$	7	$C_4^{iii},\ S_2^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	4, 3	1	1	16441.	1.2155×10^{6}
$\mathcal{L}_{31}$	7	$C_5^{iii},\ S_1^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	4, 7	−1	1	14175.	14343.
$\mathcal{L}_{32}$	9	$C_5^{iii},\ S_2^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	1, 4	2	0	14977.	13932.
$\mathcal{L}_{33}$	9	$C_5^{iii},\ S_3^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	2, 5	1	1	15259.	15924.
$\mathcal{L}_{34}$	7	$C_5^{iii},\ S_1^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	1, 4	2	0	16456.	14769.
$\mathcal{L}_{35}$	7	$C_5^{iii},\ S_2^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	2, 5	1	1	15252.	32085.
$\mathcal{L}_{36}$	9	$C_6^{iii},\ S_1^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	6, 7	−1	1	113.07	336.49

$\mathcal{L}_{37}$	11	$C_6^{iii},\ S_2^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$3,4$	2	0	4.22×10^{-8} ★	9.0628×10^{-6} ★
$\mathcal{L}_{38}$	11	$C_6^{iii},\ S_3^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$4,5$	1	1	4.3012×10^{-7} ★	6.4597×10^{-6} ★
$\mathcal{L}_{39}$	9	$C_6^{iii},\ S_1^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	$3,4$	2	0	700.57	561.51
$\mathcal{L}_{40}$	9	$C_6^{iii},\ S_2^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	$4,5$	1	1	1149.2	28215.
$\mathcal{L}_{41}$	5	$C_1^{iv},\ S_1^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$2,3$	-1	1	3386.8	352230.
$\mathcal{L}_{42}$	7	$C_1^{iv},\ S_2^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$-1,0$	2	0	2253.8	1795.8
$\mathcal{L}_{43}$	7	$C_1^{iv},\ S_3^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$0,1$	1	1	240020.	448.29
$\mathcal{L}_{44}$	5	$C_1^{iv},\ S_1^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	$-1,0$	2	0	600640.	565490.
$\mathcal{L}_{45}$	5	$C_1^{iv},\ S_2^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	$0,1$	1	1	161970.	1.4956×10^{6}
$\mathcal{L}_{46}$	5	$C_2^{iv},\ S_1^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$2,5$	-1	1	8707.	352230.
$\mathcal{L}_{47}$	7	$C_2^{iv},\ S_2^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$-1,2$	2	0	1403.1	767.31
$\mathcal{L}_{48}$	7	$C_2^{iv},\ S_3^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$0,3$	1	1	1088.	35251.
$\mathcal{L}_{49}$	5	$C_2^{iv},\ S_1^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	$-1,2$	2	0	9837.9	947960.
$\mathcal{L}_{50}$	5	$C_2^{iv},\ S_2^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	$0,3$	1	1	3508.8	2800.7
$\mathcal{L}_{51}$	7	$C_3^{iv},\ S_1^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$4,3$	-1	1	522.18	1253.7
$\mathcal{L}_{52}$	9	$C_3^{iv},\ S_2^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$1,0$	2	0	161.84	0.00036262 ★
$\mathcal{L}_{53}$	9	$C_3^{iv},\ S_3^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$2,1$	1	1	277.13	23.797 ☆
$\mathcal{L}_{54}$	7	$C_3^{iv},\ S_1^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	$1,0$	2	0	2057.2	13592.
$\mathcal{L}_{55}$	7	$C_3^{iv},\ S_2^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	$2,1$	1	1	1851.3	62776.
$\mathcal{L}_{56}$	7	$C_4^{iv},\ S_1^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$4,5$	-1	1	630.29	1253.7
$\mathcal{L}_{57}$	9	$C_4^{iv},\ S_2^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$1,2$	2	0	78.769	0.022598 ★
$\mathcal{L}_{58}$	9	$C_4^{iv},\ S_3^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$2,3$	1	1	402.4	23.795 ☆
$\mathcal{L}_{59}$	7	$C_4^{iv},\ S_1^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	$1,2$	2	0	2693.	9940.5
$\mathcal{L}_{60}$	7	$C_4^{iv},\ S_2^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	$2,3$	1	1	1849.4	2339.9
$\mathcal{L}_{61}$	7	$C_5^{iv},\ S_1^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$2,7$	-1	1	161.86	7777.4
$\mathcal{L}_{62}$	9	$C_5^{iv},\ S_2^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$-1,4$	2	0	44.091 ☆	1157.5
$\mathcal{L}_{63}$	9	$C_5^{iv},\ S_3^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$0,5$	1	1	434.31	7054.7
$\mathcal{L}_{64}$	7	$C_5^{iv},\ S_1^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	$-1,4$	2	0	18201.	529890.
$\mathcal{L}_{65}$	7	$C_5^{iv},\ S_2^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	$0,5$	1	1	11135.	306800.
$\mathcal{L}_{66}$	9	$C_6^{iv},\ S_1^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$6,3$	-1	1	0.027304 ★	517.49
$\mathcal{L}_{67}$	11	$C_6^{iv},\ S_2^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$3,0$	2	0	5.7442×10^{-7} ★	4.6436×10^{-6} ★
$\mathcal{L}_{68}$	11	$C_6^{iv},\ S_3^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$4,1$	1	1	2.3688×10^{-6} ★	4.8531×10^{-6} ★
$\mathcal{L}_{69}$	9	$C_6^{iv},\ S_1^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	$3,0$	2	0	854.45	149.03
$\mathcal{L}_{70}$	9	$C_6^{iv},\ S_2^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	$4,1$	1	1	1138.5	20566.
$\mathcal{L}_{71}$	9	$C_7^{iv},\ S_1^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$4,7$	-1	1	0.16787 ★	387.22
$\mathcal{L}_{72}$	11	$C_7^{iv},\ S_2^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$1,4$	2	0	9.3298×10^{-6} ★	0.031896 ★
$\mathcal{L}_{73}$	11	$C_7^{iv},\ S_3^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$2,5$	1	1	2.4193×10^{-6} ★	0.000011215 ★
$\mathcal{L}_{74}$	9	$C_7^{iv},\ S_1^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	$1,4$	2	0	1179.1	13590.
$\mathcal{L}_{75}$	9	$C_7^{iv},\ S_2^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	$2,5$	1	1	1514.8	11485.
$\mathcal{L}_{76}$	9	$C_8^{iv},\ S_1^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$6,5$	-1	1	0.027269 ★	496.91
$\mathcal{L}_{77}$	11	$C_8^{iv},\ S_2^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$3,2$	2	0	2.9021×10^{-7} ★	6.2417×10^{-6} ★
$\mathcal{L}_{78}$	11	$C_8^{iv},\ S_3^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3})$	$4,3$	1	1	50.42	1.8376×10^{-6} ★
$\mathcal{L}_{79}$	9	$C_8^{iv},\ S_1^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	$3,2$	2	0	584.94	566.62
$\mathcal{L}_{80}$	9	$C_8^{iv},\ S_2^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{3}')$	$4,3$	1	1	1138.5	1829.8
$\mathcal{L}_{81}$	5	$C_1^{v},\ S_1^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3})$	$-1,0$	2	0	4264.	776200.
$\mathcal{L}_{82}$	5	$C_1^{v},\ S_2^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3})$	$0,1$	1	1	472710.	442330.
$\mathcal{L}_{83}$	5	$C_1^{v},\ S_1^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$2,3$	-1	1	550520.	568190.
$\mathcal{L}_{84}$	7	$C_1^{v},\ S_2^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$-1,0$	2	0	992.93	1078.7
$\mathcal{L}_{85}$	7	$C_1^{v},\ S_3^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$0,1$	1	1	148.97	1947.7
$\mathcal{L}_{86}$	5	$C_2^{v},\ S_1^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3})$	$-1,2$	2	0	13096.	966560.

$\mathcal{L}_{87}$	5	$C_2^v,\ S_2^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3})$	$0,3$	1	1	4134.9	6434.3
$\mathcal{L}_{88}$	5	$C_2^v,\ S_1^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$2,5$	-1	1	64433.	144240.
$\mathcal{L}_{89}$	7	$C_2^v,\ S_2^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$-1,2$	2	0	19419.	932.59
$\mathcal{L}_{90}$	7	$C_2^v,\ S_3^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$0,3$	1	1	3173.	58583.
$\mathcal{L}_{91}$	7	$C_3^v,\ S_1^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3})$	$1,0$	2	0	2106.3	753930.
$\mathcal{L}_{92}$	7	$C_3^v,\ S_2^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3})$	$2,1$	1	1	1739.2	98721.
$\mathcal{L}_{93}$	7	$C_3^v,\ S_1^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$4,3$	-1	1	1325.4	8188.4
$\mathcal{L}_{94}$	9	$C_3^v,\ S_2^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$1,0$	2	0	4.1601×10^{-6} ★	0.0489 ★
$\mathcal{L}_{95}$	9	$C_3^v,\ S_3^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$2,1$	1	1	3.8817 ★	0.49665 ★
$\mathcal{L}_{96}$	7	$C_4^v,\ S_1^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3})$	$1,2$	2	0	1994.7	790420.
$\mathcal{L}_{97}$	7	$C_4^v,\ S_2^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3})$	$2,3$	1	1	1885.	35634.
$\mathcal{L}_{98}$	7	$C_4^v,\ S_1^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$4,5$	-1	1	1325.5	8188.4
$\mathcal{L}_{99}$	9	$C_4^v,\ S_2^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$1,2$	2	0	3.6746×10^{-6} ★	0.0016914 ★
$\mathcal{L}_{100}$	9	$C_4^v,\ S_3^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$2,3$	1	1	3.8879 ★	0.000010449 ★
$\mathcal{L}_{101}$	7	$C_5^v,\ S_1^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3})$	$-1,4$	2	0	4063.8	776710.
$\mathcal{L}_{102}$	7	$C_5^v,\ S_2^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3})$	$0,5$	1	1	18711.	510830.
$\mathcal{L}_{103}$	7	$C_5^v,\ S_1^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$2,7$	-1	1	18246.	248560.
$\mathcal{L}_{104}$	9	$C_5^v,\ S_2^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$-1,4$	2	0	230.85	750.93
$\mathcal{L}_{105}$	9	$C_5^v,\ S_3^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$0,5$	1	1	1.6783 ★	1931.9
$\mathcal{L}_{106}$	9	$C_6^v,\ S_1^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3})$	$3,0$	2	0	1243.9	753490.
$\mathcal{L}_{107}$	9	$C_6^v,\ S_2^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3})$	$4,1$	1	1	1285.4	8190.8
$\mathcal{L}_{108}$	9	$C_6^v,\ S_1^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$6,3$	-1	1	4.4337 ★	565.99
$\mathcal{L}_{109}$	11	$C_6^v,\ S_2^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$3,0$	2	0	5.7955×10^{-6} ★	3.011×10^{-7} ★
$\mathcal{L}_{110}$	11	$C_6^v,\ S_3^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$4,1$	1	1	1.4515×10^{-7} ★	6.2481×10^{-7} ★
$\mathcal{L}_{111}$	9	$C_7^v,\ S_1^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3})$	$1,4$	2	0	1900.2	857850.
$\mathcal{L}_{112}$	9	$C_7^v,\ S_2^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3})$	$2,5$	1	1	1666.3	29604.
$\mathcal{L}_{113}$	9	$C_7^v,\ S_1^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$4,7$	-1	1	3.2411 ★	909.64
$\mathcal{L}_{114}$	11	$C_7^v,\ S_2^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$1,4$	2	0	8.1926×10^{-6} ★	6.2147×10^{-6} ★
$\mathcal{L}_{115}$	11	$C_7^v,\ S_3^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$2,5$	1	1	2.5482×10^{-6} ★	0.000010614 ★
$\mathcal{L}_{116}$	9	$C_8^v,\ S_1^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3})$	$3,2$	2	0	1158.5	763300.
$\mathcal{L}_{117}$	9	$C_8^v,\ S_2^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3})$	$4,3$	1	1	1551.1	9481.8
$\mathcal{L}_{118}$	9	$C_8^v,\ S_1^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$6,5$	-1	1	4.4337 ★	423.84
$\mathcal{L}_{119}$	11	$C_8^v,\ S_2^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$3,2$	2	0	2.9937×10^{-6} ★	7.6585×10^{-6} ★
$\mathcal{L}_{120}$	11	$C_8^v,\ S_3^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$4,3$	1	1	1.1411×10^{-6} ★	3.5164×10^{-6} ★
$\mathcal{L}_{121}$	5	$C_1^{vi},\ S_1^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3})$	$1,0$	2	0	17089.	1.2165×10^{6}
$\mathcal{L}_{122}$	5	$C_1^{vi},\ S_2^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3})$	$2,1$	1	1	16588.	314100.
$\mathcal{L}_{123}$	5	$C_1^{vi},\ S_1^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$4,3$	-1	1	1.2445×10^{6}	593190.
$\mathcal{L}_{124}$	7	$C_1^{vi},\ S_2^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$1,0$	2	0	14194.	13939.
$\mathcal{L}_{125}$	7	$C_1^{vi},\ S_3^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$2,1$	1	1	13986.	13890.
$\mathcal{L}_{126}$	5	$C_2^{vi},\ S_1^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3})$	$1,2$	2	0	16672.	1.2159×10^{6}
$\mathcal{L}_{127}$	5	$C_2^{vi},\ S_2^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3})$	$2,3$	1	1	17214.	316900.
$\mathcal{L}_{128}$	5	$C_2^{vi},\ S_1^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$4,5$	-1	1	1.2447×10^{6}	593550.
$\mathcal{L}_{129}$	7	$C_2^{vi},\ S_2^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$1,2$	2	0	14099.	14274.
$\mathcal{L}_{130}$	7	$C_2^{vi},\ S_3^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$2,3$	1	1	14582.	14622.
$\mathcal{L}_{131}$	7	$C_3^{vi},\ S_1^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3})$	$3,0$	2	0	1823.2	1.1307×10^{6}
$\mathcal{L}_{132}$	7	$C_3^{vi},\ S_2^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3})$	$4,1$	1	1	1939.5	11163.
$\mathcal{L}_{133}$	7	$C_3^{vi},\ S_1^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$6,3$	-1	1	2153.7	1961.1
$\mathcal{L}_{134}$	9	$C_3^{vi},\ S_2^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$3,0$	2	0	0.013825 ★	2.7009×10^{-6} ★
$\mathcal{L}_{135}$	9	$C_3^{vi},\ S_3^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3}')$	$4,1$	1	1	82.433	0.48312 ★
$\mathcal{L}_{136}$	7	$C_4^{vi},\ S_1^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{3})$	$3,2$	2	0	15362.	916580.

$\mathcal{L}_{137}$	7	$C_4^{vi},\ S_2^{iii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{3})$	4, 3	1	1	17000.	18184.
$\mathcal{L}_{138}$	7	$C_4^{vi},\ S_1^{iv}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{3'})$	6, 5	−1	1	14418.	15581.
$\mathcal{L}_{139}$	9	$C_4^{vi},\ S_2^{iv}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{3'})$	3, 2	2	0	13898.	13955.
$\mathcal{L}_{140}$	9	$C_4^{vi},\ S_3^{iv}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{3'})$	4, 3	1	1	13970.	14366.
$\mathcal{L}_{141}$	7	$C_5^{vi},\ S_1^{iii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{3})$	1, 4	2	0	3612.2	1.2027×10^{6}
$\mathcal{L}_{142}$	7	$C_5^{vi},\ S_2^{iii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{3})$	2, 5	1	1	2723.	312050.
$\mathcal{L}_{143}$	7	$C_5^{vi},\ S_1^{iv}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{3'})$	4, 7	−1	1	943440.	220370.
$\mathcal{L}_{144}$	9	$C_5^{vi},\ S_2^{iv}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{3'})$	1, 4	2	0	292.34	7.3372 ★
$\mathcal{L}_{145}$	9	$C_5^{vi},\ S_3^{iv}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{3'})$	2, 5	1	1	90.884	0.26011 ★
$\mathcal{L}_{146}$	9	$C_6^{vi},\ S_1^{iii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{3})$	3, 4	2	0	1223.9	915870.
$\mathcal{L}_{147}$	9	$C_6^{vi},\ S_2^{iii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{3})$	4, 5	1	1	1256.9	16814.
$\mathcal{L}_{148}$	9	$C_6^{vi},\ S_1^{iv}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{3'})$	6, 7	−1	1	253.63	808.7
$\mathcal{L}_{149}$	11	$C_6^{vi},\ S_2^{iv}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{3'})$	3, 4	2	0	9.25×10^{-7} ★	0.00012515 ★
$\mathcal{L}_{150}$	11	$C_6^{vi},\ S_3^{iv}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{3'})$	4, 5	1	1	17.788 ☆	0.0066197 ★
$\mathcal{L}_{151}$	6	$C_1^{vii},\ S_1^{i}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{3})$	3	−1	1	49099.	1.1913×10^{6}
$\mathcal{L}_{152}$	8	$C_1^{vii},\ S_2^{i}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{3})$	0	2	0	47898.	46776.
$\mathcal{L}_{153}$	8	$C_1^{vii},\ S_3^{i}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{3})$	1	1	1	46514.	113290.
$\mathcal{L}_{154}$	6	$C_1^{vii},\ S_1^{ii}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{3'})$	0	2	0	142290.	47617.
$\mathcal{L}_{155}$	6	$C_1^{vii},\ S_2^{ii}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{3'})$	1	1	1	48747.	160700.
$\mathcal{L}_{156}$	10	$C_2^{vii},\ S_1^{i}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{3})$	5	−1	1	697.01	502.07
$\mathcal{L}_{157}$	12	$C_2^{vii},\ S_2^{i}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{3})$	2	2	0	0.082778 ★	0.22999 ★
$\mathcal{L}_{158}$	12	$C_2^{vii},\ S_3^{i}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{3})$	3	1	1	328.81	0.0038639 ★
$\mathcal{L}_{159}$	10	$C_2^{vii},\ S_1^{ii}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{3'})$	2	2	0	1362.3	926.28
$\mathcal{L}_{160}$	10	$C_2^{vii},\ S_2^{ii}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{3'})$	3	1	1	1791.1	73520.
$\mathcal{L}_{161}$	4	$C_1^{viii},\ S_1^{i}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{3})$	3	−1	1	1.2001×10^{6}	601670.
$\mathcal{L}_{162}$	6	$C_1^{viii},\ S_2^{i}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{3})$	0	2	0	15013.	98289.
$\mathcal{L}_{163}$	6	$C_1^{viii},\ S_3^{i}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{3})$	1	1	1	15002.	392860.
$\mathcal{L}_{164}$	4	$C_1^{viii},\ S_1^{ii}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{3'})$	0	2	0	17474.	1.2165×10^{6}
$\mathcal{L}_{165}$	4	$C_1^{viii},\ S_2^{ii}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{3'})$	1	1	1	20453.	1.2193×10^{6}
$\mathcal{L}_{166}$	8	$C_2^{viii},\ S_1^{i}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{3})$	5	−1	1	491.1	9783.5
$\mathcal{L}_{167}$	10	$C_2^{viii},\ S_2^{i}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{3})$	2	2	0	785.1	545.85
$\mathcal{L}_{168}$	10	$C_2^{viii},\ S_3^{i}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{3})$	3	1	1	814.27	98.177
$\mathcal{L}_{169}$	8	$C_2^{viii},\ S_1^{ii}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{3'})$	2	2	0	2052.5	1.2019×10^{6}
$\mathcal{L}_{170}$	8	$C_2^{viii},\ S_2^{ii}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{3'})$	3	1	1	5262.4	1.1792×10^{6}
$\mathcal{L}_{171}$	10	$C_3^{viii},\ S_1^{i}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{3})$	7	−1	1	114.8	10.001 ★
$\mathcal{L}_{172}$	12	$C_3^{viii},\ S_2^{i}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{3})$	4	2	0	1.6244×10^{-7} ★	6.7774×10^{-7} ★
$\mathcal{L}_{173}$	12	$C_3^{viii},\ S_3^{i}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{3})$	5	1	1	3.236 ★	9.7519×10^{-6} ★
$\mathcal{L}_{174}$	10	$C_3^{viii},\ S_1^{ii}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{3'})$	4	2	0	1728.6	99249.
$\mathcal{L}_{175}$	10	$C_3^{viii},\ S_2^{ii}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{3'})$	5	1	1	2094.8	123890.
$\mathcal{L}_{176}$	4	$C_1^{ix},\ S_1^{iii}$	$(\mathbf{3},\ \mathbf{3'},\ \mathbf{3})$	0	2	0	17727.	1.2171×10^{6}
$\mathcal{L}_{177}$	4	$C_1^{ix},\ S_2^{iii}$	$(\mathbf{3},\ \mathbf{3'},\ \mathbf{3})$	1	1	1	17728.	1.2171×10^{6}
$\mathcal{L}_{178}$	4	$C_1^{ix},\ S_1^{iv}$	$(\mathbf{3},\ \mathbf{3'},\ \mathbf{3'})$	3	−1	1	1.4398×10^{6}	681190.
$\mathcal{L}_{179}$	6	$C_1^{ix},\ S_2^{iv}$	$(\mathbf{3},\ \mathbf{3'},\ \mathbf{3'})$	0	2	0	16091.	14847.
$\mathcal{L}_{180}$	6	$C_1^{ix},\ S_3^{iv}$	$(\mathbf{3},\ \mathbf{3'},\ \mathbf{3'})$	1	1	1	16109.	14829.
$\mathcal{L}_{181}$	8	$C_2^{ix},\ S_1^{iii}$	$(\mathbf{3},\ \mathbf{3'},\ \mathbf{3})$	2	2	0	3048.3	1.2024×10^{6}
$\mathcal{L}_{182}$	8	$C_2^{ix},\ S_2^{iii}$	$(\mathbf{3},\ \mathbf{3'},\ \mathbf{3})$	3	1	1	3199.8	1.1378×10^{6}
$\mathcal{L}_{183}$	8	$C_2^{ix},\ S_1^{iv}$	$(\mathbf{3},\ \mathbf{3'},\ \mathbf{3'})$	5	−1	1	2325.7	25253.
$\mathcal{L}_{184}$	10	$C_2^{ix},\ S_2^{iv}$	$(\mathbf{3},\ \mathbf{3'},\ \mathbf{3'})$	2	2	0	27.772 ☆	4.6365 ★
$\mathcal{L}_{185}$	10	$C_2^{ix},\ S_3^{iv}$	$(\mathbf{3},\ \mathbf{3'},\ \mathbf{3'})$	3	1	1	591.84	1.3997 ★
$\mathcal{L}_{186}$	10	$C_3^{ix},\ S_1^{iii}$	$(\mathbf{3},\ \mathbf{3'},\ \mathbf{3})$	4	2	0	2293.1	1.0043×10^{6}

$\mathcal{L}_{187}$	10	$C_3^{ix},\ S_2^{iii}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{3})$	5	1	1	1853.4	10629.
$\mathcal{L}_{188}$	10	$C_3^{ix},\ S_1^{iv}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{3}')$	7	-1	1	371.57	20311.
$\mathcal{L}_{189}$	12	$C_3^{ix},\ S_2^{iv}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{3}')$	4	2	0	9.9122 ★	0.000083367 ★
$\mathcal{L}_{190}$	12	$C_3^{ix},\ S_3^{iv}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{3}')$	5	1	1	156.67	187.17
$\mathcal{L}_{191}$	6	$C_1^{x},\ S_1^{iii}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{3})$	0	2	0	2.4405×10^{6}	3.5204×10^{6}
$\mathcal{L}_{192}$	6	$C_1^{x},\ S_2^{iii}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{3})$	1	1	1	2.4405×10^{6}	2.5876×10^{6}
$\mathcal{L}_{193}$	6	$C_1^{x},\ S_1^{iv}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{3}')$	3	-1	1	2.5471×10^{6}	2.4393×10^{6}
$\mathcal{L}_{194}$	8	$C_1^{x},\ S_2^{iv}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{3}')$	0	2	0	2.4379×10^{6}	2.4374×10^{6}
$\mathcal{L}_{195}$	8	$C_1^{x},\ S_3^{iv}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{3}')$	1	1	1	2.4396×10^{6}	2.4384×10^{6}
$\mathcal{L}_{196}$	10	$C_2^{x},\ S_1^{iii}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{3})$	2	2	0	3066.3	760350.
$\mathcal{L}_{197}$	10	$C_2^{x},\ S_2^{iii}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{3})$	3	1	1	1888.9	65468.
$\mathcal{L}_{198}$	10	$C_2^{x},\ S_1^{iv}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{3}')$	5	-1	1	1203.8	1767.8
$\mathcal{L}_{199}$	12	$C_2^{x},\ S_2^{iv}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{3}')$	2	2	0	0.0014246 ★	6.7467×10^{-7} ★
$\mathcal{L}_{200}$	12	$C_2^{x},\ S_3^{iv}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{3}')$	3	1	1	0.0016262 ★	64.922
$\mathcal{L}_{201}$	8	$C_1^{i},\ T_1^{i}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$0,2,4$	2	1	1140.7	1.2004×10^{6}
$\mathcal{L}_{202}$	8	$C_1^{i},\ T_2^{i}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$1,3,5$	1	2	3091.2	665500.
$\mathcal{L}_{203}$	10	$C_1^{i},\ T_3^{i}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$-2,0,2$	4	1	3.4216×10^{-7} ★	7.3653×10^{-7} ★
$\mathcal{L}_{204}$	10	$C_1^{i},\ T_4^{i}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$-1,1,3$	3	2	340.6	1.0964×10^{-7} ★
$\mathcal{L}_{205}$	10	$C_1^{i},\ T_5^{i}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$2,4,6$	0	3	1145.8	1.2004×10^{6}
$\mathcal{L}_{206}$	8	$C_1^{i},\ T_1^{ii}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$2,4,6$	0	1	566.08	18795.
$\mathcal{L}_{207}$	8	$C_1^{i},\ T_2^{ii}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$3,5,7$	-1	2	1159.4	506.21
$\mathcal{L}_{208}$	10	$C_1^{i},\ T_3^{ii}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$0,2,4$	2	1	10.205 ★	1.9213×10^{-6} ★
$\mathcal{L}_{209}$	10	$C_1^{i},\ T_4^{ii}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$1,3,5$	1	2	1.4197×10^{-8} ★	1.8291×10^{-7} ★
$\mathcal{L}_{210}$	10	$C_1^{i},\ T_5^{ii}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$4,6,8$	-2	3	3.0531×10^{-7} ★	2.5318×10^{-6} ★
$\mathcal{L}_{211}$	8	$C_1^{ii},\ T_1^{iii}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$2,4,6$	0	1	687.91	1112.1
$\mathcal{L}_{212}$	8	$C_1^{ii},\ T_2^{iii}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$3,5,7$	-1	2	736.98	536.37
$\mathcal{L}_{213}$	10	$C_1^{ii},\ T_3^{iii}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$0,2,4$	2	1	1.7068×10^{-7} ★	8.8418×10^{-9} ★
$\mathcal{L}_{214}$	10	$C_1^{ii},\ T_4^{iii}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$1,3,5$	1	2	8.3469×10^{-8} ★	6.2284×10^{-8} ★
$\mathcal{L}_{215}$	10	$C_1^{ii},\ T_5^{iii}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$4,6,8$	-2	3	195.93	1.2967×10^{-7} ★
$\mathcal{L}_{216}$	8	$C_1^{ii},\ T_1^{iv}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$0,2,4$	2	1	1852.2	529.17
$\mathcal{L}_{217}$	8	$C_1^{ii},\ T_2^{iv}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$1,3,5$	1	2	1036.3	546.04
$\mathcal{L}_{218}$	10	$C_1^{ii},\ T_3^{iv}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$-2,0,2$	4	1	612.89	36.251 ☆
$\mathcal{L}_{219}$	10	$C_1^{ii},\ T_4^{iv}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$-1,1,3$	3	2	190.36	539.61
$\mathcal{L}_{220}$	10	$C_1^{ii},\ T_5^{iv}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$2,4,6$	0	3	254.45	4.1772×10^{-6} ★
$\mathcal{L}_{221}$	5	$C_1^{iii},\ T_1^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$1,0$	2	1	16943.	1.2162×10^{6}
$\mathcal{L}_{222}$	5	$C_1^{iii},\ T_2^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$2,1$	1	2	17957.	713460.
$\mathcal{L}_{223}$	7	$C_1^{iii},\ T_3^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$-1,-2$	4	1	14437.	14376.
$\mathcal{L}_{224}$	7	$C_1^{iii},\ T_4^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$0,-1$	3	2	14327.	14436.
$\mathcal{L}_{225}$	7	$C_1^{iii},\ T_5^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$3,2$	0	3	16943.	1.2162×10^{6}
$\mathcal{L}_{226}$	5	$C_1^{iii},\ T_1^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$3,2$	0	1	18874.	287460.
$\mathcal{L}_{227}$	5	$C_1^{iii},\ T_2^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$4,3$	-1	2	1.188×10^{6}	593290.
$\mathcal{L}_{228}$	7	$C_1^{iii},\ T_3^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$1,0$	2	1	13929.	14346.
$\mathcal{L}_{229}$	7	$C_1^{iii},\ T_4^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$2,1$	1	2	14278.	14434.
$\mathcal{L}_{230}$	7	$C_1^{iii},\ T_5^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$5,4$	-2	3	17293.	15665.
$\mathcal{L}_{231}$	5	$C_2^{iii},\ T_1^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$1,2$	2	1	16369.	1.2156×10^{6}
$\mathcal{L}_{232}$	5	$C_2^{iii},\ T_2^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$2,3$	1	2	18999.	1.2184×10^{6}
$\mathcal{L}_{233}$	7	$C_2^{iii},\ T_3^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$-1,0$	4	1	15771.	15833.
$\mathcal{L}_{234}$	7	$C_2^{iii},\ T_4^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$0,1$	3	2	15771.	15833.
$\mathcal{L}_{235}$	7	$C_2^{iii},\ T_5^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$3,4$	0	3	16342.	1.2156×10^{6}
$\mathcal{L}_{236}$	5	$C_2^{iii},\ T_1^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$3,4$	0	1	1.3373×10^{6}	595370.

$\mathcal{L}_{237}$	5	$C_2^{iii},\ T_2^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$4,5$	-1	2	18842.	538760.
$\mathcal{L}_{238}$	7	$C_2^{iii},\ T_3^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$1,2$	2	1	15618.	16756.
$\mathcal{L}_{239}$	7	$C_2^{iii},\ T_4^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$2,3$	1	2	375140.	14339.
$\mathcal{L}_{240}$	7	$C_2^{iii},\ T_5^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$5,6$	-2	3	17755.	17278.
$\mathcal{L}_{241}$	7	$C_3^{iii},\ T_1^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$3,0$	2	1	1938.2	1.2012×10^6
$\mathcal{L}_{242}$	7	$C_3^{iii},\ T_2^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$4,1$	1	2	3093.4	666810.
$\mathcal{L}_{243}$	9	$C_3^{iii},\ T_3^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$1,-2$	4	1	229.19	457.03
$\mathcal{L}_{244}$	9	$C_3^{iii},\ T_4^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$2,-1$	3	2	409.77	55.131
$\mathcal{L}_{245}$	9	$C_3^{iii},\ T_5^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$5,2$	0	3	2125.7	1.2013×10^6
$\mathcal{L}_{246}$	7	$C_3^{iii},\ T_1^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$5,2$	0	1	1340.6	268940.
$\mathcal{L}_{247}$	7	$C_3^{iii},\ T_2^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$6,3$	-1	2	1867.7	1462.9
$\mathcal{L}_{248}$	9	$C_3^{iii},\ T_3^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$3,0$	2	1	39.286 ☆	514.84
$\mathcal{L}_{249}$	9	$C_3^{iii},\ T_4^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$4,1$	1	2	301.67	380.77
$\mathcal{L}_{250}$	9	$C_3^{iii},\ T_5^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$7,4$	-2	3	479.	437.49
$\mathcal{L}_{251}$	7	$C_4^{iii},\ T_1^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$3,2$	2	1	16324.	1.2156×10^6
$\mathcal{L}_{252}$	7	$C_4^{iii},\ T_2^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$4,3$	1	2	16981.	1.2163×10^6
$\mathcal{L}_{253}$	9	$C_4^{iii},\ T_3^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$1,0$	4	1	15771.	15833.
$\mathcal{L}_{254}$	9	$C_4^{iii},\ T_4^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$2,1$	3	2	15771.	15833.
$\mathcal{L}_{255}$	9	$C_4^{iii},\ T_5^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$5,4$	0	3	16359.	1.2156×10^6
$\mathcal{L}_{256}$	7	$C_4^{iii},\ T_1^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$5,4$	0	1	1.3372×10^6	595370.
$\mathcal{L}_{257}$	7	$C_4^{iii},\ T_2^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$6,5$	-1	2	17247.	538920.
$\mathcal{L}_{258}$	9	$C_4^{iii},\ T_3^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$3,2$	2	1	15618.	16755.
$\mathcal{L}_{259}$	9	$C_4^{iii},\ T_4^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$4,3$	1	2	375080.	14275.
$\mathcal{L}_{260}$	9	$C_4^{iii},\ T_5^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$7,6$	-2	3	17752.	17431.
$\mathcal{L}_{261}$	7	$C_5^{iii},\ T_1^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$1,4$	2	1	16271.	1.2155×10^6
$\mathcal{L}_{262}$	7	$C_5^{iii},\ T_2^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$2,5$	1	2	17005.	679450.
$\mathcal{L}_{263}$	9	$C_5^{iii},\ T_3^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$-1,2$	4	1	14499.	15978.
$\mathcal{L}_{264}$	9	$C_5^{iii},\ T_4^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$0,3$	3	2	14676.	16319.
$\mathcal{L}_{265}$	9	$C_5^{iii},\ T_5^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$3,6$	0	3	16282.	1.2155×10^6
$\mathcal{L}_{266}$	7	$C_5^{iii},\ T_1^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$3,6$	0	1	17730.	14832.
$\mathcal{L}_{267}$	7	$C_5^{iii},\ T_2^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$4,7$	-1	2	17359.	16266.
$\mathcal{L}_{268}$	9	$C_5^{iii},\ T_3^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$1,4$	2	1	14434.	14462.
$\mathcal{L}_{269}$	9	$C_5^{iii},\ T_4^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$2,5$	1	2	14153.	14393.
$\mathcal{L}_{270}$	9	$C_5^{iii},\ T_5^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$5,8$	-2	3	16416.	15450.
$\mathcal{L}_{271}$	9	$C_6^{iii},\ T_1^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$3,4$	2	1	1374.3	1.2005×10^6
$\mathcal{L}_{272}$	9	$C_6^{iii},\ T_2^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$4,5$	1	2	3114.4	665120.
$\mathcal{L}_{273}$	11	$C_6^{iii},\ T_3^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$1,2$	4	1	205.15	1.1012×10^{-7} ★
$\mathcal{L}_{274}$	11	$C_6^{iii},\ T_4^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$2,3$	3	2	174.83	36.217 ☆
$\mathcal{L}_{275}$	11	$C_6^{iii},\ T_5^{i}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$5,6$	0	3	1377.	1.2008×10^6
$\mathcal{L}_{276}$	9	$C_6^{iii},\ T_1^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$5,6$	0	1	639.65	194.22
$\mathcal{L}_{277}$	9	$C_6^{iii},\ T_2^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$6,7$	-1	2	195.29	73.069
$\mathcal{L}_{278}$	11	$C_6^{iii},\ T_3^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$3,4$	2	1	1.0984×10^{-6} ★	3.8508×10^{-7} ★
$\mathcal{L}_{279}$	11	$C_6^{iii},\ T_4^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$4,5$	1	2	3.5421×10^{-7} ★	5.4817×10^{-6} ★
$\mathcal{L}_{280}$	11	$C_6^{iii},\ T_5^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$7,8$	-2	3	81.444	0.97818 ★
$\mathcal{L}_{281}$	5	$C_1^{iv},\ T_1^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$-1,0$	2	1	355550.	1.5543×10^6
$\mathcal{L}_{282}$	5	$C_1^{iv},\ T_2^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$0,1$	1	2	65130.	667250.
$\mathcal{L}_{283}$	7	$C_1^{iv},\ T_3^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$-3,-2$	4	1	5316.8	3575.
$\mathcal{L}_{284}$	7	$C_1^{iv},\ T_4^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$-2,-1$	3	2	354480.	433120.
$\mathcal{L}_{285}$	7	$C_1^{iv},\ T_5^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$1,2$	0	3	355550.	1.5543×10^6
$\mathcal{L}_{286}$	5	$C_1^{iv},\ T_1^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$1,2$	0	1	3839.5	352200.

$\mathcal{L}_{287}$	5	$C_1^{iv},\ T_2^{ii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2'})$	$2,3$	-1	2	3732.8	352360.
$\mathcal{L}_{288}$	7	$C_1^{iv},\ T_3^{ii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2'})$	$-1,0$	2	1	3196.8	3762.1
$\mathcal{L}_{289}$	7	$C_1^{iv},\ T_4^{ii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2'})$	$0,1$	1	2	3200.	349980.
$\mathcal{L}_{290}$	7	$C_1^{iv},\ T_5^{ii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2'})$	$3,4$	-2	3	2327.2	1961.2
$\mathcal{L}_{291}$	5	$C_2^{iv},\ T_1^{i}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$-1,2$	2	1	19897.	1.219×10^6
$\mathcal{L}_{292}$	5	$C_2^{iv},\ T_2^{i}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$0,3$	1	2	65644.	667730.
$\mathcal{L}_{293}$	7	$C_2^{iv},\ T_3^{i}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$-3,0$	4	1	5210.5	3600.4
$\mathcal{L}_{294}$	7	$C_2^{iv},\ T_4^{i}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$-2,1$	3	2	18360.	19464.
$\mathcal{L}_{295}$	7	$C_2^{iv},\ T_5^{i}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$1,4$	0	3	18440.	1.2185×10^6
$\mathcal{L}_{296}$	5	$C_2^{iv},\ T_1^{ii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2'})$	$1,4$	0	1	6640.5	352200.
$\mathcal{L}_{297}$	5	$C_2^{iv},\ T_2^{ii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2'})$	$2,5$	-1	2	190910.	1971.9
$\mathcal{L}_{298}$	7	$C_2^{iv},\ T_3^{ii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2'})$	$-1,2$	2	1	3869.	137340.
$\mathcal{L}_{299}$	7	$C_2^{iv},\ T_4^{ii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2'})$	$0,3$	1	2	31555.	2296.7
$\mathcal{L}_{300}$	7	$C_2^{iv},\ T_5^{ii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2'})$	$3,6$	-2	3	2594.3	1941.8
$\mathcal{L}_{301}$	7	$C_3^{iv},\ T_1^{i}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$1,0$	2	1	2081.4	1.2014×10^6
$\mathcal{L}_{302}$	7	$C_3^{iv},\ T_2^{i}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$2,1$	1	2	18503.	665980.
$\mathcal{L}_{303}$	9	$C_3^{iv},\ T_3^{i}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$-1,-2$	4	1	547.46	299.61
$\mathcal{L}_{304}$	9	$C_3^{iv},\ T_4^{i}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$0,-1$	3	2	437.77	309.13
$\mathcal{L}_{305}$	9	$C_3^{iv},\ T_5^{i}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$3,2$	0	3	2080.7	1.2014×10^6
$\mathcal{L}_{306}$	7	$C_3^{iv},\ T_1^{ii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2'})$	$3,2$	0	1	859.71	851.81
$\mathcal{L}_{307}$	7	$C_3^{iv},\ T_2^{ii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2'})$	$4,3$	-1	2	2434.5	554.97
$\mathcal{L}_{308}$	9	$C_3^{iv},\ T_3^{ii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2'})$	$1,0$	2	1	37.258 ☆	384.58
$\mathcal{L}_{309}$	9	$C_3^{iv},\ T_4^{ii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2'})$	$2,1$	1	2	346.85	537.37
$\mathcal{L}_{310}$	9	$C_3^{iv},\ T_5^{ii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2'})$	$5,4$	-2	3	4.2439×10^{-6} ★	468.26
$\mathcal{L}_{311}$	7	$C_4^{iv},\ T_1^{i}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$1,2$	2	1	1962.5	1.2012×10^6
$\mathcal{L}_{312}$	7	$C_4^{iv},\ T_2^{i}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$2,3$	1	2	4631.4	665980.
$\mathcal{L}_{313}$	9	$C_4^{iv},\ T_3^{i}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$-1,0$	4	1	1080.9	299.64
$\mathcal{L}_{314}$	9	$C_4^{iv},\ T_4^{i}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$0,1$	3	2	481.76	309.17
$\mathcal{L}_{315}$	9	$C_4^{iv},\ T_5^{i}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$3,4$	0	3	1999.6	1.2012×10^6
$\mathcal{L}_{316}$	7	$C_4^{iv},\ T_1^{ii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2'})$	$3,4$	0	1	751.94	851.79
$\mathcal{L}_{317}$	7	$C_4^{iv},\ T_2^{ii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2'})$	$4,5$	-1	2	2434.5	526.76
$\mathcal{L}_{318}$	9	$C_4^{iv},\ T_3^{ii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2'})$	$1,2$	2	1	729.86	422.69
$\mathcal{L}_{319}$	9	$C_4^{iv},\ T_4^{ii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2'})$	$2,3$	1	2	347.07	336.91
$\mathcal{L}_{320}$	9	$C_4^{iv},\ T_5^{ii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2'})$	$5,6$	-2	3	16.094 ☆	539.89
$\mathcal{L}_{321}$	7	$C_5^{iv},\ T_1^{i}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$-1,4$	2	1	5454.9	1.204×10^6
$\mathcal{L}_{322}$	7	$C_5^{iv},\ T_2^{i}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$0,5$	1	2	64731.	666820.
$\mathcal{L}_{323}$	9	$C_5^{iv},\ T_3^{i}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$-3,2$	4	1	3817.2	2821.8
$\mathcal{L}_{324}$	9	$C_5^{iv},\ T_4^{i}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$-2,3$	3	2	4006.2	17832.
$\mathcal{L}_{325}$	9	$C_5^{iv},\ T_5^{i}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$1,6$	0	3	5690.7	1.2041×10^6
$\mathcal{L}_{326}$	7	$C_5^{iv},\ T_1^{ii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2'})$	$1,6$	0	1	1882.1	5601.1
$\mathcal{L}_{327}$	7	$C_5^{iv},\ T_2^{ii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2'})$	$2,7$	-1	2	2292.5	2098.8
$\mathcal{L}_{328}$	9	$C_5^{iv},\ T_3^{ii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2'})$	$-1,4$	2	1	561.2	1084.3
$\mathcal{L}_{329}$	9	$C_5^{iv},\ T_4^{ii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2'})$	$0,5$	1	2	273.4	606.72
$\mathcal{L}_{330}$	9	$C_5^{iv},\ T_5^{ii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2'})$	$3,8$	-2	3	1881.2	1942.1
$\mathcal{L}_{331}$	9	$C_6^{iv},\ T_1^{i}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$3,0$	2	1	1827.8	1.2011×10^6
$\mathcal{L}_{332}$	9	$C_6^{iv},\ T_2^{i}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$4,1$	1	2	3133.3	664950.
$\mathcal{L}_{333}$	11	$C_6^{iv},\ T_3^{i}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$1,-2$	4	1	527.05	9.1714×10^{-6} ★
$\mathcal{L}_{334}$	11	$C_6^{iv},\ T_4^{i}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$2,-1$	3	2	212.75	4.6061×10^{-6} ★
$\mathcal{L}_{335}$	11	$C_6^{iv},\ T_5^{i}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$5,2$	0	3	1821.5	1.2011×10^6
$\mathcal{L}_{336}$	9	$C_6^{iv},\ T_1^{ii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2'})$	$5,2$	0	1	560.47	551.63

$\mathcal{L}_{337}$	9	$C_6^{iv},\ T_2^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$6,3$	-1	2	634.92	0.33874 ★
$\mathcal{L}_{338}$	11	$C_6^{iv},\ T_3^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$3,0$	2	1	2.3314×10^{-6} ★	8.6728×10^{-6} ★
$\mathcal{L}_{339}$	11	$C_6^{iv},\ T_4^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$4,1$	1	2	6.9389 ★	8.3984×10^{-6} ★
$\mathcal{L}_{340}$	11	$C_6^{iv},\ T_5^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$7,4$	-2	3	0.000018297 ★	5.0812×10^{-8} ★
$\mathcal{L}_{341}$	9	$C_7^{iv},\ T_1^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$1,4$	2	1	2790.1	1.2012×10^{6}
$\mathcal{L}_{342}$	9	$C_7^{iv},\ T_2^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$2,5$	1	2	62812.	665160.
$\mathcal{L}_{343}$	11	$C_7^{iv},\ T_3^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$-1,2$	4	1	35.602 ★	8.5021×10^{-6} ★
$\mathcal{L}_{344}$	11	$C_7^{iv},\ T_4^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$0,3$	3	2	7.3244×10^{-7} ★	0.0070242 ★
$\mathcal{L}_{345}$	11	$C_7^{iv},\ T_5^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$3,6$	0	3	3041.1	1.2016×10^{6}
$\mathcal{L}_{346}$	9	$C_7^{iv},\ T_1^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$3,6$	0	1	503.88	238.41
$\mathcal{L}_{347}$	9	$C_7^{iv},\ T_2^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$4,7$	-1	2	643.15	92.843
$\mathcal{L}_{348}$	11	$C_7^{iv},\ T_3^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$1,4$	2	1	1.4136×10^{-7} ★	2.522×10^{-6} ★
$\mathcal{L}_{349}$	11	$C_7^{iv},\ T_4^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$2,5$	1	2	0.90088 ★	191.99
$\mathcal{L}_{350}$	11	$C_7^{iv},\ T_5^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$5,8$	-2	3	2.1671×10^{-7} ★	22.786 ★
$\mathcal{L}_{351}$	9	$C_8^{iv},\ T_1^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$3,2$	2	1	1423.	1.2004×10^{6}
$\mathcal{L}_{352}$	9	$C_8^{iv},\ T_2^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$4,3$	1	2	16971.	664950.
$\mathcal{L}_{353}$	11	$C_8^{iv},\ T_3^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$1,0$	4	1	565.78	7.1908×10^{-6} ★
$\mathcal{L}_{354}$	11	$C_8^{iv},\ T_4^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$2,1$	3	2	212.76	1.5524×10^{-6} ★
$\mathcal{L}_{355}$	11	$C_8^{iv},\ T_5^{i}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2})$	$5,4$	0	3	1368.8	1.2004×10^{6}
$\mathcal{L}_{356}$	9	$C_8^{iv},\ T_1^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$5,4$	0	1	560.33	546.3
$\mathcal{L}_{357}$	9	$C_8^{iv},\ T_2^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$6,5$	-1	2	646.21	0.33932 ★
$\mathcal{L}_{358}$	11	$C_8^{iv},\ T_3^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$3,2$	2	1	7.343×10^{-7} ★	2.9507×10^{-6} ★
$\mathcal{L}_{359}$	11	$C_8^{iv},\ T_4^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$4,3$	1	2	6.9387 ★	5.7437×10^{-6} ★
$\mathcal{L}_{360}$	11	$C_8^{iv},\ T_5^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ \mathbf{2}')$	$7,6$	-2	3	178.45	7.6032×10^{-6} ★
$\mathcal{L}_{361}$	5	$C_1^{v},\ T_1^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$1,2$	0	1	3807.8	477220.
$\mathcal{L}_{362}$	5	$C_1^{v},\ T_2^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$2,3$	-1	2	3728.2	88280.
$\mathcal{L}_{363}$	7	$C_1^{v},\ T_3^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$-1,0$	2	1	3150.2	3660.1
$\mathcal{L}_{364}$	7	$C_1^{v},\ T_4^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$0,1$	1	2	3189.3	429580.
$\mathcal{L}_{365}$	7	$C_1^{v},\ T_5^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$3,4$	-2	3	2296.9	1951.
$\mathcal{L}_{366}$	5	$C_1^{v},\ T_1^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$-1,0$	2	1	1.9627×10^{6}	904630.
$\mathcal{L}_{367}$	5	$C_1^{v},\ T_2^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$0,1$	1	2	6558.7	801450.
$\mathcal{L}_{368}$	7	$C_1^{v},\ T_3^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$-3,-2$	4	1	3339.8	3543.1
$\mathcal{L}_{369}$	7	$C_1^{v},\ T_4^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$-2,-1$	3	2	712200.	464840.
$\mathcal{L}_{370}$	7	$C_1^{v},\ T_5^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$1,2$	0	3	467680.	461540.
$\mathcal{L}_{371}$	5	$C_2^{v},\ T_1^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$1,4$	0	1	405420.	6086.8
$\mathcal{L}_{372}$	5	$C_2^{v},\ T_2^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$2,5$	-1	2	19938.	1948.8
$\mathcal{L}_{373}$	7	$C_2^{v},\ T_3^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$-1,2$	2	1	41516.	798.73
$\mathcal{L}_{374}$	7	$C_2^{v},\ T_4^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$0,3$	1	2	128350.	547.52
$\mathcal{L}_{375}$	7	$C_2^{v},\ T_5^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$3,6$	-2	3	2593.9	1955.3
$\mathcal{L}_{376}$	5	$C_2^{v},\ T_1^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$-1,2$	2	1	241290.	164240.
$\mathcal{L}_{377}$	5	$C_2^{v},\ T_2^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$0,3$	1	2	407520.	247900.
$\mathcal{L}_{378}$	7	$C_2^{v},\ T_3^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$-3,0$	4	1	2450.	3547.1
$\mathcal{L}_{379}$	7	$C_2^{v},\ T_4^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$-2,1$	3	2	18440.	618.93
$\mathcal{L}_{380}$	7	$C_2^{v},\ T_5^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$1,4$	0	3	4677.5	3129.1
$\mathcal{L}_{381}$	7	$C_3^{v},\ T_1^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$3,2$	0	1	2130.3	407.97
$\mathcal{L}_{382}$	7	$C_3^{v},\ T_2^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$4,3$	-1	2	2487.8	4646.
$\mathcal{L}_{383}$	9	$C_3^{v},\ T_3^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$1,0$	2	1	755.23	5.9632×10^{-7} ★
$\mathcal{L}_{384}$	9	$C_3^{v},\ T_4^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$2,1$	1	2	168.63	540.2
$\mathcal{L}_{385}$	9	$C_3^{v},\ T_5^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$5,4$	-2	3	666.	10.461 ☆
$\mathcal{L}_{386}$	7	$C_3^{v},\ T_1^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$1,0$	2	1	1505.3	568.34

$\mathcal{L}_{387}$	7	$C_3^v,\ T_2^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$2,1$	1	2	1024.4	1961.8
$\mathcal{L}_{388}$	9	$C_3^v,\ T_3^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$-1,-2$	4	1	187.1	96.913
$\mathcal{L}_{389}$	9	$C_3^v,\ T_4^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$0,-1$	3	2	271.23	1.6819×10^{-7} ★
$\mathcal{L}_{390}$	9	$C_3^v,\ T_5^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$3,2$	0	3	593.6	460.62
$\mathcal{L}_{391}$	7	$C_4^v,\ T_1^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$3,4$	0	1	2130.3	407.98
$\mathcal{L}_{392}$	7	$C_4^v,\ T_2^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$4,5$	-1	2	2487.8	1145.5
$\mathcal{L}_{393}$	9	$C_4^v,\ T_3^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$1,2$	2	1	755.23	9.2856×10^{-7} ★
$\mathcal{L}_{394}$	9	$C_4^v,\ T_4^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$2,3$	1	2	180.35	124.03
$\mathcal{L}_{395}$	9	$C_4^v,\ T_5^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$5,6$	-2	3	666.	10.554 ☆
$\mathcal{L}_{396}$	7	$C_4^v,\ T_1^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$1,2$	2	1	2467.5	568.34
$\mathcal{L}_{397}$	7	$C_4^v,\ T_2^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$2,3$	1	2	1068.4	567.26
$\mathcal{L}_{398}$	9	$C_4^v,\ T_3^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$-1,0$	4	1	187.1	238.24
$\mathcal{L}_{399}$	9	$C_4^v,\ T_4^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$0,1$	3	2	683.6	1.6396×10^{-6} ★
$\mathcal{L}_{400}$	9	$C_4^v,\ T_5^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$3,4$	0	3	593.6	465.88
$\mathcal{L}_{401}$	7	$C_5^v,\ T_1^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$1,6$	0	1	3004.	4389.5
$\mathcal{L}_{402}$	7	$C_5^v,\ T_2^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$2,7$	-1	2	2623.8	52862.
$\mathcal{L}_{403}$	9	$C_5^v,\ T_3^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$-1,4$	2	1	2353.1	2154.8
$\mathcal{L}_{404}$	9	$C_5^v,\ T_4^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$0,5$	1	2	2990.7	2350.9
$\mathcal{L}_{405}$	9	$C_5^v,\ T_5^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$3,8$	-2	3	1869.3	1934.1
$\mathcal{L}_{406}$	7	$C_5^v,\ T_1^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$-1,4$	2	1	1.1072×10^{6}	39729.
$\mathcal{L}_{407}$	7	$C_5^v,\ T_2^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$0,5$	1	2	5099.2	405720.
$\mathcal{L}_{408}$	9	$C_5^v,\ T_3^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$-3,2$	4	1	4604.1	3333.3
$\mathcal{L}_{409}$	9	$C_5^v,\ T_4^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$-2,3$	3	2	262570.	6698.3
$\mathcal{L}_{410}$	9	$C_5^v,\ T_5^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$1,6$	0	3	24083.	13954.
$\mathcal{L}_{411}$	9	$C_6^v,\ T_1^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$5,2$	0	1	797.18	6.2842×10^{-6} ★
$\mathcal{L}_{412}$	9	$C_6^v,\ T_2^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$6,3$	-1	2	490.2	502.65
$\mathcal{L}_{413}$	11	$C_6^v,\ T_3^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$3,0$	2	1	9.6773×10^{-8} ★	1.13×10^{-6} ★
$\mathcal{L}_{414}$	11	$C_6^v,\ T_4^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$4,1$	1	2	6.2373×10^{-8} ★	6.7794×10^{-6} ★
$\mathcal{L}_{415}$	11	$C_6^v,\ T_5^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$7,4$	-2	3	8.4667×10^{-7} ★	4.3284×10^{-7} ★
$\mathcal{L}_{416}$	9	$C_6^v,\ T_1^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$3,0$	2	1	781.9	8.1908×10^{-6} ★
$\mathcal{L}_{417}$	9	$C_6^v,\ T_2^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$4,1$	1	2	661.16	4.2934×10^{-7} ★
$\mathcal{L}_{418}$	11	$C_6^v,\ T_3^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$1,-2$	4	1	4.0709×10^{-7} ★	1.3395×10^{-6} ★
$\mathcal{L}_{419}$	11	$C_6^v,\ T_4^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$2,-1$	3	2	9.4405×10^{-8} ★	6.1299×10^{-7} ★
$\mathcal{L}_{420}$	11	$C_6^v,\ T_5^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$5,2$	0	3	7.0651×10^{-6} ★	6.2426×10^{-6} ★
$\mathcal{L}_{421}$	9	$C_7^v,\ T_1^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$3,6$	0	1	1756.9	5.2284×10^{-6} ★
$\mathcal{L}_{422}$	9	$C_7^v,\ T_2^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$4,7$	-1	2	527.42	560.86
$\mathcal{L}_{423}$	11	$C_7^v,\ T_3^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$1,4$	2	1	0.000012628 ★	7.2321×10^{-7} ★
$\mathcal{L}_{424}$	11	$C_7^v,\ T_4^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$2,5$	1	2	9.3807×10^{-8} ★	6.6696×10^{-6} ★
$\mathcal{L}_{425}$	11	$C_7^v,\ T_5^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$5,8$	-2	3	9.997×10^{-7} ★	3.7355×10^{-6} ★
$\mathcal{L}_{426}$	9	$C_7^v,\ T_1^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$1,4$	2	1	698.06	544.5
$\mathcal{L}_{427}$	9	$C_7^v,\ T_2^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$2,5$	1	2	282.74	545.49
$\mathcal{L}_{428}$	11	$C_7^v,\ T_3^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$-1,2$	4	1	187.1	4.6762×10^{-6} ★
$\mathcal{L}_{429}$	11	$C_7^v,\ T_4^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$0,3$	3	2	19.909 ☆	1.9177×10^{-6} ★
$\mathcal{L}_{430}$	11	$C_7^v,\ T_5^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$3,6$	0	3	54.162	0.000025247 ★
$\mathcal{L}_{431}$	9	$C_8^v,\ T_1^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$5,4$	0	1	1249.8	5.3274×10^{-7} ★
$\mathcal{L}_{432}$	9	$C_8^v,\ T_2^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$6,5$	-1	2	490.23	503.52
$\mathcal{L}_{433}$	11	$C_8^v,\ T_3^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$3,2$	2	1	1.9113×10^{-6} ★	7.0267×10^{-6} ★
$\mathcal{L}_{434}$	11	$C_8^v,\ T_4^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$4,3$	1	2	5.8142×10^{-7} ★	1.5269×10^{-7} ★
$\mathcal{L}_{435}$	11	$C_8^v,\ T_5^{iii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$7,6$	-2	3	1.312×10^{-6} ★	6.3935×10^{-7} ★
$\mathcal{L}_{436}$	9	$C_8^v,\ T_1^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$3,2$	2	1	781.95	8.3729×10^{-6} ★

$\mathcal{L}_{437}$	9	$C_8^v,\ T_2^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$4,3$	1	2	680.47	7.0434×10^{-6} ★
$\mathcal{L}_{438}$	11	$C_8^v,\ T_3^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$1,0$	4	1	8.486×10^{-8} ★	5.1971×10^{-6} ★
$\mathcal{L}_{439}$	11	$C_8^v,\ T_4^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$2,1$	3	2	2.017×10^{-7} ★	1.1158×10^{-6} ★
$\mathcal{L}_{440}$	11	$C_8^v,\ T_5^{iv}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$5,4$	0	3	1.5132×10^{-6} ★	3.98×10^{-6} ★
$\mathcal{L}_{441}$	5	$C_1^{vi},\ T_1^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$3,2$	0	1	19206.	40149.
$\mathcal{L}_{442}$	5	$C_1^{vi},\ T_2^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$4,3$	-1	2	1.0275×10^{6}	497970.
$\mathcal{L}_{443}$	7	$C_1^{vi},\ T_3^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$1,0$	2	1	14888.	13936.
$\mathcal{L}_{444}$	7	$C_1^{vi},\ T_4^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$2,1$	1	2	14093.	14434.
$\mathcal{L}_{445}$	7	$C_1^{vi},\ T_5^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$5,4$	-2	3	17135.	16428.
$\mathcal{L}_{446}$	5	$C_1^{vi},\ T_1^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$1,0$	2	1	16419.	15838.
$\mathcal{L}_{447}$	5	$C_1^{vi},\ T_2^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$2,1$	1	2	16222.	15851.
$\mathcal{L}_{448}$	7	$C_1^{vi},\ T_3^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$-1,-2$	4	1	14804.	13988.
$\mathcal{L}_{449}$	7	$C_1^{vi},\ T_4^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$0,-1$	3	2	14163.	14436.
$\mathcal{L}_{450}$	7	$C_1^{vi},\ T_5^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$3,2$	0	3	15771.	15833.
$\mathcal{L}_{451}$	5	$C_2^{vi},\ T_1^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$3,4$	0	1	17603.	40458.
$\mathcal{L}_{452}$	5	$C_2^{vi},\ T_2^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$4,5$	-1	2	1.0277×10^{6}	498180.
$\mathcal{L}_{453}$	7	$C_2^{vi},\ T_3^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$1,2$	2	1	15272.	13914.
$\mathcal{L}_{454}$	7	$C_2^{vi},\ T_4^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$2,3$	1	2	14131.	14435.
$\mathcal{L}_{455}$	7	$C_2^{vi},\ T_5^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$5,6$	-2	3	17108.	16318.
$\mathcal{L}_{456}$	5	$C_2^{vi},\ T_1^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$1,2$	2	1	16590.	15833.
$\mathcal{L}_{457}$	5	$C_2^{vi},\ T_2^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$2,3$	1	2	16366.	15835.
$\mathcal{L}_{458}$	7	$C_2^{vi},\ T_3^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$-1,0$	4	1	14798.	14455.
$\mathcal{L}_{459}$	7	$C_2^{vi},\ T_4^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$0,1$	3	2	14576.	14457.
$\mathcal{L}_{460}$	7	$C_2^{vi},\ T_5^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$3,4$	0	3	15771.	15833.
$\mathcal{L}_{461}$	7	$C_3^{vi},\ T_1^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$5,2$	0	1	1508.7	1750.4
$\mathcal{L}_{462}$	7	$C_3^{vi},\ T_2^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$6,3$	-1	2	1472.4	1728.6
$\mathcal{L}_{463}$	9	$C_3^{vi},\ T_3^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$3,0$	2	1	786.57	7.278×10^{-6} ★
$\mathcal{L}_{464}$	9	$C_3^{vi},\ T_4^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$4,1$	1	2	201.4	3.6306 ★
$\mathcal{L}_{465}$	9	$C_3^{vi},\ T_5^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$7,4$	-2	3	572.41	474.46
$\mathcal{L}_{466}$	7	$C_3^{vi},\ T_1^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$3,0$	2	1	2530.2	585.82
$\mathcal{L}_{467}$	7	$C_3^{vi},\ T_2^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$4,1$	1	2	2331.2	568.5
$\mathcal{L}_{468}$	9	$C_3^{vi},\ T_3^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$1,-2$	4	1	896.9	92.888
$\mathcal{L}_{469}$	9	$C_3^{vi},\ T_4^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$2,-1$	3	2	260.76	8.0307×10^{-7} ★
$\mathcal{L}_{470}$	9	$C_3^{vi},\ T_5^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$5,2$	0	3	625.3	566.28
$\mathcal{L}_{471}$	7	$C_4^{vi},\ T_1^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$5,4$	0	1	17916.	15505.
$\mathcal{L}_{472}$	7	$C_4^{vi},\ T_2^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$6,5$	-1	2	14643.	14441.
$\mathcal{L}_{473}$	9	$C_4^{vi},\ T_3^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$3,2$	2	1	13909.	13905.
$\mathcal{L}_{474}$	9	$C_4^{vi},\ T_4^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$4,3$	1	2	13925.	13890.
$\mathcal{L}_{475}$	9	$C_4^{vi},\ T_5^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$7,6$	-2	3	14469.	13899.
$\mathcal{L}_{476}$	7	$C_4^{vi},\ T_1^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$3,2$	2	1	15931.	14466.
$\mathcal{L}_{477}$	7	$C_4^{vi},\ T_2^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$4,3$	1	2	15129.	14455.
$\mathcal{L}_{478}$	9	$C_4^{vi},\ T_3^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$1,0$	4	1	14621.	14216.
$\mathcal{L}_{479}$	9	$C_4^{vi},\ T_4^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$2,1$	3	2	14167.	14444.
$\mathcal{L}_{480}$	9	$C_4^{vi},\ T_5^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$5,4$	0	3	14454.	14455.
$\mathcal{L}_{481}$	7	$C_5^{vi},\ T_1^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$3,6$	0	1	5308.6	25927.
$\mathcal{L}_{482}$	7	$C_5^{vi},\ T_2^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$4,7$	-1	2	802860.	175390.
$\mathcal{L}_{483}$	9	$C_5^{vi},\ T_3^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$1,4$	2	1	996.51	0.00005391 ★
$\mathcal{L}_{484}$	9	$C_5^{vi},\ T_4^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$2,5$	1	2	184.76	538.57
$\mathcal{L}_{485}$	9	$C_5^{vi},\ T_5^{iii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2})$	$5,8$	-2	3	3228.3	2518.
$\mathcal{L}_{486}$	7	$C_5^{vi},\ T_1^{iv}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ \mathbf{2}')$	$1,4$	2	1	2530.3	1947.1

$\mathcal{L}_{487}$	7	$C_5^{vi},\ T_2^{iv}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{2'})$	$2,5$	1	2	2329.5	1954.2
$\mathcal{L}_{488}$	9	$C_5^{vi},\ T_3^{iv}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{2'})$	$-1,2$	4	1	879.57	91.884
$\mathcal{L}_{489}$	9	$C_5^{vi},\ T_4^{iv}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{2'})$	$0,3$	3	2	264.89	541.25
$\mathcal{L}_{490}$	9	$C_5^{vi},\ T_5^{iv}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{2'})$	$3,6$	0	3	1881.6	1943.8
$\mathcal{L}_{491}$	9	$C_6^{vi},\ T_1^{iii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{2})$	$5,6$	0	1	686.97	1106.3
$\mathcal{L}_{492}$	9	$C_6^{vi},\ T_2^{iii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{2})$	$6,7$	-1	2	776.06	5847.2
$\mathcal{L}_{493}$	11	$C_6^{vi},\ T_3^{iii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{2})$	$3,4$	2	1	0.000017897 ★	0.000025566 ★
$\mathcal{L}_{494}$	11	$C_6^{vi},\ T_4^{iii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{2})$	$4,5$	1	2	0.000015641 ★	1.2548×10^{-6} ★
$\mathcal{L}_{495}$	11	$C_6^{vi},\ T_5^{iii}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{2})$	$7,8$	-2	3	197.93	6.6962×10^{-6} ★
$\mathcal{L}_{496}$	9	$C_6^{vi},\ T_1^{iv}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{2'})$	$3,4$	2	1	1854.1	518.18
$\mathcal{L}_{497}$	9	$C_6^{vi},\ T_2^{iv}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{2'})$	$4,5$	1	2	1037.5	520.58
$\mathcal{L}_{498}$	11	$C_6^{vi},\ T_3^{iv}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{2'})$	$1,2$	4	1	605.95	36.29 ☆
$\mathcal{L}_{499}$	11	$C_6^{vi},\ T_4^{iv}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{2'})$	$2,3$	3	2	181.58	3.3821×10^{-7} ★
$\mathcal{L}_{500}$	11	$C_6^{vi},\ T_5^{iv}$	$(\mathbf{2'}\oplus\mathbf{1},\ \mathbf{3'},\ \mathbf{2'})$	$5,6$	0	3	500.9	0.00010974 ★
$\mathcal{L}_{501}$	6	$C_1^{vii},\ T_1^{i}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{2})$	0	2	1	48764.	1.248×10^{6}
$\mathcal{L}_{502}$	6	$C_1^{vii},\ T_2^{i}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{2})$	1	1	2	48769.	749510.
$\mathcal{L}_{503}$	8	$C_1^{vii},\ T_3^{i}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{2})$	-2	4	1	48230.	47817.
$\mathcal{L}_{504}$	8	$C_1^{vii},\ T_4^{i}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{2})$	-1	3	2	47821.	47594.
$\mathcal{L}_{505}$	8	$C_1^{vii},\ T_5^{i}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{2})$	2	0	3	48760.	1.248×10^{6}
$\mathcal{L}_{506}$	6	$C_1^{vii},\ T_1^{ii}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{2'})$	2	0	1	50369.	1.2446×10^{6}
$\mathcal{L}_{507}$	6	$C_1^{vii},\ T_2^{ii}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{2'})$	3	-1	2	49101.	253200.
$\mathcal{L}_{508}$	8	$C_1^{vii},\ T_3^{ii}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{2'})$	0	2	1	47451.	46731.
$\mathcal{L}_{509}$	8	$C_1^{vii},\ T_4^{ii}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{2'})$	1	1	2	47970.	47592.
$\mathcal{L}_{510}$	8	$C_1^{vii},\ T_5^{ii}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{2'})$	4	-2	3	50916.	180840.
$\mathcal{L}_{511}$	10	$C_2^{vii},\ T_1^{i}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{2})$	2	2	1	1889.7	1.2011×10^{6}
$\mathcal{L}_{512}$	10	$C_2^{vii},\ T_2^{i}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{2})$	3	1	2	3311.9	665370.
$\mathcal{L}_{513}$	12	$C_2^{vii},\ T_3^{i}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{2})$	0	4	1	1302.2	368.07
$\mathcal{L}_{514}$	12	$C_2^{vii},\ T_4^{i}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{2})$	1	3	2	679.58	339.15
$\mathcal{L}_{515}$	12	$C_2^{vii},\ T_5^{i}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{2})$	4	0	3	1921.1	1.2023×10^{6}
$\mathcal{L}_{516}$	10	$C_2^{vii},\ T_1^{ii}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{2'})$	4	0	1	1193.8	568.5
$\mathcal{L}_{517}$	10	$C_2^{vii},\ T_2^{ii}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{2'})$	5	-1	2	925.91	57.246
$\mathcal{L}_{518}$	12	$C_2^{vii},\ T_3^{ii}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{2'})$	2	2	1	822.06	39.114 ☆
$\mathcal{L}_{519}$	12	$C_2^{vii},\ T_4^{ii}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{2'})$	3	1	2	568.28	417.44
$\mathcal{L}_{520}$	12	$C_2^{vii},\ T_5^{ii}$	$(\mathbf{3},\ \mathbf{3},\ \mathbf{2'})$	6	-2	3	376.6	5.0468 ★
$\mathcal{L}_{521}$	4	$C_1^{viii},\ T_1^{i}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{2})$	0	2	1	17609.	1.2169×10^{6}
$\mathcal{L}_{522}$	4	$C_1^{viii},\ T_2^{i}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{2})$	1	1	2	2.5472×10^{6}	3.0715×10^{6}
$\mathcal{L}_{523}$	6	$C_1^{viii},\ T_3^{i}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{2})$	-2	4	1	15934.	15833.
$\mathcal{L}_{524}$	6	$C_1^{viii},\ T_4^{i}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{2})$	-1	3	2	16012.	15836.
$\mathcal{L}_{525}$	6	$C_1^{viii},\ T_5^{i}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{2})$	2	0	3	17609.	1.2169×10^{6}
$\mathcal{L}_{526}$	4	$C_1^{viii},\ T_1^{ii}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{2'})$	2	0	1	1.3943×10^{6}	604730.
$\mathcal{L}_{527}$	4	$C_1^{viii},\ T_2^{ii}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{2'})$	3	-1	2	853880.	569500.
$\mathcal{L}_{528}$	6	$C_1^{viii},\ T_3^{ii}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{2'})$	0	2	1	16975.	461770.
$\mathcal{L}_{529}$	6	$C_1^{viii},\ T_4^{ii}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{2'})$	1	1	2	1.2148×10^{6}	583690.
$\mathcal{L}_{530}$	6	$C_1^{viii},\ T_5^{ii}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{2'})$	4	-2	3	785680.	465790.
$\mathcal{L}_{531}$	8	$C_2^{viii},\ T_1^{i}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{2})$	2	2	1	1902.	1.2011×10^{6}
$\mathcal{L}_{532}$	8	$C_2^{viii},\ T_2^{i}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{2})$	3	1	2	4663.1	666160.
$\mathcal{L}_{533}$	10	$C_2^{viii},\ T_3^{i}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{2})$	0	4	1	187.76	424.64
$\mathcal{L}_{534}$	10	$C_2^{viii},\ T_4^{i}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{2})$	1	3	2	385.31	53.129
$\mathcal{L}_{535}$	10	$C_2^{viii},\ T_5^{i}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{2})$	4	0	3	2267.3	1.2014×10^{6}
$\mathcal{L}_{536}$	8	$C_2^{viii},\ T_1^{ii}$	$(\mathbf{3'},\ \mathbf{3},\ \mathbf{2'})$	4	0	1	1460.7	10080.

$\mathcal{L}_{537}$	8	$C_2^{viii},\ T_2^{ii}$	$(\mathbf{3}',\ \mathbf{3},\ \mathbf{2}')$	5	-1	2	1804.6	827.15
$\mathcal{L}_{538}$	10	$C_2^{viii},\ T_3^{ii}$	$(\mathbf{3}',\ \mathbf{3},\ \mathbf{2}')$	2	2	1	61.498	494.96
$\mathcal{L}_{539}$	10	$C_2^{viii},\ T_4^{ii}$	$(\mathbf{3}',\ \mathbf{3},\ \mathbf{2}')$	3	1	2	388.24	543.55
$\mathcal{L}_{540}$	10	$C_2^{viii},\ T_5^{ii}$	$(\mathbf{3}',\ \mathbf{3},\ \mathbf{2}')$	6	-2	3	460.72	162.48
$\mathcal{L}_{541}$	10	$C_3^{viii},\ T_1^{i}$	$(\mathbf{3}',\ \mathbf{3},\ \mathbf{2})$	4	2	1	1979.9	1.2012×10^6
$\mathcal{L}_{542}$	10	$C_3^{viii},\ T_2^{i}$	$(\mathbf{3}',\ \mathbf{3},\ \mathbf{2})$	5	1	2	63096.	665420.
$\mathcal{L}_{543}$	12	$C_3^{viii},\ T_3^{i}$	$(\mathbf{3}',\ \mathbf{3},\ \mathbf{2})$	2	4	1	1.2137 ★	7.9894×10^{-6} ★
$\mathcal{L}_{544}$	12	$C_3^{viii},\ T_4^{i}$	$(\mathbf{3}',\ \mathbf{3},\ \mathbf{2})$	3	3	2	228.73	0.000021417 ★
$\mathcal{L}_{545}$	12	$C_3^{viii},\ T_5^{i}$	$(\mathbf{3}',\ \mathbf{3},\ \mathbf{2})$	6	0	3	2089.4	1.2012×10^6
$\mathcal{L}_{546}$	10	$C_3^{viii},\ T_1^{ii}$	$(\mathbf{3}',\ \mathbf{3},\ \mathbf{2}')$	6	0	1	746.74	3.0906×10^{-6} ★
$\mathcal{L}_{547}$	10	$C_3^{viii},\ T_2^{ii}$	$(\mathbf{3}',\ \mathbf{3},\ \mathbf{2}')$	7	-1	2	920.88	20.815 ☆
$\mathcal{L}_{548}$	12	$C_3^{viii},\ T_3^{ii}$	$(\mathbf{3}',\ \mathbf{3},\ \mathbf{2}')$	4	2	1	73.527	1.3855×10^{-6} ★
$\mathcal{L}_{549}$	12	$C_3^{viii},\ T_4^{ii}$	$(\mathbf{3}',\ \mathbf{3},\ \mathbf{2}')$	5	1	2	88.114	4.1593×10^{-6} ★
$\mathcal{L}_{550}$	12	$C_3^{viii},\ T_5^{ii}$	$(\mathbf{3}',\ \mathbf{3},\ \mathbf{2}')$	8	-2	3	0.000042377 ★	7.1351×10^{-6} ★
$\mathcal{L}_{551}$	4	$C_1^{ix},\ T_1^{iii}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2})$	2	0	1	1.2803×10^6	217580.
$\mathcal{L}_{552}$	4	$C_1^{ix},\ T_2^{iii}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2})$	3	-1	2	1.5723×10^6	677650.
$\mathcal{L}_{553}$	6	$C_1^{ix},\ T_3^{iii}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2})$	0	2	1	319130.	15089.
$\mathcal{L}_{554}$	6	$C_1^{ix},\ T_4^{iii}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2})$	1	1	2	261260.	14612.
$\mathcal{L}_{555}$	6	$C_1^{ix},\ T_5^{iii}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2})$	4	-2	3	450660.	216880.
$\mathcal{L}_{556}$	4	$C_1^{ix},\ T_1^{iv}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2}')$	0	2	1	859540.	16526.
$\mathcal{L}_{557}$	4	$C_1^{ix},\ T_2^{iv}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2}')$	1	1	2	447210.	15855.
$\mathcal{L}_{558}$	6	$C_1^{ix},\ T_3^{iv}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2}')$	-2	4	1	14822.	14453.
$\mathcal{L}_{559}$	6	$C_1^{ix},\ T_4^{iv}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2}')$	-1	3	2	286800.	14452.
$\mathcal{L}_{560}$	6	$C_1^{ix},\ T_5^{iv}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2}')$	2	0	3	15886.	15846.
$\mathcal{L}_{561}$	8	$C_2^{ix},\ T_1^{iii}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2})$	4	0	1	3499.5	4480.8
$\mathcal{L}_{562}$	8	$C_2^{ix},\ T_2^{iii}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2})$	5	-1	2	1479.5	21711.
$\mathcal{L}_{563}$	10	$C_2^{ix},\ T_3^{iii}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2})$	2	2	1	991.98	393.09
$\mathcal{L}_{564}$	10	$C_2^{ix},\ T_4^{iii}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2})$	3	1	2	200.42	85.593
$\mathcal{L}_{565}$	10	$C_2^{ix},\ T_5^{iii}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2})$	6	-2	3	918.36	2596.8
$\mathcal{L}_{566}$	8	$C_2^{ix},\ T_1^{iv}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2}')$	2	2	1	2528.3	603.43
$\mathcal{L}_{567}$	8	$C_2^{ix},\ T_2^{iv}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2}')$	3	1	2	2313.6	566.86
$\mathcal{L}_{568}$	10	$C_2^{ix},\ T_3^{iv}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2}')$	0	4	1	894.72	548.97
$\mathcal{L}_{569}$	10	$C_2^{ix},\ T_4^{iv}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2}')$	1	3	2	253.16	547.84
$\mathcal{L}_{570}$	10	$C_2^{ix},\ T_5^{iv}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2}')$	4	0	3	633.14	565.62
$\mathcal{L}_{571}$	10	$C_3^{ix},\ T_1^{iii}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2})$	6	0	1	1107.9	1688.6
$\mathcal{L}_{572}$	10	$C_3^{ix},\ T_2^{iii}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2})$	7	-1	2	823.66	544.89
$\mathcal{L}_{573}$	12	$C_3^{ix},\ T_3^{iii}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2})$	4	2	1	3.1642 ★	9.4269×10^{-6} ★
$\mathcal{L}_{574}$	12	$C_3^{ix},\ T_4^{iii}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2})$	5	1	2	0.000071568 ★	1.338×10^{-6} ★
$\mathcal{L}_{575}$	12	$C_3^{ix},\ T_5^{iii}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2})$	8	-2	3	631.23	566.27
$\mathcal{L}_{576}$	10	$C_3^{ix},\ T_1^{iv}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2}')$	4	2	1	1183.7	526.27
$\mathcal{L}_{577}$	10	$C_3^{ix},\ T_2^{iv}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2}')$	5	1	2	633.21	18.676 ☆
$\mathcal{L}_{578}$	12	$C_3^{ix},\ T_3^{iv}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2}')$	2	4	1	419.77	6.4264×10^{-6} ★
$\mathcal{L}_{579}$	12	$C_3^{ix},\ T_4^{iv}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2}')$	3	3	2	63.734	7.0782×10^{-6} ★
$\mathcal{L}_{580}$	12	$C_3^{ix},\ T_5^{iv}$	$(\mathbf{3},\ \mathbf{3}',\ \mathbf{2}')$	6	0	3	385.91	3.0992×10^{-7} ★
$\mathcal{L}_{581}$	6	$C_1^{x},\ T_1^{iii}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{2})$	2	0	1	2.4404×10^6	2.7688×10^6
$\mathcal{L}_{582}$	6	$C_1^{x},\ T_2^{iii}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{2})$	3	-1	2	2.4407×10^6	2.609×10^6
$\mathcal{L}_{583}$	8	$C_1^{x},\ T_3^{iii}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{2})$	0	2	1	2.4395×10^6	2.4382×10^6
$\mathcal{L}_{584}$	8	$C_1^{x},\ T_4^{iii}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{2})$	1	1	2	2.4395×10^6	2.4393×10^6
$\mathcal{L}_{585}$	8	$C_1^{x},\ T_5^{iii}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{2})$	4	-2	3	2.4425×10^6	2.5455×10^6
$\mathcal{L}_{586}$	6	$C_1^{x},\ T_1^{iv}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{2}')$	0	2	1	2.4409×10^6	2.5713×10^6

$\mathcal{L}_{587}$	6	$C_1^x,\ T_2^{iv}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{2}')$	1	1	2	2.4408×10^6	2.5503×10^6
$\mathcal{L}_{588}$	8	$C_1^x,\ T_3^{iv}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{2}')$	-2	4	1	2.4396×10^6	2.4383×10^6
$\mathcal{L}_{589}$	8	$C_1^x,\ T_4^{iv}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{2}')$	-1	3	2	2.4396×10^6	2.4393×10^6
$\mathcal{L}_{590}$	8	$C_1^x,\ T_5^{iv}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{2}')$	2	0	3	2.4396×10^6	2.4393×10^6
$\mathcal{L}_{591}$	10	$C_2^x,\ T_1^{iii}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{2})$	4	0	1	1254.7	3480.4
$\mathcal{L}_{592}$	10	$C_2^x,\ T_2^{iii}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{2})$	5	-1	2	2445.9	4652.5
$\mathcal{L}_{593}$	12	$C_2^x,\ T_3^{iii}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{2})$	2	2	1	780.06	1.4494 ★
$\mathcal{L}_{594}$	12	$C_2^x,\ T_4^{iii}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{2})$	3	1	2	657.74	1.8528 ★
$\mathcal{L}_{595}$	12	$C_2^x,\ T_5^{iii}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{2})$	6	-2	3	352.33	332.56
$\mathcal{L}_{596}$	10	$C_2^x,\ T_1^{iv}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{2}')$	2	2	1	1394.7	811.01
$\mathcal{L}_{597}$	10	$C_2^x,\ T_2^{iv}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{2}')$	3	1	2	2443.3	533.21
$\mathcal{L}_{598}$	12	$C_2^x,\ T_3^{iv}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{2}')$	0	4	1	507.02	2.2044 ★
$\mathcal{L}_{599}$	12	$C_2^x,\ T_4^{iv}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{2}')$	1	3	2	656.56	4.8755 ★
$\mathcal{L}_{600}$	12	$C_2^x,\ T_5^{iv}$	$(\mathbf{3}',\ \mathbf{3}',\ \mathbf{2}')$	4	0	3	365.3	337.42
$\mathcal{L}_{601}$	8	$C_1^i,\ W_1^i$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3},\ -)$	$1,3,5$	1	–	1793.6	497.52
$\mathcal{L}_{602}$	12	$C_1^i,\ W_2^i$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3},\ -)$	$0,2,4$	2	–	8.2969×10^{-8} ★	2.9786×10^{-7} ★
$\mathcal{L}_{603}$	12	$C_1^i,\ W_3^i$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3},\ -)$	$-1,1,3$	3	–	4.5597×10^{-9} ★	1.2025×10^{-7} ★
$\mathcal{L}_{604}$	8	$C_1^{ii},\ W_1^{ii}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$1,3,5$	1	–	1926.1	540.66
$\mathcal{L}_{605}$	12	$C_1^{ii},\ W_2^{ii}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$0,2,4$	2	–	4.3831×10^{-8} ★	1.034×10^{-6} ★
$\mathcal{L}_{606}$	12	$C_1^{ii},\ W_3^{ii}$	$(\mathbf{1}\oplus\mathbf{1}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$-1,1,3$	3	–	5.9865×10^{-8} ★	1.6773×10^{-7} ★
$\mathcal{L}_{607}$	5	$C_1^{iii},\ W_1^i$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ -)$	$2,1$	1	–	14926.	553780.
$\mathcal{L}_{608}$	9	$C_1^{iii},\ W_2^i$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ -)$	$1,0$	2	–	13891.	13889.
$\mathcal{L}_{609}$	9	$C_1^{iii},\ W_3^i$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ -)$	$0,-1$	3	–	13891.	13891.
$\mathcal{L}_{610}$	5	$C_2^{iii},\ W_1^i$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ -)$	$2,3$	1	–	14923.	382030.
$\mathcal{L}_{611}$	9	$C_2^{iii},\ W_2^i$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ -)$	$1,2$	2	–	14263.	14287.
$\mathcal{L}_{612}$	9	$C_2^{iii},\ W_3^i$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ -)$	$0,1$	3	–	14323.	13892.
$\mathcal{L}_{613}$	7	$C_3^{iii},\ W_1^i$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ -)$	$4,1$	1	–	501.26	766.07
$\mathcal{L}_{614}$	11	$C_3^{iii},\ W_2^i$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ -)$	$3,0$	2	–	2.168×10^{-8} ★	7.0231×10^{-7} ★
$\mathcal{L}_{615}$	11	$C_3^{iii},\ W_3^i$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ -)$	$2,-1$	3	–	0.06423 ★	3.7879×10^{-6} ★
$\mathcal{L}_{616}$	7	$C_4^{iii},\ W_1^i$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ -)$	$4,3$	1	–	14783.	382030.
$\mathcal{L}_{617}$	11	$C_4^{iii},\ W_2^i$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ -)$	$3,2$	2	–	13926.	13899.
$\mathcal{L}_{618}$	11	$C_4^{iii},\ W_3^i$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ -)$	$2,1$	3	–	13898.	13893.
$\mathcal{L}_{619}$	7	$C_5^{iii},\ W_1^i$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ -)$	$2,5$	1	–	16904.	17671.
$\mathcal{L}_{620}$	11	$C_5^{iii},\ W_2^i$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ -)$	$1,4$	2	–	14960.	14720.
$\mathcal{L}_{621}$	11	$C_5^{iii},\ W_3^i$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ -)$	$0,3$	3	–	14922.	16430.
$\mathcal{L}_{622}$	9	$C_6^{iii},\ W_1^i$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ -)$	$4,5$	1	–	603.11	540.77
$\mathcal{L}_{623}$	13	$C_6^{iii},\ W_2^i$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ -)$	$3,4$	2	–	4.7758×10^{-6} ★	1.584×10^{-7} ★
$\mathcal{L}_{624}$	13	$C_6^{iii},\ W_3^i$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3},\ -)$	$2,3$	3	–	8.0053×10^{-7} ★	7.7523×10^{-7} ★
$\mathcal{L}_{625}$	5	$C_1^{iv},\ W_1^i$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ -)$	$0,1$	1	–	643700.	2477.7
$\mathcal{L}_{626}$	9	$C_1^{iv},\ W_2^i$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ -)$	$-1,0$	2	–	903.82	1708.1
$\mathcal{L}_{627}$	9	$C_1^{iv},\ W_3^i$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ -)$	$-2,-1$	3	–	277.89	335.84
$\mathcal{L}_{628}$	5	$C_2^{iv},\ W_1^i$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ -)$	$0,3$	1	–	20077.	36162.
$\mathcal{L}_{629}$	9	$C_2^{iv},\ W_2^i$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ -)$	$-1,2$	2	–	1345.	737.69
$\mathcal{L}_{630}$	9	$C_2^{iv},\ W_3^i$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ -)$	$-2,1$	3	–	18002.	249.64
$\mathcal{L}_{631}$	7	$C_3^{iv},\ W_1^i$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ -)$	$2,1$	1	–	1137.9	683.35
$\mathcal{L}_{632}$	11	$C_3^{iv},\ W_2^i$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ -)$	$1,0$	2	–	6.7733×10^{-7} ★	2.9602×10^{-7} ★
$\mathcal{L}_{633}$	11	$C_3^{iv},\ W_3^i$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ -)$	$0,-1$	3	–	2.539×10^{-6} ★	9.3844×10^{-7} ★
$\mathcal{L}_{634}$	7	$C_4^{iv},\ W_1^i$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ -)$	$2,3$	1	–	1131.7	538.58
$\mathcal{L}_{635}$	11	$C_4^{iv},\ W_2^i$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ -)$	$1,2$	2	–	9.203×10^{-6} ★	7.9597×10^{-6} ★
$\mathcal{L}_{636}$	11	$C_4^{iv},\ W_3^i$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ -)$	$0,1$	3	–	2.0268×10^{-6} ★	4.9713×10^{-6} ★

$\mathcal{L}_{637}$	7	$C_5^{iv},\ W_1^i$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ -)$	$0,5$	1	–	17691.	1908.6
$\mathcal{L}_{638}$	11	$C_5^{iv},\ W_2^i$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ -)$	$-1,4$	2	–	8.4048×10^{-7} ★	0.00014465 ★
$\mathcal{L}_{639}$	11	$C_5^{iv},\ W_3^i$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ -)$	$-2,3$	3	–	4.3825×10^{-7} ★	4.0431×10^{-6} ★
$\mathcal{L}_{640}$	9	$C_6^{iv},\ W_1^i$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ -)$	$4,1$	1	–	804.22	6.2024×10^{-6} ★
$\mathcal{L}_{641}$	13	$C_6^{iv},\ W_2^i$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ -)$	$3,0$	2	–	1.433×10^{-6} ★	4.3132×10^{-6} ★
$\mathcal{L}_{642}$	13	$C_6^{iv},\ W_3^i$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ -)$	$2,-1$	3	–	2.3067×10^{-8} ★	1.1938×10^{-7} ★
$\mathcal{L}_{643}$	9	$C_7^{iv},\ W_1^i$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ -)$	$2,5$	1	–	916.23	523.86
$\mathcal{L}_{644}$	13	$C_7^{iv},\ W_2^i$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ -)$	$1,4$	2	–	3.4225×10^{-7} ★	1.5807×10^{-6} ★
$\mathcal{L}_{645}$	13	$C_7^{iv},\ W_3^i$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ -)$	$0,3$	3	–	5.9604×10^{-6} ★	8.5215×10^{-7} ★
$\mathcal{L}_{646}$	9	$C_8^{iv},\ W_1^i$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ -)$	$4,3$	1	–	708.63	6.315×10^{-6} ★
$\mathcal{L}_{647}$	13	$C_8^{iv},\ W_2^i$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ -)$	$3,2$	2	–	6.7924×10^{-6} ★	5.3925×10^{-7} ★
$\mathcal{L}_{648}$	13	$C_8^{iv},\ W_3^i$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3},\ -)$	$2,1$	3	–	7.5352×10^{-8} ★	2.0431×10^{-7} ★
$\mathcal{L}_{649}$	5	$C_1^{v},\ W_1^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$0,1$	1	–	2.0198×10^{6}	993620.
$\mathcal{L}_{650}$	9	$C_1^{v},\ W_2^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$-1,0$	2	–	904.74	1039.4
$\mathcal{L}_{651}$	9	$C_1^{v},\ W_3^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$-2,-1$	3	–	852.89	825.4
$\mathcal{L}_{652}$	5	$C_2^{v},\ W_1^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$0,3$	1	–	20947.	261710.
$\mathcal{L}_{653}$	9	$C_2^{v},\ W_2^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$-1,2$	2	–	688.88	221.94
$\mathcal{L}_{654}$	9	$C_2^{v},\ W_3^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$-2,1$	3	–	7.8802 ★	105.8
$\mathcal{L}_{655}$	7	$C_3^{v},\ W_1^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$2,1$	1	–	1374.	8795.8
$\mathcal{L}_{656}$	11	$C_3^{v},\ W_2^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$1,0$	2	–	1.3986×10^{-6} ★	2.6253×10^{-6} ★
$\mathcal{L}_{657}$	11	$C_3^{v},\ W_3^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$0,-1$	3	–	3.7538×10^{-8} ★	5.6406×10^{-7} ★
$\mathcal{L}_{658}$	7	$C_4^{v},\ W_1^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$2,3$	1	–	1375.3	1091.2
$\mathcal{L}_{659}$	11	$C_4^{v},\ W_2^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$1,2$	2	–	7.8693×10^{-7} ★	2.5969×10^{-6} ★
$\mathcal{L}_{660}$	11	$C_4^{v},\ W_3^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$0,1$	3	–	5.6216×10^{-7} ★	4.1554×10^{-7} ★
$\mathcal{L}_{661}$	7	$C_5^{v},\ W_1^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$0,5$	1	–	20809.	189640.
$\mathcal{L}_{662}$	11	$C_5^{v},\ W_2^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$-1,4$	2	–	79.493	784.6
$\mathcal{L}_{663}$	11	$C_5^{v},\ W_3^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$-2,3$	3	–	1501.4	1083.
$\mathcal{L}_{664}$	9	$C_6^{v},\ W_1^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$4,1$	1	–	793.2	0.40969 ★
$\mathcal{L}_{665}$	13	$C_6^{v},\ W_2^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$3,0$	2	–	1.0203×10^{-6} ★	4.9244×10^{-7} ★
$\mathcal{L}_{666}$	13	$C_6^{v},\ W_3^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$2,-1$	3	–	3.0222×10^{-8} ★	1.6573×10^{-7} ★
$\mathcal{L}_{667}$	9	$C_7^{v},\ W_1^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$2,5$	1	–	726.64	511.71
$\mathcal{L}_{668}$	13	$C_7^{v},\ W_2^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$1,4$	2	–	1.0471×10^{-6} ★	0.00054006 ★
$\mathcal{L}_{669}$	13	$C_7^{v},\ W_3^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$0,3$	3	–	3.0553×10^{-7} ★	3.1028×10^{-6} ★
$\mathcal{L}_{670}$	9	$C_8^{v},\ W_1^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$4,3$	1	–	790.94	0.41065 ★
$\mathcal{L}_{671}$	13	$C_8^{v},\ W_2^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$3,2$	2	–	1.3029×10^{-6} ★	1.487×10^{-6} ★
$\mathcal{L}_{672}$	13	$C_8^{v},\ W_3^{ii}$	$(\mathbf{2}\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$2,1$	3	–	7.5059×10^{-7} ★	6.5796×10^{-8} ★
$\mathcal{L}_{673}$	5	$C_1^{vi},\ W_1^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$2,1$	1	–	16027.	29609.
$\mathcal{L}_{674}$	9	$C_1^{vi},\ W_2^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$1,0$	2	–	13992.	14653.
$\mathcal{L}_{675}$	9	$C_1^{vi},\ W_3^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$0,-1$	3	–	13889.	13906.
$\mathcal{L}_{676}$	5	$C_2^{vi},\ W_1^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$2,3$	1	–	16141.	29781.
$\mathcal{L}_{677}$	9	$C_2^{vi},\ W_2^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$1,2$	2	–	13889.	14579.
$\mathcal{L}_{678}$	9	$C_2^{vi},\ W_3^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$0,1$	3	–	13945.	14328.
$\mathcal{L}_{679}$	7	$C_3^{vi},\ W_1^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$4,1$	1	–	2048.9	15589.
$\mathcal{L}_{680}$	11	$C_3^{vi},\ W_2^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$3,0$	2	–	1.6387×10^{-6} ★	7.216×10^{-6} ★
$\mathcal{L}_{681}$	11	$C_3^{vi},\ W_3^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$2,-1$	3	–	1.186×10^{-7} ★	7.3538×10^{-8} ★
$\mathcal{L}_{682}$	7	$C_4^{vi},\ W_1^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$4,3$	1	–	15953.	14457.
$\mathcal{L}_{683}$	11	$C_4^{vi},\ W_2^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$3,2$	2	–	13893.	13889.
$\mathcal{L}_{684}$	11	$C_4^{vi},\ W_3^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$2,1$	3	–	13889.	13890.
$\mathcal{L}_{685}$	7	$C_5^{vi},\ W_1^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$2,5$	1	–	2127.3	15123.
$\mathcal{L}_{686}$	11	$C_5^{vi},\ W_2^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$1,4$	2	–	2.3472×10^{-6} ★	1168.7

$\mathcal{L}_{687}$	11	$C_5^{vi},\ W_3^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$0,3$	3	–	3.806×10^{-7} ★	1.5723×10^{-7} ★
$\mathcal{L}_{688}$	9	$C_6^{vi},\ W_1^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$4,5$	1	–	1571.1	547.18
$\mathcal{L}_{689}$	13	$C_6^{vi},\ W_2^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$3,4$	2	–	2.2998×10^{-7} ★	5.5402×10^{-6} ★
$\mathcal{L}_{690}$	13	$C_6^{vi},\ W_3^{ii}$	$(\mathbf{2}'\oplus\mathbf{1},\ \mathbf{3}',\ -)$	$2,3$	3	–	3.5309×10^{-8} ★	1.2902×10^{-7} ★
$\mathcal{L}_{691}$	6	$C_1^{vii},\ W_1^{i}$	$(\mathbf{3},\ \mathbf{3},\ -)$	1	1	–	446650.	252810.
$\mathcal{L}_{692}$	10	$C_1^{vii},\ W_2^{i}$	$(\mathbf{3},\ \mathbf{3},\ -)$	0	2	–	45685.	45686.
$\mathcal{L}_{693}$	10	$C_1^{vii},\ W_3^{i}$	$(\mathbf{3},\ \mathbf{3},\ -)$	-1	3	–	45714.	45972.
$\mathcal{L}_{694}$	10	$C_2^{vii},\ W_1^{i}$	$(\mathbf{3},\ \mathbf{3},\ -)$	3	1	–	1333.3	88.846
$\mathcal{L}_{695}$	14	$C_2^{vii},\ W_2^{i}$	$(\mathbf{3},\ \mathbf{3},\ -)$	2	2	–	9.5573×10^{-6} ★	0.000023496 ★
$\mathcal{L}_{696}$	14	$C_2^{vii},\ W_3^{i}$	$(\mathbf{3},\ \mathbf{3},\ -)$	1	3	–	0.0022952 ★	0.00096709 ★
$\mathcal{L}_{697}$	4	$C_1^{viii},\ W_1^{i}$	$(\mathbf{3}',\ \mathbf{3},\ -)$	1	1	–	15281.	964190.
$\mathcal{L}_{698}$	8	$C_1^{viii},\ W_2^{i}$	$(\mathbf{3}',\ \mathbf{3},\ -)$	0	2	–	14869.	14906.
$\mathcal{L}_{699}$	8	$C_1^{viii},\ W_3^{i}$	$(\mathbf{3}',\ \mathbf{3},\ -)$	-1	3	–	14855.	14906.
$\mathcal{L}_{700}$	8	$C_2^{viii},\ W_1^{i}$	$(\mathbf{3}',\ \mathbf{3},\ -)$	3	1	–	959.87	549.46
$\mathcal{L}_{701}$	12	$C_2^{viii},\ W_2^{i}$	$(\mathbf{3}',\ \mathbf{3},\ -)$	2	2	–	4.6402 ★	0.000023064 ★
$\mathcal{L}_{702}$	12	$C_2^{viii},\ W_3^{i}$	$(\mathbf{3}',\ \mathbf{3},\ -)$	1	3	–	7.4548×10^{-6} ★	9.5782×10^{-7} ★
$\mathcal{L}_{703}$	10	$C_3^{viii},\ W_1^{i}$	$(\mathbf{3}',\ \mathbf{3},\ -)$	5	1	–	858.55	492.5
$\mathcal{L}_{704}$	14	$C_3^{viii},\ W_2^{i}$	$(\mathbf{3}',\ \mathbf{3},\ -)$	4	2	–	6.4208×10^{-8} ★	3.6295×10^{-6} ★
$\mathcal{L}_{705}$	14	$C_3^{viii},\ W_3^{i}$	$(\mathbf{3}',\ \mathbf{3},\ -)$	3	3	–	2.1561×10^{-6} ★	3.2065×10^{-6} ★
$\mathcal{L}_{706}$	4	$C_1^{ix},\ W_1^{ii}$	$(\mathbf{3},\ \mathbf{3}',\ -)$	1	1	–	20607.	540020.
$\mathcal{L}_{707}$	8	$C_1^{ix},\ W_2^{ii}$	$(\mathbf{3},\ \mathbf{3}',\ -)$	0	2	–	14681.	14844.
$\mathcal{L}_{708}$	8	$C_1^{ix},\ W_3^{ii}$	$(\mathbf{3},\ \mathbf{3}',\ -)$	-1	3	–	14677.	14761.
$\mathcal{L}_{709}$	8	$C_2^{ix},\ W_1^{ii}$	$(\mathbf{3},\ \mathbf{3}',\ -)$	3	1	–	2169.1	15652.
$\mathcal{L}_{710}$	12	$C_2^{ix},\ W_2^{ii}$	$(\mathbf{3},\ \mathbf{3}',\ -)$	2	2	–	9.0072×10^{-7} ★	1.5691×10^{-6} ★
$\mathcal{L}_{711}$	12	$C_2^{ix},\ W_3^{ii}$	$(\mathbf{3},\ \mathbf{3}',\ -)$	1	3	–	3.2782×10^{-6} ★	0.011709 ★
$\mathcal{L}_{712}$	10	$C_3^{ix},\ W_1^{ii}$	$(\mathbf{3},\ \mathbf{3}',\ -)$	5	1	–	882.55	0.00473 ★
$\mathcal{L}_{713}$	14	$C_3^{ix},\ W_2^{ii}$	$(\mathbf{3},\ \mathbf{3}',\ -)$	4	2	–	3.7776×10^{-7} ★	1.0746×10^{-7} ★
$\mathcal{L}_{714}$	14	$C_3^{ix},\ W_3^{ii}$	$(\mathbf{3},\ \mathbf{3}',\ -)$	3	3	–	1.5696×10^{-7} ★	5.6074×10^{-6} ★
$\mathcal{L}_{715}$	6	$C_1^{x},\ W_1^{ii}$	$(\mathbf{3}',\ \mathbf{3}',\ -)$	1	1	–	2.4403×10^{6}	2.609×10^{6}
$\mathcal{L}_{716}$	10	$C_1^{x},\ W_2^{ii}$	$(\mathbf{3}',\ \mathbf{3}',\ -)$	0	2	–	2.4373×10^{6}	2.438×10^{6}
$\mathcal{L}_{717}$	10	$C_1^{x},\ W_3^{ii}$	$(\mathbf{3}',\ \mathbf{3}',\ -)$	-1	3	–	2.4374×10^{6}	2.4382×10^{6}
$\mathcal{L}_{718}$	10	$C_2^{x},\ W_1^{ii}$	$(\mathbf{3}',\ \mathbf{3}',\ -)$	3	1	–	921.86	155.46
$\mathcal{L}_{719}$	14	$C_2^{x},\ W_2^{ii}$	$(\mathbf{3}',\ \mathbf{3}',\ -)$	2	2	–	0.000011234 ★	0.000048871 ★
$\mathcal{L}_{720}$	14	$C_2^{x},\ W_3^{ii}$	$(\mathbf{3}',\ \mathbf{3}',\ -)$	1	3	–	7.8338×10^{-6} ★	0.000037615 ★

Table 3: All models generated by combinations of charged lepton sector and neutrino sector. We have list the number of parameters involved in each model in the second column. The combinations between charged lepton sector and neutrino sector are given in the third column. At the following columns, we have given the representation assignments, weights, and best fit values of χ^2 respectively. If the $\chi^2_{\rm min}$ is marked with ★, then the model can accommodate the experimental data within 3σ limits, if it is marked with ☆, then the best fit values of observables slightly deviate the 3σ limits, for other cases, the experimental data can not be explained by the corresponding model.

2 Quark Sector

In the quark sector, we tried the same representation assignments in the lepton sector as given in table 4 for $\rho_Q, \rho_{U^c}/\rho_{D^c}$, but the experimentally favored data can not be produced by these models. Considering the Cabibbo mixing pattern as an approximation of CKM matrix, we further consider the assignment $\mathbf{2}\oplus\mathbf{1}$ or $\mathbf{2}'\oplus\mathbf{1}$ for both ρ_Q and ρ_{U^c}/ρ_{D^c}. In table 4, we list the possible representations assignments for quark fields, and the numbers of models. As what we have done in the charged lepton sector, we can write out the superpotential and the corresponding quark mass matrix for each possible model. Due to the large number of models, we don't provide all the relevant details here, and we only show the models that are in good agreement with the experiments like $\mathcal{Q}_{1\ldots4}$ (see text below), all other models can be constructed in a similar fashion. Through the combination of the up quark and down quark sectors, we have obtained 664 models with 9 parameters, 892 models with 11 parameters and 358 models with 13 parameters. We cannot construct a model with 10 or 12 parameters since the real parameters increase in pair when we add more complex parameters. After the numerical fitting, we find that the models with 9 parameters cannot explain the experimental data of quarks, while four models with 11 parameters and 18 models with 13 parameters can explain the experimental results well.

	G^{i}	G^{ii}	G^{iii}	G^{iv}
ρ_Q	$\mathbf{2}\oplus\mathbf{1}$	$\mathbf{2}\oplus\mathbf{1}$	$\mathbf{2}'\oplus\mathbf{1}$	$\mathbf{2}'\oplus\mathbf{1}$
ρ_{U^c}/ρ_{D^c}	$\mathbf{2}\oplus\mathbf{1}$	$\mathbf{2}'\oplus\mathbf{1}$	$\mathbf{2}\oplus\mathbf{1}$	$\mathbf{2}'\oplus\mathbf{1}$
# of models (total number)	30 (46)	21 (26)	21 (26)	30 (46)

Table 4: The number (in bracket) of possible quark models for different representation assignments of Q and ρ_{U^c}/ρ_{D^c} under the finite modular group A_5' up to weight 6 modular forms, where the case without modular forms is not counted. We also list the number (without bracket) of models which contain three or four independent terms in the quark superpotential $\mathcal{W}_{u,d}$.

The four models $\mathcal{Q}_{1\ldots4}$ with 11 parameters are given as follows

$$\mathcal{Q}_1 \sim \langle G_1^{i}, G_1^{ii}\rangle$$

$$G_1^{i}\colon k_{Q_D}=k_{Q_3}+5,\, k_{U_D}=-k_{Q_3}-3,\, k_{U_3}=-k_{Q_3}$$

$$W_u=\alpha_u\left(Y_{\mathbf{3}}^{(2)}U_D^cQ_DH_u\right)_{\mathbf{1}}+\beta_u\left(Y_{\mathbf{2}}^{(5)}U_3^cQ_DH_u\right)_{\mathbf{1}}+\gamma_u\left(U_3^cQ_3H_u\right)_{\mathbf{1}}$$

$$M_u=\begin{pmatrix}-\sqrt{2}\alpha_uY_{\mathbf{3},2}^{(2)} & -\alpha_uY_{\mathbf{3},1}^{(2)} & 0\\ -\alpha_uY_{\mathbf{3},1}^{(2)} & \sqrt{2}\alpha_uY_{\mathbf{3},3}^{(2)} & 0\\ -\beta_uY_{\mathbf{2},2}^{(5)} & \beta_uY_{\mathbf{2},1}^{(5)} & \gamma_u\end{pmatrix}v_u$$

$$G_1^{ii}\colon k_{Q_D}=k_{Q_3}+5,\, k_{D_3}=-k_{Q_3},\, k_{D_D}=1-k_{Q_3}$$

$$W_d=\alpha_d\left(Y_{\mathbf{4}I}^{(6)}D_D^cQ_DH_d\right)_{\mathbf{1}}+\beta_d\left(Y_{\mathbf{4}II}^{(6)}D_D^cQ_DH_d\right)_{\mathbf{1}}+\gamma_d\left(Y_{\mathbf{2}}^{(5)}D_3^cQ_DH_d\right)_{\mathbf{1}}+\delta_d\left(D_3^cQ_3H_d\right)_{\mathbf{1}}$$

$$M_d=\begin{pmatrix}-\alpha_dY_{\mathbf{4}I,2}^{(6)}-\beta_dY_{\mathbf{4}II,2}^{(6)} & \alpha_dY_{\mathbf{4}I,1}^{(6)}+\beta_dY_{\mathbf{4}II,1}^{(6)} & 0\\ \alpha_dY_{\mathbf{4}I,4}^{(6)}+\beta_dY_{\mathbf{4}II,4}^{(6)} & \alpha_dY_{\mathbf{4}I,3}^{(6)}+\beta_dY_{\mathbf{4}II,3}^{(6)} & 0\\ -\gamma_dY_{\mathbf{2},2}^{(5)} & \gamma_dY_{\mathbf{2},1}^{(5)} & \delta_d\end{pmatrix}v_d$$

$\mathcal{Q}_2 \sim \langle G_2^{i}, G_2^{ii} \rangle$
G_2^{i}: $k_{Q_D} = k_{Q_3}+1, k_{U_3} = 4-k_{Q_3}, k_{U_D} = 1-k_{Q_3}$ $W_u = \alpha_u \left(Y_{\mathbf{3}}^{(2)} U_D^c Q_D H_u\right)_{\mathbf{1}} + \beta_u \left(Y_{\mathbf{2}}^{(5)} U_3^c Q_D H_u\right)_{\mathbf{1}} + \gamma_u \left(Y_{\mathbf{1}}^{(4)} U_3^c Q_3 H_u\right)_{\mathbf{1}}$ $M_u = \begin{pmatrix} -\sqrt{2}\alpha_u Y_{\mathbf{3},2}^{(2)} & -\alpha_u Y_{\mathbf{3},1}^{(2)} & 0 \\ -\alpha_u Y_{\mathbf{3},1}^{(2)} & \sqrt{2}\alpha_u Y_{\mathbf{3},3}^{(2)} & 0 \\ -\beta_u Y_{\mathbf{2},2}^{(5)} & \beta_u Y_{\mathbf{2},1}^{(5)} & \gamma_u Y_{\mathbf{1},1}^{(4)} \end{pmatrix} v_u$
G_2^{ii}: $k_{Q_D} = k_{Q_3}+1, k_{D_3} = 4-k_{Q_3}, k_{D_D} = 5-k_{Q_3}$ $W_d = \alpha_d \left(Y_{\mathbf{4}I}^{(6)} D_D^c Q_D H_d\right)_{\mathbf{1}} + \beta_d \left(Y_{\mathbf{4}II}^{(6)} D_D^c Q_D H_d\right)_{\mathbf{1}} + \gamma_d \left(Y_{\mathbf{2}}^{(5)} D_3^c Q_D H_d\right)_{\mathbf{1}} + \delta_d \left(Y_{\mathbf{1}}^{(4)} D_3^c Q_3 H_d\right)_{\mathbf{1}}$ $M_d = \begin{pmatrix} -\alpha_d Y_{\mathbf{4}I,2}^{(6)} - \beta_d Y_{\mathbf{4}II,2}^{(6)} & \alpha_d Y_{\mathbf{4}I,1}^{(6)} + \beta_d Y_{\mathbf{4}II,1}^{(6)} & 0 \\ \alpha_d Y_{\mathbf{4}I,4}^{(6)} + \beta_d Y_{\mathbf{4}II,4}^{(6)} & \alpha_d Y_{\mathbf{4}I,3}^{(6)} + \beta_d Y_{\mathbf{4}II,3}^{(6)} & 0 \\ -\gamma_d Y_{\mathbf{2},2}^{(5)} & \gamma_d Y_{\mathbf{2},1}^{(5)} & \delta_d Y_{\mathbf{1},1}^{(4)} \end{pmatrix} v_d$

$\mathcal{Q}_3 \sim \langle G_1^{iv}, G_2^{iv} \rangle$
G_1^{iv}: $k_{Q_D} = k_{Q_3}+5, k_{U_D} = -k_{Q_3}-3, k_{U_3} = -k_{Q_3}$ $W_u = \alpha_u \left(Y_{\mathbf{3'}}^{(2)} U_D^c Q_D H_u\right)_{\mathbf{1}} + \beta_u \left(Y_{\mathbf{2'}}^{(5)} U_3^c Q_D H_u\right)_{\mathbf{1}} + \gamma_u \left(U_3^c Q_3 H_u\right)_{\mathbf{1}}$ $M_u = \begin{pmatrix} -\sqrt{2}\alpha_u Y_{\mathbf{3'},3}^{(2)} & \alpha_u Y_{\mathbf{3'},1}^{(2)} & 0 \\ \alpha_u Y_{\mathbf{3'},1}^{(2)} & \sqrt{2}\alpha_u Y_{\mathbf{3'},2}^{(2)} & 0 \\ -\beta_u Y_{\mathbf{2'},2}^{(5)} & \beta_u Y_{\mathbf{2'},1}^{(5)} & \gamma_u \end{pmatrix} v_u$
G_2^{iv}: $k_{Q_D} = k_{Q_3}+5, k_{D_D} = -k_{Q_3}-1, k_{D_3} = -k_{Q_3}$ $W_d = \alpha_d \left(Y_{\mathbf{1}}^{(4)} D_D^c Q_D H_d\right)_{\mathbf{1}} + \beta_d \left(Y_{\mathbf{3'}}^{(4)} D_D^c Q_D H_d\right)_{\mathbf{1}} + \gamma_d \left(Y_{\mathbf{2'}}^{(5)} D_3^c Q_D H_d\right)_{\mathbf{1}} + \delta_d \left(D_3^c Q_3 H_d\right)_{\mathbf{1}}$ $M_d = \begin{pmatrix} -\sqrt{2}\beta_d Y_{\mathbf{3'},3}^{(4)} & \beta_d Y_{\mathbf{3'},1}^{(4)} - \alpha_d Y_{\mathbf{1},1}^{(4)} & 0 \\ \alpha_d Y_{\mathbf{1},1}^{(4)} + \beta_d Y_{\mathbf{3'},1}^{(4)} & \sqrt{2}\beta_d Y_{\mathbf{3'},2}^{(4)} & 0 \\ -\gamma_d Y_{\mathbf{2'},2}^{(5)} & \gamma_d Y_{\mathbf{2'},1}^{(5)} & \delta_d \end{pmatrix} v_d$

$\mathcal{Q}_4 \sim \langle G_3^{iv}, G_4^{iv} \rangle$
G_3^{iv}: $k_{Q_D} = 1+k_{Q_3}, k_{U_D} = 1-k_{Q_3}, k_{U_3} = 4-k_{Q_3}$ $W_u = \alpha_u \left(Y_{\mathbf{3'}}^{(2)} U_D^c Q_D H_u\right)_{\mathbf{1}} + \beta_u \left(Y_{\mathbf{2'}}^{(5)} U_3^c Q_D H_u\right)_{\mathbf{1}} + \gamma_u \left(Y_{\mathbf{1}}^{(4)} U_3^c Q_3 H_u\right)_{\mathbf{1}}$ $M_u = \begin{pmatrix} -\sqrt{2}\alpha_u Y_{\mathbf{3'},3}^{(2)} & \alpha_u Y_{\mathbf{3'},1}^{(2)} & 0 \\ \alpha_u Y_{\mathbf{3'},1}^{(2)} & \sqrt{2}\alpha_u Y_{\mathbf{3'},2}^{(2)} & 0 \\ -\beta_u Y_{\mathbf{2'},2}^{(5)} & \beta_u Y_{\mathbf{2'},1}^{(5)} & \gamma_u Y_{\mathbf{1},1}^{(4)} \end{pmatrix} v_u$
G_4^{iv}: $k_{Q_D} = k_{Q_3}+1, k_{D_3} = 4-k_{Q_3}, k_{D_D} = 3-k_{Q_3}$ $W_d = \alpha_d \left(Y_{\mathbf{1}}^{(4)} D_D^c Q_D H_d\right)_{\mathbf{1}} + \beta_d \left(Y_{\mathbf{3'}}^{(4)} D_D^c Q_D H_d\right)_{\mathbf{1}} + \gamma_d \left(Y_{\mathbf{2'}}^{(5)} D_3^c Q_D H_d\right)_{\mathbf{1}} + \delta_d \left(Y_{\mathbf{1}}^{(4)} D_3^c Q_3 H_d\right)_{\mathbf{1}}$ $M_d = \begin{pmatrix} -\sqrt{2}\beta_d Y_{\mathbf{3'},3}^{(4)} & \beta_d Y_{\mathbf{3'},1}^{(4)} - \alpha_d Y_{\mathbf{1},1}^{(4)} & 0 \\ \alpha_d Y_{\mathbf{1},1}^{(4)} + \beta_d Y_{\mathbf{3'},1}^{(4)} & \sqrt{2}\beta_d Y_{\mathbf{3'},2}^{(4)} & 0 \\ -\gamma_d Y_{\mathbf{2'},2}^{(5)} & \gamma_d Y_{\mathbf{2'},1}^{(5)} & \delta_d Y_{\mathbf{1},1}^{(4)} \end{pmatrix} v_d$

Due to limited space, we will not give the results of models with 13 parameters. We can find from the above four models that $\mathcal{Q}_1$ is similar to $\mathcal{Q}_2$, and $\mathcal{Q}_3$ is similar to $\mathcal{Q}_4$. Their predictions of quark mass matrices M_u, M_d only differ in $(3,3)$ element, and this difference can be eliminated by redefining γ_u and δ_d. Therefore, each pair of the models will give the same predictions. So we only need to focus on the models $\mathcal{Q}_1$ and $\mathcal{Q}_3$. In this section, we present the numerical results of model $\mathcal{Q}_1$, the best fit results are given in table 5. We found that only $m_u/m_c = 0.003002$ slightly deviates from the experimental 1σ limit $[0.001327, 0.002530]$, but it is within 3σ limits.

The numerical results of $\mathcal{Q}_3$ is not shown here, because it can not only meet the experimental requirements of quark sector separately, but also interpret lepton and quark experimental data simultaneously under the unified framework of modular symmetry A'_5. We will show the results of $\mathcal{Q}_3$ in the next section when we present the unified model in table 6.

quark model $\mathcal{Q}_1$			
Input		Observable	
$\mathtt{Re}(\tau)$	-0.4973	θ^q_{13}	0.003464
$\mathtt{Im}(\tau)$	2.221	θ^q_{12}	0.2273
β_u/α_u	384.6	θ^q_{23}	0.04015
γ_u/α_u	7.438	δ^q/π	0.3870
$\lvert\beta_d/\alpha_d\rvert$	0.3804	m_u/GeV	0.0007407
$\lvert\delta_d/\alpha_d\rvert$	0.06164	m_c/GeV	0.2467
γ_d/α_d	1.207	m_t/GeV	87.46
$\arg(\beta_d/\alpha_d)/\pi$	-0.01782	m_d/GeV	0.0009206
$\arg(\delta_d/\alpha_d)/\pi$	-0.2672	m_s/GeV	0.01753
$\lvert\alpha_u v_u\rvert/\text{GeV}$	0.05121	m_b/GeV	0.9682
$\lvert\alpha_d v_d\rvert/\text{GeV}$	0.07099	χ^2_{min}	3.382

Table 5: Numerical results of the quark model $\mathcal{Q}_1$. On the left, the best fit values of the input parameters are given, on the right, we list the quark mixing parameters and predictions of quark masses, and χ^2_{min}.

3 Unified model of lepton and quark

A model that can explain lepton and quark experimental data simultaneously should explain them separately. Therefore, in order to construct a unified model of lepton and quark, we have selected the 25 NO models in table 3 that marked with ★ (currently, NO is more favored with the experimental data, for simplicity, we only consider this scenario). For quark sector, to find the minimal unified model, we only focus on two independent models $\mathcal{Q}_1$ and $\mathcal{Q}_3$ with 11 parameters as given in the previous section. By combining the lepton sector and the quark sector, we have obtained 50 unified models. We have performed a systematic numerical analysis of these models, and find that the unified models generated by lepton model with 9 parameters and quark model with 11 parameters cannot explain the experimental data. In the remaining models, we found that the model combination $\mathcal{L}_2$ and $\mathcal{Q}_3$ can well explain the experimental results. We show the best fit results of this unified model in table 6. We can find that both the lepton model and quark model can accommodate the experimental data within the 3σ limits.

best fit results of the unified model			
lepton model $\mathcal{L}_2$		quark model $\mathcal{Q}_3$	
input	value	input	value
β/α	24.5400	β_u/α_u	32.6296
γ/α	654.9320	γ_u/α_u	11.1981
$\lvert\delta/\alpha\rvert$	100.8429	$\lvert\beta_d/\alpha_d\rvert$	6.3229
$\arg(\delta/\alpha)/\pi$	1.3895	γ_d/α_d	1.7462
$\lvert g_2/g_1\rvert$	0.3818	$\lvert\delta_d/\alpha_d\rvert$	1.9895
$\arg(g_2/g_1)/\pi$	1.7542	$\arg(\beta_d/\alpha_d)/\pi$	0.0002176
$\lvert\alpha v_d\rvert$/MeV	0.04361	$\arg(\delta_d/\delta_d)/\pi$	1.7336
$(g_1^2 v_u^2/\Lambda)$/meV	1.0895	$\lvert\alpha_u v_u\rvert$/GeV	0.03432
lepton observable	value	$\lvert\alpha_d v_d\rvert$/GeV	0.002429
$\sin^2\theta_{13}$	0.02231	quark observable	value
$\sin^2\theta_{12}$	0.3019	θ^q_{13}	0.003498
$\sin^2\theta_{23}$	0.4570	θ^q_{12}	0.2276
δ_{CP}/π	1.1671	θ^q_{23}	0.04023
α_{21}/π	1.3593	δ^q/π	0.3843
α_{31}/π	0.4762	m_u/GeV	0.00005300
m_1/meV	77.2709	m_c/GeV	0.2467
m_2/meV	77.7495	m_t/GeV	87.4555
m_3/meV	92.1717	m_d/GeV	0.0005920
m_β/meV	77.7755	m_s/GeV	0.01712
$m_{\beta\beta}$/meV	48.9783	m_b/GeV	0.9682
$\chi^2_{\text{min,L}}$	33.9453	$\chi^2_{\text{min,Q}}$	15.2279

common input	value
$\texttt{Re}(\tau)$	0.5000
$\texttt{Im}(\tau)$	0.8944

Table 6: The best fit results of the unified model of $\mathcal{L}_2$ and $\mathcal{Q}_3$. The values of input parameters and predictions of observables are given in both lepton and quark sectors.