Leptogenesis constraints from flavour symmetry induced lepton mixing

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Outline

The paper

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Type I seesaw m_ν

$$\hat{m}_\nu = D\,(U_{TB}^T U_L)\,\hat{m}_D\,(U_R^\dagger\,V_R)\,\hat{M}_R^{-1}\,(V_R^T\,U_R^*)\,\hat{m}_D\,(U_L^T\,U_{TB})\,D$$

The notation

D diagonal (with the Majorana phases)
U_L, U_R diagonalize m_D
V_R diagonalizes M_R

General remarks on leptogenesis

The asymmetry

$$\epsilon_{N_\alpha} \propto \frac{\sum_{\beta\neq\alpha} \mathbb{I}\mathrm{m}\left[\left((m_D^{R\dagger}\, m_D^R)_{\beta\alpha}\right)^2\right]}{(m_D^{R\dagger} m_D^R)_{\alpha\alpha}}$$

$m_D^R \equiv m_D V_R$

Casas-Ibarra parametrisation

The R matrix

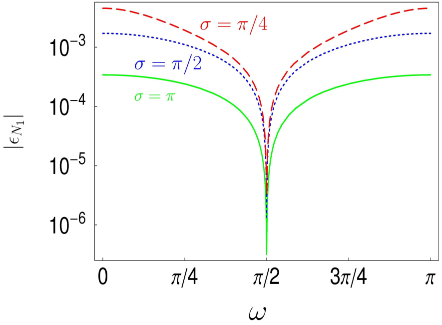
$$R^* = (\hat{m}_\nu)^{-1/2}\, U^T\, m_D^R\, (\hat{M}_R)^{-1/2}$$

The return of the asymmetry

$$\epsilon_{N_\alpha} \propto M_\alpha \frac{\mathbb{I}\mathrm{m}\left[\sum_j m_j^2 R_{j\alpha}^2\right]}{\sum_j m_j |R_{j\alpha}|^2}$$

Leptogenesis with exact mixing schemes

Possible to have TB (by chance) and leptogenesis



ω is an angle of the R matrix, has no connection with U.

Form-diagonalisable matrices

$$\hat{m}_\nu = D\,(U_{TB}^T U_L)\,\hat{m}_D\,(U_R^\dagger\, V_R)\,\hat{M}_R^{-1}\,(V_R^T U_R^*)\,\hat{m}_D\,(U_L^T\, U_{TB})\,D$$

No fine tuning

$$U_{TB}^T U_L = P_L\, O_{D_i} \quad \text{and} \quad U_R^\dagger\, V_R = O_{D_i}^\dagger\, P_R\, O_{R_m}$$

P_L, P_R are diagonal phase matrices
The O are orthogonal and interchange degenerate eigenvalues

Re-expressing

$$\hat{m}_\nu = D\,(U_{TB}^T U_L)\,\hat{m}_D\,(U_R^\dagger\, V_R)\,\hat{M}_R^{-1}\,(V_R^T U_R^*)\,\hat{m}_D\,(U_L^T\, U_{TB})\,D$$

$$\hat{m}_\nu = D\,U_{TB}^T U_L\,\hat{m}_D\,P_R\,\hat{M}_R^{-1}\,(V_R^T U_R^*)\,\hat{m}_D\,(U_L^T\, U_{TB})\,D$$

The m_D^R matrix

$$m_D^R = U_{TB}\,P_L\,diag(v_1\,,\,v_2\,,\,v_3)\;P_R\,.$$

Redefining v_i (absorb P_L,P_R and move to the left to P)

$$m_D^R = U_{TB}\,P\hat{v}.$$

$\hat{v} = diag(|v_1|,|v_2|,|v_3|)$

Explicit reality

$$\hat{m}_\nu = D\, U_{TB}^T\, (U_{TB}\, P\, \hat{v}\,) \hat{M}_R^{-1} (\hat{v}\, P\, U_{TB}^T) U_{TB}\, D$$
$$= (\hat{v} \hat{M}_R^{-1/2} R^\dagger)(R^* \hat{M}_R^{-1/2} \hat{v})$$

The R matrix reloaded

$$\hat{m}_\nu^{-1/2}\, \hat{v}\, \hat{M}_R^{-1/2} R^\dagger = 1$$
$$R^* = \hat{m}_\nu^{-1/2}\, \hat{v}\, \hat{M}_R^{-1/2}$$

R is explicitly real.

See also...

Our paper [0908.0907]

- All the technical details
- Sections about deviations from TB and associated predictions

Other papers on Leptogenesis and flavour symmetries

- Bertuzzo, Di Bari, Feruglio, Nardi [0908.0161] (group theory)
- González Felipe, Serôdio [0908.2947] (matrix symmetry)
- Choubey,King, Mitra [1004.3756] (R matrix)

Summary

Conclusion

In type I seesaw scenarios with exact mixing schemes (form-diagonal matrices) Leptogenesis is not possible.