Connections between family invariants and neutrino phenomenology (based on 1101.0602, with González Felipe and Serôdio)

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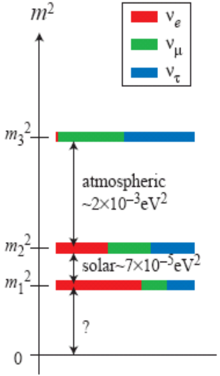
Outline

Summary of data: lepton mixing

Tribimaximal (TBM)

$$V_{PMNS} = \begin{pmatrix} -\sqrt{\frac{2}{3}} & \sqrt{\frac{1}{3}} & 0 \\ \sqrt{\frac{1}{6}} & \sqrt{\frac{1}{3}} & \sqrt{\frac{1}{2}} \\ \sqrt{\frac{1}{6}} & \sqrt{\frac{1}{3}} & -\sqrt{\frac{1}{2}} \end{pmatrix}$$



TBM decomposed

Decomposition

$$m_{TB} = U_{TB} d_\nu U_{TB}^T = x' C + y' P + z' D$$

$$C = \frac{1}{3} \begin{pmatrix} 2 & -1 & -1 \\ -1 & 2 & -1 \\ -1 & -1 & 2 \end{pmatrix}$$

$$P = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix} \quad D = \frac{1}{3} \begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix}$$

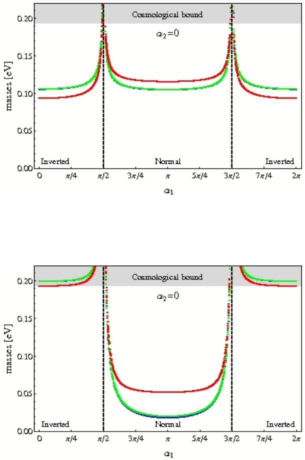
Masses: expresions

$$m_1 = \left| x e^{i\alpha_1} + y \right|$$

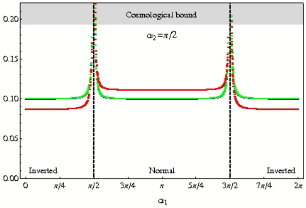
$$m_2 = \left| y + z e^{i\alpha_2} \right|$$

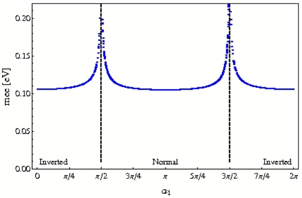
$$m_3 = \left| x e^{i\alpha_1} - y \right|$$

Top: $z = 0.1$ eV
Bottom: $z = 3.3 \times 10^{-3}$ eV



More plots


Cosmological bound
$\alpha_2=\pi/2$
Inverted
Normal
Inverted
0.20
0.15
0.10
0.05
0.00
0
$\pi/4$
$\pi/2$
$3\pi/4$
π
$5\pi/4$
$3\pi/2$
$7\pi/4$
2π
α_1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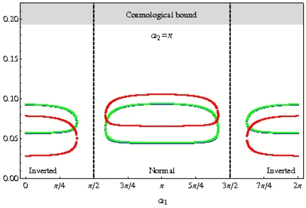
Cosmological bound
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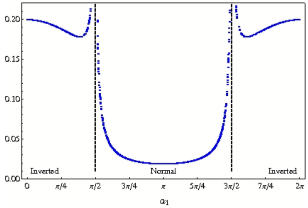
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$3\pi/2$
$7\pi/4$
2π
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Mixing scheme X

Other mass independent mixing schemes

$$m_\nu = U_X d_\nu U_X^T$$

$$U_X = K_X U_{TB}$$

$$m_\nu = K_X m_{TB} K_X^T$$

3 triplet invariants

$$\mathbf{1}^{3\varphi}_{0(0)}(q=0): \quad \frac{1}{\sqrt{3}}\{\varphi''_1(\varphi'_1\varphi_1+\varphi'_2\varphi_3+\varphi'_3\varphi_2)+\varphi''_2(\varphi'_2\varphi_2+\varphi'_1\varphi_3+\varphi'_3\varphi_1)+\varphi''_3(\varphi'_3\varphi_3+\varphi'_1\varphi_2+\varphi'_2\varphi_1)\},$$

$$\mathbf{1}^{3\varphi}_{0(0)}(\mathrm{sym}): \quad \frac{1}{\sqrt{3}}\{\varphi''_1(2\varphi'_1\varphi_1-\varphi'_2\varphi_3-\varphi'_3\varphi_2)+\varphi''_2(2\varphi'_2\varphi_2-\varphi'_1\varphi_3-\varphi'_3\varphi_1)+\varphi''_3(2\varphi'_3\varphi_3-\varphi'_1\varphi_2-\varphi'_2\varphi_1)\}$$

$$\mathbf{1}^{3\varphi}_{0(0)}(\mathrm{asym}): \quad i\,(\varphi''_1\varphi'_2\varphi_3+\varphi''_2\varphi'_3\varphi_1+\varphi''_3\varphi'_1\varphi_2-\varphi''_1\varphi'_3\varphi_2-\varphi''_2\varphi'_1\varphi_2-\varphi''_3\varphi'_2\varphi_1)\,.$$

$\Delta(12)$ (A_4)

Relevant invariants

- At the effective level $LHLH\phi$, with $\langle\phi\rangle = (1,1,1)$ can get C, P (and tribimaximal), but without D.
- Can get D at higher order (e.g. $LH\phi LH\phi$).

$\Delta(12)$, D at different order (if present): expect z small.

$\Delta(3n^2)$

Relevant invariants

- At effective level mixing comes from *LL*: repeated irreps.
- In type II mixing scheme comes directly from *LL*: repeated irreps.
- In type I (III) mixing involves for *NN*, but indirectly.

$\Delta(48)$ ($n = 4$) with C, P and D: expect z not small.
(Incompatible with P from *LL*, as often done in $\Delta(12)$).

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