Neutrino mixing matrices with prescribed singular values

Kamil Porwit, Wojciech Flieger, Janusz Gluza

Parametrization:

$$V = (1 - \alpha)U = T\,U$$

Current constrains:

$$\alpha_{m>EW} \leq \begin{pmatrix} 0.0013 & 0 & 0 \\ |0.00068| & 0.00022 & 0 \\ |0.0027| & |0.0012| & 0.0028 \end{pmatrix}$$

Singular values:

Singular values $\sigma_i(A)$ of a matrix A:

$$\sigma_i(A) \equiv \sqrt{\lambda_i(AA^\dagger)} \quad i = 1, 2, 3$$

operator norm: $\|A\| \equiv max_i \sigma_i(A)$, contraction: $\|A\| \leq 1$

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Extension from three neutrino model scenario:

$$V \to W = \begin{pmatrix} V & V_{lh} \\ V_{hl} & V_{hh} \end{pmatrix}, \quad \text{matrix } W \text{ is unitary } \to \|W\| = 1$$

For any submatrix V of $W \to \|V\| \leq \|W\| = 1$

Any deviation of any singular value of V from unity $\to$ BSM scenario.

3+1 case:

$$\sigma(T) = \{1.00, 1.00, \sigma_3\}, \quad \sigma_3 < 1$$

Results:

$$T_{m>EW}$$

$$\begin{pmatrix} 0.9987 & 0 & 0 \\ 0.0007 & 0.9988 & 0 \\ 0.0027 & 0.0012 & 0.9972 \end{pmatrix}$$

$$\sigma_3 = 0.9917$$