

The Singly-Charged Scalar Singlet as the Origin of Neutrino Masses

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Add singly-charged scalar singlet $h \sim (1, 1, 1)$ to the SM.

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Only one renormalisable coupling of h to SM fermions: $y_h^{ij} L_i L_j h + \text{h.c.}$

Antisymmetric coupling matrix:
$$y_h = \begin{pmatrix} 0 & y_h^{e\mu} & y_h^{e\tau} \\ -y_h^{e\mu} & 0 & y_h^{\mu\tau} \\ -y_h^{e\tau} & -y_h^{\mu\tau} & 0 \end{pmatrix}$$

→ Eigenvector $v_h = (y_h^{\mu\tau}, -y_h^{e\tau}, y_h^{e\mu})^T$ with eigenvalue zero, $y_h v_h = 0$.

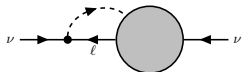
Neutrino Mass Matrix

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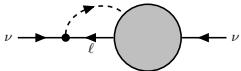


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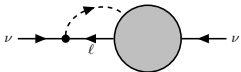
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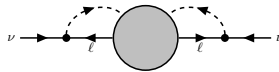
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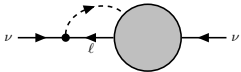


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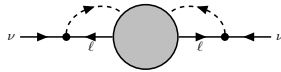
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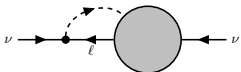
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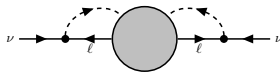
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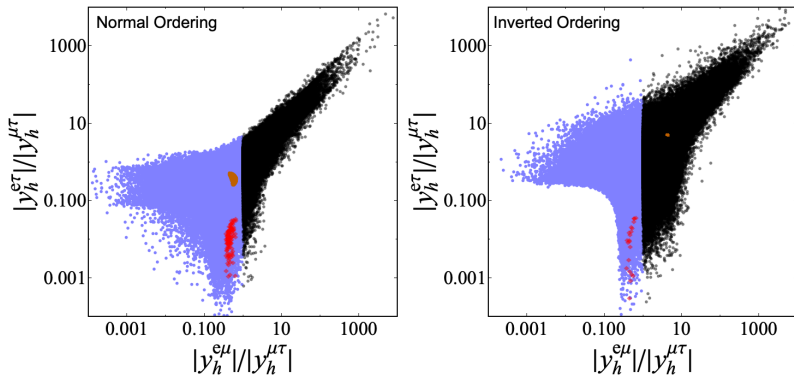


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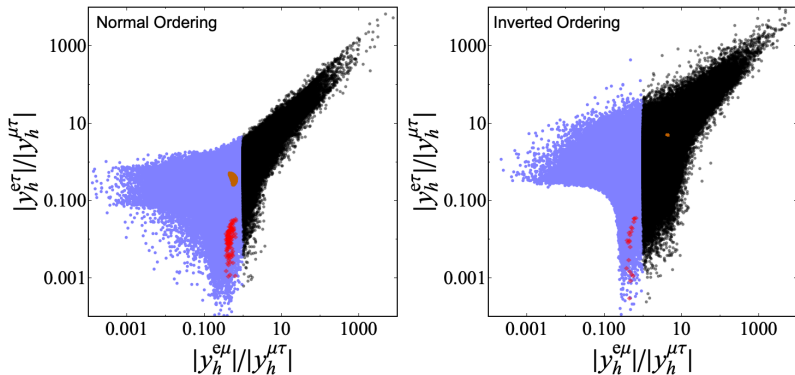
Constraints directly relate the couplings y_h^{ij} to measured neutrino data. They are independent of the mechanism of lepton-number breaking.

Solution to the Neutrino-Mass Constraints



Neutrino-mass constraints shape available parameter space for y_h^{ij} non-trivially.

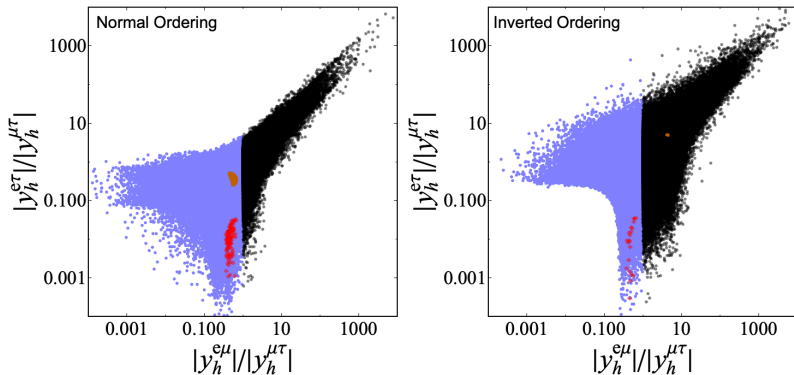
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Neutrino-mass constraints shape available parameter space for y_h^{ij} non-trivially.

- Quadratic case (brown): **Very predictive**, stringently constrained.
- Linear case (blue, black): **Less predictive**, but **simultaneous explanation of LFU anomalies** (V_{us}^{CKM} , $l_i \rightarrow l_j \bar{\nu} \nu$; in red) at 1σ possible.

Assumption: Neutrino masses generated via a singly-charged scalar singlet.
→ **Model-independent constraints** for couplings y_h^{ij} in terms of neutrino data.

Discussion of *two distinct structures* of the neutrino mass matrix:

- *Linear case*: **Zee Model** and variants, ...
- *Quadratic case*: **Zee-Babu Model**, **Krauss-Nasri-Trodden Model** and their variants, ...

The Singly-Charged Scalar Singlet as the Origin of Neutrino Masses.
T. Felkl, J. Herrero-Garcia and M. A. Schmidt. e-Print: 2102.09898

Thank you for attending the talk!