The Dark Linear Seesaw

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Dark linear seesaw mechanism

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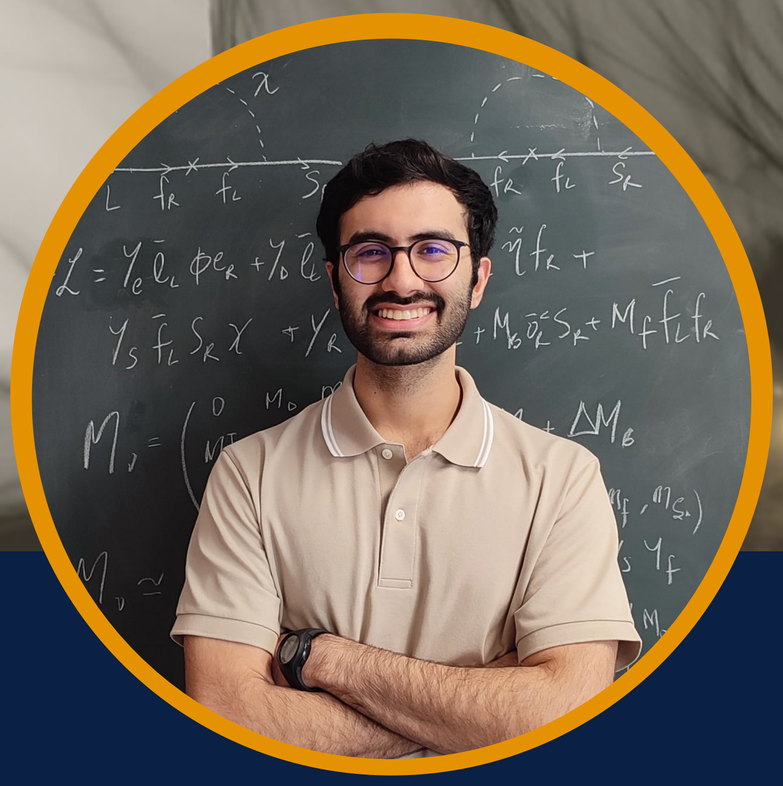

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PhD Programme: Neutrinos: a window to the Universe

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José W. F. Valle (IFIC, València)

2022: MSc in Physics

MSc Thesis:

h to ϒγ as a Novel Probe for New Physics

Supervisor:

Rahul Srivastava

MSc Thesis

Highlighted Publications:

- **Axion paradigm with color-mediated neutrino masses**
  A. Batra, H.B. Câmara, F.R. Joaquim, R. Srivastava, J.W.F. Valle
  Accepted in Phys. Rev. Lett.
  e-Print: 2309.06473 [hep-ph]

- **Phenomenology of the simplest linear seesaw mechanism**
  A. Batra, P. Bharadwaj, S. Mandal, R. Srivastava, J.W.F. Valle
  Published in: JHEP 07 (2023) 221

- **W-mass Anomaly in the Simplest Linear Seesaw Mechanism**
  A. Batra, P. Bharadwaj, S. Mandal, R. Srivastava, J.W.F. Valle
  Published in: Phys.Lett.B 834 (2022) 137408

- **Heavy neutrino signatures from leptophilic Higgs portal in the linear seesaw**
  A. Batra, P. Bharadwaj, S. Mandal, R. Srivastava, J.W.F. Valle
  e-Print: 2304.06080 [hep-ph]

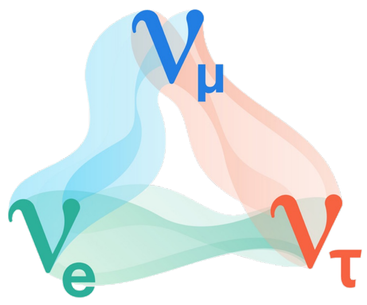
- **h→ϒγ Decay: Smoking Gun Signature of Wrong-Sign hbb Coupling**
  A. Batra, S. Mandal, R. Srivastava
  e-Print: 2209.01200 [hep-ph]

Full Publication List

The problems: the Standard Model cannot explain:

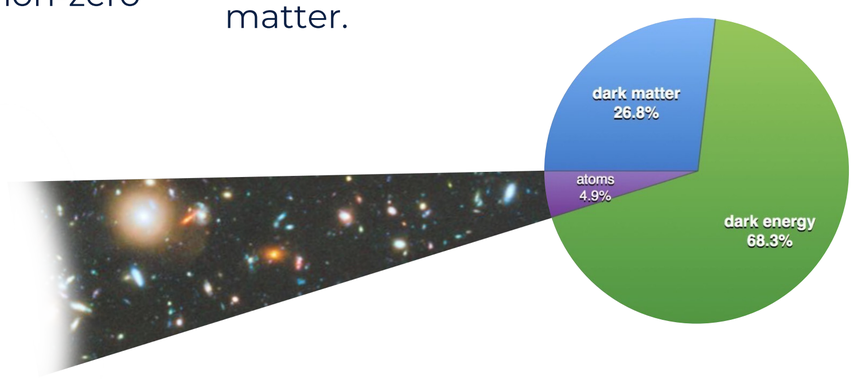
Neutrino flavour oscillations

- Neutrinos can change from one type to the other while they propagate.
- This is only possible if they have non-zero masses.



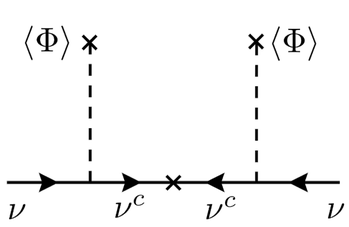
Observed Dark Matter abundance

- Cosmological evidence suggests that 26.8% of the total matter in the Universe appears in the form of dark matter.



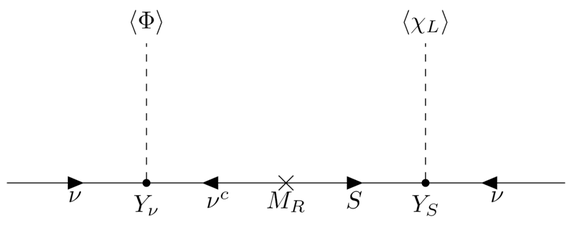
Popular solutions

Type-I Seesaw Model



$$m_\nu \sim \frac{v_\Phi^2}{M_R}$$

Linear Seesaw Model



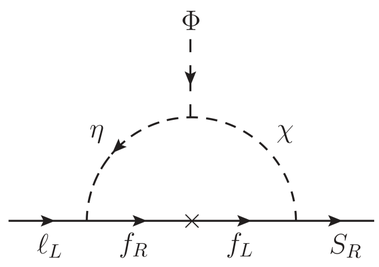
$$m_\nu \sim \frac{v_\Phi v_\chi}{M_R}$$

- The **Type-I Seesaw** is by far the **simplest solution** to the neutrino mass problem.
- A major drawback of this model is the large mass scale of the right-handed neutrinos, far away from the reach of current experiments.
- **The Linear Seesaw**, despite being more complicated, is a

low-scale solution

that offers more testability prospects at ongoing experiments.

Our approach:



The **lepton number symmetry** is violated by the scalar potential term:

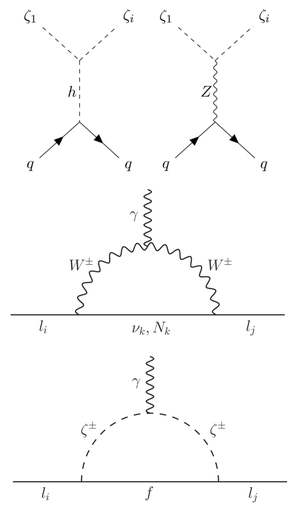
$$V_{\rm soft} = \kappa \left(\eta^\dagger \Phi\right) \chi + \text{H.c.}\,,$$

	Fields	$\mathrm{SU(2)_L \otimes U(1)_Y}$	$\mathrm{U(1)}_L$	$\mathcal{Z}_2$
Fermions	L	$(\mathbf{2}, -1)$	1	+
	e_R	$(\mathbf{1}, 2)$	1	+
	ν_R	$(\mathbf{1}, 0)$	1	+
	S_R	$(\mathbf{1}, 0)$	-1	+
	$f_{L,R}$	$(\mathbf{1}, 0)$	-1	-
Scalars	Φ	$(\mathbf{2}, 1)$	0	+
	η	$(\mathbf{2}, 1)$	-2	-
	χ	$(\mathbf{1}, 0)$	0	-

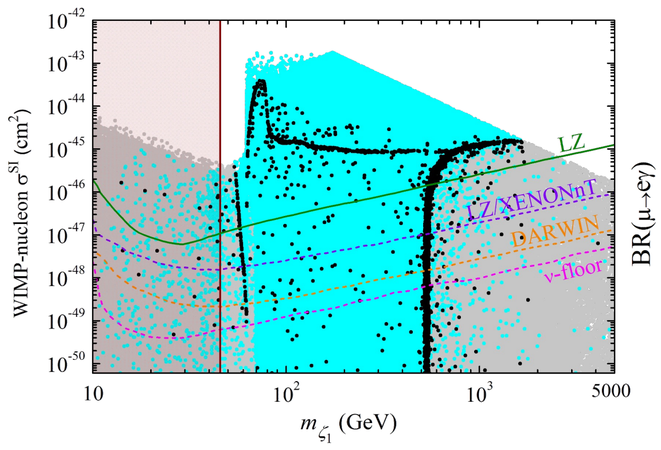
We propose a model where the **low-scale linear seesaw** neutrino mass generation mechanism is seeded by cosmologically stable dark matter particles accounting for both **neutrino flavour oscillations** and the observed **dark matter** abundance.

The results

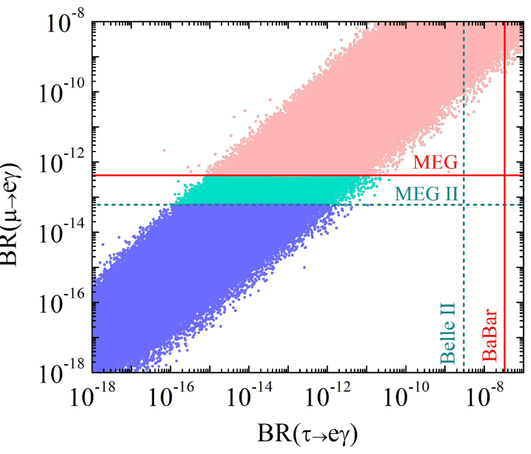
We have performed a complete numerical study to test our framework



Dark matter direct detection



Charged lepton flavour violation



The **scalar dark matter** particles can interact with normal matter directly through the Higgs or Z boson. Furthermore, the new particles can mediate **charged lepton flavour violating decays** with sizable branching ratios. Therefore, our model can be probed through these processes at various current and upcoming experiments.

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