

# Neutrinos beyond the Standard Model

Matheus Hostert

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## Theoretical aspects of neutrino masses

Apart from the standard textbooks in the field (Giunti & Kim, Mohapatra, Kayser, and others), I list some more useful references below.

- Review on neutrino masses by Bilenky & Petcov [1] – somewhat outdated, but very precise and useful.
- A fantastic set of lectures by Mohapatra at ICTP [2].
- Andre de Gouvea’s 2004 TASI lectures on neutrinos [3] — see also the YouTube videos from the 2020 edition [4].
- Spinor techniques:
  - Here is a nice and clean introduction to two-component spinors [5]. To become an expert, spend some time with [6].
  - There are some intuitive stories to understand the difference between chirality, helicity, and how Dirac masses work. I highly recommend this blog post by Flip Tanedo [7].
- Effective field theories and fundamental symmetries:
  - If you are interested about the techniques behind the Weinberg operator, there are some fantastic lectures by Timothy Cohen on effective field theories from TASI 2018 [8].

## Phenomenological aspects of neutrino masses

- Review on heavy neutral leptons [9] (see also [10]). For a comprehensive list of HNL decay modes and production at accelerator neutrino experiments, see, for example, Ref. [11].

## References

- [1] S. M. Bilenky and S. T. Petcov, *Rev. Mod. Phys.* **59**, 671 (1987), [Erratum: *Rev.Mod.Phys.* 61, 169 (1989), Erratum: *Rev.Mod.Phys.* 60, 575–575 (1988)].
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- [4] A. de Gouvêa, “[https://www.youtube.com/watch?v=m\\_HKocZ4ZdI](https://www.youtube.com/watch?v=m_HKocZ4ZdI),” (2020).
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- [6] H. K. Dreiner, H. E. Haber, and S. P. Martin, *Phys. Rept.* **494**, 1 (2010), [arXiv:0812.1594](https://arxiv.org/abs/0812.1594) [[hep-ph](#)] .
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- [8] T. Cohen, PoS **TASI2018**, 011 (2019), [arXiv:1903.03622](https://arxiv.org/abs/1903.03622) [[hep-ph](#)] .
- [9] A. M. Abdullahi *et al.*, *J. Phys. G* **50**, 020501 (2023), [arXiv:2203.08039](https://arxiv.org/abs/2203.08039) [[hep-ph](#)] .
- [10] C. Antel *et al.*, *Eur. Phys. J. C* **83**, 1122 (2023), [arXiv:2305.01715](https://arxiv.org/abs/2305.01715) [[hep-ph](#)] .
- [11] P. Coloma, E. Fernández-Martínez, M. González-López, J. Hernández-García, and Z. Pavlovic, *Eur. Phys. J. C* **81**, 78 (2021), [arXiv:2007.03701](https://arxiv.org/abs/2007.03701) [[hep-ph](#)] .