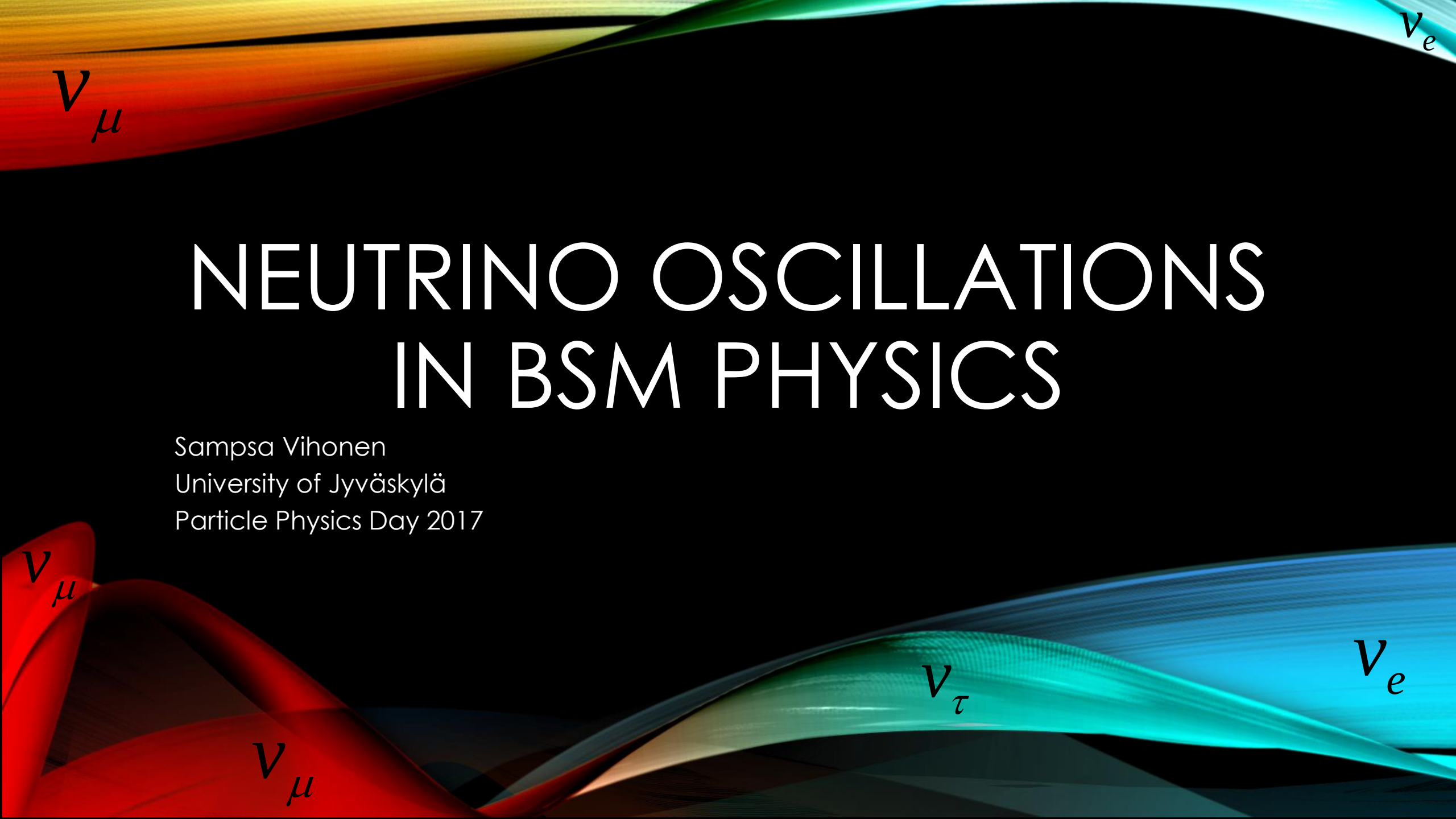


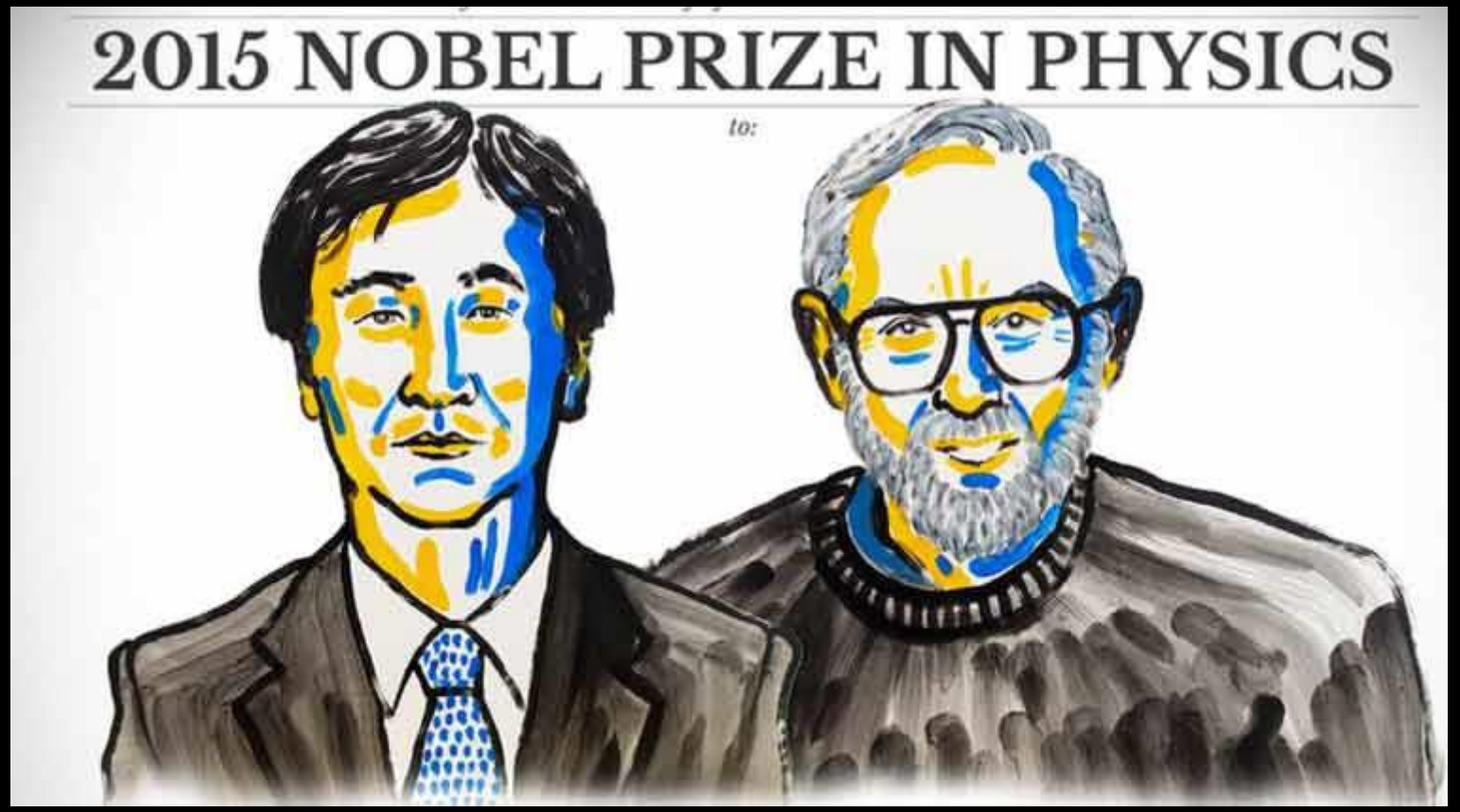
NEUTRINO OSCILLATIONS IN BSM PHYSICS

Sampsa Vihonen
University of Jyväskylä
Particle Physics Day 2017

ν_μ

ν_e

THE DISCOVERY OF NEUTRINO MASS



"for the discovery of neutrino oscillations,
which show that neutrinos have mass"

ν_μ

ν_e

THE DISCOVERY OF NEUTRINO MASS

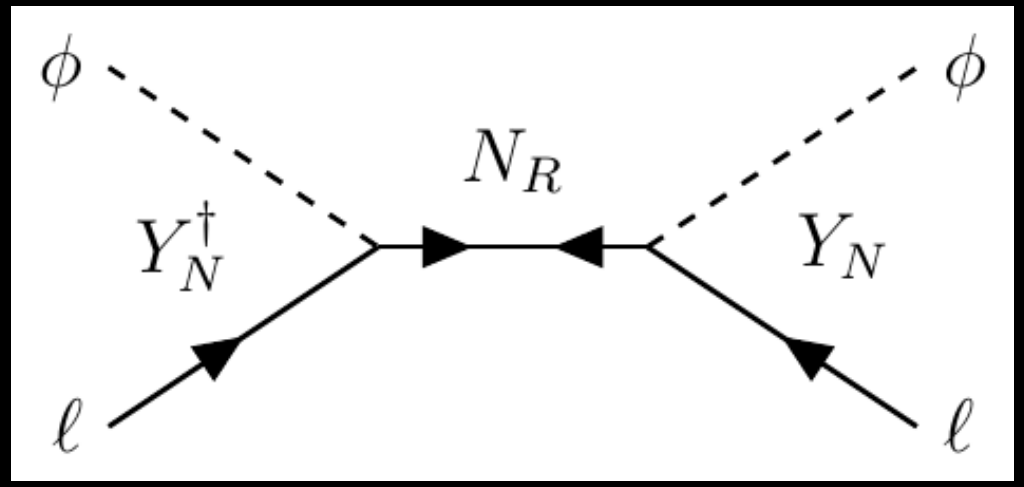
Standard Model: *Neutrinos do not have mass!*

…and therefore it must be accommodated.

ν_μ

ν_e

THE ORIGIN OF NEUTRINO MASS



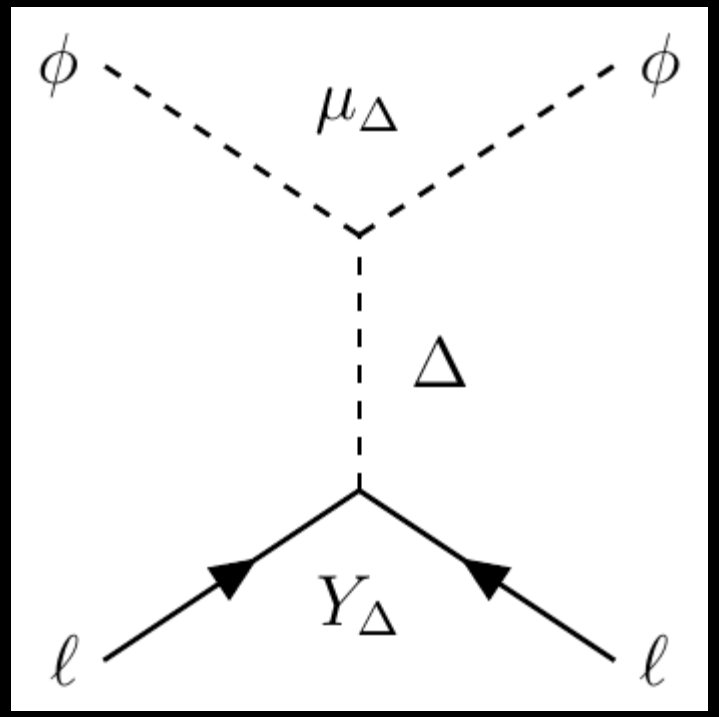
Type I seesaw models

$$m_\nu = -\frac{1}{2} Y_N^T \frac{v^2}{M_N} Y_N$$

ν_μ

ν_e

THE ORIGIN OF NEUTRINO MASS



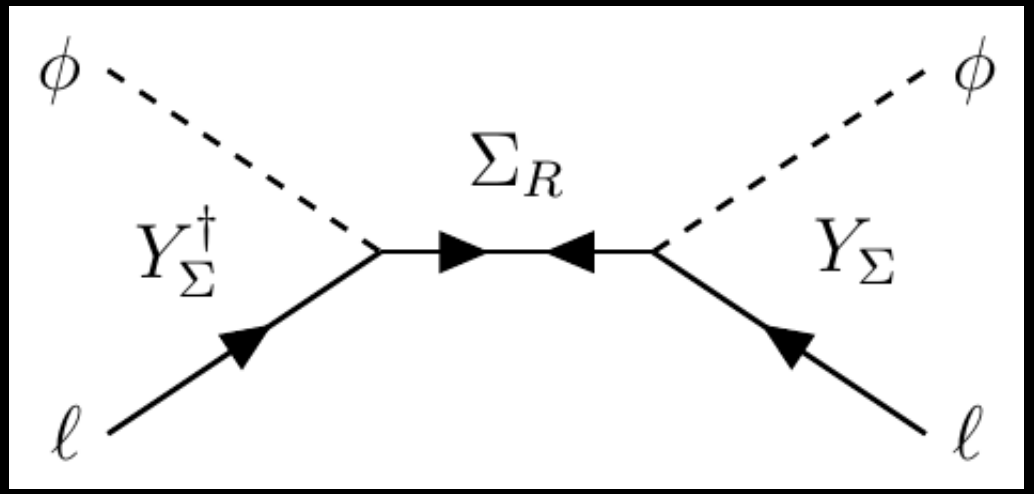
Type II seesaw models

$$m_\nu = -2Y_\Delta v^2 \frac{\mu_\Delta}{M_\Delta^2}$$

ν_μ

ν_e

THE ORIGIN OF NEUTRINO MASS



Type III seesaw models

$$m_\nu = -\frac{v^2}{2} Y_\Sigma^{\mathrm{T}} \frac{1}{M_\Sigma} Y_\Sigma$$

ν_μ

ν_e

HOW SHOULD ONE INTERPRET THIS?

- Attempts to accommodate the small neutrino mass usually include at least one of the following:
  - Non-unitary mixing matrix (Types I, III)
  - Non-standard neutrino interactions (Type II)
  - Majorana nature (Types I, III)
- Non-unitarity and non-standard interaction effects manifest themselves as deviations from standard oscillations

ν_μ

ν_e

HOW SHOULD ONE INTERPRET THIS?

Nuisance

ν_μ

ν_e

HOW SHOULD ONE INTERPRET THIS?

Opportunity

ν_μ

ν_e

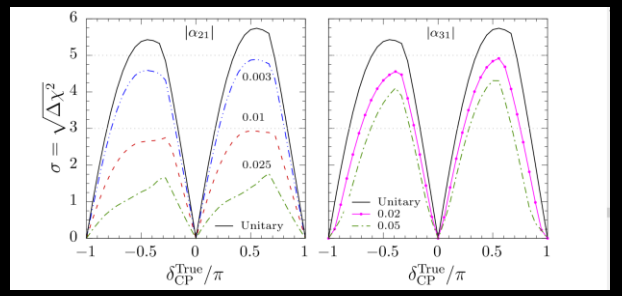
HOW SHOULD ONE INTERPRET THIS?

Nuisance

…because we hardly even know the standard oscillation case.

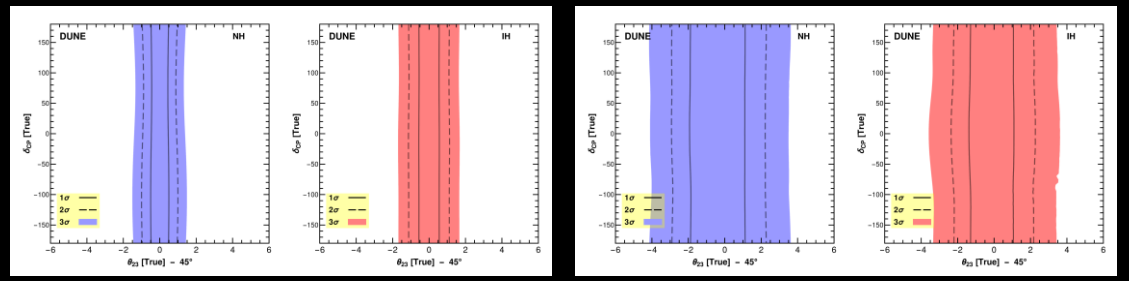
Liao et al. (2016), Masud et al. (2016), Masud and Mehta (2016), Rout et al. (2017), Miranda et al. (2017), de Gouvêa and Kelly (2016), Ge and Smirnov (2016), Dutta and Ghoshal (2016), Dutta et al. (2017), Deepthi et al. (2016), Agarwalla et al. (2016), Dutta et al. (2017)……

CP violation searches



Escrihuela *et al*, arXiv:1612.07377

Determination of the θ_{23} octant



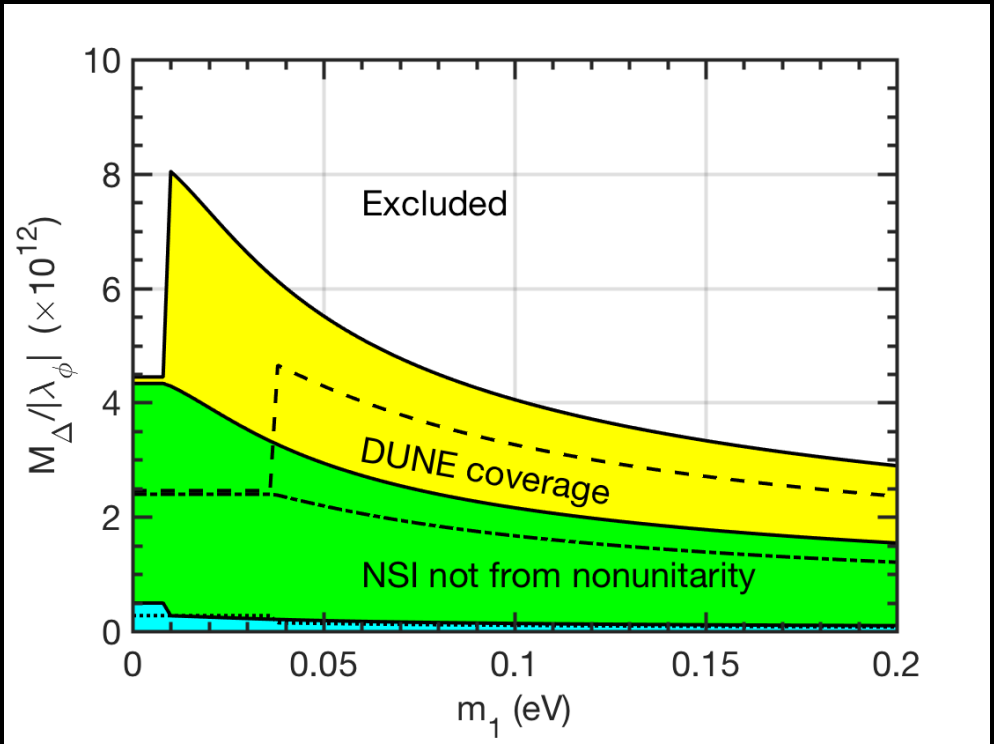
C.R. Das *et al*, arXiv:1708.05182

ν_μ

ν_e

HOW SHOULD ONE INTERPRET THIS?

Search for Type II seesaw triplet



Opportunity

…but only if we do everything precisely.

K. Huitu et al, manuscript under preparation

ν_μ

ν_e

SUMMARY

- The problem of neutrino mass indicates physics beyond the Standard Model
- New physics effects could impose departures from the standard three neutrino paradigm
- If overlooked, the extra degrees of freedom will likely jeopardize the sensitivity for current experimental goals
- But if everything is done right, the access to BSM physics could turn out a great new opportunity