New limits on W_R from meson decays

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Right hand currents in a nutshell

- The Left-Right Symmetric Model (LRSM) is one of the simplest and best motivated extensions of the SM. Based on

$$SU(2)_L \otimes SU(2)_R \otimes U(1)_{B-L}$$

- Features:

  - Additional gauge bosons W_R, Z_R - RH neutrinos are active under this sector!

  - Links parity violation of the SM to the breaking of the L-R symmetry.

  - Connects the point above to the generation of neutrino masses.

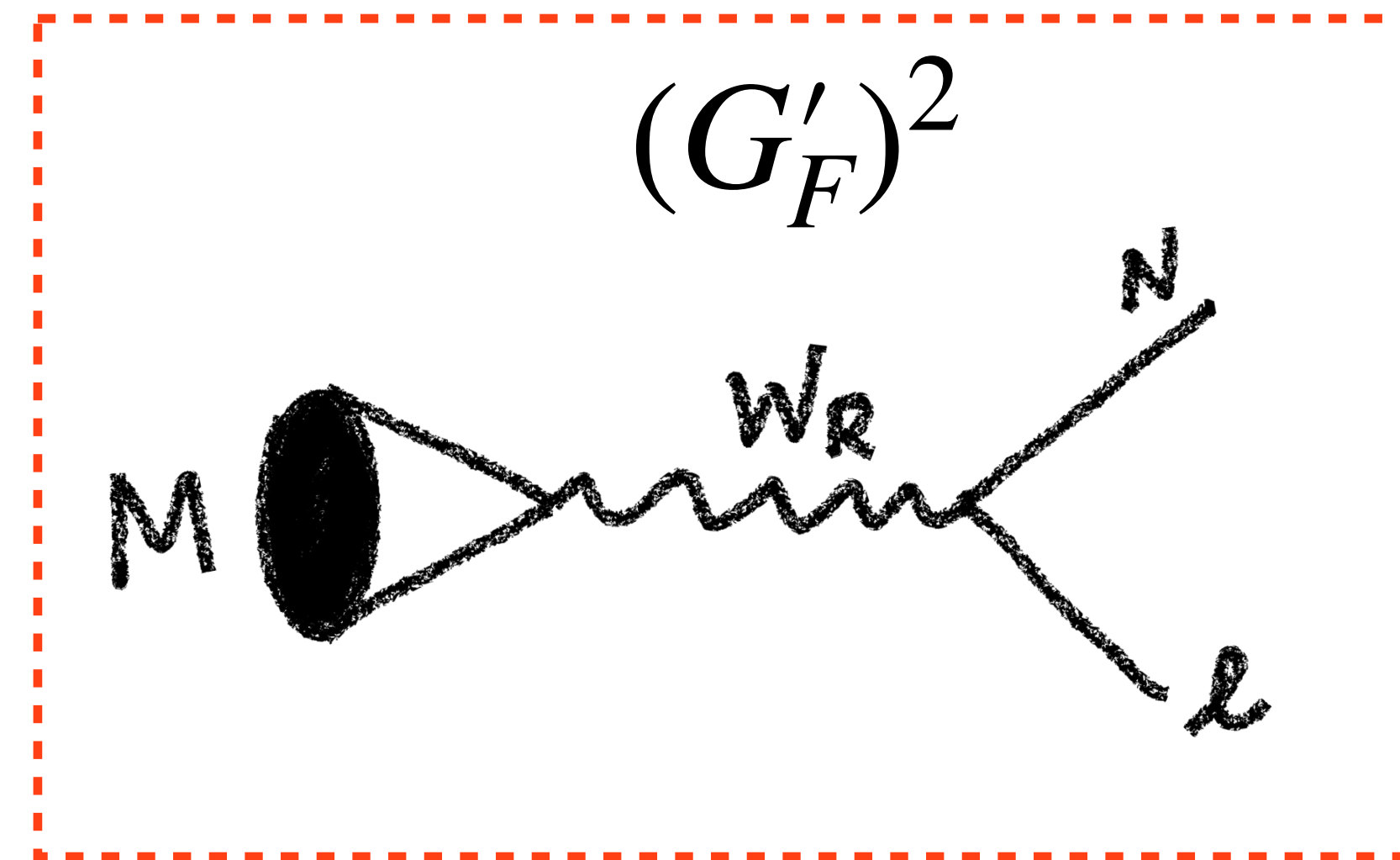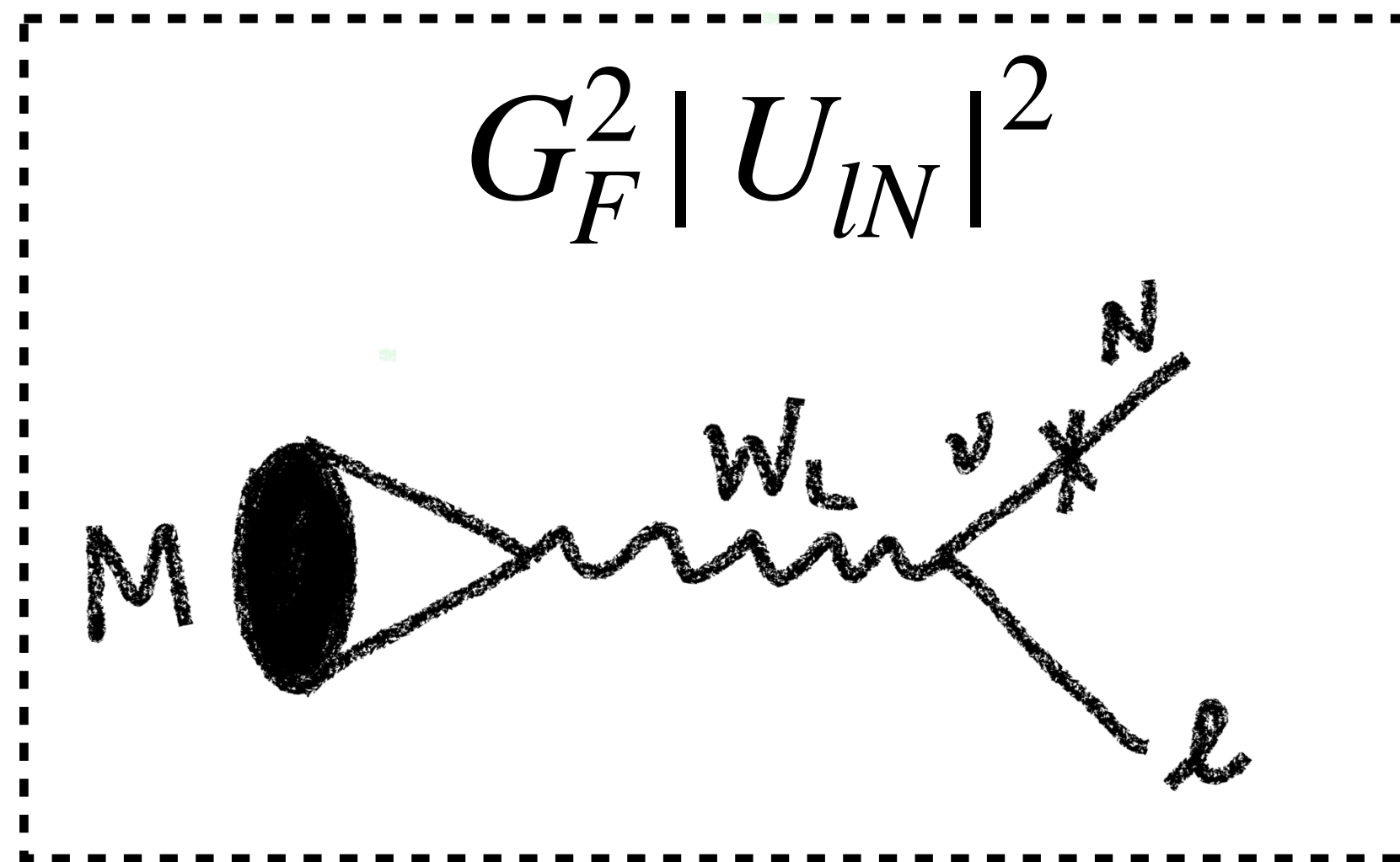Pati and Salam, Phys. Rev. D 10, 275
R. N. Mohapatra and G. Senjanovic, Phys. Rev. Lett. 44
N. G. Deshpande, et. al, Phys. Rev. D 44
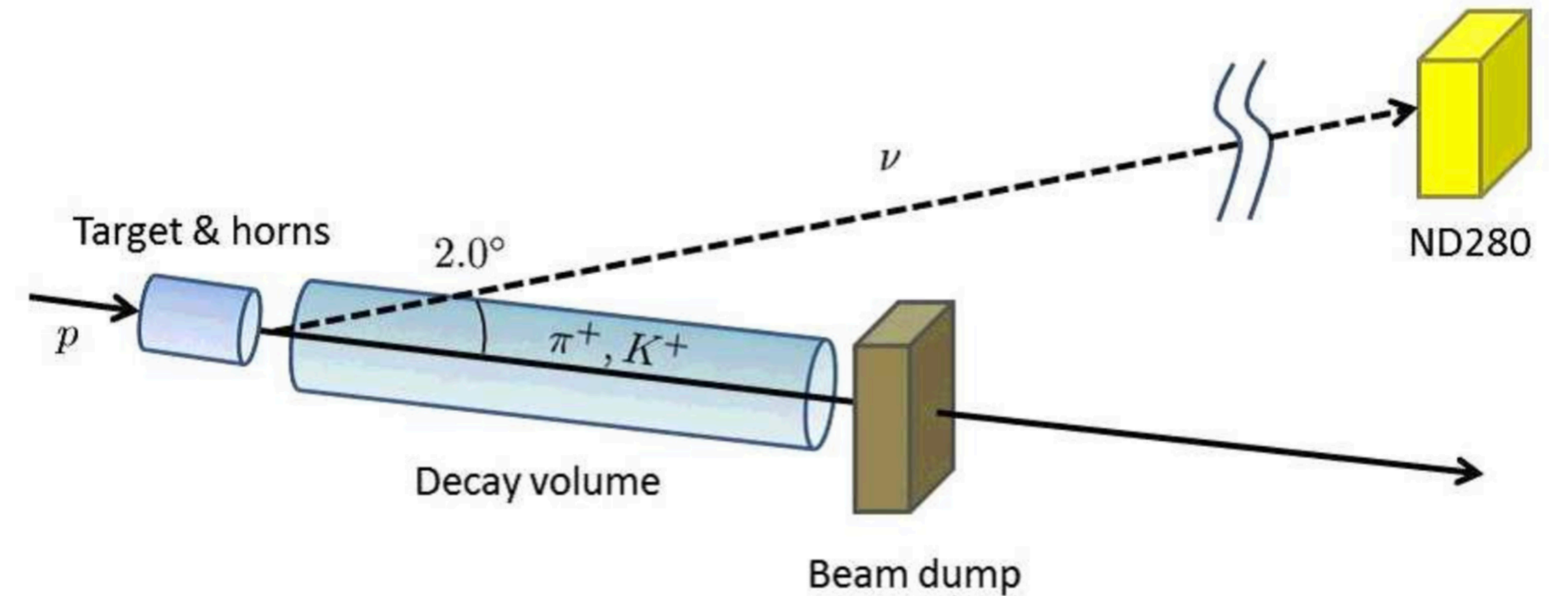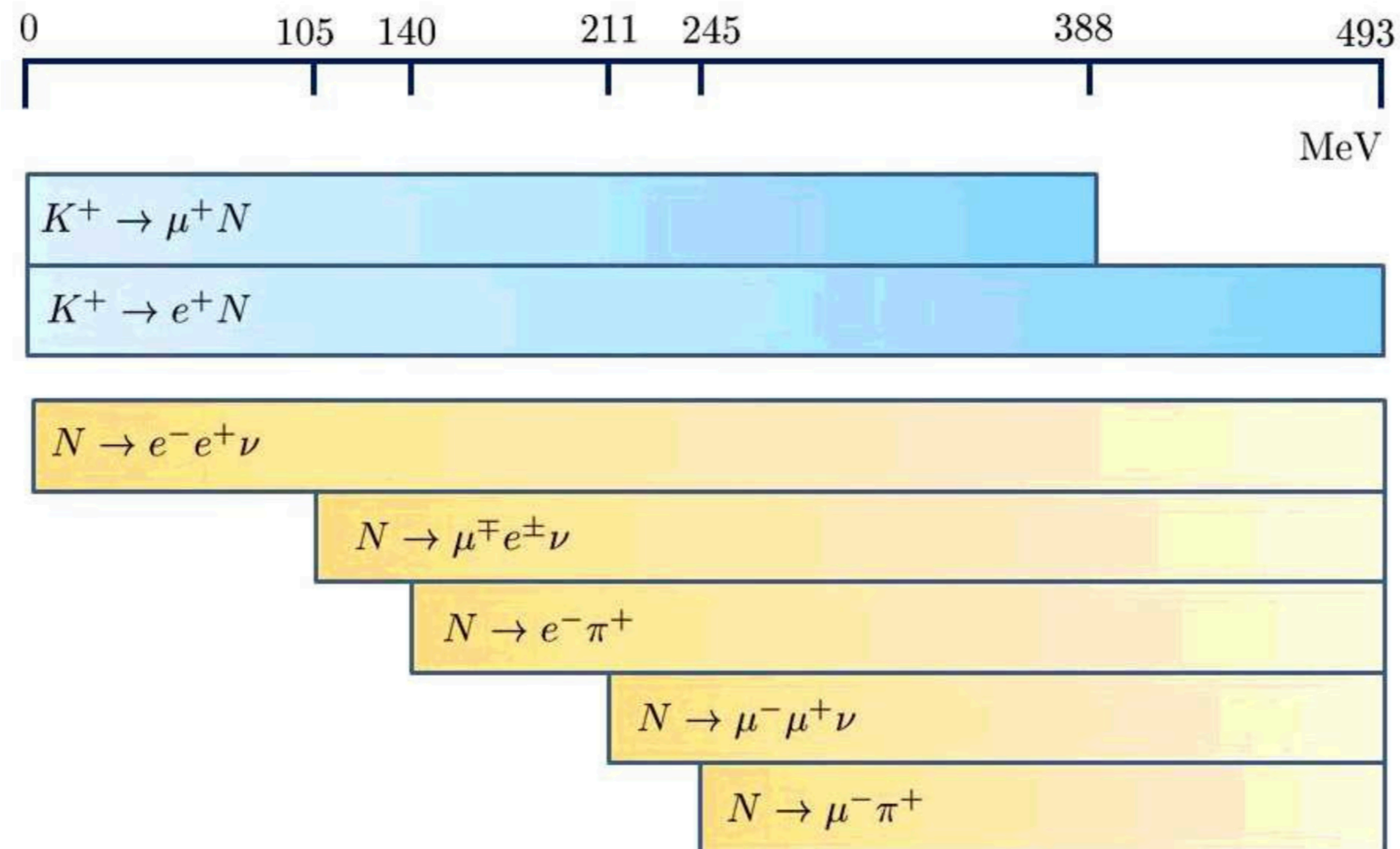Senjanovic, arXiv:2011.01264

Testing the RH scale: Portals for the RH neutrino

- The active-sterile mixture depends on the mass generation mechanism.

- In a LR symmetric framework, can we have right handed current dominance?

$$G_F^2 |U_{lN}|^2$$

$$(G_F')^2$$

Visible searches

- Look for visible decays of heavy neutral leptons.

- Example: T2K ND280.

Abe et. al, arXiv:1902.07598
Asaka et. al., arXiv:1212.1062
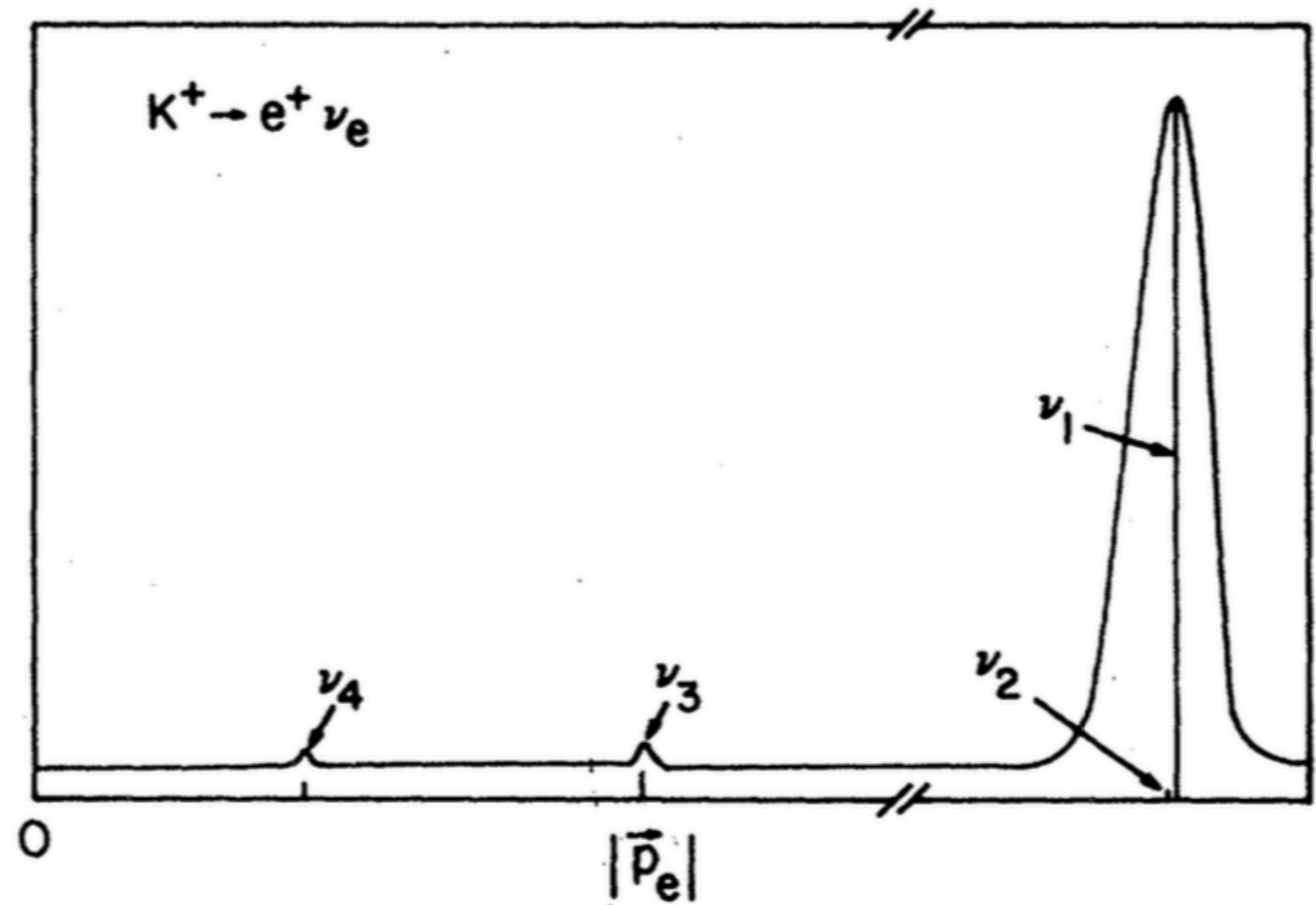
Invisible searches

- Emission of massive neutrinos manifest itself indirectly through peaks in the energy spectrum.

- The idea is to compare the experimental ratio with the SM calculation:

$$B(M^+ \to e^+ N) = B^{\mathrm{SM}}(M^+ \to e^+ \nu_e)\rho_e^{MN}|U_{lN}|^2$$

$$\downarrow$$

$$B(M^+ \to e^+ N) = B^{\mathrm{SM}}(M^+ \to e^+ \nu_e)\rho_e^{MN}\left(\frac{G'_F}{G_F}\right)^2$$

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Meson Decay Ratios
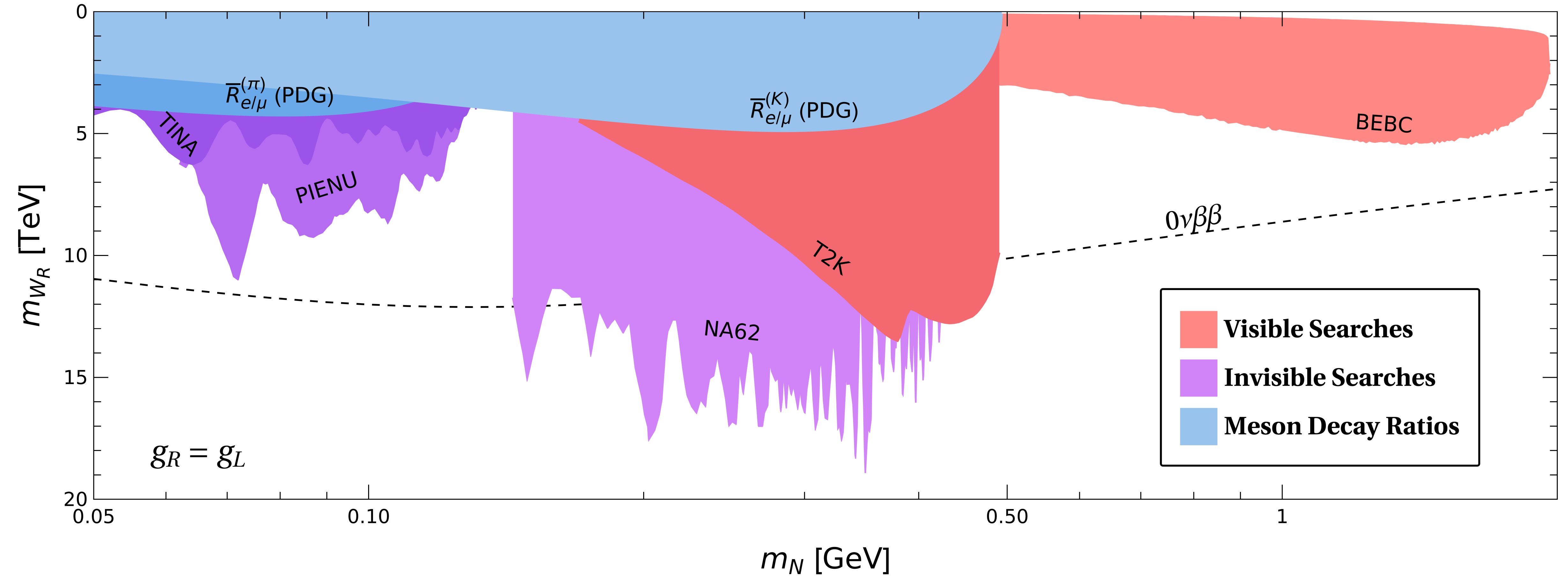
- The decay $\pi \to e\nu$ is helicity suppressed but $\pi \to eN$ is not!

- The idea is to compare the theoretical prediction and experimental value for the ratio:

$$R_{e/\mu}^{\mathrm{SM}} = \frac{B(M \to e\nu_e)}{B(M \to \mu\nu_\mu)}$$

- Heavy neutral lepton emission would impact the value!

$$R_{e/\mu} = \frac{1 + R_{N/\nu_e}}{1 + R_{N/\nu_\mu}} R_{e/\mu}^{\mathrm{SM}} \qquad R_{N/\nu_\alpha} = \frac{B(M \to l_\alpha N)}{B(M \to l_\alpha \nu_\alpha)}$$

Constraints on a RH current

Conclusions

- We have used low energy pseudoscalar mesons leptonic decays to constrain the mass of a right hand gauge boson.

- Our bounds cover the mass range $50 \leq m_N/MeV \leq 1900$ and are complementary to the LHC bounds on m_{W_R} for lighter neutral leptons.

- Different portals can be studied in this framework!

- Experiments such as PIONEER, ICARUS, MicroBooNE, SBND, DUNE, Belle II, SuperKEKB and HIKE can constrain even more this scenario in the future.