Neutrinoless Double Beta Decay: Beyond the "Tonne-Scale" - I ACFI virtual workshop, Dec 9-11 2020

# Panel Discussion: Setting benchmarks beyond the tonne scale

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## Preamble

- We simply don't know the origin of neutrino mass and the scale  $\Lambda$  associated with LNV. Therefore, ton-scale (and beyond)  $0\nu\beta\beta$ searches (T<sub>1/2</sub> >10<sup>27-28</sup> yr) have huge discovery potential.
- But funding agencies like benchmarks...
- Benchmarks make sense within specific scenarios of LNV and neutrino masses.
- Organizing principle? EFT ~ scale of LNV (related to mass of new particles inducing LNV, such as V<sub>R</sub>'s)



I/Coupling

### Some possible benchmarks

- High scale seesaw (crab plot): natural target is  $m_{\beta\beta} \sim meV$ . Falsifiable correlations with other probes of V mass. Future data can unravel new LNV sources or physics beyond " $\Lambda$ CDM +  $m_{\nu}$ "
- LNV in multi-TeV region: minimal target is to match the sensitivity of LHC (and future colliders) in same-sign dilepton. Best illustrated in simplified models motivated by clear connection to V mass: minimal LRSM, leptoquarks, type I+II, I+III seesaw.
- General type-I seesaw (varying M<sub>R</sub>): minimal UV complete scenario + extension with EFT interactions beyond Yukawa. Connection to cosmological implications and other observables (meson decays, collider) relatively mature.

## **Related challenges**

• Controlled theory uncertainty: for example, given a measurement (bound) on  $T_{1/2}$ , what is the corresponding  $m_{\beta\beta}$ ? A lot to do, but exciting prospects thanks to advances and cross fertilization in EFT, lattice QCD, and nuclear structure

- Model diagnosing: what do we learn about the underlying LNV model from a positive (null) experimental result? Tools:
  - Within  $0\nu\beta\beta$ : total rate variation with isotope; differential rate: single electron spectra and electron's angle.
  - 0νββ vs other probes: meson & lepton decays, collider, cLFV,
    ...

#### Some relevant Lol's

#### (Very incomplete list)

Bridging particle and nuclear physics for neutrinoless double beta decay with EFTs

#### Neutrinoless double beta decay in effective field theory and simplified models

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