Search for light exotic fermions in double-beta decay

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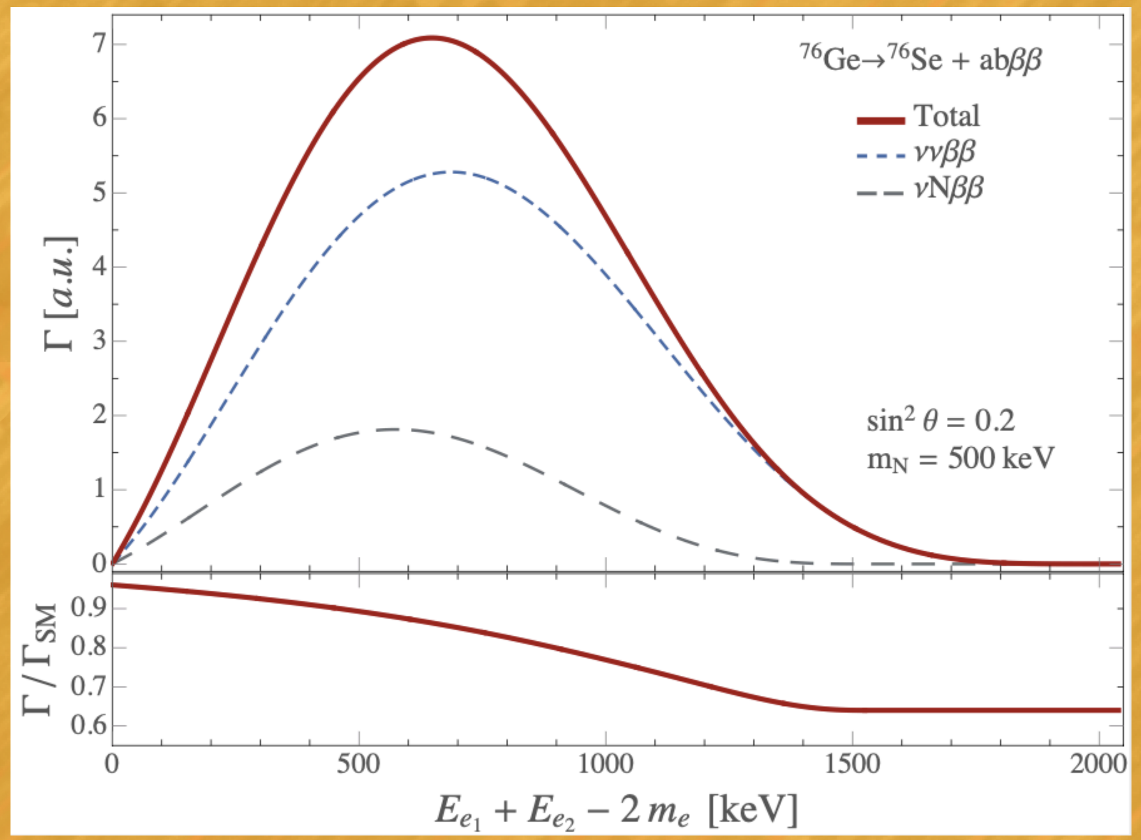
SFB 1258 Neutrinos Dark Matter Messengers

1) What

- Introduction of a new fermion in the Standard Model, possibly related to mechanism of neutrino mass generation and/or dark matter of the Universe.
- Sterile neutrino N / Z_2-odd fermion χ
- Mass and coupling strength to Standard Model particles are free parameters: they have to be constrained by laboratory experiments, or astrophysical and cosmological observations.
- Weak laboratory constraints on N in the mass range between 100keV and 100MeV. No laboratory constraints on χ.

2) How



- N and χ couple with neutrino -> production in double-beta decay

! $(A,Z) \rightarrow (A,Z+2) + 2e + 2\bar{\nu}$

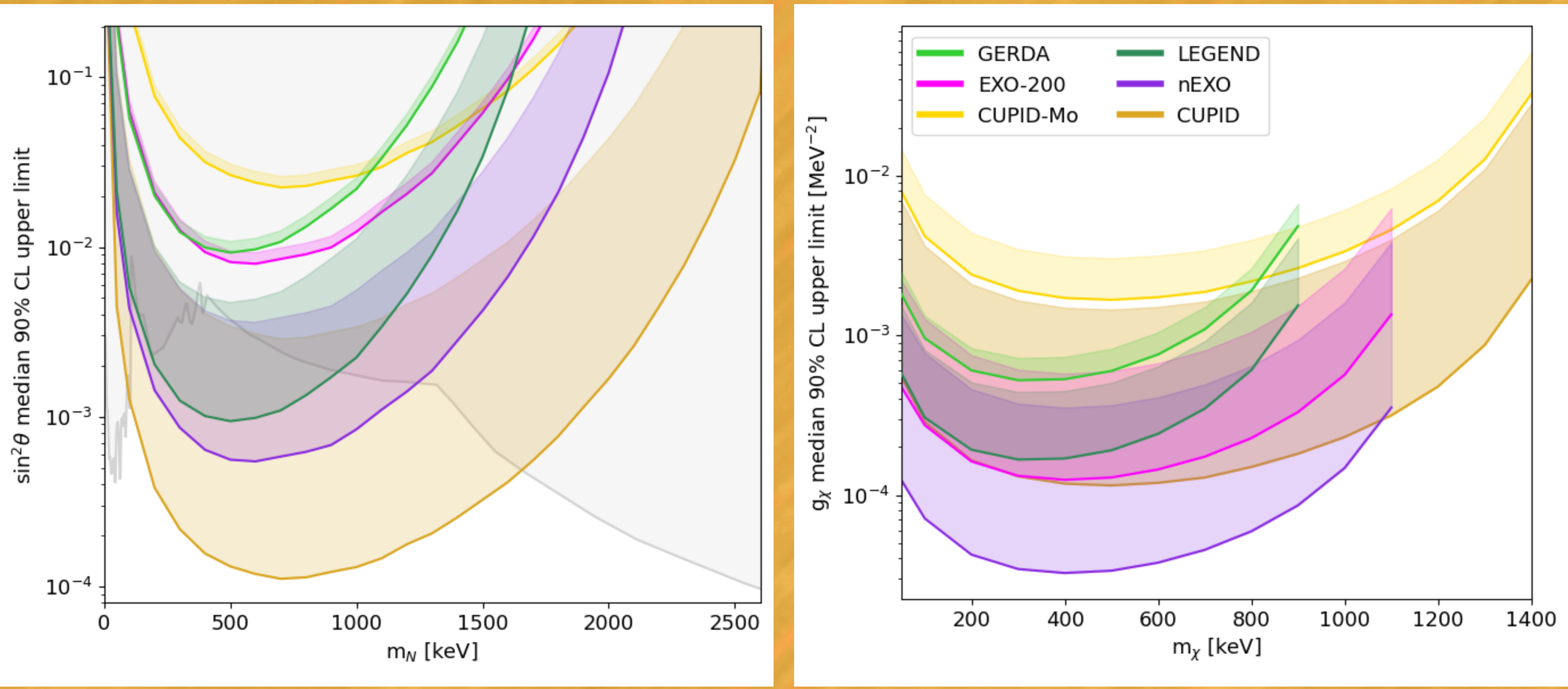
? $(A,Z) \rightarrow (A,Z+2) + 2e + N + \bar{\nu}$

? $(A,Z) \rightarrow (A,Z+2) + 2e + 2\chi$

- The energy distribution of the emitted electrons can be accurately measured and used to probe which other particles have been emitted

3) Results

- Frequentist analysis: binned maximum-likelihood fit based on a profile-likelihood test statistic. Systematic uncertainties included in the distribution of the test statistic.
- Sensitivity for a selection of current- and next-generation experiments given in terms of the median 90% C.L. upper limit on the coupling.



- LEFT. Sensitivity of current double-beta decay experiments are weaker than existing limits, but larger exposure of future experiments encourages a dedicated search.
- RIGHT. Double-beta decay experiments offer a unique opportunity of probing models in which only the double production of light exotic fermions is allowed, and can lead to the first laboratory constraints.

XIX International Workshop on Neutrino Telescopes 18-26 February 2021 Online

[1] M. Agostini, E. Bossio, A. Ibarra et al., Search for light exotic fermions in double-beta decays, Physics Letters B 815 (2021) [2] P. D. Bolton et al. Two-neutrino double beta decay with sterile neutrinos. arXiv:2011.13387v1