Unlocking the source of LNV with other 0ν modes

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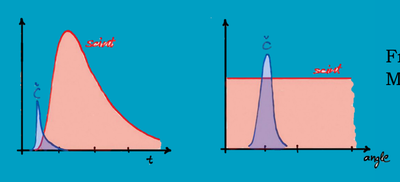
Novel detector

NuDoubt^{++} experiment from Mainz [3] aims to discover $2\nu\beta^+\beta^+$ with enriched Kr^{78} gas within 1 tonne-week

New detector concept:

Hybrid (Scintillation and Cherenkov light)

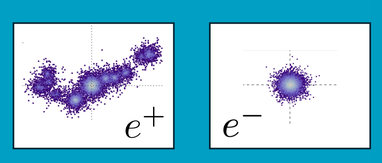
- ❑ Excellent timing and directionality



From M. Wurm

Opaque (Light confined and collected with optical fibres)

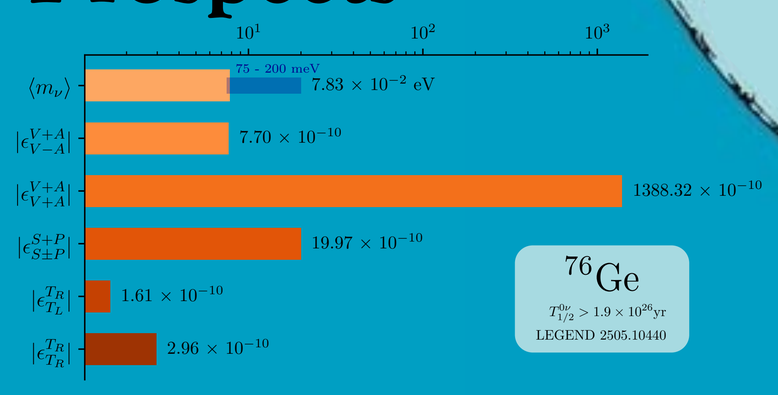
- ❑ Unique particle ID with topology [4]



From [4]

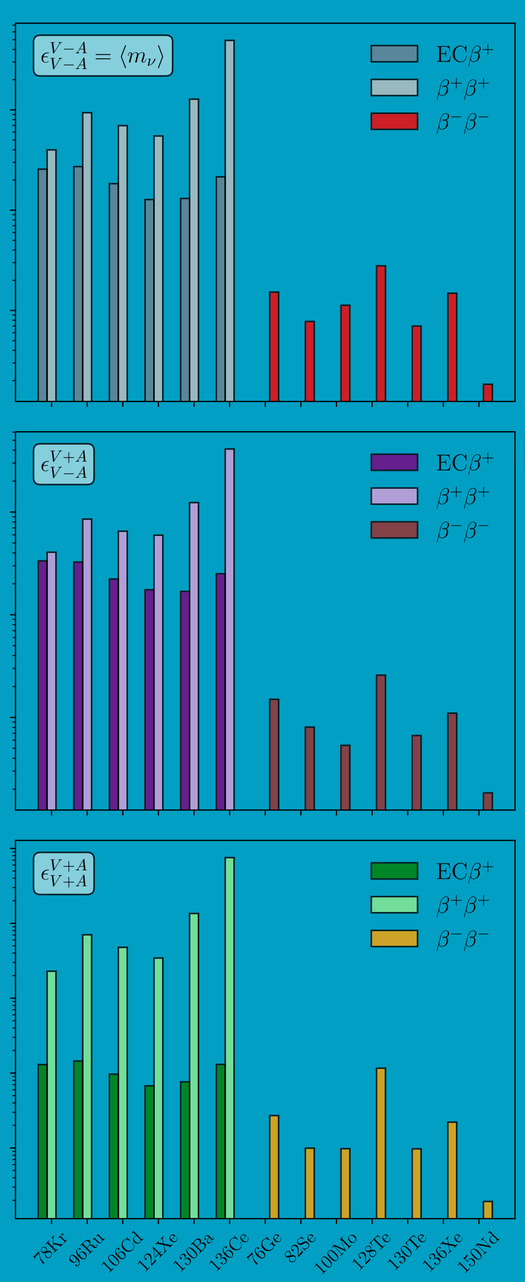
Particularly suitable for detecting e^+

Prospects



Limits obtained 'on-axis'. Next steps:

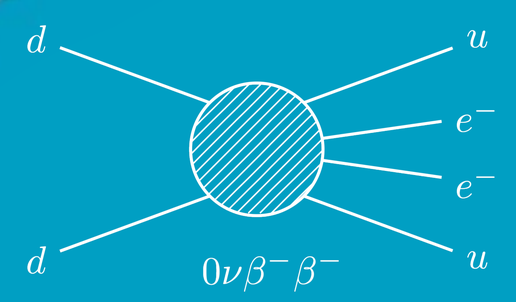
- ❑ Full fit!
- ❑ Non-standard currents
- ❑ Reach of experimental projects

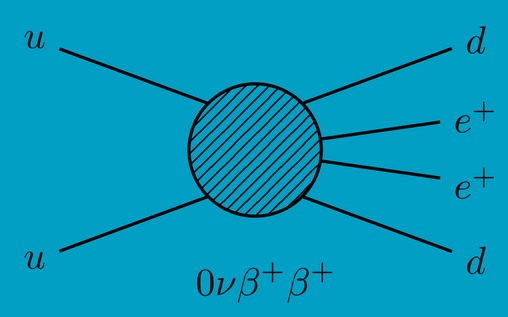


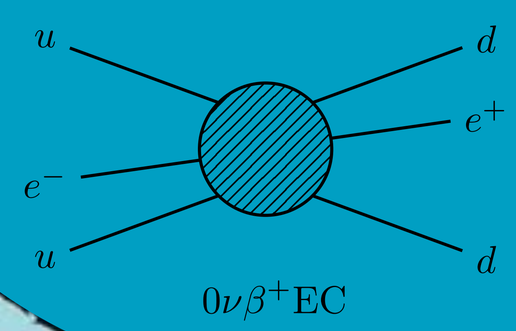
Plots of V ± A currents for a range of isotopes given an equal half-life limit

$0\nu\beta\beta$

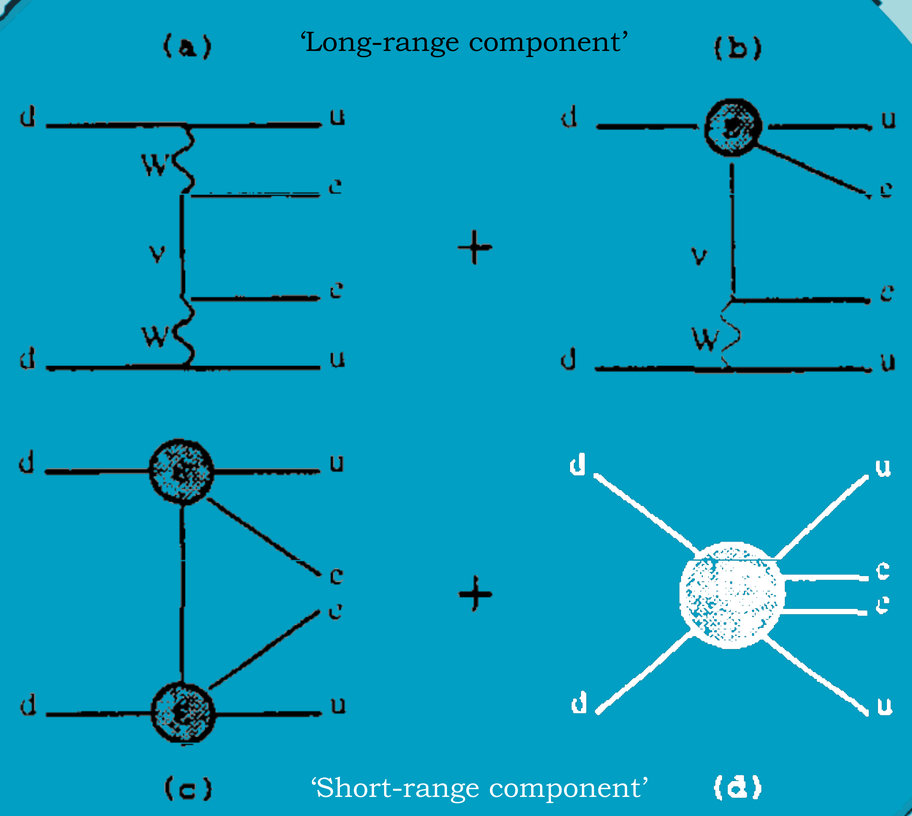
Signatures







Mechanisms



From [6]

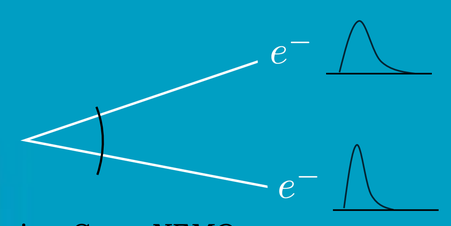
What happens after $0\nu\beta\beta$ discovery?

The ■-theorem [1] tells us that an observation of guarantees that neutrinos have a finite Majorana mass.

However, $0\nu\beta\beta$ could be dominated by some other source of LNV [2].

To understand the LNV, study the $0\nu\beta\beta$ more closely. Looking at:

1) Kinematics of the outgoing e



i.e. *SuperNEMO*

2) With different isotopes

$$\frac{T_{1/2}\left({}^{A'}X'\right)}{T_{1/2}\left({}^{A}X\right)}$$

Mechanism-dependent ratios!

Predictions

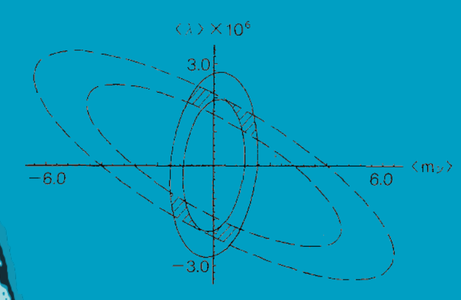
Neutrino exchange between V − A vertices

$$\langle m_\nu \rangle = \epsilon^{V-A}_{V-A}$$

Other LNV physics could appear as scalar, pseudoscalar and tensor currents. For the long-range component (≤ dim 7), the effective vertices are [5]:

$$\epsilon^{V+A}_{V-A}, \quad \epsilon^{V+A}_{V+A}, \quad \epsilon^{S+P}_{S\pm P}, \quad \epsilon^{TR}_{TL}, \quad \epsilon^{TR}_{TR}$$

Previous work on these signatures suggests unique sensitivity to V + A currents [6].



From [5]

References

[1] J. Schechter and J.W.F. Valle, 10.1103/PhysRevD.25.2951 1982

[2] M. Duerr, M. Lindner & A. Merle. 10.1007/JHEP06(2011)091 2011

[3] M. Böhles *et al.* [NuDoubt^{++}] 10.1140/epjc/s10052-025-13847 2025

[4] A. Cabrera *et al.* [LiquidO] 10.1038/s42005-021-00763-5 2021

[5] M. Hirsch, K. Muto, T. Oda & H. V. Klapdor-Kleingrothaus 10.1007/BF01292371 1994

[6] H. Päs, M. Hirsch, H.V. Klapdor-Kleingrothaus, S.G. Kovalenko, 10.1016/S0370-2693(99)00330 1999

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Discuss?