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Overview of KATRIN Results on the Neutrino Mass and New Physics Searches

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The KATRIN experiment aims to measure the neutrino mass by precision spectroscopy of tritium β-decay. Recently, KATRIN has improved the upper bound on the effective electron-neutrino mass to 0.8 eV/c² at 90% confidence level [1] and is continuing to take data for a target sensitivity of 0.2 eV/c².
In addition to the search for the neutrino mass, the ultra-precise measurement of the β-spectrum can be used to probe physics beyond the Standard Model.
Some extensions of the Standard Model allow Lorentz invariance violations. Even though strong constraints in the neutrino sector have been set by oscillation experiments, certain Lorentz-invariance-violating parameters can only be accessed using interaction processes. The layout of the KATRIN experiment makes it possible to investigate those parameters which would manifest themselves as a sidereal oscillation of the spectral endpoint [2].
Motivated by a range of anomalies in neutrino physics experiments, the KATRIN data is investigated for an eV-scale sterile neutrino. For this search a model with three active and one sterile neutrino species is considered. A sterile neutrino shows up as a kink-like structure in the electron energy spectrum [3].
The KATRIN data also enables probing the local relic neutrino background by threshold-free neutrino capture on tritium. This process is characterised by an electron peak positioned two times the neutrino mass above the spectral endpoint [4].
Furthermore, general neutrino interactions (GNI) [5] can be investigated through a search for potential shape variations of the β-spectrum. For this purpose, all theoretically allowed interaction terms for neutrinos are combined in one effective field theory. This enables a model-independent description of novel interactions, which could provide small contributions to the weak interaction. Such potential modifications can then be identified in the KATRIN β-spectrum by means of energy-dependent contributions to the rate.

[1] The KATRIN Collaboration. Direct neutrino-mass measurement with sub-electronvolt sensitivity. Nature Physics 18, 160–166, 2022.
[2] The KATRIN Collaboration. Search for Lorentz-Invariance Violation with the first KATRIN data. Arxiv, 2022.
[3] The KATRIN Collaboration. Improved eV-scale sterile-neutrino constraints from the second KATRIN measurement campaign. Phys. Rev. D, 2022.
[4] The KATRIN Collaboration. New Constraint on the Local Relic Neutrino Background Overdensity with the First KATRIN Data Runs. Phys. Rev. Lett., 2022.
[5] Ingolf Bischer and Werner Rodejohann. General neutrino interactions from an effective
field theory perspective. Nuclear Physics B, 947, 2019.

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