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Towards Quantum Sensor Arrays for a Next-Generation Neutrino-Mass Measurement using Tritium

venerdì 21 giugno 2024 17:30 (2 ore)

The Karlsruhe Tritium Neutrino (KATRIN) experiment aims to probe the effective electron anti-neutrino mass by measuring the beta-decay spectrum of molecular tritium close to the endpoint region. By the end of 2025, a final sensitivity better than $0.3\,\mathrm{eV}/c^2$ (90 % CL) will be anticipated with a total of 1000 days of measurement. For going beyond, i.e. to set up a next-generation neutrino mass experiment probing inverted or even normal mass ordering, novel, ground-breaking technology must be developed to significantly improve statistics, energy resolution and background reduction. One potential strategy is the upgrade / extension of the present KATRIN beamline by an atomic tritium source as well as an energy-dispersive quantum sensor to measure the energy of the electrons passing the main KATRIN spectrometer operated with a fixed retarding potential. To judge the suitability of such an approach, we initiated the ELECTRON project aiming to proof that magnetic microcalorimeters (MMCs), a special type of superconducting quantum sensor, can be employed for high-resolution electron spectroscopy without performance degradation and to investigate potential systematic effects occurring for electron detection. Outside of ELECTRON, we also study how MMCs can be made resilient to magnetic background fields in the range of 10-100 mT and how quantum sensor arrays can be coupled to a warm beamline without using radiation windows. In this contribution, we will present the present status our work as well as very recent measurements yielding a ^{83m}Kr spectrum with the present best energy resolution. We will also discuss our efforts put towards the first ever measurements of the tritium β-decay spectrum using a novel compact tritium source. Finally, we will outline some ideas how to operate a superconducting quantum sensor array at the KATRIN beamline.

Poster prize

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