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MetroMMC: Electron-capture spectrometry with cryogenic calorimeters for science and technology

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Accurate decay data on radioactive nuclides are necessary for many fields of science and technology, ranging from medicine and particle physics to metrology. However, data that are in use today are mostly based on measurements or theoretical calculations that are rather old. Recent measurements with cryogenic detectors and other methods show in some cases significant discrepancies to both older experimental data and theory. Moreover, the old results often suffered from large uncertainties. This is true especially for electron-capture (EC) decays, where only a few selected radionuclides were measured at all.

To systematically address these shortcomings, the European metrology project MetroMMC aims at investigating 6 radionuclides decaying by electron capture. The nuclides are chosen to cover a wide range of atomic charges Z , which results in a wide range of decay energies and includes different decay modes, such as pure EC or EC accompanied by γ - and/or β^+ -transitions.

Metallic magnetic calorimeters (MMCs) are cryogenic energy-dispersive detectors with high energy resolution and low energy threshold, that are well suited for total decay energy and X-ray spectrometry. Within the MetroMMC project, these detectors are used to apply calorimetry with highest energy resolution to obtain X-ray spectra of external sources as well as fractional EC probabilities of sources embedded in a 4π absorber. Experimentally determined nuclear and atomic data are then compared to newly developed state-of-the-art theoretical calculations which are also being developed within the project.

This contribution will introduce the MetroMMC project and in particular its experimental approach. The challenges in EC spectrometry are to adapt the detectors and the source preparation to the different decay channels and the wide energy range involved, while keeping the good resolution and especially the low energy threshold to measure the captures from outer shells.

Less than 5 years of experience since completion of Ph.D

Y

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