Study of the excited states in ^{195}Au populated in the beta-decay of the 13/2$^+$ isomer of ^{195}Hg, including linear polarization analysis

Project: MSc/Phd level
Supervisor: Elena Lawrie
Start date: 2024

Project Aim / Scope:
This project involves a study of the low- to medium-spin states in ^{195}Au, populated in the beta decay of the 13/2$^+$ isomer of ^{195}Hg, which is produced in the ^{197}Au(p,3n) reaction. The tape-station set-up on the A-line will be used, comprising of 7 clovers, one segmented clover, and a Si(Li) detector. The 66-MeV proton beam will be degraded to 35 MeV and an available target of ^{197}Au will be irradiated in the isotope production vault, using the RERAME target station. The requested beam time of 8 hours was approved through a discretionary beam time request in December 2022. The data will be sufficient for 1 PhD project or for three MSc projects. In the following one of these MSc projects is described.
The aim of the MSc project will be to carry out preliminary data analysis, and then to deduce transition multipolarity and mixing ratios using angular distribution, and internal conversion coefficients measurements.

Abstract:
Deformed triaxial nuclei can rotate simultaneously around their three major axes [1]. Such 3D rotation looks like precession of the total angular momentum in a similar way as the precession of a rotating top around the vertical axis. Rotational bands in triaxial nuclei, where the tilt of the total angular momentum is caused by collective rotation (with some single-particle component in odd-mass nuclei) are called tilted precession bands (TiP) [2], while if the tilt is caused by vibrational phonons, the bands are called wobbling phonon bands and are denoted by the number of excited phonons [3,4].
In the past decade bands with wobbling phonon nature were proposed in several isotopes, including ^{183}Au, ^{187}Au [5,6]. The most important experimental evidence for the proposed wobbling nature of these bands was the measured large mixing ratios of the transitions linking the excited and the yrast bands. The measured large magnitude for these ratios for the $h_{9/2}$ bands in ^{183}Au and ^{187}Au, were considered as a proof of

their wobbling phonon nature. However, more recent experimental data on the mixing ratios in ^{187}Au showed that the previous results were incorrect and that the mixing ratios are in fact small and indicate excitations with dominant single-particle nature [7]. These conflicting experimental results and the differences in the interpretation makes the nature of the excited bands in the Au isotopes an interesting topic in nuclear structure. To study further the Au isotopes PR329, focusing on ^{193}Au, is being analysed at present (PhD project of Ms Sinegugu Mthembu). The present proposal extends these studies to ^{195}Au, and in particular aims at measuring mixing ratios for transitions in the bands with $h_{9/2}$ nature, based on linear polarization analysis.
Beta-decay studies on excited states in the ^{195}Au isotopes were last done some 50 years ago, [8-10]. With the now available HpGe detectors and digital electronics we will probably observe several new transitions, as confirmed by our ongoing investigations on ^{193}Au.

More precisely the project includes the following:
(i) hands-on experience with setting-up the experiment and collecting experimental data, (ii) preliminary data analysis, such as gain-matching and gain-drift correction, and energy and efficiency calibrations, (iii) sorting of the data in γ and electron spectra and also in γ-γ coincidence matrices, (iv) analysis of the symmetric γ-γ matrix to establish γ-coincidences, (v) deducing the polarization sensitivity of the clover detects from the tape-station set-up and applying the linear polarization technique for the ^{195}Au data to measure the electric and magnetic nature of the observed transitions as well as determining mixing ratios for transitions with M1+E2 multipolarities, (vi) measure the branching intensity ratios for the ^{195}Au data, (vii) conclusion about the nature of the observed states based on the performed analyses.

Relevant References:

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