ISOMERIC RATIOS IN ^{206}Hg*

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^{206}Hg was populated in the fragmentation of an $E/A = 1$ GeV ^{208}Pb beam at GSI. It was part of a campaign to study nuclei around ^{208}Pb via relativistic Coulomb excitation. The observation of the known isomeric states confirmed the identification of the fragmentation products. The isomeric decays were also used to prove that the correlations between beam identification detectors and the AGATA γ-ray tracking array worked properly and that the tracking efficiency was independent of the time relative to the prompt flash.

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1. Introduction

Spectroscopic data from doubly-magic nuclei and their nearest neighbours are essential to constrain nuclear models. One of the key observables is the $B(\mathrm{E2}; 2^+ \to 0^+)$ transition strength which provides information about collectivity. Under the umbrella of the PReSPEC-AGATA campaign, an experiment to measure $B(\mathrm{E2})$ values in even-mass nuclei around ^{208}Pb was performed at GSI, Darmstadt, Germany. Relativistic energy Coulomb excitation was employed. As a first step of such measurements, the secondary beam composition has to be determined. Isomeric decay studies are ideally suited for this, allowing unambiguous isotopic identification. In addition, the isomeric and ground-state content of the nucleus of interest can be determined. In the present contribution, isomeric decays were used to check the performance of the γ-ray detection system.

2. Experimental details

The experiment took place during October 2012. A primary beam of $E/A = 1$ GeV ^{208}Pb was fragmented on a 2.5 g/cm^2 Be target. The secondary fragments were selected and identified using the FRS fragment separator. Settings centred on ^{198,200,202,206,208}Pb, ^{206}Hg and ^{200}Pt were used. In the isomeric decay part of the experiment, the secondary gold Coulomb excitation target was removed and the nuclei were stopped in a 10 mm thick perspex stopper. The stopper was positioned 15 cm downstream from the centre of the AGATA tracking array [1]. The identification information from the FRS detectors was correlated with the γ-ray information provided by AGATA; 17 crystals were available for this experiment.

The identification of the fragmentation products is shown in Fig. 1. The observation of isomeric decays in ^{205}Hg and ^{206}Hg provide verification of consistency with the simulation.

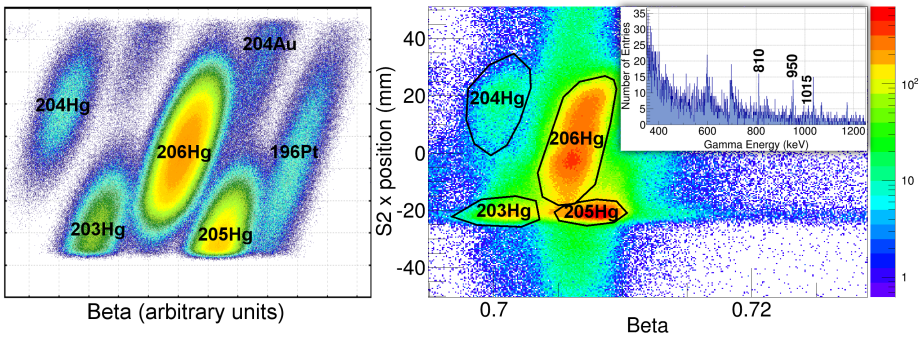

Fig. 1. Identification of the fragmentation products; LISE++ simulation is shown on the left-hand side, and is compared with the experiment shown on the right-hand side. The inset shows the delayed γ-ray spectrum associated with ^{205}Hg.

3. Results and conclusions

The isomeric ratio is defined as the number of nuclei in the isomeric state divided with the total number of nuclei. It can be experimentally determined using the equation: $\mathrm{IR} = \frac{N_\gamma(1+\alpha)}{N_{\mathrm{ion}}\epsilon b F G}$, where N_γ is the number of γ-rays detected, α is the conversion electron coefficient, b is the branching ratio, ϵ is the γ-ray detection efficiency, N_{ion} is the total number of ions, F is a correction factor for the in-flight isomeric decays and G considers that we measure only for a limited time window. For details of the procedure, see Ref. [2].

In the case of ^{206}Hg, there are two known isomeric states: a 5^- state with a half-life of 2.15(21) μs [3, 4], and a 10^+ state at a higher excitation energy, with a half-life of just 92(8) ns [3, 5]. In this experiment, 1.5 million ^{206}Hg ions were implanted. The delayed γ-ray spectrum associated with this nucleus, together with the relevant level scheme, is shown in Fig. 2. The half-life of the 5^- isomer was measured as $T_{1/2} = 2.19(7)$ μs, which is in good agreement with the Nuclear Data Sheet value [3], and is slightly longer than the 2.09(2) μs obtained from a similar fragmentation experiment [6].

The isomeric ratio was determined in two different ways:

(i) using the AGATA detectors as traditional HPGe detectors, *i.e.* using only the core signals from the Ge crystals, and

(ii) using the Mars-Gamma Tracking algorithm (MGT), reconstructing each event from individual interactions within the array.

In order to investigate the functionality of the system and the tracking efficiency dependence on the γ-ray rate, the isomeric ratio was determined using different delayed time windows. The γ-ray rate during the considered time window changed by a factor of three.

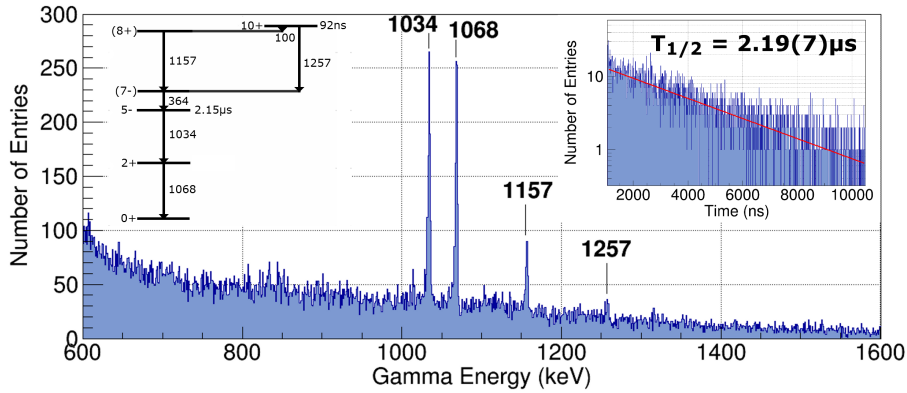

Fig. 2. Delayed, Δt = 84–384 ns, tracked γ-ray spectrum for ^{206}Hg. The level scheme and the time spectrum associated with the 5^- isomeric state are also shown.

The results were normalised to 1.00 in order to remove systematic uncertainties related to the level scheme as well as detection efficiency. The normalised isomeric ratio results are given in Table I. The extracted isomeric ratio, as it is supposed to be, is independent of the time window in which delayed γ rays are accepted. This proves that the correlations between the two subsystems (FRS and AGATA) worked correctly and that the tracking efficiency was independent of the time relative to the prompt flash. In addition, the ratio of the two isomeric ratios was determined as: $\mathrm{IR}(10^+)/\mathrm{IR}(5^-) = 0.11(2)$. This compares well, and improves the precision of the previously measured value of 0.10(4) [6].

TABLE I

Normalised isomeric ratios for the 5^- isomer in ^{206}Hg, determined with and without tracking and for different time windows.

Time window [ns]	IR (non-tracked) [%]	IR (tracked) [%]
384–2384	1.00	1.00
1384–3384	1.02(3)	1.01(4)
2384–4384	1.00(3)	1.02(4)
3384–5384	1.03(3)	0.99(4)

The Coulomb excitation data is being presently analysed. Combined with the beam composition information provided by the isomeric states, the B(E2) values will be determined in the future.

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