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ISOMERIC STATES IN ^{208}Hg AND ^{209}Tl POPULATED IN FRAGMENTATION OF ^{238}U* **

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The nuclear structure of neutron-rich $N > 126$ nuclei has been investigated following their production via relativistic projectile fragmentation of a $E/A = 1$ GeV ^{238}U beam on a Be target. The preliminary analysis indicates the presence of previously unreported isomeric states in the $N = 128$ isotones ^{208}Hg and ^{209}Tl.

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1. Introduction

The understanding of how shell structure arises and develops is a major goal in nuclear physics. To this end it is of particular importance to measure the properties of nuclei close to closed shells. To date our knowledge of the properties of heavy nuclei at or near the $N = 126$ shell is very limited. In the case of nuclei with $N > 126$ and $Z < 82$ excited states were reported only in ^{208}Tl [1] and ^{209}Tl [2]. The lack of information on nuclei in this region is mainly due to the difficulties in creating and populating excited states in these neutron-rich nuclei. Fragmentation has proved to be an efficient tool for producing exotic nuclear species [3]. The aim of the present work is to obtain information on the structure of heavy neutron-rich nuclei with $N > 126$.

2. Experimental details

The SIS-18 synchrotron at GSI provided a ^{238}U beam at $E/A = 1$ GeV. The primary beam intensity was $\leq 10^9$ ions/spill (spill length $\simeq 5$ s). The ^{238}U ions impinged on a target composed of 2.5 g/cm^2 ^{9}Be + 223 mg/cm^2 Nb. The nuclides of interest were selected and identified in flight by the FRagment Separator (FRS) [4].

A degrader of thickness 2176 mg/cm^2 Al equivalent was placed at the first focal plane (S1) to prevent the high intensity charge states of the primary beam from reaching and damaging the detectors at the intermediate focal plane (S2). The thickness of the wedge shaped degrader at S2 was 2.8 g/cm^2 Al equivalent. 93.8%, 91.0% and 80.7% of the ^{205}Pt ions were fully stripped leaving the target, the degrader at S1 and the degrader at S2 in the FRS respectively, according to the charge state calculations using the GLOBAL code [5]. Compared to our previous experiments [3,6], there were some improvements in the FRS detector setup: *(i)* Time Projection Chambers (TPC) were used to track the ions by measuring X and Y in two different positions along the beam line both in S2 and the final focal plane (S4). Our pervious standard setup used Multiwire (MW) proportional chambers for tracking at S4 (see Fig. 1), and a single scintillator detector to get position at S2. The high rate acceptance of TPCs allowed tracking even at S2. *(ii)* An automatic correction for pressure change of the MUlti Sampling Ionization Chambers (MUSIC) was used.

The ions of interest were stopped in an active stopper. The stopper [7] consists of six 5×5 cm Double Sided Silicon Detectors (DSSSDs), each with 16 horizontal and vertical strips. It was surrounded by the Rare ISotope INvestigations at GSI (RISING) germanium array, which detected the delayed γ radiation following either an isomeric decay or β-decay. The RISING array consists of fifteen Euroball cluster germanium detectors, and has a full-peak efficiency of $\sim 15\%$ at 661 keV [8].

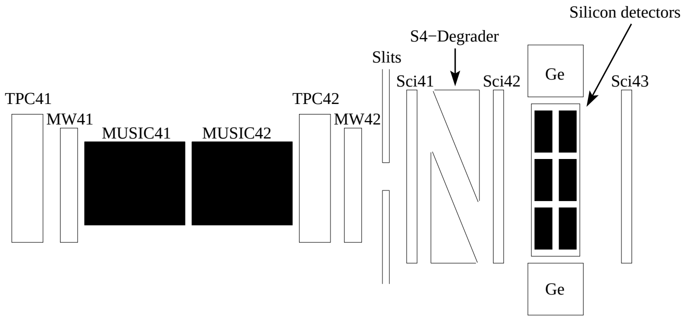

Fig. 1. Schematic of the detectors configuration at S4 of the FRS.

3. Experimental results

The secondary products of interest were transmitted through the FRS and the particle identification was made on event-by-event basis. Details of the particle identification technique are given in Refs. [3,9]. The particle identification is confirmed by the observation of the previously reported isomeric decays in ^{206}Hg [10]. Evidence of decays from isomeric states in the $N = 128$ isotones, ^{208}Hg and ^{209}Tl has been presented for the first time (see Fig. 2). Transitions at 203, 425 and 669 keV are clearly identified in isomeric

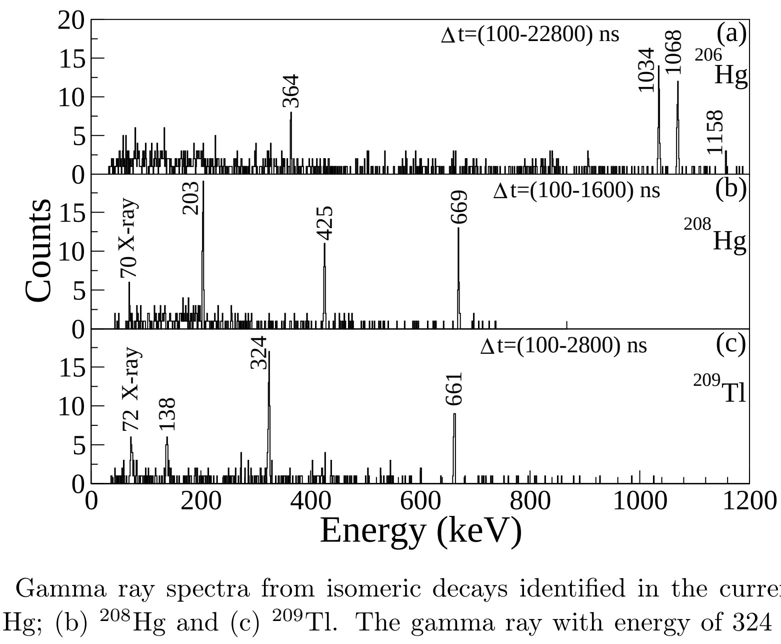

Fig. 2. Gamma ray spectra from isomeric decays identified in the current work. (a) ^{206}Hg; (b) ^{208}Hg and (c) ^{209}Tl. The gamma ray with energy of 324 keV was previously reported in Ref. [2].

decay of ^{208}Hg. A similar time range isomeric decay is also in evidence for ^{209}Tl with γ rays at 138, 324 and 661 keV clearly observed. The results will provide input for comparisons with shell model calculations for this region and in particular provide empirical data with which to compare residual interactions between protons holes and neutrons particles around the ^{208}Pb double magic nucleus.

4. Summary and conclusions

The preliminary analysis of the current data indicates the presence of previously unreported isomeric states in the $N = 128$ isotones ^{208}Hg and ^{209}Tl. The results will be interpreted in the framework of the shell model.

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