ISOMERIC DECAYS IN ^{200}Pt* **

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for the GSI ISOMER collaboration

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A projectile fragmentation experiment has been performed to populate the neutron-rich $A \sim 190$ mass region, approaching the $Z = 82$, $N = 126$ closed shell. A previously unreported isomer is found in ^{200}Pt, being the first new example, from fragmentation reactions, of a seniority 4 state established from γ–γ coincidences.

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1. Introduction

Shell model predictions (spherical and deformed) can be tested by the population of nuclei in isomeric states [1]. Here we present results from the use of projectile fragmentation to reach the neutron rich region below the $Z = 82$, $N = 126$ doubly closed shell, which is inaccessible using fusion reactions with stable beam/target combinations. Gamma radiation at the target, emmitted by the exotic fragments of interest, is obscured by relatively intense prompt background. However, nuclei produced in long-lived

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isomeric states can be separated for identification through a spectrometer, before discrete spectroscopy of the gamma-rays depopulating isomeric states is performed at a germanium detector array, more than 300 ns after production. The technique was first applied to such heavy nuclei by Pfützner *et al.* [2].

2. Experimental details

Ions produced in the fragmentation of a 1 GeV/A ^{208}Pb beam on a 1.6 gcm^{-2} beryllium target were separated and identified at the FRagment Separator (FRS) [3] at GSI, Darmstadt. Ions were identified on an event by event basis, by time-of-flight, energy loss and magnetic rigidity measurements. Mass-to-charge (A/Q) ratio of ions was calculated with respect to x-position at the intermediate focal plane of the FRS, providing separation according to charge state: fully-stripped, hydrogen-like and helium-like. The MUlti-Sampling Ionisation Chamber (MUSIC) at the final focal plane of the spectrometer provided further selection for Z. Ions were slowed down in a variable thickness degrader before being finally implanted in a 4 mm thick aluminium catcher surrounded by an array of four Segmented Clover detectors. The absolute photopeak efficiency of the Segmented Clover array was measured to be about 6% at 1.3 MeV and about 17% at 300 keV for the central position of the catcher. Different settings of magnetic rigidity of the spectrometer were employed to reach particular areas of the nuclide chart.

3. Data analysis and experimental results

Identification of fragments was achieved as outlined in reference [4]. Initial analysis of these data for a different FRS setting showed [5] previously reported $K = 35/2$ isomers in ^{175}Hf, ^{179}W and ^{181}Re [6], representing the highest discrete spin identified in a fragmentation reaction to date. Decays from the previously identified isomeric decays in ^{200}Pt [7] and ^{206}Hg [8] were used to confirm the isotopic identification technique and also provided a check for isomer decay half-life measurements. Isomeric decays were also observed in ^{190}W [4,9], and in ^{188}Ta, ^{192}Re, ^{193}Re, ^{197}Ir, ^{201}Pt and ^{202}Pt [10], providing the first spectroscopic information obtained on the structure of these nuclei.

The decay level scheme for ^{200}Pt obtained by Yates *et al.* [7] has been extended to include a previously unreported isomer (see Figure 1). The 7^- isomer was reported [7] to decay with a half-life of 14 ns. Ordinarily such a short-lived state would not survive the flight time through the spectrometer, but we propose it does due to the transition energy, which we do not observe, being less than the K-shell binding energy in platinum (78 keV). The electron

conversion mechanism de-exciting the isomeric state is inhibited as the ion is in a hydrogen-like charge-state. It is only when the fragment is implanted in the catcher that the isomeric state can be depopulated by electron conversion and attain its natural atomic half-life.

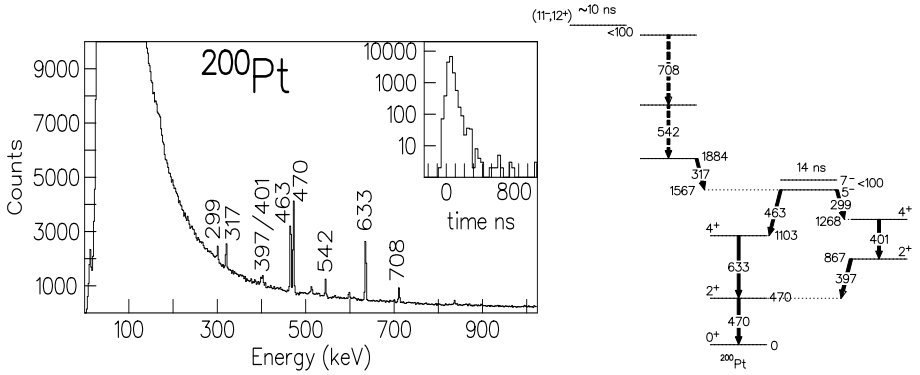

Fig. 1. Gamma-ray singles spectrum (gated by ^{200}Pt ions) and proposed decay level scheme for ^{200}Pt. The insert shows a time projection. The ordering of the 542 and 708 keV transitions is not determined. The suggested spin assignments for the upper isomer are based on Nilsson model calculations. The levels up to 1884 keV are from Yates *et al.* [7].

Gamma–gamma coincidences for ^{200}Pt are illustrated in Fig. 2. The 317 keV transition is placed by Yates *et al.* [7] feeding into the 5^-, 1567 keV level, and the newly observed 542 and 708 keV transitions evidently are in cascade, though their relative ordering is not determined (see Figs 1 and 2). However, a 781 keV transition placed by Yates *et al.* between the 1884 and 1103 keV levels is not observed in our work, and it remains a possibility that our 317 keV transition is different from that of Yates *et al.* . The relative intensities of the 708, 542 and 633 keV gamma-ray decays over time have shown that the half-life of the upper isomer is slightly shorter than that of the lower (14 ns) isomer. On account of the short ($\approx$10 ns) half-life, there must be a missing, highly converted (and therefore low energy, <100 keV) transition directly depopulating the isomer. Just as for the lower (14 ns) isomer, the hydrogen-like ^{200}Pt ion can then have a much longer in-flight half-life.

We have made Nilsson model calculations (with $\beta_2 \approx 0.1$) of the type described by Jain *et al.* [11] in an attempt to understand the structure of the upper isomer. It is most likely based on a two broken pair structure, *i.e.* 4 quasiparticles, with spin/parity 11^- or 12^+. This therefore appears to be the first new example, from fragmentation reactions, of a seniority 4 state established from γ–γ coincidences.

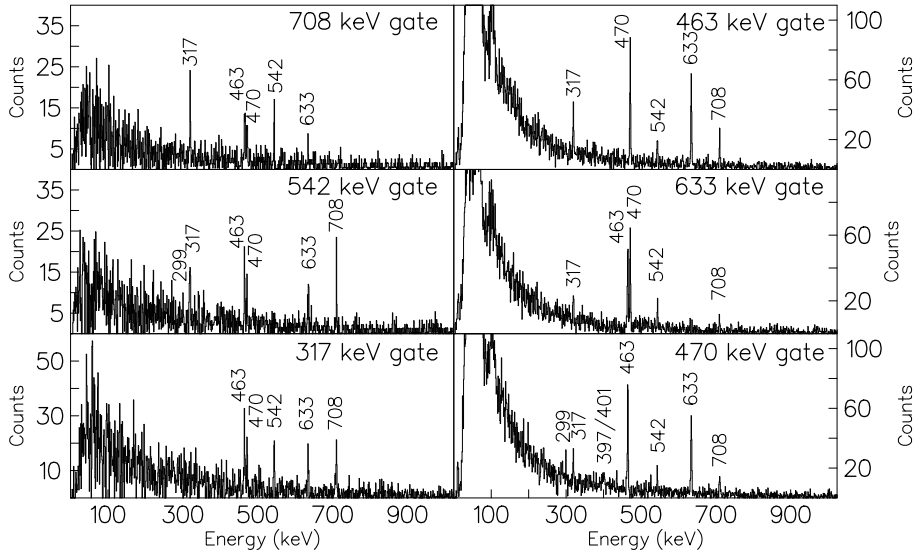

Fig. 2. Gamma-gamma coincidences for ^{200}Pt. The events are all within 200 ns of the ^{200}Pt ion arrival time. Gamma-ray decays at 708, 633, 542, 470, 463 and 317 keV are clearly in coincidence with each other.

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