

Isomer and β Decay Studies in Neutron-Rich $A \sim 180$ Nuclei

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Deep-inelastic collisions of ^{136}Xe ions with tantalum and tungsten targets have been used to study β -decays and high-spin isomers in neutron-rich $A \approx 180$ nuclei at the GSI on-line mass separator. Reaction products were extracted from the thermal ion source (TIS), accelerated to 55 keV, mass separated with a dipole magnet, and transported to a β/γ counting station. The implanted activity was periodically removed, with periods 160 s, 1600 s and 16000 s. Electron-gamma coincident events were written to magnetic tape in list mode, so that they could be analysed with respect to the half-lives involved.

Gamma-rays associated with the decay of the well known $K^\pi = \frac{37}{2}^-$, 51.4 min isomer in ^{177}Hf were observed with an unexpectedly high yield as shown in Fig. 1.

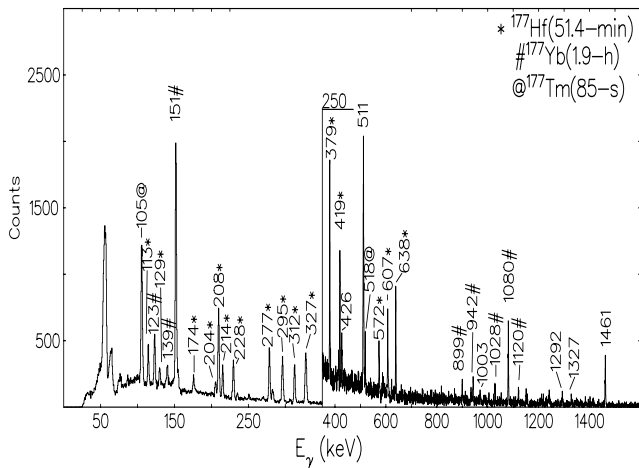


Figure 1: Gamma-ray spectrum for $A=177$ with a tantalum target.

The single-component grow-in analysis, for the sum of lines depopulating the $K^\pi = \frac{37}{2}^-$ isomer, gives a half-life of 76.4_{-9}^{+16} minutes which is distinctly longer than the previous measurements for this decay of $t_{1/2} = 51.4$ min [1]. Other half-lives are well reproduced in the same $A=177$ data set.

One possible explanation is that the $K^\pi = \frac{37}{2}^-$ decay in ^{177}Hf is due to the production of a theoretically predicted $K^\pi = \frac{39}{2}^-$, isomeric state in ^{177}Lu , which β decays (after extraction from the ion source) to ^{177}Hf .

A two component grow-in analysis for the observed decays from the $K^\pi = \frac{37}{2}^-$ isomer in ^{177}Hf gives a first component of 6_{-2}^{+3} min, when the second component is fixed to the published value of $t_{1/2} = 51.4$ min, as shown in Fig. 2. If this interpretation is correct, this would constitute the highest-spin beta-decaying state yet identified.

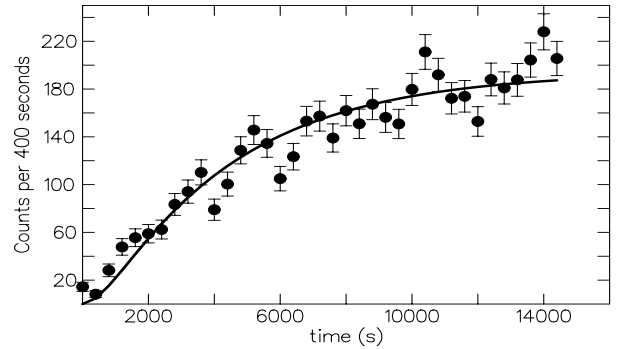


Figure 2: Two-parameter grow-in fit for the $K^\pi = \frac{37}{2}^-$ isomer in ^{177}Hf (assuming the half-life for the ^{177}Hf isomer is 51.4 minutes).

A follow-up experiment has been performed at the GSI mass separator, using the total absorption spectrometer (TAS) which comprises a silicon detector, and a germanium crystal for X-ray, γ -ray and β -spectroscopy, inside a large NaI(Tl) γ -ray detector [2], operated in both coincidence and anticoincidence modes. Preliminary analysis has shown, at $A=182$, well resolved ytterbium ($Z=70$) X-rays in association with a new γ -ray transition at 102 keV, proposed as the $2^+ \rightarrow 0^+$ transition in ^{182}Yb , which lies just above the 98 keV $2^+ \rightarrow 0^+$ transition of ^{182}Hf [1]. This is the first observational evidence for ^{182}Yb and its excited states. Apart from this new result, it is hoped that the TAS data will clarify the decay of high-K isomers at $A=177$.

References

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- [2] M. Karny *et al.*, Nuclear Instruments and Methods **B126**, 411 (1997)