NEW GAMMA RAYS FOLLOWING THE $^{233}U$ α-DECAY

O. El Samad, C. Ardisson, M. Hussonnois* and
G. Ardisson

Laboratoire de Radiochimie,
Université de Nice Sophia Antipolis,
28, avenue Valrose, F06108 Nice Cédex 2, France

*Institut de Physique Nucléaire,
BP 1, F91406 Orsay Cédex, France

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$^{233}U$ α-decay was reinvestigated using a
radiochemically purified source and high
efficiency HPGe coaxial detectors; the low-
energy γ-spectrum was also measured using a
LEPS detector. The energy and intensity
values of one hundred sixty three γ-lines
were determined, from which forty eight are
newly reported with respect to the last
study of Canty et al. A revised $^{229}$Th level
scheme was built, using the Ritz combina-
tion principle, in which nine levels are
newly observed, at 371.3, 381.8, 465.5,
569.2, 584.9, 605.1, 620.8, 656.9 and
749.9 keV.

INTRODUCTION

The decay of long-lived $^{233}U$ ($T = 1.59 \times 10^5$ y) has
been investigated by many authors during the 1970's,
by high resolution γ-spectroscopy using Ge detectors.
The main work is due to Kröger and Reich$^{1,2}$ which used
both single $\gamma$-spectroscopy with Ge(Li) detectors and $\gamma-\gamma$ coincidence experiments; these authors reported the existence of 118 $\gamma$-rays between 25 and 1119 keV. However, 29 $\gamma$-lines could not be interpreted in the $^{229}$Th level scheme. A later study performed by Canty et al.\textsuperscript{3} demonstrated the existence of 117 $\gamma$-lines, among which 26 were newly reported below 480 keV, whereas seventeen high energy $\gamma$-lines described by Kröger and Reich\textsuperscript{1} were not confirmed. Although these results\textsuperscript{1-3} were compiled entirely in the recent issue of Nuclear Data Sheets\textsuperscript{4} for the mass 233, and considering the rather interesting situation of the $^{229}$Th nucleus, at the borderline of the region of masses for which the reflection asymmetric rotor model has been successfully applied, it seemed to us quite necessary to remeasure the $\gamma$-spectrum following the $^{233}$U $\alpha$-decay using high-efficiency HPGe detectors as well as a low-energy photon spectrometer (LEPS).

This work is a part of our reinvestigations devoted to the decay chain $^{241}$Am$\rightarrow^{237}$Np$\rightarrow^{233}$Pa$\rightarrow^{233}$U (Refs 5,6).

**Source preparation**

Two $^{233}$U samples, provided by the C.E.A., of 10 and 100 mg masses and with isotopic purity better than 99.9\%, were used. The main contaminant was $^{232}$U ($T = 70$ $\gamma$) produced by the interfering reaction $^{233}$U(n,2n) during the $^{232}$Th target irradiation in the reactor. Hence, the source contained both $^{229}$Th and daughters from $^{233}$U decay, and $^{228}$Th and its short-lived daughters, $^{212}$Pb, $^{212}$Bi, and $^{208}$Tl, from $^{232}$U $\alpha$-decay. So a radiochemical separation was envisaged before measurements to discard the main part of high-energy $\gamma$-emitters which could obscure the low-intensity $\gamma$-lines following $^{233}$U decay.