Gamma ray energies of $^{143\text{-}145}$Cs and of their beta decay products (fission products)

1973 J. Phys. A: Math. Nucl. Gen. 6 L93

(http://iopscience.iop.org/0301-0015/6/7/005)

J. Phys. A: Math., Nucl. Gen., Vol. 6, July 1973. Printed in Great Britain. © 1973

LETTER TO THE EDITOR

Gamma ray energies of $^{143-145}$Cs and of their beta decay products

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Received 21 May 1973

Abstract. Spectroscopic measurements have been performed on neutron-rich fission products from ^{235}U (n_{th}, f). We report the mass separation of thermally ionized short-lived Cs ions in an on-line mass separator. γ ray lines of ^{143,144,145}Cs, ^{143,144,145}Ba and ^{144}La are reported.

An existing mass spectrometer has been used as an on-line isotope separator for fission products in order to do γ ray spectroscopy on short-lived, neutron-rich nuclei. The experimental set-up is similar to the one described by Klapisch *et al* (1967).

^{235}U(0,5g) incorporated in porous carbon sheets is exposed to the flux of a neutron guide tube (7×10^6 n cm^{-2} s^{-1}) at the Munich research reactor (FRM). The carbon sheets are placed in a tantalum tube heated to about 1700 K and the recoiling fission products are stopped in the graphite. Due to the high temperature they diffuse quickly to the graphite surface. The low ionization potentials of Rb and Cs isotopes allow a thermal ionization at the surface of the surrounding tantalum. The ions are extracted through a slit in the tantalum foil and accelerated by 15 kV.

In order to achieve a mass separation the particles are deflected by a magnetic sector field (deflecting angle 77·5°, radius 21·5 cm). Particles of one mass then pass through an exit slit of the separator and impinge on a transport tape. Particles of neighbouring masses contribute less than 1 %. Si surface barrier detectors and Ge(Li) detectors are used to record the β and γ ray activities of the fission particles, respectively. The tape velocity determines the time during which the particles stay in the sensitive region of the detectors. The variation in the intensity of the γ ray lines as a function of the tape velocity allows the determination of the emitting nucleus in an isobaric β decay chain.

The whole experimental set-up has been tested by recording the γ ray spectra of ^{141}Cs and ^{142}Cs isotopes. We achieved good agreement with the results of other authors (Alväger *et al* 1968, Carlson *et al* 1969, Hopkins *et al* 1971, Kratz 1971). Since we separate Cs isotopes directly (on-line) we find higher intensities in the very neutron-rich isotopes.

To reduce the γ ray background, the γ ray quanta are registered only in coincidence with β particles. The half-lives of the nuclei under consideration were determined by chopping the ion beam. The build-up and the decay of the β activity yielded values which are in good agreement with known half-lives (Amarel *et al* 1969, Carlson *et al* 1969,

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Table 1. γ ray energies observed in the decay of the investigated nuclei

Isotopes	E_γ (keV), $\Delta E_{\gamma,\max} = \pm 1$ keV						
^{143}Cs	74·5	85·3	117·7	158·5	195·4	232·5	263·2
	(75)	(85)		(159)	(196·5)	(232)	
	273·0	299·2	306·4	466·0	527·0	534·5	569·9
	604·5	626·2	659·8				
	(604)						
^{143}Ba	178·3	211·3	254·2	291·5	430·5	435·3	718·8
	797·7						
^{144}Cs	200·2	331·3	558·4	638·7	758·4		
^{144}Ba	105·0	158·0	173·6				
^{144}La	260·9	397·0	540·8	584·4			
^{145}Cs	112·6	175·1	199·0				
^{145}Ba	92·3	97·1					

Values given in brackets are taken from Kratz (1972) and Amiel (1970).

Tracey *et al* 1971). The γ ray energies obtained in this experiment are shown in table 1; the maximum error being 1 keV. Values published elsewhere are given in brackets to allow easy comparison of our results with those of other investigations.

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