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Abstract

A new isomer [ $T_{1/2} = (6.3 \pm 0.3) \text{ s}$ ] has been identified in  $^{124}\text{Cs}$ . Its  $2^+$  decay has been studied by gamma- and electron - spectroscopy on mass separated samples.

1. Introduction

To get more detailed information about low-spin levels in the neutron-deficient transitional nuclei of the  $54 < Z < 58$  region, a systematic search for isomeric levels and their decay has been undertaken with the mass separator Isocele II operating on-line to the Orsay synchrocyclotron.

In the cesium isotopes ( $Z = 55$ ) a large number of ground states and isomeric states have been already identified at CERN and their spins have been measured <sup>1)</sup>. For the odd-odd nuclei, two different half-lives have been reported for  $^{122}\text{Cs}$  and  $^{130}\text{Cs}$  but only one has been observed for  $^{124}, ^{126}, ^{128}\text{Cs}$ .

Looking at the intrinsic states already identified in odd-A xenon (odd neutron) and in

odd-A cesium (odd proton) isotopes <sup>2)</sup> the  $1^+$  ground state of odd-odd cesium nuclei can be explained from  $A = 130$  to  $A = 122$  but the absence of isomer in  $^{128}, ^{126}, ^{124}\text{Cs}$  is surprising and suggests new systematic investigations in a large range of half-lives.

2. Experimental techniques

The mass-separated samples were produced by bombardment of a molten cerium metallic target <sup>3)</sup> with a 280 MeV  $^3\text{He}$  beam or a 200 MeV proton beam. The cesium activities were carried out from the collecting point of the isotope separator to the detectors, using a rapid tape driver system. Different techniques have been used to study these activities, mainly based upon  $\gamma$ , X and  $e^-$  singles measurements at very low-energy. A multispectrum analysis has been performed on the  $\gamma$ -ray singles and the conversion electron spectra.  $\gamma$ - $\gamma$ -t,  $\gamma$ -X-t,  $\gamma$ - $e^-$ -t and X- $e^-$ -t three parameters coincidences have also been recorded.

3. Preliminary experimental results

Up to now, the data are not completely analysed, but several results are clearly extracted. In addition to the transitions previously observed in the decay of  $^{124}\text{Cs} \rightarrow ^{124}\text{Xe}$  <sup>4)</sup> four new gamma lines at 53.7, 58.0, 89.3 and 96.3 keV have been found in the low-energy part of the  $\gamma$ -ray singles spectra of  $^{124}\text{Cs}$  samples.

From the multispectrum analysis (eight time groups per spectrum) of the  $\gamma$ -ray singles spectra, the decay curves (reproduced in figure 1) have been determined. So, in addition to the previous 31 seconds activity already measured in  $^{124}\text{Cs}$ , a new half-life of  $(6.3 \pm 0.3)$  seconds has been clearly detected.

In the electron spectra recorded with the magnetic selector associated with a silicon detector <sup>5)</sup>, the K, L and M lines corresponding to the internal conversion in cesium of these  $\gamma$ -rays have been observed (figure 2). Moreover, two other transitions at  $(64.7 \pm 0.1) \text{ keV}$  and  $(161.0 \pm 0.2) \text{ keV}$  have also been detected by their conversion electrons in cesium (figure 2). These electron lines have the 6.3 seconds half-life.

All these new transitions have not been observed in samples collected at a mass  $(124 + 19)$  and corresponding to  $\text{BaF}^+$  ions of the "fluorine technique" developed at Isocele II <sup>3)</sup>. Moreover, in the  $\gamma$ -X and  $e^-$ -X coincidence spectra they are in coincidence with the Cs X-rays and they can be unambiguously assigned to  $^{124}\text{mCs}$ . Multipolarities have been deduced from the relative  $I_{e^-}/I_\gamma$  intensities. A first normalization has been made for the stronger, medium energy  $\gamma$ -rays (96.3 and 89.3 keV) with the 353.9 keV E2 transition,  $2^+ \rightarrow 0^+$  of the  $^{124}\text{Xe}$  ground band. From this estimation the 89.3 keV appears as a pure E1 transition and has been used to normalize the  $\alpha$  conversion coefficients of the very low energy lines (Table 1).

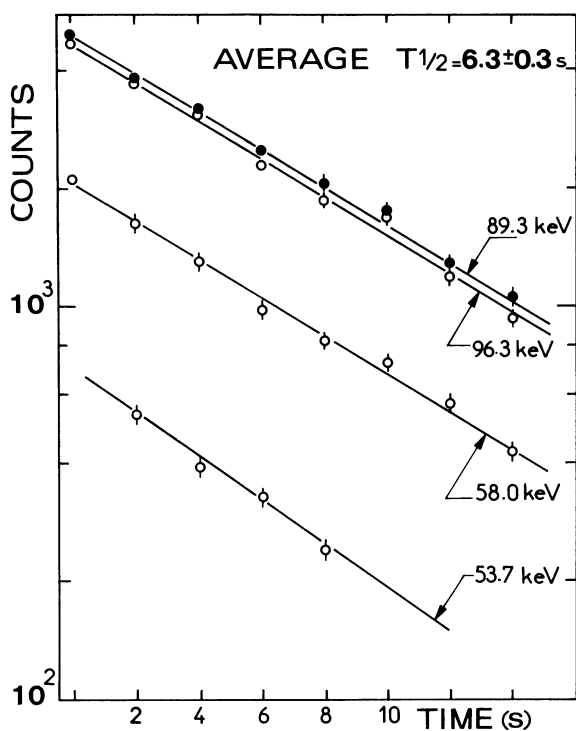


Fig. 1 Decay curves for low energy  $\gamma$ -rays observed in  $^{124}\text{Cs}$ .

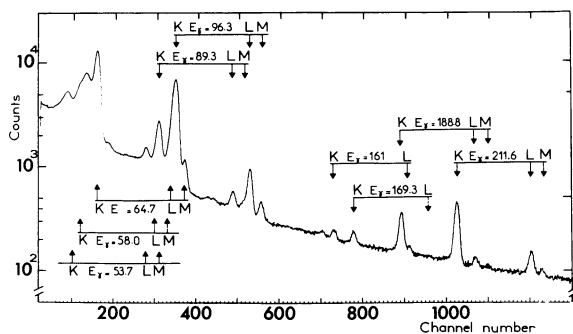


Fig. 2 Conversion electron spectrum measured with  $^{124}\text{Cs}$  samples.

Due to the large variations of the efficiency of both the magnetic selector and the gamma detector, the uncertainties on  $\alpha_K$  and  $\alpha_L$  are important but the K/L ratios give supplementary values, useful to determine the multiplicities.

Table 1 . Characteristics of the transitions

$E_\gamma$ (keV)	$I_\gamma$ rel.	$I(e^-K)/I_\gamma$ (norm.)	K/L	Multiplicity
53.7	7.1	$\sim 3.2$	6.6	M1, E2
58.0	20.9	$\sim 1.1$	8	E1
64.7	2.6	$\sim 28$	3.6	M2
89.3	52.5	0.26	6.9	E1
96.3	51.9	0.98	7.7	M1(E2)
161.0	-	-	1.0	(E3)
169.3	5.8	0.14	-	M1, E2
188.8	27.6	0.14	6.2	M1, E2
211.6	56.2	0.12	4.8	E2, M1

Before a complete analysis of the data, it is impossible to place unambiguously the low-energy levels of  $^{124}\text{Cs}$ .

Recent  $\gamma$ - $\gamma$ -t,  $\gamma$ -X-t and  $\gamma$ - $e^-$ -t coincidence experiments have been performed with  $^{124}\text{Ba}$  samples to precise the same part of the level scheme.

Nevertheless, mainly from the  $\gamma$ - $\gamma$  coincidences, it appears that the  $^{124}\text{mCs}$  isomeric level is deexcited by two different paths. The first one corresponds to a cascade of four transitions 64.7 keV (M2), 96.3 keV (M1), 89.3 keV (E1) and 211.6 keV (E2, M1) (Figure 3 and 4). The second cascade contains the 161.0 keV transition (probably E3) followed by the 58.0 keV (E1), 53.7 keV (M1,E2) and 188.8 keV (M1, E2) transitions.

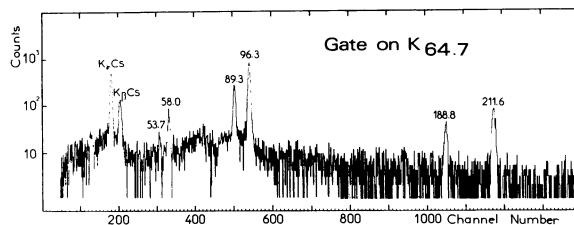


Fig. 3 :  $e^-$  -  $\gamma$  coincidence spectrum gated on the  $K_{64.7}$  line.

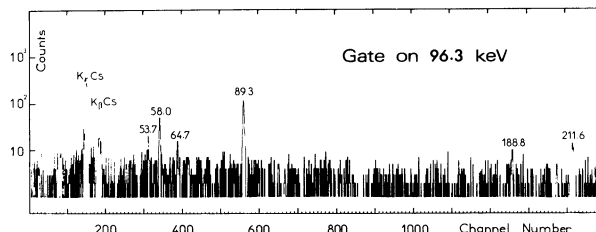


Fig. 4 :  $\gamma$ - $\gamma$  coincidence spectrum gated on the 96.3 keV  $\gamma$ -ray.

The 161.0 keV transition, observed on the electron singles spectra appears very likely as the cross-over of the 64.7 keV + 96.3 keV lines of the main cascade. So, the two different paths could feed the same level at  $(300.8 \pm 0.2)$  keV established by the two different sums  $89.3 + 211.5 = 300.8 \pm 0.2$  keV and  $58.0 + 53.7 + 188.8 = 300.5 \pm 0.3$  keV. This 300.8 keV level, which is deexcited by E1 transitions would also present a weak half-life and it is a candidate for a second low-energy isomeric level in  $^{124}\text{Cs}$ . The ground state of  $^{124}\text{Cs}$  has spin and parity  $1^+$  1). From the multiplicities of the transitions and the  $\gamma$ - $\gamma$  coincidence relationships established in the decay of  $^{124}\text{mCs}$ , the 6.3 seconds isomeric level at 461.8 keV could very likely support a  $(7^+)$  assignment while the level at 300.8 keV could be a  $(4^-)$  state. Up to now, the partial analysis of the data does not permit to determine unambiguously the neutron and proton orbitals involved in the description of the low-energy states of this odd-odd  $^{124}_{55}\text{Cs}$  nucleus.

#### References

- 1) C. Ekström et al., N.P. A292 (1977) 144 and Phys. Lett. 76B (1978) 565
- 2) J. Genevey et al., communication to this Conference and references in.
- 3) J.C. Puteaux et al., contribution to the 10th EMIS Conf., ZINAL, Sept. 1980, to be published in Nucl. Inst. Meth.
- 4) A. Charvet et al., J. de Phys. 38, (1977), L 242
- 5) P. Paris, J. Tréherne, Rev. Phys. Appl. 4 (1969) 291.