The Decay of $^{136}$Te (20.9 s)

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The beta decay of $^{136}$Te has been investigated with the on-line mass separator LOHENGRIN from the Institute Laue-Langevin at Grenoble in conjunction with an air-jet collecting system. A level scheme of $^{136}$I based on coincidence measurements has been established. The measured $Q_\beta$ value is $5100 \pm 150$ keV.

I. Introduction

$^{136}$I belongs to the family of odd-odd nuclei with 83 neutrons of which $^{138}$Cs [1–3], $^{140}$La [4] and $^{142}$Pr [5] are well known. The experimental study of this kind of nuclei by beta decay from a 0$^+$ parent nuclei is not so fruitful as some other approaches; nevertheless, in the case of $^{136}$I, owing to its situation in the chart of nuclides, radioactivity is the only possibility to observe some low spin states.

The decay of $^{136}$Te has first been investigated by Folger [6] who observed two gamma lines of 332.6 keV and 738.2 keV with a half-life of $20.9 \pm 0.5$ s. A few more gamma lines have been observed by Lundan [8] after a mass separation of the fission products. A value of 24 $\pm 2$ s for the half-life of $^{136}$Te has also been measured with delayed neutrons by Grappengiesser et al. [7].

In order to obtain a more detailed knowledge about the level scheme of $^{136}$I, the decay of $^{136}$Te produced by thermal neutron induced fission of $^{233}$U was studied with the use of the parabola separator LOHENGRIN at the high flux reactor of the Institut Laue-Langevin at Grenoble.

II. Experimental Techniques

Lohengrin [9] separates the fission products with a magnetic sector field and an electrostatic cylindrical field according to their mass $A$, their initial kinetic energy $E_k$ and their ionic charge $q$, along a parabola. The resolution $A/A_A$ can be chosen conveniently (of the order of 1000, FWHM) to provide beams of a pure mass at the exit slit of 72 cm length and a few mm width. The beam intensity amounts to about 1000 per s and cm of parabola length, for fission products with high fission yields.

An air jet device of 17 capillaries [10] is used to concentrate the separated fission products on a spot of about 3 mm diameter located on a discontinuously moving plastic tape. The transport time of the jet is about 0.7 s, and its efficiency is close to 100% for non volatiles elements; for iodine, however, the efficiency is less than 10%. This drawback enabled us to reduce considerably the iodine activity in the mass chain 136 which otherwise would mask the activity of tellurium, as observed in the spectra shown by Lundan [8].

The $\gamma$-ray spectra, $\gamma$-$\gamma$ and $\beta$-$\gamma$ coincidences were measured with Ge(Li) detectors of 2.3 keV resolution and 15% efficiency for the 1332.5 keV $\gamma$ line of $^{60}$Co.
The γ-γ coincidences were stored on a magnetic tape by use of a multiparameter data acquisition system M 20-INTERTECHNIQUE, and then analysed with a PDP 10 computer.

The β-spectra were detected by a β-detector telescope in coincidence with a Ge(Li) γ-detector. The β-detector telescope consisted of a 75 mm × 75 mm Ø plastic scintillator (NE 102 A) and a 0.5 mm thick plastic AE-detector in front of it to reduce the γ-sensitivity and the backscattering effect. Each scintillator was coupled to a EMI 9531 photomultiplier.

The energy calibration of the β-detector telescope was performed at the conversion electron spectrometer Bill [11] in addition to internal calibrations using known β-endpoint energies.

The observed βγ coincidence events were stored in a two-dimensional 64 k disc memory (128 β-channels × 512 γ-channels). Coincidences with strong γ-lines were obtained by use of a PDP 10 computer.

III. Experimental Results

The single gamma ray spectrum corresponding to the decay of $^{136}$Te is shown Figure 1: it is the first of two spectra measured during two successive time intervals of 20 s, the transport time or cooling time being 1 s. Besides the γ-lines of $^{136}$Te whose time behaviour agrees with the half-life of 20.9 s measured by Folger [6], we observe the strongest lines of $^{136}$I, essentially...