The decay of the isomeric state of Cs$^{134m}$ was studied. The decay half-time $T_{1/2} = 2.93 \pm 0.05$ hours was determined. From measurements carried out by means of a spectrometer with short lens, scintillation measurements and chemical separations, the non-existence of the weak decay $\beta$ of this state was proved, contrary to statements found previously in the literature (maximum possible intensity 0.02%, compared to the value of ~ 1% found in the literature). The spectrum of conversion electrons was measured by a double-focusing spectrometer, and the following transition energies were determined: 127.3 $\pm$ 0.3 keV (E3) and 138.4 $\pm$ 0.4 keV (M4) ($K: L: M = 92: 100: 27$ for the 127.3 keV transition, and $206: 100: 31$ for the 138.4 keV transition). The conversion coefficient of the 127 keV transition was measured, resulting in a value of $\chi_K = 2.55 \pm 0.4$. The ratio of transition intensities is $I_{138}: I_{127} = 5.7: 1000$.

INTRODUCTION

The decay of Cs$^{134m}$ was observed after the irradiation of Cs$^{133}$ in the $(n, \gamma)$ reaction or the $(d, p)$ reaction in papers [1-3] and the first informative data were published. The half-time was determined as 3.15 hours.

More detailed measurements were carried out by Caldwell [4] using a spectrometer with a permanent magnet. Caldwell determined the energy of the isomeric transition as 128 keV, and the ratio $K: L: M = 23: 34: 6$. Similar work was carried out by Mihelich [5], using a high-resolution spectrometer, and by Sunyar [5], using a scintillation spectrometer. These authors determined the transition energy as 127.6 keV and the coefficient $\chi_K$ as 2.2 $\pm$ 0.4. From the conversion coefficients, the transition character was obtained as E3, which did not agree with the experimentally determined spin 8 of the isomeric level [8] and the ground state spin 4.

Therefore, Sunyar et al. [7] carried out combined measurements with a magnetic spectrometer and a proportional counter. They found the intermediate state with energy 10.5 keV and spin 5, decaying to the ground state, and a weak transition of 137.4 keV (0.8%) directly from the isomeric to the ground state. In the work of Keister et al. [11] with a lens spectrometer, a weak $\beta$ spectrum was found, which had an intensity of $\sim 1\%$ and a maximum energy of 550 keV.

PREPARATION OF SOURCES

Cs$^{134m}$ may be obtained most simply by means of the reactions Cs$^{133}(n, \gamma)$ or Cs$^{133}(d, p)$. Since in the course of irradiation the isomeric as well as the ground state is formed, the reaction and irradiation conditions must be selected in such a way that the most favourable ratio of isomeric to normal Cs$^{134}$ ($T = 2.2$ years) activity is obtained, together with a sufficiently high specific activity. On comparing reactor and cyclotron irradiation, an 8 times better Cs$^{134m}$ ratio was found in the reaction with deuterons but the specific activity was substantially lower, and complications
Decay of $^{134}{\text{Cs}}$ ...

occurred in chemical treatment since it was necessary to remove the products of competing reactions, for instance $(d, n), (d, 2n)$. The irradiation of $^{134}{\text{CsNO}_3}$ by thermal neutrons was therefore selected. Irradiation was carried out for 2 hours with a flux of $\sim 10^{13}$ n/cm$^2$ sec.

The relatively thin and homogeneous sources were obtained by precipitating $^{134}{\text{CsNO}_3}$ from an aqueous solution in ethyl alcohol (5 drops of a concentrated $^{134}{\text{CsNO}_3}$ solution were injected into 3 ml ethyl alcohol). The precipitate was centrifuged onto a preparation backing, and after drying was used as a source. In order to permit evaluation of the influence of the source thickness on the spectrum form, $^{137}{\text{Cs}}$ sources of varying thickness were prepared in the same way, their spectrum being of a well known form, and the dependence of the spectrum deformation on the source thickness was investigated. The most suitable thickness was found to be 0.2 mg/cm$^2$. Measurements on the lens spectrometer were carried out with sources 1 mg/cm$^2$.

**DECAY OF $^{134}{\text{Cs}}$**

a) $\beta$ spectrum measurements using a short-lens spectrometer. A continuous electron spectrum, decaying with a half-time of $\sim 3$ hours, was found by the measurements in addition to the lines of the 127 keV transition. The maximum energy of these electrons was 390 keV, which disagreed with the energy of 550 keV mentioned by Keister et al. [11]. The mean intensity was 0-6% disintegration. Half-times were calculated for each point of the spectrum, and from the mean of all points and measurements the value of $T_{1/2} = 2.93 \pm 0.05$ was determined.

The Fermi-Curie graph was calculated for this spectrum. Its form could not be linearized by means of correction factors for forbidden spectra, not even on the assumption of positron decay, and with energies of around 200 keV it bent sharply downwards. This effect could not be caused by discrimination of the scintillation counter with an anthracene crystal, used in the spectrometer as a detector, since Fermi-Curie graphs for the spectra of $^{137}{\text{Cs}}$ and $^{134}{\text{Cs}}$, obtained for sources of equal quality, gave forms identical to known ones, and distortion due to discrimination appeared only in a region below 100 keV.

$\beta$-decay with the energy determined would have to lead in the $^{134}{\text{Ba}}$ nucleus to a level of approximately 1800 keV, with a spin value close to 8. For this reason, $\gamma$ spectrum measurements with a scintillation spectrometer and Ba isolations were carried out at the same time, for the case that a Ba daughter isomer would be formed.

b) Measurements of the $^{134m}{\text{Cs}}$ spectrum. The $\gamma$ spectrum was measured by means of a NaI crystal and a 200-channel analyzer. Measurements up to 2 MeV were carried out at intervals of 1-5 hours after irradiation, and then on following days. A single measured energy of 127 keV corresponded to $^{134m}{\text{Cs}}$ decay. The rest of the spectrum showed no change with time, within the limits of experimental error, corresponding precisely to the decay spectrum of the $^{134}{\text{Cs}}$ ground state.

c) Isolation of Ba from Cs. In order to judge the possibility of decay to some long-time isomeric level in $^{134}{\text{Ba}}$, chemical isolation was carried out. From a solution