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ABSTRACT

The gamma spectrum of 25.5 ± 2-min. Sb^{131} was investigated with a scintillation spectrometer. Gamma rays with energies of 0.645 and 0.950 MeV were observed, and their absolute abundances determined.

Nuclei near doubly closed shells are of special interest because of the applicability of shell-model calculations. In the past, nuclei in the region of doubly magic Sn^{132} have not been investigated to the same extent as those near Pb^{208} and Ca^{40}. Studies in the region of Sn^{132} have been limited by lack of a rapid chemical separation of Sb and Sn from fission products. With the recent development by Love and Greendale of a rapid Sn and Sb separation from fission products,[1,2] this region has now been opened to investigation.

Neutron-excess isotopes of Sb with mass numbers less than 131 have been quite thoroughly investigated. The only data previously reported on Sb^{131}, Sb^{132}, and Sb^{133} are their half lives. In 1955 Pappas and Wiles reported half lives of 23, 2.1 and 4.1 min, respectively, for these isotopes.[3] Recently two half lives have been reported for Sb^{131}, both of 26 min,[4,5] and a half life of 2.6 min for Sb^{133}.[1] The present report is concerned only with Sb^{131}.

The isotopes of interest are produced in the spontaneous fission of Cf^{252}, which is available at this laboratory as a thin source from which the fragments readily escape.

EXPERIMENTAL METHOD

The chemical separation of Sb from fission products followed closely the procedure given by Love and Greendale.[1] A sodium bicarbonate tablet was used to catch fission fragments from a 11-μg source of Cf^{252}. The tablet was dissolved in 30% sulfuric acid. Stibine gas (SbH_3) was produced by adding the sulfuric acid solution to granular zinc. The stibine was decomposed by passing it through a quartz tube heated with nichrome wire. The radiochemically pure Sb metal condensed on the walls of the quartz tube. Love and Greendale report the following decontamination factors: Te(4×10^4), Sn($> 10^5$), and mixed fission products (10^5).

The relative yield of Sb^{131} with respect to the long-lived and short-lived Sb activities was maximized by collecting fission fragments for about 30 min (minimizing the activity of the long-lived isotopes) and allowing the short-lived activities to decay (about 10 min) before the Sb separation. The fission yield[6] also acts to limit the amount of Sb activities with mass number less than 129.

The gamma spectrum was measured with a 3- by 3-in. NaI(Tl) crystal. The pulse-height spectrum from the crystal was recorded on a 400-channel analyzer.

RESULTS AND DISCUSSIONS

The prominent 0.645- and 0.950-MeV photopeaks in the gamma spectrum (Fig. 1) of the separated fission-product Sb have been assigned to Sb^{131}. This assignment is based on their half lives and the growth of the daughter, Te^{131}. The predominant interfering activities are the 6- and 37- min isomers of Sb^{130} and the 25-min isomer of Te^{131}. The growth and decay curve of the 0.150-MeV gamma ray of Te^{131} is given in Fig. 2.

The half life was originally measured to be 23 min.[3] However, more recently reported values are 26 min.[4,5] In the present study, an average half life of 25.5 ± 2 min was obtained. The decay curve of the 0.645-MeV photopeak (Fig. 3) gave a half life of 26 ± 2 min, and the 0.950-MeV photopeak (Fig. 4) gave a half life of 25 ± 2 min. The best estimations of the half lives were obtained by using a least-squares fitting program.

Based on the absolute abundances of the gamma rays of Te^{131} as given by Ferguson and Tomnovec,[7] and on the percent branching as given by Sarantites,[8] the absolute abundances of the Sb^{131} gamma rays (Table 1) were calculated by using the relative abundances of the 0.145-MeV photopeak of Te^{131} and the 0.645-and 0.950-MeV photopeaks of Sb^{131} taken from a spectrum obtained 17.5 min after the chemical separation.

We wish to thank Claudette Rugge for work connected with least-squares fitting of our decay curves, and Joan Phillips for her help in preparing the manuscript.

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Table 1. Summary.

E (MeV)	Abundances (gammas/disintegration)	Half life (min)
0.645 ± .015	0.37 ± .17	26 ± 2
0.950 ± .020	0.48 ± .20	25 ± 2

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FIGURE LEGENDS

Figure 1. Gamma-ray spectrum (A) measured 4.3 min after the Sb separation. A small peak appears at 0.110 MeV which decays with a half life of less than 4 min; this is possibly Sb^{132} or Sb^{133}. Gamma ray spectrum (B) was measured 14.7 min after the Sb separation.

Figure 2. Growth and decay curve of the 0.150-MeV gamma ray of Te^{131}.

Figure 3. Decay of the 0.645-MeV photopeak of Sb^{131}.

Figure 4. Decay of the 0.950-MeV photopeak of Sb^{131}.

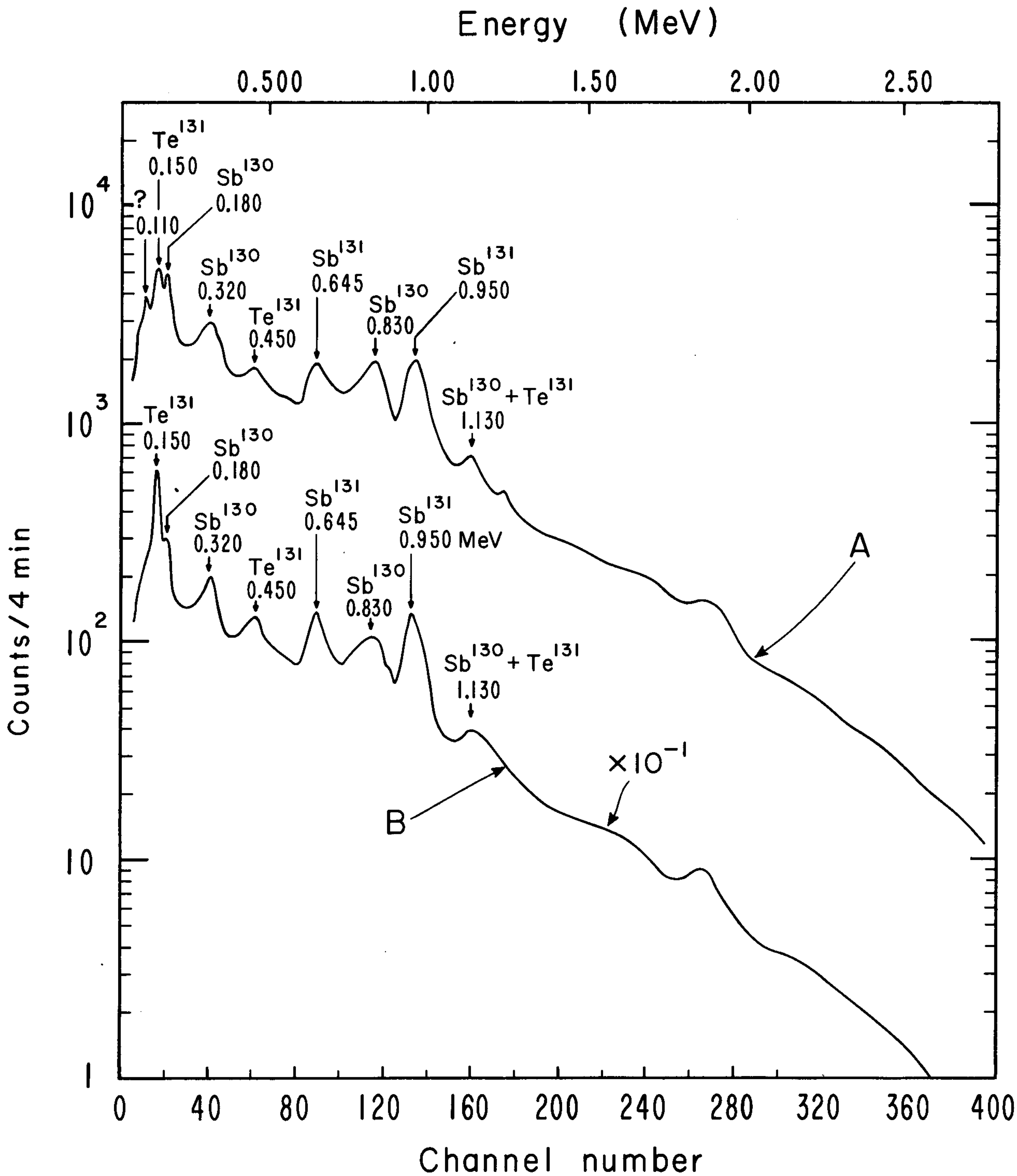

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Fig. 1

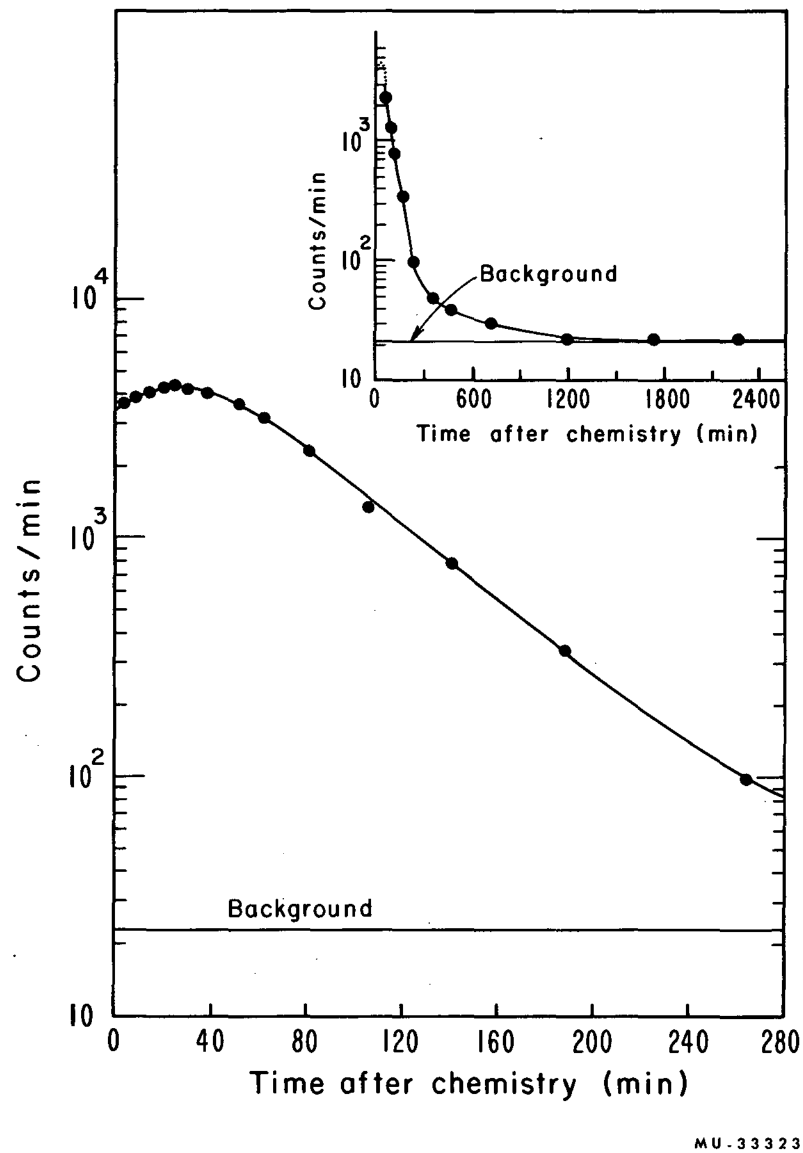
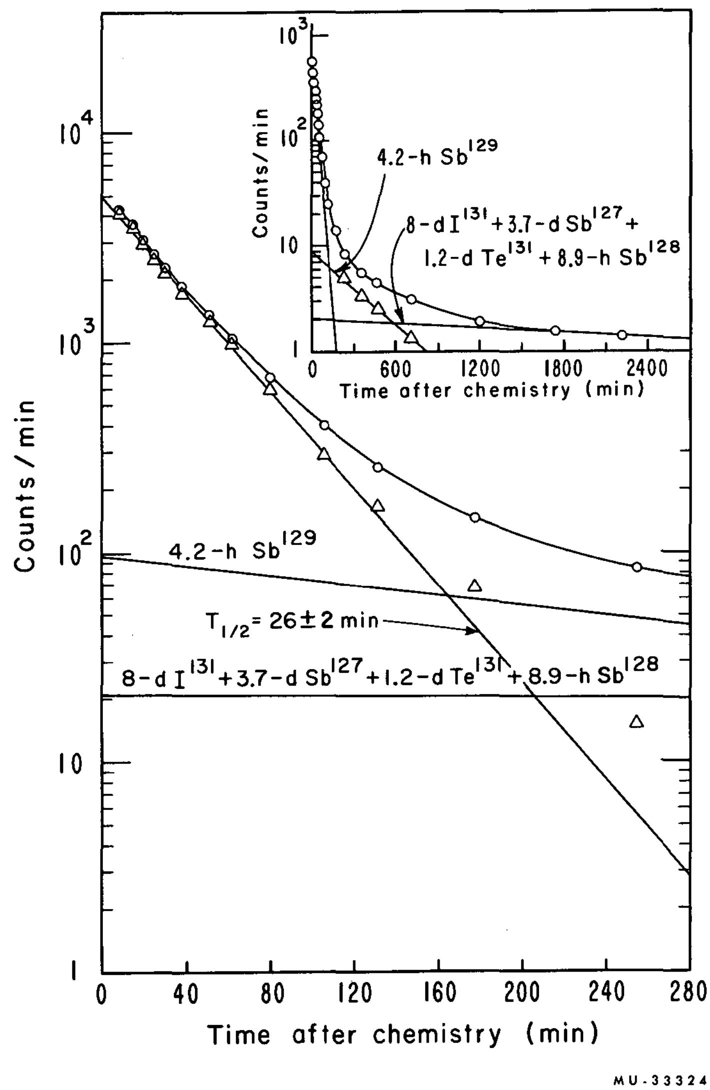
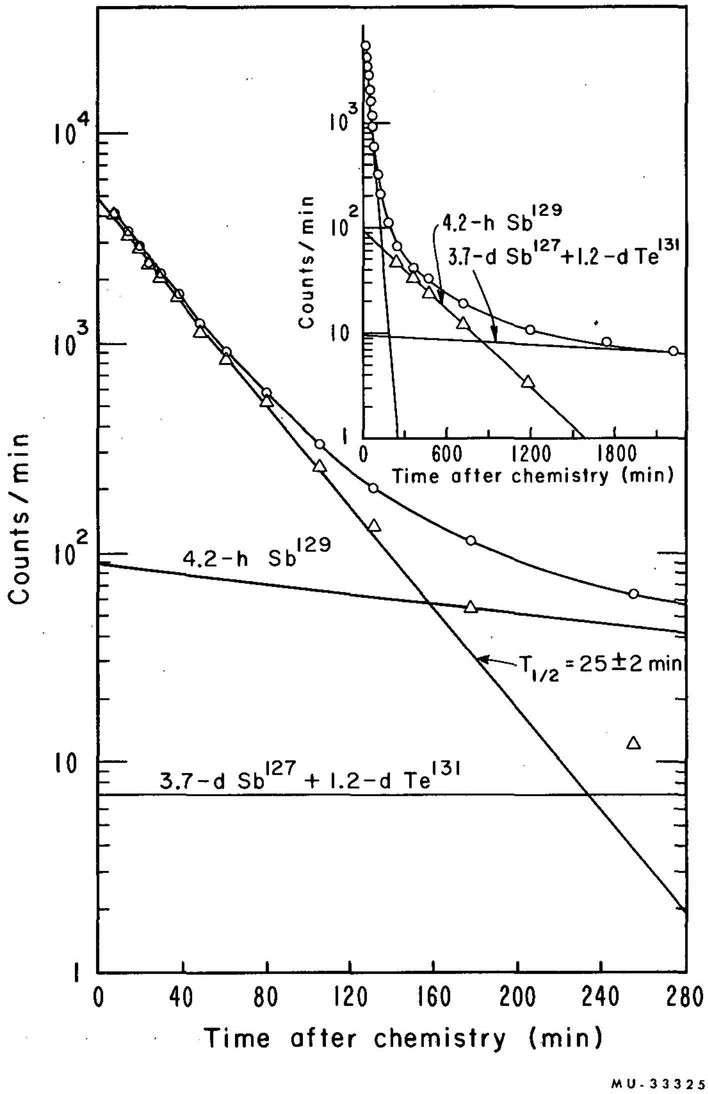

Counts/min
Background
Time after chemistry (min)
Counts / min
Background
Time after chemistry (min)
MU-33323

Fig. 2



Counts / min
Time after chemistry (min)
4.2-h Sb129
T1/2= 26±2 min
8-d I131+3.7-d Sb127+1.2-d Te131+8.9-h Sb128
Time after chemistry (min)
MU-33324

Fig. 3



Counts / min
Time after chemistry (min)
4.2-h Sb^{129}
3.7-d Sb^{127} + 1.2-d Te^{131}
$T_{1/2}$ = 25 ± 2 min
MU-33325

Fig. 4