A new tin isotope—^{106}Sn

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A new radioactive isotope of tin, with atomic mass 106 and half-life $T_{1/2} = 1.9 \pm 0.3$ min, was obtained and identified using the extracted beam of the isochronous cyclotron of the Nuclear Physics Institute of the Kazakh Academy of Sciences and the reaction ^{106}Cd(^{3}He, 3n). The energies and relative intensities of the ^{106}Sn γ rays were measured.

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As part of the program of study of neutron-deficient isotopes far from the β-stability line, performed with the isochronous cyclotron of our Institute, we undertook a search and identification of the unknown isotope ^{106}Sn. The apparatus and the research method were described by us in[1–3].

To obtain the isotope ^{106}Sn we used the reaction ^{106}Cd(^{3}He, 3n). The energy of the ^{3}He ions was measured in the range 21—59 MeV. The targets were foils of metallic cadmium enriched to 64% of ^{106}Cd. The bombarded targets were transported to a Ge(Li) γ spectrometer by a pneumatic system. To obtain the necessary statistics, the pulse spectra were accumulated in an AI-4096 analyzer in succession from 22 irradiated targets. Each target was irradiated for 10 seconds. The measurement of the γ spectrum was started 30 sec after the end of the bombardment and lasted 2 minutes.

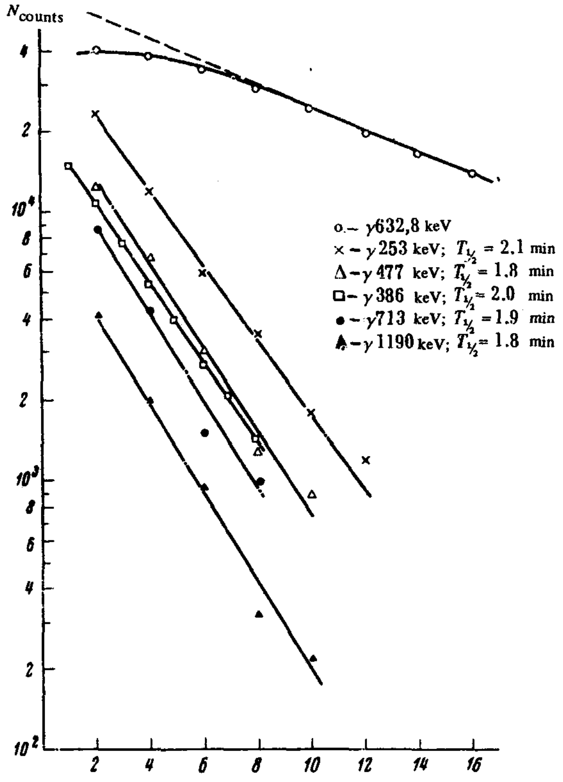

FIG. 1. Time dependences of the intensities of the γ lines with energies 253, 386, 477, 713, 1190 keV (^{106}Sn) and 632.8 keV (^{106}In).

By bombarding the targets with ^{3}He ions in the indicated energy range, we obtained and identified (by their γ rays) the known radioactive isotopes ^{105}In (Refs. 2,4), ^{106}In (Refs. 5,6), ^{107}In (Ref. 7), ^{107}Sn (Ref. 8), and also ^{104,105}Cd (Refs. 9,5) and ^{104}Ag (Ref. 10), the yield of the last two being much smaller.

In addition to the γ lines of the known isotopes, we observed in the spectra γ rays with energies (in keV) and relative intensities (in the parentheses) 122 ± 1 (40 ± 15), 253 ± 1 (62 ± 5), 386 ± 1 (100), 477 ± 1 (74 ± 7), 713 ± 2 (50 ± 20), and 1190 ± 2 (50 ± 10) and with a half life $T_{1/2} = 1.9 \pm 0.3$ min, which we ascribe, on the basis of the identification described below, to the decay of a new isotope, ^{106}Sn. The 122-keV line turned out to be complicated so that its assignment to ^{106}Sn is less reliable. Figure 1 shows plots of the intensities of the new γ lines against the time.

The new activity was identified in the following manner: Inasmuch as the employed ^{106}Cd targets contained as impurities other cadmium isotopes, measurements were made with cadmium targets of varying isotopic compositions. These have made it possible to establish that the new activity is produced only in a reaction with ^{106}Cd.

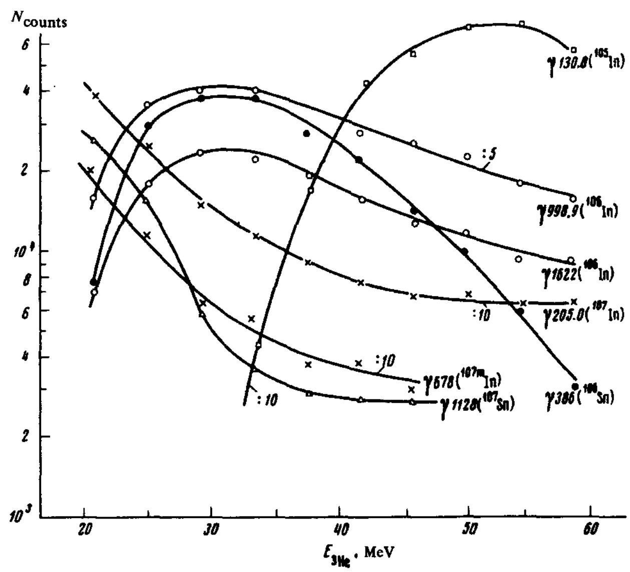

FIG. 2. Excitation functions of certain γ lines of ^{106}Sn, ^{107}Sn, ^{105}In, ^{106}In, ^{107}In, obtained by bombarding a ^{106}Cd target with ^{3}He ions.

To determine the atomic mass of the investigated activity with $T_{1/2}=1.9$ min, we measured the excitation functions of the observed γ lines. Figure 2 shows the excitation functions of certain γ lines, obtained by bombarding the ^{106}Cd target with ^{3}He ions.

From an analysis of the excitation functions of the observed γ lines it was determined that the new activity belongs to the atomic mass $A=106$, and this activity can be ascribed either to ^{106}Sn or to a new isomer state of ^{106}In. This was also evidenced by the time variation of the intensity of the γ transition from the first excited 632.8-keV level in ^{106}Cd (Fig. 1), which shows that the ^{106}In is fed by an unknown parent activity. The estimated half-life of this activity, determined graphically from the curve on Fig. 1, amounted to ~2 min.

To draw unequivocal conclusions as to the origin of the new γ lines, we investigated the reaction products obtained by bombarding a ^{107}Ag target with ^{3}He ions. In this case no tin isotopes were produced, while the two known states of ^{106}In (state with high spin, $T_{1/2}=6.3$ min, and state with low spin, $T_{1/2}=5.3$ min)[6] were produced with a large yield, and their γ spectra had an appreciable intensity. These spectra did not contain at all the new γ lines with $T_{1/2}=1.9$ min, so that their being due to the decay of a possible isomeric state in ^{106}In could be excluded, and they could be ascribed to ^{106}Sn decay.

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