Reports of the Academy of Sciences of the USSR

A. K. LAVRUKHINA, G. M. KOLESOV

1963

SovietRxiv

Fig. 1. Change in the activity of daughter Ce134 as a function of time (separation was carried out after 1 hr)

Figure 1: Fig. 1. Change in the activity of daughter Ce134 as a function of time (separation was carried out after 1 hr)

Fig. 2. Decay curve of lanthanum isotopes. 1 –T1 = 4.3 hr; 2 –T2 = 1.1 hr; 3 –T3 = 20 min.

Figure 2: Fig. 2. Decay curve of lanthanum isotopes. 1 –T1 = 4.3 hr; 2 –T2 = 1.1 hr; 3 –T3 = 20 min.

Abstract

Full Text

Reports of the Academy of Sciences of the USSR
1963. Volume 148, No. 5

PHYSICS

A. K. LAVRUKHINA, G. M. KOLESOV

NEW NEUTRON-DEFICIENT ISOTOPES OF RARE-EARTH ELEMENTS OF THE CERIUM GROUP

(Presented by Academician A. P. Vinogradov, 27 VIII 1962)

Earlier ([1–3]), the formation during the spallation of samarium by high-energy protons of new neutron-deficient isotopes Eu^{143}, Sm^{141}, Sm? (possibly an isomer, $T \sim 9$ hr), $Pm^{138?}$, Pr^{134}, and La^{129} was suggested. In the present work, the half-lives of Pr^{134} and La^{129} have been refined, and the search for new light isotopes of rare-earth elements of the cerium group has been continued. Interest in this group of isotopes is due to the discovery of a new region of deformed nuclei, for which $50 < N < 82$ ([4]).

Fig. 1. Change in the activity of daughter Ce^{134} as a function of time (separation was carried out after 1 hr)

Fig. 2. Decay curve of lanthanum isotopes.
1 $-T_1 = 4.3$ hr; 2 $-T_2 = 1.1$ hr; 3 $-T_3 = 20$ min.

As the target, praseodymium oxide with a content of Pr_6O_{11} of 99.96% was used; it was irradiated with protons of energy 660 MeV on the synchrocyclotron of the Joint Institute for Nuclear Research. Fractions of rare-earth elements were obtained by the chromatographic method, and cerium was isolated in a radiochemically pure state by extraction of $H_2[Ce(NO_3)_6]$ with diethyl ether from 8-10 N nitric acid. The time for separating cerium radioisotopes by the chromatographic method was 2-2.5 hr, and by extraction about 1.5 hr. The samples were measured on an MTS-20 end-window counter and on a scintillation γ-spectrometer with a 100-channel pulse-height analyzer.

The half-life of Pr^{134} was determined by systematic separation from the irradiated praseodymium of daughter Ce^{134} with $T = 3.1$ days every 30-60 min.

From the course of the time dependence of the change in activity of the daughter Ce^{134} (number of separations), shown in Fig. 1, it follows that the half-life of Pr^{134} is 36 min. The average value, determined from 4 experiments, is 40 ± 7 min. One of the components of the γ-line with $E_\gamma \simeq 720$ keV, found in the praseodymium fraction, has the same half-life. It is possible that γ-rays of this energy appear in the decay of the isotope Pr^{134}.

Analysis of the decay curve of the activity of the lanthanum fraction (Fig. 2) makes it possible to identify the following short-lived isotopes: $\mathrm{La}^{132,133}$ with $T = 4.3$ h, La^{131} with $T = 1.1$ h, and a new isotope with $T \sim 20$ min, apparently with $A = 129$.

The mass number of the lanthanum isotope with $T \sim 20$ min was established from the daughter isotope Ba^{129} with $T = 2.1$–2.4 h [5–7]. The half-life of La^{129}, determined imprecisely because of the low activity of Ba^{129}, proved to be ~ 24 min.

In the γ-spectrum of the cerium fraction, γ-rays with energy 80 ± 15 keV were found, and in the lanthanum fraction—with $E_\gamma = 115 \pm 20$ keV and $E_\gamma = 175 \pm 15$ keV and a half-life of 2.2 h, which may be attributed to Ba^{129} [6,7]. In addition, activity with $T \sim 13$ min was found in the cerium fraction, as well as γ-radiation with energies 80 ± 15, 315 ± 20, and 745 ± 20 keV, whose intensity decreased with $T \sim 15$ min. On the basis of these data one may suppose that in the lanthanum and cerium fractions we detect individual members of the chain of isobars with $A = 129$:

$$\mathrm{Ce}^{129} \xrightarrow[\sim 13\ \mathrm{min}]{} \mathrm{La}^{129} \xrightarrow[\sim 20\ \mathrm{min}]{} \mathrm{Ba}^{129} \xrightarrow[2.2\ \mathrm{h}]{} \ldots \rightarrow \mathrm{Xe}^{129} \text{ stable.}$$

The authors thank L. D. Firsova and R. I. Kuznetsova for their help in carrying out the experiments.

Institute of Geochemistry and Analytical Chemistry
named after V. I. Vernadsky
Academy of Sciences of the USSR

Received
27 VII 1962

SovietRxiv

CITED LITERATURE

1. A. K. Lavrukhina, G. M. Kolesov, Materials of the II Conference on neutron-deficient isotopes of rare-earth elements, Joint Institute for Nuclear Research, Dubna, 3, 1959, p. 63.

2. A. K. Lavrukhina, G. M. Kolesov, Materials of the IV Conference on nuclear spectroscopy of neutron-deficient isotopes and nuclear theory, Joint Institute for Nuclear Research, Dubna, 1962, p. 106.

3. A. K. Lavrukhina, G. M. Kolesov, Izv. AN SSSR, ser. fiz., **24**, No. 9, 1113 (1960).

4. R. K. Sheline, T. Sikkeland, R. W. Chanda, Phys. Rev. Lett., **7**, No. 12, 446 (1961).

5. C. C. Tomes, E. O. Wiig, J. Am. Chem. Soc., **72**, 2818 (1950).

6. W. Henkes, Phys. Rev., **113**, No. 3 (1959).

7. E. Arbman, I. B. Häller, Nucl. Phys., **22**, 341 (1961).

Note: Figure translations are in progress. See original paper for figures.