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Новый изотоп ^{157}Tm, $T_{1/2}$= (3,6±0,3) мин

Обнаружен новый изотоп ^{157}Tm. Измерен период полураспада $T_{1/2}$ = (3,6±0,3) мин, энергии и интенсивности γ-лучей, возникающих в его распаде.

Предлагается схема распада.

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The New ^{157}Tm Isotope, $T_{1/2}$=(3.6 ± 0.3) min

The new isotope ^{157}Tm has been discovered and its half-life $T_{1/2}$=(3.6 ± 0.3) min has been measured. On the basis of the balance of energies and intensities of γ-transitions occuring in the ^{157}Tm decay we have found a number of excited states of the ^{157}Er nucleus with energies of 110.2; 241.3; 357.3 and 457.1 keV.

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Dubna 1975

Methods for Obtaining Sources

The neutron-deficient isotopes of rare-earth elements were obtained in the spallation of a tantalum target by the E = 660 MeV protons on the JINR synchrocyclotron.

In studying the gamma-ray spectra of ^{157}Tm two types of radioactive sources were used. The first of them is the isobar radioactive source, being a mixture of rare-earth element isobars with the atomic number A = 157, the second one is the radioactive source ^{157}Tm chemically selected from isobars with A = 157.

The radioactive isobar sources with A = 157 were obtained by a method described in detail in ref. /1/. The tantalum foil 0.05 mm thick and the weight of 0.3 - 0.4 g irradiated with protons was placed in the vaporizer of an ion source of the mass-separator. The ion source was heated up to temperature T = 2500 - 2800° K and the spallation products diffusing from the target were ionized and separated over isobars. The time interval between the end of the target irradiation and the beginning of measurements of the γ-ray spectra of isobars was not longer than 4 min.

The ^{157}Tm separation from the isobars with A = 157 was performed by the extraction chromatography method in the HDEHP-HCl system /2,3/. Ions with A = 157 were focused in the mass-separator on a 12 x 12 mm glass plate covered with a thin layer of NH_4Cl. After the separation was completed the plate was removed and the layer of NH_4Cl together with foreign atoms introduced there was washed off the plate by the HCl solution (0.02 cm^3 1M HCl). The solution containing the radioactive isoto-

pes was transferred to the chromatographic column (100 mm long, dia. 2 mm, filling - silicagel KCK No 2, grain diameter being 0.015 mm, siliconized, containing 0.6 cm^3 HDEHP per gram of silicagel, with free volume of 0.25 cm^3) and the rare-earth elements were eluated subsequently by 8MHCl with saturated HDEHP with a 2 cm^3/cm^2 min velocity. After 7 minutes a fraction containing a ^{157}Ho and ^{157}Er mixture was selected and 2 minutes later a fraction with ^{157}Tm was selected. All the chemical operations lasted about 11 minutes.

Measurement Results

The γ-ray spectra were investigated by γ-spectrometers with Ge(Li) -detectors having a volume of 3.0 and 50.0 cm^3. Their energy resolution was 1.0 keV at the energy of 120 keV for the first detector and 2.7 keV at the energy of 1333 keV for the second one. In the γ-ray spectra of isobars A = 157 we have found, in addition to the known γ-transitions arising in the ^{157}Ho decay ($T_{1/2}$ = 12.6 min)/4,5/ and in the ^{157}Er decay ($T_{1/2}$ = 24 min) /6/ , a series of γ-transitions (Fig.1) whose intensity decreases with the halflife of $T_{1/2} \approx$ 3.5 min. Also the $K\alpha$ and $K\beta$ X-rays of Er were observed (Fig. 2) the intensity of which decreases with the halflife $T_{1/2}$ = (3.6 ± 0.3) min (Fig. 3). The results obtained are listed in Table 1.

In the ^{157}Tm γ-spectrum obtained by a chemical separation of the isobar source with A = 157 we have also observed the Er KX-rays and some other γ-transitions (Table 2). Fig. 4 shows parts of γ-ray spectra of a fraction containing the mixture of holmium and erbium and that of a fraction containing Tm. The Tm fraction was measured by 2 minutes later on the same detector (Ge(Li) - 50 cm^3). The comparison of these spectra allows one to identify a number of γ-transitions as transitions arising at the ^{157}Tm decay. Poor statistics limits the accuracy of definition of energies and intensities of the observed transitions.

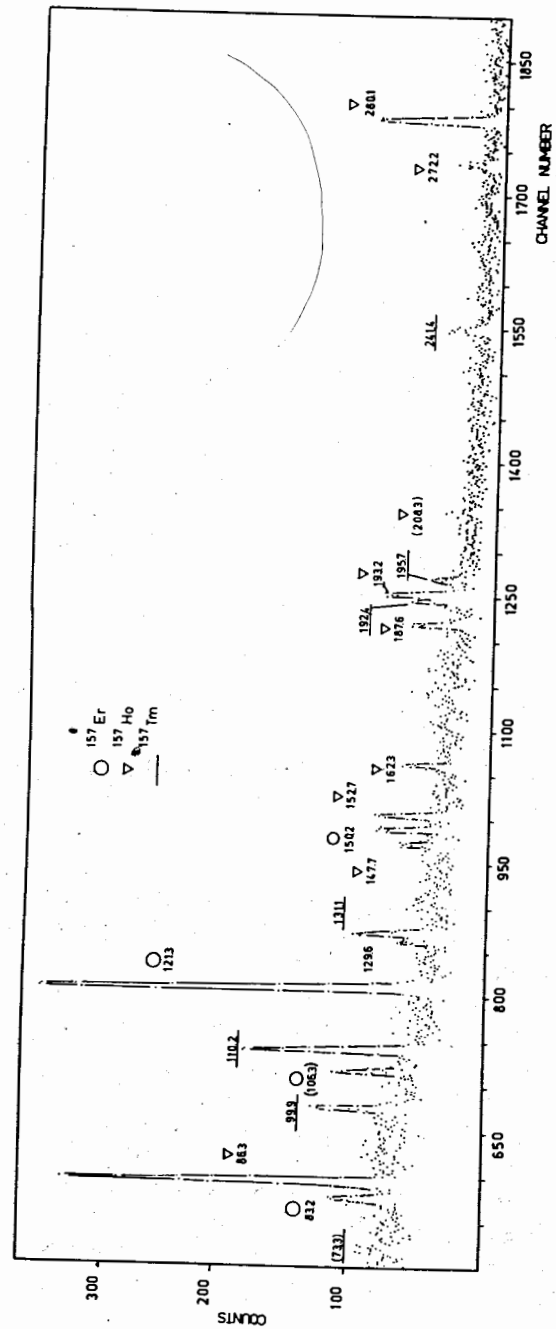


Fig. 1. A part of the γ-ray spectra of isobars with A = 157.

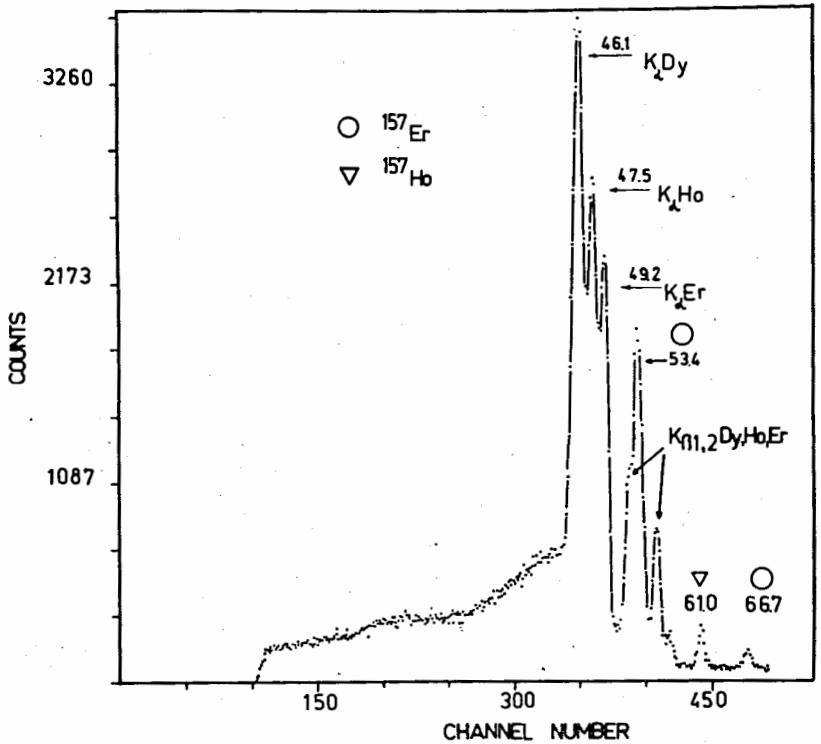


Fig. 2. The X-ray spectra of isobars with A = 157.

Thus, the results obtained here indicate that the half-life $T_{1/2}$= (3.6 ± 0.3) min refers to the decay of the new ^{157}Tm isotope.

On the basis of the balance of energues and intensities a number of ^{157}Er levels are proposed which are excited at the ^{157}Tm decay (Fig. 5).

The absence of data on the multipolarity of γ-transitions makes it impossible to draw a conclusion about the spins and parities of assumed excited states. Preliminary of this work have been published in ref./7/.

In conclusion the authors thank Professor K.Ya.Gromov for support and regular interest in the work, Yu.Yushke-

Table 1. γ- rays in the ^{157}Tm decay observed in the γ-spectrum of the isobar source.

$E_\gamma \pm \Delta E_\gamma$ [keV]	$I_\gamma \pm \Delta I_\gamma$ [a.u]	$T_{1/2} \pm \Delta T_{1/2}$ [min.]
Kα-rays of Er	~1400	3.6 ± 0.3
(73.3)		
99.9 ± 0.1	19 ± 2	~ 3.6
110.2 ± 0.1	49 ± 5	3.7 ± 0.4
131.1 ± 0.1	24 ± 3	3.6 ± 0.4
195.7 ± 0.2	16 ± 3	~3.7
241.4 ± 0.2	46 ± 5	~3.5

Table 2. γ-rays in the ^{157}Tm decay observed in the γ-spectrum of the chemically separated fraction of ^{157}Tm

E_γ [keV] a)	$I_\gamma \pm \Delta I_\gamma$ [in units of table I]
Kα-rays of Er	
100.0	~ 18
110.0	40 ± 10
131.0	~ 30
192.0 b)	~ 30
196.0	~ 25
241.5	~ 45
247.3	~ 20
347.0	100 ± 20
351.0	~ 30
357.0	~ 75
370 c)	~ 50
385.0	~ 60
467.0	100 ± 30

a) The error in energy measurement is not larger than 1 keV.
b) The transition can be due to the ^{158}Tm admixture ($T_{1/2}$=3.8 min).
c) The compound transition.

vich for supplying separated sources, V.I.Gulev and S.V.Medved' for making available the apparatus for successful experiments.

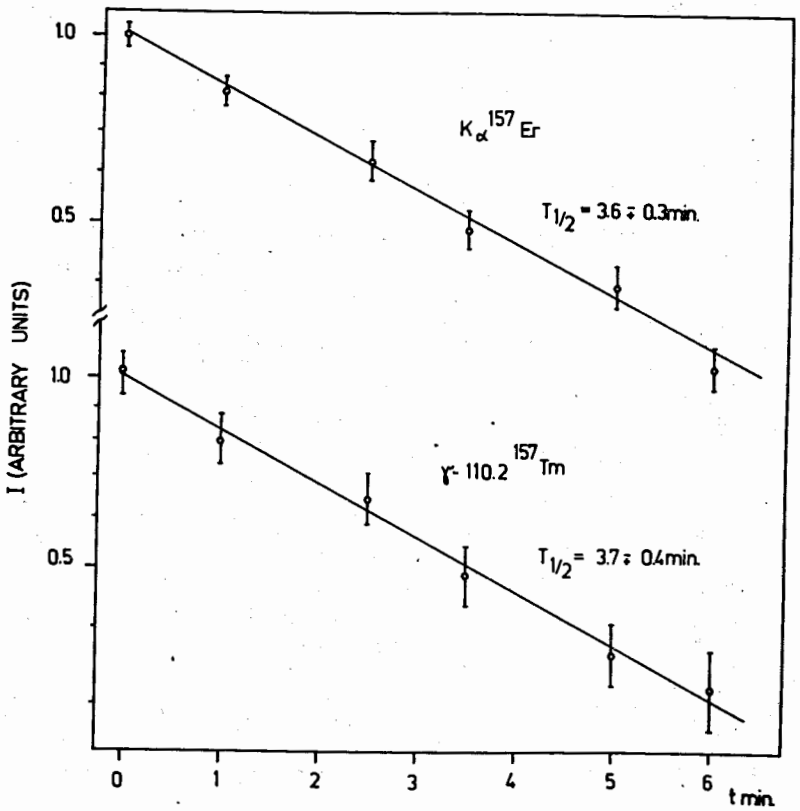
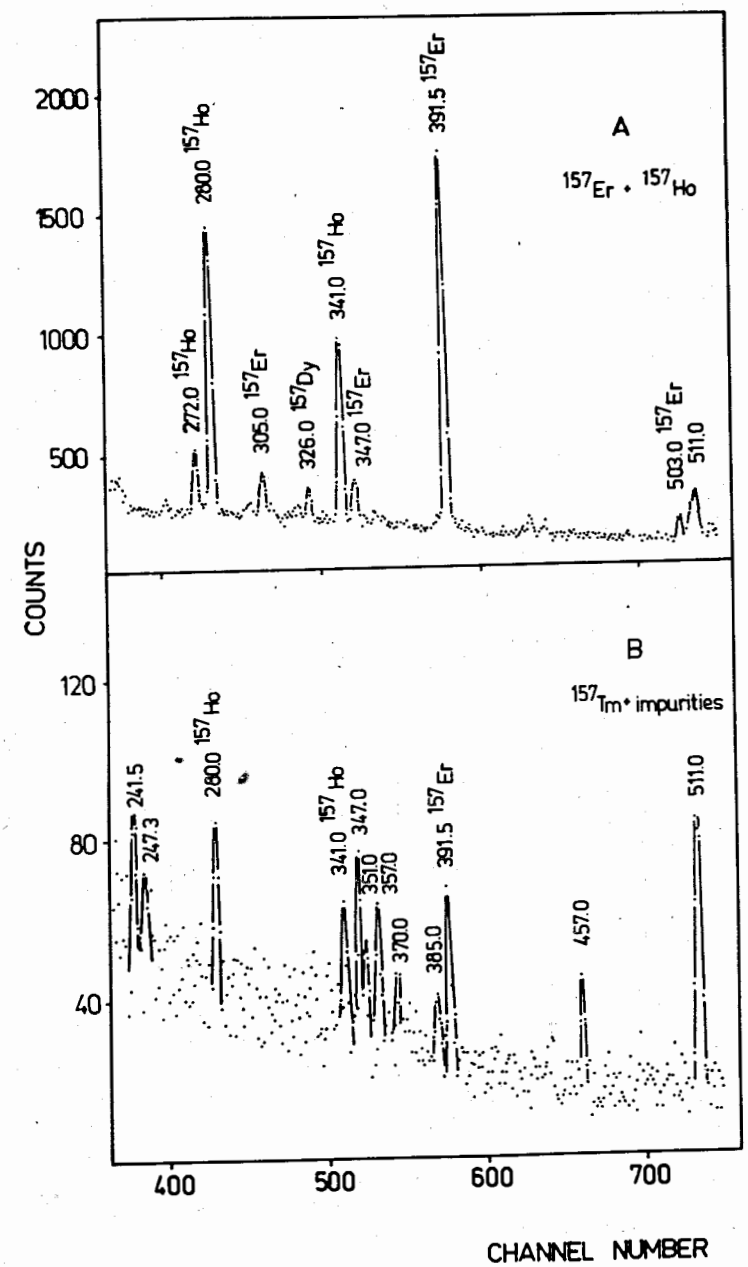


Fig. 3. The curves of the intensity decrease for K-transition and γ - 110.1 keV transition.

Fig. 4. The parts of the γ-ray spectra of subsequently chemically selected fractions of ^{157}Ho and ^{157}Er(A) and of ^{157}Tm(B), obtained from one of the several measurements.



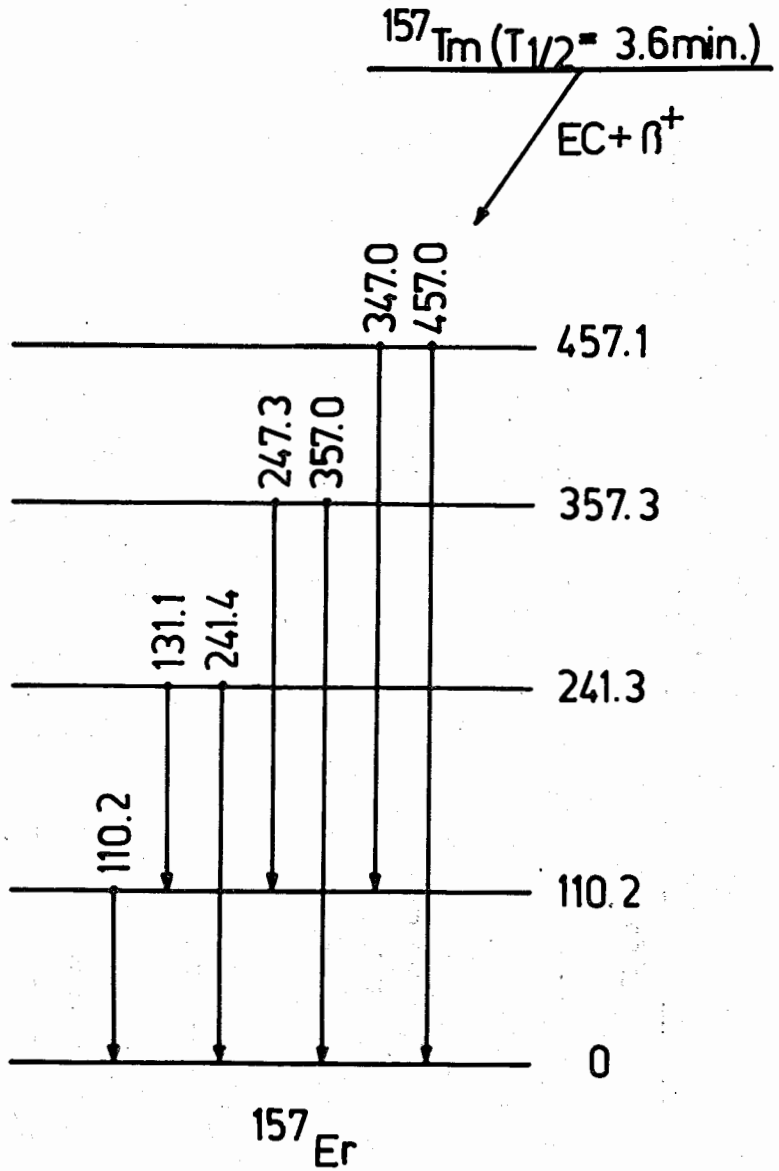


Fig. 5. The excited states of ^{157}Er arising in the ^{157}Tm decay.

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