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DECAY OF Er^{161}

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The radiation accompanying the decay of Er^{161} was studied using a scintillation spectrometer and a double-focusing β spectrometer. On the basis of these and previously obtained data, a decay scheme is proposed for this isotope.

According to the data of Handley and Olson,[1] the decay of Er^{161} established by them is accompanied by the emission of γ radiation which includes quanta of the following energies: 65, 195, 824 and 1125 kev. The mass number of this isotope was measured by time of flight on a mass spectrometer.[2] The best value for the half-life is 183 min.[3]

In investigating the spectrum of conversion electrons from the decay of this isotope,[4] an E3 transition with an energy of (210.6 ± 0.7) kev was discovered in the daughter nucleus Ho. It was assumed that this transition takes place between the levels $1/2^{+}[411]$ and $7/2^{-}[523]$. The occurrence of this isomeric transition and its location were confirmed in the work of Harmatz et al.,[5] carried out on a permanent-magnet spectrometer. However, other transitions listed in papers 1 and 4, in particular the intense γ transition at 826 kev, occurring in the Ho^{161} nucleus, were not found by these authors.

To clarify the nature of the transition with $h\nu = 826$ kev, we investigated the erbium fraction formed by bombardment of tantalum with 660 Mev protons from the synchrocyclotron of the Joint Institute for Nuclear Research. The measurements were done with a double-focusing β spectrometer[6] and a scintillation spectrometer whose efficiency was calibrated against standards.

A value of (190 ± 10) min was obtained for the half-life of this transition; the energy is (826.5 ± 1.5) kev.

The conversion coefficient for this transition was determined by making measurements of the ratio of the heights of the electron conversion lines and the ratio of the heights of the photopeaks from the γ spectra of this transition and the 661.6 kev transition in Ba^{137}.

It was necessary to take account of the radiation from decay products of other isotopes of erbium which were present in our sample: Er^{160} ($T_{1/2} = 30$ hr) and Er^{158} ($T_{1/2} = 2.5$ hr). It is easy to make corrections for the presence of Er^{160} because of the large difference in the half lives.

A more important correction is the taking account of the fractions of γ radiations at 848 and 851 kev from the decay of Ho^{158} (reference 7) in the photopeak measured by us at 826 kev, since the resolving power of the crystal, which is 9%, does not allow us to see the photopeaks of these radiations separately. From our earlier data[7] the transitions at 848 and 851 kev, which occur between the levels of the second and first rotational bands, should be E2. This determines the conversion coefficient so that from the ratios of the heights of the conversion lines we were able to find the ratio of the intensities of the γ radiations:

$$I_{\gamma 826}/I_{\gamma 848,851} = 4.0 \pm 0.2.$$

The value obtained for the conversion coefficient of the 826-kev transition in the K shell, including all corrections, is

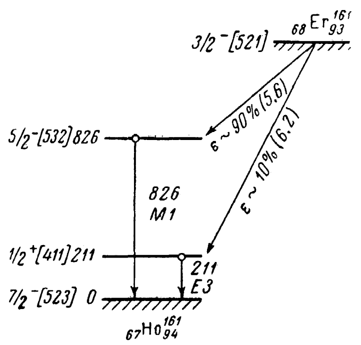
$$\alpha_K = 0.008 \pm 0.002.$$

According to the tables of Sliv and Band[8] this value allows us to assign this γ transition as M1 or E3. We can use the K/L ratio as an additional argument for choosing the type of transition. The theoretical values of this ratio for different types of transition are the following:

E1	E2	E3	M1	M2	M3
5.72	5.63	4.91	6.41	6.25	5.51

The experimental value of the ratio, K/L = 7.0 ± 0.8, clearly allows us to exclude E3.

The complexity of the γ spectrum obtained with the scintillation spectrometer does not permit us to make an estimate of the ratio of the intensities of the 211- and 826-kev γ transitions directly from the photopeaks. The ratio of the intensities of these transitions calculated from their conversion lines is



$$I_{\gamma 826}/I_{\gamma 211} = 8.0 \pm 1.5.$$

The large intensity of the 826-kev γ transition shows that there is a level at 826 kev in Ho^{161}, which is populated in 90% of the decays of Er^{161}.

The multipolarity of the transition and the spin $7/2^-$ of the ground state of Ho^{161} determine the spin and parity of this level to be $5/2^-$, which corresponds to the single particle level $5/2^-$[532] in the Nilsson diagram. Since the ground state of Er^{161} is most probably $3/2^-$[521], such an interpretation of the levels enables us to explain the relative intensity of the electron transitions. The electron transition to the 826 kev level of Ho^{161} is allowed by the selection rules on spin and parity while the transition to the isomeric level at 211 kev is first forbidden.

In the figure we show the decay scheme of Er^{161} constructed on the basis of the above considerations. The asymptotic Nilsson quantum numbers N, n_z, and Λ are given in square brackets. The data on intensities of the electron transitions are indicated next to the sloping lines. The ft values, calculated on the assumption that the decay energy of Er^{161} is 2 or 2.5 Mev (according to Cameron[9] it is 2033 kev), are given in parentheses.

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