SOVIET PHYSICS JETP VOLUME 14, NUMBER 5 MAY, 1962

DECAY SCHEME FOR Br^{75}

K. A. BASKOVA, S. S. VASIL'EV, NO SENG CH'ANG, and L. Ya. SHAVTVALOV

Institute of Nuclear Physics, Moscow State University

Submitted to JETP editor June 26, 1961

J. Exptl. Theoret. Phys. (U.S.S.R.) 41, 1484-1486 (November, 1961)

The β^+ and γ spectra of Br^{75} with half-life of 100 ± 5 min are investigated. The β^+ spectrum consists of three components with end-point energies 1720, 1100, and 650 kev. Gamma transitions with energies 285 and 620 kev are observed. A study of $\beta^+\gamma$ coincidences indicates the existence of a temporal correlation between the β^+ transition (1720 kev) and γ transition (285 kev). A probable decay scheme is suggested for Br^{75}.

THE single-particle model of the nucleus describes well such quantum characteristics as the total angular momentum and the parity of the ground state of odd nuclei [1]. For certain nuclei, however, the values of the angular momentum do not agree with experiment. One such nucleus is $_{34}Se_{41}^{75}$, with a ground-state total momentum of $5/2$.[2] In addition, Se^{75} has an anomalously large quadrupole moment. Nemirovskii [3] noted in his book that the deformation of the nuclear surface plays an appreciable role here.

The present investigation was devoted to a study of β^+ and γ radiation from Br^{75}, which decays to Se^{75}. In an investigation of the activities induced in enriched Se^{75} bombarded by protons and deuterons in a cyclotron, Woodward, McCown, and Pool first succeeded in observing the radioactive isotope Br^{75} with a half life of 102 minutes. A magnetic-spectrometer investigation[5] of the β^+ radiation from Br^{75} disclosed the existence of four partial β^+ transitions with end-point energies 1700 ± 20, 800, 600, and 300 kev. The γ spectrum of Br^{75} was investigated by Beydon et al.[6] with the aid of a luminescent γ spectrometer, in which an investigation of the products of the reaction $Cu + C^{12}$ disclosed a 285-kev γ transition. The intensity of this γ transition decreased with a half life of 95 ± 5 minutes.

In the present investigation, the Br^{75} was obtained by bombarding Se^{74} (enriched to 40.9%) with deuterons in the 120-cm cyclotron of the Nuclear Physics Research Institute of the Moscow State University. The targets were exposed for about 3 hours. The β^+ spectrum of Br^{75} was investigated in a thin-lens magnetic β spectrometer. An analysis of the Fermi plot of the resultant β^+ spectrum yielded two partial β^+ transitions with end-point energies 1720 ± 50, 1100, and 650 kev

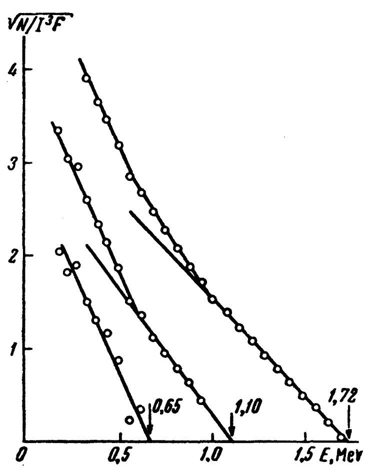

FIG. 1. Fermi plot of β^+ spectrum of Br^{75}.

(Fig. 1) and with respective intensities 80, 15 and 5%.

The γ spectrum was investigated with a luminescent γ spectrometer with a 100-channel analyzer. The resolution of the γ spectrometer was 8.7% for the Cs^{137} 662-kev γ transition. The initial measurement of the γ spectrum of Br^{75} disclosed the presence of a single γ transition with energy 285 kev. The β^+ spectrum, however, indicates that a $1720 - 1100 = 620$ kev γ transition is possible on the skirt of the powerful annihilation peak. To observe the γ transition it was necessary to reduce the intensity of the annihilation peak. For this purpose we used a conical lead collimator[7] and a thin source, so as to be able to neglect the annihilation in the source itself.

The γ spectrum thus obtained is shown in Fig. 2. We see in this spectrum a strong 285-kev γ and a weak 620-kev γ transition. The low-intensity γ radiation with energy $E_\gamma > 700$ kev is due to long-lived activity of Br^{82} (T = 36 hours). The

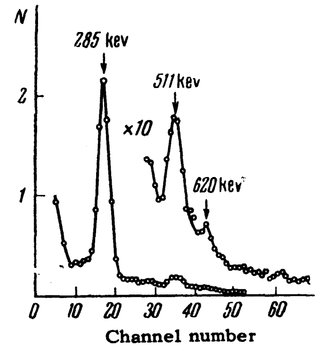

FIG. 2. γ spectrum of Br^{75}, measured with conical lead collimator.

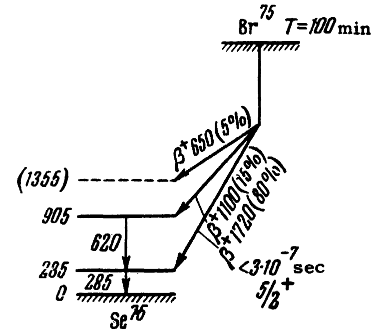

FIG. 4. Probable decay scheme of Br^{75}.

half-life of the Br^{75} is determined from the change in the intensity of the 285-kev γ line and the annihilation peak, and was found to be 100 ± 5 minutes. The 620-kev γ-line had the same half life.

The $\beta^+\gamma$ coincidences were investigated with a magnetic-lens β spectrometer and with a luminescent spectrometer, connected for coincidence. The resolution time was determined periodically during the measurement of the true coincidences, and was found to be 0.25 μsec. Figure 3 shows the Fermi plot of the β^+ spectrum, which is in correlation with the 285-kev γ quanta. It is seen from Fig. 3 that the points lie sufficiently close to a straight line. The end-point energy was found in this case to be 1700 ± 100 kev. The 285-kev transition thus follows the 1720-kev β^+ transition. This result contradicts the Br^{75} decay scheme given by Dzhelepov and Peker,[8] who assumed the 1720-kev β^+ transition to go to the ground state of Se^{75}.

We have therefore drawn a probable decay scheme for Br^{75} (Fig. 4), in which the 1335-kev level expected from the 650 kev β^+ transition is shown dotted. From measurements of the 285-kev γ-transition intensity and of the annihilation peak we estimated the relative K-capture probability, compared with β^+ decay. This was found to be approximately 10%, which does not contradict the paper by Kuznetsova and Mekhedov[9] where a value $\sim$15% is cited. The total Br^{75}—Se^{75} decay energy resulting from the proposed Br^{75} decay scheme is 3025 kev, which is closer to the 3236 kev calculated by the Cameron formula.[10] The cause of the excited states of the nucleus is difficult to establish without data on the total angular momenta. However, the observed excited levels are apparently not rotational.

The authors are grateful to Yu. A. Vorob'ev and V. S. Zazulin for help with the work.

[1] M. Goeppert Mayer and J. H. D. Jensen, Elementary Theory of Nuclear Shell Structure, Wiley, N. Y., 1955.

[2] L. C. Aamodt and P. C. Fletcher Phys. Rev. **98**, 1224 (1955).

[3] P. É. Nemirovskii, Sovremennye modeli atomnogo yadra (Modern Models of the Atomic Nucleus), Atomizdat, 1960.

[4] Woodward, McCown, and Pool. Phys. Rev. **74**, 870 (1948).

[5] S. C. Fultz and M. L. Pool. Phys. Rev. **86**, 347 (1952).

[6] Beydon, Chaminade, Dru, Farragi, Olkowsky, and Papineau. Nucl. Phys. **2**, 593 (1957).

[7] Konijn, van Nooijen, Mostert, and Endt. Physica **22**, 887 (1956).

[8] B. S. Dzhelepov and A. K. Peker, Skhemy raspada radioaktivnykh yader (Decay Schemes of Radioactive Nuclei), An SSSR, 1958.

[9] M. Kuznetsova and V. Mekhedov. Izv. AN SSSR, ser. fiz. **21**, 1020 (1957), Columbia Tech. Transl. p. 1021.

[10] B. S. Dzhelepov and G. F. Dranitsina, Sistematika energii β-raspada (Systematics of β-Decay Energies), AN SSSR, 1960.

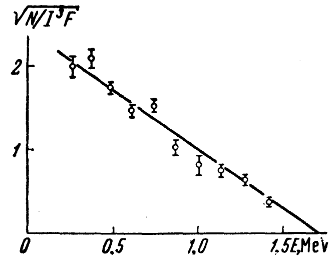

FIG. 3. Fermi plot of β^+ spectrum of Br^{75}, which correlates with the 285-kev quanta.

Translated by J. G. Adashko
252