Scandium 51

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Dedicated to Professor Dr. W. Gentner *on the occasion of his 60th birthday*

Previously unreported decay characteristics of ^{51}Sc are studied. The activity was obtained from a series of bombardments of an enriched ^{48}Ca target (in the carbonate form) with 18 MeV α particles. β ray measurement of the investigated sample indicated a component of ~ 5 MeV end-point energy which decays with a half life of 12 sec. γ ray measurements gave new lines at 1.44 MeV and 2.16 MeV, both decaying with a half life of ~ 12 sec. The γ-ray energies coincide with some of the energies of the states observed in ^{51}Ti from the ^{50}Ti(d, p) reaction and the β end-point energy is in agreement with the known Q value of the ^{48}Ca(α, p)^{51}Sc reaction. All decay characteristics are quite consistent with theoretical predictions.

The ground state Q value for the ^{48}Ca(α, p)^{51}Sc reaction was recently reported [1], but the decay of ^{51}Sc has not been studied. The half life of this nuclide has been expected to be of the order of seconds [2].

We have tried to identify the activity of ^{51}Sc by bombarding enriched $^{48}CaCO_3$ with the 18 MeV α beam from the tandem accelerator of the Max-Planck-Institut für Kernphysik. A new 12 sec activity was found which can be unambiguously assigned to ^{51}Sc.

β ray measurement

β and γ rays following the bombardment were observed in two separate runs. The β detector was a hole-type plastic scintillator with essentially 4π geometry [3]. The calcium carbonate target was ~ 20 mg/cm^2 thick and 97% enriched in ^{48}Ca.

After a 10 sec bombardment the sample was automatically displaced and brought into the centre of the plastic detector. The β spectra were recorded in nine consecutive 10 sec intervals, starting ten seconds after the end of the bombardment. Long life background was also recorded in the following four minutes.

Fig. 1 shows the Curie plots of β spectra taken at different times after the bombardment. A component with an end point of ~ 5 MeV is seen to decay with a half life of (12.5 ± 1) sec. The higher energy component with an end point ~ 10 MeV and a half life of ~ 7 sec was assigned to ^{16}N produced by the

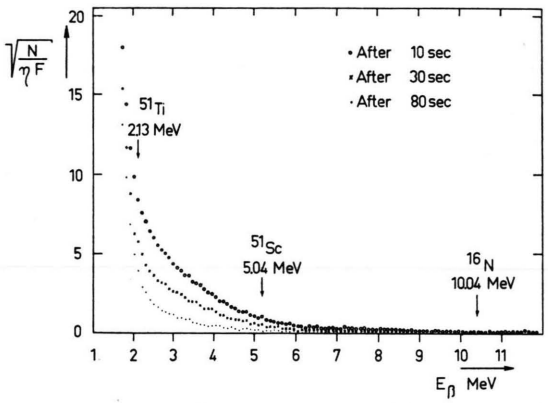

Fig. 1. Curie plots of β spectra taken at different times after α particle bombardment of ^{48}Ca.

^{13}C(α, p)^{16}N reaction. The low energy component with an end point at ~ 2.13 MeV is due to ^{51}Ti produced by the ^{48}Ca(α, n) reaction.

γ ray measurement

γ rays were detected by means of a $4'' \times 5''$ NaI (Tl) crystal. γ spectra were recorded on a 8×512 channels P.H.A. in seven consecutive 13 sec intervals, starting 2 sec after the end of the bombardment. The whole measurement cycle was automatically repeated a 100 times. The resulting γ spectrum is shown in Fig. 2. New lines of 1.44 MeV and 2.16 MeV are observed, both decaying with a half life of ~ 12 sec. These energies correspond to known levels

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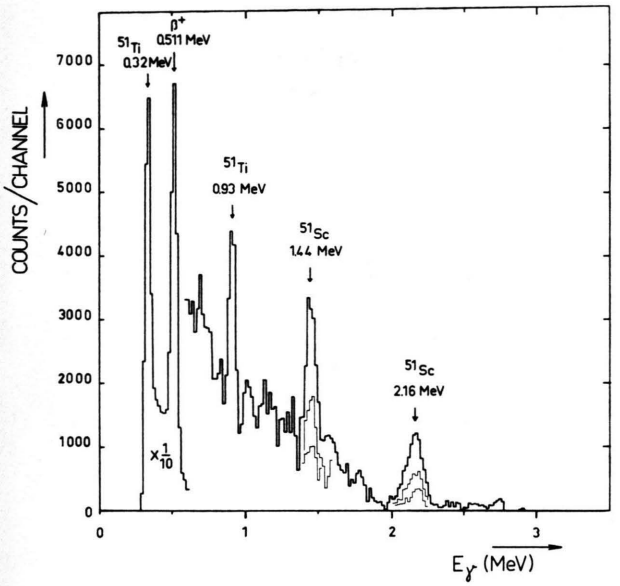

Fig. 2. Delayed γ spectrum recorded in the time interval from 2 to 15 sec after the bombardment (long life background has been subtracted). Spectra taken in the two following 13 sec intervals are also shown in the region corresponding to ^{51}Sc lines.

of ^{51}Ti as observed in the ^{50}Ti(d, p) reaction [4–6].

The expected γ rays of 1.57 MeV and 0.7 MeV energy are possibly present, but with smaller intensities. No other identified lines are observed in the spectrum but those due to 5.8 min ^{51}Ti and positrons.

The relative intensities of the main γ transitions are given in Table 1. Since the 0.7 MeV γ ray – if any – has a very small intensity, two main β components are expected having 5.04 MeV and 4.32 MeV end points, if we assume $Q = -5.86$ MeV for the ^{48}Ca(α, p)^{51}Sc reaction [1]. The higher energy β component clearly appears from the CURIE plot in Fig. 1, with the expected end point.

Half life sec	γ energy MeV	β end point MeV	Relative intensity	Partial half life sec	log ft
12	1.44	5.04	1.25	22	5.0
	2.15	4.32	1	27	4.8

Table 1. Decay characteristics of ^{51}Sc.

Conclusions

The proposed decay scheme is shown in Fig. 3, where the l values from stripping are also given. Both 1.44 MeV and 2.16 MeV levels are assigned to $l = 3$ transitions and are proposed to be $5/2^-$ states.

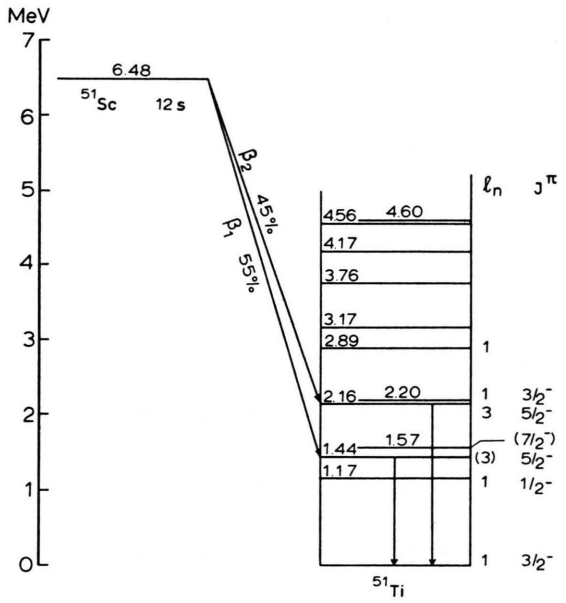

Fig. 3. Decay scheme of ^{51}Sc.

Our results fit well into this picture, since the expected spin of the ^{51}Sc ground state is $7/2^-$, following the shell model which should work well in this region.

The log ft values calculated assuming only two β transitions are 5.0 and 4.8, respectively for the 5.04 MeV and the 4.32 MeV components.

Finally, the ratio of the integrated cross sections for the ^{48}Ca(α, p)^{51}Sc and ^{48}Ca(α, n)^{51}Ti reactions can be estimated from present data to be about 10^{-4}.

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