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

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

We have tried to identify the activity of $^{51}\text{Sc}$ by bombarding enriched $^{48}\text{CaCO}_3$ with the 18 MeV $\alpha$ 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 $^{51}\text{Sc}$.

$\beta$ ray measurement

$\beta$ and $\gamma$ rays following the bombardment were observed in two separate runs. The $\beta$ detector was a hole-type plastic scintillator with essentially 4 $\pi$ geometry. The calcium carbonate target was $\sim 20$ mg/cm$^2$ thick and 97% enriched in $^{48}\text{Ca}$.

After a 10 sec bombardment the sample was automatically displaced and brought into the centre of the plastic detector. The $\beta$ 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 $\beta$ spectra taken at different times after the bombardment. A component with an end point of $\sim 5$ MeV is seen to decay with a half life of (12.5 $\pm$ 1) sec. The higher energy component with an end point $\sim 10$ MeV and a half life of $\sim 7$ sec was assigned to $^{16}\text{N}$ produced by the $^{12}\text{C}(\alpha, n)$ reaction. The low energy component with an end point at $\sim 2.13$ MeV is due to $^{51}\text{Ti}$ produced by the $^{48}\text{Ca}(\alpha, n)$ reaction.

$\gamma$ ray measurement

$\gamma$ rays were detected by means of a $4'' \times 5''$ NaI (TI) crystal. $\gamma$ spectra were recorded on a $8 \times 512$ 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 $\gamma$ 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 $\sim 12$ sec. These energies correspond to known levels

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R. MESSLINGER, to be published.
of $^{51}\text{Ti}$ as observed in the $^{50}\text{Ti}(d, p)$ reaction $^{4-6}$.

The expected $\gamma$ 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 $^{51}\text{Ti}$ and positrons.

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

<table>
<thead>
<tr>
<th>Half life sec</th>
<th>$\gamma$ energy MeV</th>
<th>$\beta$ end point MeV</th>
<th>Relative intensity</th>
<th>Partial half life sec</th>
<th>log $ft$</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>1.44</td>
<td>5.04</td>
<td>1.25</td>
<td>22</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td>2.15</td>
<td>4.32</td>
<td>1</td>
<td>27</td>
<td>4.8</td>
</tr>
</tbody>
</table>

Table 1. Decay characteristics of $^{51}\text{Sc}$.

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 $^{51}\text{Sc}$.

Fig. 2. Delayed $\gamma$ 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 $^{51}\text{Sc}$ lines.

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

The log $ft$ values calculated assuming only two $\beta$ 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 $^{48}\text{Ca}(p, n)^{51}\text{Sc}$ and $^{48}\text{Ca}(p, n)^{51}\text{Ti}$ reactions can be estimated from present data to be about $10^{-4}$.

Acknowledgments

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$^{4}$ G. F. PLEFRE, Phys. Rev. 88, 1299 [1952].
$^{5}$ K. RAMAVATARAM, Phys. Rev. 132, 2255 [1963].