

ENERGY LEVELS OF Mg^{26} FROM THE DECAY OF Al^{26}

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ABSTRACT

Gamma-rays accompanying the decay of long-lived Al^{26} have been studied by means of coincidence scintillation spectrometry. A level scheme for Mg^{26} has been proposed in essential agreement with earlier results.

1. INTRODUCTION

THE low-lying levels of Mg^{26} are of interest since Mg^{24} is known to have a rotational spectrum and Mg^{26} probably lies in the region of transition toward vibrational type of spectrum. One might then expect to find 2^+ and 4^+ levels around 3.6 Mev. which is approximately twice the energy of the first excited state (2^+) at 1.85 Mev. Since there is known to exist a level at 2.97 Mev., which is probably a 2^+ level, judging from its decay mode, it seemed worthwhile to look for a 4^+ level around 3.6–3.8 Mev. The Al^{26} — Mg^{26} decay energy is about 4 Mev. Hence, there is plenty of energy available for electron capture to a 4^+ level. In particular, since the spin of Al^{26} is probably 5^+ , allowed decay to 4^+ excited state may even be preferred to decay to low-lying low-spin states *via* forbidden transitions. In fact, a reported gamma-ray of 0.707 Mev. might well represent a transition between the 2^+ and 4^+ levels. Therefore, a careful study of the gamma-spectrum following the decay of long-lived Al^{26} (obtained from Nuclear Science and Engineering Corp., Pittsburgh) was undertaken.

2. EXPERIMENTAL RESULTS

Figure 1 shows a single gamma-ray spectrum measured in a heavily shielded 1"×2" NaI counter. Only well-known gamma-rays at 1.12, 1.85 and 2.95 Mev. are seen to be present. A careful search was made (both in singles and coincidence spectra) for additional gamma-rays, in particular for the reported 0.707 Mev. gamma-ray. In this search, the low-energy region was scanned by NaI counter covered by a thin Al-window. The results were, however, negative.

Recent experiments of Dearnaley and Ferguson¹ have pointed to the existence of a first excited state in Mg^{26} at 1.33 ± 0.02 Mev., contrary to earlier results which have placed the first excited state at 1.84 Mev.² A special search was made for this reported state, by looking for coincidences between annihilation radiation and a 0.51 Mev. gamma-ray which might possibly connect the 1.33 and 1.84 Mev. levels. Two scintillation counters placed at right angles to each other were used. An upper limit of 1.0×10^{-8} for the number of photons per 1.84 Mev. gamma-ray could be set.

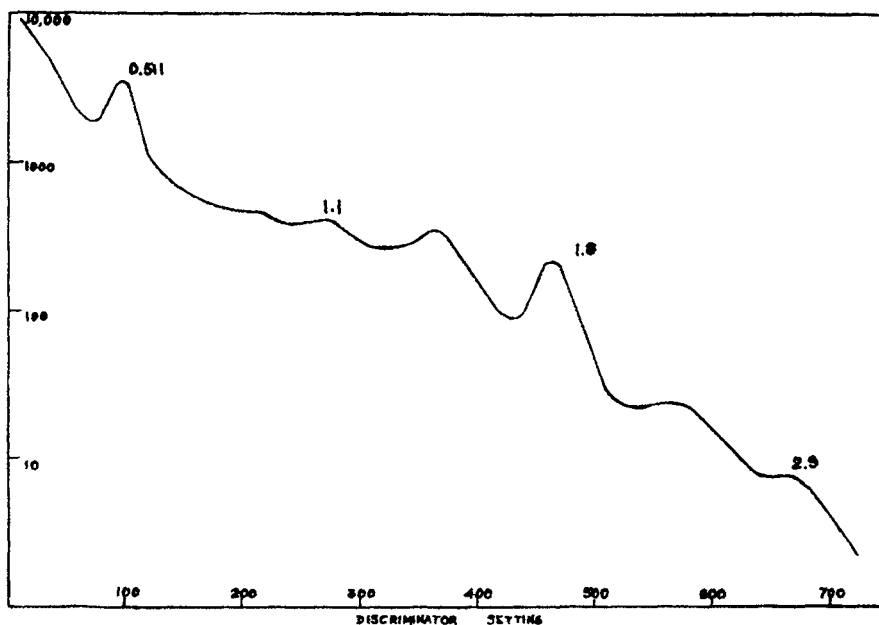


FIG. 1. Al^{26} Singles gamma spectrum in shielded NaI counter

Table I gives the various coincidences observed. The crosses represent positive results.

Table II lists the various gamma-rays and their relative intensities.

From the relative intensity data, one infers a (capture/positron) ratio of about 0.11 to the 1.84 Mev. level. For an allowed transition this ratio is 0.01 and for a unique second-forbidden transition it is approximately given by the relation:

$$\left[\frac{\text{Capture}}{\text{Positron}} \right]_{\text{unique}} \approx \left[\frac{2(W_0 + 1)}{W_0 - 1} \right]^2 \left(\frac{\text{Capture}}{\text{Positron}} \right)_{\text{allowed}}$$

Here W_0 is the transition energy in m_0c^2 units. The computed ratio is 0.13 in reasonable agreement with the measured value of 0.11. This is also consistent with the $\Delta J = 3$. No shape inferred from the positron spectrum. Besides, the calculated $\log ft$ value of 13.7 is consistent with the value found for other similar transitions.

TABLE I
Al²⁶ Coincidences

γ -rays	0.51 (annihilation)	1.1	1.8	2.9
0.51 (annihilation)	X	..	X	..
1.1	X	..
1.8	X	X
2.9

TABLE II
Relative gamma-ray intensities

Energy of γ -ray (Mev.)	Relative Intensity
0.7	<1
1.1	5
1.33	<0.1
1.8	100
2.9	06

3. DISCUSSION

The fact that no 0.707 Mev. gamma-ray was observed agrees with the results of Ferguson.³ The negative result in the search for 1.33 Mev. level reported by Dearnaley and Ferguson¹ implies that the level if at all it exists

must be 0^+ . However, other arguments can be advanced which make the presence of a 0^+ first excited state in Mg^{26} very unlikely.

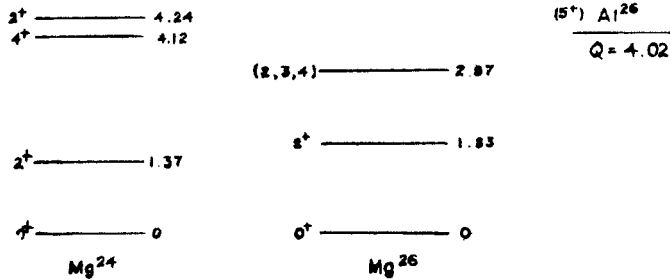


FIG. 2. Level Schemes of Mg^{24} and Mg^{26}

The level scheme for Mg^{26} resulting from the present work is shown in Fig. 2 together with that of the neighbour, Mg^{24} .

The spin of the 2.95 Mev. level may be 1, 2 or 3. One can rule out a choice of 1^+ since the electron capture from the $5^+ Al^{26}$ would be highly forbidden and the decay would not be observed. Among the remaining possibilities, 2^+ is to be preferred over 3^+ because of the cross-over intensity. However, if the spin is 3^- , then no such preference can be justified. Directional correlation studies on the 1.84–1.1 Mev. gamma-cascade can give a more definitive answer for the spin assignment. It would also be interesting to measure the conversion coefficient of the 1.1 Mev. transition. Preliminary angular correlation studies on the above-mentioned cascade have so far been inconclusive due to poor counting statistics. A long-term experiment (which is planned) may hopefully give an unambiguous answer.

4. ACKNOWLEDGMENT

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