K particles with mean lives short enough not to show up after 12.4 mμsec.

Our rates appear to be consistent with cloud chamber and emulsion rates, but large uncertainties are involved in the comparison.

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Energy Levels of Al^{26}†

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It has been pointed out[1] that the Al^{26} nucleus is of considerable interest from the standpoint of charge independence of nuclear forces and the isobaric-spin concept. If a plot is made of the known energy differences between the lowest-lying $T=0$ state and the lowest $T=1$ state *versus* mass number for the mass range 6 to 54, a consistent trend is seen. Interpolation on this plot suggests that in Al^{26} the lowest $T=1$ state will be very near the lowest $T=0$ state. In fact, it is possible that the ground state has $T=1$, as in the case[2] of Cl^{34}. Previous data on Al^{26} are inconsistent and leaves the energy and the isobaric spin of the ground state in doubt.[1]

The reaction $Si^{28}(d,\alpha)Al^{26}$ is suitable for investigating the $T=0$ levels of Al^{26} as it has an estimated Q value of 1 to 2 Mev. The deuteron, the alpha particle, and Si^{28} are all $T=0$ nuclei; therefore, to the degree that isobaric spin-selection rules are valid, levels with $T=1$ will not be observed.

The MIT-ONR electrostatic generator and associated high-resolution magnetic-analysis equipment have been used to study Al^{26} from its ground state to 2-Mev excitation. Fresh targets of natural SiO_2 evaporated on thin Formvar backings were used. Because of low yield from this reaction, the targets used were of such thickness as to give an energy spread in the alpha groups several times the analyzer resolution. The alpha particles were observed at 90 degrees to the incident beam. Assignment of observed alpha groups to Al^{26} was based on observation of the change in alpha energy with a change in bombarding energy.

Table I. Reaction energies for the $Si^{28}(d,\alpha)Al^{26}$ reaction.

Q Value in Mev	Excitation of Al^{26} in Mev
1.416 ±0.008	0
0.998 ±0.008	0.418
0.364 ±0.008	1.052
−0.334 ±0.008	1.750
(−0.430)±0.015	(1.846)
−0.648 ±0.008	2.064

The results are given in Table I. Each Q value is the weighted average of at least three measurements made at bombarding energies ranging from 5 to 7 Mev. The excitation energy of Al^{26} given in the last column is based on the average ground-state Q value as shown. The 1.85-Mev level was completely resolved at only one bombarding energy. An accurate "energy shift" measurement was therefore not obtained. Thus, the assignment of this group to Al^{26} is not completely certain.

A region of about 3 Mev below the ground state has been covered with no indication of lower levels. An alpha of 10 percent of the intensity of the ground-state group would have been seen. No group of alphas from this reaction was seen between the listed ground state and the first excited state. At 6.5- and 7-Mev bombarding energy, the limit is about 3 percent of the intensity of the ground-state group.

Figure 1 shows the $T=0$ energy levels of Al^{26} and their relation to reactions that have been studied elsewhere. Recent work of Haslam,[3] using the $Al^{27}(\gamma,n)$ reaction and counting positrons from the Al^{26} decay as well as the neutrons, is in agreement with the presently

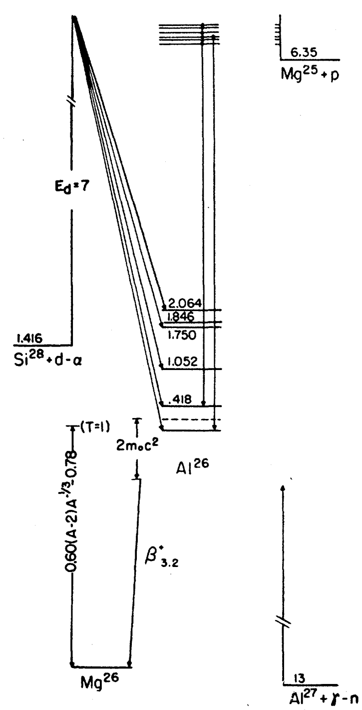

Fig. 1. Energy level scheme for Al^{26}. The levels up to 2 Mev are those observed in the present work. The calculated position of the lowest $T=1$ level is shown. This is seen to coincide with the position given by the observed β^+ decay end point. The $Al^{27}(\gamma,n)$ threshold then agrees with the ground state. The high-lying levels are indicated by the resonances and gamma-ray energies observed by Kluyver *et al.*

determined position of the ground state and suggests that the short-lived level (presumably $T=1$) responsible for the observed positrons lies roughly 200 kev above the ground state. The position of the $T=1$ level relative to the ground state of Mg^{26} may be estimated, using a calculated Coulomb energy difference and the p-n mass difference. The expected position is shown in Fig. 1 and is seen to agree with this suggestion.

Kluyver *et al.*[4] have measured energies of gamma rays from $Mg^{25}(p,\gamma)Al^{26}$. These agree with the ground state and the 0.418-Mev level shown. The conclusion of Kluyver *et al.* that the 0.418-Mev level has $T=1$ is inconsistent with the fact that it is seen here in the $Si^{28}(d,\alpha)$ reaction with intensity comparable to the ground state. The lack of a gamma ray to the $T=1$ level may be the result of a high spin difference between this state and the capturing state.[5]

It would be desirable to study a reaction not involving isobaric spin-selection rules to see both the $T=0$ and $T=1$ levels. Resolution of better than 100 kev may be required, however. Possible reactions are $Si^{29}(p,\alpha)Al^{26}$ and $Mg^{24}(He^3,p)Al^{26}$. The first requires higher bombarding energies than are available at present with the MIT-ONR machine. The second of course entails operation of an ion source with He^3.

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Coulomb Excitation of Energy Levels in Rhodium and Silver

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COULOMB excitation has revealed two hitherto unknown energy levels in each of the nuclei Rh^{103}, Ag^{107}, and Ag^{109}; their energies and excitation cross sections (transition probabilities) are quite similar and seen to continue the striking similarity of nuclear properties which have been known to exist in these three nuclei, namely: spin $\frac{1}{2}$ and negative parity ($p_{\frac{1}{2}}$ configuration) in their ground states, and a low-lying isomeric transition of the $E3$ type, coming from a level of spin $7/2^+$ (Rh^{103}: $E=40$ kev, $t_{\frac{1}{2}}=57$ min; Ag^{107}: $E=94$ kev, $t_{\frac{1}{2}}=44$ sec; Ag^{109}: $E=87$ kev, $t_{\frac{1}{2}}=39$ sec).

We have reported the levels in rhodium as lying at 305 and 370 kev;[1] these values are now slightly revised to 295 and 357 kev, respectively. We reported that silver showed no gamma radiation under 3-Mev alpha particle bombardment.[2] A reexamination with

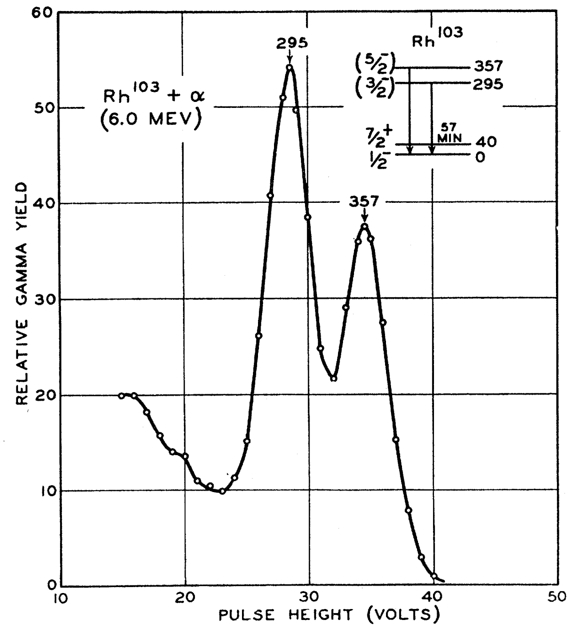

Fig. 1. Pulse-height distribution of gamma radiation from rhodium bombarded with 6-Mev alpha particles.

2-Mev protons revealed two lines at around 310 and 410 kev in ordinary silver.

In the meantime we found that the doubly charged helium-ion current from our rf ion source ($\sim 0.3\ \mu a$) at *twice* the generator voltage was a very effective tool for

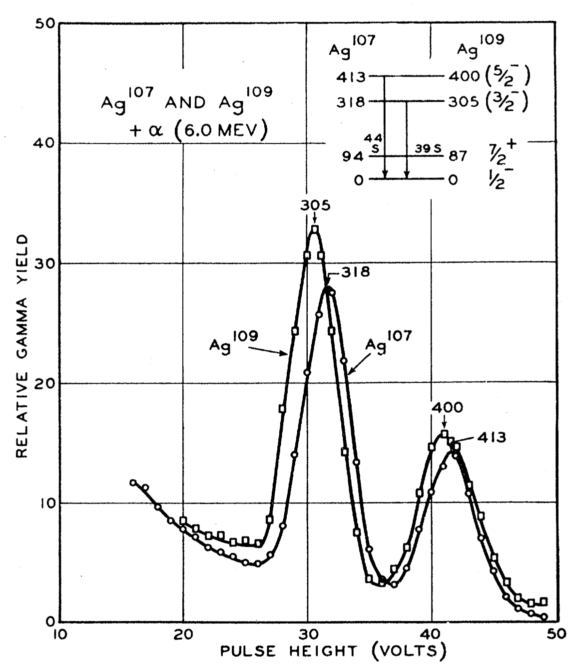

Fig. 2. Pulse-height distributions from silver isotopes bombarded with 6-Mev alpha particles. Circles refer to Ag^{107} (enriched to 90.26 percent, metallic target); squares refer to Ag^{109} (enriched to 99.54 percent, AgCl target corrected for Cl). Relative intensities of all three curves are meaningful.