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Study of ^{42}Ar Using the ^{40}Ar($t,p\gamma$)^{42}Ar Reaction*

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Nuclear properties of the excited states of ^{42}Ar were measured by using the ^{40}Ar($t,p\gamma$)^{42}Ar reaction at a bombarding energy of 2.9 MeV. Angular correlations of γ rays were measured using a spectrometer consisting of five NaI(Tl) counters in time coincidence with an annular particle detector positioned about 180°. The analysis of these correlations yielded multipole-mixing and branching-ratio information for the electromagnetic deexcitations of ^{42}Ar states, as well as spin assignments for some of the excited states. Coincident γ-ray spectra were also obtained using a Ge(Li) detector. Some of the measured excitations and spin assignments [E_x (kev); J] are: [1207±1.5; 2], [2414±5], [2485±3; 2], [2510±3], [3012±3; 1,2,3], [3092 ±3; 4], [3555±3; 2], [4004±5], [4123±4; ≤2], [4285±5, 1,2,3], and [4629±5; ≥1]. The results of this experiment are compared with recent shell-model calculations.

I. INTRODUCTION

^{42}Ar is the $T_z = 3$ member of the mass-42 isobaric multiplet. The $J^\pi = 0^+$ ground state decays via successive β^- emission through ^{42}K to ^{42}Ca. This information as well as the existence of an excited state in the region of 1 MeV is all the experimental information[1] that was published concerning this nucleus. This lack of information on the spectroscopy of this nucleus is a reflection of the fact that the ^{40}Ar(t,p)^{42}Ar reaction with a positive Q value of 7.04 MeV is the only reasonably available means of investigating this nucleus and only a few laboratories have triton beams. The present investigation consisted in obtaining particle-γ-ray angular correlations in a colinear geometry using both NaI(Tl) and Ge(Li) γ-ray detectors. The subsequent analysis of these data resulted in the procurement of previously unavailable information on level excitations, their spins, and the γ-ray branching and multipole mixing ratios associated with their subsequent deexcitations.

The ^{42}Ar nucleus can be characteristically described as having four neutrons in $f_{7/2}$ orbits and two proton holes in the $d_{3/2}$ subshell. Excitations of the four valence neutrons alone should be responsible[2] for a good part of the low-lying nuclear structure such that one would expect some resemblence in the spectroscopy of ^{42}Ar to that of ^{44}Ca. In a simple $(\nu f_{7/2})^4$ model[2] a ground state of $J^\pi = 0^+$ and, seniority, $\nu = 0$ is expected along with a set of states having $\nu = 2$ and $J^\pi = 2^+,\ 4^+,\ 6^+$. Along with these states there is also expected at low excitations a set of states having $\nu = 4$ and $J^\pi = 2^+,\ 4^+,\ 5^+$, and 8^+. Furthermore it is expected that a state similar to the core-excited $J^\pi = 0^+$ state found in ^{44}Ca should also be present in ^{42}Ar at a similar excitation energy. The present experiment was partly motivated by the anticipation of shell-model calculations using a complete set of basis states involving $d_{3/2}$, $f_{7/2}$, and $p_{3/2}$ orbits which were being performed at Argonne National Laboratory concurrent to this investigation. The results of the present experiment will be compared with these shell-model calculations in the final section of this paper.

II. EXPERIMENTAL PROCEDURE

The ^{40}Ar($t,p\gamma$) reaction was used to populate levels in ^{42}Ar with tritons of energy 2.9 MeV being provided by the Lockheed 3.0-MV Van de Graaff accelerator. The target was a gas cell 6.3 mm thick with an entrance window made of 0.0014-in.-thick molybdenum foil. The beam was stopped on a 0.001-in.-thick piece of tantalum foil positioned at the back of the gas cell. Natural argon gas was used as the target material at a pressure of 0.5 atm. Reaction protons passed through the entrance window and were detected in a 1000-μ-thick annular silicon counter which subtended an angle of 171 ± 4° in the laboratory system. The proton detector was shielded from the scattered tritons with 10.3 mg/cm^2 of Al foil. The over-all resolution of the system was 120 keV full width at half maximum (FWHM) for the proton group representing the first excited state.

In measuring the angular correlations, five NaI(Tl) detectors were positioned at angles equivalent to 5, 35, 45, 60, and 90° with respect to the beam axis at a distance of 8 in. from the center of the gas cell. The spectra in these counters were collected in time coincidence with the proton spectra detected by the annular particle counter. The data were handled by conventional modular electronics coupled to analog-to-digital converters which were interfaced to an SEL-810A computer used "on-line." This arrangement allowed a three parameter collection of data onto magnetic tape with simultaneous on-line and/or subsequent off-line data analysis. A more detailed description of the electronic and computer system can be found in a report by Chalmers.[3] Preliminary checks of the isotropy of the five-counter array were made by observing the γ-ray decay of known spin $J=0$ or $\frac{1}{2}$ states in a number of *sd* shell nuclei. Subsequent on-line checks were made during the experiment by observing β-γ coincidences from a ^{228}Th source mounted on a plastic scintillator positioned equidistant from the NaI detectors. These monitoring data were stored on tape with appropriate identification flags and served as a dead-time monitor for each of the five counters. The usual corrections made for dead time and instrumental anisotropy were found to be negligible.

The correlation data were analyzed by a least-squares fitting procedure (and χ^2 analysis in terms of initial spins) of the experimental points to the theoretical angular distributions calculated according to the formulas of the "Method II Geometry" of Litherland and Ferguson.[4] A least-squares fit to an expansion of even-order Legendre polynomials was also made, and the resulting coefficients appear in Table I. In the colinear geometry employed, γ rays from only $m=0$ and ±1 substates were observed.[4] To account for the finite solid angle of the particle detector it was assumed in the analysis that the relative population of the $m=\pm2$ and 0 substates is $P(2)/P(0) \leq 0.05$. The finite-solid-angle effect was in most cases small and the results are incorporated into the χ^2 curves illustrated. Whenever possible the χ^2 analysis for a given state included data of all γ rays whose angular correlations are dependent on the alignment of the initial state. Table II lists the measured multipole-mixing ratios obtained from the above analyses.

The excitations energies of states in ^{42}Ar had not previously been reported. In order to make more certain the correspondence between groups in the proton spectrum and states in ^{42}Ar, a Ge(Li) spectrometer was used in coincidence with the particle detector. The Ge(Li) detector had a volume of 20 cm^3 and was positioned alternately at 0, 45, and 90° in order to obtain angular correlation data as well as to fulfill the objective stated above. These coincident γ-ray spectra were also used to measure γ-ray branching ratios. Because of the nature of the target, Doppler-shift-attenuation measurements were not possible for obtaining the mean lifetimes of states in ^{42}Ar. After analyzing the γ-ray spectra associated with the proton groups illustrated in Fig. 1, the excited states of ^{42}Ar were identified and are labeled. The excitation energy of the initial state was derived from the sum of the energies of the cascading γ rays. These γ-ray spectra revealed that for proton groups corresponding to excitations greater than 3555 keV in ^{42}Ar, a number of γ-ray lines were observed which corresponded to real β-γ coincidence from the particle background. Most troublesome of these lines was a 1.27-MeV γ ray from the β decay of ^{39}Cl to ^{39}Ar. The former nucleus is produced in the ^{40}Ar$(t, \alpha)^{39}$Cl reaction.

TABLE I. The Legendre-polynomial-expansion coefficients for the angular correlations obtained at a beam energy of $E_t=2.9$ MeV. The analyses include the appropriate correction for the solid angle of the γ-ray detectors.

State (keV)	E_i (keV)	E_f (keV)	a_2/a_0	a_4/a_0
1207	1207	0	0.64 ± 0.06	−1.56 ± 0.06
2485	2485	0	0.45 ± 0.29	−1.30 ± 0.31
	2485	1207	0.39 ± 0.11	
2510	2510	1207	0.10 ± 0.08	
3012	3012	1207	0.53 ± 0.09	−0.21 ± 0.10
	1207	0	0.54 ± 0.13	0.10 ± 0.12
3092	3092	1207	0.87 ± 0.10	−0.45 ± 0.10
	1207	0	−0.53 ± 0.05	−0.45 ± 0.06
3555	3555	1207	0.47 ± 0.02	−0.07 ± 0.02
	1207	0	0.33 ± 0.12	0.65 ± 0.15
4123	4123	1207	0.17 ± 0.14	−0.17 ± 0.17
	1207	0	0.12 ± 0.16	−0.08 ± 0.19
4285	4285	1207	0.26 ± 0.04	−0.07 ± 0.05
4629	4629	1207	−0.34 ± 0.12	0.10 ± 0.13

TABLE II. Multipole-mixing ratios for various γ-ray transitions in ^{42}Ar as observed in the present sudies.

E_i (keV)	E_f (keV)	J_i	J_f	Multipole-mixing ratio [a]
3012	1207	1	2	0.40 ± 0.45, ∞
3012	1207	2	2	0.12 ± 0.11
3012	1207	3	2	−0.30 ± 0.17
3092	1207	4	2	−0.07 ± 0.08
3555	1207	2	2	0 ± 0.07
4123	1207	1	2	Undetermined
4123	1207	2	2	0.3 ± 0.2, −5.6 ± 3.0
4285	1207	1	2	Undetermined
4285	1207	2	2	0.04 ± 0.08, −3.1 ± 1.0
4285	1207	3	2	−0.30 ± 0.15

[a] The mixing ratio is defined in terms of $\langle L+1\rangle/\langle L\rangle$, and has the phase convention of Ref. 4 and H. J. Rose and D. M. Brink, Rev. Mod. Phys. 39, 306 (1967).

III. RESULTS

A. 1207-keV State

The coincident γ-ray spectrum observed at $\theta_\gamma = 45°$ is illustrated in Fig. 2(a). The angular correlation derived from spectra similar to this is illustrated in Fig. 3 along with the results of the least-squares fit. Only spin possibilities $J \leq 3$ are considered since the lifetime of a state with $J \geq 3$ and which decays to the ground state would be too long to be detected with any efficiency for the coincident resolving time used. It is obvious from the curves illustrated, as well as the χ^2 value listed in that figure for the corresponding spins tested, that this state has a unique spin assignment of $J = 2$. The corresponding Legendre polynomial coefficients are given in Table I.

B. 2414-, 2485-, and 2510-keV States

The peak in the proton-energy spectrum corresponding to these states is illustrated in Fig. 1 while NaI(Tl) γ-ray spectra taken in coincidence with portions of this peak are illustrated in Figs. 2(b) and 2(c). A Ge (Li) spectrum taken in coincidence with the entire proton peak is illustrated in Fig. 4(a). As is evident from the peaks labeled in Fig. 4(a), there are at least two states being populated, with excitation energies of 2485 and 2510 keV. The Ge(Li) spectra also indicate that the 2485-keV state decays to the ground state by a weak 15± 5% branch. From the NaI(Tl) spectrum obtained in coincidence with this entire group it was possible to extract an angular correlation for the 2485 → 0 transition from which the least-squares fit and χ^2 analysis resulted in a $J = 2$ assignment for this state. The resulting χ^2 values are 11.4, 1.2, and 13.3 for spins $J = 1$ thru 3: the 0.1% limit is at a χ^2 value of 6.3. The angular correlations for the decay of the 2485- and

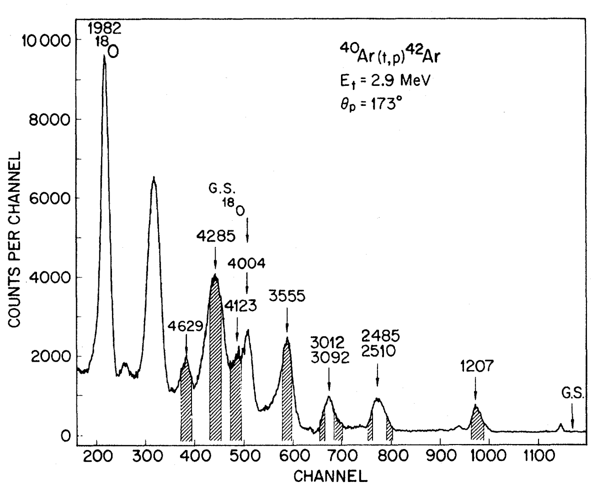

FIG. 1. The proton spectrum measured in time coincidence with all γ rays observed in the Ge(Li) detector. The proton groups associated with the ^{40}Ar$(t,p)^{42}$Ar reaction are all labeled with the excitation energies of the corresponding states. Random coincidences have been subtracted from this spectrum. The particle-detector resolution was approximately 120 keV FWHM for the 1207-keV group. The hatched bars represent the channels over which the coincident γ-ray spectra were taken during the angular correlation measurements and are referred to in more detail in the text.

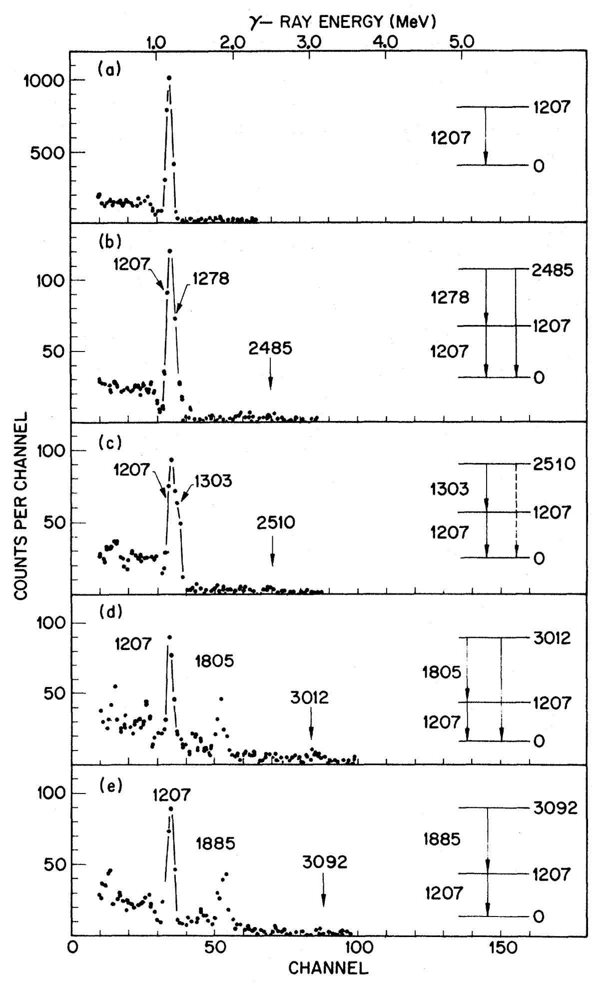

FIG. 2. The γ-ray spectra obtained at $\Theta_\gamma = 45°$ in time coincidence with proton groups leading to five of the excited states in ^{42}Ar. The proton energy requirements for the coincident conditions relate to the five corresponding hatched-marked regions of Fig. 1. Random coincidences have been subtracted from these spectra. The photopeaks of the deexcitation γ rays are labeled by their associated energy in keV. The spectrum of (b) contains the 1207-keV line from the decay of the 2414-keV state as well as those indicated.

2510-keV states to the first excited state could not be extracted from the NaI(Tl) data. The coincident Ge(Li) data indicated an essentially isotropic distribution for the 2510 → 1207-keV transition while that for the 2485 → 1207-keV transition was slightly anisotropic. No information about the spin of the 2510-keV state could be obtained.

Upon close examination one finds that the counts in the 1207-keV peak illustrated in Fig. 4(a) do not equal the sum of counts in the 1278- and 1303-keV photopeaks when corrected for photopeak efficiencies. In order to understand this more thoroughly, spectra similar to that plotted in Fig. 4(a) were obtained in coincidence with the five portions of the proton group illustrated in Fig. 4(c). From these five spectra the ratio of the counts in the 1207-keV peak to the sum of the counts in the 1278- and 1303-keV peaks was obtained and is plotted in Fig. 4(b) directly above the center of each of the five portions of the proton group. This plot indicates that for the first three groups this ratio is essentially 1, indicating that through this region of the proton group there is evidence of just two states. However, in the last two portions this ratio deviates significantly from a value of 1. It is hypothesized that a third state exists in this region with an excitation energy that is twice the energy of the first excited state such that the γ ray from the decay of this state to the 1207-keV state is energy degenerate with the 1207 → 0-keV transition. An excitation energy of 2414 ± 5 keV is attached to this state and no angular correlation data could be reduced for this state. Recent measurements[5] at Los Alamos confirm the existence of this state and find the spin to be $J = 4$.

C. 3012- and 3092-keV States

The peak in the proton spectrum representing these two states is illustrated in Fig. 1 while NaI(Tl) γ-ray spectra obtained in coincidence with this group are illustrated in Figs. 2(d) and 2(e). The angular correlations for the transitions from

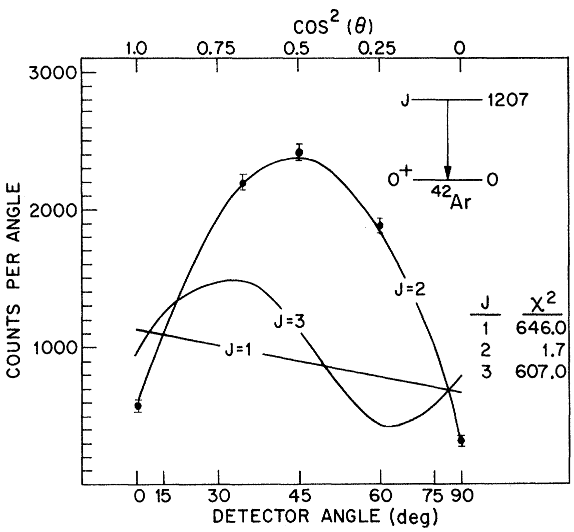

FIG. 3. The angular correlation of the γ-ray deexcitation of the 1207-keV state. The solid lines represent the best fits for each of the spins indicated and have been corrected for the solid angle of the γ-ray detectors. The finite-size effect of the particle counter has also been incorporated into the analyses. The χ^2 value shown corresponds to the best fit for each of the corresponding spin assignments.

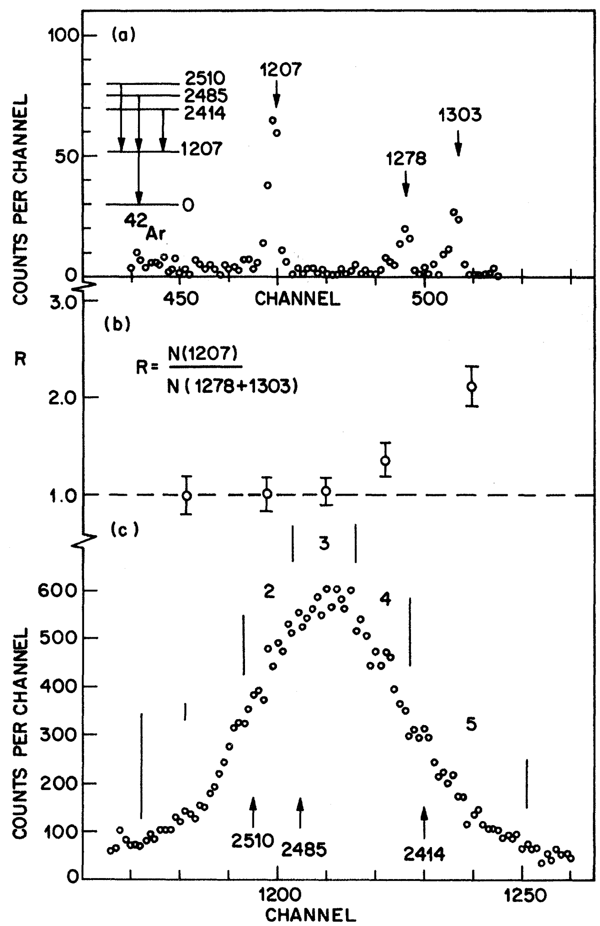

FIG. 4. (a) A portion of the Ge(Li) γ-ray spectrum obtained at $\Theta_\gamma = 90°$ in coincidence with the entire proton group representing states in the region of 2.48 MeV. (b) A plot of the ratio of the counts in the 1207-keV photopeak to the sum of the counts of the 1278- and 1303-keV peaks (corrected for photopeak efficiencies) versus the portion of the proton group for which the data are associated. (c) Represents the five portions into which the proton group for the 2.48-MeV multiplet was divided for the above analysis.

these two states were reliably retrieved by using only the NaI(Tl) γ-ray spectra which are in coincidence with the outer extremes of the proton peak as illustrated in Fig. 1. The least-squares fit and χ^2 analysis of the angular correlation data for the 3010-keV state indicated acceptable fits for spins $J=1$, 2, and 3. The corresponding mixing ratio associated with this analysis is given in Table II. A weak branch of $8\pm4\%$ was observed from this state to the ground state but its angular correlation could not be reliably extracted. In view of the octupole radiation implied by this branch for a spin $J=3$, the alternate spins of $J=1$ and 2 are favored.

The angular correlations for the γ ray from the 3092-keV state are illustrated in Fig. 5 along with the results of the associated least-squares fit and χ^2 analysis. This analysis indicates that the only acceptable fit to the data is obtained for a spin assignment of $J=4$.

D. 3555-keV State

The proton group leading to the 3555-keV state, as illustrated in Fig. 1 was well resolved from any nearby states. The angular correlations of the cascading γ rays obtained from spectra collected in coincidence with this group are illustrated in Fig. 6. The results of the associated least-squares fit and χ^2 analysis are illustrated in the same figure and indicate that the only acceptable fit is for a $J=2$ assignment to this state.

E. 4004-, 4123-, 4285-, and 4629-keV States

For states higher than 3555 keV excitation in ^{42}Ar the corresponding proton groups are super-

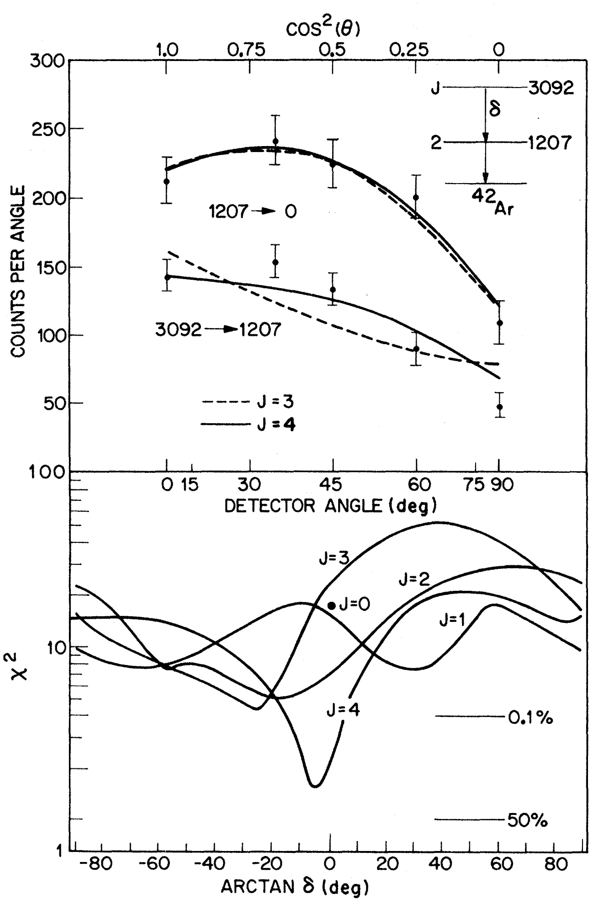

FIG. 5. The angular correlations of the γ rays cascading from the 3092-keV state and the associated χ^2 analyses thereof. The solid lines through the data points represent the best fit for the spin $J=4$ and have been corrected for the solid angle of the γ-ray detectors. The finite-size effect of the particle counter has also been incorporated into the analyses.

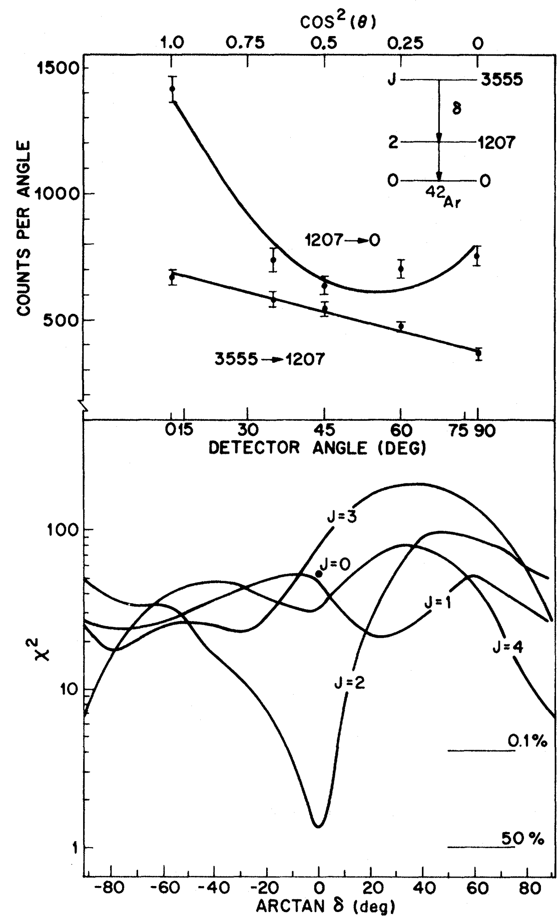

FIG. 6. The angular correlations of the γ rays cascading from the 3555-keV state and the associated χ^2 analyses thereof. The solid lines through the data points represent the best fit for the spin $J=2$ and have been corrected for the solid angle of the γ-ray detectors. The finite-size effect of the particle counter has also been incorporated into the analyses.

imposed on a background associated with real β-γ coincidences. There are a number of γ rays associated with this background, chief of which is a 1.27-MeV line from the β decay of ^{39}Cl. In addition, there are many states[5] at these higher excitations which are close in excitation energy and are weakly populated so that a reliable extraction of information from the present data was rendered difficult. The first state in this region for which evidence regarding its existence was found is the 4004-keV state. The main branch in the decay of this state is to the 1207-keV state. This state is at an excitation energy such that the corresponding proton group lies at the same energy as the intense group leading to the ^{18}O ground state. No reliable angular correlations could be obtained for the γ-ray transitions from this state. The coincident Ge(Li) γ-ray spectra indicated two lines which would correspond to transition from the 4004-keV state to the 3012- and 2485-keV states in addition to the stronger transition to the 1207-keV state.

The 4123-keV state decays nearly entirely to the first excited 1207-keV state with a maximum branch of $\leqslant 5\%$ to the ground state. The angular correlations of the cascading γ rays were essentially isotropic (see Table I). The least-squares fit of this data allows a spin assignment of $J = 0$, 1, or 2 for the 4123-keV state.

The proton group representing the region of excitation around 4.3 MeV was found to be mainly associated with a state of 4285-keV excitation energy. This state has its main decay route through the 1207-keV state. In addition two lines were observed in the Ge(Li) spectra which had energies corresponding to transitions from the 4285-keV state to the 2485- and 3092-keV states. The analysis of the angular correlations for the 4285 → 1207-keV transition limits the spin of this state to $J = 1$, 2, or 3. The corresponding value of mixing ratio associated with the minimum in the χ^2 analysis can be found in Table II.

The coincident γ-ray spectra associated with the proton peak in the region of 4.6 MeV excitation was found to be predominantly associated with a 4629-keV state. The main decay mode of this state is through the 1207-keV state. The angular correlation for this transition was anisotropic (see Table I) and the analysis thereof indicates a spin assignment of $J \geqslant 1$ for the 4629-keV state. It was difficult to set limits on any other possible modes of decay for this state.

IV. DISCUSSION

The Argonne shell-model calculations[6] involve $d_{3/2}$, $f_{7/2}$, and $p_{3/2}$ orbits for the active valence particles and holes. In determining the matrix elements they performed two calculations. One assumes that the $p_{3/2}$ single-particle level is at 1.4 MeV in ^{37}S and the other calculations uses 0.7 MeV for the excitation of this state. The results are not significantly different for the two assumptions and for the present discussions the first set is used.

A synthesis of the results obtained in the present experiment for properties of the level structure of ^{42}Ar is given in Fig. 7. The level positions resulting from the shell-model calculations are shown in comparison to the known states in Fig. 8. Included in this figure are the l values for some of the states obtained in the (t, p) transfer studies performed at Los Alamos.[5]

The formation of the 1207-keV state was found to be associated with an $l = 2$ transfer. This concurs with the present spin assignment for this state and in addition implies that the parity is positive. The first predicted $J^\pi = 2^+$ state lies at 1180 keV excitation and has seniority $\nu = 2$. This state is identified with the above observed first excited state.

The spin of the 2414-keV state was not measured in the present experiment; it was, however, observed to be formed by an $l = 4$ transfer in the Los

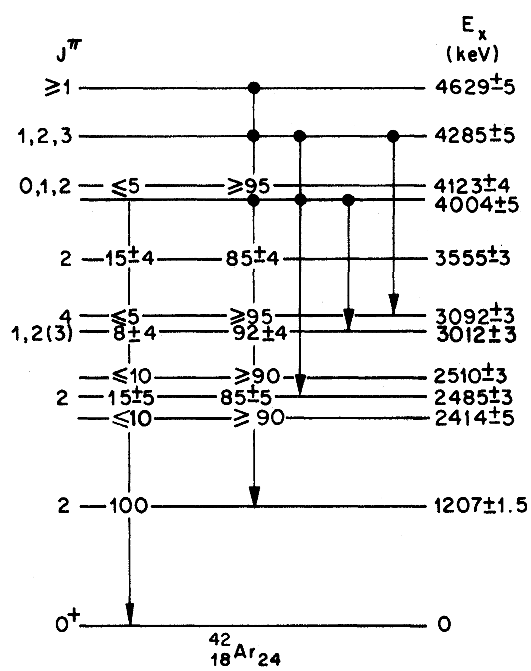

FIG. 7. A summary of the spectroscopic information obtained in the present experiment for the excited states of ^{42}Ar. The dots represent those transitions which were observed experimentally but for which no corresponding branching ratio could be assigned. See the text for further information regarding these transitions.

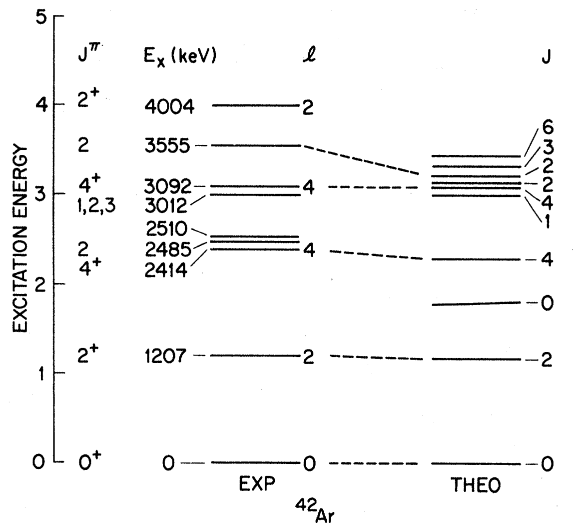

FIG. 8. A comparison of the results for the positive-parity states of the shell-model calculations of Ref. 6 with the known experimental properties of ^{42}Ar. The l values are the results of the (t, p) direct transfer studies of Ref. 5 while the spin and parity assignments are those from the present studies and Ref. 5. The dashed lines connect those states believed to be equivalents.

Alamos studies. This implies that the spin and parity of this state must be $J^\pi = 4^+$. Consequently this state is identified with the $J^\pi = 4^+$, $\nu = 4$ state predicted to be at approximately 2290 keV excitation. It should be pointed out that in the Argonne calculations[6] the $J = 4$, $\nu = 4$ state is placed at a lower excitation than the $J = 2$, $\nu = 4$ state.

The 2485-keV state was found to be $J = 2$ in the present experiment and was unfortunately too weakly populated in the direct reaction studies[5] to allow any information to be obtained. It is assumed that the parity of this state is positive and that it can be identified[6] with the $J^\pi = 2^+$, $\nu = 4$ state or with a core-excited state of the same spin and parity, both of which are predicted to lie in this region of excitation.

No spin information could be obtained in the present experiment regarding the 2510-keV state. Just as in the case of the 2485 state this state was weakly populated in the direct reaction studies[5] and no information regarding its formation was obtained.

The 3012-keV state was found to be $J = 1$, 2, or (3) in the present experiment and was not seen in the direct reaction studies.[5] The 3092-keV state was assigned a spin of $J = 4$ in the present experiment and was found in the direct reaction studies to be associated with an $l = 4$ transfer. This concurs with the present spin assignment and in addition implies that the parity of this state is positive. This state is therefore associated with the $\nu = 2$, $J^\pi = 4^+$ state predicted at an excitation of 3058 keV.

In regard to the remaining predicted states, it is not clear what correspondence should be made with the measured excited states. There is in addition to the states already mentioned a predicted $J^\pi = 0^+$ state which is associated with core excitations and is the equivalent to the 1.9-MeV state in ^{44}Ca. The Argonne calculations place this state at approximately 1.8 MeV excitation; in both the direct reaction studies[5] and the present work no evidence could be found for such a state. The only possible known candidate for such a state is the 2510-keV state which has no spin assignment thus far. The isotropic angular correlation of the transition from this state to the 1207-keV state allows the possibility of a $J = 0$ assignment but unfortunately does not reject other spin assignments. If the 2510-keV state is not this core excited $J^\pi = 0^+$ state then a reasonable explanation is that the core is not excited at beam energies of $E_t = 2.9$ MeV. This, however, does not explain its absence at $E_t = 20$ MeV as reported by the Los Alamos group.[5] The only other candidate for a $J = 0$ state is the 4123-keV state which also was associated with isotropic angular correlations for the cascading γ rays. This state is most likely equivalent to the predicted $J^\pi = 0^+$ state at approximately this excitation.

There are a number of states above 3.5 MeV excitation which are not found in the present experiment but which were observed in the direct-reaction studies.[5] Since these states have no bearing on the present discussions they will not be mentioned; the reader is referred to that paper[5] for further details.

A detailed comparison between the measured relative branching ratios and those predicted by the Argonne calculations can be found in Ref. 6. It is this comparison which is used in affirming the identification between predicted and experimental states. Preliminary shell-model calculations[7] performed at Rehovot using only a $d_{3/2}$, $f_{7/2}$ model produce somewhat similar results as the Argonne calculations when using the same model. With the inclusion of a $p_{3/2}$ orbit the agreement with experiment should likewise improve.

ACKNOWLEDGMENTS

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Mean Lifetimes of Levels in ^{26}Al†

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The mean lifetimes of levels in ^{26}Al below 4 MeV have been investigated with the Doppler-shift attenuation method and the ^{24}Mg(^{3}He, p)^{26}Al reaction at 6 MeV. The outgoing protons have been detected at angles of ±60° with respect to the beam axis, in coincidence with γ rays detected at 90° in an 80-cm^3 Ge(Li) detector. The results for levels below 3 MeV are generally in agreement with earlier lifetime studies. New information is reported for the following levels (energy in keV, lifetime in fsec): 2741 (54 ± 8), 3074 (290 ± 70), 3161 (36 ± 10), 3597 (44 ± 17), 3680 (27 ± 12), 3721 (<23), 3750 (43 ± 9), 3754 (27 ± 11), and 3962 (68 ± 14). The 3074-keV level is assigned positive parity on the basis of the present lifetime results. Experimental transition strengths are extracted and discussed in terms of isospin selection rules in electromagnetic transitions.

INTRODUCTION

Although nuclei in the middle of the s-d shell have been known for sometime to have properties consistent with stable deformation,[1] indications of rotational structure in the nucleus ^{26}Al have not been readily apparent. Experimental spectroscopic factors obtained from an analysis of the ^{25}Mg(^{3}He, d)^{26}Al and ^{25}Mg(d, n)^{26}Al reactions[2,3] have not agreed particularly well with the predictions of the Nilsson model, and later γ-ray studies[4] also found little evidence for well defined rotational bands. However the group at Liverpool has recently located levels with properties consistent with those of members of two rotational bands[5,6] which would indicate that ^{26}Al may indeed be a deformed nucleus after all. A comprehensive study of electromagnetic transitions is clearly of interest in assessing the applicability of a unified-model description of ^{26}Al and also as a test of current shell-model calculations in the s-d shell region. The present work reports a study of the mean lifetimes of the levels in ^{26}Al below 4 MeV populated in the ^{24}Mg(^{3}He, p)^{26}Al reaction. The study of lifetimes in ^{26}Al is also of interest in testing the validity of isospin selection rules in electromagnetic transitions. The $T=1$ states in such odd-odd $T=0$ nuclei lie at low excitation energy along with a large number of $T=0$ states, and this then gives rise to the possibility of many examples of $\Delta T=0$ or 1 γ-ray transitions.

Figure 1 summarizes the presently available experimental information on the 25 known levels in ^{26}Al below 4 MeV. The energies, spin assignments, and decay properties of most of these levels come primarily from the work of Bissinger *et al.*,[4,7] Price *et al.*,[6] and Hausser *et al.*[8] The parities of the levels come from 1-value assignments from the reaction studies of Refs. 2 and 3 except for the cases of the 2071.7- and 3074-keV