The spectrum whose ground state is lower than that of any other spectrum would be closer to the physical situation. This suggests that if the HF state gives the experimental spectrum quite correctly then $E_K{}^K < E'_K{}^K$, where $E'_K{}^K$ is the energy of the $I=K$ state projected from any other state ϕ'_K having the same symmetries and the single-particle basis as the HF state ϕ_K. In the last section we have shown, in a certain approximation, that $E_K{}^K < E'_K{}^K$, explaining thereby the importance of the HF state in obtaining the low-lying excited states of nuclei by the projection technique.

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Electric Quadrupole Transitions near $A=16$: the Lifetimes of the N^{16} 0.120-, F^{18} 1.125-, F^{19} 0.197-, and Ne^{19} 0.241-MeV Levels*

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Continuing a program to study $E2$ lifetimes in the neighborhood of $A=16$, we have remeasured the mean lifetimes of the following states: the 0.197-MeV level of F^{19}; the 0.241-MeV level of Ne^{19}; the 0.120-MeV level of N^{16}; and the 1.125-MeV level of F^{18}. We find $(129.9\pm2.3)\times10^{-9}$sec, $(26.6\pm1.2)\times10^{-9}$ sec, $(7.58\pm0.09)\times10^{-6}$ sec, and $(221\pm21)\times10^{-9}$ sec, respectively.

INTRODUCTION

As has been pointed out on numerous occasions, the independent particle model (IPM) characterized by the calculations of Kurath and others[1,2] describes quite well level schemes in the $1p$ and $(2s, 1d)$ shells; and new calculations[3,4] indicate even more success. However, the success in describing the level schemes has not extended itself to the description of electromagnetic transitions between these states, most particularly $E2$ transitions, although the most recent calculations[3,4] seem to indicate a more substantive agreement[5,6] with theory. Perhaps the IPM wave functions may be repaired to include collective effects of admixtures of higher states which will explain these strong $E2$ transitions.

The region near $A=16$ represents a fertile testing ground as the number of additional particles or holes past the filled $1p$ shell is small. Particularly, we have remeasured[7] the lifetimes of the first excited states of O^{17} and F^{17} since, representing as they do $2s\to1d$ jumps, they are most relevant to the problem of $E2$ enhancement. We have undertaken further remeasurements[8] on $E2$ transitions near $A=16$: the lifetimes of the first excited states of Ne^{19} (0.241-MeV) and N^{16} (0.120-MeV), the second excited state of F^{19} (0.197-MeV), and also the 1.125-MeV level of F^{18}.

Previous measurements of these mean lifetimes are

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TABLE I. Lifetime measurements.

State	Previous work Mean lifetime (sec)	Reference	This work Mean lifetime (sec)
N^{16} 0.120-MeV	$(9.67\pm0.72)\times10^{-6}$	9	$(7.58\pm0.09)\times10^{-6}$
	$(7.83\pm0.32)\times10^{-6}$	10	
F^{19} 0.197-MeV	$(1.0\ \pm0.2)\times10^{-7}$	11	$(129.9\pm2.3)\times10^{-9}$
	$0.8\ \times10^{-7}$	12	
	$(1.25\pm0.025)\times10^{-7}$	13	
	$(1.23\pm0.07)\times10^{-7}$	14	
	$(1.28\pm0.02)\times10^{-7}$	15	
N^{19} 0.241-MeV	$(26\ \pm3)\times10^{-9}$	16	$(26.6\pm1.2)\times10^{-9}$
F^{18} 1.125-MeV	$(190\pm45)\times10^{-9}$	17	$(221\pm21)\times10^{-9}$
	$(215\pm10)\times10^{-9}$	18	

summarized in Table I.[9–18] The present measurements have been undertaken with the aim of establishing hopefully better determinations of the mean lifetimes of these levels where general agreement exists as well as to clear up the discrepancy in the case of the N^{16} 0.120-MeV level,[6] where the previous values in the literature for the mean lifetime, $(9.67\pm0.72)\times10^{-6}$ sec[9] and $(7.83\pm0.32)\times10^{-6}$ sec,[10] are in pronounced disagreement. We report herein only the experimental observations for these mean lifetimes.

EXPERIMENT

The method used for these lifetime measurements was either that of the pulsed beam or the associated particle. Time-to-height conversion was employed to measure time distributions except for the study of the N^{16} 0.120-MeV level, where direct scaling techniques were employed. The bodies of interest were produced with charged-particle induced reactions using ion beams accelerated with the Brookhaven National Laboratory Van de Graaff accelerator.

NaI(Tl) scintillation spectrometers were employed throughout for detection of gamma radiations, and a solid-state detector spectrometer was employed for the detection of charged particles. Signals for timing purposes were obtained from the radiation spectrometers by detection of the zero crossing[19] of the double delay line amplified energy analog signals. When the pulsed-beam method was employed, beam pulses of short duration were produced every 350 nsec using an external beam sweeper.[20] In this method the distribution of time intervals between signals from a radiation detector and a signal derived from the beam modulating rf signal is measured. When the associated particle method is employed, a signal indicating formation of the state being studied is obtained by detecting prompt reaction events (particles or γ rays) and measuring time intervals between these events and subsequent decays.

The relationship in time between events was measured with a start-stop type time-to-height converter[21] with a useful time range of 1 μsec. The time distributions were collected using both one- and two-parameter analysis. Throughout the experiment, care was taken to keep the count rates presented to the time-to-height converter commensurate with the 1-μsec sweep time of the converter; hence premature stops of the converter sweep did not bias the measured time distributions.

A. The F^{19} 0.197-MeV Level

The pulsed-beam method was used to study the F^{19} 0.197-MeV level. This state was populated with the

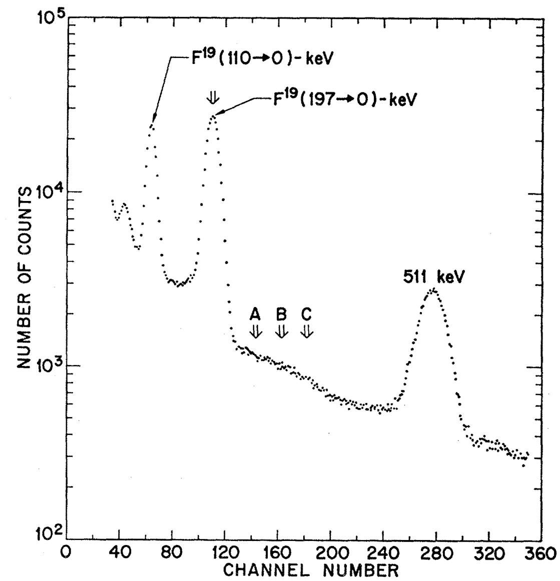

FIG. 1. Pulse-height distribution of events in the 3-in.-diam $\times$3-in.-long NaI(Tl) scintillator observed during bombardment of a CaF_2 target with 2.4-MeV protons. Pulse-height selection criteria employed in measuring the time distributions of the 0.197-MeV γ ray are indicated by the broad vertical arrows in the figure. γ rays are labeled according to full energy loss in the scintillator.

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$F^{19}(p,p')F^{19}$ reaction by bombarding a CaF_2 target with 2.4-MeV protons. The target was prepared by evaporating CaF_2 onto a Ni backing. The beam was pulsed at 1394 kHz, producing bursts of beam upon the target about every 350 nsec. Gamma radiations were detected in a right cylindrical NaI(Tl) detector 3 in. in diameter by 3 in. long located 90° with respect to the incident beam direction and 2 in. from the reaction site. Figure 1 illustrates a γ-ray pulse-height distribution recorded with this arrangement. Full energy loss peaks corresponding to γ rays of energy 0.110 and 0.197 MeV are evident in the figure, as well as 0.511-MeV radiation. Five measurements of the time distribution of γ rays with pulse heights corresponding to 0.197 MeV were recorded; the pulse-height selection criteria used is indicated by the broad arrow near channel 110 in Fig. 1. One of the five time distributions recorded is presented in Fig. 2. Since the time interval between pulses is not long compared with the observed lifetime (see Fig. 2) it is not possible to estimate the background by extrapolation of the number of counts observed at long delay times; hence, we estimated the background by measuring time distributions of γ rays with pulse heights included in the regions marked A, B, and C in Fig. 1. For the illustrated time distribution, the extrapolated background amounted to 12 counts/channel and has been subtracted from these data. Time calibration was effected by measuring the frequency of the rf beam deflecting voltage and measuring the location of radiations which are prompt with respect to the beam burst. The time calibration arrived at in this fashion for the time distribution of Fig. 2 was $(5.422\pm0.005)\times10^{-9}$ sec/channel. The time distributions were analyzed following the procedure outlined in Ref. 7. The delayed portion of the curve is analyzed in two parts, Regions I and II of Fig. 2, to ensure that the decay is indeed a single-valued exponential over the region analyzed. Regions I

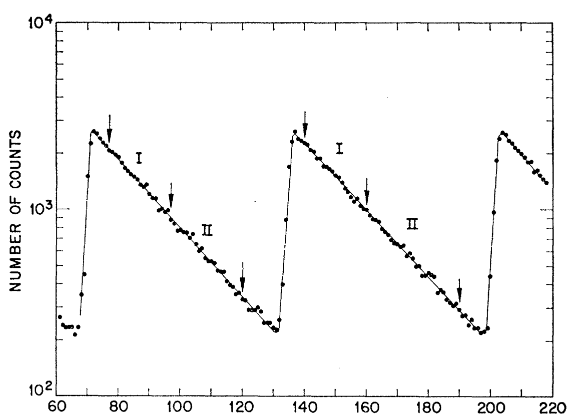

FIG. 2. Typical distributions in time obtained for the decay of the 0.197-MeV excited state of F^{19}. A constant background of 12 counts/channel has been subtracted from these data. The time calibration is $(5.422\pm0.005)\times10^{-9}$ sec/channel.

TABLE II. Mean lifetime of the 0.197-MeV state of F^{19}(units of 10^{-10} sec).[a]

Run	τ_{I}	$\epsilon_{\tau I}$	τ_{II}	$\epsilon_{\tau II}$	τ
		Channels 76–120			
11	1313	34	1309	38	
12	1300	33	1318	38	
13	1345	35	1242	33	
14	1293	31	1307	36	
15	1262	31	1326	38	
Mean value	1300±16		1297±18		
		Channels 142–188			
11	1330	38	1342	33	
12	1260	34	1300	31	
13	1322	37	1290	30	
14	1276	33	1338	31	
15	1325	37	1246	28	
Mean value	1300±18		1300±15		
Adopted value					1299±18

[a] The errors stated here are those of the decay analysis only and contain no allowance for error in the time calibration.

and II are chosen to have approximately equal statistics. The mean life τ_m is arrived at by compounding τ_{I} and τ_{II} together with their associated errors. To estimate the effect of the background uncertainty upon the mean lifetime, the decay analysis was repeated using the estimated upper and lower bounds of the background. This resulted in an error of $\pm0.5\%$ in the mean lifetime. Table II presents the results of the decay analysis.

As a result of this measurement, we adopt the value for the mean lifetime of the F^{19} 0.197-MeV level:

$$\tau_m=(129.9\pm2.3)\times10^{-9}\ \text{sec}.$$

The error quoted has been arrived at by compounding

(1) the $\pm1.4\%$ due to the decay analysis (Table II),
(2) the $\pm0.5\%$ due to the background uncertainty,
(3) the $\pm0.1\%$ due to the time calibration, and
(4) an additional 1.0% which we feel is adequate to cover possible systematic errors.

B. Ne^{19} 0.241-MeV Level

We employed the $Ne^{20}(He^3,\alpha)Ne^{19}$ reaction ($Q=3.70$ MeV) to populate the 0.241-MeV level of Ne^{19}. Ne^{20} gas[22] enriched to $>99.9\%Ne^{20}$ contained in a cylindrical gas cell 1 cm wide$\times$2 cm long at a pressure of 11.5 in. Hg was bombarded with 3.1-MeV He^3 particles. The beam impinged on the gas through a Ni window of 0.05-mil thickness (500 keV thick for 3-MeV He^3 particles). γ radiations were detected in 2 NaI(Tl) scintillators, detectors I and II. Detector I, a 3-in.-diam by 3-in.-long scintillator, was located 2 cm from the target cell and at $+90°$ with respect to the incident beam direction, while detector II, a 5-in.-diam by 5-in.-long scintillator, was located 3 cm from the target cell and at $-90°$ with respect to the incident beam direction. The timing pulses were taken from detector I analog signals, and detector II was operated in anti-

[22] A. J. Howard and W. W. Watson, J. Chem. Phys. 40, 1409 (1964). A. J. Howard kindly made the Ne^{20} gas accessible to us.

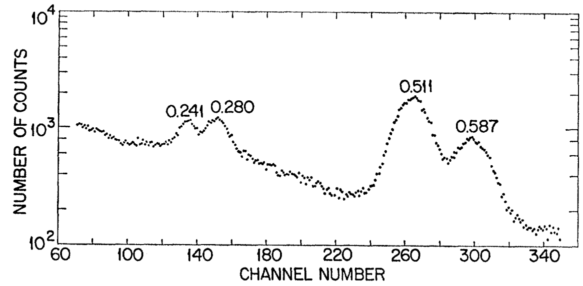

FIG. 3. Pulse-height distribution of events in the 3-in.-diam ×3-in.-long NaI(Tl) scintillator observed during bombardment of a Ne^{20} gaseous target with 3.3-MeV He^3 particles. γ rays are labeled according to full energy loss in the scintillator.

coincidence with detector I to reduce the contribution of 0.51-MeV radiations to the recorded time distributions. A representative pulse-height distribution of events in detector I is illustrated in Fig. 3. These data were taken at $E_{He^3}=3.3$ MeV and show quite clearly the 0.241- and 0.280-MeV photopeaks from the $Ne^{20}(He^3,\alpha)Ne^{19}$ reaction. In addition to 0.51-MeV annihilation radiation we see also a 0.587-MeV γ ray from the Ne^{20}-$(He^3,p)Na^{22}$ reaction ($Q=5.78$ MeV). In the data of Fig. 3 evidence is also found for a weak 0.350-MeV transition (channel number ~185) from the Ne^{20}-$(d,p)Ne^{21}$ reaction ($Q=4.53$ MeV), which results from a small deuteron contamination of the He^3 beam. The lifetime measurements were done at $E_{He^3}=3.1$ MeV, where the ratio of the 0.241-MeV photopeak to background was less favorable; however, the time decay of the entire γ-ray pulse-height distribution was obtained through two-parameter analyses which permitted a convenient separation of the 0.241-MeV γ-ray time distribution. To determine the extent to which the background radiations may perturb the study of the Ne^{19} 0.241-MeV level we inquire into the lifetime information available on the corresponding levels. The

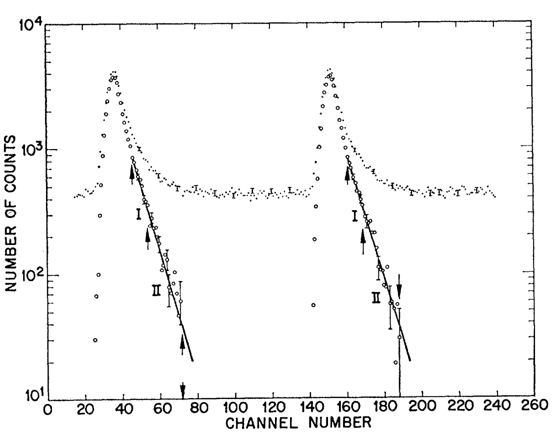

FIG. 4. A distribution in time obtained for the decay of the 0.241-MeV first excited state of Ne^{19}. Raw data are represented by the dark points, and the open circles represent the time distribution resulting after the subtraction of background. The time calibration is $(3.110\pm0.005)\times10^{-9}$ sec/channel.

Ne^{19} 0.280-MeV level has been reported[16] to have a lifetime $<5\times10^{-9}$ sec, while the Ne^{21} 0.350-MeV level has a mean lifetime[23] $\tau_m=(6.2\pm6.2)\times10^{-11}$ sec. The lifetime of the Na^{22} 0.587-MeV level has a measured[24] lifetime $\tau_m=(243\pm2)\times10^{-9}$ sec. We expect a small contribution to the time distribution of γ rays with energy ~0.241 MeV from this last γ ray even though the intensity ratio of full-energy peaks $I(0.241)/I(0.587)$ is $\frac{1}{2}$, as the contribution from the 0.587-MeV γ ray is reduced by the NaI(Tl) scintillator peak-to-total ratio and the long mean lifetime of this level. The main difficulty is the proximity of the 0.280-MeV γ ray and the large amount of background radiation. The time distributions were collected with a two-parameter analyzer, the other parameter being γ-ray pulse height. The region of γ-ray pulse height in the two-parameter analysis included 0.1 to 0.4 MeV. Figure 4 illustrates the time distribution of γ rays with energy near 0.241-MeV.

Background determinations were made by averaging the counts in the background region, for example,

TABLE III. Mean lifetime of the 0.241-MeV state of Ne^{19} (units of 10^{-11} sec).[a]

Run	τ_I	$\epsilon_{\tau I}$	τ_{II}	$\epsilon_{\tau II}$	τ
1	2735	165	2693	198	
2	2684	175	2798	253	
3	2734	185	2660	218	
4	2625	181	2678	242	
5	2664	209	2557	252	
6	2446	188	2800	310	
7	2656	206	2455	248	
Mean value	2657±101		2653±76		
Adopted value					2655±89

[a] The errors stated here are those of the decay analysis only and contain no allowance for error in background determination or time calibration.

channels 93 to 113 in Fig. 4, and assuming a linear extrapolation. In Fig. 4 the raw data are represented by the dark points, and the open circles represent the time distribution obtained after the subtraction of the background.

Time calibration was established as for the F^{19} 0.197-MeV level study and was determined to be $(3.110\pm0.005)\times10^{-9}$ sec/channel for these data. The uncertainty in the mean lifetime caused by the uncertainty in the background determination was estimated by repeating the decay analysis using the upper and lower bounds of the background. Analysis of the data was carried out as described for the F^{19} 0.197-MeV level; the results are presented in Table III.

As a result of these measurements, we adopt for the mean lifetime of the Ne^{19} 0.241-MeV level the value

$$\tau_m=(26.6\pm1.2)\times10^{-9}\text{ sec.}$$

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The error above has been arrived at by compounding

(1) the $\pm 3.4\%$ error due to the decay analysis (Table III),

(2) the $\pm 2.6\%$ error arising from the background uncertainty,

(3) the $\pm 0.15\%$ error due to the uncertainty in the time calibration, and

(4) an additional 2.0% included as an estimate of possible systematic errors.

The time distribution of the 0.280-MeV γ ray was also examined, and an upper limit $\tau_m \leq 5\times 10^{-9}$ sec was deduced for the mean lifetime of the Ne^{19} 0.280-MeV level, in agreement with previous results.[14]

C. The N^{16} 0.120-MeV Level

The associated particle method was used to study the N^{16} 0.120-MeV level. The 0.396-MeV level of N^{16} has[8] a 75% γ-ray branch to the 0.120-MeV level and mean lifetime short compared with the expected lifetime of the 0.120-MeV level.[9,10] Measurement of the time distribution of 0.120-MeV γ rays relative to

TABLE IV. Mean lifetime of the 0.120-MeV state of N^{16} (units of 10^{-9} sec).[a]

Run	τ	ϵ_τ
1	7584	82
2	7617	71
3	7552	65
4	7586	81
Mean value	7583±43	

[a] The errors stated here are those of the decay analysis only and contain no allowance for error in the time calibration.

the $t=0$ signal obtained by detection of the 0.276 $(0.396\rightarrow 0.120)$-MeV γ rays was used to obtain the 0.120-MeV level mean lifetime. This method is insensitive to the lifetime of the 0.396-MeV level.

N^{16*} was formed in the 0.396-MeV state using the $N^{15}(d,p)N^{16}$ reaction ($Q=0.276$ MeV); a thick TiN^{15} target was bombarded with 2.7-MeV deuterons. γ rays were detected with 2 coaxial 3 in.-diam by 3-in.-long NaI(Tl) scintillators, which we designate as detectors I and II, located at $+90°$ and $-90°$ with respect to the incident beam direction. The front face of each detector was 1.7 cm from the reaction site. Figure 5 illustrates a pulse-height distribution taken with one of the spectrometers. Full-energy-loss peaks correspond to N^{16} γ rays of energy 0.120 MeV and the 0.276-, 0.296-MeV doublet. To measure the time distribution, an event in spectrometer I with pulse height in the $0.276(0.396\rightarrow 0.120)$-MeV region was used to initiate a pulsed oscillator,[25] while detection of a 0.120-MeV γ ray in spectrometer II was used to stop the pulsed oscillator. The oscillator pulse train was binary scaled,

[25] Technical Measurement Corporation, North Haven, Connecticut.

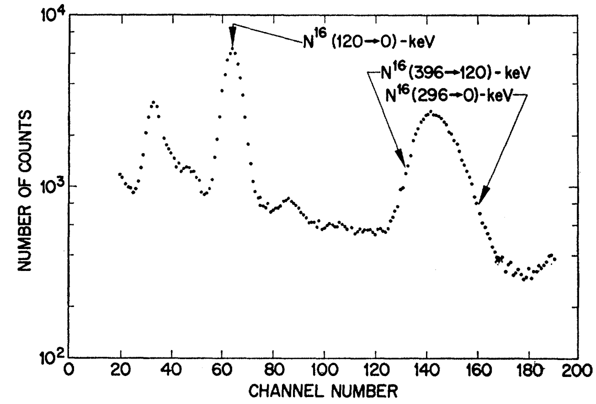

FIG. 5. Pulse-height distribution of events in a 3-in.-diam×3-in.-long NaI(Tl) scintillator observed during bombardment of a TiN^{15} target with 2.7-MeV deuterons. γ rays are labeled according to full energy loss in the scintillator.

and events were recorded in the memory of a compatible 256-channel analyzer. Figure 6 illustrates one of the 4 analyzed time distributions. Background was estimated by assuming the random background at long delay times was a true estimate of the background under the delayed portion of the time distribution. The heavy points of Fig. 6 represent the raw data minus the background correction, and the light points represent the raw data. Time calibration was effected by measuring the frequency of the oscillator in three of the four runs; the fourth run utilized a crystal-controlled 1-MHz oscillator. The time calibration associated with Fig. 6 0.5000 μsec/channel. Table IV summarizes the analysis of the four runs; here the estimated background and its associated error were included in the decay analysis as a long-lived component. As a result of this measurement

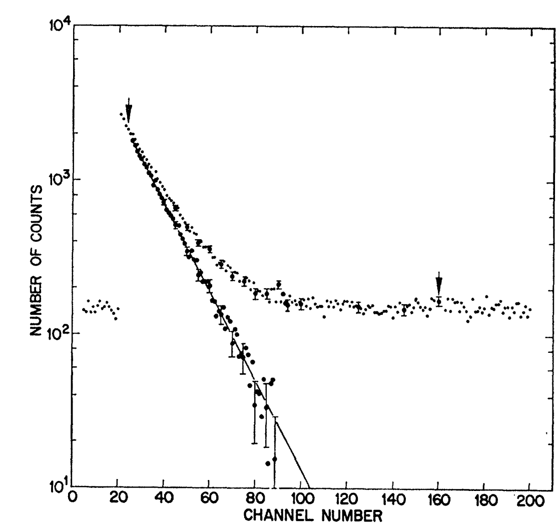

FIG. 6. A distribution in time obtained for the decay of the 0.120-MeV level of N^{16}. Raw data are represented by the light points and the heavy points represent the time distribution resulting after the subtraction of background. The time calibration is 0.5000×10^{-6} sec/channel.

we adopt the value for the mean lifetime of the N^{16} 0.120-MeV level:

$$\tau_m = (7.58 \pm 0.09) \times 10^{-6} \text{ sec}.$$

The error quoted has been arrived at by compounding

(1) the error due to the decay analysis, $\pm 0.6\%$ (Table IV),

(2) $\pm 0.1\%$ for the error in the time calibration, and

(3) an additional $\pm 1.0\%$ which we feel should cover possible systematic errors.

D. The F^{18} 1.125-MeV Level

The associated particle method was used to measure the lifetime of the F^{18} 1.125-MeV level. The time distribution of γ rays de-exciting this level was measured relative to the outgoing reaction charged particles indicating formation of the level. F^{18*} was formed in the 1.125-MeV level using the $O^{16}(He^3,p)F^{18}$ reaction ($Q = 2.021$ MeV). A quartz target was bombarded with He^3 particles accelerated to 3.0 MeV. Charged particles were detected in a solid-state counter 1.2 cm from the reaction site and 90° to the incident beam direction. Tantalum collimators limited the angular spread of detected particles to $\sim 10°$. Elastically scattered He^3 particles were absorbed in an Al foil (3 mg/cm²) placed over the counter surface; with this arrangement the particle groups corresponding to population of the quartet of levels near 1-MeV excitation energy in F^{18} were not resolved. γ radiations from the reaction site were detected in a 5-in.-diam by 5-in.-long NaI(Tl) scintillation spectrometer. The NaI(Tl) scintillator, supported by the Lucite lid of the scattering chamber, was placed directly over and 2 cm from the reaction site, i.e., 90° with respect to the incident beam direction and 90° to the plane formed by the beam axis and the solid-state detector. Figure 7 illustrates a γ-ray pulse-height distribution collected with this arrangement. The full-energy-loss peaks of Fig. 7 correspond to F^{18} γ-ray transitions with energies of 0.66 ($1.70 \rightarrow 1.04$), 0.940, 1.02 ($2.10 \rightarrow 0.940$), 1.04, 1.08, and 1.16 ($2.10 \rightarrow 0.94$) MeV, and annihilation radiation.

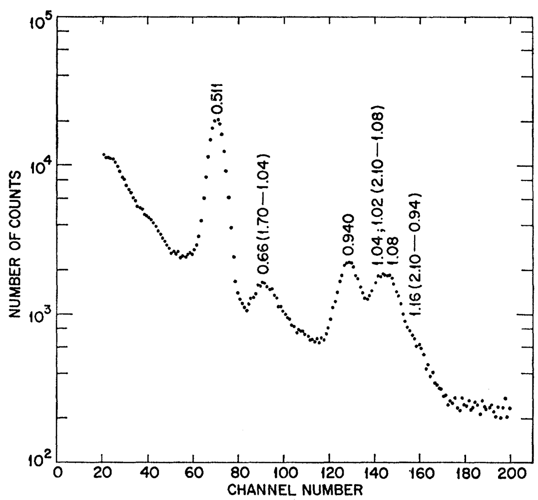

FIG. 7. Pulse-height distribution of events in the 5-in.-diam ×5-in.-long NaI(Tl) scintillator observed during bombardment of a SiO_2 target with 3.0-MeV He^3 particles. γ rays are labeled according to full energy loss in the scintillator.

As the 0.94-MeV level has a mean lifetime[26] $\tau^m = (6.8 \pm 0.7) \times 10^{-11}$ sec, which is short compared with the expected[17,18] mean lifetime of the 1.125-MeV level, and the 1.125-MeV level decays[17,27] 100% with cascade radiation through the 0.94-MeV level, it is more convenient experimentally to measure the mean lifetime of the 1.125-MeV level by measuring the time distribution of the 0.94-MeV γ rays, even through the corresponding charged-particle groups to the 0.94-, 1.04-, 1.08-, 1.125-MeV levels were not resolved in the charged-particle pulse-height distribution. This procedure has the obvious drawback that much "prompt" radiation from the 0.94-MeV level, as well as radiation from the decay of 1.04-MeV and 1.08-MeV levels are included in the time distribution. However, the 1.04- and 1.08-MeV levels possess mean lifetimes[26,28] such that inclusion of these latter events will not perturb the F^{19} 1.125-MeV level study.

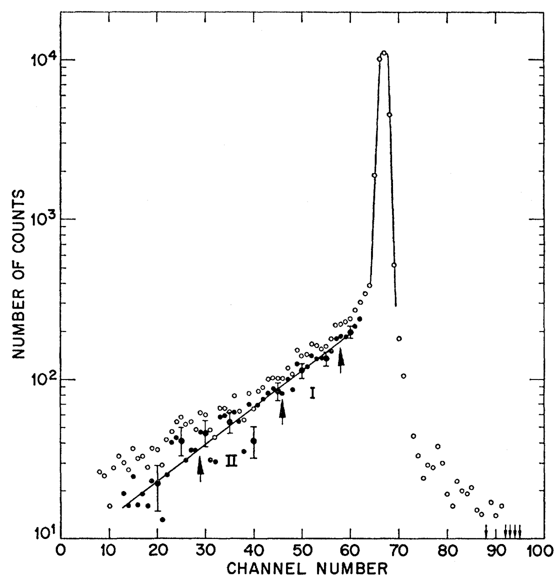

FIG. 8. A distribution in time obtained for the decay of the 1.125-MeV level of F^{18}. Raw data are represented by open circles and the dark points represent the time distribution resulting after the subtraction of background. The time calibration is $(12.45 \pm 0.05) \times 10^{-9}$ sec/channel.

[26] T. K. Alexander, K. W. Allen, and D. C. Healey, Bull. Am. Phys. Soc. 1, 44 (1966).

[27] A. R. Poletti and E. K. Warburton, Phys. Rev. **137**, B595 (1965).

[28] A. E. Litherland, M. J. L. Yates, B. M. Hinds, and D. Eccleshall, Nucl. Phys. **44**, 220 (1963).

The 1.04-MeV level has a mean lifetime $\tau < 3\times10^{-13}$ sec[28], while for the 1.08-MeV level the measured[26] lifetime is $\tau_m = (3\pm0.3)\times10^{-11}$ sec. Nevertheless, in a separate experiment, the pulsed-beam method was employed to study the 1.125-MeV level. Again the time distribution of 0.94-MeV γ rays was measured; however the supervisory slow coincidence conditions imposed resulted in the collection of only 0.94-MeV γ rays in the $1.125 \rightarrow 0.94 \rightarrow 0$ cascade. This study resulted in detection of delayed radiation assigned to the 1.125-MeV level of approximately the expected lifetime.

To continue, a two-parameter analysis of the charged-particle pulse-height distribution and the time distribution of γ rays with energies in the neighborhood of 0.94-MeV was made, and Fig. 8 illustrates one of the time distributions extracted from these data. In the figure, open circles represent the recorded data and the closed circles result after the background subtraction. Altogether, four separate runs roughly equivalent in duration were made, and the time distributions were analyzed for an exponential decay assuming the background of the $t<0$ side of the prompt peak specifies the background beneath the delayed portion of the distribution. The background was estimated by examination of the time distributions of prompt γ rays coincident with lower-energy protons and normalization to the counts on the $t<0$ side of the prompt peak. The decay analysis was effected for two such estimates, designated A and B; the corresponding mean lifetimes should, of course, be consistent, one with the other. The decay portion of the time distribution was again analyzed in two regions, as described in Ref. 7 and Sec. B. The results of the decay analysis are presented in Table V. The time calibration used in this analysis was effected by switching on the beam-sweeping system and measuring the frequency of the beam-deflecting voltage (1394 kHz) and the location of prompt radiations in the usual manner and was $(12.45\pm0.05)\times10^{-9}$ sec/channel.

TABLE V. Mean lifetime of the 1.125-MeV state of F^{18} (units of 10^{-10} sec.)[a]

Run	τ_{I}	$\epsilon_{\tau\mathrm{I}}$	τ_{II}	$\epsilon_{\tau\mathrm{II}}$
		Background A:		
1	2262	371	2363	359
2	2099	281	1970	250
3	2097	268	2548	388
4	2225	359	2322	359
Mean value	2151 ± 187		2217 ± 198	
Mean value of $\tau = 2182\pm193$				
		Background B:		
1	2224	342	2398	355
2	2244	318	2570	423
3	2277	330	2508	398
4	1921	339	2033	359
Mean value	2169 ± 192		2356 ± 222	
Mean value of $\tau = 2249\pm208$				
Adopted value of $\tau = 2213\pm200$				

[a] The errors stated here are those of the decay analysis only and contain no allowance for error in the time calibration.

As a result of this analysis, we adopt for the mean lifetime of the F^{18} 1.125-MeV level

$$\tau_m = (221\pm21)\times10^{-9}\ \text{sec}.$$

The error quoted above has been arrived at by compounding

(1) the error due to the decay analysis, which includes the statistical error in the background determination, $\pm9.0\%$ (Table V),

(2) $\pm0.4\%$ for the error in the time calibration, and

(3) an additional 2.0% which we feel should cover systematic errors.

Table I tabulated the results of previous determinations of the lifetime of the several states we have studied; to facilitate comparison, we have also tabulated the results of our investigation in Table I.