temperature monitoring during laser-beam-survace interactions. It is interesting to note that the equations for thermal conductivity and thermionic emission give reasonable results in the time intervals involved in these experiments.

We would like to express appreciation to Mr. Robert Oswald and Mr. Dick Linner for their aid in the experimental program and to the many members of the Research Center for helpful and stimulating discussions. Special thanks are due to Dr. R. B. McQuistan for persistent, searching, and illuminating questions.

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3.86-MeV LEVEL IN F^{17}†

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In a recent experiment, Broude, Alexander, and Litherland[1] have shown that the 3.85-MeV level in O^{17} probably has $J^\pi = \frac{5}{2}^-$ instead of the long-accepted value[2] of $\frac{7}{2}^-$. The latter assignment, along with some other evidence, had been taken[3] to indicate a "good" single-particle level described by the configuration $O^{16}(1f_{7/2})$. Since the assignment of $\frac{5}{2}^-$ to this state would have an important effect on the location and nature of the single-particle levels in the mass-17 nuclei, it was decided to re-examine the original assignment[4] of $\frac{7}{2}^-$ to the analog state in F^{17} at 3.86 MeV. There is considerable evidence to show that in both F^{17} and O^{17} the state is produced by the interaction of f-wave nucleons with O^{16}. This narrows the assignment to $\frac{7}{2}^-$ or $\frac{5}{2}^-$. Since the only evidence[4] for $\frac{7}{2}^-$, obtained from $O^{16}(p,p)O^{16}$, is not entirely conclusive,[5] a definitive assignment was sought in the radiative capture $O^{16}(p,\gamma)F^{17}$ which, as will appear, is ideal for this purpose.

Rotating targets[6] of Ta_2O_5 were irradiated with a 10-μA proton beam, $E_p = 3.4$-3.5 MeV, and the resulting radiation was detected with a NaI crystal, 10 in. in diameter by 8 in. thick. The reaction was also monitored with a 4-×4-in. crystal. The only appreciable radiation observed above $E_\gamma = 1.5$ MeV was at 5.3 MeV from $O^{18}(p,\alpha\gamma)N^{15}$, at 3.86 MeV primarily from resonant radiative capture to the ground state of F^{17} (the desired process), and at 3.36 MeV from direct capture to the first excited state. A spectrum is shown in Fig. 1. Yield curves for the 3.86-MeV radiation at $\theta = 90°$ are illustrated in Fig. 2. The shape of the lower curve is taken to indicate a target thicker than the width of the resonance. With this target, angular distributions were obtained at $E_p = 3.473$, 3.470, and 3.465 MeV[7] as depicted in Fig. 3.

The data were fitted with the expressions $A_0(1+\sum_1^N A_n P_n)$ with $N = 1$-6. The coefficients (for $N = 4$), corrected for the solid angle of the detector, are listed in Table I. At $E_p = 3.473$ MeV, where the yield is integrated over the whole resonance, the angular distribution is very well represented by $1 + A_2 P_2(\theta)$ with $A_2 = 0.47 \pm 0.03$. Hence the radiation is almost pure dipole, and the assignment to the level is $\frac{5}{2}^-$, since the theoretical values are $A_2 = -0.36$ and 0.46 for $\frac{7}{2}^-$ and $\frac{5}{2}^-$, respectively. If f-wave interaction is not assumed, the present result eliminates the assignments $\frac{1}{2}^\pm$, $\frac{3}{2}^\pm$, $\frac{7}{2}^\pm$, $\frac{9}{2}^\pm$, and higher spins. Since the angular distributions are insensitive to parity, the value

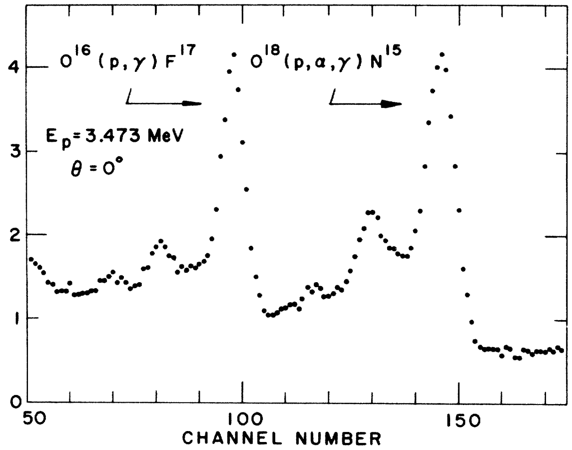

FIG. 1. NaI pulse-height spectrum for radiation emitted at 0° in proton bombardment ($E_p = 3.473$ MeV) of a tantalum oxide target. The energy is 3.86 MeV for the resonant capture radiation.

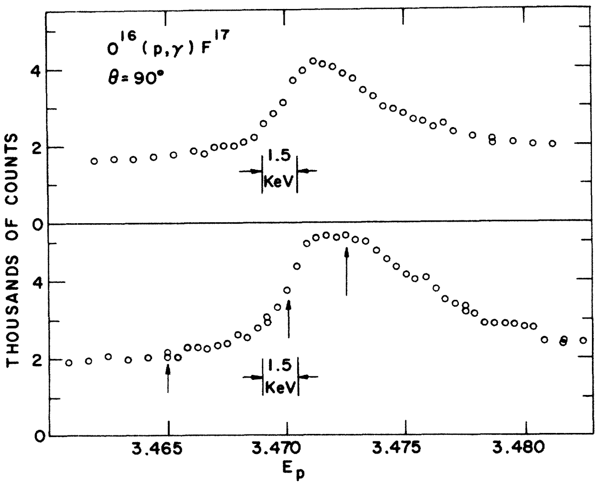

FIG. 2. Differential yield ($\theta = 90°$) for $O^{16}(p,\gamma)F^{17}$ for two tantalum oxide targets of different thickness. Each point gives the total count in the channels corresponding to the 3.86-MeV peak; no background has been subtracted. Well below resonance the actual yield of 3.86-MeV radiation is less than 0.1 times the on-resonance value. The resonant energy is taken equal to 3.470 MeV. The arrows indicate points at which angular distributions (Fig. 3) were measured.

$\frac{5}{2}^+$ cannot be eliminated (but see below). At $E_p = 3.470$ MeV, where yield from the lower half of the resonance is obtained, the distribution is $1 + A_1P_1 + A_2P_2$ with $A_1 = 0.16 \pm 0.07$ and $A_2 = 0.39 \pm 0.11$. The term in P_2 agrees with the above result for the whole resonance while the appearance of a small term in P_1 would indicate interference with off-resonance radiation. At $E_p = 3.465$ MeV the distribution may be more complex, but the measurements are rather uncertain because the yield is low relative to background.

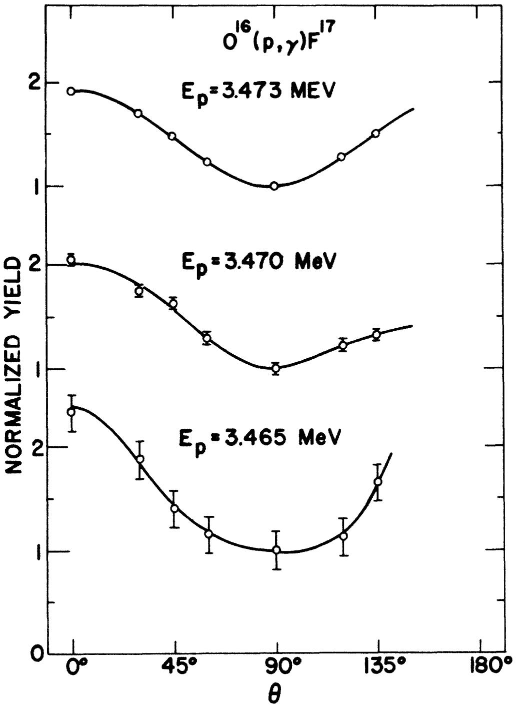

FIG. 3. Angular distributions measured with the target used in the lower part of Fig. 2. The distributions are normalized to unity at 90°. The indicated errors are statistical. The curves drawn are based on the coefficients of Table I.

Analysis of the yield curves of Fig. 2 gives a value of $\Gamma_\gamma = (0.11 \pm 0.02)$ eV corresponding to a radiative lifetime of $(0.6 \pm 0.1) \times 10^{-14}$ sec for the state. Broude, Alexander, and Litherland[1] found $\tau < 2.5 \times 10^{-14}$ sec for the analog state in O^{17}. The $E1$ width of 0.1 eV, which is 1/250 times the single-particle estimate, indicates a weak $E1$ transition,[8] instead of the strong transition one would have expected from a good single-particle f level to a d level. The uncertainty in the experimental value of A_2 would allow an undetected quadrupole component with approximately 10^{-3} times the dipole strength. This quadrupole limit of 10^{-4} eV is about equal to the single-particle $M2$ estimate. For the assignment of $\frac{5}{2}^+$ (mentioned above), however, the $E2$ width would be less than 0.05 times the single-particle value. This inhibition makes this assignment rather improbable.

The rising slopes of the yield curves in Fig. 2

Table I. Coefficients obtained in a least-squares fit of the expression $A_0(1+\sum_1^4 A_nP_n)$ to the data in Fig. 3. The quantity A_0 is expressed in arbitrary units.

E_p (MeV)	A_0	A_1	A_2	A_3	A_4
3.473	2.55 ±0.02	0.00 ±0.02	0.47 ±0.03	0.05 ±0.04	-0.04 ±0.03
3.470	1.50 ±0.05	0.16 ±0.07	0.39 ±0.11	0.13 ±0.14	-0.09 ±0.10
3.465	0.33 ±0.02	-0.16 ±0.05	0.81 ±0.07	-0.22 ±0.10	0.29 ±0.07

give a width of 1.5 keV ($\frac{1}{4}$ point – $\frac{3}{4}$ point), which probably represents the width of the resonance. However, since instrumental broadening of this amount cannot be ruled out in these data, this value is considered an upper limit, $\Gamma_{\text{tot}} < 1.5$ keV, which leads to a reduced width, $\gamma^2 < 0.13 \times 10^{-13}$ MeV-cm, less than 0.01 times the Wigner limit $3\hbar^2/2\mu a$. This small value may be compared with the reduced particle width of 0.50 times the Wigner limit for the "good" $d_{3/2}$ level at 5.10 MeV.[9]

In summary, the state in F^{17} at 3.86 MeV has $J^\pi = \frac{5}{2}^-$ and very small radiation and particle widths, and so does not exhibit a strong single-particle character. This is satisfying since an "inverted" $f_{5/2,7/2}$ structure would be very disturbing. The long-standing difficulty of explaining an $f_{7/2}$ level within 4 MeV of the $d_{5/2}$ ground state and below the $d_{3/2}$ level has been removed. The lowest $f_{7/2}$ level now appears to lie[9,10] at 5.7 MeV, with $\gamma^2/(3\hbar^2/2\mu a) \approx 0.1$ and 0.04 in O^{17} and F^{17}, respectively. The situation for the $\frac{5}{2}^-$ level in O^{17} is less clear. Since it is bound, it is necessary to appeal to widths obtained in (d,p) stripping. At $E_d = 15$ MeV, Keller[11] observes a very good stripping pattern and a reduced width which, though small, is perhaps a quarter of that expected[3] for a good f level. Nevertheless, the relative reduced width is probably significantly less than for the $\frac{7}{2}^-$ level at 5.7 MeV.[10,11]

We are indebted to M. H. Macfarlane for several provocative discussions.

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BETA-DECAY ASYMMETRY AND NUCLEAR MAGNETIC MOMENT OF NEON-19†

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The angular distribution of decay electrons from polarized beta-radioactive spin-$\frac{1}{2}$ nuclei is given by[1]

$$I(\theta) = 1 + A(v/c)\cos\theta \qquad (1)$$

where v is the electron velocity, c is the velocity of light, and θ is the angle between the electron velocity vector and the spin polarization axis. We have determined the asymmetry parameter A of neon-19, and have measured the nuclear magnetic moment of neon-19 by observing the reversal of beta-decay asymmetry which occurs when polarized neon-19 nuclei undergo resonance reorientation. The results are

$$A(\mathrm{Ne}^{19}) = -0.057 \pm 0.005$$

$$\mu(\mathrm{Ne}^{19}) = -1.886 \pm 0.001 \text{ nm}.$$

In both of these results we assume $I = \frac{1}{2}$ and $\mu < 0$.[2] The result for A leads to an interesting interpretation of the relative sign of Fermi and Gamow-Teller matrix elements in Ne^{19} decay. The result for μ provides a useful datum in the study of the structure of light nuclei.

The experimental method is as follows: A beam of neon-19 in the $^1S_0$ ground state emerges from an atomic beam source at 77°K and trav-