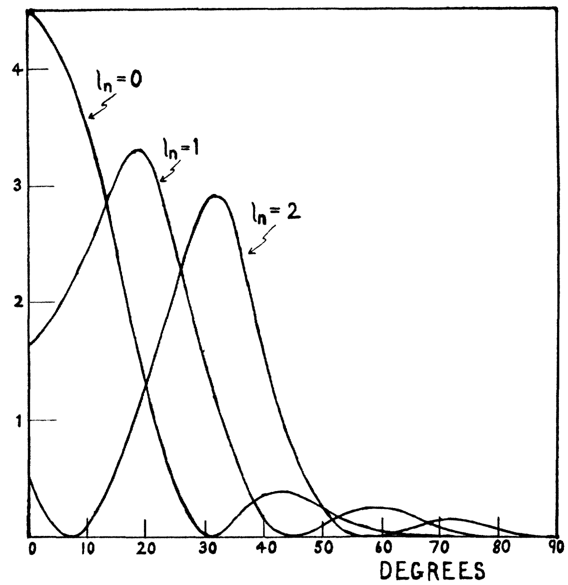

FIG. 1. Theoretical angular distributions for (d, p) and (d, n) reactions for different angular momentum transfers to the initial nucleus.

values. For deuteron energies above the Coulomb barrier, the distributions for the different values 0, 1, and 2 of l_n are generally of the form shown[3] in Fig. 1.

The possibility that the whole deuteron may enter the nucleus has been neglected. This is justified for large impact parameters, and hence the results should be reliable at small angles which are important for the present analysis. It is found that in any one case the experimental distribution agrees extremely well at small angles with one of the possible theoretical curves. We can thus identify the angular momentum transferred to the nucleus, and hence determine the spin and parity of the final nucleus from that of the initial nucleus.

For example, from the experimental angular distributions[1] for the reaction $O^{16}(d, p)O^{17}$ with 7.9-Mev incident deuterons, it is found that the theoretical curve required to obtain coincidence with the experimental one at small angles is, for the ground state of O^{17} that for $l_n=2$, and for the first excited state (0.88 Mev above ground) that for $l_n=0$. This agreement is illustrated in Figs. 2 and 3. Since the ground state of O^{16} has spin 0 and even parity, this implies that the ground state of O^{17} has spin 5/2 or 3/2

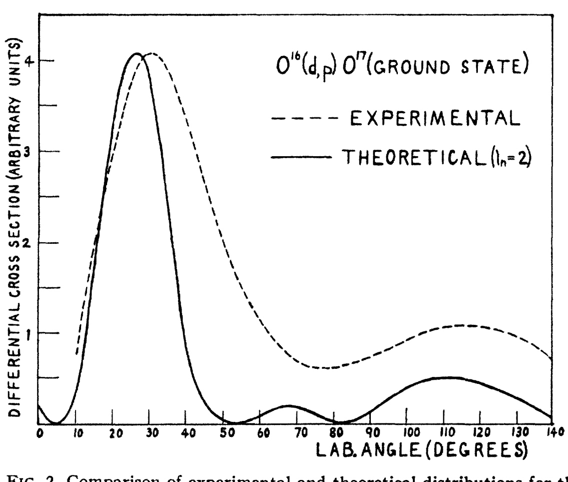

FIG. 2. Comparison of experimental and theoretical distributions for the ground-state transition of the reaction $O^{16}(d, p)O^{17}$ with 7.9-Mev incident euterons. The theoretical curve is that for $l_n=2$.

and even parity, and that the first excited state of O^{17} has spin 1/2 and even parity.

Table I gives spin and parity assignments which have so far been made from the experimental evidence of Burrows, Gibson,

TABLE I. Spin and parity assignments.

Reaction	Ground state initial nucleus	Final nucleus: Ground state	Final nucleus: First excited state
$O^{16}(d, p)O^{17}$ [a]	0+	(5/2 or 3/2)+	1/2+
$N^{14}(d, p)N^{15}$ [a]	1+	(1/2, 3/2, or 5/2)−	
$C^{12}(d, p)C^{13}$ [a]	0+	(1/2 or 3/2)−	
$Al^{27}(d, p)Al^{28}$ [b]	5/2+	(2 or 3)+	(0, 1, 4, or 5)+

[a] See reference 1.
[b] See reference 2.

and Rotblat, and of Holt and Young. For the ground states of C^{13} and N^{15} the assignments are consistent with what is already known.

Full details of these calculations, together with further assignments of spins and parities, will be published elsewhere.

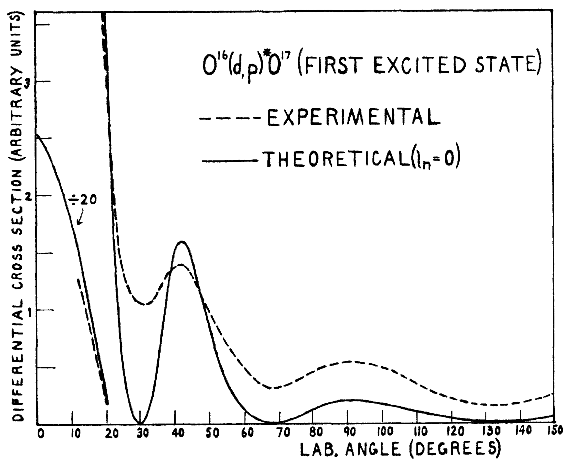

FIG. 3. Comparison of experimental and theoretical distributions for the transition to the 0.88-Mev excited state of O^{17} in the reaction $O^{16}(d, p)O^{17}$ with 7.9-Mev incident deuterons. The theoretical curve is that for $l_n=0$.

My sincere thanks are due to Professor Peierls not only for suggesting the problem, but also for many very helpful discussions during the course of the work. I must also thank Professor Rotblat and Dr. Gibson for making experimental results available before publication.

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[1] Burrows, Gibson, and Rotblat, Phys. Rev. **80**, 1095 (1950), preceding letter, and report at Harwell Nuclear Physics Conference, 1950.
[2] Holt and Young, Proc. Phys. Soc. London **78**, 833 (1950).
[3] Although not shown in Fig. 1, the absolute values of the maxima usually decrease with increase of l_n, so that in those cases in which more than one value of l_n is allowed, the lowest value is the most important.

On the Entry into the Earth's Atmosphere of 57-Kev Protons during Auroral Activity

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October 27, 1950

THE occurrence of a major auroral storm during the two nights of August 18 and 19, 1950, made it possible to utilize a grating spectrograph of sufficient resolution to study the Hα wave-length region. The spectrograph was pointed toward the magnetic zenith for three spectra and toward the north magnetic horizon for five spectra. Some spectra from both orientations

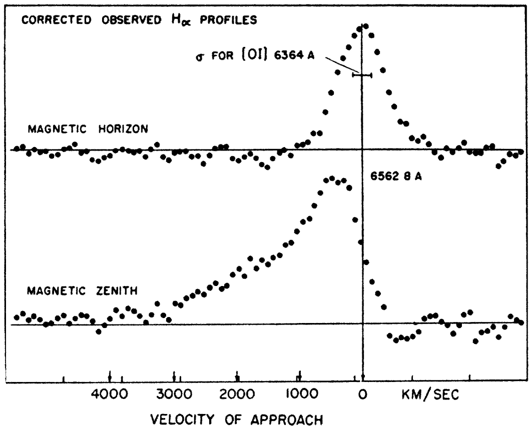

FIG. 1. Corrected observed profiles for Hα in the auroral spectrum for two magnetic orientations.

showed Hα in considerable intensity. A spectrum of a flaming feature which did not show Hα in appreciable intensity was used as a comparison for the effect of the first positive bands of N_2 that are adjacent to Hα.

Previous observations by Vegard,[1] Gartlein,[2] and others, of diffuse hydrogen emissions had been interpreted as scattering of rapidly moving incident protons. No Doppler displacement, however, was established. The current spectra, obtained with respect to the geomagnetic coordinates, have enabled an unambiguous evaluation of the nature of auroral hydrogen. The profile of Hα observed from the magnetic zenith is very asymmetrical, with the entire line shifted to the violet. The profile of Hα in the magnetic horizon is symmetrical but broadened. Figure 1 shows the mean of four separate microphotometer traces for each magnetic orientation after correction for the first positive bands of N_2.

The velocity profile of Hα in the zenith cannot indicate a real velocity spread of the incident protons because of their nearly simultaneous arrival in the auroral zone. The profile, therefore, must be a consequence of the loss of energy of the protons upon entering the upper atmosphere. The violet wing indicates that the velocity of the protons before entering the atmosphere is greater than 3300 km/sec., corresponding to an energy of 57 kev. This velocity is considerably greater than has been deduced from indirect correlations.

It has been pointed out by J. R. Platt[3] that protons moving with these velocities have a small probability of emitting Hα-radiation through electron capture. The probability increases to a maximum when the velocity of the proton is equal to the Bohr orbital velocity for the 3s shell (730 km/sec.). As a consequence, it would be difficult to detect protons moving with much higher velocities than those currently observed; hence, the velocity of 3300 km/sec. represents only a lower limit to the velocity of the auroral protons.

[1] Vegard, report to the Gassiot Comm., Phys. Soc. London, p. 82 (1948).
[2] Gartlein, Trans. Am. Geophys. Union 31, No. 1, 7 (1950).
[3] J. R. Platt, private communication.

Radioactivity of F^{17}

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October 23, 1950

FLUORINE[17] has long been known to be a positron emitter. Early cloud-chamber investigations by Kurie, Richardson, and Paxton[1] showed that the maximum energy of the transition was approximately 2.1 Mev. An excess of positrons at the low energy end of the spectrum was interpreted by Bethe, Hoyle, and Peierls[2] as possibly being due to a low energy beta-group followed by a gamma-ray of approximately 900-kev energy.

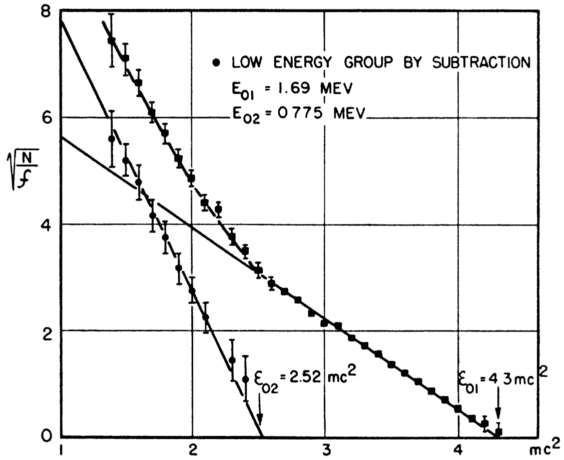

FIG. 1. β-spectrum of F^{17}.

The beta-ray spectrum of F^{17} has recently been investigated in this laboratory, using the technique of bombarding gases in the cyclotron and transporting them by a circulating pump to the source chamber of a semicircular focusing spectrometer as described previously.[3] The F^{17} was produced by a (d, n) reaction on O^{16}. A Fermi plot of the spectrum (Fig. 1) shows that it is of the allowed shape down to 2.5 mc^2, where it deviates considerably from linearity. The end-point energy (average of several such runs and corrected for window absorption) is $E_{01}=4.35\ mc^2$ which corresponds to a maximum energy of 1.72±0.03 Mev. On subtracting the high energy spectrum a low energy group of the allowed shape is obtained, having an end-point energy of $E_{02}=0.78$ Mev.

The relative intensity of the two groups was calculated from the intercepts of the two Fermi plot lines on the vertical and horizontal axes. The data obtained indicate that the low energy group is 33±5 percent as intense as the high energy group. The partial lives for the two transitions are found to be $t_1=93$ sec. and $t_2=285$ sec. (based on an observed half-life[4] of 70.0 sec.) with the corresponding Ft values $Ft_1=3240$ sec. and $Ft_2=350$ sec.

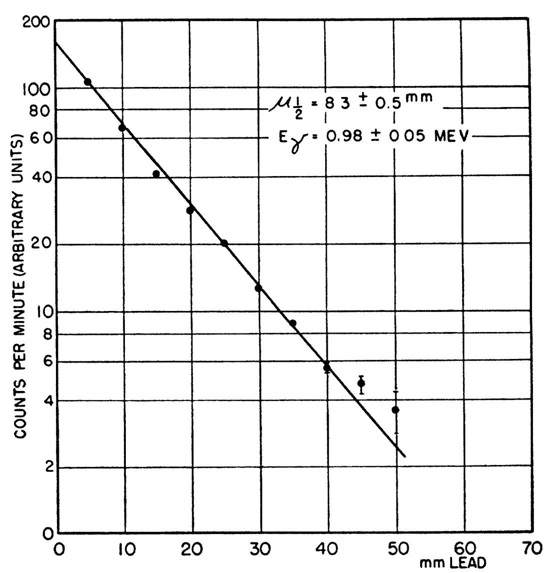

FIG. 2. F^{17} γ-ray absorption curve in lead.