Table I. Summary of measured asymmetries in the β-α angular correlations of Li^8 and B^8.

β decay and E_β	Target angle to beam	Corrected $I_{180°}/I_{90°}$
Li^8, $E_\beta > 9.7$ Mev	45°	1.03 ± 0.02
Li^8, 3.8 Mev $< E_\beta < 6.1$ Mev	45°	1.03 ± 0.02
Li^8, $1.5 < E_\beta < 3.8$ Mev	45°	1.05 ± 0.02
B^8, $E_\beta > 9.7$ Mev	30°	1.02 ± 0.03
B^8, $E_\beta > 9.7$ Mev	20°	1.00 ± 0.05
B^8, $E_\beta > 9.7$ Mev	30°	1.00 ± 0.03[a]

[a]Using the dashed extrapolations in Fig. 2.

that the $M1$ matrix element is anomalously small, then the present experiment would not be a suitable method for testing the conserved vector current hypothesis, since there are probably other corrections of the order of a few percent which could mask the expected anisotropy,[5] for example, a term proportional to the $E2$ matrix element.

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[1]J. Bernstein and R. R. Lewis, Phys. Rev. 112, 232 (1958).

[2]R. P. Feynman and M. Gell-Mann, Phys. Rev. 109, 193 (1958); M. Gell-Mann, Phys. Rev. 111, 362 (1958); E. C. G. Sudarshan and R. E. Marshak, Phys. Rev. 109, 1860 (1958); S. S. Gershtein and J. B. Zeldovich, Zhur. Eksptl. i Teoret. Fiz. 29, 698 (1955) [translation: Soviet Phys. JETP 2, 576 (1957)].

[3]Hanna, LaVier, and Class, Phys. Rev. 95, 110 (1954); D. StP. Bunbury, Phys. Rev. 90, 110 (1953).

[4]Lauritsen, Barnes, Fowler, and Lauritsen, Phys. Rev. Letters 1, 326 (1958); Barnes, Fowler, Greenstein, Lauritsen, and Nordberg, Phys. Rev. Letters 1, 328 (1958).

[5]M. Morita, Phys. Rev. 113, 1584 (1959).

DECAY OF OXYGEN 20†

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It is of considerable theoretical interest to discover the decay of the isotope O^{20} and its properties. Jarmie and Silbert,[1] by studying the energies of the protons produced in the reaction $O^{18}(t,p)O^{20}$, were able to deduce for the energy difference $Q(O^{20} \rightarrow F^{20}) = 3.75$ Mev. However, earlier attempts[2-4] to search for the decay of the isotope have been unsuccessful. Katcoff and Hudis[3] were able to exclude a half-life of 10 min $\leq \tau_{1/2}(O^{20}) \leq 150$ yr with reasonable certainty, and Amiel and Segel[4] showed that $\tau_{1/2} \leq 30$ to 50 sec.

We studied the decay of O^{20} produced by 2.66-Mev tritons from the 3-Mev Los Alamos Van de Graaff in an O^{18} (95% enriched) gas target. As detector for the γ rays we used a scintillation spectrometer. The front face of a 3 in. $\times$ 3 in. NaI(Tl) crystal was placed about 4 in. from the target, behind a $\frac{5}{8}$-inch Be absorber which removed β rays. A one-hundred channel pulse-height analyzer served to study the spectrum. Bombardments of one to five seconds duration were used. The spectra obtained during 10-sec counts, starting at various intervals (1-40 sec) after bombardment, were printed out. In addition to the 1.63-Mev line from F^{20}, which is the daughter product of O^{20} and also independently produced in the reaction $O^{18}(t,n)F^{20}$, we observed a weaker γ ray (~6% of the 1.63-Mev line) at 1.067 ± 0.020 Mev (Fig. 1, curve A). This energy agrees within limits of error with that of the fourth excited state[5] of F^{20} (1.059 ± 0.008 Mev), found in the reaction $F^{19}(d,p)F^{20}$. The decay curves of both the 1.63-Mev and the 1.067-Mev γ rays were followed by taking 1-sec counts obtained within a channel set at the appropriate energy. It was observed that both γ rays decay with half-lives of ~12.5 sec, which is in fair agreement with the 11.4-sec half-life reported[5] for F^{20}. The 1.06-Mev photopeak, of course, is superimposed on the Compton spectrum of the 1.63-Mev γ ray. The latter accounts for about 60-70% of the counts in the channel.[6]

We now made the tentative assumption that the beta decay of O^{20} takes place mainly to the 1.06-Mev state in F^{20} and that the half-life of O^{20} differs only slightly from that of F^{20}. To prove this we decided to measure the half-life and gamma-ray spectrum of F^{20} in the absence of O^{20}. For this purpose F^{20} was produced by bombarding F^{19} (CaF_2 crystal) with 2-Mev deuterons in another Los Alamos Van de Graaff generator. The same detector, in approximately the same geometry as before, was used for these measurements (curves B on Figs. 1 and 2). It is seen (a) that the 1.06-Mev peak does not occur in the F^{20} spectrum, and (b) that the decay of the 1.63-Mev γ ray from the pure F^{20} is slightly steeper than that from the O^{20}-F^{20} mixture. [$\tau_{1/2}(F^{20}) = 11.2 \pm 0.1$ sec.] This confirms our tentative assumption stated above.

A computer analysis of the decay curves obtained from the O^{20}-F^{20} mixture, analyzed on the basis of a single activity plus a background, yielded apparent half-lives of 12.4 ± 0.1 sec for the 1.06-Mev peak and 12.1 ± 0.1 sec for the 1.63-Mev peak. As is evident from Fig. 2, the decay curve of the 1.63-Mev peak from the O^{20}-F^{20} mixture closely approximates a straight line. The data were further analyzed, however, by

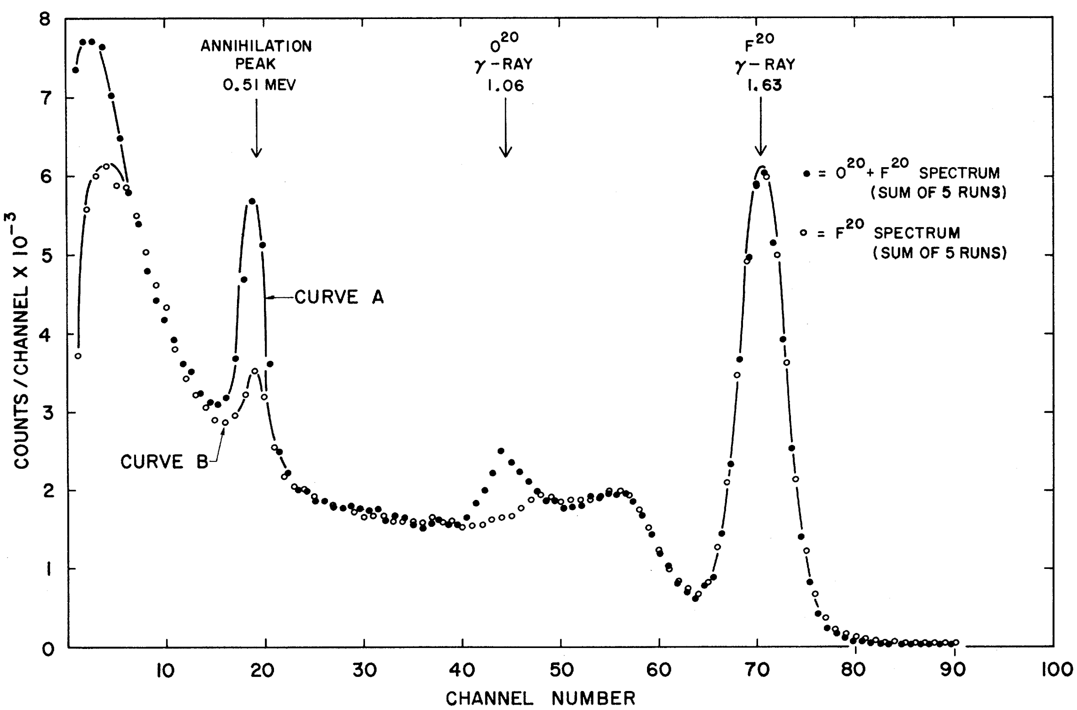

FIG. 1. Scintillation spectra obtained following the bombardment of O^{18} (95% enriched) with tritons (Curve A) and F^{19} with deuterons (Curve B). The annihilation peak is due to positrons from 1.87-hr F^{18}, formed by the reaction $O^{16}(t,n)$.

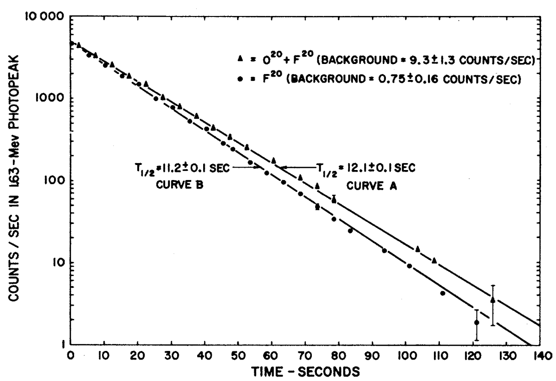

FIG. 2. Decay of the 1.63-Mev γ ray. The lines are based on an IBM-704 least-squares fit of the data which have been corrected for background.

fitting them to the decay of two—partly genetically related—activities plus a background, using the measured F^{20} half-life of 11.2 sec as one of the activities. This analysis yielded a value for the O^{20} half-life of 13.6 ± 1.0 sec.

The amount of O^{20} relative to F^{20} produced in the target was deduced from this analysis and also calculated independently from the $O^{20}+F^{20}$ spectrum (Fig. 1, Curve A). The validity of the analysis using two activities plus a background is substantiated by the good agreement between these two values, $6.2 \pm 3.5\%$ and $5.8 \pm 1.0\%$, respectively.

Figure 3 shows the proposed decay scheme of O^{20}. From the values for $\tau_{1/2}(O^{20})$ and for $E_{\beta\max}(O^{20}) = (3.75 - 1.06)$ Mev $= 2.69$ Mev, we compute $\log ft = 3.77$. The analysis of the stripping reaction $F^{19}(d,p)F^{20}$ has shown[5] that the 1.06-Mev state in F^{20} is either 1+ or 0+. The low $\log ft$ value for the beta transition from O^{20} ($I = 0$, even) to the 1.06-Mev state indicates that the transition is of the Gamow-Teller type, as a Fermi transition with $\Delta T = 1$ is forbidden. Hence we conclude that the 1.06-Mev state in F^{20} is 1+.

We wish to thank Dr. A. Schardt for his generous advice and help given during the course of this experiment. One of us (G. S.-G.) should like to thank the staff of Los Alamos Scientific Laboratory for their hospitality.

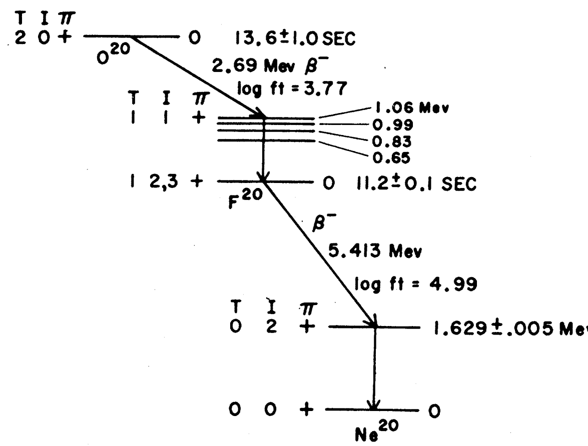

FIG. 3. Proposed decay scheme for O^{20}. The excited states of F^{20} and the decay scheme of F^{20} are taken over from reference 5. The spin and parity assignment of the 1.06-Mev state results from the present work.

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[1]N. Jarmie and M. G. Silbert, Phys. Rev. Letters 3, 50 (1959).

[2]Sheline, Campbell, and Peele, Oak Ridge National Laboratory Report ORNL-1798, 1954 (unpublished).

[3]S. Katcoff and J. Hudis, J. Inorg. Nuclear Chem. 3, 253 (1956).

[4]S. Amiel and R. E. Segel, J. Inorg. Nuclear Chem. 10, 4 (1959).

[5]F. Ajzenberg-Selove and T. Lauritsen, Nuclear Phys. 11, 1 (1959).

[6]Amiel and Segel (reference 4) "observed the possible presence of a weak γ ray of 1.1 Mev and a half-life of 13.5 sec for the decay of the 1.63-Mev γ ray, somewhat higher than but consistent with the 11.4-sec half-life" reported for F^{20}. They did not pursue the problem further.