NEW ISOTOPE OF FLUORINE: F^{22}

F. J. Vaughn, R. A. Chalmers, L. F. Chase, Jr., and S. R. Salisbury

Lockheed Palo Alto Research Laboratories, Palo Alto, California

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Evidence for the production of fluorine-22 by the reaction $Ne^{22}(n,p)F^{22}$ has been obtained. The half-life of F^{22} has been measured, and information about its decay scheme has been obtained. This work continues the investigation of light neutron-rich $T=2$ nuclei, which has previously resulted in the identification of nitrogen-18.[1]

Neutrons with an energy of about 14.8 MeV were produced by the reaction $T(d,n)He^4$ using the Lockheed 3.5-MeV Van de Graaff accelerator. These neutrons irradiated a Ne^{22} gas sample, which consisted of about 3 g of Ne^{22} contained at a pressure of about 2000 psi in a stainless steel cylinder. The cylinder was filled by first freezing the Ne^{22} into a small (3 cc) container in a liquid-He bath and then allowing this container and the final cylinder to warm to room temperature while connected. The enrichment of the neon gas was 99.7%. An identical but empty cylinder was used to determine background contributions. Bombardments of this second container filled with oxygen gas to a pressure of 2000 psi were carried out to produce N^{16} by the reaction $O^{16}(n,p)N^{16}$. The known end-point energy of the β rays from the 7.4-sec N^{16} activity was used for energy calibration of the β counter.

The experimental procedure consisted of carrying out a series of irradiate-count cycles of the sample. Each cycle began with a three-second bombardment of the sample, which was then transferred by a pneumatic "rabbit" into position in a shielded counter array. The counter array was about 30 ft from the "irradiate" position; the transfer time was about one second. The counters were designed to observe β rays and/or β-γ coincidences. Gated pulses were routed successively to three 200-channel subgroups of an 800-channel pulse-height analyzer in consecutive two-second time intervals following the arrival of the sample in counting position. The γ counter was a 10.2- by 10.2-cm NaI(Tl) scintillator, and the β-ray counter was a telescope consisting of a 7.6- by 7.6-cm scintillator positioned immediately behind a 0.25-cm thick plastic scintillator.

The γ-ray spectrum observed in coincidence with β rays of energy $\gtrsim 1$ MeV is shown in Fig. 1.

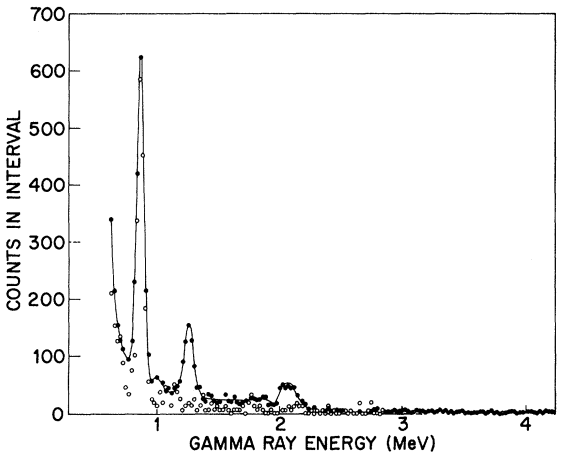

FIG. 1. Gamma-ray spectra observed in coincidence with β rays with energy $\gtrsim 1$ MeV. The solid points show the gamma spectrum obtained with the Ne^{22} sample, and the open circles indicate the spectrum observed from an empty container, normalized to the same number of incident neutrons. The 0.84-MeV gamma ray is from decay of Mn^{56}, and the gamma rays at 1.28 and 2.06 MeV are from F^{22} decay.

The solid points show the gamma spectrum obtained with the Ne^{22} sample, while the open circles show the spectrum observed with the empty container, normalized to the same number of incident neutrons. The 0.84-MeV gamma ray results from decay of Mn^{56} produced in the iron of the sample cylinder by the reaction $Fe^{56}(n,p)Mn^{56}$. This gamma ray follows decay of the Mn^{56} by emission of a 2.86-MeV end-point β ray. Other γ rays emitted in the decay of Mn^{56} are not seen, since their preceding β rays are too low in energy to produce pulses above the electronic bias setting in the 7.6- by 7.6-cm plastic scintillator. The other γ-ray lines on Fig. 1 have energies of 1.28 ± 0.02 and 2.06 ± 0.03 MeV. The ratio of the number of 1.28-MeV γ rays to that of 2.06-MeV γ rays is 1.49 ± 0.16.

Observations of the β-ray spectrum of F^{22} with no γ-ray coincidence requirement and of the spectrum in coincidence with γ rays with energy $\gtrsim 1$ MeV were also made. Comparison of the observed end point of the ungated β spectrum with the spectrum of 10.41-MeV end-point β rays from N^{16} gives an end-point energy of 11.2 ± 0.6 MeV for the F^{22} β rays. Unfortunately, the counting rate of β's gated by γ rays was so low that it was not possible to determine from the data whether the β spectrum in coincidence with γ rays has a different end point than the ungated spectrum. All that can be said at the present is that the observations are consistent with the two spectra having the same end point; the same end point for both spectra implies that no β-ray transitions directly to the ground state of Ne^{22} occur.

Measurements of the half-life of F^{22} were made by observing the number of β rays emitted from F^{22} (with and without a γ-ray coincidence requirement) as a function of time. The observed half-life is 4.0 ± 0.4 seconds.

A proposed decay scheme of F^{22} is shown in Fig. 2. The levels of Ne^{22} with their spin and parity assignments are those reported by other workers.[2-3] The branching ratios of 0.67 and 0.33 to the 3.35- and 1.28-MeV states of Ne^{22} are those obtained from the relative intensities of the 1.28- and 2.07-MeV γ rays. Other work indicates that the γ decay of the 3.35-MeV state goes essentially entirely through the 1.28 state; the lack of a 3.35-MeV γ ray in our observed γ-ray spectrum is in agreement with this decay. No β branch to the ground state is shown on the decay diagram; as indicated previously, the β-spectrum observations are consistent with this decay but are not precise enough to definitely confirm it. The log*ft* values for the decays of the 3.35- and 1.28-MeV states were calculated to be 5.9 and 6.4, respectively; these values are close to the upper end of the range for allowed transitions. If both these decays are by allowed transitions, the ground state of F^{22} must have a spin-parity assignment of 3^+; it could not then decay to the 0^+ ground state of Ne^{22} by an allowed transition. From the observed β-ray end-point energy and the proposed decay scheme, the F^{22}-Ne^{22} mass difference is 12.5 ± 0.6 MeV.

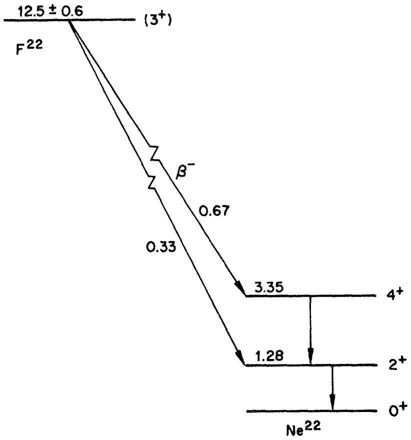

FIG. 2. Proposed decay scheme of F^{22}.

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SEARCH FOR C-INVARIANCE VIOLATION IN η(958 MeV) AND η(549 MeV) DECAYS*

Alan Rittenberg
Lawrence Radiation Laboratory, University of California, Berkeley, California

and

George R. Kalbfleisch
Brookhaven National Laboratory, Upton, New York

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There is now much interest in the possibility of C (charge conjugation) noninvariance in strong or electromagnetic interactions, which is due to the existence of C-nonconserving but parity-conserving interactions.[1,2] The C-invariance violation is a few percent at most for the strong interactions and can be maximal for the electromagnetic interactions. Such C-nonconserving effects may be found by looking for (1) C-nonconserving decay modes of neutral mesons[3-6] or (2) asymmetries between π^+ and π^- in the three-particle decay modes of these same mesons.[3,4,7] We have looked for such decay modes and asymmetries arising from η(958) and η(549)[8]