Gamma decays of 2.97-MeV doublet in ^{20}F

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The new member of the 2.97-MeV doublet in ^{20}F has a dominant γ decay to a (3^-) state at 1971 keV, further evidence that the new state has $J^\pi = (4^-)$. The excitation energy is 2968.0 ± 1.5 keV.

[NUCLEAR REACTION ^{11}B(^{13}C,$\alpha\gamma$), E=18.5 MeV; measured E_α, E_γ, $\alpha\gamma$ coincidences. ^{20}F deduced levels, gamma branchings, J, π.]

The 2.97-MeV "level" of ^{20}F was recently found[1,2] to consist of a close-lying doublet. One member, at 2.9661 ± 0.04 keV, is known[3] to have $J^\pi = 3^+$. It was suggested that the new member might have $J^\pi = 4^-$ and be the state expected from weakly coupling a $p_{1/2}$ hole to the $\frac{7}{2}^+$ excited state of ^{21}Ne. The 3^- state of this configuration is probably[1] the state at 2.86 MeV. Earlier studies[3-5] of the γ decays of this state had reported conflicting branching ratios (as depicted in Fig. 1), giving additional credence to the suggestion that the state is really a doublet.

We have investigated the γ decays by making use of the ^{11}B(^{13}C,α)^{20}F reaction. An earlier study[6] had shown very strong population of the 2.97-MeV level in this reaction. A spectrum from that work is displayed in Fig. 2.

In the present experiment, a beam of 18.5-MeV ^{13}C ions bombarded an enriched ^{11}B foil. Outgoing α particles were detected at 0° in an Si surface-barrier detector. γ rays in coincidence with outgoing α particles were detected in a GeLi detector placed at 90° to the beam direction.

Results of the present investigation for γ decays in coincidence with α particles feeding the group of states near 3 MeV in ^{20}F are displayed in Table I. The 2146-keV γ ray can arise only from decay of the 2966-keV state to the state at 823 keV. Likewise the 996-keV γ ray must arise from decay of the 2966-keV state to the 1971-keV state. The majority of the 1147.6-keV γ rays undoubtedly arise from decay of the 1971-keV level to the 823-keV state, but could contain a contribution of $2966 \rightarrow 1824$. Our results for the decays of the 2966-keV doublet are displayed in the last column of Fig. 1, where they are compared with the earlier work.[3-5] The branch to the 1971-keV level is considerably larger than previously measured and almost certainly arises from the new member of the doublet. Since the 1.97-MeV state has a (3^-) as-

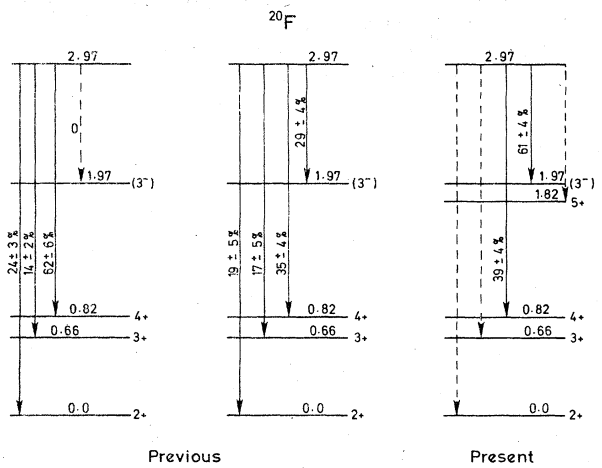

FIG. 1. Decays of the 2.97-MeV "level", from Ref. 4 (left), Ref. 5 (middle), and present work (right).

TABLE I. γ rays in coincidence with α particles feeding the 3-MeV group in ^{11}B(^{13}C, α)^{20}F.

E_γ (keV)	Identification	Ideal E_γ (keV)	Yield[a]
350.9	^{21}Ne		196
657.1	$656 \rightarrow 0$[b]	656.0 ± 0.2	626
821.6	$823 \rightarrow 0$	822.9 ± 0.2	165
983.7	$984 \rightarrow 0$	983.8 ± 0.2	64
996.4	$2968 \rightarrow 1971$	997.6 ± 1.5	279
1020.1	$2865 \rightarrow 1843$	1021.6 ± 1.0	46
1147.6	$1971 \rightarrow 823$	1147.7 ± 0.4	176
1310.9	$1309 \rightarrow 0$	1309.2 ± 0.2	218
2146.1	$2968 \rightarrow 823$	2145.3 ± 1.4	175
2855.6[c]	^{21}Ne		594

[a] Corrected for efficiency.
[b] Also contains gammas from $1971 \rightarrow 1309$.
[c] Broad.

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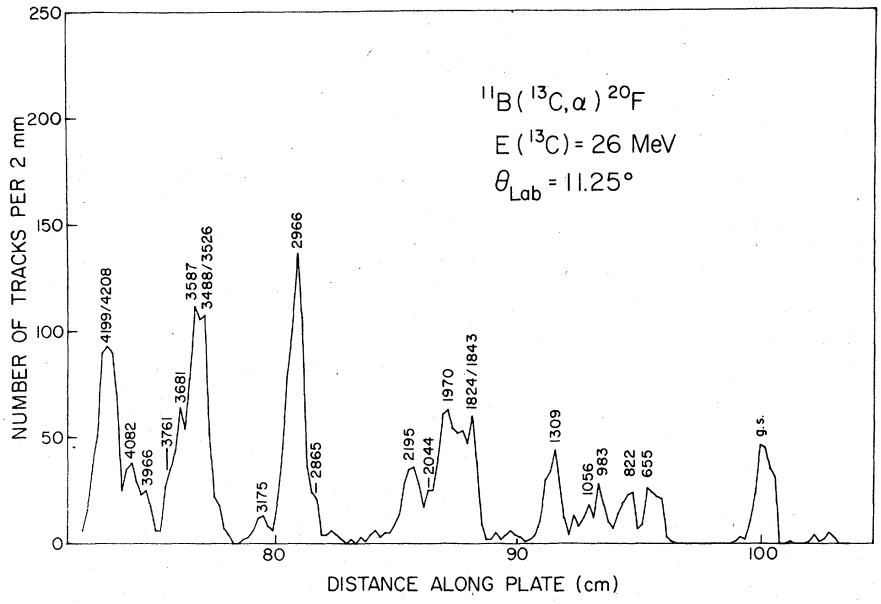

FIG. 2. Spectrum of the $^{11}B(^{13}C,\alpha)^{20}F$ reaction from Ref. 6.

signment, the present decay puts further credence to a (4^-) assignment for the new state. No decays are seen to states with $J<3$ in the present work. We therefore make a tentative (4^-) assignment to the new member of the 2.97-MeV doublet. Our measured γ-ray energies, combined with energies from the compilation[3] for the 1971- and 823-keV levels, imply an excitation energy of 2968.0 ±1.5 keV.

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