Adopted Levels

S(p)=−2730 *SY* 2021Wa16

The ^{13}F nucleus is unbound to proton emission. A resonance is observed in (2021Ch19); however, since this resonance is reported at a higher energy than expected for the ground state, it is believed to correspond to an excited state.

In (2013Ti01), the Kelson-Garvey mass systematics (1966Ga25) are improved to provide reliable predictions of the masses of proton-rich nuclei, based on analysis of their neutron-rich mirror nuclei. For ^{13}F, the predicted binding energy E_{bind}=53.666 MeV *16* and mass excess ΔM=43.386 MeV 16 are based on comparison with ^{13}Be.

In (2012Fo22) a potential model is developed that is informed by ^{12,13}Be and ^{12}O properties. The expected $J^{\pi}=1/2^{+}$ ground state is predicted near the resonance energy E_p=2.4 MeV with Γ≈0.6 MeV, relative to $^{12}O_{g.s.}$. The $J^{\pi}=5/2^{+}$ excited state is predicted near E_p≈5 MeV with Γ≈0.35 MeV. The analysis is updated in (2013Fo22) with similar results.

See (1993Po11) for earlier shell-model analysis of ground-state binding energies, including ^{13}F.

^{13}F Levels

Cross Reference (XREF) Flags

^{9}Be(^{13}O,^{13}F)

E(level)[†]	J^{π}	Γ	E_T (MeV)[‡]	XREF	Comments
x	(5/2^{+})	1.01 MeV *27*	7.06 *9*		Analysis of the invariant-mass spectrum is consistent with sequential proton decay via ^{12}O(0:0$^{+}_{1}$, 2.2 MeV:2$^{+}_{1}$, 4.8 MeV:2$^{+}_{2}$) with intensities of (40 *16*)%, (28 *18*)% and (32 *16*)%, respectively.

[†] The authors suggest the $J^{\pi}=5/2^{+}$ excited state has been observed. The $1/2^{+}$ g.s. is expected ≈3 MeV lower in energy.

[‡] ^{10}C+3p Invariant Mass.

^{9}Be(^{13}O,^{13}F) 2021Ch19

2021Ch19: XUNDL dataset compiled by TUNL (2021).

The authors analyzed the excitation spectra of particle-unbound nuclides produced in ^{13}O reactions on a ^{9}Be target. The first observation of a ^{13}F resonance, produced via charge-exchange reactions, was reported.

A beam of 69.5 MeV/nucleon ^{13}O ions, from the NSCL/A1900 fragment separator, was purified in the Radio Frequency Fragment Separator before impinging on a 1 mm thick ^{9}Be target. ^{13}F nuclides were produced and decayed in-flight via ^{13}F→p+^{12}O→3p+^{10}C reactions. All decay products were detected using the HiRA High-Resolution position sensitive ΔE-E telescope array, which covered the polar angles θ_{lab}=2.1° to 12.4°. The invariant-mass spectrum, E_T, was deduced by analyzing the momenta of the 3p+^{10}C decay products. As in the past study of ^{11}O (2020We08), structures in the excitation spectrum are enhanced by analyzing events where ^{10}C is ejected perpendicular to the beam direction in the ^{13}F center-of-mass system.

The invariant-mass spectrum is dominated by a Γ≈1 MeV peak around E_T≈7 MeV that sits on top of a broad smooth background. For perspective, (2012Fo22) predicts a $J^\pi=1/2^+$ ground state at around E_T=4 MeV and a $J^\pi=5/2^+$ first excited state near E_T=7 MeV. No evidence is seen for a lower energy resonance; the authors suggest the lower state may have a broad width that prevents its observation in the present measurement. Comparison with the mirror ^{13}Be nucleus ground state provides ambiguous results for the measured $1/2^+$ width, leaving uncertainty on the expectation for ^{13}F.

A Monte Carlo simulation was developed to interpret the observed features, since the level structures of ^{12}O and ^{10}C are convoluted in the spectrum. Involvement of the ^{10}C*(3353 keV) first excited state is generally inconsistent with the observed invariant-mass spectrum so the analysis is limited to final population of $^{10}C_{g.s.}$. Hence the analysis focused on branching ratios for sequential decay of a $(5/2^+)$ ^{13}F resonance through ^{12}O states that subsequently 2p decay via processes described in (2019We11), and the total decay energy was assummed to be carried in the 3p+^{10}C kinetic energies.

Sequential decays via low-lying ^{12}O states are considered in the Monte Carlo simulation. See the text for discussion and comparison of expectations based on the mirror ^{13}Be nucleus. The branching ratios to the $J^\pi=0^+_1$ and 2^+_1 and 2^+_2 ^{12}O states are found as (40 *16*)%, (28 *18*)% and (32 *16*)%, respectively. An alternate and reasonable fit to the data assumed zero contribution from the 2^+_2 state; in this case the relative ratios for the 0^+_1 and 2^+_1 states remained consistent with the initial three-level fit.

^{13}F Levels

E(level)[†]	J^π	Γ	E_T (MeV)[‡]	Comments
x	$(5/2^+)$	1.01 MeV *27*	7.06 *9*	Analysis of the invariant-mass spectrum is consistent with sequential proton decay via ^{12}O(0:0^+_1, 2.2 MeV:2^+_1, 4.8 MeV:2^+_2) with intensities of (40 *16*)%, (28 *18*)% and (32 *16*)%, respectively.

[†] The authors suggest the $J^\pi=5/2^+$ excited state has been observed. The $1/2^+$ g.s. is expected 3 MeV lower in energy.

[‡] Invariant Mass.

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