^{17}Ne β^+ decay 2002Mo19

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	J. Kelley and J. Shuman	ENSDF	25-Sept-2018

Parent: ^{17}Ne: E=0; J$^\pi$=1/2$^-$; $T_{1/2}$=109.2 ms *6*; Q(β^+)=14548.7 *4*; %β^+ decay=100.0

^{17}Ne-$T_{1/2}$: weighted mean from (1971Ha05,1988Bo39).

^{17}Ne-Q(β^+): from (2017Wa10).

1963Ba63: A variety of targets were bombarded by a 97 MeV proton beam from the McGill synchrocyclotron. The results on ^{17}Ne were obtained by comparing the delayed protons emitted following bombardment of NaF and LiF targets. Proton groups with $E_p\approx$3.6 and 4.6 were measured using a silicon detector telescope and were attributed to β-delayed proton decay from ^{17}Ne. The lifetime was longer than the 2.5 ms period between cyclotron beam bursts.

1964Da13: A beam of 120 MeV ^{12}C ions, from the Yale heavy ion accelerator, bombarded either a $\approx$12 mg/cm^2 ^{9}Be target or a $\approx$12 mg/cm^2 ^{12}C target. Reaction products, produced in the target, were studied using a Si surface barrier detector for charged particles, a thick plastic scintallator for β^+ particles and a 3 inch$\times$3 inch NaI(Tl) crystal to detect γ rays.

Proton groups with E_p=2.3, 3.8, 4.55, 4.9 and 5.1 MeV are attributed to β-delayed proton emission from ^{17}Ne. The life-time T=690 ms 30 is deduced; the discrepancy with the accepted value is not understood.

1963Ka36,1964Fl03: A beam of 140 MeV ^{20}Ne ions, from the JINR cyclotron, bombarded a 10 μm thick ^{nat}Ni target that was upstream of a rotating aluminum disk. The reaction products escaping from the target were implanted in the disk and transported to a counter telescope comprising a thin aluminum absorber, a gas proportional counter and two Si surface barrier detectors. An E$\approx$5 MeV proton group was observed in the β-delayed particles emitted from reaction products. The activity was also produced in ^{20}Ne bombardment of tantalum, copper and aluminum targets, indicating the activity results from a multi-nucleon transfer on ^{20}Ne; ^{17}Ne or ^{20,21}Mg were most favored. Analysis of the decay curve indicated $T_{1/2}$=85 ms *15*.

1964Mc16: An activation target assembly was mounted on a probe that could be inserted into the McGill synchrocyclotron. Various targets containing LiF or CF_2 (teflon) were inserted into the cyclotron for proton bombardment at E_p=40 to 80 MeV. The cyclotron was operated in a mode to provide an activation period, a beam dissipation period of 100 ms and a $\approx$500 ms counting period. Three proton groups at E_p=4.10, 4.92 and 5.40 are consistent with β-delayed proton emission. The different target compositions yielded different lifetime results, suggesting some diffusion from the target. A half-life of T=102 ms *7* is measured, though 103 ms *7* is arbitrarily suggested to account for neon diffusion from the target. Analysis of the excitation function indicates a reaction threshold of 36.6 MeV *3*.

1965Ha20: In this follow-up of (1964Mc16) additional statistics were obtained and further analysis was carried out on ^{17}F levels fed in the decay of ^{17}Ne. See also (1966Ha22,1966Ma12).

1967Es02: Beams of 26 to 32 MeV ^{3}He ions, from the Brookhaven 60 inch cyclotron, impinged on either a gaseous O_2 or thin Al_2O_3 target producing ^{17}Ne residuals. An array of two Si detector telescopes were used to measure the energy spectrum of β-delayed particle emissions. Ten groups were observed in the energy spectrum. The target was irradiated for periods of 300 ms, while counting lasted for 500 ms. Analysis of the decay curve yielded T=105 ms *5*. A careful study of the excitation function for the reaction indicated Q=$-$22.42 MeV *19* for the (^{3}He,2n) reaction, which corresponds to ΔM=14.52 MeV *19* using the 1964 mass tables.

1971Ha05: A beam of ^{3}He ions from the Berkeley/88-inch produced ^{17}He nuclides, via the ^{16}O(^{3}He,2n) reaction. The ^{17}Ne nuclides were transported to a counting cell where β-delayed protons were detected using a ΔE-E telescope; a NaI(Tl) γ-ray detector was also employed to clarify proton feedings to ^{16}O levels. A total of 17 proton groups to ^{16}O*(0,6.05,6.13,6.92,7.11) were observed. The half-life $T_{1/2}$=109.0 ms *10* was also measured.

See also (1989Re02).

1988Bo39: A beam of ^{17}Ne ions was produced at the CERN/ISOLDE facility using proton spallation reactions on a MgO target. Neon ions from the target were collected, post-accelerated to 60 keV and magnetically separated to obtain the ^{17}Ne beam, which was implanted in a 50 μg/cm^2 carbon foil. An annular plastic scintillator detector was placed on the upstream side of the target (w.r.t. beam) while a series of different ΔE Si surface-barrier detectors (covering $\approx$0.2% of 4π) were separately placed on the downstream side of the target. The Si detectors ranged had thicknesses of 10, 15, 27 and 1000 μm and were used to characterize the proton and α groups the delayed particle spectrum. Twenty-eight different groups of β-delayed protons and αs were identified. The lifetime was measured by collecting ^{17}Ne ions for 0.2 s and counting for 1.0 s. The value T=109.3 ms *6* was obtained. See other results on decay to ^{17}F in (1993Bo36,1993RiZY).

1996OzZZ,1997OzZZ,1998Oz01: Beams of $\approx$32 and 49 MeV/nucleon ^{17}Ne ions were produced by fragmenting a ^{20}Ne beam at the RIKEN/RIPS fragment separator. The ^{17}Ne ions were counted as they were implanted into a plastic plate beam stop. A high ^{15}O contamination was also present. The experiment was focused on determining the branching ratio for first forbidden β feeding

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to ^{17}F*(495). Detectors included a plastic telescope for β counting, and two HPGe detectors. The $T_{1/2}$=108.3 ms *31* and Iβ(^{17}F*(495))=(1.56 *20*)% were deduced in the analysis.

2004Ba12: A beam of 260 keV ^{17}Ne ions, produced in spallation reactions of protons on a MgO target at the CERN/REX ISOLDE facility, was polarized via the tilted foil technique and implanted in a Pt stopper foil. The induced polarization was 2-3%. Analysis of the β asymmetry, mainly to ^{17}F*(4700,5520), indicated μ=0.74 *3*.

1997Ki19,1998Ch05,2002Ch61,2002Mo19: A series of experiments on ^{17}Ne decay were carried out at the TRIUMF/TISOL facility. The aim of the measurements was to exploit the ^{17}Ne(βp) reaction as a means to populate astrophysically important states in ^{16}O. Proton spallation of a MgO target resulted in ^{17}Ne ions that were implanted on a collection tape that was positioned at the center of various counting station configurations.

1998Ch05: A set of four ΔE-E telescopes were used to study the decay ^{17}Ne(β)^{17}F*(11193 keV)≥p+^{16}O*(9590) and ^{17}Ne(β)^{17}F*(11193 keV)≥α+^{13}N*(2365,3502+3547); a total of 11 decay branches were observed for the decay of ^{17}F*(11193 keV).

2002Ch61: The configuration of (1998Ch05) was improved by implementing double-sided Si strip detectors into parts of the counting station; this lowered the pile-up and random coincidence rates. It is noted that the reported branching ratios show a significant systematic dependence on the detector configuration.

2002Mo19: ^{17}Ne β delayed particle emission was studied using four different experimental techniques: proton-γ coincidences, proton-γ angular correlations, ToF spectra for the proton and α particle spectra, and a ratio cut for a clean α spectrum. Proton-γ coincidences were determined using a beam of ^{17}Ne ions at the TISOL facility at TRIUMF. The beam traveled through a four-sector annular silicon detector and onto a collection tape directly in front of a plastic scintillator and a HPGe detector that was not in the vacuum system. Counting rates were very high so only γ-ray events with energy above 4 MeV were accepted. A particle-β coincidence spectrum was also recorded by the silicon detector.

Proton-γ angular correlations were studied using two HPGe γ-ray detectors and four ion-implanted silicon detectors surrounding a carbon collector foil. Angular correlations between emitted protons and ^{16}O γ rays were measured. Using this method, J^π was determined for states in ^{17}F.

ToF spectra were determined for proton and α particle emissions. A beam of ^{17}Ne ions passed through a carbon collector foil that was positioned at an angle and centered between to scitillation paddles, the beam then passed into a SSB detector. Time and pulse-height information were recorded. A clean α spectrum was not able to be produced because β-proton coincidences at low energies were very strong and obscured the weaker α decay peaks. Therefore, the ratio cut technique was used to get a cleaner spectrum.

A thin SSB detector was placed on the opposite side of a collector foil and a PIPS detector. Each detector had a thicker detector behind it in order to reject background events due to electrons and high energy protons. The PIPS detector recorded particle recoil and the SSB detector recorded coincident α particles. Additional background events were removed using the ratio-cut technique.

Using these methods, relative proton and α branching ratios were determined along with branching ratios for the β decay of ^{17}Ne. Using these branching ratios, reduced Gammow-Teller matrix elementes determined. β-delayed proton decay to α-unbound states in ^{16}O was also examined because of its relevance to astrophysics (helium-burning stage of stellar evolution).

The values %βp=95.4 *46* and %$\beta\alpha$=2.77 *19* are deduced from the tables given in (2002Mo19).

^{17}F Levels

E(level)†	J^π‡	Γ‡	E(level)†	J^π‡	Γ‡
0	5/2+		8436 *10*	1/2−	59 keV *10*
495.33 *10*	1/2+		8825 *25*	3/2−	500 keV *40*
3104 *3*	1/2−		9450 *50*	1/2−	
4640 *20*	3/2−		10030 *60*	3/2−	
5488 *11*	3/2−		10660 *20*	(1/2,3/2)−	
6037 *9*	1/2−		1091×10^1 *10*	1/2−	
8075 *10*	3/2−	53 keV *10*	11192.9 *23*	1/2−	
8200	3/2−		12250 *40*	3/2−	

† From Adopted Levels of ^{17}F in ENSDF database.

‡ From (2002Mo19).

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ε,β^+ radiations

E(decay)	E(level)	$I\beta^{+}$[#]	$I\varepsilon$[#]	Log *ft*	$I(\varepsilon+\beta^+)$[†‡#]	Comments
(2.30×10^{3} *4*)	12250	≥0.0021	≥1.1×10^{-5}	≤4.7	≥0.0021	av Eβ=530 *18*; εK=0.0050 *6*; εL=0.00030 *3*
(3355.8 *23*)	11192.9	0.765 *30*		3.246 *18*	0.765 *30*	av Eβ=1018.6 *11*
(3.64×10^{3} *10*)	10910	0.785 *46*		3.45 *8*	0.785 *46*	av Eβ=1153 *48*
(3889 *20*)	10660	0.81 *6*		3.62 *4*	0.81 *6*	av Eβ=1271.8 *96*
(4.52×10^{3} *6*)	10030	0.64 *3*		4.11 *4*	0.64 *3*	av Eβ=1575 *29*
(5.10×10^{3} *5*)	9450	1.89 *5*		3.94 *3*	1.89 *5*	av Eβ=1856 *25*
(5.72×10^{3} *3*)	8825	4.82 *15*		3.815 *18*	4.82 *15*	av Eβ=2161 *13*
(6113 *10*)	8436	5.54 *16*		3.914 *14*	5.54 *16*	av Eβ=2351.4 *49*
(6348.7 *4*)	8200	4.17 *20*		4.129 *21*	4.17 *20*	av Eβ=2467.23
(6474 *10*)	8075	7.44 *41*		3.924 *25*	7.44 *41*	av Eβ=2528.6 *50*
(8512 *9*)	6037	7.47 *41*		4.569 *24*	7.47 *41*	av Eβ=3535.2 *45*
(9061 *11*)	5488	49 *3*	0.00107 *6*	3.895 *24*	49.3 *27*	av Eβ=3806.0 *55*; εK=2.050×10^{-5} *9*; εL=1.232×10^{-6} *5*
(9909 *20*)	4640	14.1 *8*		4.65 *3*	14.1 *8*	av Eβ=4226 *10*
(11445 *3*)	3104	0.154 *14*		6.94 *4*	0.154 *14*	av Eβ=4989.4 *15*
(14053.4 *4*)	495.33	1.59 *17*		6.39 *5*	1.59 *17*	av Eβ=6287.63
(14548.7 *4*)	0	<0.55		>6.9	<0.55	av Eβ=6534.31

† From (2002Mo19).

‡ $I\beta^+_{g.s.}$ is unmeasured; <0.55% is taken from (1997Mi08). $I\beta^+$(495 keV) is taken from (1993Bo36,1998Oz01), but with corrections for the γ-ray feeding from the 11193 keV isobaric analog state. Finally, the feeding to the particle unbound states is determined by normalizing the remaining %β^+ strength to the relative $I\beta^+$-p and $I\beta^+$-α branching ratios using the measured β^+p, β^+pγ, $\beta^+\alpha$, $\beta^+\alpha\gamma$ observations.

Absolute intensity per 100 decays.

$\gamma(^{17}F)$

E_γ	I_γ[†]	E_i(level)	J^π_i	E_f	J^π_f
495	1.61 *17*	495.33	$1/2^+$	0	$5/2^+$
10695	0.021 *10*	11192.9	$1/2^-$	495.33	$1/2^+$

† Absolute intensity per 100 decays.

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Decay Scheme

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays