Adopted Levels, Gammas

Q(β^-)=13162 *23*; S(n)=734 *18*; S(p)=2.337×10^4 *3*; Q(α)=−15052 *20* 2017Wa10

Previous Level Evaluations: 1971Aj02, 1977Aj04, 1982Aj01, 1986Aj04, 1993Ti07.

Enhancement of neutron density profile:

Analyses of the ^{17}C density profile have been carried out based on measurements of various reaction cross sections and momentum distributions of breakup products. The excess of neutrons in ^{17}C do not appear to form a halo. See discussions in references listed below.

2004Sa14: E(^{17}C)=49 MeV/nucleon, carbon target, σ_{1n}=84 mb *9*, FWHM of $P^{c.m.}_{parallel}$=111 MeV/c *3* and of $P^{c.m.}_{px}$=140 MeV/c *3*. Also measured FWHM of $P^{c.m.}_{parallel}$=121 MeV/c *7* on a Ta target. Deduce J$^\pi$=3/2$^+$.

2001Ma08,2001Ma21: E(^{17}C)≈62 MeV/nucleon, ^{9}Be target surrounded by 11 NaI detectors; σ_{1n}=115 mb *14*.

2004Wu03: E(^{17}C)≈79 MeV/nucleon, carbon target, $\sigma_{reaction}$=1350 mb. See also comments on deformation in (2014Fa02).

2005Wu01: E(^{17}C)≈79 MeV/nucleon, carbon target, σ_{1n}=116 mb *18*, σ_{2n}=70 mb *+33−18*, σ_{3n}=40 mb *+30−13*.

1998Ba28: E(^{17}C)≈84 MeV/nucleon, Be target, σ(Be)$_{1n}$=26 mb and FWHM(^{16}C $P_{parallel}$)=145 MeV/c *5*.

1995Ba28: E(^{17}C)≈96.8 MeV/nucleon, Be target, σ(Be)$_{1n}$=40.9 mb *43* and Γ(^{16}C $P_{parallel}$)=94 MeV/c *19*.

1998Ba87,2001Co06: E(^{17}C)≈910 MeV/nucleon, carbon target, FWHM(^{16}C $P_{parallel}$)=141 MeV/c *6* and σ_{1n}=129 mb *22*.

2001Oz03: E(^{17}C)=965 MeV/nucleon, carbon target, $\sigma_{interaction}$=1056 mb *10*, analyzed relation of σ_i to effective matter radius: R_{rms}≈2.72 fm *3*. See also (2004Oz02).

2000Sa47: E(^{17}C)=49 MeV/nucleon, carbon target,FWHM(^{16}C $P_{parallel}$)$_{lab}$=111 MeV/c *3*, σ_{1n}=84 mb *9*. The authors suggest J$^\pi$=3/2$^+$ from a 1d$_{5/2}$ neutron coupled to the ^{16}C J$^\pi$=2^+_1 state.

For experimental reviews mainly on the nuclear radius see: 1997Or03, 2000Co31, 2000Oz03, 2001Lo20, 2009Ch45, 2011Al11.

For theoretical reviews mainly on the nuclear radius see: 1992La13, 1996Sh13, 1997Ki22, 1999La04, 1998Ri02, 1999Kn04, 2000Be58, 2000Gu04, 2001Le21, 2002Gu10, 2011Fo18, 2013Lu02, 2015Ha20, 2016Fo24, 2016Ya05.

Theoretical reviews mainly of ^{17}C: 1989Wa06, 1996Re19, 2008Ka39, 2008Sa39, 2008Su22, 2009Su17, 2010Ti02, 2012Am01, 2013Am01, 2014Fo02.

General theoretical reviews of carbon isotopes: 1996Re19, 1996Ka14, 1998Sh16, 2000De35, 2003Sa50, 2003Su09, 2003Th06, 2004Th11, 2004Sa58, 2005Sa63, 2006Le33, 2006Ta28, 2007Sa50, 2009Um05, 2010Co05, 2014Ja14.

General theoretical reviews including many nuclides: 1987Sa15, 1993Po11, 1996Su24, 1997Ho04, 1997Ba54, 2001Ka66, 2002Ka73, 2002Me12, 2003Le34, 2004La24, 2004Ne16, 2004Su23, 2006Ko02, 2007Ha53, 2007Do20, 2010Ha07, 2012Am06, 2012Yu07, 2015Sh21.

^{17}C Levels

Cross Reference (XREF) Flags

A	^{1}H(^{17}C,p′γ)	H	^{9}Be(^{40}Ar,^{17}C)	O	^{208}Pb(^{18}C,^{17}C)
B	^{1}H(^{17}C,^{16}Cn),^{1}H(^{19}C,^{16}Cn)	I	C(^{36}S,Xγ)	P	^{208}Pb(^{18}O,^{17}C),^{207}Pb(^{18}O,^{17}C)
C	^{1}H(^{18}C,^{17}Cγ)	J	^{14}C(^{12}C,^{9}C)	Q	U(p,^{17}C)
D	^{1}H(^{19}C,2n^{17}Cγ)	K	^{17}B β^- decay:5.08 ms	R	^{232}Th(^{18}O,^{17}C)
E	^{9}Be(^{17}C,X)	L	^{48}Ca(^{18}O,^{17}C)	S	^{232}Th(^{22}Ne,^{17}C)
F	^{9}Be(^{18}C,^{17}Cγ):RIKEN	M	^{93}Nb(^{22}Ne,^{17}C)		
G	^{9}Be(^{18}C,^{17}Cγ):NSCL	N	^{208}Pb(^{17}C,^{17}C)		

E(level)	J$^\pi$	T$_{1/2}$ or Γ	XREF	Comments
0	3/2$^+$	193 ms *6*	ABCDEFGHI KLMNOPQRS	%β^-=100; %β^-n=26.0 *18* T$_{1/2}$ or Γ: 193 ms *6* is accepted. This is the weighted average of the values 193 ms *6* (1995Sc03) 191 ms *12* (P.L. Reeder et al., Int. Conf. on Nucl. Data for Science and Technology, May 9-13, 1994, Gatlinburg, Tennessee), 180 ms *31* (1988Sa04), 202 ms *17* (1986Cu01), 220 ms *80* (1986Du07). See other reported values 174 ms *31* (1991Re02) and 188 ms *10* (1995ReZZ,2008ReZZ). Also see 191 ms *6* from analysis given in 2015Bi05. %β^-n: The experimental works of (1988Mu08) and (1995Sc03) found %β^-n<11% and (10.8 *22*)%, respectively, but in those cases the detectors had rather high energy thresholds. In the works of Reeder et

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

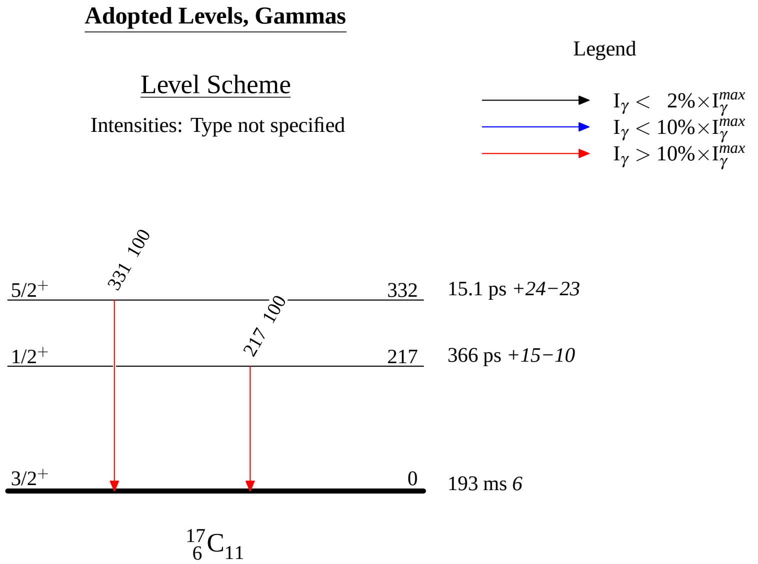
^{17}C Levels (continued)

E(level)	J^{π}	$T_{1/2}$ or Γ	XREF	Comments
				al., a zero-threshold ^{3}He counter was used. The evaluator favors the latest published value from 1994 Gatlinburg (26.0 *18*)%, but see also associated values of (32.0 *27*)% (1991Re02) and (28.4 *13*)% from unpublished comments (1995ReZZ,2008ReZZ). %β^{-}n from 1994 Reeder.
217 *1*	$1/2^{+}$	366 ps *+15−10*	CD FG I K O	E(level): from weighted average of all reported values: E_x= 210 keV *4* (2005El07), 212 keV *8* (2008Su12), 218 keV *1* (2015Sm03), 201 keV *15* (2008St18), and 217 keV *2* (2013Ue01). $T_{1/2}$ or Γ: from (2015Sm03). See also $T_{1/2}$=404 ps *15* (*25* ps *sys.*) (2008Su12).
332 *2*	$5/2^{+}$	15.1 ps *+24−23*	A CD FG IJKL O	E(level): from weighted average of reported values at: E_x= 331 keV *6* (2005El07), 333 keV *10* (2008Su12), 332 keV *1* (2015Sm03), 329 keV *5* (2008St18), 331 keV *2* (2013Ue01). See also E_x= 310 keV *40* (2007Bo10), 292 keV *20* (1977No08), 295 keV *10* (1982Fi10), $T_{1/2}$ or Γ: from (2015Sm03). See also $T_{1/2}$=13.1 ps *4* (*3.3* ps *sys.*) (2008Su12).
2150 *70*	$7/2^{+}$	0.53 MeV *4*	B J	E(level): from Method of Best Representation averaging technique (2014Bi14). E_x=2060 keV 50 (2007Bo10) and 2200 keV *30* (2008Sa03). $T_{1/2}$ or Γ: From (2008Sa03), see also Γ=250 keV *100* (2007Bo10). J^{π}: from (2008Sa03): DWBA analysis of $\sigma(\theta)$.
2710 *20*	$1/2^{-}$	0.04 MeV *1*	K	
3085 *25*	$9/2^{+}$	0.10 MeV *5*	B J	E(level): from Weighted Average of E_x=3050 keV *30* (2008Sa03) and 3100 keV *20* (2007Bo10). $T_{1/2}$ or Γ: From (2007Bo10). J^{π}: From (2008Sa03): DWBA analysis of $\sigma(\theta)$.
3930 *20*	$3/2^{-}$	0.16 MeV *4*	K	
4050 *20*	$(5/2^{-})$	0.06 MeV *6*	K	
4250 *20*	$(5/2^{+},7/2^{+},9/2^{+})$	0.14 MeV *8*	J	
4780 *20*		0.3 MeV *3*	K	
6080 *30*		2.5 MeV *7*	K	
6200 *30*	$(5/2^{+})$	0.35 MeV *15*	B J	E(level),$T_{1/2}$ or Γ,J^{π}: from (2007Bo10). See also E_x=6130 keV *90* and Γ=0.26 MeV *+40−26* (2008Sa03).
7470 *30*	$(11/2^{+})$	0.58 MeV *10*	J	
8850 *50*	$(9/2^{+})$	0.66 MeV *20*	J	
10560 *30*	$(13/2^{+})$	0.30 MeV *10*	J	
11710 *50*		0.30 MeV *15*	J	
12610 *30*		0.45 MeV *20*	J	
13700 *50*		0.6 MeV *2*	J	
16.3×10^{3}? *1*		0.5 MeV *2*	J	

Adopted Levels, Gammas (continued)

$\gamma(^{17}C)$

E_i(level)	J_i^π	E_γ	I_γ	E_f	J_f^π	Comments
217	$1/2^+$	217 *2*	100	0	$3/2^+$	B(M1)↓=1.04×10^{-2} *+3−12*
332	$5/2^+$	331 *2*	100	0	$3/2^+$	B(M1)↓=7.12×10^{-2} *+127−96*



$^{1}H(^{17}C,p'\gamma)$ 2005El07

Beam=^{17}C, target=liquid H_2.

2005El07:

XUNDL set compiled by J. Roediger and B. Singh (McMaster) July 2005.

A ≈100% pure beam of 43.3 MeV/nucleon ^{17}C, produced by fragmentation of 110 MeV/nucleon ^{22}Ne ions on a ^{9}Be target at the RIKEN/RIPS facility, impinged on a liquid H_2 target. Incident particles were identified using standard ΔE, and time-of-flight (tof) techniques.

The target was surrounded by the 158 NaI(Tl) scintillator DALI2 array. A 48×48 mm^2 ΔE-ΔE-E-Veto Si detector telescope was placed 80 cm downstream of the target (θ<1.7°). Eγ, Iγ, $\gamma\gamma$, and particle-γ coin were measured.

2005Ka26: The authors searched for evidence of an isomeric state with E_x<300 keV and $T_{1/2}$<500 ns, as predicted by shell model calculations.

A cocktail beam, including ^{19}C and ^{17}C, was produced by fragmenting a ^{22}Ne beam on a ^{9}Be target at RIKEN. Beam particles were identified from analysis of ΔE, time-of-flight and beam rigidity. The beam impinged on a liquid hydrogen target that was surrounded by NaI γ-ray detectors; results for prompt transitions are reported in (2005El07). After the target, the beam was stopped in a ΔE-ΔE-ΔE-E telescope that was surrounded by thin plastic scintillators (for identification of β decay events) and an array of segmented HPGe clover detectors that were intended to observed delayed de-excitations from isomeric states populated in the reaction. Several transitions related to β-decay of daughters and granddaughters were identified. No definitive evidence in support of an isomeric state was found.

^{17}C Levels

E(level)	J$^\pi$ †	Comments
0.0	3/2$^+$	Possible configuration=mixture of $[\nu d^3_{5/2}]_{3/2}$ and $\nu s_{1/2}\otimes[\nu d^2_{5/2}]_{3/2}$.
331 *6*	(5/2$^+$)	Possible configuration=$d_{5/2}$; β_2=0.52 *4*, deduced from integrated experimental cross section for this level from 0°−1.7° and an assumed J$^\pi$ of 5/2$^+$. Cross sections: 33 mb *4* in (^{19}C,2n^{17}C) reaction, 13.8 mb *15* in (p,p′).

† Tentative assignments to excited states based upon systematics of transition strengths combined with considerations of g.s. configuration.

$\gamma(^{17}C)$

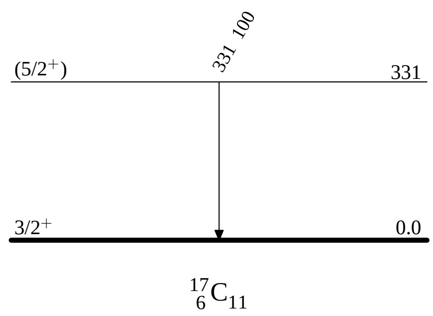
E$_\gamma$ †	I$_\gamma$	E$_i$(level)	J$^\pi_i$	E$_f$	J$^\pi_f$
331 *6*	100	331	(5/2$^+$)	0.0	3/2$^+$

† 210 and 331 γ-ray peaks observed prominently in $^{1}H(^{19}C,^{17}C\gamma)^{3}H$ reaction, while only the 311 transition is strong in the $^{1}H(^{17}C,^{17}C'\gamma)$ reaction spectrum. Quoted uncertainties stem from statistical error and Doppler correction.

^{1}H(^{17}C,p′γ) 2005El07

Level Scheme

Intensities: Relative I_γ



^{1}H(^{17}C,^{16}Cn),^{1}H(^{19}C,^{16}Cn) 2008Sa03

Beam=^{17}C and ^{19}C, target=liquid H_2.
2008Sa03:
XUNDL set compiled by S. Geraedts and B. Singh (McMaster) Feb 2008.
Beams of E=70 MeV/nucleon ^{17}C and ^{19}C were separately produced at the RIKEN/RIPS facility by fragmenting a 110 MeV/nucleon ^{22}Ne in a thick target. The beams impinged on a 3 cm diameter cryogenic hydrogen target with 120 mg/cm^2 areal density. The γ-rays from reactions in the target were detected using 48 NaI(Tl) scintillators while charged particles were detected with a plastic counter hodoscope. Neutrons, from ^{17}C breakup, were detected using a neutron hodoscope consisting of two walls of plastic scintillator array.
The authors measured (charged fragments)(neutron) coin, (γ)(charged particles) coin, angular distributions of charged particles. DWBA analysis. The inclusive ^{17}C→^{16}C+n and exclusive →^{16}C+n+γ[^{16}C*(2$^+$)=1.77 MeV] spectra were analyzed. A resonance at E(rel)=1.47 MeV *2* was observed in the inclusive spectrum, but absent in the exclusive γ-ray coincidence events; evidence the state decays to $^{16}C_{g.s.}$. Other resonances at E_{res}=0.55 and 3.63 MeV were observed in coincidence with the ^{16}C*(2$^+$)=1.77 MeV de-excitation γ ray.
The angular distributions of the E_x=2.2 and 3.1 MeV resonances were analyzed and compared with DWBA calculations.
1999He33: A theoretical analysis of the ^{16}C+n astrophysical neutron capture reaction rate given.
See also discussions in (2008Ka39,2008Sa39).

^{17}C Levels

E(level)[†]	J$^\pi$	Γ (MeV)	σ (mb)[a]	Comments
0	3/2$^+$			
2200[#] *30*	7/2$^+$[‡]	0.53 MeV *4*	3.8 *2*	Resonance energy (c.m.)=1470 *20* (g.s. in ^{16}C).
3050[@&] *30*	9/2$^+$[‡]		0.40 *4*	Resonance energy (c.m.)=550 *20* (1770 *10*, 2$^+$ excitation energy in ^{16}C).
6130[@&] *90*	5/2$^+$	0.26 MeV *+40−26*	0.8 *1*	J$^\pi$: from comparisons with structure calculations. Resonance energy=3630 *90* (1770 *10*, 2$^+$ excitation energy in ^{16}C).

† Excitation energy=resonance energy+S(n)+excitation energy of the daughter nucleus ^{16}C.
‡ From comparison of $\sigma(\theta)$ distributions with DWBA calculations for ^{17}C(p,p′) reaction.
\# Observed in ^{1}H(^{17}C,$^{16}C_{g.s.}$n) reactions.
@ Observed in ^{1}H(^{17}C,^{16}C*(1.77 MeV)n) reactions.
& Observed in ^{1}H(^{19}C,^{16}C*(1.77 MeV)n) reactions.
a Experimental cross-sections.

$^{1}H(^{18}C,^{17}C\gamma)$ 2009Ko02

The authors produced a E(^{18}C)=68 MeV/nucleon beam by fragmenting ^{22}Ne ions at the RIKEN/RIPS facility. The beam impinged on a 120 mg/cm^2 liquid hydrogen target in the CRYPTA (cryogenic proton/α) target system. The trajectory of the incident beam on target was measured, and the outgoing particles were momentum analyzed using a large acceptance magnetic spectrometer that selected ^{17}C particles following one-neutron removal. In addition, the 48 NaI crystal DALI γ-ray array surrounded the hydrogen target and measured γ-rays in coincidence with the ^{17}C fragments. Two γ-ray transitions were observed in coincidence with ^{17}C particles in the focal plane; the deduced level scheme is understood based on the known first and second excited states decaying to $^{17}C_{g.s.}$.

In the analysis, transverse momentum distributions of ^{17}C reaction products were generated for coincidences with each of the γ-ray transitions. The momentum distributions were then evaluated, via CDCC analysis, to obtain *l* values of the removed neutrons.

Also deduced σ_{1n}= 54 mb *11*.

^{17}C Levels

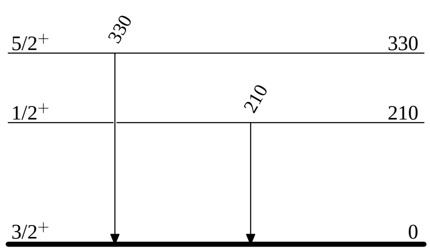
E(level)	J$^\pi$	L	σ (mb)	Comments
0	3/2$^+$		<12	J$^\pi$: from shell model expectations.
210	1/2$^+$	0	11 *2*	
330	5/2$^+$	2	43 *5*	

$\gamma(^{17}C)$

E$_\gamma$	E$_i$(level)	J$^\pi_i$	E$_f$	J$^\pi_f$
210	210	1/2$^+$	0	3/2$^+$
330	330	5/2$^+$	0	3/2$^+$

$^{1}H(^{18}C,^{17}C\gamma)$ 2009Ko02

Level Scheme



$^{17}_{6}C_{11}$

$^{1}H(^{19}C,2n^{17}C\gamma)$ 2005El07

Beam=^{19}C, target=liquid H_2.
2005El07:
XUNDL set compiled by J. Roediger and B. Singh (McMaster) July 2005.
A 20% pure beam of 49.4 MeV/nucleon ^{19}C, produced by fragmentation of 110 MeV/nucleon ^{22}Ne ions on a ^{9}Be target at the RIKEN/RIPS facility, impinged on a liquid H_2 target. Incident particles were identified using standard energy-loss, and time-of-flight (tof) techniques. The mean energy in the target was 49.4 MeV/nucleon for ^{19}C.
The target was surrounded by the 158 NaI(Tl) scintillator DALI2 array. A 48×48 mm^2 ΔE-ΔE-E-Veto Si detector telescope was placed 80 cm downstream of the target (θ<1.7°). Eγ, Iγ, $\gamma\gamma$, and particle-γ coin were measured.

^{17}C Levels

E(level)	J^{π} †	Comments
0.0	3/2$^+$	Possible configuration=mixture of $[\nu d^3_{5/2}]_{3/2}$ and $\nu s_{1/2}\otimes[\nu d^2_{5/2}]_{3/2}$.
210 *4*	(1/2$^+$)	Configuration of state suggested to have small $[d^3_{5/2}]_{1/2}$ admixture. E(level): uncertainty of 6 keV is also stated in the abstract of (2005El07). Cross sections: 37 mb *4* in (^{19}C,2n^{17}c) reaction, ≈1.5 mb in (p,p′).
331 *6*	(5/2$^+$)	Possible configuration=$d_{5/2}$; β_2=0.52 *4*, deduced from integrated experimental cross section for this level from 0°−1.7° and an assumed J^{π} of 5/2$^+$. Cross sections: 33 mb *4* in (^{19}C,2n^{17}C) reaction, 13.8 mb *15* in (p,p′).

† Tentative assignments to excited states based upon systematics of transition strengths combined with considerations of g.s. configuration.

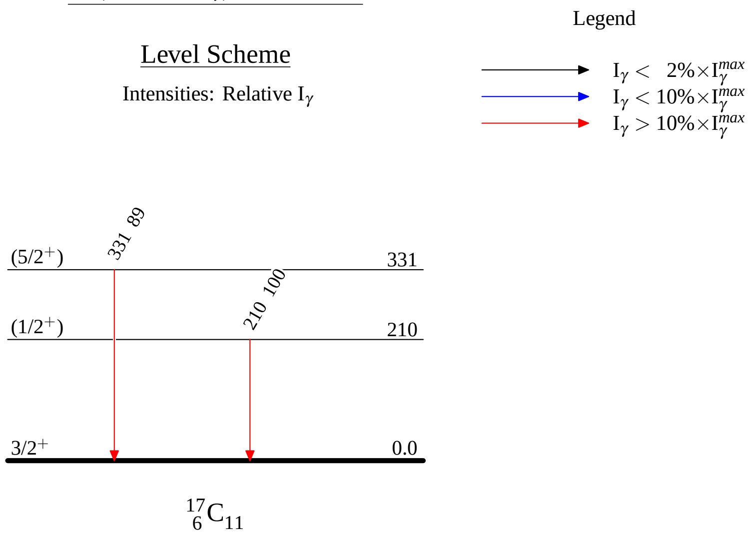
$\gamma(^{17}C)$

E_γ	I_γ	E_i(level)	J^{π}_i	E_f	J^{π}_f
210 *4*	100 *11*	210	(1/2$^+$)	0.0	3/2$^+$
331 *6*	89 *11*	331	(5/2$^+$)	0.0	3/2$^+$

$^{1}H(^{19}C,2n^{17}C\gamma)$ 2005El07

Level Scheme

Intensities: Relative I_γ



^{9}Be(^{17}C,X) 2001Ma08

2001Ma08,2001Ma21: E(^{17}C)≈62 MeV/nucleon, ^{9}Be target surrounded by 11 NaI detectors; σ_{1n}=115 mb *14*. Measured parallel momentum distribution widths corresponding to population of different ^{16}C states by analyzing coincidences with γ rays. Deduced (22 *11*)% of 1n-removal events populate $^{16}C_{g.s.}$($J^{\pi}=0^{+}$) via *l*=2, (52 *8*)% populate ^{16}C*(1.77 MeV: $J^{\pi}=2^{+}$) via *l*=0((14 *6*)%) and *l*=2((38 *8*)%) and (29 *5*)% populate states near ^{16}C*(4.1 MeV: $J^{\pi}\approx2,3^{(+)},4^{+}$) via *l*=0 ((2 *2*)%) and *l*=2 ((27 *5*)%). Their analysis of the $^{17}C_{g.s.}$ J^{π} value, based on *l*=2 feeding of $^{16}C_{g.s.}$ with no *l*=0 component, indicates J^{π}(^{17}C)=3/2^{+}.

^{17}C Levels

E(level)	J^{π}
0	3/2^{+}

$^{9}Be(^{18}C,^{17}C\gamma)$:RIKEN 2008Su12

2008Su12:
XUNDL set compiled by F.G. Kondev, ANL, August 2008.
The experiment was performed at the RIKEN Accelerator Research Facility using a ^{18}C secondary beam from the RIKEN Projectile-fragment Separator (RIPS). The secondary beam was produced by fragmenting 110 MeV/nucleon ^{22}Ne ions on a 1.02 g/cm^2 ^{9}Be production target with a typical beam intensity of 320 pnA. Particle identification of the ^{18}C beam was performed on an event-by-event basis by means of the ToF-ΔE method using two 1.0 mm thick plastic scintillation counters, placed 5.1 m apart along the beam line. The ^{18}C secondary beam had a typical intensity of 2.3×10^4 counts per second with a purity of about 60%, and was directed onto a 370 mg/cm^2 ^{9}Be reaction target set at the final focal plane of RIPS. Positions and incident angles of the secondary beam particles were recorded with two sets of parallel plate avalanche counters (PPACs) placed upstream of the reaction target. Outgoing particles were detected by a plastic scintillator hodoscope, located 3.8 m downstream of the target. The scattering angle of the particle was determined by combining the hit position on the hodoscope with those on the PPACs for the incoming particles.
Detectors: 130 NaI(Tl) detectors from the DALI and DALI2 arrays, divided into ten separate layers, surrounded the target to detect deexciting γ rays.
Measured: Eγ, $\gamma(\theta)$ and $T_{1/2}$. The lifetime measurements were performed by employing the recoil shadow method with intermediate-energy radioactive-isotope beams. In this method, the lifetime is obtained by observing the angular distribution of γ rays emitted from excited ^{17}C nuclei in flight.

^{17}C Levels

E(level)[†]	J^{π}[‡]	$T_{1/2}$[#]	Comments
0[@]	3/2+		
212 *8*	(1/2+)	404 ps *15*	$T_{1/2}$: the quoted uncertainty is statistical. The systematics uncertainty is 24 ps (2008Su12). E(level): configuration=$\nu_{1/2}$[211] with less mixing from the $\nu_{1/2}$[220] ($1d_{5/2}$) and $\nu_{1/2}$[200] ($1d_{3/2}$) orbitals.
333[@] *10*	(5/2+)	13.1 ps *4*	$T_{1/2}$: the quoted uncertainty is statistical. The systematics uncertainty is 3.3 ps (2008Su12).

[†] From the measured Eγ.
[‡] Based on deduced transition strengths; shell model.
[#] Recoil shadow method (2008Su12). Uncertainties are statistical. The systematic uncertainties are given under comments.
[@] Band(A): $\nu_{3/2}$[211] band.

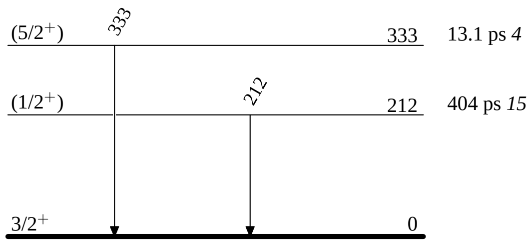
$\gamma(^{17}C)$

E_{γ}[†]	E_i(level)	J^{π}_i	E_f	J^{π}_f
212 *8*	212	(1/2+)	0	3/2+
333 *10*	333	(5/2+)	0	3/2+

[†] Values deduced after correcting for Doppler effect.

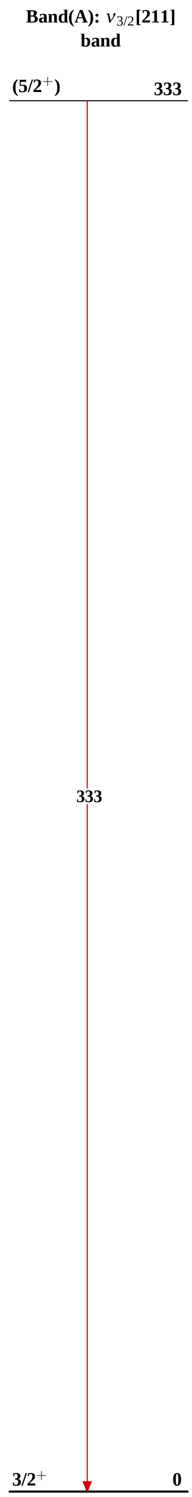
$^{9}Be(^{18}C,^{17}C\gamma)$:RIKEN 2008Su12

Level Scheme



$^{17}_{6}C_{11}$

$^{9}Be(^{18}C,^{17}C\gamma)$:RIKEN 2008Su12



$^{17}_{6}C_{11}$

^{9}Be(^{18}C,^{17}Cγ):NSCL 2015Sm03

The authors measured the lifetimes of relatively long-lived states in ^{17}C using the TRIple PLunger for EXotic beams (TRIPLEX).

A beam of 74.2 MeV/nucleon ^{18}C ions was produced by fragmenting a ^{22}Ne beam on a ^{9}Be target at the NSCL/A1900 fragment separator. The beam impinged on a 370 mg/cm^2 ^{9}Be target located at the target position of the S800 spectrometer, where the TRIPLEX plunger system was located. The TRIPLEX comprised the ^{9}Be target and a set of 1640 and 950 mg/cm^2 Ta energy degrading targets that were located at variable distances from the Be target. De-excitation γ rays from the decay of ^{17}C states, produced in ^{9}Be(^{18}C,^{17}C*) reactions, were observed using the GRETINA array, which covered θ=25° to 90°. Two de-excitation peaks were observed at E_γ=218 keV *1* and 332 keV *1*. Analysis of the intensities of the velocity dependent Doppler shifted γ rays, after each plunger degrader, permitted a determination of the lifetime of the parent states. The center Ta degrader of the plunger device was located to give optimal lifetime sensitivity.

Finally, B(M1) values are deduced for the two observed transitions. Pure M1 decay is assumed for the observed transitions, but for the E_γ=218 keV *1* (J^π=1/2$^+$ to 3/2$^+$) transition, in the calculation of B(M1), an additional $\tau=^{+47}_{-0}$ uncertainty is added to the M1 partial lifetime to account for any E2 contributions. Discussion on the structure of ^{17}C and transition rate was included, especially on the roles played by three-body interactions and the continuum.

^{17}C Levels

E(level)	$J^{\pi\dagger}$	$T_{1/2}$	Comments
0	3/2$^+$		
218 *1*	1/2$^+$	366 ps *+15−10*	$T_{1/2}$: from τ=528 ps *+21−14*.
322 *1*	5/2$^+$	15.1 ps *+24−23*	$T_{1/2}$: from τ=21.8 ps *+34−33*.

† From (2013Ue01).

γ(^{17}C)

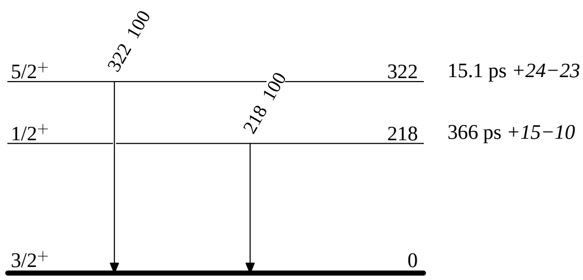
E_i(level)	J^π_i	E_γ†	I_γ	E_f	J^π_f	Comments
218	1/2$^+$	218 *1*	100	0	3/2$^+$	B(M1)↓=1.04×10^{-2} *+3−12*
322	5/2$^+$	322 *1*	100	0	3/2$^+$	B(M1)↓=7.12×10^{-2} *+127−96*

† From Doppler shift correction.

^{9}Be(^{18}C,^{17}Cγ):NSCL 2015Sm03

Level Scheme

Intensities: Relative photon branching from each level



$^{17}_{6}C_{11}$

^{9}Be(^{40}Ar,^{17}C) 2000Oz01,2012Kw02

2000Oz01: Production yields for fragmentation of 1 GeV/nucleon ^{40}Ar projectiles on a Be target were measured for a variety of nuclides. $\sigma(^{17}C)\approx 1.5\times 10^{-5}$ b was deduced.

2003Oz01,2007No13: Production yields for fragmentation of 94 MeV/nucleon ^{40}Ar projectiles were measured. For a berylium target, $\sigma\approx 5.7\times 10^{-6}$ b was deduced. Also, $\sigma\approx 7.3\times 10^{-5}$ b was deduced for a tantalum target.

2012Kw02: Production yields for fragmentation of 120 MeV/nucleon ^{40}Ar projectiles on berylium, nickel and tantalum targets were measured. The cross section of roughly 1×10^{-2} mb was deduced for ^{9}Be.

See also analysis of transverse momentum widths of nuclides produced in ^{40}Ar+^{9}Be at E(^{40}Ar)=95 MeV/nucleon (2015Mo17).

^{17}C Levels

E(level)
0

C(^{36}S,Xγ) 2008St18,2004St10

2004St10,2004ST29,2008ST18:
XUNDL sets compiled by S. Geraedts and B. Singh (McMaster) 2007-2008.
Two-step fragmentation reaction. The authors populated ^{17}C using a cocktail beam of neutron-rich nuclides [^{25}Ne, ^{26}Ne, ^{27}Na, ^{28}Na, ^{29}Mg, and ^{30}Mg] that were produced by fragmenting an initial 77.5 MeV/nucleon ^{36}S beam at the GANIL/SISSI beamline. The cocktail beam was selected using the α spectrometer and focused on a carbon target that was coupled to a plastic scintillator.
Eγ, $\gamma\gamma$, γ(fragment) coincidences were measured using 74 BaF_2 detectors that surrounded the target with 4π and the SPEG spectrometer. The ^{17}C were identified using time-of-flight, energy loss and focal-plane position information. The γ-ray transitions are observed. Results are compared with shell-model calculations for analysis of J^π values.
All data are from (2008St18).

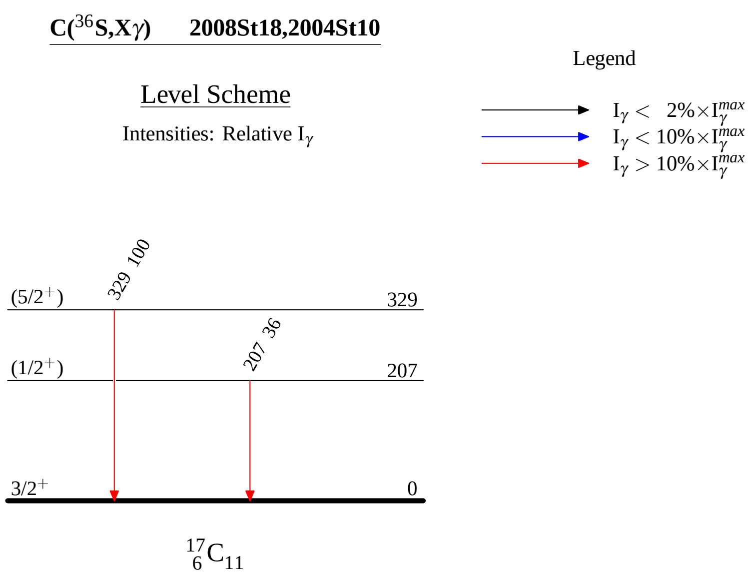
^{17}C Levels

E(level)	$J^{\pi\dagger}$
0	$3/2^+$
207 *15*	$(1/2^+)$
329 *5*	$(5/2^+)$

† From literature, and consistent with shell-model predictions shown in figure 4 of (2008St18).

γ(^{17}C)

E_γ	I_γ	E_i(level)	J^π_i	E_f	J^π_f
207 *15*	36 *9*	207	$(1/2^+)$	0	$3/2^+$
329 *5*	100 *10*	329	$(5/2^+)$	0	$3/2^+$



$^{14}C(^{12}C,^{9}C)$ 2007Bo10

2004Bo23,2005Bo39,2007Bo10:
XUNDL set compiled by S. Geraedts and B. Singh (McMaster) Aug 2007.
An E(^{12}C)=231.3 MeV beam was delivered to a target with 384 μg/cm^2 ^{14}C by the isochron cyclotron at the Berlin HMI/ISL. Reaction products were momentum analyzed using the Q3D magnetic spectrograph, which was positioned to cover θ=3.0-7.0°. The overall energy resolution was ΔE(FWHM)=250 keV. Products were identified with a gas-filled (ΔE) focal plane detector and a scintillator (E) detector and the time-of-flight through the spectrometer.
The observed levels are compared with shell-model calculations and interpreted in terms of (sd)^3 structures.

^{17}C Levels

E(level)†	J$^\pi$	Γ	dσ/dΩ (nb/sr)	Comments
0?	3/2$^+$		10 *5*	dσ/dΩ≤10 nb/sr *5*. No peak was identified in the spectrum.
310 *40*	5/2$^+$		50 *30*	
2060 *50*	(3/2$^+$,7/2$^+$)	0.25 MeV *10*	45 *25*	
3100 *20*	9/2$^+$	0.10 MeV *5*	300 *20*	
4250 *20*	(5/2$^+$,7/2$^+$,9/2$^+$)	0.14 MeV *8*	140 *15*	
6200 *30*	(5/2$^+$)	0.35 MeV *15*	110 *15*	
7470 *30*	(11/2$^+$)	0.58 MeV *10*	293 *30*	
8850 *50*		0.66 MeV *20*	220 *30*	
10560 *30*		0.30 MeV *10*	130 *15*	
11710 *50*		0.30 MeV *15*	72 *15*	
12610 *30*		0.45 MeV *20*	110 *15*	
13700 *50*		0.6 MeV *2*	160 *20*	
16.3×10^3? *1*		0.5 MeV *2*	73 *20*	

† A systematic uncertainty of 40 keV is estimated by (2007Bo10) througout the energy region.

^{17}B β^- decay:5.08 ms 2013Ue01

Parent: ^{17}B: E=0; $J^\pi=(3/2^-)$; $T_{1/2}$=5.08 ms *5*; $Q(\beta^-)=2274\times10^1$ *17*; %β^- decay=100.0
^{17}B-$Q(\beta^-)$: From 2012Wa38.
^{17}B-J^π,$T_{1/2}$: From ^{17}B Adopted Levels in ENSDF database.
^{17}B-P_{0n}=0.22 *4*, P_{1n}=0.63 *5*, P_{2n}=0.12 *2* P_{3n}=0.035 *7* and P_{4n}=0.004 *3* (1988Du09, 2013Ue01).

1988Du09,1987DuZU,1988DuZT,1989MuZU: ^{17}B was produced by fragmentation of a 60 MeV/n ^{22}Ne beam impinging on either a tantalum or a carbon target and was selected using the LISE spectrometer. The β-particles were detected by a plastic scintillator while the delayed neutrons were detected through the Gd(n,γ) reaction in a 500 liter 4π neutron ball. $T_{1/2}$=5.08 ms *5*, P_{0n}=0.21 *2*, P_{1n}=0.63 *1*, P_{2n}=0.11 *7*, P_{3n}=0.035 *7* and P_{4n}=0.004 *3* were measured. See also (1989Le16).

1991Re02,1995ReZZ,2008ReZZ: Spallation products from 800 MEV proton bombardment of a ^{232}Th target were captured by a transport line with a mass-to-charge filter and transferred to the TOFI spectrometer at LAMPF. The beamline was separately tuned to transport a number of different nuclides. The neutrons were detected in a polyethylene moderate ^{3}He counter, and standard techniques were implemented. The β-delayed neutron probabilities were deduced from analysis of the number of implanted ions (per beam pulse) and the rate of β-delayed neutrons detected in the zero-threshold counter. In (1991Re02) the β-delayed neutron probability $P_n(=P_{1n}+2P_{2n}+3P_{3n}+...)$=(65 *35*)% and $T_{1/2}$=5.9 ms *30* were deduced. In later publication, such as (P.L. Reeder et al., Int. Conf. on Nucl. Data for Science and Technology, May 9-13, 1994, Gatlinburg, Tennessee), and (1995ReZZ,2008ReZZ) P_n=(104 *26*)% and $T_{1/2}$=5.20 ms *45* were deduced.

1996Ra02: A beam of ^{17}B ions was produced by fragmenting a ^{22}Ne beam on a ^{9}Be target. The beam was magnetically separated, degraded to lower energies, and finally stopped in a plastic scintillator. The implantation detector was sandwiched between four other scintillator β-ray detectors. A valid ^{17}B decay event required a coincidence between three ajacent detectors. Three neutron walls surrounded the implantation target and covered about 1.4 sr. The decay neutron energy was deduced by the time of flight between the implantation detector and the neutron wall detectors.

The measured neutron spectrum shows two prominent decay groups of ^{17}B β delayed neutrons at E_n=2.91 and 1.80 MeV, as well as a strong peak at E_n=0.82 MeV from the ^{16}N daughter decay. A full analysis of the neutron energy spectrum revealed two neutron groups corresponding to known branches in ^{16}N decay and four groups at E_n=0.42, 1.43, 1.80 and 2.91 MeV that are attributed to neutron decay from ^{17}C to $^{16}C_{g.s.}$. In later works, the E_n=1.43 MeV branch is attributed to decay to ^{16}C*(1766) while the E_n=0.42 MeV branch is not found. in 1996Ra02, the results are presented by normalizing to %β^{-1}n=(63 *1*)% from (1988Du09).

2013Ue01,1997YaZX: An E(^{22}Ne)=110 MeV/nucleon beam was fragmented in a 1.07 g/cm^2 ^{93}Nb target and the ^{17}B ions at $\theta_{lab}=1.5°-5.0°$ were accepted in the RIKEN/RIPS fragment separator. The ^{17}B beam was then implanted at the center of a stack of four 100 μm thick Pt stopper foils which were held in a 50 mT magnetic field. A β-NMR technique was implemented to maximize the sensitivity to spin dependent observables.

Two plastic scintillators were placed in positions above and below the Pt foil stack and were used to detect β-rays from decays in the foil. Coincidences among the two foils were used to reject events, for example, from cosmic-ray events.

Neutron bound and neutron unbound states in ^{17}C could be populated in the decay, and furthermore the neutron-unbound levels can decay with low-energy or high-energy neutron emission. A 12 element plastic scintillator high-energy neutron detector array ($E_n\approx$0.5-10 MeV) covered $\Omega_n=0.21\times4\pi$ sr with a 5.6% efficiency for detecting 1 MeV neutrons. The neutron energies were determined by time-of-flight where the β-ray signal provided a start signal and the neutron array provided the stop signal (1.5 m flight path). A 10 element plastic scintillator low-energy neutron detector array ($E_n\geq$0.01 MeV) covered $\Omega_n=0.037\times4\pi$ sr with a 0.5 m flight path.

A HPGe clover detector and four NaI(Tl) detectors measured the emitted γ-rays. Plastic scintillator detectors covered the front faces of the detectors and helped reject β-rays entering the γ-ray detectors. The plastic scintillators plus NaI(Tl) detectors were also used to measure the β-ray energy spectrum.

The decay curve of photopeak counts is evaluated and constraints are placed to guide consideration of transitions resulting from levels fed by ^{17}B β-decay or ^{17}B β^-Xn decay. In the case of 0-n decay to neutron bound levels of ^{17}C, the γ-ray transitions with energies below the neutron separation energy, Sn≈730 keV (2012Wa38), were evaluated. Transitions with Eγ=217, 295 and 331 keV were identified as possible decays in ^{17}C. However because feeding to low-lying states of ^{17}C can be connected with emission of high energy β-rays the γ-ray spectra were analyzed with the condition of a coincident E$\beta\geq$10 MeV β-ray; only peaks corresponding to Eγ=217 and 331 keV were found. Analysis of β-γ-γ coincidences yielded no results, so the ^{17}B 0n-β decay is found to decay to ^{17}C*(217, 331) which then γ-decay to the ^{17}C ground state.

Numerous other time correlated γ-ray transitions (connected with decay of levels fed by β-xn decay) and time uncorrelated γ-transitions (connected with subsequent β-decay of daughters) are characterized.

The E_n=0.82 MeV neutron group is correlated with the neutron emission group from ^{16}N*(3353)→$^{15}N_{g.s.}$ that is populated in 84.4% (1976Al02) of ^{16}C decay events. This branching ratio is used with the presently observed intensity of the E_n=0.82 MeV

$^{17}B\ \beta^-$ decay:5.08 ms 2013Ue01 (continued)

neutron group to obtain %β^-1n=(67 *7*)% for ^{17}B decay.

The Eγ=5299 keV transition is identified in the γ-ray spectrum and is connected with β^-2n decay to ^{15}C, which then β-decays to ^{15}N. The Eγ=5299 keV γ-ray is populated in 63.2% of ^{15}C decays (1984Wa07); this branching ratio is used with the presently observed %Iγ(5290)=(7.5 *11*)% to deduce %β^-2n=(12 *2*)%.

^{17}C Levels

E(level)	J^{π}†	Γ	Comments
0	3/2+		
217 *2*	1/2+		
331 *2*	5/2+		
2710 *20*	1/2−	0.04 MeV *1*	E(level),Γ: from E_n=1.86 MeV *1* that populated $^{16}C_{g.s.}$ (2013Ue01). See also E_n=1.80 MeV *2* (1996Ra02).
3930 *20*	3/2−	0.16 MeV *4*	E(level),Γ: from E_n=3.01 MeV *1* that populated $^{16}C_{g.s.}$ (2013Ue01). See also E_n=2.91 MeV *5* (1996Ra02).
4050 *20*	(5/2−)	0.06 MeV *6*	E(level),Γ: from E_n=1.46 MeV *1* that populated ^{16}C*(1766).
4780 *20*		0.3 MeV *3*	E(level),Γ: from E_n=3.81 MeV *1* that populated $^{16}C_{g.s.}$.
6080 *30*		2.5 MeV *7*	E(level),Γ: from E_n=5.04 MeV *2* that populated $^{16}C_{g.s.}$.

† From (2013Ue01) for levels above 1 MeV. Below this energy assignments are from (2008Su12).

β^- radiations

E(decay)	E(level)	$I\beta^-$†	Log *ft*	Comments
(1.666×10^4 *17*)	6080	4 *1*	5.31 *11*	
(1.796×10^4 *17*)	4780	0.9 *1*	6.12 *6*	
(1.869×10^4 *17*)	4050	1.5 *2*	5.98 *7*	β asymmetry parameter A_β=−4 *15*.
(1.881×10^4 *17*)	3930	20 *3*	4.87 *7*	β asymmetry parameter A_β=+0.04 *99*.
(2.003×10^4 *17*)	2710	33 *4*	4.78 *6*	β asymmetry parameter A_β=−1.0 *5*.
(2.241×10^4 *17*)	331	2.1 *2*	6.22 *5*	
(2.252×10^4 *17*)	217	2.8 *11*	6.1 *2*	
(2.274×10^4 *17*)	0	17 *4*	5.34 *11*	$I\beta^-$: using the known ^{17}N*(1373, 1849) γ-transition intensities following ^{17}C decay (1993Ti03) permitted normalization of the present 0-n emission results so that %β^-0n=(22 *4*)% was deduced from the weighted average of (%β^-0n: from 1382)=(25 *9*)% and (%β^-0n: from 1855)=(21 *5*)%. Then Iβ(g.s.)=(22 *4*)% − (summed β feeding=(4.9 *11*)% to 217+331 levels)=(17 *4*)%.

† Absolute intensity per 100 decays.

$\gamma(^{17}C)$

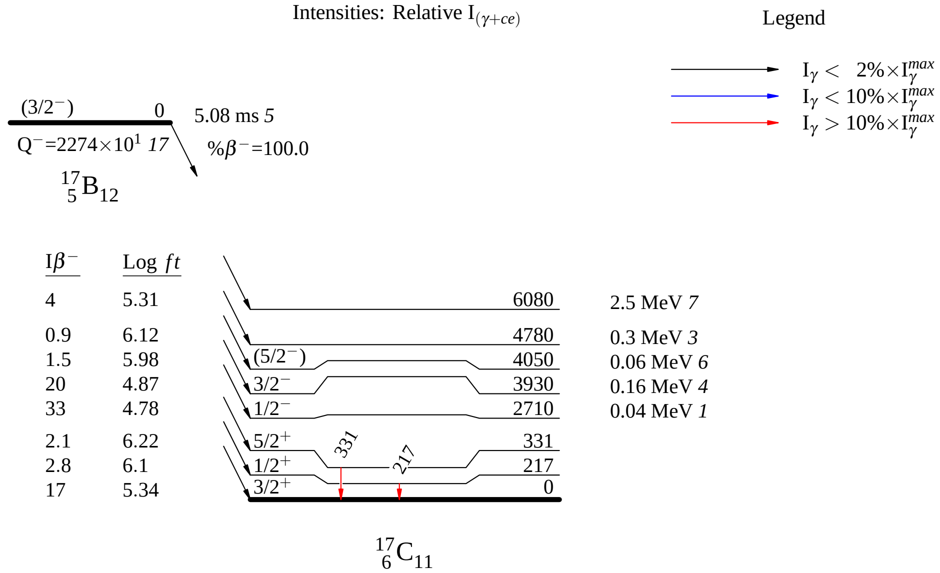
E_γ	I_γ†	E_i(level)	J^π_i	E_f	J^π_f
217 *2*	2.8 *11*	217	1/2+	0	3/2+
331 *2*	2.1 *2*	331	5/2+	0	3/2+

† Absolute intensity per 100 decays.

^{17}B β^- decay:5.08 ms 2013Ue01

Decay Scheme

Intensities: Relative $I_{(\gamma+ce)}$



^{48}Ca(^{18}O,^{17}C) 1977No08

1977No08: The authors studied the low-lying excitations of ^{17}C. A beam of E(^{18}O)=102 MeV ions, from the Heidelberg tandem, impinged on a 25 μg/cm^2 ^{48}Ca target. Reaction products were momentum analyzed using a Q3D spectrograph that was positioned at θ=7.4° and θ=8.1°. The focal plane comprised a set of position sensitive detectors alond with ΔE-E detectors for particle identification of the ^{17}C products. The ground state and an excited state were clearly identified in the spectrum; a much smaller third group was also visible in the spectrum. In addition, groups corresponding to excited ^{49}Ti were present at positions on the focal plane that would correspond to neutron-unbound ^{17}C states. Lastly, there was inconclusive discussion on shell structure and a comparison to ^{17}O states. Also see (1977BhZC).

The mass excess,ΔM=21023 keV *35*, was deduced using (1971Wa37); a comparison with (2012Wa38) is similar, having nearly offsetting changes in the ^{48}Ca and ^{49}Ti masses. The excited state was observed with E_x=292 keV *20*.

1982Fi10: The authors measured the Q-value for ^{48}Ca(^{18}O,^{17}C) along with that of the ^{48}Ca(^{18}O,^{17}C) reaction. A beam of 112 MeV ^{18}O ions from the Australian National University Pelletron impinged on a 97% enriched 100 μg/cm^2 ^{48}Ca target. The reaction products were momentum analyzed at θ=5° using an Enge split-pole spectrometer with ΔE≈200 keV (FWHM). The ground state was observed with ΔM=21039 keV *20* and an excited state was found at E_x=295 keV *10*. There was no indication of other excited states.

^{17}C Levels

E(level)	Comments
0	
294 *9*	E(level): Average of reported values.

^{93}Nb(^{22}Ne,^{17}C) 2002Og02,2004Ue03

2001As07,2002Og02,2002Og14,2004Ue03: Spin-polarized ^{17}C ions, produced by fragmentation of a 110 MeV/nucleon ^{22}Ne beam at RIKEN, were implanted in a cryogenically cooled Pt stopper that was in a static magnetic field. A β-NMR technique was used to determine the ground state *g*-factor, $g(^{17}C)=0.5054$ *25* A comparison with theoretical expectations indicates $J^{\pi}=3/2^{+}$ where $\nu(d_{5/2})^{3}$ and $\nu(d_{5/2})^{2}s_{1/2}$ share nearly equal strengths.

^{17}C Levels

E(level)	J^{π}	Comments
0	$(3/2^{+})$	g=0.5054 *25*

^{208}Pb(^{17}C,^{17}C) 2001Au04,2003Pr01

2001Au04,2002Pr10: The authors probed the dipole excitation strength function by measuring the Coulomb dissociation of ^{17}C into ^{16}C+n on a 1.8 g/cm^2 lead target using a ≈500 MeV/nucleon beam from the GSI/FRS. The Coulomb excitation energy spectrum was reconstructed from a measurements of the ^{16}C+n momenta. Neutrons were detected using the LAND array, ^{16}C ions were momentum analyzed using a dipole magnet, and events with γ rays were determined using the 160 element NaI 4π Crystal Ball array. A sizeable l=0 component to ^{16}C*(1.77 MeV:J$^\pi$=2$^+$) was observed, which implies J$^\pi$=(3/2,5/2)$^+$.

In (2001Pr09,2001Pr18,2002Da30,2003Pr01), the authors report further analysis of the γ-ray data where the cross sections feeding the $^{16}C_{g.s.}$ (9 mb *+15−9*), ^{16}C*(1.77 MeV:J$^\pi$=2$^+$) (62 mb *7*) and ^{16}C*(≈3-4 MeV:J$^\pi$=4$^+$) (25 mb *7*) are discussed. The results suggest a (64 *9*)% $^{17}C_{g.s.}$ configuration of ^{16}C(2$^+$)⊗$\nu_{s,d}$, with J$^\pi$=3/2$^+$ preferred.

See also theoretical analysis in (2004Ta31).

^{17}C Levels

E(level)	J$^\pi$
0	(3/2,5/2)$^+$

^{208}Pb(^{18}C,^{17}C) 2017He04

XUNDL set compiled by J. Kelley and C.G. Sheu Feb 2017.

The authors studied the Coulomb dissociation of ^{18}C to states in ^{17}C with the aim of gaining insight into the astrophysically important ^{17}C(n,γ) radiative neutron capture reaction.

A 425 MeV/nucleon beam of ^{18}C ions was produced at the GSI/FRS facility by fragmenting ^{40}Ar on a thick beryllium target. The beam impinged on a 2145 mg/cm^2 lead target that was at the center of the Crystal Ball γ-ray array. The momentum of the ^{17}C breakup particles was determined using beam tracking detectors ahead of the target position, magnetic analysis in the ALADiN dipole magnet and a set of position sensitive Si detectors after the magnet. The reaction neutrons were characterized using the position sensitive ToF wall and LAND neutron arrays. The final reaction kinematics were analyzed by considering the n+^{17}C kinematics along with the γ-rays associated with the kinematic groups. Finally, data on a 935 mg/cm^2 carbon target permitted an estimate of the nuclear contributions so the Coulomb component could be isolated.

Reactions consistent with Coulomb breakup to ^{17}C*(0,0.22,0.33 MeV) are observed. The cross sections are analyzed and compared with model calculations to obtain spectroscopic factors. Finally, discussion is given on the thermonuclear reaction rate and the impact on r-process network calculations.

^{17}C Levels

E(level)[†]	J^{π}[†]	S	Comments
0	3/2$^+$	1.18 *51*	σ=32 *13*(stat) *5*(sys) mb, S=1.18 *48*(stat) *19*(sys).
217	1/2$^+$	0.52 *13*	σ=40 *8*(stat) *5*(sys) mb, S=0.52 *11*(stat) *7*(sys).
331	5/2$^+$	1.74 *24*	σ=43 *6*(stat) *1*(sys) mb, S=1.74 *24*(stat) *4*(sys).

† From (2013Ue01).

^{208}Pb(^{18}O,^{17}C),^{207}Pb(^{18}O,^{17}C) 1979Ba31

1979Ba31: A beam of 93 MeV ^{18}O ions impinged on either a ^{208}Pb (98.2% enriched) or ^{207}Pb (92.4% enriched) carbon foil backed lead target with an areal density near 250 μg/cm^2. Reaction products were detected at θ=80° and θ=85° in the Chalk River QD^3 spectrometer focal plane. Energy resolutions were typically ΔE≈260 keV. The Q-value =−26.87 MeV *22* was deduced for the reaction on ^{207}Pb, which corresponds to ΔM(^{17}C)=21.10 MeV *22*.

^{17}C Levels

E(level)	Comments
0	ΔM(^{17}C)=21.10 MeV *22* was deduced.

U(p,^{17}C) 1968Po04

1968Po04: The first observation of ^{17}C is credited to (1968Po04) who identified the spallation products from proton bombardment of of a uranuim target. In their measurements, 5.5 GeV protons bombarded a 27 mg/cm^2 uranium target; the products were detected at θ= 45° utilizing a measurement of the time-of flight between detectors located 18 cm and 38 cm from the target and a ΔE-ΔE-E-VETO telescope. By combining the energy-loss, energy and time-of-flight measurements, ^{17}C was clearly identified in the spallation products. See also (2012Th01).

1986Pi09: Spallation products from 800 MeV proton bombardment of a uranium target at LAMPF were detected using a series of detectors that provided ΔE, E and time-of-flight information. The products were analyzed to obtain A and Z identification, and mass excesses were obtained for a few carbon, nitrogen, oxygen, florine and neon isotopes. ΔM=20.0 MeV *49* was obtained for ^{18}C.

^{17}C Levels

E(level)
0

^{232}Th(^{18}O,^{17}C) 1968Ar13

1968Ar13: The observation of ^{17}C was confirmed by analyzing the reaction products from 122 MeV ^{18}O bombardment of a 5 mg/cm^2 ^{232}Th target. The reaction products were momentum analyzed using a dipole magnet before being detected using position sensitive detectors and ΔE-E detectors located at the focal plane of the magnet.

^{17}C Levels

E(level)
0

^{232}Th(^{22}Ne,^{17}C) 1977Ar06

1977Ar06: The authors studied the systematics of Deep Inelastic Transfer reactions (DIT) by using 172 MeV ^{22}Ne ions impinging on a ^{232}Th target and analyzing the reaction dynamics of nuclides detected at θ=12°. The reaction products are momentum analyzed in a magnet and uniquely identified via ΔE-E techniques. Data from θ=40° are included in the analysis. The results, which included ^{17}C production, confirmed that DIT is the production mechanism for most light nuclides in this reaction at θ=12°. Also see (1973Ar08) E(^{22}Ne)=174 MeV and θ=40°.

^{17}C Levels

E(level)
0

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