Energy Levels of Light Nuclei
$A = 17$

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Abstract: An evaluation of $A = 16$–17 was published in *Nuclear Physics A*460 (1986), p. 1. This version of $A = 17$ differs from the published version in that we have corrected some errors discovered after the article went to press. Figures and introductory tables have been omitted from this manuscript. Reference key numbers have been changed to the NNDC/TUNL format.

(References closed June 01, 1986)

The original work of Fay Ajzenberg-Selove was supported by the US Department of Energy [DE-AC02-76-ER02785]. Later modification by the TUNL Data Evaluation group was supported by the US Department of Energy, Office of High Energy and Nuclear Physics, under: Contract No. DEFG05-88-ER40441 (North Carolina State University); Contract No. DEFG05-91-ER40619 (Duke University).

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^{17}He, ^{17}Li

(Not illustrated)

Not observed: see (1983ANZQ; theor.).

^{17}Be

(Not illustrated)

This nucleus has not been observed. Its atomic mass excess is calculated to be 70.67 MeV: see (1977AJ02). It is then unstable with respect to breakup into ^{16}Be + n and ^{15}Be + 2n by 3.38 and 3.35 MeV, respectively. See also (1983ANZQ; theor.).

^{17}B

(Not illustrated)

^{17}B has been observed in the 4.8 GeV proton bombardment of uranium: it is particle stable and its ground state J^π is probably $\frac{3}{2}^-$ (1974BO05). Its atomic mass excess is estimated by (1985WA02) to be 44.01 ± 0.70 MeV. It is then stable with respect to decay into ^{15}B + 2n by 1.10 MeV. E_{β^-}(max) for the decay to ^{17}C$_{\text{g.s.}}$ would then be 22.98 MeV. See also (1984MU27) and (1983ANZQ, 1985PO10; theor.).

^{17}C

(Fig. 9)

A Q-value measurement of the ^{48}Ca(^{18}O, ^{17}C)^{49}Ti reaction leads to an atomic mass excess of 21.039 ± 20 keV (1982FI10; E(^{18}O) $= 112$ MeV) for ^{17}C, using the (1985WA02) a.m.e. values for ^{18}O, ^{48}Ca and ^{49}Ti. See also (1982AJ01). ^{17}C is then stable with respect to ^{16}C + n by 0.73 MeV. E_{β^-}(max) to ^{17}N$_{\text{g.s.}}$ $= 13.17$ MeV. See also (1984KL06). The half-life of ^{17}C is 202 ± 17 msec (1986CU01). An excited state of ^{17}C is reported at $E_x = 292 \pm 20$ keV [see (1982AJ01)], 295 ± 10 keV (1982FI10). Three closely spaced low-lying states are expected [$J^\pi = \frac{5}{2}^+, \frac{3}{2}^+, \frac{1}{2}^+$] (1982CUZZ): it is not clear which is the assignment of the ground state. See also (1982AJ01), (1982OR1D, 1984HI1A) and (1983ANZQ, 1983FR1A, 1983WI1A, 1984AS1D; theor.).

^{17}N

(Figs. 6 and 9)

GENERAL: (See also (1982AJ01).)

Theoretical papers and reviews: (1983ANZQ, 1983AU1B, 1983EN04, 1983FR1A, 1983MA06, 1983WI1A, 1984AS1D, 1984BA24, 1985PO11, 1986HA1P).

Table 17.1: Energy levels of ^{17}N [a]

E_x in ^{17}N (MeV $\pm$ keV)	$J^\pi; T$	τ or Γ	Decay	Reactions
0	$\frac{1}{2}^-; \frac{3}{2}$	$\tau_{1/2} = 4.173 \pm 0.004$ sec	β^- [b]	1, 2, 3, 4, 5, 6, 7
1.3739 ± 0.3	$\frac{3}{2}^-$	$\tau_m = 93 \pm 35$ fsec	γ	2, 4, 5, 6, 7
1.8496 ± 0.3	$\frac{1}{2}^+$	41^{+20}_{-9} psec	γ	2, 4, 5, 6, 7
1.9068 ± 0.3	$\frac{5}{2}^-$	11 ± 2 psec	γ	2, 3, 4, 5, 6, 7
2.5260 ± 0.5	$\frac{5}{2}^+$	33 ± 3 psec	γ	2, 3, 4, 6, 7
3.1289 ± 0.5	$\frac{7}{2}^-$	275 ± 80 fsec	γ	2, 4, 6, 7
3.2042 ± 0.9	$\frac{3}{2}^-$	< 30 fsec	γ	2, 4, 6, 7
3.6287 ± 0.7	$(\frac{7}{2}, \frac{9}{2})^-$	12 ± 2 psec	γ	2, 3, 4
3.663 ± 4	$\frac{1}{2}^-$	< 350 fsec	γ	2, 4
3.9060 ± 2.0	$(\frac{3}{2}, \frac{5}{2})^-$	52 ± 22 fsec	γ	2, 4
4.0064 ± 2.0	$\frac{3}{2}^{(-)}$	< 15 fsec	γ	2, 3, 4, 6
4.209 ± 3	$\frac{5}{2}^+$	< 70 fsec	γ	2, 4
4.415 ± 3	$(\frac{3}{2}, \frac{5}{2})^-$	$(< 60$ fsec)	γ	2, 4
5.170 ± 2	$(\frac{9}{2}^+)$	< 60 fsec	γ	2, 3, 4, 6
5.195 ± 3	$(\frac{1}{2}, \frac{3}{2})^+$	< 95 fsec	γ	2, 4
5.515 ± 3	$\frac{3}{2}^-$	< 100 fsec	γ	2, 4, 6
5.772 ± 3	$\leq \frac{7}{2}$	< 120 fsec	γ	2, 4
(6.08 ± 30)				2
6.233 ± 8				2, 4
6.449 ± 3				2, 4
6.615 ± 19				2, 4
6.938 ± 15				4
6.981 ± 20	$(\frac{3}{2})^-$			2, 4, 6
7.013 ± 22				2, 4, 6
7.17 ± 40				2
7.37 ± 40				2
7.63 ± 40				2
7.73 ± 40				2
8.00 ± 25				2
8.14 ± 40				2

Table 17.1: Energy levels of ^{17}N [a] (continued)

E_x in ^{17}N (MeV $\pm$ keV)	$J^\pi; T$	τ or Γ	Decay	Reactions
8.55 ± 40		broad		2
8.93 ± 40		broad		2
9.26 ± 40		broad		2
9.74 ± 40		broad		2
10.14	$(\frac{1}{2}, \frac{3}{2})^-$			6

[a] See also (1984BA24) and Table 17.2.
[b] See also Tables 17.2 and 17.3.

Experimental papers: (1981ME13, 1981OL1C, 1983OL1A, 1983PL1A, 1984GR08, 1984HI1A, 1985BE40, 1985FL1D).

1. (a) ^{17}N(β^-)^{17}O* $\rightarrow$ ^{16}O + n $\qquad Q_m = 4.557$
   (b) ^{17}N(β^-)^{17}O $\qquad Q_m = 8.680$

The half-life of ^{17}N is 4.173 ± 0.004 sec. The decay is principally [see Table 17.3] to the neutron unbound states ^{17}O*(4.55, 5.38, 5.94) [$J^\pi = \frac{3}{2}^-, \frac{3}{2}^-, \frac{1}{2}^-$]. The nature of the decay is in agreement with $J^\pi = \frac{1}{2}^-$ for ^{17}N$_{g.s.}$: see (1982AJ01). For a comparison of the ^{17}N and ^{17}Ne decays see Table 17.4. For GT transition rates see (1983SN03) and (1983RA29). See also (1977FR19).

2. ^{11}B(^{7}Li, p)^{17}N $\qquad Q_m = 8.415$

Observed proton groups and γ-rays are displayed in Table 17.5. Table 17.2 shows branching ratio and lifetime measurements.

3. ^{14}C(^{6}Li, ^{3}He)^{17}N $\qquad Q_m = -5.697$

At $E(^6\text{Li}) = 34$ MeV angular distributions have been studied to ^{17}N*(1.91, 2.53, 3.63, 4.10, 5.17) and the results compared with those for the analog reaction to ^{17}O (reaction 16) (1983CU04).

Table 17.2: Radiative transitions and lifetimes of ^{17}N states [a]

E_i (MeV)	E_f (MeV)	Mult.	Branch (%)	Γ_γ/Γ_W [b] (W.u.)	τ_m
1.37	0	M1	100	0.13 ± 0.05	93 ± 35 fsec
1.85	0	E1	86.5 ± 2.5		41^{+20}_{-9} psec
	1.37	E1	13.5 ± 2.5	$(3.2 \pm 1.5) \times 10^{-5}$	
1.91	0	E2	77.0 ± 2.5	0.9 ± 0.2	11 ± 2 psec
	1.37	M1	23.0 ± 2.5	$(5 \pm 1) \times 10^{-3}$ [c]	
2.53	0	M2	11 ± 1	0.22 ± 0.04	33 ± 3 psec
	1.37	E1	34 ± 3	$(1.0 \pm 0.2) \times 10^{-5}$	
	1.85	E2	12.0 ± 1.5	8.1 ± 1.6	
	1.91	E1	41.0 ± 2.5		
3.13 [d]	1.91	M1	100	0.06 ± 0.02	275 ± 80 fsec
3.20 [e]	0	M1	88 ± 4	> 0.025 [f]	< 30 fsec
	1.91	M1	12 ± 4	> 0.05	
3.63 [g]	1.91	E2	47 ± 10	0.8 ± 0.2	12 ± 2 psec
	3.13	M1	53 ± 10	0.010 ± 0.03	
3.66	1.85	E1	100	$> 7 \times 10^{-4}$	< 350 fsec
3.91	1.91	M1	100	$(8^{+5}_{-3}) \times 10^{-2}$ [h]	52 ± 22 fsec
4.01	1.85		$\leq 15 \pm 5$ [i]		
	2.53	(M1)	85 ± 5	0.55	< 15 fsec
4.21	1.37		100		< 70 fsec
4.42	1.91		100		$(< 60$ fsec$)$
5.17	2.53	E2	37 ± 7	> 15	< 60 fsec
	3.13		63 ± 7		
5.20	1.85		≈ 42		< 95 fsec
	1.91		≈ 58		
5.52	0		≈ 50		< 100 fsec
	1.37		≈ 50		
5.77	1.37		≈ 25		< 120 fsec
	1.91		≈ 25		
	4.01		≈ 50 [i]		

[a] See Tables 17.5 in (1977AJ02, 1982AJ01) for references and additional detail.
[b] Assuming pure multipole transitions and J^π from Table 17.1: see also Table 2 in the Introduction here.
[c] $\Gamma_\gamma/\Gamma_W = 0.4^{-0.4}_{+1.3}$ (E2).
[d] Branches to ^{17}N*(0, 1.37, 18.5, 2.53) are, respectively, < 2, < 5, < 2 and < 3%.
[e] Branches to ^{17}N*(1.37, 1.85, 2.53) are, respectively, < 5, < 6 and < 3%.
[f] $\delta = -0.06 \pm 0.08$ or 2.1 ± 0.4. All other δ are consistent with 0.
[g] Branches to ^{17}N*(0, 1.37, 18.5, 2.53, 3.20) are, respectively, < 10, < 10, < 7, < 3 and < 2%.
[h] This number appears to be in error: see Table 2 in the Introduction here.
[i] This branch is uncertain.

Table 17.3: Beta decay of ^{17}N [a]

Decay to ^{17}O* (keV)	J^π	Branch (%)	Log ft
0	$\frac{5}{2}^+$	1.6 ± 0.5	7.29 ± 0.11 [f]
871	$\frac{1}{2}^+$	3.0 ± 0.5	6.80 ± 0.07
3055.2 ± 0.3 [b]	$\frac{1}{2}^-$	0.34 ± 0.06	7.08 ± 0.08
3841	$\frac{5}{2}^-$	$< 7 \times 10^{-3}$	> 8.5
4551.2 ± 1.3 [c]	$\frac{3}{2}^-$	38.0 ± 1.3 [e]	4.41 ± 0.02
5083 ± 21 [c]	$\frac{3}{2}^+$	0.6 ± 0.4	5.9 ± 0.5
5389.0 ± 1.2 [c,d]	$\frac{3}{2}^-$	50.1 ± 1.3 [e]	3.86 ± 0.02
5738	$(\frac{1}{2}^+)$	< 0.23	> 6.0
5868	$\frac{3}{2}^+$	< 0.15	> 6.0
5951.8 ± 1.9 [c,d]	$\frac{1}{2}^-$	6.9 ± 0.5 [e]	4.35 ± 0.03
6356	$\frac{1}{2}^+$	< 0.08	> 6.0

[a] See Table 17.2 in (1982AJ01) for references and additional information.
[b] Direct ground state decay < 1.5%.
[c] From neutron groups. [The E_x were calculated on the basis of 4144.3 ± 0.8 keV for E_b for a neutron in ^{17}O.] Γ_n for ^{17}O*(4.55, 5.08, 5.38, 5.94) are, respectively, 54.8 ± 0.4, 113 ± 55, 63.2 ± 1.1 and 60.5 ± 3.2 keV. See also Table 17.12.
[d] See, however, Tables 17.12 and 17.7.
[e] Calculated to lead to a total neutron emission probability of (95 ± 1)% [100% less the branches to ^{17}O*(0, 0.87, 3.06)].
[f] $\log f_1 t = 9.56 \pm 0.13$ (1971TO08).

4. ^{15}N(t, p)^{17}N $Q_{\rm m} = -0.109$

Observed proton groups are displayed in Table 17.6.

5. ^{18}O(γ, p)^{17}N $Q_{\rm m} = -15.942$

The giant resonance at $E_{\rm x} = 23.5$ MeV decays to ^{17}N$_{\rm g.s.}$ and to the first excited states of ^{17}N (1982BA03). See also ^{18}O in (1983AJ01).

6. ^{18}O(d, ^{3}He)^{17}N $Q_{\rm m} = -10.449$

Observed groups of ^{3}He ions are displayed in Table 17.5. See also (1982AJ01) and ^{20}F in (1983AJ01).

7. ^{18}O(t, α)^{17}N $Q_{\rm m} = 3.872$

See Tables 17.2 and 17.5.

Table 17.4: Comparison of ^{17}N and ^{17}Ne β-decay [a]

Final state in ^{17}O	Final state in ^{17}F	J^π	$\Gamma_{\rm n}$ [b,c] (keV)	$\Gamma_{\rm p}$ [b] (keV)	$(ft)^-$ [d,e]	$(ft)^+$ [d]	δ [f]
3.06	3.10	$\frac{1}{2}^-$	0	19	$(1.2 \pm 0.2) \times 10^7$	$(2.78 \pm 0.40) \times 10^6$	-0.77 ± 0.08
4.55	4.70	$\frac{3}{2}^-$	55	230	$(2.57 \pm 0.13) \times 10^4$	$(3.92 \pm 0.18) \times 10^4$	0.53 ± 0.11
5.38	5.52	$\frac{3}{2}^-$	63	69	$(7.2 \pm 0.3) \times 10^3$	$(7.22 \pm 0.15) \times 10^3$	0.00 ± 0.04
5.94	6.04	$\frac{1}{2}^-$	61	28	$(2.24 \pm 0.16) \times 10^4$	$(2.61 \pm 0.07) \times 10^4$	0.17 ± 0.09

[a] See Table 17.3 in (1982AJ01) for references.
[b] $\Gamma_{\rm n}$ and $\Gamma_{\rm p}$ are the neutron and proton widths of the ^{17}O and ^{17}F states, respectively.
[c] $\Gamma_{\rm n}$ for ^{17}O*(4.55, 5.08, 5.38, 5.94) are reported to be, respectively, 54.8 ± 0.4, 113 ± 55, 63.2 ± 1.1 and 60.5 ± 3.2 keV.
[d] $(ft)^-$ and $(ft)^+$ are for the ^{17}N and ^{17}Ne decays, respectively.
[e] See Table 17.3.
[f] $\delta \equiv [(ft)^+/(ft)^-] - 1$.

Table 17.5: Excited states of ^{17}N from ^{11}B(^{7}Li, p), ^{18}O(d, ^{3}He) and ^{18}O(t, α) [a]

E_x (keV)		l	J^π	C^2S
A	B			
	0	1	$\frac{1}{2}$	2.02
1373.7 ± 0.5	1374.1 ± 0.4	1	$\frac{3}{2}^-$	0.38
1850.0 ± 0.5	1849.5 ± 0.3	0	$\frac{1}{2}^+$	0.41 ± 0.14
1906.8 ± 0.4	1906.9 ± 0.5		$\frac{5}{2}^-$	
2526.3 ± 1.0	2525.9 ± 0.6	2	$\frac{5}{2}^+$	0.53 ± 0.17
3128.7 ± 0.6	3129.2 ± 0.6		$\frac{7}{2}^{(-)}$	
3203 ± 2	3204.4 ± 0.9	1	$\frac{3}{2}^-$	0.05
3628.7 ± 0.7			$> \frac{3}{2}$ [d]	
3663 ± 4			$(\frac{1}{2}, \frac{3}{2})^-$	
3906.0 ± 2.0			$\leq \frac{7}{2}$	
4006.4 ± 2.0	4000	(1)	$\frac{3}{2}^{(-)}$	0.04
4208 ± 3			$\leq \frac{5}{2}$	
4415 ± 3			$\leq \frac{7}{2}$	
5170 ± 2	5170	(2)	$\frac{3}{2} \leq J \leq \frac{9}{2}$ [e]	0.08
5195 ± 3			$(\frac{1}{2}, \frac{3}{2}, \frac{5}{2})^+$	
5514 ± 3	$\equiv 5523$	1	$\frac{3}{2}^-$	1.83
5770 ± 3			$\leq \frac{7}{2}$	
6080 ± 30				
6240 ± 25				
6430 ± 30				
6610 ± 25				
6990 ± 20	6990 [c]	1	$(\frac{3}{2})^-$	0.32
7170 ± 40				
7370 ± 40				
	7510	(1)	$(\frac{1}{2}, \frac{3}{2})^-$	0.09
7630 ± 40				
7730 ± 40				
8000 ± 25				
8140 ± 40				
8550 ± 40 [b]				
8930 ± 40				
9260 ± 40				

Table 17.5: Excited states of ^{17}N from ^{11}B(^{7}Li, p), ^{18}O(d, ^{3}He) and ^{18}O(t, α) [a] (continued)

E_x (keV)		l	J^π	C^2S
A	B			
9740 ± 40				
	10140	(1)	$(\frac{1}{2}, \frac{3}{2})^-$	0.5

A: ^{11}B(^{7}Li, p)^{17}N.

B: ^{18}O(t, α)^{17}N and ^{18}O(d, ^{3}He)^{17}N.

[a] See also Tables 17.4 in (1977AJ02, 1982AJ01) for references and additional information.

[b] This state and the ones below are broad.

[c] Unresolved.

[d] Probably $(\frac{7}{2}, \frac{9}{2})^-$.

[e] Probably $(\frac{7}{2}, \frac{9}{2})^+$.

Table 17.6: States of ^{17}N from ^{15}N(t, p) [a]

E_x (keV)	L	J^π	E_x (keV)	L	J^π
0 [b]	0	$\frac{1}{2}^-$	4420 ± 7 [b]	2	$(\frac{3}{2}, \frac{5}{2})^-$
1372 ± 6 [b]	2	$(\frac{3}{2}, \frac{5}{2})^-$	5179 ± 4 [c] }	5	$(\frac{9}{2}^+)$
1851 ± 4	1	$(\frac{1}{2}, \frac{3}{2})^+$		1	$((\frac{1}{2}, \frac{3}{2})^+)$
1909 ± 3 [b]	2	$(\frac{3}{2}, \frac{5}{2})^-$	5517 ± 6	(2)	
2524 ± 4	3	$(\frac{5}{2}, \frac{7}{2})^+$	5780 ± 6	(1)	
3127 ± 6 [b]	4	$(\frac{7}{2}, \frac{9}{2})^-$	6233 ± 8 [d]	(2)	
3201 ± 5 [b]	2	$(\frac{3}{2}, \frac{5}{2})^-$	6449 ± 3	(4, 5)	
3625 ± 6 [b]	4	$(\frac{7}{2}, \frac{9}{2})^-$	6627 ± 30	weak	
3664 ± 6 [b]	0	$\frac{1}{2}^-$	6938 ± 15		
3906 ± 5 [b]	2	$(\frac{3}{2}, \frac{5}{2})^-$	6981 ± 20	(3, 4)	
4011 ± 6	(1)		7013 ± 22		
4213 ± 6	3	$\frac{5}{2}^+$ [e]			

[a] (1979FO14): $E_t = 15.0$ MeV; DWBA analysis.

[b] Predominantly 2p-1h states.

[c] Unresolved states.

[d] ^{17}N*(6.08) is not observed.

[e] The $\frac{7}{2}^+$ possibility can be eliminated because the $4.21 \rightarrow 1.37$ MeV transition would then have too large an M2 strength (> 500 W.u.) [P.M. Endt, private communication].

^{17}O

(Figs. 7 and 9)

GENERAL: (See also (1982AJ01).)

Shell model: (1978WI1B, 1982BA53, 1982KU1B, 1982WA1Q, 1982YA1D, 1982ZH01, 1984ZI04).

Collective and cluster models: (1983JA09, 1983ME18, 1984ZI04, 1985ME06).

Special states: (1978WI1B, 1981WI1K, 1982BA53, 1982HA43, 1982ZA1D, 1983AU1B, 1983LI10, 1983ME18, 1983SH15, 1984ANZV, 1984ST1E, 1984WI17, 1985AR1H, 1985ME06, 1985SH24).

Electromagnetic transitions and giant resonances: (1982AW02, 1982BA53, 1982BR24, 1982KU14, 1983TO08, 1984SAZW, 1985AL21, 1985BL20).

Astrophysical questions: (1981PE1F, 1981WA1Q, 1981WE1F, 1982BU1A, 1982CA1A, 1982RO1A, 1982WI1B, 1982WO1A, 1983AL1M, 1984HA1R, 1984HA1Z, 1985HA1Z, 1985HA1R, 1986DO1L).

Applications: (1983KU1C).

Complex reactions involving ^{17}O: (1981OL1C, 1983CH23, 1983DE26, 1983FR1A, 1983JA05, 1983LA1E, 1983LI10, 1983OL1A, 1983SA06, 1983WI1A, 1984GR08, 1984HI1A, 1984HO23, 1985AR1H, 1985GAZT, 1985MO08, 1985PO11, 1985WA22, 1986FE03, 1986MA19).

Pion capture and reactions (See also reactions 31 and 38.): (1982BI08).

Hypernuclei: (1981BA2Q, 1982BA2P, 1982KA1D, 1983CH1T, 1983DO1B, 1983KO1V, 1983SH1E, 1984AS1D, 1984CH1G, 1984DA03, 1985BA2N, 1985BA1F, 1985YA1K, 1985YA1B, 1985YA1C, 1986SH1K).

Antiproton interactions: (1984PO1A, 1985DU05, 1985LE1B).

Other topics: (1978WI1B, 1981PL03, 1981SH17, 1982AW02, 1982CA12, 1982HA43, 1982LA02, 1982ZA1D, 1983AR1J, 1983KH1D, 1983MA38, 1983MA35, 1983SH1T, 1983SH15, 1983TO08, 1984CL06, 1984WI17, 1985AL21, 1985AN28, 1985SH24, 1986WI03).

Ground state of ^{17}O: (1978WI1B, 1982CA12, 1982HA43, 1982LA02, 1982LO13, 1982ZA1D, 1983AD1B, 1983ANZQ, 1983AR1J, 1983AU1B, 1983BU07, 1983DE1X, 1983MA38, 1983TO08, 1983ZI1C, 1984ANZW, 1984AR1D, 1984BE11, 1984BL03, 1984FR13, 1984ST1E, 1984WE04, 1984ZI04, 1985AN28, 1985AR11, 1985BL20, 1985HA18, 1985NA1A, 1985ZI05, 1986WI03).

$$\mu = -1.89379\ (9)\ \text{nm [see (1978LEZA)].}$$

$$Q = -25.78\ \text{mb [see (1978LEZA)].}$$

Isotopic abundance $= (0.038 \pm 0.003)$% (1984DE53).

Table 17.7: Energy levels of ^{17}O

E_x in ^{17}O (MeV $\pm$ keV)	$J^\pi; T$	τ_m or $\Gamma_{c.m.}$ (keV)	Decay	Reactions
0	$\frac{5}{2}^+; \frac{1}{2}$		stable	1, 2, 5, 6, 7, 10, 11, 13, 14, 16, 17, 18, 19, 23, 24, 25, 26, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54
0.87081 ± 0.12	$\frac{1}{2}^+$	$\tau_m = 258.6 \pm 2.6$ psec	γ	1, 2, 5, 6, 7, 8, 10, 11, 13, 14, 16, 17, 18, 19, 23, 24, 25, 26, 31, 32, 33, 34, 35, 37, 39, 40, 42, 44, 47, 48, 49, 51, 52, 53
3.05536 ± 0.16	$\frac{1}{2}^-$	$\tau_m = 120^{+80}_{-60}$ fsec	γ	5, 6, 7, 10, 11, 16, 18, 19, 23, 25, 26, 31, 32, 33, 34, 35, 37, 39, 47, 48, 52
3.841 ± 3	$\frac{5}{2}^-$	$\tau_m \leq 25$ fsec	γ	5, 6, 7, 10, 11, 12, 16, 18, 19, 23, 24, 32, 33, 37, 38, 47, 48, 52
4.552 ± 2	$\frac{3}{2}^-$	$\Gamma = 40 \pm 5$	γ, n	5, 7, 10, 11, 16, 18, 19, 23, 24, 27, 32, 33, 35, 36, 37, 38, 47, 48, 52
5.085 ± 2	$\frac{3}{2}^+$	96 ± 5	γ, n	2, 6, 7, 10, 11, 18, 19, 23, 27, 32, 35, 36, 37, 47, 48
5.218	$(\frac{9}{2}^-)$	< 0.1	γ, n	6, 7, 10, 11, 12, 18, 19, 23, 24, 25, 27, 32, 37, 38, 47, 52
5.378 ± 2	$\frac{3}{2}^-$	28 ± 7	γ, n	7, 18, 19, 23, 27, 32, 33, 35, 36, 37, 47, 48, 52

Table 17.7: Energy levels of ^{17}O (continued)

E_x in ^{17}O (MeV ± keV)	$J^\pi; T$	τ_m or $\Gamma_{c.m.}$ (keV)	Decay	Reactions
5.697 ± 2	$\frac{7}{2}^-$	3.4 ± 0.3	γ, n	2, 6, 10, 11, 16, 18, 19, 23, 24, 27, 32, 36, 37, 38, 48
5.733 ± 2		< 1	n	2, 5, 6, 10, 11, 16, 18, 19, 27, 32, 52
5.868 ± 2	$\frac{3}{2}^+$	6.6 ± 0.7	n	6, 7, 10, 11, 18, 19, 23, 27, 32, 52
5.939 ± 4	$\frac{1}{2}^-$	32 ± 3	γ, n	5, 6, 10, 11, 18, 19, 23, 27, 32, 35, 37, 48, 52
6.356 ± 8	$\frac{1}{2}^+$	124 ± 12	γ, n	5, 7, 16, 18, 23, 27, 36, 37
6.862 ± 2		< 1	γ, n	5, 6, 7, 10, 11, 18, 19, 23, 27, 32, 37, 48, 52
6.972 ± 2		< 1	γ, n	6, 7, 10, 11, 18, 19, 23, 27, 37, 52
7.1657 ± 0.8	$\frac{5}{2}^-$	1.38 ± 0.05	n, α	5, 6, 7, 9, 10, 11, 18, 23, 27, 30
7.202 ± 10	$\frac{3}{2}^+$	280 ± 30	n, α	10, 11, 18, 27, 30
7.3792 ± 1.0	$\frac{5}{2}^+$	0.64 ± 0.23	γ, n, α	5, 6, 7, 9, 10, 11, 23, 24, 27, 30, 37, 48, 52
7.3822 ± 1.0	$\frac{5}{2}^-$	0.96 ± 0.20	γ, n, α	5, 7, 9, 10, 11, 18, 24, 27, 30, 36, 37, 48, 52
7.559 ± 20	$\frac{3}{2}^-$	500 ± 50	n, α	27, 30, 32
7.576 ± 2	$(\frac{7}{2}^-)$	< 0.1	γ, n, α	5, 6, 9, 10, 11, 18, 23, 27, 37
7.6882 ± 0.9	$\frac{7}{2}^-$	14.4 ± 0.3	γ, n, α	5, 6, 9, 10, 11, 23, 27, 30, 36
7.757 ± 9	$\frac{11}{2}^-$		γ	16, 23, 24, 25, 37, 38
7.956 ± 6	$\frac{1}{2}^+$	90 ± 9	n, α	9, 23, 27, 30

Table 17.7: Energy levels of ^{17}O (continued)

E_x in ^{17}O (MeV ± keV)	$J^\pi; T$	τ_m or $\Gamma_{c.m.}$ (keV)	Decay	Reactions
7.99 ± 50	$\frac{1}{2}^-$	270 ± 30	n, α	27, 30
8.070 ± 10	$\frac{3}{2}^+$	85 ± 9	n, α	9, 23, 27, 30
8.200 ± 7	$\frac{3}{2}^-$	60	γ, n, α	9, 16, 23, 27, 30, 36, 48
8.3424 ± 0.9	$\frac{1}{2}^+$	11.4 ± 0.5	γ, n, α	9, 23, 27, 30, 37
8.4023 ± 0.8	$\frac{5}{2}^+$	6.17 ± 0.13	γ, n, α	6, 9, 10, 11, 23, 27, 30, 37
8.4660 ± 0.8	$\frac{7}{2}^+$	2.13 ± 0.11	(γ), n, α	5, 6, 9, 10, 11, 23, 27, 30, 37, 48
8.5007 ± 0.8	$\frac{5}{2}^-$	6.89 ± 0.22	γ, n, α	6, 9, 10, 11, 23, 27, 30, 36, 37
8.6870 ± 1.0	$\frac{3}{2}^-$	55.3 ± 0.6	γ, n, α	9, 23, 27, 30, 36, 48
8.885 ± 14 [b]	$\frac{7}{2}^-, \frac{9}{2}^-$	6	γ	37
8.897 ± 8	$\frac{3}{2}^+$	101 ± 3	n, α	6, 9, 10, 11, 23, 24, 27, 30, 37
8.9672 ± 1.7	$\frac{7}{2}^-$	26 ± 2	γ, n, α	6, 9, 10, 11, 23, 27, 30, 36, 37
9.147 ± 4	$\frac{1}{2}^-$	4 ± 3	γ, n, α	6, 8, 9, 10, 11, 48
9.15 ± 20	$\frac{9}{2}^-$		γ	23, 24, 25, 37
9.18	$\frac{7}{2}^-$	3	α	9, 10, 11
9.1939 ± 0.8	$\frac{5}{2}^+$	3.53 ± 0.13	n, α	9, 10, 11, 27
9.42	$\frac{3}{2}^-$	120	n	27
9.492 ± 4	$\frac{5}{2}^-$	15 ± 1	n, α	5, 9, 11, 23, 27, 48
9.7119 ± 0.9	$\frac{7}{2}^+$	23.1 ± 0.3	n, α	9, 11, 16, 23, 27
9.7833 ± 0.9	$\frac{3}{2}^+$	11.7 ± 0.3	n, α	9, 11, 27
9.8589 ± 0.9	$(\frac{5}{2}^-)$	4.01 ± 0.23	n, α	9, 11, 23, 27
9.8765 ± 1.3	$(\frac{1}{2}^-)$	16.7 ± 1.7	n, α	9, 11, 23, 27
9.976 ± 20	$\frac{5}{2}^+$	≈ 80	n, α	9
10.045 ± 20		≈ 100	n, α	9
10.1678 ± 1.0	$\frac{7}{2}^-$	49.1 ± 0.8	n, α	9, 27

Table 17.7: Energy levels of ^{17}O (continued)

E_x in ^{17}O (MeV ± keV)	$J^\pi; T$	τ_m or $\Gamma_{c.m.}$ (keV)	Decay	Reactions
10.336 ± 15	$\frac{5}{2}^+, \frac{7}{2}^-$	150	n, α	9, 23
10.423 ± 3		14 ± 3	n, α	9, 16
10.49	$\frac{5}{2}^+, \frac{7}{2}^-$	75 ± 30	n, α	9
10.5591 ± 1.0	$(\frac{7}{2}^-)$	42.5 ± 1.1	n, α	9, 12, 23, 27, 28
10.777 ± 3	$\frac{1}{2}^+, \frac{7}{2}^-$	74 ± 3	n, α	9, 11, 19, 23, 28
10.9129 ± 2.8	$(\frac{5}{2}^+)$	41.7 ± 1.4	n, α	9, 23, 27, 28
11.036 ± 3	$T = \frac{1}{2}$	31 ± 3	n, α	9, 23
11.0787 ± 0.9 [a]	$\frac{1}{2}^-; \frac{3}{2}$	2.4 ± 0.3	γ, n, α	8, 9, 23, 27, 37, 48, 49
11.238		80 ± 3	n, α	5, 9, 16
11.51	$\geq \frac{3}{2}$	190	n	27, 28
11.622		65 ± 2	n, α	9
11.750 ± 10		40 ± 25	γ, n, α	9, 37
11.815 ± 15		12 ± 3	n, α	9, 16
12.005 ± 15	$\geq \frac{3}{2}$	270	γ, n, α	9, 16, 19, 27, 28, 37
12.11 ± 20		150 ± 50	n, α	9, 12, 28
12.22 ± 20		≤ 20	γ	37
12.274 ± 15		100 ± 30	n, α	9, 16
12.38 ± 20			n, α	9, 27
12.420 ± 15			n, α	9
12.4660 ± 1.0	$\frac{3}{2}^-; \frac{3}{2}$	6.9 ± 1.1	γ, n, α	9, 27, 28, 37, 48, 49
12.595 ± 15		75 ± 30	n, α	9
12.669 ± 15		≈ 5	γ, n, α	9, 27, 28, 37
12.81 ± 25			n, α	9
12.93 ± 20		≥ 150	n, α	9
12.944 ± 5	$\frac{1}{2}^+; \frac{3}{2}$	6 ± 2	n, α	9, 27, 28, 48, 49
12.9982 ± 1.0	$\frac{5}{2}^-; \frac{3}{2}$	2.5 ± 1.0	γ, n, α	9, 27, 37, 49
13.076 ± 15		16 ± 4	n, α	9
13.484 ± 15		≈ 120	n, α	9

Table 17.7: Energy levels of ^{17}O (continued)

E_x in ^{17}O (MeV $\pm$ keV)	$J^\pi; T$	τ_m or $\Gamma_{c.m.}$ (keV)	Decay	Reactions
13.58 ± 20	$(\frac{11}{2}^-, \frac{13}{2}^-)$		(γ)	10, 11, 37
13.609 ± 15		250 ± 100	n, α	9
13.6353 ± 2.5	$(\frac{5}{2})^+; \frac{3}{2}$	9 ± 5	n, α	27, 48, 49
(13.67)		400	n	27
14.15 ± 100	$(\frac{9}{2}^+, \frac{11}{2}^+)$	≈ 100		10
14.2303 ± 1.7	$(\frac{7}{2})^-; \frac{3}{2}$	20.5 ± 1.6	γ, n, α	27, 37, 49
14.286 ± 3	$T = \frac{3}{2}$	7.5 ± 4	n, α	27, 29
14.451 ± 3		40 ± 6	n, α	27
14.76 ± 100	$(\geq \frac{3}{2})$	340	γ, n	27, 37
14.791 ± 3	$(\frac{1}{2}^-, \frac{3}{2})$	36 ± 13	(γ), n, α	27, 37
15.00		180	n, d, α	22, 27
15.1 ± 100	$(\frac{9}{2}^+, \frac{11}{2}^+)$	≈ 500		10
15.199 ± 3	$(\frac{3}{2}; \frac{3}{2})$	52 ± 14	γ, n, d, α	16, 22, 27, 37
15.368 ± 3	$(\frac{5}{2}^+; \frac{3}{2})$	40 ± 6	n, d, α	21, 27
(15.6)		≈ 300	p, d, α	20, 21, 22
15.78 ± 20	$(\frac{9}{2}^-); \frac{3}{2}$	≤ 30	γ	37
15.95 ± 150	$(\frac{9}{2}^+, \frac{11}{2}^+)$	≈ 700		10
16.243 ± 4	$(\frac{9}{2}^+; \frac{3}{2})$	21 ± 10	n, p, d, α	20, 27
16.58 ± 10	$(\frac{1}{2}, \frac{3}{2})^-; \frac{3}{2}$	≈ 300	γ	37, 48
16.6 ± 150	$(\frac{11}{2}^-, \frac{13}{2}^-)$			10
17.06 ± 20	$(\frac{7}{2})^-; \frac{3}{2}$	≤ 20	γ	10, 37, 38
17.436 ± 11	$(T = \frac{3}{2})$	66 ± 20	n, α	27
17.92 ± 20		98 ± 16	γ	37
18.110 ± 4	$\frac{3}{2}^-; \frac{3}{2}$	46 ± 12	n, α	27, 48
18.72 ± 20		87 ± 33		37
19.6 ± 150	$(\frac{13}{2}^+, \frac{15}{2}^+)$	≈ 250		10
19.82 ± 40	$\frac{3}{2}$	550 ± 50	γ, t	17, 37
20.14 ± 20	$(\frac{13}{2})^-; \frac{1}{2}$	31 ± 5	γ	37
20.2 ± 150	$(\frac{13}{2}^+, \frac{15}{2}^+)$	≈ 250		10
20.39 ± 50	$\frac{5}{2}, \frac{7}{2}^-$	660 ± 70	γ, t	17

Table 17.7: Energy levels of ^{17}O (continued)

E_x in ^{17}O (MeV ± keV)	$J^\pi; T$	τ_m or $\Gamma_{c.m.}$ (keV)	Decay	Reactions
20.58 ± 50	$\frac{1}{2}$	570 ± 80	γ, t	17
20.70 ± 20	$(\frac{11}{2})^-; \frac{3}{2}$	≤ 20	γ	37
21.05 ± 50	$\frac{3}{2}$	470 ± 60	γ, t	17
21.2	$(\frac{13}{2}^+, \frac{15}{2}^+)$			10
21.7 ± 100	$\frac{5}{2}^+$	≈ 750	γ, ^{3}He, α	14, 15
22.1 ± 100	$\frac{7}{2}^-$	≈ 750	γ, n, ^{3}He, α	10, 14, 15
22.5 ± 200	$\frac{3}{2}^{(-)}$	≈ 1000	γ, ^{3}He	14
23		≈ 6000	γ, n	36, 37
23.0	$\frac{1}{2}^+$	≈ 400	γ, ^{3}He	14, 15
23.5			γ, ^{3}He	14
24.4			γ, ^{3}He	14

[a] See also Tables 17.11 and 17.14, and see Table 17.6 in (1977AJ02).
[b] See also (1971AJ02).

For Coulomb excitation of ^{17}O*(0.87) see (1982KU14).

1. ^{7}Li(^{14}N, α)^{17}O $\quad Q_m = 16.155$

See (1977AJ02).

2. ^{9}Be(^{16}O, ^{8}Be)^{17}O $\quad Q_m = 2.4782$

See (1982AJ01).

3. (a) ^{10}B(^{7}Li, p)^{16}N $\quad Q_m = 13.986$ $\quad E_b = 27.767$
   (b) ^{10}B(^{7}Li, d)^{15}N $\quad Q_m = 13.720$
   (c) ^{10}B(^{7}Li, t)^{14}N $\quad Q_m = 9.144$
   (d) ^{10}B(^{7}Li, α)^{13}C $\quad Q_m = 21.4076$

See (1977AJ02).

4. (a) ^{11}B(^{6}Li, p)^{16}N $Q_m = 9.782$ $E_b = 23.563$
(b) ^{11}B(^{6}Li, d)^{15}N $Q_m = 9.5163$
(c) ^{11}B(^{6}Li, t)^{14}N $Q_m = 4.9403$
(d) ^{11}B(^{6}Li, α)^{13}C $Q_m = 17.2037$

See (1977AJ02).

5. ^{12}C(^{6}Li, p)^{17}O $Q_m = 7.606$

See (1982AJ01) and (1985SMZZ).

6. ^{12}C(^{7}Li, d)^{17}O $Q_m = 2.580$

See Table 17.7 in (1977AJ02) and ^{19}F in (1983AJ01).

7. ^{12}C(^{9}Be, α)^{17}O $Q_m = 9.7321$

Angular distributions have been reported at $E(^9\text{Be}) = 16.1$ to 20 MeV [see (1982AJ01)] and at $E(^9\text{Be}) = 12.0$ to 27.0 MeV (1981JA09; α_0, α_2). For excitation functions see (1982AJ01) and (1982HU06, 1983JA09). See also (1983VO1A).

8. ^{13}C(α, γ)^{17}O $Q_m = 6.3592$

At $E_\alpha = 3.65$ and 6.17 MeV [^{17}O*(9.15, 11.08)] $\Gamma_\alpha\Gamma_{\gamma_1}/\Gamma = 0.65 \pm 0.07$ and 1.46 ± 0.13 eV, respectively. Assuming $\Gamma_\alpha/\Gamma = 0.45$ for the lower resonance, Γ_{γ_1} for the E1 transition from ^{17}O*(9.15) [$J^\pi = \frac{1}{2}^-$] to ^{17}O*(0.87) [$\frac{1}{2}^+$] is 1.44 ± 0.26 eV. The parameters of ^{17}O*(11.08) are discussed in Table 17.11 (1983RA29).

9. (a) ^{13}C(α, n)^{16}O $Q_m = 2.2156$ $E_b = 6.3592$
(b) ^{13}C(α, α)^{13}C

The yield of neutrons increases monotonically for $E_\alpha = 0.475$ to 1 MeV: for $S(E)$ see (1977AJ02, 1982AJ01). Resonances observed in the yield of neutrons and through the anomalies in the elastic scattering in Table 17.8. See also (1982BA1D, 1982KR05) and (1985DE1Q; theor.).

Table 17.8: Resonances in ^{13}C(α, n) and ^{13}C(α, α) [a]

$E_{\rm res}$ (MeV $\pm$ keV)	$\Gamma_{\rm c.m.}$ (keV)	Γ_α/Γ	J^π	$E_{\rm x}$ (MeV)
1.0563 ± 1.5	1.5 ± 0.2		$\frac{5}{2}$	7.1669
1.3367 ± 1.5	$0.6^{+0.2}_{-0.1}$			7.3813
1.3406 ± 1.5	$0.8^{+0.3}_{-0.2}$			7.3842
1.590 ± 2	≤ 1		$\frac{7}{2}^-$	7.575
1.745 ± 6	≤ 15		$\frac{5}{2}^+$	7.693
2.083 ± 8	75	0.03	$\frac{1}{2}^-$	7.952
2.250 ± 8	110	0.05	$\frac{3}{2}^+$	8.080
2.407 ± 8	70	0.11	$\frac{3}{2}^-$	8.200
2.604 ± 4	9 ± 3	0.44	$\frac{1}{2}^+$	8.350
2.680 ± 3	4 ± 3	0.08	$\frac{5}{2}^+$	8.408
2.763 ± 3	7 ± 3	0.97	$\frac{7}{2}^+$	8.472
2.808 ± 3	5 ± 3	0.26	$\frac{5}{2}^-$	8.506
3.059 ± 5	50 ± 3	0.06	$\frac{3}{2}^-$	8.698
(3.1)	broad		$\frac{1}{2}^-$	(8.7)
3.318 ± 8	101 ± 3	0.50	$\frac{3}{2}^+$	8.896
3.415 ± 4	21 ± 3	0.04	$\frac{7}{2}^-$	8.970
3.645 ± 4	4 ± 3	0.45	$\frac{1}{2}^-$	9.146
(3.69)	3	1.00	$\frac{7}{2}^-$	(9.18)
3.714 ± 4	5.5 ± 1	0.20	$\frac{5}{2}^+$	9.199
4.096 ± 4	15 ± 1	0.85	$\frac{5}{2}^-$	9.491
(4.3)			$\frac{3}{2}^-$	(9.6)
4.394 ± 5	16 ± 1	0.70	$\frac{7}{2}^+$	9.719
4.465 ± 15	≈ 25	0.90	$\frac{3}{2}^+$	9.773
4.583 ± 5	14			9.863
4.600 ± 15	≈ 10			9.876
4.730 ± 20	≈ 80	0.78	$\frac{5}{2}^+$	9.976
4.820 ± 20	≈ 100			10.044
(4.94)	138	0.85	$\frac{5}{2}^+$	(10.14)
4.993 ± 5	45	0.15	$\frac{7}{2}^-$	10.177
(5.08)	122	0.60	$\frac{7}{2}^+$	(10.2)
5.200 ± 15	150		$\frac{5}{2}^+$, $\frac{7}{2}^-$	10.335

Table 17.8: Resonances in ^{13}C(α, n) and ^{13}C(α, α) [a] (continued)

E_{res} (MeV $\pm$ keV)	$\Gamma_{\text{c.m.}}$ (keV)	Γ_{α}/Γ	J^{π}	E_{x} (MeV)
5.315 ± 3	14 ± 3			(10.423)
5.40	75 ± 30		$\frac{5}{2}^{+}, \frac{7}{2}^{-}$	10.49
5.492 ± 3	51 ± 2		$\frac{7}{2}^{-}, \frac{9}{2}^{+}$	(10.558)
(5.68)	≤ 25	1.00	$(\frac{7}{2}^{+})$	(10.70)
5.778 ± 3	74 ± 3		$\frac{1}{2}^{+}, \frac{7}{2}^{-}$	(10.777)
5.945 ± 3	46 ± 2		$\frac{5}{2}$	(10.904)
6.117 ± 3	31 ± 3			(11.036)
6.168	5.0 ± 1.1		$\frac{1}{2}^{-}; T = \frac{3}{2}$	(11.075 ± 0.005)
6.380 ± 3	80 ± 3			(11.237)
6.883 ± 3	65 ± 2			(11.621)
7.051 ± 10	40 ± 25			11.750
7.136 ± 15	12 ± 3			11.815
7.384 ± 15				12.004
7.52 ± 20	150 ± 50			12.11
7.736 ± 15	100 ± 30			12.273
7.88 ± 20				12.38
7.927 ± 15				12.419
7.976	8 ± 2		$\frac{3}{2}^{-}; T = \frac{3}{2}$	12.457 ± 0.005
8.156 ± 15	75 ± 30			12.594
8.253 ± 15	≈ 5			12.668
8.44 ± 25				12.81
8.59 ± 20	≥ 150			12.93
8.612	6 ± 2		$\frac{1}{2}^{+}; T = \frac{3}{2}$	12.943 ± 0.006
8.676	≤ 3		$\frac{5}{2}^{-}; T = \frac{3}{2}$	12.992 ± 0.006
8.72 ± 20				13.03
8.785 ± 15	16 ± 4			13.075
9.319 ± 15	≈ 120			13.483
9.483 ± 15	250 ± 100			13.609

[a] See references listed in Tables 17.8 of (1977AJ02, 1982AJ01). See also Table 17.12 here.

10. ^{13}C(^{6}Li, d)^{17}O $\qquad Q_m = 4.884$

At $E(^{6}\text{Li}) = 35.5$ MeV angular distributions are reported to ^{17}O*(13.58 ± 0.02) which is strongly populated. Comparisons with ^{12}C(^{6}Li, d)^{16}O*(16.29) and with the results of reaction 11 here suggest that the peak corresponding to ^{17}O*(13.58) contains a state or states of spin $\frac{11}{2}^-$, $\frac{13}{2}^-$, or both, based on ^{16}O*(16.29) (1978CL08). (d, α) angular correlations [$E(^{6}\text{Li}) = 26$, 29 and 34 MeV] indicate the involvement of ^{17}O states at 13.6 ± 0.1 [$l = 6$], 14.15 ± 0.1[5], 15.1 ± 0.1[5], 15.95 ± 0.15[5], 16.6 ± 0.15[6], 17.1 ± 0.15[6], 19.6 ± 0.15[7], 20.2 ± 0.15[7], 21.2[7] and 22.1 MeV, $\Gamma \approx 0.1$, 0.5, 0.7, 0.25 and 0.25 MeV for ^{17}O*(14.2, 15.1, 16.0, 19.6, 20.2) (1978AR15). See, however, (1984CA39). For the earlier work see Table 17.7 in (1977AJ02).

11. ^{13}C(^{7}Li, t)^{17}O $\qquad Q_m = 3.891$

At $E(^{7}\text{Li}) = 35.7$ MeV angular distributions are reported to ^{17}O*(3.06) and to ^{17}O*(13.58) which is preferentially populated (see discussion in reaction 10). Narrow states at $E_x = 14.86$, 18.17 and 19.24 MeV are also strongly excited (1978CL08). For the earlier work see Table 17.7 in (1977AJ02).

12. ^{13}C(^{13}C, ^{9}Be)^{17}O $\qquad Q_m = -4.2884$

At $E(^{13}\text{C}) = 105$ MeV states of ^{17}O with $E_x = 3.9$, 5.2, 5.8 ± 0.1, 7.2, 7.6, 8.4 ± 0.06, 8.9, 9.8 ± 0.07, 10.55 ± 0.06, 12.1 ± 0.06, 13.3, 14.6 and 18.9 ± 0.14 MeV are reported (1979BR04).

13. ^{13}C(^{16}O, ^{12}C)^{17}O $\qquad Q_m = -0.8027$

Angular distributions involving ^{17}O*(0, 0.87) have been studied for $E(^{16}\text{O}) = 12$ to 25 MeV: see (1977AJ02, 1982AJ01). See also (1979GO1C).

14. ^{14}C(^{3}He, γ)^{17}O $\qquad Q_m = 18.7605$

The capture cross sections at 90° for γ_0 and for γ_1 have been studied for $E(^{3}\text{He}) = 3.2$ to 7.5 MeV and angular distributions of the γ-rays have been studied at the six observed resonances: see Table 17.9.

Table 17.9: States of ^{17}O from ^{14}C + ^{3}He [a]

$E_{\rm res}$ (MeV)	Resonant for	$\Gamma_{\rm c.m.}$ (MeV)	$E_{\rm x}$ (MeV)	J^{π}
3.6 ± 0.1	γ_0, (γ_1), α_0, α_1	0.75	21.7	$\frac{5}{2}^{+}$
4.1 ± 0.1	γ_0, n_0, n_{3+4}, α_0, α_1	0.75	22.1	$\frac{7}{2}^{-}$
4.6 ± 0.2	γ_1	≈ 1	22.5	$\frac{3}{2}^{(-)}$
5.1 ± 0.1	γ_0, ^{3}He	≈ 0.4	23.0	$\frac{1}{2}^{+}$
5.7 ± 0.1	γ_1		23.5	
6.9 ± 0.1	γ_1		24.4	

[a] For references see Table 17.9 in (1977AJ02).

15. (a) ^{14}C(^{3}He, n)^{16}O $\qquad Q_{\rm m} = 14.6169 \qquad E_{\rm b} = 18.7605$

(b) ^{14}C(^{3}He, ^{3}He)^{14}C

(c) ^{14}C(^{3}He, α)^{13}C $\qquad Q_{\rm m} = 12.4013$

See Table 17.9. See also (1977AJ02), ^{13}C and ^{14}C in (1986AJ01) and ^{16}O here.

16. ^{14}C(^{6}Li, t)^{17}O $\qquad Q_{\rm m} = 2.9649$

At $E(^{6}\text{Li}) = 34$ MeV angular distributions have been reported to ^{17}O*(0, 0.87, 3.06, 3.84, 4.55, 5.70, 6.36, 7.17(u), 7.38(u), 7.76, 8.20, 8.47(u), 9.18(u), 9.71, 9.87(u), 10.42, 11.24, 11.82, 12.01, 12.27, 13.00(u), 13.6(u), 14.76(u), 15.20, 16.3(u)) (1981CU11, 1983CU02, 1983CU04; u = unresolved). (1983CU02) suggests evidence for two 3p-2h bands in ^{17}O and (1983CU04) for analog states in ^{17}N–^{17}O. See these two papers for spectroscopic factors.

17. ^{14}N(t, γ)^{17}O $\qquad Q_{\rm m} = 18.6226$

The excitation functions for γ_0 and γ_1 have been measured for $E_{\rm t} = 0.8$ to 3.3 MeV: broad resonances are observed at 2.2 and 2.8 MeV in the γ_0 cross section, and at 2.4 and 2.8 MeV in the γ_1 cross section. Both also exhibit a structure at 1.5 MeV. The data are consistent with states at $E_{\rm x} = 19.76 \pm 0.06$ [$J = \frac{3}{2}$], 20.39 ± 0.05 [$\frac{5}{2}$, $\frac{7}{2}^{-}$], 20.58 ± 0.05 [$\frac{1}{2}$] and 21.05 ± 0.05 MeV [$\frac{3}{2}$] with $\Gamma = 0.55 \pm 0.05$, 0.66 ± 0.07, 0.57 ± 0.08 and 0.47 ± 0.06 MeV, and possibly with a state at ≈ 19.3 MeV. $\Gamma_{\gamma_0} > 1.0$, 4.3 and 5.8 eV for ^{17}O*(19.8, 20.4, 21.1) and $\Gamma_{\gamma_1} > 2.3$, 5.1 and 6.5 eV for ^{17}O*(19.8, 20.6, 21.1) (1980LI05). For the charged particle channels see (1977AJ02).

18. (a) ^{14}N(α, p)^{17}O $\qquad Q_m = -1.1914$

(b) ^{14}N(α, αp)^{13}C $\qquad Q_m = -7.55062$

Angular distributions have been measured for ^{17}O states with $E_x < 7.6$ MeV in the range $E_\alpha = 8.1 \to 33.3$ MeV: see a listing of the references in (1971AJ02). The sequential decay (reaction (b)) appears to take place via ^{17}O states with $8.46 \le E_x \le 13.57$ MeV. Those involved are believed to have $J \ge \frac{5}{2}$, $\Gamma_\alpha/\Gamma \ge 0.6$.

19. (a) ^{14}N(^{6}Li, ^{3}He)^{17}O $\qquad Q_m = 2.827$

(b) ^{14}N(^{6}Li, ^{3}Heα)^{13}C $\qquad Q_m = -3.5322$

Angular distributions (reaction (a)) and angular correlations (reaction (b)) have been measured at $E(^6\text{Li}) = 36$ MeV involving ^{17}O*(8.48, 10.7, 12.0, 13.53, 14.88). Comparisons are made with the results in the analog reaction [(^{6}Li, t)] involving states in ^{17}F (1984ET01). [Comment: compare the experimental resolution with the density of states]. For the earlier work see (1982AJ01).

20. (a) ^{15}N(d, n)^{16}O $\qquad Q_m = 9.9030 \qquad E_b = 14.0466$

(b) ^{15}N(d, p)^{16}N $\qquad Q_m = 0.266$

Excitation functions have been measured for $E_d = 0.5$ to 5.9 MeV (reaction (a)) and 0.3 to 6.3 MeV (reaction (b)): see (1977AJ02). Unresolved structures are observed in the neutron data. There is some evidence for structures at $E_d = 1.8$ MeV [p_0, p_1, p_3] and 2.4 MeV [p_2] [^{17}O*(15.6, 16.2)]: see (1982AJ01). See also (1984HE20) and ^{16}N, ^{16}O here.

21. ^{15}N(d, d)^{15}N $\qquad E_b = 14.0466$

Excitation functions for d_0 have been measured for $E_d = 1.4$ to 6.25 MeV. Structures are reported at ≈ 1.4 and 1.8 MeV: see (1982AJ01).

22. ^{15}N(d, α)^{13}C $\qquad Q_m = 7.6874 \qquad E_b = 14.0466$

Yield curves have been measured for $E_d = 0.8$ to 2.7 MeV. Structures are reported at $E_d = 1.06$, 1.25 and ≈ 1.8 MeV. The latter has $\Gamma \approx 300$ keV: see (1982AJ01). See also (1986SA2H; applied).

Table 17.10: Levels of ^{17}O from ^{15}N(^{3}He, p)^{17}O [a]

E_x [b] (MeV)	L [c]	E_x [b] (MeV)	L [c]
0	$(1+3)$	8.192	0
0.874	1	8.322	
3.053	0	8.390	
3.845	2	8.492	(2)
4.549	0	8.682	
5.081	(1)	8.900	
5.215	(4)	8.955	
5.381	0	9.16	(4)
5.698	2	9.495	
5.873	(1)	9.712	
5.938	0	9.856	
6.37		(10.24)	
6.861	(0)	10.33	
6.973	$(1+3)$	10.57	
7.162	2	10.782	
7.382	2	10.913	
7.561		11.032 ± 0.004 [d]	
7.687		11.075 ± 0.004 [e]	
7.761	4		
7.938			
8.054	(1)		

[a] For references see Table 17.10 in (1982AJ01).

[b] ± 10 keV, except where shown otherwise.

[c] $E(^3\text{He}) = 18$ MeV.

[d] $T = \frac{1}{2}$.

[e] $J^\pi = \frac{1}{2}^-$; $T = \frac{3}{2}$: see Table 17.11.

Table 17.11: Decay properties of the lowest $T = \frac{3}{2}$ states in $A = 17$ [a]

		^{17}O*(11.0787 ± 0.0008) [b]	^{17}F*(11.1928 ± 0.0021) [c]
J^π		$\frac{1}{2}^-$	$\frac{1}{2}^-$
$\Gamma_{c.m.}$ (keV)		2.4 ± 0.3 [b]	0.24 ± 0.04
Branching ratio (%) to			
^{16}O* (MeV)	J^π		
0	0^+	81 ± 6	9.3 ± 1.3
6.05	0^+ }	5 ± 2 (6.05 + 6.13)	< 3
6.13	3^- }		22 ± 2
6.92	2^+		24 ± 6
7.12	1^-		44 ± 4
^{13}C + α_0 or ^{13}N + α_0		7 ± 1 [d]	< 7
Partial widths [Γ_p or Γ_n] to			
^{16}O(0)		1.88 ± 0.12 keV	19 ± 3 eV
^{16}O*(6.05)			< 8 eV
^{16}O*(6.13)		0.12 ± 0.05 keV	45 ± 14 eV [e]
^{16}O*(6.92)			49 ± 19 eV [e]
^{16}O*(7.12)			90 ± 27 eV [e]
Γ_{α_0}		0.162 ± 0.030 keV [f]	< 19 eV [d]
Γ_{γ_1}		21.6 ± 3.6 eV [f]	6.0 ± 2.5 eV
θ^2(g.s.)/θ^2(6.13)		0.31 ± 0.14	0.065 ± 0.019

[a] See also Table 2 in (1973AD02) and reaction 8.

[b] (1981HI01) [see for IMME parameters for six $T = \frac{3}{2}$ states].

[c] For references see Table 17.11 in (1982AJ01).

[d] (1976MC11).

[e] Note that the total width is 200 ± 40 eV.

[f] Using $[\Gamma_{\alpha_0}/\Gamma_{n_0}]^{1/2}/\Gamma_{tot} = 0.23$ (1976MC11), $\Gamma_{\alpha_0}\Gamma_{\gamma_1}/\Gamma_{tot} = 1.46 \pm 0.13$ eV (1983RA29) and the Γ_{n_0} and Γ_{tot} values shown above, these values are calculated for Γ_{α_0} and Γ_{γ_1}, and $\delta = 3.1 \pm 1.9$. However *these values do not take into account any error in the measurement of* $[\Gamma_{\alpha_0}\Gamma_{n_0}]^{1/2}/\Gamma_{tot}$ [F.C. Barker, private communication]. I am also indebted to C. Rangacharyulu for his comment [(A later communication with Dr. A.B. McDonald suggests that $\Gamma_{\alpha_0}\Gamma_{n_0}/\Gamma_{tot} = 0.27$ keV [$\pm \approx 20\%$] (from a re-examination of (1976MC11)). Then $\Gamma_{\alpha_0} = 0.3$ keV and $\Gamma_{\gamma_1} = 12$ eV. I am indebted to Prof. McDonald for his comments)].

23. ^{15}N(^{3}He, p)^{17}O $\qquad Q_{\rm m} = 8.5531$

Observed proton groups are displayed in Table 17.10. For the parameters of the first $T = \frac{3}{2}$ state see Table 17.11.

24. ^{15}N(α, d)^{17}O $\qquad Q_{\rm m} = -9.8001$

At $E_\alpha = 45.4$ MeV, the deuteron spectrum is dominated by the groups corresponding to states with $E_{\rm x} = 7.742 \pm 0.020$ and 9.137 ± 0.030 MeV. These states are assigned $J^\pi = (\frac{11}{2}^-)$ and $(\frac{9}{2}^-)$ and arise from a dominant $({\rm d}_{5/2})^2_5{\rm p}^{-1}_{1/2}$ configuration: see (1977AJ02).

25. ^{15}N(^{11}B, ^{9}Be)^{17}O $\qquad Q_{\rm m} = -1.7689$

See (1982AJ01).

26. ^{16}O(n, γ)^{17}O $\qquad Q_{\rm m} = 4.1436$

$$\sigma_{\rm capt.} = 202 \pm 28\ \mu{\rm b}$$ (1977MC05). See also (1981MUZQ).

At thermal energies the branchings via ^{17}O*(0.87, 3.05) are (18 ± 3) and (82 ± 3)%; $E_\gamma = 870.89 \pm 0.22$ and 2184.47 ± 0.12 keV [the latter leads to $E_{\rm x} = 3055.43 \pm 0.19$ keV for ^{17}O*(3.09); A.H. Wapstra, private communication]. The cross section for two-photon emission $\sigma_{2\gamma} < 3 \pm 19\ \mu$b for $1200 < E_\gamma < 2943$ keV. The two-photon branching ratio is $(1.6 \pm 10) \times 10^{-2}$ (1977MC05).

27. ^{16}O(n, n)^{16}O $\qquad E_{\rm b} = 4.1436$

The scattering amplitude (bound) $a = 5.805 \pm 0.005$ fm, $\sigma_{\rm free} = 3.761 \pm 0.007$ b (1979KO26). See also (1981MUZQ). Resonances observed in the elastic scattering and in the (n, α) reaction are displayed in Table 17.12. A two-channel R-matrix analysis finds that five states contain nearly 100% of the $1{\rm d}_{3/2}$ strength and have their eigenenergy at $E_{\rm x} \approx 5.7$ MeV [the dominant state is ^{17}O*(5.08)]. Spectroscopic factors are deduced for 26 states in ^{17}O for $4.5 < E_{\rm x} < 9.5$ MeV [see Table 17.12 in (1977AJ02)]: the sum of these factors is 1% for $J^\pi = \frac{1}{2}^+$, 5% for $\frac{1}{2}^-$, 12% for $\frac{3}{2}^-$, 99% for $\frac{3}{2}^+$, 0.1% for $\frac{5}{2}^+$, 1% for $\frac{5}{2}^-$ and 14% for $\frac{7}{2}^-$. $T = \frac{3}{2}$ resonances are discussed by (1981HI01): see Tables 17.11 and 17.12.

Table 17.12: Resonances [a] in ^{16}O(n, n) and ^{16}O(n, α)

E_n (keV)	$\Gamma_{c.m.}$ (keV)	Γ_n (keV)	Γ_α (keV)	J^π	E_x (keV)
433 ± 2 [b]	45	45		$\frac{3}{2}^-$	4551
1000 ± 2	96	96		$\frac{3}{2}^+$	5084
1140 [c]	< 0.1				5216
1312 ± 2	42	41.5		$\frac{3}{2}^-$	5378
1651 ± 2	3.4 ± 0.3	3.4		$\frac{7}{2}^-$	5697
1689 ± 2	< 1			[d]	5732
1833 ± 2	6.6 ± 0.7	6.6		$\frac{3}{2}^+$	5868
1908 ± 4	32 ± 3	31.5		$\frac{1}{2}^-$	5938
2351 ± 8 [i]	124 ± 12	124		$\frac{1}{2}^+$	6355
2889 ± 2	< 1			[d]	6861
3006 ± 2	< 1			[d]	6971
3211.70 ± 0.17	1.38 ± 0.05	1.38 ± 0.05 [e]	0.0033	$\frac{5}{2}^-$	7164.5
3250 ± 10	280 ± 30	280	0.07	$\frac{3}{2}^+$	7201
3438.38 ± 0.19	0.64 ± 0.23	0.64 ± 0.23 [e]	0.01	$\frac{5}{2}^+$	7377.7
3441.73 ± 0.14	0.96 ± 0.20	0.96 ± 0.20 [e]	0.003	$\frac{5}{2}^-$	7380.8
3630 ± 20	500 ± 50	500	0.08	$\frac{3}{2}^-$	7558
3647 [c]	< 0.1				7574
3767.76 ± 0.22	14.4 ± 0.3	13.0 ± 0.6 [e]	0.01	$\frac{7}{2}^-$	7687.5
4053 ± 8	90 ± 9	84	6.7	$\frac{1}{2}^+$	7956
4090 ± 50	270 ± 30	250	16	$\frac{1}{2}^-$	7991
4162 ± 8	85 ± 9	71	15	$\frac{3}{2}^+$	8058
4290 ± 20	69 ± 7	68	0.8	$\frac{1}{2}^-$	(8179)
4310 ± 10	52	48	4.0	$(\frac{3}{2}^-)$	8197
4463.41 ± 0.26	11.4 ± 0.5	8.1 ± 0.3	2.2	$\frac{1}{2}^+$	8341.7
4527.12 ± 0.07	6.17 ± 0.13	4.75 ± 0.11	0.54	$\frac{5}{2}^+$	8401.6
4594.83 ± 0.09	2.13 ± 0.11	1.18 ± 0.04	(7.6)	$\frac{7}{2}^+$	8465.3
4631.78 ± 0.12	6.89 ± 0.22	2.86 ± 0.08	1.9	$\frac{5}{2}^-$	8500.0
4829.9 ± 0.4	55.3 ± 0.6	48.9 ± 1.1	1.8	$\frac{3}{2}^-$	8686.3
5050	78	68	9.5	$\frac{3}{2}^+$	8893
5127.0 ± 1.6	26.3 ± 1.9	23.5 ± 1.9		$\frac{7}{2}^-$	8965.7
5368.90 ± 0.09	3.53 ± 0.13	2.37 ± 0.08		$\frac{5}{2}^+$	9193.2

Table 17.12: Resonances [a] in ^{16}O(n, n) and ^{16}O(n, α) (continued)

$E_{\rm n}$ (keV)	$\Gamma_{\rm c.m.}$ (keV)	$\Gamma_{\rm n}$ (keV)	Γ_α (keV)	J^π	$E_{\rm x}$ (keV)
5610	120	120		$\frac{3}{2}^-$	9420
5640	140			$\geq \frac{3}{2}$	9448
5919.67 ± 0.14	23.1 ± 0.3	18.0 ± 0.6		$\frac{7}{2}^+$	9711.1
5995.68 ± 0.15	11.7 ± 0.3	10.3 ± 0.3		$\frac{3}{2}^+$	9782.6
6076.08 ± 0.15	4.01 ± 0.23	3.37 ± 0.23		$(\frac{5}{2}^-)$	9858.2
6094.8 ± 1.0	16.7 ± 1.7	10.9 ± 1.2		$(\frac{1}{2}^-)$	9875.8
6404.6 ± 0.5	49.1 ± 0.8	22.3 ± 0.6		$(\frac{7}{2}^-)$	10167.1
6820.7 ± 0.6	42.5 ± 1.1	17.2 ± 0.7 [e]		$(\frac{7}{2}^-)$	10558.4
7199.3 ± 1.3	41.7 ± 1.4	26.4 ± 0.9 [e]		$(\frac{5}{2}^+)$	10914.4
7373.31 ± 0.18	2.4 ± 0.3	1.88 ± 0.12 [e]		$\frac{1}{2}^-$ [f]	11078.0
7830	190			$\geq \frac{3}{2}$	11507
8320	270			$\geq \frac{3}{2}$	11968
8740	130				12363
8848.8 ± 0.6	6.9 ± 1.1	1.27 ± 0.14 [e]		$\frac{3}{2}^-$ [f]	12465.3
9050	95				12654
9353 ± 6	6 ± 2	0.21 ± 0.14 [e]		$\frac{1}{2}^+$ [f]	12939
9414.9 ± 0.6	2.5 ± 1.0	0.40 ± 0.06 [e]		$\frac{5}{2}^-$ [f]	12997.5
10092.5 ± 2.4	9 ± 5	0.24 ± 0.09 [e]		$(\frac{5}{2}^+)$ [f]	13634.6
10130	400				13670
10725.5 ± 1.5	20.5 ± 1.6	2.07 ± 0.16 [e]		$(\frac{7}{2}^-)$ [f]	14229.6
10785 ± 3	7.5 ± 4	0.80 ± 0.16 [g]		[f]	14286
10960 ± 3	40 ± 6	13 ± 6 [g]			14450
11140	340			$(\geq \frac{3}{2})$	14619
11322 ± 3	36 ± 13	3.2 ± 1.0 [g]		$(\frac{1}{2}^-)$ [h]	14790
11540	180				14995
11756 ± 3	52 ± 14	11 ± 3 [g]		$(\frac{3}{2})$ [h]	15198
11936 ± 3	40 ± 6	7 ± 1 [g]		$(\frac{5}{2}^+)$ [h]	15368
12867 ± 4	21 ± 10	2 ± 0.5 [g]		$(\frac{9}{2}^+)$ [h]	16243
14136 ± 11	66 ± 20	8.0 ± 2.4 [g]		[f]	17435
14853 ± 4	43 ± 12	1.0 ± 0.3 [e]		$\frac{3}{2}^-$	18109

[a] See Tables 17.12 in (1977AJ02) and (1982AJ01).
[b] $\Gamma_\gamma < 4.0$ eV, $\Gamma_n = 60 \pm 15$ keV.
[c] Not observed in σ_t.
[d] Not $\frac{1}{2}^+$.
[e] Γ_{n_0}.
[f] $T = \frac{3}{2}$.
[g] $(J \pm \frac{1}{2})\Gamma_{n_0}$ (1981HI01).
[h] J^π assignment by comparison with ^{17}N states presumed to be analogs; then $T = \frac{3}{2}$ (1981HI01).
[i] See also (1980JO1A).

Cross-section measurements are listed in Table 17.10 of (1971AJ02) and in (1977AJ02, 1982AJ01). An optical model analysis of angular distributions leads to predictions of σ_R and σ_T for $E_n = 6$ to 9 MeV (1983DA22). A_y measurements for n_0 have been carried out at $E_n = 5$ to 17 MeV (1985ANZX) and at 23 MeV (1985LA13).

See also ^{16}O, (1982RA1A, 1983GO1H, 1984ISZZ), (1982DI1E, 1983HA1U; applications) and (1981AO01, 1981SH1A, 1982HO03, 1982LI13, 1982YA07, 1983UE01, 1985TI07; theor.).

28. ^{16}O(n, n′)^{16}O* $\qquad E_b = 4.1436$

A number of resonances have been observed in the cross sections for production of 6.13 and $(6.92 + 7.12)$ γ-rays: see Table 17.13 in (1977AJ02) and (1982AJ01). For cross-section measurements see Table 17.10 in (1971AJ02) and (1977AG03, 1982AJ01).

29. (a) ^{16}O(n, p)^{16}N $\qquad Q_m = -9.637 \qquad E_b = 4.1436$
(b) ^{16}O(n, d)^{15}N $\qquad Q_m = -9.9030$
(c) ^{16}O(n, t)^{14}N $\qquad Q_m = -14.4790$

See (1982AJ01). See also (1981HAZJ, 1982HA1A).

30. ^{16}O(n, α)^{13}C $\qquad Q_m = -2.2156 \qquad E_b = 4.1436$

Table 17.12 displays the results from a multilevel two-channel R-matrix analysis of the data from this reaction and from the elastic scattering of neutrons: see (1982AJ01). See also (1981HAZJ, 1982HA1A).

31. ^{16}O(p, π^+)^{17}O $\qquad Q_m = -136.206$

Angular distributions have been reported at $E_p = 185$ and 800 MeV [to ^{17}O*(0, 0.87, 3.05)] [see (1982AJ01)] as well as at $E_p = 154$ to 185 MeV (1981SJ03) and $E_{\vec{p}} = 157$ MeV (1981SJ02; also A_y) [both for π^+ to ^{17}O*(0, 0.87)]. See also (1982AJ01, 1982FE1A, 1982HO1C, 1982NA1K, 1982WA1G) and (1981CO18, 1982CO07; theor.).

32. ^{16}O(d, p)^{17}O $\qquad Q_m = 1.9191$

Observed proton groups are displayed in Table 17.14 of (1977AJ02). Angular distributions have been measured at many energies in the range $E_d = 0.3$ to 63.2 MeV and at $E_d = 698$ MeV [see (1982AJ01)] and at 7.5 MeV (1985GR1B; p_0, p_1, p_3). Reported level parameters are $\tau_m = 258.6 \pm 2.6$ psec [see Table 17.7 in (1971AJ02)] and $E_x = 870.749 \pm 0.020$ keV [$E_\gamma = 870.725 \pm 0.020$ keV] for ^{17}O*(0.87) and $\Gamma_n = 97 \pm 5$ keV for ^{17}O*(5.09): see (1982AJ01).

See also ^{18}F in (1983AJ01, 1987AJ02), (1982BE1R, 1985LI1H, 1986DU1K; applications), (1982LO1B, 1982YA1A) and (1982SH06, 1982TH02, 1983IC01, 1983SH15; theor.).

33. (a) ^{16}O(^{7}Li, ^{6}Li)^{17}O $\qquad Q_m = -3.107$
(b) ^{16}O(^{9}Be, ^{8}Be)^{17}O $\qquad Q_m = 2.4782$
(c) ^{16}O(^{11}B, ^{10}B)^{17}O $\qquad Q_m = -7.311$

For reactions (a) and (c) see (1982AJ01). For reaction (b) see (1979CU1A, 1985CU1A).

34. (a) ^{16}O(^{13}C, ^{12}C)^{17}O $\qquad Q_m = -0.8027$
(b) ^{16}O(^{14}N, ^{13}N)^{17}O $\qquad Q_m = -6.4098$

For reaction (a) see (1985BE37) and (1983OS08; theor.). For reactions (a) and (b) see (1982AJ01).

35. ^{17}N(β^-)^{17}O $\qquad Q_m = 8.680$

The decay is principally to ^{17}O*(4.55, 5.38, 5.94): see Table 17.3.

36. (a) ^{17}O(γ, n)^{16}O $\qquad Q_m = -4.1436$
(b) ^{17}O(γ, 2n)^{15}O $\qquad Q_m = -19.8075$

Table 17.13: Transition probabilites and ground state radiative widths from ^{17}O(e, e) [a]

E_x (MeV)	J^{π} [b]	Mult.	Γ_{γ_0}(Cλ) (eV)	B(C$\lambda\uparrow$) ($e^2 \cdot$ fm$^{2\lambda}$)	Mult.	Γ_{γ_0}(Mλ) (eV)	B(M$\lambda\uparrow$) ($e^2 \cdot$ fm$^{2\lambda}$)
0.87	$\frac{1}{2}^+$	C2					
3.06	$\frac{1}{2}^-$	C3	$(8.7 \pm 1.7) \times 10^{-8}$	31 ± 6			
3.84	$\frac{5}{2}^-$	C3	$(7.1 \pm 0.3) \times 10^{-7}$	153 ± 6	M2	$(4.6 \pm 1.8) \times 10^{-3}$	$(5 \pm 2) \times 10^{-2}$
4.55	$\frac{3}{2}^-$	C3	$(2.2 \pm 0.2) \times 10^{-6}$	98 ± 8	M2	$(1.8 \pm 0.7) \times 10^{-2}$	$(5.4 \pm 2.1) \times 10^{-2}$
5.09	$\frac{3}{2}^+$	C2	$(1.0 \pm 0.3) \times 10^{-2}$	2.5 ± 0.7			
5.22	$(\frac{9}{2}^-)$	C3	$(8.5 \pm 0.3) \times 10^{-6}$	360 ± 11	M2	$< 1 \times 10^{-2}$	$< 4 \times 10^{-2}$
5.38	$\frac{3}{2}^-$	C3	$(3.3 \pm 0.9) \times 10^{-6}$	45 ± 12	M2	$(4.5 \pm 2.2) \times 10^{-2}$	$(6 \pm 3) \times 10^{-2}$
5.70	$\frac{7}{2}^-$	C3	$(1.5 \pm 0.2) \times 10^{-5}$	270 ± 32	M2	0.15 ± 0.10	0.3 ± 0.2
5.94	$\frac{1}{2}^-$	C3	$(5.0 \pm 2.9) \times 10^{-6}$	17 ± 10			
6.36	$\frac{1}{2}^+$	C2	$(5.3 \pm 3.3) \times 10^{-2}$	2.1 ± 1.3			
6.86 [d]	$(\frac{1}{2}^-)$	C3	$(1.2 \pm 0.3) \times 10^{-4}$	147 ± 34			
6.97 [d]	$(\frac{5}{2}^+)$	C2	$(2.5 \pm 1.3) \times 10^{-2}$	1.9 ± 1.0			
				5.5 ± 1.0			
7.38 [c]	$\frac{5}{2}^+$	CO, or C2	$(6.3 \pm 1.8) \times 10^{-2}$				
				3.6 ± 1.0			
7.38 [c]	$\frac{5}{2}^-$	C3	$(2.1 \pm 1.7) \times 10^{-5}$				
				47 ± 38			
7.58 [e]	$\frac{7}{2}^-$	C1	26 ± 7	$(7.8 \pm 2.0) \times 10^{-2}$			
		C3	$(4.3 \pm 1.0) \times 10^{-5}$	109 ± 26			
7.76	$(\frac{11}{2}^-)$	C3	$(1.16 \pm 0.05) \times 10^{-4}$	369 ± 15			
8.35 [c]	$\frac{1}{2}^+$	CO, or C2		7.6 ± 1.4			
8.40 [c]	$\frac{5}{2}^+$			8.3 ± 2.6			
8.47 [c,e]	$\frac{7}{2}^+$						
8.50 [c]	$\frac{5}{2}^-$						
8.90 [f]	$\frac{7}{2}^-$, $\frac{9}{2}^-$						
9.15 [f]					M2		
11.08 [g]	$\frac{1}{2}^-$ [h]				M2		$(6.7 \pm 2.1) \times 10^{-2}$
12.47 [g]	$\frac{3}{2}^-$ [h]				M2		$(7 \pm 3) \times 10^{-2}$ [i]
13.00 [g]	$\frac{5}{2}^-$ [h]				M2		$(7 \pm 3) \times 10^{-2}$ [i]
14.23 [g]	$(\frac{7}{2})^-$ [h]				M2		$(51 \pm 8) \times 10^{-2}$

Table 17.13: Transition probabilites and ground state radiative widths from ^{17}O(e, e) [a] (continued)

E_x (MeV)	J^π [b]	Mult.	Γ_{γ_0}(Cλ) (eV)	B(C$\lambda\uparrow$) ($e^2 \cdot \mathrm{fm}^{2\lambda}$)	Mult.	Γ_{γ_0}(Mλ) (eV)	B(M$\lambda\uparrow$) ($e^2 \cdot \mathrm{fm}^{2\lambda}$)
14.75 [g]	[j]				M2		$(30 \pm 10) \times 10^{-2}$
15.10 [g]	[j]				(M1)		$(1.5 \pm 0.4) \times 10^{-3}$
15.78 ± 0.02 [k]	$(\frac{9}{2})^-; \frac{3}{2}$		≤ 30		M4		177 ± 17
16.50 ± 0.02 [k,l]			≤ 20				
17.06 ± 0.02 [k]	$(\frac{7}{2})^-; \frac{3}{2}$		≤ 20		M4		76 ± 6
18.83 ± 0.02 [k,l]			≤ 20				
19.85 ± 0.04 [k]			530 ± 150				
20.14 ± 0.02 [k]	$(\frac{13}{2})^-; \frac{1}{2}$		31 ± 5		M4		349 ± 18
20.70 ± 0.02 [k,m]	$(\frac{11}{2})^-; \frac{3}{2}$		≤ 20		M4		177 ± 10

[a] (1978KI01), except where footnote is shown. See also Table 17.14.

[b] Used to evaluate the widths.

[c] These levels were unresolved and were analyzed as a group.

[d] However (D.M. Manley, private communication) reports that ^{17}O*(6.86, 6.97) had form factors which were, respectively, characteristic of C2 and of C3 leading to $J^\pi = \frac{1}{2}^+ \to \frac{9}{2}^+ [\frac{1}{2}^+$ excluded by ^{16}O(n, n) results] and $\frac{1}{2}^- \to \frac{11}{2}^-$ for these two states. The widths shown are from the work of (1978KI01) based on an analysis of unresolved states.

[e] However (D.M. Manley, private communication) reports a form factor consistent with C2 and therefore $J^\pi = \frac{7}{2}^+, \frac{9}{2}^+$ for ^{17}O*(7.58). The group to ^{17}O*(8.47) is very strong; the form factor is consistent with C2.

[f] (D.M. Manley, private communication): $E_x = 8.90 \pm 0.02$ MeV. The group corresponding to ^{17}O*(9.15) is weak at $90°$ and strong at $160°$, consistent with a large M2 strength.

[g] (1983RA27). [Comment: See, however, the density of states in this excitation region.]

[h] $T = \frac{3}{2}$.

[i] If pure M2. If pure C1, $B(\mathrm{C1}\uparrow) = (1.0 \pm 0.4) \times 10^{-2}$ and $(0.4 \pm 0.2) \times 10^{-2}$ $e^2 \cdot \mathrm{fm}^2$, respectively for ^{17}O*(12.47, 13.00) (1983RA27).

[j] ^{17}O*(14.75) is suggested to have $J^\pi = \frac{9}{2}^-$ from analog states considerations. If the transition is M1 ^{17}O*(15.10) has $J^\pi = (\frac{3}{2}, \frac{5}{2}, \frac{7}{2})^+$ (1983RA27).

[k] [(1986MA48): $E_e = 180$ to 268 MeV]. The values for B(M4$\uparrow$) are based on 1513 ± 76 $e^2 \cdot \mathrm{fm}^8$ for ^{16}O*(18.98) [$J^\pi = 4^-$].

[l] Weakly excited.

[m] No other states are observed with $21 < E_x < 23.5$ MeV.

Table 17.14: Some inelastic groups observed in ^{17}O(e, e) [a]

E_x (MeV)	Γ (keV)	E_x (MeV)	Γ (keV)
11.71 ± 0.05 [b]	narrow	14.76 ± 0.10 [b]	> 300
11.95 ± 0.05 [b]	≈ 250	15.24 ± 0.10 [b]	≈ 200
12.22 ± 0.02 [c]	≤ 20	16.52 ± 0.05 [b]	≈ 300
12.66 ± 0.05 [b]	≈ 90	17.92 ± 0.02 [c]	98 ± 16
12.96 ± 0.05 [b]	≈ 200	18.72 ± 0.02 [c]	87 ± 33
13.56 ± 0.05 [b]	≈ 150	22.0 [b,d]	
14.14 ± 0.10 [b]	≈ 100	23.0 [b,d]	
14.72 ± 0.02 [c]	35 ± 11		

[a] See also Table 17.13 for other inelastic groups.
[b] (1977NO06).
[c] (1986MA48) and D.M. Manley, private communication. I am very indebted to Dr. Manley for his many useful comments.
[d] C1.

Monoenergetic photons with $E_\gamma = 8.5$ to 39.7 MeV have been used to measure the (γ, n) and the (γ, 2n) [above 10 MeV] cross sections. The giant dipole resonance, 6 MeV broad, is centered at 23 MeV; a pigmy resonance is also observed at 13 MeV. The pigmy resonance [$J^\pi = \frac{3}{2}^-$] decays primarily to ^{16}O$_{\rm g.s.}$. Above $E_x \approx 17$ MeV nearly all of the decay is to excited states of ^{16}O. Four resonances have been inferred at $E_x = 10.5$, 14.0, 16.6 and 21.0 MeV with $J^\pi = \frac{5}{2}^-, \frac{3}{2}^-, \frac{7}{2}^-$ and $\frac{7}{2}^-$, respectively (1985JU02). Most of the GDR strength decays to $T = 1$ states in ^{16}O: this implies a $T = \frac{3}{2}$ assignment for the main part of the GDR. A broad structure, of $T = \frac{1}{2}$ nature, with $28 < E_x < 36$ MeV is also reported (1980JU01). For radiative widths see Table 17.13 in (1982AJ01). See also (1983RO1J) and (1981HO1H, 1982JU03, 1985PY01).

37. ^{17}O(e, e)^{17}O

The ^{17}O charge radius, $\langle r^2 \rangle^{1/2} = 2.710 \pm 0.015$ fm (1978KI01). The r.m.s. radius of the 1d$_{5/2}$ neutron orbit is calculated to be 3.56 ± 0.09 fm (1982HI01). Inelastic scattering is reported to a number of ^{17}O states: see Tables 17.13 and 17.14. Form factor measurements have been made at 90° and 160° to all the states with $E_x < 7.8$ MeV and to 45 other states with $E_x \leq 20.7$ MeV (1986MA48; D.M. Manley, private communication).

See also (1986KA2E, 1986MAZW), (1982BE1J, 1982BE1A, 1982NO04, 1983BE36, 1983BU08, 1983DE1N, 1983FR1B, 1984DO20), (1982BO1H, 1982CO03, 1982MC01, 1985KIZY; theor.) and reaction 44.

38. ^{17}O($\pi^\pm$, $\pi^\pm$)^{17}O

At $E_{\pi^\pm} = 164$ MeV angular distributions to ^{17}O*(3.85, 4.55, 5.22, 5.69, 7.76, 8.1, 8.4, 15.7, 17.1) have been analyzed by DWBA. Evidence is suggested for E2 strength near 8 MeV and for M4 strength to the two states at $E_x = 15.7$ and 17.1 MeV (1984BL17). [See, however, caveat on p. 1900 of that reference, and the density of states above $E_x = 5$ MeV in Table 17.7.]

39. (a) ^{17}O(p, p)^{17}O
(b) ^{17}O(d, d)^{17}O

Angular distributions for the elastic scattering have been reported for $E_p = 8.6$ to 65.8 MeV and $E_d = 18$ MeV: see (1982AJ01) and at $E_{\vec{p}} = 89.7$ MeV (1985VO12). For reaction (a) see also ^{18}F in (1983AJ01), (1982BE1A) and (1983IC01; theor.).

40. (a) ^{17}O(^{3}He, ^{3}He)^{17}O
(b) ^{17}O(α, α)^{17}O

Elastic angular distributions have been measured at $E(^3\text{He}) = 11.0$ and 17.3 MeV [see (1977AJ02)], at 14 MeV (1982AB04) and at $E(^3\vec{\text{He}}) = 33.3$ MeV (1983LE03; also A_y; to both ^{17}O*(0, 0.87)). For reaction (b) see (1982AJ01). See also ^{20}Ne in (1987AJ02) and (1981CO15, 1985HA11; theor.).

41. (a) ^{17}O(^{9}Be, ^{9}Be)^{17}O
(b) ^{17}O(^{10}B, ^{10}B)^{17}O

Fusion cross section measurements for reaction (b) are reported by (1982CH07). See also (1982AJ01, 1983BI1A, 1984HA53) and (1983GO13, 1984FR1A; theor.).

42. (a) ^{17}O(^{12}C, ^{12}C)^{17}O
(b) ^{17}O(^{13}C, ^{13}C)^{17}O
(c) ^{17}O(^{14}C, ^{14}C)^{17}O

Elastic angular distributions (reactions (a) and (b)) have been reported at $E(^{17}\text{O}) = 30.5$ to 33.8 MeV [see (1982AJ01)] and at $E(^{17}\text{O}) = 40$ to 70 MeV (1986FR04; also ^{17}O*(0.87)) and 85.4, 120 and 140 MeV (1982HE07). For fusion cross section and yield measurements see (1982AJ01) and (1982HE07, 1983FR17, 1985BE40, 1985BE37, 1986FR04). See also (1983BI1A, 1983DU13, 1984FR1A, 1984HA53) and (1982LO13, 1983AB08, 1984AB1A, 1984AB1F, 1985CH1R, 1985HU04, 1985MI13, 1985PAZY, 1986CI01, 1986PAZW, 1986PA04; theor.).

43. ^{17}O(^{15}N, ^{15}N)^{17}O

See (1983DU13).

44. (a) ^{17}O(^{16}O, ^{16}O)^{17}O
(b) ^{17}O(^{18}O, ^{18}O)^{17}O

Angular distributions involving ^{17}O*(0, 0.87) in reaction (a) have been studied at E(^{16}O) $= 22$ to 32 MeV and E(^{17}O) $= 25.7$ to 32.0 MeV [see (1977AJ02)] as well as at E(^{17}O) $= 22$ MeV (1983BU08; elastic $\sigma(\theta)$ to ± 1%). A model independent value of 0.82 ± 0.07 is obtained for the coupling constant of the 1d$_{5/2}$ neutron in ^{17}O. A review of magnetic electron scattering on ^{17}O then leads to a spectroscopic factor $S = 1.03 \pm 0.07$. This corresponds to (91 ± 7)% of the single-particle value (1983BU08). For fusion cross sections see (1982AJ01) and (1986TH01). The elastic scattering angular distribution in reaction (b) has been reported at E(^{17}O) $= 36$ MeV: see (1982AJ01). See also (1982HO1E, 1983DU13, 1983BI1A, 1983FR1B, 1984HA53).

45. (a) ^{17}O(^{22}Ne, ^{22}Ne)^{17}O
(b) ^{17}O(^{24}Mg, ^{24}Mg)^{17}O
(c) ^{17}O(^{27}Al, ^{27}Al)^{17}O
(d) ^{17}O(^{28}Si, ^{28}Si)^{17}O
(e) ^{17}O(^{40}Ca, ^{40}Ca)^{17}O

See (1982AJ01), (1983DU13, 1983GR1M, 1984FR1A) and (1982LA02, 1982LO13, 1982PA09, 1984QU03; theor.).

46. ^{17}F(β^+)^{17}O $\qquad Q_{\rm m} = 2.7608$

See ^{17}F.

47. ^{18}O(p, d)^{17}O $\qquad$ $Q_m = -5.820$

Angular distributions have been measured at a number of energies for $E_p = 17.6$ to 51.9 MeV: see (1977AJ02, 1982AJ01).

48. ^{18}O(d, t)^{17}O $\qquad$ $Q_m = -1.787$

See Table 17.15. See also reaction 6 in ^{17}N.

49. ^{18}O(^{3}He, α)^{17}O $\qquad$ $Q_m = 12.534$

See Tables 17.16 and 17.11. See also (1982AJ01).

50. (a) ^{18}O(^{10}B, ^{11}B)^{17}O $\qquad$ $Q_m = 3.410$
(b) ^{18}O(^{11}B, ^{12}B)^{17}O $\qquad$ $Q_m = -4.674$

Angular distributions (reaction (a)) have been measured at $E(^{18}\text{O}) = 20$ and 24 MeV: see (1977AJ02). For S-factor measurements see (1977AJ02). Cross sections for reaction (b) are several orders of magnitude less than those for reaction (a) for $E(^{18}\text{O})_{\text{c.m.}} = 3 \rightarrow 7.7$ MeV: see (1977AJ02).

51. (a) ^{19}F(n, t)^{17}O $\qquad$ $Q_m = -7.5566$
(b) ^{19}F(p, ^{3}He)^{17}O $\qquad$ $Q_m = -8.320$

See (1977AJ02).

52. ^{19}F(d, α)^{17}O $\qquad$ $Q_m = 10.033$

Observed α-groups are displayed in Table 17.14 of (1977AJ02). Angular distributions have been measured at many energies in the range $E_d = 0.3$ to 27.5 MeV [see (1977AJ02)] and at $E_d = 2.75$ MeV (1985BE2J; α_0). See also (1983JI04).

Table 17.15: States of ^{17}O from ^{18}O(d, t) [a]

E_x [b] (MeV)	$J^\pi; T$ [b]	l	C^2S
0	$\frac{5}{2}^+; \frac{1}{2}$	2	1.53
0.87	$\frac{1}{2}^+; \frac{1}{2}$	0	0.21
3.06	$\frac{1}{2}^-; \frac{1}{2}$	1	1.08
3.84	$\frac{5}{2}^-; \frac{1}{2}$	> 2	
4.55	$\frac{3}{2}^-; \frac{1}{2}$	1	0.12
5.09	$\frac{3}{2}^+; \frac{1}{2}$	2	0.10
5.38	$\frac{3}{2}^-; \frac{1}{2}$	1	0.53
5.70	$\frac{7}{2}^-; \frac{1}{2}$		
5.94	$\frac{1}{2}^-; \frac{1}{2}$	1	0.06
6.86		$\neq 1$	
7.38 [c]	$\frac{5}{2}^+ + \frac{5}{2}^-$	$\neq 2$	
8.20	$\frac{3}{2}^-; \frac{1}{2}$	1	0.15
8.47	$\frac{7}{2}^+; \frac{1}{2}$		
8.69	$\frac{3}{2}^-; \frac{1}{2}$	1	0.10
9.15	$\frac{1}{2}^-; \frac{1}{2}$	1	0.10
9.49	$\frac{5}{2}^-; \frac{1}{2}$		
11.08	$\frac{1}{2}^-; \frac{3}{2}$	1	0.96
11.41 ± 0.01 [a]	$T = \frac{1}{2}$ [a]	(1)	0.04
12.12 ± 0.01 [a]	$T = \frac{1}{2}$ [a]	(1)	0.24
12.47	$\frac{3}{2}^-; \frac{3}{2}$	1	0.24
12.76 ± 0.01 [a]	$T = \frac{1}{2}$ [a]	(1)	0.17
12.94	$\frac{1}{2}^+; T = \frac{3}{2}$	0	0.19 ± 0.05
13.64	$(\frac{5}{2})^+; \frac{3}{2}$	2	0.29 ± 0.12
16.58 ± 0.01 [a]	$(\frac{1}{2}, \frac{3}{2})^-; \frac{3}{2}$ [a]	1	0.93
18.14 ± 0.01 [a]	$(\frac{1}{2}, \frac{3}{2})^-; \frac{3}{2}$ [a]	1	0.17

[a] (1977MA10): $E_d = 52$ MeV; DWBA analysis. See also Table 17.16 in (1982AJ01). Comparisons of the (d, t) and (d, ^{3}He) reactions to analog states of ^{17}N and ^{17}O have been made by (1977MA10).

[b] From Table 17.7, unless footnote is shown.

[c] Unresolved.

Table 17.16: $T = \frac{3}{2}$ states of ^{17}O from ^{18}O(^{3}He, α)^{17}O [a]

E_x (MeV ± keV)	l_n	J^π	C^2S [b]
11.082 ± 6	1	$(\frac{1}{2})^-$	0.49
12.471 ± 5	1	$(\frac{3}{2})^-$	0.27
12.950 ± 8	0	$\frac{1}{2}^+$	0.096
12.994 ± 8			
13.640 ± 5	2	$(\frac{5}{2})^+$	0.39
14.219 ± 8			
14.282 ± 12			
15.101 ± 8			

[a] See also Table 17.11, and Table 17.17 in (1982AJ01).
[b] Calculated assuming $C^2S = 4$ for ^{15}O*(6.18) in ^{16}O(^{3}He, α)^{15}O.

53. (a) ^{19}F(α, ^{6}Li)^{17}O $\qquad Q_m = -12.339$
(b) ^{20}Ne(n, α)^{17}O $\qquad Q_m = -0.590$

See (1977AJ02).

54. ^{23}Na(d, ^{8}Be)^{17}O $\qquad Q_m = -0.528$

See (1984NE1A).

^{17}F

(Figs. 8 and 9)

GENERAL: (See also (1982AJ01).)

Nuclear models: (1982ZH01, 1983BR29, 1984ZI04, 1985ME06).

Special states: (1981WI1K, 1983AU1B, 1983BR29, 1983WI15, 1984ANZV, 1985ME06, 1985SH24).

Electromagnetic transitions: (1982BR24, 1983BR29, 1983TO08, 1984SAZW, 1985AL21).

Astrophysical questions: (1981WA1Q, 1981WE1F, 1982WI1B).

Complex reactions involving ^{17}F: (1984GR08, 1984HI1A, 1984HO23).

Pion reactions: (1980CR03).

Hypernuclei: (1981KO1V, 1984AS1D).

Other topics: (1981SH17, 1983AR1J, 1983BR29, 1983KH1D, 1983MA38, 1983SH1T, 1983TO08, 1985AL21, 1985AN28, 1985SH24, 1986WI03).

Ground state of ^{17}F: (1983AD1B, 1983ANZQ, 1983AR1J, 1983AU1B, 1983BU07, 1983DE1X, 1983MA38, 1983TO08, 1983ZI1C, 1984BE11, 1984BO11, 1984BR25, 1984ZI04, 1985AN28, 1985AR11, 1985HA18, 1985ZI05, 1986WI03).

$$\mu = 4.7223 \pm 0.0012 \text{ nm (1978LEZA)},$$

$$Q = 0.10 \pm 0.02 \text{ b (1974MI21)}.$$

1. ^{17}F(β^+)^{17}O $\qquad Q_m = 2.7608$

The half-life of ^{17}F is 64.49 ± 0.16 sec; $\log ft = 3.358 \pm 0.002$. The $\log ft$ for the transition to ^{17}O*(0.87) is > 5.6: see (1982AJ01). See also (1983GO2C, 1983RA29, 1985BR29) and (1981ME1H, 1982OS1C, 1984AR1D, 1984BE11; theor.).

2. ^{12}C(^{14}N, ^{9}Be)^{17}F $\qquad Q_m = -10.4358$

See (1982AJ01).

3. ^{14}N(^{3}He, γ)^{17}F $\qquad Q_m = 15.8432$

Table 17.17: Energy levels of ^{17}F [a]

E_x in ^{17}F (MeV $\pm$ keV)	$J^\pi; T$	τ or $\Gamma_{c.m.}$ (keV)	Decay	Reactions
0	$\frac{5}{2}^+; \frac{1}{2}$	$\tau_{1/2} = 64.49 \pm 0.16$ sec	β^+	1, 2, 3, 4, 5, 6, 12, 13, 14, 15, 16, 17, 18, 19, 20
0.49533 ± 0.10	$\frac{1}{2}^+$	$\tau_m = 412 \pm 9$ psec	γ	2, 3, 4, 5, 6, 12, 13, 14, 15, 16, 17, 19
3.104 ± 3	$\frac{1}{2}^-$	$\Gamma = 19 \pm 1$	γ, p	3, 4, 5, 6, 7, 12, 13, 17, 19
3.857 ± 4	$\frac{5}{2}^-$	1.5 ± 0.2	γ, p	3, 4, 5, 6, 7, 12, 13, 19
4.64 ± 20	$\frac{3}{2}^-$	225	p	4, 5, 7, 12, 15, 17
5.00 ± 20	$\frac{3}{2}^+$	1530	p	7
5.220 ± 10	$(\frac{9}{2}^-)$			4, 5, 14
5.488 ± 11	$\frac{3}{2}^-$	68	p	4, 5, 7, 17
5.672 ± 20	$\frac{7}{2}^-$	40	p	4, 5, 7
5.682 ± 20	$\frac{1}{2}^+$	< 0.6	p	4, 5, 7
5.82 ± 20	$\frac{3}{2}^+$	180	p	4, 7, 15
6.037 ± 9	$\frac{1}{2}^-$	30	p	4, 5, 7, 17
6.406 ± 30	$(\frac{1}{2}^-, \frac{3}{2}^-)$		p	17
6.56 ± 20	$\frac{1}{2}^+$	200	p	7
6.697 ± 7	$\frac{5}{2}^+$	$\leq 1.6 \pm 0.2$	p	4, 5, 7
6.774 ± 20	$\frac{3}{2}^+$	4.5	p	7
7.027 ± 20	$\frac{5}{2}^-$	3.8	p	5, 7
7.356 ± 20	$\frac{3}{2}^+$	10 ± 2	p, α	5, 7, 11
7.448 ± 20		≤ 5	p	7
7.454 ± 20		7 ± 2	p, α	7, 11
7.471 ± 20		5 ± 2	p	7
7.479 ± 20	$\frac{3}{2}^+$	795	p	7
7.546 ± 20	$\frac{7}{2}^-$	30	p	7
7.75 ± 40 [b]	$(\frac{1}{2}^+)$	179 ± 30	p, α	7, 11, 17
7.95 ± 30		10 ± 3	p	7
8.01 ± 40		50 ± 20	p, α	7, 11
8.07 ± 30	$\frac{5}{2}^{(+)}$	100 ± 20	p, α	5, 7, 11

Table 17.17: Energy levels of ^{17}F [a] (continued)

E_x in ^{17}F (MeV ± keV)	$J^\pi; T$	τ or $\Gamma_{c.m.}$ (keV)	Decay	Reactions
8.075 ± 10	$(\frac{1}{2}, \frac{3}{2})^-$		p	5, 17
8.2	$\frac{3}{2}^{(-)}$	700 ± 250	p, α	7, 11
8.383 ± 10	$\frac{5}{2}^{(-)}$	11 ± 5	p, α	7, 11
8.416 ± 20	$(\frac{7}{2}^+)$	45 ± 10	p, α	7, 11
8.436 ± 10	$(\frac{1}{2}, \frac{3}{2})^-$		p	17
8.75 ± 60	$\frac{5}{2}^{(+)}$	170 ± 30	p, α	7, 11
8.76	$\frac{3}{2}^+$	90 ± 20	p	7
8.825 ± 25	$(\frac{1}{2}, \frac{3}{2})^-$		p	17
8.98 ± 20	$\frac{7}{2}^-$	165 ± 30	p, α	7, 11
9.17 ± 60	$\frac{3}{2}^{(+)}$	140 ± 30	p, α	7, 11, 15
9.92	$\frac{9}{2}^+$	90 ± 30	p, α	7, 11
10.04 ± 40	$\frac{7}{2}$	280 ± 100	p	7
10.22 ± 40		250 ± 80	α	11
10.40 ± 40	$(\frac{5}{2}^+)$	160 ± 40	p	7
10.499 ± 30	$\frac{7}{2}^-$	165 ± 25	p, α	7, 11
10.79 ± 40		120 ± 40	p, (α)	7, 11
10.91 ± 100	$\frac{1}{2}^-$	560 ± 100	p	7
10.95 ± 40		190 ± 50	p, (α)	7, 11
11.1929 ± 2.3	$\frac{1}{2}^-; \frac{3}{2}$	0.20 ± 0.04	γ, p, α	5, 6, 7, 11, 17
11.43 ± 40		240 ± 50	p, α	7, 11
11.58 ± 50		160 ± 30	p	7
12.00 ± 40		120 ± 40	p, α	7, 11
12.25 ± 40	$\frac{3}{2}^-$	300 ± 30	p	7
12.355 ± 20	$\frac{1}{2}^-$	190 ± 20	p	7
≈ 12.50	$\frac{7}{2}^-$	≈ 600	p	7
12.5501 ± 0.9	$\frac{3}{2}^-; \frac{3}{2}$	2.83 ± 0.12	γ, p, α	5, 6, 7, 11
13.061 ± 4	$\frac{5}{2}^-; \frac{3}{2}$	2 ± 1	γ, p, α	5, 6, 7, 11
13.080 ± 4	$(\frac{1}{2}^+); \frac{3}{2}$	2 ± 1	p, α	7, 11
13.13 ± 100	$\frac{5}{2}^-$	520 ± 50	p	7
13.781 ± 4	$\frac{5}{2}^+; \frac{3}{2}$	12 ± 5	p, α	7, 11
14.00 ± 50	$\frac{7}{2}^-$	260 ± 30	p	7

Table 17.17: Energy levels of ^{17}F [a] (continued)

E_x in ^{17}F (MeV ± keV)	$J^\pi; T$	τ or $\Gamma_{c.m.}$ (keV)	Decay	Reactions
14.176 ± 6	$\frac{3}{2}^-; \frac{3}{2}$	30 ± 5	γ, p	6, 7
14.3038 ± 3.1	$\frac{7}{2}^-; \frac{3}{2}$	19.3 ± 1.6	γ, p, α	6, 7, 11
14.38 ± 50	$\frac{5}{2}^-$	610 ± 50	p	7, 15
14.71 ± 100	$\frac{1}{2}^-$	470 ± 100	p	7
14.809 ± 20	$\frac{1}{2}^+$	190 ± 25	p	7
15.6		≈ 550	p	7
17.1	$\frac{5}{2}^-$	1500	p	7
20.1 ± 200		1070 ± 160	γ, ^{3}He	3
20.4 ± 100		700 ± 100	γ, ^{3}He	3
20.9	$\frac{9}{2}^+$	600	p	7
21.3 ± 100		900 ± 100	γ, ^{3}He	3
21.8	$(\frac{9}{2}^+)$	400	p	7
22.7	$\frac{7}{2}^+$	600	p	7
23.8	$\frac{7}{2}^+$	600	p	7
25.4	$\frac{7}{2}^-$	1500	p	7
27.2	$\frac{5}{2}^-$	1500	p	7
28.9	$\frac{5}{2}^+$	2000	p	7

[a] See also Table 17.19. I am very indebted to Drs. H.T. Richards and E.K. Warburton for their comments.

[b] May be a doublet: compare Table 17.19 and 17.21.

Excitation functions for γ_{0+1}, γ_2 and γ_3 have been studied for $E(^3\text{He}) \approx 3$ to 18 MeV. Resonances are reported corresponding to ^{17}F states at 20.1 ± 0.2 (γ_2) [$\Gamma = 1.07 \pm 0.16$ MeV], 20.4 ± 0.1 (γ_1) [0.7 ± 0.1] and 21.3 ± 0.1 MeV (γ_1) [0.9 ± 0.1] (1983WA05): see Table 17.19 in (1982AJ01). For neutron and charged-particle channels see reaction 6 in (1982AJ01).

4. (a) ^{14}N(^{6}Li, t)^{17}F $\qquad Q_m = 0.0476$

(b) ^{14}N(^{6}Li, tα)^{13}N $\qquad Q_m = -5.7713$

Angular distributions (reaction (a)) have been measured at $E(^6\text{Li}) = 36$ MeV involving ^{17}F*(8.43, 10.7, 11.9, 13.51, 14.84). Comparisons are made with the results in the analog reaction (reaction 19) in ^{17}O (1984ET01). [Comment: compare the experimental resolution with the density of states]. For the earlier work see (1982AJ01).

Table 17.18: Resonances in ^{16}O(p, γ)^{17}F [a]

E_p (MeV $\pm$ keV)	Resonant in [b]	Γ_γ (eV)	Γ (keV)	E_x (MeV)	$J^\pi; T$
2.66	γ_1	$(12 \pm 2) \times 10^{-3}$		3.11	$\frac{1}{2}^-; \frac{1}{2}$
3.47	γ_0	0.11 ± 0.02	< 1.5	3.86	$\frac{5}{2}^-; \frac{1}{2}$
11.275 ± 6	γ_1	6.0 ± 2.5 [c]	≤ 1.6	11.204	$\frac{1}{2}^-; \frac{3}{2}$
12.707 ± 1	$\gamma_0 + \gamma_1$	11.3 ± 3.4 [c]	1.8 ± 0.5	12.550	$\frac{3}{2}^-; \frac{3}{2}$
13.255 ± 6	$\gamma_0 + \gamma_1$	2.8 ± 1.8 [c]	5.0 ± 1.5	13.065	$\frac{5}{2}^-; \frac{3}{2}$
14.435 ± 10	γ_0	72 ± 37 [e]	41 ± 10	14.174	$\frac{3}{2}^-; \frac{3}{2}$
14.583 ± 6 [d]	$\gamma_0 + \gamma_1$	13.4 ± 7.0 [c]	28 ± 5	14.313	$\frac{7}{2}^-; \frac{3}{2}$

[a] See also Table 17.19 and Table 17.20 in (1982AJ01).

[b] γ_0 and γ_1 correspond to transitions to ^{17}F*(0, 0.50), respectively.

[c] These Γ_γ are based on J^π and Γ_{p_0}/Γ determinations quoted by (1975HA06). The B(E1) values for these four states are 4.7 ± 2.0, 5.4 ± 1.6, 1.2 ± 0.8 and $4.4 \pm 2.3[\times 10^{-3}]e^2 \cdot$ fm^2.

[d] See the text of reaction 6 for discussion of the observed pigmy and giant resonances (1975HA07).

[e] See also Table 17.18 in (1977AJ02).

5. ^{15}N(^{3}He, n)^{17}F $\qquad Q_m = 5.0099$

Angular distributions have been reported to most of the states of ^{17}F with $E_x < 8.1$ MeV at $E(^3\text{He}) = 3.8$ and 4.8 MeV. Neutron groups have also been reported to ^{17}F states at $E_x = 11.195 \pm 0.007$, 12.540 ± 0.010 and 13.059 MeV, with $\Gamma < 20$, < 25 and < 25 keV, respectively. Angular distributions at $E(^3\text{He}) = 10.36$ and 11.88 MeV lead to $J^\pi = \frac{1}{2}^-$ for ^{17}F*(11.20)[$L = 0$], $\frac{3}{2}^-$ or $\frac{5}{2}^-$ for ^{17}F*(12.54) and $(\frac{3}{2}^-, \frac{5}{2}^-)$ for ^{17}F*(13.06). These three states are probably the first three $T = \frac{3}{2}$ states in ^{17}F (1969AD02). The branching ratios for transitions to ^{16}O*(0, 6.05, 6.13) for ^{17}F*(11.20) and for the analog $T = \frac{3}{2}$ state in ^{17}O are displayed in Table 17.11: the ratios of the reduced widths are quite different in the two mirror nuclei. See (1977AJ02) for references.

6. ^{16}O(p, γ)^{17}F $\qquad Q_m = 0.6005$

At low energies the direct capture to ^{17}F*(0, 0.50) is observed. Extrapolation of cross-section data leads to $S(0) \approx 8$ keV $\cdot$ b: see (1977AJ02). In addition to two $T = \frac{1}{2}$ resonances, five resonances corresponding to $T = \frac{3}{2}$ states are observed in the γ_1 and $\gamma_0 + \gamma_1$ yields: see Table 17.18 for the reported parameters. The lowest $T = \frac{3}{2}$ states of even parity at $E_x = 13.27$ and 14.02 MeV [$J^\pi = (\frac{1}{2}^+)$ and $\frac{5}{2}^+$] (see Table 17.19) are not observed here: $\Gamma_\gamma \leq 7$ and ≤ 11.8 eV, respectively (1975HA06).

The $(\gamma_0 + \gamma_1)$ yield at $90°$ has been studied for $E_p = 15.75$ to 31.66 MeV: it shows the giant dipole resonance centered at $E_x = 22$ MeV with a width of ≈ 5 MeV and a pigmy resonance centered at 17.5 MeV. The integrated strength of the, mainly $T = \frac{1}{2}$, giant resonance is 10 MeV $\cdot$ mb: the observed strength distribution is in good agreement with odd parity 2p-1h, 1p excitation calculations. The pigmy resonance is due to $f_{7/2} \rightarrow d_{5/2}$. The main $f_{7/2}$ strength lies in two states at $E_x = 16.9$ and 18.0 MeV (1975HA07). See also (1982AN1D, 1982BE29, 1983RA1G, 1984JEZY), (1982BA80, 1984BO1Q; astrophysics), (1985BL1B, 1986WE1D) and (1982DU1A, 1984PE02; theor.).

7. (a) ^{16}O(p, p)^{16}O $E_b = 0.6005$

(b) ^{16}O(p, 2p)^{15}N $Q_m = -12.1276$

(c) ^{16}O(p, pn)^{15}O $Q_m = -15.6639$

(d) ^{16}O(p, pα)^{12}C $Q_m = -7.16195$

Yield curves for elastic protons, protons scattered to ^{16}O*(6.05, 6.13, 6.92, 7.12, 8.87) and for γ-rays from ^{16}O*(6.13, 6.92) have been studied at many energies up to $E_p = 46$ MeV: see (1971AJ02, 1977AJ02, 1982AJ01). The observed resonances are displayed in Table 17.19. Absolute $\sigma(\theta)$ [$\theta = 110°$ to $160°$] have been measured for $E_p = 0.60$ to 2.00 MeV to ±5% (1983BR11). Cross sections for bremsstrahlung emission are reported in the vicinity of the $E_p = 2.66$ MeV resonance by (1983TRZZ). The cross sections of the 6.13 MeV γ-ray at $E_p = 23.7$ and 44.6 MeV have been measured by (1981NA14), and (1979SC07) report the σ_t for $E_p = 190$ to 558 MeV. See also (1982AJ01).

A_y measurements have beem recently reported at $E_{\vec{p}} = 35$ MeV (1986OH1C; to ^{16}O*(10.96, 12.80)), 65 MeV (1982SA19; p$_0$), 65 MeV (1984HO17; to ^{16}O*(10.96, 12.80)), 135 and 180 MeV (1983HYZZ; to ^{16}O*(8.87)), 180 MeV (1983FIZW; to many states including ^{16}O*(11.10)) and 200 MeV (1985GL01; p$_0$). At $E_{\vec{p}} = 318$ and 498 MeV (1983LOZW, 1986LO1D) have measured A_y and spin transfer observables for the p$_0$, p$_2$, p$_3$ and p$_4$ groups. Polarization transfer coefficients have been studied at $E_{\vec{p}} = 200$ MeV to the 4^- states ^{16}O*(17.79, 19.81) [$T = 0$] and ^{16}O*(18.98) [$T = 1$] (1985WIZW, 1986OL1A). The spin rotation parameter Q has been measured for the elastic scattering at $E_{\vec{p}} = 65$ MeV by (1986SA1J), at 200 MeV by (1985STZW, 1986ST1G) [see (1986ST1F) for polarization transfer coefficients for ^{16}O*(17.79, 18.98, 19.81)] and at 800 MeV by (1986FE01). See also (1986GL1G). For the earlier work see (1982AJ01).

For reaction (b) see (1982REZZ). For reaction (c) see (1983WA1C, 1984WA21). See also (1982REZZ). For fragmentation see (1985GU1A, 1985VDZX). See also ^{16}O and (1982AU1A, 1982BE1A, 1982YA1A, 1983BE1A, 1984GE1A, 1984RE14) and (1981PI11, 1981SH1A, 1982CO17, 1982KO23, 1982NA13, 1982YA07, 1983BE1B, 1983KE1B, 1983KO1B, 1983SH05, 1984GO04, 1984HY01, 1984PH02, 1984PI05, 1984PI17, 1984WO12, 1985AU02, 1985DY03, 1985HY01, 1985KE1A, 1985KO37, 1986DE1G, 1986KU1D, 1986LO1A; theor.).

Table 17.19: Resonances in ^{16}O(p, p)^{16}O and ^{16}O(p, α)^{13}N [a]

E_p (MeV ± keV)	$\Gamma_{c.m.}$ (keV)	Particles out	Γ_{p_0}/Γ	^{17}F* (MeV)	$J^\pi; T$
2.663 ± 7	19 ± 1	p_0		3.105	$\frac{1}{2}^-$
3.47	1.53 ± 0.2	p_0		3.86	$\frac{5}{2}^-$
4.304 ± 20 [b]	225	p_0		4.649	$\frac{3}{2}^-$
4.672 ± 20 [b]	1530	p_0		4.995	$\frac{3}{2}^+$
5.231 ± 20	68	p_0		5.521	$\frac{3}{2}^-$
5.392 ± 20	40	p_0		5.672	$\frac{7}{2}^-$
5.402 ± 20	< 0.6	p_0		5.682	$\frac{1}{2}^+$
5.546 ± 20	180	p_0		5.817	$\frac{3}{2}^+$
5.779 ± 20	30	p_0		6.036	$\frac{1}{2}^-$
6.332 ± 20	200	p_0		6.556	$\frac{1}{2}^+$
6.482 ± 7 [c]	$\leq 1.6 \pm 0.2$	p_0	$\geq 0.25 \pm 0.04$	6.697	$\frac{5}{2}^+$
6.564 ± 20	4.5	p_0		6.774	$\frac{3}{2}^+$
6.833 ± 20	3.8	$p_0, \gamma_{6.13}$		7.027	$\frac{5}{2}^-$
7.183 ± 20	10 ± 2	p_0, p_2, α_0		7.356	$\frac{3}{2}^+$
7.280 ± 20	≤ 5	p_0		7.448	
7.287 ± 20	7 ± 2	p_0, p_1, p_2, α		7.454	
7.305 ± 20	5 ± 2	p_0, p_2		7.471	
7.313 ± 20	795	p_0		7.479	$\frac{3}{2}^+$
7.385 ± 20	30	$p_0, p_2, \gamma_{6.13}$		7.546	$\frac{7}{2}^-$
7.60 ± 40	179 ± 30	p_0, p_1, α_0		7.75	$\frac{1}{2}^+$
7.81 ± 30	10 ± 3	p_2		7.95	
7.88 ± 40	50 ± 20	$p_0, \gamma_{6.13}, \gamma_{6.92}, \alpha_0$		8.01	
7.94 ± 30	100 ± 20	p_0, p_1, α_0		8.07	$\frac{5}{2}^{(+)}$
8.1	700 ± 250	$(p_0), p_1, \alpha_0$		8.2	$\frac{3}{2}^{(-)}$
8.275 ± 10	11 ± 5	$p_0 \to p_3, \alpha_0$		8.383	$\frac{5}{2}^{(-)}$
8.310 ± 20	45 ± 10	$p_0 \to p_3, \gamma_{6.13}, \gamma_{6.92}, \alpha_0$		8.416	$(\frac{7}{2}^+)$
8.66 ± 60	170 ± 30	p_2, p_3, p_4, α_0		8.75	$\frac{5}{2}^{(+)}$
8.68	90 ± 20	p_0	0.2	8.76	$\frac{3}{2}^+$
8.91	165 ± 30	$p_0 \to p_4, \gamma_{6.13}, \gamma_{6.92}, \alpha_0$	0.34 ± 0.05	8.98 ± 0.02	$\frac{7}{2}^-$
9.11	140 ± 30	$p_0 \to p_4, \gamma_{6.13}, \gamma_{6.92}, \alpha_0$	0.55 ± 0.05	9.17 ± 0.06	$\frac{3}{2}^{(+)}$
9.91	90 ± 30	p_0, p_2, α_0	0.095 ± 0.005	9.92	$\frac{9}{2}^+$
10.04 ± 40	280 ± 100	p_0, p_1		10.04	$\frac{7}{2}$
10.23 ± 40	250 ± 80	α_0		10.22	

Table 17.19: Resonances in ^{16}O(p, p)^{16}O and ^{16}O(p, α)^{13}N [a] (continued)

E_p (MeV ± keV)	$\Gamma_{c.m.}$ (keV)	Particles out	Γ_{p_0}/Γ	^{17}F* (MeV)	$J^\pi; T$
10.42 ± 40	160 ± 40	p_0, p_1, p_3		10.40	$(\frac{5}{2}^+)$
10.525 ± 30	165 ± 25	p_0, p_2, α_0	0.28 ± 0.03	10.499	$\frac{7}{2}^-$
(10.75 ± 50)		p_0, p_1, α_0		(10.71)	$(\frac{7}{2}^-)$
10.83 ± 40	120 ± 40	$p_0, p_2, (p_3), (\alpha_0)$		10.79	
10.96 ± 100	560 ± 100	p_0	0.25 ± 0.07	10.91	$\frac{1}{2}^-$
11.00 ± 40	190 ± 50	$(p_2), p_3, (\alpha_0)$		10.95	
11.2636 ± 2.0 [d]	0.20 ± 0.04	p_0, p_2, p_4, α_0	0.093 ± 0.013	11.1929 ± 2.1	$\frac{1}{2}^-; \frac{3}{2}$
11.52 ± 40	240 ± 50	p_2, α_0		11.43	
11.67 ± 50	160 ± 30	p_0, p_3		11.58	
12.12 ± 40	120 ± 40	p_2, α_0		12.00	
12.39 ± 40	300 ± 30	p_0, p_2	0.26 ± 0.03	12.25	$\frac{3}{2}^-$
12.500 ± 20	190 ± 20	p_0, p_1, p_4	0.31 ± 0.03	12.355	$\frac{1}{2}^-$
≈ 12.65	≈ 600	p_0	≈ 0.09	≈ 12.50	$\frac{7}{2}^-$
12.7077 ± 2.0 [e]	2.83 ± 0.12	$p_0, p_2, p_4, p_5, \alpha_0, \alpha_1$	0.332 ± 0.018	12.5505 ± 2.3	$\frac{3}{2}^-; \frac{3}{2}$
(13.06 ± 100)		p_0		(12.88)	$(\frac{7}{2}^-)$
(13.06 ± 50)		p_0		(12.88)	$(\frac{1}{2}^+)$
13.250 ± 4	2 ± 1	$p_0, p_{1+2}, p_{3+4}, p_5, \alpha_0$	0.15 ± 0.04	13.060	$\frac{5}{2}^-; \frac{3}{2}$
13.271 ± 4	2 ± 1	$p_0 \rightarrow p_4, \alpha_0$	0.04 ± 0.02	13.080	$(\frac{1}{2}^+); \frac{3}{2}$
13.32 ± 100	520 ± 50	p_0	0.163 ± 0.016	13.13	$\frac{5}{2}^-$
14.017 ± 4	12 ± 5	$p_0, p_{1+2}, p_{3+4}, \alpha_0$	0.02 ± 0.01	13.781	$\frac{5}{2}^+; \frac{3}{2}$
(14.20 ± 50)		p_0		(13.95)	$(\frac{1}{2}^+)$
14.25 ± 50	260 ± 30	p_0	0.08 ± 0.01	14.00	$\frac{7}{2}^-$
14.438 ± 6	27 ± 5	p_0, p_{3+4}	0.04 ± 0.02	14.177	$\frac{3}{2}^-; \frac{3}{2}$
14.5730 ± 3.0 [f]	19.3 ± 1.6	$p_0, p_{1+2}, p_{3+4}, p_5, \alpha_0$	0.085 ± 0.008	14.3038 ± 3.1	$\frac{7}{2}^-; \frac{3}{2}$
14.65 ± 50	610 ± 50	p_0	0.10 ± 0.01	14.38	$\frac{5}{2}^-$
(14.94 ± 100)		p_0			$(\frac{3}{2}^-)$
15.00 ± 100	470 ± 100	p_0	0.25 ± 0.03	14.71	$\frac{1}{2}^-$
15.110 ± 20	190 ± 25	p_0	0.150 ± 0.015	14.809	$\frac{1}{2}^+$
(15.245 ± 100)		p_0		(14.94)	$(\frac{5}{2}^+)$
(15.30 ± 50)		p_0		(14.98)	$(\frac{3}{2}^+)$
(15.37 ± 100)		p_0		(15.05)	$(\frac{3}{2}^-)$
(15.545 ± 100)		p_0		(15.22)	$(\frac{7}{2}^-)$
15.9 [g]	≈ 550	p_0, p_{1+2}		15.6	

Table 17.19: Resonances in ^{16}O(p, p)^{16}O and ^{16}O(p, α)^{13}N [a] (continued)

E_p (MeV $\pm$ keV)	$\Gamma_{c.m.}$ (keV)	Particles out	Γ_{p_0}/Γ	^{17}F* (MeV)	$J^\pi; T$
17.6	1500	p_0, p_{3+4}		17.1	$\frac{5}{2}^-$
20.4	600	p_0		19.8	$\frac{3}{2}^+$
21.6	600	p_0, (α)		20.9	$\frac{9}{2}^+$
22.6	400	p_0, (α)		21.8	$(\frac{9}{2}^+)$
23.5	600	p_0, p_5		22.7	$\frac{7}{2}^+$
24.7	600	p_0, (α)		23.8	$\frac{7}{2}^+$
26.4	1500	p_0, (α)		25.4	$\frac{7}{2}^-$
28.3	1500	p_0		27.2	$\frac{5}{2}^-$
30.1	2000	p_0		28.9	$\frac{5}{2}^+$

[a] See earlier references and comments in Tables 17.20 (1971AJ02), 17.19 (1977AJ02) and 17.21 (1982AJ01). See also Table 17.18 here. Uncertainties in E_p (below 12.7 MeV) have been increased because of a possible error in calibrating the magnet used in many of the measurements reported in (1971AJ02). See also (1964DA02). [Reviewer's comment: these measurements should be repeated.] I am grateful to Drs. H.T. Richards and E.K. Warburton for their many comments.

[b] E_r, not E_λ, is used for calculating E_x.

[c] (1982SE01). Uncertainty in E_p estimated by reviewer. See also (1982AJ01).

[d] $\Gamma_{p_0} = 19 \pm 3$ eV (1976HI09).

[e] $\Gamma_{p_0} = 0.94 \pm 0.06$ keV, $\Gamma_{\alpha_0} = 62 \pm 16$ eV, $\Gamma_{\alpha_1} = 53 \pm 22$ eV (1976HI09); J. Lowe, private communication.

[f] $\Gamma_{p_0} = 1.65 \pm 0.12$ keV, $\Gamma_{\alpha_0} = 2.6 \pm 0.7$ keV (1976HI09).

[g] See also Table 17.20 of (1971AJ02) for possible other resonances.

8. ^{16}O(p, n)^{16}F $\qquad Q_m = -16.199 \qquad E_b = 0.6005$

The analyzing power for the transition to the 4^- state ^{16}F*(6.37) has been measured at $E_{\vec{p}} = 135$ MeV (1982MA11). See also ^{16}F.

9. ^{16}O(p, d)^{15}O $\qquad Q_m = -13.4393 \qquad E_b = 0.6005$

The excitation function for d_0 ($\theta = 70°$) has been measured for $E_p = 21$ to 38.5 MeV. A strong resonance is observed at $E_p = 24$ MeV: see Table 17.19. The analyzing power has been measured for the d_0 group at $E_{\vec{p}} = 65$ MeV (1980HO18). See (1982AJ01) for the earlier work.

10. (a) ^{16}O(p, t)^{14}O $\qquad Q_{\rm m} = -20.4045 \qquad E_{\rm b} = 0.6005$

(b) ^{16}O(p, ^{3}He)^{14}N $\qquad Q_{\rm m} = -15.2428$

See (1982AJ01) and ^{14}N, ^{14}O in (1986AJ01).

11. ^{16}O(p, α)^{13}N $\qquad Q_{\rm m} = -5.2184 \qquad E_{\rm b} = 0.6005$

Observed resonances are displayed in Table 17.19. Some broad structures have been reported above $E_{\rm p} \approx 15$ MeV; particularly strong peaks appear at $E_{\rm p} \approx 22$ and 25.5 MeV: see (1977AJ02).

This reaction is involved in explosive burning in stars: see (1977AJ02, 1982AJ01) for the earlier work and (1979MO04).

12. ^{16}O(d, n)^{17}F $\qquad Q_{\rm m} = -1.6241$

Parameters of the first excited state of ^{17}F are $E_{\rm x} = 495.33 \pm 0.10$ keV, $\tau_{\rm m} = 407 \pm 9$ psec: see (1971AJ02). See also Table 17.21 in (1971AJ02). For polarization measurements see (1981LI23) and ^{18}F in (1983AJ01). See also (1983CR1A).

13. ^{16}O(^{3}He, d)^{17}F $\qquad Q_{\rm m} = -4.8931$

At $E(^3{\rm He}) = 18$ MeV, angular distributions of the deuterons to ^{17}F*(0, 0.50, 3104 ± 0.003, 3.857 ± 0.004) have been measured. The spectroscopic factors for ^{17}F*(0, 0.50) are 0.94 and 0.83. Two-step processes appear to be involved in the excitation of ^{17}F*(3.10, 3.86). Angular distributions have also been measured at $E(^3{\rm He}) = 30$ MeV (to ^{17}F*(5.1, 5.7)) and at $E(^3\vec{\rm He}) = 33$ MeV (d_0, d_1): see (1982AJ01) for references.

14. (a) ^{16}O(^{10}B, ^{9}Be)^{17}F $\qquad Q_{\rm m} = -5.9855$

(b) ^{16}O(^{11}B, ^{10}Be)^{17}F $\qquad Q_{\rm m} = -10.6276$

(c) ^{16}O(^{12}C, ^{11}B)^{17}F $\qquad Q_{\rm m} = -15.3566$

(d) ^{16}O(^{13}C, ^{12}B)^{17}F $\qquad Q_{\rm m} = -16.933$

(e) ^{16}O(^{14}N, ^{13}C)^{17}F $\qquad Q_{\rm m} = -6.9502$

(f) ^{16}O(^{16}O, ^{15}N)^{17}F $\qquad Q_{\rm m} = -11.5271$

See (1982AJ01). See also (1984CL09; theor.) for reaction (f).

15. ^{17}O(p, n)^{17}F $\quad\quad Q_m = -3.5432$

At $E_p = 135.2$ MeV differential cross sections are reported for the transitions to ^{17}F*(0, 0.5 ± 0.05, 4.84 ± 0.1, 5.89 ± 0.2, 6.34 ± 0.2, 7.26 ± 0.2, 7.64 ± 0.2, 9.3 ± 0.1, 14.3 ± 0.1). [Note known density of states.] The group to ^{17}F*(4.84) has $\Gamma = 1.8 \pm 0.05$ MeV (1985PU1A). For a discussion of Gamow-Teller transition probabilites see (1985WA24). For A_y measurements see (1985PU1A, 1983PUZZ). For the earlier work see (1982AJ01).

16. ^{17}O(^{3}He, t)^{17}F $\quad\quad Q_m = -2.7794$

Angular distributions have been studied at $E(^3\text{He}) = 17.3$ MeV [t_0, t_1] and at $E(^3\vec{\text{He}}) = 33$ MeV [t_0]: see (1982AJ01).

17. ^{17}Ne(β^+)^{17}F $\quad\quad Q_m = 14.53$

See ^{17}Ne.

18. ^{18}O(^{18}O, ^{19}N)^{17}F $\quad\quad Q_m = -19.39$

See (1983DE1A).

19. ^{19}F(p, t)^{17}F $\quad\quad Q_m = -11.0998$

See (1977AJ02).

20. ^{26}Mg(^{18}O, ^{27}Na)^{17}F $\quad\quad Q_m = -13.30$

See (1985FI08).

^{17}Ne

(Figs. 8 and 9)

GENERAL: (See also (1982AJ01).)

Theory and reviews: (1983ANZQ, 1983AU1B, 1985AN28).

1. (a) ^{17}Ne(β^+)^{17}F* $\rightarrow$ ^{16}O + p $\qquad Q_{\rm m} = 13.93$
   (b) ^{17}Ne(β^+)^{17}F $\qquad Q_{\rm m} = 14.53$

The half-life of ^{17}Ne is 109.0 ± 1.0 msec (1971HA05). Earlier values (see (1971AJ02)) gave a mean value of 108.0 ± 2.7 msec. The decay is primarily to the proton unstable states of ^{17}F at 4.70, 5.52 and 6.04 MeV with $J^\pi = \frac{3}{2}^-, \frac{3}{2}^-$ and $\frac{1}{2}^-$: see Table 17.21. The super-allowed decay to the analog state [^{17}F*(11.20)] has $\log ft = 3.29^{+0.04}_{-0.07}$. The character of the decay leads to $J^\pi = \frac{1}{2}^-$ for ^{17}Ne$_{\rm g.s.}$ (1971HA05). See Table 17.3 for a comparison of the mirror ^{17}N and ^{17}Ne decays and Table 17.11 for the decay of ^{17}F*(11.20). See also (1983RA29).

Table 17.20: Energy levels of ^{17}Ne [a]

$E_{\rm x}$ in ^{17}Ne (MeV)	$J^\pi; T$	$\tau_{1/2}$ (msec)	Decay	Reaction
0	$\frac{1}{2}^-; \frac{3}{2}$	109.0 ± 1.0	β^+ [b]	1

[a] The evidence for excited states of ^{17}Ne has not been published: see (1977AJ02).

[b] See also Tables 17.3 and 17.21.

^{17}Na

(Not illustrated)

^{17}Na has not been observed: its mass excess is predicted to be 35.61 MeV by (1966KE16). It is then unbound with respect to breakup into ^{16}Ne + p by 4.3 MeV and with respect to breakup into ^{14}O + 3p by 5.7 MeV. See also (1983ANZQ, 1985AN28; theor.).

^{17}Mg, ^{17}Al, ^{17}Si, ^{17}P

(Not observed)

See (1983ANZQ; theor.).

Table 17.21: β^+ decay of ^{17}Ne [a]

Decay to ^{17}F* (MeV ± keV)	J^π	Branching (%)	log ft [b]	Decay to ^{16}O* (MeV)	Decay (%)
0	$\frac{5}{2}^+$	0.5 ± 0.2 [f]	6.95 ± 0.13		
0.50	$\frac{1}{2}^+$	1.1 ± 0.5 [f]	6.55 ± 0.21		
3.084 ± 30	$\frac{1}{2}^-$	0.48 ± 0.07	6.44 ± 0.06	0	100
4.609 ± 15 [c]	$\frac{3}{2}^-$	16.2 ± 0.7	4.59 ± 0.02	0	100
5.480 ± 10	$\frac{3}{2}^-$	54.0 ± 0.7	3.86 ± 0.01	0	100
6.037 ± 10	$\frac{1}{2}^-$	10.6 ± 0.2	4.42 ± 0.01	0	100
6.406 ± 30	$(\frac{1}{2}^-, \frac{3}{2}^-)$	0.35 ± 0.10	5.80 ± 0.13	0	100
7.708 ± 30	$(\frac{1}{2}^-, \frac{3}{2}^-)$	0.18 ± 0.05	5.67 ± 0.12	0	> 95
				6.05	< 5
8.075 ± 10	$(\frac{1}{2}, \frac{3}{2})^-$	6.83 ± 0.11	3.96 ± 0.01	0	99.5
				6.05	0.49 ± 0.02
8.436 ± 10	$(\frac{1}{2}, \frac{3}{2})^-$	6.51 ± 0.26	3.85 ± 0.02	0	94.3
				6.05	5.7 ± 0.5
8.825 ± 25	$(\frac{1}{2}, \frac{3}{2})^-$	1.90 ± 0.06	4.23 ± 0.02	0	92.4
				6.05	7.6 ± 1.1
11.19 [d]	$\frac{1}{2}^-; T = \frac{3}{2}$	$0.71^{+0.10}_{-0.05}$	$3.29^{+0.04}_{-0.07}$	0	10 ± 2
				6.13	22 ± 2
				6.92	24 ± 6
				7.12	44 ± 4
[e]					

[a] (1971HA05). See also Table 17.23 in (1971AJ02). I am indebted to Drs. H.T. Richards and E.K. Warburton for their comments.

[b] log ft values calculated by (1971HA05) using an atomic mass excess of 16.517 ± 0.026 MeV [and $\tau_{1/2} = 109.0 \pm 1.0$ msec] rather than the presently adopted 16.48 ± 0.05 MeV. Since this energy difference leads to quite small changes, the original calculations are quoted here. However, Table 17.4 (which compares the analog decays) shows corrected ft values.

[c] E.K. Warburton calculates $E_x = 4613 \pm 15$ keV by weighing of the Fermi function over the width of this level.

[d] See also Table 17.11.

[e] A proton group with $E_{c.m.} = 2.83$ MeV has been observed: the level in ^{17}F to which it corresponds is not known.

[f] Calculated branchings, based on the mirror ^{17}N decay.

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