Energy Levels of Light Nuclei
$A = 20$

F. Ajzenberg-Selove

University of Pennsylvania, Philadelphia, Pennsylvania 19104-6396

Abstract: An evaluation of $A = 18$–20 was published in *Nuclear Physics A*392 (1983), p. 1. This version of $A = 20$ 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 May 1, 1982)

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).

Table of Contents for $A = 20$

Below is a list of links for items found within the PDF document. Figures from this evaluation have been scanned in and are available on this website or via the link below.

^{20}n

(Not illustrated)

^{20}n has not been observed. See (1978SA1E; theor.).

^{20}B

(Not illustrated)

^{20}B has not been observed. The mass excess is predicted to be 69.08 MeV (1974TH01). ^{20}B is then unstable with respect to breakup into ^{19}B + n by 0.9 MeV [see ^{19}B]. See also (1978AJ03).

^{20}C

(Not illustrated)

^{20}C has been observed in the fragmentation of 213 MeV/nucleon ^{48}Ca by Be: it is particle stable (1981ST23). Assuming the mass excess of ^{20}C to be 37.3 MeV [see (1978AJ03)], ^{20}C is then stable with respect to ^{19}C + n and ^{18}C + 2n by 3.2 and 3.75 MeV, respectively [see ^{18}C and ^{19}C]. See also (1978AJ03) and (1978NA07, 1981KI04; theor.).

^{20}N

(Not illustrated)

^{20}N is particle stable: see (1972AJ02). Assuming that the atomic mass excess is 22.0 MeV, ^{20}N is then stable with respect to ^{19}N + n by 1.94 MeV (see ^{19}N). See also (1978AJ03).

^{20}O

(Figs. 9 and 13)

GENERAL: (See also (1978AJ03).)

Model calculations: (1977GR16).

Special states: (1977GR16).

Astrophysical questions: (1979WO07).

Other topics: (1977GR16, 1978RA1J, 1979BE1H).

1. ^{20}O(β^-)^{20}F $\qquad Q_{\rm m} = 3.816$

Table 20.1: Energy levels of ^{20}O

E_x (MeV $\pm$ keV)	$J^\pi; T$	τ	Decay	Reactions
0	$0^+; 2$	$\tau_{1/2} = 13.57 \pm 0.1$ sec	β^-	1, 2, 3, 4
1.67368 ± 0.15	2^+	$\tau_m = 10.5 \pm 0.4$ psec	γ	2, 3, 4
		$g = -0.352 \pm 0.015$		
3.570 ± 7	4^+		(γ)	2, 3, 4
4.072 ± 4	2^+		γ	2, 4
4.456 ± 5	0^+		γ	2, 4
4.850 ± 15	4^+		(γ)	2
5.002 ± 6			(γ)	2
5.234 ± 5	2^+		(γ)	2
5.304 ± 6	2^+		(γ)	2
5.387 ± 6	0^+		(γ)	2
5.614 ± 3	(3^-)		(γ)	2
6.555 ± 8	(2)		(γ)	2
7.252 ± 8	5^-		(γ)	2
7.622 ± 7	$3^- + 4^+$			2
7.754 ± 5	4^+			2, 3
7.855 ± 6	(5^-)			2, 3
8.554 ± 8	4^+			2
8.804 ± 9	3^-			2
8.962 ± 21	(0^+)			2
9.770 ± 8	0^+			2
10.125 ± 11	2^+			2, 3

^{20}O decays to ^{20}F*(1.06) [$J^\pi = 1^+$] with a half-life of 13.51 ± 0.05 sec (weighted mean of (1970MA42, 1974AL09)), $\log ft = 3.75 \pm 0.01$. Upper limits for the branching to other states of ^{20}F are shown in Table 20.2 of (1978AJ03) and in Table IV of (1974AL09). See also (1981KA32; theor.).

2. ^{18}O(t, p)^{20}O $\quad Q_m = 3.079$

Observed proton groups are displayed in Table 20.2. The first excited state, ^{20}O*(1.67) has $\tau_m = 10.7 \pm 0.4$ psec (1980RU01) [M^2|E2| $= 1.76 \pm 0.07$ W.u.], 9.8 ± 0.7 psec (1977HE12); g $= -0.352 \pm 0.015$ [(1980RU01) and see (1978AJ03)]. ^{20}O*(4.07) decays to ^{20}O*(0, 1.67) with branchings of 26 ± 4 and 74 ± 4 %. The p-γ angular correlations lead to $J = 2$; the strength of the transition favors $\pi = +$[δ(E2/M1) $= -0.18 \pm 0.08$ for the $2^+ \rightarrow 2^+$ transition]. ^{20}O*(4.46) and ^{20}O*(5.39) decay primarily via ^{20}O*(1.67); the direct ground-state decay is $< 4\%$ for the first and $< 7\%$ for the second of these states. The angular correlations are essentially isotropic, favoring $J^\pi = 0^+$. The transition ^{20}O*($5.39 \rightarrow 4.07$) is not observed: the upper limit is 8% (1981YO03).

3. ^{18}O(α, 2p)^{20}O $\quad Q_m = -16.735$

At $E_\alpha = 65$ MeV the population of ^{20}O*(0, 1.67, 3.57) and of states at 7.78, 8.78 and 10.2 [± 0.1] MeV are reported (1978JA10). See also (1978BI1N).

4. ^{18}O(^{18}O, ^{16}O)^{20}O † $\quad Q_m = -0.628$

Angular distributions have been measured to ^{20}O*(0, 1.67) at $E(^{18}\text{O}) = 24$ to 36 MeV (1977KA21) and to ^{20}O*(0, 1.67, 3.57, 4.07, 4.46) (1979KU01). A FRDWBA analysis shows $L = 0$ for the transitions to ^{20}O*(0, 4.46) but underestimates the absolute cross sections by an order of magnitude (1979KU01).

† For other reactions leading to ^{20}O see (1978AJ03).

Table 20.2: Energy levels of ^{20}O from ^{18}O(t, p)^{20}O [a]

E_x (keV)	L	J^π
0.0	0	0^+
1674 ± 3 [b]	2	2^+
3570 ± 7	4	4^+
4072 ± 4	2	2^+
4456 ± 5 [c]	0	0^+
4850 ± 15	4	4^+
5002 ± 6		
5234 ± 5	2	2^+
5304 ± 6 [c]	2	2^+
5387 ± 6	0	0^+
5614 ± 3	(3)	(3^-)
6555 ± 8		(2)
7252 ± 8	5	5^-
7622 ± 7	$3 + 4$	$3^- + 4^+$
7754 ± 5	4	4^+
7855 ± 6	(5)	(5^-)
8554 ± 8	4	4^+
8804 ± 9	3	3^-
8962 ± 21	(0)	(0^+)
9770 ± 8 [d]	0	0^+
10125 ± 11	2	2^+

[a] (1979LA18): $E_t = 15$ MeV. See also Table 20.3 in (1978AJ03) and (1979FO17, 1979PI01).

[b] E_γ leads to $E_x = 1673.68 \pm 0.15$ keV (1973WA19).

[c] 6p-2h structure: see (1979LA04, 1979LA18).

[d] This strong state suggests that (fp)^2 excitations are important (1979LA18).

^{20}F

(Figs. 10 and 13)

GENERAL: (See also (1978AJ03).)

Shell model: (1978MA2H, 1981EL1D, 1982KI02).

Electromagnetic transitions: (1976MC1G).

Special states: (1978MA2H, 1981EL1D, 1982KI02).

Complex reactions involving ^{20}*F:* (1978SH18, 1982FR03).

Astrophysical questions: (1979WO07).

Muon and pion capture and reactions: (1979KN1G, 1980TR1A).

Other topics: (1977GR16, 1978MA2H, 1978RA1J, 1979BE1H, 1981EL1D, 1982KI02, 1982QUZY).

Ground state of ^{20}*F:* (1976MC1G).

$$\mu = +2.094\ (2)\ \text{nm}\ (\text{1978LEZA});$$

$$Q = 0.070\ (13)\ \text{b}\ (\text{1978LEZA}).$$

1. ^{20}F(β^-)^{20}Ne $\qquad Q_m = 7.0259$

The half-life of ^{20}F is 11.00 ± 0.02 sec: see (1978AJ03). See also (1975SA1D, 1978CA02). ^{20}F decays principally to ^{20}Ne*(1.63): see ^{20}Ne, reaction 42.

2. ^{12}C(^{9}Be, p)^{20}F $\qquad Q_m = 4.0761$

At $E(^9\text{Be}) = 12$ to 27 MeV angular distributions are reported (1979JA22, 1981JA09: p_0, $p_{1+2+3+4}$). See also (1978AJ03).

3. ^{13}C(^{7}Li, ^{7}Li)^{13}C $\qquad E_b = 18.050$

See (1976PO02, 1978DR07) and ^{13}C in (1981AJ01). For fusion cross sections see (1981DEZE, 1981DEZW).

4. ^{13}C(^{9}Be, d)^{20}F $\qquad Q_m = 1.3543$

At $E(^{13}\text{C}) = 27.9$ MeV angular distributions are reported by (1980BO21: d_0, $d_{1+2+3+4}$).

Table 20.3: Energy levels of ^{20}F [a]

E_x (MeV $\pm$ keV)	$J^\pi; T$	τ	Decay	Reactions
0	$2^+; 1$	$\tau_{1/2} = 11.0 \pm 0.02$ sec	β^-	1, 2, 4, 6, 7, 13, 14, 21, 22, 25, 26, 27, 28, 29
0.65594 ± 0.15	3^+	$\tau_m = 0.39 \pm 0.03$ psec	γ	2, 4, 6, 7, 12, 13, 14, 22, 23, 26, 28
0.82288 ± 0.20	4^+	79 ± 6 psec	γ	2, 4, 5, 6, 7, 12, 13, 14, 22, 26, 28
0.98371 ± 0.20	1^-	2.0 ± 0.2 psec	γ	2, 4, 6, 7, 12, 13, 14, 22, 26, 28
1.05693 ± 0.20	1^+	45 ± 13 fsec	γ	2, 4, 6, 7, 13, 14, 22, 24, 25, 26, 28
1.30923 ± 0.20	2^-	1.6 ± 0.3 psec	γ	6, 7, 12, 13, 14, 22, 25, 26, 28
1.8244 ± 1.2	5^+	≤ 65 fsec	γ	5, 6, 12, 13, 22, 28
1.84337 ± 0.30	2^-	30 ± 20 fsec	γ	7, 13, 14, 22, 25, 26, 28
1.9707 ± 0.4	(3^-)		γ	6, 7, 12, 13, 14, 22, 28
2.04400 ± 0.30	2^+	37 ± 16 fsec	γ	6, 7, 13, 14, 22, 23, 26, 28
2.1948 ± 0.4	(3^+)	< 12 fsec	γ	6, 7, 13, 14, 22, 26, 28
2.8649 ± 1.5	(3^-)		γ	6, 7, 13, 22, 28
2.9661 ± 0.4	3^+	60 ± 40 fsec	γ	6, 7, 13, 14, 22, 28
2.968 ± 1.5	(4^-)		γ	5, 6, 7
3.1740 ± 1.5	1^+		γ	6, 7, 13, 22, 28
3.48843 ± 0.25	1^+	44 ± 11 fsec	γ	13, 14, 22, 28
3.5260 ± 0.4	0^+	30 ± 15 fsec	γ	6, 7, 13, 14, 22
3.5871 ± 0.3	$(1, 2, 3)^+$	≤ 60 fsec	γ	6, 7, 13, 14, 22, 28
3.6810 ± 0.4	$(1, 2, 3)^+$		γ	6, 7, 13, 14, 22, 28
3.7611 ± 1.9	$(2^-, 3^+)$		γ	6, 7, 13, 22, 28
3.9660 ± 1.5	1^+		γ	6, 7, 13, 14, 22, 28
4.0823 ± 0.4	$(1)^+$		γ	6, 7, 13, 14, 22, 28
4.1989 ± 2.7			(γ)	6, 7, 22, 28
4.2077 ± 2.6			(γ)	6, 7, 22, 28
4.2766 ± 0.5	$(1, 2, 3)^+$		γ	6, 7, 14, 22, 28
4.3154 ± 2.0	$(0, 1)^+$		(γ)	6, 7, 22, 28
4.3745 ± 2.0	$0^{(-)}$		(γ)	6, 7, 22, 28
4.5105 ± 2.0	$(6^+, 4^-)$		(γ)	6, 7, 22, 28

Table 20.3: Energy levels of ^{20}F [a] (continued)

E_x (MeV ± keV)	$J^\pi; T$	τ	Decay	Reactions
4.5808 ± 1.8			(γ)	6, 7, 22, 28
4.5922 ± 2.9			(γ)	6, 7, 22, 28
4.7310 ± 2.0	$(5^+, 6^+, 4^-)$		(γ)	6, 7, 22, 28
4.7656 ± 2.0	$(5^+, 6^+, 4^-)$		(γ)	6, 7, 22, 28
4.8916 ± 2.8			(γ)	22, 28
4.8982 ± 2.8			(γ)	22, 28
5.0402 ± 3.1	$(0, 1, 2)^-$		(γ)	7, 22, 28
5.0655 ± 3.1			(γ)	7, 22, 28
5.135 ± 4			(γ)	7, 22, 28
5.2240 ± 2.8	$(0, 1, 2)^-$		(γ)	7, 22, 28
5.284 ± 3	$(1, 0)^+$		(γ)	22, 28
5.318 ± 3			(γ)	7, 22, 28
5.349 ± 4	$(1, 2, 3)^+$		(γ)	7, 22, 28
5.4131 ± 0.6			γ	7, 14, 22, 28
5.4503 ± 3.8			(γ)	22, 28
5.4554 ± 3.2			(γ)	22, 28
5.463 ± 3	$(1, 2, 3)^+$		(γ)	7, 22
5.5629 ± 2.0	$(0, 1, 2)^-$		γ	7, 14, 22, 28
5.5881 ± 1.5			(γ)	7, 22, 28
5.620 ± 3			(γ)	7, 22, 28
5.713 ± 2			γ	14, 22, 28
5.7640 ± 2.5	$(1, 2, 3)^+$		(γ)	7, 22, 28
5.8104 ± 2.5	$(2^-, 1^+)$		(γ)	7, 22, 28
5.9361 ± 0.3	$(1^-, 2^-)$		γ	7, 14, 22, 28
6.0174 ± 0.3	(2^-)		γ	7, 14, 22, 28
6.0446 ± 0.4			γ	7, 14, 22, 28
6.163 ± 6			(γ)	7, 28
6.205 ± 6			(γ)	7, 28
6.240 ± 7			(γ)	28
6.300 ± 5			(γ)	28
6.337 ± 5			(γ)	28
6.370 ± 6			(γ)	28
6.407 ± 12			(γ)	28

Table 20.3: Energy levels of ^{20}F [a] (continued)

E_x (MeV ± keV)	$J^\pi; T$	τ	Decay	Reactions
6.441 ± 9			(γ)	28
6.480 ± 5			(γ)	28
6.519 ± 3	$0^+; 2$		γ	13, 27
6.588 ± 5			(γ)	28
6.6269 ± 0.6	2^-	0.310 ± 0.020	γ, n	14, 15
6.6425 ± 0.6	(3, 4)	< 0.08	γ, n	14, 28
6.6474 ± 0.7	1^-	1.59 ± 0.10	γ, n	14, 15, 28
6.6933 ± 0.8	1^-	13.8 ± 0.8	γ, n	14, 15, 28
6.7660 ± 1.1		≤ 0.6	γ, n	14, 28
6.829			n	16
6.8566 ± 1.2	2	10 ± 2	γ, n	14, 16, 28
(6.858 ± 8)	1		γ, n	14
6.905 ± 8				28
6.9677 ± 1.2	1^-	5 ± 1	γ, n	14, 16
(7.0670 ± 1.2)	0^-	(2.4 ± 0.6)	γ, n	14, 16
7.076	(1^+)	24	n	15
7.166 ± 2	$2^{(+)}$	8 ± 1	γ, n	14, 15, 16
7.311	(1)	33	γ, n	14, 15
7.361	(1)	19	n	15, 16
7.410	(2^+)	10	γ, n	14, 15, 16
7.50	(2)	80	γ, n	14, 15
7.67	(2^+)	65	γ, n	14, 15, 16
7.79		140	n	15, 16
(7.831 ± 12)	1^-	(50 ± 10)	γ, n	14
7.988 ± 3	1	14 ± 2	γ, n	14
8.05 ± 100	$2^+; 2$			27
8.13		195	γ, n	14, 15, 16
8.163		15	n	16
8.421		27	n	16
8.50		140	n	15
8.728		≤ 30	n	15, 16
8.77		76	n	15
8.942		73	n	15, 16

Table 20.3: Energy levels of ^{20}F [a] (continued)

E_x (MeV $\pm$ keV)	$J^\pi; T$	τ	Decay	Reactions
9.165			n	16
9.521		110	n	16
9.654		100	n	15, 16
9.830		33	n	16
9.85		120	n	15
(9.886 ± 10)			n	15
9.901		≤ 30	n	16
(9.929 ± 10)			n	15
(9.981 ± 10)			n	15
10.024 ± 10		150	n, α	15, 26, 20
10.10 ± 50			n, α	20
10.228 ± 10	0^-, 1	≈ 200	n, α	15, 20
10.480 ± 10		≈ 10	n, α	15, 20
10.641 ± 10	1, 2	70	n	15, 16
10.807 ± 10	0^-, 1	≈ 310	n, α	15, 20
10.988		190	n	16
(11.045 ± 10)		≈ 30	n	15
(11.130 ± 10)		< 25	n	15
(11.244 ± 10)		< 25	n	15, 16
(11.287 ± 10)			n	15
11.49 ± 50			n, α	20
12.0			n, α	20
12.2 ± 100			n, α	20
12.39			n, α	20
12.82			n, α	20
13.2			n, α	20
13.66			n, α	16, 20
14.0			n, α	20

[a] See also Tables 20.4 and 20.5.

Table 20.4: Radiative transitions in ^{20}F [a]

E_i (MeV)	J^π_i	E_f (MeV)	Branching (%)	δ
0.66	3^+	0	100	0.10 ± 0.05
0.82	4^+	0	41 ± 4	
		0.66	59 ± 5	
0.98 [c]	1^-	0	≥ 96	[b]
1.06 [c]	1^+	0	≥ 96	
1.31 [c]	2^-	0	100	[b]
1.82 [c]	5^+	0.82	≥ 95	-0.03 ± 0.07
1.84 [c]	2^-	0	≥ 94	
1.97 [c]	(3^-)	0	16 ± 4	-0.06 ± 0.14
		0.82	55 ± 3	$+0.27 \pm 0.30$
		1.31	29 ± 3	
2.04 [c]	2^+	0	8 ± 4	
		0.66	92 ± 4	$0.08^{+0.06}_{-0.1}$
2.19 [c]	(3^+)	0	58 ± 4	0 ± 0.09
		0.82	42 ± 4	$+0.07 \pm 0.10$
2.86		0	(100)	
2.966	3^+	0	19 ± 5	
		0.66	17 ± 5	
		0.82	35 ± 4	
		1.97	29 ± 4	
2.968 [d]	(4^-)	0.82	39 ± 4	
		1.97	61 ± 4	
3.17 [c]	(1^+)	0.98	> 95	
3.49	1^+	0	68 ± 4	
		0.98	7 ± 1	
		1.06	7 ± 1	
		1.31	10 ± 2	
		1.84	8 ± 2	
3.53	0^+	1.06	100	
3.59	$(1, 2, 3)^+$	0	63	
		2.04	37	

Table 20.4: Radiative transitions in ^{20}F [a] (continued)

E_i (MeV)	J^π_i	E_f (MeV)	Branching (%)	δ
3.68	$(1, 2, 3)^+$	0	33	
		0.66	67	
3.76		0.66	observed	
3.97	1^+	0.98	22 ± 7	
		1.31	78 ± 7	
4.08	$(1)^+$	0	45 ± 7	
		1.06	55 ± 7	
[e]				

[a] For references see Table 20.5 in (1978AJ03).

[b] Pure E1.

[c] For upper limits for transitions to other states of ^{20}F see Table 20.5 in (1978AJ03).

[d] (1978LE19).

[e] For the decays of higher states see Table 20.5 in (1978AJ03), and Tables 20.8 and 20.9 here.

5. ^{13}C(^{11}B, α)^{20}F $\qquad Q_m = 9.3851$

The upper of the two states at 2.97 MeV has an excitation energy of 2968 ± 1.5 keV and γ branching ratios of 61 ± 4 and 39 ± 4 %, respectively, to ^{20}F*(1.97, 0.82) [$J^\pi = (3^-), 4^+$]: this is consistent with $J^\pi = (4^-)$ for ^{20}F*(2.968) (1978LE19).

6. ^{14}N(^{7}Li, p)^{20}F $\qquad Q_m = 12.054$

The ^{20}F states observed in this reaction at $E(^7\text{Li}) = 16$ MeV are displayed in Table 20.7. The cross sections for forming states of known J^π are proportional to $2J_f + 1$ with slopes which are different for the even- and the odd-parity states. Extrapolation of these relationships to states of unknown J^π leads to the assignments shown in Table 20.6 (1977FO11).

7. ^{16}O(^{7}Li, ^{3}He)^{20}F $\qquad Q_m = -4.743$

Angular distributions have been measured at $E(^7\text{Li}) = 24$ MeV for the ^{3}He groups corresponding to the states shown in Table 20.7. It is suggested that the states at $E_x = 4.20$, 4.52, 4.58 and 5.41 MeV have high spin and (sd)^4 configurations (1978FO14).

Table 20.5: Lifetime measurements of some ^{20}F states [a]

^{20}F* (MeV)	τ_m
0.66	0.39 ± 0.03 psec
0.82	79 ± 6 psec
0.98	2.03 ± 0.20 psec [a]
	1.8 ± 0.3 psec [b]
	2.0 ± 0.2 psec [c]
1.06	45 ± 13 fsec
1.31	1.16 ± 0.20 psec [a]
	1.9 ± 0.3 psec [b]
	1.6 ± 0.3 psec [c]
1.82	≤ 65 fsec
1.84	30 ± 20 fsec
1.97	1.4 ± 0.4 psec
2.04	37 ± 16 fsec
2.19	< 12 fsec
2.97	60 ± 40 fsec
3.49	44 ± 11 fsec
3.53	30 ± 15 fsec
3.59	30 ± 30 fsec

[a] For references see Table 20.6 in (1978AJ03).

[b] (1980KO1H; abstract) and R.L. Kozub (private communication).

[c] "Best" value.

Table 20.6: States of ^{20}F from ^{14}N(^{7}Li, p) and ^{16}O(^{7}Li, ^{3}He)

E_x (keV) [a]	E_x (keV) [b]	J^{π} [a,b]
0	0	2^+
657 ± 6	654 ± 4	3^+
820 ± 5	819 ± 3	4^+
984 ± 5	974 ± 6	1^-
1049 ± 5	1044 ± 6	1^+
1310 ± 6	1310 ± 2	2^-
1826 ± 4 [c]		5^+
	1824 ± 2 [c]	(2^-)
1969 ± 5	1973 ± 3	(3^-)
2040 ± 3	2043 ± 3	2^+
2194 ± 6	2197 ± 3	3^+
2863 ± 5	2866 ± 2	(3^-)
2962 ± 3 [c]	2968 ± 3	
3171 ± 4	3176 ± 3	1^+
3491 ± 3 [c]	3491 ± 4 [c]	0^+
3578 ± 5 [d]	3593 ± 3	
3674.2 ± 2.8 [d]	3680 ± 5	
3756.5 ± 2.3	3760 ± 2	$(2^-, 3^+)$ [e]
3967 ± 5	3972 ± 4	1^+
4080 ± 4 [d]	4082 ± 10	
4198 ± 3 [c]	4205 ± 3 [c]	
4274 ± 3 [c]	4285 ± 5 [c]	
4366 ± 8	4372 ± 12	$0^{(-)}$
4508 ± 4	4513 ± 3	$(6^+, 4^-)$ [e]
4576.8 ± 2.6 [c]	4583 ± 3 [c]	
4736 ± 4	4729 ± 3	$(5^+, 6^+, 4^-)$
4768 ± 4	4767 ± 4	$(5^+, 6^+, 4^-)$
4887.9 ± 2.9 [c]	4901 ± 4 [c]	
	5057 ± 7 [c]	
	5144 ± 6	
	5236 ± 7	

Table 20.6: States of ^{20}F from ^{14}N(^{7}Li, p) and ^{16}O(^{7}Li, ^{3}He) (continued)

E_x (keV) [a]	E_x (keV) [b]	J^π [a,b]
	5326 ± 3 [c]	
	5414 ± 3	
	5470 ± 4 [c]	
	5554 ± 9 [c]	
	5608 ± 12	
	5776 ± 5 [c]	
	5951 ± 4	
	6033 ± 4 [c]	
	6199 ± 10 [c]	

[a] (1977FO11): $E(^{7}\text{Li}) = 16$ MeV. Some E_x values have been rounded off.
[b] (1978FO14): $E(^{7}\text{Li}) = 24$ MeV.
[c] Unresolved.
[d] Possible doublet.
[e] If single state.

8. ^{17}O(t, p)^{19}O † $Q_m = 3.520$ $E_b = 14.157$

See ^{19}O.

9. ^{17}O(^{13}C, ^{10}B)^{20}F $Q_m = -9.719$

See (1979GO17).

10. (a) ^{18}O(d, n)^{19}F $Q_m = 5.7685$ $E_b = 12.3699$
(b) ^{18}O(d, p)^{19}O $Q_m = 1.732$

Vector analyzing power measurements [reaction (b)] have been carried out at $E_{\vec{d}} = 10$ MeV (1979ST21; p_0, p_2, p_3, p_4) and at 14 MeV: see (1978AJ03). See also (1981NE1B; theor.). See also ^{19}O. For reaction (a) see ^{19}F.

† Additional reactions on which no new work is reported are listed in (1978AJ03).

Table 20.7: States in ^{20}F for ^{18}O(^{3}He, p)^{19}F [a]

E_x (keV)		L [b]	J^{π} [c]
(1970RO06)	(1974CR04)		
0	0	2	2_1^+
657.2 ± 1.3	656	$2+4$	3_1^+
823.5 ± 1.5	822.6 ± 1.9	4	4_1^+
982.9 ± 1.3	983.3 ± 5.3	[g]	1^-
1058.1 ± 1.4	1057.5 ± 2.4	$0+2$	1_1^+
1309.1 ± 1.4	1310.2 ± 3.1	[g]	2^-
1824.4 ± 1.6 [d]	1824.1 ± 3.6	4	5_1^+
1843.0 ± 1.7 [d]			(2^-)
1971.9 ± 1.6	1978.0 ± 2.8	[g]	(3^-)
2044.0 ± 1.6	2044.9 ± 2.2	2	2_2^+
2195.5 ± 2.0	2194.7 ± 2.8		(3^+)
2868.2 ± 2.3	2863.6 ± 3.9	[g]	
2967.1 ± 2.0	2961.4 ± 3.5		see [b]
	3167.2 ± 3.8	$(0+2)$ [a]	(1^+)
3487.8 ± 2.2	3485.9 ± 2.3	$0+2$	1_2^+
	3.53	[g]	(0^+)
3586.3 ± 2.2	3583.1 ± 2.7		see [b]
3681.0 ± 2.5	3669.4 ± 4.9		see [b]
3761.0 ± 3.1 [e]	3760 ± 10	[g]	
3966.9 ± 2.8		$0+2$ [a]	1^+
4083.7 ± 2.9			
6519 ± 3 [f]			$0^+; T=2$ [f]

[a] For a complete listing of references see reaction 13 and Table 20.8 in (1978AJ03).

[b] $E(^{3}\mathrm{He}) = 18$ MeV (1974CR04): predominant L-values.

[c] From L-values, γ-ray polarization data and branching ratio and lifetime measurements: see also Tables 20.4 and 20.5.

[d] $E_x = 1824.4 \pm 2.1$ and 1843.0 ± 2.2 keV (1967QU01).

[e] $E_x = 3765 \pm 6$ keV, based on $E_x = 657 \pm 1$ keV (1973PR01).

[f] Decays principally ($> 90\%$) to ^{20}F*(1.06): the γ-rays are isotopic [$\Gamma_\gamma = 3.6 \pm 0.6$ eV, based on the analog decay in ^{20}Ne]. ^{20}F*(6.52) is the 0^+, $T = 2$ analog of the ground states of ^{20}O and ^{20}Mg (1976MI01, 1977BA50).

[g] Weakly populated.

11. ^{18}O(d, d)^{18}O $E_b = 12.3699$

VAP measurements involving the elastic group have been carried out at $E_{\vec{d}} = 10$ MeV (1979ST21) and at 14.8 MeV: see (1978AJ03).

12. (a) ^{18}O(d, ^{3}He)^{17}N $Q_m = -10.449$ $E_b = 12.3699$

(b) ^{18}O(d, α)^{16}N $Q_m = 4.246$

VAP measurements are reported at $E_{\vec{d}} = 52$ MeV for reaction (a) (1981MA14: to ^{17}N*(0, 1.37, 1.85, 2.53, 5.51, 6.99) and (b) (1982MA25: to ^{16}N*(0, 0.30, 3.36, 3.96, 4.32, 6.17). TAP measurements are reported to reaction (b) at $E_{\vec{d}} = 8.5$ to 11.3 MeV (1978BA43). For excitation functions see (1972AJ02). See also ^{16}N, ^{17}N in (1982AJ01) and (1979SE04).

12. ^{18}O(t, n)^{20}F $Q_m = 6.1126$

See (1978AJ03).

13. ^{18}O(^{3}He, p)^{20}F $Q_m = 6.8764$

States of ^{20}F observed in this reaction are displayed in Table 20.7. For a complete listing of the references see (1978AJ03).

14. ^{19}F(n, γ)^{20}F $Q_m = 6.6012$

The thermal capture cross section is 9.8 ± 0.7 mb (1974SH1E). A number of resonances have been observed: see Table 20.8. See also (1981MUZQ). The primary γ-rays resulting from capture at thermal energies (^{20}F*(6.60); $J^\pi = 0^+, 1^+$) and at $E_n = 27$, 44 and 49 keV (^{20}F*(6.63, 6.643, 6.647); $J^\pi = 2^-$, (3, 4) and 1^-) have been studied by several groups: see (1972AJ02) and Table 20.9 here. It appears that the thermal capture [^{20}F*(6.60)] is dominated by two intense transitions (probably E1) to ^{20}F*(5.94, 6.02) [thus $J^\pi = 1^-, 2^-$]. If the ground-state transition is mainly M1, these two E1 transitions are (in terms of W.u.) about 150 times stronger than the M1 transition (1968SP01). It appears also that at ^{20}F*(6.63, 6.64, 6.65) [$J^\pi = 2^-$, (3, 4) and 1^-] the E1 transitions to the ground state are very weak, even though other E1 transitions in the decay of these two states have approximately normal strengths (1967BE36, 1974KE18). The strongest transitions from the 27 keV resonance appear to be M1. On the basis of the J^π of the final states involved in

Table 20.8: Resonances in $^{19}F(n, \gamma)^{20}F$ [a]

E_n (keV)	J^π [b]	Γ_γ (eV)	$\Gamma_{c.m.}$ (keV)	E_x in ^{20}F (MeV)
27.07 ± 0.05	2^-	1.4 ± 0.3	0.355 ± 0.03	6.6269
43.5 ± 0.1	(3, 4)	[c]	< 0.08	6.6425
48.7 ± 0.3	1^-	1.6 ± 0.3	1.96 ± 0.3	6.6474
97.0 ± 0.5	1^-	6.0 ± 1.8 [d]	13.5 ± 1.5	6.6933
173.5 ± 0.9		[e]	≤ 0.6	6.7660
269 ± 1	2	3.5 ± 0.8	10 ± 2	6.8566
(270 ± 8)	1	≤ 4.4		(6.858)
386 ± 1	1^-	2.4 ± 0.8	5 ± 1	6.9677
(490.5 ± 1)	0^-	$(\geq 10 \pm 3)$	(2.4 ± 0.6)	(7.0670)
595 ± 2	2	6.3 ± 1.2	8 ± 1	7.166
760		2.9	60	7.32
865			60	7.42
950		2.8	95	7.50
1125		3.9	80	7.67
(1295 ± 12)	1^-	8.6	(50 ± 10)	(7.831)
1460 ± 3	1	$\geq 11 \pm 3$	14 ± 2	7.988
1635		11 ± 3	180	8.15

[a] For complete references see Table 20.9 in (1978AJ03).

[b] Assumed: (1973MA14).

[c] $g\Gamma_n = 0.086 \pm 0.02$ eV (1973MA14).

[d] May be two resonances.

[e] $g\Gamma_n = 0.35 \pm 0.1$ eV (1973MA14).

Table 20.9: Primary capture transitions in ^{19}F(n, γ)^{20}F [a]

Final state ^{20}F* (MeV)	I_γ [b] from			
	^{20}F*(6.60) [c]	^{20}F*(6.63)	^{20}F*(6.64)	^{20}F*(6.65)
0	10	2.0 ± 0.5		
0.66		6 ± 1	42 ± 7	
0.82			23 ± 7	
0.98				18 ± 4
1.06	6			9 ± 4
1.31		31 ± 2		
1.84		8 ± 2		
1.97		46 ± 4		
2.04	6	1.5 ± 1		59 ± 6
2.97			35 ± 9	
3.49		3 ± 1		14 ± 5
3.53		8 ± 1		
4.08		2.5 ± 1		
5.94	15			
6.02	43			

[a] For complete references see Table 20.10 in (1978AJ03). See also Tables 20.4 and 20.8 here.

[b] In units of photons/100 captures.

[c] $I_\gamma < 5$ not shown: see Table 20.10 in (1978AJ03). Transitions from thermal energy capture.

Table 20.10: States of ^{20}F involved in ^{19}F(n, γ)^{20}F [a]

E_x (keV)	
0	3526.0 ± 0.5
656.3 ± 0.3 [b]	3587.3 ± 0.3
822.9 ± 0.3	3681.0 ± 0.4
983.8 ± 0.3 [b]	3967 ± 2 [c]
1057.2 ± 0.3	4082.2 ± 0.5
1309.1 ± 0.3	4276.7 ± 0.5
1843.4 ± 0.3	5413.1 ± 0.6
1970.6 ± 0.3	5554.7 ± 0.6
2044.2 ± 0.4	5713 ± 2 [c]
2194.5 ± 0.6	5936.0 ± 0.3
2965.8 ± 0.5	6017.3 ± 0.3
3488.3 ± 0.3	6044.6 ± 0.4
	6601.1 ± 0.3 [d]

[a] (1968SP01).
[b] 656.1 ± 0.3 and 983.4 ± 0.4 keV (1972OP01).
[c] (1969HA04).
[d] 6602.0 ± 0.6 keV (1969HA04).

the decay of the 44 keV resonance $J = 3$ or 4, assuming dipole transitions (1974KE18). Branching ratios for other ^{20}F states involved in this reaction are shown in Table 20.4.

Table 20.10 displays excitation energies for ^{20}F states involved in cascade and in primary γ-transitions.

15. ^{19}F(n, n)^{19}F $E_b = 6.6012$

The scattering amplitude (bound) $a = 5.654 \pm 0.010$ fm, $\sigma_{free} = 3.641 \pm 0.010$ b (1979KO26). See also (1981MUZQ).

The total cross section has been measured for $E_n = 0.5$ to 29.1 MeV: see (1978AJ03). Observed resonances are displayed in Table 20.11. See also ^{19}F.

16. ^{19}F(n, n′)^{19}F* $E_b = 6.6012$

Observed resonances in the excitation functions involving ^{19}F*(0.11, 1.5 [u]) are displayed in Table 20.12. See also (1978CO18, 1980CO1U) and (1978AJ03).

17. ^{19}F(n, 2n)^{18}F $Q_{\rm m} = -10.4313$ $E_{\rm b} = 6.6012$

Cross sections have been measured for $E_{\rm n} = 10$ to 37 MeV [see (1978AJ03)] and at $E_{\rm n} = 14.7-19.0$ MeV (1978RY02) and $16.2-21.8$ MeV (1978CO18, 1980CO1U). See also (1979HA60).

18. ^{19}F(n, p)^{19}O $Q_{\rm m} = -4.036$ $E_{\rm b} = 6.6012$

The differential cross section at $92°$ for production of the 96 keV γ-ray has been studied by (1976MO13: $E_{\rm n} = 4.0$ to 18.6 MeV): the cross section increases sharply at $E_{\rm n} = 6$ MeV and then gradually decreases beyond $E_{\rm n} = 12$ MeV. Cross sections have also been measured for $E_{\rm n} = 12.6$ to 21 MeV: see (1972AJ02) and the summary in (1976GAYV). See also (1978SM1E, 1979BR08, 1979HA60).

19. (a) ^{19}F(n, d)^{18}O $Q_{\rm m} = -5.7688$ $E_{\rm b} = 6.6012$
(b) ^{19}F(n, t)^{17}O $Q_{\rm m} = -7.556$

For reaction (a) see (1978CO18, 1980CO1U). For reaction (b) see (1978QA01). For both see also (1978AJ03).

20. ^{19}F(n, α)^{16}N $Q_{\rm m} = -1.522$ $E_{\rm b} = 6.6012$

Reported resonances are shown in Table 20.13: see graph in (1976GAYV). See also (1978SM1E, 1979BR08).

21. ^{19}F(p, π^+)^{20}F $Q_{\rm m} = -133.748$

Cross sections at 5.3 and 10.4 MeV above threshold are reported by (1979MA39).

22. ^{19}F(d, p)^{20}F $Q_{\rm m} = 4.3765$

Table 20.11: Resonances in ^{19}F(n, n)^{19}F [a]

E_n (keV)	Γ_{lab} (keV)	J^π	^{20}F* (MeV)
26.99	0.325 ± 0.020	2^-	6.6268
48.78	1.67 ± 0.10	1^-	6.6475
97.50	14.5 ± 0.8	1^-	6.6938
500	25 [b]	(1^+)	7.076
600	15 [b]	(2^+)	7.171
747	35 [b]	(1)	7.311
794	20	(1)	(7.355)
852	11 [b]	(2^+)	7.410
935	60	(2)	7.489
1100	50	(2^+)	7.65
1250	150		7.79
1620	220		8.14
2000	150		8.50
2250	≤ 30		8.74
2280	80		8.77
2520	150		8.99
3250	150		9.69
3420	130		9.85
3460 ± 10			(9.886)
3505 ± 10			(9.929)
3560 ± 10			(9.981)
3605 ± 10	200		10.024
3820 ± 10	≈ 200	0^-, 1	10.228
4085 ± 10	≈ 10		10.480
4255 ± 10	≈ 60	1, 2	10.641
4430 ± 10	≈ 330	0^-, 1	10.807
4680 ± 10	≈ 30		11.045
4770 ± 10	< 25		11.130
4890 ± 10	< 25		11.244
(4935)			(11.287)

[a] For references see Table 20.12 in (1978AJ03).
[b] $\Gamma_\gamma = 3.3 \pm 1.0, 6.3 \pm 1.2, 2.4 \pm 0.8$ and 1.5 ± 0.5 eV for ^{20}F*(7.08, 7.17, 7.31, 7.41) (1973MU14).

Table 20.12: States of ^{20}F from resonances in ^{19}F(n, n′γ)^{19}F

E_n (keV)	Γ_{lab} (keV)	Resonance in		E_x in ^{20}F
		$\gamma_{0.11}$ [a]	$\gamma_{1.5}$ [b]	(MeV)
240		r		6.829
270		r		6.858
386		r		6.968
420		r		7.000
490		r		7.066
620		r		7.190
800		r		7.361
860		r		7.418
1150 [c]		r		7.693
1250		r		7.788
1580		r		8.101
1645	15	r	r	8.163
1916	28		r	8.421
2240	45		r	8.728
2465	75	r	r	8.942
2700		r		9.165
3075	120		r	9.521
3215	80		r	9.654
3400	35		r	9.830
3475	≤ 30		r	9.901
3620	120	r	r	10.038
4240	90	r	r	10.627
4620	200		r	10.988
4900	≤ 50		r	11.254
7300		r		13.532

r = resonant.

[a] Resonances in yield of 0.11 MeV γ-rays at $\theta = 92°$: values for E_n read by reviewer from differential cross section tables (1976MO13).

[b] Resonances in yields of ^{19}F with $E_x \approx 1.5$ MeV: see (1973MA14).

[c] Appears to be unresolved.

Table 20.13: Resonances in ^{19}F(n, α)^{16}N [a]

E_n (MeV $\pm$ keV)	E_x (MeV)
3.4	9.8
3.61 ± 50	10.03
3.69 ± 50	10.10
3.76 ± 40	10.17
4.09 ± 40	10.48
4.39 ± 40	10.77
4.52 [b]	10.89
4.82 ± 40	11.18
5.15 ± 50	11.49
5.40 [b]	11.73
5.7	12.0
5.9 ± 100 [b]	12.2
6.10	12.39
6.55	12.82
6.9	13.2
7.44	13.66
7.8	14.0

[a] For references see Table 20.14 in (1978AJ03).

[b] Not resolved.

States of ^{20}F observed in this reaction are displayed in Table 20.14. Angular distributions have been measured at $E_d = 0.6$ to 16 MeV [see (1978AJ03)] and at 12 MeV (1977MO16). See (1978AJ03) for a discussion of the earlier work. See also (1980HU1D, 1980HU1J).

23. ^{19}F(^{13}C, ^{12}C)^{20}F $\qquad Q_m = 1.6548$

See (1978AJ03).

24. ^{20}O(β^-)^{20}F $\qquad Q_m = 3.816$

See ^{20}O.

Table 20.14: States in ^{20}F from ^{19}F(d, p)^{20}F [a]

E_x (keV) [b]	l_n [c]	J^π	$(2J+1)S$ [c]	n, l, j [c]
0	2	2^+	0.054	$1d_{5/2}$
655.9 ± 0.2	2	3^+	2.32	$1d_{5/2}$
823.0 ± 0.3	[d]	4^+	0.32	$1g_{9/2}$
983.9 ± 0.3	[d]	1^-	0.014	$1p_{1/2}$
1057.0 ± 0.2	$0 + 2$	1^+	0.013	$2s_{1/2}$
1309.3 ± 0.2	[d]	2^-	0.017	$1p_{3/2}$
1820 ± 10	[d]	(5^+)	0.35	$1g_{9/2}$
1843.5 ± 0.7	[d]	2^-	0.007	$2p_{3/2}$
1970 ± 10	[d]	(3^-)	0.038	$1f_{7/2}$
2043.7 ± 0.5	2	2^+	2.32	$1d_{5/2}$
2194.5 ± 0.6	2	3^+	0.55	$1d_{5/2}$
2863.7 ± 1.6	[d]		0.044	$1f_{7/2}$
2966.8 ± 0.6	2	3^+	0.38	$1d_{3/2}$
3175.6 ± 1.3	[d]		0.019	$1d_{5/2}$
3488.5 ± 0.3	0	1^+	1.20 [e]	$2s_{1/2}$
3525.9 ± 0.5	0	0^+	0.28 [e]	$2s_{1/2}$
3586.5 ± 0.6	2	$\pi = +$	0.038	$1d_{3/2}$
3681.0 ± 2.5	2	$\pi = +$	0.031	$1d_{5/2}$
3760.8 ± 2.7	[d]		[c]	
3964.5 ± 2.5	2	$\pi = +$	0.036	$1d_{5/2}$
4082.5 ± 0.8	$0 + 2$	$\pi = +$	0.13	$1s_{1/2}$
4198.9 ± 2.7				
	[d]		0.083	$1d_{3/2}$
4207.7 ± 2.6				
4279.0 ± 2.0	2	$\pi = +$	0.087	$1d_{5/2}$
4315.4 ± 2.0	0	$(0, 1)^+$	0.20	$2s_{1/2}$
4374.5 ± 2.0			[f]	
4509.5 ± 3.0			[f]	
4583.8 ± 3.0			0.02	$2p_{3/2}$
	1	$(0-2)^-$		
4592.2 ± 2.9			(< 0.05)	$(1f_{7/2})$

Table 20.14: States in ^{20}F from ^{19}F(d, p)^{20}F [a] (continued)

E_x (keV) [b]	l_n [c]	J^π	$(2J+1)S$ [c]	n, l, j [c]
4730.2 ± 2.9	2, 3		[f]	
4763.8 ± 2.7	2, 3		[f]	
4891.6 ± 2.8			[f]	
4898.2 ± 2.8			[f]	
5048.7 ± 1.5			[f]	
5069.0 ± 3	2	$(1, 2, 3)^+$	0.09	$1d_{5/2}$
5132.4 ± 3.5			[f]	
5225.0 ± 3	1, 3		0.09	$2p_{3/2}$
5284.0 ± 3	0	$(1, 0)^+$	0.34	$2s_{1/2}$
5318.0 ± 3	2 or $1+3$	$(1, 2, 3)^+$ or 2^-	0.10	$1d_{5/2}$
5349.0 ± 4	2	$(1, 2, 3)^+$	0.06	$1d_{5/2}$
5408.2 ± 2.5			[f]	
5450.3 ± 3.8				
5455.4 ± 3.2				
5463.0 ± 3	2	$(1, 2, 3)^+$	0.27	$1d_{5/2}$
5562.9 ± 2.0	1	$(0, 1, 2)^-$	0.03	$2p_{3/2}$
5588.1 ± 1.5			[f]	
5620.0 ± 3	[d]			
5710.8 ± 6.0	[d]			
5764.0 ± 3	2	$(1, 2, 3)^+$	0.15	$1d_{5/2}$
5810.0 ± 3	$0+2$ or $1+3$	$(2^-, 1^+)$	[f]	
5935.0 ± 3	1(+3)	$(1^-, 2^-)$	0.43	$2p_{3/2}$
6015.0 ± 3.8	$1+3$	(2^-)	0.68	$2p_{3/2}$
			1.40	$1f_{7/2}$
6043.3 ± 3.7				

[a] For complete references see Table 20.15 in (1978AJ03).

[b] Best values from data for proton groups and γ-rays taken from data shown in the (1978AJ03) table and in (1977MO16).

[c] See (1974FO21, 1977MO16): $E_d = 12$ MeV; assumed in analysis.

[d] Weak groups.

[e] At $E_d = 16$ MeV.

[f] See (1977MO16).

Table 20.15: Analog states of $A = 20$ observed in ^{21}Ne(d, ^{3}He)^{20}F and ^{21}Ne(d, t)^{20}Ne [a]

^{20}F* (MeV) [b]	J^{π}	^{20}Ne* (MeV ± keV)	l	C^2S			
				^{20}F		^{20}Ne	
0	2^+	10.27 [b]	$0+2$	$0.24+0.58$		$0.08+0.25$	
0.66	3^+	10.880 ± 10	2	0.66		0.42	
0.82	4^+	11.086 ± 10	2	0.26		0.18	
0.98	1^-		1		0.84		0.52
		11.27					
1.06	1^+		$0+2$	$0.08+0.25$		$0.03+0.18$	
1.31	2^-	11.601 ± 10	1		0.86		0.50
1.84	2^-	12.100 ± 10	1		0.69		0.43
2.04	2^+		2	0.15			
2.19	(3^+)		2	0.16			
				$l=0+2$	$l=1$	$l=0+2$	$l=1$
			sums:	2.38	2.39	1.14	1.45

[a] (1974MI13): $E_d = 26$ MeV: DWBA analysis of angular distributions. See Table 20.34 for $T = 0$ states in ^{20}Ne observed in the (d, t) reaction.
[b] E_x are nominal.

25. ^{20}Ne(π^-, γ)^{20}F $\qquad Q_m = 132.541$

The branching ratio to ^{20}F*(1.06) [$J^{\pi} = 1^+$] is compared to the analogous M1 decay width ^{20}Ne*(11.24) [$J^{\pi} = 1^+$] $\rightarrow$ ^{20}Ne$_{\text{g.s.}}$. The M1 amplitude contains $(47 \pm 16)\%$ spin flip, in agreement with shell-model calculations. The population of ^{20}F*(0, 1.31, 1.84) [$J^{\pi} = 2^+, 2^-, 2^-$] is also reported (1981MA04). See also (1979TR1B, 1982RI1B).

26. ^{21}Ne(d, ^{3}He)^{20}F $\qquad Q_m = -7.511$

The ^{20}F states observed at $E_d = 26$ MeV in this reaction and analog [$T = 1$] states observed in ^{20}Ne in the (d, t) reaction are displayed in Table 20.15. The spectroscopic factors of analog states are consistent to within 20% for states excited by a single l-transfer (1974MI13).

27. ^{22}Ne(p, ^{3}He)^{20}F $\qquad Q_m = -15.6513$

Table 20.16: States of ^{20}F from ^{22}Ne(d, α)^{20}F [a]

E_x (keV)	E_x (keV)	E_x (keV)	E_x (keV)
655 ± 2	3680 ± 3	5224 ± 6	6205 ± 6
824 ± 3	3762 ± 4	5276 ± 5	6240 ± 7
983 ± 3	3964 ± 4	5321 ± 4 [b]	6300 ± 5
1056 ± 4	4083 ± 4	5405 ± 5	6337 ± 5
1307 ± 3	4206 ± 4 [b]	5451 ± 5 [b]	6370 ± 6
1830 ± 7 [b]	4279 ± 4 [b]	5557 ± 5	6407 ± 12
1970 ± 4	4372 ± 4	5574 ± 6	6441 ± 9
2042 ± 3	4518 ± 4	5623 ± 4	6480 ± 5
2192 ± 3	4597 ± 4 [b]	5710 ± 11	6588 ± 5
2864 ± 3	4728 ± 8	5765 ± 3	6645 ± 5 [b]
2967 ± 3	4764 ± 7	5813 ± 4	6711 ± 5 [b]
3174 ± 3	4888 ± 4 [b]	5940 ± 5	6772 ± 6
3491 ± 4 [b]	5048 ± 4 [b]	6040 ± 4 [b]	6860 ± 13
3589 ± 3	5131 ± 5	6163 ± 6	6905 ± 8

[a] (1976FO16): $E_d = 10$ MeV.
[b] Unresolved.

At $E_p = 43.7$ to 45.0 MeV analog states have been studied in ^{20}F and ^{20}Ne [the latter via ^{22}Ne(p, t)^{20}Ne]. Angular distributions for the ^{3}He ions and the tritons corresponding to the first $T = 2$ states ($J^\pi = 0^+$) [^{20}Ne*(16.722 ± 0.025) and ^{20}F*(6.513 ± 0.033)] have been compared. There is indication also for the excitation of the 2^+; $T = 2$ states [at $E_x = 8.05$ MeV in ^{20}F and at 18.5 MeV in ^{20}Ne (estimated errors ± 0.1 MeV)] (1964CE05, 1969HA38).

28. ^{22}Ne(d, α)^{20}F $\qquad Q_m = 2.7019$

Angular distributions have been obtained at $E_d = 10$ MeV to all ^{20}F states with $E_x < 4.4$ MeV: they are generally featureless. Observed states of ^{20}F are displayed in Table 20.16. See also (1978AJ03).

29. ^{23}Na(n, α)^{20}F $\qquad Q_m = -3.866$

See (1978AJ03).

^{20}Ne

(Figs. 11 and 13)

GENERAL: (See also (1978AJ03).)

Shell model: (1977GR16, 1977HA1Z, 1977SC27, 1978AR1H, 1978CH26, 1978HA2C, 1978HE04, 1978MA2H, 1978RA1B, 1978TO07, 1979DA15, 1979EL04, 1979HA50, 1979HA59, 1979SI12, 1979WU06, 1980CA12, 1980MC1D, 1980RO11, 1980TE02, 1981ER03, 1981GR06, 1981KR1G, 1981SC12, 1982KAZK, 1982KI02).

Collective, deformed and rotational models: (1977FO1E, 1977HA1Z, 1978HO1E, 1978PE09, 1978PI08, 1978TO07, 1979EL04, 1979FU06, 1979FU08, 1979FU09, 1979KO38, 1979MA01, 1979MA1J, 1980CA12, 1980FU1H, 1980LE26, 1980RO11, 1981KR1G, 1981MC1C, 1981MI13, 1981RA14).

Cluster and α-particle models: (1977BA30, 1977BU22, 1977FO1E, 1977SA1C, 1978AR1H, 1978CH26, 1978HE04, 1978HO1E, 1978IS04, 1978KA22, 1978PI06, 1978TA1A, 1978TH1A, 1978TO07, 1979FU06, 1979FU08, 1979FU09, 1979GO24, 1980FU1G, 1980FU1H, 1980IK1B, 1981FU1F, 1981KN12, 1981WI01).

Electromagnetic transitions: (1976MC1G, 1977MA1Y, 1978GO1K, 1978GR06, 1978HA2C, 1978RO07, 1978SC19, 1978SI11, 1978TO07, 1979FU06, 1979FU08, 1979FU09, 1979KA40, 1979SI12, 1980BR09, 1980KO1L, 1981CO04, 1981KH04, 1981KN06, 1981MC1C, 1981SC12, 1982HA07, 1982HA15, 1982HA10, 1982LA26, 1982RI1B).

Special states: (1977BA30, 1977FO1E, 1977SC27, 1977SH18, 1978AL1T, 1978GO1K, 1978GR06, 1978HO1E, 1978KA22, 1978MA2H, 1978MC04, 1978PE09, 1978PI06, 1978PI08, 1978RA1B, 1978RO07, 1978SC19, 1978SI11, 1978TA1A, 1978TO07, 1978ZA04, 1979DA15, 1979FU06, 1979FU08, 1979FU09, 1979IN07, 1979KA40, 1979KOZY, 1979MI1L, 1979SI12, 1979WI1Q, 1980BI05, 1980BR21, 1980CA12, 1980FO02, 1980FU1H, 1980KL1B, 1980KO29, 1981CO04, 1981ER03, 1981RA14, 1981SC12, 1981WI01, 1981WI1K, 1982AO1B, 1982KI02, 1982MI1B).

Giant resonance (See also reactions 43 and 45.): (1978HE04, 1980SP1E, 1980WI1J, 1981KN12, 1981SP1D).

Astrophysical questions: (1977AL2C, 1977FR1K, 1978BU1H, 1978CL1F, 1978DI1D, 1978DW1B, 1978ME1D, 1978OR1A, 1978PO1B, 1978TR1D, 1979CH1T, 1979DI1B, 1979GA1M, 1979LA1H, 1979LE1F, 1979MA2D, 1979ME1L, 1979RA1C, 1979SI1D, 1979WO07, 1980BH1B, 1980CO1R, 1980FR1C, 1980MO1L, 1980SC1L, 1981WI1D, 1981AU1D, 1981DU1E, 1981SH1J, 1981WE1F, 1981WO1B).

Applied topics: (1979KU20).

Complex reactions involving ^{20}Ne: (1978CA1N, 1978HE18, 1978KA1Y, 1978OB01, 1978SA33, 1978SH18, 1978VO1D, 1978WI1G, 1978YO01, 1979AL1H, 1979BE31, 1979CE1B, 1979DA1F, 1979GA04, 1979GA1L, 1979GO11, 1979HA07, 1979HE1D, 1979KN1H, 1979MC1D, 1979MO17,

1979NA1F, 1979SA1W, 1979ST1R, 1979SY01, 1979TA19, 1980AK02, 1980CH1G, 1980EV1A, 1980GR10, 1980NA1C, 1980RA1G, 1981CE07, 1981EG01, 1981GR08, 1981HI1C, 1981LO1F, 1981MA1G, 1981NA1E, 1981SC03, 1981TA02, 1982ME1C, 1982SU01, 1982TA02).

Table 20.17: Energy levels of ^{20}Ne [a]

E_x (MeV $\pm$ keV)	$J^\pi; T$	K^π	τ_m or $\Gamma_{c.m.}$ (keV)	Decay	Reactions
0	$0^+; 0$	0^+_1		stable	2, 3, 7, 8, 9, 13, 17, 18, 22, 23, 24, 25, 30, 31, 32, 33, 38, 39, 40, 41, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 57, 58, 62, 63, 64, 67, 68, 69, 70, 71, 72, 77
1.633674 ± 0.015	$2^+; 0$	0^+_1	$\tau_m = +1.05 \pm 0.06$ psec $g = +0.54 \pm 0.04$	γ	2, 3, 7, 8, 9, 10, 13, 17, 18, 21, 22, 23, 24, 25, 27, 29, 30, 31, 32, 33, 38, 39, 40, 41, 42, 45, 47, 48, 50, 51, 52, 55, 62, 63, 64, 67, 68, 69, 70, 71, 72, 77
4.2477 ± 1.1	$4^+; 0$	0^+_1	$\tau_m = 93 \pm 9$ fsec $g = -0.01 \pm 0.14$	γ	2, 3, 7, 8, 9, 13, 17, 18, 21, 22, 23, 24, 25, 27, 29, 30, 31, 32, 38, 39, 40, 41, 47, 48, 50, 51, 55, 64, 67, 68, 69, 70, 71, 72
4.96651 ± 0.20	$2^-; 0$	2^-	$\tau_m = 4.8 \pm 0.5$ psec	γ	2, 3, 7, 8, 9, 13, 17, 30, 33, 38, 39, 40, 41, 42, 47, 64, 67, 68, 71, 72
5.6214 ± 1.7	$3^-; 0$	2^-	200 ± 50 fsec	γ, α	2, 3, 7, 8, 13, 17, 27, 38, 40, 41, 47, 65, 67, 70, 71, 72
5.785 ± 2.3	$1^-; 0$	0^-		γ, α	2, 3, 7, 8, 13, 14, 17, 18, 27, 31, 39, 40, 41, 47, 65, 67, 70, 71
6.724 ± 5	$0^+; 0$	0^+_2	$\Gamma = 15 \pm 7$ keV	γ, α	8, 13, 17, 30, 38, 39, 41, 45, 47, 67, 71
7.004 ± 3.6	$4^-; 0$	2^-	$\tau_m = 440 \pm 90$ fsec	γ	2, 7, 8, 17, 39, 47, 71
7.1563 ± 0.5	$3^-; 0$	0^-	$\Gamma = 8.1 \pm 0.3$ keV	γ, α	2, 4, 7, 8, 13, 14, 17, 18, 20, 23, 29, 30, 31, 38, 39, 47, 71
7.191 ± 3	$0^+; 0$	0^+_3	4	γ, α	5, 6, 7, 13, 14, 45, 47, 71
7.4214 ± 1.0	$2^+; 0$	0^+_2	8	γ, α	2, 5, 6, 7, 13, 14, 17, 39, 41, 45, 47, 63, 65, 71
7.8290 ± 2.0	$2^+; 0$	0^+_3	2.4	γ, α	2, 6, 7, 13, 14, 30, 38, 39, 45, 47, 63, 65, 71
≈ 8.3	$0^+; 0$	0^+_4	≈ 800	α	14, 39
8.4486 ± 2.3	$5^-; 0$	2^-	0.013 ± 0.004	γ, α	2, 6, 7, 13, 14, 17, 23, 39, 47, 71

Table 20.17: Energy levels of ^{20}Ne [a] (continued)

E_x (MeV ± keV)	$J^\pi; T$	K^π	τ_m or $\Gamma_{c.m.}$ (keV)	Decay	Reactions
8.699 ± 5	$1^-; 0$	(1^-)	2.1 ± 0.8	γ, α	7, 13, 39, 47, 71
8.7767 ± 2.3	$6^+; 0$	0^+_1	< 3	γ, α	2, 4, 6, 7, 13, 14, 17, 18, 20, 21, 23, 29, 30, 38, 39, 47, 71
≈ 8.8	$2^+; 0$	0^+_4	> 800	α	14
8.848 ± 5	$1^-; 0$	1^-	19	α	7, 13, 14, 39, 65, 71
9.030 ± 4	$4^+; 0$	0^+_3	3.2	γ, α	2, 6, 7, 13, 14, 39, 47, 71
9.1124 ± 2.4	$3^-; 0$		3.2	γ, α	2, 7, 13, 14, 38, 39, 47, 71
9.310 ± 6	$(1, 2, 3)^+$				7, 39, 47, 71
9.466 ± 7					71
9.508 ± 12	$2^+; 0$		29 ± 15	γ, α	13, 14, 38, 39, 47, 63
9.873 ± 4	$3^+; 0$			γ	7, 39, 63
9.935 ± 12	$(1^+); 0$		$\tau_m < 35$ fsec	γ	39, 71
10.005 ± 17	$4^+; 0$	0^+_2	$\Gamma = 155 \pm 30$	γ, α	2, 13, 14, 30, 38, 39, 71
10.261 ± 4	$5^-; 0$	0^-	145 ± 40	α	2, 4, 7, 14, 17, 18, 20, 23, 29
10.2724 ± 2.0	$2^+; 1$		0.4 ± 0.2	γ, α	13, 14, 30, 39, 63, 65, 71
10.403 ± 5	$3^-; 0$	1^-	80	α	7, 14, 31, 39, 65, 71
10.548 ± 5	$4^+; 0$		16	α	7, 14, 39
10.583 ± 6	$2^+; 0$		24	α	14, 39, 63, 71
10.609 ± 6	$6^-; 0$	2^-	$\tau_m = 23 \pm 7$ fsec	γ	2, 6, 7
10.694 ± 6	$4^-, 3^+; 0$			γ	6, 7
10.79 ± 100	$4^+; 0$	0^+_4	$\Gamma = 350$	α	14
10.837 ± 5	$2^+; 0$		13	α	14, 39, 63
10.840 ± 6	(3^-)	(1^-)	45	α	7, 14
10.89 ± 10	$3^+; 1$		$\tau_m < 30$ fsec	γ	7, 39, 63, 65
10.97 ± 150	$0^+; 0$		$\Gamma = 580$	α	14
11.015 ± 6	$4^+; 0$		24	α	6, 7, 14, 71
11.087 ± 3	$4^+; 1$		≤ 0.5	γ, α	13, 14, 39, 65
11.23 ± 10	$1^+; 1$			γ	38, 45, 63, 65
11.261 ± 5	$1^-; 0$		170	α	14
11.268 ± 4	$1^-; 1$		≤ 0.3	γ, α	13, 14, 39, 63, 65
11.322 ± 7	$2^+; 0$		40 ± 10	α	14, 63
11.528 ± 6	$3^+, 4^-; 0$		$\tau_m \leq 30$ fsec	γ	7
11.555 ± 6	$1^+, 2^-, 3^+$			γ	7, 39
11.556 ± 6	$(2^+, 0^+)$		$\Gamma = 1.1 \pm 0.5$	γ, α	13, 14
11.601 ± 10	$2^-; 1$				65
11.66	$(3^+); 0$			γ	6, 7
11.866 ± 9	$2^+; 0$		46	α	7, 14, 39, 63, 71

Table 20.17: Energy levels of ^{20}Ne [a] (continued)

E_x (MeV ± keV)	$J^\pi; T$	K^π	τ_m or $\Gamma_{c.m.}$ (keV)	Decay	Reactions
11.925 ± 4	$4^+; 0$		0.44 ± 0.15	γ, α	13, 14, 71
11.950 ± 4	$8^+; 0$	0^+_1	$(3.5 \pm 1.0) \times 10^{-2}$	γ, α	4, 6, 7, 8, 13, 14, 17, 18, 20, 21, 23, 71
11.962 ± 8	$1^-; 0$		30 ± 5	α	14, 71
12.100 ± 10	$2^-; 1$				65
12.136 ± 4	$6^+; 0$	0^+_3	0.13 ± 0.07	α	5, 6, 7, 8, 14, 17
12.218 ± 4	$2^+; 1$		< 0.1	γ, α	13, 30, 38, 39
12.24 ± 30	$4^+; 0$		148 ± 20	α	14
12.253 ± 3	$3^-; 1$		< 1	γ, α	13, 14
(12.35 ± 100)	(2^+)		≈ 500	α	14
12.394 ± 4	$3^-; (1)$		37.3 ± 0.9	γ, α	6, 7, 13, 14, 39, 71
12.436 ± 4	$0^+; 0$	0^+_6	24.4 ± 0.5	γ, α	7, 13, 14, 30, 39, 71
12.582 ± 12	$6^+; 0$	0^+_4	70 ± 20	α	6, 7, 14, 17, 18, 20, 21, 71
12.600 ± 10	$6^+; 0$		130 ± 20	α	6, 7, 14, 17, 18, 20, 21, 71
12.683 ± 15	$5^-; 0$	1^-	97	α	14
12.730 ± 10	$4^+; 0$		100	α	6, 7, 14
12.83 ± 30			55	α	14, 30, 39
12.919 ± 10					7, 71
13.010 ± 10	$(4^+; 0)$		60	α	7, 14
13.049 ± 10	$(4^+; 0)$		70	α	6, 7, 14, 39
13.060 ± 3.5	2^-		1.0	p, α	36, 38, 39
13.1680 ± 0.6	$1^+; (1)$		2.3 ± 0.2	γ, p, α	33, 34, 36, 38
13.190 ± 10	$(4^+; 0)$		60	α	6, 7, 14
13.225	1^-		95	p, α	36
13.225	0^+		95	p, α	36
13.3038 ± 0.7	1^+		0.9 ± 0.1	γ, p, α	33, 34, 36
13.334 ± 6	$7^-; 0$	2^-	$(8 \pm 3) \times 10^{-2}$	α	6, 7, 8, 14
13.343 ± 6	$4^+; 0$		20 ± 5	α	14
13.412 ± 1	2^-		26 ± 3	γ, p, α	14, 33, 34, 36
(13.42 ± 140)	$(4^+; 0)$		110	α	14
13.462 ± 20	1^-		190	p, α	36
13.482 ± 1	$1^+; 1$		6.4 ± 0.3	γ, p, α	33, 34, 36, 38
13.519	(1^-)		33	p, α	34, 36
13.569 ± 15	2^+		63	p, α	7, 36
13.583 ± 2	2^+		9 ± 1	p, α	30, 34, 36
13.644 ± 2	$0^+; 1$		17 ± 1	p, α	7, 34, 36, 38
(13.66)	(1^-)		110	p, α	7, 36
13.6729 ± 0.7	(2^-)		4.5 ± 0.2	γ, p, α	33, 34, 36

Table 20.17: Energy levels of ^{20}Ne [a] (continued)

E_x (MeV ± keV)	$J^\pi; T$	K^π	τ_m or $\Gamma_{c.m.}$ (keV)	Decay	Reactions
13.7 ± 400	$(3, 7)^-$		320	α	14
(13.73)	(0^+)		≈ 170	p, α	36
13.733 ± 1.4	1^+		7.7 ± 0.5	γ, p, α	33, 34, 36
13.845 ± 15	(1^-)		≈ 190	p, α	7, 36
13.878 ± 1	$2^+; 1$		0.14 ± 0.05	γ, p, α	7, 8, 33, 34, 36, 38
13.904	2^+		47	p, α	30, 36
13.923 ± 1	0^+		≈ 70	p, α	36
13.926 ± 9	6^+	0_2^+	113 ± 7	α	6, 7, 17, 18
14.017	1^-		≈ 70	p, α	36
14.060 ± 1	2^+		≈ 140	p, α	34, 36
14.124 ± 1	2^-		4.7 ± 0.7	γ, p, α	33, 34, 36
14.127 ± 3	2^+		34 ± 1	p, α	7, 14, 36
14.147 ± 1	2^-		11.8 ± 1.0	γ, p, α	33, 34, 36
14.195	1^+		14 ± 1	γ, p	30, 33, 34
14.298 ± 12	6^+		100 ± 20		6, 7, 14, 17, 18
14.311 ± 10	6^+		< 50	α	7
14.367 ± 1	0^+		86 ± 5	p, α	7, 34, 36
14.451 ± 2			33 ± 3	p, α	34, 36
14.471 ± 6	0^+		68 ± 2	p, α	36
14.594 ± 7	1^-		116 ± 5	p, α	36
14.6 ± 300	(4^+)		240	α	14
14.650 ± 10				p, α	36
14.695 ± 2.5	$(0^+, 1^+)$		36 ± 10	p, α	34, 36
14.772 ± 3.0			110 ± 20	p, α	34, 36
14.812 ± 15	$(2^+, 4^+)$		≈ 100	p, α	6, 7, 14, 36
15.034 ± 15	(2^+)		≈ 100	p, α	7, 14, 36
15.159 ± 5	6^+	(0_6^+)	60 ± 15	α	6, 7
15.23			28	p, α	36
15.27	(1^-)		285	p, α	36
15.30	(0^+)		285	p, α	14, 36
15.336 ± 15	7^-	0^-	380 ± 60	α	4, 6, 7, 17, 18, 20, 21, 29
15.438 ± 10			100 ± 20	p, α	7, 36
15.47			55	p, α	36
b					
15.70 ± 15	(6^+)			α	6, 7, 14
15.874 ± 9	8^+	0_3^+	100 ± 15	α	5, 6, 7, 21, 29
(15.97)	(6^+)			α	14
16.01 ± 25	$(2^+; 1)$		100	p, α	30, 36

Table 20.17: Energy levels of ^{20}Ne [a] (continued)

E_x (MeV $\pm$ keV)	$J^\pi; T$	K^π	τ_m or $\Gamma_{c.m.}$ (keV)	Decay	Reactions
16.139 ± 15			38	p, α	6, 7, 14, 36
16.25				α	6, 14
16.326 ± 15	4^+		43	p, α	14, 36
16.434 ± 15	$(0, 2, 4)^+$		34	α	14
16.506 ± 11	6^+		25 ± 3	α	6, 14
16.579 ± 8	7^-	1^-	86 ± 6	α	7, 14, 17, 18, 20
16.600 ± 15	7^-	1^-	160 ± 30	α	7
16.634 ± 14	3^-		51 ± 14	α	14
16.671 ± 12	4^+		79 ± 11	α	14
16.716 ± 8	$(5, 3)^-$		14 ± 7	α	6, 7, 14
16.730 ± 3	$0^+; 2$		2.0 ± 0.5	γ, p, α	30, 33, 34, 36
16.8	7^-			α	7
16.850 ± 11	5^-		16 ± 5	α	14
16.98			100	p, α	36
17.156 ± 11	5^-		33 ± 3	α	14
17.205 ± 12	4^+		142 ± 9	α	14
17.259 ± 11	$7^-(9^-)$		162 ± 20	α	7
17.301 ± 14	8^+	0_4^+	52 ± 10	α	4, 14, 17, 18, 20, 21, 29
17.394 ± 14	9^-	2^-	241 ± 13	α	6, 7, 8, 14
17.542 ± 15	6^+		136	α	14
17.55 ± 10	$(2^+; 1)$		19	n, p, α	30, 35, 36
17.752 ± 15	$4^-, (0^+)$		36	p, α	14, 36
17.91 ± 20	(0^+)			n, p	30, 35
18.002 ± 15	7^-		< 10	α	14
18.024 ± 8	5^-		35 ± 3	α	14
18.119 ± 8	7^-		29 ± 3	α	6, 7, 8, 14
18.32 ± 20	(6^+)		240	α	6, 14
18.427 ± 7	$2^+; 2$		9.5 ± 3	γ, n, p, α	33, 34, 35, 36
18.538 ± 7	8^+	(0_6^+)	138 ± 13	α	7
18.7 ± 100	$(6^+, 7^-)$		600	α	14, 17
19.113 ± 10	6^+		149 ± 18	α	8, 14
19.322 ± 9	6^+		123 ± 10	α	14, 30
19.437 ± 10	6^+		102 ± 7	α	14
19.648 ± 10	6^+		89 ± 8	α	14
19.914 ± 12	5^-		203 ± 19	α	14
20.130 ± 17	7^-		156 ± 21	α	14, 17
20.317 ± 12	7^-		203 ± 19	α	14
20.433 ± 16	6^+		346 ± 32	α	14

Table 20.17: Energy levels of ^{20}Ne [a] (continued)

E_x (MeV ± keV)	$J^\pi; T$	K^π	τ_m or $\Gamma_{c.m.}$ (keV)	Decay	Reactions
20.478 ± 11	8^+	0_2^+	250 ± 30	α	7
20.683 ± 9	(9^-)		75 ± 9	α	7, 14, 18
20.782 ± 11	7^-		122 ± 13	α	14, 17
20.920 ± 12	7^-		181 ± 22	α	7, 14
21.056 ± 26	9^-	(1^-)	120 ± 50	α	4, 7, 18, 20, 29
21.3 ± 100	$7^-, 8^+$		300	α	14, 17
21.65 ± 100	$(7^-, 9^-)$		240 ± 50	α	7, 14, 17
22.03 ± 100	(8^+)		630 ± 80	α	7, 14, 17
22.7 ± 100	9^-		500 ± 150	α	7, 14
22.87 ± 40	9^-	0^-	225 ± 40	α	4, 7, 14, 18, 20
23.70 ± 30	$9^-, (8^+)$		230 ± 100	α	7, 14, 17, 18
24.21 ± 25	8^+		≈ 500	α	14, 18
24.374 ± 30	$7^-, (5^-)$		200 ± 50	α	7
25.10 ± 50	8^+		≤ 200	α	14, 18
25.67 ± 50			≈ 500	α	14, 18
27.1 ± 100	(9^-)		700	α	14, 17
28	8^+		1600	α	14, 26
28.1 ± 100	(10^+)		700	α	14, 17

[a] See also Table 20.18.

[b] For other states with $E_x > 15.5$ MeV see Tables 20.27, 20.28, 20.29 and 20.30 and reactions 1, 43 and 45. It is clear that there are many states with low angular momentum and with unnatural parity which have not been located at high E_x.

Muon and neutrino capture and reactions: (1978IT1A, 1979YU02, 1980GA10, 1981PA1D).

Pion and kaon capture and reactions: (1977BA1Q, 1977NO1G, 1977ST1G, 1977YE1B, 1978AN20, 1978AT01, 1978BE1X, 1978YU1B, 1979AK02, 1979AL1V, 1979BA2V, 1979BE31, 1979HA07, 1979JA11, 1979KN1G, 1979MIZX, 1979NA1F, 1979NA12, 1979SA1W, 1979TA19, 1979TR1B, 1980OT1A, 1980ST25, 1980TR1A, 1981AN1H, 1981AS01, 1981GY1B, 1981MA04, 1982BI1H, 1982MU1C, 1982OS01, 1982RA1C).

Other topics: (1977BO33, 1977GR16, 1977SA2C, 1977SH18, 1978AN15, 1978FI1C, 1978MA2H, 1978MC04, 1978RA1J, 1978RO17, 1978SA1R, 1978TA1Y, 1979BE1H, 1979BO17, 1979BR30, 1979CH2E, 1979CO10, 1979CO09, 1979EL04, 1979GO24, 1979HA50, 1979HA59, 1979HE1F, 1979KA40, 1979ST1V, 1979WI1Q, 1979WU06, 1980BR21, 1980DI06, 1980KO29, 1980RO11, 1980TE02, 1980ZO1A, 1981AR1D, 1981CA1H, 1981ER03, 1982IS1B, 1982KI02).

Ground state of ^{20}Ne: (1976MC1G, 1977BO33, 1977HA1Z, 1977MA1Y, 1977ZA1D, 1978AN07, 1978AR1R, 1978CH26, 1978FI1C, 1978GO1K, 1978HE1D, 1978RO17, 1978SM02, 1978SV01,

1978DE1V, 1978TA1Y, 1978ZA1D, 1979BO17, 1979BR30, 1979CH2E, 1979HA50, 1979HA59, 1979IN07, 1979KA40, 1979MA01, 1979SI12, 1979WU06, 1980BR09, 1980BR13, 1980DI06, 1980LE26, 1980MO05, 1980TE02, 1981AR1D, 1981HA46, 1981SC12, 1982DE1N).

$$Q_{1.63} = -0.27 \pm 0.03\ e \cdot \mathrm{b}$$ (1978GR06). See also (1978AJ03, 1981SP07);

$$\mathrm{g}_{1.63} = +0.54 \pm 0.04$$ (1975HO15). See also (1982SP02);

$$B(\mathrm{E2})\uparrow[0 \rightarrow 1.63] = 0.0330 \pm 0.0015\ e^2 \cdot \mathrm{b}^2$$ (1978GR06). See also (1978AJ03);

$$Q_{4.25} = 0.022 \pm 0.003\ e^2 \cdot \mathrm{b}^2$$ (1978GR06);

$$\mathrm{g}_{4.25} = -0.10 \pm 0.19$$ (1980SP02), $+0.08 \pm 0.20$ (1982SP02):

weighted mean $= -0.01 \pm 0.14$ (1982SP02).

1. (a) ^{10}B(^{10}B, ^{10}B)^{10}B $\qquad E_b = 31.1464$
   (b) ^{10}B(^{10}B, α)^{16}O $\qquad Q_m = 26.4155$

Excitation functions for reactions (a) and (b) have been measured for $E_{\mathrm{c.m.}} = 3$ to 10 MeV: large resonant structures are observed in reaction (b). Particularly pronounced structures [≈ 0.6 MeV] corresponding to $E_x \approx 38$ MeV (α_0) and 38.6 MeV (α to ^{16}O*(7.0, 10.3, 16.2 [u]) are reported (1978MA07). The elastic excitation function has also been studied for $E(^{10}\mathrm{B}) = 8$ to 30 MeV by (1975DI08). See also (1978AJ03), ^{10}B in (1979AJ01) and ^{16}O in (1982AJ01).

2. ^{10}B(^{14}N, α)^{20}Ne $\qquad Q_m = 19.5332$

At $E(^{14}\mathrm{N}) = 25$ and 35 MeV angular distributions of the α-particles to ^{20}Ne*(0, 1.63, 4.25, 4.97, 5.62, 5.78, 7.00, 7.17, 7.42, 7.83, 8.45, 8.78, $9.03+9.12$, 9.99, 10.26, 10.61) have been measured by (1974MA38, 1975LE23). The average behavior of the cross section is generally well described by a statistical mechanism but the reaction mechanism is not purely statistical (1975LE23). Angular distributions are also reported at $E(^{14}\mathrm{N}) = 23.5$ MeV (1978DU08: α_0, α_1, α_2, α_{4+5}). For experiments relating to the compound nucleus see (1978AJ03) and (1977MA33, 1978DU08, 1978DU23, 1978WU1C, 1981BA26). See also (1976KL1B, 1978HO1C).

3. ^{10}B(^{16}O, ^{6}Li)^{20}Ne $\qquad Q_m = 0.270$

At $E(^{16}\mathrm{O}) = 19.5$, 24.3, 31.5, 35.9 and 42 MeV angular distributions have been measured for the ^{6}Li ions corresponding to transitions to ^{20}Ne*(0, 1.63, 4.25, 4.97, $5.62 + 5.78$, $6.7 - 7.2$). Hauser-Feshbach calculations are generally in good agreement with the data (1976LO03). See also (1977MO1A) and (1978AJ03).

Table 20.18: Radiative decays in ^{20}Ne [a]

E_i (MeV)	$J^{\pi}_i; T$	E_f (MeV)	Branch (%)	Γ_γ (meV)
1.63	$2^+; 0$	0	100	0.63 ± 0.04 [b]
4.25	$4^+; 0$	1.63	≈ 100	7.1 ± 0.7 [b]
4.97	$2^-; 0$	0	0.6 ± 0.2	$(8 \pm 3) \times 10^{-4}$ [b]
		1.63	99	0.14 ± 0.02 [b]
				δ(M2/E1) $= 0.076 \pm 0.011$
				δ(E3/E1) $= 0.043 \pm 0.016$
5.62	$3^-; 0$	0	7.6 ± 1.0	0.018 ± 0.006 [n]
		1.63	87.6 ± 1.0	0.21 ± 0.06 [n]
		4.97	4.8 ± 1.6	0.012 ± 0.005 [n]
5.79	$1^-; 0$	0	18 ± 5	0.8 ± 0.3 [o]
		1.63	82 ± 5	3.8 ± 0.8 [o]
6.72	$0^+; 0$	0		$\|M\|^2 = 7.4 \pm 2.0$ fm^2 [i]
		1.63	100	33
7.00	$4^-; 0$	1.63	0.5 ± 0.2	$(7 \pm 3) \times 10^{-3}$ [b]
		4.25	63.5	0.95 [b]
		4.97	11	0.16 [b]
		5.62	25	0.37 [b]
7.16 [c]	$3^-; 0$	4.25	60 ± 5	0.97 ± 0.11
		5.79	40 ± 5	0.64 ± 0.10
7.19	$0^+; 0$	0		$\Gamma_\pi = 3.9 \times 10^{-2}$
				6.9 ± 1.4 fm^2 [i]
		1.63	100	4.35 ± 0.75
7.42	$2^+; 0$	0	$\leq 9.4 \pm 1.4$	$\leq 3.0 \pm 0.6$
		1.63	$\geq 90.6 \pm 1.4$ [m]	29 ± 4
		4.25	≤ 7.6	
7.83	$2^+; 0$	0	83 ± 1	57 ± 7
		1.63	17 ± 1	11.7 ± 1.6
		4.25	< 3	< 2
8.45	$5^-; 0$	5.62	100	13 ± 3
8.70 [d]	$1^-; 0$	0	87 ± 8	61 ± 16
		1.63	13 ± 8	9 ± 6
8.78	$6^+; 0$	4.25	100	100 ± 15

Table 20.18: Radiative decays in ^{20}Ne [a] (continued)

$E_{\rm i}$ (MeV)	$J^{\pi}_{\rm i}; T$	$E_{\rm f}$ (MeV)	Branch (%)	Γ_{γ} (meV)
9.03	$4^+; 0$	1.63	100	340 ± 42
		4.25	< 2	< 6.8
9.11 [d]	$3^-; 0$	1.63	50 ± 5	13 ± 2
		4.97	33 ± 5	8.6 ± 1.7
		5.62	17 ± 4	4.4 ± 1.1
9.51	$2^+; 0$	0		$\lesssim 60$
		1.63	(100)	260 ± 100
9.87	$3^+; 0$	0	< 0.5	
		1.63	78	[k]
		4.25	12 ± 3	
		4.97	≤ 5	
		5.62	≈ 7	
		7.42	≈ 3	
9.94	$(1^+); 0$	1.63	78 ± 5	
		4.97	22 ± 5	
10.01	$4^+; 0$	0		$\lesssim 70$
		1.63	(100)	900 ± 400
10.27	$2^+; 1$	0	0.65 ± 0.14	29 ± 8
		1.63	88.9 ± 0.5	4080 ± 440
		4.97	1.3 ± 0.1	60 ± 8
		5.62	2.1 ± 0.2	97 ± 14
		7.42	6.9 ± 0.4	310 ± 40
		7.83	0.22 ± 0.06	8 ± 2
10.61	$6^-; 0$	7.00	95.5 ± 1.2	29 ± 9 [b]
		8.45	4.5 ± 1.2	1.3 ± 0.4 [o]
10.69	$4^-, 3^+; 0$	4.25	25 ± 4	
		4.97	75 ± 4	
10.89	$3^+; 1$	1.63	26 ± 3	
		4.25	74 ± 3	[l]
11.09 [d,e]	$4^+; 1$	1.63	0.5 ± 0.25	2 ± 1
		4.25 [p]	99.5 ± 0.25	338 ± 40
11.27 [d,e]	$1^-; 1$	0	55 ± 2	390 ± 47

Table 20.18: Radiative decays in ^{20}Ne [a] (continued)

E_i (MeV)	$J_i^\pi; T$	E_f (MeV)	Branch (%)	Γ_γ (meV)
		1.63	2.5 ± 1	18 ± 7
		4.97	6.5 ± 1	46 ± 9
		8.85	27 ± 1.5	189 ± 24
		9.31	9 ± 1	63 ± 10
11.53	$3^+, 4^-; 0$	4.25	30 ± 3	
		4.97	70 ± 3	
		7.00	[f]	
11.555 [f]	$1^+, 2^-, 3^+; 0$	1.63		
		7.00		
11.556 [d]	$(0^+, 2^+); 0$	1.63	100	
		4.25	< 8	
11.66	(3^+)	1.63	14 ± 3	
		4.25	86 ± 3	
11.93 [d]	$4^+; 0$	1.63	21 ± 11	5.5 ± 3.0
		4.25	79 ± 11	20.5 ± 5.5
11.95 [g]	$8^+; 0$	8.78	100	7.7 ± 1.1
12.25 [d]	$3^-; 1$	1.63	63 ± 1.5	
		5.62	37 ± 1.5	
12.39 [h]	$3^-; (1)$	0	≈ 1	
		1.63	≈ 29	80
		4.25	≈ 70	200
12.44 [h]	$0^+; 0$	1.63	100	170 ± 50
13.48	$1^+; 1$	1.63	95	
		4.97	5	
13.88		1.63	20	
		4.97	80	
16.73	$0^+; 2$	1.63	[j]	
		5.79	[j]	
		11.23	(100)	≈ 5000 [j]
18.43	$2^+; 2$	12.22	(100)	≈ 300

[a] For earlier references see Table 20.19 in (1978AJ03). See also Tables 20.21 and 20.25 here.
[b] From τ_m: see Table 20.20 in (1978AJ03) and branching ratios.
[c] (1980MA27).
[d] (1980FI01).
[e] See also Table 20.19 in (1978AJ03).
[f] See discussion in (1976FI10).
[g] (1980HU08).
[h] (1978ST08).
[i] Monopole matrix element.
[j] See footnote [a] in Table 2 of (1976MA01).
[k] $\Gamma_\gamma(\mathrm{total})/\Gamma = 0.82 \pm 0.27$.
[l] $\Gamma_\gamma(\mathrm{total})/\Gamma < 0.3$.
[m] $\delta(\mathrm{E2/M1}) = -8.36^{+1.0}_{-1.5}$.
[n] $\Gamma_\gamma(\mathrm{total}) = 240 \pm 64$ μeV: see Table 20.20 (P.M. Endt, private communication).
[o] P.M. Endt, private communication.
[p] $\delta = +0.01 \pm 0.06$ (1980FI01).

4. ^{11}B(^{16}O, ^{7}Li)^{20}Ne $\qquad$ $Q_\mathrm{m} = -3.934$

At $E(^{11}\mathrm{B}) = 115$ MeV, angular distributions are reported to ^{20}Ne*(7.17, 8.78, 10.25, 11.95, 15.4). ^{20}Ne*(8.78, 15.4, 17.3, 21.0 ± 0.07, 22.78 ± 0.06) are particularly strongly populated. It is suggested that these five states have $J^\pi = 6^+$, 7^-, (8^+), 9^- and 9^- (1979BR03, 1979RA10). See also (1978AJ03).

5. ^{12}C(^{9}Be, n)^{20}Ne $\qquad$ $Q_\mathrm{m} = 10.3196$

At $E(^{9}\mathrm{Be}) = 16$ and 24 MeV angular distributions have been measured for ^{20}Ne*(7.3 ± 0.4, 9.2 ± 0.4, 10.9 ± 0.3, 12.2 ± 0.3, 15.7 ± 0.3). It is suggested that ^{20}Ne*(7.3, 9.2, 12.2, 15.7) correspond to the $0^+ + 2^+$, 4^+, 6^+ and 8^+ members of the $K^\pi = 0_3^+$ band (1981SU01).

6. (a) ^{12}C(^{10}B, d)^{20}Ne $\qquad$ $Q_\mathrm{m} = 5.9589$
(b) ^{12}C(^{11}B, t)^{20}Ne $\qquad$ $Q_\mathrm{m} = 0.7610$

At $E(^{12}\mathrm{C}) = 45$ MeV the population of states of ^{20}Ne with $E_\mathrm{x} = 8.45$, *8.78*, 9.03, 10.61, 10.67, 10.99, 11.01, 11.66, *11.94*, *12.14*, *12.39*, *12.58*, 12.73, 13.05, 13.17, *13.34* [7^-], *13.69*, 13.91, 14.29, 14.36, 14.81, *15.17* [6^+], *15.38* [7^-], *15.71* [(7, 8)], *15.89* [(7)], 16.16, 16.22, *16.51* [(8)], 16.73, *17.39* [9^-], 18.18 and *18.32* MeV is reported. [Values in brackets are J^π suggested on basis of Hauser-Feshbach calculations. The states in italics are well resolved: the authors indicate ± 20 keV for such states.] The relative intensities of the groups to ^{20}Ne*(17.39, 15.38) [$J^{\pi} = 9^-, 7^-$] argue against the existence of a superband (1976KL03). At $E(^{10}\text{B}) = 20.0$ and 20.5 MeV angular distributions are reported to the 2^+ states ^{20}Ne*(7.42, 7.83). ^{20}Ne*(7.83) is more strongly populated than ^{20}Ne*(7.42), and it, and ^{20}Ne*(7.19), have integrated cross sections which deviate from the $(2J+1)$ "rule" by a factor of about two (1978FO01). See also (1978AJ03) and (1976KL1B, 1978HO1C).

7. ^{12}C(^{12}C, α)^{20}Ne $\qquad Q_{\text{m}} = 4.6181$

Double and triple (α, α, γ) correlations and γ-ray branching measurements [see Table 20.18] lead to the J^{π} assignments shown in Table 20.19, which also shows level assignments to rotational bands. Angular distributions have been reported at $E(^{12}\text{C}) = 4.9$ to 51 MeV [see (1978AJ03)] and at $E(^{12}\text{C}) = 6.3$ to 6.6 MeV (1980IS1B; α_0, α_1), 10 MeV (1981BE60; α_0), 12 MeV (1981BE60; α_1), 19.3 MeV (1980AN08; α_0) and 33 to 40 MeV (1982FO03; α_0). τ_{m} for ^{20}Ne*(4.25) is 95 ± 13 fsec (1982SP02) [see also for g-value, the "*Ground state of* ^{20}*Ne*" section here].

The yields of various groups of α-particles and their relevance to states of ^{24}Mg, and fusion cross sections, have been studied by many groups: see (1978AJ03) for the earlier work and (1977CI1E, 1977CO25, 1977PA1G, 1978TR06, 1979DE08, 1980AN08, 1980CO03, 1980ER06, 1980IS1B, 1980KO02, 1981BE60, 1982FO03). See also (1978MA2J), (1978SC1G, 1979GO1C), (1978RO1D, 1978RO1L, 1981BE60, 1982IB1A; astrophys.) and (1972NO01, 1977AB1E, 1978BR12, 1978MA1G, 1978TO12, 1980GA18, 1981SU1J; theor.).

8. ^{12}C(^{14}N, ^{6}Li)^{20}Ne $\qquad Q_{\text{m}} = -4.181$

Angular distributions of the ^{6}Li ions to many states of ^{20}Ne below 17.5 MeV have been reported for $E(^{14}\text{N}) = 30$ to 78 MeV and $E(^{12}\text{C}) = 67.2$ MeV. Compound nucleus formation appears to be dominant. In the latter work (1973BE11) ^{20}Ne*(16.67, 17.38, 18.11, 19.16, 19.6) are particularly strongly populated. For complete references see (1978AJ03). See also (1977ST34) and (1976KL1B, 1978HO1C).

9. (a) ^{12}C(^{18}O, ^{10}Be)^{20}Ne $\qquad Q_{\text{m}} = -6.3476$
(b) ^{12}C(^{19}F, ^{11}B)^{20}Ne $\qquad Q_{\text{m}} = -3.1122$

See (1978AJ03). See also (1981YO05; theor.).

10. ^{13}C(^{13}C, α2n)^{20}Ne $\qquad Q_{\text{m}} = -5.2747$

See (1982CH05).

Table 20.19: Excited states of ^{20}Ne from ^{12}C(^{12}C, α)^{20}Ne [a]

E_x [c] (MeV $\pm$ keV)	J^π [b]	$\Gamma_{c.m.}$ (keV)	K^π [b]	θ^2_α
1.6329 ± 1.0	2^+		0_1^+	
4.2456 ± 2.5	4^+		0_1^+	
4.9663 ± 2.5	2^-		2^-	
5.618 ± 4	3^-		2^-	
5.774 ± 6	1^-		0^-	
6.725 ± 6	0^+		0_2^+	
7.004 ± 4	4^-		2^-	
7.169 ± 6	3^-		0^-	
7.196 ± 6	0^+		0_3^+	0.026 [p]
7.435 ± 6	2^+		0_2^+	
7.835 ± 6	2^+		0_3^+	0.015 [p]
8.449 ± 6	5^-		2^-	$(1.6 \pm 0.5) \times 10^{-3}$ [q]
8.694 ± 6	1^-		(1_2^-)	0.0027 [p]
8.779 ± 6	6^+		0_1^+	
8.85	1^-		(1_1^-)	0.0179 [p]
9.033 ± 6	4^+		0_3^+ [a]	0.033 [p], 0.022 [q]
9.110 ± 6	[a]			
9.318 ± 6	[a]			
9.533 ± 6				
9.872 ± 6	$1^+, 2^-, 3^+$ [a]			
9.950 ± 6	$1^+, 2^-, 3^+$ [a]			
10.024 ± 6				
10.264 ± 6	5^-		0^-	
10.407 ± 6	(3^-)		(1_1^-)	0.078 [p]
10.545 ± 6				
10.609 ± 5	6^-		2^-	
10.694 ± 6	$4^-, 3^+$ [a]			
10.840 ± 6	(3^-)		(1_2^-)	0.0099 [p]
10.917 ± 6	3^+ [a]			
11.013 ± 6				

Table 20.19: Excited states of ^{20}Ne from ^{12}C(^{12}C, α)^{20}Ne [a] (continued)

E_x [c] (MeV ± keV)	J^{π} [b]	$\Gamma_{c.m.}$ (keV)	K^{π} [b]	θ^2_{α}
11.528 ± 6				
11.555 ± 6	$1^+, 2^-, 3^+$ [a]			
11.656 ± 6	(3^+) [a]			
11.871 ± 6	[a]			
11.949 ± 6	8^+		0^+_1	$(7.6 \pm 2.2) \times 10^{-3}$ [q]
12.135 ± 5 [d]	6^+		0^+_3	$(4.9 \pm 2.6) \times 10^{-4}$ [q,s]
12.381 ± 6				
12.436 ± 5 [e]	0^+ [r]	15 ± 1	[r]	[q,r]
12.600 ± 10 [aa]	6^+	50 ± 10		0.09 ± 0.02
12.730 ± 6	(5^-)		(1^-)	0.129 [p]
12.919 ± 6				
13.010 ± 6				
13.049 ± 6				
13.190 ± 6				
13.277 ± 6				
13.335 ± 6	7^-		2^-	$(2.4 \pm 1.0) \times 10^{-4}$ [q,t]
13.441 ± 6	(5^-)		(1^-_2)	≤ 0.023 [p]
13.569 ± 15				
13.631 ± 15				
13.679 ± 15				
13.845 ± 15				
13.886 ± 15				
13.927 ± 5	6^+	113 ± 7	0^+_2	0.10 ± 0.01 [q]
14.144 ± 15				
14.311 ± 15 [bb]	6^+	< 50		$\lesssim 0.45$
14.60				
14.812 ± 15				
15.034 ± 15	[a]			
15.159 ± 5 [e]	6^+	60 ± 15	(0^+_6)	$< 8 \times 10^{-4}$ [q,u]
15.359 ± 15 [f]	7^-	410 ± 30	0^-	

Table 20.19: Excited states of ^{20}Ne from ^{12}C(^{12}C, α)^{20}Ne [a] (continued)

E_x [c] (MeV ± keV)	J^π [b]	$\Gamma_{c.m.}$ (keV)	K^π [b]	θ^2_α
15.438 ± 10 [g]		100 ± 20		
15.691 ± 15				
15.874 ± 9 [h]	8^+	100 ± 15	0^+_3	0.047 ± 0.013 [q,v]
16.139 ± 15				
16.600 ± 15 [cc]	7^-	160 ± 30		[cc]
16.717 ± 10		37 ± 10		
17.259 ± 11 [k]	7^- (9^-)	162 ± 20	2^-	0.019 ± 0.004 [q,x]
18.153 ± 10 [l,q]	7^-			
18.538 ± 7 [m]	8^+	138 ± 13	0^+_6	$(3.2 \pm 1.5) \times 10^{-3}$ [q,y]
20.478 ± 11 [n]	8^+	250 ± 30	0^+_2	0.11 ± 0.04 [q,z]
20.704 ± 11 [o]	8^+ (10^+)	≈ 120		[q]
20.89 ± 30				
21.05 ± 20		140 ± 50		
21.65 ± 100	$(7^-, 9^-)$	240 ± 50		
22.03 ± 100	(8^+)	630 ± 80		
22.7 ± 100		500 ± 150		
23.2 ± 100		300 ± 100		
23.74 ± 100		230 ± 100		
24.374 ± 30	7^- (5^-)	200 ± 50		

[a] For complete references see Table 20.21 in (1978AJ03).

[b] See discussion in (1975ME04).

[c] Uncertainties shown for $E_x > 5.7$ MeV are approximate: see footnote [c] in Table 20.21 (1978AJ03).

[d] Alpha decay is by α_2 to ^{16}O*(6.13): $\Gamma_{\alpha'}/\Gamma = (6.0 \pm 0.15)\%$: assuming $\Gamma_\alpha \Gamma_{\alpha'}/\Gamma = 7.7 \pm 3.8$ eV this leads to $\Gamma_\alpha = 0.128 \pm 0.072$ keV for this 6^+ state (1972BA97). See also (1982HI1K).

[e] Alpha decay is $(2 \pm 2)\%$ by α_0, $(46 \pm 2)\%$ via α_{1+2} (mainly α_2) and $(52 \pm 2)\%$ via α_{3+4} (mainly α_3) (1979YO04).

[f] Alpha decay is $(32 \pm 2)\%$ by α_0, $(58 \pm 2)\%$ via α_{1+2} (mainly α_2) and $(10 \pm 2)\%$ via α_{3+4} (mainly α_3) $\Gamma_{\alpha_0}/\Gamma = 0.3 \pm 0.02$, assuming a single state. The state may correspond to a doublet (1979YO04).

[g] Alpha decay is $(20 \pm 5)\%$ by α_0, $(57 \pm 7)\%$ by α_{1+2} and $(23 \pm 4)\%$ by α_{3+4} (1982HI1K).

[h] Alpha decay is $(9 \pm 2)\%$ by α_0, $(79 \pm 2)\%$ via α_{1+2} (mainly α_2) and $(12 \pm 4)\%$ via α_{3+4} (mainly α_3) (1979YO04); $(24 \pm 5)\%$ via α_0, $(51 \pm 7)\%$ via α_{1+2}, $(25 \pm 5)\%$ via α_{3+4} (1982HI1K).

[i] Alpha decay is $(72 \pm 3)\%$ via α_0, $(20 \pm 3)\%$ via α_{1+2} (mainly α_2) and $(8 \pm 3)\%$ via α_{3+4} (mainly α_3) (1979YO04).

[j] Alpha decay is $(5 \pm 2)\%$ via α_0, $(52 \pm 2)\%$ via α_{1+2} (mainly α_2) and $(43 \pm 2)\%$ via α_{3+4} (mainly α_3) (1979YO04); $(60 \pm 5)\%$ via α_0, $(20 \pm 5)\%$ via α_{1+2}, $(20 \pm 5)\%$ via α_{3+4} (1982HI1K).

[k] Alpha decay is $(15 \pm 2)\%$ via α_0, $(50 \pm 6)\%$ via α_{1+2} and $(35 \pm 7)\%$ via α_{3+4} (1982HI1K). See also (1979YO04).

[l] Alpha decay is $(71 \pm 6)\%$ via α_0 and $(29 \pm 6)\%$ via α_{1+2} (mainly α_2) (1979YO04).

[m] Alpha decay is $(1.8 \pm 0.9)\%$ via α_0, $(60 \pm 8)\%$ via α_{1+2} and $(26 \pm 4)\%$ via α_{3+4}. Decay to $^{12}C_{g.s.}+$ $^{8}Be_{g.s.}$ is also observed: the branching ratio is 12%. This state may be a member of an excited 8p-4h ($K^\pi = 0_6^+$) band of which ^{20}Ne*(12.44) is the 0^+ band head (1981HI02, 1982HI1K).

[n] Decay is $(66 \pm 26)\%$ via α_0, $(14 \pm 7)\%$ via α_{1+2} and $(13.2 \pm 2.5)\%$ via $^{12}C + {}^{8}Be$ (1982HI1K).

[o] Decay is $\lesssim 14\%$ via α_0, $(25 \pm 15)\%$ via α_{1+2}, $(46 \pm 22)\%$ via α_{3+4} and $(4.5 \pm 0.9)\%$ via $^{12}C + {}^{8}Be$ (1982HI1K). See also (1979YO04).

[p] (1979YO04).

[q] (1981HI02, 1982HI1K). θ^2_α shown are $\theta^2_{\alpha_0}$ (1982HI1K) and P.D. Parker, private communication.

[r] See footnote [f] in Table 20.21 (1981GA35).

[s] $\theta^2_{\alpha_2} = 0.66 \pm 0.36$ (1982HI1K).

[t] $\theta^2_{\alpha_2} = 0.025 \pm 0.010$ (1982HI1K).

[u] $\theta^2_{\alpha_2} = 0.05 \pm 0.013$, $\theta^2_{\alpha_3} = 0.91 \pm 0.23$ (1982HI1K).

[v] $\theta^2_{\alpha_2} = 0.94 \pm 0.14$, $\theta^2_{\alpha_3} = 4.2 \pm 0.9$ (1982HI1K).

[w] $\theta^2_{\alpha_2} = 0.048 \pm 0.013$, $\theta^2_{\alpha_3} = 0.44 \pm 0.12$ (1982HI1K).

[x] $\theta^2_{\alpha_2} = 0.071 \pm 0.013$, $\theta^2_{\alpha_3} = 0.32 \pm 0.08$ [all θ^2_α assume $J^\pi = 7^-$] (1982HI1K).

[y] $\theta^2_{\alpha_2} = 0.085 \pm 0.014$, $\theta^2_{\alpha_3} = 0.24 \pm 0.04$, $\theta^2_{^{12}C} = 1.50 \pm 0.21$ (1982HI1K).

[z] $\theta^2_{\alpha_2} = 0.016 \pm 0.008$, $\theta^2_{^{12}C} = 0.24 \pm 0.05$ (1982HI1K).

[aa] For the new level at 12.600 ± 10 see (1983HI06).

[bb] For the new level at 14.311 ± 15 see (1983HI06).

[cc] For the new level at 16.600 ± 15 see (1983HI06).

11. (a) ^{14}N(^{6}Li, p)^{19}F — $Q_m = 11.1491$ — $E_b = 23.994$
(b) ^{14}N(^{6}Li, d)^{18}F — $Q_m = 2.942$
(c) ^{14}N(^{6}Li, α)^{16}O — $Q_m = 19.2628$

Yield curves for $E(^{6}\text{Li}) = 4.1$ to 9.2 MeV do not show any structure: see (1978AJ03).

12. (a) ^{14}N(^{12}C, ^{6}Li)^{20}Ne — $Q_m = -4.181$
(b) ^{15}N(^{12}C, ^{7}Li)^{20}Ne — $Q_m = -7.764$

For reaction (a) see (1979GO1C). For reaction (b) see (1979RA10).

Table 20.20: Resonances in $^{16}O(\alpha, \gamma)^{20}Ne$ [a]

E_α (MeV ± keV)	$\Gamma_{c.m.}$ (keV)	$\omega\gamma$ [b] (eV)	E_x (MeV ± keV)	$J^\pi; T$	K^π
1.116 ± 4	2.6×10^{-6} [c]	$(1.7 \pm 0.3) \times 10^{-3}$	5.624	$3^-; 0$	2^-
1.3174 ± 2.2 [d]	$(2.8 \pm 0.3) \times 10^{-2}$ [c]	$(1.4 \pm 0.3) \times 10^{-2}$	5.785	$1^-; 0$	0^-
2.490 ± 8	15 ± 7 [c]	$(3.8 \pm 1.0) \times 10^{-2}$	6.722	$0^+; 0$	
3035.9 ± 2.3 [d]	8.1 ± 0.3		7.1563 ± 0.5	$3^-; 0$	0^-
3.074	4	$(4.4 \pm 0.8) \times 10^{-3}$	7.189 ± 3	$0^+; 0$	
3.363	8	0.146 ± 0.019	7.421 ± 1	$2^+; 0$	
3.872	2.4	0.343 ± 0.035	7.828 ± 3	$2^+; 0$	
(4.647 ± 3)			(8.447)	$(5^-; 0)$	
4.969 ± 9 [e]	2.1 ± 0.8	0.21 ± 0.05	8.705 ± 7	$1^-; 0$	
5.06	< 3	1.35 ± 0.15	8.776 ± 3.2	$6^+; 0$	
5.368	3.2	3.05 ± 0.38	9.024 ± 3	$4^+; 0$	
5.477 ± 4 [e]	< 4	0.18 ± 0.02	9.111 ± 3	$3^-; 0$	
5.94 ± 30	29 ± 15	1.3 ± 0.5	9.48	$2^+; 0$	
6.61 ± 30	155 ± 30	8 ± 3	10.02	$(4^+); 0$	
6.924 ± 7 [f,g]	≤ 1	19.5 ± 1.5 [h]	10.271 ± 7 [i]	$2^+; 1$	
7.948 ± 4 [e,g]	< 1	30.2 ± 3.5	11.087 ± 3	$4^+; 1$	
8.180 ± 5 [e,g,j]	< 1	2.06 ± 0.25 [k]	11.272 ± 4	$1^-; 1$	
8.535 ± 6 [e,g]	1.3 ± 0.8	0.41 ± 0.05	11.556 ± 6	$(0^+, 2^+); 0$	
8.994 ± 8 [e]	< 1	0.23 ± 0.05 [l]	11.923 ± 6	$4^+; 0$	
9.02 [m]		0.131 ± 0.018	11.950 ± 4	$8^+; 0$	
(9.05 ± 50) [g]	< 40		(11.97)		
(9.15 ± 50) [g]	< 40		(12.05)		
9.362 ± 5 [e]	< 1	1.41 ± 0.23	12.218 ± 4	$2^+; 1$	
9.406 ± 4 [e]	< 1	6.6 ± 0.8 [n]	12.253 ± 3	$3^-; 1$	
9.57 ± 10 [g]	33 ± 4	1.94 ± 0.15	12.38	$3^-; (1)$	
9.70 ± 30 [g]	≤ 10	0.17 ± 0.05	12.49		

[a] For complete references see Table 20.22 in (1978AJ03).
[b] $\omega\gamma = (2J+1)\Gamma_\alpha\Gamma_\gamma/\Gamma$.
[c] This is also Γ_α.
[d] (1980MA27). The strength of the γ-decay of ^{20}Ne*(7.16) to ^{20}Ne*(5.78) (see Table 20.18) is strong evidence that these two states are members of the $K^\pi = 0^-$ band.
[e] (1980FI01). See also Table 20.18.
[f] See also (1978SN1B).
[g] (1978ST08).
[h] $\omega\gamma = 19.2 \pm 1.9$ eV (1978ST08); $\Gamma_\alpha = 116 \pm 20$ eV (1976IN05); $\Gamma_\gamma = 4.26 \pm 0.23$ eV (1977FI08) [summary of several measurements].
[i] From E_γ measurements (1977FI08). The measurements of the decay of this state leads to $E_x = 4247.9 \pm 1.3$, 4966.0 ± 1.9, 5621.0 ± 3.5, 7423.1 ± 3.0, 7828.1 ± 3.8 and 8776.7 ± 2.3 keV (1977FI08).
[j] (1978DA19) find $E_x = 11.278 \pm 0.004$ MeV, $\omega\gamma_0 = 1.0 \pm 0.3$ eV.
[k] The γ-decay is partly (see Table 20.18) to a state at $E_x = 9318 \pm 2$ keV. The strength of this transition and the subsequent decay to ^{20}Ne*(1.63) (and not to the ground state) favor 2^- for ^{20}Ne*(9.32). The other M1 transition [$11.27 \rightarrow 8.85$] is also strong suggesting similar structures for ^{20}Ne*(8.85, 9.32) (1980FI01).
[l] Also observed as a resonance in the yield of 6.13 MeV γ-rays with $(2J+1)\Gamma_{\alpha_0}\Gamma_{\alpha_2}/\Gamma = 5.2 \pm 0.9$ eV (1980FI01).
[m] (1980HU08).
[n] (1980FI01): see also for a discussion of the decay of the 18.43 MeV, $J^\pi = 2^+$, $T = 2$ state.

13. ^{16}O(α, γ)^{20}Ne $Q_m = 4.7309$

Observed resonances in the yield of capture γ-rays over the range $E_\alpha = 0.8$ to 10 MeV are displayed in Table 20.20. Information on the character of the radiative decay is shown in Table 20.18. ^{20}Ne*(11.261) [$J^\pi = 1^+$; $T = 1$] is not observed: $\Gamma_\alpha < 3 \times 10^{-5}$ eV, leading to $| < 1^+ V_{\mathrm{PNC}} 1^- > | < 1.2$ eV (1980FIZX). ^{20}Ne*(12.25) is the 3^-; $T = 1$ analog of ^{20}F*(1.97) (1980FI01). See also (1978AJ03, 1979NO11), (1982IB1A; astrophys.) and (1982DU1A; theor.).

14. (a) ^{16}O(α, α)^{16}O $E_b = 4.7309$
(b) ^{16}O(α, 2α)^{12}C $Q_m = -7.1620$

Excitation functions have been measured over a wide range for elastically and inelastically scattered α-particles, and γ-rays from the decay of ^{16}O*(6.13, 6.92, 7.12): see (1978AJ03) and (1981GA35; 9.5 to 9.8 MeV; α_1), (1979BI10; 14.6 to 20.4 MeV; $\alpha_0 \rightarrow \alpha_5$), (1979AR05; 17.5 to 22.7 MeV; α_0) and (1978CO10; 27 to 33.6 MeV; α_0).

A number of anomalies are observed: they are displayed in Table 20.21: see, in particular, (1972HA07, 1973HA63, 1979BI10). (1979AR05) report structures in the range $E_x = 18.7 - 22.9$

MeV which are similar to those observed in ^{16}O(^{6}Li, d)^{20}Ne* $\rightarrow \alpha + {}^{16}\mathrm{O}_{\mathrm{g.s.}}$. The excitation function for α_0 at 178.1° shows a very strong structure at $E_\alpha \approx 29.5$ MeV as does the excitation function for deuterons to ^{18}F*(1.13) [$J^\pi = 5^+$] (1978CO10, 1979CO1P): this anomalous scattering is correlated with a large variation in the degree of forward peaking of the (α, d) process.

Table 20.21: Resonances in ^{16}O(α, α) [a]

E_α (MeV ± keV)	$\Gamma_{\mathrm{c.m.}}$ (keV)	Outgoing particles	θ^2 (%)	E_x (MeV ± keV)	J^π	K^π
1.3174 ± 2.2 [b]	$(2.8 \pm 0.3) \times 10^{-2}$ [b]	α_0		5.785	1^-	0^-
2.490 ± 10	19	α_0	22	6.722	0^+	0^+_2
3.0359 ± 2.3 [b]	8.1 ± 0.3 [b]	α_0	36	7.1563 ± 0.5	3^-	0^-
3.090 ± 10	4	α_0	1.1	7.202	0^+	0^+_3
3.380 ± 10	8	α_0	4.7	7.434	2^+	0^+_2
3.885 ± 10	2	α_0	0.6	7.838	2^+	0^+_3
4.653 ± 5	0.013 ± 0.004	α_0	0.07	8.452	5^-	2^-
≈ 4.9	> 800	α_0	≈ 70	≈ 8.6	0^+	0^+_4
5.002	2.5	α_0	0.23	8.731	1^-	
5.058 ± 3	0.11 ± 0.02	α_0	8.5 ± 1.5	8.776	6^+	0^+_1
≈ 5.1	> 800	α_0	≈ 95	≈ 8.8	2^+	0^+_4
5.11	< 1	α_0		8.82	(5^-)	
5.152 ± 5	19	α_0	1.1	8.851	1^-	
5.395 ± 5	3	α_0	3.9	9.046	4^+	0^+_3
5.486 ± 5	3.2	α_0	0.49	9.118	3^-	
5.955 ± 10	24	α_0	1.4	9.493	2^+	
6.569 ± 10	97	α_0	17	9.984	4^+	0^+_2
6.912 ± 5	141	α_0	66	10.259	5^-	0^-
6.92 ± 10 [c]	≤ 0.3	α_0	$\leq 1.3 \times 10^{-3}$	10.27	(2^+)	
7.092 ± 5	81	α_0	4.8	10.403	3^-	
7.276 ± 5	16	α_0	1.8	10.550	4^+	
7.314 ± 10	24	α_0	0.85	10.580	2^+	
7.580 ± 100	349	α_0	33	10.79	4^+	0^+_4
7.635 ± 5	13	α_0	0.42	10.837	2^+	
7.636	45	α_0	2.1	10.838	3^-	
(7.75)	80	α_0		(10.93)		
7.80 ± 150	576	α_0	14	10.97	0^+	
7.860 ± 10	24	α_0	2.0	11.017	4^+	
7.93 ± 10 [c]	≤ 0.5	α_0	≤ 0.05	11.07	(4^+)	
8.132 ± 30	172	α_0	4.2	11.234	1^-	
8.16 ± 10 [c]	≤ 0.3	α_0	≤ 0.009	11.26	(1^-)	
8.24 ± 10 [c]	40 ± 10	α_0	1.4	11.32	2^+	
8.528 ± 10 [c]	1.0 ± 0.5	α_0	0.03, 0.02	11.551	$(2^+, 0^+)$	

Table 20.21: Resonances in ^{16}O(α, α) [a] (continued)

(≈ 8.6)	≈ 500	α_0		(≈ 11.6)	(2^+)	
8.930 ± 20	46	α_0	1.1	11.872	2^+	
8.997 ± 5	0.44 ± 0.15	$\alpha_0, \gamma_{6.13}$	0.04 ± 0.01	11.926	4^+	
9.026 ± 5	$(35 \pm 10) \times 10^{-3}$	α_0	1.0 ± 0.3	11.949	8^+	0_1^+
9.043 ± 10 [c]	30 ± 5	α_0	0.72	11.962	1^-	
9.26		$\gamma_{6.13}$	[d]	12.137 ± 5	6^+	0_3^+
9.39 ± 30 [c]	148 ± 20	α_0	7.7	12.24	4^+	
9.406 ± 4	< 1	$\gamma_{6.13}$	[d]	12.253 ± 3	$3^-; 1$	
9.53 ± 100 [c]	≈ 500	α_0	≈ 13	12.35	2^+	
9.58 [c,e]	37.3 ± 0.9	$\alpha_0, \gamma_{6.13}$		12.394 ± 4	3^-	
9.64 [f]	24.4 ± 0.5	α_0, α_1	[f]	12.436 ± 4	0^+	
9.790 ± 10 [c]	88 ± 10	α_0	28	12.560	6^+	0_4^+
(9.860 ± 100)		α_0		(12.62)		
9.944 ± 15	97	α_0	7.3	12.683	5^-	
10.050 ± 100	100	α_0		12.77	4^+	
10.14 ± 70	55	$\alpha_0, \gamma_{6.13}$		12.84		
10.32 ± 75 [g]	60	$\alpha_0, \gamma_{6.13}$		12.98	(4^+)	
10.43 ± 90	70	$\alpha_0, \gamma_{6.13}$		13.07	(4^+)	
10.57 ± 75	60	$\alpha_0, \gamma_{6.13}$		13.18	(4^+)	
10.759 ± 6	$(80 \pm 30) \times 10^{-3}$	α_0	0.08 ± 0.03	13.334	7^-	2^-
10.770 ± 6	20 ± 5	$\alpha_0, \gamma_{6.13}$	0.7 ± 0.2	13.343	4^+	
10.83 ± 50	40	$\gamma_{6.13}$		13.39		
10.87 ± 140	110	$\alpha_0, \gamma_{6.13}$		13.42	(4^+)	
11.20 ± 400	320	$\alpha_0, \gamma_{6.13}$		13.7	$(3, 7)^-$	
(11.51 ± 125) [g]	(400)	$(\alpha_0, \gamma_{6.13})$		13.93	(6^+)	
11.77		$\alpha_0, \gamma_{6.9+7.1}$		14.14		
E_α (MeV $\pm$ keV)	$\Gamma_{\text{c.m.}}$ (keV)	Outgoing particles	Γ_{α_0}/Γ	E_{x} (MeV $\pm$ keV)	J^π	K^π
11.97 ± 300	240	$\alpha_0, \gamma_{6.13}, \gamma_{6.9+7.1}$		14.3	6^+	
(12.06)		$\alpha_0, \gamma_{6.9+7.1}$		(14.37)		
12.31 ± 300	240	$\alpha_0, \gamma_{6.9+7.1}$		14.6	(4^+)	
12.66 ± 150	120	$\alpha_0, \gamma_{6.13}, \gamma_{6.9+7.1}$		14.85		
12.86 ± 150	120	$\alpha_0, \gamma_{6.13}, \gamma_{6.9+7.1}$		15.01		
13.165 ± 150	120	$\alpha_0, \gamma_{6.13}$		15.26		
13.22		α_0		15.30		
13.37 ± 470	380	$\alpha_0, \gamma_{6.13}, \gamma_{6.9+7.1}$		15.4	7^-	0^-
13.58		$\alpha_0, \gamma_{6.13}, \gamma_{6.9+7.1}$		15.59		
13.73		$\alpha_0, \gamma_{6.13}, \gamma_{6.9+7.1}$		15.71	(6^+)	
14.05		$\alpha_0, \gamma_{6.13}, \gamma_{6.9+7.1}$		15.97	(6^+)	

Table 20.21: Resonances in $^{16}O(\alpha, \alpha)$ [a] (continued)

14.26		$\gamma_{6.13}, \gamma_{6.9+7.1}$		16.13		
14.40		$\gamma_{6.13}$		16.25		
14.501 ± 15	43	α_0, α_{1+2}		16.326	4^+	
14.636 ± 15	34	α_0, α_{1+2}		16.434	$(0, 2, 4)^+$	
14.726 ± 11 [h]	25 ± 3	α_0, α_{1+2}	0.473 ± 0.024	16.506	6^+	
14.815 ± 15 [h]	86 ± 6	α_0	0.446 ± 0.019	16.577 ± 12	7^-	
14.886 ± 17 [h]	51 ± 14	α_0	0.173 ± 0.014	16.634 ± 14	3^-	
14.932 ± 12 [h]	79 ± 11	α_0	0.259 ± 0.025	16.671	4^+	
14.988 ± 12 [h]	14 ± 7	α_0, α_{1+2}	0.062 ± 0.026	16.715	$(5, 3)^-$	
15.156 ± 11 [h]	16 ± 5	α_0, α_{1+2}	0.126 ± 0.021	16.850	5^-	
15.540 ± 11 [h]	33 ± 3	α_0, α_{1+2}	0.291 ± 0.019	17.156	5^-	
15.601 ± 15 [h]	142 ± 9	α_0	0.460 ± 0.019	17.205 ± 12	4^+	
15.691 ± 12 [h]	52 ± 10	α_0	0.155 ± 0.019	17.277	4^+	
15.721 ± 17 [h]	213 ± 12	α_0	0.237 ± 0.013	17.301 ± 14	8^+	
15.828 ± 15	< 10	α_{1+2}		17.387		
15.837 ± 17 [h]	241 ± 13	α_0	0.209 ± 0.012	17.394 ± 14	9^-	
16.023 ± 15	136	α_0, α_{1+2}		17.542	6^+	
16.285 ± 15	36	α_0, α_{1+2}		17.752	$(4, 0)^+$	
16.598 ± 15	< 10	α_0, α_{1+2}		18.002	7^-	
16.625 ± 10 [h]	35 ± 3	α_0, α_{1+2}	0.372 ± 0.018	18.024 ± 8	5^-	
16.744 ± 9 [h]	29 ± 3	α_0, α_{1+2}	0.420 ± 0.024	18.119 ± 8	7^-	
16.98 ± 300	240	$\alpha_0, \gamma_{6.13}, \gamma_{6.9+7.1}$		18.31	(6^+)	
17.45	600	$\alpha_0, \gamma_{6.13}$		18.7	(6^+)	
17.988 ± 12 [h]	149 ± 18	α_1	0.420 ± 0.012 [i]	19.113 ± 10	6^+	
18.250 ± 11 [h]	123 ± 10	α_1	0.272 ± 0.014 [i]	19.322 ± 9	6^+	
18.393 ± 12 [h]	102 ± 7	α_1	0.466 ± 0.012 [i]	19.437 ± 10	6^+	
18.658 ± 12 [h]	89 ± 8	α_1	0.332 ± 0.012 [i]	19.648 ± 10	6^+	
18.990 ± 15 [h]	203 ± 19	α_1	0.379 ± 0.017 [i]	19.914 ± 12	5^-	
19.261 ± 21 [h]	156 ± 21	α_1	0.301 ± 0.020 [i]	20.130 ± 17	7^-	
19.495 ± 15 [h]	203 ± 19	α_1	0.343 ± 0.021 [i]	20.317 ± 12	7^-	
19.640 ± 20 [h]	346 ± 32	α_1	0.444 ± 0.020 [i]	20.433 ± 16	6^+	
19.953 ± 11 [h]	75 ± 9	α_0	0.247 ± 0.018	20.683 ± 9	9^-	
20.076 ± 14	122 ± 13	α_1	0.395 ± 0.020	20.782 ± 11	7^-	
20.249 ± 15	181 ± 22	α_1	0.339 ± 0.017	20.920 ± 12	7^-	
20.45 ± 40	80	α_0		21.08	9^-	
20.70	300	α_0		21.3	7^-	
21.3 ± 200	300	α_0		21.8	7^-	
22.0 ± 200	500	α_0		22.3	7^-	
22.5 ± 250	500	α_0		22.7	9^-	

Table 20.21: Resonances in ^{16}O(α, α) [a] (continued)

22.65 ± 125	250	α_0		22.84	9^-	
23.3 ± 250	500	α_0		23.4	8^+	
24.24 ± 150	350	α_0		24.11	8^+	
25.4 ± 300	600	α_0		25.0	8^+	
26.2 ± 200	400	α_0		25.7		
28.1 ± 350	700	α_0		27.2		
29	1600	α_0		28	8^+	
29.4 ± 350	700	α_0		28.2		

[a] See also Table 20.20, and Table 2 in (1973HA63). For a complete listing of references see Table 20.23 in (1978AJ03).
[b] (1980MA27): $\Gamma_{\rm c.m.} = \Gamma_\alpha$.
[c] (1978ST08).
[d] $(2J+1)\Gamma_{\alpha_0}\Gamma_{\alpha_2}/\Gamma = 81 \pm 12$ eV and 14 ± 2 eV, respectively, for ^{20}Ne*(12.14, 12.25) (1980FI01).
[e] (1981GA35): $\omega\gamma_{\rm c.m.} = 3.3 \pm 0.3$ keV. See also (1978ST08).
[f] $\omega\gamma_{\rm c.m.} = 2.82 \pm 0.29$, $\Gamma_{\alpha_1} = 20.8 \pm 0.4$ keV, $\Gamma_{\alpha_0} = 3.2 \pm 0.4$ keV. The spectroscopic factors are ≈ 1 and 0.001 for the α_1 and α_0 decays suggesting that the wave function of ^{20}Ne*(12.44) contains a large amount of 8p-4h configuration (1981GA35). See also (1980CA1K).
[g] (1981CA1J; abstract) suggest 8p-4h 2^+ and 4^+ states at $E_{\rm x} = 12.95$ and 13.96 MeV; $\theta^2 = 0.004$ and 0.001, respectively. (1982HIZY; abstract) find $\Gamma_{\alpha_1}/\Gamma < 0.6\%$ [^{16}O*(12.98)], $\Gamma_{\alpha_3}/\Gamma < 0.1\%$ [^{16}O*(13.34)] and $\Gamma_{\alpha_1}/\Gamma = (0.7 \pm 0.5)$, $\Gamma_{\alpha_{3+4}}/\Gamma = (1.0 \pm 0.4)$ [^{16}O*(13.93)]. The corresponding reduced widths are very small and indicate that these states are not the 8p-4h 2^+ and 4^+ states suggested by (1981CA1J).
[h] (1979BI10). The state at $E_{\rm x} = 19.577$ MeV has been withdrawn. The quoted errors in the branching ratios reported by (1979BI10) correspond to a χ^2 doubling as the parameter is varied. However because of correlations in the fitting program, the uncertainties may well be as large as ± 0.1. The uncertainties in the quoted widths may be appreciably larger than shown (H.T. Richards and S. Riedhauser, private communication).
[i] $(\Gamma_{\alpha_0}\Gamma_{\alpha_1})^{1/2}/\Gamma$.
[j] Preliminary work by G. Caskey indicates that the resonance at $E_\alpha = 11183 \pm 5$ keV corresponds to a state at $E_{\rm x} = 13672 \pm 4$ keV [$\Gamma_{\rm c.m.} = 15 \pm 6$ keV] with $J^\pi = 5^-$ (H.T. Richards, private communication).

For reaction (b) see (1980AJ01). For spallation reactions see (1978AJ03) and (1979VI05, 1980GO1E, 1980RE1B, 1981GOZY). See also (1981BE2D), (1979RA1C; astrophys.), (1977ST1X, 1982FI1C) and (1976PA20, 1977BA1N, 1977BA30, 1977IK1A, 1977TO1K, 1978FL1D, 1978KA22, 1978NO1B, 1978TA1A, 1978TH1A, 1978TO07, 1979AR05, 1979LE1B, 1979LE11, 1979VE09, 1979VE1C, 1980BA2K, 1980FL1C, 1980FU1F, 1980LE26, 1980TO1D, 1981AO01, 1981FI1B, 1981GY01, 1981WI01, 1982AO1B, 1982BI1D, 1982FL1A, 1982LA04; theor.).

15. ^{16}O(α, n)^{19}Ne $Q_{\rm m} = -12.1344$ $E_{\rm b} = 4.7309$

The excitation function (activation measurements) has been measured from threshold to E_α = 26.8 MeV (1973GR29). See also ^{19}Ne, (1979BA48), (1979BU19; applied) and (1977GR18).

16. (a) ^{16}O(α, p)^{19}F $\qquad Q_m = -8.1137 \qquad E_b = 4.7309$

(b) ^{16}O(α, d)^{18}F $\qquad Q_m = -16.3204$

For reaction (a) see ^{19}F. For reaction (b) see (1978CO10, 1979CO1P) and reaction 14.

17. ^{16}O(^{6}Li, d)^{20}Ne $\qquad Q_m = 3.257$

Deuteron groups have been observed to many states of ^{20}Ne: see Table 20.22. Angular distributions have been measured for $E(^6\text{Li}) = 5.5$ to 45 MeV [see (1978AJ03)] and at 20 and 38 MeV (1979AN01; d_0, d_1, d_2), 32 MeV (1979AN01; to all states shown in Table 20.23 with $E_x < 12.2$ MeV, except ^{20}Ne*(10.7)), 42 MeV (1978BE43; d_0, d_1) and 75.4 MeV (1981TA06, 1981TA23; d to ^{20}Ne*(0, 1.63, 4.25, 5.78, 7.17, 8.78, 10.26, 11.95); $S_\alpha = 1.0, 0.96, 1.0, < 0.93$, 0.49, 0.98, 0.88, 0.65, respectively; ^{20}Ne*(12.59, 13.90, 15.34, 17.30) were also populated. Reaction processes are discussed by (1979AN01). See also reaction 14 (1979AR05) and (1979ES01; d-γ involving ^{20}Ne*(1.63, 4.25)). For excitation functions see (1978HO01). See also (1980MA1N), (1977ST1X, 1979FU1N, 1980AN16) and (1981GY01, 1981LE10, 1981MA26, 1981XE01, 1982SE1E; theor.).

18. ^{16}O(^{7}Li, t)^{20}Ne $\qquad Q_m = 2.264$

States observed in this reaction are displayed in Table 20.22. Angular distributions are reported at $E(^7\text{Li}) = 15$ to 38 MeV [see (1978AJ03)] and at 50 and 68 MeV (1979BR03; to ^{20}Ne*(1.63, 4.25, 7.17, 8.78, 10.25, 15.4; see also for C^2S). See also (1978AJ03).

19. ^{16}O(^{9}Be, αn)^{20}Ne $\qquad Q_m = 3.1576$

See (1979CH12, 1979CU1A).

20. (a) ^{16}O(^{12}C, ^{8}Be)^{20}Ne $\qquad Q_m = -2.6358$

(b) ^{16}O(^{12}C, 2α)^{20}Ne $\qquad Q_m = -2.5439$

Table 20.22: States of ^{20}Ne from ^{16}O(^{6}Li, d), ^{16}O(^{7}Li, t) and ^{16}O(^{12}C, ^{8}Be) [a]

E_x (MeV $\pm$ keV)				$\Gamma_{c.m.}$ (keV)	Γ_{α_0}/Γ [b]	S [c]	J^π	K^π [a,b,c]
	(^{6}Li, d)	(^{7}Li, t)	(^{12}C, ^{8}Be) [b]					
0	0	0				1.00	0^+	0_1^+
1	1.63	1.63				0.41	2^+	0_1^+
2	4.25	4.25				0.22	4^+	0_1^+
3	4.97						2^-	2^-
4	5.62					0.06	3^-	2^-
5	5.78	5.78				0.54	1^-	0^-
6	6.72					0.56	0^+	
7	7.00						4^-	2^-
8	7.16	7.16	7.16			0.26	3^-	0^-
9	7.42					0.13	2^+	
10	8.45					0.04	5^-	0^-
11	8.78	8.78	8.78			0.20	6^+	0_1^+
12	10.3 ± 100	10.26	10.26	145 ± 40	1	0.15	5^-	0^-
13	10.7 ± 100						4^+	(0_2^+)
14	11.95	11.95	11.95		0.85 ± 0.15	0.51	8^+	0_1^+
15	12.15					0.05	6^+	
16	12.6 ± 100	12.591 ± 10	12.59	110 ± 40	0.80 ± 0.10		6^+	0_2^+
17	13.9	13.904 ± 20		≈ 100			6^+	
18	14.3	14.310 ± 20		< 100			6^+	
19	15.35 ± 100	15.336 ± 15	15.34	380 ± 60	0.90 ± 0.10		7^-	0^-
20	15.9 ± 100			< 250			7^-	
21	16.7 ± 100	16.63 ± 20	16.63	190 ± 40	0.90 ± 0.10		7^- [e]	0^-

Table 20.22: States of ^{20}Ne from ^{16}O(^{6}Li, d), ^{16}O(^{7}Li, t) and ^{16}O(^{12}C, ^{8}Be) [a] (continued)

E_x (MeV ± keV)				$\Gamma_{c.m.}$ (keV)	Γ_{α_0}/Γ [b]	S [c]	J^π	K^π [a,b,c]
	(^{6}Li, d)	(^{7}Li, t)	(^{12}C, ^{8}Be) [b]					
22	17.35 ± 100	17.30 ± 20	17.30	220 ± 40	$\geq 0.40 \pm 0.10$		8^+ [e]	0_2^+
23	18.7 ± 100						7^-	
24	19.4 ± 100			400			7^-	
25	19.9 ± 100			400			7^-	
26		20.67 ± 40						
27	20.8 ± 100						7^- (6^+)	
28		21.08 ± 30	21.08	100 ± 50	0.65 ± 0.15		9^-	0^-
29	21.3 ± 100			300			8^+	
30	21.8 ± 100			300			8^+	
31	22.3 ± 100			300			8^+	
32		22.87 ± 40	22.87	225 ± 40	0.90 ± 0.10		9^-	0^-
33	23.5 ± 100	23.70 ± 30		≤ 200			9^- (8^+)	
34		24.21 ± 25		≈ 500				
35		25.10 ± 50		≤ 200				
36		25.67 ± 50 [f]		≈ 500				
37	27.1 ± 100 [d]						9^-	
38	28.1 ± 100 [d]						10^+	
39	(29.4) [d]						(10^+)	
40	((33.4)) [d]						((10^+))	

[a] For complete references see Table 20.24 in (1978AJ03).

[b] (1979SA29): $E(^{12}C) = 78$ MeV.

[c] Relative α-particle spectroscopic factors (1979AN01): $E(^{6}Li) = 32$ MeV (DWBA). S_{α} values are reported by (1981TA06, 1981TA23: $E(^{6}Li) = 75.4$ MeV). See also Table 20.24 in (1978AJ03), (1978BE43) and (1979BR03).

[d] (1977AR18): $E(^{6}Li) = 57.8$ MeV.

[e] (1979FO20) suggest an admixture of 6^{+} or 8^{+} in the d-α angular correlation involving ^{20}Ne*(16.6) and a doublet $(8^{+} + 7^{-})$ at $E_{x} = 17.4$ MeV.

Angular distributions in reaction (a) have been measured for $E(^{16}O) = 27.1$ to 46.4 MeV [see (1978AJ03)] and 28.5 to 35.2 MeV (1979VI08; g.s.), 43.2 to 53.0 MeV (1979JA19; g.s.) and 43.9 MeV (1979EB01; g.s.), and at $E(^{12}C) = 56$ MeV (1976MA12), 22.7 to 32.4 MeV (1980HU07; g.s.) and 78 MeV (1979SA29; see Table 20.23). Γ_{α_0}/Γ measurements derived from ^{8}Be-α correlations are listed in Table 20.22 (1979SA29). For reaction (b) see (1978AJ03). For yield and cross-section measurements see (1977BR38, 1978CH15, 1978DI1F, 1978KA1L, 1978TA11, 1979EB01, 1979FLZW, 1979JA19, 1979KO03, 1979VI08, 1980HA1L, 1980HU07, 1980SI15). See also (1979GO1C, 1981RAZP) and (1981SA1J; theor.).

21. ^{16}O(^{13}C, ^{9}Be)^{20}Ne $\qquad Q_m = -5.9170$

At $E(^{13}C) = 105$ MeV angular distributions to ^{20}Ne*(1.63, 4.25, 8.78, 11.95, 15.34, 21.0) have been studied by (1979BR03): the first four states are the 2^+, 4^+, 6^+ and 8^+ members of the 0^+ band; the two higher states [$J^\pi = 7^-, 9^-$] belong to the 0^- band whose band head is ^{20}Ne*(5.79). In addition distributions are reported to ^{20}Ne*(12.56, 15.9, 17.3) [$J^\pi = 6^+, 8^+, 8^+$] (1979BR03). See also (1977FO1E, 1978AJ03).

22. ^{16}O(^{14}N, ^{10}B)^{20}Ne $\qquad Q_m = -6.8823$

Angular distributions are reported at $E(^{14}N) = 76.2$ MeV to ^{20}Ne*(0, 1.63, 4.25) (1977MO1A, 1979MO14). See also (1977FO1E, 1978AJ03).

23. ^{16}O(^{16}O, ^{12}C)^{20}Ne $\qquad Q_m = -2.4310$

Angular distributions have been reported at $E(^{16}O) = 23.9$ to 51.5 MeV [see (1978AJ03)] and at 35 MeV (1977KA26; ^{20}Ne*(0, 1.63)), 68 and 90 MeV (1977PO14, 1979PO14; ^{20}Ne*(0, 1.63, 4.25, 7.16, 8.45, 8.78, 10.26, 11.95)) and 95.2 MeV (1977MO1A, 1979MO14; ^{20}Ne*(0, 1.63)). (1979PO14, 1981PO1A) report that ^{20}Ne*(7.17, 8.45, 8.78) are strongly aligned and polarized along an axis perpendicular to the reaction plane. See also (1977PO14) and (1980BO1K; theor.). For partial fusion excitation functions see (1978FE04, 1978TS04, 1979KO15). See also (1978AJ03, 1978FI1E, 1979GO1C, 1981BR1P) and (1981KR09, 1982KO07; theor.).

24. (a) ^{16}O(^{17}O, ^{13}C)^{20}Ne $\qquad Q_m = -1.629$
(b) ^{16}O(^{18}O, ^{14}C)^{20}Ne $\qquad Q_m = -1.4970$

Angular distributions are reported at $E(^{17}O) = 35$ MeV to ^{20}Ne*(0, 1.63) and at $E(^{18}O) = 36.1$ MeV to ^{20}Ne*(0, 1.63, 4.25) (1977KA26). See also (1978AJ03).

Table 20.23: States of ^{20}Ne from ^{18}O(^{3}He, n) [a]

E_x (MeV $\pm$ keV)	L	$J^\pi; T$
0	0	0^+
1.65 ± 15	2	2^+
4.21 ± 30	4	4^+
4.96 ± 150		
5.71 ± 30		
6.72 ± 70		
7.15 ± 20		
7.86 ± 100		
8.79 ± 60		
9.05 ± 60		
9.98 ± 50		
10.24 ± 30	2	2^+; (1)
10.88 ± 50		
11.27 ± 50		
11.48 ± 60	(0)	(0^+)
11.59 ± 40		
12.21 ± 15	2	2^+
12.41 ± 30	0	0^+
12.83 ± 30		
13.10 ± 30	0	0^+
13.34 ± 30		
13.48 ± 30		
13.59 ± 20	(2)	(2^+)
13.90 ± 25	(2)	(2^+)
14.22 ± 30		
15.52 ± 15	(2)	$(2^+; 1)$
16.01 ± 25	(2)	$(2^+; 1)$
16.730 ± 6 [b]	0	$0^+; T = 2$
17.55 ± 10	(2)	$(2^+; 1)$
17.91 ± 20	(0)	(0^+)
19.33 ± 15		

[a] For references see Table 20.25 in (1978AJ03).
[b] $\Gamma < 20$ keV.

25. ^{16}O(^{19}F, ^{15}N)^{20}Ne $\quad Q_m = 0.7171$

Angular distributions involving ^{20}Ne*(0, 1.63) have been studied at $E(^{19}\text{F}) = 36$ MeV and $E(^{16}\text{O}) = 46$, 58 and 68 MeV: see (1978AJ03) and (1980TA1K; theor.).

26. (a) ^{17}O(^{3}He, n)^{19}Ne $\quad Q_m = 4.299 \quad E_b = 21.164$

(b) ^{17}O(^{3}He, t)^{17}F $\quad Q_m = -2.780$

(c) ^{17}O(^{3}He, ^{3}He)^{17}O

(d) ^{17}O(^{3}He, α)^{16}O $\quad Q_m = 16.4335$

For reaction (a) see ^{19}Ne. The excitation function for α_0 [$E(^3\text{He}) = 7.0$ to 10.0 MeV] shows a resonance corresponding to ^{20}Ne*(28.): see (1978AJ03). Polarization measurements are reported at $E(^3\vec{\text{He}}) = 33$ MeV for the t_0 group [reaction (b)], the ^{3}He groups to ^{17}O*(0, 0.87) [reaction (c)] and the α-groups to ^{16}O*(12.97, 13.26) [reaction (d)] (1981BA1G, 1981KA1L, 1981LE1H). See also (1981RO1H).

27. ^{17}O(α, n)^{20}Ne $\quad Q_m = 0.587$

Angular distributions have been measured at $E_\alpha = 9.8$ to 12.3 MeV for the n_1, n_2 and n_{4+5} groups: see (1978AJ03). See also (1979BU19; applied) and (1981CH1K; astrophys.).

28. ^{17}O(^{6}Li, t)^{20}Ne $\quad Q_m = 5.370$

See (1978AJ03).

29. (a) ^{17}O(^{11}B, ^{8}Li)^{20}Ne $\quad Q_m = -6.046$

(b) ^{17}O(^{12}C, ^{9}Be)^{20}Ne $\quad Q_m = -5.115$

At $E = 115$ MeV the 8^+ state at $E_x = 11.95$ MeV is particularly strongly populated in both reactions. ^{20}Ne*(1.63, 4.25, 7.16, 8.78, 10.3, 15.3, 15.9, 17.3, 21.1) are also observed (1979GO17).

30. ^{18}O(^{3}He, n)^{20}Ne $\quad Q_m = 13.1199$

Angular distributions have been measured for $E(^3\text{He}) = 2.8$ to 18.3 MeV. States of ^{20}Ne observed in this reaction are displayed in Table 20.23. See also (1978AJ03).

31. ^{18}O(^{11}B, ^{9}Li)^{20}Ne $\qquad Q_{\text{m}} = -10.027$

At $E(^{11}\text{B}) = 114$ MeV, ^{20}Ne*(4.25, 8.9, 10.39, 15.43) are relatively strongly populated: see (1978AJ03).

32. ^{18}O(^{12}C, ^{10}Be)^{20}Ne $\qquad Q_{\text{m}} = -4.7816$

At $E(^{12}\text{C}) = 46$ MeV angular distributions to ^{20}Ne*(0, 1.63, 4.25) have been studied: the 2p spectroscopic factors are 0.58, 0.24 and 0.20, respectively (1975CO15).

33. ^{19}F(p, γ)^{20}Ne $\qquad Q_{\text{m}} = 12.8447$

Over the range $E_{\text{p}} = 2.9$ to 12.8 MeV, the γ_0 and γ_1 yields are dominated by the E1 giant resonance ($\Gamma \approx 6$ MeV) with the γ_1 giant resonance displaced upward in energy. Strong well-correlated structure is observed with a characteristic $\Gamma \approx 175$ keV. Angular distributions taken over the energy range do not vary greatly with energy. They are incompatible with γ_0 and γ_1 coming from the same levels in ^{20}Ne (1967SE02). The 90° γ_0 yield for $E_{\vec{\text{p}}}$ and $E_{\text{p}} = 3.5$ to 10 MeV has been measured: the results are interpreted in terms of four primary doorway states at $E_{\text{x}} = 16.7$, 17.8, 19.1 and 20.2 MeV (1980CA11).

The yield curve for 11.2 MeV γ-rays [from the decay of ^{20}Ne*(11.23), $J^\pi = 1^+$, $T = 1$, to the ground state] displays a resonance at $E_{\text{p}} = 4.090 \pm 0.005$ MeV [^{20}Ne*(16.73)]. The 11.2 MeV γ-rays are isotropic which is consistent with the presumed 0^+ character of this lowest $T = 2$ state in ^{20}Ne: $\Gamma_{\text{p}}\Gamma_\gamma/\Gamma \approx 0.5$ eV. Since Γ_{p}/Γ (from the elastic scattering) is ≈ 0.1, $\Gamma_\gamma \approx 5$ eV (1967KU06). For $E_{\text{p}} = 5.65$ to 6.21 MeV, the γ_0 and γ_1 yields are not resonant but the yield of 10.6 MeV γ-rays is resonant at 5.879 ± 0.007 MeV [$\Gamma_{\text{c.m.}} = 9.5 \pm 3$ keV, $\Gamma_{\text{p}0}\Gamma_\gamma/\Gamma \approx 0.05$ eV; $\Gamma_\gamma \approx 0.3$ eV]. The 10.6 MeV γ-ray is due to the cascade decay of ^{20}Ne*(18.43), $J^\pi = 2^+$; $T = 2$ via ^{20}Ne*(12.22) to the 2^+ state at 1.63 MeV (1972KU24). (1976MA01) have determined the upper limits to the strengths of the transitions to various states of ^{20}Ne from the 0^+ and 2^+ $T = 2$ states: these are displayed in Table 20.18. No evidence is found for an isotensor transition amplitude (1976MA01). Resonances observed in this capture reaction are displayed in Table 20.24. See also (1979HA1G) and (1978SC19, 1980SC1M; theor.).

34. (a) ^{19}F(p, p)^{19}F $\qquad E_{\text{b}} = 12.8447$
(b) ^{19}F(p, p$'$)^{19}F*

Table 20.24: Resonances in ^{19}F(p, γ)^{20}Ne [a]

E_p (keV)	Γ_{lab} (keV)	$\Gamma_{\gamma 0}$ (eV)	Γ_{γ_1} (eV)	^{20}Ne* (MeV)	$J^\pi; T$
340 [b]		< 0.07	0.28 ± 0.06	13.168	
484 [b]		≈ 0.05	0.42	13.304	
597 ± 1 [b]	30 ± 3	< 0.6	12	13.412	
671 ± 1 [b,c]	6.0 ± 0.7	1.0×10^{-2}	2.2	13.482	1^+
874 [b]				13.675	
935 [b]				13.733	
980				13.775	
1091 [b]	0.8		1.1	13.881	$2^+; 1$
1280				14.060	
1320	4.0			14.098	
1350				14.127	
1370				14.146	
1420	15.7			14.193	
4090 ± 5		$\Gamma_\gamma \approx 5$ eV		16.728	$0^+; 2$
5879 ± 7	10 ± 3	$\Gamma_\gamma \approx 0.3$ eV		18.427	$2^+; 2$

[a] For earlier references see Table 20.26 in (1978AJ03). See also Table 20.18 and the text of reaction 33.

[b] See (1979SU13).

[c] See also (1980BI05).

The elastic scattering has been studied in the range $E_p = 0.5$ to 7.5 MeV and 24.9 to 46.3 MeV: see (1978AJ03). The observed anomalies are displayed in Table 20.25.

Resonances for inelastic scattering [p_1 and p_2] are listed in Table 20.26. In general the resonances observed are identical with those reported from other ^{19}F + p reactions, although the relative intensities differ greatly. For reduced widths see Table 20.28 in (1978AJ03). See also (1981KE1E; thick target yields; $E_p = 1.75$ to 2.75 MeV), (1980CU09, 1982FI1C) and (1977PH02; theor.).

35. ^{19}F(p, n)^{19}Ne $\qquad Q_m = -4.0207 \qquad E_b = 12.8447$

Observed resonances are displayed in Table 20.27. See also (1980HU1D, 1980HU1J).

Table 20.25: Levels of ^{20}Ne from ^{19}F(p, p_0) [a]

E_p (keV)	Γ_{lab} (keV)	l	$J^\pi; T$	Γ_p/Γ	θ_p^2 (%)	^{20}Ne* (MeV)
340	2.9	0	1^+	0.016	3.8	13.168
483			1^+			13.303
598	37	1	2^-	0.0012	0.38	13.413
669	7.5	0	1^+	0.98	9.6	13.480
843	23	0	0^+	0.996	10.8	13.645
873	5.2	1	2^- [b]	0.21	1.5	13.674
935	8.0	0	1^+	0.17	0.44	13.733
1346	4.5	1	2^- [b]	0.067	0.07	14.123
1372	15	1	2^- [b]	0.17	0.52	14.148
1422	14.6	0	1^+	0.85	0.92	14.195
1694						14.453
1940		(0)	$(0^+, 1^+)$			14.687
2030						14.772
4094 ± 3	2.1 ± 0.5	0	$0^+; 2$	0.062 ± 0.004		16.732
5879 ± 7 [c]	10 ± 3	2	$2^+; 2$	≈ 0.2		18.427

[a] For references see Table 20.27 in (1978AJ03). For θ^2 see Table 20.28 in (1978AJ03).

[b] 1^- not excluded by elastic scattering alone.

[c] Resonance also observed in p_1, p_3, p_4 and p_5 yields.

Table 20.26: Resonances in ^{19}F(p, p′)^{19}F* [a]

E_p (keV)	J^π	Γ_{lab} (keV)	Γ_{p_1} (eV)	Γ_{p_2} (eV)	$\theta^2_{p_1}$ (%)	$\theta^2_{p_2}$ (%)	E_x in ^{20}Ne (MeV)
340	1^+	2.9	< 0.5	< 0.1	< 15		13.168
483	1^+	2.2	< 1.3	< 1.2			13.303
598	2^-	37	< 100	< 60	< 28	< 145	13.413
669	1^+	7.5	46	< 0.5	0.6	< 0.4	13.480
720		≈ 30	< 10000	< 10000			13.528
780		≈ 10	< 400	≈ 9000			13.585
831		8.3	< 6	≈ 2300			13.634
845	0^+	23	≈ 50	< 10	≈ 0.14	< 0.92	13.647
873	2^-	5.2	< 2	570	< 0.07	2.7	13.674
900		4.8	< 30	≈ 2200			13.699
935	1^+	8.0	3000	< 20	5.0	< 0.8	13.733
1092 [b]	2^+	0.8	173	592			13.882
1137		3.7	< 40	≈ 2100			13.924
≈ 1250		≈ 80	≈ 70000	< 4000			14.03
1290		19	< 600	≈ 900			14.070
1346	2^-	4.5	300	600	0.92	0.24	14.123
1372	2^-	15	700	1400	1.93	0.56	14.148
1422	1^+	14.6 ± 1	2200	≤ 35	0.56	≤ 0.11	14.195
1610		≈ 5					14.374
1660							14.421
1700							14.459
5879 [c]	$2^+; 2$		r				18.427

r = resonant.

[a] For references see Table 20.29 in (1978AJ03).

[b] (1979SU13): $\Gamma_{p_0} = 29$ eV.

[c] Resonance also observed in p_3, p_4 and p_5 yields.

Table 20.27: Resonances in ^{19}F(p, n)^{19}Ne [a]

E_p (MeV) [b]	Γ_{lab} (keV)	^{20}Ne* (MeV)
4.30	45	16.93
4.46	80	17.08
4.52	20	17.14
4.61	60	17.22
4.72	25	17.33
4.75	45	17.35
4.87		17.47
4.95	20	17.55
5.03		17.62
5.11		17.70
5.23		17.81
5.25		17.84
5.37		17.94
(5.44)		(18.01)
5.50		18.07
5.57		18.13
(5.62)		(18.18)
(5.69)		(18.25)
5.72		18.28
5.77		18.32
5.84		18.39
5.879 ± 0.007 [c]	10 ± 3	18.427
5.90		18.45
6.00		18.54
6.15		18.68
6.35		18.87
6.53		19.04
6.81		19.31
7.14		19.62
7.27		19.75
7.41		19.88

Table 20.27: Resonances in ^{19}F(p, n)^{19}Ne [a] (continued)

E_p (MeV) [b]	Γ_{lab} (keV)	^{20}Ne* (MeV)
7.52		19.98
7.74		20.19
8.02		20.46
8.15		20.58
8.28		20.71
8.37		20.79
8.70		21.10
8.82		21.22
9.08		21.47
9.2		21.6
9.5		21.9
9.8		22.1
10.2		22.5

[a] For references see Table 20.30 in (1978AJ03).
[b] ± 5 keV for $E_x < 6.1$ MeV; ± 20 keV for $E_x < 9.1$ MeV.
[c] Anomaly in n_0 and n_{1+2} yields: 2^+; $T = 2$.

36. ^{19}F(p, α)^{16}O $\qquad Q_m = 8.1137 \qquad E_b = 12.8447$

Many resonances occur in this reaction. They are displayed in Tables 20.28, 20.29 and 20.30 depending on whether they are observed in the α_0 yield [Table 20.28], in the α_1 [or α_π] yield to ^{16}O*(6.05) [Table 20.29] or in the α_2, α_3 and α_4 yields [or in the yield of the γ-rays from ^{16}O*(6.13, 6.92, 7.12)] [Table 20.30]. Resonances for α_0 and α_1 are required to have even J, even π or odd J, odd π, while the α_2, α_3 and α_4 resonances are all odd-even or even-odd, with the exception of the $T = 2$ resonance.

Listings of the earlier yield studies are given in (1972AJ02, 1978AJ03). A detailed discussion of the evidence leading to many of the J^π assignments is given in (1959AJ76). For values of θ^2 see Table 20.28 in (1978AJ03). Recent measurements are reported by (1978DE1D, 1980CU09; 0.70 to 2.68 MeV; α_0, α_π, α_2, α_3, α_4), (1980DI03; 0.4 to 2.0 MeV; α_0, $\alpha\gamma$) and (1977ST03; 12.4 to 18.0 MeV; α_0). In the latter work resonant structures with $\Gamma \approx 0.5$ to 1 MeV are reported at $E_p = 13.0$, 14.3, 15.3, 16.5, (17.5), corresponding to ^{20}Ne*(25.2, 26.4, 27.4, 28.5, (29.5)) (1977ST03).

Table 20.28: Resonances for ground-state α-particles (α_0) in ^{19}F(p, α_0) [a]

E_p (keV)	Γ_{lab} (keV)	θ^2_α (%) [a]	J^π	^{20}Ne* (MeV)
400	100		1^-	13.225
400	100		0^+	13.225
650 ± 20 [b]	200		1^-	13.462 [h]
710	35	0.6	(1^-)	13.519
733	66	1.0	2^+	13.541
777 ± 2 [b]	9 ± 1	0.02	2^+	13.583
842 ± 2 [b]	18 ± 1	0.16 [c]	(2^+) [d]	13.644
≈ 860	120	2.1	1^-	13.66
≈ 930	≈ 180	2.9	0^+	13.73
≈ 1080	≈ 200	3.4	1^-	13.87
1115	50	0.55	2^+	13.904
1160	≈ 70	1.1	0^+	13.946
1235	≈ 70	1.2	1^-	14.017
≈ 1250	≈ 150	2.7	2^+	14.03
1350 ± 3 [b]	36 ± 1		2^+	14.127
1652 ± 5 [b]	90 ± 5			14.413
1713 ± 6 [b,e]	72 ± 2		0^+	14.471
1842 ± 7 [b,e]	122 ± 5		1^-	14.594
1901 ± 10 [b]				14.650
2110 [f]	75		$(2^+, 4^+)$	14.85
2310 [f]	90		(2^+)	15.04
2550	300		(1^-)	15.27
2590 [f]	300		(0^+)	15.30
2680	80			15.39
2730	60			15.44
2820	160			15.52
2940				(15.64)
3120	170			(15.81)
3340	105			16.02
3680	(100)			16.34
3860				16.51

Table 20.28: Resonances for ground-state α-particles (α_0) in ^{19}F(p, α_0) [a] (continued)

E_p (keV)	Γ_{lab} (keV)	θ^2_α (%) [a]	J^π	^{20}Ne* (MeV)
3980	135			16.62
4130	100			16.77
4360	100			16.98
4460	95			17.08
4690	65			17.30
4900	90			17.50
4990	40			17.58
5879 ± 7	10 ± 3	[g]	$2^+; T = 2$	18.427

[a] For earlier references and additional comments see Table 20.31 in (1978AJ03).
[b] (1980DI03).
[c] $\Gamma_{\alpha_0} \approx 0.06$ keV.
[d] $J = 0$ from ^{19}F(p, p); possibly $T = 0$.
[e] See also (1978DE1D).
[f] See also (1980CU09).
[g] $\Gamma_{\alpha_0} \approx 0.3$ keV.
[h] (1981OH04) find a weak resonance corresponding to the parity forbidden $J^\pi = 1^+$; $T = 1$ state ^{20}Ne*(13.48): see text.

Longitudinally polarized protons with $E_{\vec{p}} \approx 0.67$ MeV have been used to study ^{20}Ne*(13.48) [$J^\pi = 1^+$; $T = 1$]: the maximum of the analyzing power was found to be $(6.6 \pm 2.4) \times 10^{-3}$. The parity mixing of the 670 keV resonance appears to be caused by the $T = 0$ continuum as well as by the 1^- state at $E_x = 13.46$ MeV (1981OH04). Anomalies are observed in α_0, α_1, α_2, α_4 and α_8 but not in α_3, α_5, α_7 and α_9 corresponding to the formation of the 2^+; $T = 2$ state at 18.43 MeV [$E_p = 5.88$ MeV] (1972KU24). See also (1979SU13, 1979TR1G, 1981KE1E), (1978ZI1A, 1980DI03; applications) and (1977GA1H, 1980BI05; theor.).

37. ^{19}F(p, ^{8}Be)^{12}C $\qquad Q_m = 0.8599 \qquad E_b = 12.8447$

See (1978AJ03).

38. ^{19}F(d, n)^{20}Ne $\qquad Q_m = 10.6200$

Table 20.29: Nuclear pair resonances (α_π) in ^{19}F(p, α_π) [a]

E_p (keV)	Γ_{lab} (keV)	σ (mb)	θ^2_α (%)	J^π	^{20}Ne* (MeV)
710	35	≈ 0.2	2	1^-	13.519
780	≈ 10	≈ 0.2	0.15	2^+	13.585
842	23	3.4	0.27	2^+ [d]	13.644
1115	50	1.5	3.6	2^+	13.904
1236	≈ 70	3	1.0	1^-	14.018
1367	30	6.0	0.29	2^+	14.143
1630 [b]	60				14.39
1720 [b]	95	≈ 18			14.48
1880 [b]	170				14.63
2080 [c]	60	12.1		(2^+)	14.82
2170 [c]	70	12.2		(0^+)	14.91
2330 [c]	70	17.0		(2^+)	15.06
2600	100				15.31
2680	100				15.39
2820	125				15.52
3120	145				15.81
3340	100				16.02
(3500)	(80)				(16.17)
(3590)	(115)				(16.25)
3960	200				16.60
4360	95				16.98
4690	< 150				17.30
4900	115				17.50
4990	40				17.58
5170	220				17.75

[a] For references see Table 20.32 in (1978AJ03).
[b] See also (1978DE1D).
[c] (1980CU09): see also for partial widths.
[d] See footnote [d] in Table 20.28.

Table 20.30: Resonances for $6-7$ MeV γ-rays (α_2, α_3, α_4) in ^{19}F(p, α) [a]

E_p (keV)	Γ_{lab} (keV)	Γ_{α_2} (eV)	Γ_{α_3} (eV)	Γ_{α_4} (eV)	J^π	^{20}Ne* (MeV)
226.9 ± 3.4	1.0	1000	< 2.5	< 2.5	2^-	13.060
340.46 ± 0.04	2.4 ± 0.2	2800	16	75	1^+	13.1680
483.8 ± 0.3 [b]	0.9 ± 0.1	700	19	190	1^+	13.3038
594 ± 3 [b]	25 ± 3					13.409
667.5 ± 2 [b]	6.7 ± 0.3					13.479
832.1 ± 1 [b]						13.635
872.11 ± 0.20 [b]	4.7 ± 0.2	2200	620	180	2^- [d]	13.6729
935.4 ± 1.3 [b]	8.1 ± 0.5	2900	110	720	1^+	13.733
1087.7 ± 1 [b]	0.15 ± 0.05					13.878
1135.6 ± 1 [b]						13.923
1280 ± 1 [b]						14.060
1347.7 ± 1 [b]	4.9 ± 0.7	2250	650	1200	2^-	14.124
1371.0 ± 1 [b]	12.4 ± 1.0	6650	700	300	2^-	14.147
1603 ± 2 [b]						14.367
1692 ± 2 [b]	35 ± 3					14.451
1949 ± 2.5 [b]	40 ± 10					14.695
2030 ± 3.0 [b]	120 ± 20					14.722
2320	85					15.05
2510	30					15.23
2630	90					15.34
2800	60					15.50
3020	30					15.71
3190	80					15.87
3490	40					16.16
3920	30					16.57
4000	110					16.64
4090 [c]					$0^+; T=2$	16.73
4290	50					16.92
4490	30					17.11
4570	30					17.18
4710	30					17.32

Table 20.30: Resonances for $6 - 7$ MeV γ-rays (α_2, α_3, α_4) in ^{19}F(p, α) [a] (continued)

E_p (keV)	Γ_{lab} (keV)	Γ_{α_2} (eV)	Γ_{α_3} (eV)	Γ_{α_4} (eV)	J^π	^{20}Ne* (MeV)
4780	35					17.38
4990	20					17.58
5070	35					17.66
5200	70					17.78

[a] See Table 20.33 in (1978AJ03) for earlier references and for additional comments.

[b] (1980DI03).

[c] See (1972AJ02).

[d] See, however, footnote [j] in Table 20.21.

Levels of ^{20}Ne derived from reported neutron groups are displayed in Table 20.31. Angular distributions have been measured for $E_d = 0.5$ to 6.1 MeV: see (1972AJ02). See also (1978AJ03).

39. ^{19}F(^{3}He, d)^{20}Ne $\qquad Q_m = 7.3511$

Levels of ^{20}Ne observed in this reaction are displayed in Table 20.32. Deuteron angular distributions have been studied at $E(^3\text{He}) = 9.5$ to 21 MeV: see (1978AJ03). See also (1979GR11, 1980MU13; theor.).

40. ^{19}F(α, t)^{20}Ne $\qquad Q_m = -6.9694$

Angular distributions have been measured at $E_\alpha = 18.5$ and 28.5 MeV [see (1972AJ02, 1978AJ03)] and at 25.0 MeV (1978LE08; t_0, t_1, t_2). The distributions of the tritons to ^{20}Ne*(0, 1.63, 4.25) have been analyzed by (1974OB02): $C^2S = 0.08$, 0.16 and 0.0 (CCBA) [the DWBA results are nearly the same]. Agreement with the values obtained in the (d, n) and (^{3}He, d) reactions is poor (1974OB02). See also (1979BAYR).

41. ^{19}F(^{7}Li, ^{6}He)^{20}Ne $\qquad Q_m = 2.867$

Angular distributions have been studied at $E(^7\text{Li}) = 34$ MeV for the transitions to ^{20}Ne*(0, 1.63, 4.25, 4.97 (partial), 5.62, 5.78, 6.72, 7.1, 7.42). The spectroscopic factors, C^2S, for ^{20}Ne*(0, 1.63, 4.25, 5.78, 6.72, 7.42) are 0.36, 0.54, 0.06, 0.20 and 0.22, respectively, in good agreement with those reported in the (d, n) and (^{3}He, d) reactions (1975WI30).

Table 20.31: Neutron groups from $^{19}F(d, n)^{20}Ne$ [a]

E_x (MeV $\pm$ keV)	l_p	$J^\pi; T$
0	0	0^+
1.74 ± 30	2	2^+
4.20 ± 40		
4.96 ± 50		
5.62 ± 40		
6.80 ± 10	0	0^+
7.16 ± 90		
7.41 ± 50		
7.90 ± 40		
(8.71 ± 10)		
9.15 ± 40		
(9.50 ± 40)		
10.01 ± 30		
10.32 ± 50		
10.59		
10.879 ± 40	2	$T = 1$
11.03 ± 80 [b]		
11.26 ± 40	0	$1^+; (1)$
11.568 ± 35	2	$(T = 1)$
11.915 ± 30		
(12.09 ± 10)	[c]	$(T = 1)$
(12.15 ± 10)	[c]	$(T = 0)$
12.179 ± 25		
(12.20 ± 10)	[c]	$(T = 1)$
12.25 ± 10	2	$T = 1$
12.397 ± 20	0	$T = 0$
13.086 ± 15		
13.170 ± 15	0	$1^+; (1)$
13.481 ± 15	0	$1^+; 1$
13.650 ± 15	0	$(0^+); 1$
13.882 ± 15		

[a] For references and additional comments see Tables 20.34 in (1978AJ03) and 20.31 and 20.32 in (1972AJ02).
[b] This state decays to $^{20}Ne^*(1.63)$.
[c] Weak group.

Table 20.32: States of ^{20}Ne from ^{19}F(^{3}He, d)^{20}Ne [a]

E_x (MeV ± keV)	Γ (keV)	nlj [b]	$J^\pi; T$	K^π	$(2J+1)C^2S$	
					$DWBA$	$CCBA$ [c]
0		$2s_{1/2}$	0^+	0^+_1		0.37
1.6353 ± 1.8		$1d_{5/2}$	2^+	0^+_1		1.7
4.249 ± 2.5		n.s.	4^+	0^+_1		0.08
4.968 ± 3		$1p_{3/2}$	2^-	2^-	(0.03)	0.03
5.623 ± 3		$1f_{7/2}$	3^-	2^-	(0.09)	0.06
5.785 ± 3		$2p_{3/2}$	1^-	0^-	0.16	0.11
6.722 ± 3		$2s_{1/2}$	0^+	0^+_2	0.52	0.30
7.00		$1f_{7/2}$	4^-	2^-		0.12
7.156 ± 8		$1f_{7/2}$	3^-	0^-	0.42	0.12
7.422 ± 3		$1d_{5/2}$	2^+	0^+_2	0.79	0.50
7.829 ± 10		$1d_{5/2}$	2^+	0^+_3	0.06	0.046
≈ 8.3	≈ 800	$2s_{1/2}$	0^+	0^+_4	0.13	
8.45		n.s.	5^-	2^-		
8.70		n.s.	1^-			
8.769 ± 10		n.s.	6^+	0^+_1		
8.8	broad	$1d_{5/2}$	2^+		0.21	
8.841 ± 10		$2p_{3/2}$	1^-		(0.01)	
9.03		n.s.	4^+	0^+_3		
9.12		n.s.	3^-			
9.305 ± 10		$1d_{5/2}$	$(1, 2, 3)^+$		0.04	
9.469 ± 10		$1d_{5/2}$	2^+		0.03	
9.859 ± 3		$1d_{5/2}$	3^+ [e]		2.37	
9.92		n.s.	(1^+)			
9.99		n.s.	4^+	0^+_2		
10.257 ± 15		$1d_{5/2}$	$2^+; 1$		0.07	
10.40						
10.55						
10.568 ± 15	27	$1d_{5/2}$	2^+		0.05	
10.815 ± 15	12	$1d_{5/2}$	2^+		0.05	
10.860 ± 15		$1d_{5/2}$	$3^+; 1$ [e]		2.82	

Table 20.32: States of ^{20}Ne from ^{19}F(^{3}He, d)^{20}Ne [a] (continued)

E_x (MeV ± keV)	Γ (keV)	nlj [b]	$J^\pi; T$	K^π	$(2J+1)C^2S$	
					$DWBA$	$CCBA$ [c]
10.951 ± 15						
11.067 ± 15		n.s.	$(4^+; 1)$			
11.239 ± 15					see [a]	
11.27 ± 15	73	n.s.				
11.549 ± 15		$1d_{5/2}$	3^+ [e]		1.00	
11.83 ± 15	81	$1d_{5/2}$			0.10	
11.992 ± 15		n.s.	(8^+)	0^+_1		
12.082 ± 15		$1d_{5/2}$			0.35	
12.190 ± 15	< 0.1	$1d_{5/2}$	$(1, 2, 3)$ [e]		2.10	
12.367 ± 15 [d]	< 200		3^- [e]		see [a,e]	
12.423 ± 15	160	$1d_{5/2}$	(2^+)		0.19	
12.503 ± 15		$1d_{5/2}$			0.02	
12.823 ± 15		$2s_{1/2}$			0.15	
13.037 ± 15		$1d_{5/2}$				
13.135 ± 15						
13.270 ± 15						

n.s. = not stripping.

[a] For complete references see Table 20.35 in (1978AJ03).

[b] Orbital for direct transfer.

[c] Average of values displayed in Table 20.35 (1978AJ03).

[d] α-decays to ^{16}O*(6.13) (1977MA07).

[e] Gamma-ray measurements (1977MA07): $E_x = 9.88 \pm 0.03$, 10.89 ± 0.03, 11.59 ± 0.03, 12.22, 12.40 ± 0.04 MeV. The E_x measured by (1975BE02) appear to be systematically low by $14 - 30$ keV: see (1977MA07).

42. ^{20}F(β^-)^{20}Ne $\qquad Q_m = 7.0259$

The decay is principally to ^{20}Ne*(1.63) with a half-life of 11.00 ± 0.02 sec: see reaction 1 in ^{20}F. Besides the principal decay to ^{20}Ne*(1.63) [$\log f_0 t = 4.97$], ^{20}F also decays to ^{20}Ne*(4.97) [$J^\pi = 2^-$] with a branching ratio of $0.0090 \pm 0.0004\%$ [$\log f_0 t = 7.16 \pm 0.02$; however the transition is first-forbidden] (1981AL13). The upper limit for the ground-state decay is 0.001% [$\log f_0t > 10.5$] (1978CA02). For other values see Table 20.36 in (1978AJ03). The energy of the γ-ray from ^{20}Ne*(1.63) is 1633.602 ± 0.015 keV (1981WA06). E_γ for the $4.97 \rightarrow 1.63$ transition is 3332.54 (19) keV which gives $E_x = 4966.51\ (20)$ keV based on $E_x = 1633.674\ (15)$ keV for the first excited state (1981AL13). The shape of the β-spectrum has been measured by (1978CA02) and compared with predictions of the CVC theory: the results are not inconsistent with the predictions of CVC. β-γ correlation measurements lead to an upper limit for the second-class current contribution to the correlation which is consistent with zero (1978DU14, 1978TR07). For the earlier work see (1978AJ03). See also (1982QUZY), (1976BE1E, 1977DE1W, 1978CA1H) and (1976KI1N, 1977OK1A, 1978BE58, 1978CA1H, 1981HO06, 1981KA32; theor.).

43. (a) ^{20}Ne(γ, n)^{19}Ne $\quad Q_m = -16.8653$

(b) ^{20}Ne(γ, 2n)^{18}Ne $\quad Q_m = -14.419$

(c) ^{20}Ne(γ, p)^{19}F $\quad Q_m = -12.8447$

(d) ^{20}Ne(γ, α)^{16}O $\quad Q_m = -4.7309$

The photoneutron cross section (bremsstrahlung photons) shows peaks at $E_x = 17.78 \pm 0.05$, 19.00 ± 0.05, 20.15 ± 0.15 [main peak of the GDR], 22.6 ± 0.3, 24.9 ± 0.5 and 27.5 MeV [the latter three states are broad]: the integrated cross section to 28.5 MeV is 58 ± 6 MeV · mb [exhausting $\approx 20\%$ of the dipole sum] (1981AL05). The cross section for (γ, Tn) using monoenergetic photons shows a structure at 18 MeV and some fluctuations atop the broad giant resonance, $\sigma_{max} \approx 7$ mb. The double photoneutron cross section, $\sigma(\gamma, 2n)$, is dominated by a single peak at ≈ 20.5 MeV, $\sigma_{max} \approx 1.1$ mb (1974VE06). For reactions (c) and (d) see (1978AJ03) and reaction 45. See also (1980FL1C; theor.).

44. ^{20}Ne(γ, γ)^{20}Ne

See (1980AC1A, 1981WI1E).

45. (a) ^{20}Ne(e, e)^{20}Ne

(b) ^{20}Ne(e, ep)^{19}F $\quad Q_m = -12.8447$

(c) ^{20}Ne(e, eα)^{16}O $\quad Q_m = -4.7309$

The ^{20}Ne charge radius, $\langle r^2 \rangle^{1/2} = 3.004 \pm 0.025$ fm (1981KN07). Form factors for many excited states of ^{20}Ne with $E_x < 8$ MeV have been reported: see (1978AJ03).

At $E_e = 39$ and 56 MeV, the 180° inelastic scattering is dominated by the transition to a $J^\pi = 1^+$, $T = 1$ state at $E_x = 11.22 \pm 0.05$ MeV with $\Gamma_{\gamma_0} = 11.2^{+2.1}_{-1.8}$ eV. A subsidiary peak is observed corresponding to a state at an $E_x = 0.35\pm0.03$ MeV higher [if $J^\pi = 1^+$ or 2^+, $\Gamma_{\gamma 0} = 0.65\pm0.18$ or 0.40 ± 0.13 eV]. A number of small peaks are also reported corresponding to $E_x \approx 12.0$, 12.9, 13.9, 15.8, 16.9, 18.0 and 19.0 MeV (1971BE18, and W.L. Bendel, private communication). Prominent electric dipole peaks are reported at $E_x = 17.7$, 19.1, 20.2 and 23 MeV, in addition to weaker structures between 12.5 and 15 MeV; and prominent electric-quadrupole peaks are observed at $E_x = 13.0$, 13.7, 14.5, 15.0, 15.4 and 16.2 MeV and there is a broad quadrupole excitation between 16 and 25 MeV (1978SZ02; $E_e = 59.5$ to 119.7 MeV): the GDR cross section integrated from 11 to 25 MeV contains about 65% of the dipole EWSR while over 90% of the isoscalar quadrupole EWSR is exhausted by the strength in the region $10 - 25$ MeV. For reaction (b) see (1978AJ03).

Reaction (c) has been studied in order to obtain the (γ, α_0) cross section in the giant resonance region: the cross section at 90° for $E_x = 15$ to 24 MeV is dominated by an E1 resonance [1^-; $T = 1$, with an admixture of $T = 0$ which permits the α_0 decay] at $E_x = 20$ MeV; lesser E1 structures are reported at $E_x = 16.7$, 17.1, 21 and 22 MeV. A relatively strong 2^+; $T = 0$ resonance appears at $E_x = 18.5$ MeV, and evidence is reported for increasing E2 strength below 16 MeV (1975SK06).

See also (1978GU13, 1978HA43, 1978SI11, 1979CH2E, 1979IN06, 1979SI12, 1981ST1B; theor.).

46. ^{20}Ne(n, n)^{20}Ne

See (1978AJ03).

47. (a) ^{20}Ne(p, p)^{20}Ne

(b) ^{20}Ne(p, pα)^{16}O $Q_m = -4.7309$

(c) ^{20}Ne(p, 2p)^{19}F $Q_m = -12.8447$

Angular distributions of elastically scattered protons and of a number of inelastic groups have been measured for $E_p = 2.15$ to 41.8 MeV [see (1978AJ03)] and at $E_p = 4.5$ to 7.9 MeV (1981FE05; p$_0$), 35.2 MeV (1980FA07; p$_0$) and $E_{\vec{p}} = 65$ MeV (1979SA38; p$_0$).

Angular distributions at $E_p = 24.5$ and 30 MeV for the 0^+, 2^+ and 4^+ members of the ground-state $K^\pi = 0^+$ band are well fitted using coupled-channels calculations and deformation parameters of $\beta_2 = +0.47 \pm 0.04$ and $\beta_4 = +0.28 \pm 0.05$. When the 6^+ state is included [^{20}Ne*(8.78)], the fit is improved if $\beta_6 = -0.10$ is included: see (1978AJ03).

For yield measurements [p$_0$, p$_1$] see (1981FE05). See (1981CA02) for reaction (b). For reaction (c) see (1978AJ03). See also (1981AZ1A), (1979RA1C; astrophys.) and (1977PH02, 1978MA2K, 1979MA01, 1981SM1B; theor.).

48. ^{20}Ne(d, d)^{20}Ne

Angular distributions have been reported at $E_d = 10.0$ to 52 MeV [see (1978AJ03)] and at $E_d = 10 - 12$ MeV (1979DA17; d_0, d_1) and 52 MeV (1980MA10; d_0). See also (1979GR11; theor.).

49. ^{20}Ne(t, t)^{20}Ne

See (1978AJ03).

50. ^{20}Ne(^{3}He, ^{3}He)^{20}Ne

Angular distributions have been measured at $E(^3\text{He}) = 10$ to 35 MeV and at 68 MeV: see (1978AJ03). See also (1975AU01: S_α) and (1977MA1Y; theor.).

51. (a) ^{20}Ne(α, α)^{20}Ne
(b) ^{20}Ne(α, 2α)^{16}O $\quad Q_m = -4.7309$

Angular distributions have been measured at $E_\alpha = 3.8$ to 155 MeV [see (1978AJ03)], at 21.7 to 23.7 MeV (1982PE1C) and at 25.8, 27.0 and 31.1 MeV (1978CO11; α_0). A coupled-channel analysis of angular distributions at $E_\alpha = 104$ MeV leads to $\beta_2 = +0.35 \pm 0.01$, $\beta_4 = +0.11 \pm 0.01$, $Q_{20} = +0.46 \pm 0.02$ b and $Q_{40} = +0.026 \pm 0.002$ b^2 (1972RE05). At $E_\alpha = 155$ MeV (1976KN05) find that the strength concentrated in the giant quadrupole resonance exhausts more than 30% of the isoscalar energy-weighted sum rule. See also (1979KN1F).

For yield measurements see (1978AJ03) and (1981DA13). For reaction (b) see (1978AJ03) and (1980WA07; 140 MeV: $S_\alpha = 0.202 \pm 0.029$). See also (1981AN1K), (1979RA1C; astrophys.), (1977MA2E, 1980SP1E, 1980ST1J) and (1978AN20, 1978YO1F, 1979CO15, 1979GO24, 1982BU1D; theor.).

52. ^{20}Ne(^{7}Li, ^{7}Li)^{20}Ne

Angular distributions have been reported at $E(^7\text{Li}) = 36$ MeV (1976CO23; g.s.) and 68 and 89 MeV (1979BR03; ^{20}Ne*(0, 1.63)). see also (1979VA1B).

53. (a) ^{20}Ne(^{10}B, ^{10}B)^{20}Ne
(b) ^{20}Ne(^{11}B, ^{11}B)^{20}Ne

Elastic scattering angular distributions have been measured at $E(^{10}\mathrm{B}) = 65.9$ MeV (1979MO14) and $E(^{11}\mathrm{B}) = 115$ MeV (1981GO11).

54. (a) ^{20}Ne(^{12}C, ^{12}C)^{20}Ne
(b) ^{20}Ne(^{12}C, α^{8}Be)^{20}Ne $Q_{\mathrm{m}} = -7.3667$

Elastic angular distributions have been obtained at $E(^{12}\mathrm{C}) = 22.2$ to 42.7 MeV [see (1978AJ03)] and 77.4 MeV (1979MO14) and at $E(^{20}\mathrm{Ne}) = 65.9$ MeV (1978DO01) and 74 and 75.2 MeV (1979FO22, 1979SH18; back angles). See also (1980RI1D, 1980SH1T). For yield and fusion measurements see (1978DO01, 1979FO22, 1979SA26, 1979SH18, 1980CO08, 1980HU12, 1980RI1D, 1980SK1A, 1980TS03, 1981DE20, 1981SHZR, 1982DE10). See also (1981VA1E; theor.). For pion production see (1979NA12). For reaction (b) see (1981OS07, 1982DE10). See also (1980MA1T, 1981ST20), (1978RO1L, 1981RO1W; astrophys.), (1979GO1C, 1981SC1J) and (1978TR08, 1978VO06, 1978VO13, 1980OH05, 1981AB1A, 1981AN1D, 1982RA1D; theor.).

55. ^{20}Ne(^{16}O, ^{16}O)^{20}Ne

Angular distributions have been studied at $E(^{20}\mathrm{Ne}) = 50$ MeV (1976ST18) and 94.8 MeV (1977MO1A, 1979MO14) involving $^{16}\mathrm{O}_{\mathrm{g.s.}}$ and ^{20}Ne*(0, 1.63, 4.25). Yield and fusion measurements are reported by (1978GA1G, 1978SH1P, 1979GA1F, 1979GAZY, 1979KOZL, 1979REZS, 1980DI1B, 1980GAZX, 1981GA1D). For pion production see (1981GA1F). See also (1979VA1B, 1981BR1P) and (1979JA11, 1979LE1B, 1980OH05, 1981AN1D, 1982SM1D; theor.).

56. ^{20}Ne(^{19}F, ^{19}F)^{20}Ne

See (1979SI1K; theor.).

57. ^{20}Ne(^{20}Ne, ^{20}Ne)^{20}Ne

For yield and fusion measurements see (1978SH1P, 1980DI1B). See also (1979SH22) and (1979CA11, 1979CU1C, 1979PI03, 1979RA06, 1979YA12, 1980BO1J, 1980CU1D, 1981BO11, 1981CU1G, 1981CU1K, 1981JE1B, 1982SM1D; theor.).

58. ^{20}Ne(^{24}Mg, ^{24}Mg)^{20}Ne

Elastic angular distributions have been measured at $E(^{20}\mathrm{Ne}) = 50$, 60, 80, 90 and 100 MeV (1981BE22). For yield and fusion cross sections see (1981BE22, 1981GR08). See also (1980KO46; theor.).

59. ^{20}Ne(^{27}Al, ^{27}Al)^{20}Ne

For yield measurements see (1978OB1B, 1979OBZZ, 1980OB1A, 1981NA07). See also (1978GE08, 1980MA1T, 1981WEZY), (1977SC1G, 1979BE16) and (1979SA10, 1979YA1F; theor.).

60. ^{20}Ne(^{28}Si, ^{28}Si)^{20}Ne

See (1978SA1T, 1979SA10, 1979YA1F; theor.).

61. ^{20}Ne(^{32}S, ^{32}S)^{20}Ne

See (1978AJ03).

62. ^{20}Ne(^{40}Ca, ^{40}Ca)^{20}Ne

Elastic angular distributions are reported at $E(^{20}\mathrm{Ne}) = 44.1$ to 70.4 MeV (1979NG02), 54 and 60.5 MeV (1978NG01; also to ^{20}Ne*(1.63)) and 151 MeV (1980SE06). For yield and fusion measurements see (1978NG01, 1978TRZY, 1979NG02, 1980SE06, 1981KOZS). See also (1979UD02, 1980MA34; theor.).

63. ^{20}Na(β^+)^{20}Ne $\qquad Q_\mathrm{m} = 13.887$

^{20}Na has a half-life of 446 ± 3 msec: see reaction 1 in ^{20}Na. It decays to a number of states of ^{20}Ne, principally ^{20}Ne*(1.63): see Table 20.33. The ratio of the mirror decays $^{20}\mathrm{Na} \xrightarrow{\beta^+} {}^{20}\mathrm{Ne}^*(1.63)$ and $^{20}\mathrm{F} \xrightarrow{\beta^-} {}^{20}\mathrm{Ne}^*(1.63)$, $(ft)^+/(ft)^- = 1.026 \pm 0.024$ (1973TO08), 1.033 ± 0.022 (1976IN06). β-γ correlation measurements, as in the decay of ^{20}F, lead to an upper limit for the second-class contribution to the correlation which is consistent with zero (1978DU14, 1981TR04). See also (1981CL1D), (1977DE1W, 1977GA1E, 1978AJ03, 1978RA2A) and (1978BE58, 1978CA1H, 1980OK01, 1981HO06; theor.).

Table 20.33: Decay of ^{20}Na [a]

Decay to ^{20}Ne* (MeV ± keV)	$J^{\pi}; T$	Branching ratio (%) (1973TO08)	Branching ratio (%) (1976IN06) [c]	log ft
1.633 ± 2	$2^+; 0$	79.47 ± 1.57	79.18 ± 1.58	4.988 ± 0.009 [d]
7.415 ± 5	$2^+; 0$	16.37 ± 1.28		4.19 ± 0.05
7.826 ± 7	$2^+; 0$	0.674 ± 0.055		5.417 ± 0.033
8.82 ± 10		0.034 ± 0.007		6.27 ± 0.08
9.481 ± 7	$2^+; 0$	0.247 ± 0.020		5.064 ± 0.034
9.873 ± 5	$3^+; 0$		0.0272 ± 0.0138	5.78 ± 0.18 [d]
10.274 ± 3 [b]	$2^+; 1$	2.89 ± 0.23	2.944 ± 0.224	3.471 ± 0.033 [d]
10.584 ± 7	$2^+; 0$	0.087 ± 0.009		4.76 ± 0.05
10.848 ± 7	$2^+; 0$	0.193 ± 0.016		4.179 ± 0.035
10.884 ± 3	$3^+; 1$		0.0392 ± 0.0139	4.84 ± 0.13 [d]
11.261 ± 5	$1^+; 1$		0.203 ± 0.026	3.73 ± 0.05
11.320 ± 15	$2^+; 0$	0.036 ± 0.004		4.41 ± 0.05
11.856 ± 20	$2^+; 0$	0.0016 ± 0.0004		4.98 ± 0.10

[a] For additional comments and references see Table 20.37 in (1978AJ03).

[b] 10.278 ± 5 (1973TO08).

[c] Electron capture $+\beta^+$.

[d] Includes radiative, nuclear size, lepton wavelength, electron screening and electron capture corrections (1976IN06).

64. ^{21}Ne(p, d)^{20}Ne $\quad Q_m = -4.537$

Angular distributions have been measured for $d_0 \rightarrow d_3$ at $E_p = 14.1$ and 20 MeV: see (1978AJ03).

65. ^{21}Ne(d, t)^{20}Ne $\quad Q_m = -0.504$

The $T = 1$ states observed in this reaction, and the analog states observed in ^{20}F in the (d, ^{3}He) reaction, are displayed in Table 20.15. $T = 0$ states are presented in Table 20.34.

66. ^{21}Ne(^{3}He, α)^{20}Ne $\quad Q_m = 13.816$

Table 20.34: $T = 0$ states of ^{20}Ne from ^{21}Ne(d, t)^{20}Ne (1974MI13) [a]

E_x (MeV ± keV)	l	nlj [b]	C^2S	J^π [c]
≡ 5.622	1	$1p_{3/2}$	0.02	3^-
5.785 ± 4	1	$1p_{1/2}$	0.03	1^-
≡ 7.424	0 + 2	$2s_{1/2}$	0.05	
		$1d_{5/2}$	0.07	2^+
7.827 ± 9	0 + 2	$2s_{1/2}$	0.005	
		$1d_{5/2}$	0.023	2^+
8.839 ± 8	1	$1p_{1/2}$	0.33	1^- [e]
9.084 ± 21 [d]	2	$1d_{5/2}$	≤ 0.12	
9.357 ± 17 [d]	1	$1p_{1/2}$	≤ 0.1	[f]
9.913 ± 19 [d]	2	$1d_{5/2}$	< 0.16	
10.385 ± 12	1	$1p_{3/2}$	0.08	3^- [e]
10.880 ± 10 [d]	1	$1p_{3/2}$	0.13	

[a] For $T = 1$ states see Table 20.15.

[b] Values used in DWBA calculations.

[c] From Table 20.17.

[d] Unresolved.

[e] $K^\pi = (1^-)$.

[f] See, however, discussion in (1974MI13).

See (1978AJ03) and (1979CO15; theor.).

67. ^{22}Ne(p, t)^{20}Ne $\qquad Q_m = -8.644$

Angular distributions have been reported at $E_p = 26.9$ to 43.7 MeV [see (1978AJ03)] and at $E_p = 23$ MeV (1980AN21; t_0). The angular distributions of the tritons to the ground state of ^{20}Ne and to the first 0^+, $T = 2$ state [$E_x = 16.722 \pm 0.025$ MeV (1969HA38)] have been fitted by $L = 0$ and the tritons to ^{20}Ne*(18.5) by $L = 2$. The latter is the first 2^+, $T = 2$ state. The 0^+, $T = 2$ state [^{20}Ne*(16.73)] decays by α_0 [$(-6 \pm 5)\%$], $\alpha_1 + \alpha_2$ [$35 \pm 12\%$], $\alpha_3 + \alpha_4$ [$(29 \pm 12)\%$], $p_0 + p_1 + p_2$ [$(14 \pm 9)\%$] and $p_3 + p_4 + p_5$ [$(13 \pm 8)\%$] [measured branching ratios in percent are given in the brackets] to final states in ^{16}O and ^{19}F (1970MC04). The ratios of the cross section for formation of the analog states ^{20}Ne*(10.27)/^{20}F*(0) and ^{20}Ne*(12.25 ± 0.03)/^{20}F*(1.85) are 2.00 ± 0.20 and 1.40 ± 0.15, respectively, at $E_p = 45$ MeV (1969HA19).

At $E_p = 40$ MeV angular distributions of the tritons to ^{20}Ne(4.97, 5.62, 7.00) [$J^\pi = 2^-$, 3^-, 4^-, respectively] have been measured. Coupled-channels calculations reproduce the distributions to the 2^- and 3^- states, but the distribution to the 4^- states cannot be explained entirely in terms of multistep inelastic processes (1975CH17).

68. ^{23}Na(p, α)^{20}Ne $\qquad Q_m = 2.377$

Angular distributions have been measured at $E_p = 10.0$ and 45.5 MeV: see (1972AJ02). For yield measurements see (1978AJ03) and (1979KU06). See also (1966YO1A, 1979CH2D) and (1975ZI1A, 1981ZY04; astrophys.).

69. ^{23}Na(^{3}He, ^{6}Li)^{20}Ne $\qquad Q_m = -1.643$

At $E(^3\mathrm{He}) = 40.7$ MeV, angular distributions have been measured to ^{20}Ne*(0, 1.63, 4.25) and analyzed using zero-range DWBA (1972OH01).

70. (a) ^{24}Mg(γ, α)^{20}Ne $\qquad Q_m = -9.3125$

(b) ^{24}Mg(p, pα)^{20}Ne $\qquad Q_m = -9.3125$

(c) ^{24}Mg(α, 2α)^{20}Ne $\qquad Q_m = -9.3125$

See (1978AJ03). For reaction (b) see also (1981CA02).

71. ^{24}Mg(d, ^{6}Li)^{20}Ne $\qquad Q_m = -7.839$

Angular distributions have been studied to many states of ^{20}Ne at $E_d = 28$ and 35 MeV [see (1978AJ03)] and at $E_d = 28$ MeV (1978FO08), 54.25 MeV (1980YA02), 55 MeV (1981VE05) and at 80 MeV (1979OE02, 1980OE01): see Table 20.35. See also (1978BE1H) and (1978TA1F; theor.).

72. ^{24}Mg(^{3}He, ^{7}Be)^{20}Ne $\qquad Q_m = -7.726$

Angular distributions have been studied at $E(^3\mathrm{He}) = 25.5$ and 70 MeV: see (1978AJ03). For polarization measurements see (1980LE1J, 1981LE1F).

Table 20.35: States of ^{20}Ne from ^{24}Mg(d, ^{6}Li)^{20}Ne

E_x (MeV ± keV) [a]	L [a]	J^{π} [a]	S_α [a,b]	S_α [c]	S_α [d]
0	0	0^+	1.00	$\equiv 1.00$	$\equiv 1.00$
1.632	2	2^+	0.80	0.79	0.31
4.248	4	4^+	0.91	see [c]	0.85
4.963 ± 7					
5.619	3	3^-	3.02	8.15	3.1
5.786 ± 7	1	1^-	0.24	1.6	0.42 [d]
6.715 ± 10	0	0^+	0.04	see [c]	
7.004 ± 7					
7.180 ± 7	see [a]		see [a]	1.1	0.67 [d]
7.416 ± 7	2	2^+	0.19	see [c]	0.67
7.829	2	2^+	see [a]	see [c]	5.9 [d]
8.449	5	5^-	1.02	≈ 1	2.0
8.704 ± 15	1	1^-		see [c]	
8.777	6	6^+	1.64	1.2	7.0
8.86 ± 20	1	1^-	0.07	see [c]	
9.026 ± 7	4	4^+	see [a]		14 [d]
9.100 ± 15	3	3^-	0.30		
9.300 ± 7					
9.466 ± 7					
9.943 ± 15					
10.04 ± 30	4		0.34	0.70	
10.27 [c]				0.34	
10.40 [c]				0.66	
10.572 ± 7	2		0.16		
10.848 ± 7	$2 + 3$		see [a]	0.32	
10.90 ± 20					
11.00 ± 20	4		0.27	0.32	
11.22 ± 20	1		0.12		
11.30 ± 20	2		0.08		
11.56 ± 20					
11.85 ± 20	2		0.13		

Table 20.35: States of ^{20}Ne from ^{24}Mg(d, ^{6}Li)^{20}Ne (continued)

E_x (MeV ± keV) [a]	L [a]	J^π [a]	S_α [a,b]	S_α [c]	S_α [d]
11.92 ± 20	4		0.32	0.13	
11.95 [c]				1.2	
11.96 [c]				0.32	
12.39 ± 20	0 + 3		see [a]	see [c]	
12.54 ± 20					
12.95 ± 20					
13.34 ± 20					
13.68 ± 20					
13.91 ± 20					

[a] (1981VE05): $E_d = 55$ MeV. E_x values without uncertainties were used for calibration. L-values shown are the dominant ones.
[b] Average of values from ZRDWBA and FRDWBA analyses. K^π assignments are also discussed by (1981VE05). See also (1976CO23, 1980YA02) for S_α.
[c] (1980OE01): $E_d = 80$ MeV; DWUCK 5 analysis; values recalculated relative to unity for the ground state.
[d] (1978FO08): $E_d = 28$ MeV; DWBA analysis; values recalculated relative to unity for the ground state. K^π assignments are also discussed.

73. ^{24}Mg(α, ^{8}Be)^{20}Ne $Q_m = -9.404$

See (1980WO1C, 1981WO1A) and (1982SH02; theor.).

74. (a) ^{24}Mg(^{12}C, ^{16}O)^{20}Ne $Q_m = -2.151$
(b) ^{24}Mg(^{16}O, ^{20}Ne)^{20}Ne $Q_m = -4.582$
(c) ^{24}Mg(^{18}O, ^{22}Ne)^{20}Ne $Q_m = 0.355$

For reaction (a) see (1978NO02). See also (1980LE21; theor.). For reaction (b) see (1979LA07; theor.). For reaction (c) see (1980MO1F).

75. ^{27}Al(^{16}O, α^{12}C)^{20}Ne $Q_m = -17.313$

See (1980SA1H).

76. $^{28}Si(\alpha, ^{12}C)^{20}Ne$ $Q_{\rm m} = -16.873$

See (1980BE04, 1980BE15: $E_\alpha = 90.3$ MeV).

77. $^{28}Si(^{18}O, ^{26}Mg)^{20}Ne$ $Q_{\rm m} = 0.981$

See (1979ME12).

^{20}Na

(Figs. 11, 12 and 13)

GENERAL: (See also (1978AJ03).)

(1977SI1D, 1979BE1H, 1979WO07, 1980OK01, 1981AY01).

$$J = 2 \text{ (1975SC20)};$$

$$\mu = 0.3694 \pm 0.0002 \text{ nm (1975SC20)}.$$

1. ^{20}Na(β^+)^{20}Ne $\quad Q_{\rm m} = 13.887$

^{20}Na decays by positron emission to ^{20}Ne*(1.63) and to a number of other excited states of ^{20}Ne: see Table 20.33 and reaction 63 in ^{20}Ne. The half-life of ^{20}Na is 446 ± 3 msec; $J^\pi = 2^+$: see (1978AJ03).

2. ^{16}O(^{12}C, ^{8}Li)^{20}Na $\quad Q_{\rm m} = -32.528$

See (1979RA10).

3. ^{20}Ne(p, n)^{20}Na $\quad Q_{\rm m} = -14.669$

Neutron groups have been observed at $E_{\rm p} = 22.9$ MeV to states with $E_{\rm x} < 1.4$ MeV: see Table 20.40 in (1978AJ03).

4. ^{20}Ne(^{3}He, t)^{20}Na $\quad Q_{\rm m} = -13.906$

Triton groups have been observed at $E(^3\text{He}) = 32$ MeV to nine states of ^{20}Na: see Table 20.40 in (1978AJ03).

5. ^{20}Mg(β^+)^{20}Na $\quad Q_{\rm m} = 10.724$

The first 0^+; $T = 2$ state in ^{20}Na is reported at $E_{\rm x} = 6.57 \pm 0.05$ MeV. It decays by proton emission: see ^{20}Mg.

Table 20.36: Energy levels of ^{20}Na

E_x (MeV ± keV)	$J^\pi; T$	$\tau_{1/2}$ or $\Gamma_{c.m.}$	Decay	Reactions
0	$2^+; 1$	$\tau_{1/2} = 446 \pm 3$ msec	β^-	1, 3, 4
0.591 ± 12			(γ)	3, 4
0.768 ± 8			(γ)	3, 4
(0.85 ± 50)			(γ)	4
0.958 ± 8			(γ)	3, 4
(1.010 ± 14)			(γ)	3
1.310 ± 10			(γ)	3, 4
1.92 ± 40				4
2.89 ± 50		[a]		4
4.33 ± 100		[a]		4
6.57 ± 50	$0^+; 2$		p	5

[a] Broad or unresolved.

^{20}Mg

(Figs. 12 and 13)

^{20}Mg has been populated in the ^{24}Mg(α, ^{8}He) reaction [see (1978AJ03)], and in the ^{20}Ne(^{3}He, 3n) reaction at 70 MeV (1981AY01, 1979MO02). The super-allowed decay of ^{20}Mg to the first $T = 2$ ($J^\pi = 0^+$) state of ^{20}Na [$E_x = 6.57 \pm 0.05$ MeV] has been reported from observations of the subsequent decay of that state by proton emission [see Fig. 12]. The partial half-life is 95^{+80}_{-50} msec leading to a branching ratio of $(3 \pm 2)\%$ for the super-allowed decay; $\log ft = 3.18$. The results for $A = 20$ are in agreement with the quadratic form of the IMME (1981AY01). See also (1978AJ03) and (1979BE1H, 1980TR1E, 1981HA2C).

^{20}Al

(Not illustrated)

^{20}Al has not been observed: see (1966KE16).

References

(Closed 01 May 1982)

References are arranged and designated by the year of publication followed by the first two letters of the first-mentioned author's name and then by two additional characters. Most of the references appear in the National Nuclear Data Center files (Nuclear Science References Database) and have NNDC key numbers. Otherwise, TUNL key numbers were assigned with the last two characters of the form 1A, 1B, etc. In response to many requests for more informative citations, we have, when possible, included up to ten authors per paper and added the authors' initials.

1959AJ76 F. Ajzenberg and T. Lauritsen, Nucl. Phys. 11 (1959) 1

1964CE05 J. Cerny, R.H. Pehl and G.T. Garvey, Phys. Lett. 12 (1964) 234

1966KE16 I. Kelson and G.T. Garvey, Phys. Lett. 23 (1966) 689

1966YO1A Young et al., Nucl. Instrum. Meth. Phys. Res. 44 (1966) 109

1967BE36 I. Bergqvist, J.A. Biggerstaff, J.H. Gibbons and W.M. Good, Phys. Rev. 158 (1967) 1049

1967KU06 H.M. Kuan, D.W. Heikkinen, K.A. Snover, F. Riess and S.S. Hanna, Phys. Lett. B25 (1967) 217

1967QU01 P.A. Quin, A.A. Rollefson, G.A. Bissinger, C.P. Browne and P.R. Chagnon, Phys. Rev. 157 (1967) 991

1967SE02 R.E. Segel, Z. Vager, L. Meyer-Schutzmeister, P.P. Singh and R.G. Allas, Nucl. Phys. A93 (1967) 31

1968SP01 P. Spilling, H. Gruppelaar, H.F. De vries and A.M.J. Spits, Nucl. Phys. A113 (1968) 395

1969HA04 R. Hardell and A. Hasselgren, Nucl. Phys. A123 (1969) 215

1969HA19 J.C. Hardy, H. Brunnader and J. Cerny, Phys. Rev. Lett. 22 (1969) 1439

1969HA38 J.C. Hardy, H. Brunnader, J. Cerny and J. Janecke, Phys. Rev. 183 (1969) 854

1970MA42 H.B. Mak, H. Spinka and H. Winkler, Phys. Rev. C2 (1970) 1729

1970MC04 R.L. McGrath, J. Cerny, J.C. Hardy, G. Goth and A. Arima, Phys. Rev. C1 (1970) 184

1970RO06 A.A. Rollefson, P.F. Jones and R.J. Shea, Phys. Rev. C1 (1970) 1761

1971BE18 W.L. Bendel, L.W. Fagg, S.K. Numrich, E.C. Jones, Jr. and H.F. Kaiser, Phys. Rev. C3 (1971) 1821

1972AJ02 F. Ajzenberg-Selove, Nucl. Phys. A190 (1972) 1

1972BA97 D.P. Balamuth, J.W. Noe, H.T. Fortune and R.W. Zurmuhle, Phys. Rev. C6 (1972) 1694

1972HA07 O. Hausser, A.J. Ferguson, A.B. McDonald, I.M. Szoghy, T.K. Alexander and D.L. Disdier, Nucl. Phys. A179 (1972) 465

1972KU24 H.M. Kuan, G.L. Latshaw, W.J. O'Connell, D.W. Heikkinen, E.G. Adelberger, A.V. Nero and S.S. Hanna, Nucl. Phys. A193 (1972) 497

1972NO01 J.V. Noble, Phys. Rev. Lett. 28 (1972) 111; Erratum Phys. Rev. Lett. 46 (1981) 1045

1972OH01 I.K. Oh, C.S. Zaidins, C.D. Zafiratos and S.I. Hayakawa, Nucl. Phys. A178 (1972) 497

1972OP01 A.M.F. Op den Kamp and A.M.J. Spits, Nucl. Phys. A180 (1972) 569

1972RE05 H. Rebel, G.W. Schweimer, G. Schatz, J. Specht, R. Lohken, G. Hauser, D. Habs and H. Klewe-Nebenius, Nucl. Phys. A182 (1972) 145

1973BE11 T.A. Belote, N. Anyas-Weiss, J.A. Becker, J.C. Cornell, P.S. Fisher, P.N. Hudson, A. Menchaca-Rocha, A.D. Panagiotou and D.K. Scott, Phys. Rev. Lett. 30 (1973) 450

1973GR29 W. Gruhle, T. Bauer, T.H. Seligman and H.H. Hackenbroich, Z. Phys. 262 (1973) 271

1973HA63 O. Hausser, T.K. Alexander, D.L. Disdier, A.J. Ferguson, A.B. McDonald and I.S. Towner, Nucl. Phys. A216 (1973) 617

1973MA14 R.L.Macklin and R.R.Winters, Phys. Rev. C7 (1973) 1766

1973MU14 S.F. Mughabghab and D.I. Garber, BNL 325, 3rd Edition, Vol. 1 (1973)

1973PR01 J.G. Pronko, Phys. Rev. C7 (1973) 127

1973TO08 D.F. Torgerson, K. Wien, Y. Fares, N.S. Oakey, R.D. Macfarlane and W.A. Lanford, Phys. Rev. C8 (1973) 161

1973WA19 E.K. Warburton, P. Gorodetzky and J.A. Becker, Phys. Rev. C8 (1973) 418

1974AL09 D.E. Alburger and D.R. Goosman, Phys. Rev. C9 (1974) 2236

1974CR04 D.J. Crozier and H.T. Fortune, Phys. Rev. C10 (1974) 1697

1974FO21 H.T.Fortune and R.R.Betts, Phys. Rev. C10 (1974) 1292

1974KE18 M.J. Kenny, P.W. Martin, L.E. Carlson and J.A. Biggerstaff, Aust. J. Phys. 27 (1974) 759

1974MA38 N. Marquardt, R. Volders, C. Cardinal and J. L'Ecuyer, Phys. Rev. Lett. 33 (1974) 1389

1974MI13 G.F. Millington, J.R. Leslie, W. McLatchie, G.C. Ball, W.G. Davies and J.S. Forster, Nucl. Phys. A228 (1974) 382

1974OB02 A.W. Obst and K.W. Kemper, Phys. Rev. C9 (1974) 1643

1974SH1E Sher, IAEA, STI/DOC/10/156 (1974) 1

1974TH01 C. Thibault and R. Klapisch, Phys. Rev. C9 (1974) 793

1974VE06 A. Veyssiere, H. Beil, R. Bergere, P. Carlos, A. Lepretre and A. de Miniac, Nucl. Phys. A227 (1974) 513

1975AU01 G. Audi, C. Detraz, M. Langevin and F. Pougheon, Nucl. Phys. A237 (1975) 300

1975BE02 R.R. Betts, H.T. Fortune and R. Middleton, Phys. Rev. C11 (1975) 19

1975CH17 W.S. Chien, C.H. King, J.A. Nolen, Jr. and M.A.M. Shahabuddin, Phys. Rev. C12 (1965) 332

1975CO15 M. Conjeaud, S. Harar, E.F. Da Silveira and C. Volant, Nucl. Phys. A250 (1975) 182

1975DI08 G. Dietl, G. Gruber, H. Schmidt-Bocking and K. Bethge, Nucl. Phys. A250 (1975) 322

1975HO15 R.E. Horstman, J.L. Eberhardt, H.A. Doubt, C.M.E. Otten and G. Van Middelkoop, Nucl. Phys. A248 (1975) 291

1975LE23 J. L'Ecuyer, R. Volders, C. Cardinal, L. Deschenes and N. Marquardt, Phys. Rev. C12 (1975) 1878

1975ME04 L.R. Medsker, H.T. Fortune, R.R. Betts and R. Middleton, Phys. Rev. C11 (1975) 1880

1975SA1D Sanchez, Casanova and Casanova, An. Fis. 71 (1975) 119

1975SC20 H. Schweickert, J. Dietrich, R. Neugart and E.W. Otten, Nucl. Phys. A246 (1975) 187

1975SK06 D.M. Skopik, Y.M. Shin and J.J. Murphy, II, Can. J. Phys. 53 (1975) 1398

1975WI30 M.E. Williams-Norton, G.M. Hudson, K.W. Kemper, G.E. Moore, G.A. Norton, R.J. Puigh and A.F. Zeller, Phys. Rev. C12 (1975) 1899

1975ZI1A Zimmerman, Fowler and Caughlan, OAP-399 (1975)

1976BE1E Behrens and Lzybisz, Phys. Data 6-1; ZAED (1976)

1976CO23 M.E. Cobern, D.J. Pisano and P.D. Parker, Phys. Rev. C14 (1976) 491

1976FI10 L.K. Fifield, R.W. Zurmuhle and D.P. Balamuth, Phys. Rev. C14 (1976) 1010

1976FO16 H.T. Fortune and J.D. Garrett, Phys. Rev. C14 (1976) 1695

1976GAYV D.I. Garber and R.R. Kinsey, BNL 325, 3rd Edition, Vol. 2 (1976)

1976IN05 P.D. Ingalls, Nucl. Phys. A265 (1976) 93

1976IN06 P.D. Ingalls, Phys. Rev. C14 (1976) 254

1976KI1N Kim and Kim, J. Korean Phys. Soc. 9 (1976) 49

1976KL03 H.V.Klapdor, H.Reiss and G.Rosner, Nucl. Phys. A262 (1976) 157

1976KL1B Klapdor, Reiss and Rosner, Nukleonika 21 (1976) 763

1976KN05 K.T. Knopfle, G.J. Wagner, A. Kiss, M. Rogge, C. Mayer-Boricke and T. Bauer, Phys. Lett. B64 (1976) 263

1976LO03 M. Lowry, J.S. Schweitzer, R. Dayras and R.G. Stokstad, Nucl. Phys. A259 (1976) 122

1976MA01 R.E.Marrs, E.G.Adelberger, K.A.Snover and M.D.Cooper, Nucl. Phys. A256 (1976) 1

1976MA12 E. Mathiak, K.A. Eberhard, J.G. Cramer, H.H. Rossner, J. Stettmeier and A. Weidinger, Nucl. Phys. A259 (1976) 129

1976MC1G McGrory, 1974 Gamma Ray Transition Probabilities (1976) 469

1976MI01 G.F. Millington, R.M. Hutcheon, J.R. Leslie and W. McLatchie, Phys. Rev. C13 (1976) 879

1976MO13 G.L. Morgan and J.K. Dickens, Nucl. Sci. Eng. 60 (1976) 36

1976PA20 R.A. Partridge, Y.C. Tang, D.R. Thompson and R.E. Brown, Nucl. Phys. A273 (1976) 341

1976PO02 J.E. Poling, E. Norbeck and R.R. Carlson, Phys. Rev. C13 (1976) 648

1976ST18 R. Stock, U. Jahnke, D.L. Hendrie, J. Mahoney, C.F. Maguire, W.F.W. Schneider, D.K. Scott and G. Wolschin, Phys. Rev. C14 (1976) 1824

1977AB1E Abe, RIFP-296 (Kyoto) (1977)

1977AL2C Alaerts, Lewis and Anders, Science 198 (1977) 927

1977AR18 K.P. Artemov, V.Z. Goldberg, I.P. Petrov, V.P. Rudakov, I.N. Serikov, V.A. Timofeev, R. Wolski and J. Schmider, Yad. Fiz. 26 (1977) 9; Sov. J. Nucl. Phys. 26 (1977) 4

1977BA1N D. Baye, J. Deenen and Y. Salmon, Nucl. Phys. A289 (1977) 511

1977BA1Q Baer, High Energy Phys. Nucl. Struct., Zurich, 1977 (1977) 245

1977BA30 A.I. Baz, V.Z. Goldberg, K.A. Gridnev and V.M. Semenov, Yad. Fiz. 25 (1977) 759; Sov. J. Nucl. Phys. 25 (1977) 404

1977BA50 D.P. Balamuth and E.G. Adelberger, Phys. Rev. C16 (1977) 928

1977BO33 A. Bonaccorso, M. Di Toro and G. Russo, Phys. Lett. B72 (1977) 27

1977BR38 D. Branford, B.N. Nagorcka and J.O. Newton, J. Phys. (London) G3 (1977) 1565

1977BU22 B. Buck, H. Friedrich and A.A. Pilt, Nucl. Phys. A290 (1977) 205

1977CI1E Cindro, Cocu, Fieni and Holub, Fiz. Suppl. 9 (1977) 20

1977CO25 F. Cocu, J. Uzureau, S. Plattard, J.M. Fieni, A. Michaudon, G.A. Keyworth, M. Cates and N. Cindro, J. Phys. Lett. (Paris) 38 (1977) L-421

1977DE1W Deutsch, Proc. Int. Conf. Nucl. Struct., Tokyo (1977); J. Phys. Soc. Jpn. Suppl. 44 (1978) 809

1977FI08 L.K. Fifield, F.P. Calaprice, C.H. Zimmerman, M.J. Hurst, A. Pakkanen, T.J.M. Symons, F. Watt and K.W. Allen, Nucl. Phys. A288 (1977) 57

1977FO11 H.T.Fortune and J.N.Bishop, Nucl. Phys. A293 (1977) 221

1977FO1E Fortune, Proc. Int. Conf. Nucl. Struct., Tokyo (1977); J. Phys. Soc. Jpn. Suppl. 44 (1978) 99

1977FR1K Freedman, Schramm and Tubbs, Ann. Rev. Nucl. Sci. 27 (1977) 167

1977GA1E Garvey, AIP Conf. Proc. 37 (1977) 104

1977GA1H Gadioli and Erba, Nucl. Instrum. Meth. 146 (1977) 265

1977GR16 R. Gross and I. Talmi, Nucl. Phys. A286 (1977) 211

1977GR18 Gruhle and Mobius, Z. Phys. A283 (1977) 97

1977HA1Z Harvey, Proc. Int. Conf. Nucl. Struct., Tokyo (1977); J. Phys. Soc. Jpn. Suppl. 44 (1978) 127

1977HE12 J.A.J. Hermans, G.A.P. Engelbertink, L.P. Ekstrom, H.H. Eggenhuisen and M.A. Van Driel, Nucl. Phys. A284 (1977) 307

1977IK1A Ikeda and Tamagaki, Prog. Theor. Phys. Suppl. 62 (1977) 1

1977KA21 D. Kalinsky, D. Melnik, U. Smilansky, N. Trautner, Y. Horowitz and S. Mordechai, Nucl. Phys. A289 (1977) 205

1977KA26 D. Kalinsky, D. Melnik, U. Smilansky, N. Trautner, S. Weisrose and O. Dietzsch, Nucl. Phys. A293 (1977) 509

1977MA07 R.E.Marrs, E.G.Adelberger and K.A.Snover, Nucl. Phys. A277 (1977) 429

1977MA1Y Mackintosh, Rept. Prog. Phys. 40 (1977) 731

1977MA2E Mayer-Boricke, Nukleonika 22 (1977) 1131

1977MA33 N. Marquardt, W. Hoppe and D. Siegel, Phys. Rev. C16 (1977) 2291

1977MO16 C.A. Mosley, Jr. and H.T. Fortune, Phys. Rev. C16 (1977) 1697

1977MO1A T. Motobayashi, Rept. Inst. Phys. Chem. Res. 53 (1977) 81

1977NO1G Novak et al., Proc., Zurich-Sin (1977) 39

1977OK1A Oka and Kubodera, Proc., Zurich-Sin. (1977) 329

1977PA1G Papineau, Nucl. Instrum. Meth. 146 (1977) 253

1977PH02 D.-L. Pham and R. de Swiniarski, Nuovo Cim. A41 (1977) 543

1977PO14 F. Pougheon, P. Roussel, M. Bernas, B. Fabbro, F. Naulin, A.D. Panagiotou, E. Plagnol and G. Rotbard, J. Phys. Lett. (Paris) 38 (1977) L-417

1977SA1C Saito, Prog. Theor. Phys. Suppl. 62 (1977) 11

1977SA2C H. Sato, Phys. Rev. C16 (1977) 2094

1977SC1G Schroder and Huizenga, Ann. Rev. Nucl. Sci. 27 (1977) 465

1977SC27 K.W. Schmid and H. Muther, Phys. Rev. C16 (1977) 2050

1977SH18 J. Shurpin, H. Muther, T.T.S. Kuo and A. Faessler, Nucl. Phys. A293 (1977) 61

1977SI1D Silberberg and Tsao, Astrophys. J. Suppl. 35 (1977) 129

1977ST03 A. Stabler, W. Buck, G. Staudt and H. Oeschler, Nucl. Phys. A275 (1977) 269

1977ST1G Steiner, High Energy Phys. Nucl. Struct., Zurich (1977) 261

1977ST1X Strazzeri, Nuovo Cim. A41 (1977) 570; Erratum Nuovo Cim. A43 (1978) 143

1977ST34 R.G. Stokstad, M.N. Namboodiri, E.T. Chulick, J.B. Natowitz and D.L. Hanson, Phys. Rev. C16 (1977) 2249

1977TO1K Tohsaki and Suzuki, Prog. Theor. Phys. Suppl. 62 (1977) 191

1977YE1B W.M. Yeager, W.D. Walker, W.J. Robertson, J.S. Loos, J.W. Lamsa, A.T. Goshaw, L.R. Fortney, J.R. Elliott, C.R. Sun and S. Dhar, Phys. Rev. D16 (1977) 1294

1977ZA1D P.C. Zalm, A. Holthuizen, J.A.G. De Raedt and G. Van Middelkoop, Phys. Lett. B69 (1977) 157

1978AJ03 F. Ajzenberg-Selove, Nucl. Phys. A300 (1978) 1

1978AL1T Alexander and Forster, Advances in Nucl. Phys. 10 (1978) 197

1978AN07 I. Angeli and M. Csatlos, ATOMKI Kozlem. 20 (1978) 11

1978AN15 N. Anyas-Weiss and D. Strottman, Nucl. Phys. A306 (1978) 201

1978AN20 M.K. Anikina, G.L. Vardenga, A.I. Golokhvastov, M.S. Zhuravleva, V.L. Ilina, E.S. Kuznetsova, Y. Lukstinsh, E.O. Okonov, T.G. Ostanevich, S.A. Khorozov et al., Yad. Fiz. 27 (1978) 724; Sov. J. Nucl. Phys. 27 (1978) 387

1978AR1H Arima, AIP Conf. Proc. 47 (1978) 1

1978AR1R Arima, Hyperfine Interactions 4 (1978) 151

1978AT01 M. Atarashi, K. Hira and H. Narumi, Prog. Theor. Phys. 60 (1978) 209

1978BA43 A.M. Baxter, P.G. Ikossi, A.M. McDonald and J.A. Kuehner, Nucl. Phys. A305 (1978) 213

1978BE1H Becchetti, AIP Conf. Proc. 47 (1978) 308

1978BE1X G.F. Bertsch and D.O. Riska, Phys. Rev. C18 (1978) 317

1978BE43 F.D. Becchetti, J. Janecke and C.E. Thorn, Nucl. Phys. A305 (1978) 313

1978BE58 H. Behrens, H. Genz, M. Conze, H. Feldmeier, W. Stock and A. Richter, Ann. Phys. 115 (1978) 276

1978BI1N Bice, Stahel, de Meijer and Cerny, Bull. Amer. Phys. Soc. 23 (1978) 929

1978BR12 D. Branford, J. Phys. (London) G4 (1978) L29

1978BU1H Butler, Newman and Talbot, Science 201 (1978) 522

1978CA02 F.P. Calaprice and D.E. Alburger, Phys. Rev. C17 (1978) 730

1978CA1H Calaprice, Hyperfine Interactions 4 (1978) 25

1978CA1N Cassagnou, AIP Conf. Proc. 47 (1978) 434

1978CH15 Y.-D. Chan, H. Bohn, R. Vandenbosch, K.G. Bernhardt, J.G. Cramer, R. Sielemann and L. Green, Nucl. Phys. A303 (1978) 500

1978CH26 W. Chung, J. van Hienen, B.H. Wildenthal and C.L. Bennett, Phys. Lett. B79 (1978) 381

1978CL1F Clayton, Ann. Rev. Nucl. Part. Sci. 28 (1978) 501

1978CO10 A.A. Cowley, S.J. Mills and G. Heymann, J. Phys. (London) G4 (1978) L149

1978CO11 A.A. Cowley, J.C. van Staden, S.J. Mills, P.M. Cronje, G. Heymann and G.F. Burdzik, Nucl. Phys. A301 (1978) 429

1978CO18 V. Corcalciuc, B. Holmqvist, A. Marcinkowski and G.A. Prokopets, Nucl. Phys. A307 (1978) 445

1978DA19 J.M. Davidson and M.M. Lowry, Phys. Rev. C18 (1978) 2776

1978DE1D De Rosa et al., Nuovo Cim. A44 (1978) 433

1978DE1V de Swiniarski, Proc., Cluster, Winnipeg (1978) G1

1978DI1D Dietrich and Simpson, Astrophys. J. 225 (1978) L41

1978DI1F Disdier et al., Proc., Cluster, Winnipeg (1978) B23

1978DO01 H. Doubre, J.C. Roynette, E. Plagnol, J.M. Loiseaux, P. Martin and P. deSaintignon, Phys. Rev. C17 (1978) 131

1978DR07 W. Dreves, P. Zupranski, P. Egelhof, D. Kassen, E. Steffens, W. Weiss and D. Fick, Phys. Lett. B78 (1978) 36

1978DU08 P. Duck, H. Frohlich, W. Galster, W. Treu and H. Voit, Phys. Rev. C18 (1978) 290, Erratum Phys. Rev. C18 (1978) 2810

1978DU14 N. Dupuis-Rolin, J.P. Deutsch, D. Favart and R. Prieels, Phys. Lett. B79 (1978) 359

1978DU23 P. Duck, H. Frohlich, W. Galster, W. Treu and H. Voit, S. African J. Phys. 1 (1978) 242

1978DW1B Dwyer, Astrophys. J. 224 (1978) 691

1978FE04 B. Fernandez, C. Gaarde, J.S. Larsen, S. Pontoppidan and F. Videbaek, Nucl. Phys. A306 (1978) 259

1978FI1C Filippov, Steshenko and Pavlenko, Sov. J. Nucl. Phys. 28 (1978) 458

1978FI1E Fick, 3rd Int. Conf. on Clustering Aspects of Nucl. Struct. Nucl. Reactions, Winnipeg (1978)

1978FL1D Fliessbach, Z. Phys. A288 (1978) 219

1978FO01 H.T. Fortune, R.R. Betts and R. Middleton, Phys. Rev. C17 (1978) 401

1978FO08 H.T. Fortune, W.J. Courtney, J.R. Comfort, W.J. Braithwaite, J.R. Duray and A.A. Pilt, Phys. Rev. C17 (1978) 1955

1978FO14 H.T. Fortune and J.N. Bishop, Nucl. Phys. A304 (1978) 221

1978GA1G Gai et al., Bull. Amer. Phys. Soc. 23 (1978) 933

1978GE08 K.A. Geoffroy, J.B. Natowitz, R. Eggers, P. Kasiraj and M.N. Namboodiri, Nucl. Phys. A302 (1978) 333

1978GO1K A.S. Goldhaber and G. Scharff-Goldhaber, Phys. Rev. C17 (1978) 1171

1978GR06 E.E. Gross, T.P. Cleary, J.L.C. Ford, D.C. Hensley and K.S. Toth, Phys. Rev. C17 (1978) 1665

1978GU13 I.S. Gulkarov and R.K. Vakil, Izv. Akad. Nauk SSSR Ser. Fiz. 42 (1978) 159; Bull. Acad. Sci. USSR Phys. Ser. 42 (1978) 137

1978HA2C Harvey, Lee and Amiot, Ann. Phys. 112 (1978) 1

1978HA43 M.Y.M. Hassan, A. Rabie and M.S.M. Noor El-Din, Atonkernenergie 32 (1978) 193

1978HE04 K.T. Hecht and D. Braunschweig, Nucl. Phys. A295 (1978) 34

1978HE18 A. Hertz, H. Essel, H.J. Korner, K.E. Rehm and P. Sperr, Phys. Rev. C18 (1978) 2780

1978HE1D Heitzmann, Atomkernenergie 31 (1978) 262

1978HO01 L.J. House and K.W. Kemper, Phys. Rev. C17 (1978) 79

1978HO1C Hodgson, Riv. Nuovo Cim. 1 (1978) 1

1978HO1E Horiuchi, 3rd Int. Conf. on Clustering Aspects of Nucl. Struct. Nucl. Reactions, Winnipeg (1978)

1978IS04 M. Ismail, Atomkernenergie 31 (1978) 44

1978IT1A N. Itoh and Y. Kohyama, Nucl. Phys. A306 (1978) 527

1978JA10 R. Jahn, D.P. Stahel, G.J. Wozniak, R.J. de Meijer and J. Cerny, Phys. Rev. C18 (1978) 9

1978KA1L Katori, Ooi, Furuno and Hanashima, Proc., Cluster, Winnipeg (1978) B24

1978KA1Y Kanofsky, Allen and Hasan, Proc., Cluster, Winnipeg (1978) D18

1978KA22 K. Kato and H. Bando, Prog. Theor. Phys. 59 (1978) 774

1978LE08 V.M. Lebedev, A.V. Spassky, I.B. Teplov, L.N. Fateeva and L.Z. Ismail, Nucl. Phys. A298 (1978) 206

1978LE19 J.C. Legg, D.J. Crozier, G.G. Seaman and H.T. Fortune, Phys. Rev. C18 (1978) 2202

1978LEZA C.M. Lederer, V.S. Shirley, E. Browne, J.M. Dairiki, R.E. Doebler, A.A. Shihab-Eldin, L.J. Jardine, J.K. Tuli and A.B. Buyrn, Table of Isotopes 7th Ed. (1978)

1978MA07 N. Marquardt, D. Sprengel, H.V. Buttlar and W. Hoppe, Z. Phys. A285 (1978) 89

1978MA1G Matsuse, Proc. Int. Conf. on Resonances in Heavy Ion Reactions, Hvar, 1977 (1978) 247

1978MA2H Mavromatis, Muther and Faessler, Z. Phys. A284 (1978) 195

1978MA2J Marquardt, Hoppe, von Buttlar and Sprengel, Proc. Int. Conf. on Resonances in Heavy Ion Reactions, Hvar, 1977 (1978) 346

1978MA2K R.S. Mackintosh, Nucl. Phys. A307 (1978) 365

1978MC04 A.B. McDonald and E.G. Adelberger, Phys. Rev. Lett. 40 (1978) 1692

1978ME1D Meyer, Nature 272 (1978) 675

1978NA07 R. Nayak and L. Satpathy, Nucl. Phys. A304 (1978) 64

1978NG01 Nguyen Van Sen, G. Ratel, R. Darves-Blanc, J.C. Gondrand and F. Merchez, Phys. Rev. C17 (1978) 639

1978NO02 R. Novotny, G. Hammer, D. Pelte, H. Emling and D. Schwalm, Nucl. Phys. A294 (1978) 255

1978NO1B Y. Nogami and C.S. Warke, Phys. Rev. C17 (1978) 1905

1978OB01 F.E. Obenshain, R.L. Ferguson, M.L. Halbert, D.C. Hensley, H. Nakahara, F. Plasil, F. Pleasonton, A.H. Snell and R.G. Stokstad, Phys. Rev. C18 (1978) 764

1978OB1B Obenshain et al., Bull. Amer. Phys. Soc. 23 (1978) 522

1978OR1A Orth, Buffington, Smoot and Mast, Astrophys. J. 226 (1978) 1147

1978PE09 T. Pedersen and E. Osnes, Nucl. Phys. A303 (1978) 345

1978PI06 A.A. Pilt and H.T. Fortune, J. Phys. (London) G4 (1978) L77

1978PI08 A.A. Pilt and H.T. Fortune, Lett. Nuovo Cim. 21 (1978) 502

1978PO1B Podosek, Ann. Rev. Astron. Astrophys. 16 (1978) 293

1978QA01 S.M. Qaim and R. Wolfle, Nucl. Phys. A295 (1978) 150

1978RA1B Ragnarsson, Nilsson and Sheline, Phys. Rept. 45 (1978) 1

1978RA1J Raichev, Rusev and Stefanov, Bulg. J. Phys. (Bulgaria) 5 (1978) 268

1978RA2A S. Raman, C.A. Houser, T.A. Walkiewicz and I.S. Towner, At. Data Nucl. Data Tables 21 (1978) 567; Erratum At. Data Nucl. Data Tables 22 (1978) 369

1978RO07 D.J. Rowe, S.S.M. Wong, H. Chow and J.B. McGrory, Nucl. Phys. A298 (1978) 31

1978RO17 D. Robson, Nucl. Phys. A308 (1978) 381

1978RO1D Rolfs and Trautvetter, Ann. Rev. Nucl. Part. Sci. 28 (1978) 115

1978RO1L Rolfs, AIP Conf. Proc. 47 (1978) 197

1978RY02 T.B. Ryves, P. Kolkowski and K.J. Zieba, J. Phys. (London) G4 (1978) 1783

1978SA1E Satpathy and Navak, J. Phys. (London) G4 (1978) L161

1978SA1R Sato, Proc., Cluster, Winnipeg (1978) E7

1978SA1T Sato et al., Z. Phys. A288 (1978) 383

1978SA33 H. Sakaguchi, M. Nakamura, K. Hatanaka, A. Goto, T. Noro, F. Ohtani, S. Kobayashi, K. Hosono and M. Kondo, Fiz. Suppl. 10 (1978) 53

1978SC19 K.W. Schmid and G. Do Dang, Phys. Rev. C18 (1978) 1003

1978SC1G Schiffer, Proc. Int. Conf. Nucl. Struct., Tokyo (1977); J. Phys. Soc. Jpn. Suppl. 44 (1978) 9

1978SH18 T. Shibata, H. Ejiri, J. Chiba, S. Nagamiya and K. Nakai, Nucl. Phys. A308 (1978) 513

1978SH1P Shapira et al., Bull. Amer. Phys. Soc. 23 (1978) 949

1978SI11 R.P. Singhal, R.G. Arthur, E.A. Knight, M.W.S. Macauley, D. Kelvin, A. Watt and R.R. Whitehead, Phys. Lett. B76 (1978) 170

1978SM02 Y.F. Smirnov and G.F. Filippov, Yad. Fiz. 27 (1978) 73; Sov. J. Nucl. Phys. 27 (1978) 39

1978SM1E Smith, Meadows and Whalen, Bull. Amer. Phys. Soc. 23 (1978) 936

1978SN1B Snover, Kim and Dickey, Bull. Amer. Phys. Soc. 23 (1978) 501

1978ST08 D.J. Steck, Phys. Rev. C17 (1978) 1034

1978SV01 J.P. Svenne and R.S. Mackintosh, Phys. Rev. C18 (1978) 983

1978SZ02 Z.M. Szalata, K. Itoh, G.A. Peterson, J. Flanz, S.P. Fivozinsky, F.J. Kline, J.W. Lightbody, Jr., X.E. Maruyama and S. Penner, Phys. Rev. C17 (1978) 435

1978TA11 P. Taras, G.R. Rao and G. Azuelos, Phys. Rev. Lett. 41 (1978) 840

1978TA1A Tang, Lemere and Thompson, Phys. Rept. 47 (1978) 167

1978TA1F Takimoto et al., Proc., Cluster, Winnipeg (1978) F16

1978TA1Y Tarasov, Kirichenko, Inopin and Gonchar, Ukr. Fiz. Zh. (USSR) 23 (1978) 1499

1978TH1A Thompson, AIP Conf. Proc. 47 (1978) 69

1978TO07 T. Tomoda and A. Arima, Nucl. Phys. A303 (1978) 217

1978TO12 A. Tohsaki-Suzuki, Prog. Theor. Phys. 60 (1978) 1013

1978TR06 W. Treu, H. Frohlich, W. Galster, P. Duck and H. Voit, Phys. Rev. C18 (1978) 2148

1978TR07 R.E. Tribble and D.P. May, Phys. Rev. C18 (1978) 2704

1978TR08 H.P. Trautvetter, H.W. Becker, G. Hulke, K.U. Kettner, C. Rolfs and P. Schmalbrock, S. Afr. J. Phys. 1 (1978) 206

1978TR1D Truran and Cameron, Astrophys. J. 219 (1978) 226

1978TRZY W. Treu, H. Frohlich and K. Nagatani, Bull. Amer. Phys. Soc. 23 (1978) 523, BG8

1978TS04 I. Tserruya, Y. Eisen, D. Pelte, A. Gavron, H. Oeschler, D. Berndt and H.L. Harney, Phys. Rev. C18 (1978) 1688

1978VO06 C. Von Charzewski, V. Hnizdo and C. Toepffer, Nucl. Phys. A307 (1978) 309

1978VO13 C. von Charzewski, V. Hnizdo and C. Toepffer, S. Afr. J. Phys. 1 (1978) 222

1978VO1D Volkov, Phys. Rept. 44 (1978) 93

1978WI1G Wilson, Bull. Amer. Phys. Soc. 23 (1978) 620

1978WU1C Wu, Overley, Barnes and Switkowski, LAP-164 (1978)

1978YO01 J. Yonnet, M. Louvel, C. Lebrun, G. Roche, G. Landaud, A. Devaux, J. Castor, A. Baldit and J.P. Alard, Phys. Rev. Lett. 40 (1978) 164

1978YO1F Yokota and Suzuki, Proc., Cluster, Winnipeg (1978) B15

1978YU1B Yuldashev et al., Acta Phys. Pol. B9 (1978) 513

1978ZA04 P.C. Zalm and P.J. Brussaard, Z. Phys. A287 (1978) 265

1978ZA1D Zalm, Van Hienen and Glaudemans, Z. Phys. A287 (1978) 255

1978ZI1A Ziegler et al., Nucl. Instrum. Meth. Phys. Res. 149 (1978) 19

1979AJ01 F. Ajzenberg-Selove, Nucl. Phys. A320 (1979) 1

1979AK02 V. Aksinenko, M. Anikina, A. Banasiuk, V. Buttsev, L. Chkaidze, N. Glagoleva, A. Golokhvastov, V. Ilina, S. Kadikova, N. Kaminsky et al., Nucl. Phys. A324 (1979) 266

1979AL1H Alma-Ata-Dubna-Warsaw Collaboration, Conf. Proc. TRIUMF, Vancouver (1979) Paper 6D23

1979AL1V Allen et al., AIP Conf. Proc. 54 (1979) 197, 199, 201, 203

1979AN01 N. Anantaraman, H.E. Gove, R.A. Lindgren, J. Toke, J.P. Trentelman, J.P. Draayer, F.C. Jundt and G. Guillaume, Nucl. Phys. A313 (1979) 445

1979AR05 K.P. Artemov, V.Z. Goldberg, I.P. Petrov, V.P. Rudakov, I.N. Serikov, V.A. Timofeev and P.R. Christensen, Nucl. Phys. A320 (1979) 479

1979BA2V Band et al., Conf. Proc. TRIUMF, Vancouver (1979) Paper 6E20

1979BA48 J.K. Bair and J. Gomez del Campo, Nucl. Sci. Eng. 71 (1979) 18

1979BAYR D.P. Balamuth, D. Bybell, J.M. Lind and W.K. Wells, Bull. Amer. Phys. Soc. 24 (1979) 847, FD14

1979BE16 R.R. Betts and S.B. DiCenzo, Phys. Rev. C19 (1979) 2070

1979BE1H Benenson and Kashy, Rev. Mod. Phys. 51 (1979) 527

1979BE31 W. Benenson, G. Bertsch, G.M. Crawley, E. Kashy, J.A. Nolen, Jr., H. Bowman, J.G. Ingersoll, J.O. Rasmussen, J. Sullivan, M. Koike et al., Phys. Rev. Lett. 43 (1979) 683; Erratum Phys. Rev. Lett. 44 (1980) 56

1979BI10 J.H. Billen, Phys. Rev. C20 (1979) 1648

1979BO17 A. Bonaccorso, M. Di Toro and J. Lomnitz-Adler, Nucl. Phys. A324 (1976) 115

1979BR03 H.S. Bradlow, W.D.M. Rae, P.S. Fisher, N.S. Godwin, G. Proudfoot and D. Sinclair, Nucl. Phys. A314 (1979) 171

1979BR08 A. Bruggeman, W. Maenhaut and J. Hoste, J. Inorg. Nucl. Chem. 41 (1979) 445

1979BR30 B.A. Brown, S.E. Massen and P.E. Hodgson, J. Phys. (London) G5 (1979) 1655

1979BU19 V.I. Bulanenko, At. Energ. 47 (1979) 28; Sov. At. Energy 47 (1979) 531

1979CA11 D.J.E. Callaway, L. Wilets and Y. Yariv, Nucl. Phys. A327 (1979) 250

1979CE1B G. Cecil, S. Das Gupta and A. Mekjian, Phys. Rev. C20 (1979) 1021

1979CH12 J.E. Christiansson, J. Dubois and H. Roth, Phys. Scr.19 (1979) 245

1979CH1T Chance and Harris, Astron. Astrophys. 74 (1979) 247

1979CH2D Cheng et al., Phys. Energ. Fortis Phys. Nucl. (China) 3 (1979) 624

1979CH2E Chung and Wildenthal, Int. Conf. Nucl. Phys. with Electromag. Interact., Mainz (1979) 1.8, 1.9

1979CO09 A. Cortes and A.P. Zuker, Phys. Lett. B84 (1979) 25

1979CO10 M. Conze and P. Manakos, J. Phys. (London) G5 (1979) 671

1979CO15 A.A. Cowley, Nucl. Phys. A325 (1979) 83

1979CO1P Cowley, Mills and Heymann, S. African J. Phys. 2 (1979) 85

1979CU1A B. Cujec, Shiu-Chin Wu and C.A. Barnes, Phys. Lett. B89 (1979) 151

1979CU1C Cusson, Howard and Meldner, Nucl. Interactions, Canberra, Australia (1979) 483

1979DA15 B.J. Dalton, W.J. Baldridge and J.P. Vary, Phys. Rev. C20 (1979) 1908

1979DA17 S.K. Datta, G.P.A. Berg and P.A. Quin, Nucl. Phys. A332 (1979) 125

1979DA1F S. Das Gupta and C.S. Lam, Phys. Rev. C20 (1979) 1192

1979DE08 L.C. Dennis, S.T. Thornton and K.R. Cordell, Phys. Rev. C19 (1979) 777

1979DI1B Dietrich and Simpson, Astrophys. J. 231 (1979) L91

1979EB01 K.A. Eberhard, H. Bohn and K.G. Bernhardt, Phys. Rev. Lett. 42 (1979) 432

1979EL04 J.P. Elliott and J.A. Evans, Nucl. Phys. A324 (1979) 12

1979ES01 M.A. Eswaran, R.N. Boyd, E. Sugarbaker, R. Cook and H.E. Gove, Nucl. Phys. A313 (1979) 467

1979FLZW N.R. Fletcher, J.D. Fox, A.D. Frawley, J.F. Mateja and C.B. Saw, Bull. Amer. Phys. Soc. 24 (1979) 851, GB3

1979FO17 H.T. Fortune, L. Bland, R. Middleton, W. Chung and B.H. Wildenthal, Phys. Lett. B87 (1979) 29

1979FO20 C.-M. Fou, D.P. Balamuth, R.W. Zurmuhle and K.C. Young, Jr., Phys. Rev. C20 (1979) 1754

1979FO22 J.L.C. Ford, Jr., J. Gomez del Campo, D. Shapira, M.R. Clover, R.M. DeVries, B.R. Fulton, R. Ost and C.F. Maguire, Phys. Lett. B89 (1979) 48

1979FU06 Y. Fujiwara, Prog. Theor. Phys. 62 (1979) 122

1979FU08 Y. Fujiwara, Prog. Theor. Phys. 62 (1979) 138

1979FU09 Y. Fujiwara, H. Horiuchi and R. Tamagaki, Prog. Theor. Phys. 61 (1979) 1629

1979FU1N Fulbright, Ann. Rev. Nucl. Part. Sci. 29 (1979) 161

1979GA04 J.A. Gaidos, L.J. Gutay, A.S. Hirsch, R. Mitchell, T.V. Ragland, R.P. Scharenberg, F. Turkot, R.B. Willmann and C.L. Wilson, Phys. Rev. Lett. 42 (1979) 82

1979GA1F Gai, Bull. Amer. Phys. Soc. 24 (1979) 843

1979GA1L S.I.A. Garpman and D. Sperber, Phys. Lett. B86 (1979) 133

1979GA1M Garcia-Munoz, Simpson and Wefel, Astrophys. J. 232 (1979) L95

1979GAZY M. Gai, P. Braun-Munzinger, G.M. Berkowitz, C.M. Jachcinski, T.R. Renner and C.D. Uhlhorn, Bull. Amer. Phys. Soc. 24 (1979) 570, AL2

1979GO11 J. Gomez del Campo, R.G. Stokstad, J.A. Biggerstaff, R.A. Dayras, A.H. Snell and P.H. Stelson, Phys. Rev. C19 (1979) 2170

1979GO17 N.S. Godwin, W.D. Rae, B. Cooke, N.J. Eyre, P.S. Fisher, G. Proudfoot and D. Sinclair, Nucl. Phys. A331 (1979) 237

1979GO1C Gobbi and Bromley, Heavy Ion Collisions 1 (1979) 487

1979GO24 Y. Goto and H. Horiuchi, Prog. Theor. Phys. 62 (1979) 662

1979GR11 J.M. Greben and F.S. Levin, Nucl. Phys. A325 (1979) 145

1979HA07 R.L. Hatch and S.E. Koonin, Phys. Lett. B81 (1979) 1

1979HA1G Hanna, Proc. Mainz, 1979, Springer Lec. Notes 108 (1979) 288

1979HA50 M.Y.M. Hassan and A.S. Ghazal, Acta Phys. Pol. B10 (1979) 77

1979HA59 M.Y.M. Hassan, S. Moharram, M.M. Osman and H.M. Abdel Monem, Acta Phys. Pol. B10 (1979) 845

1979HA60 L. Hannappel, H. Henschel and H. Schneider, Nucl. Instrum. Meth. 167 (1979) 289

1979HE1D Hering et al., BNL-51115 (1979) 759

1979HE1F K.T. Hecht and W. Zahn, Nucl. Phys. A313 (1979) 77

1979IN06 E.V. Inopin, V.S. Kinchakov, V.K. Lukyanov and Y.S. Pol, Ann. Phys. 118 (1979) 307

1979IN07 E.V. Inopin, A.E. Inopin, E.G. Kopanets and L.P. Korda, Izv. Akad. Nauk SSSR Ser. Fiz. 43 (1979) 2308; Bull. Acad. Sci. USSR Phys. Ser. 43 (1979) 54

1979JA11 B. Jakobsson, J.P. Bondorf and G. Fai, Phys. Lett. B82 (1979) 35

1979JA19 D.R. James and N.R. Fletcher, Phys. Rev. C20 (1979) 560

1979JA22 L. Jarczyk, B. Kamys, J. Okolowicz, J. Sromicki, A. Strzalkowski, H. Witala, Z. Wrobel, M. Hugi, J. Lang, R. Muller et al., Nucl. Phys. A325 (1979) 510

1979KA40 V.B. Kamble and S.B. Khadkikar, Pramana 13 (1979) 475

1979KN1F Knopfle, Proc. Mainz, 1979, Springer Lect. Notes 108 (1979) 311

1979KN1G Knupfer, Ender and Huber, Conf. Proc. TRIUMF, Vancouver (1979) Paper 5A13

1979KN1H J. Knoll and J. Randrup, Nucl. Phys. A324 (1979) 445

1979KO03 J.J. Kolata, R.M. Freeman, F. Haas, B. Heusch and A. Gallmann, Phys. Rev. C19 (1979) 408

1979KO15 J.J. Kolata, R.M. Freeman, F. Haas, B. Heusch and A. Gallmann, Phys. Rev. C19 (1979) 2237

1979KO26 L. Koester, K. Knopf and W. Waschkowski, Z. Phys. A292 (1979) 95

1979KO38 N. Kovacevic and L. Sips, Fizika (Zagreb) 11 (1979) 127

1979KOZL J. Kolata, P. DeYoung, R. Malmin, S. Tripathi, R. Luhn and S. Davis, Bull. Amer. Phys. Soc. 24 (1979) 825, BB3

1979KOZY R.T. Kouzes, P.J. Besl, F.P. Calaprice, D. Mueller and M. Schneider, Bull. Amer. Phys. Soc. 24 (1979) 52, HF3

1979KU01 S. Kubono, T.K. Li, D. Dehnhard, D.A. Lewis, J.F. Petersen and J.L. Artz, Nucl. Phys. A313 (1979) 434

1979KU06 E. Kuhlmann, F. Borchers, H. De Jong and J. Krug, Nucl. Phys. A318 (1979) 125

1979KU20 G.J. Kumbartzki, K. Hagemeyer, W. Knauer, G. Krosing, R. Kuhnen, V. Mertens, K.-H. Speidel, J. Gerber and W. Nagel, Hyperfine Interactions 7 (1979) 253

1979LA04 S. La France, H.T. Fortune, S. Mordechai and R. Middleton, J. Phys. (London) G5 (1979) L59

1979LA07 S. Landowne and H.H. Wolter, Nucl. Phys. A323 (1979) 161

1979LA18 S. LaFrance, H.T. Fortune, S. Mordechai, M.E. Cobern, G.E. Moore, R. Middleton, W. Chung and B.H. Wildenthal, Phys. Rev. C20 (1979) 1673

1979LA1H Lazareff, Audouze, Starrfield and Truran, Astrophys. J. 228 (1979) 875

1979LE11 M. LeMere, D.J. Stubeda, H. Horiuchi and Y.C. Tang, Nucl. Phys. A320 (1979) 449

1979LE1B M. LeMere and Y.C. Tang, Phys. Rev. C19 (1979) 391

1979LE1F Lee, Schramm, Wefel and Blake, Astrophys. J. 232 (1979) 854

1979MA01 R.S. Mackintosh and J.K. Hamilton, Nucl. Phys. A313 (1979) 173

1979MA1J MacGregor, Phys, Rev. Lett. 42 (1979) 1724

1979MA2D Mason, Gloeckler and Hovestadt, Bull. Amer. Phys. Soc. 24 (1979) 693

1979MA39 R.E. Marrs and R.E. Pollock, Phys. Rev. C20 (1979) 2446

1979MC1D McVoy and Nemes, Bull. Amer. Phys. Soc. 24 (1979) 816

1979ME12 M.C. Mermaz, A. Greiner, B.T. Kim, M.A.G. Fernandes, N. Lisbona, E. Muller, W. Chung and B.H. Wildenthal, Phys. Rev. C20 (1979) 2130

1979ME1L Mewaldt, Spalding, Stone and Vogt, Astrophys. J. 231 (1979) L97

1979MI1L H.G. Miller, Nucl. Phys. A328 (1979) 585

1979MIZX J.P. Miller, J.A. Bistirlich, K.M. Crowe, C.J. Martoff, S.S. Rosenblum, W.A. Zajc, H.W. Baer, G. Strassner, P. Truol and A.H. Wapstra, Bull. Amer. Phys. Soc. 24 (1979) 647, GK10

1979MO02 D.M. Moltz, J. Aysto, M.D. Cable, R.D. von Dincklage, R.F. Parry, J.M. Wouters and J. Cerny, Phys. Rev. Lett. 42 (1979) 43

1979MO14 T. Motobayashi, I. Kohno, T. Ooi and S. Nakajima, Nucl. Phys. A331 (1979) 193

1979MO17 D.J. Morrissey, L.F. Oliveira, J.O. Rasmussen, G.T. Seaborg, Y. Yariv and Z. Fraenkel, Phys. Rev. Lett. 43 (1979) 1139

1979NA12 K. Nakai, J. Chiba, I. Tanihata, M. Sasao, H. Bowman, S. Nagamiya and J.O. Rasmussen, Phys. Rev. C20 (1979) 2210

1979NA1F Nagamiya, BNL-51115 (1979) 131

1979NG02 Nguyen Van Sen, R. Darves-Blanc, J.C. Gondrand and F. Merchez, Phys. Rev. C20 (1979) 969

1979NO11 P.J. Nolan and J.F. Sharpey-Schafer, Rept. Prog. Phys. 42 (1979) 1

1979OBZZ F.E. Obenshain, R.L. Ferguson, F. Plasil, R.L. Robinson, D. Shapira and A.H. Snell, Bull. Amer. Phys. Soc. 24 (1979) 825, BB5

1979OE02 W. Oelert, W. Chung, M. Betigeri, A. Djaloeis, C. Mayer-Boricke and P. Turek, Phys. Rev. C20 (1979) 459

1979PI01 A.A. Pilt, M.A.M. Shahabuddin and J.A. Kuehner, Phys. Rev. C19 (1979) 20

1979PI03 H.J. Pirner and B. Schurmann, Nucl. Phys. A316 (1979) 461

1979PO14 F. Pougheon, P. Roussel, M. Bernas, F. Diaf, B. Fabbro, F. Naulin, E. Plagnol and G. Rotbard, Nucl. Phys. A325 (1979) 481

1979RA06 J. Randrup, Nucl. Phys. A316 (1979) 509

1979RA10 Rae et al., Nucl. Phys. A319 (1979) 239

1979RA1C Ramaty, Kozlovsky and Lingenfelter, Astrophys. J. Suppl. 40 (1979) 487

1979REZS T.R. Renner, M. Gai, P. Braun-Munzinger, G.M. Berkowitz, C.M. Jachcinski and C.D. Uhlhorn, Bull. Amer. Phys. Soc. 24 (1979) 843, FB14

1979SA10 K. Sato, S. Yamaji, K. Harada and S. Yoshida, Z. Phys. A290 (1979) 149

1979SA1W M. Sandel, J.P. Vary and S.I. Garpman, Phys. Rev. C20 (1979) 744

1979SA26 F. Saint-Laurent, M. Conjeaud, S. Harar, J.M. Loiseaux, J. Menet and J.B. Viano, Nucl. Phys. A327 (1979) 517

1979SA29 S.J. Sanders, L.M. Martz and P.D. Parker, Phys. Rev. C20 (1979) 1743

1979SA38 H. Sakaguchi, M. Nakamura, K. Hatanaka, A. Goto, T. Noro, F. Ohtani, H. Sakamoto and S. Kobayashi, Phys. Lett. B89 (1979) 40

1979SE04 F. Seiler and H.W. Roser, Nucl. Phys. A315 (1979) 45

1979SH18 D. Shapira, J.L.C. Ford, Jr., J. Gomez del Campo, R.G. Stokstad and R.M. DeVries, Phys. Rev. Lett. 43 (1979) 1781; Erratum Phys. Rev. Lett. 44 (1980) 110

1979SH22 D. Shapira, R. Dayras, J.L.C. Ford, Jr., J. Gomez del Campo, A.H. Snell, P.H. Stelson and R.G. Stokstad, Nucl. Instrum. Meth. Phys. Res. 163 (1979) 325

1979SI12 R.P. Singhal, D. Kelvin, E.A. Knight, A. Watt and R.R. Whitehead, Nucl. Phys. A323 (1979) 91

1979SI1D Simpson, Bull. Amer. Phys. Soc. 24 (1979) 69

1979SI1K P.J. Siemens and J.I. Kapusta, Phys. Rev. Lett. 43 (1979) 1486

1979ST1R Stock, Nukleonika 24 (1979) 165

1979ST1V Stamp and Thompson, Nucl. Interactions, Canberra, Australia (1979) 387

1979ST21 E.J. Stephenson, B.P. Hichwa and J.D. Hutton, Nucl. Phys. A331 (1979) 269

1979SU13 K.M. Subotic, R. Ostojic and B.Z. Stepancic, Nucl. Phys. A331 (1979) 491

1979SY01 T.J.M. Symons, Y.P. Viyogi, G.D. Westfall, P. Doll, D.E. Greiner, H. Faraggi, P.J. Lindstrom, D.K. Scott, H.J. Crawford and C. McParland, Phys. Rev. Lett. 42 (1979) 40

1979TA19 I. Tanihata, S. Nagamiya, O. Chamberlain, M.-C. Lemaire, S. Schnetzer, G. Shapiro and H. Steiner, Phys. Lett. B87 (1979) 349

1979TR1B Truol, Proc. Mainz, 1979, Springer Lect. Notes 108 (1979) 351

1979TR1G Trautvetter, Elix, Rolfs and Brnad, Nucl. Instrum. Meth. 161 (1979) 173

1979UD02 T. Udagawa, T. Tamura, T. Shimoda, H. Frohlich, M. Ishihara and K. Nagatani, Phys. Rev. C20 (1979) 1949

1979VA1B Van Bibber, BNL-51115 (1979) 365

1979VE09 G.A. Vershinin and I.P. Chernov, Izv. Akad. Nauk SSSR Ser. Fiz. 43 (1979) 1047; Bull. Acad. Sci. USSR Phys. Ser. 43 (1979) 129

1979VE1C Vershinin, Izv. Vuz. Fiz. (USSR) 22 (1979) 44

1979VI05 A. Vidal-Quadras and M. Ortega, Nuovo Cim. A49 (1979) 235

1979VI08 D.A. Viggars, T.W. Conlon, F.P. Brady and I. Naqib, Phys. Rev. C19 (1979) 2186

1979WI1Q Wildenthal and Chung, MSUCL-319 (1979); Proc. Conf. on “The (p, n) Reaction and the Nucleon-Nucleon Force”, Colorado (1979)

1979WO07 S.E. Woosley, W.A. Fowler, J.A. Holmes and B.A. Zimmerman, At. Data Nucl. Data Tables 22 (1978) 371

1979WU06 G. Wunner, Nucl. Phys. A318 (1979) 304

1979YA12 Y. Yariv and Z. Fraenkel, Phys. Rev. C20 (1979)2227; Erratum Phys. Rev. C21 (1980) 2139

1979YA1F Yamaji, Sci. Pap. Inst. Phys. Chem. Res. (Japan) 73 (1979) 19

1979YO04 K.C. Young Jr., R.W. Zurmuhle, J.M. Lind and D.P. Balamuth, Nucl. Phys. A330 (1979) 452

1979YU02 T. Yukawa and S. Furui, Phys. Rev. C20 (1979) 2316

1980AC1A Ackermann et al., Proc. Int. Conf. on Nucl. Phys., Berkeley (1980) 274

1980AJ01 F. Ajzenberg-Selove and C.L. Busch, Nucl. Phys. A336 (1980) 1

1980AK02 V.D. Aksinenko et al., SKM-200 Collaboration, Nucl. Phys. A348 (1980) 518

1980AN08 G. Andritsopoulos, X. Aslanoglou, P. Bakoyeorgos and G. Vourvopoulos, Phys. Rev. C21 (1980) 1648

1980AN16 N. Anantaraman, H.W. Fulbright and P.M. Stwertka, Phys. Rev. C22 (1980) 501

1980AN21 N. Anantaraman, Phys. Rev. C22 (1980) 945

1980BA2K Barashencov and Musulmanbecov, Z. Phys. A296 (1980) 371

1980BE04 F.D. Becchetti, K.T. Hecht, J. Janecke, D. Overway and G. Kekelis, Phys. Rev. C21 (1980) 444

1980BE15 F.D. Becchetti, K.T. Hecht, J. Janecke, D. Overway and G. Kekelis, Nucl. Phys. A339 (1980) 132

1980BH1B Bhatia and Singh, Astrophys. Space Sci. 69 (1980) 461, 471

1980BI05 P.G. Bizzeti and P.R. Maurenzig, Nuovo Cim. A56 (1980) 492

1980BO1J A.R. Bodmer, C.N. Panos and A.D. MacKellar, Phys. Rev. C22 (1980) 1025

1980BO1K P.D. Bond, Phys. Rev. C22 (1980) 1539

1980BO21 K. Bodek, M. Hugi, L. Jarczyk, B. Kamys, J. Lang, R. Muller, M. Porebska, J. Sromicki, A. Strzalkowski, E. Ungricht et al., J. Phys. (London) G6 (1980) 1017

1980BR09 B.A. Brown, W. Chung and B.H. Wildenthal, Phys. Rev. C21 (1980) 2600

1980BR13 B.A. Brown, W. Chung and B.H. Wildenthal, Phys. Rev. C22 (1980) 774

1980BR21 B.A. Brown, W.A. Richter and N.S. Godwin, Phys. Rev. Lett. 45 (1980) 1681

1980CA11 J.R. Calarco, P.M. Kurjan, G.A. Fisher and S.S. Hanna, Phys. Lett. B92 (1980) 67

1980CA12 E. Caurier and B. Grammaticos, Phys. Lett. B92 (1980) 236

1980CA1K Caskey and Richards, Bull. Amer. Phys. Soc. 25 (1980) 727

1980CH1G M. Chemtob and B. Schurmann, Nucl. Phys. A336 (1980) 508

1980CO03 E.R. Cosman, R. Ledoux and A.J. Lazzarini, Phys. Rev. C21 (1980) 2111

1980CO08 A.J. Cole, N. Longequeue, J. Menet, J.J. Lucas, R. Ost and J.B. Viano, Nucl. Phys. A341 (1980) 284

1980CO1R Cook, Stone and Vogl, Astrophys. J. 238 (1980) L97

1980CO1U Corcalciuc, Stud. Cercet. Fiz. 32 (1980) 1135, 1166

1980CU09 P. Cuzzocrea, A. De Rosa, G. Inglima, E. Perillo, E. Rosato, M. Sandoli and G. Spadaccini, Lett. Nuovo Cim. 28 (1980) 515

1980CU1D J. Cugnon, Phys. Rev. C22 (1980) 1885

1980DI03 D. Dieumegard, B. Maurel and G. Amsel, Nucl. Instrum. Meth. Phys. Res. 168 (1980) 93

1980DI06 M. Di Toro, G. Russo and F. Duggan, Phys. Rev. C21 (1980) 2054

1980DI1B Digregorio et al., Bull. Amer. Phys. Soc. 25 (1980) 523

1980ER06 K.A. Erb, R.R. Betts, S.K. Korotky, M.M. Hindi, P.P. Tung, M.W. Sachs, S.J. Willett and D.A. Bromley, Phys. Rev. C22 (1980) 507

1980EV1A Evans et al., Bull. Amer. Phys. Soc. 25 (1980) 745

1980FA07 E. Fabrici, S. Micheletti, M. Pignanelli, F.G. Resmini, R. De Leo, G. D'Erasmo and A. Pantaleo, Phys. Rev. C21 (11980) 844

1980FI01 L.K. Fifield, M.J. Hurst, E.F. Garman, T.J.M. Symons, F. Watt and K.W. Allen, Nucl. Phys. A334 (1980) 109

1980FIZX L.K. Fifield, W.N. Catford, S.H. Chew, E.F. Garman, K.W. Allen, J. Lowe and C.E. Waltham, Proc. Int. Conf. on Nucl. Phys., Berkeley (1980) 88

1980FL1C Fliessbach and Manakos, Proc. Int. Conf. on Nucl. Phys., Berkeley (1980) 280

1980FO02 J.L.C. Ford, Jr., T.P. Cleary, J. Gomez del Campo, D.C. Hensley, D. Shapira and K.S. Toth, Phys. Rev. C21 (1980) 764

1980FR1C Freier, Fickle, Waddington and Young, Bull. Amer. Phys. Soc. 25 (1980) 546

1980FU1F Fujiwara and Horiuchi, Prog. Theor. Phys. 63 (1980) 895

1980FU1G Furutani et al., Suppl. Prog. Theor. Phys. 68 (1980) 193

1980FU1H Fujiwara et al., Supll. Prog. Theor. Phys. 68 (1980) 29

1980GA10 Y.K. Gambhir and R. Parthasarathy, Phys. Rev. C21 (1980) 1637

1980GA18 W. Galster, P. Duck, H. Frohlich, W. Treu, H. Voit and S.M.B. Lee, Phys. Rev. C22 (1980) 515

1980GAZX M. Gai, G.M. Berkowitz, P. Braun-Munzinger, C.M. Jachcinski, C.E. Ordonez, T.R. Renner and C.D. Uhlhorn, Bull. Amer. Phys. Soc. 25 (1980) 592, JE11

1980GO1E Gokeman et al., Bull. Amer. Phys. Soc. 25 (1980) 594

1980GR10 R.E.L. Green and R.G. Korteling, Phys. Rev. C22 (1980) 1594

1980HA1L Hanashima et al., Proc. Int. Conf. on Nucl. Phys., Berkeley (1980) 535

1980HU07 J.R. Hurd, N.R. Fletcher, A.D. Frawley and J.F. Mateja, Phys. Rev. C22 (1980) 528

1980HU08 M.J. Hurst, L.K. Fifield, E.F. Garman, T.J.M. Symons, F. Watt and K.W. Allen, J. Phys. (London) G6 (1980) 891

1980HU12 G. Hulke, C. Rolfs and H.P. Trautvetter, Z. Phys. A297 (1980) 161

1980HU1D Hugg and Hanna, Proc. Int. Conf. on Nucl. Phys., Berkeley (1980) 891

1980HU1J Hugg and Hanna, Polarization, Santa Fe (1980) 294

1980IK1B Ikeda, Horiuchi and Saito, Prog. Theor. Phys. Suppl. 68 (1980) 1

1980IS1B Isenbugel et al., Proc. Int. Conf. on Nucl. Phys., Berkeley (1980) 563

1980KL1B Klapdor, Nukleonika 25 (1980) 291

1980KO02 J.J. Kolata, R.M. Freeman, F. Hass, B. Heusch and A. Gallmann, Phys. Rev. C21 (1980) 579

1980KO1H Kozub et al., Bull. Amer. Phys. Soc. 25 (1980) 723

1980KO1L Kostin, Koval, Kopanets and Tsytko, Ukr. Fiz. Zh. 25 (1980) 881

1980KO29 V.K.B. Kota, S.P. Pandya and V. Potbhare, Nucl. Phys. A349 (1980) 397

1980KO46 T. Kozik, Acta Phys. Pol. B11 (1980) 863

1980LE1J Lezoch, Trost, Rahman and Strohbusch, Proc. Int. Conf. on Nucl. Phys., Berkeley (1980) 472

1980LE21 M. Lemere, Y.C. Tang, E.J. Kanellopoulos and W. Sunkel, Nucl. Phys. A348 (1980) 321

1980LE26 H. Leeb and E.W. Schmid, Z. Phys. A298 (1980) 113

1980MA10 G. Mairle, K.T. Knopfle, H. Riedesel, G.J. Wagner, V. Bechtold and L. Friedrich, Nucl. Phys. A339 (1980) 61

1980MA1N Maher et al., Bull. Amer. Phys. Soc. 25 (1980) 723

1980MA1T Madey et al., Proc. Int. Conf. on Nucl. Phys., Berkeley (1980) 617

1980MA27 J.D. MacArthur, H.C. Evans, J.R. Leslie and H.-B. Mak, Phys. Rev. C22 (1980) 356

1980MA34 G. Madurga, M. Lozano and A. Jadraque, Phys. Lett. B95 (1980) 358

1980MC1D McGrory, Bull. Amer. Phys. Soc. 25 (1980) 573

1980MO05 I. Morrison, Phys. Lett. B91 (1980) 4

1980MO1F Moses et al., Bull. Amer. Phys. Soc. 25 (1980) 524

1980MO1L Morgan, Astrophys. J. 238 (1980) 674

1980MU13 B. Mughrabi and P.J. Ellis, Phys. Rev. C22 (1980) 2354

1980NA1C Nagatani, Bull. Amer. Phys. Soc. 25 (1980) 601

1980OB1A Obenshain et al., Proc. Int. Conf. on Nucl. Phys., Berkeley (1980) 608

1980OE01 W. Oelert, W. Chung, A. Djaloeis, C. Mayer-Boricke and P. Turek, Phys. Rev. C22 (1980) 408

1980OH05 M. Ohta and S. Okai, Prog. Theor. Phys. 63 (1980) 881

1980OK01 M. Oka and K. Kubodera, Phys. Lett. B90 (1980) 45

1980OT1A I. Otterlund, Nucl. Phys. A335 (1980) 507

1980RA1G J. Randrup and C.M. Ko, Nucl. Phys. A343 (1980) 519

1980RE1B Read et al., Bull. Amer. Phys. Soc. 25 (1980) 592

1980RI1D Riedhauser, Bull. Amer. Phys. Soc. 25 (1980) 738

1980RO11 G. Rosensteel, Nucl. Phys. A341 (1980) 397

1980RU01 A.J. Rutten, A. Holthuizen, J.A.G. De Raedt, W.A. Sterrenburg and G. Van Middelkoop, Nucl. Phys. A344 (1980) 294

1980SA1H Sasagase et al., Proc. Int. Conf. on Nucl. Phys., Berkeley (1980) 527

1980SC1L Schramm, Nukleonika 25 (1980) 1543

1980SC1M Schmid, Ann. Fis. 76 (1980) 63

1980SE06 Nguyen Van Sen, J.C. Gondrand, F. Merchez and R. Darves-Blanc, Phys. Rev. C22 (1980) 2424

1980SH1T Shapira, Ford, Gomez Del Campo and Stelson, Proc. Int. Conf. on Nucl. Phys., Berkeley (1980) 494

1980SI15 R. Singh, K.A. Eberhard and R.G. Stokstad, Phys. Rev. C22 (1980) 1971

1980SK1A Skrzypczak et al., Proc. Int. Conf. on Nucl. Phys., Berkeley (1980) 575

1980SP02 K.-H. Speidel, G.J. Kumbartzki, W. Knauer, V. Mertens, P.N. Tandon, N. Ayres de Campos, J. Gerber and M.B. Goldberg, Phys. Lett. B92 (1980) 289

1980SP1E J. Speth and J. Wambach, Nucl. Phys. A347 (1980) 389

1980ST1J Stach, Kretschmer, Wango and Rebel, Nukleonika 25 (1980) 1025

1980ST25 K. Stricker, J.A. Carr and H. McManus, Phys. Rev. C22 (1980) 2043

1980TA1K Tamura, Udagawa and Mermaz, Phys. Rept. 65 (1980) 345

1980TE02 W. Textor, Nuovo Cim. A56 (1980) 355

1980TO1D Tohsaki-Suzuki, Kamimura and Ikeda, Proc. Int. Conf. on Nucl. Phys., Berkeley (1980) 411

1980TR1A P. Truol, Nucl. Phys. A335 (1980) 55

1980TR1E Tribble, Proc. Int. Conf. in At. Masses and Fund. Constants; Eds., Nolen and Benenson (1980) 13

1980TS03 I. Tserruya, J. Barrette, S. Kubono, P. Braun-Munzinger, M. Gai and C.D. Uhlhorn, Phys. Rev. C21 (1980) 1864

1980WA07 C.W. Wang, N.S. Chant, P.G. Roos, A. Nadasen and T.A. Carey, Phys. Rev. C21 (1980) 1705

1980WI1J Wienhard et al., Polarization, Santa Fe (1980) 2.123

1980WO1C Wolfe, Bull. Amer. Phys. Soc. 25 (1980) 784

1980YA02 T. Yamaya, K. Umeda, T. Suehiro, K. Takimoto, R. Wada, E. Takada, M. Fukada, J. Schimizu and Y. Okuma, Phys. Lett. B90 (1980) 219

1980ZO1A Zofka, Czech. J. Phys. B30 (1980) 95

1981AB1A Abe, RIFP-421 (1981) 428

1981AJ01 F. Ajzenberg-Selove, Nucl. Phys. A360 (1981) 1

1981AL05 P.D. Allen, E.G. Muirhead and D.V. Webb, Nucl. Phys. A357 (1981) 171

1981AL13 D.E. Alburger and E.K. Warburton, Phys. Rev. C24 (1981) 296

1981AN1D Anikina et al., Proc. Versailles Conf. (1981) 447

1981AN1H Anikina et al., Z. Phys. C9 (1981) 105

1981AN1K Anikina et al., Yad. Fiz. 33 (1981) 1568

1981AO01 K. Aoki and H. Horiuchi, Prog. Theor. Phys. 66 (1981) 1508

1981AR1D A. Arima, Nucl. Phys. A354 (1981) 19

1981AS01 F. Asai, H. Sato and M. Sano, Phys. Lett. B98 (1981) 19

1981AU1D Audouze, Prog. Part. Nucl. Phys. 6 (1981) 125

1981AY01 J. Aysto, M.D. Cable, R.F. Parry, J.M. Wouters, D.M. Moltz and J. Cerny, Phys. Rev. C23 (1981) 879

1981AZ1A Azimov et al., Yad. Fiz. 33 (1981) 169

1981BA1G Basak et al., Santa Fe 1980, AIP Conf. Proc. 69 (1981) 593

1981BA26 Z. Basrak, P. Duck, H. Frohlich, W. Treu and H. Voit, Nucl. Phys. A363 (1981) 242

1981BE22 P. Belery, Th. Delbar, Gh. Gregoire, K. Grotowski, N.S. Wall, T. Kozik and S. Micek, Phys. Rev. C23 (1981) 2503

1981BE2D Begchanov et al., Proc. Samarkand Conf. (1981) 656

1981BE60 H.W. Becker, K.U. Kettner, C. Rolfs and H.P. Trautvetter, Z. Phys. A303 (1981) 305

1981BO11 A.R. Bodmer and C.N. Panos, Nucl. Phys. A356 (1981) 517

1981BR1P Bromley, Int. Workshop on Resonances in Heavy Ion Collisions, Bad Honnef (1981)

1981CA02 T.A. Carey, P.G. Roos, N.S. Chant, A. Nadasen and H.L. Chen, Phys. Rev. C23 (1981) 576

1981CA1H Cahn and Glashow, Science 213 (1981) 607

1981CA1J Caskey, Bull. Amer. Phys. Soc. 26 (1981) 1126

1981CE07 R.A. Cecil, B.D. Anderson, A.R. Baldwin, R. Madey, W. Schimmerling, J.W. Kast and D. Ortendahl, Phys. Rev. C24 (1981) 2013

1981CH1K Chechev and Kramarovskii, Usp. Fiz. Nauk 134 (1981) 431

1981CL1D E.T.H. Clifford, J.C. Hardy, H. Schmeing, R.E. Azuma, H.C. Evans, T. Faestermann, E. Hagberg, K.P. Jackson, V.T. Koslowsky and U.J. Schrewe, Proc. Int. Conf. in Helsingor, June 1980; CERN 81-09 (1981) 306

1981CO04 C.R. Countee, J.P. Draayer, T.R. Halemane and K. Kar, Nucl. Phys. A356 (1981) 1

1981CU1G J. Cugnon, Phys. Rev. C23 (1981) 2094

1981CU1K J. Cugnon, J. Knoll and J. Randrup, Nucl. Phys. A360 (1981) 444

1981DA13 C.A. Davis, Phys. Rev. C24 (1981) 1891

1981DE20 P.A. DeYoung, J.J. Kolata, R.C. Luhn, R.E. Malmin and S.N. Tripathi, Phys. Rev. C24 (1981) 166

1981DEZE L.C. Dennis, K.M. Abdo, A.D. Frawley and K.W. Kemper, Bull. Amer. Phys. Soc. 26 (1981) 1236, HE15

1981DEZW L.C. Dennis, K. Abdo, A.D. Frawley and K.W. Kemper, Bull. Amer. Phys. Soc. 26 (1981) 554, BI10

1981DU1E Dunphy et al., Astrophys. J. 244 (1981) 1081

1981EG01 Ch. Egelhaaf, G. Bohlen, H. Fuchs, A. Gamp, H. Homeyer and H. Kluge, Phys. Rev. Let. 46 (1981) 813

1981EL1D J.P. Elliot and J.A. Evans, Phys. Lett. B101 (1981) 216

1981ER03 M. Erculisse, J. Phys. (London) G7 (1981) 951

1981FE05 M. Fernandez, G. Murillo, J. Ramirez, O. Avila, S.E. Darden, M.C. Rozak, J.L. Foster, B.P. Hichwa and P.L. Jolivette, Nucl. Phys. A369 (1981) 425

1981FI1B H.R. Fiebig and W. Timm, Nucl. Phys. A368 (1981) 164

1981FU1F Fujiwara and Horiuchi, Prog. Theor. Phys. 65 (1981) 1632

1981GA1D Gai, Bull. Amer. Phys. Soc. 26 (1981) 612

1981GA1F Gasparian, Proc. Versailles Conf. (1981) 514

1981GA35 E.F. Garman, L.K. Fifield, W.N. Catford, D.P. Balamuth, J.M. Lind and R.W. Zurmuhle, Nucl. Phys. A372 (1981) 194

1981GO11 N.S. Godwin, W.D.M. Rae, B. Cooke, A. Etchegoyen, N.J. Eyre, P.S. Fisher, G. Proudfoot and D. Sinclair, Nucl. Phys. A363 (1981) 493

1981GOZY A. Gokmen, H. Breuer, B.G. Glagola, A.C. Mignerey, K. Kwiatkowski and V.E. Viola, Bull. Amer. Phys. Soc. 26 (1981) 580, EG9

1981GR06 S.M. Grimes and S.D. Bloom, Phys. Rev. C23 (1981) 1259

1981GR08 K. Grotowski, P. Belery, Th. Delbar, Y. El Masri, Gh. Gregoire, R. Janssens, J. Vervier, G. Paic, M. Albinska, J. Albinski et al., Phys. Rev. C23 (1981) 2513

1981GY01 B. Gyarmati, K.F. Pal and T. Vertse, Phys. Lett. B104 (1981) 177

1981GY1B M. Gyulassy and S.K. Kauffmann, Nucl. Phys. A362 (1981) 503

1981HA2C Hansen, Nucl. Struct., NATO B67 (1981) 289

1981HA46 T.R. Halemane, A. Abbas and L. Zamick, J. Phys. (London) G7 (1981) 1639

1981HI02 M.M. Hindi, J.H. Thomas, D.C. Radford and P.D. Parker, Phys. Lett. B99 (1981) 33

1981HI1C Hirsch et al., Bull. Amer. Phys. Soc. 26 (1981) 582

1981HO06 B.R. Holstein, Phys. Rev. C23 (1981) 1829

1981JA09 L. Jarczyk, B. Kamys, A. Magiera, J. Sromicki, A. Strzalkowski, G. Willim, Z. Wrobel, D. Balzer, K. Bodek, M. Hugi et al., Nucl. Phys. A369 (1981) 191

1981JE1B B.K. Jennings, L. Satpathy and S. Das Gupta, Phys. Rev. C24 (1981) 440

1981KA1L Karban, Basak, Morrison, Nelson and Roman, Santa Fe 1980, AIP Conf. Proc. 69 (1981) 703

1981KA32 K. Kar, Nucl. Phys. A368 (1981) 285

1981KE1E Kenny, Astralian J. Phys. 34 (1981) 35

1981KH04 Yu.I. Kharitonov, Yu.F. Smirnov and L.A. Sliv, Izv. Akad. Nauk SSSR Ser. Fiz. 45 (1981) 66

1981KI04 Yu.V. Kirichenko, V.Yu. Gonchar, E.V. Inopin and V.N. Tarasov, Ukr. Fiz. Zh. 26 (181) 904

1981KN06 W. Knupfer and A. Richter, Phys. Lett. B101 (1981) 375

1981KN07 E.A. Knight, R.P. Singhal, R.G. Arthur and M.W.S. Macauley, J. Phys. (London) G7 (1981) 1115

1981KN12 V.A. Knyr and Yu.F. Smirnov, Acta Phys. Pol. B12 (1981) 1067

1981KOZS D.G. Kovar, W. Bohne, M. Burgel, Ch. Egelhaaf, H. Fuchs, A. Gamp, K. Grabisch, D. Hilscher, H. Homeyer, H. Morgenstern et al., Bull. Amer. Phys. Soc. 26 (1981) 1133, CB12

1981KR09 O. Krause, B. Apagyi and W. Scheid, Nucl. Phys. A364 (1981) 159

1981KR1G Krieger, Weiss, Flocard and Heenen, Bull. Amer. Phys. Soc. 26 (1981) 1145

1981LE10 P. Lezoch, H.-J. Trost and U. Strohbusch, Phys. Rev. C23 (1981) 2763

1981LE1F Lezoch, Trost, Rahman and Strohbusch, Santa Fe 1980, AIP Conf. Proc. 69 (1981) 745

1981LE1H Lewis et al., Santa Fe 1980, AIP Conf. Proc. 69 (1981) 590

1981LO1F W. Loveland, L. Cheng, P.L. McGaughey, D.J. Morrissey and G.T. Seaborg, Phys. Rev. C24 (1981) 464

1981MA04 C.J. Martoff, J.A. Bistirlich, K.M. Crowe, M. Koike, J.P. Miller, S.S. Rosenblum, W.A. Zajc, H.W. Baer, A.H. Wapstra, G. Strassner et al., Phys. Rev. Lett. 46 (1981) 891

1981MA14 G. Mairle, G.J. Wagner, K.T. Knopfle, Ken Pao Liu, H. Riedesel, V. Bechtold and L. Friedrich, Nucl. Phys. A363 (1981) 413

1981MA1G N. Masuda, K. Inoue and Y. Ito, Phys. Rev. C23 (1981) 1543; Erratum Phys. Rev. C24 (1981) 1820

1981MA26 V.S. Mathur and R. Prasad, J. Phys. (London) G7 (1981) 1455

1981MC1C McGrory, Nucl. Struct., NATO B67 (1981) 1

1981MI13 H.G. Miller and H.P. Schroder, Nucl. Phys. A368 (1981) 237

1981MUZQ S.F. Mughabghab, M. Divadeenam and N.E. Holden, Neutron Cross Sections Vol. 1 Part A, Z=1-60 (1981)

1981NA07 M.N. Namboodiri, P. Gonthier, H. Ho, J.B. Natowitz, R. Eggers, L. Adler, P. Kasiraj, C. Cerruti, A. Chevarier, N. Chevarier et al., Nucl. Phys. A367 (1981) 313

1981NA1E S. Nagamiya, M.-C. Lemaire, E. Moeller, S. Schnetzer, G. Shapiro, H. Steiner and I. Tanihata, Phys. Rev. C24 (1981) 971

1981NE1B O.F. Nemets and A.M. Vasnogordsky, Fiz. Elem. Chastits At. Yadra 12 (1981) 424

1981OH04 J. Ohlert, O. Traudt and H. Waffler, Phys. Rev. Lett. 47 (1981) 475

1981OS07 R. Ost, S. Kox, A.J. Cole, N. Longequeue, J.J. Lucas, J. Menet and J.B. Viano, Nucl. Phys. A361 (1981) 453

1981PA1D Parthasarathy, Proc. Versailles Conf. (1981) 494

1981PO1A Pougheon et al., Santa Fe 1980, AIP Conf. Proc. 69 (1981) 1120

1981RA14 I. Ragnarsson, S. Aberg and R.K. Sheline, Phys. Scr. 24 (1981) 215

1981RAZP W.D. Rae, A.J. Cole, C.R. Albiston, B.G. Harvey, M.J. Murphy, R.G. Stokstad and I. Tserruya, Bull. Amer. Phys. Soc. 26 (1981) 1121, BB3

1981RO1H Roman, Santa Fe 1980, AIP Conf. Proc.69 (1981) 282

1981RO1W Rolfs, Nucl. Struct., NATO B67 (1981) 369

1981SA1J T. Sasakawa and S.K. Adhikari, Phys. Rev. Lett. 46 (1981) 1379

1981SC03 R.P. Schmitt, G.J. Wozniak, G.U. Rattazzi, G.J. Mathews, R. Regimbart and L.G. Moretto, Phys. Rev. Lett. 46 (1981) 522

1981SC12 K.W. Schmid, Phys. Rev. C24 (1981) 1283

1981SC1J Scott, MSUCL-355 (1981)

1981SH1J Shenkin, Bull. Amer. Phys. Soc. 26 (1981) 802

1981SHZR D. Shapira, Y.D. Chan, D. DiGregorio, J.L. Ford, J. Gomez del Campo, R. Novotny, M.E. Ortiz and F. Pougheon, Bull. Amer. Phys. Soc. 26 (1981) 1131, CB4

1981SM1B Smirnov and Chuvilski, Proc. Samarkand Conf. (1981) 484

1981SP07 R.H. Spear, Phys. Rept. 73 (1981) 369

1981SP1D Speth and van der Woude, Rept. Prog. Phys. 44 (1981) 719

1981ST1B Stamp, Bull. Amer. Phys. Soc. 26 (1981) 590

1981ST20 J.D. Stevenson, J. Martinis and P.B. Price, Phys. Rev. Lett. 47 (1981) 990

1981ST23 J.D. Stevenson and P.B. Price, Phys. Rev. C24 (1981) 2102

1981SU01 E. Sugarbaker, R.N. Boyd, D. Elmore and H.E. Gove, Nucl. Phys. A351 (1981) 481

1981SU1J Suzuki and Hecht, Bull. Amer. Phys. Soc. 26 (1981) 1141

1981TA02 E. Takada, T. Shimoda, N. Takahashi, T. Yamaya, K. Nagatani, T. Udagawa and T. Tamura, Phys. Rev. C23 (1981) 772

1981TA06 T. Tanabe, M. Yasue, K. Sato, K. Ogino, Y. Kadota, Y. Taniguchi, K. Makino and M. Tochi, Phys. Lett. B100 (1981) 241

1981TA23 T. Tanabe, M. Yasue, K. Sato, K. Ogino, Y. Kadota, Y. Taniguchi, K. Obori, K. Makino and M. Tochi, Phys. Rev. C24 (1981) 2556

1981TR04 R.E. Tribble, D.P. May and D.M. Tanner, Phys. Rev. C23 (1981) 2245

1981VA1E R. Vandenbosch and A.J. Lazzarini, Phys. Rev. C23 (1981) 1074

1981VE05 J.C. Vermeulen, A.G. Drentje, H.T. Fortune, L.W. Put, R.R. De Ruyter Van Steveninck, R.H. Siemssen, J.F.A. Van Hienen and H. Hasper, Nucl. Phys. A362 (1981) 189

1981WA06 E.K. Warburton and D.E. Alburger, Phys. Rev. C23 (1981) 1234

1981WE1F Wefel, Schramm, Blake and Pridmore-Brown, Astrophys. J. 45 (1981) 565

1981WEZY G.D. Westfall, N. Anantaraman, G.M. Crawley, M. Curtin, C.K. Gelbke, B. Jacak, B. Hasselquist, W.A. Lynch, D.K. Scott, M.B. Tsang et al., Bull. Amer. Phys. Soc. 26 (1981) 1111, AB2

1981WI01 H.J. Wiebicke and M.V. Zhukov, Nucl. Phys. A351 (1981) 321

1981WI1D M.E. Wiedenbeck and D.E. Greiner, Phys. Rev. Lett. 46 (1981) 682

1981WI1E Wienhard et al., Santa Fe 1980, AIP Conf. Proc. 69 (1981) 747

1981WI1K Wildenthal, Nucl. Struct. Part. Phys. Conf., Oxford (1981)

1981WO1A Wolfe, Nucl. Sci. 28 (1981) 1551

1981WO1B Woosley and Weaver, Astrophys. J. 243 (1981) 651

1981XE01 A.C. Xenoulis, A.E. Aravantinos, C.J. Lister, J.W. Olness and R.L. Kozub, Phys. Lett. B106 (1981) 461

1981YO03 K.C. Young, Jr., D.P. Balamuth, J.M. Lind and R.W. Zurmuhle, Phys. Rev. C23 (1981) 980

1981YO05 M.I. Yousef and R. Reif, Yad. Fiz. 33 (1981) 1006; Sov. J. Nucl. Phys. 33 (1981) 531

1981ZY04 J. Zyskind, M. Rios and C. Rolfs, Astrophys. J. 243 (1981) L53; Erratum Astrophys. J. 245 (1981) L97

1982AJ01 F. Ajzenberg-Selove, Nucl. Phys. A375 (1982) 1

1982AO1B Aoki and Horiuchi, KUNS 620 (1982)

1982BI1D Bistrenko, in Kiev (1982) 243

1982BI1H Birbrair and Kalachnikov, in Kiev (1982) 172, 173

1982BU1D Burtebaev, Duisebaev and Ivanov, in Kiev (1982) 327

1982CH05 J.L. Charvet, R. Dayras, J.M. Fieni, S. Joly and J.L. Uzureau, Nucl. Phys. A376 (1982) 292

1982DE10 P.A. DeYoung, J.J. Kolata, R.C. Luhn, R.E. Malmin and S.N. Tripathi, Phys. Rev. C25 (1982) 1420

1982DE1N de Wet, Found. Phys. 12 (1982) 285

1982DU1A Dubovoi and Chitanava, in Kiev (1982) 421

1982FI1C E. Fiorini, Nucl. Phys. A374 (1982) 577

1982FL1A T. Fliessbach and H. Walliser, Nucl. Phys. A377 (1982) 84

1982FO03 H.T. Fortune, S.C. Headley, A. Spadafora, J. Sweet, S. LaFrance, M.E. Cobern, G.E. Moore, M. Newcomer, E. Wallash, L. Bland et al., Phys. Lett. B108 (1982) 95

1982FR03 D.J. Frantsvog, A.R. Kunselman, R.L. Wilson, C.S. Zaidins and C. Detraz, Phys. Rev. C25 (1982) 770

1982HA07 T.R. Halemane, Phys. Lett. B108 (1982) 256

1982HA10 T.R. Halemane and J.B. French, Z. Phys. A304 (1982) 363

1982HA15 T.R. Halemane and J.B. French, Phys. Rev. C25 (1982) 2029

1982HI1K Hindi, Thomas, Radford and Parker, Yale 3074-678 (1982)

1982HIZY M.M. Hindi, D.H. Dowell, S. Gil and K.A. Snover, Bull. Amer. Phys. Soc. 27 (1982) 493, DXa12

1982IB1A Iben, Astrophys. J. 253 (1982) 248

1982IS1B C. Ishii, Phys. Rev. C25 (1982) 1652

1982KAZK I.M. Kapitonov and A.V. Shumakov, in Kiev (1982) 53

1982KI02 M.M. King Yen, S.T. Hsieh, H.C. Chiang and D.S. Chuu, J. Phys. (London) G8 (1982) 245

1982KO07 Y. Kondo and T. Tamura, Phys. Lett. B109 (1982) 171

1982LA04 K. Langanke, Nucl. Phys. A373 (1982) 493

1982LA26 J. Lange, K. Kumar and J.H. Hamilton, Rev. Mod. Phys. 54 (1982) 119

1982MA25 G. Mairle, G.J. Wagner, P. Grabmayr, K.T. Knopfle, Liu Ken Pao, H. Riedesel, K. Schindler, V. Bechtold, L. Friedrich and P. Ziegler, Nucl. Phys. A382 (1982) 173

1982ME1C Mercier, Hill, Wohn and Smith, Bull. Amer. Phys. Soc. 27 (1982) 540

1982MI1B H.G. Miller and H.P. Schroder, Nucl. Phys. A378 (1982) 340

1982MU1C Murphy et al., Bull. Amer. Phys. Soc. 27 (1982) 32

1982OS01 E. Oset and D. Strottman, Nucl. Phys. A377 (1982) 297

1982PE1C Perez Tamayo et al., in Kiev (1982) 326

1982QUZY P.A. Quin, R. Allard, R.A. Bigelow, K. Fletcher and Z.-J. Wang, Bull. Amer. Phys. Soc. 27 (1982) 525, EYb14

1982RA1C Rasmussen et al., Bull. Amer. Phys. Soc. 27 (1982) 26

1982RA1D H.M. Radi, J.O. Rasmussen, J.P. Sullivan, K.A. Frankel and O. Hashimoto, Phys. Rev. C25 (1982) 1518

1982RI1B A. Richter, Nucl. Phys. A374 (1982) 177

1982SE1E Semionov, Subbotin, Gridnev and Khefter, in Kiev (1982) 388

1982SH02 N.R. Sharma and B.K. Jain, Nucl. Phys. A377 (1982) 201

1982SM1D Smirnov and Chuvilskii, in Kiev (1982) 231

1982SP02 K.-H. Speidel, P.N. Tandon, V. Mertens, W. Trolenberg, G.J. Kumbartzki, N. Ayres de Campos, M.B. Goldberg, J. Gerber and M. Toulemonde, Nucl. Phys. A378 (1982) 130

1982SU01 J.P. Sullivan, J.A. Bistirlich, H.R. Bowman, R. Bossingham, T. Buttke, K.M. Crowe, K.A. Frankel, C.J. Martoff, J. Miller, D.L. Murphy et al., Phys. Rev. C25 (1982) 1499

1982TA02 N. Takahashi, T. Yamaya, R.E. Tribble, E. Takada, Y.-W. Lui, D.M. Tanner and K. Nagatani, Phys. Lett. B108 (1982) 177

1983HI06 M.M. Hindi, J.H. Thomas, D.C. Radford and P.D. Parker, Phys. Rev. C27 (1983) 2902