Energy Levels of Light Nuclei
$A = 7$

F. Ajzenberg-Selove

University of Pennsylvania, Philadelphia, Pennsylvania 19104-6396

Abstract: An evaluation of $A = 5$–10 was published in *Nuclear Physics A*413 (1984), p. 1. This version of $A = 7$ 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. Also, Reference key numbers have been changed to the NNDC/TUNL format.

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Table of Contents for $A = 7$

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^{7}H

(Not illustrated)

^{7}H has not been observed. Attempts have been made to detect it in the spontaneous fission of ^{252}Cf (1982ALZK) and in the ^{7}Li(π^-, π^+) reaction (1981EV01, 1981SE1J, 1981SEZR). See also (1979AJ01).

^{7}He

(Fig. 10)

GENERAL: (See also (1979AJ01).)

Reactions involving pions: (1978FU09, 1979BA1M, 1979PE1C).

Hypernuclei: (1978DA1A, 1978SO1A, 1979BU1C, 1981WA1J, 1982KO11).

Other topics: (1979BE1H, 1981AV02, 1982AW02, 1982NG01).

1. ^{7}Li(π^-, γ)^{7}He $\qquad Q_{\rm m} = 128.36$

See (1979AJ01).

Table 7.1: Energy levels of ^{7}He

$E_{\rm x}$ (MeV)	$J^\pi; T$	$\Gamma_{\rm c.m.}$ (keV)	Decay	Reactions
g.s.	$(\frac{3}{2})^-; \frac{3}{2}$	160 ± 30	n [a]	1, 2, 3, 4

[a] Q_0 for ^{7}Li(t, ^{3}He)^{7}He is -11.18 MeV. This leads to 26.11 ± 0.03 MeV for the atomic mass excess of ^{3}He: $Q_{\rm m}$ for ^{7}He$_{\rm g.s.} \rightarrow {}^{6}He\,+\,$n is then 0.44 ± 0.03 MeV: see (1979AJ01).

2. ^{7}Li(n, p)^{7}He $\qquad Q_{\rm m} = -10.42$

At $E_{\rm n} = 14.8$ MeV a proton group is reported corresponding to ^{7}He$_{\rm g.s.}$: $\Gamma < 0.2$ MeV: see (1979AJ01). See also (1981BR1K).

3. ^{7}Li(t, ^{3}He)^{7}He $\qquad Q_{\rm m} = -11.18$

The ^{3}He particles to the ground state of ^{7}He have been observed at $E_{\rm t} = 22$ MeV. The width of the ground state is 160 ± 30 keV; for a radius of 2.2 fm and $l_{\rm n} = 1$, this width is 0.22 of the Wigner limit. The angular distribution is peaked in the forward direction. No other states of ^{7}He were observed for $E_{\rm x} < 2.4$ MeV: see (1979AJ01).

4. ^{9}Be(^{6}Li, ^{8}B)^{7}He $\quad\quad Q_{\rm m} = -23.60$

At $E(^{6}{\rm Li}) = 80.0$ and 93.3 MeV the ground state of ^{7}He is strongly populated, indicating negative parity, as expected. There is no indication of relatively sharp states of ^{7}He with $E_{\rm x} \leq 10$ MeV (1977WE03).

^{7}Li

(Figs. 8 and 10)

GENERAL: (See also (1979AJ01).)

Shell model: (1978FU13, 1978MI13, 1979MA11, 1981BO1Y, 1982BA52, 1982FI13).

Cluster and α-particle models: (1978MI13, 1979MA11, 1979VE08, 1980KA16, 1980SU04, 1981BE27, 1981EL06, 1981FI1A, 1981HA1Y, 1981KR1J, 1981RA1M, 1981SR01, 1982DE12, 1982FI13, 1982MU10, 1983DUZX, 1983KA1K).

Special states: (1978MI13, 1979BU14, 1979DU11, 1979KI10, 1980GO1Q, 1980SH1N, 1981BE27, 1981BO1Y, 1982BA52, 1982FI13, 1982MU10, 1983DUZX, 1983GO1R).

Electromagnetic transitions, giant resonances: (1978FU13, 1979DO17, 1981BO1Y, 1982BA52, 1982PE06, 1983WA1M).

Astrophysical questions: (1978BU1B, 1978CA1C, 1978DW1A, 1978HA1E, 1978OR1A, 1978ST1C, 1978ST1D, 1979BA1P, 1979MA1F, 1979MC1A, 1979MO04, 1979RA1C, 1979RO1A, 1979WI1D, 1979YA1C, 1980CA1C, 1980CO1R, 1980FR1G, 1980LA1G, 1980RE1B, 1980SC1K, 1981AU1D, 1981AU1G, 1981GA1C, 1981SC1M, 1982BA80, 1982PA1G, 1982SP1B).

Applied work: (1978BR34, 1979AN1B, 1979FO1F, 1979FU1E, 1979GR1E, 1979JA1B, 1979RE1B, 1979WI1C, 1980CO1H, 1981EG1B, 1981KO1D, 1981ZU1A, 1983ST1J).

Complex reactions involving ^{7}Li: (1978BH03, 1978DU1B, 1978HE1C, 1978KN1C, 1979AL22, 1979DY01, 1979GA04, 1979GE1A, 1979GO11, 1979LO11, 1979MO22, 1979SC08, 1979SC1D, 1979ST1D, 1979VI05, 1979WE06, 1980BO31, 1980GR10, 1980GU1E, 1980ME1F, 1980MI01, 1980MO28, 1980ST06, 1980WI1L, 1980ZU01, 1981BH02, 1981BL1G, 1981BO1X, 1981CH18, 1981CI03, 1981EG1E, 1981HN02, 1981ME13, 1981MO20, 1981MU10, 1981PH1D, 1981TA22, 1981ZU1B, 1982BO1J, 1982BO1Q, 1982BO35, 1982BO40, 1982DE1Y, 1982FU04, 1982GL01, 1982GO1E, 1982GU1H, 1982JA1C, 1982LU01, 1982LY1A, 1982MO13, 1982MO1N, 1982MU10, 1982NI03, 1982OH09, 1982WU1B, 1983FU04, 1983KW01, 1983MO03, 1983SA06, 1983TH04).

Muon and neutrino capture and reactions: (1977GR1C, 1978BA54, 1978BR1C, 1979BE1G, 1979DO1E, 1981AV1A, 1981PR1F, 1982BA80, 1982KR1E).

Pion capture and reactions involving pions: (1978DY01, 1978ER1A, 1978FU09, 1978KI13, 1978KN1C, 1978SI1D, 1979AK02, 1979AL1J, 1979BA17, 1979BA1M, 1979BO1F, 1979BO1G, 1979BO23, 1979CO1C, 1979DO17, 1979EN1C, 1979IN1A, 1979KI1G, 1979MA02, 1979ME07, 1979MI1C, 1979NA04, 1979PE1D, 1979RE1A, 1979SI16, 1979TI1A, 1980BA27, 1980BO03, 1980ER01, 1980JO06, 1980JO1D, 1980KA11, 1980LE02, 1980PE1C, 1980SA04, 1980SC24, 1980WH1A, 1981AS07, 1981BE63, 1981BE13, 1981BL1F, 1981DU1H, 1981EV01, 1981HE1H, 1981IO01, 1981IS11, 1981OS04, 1981SE11, 1981SE1H, 1981SEZR, 1981SI1D, 1981WH01, 1981WH1D, 1982AL31, 1981WHZZ, 1982AP1A, 1982BL1G, 1982DO02, 1982IS10, 1982LEZY, 1982OS01, 1982RI1A, 1982SE08, 1982WA1G, 1982WH1A, 1983HU02, 1983IRZZ, 1983PIZW, 1983RI1C, 1983SEZV).

Reactions involving kaons: (1978DA1A, 1979GA1E, 1980AU1C, 1980DO1E, 1980GA1C, 1981BE17, 1981BE45, 1981BO09, 1981HU1C, 1982DEZQ, 1982MA1Y, 1982MO1Q, 1982PI1J, 1982PO1C).

Reactions involving antiprotons: (1981BL1F, 1981YA1C).

Hypernuclei: (1978DA1A, 1978PO1A, 1978SO1A, 1979GA1D, 1979GA1E, 1980AU1C, 1980GA1P, 1980IW1A, 1981BE45, 1981BE17, 1981BO09, 1981DA1C, 1981WA1J, 1982DEZQ, 1982DO1M, 1982ER1B, 1982ER1E, 1982JO1C, 1982KO11, 1982MA1Y, 1982MO1Q, 1982PI1J, 1982RA1L, 1983JO1E).

Other topics: (1978RO17, 1979BE1H, 1979BU14, 1980BOZN, 1980GA1P, 1980GO1Q, 1980SH1N, 1981AV02, 1981MU10, 1981MU1H, 1982BA2G, 1982NG01, 1983FI1J, 1983GO1R, 1983MO03).

Ground-state properties of ^{7}*Li:* (1978HE1D, 1980BOZN, 1980KA16, 1980SU04, 1981BE27, 1981BO1Y, 1981EG1E, 1981EL06, 1981HN02, 1981MO08, 1981RA1M, 1981SA16, 1981SR01, 1982BA2G, 1982DE35, 1982FIZY, 1982FI13, 1982HN1A, 1982MO13, 1982MU10, 1982NG01, 1982PE06, 1983DUZX).

$\mu = +3.256424$ (2) nm; see (1978LEZA)

$Q = (-34 \pm 6)\ e \cdot$ mb: see (1980EG03). See also (1978LEZA, 1982MO13).

B(E2: $\frac{3}{2}^- \rightarrow \frac{1}{2}^-$) $= 8.3 \pm 0.6\ e^2 \cdot$ fm^4: see (1973HA47). See also (1979AJ01) and (1982BA52, 1982PE06).

1. ^{3}H(α, γ)^{7}Li $\qquad Q_{\rm m} = 2.4681$

Excitation functions and angular distributions have been studied for $E_\alpha = 0.5$ to 1.9 MeV. The cross section rises smoothly as expected for a direct-capture process: see (1966LA04). For calculations of the low-energy S-factor see (1981WI04). See also (1979YA1C; astrophysics).

2. ^{3}H(α, n)^{6}Li $\qquad Q_{\rm m} = 4.7820 \qquad E_{\rm b} = 2.4681$

The cross section for this reaction has been measured for $E_\alpha = 11$ to 18 MeV: the data show the effect of ^{7}Li*(7.46) and indicate a broad resonance near $E_\alpha = 16.8$ MeV [^{7}Li*(9.6)]. The level parameters derived from this reaction and from reaction 3 are displayed in Table 7.3. The yield of ^{6}Li ions at 0° (lab) has also been measured for $E_\alpha = 11.310$ to 11.930 MeV with 2–3% accuracy: the data were then reduced to obtain the cm differential cross sections at 0° and 180° for the inverse reaction in the energy region corresponding to formation of ^{7}Li*(7.46) (1977BR21). See also (1977KN1A).

Table 7.2: Energy levels of ^{7}Li

E_x (MeV ± keV)	$J^\pi; T$	τ_m or $\Gamma_{c.m.}$ (keV)	Decay	Reactions
g.s.	$\frac{3}{2}^-; \frac{1}{2}$		stable	1, 4, 5, 6, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 43, 44, 45, 46, 47, 48
0.477612 ± 0.003	$\frac{1}{2}^-; \frac{1}{2}$	$\tau_m = 105 \pm 5$ fsec [a]	γ	4, 5, 6, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 24, 27, 28, 29, 30, 31, 32, 33, 34, 37, 38, 39, 41, 43, 45, 46, 47, 48
4.630 ± 9	$\frac{7}{2}^-; \frac{1}{2}$	$\Gamma = 93 \pm 8$ keV	t, α	3, 5, 11, 12, 15, 16, 17, 18, 19, 20, 21, 31, 32, 34, 39, 42, 47
6.68 ± 50	$\frac{5}{2}^-; \frac{1}{2}$	875^{+200}_{-100}	t, α	3, 12, 15, 16, 17, 18, 32, 39
7.4597 ± 1.2	$\frac{5}{2}^-; \frac{1}{2}$	89 ± 7	n, t, α	2, 3, 7, 10, 12, 13, 15, 16, 18, 21, 29, 31, 32, 39
9.67 ± 100 [b]	$\frac{7}{2}^-; \frac{1}{2}$	≈ 400	n, t, α	2, 3, 7, 12, 16, 18, 32
9.85	$\frac{3}{2}^-; \frac{1}{2}$	≈ 1200	n, α	7, 10, 29
11.24 ± 30	$\frac{3}{2}^-; \frac{3}{2}$	260 ± 35	n, p	7, 8, 15, 31

[a] See Table 7.2 in (1979AJ01) and Table 7.5.

[b] See also reactions 7 and 13 for additional states.

Table 7.3: ^{7}Li levels from ^{3}H + ^{4}He [a]

E_x (MeV + keV)	J^π	l_α	LS term	R (fm)	θ^2_α [b]	$\theta^2_{n_0}$
4.65 ± 20	$\frac{7}{2}^-$	3	$^2F_{7/2}$	4.0	0.57 ± 0.04	
{ 6.64 ± 100	$\frac{5}{2}^-$	3	$^2F_{5/2}$	4.0	1.36 ± 0.13	0.000 ± 0.002
{ 6.79 ± 90	$\frac{5}{2}^-$	3	$^2F_{5/2}$	4.4	0.52	
7.47 ± 30	$\frac{5}{2}^-$	3	$^4P_{5/2}$	4.0	0.011 ± 0.001	0.26 ± 0.02
9.67 ± 100	$\frac{7}{2}^-$	3	$^4D_{7/2}$	4.0	0.53 ± 0.22	2.3 ± 0.7 [c]

[a] For references see Table 7.3 in (1979AJ01).
[b] $\gamma^2/(\frac{3}{2}\hbar^2/\mu a^2)$.
[c] $\theta^2_{n_1}$ to ^{6}Li*(2.19).

3. ^{3}H(α, α)^{3}H $\qquad E_b = 2.4681$

The excitation curves for the elastic scattering show the effects of ^{7}Li*(4.63, 6.68, 7.46, 9.67). The derived level parameters are displayed in Table 7.3. Angular distributions have been studied for $E_\alpha = 2.13$ to 2.98 MeV [see (1979AJ01)] and $E_{\vec{t}} = 6.0$ to 17 MeV (1977BR21, 1980JAZL, 1981JA1G; very accurate $\sigma(\theta)$). Analyzing power measurements are reported for $E_{\vec{t}} = 6.0$ to 17 MeV (1976HA17, 1980JAZL, 1981JA1G): a polarization extremum ($A_y = -1$) occurs near $E_t = 11.1$ MeV, $\theta_{c.m.} = 95°$. There is some suggestion for a $J^\pi = \frac{1}{2}^-$ state in ^{7}Li at $E_x = 9.6$ MeV (1981JA1G; N. Jarmie, private communication): see also reaction 7. The breakup of ^{7}Li [at kinematic energy of 70 MeV] into α + t proceeds sequentially via ^{7}Li*(4.63) when ^{12}C is bombarded. When ^{208}Pb is hit by ^{7}Li, both this sequential process and breakup in the nuclear field of the ^{208}Pb nucleus appear to occur (1981SH01). See also (1977KN1A, 1978BR1A) and (1977HA1E, 1978MI13, 1978TA1A, 1978TH1A, 1979LE1B, 1979WI1B, 1981AO02, 1981BE01, 1981FR1N, 1982FU01, 1982KA11, 1983AO03; theor.).

4. ^{4}He(α, p)^{7}Li $\qquad Q_m = -17.3459$

Angular distributions have been reported at $E_\alpha = 39.9$ to 49.5 MeV (p_0, p_1) and 60.2, 92.4 and 140.0 MeV (p_{0+1}) [see (1979AJ01)] and at $E_\alpha = 37.5$ to 43.0 MeV (1982SL01; p_0, p_1). See also (1978GL03, 1979AL34), (1982RA1M; astrophys.) and ^{8}Be.

5. ^{4}He(^{3}He, π^+)^{7}Li $\qquad Q_m = -137.118$

At $E(^3\text{He}) = 266.5$ and 280.5 MeV, ^{7}Li*(0 + 0.48, 4.63) are populated (1982BI06). See also (1982GE1C, 1982LE1L) and (1982KL1B; theor.).

6. ^{6}Li(n, γ)^{7}Li $\qquad Q_{\rm m} = 7.2501$

The thermal capture cross section is 38.5 ± 3.0 mb (1981MUZQ). Gamma rays are observed corresponding to transitions to ^{7}Li*(0, 0.48) with branching ratios of (61 ± 3) and $(39 \pm 2)\%$. ^{7}Li*(4.63) is not involved in the decay [$\lesssim 2\%$]: see (1979AJ01). See also (1980BA34; theor.).

7. ^{6}Li(n, n)^{6}Li $\qquad E_{\rm b} = 7.2501$

The scattering amplitude (bound) $a = 2.2 \pm 0.25i$ fm, $\sigma_{\rm free} = 0.45 \pm 0.08$ b. The thermal scattering cross section $= 0.75 \pm 0.02$ b (1981MUZQ). The total cross section has been measured from $E_{\rm n} = 4$ eV to 49.6 MeV [see (1976GAYV)]. Recent measurements include those of (1982SM02: $E_{\rm n} = 0.1$ to 0.8 MeV) and (1979KEZU, 1979LAZP; $E_{\rm n} = 2.99$ to 49.64 MeV) and the integrated cross sections of (1979KN01; n_0; 4.1 to 7.5 MeV) and (1979HO11; n_0 and n_1; 7.47 to 13.94 MeV). A pronounced resonance occurs at $E_{\rm n} = 244.5 \pm 1.0$ keV with a peak cross section of 11.2 ± 0.2 b (1982SM02): see Table 7.4 [$E_{\rm x} = 7459.7 \pm 1.2$ keV]. No other clearly defined resonance is observed to $E_{\rm n} = 49.6$ MeV although the total cross section exhibits a broad maximum at $E_{\rm n} \approx 4.5$ MeV J.A. Harvey and N.W. Hill, private communication). The analyzing power has been measured for $E_{\vec{\rm n}} = 1.48$ to 4.38 MeV (1982DR06) and at 2 to 5 MeV (1975HO01, 1981CH12). An R-matrix analysis of the latter results as well as $\sigma_{\rm t}$, $\sigma(\theta)$ and (n, α) results leads to a set of parameters for ^{7}Li states. These include a bound $\frac{1}{2}^{+}$ and an unbound $\frac{3}{2}^{+}$ state (at 9.38 ± 0.03 MeV) [neither reported in other reactions] as well as the $\frac{5}{2}^{-}$ state at 7.46 MeV [$\Gamma_\alpha = 33 \pm 1$ keV, reduced width 0.96 ± 0.01 MeV], a $\frac{3}{2}^{-}$ state at 9.16 ± 0.14 MeV [$\Gamma_\alpha = 2.09 \pm 0.18$ MeV, $\gamma^2 = 0.13 \pm 0.05$ MeV] and a $\frac{1}{2}^{-}$ state at 9.74 ± 0.05 MeV [no significant Γ_α, $\gamma^2 = 1.87 \pm 0.18$ MeV] (1981CH12). Another recent R-matrix analysis (1983KN06) suggests an unbound $\frac{1}{2}^{+}$ state at 8.81 MeV, a $\frac{3}{2}^{+}$ state at 9.97 MeV and a $\frac{1}{2}^{-}$ state at 10.31 MeV, in addition to the previously known states. The spectroscopic factors for the $l = 0$ decay to ^{6}Li$_{\rm g.s.}$ are $S = 0.2$ and 0.8 for ^{7}Li*(8.81, 9.97). The states suggested by (1983KN06) are very broad and cannot be seen directly in reaction or compound nucleus cross-section work (see also reaction 13). The two positive-parity states in ^{7}Li are consistent with the ^{6}Li + n scattering and reaction cross sections and provide an explanation for the anisotropy of the ^{6}Li(n, t)α reaction at low energies (1983KN06). See also (1982ST15; theor.).

The excitation function for 3.56 MeV γ-rays exhibits an anomaly, also seen in the (n, p) reaction (reaction 8). The data are well fitted assuming $E_{\rm res} = 3.50$ and 4.60 MeV [$E_{\rm x} = 10.25 \pm 0.10$ and 11.19 ± 0.05 MeV], $T = \frac{1}{2}$ and $\frac{3}{2}$, $\Gamma_{\rm c.m.} = 1.40 \pm 0.10$ and 0.27 ± 0.05 MeV, respectively; both $J^\pi = \frac{3}{2}^{-}$. The reduced widths for the $T = \frac{3}{2}$ state [^{7}Li*(11.19)] are $\theta^2_{\rm n} = 2 \times 10^{-4}$, $\theta^2_{\rm n''} = 0.16$ [to ^{6}Li*(3.56)] and $\theta^2_{\rm p} = 0.09$: see also (1979AJ01) for a discussion of these and other (unpublished) data.

See also ^{6}Li, (1979CZ1A, 1980MI02, 1982SA1F), (1977DE1C, 1977KN1A, 1981JAZZ) and (1977HA1E, 1978KO12, 1978TA1A, 1980BA34, 1982LE10, 1983FU06; theor.).

Table 7.4: Resonance parameters for 7.5-7.2 MeV levels in ^{7}Li and ^{7}Be [a]

Reaction	^{6}Li + n	^{6}Li + p
E_r (keV, lab)	262 [b]	1840
$\Gamma(E_r)$ (keV, c.m.)	154	836
E_λ (keV above g.s.)	7700	7580
$\Gamma_{n,p}(E_r)$ (keV, c.m.)	118	798
radius (n, p) in fm	3.94	4.08
$\gamma^2_{n,p}$ (MeV · fm)	4.85	5.02
$\theta^2_{n,p}$	0.26	0.28
$\Gamma_\alpha(E_r)$ (keV, c.m.)	36	38
radius (α) in fm	4.39	4.39
γ^2_α (MeV · fm)	0.101	0.101
θ^2_α	0.012	0.012

[a] These states are believed to have a $^4P_{5/2}$ character, consistent with their large θ^2_n and θ^2_p. For references see Table 7.4 in (1979AJ01).

[b] 244.5 ± 1.0 keV (1982SM02). See also (1981CH12).

8. (a) ^{6}Li(n, 2n)^{5}Li $\qquad Q_m = -5.66 \qquad E_b = 7.2501$

   (b) ^{6}Li(n, p)^{6}He $\qquad Q_m = -2.724$

For reaction (a) see (1976GO12). The excitation function, measured from threshold to $E_n = 8.9$ MeV, exhibits an anomaly at $E_n = 4.6$ MeV. The excitation function, at forward angles, of p_0 is approximately constant for $E_n = 4.4$ to 7.25 MeV: see (1979AJ01). See also ^{6}He, (1980MI02) and (1982SH1K; applied).

9. ^{6}Li(n, d)^{5}He $\qquad Q_m = -2.37 \qquad E_b = 7.2501$

The excitation function, at forward angles, of deuterons increases monotonically for $E_n = 5.4$ to 6.8 MeV: see (1979AJ01), ^{5}He and (1982SH1K).

10. ^{6}Li(n, α)^{3}H $\qquad Q_m = 4.7820 \qquad E_b = 7.2501$

The isotopic thermal cross section is 940 ± 4 b: see (1981MUZQ). See also (1981EN01). Below 5 keV, the total cross section is given by $\sigma = (149.5/\sqrt{E}\ (\text{eV}))\ + 0.696$ b: see (1979AJ01). See also (1981IN1B). The $1/v$ dependence of the cross section (strong $l = 0$ waves) is not understood in terms of the known level structure of ^{7}Li: see e.g. (1982SM02). In the 1 eV to 10 keV energy region, the ORNL results give an energy dependence for the asymmetry in the forward-to-backward 66° cone (lab) of the form $A = 1 + 0.0055\sqrt{E_n}$, where E_n is the energy in eV (J.A. Harvey and I.G. Schroder, private communication). See, however, reaction 7.

A resonance occurs at $E_n = 241 \pm 3$ keV with $\sigma_{max} = 3.15 \pm 0.08$ b (1978LA23; $E_n = 3$ to 800 keV), 3.36 ± 0.6 b (1978RE1B; $E_n = 80$ to 470 keV). The resonance is formed by p-waves, $J^\pi = \frac{5}{2}^-$, and has a large neutron width and a small α-width: see Table 7.4. Above the resonance the cross section decreases monotonically to $E_n = 18.2$ MeV (1983BA17), except for a small bump near $E_n \approx 1.8$ MeV [see (1976GAYV, 1979AJ01)] and an inflection near $E_n = 3.5$ MeV, corresponding, presumably, to the anomaly reported in (n, n′γ)–see reaction 7–[^{7}Li*(10.25), $J^\pi = \frac{3}{2}^-, T = \frac{1}{2}$] (1979BA37; $E_n = 2.2$ to 9.7 MeV). See also (1980BA39).

Angular distributions have been measured at many energies in the range $E_n = 0.1$ to 7.3 MeV [see (1979AJ01)], 2 and 24 keV (1979ST03), 2.0 to 3.5 MeV (1982KNZZ), 2.16 to 9.66 MeV (1980BA39) and at 14.1 MeV (1982HI06). See also (1977HA1J).

(1979BO1E) report a right-left asymmetry for polarized thermal neutrons of $(0.95 \pm 0.4) \times 10^{-4}$. Polarization measurements are reported by (1977KA06) for $E_{\vec{n}} = 0.2$ to 2.4 MeV: the data suggest interference between s-waves and the p-wave resonance at 0.25 MeV. Interference between this $\frac{5}{2}^-$ state and a broad $\frac{3}{2}^-$ state 2 MeV higher also appears to contribute. At the higher energies A_y is close to $+0.9$ near 90° and varies slowly with E_n (1977KA06). See also (1982KNZZ).

See also (1977GA1A, 1980CZ1A), (1979DA1C, 1980BR1L, 1980UC1A, 1981HA1N, 1982SH1K; applications), (1977DE1C, 1977HA1E, 1977KN1A, 1982HA1X) and (1977HA1H, 1978KO12, 1979WE03, 1980BA34; theor.).

11. ^{6}Li(p, π^+)^{7}Li $\qquad Q_m = -133.100$

At $E_p = 600$ MeV, the reaction prefereantially excites ^{7}Li*(4.63). Angular distributions have been obtained for the pions to ^{7}Li*(0, 0.48, 4.63) at $E_p = 600$ MeV (1977BA37) and 800 MeV (1981NAZY). The $T = \frac{3}{2}$ state ^{7}Li*(11.24) is not observed (1977BA37). See also (1980KE1D, 1981WI1F, 1982LE1L, 1982NA1K, 1982LO1B) and (1979ME2A, 1980WH1A).

12. (a) ^{6}Li(d, p)^{7}Li $\qquad Q_m = 5.0255$
(b) ^{6}Li(d, np)^{6}Li $\qquad Q_m = -2.22458$
(c) ^{6}Li(d, pt)^{4}He $\qquad Q_m = 2.5574$

Angular distributions of proton groups have been studied for $E_d = 0.12$ to 15 MeV [see (1966LA04, 1974AJ01, 1979AJ01)] and at 698 MeV (1981BO03; $p_0 \rightarrow p_3$). $S = 0.90$ and

1.15 for ^{7}Li*(0, 0.48) [DWBA analysis]; J^π of ^{7}Li*(0.48) is $\frac{1}{2}^-$. The two higher states have $E_x = 4.630 \pm 0.009$ and 7.464 ± 0.010 MeV, $\Gamma_{c.m.} = 93 \pm 8$ and 91 ± 8 keV. ^{7}Li*(7.46) appears to be a ^{24}P state: see (1974AJ01). Reaction (b) at $E_d = 10$ MeV appears to proceed via ^{7}Li*(7.46) and possibly ^{7}Li*(9.6) [$\Gamma = 0.5 \pm 0.1$ MeV]. Reaction (c) strongly involves ^{7}Li*(4.63, 7.46) ($E_d = 7.5 \rightarrow 10.5$ MeV): see (1979AJ01). See also (1979HO04). For the breakup involving ^{3}He emission see (1979HO04). See also ^{8}Be, (1981CE04) and (1979ME2A, 1980WH1A, 1982LO1B).

13. (a) ^{7}Li(γ, n)^{6}Li — $Q_m = -7.2501$
(b) ^{7}Li(γ, 2n)^{5}Li — $Q_m = -12.91$
(c) ^{7}Li(γ, p)^{6}He — $Q_m = -9.975$
(d) ^{7}Li(γ, pn)^{5}He — $Q_m = -11.84$
(e) ^{7}Li(γ, d)^{5}He — $Q_m = -9.62$
(f) ^{7}Li(γ, t)^{4}He — $Q_m = -2.4681$
(g) ^{7}Li(γ, pt)^{3}H — $Q_m = -22.2821$

The total photoneutron cross section rises sharply from 10 MeV to reach a broad plateau at about 15 mb from 14 to 20 MeV, decreases more slowly to about 0.5 mb at 25 MeV and then decreases further to about 0.3 mb at $E_\gamma = 30$ MeV (monoenergetic photons): there are indications of weak structure throughout the entire region. Differential cross sections for n_0 and n_1 have been reported for $E_\gamma = 7$ to 25 MeV. The integrated cross section to 23 MeV is 39 ± 4 MeV $\cdot$ mb for the n_0 transition and 17 ± 4 MeV $\cdot$ mb for the n_1 transition: together these account for 0.4 of the exchange augmented dipole sum of ^{7}Li: see (1979AJ01). The integrated cross section for formation of ^{6}Li*(3.56) is 4 ± 1 MeV$\cdot$mb to 30 MeV and 11 ± 3 MeV$\cdot$mb to 55 MeV (1978DE13).

The total absorption cross section for *natural* Li in the range 10 to 340 MeV shows a broad peak at ≈ 30 MeV ($\sigma_{max} \approx 3$ mb), a minimum centered at ≈ 150 MeV at ≈ 0.3 mb and a fairly smooth increase in cross section to ≈ 3 mb at ≈ 320 MeV (1979AH1A, 1979ZI1A). See also the references in (1979AJ01).

The cross section for the (γ, p) reaction (reaction (c)) shows a maximum at ≈ 15.6 MeV with a width of ≈ 4 MeV: see (1974AJ01). It then decreases fairly smoothly to 27 MeV (1979JU02). The integrated cross section for $11 \rightarrow 28$ MeV is 13.2 ± 2.0 MeV $\cdot$ mb (1979JU02). For the earlier work see (1979AJ01). Differential cross sections for the (γ, $n_0 + n_2$) and (γ, p_0) processes are reported by (1983SE07; $E_\gamma = 60$ to 120 MeV). Reaction (e) has been studied in the giant resonance reaction with $E_{bs} \lesssim 30$ MeV. Deuteron groups to ^{5}He$_{g.s.}$ and possibly to the first excited state are reported. States of ^{7}Li with $E_x = 25 - 30$ MeV may be involved when $E_{bs} = 37$ to 50 MeV is used: see (1979AJ01). See also (1979JU02, 1982KIZW).

The cross section for reaction (f) at 90° displays a broad resoannce at $E \approx 7.7$ MeV ($\Gamma = 7.2$ MeV) with an integrated cross section of 6.2 MeV $\cdot$ mb, a plateau for $12 \rightarrow 22$ MeV (at ≈ 0.6 the cross section at 7.7 MeV) and a gradual decrease to 48 MeV. The (γ, t) cross section integrated from threshold to 50 MeV is 8.1 MeV $\cdot$ mb (1979SK05; monoenergetic photons; angular distributions).

See also (1979JU02). For the earlier work on this reaction see (1966LA04, 1979AJ01). For reaction (g) see (1978VO03) and (1979AJ01). For pion production see (1979BO23, 1981BE13) and ^{7}Be. See also (1980IS10, 1981IS06), (1978CH1E, 1979MA1G, 1980AH1A) and (1978FI10, 1979KI1D, 1980BA34, 1980MO1M, 1980SU04, 1980TA1D, 1981DE18, 1981IS11, 1982DE12, 1983BU1F; theor.).

14. ^{7}Li(γ, γ)^{7}Li*

See Table 7.4 in (1966LA04) [summary of early measurements] for $\tau_{\rm m}$ of ^{7}Li*(0.48) $= 107\pm5$ fsec. See also (1980IS10, 1981IS06) and (1983ZH1D); theor.).

15. (a) ^{7}Li(e, e$'$)^{7}Li*
(b) ^{7}Li(e, ep)^{6}He $\quad Q_{\rm m} = -9.975$
(c) ^{7}Li(e, en)^{6}Li $\quad Q_{\rm m} = -7.251$
(d) ^{7}Li(e, et)^{4}He $\quad Q_{\rm m} = -2.467$

The electric form factor measurements for $E_{\rm e} = 100$ to 600 MeV are well accounted for by a simple harmonic oscillator shell model with a quadrupole contribution described by an undeformed p-shell: $R_{\rm rms} = 2.39 \pm 0.03$ fm, $|Q| = 42 \pm 2.5$ mb. From results obtained for $E_{\rm e} = 24.14$ to 97.19 MeV, $R_{\rm rms} = 2.35 \pm 0.10$ fm (model independent), 2.29 ± 0.04 fm (shell model). A study of the ratio of the electric charge scattering from ^{6}Li and from ^{7}Li as a function of (momentum transfer)^2 yields $\langle r^2\rangle_6^{1/2}/\langle r^2\rangle_7^{1/2} = 1.001\pm0.008$. The rms radius of the ground-state magnetization density distribution, $\langle r^2\rangle_{\rm M}^{1/2} = 2.98 \pm 0.05$ fm. From the ratio of transverse inelastic and elastic cross sections at 180°, B(M1, ↑; 0.48) $= 2.50 \pm 0.12$ $\mu_{\rm N}^2$. The cross section for the longitudinal excitation of ^{7}Li*(0.48) has been found from the scattering through angles of 90° to 150°, B(C2, ↑; 0.48) $= 7 \pm 4$ fm^4: see (1979AJ01) for references. The form factor for ^{7}Li*(0.48) has been measured at $\theta = 180°$ for $0.4 < q < 0.75$ fm^{-1} (1982BU09): Γ_0(M1) $= (7.5 \pm 1.7) \times 10^{-3}$ eV, in good agreement with earlier values. Form factors for ^{7}Li*(0, 0.48) are also reported for $0.8 < q < 2.9$ fm $^{-1}$ (1983LI07).

Inelastic scattering studies show peaks corresponding to ^{7}Li*(4.63, 6.68, 7.46, 11.24) in addition to ^{7}Li*(0.48): see (1974AJ01) and Table 7.5. Quasi-elastic processes have been studied by (1978KU06; $250 \rightarrow 580$ MeV/c). At $E_{\rm e} = 700$ MeV the proton separation spectra (reaction (b)) are similar to those observed in (p, 2p) (1978NA05). See also (1980AS02) and ^{6}He, ^{6}Li for reactions (b) and (c). At $E_{\rm e} = 450$ to 1096 MeV (1980TI05) have studied the contributions of longitudinal and transverse components of the cross section for inelastic scattering: the effect of meson-exchange currents is observed.

See also (1979AF1A), (1979AJ01, 1979WA1D) and (1978FU13, 1979DO17, 1980ER01, 1980KA16, 1981DE1T, 1981EL06, 1981IS11, 1981LI25, 1981RA1M, 1981SR01, 1982BO1G, 1982KA11, 1982MU10, 1982PE06; theor.).

Table 7.5: Levels of ^{7}Li from ^{7}Li(e, e′) [a]

E_x (MeV)	$J^\pi; T$	$\Gamma_{\gamma 0}$ (eV)	Type	$\Gamma_{\gamma 0}/\Gamma_W$
0.48	$\frac{1}{2}^-; \frac{1}{2}$	$(2.8 \pm 1.6) \times 10^{-7}$	E2	17
		$(6.30 \pm 0.31) \times 10^{-3}$	M1	2.8
4.63 ± 0.05 [b]	$\frac{7}{2}^-; \frac{1}{2}$		E2 [d]	
6.6 ± 0.1 [c]	$\frac{5}{2}^-; \frac{1}{2}$		E2	
7.5 ± 0.08	$\frac{5}{2}^-; \frac{1}{2}$	0.6 ± 0.3	E2	
		0.9 ± 0.4 [e]		

[a] For a summary of B(E2↑) measurements, see Table 7.6 in (1966LA04) and ^{7}Li, the "GENERAL" section. For references see (1979AJ01). See also (1982PE06, 1983LI07).
[b] $B(\text{E2}\uparrow)[\frac{3}{2}^- \rightarrow \frac{7}{2}^-] = 17.5\ e^2 \cdot \text{fm}^4$ (1982PE06).
[c] $\Gamma_{\text{c.m.}} = 875^{+200}_{-100}$ keV.
[d] Purely longitudinal.
[e] From ^{7}Li(γ, n).

16. ^{7}Li(π, π')^{7}Li*

Angular distributions have been measured at $E_{\pi^+} = 49.7$ MeV (1978DY01; elastic), $E_{\pi^\pm} = 143$ MeV (1982GI01; to ^{7}Li*(0, 0.48, 4.63, 6.68, 7.46, 9.67)) and 164.4 MeV (1979BO1F, 1979BO1G; to ^{7}Li*(0, 0.48, 4.63, 6.68)). Total cross sections for π on Li (from which partial cross sections were then derived) have been obtained for π^+ and π^- at sevseral energies in the range $85 \rightarrow 315$ MeV (1981AS07, 1979NA04). See also (1982OS01; theor.) and the "GENERAL" section here.

17. (a) ^{7}Li(n, n′)^{7}Li*
(b) ^{7}Li(n, nt)^{4}He $\qquad Q_m = -2.467$

Angular distributions have been measured at $E_n = 1.5$ to 14.6 MeV [see (1979AJ01)] and at $E_n = 4.1$ to 7.5 MeV (1979KN01; n_{0+1}), 6.97 to 13.94 MeV (1979HO11; n_{0+1}), 8.96 to 13.94 MeV (1979HO11; n_2), 9.1 MeV (1977BI12; n_{0+1}, n_2) and 10 to 18 MeV (1981DAZZ; n_0). Reaction (b) at $E_n = 14.4$ MeV proceeds primarily via ^{7}Li*(4.63) although some involvement of ^{7}Li*(6.68) may also occur: see (1979AJ01). See also ^{8}Li, (1979BAYQ), (1980KA1R; applications) and (1982KO1U); theor.).

18. (a) ^{7}Li(p, p′)^{7}Li*

(b) ^{7}Li(p, 2p)^{6}He $\quad Q_\mathrm{m} = -9.975$

(c) ^{7}Li(p, pd)^{5}He $\quad Q_\mathrm{m} = -9.62$

(d) ^{7}Li(p, pα)^{3}H $\quad Q_\mathrm{m} = -2.4681$

(e) ^{7}Li(p, p2d)^{3}H $\quad Q_\mathrm{m} = -26.3148$

Angular distributions of protons have been measured for $E_\mathrm{p} = 49.8$ to 155 MeV: see (1974AJ01) and at $E_\mathrm{p} = 24.4$ MeV (1982PE06; p_0, p_1, p_2). Inelastic proton groups have been observed corresponding to ^{7}Li*(0.48, 4.63, 6.68, 7.46, 9.6 ± 0.2): see (1952AJ38, 1974AJ01).

For reaction (b) see (1980CH05; 800 MeV), ^{6}He and (1979AJ01). For reaction (c) see (1981ER10; 670 MeV) and ^{5}He. Reaction (d) proceeds sequentially via ^{7}Li*(4.63, 6.68). At $E_\mathrm{p} = 100$ MeV (1977RO02) find $S_\alpha = 0.94 \pm 0.05$, using a DWIA analysis, a value close to that predicted by simple LS-coupling shell-model predictions. See also (1978LA11, 1980KI1D, 1982GO1H) and (1979AJ01). For reaction (e) see (1979AJ01) and (1982ER06; 670 MeV). See also ^{8}Be, (1982YA1A) and (1978BA1C, 1978WO1A, 1979KI10, 1980KO1V, 1981IS11, 1982BA1W; theor.).

19. ^{7}Li(d, d$'$)^{7}Li*

Angular distributions have been reported for $E_\mathrm{d} = 1.0$ to 28 MeV: see (1974AJ01, 1979AJ01). See also ^{9}Be.

20. ^{7}Li(^{3}He, ^{3}He)^{7}Li

Angular distributions are reported at $E(^3\mathrm{He}) = 11$ MeV (elastic) [see (1974AJ01)], at 44.04 MeV (1979GO07; g.s.) and at $E(^3\vec{\mathrm{He}}) = 33.3$ MeV (1981BA37; ^{7}Li*(0, 0.48, 4.63). See also ^{10}B and (1979KA1G). At $E(^3\mathrm{He}) = 37.5$ MeV, the three-body final states which are most strongly populated are the $^3\mathrm{He} + \alpha + \mathrm{t}$ and $^3\mathrm{He} + \mathrm{d} + {}^5\mathrm{He}$ branches. Detection of ^{3}He–t coincidences lead to a most probable momentum for the spectator α-particle of 60 MeV/c; the d–^{3}He breakup results suggest the unlikelihood of deuteron clusters in ^{7}Li: see (1979AJ01).

21. (a) ^{7}Li(α, α')^{7}Li*

(b) ^{7}Li(α, 2α)^{3}H $\quad Q_\mathrm{m} = -2.4681$

Angular distributions (reaction (a)) have been reported for $E_\alpha = 3.6$ to 29.4 MeV [see (1974AJ01)] and at 5 and 6 MeV (1982WA23). Reaction (b) has been studied at $E_\alpha = 18$ to 64.3 MeV: see (1974AJ01) and (1980KI1D, 1980ZH1A). ^{7}Li*(4.63) is strongly involved in the sequential decay. ^{7}Li*(7.46) may also be involved. For pion production see (1981AB04). See also (1979ST25),

(1979AJ01), (1978GU16, 1981BA20, 1981GU1B, 1982GUZS; theor.) and ^{11}B in (1980AJ01, 1985AJ01).

22. (a) ^{7}Li(^{6}Li, ^{6}Li)^{7}Li
(b) ^{7}Li(^{7}Li, ^{7}Li)^{7}Li

For reaction (a) see (1981GU1B; theor.). The elastic angular distribution (reaction (b)) has been studied for $E(^{7}\text{Li}) = 4.0$ to 6.5 MeV: see (1974AJ01).

23. ^{7}Li(^{9}Be, ^{9}Be)^{7}Li

The elastic angular distribution has been measured at $E(^{7}\text{Li}) = 34$ MeV (1977KE09).

24. (a) ^{7}Li(^{12}C, ^{12}C)^{7}Li
(b) ^{7}Li(^{13}C, ^{13}C)^{7}Li

The elastic scattering (reaction (a)) has been studied at $E(^{7}\text{Li}) = 4.5$ to 36 MeV [see (1975AJ02, 1979AJ01)] and at 48, 63.0, 78.7 MeV (1979ZE01, 1980ZE03; also ^{7}Li*(0.48) [and ^{12}C*(0, 4.4)]) and 89 MeV (1979BR04; and ^{12}C*(0, 4.4)). For elastic scattering studies involving ^{13}C see (1979AJ01, 1981AJ01). For fusion measurements and yield curves see (1982DE30, 1982TA23). See also (1981SH01) and (1979SU1F, 1981GU1B, 1982CO16; theor.).

25. (a) ^{7}Li(^{15}N, ^{15}N)^{7}Li
(b) ^{7}Li(^{16}O, ^{16}O)^{7}Li
(c) ^{7}Li(^{20}Ne, ^{20}Ne)^{7}Li

The elastic scattering has been studied at $E(^{7}\text{Li}) = 28.8$ MeV (1982WO09; reaction (a)), 68 and [reaction (c)] 89 MeV (1979BR03). See also (1979AJ01, 1979VA1B), (1980KH09, 1981GU1B; theor.) and ^{20}Ne in (1983AJ01).

26. (a) ^{7}Li(^{24}Mg, ^{24}Mg)^{7}Li
(b) ^{7}Li(^{25}Mg, ^{25}Mg)^{7}Li
(c) ^{7}Li(^{26}Mg, ^{26}Mg)^{7}Li
(d) ^{7}Li(^{27}Al, ^{27}Al)^{7}Li

The elastic scattering has been studied at $E(^7\text{Li}) = 89$ MeV (1980CO11, 1980ST06, 1981CO05, 1982CO16, 1982CO18), and at 27 MeV (1982WO09; reaction (b)). See also (1982HN1A, 1982TA23) and (1983CO05; theor.).

27. (a) ^{7}Li(^{28}Si, ^{28}Si)^{7}Li
(b) ^{7}Li(^{40}Ca, ^{40}Ca)^{7}Li
(c) ^{7}Li(^{48}Ca, ^{48}Ca)^{7}Li

Angular distributions involving ^{7}Li*(0, 0.48) and various states of ^{28}Si and ^{40}Ca have been studied at $E(^7\text{Li}) = 45$ MeV (1982EC01). The elastic scattering (reactions (b) and (c)) has been studied at $E(^7\text{Li}) = 28$ and 34 MeV (1977CU02), 88.7 MeV (1980ST06) and 89 MeV (1982NA14; also ^{7}Li*(0.48)). See also (1982HN1A) and (1982CO18, 1983CO05; theor.).

28. ^{7}Be(ϵ)^{7}Li $\qquad Q_\text{m} = 0.862$

The decay proceeds to the ground and 0.48 MeV states. The branching ratio to ^{7}Li*(0.48) is $10.39 \pm 0.06\%$: see Table 7.6. A recent value of $15.4 \pm 0.8\%$ has been suggested by (1982ROZS). However subsequently a number of groups have remeasured the branching ratio and find agreement with an earlier value. [In (1979AJ01) the value of (1974GO26) was improperly quoted; it is $(10.35 \pm 0.08)\%$]. The adopted half-life is 53.29 ± 0.07 d. Both transitions are superallowed: $\log ft = 3.32$ and 3.55 for the decays to ^{7}Li*(0, 0.48). See (1978RA2A, 1979AJ01) for references.

The energy of the γ-ray is 477.605 ± 0.003 keV (1978HE21), 477.6064 ± 0.0026 keV (1983KU03) [E_x derived from the mean E_γ is 477.612 ± 0.002 keV]. See also (1978SA1B, 1981SA22), (1974AJ01, 1979HE19, 1980VA1D, 1981KHZY, 1982MC1D), (1975ZI1A, 1978BA1E, 1979DA1D, 1980PE1N, 1981BA1L, 1981BA2G, 1982BA80, 1982CO1D, 1983LI01, 1983TR1F; astrophysics) and (1979DE15; theor.).

29. ^{9}Be(π^-, 2n)^{7}Li $\qquad Q_\text{m} = 119.865$

The capture of stopped pions has been studied in a kinematically complete experiment: ^{7}Li*(0, 0.48) are weakly populated. Two large peaks are attributed to the excitation of ^{7}Li*(7.46, 10.25) [see, however, Table 7.2]. The recoil momentum distributions corresponding to these peaks are rather similar and both indicate a strong $L = 0$ component (1977BA51).

30. ^{9}Be(n, t)^{7}Li $\qquad Q_\text{m} = -10.438$

Table 7.6: The branching ratio of ^{7}Be(ϵ)^{7}Li to ^{7}Li*(0.48) [a]

Branching ratio (%)	Reference
10.32 ± 0.16	(1962TA11)
10.42 ± 0.18	(1973PO10)
10.35 ± 0.08	(1974GO26)
10.10 ± 0.45	(1983BA15)
10.61 ± 0.23	(1983DA14)
10.6 ± 0.5	(1983DO07) [c]
10.7 ± 0.3	(1983FIZV)
10.7 ± 0.2	(1983MA34)
9.8 ± 0.5	(1983NO03) [c]
10.39 ± 0.06	weighted mean [b]

[a] See also (1983DO1L, 1983KNZZ, 1983TAZY), (1983WA1M; theor.) and the text of reaction 28.

[b] Not including the preliminary value of (1983FIZV).

[c] And private communication.

Angular distributions of the t_0 and t_1 groups are reported at $E_n = 13.99$ MeV: see (1979AJ01). See also (1978DR03) and ^{10}Be.

31. ^{9}Be(p, ^{3}He)^{7}Li $\qquad Q_m = -11.201$

At $E_p = 43.7$ MeV angular distributions have been obtained for the ^{3}He particles corresponding to ^{7}Li*(0, 0.48, 4.63, 7.46). The 7.46 MeV state is strongly excited while the mirror state in ^{7}Be is not appreciably populated in the mirror reaction (see reaction 15 in ^{7}Be). The angular distribution indicates that the transition to ^{7}Li*(7.46) involves both $L = 0$ and 2, with a somewhat dominant $L = 0$ character. The $J^\pi = \frac{3}{2}^-$, $T = \frac{3}{2}$ state is located at $E_x = 11.28 \pm 0.04$ MeV, $\Gamma = 260 \pm 50$ keV: see (1979AJ01) for references. See also (1981DE1X).

32. (a) ^{9}Be(d, α)^{7}Li $\qquad Q_m = 7.152$

(b) ^{9}Be(d, t)^{4}He^{4}He $\qquad Q_m = 4.6836$

Angular distributions have been measured for $E_d = 0.4$ to 27.5 MeV: see (1966LA04, 1974AJ01, 1979AJ01). A study at 11 MeV finds $\Gamma_{c.m.} = 93 \pm 25$ and 80 ± 20 keV, respectively, for ^{7}Li*(4.63, 7.46). No evidence is found for the $T = \frac{3}{2}$ state ^{7}Li*(11.25). In a kinematically complete study of reaction (b) at $E_{\rm d} = 26.3$ MeV, ^{7}Li*(4.6, $6.5 + 7.5$, 9.4) are strongly excited. No sharp α-decaying states of ^{7}Li are observed with $10 < E_{\rm x} < 25$ MeV. Parameters for ^{7}Li*(9.7) are $E_{\rm x} = 9.36 \pm 0.05$ MeV, $\Gamma = 0.8 \pm 0.2$ MeV: see (1979AJ01). See also ^{8}Be, ^{11}B in (1980AJ01, 1985AJ01) and (1980DE42, 1980DE43, 1980NE11, 1982LA09).

33. ^{9}Be(^{6}Li, ^{8}Be)^{7}Li $\qquad Q_{\rm m} = 5.585$

Angular distributions to ^{7}Li*(0, 0.48) have been studied at $E(^6{\rm Li}) = 5.5$ and 6.5 MeV: see (1979AJ01).

34. ^{10}B(n, α)^{7}Li $\qquad Q_{\rm m} = 2.790$

Angular distributions of α_0, α_1 and of α_2 at the higher energies have been measured at $E_{\rm n} = 0.2$ to 14.4 MeV [see (1979AJ01)] and at 2 and 24 keV (1979ST03; α_0, α_1). See also ^{11}B in (1980AJ01), (1978LI32) and (1980MU1D; applied).

35. ^{10}B(d, ^{5}Li)^{7}Li $\qquad Q_{\rm m} = -1.40$

See (1982DOZT; $E_{\rm d} = 13.6$ MeV).

36. ^{10}B(α, ^{7}Be)^{7}Li $\qquad Q_{\rm m} = -16.200$

See reaction 20 in ^{7}Be.

37. ^{11}Be(β^-)^{11}B* $\rightarrow$ ^{7}Li + α $\qquad Q_{\rm m} = 2.844$

Delayed α-particles have been observed in the β^- decay of ^{11}Be: they are due to the decay of ^{11}B*(9.88) [$J^\pi = \frac{3}{2}^+$]. This state decays by α-emission $87.4 \pm 1.2\%$ to the ground state of ^{7}Li and $12.6 \pm 1.2\%$ to ^{7}Li*(0.48) (1981AL03). See also ^{11}Be, ^{11}B in (1985AJ01).

38. ^{11}B(d, ^{6}Li)^{7}Li $\qquad Q_{\rm m} = -7.189$

At E_d = 13.6 and 19.5 MeV angular distributions have been measured for the transitions to $^6Li_{g.s.}$ and ^{7}Li*(0, 0.48): see ^{6}Li.

39. $^{11}B(\alpha, {}^8Be){}^7Li$ $Q_m = -8.756$

Angular distributions have been measured at E_α = 27.2 MeV (1983DO1F, 1983DOZX; see ^{8}Be) and at $E_\alpha = 28.4$ and 29.0 MeV (to ^{7}Li*(0, 0.48) and ^{8}Be*(0, 2.9)) and at 65 MeV (to ^{7}Li*(0, 4.63)). At $E_\alpha = 65$ and 72.5 MeV, ^{7}Li*(0, 4.63) are very strongly populated while ^{7}Li*(0.48, 6.68, 7.46) are weakly excited. See (1979AJ01) for references.

40. (a) $^{12}C(\gamma, p\alpha){}^7Li$ $Q_m = -24.6206$
(b) $^{12}C(p, 2p\alpha){}^7Li$ $Q_m = -24.6206$

For reaction (a) see (1979KI04). For reaction (b) see (1981AU1D; astrophysics) and (1982ZH02; theor.).

41. $^{12}C(d, {}^7Be){}^7Li$ $Q_m = -17.539$

At E_d = 39.8 MeV, angular distributions have been measured for the transitions to ^{7}Li(0) + ^{7}Be(0), ^{7}Li*(0.48) + ^{7}Be(0), ^{7}Li(0) + ^{7}Be*(0.43), and ^{7}Li*(0.48) + ^{7}Be(0.43). Assymetries exceeding 20% are observed in the ratio of the cross sections to ^{7}Li(0) and ^{7}Be(0): see (1979AJ01).

42. $^{12}C(\alpha, {}^9B){}^7Li$ $Q_m = -24.897$

At $E_\alpha = 65$ MeV this reaction proceeds via ^{7}Li*(4.63) (1978SA26).

43. $^{12}C({}^6Li, {}^{11}C){}^7Li$ $Q_m = -11.471$

Angular distributions have been obtained at $E(^6Li) = 36$ MeV for the transitions to ^{7}Li*(0, 0.48): see (1979AJ01).

44. $^{13}C(p, {}^7Be){}^7Li$ $Q_m = -20.261$

An angular distribution involving $^{7}Li_{g.s.} + {}^{7}Be_{g.s.}$ has been measured at $E_p = 45.0$ MeV: see (1974AJ01).

45. ^{13}C(d, ^{8}Be)^{7}Li $Q_m = -3.5875$

At $E_d = 14.6$ MeV angular distributions are reported for the transitions to ^{7}Li*(0, 0.48) and $^{8}Be_{g.s.}$: see (1979AJ01). See also (1982DOZT) and ^{8}Be.

46. ^{13}C(^{6}Li, ^{12}C)^{7}Li $Q_m = 2.304$

At $E(^{6}Li) = 34$ MeV angular distributions have been measured for the transitions involving $^{7}Li_{g.s.} + {}^{12}C_{g.s.}$, $^{7}Li^{*}_{0.48} + {}^{12}C_{g.s.}$, $^{7}Li_{g.s.} + {}^{12}C^{*}_{4.4}$, and $^{7}Li^{*}_{0.48} + {}^{12}C^{*}_{4.4}$: see (1979AJ01).

47. ^{14}N(n, 2α)^{7}Li $Q_m = -8.8217$

At $E_n = 14.1$ MeV, ^{7}Li*(0, 0.48) are approximately equally populated. At $E_n = 18.2$ MeV, ^{7}Li*(4.63) may be involved: see (1979AJ01).

48. (a) ^{17}O(d, ^{12}C)^{7}Li $Q_m = -2.580$
(b) ^{18}O(d, ^{13}C)^{7}Li $Q_m = -5.678$
(c) ^{19}F(d, ^{14}N)^{7}Li $Q_m = -6.122$

At $E_d = 14.6$ to 15.0 MeV, angular distributions have been measured for the transitions to ^{12}C(0)$+^{7}$Li*(0, 0.48) [reaction (a)], ^{13}C(0)$+^{7}$Li*(0, 0.48) [reaction (b)] and ^{14}N(0)$+^{7}$Li*(0, 0.48) [reaction (c)]: see (1979AJ01). Angular distributions involving ^{7}Li*(0, 0.48) are also reported at $E_d = 13.6$ MeV (reaction (b)) (1980GA1K).

^{7}Be

(Figs. 9 and 10)

GENERAL: (See also (1979AJ01).)

Nuclear models: (1978RE1A, 1979WI1B, 1980HA1M, 1981KU13, 1982FI13, 1983WA1M).

Astrophysical questions: (1978BU1B, 1979MO04, 1979RA20, 1979RA1C, 1980CA1C, 1980LA1G, 1980WI1M, 1983LI01).

Applied work: (1979LA1E, 1982HA1D, 1983HA1W).

Complex reactions involving ^{7}Be: (1978DI1A, 1978DU1B, 1978HA40, 1978HE1C, 1979BO22, 1979KA07, 1979LO11, 1979PO10, 1979RA20, 1979SC1D, 1979VI05, 1980GR10, 1980MI01, 1980WI1K, 1980WI1L, 1980WO05, 1981CI03, 1981GR08, 1981ME13, 1981MO20, 1981TA22, 1982BO1J, 1982BO1N, 1982BO35, 1982FU04, 1982GL01, 1982GR09, 1982GU1H, 1982HA1V, 1982HI12, 1982LU01, 1982LY1A, 1982MO1N, 1983PU01, 1983SA06).

Reactions involving pions and kaons: (1978WA1B, 1979AL1J, 1979BO23, 1979SI16, 1980BA27, 1980LE02, 1981OS04, 1981SI09, 1982AL31, 1982DO02, 1982LEZY, 1983IRZZ, 1983PIZW).

Hypernuclei: (1978PO1A, 1978SO1A, 1981WA1J).

Other topics: (1979BE1H, 1982NG01).

Ground state of ^{7}Be: (1982FI13, 1982NG01).

1. ^{7}Be(ϵ)^{7}Li $\qquad Q_{\rm m} = 0.862$

The decay is complex: see ^{7}Li.

2. ^{4}He(^{3}He, γ)^{7}Be $\qquad Q_{\rm m} = 1.5876$

The capture cross section has been measured for $E_\alpha = 0.38$ to 5.80 MeV [see (1974AJ01)], 0.250 to 2.954 MeV (1982KR05), 0.385 to 2.730 MeV (1982OS02), at $E_{\rm c.m.} = 0.897$ MeV (1983RO1C) and for $E(^3\text{He}) = 19$ to 26 MeV (1983WA05; γ_{0+1} excitation function at 90°).

The branching ratios DC $\rightarrow$ 429/DC $\rightarrow$ 0 and the cross section for the DC $\rightarrow$ 429 branch have been measured for $E_{\rm c.m.} = 107$ to 1266 keV: the branching ratio is approximately constant at 0.43 ± 0.02 over that energy range; the cross section is 0.117 ± 0.016 nb at 107 keV. It increases to 421 ± 39 nb at $E_{\rm c.m.} = 1266$ keV (1982KR05). These data lead to a value of $S(0) = 0.56 \pm 0.03$ keV $\cdot$ b (using microscopic DC model calculations, and a branching ratio, $10.42 \pm 0.06\%$, for the ^{7}Be decay to ^{7}Li*(0.48)) [see reaction 28 in ^{7}Li] (1983VO01).

Table 7.7: Energy levels of ^{7}Be

E_x (MeV ± keV)	$J^\pi; T$	τ or $\Gamma_{c.m.}$	Decay	Reactions
g.s.	$\frac{3}{2}^-; \frac{1}{2}$	$\tau_{1/2} = 53.29 \pm 0.07$ d	ϵ	1, 2, 5, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30
0.42908 ± 0.10	$\frac{1}{2}^-; \frac{1}{2}$	$\tau_m = 192 \pm 25$ fsec	γ	2, 5, 9, 10, 11, 12, 13, 14, 15, 17, 19, 22, 23, 24, 25, 27, 28, 29, 30
4.57 ± 50	$\frac{7}{2}^-; \frac{1}{2}$	$\Gamma = 175 \pm 7$ keV	^{3}He, α	3, 10, 13, 14, 15
6.73 ± 100	$\frac{5}{2}^-; \frac{1}{2}$	1.2 MeV	^{3}He, α	3, 8, 9, 13, 15
7.21 ± 60	$\frac{5}{2}^-; \frac{1}{2}$	≤ 0.5 MeV	p, ^{3}He, α	3, 6, 8, 9, 13
9.27 ± 100	$\frac{7}{2}^-; \frac{1}{2}$		p, ^{3}He, α	3
9.9	$\frac{3}{2}^-; \frac{1}{2}$	≈ 1.8 MeV	p, ^{3}He, α	3, 6
11.01 ± 30	$\frac{3}{2}^-; \frac{3}{2}$	320 ± 30	p, ^{3}He, α	3, 6, 13, 15
17	$\frac{1}{2}^-; \frac{1}{2}$	≈ 6.5 MeV	^{3}He	3, 13

(1982OS02) obtain $S(0) = 0.52 \pm 0.03$ keV · b and (1983RO1C) find 0.63 ± 0.04 keV · b. See also (1974AJ01) and (1981WI04; theor.). (1983RO1C) suggest, prior to (1983VO01), that $S(0) = 0.56 \pm 0.07$ keV · b should be adopted. $C^2S = 1.0$ for ^{7}Be*(0, 0.43) (1982KR05). See also (1980BA1P, 1980BA2M, 1980PE1N, 1981BA2F, 1981RO1W, 1982BA80; astrophysics) and (1981KI01, 1981LI01, 1982TA1G, 1983WA1M; theor.).

3. (a) ^{4}He(^{3}He, ^{3}He)^{4}He $\qquad E_b = 1.5876$

(b) ^{4}He(^{3}He, p)^{6}Li $\qquad Q_m = -4.0182$

Elastic scattering studies have been reported for $E = 1.72$ to 140 MeV [see (1974AJ01, 1979AJ01)] and at $E_\alpha = 0.25$ to 2.95 MeV (1982KR05) and 140 MeV (1980RO03) and at $E(^3\text{He}) = 18$ to 70 MeV (1978BA75) and 198.4 MeV (1980RO03). Polarization measurements have been carried out at $E = 4.3$ to 98 MeV: see (1979AJ01).

For $l \leq 4$, only f-wave phase shifts show resonance structure for $E(^3\text{He}) < 18$ MeV, corresponding to ^{7}Be*(4.57, 6.73, 9.27): see Table 7.7. No structure corresponding to ^{7}Be*(7.21) ($J^\pi = \frac{5}{2}^-$) is seen in the elastic data. The s-wave phase shift is somewhat greater than hard-sphere. The decay of ^{7}Be*(9.27) ($J^\pi = \frac{7}{2}^-$) to ^{6}Li(0) requires f-shell configuration admixture. An estimate of the yield of ground-state protons relative to those corresponding to ^{6}Li*(2.19) yields $\gamma^2(p_0)/\gamma^2(p_1) = (16^{+5}_{-10})$%. A phase-shift analysis (single-level R-matrix) has been carried out for

Table 7.8: ^{7}Be levels from ^{3}He + ^{4}He [a]

E_x (MeV ± keV)	J^π	l_α	LS term	θ^2_α [b]	θ^2_p
4.57 ± 50	$\frac{7}{2}^-$	3	$^2F_{7/2}$	0.70 ± 0.04	
6.73 ± 100	$\frac{5}{2}^-$	3	$^2F_{5/2}$	1.36 ± 0.13	0.000 ± 0.002
7.21 ± 60	$\frac{5}{2}^-$	3	$^4P_{5/2}$	0.010 ± 0.001	0.26 ± 0.02
9.27 ± 100	$\frac{7}{2}^-$	3	$^4D_{7/2}$	0.70 ± 0.26	$0.29^{+0.09}_{-0.18}$ [f]
10.0 [c]	$\frac{3}{2}^-$	1	$(^4P_{3/2})$		
≈ 10.0 [d]	$\frac{1}{2}^-$		$(^4P_{1/2})$		
11.00 ± 50 [e]	$\frac{3}{2}^-$	1	$(^2P_{3/2}, {}^2D_{3/2})$		0.13 ± 0.02 [g]

[a] See also Table 7.10 in (1966LA04). For references see Table 7.7 in (1979AJ01).

[b] $\gamma^2/(\frac{3}{2}\hbar^2/\mu a^2)$. $R = 4.0$ fm.

[c] $\Gamma = 1.8$ MeV.

[d] Broad.

[e] $\Gamma = 0.4 \pm 0.05$ MeV; $T = \frac{3}{2}$.

[f] $\theta^2_{p_1} = 1.8 \pm 0.5$

[g] $\theta^2_{p_2}$.

$E(^3\text{He}) = 18$ to 32 MeV: the p-wave phase shifts indicate a $\frac{1}{2}^-$ state at $E_x \approx 16.7$ MeV ($E_r = 26.4$ MeV), with $\Gamma = 6.5$ MeV (1978LU05). The work of (1978BA75) is consistent with the results of (1978LU05) and, in addition, suggests broad $l = 4$ and 5 states at $E(^3\text{He}) > 30$ MeV [$E_x > 19$ MeV].

The differential cross section for reaction (b) has been determined for $E(^3\text{He}) = 8$ to 28 MeV [see (1979AJ01)] and at $E_\alpha = 22.2$ to 26.5 MeV (1980NE08; p_0). Resonances are observed corresponding to ^{7}Be*(7.21, 9.27) in the p_0 yield, to ^{7}Be*(9.27) in the p_1 yield and to states at $E_x \approx 10$ MeV ($T = \frac{1}{2}$) and 11.0 MeV ($T = \frac{3}{2}$) in the yield of 3.56 MeV γ-rays. The evidence for the latter derives mainly through interference arguments. There is also some evidence for an extremely broad $J^\pi = \frac{1}{2}^-$ structure at $E_x \geq 10$ MeV [see also ^{6}Li(p, p)]: see Table 7.8 and (1974AJ01). See also (1980NE08). See aslo (1981BA1Q), (1978BR1A, 1979KA1G, 1982YA1A) and (1978DU1D, 1978TA1A, 1979KOZV, 1979LE11, 1979WI1B, 1981FI1B, 1981SH07, 1982AZ01, 1982FU01, 1982KA11, 1982LE23, 1983HO1F, 1983SA1G; theor.).

4. ^{4}He(α, n)^{7}Be $\qquad Q_m = -18.9902$

See (1978GL03, 1979AL34), (1979AJ01) and ^{8}Be.

5. ^{6}Li(p, γ)^{7}Be $\qquad Q_m = 5.606$

Gamma transitions are observed to the ground (γ_0) and to the 0.43 MeV (γ_1) states. The yield shows no evidence of resonance for $E_p = 0.2$ to 1.0 MeV and the branching ratio remains approximately constant at $(62 \pm 5)\%$ to the ground state, 38% to ^{7}Be*(0.43), $< 4\%$ to ^{7}Be*(4.57): see (1974AJ01). The total cross section for $E_p = 0.2$ to 1.2 MeV has been obtained by (1979SW02): at $E_p = 0.8$ MeV it is 3.1 ± 0.4 μb, in good agreement with previous values. The branching ratio to ^{7}Be*(0.43) is $(41 \pm 3)\%$ (1979SW02). The weighted mean of this and previous measurements is $(39 \pm 2)\%$ (1979SW02). See also (1980BA34).

6. (a) ^{6}Li(p, p)^{6}Li $E_b = 5.606$

(b) ^{6}Li(p, 2p)^{5}He $Q_m = -4.59$

(c) ^{6}Li(p, pα)^{2}H $Q_m = -1.4753$

Measurements of elastic angular distributions have been reported for $E_p = 0.5$ to 600 MeV: see (1966LA04, 1974AJ01) and ^{6}Li. Two resonances are reported at $E_p = 1.84$ and 5 MeV in the elastic yield [^{7}Be*(7.21, 9.9)]. The parameters of the lower resonance are shown in Table 7.4. The 5 MeV resonance has $\Gamma \approx 1.8$ MeV and appears to also be formed by p-waves: γ_p^2 is then 3 ± 2 MeV $\cdot$ fm. A weak rise near $E_p = 8$ to 9 MeV may indicate a further level, ^{7}Be* ≈ 13 MeV. A broad resonance at $E_p = 14$ MeV has also been suggested. Polarization measurements have been carried out for $E_p = 1.2$ to 155 MeV [see (1974AJ01, 1979AJ01)] and at $E_{\vec{p}} = 25$ and 35 MeV (1982ROZT; 0_0, p$_1$) and 800 MeV (1979GL1C; p$_2$). A phase shift analysis for $E_p = 0.5$ to 5.6 MeV shows that only ^{2}S, ^{4}S and ^{4}P are involved. The ^{4}P$_{5/2}$ phase resonates at $E_p = 1.8$ MeV, and the broad resonance at 5 MeV can be reproduced equally well by either ^{4}P$_{3/2}$ or ^{4}P$_{1/2}$: tensor polarization measurements are necessary to distinguish between the two: see (1974AJ01).

The reaction cross section for formation of ^{6}Li*(2.19) has been measured for $E_p = 3.6$ to 9.40 MeV: a broad resonance indicates the presence of a state with $E_x \approx 10$ MeV, $\Gamma = 1.8$ MeV, $J^\pi = (\frac{3}{2}, \frac{5}{2})^-$, $T = \frac{1}{2}$. The cross section and angular distributions of p$_2$ (^{6}Li*(3.56)) for $E_p = 4.26$ to 9.40 MeV is analyzed in terms of two $J^\pi = \frac{3}{2}^-$ states at $E_x \approx 10$ and 11 MeV: see reaction 3. The total cross section for formation of ^{6}Li*(3.56) decreases slowly with energy for $E_p = 24.3$ to 46.4 MeV. The reaction cross section has been measured for $E_p = 25.0$ to 48 MeV: see (1979AJ01).

For reaction (b) see ^{5}He, (1978NA18; $E_{\vec{p}} = 635$ MeV) and (1979AJ01). For reaction (c) see ^{6}Li and (1979AJ01). Studies of inclusive cross sections are reported at 640 MeV (1981ER07) and 400 GeV (1979BA28, 1979FR12, 1980NI09). For pion and kaon production see (1980NI09; 400 GeV). See also (1982AB1D) and (1981BR21, 1981FR1R, 1981FR1T, 1981KR15, 1982ST15; theor.).

7. ^{6}Li(p, n)^{6}Be $Q_m = -5.070$ $E_b = 5.606$

The yield of neutrons increases approximately monotonically from threshold to $E_p = 14.3$ MeV. Polarization measurements are reported at $E_p = 30$ and 50 MeV: see (1974AJ01). See also ^{6}Be.

8. ^{6}Li(p, α)^{3}He $\quad Q_m = 4.0182 \quad E_b = 5.606$

$Q_0 = 4018.2 \pm 1.1$ keV: see (1981RO02)

Over the range $E_p = 25$ to 50 keV, the cross section rises from 0.8 to 72 μb: in the formula $\sigma \approx E^{-1}\ e^{-B/\sqrt{E}}$, $B = 90 \pm 6$ keV$^{1/2}$. Cross-section measurements for $E_p = 62$ to 188 keV show deviation from an s-wave Gamow plot above ≈ 130 keV (1966GE11). Using cross-section measurements at $E_p = 136 \rightarrow 297$ keV, as well as the (1966GE11) results, (1979EL10) calculate $S(0) = 3.145$ MeV $\cdot$ b [$E_{c.m.} = 1$ keV $\rightarrow 500$ keV]. Thermonuclear reaction rates are also derived (1979EL10). See also (1979SH14; $125 \rightarrow 700$ keV; $S(0) = 3$ MeV $\cdot$ b) and (1979AJ01).

At higher energies the cross section exhibits a broad, low maximum near $E_p = 1$ MeV and a pronounced resonance at $E_p = 1.85$ MeV ($\Gamma < 0.5$ MeV). No other structure is reported up to $E_p = 5.6$ MeV. Measurements between $E_p = 0.4$ and 3.4 MeV show that the polarizations are generally large and positive. The $E_p = 1.9$ MeV resonance appears in A_1 and A_2: see (1974AJ01).

Angular distributions have been reported for $E_p = 0.15$ to 45 MeV [see (1974AJ01, 1979AJ01)] and at $E_p = 125$ to 700 keV (1979SH14), 136 to 297 keV (1979EL10) and 47.8, 53.5, 58.5 and 62.5 MeV (1982BA1V). See also (1979DE1E, 1979HA1C, 1980HA1Y, 1981JA1F; applied), (1981HO1E) and (1978PL1A; theor.).

9. ^{6}Li(d, n)^{7}Be $\quad Q_m = 3.381$

Angular distributions of the n_0 and n_1 groups have been measured at $E_d = 0.20$ to 15.25 MeV: see (1974AJ01, 1979AJ01). The n-γ correlations are isotropic, indicating $J^\pi = \frac{1}{2}^-$ for ^{7}Be*(0.43). Broad maxima are observed in the ratio of low-energy to high-energy neutrons at $E_d = 4.2$ and 5.1 MeV [^{7}Be*(6.5, 7.2), $\Gamma_{c.m.} = 1.2$ and 0.5 MeV, respectively]: see (1966LA04). See also (1979HO04, 1980GU26) in ^{8}Be.

10. ^{6}Li(^{3}He, d)^{7}Be $\quad Q_m = 0.112$

Angular distributions of the d_0 and d_1 groups to ^{7}Be*(0, 0.43) have been measured at $E(^3\text{He}) =$ 8, 10, 14 and 18 MeV: all the distributions show an $l = 1$ maximum at small angles: see (1974AJ01). At $E(^3\vec{\text{He}}) = 33.3$ MeV angular distributions and A_y measurements to ^{7}Be*(0, 0.43) have been analyzed using coupled channels and DWBA. ^{7}Be*(4.57) is also populated (1981BA38).

11. ^{6}Li(α, t)^{7}Be $\quad Q_m = -14.208$

See (1979AJ01).

12. (a) ^{7}Li(γ, π^-)^{7}Be $\quad Q_m = -140.429$
(b) ^{7}Li(π^+, π^0)^{7}Be $\quad Q_m = 3.742$

For reaction (a) see (1979BO23). Forward-angle differential cross sections to ^{7}Be$_{\rm g.s.}$ have been measured at $E_{\pi^+} = 48$ MeV (1982LEZY), and $70 \rightarrow 180$ MeV (1980BA27, 1982DO02). See also (1982AL35).

13. ^{7}Li(p, n)^{7}Be $\quad Q_m = -1.644$

The excitation energy of ^{7}Be*(0.43) is 429.20 ± 0.10 keV, $\tau_m = 192 \pm 25$ fsec: see (1979AJ01). Angular distributions of n_0 and n_1 are reported at $E_p = 1.9$ to 50 MeV [see (1974AJ01, 1979AJ01)] and at 119.8 MeV (1979GO16, 1980GO07; n_{0+1}). The population of ^{7}Be*(4.55, 6.51, 7.19, 10.79) has also been observed: see (1974AJ01, 1979AJ01). The ratios σ_1/σ_0 (^{7}Be*(0.43)/^{7}Be$_{\rm g.s.}$) have been measured at 24.8, 35 and 45 MeV: an analysis of these yields the ratio of spin-flip to spin-nonflip strength $|V_{\sigma\tau}/V_\tau|^2$ (1980AU02). (1983TAZY) report cross-section measurements at $E_p = 60$ to 200 MeV. See also (1981SH1F, 1982KI1F, 1982TAZQ), (1979CH1B, 1980SE1D, 1982SA1M; applied), (1982GO1C, 1982PE06, 1982TA03), (1982GU1D, 1983GU1G; theor.) and ^{8}Be.

14. ^{7}Li(^{3}He, t)^{7}Be $\quad Q_m = -0.881$

Angular distributions of t_0 and t_1 have been measured at $E(^3$He$) = 3.0$ to 4.0 MeV [see (1974AJ01)] and at $E(^3\vec{\rm He}) = 33.3$ MeV (1981BA37). The width of ^{7}Be*(4.57), $\Gamma_{\rm c.m.} = 175 \pm 7$ keV: see (1974AJ01). See also ^{10}B.

15. ^{9}Be(p, t)^{7}Be $\quad Q_m = -12.082$

Angular distributions of tritons have been measured at $E_p = 43.7$ MeV (^{7}Be*(0, 0.43, 4.57, 6.51, 11.01)) and 46 MeV (^{7}Be*($0 + 0.43$, 4.57, 6.51, 10.69)), and at $E_p = 50$ and 72 MeV (1982ZA1B; t_0, t_1). The 11 MeV state has $E_x = 11.01 \pm 0.04$ MeV, $\Gamma = 298 \pm 25$ keV, $J^\pi = \frac{3}{2}^-$, $T = \frac{3}{2}$ [the J^π; T assignments are based on the similarity of the angular distribution to that in the (p, ^{3}He) reaction to ^{7}Li*(11.13)]: see (1979AJ01).

16. ^{9}Be(^{3}He, ^{5}He)^{7}Be $\quad Q_{\rm m} = -0.88$

See reaction 23 in ^{5}He.

17. ^{10}B(p, α)^{7}Be $\quad Q_{\rm m} = 1.146$

Angular distributions have been measured for $E_{\rm p} = 2.8$ to 7.0 MeV: see (1974AJ01). $E_{\rm x} = 428.89 \pm 0.13$ keV (1979RI12). See also ^{11}C in (1980AJ01, 1985AJ01).

18. ^{10}B(d, ^{5}He)^{7}Be $\quad Q_{\rm m} = -1.97$

See (1982DOZT).

19. ^{10}B(^{3}He, ^{6}Li)^{7}Be $\quad Q_{\rm m} = -2.873$

See ^{6}Li.

20. ^{10}B(α, ^{7}Li)^{7}Be $\quad Q_{\rm m} = -16.200$

At $E_{\alpha} = 45.6$ MeV the angular distributions of the ^{7}Li and of the ^{7}Be ions, corresponding to the ground-state transitions, have been measured. At a given angle the intensities of the two ions are the same, implying that the wave functions of the ground states of ^{7}Li and ^{7}Be are very similar: see (1974AJ01).

21. ^{12}C(γ, nα)^{7}Be $\quad Q_{\rm m} = -26.265$

See (1979KI04).

22. ^{12}C(p, ^{6}Li)^{7}Be $\quad Q_{\rm m} = -22.565$

See ^{6}Li.

23. ^{12}C(d, ^{7}Li)^{7}Be $\qquad Q_{\mathrm{m}} = -17.539$

See ^{7}Li.

24. ^{12}C(^{3}He, ^{8}Be)^{7}Be $\qquad Q_{\mathrm{m}} = -5.779$

Angular distributions are reported at $E(^{3}\mathrm{He}) = 25.5$ to 30 MeV involving ^{7}Be*(0, 0.43) [see (1979AJ01)] and at 41 MeV (1981LE01) and ^{15}O in (1981AJ01).

25. ^{12}C(α, ^{9}Be)^{7}Be $\qquad Q_{\mathrm{m}} = -24.691$

At $E_{\alpha} = 42$ MeV, angular distributions have been measured involving ^{7}Be*(0, 0.43) and $^{9}\mathrm{Be}_{\mathrm{g.s.}}$: see (1974AJ01).

26. ^{13}C(p, ^{7}Li)^{7}Be $\qquad Q_{\mathrm{m}} = -20.261$

See ^{7}Li.

27. ^{16}O(^{3}He, ^{12}C)^{7}Be $\qquad Q_{\mathrm{m}} = -5.5744$

Angular distributions are reported at $E(^{3}\mathrm{He}) = 25.5$, 30 and 70 MeV to ^{7}Be*(0, 0.43) and various states of ^{12}C [see ^{12}C in (1980AJ01)] and at 41 MeV (1981LE01).

28. ^{16}O(α, ^{13}C)^{7}Be $\qquad Q_{\mathrm{m}} = -21.2058$

See ^{13}C in (1981AJ01).

29. ^{19}F(d, ^{14}C)^{7}Be $\qquad Q_{\mathrm{m}} = -7.140$

The angular distributions to ^{7}Be*(0, 0.43) + $^{14}\mathrm{C}_{\mathrm{g.s.}}$ has been measured at $E_{\mathrm{d}} = 14.9$ MeV: see (1974AJ01).

30. (a) ^{19}F(^{3}He, ^{15}N)^{7}Be $Q_{\rm m} = -2.426$

(b) ^{20}Ne(^{3}He, ^{16}O)^{7}Be $Q_{\rm m} = -3.146$

See ^{15}N in (1981AJ01) and ^{16}O in (1982AJ01).

^{7}B
(Fig. 10)

GENERAL: (See also (1979AJ01).)

See (1979BE1H, 1982NG01).

Mass of ^{7}B: This nucleus has been studied in the ^{7}Li(π^{+}, π^{-})^{7}B and ^{10}B(^{3}He, ^{6}He)^{7}B reactions. In the (π^{+}, π^{-}) work (1981SEZR; preliminary) find the mass excess to be 27.80 ± 0.10 MeV and Γ for the ground state is 1.2 ± 0.2 MeV. In the earlier (^{3}He, ^{6}He) work [see (1974AJ01)] $M - A$ was reported to be 27.94 ± 0.10 MeV, $\Gamma = 1.4 \pm 0.2$ MeV. We adopt 27.87 ± 0.10 MeV, $\Gamma = 1.3 \pm 0.2$ MeV. The isobaric quartet mass law would predict $M - A = 27.76 \pm 0.17$ MeV. ^{7}B is unbound with respect to ^{6}Be + p ($Q = 2.21$), ^{5}Li + 2p ($Q = 1.61$), ^{4}He + 3p ($Q = 3.58$). The expected single-particle width is $\Gamma = 0.64$ MeV: it is suggested that the two-proton and three-proton decays make an appreciable contribution to the width: see (1974AJ01).

^{7}C
(Not illustrated)

Not observed: see (1982NG01; theor.).

References

(Closed 1 June 1983)

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.

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