$^{11}B(p,\gamma)$:res 1964Al20,1965Se05,1977Ad02

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	J. H. Kelley, J. E. Purcell and C. G. Sheu	NP A968,71 (2017)	1-Jan-2017

1964Al20: $^{11}B(p,\gamma)$ E_p=4-14 MeV, measured $\sigma(E,\theta)$, E_γ.
1965Se06: $^{11}B(p,\gamma)$ E_p=0.5-4.0 MeV, ^{12}C deduced levels, nuclear properties.
1969Ke02: $^{11}B(p,\gamma)$ E=13-21 MeV, measured $\sigma(E,E_\gamma,\theta)$.
1972Br26: $^{11}B(p,\gamma)$ E=14-22 MeV, measured $\sigma(E,E_\gamma,\theta(\gamma))$. ^{12}C deduced giant resonance structure, isospin mixing.
1972Gl01: ^{11}B(pol. p,γ) E=6-14 MeV, measured analyzing power(E,θ). ^{12}C deduced giant E1 resonance configurations.
1972Su08: $^{11}B(p,\gamma)$ E<3 MeV, measured $\sigma(E,E_\gamma,\theta(\gamma\text{-}\gamma))$. ^{12}C deduced resonance, level-width, J, π.
1974An19: $^{11}B(p,\gamma)$ E=163 keV, measured σ. ^{12}C levels deduced p-width, γ-width, S.
1976Ad03: $^{11}B(p,\gamma)$, measured resonance γ. ^{12}C levels deduced γ-branching.
1977Ad02: $^{11}B(p,\gamma)$ E=163 keV, measured $\sigma(E_\gamma)$. ^{12}C resonances deduced Γ-γ, isospin mixing.
1977Fr20: $^{11}B(p,\gamma)$ E=resonance, measured yields. ^{12}C deduced resonances.
1977Sn01: $^{11}B(p,\gamma)$ E=6-23 MeV, measured $\sigma(90°)$ for transitions to the 0^+_1,2^+,0^+_2, 3^- levels in ^{12}C.
1979Ko05: $^{11}B(p,\gamma)$ E=40,60,80 MeV, measured E_γ, I_γ. ^{12}C deduced evidence for second-harmonic giant resonances.
1980Co16: $^{11}B(p,\gamma)$ E=20-40 MeV, measured $\sigma(\theta)$.
1982Co11: $^{11}B(p,\gamma)$ E=5-14 MeV, measured E_γ, absolute $\sigma(\theta=90°,E_\gamma)$. Deduced total σ.
1982Ha12: $^{11}B(p,\gamma)$ E=0.82-2.83 MeV, measured $\sigma(\theta)$ vs E, $\gamma(\theta)$. ^{12}C levels deduced J, π, transition strengths, Γ_γ.
1982We08: $^{11}B(p,\gamma)$ E=23-60 MeV, measured σ(E). ^{11}B(pol. p,γ) E=28.7 MeV, measured $\sigma(\theta)$, A(θ). ^{12}C deduced possible giant resonances.
1982Wr01: $^{11}B(p,\gamma)$ E=2.9-4.6 MeV, measured E_γ, I_γ, $\sigma(\theta)$ vs E. ^{12}C transition deduced M1 quenching.
1983An09: $^{11}B(p,\gamma)$ E=18-43 MeV, measured $\sigma(\theta)$. ^{12}C deduced resonances, J, π, interference effects, giant resonance characteristics.
1983An16: $^{11}B(p,\gamma)$ E=10-90 MeV, measured $\sigma(\theta)$. Deduced E1, E2 interference effects. ^{12}C deduced resonances, configurations.
1984Bl10: $^{11}B(p,\gamma)$,(pol. p,γ) E=24-80 MeV, measured $\sigma(\theta)$, analyzing power vs θ. Deduced reaction mechanism.
1984Ce08,1984Ce03,1985Ce07: $^{11}B(p,\gamma)$ E=163 keV, measured E_γ, I_γ, $\Gamma_\gamma/\Gamma_\alpha$ branching ratio.
1985No01: ^{11}B(pol. p,γ) E=50 MeV, measured $\sigma(\theta)$, A(θ). Deduced final state configuration role.
1987Ra23: $^{11}B(p,\gamma)$ E=7-9 MeV, measured absolute thick target γ yield, relative neutron yield.
1988Ha04,1985Ha05: ^{11}B(pol. p,γ) E=20-100 MeV, measured E_γ, I_γ, $\sigma(\theta)$, analyzing power vs θ. ^{12}C deduced GDR, parameters, EWSR.
1992Ce02: $^{11}B(p,\gamma)$ E=40-180 keV, measured capture E_γ, I_γ, $\gamma(\theta)$. Deduced astrophysical S-factor. ^{12}C levels deduced γ-ray to charged particle branching ratio.
1992Ho04: $^{11}B(p,\gamma)$ E=98 MeV, measured $\sigma(\theta)$, radiative capture.
1993An06: $^{11}B(p,\gamma)$ E=140-260 keV, measured thick target yield. Deduced absolute astrophysical S-factor vs E, electron screening.
1993Ho07,1997Tr01: $^{11}B(p,\gamma)$,(p,e^+e^-) E=98 MeV, measured $\sigma(\theta,E_\gamma)$, $\sigma(\theta)$, pair production energy spectra, invariant mass distribution. Deduced reaction mechanism.
1996Br20: $^{11}B(p,\gamma)$ E=98,176 MeV, measured $\sigma(\theta)$. Deduced reaction mechanism.
2000Ke10: ^{11}B(pol. p,γ) E<100 keV, measured E_γ, I_γ, σ, $A_y(\theta=90°)$. Deduced astrophysical S-factor, influence of low-lying resonances.
2004Ch06: $^{11}B(p,\gamma)$ E=7.2, 17-24 MeV, measured E_γ, I_γ, σ. Deduced GDR contribution. ^{12}C deduced GDR energy, width.
2008Ch13: $^{11}B(p,\gamma)$ E=7-24.5 MeV, measured E_γ, I_γ, capture cross sections. ^{12}C deduced resonances.
2016He05: XUNDL dataset compiled by TUNL, 2016.
Beams of 160 to 310 keV protons, from the Lanzhou Institute of Modern Physics 320-kV platform, impinged on a 6.3 $\mu g/cm^2$ natural boron target (80% ^{11}B). The capture γ-rays were detected in a 4×4 HPGe clover detector (200% efficiency relative to a 3 inch×3 inch NaI detector). Events were analyzed in singles mode to minimize complications from cascade summing. The detector efficiencies were determined using standard calibration sources and γ rays populated in the $^{14}N(p,\gamma)$ reaction. The present results determined $E_{c.m.}$(res)=150.0 keV *5* and $\Gamma_{c.m.}$=5.0 keV *8* for ^{12}C*(16.1 MeV). In addition, in the region of $E_{c.m.}$=170 to 240 keV the authors find a ≈15-50% enhanced cross section when compared with previous results.
2016La27: A beam of E≈163 keV protons, from the Aarhus Van de Graaff accelerator, impinged on natural boron targets with thicknesses near 10-15 $\mu g/cm^2$ that were placed with a steep angle with respect the incident beam. A set of two 5 cm×5 cm double-sided Si strip detectors were positioned 2.5 cm from the target on the horizontal axis and covered θ_1=60° to 150° and θ_2=−35° to −120°; particles emitted roughly perpendicular to the incident beam were detected.

^{11}B(p,γ):res 1964Al20,1965Se05,1977Ad02 (continued)

The events with three α particles detected in the final state are analyzed to obtain the ^{12}C excitation energy. While the 3α reconstructed energy spectrum is expected to be dominated by the α_0 (5%) and α_1 (90%) decays to ^{8}Be, additional peaks appear in the spectrum; these peaks correspond to the sequential process of γ decay to lower ^{12}C states followed by α emission. Peaks corresponding to α decay from ^{12}C*(9641,10847,12710) are observed along with unresolved strength to other states with E_x=9.8 to 10.25 MeV and E_x=11.5 to 13.0 MeV. The branching ratios for γ decay to α particle unbound levels are first deduced, then the partial widths are deduced using Γ=5.3 keV *2*.

^{12}C Levels

E(level)	J$^\pi$	T$_{1/2}$	Comments
0			
4440			
7654			
9641			
10847			
12710			
15110			
16106.9 *6*	2$^+$	5.0 keV *8*	T=1; $\Gamma_{\gamma0}/\Gamma_{\gamma1}$=0.046 *7*; $\Gamma_{\gamma1}/\Gamma_{\gamma}$=2.42×10^{-3} *29* $\Gamma_{\gamma0}$=0.59 eV *11*; Γ_p=21.5 eV *33*; $\Gamma_{\gamma1}$=12.8 eV *18* (1977Ad02) E(level): Deduced using E_{res}=150.0 keV *5* and S_p=15956.85 keV *42*; see (2016He05). For adopted E: from E_{res}(c.m.)=149.1 keV *7*. This is the weighted average (Limitation of Statistical Weights Method) of the values 16106.9 keV *6* (2016He05) from (p,γ) and 16105.2 keV *4* (1987Be17) and 16106.7 keV *4* (1979Da03) from (p,α). The adopted value is E_x=16106.0 keV *8*.
16576	2$^-$	300 keV	T=1; $\Gamma_{\gamma0}$=48×10^{-3} eV *8*; $\Gamma_{\alpha0}$<0.27 keV; Γ_p=150 keV $\Gamma_{\gamma1}$=8.0 eV; $\Gamma_{\alpha1}$=150 keV (1965Se06)
17230	1$^-$	1150 keV	T=1; $\Gamma_{\gamma0}$=44 eV; $\Gamma_{\alpha0}$=10 keV; Γ_p=1 MeV $\Gamma_{\gamma1}$=5. eV; $\Gamma_{\alpha1}$=140 keV (1965Se06)
17.76×10^3	0$^+$	96 keV *5*	T=1; $\Gamma_{\alpha0}$=4.6 keV; Γ_p=76 keV $\Gamma_{\alpha1}$=11.4 keV (1965Se06)
18.13×10^3	(1$^+$)	0.60 MeV *10*	T=0
18.38×10^3	3$^-$	≈400 keV	T=1; $\Gamma_{\gamma0}$≈2×10^{-3} eV; $\Gamma_{\alpha0}$=65 keV; Γ_p=68 keV $\Gamma_{\gamma1}$=3.2 eV; $\Gamma_{\alpha1}$=177 keV (1965Se06)
18.39×10^3	0$^-$	43 keV	$\Gamma_{\gamma0}$<0.5 eV; $\Gamma_{\alpha0}$<1 keV; Γ_p=33 keV $\Gamma_{\gamma1}$<0.5 eV; $\Gamma_{\alpha1}$<5 keV (1965Se06)
18.81×10^3	2$^+$	100 keV	T=1; $\Gamma_{\gamma0}$=0.4 eV; $\Gamma_{\alpha0}$<0.2 keV; Γ_p=97 keV $\Gamma_{\gamma1}$=2.0 eV; $\Gamma_{\alpha1}$<1.5 keV (1965Se06)
19.2×10^3	(1$^-$)	1100 keV	T=1; $\Gamma_{\gamma0}$=25 eV; $\Gamma_{\alpha0}$=50 keV; Γ_p=300 keV $\Gamma_{\gamma1}$=10. eV; $\Gamma_{\alpha1}$=200 keV (1965Se06)
19.39×10^3	(2$^+$)	1100 keV	T=0; $\Gamma_{\gamma0}$<3 eV; $\Gamma_{\alpha0}$=20 keV; Γ_p=450 keV $\Gamma_{\gamma1}$=3. eV; $\Gamma_{\alpha1}$=450 keV (1965Se06) E(level),J$^\pi$: From (1955Ba22,1963Sy01).
20.47×10^3		180 keV	E(level): From (1955Ba22,1963Sy01).
20.64×10^3	(3$^-$)	275 keV	T=1 E(level),J$^\pi$: From (1955Ba22,1963Sy01).
21.5×10^3			E(level): From (1964Al20).
22.1×10^3		500 keV	E(level): From (1964Al20).
22.6×10^3	(1$^-$)	3200 keV	T=1; $\Gamma_{\gamma0}$>2500 keV E(level),J$^\pi$: From (1964Al20).
23.6×10^3			E(level): From (1964Al20).
24.41×10^3		1.3 MeV *3*	E(level): From (2008Ch13). (2J+1)$\Gamma_{p0}\Gamma_g/\Gamma$=20.8 *28*.
25.4×10^3		≈6500 keV	E(level): From (1964Al20).
26.72×10^3	(1$^-$)		E(level),J$^\pi$: From (1964Al20,1967Fe04).

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$^{11}B(p,\gamma)$:res 1964Al20,1965Se05,1977Ad02 (continued)

^{12}C Levels (continued)

E(level)	$T_{1/2}$	Comments
27.4×10^3	≈700 keV	E(level): From (1967Fe04).
27.94×10^3		E(level),J^π: From (1964Al20,1967Fe04).
28.6×10^3	≈2500 keV	E(level): From (1967Fe04).
28.81×10^3	2.0 MeV *2*	E(level): From (2008Ch13).
29.0×10^3		E(level): From (1967Fe04).
29.5×10^3		E(level): From (1969Ke02). $T_{1/2}$: Broad.

$\gamma(^{12}C)$

E_γ	I_γ	E_i(level)	J_i^π	E_f	Mult.	Comments
3020	100	18.13×10^3	(1^+)	15110		I_γ: From (1972Su08) (2J+1)$\Gamma\gamma(\rightarrow15110)\geq2.8$ eV *6*.
3396	1.46 *25*	16106.9	2^+	12710		
4438	100	4440		0	E2	
5050	100	17.76×10^3	0^+	12710		I_γ: From (1965Se06), $\Gamma\gamma(\rightarrow12710)=3.7$ eV *15*.
5259		16106.9	2^+	10847	E1	B(E1)=$(3.2\pm0.3(stat)\pm0.7(syst))\times10^{-5}$. $\Gamma\gamma=0.48\pm0.04(stat)\pm0.11(syst)$ eV (2016La27).
6465	2.4 *4*	16106.9	2^+	9641		
8739	100	18.38×10^3	3^-	9641		I_γ: From (1965Se06).
9.31×10^3		24.41×10^3		15110		
11662	100	16106.9	2^+	4440	M1	I_γ: From (1977Ad02).
12129	100	16576	2^-	4440		I_γ: From (1965Se06).
12782	11	17230	1^-	4440		
13.7×10^3		28.81×10^3		15110		
13942	56	18.38×10^3	3^-	4440		
14372	100	18.81×10^3	2^+	4440		I_γ: From (1965Se06).
14.76×10^3	40	19.2×10^3	(1^-)	4440		
14950	100	19.39×10^3	(2^+)	4440		I_γ: From (1965Se06).
16094	4.6 *7*	16106.9	2^+	0	E2	
16564	0.6 *1*	16576	2^-	0		
17217	100	17230	1^-	0		I_γ: From (1965Se06).
17.7×10^3		22.1×10^3		4440		
18380	3.5×10^{-4}	18.38×10^3	3^-	0		
18810	<20	18.81×10^3	2^+	0		
19.07×10^3		26.72×10^3	(1^-)	7654		
19.2×10^3	100	19.2×10^3	(1^-)	0		I_γ: From (1965Se06).
19.2×10^3		23.6×10^3		4440		
20.47×10^3		20.47×10^3		0		
20.64×10^3		20.64×10^3	(3^-)	0		
21.0×10^3		25.4×10^3		4440		
21.5×10^3		21.5×10^3		0		
22.1×10^3		22.1×10^3		0		
22.28×10^3		26.72×10^3	(1^-)	4440		
22.6×10^3		22.6×10^3	(1^-)	0		
23.5×10^3		27.94×10^3		4440		
23.6×10^3		23.6×10^3		0		
24.1×10^3		28.6×10^3		4440		
25.4×10^3		25.4×10^3		0		
27.4×10^3		27.4×10^3		0		
27.94×10^3		27.94×10^3		0		

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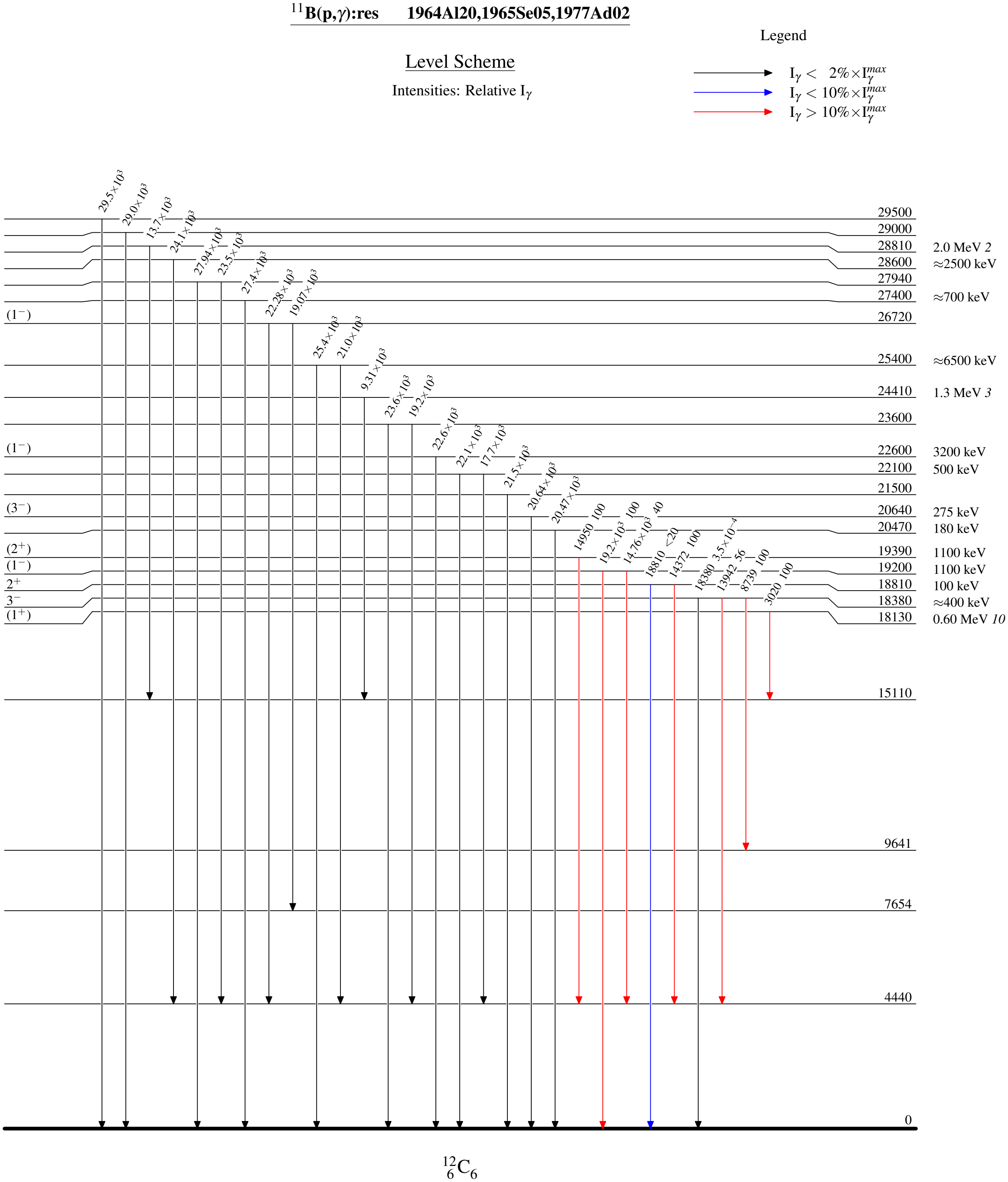
$^{11}B(p,\gamma)$:res 1964Al20,1965Se05,1977Ad02 (continued)

$\gamma(^{12}C)$ (continued)

E_γ	E_i(level)	E_f
29.0×10^3	29.0×10^3	0
29.5×10^3	29.5×10^3	0



11B(p,γ):res 1964Al20,1965Se05,1977Ad02
Level Scheme
Intensities: Relative Iγ
Legend
Iγ < 2%×Iγmax
Iγ < 10%×Iγmax
Iγ > 10%×Iγmax
29500
29000
28810 2.0 MeV 2
28600 ≈2500 keV
27940
27400 ≈700 keV
(1−) 26720
25400 ≈6500 keV
24410 1.3 MeV 3
23600
(1−) 22600 3200 keV
22100 500 keV
21500
(3−) 20640 275 keV
20470 180 keV
(2+) 19390 1100 keV
(1−) 19200 1100 keV
2+ 18810 100 keV
3− 18380 ≈400 keV
(1+) 18130 0.60 MeV 10
15110
9641
7654
4440
0
29.5×10³
29.0×10³
13.7×10³
24.1×10³
27.94×10³
23.5×10³
27.4×10³
22.28×10³
19.07×10³
25.4×10³
21.0×10³
9.31×10³
23.6×10³
19.2×10³
22.6×10³
22.1×10³
17.7×10³
21.5×10³
20.64×10³
20.47×10³
14950 100
19.2×10³ 100
14.76×10³ 40
18810 <20
14372 100
18380 3.5×10⁻⁴
13942 56
8739 100
3020 100
$^{12}_{6}C_{6}$

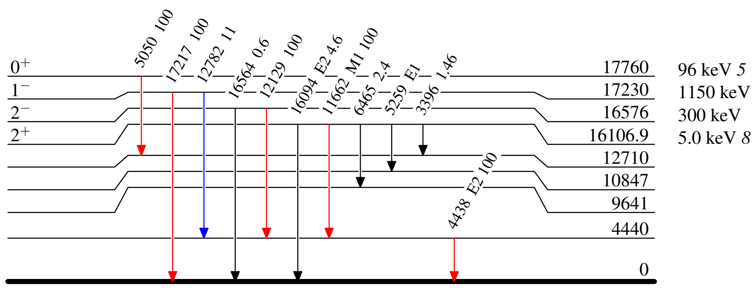
$^{11}B(p,\gamma)$:res 1964Al20,1965Se05,1977Ad02

Level Scheme (continued)

Intensities: Relative I_γ

Legend

- $I_\gamma < 2\% \times I_\gamma^{max}$
- $I_\gamma < 10\% \times I_\gamma^{max}$
- $I_\gamma > 10\% \times I_\gamma^{max}$



$^{12}_{6}C_{6}$