

$^{12}\text{C}(\text{p},\text{p}')$ 1977Bu19,1969Su03,1974Jo14

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

1964Bo18: $^{12}\text{C}(\text{p},\text{p})$ $E_p=4.5$ MeV, measured $\text{pol}(\theta)$.
 1964Dr04: $^{12}\text{C}(\text{p},\text{p})$ $E_p=4.5\text{-}5.2$ MeV, measured asymmetry. Deduced polarizations.
 1965Mo15: $^{12}\text{C}(\text{p},\text{p})$ $E=4.7\text{-}11.3$ MeV, measured polarization (E,θ) , $\sigma(E,\theta)$. Deduced phase shifts.
 1966Ba35,1966Sw04,1967Cl04: $^{12}\text{C}(\text{p},\text{p}),(\text{p},\text{p}')$ $E=2.4\text{-}11.6$ MeV, measured polarization, $\sigma(E,\theta)$.
 1966Cr04: $^{12}\text{C}(\text{pol. p},\text{p}),(\text{pol. p},\text{p}')$ $E=20\text{-}28$ MeV, measured polarization (E,θ) .
 1967Fa06: $^{12}\text{C}(\text{p},\text{p}),(\text{p},\text{p}')$ $E=49.5$ MeV, measured $\sigma(\theta)$.
 1967Pa25: $^{12}\text{C}(\text{p},\text{p})$ $E=1$ GeV, measured $\sigma(\theta)$.
 1967Tr08: $^{12}\text{C}(\text{p},\text{p})$ $E=1.5\text{-}3$ MeV, measured polarization $P(E,\theta)$. Deduced phase shifts.
 1968An25: $^{12}\text{C}(\text{p},\text{p}),(\text{p},\text{p}')$ $E=6$ MeV, measured $\sigma(E_p',\theta_p')$.
 1968An27: $^{12}\text{C}(\text{p},\text{p})$ $E\approx 6$ MeV, measured $\sigma(E_p',\theta)$.
 1968Be31: $^{12}\text{C}(\text{p},\text{p})$ $E=5.38,5.88,9.13$ MeV, measured $\sigma(E,\theta)$, $P(\theta)$.
 1968SI01: $^{12}\text{C}(\text{pol. p},\text{p})$ $E=1\text{-}3$ MeV, measured $P(E,\theta)$.
 1969Fa04: $^{12}\text{C}(\text{p},\text{p}),(\text{p},\text{p}')$ $E=11\text{-}22.7$ MeV, measured polarization $P(E,\theta)$.
 1969Fu07: $^{12}\text{C}(\text{p},\text{p})$ $E=61.4$ MeV, measured $\sigma(\theta)$. Deduced optical model parameters.
 1969Gu02: $^{12}\text{C}(\text{p},\text{p})$ $E=7$ MeV, measured $\sigma(E_p,\theta)$, $P(\theta)$. Deduced optical parameters.
 1969Ko07: $^{12}\text{C}(\text{p},\text{p}),(\text{p},\text{p}')$ $E=9\text{-}20$ MeV, measured $\sigma(E,E_p',\theta)$. Deduced spin-flip probability(θ).
 1969Le18: $^{12}\text{C}(\text{p},\text{p}),(\text{p},\text{p}')$ $E=9\text{-}21$ MeV, measured $\sigma(E)$.
 1969Su03: $^{12}\text{C}(\text{p},\text{p}')$ $E=185$ MeV; measured $\sigma(E_p',\theta)$. ^{12}C deduced levels, L.
 1970BI03: $^{12}\text{C}(\text{pol. p},\text{p}),(\text{pol. p},\text{p}')$ $E=20.3$ MeV, measured asymmetry, $\sigma(\theta)$.
 1970Gi04: $^{12}\text{C}(\text{p},\text{p})$ $E=20\text{-}30$ MeV, measured $\sigma(E,\theta)$.
 1970Ko15: $^{12}\text{C}(\text{p},\text{p}),(\text{p},\text{p}')$ $E=12\text{-}14$ MeV, measured $\sigma(E,\theta)$, spin-flip probability(θ).
 1970Ts03: $^{12}\text{C}(\text{p},\text{p})$ $E=41\text{-}50$ MeV, measured polarization analyzing power(E).
 1971KI03: $^{12}\text{C}(\text{p},\text{p})$ $E=1\text{-}3.5$ MeV, measured $P(E,\theta)$.
 1972Ba14: $^{12}\text{C}(\text{p},\text{p})$ $E=14.2$ MeV, measured $\sigma(E)$, $\theta(\text{lab})=165^\circ$.
 1972Dz05: $^{12}\text{C}(\text{p},\text{p})$ $E\approx 14.23$ MeV, measured $\sigma(E)$.
 1972Gr02: $^{12}\text{C}(\text{pol. p},\text{p}),(\text{pol. p},\text{p}')$, measured $\sigma(\theta)$, $P(\theta)$, analyzing power(θ). Deduced effective interactions.
 1972Ja07: $^{12}\text{C}(\text{p},\text{p})$ $E=144$ MeV, measured $\sigma(\theta)$. Deduced scattering amplitudes, optical model parameters.
 1972Vo20: $^{12}\text{C}(\text{p},\text{p})$ $E=1000$ MeV, measured polarization(θ).
 1972Wi24: $^{12}\text{C}(\text{p},\text{p})$ $E=46$ MeV, measured $\sigma(\theta)$. Deduced optical model parameters.
 1972Wi26: $^{12}\text{C}(\text{p},\text{p})$ $E=9.95\text{-}10.90$ MeV, measured $\sigma(E,\theta)$, $P(E,\theta)$. Deduced phase shifts.
 1973An07: $^{12}\text{C}(\text{p},\text{p})$ $E=1.5\text{-}3$ MeV, analyzed $\sigma(E,\theta)$ data. Deduced phase shifts.
 1973Be29: $^{12}\text{C}(\text{p},\text{p}),(\text{p},\text{p}')$ $E=1.04$ GeV, measured $\sigma(E_p',\theta)$.
 1973Be37: $^{12}\text{C}(\text{p},\text{p})$ $E=7\text{-}8$ MeV, measured $\sigma(E)$.
 1973Hu07: $^{12}\text{C}(\text{p},\text{p})$, measured $\sigma(E)$.
 1973Me03: $^{12}\text{C}(\text{pol. p},\text{p}),(\text{pol. p},\text{p}')$ $E=9.5\text{-}11.5$ MeV, measured $\sigma(E,\theta)$, vector analyzing power $A(E,\theta)$.
 1974Ae01: $^{12}\text{C}(\text{p},\text{p})$ $E=399\text{-}576$ MeV, measured $A(\theta)$.
 1974Al31: $^{12}\text{C}(\text{p},\text{p}),(\text{pol. p},\text{p})$ $E=4.6\text{-}6$ MeV, measured $\sigma(E,\theta)$, analyzing power $A(E,\theta)$.
 1974Co09: $^{12}\text{C}(\text{p},\text{p})$ $E=156$ MeV, measured $\sigma(\theta)$. Deduced optical model parameters.
 1974Fe08: $^{12}\text{C}(\text{p},\text{p}),(\text{p},\text{p}')$ $E=24$ MeV, measured $\sigma(E_p',\theta)$.
 1974Gu04: $^{12}\text{C}(\text{p},\text{p})$ $E=5.8\text{-}6.3$ MeV, measured $P(E)$.
 1974Ja25: $^{12}\text{C}(\text{p},\text{p})$ $E=10\text{-}20$ MeV, measured $\sigma(\theta)$.
 1974Jo14: $^{12}\text{C}(\text{p},\text{p})$, measured Q values.
 1974Jo15: $^{12}\text{C}(\text{p},\text{p})$, measured $\sigma(E)$. ^{12}C deduced level.
 1974Lo19: $^{12}\text{C}(\text{p},\text{p})$ $E=4.8$ MeV, measured $\sigma(E,E_p)$. ^{12}C deduced resonance.
 1974Ro42: $^{12}\text{C}(\text{pol. p},\text{p})$ $E=6.2$ MeV, measured $A(\theta)$.
 1975Cr06: $^{12}\text{C}(\text{p},\text{p})$ $E=1770,1900$ keV, measured $\sigma(E_\gamma)$.
 1975De26: $^{12}\text{C}(\text{p},\text{p}),(\text{p},\text{p}')$ $E=6$ MeV, measured $\sigma(E_p',\theta)$.
 1975Go03: $^{12}\text{C}(\text{p},\text{p})$ $E=14.22\text{-}14.24$ MeV, measured $\sigma(E)$.

$^{12}\text{C}(\text{p},\text{p}')$ 1977Bu19,1969Su03,1974Jo14 (continued)

- 1975Hi07: $^{12}\text{C}(\text{p},\text{p}),(\text{p},\text{p}')$ E=14.222-14.242 MeV, measured $\sigma(E,\theta)$.
- 1976Cu08: $^{12}\text{C}(\text{p},\text{p})$ E=1.5-4.0 MeV, measured $\sigma(E,\theta)$.
- 1976Ma55: $^{12}\text{C}(\text{p},\text{p})$ E=1.765,1.795,1.895 MeV, measured bremsstrahlung spectrum. Deduced nuclear time delays.
- 1976Me18: $^{12}\text{C}(\text{pol. p},\text{p})$ E=11.5-18.1 MeV, measured $\sigma(E,\theta)$, $A(E,\theta)$.
- 1976Me22: $^{12}\text{C}(\text{p},\text{p})$ E=0.3-2.0 MeV, measured absolute $\sigma(E,\theta)$.
- 1976WuZZ: $^{12}\text{C}(\text{p},\text{p})$, measured $\sigma(\theta)$. $^{12}\text{C}(\text{pol. p},\text{p})$, measured $A(\theta)$.
- 1977Al25: $^{12}\text{C}(\text{p},\text{p})$ E=1 GeV, measured polarization $P(\theta)$.
- 1977Bl09: $^{12}\text{C}(\text{p},\text{p})$ E=0.8 GeV, measured $\sigma(\theta)$.
- 1977Bu19: $^{12}\text{C}(\text{p},\text{p}')$, E=45,155 MeV, measured $\sigma(\theta)$. ^{12}C deduced levels, J, π , L, t, λ , $\beta_L R$, strengths.
- 1978Cu04: $^{12}\text{C}(\text{p},\text{p})$ E=49.48 MeV, analyzed data. $^{12}\text{C}(\text{p},\text{p})$ E=3.0 MeV, measured $\sigma(\theta)$.
- 1978Fr12: $^{12}\text{C}(\text{pol. p},\text{p})$ E=800 MeV, measured $A(\theta)$.
- 1978Ho05: $^{12}\text{C}(\text{pol. p},\text{p})$ E=0.8 GeV, measured $A(\theta)$, $\sigma(\theta)$.
- 1978Ra17: $^{12}\text{C}(\text{pol. p},\text{p})$ E=800 MeV, analyzed $\sigma(\theta)$, $A(\theta)$. ^{12}C deduced neutron densities, rms radii.
- 1979Al26: $^{12}\text{C}(\text{p},\text{p})$ E=1 GeV, measured $\sigma(\theta)$. Deduced nuclear density parameters, quadrupole effects.
- 1979Be44: $^{12}\text{C}(\text{pol. p},\text{p})$ E=300-560 MeV, measured $A(\theta)$.
- 1979Bo03: $^{12}\text{C}(\text{p},\text{p})$ E=3-61.4 MeV, measured $\sigma(\theta)$. Deduced α -structure in target.
- 1979Ga13: $^{12}\text{C}(\text{p},\text{p})$ E=19.15-23.34 MeV, measured $\sigma(E,\theta)$, $A(E,\theta)$.
- 1979Kr18: $^{12}\text{C}(\text{pol. p},\text{p})$ E=450-600 keV, measured $A(\theta)$. R-matrix analysis.
- 1979Pr04: $^{12}\text{C}(\text{p},\text{p}),(\text{p},\text{p}')$ E=6.9 MeV, measured $\sigma(\theta)$, spin flip probability. Deduced reaction mechanism.
- 1980Al09: $^{12}\text{C}(\text{p},\text{p})$ E=1 GeV, measured $P(\theta)$. Deduced spin-orbit amplitude parameters.
- 1980Co05: $^{12}\text{C}(\text{p},\text{p}),(\text{p},\text{p}')$ E=122 MeV, measured $\sigma(E_p,\theta)$. ^{12}C level deduced β_2 . DWIA analysis.
- 1980Fa07: $^{12}\text{C}(\text{p},\text{p}),(\text{p},\text{p}')$ E=35.2 MeV, measured $\sigma(\theta)$. Deduced optical-model parameters. ^{12}C level deduced β_2 .
- 1980Ka02: $^{12}\text{C}(\text{p},\text{p})$ E=40-75 MeV, measured $\sigma(\theta)$, $P(\theta)$.
- 1980Th05: $^{12}\text{C}(\text{pol. p},\text{p})$ E=14.226-14.236 MeV, measured $\sigma(E,\theta)$, analyzing power vs E,θ .
- 1981Me02: $^{12}\text{C}(\text{pol. p},\text{p})$ E=200 MeV, measured $\sigma(\theta)$, analyzing power vs θ . ^{12}C deduced optical potential parameters.
- 1981Me11: $^{12}\text{C}(\text{p},\text{p})$ E=200 MeV, measured $\sigma(\theta)$.
- 1982Al18: $^{12}\text{C}(\text{p},\text{p})$ E=1 GeV, measured $P(\theta)$. Deduced neutron, matter densities, nuclear density parameters.
- 1982PeZV: $^{12}\text{C}(\text{p},\text{p})$ E=401 keV, analyzed $\sigma(\theta)$. ^{12}C deduced resonance, reduced Γ .
- 1982Ta11: $^{12}\text{C}(\text{p},\text{p}_0)$ E=1.5-1.9 MeV, measured $\sigma(E)$. $^{12}\text{C}(\text{p},\text{p}')$ E=1.7,1.765,1.795,1.835 MeV, measured $\sigma(E_{p'})$, $\sigma(E_\gamma,\theta_\gamma,\theta_{p'})$, bremsstrahlung photons. Deduced incident, exit channel phase difference, time delay.
- 1982VoZZ: $^{12}\text{C}(\text{p},\text{p})$ E=122,160,200 MeV, analyzed data. Deduced meson effects.
- 1983Ba57: $^{12}\text{C}(\text{p},\text{p}'),(\text{p},\text{p})$ E=135 MeV, measured $\sigma(\theta)$. DWBA analyses.
- 1983Ch26: $^{12}\text{C}(\text{p},\text{p})$ E=1.04 GeV, analyzed $\sigma(\theta)$. Deduced neutron distribution sensitivity.
- 1983De36: $^{12}\text{C}(\text{p},\text{p}),(\text{p},\text{p}')$ E=29.95,35.2,39.9 MeV, measured $\sigma(\theta)$, $\sigma(E_{p'})$. ^{12}C levels deduced β_2 , β_4 , $B(\lambda)$, deformation lengths, monopole form factor.
- 1983Gr14: $^{12}\text{C}(\text{p},\text{p})$ E=48.5 MeV, measured $\sigma(\theta)$. Deduced singlet, triplet scattering lengths.
- 1983Ha54: $^{12}\text{C}(\text{pol. p},\text{p})$ E=65 MeV, measured polarization.
- 1983Me02: $^{12}\text{C}(\text{pol. p},\text{p})$ E=122,160 MeV, measured $\sigma(\theta)$, $A(\theta)$. Deduced optical potential parameters.
- 1983Na11: $^{12}\text{C}(\text{pol. p},\text{p})$ E=65 MeV, measured depolarization parameters vs θ .
- 1983Ta12: $^{12}\text{C}(\text{pol. p},\text{p}),(\text{pol. p},\text{p}')$ E=159.4 MeV, measured $\sigma(\theta)$, analyzing power vs θ . DWBA, DWIA analyses.
- 1984Ph02: $^{12}\text{C}(\text{pol. p},\text{p})$ E=800 MeV, measured $\sigma(\theta)$, analyzing power vs θ . Deduced optical model parameters.
- 1985Al16: $^{12}\text{C}(\text{p},\text{p})$ E=1 GeV, measured $\sigma(\theta)$. Deduced model parameters, rms matter radii.
- 1985Bl22: $^{12}\text{C}(\text{p},\text{p}),(\text{pol. p},\text{p})$ E=0.8 GeV, measured $\sigma(\theta)$, analyzing power vs θ . Deduced optical potential parameters.
- 1985Me07: $^{12}\text{C}(\text{p},\text{p})$ E=300 MeV, measured $\sigma(\theta)$. Deduced model parameters, isobar effects.
- 1985Zh07: $^{12}\text{C}(\text{pol. p},\text{p})$ E=200 MeV, measured polarization, analyzing power, Wolfenstein parameters vs θ . Distorted wave approximation.
- 1986Ho26: $^{12}\text{C}(\text{p},\text{p})$ E=350-550 keV, measured $\sigma(E)$ vs θ .
- 1986Pi01: $^{12}\text{C}(\text{p},\text{p}),(\text{p},\text{p}')$ E=26-40 MeV, measured $\sigma(\theta)$. Deduced transition potentials. ^{12}C deduced ground state transition densities, multipole moments.
- 1986Vu02: $^{12}\text{C}(\text{pol. p},\text{p})$ E=4-8 MeV, measured analyzing power vs θ .
- 1987Er01: $^{12}\text{C}(\text{p},\text{p}),(\text{p},\text{p}'\gamma)$ E=1.6-1.9 MeV, measured $\sigma(E_p,\theta_p)$, $\sigma(E_\gamma,\theta_\gamma)$, $\gamma(\theta)$. R-matrix analyses.
- 1987HoZZ: $^{12}\text{C}(\text{pol. p},\text{p})$ E=500 MeV, measured $\sigma(\theta)$, analyzing power vs θ , spin rotation, depolarization parameters.

$^{12}\text{C}(\text{p},\text{p}')$ 1977Bu19,1969Su03,1974Jo14 (continued)

- 1988Me02: $^{12}\text{C}(\text{pol. p,p})$ E=200-300 MeV, measured $\sigma(E,\theta)$, $A(E,\theta)$. Deduced optical model parameters, energy dependence.
- 1989Vo05: $^{12}\text{C}(\text{pol. p,p})$ E=72 MeV, measured $\sigma(\theta)$, $A_y(\theta)$. Deduced optical model potential.
- 1990Er02: $^{12}\text{C}(\text{p,p})$ E $\leq$ 1.93 MeV, measured bremsstrahlung γ -yield. R-matrix analysis.
- 1990Ev01: $^{12}\text{C}(\text{pol. p,p})$ E=71.2 MeV, measured analyzing power vs θ .
- 1990Ho06: $^{12}\text{C}(\text{pol. p,p})$ E=494 MeV, measured $\sigma(\theta)$, analyzing powers, spin rotation depolarization observables. Deduced phenomenological Dirac optical potentials.
- 1991Ba45: $^{12}\text{C}(\text{pol. p,p})$ E=500 MeV, measured analyzing power, spin rotation depolarization parameters.
- 1991Ka12: $^{12}\text{C}(\text{p,p}),(\text{p},\text{p}')$ E $\approx$ 11-13 MeV, measured $\sigma(\theta)$ vs E.
- 1991Ya10: $^{12}\text{C}(\text{p,p})$ E=2.5-3.6 MeV, measured $\sigma(\theta=170^\circ)$ vs E.
- 1992Ba30: $^{12}\text{C}(\text{pol. p,p})$ E=1-2.1 MeV, measured analyzing powers $A_y(E,\theta)$.
- 1992Wi01: $^{12}\text{C}(\text{pol. p,p})$ E=189 MeV, measured analyzing power, polarization transfer coefficients.
- 1992Wi13: $^{12}\text{C}(\text{pol. p,p})$ E $\approx$ resonance, measured $\sigma(\theta,E)$, analyzing power vs E, θ . Deduced $\sigma(E)$.
- 1993Ba37: $^{12}\text{C}(\text{pol. p,p}),(\text{pol. p,p}')$ E=318 MeV, measured $\sigma(\theta,E_p)$, spin-flip probability. Deduced model parameters. ^{12}C deduced $\Delta S=0$, $\Delta S=1$ multipole transition strength distributions. DWIA analysis.
- 1993Sy01: $^{12}\text{C}(\text{pol. p,p})$ E=3.5-7.5 MeV, measured $\sigma(\theta)$, analyzing power vs θ .
- 1994Ai04: $^{12}\text{C}(\text{p,p})$ E $\approx$ 16.5-20 MeV, measured $\sigma(\theta)$ vs E.
- 1996Ho08: $^{12}\text{C}(\text{pol. p,p})$ E=500 MeV, measured polarization transfer parameter D(NN). DWBA analysis.
- 1996Yu02: $^{12}\text{C}(\text{p,p})$ E=200 MeV, measured spectra, $\sigma(\theta)$. Deduced model parameters. DWIA analysis.
- 2003An11: $^{12}\text{C}(\text{p,p})$ E=22 MeV, measured $\sigma(\theta)$.
- 2003Ha12: $^{12}\text{C}(\text{pol. p,p})$ E=150 MeV, measured $\sigma(\theta)$.
- 2006Ca19: $^{12}\text{C}(\text{p,p})$ E=3-7 MeV, measured $\sigma(\theta=150^\circ)$.
- 2006Le45: $^{12}\text{C}(\text{p,p}),(\text{p},\text{p}\gamma)$ E=7.5 MeV, measured σ and angular distributions for ground state and low excited states.
- 2010Az01: $^{12}\text{C}(\text{p,p})$ E=0.2-2.5 MeV, analyzed $\sigma(\theta)$, proton widths, γ widths, S-factor and nuclear phase shift using R-matrix analysis.
- 2010Ok01: XUNDL dataset compiled by TUNL, 2010.
- Elastic and inelastic proton scattering on ^{12}C was measured at 300 MeV with specific attention on the structure of the $E_x=7654$ keV Hoyle state. The 300 MeV proton beam, from the Osaka University Research Center for Nuclear Physics cyclotron, impinged on ^{12}C (30 mg/cm²) or polyethylene (4.6 mg/cm²) targets and the angular distributions ($\theta=2.7^\circ$ to 40°) were measured in the "Grand Raiden" spectrometer. Optical potential parameters for the elastic distributions were obtained in ECIS95 analysis, while the inelastic data were analyzed via three DWBA approaches (1) macroscopic collective model (2) microscopic α -cluster model (3) microscopic α -cluster condensation model.
- 2010To03: $^{12}\text{C}(\text{p,p})$ E=4.9-6.1 MeV, measured scattered protons. Deduced yields, stopping σ , sharp nuclear resonances.
- 2011Ab05: $^{12}\text{C}(\text{p,p})$ E<2.7-7 MeV, measured reaction products, E_p , I_p . Deduced $\sigma(\theta)$.
- 2011Du19: $^{12}\text{C}(\text{p,p})$ E=590-1150 keV, measured reaction products, proton spectra; deduced $\sigma(\theta)$, S-factors.
- 2013Ko14: XUNDL dataset compiled by TUNL, 2013.
- The width of $^{12}\text{C}^*(9641)$ was measured.
- A 66 MeV proton beam impinged on a 1 mg/cm² ($\Delta E \approx 9$ keV) thick ^{12}C target at the iThemba LABS in South Africa. Scattered protons were momentum analyzed at $\theta_{\text{lab}}=10^\circ$, 16° and 28° using the K600 spectrometer. Target energy loss effects were minimized by rotating the target angle to $\theta=0^\circ$, 5° and 14° for the different spectrometer settings, respectively; a systematic uncertainty of 2 keV is associated with energy loss differences for the interaction location in the target. The overall system resolution of 23 keV I (FWHM) is deduced from analysis of the $^{12}\text{C}^*(7654)$ state peak. The $^{12}\text{C}^*(9641)$ peak was first analyzed by fitting a resolution convoluted Voigt lineshape resulting in $\Gamma=40.4$ keV [4]. However, the decay mechanism, $L=3$ via $^8\text{Be}_{\text{g.s.}}$, distorts the lineshape and a more complex R-matrix formalism was selected for the preferred fit. In this case $\Gamma=48$ keV [2] is deduced. This width is 30% of the Wigner limit and implies a significant α -particle content for the state.

 ^{12}C Levels

See discussion on deformation parameters in (2017Ke05).

$^{12}\text{C}(\text{p,p}') \quad 1977\text{Bu19}, 1969\text{Su03}, 1974\text{Jo14} \text{ (continued)}$ ^{12}C Levels (continued)

E(level)	J^π	$T_{1/2}$	Comments
0			
4439.0 11	2^+	38 fs 5	T=0 $\Gamma_\gamma=12.0$ eV 15. E(level): This state is identified at $E_x=4437$ keV 7 (1962Br10), 4440.0 keV 5 (1967Ko14), 4442.2 keV 15 (1971St22), 4439.2 keV 5 (1974No07), and 4439.0 keV 11 (1974Jo14). $T_{1/2}$: From $\tau_m=55$ fs 7 (1968Ri16); $\Gamma_\gamma=12.0$ eV 15. $\beta_2=0.55$ 11 (2010Ok01).
7654.00 20	0^+		T=0 E(level): See $E_x=7655.9$ keV 25 (1971St22), 7656.2 keV 21 (1971Au16), 7655.2 keV 11 (1974Jo15), and 7654.00 keV 20 (1976No02). Using the recommended value $E_x=7654.07$ keV 19 from (1976No02) gives $Q(3\alpha)=379.33$ keV 20. $\Gamma_\pi/\Gamma=6.0\times 10^{-6}$ 11 (1977Ro05) and 7.1×10^{-6} 8 (1977Al31). $\beta_0=0.15$ 3 (2010Ok01). DWBA analysis is consistent with the assumption this is the dilute α -cluster condensed state (2001To23).
9.64×10^3 4	3^-	48 keV 2	T=0 Γ : From (2013Ko14). $\beta_3=0.39$ 8 (2010Ok01).
9.75×10^3 15	2^+	0.75 MeV 15	E(level), Γ : From (2012Fr05). See also $E_x\approx 9.6$ MeV (2011Zi01).
10.78×10^3 10	1^-		T=0
$11.83\times 10^3?$			
12.70×10^3 8	1^+		T=0
$13.35\times 10^3?$			
14.05×10^3 10	4^+		T=0
15.11×10^3 5	1^+		T=1
			Add $a_\pi=3.3\times 10^{-3}$ 5 (1993Bu23).
15.4×10^3 1	2^+	1.41 MeV 15	T=0 E(level), Γ : See $E_x=15.3$ MeV 2 (1977Bu19) and 15.4 MeV 1 (1979Go16); $\Gamma=2.0$ MeV 2 (1977Bu19) and 1.41 MeV 15 (1979Go16).
16.11×10^3			
16.57×10^3			
18.30×10^3 3	(2^-)	0.38 MeV 3	T=0 E(level), Γ : See $E_x=18.20$ MeV 10 (1965Ha17,1969Su03), 18.35 MeV 5 (1974Bu17), 18.35 MeV 3 (1977Bu19), and 18.30 MeV 3 (1983Jo08); $\Gamma=0.35$ MeV 10 (1977Bu19) and 0.38 MeV 3 (1983Jo08). $J^\pi=(2^+,3^-)$ (1977Bu19) and 2^- (1983Jo08).
19.40×10^3 3	2^-	0.48 MeV 4	T=1 E(level), Γ : See $E_x=19.35$ MeV 10 (1965Ha17,1969Su03), 19.40 MeV 5 (1977Bu19), and 19.40 MeV 3 (1983Jo08); $\Gamma=0.53$ MeV 10 (1977Bu19) and 0.48 MeV 4 (1983Jo08).
$19.65\times 10^3?$ $\dagger$ 5	(4^+)	0.44 MeV 10	
20.27×10^3 $\dagger$ 5		0.14 MeV 5	
20.57×10^3 $\dagger$ 5	3^-	0.35 MeV 10	T=1
21.65×10^3 $\dagger$ 10	3^-	1.20 MeV 15	T=0
$21.95\times 10^3?$ $\dagger$ 15	1^-	0.8 MeV 1	T=1
$22.36\times 10^3?$ $\dagger$ 5		0.30 MeV 5	
$22.6\times 10^3?$ $\dagger$ 1	1^-	0.9 MeV 1	T=1
23.50×10^3 $\dagger$ 5	1^-	0.23 MeV 10	T=1
23.92×10^3 $\dagger$ 8	1^-	0.4 MeV 1	T=1
$25.30\times 10^3?$ $\dagger$ 15	1^-	0.51 MeV 10	T=1

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$^{12}\text{C}(\text{p},\text{p}')$ [1977Bu19](#),[1969Su03](#),[1974Jo14](#) (continued)

^{12}C Levels (continued)

E(level)	J^π	$\text{T}_{1/2}$	Comments
$25.8\times10^3\text{?}^\dagger$ 3	(1 ⁻)	0.75 MeV 15	T=1
$27.0\times10^3\text{?}^\dagger$ 3	1 ⁻	1.4 MeV 2	T=1
$29.4\times10^3\text{?}^\dagger$ 3	(2 ⁺)		T=1

[†] E(level), J^π and Γ from [\(1977Bu19\)](#).