^{12}C(p,p):res

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	J. H. Kelley, C. G. Sheu and J. E. Purcell	NDS 198,1 (2024)	1-Aug-2024

1951Ja21: ^{12}C(p,p) E_p=0.32-4.0 MeV; analyzed (1951Go50) data via partial wave analysis and deduced a $S_{1/2}$ level at E_x=2379, $P_{3/2}$ at 3501 and $D_{5/2}$ at 3549 keV with Γ=33, 42 and 40 keV, respectively.

1952Ja21, 1953Ja03, 1953Ja04: ^{12}C(p,p) E=0.32-4 MeV; deduced E_p 0.461, 1.698, 1.748, with Γ_{cm}=31, 55, 61 keV, and J^π= $1/2^+$, $3/2^-$ and $5/2^+$, respectively. See further discussion on reduced widths.

1954Mi05: ^{12}C(p,p) E=300-550 keV; measured σ(θ) for θ=30° to 160°. Deduced E_{res}=462 keV *4* with $\Gamma_{c.m.}$=32 keV.

1954Wo09: ^{12}C(p,pγ) E=1-3 MeV; observed influences of $^{13}N^*$(2.37,3.51,3.58 MeV) states. Observed (p,γ) capture to $^{13}N^*$(2.37) followed by proton emission. They note the higher $5/2^+$ state is suppressed in the capture reaction.

1956Br27: ^{12}C(p,p′) E_p=1.5-5.5 MeV; measured scattered proton yield. Deduced state at E_{res}=5.891 MeV with Γ_{lab}=55 keV.

1956Re39: ^{12}C(p,p′)1.5-5.5 MeV; deduced resonances at E_p=4.808 MeV *8* and 5.37 MeV with J^π=$5/2^+$ and $3/2^+$, and with Γ_{lab}=12 keV and 125 keV, respectively. J^π(5.37) from angular distribution of ^{12}C(p,p′$\gamma_{4.4}$). See further discussion on reduced widths.

1956Sc29: ^{12}C(p,p),(p,p′) E=4.7-7 MeV; measured σ(E) for θ=40° to 160°. Deduced levels at E_{res}=5.05, 5.30, 5.85, 6.65 MeV ^{13}N((6.61), 6.84, 7.35, (8.1)) with L:J^π=0:$1/2^+$, 2:$3/2^+$, 1:$3/2^-$, 2:$3/2^+$ and with Γ=75, 50, 50 and 350 keV, respectively. These states are not all accepted.

1960Ev02: ^{12}C(p,p_0) E=2.3-4.3 MeV; measured induced polarization at θ=60°.

1960St09: ^{12}C(p,p_0) E=9.4 MeV; measured induced polarization for θ=34° to 140°.

1960To09: ^{12}C(p,p_0) E=3-5 MeV; measured induced polarization for θ=50° to 160°.

1960Ya07: ^{12}C(p,p) E=14,16 MeV; measured induced polarization for θ=45°.

1960Yo05: ^{12}C(p,p′γ) E=5.3-6.1 MeV; measured excitation function for γ(^{12}C=4.4 MeV). Deduced resonances at E_{res}=5.37, 5.69 and 5.93 MeV (E_x=6.91, 7.17 and 7.42 MeV); analyzed angular correlation (θ≈35° to 140°) of γ-p for E_x=7.42 MeV.

1961Ad04: ^{12}C(p,p′γ(4.44)) E=5-12 MeV; measured yield at θ=90°. Deduced resonances E_{res}=5.36, 5.89, 7.55, 8.17, 9.12, 10.51, 10.74 and 10.99 MeV and widths for $^{13}N^*$(6.89, 7.38, 8.91, 9.48, 10.36, 11.64, 11.85, 12.09) with Γ_{lab}=140, 70, 255, 38, 70, 85, 140, 150 keV, respectively.

1961Ba25, 1961Mc11: ^{12}C(p,p) E=5-11.5 MeV; measured angular distributions (θ=10° to 170°) and excitation functions with resonances at E_p≈5.4, 5.9, 6.65, 7.6, 8.2, 9.2 and 10.5 MeV including new states at E_x≈8.9, 9.5, 10.4 and 11.6 MeV.

1961Mc16: ^{12}C(p,p′) E=5-11.5 MeV measured angular distributions (θ=25° to 170°) and excitation functions with resonances at E_p≈7.6, 8.2, 9.2, 10.3, 10.5 and 11.0 MeV.

1961Na02: ^{12}C(p,$p_{0,1}$) E=6.5-16 MeV; measured angular distributions for θ=21.8° to 166.2°. Deduced resonances at E_p=(6.65), 9.1, 10.5, 12.5, 13.2, 13.7 and 15.1 MeV for $^{13}N^*$(8.08, 10.4, 11.6. 13.5, 14.2, 14.6, 15.9 MeV) Widths of Γ=150, 700, 500, 500, 500 keV are deduced for $^{13}N^*$(10.4, 11.6. 13.5, 14.2, 14.6), respectively.

1962Sh22: ^{12}C(p,p) E=5-11.5 MeV; measured σ(E) for θ=30° to 170°. Deduced levels at E_{res}=5.38, 5.90, 6.6, 7.53, 8.17, 9.14 MeV with J^π=$3/2^+$, $5/2^+$, $3/2^+$, $1/2^-$, $3/2^-$, $7/2^-$, with Γ=115, 80, 1400, 225, 30 and 73 keV. Reduced widths of θ^2=0.01, 0.01, 0.14, 0.02, 0.001 and 0.01 are also given. Phase-shift analysis.

1962Wa31: ^{12}C(p,γ), (p,p′γ(4.44,12.7, 15.1)),(p,d) E=14-20 MeV and θ(γ)=90°. Yields for (p,γ) and (p,d) reactions were reported as relatively structureless. For (p,p′γ(15.1)) resonances corresponding at E_p=17.5, 18.05 and 19.3 MeV $^{13}N^*$(18.1, 18.65, 19.8 MeV) are reported. The width of the 18.1 MeV level is $\Gamma_{c.m.}$=330 keV *100*, while the other two levels have $\Gamma_{c.m.}$≤200 keV.

1963Ba36: ^{12}C(p,$p_{0,1}$) E=5.2-6.6 MeV; measured σ(θ) for θ≈30° to 150° (table provided). Also measured angular distribution of Eγ=4.44 MeV. Deduce E_{res}=5.35 MeV *1*, 5.65 MeV *1* and 5.89 MeV *1* for $^{13}N^*$(6.88, 7.16, 7.38 MeV) with $\Gamma_{c.m.}$=114, 7.7 and 61 keV, J^π=$3/2^+$, $7/2^+$ and ($5/2^-$,$7,2^-$), respectively. J^π(7.38)=$7/2^-$ is preferred, but $5/2^-$ is accepted in the Adopted Levels giving Γ_{p0}=51, 0.03 and 5.0 keV and Γ_{p1}=63, 7.4 and 56 keV, respectively for the states.

1963Ba43: Theoretical analysis of E_x≈7 MeV state spins. Find $^{13}N^*$(7.42) should be J^π=$5/2^-$.

1963Di16: ^{12}C(p,p′γ) E=18-30 MeV; measured σ(E_p,θ) for θ=14° to 153° (tables provided).

1963Me04: ^{12}C(p,p′γ) E≤50 MeV; measured excitation function for proton scattering to $^{12}C^*$(12.7,15.11). Deduced some evidence for a resonance at E_p=20 MeV and give discussion on a possible width 0.27 MeV<Γ_p<3.7 MeV. They give additional discussion suggesting as many as 4 resonances in the region.

1963Ni05: ^{12}C(p,p$\gamma_{4.4}$) E=5-6 MeV; measured σ(Eγ,θ) for θ≈5° to 150°. Deduced resonances at E_p=5.38, 5.68 and 5.90 MeV indicating $^{13}N^*$(6.91, 7.19, 7.40 MeV) with $\Gamma_{c.m.}$=115 keV *5*, 9.0 keV *5* and 69 keV *5*, respectively. The J^π values of $3/2^+$, $7/2^+$ and $5/2^-$ and c.m. elastic proton widths Γ_p=46 keV, 0.36 keV and 6.9 keV, respectively, are also deduced.

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1964Bo18: $^{12}C(p,p_0)$ E_p=4.5 MeV; measured induced polarization for θ=50° to 128°.
1964Da03: $^{12}C(p,p_{0,1})$ E_p=13.6-19.6 MeV; measured $\sigma(\theta)$ for θ=15° to 160°. Suggest fluctuations at Ep= 13.9, 14.4, 14.9, 15.3, 15.6, 16.5, 17.9, 18.2, 18.8 MeV with ΔE≈50-100 keV. They indicate higher resolution is necessary for meaningful results.
1964Dr04: $^{12}C(p,p_0)$ E_p=4.5-5.2 MeV; measured induced polarization at 48°.
1964Ta15: optical model analysis of the (1963Di16) data. Deduced resonances at $E_{c.m.}$=19.75 ($3/2^+$), 20.05 ($5/2^+$), 24.93 MeV with $\Gamma_{c.m.}$=2.49, 1.46 and 2.17 MeV, respectively.
1965Be12: $^{12}C(p,p'\gamma)$ E=5.37 MeV (E_x=6.91 MeV); measured triple correlation for θ_p=40° to 150° and θ_γ=0° and 150°. Compared with phase-shift analysis of (1956Re39). Data is well represented with a $3/2^-$ state interfering with a small mixture of a $1/2^-$ state. This is in disagreement with accepted interpretation.
1965Ma26: ^{12}C(p,p) E=16-28 MeV; measured total reaction cross sections; estimated elastic and inelastic cross sections. Deduced resonances at $E_{c.m.}$=19.8, 20.01 and 24.9 MeV $^{13}N^*$(21.7, 21.94, 26.8 MeV).
1965Mo15: ^{12}C(p,p) E=4.7-11.3 MeV; measured induced proton polarization for θ=20° to 140°.
1966Ar03: ^{12}C(p,p) E=1.48-2.02 MeV; measured $\sigma(\theta)$ for θ=25° to 125.5°. Deduced resonances at E_p=1686 keV *6* and 1734 keV *6* with $J^\pi=3/2^-$ and $5/3^+$, with reduced widths θ^2=0.036 *2* and 0.25 *2* and with Γ=63 keV and 74 keV, respectively. The level energy difference is 48 keV *2*. Cross-sections table given.
1966Ba35: ^{12}C(p,p) E=2.4-11.6 MeV, ^{12}C(p,p′) E=6.6-11.6 MeV, $^{12}C(p,\alpha)$ E=11.6 MeV; measured $\sigma(E,\theta)$. Deduced resonances at E_p=4.80, 5.30, 5.88, 6.35, 7.53, 8.16, 9.13 MeV for $^{13}N^*$(6.37, 6.83, 7.37, 7.79, 8.89, 9.47, 10.37) with $J^\pi=5/2^+$, $3/2^+$, $5/2^-$, $3/2^+$, $1/2^-$, $3/2^-$, $7/2^-$ and with Γ_{lab}=12, 74, 70, 1720, 250, 30 and 84 keV, respectively.
1966Cr04,1966Cr14: ^{12}C(pol. p,p),(pol. p,p′) E=20-28 MeV; measured polarization observables for θ=20° to 160°. Compared with earlier predictions of (1964Ta15).
1966Lo16: ^{12}C(p,p) E=20-28 MeV; measured $\sigma(\theta)$ for θ=15° to 160°. Deduced three states at $E_{c.m.}$=19.0, 20.8, ≈22.2 MeV with J^π=(5/2,9/2), (5/2,9/2) and 7/2 with Γ=1.5, 1.0, 0.5 MeV, respectively.
1966Sh10: $^{12}C(p,p'\gamma)$ E=5.9 MeV; measured $\sigma(E_p,\theta_p,\theta_{\gamma 4.44})$ for θ_p=30° to 145°. Analyzed in-plane p-γ correlations with the aim of resolving the $^{13}N^*$(7.4 MeV) J^π spin assignment. $5/2^-$ is favored, but not fully adopted.
1966Sw04: ^{12}C(p,p) E=4.7-12.8 MeV, ^{12}C(p,p′) E=6.0-12.8 MeV, measured $\sigma(E,\theta)$ for θ=25.4°−159.5°. Deduced new level at E_x=10.38 MeV.
1967Ba84: Theory, phase-shift analysis of E_x≈6.5 MeV region. Deduce the E_p=4.808 and ≈5.3 MeV features are due to the 0.461 keV *s*-wave resonance.
1967Du12: ^{12}C(p,p) E=5.179-5.480 MeV and θ=30° to 150°. Phase-shift analysis. Deduce resonance energy E_0=5374 keV *20*; discuss earlier results including some discussion on the complex process for determining the total width.
1967Cl04: ^{12}C(pol. p,p),(pol. p,p′) E=4-12 MeV; measured polarization observables for θ=17° to 60°.
1967Fa06: ^{12}C(pol. p,p),(pol. p,p′) E=49.5 MeV Measured $\sigma(\theta)$ for θ=11° to 147°.
1967Ku02: ^{12}C(p,p) E=13-19 MeV; measured $\sigma(E,\theta)$ for $\theta_{c.m.}$= 90° and 166.5°. Deduced T=3/2 resonances at E_x=18.43 MeV *2* and 18.98 MeV *2*. For 18.43, Γ≈30 keV is aparent, but if these are analogs of $^{13}N^*$(3.68,3.71) the width is unclear. For 19.89, Γ<10 keV and *l*=1 is likely from comparison with E_x=15.07; $J=1/2^-$ is suggested . They suggest population of T=1/2 states at E_p=14.4, 15.2 (broad), and 17.6 MeV.
1967Pa25: ^{12}C(p,p) E=1 BeV; measured $\sigma(\theta)$ for θ=6° to 18°.
1967Sc11: $^{12}C(p,p'\gamma(15.11))$ E=20.5-30.3 MeV; measured excitation function. Deduced levels at $^{13}N^*$(20.9, 22.5, 25.5) with $J^\pi=5/2^+$, $5/2^-$ and $3/2^-$, respectively. See further discussion on L-values.
1967Sw02: ^{12}C(p,p) E=8.20 and 9.10-9.26 MeV: measured $\sigma(\theta)$ for θ=20° to 160°. phase-shift analysis. Deduced resonances at E_p= 9145 and 9152 keV with $J^\pi=5/2^-$ and $7/2^-$ and with Γ_{lab}=12 and 90 keV, respectively.
1967Tr08: ^{12}C(pol. p,p) E=1.5-3 MeV; measured polarization observables for θ=30° to 140°. Phase-shift analysis in the region around E_x=3.5 MeV.
1968An25: ^{12}C(p,p),(p,p′) E=6 MeV; measured $\sigma(E_p,\theta)$.
1968Be31: ^{12}C(pol. p,p) analyzed the data of (1968Te05). For the E_{res}=5.38 and 5.88 MeV levels, they deduce $J^\pi=3/2^+$ and $5/2^-$, respectively. For 5.88 MeV, Γ_{lab}=70 keV and Γ_{p0}/Γ=0.08 are deduced. The resonance at 9.13 MeV is identified as two overlapping states whose energies differ by less than 2 keV. The states have $J^\pi=5/2^-$ with Γ_{lab}=33 keV and Γ_{p0}/Γ=0.26 and $J^\pi=7/2^-$ with Γ_{lab}=82 keV and Γ_{p0}/Γ=0.81.
1968Sl01: ^{12}C(pol. p,p) E=1-3 MeV; measured induced proton polarization.
1968Te05: ^{12}C(pol. p,p) E=4.6 to 7.2 MeV; measured polarization observables for θ≈40° to 165°. Data is analyzed in (1968Be31).
1969Fa04: ^{12}C(p,p),(p,p′) E=11-22.7 MeV; measured polarization observables at θ=55°.
1969Fu07: ^{12}C(p,p) E=61.4 MeV; measured $\sigma(\theta)$ for θ=15° to 110°. For a broad collection of targets they deduced OM potential parameters.

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1969Gu02: ^{12}C(p,p) E=7 MeV; measured $\sigma(\theta)$ and polarization observables for θ=20° to 160°. Deduced OM parameters.
1969Ko07: ^{12}C(p,p′) E=9-20 MeV; measured $\sigma(\theta)$ for θ=30° to 160°. Deduced spin-flip probabilities.
1969Le18: ^{12}C(p,p) E≈9.4-21.5 MeV. Measured σ(E,θ) for θ=25° to 165°. Deduced resonances in $\alpha_{0,1}$ and $p_{0,1}$. In (1970Aj04) the full collection of states given in Table 1 of (1969Le18) are associated with the (p,α) reaction; but this seems arbitrary given their θ=60° data shown in Fig 7. Isospin values are discussed. The results shown in Table 1 include ^{13}N states from E_x=13.96 to 19.88 MeV that were studied via phase-shift analysis. The complex of states around E_p=10.5 to 11 MeV were analyzed, but no results could be obtained.
1970Bl03: ^{12}C(pol. p, p),(pol. p, p′) E=20.3 MeV; measured polarization observables for θ≈40° to 160°.
1970Di08: ^{12}C(p,p) E=9.9-19.5 MeV; measured attenuation. Deduced broad levels near E_p≈10.4 and 13.8 MeV.
1970Gi04: ^{12}C(pol. p,p) E=20-30 MeV; measured σ(E,θ) for θ=20° to 150°. Results are combined with ^{10}B(^{3}He,α) at E(^{3}He)=1-10 MeV; deduced resonances at E_{res}(^{3}He)=3, 5.8, and 8 MeV (^{13}N*(24, 26.1, 28 MeV)) with Γ= 0.75 *25*, 1.35 *15* and 2.25 *25* MeV and J^π=7/2$^-$, 7/2$^-$ and 9/2$^+$, respectively. See ^{10}B(^{3}He,α).
1970Ko15: ^{12}C(p,p′γ(4.44)) E=12-14 MeV; measured $\sigma(\theta)$ for θ=30° to 160°; analyzed spin-flip probability. Focused on the region around E_{res}=13.1 MeV.
1970Ts03: ^{12}C(p,p) E=41-50 MeV; measured polarization observables.
1971Na29: ^{12}C(p,p) E≈4.81 MeV; measured polarization observables around the E_p=4.81 MeV resonance at θ=50° and 137.5°.
1972Ba14: ^{12}C(p,p) E=14.2 MeV; measured σ(E) for θ=165° near the E_x=15.07 MeV T=3/2 resonance. Deduced change in resonance shape attributed to molecular ion beams.
1972Be15: ^{12}C(p,pγ) E≈8.2 MeV; measured elastic, inelastic and spin-flip cross sections for θ≈30° to 160°. Analyzed resonance and found E_{res}=8.18 MeV, Γ_{lab}≈28 keV and Γ_{p1}/Γ=0.72. Deduced resonance is a proton coupled to ^{12}C*(4.44 MeV).
1972Dz05: ^{12}C(p,p) E≈14.23 MeV; measured $\sigma(\theta)$ at θ=40°, 140° and 165°. Used the observed width, FWHM=1.6 keV, and previously reported width, Γ=1.22 keV to estimated their systems′s resolution function.
1972Gr02: ^{12}C(pol. p, p),(pol. p, p′) E=30.4 MeV; measured $\sigma(\theta)$ and polarization observables for θ=20° to 170°. Deduced effective interactions.
1972Ja07: ^{12}C(p,p) E=144 MeV; measured $\sigma(\theta)$. Deduced scattering amplitudes and OM parameters.
1972Vo20: ^{12}C(p,p) E=1 GeV; measured induced proton polarization for θ<13°.
1972Wi24: ^{12}C(p,p) E=46 MeV measured $\sigma(\theta)$. Deduced OM parameters.
1972Wi26: ^{12}C(pol p,p) E=9.95-10.90 MeV; measured $\sigma(\theta)$, $A_y(\theta)$ for θ=50° to 150°. Deduced phase shifts, resonances. Tabular data. Resonances at E_{res}=10.25 MeV *10*, 10.51 MeV *2*, 10.54 MeV *5* and 10.70 MeV *5* (^{13}N*(11.40, 11.64, 11.67, 11.82 MeV)), with J^π=5/2$^+$, 5/2$^-$, 3/2$^-$, 3/2$^+$, and with Γ=0.45 MeV *10*, 120 keV *30*, 230 keV *50*, 250 keV *50*, and with Γ_{p0}/Γ= 0.65 *15*, 0.55 *5*, 0.45 *10* and 0.62 *10*, respectively.
1973Be29: ^{12}C(p,p), (p,p′) E=1.04 GeV; measured $\sigma(\theta)$ for θ≈4° to 35°.
1973Be37: ^{12}C(p,p), (p,p′) E=7-8 MeV; measured σ(E). As in (1972Be15), measured elastic, inelastic and spin-flip cross sections for θ≈45° to 165°. Analyzed resonance and found E_{res}=7.575 (assumed) with Γ=0.25 MeV. They find the decay is dominated by f-wave proton emission.
1973Ha59: 12C(p,p) E=2.0-4.5 MeV; measured A_y.
1973Hu07,1974Hu15: 12C(p,p) E≈14.2 MeV; measured σ(E). Find T=3/2 resonance at E_p=14230.75 keV *20*.
1973Me03: ^{12}C(pol. p,p), (pol. p,p′) E=9.5-11.5 MeV, measured $\sigma(\theta)$, $A_y(\theta)$ for θ=20° to 160°. Phase-shift analysis. Deduced resonances with E_{res}=10.35 MeV *5*, 10.58 MeV *3*, 10.62 MeV *4*, 10.62 MeV *5*, 10.75 MeV *4* and 11.05 MeV *5* (^{13}N*(11.49, 11.71, 11.75, 11.75, 11.86, 12.14 MeV)), with J^π=5/2$^+$, 5/2$^-$, 3/2$^+$, 3/2$^-$, 1/2$^+$ and 7/2$^-$, with $\Gamma_{c.m.}$= 430 keV *35*, 115 keV *30*, 250 keV *30*, 530 keV *80*, 380 keV *50* and 250 keV *30*, and with Γ_p/Γ=0.70 *5*, 0.60 *4*, 0.30 *5*, 0.55 *5*, 0.35 *5* and 0.30 *5*. See further discussion on reduced widths.
1973Me12: ^{12}C(p,p′γ) E=9-24 MeV; measured E_γ, I_γ excitation function capture γs and ^{12}C*(12.7, 15.11 MeV) de-excitation. A high background has resulted in multiple solutions for deduced widths in the γ_0 capture analysis; the preferred option is listed. For ^{12}C(p,γ_0) resonances at E_p=9.01 MeV *15*, 10.62 MeV *12*, 12.5 MeV *2*, 13.12 MeV *9* 14.5 MeV *2* for ^{13}N*(10.25, 11.74, 13.0, 14.04, 15.3 MeV), with J^π=3/2$^+$, (3/2$^+$,1/2$^+$), 3/2$^+$, 3/2$^+$, (3/2$^+$), and with Γ=0.28 MeV *10*, 220 keV *50*, 7 MeV, 170 keV *20* and 0.38 MeV *15*, and with $\Gamma_{\gamma0}$ ≥0.6 eV, 4.2 eV, ≥1.1 keV, 76 eV *28* and ≥0.5 eV. See further discussion in text. Levels in ^{12}C(p,p′γ) are found at E_p=15.27 MeV *3* (E_x=16.02) with Γ=130 keV *30*, Γ_{p0}≈7.5 keV, $\Gamma_{p12.71}$≈30 keV; E_p=19.35 MeV *20* (E_x=19.77) with J^π=(5/2$^+$), Γ=800 keV, Γ_{p0}≈80 keV, $\Gamma_{p15.11}$≈300 keV (*Not accepted*); E_p=20.55 MeV *30* (E_x=20.87) with J^π=(5/2$^+$), Γ=1.1 MeV, Γ_{p0}≈110 keV, $\Gamma_{p15.11}$≈400 keV; E_p=22.2 MeV *5* (E_x=22.7) with J^π=(7/2$^+$), Γ=2 MeV, Γ_{p0}≈200 keV, $\Gamma_{p15.11}$≈450 keV. Significant comparison with literature values.
1974Ae01: ^{12}C(p,p) E=399-576 MeV; measured $A_y(\theta)$ for θ=4° to 10°.
1974Al31: ^{12}C(p,p), (pol. p,p) E=4.6-6 MeV; measured $\sigma(\theta)$ and $A_y(\theta)$.

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1974Co09: ^{12}C(p,p) E=156 MeV; measured $\sigma(\theta)$ for θ=5° to 65°. Deduced OM parameters.
1974Fe08: ^{12}C(p,p), (p,p′) E=24 MeV; measured $\sigma(\theta)$.
1974Gu04: ^{12}C(p,p) E=5.8-6.3 MeV; measured induced proton polarization.
1974Ja25: ^{12}C(p,p) E=10-20 MeV; measured $\sigma(\theta)$ for θ=15° to 70°.
1974Lo19: ^{12}C(p,p) E≈4.8 MeV; measured $\sigma(E_p)$. Analyzed E_{res}=4.8 MeV level properties.
1974Ro42: ^{12}C(pol. p,p) E=6.2 MeV; measured $A_y(\theta)$.
1975Cr06: ^{12}C(p,p) E=1770, 1900 keV; measured $\sigma(E_\gamma)$. Analyzed proton induced bremsstrahlung spectrum for near-resonance energies.
1975De26: ^{12}C(p,p), (p,p′) E=6 MeV; measured $\sigma(E_{p'},\theta)$.
1975De32: ^{12}C(p,p′γ) E=15.9-37.6 MeV; measured $\sigma(E_{p'},\theta)$. for θ=40° to 170°. Observed resonances at E_p=20 and 29 MeV. Suggest E1 and E2, respectively.
1975Ge15: ^{12}C(p,p′γ) E=22.5-45 MeV; measured $\sigma(E_{p'},\theta)$. for θ=20° to 160°.
1975Go03: ^{12}C(p,p) E=14.22-14.24 MeV; measured σ(E) around the T=3/2 resonance using a broad range spectrometer to determine the proton energy. Various thin targets from 10-20 $\mu g/cm^2$ were utilized. Deduced E_{res}=14232.5 keV *22* from phase-shift analysis. The value Γ_p/Γ≈0.18 was used in their fit.
1975Hi07: ^{12}C(p,p),(p,p′),(p,α) E=14.222-14.242 MeV; measured σ(E) at θ=175°. Analyzed $^{13}N^*$(15.07) mainly from (p,p) analysis. They deduced Γ=1.10 keV *9*, Γ_p=210 eV *11* and Γ_p/Γ=0.191 *17*. Analyzed other level decay properties such as partial widths, but they used branching ratios from (1973Ad02) with their Γ and Γ_p.
1975Sl02: ^{12}C(p,p) E=20-44 MeV; measured total σ(E). Observed structures at E_p=23.8 and 25.9 MeV.
1976Be28: ^{12}C(p,pγ(12.71,15.11)) E≤24 MeV; measured σ(E) for θ=90° and 55°. States at E_p=17.87, 18.46, 19.5 MeV and 20.5 MeV are observed in E_γ(15.11) excitation spectrum (seems shifted). E_x=18.456 MeV *15* for the E_p=17.87 state. For E_γ(12.71), structures are seen at E_p=15.27, 16.8, 20.5 MeV. They suggest the 20.5 could be ($3/2^+$), but express uncertainty.
1976Cu08: ^{12}C(p,p) E=1.5-4.0 MeV; measured $\sigma(E,\theta)$ for θ=5° to 41°. Deduced OM parameters.
1976Fe11: ^{12}C(p,p′γ(4.44,12.7,15.1)), ^{12}C(p,$\gamma_{0,2,3}$) E=16-40 MeV; measured σ(E). Observed resonances at E_p=20, 27, 32 MeV (E_x≈20.4, 26.8, 31.5 MeV). The 20 MeV resonance is seen in all channels, while the 27 MeV state is not seen in capture reactions. The 32 MeV resonance is seen in ^{12}C(p,p′γ(4.44)).
1976Ma06,1976Ma55: ^{12}C(p,p) E=1.765, 1.795, 1.895 MeV; analyzed proton induced bremsstrahlung spectrum for near-resonance energies.
1976Me18: ^{12}C(pol. p,p) E=11.5-18.1 MeV; measured $\sigma(\theta)$, $A_y(\theta)$ for θ≈20° to 160°. Phase-shift analysis. Deduced resonances at E_p=13.13 MeV *2*, 15.24 MeV *4*, 17.58 MeV *3* and 17.60 MeV *2* ($^{13}N^*$(14.06, 16.00, 18.16, 18.18 MeV)) with J^π=$3/2^+$, $7/2^+$, $3/2^+$, $1/2^-$, and with $\Gamma_{c.m.}$=180 keV *35*, 135 keV *90*, 322 keV *75*, 225 keV *50*, and with Γ_p/Γ=0.29 *7*, 0.05 *4*, 0.08 *2* and 0.24 *6*. See further discussion on reduced widths and other fitting parameters. They suggest systematic errors in (1969Le18) that require ≤70 keV energy shifts.
1976Me22: ^{12}C(p,p) E=0.3-2.0 MeV; measured $\sigma(\theta)$ for θ=89.1°, 118.7° and 146.9°. R-Matrix analysis deduced levels at $E_{c.m.}$= 424 , 1558, 1604 keV with $\Gamma_{c.m.}$=33, 55, 50 keV. These data were included in a reanalysis given in (2023Ke11); see discussion in ^{12}C(p,γ). Of particular relevance was the description of the E_p=1735.5 keV *5* resonance with J^π=$5/2^+$, and Γ=49.0 keV *5*.
1976So02: ^{12}C(p,p) E=8.0-8.3 MeV, 8.909.4 MeV; measured $\sigma(\theta)$ for θ=87.4°. Analyzed the region around the E_{res}=9.14 MeV doublet by analyzing cross sections and spin-flip probability.
1977Bl09: ^{12}C(p,p) E=0.8 GeV; measured $\sigma(\theta)$ and $A_y(\theta)$ for θ≈1° to 30°.
1977Ma16: ^{12}C(p,p) E=14.23 MeV, $^{13}N^*$(15.066 MeV T=3/2). Observed p decay to ^{12}C(0,4.4, 7.65, 9.65) and associated γ rays.
1978Cu04: ^{12}C(p,p) E=3.0, 49.48 MeV; measured $\sigma(\theta)$ for θ= 3° to 90°. Deduced OM parameters.
1978Fr12,1978Ho05: ^{12}C(pol. p,p) E=800 MeV; measured $\sigma(\theta)$ and $A(\theta)$ for θ=2° to 30°.
1979Al26: ^{12}C(p,p) E=1 GeV; measured $\sigma(\theta)$ for θ=5° to 25°. Analyzed nuclear density. Discussed quadrupole moments.
1979Be44: ^{12}C(pol. p,p) E=300-560 MeV; measured $A(\theta)$ for θ=5° to 20°.
1979Bo03: ^{12}C(p,p) E=3-61.4 MeV; measured and analyzed literature $\sigma(\theta)$. Deduced α-cluster structure in ^{12}C.
1979Ga13: ^{12}C(pol. p,p),(pol. p,p′) E=19.15-23.34 MeV; measured $\sigma(\theta)$ and $A_y(\theta)$ for θ=20° to 160° and for protons to ^{12}C(0, 4.4, 12.7 MeV). Deduced resonances at E_x= (≥19.5 MeV), 19.9 MeV, 20.2, 20.9, 21.4 and 22.4 MeV with J^π=$1/2^+$, $7/2^+$, $5/2^-$, $1/2^+$, $5/2^-$,$1/2^+$, and with Γ=(≥1.0), 0.75, 1.0, 1.2, 0.75 and (1.0) MeV. Evidence for additional states around 21.7 with J^π=$3/2^+$ and above 22.7 with $3/2^+$ was discussed. They give an overview comparison of their results for this region with those of (1966Lo16, 1964Ta15, 1967Sc11, 1969Le18).
1979Kr18: ^{12}C(pol. p,p) E=450-600 keV; measured $A(\theta)$ for θ=90° and 120°. Deduced evidence for Mott-Schwinger interaction.
1979Pr04: ^{12}C(p,p), (p,p′) E=6.9 MeV; measured $\sigma(\theta)$. Analyzed spin-flip probability. Deduced reaction mechanism.
1980Al09: ^{12}C(p,p) E=1 GeV; measured polarization observables for θ=3° to 19° Deduced spin-orbit amplitude parameters.

^{12}C(p,p):res (continued)

1980Co05: ^{12}C(p,p), (p,p′) E=122 MeV; measured $\sigma(E_P,\theta)$ for θ=10° to 60°. DWIA analysis. Analyzed spin-orbit tensor effective interaction.
1980Fa07: ^{12}C(p,p), (p,p′) E=35.2 MeV; measured $\sigma(\theta)$ for θ= 30° to 170°. Deduced OM parameters.
1980Ka02: ^{12}C(p,p) E=40-75 MeV; measured $\sigma(\theta)$ and polarization observables forθ=47.5°. Presented measurements for θ=15° to 115° at E_p=65 MeV.
1980Th05: ^{12}C(pol p,p) E=14.226-14.236 MeV; measured $\sigma(\theta)$, $A_y(\theta)$ for θ=60° to 160°. For $^{13}N^*$(15.07) deduced Γ_{lab}=1010 eV *30* and Γ_{p-lab}=285 eV *15* with a beam energy resolution of 850 eV; analyzed atomic excitation effects for the E_p=14230.75 keV state.
1980Tr03: ^{12}C(p,p) E≈1.7 MeV; measured σ(E). Analyzed interaction of proton induced bremsstrahlung with resonance.
1981Dy03: ^{12}C(p,p′γ(4.44)) E≈5-23 MeV; measured σ(E).
1981Me02, 1981Me11: ^{12}C(pol. p,p) E=200 MeV; measured $\sigma(\theta)$ and $A_y(\theta)$ for θ=6° to 115°.
1982Al18: ^{12}C(p,p) E=1 GeV; measured induced proton polarization, deduced spin-orbit parameters.
1981Fu12: ^{12}C(pol p,p′γ) E=22-29 MeV; measured polarization observables θ=45° to 150°.
1982Le03: ^{12}C(p,p) E=591, 696, 796 keV; analyzed interaction of proton induced bremsstrahlung with resonance.
1982Ta09,1982Ta11: ^{12}C(p,p) E≈1.7 MeV; measured σ(E). Analyzed interaction of proton induced bremsstrahlung with resonance.
1983Ba57: ^{12}C(p,p′), (p,p) E=135 MeV; measured $\sigma(\theta)$ for θ=10° to 70°. Deduced OM parameters.
1983Me02: ^{12}C(pol. p,p) E=122, 160 MeV; measured $\sigma(\theta)$, A(θ) for θ=5° to 154°. Deduced OM parameters.
1983Ta12: ^{12}C(pol. p,p′(4.44)) E=159.4 MeV; measured $\sigma(\theta)$ and $A_y(\theta)$ for θ=7.5° to 45° DWBA/DWIA analyses.
1985Al16: ^{12}C(p,p) E=1 GeV; measured $\sigma(\theta)$ for θ=5° to 26°. Deduced OM parameters, analyzed density distribution.
1986Er06,1987Er01,1990Er02: ^{12}C(p,p) E ≈1.7 MeV; measured σ(E). Analyzed interaction of proton induced bremsstrahlung with resonances. Deduced reaction duration time and discussed $T_{1/2}$ for ^{13}N*(3.5 MeV) doublet.
1986Ho26: ^{12}C(p,p) E=350-550 keV; measured σ(E) for θ=95°, 124° and 152°.
1986Vu02: ^{12}C(pol. p,p) E=4-8 MeV; measured $A_y(\theta)$ for θ=20° to 165°.
1988Me02: ^{12}C(pol. p,p) E=200-300 MeV; measured $\sigma(\theta)$, $A_y(\theta)$ for θ=5° to 100°. Deduced OM parameters.
1989Vo05: ^{12}C(pol. p,p) E=72 MeV; measured $\sigma(\theta)$, $A_y(\theta)$ for θ≈15° to 160°. Deduced OM parameters.
1990Ev01: ^{12}C(pol. p,p) E=71.2 MeV; measured $A_y(\theta)$ for θ=40° to 48°.
1990Ho06: ^{12}C(pol. p,p) E=494 MeV; measured $\sigma(\theta)$, polarization observables for θ=5° to 37°.
1991Ba45: ^{12}C(pol. p,p) E=500 MeV; measured $A_y(\theta)$ and spin-rotation depolarization parameters for θ=10°, 15° and 20°.
1991Ka12: ^{12}C(p,p), (p,p′) E≈11-13 MeV; measured $\sigma(\theta$, E) Deduced levels and level parameters *Not accesible*.
1991Ya10: ^{12}C(p,p) E=2.5-3.6 MeV; measured $\sigma(\theta$=170°).
1992Ba30: ^{12}C(pol. p,p) E=1-2.1 MeV; measured analyzing powers $A_y(\theta)$ for θ=40° to 160°. Phase-shift analysis. Deduced E_{res}=1685 keV *6* and 1736 keV *8* for $^{13}N^*$(3.499,3.546).
1992Wi01: ^{12}C(pol. p,p) E=189 MeV; measured $A_y(\theta)$ for θ=16.3°, 17.3° and 18.3°.
1992Wi13: ^{12}C(pol. p,p), E ≈14.231 MeV; reported $\sigma(\theta)$, $A_y(\theta)$ as in (1980Th05). See also (1983Wi04).
1993Ba37: ^{12}C(pol. p,p), (pol. p,p′) E=318 MeV; measured $\sigma(\theta)$ and polarization observables. RPA, DWIA analyses.
1993Da16: ^{12}C(p,p) E=1.5-1.8 MeV; measured σ(E). Analyzed interaction of proton induced bremsstrahlung with resonances. Discussed total collision duration.
1993Sy01: ^{12}C(pol. p,p) E=3.5-7.5 MeV; measured $\sigma(\theta)$, $A_y(\theta)$ and polarization observables for θ=30° to 145°.
1994Ai04: ^{12}C(p,p) E≈16.5-20 MeV; measured $\sigma(\theta)$.
1994Fa05: ^{12}C(p,p) E=1.80, 1.83 MeV; measured $\sigma(\theta)$, Analyzed interaction of proton induced bremsstrahlung with resonances.
1996Ho08: ^{12}C(pol. p,p) E=500 MeV; measured polarization transfer parameter.
1999Ta22: ^{12}C(pol. p,p) E=392 MeV; measured polarization observables for θ=0°.
2001Op01: ^{12}C(pol. p,p′) E=198 MeV; measured polarization observables for θ=7° to 22°.
2003Ha12: ^{12}C(pol. p,p) E=150 MeV; measured polarization observables for θ≈5° to 30°.
2006Ca19: ^{12}C(p,p) E=3-7 MeV; measured $\sigma(\theta)$ for θ=150°.
2007Be47: ^{12}C(p,p′γ) E=5-25 MeV; measured E_γ, I_γ, $\sigma(\theta)$ for θ=45° to 157.5°.
2010To03: ^{12}C(p,p) E=4.9-6.1 MeV; measured scattered protons. Deduced yields, stopping σ, sharp backscattering resonance at E_p=4808 keV.
2011Ab05: ^{12}C(p,p) E=2.7-7 MeV; measured backscattered protons for θ=140° to 170°. Analyzed utility for elastic spectroscopy.
2011Gu31: ^{12}C(p,p) E=1-2, 8 MeV measured $\sigma(\theta)$ for 30° to 170°.

theoretical analysis:
1971Au02: Computed partial proton width for E_x=15.07 MeV T=3/2 state.

^{12}C(p,p):res (continued)

1973An07: ^{12}C(p,p) E=1.5-3 MeV; analyzed E≈3.5 MeV resonances.
1977Al25: ^{12}C(p,p) E=1 GeV; analyzed induced proton polarization.
1981Pe06: ^{12}C(p,p) E_p≈1.7 MeV; calculated $\sigma(\theta)$.
1983Ol04: ^{12}C(p,p) E<4.5 MeV; calculated σ(E). S-matrix formalism.
1984Ko37: ^{12}C(vec p,p_0); analyzed data for states up to E_x=7.8 MeV.
1984Ph02: ^{12}C(pol. p,p) E=800 MeV; analyzed LANL $\sigma(\theta)$ and $A_y(\theta)$ data to obtain OM parameters. See also (1985Bl22).
1993By02: ^{12}C(p,p) E=64.9, 72, 83.4 MeV; calculated $\sigma(\theta)$ for θ=20°−80°. Analyzed N-N interaction.
2019Ma89: ^{12}C(p,p′γ) E=8-22 MeV; measured $\sigma(\theta)$ for θ=50° to 140°.
2005Pi16: ^{12}C(p,p) E≈1-7 MeV. Calculated $\sigma(\theta)$ and predicted level energies.
2015Be12: ^{12}C(p,p) E < 200 MeV. Cluster model analysis of proton scattering.

^{13}N Levels

E(level)[†]	J^π	Γ	L	Comments
2369 *3*	1/2$^+$	31 keV	0	E(level),J^π,Γ: From E_{res}=461 keV *3* (1953Ja04). θ^2=0.54 (1953Ja04 × 0.66). (1951Ja21): E_x=2379 keV, Γ=33 keV. (1953Ja04): E_{res}=461 keV *3*, J^π=1/2$^+$ and Γ=31 keV from phase-shift analysis. (1954Mi05): E_{res}=462 keV *4* and $\Gamma_{c.m.}$=32 keV. (1976Me22): $E_{c.m.}$=424 keV with $\Gamma_{c.m.}$=33 keV (1976Me22).
3499 *6*	3/2$^-$	63 keV	1	θ^2=0.031 (1953Ja04 value × 0.66). E(level),J^π,Γ: From E_p=1686 keV *6* (1966Ar03). (1951Ja21): E_x=3501 keV, Γ=42 keV. (1953Ja04) E_{res}=1698 keV, J^π=3/2$^-$ and Γ=55 keV. (1966Ar03): E_p=1686 keV *6*, J^π=3/2$^-$ and Γ=63 keV. They also report ΔE(3/2$^-$,5/2$^+$)=48 keV *2* and reduced width values. (1976Me22): $E_{c.m.}$=1558 keV with $\Gamma_{c.m.}$=55 keV. (1992Ba30): E_{res}=1685 keV *6* J=3/2$^-$ from phase-shift analysis.
3544.4 *5*	5/2$^+$	49.0 keV *5*	2	E(level): E_{res}=1735.5 keV *5* from the average of E_p=1734 keV *6* (1966Ar03), E_p=1736 keV *8* (1992Ba30) and E_p=1735.5 keV *5* from the (2023Ke11) analysis of (1976Me22). J^π,Γ: From the (2023Ke11) R-matrix analysis of (1976Me22). θ^2=0.21 (1953Ja04 value × 0.66). (1951Ja21): E_x=3549 keV, Γ=40 keV (1951Ja21). (1953Ja04) E_{res}=1748 keV, J^π=5/2$^+$ and Γ=61 keV, (1966Ar03): E_p=1734 keV *6*, J^π=5/2$^+$ and Γ=74 keV. They also report ΔE(3/2$^-$,5/2$^+$)=48 keV *2* and reduced width values. (1976Me22): $E_{c.m.}$=1604 keV with $\Gamma_{c.m.}$=50 keV. A subsequent reanalysis in (2023Ke11) resulted in E_p=1735.5 keV *5* with J^π=5/2$^+$, and Γ=49.0 keV *5*. (1992Ba30): E_{res}=1736 keV *8* J=5/2$^+$ from phase-shift analysis.
6378 *8*	5/2$^+$	11 keV	2	E(level),J^π,Γ: From E_{res}=4808 keV *8* (1956Re39). θ^2=0.0031 (1956Re39). (1956Re39): E_{res}=4808 keV *8*, J^π=5/2$^+$, Γ_{lab}=12 keV and θ^2=0.0031 from phase-shift analysis. (1966Ba35): E_{res}=4.80 MeV, J^π=5/2$^+$ and Γ_{lab}=12 keV. See also (1967Ba84).
6890 *6*	3/2$^+$	115 keV *5*	2	Γ_{p0}=51 keV (1963Ba36); Γ_{p1}=63 keV (1963Ba36) θ^2=0.13 (1963Ba36). E(level): From E_{res}=5363 keV *6* from the average of E_{res}=5370 keV *8* (1956Re39), E_{res}=5.35 MeV *1* (1963Ba36) and E_p=5374 keV *20* (1967Du12). J^π: From phase-shift analysis of angular distributions and σ(E) in (1956Re39) ^{12}C(p,p),(p,$p_1\gamma(\theta)$). See also (1965Be12). Γ: From (1963Ni05). Γ_{p0}: See also Γ_{p0}=46 keV (1963Ni05).

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^{12}C(p,p):res (continued)

^{13}N Levels (continued)

E(level)[†]	J^π	Γ	L	Comments
				(1956Re39): E_{res}=5370 keV *8*, J^π=3/2$^+$ and Γ_{lab}=125 keV. (1956Sc29): E_{res}=5.30 keV, L:J^π=2:3/2$^+$, Γ=50 keV. See unpublished results in (1959Aj76). (1960Yo05): E_{res}=5.37 MeV. (1961Ad04): E_{res}=5.63 MeV and Γ_{lab}=140 keV. (1962Sh22): E_{res}=5.38 MeV, J^π=3/2$^+$, Γ=115 keV and θ^2=0.01 from phase-shift analysis. (1961Ba25, 1961Mc11): E_{res}=5.4 MeV. (1963Ba36): E_{res}=5.35 MeV *1*, J^π=3/2$^+$, $\Gamma_{c.m.}$=114 keV Γ_{p0}=51 keV, Γ_{p1}=63 keV. (1963Ni05): E_p=5.38 MeV, J^π=3/2$^+$, $\Gamma_{c.m.}$=115 keV *5* and Γ_{p0}=46 keV (1963Ni05). (1966Ba35): E_{res}=5.30 MeV, J^π=3/2$^+$ and Γ_{lab}=74 keV. (1967Du12): E_p=5374 keV *20*. (1968Be31): E_{res}=5.38 MeV, J^π=3/2$^+$.
7155 *9*	7/2$^+$	9.0 keV *5*	4	Γ_{p0}=0.36 keV; Γ_{p1}=8.64 keV *50* E(level),J^π: From E_{res}=5.65 MeV *1* (1963Ba36). Γ,Γ_{p1}: From (1963Ni05). θ^2=0.016 (1963Ba36). (1960Yo05): E_{res}=5.69 MeV (1960Yo05). (1963Ba36): E_{res}=5.65 MeV *1*, J^π=7/2$^+$, $\Gamma_{c.m.}$=7.7 keV Γ_{p0}=0.03 keV, Γ_{p1}=7.4 keV. Γ_{p0}=0.03 keV may be a typo since the value Γ_{p0}=0.3 keV gives the better accounting. Phase-shift and interference analysis. (1963Ni05) E_p=5.68 MeV, J^π=(7/2$^+$), $\Gamma_{c.m.}$=9.0 keV *5* and Γ_{p0}=0.36 keV. Phase-shift analysis.
7.38×10^3 *1*	5/2$^-$	69 keV *5*	3	Γ_{p0}=6.9 keV E(level): From (1963Ba36). J^π: From polarization data in (1968Be31). See discussion in (1966Sh10). Γ,Γ_{p0}: From (1963Ni05). See also $\Gamma_{c.m.}$=61 keV, Γ_{p0}=5.0 keV, Γ_{p1}=56 keV (1963Ba36) and Γ_{lab}=70 keV and Γ_{p0}/Γ=0.08 (1968Be31). θ^2=0.069 (1963Ba36). (1956Br27) E_{res}=5891 keV, Γ_{lab}= 55 keV. (1956Sc29): E_{res}=5.85 keV, L:J^π=1:3/2$^-$, Γ=50 keV. See unpublished results in (1959Aj76). (1960Yo05): E_{res}=5.93 MeV. (1961Ad04): E_{res}=5.89 MeV, Γ_{lab}=70 keV. (1961Ba25,1961Mc11): E_{res}=5.9 MeV. (1962Sh22): E_{res}=5.90 MeV, J^π=5/2$^+$, Γ=80 keV and θ^2=0.01 from phase-shift analysis. (1963Ba36): E_{res}=5.89 MeV *1*, J^π=(5/2$^-$,7/2$^-$), $\Gamma_{c.m.}$=61 keV, Γ_{p0}=5.0 keV, Γ_{p1}=56 keV. (1963Ni05): E_p=5.90 MeV, J^π=5/2$^-$, $\Gamma_{c.m.}$=69 keV *5* and Γ_{p0}=6.9 keV. (note:Γ_{lab}=75 keV *5* is listed in the abstract as $\Gamma_{c.m.}$. The issue is clear in the conclusions paragraph). (1966Ba35): E_{res}=5.88 MeV, J^π=5/2$^-$ and Γ_{lab}=70 keV. (1968Be31): E_{res}=5.88 MeV, J^π=5/2$^-$, Γ_{lab}=70 keV and Γ_{p0}/Γ=0.08.
8.0×10^3	3/2$^+$	≈1.5 MeV	2	E(level): E_{res}≈6530 from average of E_{res}=6.65, 6.6, 6.35 MeV. J^π: From (1962Sh22,1966Ba35). Γ: From average of Γ=1400 keV (1962Sh22) and Γ_{lab}=1.72 MeV (1966Ba35). See also Γ=350 keV (1956Sc29). θ^2=0.14 (1962Sh22). (1956Sc29): E_{res}=6.65 keV, L:J^π=2:3/2$^+$, Γ=350 keV. (1961Ba25, 1961Mc11): E_{res}=6.65 MeV. (1961Na02): E_{res}=(6.65) MeV.

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^{12}C(p,p):res (continued)

^{13}N Levels (continued)

E(level)[†]	J^π	Γ	L	Comments
				(1962Sh22): E_{res}=6.6 MeV, J^π=3/2$^+$, Γ=1400 keV and θ^2=0.14 from phase-shift analysis. (1966Ba35): E_{res}=6.35 MeV, J^π=3/2$^+$ and Γ_{lab}=1.72 MeV.
8.90×10^3	1/2$^-$	230 keV	1	E(level),Γ: From E_{res}≈7540 keV, Γ from Γ_{lab}≈250 keV. θ^2=0.02 (1962Sh22). (1961Ad04): E_{res}=7.55 MeV, Γ_{lab}=255 keV. (1961Ba25, 1961Mc11, 1961Mc16): E_{res}=7.6 MeV. (1962Sh22): E_{res}=7.53 MeV, J^π=1/2$^-$, Γ=225 keV and θ^2=0.02 from phase-shift analysis. (1966Ba35): E_{res}=7.53 MeV, J^π=1/2$^-$ and Γ_{lab}=250 keV. (1973Be37): $E_{res.}$=7575 keV and Γ=0.25 MeV.
9.48×10^3	3/2$^-$	30 keV	1	E(level): From E_{res}=8170 keV. θ^2=0.001 (1962Sh22). Γ_{p1}/Γ=0.72 (1972Be15). (1961Ad04): E_{res}=8.17 MeV, Γ_{lab}=38 keV. (1961Ba25, 1961Mc11, 1961Mc16): E_{res}=8.2 MeV. (1962Sh22): E_{res}=8.17 MeV, J^π=3/2$^-$, Γ=30 keV and θ^2=0.001 from phase-shift analysis. (1966Ba35): E_{res}=8.16 MeV, J^π=3/2$^-$ and Γ_{lab}=30 keV. (1972Be15): E_{res}=8.18, Γ_{lab}≈28 keV and Γ_{p1}/Γ=0.72.
10.37×10^3	5/2$^-$	30 keV	3	Γ_{p0}/Γ=0.26 (1968Be31). E(level),J^π,Γ: From E_{res}≈9130 keV (1968Be31). E(level): In (1966Sw04) a doublet was identified around E_{res}=9.12 MeV. Previously, only the J^π=7/2$^-$ state had been identified. Later, (1967Sw02) identified the doublet members at E_p= 9145 and 9152 keV via phase-shift analysis with J^π=5/2$^-$ and 7/2$^-$ and with Γ_{lab}=12 and 90 keV, respectively. E(level): In (1968Be31) E_{res}=9.13 MeV, J^π=5/2$^-$ from polarization data , Γ_{lab}=33 keV and Γ_{p0}/Γ=0.26. The level energies of the doublet states differ by less than 2 keV. (1961Ad04): E_{res}=9.12 MeV, Γ_{lab}=70 keV. (1961Ba25, 1961Mc11, 1961Mc16): E_{res}=9.2 MeV. (1961Na02): E_{res}=9.1 MeV, Γ=150 keV.
10.37×10^3	7/2$^-$	76 keV	3	Γ_{p0}/Γ=0.81 (1968Be31). E(level),J^π,Γ: From E_{res}≈9130 keV (1968Be31). E(level): In (1966Sw04) a doublet was identified around E_{res}=9.12 MeV. Previously, only the J^π=7/2$^-$ state had been identified. Later, (1967Sw02) identified the doublet members at E_p=9145 and 9152 keV via phase-shift analysis with J^π=5/2$^-$ and 7/2$^-$ and with Γ_{lab}=12 and 90 keV, respectively. E(level): In (1968Be31) E_{res}=9.13 MeV, J^π=7/2$^-$ from polarization data, Γ_{lab}=82 keV and Γ_{p0}/Γ=0.81. (1961Ad04): E_{res}=9.12 MeV, Γ_{lab}=70 keV. (1961Ba25, 1961Mc11, 1961Mc16): E_{res}=9.2 MeV. (1961Na02): E_{res}=9.1 MeV, Γ=150 keV. (1962Sh22): E_{res}=9.14 MeV, J^π=7/2$^-$, Γ=73 keV and θ^2=0.01 from phase-shift analysis. (1966Ba35): E_{res}=9.13 MeV, J^π=7/2$^-$ and Γ_{lab}=84 keV.
11.49×10^3 *5*	5/2$^+$	430 keV *35*	2	Γ_{p0}/Γ=0.70 *5* (1973Me03) E(level),J^π,Γ: From E_{res}=10.35 MeV *5* (1973Me03). In (1976Aj04) values from the E_p=9.5-11.5 MeV phase-shift analysis of (1973Me03) were accepted; we continue this acceptance and note that averaging with other values would have little impact. (1961Mc16): E_{res}=10.3 MeV. (1961Na02): E_{res}=10.5 MeV, Γ=700 keV. (1972Wi26): E_{res}=10.25 MeV *10*, J^π=5/2$^+$, Γ=0.45 MeV *10* and Γ_{p0}/Γ=0.65 *15*.

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^{12}C(p,p):res (continued)

^{13}N Levels (continued)

E(level)[†]	J^{π}	Γ	L	Comments
				(1973Me03): E_{res}=10.35 MeV *5*, J^{π}=5/2^{+}, $\Gamma_{c.m.}$=430 keV *35* and Γ_{p0}/Γ=0.70 *5*.
11.70×10^{3} *3*	5/2^{-}	115 keV *30*	3	Γ_{p0}/Γ=0.60 *4* (1973Me03) E(level),J^{π},Γ: E_{res}=10.58 MeV *3* (1973Me03). The E_{p}=9.5-11.5 MeV phase-shift analysis of (1973Me03) is accepted. See comment on E_{x}=10.49 MeV. (1961Ad04): E_{res}=10.51 MeV, Γ_{lab}=85 keV. (1961Ba25, 1961Mc11, 1961Mc16): E_{res}=10.5 MeV. (1972Wi26): E_{res}=10.51 MeV *2*, J^{π}=5/2^{-}, Γ=120 keV *30* and Γ_{p0}/Γ=0.55 *5*. (1973Me03): E_{res}=10.58 MeV *3*, J^{π}=5/2^{-}, $\Gamma_{c.m.}$=115 keV *30* and Γ_{p0}/Γ=0.60 *4*.
11.74×10^{3} *4*	3/2^{+}	250 keV *30*	2	Γ_{p0}/Γ=0.30 *5* (1973Me03) E(level),J^{π},Γ: E_{res}=10.62 MeV *4*, J^{π}=3/2^{+}, $\Gamma_{c.m.}$=250 keV *30* and Γ_{p0}/Γ=0.30 *5* from the E_{p}=9.5-11.5 MeV phase-shift analysis of (1973Me03) are acccepted. See comment on E_{x}=10.49 MeV. See also E_{res}=10.70 MeV *5*, J^{π}=3/2^{+}, Γ=250 keV *50* and Γ_{p0}/Γ=0.62 *10* (1972Wi26).
11.74×10^{3} *5*	3/2^{-}	530 keV *80*	1	Γ_{p0}/Γ=0.55 *5* (1973Me03) E(level),J^{π},Γ: E_{res}=10.62 MeV *5*, J^{π}=3/2^{-}, $\Gamma_{c.m.}$=530 keV *80* and Γ_{p0}/Γ=0.55 *5* from the E_{p}=9.5-11.5 MeV phase-shift analysis of (1973Me03) are acccepted. See comment on E_{x}=10.49 MeV. See also E_{res}=10.54 MeV *50*, J^{π}=3/2^{-}, Γ=230 keV *50* and Γ_{p0}/Γ=0.45 *10* (1972Wi26).
11.86×10^{3} *4*	1/2^{+}	380 keV *50*	0	Γ_{p0}/Γ=0.35 *5* (1973Me03) E(level),J^{π},Γ: E_{res}=10.75 MeV *4*, J^{π}=1/2^{+}, $\Gamma_{c.m.}$=380 keV *50* and Γ_{p0}/Γ=0.35 *5* from the E_{p}=9.5-11.5 MeV phase-shift analysis of (1973Me03) are acccepted. See comment on E_{x}=10.49 MeV. See also E_{res}=10.74 MeV, Γ_{lab}=140 keV (1961Ad04).
12.13×10^{3} *5*	7/2^{-}	250 keV *30*	3	Γ_{p0}/Γ=0.30 *5* (1973Me03) E(level): From E_{res}=11.05 MeV *5* (1973Me03). The E_{p}=9.5-11.5 MeV phase-shift analysis of (1973Me03) is acccepted. See comment on E_{x}=10.49 MeV. (1961Ad04): E_{res}=10.99 MeV, Γ_{lab}= 150 keV. (1961Mc16) E_{res}=11.0 MeV. (1973Me03): E_{res}=11.05 MeV *5*, J^{π}=7/2^{-}, $\Gamma_{c.m.}$=250 keV *30* and Γ_{p0}/Γ=0.30 *5*.
13.5×10^{3}		≈500 keV		E(level),Γ: From E_{p}=12.5 and Γ=500 keV (1961Na02).
14.05×10^{3} *2*	3/2^{+}	180 keV *35*	2	T=1/2; Γ_{p0}/Γ=0.29 *7* E(level),J^{π},Γ: From E_{res}=13.13 MeV *2*, J^{π}=3/2^{+}, $\Gamma_{c.m.}$=180 keV *35* and Γ_{p0}/Γ=0.29 *7* phase-shift analysis (1976Me18). The authors suggest a ≤70 keV systematic error in (1969Le18). See also E_{res}=13.2 MeV, Γ=500 keV (1961Na02).
14.7×10^{3}?		≈500 keV		E(level): See E_{res}=13.7 MeV, Γ=500 keV (1961Na02). This resonance does not appear in the (1981Aj01) evaluation or later.
15064.56 *40*	3/2^{-}	0.932 keV *28*	1	T=3/2 Γ_{p}=263 eV *14* (1980Th05) E(level),T: From E_{p}=14230.75 keV *20* and T=3/2 (1973Hu07). E(level): See also E_{p}=14232.5 keV *22* (1975Go03); Γ_{p}/Γ=0.18 was used in the fit. Γ: From Γ=1010 eV *30* and Γ_{p}=285 eV *15* (both lab frame) (1980Th05). Atomic excitations were taken into account, See also (1983Wi04,1992Wi13). Γ: See also $\Gamma_{c.m.}$=1.10 keV *9*, Γ_{p}=210 eV *11* and Γ_{p}/Γ=0.191 *17* (1975Hi07). J^{π}: From phase-shift analysis in (1969Le18). p decay to ^{12}C(0,4.4, 7.65, 9.65) is observed in (1977Ma16).

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^{12}C(p,p):res (continued)

^{13}N Levels (continued)

E(level)[†]	J^π	Γ	L	Comments
16.01×10^3 *4*	7/2$^+$	135 keV *90*	4	T=1/2; Γ_{p0}/Γ=0.05 *4* E(level): From average of E_{res}=15.27 MeV *3* (1973Me12) and E_{res}=15.24 MeV *4* (1976Me18). J^π: From phase-shift analysis in (1969Le18). Γ: From (1973Me12). See also (1976Me18). E(level): A second state near E_x=16 MeV with Γ≈500 keV had previously been adopted, apparently based on (1964Da03) and (1961Na02); however this seems unwarranted. In (1964Da03) the authors indicate improved data are necessary, and in (1961Na02,1967Ku02,1976Be28) the associated peaks are rather narrow. (1973Me12): E_{res}=15.27 MeV *3*, $\Gamma_{c.m.}$=130 keV *30* and Γ_p(12.71)=30 keV. (1976Me18): E_{res}=15.24 MeV *4*, J^π=7/2$^+$, $\Gamma_{c.m.}$=135 keV *90* and Γ_{p0}/Γ=0.05 *4*. (1961Na02): E_{res}=15.1 MeV (1961Na02). (1967Ku02): E_p=15.2 MeV and T=(1/2) (1967Ku02). (1976Be28) E_p=15.27 MeV (1976Be28).
17.4×10^3				E(level): From E_p=16.8 MeV (1976Be28).
18.15×10^3 *3*	3/2$^+$	322 keV *75*	2	T=1/2; Γ_{p0}/Γ=0.08 *2* E(level),J^π,Γ: From E_{res}=17.58 MeV *3* phase-shift analysis in (1976Me18). (1962Wa31): E_p=17.5 MeV and $\Gamma_{c.m.}$=0.33 MeV *10*. (1976Me18): E_{res}=17.58 MeV *3*, J^π=3/2$^+$, $\Gamma_{c.m.}$=322 keV *75* and Γ_{p0}/Γ=0.08 *2*. See also table 13.25 of (1970Aj04) where Ep=17.27 MeV *5* and $\Gamma_{c.m.}$≈400 keV from (1968Sn03) and a 1968 Private Communication with Snover are referenced.
18.17×10^3 *2*	1/2$^-$	225 keV *50*	1	T=1/2; Γ_{p0}/Γ=0.24 *6* E(level),J^π,Γ: From E_{res}=17.60 MeV *2*, J^π=1/2$^-$, $\Gamma_{c.m.}$=225 keV *50* and Γ_{p0}/Γ=0.24 *6* phase-shift analysis in (1976Me18). E(level): See also E_p=17.6 MeV and T=(1/2) (1967Ku02).
18405 *5*	3/2$^+$	66 keV *8*	2	T=3/2 E(level),Γ: From E_p=17.857 MeV in (1970Aj04) Table 13.25. E(level): In (1970Aj04), E_p=17857 keV *5* and Γ=66 keV *8* are given in Table 13.25; the values appear connected with (1968Sn03) a 1968 Private Communication with Snover. J^π: From phase-shift analysis in (1969Le18). (1967Ku02): E_x=18.43 MeV *2*, Γ≈30 and T=3/2. (1962Wa31): E_p=18.05 MeV and $\Gamma_{c.m.}$≤200 keV. (1976Be28): E_p=17.87 MeV.
18960 *9*	3/2$^-$ or 7/2$^+$	23 keV *5*		T=3/2 E(level),Γ: From E_p=18.460 MeV in (1970Aj04) Table 13.25. E(level): In (1970Aj04), E_p=18460 keV *10* and Γ=23 keV *5* are given in Table 13.25; the values appear connected with (1968Sn03) and a 1968 Private Communication with Snover. J^π: From phase-shift analysis in (1969Le18). (1967Ku02): E_x=18.98 MeV *2*, Γ≈10 keV, L=(1) and T=3/2. (1976Be28): E_p=18.46 MeV.
19.9×10^3	7/2$^+$	750 keV	4	T=1/2 E(level),J^π,Γ: From E_x=19.9 MeV, J^π=7/2$^+$, Γ=0.75 MeV polarization data in (1979Ga13); see also E_p=19.3 MeV and $\Gamma_{c.m.}$≤200 keV (1962Wa31). E(level): Several earlier Ajzenberg-Selove evaluations associate this state with resonances observed near $E_{c.m.}$=19.8 MeV; see (1965Ma26,1966Lo16,1967Sc11), but these appear to be misplaced.

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^{12}C(p,p):res (continued)

^{13}N Levels (continued)

E(level)†	Jπ	Γ	Comments
20.2×10^3	5/2$^-$	1000 keV	E(level),Jπ,Γ: From E_x=20.2 MeV, J^π=5/2$^-$, Γ=1.0 MeV polarization data in (1979Ga13). E(level): See also (1963Me04) who suggested resonances near E_p=20 MeV based on their analysis of ^{12}C(p,p′γ(12.7,15.1)).
20.90×10^3 *30*	1/2$^+$	1.2 MeV	E(level): From E_p=20.5 MeV *30* (1973Me12). Jπ,Γ: From E_x=20.9 MeV polarization data in (1979Ga13). (1966Lo16): $E_{c.m.}$=19.0 MeV, J^π=(5/2,9/2) and Γ=1.5 MeV. (1967Sc11) find E_x=20.9 MeV, J^π=5/2$^+$, L=2,0. (1973Me12): E_p=20.55 MeV *30*, J^π=(5/2$^+$), Γ=1.1 MeV, Γ_{p0}≈110 keV, $\Gamma_{p15.11}$≈400 keV. (1976Fe11): E_p=20 MeV. (1976Be28): E_p=20.5 MeV, J^π=(3/2$^+$). (1979Ga13): E_x=20.9 MeV, J^π=1/2$^+$, Γ=1.2 MeV. See (1963Me04) who suggested a resonance near E_p=20 MeV Based on their analysis of ^{12}C(p,p′γ(12.7,15.1)).
21.4×10^3	5/2$^-$	750 keV	E(level),Jπ,Γ: From E_x=21.4 MeV, J^π=5/2$^-$, Γ=0.75 MeV polarization data in (1979Ga13).
21.7×10^3	(3/2$^+$)		E(level): From (1964Ta15) analysis of (1963Di16) $E_{c.m.}$=19.75 MeV, J^π=(3/2$^+$) and $\Gamma_{c.m.}$=2.49 MeV are deduced. (1965Ma26):See $E_{c.m.}$=19.8 MeV. (1979Ga13): polarization data suggest a state around 21.7 MeV with J^π=3/2$^+$.
22.4×10^3 *5*	1/2$^+$	≈1 MeV	E(level): From E_p=22.2 MeV *5* (1973Me12). Jπ,Γ: From E_x=22.4 MeV polarization data in (1979Ga13). E(level): Resonances at several energies around E_x=22 MeV have been reported in (1963Di16, 1964Ta15, 1965Ma26, 1967Sc11). In (1970Aj04) Table 13.25 proton resonances were listed at E_x=21.99 and 22.6 MeV. However, guided by the discussion and analysis of (1979Ga13, 1981Aj01), we accept only the E_x=22.4 MeV Jπ=1/2$^+$ state. Along with the accepted states reported in (1979Ga13), their analysis indicated additional states around 21.7 with J^π=3/2$^+$ and above 22.7 with 3/2$^+$. (1964Ta15) analysis of (1963Di16): $E_{c.m.}$=20.05 MeV, J^π=(5/2$^+$) and $\Gamma_{c.m.}$=1.46 MeV. (1965Ma26): $E_{c.m.}$=20.01 MeV. (1967Sc11): E_x=22.5 MeV, J^π=5/2$^-$, L=1. (1966Lo16): $E_{c.m.}$=20.8 MeV, J^π=(5/2,9/2) and Γ=0.5 MeV. (1973Me12): E_p=22.2 MeV *5*, J^π=(5/2$^-$), Γ≈2 MeV, Γ_{p0}≈200 keV, $\Gamma_{p15.11}$≈450 keV. (1979Ga13): E_x=22.4 MeV, J^π=1/2$^+$, Γ≈1.0 MeV.
24.1×10^3	7/2	<500 keV	E(level),Jπ,Γ: From $E_{c.m.}$=22.2 MeV, J^π=7/2 and Γ=0.5 MeV polarization data in (1966Lo16). E(level): See also E_p=23.8 MeV (1975Sl02).
25.6×10^3	(3/2$^-$)		E(level): From average of E_x=25.5 MeV (1967Sc11) and E_p=25.9 MeV (1975Sl02). Jπ: From E_x=25.5 MeV, J^π=3/2$^-$, L=1 Legendre polynomial angular correlation analysis in (1967Sc11).
26.87×10^3			E(level): From (1964Ta15) analysis of (1963Di16) where $E_{c.m.}$=24.93 MeV and $\Gamma_{c.m.}$=2.17 MeV are deduced. (1965Ma26): $E_{c.m.}$=24.9 MeV (1965Ma26). (1976Fe11): E_p=27 MeV.
31.4×10^3			E(level): From E_p=32 MeV (1976Fe11); seen only in ^{12}C(p,p′γ(4.44)).

† Level energies are deduced using E_p(res) and ^{12}C, p and ^{13}C masses from (2021Wa16: AME-2020). E_x=S_p+$E_{c.m.}$(relativistic).