

$^{12}\text{C}(\pi,\pi),(\pi^-, \pi^-)$ **1984Bi12,1987Co17,1993Ko17**

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

1970Ma18: $^{12}\text{C}(\pi^+, \pi^+), (\pi^-, \pi^-)$ E=30 MeV, measured $\sigma(\theta)$.
 1972Sc18, 1974Mu03: $^{12}\text{C}(\pi^+, \pi^+)$ E=115,167,242 MeV, measured $\sigma(\theta)$. Deduced Coulomb-nuclear interference effects, real part of forward nuclear amplitude.
 1975Am03, 1976Co10, 1978Dy01, 1979Dy02: $^{12}\text{C}(\pi^+, \pi^+)$ E=50 MeV, measured $\sigma(\theta)$. Optical model analysis.
 1975Ba57: $^{12}\text{C}(\pi^+, \pi^+), ^{12}\text{C}(\pi^+, \pi^{+'})$ E=70-100 MeV, measured $\sigma(\theta)$.
 1975Ka03: $^{12}\text{C}(\pi, \pi)$ E=120-230 MeV, calculated $\sigma(\theta)$. Phenomenological model.
 1976Do06: $^{12}\text{C}(\pi^+, \pi^+)$ E=29 MeV, measured $\sigma(\theta)$.
 1977Pi02, 1977Pi09, 1978Ch33, 1979Ch05: $^{12}\text{C}(\pi^+, \pi^+), (\pi^+, \pi^{+'}), (\pi^-, \pi^-), (\pi^-, \pi^{-'})$ E=148,162,226 MeV, measured $\sigma(\theta)$.
 1978Be64: $^{12}\text{C}(\pi^-, \pi^-)$ E at 0.62-60 GeV/c. ^{12}C level deduced excitation mechanism.
 1978BIZX: $^{12}\text{C}(\pi, \pi)$ E=180,191 MeV, measured $\sigma(\text{quasi-free})$.
 1978Jo03: $^{12}\text{C}(\pi^+, \pi^+)$ E=28.4,38.6,48.9 MeV, measured $\sigma(\theta)$.
 1978Jo09: $^{12}\text{C}(\pi^-, \pi^-)$ E=29 MeV, measured $\sigma(\theta)$.
 1978Mo25: $^{12}\text{C}(\pi^+, \pi^+)$ E=49.9 MeV, measured $\sigma(\theta)$.
 1979BI07: $^{12}\text{C}(\pi^+, \pi^+)$ E=40 MeV, measured $\sigma(\theta)$.
 1979Gu01: $^{12}\text{C}(\pi^+, \pi^+)$ E=23,29,35 MeV, measured $\sigma(\theta)$, $\theta > 161^\circ$, comparison with calculations based on Ericson-Ericson-Lorentz-Lorenz effect, models of Landau-Thomas, Stricker, others.
 1979GyZZ, 1979Jo08: $^{12}\text{C}(\pi^-, \pi^-)$ E=29 MeV, measured ratios of $\sigma(\theta)$.
 1979Mo15: $^{12}\text{C}(\pi^+, \pi^+), (\pi^-, \pi^{-'})$ E=162 MeV, measured $\sigma(E_\pi +, \theta)$, $\sigma(E_\pi -, \theta)$. ^{12}C deduced isospin mixed doublet near 19.5 MeV.
 1980Ba45: $^{12}\text{C}(\pi^+, \pi^+)$ E=38.6,47.7 MeV, measured $\sigma(\theta)$. ^{12}C deduced rms charge radii differences.
 1980Fr12: $^{12}\text{C}(\pi^-, \pi^-)$ E at 40 GeV/c, measured $\pi^-\gamma$ -coin, $\sigma(\text{total})$. Deduced semicoherent channel effects on hadronic processes.
 1980Ka13: $^{12}\text{C}(\pi^-, \pi^-)$ E at 40 GeV/c, measured multiplicity, rapidity distributions, inelasticity coefficients.
 1980Th01: $^{12}\text{C}(\pi^+, \pi^+)$ E $\approx$ 100-200 MeV, measured $\sigma(E, \theta)$. ^{12}C deduced level, isospin mixing effects.
 1981Am02: $^{12}\text{C}(\pi^+, \pi^+), (\pi^+, \pi^{+'})$ E=35.68 MeV, measured $\sigma(\theta)$. Optical model, DWIA analysis.
 1981Pr03: $^{12}\text{C}(\pi^+, \pi^+)$ E=30,50 MeV, measured $\sigma(\theta)$.
 1982AnZW: $^{12}\text{C}(\pi^-, \pi^-), (\pi^-, \pi^{-'})$ E=100 MeV, measured $\sigma(\theta)$.
 1982Gi08: $^{12}\text{C}(\pi^+, \pi^+)$ E=13.9 MeV, measured $\sigma(\theta)$. Deduced absorption parameters.
 1982Gu08: $^{12}\text{C}(\pi^+, \pi^+)$ E=29,38,44,50,56 MeV, measured $\sigma(\theta)$.
 1983BI11: $^{12}\text{C}(\pi^-, \pi^-), (\pi^+, \pi^+)$ E=65,80 MeV, measured $\sigma(\theta)$. Deduced isospin effects, pion-nucleus optical potential parameters.
 1983Ob02: $^{12}\text{C}(\pi^+, \pi^+)$ E=20 MeV, measured $\sigma(\theta)$. Deduced optical model, s-, p-wave strength parameters.
 1984An11: $^{12}\text{C}(\pi^-, \pi^-), (\pi^-, \pi^{-'}), (\pi^+, \pi^+), (\pi^+, \pi^{+'})$ E=100 MeV, measured $\sigma(\theta)$, $\sigma(E_\pi)$.
 1984BI12: $^{12}\text{C}(\pi^+, \pi^{+'})$ E=170 MeV, deduced resonances, Γ , possible multipole character.
 1984De21: $^{12}\text{C}(\pi^-, \pi^-), (\pi^+, \pi^+)$ E=76 MeV, measured $\sigma(\theta)$. Deduced forward scattering amplitude vs E, Coulomb-nuclear interference role.
 1984Fa11: $^{12}\text{C}(\pi^-, \pi^{-'}), (\pi^+, \pi^{+'})$ E=220 MeV, measured $\sigma(\theta_\pi, E_\pi)$, vs missing mass. Deduced reaction mechanism.
 1984Gm01: $^{12}\text{C}(\pi^+, \pi^+)$ E=87.5,162,226 MeV, measured $\sigma(\theta)$. Deduced reaction mechanism.
 1984Le01: $^{12}\text{C}(\pi^-, \pi^-)(\pi^+, \pi^+)$ E=80 MeV, measured $\sigma(\theta)$.
 1984Ma42: $^{12}\text{C}(\pi^-, \pi^-), (\pi^-, \pi^{-'}), (\pi^+, \pi^+), (\pi^+, \pi^{+'})$ E=675.7 MeV, measured $\sigma(\theta)$. Deduced optical model parameters. DWBA analysis.
 1984Mo18: $^{12}\text{C}(\pi^+, \pi^+), (\pi^+, \pi^{+'})$ E=162 MeV, measured $\sigma(\theta)$, missing mass spectra. DWIA analysis.
 1984So12: $^{12}\text{C}(\pi^+, \pi^{+'})$ E=65,90 MeV, measured $\sigma(\theta_\pi)$, $\theta-\gamma$. Deduced nuclear matter density role, pion-nuclear reaction mechanism role.
 1984So13: $^{12}\text{C}(\pi^-, \pi^-), (\pi^-, \pi^{-'}), (\pi^+, \pi^+), (\pi^+, \pi^{+'})$ E=50 MeV, measured $\sigma(\theta)$. Deduced neutron, proton matrix elements.
 1984TaZY: $^{12}\text{C}(\pi^-, \pi^-)(\pi^-, \pi^{-'}), (\pi^+, \pi^+), (\pi^+, \pi^{+'})$ E=50 MeV, measured $\sigma(\theta)$.
 1985Ki05: $^{12}\text{C}(\pi^+, X)$ E at 2 GeV/c, measured $I_\gamma(\theta)$, Doppler line shapes. ^{12}C level deduced excitation mechanism.
 1985Mi16: $^{12}\text{C}(\pi^+, \pi^+), (\pi^-, \pi^-)$ E=50 MeV, measured, analyzed $\sigma(\theta)$. Deduced isospin dependence, neutron, proton density equality.
 1986An01: $^{12}\text{C}(\pi^+, \pi^{+'})$ E=67-100 MeV, measured $\sigma(\theta, E)$.
 1986DhZZ: $^{12}\text{C}(\pi^-, \pi^-)$ E $\approx$ resonance, measured $\sigma(E)$.
 1986Le11: $^{12}\text{C}(\pi^+, \pi^+), (\pi^+, \pi^{+'})$ E=50 MeV, measured $\sigma(\theta)$. ^{12}C transition deduced multiple scattering suppression,

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Ericson-Ericson-Lorentz-Lorenz effect evidence.

1986OI07: $^{12}\text{C}(\pi,\pi'\gamma)$ E=116,140,162,180,226 MeV, measured $\pi^-\gamma(\theta)$, $\pi^-\gamma(\Phi)$. Deduced isobar-nucleus dynamics role.

1987Co17: $^{12}\text{C}(\pi^+,\pi^+'),(\pi^-, \pi^-')$ E=100-291 MeV, measured $\sigma(\theta)$. Deduced σ . ^{12}C levels deduced isospin mixing effects. DWIA analysis.

1987Dh01: $^{12}\text{C}(\pi^+,\pi^+)$ E=100-240 MeV, measured $\sigma(\theta)$. Deduced model parameter modifications.

1988Ba27,1988OI02: $^{12}\text{C}(\pi,\pi'\gamma)$ E=116,140,162,180,226 MeV, measured $\sigma(E_\pi)$, $\pi^-\gamma$ -coin. ^{12}C levels deduced relative $\sigma(\text{ratio})$ vs E.

1988Oa03: $^{12}\text{C}(\pi^-, \pi^-'),(\pi^+, \pi^+')$ E=80-295 MeV, measured $\sigma(\theta)$. Deduced isobar excitation role. ^{12}C levels deduced σ ratio.

1988Ri03: $^{12}\text{C}(\pi^+,\pi^+'),(\pi^-, \pi^-')$ E=50 MeV, measured missing mass spectra, $\sigma(\theta)$. ^{12}C deduced 1^+ doublet excitation σ ratio anomaly nature.

1988St07: $^{12}\text{C}(\pi^+,\pi^+)$ E=180-260 MeV, analyzed $\sigma(\theta)$.

1989Kh06: $^{12}\text{C}(\pi,\pi)$ E=low, analyzed $\sigma(\theta)$, σ , other data. Deduced model parameters, π^- -nucleus scattering lengths, strong interaction shifts, widths.

1990Ja05: $^{12}\text{C}(\pi^-, \pi^-'),(\pi^-, \pi^-'),(\pi^+, \pi^+),(\pi^+, \pi^+')$ E=50 MeV, measured $\sigma(\theta)$. ^{12}C levels deduced isospin mixing features.

1990Ri04: $^{12}\text{C}(\pi^-, \pi^-'),(\pi^+, \pi^+)$ E=50 MeV, measured $\sigma(\theta)$.

1990Se04: $^{12}\text{C}(\pi^-, \pi^-)$ E=30,50 MeV, $^{12}\text{C}(\pi^+,\pi^+)$ E=50 MeV, measured $\sigma(\theta)$. Deduced optical model fits. DWBA analysis. DWBA analysis.

1991Mo13: $^{12}\text{C}(\pi^-, \pi^-)$ E=162 MeV, measured pion spectra, $\sigma(E,\theta)$.

1992RaZX: $^{12}\text{C}(\pi,\pi)$ E=400,500 MeV, measured $\sigma(\theta)$.

1993Ko17: $^{12}\text{C}(\pi^+,\pi^+'),(\pi^-, \pi^-')$, E=40,50,65 MeV; measured $\sigma(\theta)$. ^{12}C deduced level energies, Γ , sum rule strengths. DWIA analysis.

1994Bu09: $^{12}\text{C}(\pi^-, \pi^-)$ E=20,40 MeV, measured $\sigma(\theta)$. Deduced optical model parameters.

1995Bu37: $^{12}\text{C}(\pi,\pi)$ E=40 GeV, analyzed radiative scattering data. Deduced polarizability parameters determination accuracy related features.

1995Ta11: $^{12}\text{C}(\pi^-, \pi^-)$ E at 610-895 MeV/c, measured $\sigma(\theta)$. Deduced total, elastic, reaction σ .

1995TaZW: $^{12}\text{C}(\pi^-, \pi^-)$ E at 610,710,790,895,1000 MeV/c, $^{12}\text{C}(\pi^+,\pi^+)$ E at 1 GeV/c, measured $\sigma(\theta)$. Deduced reaction mechanism.

1997Ka22: $^{12}\text{C}(\pi^-, \pi^-'),(\pi^+, \pi^+)$ E=400,500 MeV, measured $\sigma(\theta)$; $^{12}\text{C}(\pi^+,\pi^+)$ E=672.5 MeV, $^{12}\text{C}(\pi^-, \pi^-)$ E=486.2,672.5 MeV, analyzed $\sigma(\theta)$.

 ^{12}C Levels

E(level)	J^π	E(level)	J^π	$T_{1/2}$
0		19.4×10^3 [†]	2^-	
4.4×10^3		19.65×10^3 [†]		
7.7×10^3		19.85×10^3 [‡]		330 keV
9.6×10^3		20.0×10^3 [#] 2		3.2 MeV 3
12.7×10^3		22.1×10^3 ^{‡@}		198 keV
15.1×10^3		22.7×10^3 [#] 4		1.0 MeV 2
16.1×10^3		22.94×10^3 [‡]		192 keV
18.25×10^3 ^{†@}	2^-	23.7×10^3 ^{‡@}		79 keV
19.25×10^3 ^{†@}	4	25.4×10^3 ^{‡@}		232 keV

[†] From (1987Co17).

[‡] From (1993Ko17).

[#] From (1984BI12).

[@] See (1982Mo25).