^{12}C(n,γ):E=thermal

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

1953Ba18: ^{12}C(n,γ); measured thermal neutron capture radiation from carbon, in addition to the 4948 keV *8* ground state γ ray previously reported, E_γ=3.68 MeV *5* was also found.
1958Gr01: ^{12}C(n,γ); measured thermal neutron capture radiation E_γ=4950 keV *15*, 3680 keV *20* and 1260 keV *15*; deduced I_γ.
1958Hu18: ^{12}C(n,γ); measured thermal capture cross sections as 3.3 mb *2*.
1961Ja19: ^{12}C(n,γ); measured thermal neutron capture radiation E_γ; deduced I_γ.
1964St25: ^{12}C(n,γ); measured thermal capture cross sections as 3.4 mb *3*.
1965Ja09: ^{12}C(n,γ); the neutron separation energy for the reaction was determined by measuring the γ-ray transitions: E_γ=4946 keV *1* implies S_n=4947.0 keV *10*.
1967Pr10: ^{12}C(n,γ); deduced S_n=4946.28 keV *17* from analysis of $E_{\gamma0}$=4945.46 keV *17*, $E_{\gamma1}$=1261.92 keV *6* and $E_\gamma(3864\to0)$=3683.94 keV *17*. Ge(Li) detector.
1967Ra24: ^{12}C(n,γ) E=thermal; measured E_γ; deduced Q. Natural targets.
1967Th05: ^{12}C(n,γ); measured thermal neutron capture radiation E_γ; deduced I_γ(4945)=66 *3* per 100 decays; I_γ(3685)=34 *2* and I_γ(1262)=34 *2*.
1968Sp01: ^{12}C(n,γ) E=thermal; measured E_γ=1261.76 keV *7*, I_γ=32 *1* per 100 decays; E_γ=3684.28 keV *14*, I_γ=32 *1*; E_γ=4945.8 keV *6*, I_γ=68 *1*; Q=4946.03. keV *15*.
1972Op01: ^{12}C(n,γ) E=thermal; measured E_γ, I_γ, used as calibration line. Ge(Li), NaI detectors.
1973Mu14: ^{12}C(n,γ); measured thermal capture cross section as 3.4 mb *3*.
1974Sp04: ^{12}C(n,γ); measured E_γ; deduced Q=4946.2 keV *4*.
1975Sm02: ^{12}C(n,γ); deduced Q from rf spectrometer mass measurement.
1978Ha14: ^{12}C(n,γ); deduced Q from double focusing mass spectrometer measurement; result implies S_n=4946.320 keV *50*.
1981MuZQ: ^{12}C(n,γ) E=thermal; measured σ(capture), ratio.
1981Pr04: ^{12}C(n,γ) E=thermal; measured thermal capture cross section on ^{nat}C as σ=3.50 mb *16*.
1982Ju01: ^{12}C(n,γ) E=thermal; measured E_γ, I_γ, at LANL Omega West reactor. Reported the thermal capture cross section as σ=3.53 mb *7*. Deduced I_γ(4946)=68.6 *9* per 100 decays and I_γ(3684)=31.0 *4*; implies I_γ(1261)≈31.4 *9*. Additionally, they observed a ground state decay from $^{13}C^*$(3089) with $I_\gamma(3089)/I_\gamma(4946)$≈0.006.
1982Mu14: ^{12}C(n,γ) E=thermal; measured E_γ, I_γ using a 55 cm^3 Ge-Li detector at Chalk River. For six transitions they deduced I_γ(4945.32)=67.47 *92* per 100 decays; I_γ(1856.6 keV *4*)=0.16 *1*; I_γ(1261.6 keV *1*)=32.36 *44*; I_γ(3684.0 keV *2*)=32.14 *64*; I_γ(595.5 keV *2*)=0.24 *1* and I_γ(3089.5 keV *4*)=0.43 *2*. Notably, $I_\gamma(3089)/I_\gamma(4946)$≈0.00597 in agreement with (1982Ju01). Analyzed capture mechanism.
1982Va13: ^{12}C(n,γ); measured γ rays from ^{1}H(n,γ):E=thermal. Using this value, the Q-values for various reactions, such as ^{12}C(n,γ) were evaluated and associated γ-ray energies were calculated.
1983Co09: ^{12}C(n,γ); deduced Q from analysis of atomic mass data.
In (1986Aj01) the E_γ values 4946.397 keV *31*, 1261.854 keV *6* and 3684.516 keV *30* are credited to van der Leun, et al., Neutron-Capture Gamma-Ray Spectroscopy and Related Topics 1981, London, No. 62 (1981) 548.
2008FiZZ and unpublished EGAF (Evaluated Gamma-ray Activation File) data: ^{12}C($n_{th.}$,γ) E=thermal; measured $\sigma(E_\gamma)$, deduced I_γ.
The authors measured thermal neutron capture reactions on several natural and enriched isotopic targets at the 10-MW Budapest Reactor. Yields were normalized to a limited set of standard targets, with the aim of improving absolute capture cross sections and transition probabilities. The capture γ rays from a graphite powder target were measured using a single Compton suppressed 27% HPGe detector. The relative γ intensities were normalized primarily to the ^{1}H(n,γ) (σ_γ=332.5±0.7 mb) cross section. The transition probabilities and cross sections were deduced by balancing the intensity feeding and deexciting each state. The neutron separation energy S_n=4946.32 keV *6* is deduced along with σ=3.87 mb *3*.
For six transitions the unpublished Budapest data used for EGAF gives: I_γ(4945.30 keV *7*)=68.6 *20* per 100 decays; I_γ(1856.98 keV *22*)=0.193 *40*; I_γ(1261.71 keV *6*)=31.2 *8*; I_γ(3684.02 keV *7*)=29.7 *10*; I_γ(595.16 keV *9*)=0.274 *25* and I_γ(3088.80 keV *21*)=0.373 *56*.
2016Fi06: XUNDL dataset compilded by TUNL, 2016.
The authors combined their EGAF data with other literature results to obtain a set of recommended values. Because the (2016Fi06) data are folded with other results, they are a resource for comparison. The present evaluation develops a different set of recommended reaction parameters based solely on reported ^{12}C($n_{th.}$,γ) data.

^{12}C(n,γ):E=thermal (continued)

For six transitions they deduced I_γ(4945.30 keV *7*)=67.8 *4* per 100 decays; I_γ(1856.98 keV *22*)=0.0162 *9*; I_γ(1261.71 keV *6*)=32.1 *4*; I_γ(3684.02 keV *7*)=32.0 *4*; I_γ(595.16 keV *9*)=0.0248 *9* and I_γ(3088.80 keV *21*)=0.041 *12*. Noteably, I_γ(3089)/I_γ(4946)≈0.00060 is in disagreement with (1982Ju01) and (1982Mu14); the three weak transitions are reported with intensities that are 10 times lower than (1982Mu14). Comparison with (2008FiZZ) suggests the discrepancy is a typo, but the collection of associated works contains many inconsistencies.

Theory:
1980Gr02: Analyzed S_n.
1981MuZQ: ^{12}C(n,γ) E=thermal; Z=1-60; compiled, evaluated thermal neutron induced σ, resonance parameter data.
1983Ho17: ^{12}C(n,γ) E=thermal; calculated radiative capture σ; deduced potential, resonance scattering interference effects.
1987Ly01: ^{12}C(n,γ) E=thermal; calculated capture σ. Optical model, Lane-Lynn-Raman method.
1999ZhZM: ^{12}C(n,γ) E=thermal; compiled, evaluated prompt γ-ray data.
2000ZhZP: ^{12}C(n,γ) E=thermal; compiled, analyzed prompt E_γ, I_γ.
2002Re13: ^{12}C(n,γ) E=thermal; compiled, analyzed prompt E_γ, I_γ.
2003MoZU: ^{12}C(n,γ) E=thermal; compiled, analyzed k_0 factors and capture σ, neutron binding energies.
2003MuZZ: compiled, analyzed thermal neutron capture σ.
2004Ma76: ^{12}C(n,γ) E=thermal; analyzed data; deduced k_0 factors, γ-emission probabilities.
2011Sl01: ^{12}C(n,γ) E=thermal; compiled, evaluated σ, $\sigma(E_\gamma)$, γ decay schemes, levels, J, π using ENDF, DICEBOX.
2021Si17: ^{12}C(n,γ) E=thermal−0.86 MeV; calculated σ, reaction rates using TALYS nuclear model code.

^{13}C Levels

E(level)†	J^π	Comments
0	1/2⁻	J^π: See (1953Ba18,1967Pr10,1967Th05,1968Sp01,1982Mu14,2016Fi06). Q_0=4946.32 keV *6* (2016Fi06), 4946.336 keV *14* (1983Co09), 4946.337 keV *20* (1982Va13); for earlier values see (1965Ja09, 1967Th05, 1968Sp01, 1974Sp04, 1975Sm02, 1978Ha14, 1980Wa24).
3089.30 *8*	1/2⁺	J^π: See (1982Mu14,2016Fi06).
3684.52 *5*	3/2⁻	J^π: See (1967Pr10, 1967Th05, 1968Sp01, 1982Mu14, 2016Fi06); see also (1953Ba18: (1/2⁻,3/2⁻)).
4946.33 *5*	1/2⁺	E(level): see (1953Ba18, 1958Gr01, 1961Ja19, 1965Ja09, 1967Pr10, 1967Th05, 1968Sp01, 1972Op01, 1980Wa24, 1982Ju01, 1982Mu14, 1982Va13, 1986Ke14). J^π: See (1967Th05,1968Sp01,1982Mu14,2016Fi06).

† From least squares fit to Eγ.

γ(^{13}C)

E_γ‡	I_γ†#	E_i(level)	J^π_i	E_f	J^π_f	Comments
595.22 *8*	0.24 *1*	3684.52	3/2⁻	3089.30	1/2⁺	E_γ,I_γ: See I_γ(*595.5 keV *2*)=0.24 *1* (1982Mu14) and I_γ(*595.16 keV *9*)=0.274 *25* (2008FiZZ); I_γ<0.6 (1967Th05).
1261.74 *4*	32.36 *44*	4946.33	1/2⁺	3684.52	3/2⁻	E_γ,I_γ: See I_γ(*1261.6 keV *1*)=32.36 *44* (1982Mu14), E_γ=*1261.92 *6* (1967Pr10), E_γ=*1261.7 *4* (1972Op01: from 1261.9 *4*, the Eγ recoil corrected value given in the text), E_γ=1261.847 *33* (1980Wa24: deduced), E_γ=1261.765 *28* (1983Ra04: listed as a calibration line) I_γ(*1261.71 *6*)=31.2 *8* (2008FiZZ), I_γ(1260 *15*)=25 (1958Gr01), I_γ(1270)=30 (1961Ja19), I_γ(1262)=34 *2* (1967Th05), I_γ(*1261.61 *7*)=32 *1* (1968Sp01: from 1261.76 *7*, the Eγ recoil corrected value given in the text), $\sigma(\gamma)$=1.14 mb 2, S-factor(dp)=0.1 with R=2.91 fm (1982Mu14).
1856.89 *19*	0.16 *1*	4946.33	1/2⁺	3089.30	1/2⁺	E_γ,I_γ: See I_γ(*1856.6 keV *4*)=0.16 *1* (1982Mu14) and I_γ(*1856.98 keV *22*)=0.193 *40* (2008FiZZ).
3088.95 *19*	0.43 *2*	3089.30	1/2⁺	0	1/2⁻	E_γ,I_γ: See I_γ(*3089.5 keV *4*)=0.43 *2* (1982Mu14) and I_γ(*3088.80 keV *21*)=0.373 *56* (2008FiZZ). If 3.1 MeV γ-ray occurs, its intensity is ≤0.10 γ/capture (1953Ba18).

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$^{12}C(n,\gamma)$:E=thermal (continued)

$\gamma(^{13}C)$ (continued)

E_γ [‡]	I_γ [†#]	E_i(level)	J^π_i	E_f	J^π_f	Comments
3683.96 *6*	32.14 *64*	3684.52	3/2⁻	0	1/2⁻	E_γ,I_γ: See I_γ(*3684.0 *2*)=32.14 *64* (1982Mu14), E_γ(*3683.94 *17*) (1967Pr10), E_γ=3683.915 *15* (1990Wa22: deduced value). I_γ(*3684.02 *7*)=29.7 *10* (2008FiZZ), I_γ(3680 *50*)=30 (1953Ba18), I_γ(3680 *20*)=25 (1958Gr01), I_γ(3680)=31 (1961Ja19), I_γ(3684)=34 *2* (1967Th05), I_γ(3684)=31.0 *4* (1982Ju01), I_γ(*3683.72 *14*)=32 *1* (1968Sp01: from 3684.28 *14*, the Eγ recoil corrected value given in the text). If 3.9 MeV γ-ray occurs (transition 3850→0), its intensity is <0.06 γ/capture (1953Ba18).
4945.32 *6*	67.47 *92*	4946.33	1/2⁺	0	1/2⁻	E_γ,I_γ: See I_γ(4945.32)=67.47 *92* (1982Mu14), E_γ=4946 *1* (1965Ja09), E_γ=*4945.46 *17* (1967Pr10), E_γ=4945.328 *20* (1982Va13: deduced from Q_0), I_γ(*4945.30 *7*)=68.6 *20* (2008FiZZ), I_γ(4948 *8*)=70 (1953Ba18), I_γ(4950 *15*)=75 (1958Gr01), I_γ(4946)=69 (1961Ja19), I_γ(4945)=66 *3* (1967Th05: I_γ<0.2 for capture state→3848 transition), I_γ(*4944.8 *6*)=68 *1* (1968Sp01: from 4945.8 *6*, the Eγ recoil corrected value given in the text), I_γ(4946)=68.6 *9* (1982Ju01), I_γ(4945)=68.4 *5* (1986Ke14). $\sigma(\gamma)$=2.38 mb *5*, S-factor(dp)=1.1 with R=2.91 fm (1982Mu14).

† From (1982Mu14).
‡ From average of values listed with *.
# Intensity per 100 neutron captures.

^{12}C(n,γ):E=thermal

Level Scheme

Intensities: I_γ per 100 neutron captures