

$^{40}\text{Ca}(\text{e},\text{e}')$ 1995Pe01,1982Bu05,1970It01

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Jun Chen	NDS 140, 1 (2017)	30-Sep-2015

Most measurements report $\sigma(\theta)$ distributions and deduce transition strengths for states excited in (e,e').

1995Pe01: E=28.4, 34.9, 45.7, 54.6, 56.5 MeV. Data for 8 M1 levels and 5 M2 levels from 9870 to 13670. $\Delta E(\text{level})=10$. The authors also quote data for 18 levels from Darmstadt group (R. Benz, Diploma thesis 1984; W. Gross, Diploma thesis 1981; both from Darmstadt).

1982Bu05 (also 1982BuZR): E=31-65 MeV; measured $\sigma(E,\theta)$, form factors. Deduced levels with $\Delta E(\text{level})=50$, transition strengths, widths.

1970It01: E=183, 250 MeV; measured $\sigma(\theta)$; DWBA analysis. $\Delta E(\text{level})=100$. Report 11 levels.

1978Gr03 (also 1978Gr02,1977Gr26): E=31-67 MeV. Data for 3353, 6950 levels.

1970Go10: E=44-54 MeV. $\Delta E(\text{level})=200$; giant resonances.

1984Og01: E=70-200 MeV. Report 3 groups.

1984Ha29: E=81.6-380 MeV. 3352 level studied.

1980St17: E=39 MeV. $\Delta E(\text{level})=5$. Data for 10319 level.

Additional information 1.

1979Gr09: E=44, 50 MeV. $\Delta E(\text{level})=5$. Data for 10319 level.

1974Na15: E=700-750 MeV. Measured electron-proton coin; deduced proton-separation energies. Report 5 groups at 10.4, 13.6, 18.4, 35.3 and 58.4 MeV.

1973Ha13: E=66-121 MeV; measured form factors. Data for 3737 and 3904 levels.

1971Fa15: E=39-56 MeV. Data for 5940, 6940, 8430 and 10340 levels.

1971He08: E=198, 250, 300 MeV. Data for 3740 and 4480 levels.

1970St10, 1968St20: E=28-60 MeV. Data for 0^+ state.

1969Ei03: E=20-60 MeV. Data for 3730, 3900 and 6940 levels.

1968Zi06: E=282.8 MeV.

1964Ho06: E=80-190 MeV. Data for 11000, 12200, 13900 and 14600 levels.

1963BI04: E=120, 150, 180, 220 MeV. Report 8 levels.

1961Pe21: E=120, 150, 180 MeV.

1956He83: E=187 MeV. Data for 3730 level.

1956Ha91: E=183 MeV. Data for 3730+3900 level.

Others:

(e,e'): 2001Di23, 1986De12, 1985Me05 (also 1984Me06), 1983De25, 1981Fr03, 1978Zi04, 1975To02, 1968Fr11, 1964We08, 1962Ed02.

(e,e): 1997Wi23, 1983Em01, 1979Si21, 1973Si15 (also 1971Si08, 1971SiYF).

(e,e'p) and (e,e' α): giant resonances deduced: 2001Di24, 2001Di23, 1998Ko20, 1995Di03, 1994Vo05, 1976Mo17, 1973Ca14, 1971Mo06.

(e,e'n): 1994Ta12.

^{40}Ca Levels

1963BI04 give B(EL)(↓), these have been converted to B(EL)(↑).

E(level) [†]	J $\pi^{\ddagger}$	T _{1/2}	Comments
0	0 ⁺		
3352 5	0 ⁺		Additional information 2. E(level): from 1984Ha29. Monopole matrix element M(E0)=2.66 e*fm ² 4I, weighted average of 2.53 e*fm ² 4I (1978Gr02), 3.6 fm ² 1I (1968St20). From monopole strength $\rho^2 E0 = [M(E0)]^2 / [e^2 R^4]$ where $R=R_0 A^{1/3}$ with $R_0=1.2$ fm, one gets $\rho^2 E0=0.025$ 8. Width of e ⁺ e ⁻ pair emission $\Gamma_\pi=3.7E-7$ eV 23 (1970St10).
3740	3 ⁻	50 ps 5	Additional information 3.

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$^{40}\text{Ca}(\text{e},\text{e}')$ 1995Pe01,1982Bu05,1970It01 (continued) ^{40}Ca Levels (continued)

<u>E(level)[†]</u>	<u>J^π[‡]</u>	<u>T_{1/2}</u>	<u>Comments</u>
			T _{1/2} : from B(E3)↑. Other: 30 ps 6 from Γ_γ in 1970St10. B(E3)↑=0.0167 16, unweighted average of 0.0100 11 (1963BI04, from $\beta_3=0.066$ 7), 0.0190 21 (1956He83, from $\beta_3=0.125$ 14 with 10% uncertainty from normalization added by the evaluator), 0.0211 25 (1969Ei03), 0.0149 7 (1973Ha13), 0.0183 7 (1970It01, average of 0.0185 7 and 0.0180 7), 0.0166 12 (1971He08, from B(E3)(W.u.)=24.9 18). $\Gamma_\gamma=15$ μeV 3 (1970St10). Additional information 4.
3900	2 ⁺	36 fs +5–4	T _{1/2} : from B(E2)↑. Other: 29 fs 6 from Γ_γ in 1970St10. B(E2)↑=0.0088 10, weighted average of 0.015 5 (1963BI04, from $\beta_2=0.016$ 5), 0.0084 10 (1969Ei03), 0.0090 10 (1973Ha13). Other: 0.012 (1970It01, from B(E2)(W.u.)=3.0). $\Gamma_\gamma=0.016$ eV 3 (1970St10). Additional information 5.
4490	5 [−]		J ^π : from 1970It01 and 1963BI04. B(E5)↑=2.12E−4 22, weighted average of 2.07E−4 22 (1963BI04, from $\beta_5=0.048$ 5), 2.8E−4 8 (1970It01, from B(E5)(W.u.)=17 5 average of 20 +9−5 and 16.3 45). Others: 1.62E−4 10 or 2.95E−4 25 (1971He08, depending on shape factor).
5250	2 ⁺		Additional information 6.
5610	2 ⁺		B(E2)↑=0.0016 (1970It01, from B(E2)(W.u.)=0.4). Additional information 7.
5940 70			B(E2)↑=0.0016 (1970It01, from B(E2)(W.u.)=0.4). Additional information 8.
6160	3 [−]		E(level): from 1971Fa15, 5900 100 from 1970It01. E(level): from 1963BI04.
6290	3 [−]	0.30 ps +7–6	B(E3)↑=0.00073 18 (1963BI04, from $\beta_3=0.0048$ 12). Additional information 9.
6590	3 [−]		E(level): from B(E3)↑ here and the adopted γ branchings in Adopted Gammas. B(E3)↑=0.0031 3 (1970It01, from B(E3)(W.u.)=4.6 4). Additional information 10.
6900	3 [−]		B(E3)↑=0.00166 13 (1970It01, from B(E3)(W.u.)=2.5 2). E(level),J ^π : from 1963BI04. This level could correspond to the 6931, 3 [−] or the 6938 level in Adopted Levels. 1969Ei03 report a composite of 6930,3 [−] and 6910,2 ⁺ .
6910	2 ⁺		E(level),J ^π : from 1978Gr03. 1969Ei03 report a composite of 6930,3 [−] and 6910,2 ⁺ . $\Gamma_0=0.190$ eV 6 (1978Gr03). B(E2)↑=0.00070 9 (1969Ei03).
6930	3 [−]		E(level),J ^π : from 1969Ei03. According to 1969Ei03, it could be an unresolved triplet of 6910 (2 ⁺), 6930 (3 [−]) and 6950 (1 [−]). Other: 6900 reported in 1963BI04. B(E3)↑=0.0011 3 (1963BI04, from $\beta_3=0.007$ 2), while 0.0092 13 from 1969Ei03 for the 6930 component of the 6910+6930 composite; however, T _{1/2} =1.4 ps 6 and no observation of g.s. transition from the 6931.29, J ^π =3 [−] level in γ studies indicates a much smaller B(E3)↑.
6950	1 [−]		Additional information 11. E(level),J ^π : from 1978Gr03. E=6940 70 from 1971Fa15, 6950 100 from 1970It01. $\Gamma_0=0.51$ eV 5 (1978Gr03).
7100	2 ⁺		E(level),J ^π : from 1963BI04.
7900	(2 ⁺ ,4 ⁺)		B(E2)↑=0.0163 18 (1963BI04, from $\beta_2=0.018$ 2). Additional information 12.
			J ^π : from 1970It01; 4 ⁺ from 1963BI04; could correspond to the 7872, 2 ⁺ level or 7928, 4 ⁺ level in Adopted Levels.
8428 5	2 [−]		B(E4)↑=0.00028 5 (1963BI04, from $\beta_4=0.011$ 2). Others: B(E2)↑=0.0053 or B(E4)↑=0.00053 from B(E2)(W.u.)=1.3 or B(E4)(W.u.)=5 in 1970It01). Additional information 13.
8500	5 [−]		E(level),J ^π : from 1980St17. $\Gamma_0=0.026$ eV +10−8 (1971Fa15). Additional information 14.
			J ^π : from 1963BI04. Other: (2 ⁺ ,4 ⁺ ,5 [−]) (1970It01).

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$^{40}\text{Ca}(\text{e},\text{e}')$ 1995Pe01,1982Bu05,1970It01 (continued) ^{40}Ca Levels (continued)

<u>E(level)[†]</u>	<u>J^π_‡</u>	<u>Comments</u>
9868 5	1 ⁺ ,2 ⁺	B(E5)↑=1.16E-4 13 (1963BI04, from $\beta_5=0.027$ 3). Other: B(E2)↑=0.0016 or B(E5)↑=0.00012 from B(E2)(W.u.)=0.4 or B(E5)(W.u.)=7.0 in 1970It01. Additional information 15. E(level),J ^π : from 1980St17, probably a doublet of 2 ⁺ and 1 ⁺ separated by 5 keV. Other: 9870 10 with J ^π =1 ⁺ ,2 ⁺ from 1995Pe01.
10319 5	1 ⁺	B(M1)↑=0.32 9 (1995Pe01), 0.43 4 (quoted by 1995Pe01 from Darmstadt group). Additional information 16. E(level): from 1979Gr09, probably the isobaric analog of the 2730 level in ^{40}K . B(M1)↑=1.06 8 (1995Pe01), 1.11 5 (quoted by 1995Pe01 from Darmstadt group), 1.12 7 (1979Gr09). $\Gamma=7.0$ eV +29-22 (1971Fa15).
10400		E(level): from 1974Na15, 1d _{3/2} state, $\Delta E=1.4$ MeV. $\Gamma=9.2$ MeV 13 (1974Na15). Additional information 17.
10670 10	2 ⁻	Additional information 18. E(level),J ^π : from 1995Pe01. Other: 10676 (quoted by 1995Pe01 from Darmstadt group). B(M2)↑=0.16 5 (1995Pe01), 0.15 3 (quoted by 1995Pe01 from Darmstadt group).
10776 6	(1 ⁻)	E(level),J ^π : from 1979Gr09.
11000	(3,4)	Additional information 19. E(level),J ^π : from 1964Ho06, $\Delta E=100$ keV.
11760 10	1 ⁺	Additional information 20. E(level),J ^π : from 1995Pe01. Other: 11775 (quoted by 1995Pe01 from Darmstadt group). B(M1)↑=0.35 3 (1995Pe01).
12040 10	1 ⁺	Additional information 21. E(level),J ^π : from 1995Pe01. Other: 12044, J ^π =2 ⁻ (quoted by 1995Pe01 from Darmstadt group); J ^π =2 ⁺ in Adopted Levels.
12200	3 ⁻	B(M1)↑=0.09 4 (1995Pe01). from 1964Ho06, $\Delta E=50$.
12350 10	2 ⁻	B(E3)↑=2.93E-4 20 (1964Ho06, from B(E3)(W.u.)=0.44 3). Additional information 22. E(level),J ^π : from 1995Pe01. Other: 12332, J ^π =(1 ⁻ ,2 ⁺) (quoted by 1995Pe01 from Darmstadt group). B(M2)↑=0.41 21 (1995Pe01).
12488	2 ⁻	E(level),J ^π : from Darmstadt group with B(M2)↑=0.17 5, quoted in 1995Pe01.
12490 10	1 ⁺	Additional information 23. E(level),J ^π : from 1995Pe01. B(M1)↑=0.10 2 (1995Pe01).
12503	2 ⁻	Additional information 24. E(level),J ^π : from Darmstadt group with B(M2)↑=0.17 5, quoted in 1995Pe01.
12622	(2)	Additional information 25. E(level),J ^π : from Darmstadt group with B(M2)↑=0.19 7, quoted in 1995Pe01.
12750 10	2 ⁻	Additional information 26. E(level),J ^π : from 1995Pe01. Other: 12749 (quoted by 1995Pe01 from Darmstadt group). B(M2)↑=0.13 6 (1995Pe01), 0.06 6 (quoted by 1995Pe01 from Darmstadt group).
12830 10	1 ⁺ ,2 ⁻	Additional information 27. E(level),J ^π : from 1995Pe01, 2 ⁻ is less probable. Other: 12830 (quoted by 1995Pe01 from Darmstadt group). B(M1)↑=0.14 3 (1995Pe01), 0.06 4 (quoted by 1995Pe01 from Darmstadt group).
13050 10	1 ⁺	Additional information 28. E(level),J ^π : from 1995Pe01. Other: 13049 (quoted by 1995Pe01 from Darmstadt group). B(M1)↑=0.26 4 (1995Pe01), 0.25 2 (quoted by 1995Pe01 from Darmstadt group).
13150 10	2 ⁻	Additional information 29. E(level),J ^π : from 1995Pe01. Other: 13147 (quoted by 1995Pe01 from Darmstadt group). B(M2)↑=0.48 6 (1995Pe01), 0.34 9 (quoted by 1995Pe01 from Darmstadt group).
13445	2 ⁻	Additional information 30. E(level),J ^π : from Darmstadt group with B(M2)↑=0.55 7, quoted in 1995Pe01.
13480 10	1 ⁺	Additional information 31. E(level),J ^π : from 1995Pe01. Other: 13480, J ^π =2 ⁻ ,(1 ⁺) (quoted by 1995Pe01 from Darmstadt group). B(M1)↑=0.26 10 (1995Pe01).

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$^{40}\text{Ca}(\text{e},\text{e}')$ 1995Pe01,1982Bu05,1970It01 (continued) ^{40}Ca Levels (continued)

<u>E(level)[†]</u>	<u>J^{π‡}</u>	<u>Comments</u>
13600		Additional information 32. E(level): from 1974Na15 , $2s_{1/2}$ state, $\Delta E=0.4$ MeV. $\Gamma=12.0$ MeV 9 (1974Na15).
13670 10	2^-	Additional information 33. E(level),J ^π : from 1995Pe01 . Other: 13666 (quoted by 1995Pe01 from Darmstadt group). B(M2) $\uparrow=0.66$ 16 (1995Pe01), 0.27 6 (quoted by 1995Pe01 from Darmstadt group).
13900	2^+	Additional information 34. E(level),J ^π : from 1964Ho06 , $\Delta E=100$ keV. B(E2) $\uparrow=7.3\text{E}-4$ 8 (1964Ho06 , from B(E2)(W.u.)=0.18 2).
14600	$(1,2^+,3^-,4^+)$	E(level),J ^π : from 1964Ho06 , $\Delta E=100$ keV. Additional information 35.
18400		E(level): from 1974Na15 , $1d_{5/2}$ state, $\Delta E=1.6$ MeV. $\Gamma=9.9$ MeV 14 (1974Na15).
35300		E(level): from 1974Na15 , $1p$ state, $\Delta E=0.5$ MeV. $\Gamma=23.5$ MeV 23 (1974Na15).
42000		
58400		E(level): from 1974Na15 , $1s$ state, $\Delta E=1.1$ MeV. $\Gamma=31.9$ MeV 11 (1974Na15).

[†] From [1970It01](#) with $\Delta E=100$ keV for levels up to 8500; from [1995Pe01](#) above 8500, unless otherwise noted.

[‡] From measurements of $\sigma(\theta)$ and deduced transition strengths ([1995Pe01](#),[1970It01](#),[1963Bl04](#)); from Adopted Levels if not noted.