

$^{40}\text{Ca}(^3\text{He},\alpha\gamma), ^3\text{He}(^{40}\text{Ca},\alpha\gamma)$ 1973BoXR,1970Ba08,1973Ke05

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Jun Chen	NDS 149, 1 (2018)	1-Jan-2018

($^3\text{He},\alpha\gamma$) reaction, unless otherwise noted.

1973BoXR: E=7.8 MeV. Measured $E\alpha$, $E\gamma$, $I\gamma$, $\alpha\gamma$ -coin, Doppler shift attenuation (DSA). Deduced levels, lifetimes.

1970Ba08 (also **1970AnZZ**): E=12 MeV ^3He beam was produced from the University of Pennsylvania tandem. Target was 250 $\mu\text{g}/\text{cm}^2$ natural Ca metal evaporated onto a 50 $\mu\text{g}/\text{cm}^2$ carbon backing. Charged particles were detected with a position-sensitive surface-barrier detector (FWHM \approx 30 keV) and γ rays were detected with four NaI(Tl) detectors. Measured $E\gamma$, $E\gamma$, $I\gamma$, $\alpha\gamma(\theta)$. Deduced levels, J, π , γ branching ratios, multipolarities, mixing ratios.

1973Ke05: E=8.0-10.0 MeV ^3He beam was produced from the 7-MV Van de Graaff at Frankfurt University. Target was natural Ca metal. α particles were detected with two Si detectors and γ rays were detected with a Ge(Li) detector. Measured $E\gamma$, $I\gamma$, $\alpha\gamma$ -coin, Doppler shift attenuation (DSA). Deduced lifetimes for 2469 and 2797 levels. Uncertainty due to stopping power is estimated to be 20% and included.

1988Al05: ($^{40}\text{Ca},\alpha\gamma$) E=110 MeV ^{40}Ca beam was produced from the MP tandem of the TASC facility at the Chalk River Nuclear Lab. Target was a ^3He -implanted Ta foil. α particles were detected with an ΔE -E silicon surface-barrier detector telescope and γ rays were detected with a Compton-suppressed Ge spectrometer. Measured $E\gamma$, $I\gamma$, $\alpha\gamma$ -coin, DSA. Deduced lifetimes for 2467 and 3030 levels.

1968Le06: E=7.48,7.8 and 7.9 MeV ^3He beams were produced from the Duke University 4-MeV Van de Graaff. Targets were 50 to 75 $\mu\text{g}/\text{cm}^2$ thick natural Ca onto carbon backings. α particles were detected with an annular surface-barrier counter (FWHM=45 keV) and γ rays were detected with a NaI crystal. Measured $E\alpha$, $E\gamma$, $I\gamma$, $\alpha\gamma$ -coin, $\alpha\gamma(\theta)$. Deduced levels, J, π , branching and mixing ratios. Comparisons with shell-model calculations. Report levels at 0, 2470, 2800, 3030, 3660, 3840, 3880, 3950 and 4020.

1983Ma47: E=13.4 MeV beam from the 7.5-MV Van de Graaff at Laboratori Nazionali di Legnaro. Surface-barrier Si detectors and Ge detector. Measured $E\gamma$, $I\gamma$, $\alpha\gamma$ -coin, DSA. Deduced lifetime for 2469 level.

1976Ve01: E=18 MeV ^3He from the Orsay MP tandem. Two Ge(Li) detectors and a Si(Li) detector. Measured $\alpha\gamma$ -coin. Deduced levels of 2469 and 2797.

 ^{39}Ca Levels

E(level) [†]	J^π [‡]	$T_{1/2}$ [#]	Comments
0	$3/2^+$		
2469.1 6	$1/2^+$	162 fs 17	E(level): weighted average of values from 1973BoXR , 1973Ke05 and 1976Ve01 . Additional information 1 . $T_{1/2}$: from 1988Al05 (including 5% uncertainty due to stopping power). Others: 180 fs 55 (1973Ke05), 159 fs +28-21 (1983Ma47), 250 fs 6 (1973BoXR).
2797.4 6	$7/2^-$	>12 ps	E(level): weighted average of values from 1973BoXR , 1973Ke05 and 1976Ve01 . Additional information 2 . J^π : $7/2$ from $2797\gamma(\theta)$ in 1968Le06 . $T_{1/2}$: from 1983Ma47 . Others: >11 ps (1973Ke05), >5.5 ps (1973BoXR).
3030 1	$3/2^-$	21 fs 11	J^π : $3/2,5/2$ from $3030\gamma(\theta)$ (1968Le06,1970Ba08). $T_{1/2}$: from 1988Al05 . Other: 0.17 ps 6 (1973BoXR).
3640 1	($9/2^-$)		J^π : $3640\gamma(\theta)$ and $843\gamma(\theta)$ in 1970Ba08 is consistent with $3/2,5/2,9/2$; with best fit for $9/2$.
3828 1		0.15 ps 6	
3882 2		>1.7 ps	E(level): weakly populated (1968Le06,1970Ba08,1973BoXR).
3939 2	($3/2^-$)	<62 fs	
3952 2	($3/2^-$)	0.75 ps +28-24	J^π : $1155\gamma(\theta)$ and $3953\gamma(\theta)$ is consistent with $1/2,3/2,5/2$; but 3952γ is most likely a doublet with 3939γ from 3939 level.
4020.7 17	$1/2^+$	0.42 ps 12	E(level): from 1976Ve01 . J^π : $1/2,3/2$ from isotropic $1551\gamma(\theta)$ (1970Ba08).

[†] Values with uncertainties are from **1973BoXR**, unless otherwise noted.

[‡] From Adopted Levels, unless otherwise noted.

[#] From DSA. Values are from **1973BoXR**, unless otherwise noted.

$^{40}\text{Ca}(^3\text{He},\alpha\gamma),^3\text{He}(^{40}\text{Ca},\alpha\gamma)$ 1973BoXR,1970Ba08,1973Ke05 (continued)

$\gamma(^{39}\text{Ca})$								
$E_i(\text{level})$	J_i^π	E_γ^\dagger	I_γ^\ddagger	E_f	J_f^π	Mult. ‡	δ^\ddagger	Comments
2469.1	1/2 ⁺	2469.0	100	0	3/2 ⁺			$\gamma(\theta)$ is isotropic (1970Ba08).
2797.4	7/2 ⁻	2797.3	100	0	3/2 ⁺	Q+O	-0.13 7	
3030	3/2 ⁻	3030	100	0	3/2 ⁺	D+Q	-0.07 2	δ : or +5.3 +7-9 (1970Ba08). Other: -0.02 3 (1968Le06).
3640	(9/2 ⁻)	843	75 10	2797.4	7/2 ⁻	D+Q	-0.24 4	
		3640	25 10	0	3/2 ⁺	O		Mult.: $\delta(\text{M4/E3})=-0.02$ 12 (1970Ba08).
3828		3828	100	0	3/2 ⁺			
3882		1085		2797.4	7/2 ⁻			
		3882		0	3/2 ⁺			
3939	(3/2 ⁻)	3939	100	0	3/2 ⁺			E_γ : from 1973BoXR only. This γ could be a doublet with the 3952 γ .
3952	(3/2 ⁻)	1155	30 10	2797.4	7/2 ⁻			
		3952	70 10	0	3/2 ⁺			this is possibly a doublet with 3939 γ . 1970Ba08 report $\delta(\text{Q/D})=-0.10$ 7 or +6.7 +22-61 for J(3952)=3/2.
4020.7	1/2 ⁺	990.7	20 10	3030	3/2 ⁻			
		1551.6	80 10	2469.1	1/2 ⁺			

[†] From level-energy differences. All transitions are observed in 1970Ba08, unless otherwise noted.

[‡] From 1970Ba08. For multipolarity, E3, E2 or M2, E1 or M1 have been replaced with O, Q and D, respectively, since there is no experimental evidence for identification of E or M.

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Intensities: % photon branching from each level

