^{12}C(^{20}Ne,nγ),^{16}O(^{16}O,nγ) 2005Je07,2008Pa27

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Jun Chen and Balraj Singh	NDS 184,29 (2022)	24-Jun-2022

Includes ^{9}Be(^{37}Ca,Xγ).

2005Je07: E(^{20}Ne)=32 MeV. Measured Eγ, Iγ, γγ, γγ(θ)(DCO) using Gammasphere array with 100 high-purity Compton-suppressed Ge detectors.

2006Je03: From the same group as 2005Je07. The authors provide data for a few additional levels, but the main content of the paper is about re-evaluation of ^{30}P(p,γ)^{31}S astrophysical reaction rates from the T=1/2 mirror states observed in ^{31}S and ^{31}P in ^{12}C(^{20}Ne,nγ) and ^{12}C(^{20}Ne,pγ) reactions. Proton widths and resonance strengths are deduced for 13 proton resonances with $E(p)_{c.m.}$ from 27.2 to 737 keV.

2008Pa27: ^{16}O(^{16}O,nγ) E=29 MeV. Target=nickel monoxide on a backing of nickel foil. Measured Eγ, lifetime of 4451 level by Doppler-shift attenuation method (DSAM) using Gammasphere array of 100 Compton-suppressed HPGe detectors at ATLAS, Argonne facility. Based on E1 transition rates for 4451 level in ^{31}S and 4431 level in ^{31}P, the two levels are identified as mirror states with J^{π}=7/2^{-}.

2010Do03: ^{9}Be(^{37}Ca,Xγ) E=195.7 MeV/nucleon: ^{37}Ca beam was produced from a primary beam of ^{40}Ca at 420 MeV/nucleon provided by the heavy ion synchrotron SIS at GSI impinging on a ^{9}Be target with 4 mg/cm^{2} thickness. From the primary reaction products ^{37}Ca was selected and incident on a 700 mg/cm^{2} secondary ^{9}Be target. RISING setup consisting of fragment separator (FRS), 15 Cluster HPGe detectors, eight MINIBALL HPGe detectors and eight Hector BaF_2 detectors. Measured lifetime of first 2^{+} state from lineshape of the γ-ray transition after applying Doppler correction and comparing to simulations.

2021To09: E=33 MeV ^{20}Ne beam was produced from the Piave-Alpi accelerator of the Laboratori Nazionali di Legnaro. Target was 0.75 mg/cm^{2} ^{12}C on a 10 mg/cm^{2} gold layer. γ rays were detected with the GASP array in configuration II and charged particles were detected with the EUCLIDES silicon ball. Measured Eγ, Iγ, γγ(θ), Doppler-shift attenuation. Deduced levels, $T_{1/2}$, mixing ratios, transition strengths. Comparisons with available Data and theoretical calculations.

^{31}S Levels

E(level)[†]	J^{π}[#]	$T_{1/2}$	Comments
0.0[@]	1/2^{+}		
1248.98[@] *10*	3/2^{+}	0.8 ps *5*	$T_{1/2}$: from 2010Do03, deduced from the lineshape analysis using cluster HPGe detectors. The uncertainty is statistical; systematic uncertainty=+0.9−0.6 ps. Other: 2.2 ps *33* (stat) *36* (syst) using the lineshape analysis and MINIBALL HPGe detectors (2010Do03). In both cases reaction was ^{9}Be(^{37}Ca,Xγ) at 195.7 MeV/nucleon.
2234.90[@] *25*	5/2^{+}		
3285.11 *19*	5/2^{+}		
3351.42[@] *21*	7/2^{+}		
4450.6[&] *3*	7/2^{-}	0.55 ps *17*	$T_{1/2}$: unweighted average of 0.38 ps *4* from 2021To09 and 0.71 ps *15* from 2008Pa27, both by DSAM.
4584.62 *25*	7/2^{+}		
5300.9[@] *3*	9/2^{+}		
5978.6 *7*	(9/2^{+})		
6160.1[‡] *6*	5/2^{-}		
6376.7[&] *4*	9/2^{-}	170 fs *31*	$T_{1/2}$: from DSAM in 2008Pa27, effective half-life.
6393.9[@] *4*	11/2^{+}		
6636.4[‡] *4*	9/2^{-}		
6833.2[&] *3*	11/2^{-}	125 fs *24*	$T_{1/2}$: from DSAM in 2008Pa27, effective half-life.
7303.7 *5*	11/2^{+}		
8461.5[&] *5*	(13/2^{-})		
9155.2[@] *10*	13/2^{+}		
10146.3 *11*	(13/2^{-})		

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$^{12}C(^{20}Ne,n\gamma),^{16}O(^{16}O,n\gamma)$ 2005Je07,2008Pa27 (continued)

^{31}S Levels (continued)

† From a least-squares fit to Eγ (by evaluators). Normalized χ^2 is 4.8, larger than critical χ^2=2.2. Some of the gamma-ray energy uncertainties are probably underestimated.
‡ Level from 2006Je03.
# As proposed by 2005Je07 based on earlier assignments for low-lying levels and γγ(θ)(DCO) ratios for high-spin levels. It is assumed that the spins ascend as the excitation energy rises due to yrast type of population of levels in heavy-ion fusion studies.
@ Member of yrast sequence based on $1/2^+$.
& Member of sequence based on $7/2^-$.

$\gamma(^{31}S)$

DCO correspond to intensity of a γ ray at forward (32° and 37°) or backward (143° and 148°) angles to those at 90°; with the experiment geometry DCO=1.6 *1* for ΔJ=2, stretched quadrupole transition (or in few cases ΔJ=0, dipole transition) and DCO=0.90 *5* for ΔJ=1, stretched dipole transition. From 2005Je07, except as noted.

E_γ†	I_γ†	E_i(level)	J^π_i	E_f	J^π_f	Mult.#	Comments
909.4 *5*	2.4 *3*	7303.7	$11/2^+$	6393.9	$11/2^+$		
1050.4 *2*	9.8 *7*	3285.11	$5/2^+$	2234.90	$5/2^+$	D+Q	DCO=1.19 *5* Mult.: ΔJ=0 transition.
1090.7 *10*	3.6 *4*	6393.9	$11/2^+$	5300.9	$9/2^+$		
1166.2 *3*	35.7 *14*	4450.6	$7/2^-$	3285.11	$5/2^+$	D	DCO=0.88 *8* B(E1)↓=7.2×10^{-6} *7*; B(M2)↓=3.1 *+59−31* (2021To09) Mult.: 2021To09 report δ(Q/D)=−0.07 *8*.
1233.8 *5*	12.7 *6*	4584.62	$7/2^+$	3351.42	$7/2^+$		
1248.9 *1*	155 *2*	1248.98	$3/2^+$	0.0	$1/2^+$	D	DCO=0.90 *3*
1299.1 *2*	7.6 *5*	4584.62	$7/2^+$	3285.11	$5/2^+$	D	DCO=1.21 *15*
1393.9 *6*	1.3 *2*	5978.6	$(9/2^+)$	4584.62	$7/2^+$		
1532.2 *2*	12.8 *6*	6833.2	$11/2^-$	5300.9	$9/2^+$	D	DCO=0.94 *7*
1628.2 *4*	3.3 *3*	8461.5	$(13/2^-)$	6833.2	$11/2^-$		
1709.2‡ *6*		6160.1	$5/2^-$	4450.6	$7/2^-$	D	DCO=0.90 *9* (2006Je03)
1852.1 *14*	<1	9155.2	$13/2^+$	7303.7	$11/2^+$		
1926.0 *3*	10.2 *5*	6376.7	$9/2^-$	4450.6	$7/2^-$	D+Q	DCO=0.44 *6*
1949.2 *2*	33.5 *16*	5300.9	$9/2^+$	3351.42	$7/2^+$	D	DCO=0.73 *3*
2035.8 *2*	27.3 *13*	3285.11	$5/2^+$	1248.98	$3/2^+$	D+Q	DCO=0.48 *3*
2049.2‡ *6*		6636.4	$9/2^-$	4584.62	$7/2^+$		E_γ: poor fit. Level-energy difference=2051.7.
2084.4 *11*	<1	8461.5	$(13/2^-)$	6376.7	$9/2^-$		
2102.4 *2*	100	3351.42	$7/2^+$	1248.98	$3/2^+$		
2187.2‡ *5*		6636.4	$9/2^-$	4450.6	$7/2^-$		
2215@		4450.6	$7/2^-$	2234.90	$5/2^+$		B(E1)↓<2.2×10^{-6} (2021To09) 2021To09 report a branching of <1 *1*.
2236.1 *5*	18.3 *6*	2234.90	$5/2^+$	0.0	$1/2^+$		
2382.8 *3*	33.1 *14*	6833.2	$11/2^-$	4450.6	$7/2^-$	Q	DCO=1.68 *6*
2760.7 *11*	12.4 *7*	9155.2	$13/2^+$	6393.9	$11/2^+$	D	DCO=1.27 *15*
2875.3‡ *8*		6160.1	$5/2^-$	3285.11	$5/2^+$		
3042.4 *4*	29.9 *15*	6393.9	$11/2^+$	3351.42	$7/2^+$	Q	DCO=1.58 *13*
3285.1‡ *5*		6636.4	$9/2^-$	3351.42	$7/2^+$	D	DCO=0.57 *19* (2006Je03)
3285.3 *11*	6.5 *5*	3285.11	$5/2^+$	0.0	$1/2^+$		
3312.9 *10*	7.4 *6*	10146.3	$(13/2^-)$	6833.2	$11/2^-$		
3952.7 *6*	12.7 *9*	7303.7	$11/2^+$	3351.42	$7/2^+$	Q	DCO=1.69 *15*

† From 2005Je07, except as noted.
‡ Eγ from 2006Je03.

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$^{12}C(^{20}Ne,n\gamma),^{16}O(^{16}O,n\gamma)$ 2005Je07,2008Pa27 (continued)

$\gamma(^{31}S)$ (continued)

Mult=D or Q is assigned by the evaluator based on DCO values from 2005Je07 and 2006Je03. The mult=D implies $\Delta J=1$, dipole, except $\Delta J=0$, dipole for 1050.4γ; and mult=Q implies $\Delta J=2$, quadrupole.

@ Placement of transition in the level scheme is uncertain.

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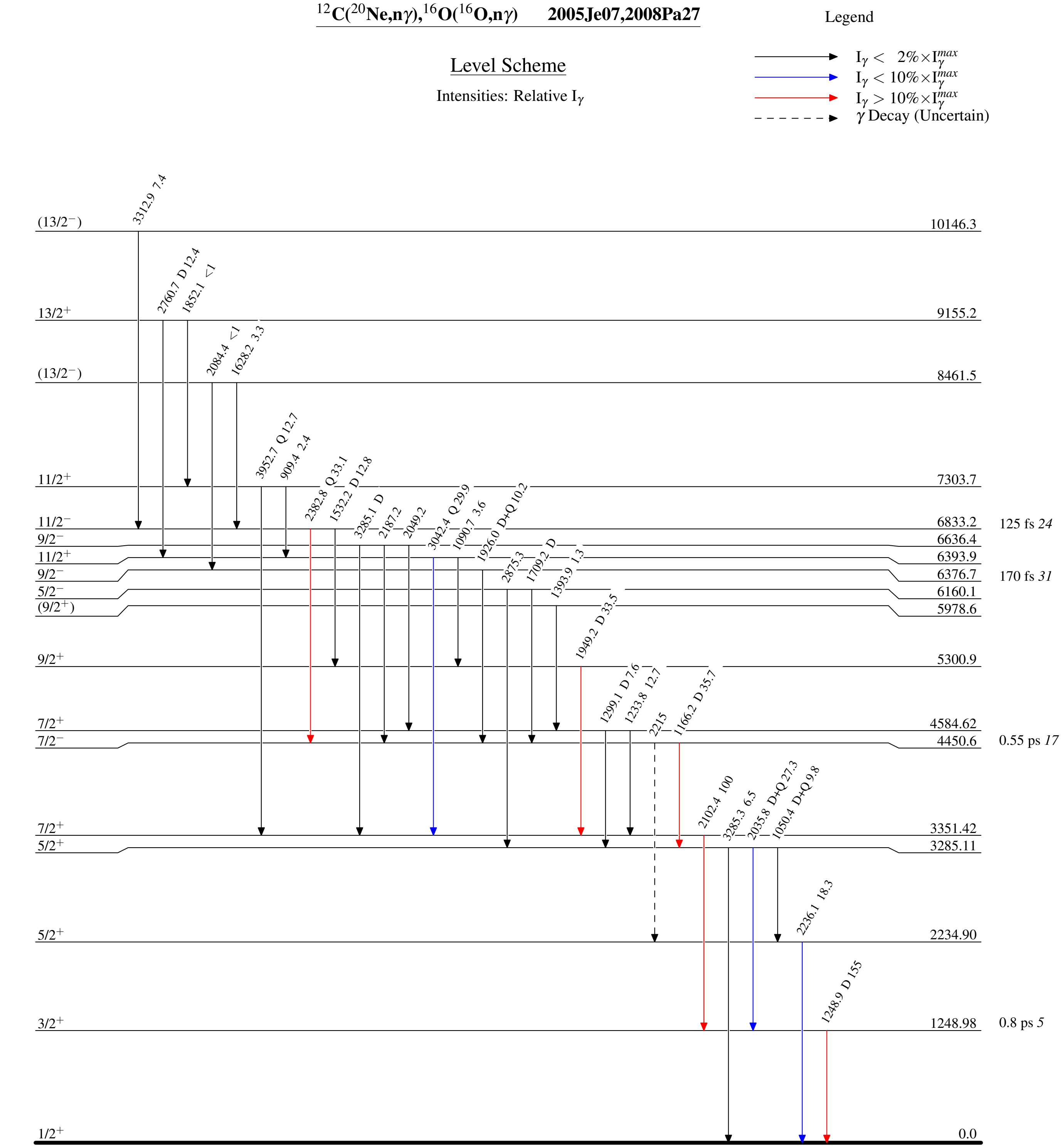
Level Scheme

Intensities: Relative I_γ



$^{31}_{16}S_{15}$