

$^{31}\text{P}(^3\text{He,t})\text{E}=20\text{ MeV}$  **2009Wr02,2007Wr01**

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

**2009Wr02:** E( $^3\text{He}$ )=20 MeV beam from Van de Graaff accelerator at Yale University. Enge magnetic spectrograph with position sensitive ionization drift chamber at focal plane. FWHM $\approx$ 25 keV. Results used to analyze reaction rates of astrophysical interest for  $^{30}\text{P}(p,\gamma)^{31}\text{S}$  reaction in temperature range of 0.08 to 0.25 GK.

$J^\pi(^{31}\text{P g.s.})=1/2^+$ .

Data for levels below 6700 were presented in **2007Wr01**.

 $^{31}\text{S}$  Levels

E(level)	$J^\pi$	$L^\dagger$	Comments
0	$1/2^+$		
4971 <i>3</i>	$3/2^-$		
5022 <i>3</i>	$(1/2,5/2^+)^b$		
5158 <i>3</i>	$1/2^+$		
5301 <i>3</i>	$9/2^+$		
5405 <i>3</i>	$(3/2,5/2,7/2)^b$		
5439 <i>3</i>	$(3/2,5/2,7/2)^b$		
5518 <i>3</i>	$(3/2,5/2,7/2)^b$		
5678 <i>3</i>	$(5/2,7/2,9/2)^b$		
5779 <i>3</i>	$5/2^+$		
5824 <i>3</i>	$(5/2,7/2,9/2)^b$		
5896 <i>3</i>	$(3/2,5/2)^+$		
5981 <i>a 3</i>	$9/2^+$		
6134 <i>&amp; 2</i>	$(3/2^+ \text{ to } 9/2^+)^b$		
6160 <i>&amp;a 3</i>	$5/2^-$		
6259 <i>&amp; 2</i>	$1/2^+$	T=1/2	
6283 <i>&amp; 2</i>	$3/2^+$	T=3/2	
6327 <i>&amp; 2</i>	$(3/2^-,7/2^+)^b$		
6357 <i>&amp; 2</i>	$(5/2^+)$		
6376.9 <i># 5</i>	$9/2^-$		
6393.3 <i># 5</i>	$11/2^+$		
6401 <i>&amp; 3</i>	$(3/2^-,5/2^-,7/2^+)^b$		
6543 <i>&amp; 2</i>	$(3/2,5/2)^-b$		
6585 <i>&amp; 2</i>	$(3/2,5/2,7/2)^-b$		
6639 <i>&amp;a 3</i>	$9/2^-$		
6720 <i>2</i>	$(1/2^+ \text{ to } 9/2^-)$		$\Gamma_{p0}/\Gamma=0.25 +7-20.$
6749 <i>2</i>	$(7/2^-,9/2^-)$	0	$\Gamma_{p0}/\Gamma=0.57 +7-32.$
6836? <i>@ 2</i>	$11/2^-$		
6836 <i>2</i>	$(1/2^+ \text{ to } 9/2^-)$	0	E(level): doublet with spins $11/2^-$ and $1/2^+ \text{ to } 9/2^-.$ $\Gamma_{p0}/\Gamma=0.48 +7-34.$
6872 <i>2</i>	$\geq 1/2^-$	1	$\Gamma_{p0}/\Gamma=0.37 +9-13.$
6939 <i>3</i>	$(1/2^+,3/2^+,5/2^+)$		$\Gamma_{p0}/\Gamma=1.3 +4-10.$
6961 <i>3</i>	$1/2^+$	0	$\Gamma_{p0}/\Gamma=0.46 +11-40.$
6975? <i>@ 3</i>			T=(3/2) $\Gamma_{p0}/\Gamma<0.38.$
7036? <i>@ 2</i>	$5/2^+$		
7036 <i>2</i>	$(1/2^+)$	0	T=(3/2) E(level): possibly a doublet with spins $5/2^+$ and $1/2^+.$

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$^{31}\text{P}(\text{}^3\text{He,t})\text{E}=20\text{ MeV}$  2009Wr02,2007Wr01 (continued) $^{31}\text{S}$  Levels (continued)

E(level)	$J^{\pi\ddagger}$	$L^{\dagger}$	Comments
7053?@ 2			$\Gamma_{p0}/\Gamma=1.05$ 5. $T=(3/2)$
7157 2	$(3/2,5/2)^+$	0	$\Gamma_{p0}/\Gamma=0.36$ +15-33.
7196 2	$\geq 1/2^-$	1	$\Gamma_{p0}/\Gamma=1.04$ +11-63.
7301 <sup>a</sup> 3	$11/2^+$		$\Gamma_{p0}/\Gamma=0.67$ +8-12.
7469 3	$(1/2^+$ to $11/2^+$ )		$\Gamma_{p0}/\Gamma<0.13$ .
7501 3	$(1/2^+$ to $13/2^-$ )	1	$\Gamma_{p0}/\Gamma=0.46$ +10-33. $(\Gamma_{p1}+\Gamma_{p2})/\Gamma<0.03$ .
7519 3	$(1/2^+$ to $13/2^-$ )	0	$\Gamma_{p0}/\Gamma=0.58$ +44-9. $(\Gamma_{p1}+\Gamma_{p2})/\Gamma<0.02$ .
7585 3	$(1/2^-$ to $13/2^-$ )	1	$\Gamma_{p0}/\Gamma=1.6$ +3-10. $(\Gamma_{p1}+\Gamma_{p2})/\Gamma<0.08$ .
7641 3	$(5/2^-$ to $13/2^-$ )		$\Gamma_{p0}/\Gamma=0.55$ +70-13. $(\Gamma_{p1}+\Gamma_{p2})/\Gamma<0.05$ .
7698 3	$(5/2^+)$	1	$\Gamma_{p0}/\Gamma=0.16$ +5-13. $(\Gamma_{p1}+\Gamma_{p2})/\Gamma<0.06$ .
7723 3	$1/2^-$		$\Gamma_{p0}/\Gamma=0.57$ +11-13. $(\Gamma_{p1}+\Gamma_{p2})/\Gamma<0.02$ .
7744 3	$\geq 5/2^+$	2	$\Gamma_{p0}/\Gamma<0.47$ .
7774 3	$(1/2^+$ to $13/2^-$ )		$(\Gamma_{p1}+\Gamma_{p2})/\Gamma=0.48$ +10-34. $\Gamma_{p0}/\Gamma=1.00$ 6. $(\Gamma_{p1}+\Gamma_{p2})/\Gamma<0.03$ .
7824 3	$(1/2^+$ to $13/2^-$ )		$\Gamma_{p0}/\Gamma=0.92$ +18-64. $(\Gamma_{p1}+\Gamma_{p2})/\Gamma<0.08$ .
7859 3	$(1/2^+$ to $13/2^-$ )		$\Gamma_{p0}/\Gamma=1.20$ +24-84. $(\Gamma_{p1}+\Gamma_{p2})/\Gamma<0.11$ .
7894 3	$(1/2^+,3/2^+,5/2^+)$		$\Gamma_{p0}/\Gamma=1.25$ +19-81. $(\Gamma_{p1}+\Gamma_{p2})/\Gamma<0.07$ .
7905 3	$(1/2^+$ to $13/2^-$ )		$\Gamma_{p0}/\Gamma=0.97$ +12-61. $(\Gamma_{p1}+\Gamma_{p2})/\Gamma=0.13$ +3-9.
7932 3	$(1/2^+$ to $13/2^-$ )	0	$\Gamma_{p0}/\Gamma=0.34$ +12-29. $(\Gamma_{p1}+\Gamma_{p2})/\Gamma<0.03$ .
7945 3	$(1/2^+$ to $13/2^-$ )		$\Gamma_{p0}/\Gamma=1.22$ +18-69. $(\Gamma_{p1}+\Gamma_{p2})/\Gamma<0.04$ .
7973 3	$(1/2^+$ to $13/2^-$ )		$\Gamma_{p0}/\Gamma=1.29$ +30-95. $(\Gamma_{p1}+\Gamma_{p2})/\Gamma<0.16$ .
8015 3	$(1/2^+,3/2^+,5/2^+)$		$T=(3/2)$ $\Gamma_{p0}/\Gamma=0.62$ +11-42. $(\Gamma_{p1}+\Gamma_{p2})/\Gamma=0.70$ +9-44.
8030?@ 3	$(1/2^+$ to $13/2^-$ )		$T=(3/2)$ $\Gamma_{p0}/\Gamma=0.67$ +19-52. $(\Gamma_{p1}+\Gamma_{p2})/\Gamma=0.53$ +12-38.
8044 3	$(1/2,3/2,5/2)^+$	0	$\Gamma_{p0}/\Gamma=1.18$ +16-75. $\Gamma_{p0}/\Gamma=0.66$ +11-44. $(\Gamma_{p1}+\Gamma_{p2})/\Gamma=0.95$ +10-41.
8060?@ 3			$\Gamma_{p0}/\Gamma<0.36$ .
8071 3	$(1/2^+$ to $13/2^-$ )		$(\Gamma_{p1}+\Gamma_{p2})/\Gamma<0.62$ .
8106?@ 10	$(1/2^+$ to $13/2^-$ )		$\Gamma_{p0}/\Gamma=1.07$ +22-75. $(\Gamma_{p1}+\Gamma_{p2})/\Gamma<0.29$ .
8131 3	$\geq 1/2^-$	1	$\Gamma_{p0}/\Gamma=1.1$ +4-9. $(\Gamma_{p1}+\Gamma_{p2})/\Gamma=0.79$ +20-59.
8178 3	$(5/2^+$ to $13/2^-$ )	2	$\Gamma_{p0}/\Gamma=0.71$ 13. $(\Gamma_{p1}+\Gamma_{p2})/\Gamma=0.05$ +2-4. $\Gamma_{p0}/\Gamma=1.00$ 15.

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$^{31}\text{P}(\text{}^3\text{He,t}) \text{E}=20 \text{ MeV}$  [2009Wr02,2007Wr01](#) (continued) $^{31}\text{S}$  Levels (continued)

E(level)	$J^\pi$ <sup>‡</sup>	$L^\dagger$	Comments
8209?@ 3	(1/2 <sup>+</sup> to 13/2 <sup>-</sup> )		( $\Gamma_{p1}+\Gamma_{p2}$ )/ $\Gamma=0.13$ +4-11. $\Gamma_{p0}/\Gamma<0.33$ .
8229 3	(1/2 <sup>+</sup> to 13/2 <sup>-</sup> )	0	( $\Gamma_{p1}+\Gamma_{p2}$ )/ $\Gamma=0.13$ +5-11. $\Gamma_{p0}/\Gamma=0.9$ +3-6.
8268 10	(1/2 <sup>+</sup> ,3/2 <sup>+</sup> ,5/2 <sup>+</sup> )		( $\Gamma_{p1}+\Gamma_{p2}$ )/ $\Gamma=0.40$ +8-28.
8330 8	(1/2 <sup>+</sup> to 13/2 <sup>-</sup> )		( $\Gamma_{p1}+\Gamma_{p2}$ )/ $\Gamma=0.49$ +18-43. $\Gamma_{p0}/\Gamma=1.16$ +20-78.
8382 10	(1/2 <sup>+</sup> to 13/2 <sup>-</sup> )		( $\Gamma_{p1}+\Gamma_{p2}$ )/ $\Gamma=0.13$ +6-12. $\Gamma_{p0}/\Gamma=0.90$ +14-58.
8418 5	(1/2 <sup>+</sup> ,3/2 <sup>+</sup> ,5/2 <sup>+</sup> )		( $\Gamma_{p1}+\Gamma_{p2}$ )/ $\Gamma=0.16$ +2-10.
8498 5	1/2 <sup>+</sup>		
8562 8			
8813 15	(1/2 <sup>+</sup> ,3/2 <sup>+</sup> ,5/2 <sup>+</sup> )		
8904 20			
8969 20	(1/2 <sup>+</sup> ,3/2 <sup>+</sup> ,5/2 <sup>+</sup> )		
9004 20			
9077 20			
9151 25	13/2 <sup>+</sup>		
9190 25			
9226 25			
9332 30			
9398 30	(3/2,5/2) <sup>+</sup>		

<sup>†</sup> For levels above 6700 values correspond to minimum proton orbital angular momentum deduced from Legendre polynomial fit (using minimum terms in the polynomial) of (t)(p)( $\theta$ ) correlations, protons from  $^{31}\text{S}$  excited states.

<sup>‡</sup> As proposed by [2009Wr02](#).

# Energy used from literature for calibration purpose.

@ Tentative level.

& From [2007Wr01](#).

<sup>a</sup> Energy determined using  $^{27}\text{Si}$  calibration standard.

<sup>b</sup> Constrained by identification as a mirror state of a level in  $^{31}\text{P}$ .