^{60}Ni(d,p),(pol d,p) 1967Co27,2013Sc06,1973Ay03

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh	ENSDF	20-Jan-2020

No changes made since the 2015 update.

1967Co27: (d,p): E=7.5 MeV. Measured σ(E(p),θ), 23 angles (c.m.) from ≈7° to 172°, magnetic spectrograph, enriched target, FWHM=10 keV.

2013Sc06, 2013ScZZ: (d,p), E(d)=10 MeV beam from WNSL-Yale tandem accelerator facility. Measured proton spectra, σ(θ), and spectroscopic factors C^2S for 19 proton groups using a split-pole Enge spectrograph. FWHM ≈33 keV. Target=204 μg/cm^2 thick 99.7% enriched. Deduced levels, J, π. DWBA analysis. Comparison with shell-model calculations.

The main purpose of the neutron adding and neutron removal reaction studies by 2013Sc06 was to obtain occupancies of neutron orbitals, proton vacancies, and energy centroids of neutron, neutron-holes, proton-single particle excitations in ^{60}Ni and ^{62}Ni, and thereby investigate closure of $0f_{7/2}$ shell. Some data details of this study are supplied in 2013ScZZ.

Others:

1964Fu04: (d,p): E=12 MeV. Measured σ(E(p),θ), 7 angles from 5° to 50°, magnetic spectrograph, enriched target , FWHM=10 keV.

1973Ay03: (pol d,p): E=10 MeV. Measured vector analyzing power, θ(c.m.)≈2.5°−70°, semi detector and magnetic spectrograph, enriched target.

For gross structure of γ-spectrum as a function of E(p) in (d,pγ), see 1968Na15.

1975Ba28 (E=3.0-4.5 MeV, θ(c.m.)≈ 10°−135°, Levels at 4762, 4907 keV), L-values and S factors.

1977St07 (E=2.8 MeV, 23 angles from 50° to 160°, FWHM ≈ 30 keV), 22 groups up to 5.3 MeV, σ(θ), L-values and S-factor.

Other: 1962Co02 (θ=9°,15°,25°,40°),

1991We07: E(d)=2.7, 3.0, 3.3 MeV, FWHM≈22 keV; measured σ(θ), DWBA analysis. Deduced density of valence neutron distributions and density differences between isotopes.

Most data listed here are from 1967Co27.

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dσ/dΩ in mb/sr (2013ScZZ)

Level	15°	35°
0	5.29	0.93
67	0.39	0.77
283	4.18	0.55
656	0.13	0.022
909	0.046	0.075
1100	0.44	0.11
1132	0.080	0.10
1185	0.97	0.22
1455	0.067	0.072
1729	0.11	0.029
2122	0.59	0.91
2124	0.94	0.19
2640	0.42	0.099
2697	1.09	0.79
2765	0.29	0.13
2801	0.055	0.091
2905		
3062	0.61	0.42
3487	0.076	0.15
3506	2.39	1.91

Level energies are quoted by 2013Sc06 from 1999-NDS (1999Bh04); values are nearly the same in Adopted Levels here

The uncertainties in cross sections are ≈4% for σ>1 mb/sr, ≈7% for 0.1<σ< 1.0 mb/sr, and ≈18% for σ<0.1 mb/sr at their respective maxima. The uncertainties arising from possible contaminants or previously unidentified states for very weak transitions could be ≈0.02 mb/sr.

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^{61}Ni Levels

E(level)[†]	Jπ[‡]	L[#]	(2J+1)C^{2}S[@]	Comments
0 *5*	3/2−	1	1.49	(2J+1)C^{2}S: 1.76 (2013Sc06,2013ScZZ). $(d\sigma/d\Omega)_{max}$=3.60 mb/sr.
68 *5*	5/2−	3	3.04	$(d\sigma/d\Omega)_{max}$=0.650 mb/sr.
284 *5*	1/2−	1	1.23	(2J+1)C^{2}S: 1.32 (2013Sc06,2013ScZZ). $(d\sigma/d\Omega)_{max}$=3.20 mb/sr.
661 *5*		1	0.053	(2J+1)C^{2}S: 0.04 for J^π=1/2− (2013Sc06,2013ScZZ). $(d\sigma/d\Omega)_{max}$=0.151 mb/sr.
916 *10*		(3)	0.345	$(d\sigma/d\Omega)_{max}$=0.080 mb/sr.
1020 *10*		[a]		$(d\sigma/d\Omega)_{max}$=0.029 mb/sr.
1106 *10*		1	0.108	(2J+1)C^{2}S: 0.12 for J^π=3/2− (2013Sc06,2013ScZZ). $(d\sigma/d\Omega)_{max}$=0.345 mb/sr.
1139 *10*		3	0.400	$(d\sigma/d\Omega)_{max}$=0.098 mb/sr.
1192 *10*	3/2−	1	0.255	(2J+1)C^{2}S: 0.26 (2013Sc06,2013ScZZ). $(d\sigma/d\Omega)_{max}$=0.825 mb/sr.
1462 *10*		3[a]	0.16	$(d\sigma/d\Omega)_{max}$=0.105 mb/sr.
1618 *10*		[a]		$(d\sigma/d\Omega)_{max}$=0.03 mb/sr.
1737 *10*		1	0.044	(2J+1)C^{2}S: 0.027 for J^π=3/2− (2013Sc06,2013ScZZ). $(d\sigma/d\Omega)_{max}$=0.159 mb/sr.
1814 *10*		[a]		$(d\sigma/d\Omega)_{max}$=0.017 mb/sr.
1996 *10*		[a]		$(d\sigma/d\Omega)_{max}$=0.021 mb/sr.
2009 *10*		[a]		$(d\sigma/d\Omega)_{max}$=0.035 mb/sr.
2025 *10*		[a]		$(d\sigma/d\Omega)_{max}$=0.025 mb/sr.
2130 *10*	9/2+&1/2−	4+1	8.45,0.392	(2J+1)C^{2}S: 0.21 for L=1, 1/2− (2013Sc06,2013ScZZ).
2417 *10*		[a]		$(d\sigma/d\Omega)_{max}$=0.035 mb/sr.
2474 *10*		[a]		$(d\sigma/d\Omega)_{max}$=0.058 mb/sr.
2536 *10*		[a]		$(d\sigma/d\Omega)_{max}$=0.022 mb/sr.
2602 *10*		[a]		$(d\sigma/d\Omega)_{max}$=0.031 mb/sr.
2648 *10*		1	0.087	(2J+1)C^{2}S: 0.09 (2013Sc06,2013ScZZ). $(d\sigma/d\Omega)_{max}$=0.369 mb/sr.
2707 *10*	5/2+	2	0.521	$(d\sigma/d\Omega)_{max}$=1.21 mb/sr.
2773 *10*		1	0.054	(2J+1)C^{2}S: 0.06 for J^π=3/2− (2013Sc06,2013ScZZ). $(d\sigma/d\Omega)_{max}$=0.233 mb/sr.
2804 *10*		3	0.291	$(d\sigma/d\Omega)_{max}$=0.090 mb/sr.
2873 *10*		1	0.032	$(d\sigma/d\Omega)_{max}$=0.141 mb/sr.
2910 *10*				L: (1) in 1967Co27 is not confirmed in (α,^{3}He) measurement by 2013Sc06, where L=3 is obtained. Thus (2J+1)C^{2}S=0.014 in 1967Co27 is not adopted. $(d\sigma/d\Omega)_{max}$=0.062 mb/sr.
3051 *10*		(1)	0.017	$(d\sigma/d\Omega)_{max}$=0.077 mb/sr.
3073 *10*		0	0.067	$(d\sigma/d\Omega)_{max}$=1.80 mb/sr.
3116 *10*		3	0.135	$(d\sigma/d\Omega)_{max}$=0.045 mb/sr.
3141 *10*		[a]		$(d\sigma/d\Omega)_{max}$=0.021 mb/sr.
3164 *10*		(1)	0.007	$(d\sigma/d\Omega)_{max}$=0.031 mb/sr.
3241 *10*		1	0.011	$(d\sigma/d\Omega)_{max}$=0.052 mb/sr.
3268 *10*		(1)	0.013	$(d\sigma/d\Omega)_{max}$=0.062 mb/sr.
3298 *10*		(1)[b]	0.038[b]	
3308 *10*		(1)[b]	0.038[b]	
3370 *10*		1	0.022	$(d\sigma/d\Omega)_{max}$=0.105 mb/sr.
3427 *10*		1	0.045	$(d\sigma/d\Omega)_{max}$=0.217 mb/sr.
3448 *10*		2	0.050	$(d\sigma/d\Omega)_{max}$=0.132 mb/sr.
3473 *10*		[a]		$(d\sigma/d\Omega)_{max}$=0.031 mb/sr.
3492 *10*		4	2.120	$(d\sigma/d\Omega)_{max}$=0.305 mb/sr.
3507 *10*		2	0.840	$(d\sigma/d\Omega)_{max}$=2.280 mb/sr.
3537 *10*		[a]		$(d\sigma/d\Omega)_{max}$=0.045 mb/sr.

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^{60}Ni(d,p),(pol d,p) 1967Co27,2013Sc06,1973Ay03 (continued)

^{61}Ni Levels (continued)

E(level)[†]	L[#]	(2J+1)C^{2}S[@]	Comments
3573 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.039 mb/sr.
3608 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.049 mb/sr.
3628 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.050 mb/sr.
3647 *10*	2	0.196	$(d\sigma/d\Omega)_{max}$=0.53 mb/sr.
3683 *10*	1	0.054	$(d\sigma/d\Omega)_{max}$=0.271 mb/sr.
3708 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.55 mb/sr.
3725 *10*	1	0.033	$(d\sigma/d\Omega)_{max}$=0.149 mb/sr.
3753 *10*	(0)	0.131	$(d\sigma/d\Omega)_{max}$=(1.5) mb/sr.
3791 *10*	(1)	0.019	$(d\sigma/d\Omega)_{max}$=0.096 mb/sr.
3819 *10*	(1)	0.009	$(d\sigma/d\Omega)_{max}$=0.045 mb/sr.
3860 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.042 mb/sr.
3879 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.145 mb/sr.
3942 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.087 mb/sr.
3954 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.080 mb/sr.
3984 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.030 mb/sr.
4018 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.034 mb/sr.
4044 *10*	(1)	0.012	$(d\sigma/d\Omega)_{max}$=0.105 mb/sr.
4082 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.036 mb/sr.
4093 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.036 mb/sr.
4131 *10*	(0)	0.005	$(d\sigma/d\Omega)_{max}$=0.076 mb/sr.
4163 *10*	2	0.08	$(d\sigma/d\Omega)_{max}$=0.281 mb/sr.
4189 *10*	2[c]	0.018[c]	
4200 *10*	2[c]	0.018[c]	
4215 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.045 mb/sr.
4226 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.121 mb/sr.
4252 *10*	(2)	0.067	$(d\sigma/d\Omega)_{max}$=0.289 mb/sr.
4287 *10*	[a]		
4295 *10*	[a]		
4314 *10*	(0)[d]	0.02[d]	
4336 *10*	(0)[d]	0.02[d]	
4360 *10*	[e]	[e]	
4374 *10*	[e]	[e]	
4386 *10*	[e]	[e]	
4403 *10*	[e]	[e]	
4425 *10*	[a]		
4448 *10*	[f]	[f]	
4476 *10*	2[f]	0.19[f]	
4501 *10*	[f]	[f]	
4522 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.130 mb/sr.
4551 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.038 mb/sr.
4569 *10*	(2)	0.030	$(d\sigma/d\Omega)_{max}$=0.096 mb/sr.
4589 *10*	2	0.032	$(d\sigma/d\Omega)_{max}$=0.100 mb/sr.
4605 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.039 mb/sr.
4623 *10*	[a]		
4635 *10*	[a]		
4650 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.035 mb/sr.
4665 *10*	[a]		
4694 *10*	[a]		
4716 *10*			
4736 *10*			
4762 *10*	2	0.958	Other: L=2 and (2J+1)S=0.715 (1975Ba28). $(d\sigma/d\Omega)_{max}$=2.69 mb/sr.

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^{60}Ni(d,p),(pol d,p) 1967Co27,2013Sc06,1973Ay03 (continued)

^{61}Ni Levels (continued)

E(level)[†]	L[#]	(2J+1)C^{2}S[@]	Comments
4795 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.042 mb/sr.
4818 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.130 mb/sr.
4837 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.045 mb/sr.
4857 *10*	(1)	0.015	$(d\sigma/d\Omega)_{max}$=0.080 mb/sr.
4872 *10*	(0)[g]	0.052[g]	
4883 *10*	(0)[g]	0.052[g]	
4916 *10*	0[h]	0.40[h]	
4954 *10*	0[h]	0.40[h]	
4968 *10*	2[i]	0.098[i]	
4980 *10*	2[i]	0.098[i]	
5005 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.080 mb/sr.
5020 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.034 mb/sr.
5034 *10*	(1)	0.021	$(d\sigma/d\Omega)_{max}$=0.115 mb/sr.
5064 *10*	0	0.163	$(d\sigma/d\Omega)_{max}$=(4.51) mb/sr.
5097 *10*	1	0.054	$(d\sigma/d\Omega)_{max}$=0.280 mb/sr.
5121 *10*	1	0.108	$(d\sigma/d\Omega)_{max}$=0.590 mb/sr.
5168 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.086 mb/sr.
5187 *10*	0	0.102	$(d\sigma/d\Omega)_{max}$=2.98 mb/sr.
5216 *10*	2	0.053	$(d\sigma/d\Omega)_{max}$=0.170 mb/sr.
5241 *10*	[a]		
5263 *10*	[a]		
5280 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.157 mb/sr.
5295 *10*	(1)	0.033	$(d\sigma/d\Omega)_{max}$=0.190 mb/sr.
5309 *10*	0	0.053	$(d\sigma/d\Omega)_{max}$=1.192 mb/sr.
5336 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.025 mb/sr.
5356 *10*	(1)	0.024	$(d\sigma/d\Omega)_{max}$=0.140 mb/sr.
5366 *10*	[j]	[j]	
5395 *10*	[j]	[j]	
5405 *10*	[j]	[j]	
5440 *10*	1	0.070	$(d\sigma/d\Omega)_{max}$=0.390 mb/sr.
5466 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.067 mb/sr.
5487 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.047 mb/sr.
5512 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.160 mb/sr.
5534 *10*	2	0.071	$(d\sigma/d\Omega)_{max}$=0.278 mb/sr.
5574 *10*	1	0.090	$(d\sigma/d\Omega)_{max}$=0.510 mb/sr.
5601 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.574 mb/sr.
5620 *10*	2	0.072	$(d\sigma/d\Omega)_{max}$=0.276 mb/sr.
5645 *10*	(1)	0.052	$(d\sigma/d\Omega)_{max}$=0.284 mb/sr.
5659 *10*	1	0.049	$(d\sigma/d\Omega)_{max}$=0.30 mb/sr.
5703 *10*	2[k]	0.521[k]	
5723 *10*	2[k]	0.521[k]	
5742 *10*	2	0.325	$(d\sigma/d\Omega)_{max}$=1.318 mb/sr.
5796 *10*	[a]		
5804 *10*	[a]		
5821 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.179 mb/sr.
5842 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.099 mb/sr.
5859 *10*	(0)	0.034	$(d\sigma/d\Omega)_{max}$=0.280 mb/sr.
5883 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.162 mb/sr.
5894 *10*	(2)[l]	0.028[l]	
5914 *10*	(2)[l]	0.028[l]	
5934 *10*	2[m]	0.098[m]	
5957 *10*	2[m]	0.098[m]	

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^{60}Ni(d,p),(pol d,p) 1967Co27,2013Sc06,1973Ay03 (continued)

^{61}Ni Levels (continued)

E(level)[†]	L[#]	(2J+1)C^2S[@]	Comments
5987 *10*	0	0.071	$(d\sigma/d\Omega)_{max}$=1.09 mb/sr.
6016 *10*	(2)	0.037	$(d\sigma/d\Omega)_{max}$=0.130 mb/sr.
6041 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.192 mb/sr.
6072 *10*	[a]		$(d\sigma/d\Omega)_{max} \leq$ 0.035 mb/sr.
6085 *10*	(2)	0.038	$(d\sigma/d\Omega)_{max}$=0.150 mb/sr.
6102 *10*	2[n]	0.192[n]	
6135 *10*	2[n]	0.192[n]	
6148 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.040 mb/sr.
6166 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.030 mb/sr.
6176 *10*	[a]		
6184 *10*	[a]		
6227 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.090 mb/sr.
6249 *10*	(2)	0.071	$(d\sigma/d\Omega)_{max}$=0.275 mb/sr.
6269 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.144 mb/sr.
6289 *10*	(0)	0.015	$(d\sigma/d\Omega)_{max}$=(0.138) mb/sr.
6314 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.185 mb/sr.
6346 *10*	2	0.115	$(d\sigma/d\Omega)_{max}$=0.492 mb/sr.
6371 *10*	2	0.053	$(d\sigma/d\Omega)_{max}$=0.231 mb/sr.
6391 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.060 mb/sr.
6413 *10*			$(d\sigma/d\Omega)_{max}$=(0.120) mb/sr.
6427 *10*	2[o]	0.213[o]	
6444 *10*	2[o]	0.213[o]	
6471 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.173 mb/sr.
6492 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.165 mb/sr.
6515 *10*	(1)[p]	0.045[p]	
6538 *10*	(1)[p]	0.045[p]	
6556 *10*	[a]		$(d\sigma/d\Omega)_{max}$=0.115 mb/sr.
6571 *10*	(2)[q]	0.094[q]	
6589 *10*	(2)[q]	0.094[q]	
6609 *10*	2	0.029	$(d\sigma/d\Omega)_{max}$=0.140 mb/sr.
6630 *10*			
6661 *10*	2[r]	0.091[r]	
6676 *10*	2[r]	0.091[r]	
6706 *10*			
6732 *10*			
6748 *10*			
6767 *10*			
6776 *10*			
6803 *10*			
6818 *10*			
6838 *10*			
6849 *10*			
6878 *10*			
6908 *10*			
6923 *10*			
6928 *10*			
6939 *10*			
6971 *10*			
6993 *10*			
7008 *10*			
7036 *10*			
7051 *10*			
7099[&] *50*			
7137[&] *50*			

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^{60}Ni(d,p),(pol d,p) 1967Co27,2013Sc06,1973Ay03 (continued)

^{61}Ni Levels (continued)

E(level)[†]	E(level)[†]	E(level)[†]	E(level)[†]
7185[&] *50*	7374[&] *50*	7604[&] *50*	7811[&] *50*
7206[&] *50*	7437[&] *50*	7620[&] *50*	7826[&] *50*
7232[&] *50*	7469[&] *50*	7698[&] *50*	7865[&] *50*
7276[&] *50*	7509[&] *50*	7722[&] *50*	7897[&] *50*
7312[&] *50*	7557[&] *50*	7747[&] *50*	7952[&] *50*

[†] From 1967Co27.
[‡] From $\sigma(\theta)$ and A_y(q) in (pol d,p) (1973Ay03).
[#] From DWBA analysis of $\sigma(\theta)$ (1967Co27).
[@] From 1967Co27 unless otherwise stated.
[&] From 1964Fu04.
[a] Corresponding angular distribution showed a nonstripping pattern.
[b] Combined for 3298+3308 levels.
[c] Combined for 4189+4200 levels.
[d] combined for 4314+4336 levels.
[e] L=2, (2J+1)S=0.284, combined for 4360+4374+4386+4403 levels.
[f] L=2, (2J+1)S=0.19, combined for 4448+4476+4501 levels.
[g] Combined for 4872+4883 levels.
[h] Combined for 4916+4954 levels.
[i] Combined for 4968+4980 levels.
[j] L=(0), (2J+1)S=0.071, combined for 5366+5395+5405 levels.
[k] Combined for 5703+5723 levels.
[l] Combined for 5894+5914 levels.
[m] Combined for 5934+5957 levels.
[n] Combined for 6102+6135 levels.
[o] Combined for 6427+6444 levels.
[p] Combined for 6515+6538 levels.
[q] Combined for 6571+6589 levels.
[r] Combined for 6661+6676 levels.