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Differential Cross Sections of (p, p) and (p, p′) Scattering from Several Odd A Nuclei in the Energy Range of 6 to 7.5 Mev

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A compiled table of numerical differential cross sections of elastic and inelastic scattering of protons from several odd-even nuclei is presented, of which measurements were carried out by the Kyoto group using a 105cm cyclotron of Kyoto University. The incident energy of protons was changed by stacked aluminium foils in the energy range of 6 MeV to 7.5 MeV. Targets nuclei are B^{11}, C^{13}, F^{19}, Mg^{25}, Al^{27}, P^{31} and Cl^{35}.

The pourpose of the experiment is to investigate the reaction mechanisms and the relation to the structure of nuclei. Discussions on the results are described briefly.

1. INTRODUCTION

Elastic and inelastic scattering of protons had been reported by many authors in the mass region from light to intermediately heavy nuclei and in the energy range from several to a few tens MeV mainly on even-even nuclei.

Important informations have been obtained by their works about scattering mechanisms, energy dependences of the cross section and of the shape of the angular distribution, the optical model parameters and the level structure.

However, the scattering from odd-A nuclei in the mass region less than A$\sim$40 had been studied relatively little, in spite of their interesting characteristics compared with that of even-even nuclei. These are: (1) the excitation of the compound nucleus which may be formed by a target nucleus and an incident proton, is considerably higher than that of neighbouring even-even nuclei. (2) Thresholds of the (p, n) reaction are lower than that of nearby even-even nuclei. (3) Relatively many levels of different spin and parity of the residual nucleus could be excited so that it would be possible to study the structure of the nucleus and scattering mechanisms by comparing the yields from these levels, because the unified model[1] has shown considerable success in understanding the level structure of odd-A nuclei. (4) The (p, p') scattering of odd-even nuclei is the mirror reaction of the (p, n) reaction of the same nucleus. It seems to be very interesting to compare these two reactions, because the residual two nuclei (in mirror nucleus) have the same spin and parity in corresponding low-lying levels.

The angular distribution and differential cross-sections and their energy dependences have been measured in the present work for nuclei, B^{11}, C^{13}, F^{19}, Mg^{25}, Al^{27}, P^{31} and Cl^{35} in the energy range of 6 to 7.5 MeV.

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2. EXPERIMENTAL PROCEDURES

A deflected beam of protons accelerated up to about 7.5 MeV by a 105cm F.F. cyclotron in our laboratory was led to a 52cm scattering chamber through a pair of quadrupole magnets.

The scattered protons were detected with a NaI or CsI scintillation counter or a solid state detector. In some case the competing (p, α) reaction can occur so that the alpha-particles were absorbed with an Al-foil in front of the detector to prevent the overlapping of peaks in pulse height spectrum. Usual electronics were used to analyze the energy spectrum.

The incident energy of the beam was determined by measuring the range in aluminium[2]. The incident energy was changed by stacked aluminium foils through which the beam emerge into the scattering chamber.

The energy spread of the beam, not defined with a magnetic beam analyzer, seems to be about 50 keV.

The target of boron was made by sedimentation of B^{11} powder (96.7% enriched, obtained from ORNL, USA) on a thin gold foil of which thickness was 0.2mg/cm^2. The thickness of the boron target was ranging 0.5 to 4mg/cm^2 from target to target.

The target of C^{13} was made by a craking method[3] from 56% enriched methane gas. The thickness was 0.38mg/cm^2.

As for F^{19}, a poly-tetra-fluorethylene (teflon) foils were used (2 to 2.5mg/cm^2 in thickness).

Mg^{25} was enriched to about 96% by a mass-separator in Department of Physics, Kyoto University, on a thin gold foil of which thickness was 0.2mg/cm^2. The amount of Mg^{25} was not known so that the absolute cross-section was determined by a comparison with the yields from a natural magnesium target with the thickness of 1.00mg/cm^2.

The target of aluminium was a commercial foil of which thickness was 0.60mg/cm^2.

For P^{31}, targets were made by sedimentation of redphosphorous powder in alcohol on a thin gold foil. The thickness was ranging 1 to 3mg/cm^2.

For chlorine, natural gas in a gas target chamber was used.

3. DISCUSSIONS ON THE RESULTS

Detailed discussions on the results had been reported elsewhere[2,4]. A rather brief discussion is made here.

Numerical values of the differential cross section are given in the following tables.

The discussion for the elastic scattering is summarized in conclusive remarks.

3-1. On the Result of B^{11}

The angular distribution of inelastically scattered protons from the first excited state at 2.13 MeV is considerably energy-dependent. The level can be considered to be a level not belonging to the rotational band of the ground state[5]. The reaction mechanism is considered to be probably the compound nuclear reaction

process in the energy region of 6.5 to 7.5 MeV[2].

3-2. On the Result of C^{13}

Inelastically scattered protons from the lowest three levels were observed. The yield from the second level ($3/2^-$) is predominant. This level can be considered to be a collective level from the result of the (α, α') scattering recently carried out by our group[6]. Therefore, the relatively large yield from this level in the (p, p') scattering is considered to show that the low energy protons excite collective levels with some enhancement over single particle excitations, as well as alpha-particles of a few tens MeV.

These aspects show themselves the existence of direct interactions between the target nucleus and the incident particle. As the energy dependence of the angular distribution of this collective level is considerably large, the interference between the direct interactions and the compound nuclear process may have to be taken into consideration.

3-3. On the Result of F^{19}

Proton groups scattered from three levels (not resolved) at about 1.4 MeV and one level at 2.78 MeV were measured. The angular distribution had little energy dependence. This is very interesting in comparison with the energy dependence of nearby even-even nuclei, for example, Ne^{20}, which showed a violent energy dependence in this energy region[7]. The reason may be explained by the difference in the height of the compound excitation (see ref. 2).

3-4. On the result on Mg^{25}

The angular distribution was measured only at the incident energy of 7 MeV. According to the Nilsson model[8], this nucleus has the same level structure of Al^{27} which has the same number of nucleons, 13[9]. The relative yield from lower several levels was observed to be qualitatively same as that of aluminium. This could be an evidence supporting the Nilsson model in these nuclei and the rotational excitation by low energy protons.

3-5. The Result on Al^{27}

Proton groups from low-lying six levels were observed.

Some energy dependences in the angular distribution were observed though they are not so violent in even-even nuclei in this energy region[7]. It should be noted that the summed angular distribution of p_4' ($Q=-2.73$ Mev) is very close to 90° symmetry. This may suggest that the yield from this level was mainly brought from the compound process according to the theory of Ericson[10]. For other groups of protons, it seems to be probable that there is a mixing of direct interactions and the compound nuclear process. A discussion on this problem will be published elsewhere in detail.

3-6. On the Result of P^{31}

The energy dependence of the angular distribution of p_1' and p_2' are relatively little. In higher energy regions (8 to 14 MeV) both angular distributions take a resembled figure with each other[11]. The monentum transfer in the excitation of both levels is equally two. Thus the resemblance suggest an excitation by direct

interactions. The shape of both angular distributions have also some resemblance in the result of present experiment. It could be considered that in this energy range the both direct and compound nuclear reactions are mixed, and the rate of the latter process would be increasing at lower incident energies.

3-7. On the Result of Cl^{35}

At present, the number of data is quite few so that no discussion can be made.

3-8. Conclusive Remarks

The energy dependence of the angular distribution of the elastic scattering is little compared with that of even-even nuclei in the same energy region. This fact was clarified by the present investigation[4]. The reasons can be considered to be the relative height of the compound nucleus and the (p, n) thresholds. The former is in general considerably high in odd-even nuclei compared with even-even nuclei. The latter is low in odd-even nuclei compared with even-even nuclei. Thus the compound nucleus decays less in the ingoing channel in odd-even nuclei than in even-even nuclei. In the latter nuclei the compound nucleus has relatively a small number of out-going channels other than a rejection to the ingoing channel so that the probability of decaying through the same channel as ingoing channel, i. e. the elastic scattering, would be relatively large in its amount in the elastic scattering in low energy protons (see ref. 4). This would cause the relatively large energy dependence of the elastic scattering in even-even nuclei compared with that in odd-even nuclei.

The integrated cross-section of the inelastic scattering is not strongly energy-dependent with few exceptions in this energy region. This aspect is also characteristic point in comparison with that of even-even nuclei and with that of another type of reactions.

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TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
B^{11}	7.45	0	3/2 −

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error* in mb/ster.
21.5	423.	6.
29.2	251.	4.
46.3	79.7	1.2
53.6	45.2	0.3
64.3	22.8	0.1
74.5	17.5	0.1
85.1	21.4	0.1
95.1	27.7	0.2
105.1	31.3	0.2
114.5	32.2	0.2
124.3	30.1	0.2
134.0	27.8	0.2
143.2	26.6	0.2
152.4	26.4	0.2
161.5	28.2	0.2

* Errors are stasistical.

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
B^{11}	7.45	−2.13	1/2 −

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
22.1	2.77	0.38
29.5	3.58	0.26
47.2	4.27	0.15
54.5	4.28	0.11
65.3	4.13	0.09
75.6	3.78	0.08
86.1	3.73	0.08
96.2	4.24	0.09
106.1	4.82	0.09
115.7	5.76	0.10
125.3	6.07	0.11
134.5	6.25	0.12
144.0	6.29	0.15
152.3	5.86	0.12
162.1	5.46	0.12

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
B^{11}	7.27	0	3/2 −

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
21.5	431.	6.
27.1	270.	4.
28.2	252.	4.
46.3	117.	1.
35.6	56.7	0.5
64.3	30.3	0.2
74.5	17.6	0.1
85.1	21.2	0.2
95.1	26.8	0.2
105.1	31.9	0.3
114.5	32.2	0.3
124.3	32.0	0.3
134.0	30.4	0.3
143.2	31.7	0.3
152.3	31.8	0.3
161.5	34.1	0.3

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
B^{11}	7.27	−2.13	1/2 −

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
47.2	4.79	0.19
54.5	3.95	0.15
65.3	4.38	0.11
75.6	4.45	0.11
86.2	4.68	0.11
96.2	5.57	0.12
106.2	6.55	0.12
115.6	7.23	0.14
125.3	7.11	0.14
134.5	7.26	0.14
144.1	7.38	0.14
152.3	6.77	0.18
162.1	6.66	0.16

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
B^{11}	7.22	−2.13	1/2 −

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
25.3	3.62	0.72
27.4	3.07	0.49
47.2	3.00	0.17
54.5	3.16	0.15
65.3	3.19	0.10
75.6	3.43	0.08
86.2	3.77	0.09
96.2	4.15	0.09
106.2	4.72	0.09
115.6	5.31	0.14
125.3	6.01	0.14
134.5	6.12	0.14
144.1	6.32	0.14
152.3	5.91	0.15
162.1	5.61	0.14

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
B^{11}	6.94	0	3/2 −

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
24.1	446.	7.
27.1	684.	10.
47.4	116.	1.
50.5	97.9	0.8
53.6	78.4	0.6
64.3	38.5	0.3
74.5	25.6	0.2
85.1	25.5	0.2
95.1	30.3	0.2
105.1	35.2	0.3
114.5	37.1	0.3
124.3	36.1	0.3
134.0	34.6	0.3
143.2	33.6	0.3
148.0	32.9	0.3
152.4	34.8	0.3
161.5	36.8	0.3

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
B^{11}	6.94	−2.13	1/2 −

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
23.5	6.48	0.60
48.4	3.84	0.15
51.4	3.73	0.12
54.6	3.92	0.11
65.3	4.42	0.10
76.0	4.93	0.10
86.2	5.29	0.13
96.3	5.22	0.12
106.2	5.01	0.14
116.0	5.38	0.15
125.4	4.81	0.14
134.6	4.91	0.14
144.1	4.37	0.18
153.1	4.53	0.15
162.1	4.38	0.15

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
B^{11}	6.81	−2.13	1/2 −

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
25.3	3.17	0.52
27.4	3.20	0.34
49.3	3.34	0.19
54.6	3.53	0.11
65.3	4.21	0.13
76.0	4.61	0.13
86.2	4.94	0.10
96.3	5.25	0.22
106.2	5.39	0.11
116.0	5.03	0.16
125.4	4.69	0.20
134.6	4.47	0.15
144.1	4.64	0.18
153.1	3.64	0.15
162.1	3.66	0.12

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
B^{11}	6.55	0	3/2 −

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
25.0	430.	6.
30.3	345.	5.
47.4	128.	1.
53.6	83.6	0.4
64.3	43.6	0.2
74.5	33.3	0.2
85.1	34.1	0.2
95.1	41.2	0.2
105.1	45.7	0.2
114.5	42.6	0.2
124.3	40.4	0.2
134.0	36.6	0.2
143.2	39.4	0.2
152.4	40.6	0.2
161.5	49.3	0.2

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
B^{11}	6.55	−2.13	1/2 −

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
25.3	3.43	0.33
31.0	3.47	0.16
46.0	3.42	0.09
54.6	3.50	0.08
65.4	3.51	0.07
76.1	3.44	0.07
86.3	3.50	0.07
96.3	3.45	0.07
106.3	3.41	0.08
116.1	3.30	0.10
125.4	3.36	0.09
134.6	3.39	0.10
144.1	4.19	0.12
153.2	3.94	0.12
162.1	4.75	0.14

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
B^{11}	6.14	0	3/2 −

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
25.0	433.	6.
30.3	328.	5.
47.4	121.	1.
53.6	80.9	0.4
64.3	43.5	0.2
74.5	30.9	0.2
85.1	32.8	0.2
95.1	39.6	0.2
105.1	44.7	0.2
114.5	48.8	0.2
124.3	49.7	0.2
134.0	51.5	0.3
143.2	50.1	0.3
152.4	59.1	0.3
161.5	66.2	0.3

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
B^{11}	6.14	−2.13	1/2 −

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
25.4	4.07	0.26
31.1	4.23	0.15
46.1	4.58	0.14
55.1	4.52	0.08
65.5	4.42	0.07
76.2	3.49	0.06
86.3	3.23	0.06
96.4	3.44	0.06
106.3	3.54	0.07
116.2	3.91	0.12
125.5	4.70	0.09
135.1	5.02	0.09
144.2	5.26	0.10
153.2	5.86	0.10
162.2	5.62	0.10

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
C^{13}	7.05	−3.09	1/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
22.1	1.92	0.84
27.5	3.98	0.54
33.0	3.44	0.28
43.9	3.89	0.20
54.6	3.59	0.12
65.2	3.47	0.15
75.7	2.92	0.07
85.9	2.76	0.10
96.0	2.02	0.07
105.9	1.44	0.13
115.7	1.40	0.14
125.2	1.51	0.10
134.6	2.13	0.14
143.9	3.17	0.16
153.0	3.12	0.15
162.1	3.66	0.17
166.6	3.87	0.18

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
C^{13}	7.05	−3.68	3/2 −

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
22.3	—	—
27.9	7.96	0.58
33.4	6.46	0.29
44.4	9.12	0.28
55.2	8.92	0.18
65.9	7.41	0.22
76.4	6.57	0.11
86.7	6.50	0.10
96.8	7.35	0.12
106.7	9.00	0.16
116.4	10.2	0.2
125.9	11.5	0.2
135.2	12.7	0.3
144.4	13.1	0.3
153.4	13.2	0.3
162.3	13.0	0.3
166.8	13.0	0.3

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
C^{13}	7.05	−3.85	5/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
22.3	—	—
27.9	2.10	0.62
33.4	3.11	0.34
44.4	4.20	0.25
55.2	3.50	0.10
65.9	3.26	0.17
76.4	3.10	0.08
86.7	2.98	0.08
96.8	3.13	0.08
106.7	2.75	0.10
116.4	2.81	0.12
125.9	3.58	0.11
135.2	3.07	0.15
144.4	4.10	0.16
153.4	4.29	0.18
162.3	4.41	0.17
166.8	4.29	0.17

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
C^{13}	6.89	−3.09	1/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
33.1	2.54	0.24
44.0	2.83	0.21
54.7	2.92	0.16
65.3	2.77	0.15
76.8	2.45	0.14
86.0	2.53	0.11
96.2	2.34	0.10
106.1	1.87	0.18
115.8	1.78	0.19
125.3	2.12	0.16
134.7	2.73	0.18
143.9	2.82	0.16
153.1	3.36	0.18
162.1	3.58	0.19
166.6	4.03	0.15

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
C^{13}	6.89	−3.68	3/2 −

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
33.5	8.01	0.31
44.4	7.93	0.32
55.3	7.32	0.31
66.0	7.07	0.23
76.5	5.72	0.21
86.8	5.12	0.20
97.4	5.41	0.21
106.8	6.03	0.21
116.5	6.68	0.22
126.0	6.80	0.22
135.3	7.16	0.23
144.4	7.44	0.22
153.5	6.75	0.21
162.4	6.28	0.21
166.8	6.85	0.21

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
C^{13}	6.89	−3.85	5/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
33.5	2.29	0.28
44.4	3.54	0.25
55.3	3.70	0.22
66.0	4.34	0.16
76.5	2.50	0.16
86.8	2.91	0.15
97.4	2.57	0.16
106.8	2.44	0.16
116.5	2.38	0.17
126.0	2.27	0.18
135.3	2.57	0.15
144.4	2.34	0.15
153.5	2.42	0.16
162.4	2.05	0.15
166.8	2.25	0.15

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
C^{13}	6.60	−3.09	1/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
33.1	2.01	0.28
44.0	1.44	0.16
54.8	2.04	0.16
65.4	2.06	0.12
75.9	1.97	0.14
86.2	2.58	0.16
96.3	2.21	0.16
106.2	2.15	0.21
115.9	2.90	0.24
125.4	3.45	0.29
134.8	3.58	0.19
144.0	4.27	0.24
153.1	4.43	0.24
162.2	5.12	0.26

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
C^{13}	6.60	−3.68	3/2 −

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
33.6	12.7	0.1
44.6	9.12	0.30
55.5	9.39	0.32
66.2	7.17	0.23
76.7	6.54	0.24
87.0	5.57	0.22
97.2	4.65	0.22
107.0	4.63	0.31
116.7	6.00	0.31
126.2	5.39	0.32
135.5	4.70	0.21
144.6	4.34	0.26
153.6	4.52	0.26
162.4	4.48	0.25

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
C^{13}	6.60	−3.85	5/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
33.6	4.25	0.43
44.6	2.87	0.21
55.5	3.14	0.20
66.2	3.69	0.19
76.7	3.32	0.19
87.0	3.29	0.20
97.2	3.58	0.26
107.0	3.37	0.26
116.7	2.74	0.26
126.2	2.23	0.24
135.5	2.76	0.20
144.6	2.13	0.21
153.6	2.04	0.22
162.4	1.76	0.21

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
F^{19}	7.42	−1.35	5/2 −
		−1.46	3/2 −
		−1.56	3/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
31.4	4.68	0.17
42.1	6.40	0.12
46.2	7.34	0.08
52.4	8.11	0.09
62.6	9.54	0.09
73.1	10.0	0.1
83.2	10.3	0.1
93.2	10.4	0.1
103.2	10.2	0.1
113.2	9.52	0.11
122.6	8.87	0.10
132.4	7.03	0.10
141.1	6.03	0.10
151.4	4.31	0.10
161.1	4.12	0.09

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
F^{19}	7.41	−2.78	(7/2, 9/2)

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
31.6	1.90	0.10
42.3	2.14	0.07
46.4	1.94	0.04
52.6	1.78	0.05
63.2	1.55	0.05
73.4	1.37	0.05
83.5	1.12	0.05
93.5	1.03	0.05
103.5	1.05	0.04
113.4	0.991	0.054
123.2	1.01	0.05
132.6	0.912	0.054
142.3	0.973	0.054
151.6	1.02	0.059
161.2	0.870	0.060

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
F^{19}	7.27	−1.35	5/2 −
		−1.46	2/2 −
		−1.56	3/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
31.4	5.24	0.19
42.1	6.18	0.10
46.2	7.11	0.14
52.4	7.83	0.08
62.6	9.20	0.08
73.1	10.6	0.1
83.2	10.6	0.1
93.2	11.0	0.1
103.2	10.6	0.1
113.1	9.98	0.07
122.6	8.75	0.08
132.4	7.57	0.08
141.1	6.23	0.08
151.4	5.05	0.08
161.1	4.44	0.08

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
F^{19}	7.27	−2.78	(7/2,9/2)

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
31.6	2.35	0.13
42.3	1.85	0.07
46.4	1.76	0.08
52.6	1.62	0.05
63.2	1.22	0.05
73.4	1.04	0.04
83.5	0.997	0.050
93.5	0.845	0.034
103.5	0.782	0.040
113.4	0.705	0.043
123.2	0.753	0.047
132.6	0.633	0.047
142.3	0.563	0.051
151.6	0.560	0.055
161.2	0.746	0.064

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
F^{19}	7.02	−1.35	5/2 −
		−1.46	3/2 −
		−1.56	3/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
31.4	8.74	0.23
42.1	9.70	0.15
52.4	11.0	0.2
62.6	12.8	0.14
73.1	14.6	0.2
83.2	15.0	0.15
93.3	14.6	0.13
103.2	13.7	0.14
113.1	11.8	0.17
122.6	10.4	0.12
132.4	8.92	0.12
142.1	7.26	0.12
151.4	6.57	0.21
161.1	4.55	0.22

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
F^{19}	7.02	−2.78	(7/2,9/2)

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
31.6	1.45	0.14
42.3	1.32	0.08
53.4	1.08	0.08
63.3	0.990	0.069
73.4	0.853	0.066
83.5	0.805	0.071
93.6	0.794	0.050
103.5	0.717	0.050
113.4	0.758	0.068
123.3	0.795	0.064
133.0	0.770	0.066
142.3	0.598	0.118
151.6	0.521	0.113
161.2	0.279	0.130

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
F^{19}	6.78	−1.35	5/2 −
		−1.46	3/2 −
		−1.56	3/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
31.4	10.0	0.3
42.1	11.3	0.3
52.4	12.9	0.2
62.6	14.7	0.2
73.1	15.2	0.5
83.2	15.4	0.2
93.3	14.9	0.2
103.2	14.2	0.2
113.1	12.3	0.2
122.6	11.0	0.2
132.4	9.54	0.26
142.1	9.07	0.27
151.4	8.14	0.21
161.1	6.72	0.26

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
F^{19}	6.78	−2.78	(7/2,9/2)

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
32.0	2.19	0.25
42.4	1.99	0.17
53.1	1.63	0.09
63.3	1.38	0.10
73.5	1.24	0.18
83.6	1.04	0.08
94.1	0.817	0.075
103.6	0.644	0.068
113.5	0.713	0.088
123.3	0.811	0.097
133.0	0.557	0.081
142.3	0.726	0.166
152.0	0.651	0.120
161.2	0.714	0.160

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Mg^{25}	7.0	0	5/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
62.0	107.3	0.6
72.2	68.3	0.5
82.3	45.1	0.4
92.3	33.9	0.3
102.3	27.6	0.2
112.2	22.8	0.3
122.0	22.2	0.3
131.8	24.8	0.4
141.5	22.0	0.3
151.2	20.7	0.3
156.0	24.4	0.3

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Mg^{25}	7.0	−0.584	1/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
51.9	3.17	0.26
62.1	2.73	0.25
72.3	2.17	0.26

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Mg^{25}	7.0	−0.976	3/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
36.4	4.13	0.50
41.6	2.30	0.40
51.9	2.73	0.19
62.1	3.12	0.12
72.3	2.78	0.12
82.4	2.28	0.13
92.5	2.26	0.10
102.4	2.39	0.17
112.3	2.74	0.31
122.1	2.19	0.41

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Mg^{25}	7.0	−1.611	(7/2) +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
36.5	10.2	0.5
41.7	10.1	0.4
52.0	11.5	0.3
62.4	9.88	0.23
72.5	7.45	0.19
82.6	5.07	0.11
92.6	4.77	0.12
102.6	4.83	0.14
112.5	5.63	0.20
122.4	7.81	0.23
132.0	8.15	0.34
141.7	7.99	0.21
151.3	6.57	0.13
156.1	6.30	0.21

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Mg^{25}	7.0	−1.962	5/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
36.6	6.44	0.76
41.8	4.61	0.34
52.1	4.54	0.22
62.4	3.80	0.15
72.6	3.22	0.14
82.7	2.59	0.13
92.7	1.96	0.09
102.7	1.85	0.11
112.6	2.26	0.16
122.4	2.68	0.16
132.1	3.02	0.30
141.8	2.29	0.14
151.4	2.03	0.17
156.6	2.08	0.17

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Mg^{25}	7.0	−2.565	1/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
36.7	1.94	0.49
41.9	—	—
52.2	1.16	0.18
62.5	1.14	0.15
72.7	0.919	0.113
82.9	0.852	0.151
92.9	0.759	0.081
102.9	0.788	0.137
112.7	0.910	0.143
122.5	0.986	0.153
132.2	1.11	1.23
141.9	0.999	0.145
151.5	0.617	0.159
156.2	0.919	0.153

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Mg^{25}	7.0	−2.736 −2.803	(7/2) + (3/2, 5/2)

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
36.8	4.81	0.47
42.0	—	—
52.3	5.78	0.22
62.6	4.89	0.19
72.8	4.90	0.17
82.9	4.02	0.16
93.0	3.49	0.11
102.9	3.40	0.14
112.8	3.69	0.13
122.6	4.92	0.20
132.3	4.82	0.32
141.9	3.89	0.18
151.5	2.94	0.17
156.2	2.86	0.17

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Mg^{25}	7.0	−3.399 −3.408	(9/2) + 3/2 −

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
36.8	4.20	0.40
42.1	4.46	0.34
52.5	6.28	0.22
62.8	8.29	0.24
73.1	5.91	0.16
83.2	4.34	0.15
93.3	3.41	0.10
103.2	3.50	0.13
113.1	4.21	0.19
122.8	5.23	0.23
132.5	4.67	0.30
142.1	4.12	0.17
151.6	3.33	0.17
156.4	3.97	0.17

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Al^{27}	7.35	0	5/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
25.5	1130.	2.
31.0	590.	2.
41.2	254.	0.6
51.4	136.	0.4
61.5	83.1	0.3
72.0	57.0	0.3
82.1	39.5	0.2
92.1	29.1	0.2
102.1	21.1	0.2
112.0	17.3	0.2
121.5	16.7	0.2
131.4	19.8	0.2
141.2	25.1	0.2
151.0	30.3	0.2
160.4	34.7	0.2

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Al^{27}	7.35	−0.842 −1.013	1/2 + 3/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
31.1	6.39	0.33
41.3	6.59	0.18
51.5	6.21	0.13
61.6	5.99	0.12
72.1	5.66	0.11
82.2	5.36	0.11
92.2	5.19	0.11
102.2	5.25	0.11
112.1	5.09	0.14
121.6	4.92	0.14
131.5	4.69	0.15
141.3	4.03	0.15
151.1	3.80	0.15
160.5	3.36	0.15

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Al^{27}	7.35	−2.208	7/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
31.2	7.39	0.31
41.4	6.12	0.16
51.6	5.56	0.12
62.1	5.20	0.11
72.2	4.56	0.11
82.3	4.54	0.11
92.3	4.21	0.10
102.3	4.27	0.10
112.2	4.26	0.15
122.1	4.44	0.15
131.6	4.22	0.15
141.4	4.25	0.16
151.2	4.17	0.16
160.5	3.43	0.15

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Al^{27}	7.35	−2.729	5/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
31.2	3.42	0.23
41.5	—	—
52.0	2.64	0.08
62.2	2.60	0.07
72.3	3.00	0.09
82.4	2.81	0.08
92.4	3.06	0.08
102.4	3.06	0.13
112.3	3.07	0.13
122.2	3.13	0.12
132.1	2.95	0.12
141.4	3.31	0.14
151.2	3.64	0.13
160.6	3.13	0.13

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Al^{27}	7.35	−2.976 −3.000	3/2 + 9/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
31.2	7.81	0.30
41.5	8.86	0.16
52.1	6.88	0.12
62.3	6.33	0.11
72.4	6.05	0.12
82.5	5.89	0.11
92.5	5.68	0.11
102.5	5.30	0.10
112.4	5.12	0.15
122.3	5.06	0.15
132.1	4.66	0.15
141.5	4.63	0.16
151.2	4.59	0.15
160.6	4.44	0.15

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Al^{27}	7.14	0	5/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
25.5	1172.	3.
31.0	616.	1.3
41.2	252.2	0.7
51.4	136.1	0.6
61.5	83.1	0.5
72.0	59.7	0.4
82.1	41.6	0.4
92.1	28.3	0.3
102.1	20.6	0.3
112.0	16.0	0.2
121.5	17.0	0.2
131.4	21.1	0.3
141.2	27.2	0.3
151.0	33.2	0.3
160.4	40.9	0.4

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Al^{27}	7.14	−0.842 −1.013	1/2 + 3/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
25.6	7.42	0.58
31.1	6.75	0.30
41.3	7.12	0.19
51.5	6.40	0.19
61.6	6.00	0.17
72.1	5.84	0.16
82.2	5.67	0.16
92.2	5.77	0.13
102.2	5.93	0.16
112.1	6.07	0.18
121.6	5.74	0.22
131.5	5.91	0.23
141.3	5.70	0.19
151.1	5.37	0.20
160.5	4.70	0.21

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Al^{27}	7.14	−2.208	7/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
26.1	5.98	0.57
31.2	4.62	0.27
41.4	5.78	0.18
51.6	5.41	0.18
62.1	5.18	0.17
72.3	5.14	0.16
82.3	5.02	0.15
92.3	4.81	0.13
102.3	4.91	0.16
112.3	5.31	0.21
122.1	5.47	0.21
141.4	5.92	0.22
151.2	6.17	0.24
160.5	5.90	0.23

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Al^{27}	7.14	−2.729	5/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
26.1	2.26	0.47
31.2	1.92	0.19
41.5	3.68	0.15
52.1	2.31	0.13
62.2	2.28	0.13
72.3	2.52	0.13
82.4	2.53	0.12
92.4	2.73	0.10
102.4	3.06	0.14
112.3	2.99	0.18
122.2	2.69	0.16
132.1	2.63	0.16
141.5	2.28	0.18
151.2	2.14	0.17
160.6	2.45	0.19

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Al^{27}	7.14	−2.975 −3.000	3/2 + 9/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
26.1	7.30	0.53
31.3	8.11	0.29
41.5	8.42	0.18
52.1	7.83	0.20
62.3	6.73	0.18
72.4	6.22	0.18
82.5	5.41	0.17
92.5	5.54	0.15
102.5	4.87	0.18
112.4	4.63	0.22
122.3	5.43	0.23
132.1	6.20	0.24
141.5	6.06	0.26
151.3	6.48	0.27
160.6	6.40	0.26

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Al^{27}	6.95	0	5/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
25.5	1285.	2.
31.0	645.	2.
41.2	267.	2.
51.4	141.3	0.7
61.5	85.9	0.5
72.0	60.3	0.5
82.1	45.6	0.4
92.1	33.2	0.3
102.1	25.3	0.3
112.0	21.6	0.3
121.5	21.9	0.3
131.4	26.1	0.3
141.2	31.9	0.4
151.0	39.0	0.4
160.4	45.1	0.4

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Al^{27}	6.95	−0.842 −1.013	1/2 + 3/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
25.6	—	—
31.1	5.93	0.30
41.3	6.19	0.18
51.5	5.57	0.19
61.6	5.02	0.17
72.1	4.96	0.16
86.2	4.60	0.16
92.2	4.63	0.16
102.2	5.00	0.15
112.1	5.27	0.19
122.0	5.38	0.20
131.5	5.60	0.21
141.3	5.00	0.22
151.1	4.80	0.21
160.5	4.45	0.21

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Al^{27}	6.95	−2.208	7/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
26.1	8.33	0.40
31.2	8.23	0.31
41.4	7.96	0.17
51.6	7.67	0.19
62.1	7.02	0.19
72.3	5.94	0.18
82.3	5.36	0.17
92.4	5.24	0.17
102.3	4.82	0.15
112.3	4.68	0.21
122.2	4.35	0.20
131.6	5.05	0.23
141.4	4.92	0.22
151.2	5.40	0.23
160.5	4.84	0.22

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Al^{27}	6.95	−2.729	5/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
26.1	3.07	0.32
31.2	3.32	0.21
41.5	4.00	0.13
52.1	3.12	0.14
62.2	2.64	0.12
72.4	2.85	0.13
82.4	2.92	0.13
92.5	2.69	0.14
102.4	2.19	0.12
112.4	2.19	0.16
122.2	2.28	0.18
132.1	3.07	0.19
141.5	2.47	0.19
151.2	2.08	0.18
160.6	2.61	0.18

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Al^{27}	6.95	−2.976 −3.000	3/2 + 9/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
26.1	14.7	0.5
31.3	12.0	0.3
41.5	10.8	0.2
52.1	8.46	0.20
62.3	6.95	0.18
72.4	5.92	0.18
82.5	5.89	0.19
92.5	5.69	0.20
102.5	6.61	0.21
112.4	7.86	0.26
122.3	8.44	0.19
132.1	8.95	0.29
141.5	9.20	0.30
151.3	9.81	0.33
160.6	9.55	0.31

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Al^{27}	6.71	0	5/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
25.5	1432.	2.
31.0	743.	2.
41.2	317.	1.
51.4	171.	0.8
61.5	105.3	0.7
72.0	69.3	0.5
82.1	50.7	0.4
92.1	39.0	0.4
102.1	30.0	0.3
112.0	25.6	0.3
121.5	23.7	0.3
131.4	27.1	0.3
141.2	32.3	0.4
151.0	40.1	0.4
160.4	46.3	0.4

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Al^{27}	6.71	−0.842 −1.013	1/2 + 3/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
25.6	5.41	0.52
31.1	5.29	0.36
41.3	5.49	0.25
51.5	6.03	0.22
62.0	5.95	0.21
72.1	5.96	0.19
82.2	5.76	0.19
92.2	5.57	0.18
102.2	5.14	0.17
112.1	4.76	0.19
122.0	5.11	0.20
131.5	5.08	0.21
141.3	5.23	0.21
151.1	4.90	0.22
160.5	4.88	0.22

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Al^{27}	6.71	−2.208	7/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
26.1	6.14	0.53
31.2	5.47	0.36
41.4	5.81	0.25
52.0	5.94	0.22
62.2	6.01	0.22
72.3	6.65	0.21
82.3	6.24	0.20
92.4	6.12	0.21
102.3	5.50	0.18
112.3	5.23	0.24
122.2	4.75	0.24
132.0	4.16	0.23
141.4	4.33	0.23
151.2	3.74	0.24
160.5	3.55	0.23

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Al^{27}	6.71	−2.729	5/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
26.1	2.17	0.43
32.2	1.25	0.26
41.5	3.71	0.22
52.1	2.29	0.15
62.3	2.45	0.18
72.4	2.82	0.17
82.5	3.43	0.18
92.5	3.36	0.18
102.5	2.99	0.16
112.4	3.51	0.18
122.3	2.77	0.18
132.1	3.10	0.18
141.5	3.01	0.21
151.2	3.03	0.21
160.6	3.28	0.21

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Al^{27}	6.71	−2.976 −3.000	3/2 + 9/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
26.1	5.23	0.54
31.3	5.18	0.33
41.5	5.74	0.24
52.1	5.51	0.22
62.3	5.60	0.24
72.4	5.77	0.22
82.5	5.51	0.23
92.5	5.90	0.24
102.5	5.54	0.19
112.4	5.22	0.24
122.3	5.54	0.35
132.1	5.08	0.22
141.5	4.83	0.23
151.3	5.12	0.24
161.0	4.54	0.24

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Al^{27}	6.57	0	5/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
25.5	—	—
31.0	715.	2.
41.2	292.	1.
51.4	158.	0.9
61.5	96.8	0.7
72.0	61.5	0.6
82.1	41.9	0.5
92.1	29.5	0.4
102.1	22.9	0.4
112.0	20.1	0.3
121.5	22.4	0.4
131.4	26.9	0.4
141.2	34.1	0.3
151.0	41.1	0.5
160.4	46.6	0.5

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Al^{27}	6.57	−0.842 −1.013	1/2 + 3/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
25.6	—	—
31.1	5.54	0.37
41.3	5.98	0.28
51.5	5.50	0.25
62.0	5.91	0.23
72.1	6.00	0.21
82.2	5.88	0.22
92.2	6.15	0.23
102.2	6.42	0.23
112.1	6.92	0.26
122.0	7.04	0.26
131.5	6.89	0.26
141.3	6.25	0·21
151.1	6.21	0.28
160.5	6.80	0.27

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Al^{27}	6.57	−2.208	7/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
26.1	—	—
31.2	4.94	0.35
41.4	4.98	0.26
52.0	4.93	0.24
62.2	5.57	0.23
72.3	5.52	0.23
82.4	6.58	0.24
92.4	6.66	0.24
102.4	5.70	0.23
112.3	5.50	0.31
122.2	5.35	0.30
132.1	4.42	0.29
141.4	4.80	0.24
151.2	4.47	0.32
160.6	4.95	0.32

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Al^{27}	6.57	-2.729	5/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
26.1	—	—
32.2	2.97	0.30
41.5	5.98	0.26
52.1	3.41	0.22
62.3	3.46	0.20
72.4	3.72	0.22
82.5	3.45	0.22
92.5	3.60	0.26
102.5	3.40	0.25
112.4	4.16	0.30
122.3	4.69	0.33
132.1	3.52	0.31
141.5	—	—
151.2	4.28	0.38
160.6	5.01	0.41

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Al^{27}	6.57	−2.976 −3.000	3/2 + 9/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
26.1	—	—
31.3	6.59	0.30
41.5	5.74	0.28
52.1	5.31	0.25
62.3	5.38	0.26
72.4	5.02	0.28
82.5	6.21	0.32
92.5	6.40	0.37
102.5	7.21	0.38
112.4	7.05	0.42
122.3	6.66	0.43
132.1	6.72	0.46
141.5	—	—
151.3	—	—
161.0	—	—

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
P^{31}	7.35	0	1/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
25.5	995.9	6.5
34.0	434.3	2.7
41.1	249.2	1.5
51.3	150.2	1.5
61.4	97.0	0.6
71.4	58.6	0.4
81.5	36.0	0.2
91.5	19.1	0.2
101.5	12.4	0.1
111.4	9.11	0.11
121.4	10.4	0.1
131.3	16.3	0.2
141.1	26.6	0.2
150.6	41.6	0.2
160.4	57.3	0.3

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
P^{31}	7.35	−1.265	3/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
34.1	5.77	0.38
41.2	5.34	0.20
51.3	5.11	0.16
61.5	4.76	0.11
71.6	4.46	0.10
82.0	3.58	0.08
92.0	3.25	0.08
102.0	2.98	0.08
111.6	3.08	0.11
121.5	3.23	0.11
131.3	3.90	0.24
141.2	3.86	0.34
151.0	3.62	0.52
160.4	3.54	0.32

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
P^{31}	7.35	−2.232	5/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
25.6	4.22	0.68
28.0	4.36	0.44
41.3	4.50	0.17
51.4	4.60	0.15
61.6	4.63	0.10
72.1	4.39	0.10
82.1	4.52	0.10
92.1	4.25	0.10
102.1	4.08	0.09
112.1	3.60	0.15
121.6	3.19	0.14
131.4	3.00	0.14
141.3	2.79	0.13
151.1	2.39	0.13
160.5	2.64	0.13

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
P^{31}	7.10	0	1/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
27.5	1112.	6.
34.0	679.	4.
43.2	349.	2.
51.3	227.	1.3
61.4	130.	1.
71.4	81.9	0.7
81.5	50.9	0.5
91.5	33.1	0.4
101.5	20.6	0.2
111.4	15.0	0.2
121.4	17.1	0.2
131.3	28.8	0.3
141.1	48.5	0.3
150.6	71.9	0.4
160.4	96.4	0.5

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
P^{31}	7.10	−1.265	3/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
34.1	4.33	0.47
43.2	4.45	0.25
51.3	4.78	0.20
61.5	5.06	0.18
71.6	5.42	0.15
82.0	5.94	0.14
92.0	6.50	0.13
102.0	4.57	0.12
111.6	4.22	0.18
121.5	3.42	0.16
131.3	3.32	0.15
141.2	3.28	0.13
151.0	3.27	0.13
160.4	3.46	0.20

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
P^{31}	7.10	-2.232	5/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
27.6	4.47	0.64
43.2	4.86	0.23
51.3	4.94	0.20
61.5	5.31	0.18
71.6	5.60	0.16
82.0	5.88	0.14
92.0	6.02	0.13
102.0	5.91	0.14
111.6	5.59	0.14
121.5	4.80	0.17
131.3	4.31	0.22
141.2	3.70	0.21
151.0	3.28	0.19
160.4	3.26	0.20

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
P^{31}	6.95	0	1/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
28.5	993.	15.
34.0	578.	9.
41.1	354.	5.
51.3	202.	3.
61.4	124.	2.
71.4	74.2	1.1
81.5	43.5	0.3
91.5	24.2	0.2
101.5	11.6	0.2
111.4	6.20	0.10
121.4	8.13	0.11
131.3	15.8	0.2
141.1	27.5	0.2
150.6	42.0	0.3
160.4	53.7	0.3

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
P^{31}	6.95	−1.265	3/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
34.1	4.65	0.26
41.2	4.34	0.18
51.3	4.41	0.15
61.5	4.18	0.13
71.6	3.88	0.11
82.0	3.39	0.11
92.0	3.37	0.10
102.0	3.34	0.11
111.6	3.45	0.14
121.5	3.89	0.15
131.3	4.45	0.20
141.2	4.98	0.15
151.2	5.27	0.15
160.4	5.45	0.15

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
P^{31}	6.95	−2.232	5/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
29.0	3.87	0.34
41.3	4.25	0.19
51.4	4.60	0.13
61.6	4.59	0.12
72.1	4.75	0.11
82.1	4.78	0.13
92.2	4.60	0.13
102.1	4.63	0.13
112.1	4.64	0.17
121.6	4.43	0.16
131.4	4.04	0.18
141.3	3.52	0.15
151.1	2.93	0.16
160.5	2.34	0.16

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
P^{31}	6.71	0	1/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
27.5	943.	14.
34.0	593.	9.
43.2	294.	5.
51.3	182.	3.
61.4	119.	2.
71.4	68.5	1.0
81.5	43.8	0.7
91.5	27.3	0.3
101.5	16.5	0.2
111.4	11.7	0.2
121.4	14.2	0.2
131.3	23.8	0.2
141.1	36.7	0.3
150.6	50.9	0.4
160.4	64.6	0.4

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
P^{31}	6.71	−1.265	3/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
34.1	4.63	0.40
43.2	4.33	0.21
51.3	4.45	0.17
61.5	4.21	0.14
71.6	3.81	0.13
82.0	3.92	0.11
92.0	3.70	0.16
102.0	3.74	0.11
111.6	3.82	0.15
121.5	4.17	0.15
131.3	4.64	0.14
141.2	4.98	0.16
151.0	5.12	0.14
160.4	5.05	0.14

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
P^{31}	6.71	−2.232	5/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
28.0	5.38	0.80
42.2	5.59	0.20
51.4	6.38	0.18
61.5	5.80	0.16
72.1	5.84	0.15
82.1	5.93	0.14
92.2	5.62	0.14
102.1	5.37	0.13
112.1	5.16	0.19
121.6	4.93	0.20
131.4	4.66	0.19
141.3	4.48	0.19
151.1	4.54	0.19
160.5	4.44	0.19

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
P^{31}	6.54	0	1/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
28.5	1824.	27.
30.6	1699.	26.
36.0	507.	8.
41.1	360.	5.
44.2	320.	5.
51.3	212.	3.
61.4	128.	2.
71.4	75.8	0.9
81.5	46.6	0.7
91.5	27.5	0.5
101.5	14.5	0.3
111.4	7.84	0.11
121.3	8.22	0.10
131.3	13.2	0.1
141.1	20.3	0.2

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
P^{31}	6.54	−1.265	3/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
36.1	4.85	0.33
41.2	4.80	0.35
44.2	5.07	0.22
51.4	5.10	0.18
61.5	4.55	0.15
71.6	4.47	0.15
82.0	4.23	0.14
92.0	4.37	0.16
102.0	4.30	0.13
111.6	3.91	0.17
121.5	4.16	0.18
131.4	4.31	0.17
141.2	4.60	0.16
151.0	4.95	0.13
160.4	4.50	0.12

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
P^{31}	6.54	−2.232	5/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
29.1	5.26	0.61
31.1	4.63	0.79
44.3	4.52	0.20
51.5	4.89	0.18
61.6	5.45	0.17
72.1	5.57	0.17
82.2	5.48	0.17
92.2	5.09	0.19
102.2	5.02	0.17
112.1	4.59	0.24
122.0	3.74	0.21
131.5	2.88	0.21
141.3	2.45	0.20
151.1	3.09	0.23
160.5	2.24	0.21

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Cl^{35+37}	7.0	0	3/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
20.5	4687.	19.
30.8	1051.	5.
46.1	381.5	2.9
61.4	144.7	6.6
71.5	84.6	0.5
81.6	52.3	0.4
91.6	27.3	0.3
106.6	12.0	0.2
121.4	13.9	0.2
136.1	28.5	0.3
150.8	39.1	0.4
160.5	46.8	0.4

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Cl^{35}	7.0	−1.22	+

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
30.9	3.84	0.34
46.3	2.46	0.37
61.6	2.46	0.28
71.7	1.59	0.12
81.8	1.15	0.11
91.8	1.34	0.12
106.8	1.53	0.18
121.6	2.59	0.12
136.3	3.40	0.11
150.9	3.79	0.14
160.6	4.09	0.15

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Cl^{35+37}	6.7	0	3/2 +

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
25.7	1618.	15.
30.8	806.	5.
41.0	380.	2.
56.3	153.	0.7
71.5	68.4	0.6
86.6	26.0	1.6
101.6	10.6	0.3
116.5	8.84	0.22
131.2	14.4	0.3
145.9	29.9	0.4
160.6	41.0	0.3

(p,p), (p,p') Scattering from 6 to 7.5 Mev

TARGET NUCLEUS	INCIDENT ENERGY (MeV)	Q-VALUE OF THE LEVEL (MeV)	SPIN & PARITY
Cl^{35}	6.7	−1.22	+

θ_{cm} in degrees	$(d\sigma/d\Omega)_{cm}$ in mb/ster.	Error in mb/ster.
25.8	—	—
30.9	4.37	0.78
41.2	2.65	0.27
56.5	2.06	0.15
71.7	1.48	0.13
86.8	1.31	0.12
101.8	1.10	0.11
116.6	—	—
131.4	2.31	0.14
146.0	3.60	0.17
160.6	3.71	0.12

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