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Elastic and Inelastic Scattering of α Particles from O^{16}, Mg^{24}, and Si^{28}*

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Abstract

Differential cross sections have been measured for elastic scattering of α particles from O^{16}, Mg^{24}, and Si^{28}, using 22.5-MeV α particles from the Indiana University cyclotron. SCAT-IV optical-model fits have been obtained for these data and evidence derived from the fits indicates that the observed backward angle peaking is at least partially explained by optical-potential focusing.[1] Differential cross sections have also been measured for inelastic scattering to the lst 5 excited states of O^{16} and Mg^{24} and the lst 4 excited states of Si^{28}. However, doublets at 6.05-6.13, and 6.92-7.12 MeV in O^{16}, 4.12-4.23 MeV in Mg^{24}, and 4.61-4.97 MeV in Si^{28} were unresolved and require special interpretation. Evidence for excitation of the 4.97-MeV state in Si^{28} ($J = 0$) indicates that it has positive parity, since (α,α') excitation of a 0^- state is rigorously forbidden. The phase relationships of the differential cross sections are discussed, along with their bearing on the band structure of the nuclei and the excitation modes of unnatural-parity states.[2]

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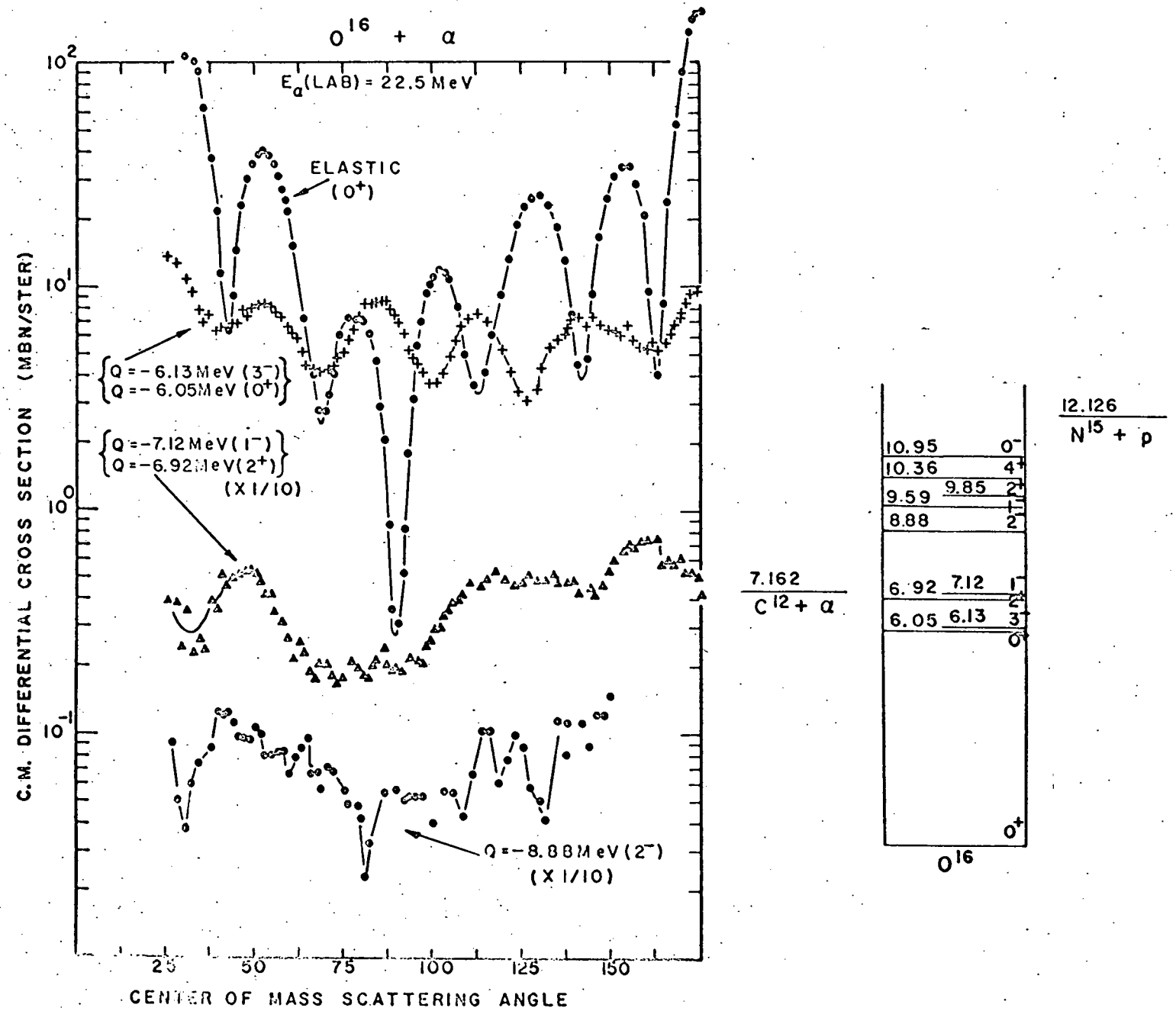
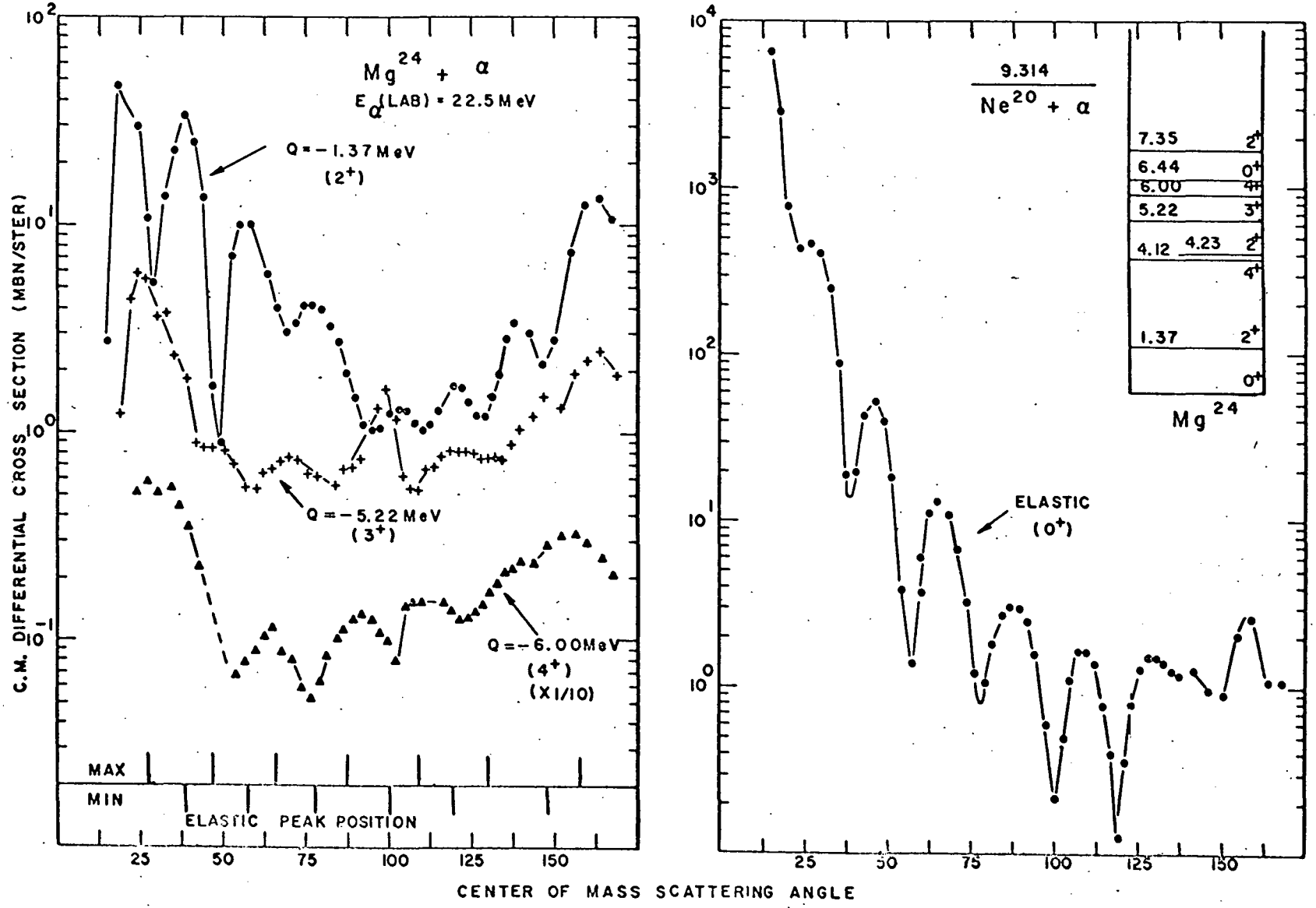
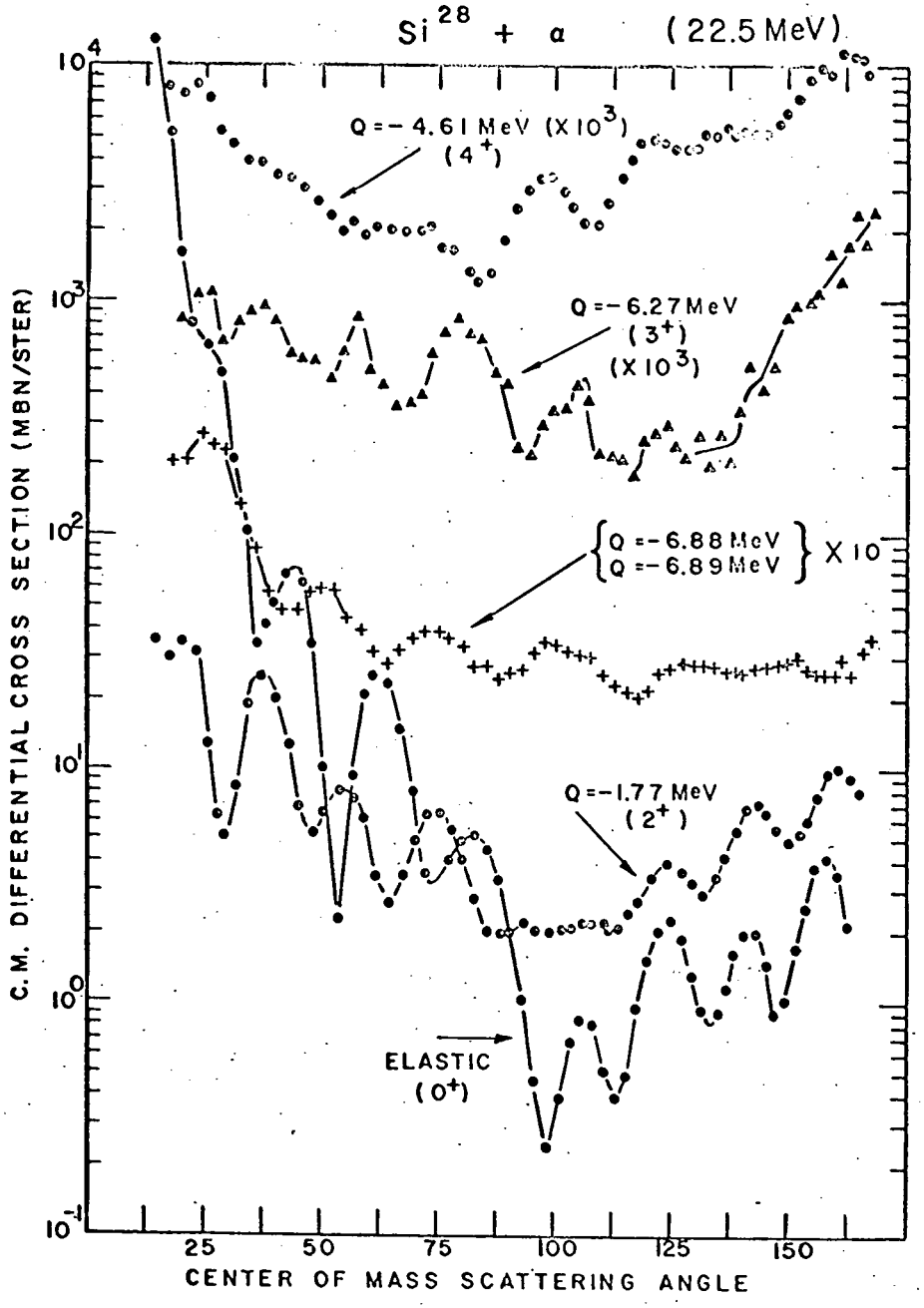
[1] A. J. Kromminga and I. E. McCarthy, Nucl. Phys. 24, 36 (1960).

[2] W. W. Eidson and J. G. Cramer, Jr., Phys. Rev. Letters 9, 497 (1962).

DISCLAIMER

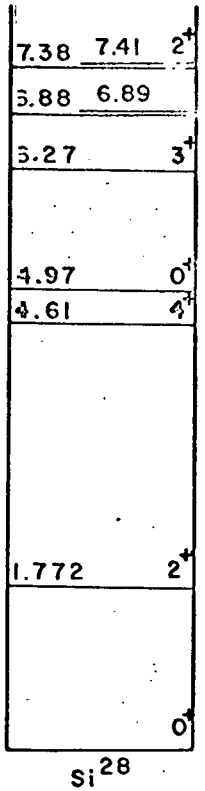

O16 + α
Eα(LAB) = 22.5 MeV
ELASTIC
(0+)
{Q = −6.13 MeV (3−)
Q = −6.05 MeV (0+)}
{Q = −7.12 MeV (1−)
Q = −6.92 MeV (2+)}
(X 1/10)
Q = −8.88 MeV (2−)
(X 1/10)
C.M. DIFFERENTIAL CROSS SECTION (MBN/STER)
CENTER OF MASS SCATTERING ANGLE
25
50
75
100
125
150
7.162
C12 + α
12.126
N15 + p
10.95 0−
10.36 4+
9.85
9.59 2+
8.88 2+
6.92 7.12 1−
6.05 6.13 3−
0+
O16

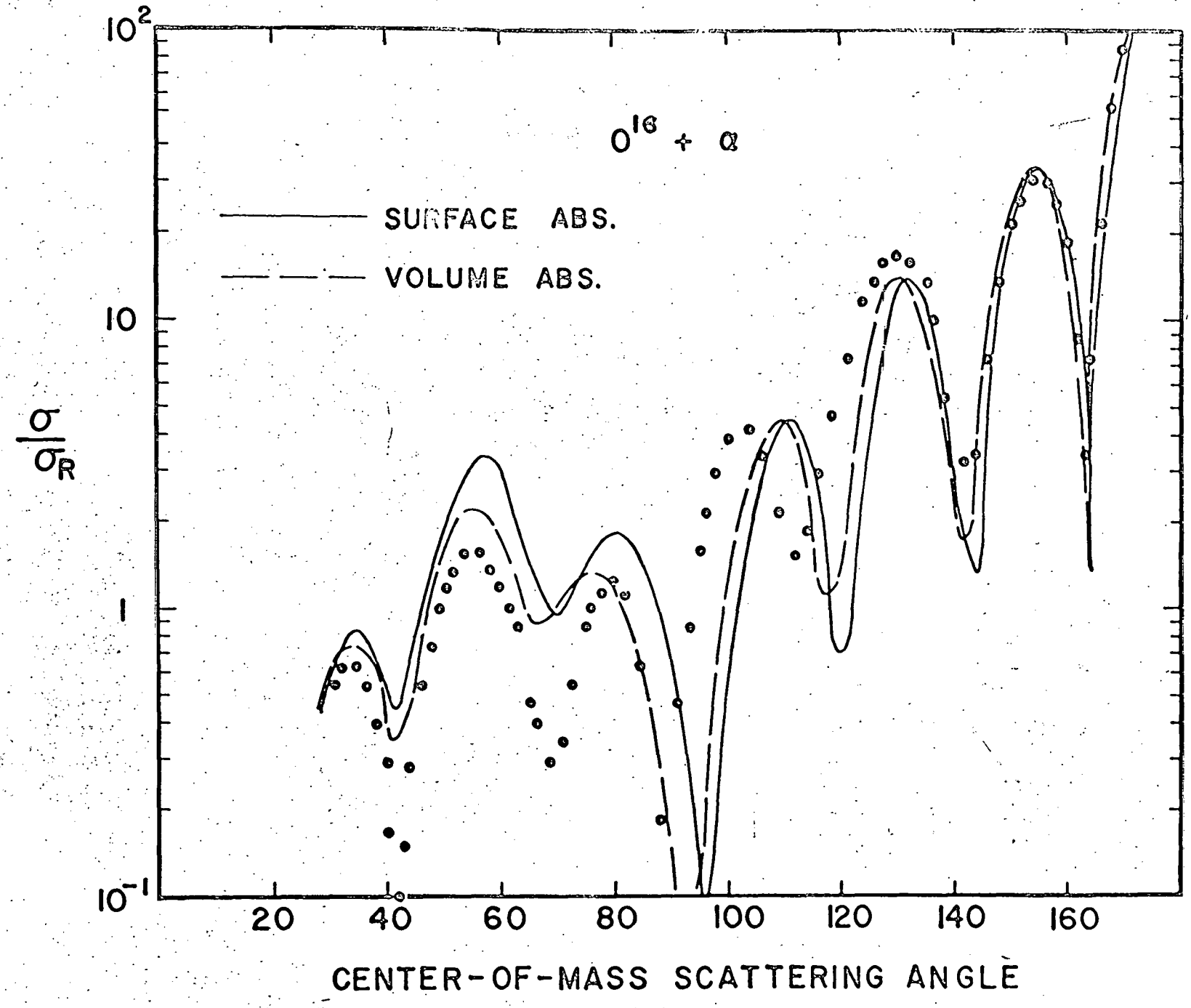

Mg^{24} + α
E_α(LAB) = 22.5 MeV
Q = −1.37 MeV
(2+)
Q = −5.22 MeV
(3−)
Q = −6.00 MeV
(4+)
(X1/10)
MAX
MIN
ELASTIC PEAK POSITION
C.M. DIFFERENTIAL CROSS SECTION (MBN/STER)
CENTER OF MASS SCATTERING ANGLE
9.314
Ne^{20} + α
ELASTIC
(0+)
7.35 2+
6.44 0+
6.00 4+
5.22 3−
4.12 4.23 2+
4+
1.37 2+
0+
Mg^{24}

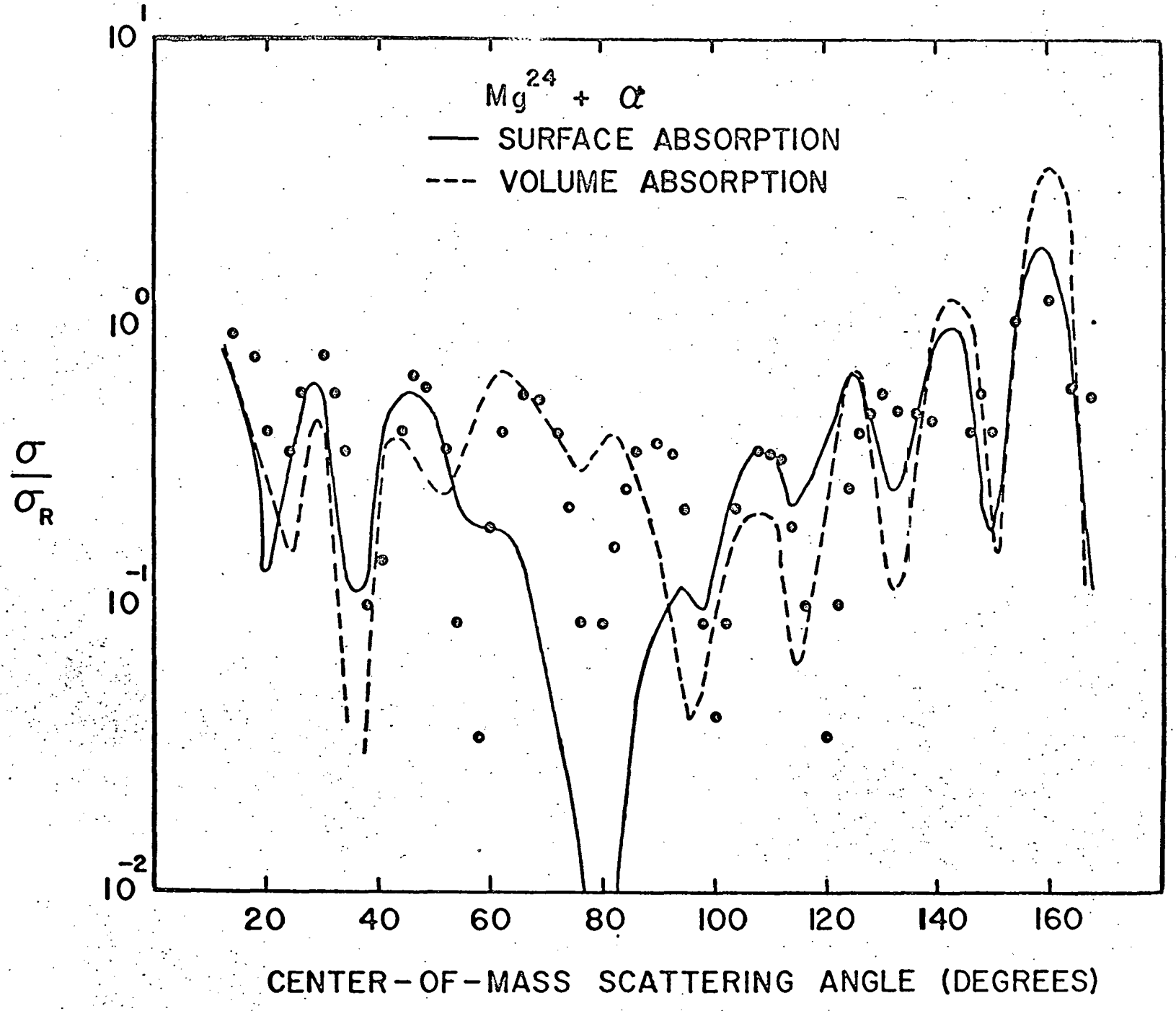


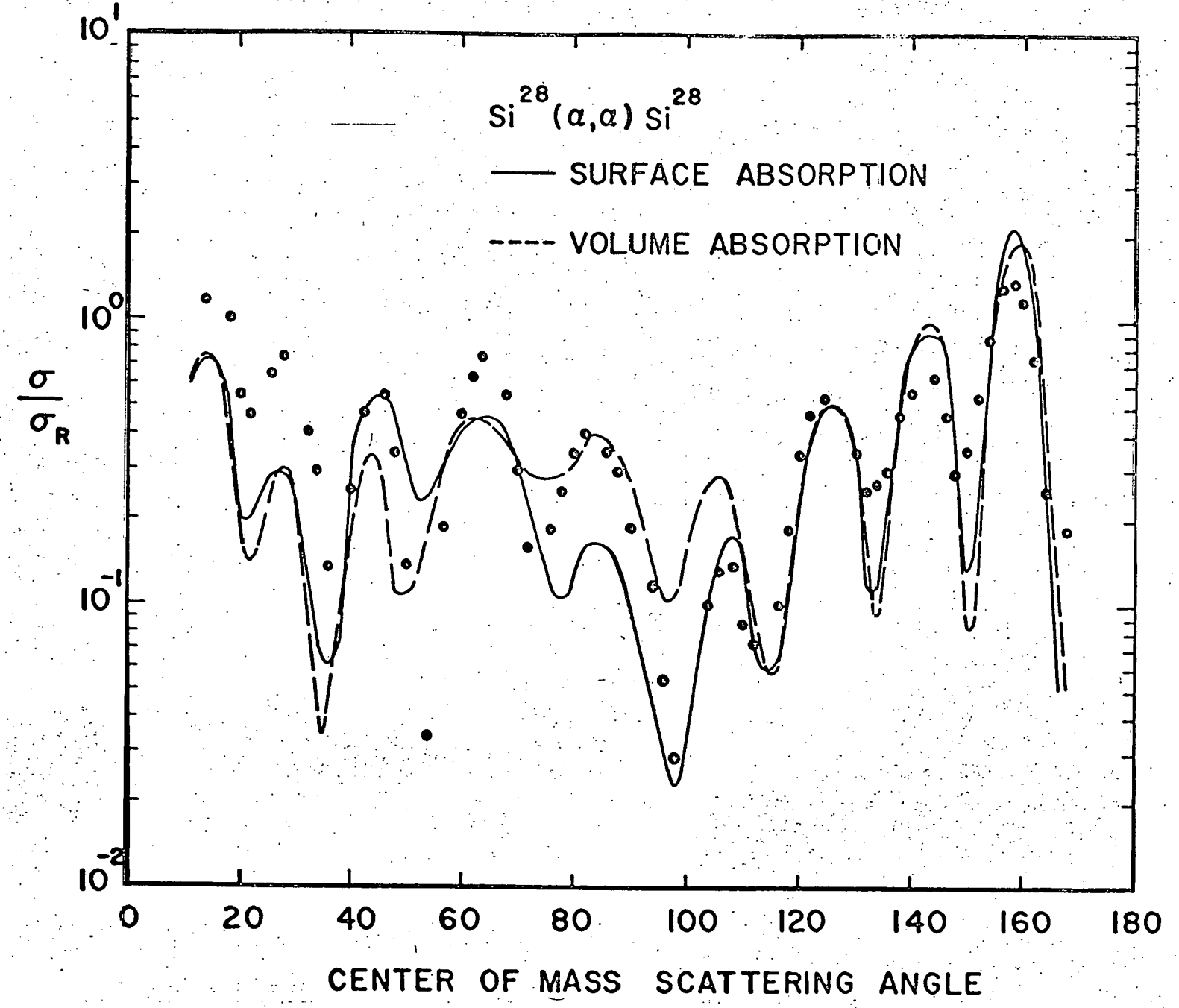
9.986
$Mg^{24} + \alpha$

11.581
$Al^{27} + p$




10^2
10
1
10^{-1}
$\frac{\sigma}{\sigma_R}$
$O^{16} + \alpha$
SURFACE ABS.
VOLUME ABS.
20
40
60
80
100
120
140
160
CENTER-OF-MASS SCATTERING ANGLE


$Mg^{24} + \alpha$
SURFACE ABSORPTION
VOLUME ABSORPTION
10^{1}
10^{0}
10^{-1}
10^{-2}
$\frac{\sigma}{\sigma_R}$
20
40
60
80
100
120
140
160
CENTER-OF-MASS SCATTERING ANGLE (DEGREES)


$Si^{28}(\alpha,\alpha)\,Si^{28}$
SURFACE ABSORPTION
VOLUME ABSORPTION
σ/σ_R
10^1
10^0
10^{-1}
10^{-2}
0
20
40
60
80
100
120
140
160
180
CENTER OF MASS SCATTERING ANGLE

Parameters Used in SCAT-IV Fits of O^{16}, Mg^{24}, and Si^{28} Elastic α-particle Scattering

E_α = 22.5 MeV Lmax = 22 ρmax = 24

$O^{16} + \alpha$:

Volume Absorption:	V = 88.0	W = 6.2
	A = 0.82	Ro = Rc = 1.2
Surface Absorption:	V = 80.0	W = 6.5
	A = 0.79	Ro = Rc = 1.3
	Bg = 1.0	Rg = 1.0

$Mg^{24} + \alpha$:

Volume Absorption:	V = 65.0	W = 7.6
	A = 0.83	Ro = Rc = 1.5
Surface Absorption:	V = 52.0	W = 8.0
	A = 0.78	Ro = Rc = 1.55
	Bg = 1.3	Rg = 1.3

$Si^{28} + \alpha$:

Volume Absorption:	V = 62.0	W = 6.8
	A = 0.77	Ro = Rc = 1.5
Surface Absorption:	V = 58.0	W = 6.0
	A = 0.77	Ro = Rc = 1.5
	Bg = 1.8	Rg = 1.1