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See Other Side

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19. Abstract. (cont)

Nine papers were published in refreed journals. Thirteen papers are either submitted to refreed journals or are under preparation. Abstracts of five papers were presented to domestic and international conferences. Dissociative attachment and polar dissociation cross sections were measured for the following molecules: HCl, NO, N2O, C6H6, S1H4, S12H6, and L1H. Direct ionization and dissociative ionization cross sections were determined for the following molecules: H2, D2, N2, O2, He, Ne, Ar, Kr, Xe, H2O, CO, CO2, CH4, S1H4, S1H4, S12H6, N2*, and NH3. An experimental apparatus for a pulsed extraction technique was fabricated and successfully tested. Keywords; Electron Impact Spectra; Hydrogen Chloride; Nitrogen Oxides; Nitrous Oxide; Benzene; Silane; Disilane; Lithium Hydride; Hydrogen; Deuterium; Nitrogen; Oxygen; Helium; Neon; Argon, Krypton; Xenon; Water; Carbon Monoxide; Carbon Dioxide; Methane; Ammonia; (ihd)

FINAL REPORT

ON

THE PROPOSAL ENTITLED" ION FORMATION BY ELECTRON IMPACT"
JPL Task plan No. 80-2501

Period of Performance: 5/31/85 to 11/30/88

Principal Investigator: Santosh K. Srivastava

AFOSR-ISSA-85-0070
AFOSR-ISSA-86-0036
AFOSR-ISSA-87-0036
AFOSR-ISSA-88-0014

FINAL REPORT ON THE PROPOSAL ENTITLED "ION FORMATION BY ELECTRON IMPACT"

Principal Investigator: Santosh K. Srivastava

The period of performance for the above mentioned task was from 5/31/85 to 11/30/88. During this period **the following was accomplished**:

1) Nine papers were published in refreed journals. (A list is attached here).
2) Thirteen papers are either submitted to refreed journals or are under preparation. (A list is attached here).
3) Abstracts of five papers were presented in domestic and international conferences.
4) One united states patent was granted on an electron gun developed under the reseach sponsored by AFOSR.
5) One united states patent filed and is pending.
6) **Dissociative attachment and polar dissociation cross sections** were measured for the following molecules:
   i) HCl (fig.1).
   ii) NO (fig.2).
   iii) N_2O (fig.3,4).
   iv) C_6H_6 (fig.5).
   v) SiH_4 (fig.6,7).
   vi) Si_2H_6(fig.8,9).
   vii) LiH (fig.10,11).
7) **Direct ionization and dissociative ionization cross sections** were determined for the following molecules:
   i) H_2 (fig. 12,13).
   ii) D_2 (fig. 14,15).
   iii) N_2 (fig.16,17).
   iv) O_2 (fig.18,19,20).
   v) He (fig. 21).
   vi) Ne (fig. 22,23,24).
   vii) Ar (fig. 25,26,27).
   viii) Kr (Fig. 28,29,30).
   ix) Xe (Fig. 31,32,33).
   x) H_2O (Fig. 34,35,36)
   xi) CO (Fig. 37).
   xii) CO_2 (fig. 38,39).

xiii) CH_4 (fig. 40,41).
xiv) SiH_4 (fig. 42).
xv) Si_2H_6 (fig. 43,44).
xvi) N_2* (fig. 45).
xvii) CH_3 (fig. 46).
8) **An experimental apparatus** for a pulsed extraction technique was fabricated and successfully tested.

PAPERS PUBLISHED IN REFEREED JOURNALS

1. M. A. Khakoo and S. K. Srivastava, "The Kinetic Energy Spectrum of Protons Produced by Dissociative Ionization of H_2 by Electron Impact, *J. Phys. B: Atom. Mol. Phys.* **18**, 2525 (1985).

2. O. J. Orient and S. K. Srivastava, "Cross Sections for H^- and $C\ell^-$ Production from $HC\ell$ by Dissociative Electron Attachment", *Phys. Rev. A.* **32**, 2678, 1985.

3. S. K. Srivastava, "Compact Electron Gun for Emitting High Current Short Duration Pulses", published as a U. S. patent No. 4, 629,937; Dec. 16, 1986.

4. O. J. Orient and S. K. Srivastava, "Electron Impact Ionization of H_2O, CO, CO_2 and CH_4", *J. Phys. B: Atom. Mol. Phys.* **20**, 5923 (1987).

5. S. K. Srivastava and Hung P. Nguyen "Parametrization of Electron Impact Ionization Cross Sections for CO, CO_2, CH_4, NH_3, and SO_2", JPL Report #87-2, 1987.

6. S. K. Srivastava, "Present Status of the Measured Dissociative Attachment Cross Sections", invited paper to appear in the "Production and Neutralization of Negative Ions and Beams" (Fourth International Symposium, Brookhaven, 1986). ed. J. Alessi, *Am. Inst. Phys.*, 1987.

7. E. Krishnakumar and S. K. Srivastava, "Ionizatiol Cross Sections of Rare Gas Atoms by Electron Impact", *J. Phys. B: At. Mol. Opt. Phys.* **21**, 1055 (1988).

8. E. Krishnakumar and S. K. Srivastava, "Cross Sections for Dissociative Attachment of Electrons to NO", *J. Phys. B: At. Mol. Opt. Phys.* **21**, 607 (1988).

9. D. P. Wang, L. C. Lee and S. K. Srivastava, "Electron Impact Ionization of CH_3 in 10-22 eV", *Chem. Phys. Lett.* **152**, 513 (1988).

PAPERS UNDER PREPARATION

1. K. Krishnakumar and S. K. Srivastava, "Cross Sections for the Production of N_2^+, $N^+ + N^{2+}$, and N^{2+} by Electron Impact on N_2", submitted to *J. Phys. B.*

2. E. Krishnakumar and S. K. Srivastava, "Dissociative Attachment of Electrons to N_2O", submitted by *J. Phys. B.*

3. E. Krishnakumar and S. K. Srivastava, "Cross Sections for Positive Ion Production by Electron Impact on SiH_4 and Si_2H_6", under preparation.

4. E. Krishnakumar and S. K. Srivastava, "Ionization of O_2 by Electron Impact", under preparation.

5. E. Krishnakumar and S. K. Srivastava, "Measurement of Cross Sections for the Production of Positive Ions from H_2 and D_2 by Electron Impact", under preparation.

6. E. Krishnakumar, M. T. Bernius and S. K. Srivastava, "An Instrument for the Measurement of Dissociative Ionization and Attachment Cross Sections of Molecules by Electron Impact", under preparation.

7. C. A. de Souza, E. Krishnakumar and S. K. Srivastava, "Dissociative Attachment of Electrons with CH_4 and SiH_4", under preparation.

8. E. Krishnakumar, I. Iga and S. K. Srivastava, "Dissociative Attachment of Electrons with Si_2H_6", under preparation.

9. D. P. Wang, L. C. Lee and S. K. Srivastava, "Dissociative Ionization of Laser Excited N_2^* by Electron Impact", accepted J. Quant. Spectr. and Rad. Trans.

10. E. Krishnakumar and S. K. Srivastava, "Cross Sections for the Production of Positive Ions by Electron Impact on SIH_4 and Si_2H_6". To be published in *Phys. Rev. A.*

11. E. Krishnakumar and S. K. Srivastava, "Negative Ion Formation by Electron Impact on Si_2H_6". To be published in *Phys. Rev. A.*

12. S. K. Srivastava, "Negative and Positive Ions from LiH Vapor", under preparation.

13. S. K. Srivastava, "Ionization Fragments Generated by Electron Impact on C_6H_6", under preparation.

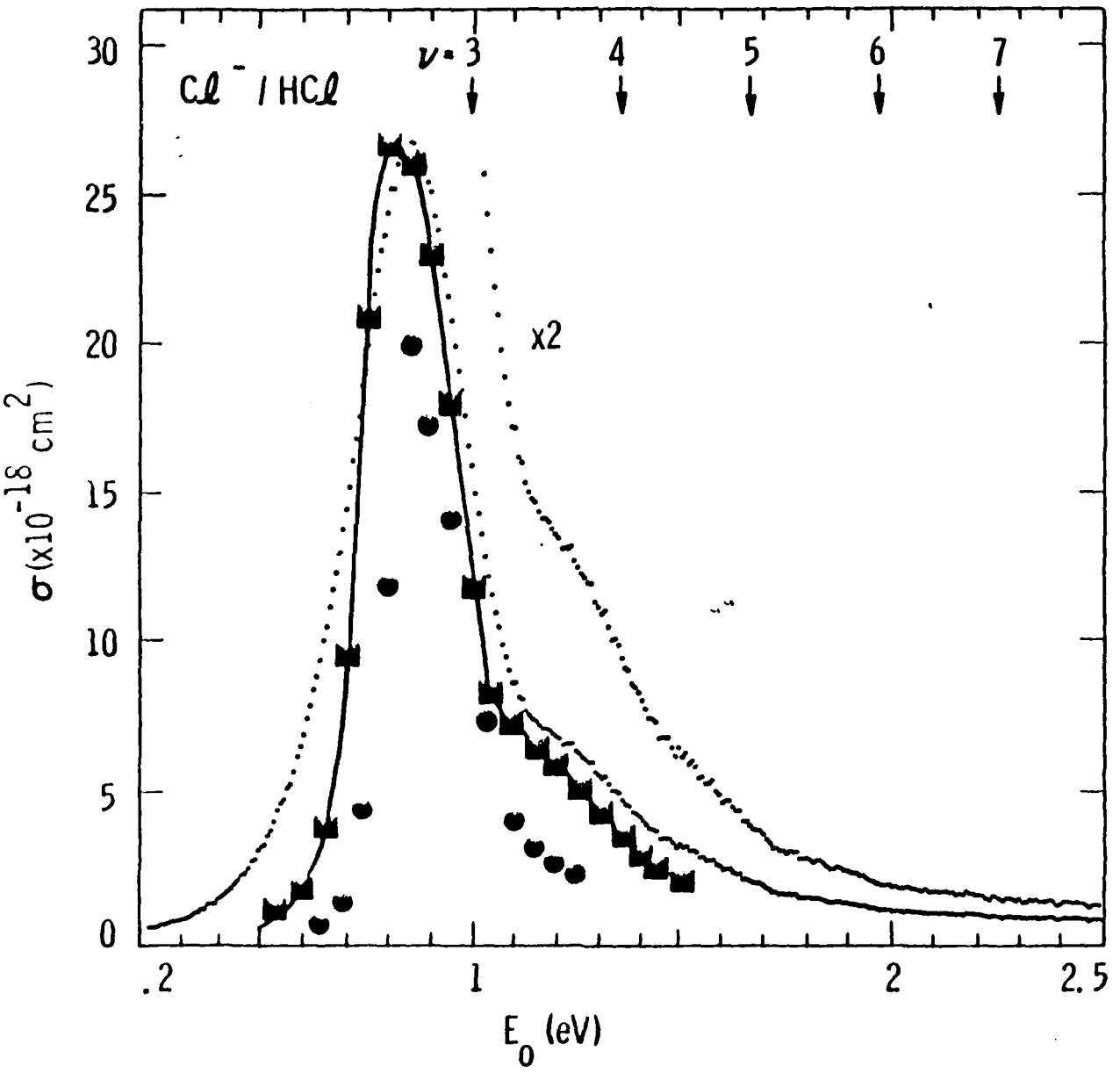
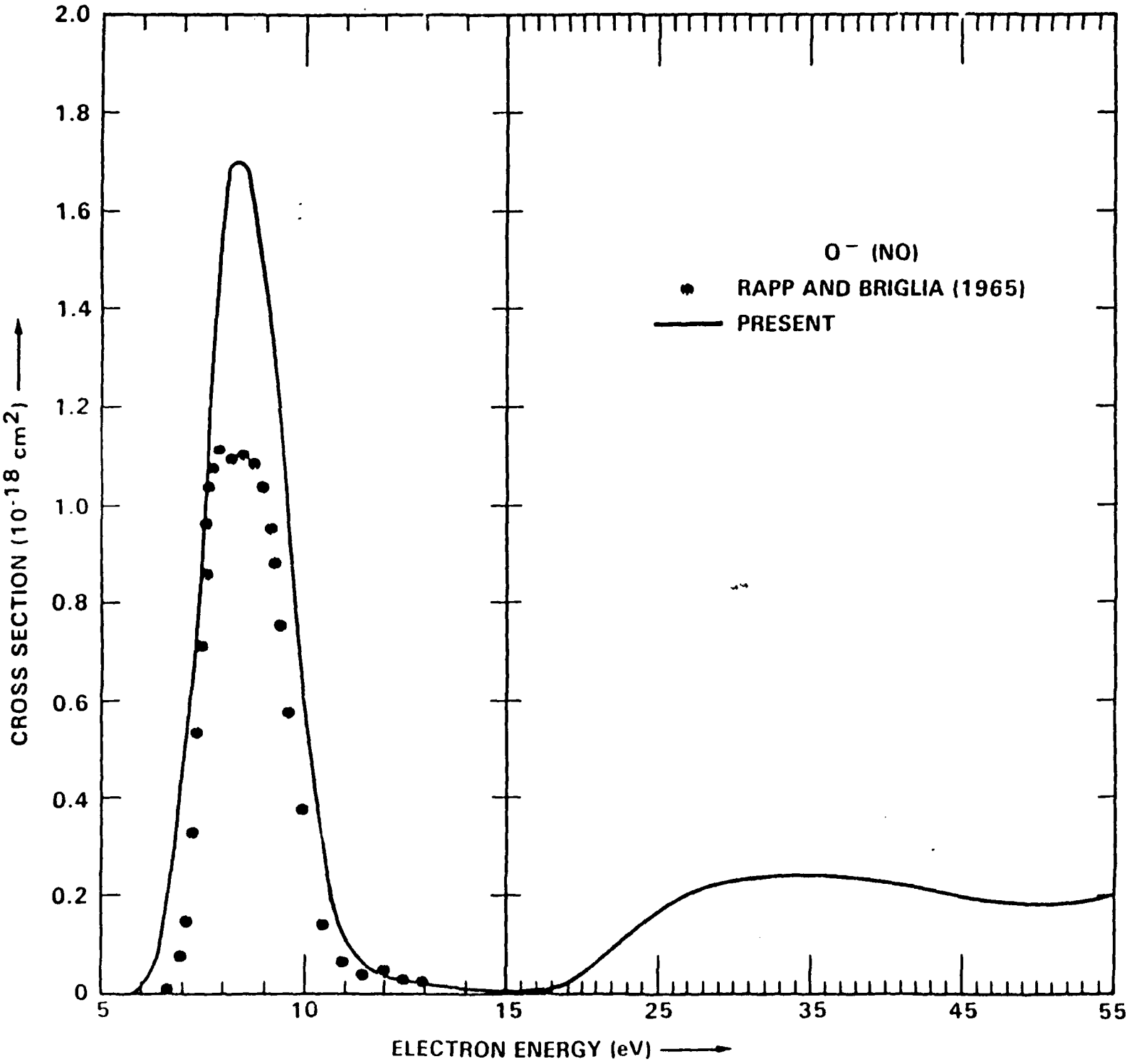
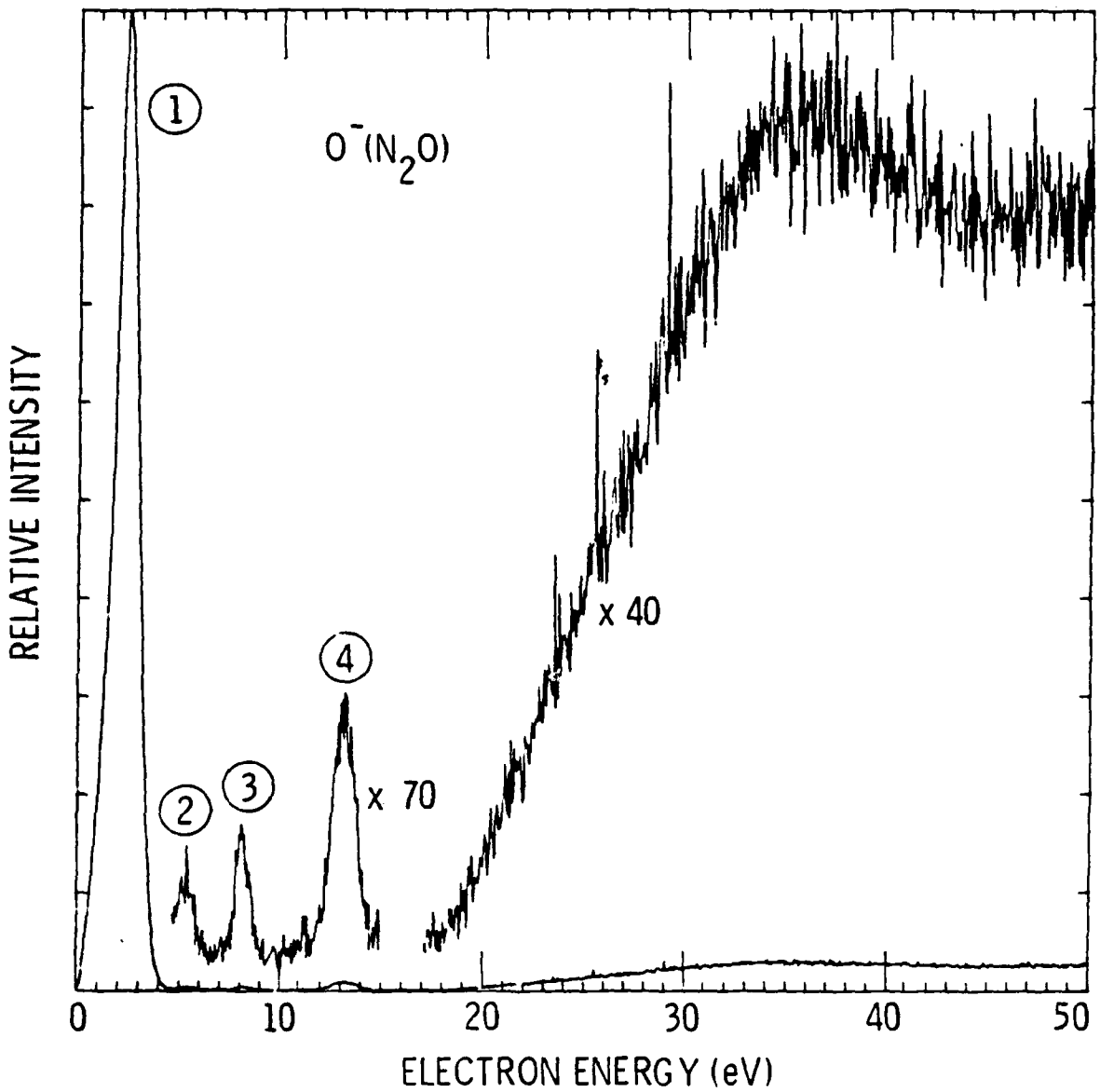
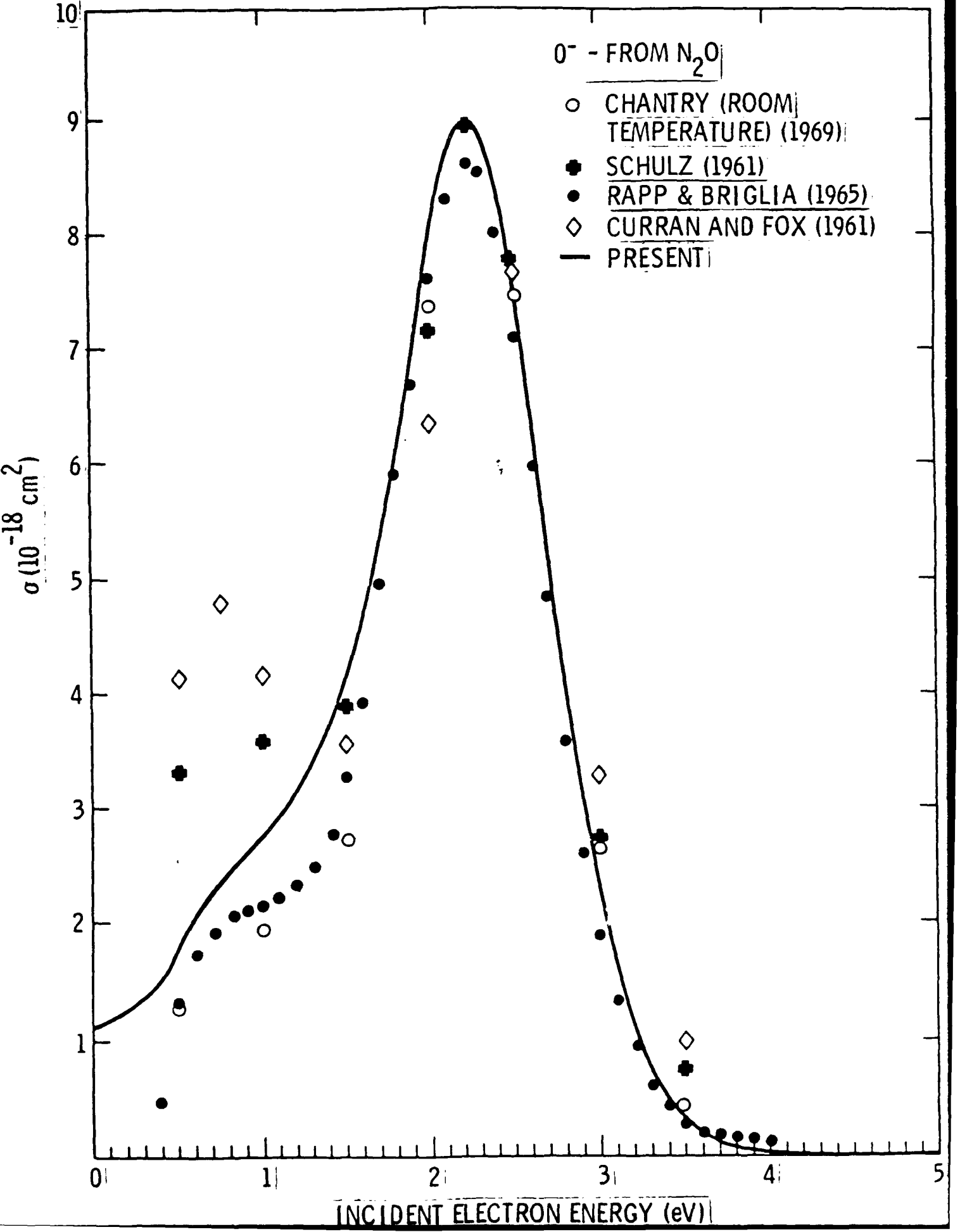
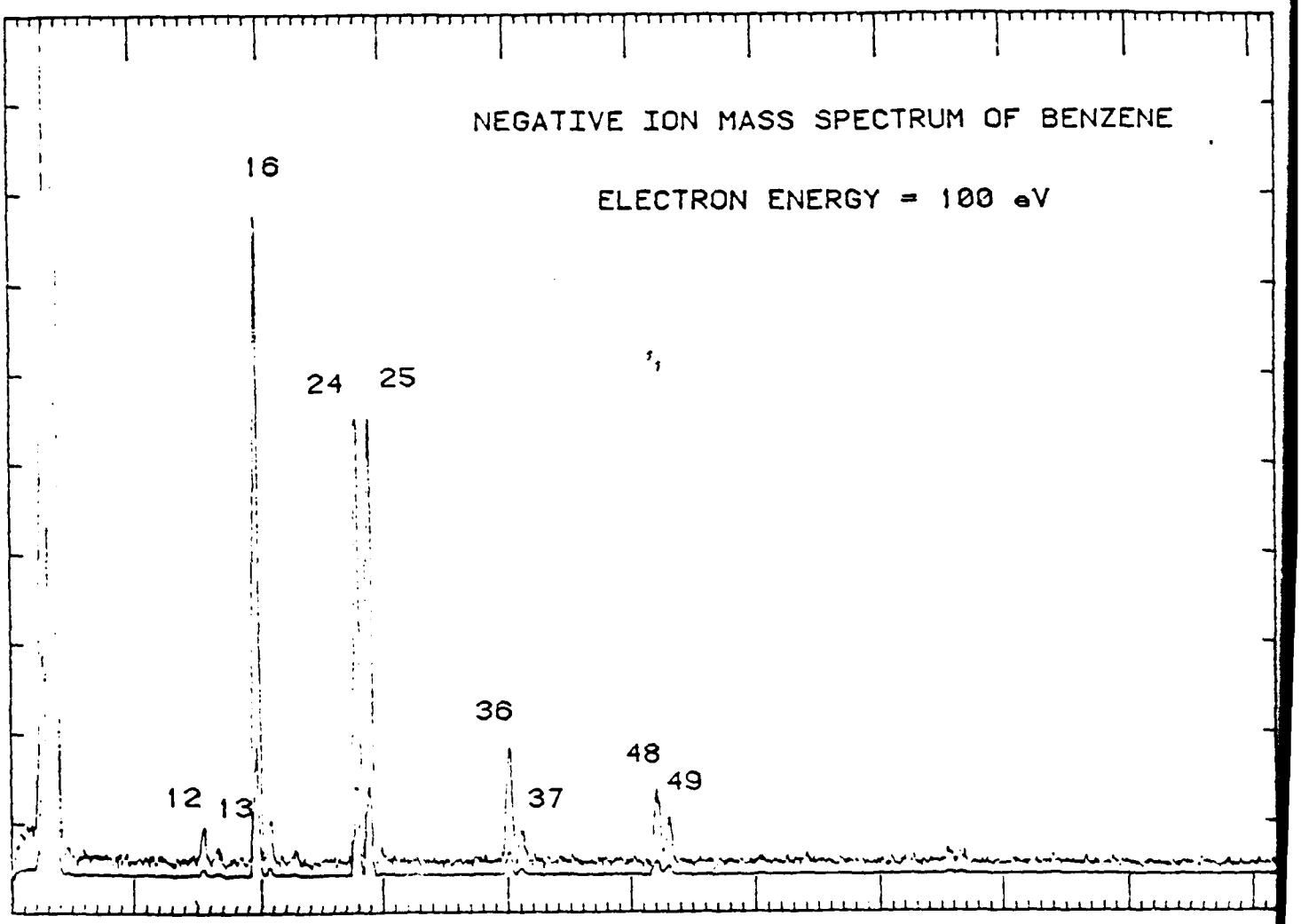


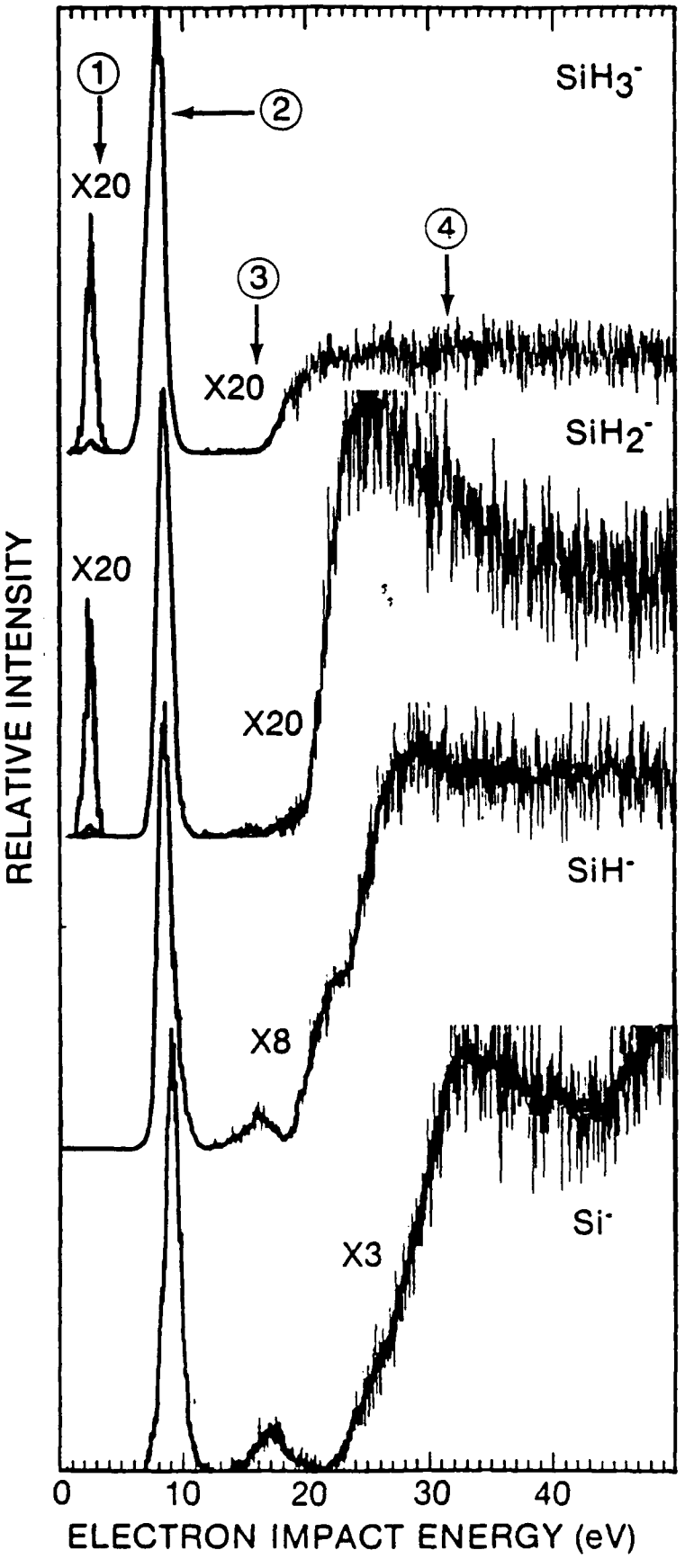
Figure 1. Dissociative electron attachment cross section for Cl^-/HCl as a function of the electron beam energy. The arrows indicate the position of the vibrational levels of the $HCl\ ^1\Sigma^+$ ground [illegible] Allen and Wong (1981).

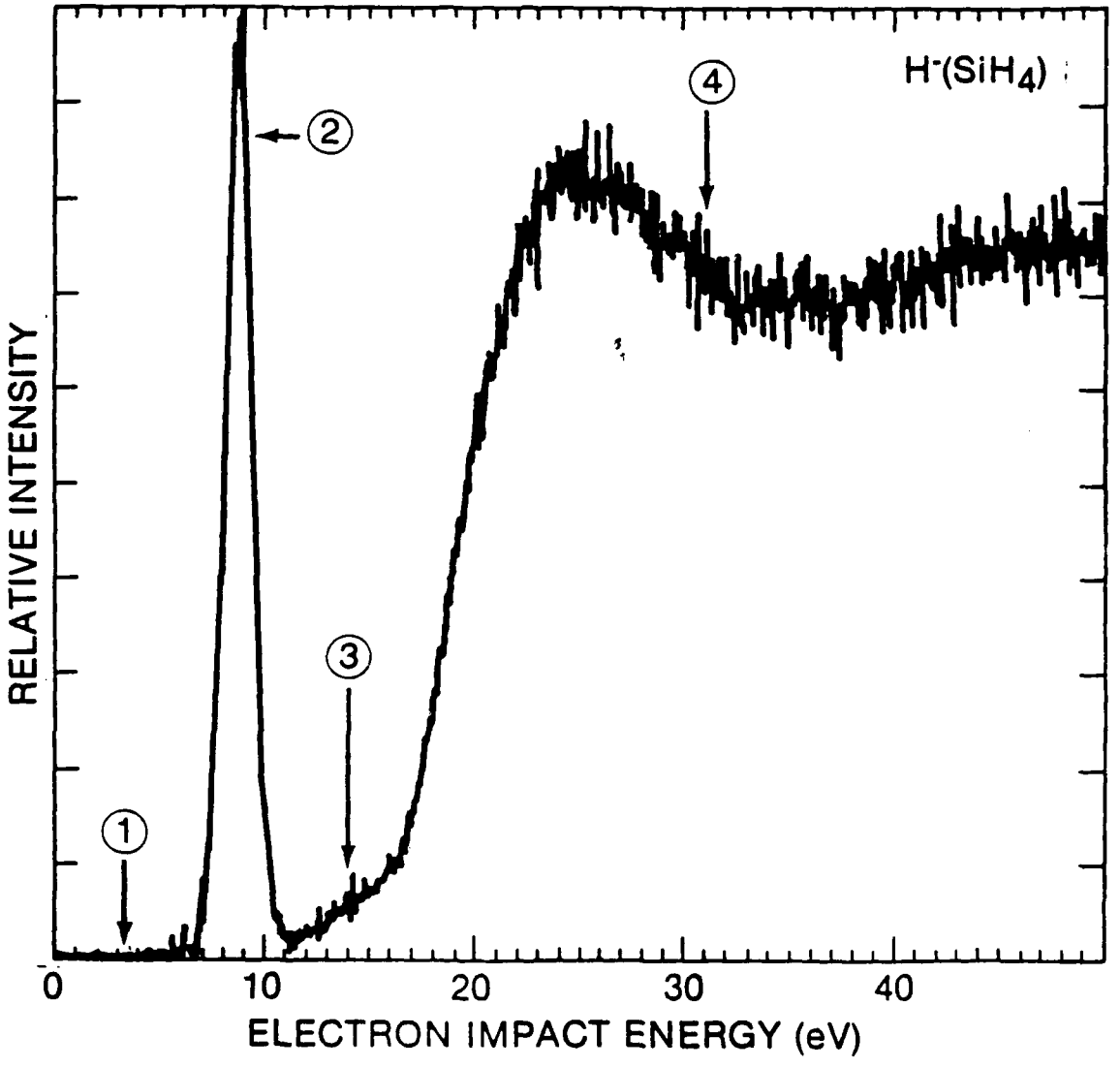

2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
CROSS SECTION (10^{-18} cm^2)
5
10
15
25
35
45
55
ELECTRON ENERGY (eV)
O^- (NO)
RAPP AND BRIGLIA (1965)
PRESENT

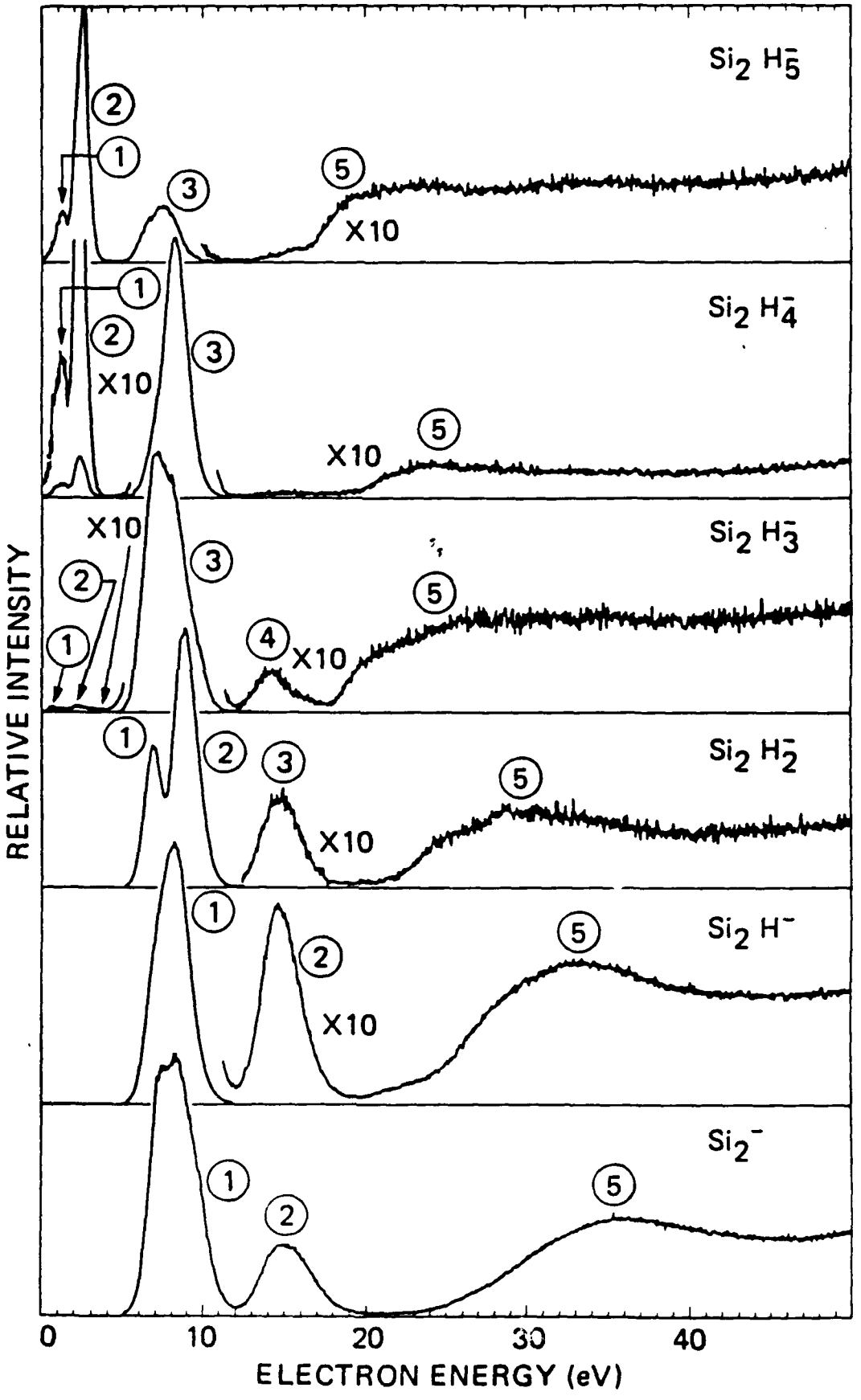

1
$O^-(N_2O)$
2
3
4
x 70
x 40
RELATIVE INTENSITY
0
10
20
30
40
50
ELECTRON ENERGY (eV)

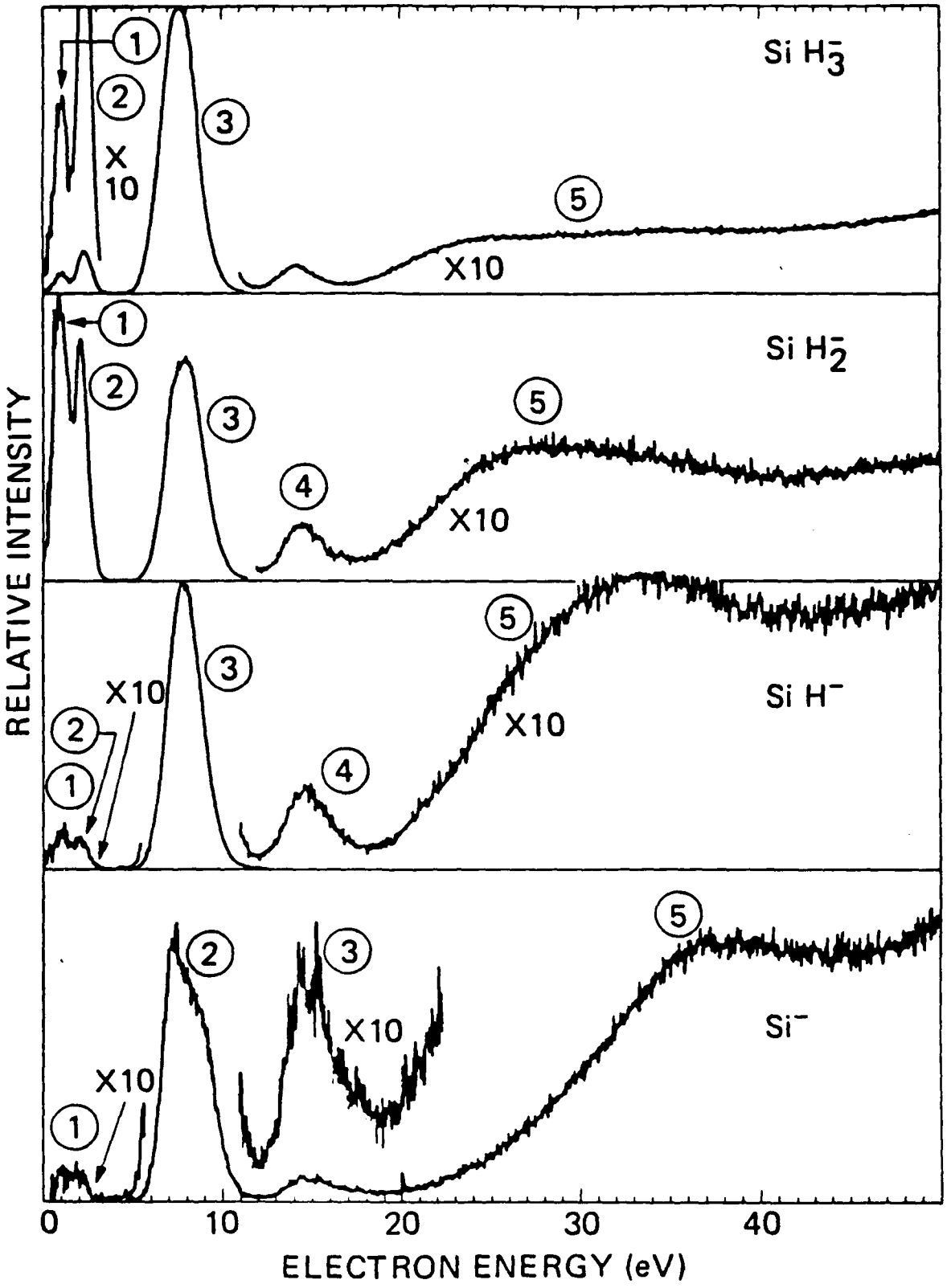

O^- - FROM N_2O
CHANTRY (ROOM TEMPERATURE) (1969)
SCHULZ (1961)
RAPP & BRIGLIA (1965)
CURRAN AND FOX (1961)
PRESENT
$\sigma(10^{-18}\ cm^2)$
INCIDENT ELECTRON ENERGY (eV)
0
1
2
3
4
5
1
2
3
4
5
6
7
8
9
10


NEGATIVE ION MASS SPECTRUM OF BENZENE
ELECTRON ENERGY = 100 eV
16
24
25
36
48
49
12
13
37
MASS IN A.M.U.

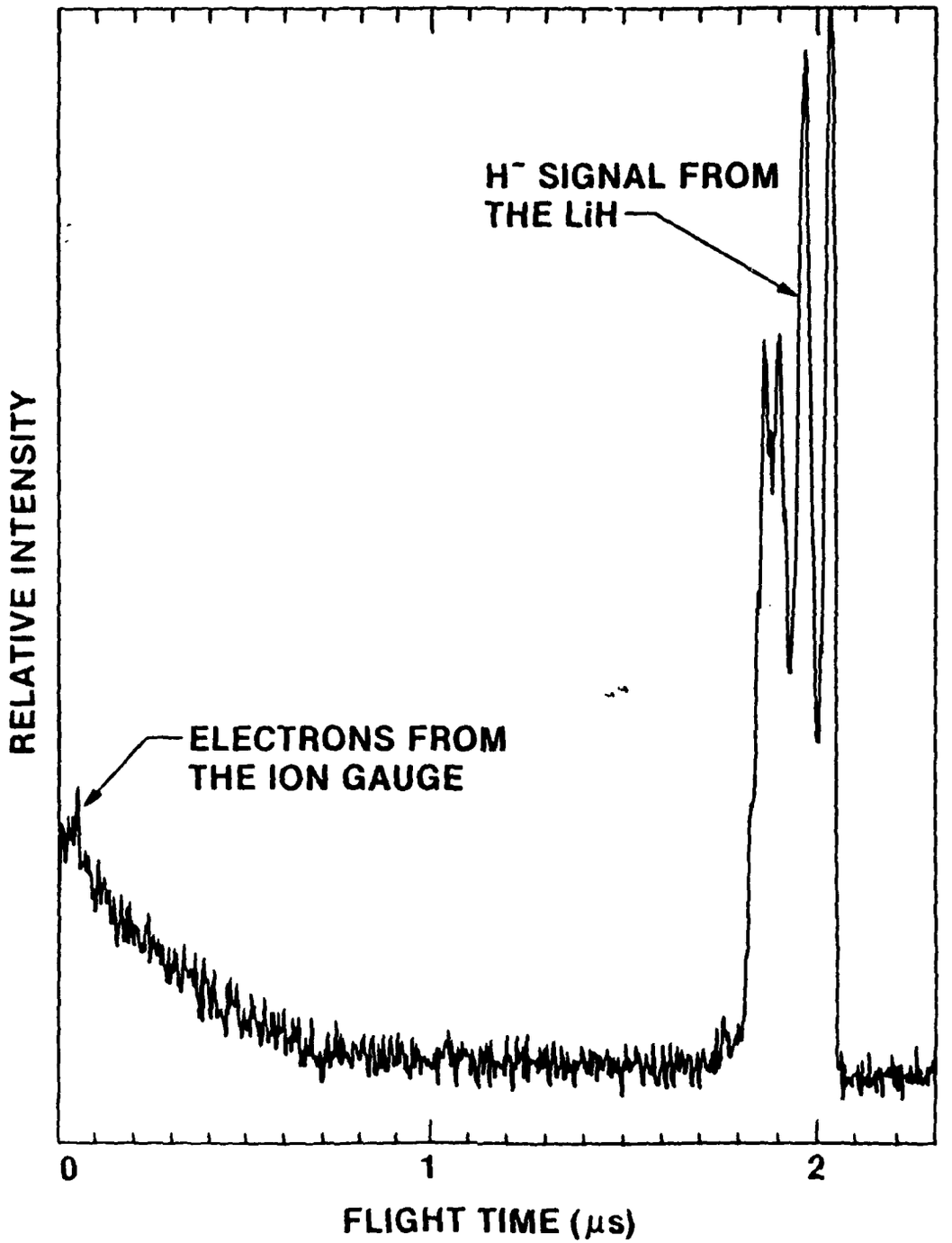

SiH3-
SiH2-
SiH-
Si-
1
2
3
4
X20
X20
X20
X20
X8
X3
RELATIVE INTENSITY
0
10
20
30
40
ELECTRON IMPACT ENERGY (eV)


$H^-(SiH_4)$
RELATIVE INTENSITY
ELECTRON IMPACT ENERGY (eV)
0
10
20
30
40
1
2
3
4

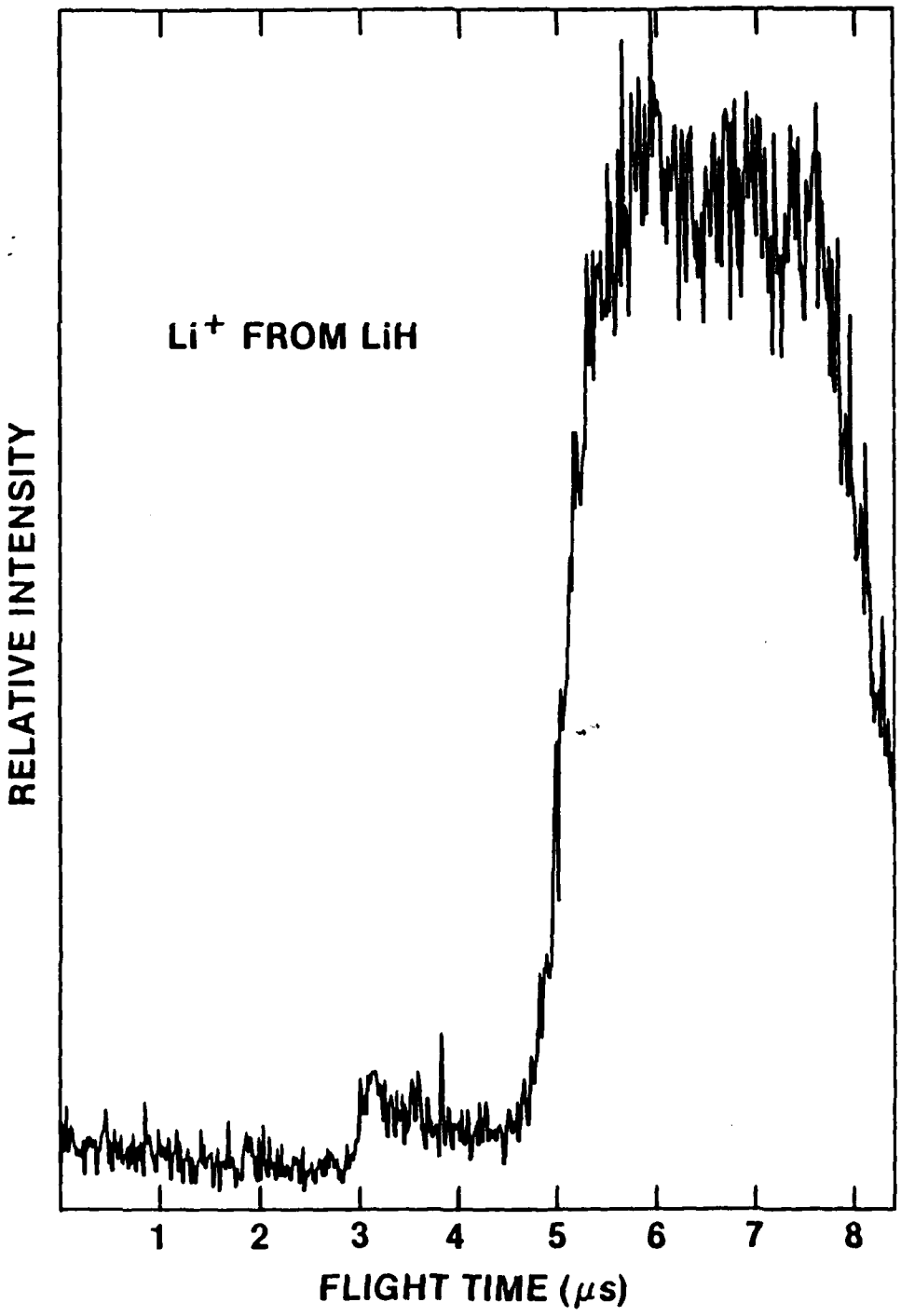

$Si_2 H_5^-$
$Si_2 H_4^-$
$Si_2 H_3^-$
$Si_2 H_2^-$
$Si_2 H^-$
Si_2^-
X10
RELATIVE INTENSITY
0
10
20
30
40
ELECTRON ENERGY (eV)

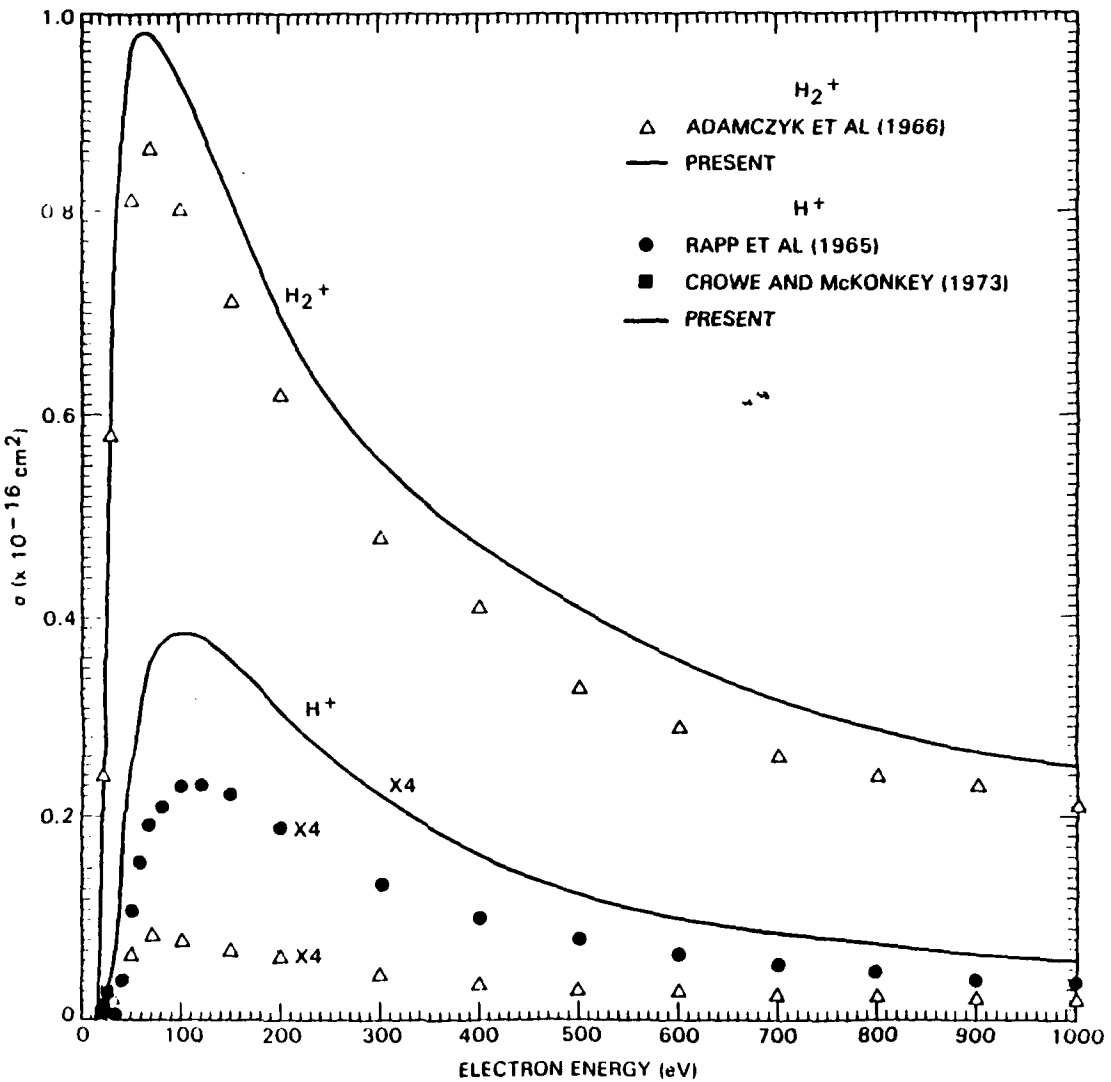

Si H$_3^-$
Si H$_2^-$
Si H$^-$
Si$^-$
X10
RELATIVE INTENSITY
0
10
20
30
40
ELECTRON ENERGY (eV)

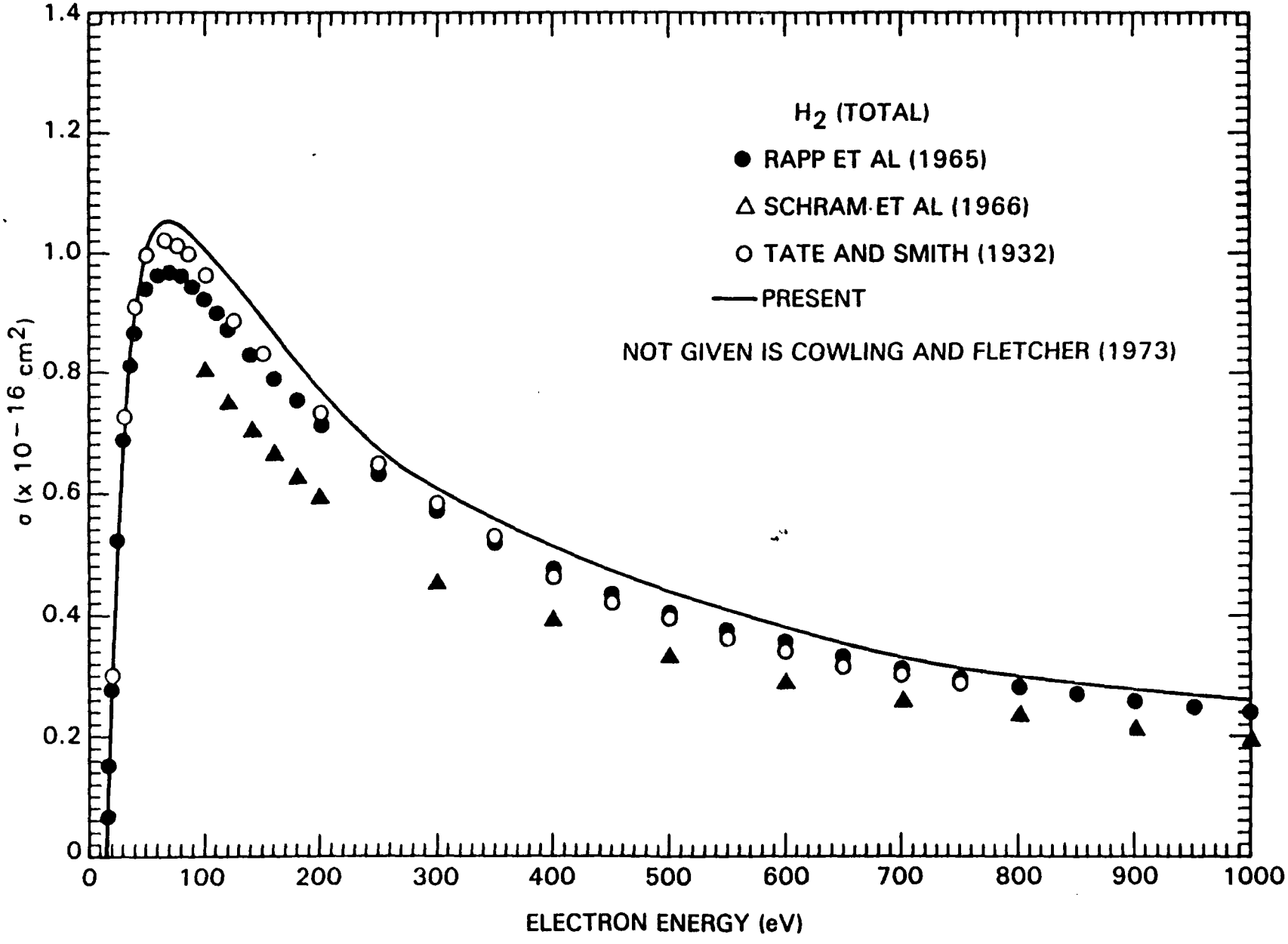
JPL

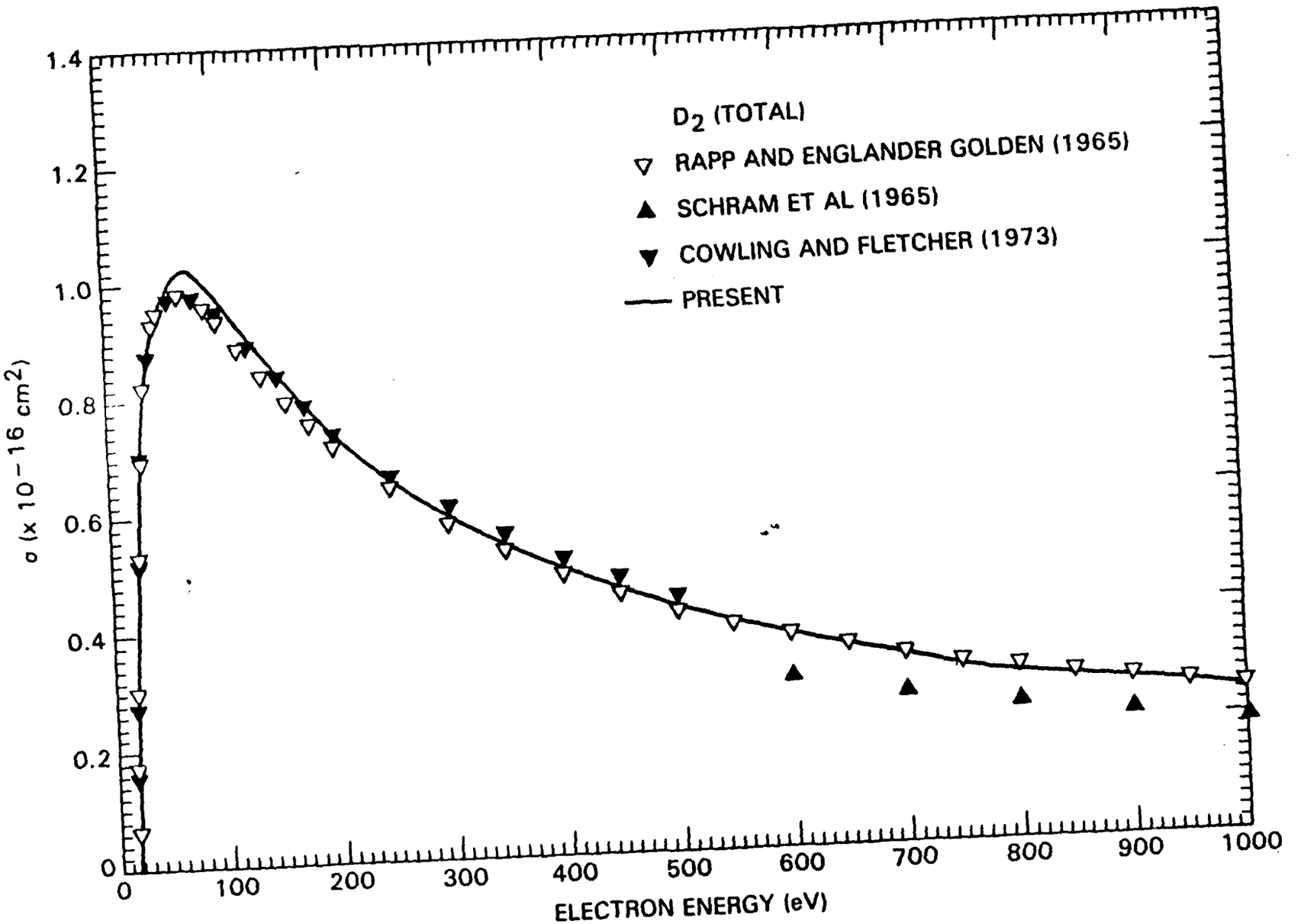

H⁻ SIGNAL FROM
THE LiH
ELECTRONS FROM
THE ION GAUGE
RELATIVE INTENSITY
0
1
2
FLIGHT TIME (μs)

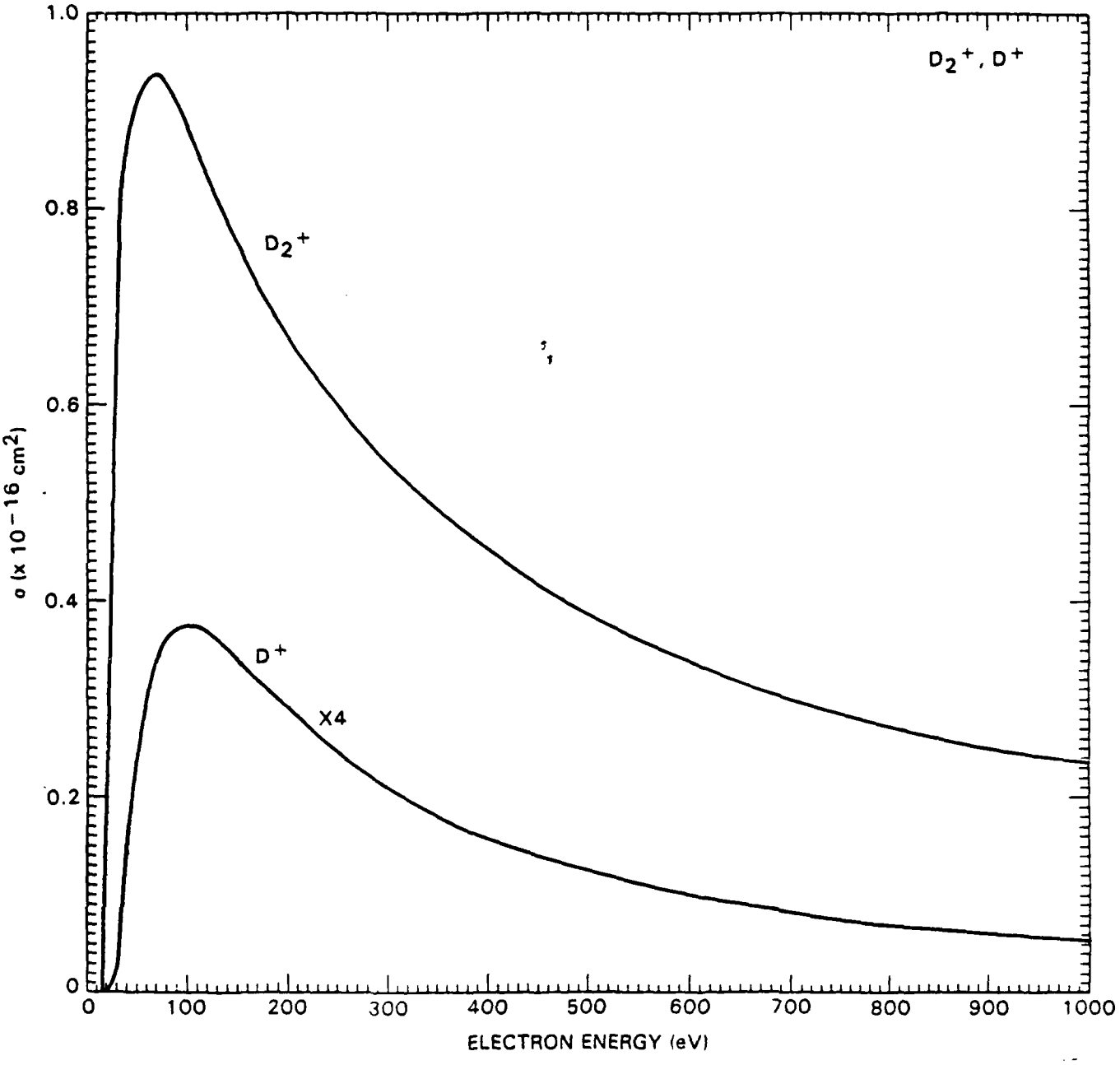
JPL

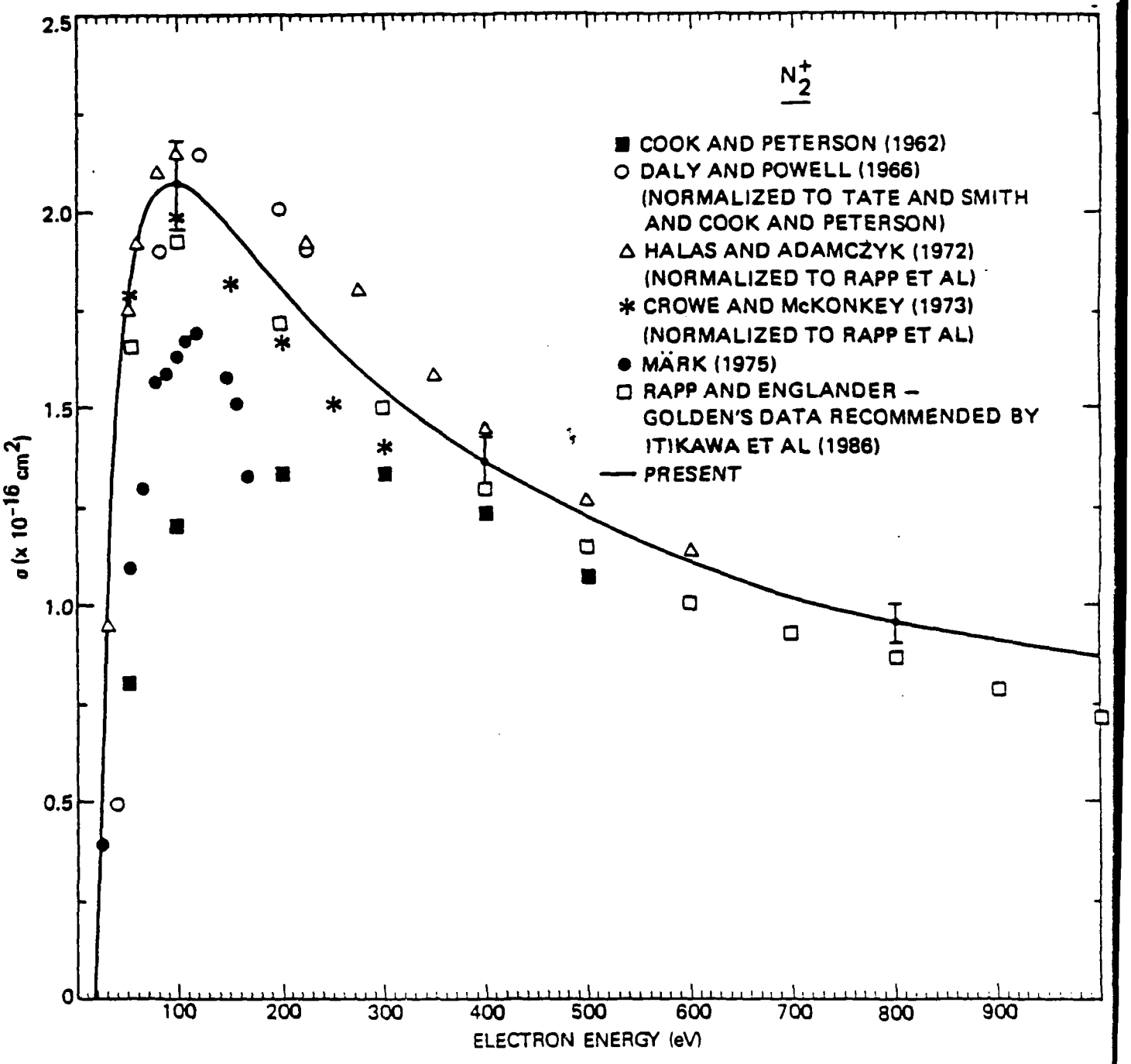


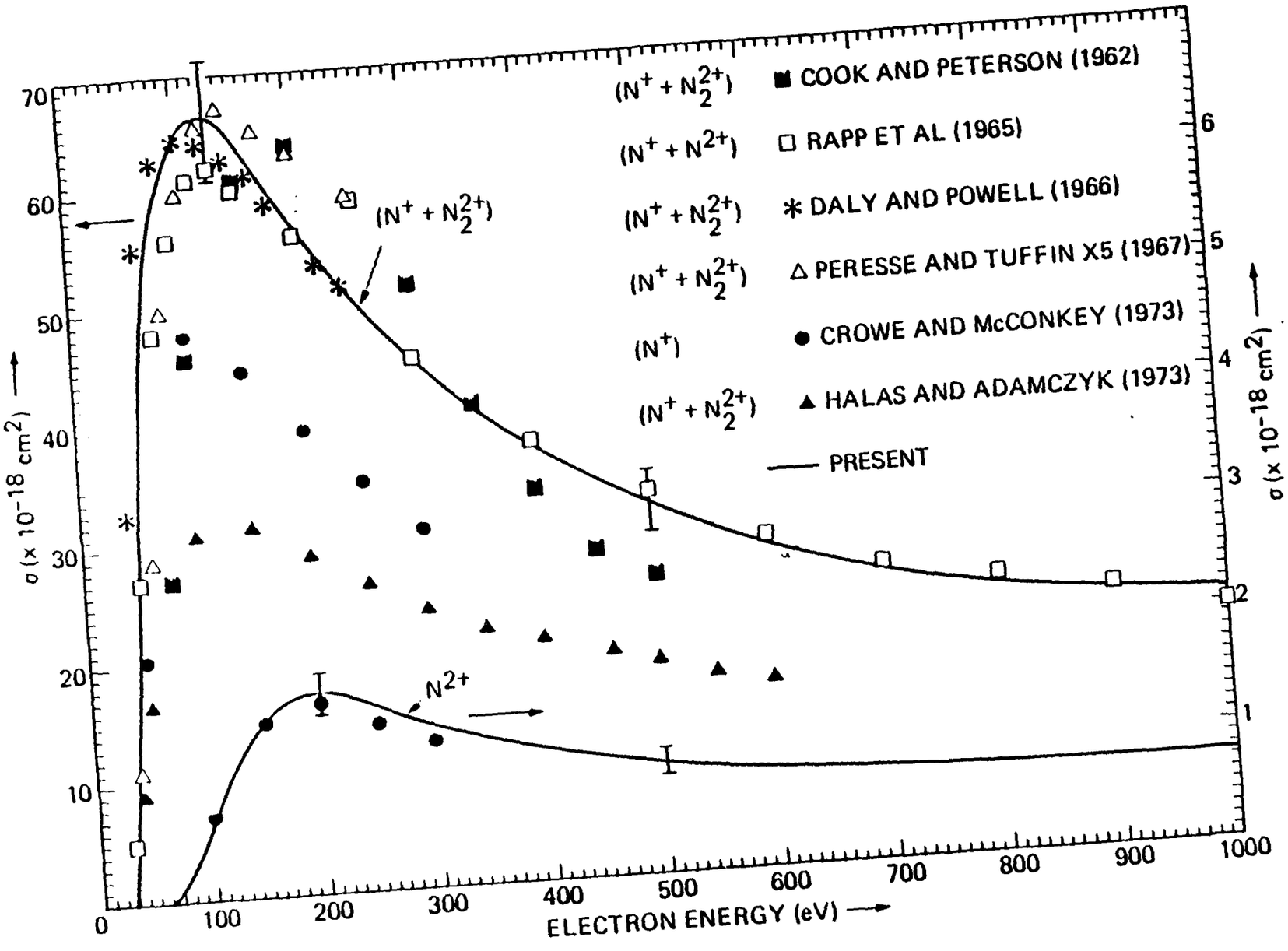

1.0
0.8
0.6
0.4
0.2
0
σ (x 10−16 cm2)
0
100
200
300
400
500
600
700
800
900
1000
ELECTRON ENERGY (eV)
H2+
ADAMCZYK ET AL (1966)
PRESENT
H+
RAPP ET AL (1965)
CROWE AND McKONKEY (1973)
PRESENT
H2+
H+
X4
X4
X4

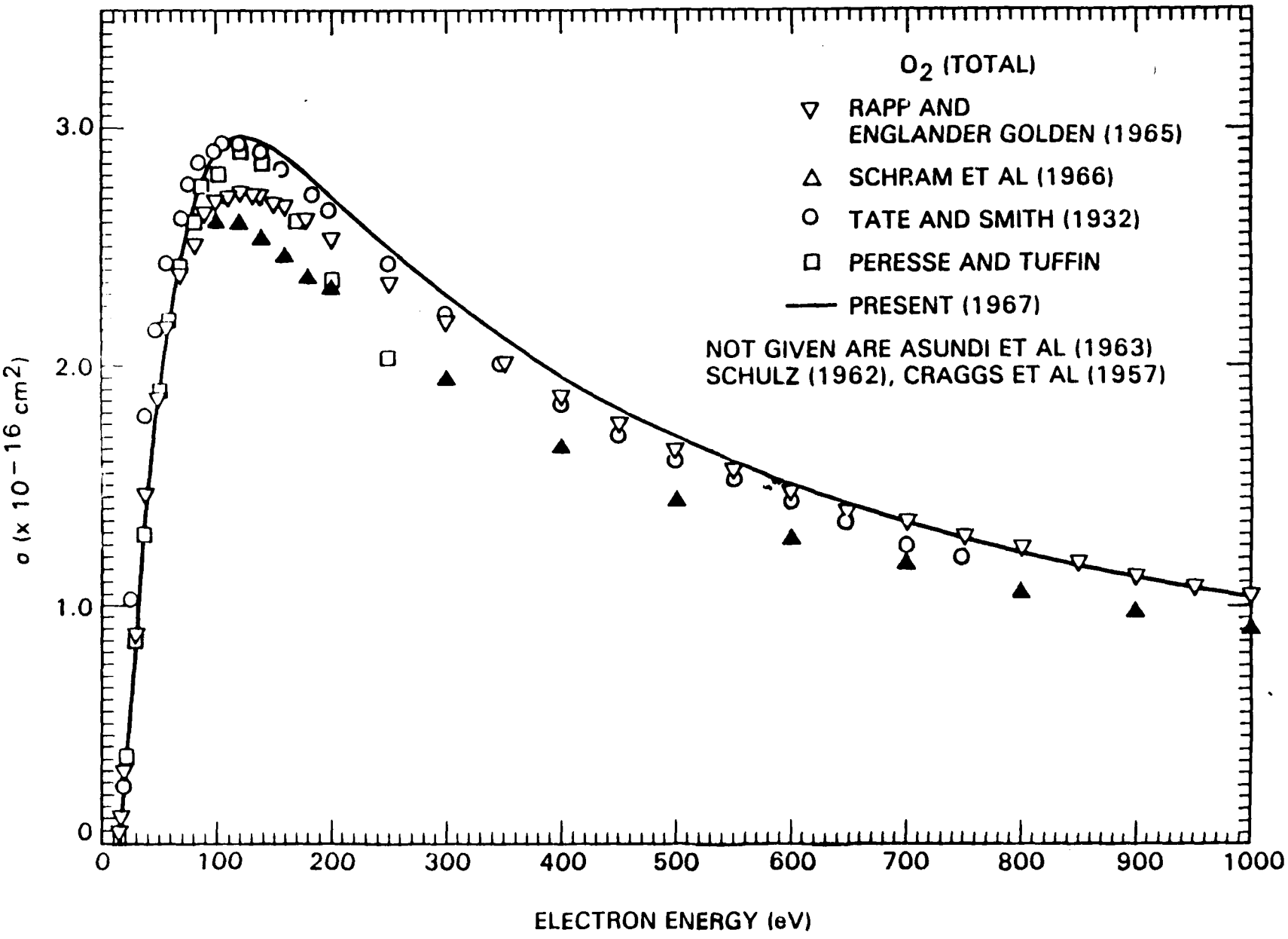

H_2 (TOTAL)
● RAPP ET AL (1965)
△ SCHRAM ET AL (1966)
○ TATE AND SMITH (1932)
— PRESENT
NOT GIVEN IS COWLING AND FLETCHER (1973)
σ (x 10−16 cm2)
ELECTRON ENERGY (eV)
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0
100
200
300
400
500
600
700
800
900
1000

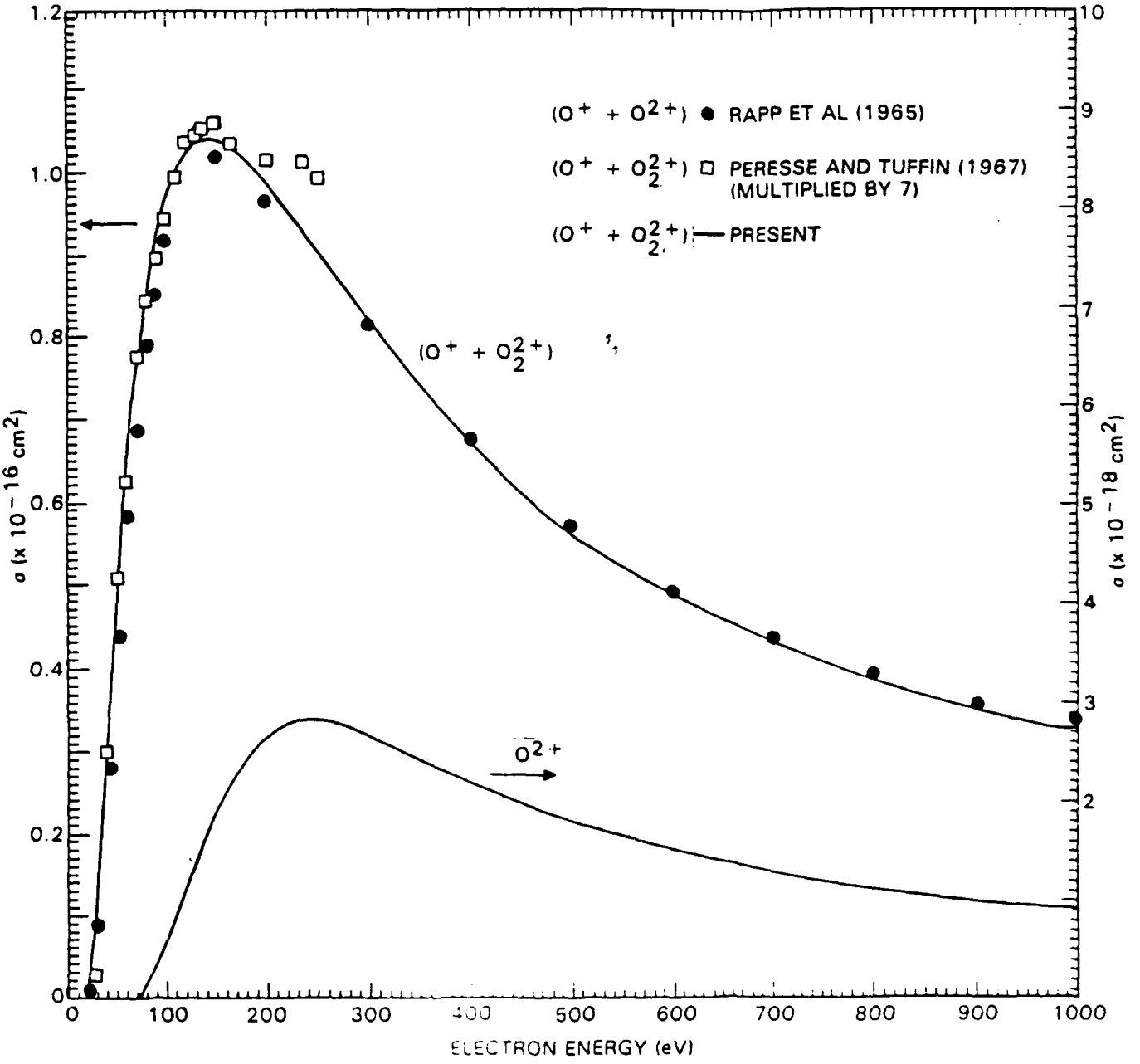

D_2 (TOTAL)
RAPP AND ENGLANDER GOLDEN (1965)
SCHRAM ET AL (1965)
COWLING AND FLETCHER (1973)
PRESENT
σ (x 10−16 cm2)
ELECTRON ENERGY (eV)
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0
100
200
300
400
500
600
700
800
900
1000

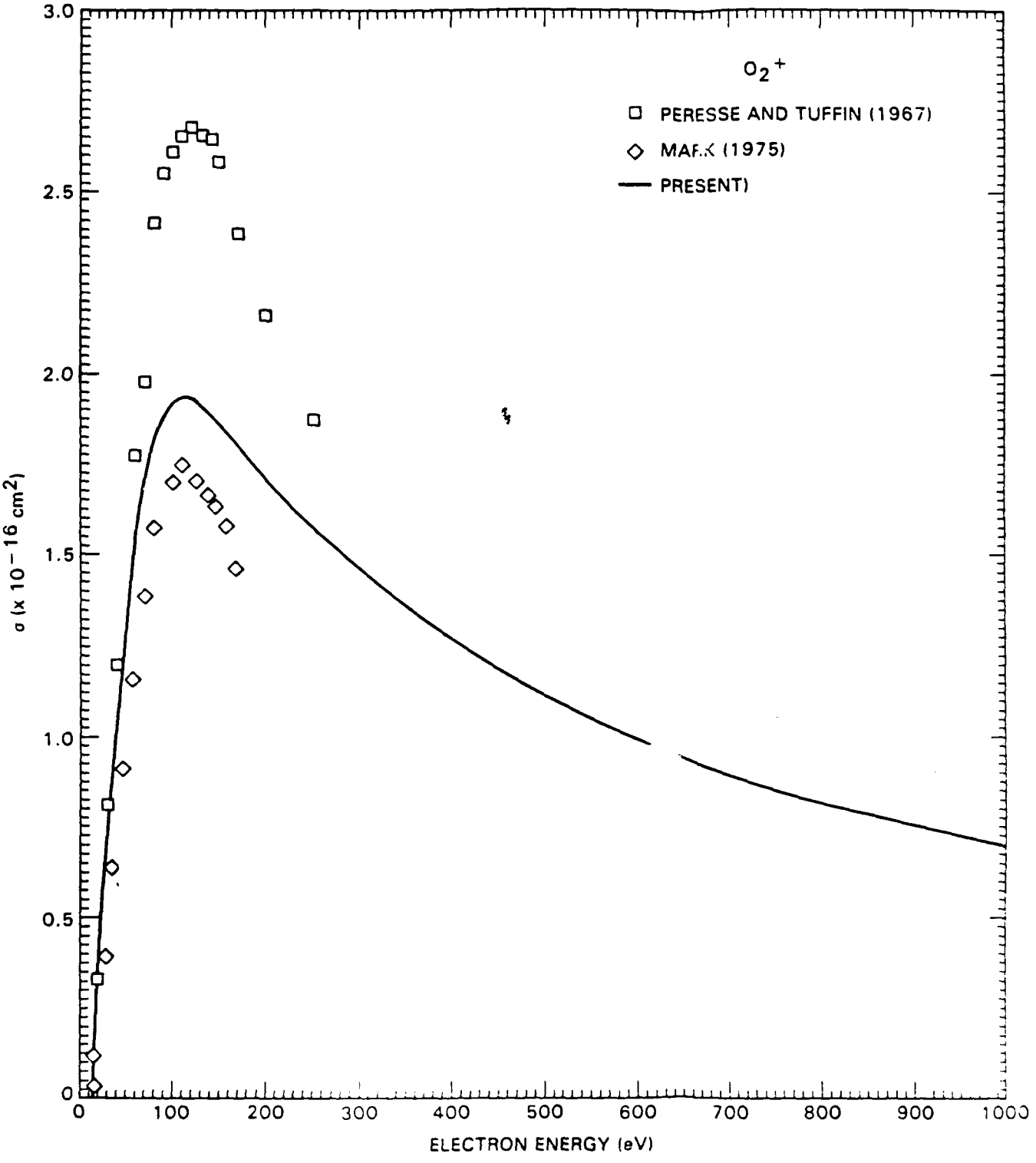

1.0
0.8
0.6
0.4
0.2
0
σ (x 10−16 cm2)
D2+, D+
D2+
D+
X4
0
100
200
300
400
500
600
700
800
900
1000
ELECTRON ENERGY (eV)

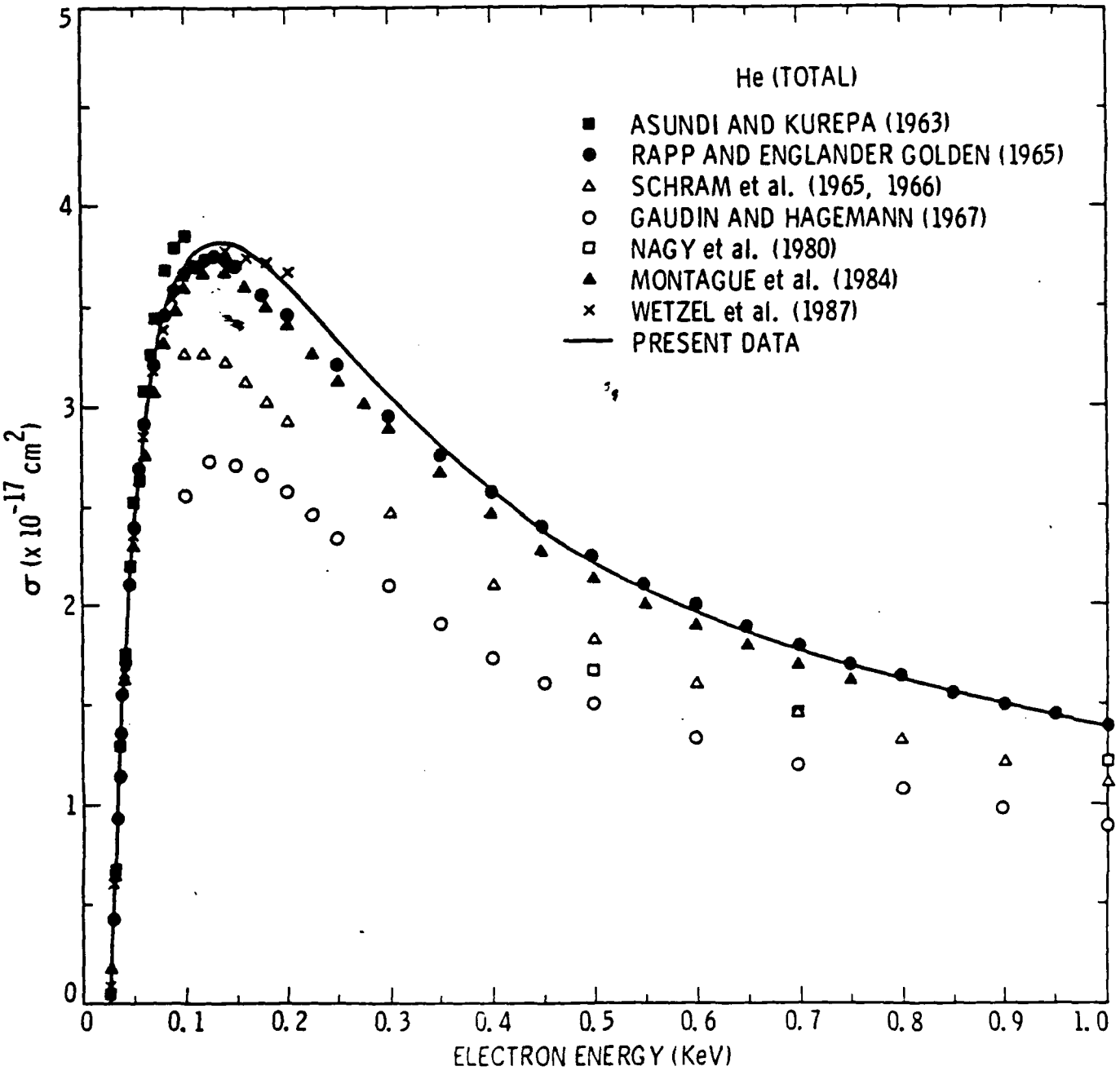

N_2^+
■ COOK AND PETERSON (1962)
○ DALY AND POWELL (1966) (NORMALIZED TO TATE AND SMITH AND COOK AND PETERSON)
△ HALAS AND ADAMCZYK (1972) (NORMALIZED TO RAPP ET AL)
✱ CROWE AND McKONKEY (1973) (NORMALIZED TO RAPP ET AL)
● MÄRK (1975)
□ RAPP AND ENGLANDER – GOLDEN'S DATA RECOMMENDED BY ITIKAWA ET AL (1986)
— PRESENT
σ (x 10⁻¹⁶ cm²)
ELECTRON ENERGY (eV)
0
0.5
1.0
1.5
2.0
2.5
100
200
300
400
500
600
700
800
900

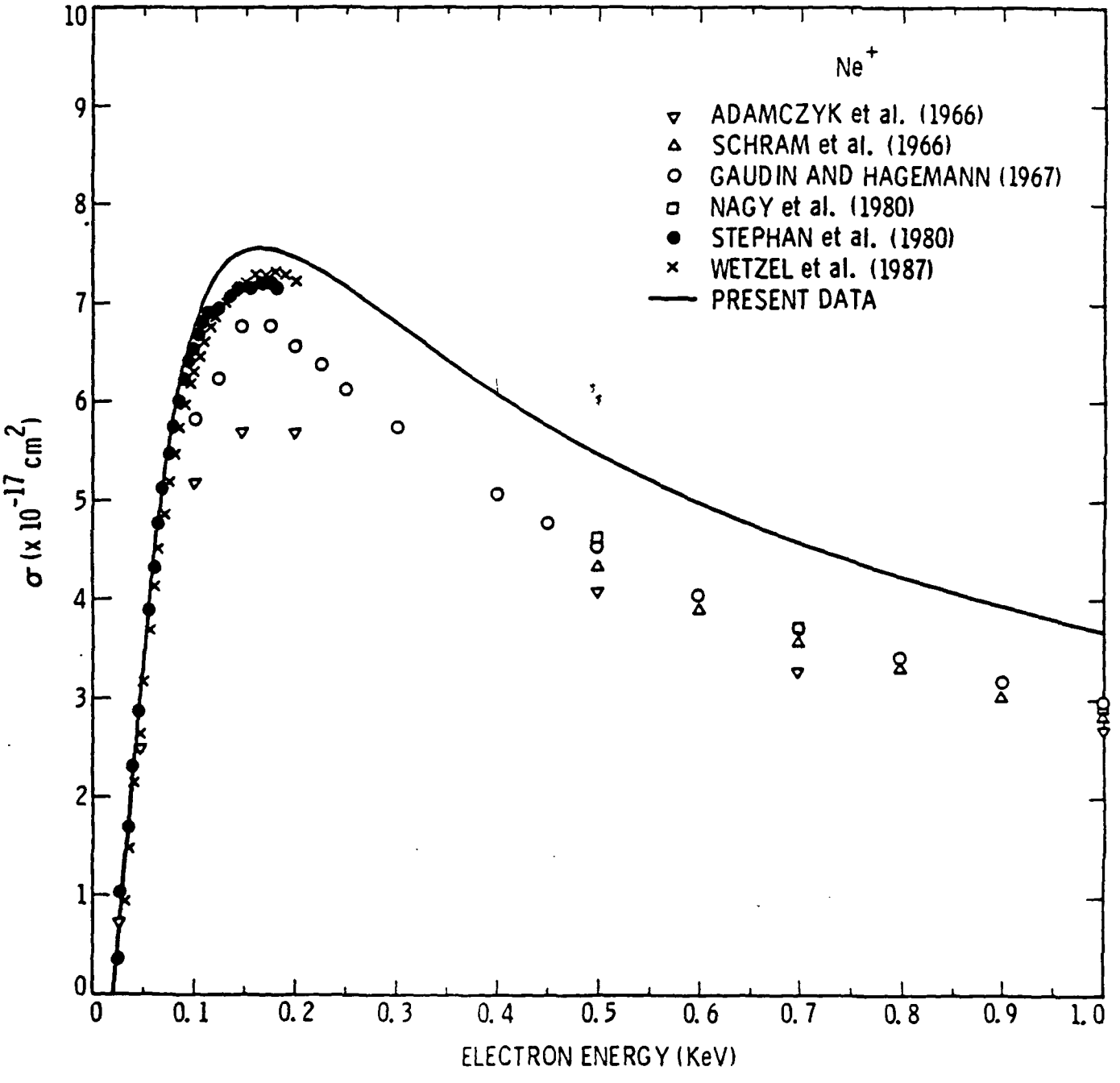

$(N^+ + N_2^{2+})$ COOK AND PETERSON (1962)
$(N^+ + N^{2+})$ RAPP ET AL (1965)
$(N^+ + N_2^{2+})$ DALY AND POWELL (1966)
$(N^+ + N_2^{2+})$ PERESSE AND TUFFIN X5 (1967)
(N^+) CROWE AND McCONKEY (1973)
$(N^+ + N_2^{2+})$ HALAS AND ADAMCZYK (1973)
PRESENT
$(N^+ + N_2^{2+})$
N^{2+}
σ (x 10^{-18} cm^2)
σ (x 10^{-18} cm^2)
ELECTRON ENERGY (eV)
0
100
200
300
400
500
600
700
800
900
1000
10
20
30
40
50
60
70
1
2
3
4
5
6

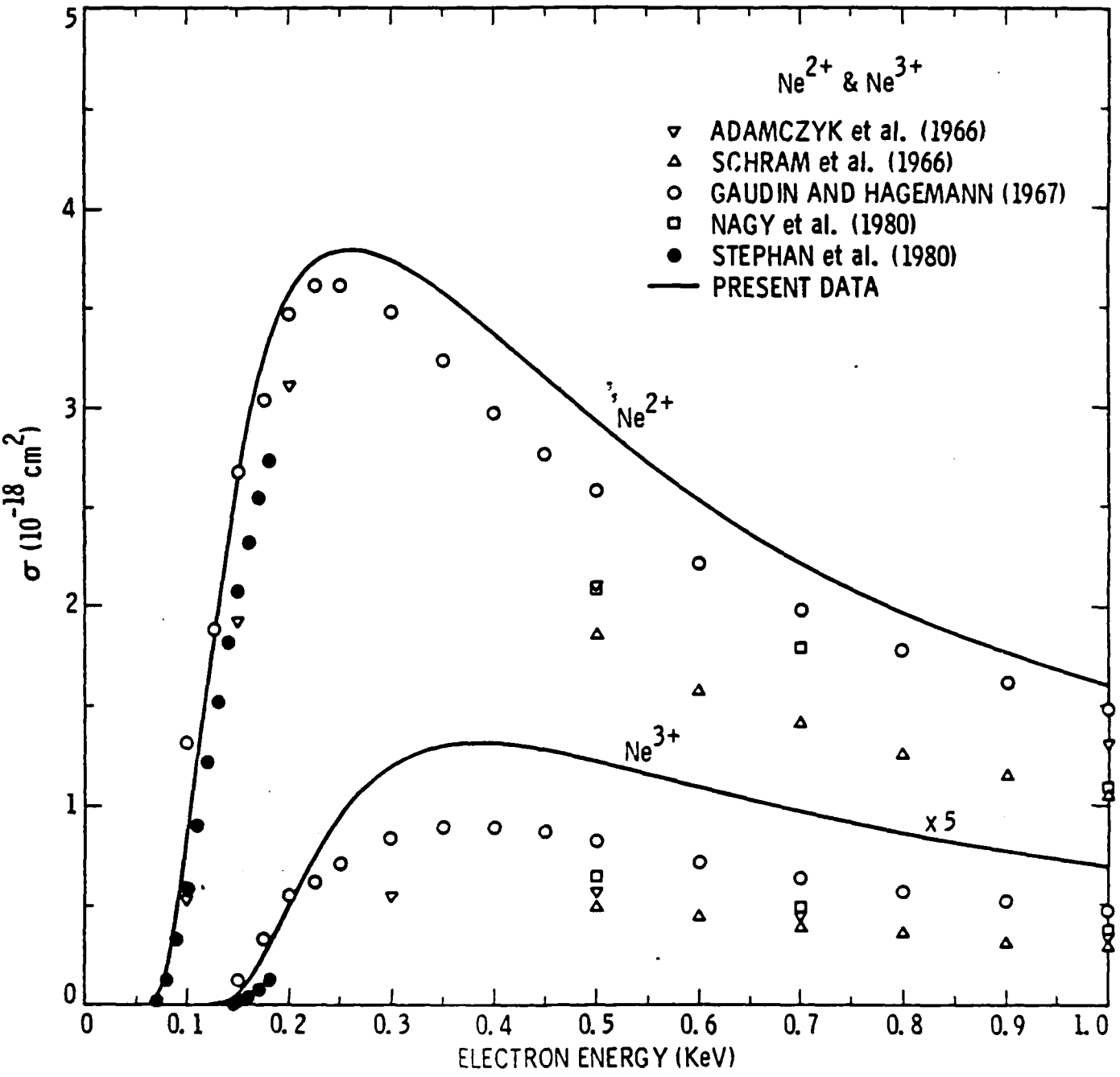

O_2 (TOTAL)
RAPP AND ENGLANDER GOLDEN (1965)
SCHRAM ET AL (1966)
TATE AND SMITH (1932)
PERESSE AND TUFFIN
PRESENT (1967)
NOT GIVEN ARE ASUNDI ET AL (1963) SCHULZ (1962), CRAGGS ET AL (1957)
σ (x 10−16 cm2)
3.0
2.0
1.0
0
0
100
200
300
400
500
600
700
800
900
1000
ELECTRON ENERGY (eV)

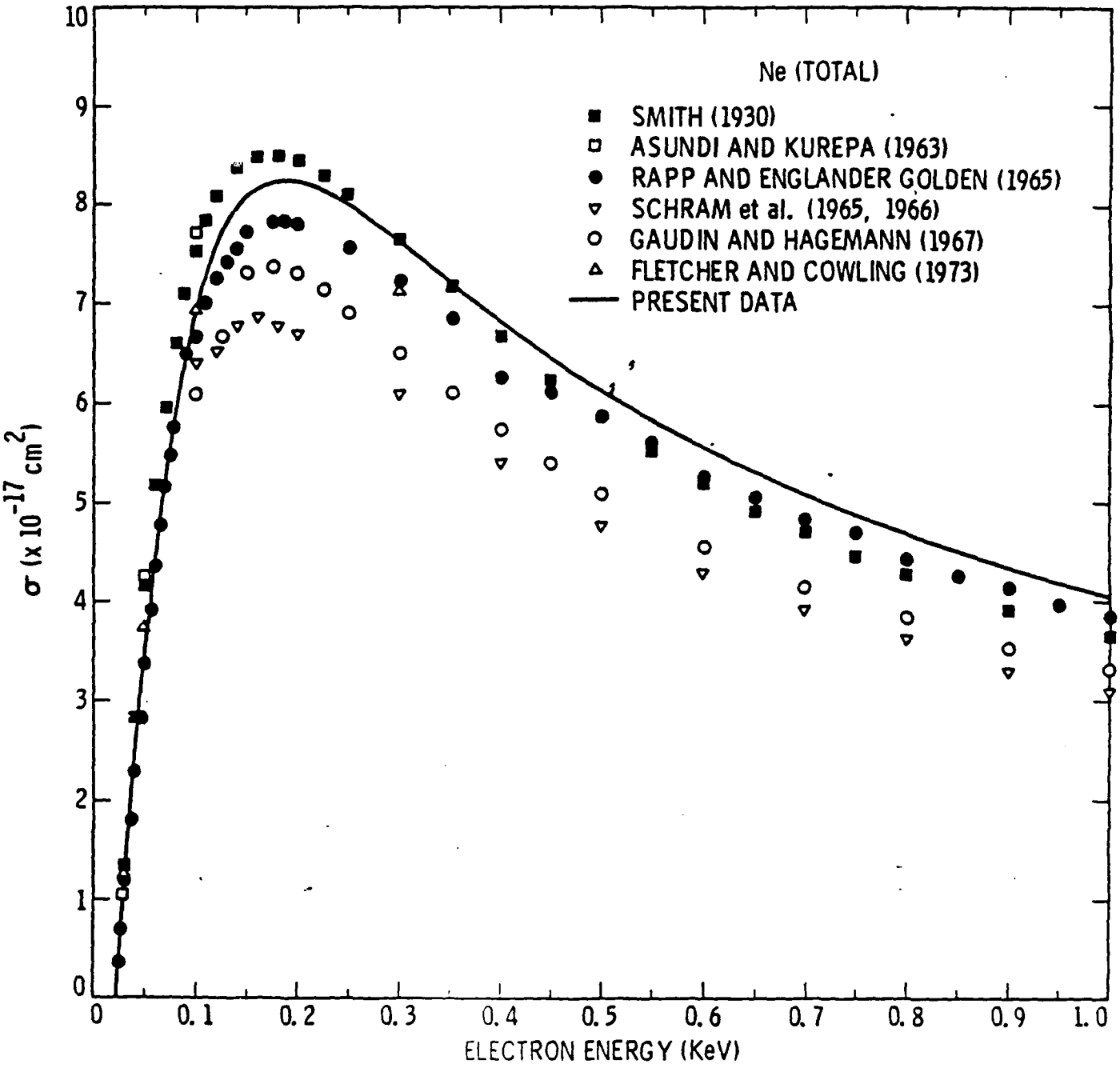

(O+ + O2+) ● RAPP ET AL (1965)
(O+ + O2 2+) □ PERESSE AND TUFFIN (1967) (MULTIPLIED BY 7)
(O+ + O2 2+) — PRESENT
(O+ + O2 2+)
O2+
σ (x 10−16 cm2)
σ (x 10−18 cm2)
ELECTRON ENERGY (eV)
0
0.2
0.4
0.6
0.8
1.0
1.2
2
3
4
5
6
7
8
9
10
100
200
300
400
500
600
700
800
900
1000

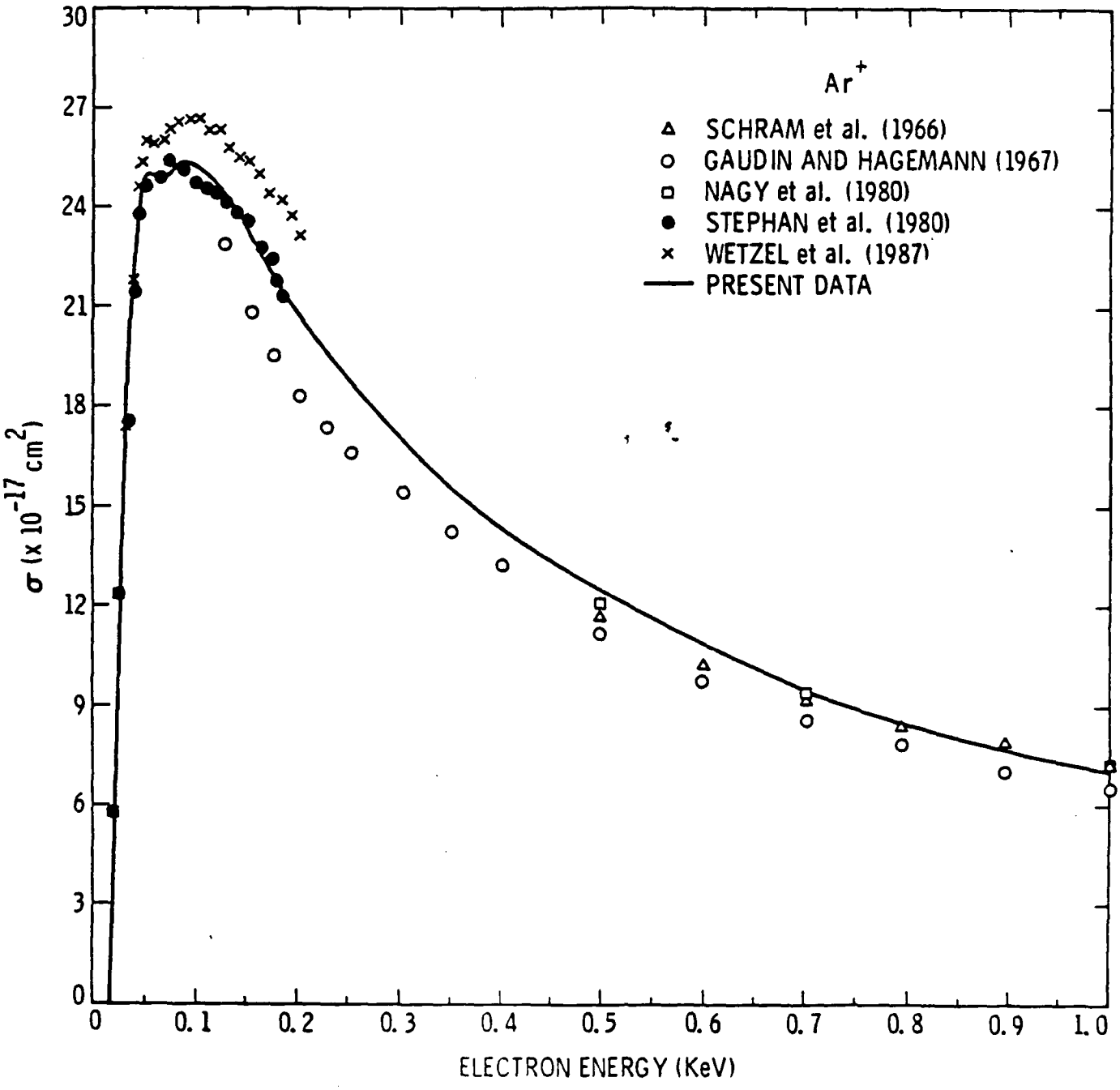

O_2^+
PERESSE AND TUFFIN (1967)
MAR.K (1975)
PRESENT)
σ (x 10−16 cm2)
ELECTRON ENERGY (eV)
0
0.5
1.0
1.5
2.0
2.5
3.0
0
100
200
300
400
500
600
700
800
900
1000

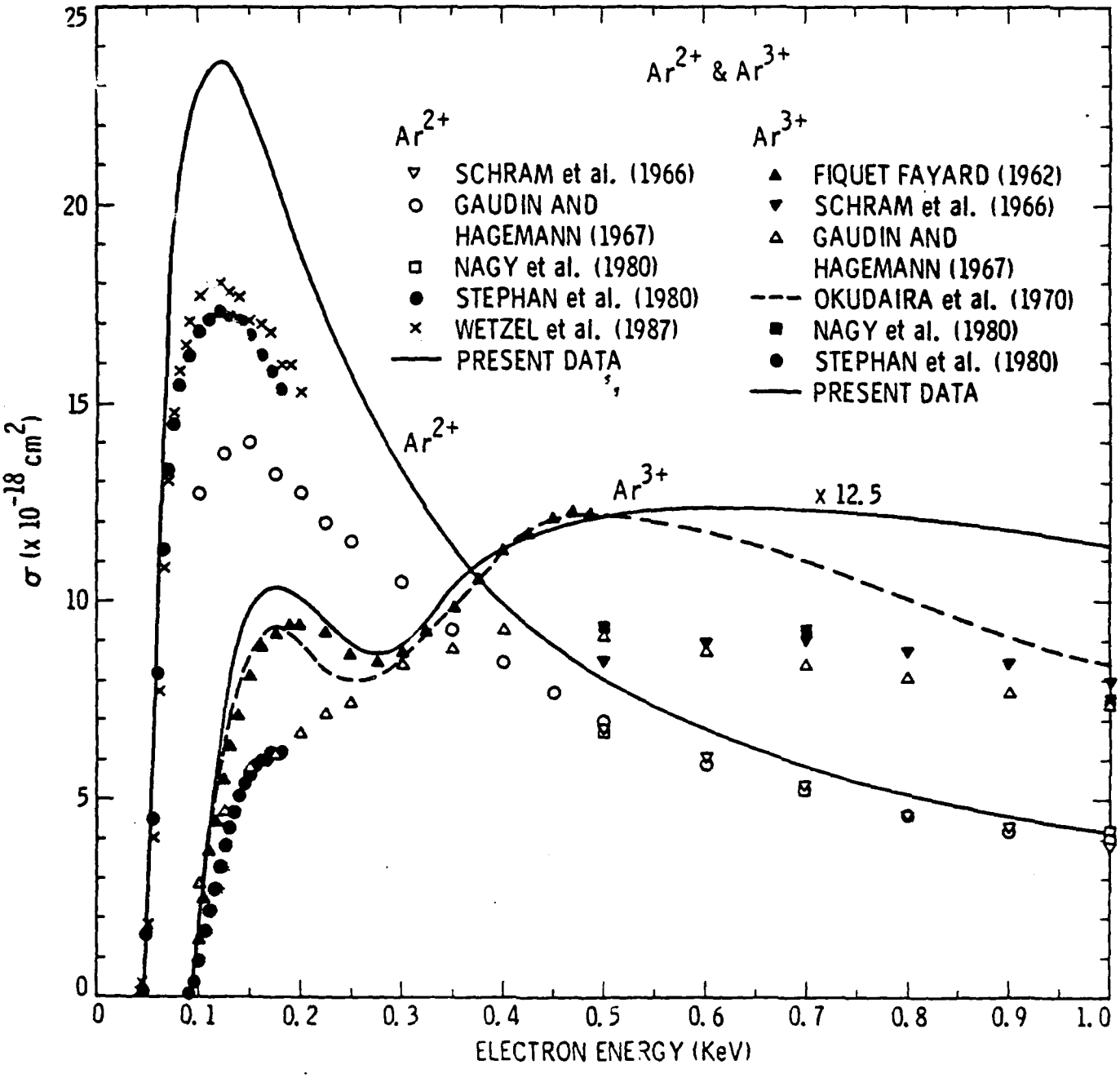

He (TOTAL)
ASUNDI AND KUREPA (1963)
RAPP AND ENGLANDER GOLDEN (1965)
SCHRAM et al. (1965, 1966)
GAUDIN AND HAGEMANN (1967)
NAGY et al. (1980)
MONTAGUE et al. (1984)
WETZEL et al. (1987)
PRESENT DATA
σ (x 10^-17 cm^2)
ELECTRON ENERGY (KeV)
0
1
2
3
4
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

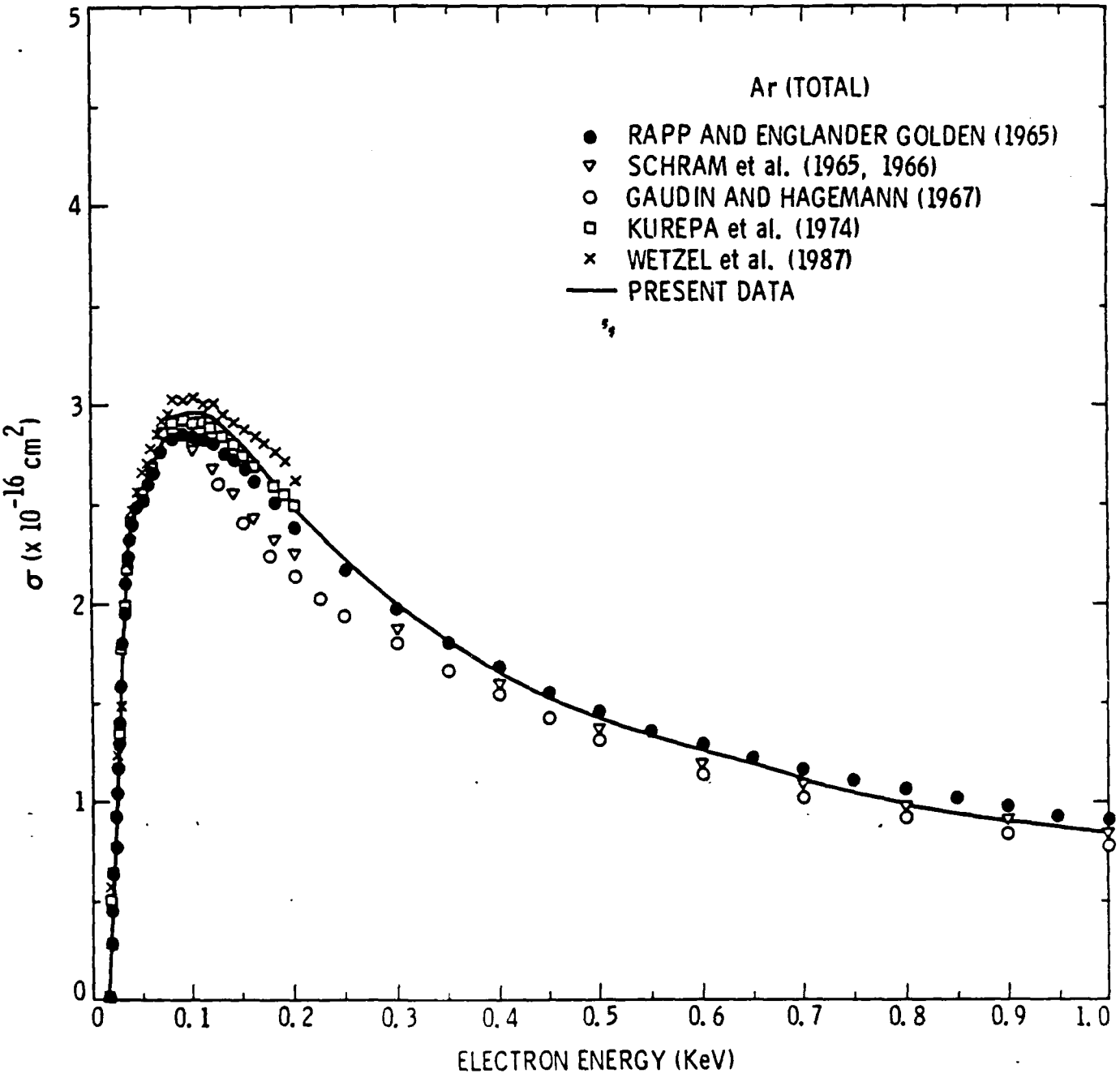

Ne+
ADAMCZYK et al. (1966)
SCHRAM et al. (1966)
GAUDIN AND HAGEMANN (1967)
NAGY et al. (1980)
STEPHAN et al. (1980)
WETZEL et al. (1987)
PRESENT DATA
σ (x 10-17 cm2)
ELECTRON ENERGY (KeV)
0
1
2
3
4
5
6
7
8
9
10
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

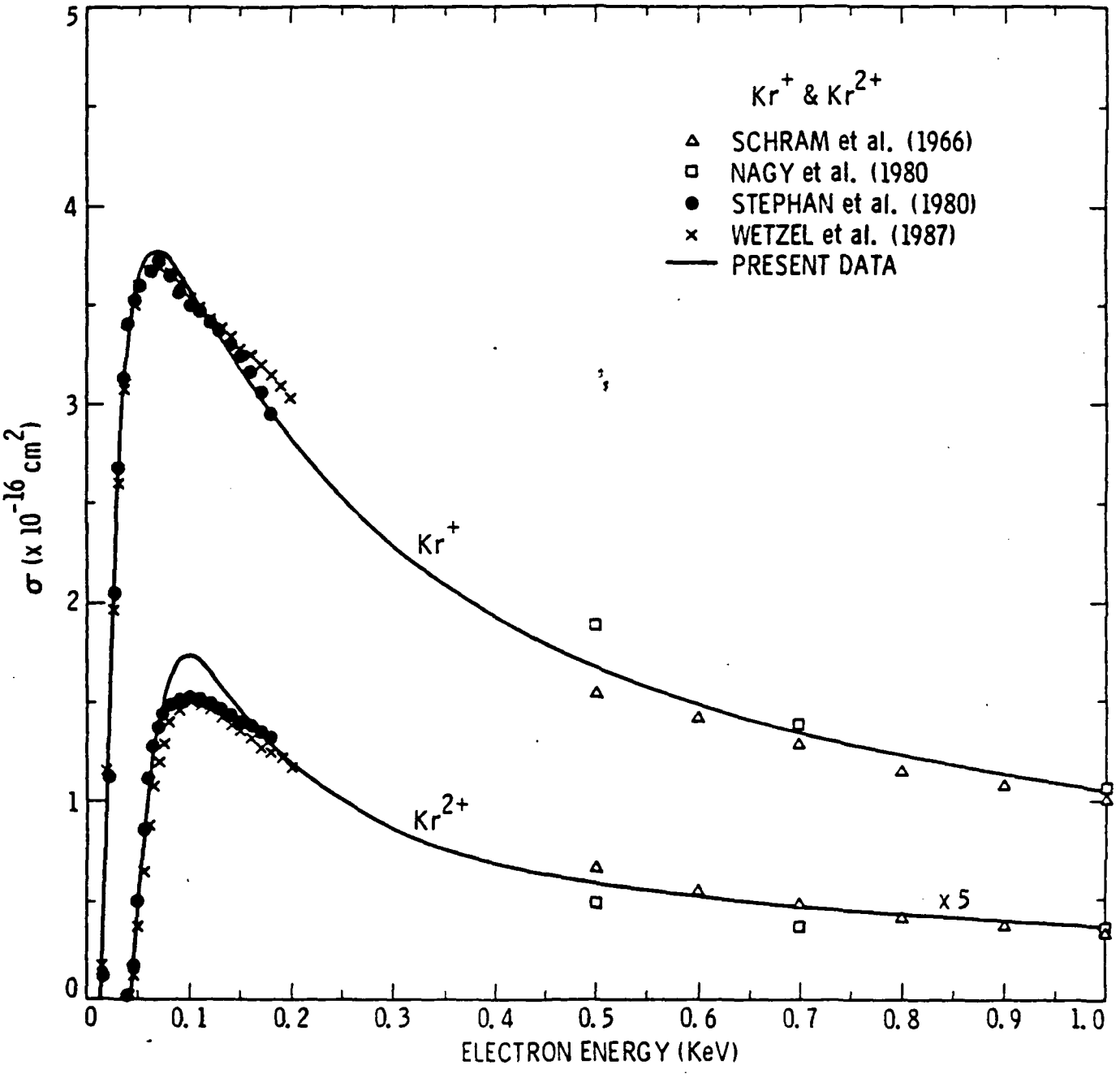

Ne2+ & Ne3+
ADAMCZYK et al. (1966)
SCHRAM et al. (1966)
GAUDIN AND HAGEMANN (1967)
NAGY et al. (1980)
STEPHAN et al. (1980)
PRESENT DATA
Ne2+
Ne3+
x 5
σ (10-18 cm2)
ELECTRON ENERGY (KeV)
0
1
2
3
4
5
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

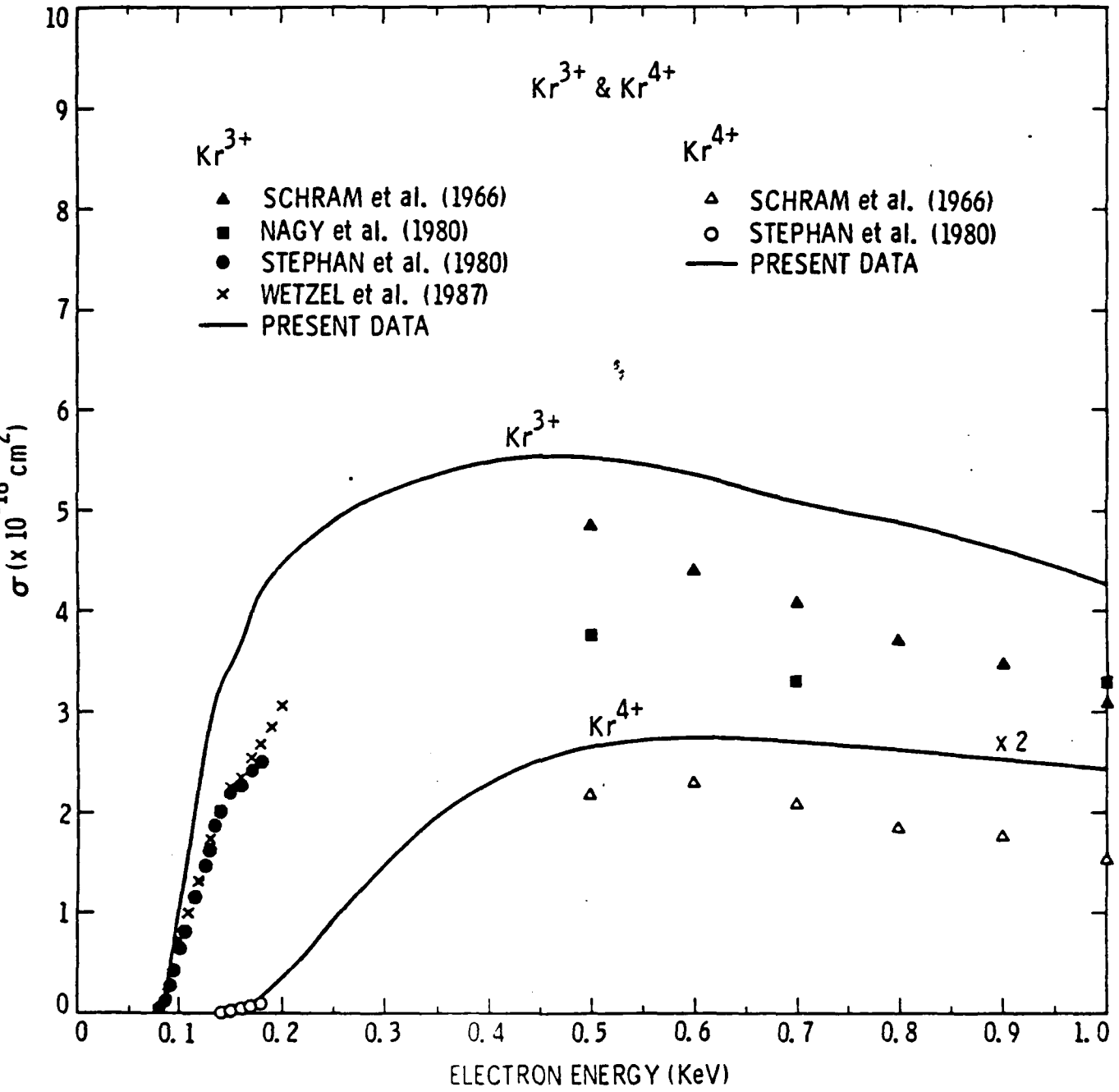

Ne (TOTAL)
SMITH (1930)
ASUNDI AND KUREPA (1963)
RAPP AND ENGLANDER GOLDEN (1965)
SCHRAM et al. (1965, 1966)
GAUDIN AND HAGEMANN (1967)
FLETCHER AND COWLING (1973)
PRESENT DATA
σ (x 10^-17 cm^2)
ELECTRON ENERGY (KeV)
0
1
2
3
4
5
6
7
8
9
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

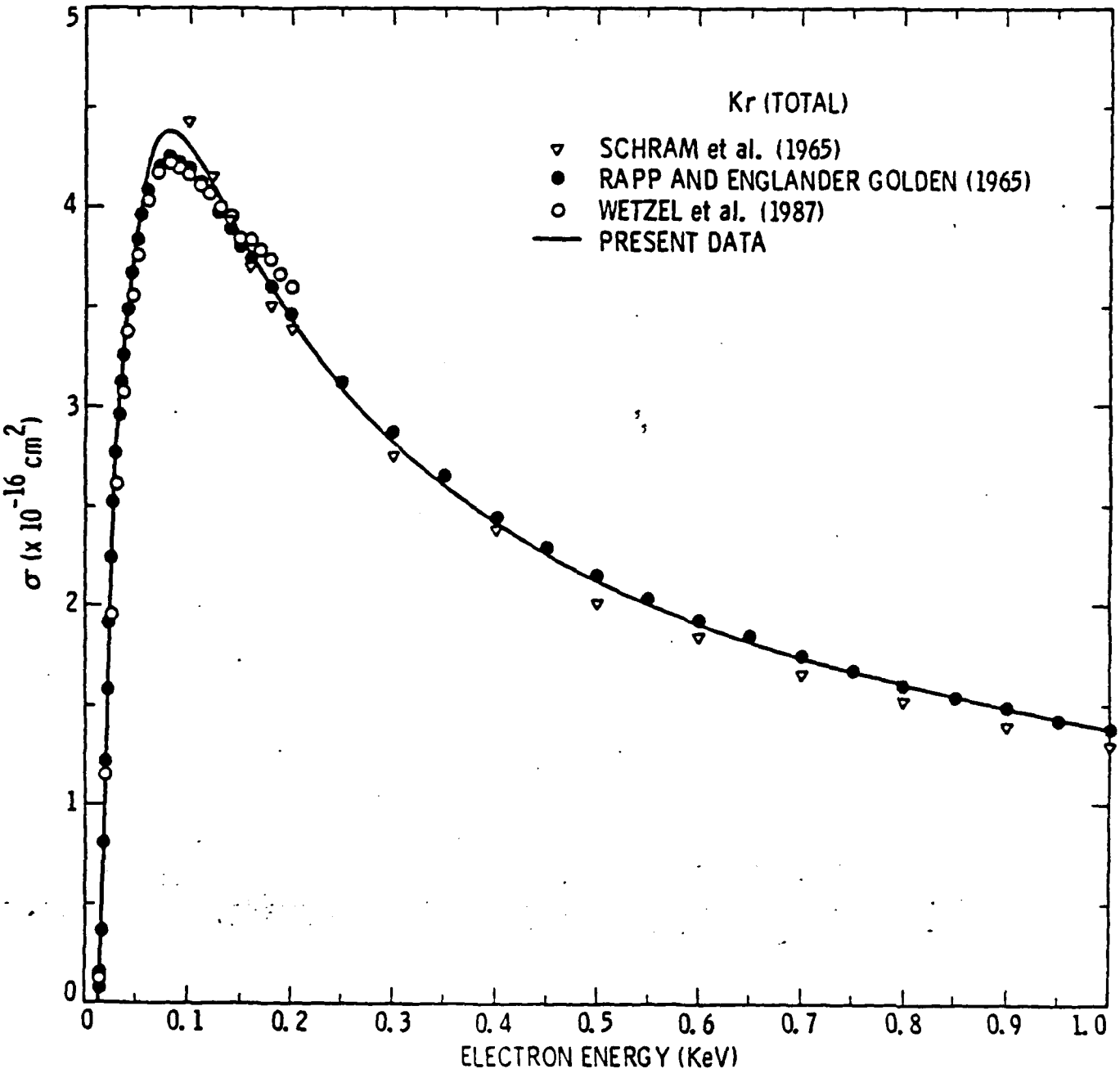

Ar^+
SCHRAM et al. (1966)
GAUDIN AND HAGEMANN (1967)
NAGY et al. (1980)
STEPHAN et al. (1980)
WETZEL et al. (1987)
PRESENT DATA
σ (x 10^{-17} cm^2)
ELECTRON ENERGY (KeV)
0
3
6
9
12
15
18
21
24
27
30
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

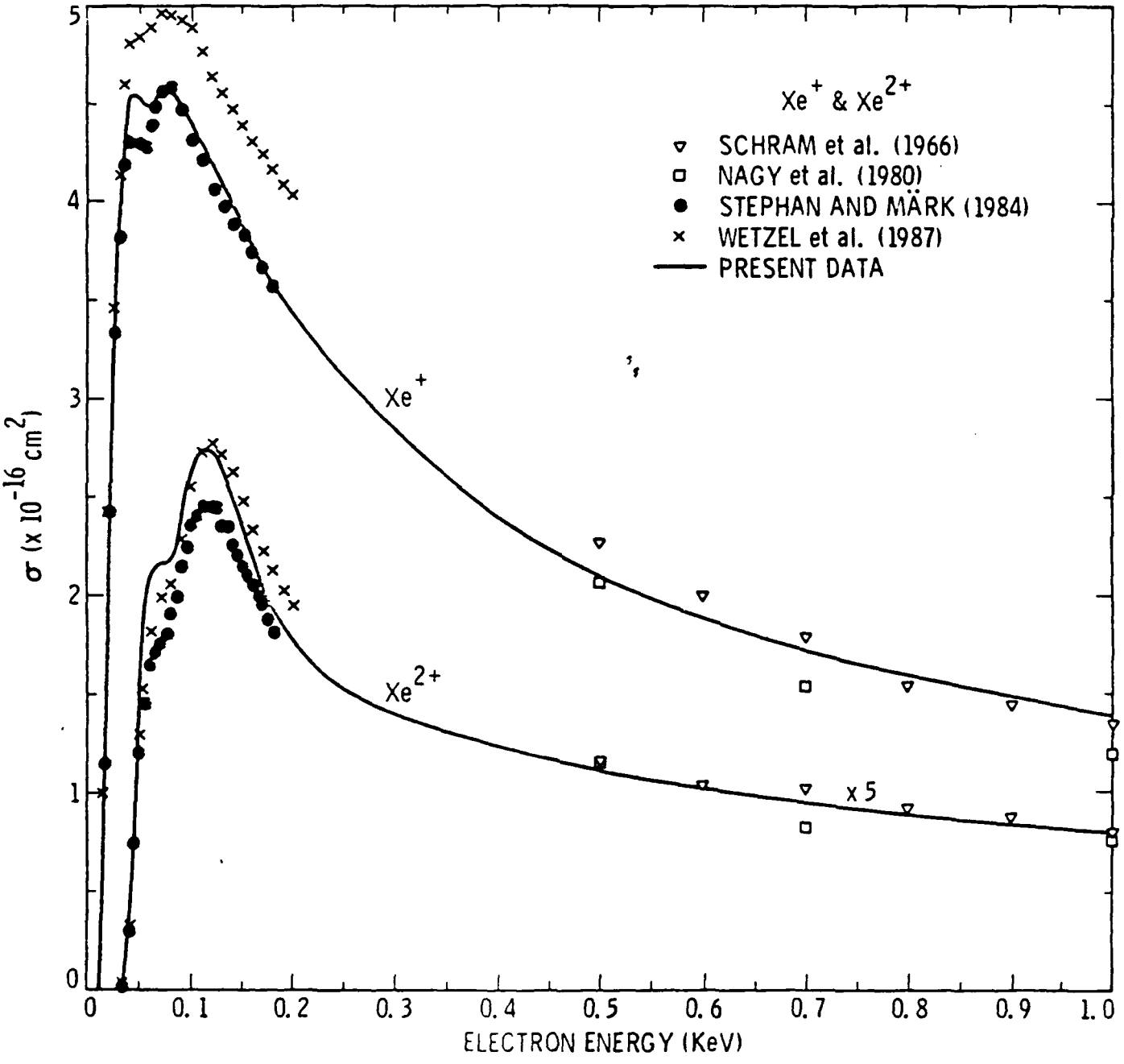

Ar^{2+} & Ar^{3+}
Ar^{2+}
SCHRAM et al. (1966)
GAUDIN AND HAGEMANN (1967)
NAGY et al. (1980)
STEPHAN et al. (1980)
WETZEL et al. (1987)
PRESENT DATA
Ar^{3+}
FIQUET FAYARD (1962)
SCHRAM et al. (1966)
GAUDIN AND HAGEMANN (1967)
OKUDAIRA et al. (1970)
NAGY et al. (1980)
STEPHAN et al. (1980)
PRESENT DATA
Ar^{2+}
Ar^{3+}
x 12.5
σ (x 10^{-18} cm^2)
ELECTRON ENERGY (KeV)
0
5
10
15
20
25
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

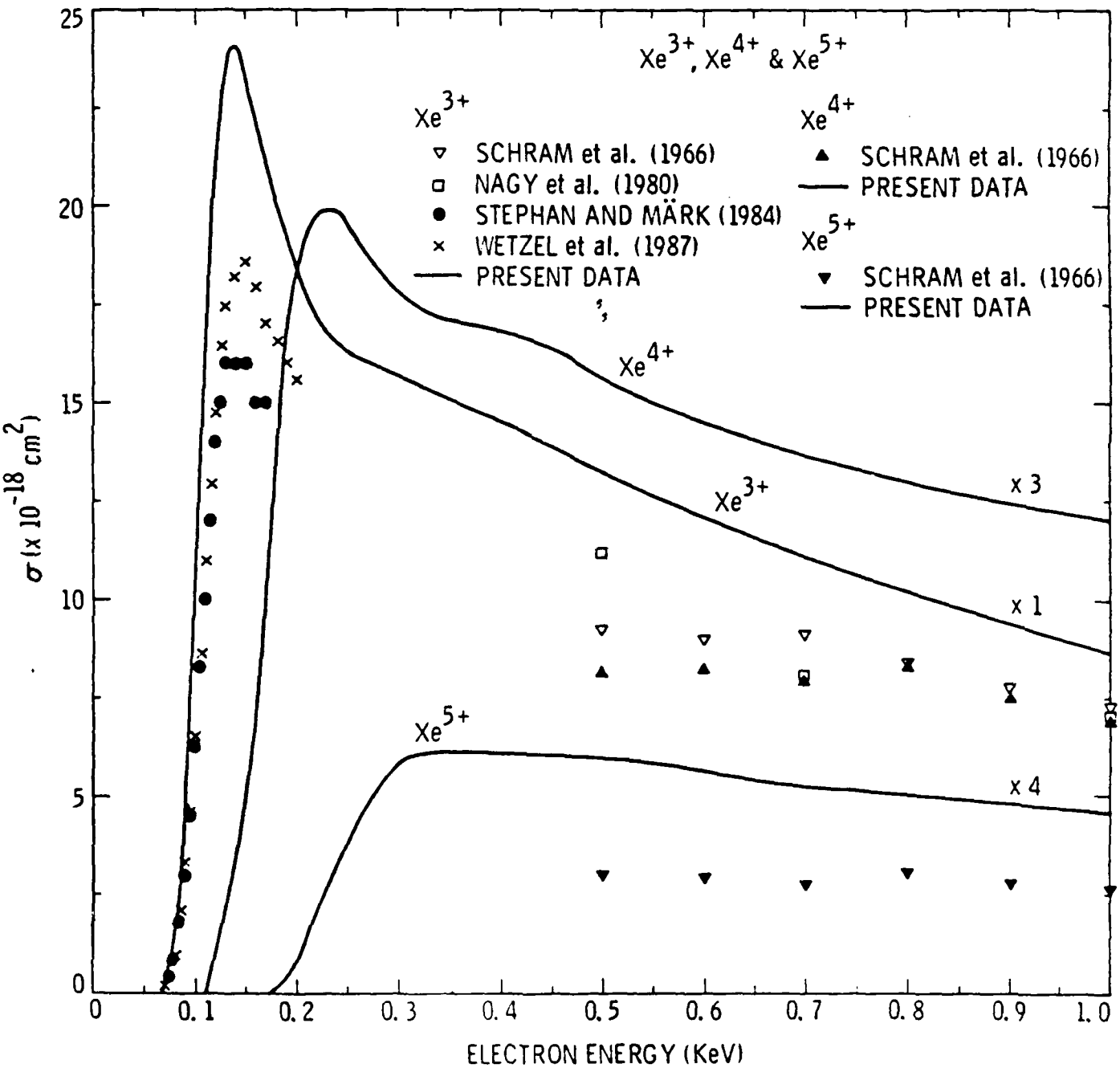

Ar (TOTAL)
RAPP AND ENGLANDER GOLDEN (1965)
SCHRAM et al. (1965, 1966)
GAUDIN AND HAGEMANN (1967)
KUREPA et al. (1974)
WETZEL et al. (1987)
PRESENT DATA
σ (x 10^-16 cm^2)
ELECTRON ENERGY (KeV)
0
1
2
3
4
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

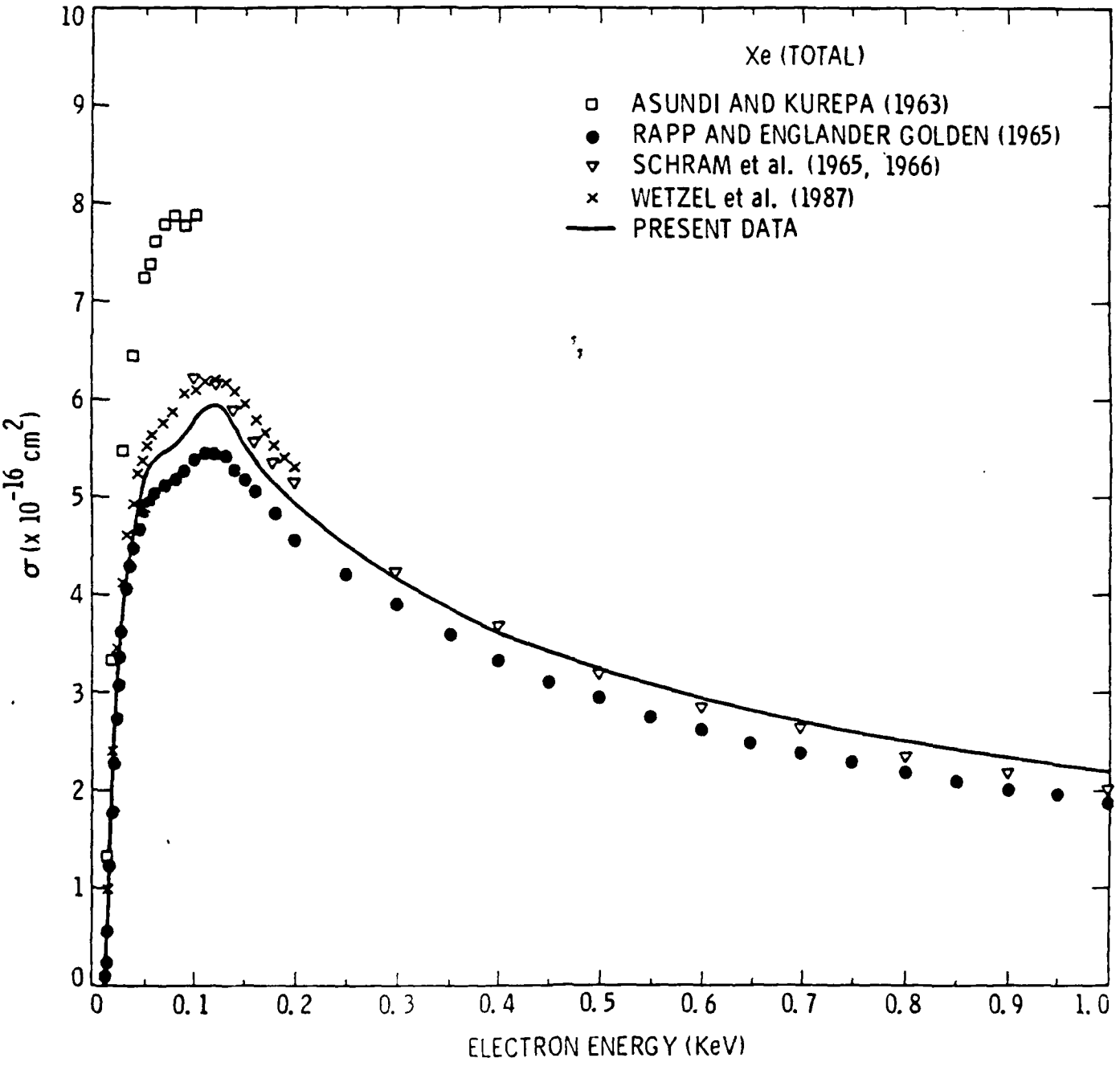

Kr^+ & Kr^{2+}
SCHRAM et al. (1966)
NAGY et al. (1980
STEPHAN et al. (1980)
WETZEL et al. (1987)
PRESENT DATA
Kr^+
Kr^{2+}
x 5
σ (x 10^{-16} cm^2)
ELECTRON ENERGY (KeV)
0
1
2
3
4
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

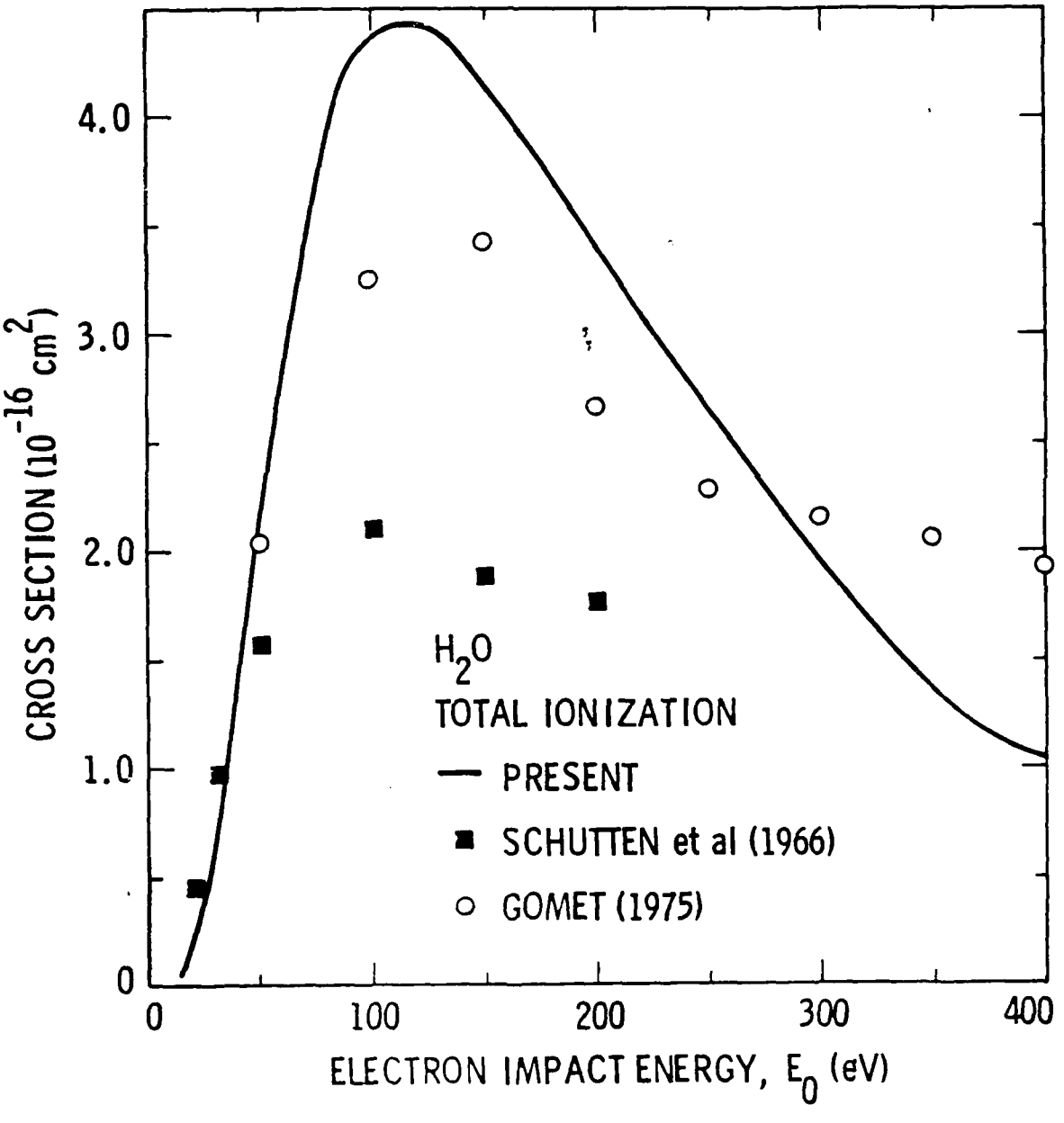

Kr^{3+} & Kr^{4+}
Kr^{3+}
SCHRAM et al. (1966)
NAGY et al. (1980)
STEPHAN et al. (1980)
WETZEL et al. (1987)
PRESENT DATA
Kr^{4+}
SCHRAM et al. (1966)
STEPHAN et al. (1980)
PRESENT DATA
Kr^{3+}
Kr^{4+}
x 2
σ (x 10^{-18} cm^2)
ELECTRON ENERGY (KeV)
0
1
2
3
4
5
6
7
8
9
10
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

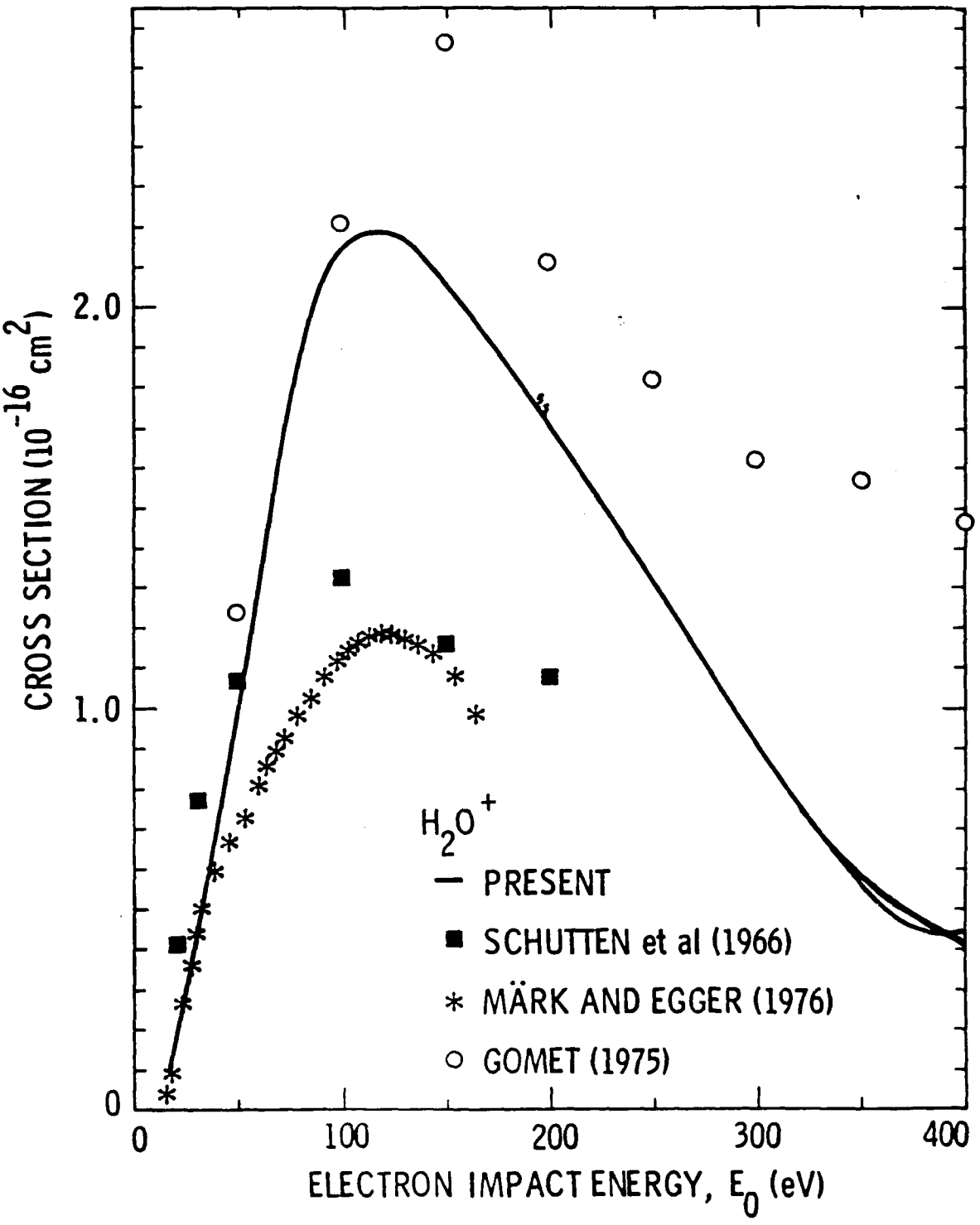

Kr (TOTAL)
SCHRAM et al. (1965)
RAPP AND ENGLANDER GOLDEN (1965)
WETZEL et al. (1987)
PRESENT DATA
σ (x 10^-16 cm^2)
ELECTRON ENERGY (KeV)
0
1
2
3
4
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

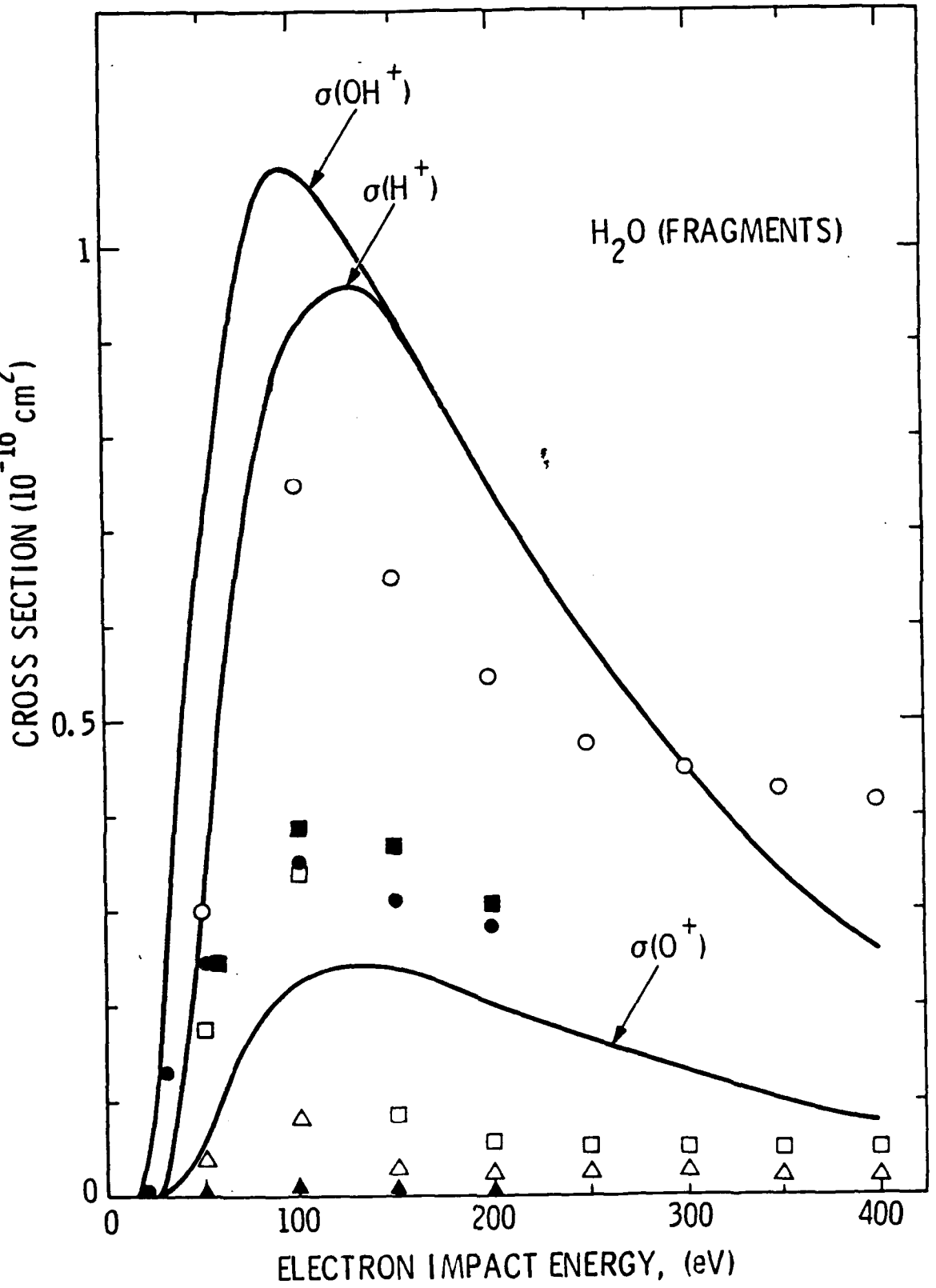

Xe^+ & Xe^{2+}
SCHRAM et al. (1966)
NAGY et al. (1980)
STEPHAN AND MÄRK (1984)
WETZEL et al. (1987)
PRESENT DATA
Xe^+
Xe^{2+}
x 5
σ (x 10^{-16} cm^2)
ELECTRON ENERGY (KeV)
0
1
2
3
4
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

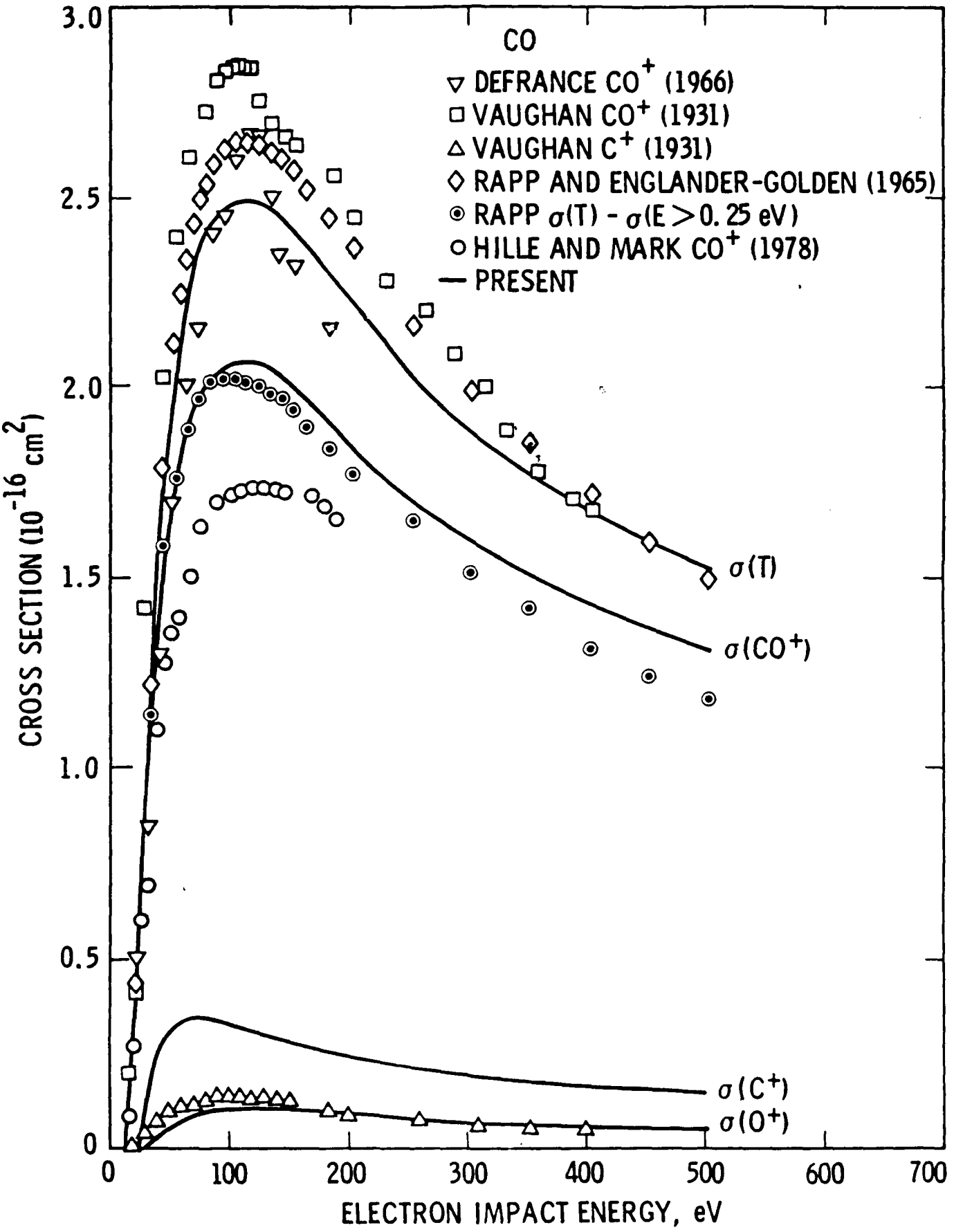

Xe^{3+}, Xe^{4+} & Xe^{5+}
Xe^{3+}
SCHRAM et al. (1966)
NAGY et al. (1980)
STEPHAN AND MÄRK (1984)
WETZEL et al. (1987)
PRESENT DATA
Xe^{4+}
SCHRAM et al. (1966)
PRESENT DATA
Xe^{5+}
SCHRAM et al. (1966)
PRESENT DATA
Xe^{4+}
Xe^{3+}
Xe^{5+}
x 3
x 1
x 4
σ (x 10^{-18} cm^2)
ELECTRON ENERGY (KeV)
0
5
10
15
20
25
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

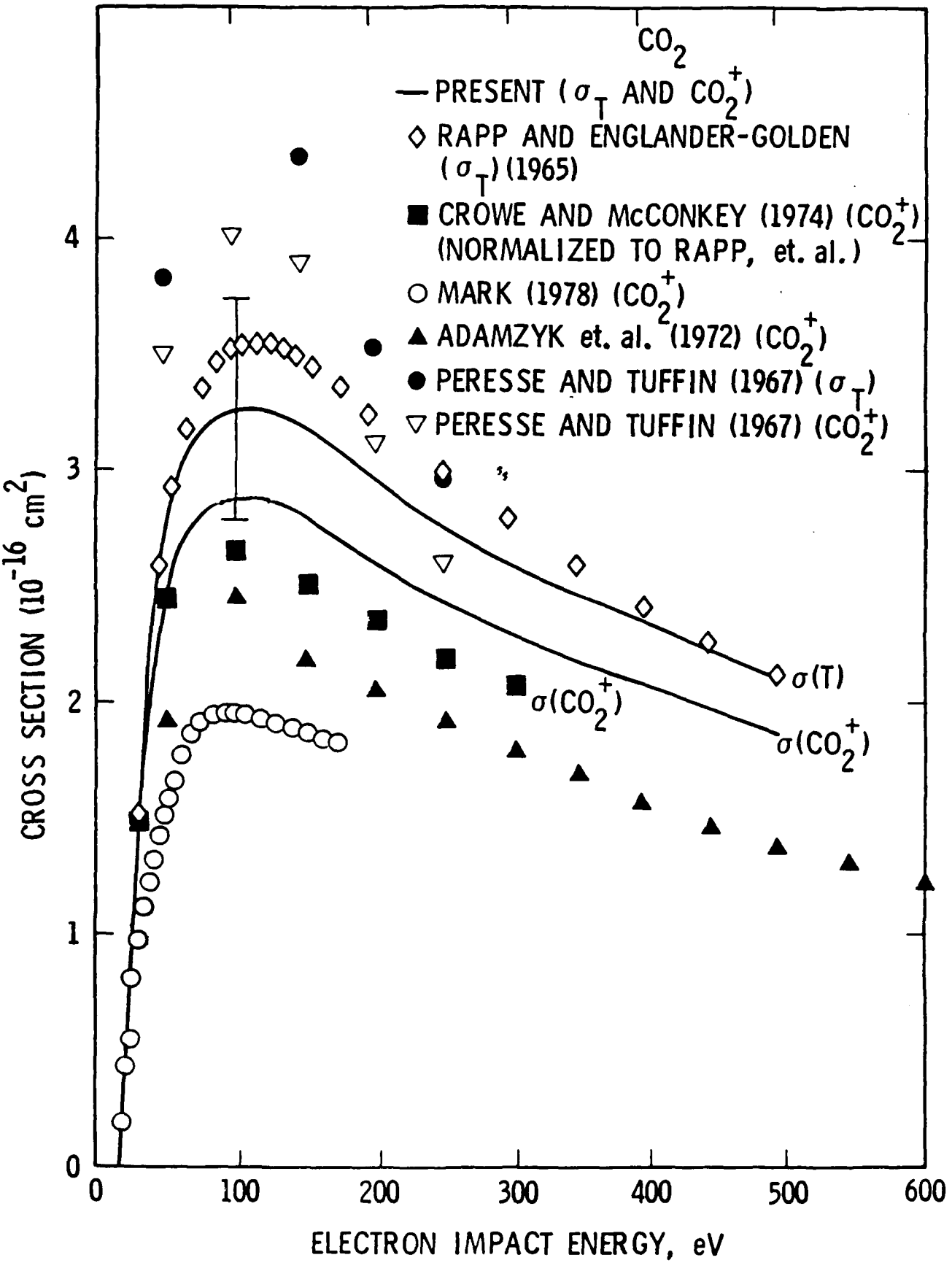

Xe (TOTAL)
ASUNDI AND KUREPA (1963)
RAPP AND ENGLANDER GOLDEN (1965)
SCHRAM et al. (1965, 1966)
WETZEL et al. (1987)
PRESENT DATA
σ (x 10^-16 cm^2)
ELECTRON ENERGY (KeV)
0
1
2
3
4
5
6
7
8
9
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

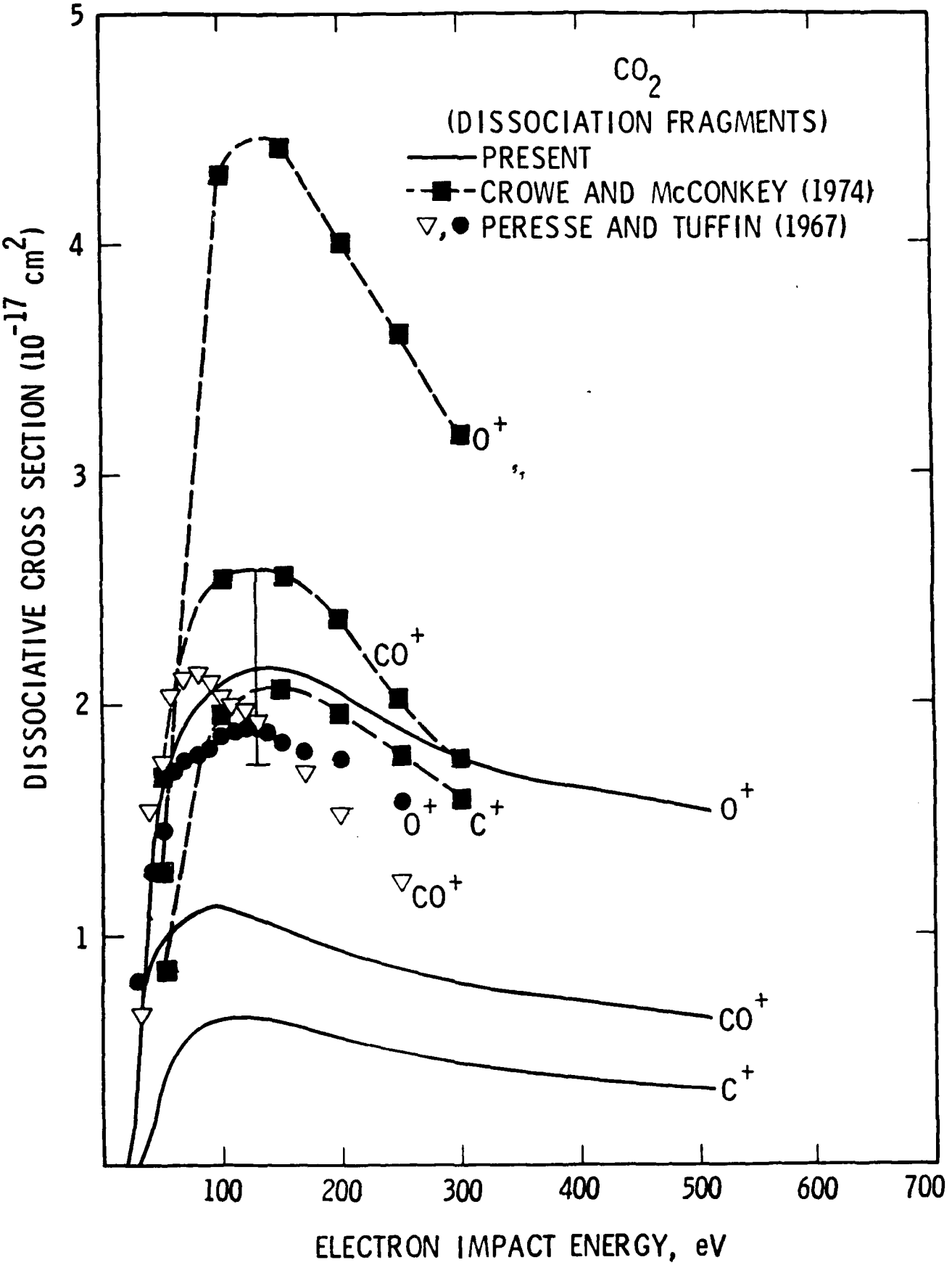

4.0
3.0
2.0
1.0
0
CROSS SECTION (10^{-16} cm^2)
0
100
200
300
400
ELECTRON IMPACT ENERGY, E_0 (eV)
H_2O
TOTAL IONIZATION
PRESENT
SCHUTTEN et al (1966)
GOMET (1975)

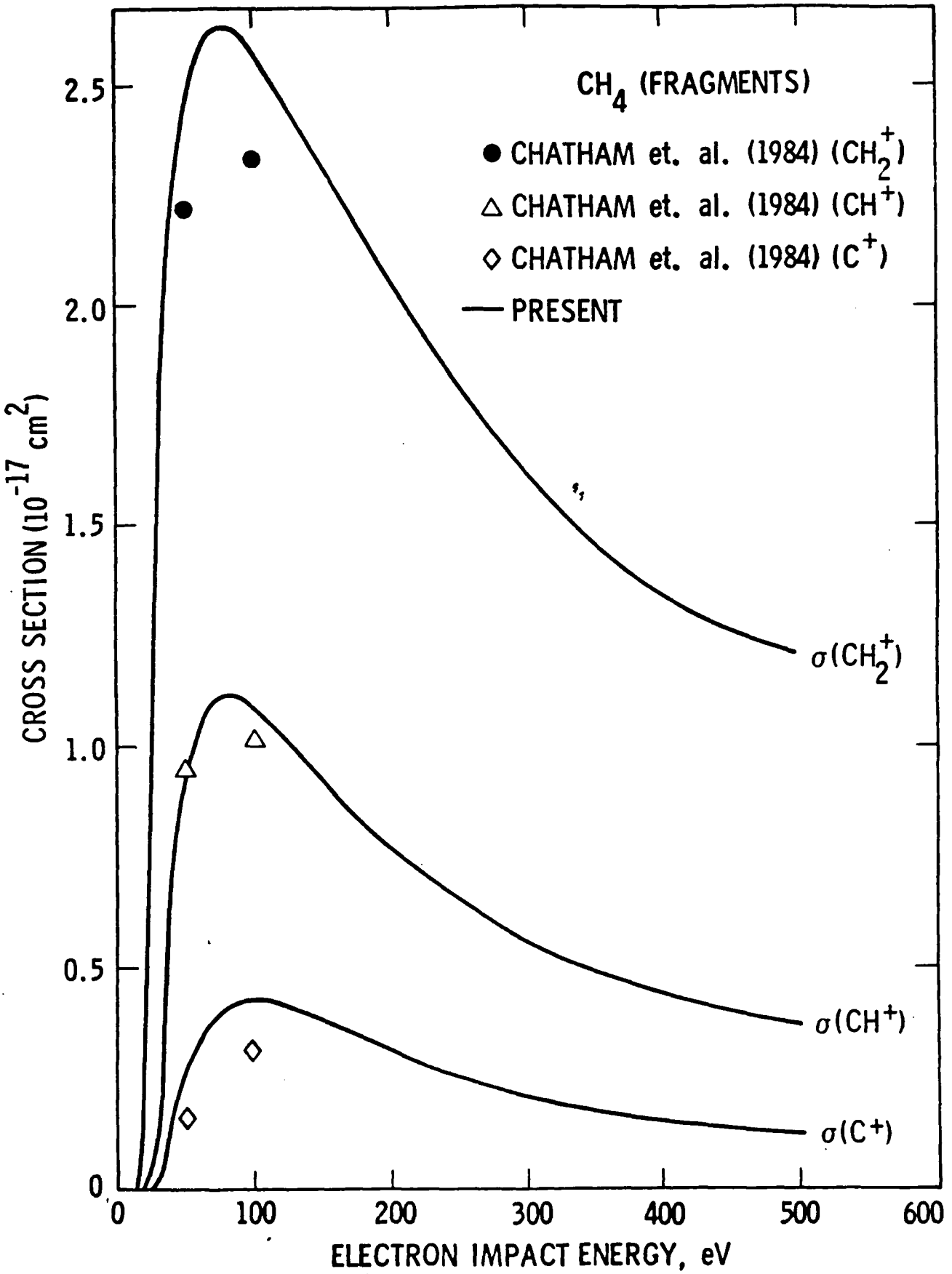

CROSS SECTION (10^{-16} cm^2)
2.0
1.0
0
0
100
200
300
400
ELECTRON IMPACT ENERGY, E_0 (eV)
H_2O^+
PRESENT
SCHUTTEN et al (1966)
MÄRK AND EGGER (1976)
GOMET (1975)

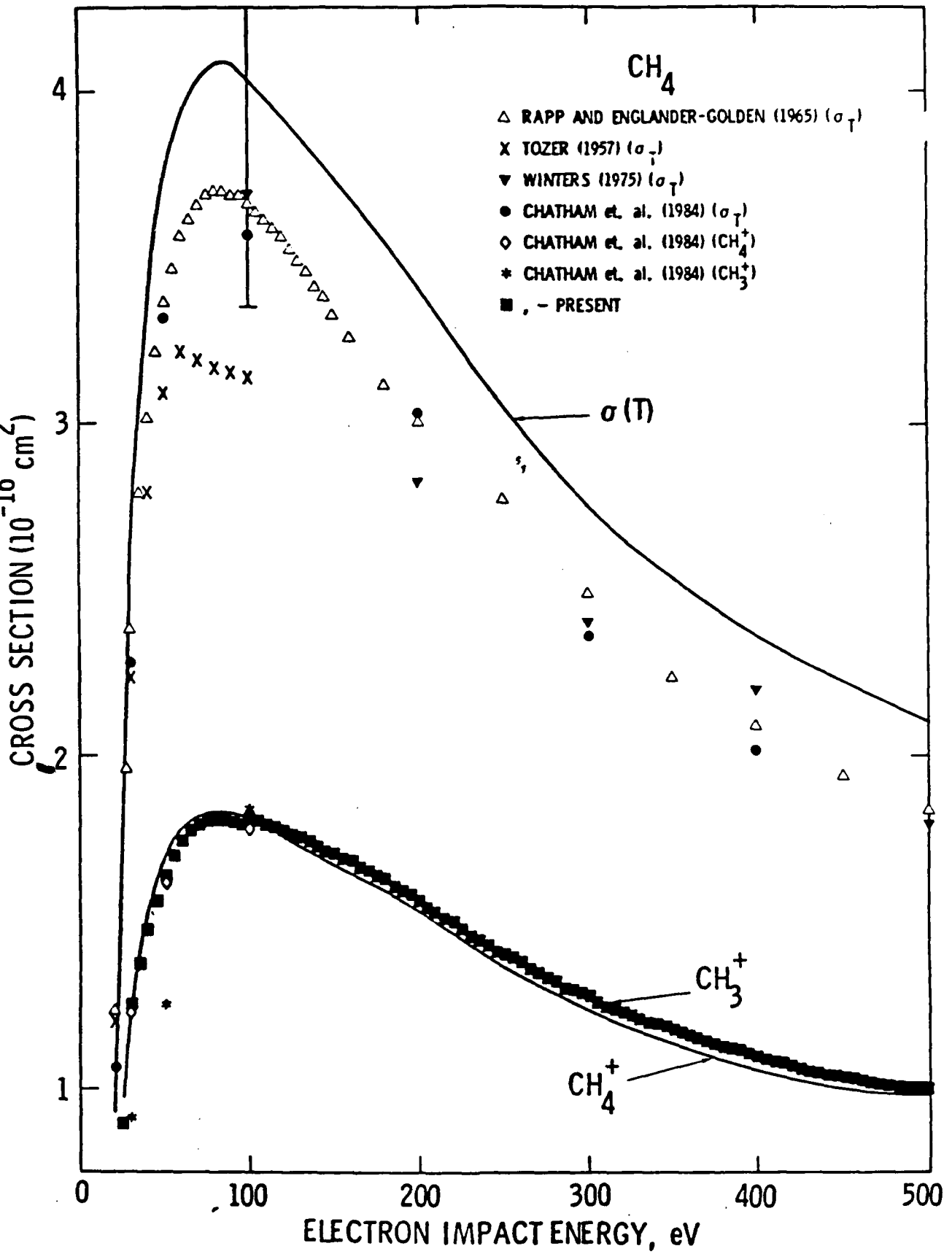

σ(OH+)
σ(H+)
H2O (FRAGMENTS)
σ(O+)
CROSS SECTION (10-16 cm2)
1
0.5
0
0
100
200
300
400
ELECTRON IMPACT ENERGY, (eV)

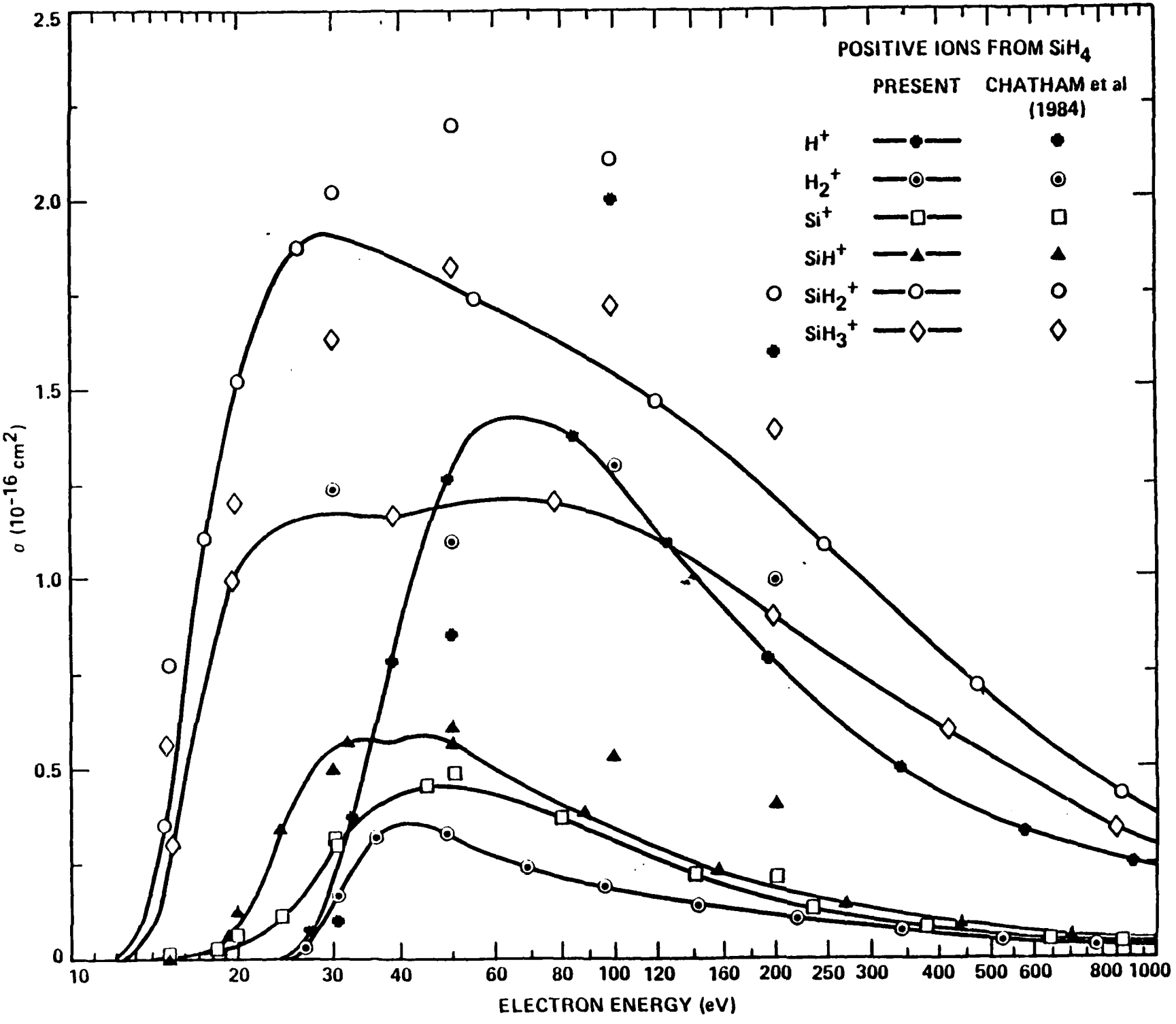

CO
DEFRANCE CO^+ (1966)
VAUGHAN CO^+ (1931)
VAUGHAN C^+ (1931)
RAPP AND ENGLANDER-GOLDEN (1965)
RAPP $\sigma(T) - \sigma(E > 0.25\ eV)$
HILLE AND MARK CO^+ (1978)
PRESENT
$\sigma(T)$
$\sigma(CO^+)$
$\sigma(C^+)$
$\sigma(O^+)$
CROSS SECTION (10^{-16} cm^2)
ELECTRON IMPACT ENERGY, eV
3.0
2.5
2.0
1.5
1.0
0.5
0
0
100
200
300
400
500
600
700

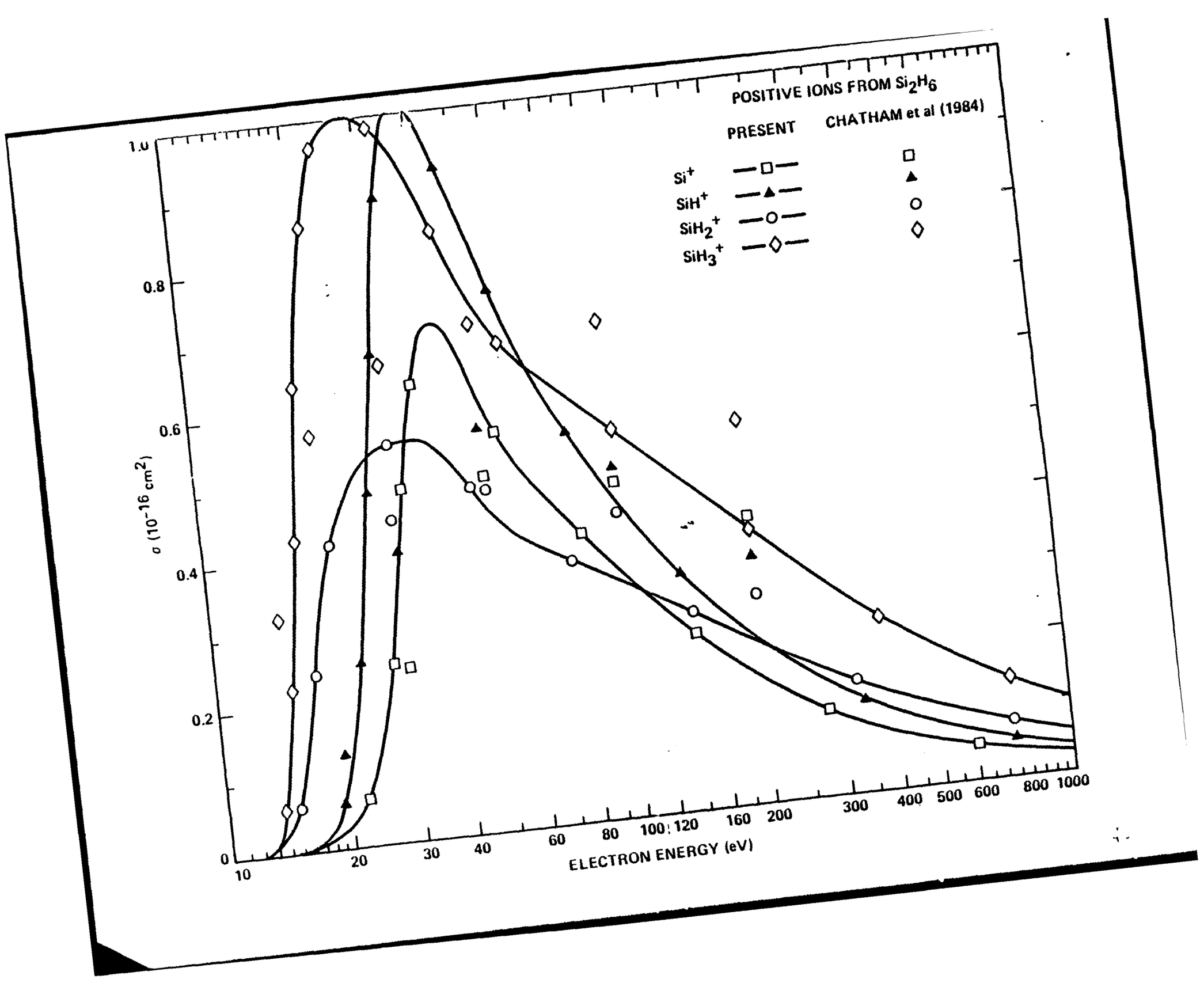

CO_2
— PRESENT (σ_T AND CO_2^+)
◇ RAPP AND ENGLANDER-GOLDEN (σ_T) (1965)
■ CROWE AND McCONKEY (1974) (CO_2^+) (NORMALIZED TO RAPP, et. al.)
○ MARK (1978) (CO_2^+)
▲ ADAMZYK et. al. (1972) (CO_2^+)
● PERESSE AND TUFFIN (1967) (σ_T)
▽ PERESSE AND TUFFIN (1967) (CO_2^+)
$\sigma(T)$
$\sigma(CO_2^+)$
$\sigma(CO_2^+)$
CROSS SECTION (10^{-16} cm^2)
0
1
2
3
4
0
100
200
300
400
500
600
ELECTRON IMPACT ENERGY, eV

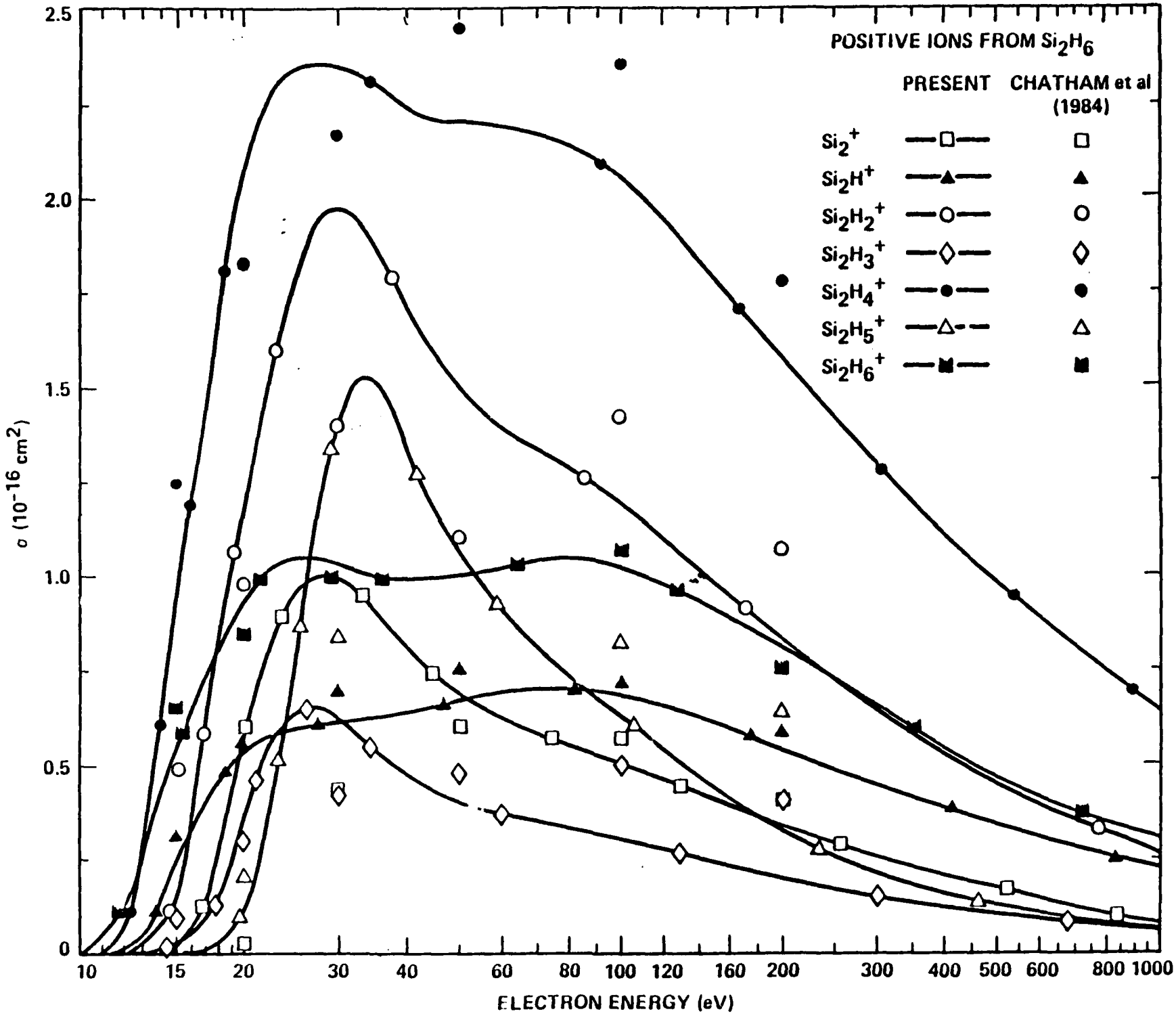

CO_2
(DISSOCIATION FRAGMENTS)
PRESENT
CROWE AND McCONKEY (1974)
PERESSE AND TUFFIN (1967)
O^+
CO^+
O^+
C^+
O^+
CO^+
CO^+
C^+
DISSOCIATIVE CROSS SECTION (10^{-17} cm^2)
ELECTRON IMPACT ENERGY, eV
1
2
3
4
5
100
200
300
400
500
600
700

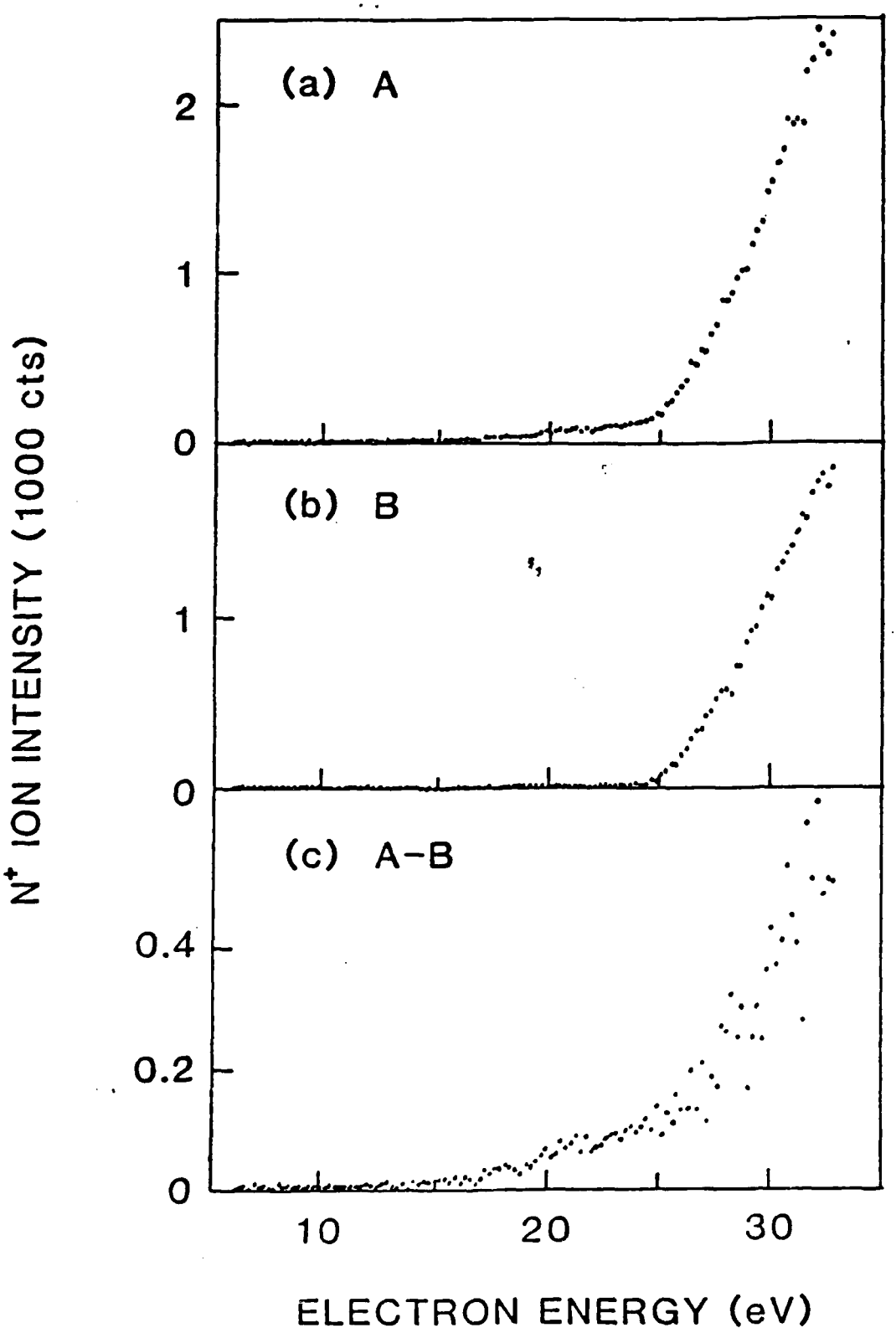

CH_4 (FRAGMENTS)
● CHATHAM et. al. (1984) (CH_2^+)
△ CHATHAM et. al. (1984) (CH^+)
◇ CHATHAM et. al. (1984) (C^+)
— PRESENT
$\sigma(CH_2^+)$
$\sigma(CH^+)$
$\sigma(C^+)$
CROSS SECTION (10^{-17} cm^2)
ELECTRON IMPACT ENERGY, eV
0
0.5
1.0
1.5
2.0
2.5
0
100
200
300
400
500
600

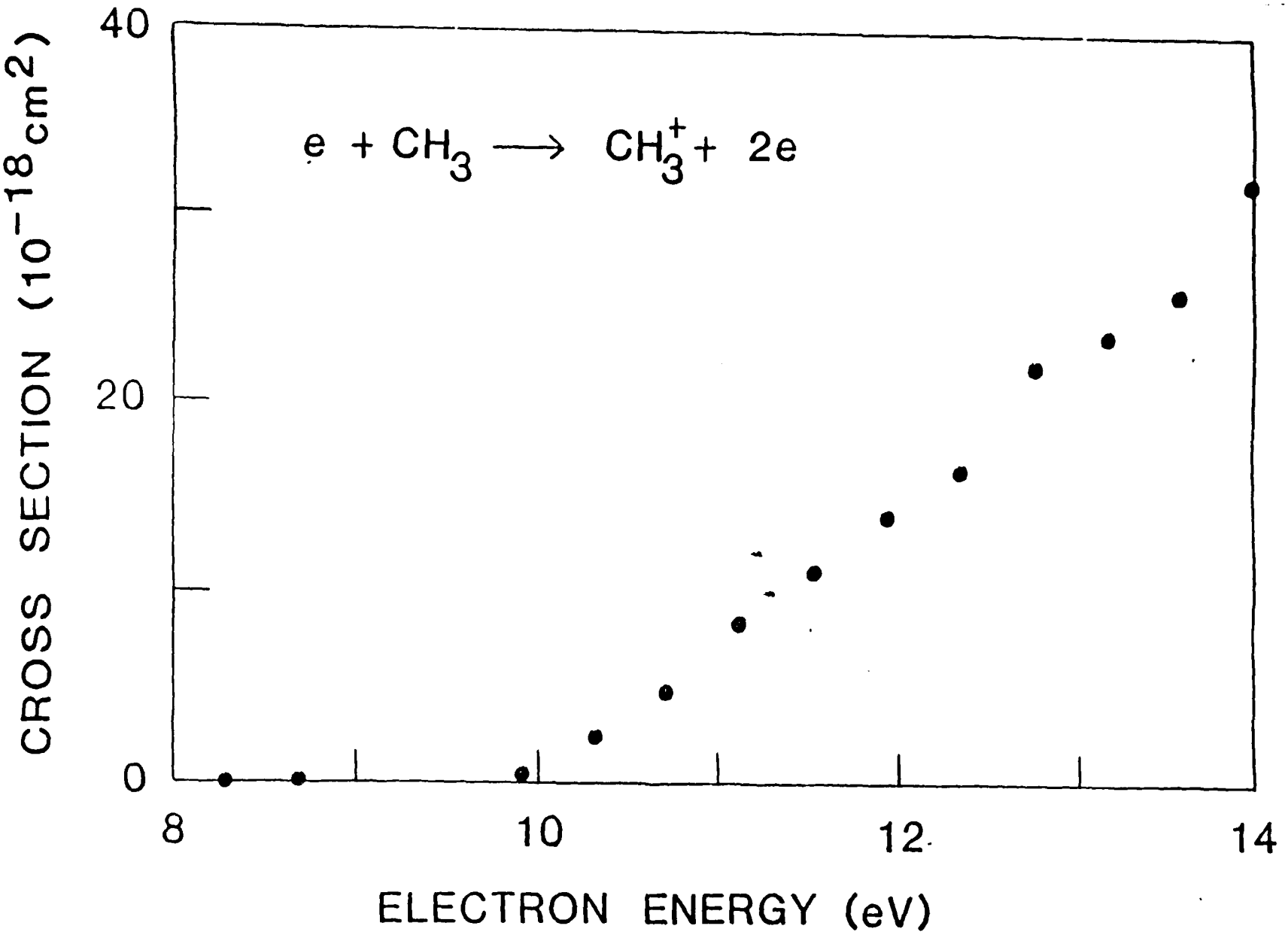

CH4
△ RAPP AND ENGLANDER-GOLDEN (1965) (σT)
X TOZER (1957) (σT)
▼ WINTERS (1975) (σT)
● CHATHAM et. al. (1984) (σT)
◇ CHATHAM et. al. (1984) (CH4+)
* CHATHAM et. al. (1984) (CH3+)
■ , – PRESENT
σ (T)
CH3+
CH4+
CROSS SECTION (10-16 cm2)
ELECTRON IMPACT ENERGY, eV
0
100
200
300
400
500
1
2
3
4


POSITIVE IONS FROM SiH_4
PRESENT
CHATHAM et al (1984)
H^+
H_2^+
Si^+
SiH^+
SiH_2^+
SiH_3^+
σ (10^{-16} cm^2)
2.5
2.0
1.5
1.0
0.5
0
10
20
30
40
60
80
100
120
160
200
250
300
400
500
600
800
1000
ELECTRON ENERGY (eV)


POSITIVE IONS FROM Si_2H_6
PRESENT
CHATHAM et al (1984)
Si^+
SiH^+
SiH_2^+
SiH_3^+
σ (10^{-16} cm^2)
1.0
0.8
0.6
0.4
0.2
0
10
20
30
40
60
80
100
120
160
200
300
400
500
600
800
1000
ELECTRON ENERGY (eV)


POSITIVE IONS FROM Si_2H_6
PRESENT
CHATHAM et al (1984)
Si_2^+
Si_2H^+
$Si_2H_2^+$
$Si_2H_3^+$
$Si_2H_4^+$
$Si_2H_5^+$
$Si_2H_6^+$
σ (10^{-16} cm^2)
2.5
2.0
1.5
1.0
0.5
0
10
15
20
30
40
60
80
100
120
160
200
300
400
500
600
800
1000
ELECTRON ENERGY (eV)


(a) A
(b) B
(c) A−B
2
1
0
1
0
0.4
0.2
0
10
20
30
N+ ION INTENSITY (1000 cts)
ELECTRON ENERGY (eV)


40
20
0
8
10
12
14
CROSS SECTION (10^{-18}cm^2)
ELECTRON ENERGY (eV)
e + CH_3 ⟶ CH_3^+ + 2e