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DATA ON COLLISIONS OF HYDROGEN ATOMS AND IONS WITH ATOMS AND MOLECULES (I)

(CROSS SECTIONS FOR CHARGE TRANSFER OF H, H^+ AND H^- WITH H_2, N_2, O_2, H_2O, C AND CARBON CONTAINING MOLECULES)

February 1983

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Data on Collisions of Hydrogen Atoms and Ions with Atoms and Molecules (I)

(Cross Sections for Charge Transfer of H, H^+ and H^- with H_2, N_2, O_2, H_2O, C and Carbon Containing Molecules)

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(Received January 24, 1983)

This report presents a compilation of the experimental data on cross sections for charge transfer of H, H^+ and H^- with H_2, N_2, O_2, H_2O, C and carbon containing molecules.

A survey has been made systematically of the literature up to the middle of 1982. The cross sections are given as a function of projectile energy in graphs and tables; a list of references is also attached.

Keywords: Charge Transfer, Hydrogen Ion, Hydrogen Atom, Impurity, Atomic Data, Atomic Collision

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水素原子・イオンと原子分子の衝突に関するデータ集(I)
(H，H^+およびH^-とH_2，N_2，O_2，H_2O，Cおよび含炭素分子の電荷移動断面積)

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(1983年1月24日受理)

この報告書は，H，H^+およびH^-とH_2，N_2，O_2，H_2O，Cおよび含炭素分子の電荷移動断面積の実験データを収集したものである。すなわち，上述の過程の1982年中頃までに発表された文献を調べた結果のものであり，断面積の値を入射粒子のエネルギーの関数としてグラフおよび数値表の形にまとめ，さらにこれに文献リストを加えている。

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1. Introduction

Collisions of hydrogen ions and atoms with various gases such as H_2, N_2, O_2, H_2O and carbon containing molecules have been the subject of many investigations. A knowledge of corresponding charge transfer cross section is essential, as many cases these gases take the form of impurities which disturb the phenomena to be investigated. Especially, for controlled thermonuclear fusion research, in the confinement region the containment time for plasmas is affected in part by charge transfer collisions with background gas. Similarly, in the outermost layers of confined plasma, in front of a material wall, a relatively cool "plasma blanket" is encountered, in which atomic processes such as charge transfer of hydrogen with impurity atoms and molecules are particularly important for plasma diagnostics and particle recycling.

Also in tokamak type fusion devices one of the most promising methods of supplementary heating is by the injection of fast neutral beams of an appropriate isotope of hydrogen. These neutral beams are generally obtained by electron capture or stripping of accelerated positive or negative ions in gas cell. The interaction of the ion beam accelerated to the energies ranging from $\sim$10 keV to $\sim$1 MeV with the impurity gases, could bring about charge transfer, detachment and dissociation, so that part of the beam interacts with surrounding surface, creating the attendant surface effects such as sputtering and outgassing, thereby introducing additional impurities.

Thus, it is imperative to know the charge transfer cross sections when H^+, H^- and H beams collide with impurity gases.

There are several data compilations on these charge transfer cross sections for hydrogen ions and atoms[1)-4)] but some of them have no

numerical data as tabular form and besides some of them are not handy to use for specific purposes.

In this report, we compile in graphical and tabular forms the experimental cross sections on charge transfer of hydrogen ions and atoms in conventional impurity or background gases, such as H_2, N_2, O_2, CO, CO_2, H_2O, CH_4, C_2H_4, C_2H_6, C_3H_8, C_4H_{10} and additionally C atoms (up to the middle of 1982). These numerical data are stored in the Atomic and Molecular Data Strage and Retrieval System (AMSTOR) of JAERI.

For the convenience of readers, detailed discussions on the charge transfer processes and experimental methods for cross section measurements are presented at Appendix.

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2. Data on Charge Transfer Cross Sections

2.1 Table of Compiled Processes

Table I Compiled Processes

Type of Cross Sections	Processes	
σ_{10}	(1) $H^+ + H_2 \rightarrow H$	(7) $H^+ + CH_4 \rightarrow H$
	(2) $H^+ + N_2 \rightarrow H$	(8) $H^+ + C_2H_4 \rightarrow H$
	(3) $H^+ + O_2 \rightarrow H$	(9) $H^+ + C_2H_6 \rightarrow H$
	(4) $H^+ + H_2O \rightarrow H$	(10) $H^+ + C_4H_{10} \rightarrow H$
	(5) $H^+ + CO \rightarrow H$	(11) $H^+ + C \rightarrow H$
	(6) $H^+ + CO_2 \rightarrow H$	
σ_{0-1}	(12) $H + H_2 \rightarrow H^-$	(14) $H + O_2 \rightarrow H^-$
	(13) $H + N_2 \rightarrow H^-$	(15) $H + CO \rightarrow H^-$
σ_{1-1}	(16) $H^+ + H_2 \rightarrow H^-$	(18) $H^+ + O_2 \rightarrow H^-$
	(17) $H^+ + N_2 \rightarrow H^-$	(19) $H^+ + H_2O \rightarrow H^-$
σ_{01}	(20) $H + H_2 \rightarrow H^+$	(26) $H + CH_4 \rightarrow H^+$
	(21) $H + N_2 \rightarrow H^+$	(27) $H + C_2H_4 \rightarrow H^+$
	(22) $H + O_2 \rightarrow H^+$	(28) $H + C_2H_6 \rightarrow H^+$
	(23) $H + H_2O \rightarrow H^+$	(29) $H + C_4H_{10} \rightarrow H^+$
	(24) $H + CO \rightarrow H^+$	(30) $H + C \rightarrow H^+$
	(25) $H + CO_2 \rightarrow H^+$	
σ_{-10}	(31) $H^- + H_2 \rightarrow H$	(35) $H^- + CO \rightarrow H$
	(32) $H^- + N_2 \rightarrow H$	(36) $H^- + CO_2 \rightarrow H$
	(33) $H^- + O_2 \rightarrow H$	(37) $H^- + C_3H_8 \rightarrow H$
	(34) $H^- + H_2O \rightarrow H$	
σ_{-11}	(38) $H^- + H_2 \rightarrow H^+$	(41) $H^- + H_2O \rightarrow H^+$
	(39) $H^- + N_2 \rightarrow H^+$	(42) $H^- + CO_2 \rightarrow H^+$
	(40) $H^- + O_2 \rightarrow H^+$	(43) $H^- + C_3H_8 \rightarrow H^+$

Note: Numbers indicated in processes correspond to the numbers of figures and tables of cross section data

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2.3 Lists of Measurements of σ_{10}, σ_{0-1}, σ_{1-1}, σ_{01}, σ_{-10} and σ_{-11}

Note on Table

Cross Section　Per target atom or molecule

σ_-,σ_+: Cross sections for slow-electron, slow-ion production

Method [See 3.2 Experimental Method]

A : Attenuation method

C : Condenser method

E : Equilibrium method

G : Growth method

MS : Mass spectrometric method

F/T

F : Data from figures read by using program READXY*,**

T : Data from tables

* READXY was prepared by T. Nakagawa, Nuclear Data Center

** Numerical values are read from figures of references by us under our responsibility

Table II A List of Measurements of σ_{10}

Authors	Year	Energy Range(eV)		Target	Method	F/T	Ref.
Ribe	1951	3.4 +4	1.49+5	H_2	A	T	44
Fogel' et al.	1955	1.23+4	3.67+4	H_2	C	T	19
Stedeford & Hasted	1955	2.3 +2	3.2 +4	H_2	C	F	54
Gilbody & Hasted	1956	1.0 +2	3.8 +4	N_2,CO	C	F	26
Stier & Barnett	1956	4.0 +3	2.0 +5	H_2,N_2,O_2	G+E	F	55
Barnett & Reynolds	1958	1.0 +4	1.0 +6	H_2,N_2	G+E	F	7
Curran et al.	1959	2.13+3	5.69+4	H_2	C	F	12
Gustafsson & Lindholm	1960	2.5 +1	9.0 +2	N_2,CO	MS	T	28
Schwirzke	1960	9.3 +3	6.00+4	H_2	A	F	49
Cramer	1961	5.0 +1	4.0 +2	H_2	C	T	11
Abbe & Adloff	1964	5.0 +2	2.0 +3	H_2,N_2	C	T	1
Gordeev & Panov	1964	1.0 +3	4.00+4	H_2	C	F	27
Stebbings et al.	1964	5.20+1	1.00+4	O_2	C	F	53
Chambers	1965	1.0 +3	5.5 +4	H_2,CO,H_2O,CH_4	G	F	9
Hollricher	1965	1.53+3	3.00+4	H_2	C	F	30
de Heer et al.	1966	1.00+4	1.40+5	H_2,N_2,O_2,He,Ne, Ar,Kr	C	T	15
Desesquelles et al.	1966	2.50+4	7.00+4	H_2,N_2,O_2,CO,CO_2	C	F	16
Williams & Dunbar	1966	2.0 +3	5.0 +4	H_2,He,Ne,Ar,Kr, Xe	G	F	62
Schryber	1967	1.04+6	4.37+6	H_2,N_2,O_2	G	T	48
Welsh et al.	1967	4.4 +5	1.38+7	H_2,N_2,He,Ar	A	T	61
Toburen & Nakai	1968	1.0 +5	2.5 +6	H_2,N_2,O_2,CO,CO_2, H_2O,CH_4,C_2H_4, C_2H_6,C_4H_{10},C,He, Ar,Kr	G	T	56
Afrosimov et al.	1969	5.0 +3	5.0 +4	H_2	A,C	F	2
McNeal & Clark	1969	2.5 +3	2.00+4	N_2	C(σ_-,σ_+)	F	37
Williams	1969	4.4 +5	2.00+6	H_2	G	T	66
Berkner et al.	1970	1.5 +2	3.50+4	CO,H_2O,CH_4	C	T	8
Coplan & Ogilvie	1970	1.0 +2	5.0 +2	CO_2,H_2O	DC	T	10
Dagnac et al.	1970	1.44+3	5.25+4	H_2O	G+E	F	14
McNeal	1970	1.00+3	2.50+4	CO,CO_2,CH_4	C(σ_-,σ_+)	F	38
Baribaud et al.	1971	5.00+3		H_2O	C	T	6
Monnom et al.	1975	1.0 +2	2.6 +3	N_2	G	F	39
Varghese et al.	1980	1.5 +6	3.0 +6	C,CH_4,C_2H_4,C_2H_6	G	T	60

Table III A List of Measurements of σ_{0-1}

Authors	Year	Energy Range(eV)		Target	Method	F/T	Ref.
Stier & Barnett	1956	4.00+3	3.00+4	H_2,N_2,O_2	G+E	F	55
Allison	1958	4.0 +3	3.0 +4	N_2	A,E	T	4
Fogel' et al.	1958	5.00+3	4.00+4	H_2,N_2,O_2,He,Ne, Ar,Kr,Xe	MS	F	23
Curran & Donahue	1960	4.00+3	3.57+4	H_2	C	F	13
Donahue & Hushfar	1961	8.38+3	3.92+4	CO,Ar	C	F	18
Pilipenko & Fogel'	1962	4.94+3	4.79+4	N_2,O_2,CO	G	F	40
McClure	1964	2.00+3	9.00+4	H_2	G	F	36
Jorgensen et al.	1965	3.00+4	1.00+5	H_2	E	F	31
Pilipenko & Fogel'	1965	3.50+3	3.25+4	N_2,O_2,CO,NO	MS	F	41
Williams	1967	2.00+3	5.00+4	H_2,He,Ne,Ar,Kr, Xe	G	F	64
Schryber	1967	2.50+5	1.01+6	H_2,N_2,He,Ar	G	F	48
Afrosimov et al.	1972	5.00+3	5.00+4	H_2	A,C	F	3
Roussel et al.	1977	5.00+2	3.00+3	H_2,He,Ne,Ar,Kr, Xe	G	F	47
Van Zyl et al.	1978	5.00+1	3.00+3	N_2,O_2	C	F	58
Van Zyl et al.	1981	5.00+1	3.00+3	H_2	C	F	59

Table IV A List of Measurements of σ_{1-1}

Authors	Year	Energy Range(eV)		Target	Method	F/T	Ref.
Fogel' & Mitin	1956	9.50+3	2.90 +4	H_2,N_2,O_2,He,Ne, Ar	G	F	20
Allison	1958	9.00+3	3.00 +4	N_2	A,E	T	4
Fogel' et al.	1959	1.97+3	6.63 +4	H_2,N_2,He,Ne,Ar, Kr,Xe	G	F	24
McClure	1963	6.00+3	4.90 +4	H_2	G	F	35
Kozlov & Bondar'	1966	1.50+2	6.13 +3	H_2,He,Ne	G+C	F	33
Williams	1966	2.00+3	5.00 +4	H_2,He,Ne,Ar,Kr, Xe	G	F	63
Schryber	1967	2.53+5	1.025+6	H_2,N_2	G	T	48
Williams	1967	4.00+5	1.00 +6	H_2	G	F	66
Toburen & Nakai	1969	7.5 +4	2.50 +5	H_2,N_2,H_2O,He,Ar, Kr	G	T	57

Table V A List of Measurements of σ_{01}

Authors	Year	Energy Range(eV)		Target	Method	F/T	Ref.
Stier & Barnett	1956	3.00 +3	2.00+5	H_2,N_2,O_2	G+E	F	55
Barnett & Reynolds	1958	1.00 +4	1.00+6	H_2, N_2	G+E	F	7
Fogel' et al.	1958	5.00 +3	4.00+4	H_2,N_2,O_2,He,Ne, Ar,Kr,Xe	G	F	23
Curran & Donahue	1960	4.00 +3	3.60+4	H_2	C+A	F	13
Donahue & Hushfar	1961	6.22 +3	3.90+4	CO,Ar	C+A	F	18
Pilipenko & Fogel'	1962	4.70 +3	4.78+4	H_2,N_2,O_2,CO	G	F	40
McClure	1964	2.0 +3	1.30+5	H_2	G	F	36
Pilipenko & Fogel'	1965	5.00 +3	3.50+4	O_2,CO	MS	F	41
Dimov & Dudnikov	1967	9.00 +5	1.3 +6	H_2,N_2,CO_2,He	G	T	17
Welsh et al.	1967	1.027+6	2.44+6	H_2,N_2,He,Ar	A	T	61
Williams	1967	2.00 +3	5.00+4	H_2,He,Ne,Ar,Kr, Xe	G	F	64
Toburen & Nakai	1968	1.00 +5	2.50+6	H_2,N_2,O_2,CO,CO_2, CH_4,C_2H_4,C_2H_6, C_4H_{10},C,H_2O,He, Ar,Kr	G	T	56
McNeal & Clark	1969	1.20 +3	2.50+4	N_2	$C(\sigma_-,\sigma_+)$	F	37
Puckett et al.	1969	(1.5 +5	4.0 +5)	H_2	$C(\sigma_-,\sigma_+)$	F	43
Dagnac et al.	1970	1.44 +3	5.25+4	H_2O	G+E	F	14
McNeal	1970	1.00 +3	2.50+4	CO,CO_2,CH_4	$C(\sigma_-,\sigma_+)$	F	38
Baribaud et al.	1971	5.00 +3		H_2O	C		6
Monnom et al.	1975	5.00 +2	3.00+3	N_2	G+E	F	39
Smith et al.	1976	2.50 +2	5.00+3	H_2,N_2,O_2,CO,CO_2, CH_4,He	G	T	51
Roussel et al.	1977	5.00 +2	3.00+3	H_2,He,Ne,Ar,Kr, Xe	G	F	47
Van Zyl et al.	1978	5.00 +1	3.00+3	N_2,O_2	C	F	58
Van Zyl et al.	1981	6.25 +1	3.00+3	H_2,He	C	F	59

Table VI A List of Measurements of σ_{-10}

Authors	Year	Energy Range(eV)		Target	Method	F/T	Ref.
Stier & Barnett	1956	4.0 +3	3.00+4	H_2,N_2,O_2	G	F	55
Rose et al.	1958	4.0 +5	1.4 +6	H_2,O_2,Ar	G	T	46
Smythe & Toevs	1965	4.2 +6	1.79+7	H_2,N_2,O_2,He,Ar	G+E	T	52
Pilipenko et al.	1966	3.00+3	3.00+4	O_2,CO,NO	C	F	42
Dimov & Dudnikov	1967	9.00+5	1.3 +6	H_2,N_2,CO_2,C_3H_8, He	G	T	17
Kovács	1967	2.00+5	5.00+5	N_2,CO_2	G	T	32
Williams	1967	2.00+3	5.00+4	H_2,He,Ne,Ar,Kr, Xe	G	F	65
Bailey & Mahadevan	1970	7.39+0	3.48+2	O_2	C	F	5
Baribaud et al.	1971	5.00+3		H_2O	C		6
Simpson & Gilbody	1972	3.00+3	3.00+4	H_2,He,Ar	A	F	50
Risley & Geballe	1974	2.00+2	1.00+4	H_2,N_2,O_2,He,Ar	A	F	45
Heinemeier et al.	1976	5.0 +4	5.00+5	H_2,N_2,He,Ar	G	T	29
Geddes et al.	1980	1.00+3	3.00+5	H_2	G	T	25

Table VII A List of Measurements of σ_{-11}

Authors	Year	Energy Range(eV)		Target	Method	F/T	Ref.
Fogel' et al.	1957	4.00+3	3.95+4	H_2,N_2,O_2,He,Ne, Ar,Kr,Xe	G	F	21
Fogel'	1957	1.03+4	3.18+4	H_2	MS	T	22
Smythe & Toevs	1965	4.2 +6	1.79+7	H_2,N_2,O_2,He,Ar	G+E	T	52
Dimov & Dudnikov	1967	9.0 +5	1.3 +6	H_2,N_2,CO_2,C_3H_8, He	G	T	17
Kovács	1967	2.00+5	5.00+5	N_2,CO_2	G	T	32
Williams	1967	2.00+3	5.00+4	H_2,He,Ne,Ar	G	F	65
Baribaud et al.	1971	5.00+3		H_2O	C		6
Heinemeier et al.	1976	5.0 +4	5.00+5	H_2,N_2,He,Ar	G	T	29
Geddes et al.	1980	1.00+3	3.00+5	H_2	G	T	25
Lichtenberg et al.	1980	3.0 +4	2.3 +5	H_2,N_2,O_2,He,Ar	G	T	34

2.4 Graphs and Tables of Cross Sections

Note on Tables

E(EV)	Projectile Energy in eV
V(10(8)*CM/SEC)	Projectile Velocity in 10^8 cm/sec
SIGMA(CM(2))	Cross Section in cm^2

Fig. 1 $H^+ + H_2 \rightarrow H$ (σ_{10})

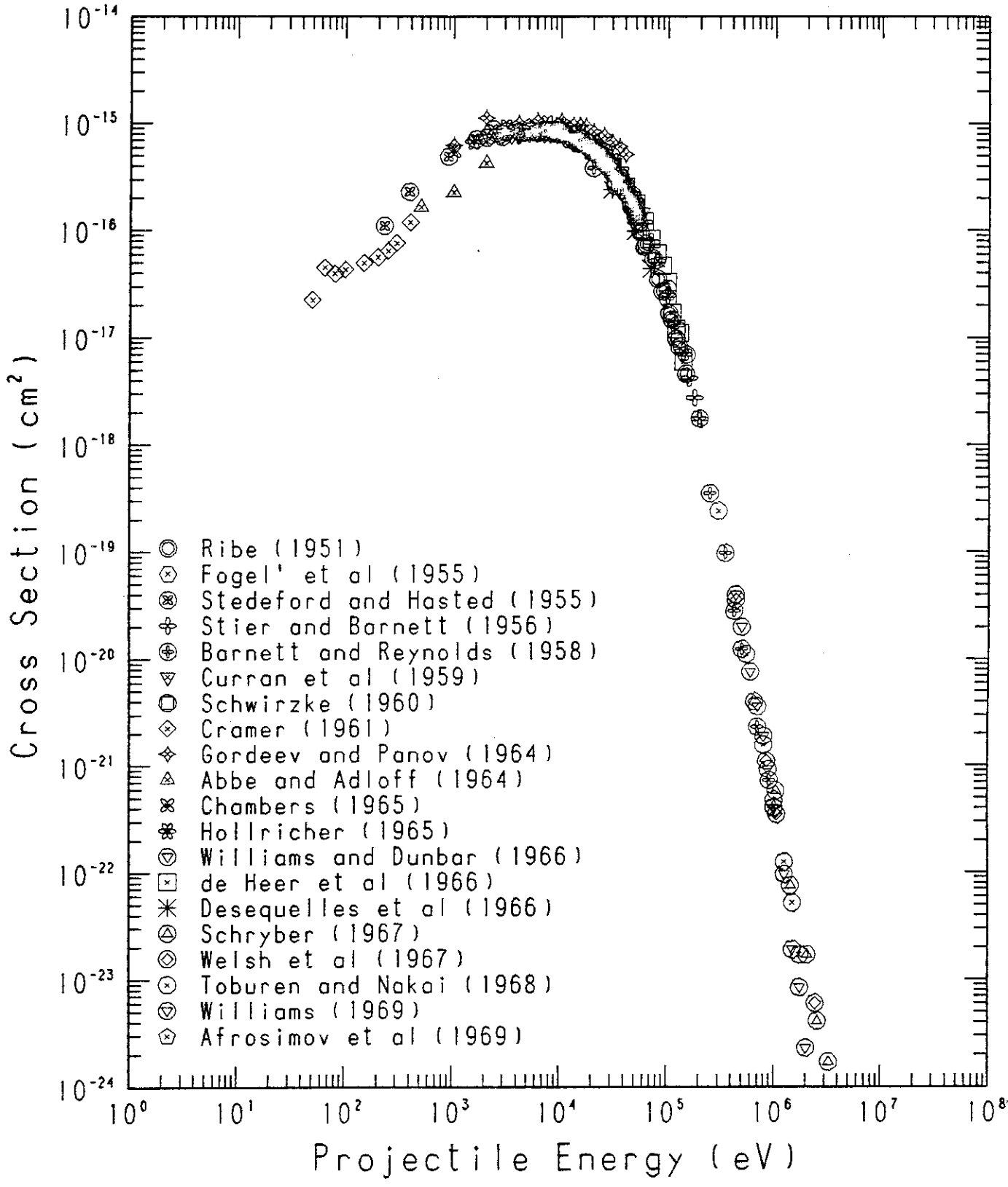

TABLE 1

PROCESS : H+ + H2 = H (10)
RIBE, PHYS. REV. 83 1217 (1951)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
3.40E+04	2.56E+00	3.04E-16
4.45E+04	2.93E+00	1.83E-16
4.83E+04	3.05E+00	1.53E-16
4.87E+04	3.07E+00	1.41E-16
5.39E+04	3.22E+00	1.15E-16
6.25E+04	3.47E+00	7.52E-17
7.29E+04	3.75E+00	5.50E-17
8.11E+04	3.96E+00	3.54E-17
8.88E+04	4.14E+00	2.72E-17
1.03E+05	4.46E+00	1.68E-17
1.09E+05	4.59E+00	1.47E-17
1.20E+05	4.81E+00	9.70E-18
1.28E+05	4.97E+00	8.20E-18
1.49E+05	5.36E+00	4.58E-18

PROCESS : H+ + H2 = H (10)
FOGEL' ET AL, SOV. PHYS. JETP 1 415 (1955)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.23E+04	1.54E+00	8.10E-16
1.66E+04	1.79E+00	6.50E-16
2.08E+04	2.00E+00	5.20E-16
2.54E+04	2.21E+00	4.50E-16
2.97E+04	2.39E+00	3.60E-16
3.30E+04	2.52E+00	3.10E-16
3.67E+04	2.66E+00	2.60E-16

PROCESS : H+ + H2 = H (10)
STEDEFORD AND HASTED, PROC. ROY. SOC. A227 466 (1955)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.30E+02	2.11E-01	1.10E-16
3.90E+02	2.74E-01	2.30E-16
8.90E+02	4.14E-01	4.90E-16
1.60E+03	5.56E-01	7.10E-16
2.30E+03	6.66E-01	8.80E-16
2.70E+03	7.22E-01	7.90E-16
2.80E+03	7.35E-01	7.50E-16
4.40E+03	9.21E-01	8.10E-16
4.40E+03	9.21E-01	8.20E-16
6.20E+03	1.09E+00	8.40E-16
6.40E+03	1.11E+00	8.70E-16

TABLE 1 - CONTINUED

9.10E+03	1.33E+00	8.10E-16
9.20E+03	1.33E+00	8.00E-16
1.40E+04	1.64E+00	6.60E-16
1.40E+04	1.64E+00	6.50E-16
1.80E+04	1.86E+00	6.00E-16
1.90E+04	1.91E+00	5.60E-16
2.30E+04	2.11E+00	4.50E-16
2.30E+04	2.11E+00	5.10E-16
2.70E+04	2.28E+00	3.90E-16
2.80E+04	2.32E+00	4.20E-16
3.20E+04	2.48E+00	2.80E-16
3.20E+04	2.48E+00	2.60E-16

PROCESS : H+ + H2 = H (10)
STIER AND BARNETT, PHYS. REV. 103 896 (1956)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.00E+03	8.79E-01	7.69E-16
6.00E+03	1.08E+00	8.06E-16
8.00E+03	1.24E+00	8.45E-16
1.00E+04	1.39E+00	8.19E-16
1.20E+04	1.52E+00	7.94E-16
1.60E+04	1.76E+00	6.79E-16
2.00E+04	1.96E+00	5.89E-16
2.50E+04	2.20E+00	5.12E-16
3.00E+04	2.41E+00	4.31E-16
4.00E+04	2.78E+00	2.65E-16
5.00E+04	3.11E+00	1.76E-16
6.00E+04	3.40E+00	1.19E-16
7.00E+04	3.68E+00	7.81E-17
8.00E+04	3.93E+00	5.20E-17
1.00E+05	4.39E+00	2.49E-17
1.20E+05	4.81E+00	1.31E-17
1.40E+05	5.20E+00	7.46E-18
1.60E+05	5.56E+00	4.18E-18
1.80E+05	5.89E+00	2.74E-18
2.00E+05	6.21E+00	1.74E-18

PROCESS : H+ + H2 = H (10)
BARNETT AND REYNOLDS, PHYS. REV. 109 355 (1958)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.00E+04	1.96E+00	3.84E-16
5.00E+04	3.11E+00	1.78E-16
1.00E+05	4.39E+00	2.32E-17
1.50E+05	5.38E+00	6.92E-18
2.00E+05	6.21E+00	1.75E-18

TABLE 1 - CONTINUED

2.50E+05	6.95E+00	3.54E-19
3.50E+05	8.22E+00	9.72E-20
4.25E+05	9.06E+00	2.82E-20
5.00E+05	9.82E+00	1.24E-20
7.00E+05	1.16E+01	2.31E-21
9.00E+05	1.32E+01	7.27E-22
1.00E+06	1.39E+01	4.09E-22

PROCESS : H+ + H2 = H (10)
CURRAN ET AL, PHYS. REV. 114 490 (1959)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.13E+03	6.41E-01	7.24E-16
2.72E+03	7.24E-01	7.48E-16
3.38E+03	8.08E-01	7.70E-16
4.04E+03	8.83E-01	7.88E-16
5.00E+03	9.82E-01	7.96E-16
5.78E+03	1.06E+00	8.10E-16
6.89E+03	1.15E+00	7.93E-16
7.79E+03	1.23E+00	7.94E-16
8.96E+03	1.31E+00	7.86E-16
1.03E+04	1.41E+00	7.62E-16
1.13E+04	1.48E+00	7.44E-16
1.26E+04	1.56E+00	7.10E-16
1.35E+04	1.61E+00	6.84E-16
1.67E+04	1.80E+00	6.19E-16
1.97E+04	1.95E+00	5.46E-16
2.32E+04	2.12E+00	4.78E-16
2.66E+04	2.27E+00	4.18E-16
3.04E+04	2.42E+00	3.62E-16
3.47E+04	2.59E+00	3.16E-16
3.87E+04	2.73E+00	2.78E-16
4.26E+04	2.87E+00	2.36E-16
4.69E+04	3.01E+00	2.09E-16
5.13E+04	3.15E+00	1.71E-16
5.69E+04	3.31E+00	1.47E-16

PROCESS : H+ + H2 = H (10)
SCHWIRZKE, Z. PHYSIK 157 510 (1960)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
9.30E+03	1.34E+00	9.15E-16
1.00E+04	1.39E+00	8.32E-16
1.50E+04	1.70E+00	6.76E-16
2.00E+04	1.96E+00	5.43E-16
2.50E+04	2.20E+00	4.23E-16
3.00E+04	2.41E+00	3.40E-16

TABLE 1 - CONTINUED

3.50E+04	2.60E+00	2.73E-16
4.00E+04	2.78E+00	2.22E-16
4.50E+04	2.95E+00	1.67E-16
5.00E+04	3.11E+00	1.34E-16
5.50E+04	3.26E+00	9.71E-17
6.00E+04	3.40E+00	7.02E-17

PROCESS : H+ + H2 = H (10)
CRAMER, J. CHEM. PHYS. 35 836 (1961)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+01	9.82E-02	2.26E-17
6.50E+01	1.12E-01	4.52E-17
8.00E+01	1.24E-01	3.96E-17
1.00E+02	1.39E-01	4.33E-17
1.50E+02	1.70E-01	4.98E-17
2.00E+02	1.96E-01	5.63E-17
2.50E+02	2.20E-01	6.48E-17
3.00E+02	2.41E-01	7.61E-17
4.00E+02	2.78E-01	1.18E-16

PROCESS : H+ + H2 = H (10)
GORDEEV AND PANOV, SOV. PHYS. TECH. PHYS. 9 656 (1964)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+03	4.39E-01	6.24E-16
2.00E+03	6.21E-01	1.12E-15
4.00E+03	8.79E-01	1.00E-15
6.00E+03	1.08E+00	1.05E-15
1.00E+04	1.39E+00	1.05E-15
1.30E+04	1.58E+00	9.66E-16
1.50E+04	1.70E+00	9.57E-16
1.70E+04	1.81E+00	9.41E-16
2.00E+04	1.96E+00	8.40E-16
2.50E+04	2.20E+00	7.73E-16
3.00E+04	2.41E+00	6.63E-16
3.50E+04	2.60E+00	6.11E-16
4.00E+04	2.78E+00	5.16E-16

PROCESS : H+ + H2 = H (10)
ABBE AND ADLOFF, BULL. SOC. CHIM. FRAN. 6 1212 (1964)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+02	3.11E-01	1.65E-16
1.00E+03	4.39E-01	2.27E-16
2.00E+03	6.21E-01	4.28E-16

TABLE 1 - CONTINUED

PROCESS : H+ + H2 = H (10)
CHAMBERS, UCRL-14214 (1965)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+03	4.39E-01	5.50E-16
2.00E+03	6.21E-01	7.37E-16
2.80E+03	7.35E-01	7.81E-16
3.50E+03	8.22E-01	7.97E-16
4.90E+03	9.72E-01	7.92E-16
5.80E+03	1.06E+00	8.27E-16
7.70E+03	1.22E+00	8.02E-16
8.60E+03	1.29E+00	7.89E-16
1.00E+04	1.39E+00	7.80E-16
1.47E+04	1.68E+00	6.24E-16
1.50E+04	1.70E+00	6.32E-16
2.00E+04	1.96E+00	5.23E-16
2.50E+04	2.20E+00	4.45E-16
3.00E+04	2.41E+00	3.68E-16
3.50E+04	2.60E+00	2.84E-16
4.00E+04	2.78E+00	2.26E-16
4.50E+04	2.95E+00	1.88E-16
5.00E+04	3.11E+00	1.43E-16
5.50E+04	3.26E+00	1.26E-16

PROCESS : H+ + H2 = H (10)
HOLLRICHER, Z. PHYS. 187 41 (1965)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.53E+03	5.43E-01	6.74E-16
3.05E+03	7.67E-01	9.14E-16
7.36E+03	1.19E+00	1.00E-15
9.74E+03	1.37E+00	9.69E-16
1.50E+04	1.70E+00	8.20E-16
2.00E+04	1.96E+00	6.83E-16
2.50E+04	2.20E+00	5.45E-16
3.00E+04	2.41E+00	4.45E-16

PROCESS : H+ + H2 = H (10)
WILLIAMS AND DUNBAR, PHYS. REV. 149 62 (1966)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.00E+03	6.21E-01	7.34E-16
3.00E+03	7.61E-01	8.40E-16
4.00E+03	8.79E-01	8.37E-16
5.00E+03	9.82E-01	8.44E-16
6.00E+03	1.08E+00	8.17E-16

TABLE 1 - CONTINUED

7.00E+03	1.16E+00	8.49E-16
8.00E+03	1.24E+00	8.56E-16
9.00E+03	1.32E+00	8.55E-16
1.00E+04	1.39E+00	8.21E-16
1.20E+04	1.52E+00	7.06E-16
1.50E+04	1.70E+00	6.84E-16
1.80E+04	1.86E+00	5.88E-16
2.00E+04	1.96E+00	5.76E-16
2.60E+04	2.24E+00	4.62E-16
3.00E+04	2.41E+00	3.82E-16
3.60E+04	2.64E+00	3.09E-16
4.00E+04	2.78E+00	2.64E-16
4.60E+04	2.98E+00	2.14E-16
5.00E+04	3.11E+00	1.70E-16

PROCESS : H+ + H2 = H (10)
DE HEER ET AL, PHYSICA 32 1766 (1966)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+04	1.39E+00	8.03E-16
1.50E+04	1.70E+00	6.72E-16
2.00E+04	1.96E+00	5.60E-16
2.50E+04	2.20E+00	4.78E-16
3.00E+04	2.41E+00	3.97E-16
3.50E+04	2.60E+00	3.25E-16
4.00E+04	2.78E+00	2.55E-16
5.00E+04	3.11E+00	1.78E-16
6.00E+04	3.40E+00	1.21E-16
7.00E+04	3.68E+00	8.30E-17
8.00E+04	3.93E+00	6.10E-17
9.00E+04	4.17E+00	4.70E-17
1.00E+05	4.39E+00	3.30E-17
1.10E+05	4.61E+00	1.70E-17
1.20E+05	4.81E+00	1.20E-17
1.30E+05	5.01E+00	1.10E-17
1.40E+05	5.20E+00	6.00E-18

PROCESS : H+ + H2 = H (10)
DESEQUELLES ET AL, COMPT. REND. B262 1329 (1966)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
3.00E+04	2.41E+00	2.40E-16
5.00E+04	3.11E+00	9.79E-17
7.00E+04	3.68E+00	4.42E-17

TABLE 1 - CONTINUED

PROCESS : H+ + H2 = H (10)
SCHRYBER, HELV. PHYS. ACTA A40 1023 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.04E+06	1.42E+01	5.80E-22
1.43E+06	1.66E+01	7.50E-23
2.05E+06	1.99E+01	1.70E-23
2.56E+06	2.22E+01	4.10E-24
3.28E+06	2.52E+01	1.70E-24

PROCESS : H+ + H2 = H (10)
WELSH ET AL, PHYS. REV. 158 85 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.40E+05	9.21E+00	3.60E-20
6.54E+05	1.12E+01	4.00E-21
8.51E+05	1.28E+01	1.10E-21
1.06E+06	1.43E+01	3.50E-22
2.45E+06	2.17E+01	6.00E-24

PROCESS : H+ + H2 = H (10)
TOBUREN AND NAKAI, PHYS. REV. 171 114 (1968)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	2.86E-17
3.00E+05	7.61E+00	2.42E-19
5.50E+05	1.03E+01	1.11E-20
8.00E+05	1.24E+01	1.56E-21
1.00E+06	1.39E+01	4.74E-22
1.25E+06	1.55E+01	1.25E-22
1.50E+06	1.70E+01	5.18E-23
1.75E+06	1.84E+01	1.69E-23

PROCESS : H+ + H2 = H (10)
WILLIAMS, PHYS. REV. 179 240 (1969)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.40E+05	9.21E+00	4.00E-20
5.00E+05	9.82E+00	2.00E-20
6.00E+05	1.08E+01	7.60E-21
7.00E+05	1.16E+01	3.60E-21
8.00E+05	1.24E+01	1.90E-21
8.80E+05	1.30E+01	9.20E-22
1.00E+06	1.39E+01	4.00E-22

TABLE 1 - CONTINUED

1.25E+06	1.55E+01	9.60E-23
1.50E+06	1.70E+01	1.90E-23
1.75E+06	1.84E+01	8.40E-24
2.00E+06	1.96E+01	2.30E-24

PROCESS : H+ + H2 = H (10)
AFROSIMOV ET AL, SOV. PHYS. JETP 29 648 (1969)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+03	9.82E-01	9.24E-16
1.00E+04	1.39E+00	8.86E-16
1.50E+04	1.70E+00	7.61E-16
2.00E+04	1.96E+00	6.30E-16
2.50E+04	2.20E+00	5.15E-16
3.00E+04	2.41E+00	4.11E-16
3.50E+04	2.60E+00	3.38E-16
4.00E+04	2.78E+00	2.65E-16
4.50E+04	2.95E+00	2.13E-16
5.00E+04	3.11E+00	1.62E-16

Fig. 2 $H^+ + N_2 \rightarrow H \quad (\sigma_{10})$

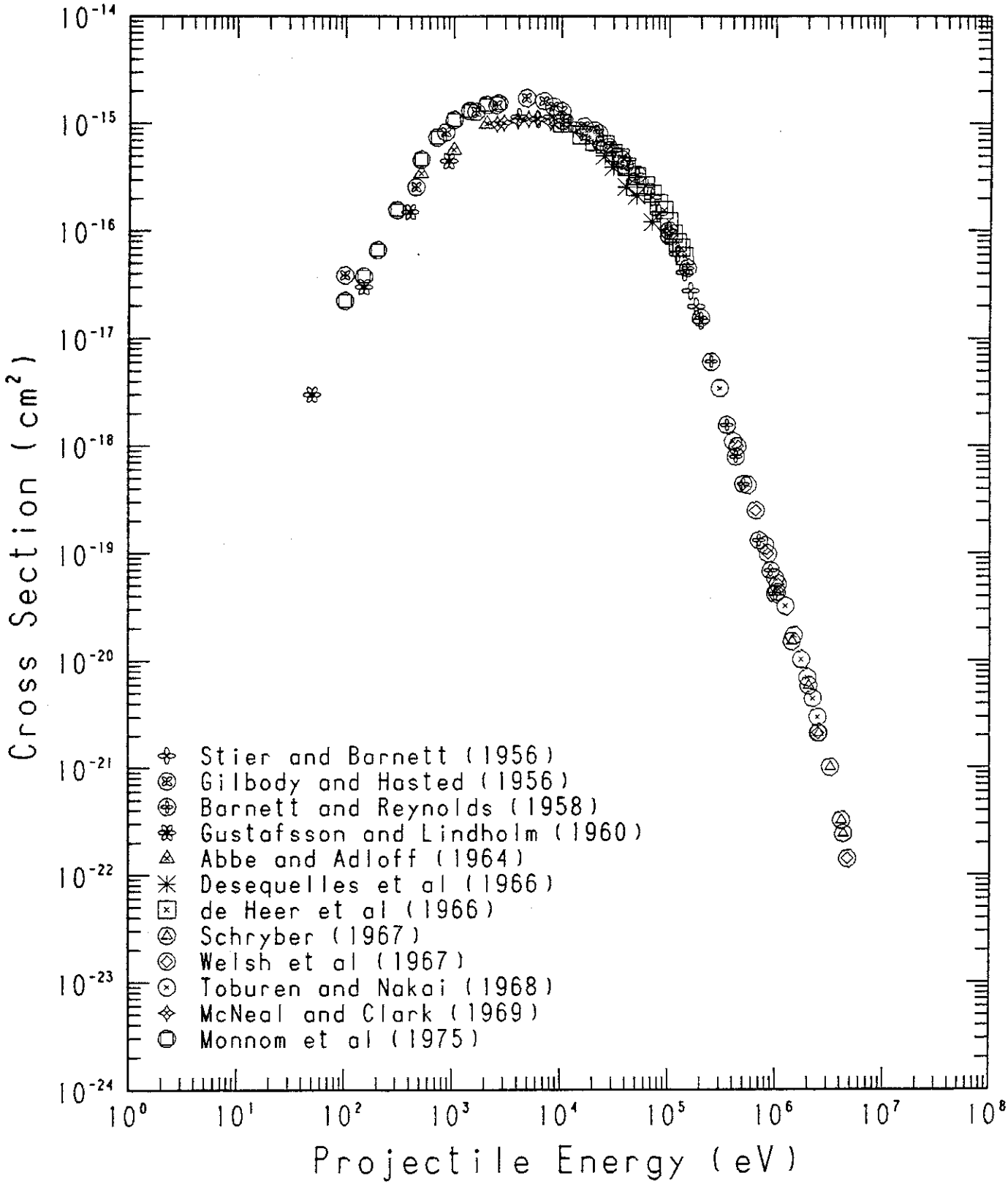

TABLE 2

PROCESS : H+ + N2 = H (10)
STIER AND BARNETT, PHYS. REV. 103 896 (1956)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.00E+03	8.79E-01	1.15E-15
6.00E+03	1.08E+00	1.10E-15
8.00E+03	1.24E+00	1.15E-15
1.00E+04	1.39E+00	1.06E-15
1.20E+04	1.52E+00	9.96E-16
1.60E+04	1.76E+00	8.50E-16
2.00E+04	1.96E+00	7.26E-16
2.50E+04	2.20E+00	6.50E-16
3.00E+04	2.41E+00	5.72E-16
4.00E+04	2.78E+00	4.37E-16
5.00E+04	3.11E+00	3.29E-16
6.00E+04	3.40E+00	2.64E-16
7.00E+04	3.68E+00	2.05E-16
8.00E+04	3.93E+00	1.45E-16
1.00E+05	4.39E+00	9.89E-17
1.20E+05	4.81E+00	6.06E-17
1.40E+05	5.20E+00	4.08E-17
1.60E+05	5.56E+00	2.75E-17
1.80E+05	5.89E+00	1.97E-17
2.00E+05	6.21E+00	1.44E-17

PROCESS : H+ + N2 = H (10)
GILBODY AND HASTED, PROC. ROY. SOC. A238 334 (1956)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+02	1.39E-01	3.86E-17
4.50E+02	2.95E-01	2.57E-16
8.40E+02	4.03E-01	8.33E-16
1.60E+03	5.56E-01	1.29E-15
2.50E+03	6.95E-01	1.48E-15
4.70E+03	9.52E-01	1.73E-15
6.80E+03	1.15E+00	1.62E-15
8.40E+03	1.27E+00	1.44E-15
1.00E+04	1.39E+00	1.31E-15
1.60E+04	1.76E+00	9.43E-16
2.00E+04	1.96E+00	8.59E-16
2.20E+04	2.06E+00	8.13E-16
2.70E+04	2.28E+00	6.06E-16
3.60E+04	2.64E+00	4.65E-16
3.80E+04	2.71E+00	4.12E-16

TABLE 2 - CONTINUED

PROCESS : H+ + N2 = H (10)
BARNETT AND REYNOLDS, PHYS. REV. 109 355 (1958)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+04	1.39E+00	1.07E-15
2.00E+04	1.96E+00	7.73E-16
5.00E+04	3.11E+00	3.37E-16
1.00E+05	4.39E+00	1.00E-16
1.50E+05	5.38E+00	4.47E-17
2.00E+05	6.21E+00	1.54E-17
2.50E+05	6.95E+00	6.05E-18
3.50E+05	8.22E+00	1.55E-18
4.25E+05	9.06E+00	7.84E-19
5.00E+05	9.82E+00	4.38E-19
7.00E+05	1.16E+01	1.31E-19
9.00E+05	1.32E+01	6.85E-20
1.00E+06	1.39E+01	4.14E-20

PROCESS : H+ + N2 = H (10)
GUSTAFSSON AND LINDHOLM, ARK. FYS. 18 219 (1960)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+01	9.82E-02	3.00E-18
1.50E+02	1.70E-01	3.00E-17
4.00E+02	2.78E-01	1.50E-16
9.00E+02	4.17E-01	4.50E-16

PROCESS : H+ + N2 = H (10)
ABBE AND ADLOFF, BULL. SOC. CHIM. FRAN. 6 1212 (1964)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+02	3.11E-01	3.46E-16
1.00E+03	4.39E-01	5.70E-16
2.00E+03	6.21E-01	1.00E-15

PROCESS : H+ + N2 = H (10)
DESEQUELLES ET AL, COMPT. REND. B262 1329 (1966)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.50E+04	2.20E+00	4.99E-16
3.00E+04	2.41E+00	3.93E-16
4.00E+04	2.78E+00	2.56E-16
5.00E+04	3.11E+00	2.12E-16
7.00E+04	3.68E+00	1.21E-16

TABLE 2 - CONTINUED

PROCESS : H+ + N2 = H (10)
DE HEER ET AL, PHYSICA 32 1766 (1966)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+04	1.39E+00	1.01E-15
1.50E+04	1.70E+00	7.84E-16
2.00E+04	1.96E+00	6.80E-16
2.50E+04	2.20E+00	6.37E-16
3.00E+04	2.41E+00	5.34E-16
3.50E+04	2.60E+00	4.83E-16
4.00E+04	2.78E+00	3.95E-16
5.00E+04	3.11E+00	3.23E-16
6.00E+04	3.40E+00	2.65E-16
7.00E+04	3.68E+00	2.22E-16
8.00E+04	3.93E+00	1.80E-16
9.00E+04	4.17E+00	1.55E-16
1.00E+05	4.39E+00	1.22E-16
1.10E+05	4.61E+00	9.40E-17
1.20E+05	4.81E+00	7.80E-17
1.30E+05	5.01E+00	6.90E-17
1.40E+05	5.20E+00	5.80E-17

PROCESS : H+ + N2 = H (10)
SCHRYBER, HELV. PHYS. ACTA A40 1023 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.04E+06	1.42E+01	4.30E-20
1.43E+06	1.66E+01	1.50E-20
2.05E+06	1.99E+01	5.80E-21
2.56E+06	2.22E+01	2.10E-21
3.28E+06	2.52E+01	1.00E-21
4.18E+06	2.84E+01	3.20E-22
4.37E+06	2.90E+01	2.40E-22

PROCESS : H+ + N2 = H (10)
WELSH ET AL, PHYS. REV. 158 85 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.40E+05	9.21E+00	9.80E-19
6.54E+05	1.12E+01	2.50E-19
8.51E+05	1.28E+01	9.80E-20
1.06E+06	1.43E+01	5.10E-20
2.51E+06	2.20E+01	2.10E-21
4.79E+06	3.04E+01	1.40E-22
1.38E+07	5.16E+01	9.90E-25

TABLE 2 - CONTINUED

PROCESS : H+ + N2 = H (10)
TOBUREN AND NAKAI, PHYS. REV. 171 114 (1968)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	9.00E-17
2.00E+05	6.21E+00	1.54E-17
3.00E+05	7.61E+00	3.42E-18
4.00E+05	8.79E+00	1.09E-18
5.50E+05	1.03E+01	4.30E-19
8.00E+05	1.24E+01	1.18E-19
1.00E+06	1.39E+01	5.77E-20
1.25E+06	1.55E+01	3.20E-20
1.50E+06	1.70E+01	1.71E-20
1.75E+06	1.84E+01	1.02E-20
2.00E+06	1.96E+01	6.90E-21
2.25E+06	2.08E+01	4.40E-21
2.50E+06	2.20E+01	2.95E-21

PROCESS : H+ + N2 = H (10)
MCNEAL AND CLARK, J. GEOPHYS. RES. 74 5065 (1969)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.50E+03	6.95E-01	9.93E-16
2.90E+03	7.48E-01	1.02E-15
3.90E+03	8.67E-01	1.07E-15
4.90E+03	9.72E-01	1.10E-15
5.90E+03	1.07E+00	1.12E-15
7.80E+03	1.23E+00	1.04E-15
1.00E+04	1.39E+00	9.77E-16
1.50E+04	1.70E+00	8.28E-16
2.00E+04	1.96E+00	6.96E-16

PROCESS : H+ + N2 = H (10)
MONNOM ET AL, COMPT. REND. B281 425 (1975)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+02	1.39E-01	2.23E-17
1.50E+02	1.70E-01	3.76E-17
2.00E+02	1.96E-01	6.65E-17
3.00E+02	2.41E-01	1.57E-16
5.00E+02	3.11E-01	4.64E-16
7.00E+02	3.68E-01	7.44E-16
1.00E+03	4.39E-01	1.08E-15
1.40E+03	5.20E-01	1.31E-15
2.00E+03	6.21E-01	1.49E-15
2.60E+03	7.08E-01	1.54E-15

Fig. 3 $H^+ + O_2 \rightarrow H \quad (\sigma_{10})$

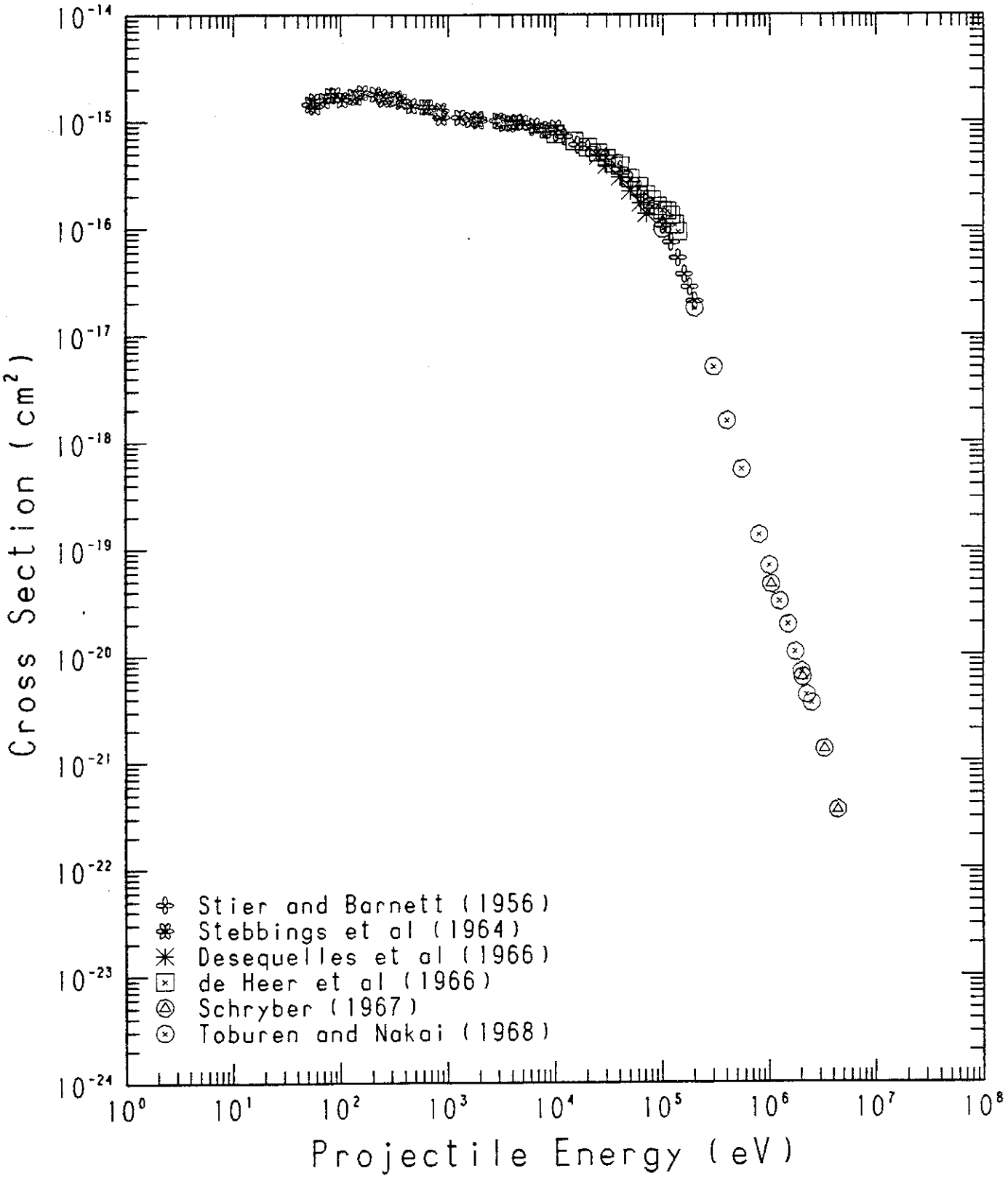

TABLE 3

PROCESS : H+ + O2 = H (10)
STIER AND BARNETT, PHYS. REV. 103 896 (1956)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.00E+03	8.79E-01	9.55E-16
6.00E+03	1.08E+00	8.80E-16
8.00E+03	1.24E+00	8.36E-16
1.00E+04	1.39E+00	7.82E-16
1.20E+04	1.52E+00	7.21E-16
1.60E+04	1.76E+00	6.04E-16
2.00E+04	1.96E+00	5.55E-16
2.50E+04	2.20E+00	5.11E-16
3.00E+04	2.41E+00	4.56E-16
4.00E+04	2.78E+00	3.52E-16
5.00E+04	3.11E+00	2.80E-16
6.00E+04	3.40E+00	2.31E-16
7.00E+04	3.68E+00	1.84E-16
8.00E+04	3.93E+00	1.57E-16
1.00E+05	4.39E+00	1.06E-16
1.20E+05	4.81E+00	7.36E-17
1.40E+05	5.20E+00	5.25E-17
1.60E+05	5.56E+00	3.70E-17
1.80E+05	5.89E+00	2.81E-17
2.00E+05	6.21E+00	2.07E-17

PROCESS : H+ + O2 = H (10)
STEBBINGS ET AL, J. GEOPHYS. RES. 69 2349 (1964)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.20E+01	1.00E-01	1.45E-15
5.65E+01	1.04E-01	1.56E-15
5.70E+01	1.05E-01	1.39E-15
7.02E+01	1.16E-01	1.58E-15
7.92E+01	1.24E-01	1.75E-15
8.76E+01	1.30E-01	1.78E-15
1.02E+02	1.40E-01	1.61E-15
1.30E+02	1.58E-01	1.72E-15
1.39E+02	1.64E-01	1.69E-15
1.58E+02	1.75E-01	1.86E-15
2.09E+02	2.01E-01	1.80E-15
2.40E+02	2.15E-01	1.72E-15
2.49E+02	2.19E-01	1.62E-15
3.15E+02	2.47E-01	1.62E-15
3.27E+02	2.51E-01	1.65E-15
3.64E+02	2.65E-01	1.55E-15
4.52E+02	2.95E-01	1.40E-15
6.06E+02	3.42E-01	1.37E-15
6.41E+02	3.52E-01	1.36E-15

TABLE 3 - CONTINUED

8.27E+02	3.99E-01	1.20E-15
8.49E+02	4.05E-01	1.26E-15
8.60E+02	4.07E-01	1.09E-15
1.28E+03	4.97E-01	1.09E-15
1.62E+03	5.59E-01	1.04E-15
1.90E+03	6.05E-01	1.06E-15
1.91E+03	6.07E-01	1.01E-15
2.89E+03	7.47E-01	1.02E-15
3.06E+03	7.68E-01	9.99E-16
3.34E+03	8.03E-01	9.50E-16
3.91E+03	8.69E-01	9.68E-16
4.36E+03	9.17E-01	9.93E-16
4.92E+03	9.74E-01	9.68E-16
6.34E+03	1.11E+00	9.10E-16
8.02E+03	1.24E+00	8.22E-16
1.00E+04	1.39E+00	8.66E-16

PROCESS : H+ + O2 = H (10)
DESEQUELLES ET AL, COMPT. REND. B262 1329 (1966)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.50E+04	2.20E+00	4.73E-16
3.00E+04	2.41E+00	3.87E-16
4.00E+04	2.78E+00	2.99E-16
5.00E+04	3.11E+00	2.21E-16
6.25E+04	3.47E+00	1.69E-16
7.10E+04	3.70E+00	1.36E-16

PROCESS : H+ + O2 = H (10)
DE HEER ET AL, PHYSICA 32 1766 (1966)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+04	1.39E+00	7.60E-16
1.50E+04	1.70E+00	6.54E-16
2.00E+04	1.96E+00	5.70E-16
2.50E+04	2.20E+00	5.05E-16
3.00E+04	2.41E+00	4.52E-16
3.50E+04	2.60E+00	4.01E-16
4.00E+04	2.78E+00	3.80E-16
5.00E+04	3.11E+00	2.90E-16
6.00E+04	3.40E+00	2.43E-16
7.00E+04	3.68E+00	2.05E-16
8.00E+04	3.93E+00	1.82E-16
9.00E+04	4.17E+00	1.59E-16
1.00E+05	4.39E+00	1.45E-16
1.10E+05	4.61E+00	1.43E-16
1.20E+05	4.81E+00	1.30E-16
1.30E+05	5.01E+00	1.07E-16
1.40E+05	5.20E+00	9.20E-17

TABLE 3 - CONTINUED

PROCESS : H+ + O2 = H (10)
SCHRYBER, HELV. PHYS. ACTA A40 1023 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.04E+06	1.42E+01	4.60E-20
2.05E+06	1.99E+01	6.20E-21
3.28E+06	2.52E+01	1.30E-21
4.37E+06	2.90E+01	3.50E-22

PROCESS : H+ + O2 = H (10)
TOBUREN AND NAKAI, PHYS. REV. 171 114 (1968)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	9.80E-17
2.00E+05	6.21E+00	1.78E-17
3.00E+05	7.61E+00	5.01E-18
4.00E+05	8.79E+00	1.56E-18
5.50E+05	1.03E+01	5.50E-19
8.00E+05	1.24E+01	1.33E-19
1.00E+06	1.39E+01	6.85E-20
1.25E+06	1.55E+01	3.18E-20
1.50E+06	1.70E+01	1.94E-20
1.75E+06	1.84E+01	1.07E-20
2.00E+06	1.96E+01	6.97E-21
2.25E+06	2.08E+01	4.25E-21
2.50E+06	2.20E+01	3.55E-21

Fig. 4 $H^+ + H_2O \rightarrow H \quad (\sigma_{10})$

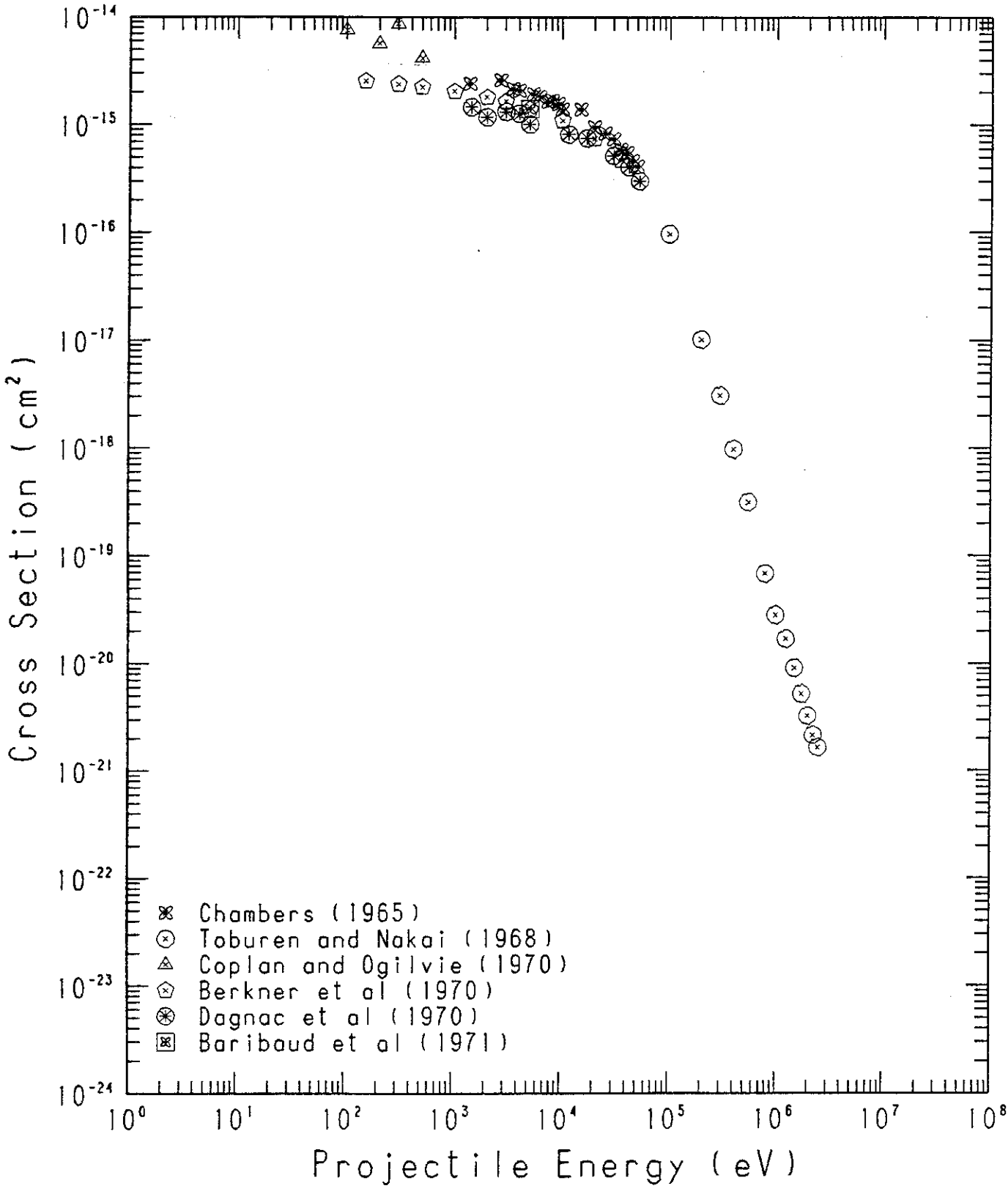

TABLE 4

PROCESS : H+ + H2O = H (10)
CHAMBERS, UCRL-14214 (1965)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.40E+03	5.20E-01	2.42E-15
2.70E+03	7.22E-01	2.61E-15
3.50E+03	8.22E-01	2.16E-15
4.00E+03	8.79E-01	2.08E-15
5.40E+03	1.02E+00	1.93E-15
6.20E+03	1.09E+00	1.82E-15
7.40E+03	1.19E+00	1.64E-15
8.10E+03	1.25E+00	1.68E-15
9.20E+03	1.33E+00	1.57E-15
1.00E+04	1.39E+00	1.39E-15
1.50E+04	1.70E+00	1.39E-15
2.00E+04	1.96E+00	9.48E-16
2.50E+04	2.20E+00	8.31E-16
3.00E+04	2.41E+00	7.35E-16
3.50E+04	2.60E+00	5.87E-16
4.00E+04	2.78E+00	5.47E-16
4.50E+04	2.95E+00	4.61E-16
5.00E+04	3.11E+00	4.09E-16

PROCESS : H+ + H2O = H (10)
TOBUREN AND NAKAI, PHYS. REV. 171 114 (1968)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	9.60E-17
2.00E+05	6.21E+00	1.01E-17
3.00E+05	7.61E+00	3.06E-18
4.00E+05	8.79E+00	9.70E-19
5.50E+05	1.03E+01	3.15E-19
8.00E+05	1.24E+01	6.80E-20
1.00E+06	1.39E+01	2.81E-20
1.25E+06	1.55E+01	1.69E-20
1.50E+06	1.70E+01	9.05E-21
1.75E+06	1.84E+01	5.21E-21
2.00E+06	1.96E+01	3.25E-21
2.25E+06	2.08E+01	2.15E-21
2.50E+06	2.20E+01	1.65E-21

PROCESS : H+ + H2O = H (10)
COPLAN AND OGILVIE, J. CHEM. PHYS. 52 4154 (1970)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+02	1.39E-01	7.60E-15
2.00E+02	1.96E-01	5.70E-15
3.00E+02	2.41E-01	8.70E-15
5.00E+02	3.11E-01	4.20E-15

TABLE 4 - CONTINUED

PROCESS : H+ + H2O = H (10)
BERKNER ET AL, NUCL. FUSION 10 145 (1970)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.50E+02	1.70E-01	2.55E-15
3.00E+02	2.41E-01	2.40E-15
5.00E+02	3.11E-01	2.25E-15
1.00E+03	4.39E-01	2.05E-15
2.00E+03	6.21E-01	1.80E-15
3.00E+03	7.61E-01	1.65E-15
5.00E+03	9.82E-01	1.40E-15
1.00E+04	1.39E+00	1.10E-15
2.00E+04	1.96E+00	7.40E-16
3.50E+04	2.60E+00	4.70E-16

PROCESS : H+ + H2O = H (10)
DAGNAC ET AL, J. PHYS. B3 1239 (1970)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.44E+03	5.27E-01	1.46E-15
2.00E+03	6.21E-01	1.18E-15
3.00E+03	7.61E-01	1.32E-15
4.00E+03	8.79E-01	1.27E-15
5.00E+03	9.82E-01	1.01E-15
1.15E+04	1.49E+00	8.17E-16
1.70E+04	1.81E+00	7.50E-16
3.00E+04	2.41E+00	5.16E-16
4.16E+04	2.83E+00	4.05E-16
5.25E+04	3.18E+00	2.99E-16

PROCESS : H+ + H2O = H (10)
BARIBAUD ET AL, COMPT. REND. B272 457 (1971)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+03	9.82E-01	1.40E-15

Fig. 5 $H^+ + CO \rightarrow H \quad (\sigma_{10})$

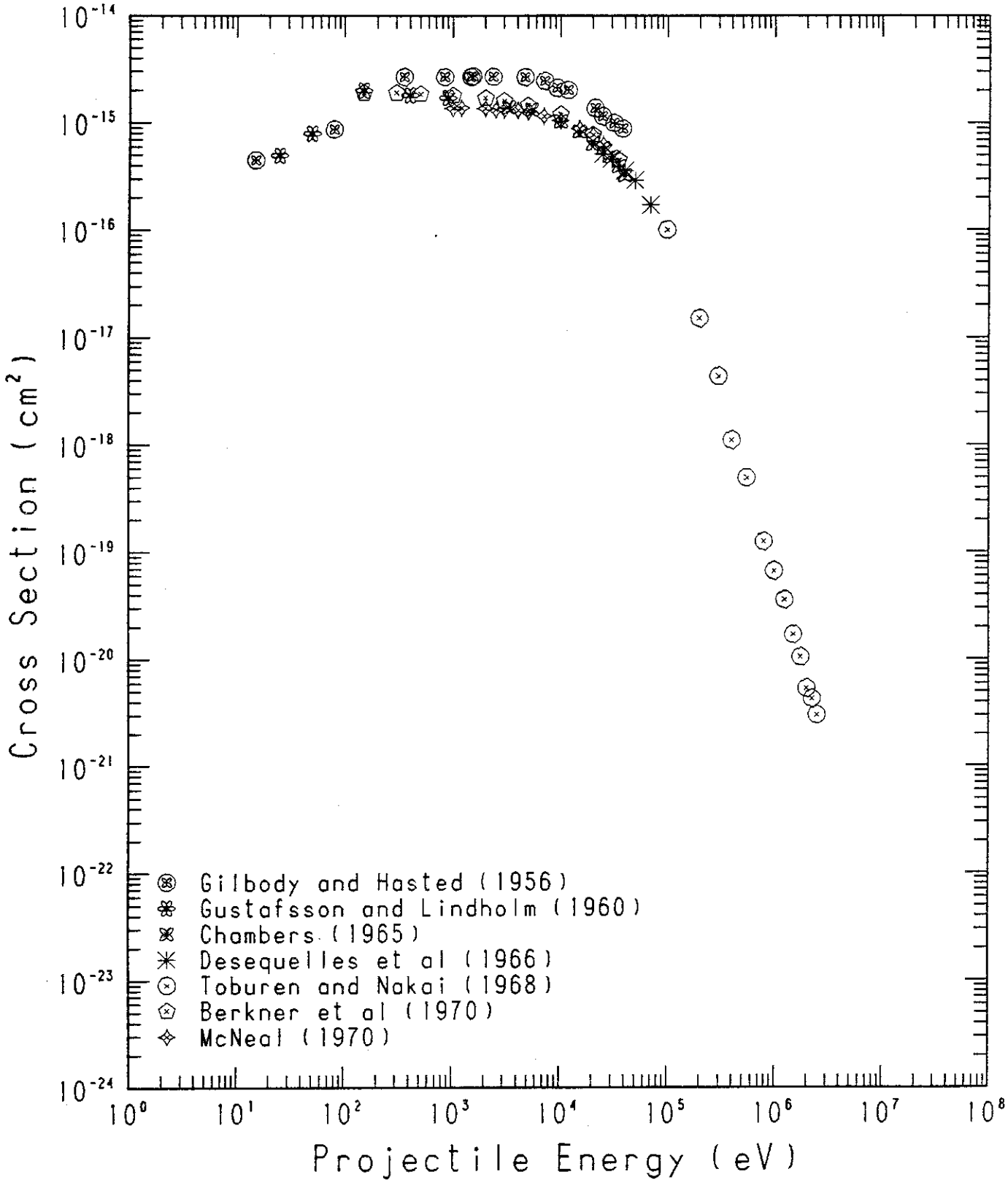

TABLE 5

PROCESS : H+ + CO = H (10)
GILBODY AND HASTED, PROC. ROY. SOC. A238 334 (1956)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.50E+01	5.38E-02	4.52E-16
8.00E+01	1.24E-01	8.76E-16
3.55E+02	2.62E-01	2.68E-15
8.41E+02	4.03E-01	2.68E-15
1.47E+03	5.33E-01	2.68E-15
1.53E+03	5.43E-01	2.72E-15
2.36E+03	6.75E-01	2.69E-15
4.69E+03	9.51E-01	2.66E-15
7.14E+03	1.17E+00	2.45E-15
9.26E+03	1.34E+00	2.11E-15
1.18E+04	1.51E+00	2.01E-15
2.10E+04	2.01E+00	1.37E-15
2.46E+04	2.18E+00	1.15E-15
3.15E+04	2.47E+00	9.93E-16
3.79E+04	2.70E+00	8.82E-16

PROCESS : H+ + CO = H (10)
GUSTAFSSON AND LINDHOLM, ARK. FYS. 18 219 (1960)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.50E+01	6.95E-02	5.00E-16
5.00E+01	9.82E-02	8.00E-16
1.50E+02	1.70E-01	2.00E-15
4.00E+02	2.78E-01	1.80E-15
9.00E+02	4.17E-01	1.70E-15

PROCESS : H+ + CO = H (10)
CHAMBERS, UCRL-14214 (1965)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
3.30E+03	7.98E-01	1.40E-15
5.40E+03	1.02E+00	1.33E-15
1.00E+04	1.39E+00	1.03E-15
1.50E+04	1.70E+00	8.29E-16
2.00E+04	1.96E+00	6.35E-16
2.50E+04	2.20E+00	5.82E-16
3.00E+04	2.41E+00	4.84E-16
3.50E+04	2.60E+00	3.92E-16
4.00E+04	2.78E+00	3.23E-16

TABLE 5 - CONTINUED

PROCESS : H+ + CO = H (10)
DESEQUELLES ET AL, COMPT. REND. B262 1329 (1966)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.50E+04	2.20E+00	5.10E-16
3.00E+04	2.41E+00	4.58E-16
4.00E+04	2.78E+00	3.55E-16
5.00E+04	3.11E+00	2.90E-16
7.00E+04	3.68E+00	1.71E-16

PROCESS : H+ + CO = H (10)
TOBUREN AND NAKAI, PHYS. REV. 171 114 (1968)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	1.01E-16
2.00E+05	6.21E+00	1.50E-17
3.00E+05	7.61E+00	4.33E-18
4.00E+05	8.79E+00	1.10E-18
5.50E+05	1.03E+01	4.92E-19
8.00E+05	1.24E+01	1.25E-19
1.00E+06	1.39E+01	6.65E-20
1.25E+06	1.55E+01	3.58E-20
1.50E+06	1.70E+01	1.70E-20
1.75E+06	1.84E+01	1.05E-20
2.00E+06	1.96E+01	5.35E-21
2.25E+06	2.08E+01	4.29E-21
2.50E+06	2.20E+01	3.01E-21

PROCESS : H+ + CO = H (10)
BERKNER ET AL, NUCL. FUSION 10 145 (1970)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.50E+02	1.70E-01	1.90E-15
3.00E+02	2.41E-01	1.90E-15
5.00E+02	3.11E-01	1.85E-15
1.00E+03	4.39E-01	1.80E-15
2.00E+03	6.21E-01	1.70E-15
3.00E+03	7.61E-01	1.60E-15
5.00E+03	9.82E-01	1.45E-15
1.00E+04	1.39E+00	1.20E-15
2.00E+04	1.96E+00	7.80E-16
3.50E+04	2.60E+00	4.50E-16

TABLE 5 - CONTINUED

PROCESS : H+ + CO = H (10)
MCNEAL, J. CHEM. PHYS. 53 4308 (1970)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+03	4.39E-01	1.36E-15
1.20E+03	4.81E-01	1.38E-15
2.00E+03	6.21E-01	1.36E-15
2.50E+03	6.95E-01	1.32E-15
3.00E+03	7.61E-01	1.33E-15
4.00E+03	8.79E-01	1.31E-15
5.00E+03	9.82E-01	1.26E-15
7.00E+03	1.16E+00	1.16E-15
1.00E+04	1.39E+00	1.05E-15
1.50E+04	1.70E+00	8.82E-16
2.00E+04	1.96E+00	7.71E-16
2.50E+04	2.20E+00	6.29E-16

Fig. 6 $H^+ + CO_2 \rightarrow H \quad (\sigma_{10})$

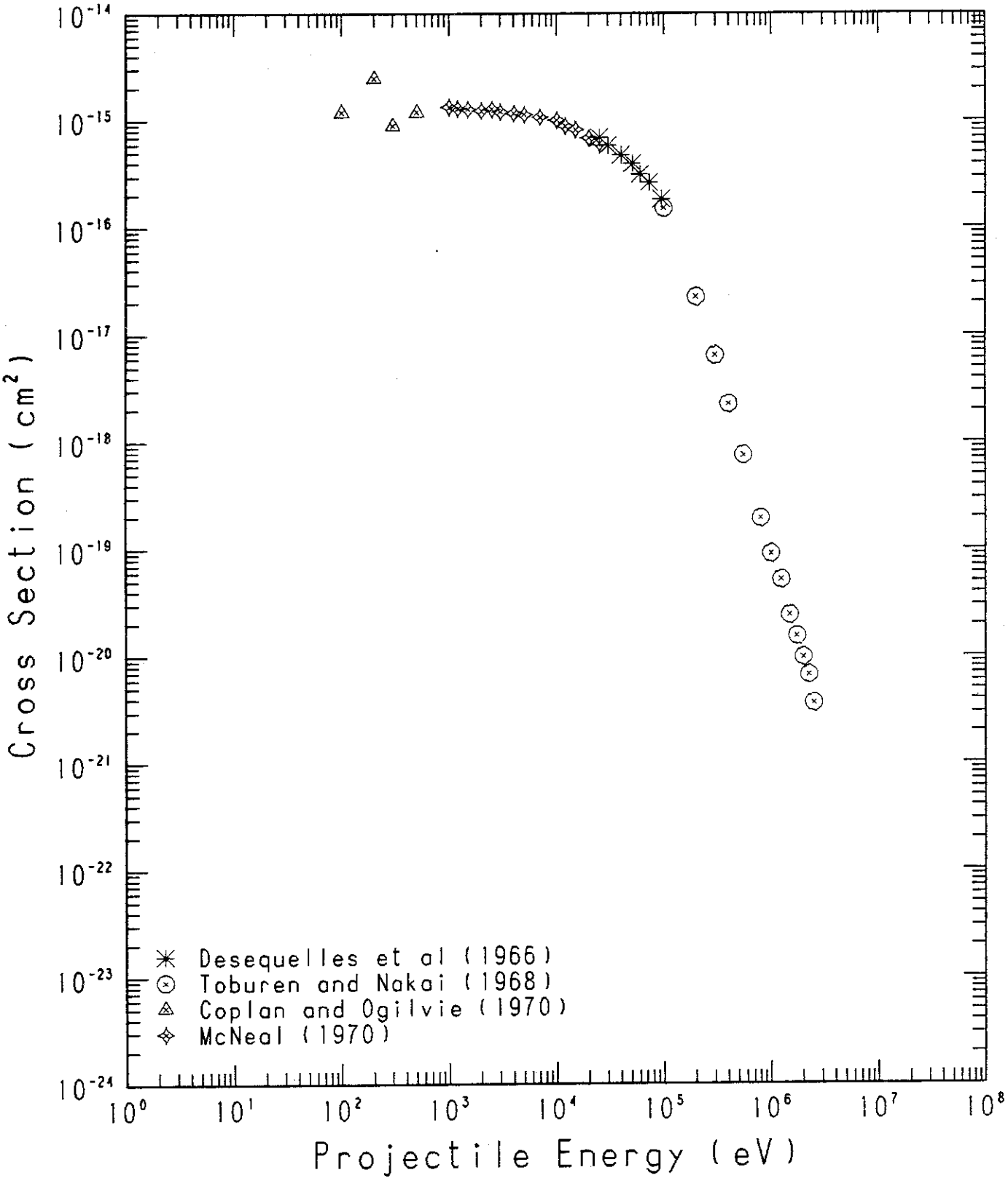

TABLE 6

PROCESS : H+ + CO2 = H (10)
DESEQUELLES ET AL, COMPT. REND. B262 1329 (1966)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.50E+04	2.20E+00	6.90E-16
3.00E+04	2.41E+00	5.83E-16
4.00E+04	2.78E+00	4.77E-16
5.10E+04	3.14E+00	3.98E-16
6.00E+04	3.40E+00	3.13E-16
7.30E+04	3.75E+00	2.64E-16
9.50E+04	4.28E+00	1.83E-16

PROCESS : H+ + CO2 = H (10)
TOBUREN AND NAKAI, PHYS. REV. 171 114 (1968)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	1.51E-16
2.00E+05	6.21E+00	2.26E-17
3.00E+05	7.61E+00	6.41E-18
4.00E+05	8.79E+00	2.25E-18
5.50E+05	1.03E+01	7.50E-19
8.00E+05	1.24E+01	1.93E-19
1.00E+06	1.39E+01	8.97E-20
1.25E+06	1.55E+01	5.14E-20
1.50E+06	1.70E+01	2.41E-20
1.75E+06	1.84E+01	1.53E-20
2.00E+06	1.96E+01	9.73E-21
2.25E+06	2.08E+01	6.63E-21
2.50E+06	2.20E+01	3.62E-21

PROCESS : H+ + CO2 = H (10)
COPLAN AND OGILVIE, J. CHEM. PHYS. 52 4154 (1970)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+02	1.39E-01	1.20E-15
2.00E+02	1.96E-01	2.50E-15
3.00E+02	2.41E-01	9.00E-16
5.00E+02	3.11E-01	1.20E-15

TABLE 6 - CONTINUED

PROCESS : H+ + CO2 = H (10)
MCNEAL, J. CHEM. PHYS. 53 4308 (1970)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+03	4.39E-01	1.34E-15
1.20E+03	4.81E-01	1.30E-15
1.50E+03	5.38E-01	1.28E-15
2.00E+03	6.21E-01	1.24E-15
2.50E+03	6.95E-01	1.28E-15
3.00E+03	7.61E-01	1.21E-15
4.00E+03	8.79E-01	1.17E-15
5.00E+03	9.82E-01	1.14E-15
7.00E+03	1.16E+00	1.08E-15
1.00E+04	1.39E+00	1.01E-15
1.20E+04	1.52E+00	8.90E-16
1.50E+04	1.70E+00	8.23E-16
2.00E+04	1.96E+00	6.85E-16
2.50E+04	2.20E+00	6.08E-16

Fig. 7 $H^+ + CH_4 \rightarrow H \quad (\sigma_{10})$

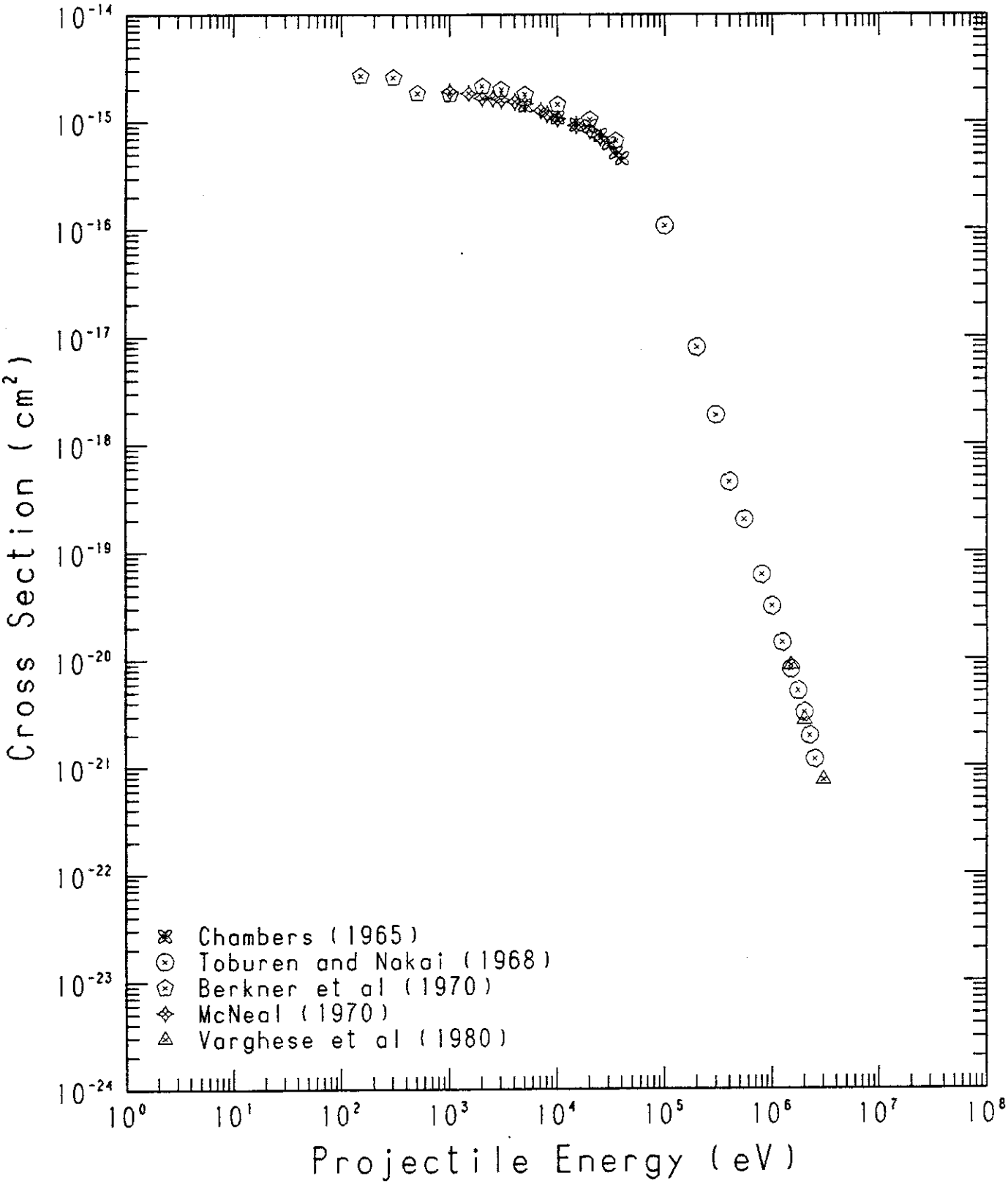

TABLE 7

PROCESS : H+ + CH4 = H (10)
CHAMBERS, UCRL-14214 (1965)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+03	9.82E-01	1.42E-15
1.00E+04	1.39E+00	1.10E-15
1.50E+04	1.70E+00	9.40E-16
2.00E+04	1.96E+00	9.14E-16
2.50E+04	2.20E+00	7.56E-16
3.00E+04	2.41E+00	6.33E-16
3.50E+04	2.60E+00	5.19E-16
4.00E+04	2.78E+00	4.60E-16

PROCESS : H+ + CH4 = H (10)
TOBUREN AND NAKAI, PHYS. REV. 171 114 (1968)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	1.08E-16
2.00E+05	6.21E+00	8.00E-18
3.00E+05	7.61E+00	1.87E-18
4.00E+05	8.79E+00	4.47E-19
5.50E+05	1.03E+01	2.00E-19
8.00E+05	1.24E+01	6.11E-20
1.00E+06	1.39E+01	3.11E-20
1.25E+06	1.55E+01	1.43E-20
1.50E+06	1.70E+01	8.07E-21
1.75E+06	1.84E+01	5.05E-21
2.00E+06	1.96E+01	3.19E-21
2.25E+06	2.08E+01	1.93E-21
2.50E+06	2.20E+01	1.16E-21

PROCESS : H+ + CH4 = H (10)
BERKNER ET AL, NUCL. FUSION 10 145 (1970)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.50E+02	1.70E-01	2.70E-15
3.00E+02	2.41E-01	2.60E-15
5.00E+02	3.11E-01	1.85E-15
1.00E+03	4.39E-01	1.80E-15
2.00E+03	6.21E-01	2.15E-15
3.00E+03	7.61E-01	2.00E-15
5.00E+03	9.82E-01	1.80E-15
1.00E+04	1.39E+00	1.45E-15
2.00E+04	1.96E+00	1.05E-15
3.50E+04	2.60E+00	6.70E-16

TABLE 7 - CONTINUED

PROCESS : H+ + CH4 = H (10)
MCNEAL, J. CHEM. PHYS. 53 4308 (1970)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+03	4.39E-01	1.92E-15
1.50E+03	5.38E-01	1.84E-15
2.00E+03	6.21E-01	1.66E-15
2.50E+03	6.95E-01	1.65E-15
3.00E+03	7.61E-01	1.60E-15
4.00E+03	8.79E-01	1.54E-15
5.00E+03	9.82E-01	1.47E-15
7.00E+03	1.16E+00	1.27E-15
8.00E+03	1.24E+00	1.18E-15
1.00E+04	1.39E+00	1.07E-15
1.50E+04	1.70E+00	9.29E-16
2.00E+04	1.96E+00	8.29E-16
2.50E+04	2.20E+00	7.15E-16

PROCESS : H+ + CH4 = H (10)
VARGHESE ET AL, NUCL. INST. METH. 170 269 (1980)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.50E+06	1.70E+01	8.76E-21
2.00E+06	1.96E+01	2.71E-21
3.00E+06	2.41E+01	7.40E-22

Fig. 8 $H^+ + C_2H_4 \rightarrow H \quad (\sigma_{10})$

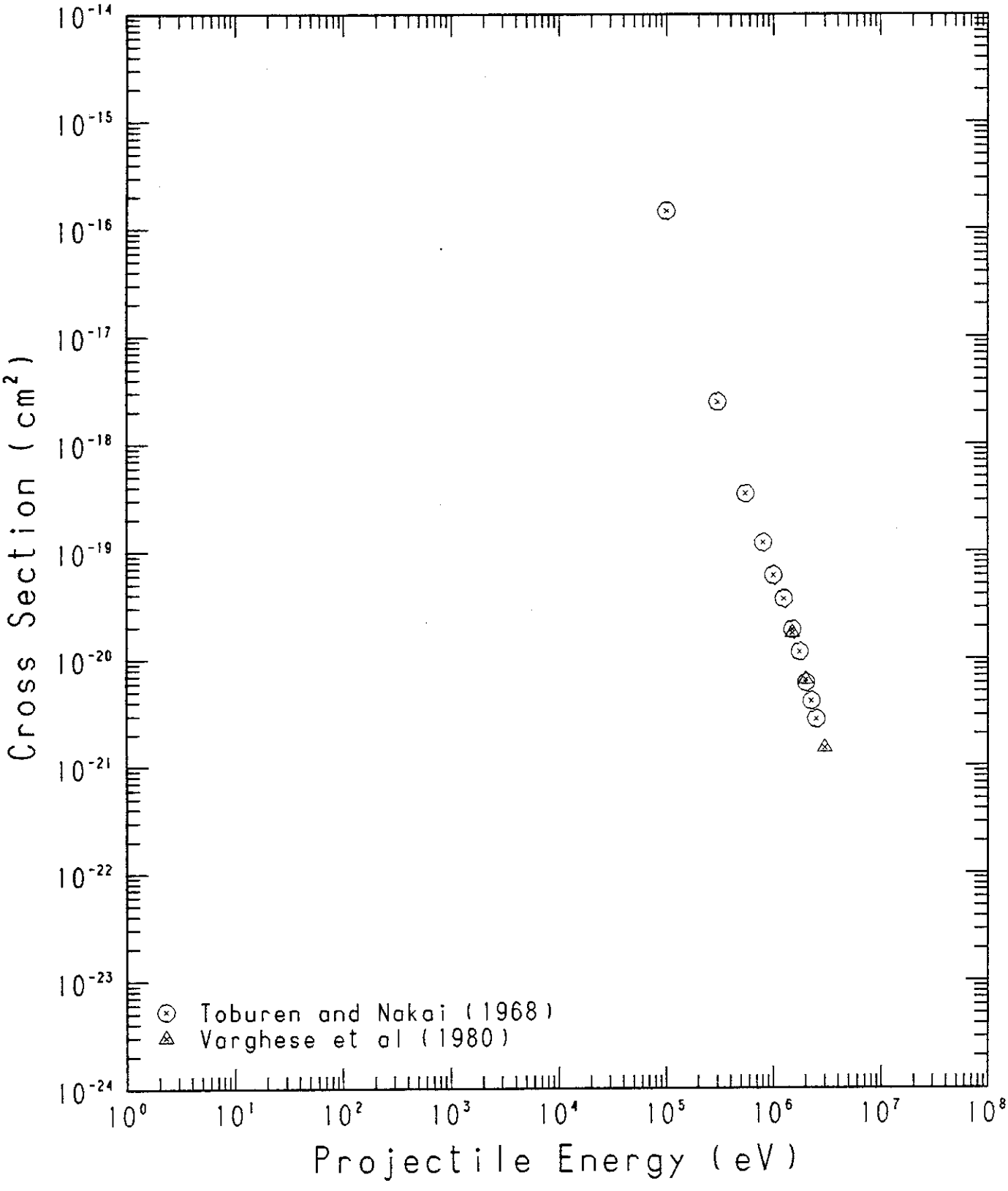

TABLE 8

PROCESS : H+ + C2H4 = H (10)
TOBUREN AND NAKAI, PHYS. REV. 171 114 (1968)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	1.47E-16
3.00E+05	7.61E+00	2.46E-18
5.50E+05	1.03E+01	3.45E-19
8.00E+05	1.24E+01	1.20E-19
1.00E+06	1.39E+01	5.96E-20
1.25E+06	1.55E+01	3.60E-20
1.50E+06	1.70E+01	1.87E-20
1.75E+06	1.84E+01	1.16E-20
2.00E+06	1.96E+01	5.96E-21
2.25E+06	2.08E+01	4.04E-21
2.50E+06	2.20E+01	2.73E-21

PROCESS : H+ + C2H4 = H (10)
VARGHESE ET AL, NUCL. INST. METH. 170 269 (1980)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.50E+06	1.70E+01	1.73E-20
2.00E+06	1.96E+01	6.34E-21
3.00E+06	2.41E+01	1.47E-21

Fig. 9 $H^+ + C_2H_6 \rightarrow H \quad (\sigma_{10})$

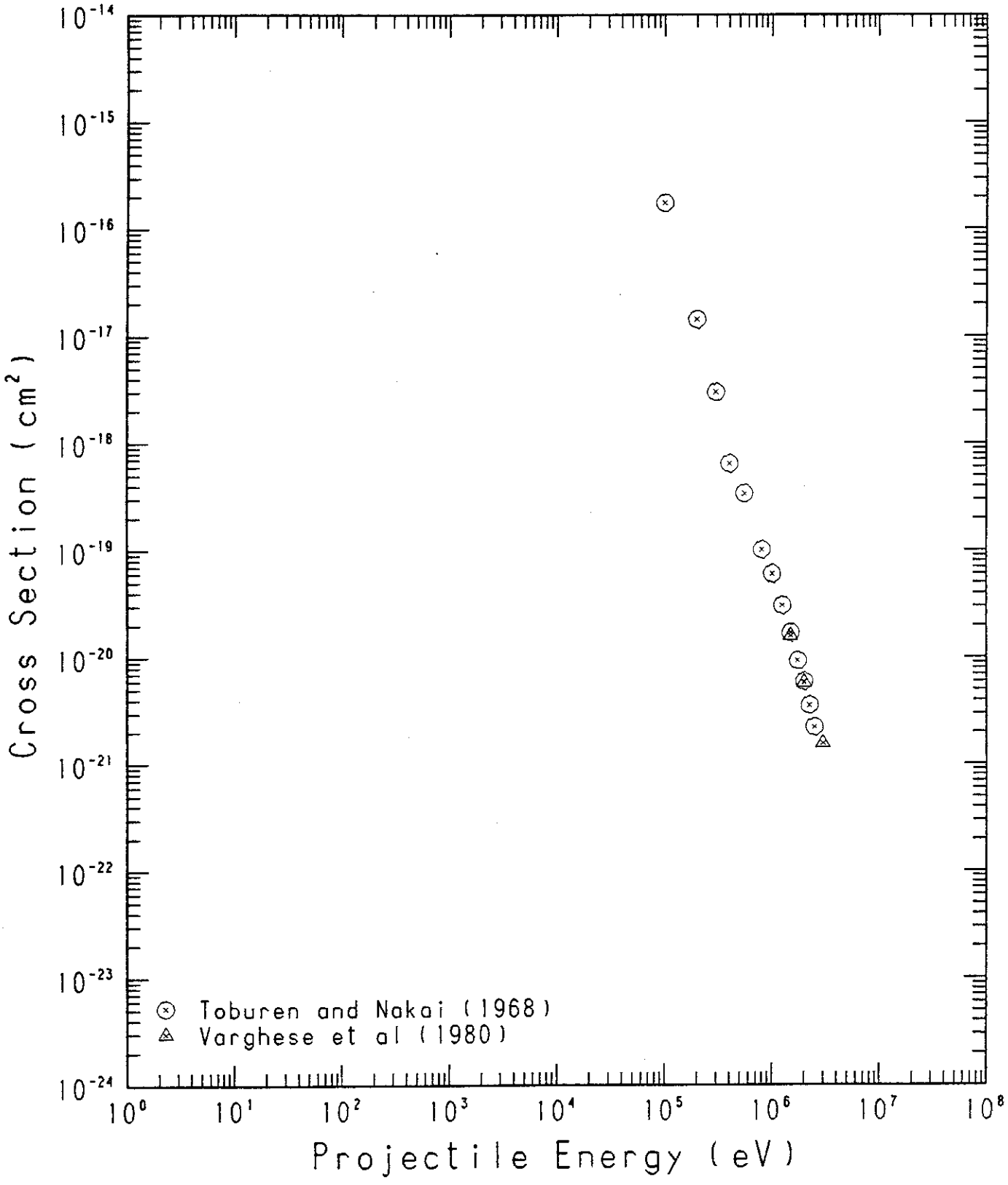

TABLE 9

PROCESS : H+ + C2H6 = H (10)
TOBUREN AND NAKAI, PHYS. REV. 171 114 (1968)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	1.75E-16
2.00E+05	6.21E+00	1.43E-17
3.00E+05	7.61E+00	3.00E-18
4.00E+05	8.79E+00	6.43E-19
5.50E+05	1.03E+01	3.40E-19
8.00E+05	1.24E+01	1.01E-19
1.00E+06	1.39E+01	6.01E-20
1.25E+06	1.55E+01	3.05E-20
1.50E+06	1.70E+01	1.70E-20
1.75E+06	1.84E+01	9.29E-21
2.00E+06	1.96E+01	5.93E-21
2.25E+06	2.08E+01	3.57E-21
2.50E+06	2.20E+01	2.22E-21

PROCESS : H+ + C2H6 = H (10)
VARGHESE ET AL, NUCL. INST. METH. 170 269 (1980)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.50E+06	1.70E+01	1.59E-20
2.00E+06	1.96E+01	5.80E-21
3.00E+06	2.41E+01	1.56E-21

Fig.10 $H^+ + C_4H_{10} \rightarrow H \quad (\sigma_{10})$

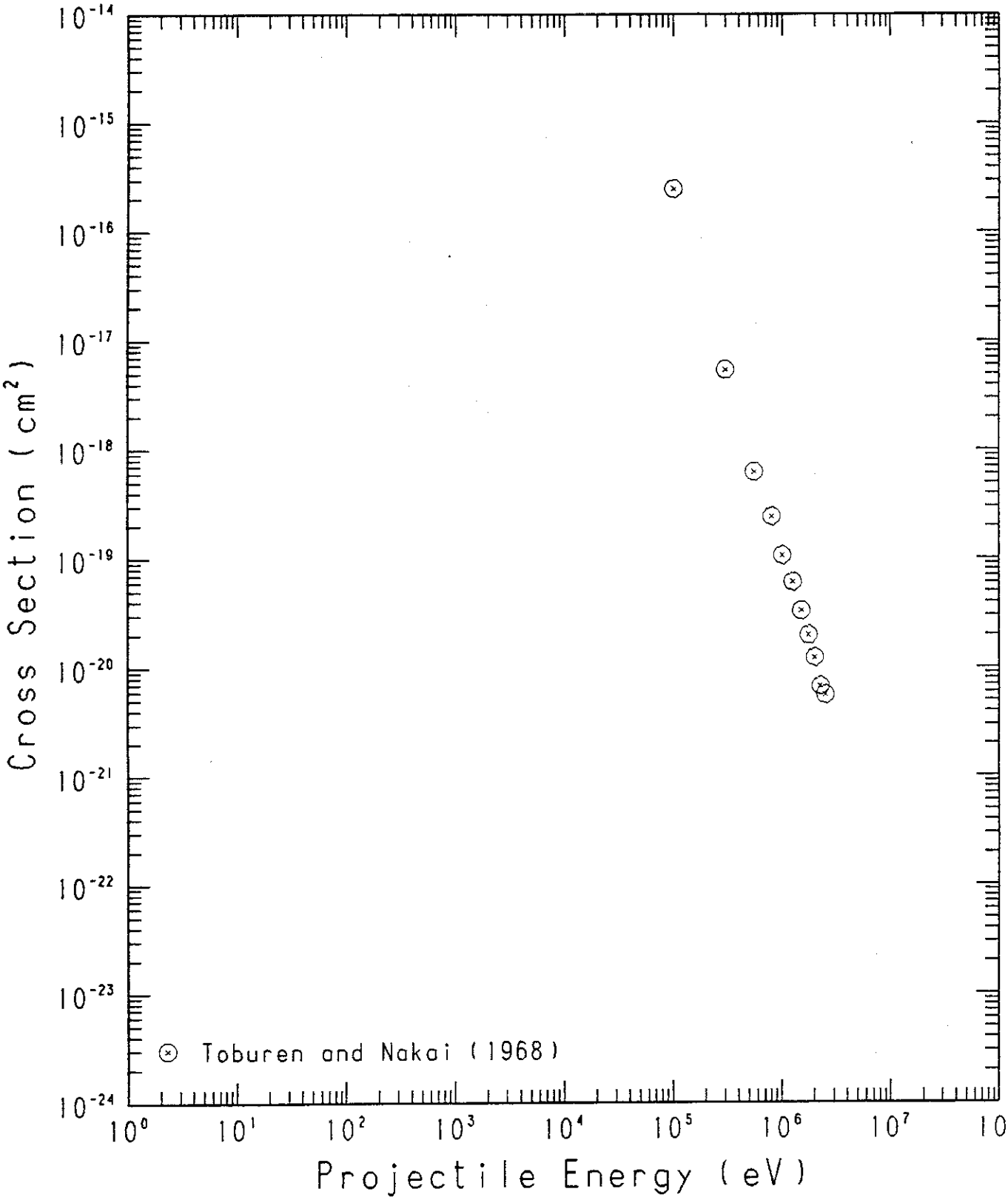

TABLE 10

PROCESS : H+ + C4H10 = H (10)
TOBUREN AND NAKAI, PHYS. REV. 171 114 (1968)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	2.50E-16
3.00E+05	7.61E+00	5.41E-18
5.50E+05	1.03E+01	6.21E-19
8.00E+05	1.24E+01	2.43E-19
1.00E+06	1.39E+01	1.06E-19
1.25E+06	1.55E+01	6.05E-20
1.50E+06	1.70E+01	3.30E-20
1.75E+06	1.84E+01	1.98E-20
2.00E+06	1.96E+01	1.23E-20
2.25E+06	2.08E+01	6.70E-21
2.50E+06	2.20E+01	5.56E-21

Fig.11 $H^+ + C \rightarrow H \quad (\sigma_{10})$

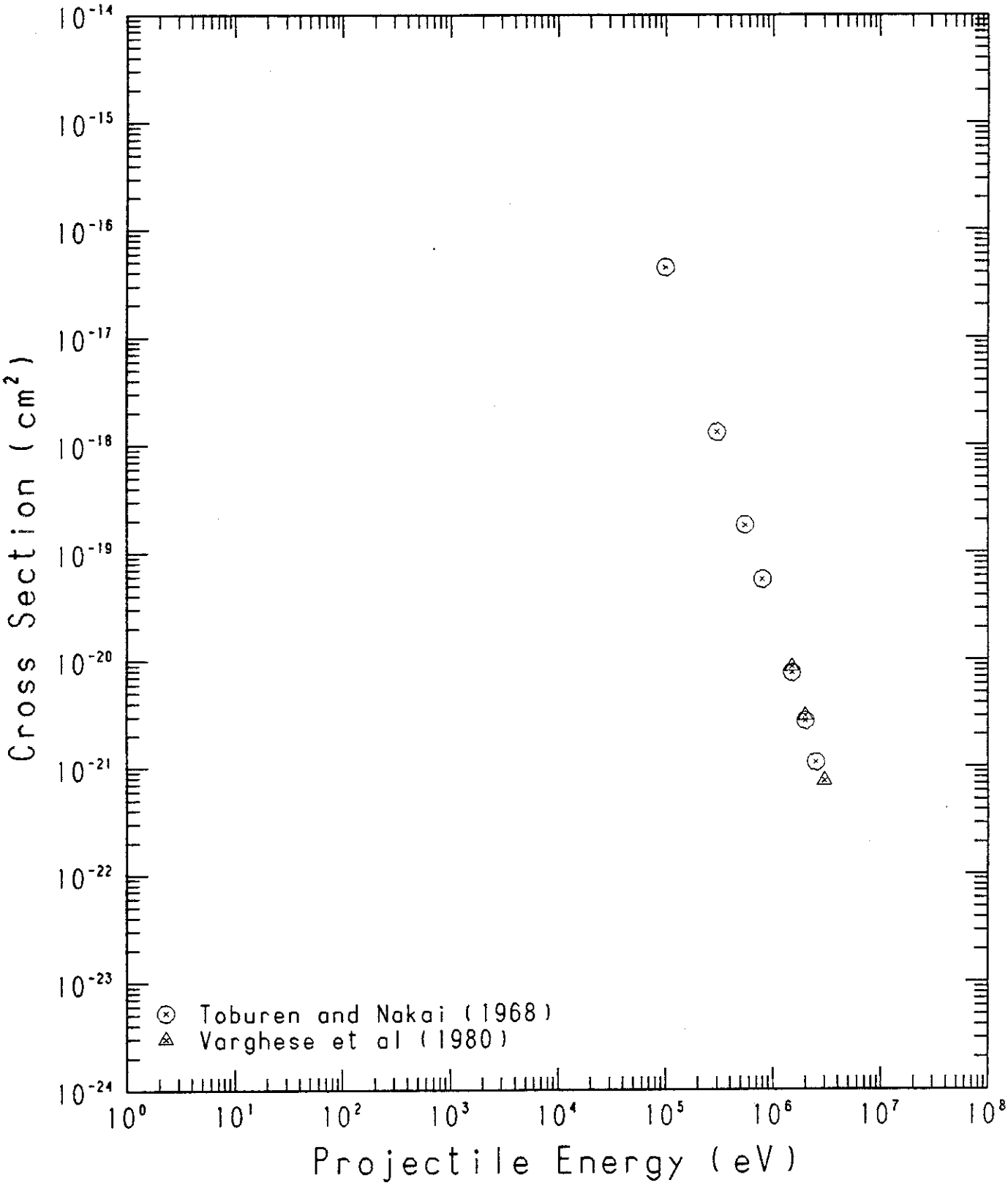

TABLE 11

PROCESS : H+ + C = H (10)
TOBUREN AND NAKAI, PHYS. REV. 171 114 (1968)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	4.48E-17
3.00E+05	7.61E+00	1.31E-18
5.50E+05	1.03E+01	1.80E-19
8.00E+05	1.24E+01	5.60E-20
1.50E+06	1.70E+01	7.60E-21
2.00E+06	1.96E+01	2.70E-21
2.50E+06	2.20E+01	1.10E-21

PROCESS : H+ + C = H (10)
VARGHESE ET AL, NUCL. INST. METH. 170 269 (1980)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.50E+06	1.70E+01	8.60E-21
2.00E+06	1.96E+01	3.00E-21
3.00E+06	2.41E+01	7.40E-22

Fig.12 $H + H_2 \rightarrow H^- (\sigma_{0-1})$

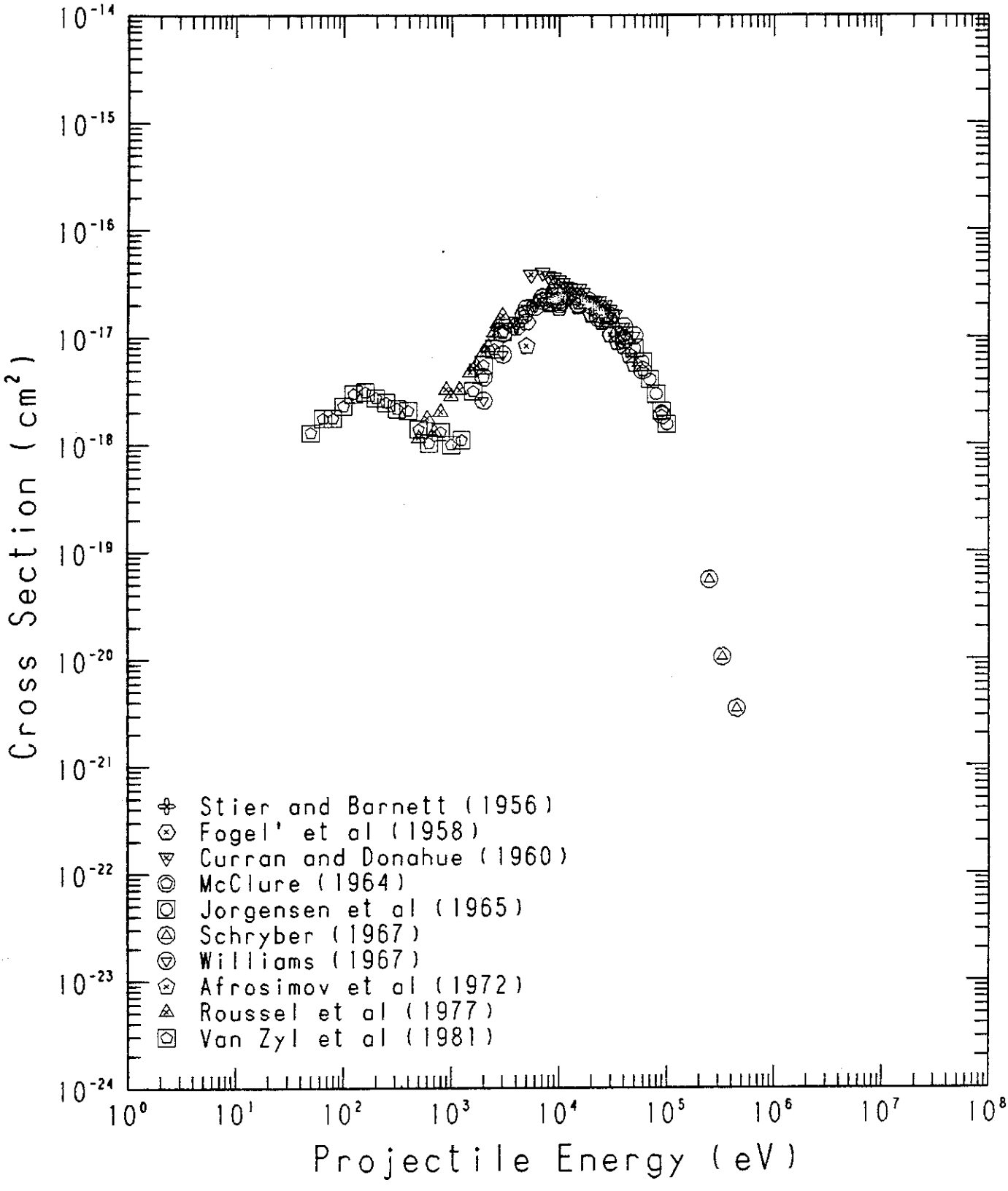

TABLE 12

PROCESS : H + H2 = H- (0-1)
STIER AND BARNETT, PHYS. REV. 103 896 (1956)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.00E+03	8.79E-01	1.29E-17
6.00E+03	1.08E+00	2.03E-17
8.00E+03	1.24E+00	2.45E-17
1.00E+04	1.39E+00	2.38E-17
1.20E+04	1.52E+00	2.30E-17
1.60E+04	1.76E+00	2.20E-17
2.00E+04	1.96E+00	1.94E-17
2.50E+04	2.20E+00	1.68E-17
3.00E+04	2.41E+00	1.44E-17

PROCESS : H + H2 = H- (0-1)
FOGEL' ET AL, SOV. PHYS. JETP 7 400 (1958)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+03	9.82E-01	1.38E-17
8.00E+03	1.24E+00	2.01E-17
1.00E+04	1.39E+00	2.07E-17
1.50E+04	1.70E+00	1.94E-17
2.00E+04	1.96E+00	1.65E-17
2.50E+04	2.20E+00	1.41E-17
3.00E+04	2.41E+00	1.05E-17
3.50E+04	2.60E+00	1.05E-17
4.00E+04	2.78E+00	9.27E-18

PROCESS : H + H2 = H- (0-1)
CURRAN AND DONAHUE, PHYS. REV. 118 1233 (1960)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.00E+03	8.79E-01	1.40E-17
5.50E+03	1.03E+00	3.80E-17
7.00E+03	1.16E+00	4.00E-17
8.00E+03	1.24E+00	3.70E-17
9.00E+03	1.32E+00	3.59E-17
1.00E+04	1.39E+00	3.40E-17
1.08E+04	1.44E+00	3.18E-17
1.17E+04	1.50E+00	2.94E-17
1.28E+04	1.57E+00	2.88E-17
1.40E+04	1.64E+00	2.81E-17
1.55E+04	1.73E+00	2.80E-17
1.65E+04	1.78E+00	2.57E-17
1.80E+04	1.86E+00	2.20E-17
1.90E+04	1.91E+00	2.21E-17

TABLE 12 - CONTINUED

2.05E+04	1.99E+00	2.19E-17
2.18E+04	2.05E+00	2.17E-17
2.35E+04	2.13E+00	2.16E-17
2.47E+04	2.18E+00	1.97E-17
2.65E+04	2.26E+00	1.97E-17
2.94E+04	2.38E+00	1.79E-17
3.28E+04	2.52E+00	1.61E-17
3.57E+04	2.62E+00	1.22E-17

PROCESS : H + H2 = H- (0-1)
MCCLURE, PHYS. REV. 134 A1226 (1964)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.00E+03	6.21E-01	4.27E-18
3.00E+03	7.61E-01	1.08E-17
4.70E+03	9.52E-01	1.61E-17
7.00E+03	1.16E+00	2.33E-17
9.00E+03	1.32E+00	2.60E-17
1.00E+04	1.39E+00	2.38E-17
1.50E+04	1.70E+00	2.03E-17
2.30E+04	2.11E+00	1.51E-17
4.00E+04	2.78E+00	9.43E-18
6.00E+04	3.40E+00	4.85E-18
9.00E+04	4.17E+00	1.86E-18

PROCESS : H + H2 = H- (0-1)
JORGENSEN ET AL, PHYS. REV. 140 A1481 (1965)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
3.00E+04	2.41E+00	1.49E-17
4.00E+04	2.78E+00	1.03E-17
5.00E+04	3.11E+00	7.86E-18
6.00E+04	3.40E+00	5.89E-18
7.00E+04	3.68E+00	4.04E-18
8.00E+04	3.93E+00	2.95E-18
9.00E+04	4.17E+00	2.04E-18
1.00E+05	4.39E+00	1.54E-18

PROCESS : H + H2 = H- (0-1)
SCHRYBER, HELV. PHYS. ACTA A40 1023 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.50E+05	6.95E+00	5.50E-20
3.30E+05	7.98E+00	1.05E-20
4.50E+05	9.32E+00	3.46E-21

TABLE 12 - CONTINUED

PROCESS : H + H2 = H- (0-1)
WILLIAMS, PHYS. REV. 153 116 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.00E+03	6.21E-01	2.58E-18
3.00E+03	7.61E-01	6.90E-18
4.00E+03	8.79E-01	1.25E-17
5.00E+03	9.82E-01	1.85E-17
6.00E+03	1.08E+00	1.91E-17
7.00E+03	1.16E+00	2.16E-17
8.00E+03	1.24E+00	2.12E-17
9.00E+03	1.32E+00	2.42E-17
1.00E+04	1.39E+00	2.03E-17
1.00E+04	1.39E+00	2.23E-17
1.20E+04	1.52E+00	2.44E-17
1.50E+04	1.70E+00	2.36E-17
1.90E+04	1.91E+00	2.17E-17
2.00E+04	1.96E+00	1.95E-17
2.50E+04	2.20E+00	1.80E-17
3.00E+04	2.41E+00	1.56E-17
4.00E+04	2.78E+00	1.25E-17
5.00E+04	3.11E+00	1.03E-17

PROCESS : H + H2 = H- (0-1)
AFROSIMOV ET AL, SOV. PHYS. JETP 35 1070 (1972)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+03	9.82E-01	8.25E-18
1.00E+04	1.39E+00	1.86E-17
1.50E+04	1.70E+00	1.96E-17
2.00E+04	1.96E+00	1.59E-17
2.50E+04	2.20E+00	1.36E-17
3.00E+04	2.41E+00	1.05E-17
3.50E+04	2.60E+00	8.84E-18
4.00E+04	2.78E+00	8.12E-18
4.50E+04	2.95E+00	6.70E-18
5.00E+04	3.11E+00	5.54E-18

PROCESS : H + H2 = H- (0-1)
ROUSSEL ET AL, PHYS. REV. A16 1854 (1977)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+02	3.11E-01	1.15E-18
6.00E+02	3.40E-01	1.76E-18
7.00E+02	3.68E-01	1.31E-18
8.00E+02	3.93E-01	2.03E-18

TABLE 12 - CONTINUED

9.00E+02	4.17E-01	3.27E-18
1.00E+03	4.39E-01	2.84E-18
1.20E+03	4.81E-01	3.27E-18
1.50E+03	5.38E-01	4.74E-18
1.70E+03	5.73E-01	5.47E-18
2.00E+03	6.21E-01	7.34E-18
2.20E+03	6.52E-01	8.09E-18
2.50E+03	6.95E-01	1.11E-17
2.70E+03	7.22E-01	1.35E-17
3.00E+03	7.61E-01	1.59E-17

PROCESS : H + H2 = H- (0-1)
VAN ZYL ET AL, J. CHEM. PHYS. 74 314 (1981)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+01	9.82E-02	1.28E-18
6.50E+01	1.12E-01	1.75E-18
8.00E+01	1.24E-01	1.75E-18
1.00E+02	1.39E-01	2.29E-18
1.25E+02	1.55E-01	2.98E-18
1.60E+02	1.76E-01	3.08E-18
2.00E+02	1.96E-01	2.73E-18
2.50E+02	2.20E-01	2.46E-18
3.15E+02	2.47E-01	2.16E-18
4.00E+02	2.78E-01	2.07E-18
5.00E+02	3.11E-01	1.39E-18
6.25E+02	3.47E-01	1.03E-18
8.00E+02	3.93E-01	1.31E-18
1.00E+03	4.39E-01	9.91E-19
1.25E+03	4.91E-01	1.10E-18
1.60E+03	5.56E-01	3.15E-18
2.00E+03	6.21E-01	5.49E-18
2.50E+03	6.95E-01	7.72E-18
3.00E+03	7.61E-01	1.12E-17

Fig.13 $H + N_2 \rightarrow H^- (\sigma_{0-1})$

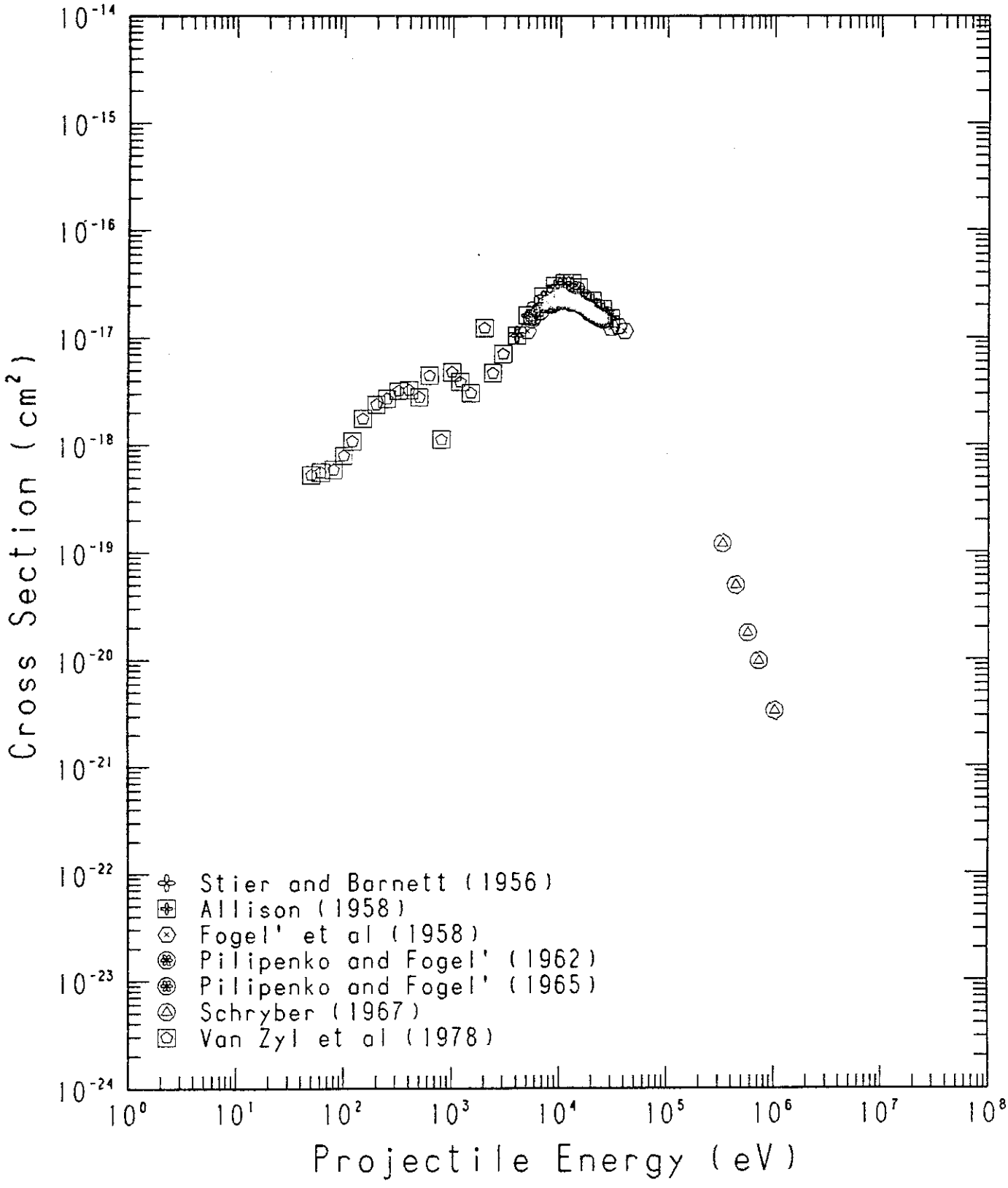

TABLE 13

PROCESS : H + N2 = H- (0-1)
STIER AND BARNETT, PHYS. REV. 103 896 (1956)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.00E+03	8.79E-01	1.06E-17
6.00E+03	1.08E+00	2.03E-17
8.00E+03	1.24E+00	2.57E-17
1.00E+04	1.39E+00	2.96E-17
1.20E+04	1.52E+00	3.05E-17
1.60E+04	1.76E+00	2.65E-17
2.00E+04	1.96E+00	2.19E-17
2.50E+04	2.20E+00	1.84E-17
3.00E+04	2.41E+00	1.52E-17

PROCESS : H + N2 = H- (0-1)
ALLISON, REV. MOD. PHYS. 30 1137 (1958)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.00E+03	8.79E-01	1.04E-17
5.00E+03	9.82E-01	1.60E-17
7.00E+03	1.16E+00	2.40E-17
9.00E+03	1.32E+00	3.00E-17
1.10E+04	1.46E+00	3.20E-17
1.30E+04	1.58E+00	3.20E-17
1.50E+04	1.70E+00	2.90E-17
2.00E+04	1.96E+00	2.20E-17
2.50E+04	2.20E+00	1.84E-17
3.00E+04	2.41E+00	1.50E-17

PROCESS : H + N2 = H- (0-1)
FOGEL' ET AL, SOV. PHYS. JETP 7 400 (1958)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+03	9.82E-01	1.15E-17
8.00E+03	1.24E+00	2.01E-17
1.00E+04	1.39E+00	2.42E-17
1.20E+04	1.52E+00	2.30E-17
1.50E+04	1.70E+00	2.06E-17
2.00E+04	1.96E+00	1.76E-17
2.50E+04	2.20E+00	1.58E-17
3.00E+04	2.41E+00	1.23E-17
3.50E+04	2.60E+00	1.28E-17
4.00E+04	2.78E+00	1.15E-17

TABLE 13 - CONTINUED

PROCESS : H + N2 = H- (0-1)
PILIPENKO AND FOGEL', SOV. PHYS. JETP 15 646 (1962)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.50E+03	1.03E+00	1.54E-17
6.51E+03	1.12E+00	1.75E-17
8.00E+03	1.24E+00	2.03E-17
8.59E+03	1.29E+00	2.05E-17
9.07E+03	1.32E+00	2.14E-17
1.00E+04	1.39E+00	2.19E-17
1.05E+04	1.42E+00	2.30E-17
1.10E+04	1.46E+00	2.32E-17
1.16E+04	1.50E+00	2.31E-17
1.21E+04	1.53E+00	2.21E-17
1.25E+04	1.55E+00	2.11E-17
1.30E+04	1.58E+00	2.11E-17
1.36E+04	1.62E+00	2.10E-17
1.40E+04	1.64E+00	2.10E-17
1.45E+04	1.67E+00	2.16E-17
1.51E+04	1.71E+00	2.05E-17
1.55E+04	1.73E+00	2.06E-17
1.61E+04	1.76E+00	1.96E-17
1.65E+04	1.78E+00	1.94E-17
1.70E+04	1.81E+00	1.92E-17
1.75E+04	1.84E+00	1.90E-17
1.80E+04	1.86E+00	1.89E-17
1.85E+04	1.89E+00	1.79E-17
1.90E+04	1.91E+00	1.71E-17
1.95E+04	1.94E+00	1.73E-17
2.00E+04	1.96E+00	1.70E-17
2.05E+04	1.99E+00	1.68E-17
2.10E+04	2.01E+00	1.62E-17
2.15E+04	2.04E+00	1.61E-17
2.20E+04	2.06E+00	1.57E-17
2.25E+04	2.08E+00	1.55E-17
2.30E+04	2.11E+00	1.53E-17
2.34E+04	2.12E+00	1.51E-17
2.40E+04	2.15E+00	1.50E-17
2.45E+04	2.17E+00	1.50E-17
2.50E+04	2.20E+00	1.47E-17
2.55E+04	2.22E+00	1.46E-17

PROCESS : H + N2 = H- (0-1)
PILIPENKO AND FOGEL', SOV. PHYS. JETP 21 266 (1965)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.50E+03	1.03E+00	1.47E-17
6.50E+03	1.12E+00	1.76E-17
7.50E+03	1.20E+00	2.02E-17

TABLE 13 - CONTINUED

8.00E+03	1.24E+00	2.02E-17
8.50E+03	1.28E+00	2.04E-17
9.00E+03	1.32E+00	2.15E-17
1.00E+04	1.39E+00	2.20E-17
1.05E+04	1.42E+00	2.31E-17
1.10E+04	1.46E+00	2.33E-17
1.15E+04	1.49E+00	2.33E-17
1.20E+04	1.52E+00	2.19E-17
1.25E+04	1.55E+00	2.16E-17
1.30E+04	1.58E+00	2.15E-17
1.35E+04	1.61E+00	2.14E-17
1.40E+04	1.64E+00	2.13E-17
1.45E+04	1.67E+00	2.15E-17
1.50E+04	1.70E+00	2.06E-17
1.55E+04	1.73E+00	2.06E-17
1.60E+04	1.76E+00	1.97E-17
1.65E+04	1.78E+00	1.95E-17
1.70E+04	1.81E+00	1.91E-17
1.75E+04	1.84E+00	1.90E-17
1.80E+04	1.86E+00	1.89E-17
1.85E+04	1.89E+00	1.83E-17
1.90E+04	1.91E+00	1.73E-17
1.95E+04	1.94E+00	1.75E-17
2.00E+04	1.96E+00	1.73E-17
2.05E+04	1.99E+00	1.69E-17
2.10E+04	2.01E+00	1.65E-17
2.15E+04	2.04E+00	1.61E-17
2.20E+04	2.06E+00	1.58E-17
2.25E+04	2.08E+00	1.56E-17
2.30E+04	2.11E+00	1.54E-17
2.35E+04	2.13E+00	1.51E-17
2.50E+04	2.20E+00	1.48E-17

PROCESS : H + N2 = H- (0-1)
SCHRYBER, HELV. PHYS. ACTA A40 1023 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
3.30E+05	7.98E+00	1.20E-19
4.40E+05	9.21E+00	4.94E-20
5.70E+05	1.05E+01	1.77E-20
7.20E+05	1.18E+01	9.71E-21
1.01E+06	1.40E+01	3.33E-21

PROCESS : H + N2 = H- (0-1)
VAN ZYL ET AL, PHYS. REV. A18 506 (1978)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+01	9.82E-02	5.26E-19

TABLE 13 - CONTINUED

6.10E+01	1.08E-01	5.57E-19
8.00E+01	1.24E-01	5.90E-19
1.00E+02	1.39E-01	7.93E-19
1.20E+02	1.52E-01	1.08E-18
1.50E+02	1.70E-01	1.75E-18
2.00E+02	1.96E-01	2.38E-18
2.50E+02	2.20E-01	2.70E-18
3.20E+02	2.48E-01	3.20E-18
4.00E+02	2.78E-01	3.25E-18
5.00E+02	3.11E-01	2.78E-18
6.20E+02	3.46E-01	4.43E-18
8.00E+02	3.93E-01	1.12E-18
1.00E+03	4.39E-01	4.76E-18
1.20E+03	4.81E-01	3.86E-18
1.50E+03	5.38E-01	3.04E-18
2.00E+03	6.21E-01	1.22E-17
2.40E+03	6.81E-01	4.64E-18
3.00E+03	7.61E-01	6.98E-18

Fig.14 $H + O_2 \rightarrow H^- (\sigma_{0-1})$

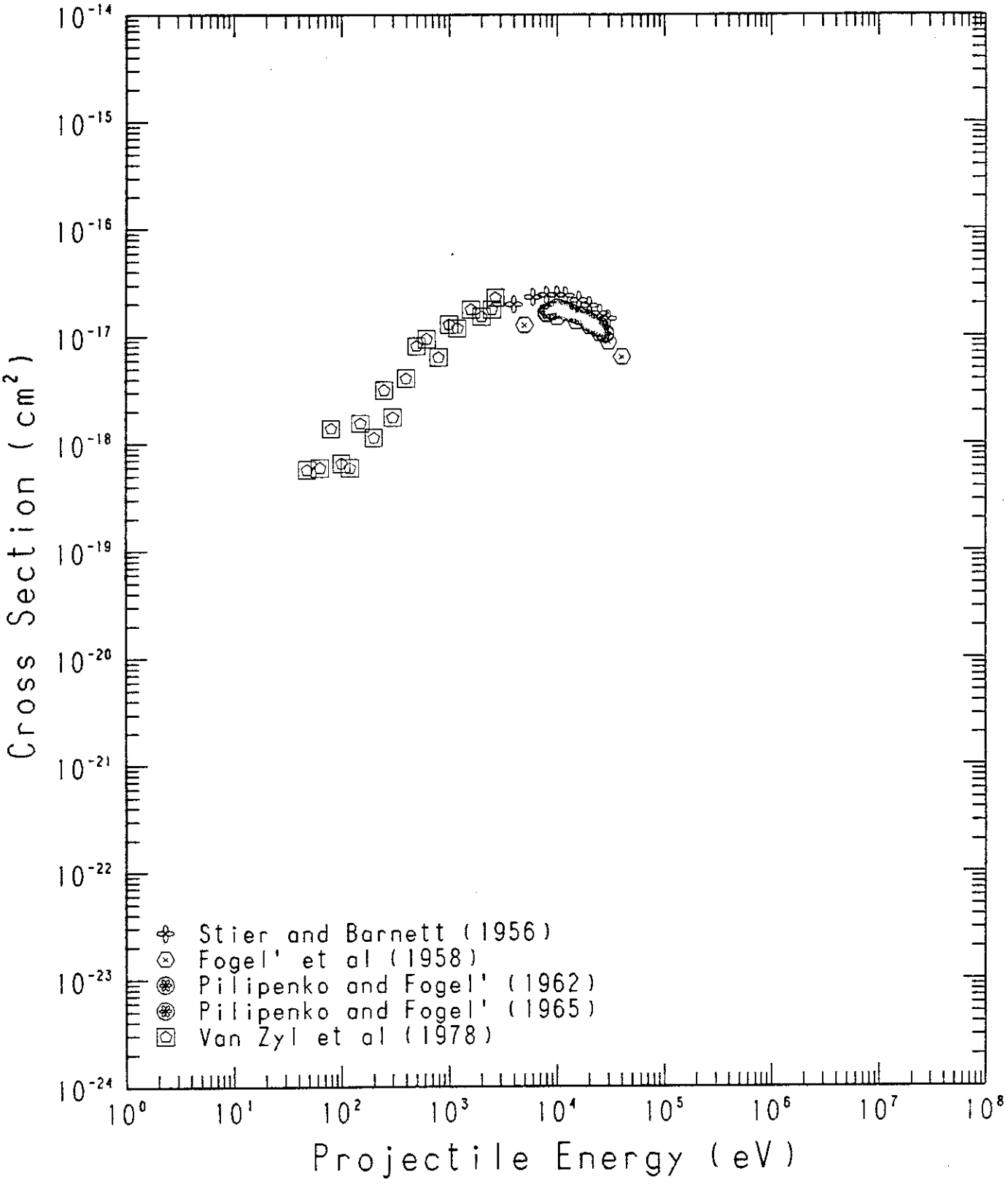

TABLE 14

PROCESS : H + O2 = H- (0-1)
STIER AND BARNETT, PHYS. REV. 103 896 (1956)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.00E+03	8.79E-01	1.97E-17
6.00E+03	1.08E+00	2.30E-17
8.00E+03	1.24E+00	2.40E-17
1.00E+04	1.39E+00	2.42E-17
1.20E+04	1.52E+00	2.38E-17
1.60E+04	1.76E+00	2.15E-17
2.00E+04	1.96E+00	1.92E-17
2.50E+04	2.20E+00	1.63E-17
3.00E+04	2.41E+00	1.45E-17

PROCESS : H + O2 = H- (0-1)
FOGEL' ET AL, SOV. PHYS. JETP 7 400 (1958)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+03	9.82E-01	1.26E-17
8.00E+03	1.24E+00	1.61E-17
1.00E+04	1.39E+00	1.49E-17
1.50E+04	1.70E+00	1.37E-17
2.00E+04	1.96E+00	1.24E-17
2.50E+04	2.20E+00	1.06E-17
3.00E+04	2.41E+00	8.83E-18
4.00E+04	2.78E+00	6.37E-18

PROCESS : H + O2 = H- (0-1)
PILIPENKO AND FOGEL', SOV. PHYS. JETP 15 646 (1962)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
8.07E+03	1.25E+00	1.62E-17
9.17E+03	1.33E+00	1.69E-17
1.00E+04	1.39E+00	1.83E-17
1.11E+04	1.46E+00	1.75E-17
1.21E+04	1.53E+00	1.67E-17
1.32E+04	1.60E+00	1.67E-17
1.37E+04	1.63E+00	1.62E-17
1.41E+04	1.65E+00	1.60E-17
1.61E+04	1.76E+00	1.52E-17
1.86E+04	1.89E+00	1.46E-17
1.91E+04	1.92E+00	1.39E-17
2.00E+04	1.96E+00	1.32E-17
2.11E+04	2.02E+00	1.30E-17
2.30E+04	2.11E+00	1.20E-17
2.51E+04	2.20E+00	1.23E-17
2.80E+04	2.32E+00	1.03E-17

TABLE 14 - CONTINUED

PROCESS : H + O2 = H- (0-1)
PILIPENKO AND FOGEL', SOV. PHYS. JETP 21 266 (1965)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
8.00E+03	1.24E+00	1.65E-17
9.00E+03	1.32E+00	1.73E-17
1.00E+04	1.39E+00	1.83E-17
1.10E+04	1.46E+00	1.79E-17
1.20E+04	1.52E+00	1.73E-17
1.30E+04	1.58E+00	1.69E-17
1.40E+04	1.64E+00	1.61E-17
1.60E+04	1.76E+00	1.55E-17
1.90E+04	1.91E+00	1.40E-17
2.00E+04	1.96E+00	1.36E-17
2.10E+04	2.01E+00	1.32E-17
2.30E+04	2.11E+00	1.24E-17
2.50E+04	2.20E+00	1.18E-17
2.80E+04	2.32E+00	1.06E-17

PROCESS : H + O2 = H- (0-1)
VAN ZYL ET AL, PHYS. REV. A18 506 (1978)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.80E+01	9.62E-02	5.72E-19
6.30E+01	1.10E-01	5.96E-19
8.00E+01	1.24E-01	1.38E-18
1.00E+02	1.39E-01	6.56E-19
1.20E+02	1.52E-01	5.94E-19
1.50E+02	1.70E-01	1.54E-18
2.00E+02	1.96E-01	1.13E-18
2.50E+02	2.20E-01	3.16E-18
3.00E+02	2.41E-01	1.75E-18
4.00E+02	2.78E-01	4.06E-18
5.00E+02	3.11E-01	8.07E-18
6.20E+02	3.46E-01	9.41E-18
8.00E+02	3.93E-01	6.34E-18
1.00E+03	4.39E-01	1.28E-17
1.20E+03	4.81E-01	1.18E-17
1.60E+03	5.56E-01	1.76E-17
2.00E+03	6.21E-01	1.51E-17
2.50E+03	6.95E-01	1.76E-17
2.70E+03	7.22E-01	2.27E-17

Fig.15 H + CO → H^- (σ_{0-1})

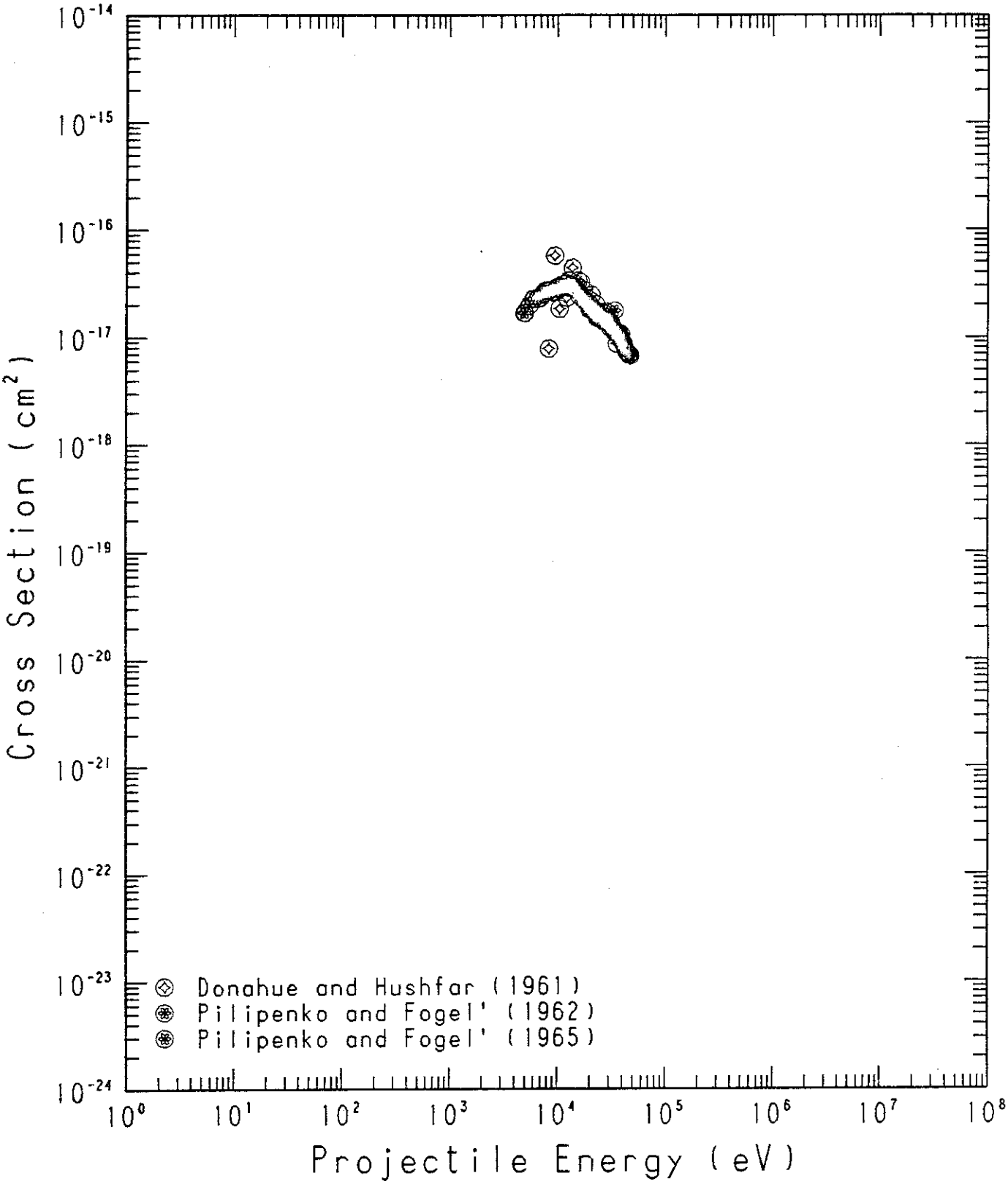

TABLE 15

PROCESS : H + CO = H- (0-1)
DONAHUE AND HUSHFAR, PHYS. REV. 124 138 (1961)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
8.38E+03	1.27E+00	7.81E-18
9.52E+03	1.36E+00	5.76E-17
1.05E+04	1.42E+00	1.83E-17
1.22E+04	1.53E+00	2.32E-17
1.28E+04	1.57E+00	3.36E-17
1.39E+04	1.64E+00	4.42E-17
1.57E+04	1.74E+00	3.35E-17
1.66E+04	1.79E+00	3.25E-17
1.77E+04	1.85E+00	2.73E-17
2.08E+04	2.00E+00	2.46E-17
2.29E+04	2.10E+00	2.01E-17
2.65E+04	2.26E+00	1.69E-17
2.89E+04	2.36E+00	1.70E-17
3.08E+04	2.44E+00	1.22E-17
3.56E+04	2.62E+00	8.70E-18
3.92E+04	2.75E+00	1.06E-17

PROCESS : H + CO = H- (0-1)
PILIPENKO AND FOGEL', SOV. PHYS. JETP 15 646 (1962)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.94E+03	9.76E-01	1.67E-17
5.48E+03	1.03E+00	1.95E-17
5.95E+03	1.07E+00	2.25E-17
6.50E+03	1.12E+00	2.24E-17
6.97E+03	1.16E+00	2.31E-17
7.31E+03	1.19E+00	2.54E-17
7.78E+03	1.23E+00	2.69E-17
8.25E+03	1.26E+00	2.70E-17
8.86E+03	1.31E+00	2.61E-17
9.34E+03	1.34E+00	2.62E-17
9.87E+03	1.38E+00	2.86E-17
1.04E+04	1.42E+00	2.96E-17
1.10E+04	1.46E+00	2.94E-17
1.14E+04	1.48E+00	3.11E-17
1.20E+04	1.52E+00	2.97E-17
1.25E+04	1.55E+00	2.97E-17
1.29E+04	1.58E+00	2.88E-17
1.34E+04	1.61E+00	2.93E-17
1.39E+04	1.64E+00	2.97E-17
1.45E+04	1.67E+00	2.93E-17
1.50E+04	1.70E+00	2.73E-17
1.55E+04	1.73E+00	2.70E-17
1.60E+04	1.76E+00	2.42E-17

TABLE 15 - CONTINUED

1.70E+04	1.81E+00	2.29E-17
1.74E+04	1.83E+00	2.26E-17
1.80E+04	1.86E+00	2.18E-17
1.85E+04	1.89E+00	2.11E-17
1.95E+04	1.94E+00	2.04E-17
2.00E+04	1.96E+00	1.80E-17
2.05E+04	1.99E+00	1.85E-17
2.10E+04	2.01E+00	1.80E-17
2.15E+04	2.04E+00	1.80E-17
2.20E+04	2.06E+00	1.80E-17
2.25E+04	2.08E+00	1.70E-17
2.30E+04	2.11E+00	1.71E-17
2.35E+04	2.13E+00	1.50E-17
2.41E+04	2.16E+00	1.50E-17
2.42E+04	2.16E+00	1.52E-17
2.49E+04	2.19E+00	1.50E-17
2.54E+04	2.21E+00	1.50E-17
2.59E+04	2.24E+00	1.50E-17
2.64E+04	2.26E+00	1.49E-17
2.69E+04	2.28E+00	1.39E-17
2.80E+04	2.32E+00	1.38E-17
2.94E+04	2.38E+00	1.40E-17
2.99E+04	2.40E+00	1.34E-17
3.04E+04	2.42E+00	1.36E-17
3.10E+04	2.45E+00	1.35E-17
3.14E+04	2.46E+00	1.31E-17
3.19E+04	2.48E+00	1.26E-17
3.25E+04	2.50E+00	1.24E-17
3.30E+04	2.52E+00	1.18E-17
3.34E+04	2.54E+00	1.16E-17
3.40E+04	2.56E+00	1.76E-17
3.44E+04	2.58E+00	1.09E-17
3.50E+04	2.60E+00	1.10E-17
3.55E+04	2.62E+00	1.10E-17
3.65E+04	2.65E+00	1.09E-17
3.69E+04	2.67E+00	1.07E-17
3.74E+04	2.69E+00	1.08E-17
3.79E+04	2.70E+00	1.03E-17
3.84E+04	2.72E+00	9.98E-18
3.90E+04	2.74E+00	9.70E-18
3.95E+04	2.76E+00	9.43E-18
3.99E+04	2.77E+00	9.16E-18
4.10E+04	2.81E+00	8.75E-18
4.20E+04	2.85E+00	8.20E-18
4.29E+04	2.88E+00	7.79E-18
4.40E+04	2.91E+00	7.31E-18
4.50E+04	2.95E+00	7.18E-18
4.60E+04	2.98E+00	6.90E-18
4.70E+04	3.01E+00	6.83E-18
4.79E+04	3.04E+00	6.70E-18

TABLE 15 - CONTINUED

PROCESS : H + CO = H- (0-1)
PILIPENKO AND FOGEL', SOV. PHYS. JETP 21 266 (1965)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+03	9.82E-01	1.67E-17
5.50E+03	1.03E+00	1.95E-17
6.00E+03	1.08E+00	2.24E-17
6.50E+03	1.12E+00	2.25E-17
7.00E+03	1.16E+00	2.32E-17
7.50E+03	1.20E+00	2.52E-17
8.00E+03	1.24E+00	2.71E-17
8.50E+03	1.28E+00	2.71E-17
9.00E+03	1.32E+00	2.62E-17
9.50E+03	1.35E+00	2.63E-17
1.00E+04	1.39E+00	2.86E-17
1.05E+04	1.42E+00	2.95E-17
1.10E+04	1.46E+00	2.93E-17
1.15E+04	1.49E+00	3.11E-17
1.20E+04	1.52E+00	2.96E-17
1.25E+04	1.55E+00	2.96E-17
1.30E+04	1.58E+00	2.86E-17
1.35E+04	1.61E+00	2.94E-17
1.40E+04	1.64E+00	2.96E-17
1.45E+04	1.67E+00	2.94E-17
1.50E+04	1.70E+00	2.73E-17
1.55E+04	1.73E+00	2.70E-17
1.60E+04	1.76E+00	2.43E-17
1.70E+04	1.81E+00	2.29E-17
1.75E+04	1.84E+00	2.24E-17
1.80E+04	1.86E+00	2.19E-17
1.85E+04	1.89E+00	2.11E-17
1.95E+04	1.94E+00	2.05E-17
2.00E+04	1.96E+00	2.02E-17
2.05E+04	1.99E+00	1.86E-17
2.10E+04	2.01E+00	1.81E-17
2.15E+04	2.04E+00	1.81E-17
2.20E+04	2.06E+00	1.81E-17
2.25E+04	2.08E+00	1.72E-17
2.30E+04	2.11E+00	1.74E-17
2.35E+04	2.13E+00	1.51E-17
2.40E+04	2.15E+00	1.52E-17
2.45E+04	2.17E+00	1.53E-17
2.50E+04	2.20E+00	1.51E-17
2.55E+04	2.22E+00	1.51E-17
2.60E+04	2.24E+00	1.51E-17
2.65E+04	2.26E+00	1.50E-17
2.70E+04	2.28E+00	1.40E-17
2.80E+04	2.32E+00	1.41E-17
2.95E+04	2.39E+00	1.43E-17

TABLE 15 - CONTINUED

3.00E+04	2.41E+00	1.36E-17
3.05E+04	2.43E+00	1.38E-17
3.10E+04	2.45E+00	1.38E-17
3.15E+04	2.47E+00	1.35E-17

Fig.16 $H^+ + H_2 \rightarrow H^- (\sigma_{1-1})$

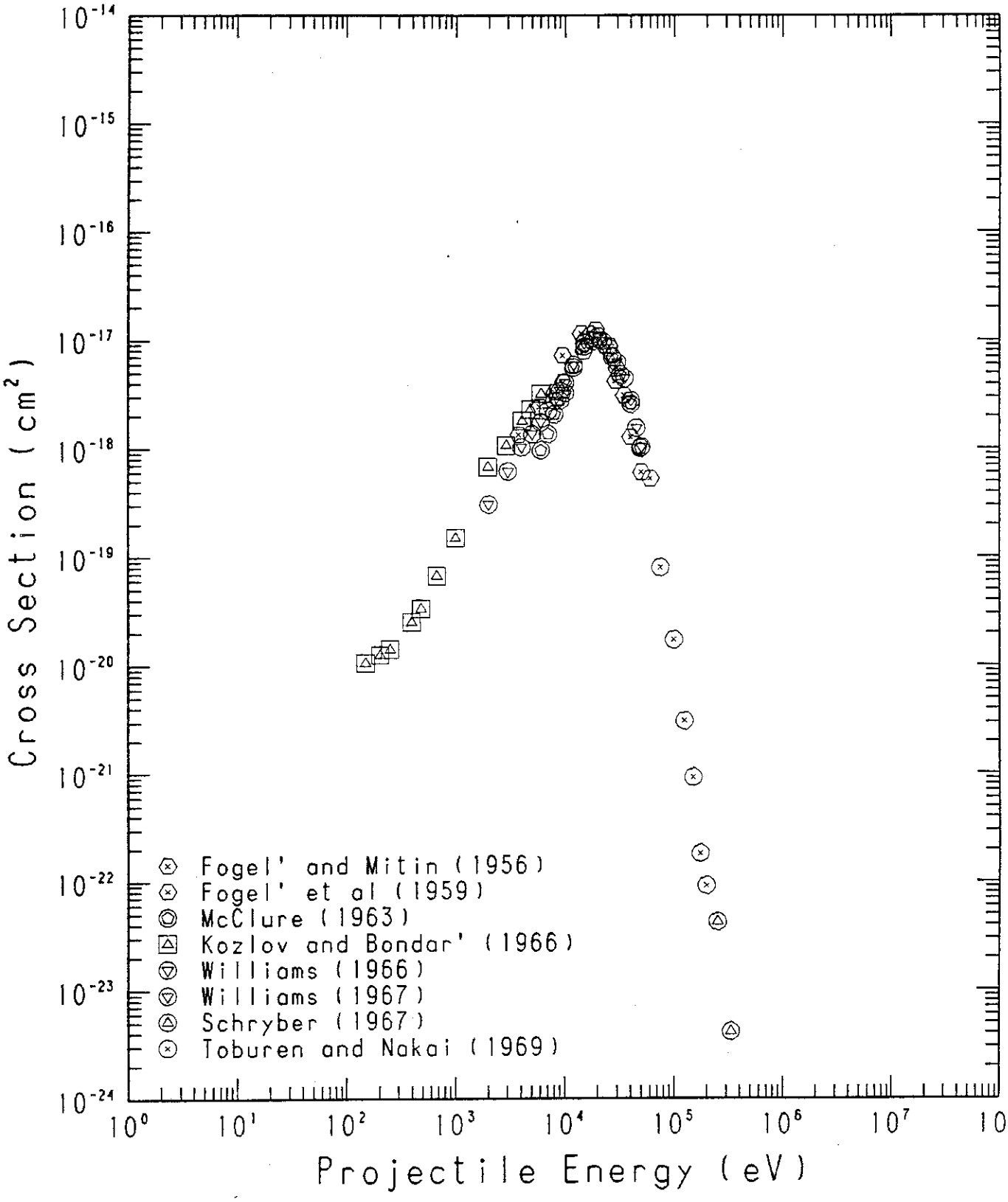

TABLE 16

PROCESS : H+ + H2 = H- (1-1)
FOGEL' AND MITIN, SOV. PHYS. JETP 3 334 (1956)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
9.50E+03	1.35E+00	7.22E-18
1.40E+04	1.64E+00	1.15E-17
1.90E+04	1.91E+00	1.24E-17
2.30E+04	2.11E+00	8.92E-18
2.70E+04	2.28E+00	7.22E-18
2.90E+04	2.37E+00	4.20E-18

PROCESS : H+ + H2 = H- (1-1)
FOGEL' ET AL, SOV. PHYS. JETP 8 390 (1959)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
3.76E+03	8.52E-01	1.33E-18
5.81E+03	1.06E+00	2.41E-18
8.07E+03	1.25E+00	3.29E-18
9.58E+03	1.36E+00	4.09E-18
1.48E+04	1.69E+00	7.84E-18
2.05E+04	1.99E+00	1.00E-17
2.53E+04	2.21E+00	8.78E-18
2.97E+04	2.39E+00	5.46E-18
3.46E+04	2.58E+00	3.08E-18
3.97E+04	2.77E+00	1.27E-18
4.98E+04	3.10E+00	6.03E-19
6.00E+04	3.40E+00	5.27E-19

PROCESS : H+ + H2 = H- (1-1)
MCCLURE, PHYS. REV. 132 1636 (1963)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
6.00E+03	1.08E+00	9.60E-19
7.00E+03	1.16E+00	1.36E-18
8.00E+03	1.24E+00	2.07E-18
9.00E+03	1.32E+00	2.76E-18
1.00E+04	1.39E+00	3.25E-18
1.20E+04	1.52E+00	5.56E-18
1.50E+04	1.70E+00	8.62E-18
1.80E+04	1.86E+00	9.78E-18
2.20E+04	2.06E+00	9.79E-18
2.70E+04	2.28E+00	6.92E-18
3.20E+04	2.48E+00	4.80E-18
4.00E+04	2.78E+00	2.57E-18
4.90E+04	3.07E+00	1.00E-18

TABLE 16 - CONTINUED

PROCESS : H+ + H2 = H- (1-1)
KOZLOV AND BONDAR', SOV. PHYS. JETP 23 195 (1966)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.50E+02	1.70E-01	1.06E-20
2.04E+02	1.98E-01	1.26E-20
2.52E+02	2.21E-01	1.42E-20
3.96E+02	2.76E-01	2.52E-20
4.84E+02	3.06E-01	3.35E-20
6.76E+02	3.61E-01	6.68E-20
1.00E+03	4.39E-01	1.50E-19
1.97E+03	6.17E-01	6.73E-19
2.89E+03	7.47E-01	1.06E-18
4.05E+03	8.84E-01	1.79E-18
4.86E+03	9.68E-01	2.29E-18
6.04E+03	1.08E+00	3.17E-18

PROCESS : H+ + H2 = H- (1-1)
WILLIAMS, PHYS. REV. 150 7 (1966)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.00E+03	6.21E-01	3.07E-19
3.00E+03	7.61E-01	6.15E-19
4.00E+03	8.79E-01	1.02E-18
5.00E+03	9.82E-01	1.35E-18
6.00E+03	1.08E+00	1.74E-18
7.00E+03	1.16E+00	2.21E-18
8.00E+03	1.24E+00	2.75E-18
9.00E+03	1.32E+00	3.40E-18
1.00E+04	1.39E+00	4.03E-18
1.20E+04	1.52E+00	5.84E-18
1.50E+04	1.70E+00	9.39E-18
1.75E+04	1.84E+00	1.11E-17
2.00E+04	1.96E+00	1.07E-17
2.50E+04	2.20E+00	8.46E-18
3.00E+04	2.41E+00	6.23E-18
3.50E+04	2.60E+00	4.44E-18
4.00E+04	2.78E+00	2.78E-18
4.50E+04	2.95E+00	1.54E-18
5.00E+04	3.11E+00	1.03E-18

TABLE 16 - CONTINUED

PROCESS : H+ + H2 = H- (1-1)
WILLIAMS, PHYS. REV. 157 97 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.00E+05	8.79E+00	5.23E-25
4.60E+05	9.42E+00	3.04E-25
4.80E+05	9.62E+00	8.92E-26
5.80E+05	1.06E+01	2.67E-26
6.30E+05	1.10E+01	1.85E-26
7.00E+05	1.16E+01	3.69E-27
8.00E+05	1.24E+01	3.04E-27
9.00E+05	1.32E+01	7.36E-28
1.00E+06	1.39E+01	1.60E-28

PROCESS : H+ + H2 = H- (1-1)
SCHRYBER, HELV. PHYS. ACTA A40 1023 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.53E+05	6.99E+00	4.20E-23
3.33E+05	8.02E+00	4.10E-24
4.60E+05	9.42E+00	8.10E-26

PROCESS : H+ + H2 = H- (1-1)
TOBUREN AND NAKAI, PHYS. REV. 177 191 (1969)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
7.50E+04	3.80E+00	7.97E-20
1.00E+05	4.39E+00	1.73E-20
1.25E+05	4.91E+00	3.08E-21
1.50E+05	5.38E+00	9.18E-22
1.75E+05	5.81E+00	1.82E-22
2.00E+05	6.21E+00	9.10E-23

Fig.17 $H^+ + N_2 \rightarrow H^- (\sigma_{1-1})$

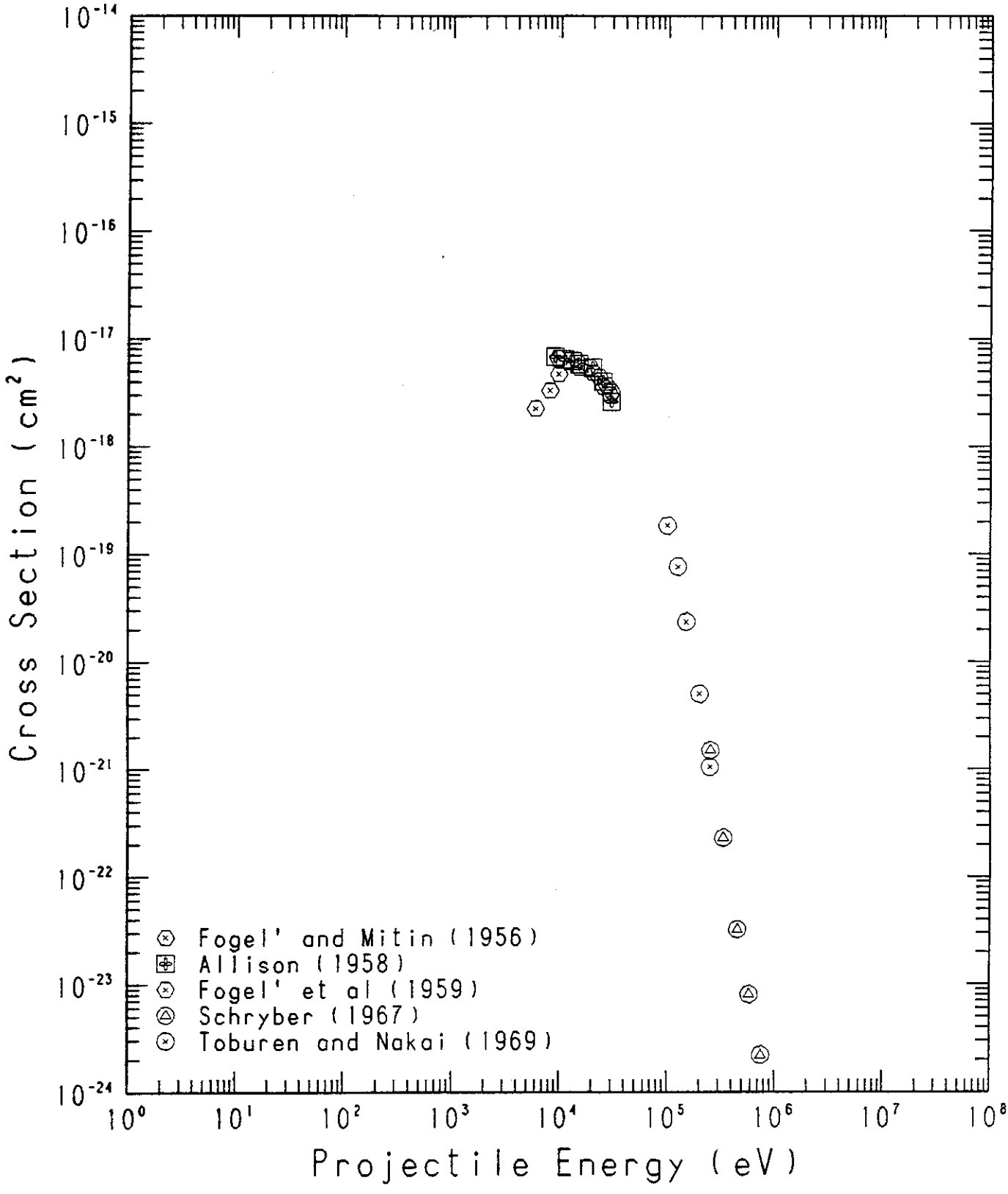

TABLE 17

PROCESS : H+ + N2 = H- (1-1)
FOGEL' ET AL, SOV. PHYS. JETP 8 390 (1959)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.92E+03	1.07E+00	2.25E-18
8.07E+03	1.25E+00	3.31E-18
9.71E+03	1.37E+00	4.70E-18
1.50E+04	1.70E+00	5.38E-18
2.00E+04	1.96E+00	4.86E-18
2.52E+04	2.21E+00	3.59E-18
3.00E+04	2.41E+00	3.24E-18

PROCESS : H+ + N2 = H- (1-1)
ALLISON, REV. MOD. PHYS. 30 1137 (1958)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
9.00E+03	1.32E+00	6.80E-18
1.10E+04	1.46E+00	6.40E-18
1.30E+04	1.58E+00	6.20E-18
1.50E+04	1.70E+00	5.80E-18
2.00E+04	1.96E+00	5.40E-18
2.50E+04	2.20E+00	4.00E-18
3.00E+04	2.41E+00	2.60E-18

PROCESS : H+ + N2 = H- (1-1)
FOGEL' AND MITIN, SOV. PHYS. JETP 3 334 (1956)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
9.50E+03	1.35E+00	6.66E-18
1.40E+04	1.64E+00	6.40E-18
1.90E+04	1.91E+00	5.40E-18
2.30E+04	2.11E+00	4.40E-18
2.70E+04	2.28E+00	3.70E-18
2.90E+04	2.37E+00	3.02E-18

PROCESS : H+ + N2 = H- (1-1)
SCHRYBER, HELV. PHYS. ACTA A40 1023 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.53E+05	6.99E+00	1.50E-21
3.33E+05	8.02E+00	2.30E-22
4.55E+05	9.37E+00	3.20E-23
5.85E+05	1.06E+01	8.00E-24
7.49E+05	1.20E+01	2.20E-24
1.02E+06	1.40E+01	5.70E-25

TABLE 17 - CONTINUED

PROCESS : H+ + N2 = H- (1-1)
TOBUREN AND NAKAI, PHYS. REV. 177 191 (1969)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	1.85E-19
1.25E+05	4.91E+00	7.63E-20
1.50E+05	5.38E+00	2.36E-20
2.00E+05	6.21E+00	5.06E-21
2.50E+05	6.95E+00	1.05E-21

Fig.18 $H^+ + O_2 \rightarrow H^- (\sigma_{1-1})$

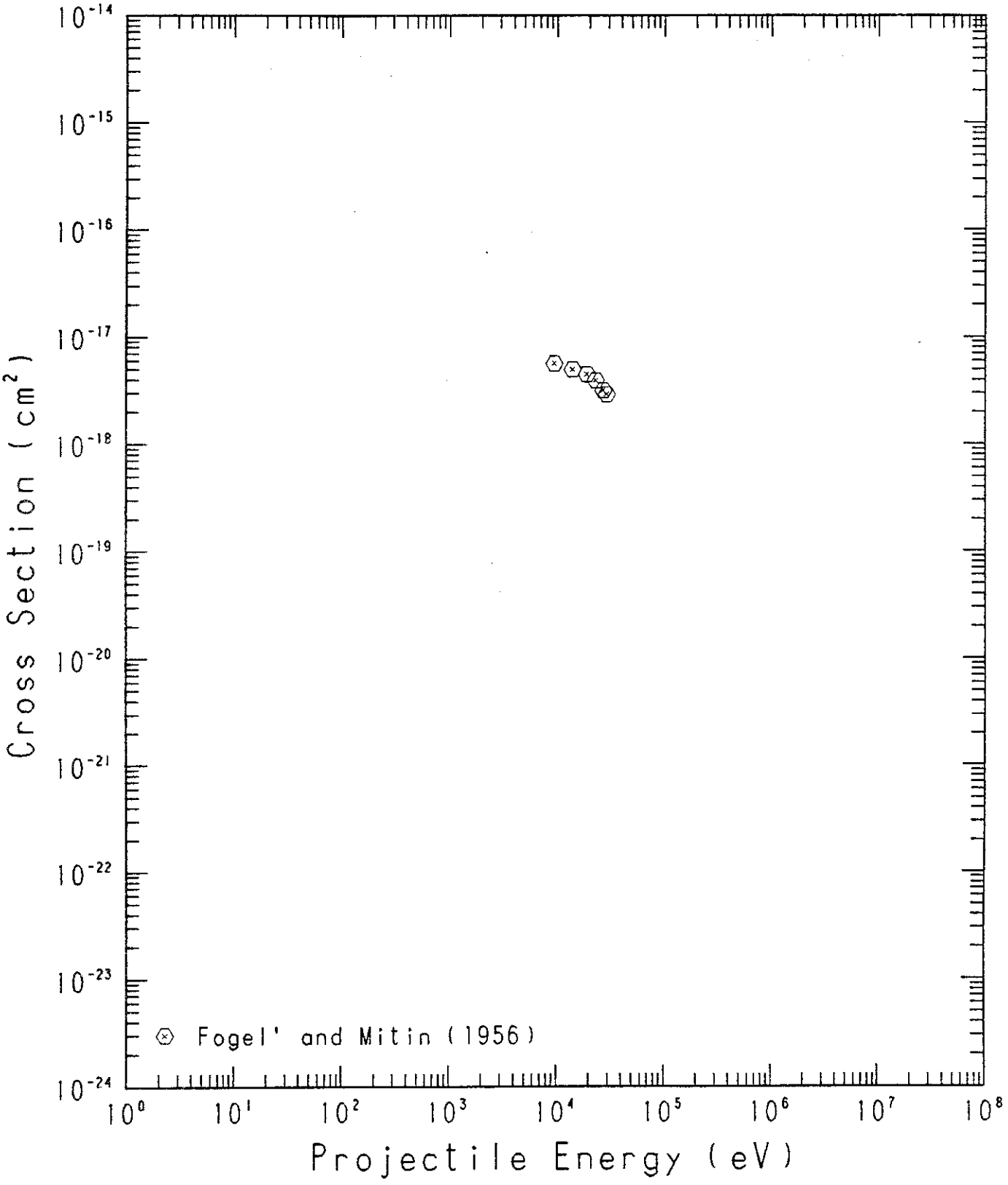

TABLE 18

PROCESS : H+ + O2 = H- (1-1)
FOGEL' AND MITIN, SOV. PHYS. JETP 3 334 (1956)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
9.50E+03	1.35E+00	5.63E-18
1.40E+04	1.64E+00	4.96E-18
1.90E+04	1.91E+00	4.46E-18
2.30E+04	2.11E+00	3.93E-18
2.70E+04	2.28E+00	3.17E-18
2.90E+04	2.37E+00	2.91E-18

Fig.19 $H^+ + H_2O \rightarrow H^- (\sigma_{1-1})$

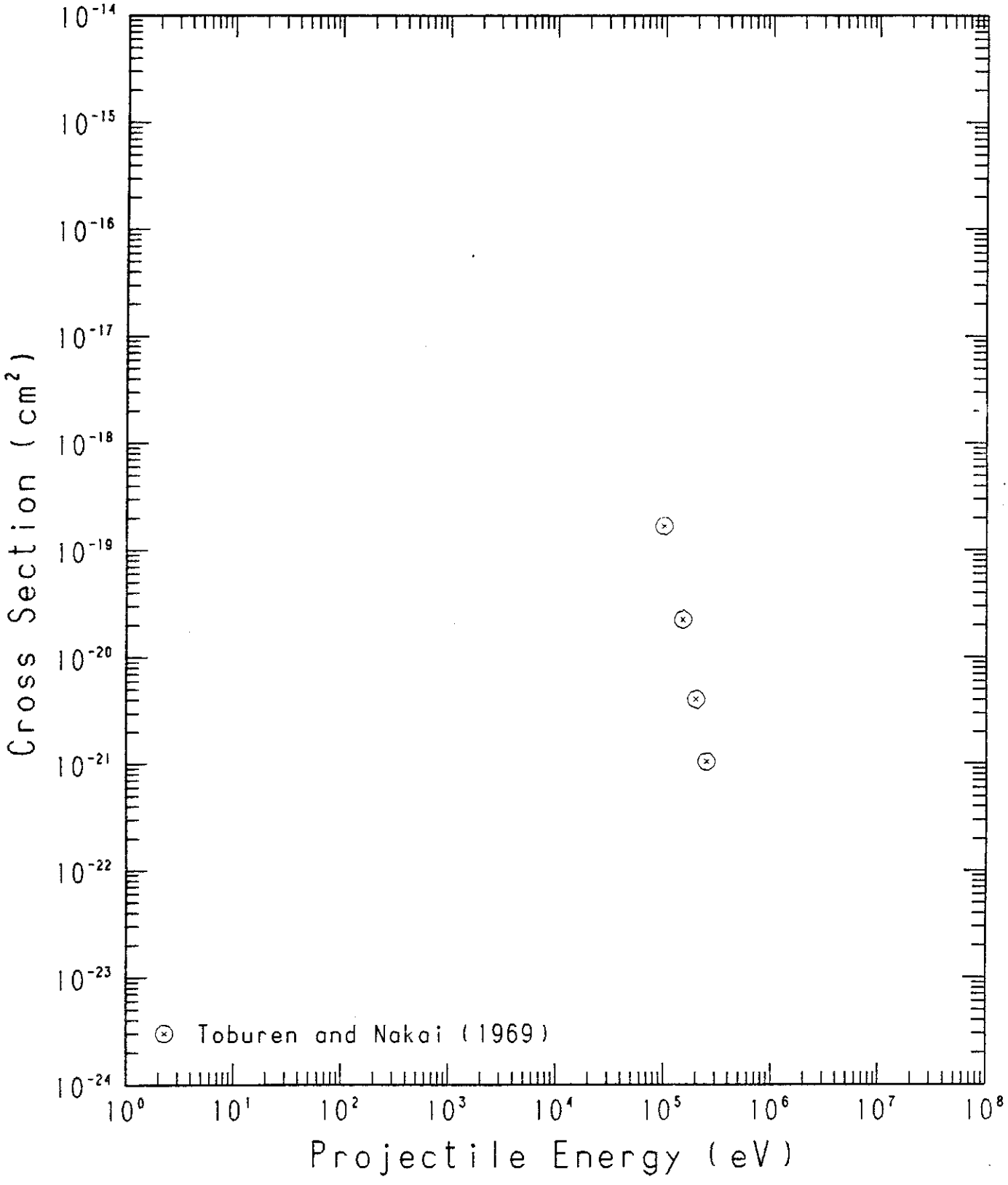

TABLE 19

PROCESS : H+ + H2O = H- (1-1)
TOBUREN AND NAKAI, PHYS. REV. 177 191 (1969)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	1.68E-19
1.50E+05	5.38E+00	2.25E-20
2.00E+05	6.21E+00	4.05E-21
2.50E+05	6.95E+00	1.05E-21

Fig.20 $H + H_2 \rightarrow H^+ (\sigma_{01})$

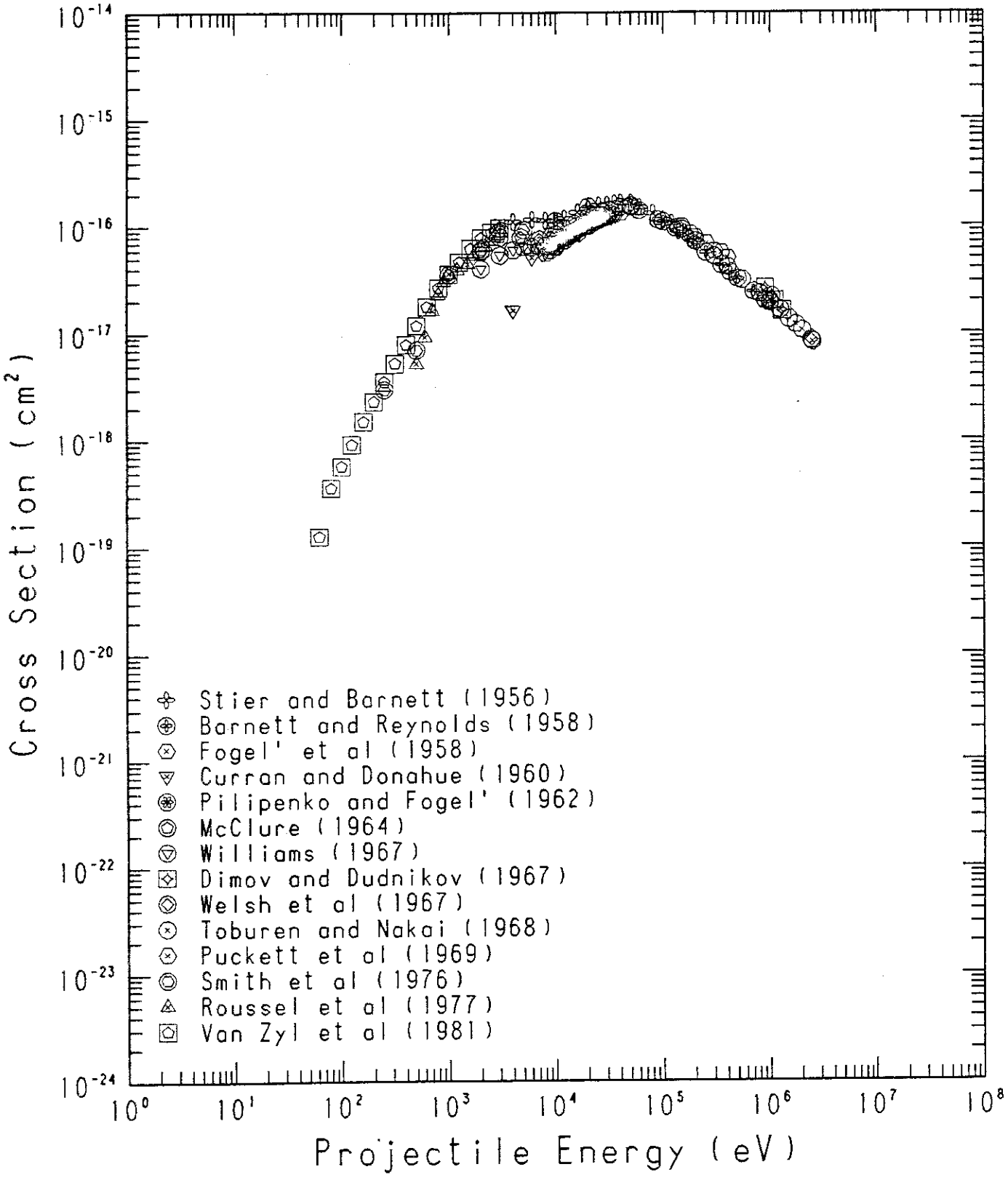

TABLE 20

PROCESS : H + H2 = H+ (01)
STIER AND BARNETT, PHYS. REV. 103 896 (1956)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.00E+03	8.79E-01	1.09E-16
6.00E+03	1.08E+00	1.14E-16
8.00E+03	1.24E+00	1.12E-16
1.00E+04	1.39E+00	1.10E-16
1.20E+04	1.52E+00	1.17E-16
1.60E+04	1.76E+00	1.33E-16
2.00E+04	1.96E+00	1.43E-16
2.50E+04	2.20E+00	1.55E-16
3.00E+04	2.41E+00	1.57E-16
3.50E+04	2.60E+00	1.62E-16
4.00E+04	2.78E+00	1.64E-16
5.00E+04	3.11E+00	1.64E-16
6.00E+04	3.40E+00	1.49E-16
8.00E+04	3.93E+00	1.31E-16
1.00E+05	4.39E+00	1.13E-16
1.20E+05	4.81E+00	1.05E-16
1.40E+05	5.20E+00	8.92E-17
1.60E+05	5.56E+00	8.49E-17
1.80E+05	5.89E+00	7.59E-17
2.00E+05	6.21E+00	7.23E-17

PROCESS : H + H2 = H+ (01)
BARNETT AND REYNOLDS, PHYS. REV. 109 355 (1958)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+04	1.39E+00	1.11E-16
2.00E+04	1.96E+00	1.51E-16
5.00E+04	3.11E+00	1.55E-16
1.00E+05	4.39E+00	1.09E-16
1.50E+05	5.38E+00	9.22E-17
2.00E+05	6.21E+00	7.21E-17
2.50E+05	6.95E+00	5.63E-17
3.50E+05	8.22E+00	4.29E-17
4.25E+05	9.06E+00	3.64E-17
5.00E+05	9.82E+00	3.18E-17
7.00E+05	1.16E+01	2.42E-17
9.00E+05	1.32E+01	2.00E-17
1.00E+06	1.39E+01	1.90E-17

TABLE 20 - CONTINUED

PROCESS : H + H2 = H+ (01)
FOGEL' ET AL, SOV. PHYS. JETP 7 400 (1958)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
8.00E+03	1.24E+00	5.49E-17
1.00E+04	1.39E+00	6.24E-17
1.50E+04	1.70E+00	8.55E-17
2.00E+04	1.96E+00	1.07E-16
2.50E+04	2.20E+00	1.17E-16
3.00E+04	2.41E+00	1.21E-16
3.50E+04	2.60E+00	1.27E-16
4.00E+04	2.78E+00	1.32E-16

PROCESS : H + H2 = H+ (01)
CURRAN AND DONAHUE, PHYS. REV. 118 1233 (1960)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.00E+03	8.79E-01	1.63E-17
6.00E+03	1.08E+00	5.07E-17
7.00E+03	1.16E+00	6.05E-17
8.00E+03	1.24E+00	5.73E-17
1.00E+04	1.39E+00	6.60E-17
1.10E+04	1.46E+00	6.60E-17
1.20E+04	1.52E+00	7.93E-17
1.30E+04	1.58E+00	8.54E-17
1.40E+04	1.64E+00	9.10E-17
1.50E+04	1.70E+00	9.35E-17
1.60E+04	1.76E+00	9.14E-17
1.80E+04	1.86E+00	9.80E-17
1.90E+04	1.91E+00	1.04E-16
2.00E+04	1.96E+00	1.05E-16
2.20E+04	2.06E+00	1.06E-16
2.30E+04	2.11E+00	1.10E-16
2.50E+04	2.20E+00	1.13E-16
2.60E+04	2.24E+00	1.16E-16
2.90E+04	2.37E+00	1.19E-16
3.30E+04	2.52E+00	1.21E-16
3.60E+04	2.64E+00	1.24E-16

PROCESS : H + H2 = H+ (01)
PILIPENKO AND FOGEL', SOV. PHYS. JETP 15 646 (1962)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
9.00E+03	1.32E+00	5.96E-17
1.00E+04	1.39E+00	6.47E-17
1.10E+04	1.46E+00	6.97E-17

TABLE 20 - CONTINUED

1.20E+04	1.52E+00	7.23E-17
1.30E+04	1.58E+00	7.90E-17
1.40E+04	1.64E+00	8.23E-17
1.50E+04	1.70E+00	8.94E-17
1.60E+04	1.76E+00	9.23E-17
1.70E+04	1.81E+00	9.59E-17
1.80E+04	1.86E+00	9.70E-17
1.90E+04	1.91E+00	1.00E-16
2.00E+04	1.96E+00	1.00E-16
2.10E+04	2.01E+00	1.02E-16
2.20E+04	2.06E+00	1.08E-16
2.30E+04	2.11E+00	1.08E-16
2.40E+04	2.15E+00	1.13E-16
2.50E+04	2.20E+00	1.15E-16
2.60E+04	2.24E+00	1.16E-16
2.70E+04	2.28E+00	1.18E-16
2.80E+04	2.32E+00	1.20E-16
2.86E+04	2.35E+00	1.20E-16
3.00E+04	2.41E+00	1.21E-16

PROCESS : H + H2 = H+ (01)
MCCLURE, PHYS. REV. 134 A1226 (1964)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.00E+03	6.21E-01	5.96E-17
3.00E+03	7.61E-01	7.86E-17
4.70E+03	9.52E-01	7.80E-17
7.00E+03	1.16E+00	7.43E-17
9.00E+03	1.32E+00	7.88E-17
1.00E+04	1.39E+00	8.31E-17
1.50E+04	1.70E+00	1.04E-16
2.30E+04	2.11E+00	1.26E-16
4.00E+04	2.78E+00	1.50E-16
6.00E+04	3.40E+00	1.39E-16
9.00E+04	4.17E+00	1.13E-16
1.30E+05	5.01E+00	9.52E-17

PROCESS : H + H2 = H+ (01)
WILLIAMS, PHYS. REV. 153 116 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.00E+03	6.21E-01	3.98E-17
3.00E+03	7.61E-01	5.33E-17
4.00E+03	8.79E-01	5.97E-17
5.00E+03	9.82E-01	6.37E-17
6.00E+03	1.08E+00	6.33E-17
7.00E+03	1.16E+00	6.47E-17

TABLE 20 - CONTINUED

8.00E+03	1.24E+00	6.48E-17
9.00E+03	1.32E+00	6.71E-17
1.00E+04	1.39E+00	7.26E-17
1.25E+04	1.55E+00	8.02E-17
1.60E+04	1.76E+00	8.56E-17
1.80E+04	1.86E+00	1.04E-16
2.00E+04	1.96E+00	1.19E-16
2.60E+04	2.24E+00	1.27E-16
3.00E+04	2.41E+00	1.37E-16
4.00E+04	2.78E+00	1.50E-16
5.00E+04	3.11E+00	1.50E-16

PROCESS : H + H2 = H+ (01)
DIMOV AND DUDNIKOV, SOV. PHYS.-TECH. PHYS. 11 919 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
9.00E+05	1.32E+01	2.60E-17
1.10E+06	1.46E+01	2.00E-17
1.30E+06	1.58E+01	1.60E-17

PROCESS : H + H2 = H+ (01)
WELSH ET AL, PHYS. REV. 158 85 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.03E+06	1.41E+01	2.20E-17
2.44E+06	2.17E+01	8.50E-18

PROCESS : H + H2 = H+ (01)
TOBUREN AND NAKAI, PHYS. REV. 171 114 (1968)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	1.09E-16
2.00E+05	6.21E+00	7.14E-17
3.00E+05	7.61E+00	5.18E-17
4.00E+05	8.79E+00	4.11E-17
5.50E+05	1.03E+01	3.10E-17
8.00E+05	1.24E+01	2.31E-17
1.00E+06	1.39E+01	1.97E-17
1.25E+06	1.55E+01	1.63E-17
1.50E+06	1.70E+01	1.34E-17
1.75E+06	1.84E+01	1.19E-17
2.00E+06	1.96E+01	1.05E-17
2.50E+06	2.20E+01	8.20E-18

TABLE 20 - CONTINUED

PROCESS : H + H2 = H+ (01)
PUCKETT ET AL, PHYS. REV. 178 271 (1969)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.50E+05	5.38E+00	9.90E-17
1.80E+05	5.89E+00	8.50E-17
2.00E+05	6.21E+00	7.80E-17
2.50E+05	6.95E+00	6.90E-17
3.00E+05	7.61E+00	5.80E-17
3.50E+05	8.22E+00	5.60E-17
4.00E+05	8.79E+00	5.00E-17

PROCESS : H + H2 = H+ (01)
SMITH ET AL, J. GEOPHYS. RES. 81 2231 (1976)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.50E+02	2.20E-01	3.00E-18
5.00E+02	3.11E-01	7.00E-18
1.00E+03	4.39E-01	3.50E-17
2.00E+03	6.21E-01	5.80E-17
3.00E+03	7.61E-01	9.00E-17
5.00E+03	9.82E-01	9.20E-17

PROCESS : H + H2 = H+ (01)
ROUSSEL ET AL, PHYS. REV. A16 1854 (1977)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+02	3.11E-01	5.21E-18
6.00E+02	3.40E-01	9.25E-18
7.00E+02	3.68E-01	1.63E-17
8.00E+02	3.93E-01	2.28E-17
9.00E+02	4.17E-01	3.05E-17
1.00E+03	4.39E-01	3.60E-17
1.20E+03	4.81E-01	3.87E-17
1.50E+03	5.38E-01	4.43E-17
1.70E+03	5.73E-01	5.27E-17
2.00E+03	6.21E-01	6.37E-17
2.20E+03	6.52E-01	6.49E-17
2.50E+03	6.95E-01	7.30E-17
2.70E+03	7.22E-01	8.21E-17
3.00E+03	7.61E-01	9.41E-17

TABLE 20 - CONTINUED

PROCESS : H + H2 = H+ (01)
VAN ZYL ET AL, J. CHEM. PHYS. 74 314 (1981)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
6.25E+01	1.10E-01	1.27E-19
8.00E+01	1.24E-01	3.60E-19
1.00E+02	1.39E-01	5.70E-19
1.25E+02	1.55E-01	9.12E-19
1.60E+02	1.76E-01	1.50E-18
2.00E+02	1.96E-01	2.31E-18
2.50E+02	2.20E-01	3.55E-18
3.15E+02	2.47E-01	5.25E-18
4.00E+02	2.78E-01	7.85E-18
5.00E+02	3.11E-01	1.18E-17
6.25E+02	3.47E-01	1.77E-17
8.00E+02	3.93E-01	2.65E-17
1.00E+03	4.39E-01	3.53E-17
1.25E+03	4.91E-01	4.61E-17
1.60E+03	5.56E-01	6.14E-17
2.00E+03	6.21E-01	7.72E-17
2.50E+03	6.95E-01	8.66E-17
3.00E+03	7.61E-01	9.52E-17

Fig.21 $H + N_2 \rightarrow H^+ (\sigma_{01})$

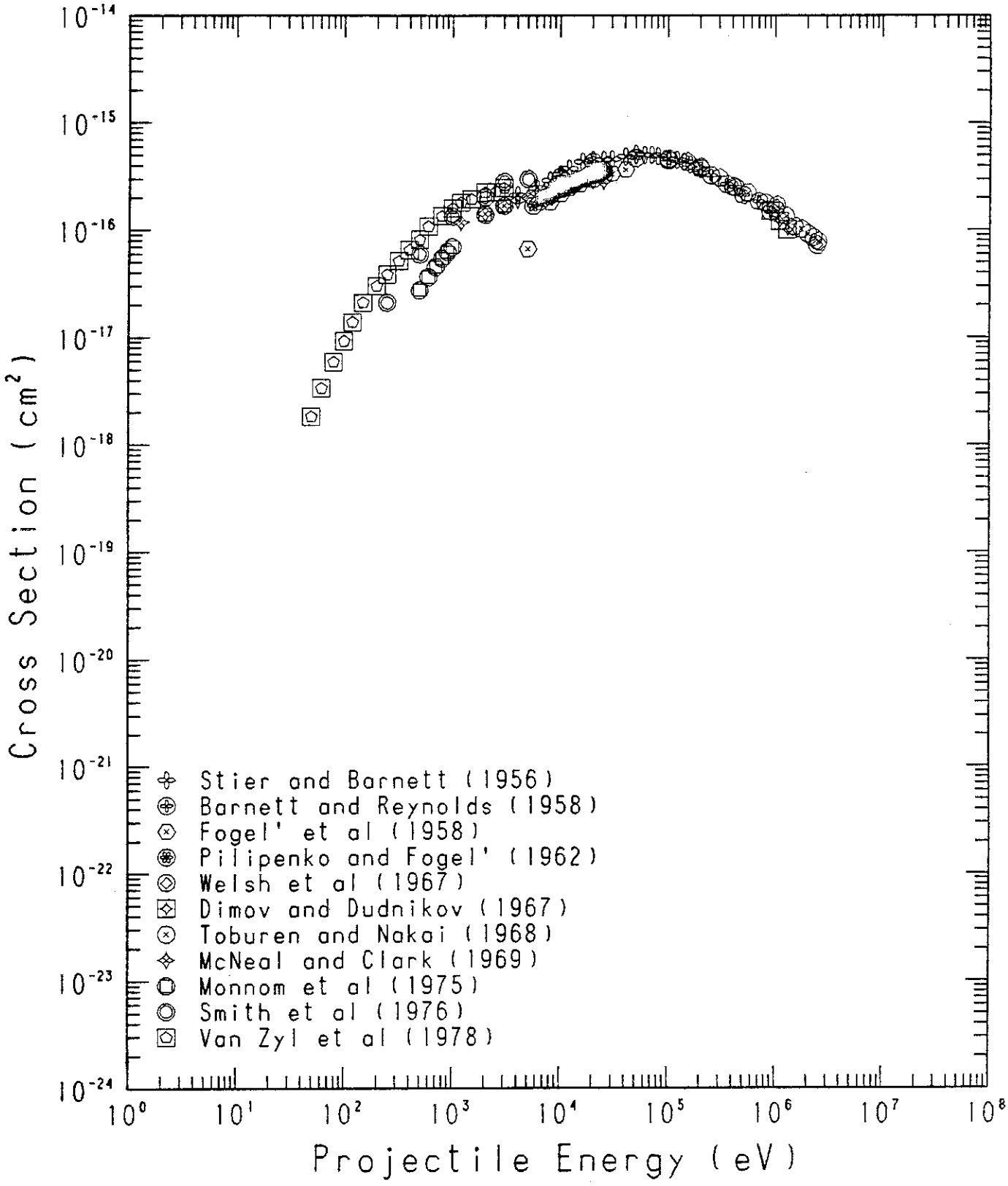

TABLE 21

PROCESS : H + N2 = H+ (01)
STIER AND BARNETT, PHYS. REV. 103 896 (1956)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.00E+03	8.79E-01	2.10E-16
6.00E+03	1.08E+00	2.46E-16
8.00E+03	1.24E+00	2.89E-16
1.00E+04	1.39E+00	3.29E-16
1.20E+04	1.52E+00	3.74E-16
1.60E+04	1.76E+00	4.33E-16
2.00E+04	1.96E+00	4.49E-16
2.50E+04	2.20E+00	4.50E-16
3.00E+04	2.41E+00	4.59E-16
4.00E+04	2.78E+00	4.85E-16
5.00E+04	3.11E+00	5.12E-16
6.00E+04	3.40E+00	4.99E-16
7.00E+04	3.68E+00	5.01E-16
8.00E+04	3.93E+00	4.88E-16
1.00E+05	4.39E+00	4.62E-16
1.20E+05	4.81E+00	4.50E-16
1.40E+05	5.20E+00	4.33E-16
1.60E+05	5.56E+00	4.09E-16
1.80E+05	5.89E+00	3.86E-16
2.00E+05	6.21E+00	3.70E-16

PROCESS : H + N2 = H+ (01)
BARNETT AND REYNOLDS, PHYS. REV. 109 355 (1958)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+04	1.39E+00	3.14E-16
2.00E+04	1.96E+00	4.30E-16
5.00E+04	3.11E+00	4.69E-16
1.00E+05	4.39E+00	4.63E-16
1.50E+05	5.38E+00	4.33E-16
2.00E+05	6.21E+00	3.75E-16
2.50E+05	6.95E+00	3.24E-16
3.50E+05	8.22E+00	2.68E-16
4.25E+05	9.06E+00	2.50E-16
5.00E+05	9.82E+00	2.11E-16
7.00E+05	1.16E+01	1.84E-16
9.00E+05	1.32E+01	1.46E-16

PROCESS : H + N2 = H+ (01)
FOGEL' ET AL, SOV. PHYS. JETP 7 400 (1958)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+03	9.82E-01	6.65E-17

TABLE 21 - CONTINUED

8.00E+03	1.24E+00	1.81E-16
1.00E+04	1.39E+00	2.15E-16
1.20E+04	1.52E+00	2.47E-16
1.50E+04	1.70E+00	2.67E-16
2.00E+04	1.96E+00	2.95E-16
2.50E+04	2.20E+00	3.18E-16
3.00E+04	2.41E+00	3.36E-16
4.00E+04	2.78E+00	3.68E-16

PROCESS : H + N2 = H+ (01)
PILIPENKO AND FOGEL', SOV. PHYS. JETP 15 646 (1962)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.57E+03	1.04E+00	1.68E-16
6.46E+03	1.12E+00	1.84E-16
7.00E+03	1.16E+00	2.00E-16
7.59E+03	1.21E+00	2.07E-16
8.00E+03	1.24E+00	2.07E-16
8.54E+03	1.28E+00	2.23E-16
9.08E+03	1.32E+00	2.36E-16
9.55E+03	1.36E+00	2.40E-16
1.00E+04	1.39E+00	2.43E-16
1.05E+04	1.42E+00	2.48E-16
1.10E+04	1.46E+00	2.60E-16
1.15E+04	1.49E+00	2.64E-16
1.22E+04	1.53E+00	2.64E-16
1.26E+04	1.56E+00	2.65E-16
1.30E+04	1.58E+00	2.68E-16
1.36E+04	1.62E+00	2.81E-16
1.40E+04	1.64E+00	2.84E-16
1.46E+04	1.68E+00	2.97E-16
1.51E+04	1.71E+00	2.97E-16
1.56E+04	1.73E+00	3.02E-16
1.61E+04	1.76E+00	3.03E-16
1.65E+04	1.78E+00	3.06E-16
1.71E+04	1.82E+00	3.11E-16
1.75E+04	1.84E+00	3.14E-16
1.81E+04	1.87E+00	3.25E-16
1.85E+04	1.89E+00	3.29E-16
1.96E+04	1.94E+00	3.30E-16
1.99E+04	1.96E+00	3.30E-16
2.05E+04	1.99E+00	3.40E-16
2.11E+04	2.02E+00	3.43E-16
2.16E+04	2.04E+00	3.42E-16
2.20E+04	2.06E+00	3.44E-16
2.25E+04	2.08E+00	3.44E-16
2.31E+04	2.11E+00	3.49E-16
2.36E+04	2.13E+00	3.50E-16
2.40E+04	2.15E+00	3.50E-16
2.46E+04	2.18E+00	3.59E-16
2.51E+04	2.20E+00	3.59E-16

TABLE 21 - CONTINUED

PROCESS : H + N2 = H+ (01)
WELSH ET AL, PHYS. REV. 158 85 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.03E+06	1.41E+01	1.70E-16
2.44E+06	2.17E+01	7.20E-17

PROCESS : H + N2 = H+ (01)
DIMOV AND DUDNIKOV, SOV. PHYS.-TECH. PHYS. 11 919 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
9.00E+05	1.32E+01	1.50E-16
1.10E+06	1.46E+01	1.20E-16
1.30E+06	1.58E+01	1.00E-16

PROCESS : H + N2 = H+ (01)
TOBUREN AND NAKAI, PHYS. REV. 171 114 (1968)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	4.47E-16
2.00E+05	6.21E+00	3.89E-16
3.00E+05	7.61E+00	3.07E-16
4.00E+05	8.79E+00	2.53E-16
5.50E+05	1.03E+01	2.22E-16
8.00E+05	1.24E+01	1.79E-16
1.00E+06	1.39E+01	1.57E-16
1.25E+06	1.55E+01	1.34E-16
1.50E+06	1.70E+01	1.07E-16
1.75E+06	1.84E+01	1.01E-16
2.00E+06	1.96E+01	9.16E-17
2.25E+06	2.08E+01	8.44E-17
2.50E+06	2.20E+01	7.79E-17

PROCESS : H + N2 = H+ (01)
MCNEAL AND CLARK, J. GEOPHYS. RES. 74 5065 (1969)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.20E+03	4.81E-01	1.17E-16
2.00E+03	6.21E-01	1.41E-16
3.00E+03	7.61E-01	1.67E-16
4.00E+03	8.79E-01	1.88E-16
5.00E+03	9.82E-01	2.03E-16
6.00E+03	1.08E+00	2.18E-16
7.00E+03	1.16E+00	2.29E-16

TABLE 21 - CONTINUED

8.00E+03	1.24E+00	2.39E-16
9.00E+03	1.32E+00	2.50E-16
1.00E+04	1.39E+00	2.63E-16
2.00E+04	1.96E+00	2.88E-16
2.50E+04	2.20E+00	2.84E-16

PROCESS : H + N2 = H+ (01)
MONNOM ET AL, COMPT. REND. B281 425 (1975)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+02	3.11E-01	2.74E-17
6.00E+02	3.40E-01	3.62E-17
7.00E+02	3.68E-01	4.51E-17
8.00E+02	3.93E-01	5.40E-17
9.00E+02	4.17E-01	6.22E-17
1.00E+03	4.39E-01	6.87E-17
2.00E+03	6.21E-01	1.38E-16
3.00E+03	7.61E-01	1.67E-16

PROCESS : H + N2 = H+ (01)
SMITH ET AL, J. GEOPHYS. RES. 81 2231 (1976)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.50E+02	2.20E-01	2.10E-17
5.00E+02	3.11E-01	5.90E-17
1.00E+03	4.39E-01	1.33E-16
2.00E+03	6.21E-01	2.02E-16
3.00E+03	7.61E-01	2.81E-16
5.00E+03	9.82E-01	2.98E-16

PROCESS : H + N2 = H+ (01)
VAN ZYL ET AL, PHYS. REV. A18 506 (1978)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+01	9.82E-02	1.82E-18
6.20E+01	1.09E-01	3.37E-18
8.00E+01	1.24E-01	5.90E-18
1.00E+02	1.39E-01	9.22E-18
1.20E+02	1.52E-01	1.38E-17
1.50E+02	1.70E-01	2.10E-17
2.00E+02	1.96E-01	2.98E-17
2.50E+02	2.20E-01	3.82E-17
3.20E+02	2.48E-01	5.12E-17
4.00E+02	2.78E-01	6.49E-17
5.00E+02	3.11E-01	8.10E-17

TABLE 21 - CONTINUED

6.00E+02	3.40E-01	1.07E-16
8.00E+02	3.93E-01	1.34E-16
1.00E+03	4.39E-01	1.58E-16
1.20E+03	4.81E-01	1.79E-16
1.50E+03	5.38E-01	1.92E-16
2.00E+03	6.21E-01	2.23E-16
2.50E+03	6.95E-01	2.26E-16
3.00E+03	7.61E-01	2.45E-16

Fig.22 $H + O_2 \rightarrow H^+ (\sigma_{01})$

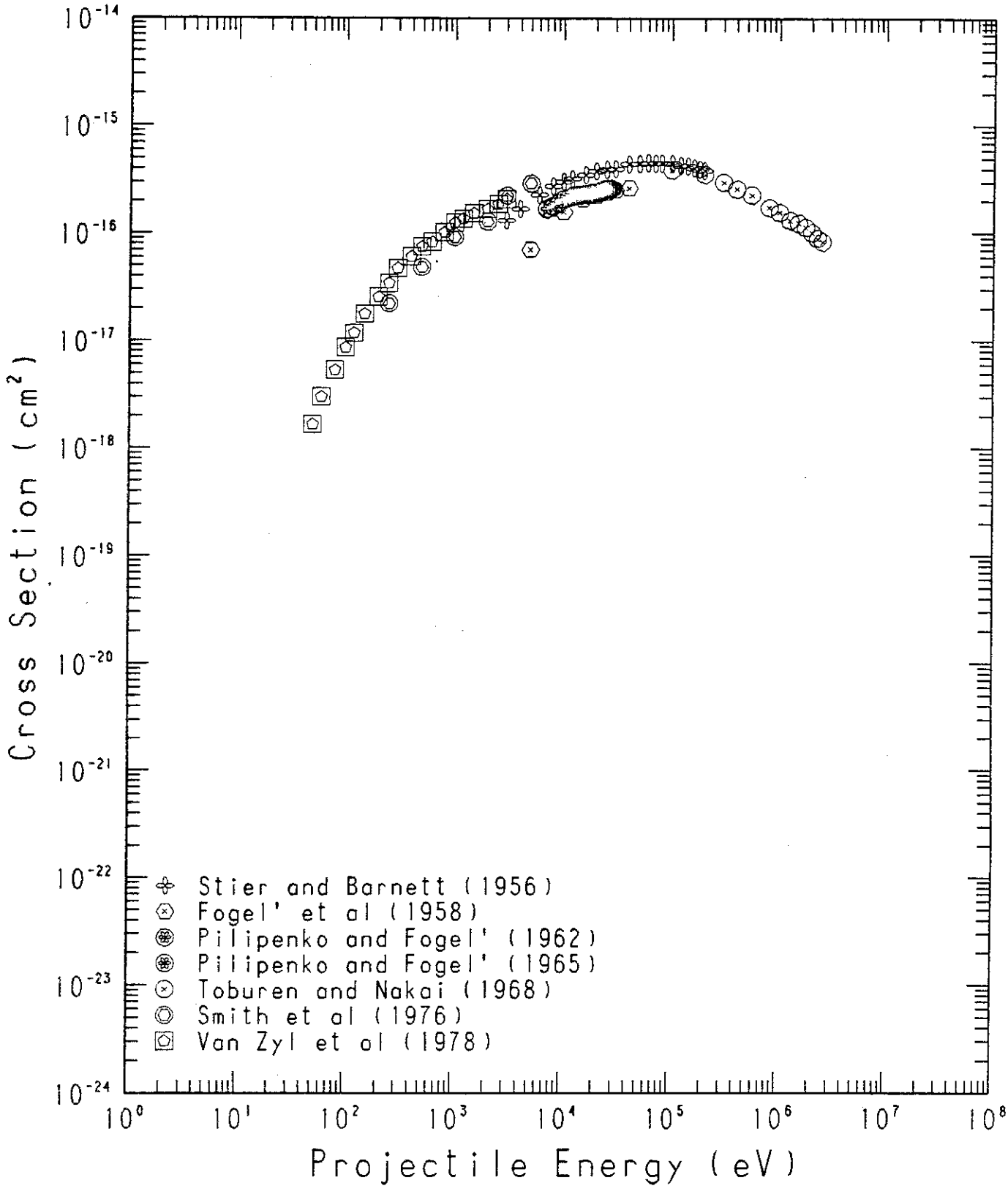

TABLE 22

PROCESS : H + O2 = H+ (01)
STIER AND BARNETT, PHYS. REV. 103 896 (1956)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
3.00E+03	7.61E-01	1.30E-16
4.00E+03	8.79E-01	1.67E-16
6.00E+03	1.08E+00	2.26E-16
8.00E+03	1.24E+00	2.73E-16
1.00E+04	1.39E+00	3.01E-16
1.20E+04	1.52E+00	3.21E-16
1.60E+04	1.76E+00	3.49E-16
2.00E+04	1.96E+00	3.79E-16
2.50E+04	2.20E+00	3.92E-16
3.00E+04	2.41E+00	3.99E-16
4.00E+04	2.78E+00	4.42E-16
5.00E+04	3.11E+00	4.44E-16
6.00E+04	3.40E+00	4.53E-16
7.00E+04	3.68E+00	4.48E-16
8.00E+04	3.93E+00	4.50E-16
1.00E+05	4.39E+00	4.46E-16
1.20E+05	4.81E+00	4.28E-16
1.40E+05	5.20E+00	4.24E-16
1.60E+05	5.56E+00	4.07E-16
1.80E+05	5.89E+00	3.96E-16
2.00E+05	6.21E+00	3.86E-16

PROCESS : H + O2 = H+ (01)
FOGEL' ET AL, SOV. PHYS. JETP 7 400 (1958)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+03	9.82E-01	7.00E-17
1.00E+04	1.39E+00	1.57E-16
1.50E+04	1.70E+00	2.07E-16
2.00E+04	1.96E+00	2.22E-16
2.50E+04	2.20E+00	2.40E-16
3.00E+04	2.41E+00	2.51E-16
4.00E+04	2.78E+00	2.64E-16

PROCESS : H + O2 = H+ (01)
PILIPENKO AND FOGEL', SOV. PHYS. JETP 15 646 (1962)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
7.00E+03	1.16E+00	1.66E-16
8.00E+03	1.24E+00	1.75E-16
9.00E+03	1.32E+00	1.89E-16
1.00E+04	1.39E+00	2.08E-16

TABLE 22 - CONTINUED

1.10E+04	1.46E+00	2.10E-16
1.20E+04	1.52E+00	2.18E-16
1.30E+04	1.58E+00	2.25E-16
1.40E+04	1.64E+00	2.25E-16
1.50E+04	1.70E+00	2.26E-16
1.60E+04	1.76E+00	2.30E-16
1.76E+04	1.84E+00	2.28E-16
1.80E+04	1.86E+00	2.30E-16
1.85E+04	1.89E+00	2.40E-16
1.90E+04	1.91E+00	2.35E-16
2.00E+04	1.96E+00	2.39E-16
2.10E+04	2.01E+00	2.39E-16
2.20E+04	2.06E+00	2.43E-16
2.30E+04	2.11E+00	2.51E-16
2.40E+04	2.15E+00	2.51E-16
2.50E+04	2.20E+00	2.58E-16
2.60E+04	2.24E+00	2.58E-16
2.70E+04	2.28E+00	2.57E-16
2.80E+04	2.32E+00	2.61E-16

PROCESS : H + O2 = H+ (01)
PILIPENKO AND FOGEL', SOV. PHYS. JETP 21 266 (1965)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
7.00E+03	1.16E+00	1.70E-16
8.00E+03	1.24E+00	1.79E-16
9.00E+03	1.32E+00	1.94E-16
1.10E+04	1.46E+00	2.13E-16
1.20E+04	1.52E+00	2.22E-16
1.30E+04	1.58E+00	2.30E-16
1.40E+04	1.64E+00	2.28E-16
1.60E+04	1.76E+00	2.34E-16
1.70E+04	1.81E+00	2.31E-16
1.80E+04	1.86E+00	2.32E-16
1.85E+04	1.89E+00	2.41E-16
1.90E+04	1.91E+00	2.38E-16
2.00E+04	1.96E+00	2.42E-16
2.10E+04	2.01E+00	2.42E-16
2.20E+04	2.06E+00	2.46E-16
2.30E+04	2.11E+00	2.55E-16
2.40E+04	2.15E+00	2.55E-16
2.50E+04	2.20E+00	2.60E-16
2.60E+04	2.24E+00	2.60E-16
2.70E+04	2.28E+00	2.60E-16
2.73E+04	2.30E+00	2.63E-16

TABLE 22 - CONTINUED

PROCESS : H + O2 = H+ (O1)
TOBUREN AND NAKAI, PHYS. REV. 171 114 (1968)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	3.91E-16
2.00E+05	6.21E+00	3.55E-16
3.00E+05	7.61E+00	3.00E-16
4.00E+05	8.79E+00	2.59E-16
5.50E+05	1.03E+01	2.28E-16
8.00E+05	1.24E+01	1.74E-16
1.00E+06	1.39E+01	1.56E-16
1.25E+06	1.55E+01	1.32E-16
1.50E+06	1.70E+01	1.24E-16
1.75E+06	1.84E+01	1.13E-16
2.00E+06	1.96E+01	1.01E-16
2.25E+06	2.08E+01	8.94E-17
2.50E+06	2.20E+01	8.34E-17

PROCESS : H + O2 = H+ (O1)
SMITH ET AL, J. GEOPHYS. RES. 81 2231 (1976)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.50E+02	2.20E-01	2.20E-17
5.00E+02	3.11E-01	4.80E-17
1.00E+03	4.39E-01	9.10E-17
2.00E+03	6.21E-01	1.27E-16
3.00E+03	7.61E-01	2.22E-16
5.00E+03	9.82E-01	2.90E-16

PROCESS : H + O2 = H+ (O1)
VAN ZYL ET AL, PHYS. REV. A18 506 (1978)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+01	9.82E-02	1.66E-18
6.00E+01	1.08E-01	2.99E-18
8.00E+01	1.24E-01	5.32E-18
1.00E+02	1.39E-01	8.57E-18
1.20E+02	1.52E-01	1.17E-17
1.50E+02	1.70E-01	1.76E-17
2.00E+02	1.96E-01	2.53E-17
2.50E+02	2.20E-01	3.40E-17
3.00E+02	2.41E-01	4.70E-17
4.00E+02	2.78E-01	6.05E-17
5.00E+02	3.11E-01	7.48E-17
6.20E+02	3.46E-01	8.26E-17
8.00E+02	3.93E-01	1.01E-16

TABLE 22 - CONTINUED

1.00E+03	4.39E-01	1.24E-16
1.20E+03	4.81E-01	1.35E-16
1.50E+03	5.38E-01	1.52E-16
2.00E+03	6.21E-01	1.67E-16
2.50E+03	6.95E-01	1.85E-16
3.00E+03	7.61E-01	2.07E-16

Fig.23 $H + H_2O \rightarrow H^+ (\sigma_{01})$

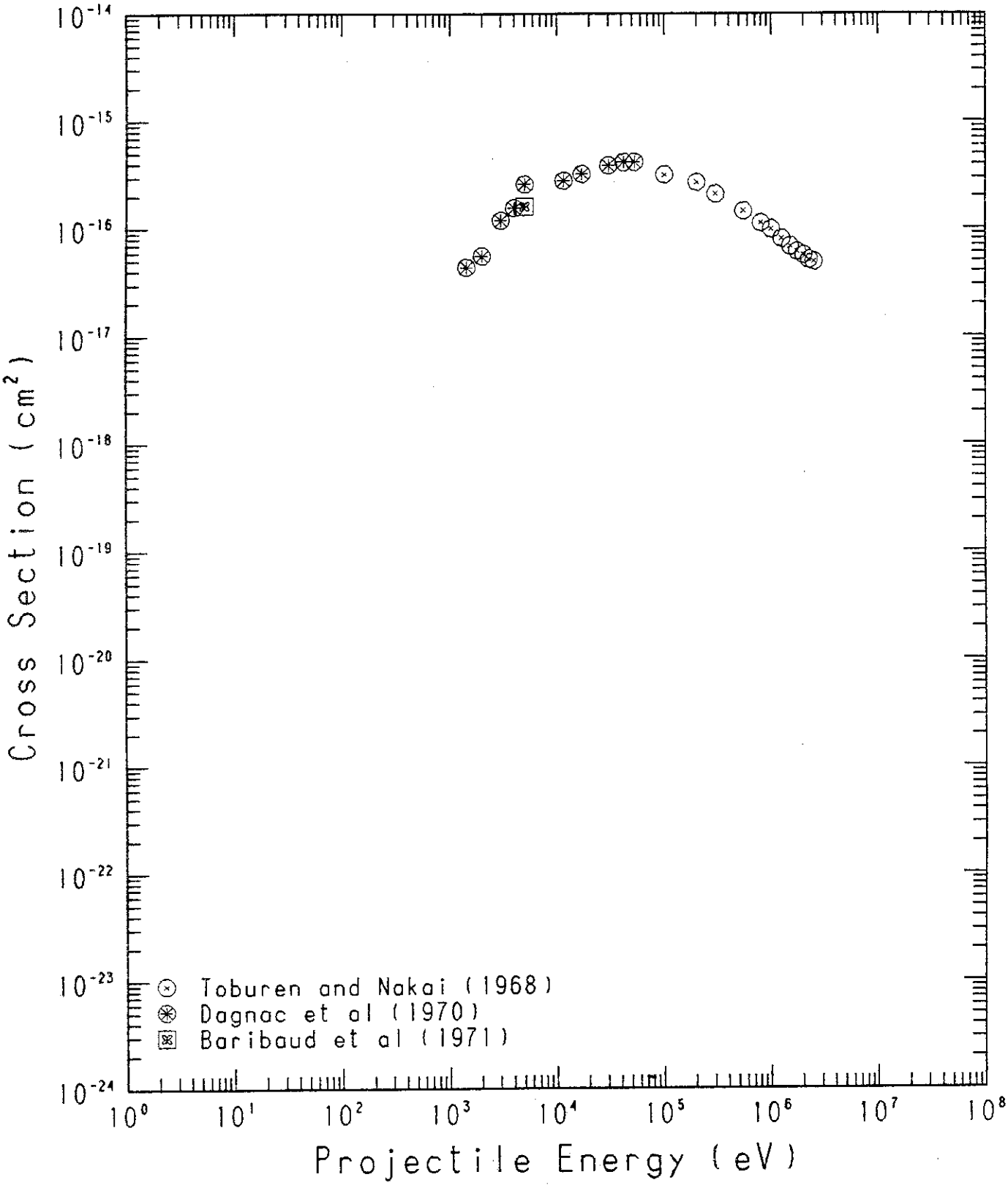

TABLE 23

PROCESS : H + H2O = H+ (01)
TOBUREN AND NAKAI, PHYS. REV. 171 114 (1968)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	3.18E-16
2.00E+05	6.21E+00	2.70E-16
3.00E+05	7.61E+00	2.10E-16
5.50E+05	1.03E+01	1.45E-16
8.00E+05	1.24E+01	1.12E-16
1.00E+06	1.39E+01	9.81E-17
1.25E+06	1.55E+01	8.02E-17
1.50E+06	1.70E+01	6.82E-17
1.75E+06	1.84E+01	6.07E-17
2.00E+06	1.96E+01	5.67E-17
2.25E+06	2.08E+01	5.11E-17
2.50E+06	2.20E+01	4.91E-17

PROCESS : H + H2O = H+ (01)
DAGNAC ET AL, J. PHYS. B3 1239 (1970)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.44E+03	5.27E-01	4.35E-17
2.00E+03	6.21E-01	5.56E-17
3.00E+03	7.61E-01	1.19E-16
4.00E+03	8.79E-01	1.56E-16
5.00E+03	9.82E-01	2.60E-16
1.15E+04	1.49E+00	2.80E-16
1.70E+04	1.81E+00	3.23E-16
3.00E+04	2.41E+00	3.87E-16
4.16E+04	2.83E+00	4.16E-16
5.25E+04	3.18E+00	4.17E-16

PROCESS : H + H2O = H+ (01)
BARIBAUD ET AL, COMPT. REND. B272 457 (1971)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+03	9.82E-01	1.60E-16

Fig.24 H + CO → H^+ (σ_{01})

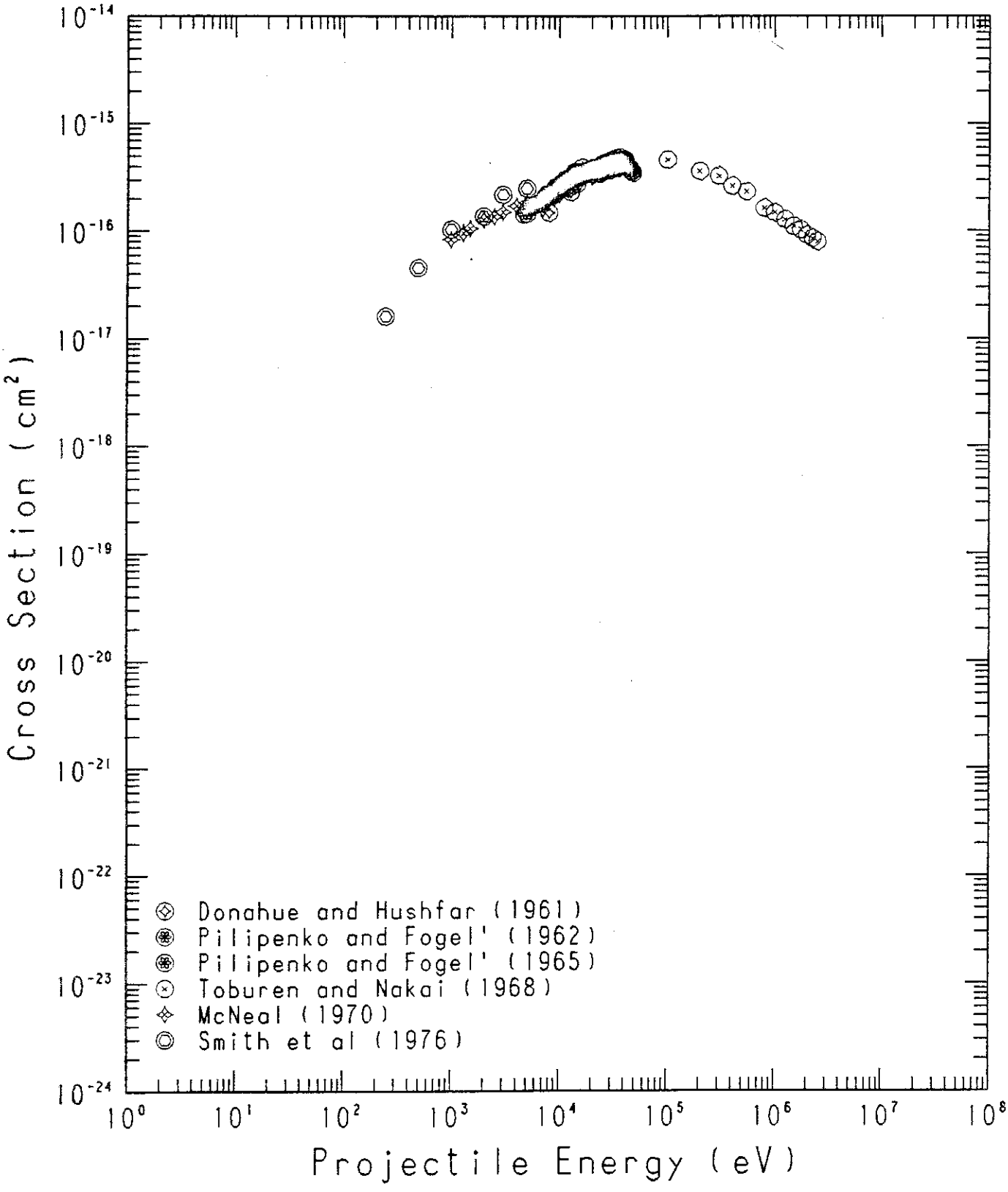

TABLE 24

PROCESS : H + CO = H+ (01)
DONAHUE AND HUSHFAR, PHYS. REV. 124 138 (1961)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
6.22E+03	1.10E+00	1.77E-16
8.03E+03	1.24E+00	1.46E-16
9.28E+03	1.34E+00	2.36E-16
1.03E+04	1.41E+00	2.71E-16
1.13E+04	1.48E+00	2.92E-16
1.20E+04	1.52E+00	2.98E-16
1.27E+04	1.57E+00	2.29E-16
1.32E+04	1.60E+00	2.66E-16
1.37E+04	1.63E+00	3.12E-16
1.45E+04	1.67E+00	2.73E-16
1.56E+04	1.73E+00	3.37E-16
1.62E+04	1.77E+00	3.87E-16
1.75E+04	1.84E+00	3.46E-16
1.88E+04	1.90E+00	3.69E-16
2.01E+04	1.97E+00	3.82E-16
2.18E+04	2.05E+00	3.78E-16
2.27E+04	2.09E+00	3.71E-16
2.41E+04	2.16E+00	3.96E-16
2.51E+04	2.20E+00	4.14E-16
2.60E+04	2.24E+00	4.27E-16
2.69E+04	2.28E+00	4.19E-16
2.87E+04	2.35E+00	4.02E-16
3.05E+04	2.43E+00	4.57E-16
3.22E+04	2.49E+00	4.17E-16
3.37E+04	2.55E+00	4.74E-16
3.52E+04	2.61E+00	4.12E-16
3.62E+04	2.64E+00	4.46E-16
3.72E+04	2.68E+00	4.20E-16
3.81E+04	2.71E+00	4.51E-16
3.91E+04	2.75E+00	4.34E-16

PROCESS : H + CO = H+ (01)
PILIPENKO AND FOGEL', SOV. PHYS. JETP 15 646 (1962)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.70E+03	9.52E-01	1.41E-16
5.21E+03	1.00E+00	1.63E-16
5.47E+03	1.03E+00	1.71E-16
6.06E+03	1.08E+00	1.78E-16
6.75E+03	1.14E+00	1.80E-16
7.09E+03	1.17E+00	1.98E-16
7.60E+03	1.21E+00	2.17E-16
8.10E+03	1.25E+00	2.18E-16
8.54E+03	1.28E+00	2.17E-16
9.13E+03	1.33E+00	2.53E-16

TABLE 24 - CONTINUED

9.56E+03	1.36E+00	2.55E-16
1.00E+04	1.39E+00	2.58E-16
1.06E+04	1.43E+00	2.80E-16
1.12E+04	1.47E+00	2.96E-16
1.16E+04	1.50E+00	3.00E-16
1.21E+04	1.53E+00	3.01E-16
1.25E+04	1.55E+00	3.10E-16
1.32E+04	1.60E+00	3.26E-16
1.35E+04	1.61E+00	3.45E-16
1.39E+04	1.64E+00	3.51E-16
1.45E+04	1.67E+00	3.36E-16
1.50E+04	1.70E+00	3.37E-16
1.54E+04	1.72E+00	3.39E-16
1.64E+04	1.78E+00	3.49E-16
1.70E+04	1.81E+00	3.57E-16
1.74E+04	1.83E+00	3.56E-16
1.79E+04	1.86E+00	3.57E-16
1.84E+04	1.88E+00	3.65E-16
1.90E+04	1.91E+00	3.63E-16
1.94E+04	1.93E+00	3.39E-16
2.00E+04	1.96E+00	3.59E-16
2.05E+04	1.99E+00	3.64E-16
2.10E+04	2.01E+00	3.69E-16
2.14E+04	2.03E+00	3.87E-16
2.19E+04	2.06E+00	3.71E-16
2.24E+04	2.08E+00	3.64E-16
2.29E+04	2.10E+00	3.42E-16
2.33E+04	2.12E+00	3.46E-16
2.38E+04	2.14E+00	3.63E-16
2.43E+04	2.17E+00	3.88E-16
2.49E+04	2.19E+00	4.18E-16
2.56E+04	2.22E+00	3.86E-16
2.65E+04	2.26E+00	3.78E-16
2.77E+04	2.31E+00	3.93E-16
2.81E+04	2.33E+00	4.14E-16
2.91E+04	2.37E+00	3.70E-16
2.92E+04	2.37E+00	3.89E-16
2.96E+04	2.39E+00	4.06E-16
3.00E+04	2.41E+00	4.30E-16
3.06E+04	2.43E+00	4.37E-16
3.12E+04	2.45E+00	4.37E-16
3.16E+04	2.47E+00	4.29E-16
3.21E+04	2.49E+00	4.36E-16
3.26E+04	2.51E+00	4.07E-16
3.32E+04	2.53E+00	3.88E-16
3.36E+04	2.55E+00	4.30E-16
3.40E+04	2.56E+00	4.05E-16
3.44E+04	2.58E+00	4.21E-16
3.50E+04	2.60E+00	4.37E-16
3.55E+04	2.62E+00	4.10E-16
3.63E+04	2.65E+00	4.45E-16
3.65E+04	2.65E+00	4.55E-16

TABLE 24 - CONTINUED

3.69E+04	2.67E+00	4.78E-16
3.76E+04	2.69E+00	4.58E-16
3.81E+04	2.71E+00	4.61E-16
3.90E+04	2.74E+00	4.50E-16
3.91E+04	2.75E+00	4.38E-16
3.98E+04	2.77E+00	4.64E-16
4.07E+04	2.80E+00	4.44E-16
4.18E+04	2.84E+00	4.10E-16
4.26E+04	2.87E+00	3.98E-16
4.37E+04	2.90E+00	3.83E-16
4.49E+04	2.94E+00	3.83E-16
4.57E+04	2.97E+00	3.66E-16
4.67E+04	3.00E+00	3.57E-16
4.78E+04	3.04E+00	3.46E-16

PROCESS : H + CO = H+ (01)
PILIPENKO AND FOGEL', SOV. PHYS. JETP 21 266 (1965)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+03	9.82E-01	1.43E-16
5.50E+03	1.03E+00	1.66E-16
6.00E+03	1.08E+00	1.73E-16
6.50E+03	1.12E+00	1.79E-16
7.00E+03	1.16E+00	1.90E-16
7.50E+03	1.20E+00	1.99E-16
8.00E+03	1.24E+00	2.19E-16
8.50E+03	1.28E+00	2.19E-16
9.00E+03	1.32E+00	2.18E-16
9.50E+03	1.35E+00	2.53E-16
1.00E+04	1.39E+00	2.54E-16
1.05E+04	1.42E+00	2.55E-16
1.10E+04	1.46E+00	2.77E-16
1.15E+04	1.49E+00	2.94E-16
1.20E+04	1.52E+00	2.99E-16
1.25E+04	1.55E+00	2.99E-16
1.30E+04	1.58E+00	3.08E-16
1.35E+04	1.61E+00	3.23E-16
1.40E+04	1.64E+00	3.41E-16
1.45E+04	1.67E+00	3.48E-16
1.50E+04	1.70E+00	3.32E-16
1.55E+04	1.73E+00	3.33E-16
1.60E+04	1.76E+00	3.36E-16
1.65E+04	1.78E+00	3.41E-16
1.70E+04	1.81E+00	3.46E-16
1.75E+04	1.84E+00	3.54E-16
1.80E+04	1.86E+00	3.52E-16
1.85E+04	1.89E+00	3.51E-16
1.90E+04	1.91E+00	3.62E-16
1.95E+04	1.94E+00	3.59E-16
2.00E+04	1.96E+00	3.36E-16

TABLE 24 - CONTINUED

2.05E+04	1.99E+00	3.56E-16
2.10E+04	2.01E+00	3.59E-16
2.15E+04	2.04E+00	3.65E-16
2.20E+04	2.06E+00	3.85E-16
2.25E+04	2.08E+00	3.64E-16
2.30E+04	2.11E+00	3.60E-16
2.35E+04	2.13E+00	3.36E-16
2.40E+04	2.15E+00	3.44E-16
2.45E+04	2.17E+00	3.57E-16
2.50E+04	2.20E+00	3.83E-16
2.55E+04	2.22E+00	4.11E-16
2.60E+04	2.24E+00	3.81E-16
2.70E+04	2.28E+00	3.73E-16
2.80E+04	2.32E+00	3.90E-16
2.85E+04	2.35E+00	4.08E-16
2.90E+04	2.37E+00	3.66E-16
2.95E+04	2.39E+00	3.83E-16
3.00E+04	2.41E+00	4.00E-16
3.05E+04	2.43E+00	4.23E-16
3.10E+04	2.45E+00	4.29E-16
3.15E+04	2.47E+00	4.32E-16
3.20E+04	2.48E+00	4.22E-16
3.25E+04	2.50E+00	4.25E-16
3.30E+04	2.52E+00	4.01E-16
3.35E+04	2.54E+00	3.83E-16
3.40E+04	2.56E+00	4.22E-16
3.45E+04	2.58E+00	3.89E-16
3.50E+04	2.60E+00	4.05E-16

PROCESS : H + CO = H+ (01)
TOBUREN AND NAKAI, PHYS. REV. 171 114 (1968)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	4.60E-16
2.00E+05	6.21E+00	3.60E-16
3.00E+05	7.61E+00	3.25E-16
4.00E+05	8.79E+00	2.63E-16
5.50E+05	1.03E+01	2.32E-16
8.00E+05	1.24E+01	1.63E-16
1.00E+06	1.39E+01	1.47E-16
1.25E+06	1.55E+01	1.27E-16
1.50E+06	1.70E+01	1.10E-16
1.75E+06	1.84E+01	1.02E-16
2.00E+06	1.96E+01	9.10E-17
2.25E+06	2.08E+01	8.51E-17
2.50E+06	2.20E+01	7.94E-17

TABLE 24 - CONTINUED

PROCESS : H + CO = H+ (01)
MCNEAL, J. CHEM. PHYS. 53 4308 (1970)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+03	4.39E-01	8.21E-17
1.30E+03	5.01E-01	9.44E-17
1.50E+03	5.38E-01	1.04E-16
2.00E+03	6.21E-01	1.25E-16
2.50E+03	6.95E-01	1.34E-16
3.00E+03	7.61E-01	1.48E-16
4.00E+03	8.79E-01	1.69E-16
5.00E+03	9.82E-01	1.81E-16
6.00E+03	1.08E+00	1.65E-16
7.00E+03	1.16E+00	1.58E-16
8.00E+03	1.24E+00	2.10E-16
9.00E+03	1.32E+00	2.01E-16
1.00E+04	1.39E+00	2.15E-16
1.20E+04	1.52E+00	2.40E-16
1.50E+04	1.70E+00	2.77E-16
2.00E+04	1.96E+00	3.15E-16
2.50E+04	2.20E+00	3.49E-16

PROCESS : H + CO = H+ (01)
SMITH ET AL, J. GEOPHYS. RES. 81 2231 (1976)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.50E+02	2.20E-01	1.60E-17
5.00E+02	3.11E-01	4.50E-17
1.00E+03	4.39E-01	1.02E-16
2.00E+03	6.21E-01	1.35E-16
3.00E+03	7.61E-01	2.15E-16
5.00E+03	9.82E-01	2.46E-16

Fig.25 H + CO_2 → H^+ (σ_{01})

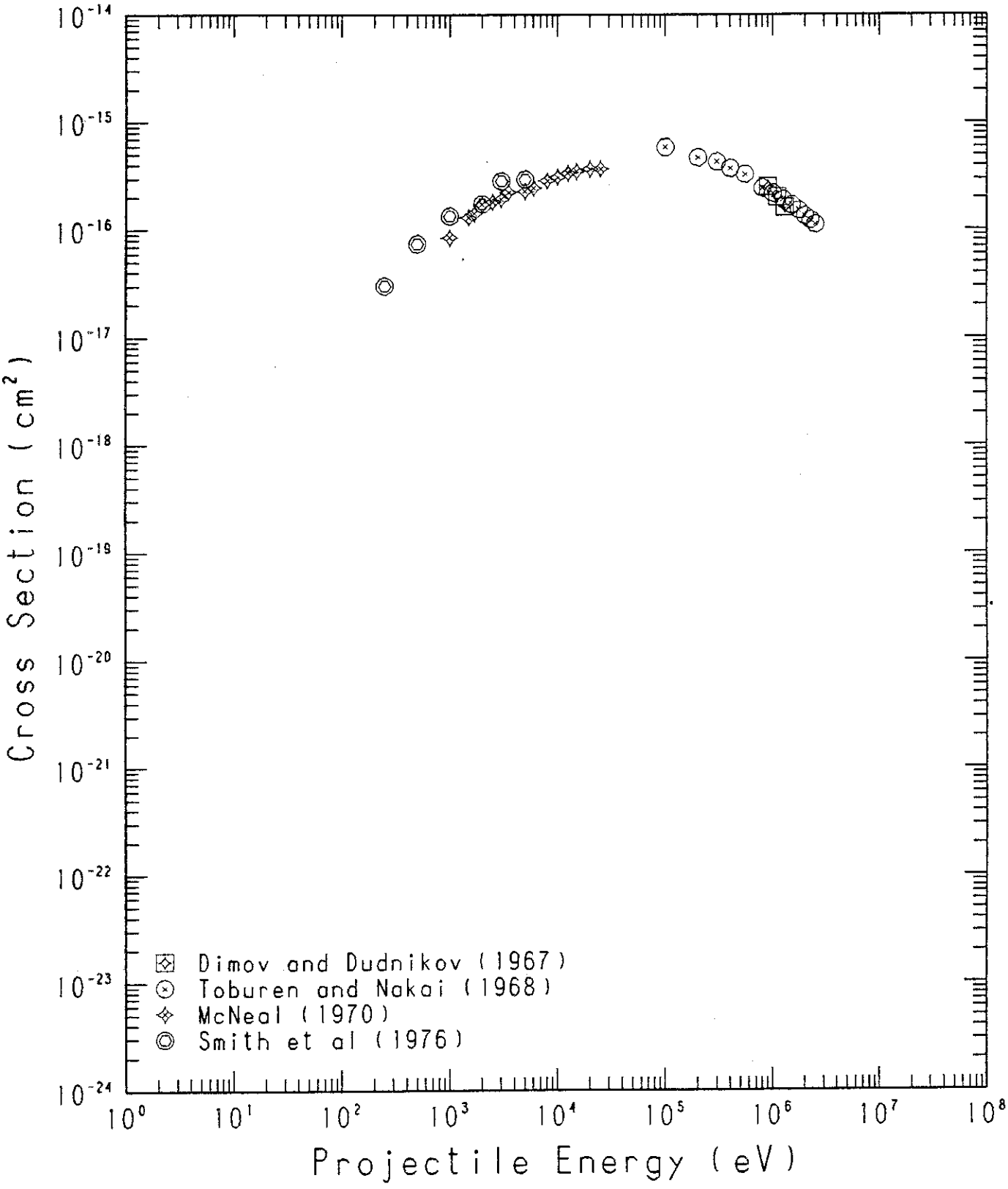

TABLE 25

PROCESS : H + CO2 = H+ (01)
DIMOV AND DUDNIKOV, SOV. PHYS.-TECH. PHYS. 11 919 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
9.00E+05	1.32E+01	2.50E-16
1.10E+06	1.46E+01	2.00E-16
1.30E+06	1.58E+01	1.60E-16

PROCESS : H + CO2 = H+ (01)
TOBUREN AND NAKAI, PHYS. REV. 171 114 (1968)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	5.85E-16
2.00E+05	6.21E+00	4.69E-16
3.00E+05	7.61E+00	4.28E-16
4.00E+05	8.79E+00	3.72E-16
5.50E+05	1.03E+01	3.27E-16
8.00E+05	1.24E+01	2.44E-16
1.00E+06	1.39E+01	2.17E-16
1.25E+06	1.55E+01	1.91E-16
1.50E+06	1.70E+01	1.69E-16
1.75E+06	1.84E+01	1.51E-16
2.00E+06	1.96E+01	1.33E-16
2.25E+06	2.08E+01	1.22E-16
2.50E+06	2.20E+01	1.11E-16

PROCESS : H + CO2 = H+ (01)
MCNEAL, J. CHEM. PHYS. 53 4308 (1970)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+03	4.39E-01	8.44E-17
1.50E+03	5.38E-01	1.30E-16
1.70E+03	5.73E-01	1.41E-16
2.00E+03	6.21E-01	1.72E-16
2.50E+03	6.95E-01	1.82E-16
3.00E+03	7.61E-01	1.92E-16
3.50E+03	8.22E-01	2.24E-16
5.00E+03	9.82E-01	2.28E-16
6.00E+03	1.08E+00	2.45E-16
8.00E+03	1.24E+00	2.86E-16
1.00E+04	1.39E+00	3.09E-16
1.25E+04	1.55E+00	3.37E-16
1.50E+04	1.70E+00	3.50E-16
2.00E+04	1.96E+00	3.68E-16
2.50E+04	2.20E+00	3.69E-16

TABLE 25 - CONTINUED

PROCESS : H + CO2 = H+ (01)
SMITH ET AL, J. GEOPHYS. RES. 81 2231 (1976)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.50E+02	2.20E-01	3.00E-17
5.00E+02	3.11E-01	7.40E-17
1.00E+03	4.39E-01	1.34E-16
2.00E+03	6.21E-01	1.74E-16
3.00E+03	7.61E-01	2.85E-16
5.00E+03	9.82E-01	2.95E-16

Fig.26 H + CH_4 → H^+ (σ_{01})

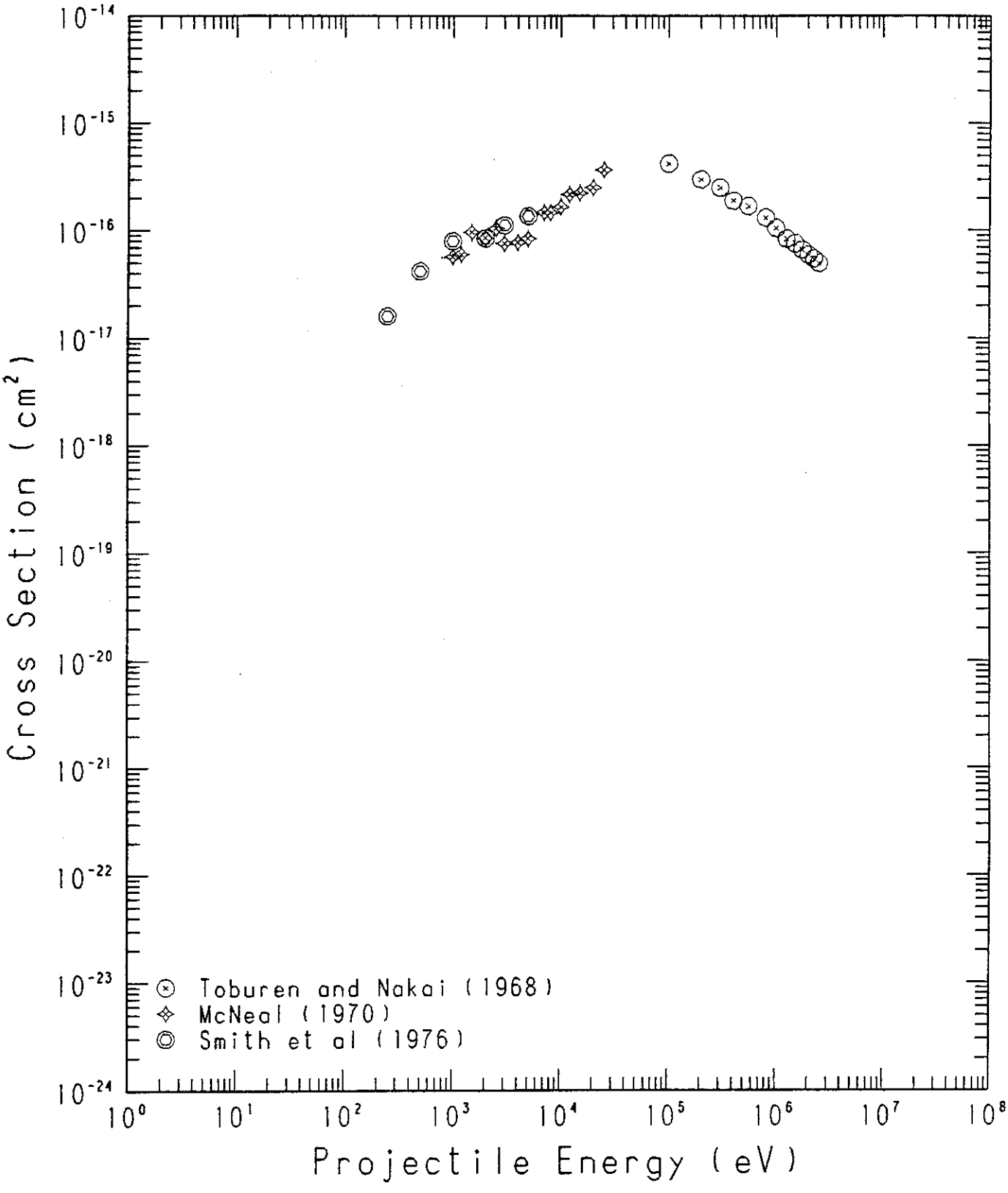

TABLE 26

PROCESS : H + CH4 = H+ (01)
TOBUREN AND NAKAI, PHYS. REV. 171 114 (1968)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	4.22E-16
2.00E+05	6.21E+00	3.00E-16
3.00E+05	7.61E+00	2.52E-16
4.00E+05	8.79E+00	1.90E-16
5.50E+05	1.03E+01	1.69E-16
8.00E+05	1.24E+01	1.32E-16
1.00E+06	1.39E+01	1.05E-16
1.25E+06	1.55E+01	8.38E-17
1.50E+06	1.70E+01	7.60E-17
1.75E+06	1.84E+01	6.67E-17
2.00E+06	1.96E+01	5.95E-17
2.25E+06	2.08E+01	5.48E-17
2.50E+06	2.20E+01	4.96E-17

PROCESS : H + CH4 = H+ (01)
MCNEAL, J. CHEM. PHYS. 53 4308 (1970)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+03	4.39E-01	5.72E-17
1.20E+03	4.81E-01	6.03E-17
1.50E+03	5.38E-01	9.68E-17
2.00E+03	6.21E-01	8.52E-17
2.50E+03	6.95E-01	1.05E-16
3.00E+03	7.61E-01	7.61E-17
4.00E+03	8.79E-01	7.79E-17
5.00E+03	9.82E-01	8.44E-17
7.00E+03	1.16E+00	1.48E-16
8.00E+03	1.24E+00	1.47E-16
1.00E+04	1.39E+00	1.67E-16
1.20E+04	1.52E+00	2.19E-16
1.50E+04	1.70E+00	2.25E-16
2.00E+04	1.96E+00	2.53E-16
2.50E+04	2.20E+00	3.71E-16

PROCESS : H + CH4 = H+ (01)
SMITH ET AL, J. GEOPHYS. RES. 81 2231 (1976)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.50E+02	2.20E-01	1.60E-17
5.00E+02	3.11E-01	4.20E-17
1.00E+03	4.39E-01	8.00E-17
2.00E+03	6.21E-01	8.50E-17
3.00E+03	7.61E-01	1.12E-16
5.00E+03	9.82E-01	1.37E-16

Fig.27 $H + C_2H_4 \rightarrow H^+ (\sigma_{01})$

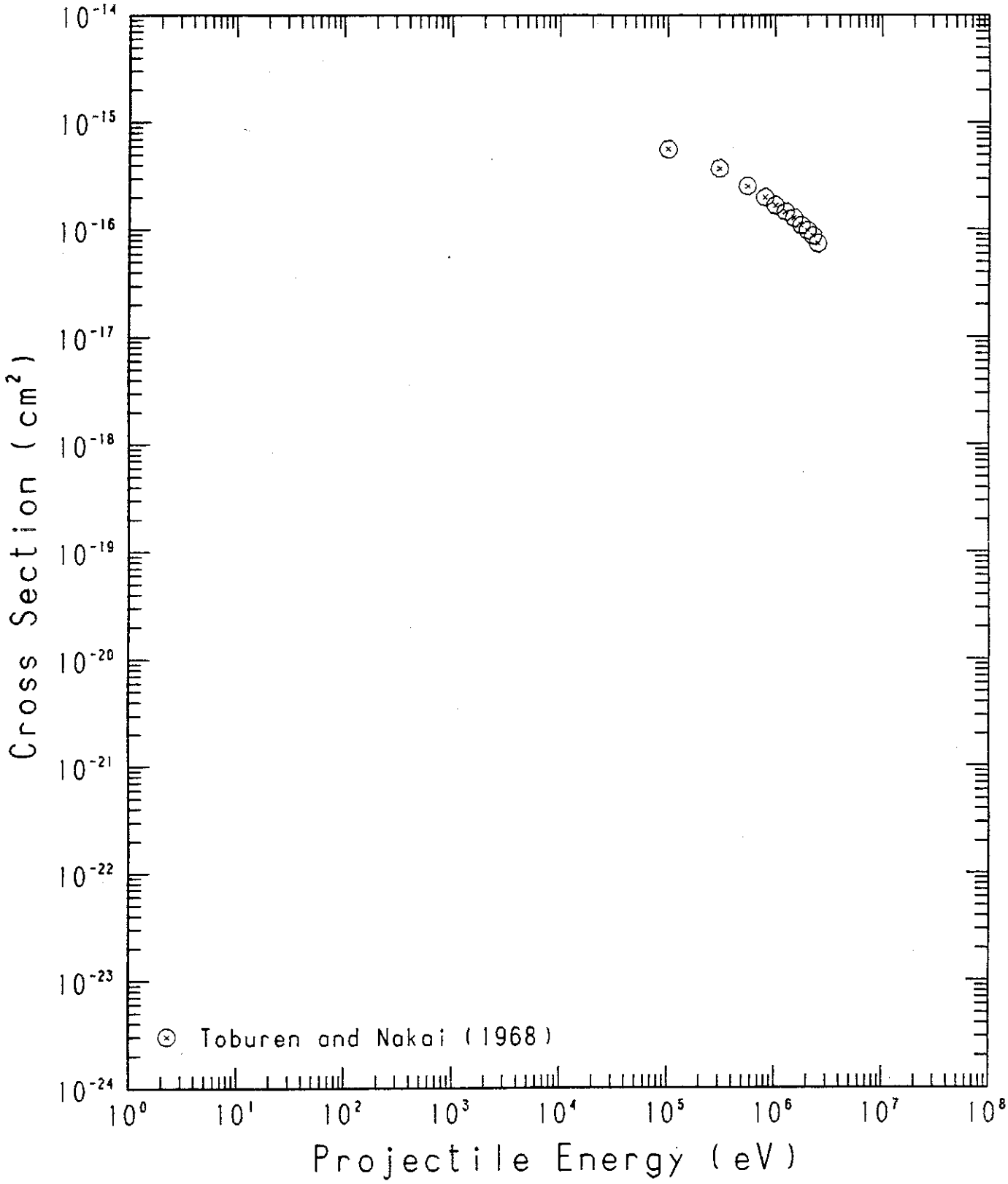

TABLE 27

PROCESS : H + C2H4 = H+ (01)
TOBUREN AND NAKAI, PHYS. REV. 171 114 (1968)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	5.63E-16
3.00E+05	7.61E+00	3.73E-16
5.50E+05	1.03E+01	2.54E-16
8.00E+05	1.24E+01	2.00E-16
1.00E+06	1.39E+01	1.68E-16
1.25E+06	1.55E+01	1.46E-16
1.50E+06	1.70E+01	1.28E-16
1.75E+06	1.84E+01	1.09E-16
2.00E+06	1.96E+01	9.78E-17
2.25E+06	2.08E+01	8.71E-17
2.50E+06	2.20E+01	7.39E-17

Fig.28 H + C_2H_6 → H^+ (σ_{01})

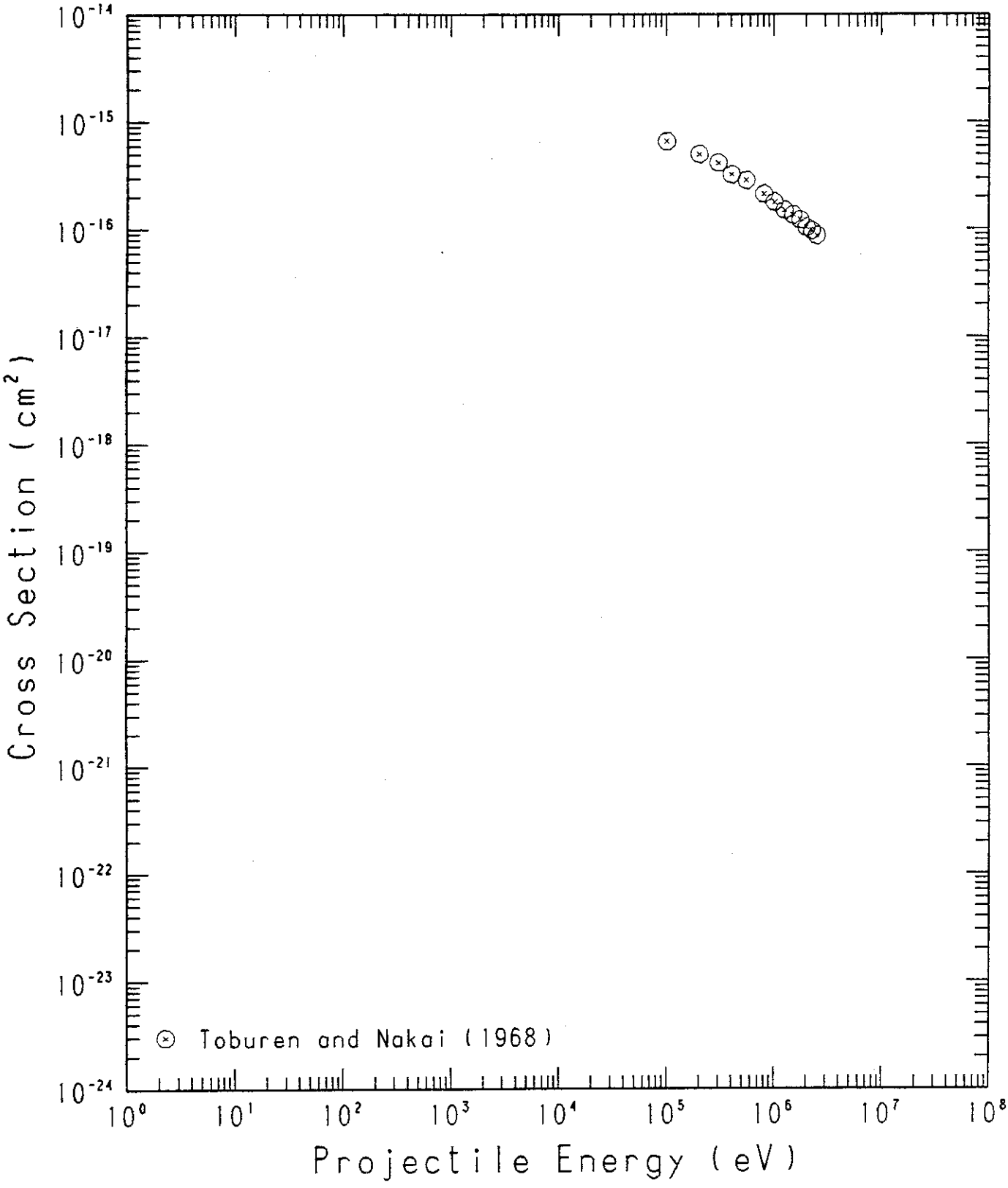

TABLE 28

PROCESS : H + C2H6 = H+ (01)
TOBUREN AND NAKAI, PHYS. REV. 171 114 (1968)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	6.57E-16
2.00E+05	6.21E+00	4.98E-16
3.00E+05	7.61E+00	4.14E-16
4.00E+05	8.79E+00	3.21E-16
5.50E+05	1.03E+01	2.85E-16
8.00E+05	1.24E+01	2.12E-16
1.00E+06	1.39E+01	1.78E-16
1.25E+06	1.55E+01	1.49E-16
1.50E+06	1.70E+01	1.35E-16
1.75E+06	1.84E+01	1.21E-16
2.00E+06	1.96E+01	1.03E-16
2.25E+06	2.08E+01	9.65E-17
2.50E+06	2.20E+01	8.68E-17

Fig.29 H + C_4H_{10} → H^+ (σ_{01})

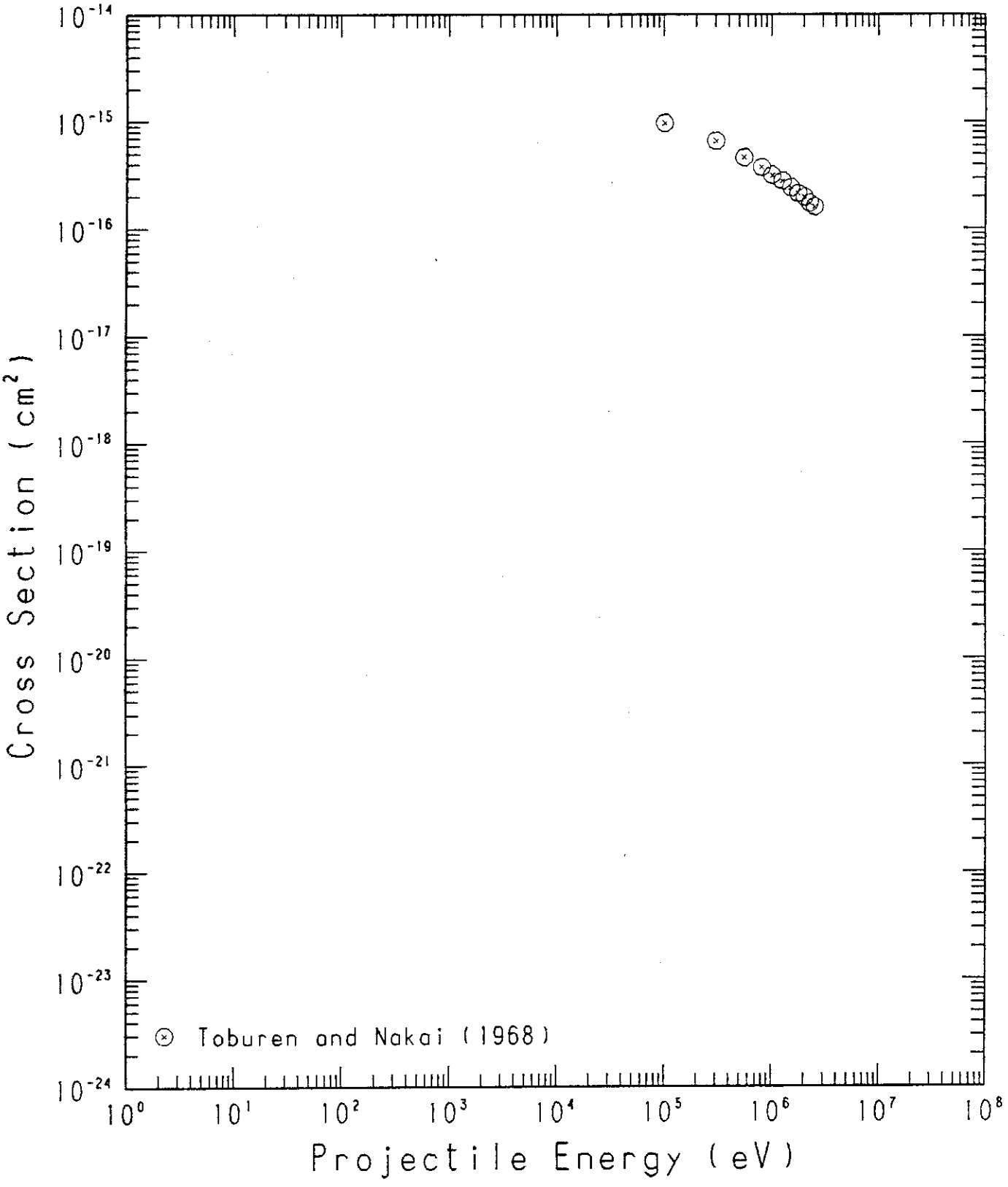

TABLE 29

PROCESS : H + C4H10 = H+ (01)
TOBUREN AND NAKAI, PHYS. REV. 171 114 (1968)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	9.69E-16
3.00E+05	7.61E+00	6.62E-16
5.50E+05	1.03E+01	4.64E-16
8.00E+05	1.24E+01	3.76E-16
1.00E+06	1.39E+01	3.17E-16
1.25E+06	1.55E+01	2.80E-16
1.50E+06	1.70E+01	2.42E-16
1.75E+06	1.84E+01	2.13E-16
2.00E+06	1.96E+01	1.98E-16
2.25E+06	2.08E+01	1.73E-16
2.50E+06	2.20E+01	1.60E-16

Fig.30 H + C → H^+ (σ_{01})

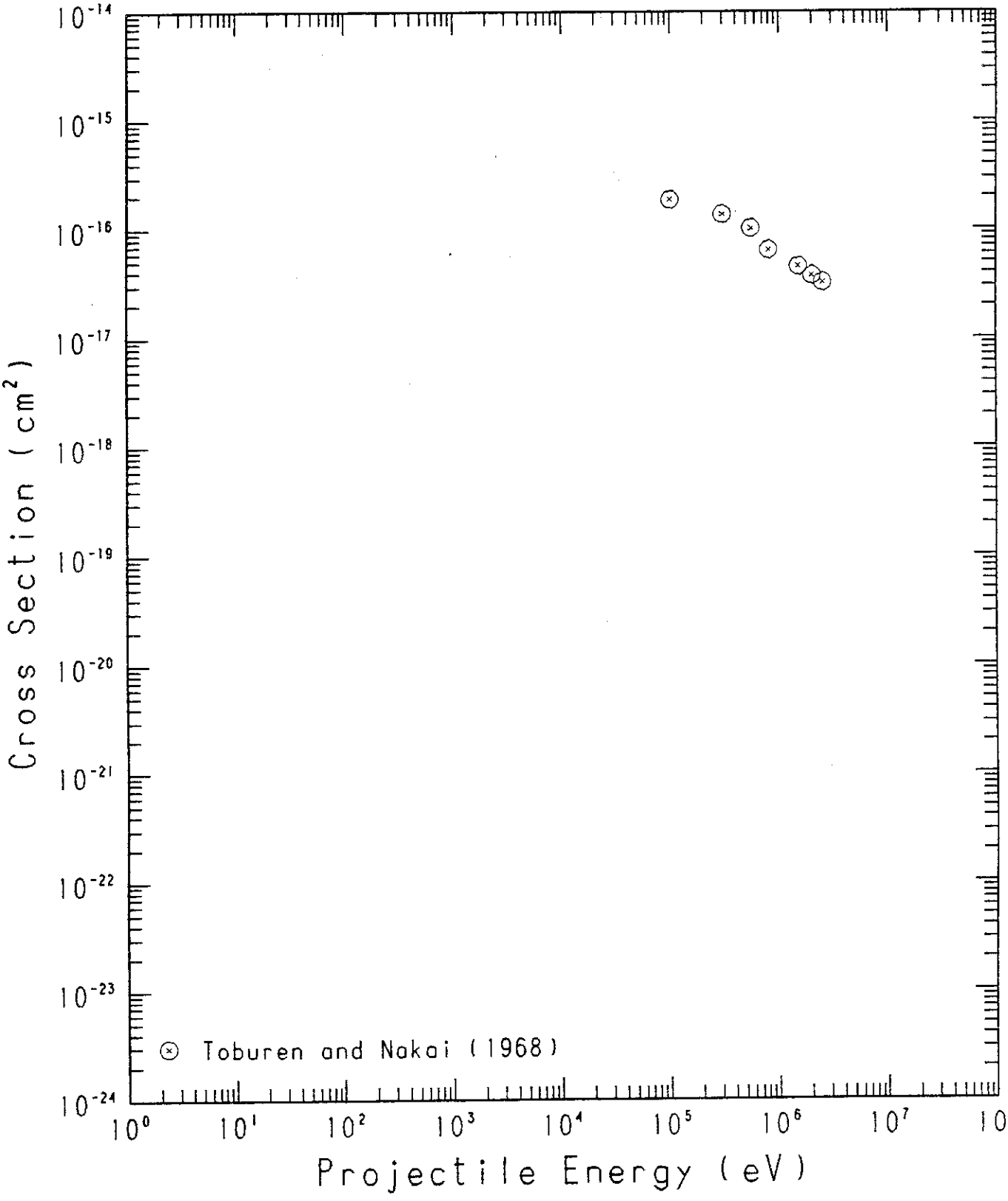

TABLE 30

PROCESS : H + C = H+ (01)
TOBUREN AND NAKAI, PHYS. REV. 171 114 (1968)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	1.87E-16
3.00E+05	7.61E+00	1.36E-16
5.50E+05	1.03E+01	1.01E-16
8.00E+05	1.24E+01	6.40E-17
1.50E+06	1.70E+01	4.50E-17
2.00E+06	1.96E+01	3.70E-17
2.50E+06	2.20E+01	3.20E-17

Fig.31 $H^- + H_2 \rightarrow H \quad (\sigma_{-10})$

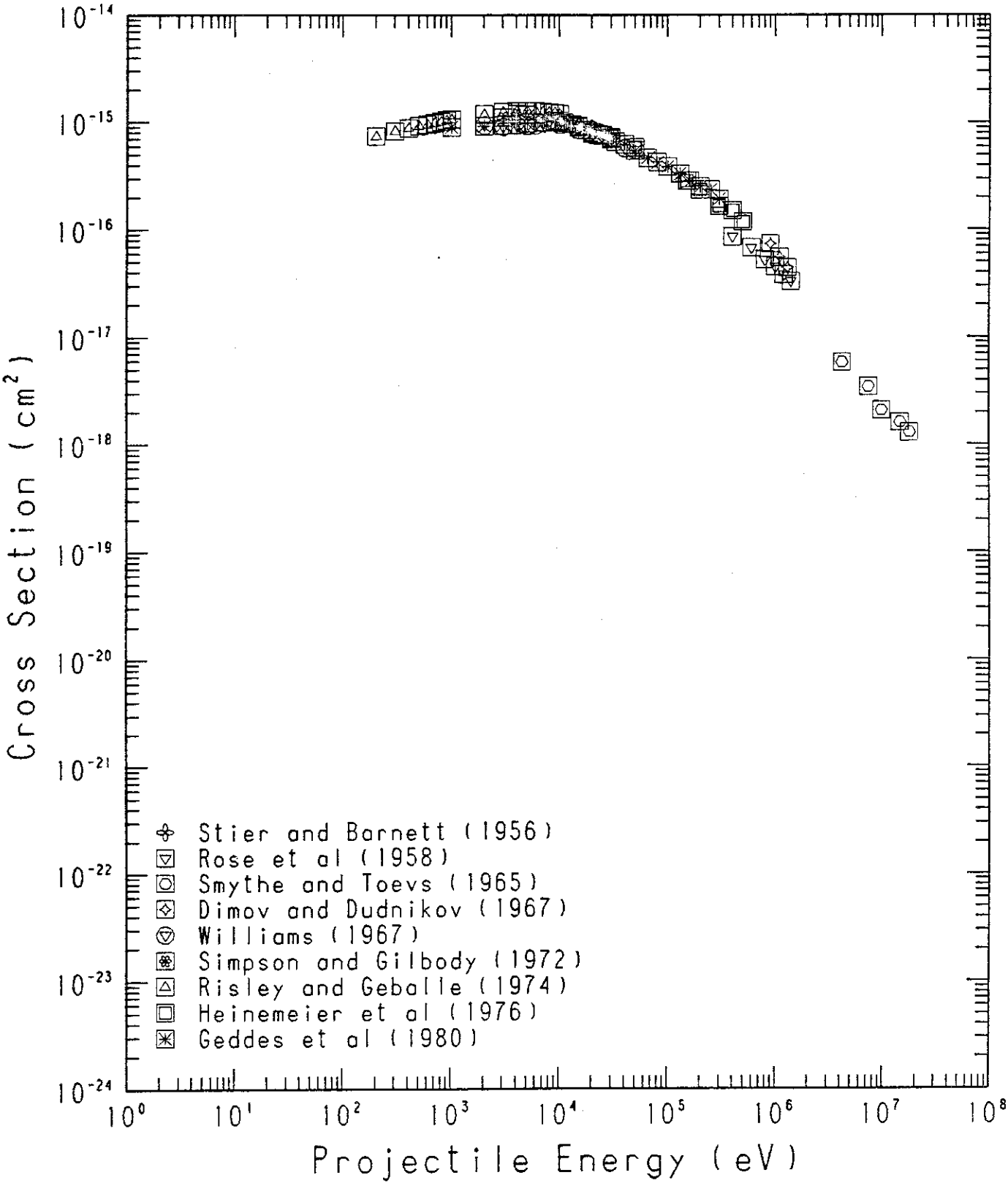

TABLE 31

PROCESS : H- + H2 = H (-10)
STIER AND BARNETT, PHYS. REV. 103 896 (1956)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.00E+03	8.79E-01	1.02E-15
6.00E+03	1.08E+00	1.02E-15
8.00E+03	1.24E+00	1.05E-15
1.00E+04	1.39E+00	1.04E-15
1.20E+04	1.52E+00	1.00E-15
1.60E+04	1.76E+00	9.14E-16
2.00E+04	1.96E+00	8.72E-16
2.50E+04	2.20E+00	7.94E-16
3.00E+04	2.41E+00	7.45E-16

PROCESS : H- + H2 = H (-10)
ROSE ET AL, BULL. AM. PHYS. SOC. II 3 40 (1958)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.00E+05	8.79E+00	8.50E-17
6.00E+05	1.08E+01	6.70E-17
8.00E+05	1.24E+01	5.20E-17
1.00E+06	1.39E+01	4.50E-17
1.20E+06	1.52E+01	3.78E-17
1.40E+06	1.64E+01	3.27E-17

PROCESS : H- + H2 = H (-10)
SMYTHE AND TOEVS, PHYS. REV. 139 A15 (1965)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.20E+06	2.85E+01	5.77E-18
7.40E+06	3.78E+01	3.43E-18
9.80E+06	4.35E+01	2.07E-18
1.46E+07	5.31E+01	1.60E-18
1.79E+07	5.88E+01	1.29E-18

PROCESS : H- + H2 = H (-10)
DIMOV AND DUDNIKOV, SOV. PHYS.-TECH. PHYS. 11 919 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
9.00E+05	1.32E+01	7.30E-17
1.10E+06	1.46E+01	5.50E-17
1.30E+06	1.58E+01	4.40E-17

TABLE 31 - CONTINUED

PROCESS : H- + H2 = H (-10)
WILLIAMS, PHYS. REV. 154 9 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.00E+03	6.21E-01	9.34E-16
3.00E+03	7.61E-01	9.08E-16
4.00E+03	8.79E-01	9.31E-16
5.00E+03	9.82E-01	9.22E-16
6.00E+03	1.08E+00	9.30E-16
7.00E+03	1.16E+00	9.78E-16
8.00E+03	1.24E+00	1.03E-15
1.00E+04	1.39E+00	9.52E-16
1.50E+04	1.70E+00	8.43E-16
2.00E+04	1.96E+00	7.60E-16
3.00E+04	2.41E+00	7.21E-16
4.00E+04	2.78E+00	5.72E-16
5.00E+04	3.11E+00	5.52E-16

PROCESS : H- + H2 = H (-10)
SIMPSON AND GILBODY, J. PHYS. B5 1959 (1972)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
3.00E+03	7.61E-01	1.10E-15
4.00E+03	8.79E-01	1.19E-15
5.00E+03	9.82E-01	1.17E-15
1.00E+04	1.39E+00	1.03E-15
1.50E+04	1.70E+00	9.29E-16
2.00E+04	1.96E+00	8.10E-16
2.50E+04	2.20E+00	7.59E-16
3.00E+04	2.41E+00	7.18E-16

PROCESS : H- + H2 = H (-10)
RISLEY AND GEBALLE, PHYS. REV. A9 2485 (1974)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.00E+02	1.96E-01	7.45E-16
3.00E+02	2.41E-01	8.28E-16
4.00E+02	2.78E-01	8.85E-16
5.00E+02	3.11E-01	9.26E-16
6.00E+02	3.40E-01	9.52E-16
7.00E+02	3.68E-01	9.83E-16
8.00E+02	3.93E-01	1.01E-15
9.00E+02	4.17E-01	1.04E-15
1.00E+03	4.39E-01	1.06E-15
2.00E+03	6.21E-01	1.18E-15
3.00E+03	7.61E-01	1.24E-15

TABLE 31 - CONTINUED

4.00E+03	8.79E-01	1.26E-15
5.00E+03	9.82E-01	1.27E-15
6.00E+03	1.08E+00	1.26E-15
7.00E+03	1.16E+00	1.25E-15
8.00E+03	1.24E+00	1.23E-15
9.00E+03	1.32E+00	1.22E-15
1.00E+04	1.39E+00	1.19E-15

PROCESS : H- + H2 = H (-10)
HEINEMEIER ET AL, J. PHYS. B9 2669 (1976)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+04	3.11E+00	5.81E-16
1.50E+05	5.38E+00	2.84E-16
2.00E+05	6.21E+00	2.34E-16
3.00E+05	7.61E+00	1.64E-16
4.00E+05	8.79E+00	1.49E-16
5.00E+05	9.82E+00	1.17E-16

PROCESS : H- + H2 = H (-10)
GEDDES ET AL, J. PHYS. B13 319 (1980)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+03	4.39E-01	9.00E-16
2.00E+03	6.21E-01	9.18E-16
3.00E+03	7.61E-01	9.37E-16
4.00E+03	8.79E-01	9.51E-16
5.00E+03	9.82E-01	9.80E-16
7.00E+03	1.16E+00	9.96E-16
9.00E+03	1.32E+00	1.02E-15
1.10E+04	1.46E+00	9.90E-16
1.30E+04	1.58E+00	9.57E-16
1.50E+04	1.70E+00	9.00E-16
1.80E+04	1.86E+00	8.44E-16
2.00E+04	1.96E+00	7.86E-16
2.30E+04	2.11E+00	7.69E-16
2.50E+04	2.20E+00	7.50E-16
3.00E+04	2.41E+00	6.97E-16
3.30E+04	2.52E+00	6.60E-16
4.00E+04	2.78E+00	6.20E-16
5.00E+04	3.11E+00	5.40E-16
6.50E+04	3.54E+00	4.65E-16
8.00E+04	3.93E+00	4.23E-16
1.00E+05	4.39E+00	3.85E-16
1.30E+05	5.01E+00	3.31E-16
1.60E+05	5.56E+00	2.84E-16
2.00E+05	6.21E+00	2.52E-16
2.50E+05	6.95E+00	2.34E-16
3.00E+05	7.61E+00	1.91E-16

Fig.32 $H^- + N_2 \rightarrow H\ (\sigma_{-10})$

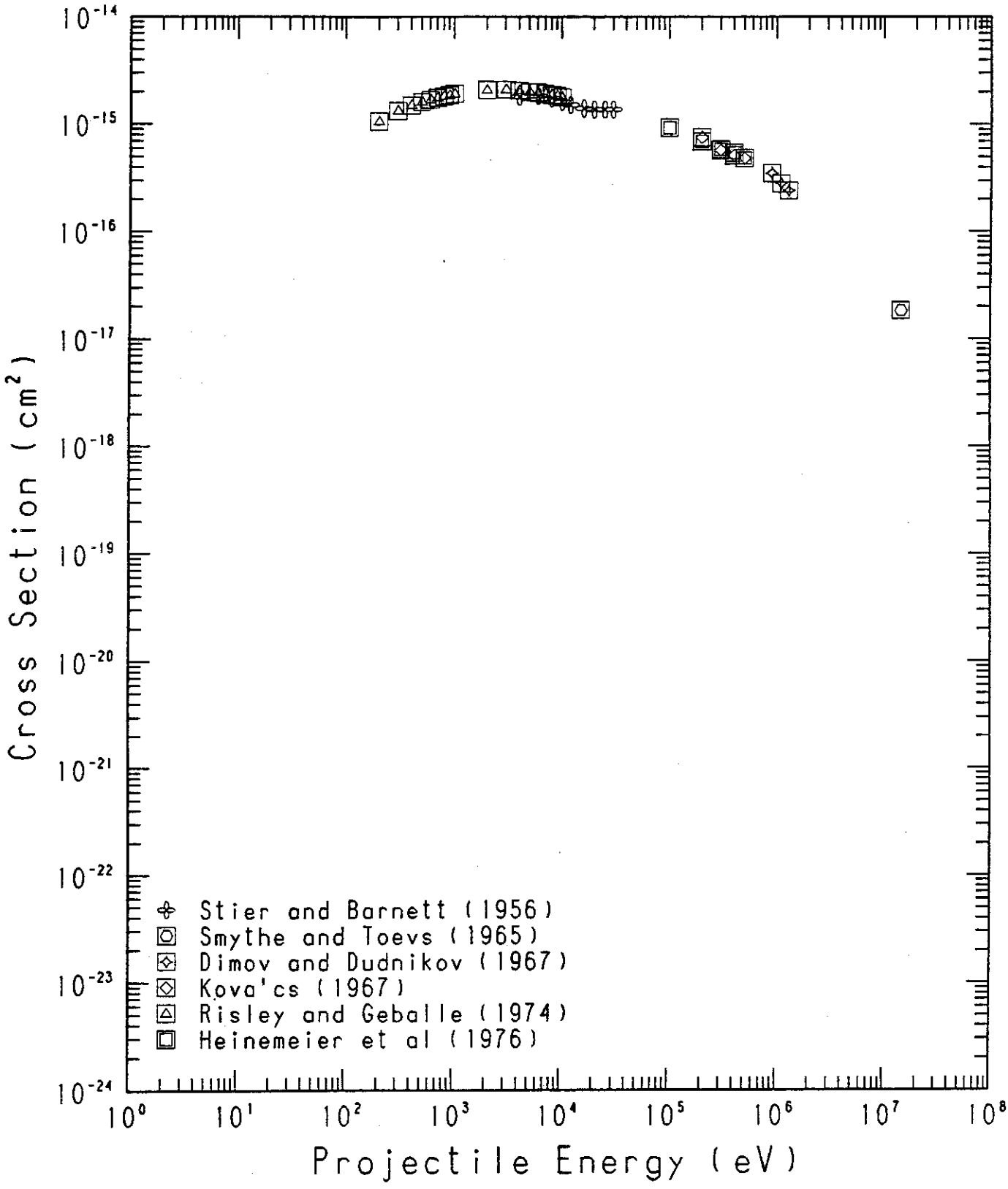

TABLE 32

PROCESS : H- + N2 = H (-10)
STIER AND BARNETT, PHYS. REV. 103 896 (1956)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.00E+03	8.79E-01	1.79E-15
6.00E+03	1.08E+00	1.82E-15
8.00E+03	1.24E+00	1.73E-15
1.00E+04	1.39E+00	1.60E-15
1.20E+04	1.52E+00	1.50E-15
1.60E+04	1.76E+00	1.39E-15
2.00E+04	1.96E+00	1.36E-15
2.50E+04	2.20E+00	1.36E-15
3.00E+04	2.41E+00	1.36E-15

PROCESS : H- + N2 = H (-10)
SMYTHE AND TOEVS, PHYS. REV. 139 A15 (1965)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.46E+07	5.31E+01	1.83E-17

PROCESS : H- + N2 = H (-10)
DIMOV AND DUDNIKOV, SOV. PHYS.-TECH. PHYS. 11 919 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
9.00E+05	1.32E+01	3.50E-16
1.10E+06	1.46E+01	2.80E-16
1.30E+06	1.58E+01	2.40E-16

PROCESS : H- + N2 = H (-10)
KOVA'CS, NUCL. INSTR. METH. 51 224 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.00E+05	6.21E+00	7.56E-16
3.00E+05	7.61E+00	5.74E-16
4.00E+05	8.79E+00	5.10E-16
5.00E+05	9.82E+00	4.80E-16

PROCESS : H- + N2 = H (-10)
RISLEY AND GEBALLE, PHYS. REV. A9 2485 (1974)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.00E+02	1.96E-01	1.05E-15

TABLE 32 - CONTINUED

3.00E+02	2.41E-01	1.31E-15
4.00E+02	2.78E-01	1.48E-15
5.00E+02	3.11E-01	1.59E-15
6.00E+02	3.40E-01	1.67E-15
7.00E+02	3.68E-01	1.74E-15
8.00E+02	3.93E-01	1.80E-15
9.00E+02	4.17E-01	1.85E-15
1.00E+03	4.39E-01	1.90E-15
2.00E+03	6.21E-01	2.08E-15
3.00E+03	7.61E-01	2.09E-15
4.00E+03	8.79E-01	2.05E-15
5.00E+03	9.82E-01	1.99E-15
6.00E+03	1.08E+00	1.96E-15
7.00E+03	1.16E+00	1.91E-15
8.00E+03	1.24E+00	1.86E-15
9.00E+03	1.32E+00	1.83E-15
1.00E+04	1.39E+00	1.77E-15

PROCESS : H- + N2 = H (-10)
HEINEMEIER ET AL, J. PHYS. B9 2669 (1976)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	9.23E-16
2.00E+05	6.21E+00	6.87E-16
3.00E+05	7.61E+00	5.83E-16
4.00E+05	8.79E+00	5.42E-16
5.00E+05	9.82E+00	4.83E-16

Fig.33 $H^- + O_2 \rightarrow H \quad (\sigma_{-10})$

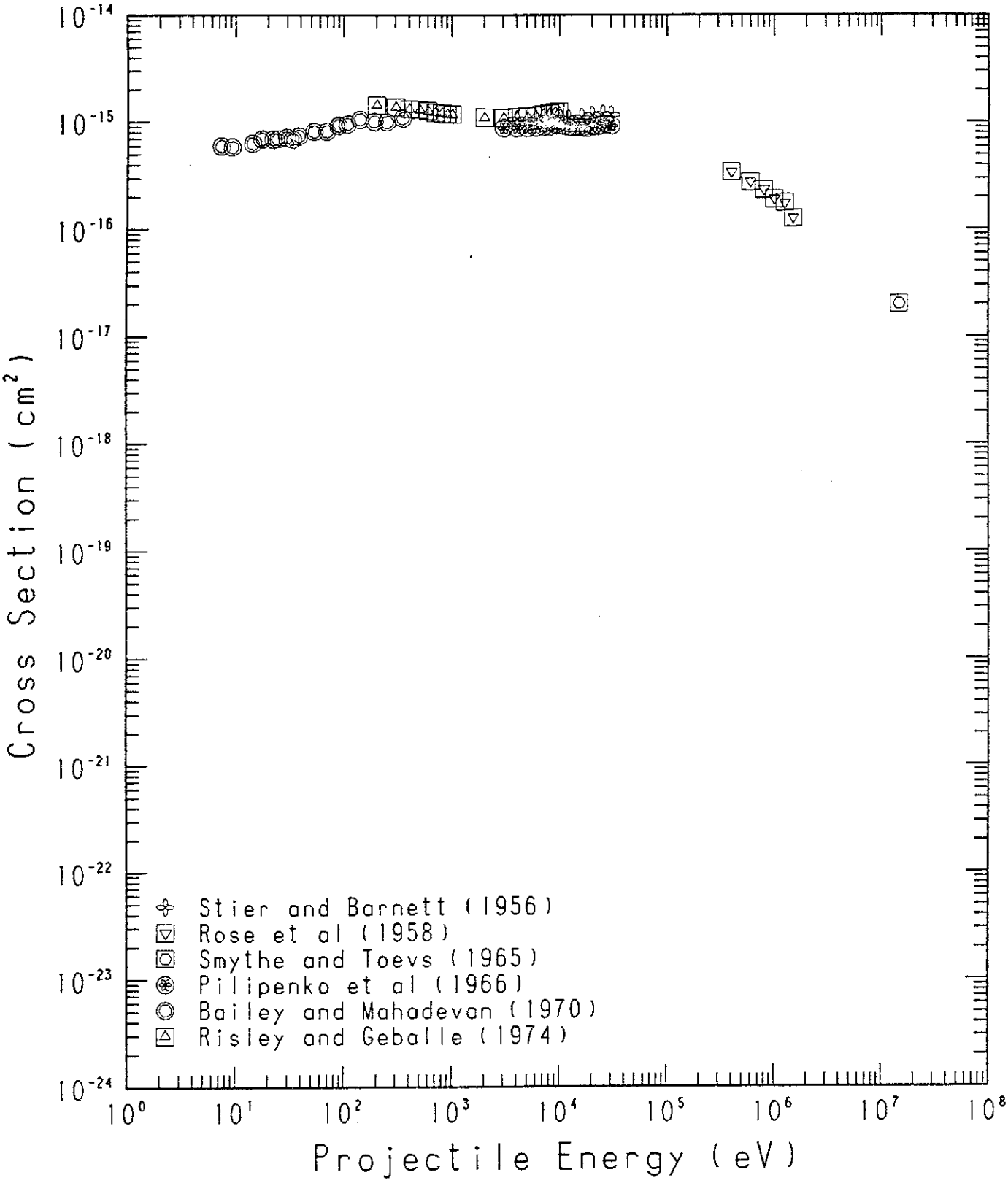

TABLE 33

PROCESS : H- + O2 = H (-10)
STIER AND BARNETT, PHYS. REV. 103 896 (1956)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.00E+03	8.79E-01	1.05E-15
6.00E+03	1.08E+00	1.04E-15
8.00E+03	1.24E+00	1.09E-15
1.00E+04	1.39E+00	1.07E-15
1.20E+04	1.52E+00	1.08E-15
1.60E+04	1.76E+00	1.10E-15
2.00E+04	1.96E+00	1.15E-15
2.50E+04	2.20E+00	1.18E-15
3.00E+04	2.41E+00	1.16E-15

PROCESS : H- + O2 = H (-10)
ROSE ET AL, BULL. AM. PHYS. SOC. II 3 40 (1958)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.00E+05	8.79E+00	3.44E-16
6.00E+05	1.08E+01	2.76E-16
8.00E+05	1.24E+01	2.35E-16
1.00E+06	1.39E+01	1.91E-16
1.25E+06	1.55E+01	1.76E-16
1.50E+06	1.70E+01	1.26E-16

PROCESS : H- + O2 = H (-10)
SMYTHE AND TOEVS, PHYS. REV. 139 A15 (1965)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.46E+07	5.31E+01	1.99E-17

PROCESS : H- + O2 = H (-10)
PILIPENKO ET AL, SOV. PHYS. JETP 22 965 (1966)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
3.00E+03	7.61E-01	8.70E-16
4.00E+03	8.79E-01	8.69E-16
5.00E+03	9.82E-01	8.67E-16
6.00E+03	1.08E+00	8.76E-16
7.00E+03	1.16E+00	8.96E-16
8.00E+03	1.24E+00	9.05E-16
9.00E+03	1.32E+00	9.35E-16
1.00E+04	1.39E+00	9.23E-16
1.10E+04	1.46E+00	9.10E-16

TABLE 33 - CONTINUED

1.20E+04	1.52E+00	8.98E-16
1.30E+04	1.58E+00	8.85E-16
1.40E+04	1.64E+00	9.05E-16
1.50E+04	1.70E+00	8.92E-16
1.60E+04	1.76E+00	8.90E-16
1.80E+04	1.86E+00	8.76E-16
2.00E+04	1.96E+00	9.05E-16
2.20E+04	2.06E+00	9.01E-16
2.40E+04	2.15E+00	9.19E-16
2.70E+04	2.28E+00	9.46E-16
3.00E+04	2.41E+00	9.19E-16

PROCESS : H- + O2 = H (-10)
BAILEY AND MAHADEVAN, J. CHEM. PHYS. 52 179 (1970)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
7.39E+00	3.78E-02	5.99E-16
9.29E+00	4.23E-02	5.88E-16
1.44E+01	5.27E-02	6.35E-16
1.75E+01	5.81E-02	6.98E-16
2.22E+01	6.54E-02	6.97E-16
2.46E+01	6.89E-02	7.00E-16
2.95E+01	7.54E-02	7.22E-16
3.35E+01	8.04E-02	6.97E-16
3.81E+01	8.57E-02	7.43E-16
5.27E+01	1.01E-01	8.20E-16
6.90E+01	1.15E-01	8.22E-16
8.81E+01	1.30E-01	9.28E-16
1.07E+02	1.44E-01	9.58E-16
1.40E+02	1.64E-01	1.06E-15
1.90E+02	1.91E-01	1.01E-15
2.48E+02	2.19E-01	1.00E-15
3.48E+02	2.59E-01	1.08E-15

PROCESS : H- + O2 = H (-10)
RISLEY AND GEBALLE, PHYS. REV. A9 2485 (1974)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.00E+02	1.96E-01	1.44E-15
3.00E+02	2.41E-01	1.38E-15
4.00E+02	2.78E-01	1.32E-15
5.00E+02	3.11E-01	1.30E-15
6.00E+02	3.40E-01	1.26E-15
7.00E+02	3.68E-01	1.22E-15
8.00E+02	3.93E-01	1.20E-15
9.00E+02	4.17E-01	1.18E-15
1.00E+03	4.39E-01	1.17E-15

TABLE 33 - CONTINUED

2.00E+03	6.21E-01	1.09E-15
3.00E+03	7.61E-01	1.08E-15
4.00E+03	8.79E-01	1.10E-15
5.00E+03	9.82E-01	1.11E-15
6.00E+03	1.08E+00	1.14E-15
7.00E+03	1.16E+00	1.17E-15
8.00E+03	1.24E+00	1.19E-15
9.00E+03	1.32E+00	1.22E-15
9.80E+03	1.38E+00	1.24E-15

Fig.34 $H^- + H_2O \rightarrow H \quad (\sigma_{-10})$

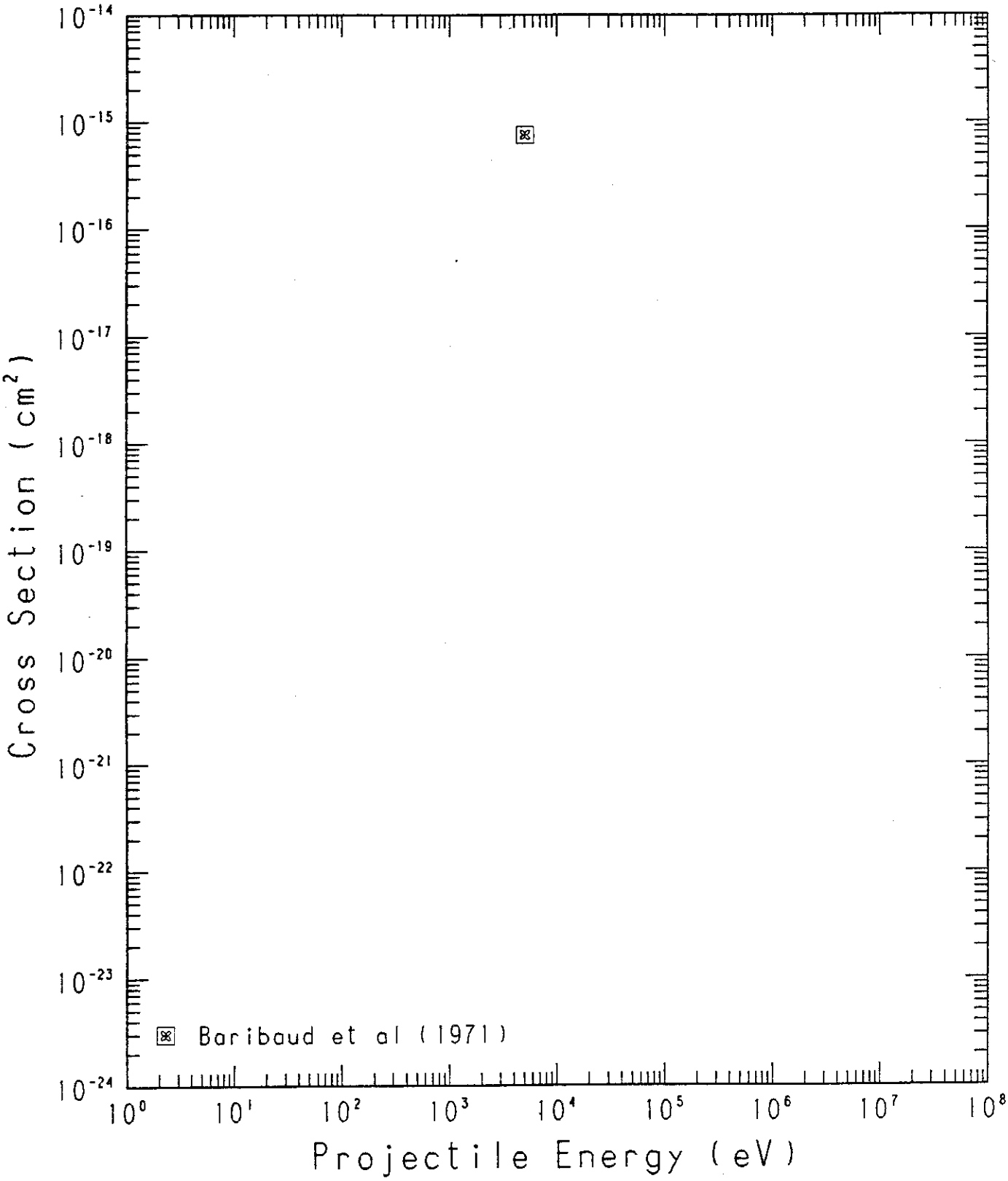

TABLE 34

PROCESS : H- + H2O = H (-10)
BARIBAUD ET AL, COMPT. REND. B272 457 (1971)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+03	9.82E-01	7.50E-16

Fig.35 $H^- + CO \rightarrow H\ (\sigma_{-10})$

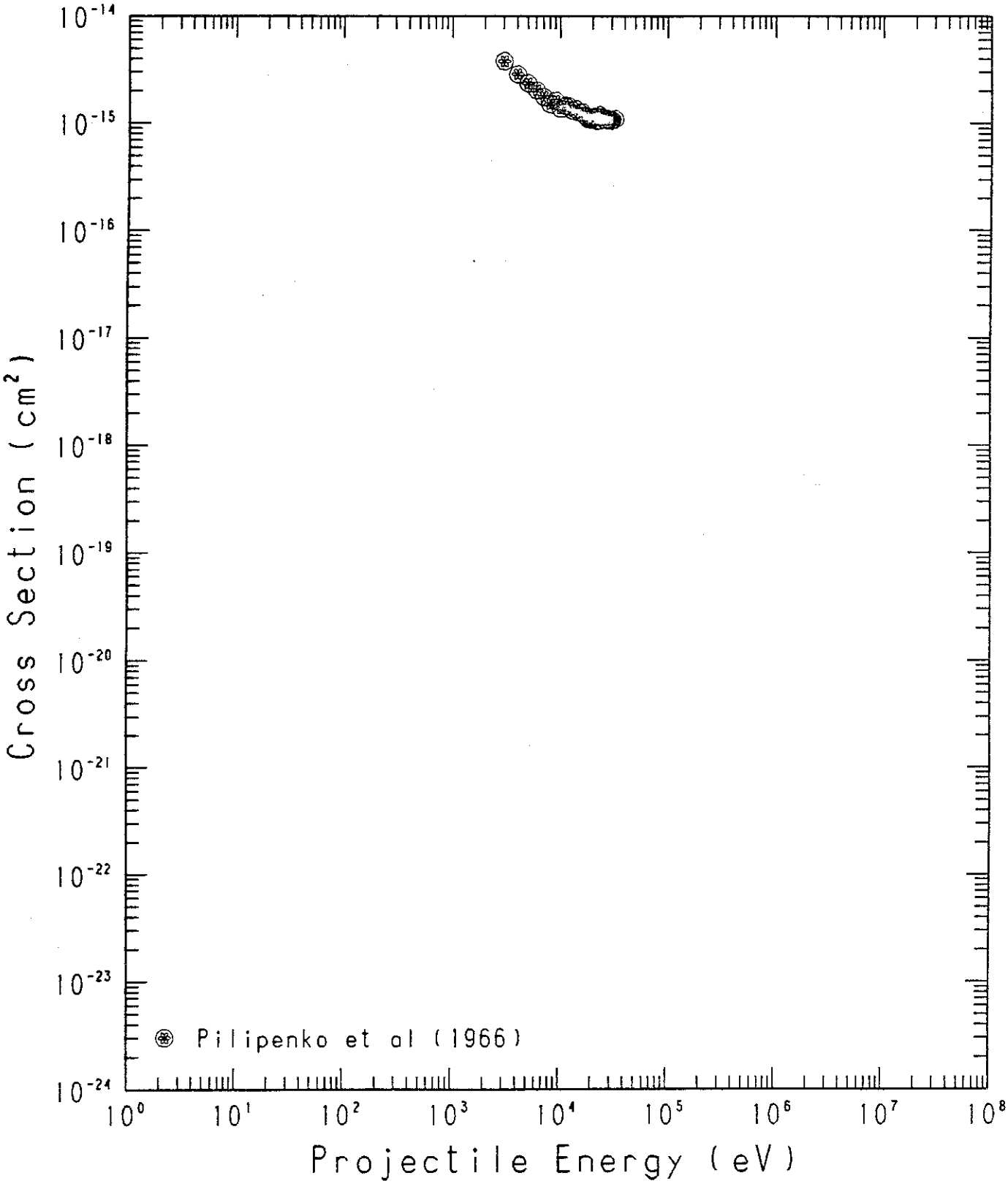

TABLE 35

PROCESS : H- + CO = H (-10)
PILIPENKO ET AL, SOV. PHYS. JETP 22 965 (1966)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
3.00E+03	7.61E-01	3.79E-15
4.00E+03	8.79E-01	2.87E-15
5.00E+03	9.82E-01	2.36E-15
6.00E+03	1.08E+00	2.03E-15
7.00E+03	1.16E+00	1.76E-15
8.00E+03	1.24E+00	1.51E-15
9.00E+03	1.32E+00	1.63E-15
1.00E+04	1.39E+00	1.37E-15
1.10E+04	1.46E+00	1.46E-15
1.20E+04	1.52E+00	1.43E-15
1.30E+04	1.58E+00	1.31E-15
1.40E+04	1.64E+00	1.35E-15
1.50E+04	1.70E+00	1.26E-15
1.60E+04	1.76E+00	1.26E-15
1.70E+04	1.81E+00	1.17E-15
1.80E+04	1.86E+00	1.11E-15
1.90E+04	1.91E+00	1.08E-15
2.00E+04	1.96E+00	1.12E-15
2.10E+04	2.01E+00	1.15E-15
2.20E+04	2.06E+00	1.06E-15
2.30E+04	2.11E+00	1.19E-15
2.40E+04	2.15E+00	1.14E-15
2.50E+04	2.20E+00	1.09E-15
2.60E+04	2.24E+00	1.08E-15
2.70E+04	2.28E+00	1.10E-15
2.80E+04	2.32E+00	1.07E-15
2.90E+04	2.37E+00	1.06E-15
3.00E+04	2.41E+00	1.07E-15
3.20E+04	2.48E+00	1.09E-15

Fig.36 $H^- + CO_2 \rightarrow H\ (\sigma_{-10})$

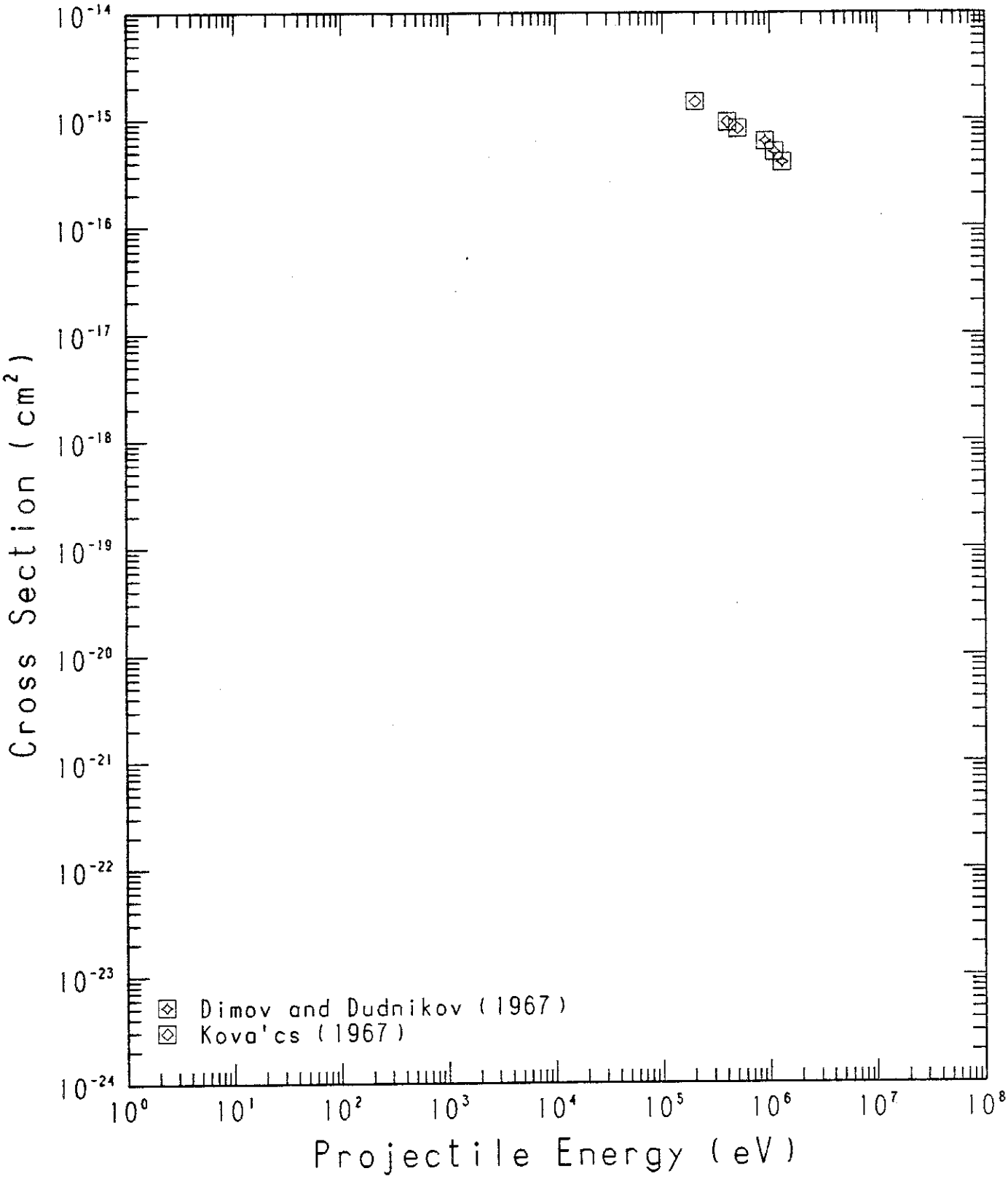

TABLE 36

PROCESS : H- + CO2 = H (-10)
DIMOV AND DUDNIKOV, SOV. PHYS.-TECH. PHYS. 11 919 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
9.00E+05	1.32E+01	6.30E-16
1.10E+06	1.46E+01	5.00E-16
1.30E+06	1.58E+01	4.00E-16

PROCESS : H- + CO2 = H (-10)
KOVA'CS, NUCL. INSTR. METH. 51 224 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.00E+05	6.21E+00	1.47E-15
4.00E+05	8.79E+00	9.42E-16
5.00E+05	9.82E+00	8.24E-16

Fig.37 $H^- + C_3H_8 \rightarrow H\ (\sigma_{-10})$

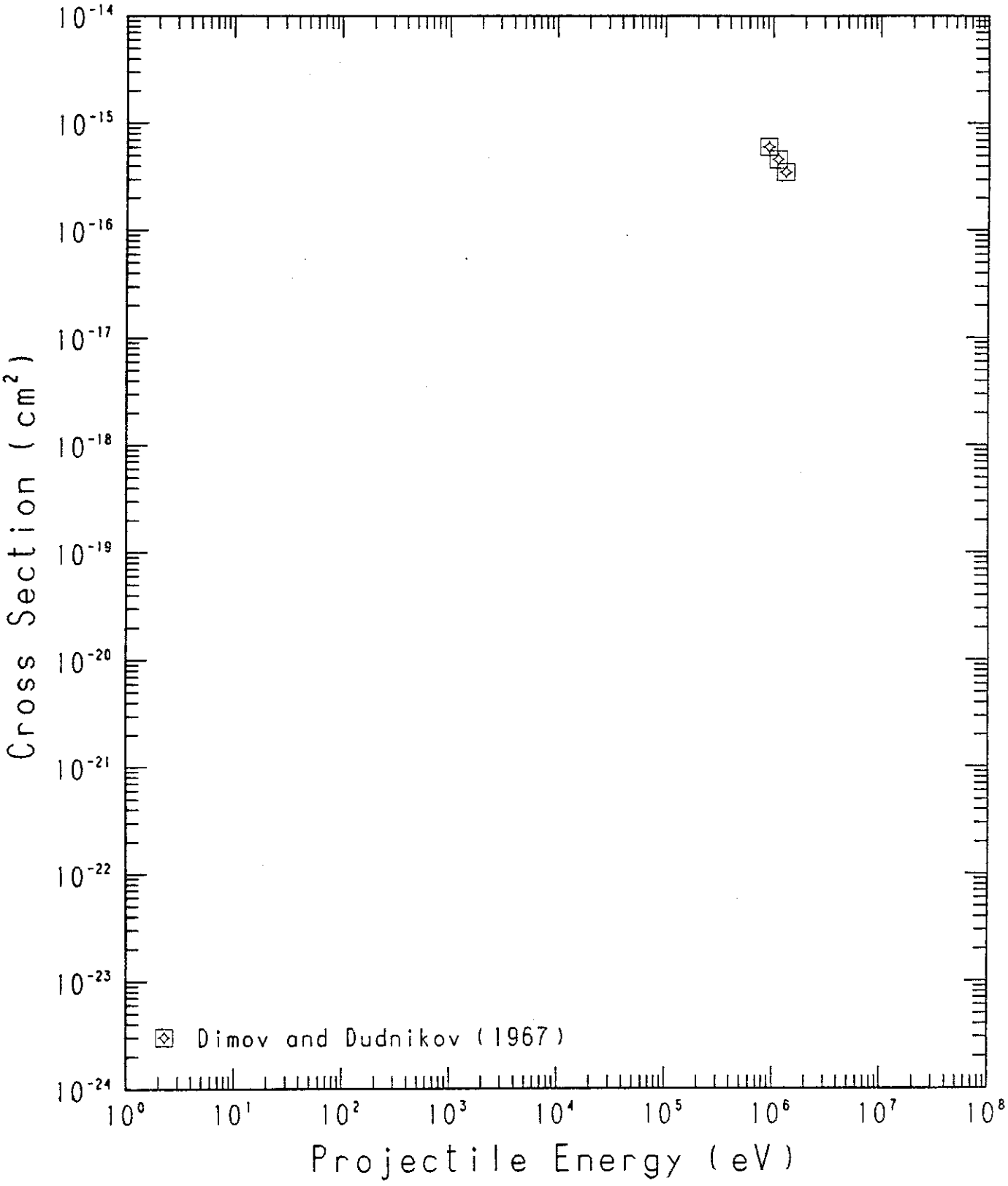

TABLE 37

PROCESS : H- + C3H8 = H (-10)
DIMOV AND DUDNIKOV, SOV. PHYS.-TECH. PHYS. 11 919 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
9.00E+05	1.32E+01	6.00E-16
1.10E+06	1.46E+01	4.60E-16
1.30E+06	1.58E+01	3.50E-16

Fig.38 $H^- + H_2 \rightarrow H^+ (\sigma_{-11})$

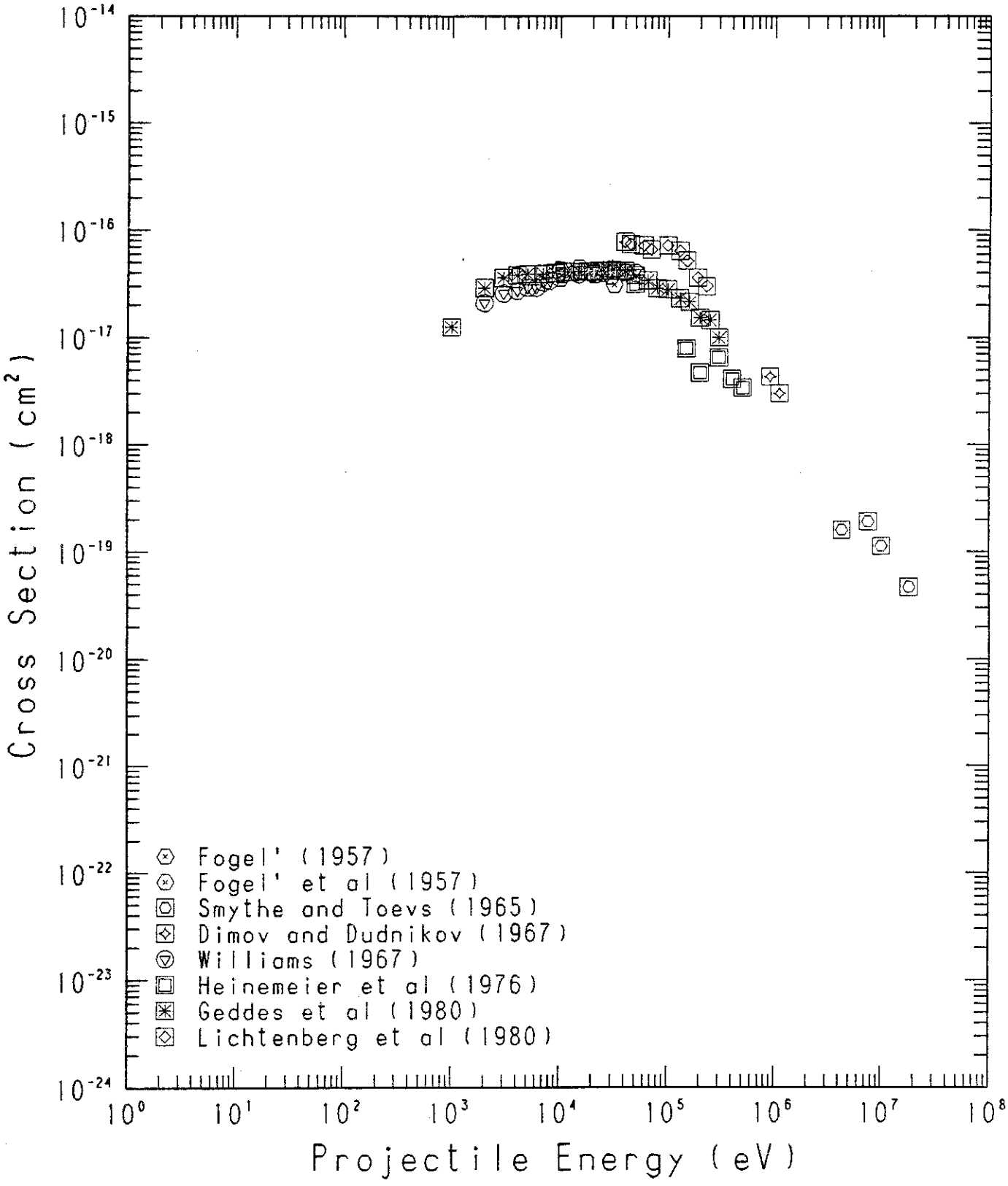

TABLE 38

PROCESS : H- + H2 = H+ (-11)
FOGEL', SOV. PHYS. JETP 5 499 (1957)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.03E+04	1.41E+00	3.80E-17
1.52E+04	1.71E+00	4.10E-17
2.07E+04	2.00E+00	3.80E-17
2.49E+04	2.19E+00	3.90E-17
2.96E+04	2.39E+00	3.70E-17
3.18E+04	2.48E+00	3.10E-17

PROCESS : H- + H2 = H+ (-11)
FOGEL' ET AL, SOV. PHYS. JETP 5 382 (1957)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.00E+03	8.79E-01	3.75E-17
1.00E+04	1.39E+00	4.31E-17
1.50E+04	1.70E+00	4.50E-17
2.00E+04	1.96E+00	4.00E-17
2.50E+04	2.20E+00	4.33E-17
3.00E+04	2.41E+00	4.12E-17
3.30E+04	2.52E+00	4.36E-17
3.95E+04	2.76E+00	4.10E-17

PROCESS : H- + H2 = H+ (-11)
SMYTHE AND TOEVS, PHYS. REV. 139 A15 (1965)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.20E+06	2.85E+01	1.60E-19
7.40E+06	3.78E+01	1.92E-19
9.80E+06	4.35E+01	1.13E-19
1.79E+07	5.88E+01	4.69E-20

PROCESS : H- + H2 = H+ (-11)
DIMOV AND DUDNIKOV, SOV. PHYS.-TECH. PHYS. 11 919 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
9.00E+05	1.32E+01	4.30E-18
1.10E+06	1.46E+01	3.00E-18

TABLE 38 - CONTINUED

PROCESS : H- + H2 = H+ (-11)
WILLIAMS, PHYS. REV. 154 9 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.00E+03	6.21E-01	2.09E-17
3.00E+03	7.61E-01	2.56E-17
4.00E+03	8.79E-01	2.72E-17
5.00E+03	9.82E-01	2.90E-17
6.00E+03	1.08E+00	2.90E-17
7.00E+03	1.16E+00	3.25E-17
8.00E+03	1.24E+00	3.38E-17
1.00E+04	1.39E+00	3.60E-17
1.50E+04	1.70E+00	3.86E-17
2.00E+04	1.96E+00	4.01E-17
3.00E+04	2.41E+00	4.34E-17
4.00E+04	2.78E+00	4.02E-17
5.00E+04	3.11E+00	4.01E-17

PROCESS : H- + H2 = H+ (-11)
HEINEMEIER ET AL, J. PHYS. B9 2669 (1976)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+04	3.11E+00	3.17E-17
1.50E+05	5.38E+00	7.90E-18
2.00E+05	6.21E+00	4.70E-18
3.00E+05	7.61E+00	6.50E-18
4.00E+05	8.79E+00	4.10E-18
5.00E+05	9.82E+00	3.40E-18

PROCESS : H- + H2 = H+ (-11)
GEDDES ET AL, J. PHYS. B13 319 (1980)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+03	4.39E-01	1.24E-17
2.00E+03	6.21E-01	2.89E-17
3.00E+03	7.61E-01	3.57E-17
4.00E+03	8.79E-01	3.78E-17
5.00E+03	9.82E-01	3.88E-17
7.00E+03	1.16E+00	3.90E-17
9.00E+03	1.32E+00	3.96E-17
1.10E+04	1.46E+00	4.08E-17
1.30E+04	1.58E+00	4.10E-17
1.50E+04	1.70E+00	4.09E-17
1.80E+04	1.86E+00	4.12E-17
2.00E+04	1.96E+00	4.14E-17
2.30E+04	2.11E+00	4.19E-17

TABLE 38 - CONTINUED

2.50E+04	2.20E+00	4.16E-17
3.00E+04	2.41E+00	4.16E-17
3.30E+04	2.52E+00	4.20E-17
4.00E+04	2.78E+00	4.18E-17
5.00E+04	3.11E+00	3.80E-17
6.50E+04	3.54E+00	3.39E-17
8.00E+04	3.93E+00	2.88E-17
1.00E+05	4.39E+00	2.81E-17
1.30E+05	5.01E+00	2.32E-17
1.60E+05	5.56E+00	2.14E-17
2.00E+05	6.21E+00	1.53E-17
2.50E+05	6.95E+00	1.45E-17
3.00E+05	7.61E+00	1.00E-17

PROCESS : H- + H2 = H+ (-11)
LICHTENBERG ET AL, J. PHYS. B13 343 (1980)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.00E+04	2.78E+00	7.80E-17
4.50E+04	2.95E+00	7.40E-17
6.00E+04	3.40E+00	7.20E-17
7.00E+04	3.68E+00	6.60E-17
1.00E+05	4.39E+00	7.20E-17
1.30E+05	5.01E+00	6.40E-17
1.50E+05	5.38E+00	5.20E-17
1.90E+05	6.05E+00	3.60E-17
2.30E+05	6.66E+00	3.00E-17

Fig.39 $H^- + N_2 \rightarrow H^+ (\sigma_{-11})$

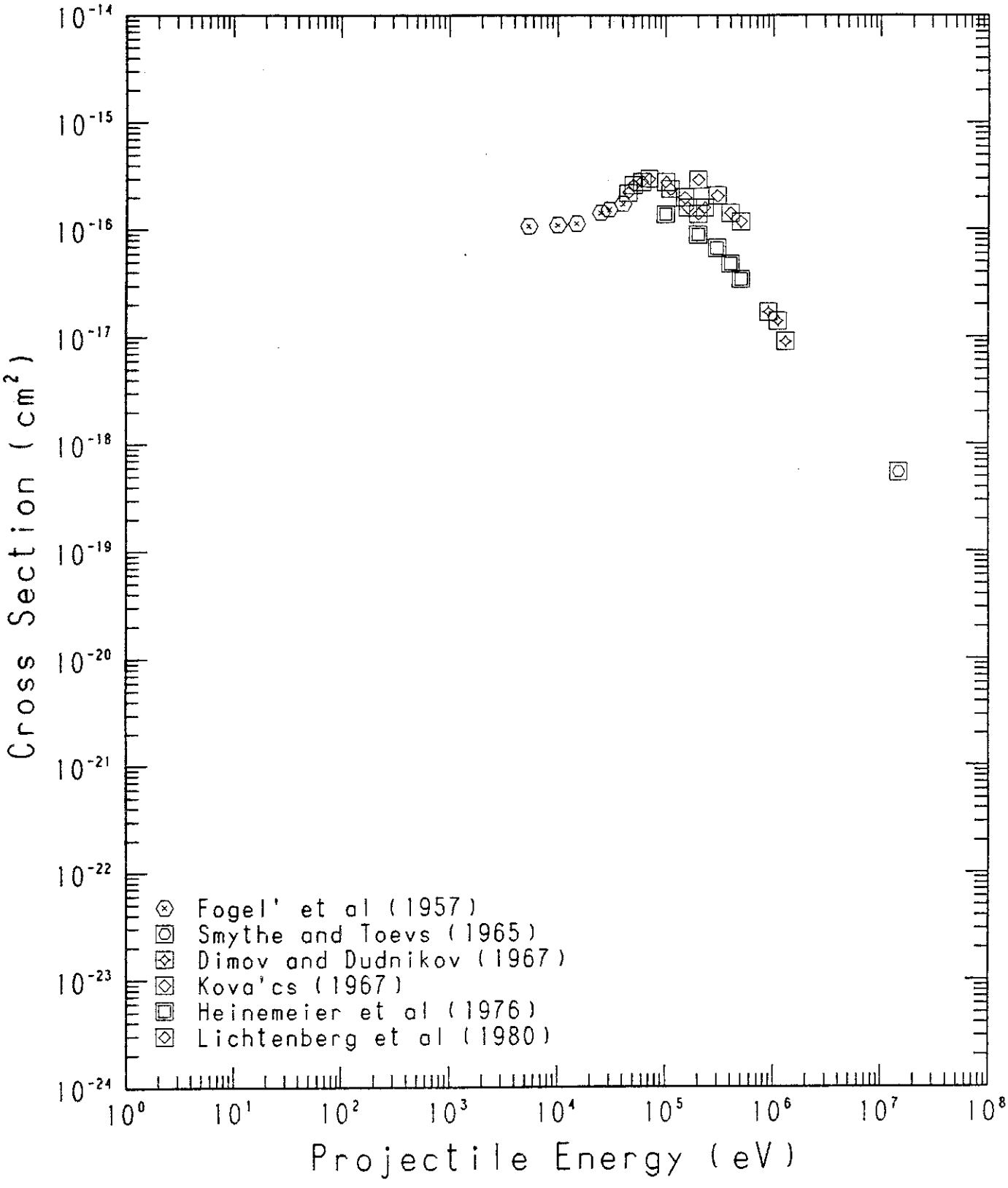

TABLE 39

PROCESS : H- + N2 = H+ (-11)
FOGEL' ET AL, SOV. PHYS. JETP 5 382 (1957)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.40E+03	1.02E+00	1.07E-16
1.00E+04	1.39E+00	1.10E-16
1.50E+04	1.70E+00	1.13E-16
2.50E+04	2.20E+00	1.43E-16
3.00E+04	2.41E+00	1.54E-16
4.00E+04	2.78E+00	1.74E-16

PROCESS : H- + N2 = H+ (-11)
SMYTHE AND TOEVS, PHYS. REV. 139 A15 (1965)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.46E+07	5.31E+01	5.45E-19

PROCESS : H- + N2 = H+ (-11)
DIMOV AND DUDNIKOV, SOV. PHYS.-TECH. PHYS. 11 919 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
9.00E+05	1.32E+01	1.70E-17
1.10E+06	1.46E+01	1.40E-17
1.30E+06	1.58E+01	9.00E-18

PROCESS : H- + N2 = H+ (-11)
KOVA'CS, NUCL. INSTR. METH. 51 224 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.00E+05	6.21E+00	2.94E-16
3.00E+05	7.61E+00	2.08E-16
4.00E+05	8.79E+00	1.42E-16
5.00E+05	9.82E+00	1.18E-16

PROCESS : H- + N2 = H+ (-11)
HEINEMEIER ET AL, J. PHYS. B9 2669 (1976)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.00E+05	4.39E+00	1.39E-16
2.00E+05	6.21E+00	8.95E-17
3.00E+05	7.61E+00	6.70E-17
4.00E+05	8.79E+00	4.80E-17
5.00E+05	9.82E+00	3.45E-17

TABLE 39 - CONTINUED

PROCESS : H- + N2 = H+ (-11)
LICHTENBERG ET AL, J. PHYS. B13 343 (1980)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
4.50E+04	2.95E+00	2.20E-16
5.00E+04	3.11E+00	2.60E-16
6.00E+04	3.40E+00	2.80E-16
7.00E+04	3.68E+00	3.00E-16
1.00E+05	4.39E+00	2.80E-16
1.10E+05	4.61E+00	2.40E-16
1.50E+05	5.38E+00	2.00E-16
1.60E+05	5.56E+00	1.60E-16
2.00E+05	6.21E+00	1.40E-16
2.30E+05	6.66E+00	1.60E-16

Fig.40 $H^- + O_2 \rightarrow H^+ (\sigma_{-11})$

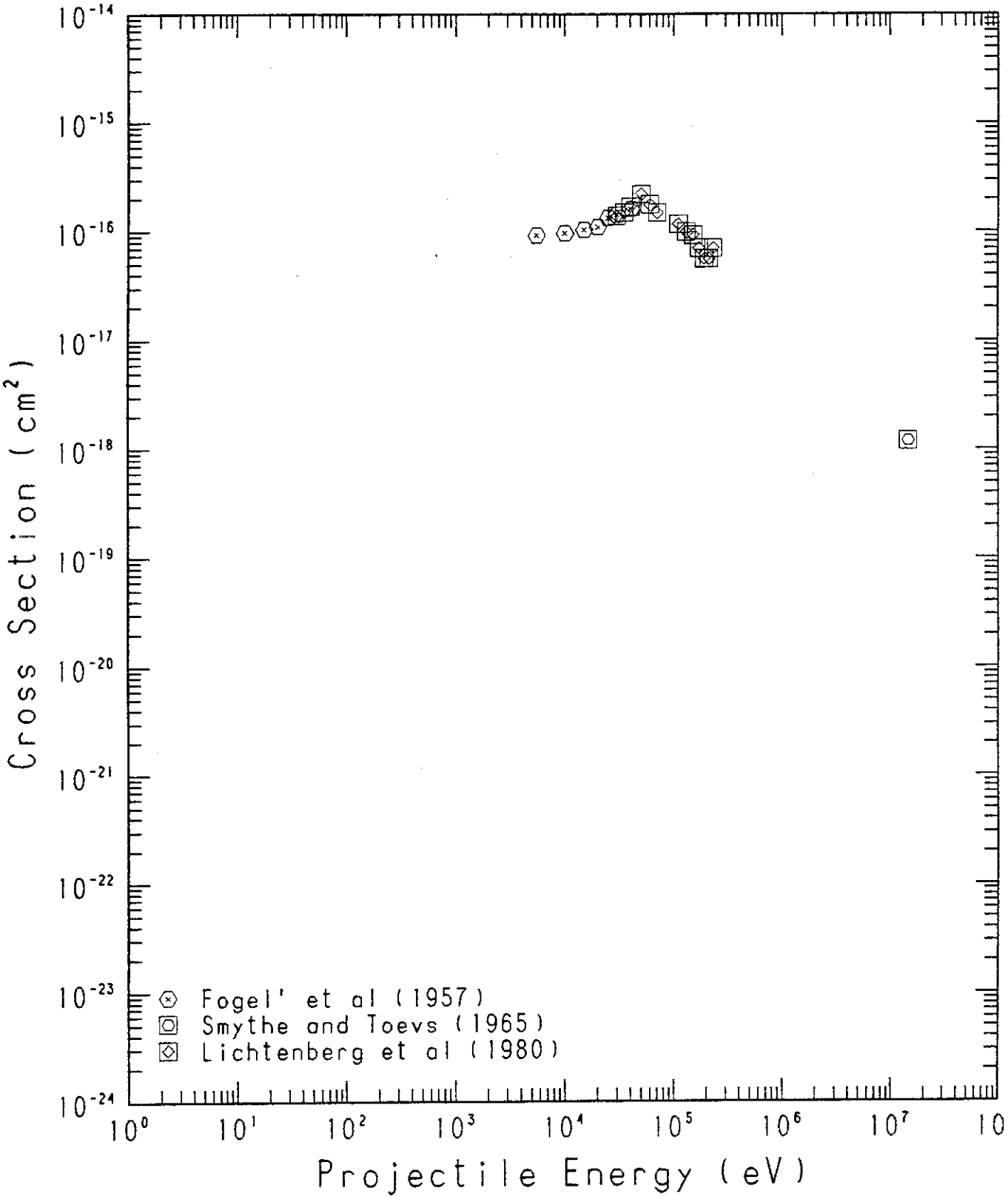

TABLE 40

PROCESS : H- + O2 = H+ (-11)
FOGEL' ET AL, SOV. PHYS. JETP 5 382 (1957)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.50E+03	1.03E+00	9.15E-17
1.00E+04	1.39E+00	9.57E-17
1.50E+04	1.70E+00	1.03E-16
2.00E+04	1.96E+00	1.09E-16
2.50E+04	2.20E+00	1.32E-16
3.00E+04	2.41E+00	1.42E-16
4.00E+04	2.78E+00	1.60E-16

PROCESS : H- + O2 = H+ (-11)
SMYTHE AND TOEVS, PHYS. REV. 139 A15 (1965)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
1.46E+07	5.31E+01	1.18E-18

PROCESS : H- + O2 = H+ (-11)
LICHTENBERG ET AL, J. PHYS. B13 343 (1980)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
3.00E+04	2.41E+00	1.38E-16
3.50E+04	2.60E+00	1.48E-16
4.00E+04	2.78E+00	1.68E-16
5.00E+04	3.11E+00	2.20E-16
6.00E+04	3.40E+00	1.76E-16
7.00E+04	3.68E+00	1.48E-16
1.10E+05	4.61E+00	1.16E-16
1.30E+05	5.01E+00	9.80E-17
1.50E+05	5.38E+00	9.20E-17
1.70E+05	5.73E+00	7.00E-17
1.90E+05	6.05E+00	5.60E-17
2.10E+05	6.37E+00	5.60E-17
2.30E+05	6.66E+00	7.00E-17

Fig.41 $H^- + H_2O \rightarrow H^+ (\sigma_{-11})$

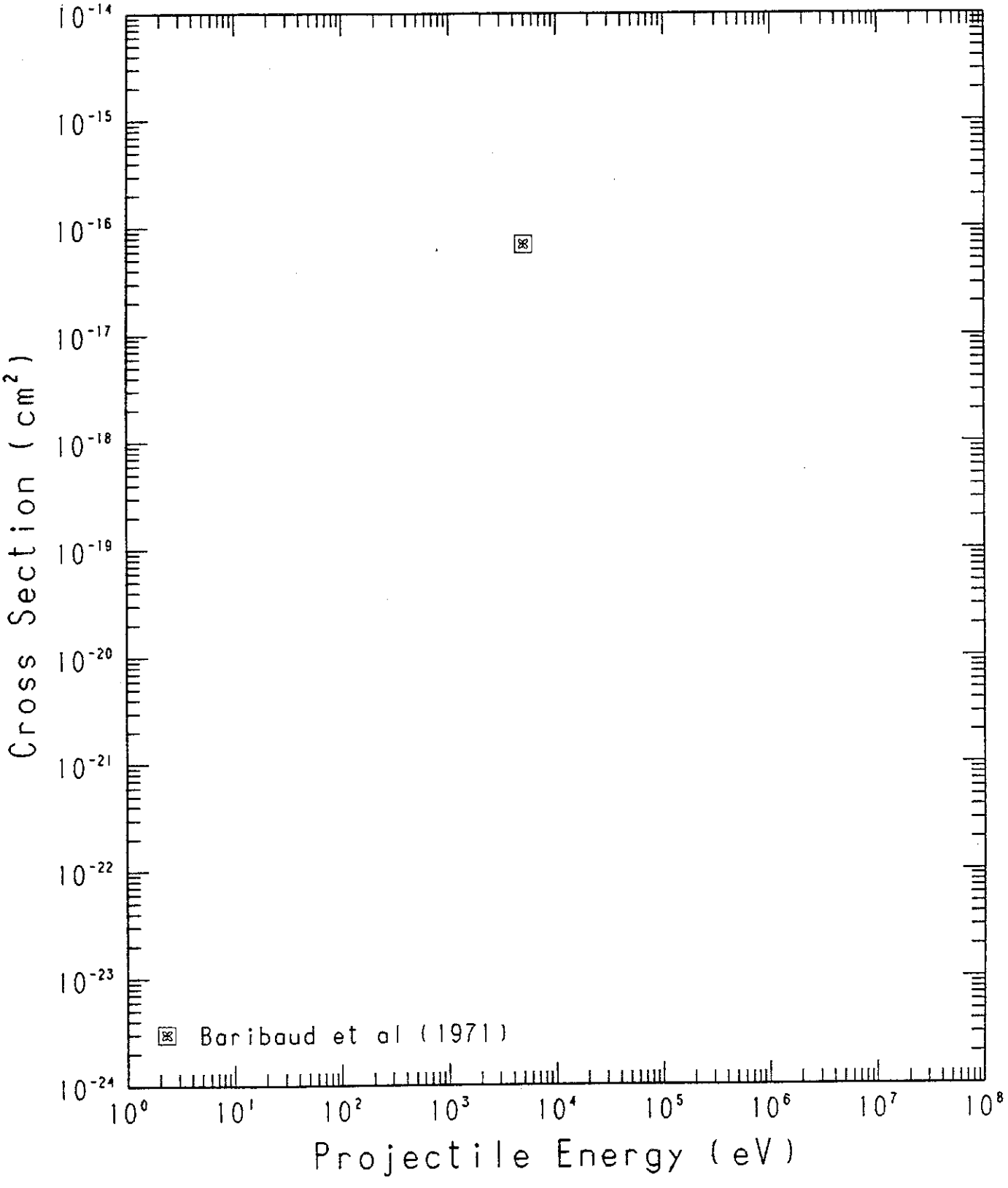

TABLE 41

PROCESS : H- + H2O = H+ (-11)
BARIBAUD ET AL, COMPT. REND. B272 457 (1971)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
5.00E+03	9.82E-01	7.00E-17

Fig. 42 $H^- + CO_2 \rightarrow H^+ (\sigma_{-11})$

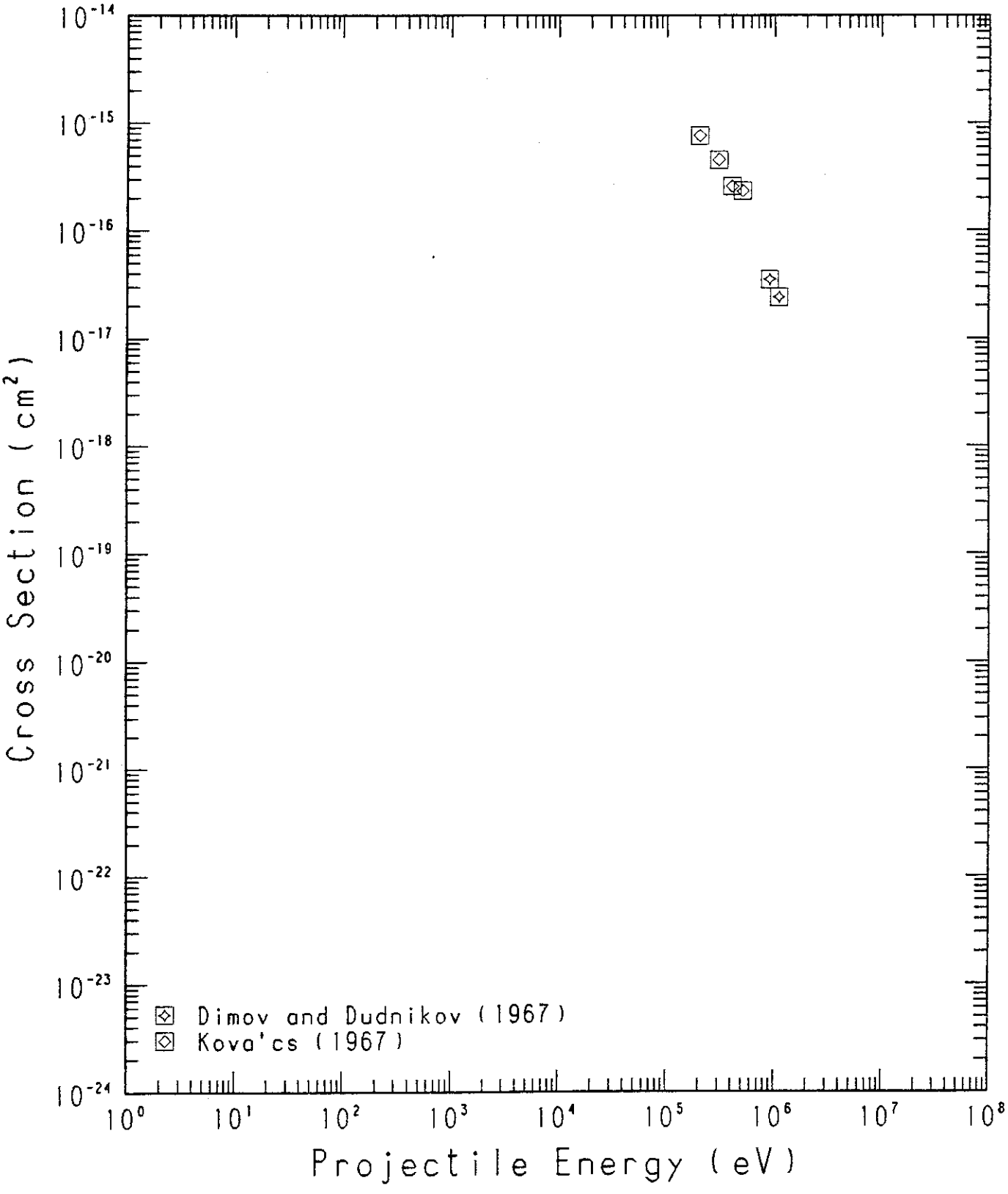

TABLE 42

PROCESS : H- + CO2 = H+ (-11)
DIMOV AND DUDNIKOV, SOV. PHYS.-TECH. PHYS. 11 919 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
9.00E+05	1.32E+01	3.50E-17
1.10E+06	1.46E+01	2.40E-17

PROCESS : H- + CO2 = H+ (-11)
KOVA'CS, NUCL. INSTR. METH. 51 224 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
2.00E+05	6.21E+00	7.59E-16
3.00E+05	7.61E+00	4.56E-16
4.00E+05	8.79E+00	2.58E-16
5.00E+05	9.82E+00	2.35E-16

Fig.43 $H^- + C_3H_8 \rightarrow H^+ (\sigma_{-11})$

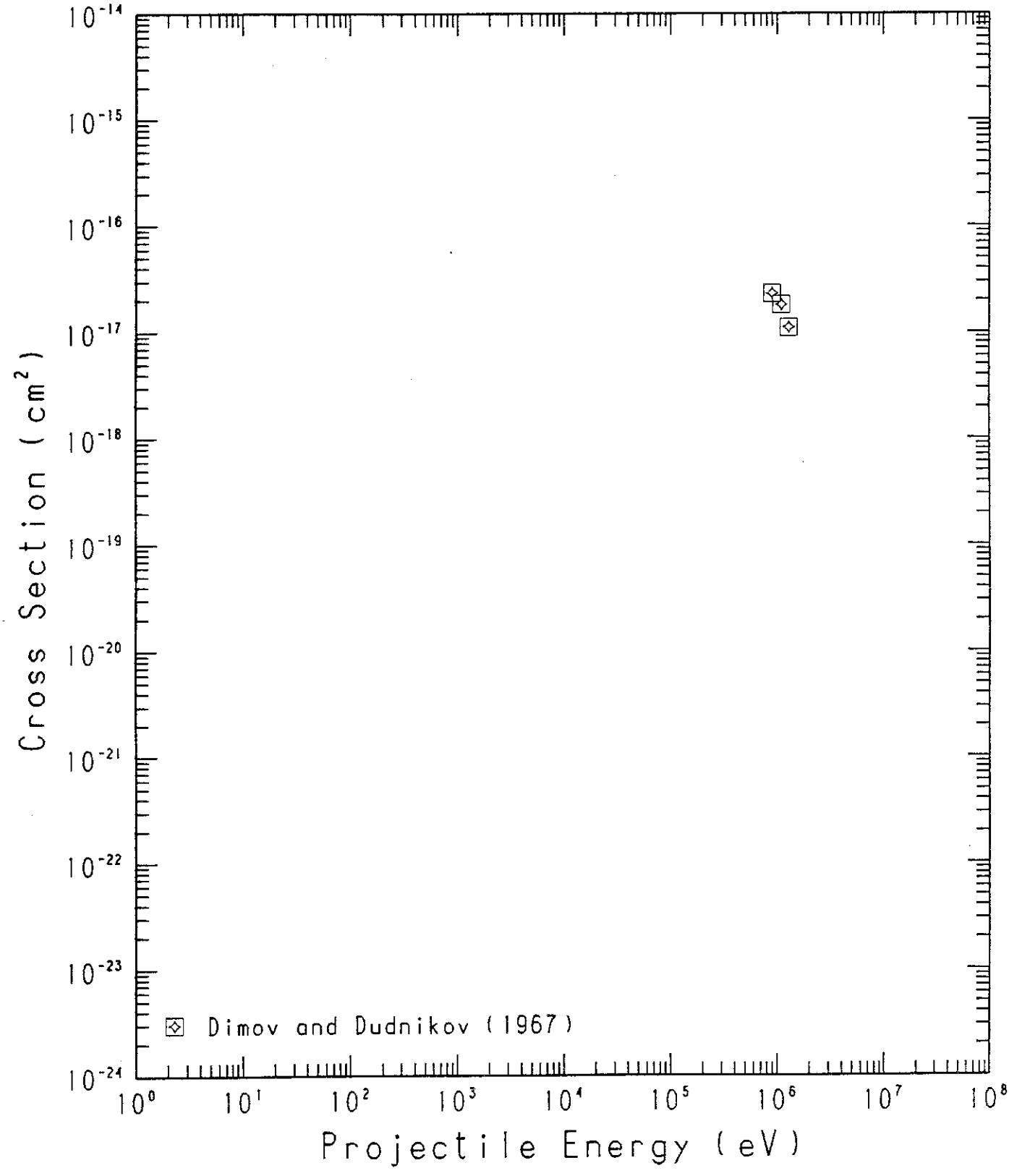

TABLE 43

PROCESS : H- + C3H8 = H+ (-11)
DIMOV AND DUDNIKOV, SOV. PHYS.-TECH. PHYS. 11 919 (1967)

E(EV)	V(10(8)*CM/SEC)	SIGMA(CM(2))
9.00E+05	1.32E+01	2.30E-17
1.10E+06	1.46E+01	1.80E-17
1.30E+06	1.58E+01	1.10E-17

3. Appendix

Charge Transfer Processes and Experimental Method for Cross Section Measurements

3.1 Descriptions of Charge Transfer Processes

In order to understand the charge transfer processes and to calculate the cross sections from experimental data a mathematical description of them must be formulated. Such a description has been presented by several authors[1)-4)] and will be reviewed here.

Consider the charge transfer processes that initially take place when a positive hydrogen ion beam interacts with a target gas:

$$H^+ + X \rightarrow H^0 + X^+ \tag{1}$$

$$\rightarrow H^- + X^- \tag{2}$$

These beam products, H^0 and H^-, may undergo further charge transfer collisions such as

$$H^0 + X \rightarrow H^- + X^+ \tag{3}$$

$$\rightarrow H^+ + X + e \tag{4}$$

$$H^- + X \rightarrow H^0 + X + e \tag{5}$$

$$\rightarrow H^+ + X + 2e \tag{6}$$

where X designates any target gas atoms and molecules. The discussion in following is confined to collisions in which the number of electrons bound to an atomic projectile is changed. Investigations on the final state of the target are not considered.

One may describe these processes mathematically by the following set of differential equations;

$$dF_0 = -F_0(\sigma_{01} + \sigma_{0-1})d\pi + F_1\sigma_{10}d\pi + F_{-1}\sigma_{-10}d\pi \tag{7}$$

$$dF_1 = -F_1(\sigma_{10} + \sigma_{1-1})d\pi + F_0\sigma_{01}d\pi + F_{-1}\sigma_{-11}d\pi \tag{8}$$

$$dF_{-1} = -F_{-1}(\sigma_{-10} + \sigma_{-11})d\pi + F_0\sigma_{0-1}d\pi + F_1\sigma_{1-1}d\pi \tag{9}$$

with $$F_1 + F_0 + F_{-1} = 1 \tag{10}$$

where F_i is the fraction of the beam of charge state i in the total beam, σ_{if} is the cross section of charge transfer from charge state i to f, and π is the number of target gas in molecules cm^{-2}.

General solutions to these equations can be obtained and evaluated for particular experimental conditions. Allison et al.[1),2)] had presented the solutions to equations (7) through (10) for incident H^+, H^o and H^- beams. These solutions are complicated by the variety of charge transfer processes which may occur. The problem of charge transfer is greatly simplified by approximation appropriate to the energy range to be investigated. In Fig. A1 are shown the cross sections for charge transfer of hydrogen beams in H_2 over a wide range of the energy to give an idea of the magnitude of the cross sections for possible all processes.

For incident H^+ or H^o particles with energies greater than 50 keV the cross sections for formation of negative hydrogens, σ_{1-1} and σ_{0-1}, respectively, are very small compared to the cross sections, σ_{10} and σ_{01}. That is, at 100 keV the cross section for H^- formation in an incident H^+ beam is less than 1 % of that for H^o formation; likewise, for an incident H^o beam the probability of H^- formation is less than 1 % of that for H^+ formation. One may, therefore, neglect the negative hydrogen component in either proton or neutral hydrogen beams with less than 1 % error at 100 keV. At higher energies the probability of H^- formation decreases much faster than the corresponding probabilities for the formation of H^+ and H^o.

When the H^- component is neglected in the set of differential equations (7)-(10) the resulting set of equations is

$$dF_0 = -F_0\sigma_{01}d\pi + F_1\sigma_{10}d\pi \tag{11}$$

$$dF_1 = -F_1\sigma_{10}d\pi + F_0\sigma_{01}d\pi \tag{12}$$

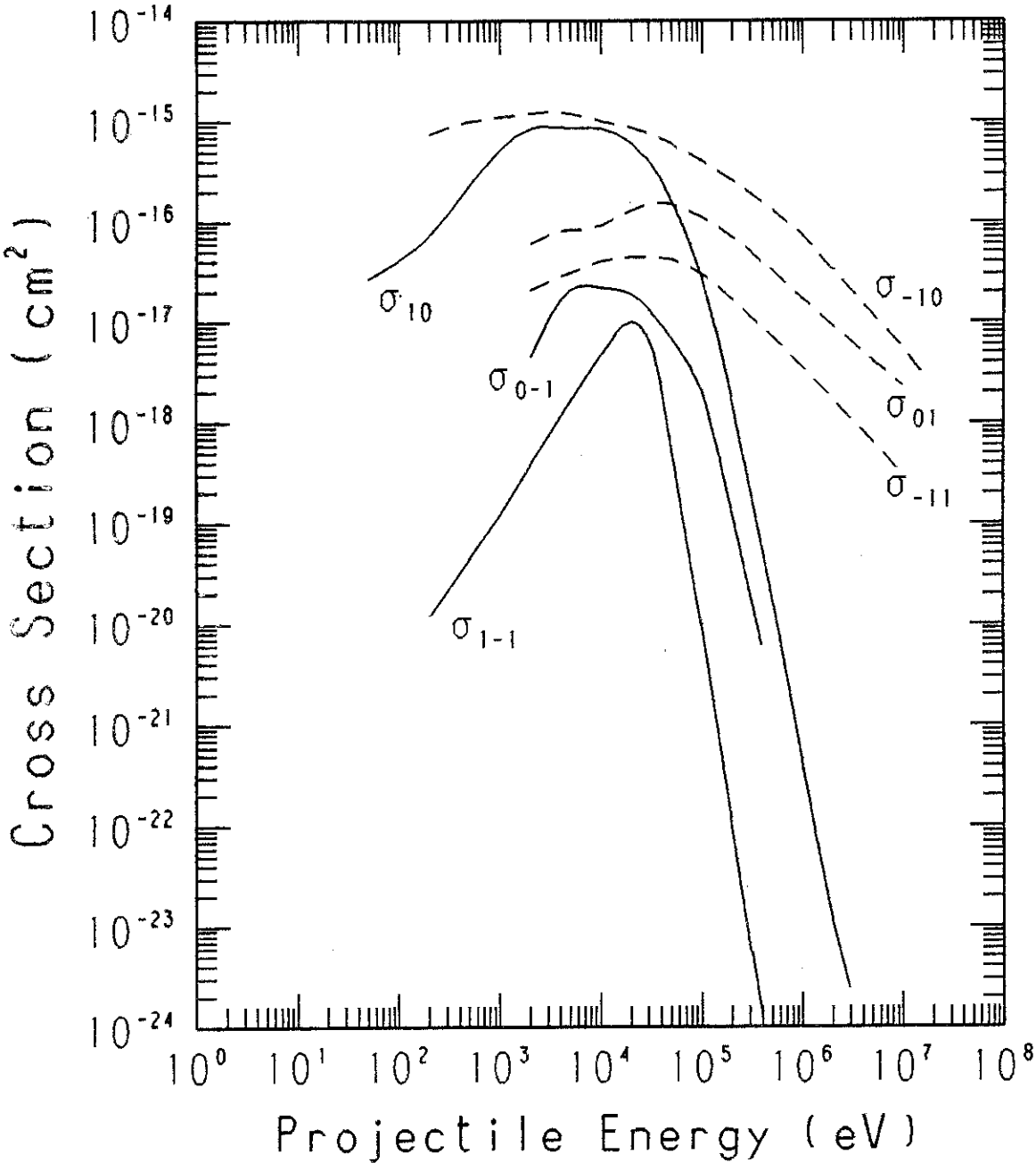

Fig. AI Charge transfer cross sections for hydrogen atoms and ions in hydrogen gas.

where the constants a's, b's, c's and r's are functions of the six cross sections in the differential equations. For small value of π these solutions may be expanded in a series. By neglecting all powers of π higher than second under the initial conditions being that $F_1=1$, $F_0=F_{-1}=0$ at $\pi=0$, Fogel'[5] had given the result,

$$F_{-1} = \sigma_{1-1}\pi + \tfrac{1}{2}(\sigma_{10}\sigma_{0-1} + \sigma_{1-1}\sigma_{10} + \sigma_{1-1}^2 - \sigma_{1-1}\sigma_{-10} - \sigma_{1-1}\sigma_{-11})\pi^2. \tag{20}$$

This result can be used to determine the double electron capture cross sections from measured fraction of negative ions.

According to the symmetry of the differential equations (7)-(9), the indices (0,1), (0,-1) or (1,-1) of eq. (20) are interchangeable. Therefore, by taking $F_i(0) = 1$, the solution of eqs. (7)-(9) can be written as

$$F_j = \sigma_{ij}\pi + \tfrac{1}{2}(\sigma_{ik}\sigma_{kj} + \sigma_{ij}\sigma_{ik} + \sigma_{ij}^2 - \sigma_{ij}\sigma_{jk} - \sigma_{ij}\sigma_{ji})\pi^2 \tag{21}$$

where i and j are the charge of the incident and observed beams to be investigated and k is the other one of the three charge sates of hydrogen beams. It is obvious that this result is more general and identical with eq. (18) for small π.

3.2 Experimental Methods

There are several different methods currently being used for measuring σ_{if} cross sections. They will be briefly described here.

(1) Charge Equilibrium Method

As a beam passes through a gas target the charge state is continuously changing such that after several collisions a statistical charge equilibrium distribution has been established as described by

with $F_0 + F_1 = 1$. (13)

The solutions of these equations may now be written as:

for an incident H^o beam,

$$F_1 = \frac{\sigma_{01}}{\sigma_{10} + \sigma_{01}} \{ 1 - \exp[-\pi(\sigma_{10} + \sigma_{01})]\}; \quad (14)$$

for an incident H^+ beam,

$$F_0 = \frac{\sigma_{10}}{\sigma_{10} + \sigma_{01}} \{ 1 - \exp[-\pi(\sigma_{10} + \sigma_{01})]\}; \quad (15)$$

For $\pi \to \infty$,

$$\left.\begin{aligned} F_1 \to F_{1\infty} &= \frac{\sigma_{01}}{\sigma_{10} + \sigma_{01}} \\ F_0 \to F_{0\infty} &= \frac{\sigma_{10}}{\sigma_{10} + \sigma_{01}} \end{aligned}\right\} \quad (16)$$

where $F_{i\infty}$ is called as an equilibrium fraction, that is, the fraction of the total beam in charge state i under equilibrium (multiple collision) conditions.

For "thin" target condition, in which only single collisions occur as the beam passes through the target gases;

$$\pi (\sigma_{10} + \sigma_{01}) << 1, \quad (17)$$

equations (14) and (15) are

$$\left.\begin{aligned} F_1 &\to \sigma_{01}\pi \\ F_0 &\to \sigma_{10}\pi \end{aligned}\right\} \quad (18)$$

respectively.

For example, to describe the two-electron capture and loss processes, one must consider the three component system. The solutions of differential equations (7)-(9) are

$$\left.\begin{aligned} F_1 &= a_0 + a_1\exp(-r_1\pi) + a_2\exp(-r_2\pi) \\ F_0 &= b_0 + b_1\exp(-r_1\pi) + b_2\exp(-r_2\pi) \\ F_{-1} &= c_0 + c_1\exp(-r_1\pi) + c_2\exp(-r_2\pi) \end{aligned}\right\} \quad (19)$$

eq. (16). Experimentally this condition is satisfied when the gas density in the collision region is increased to the point that the fraction F_i does not change with further increase in density such as $dF_i/d\pi=0$, then

$$\sum_i F_{j\infty}\sigma_{ji} = 0 \tag{22}$$

where $F_{j\infty}$ is value of F_j when $\pi \to \infty$.

To determine cross sections using the method of charge equilibrium, one may consider the simple system of only two components such as H^o and H^+ involved in the collisions of $H^+ + H_2$ at high energies greater than 100 keV. For this case, from the measured values, π, F_i and $F_{1\infty}$, and by using the equations, the cross sections can be evaluated from

$$\left.\begin{aligned} \sigma_{01} &= \frac{F_{1\infty}}{\pi} \ln\{\frac{1 - F_{1\infty}}{F_1 - F_{1\infty}}\} \\ \sigma_{10} &= \frac{1 - F_{1\infty}}{\pi} \ln\{\frac{1 - F_{1\infty}}{F_1 - F_{1\infty}}\} \end{aligned}\right\} \tag{23}$$

This method of determining cross sections is limited in its application to simple two or three component systems and rarely used.

(2) Beam Attenuation Method

If a fast particle beam is subjected to a transverse electric or magnetic field during its passage through a gas target, it is possible to arrange that while each component of original beam follows a well-defined orbit, fast product of charge transfer collisions is lost from the initial orbit soon after formation, then a beam attenuation due to charge transfer being observed.

In this case we have

$$\sum_f \sigma_{if} = -(1/\pi)\ln(F_i/F_i(\pi=0)) \tag{24}$$

from eqs. (7) through (9). Therefore, from attenuation measurement of the neutral hydrogen beam, the sum $(\sigma_{01} + \sigma_{0-1})$ can be obtained as well as the sums $(\sigma_{10} + \sigma_{1-1})$ and $(\sigma_{-10} + \sigma_{-11})$ from pure proton and negative hydrogen beams.

If the system is one of only two components, the measurement of the attenuation can be uniquely interpreted: if the components are neutral or positive,

$$\left.\begin{aligned} \sigma_{10} &= -(1/\pi)\ln(F_1/F_1(\pi=0)) \\ \sigma_{01} &= -(1/\pi)\ln(F_0/F_0(\pi=0)) \quad . \end{aligned}\right\} \tag{25}$$

However, as mentioned above, this method is not used independently for the measurement of each cross section but is combined with other methods, especially such as the equilibrium method.

(3) Growth Method

Charge transfer cross sections can also be determined by projecting a prepared beam through a gas at sufficiently lower pressure such that more than one collision is not encountered. By measuring the growth of the new charge component fraction as the pressure is increased, the cross section for that charge transfer process can be derived from the slope of the linear portion of the growth curve (see eq. (18)). This method is of special interest in determining the cross sections of capture and loss of two electrons in a single collision as described in eqs. (20) and (21).

Experimentally, measurements made by this method are comparatively easy and simple to perform. A prepared beam of the desired charge species is incident on a differentially pumped collision cell with a variable leak to increase the target gas pressure. The beam emerging from the cell is separated into its various charge components by either

electrostatic or magnetic analyzer. Either Faraday cups or particle counting detectors record the growth of one or more charge states as the cell pressure increases.

This same method also can be applied to determine uniquely a single-collision cross section even when the number of charge states is very large. In these cases the number of terms in the differential equations is increased, thereby increasing the complexity of solution.

(4) Condenser Method

The condenser method has been found to be useful in measuring charge transfer collisions at low energies where the ionization cross sections are small. When fast positive ion beams pass through a gas target they must leave behind positive ions with low kinetic energies except in the rare case where the impact parameter between the colliding atoms is small enough to transfer appreciable velocity to the target atoms. Since the process of ionization of the target gas, if occurs, produces ion pairs in equal numbers, an excess of positive over negative ion can be interpreted in terms of electron capture.

Application of a small transverse electric field guides the positive ions to a collector plate mounted at appropriate position in the collision cell and electrons created in the collision to the opposite plate. By measuring the positive and negative signal from the both plates, one can determine the cross sections of positive ion production, σ_+ and negative one, σ_-, respectively.

The major difficulty encountered with the application of the condenser method is to distinguish the slow ions produced by ionization and multiple charge transfer processes. For example, this method

applied to protons incident on gas target at low energies yields the sum $\sigma_{10} + 2\sigma_{1-1}$.

(5) Mass Spectrometric Method

A variation of the condenser method is found in a closely related mass spectrometric method in which slow ions are extracted from the collision region and subsequently mass-analyzed. This technique provides a cross section for the production of particles having a particular e/m ratio but then does not uniquely define an individual process: a combination or sum of cross sections involving ionization and charge transfer is usually determined. Thus, as in the condenser method, this method is also generally limited in application to the energy range of the incident projectile where the processes other than being considered can be neglected. Nevertheless, this method is very useful when the target gas is molecular and the main interest is in identifying the products from the target gas during collision.

3.3 References for Appendix

(1) Allison, S.K.: Rev. Mod. Phys. 30 1137 (1958).

(2) Allison, S.K. and Garcia-Munoz, M.: Atomic and Molecular Processes, ed. Bates, D.R., Academic Press, New York 721 (1962).

(3) Barnett, C.F. and Gilbody, H.B.: Methods of Experimental Physics Vol. 7 ed. Bederson, B. and Fite, W.L., Academic Press, New York 390 (1968).

(4) Massey H.S.W. and Gilbody, H.B.: Electronic and Ionic Impact Phenomena IV, Oxford (1974).

(5) Fogel', Ia.M. and Mitin R.V.: Sov. Phys. JETP 3 334 (1956).