

**TOTAL AND PARTIAL IONIZATION CROSS SECTIONS OF ATOMS
AND IONS BY ELECTRON IMPACT**

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Experimental data on electron impact ionization cross sections for atoms and ions ranging from H to U are compiled and given, in graphical form, as a function of the electron impact energy. Some selected theoretical data are also included. The literature is surveyed up to mid-1986. © 1987 Academic Press, Inc.

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INTRODUCTION

The ionization of atoms and ions by electron impact is important not only in atomic physics but also for the detailed understanding of processes in, for example, gas discharge, radiation physics, astrophysics, and fusion research. Recently, much attention has been paid to these ionization processes in such low-temperature plasmas as boundary and divertor plasmas, and for highly ionized ions in high-temperature plasmas.

As early as the 1920s, the relative ionization probabilities for rare gas atoms by electron impact were being measured.¹ Then, in the 1930s, total absolute ionization efficiencies, defined as "numbers of positive charges per electron per cm path per mm (Hg) pressure at 0°C," were determined² for the rare gas atoms and common molecules. The partial absolute ionization efficiencies for the production of Ne^{3+} , Ar^{5+} , and Hg^{5+} ions were determined also.³ Since then, a large number of experimental and theoretical investigations have been made. Results on experimental ionization cross sections were summarized and reviewed in the 1960s by Kieffer and Dunn⁴ and Kieffer.⁵ In 1981, a compilation of experimental data for ions up to atomic number $Z = 19$ and a comparison of these with some empirical formulas were given by Itikawa and Kato.⁶ Also, a critical review of the ionization cross sections for target atoms and ions up to $Z = 10$, where the direct ionization process plays a key role, was made by the Belfast group.⁷

Bibliographical references up to 1983 on the ionization of ions by electron impact can be found⁸ in an annotated listing comprising both excitation and ionization processes. A comprehensive review of the subject of electron impact ionization by Mark and Dunn⁹ was published recently.

To handle the ionization processes more easily, a number of empirical formulas for calculating the ionization cross sections have been proposed. In particular, the formula derived by Lotz for removal of a single electron is widely used. It has the form

$$\sigma = \sum a_i q_i \frac{\ln(E/P_i)}{EP_i} \{1 - b_i \exp[-c_i(E/P_i - 1)]\}, \quad (1)$$

where σ is the total ionization cross section, E the electron impact energy, P_i the binding energy of electrons in the i th subshell, q_i the number of electrons in the i th subshell; and a_i , b_i , and c_i are constants given in Lotz' papers.¹⁰ The summation is made over all subshells. Younger and Mark¹¹ have reviewed such empirical formulas of ionization cross sections.

It has recently become recognized¹² that with increasing the ionic charge of the ions, processes other than the direct Coulomb ionization tend to play an important role. Among them, the excitation-autoionization and resonant-recombination double autoionization processes contribute significantly to the total ionization.^{13,14} These processes are especially important for heavy alkali-like and alkaline-earth-like ions. It is found that these indirect processes are often predominant over the direct ionization process. Thus, the cross sections do not vary smoothly but show abrupt variations with the collision energy of the electrons. Furthermore, the contribution from inner-shell ionization becomes significant in some cases. Because of the lack of suitable ion beam sources capable of delivering such highly ionized ions, experimental data on the contribution from indirect ionization processes in highly ionized ions are still scarce. The systematics involving the indirect ionization processes are far from complete. Also,

theoretical works reported thus far are rather limited. Recently, a relatively simple empirical formula for ionization including the contribution from autoionization and inner-shell excitation processes has been proposed.^{15,16}

In the present report, experimental ionization cross sections for atoms and ions of elemental H to U published up to mid-1986 as well as selected theoretical data since 1970 are compiled and given in graphical form. Data for the common molecules H₂, D₂, N₂, and O₂ are also included. As there are few experimental data on the indirect processes, we have tried to include the calculated data on these processes where possible. The curves calculated by the Lotz empirical formula summed over the three outermost subshells are shown (for $Z \leq 30$) for comparison since this formula is often used by plasma physicists and others.

This is a revised and up-dated version of our previous report.¹⁷ The numerical tables of these cross sections, which are stored as one of our databases (AMDIS: Atomic and Molecular Data Interactive System) at our Institute, are available upon request.

Policies of Data Compilation

1. Highly ionized species produced in ion sources usually contain a significant fraction of ions in metastable states. These metastable ions are ionized differently than ground-state ions and influence the observed ionization cross sections. When original data are available for both low and high fractions of metastable ions in the beam, those for low fractions are shown in the figures.

2. This compilation has not discriminated against data which may be model dependent, such as those obtained with trapped ion beam techniques. Users should keep this fact in mind.

3. Some data which were in the previous compilation¹⁷ have been omitted here because they are believed to be in error.

4. When new experimental data have been published by the same group for the same ionization process, the more recent values are adopted in the present compilation.

5. Only absolute measurements are compiled.

6. Theoretical calculations since 1970 by Born, Coulomb-Born, Distorted-Wave, Close-Coupling, and Binary-Encounter approximations are included only when numerical data are given.

7. Calculated results from empirical and semiempirical formulas are not included except for those obtained with the Lotz formula.

8. Theoretical results which are derived from analytical fits to calculated values are not included. This accounts for the exclusion of such works as the Coulomb-Born calculations by Golden and Sampson.¹⁸

9. Averaged values for theoretical calculations of the contribution of the resonance excitations are given as it is difficult to suitably represent oscillations of the cross sections in the figures.

Acknowledgments

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EXPLANATION OF FIGURES

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy

The figures are ordered first by increasing atomic number of the target and then by increasing charge state of the target.

Heading The process corresponding to the plotted data

$\text{Li}^+ + \text{e} \rightarrow \text{Li}^{3+} + 3\text{e}$ indicates that singly charged Li^+ ions are doubly ionized by electron impact, resulting in triply charged Li^{3+} ions.

$\text{He}(2s)$ means He atoms in the metastable 2s state.

$\rightarrow \text{Sum}\{\text{A}^{n+} + (n + 1)\text{e}\}$ identifies the data as effective cross sections defined as $\sum n\sigma_n$, where σ_n is the partial ionization cross section for production of A^{n+} ions.

$\text{H}_2 + \text{e} \rightarrow \text{Sum}$ means the sum of the cross sections for all ions, molecular as well as atomic (H_2^+ and H^+ ions).

$\text{H}_2 \rightarrow \text{H}^+$ means cross section for production of atomic ions (H^+ ions in this case) from a molecular target.

Ordinate Ionization cross section per collision, in cm^2

The value for a molecular target is the cross section per molecule.

Abscissa Energy of the incident electron in eV

Legend Reference key for the data symbols

The authors (up to two) and the year of publication are listed for each reference.

A letter T or E next to an entry indicates a theoretical or an experimental paper, respectively.

Solid line Cross sections calculated by the Lotz empirical formula summed over the three outermost subshells [Eq. (1)]

LIST OF REACTION PROCESSES

Figure Number	Process	Figure Number	Process	Figure Number	Process
1.	$H_2 + e \rightarrow \text{sum}$	51.	$O^{2+} + 3e \rightarrow \text{sum}$	101.	$Ar^{11+} + e \rightarrow Ar^{12+} + 2e$
2.	$\rightarrow H_2^+ + 2e$	52.	$O^+ + e \rightarrow O^{2+} + 2e$	102.	$Si^{3+} + e \rightarrow Si^{4+} + 2e$
3.	$\rightarrow H^+$	53.	$O^{2+} + e \rightarrow O^{3+} + 2e$	103.	$P^{4+} + e \rightarrow P^{5+} + 2e$
4.	$H + e \rightarrow H + 2e$	54.	$O^{3+} + e \rightarrow O^{4+} + 2e$	104.	$S + e \rightarrow S^+ + 2e$
5.	$H + e \rightarrow H^+ + 2e$	55.	$O^{4+} + e \rightarrow O^{5+} + 2e$	105.	$\rightarrow S^{2+} + 3e$
6.	$H(2s) + e \rightarrow H^+ + 2e$	56.	$O^{5+} + e \rightarrow O^{6+} + 2e$	106.	$\rightarrow S^{3+} + 4e$
7.	$D_2 + e \rightarrow \text{sum}$	57.	$O^{6+} + e \rightarrow O^{7+} + 2e$	107.	$\rightarrow S^{4+} + 5e$
8.	$He + e \rightarrow \text{sum}$	58.	$O^{7+} + e \rightarrow O^{8+} + 2e$	108.	$S^{4+} + e \rightarrow S^{5+} + 2e$
9.	$\rightarrow He^+ + 2e$	59.	$F + e \rightarrow F + 2e$	109.	$Cl^{2+} + e \rightarrow Cl^{3+} + 2e$
10.	$\rightarrow He^{2+} + 3e$	60.	$F^{2+} + e \rightarrow F^{3+} + 2e$	110.	$Cl^{5+} + e \rightarrow Cl^{6+} + 2e$
11.	$He(2s) + e \rightarrow He^+ + 2e$	61.	$F^{5+} + e \rightarrow F^{6+} + 2e$	111.	$Ar + e \rightarrow \text{sum}$
12.	$He^+ + e \rightarrow He^{2+} + 2e$	62.	$Ne + e \rightarrow \text{sum}$	112.	$\rightarrow Ar^+ + 2e$
13.	$Li + e \rightarrow \text{sum}$	63.	$\rightarrow Ne^+ + 2e$	113.	$\rightarrow Ar^{2+} + 3e$
14.	$\rightarrow Li^+ + 2e$	64.	$\rightarrow Ne^{2+} + 3e$	114.	$\rightarrow Ar^{3+} + 4e$
15.	$\rightarrow Li^{2+} + 3e$	65.	$\rightarrow Ne^{3+} + 4e$	115.	$\rightarrow Ar^{4+} + 5e$
16.	$Li^+ + e \rightarrow Li^{2+} + 2e$	66.	$\rightarrow Ne^{4+} + 5e$	116.	$\rightarrow Ar^{5+} + 6e$
17.	$\rightarrow Li^{3+} + 3e$	67.	$\rightarrow Ne^{5+} + 6e$	117.	$\rightarrow Ar^{6+} + 7e$
18.	$Li^{2+} + e \rightarrow Li^{3+} + 2e$	68.	$Ne^+ + e \rightarrow Ne^{2+} + 2e$	118.	$\rightarrow Ar^{7+} + 8e$
19.	$Be^+ + e \rightarrow Be^{2+} + 2e$	69.	$Ne^{2+} + e \rightarrow Ne^{3+} + 2e$	119.	$Ar^+ + e \rightarrow Ar^{2+} + 2e$
20.	$B + e \rightarrow B^+ + 2e$	70.	$Ne^{3+} + e \rightarrow Ne^{4+} + 2e$	120.	$\rightarrow Ar^{3+} + 3e$
21.	$B^+ + e \rightarrow B^{2+} + 2e$	71.	$Ne^{4+} + e \rightarrow Ne^{5+} + 2e$	121.	$\rightarrow Ar^{4+} + 4e$
22.	$B^{2+} + e \rightarrow B^{3+} + 2e$	72.	$Ne^{5+} + e \rightarrow Ne^{6+} + 2e$	122.	$\rightarrow Ar^{5+} + 5e$
23.	$B^{3+} + e \rightarrow B^{4+} + 2e$	73.	$Ne^{6+} + e \rightarrow Ne^{7+} + 2e$	123.	$Ar^{2+} + e \rightarrow Ar^{3+} + 2e$
24.	$C^- + e \rightarrow C + 2e$	74.	$Ne^{7+} + e \rightarrow Ne^{8+} + 2e$	124.	$\rightarrow Ar^{4+} + 3e$
25.	$C + e \rightarrow C^+ + 2e$	75.	$Ne^{8+} + e \rightarrow Ne^{9+} + 2e$	125.	$\rightarrow Ar^{5+} + 4e$
26.	$C^+ + e \rightarrow C^{2+} + 2e$	76.	$Ne^{9+} + e \rightarrow Ne^{10+} + 2e$	126.	$Ar^{3+} + e \rightarrow Ar^{4+} + 2e$
27.	$C^{2+} + e \rightarrow C^{3+} + 2e$	77.	$Na + e \rightarrow \text{sum}$	127.	$\rightarrow Ar^{5+} + 3e$
28.	$C^{3+} + e \rightarrow C^{4+} + 2e$	78.	$\rightarrow Na^+ + 2e$	128.	$Ar^{4+} + e \rightarrow Ar^{5+} + 2e$
29.	$C^{4+} + e \rightarrow C^{5+} + 2e$	79.	$\rightarrow Na^{2+} + 3e$	129.	$\rightarrow Ar^{6+} + 3e$
30.	$C^{5+} + e \rightarrow C^{6+} + 2e$	80.	$Na^+ + e \rightarrow Na^{2+} + 2e$	130.	$Ar^{5+} + e \rightarrow Ar^{6+} + 2e$
31.	$N_2 + e \rightarrow \text{sum}$	81.	$Na^{2+} + e \rightarrow Na^{3+} + 2e$	131.	$Ar^{6+} + e \rightarrow Ar^{7+} + 2e$
32.	$\rightarrow N_2^+ + 2e$	82.	$Na^{9+} + e \rightarrow Na^{10+} + 2e$	132.	$Ar^{7+} + e \rightarrow Ar^{8+} + 2e$
33.	$\rightarrow N_2^{2+} + 3e$	83.	$Mg + e \rightarrow \text{sum}$	133.	$Ar^{8+} + e \rightarrow Ar^{9+} + 2e$
34.	$\rightarrow N^+$	84.	$\rightarrow Mg^+ + 2e$	134.	$Ar^{10+} + e \rightarrow Ar^{11+} + 2e$
35.	$\rightarrow N^{2+}$	85.	$\rightarrow Mg^{2+} + 3e$	135.	$Ar^{11+} + e \rightarrow Ar^{12+} + 2e$
36.	$N + e \rightarrow \text{sum}$	86.	$Mg^+ + e \rightarrow Mg^{2+} + 3e$	136.	$Ar^{12+} + e \rightarrow Ar^{13+} + 2e$
37.	$\rightarrow N^+ + 2e$	87.	$Mg^{2+} + e \rightarrow Mg^{3+} + 2e$	137.	$Ar^{14+} + e \rightarrow Ar^{15+} + 2e$
38.	$N^+ + e \rightarrow N^{2+} + 2e$	88.	$Mg^{9+} + e \rightarrow Mg^{10+} + 2e$	138.	$Ar^{15+} + e \rightarrow Ar^{16+} + 2e$
39.	$N^{2+} + e \rightarrow N^{3+} + 2e$	89.	$Ar + e \rightarrow \text{sum}$	139.	$Ar^{16+} + e \rightarrow Ar^{17+} + 2e$
40.	$N^{3+} + e \rightarrow N^{4+} + 2e$	90.	$\rightarrow Ar^+ + 2e$	140.	$Ar^{17+} + e \rightarrow Ar^{18+} + 2e$
41.	$N^{4+} + e \rightarrow N^{5+} + 2e$	91.	$Ar^+ + e \rightarrow Ar^{2+} + 2e$	141.	$K + e \rightarrow \text{sum}$
42.	$N^{5+} + e \rightarrow N^{6+} + 2e$	92.	$Ar^{2+} + e \rightarrow Ar^{3+} + 2e$	142.	$\rightarrow K^+ + 2e$
43.	$N^{6+} + e \rightarrow N^{7+} + 2e$	93.	$Ar^{3+} + e \rightarrow Ar^{4+} + 2e$	143.	$K^+ + e \rightarrow K^{2+} + 2e$
44.	$O_2 + e \rightarrow \text{sum}$	94.	$Ar^{4+} + e \rightarrow Ar^{5+} + 2e$	144.	$K^{2+} + e \rightarrow K^{3+} + 2e$
45.	$\rightarrow O_2^+ + 2e$	95.	$Ar^{5+} + e \rightarrow Ar^{6+} + 2e$	145.	$Ca + e \rightarrow \text{sum}$
46.	$\rightarrow O_2^{2+} + 3e$	96.	$Ar^{6+} + e \rightarrow Ar^{7+} + 2e$	146.	$\rightarrow Ca^+ + 2e$
47.	$\rightarrow O^+$	97.	$Ar^{7+} + e \rightarrow Ar^{8+} + 2e$	147.	$\rightarrow Ca^{2+} + 2e$
48.	$O^- + e \rightarrow O + 2e$	98.	$Ar^{8+} + e \rightarrow Ar^{9+} + 2e$	148.	$Ca^+ + e \rightarrow Ca^{2+} + 2e$
49.	$O + e \rightarrow \text{sum}$	99.	$Ar^{9+} + e \rightarrow Ar^{10+} + 2e$	149.	$Ca^{2+} + e \rightarrow Ca^{3+} + 2e$
50.	$\rightarrow O^+ + 2e$	100.	$Ar^{10+} + e \rightarrow Ar^{11+} + 2e$	150.	$Ca^{9+} + e \rightarrow Ca^{10+} + 2e$

LIST OF REACTION PROCESSES continued

Figure Number	Process	Figure Number	Process	Figure Number	Process
151.	$\text{Sc}^{3+} + e \rightarrow \text{Sc}^{4+} + 2e$	201.	$\text{Ge} + e \rightarrow \text{Ge}^+ + 2e$	251.	$\text{Te} + e \rightarrow \text{Te}^+ + 2e$
152.	$\text{Sc}^{4+} + e \rightarrow \text{Sc}^{5+} + 2e$	202.	$\text{Se} + e \rightarrow \text{Se}^+ + 2e$	252.	$\text{I}^+ + e \rightarrow \text{I}^{2+} + 2e$
153.	$\text{Sc}^{5+} + e \rightarrow \text{Sc}^{6+} + 2e$	203.	$\text{Kr} + e \rightarrow \text{sum}$	253.	$\text{Xe} + e \rightarrow \text{sum}$
154.	$\text{Sc}^{6+} + e \rightarrow \text{Sc}^{7+} + 2e$	204.	$\rightarrow \text{Kr}^+ + 2e$	254.	$\rightarrow \text{Xe}^+ + 2e$
155.	$\text{Sc}^{7+} + e \rightarrow \text{Sc}^{8+} + 2e$	205.	$\rightarrow \text{Kr}^{2+} + 3e$	255.	$\rightarrow \text{Xe}^{2+} + 3e$
156.	$\text{Sc}^{8+} + e \rightarrow \text{Sc}^{9+} + 2e$	206.	$\rightarrow \text{Kr}^{3+} + 4e$	256.	$\rightarrow \text{Xe}^{3+} + 4e$
157.	$\text{Sc}^{9+} + e \rightarrow \text{Sc}^{10+} + 2e$	207.	$\rightarrow \text{Kr}^{4+} + 5e$	257.	$\rightarrow \text{Xe}^{4+} + 5e$
158.	$\text{Ti} + e \rightarrow \text{Ti}^+ + 2e$	208.	$\rightarrow \text{Kr}^{5+} + 6e$	258.	$\rightarrow \text{Xe}^{5+} + 6e$
159.	$\text{Ti}^{2+} + e \rightarrow \text{Ti}^{3+} + 2e$	209.	$\rightarrow \text{Kr}^{6+} + 7e$	259.	$\rightarrow \text{Xe}^{6+} + 7e$
160.	$\text{Ti}^{3+} + e \rightarrow \text{Ti}^{4+} + 2e$	210.	$\rightarrow \text{Kr}^{7+} + 8e$	260.	$\rightarrow \text{Xe}^{7+} + 8e$
161.	$\text{V}^{5+} + e \rightarrow \text{V}^{6+} + 2e$	211.	$\rightarrow \text{Kr}^{8+} + 9e$	261.	$\rightarrow \text{Xe}^{8+} + 9e$
162.	$\text{Cr} + e \rightarrow \text{Cr}^+ + 2e$	212.	$\rightarrow \text{Kr}^{9+} + 10e$	262.	$\rightarrow \text{Xe}^{9+} + 10e$
163.	$\text{Fe} + e \rightarrow \text{Fe}^+ + 2e$	213.	$\text{Kr}^+ + e \rightarrow \text{Kr}^{2+} + 2e$	263.	$\rightarrow \text{Xe}^{10+} + 11e$
164.	$\text{Fe}^+ + e \rightarrow \text{Fe}^{2+} + 2e$	214.	$\rightarrow \text{Kr}^{3+} + 3e$	264.	$\rightarrow \text{Xe}^{11+} + 12e$
165.	$\text{Fe}^{2+} + e \rightarrow \text{Fe}^{3+} + 2e$	215.	$\text{Kr}^{2+} + e \rightarrow \text{Kr}^{3+} + 2e$	265.	$\rightarrow \text{Xe}^{12+} + 13e$
166.	$\text{Fe}^{3+} + e \rightarrow \text{Fe}^{4+} + 2e$	216.	$\rightarrow \text{Kr}^{4+} + 3e$	266.	$\rightarrow \text{Xe}^{13+} + 14e$
167.	$\text{Fe}^{4+} + e \rightarrow \text{Fe}^{5+} + 2e$	217.	$\text{Kr}^{3+} + e \rightarrow \text{Kr}^{4+} + 2e$	267.	$\text{Xe}^+ + e \rightarrow \text{Xe}^{2+} + 2e$
168.	$\text{Fe}^{5+} + e \rightarrow \text{Fe}^{6+} + 2e$	218.	$\rightarrow \text{Kr}^{5+} + 3e$	268.	$\rightarrow \text{Xe}^{3+} + 3e$
169.	$\text{Fe}^{6+} + e \rightarrow \text{Fe}^{7+} + 2e$	219.	$\text{Kr}^{4+} + e \rightarrow \text{Kr}^{6+} + 3e$	269.	$\rightarrow \text{Xe}^{4+} + 4e$
170.	$\text{Fe}^{7+} + e \rightarrow \text{Fe}^{8+} + 2e$	220.	$\text{Kr}^{18+} + e \rightarrow \text{Kr}^{19+} + 2e$	270.	$\rightarrow \text{Xe}^{5+} + 5e$
171.	$\text{Fe}^{8+} + e \rightarrow \text{Fe}^{9+} + 2e$	221.	$\text{Rb} + e \rightarrow \text{sum}$	271.	$\text{Xe}^{2+} + e \rightarrow \text{Xe}^{3+} + 2e$
172.	$\text{Fe}^{9+} + e \rightarrow \text{Fe}^{10+} + 2e$	222.	$\rightarrow \text{Rb}^+ + 2e$	272.	$\rightarrow \text{Xe}^{4+} + 3e$
173.	$\text{Fe}^{10+} + e \rightarrow \text{Fe}^{11+} + 2e$	223.	$\text{Rb}^+ + e \rightarrow \text{Rb}^{2+} + 2e$	273.	$\rightarrow \text{Xe}^{5+} + 4e$
174.	$\text{Fe}^{11+} + e \rightarrow \text{Fe}^{12+} + 2e$	224.	$\rightarrow \text{Rb}^{3+} + 3e$	274.	$\rightarrow \text{Xe}^{6+} + 5e$
175.	$\text{Fe}^{12+} + e \rightarrow \text{Fe}^{13+} + 2e$	225.	$\rightarrow \text{Rb}^{4+} + 4e$	275.	$\text{Xe}^{3+} + e \rightarrow \text{Xe}^{4+} + 2e$
176.	$\text{Fe}^{13+} + e \rightarrow \text{Fe}^{14+} + 2e$	226.	$\rightarrow \text{Rb}^{5+} + 5e$	276.	$\rightarrow \text{Xe}^{5+} + 3e$
177.	$\text{Fe}^{14+} + e \rightarrow \text{Fe}^{15+} + 2e$	227.	$\text{Sr} + e \rightarrow \text{sum}$	277.	$\rightarrow \text{Xe}^{6+} + 4e$
178.	$\text{Fe}^{15+} + e \rightarrow \text{Fe}^{16+} + 2e$	228.	$\rightarrow \text{Sr}^+ + 2e$	278.	$\text{Xe}^{4+} + e \rightarrow \text{Xe}^{5+} + 2e$
179.	$\text{Fe}^{16+} + e \rightarrow \text{Fe}^{17+} + 2e$	229.	$\rightarrow \text{Sr}^{2+} + 3e$	279.	$\rightarrow \text{Xe}^{6+} + 3e$
180.	$\text{Fe}^{17+} + e \rightarrow \text{Fe}^{18+} + 2e$	230.	$\text{Sr}^+ + e \rightarrow \text{Sr}^{2+} + 2e$	280.	$\text{Xe}^{5+} + e \rightarrow \text{Xe}^{6+} + 2e$
181.	$\text{Fe}^{18+} + e \rightarrow \text{Fe}^{19+} + 2e$	231.	$\text{Zr} + e \rightarrow \text{Zr}^+ + 2e$	281.	$\text{Xe}^{6+} + e \rightarrow \text{Xe}^{7+} + 2e$
182.	$\text{Fe}^{19+} + e \rightarrow \text{Fe}^{20+} + 2e$	232.	$\text{Zr}^{3+} + e \rightarrow \text{Zr}^{4+} + 2e$	282.	$\rightarrow \text{Xe}^{8+} + 3e$
183.	$\text{Fe}^{20+} + e \rightarrow \text{Fe}^{21+} + 2e$	233.	$\text{Mo} + e \rightarrow \text{Mo}^+ + 2e$	283.	$\rightarrow \text{Xe}^{9+} + 4e$
184.	$\text{Fe}^{21+} + e \rightarrow \text{Fe}^{22+} + 2e$	234.	$\text{Mo}^{5+} + e \rightarrow \text{Mo}^{6+} + 2e$	284.	$\text{Cs} + e \rightarrow \text{sum}$
185.	$\text{Fe}^{22+} + e \rightarrow \text{Fe}^{23+} + 2e$	235.	$\text{Mo}^{14+} + e \rightarrow \text{Mo}^{15+} + 2e$	285.	$\rightarrow \text{Cs}^+ + 2e$
186.	$\text{Fe}^{23+} + e \rightarrow \text{Fe}^{24+} + 2e$	236.	$\text{Mo}^{24+} + e \rightarrow \text{Mo}^{25+} + 2e$	286.	$\text{Cs}^+ + e \rightarrow \text{Cs}^{2+} + 2e$
187.	$\text{Fe}^{24+} + e \rightarrow \text{Fe}^{25+} + 2e$	237.	$\text{Mo}^{32+} + e \rightarrow \text{Mo}^{33+} + 2e$	287.	$\rightarrow \text{Cs}^{3+} + 3e$
188.	$\text{Fe}^{25+} + e \rightarrow \text{Fe}^{26+} + 2e$	238.	$\text{Ru} + e \rightarrow \text{Ru}^+ + 2e$	288.	$\rightarrow \text{Cs}^{4+} + 4e$
189.	$\text{Ni} + e \rightarrow \text{Ni}^+ + 2e$	239.	$\text{Pd} + e \rightarrow \text{Pd}^+ + 2e$	289.	$\rightarrow \text{Cs}^{5+} + 5e$
190.	$\text{Ni}^+ + e \rightarrow \text{Ni}^{2+} + 2e$	240.	$\text{Ag} + e \rightarrow \text{sum}$	290.	$\text{Ba} + e \rightarrow \text{sum}$
191.	$\text{Ni}^{3+} + e \rightarrow \text{Ni}^{4+} + 2e$	241.	$\rightarrow \text{Ag}^+ + 2e$	291.	$\rightarrow \text{Ba}^+ + 2e$
192.	$\text{Ni}^{17+} + e \rightarrow \text{Ni}^{18+} + 2e$	242.	$\rightarrow \text{Ag}^{2+} + 3e$	292.	$\rightarrow \text{Ba}^{2+} + 3e$
193.	$\text{Cu} + e \rightarrow \text{sum}$	243.	$\text{Cd} + e \rightarrow \text{sum}$	293.	$\rightarrow \text{Ba}^{3+} + 4e$
194.	$\text{Cu}^{2+} + e \rightarrow \text{Cu}^{3+} + 2e$	244.	$\rightarrow \text{Cd}^+ + 2e$	294.	$\rightarrow \text{Ba}^{4+} + 5e$
195.	$\text{Cu}^{3+} + e \rightarrow \text{Cu}^{4+} + 2e$	245.	$\text{In} + e \rightarrow \text{sum}$	295.	$\text{Ba}^+ + e \rightarrow \text{Ba}^{2+} + 2e$
196.	$\text{Zn} + e \rightarrow \text{sum}$	246.	$\text{Sb}^+ + e \rightarrow \text{Sb}^{2+} + 2e$	296.	$\text{Hf}^{3+} + e \rightarrow \text{Hf}^{4+} + 2e$
197.	$\rightarrow \text{Zn}^+ + 2e$	247.	$\rightarrow \text{Sb}^{3+} + 3e$	297.	$\text{Ta}^{3+} + e \rightarrow \text{Ta}^{4+} + 2e$
198.	$\rightarrow \text{Zn}^{2+} + 2e$	248.	$\rightarrow \text{Sb}^{3+} + 2e$	298.	$\text{W}^+ + e \rightarrow \text{W}^{2+} + 2e$
199.	$\text{Zn}^{19+} + e \rightarrow \text{Zn}^{20+} + 2e$	249.	$\text{Sb}^{3+} + e \rightarrow \text{Sb}^{4+} + 2e$	299.	$\text{Au} + e \rightarrow \text{sum}$
200.	$\text{Ga}^+ + e \rightarrow \text{Ga}^{2+} + 2e$	250.	$\text{Te} + e \rightarrow \text{sum}$	300.	$\rightarrow \text{Au}^+ + 2e$

LIST OF REACTION PROCESSES continued

Figure Number	Process	Figure Number	Process	Figure Number	Process
301.	$\text{Au}^{3+} + e \rightarrow \text{Au}^+ + 2e$	310.	$\rightarrow \text{Ti}^+ + 2e$	318.	$\text{Bi}^{2+} + e \rightarrow \text{Bi}^{3+} + 2e$
302.	$\text{Hg} + e \rightarrow \text{sum}$	311.	$\text{Ti}^+ + e \rightarrow \text{Ti}^{2+} + 2e$	319.	$\rightarrow \text{Bi}^{4+} + 3e$
303.	$\rightarrow \text{Hg}^+ + 2e$	312.	$\text{Pb} + e \rightarrow \text{sum}$	320.	$\text{Bi}^{3+} + e \rightarrow \text{Bi}^{4+} + 3e$
304.	$\rightarrow \text{Hg}^{2+} + 3e$	313.	$\rightarrow \text{Pb}^+ + 2e$	321.	$\text{U} + e \rightarrow \text{sum}$
305.	$\rightarrow \text{Hg}^{3+} + 4e$	314.	$\rightarrow \text{Pb}^{2+} + 3e$	322.	$\rightarrow \text{U}^+ + 2e$
306.	$\rightarrow \text{Hg}^{4+} + 5e$	315.	$\rightarrow \text{Pb}^{3+} + 4e$	323.	$\rightarrow \text{U}^{2+} + 3e$
307.	$\rightarrow \text{Hg}^{5+} + 6e$	316.	$\text{Bi}^+ + e \rightarrow \text{Bi}^{2+} + 2e$	324.	$\rightarrow \text{U}^{3+} + 4e$
308.	$\text{Hg}^+ + e \rightarrow \text{Hg}^{2+} + 2e$	317.	$\rightarrow \text{Bi}^{3+} + 3e$	325.	$\rightarrow \text{U}^{4+} + 5e$
309.	$\text{Ti} + e \rightarrow \text{sum}$				

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FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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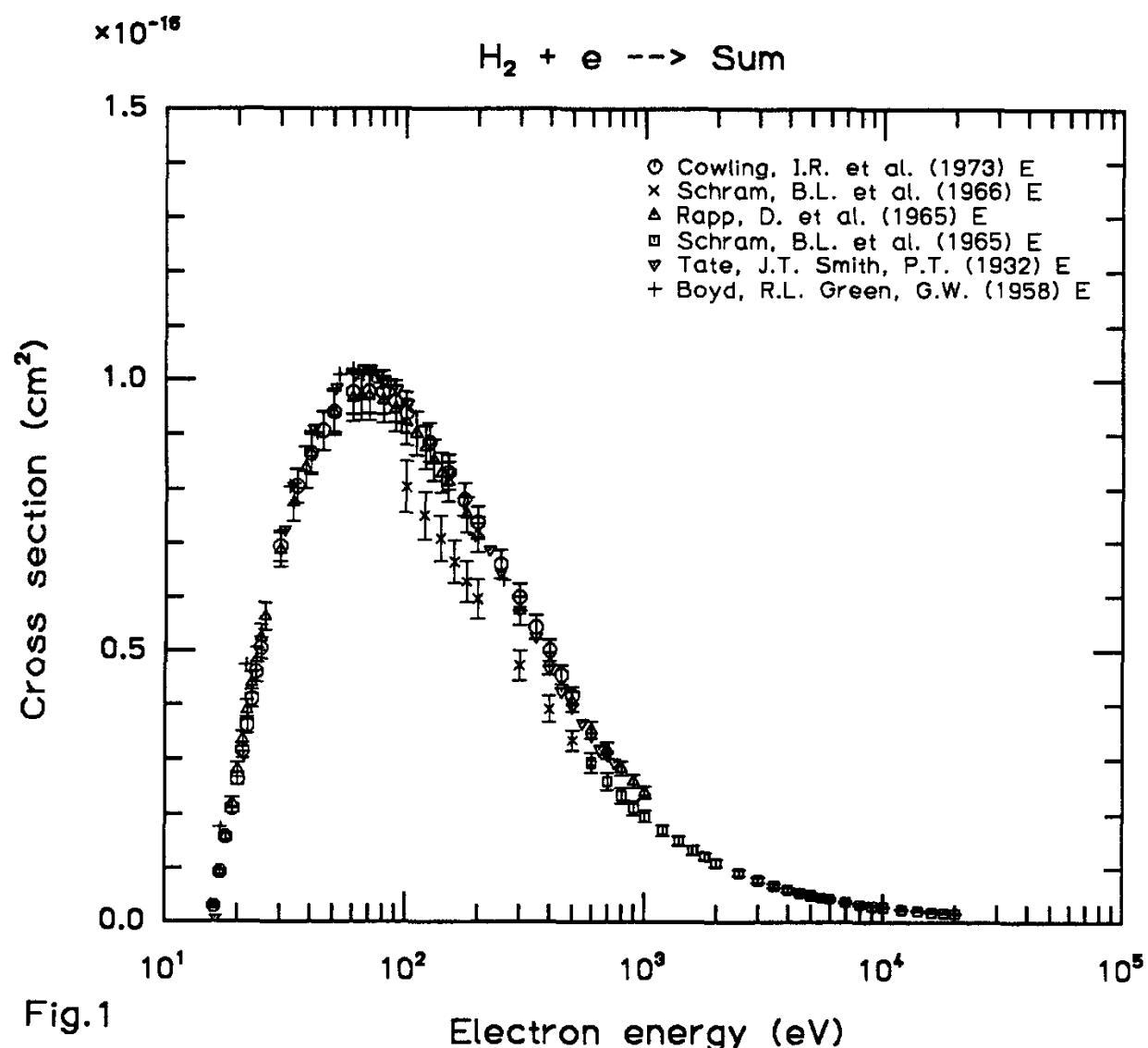


Fig.1

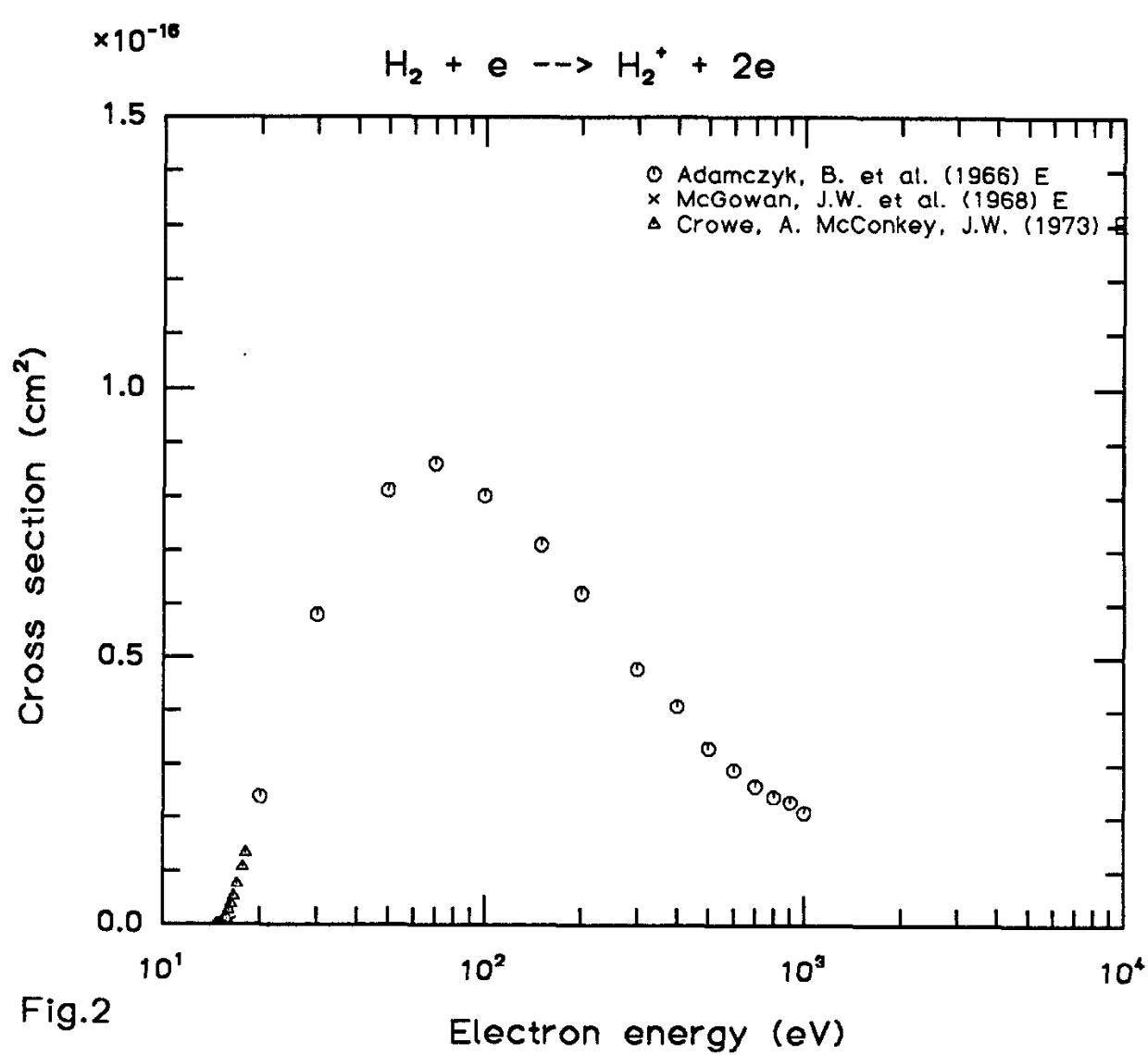


Fig.2

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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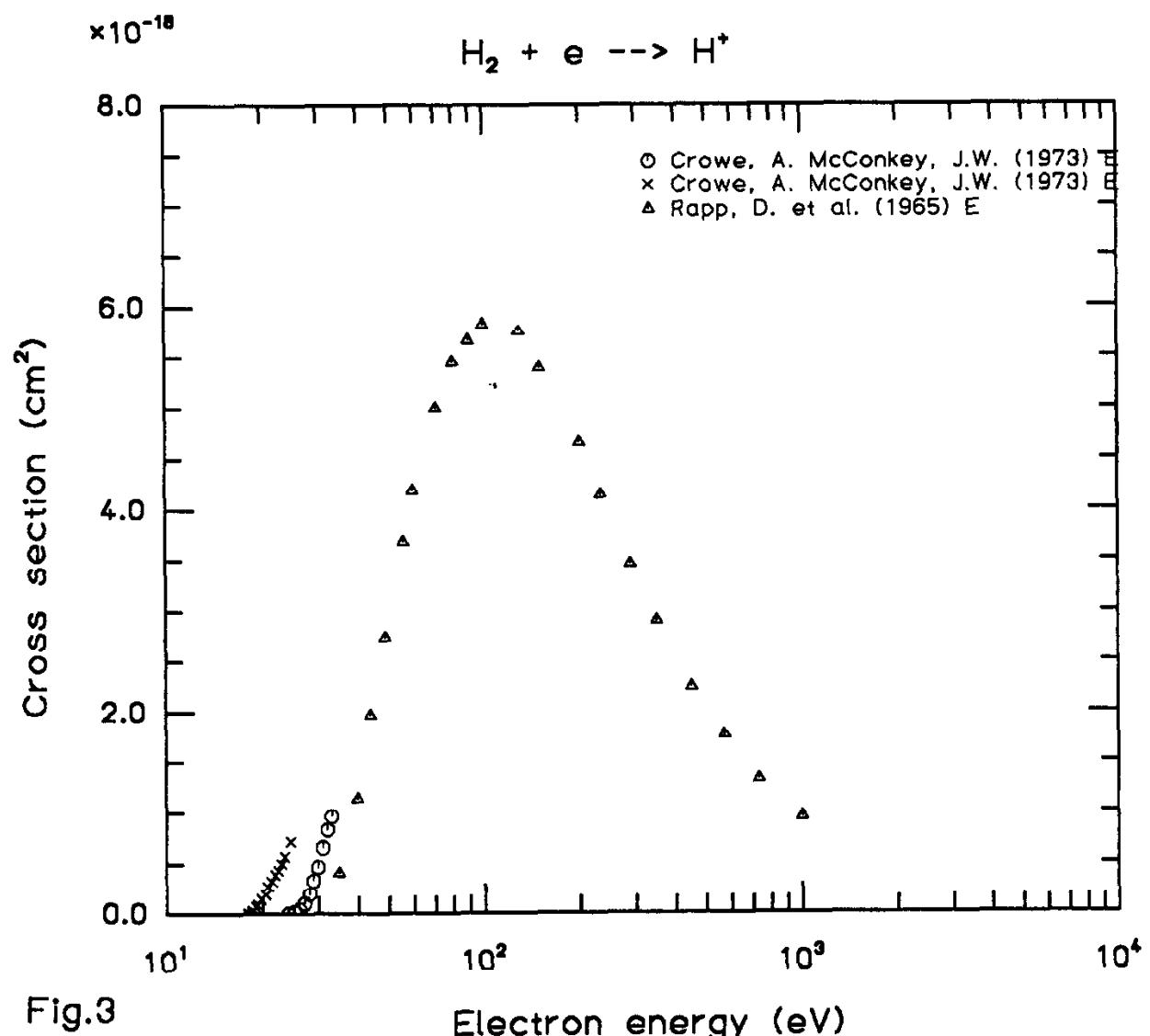


Fig.3

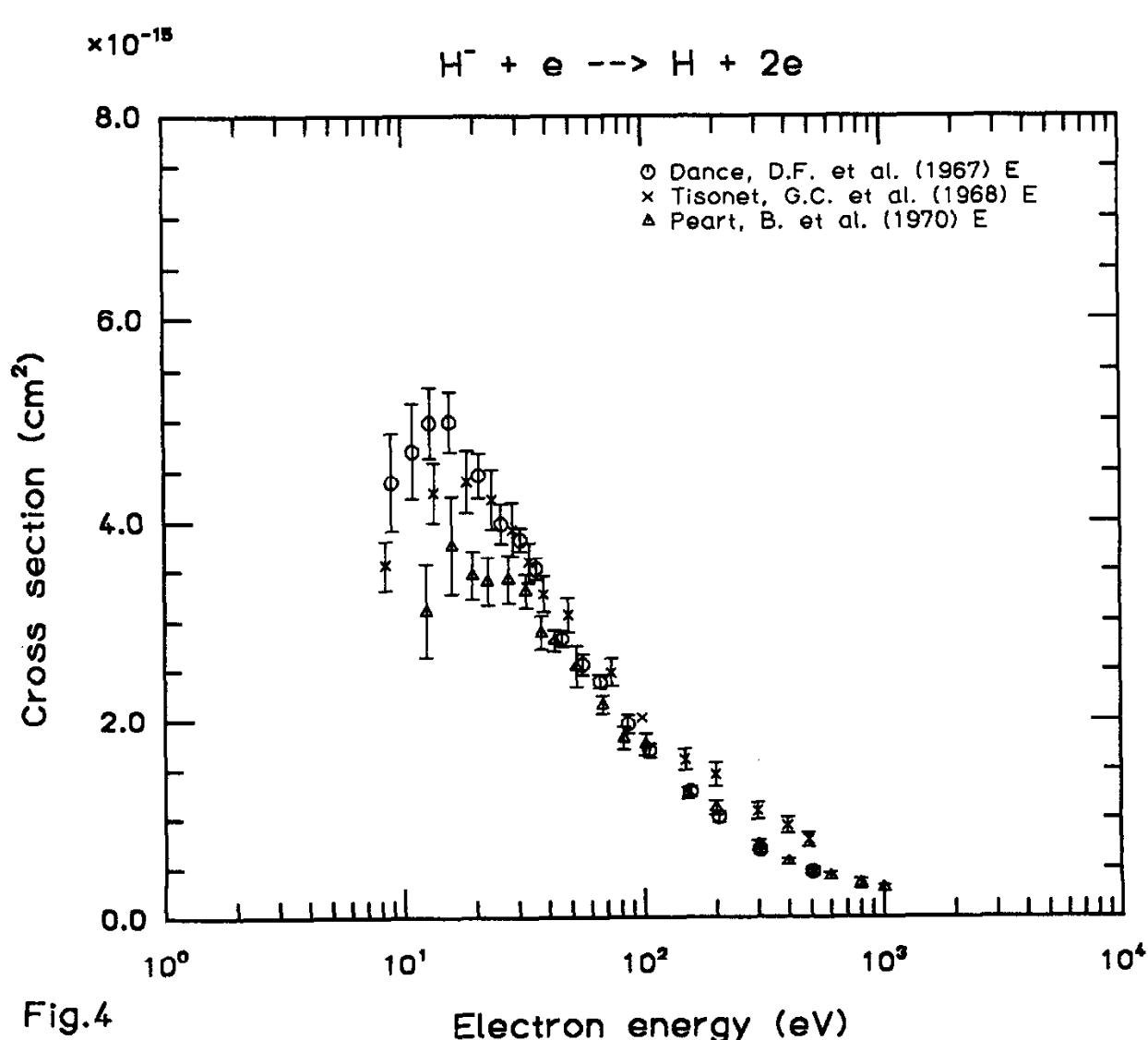


Fig.4

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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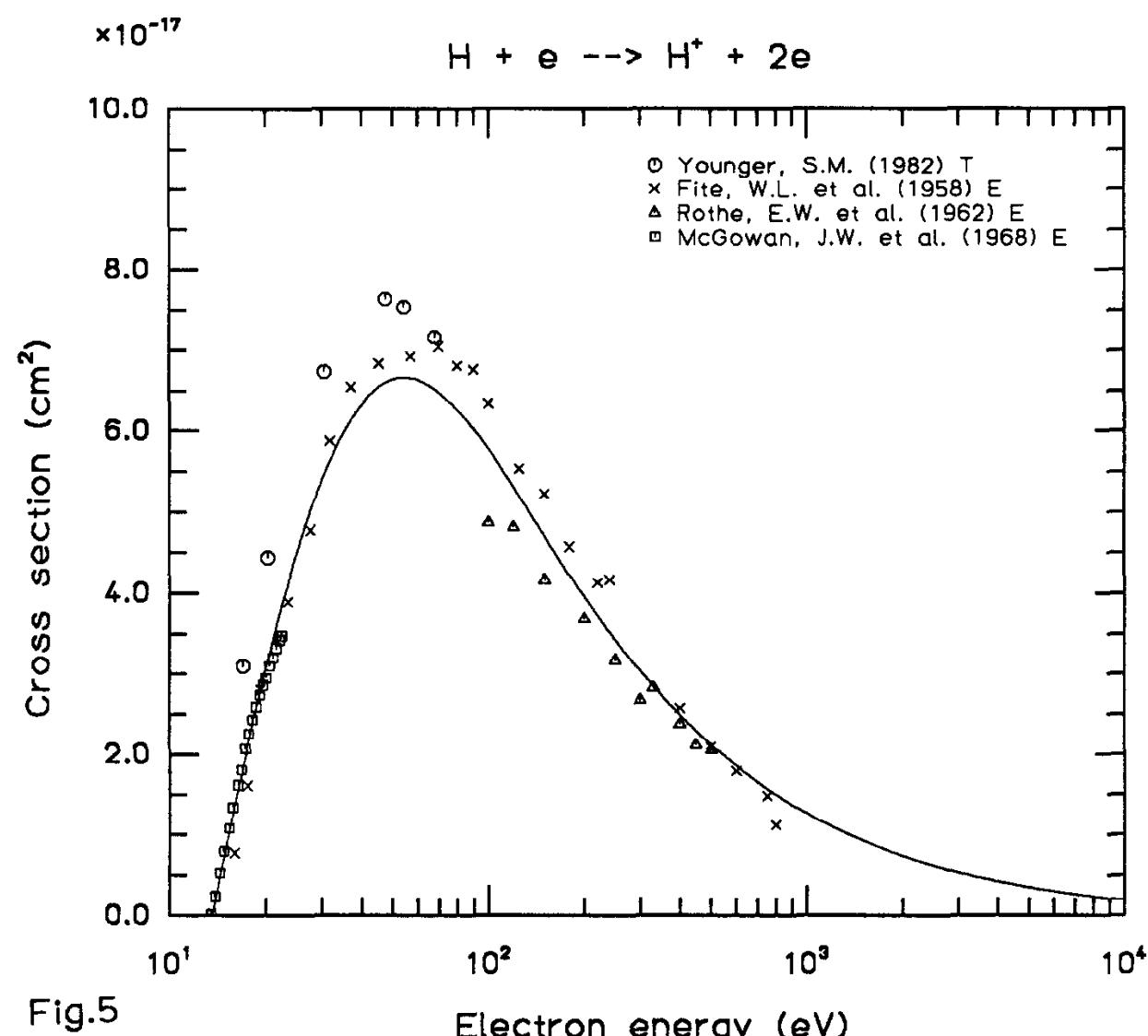


Fig.5

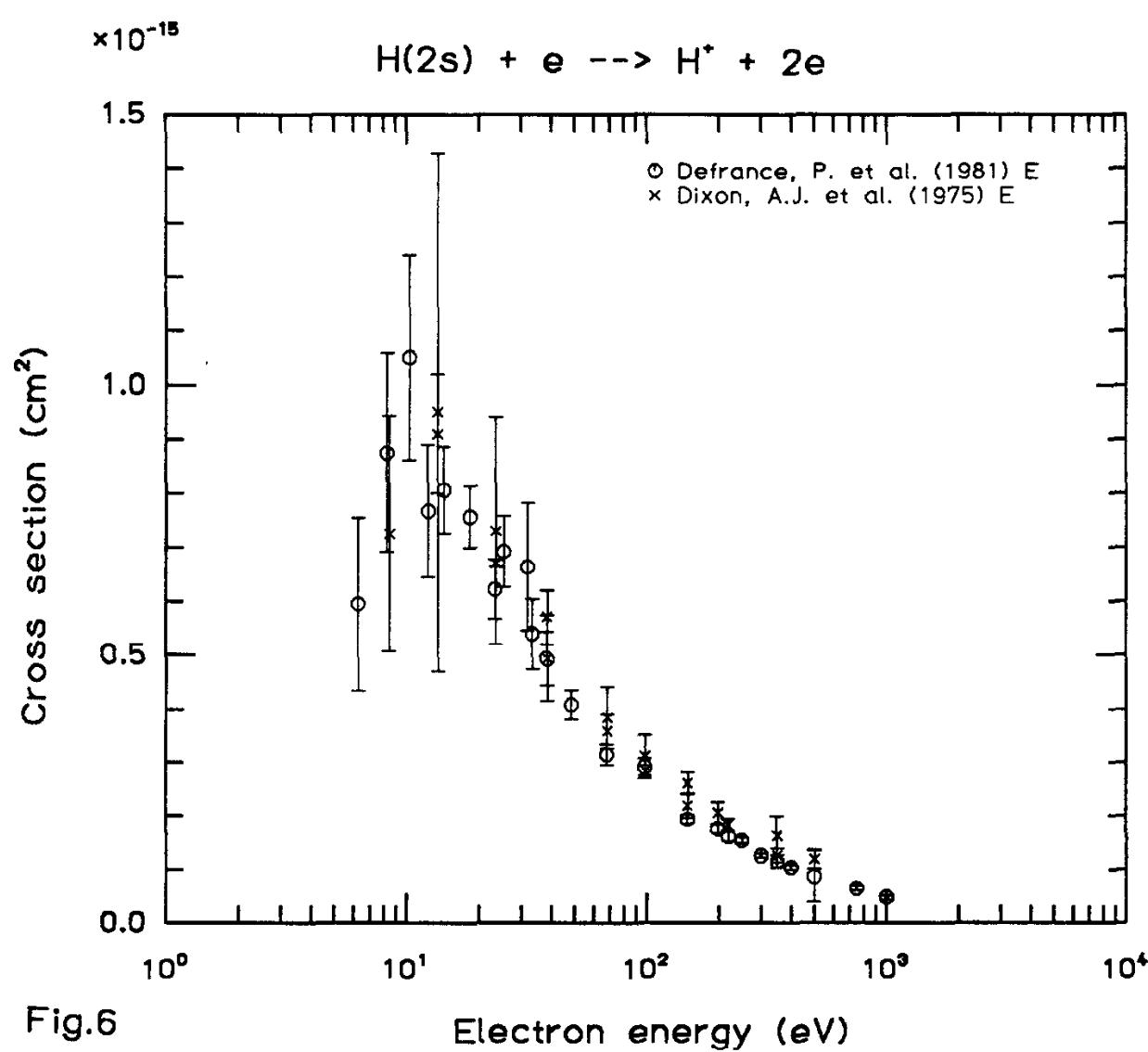


Fig.6

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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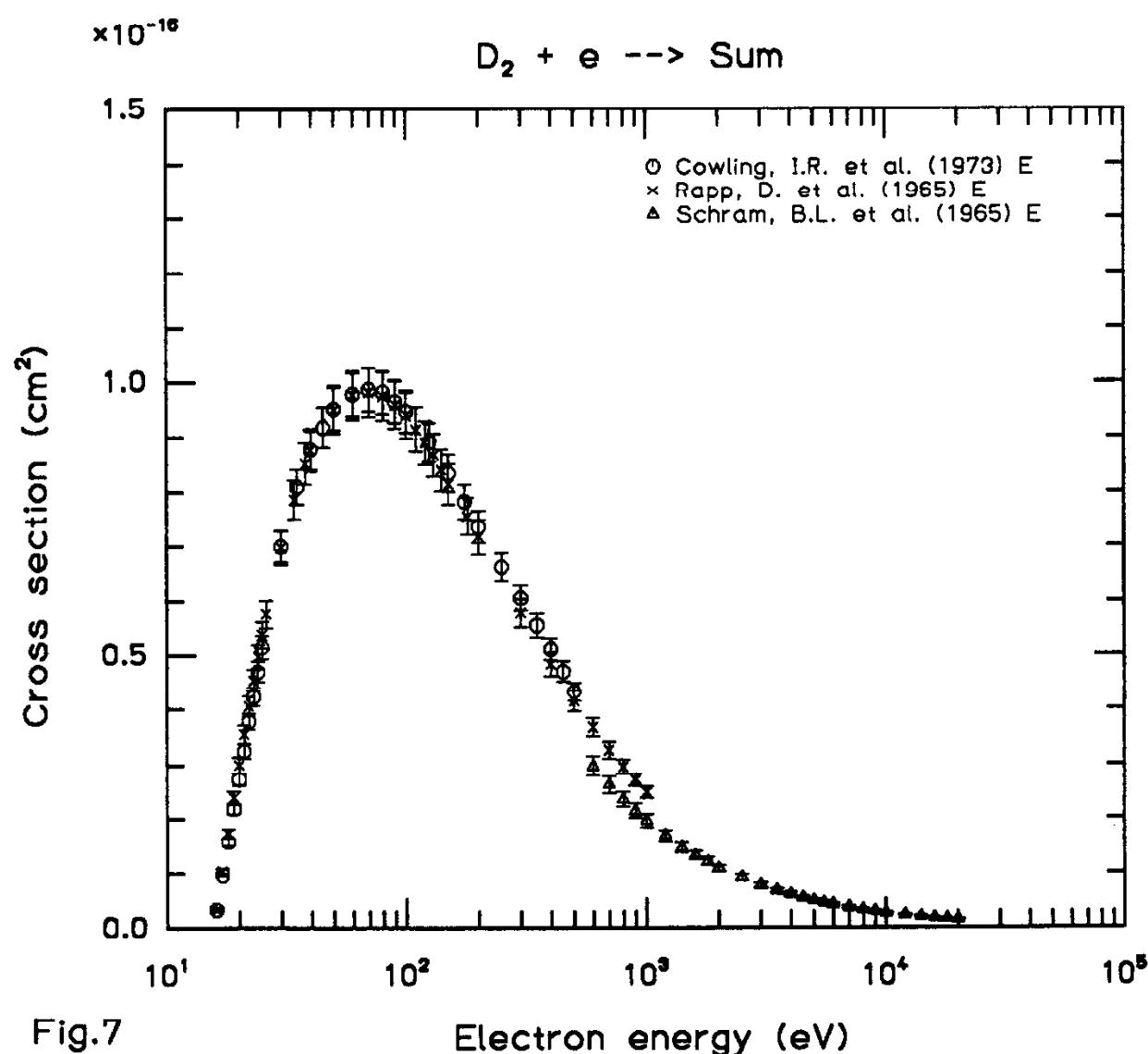


Fig.7

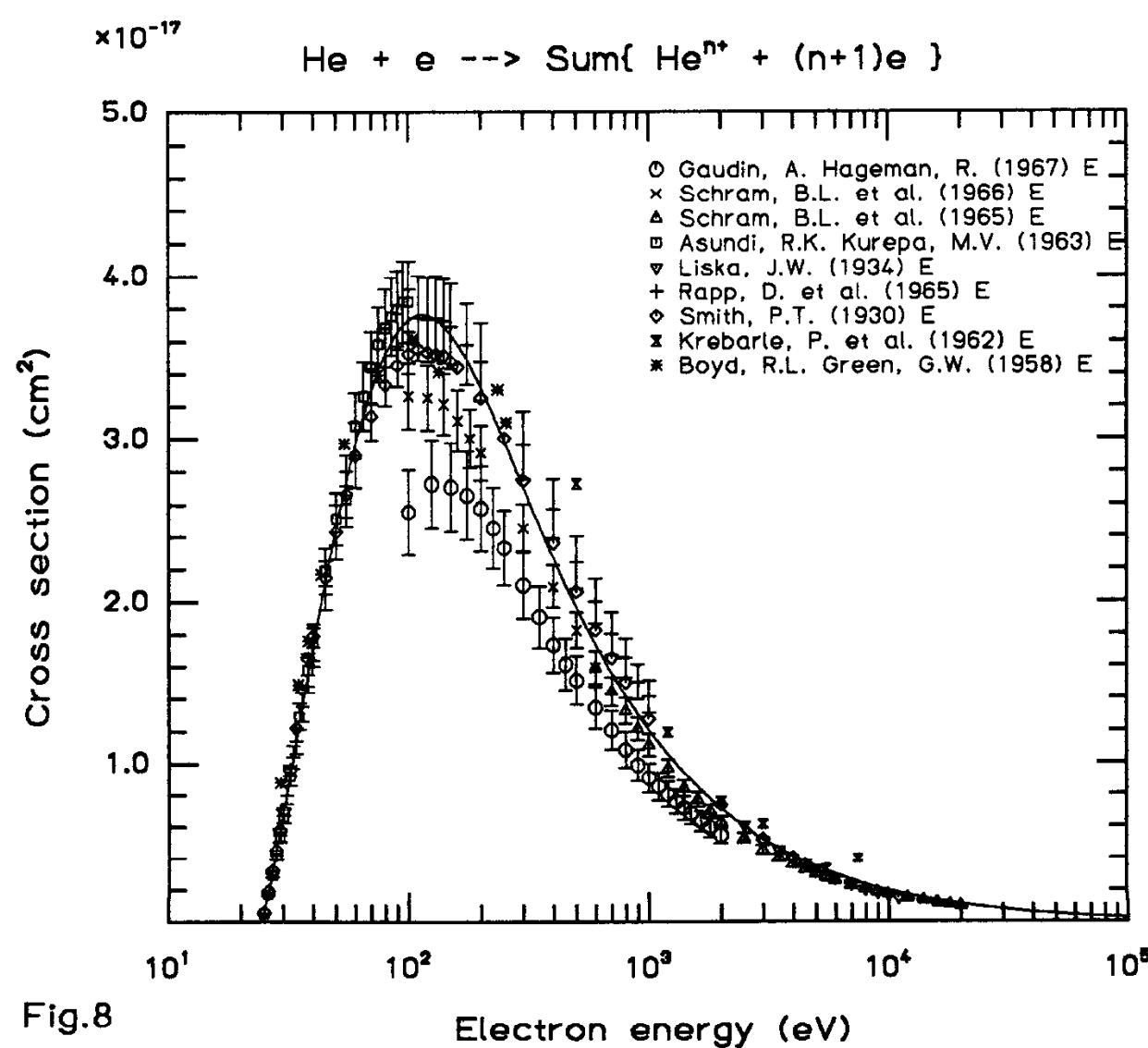


Fig.8

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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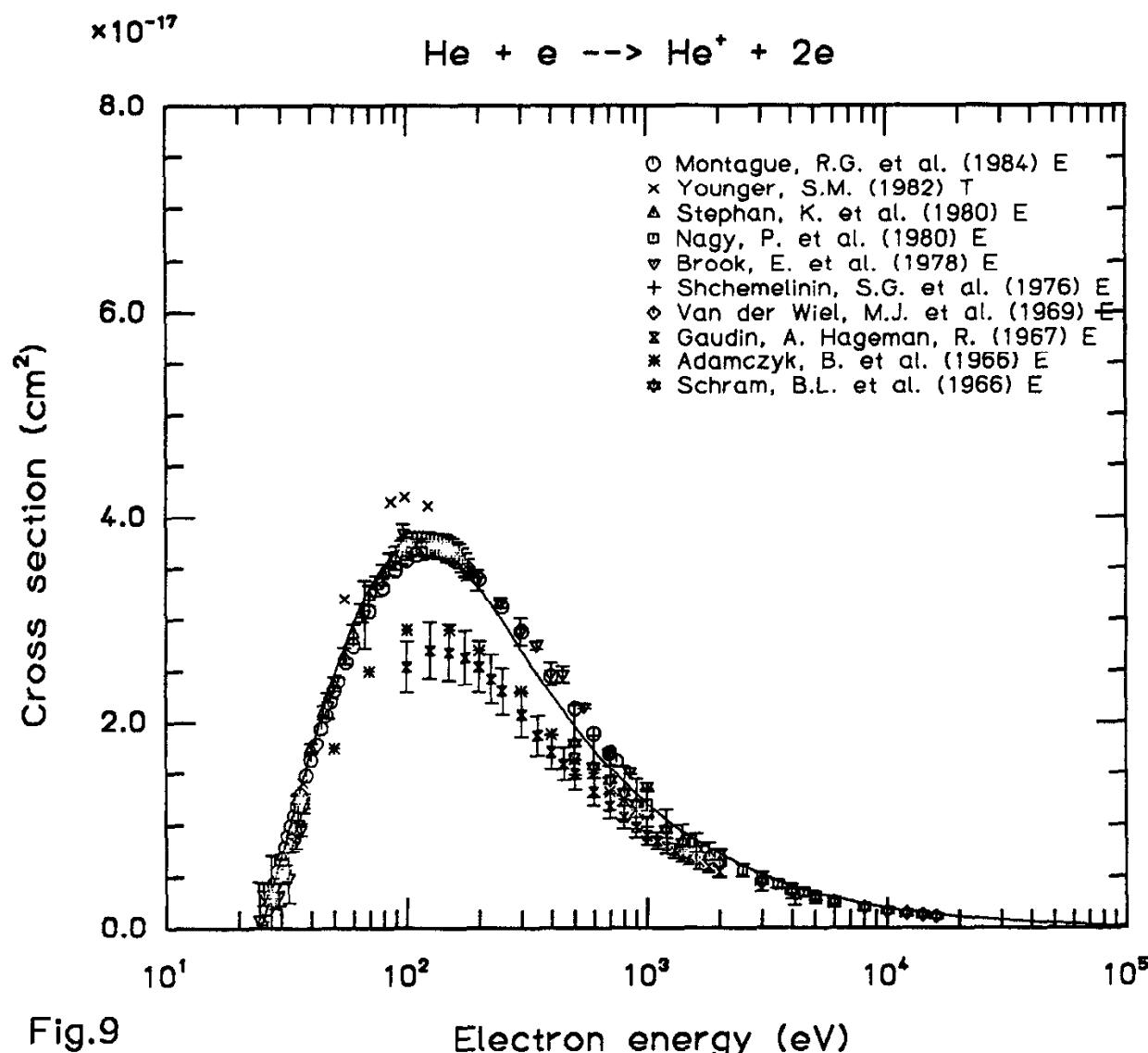


Fig.9

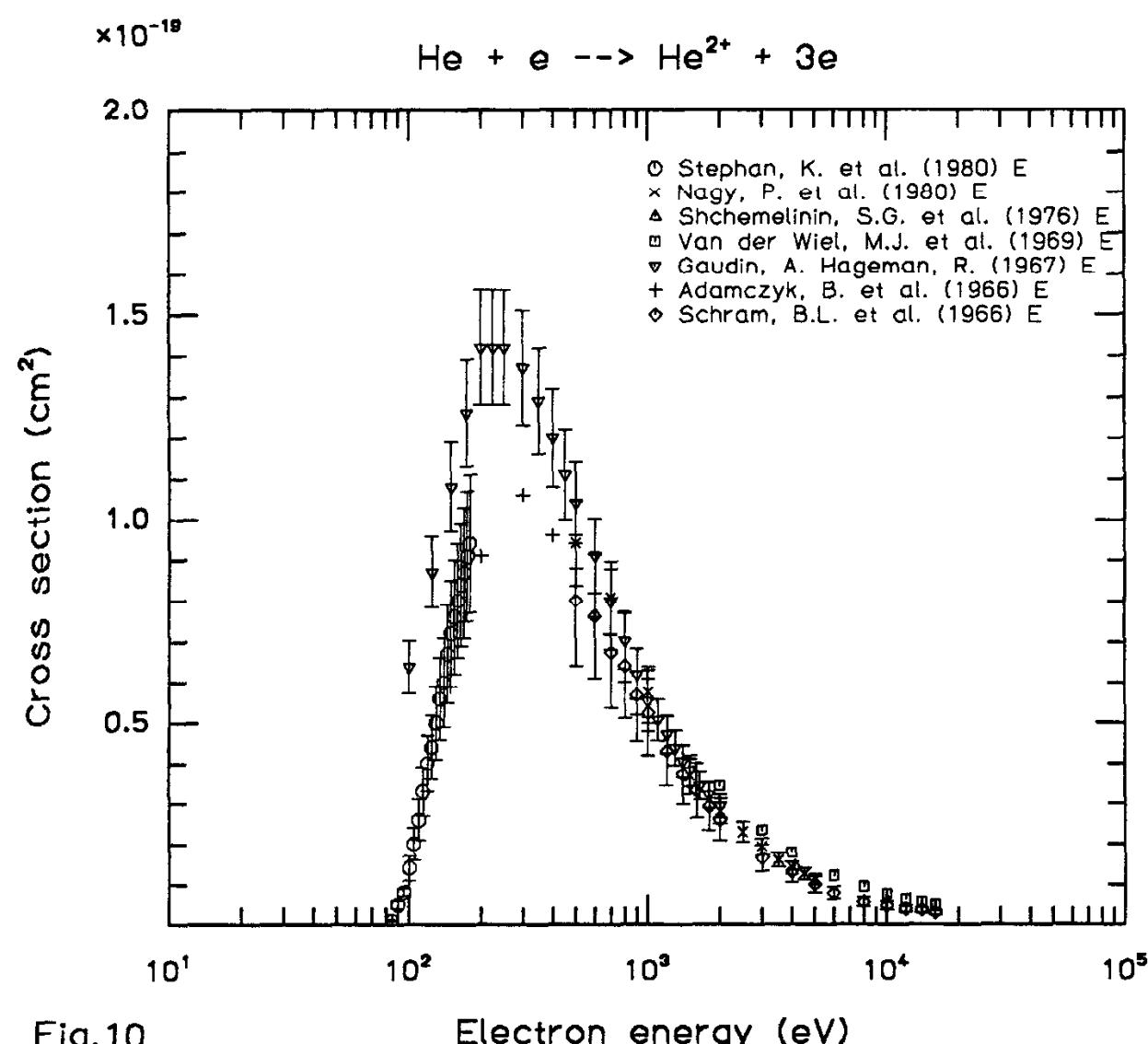


Fig.10

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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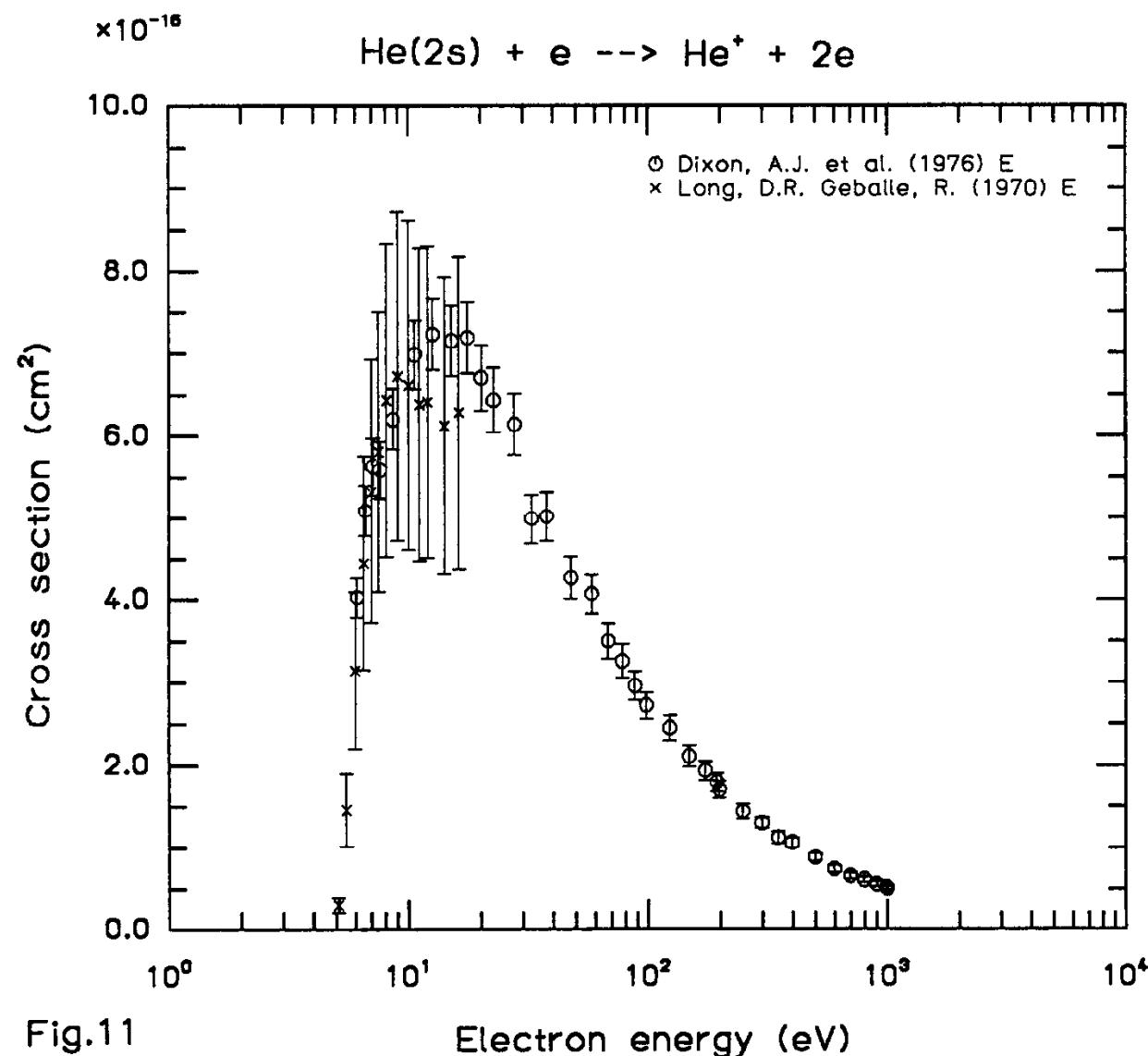


Fig.11

Electron energy (eV)

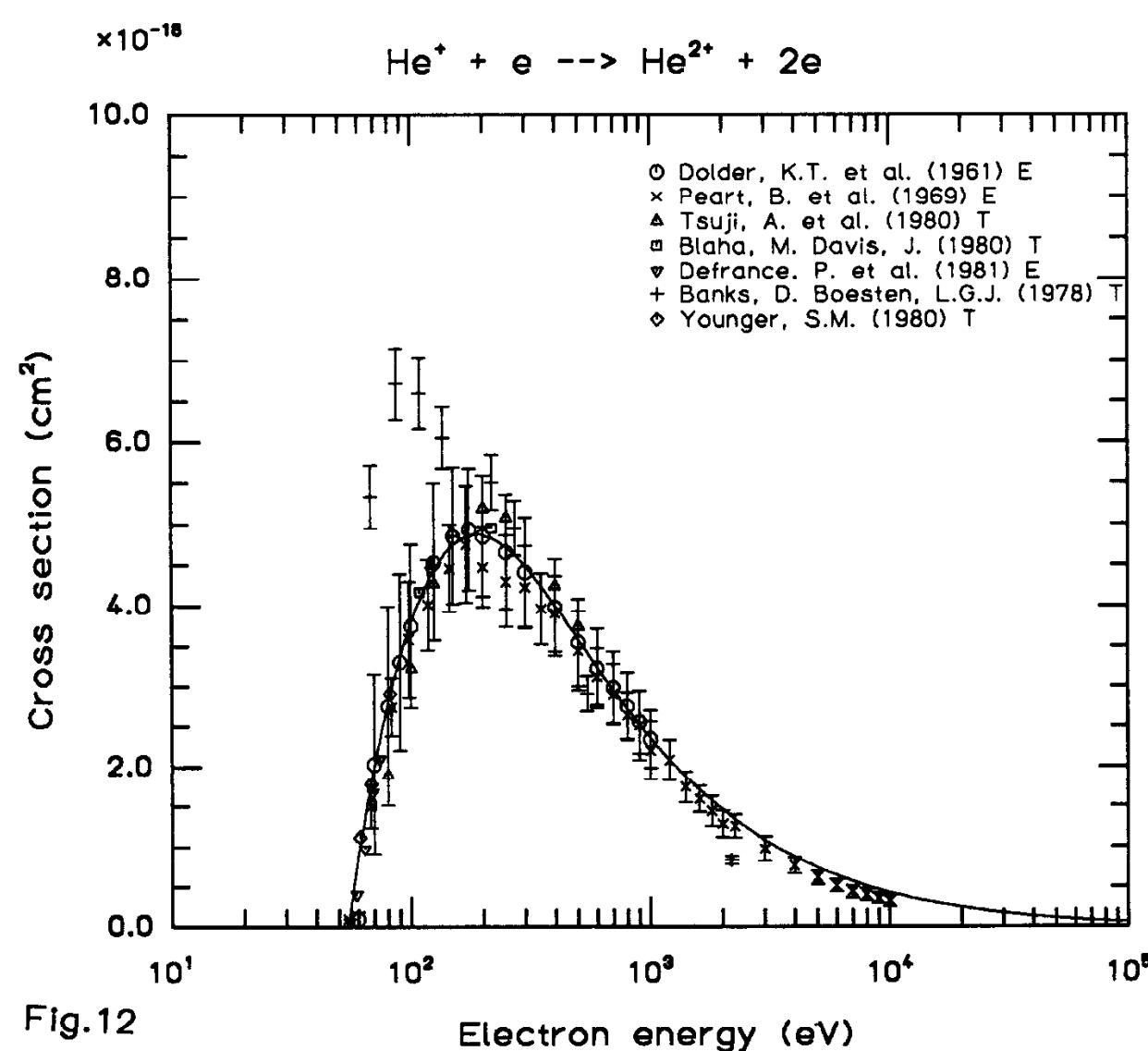


Fig.12

Electron energy (eV)

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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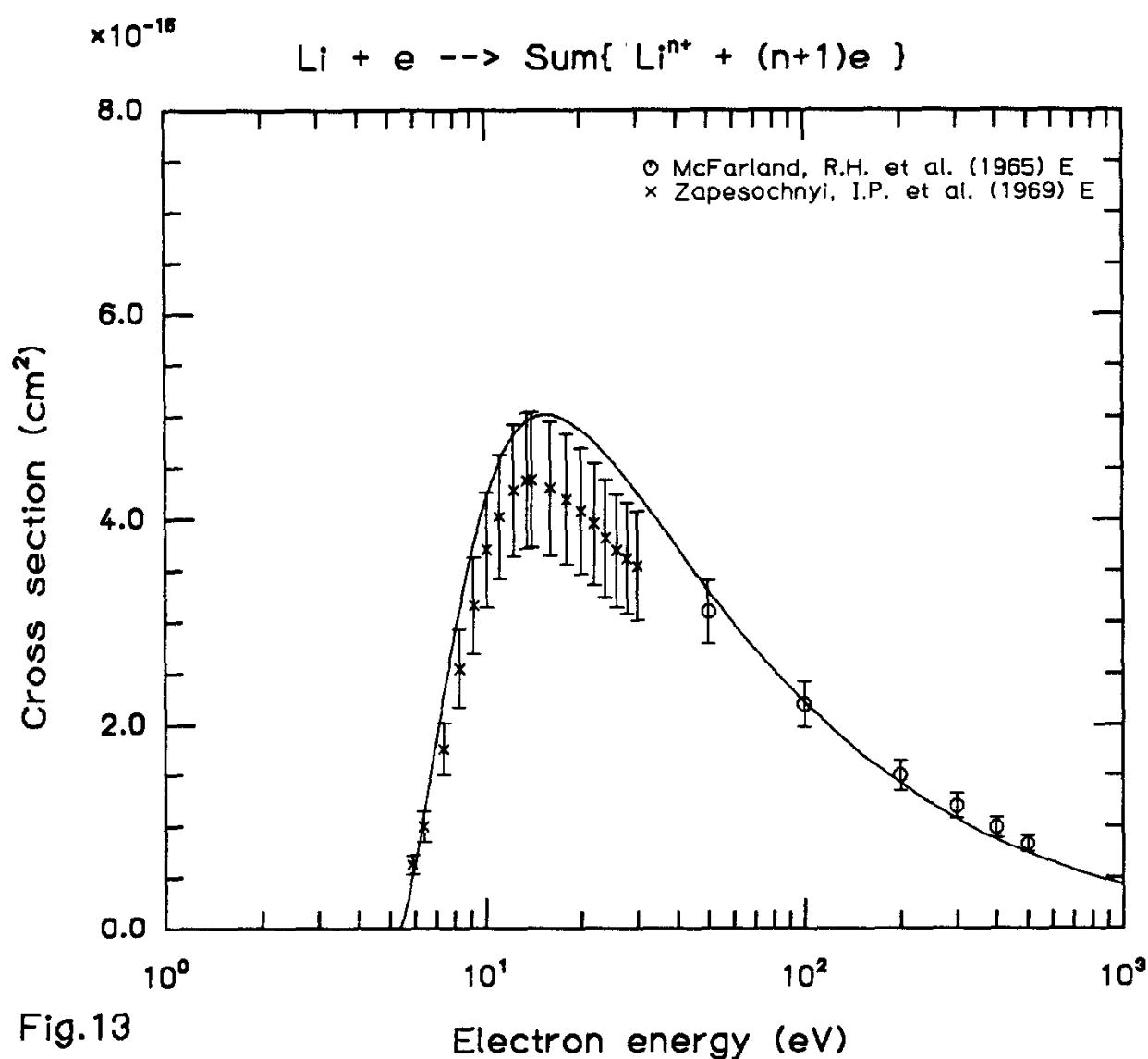


Fig.13

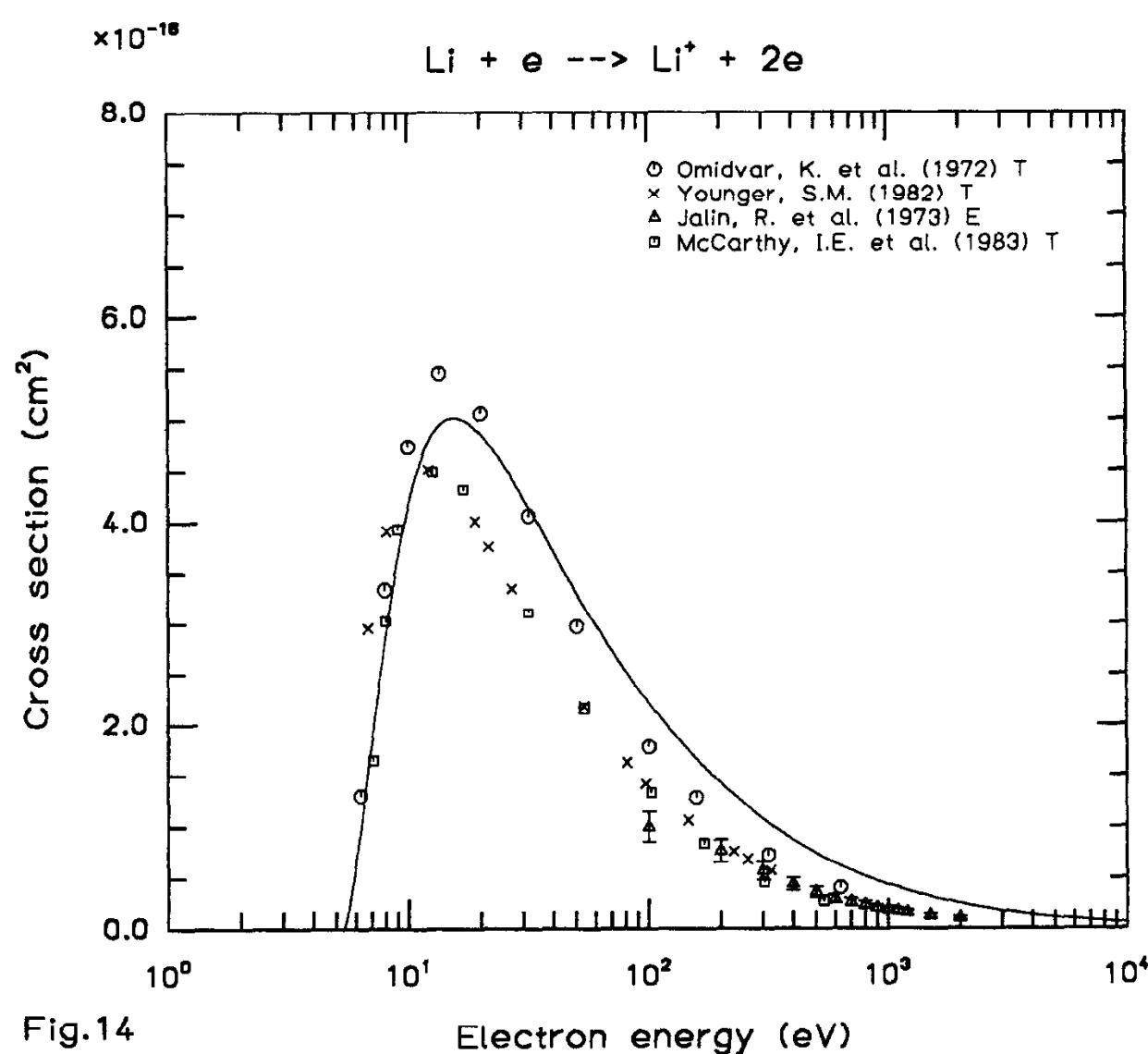


Fig.14

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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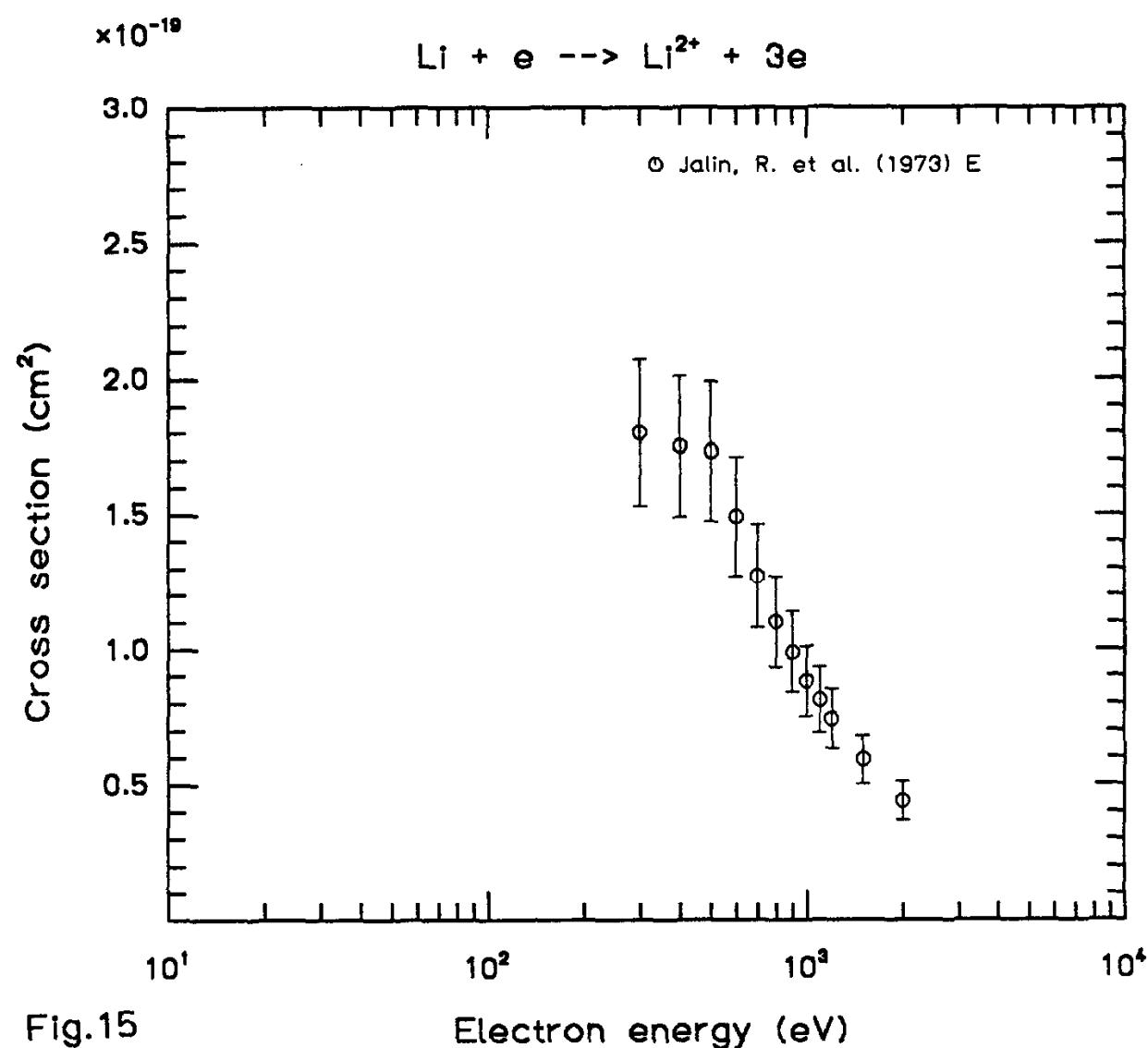


Fig.15

Electron energy (eV)

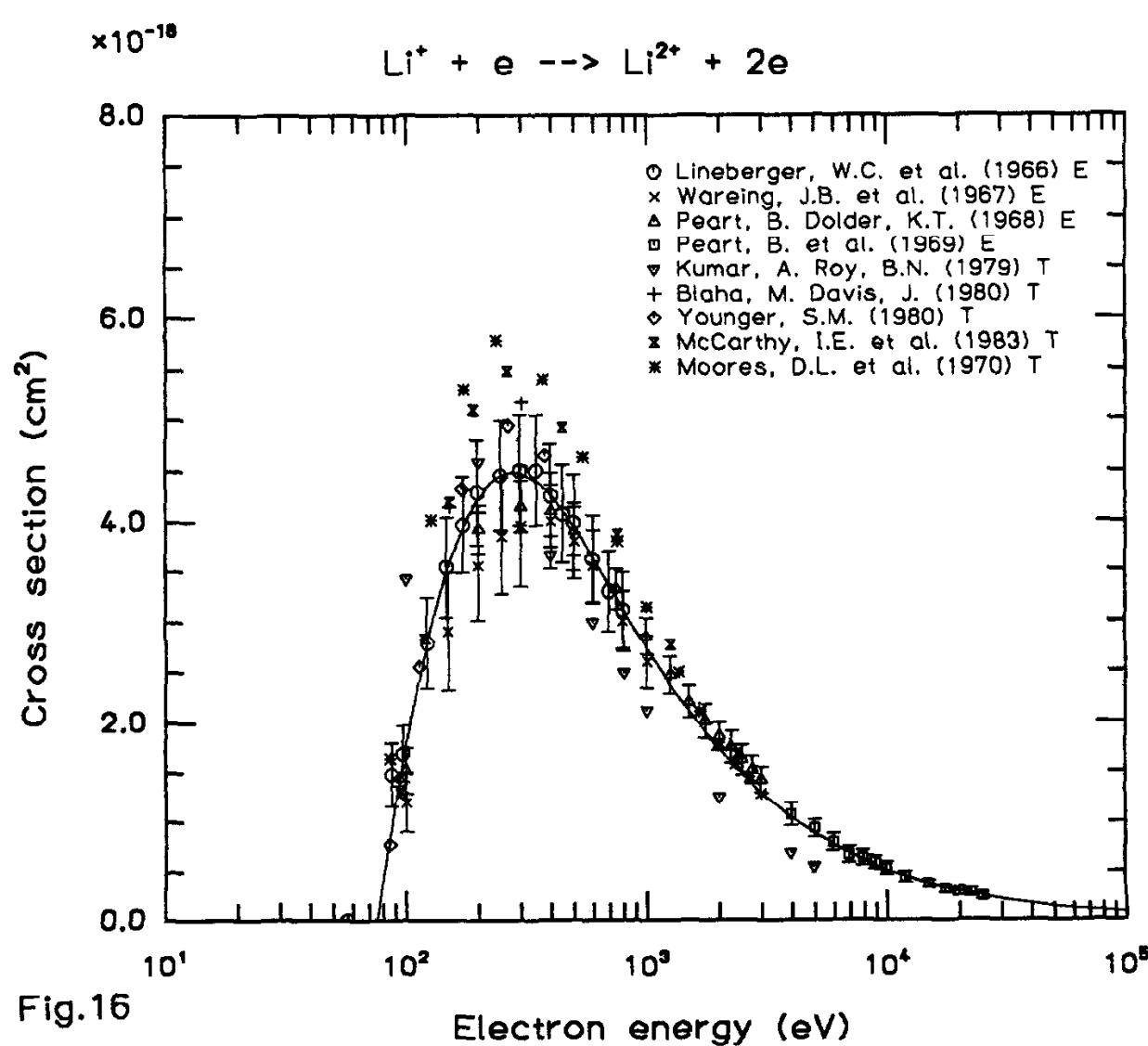
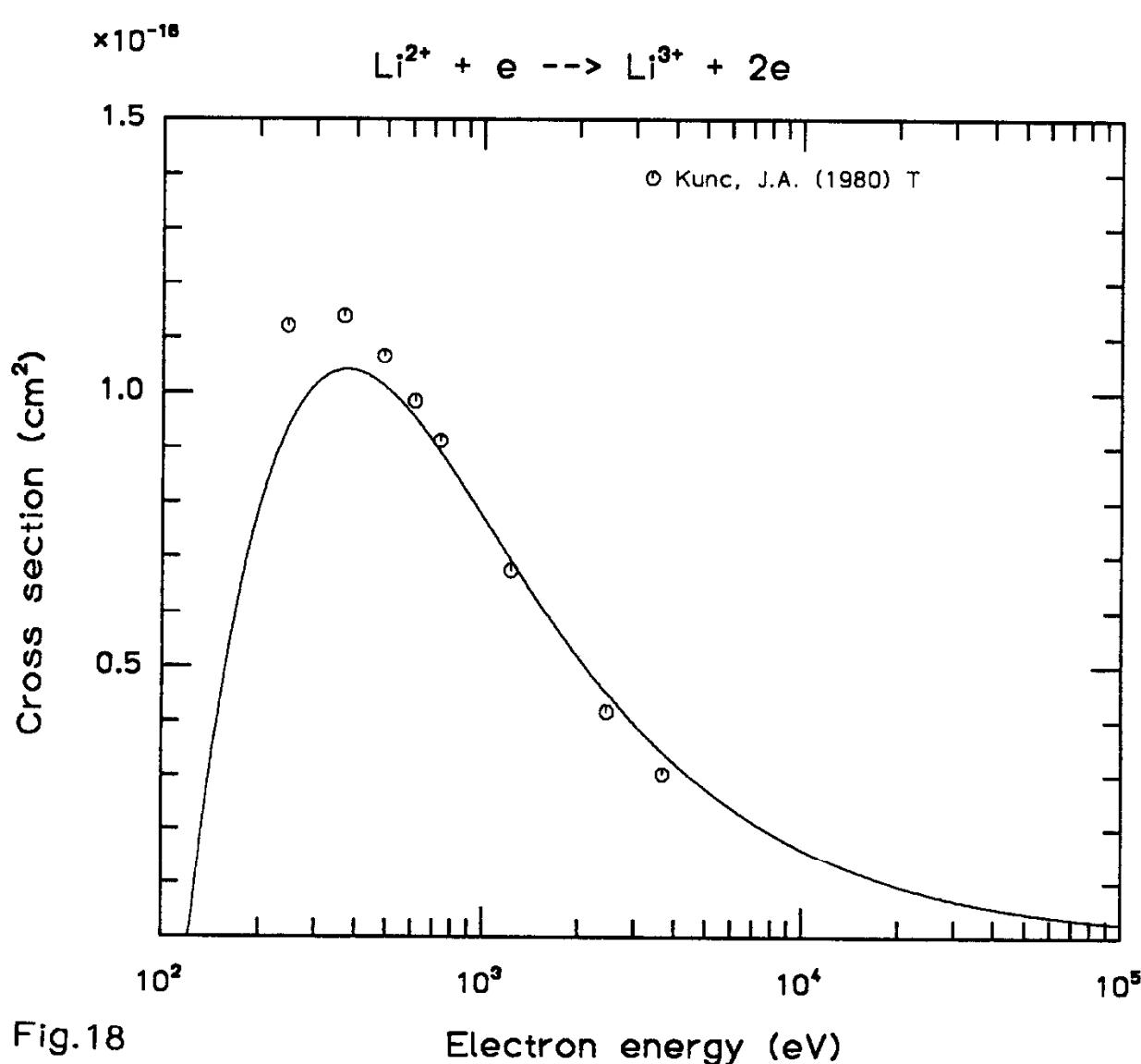
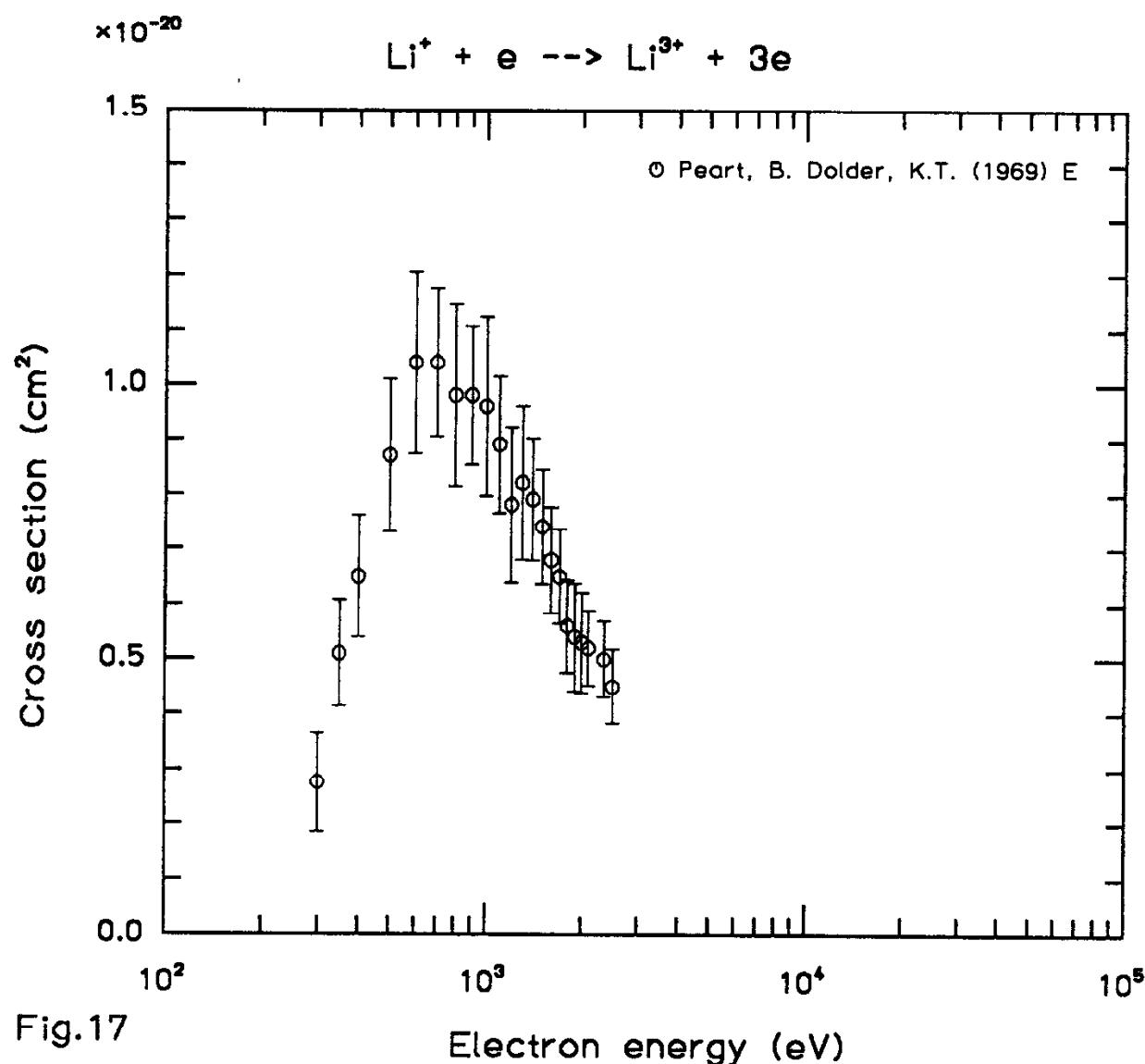


Fig.16

Electron energy (eV)

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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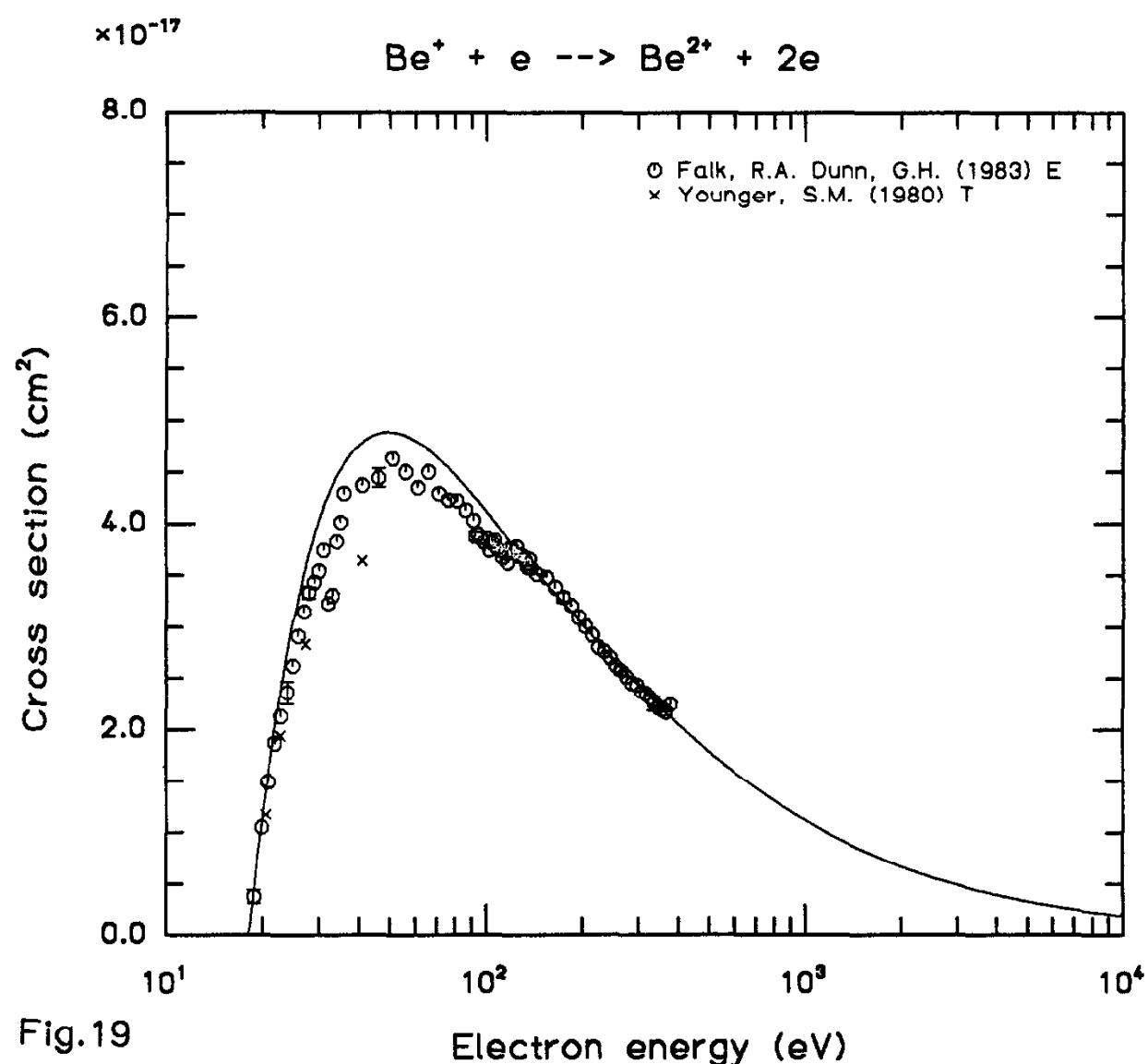


Fig.19

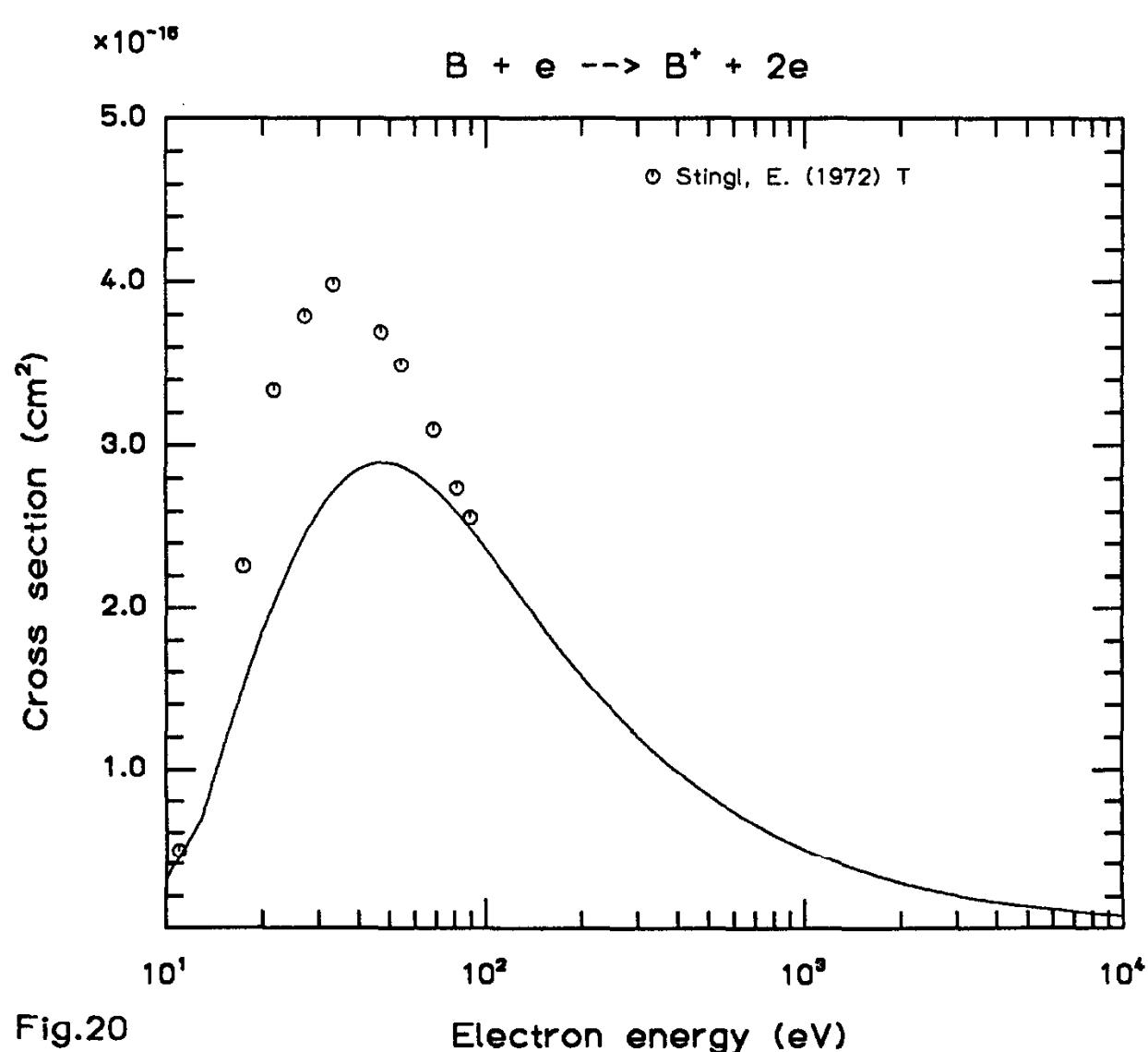


Fig.20

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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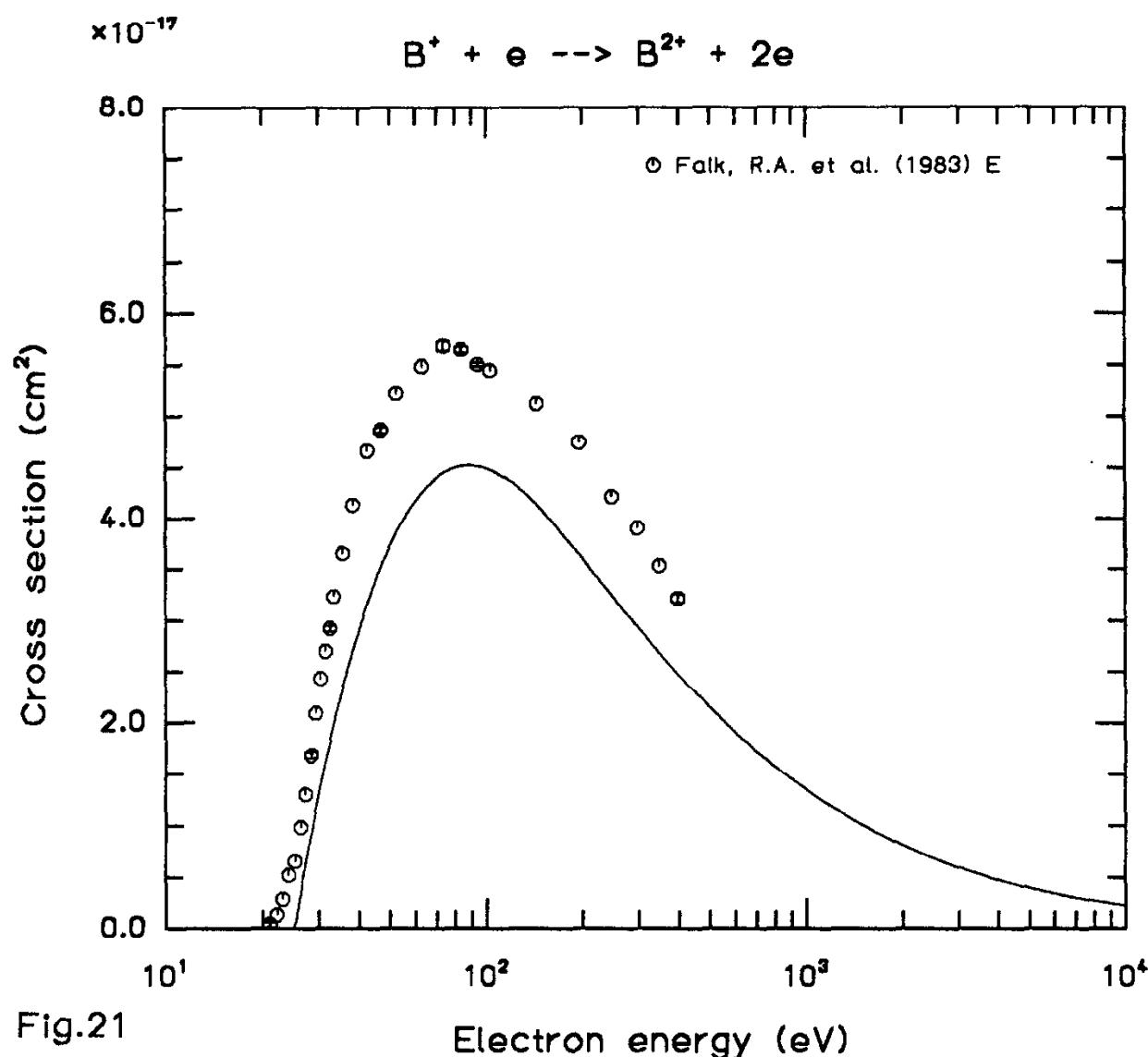


Fig.21

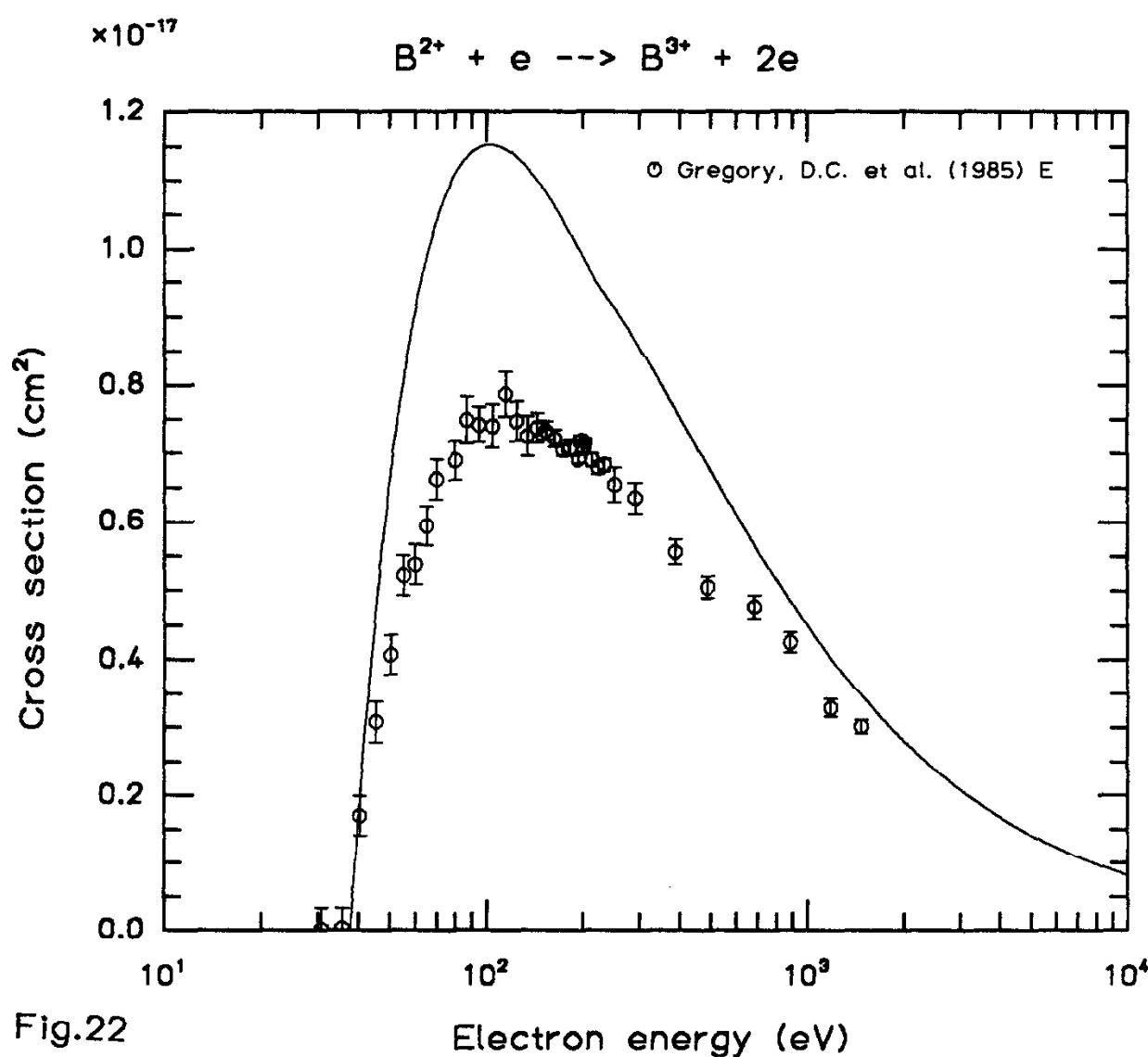


Fig.22

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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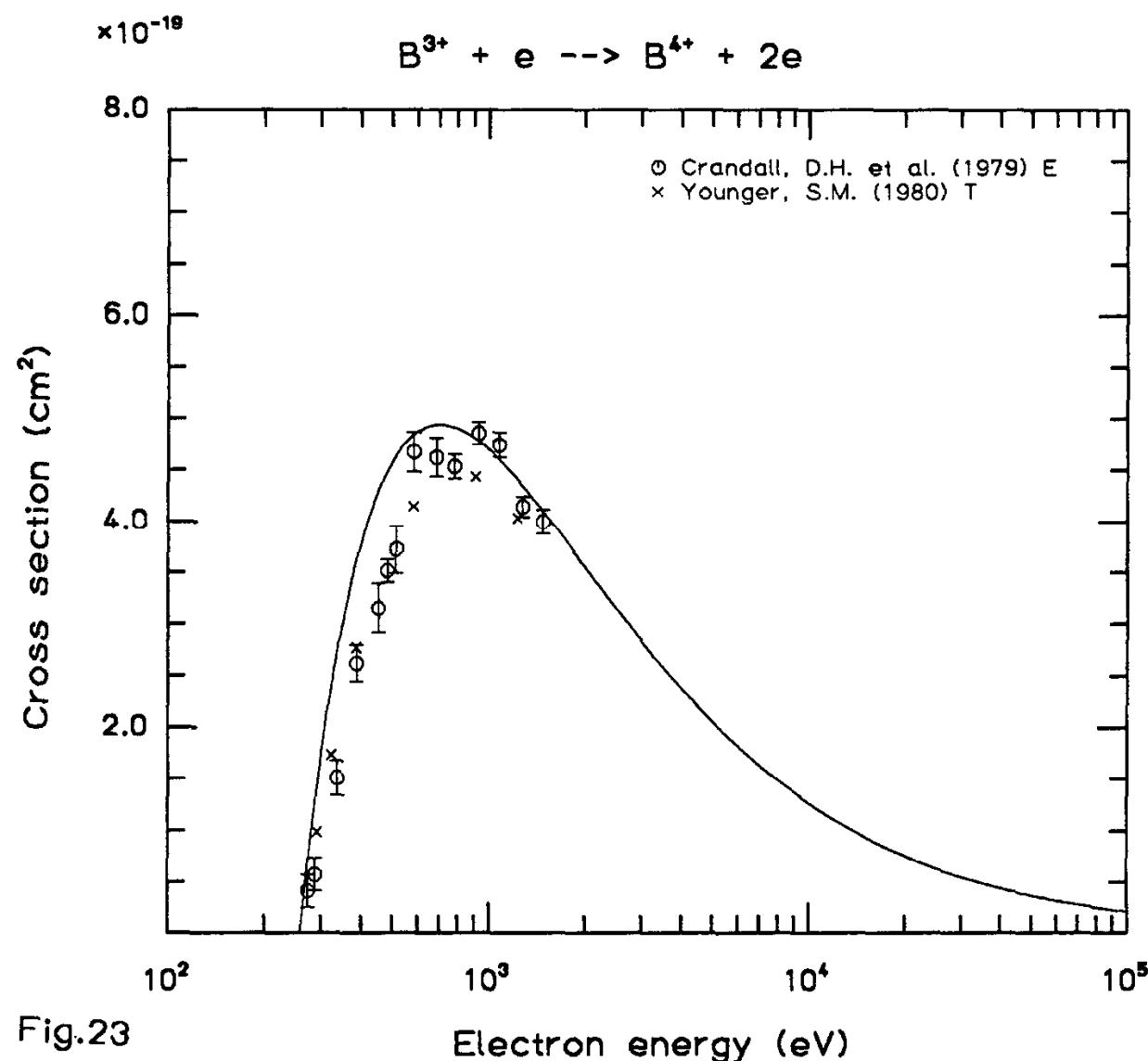


Fig.23

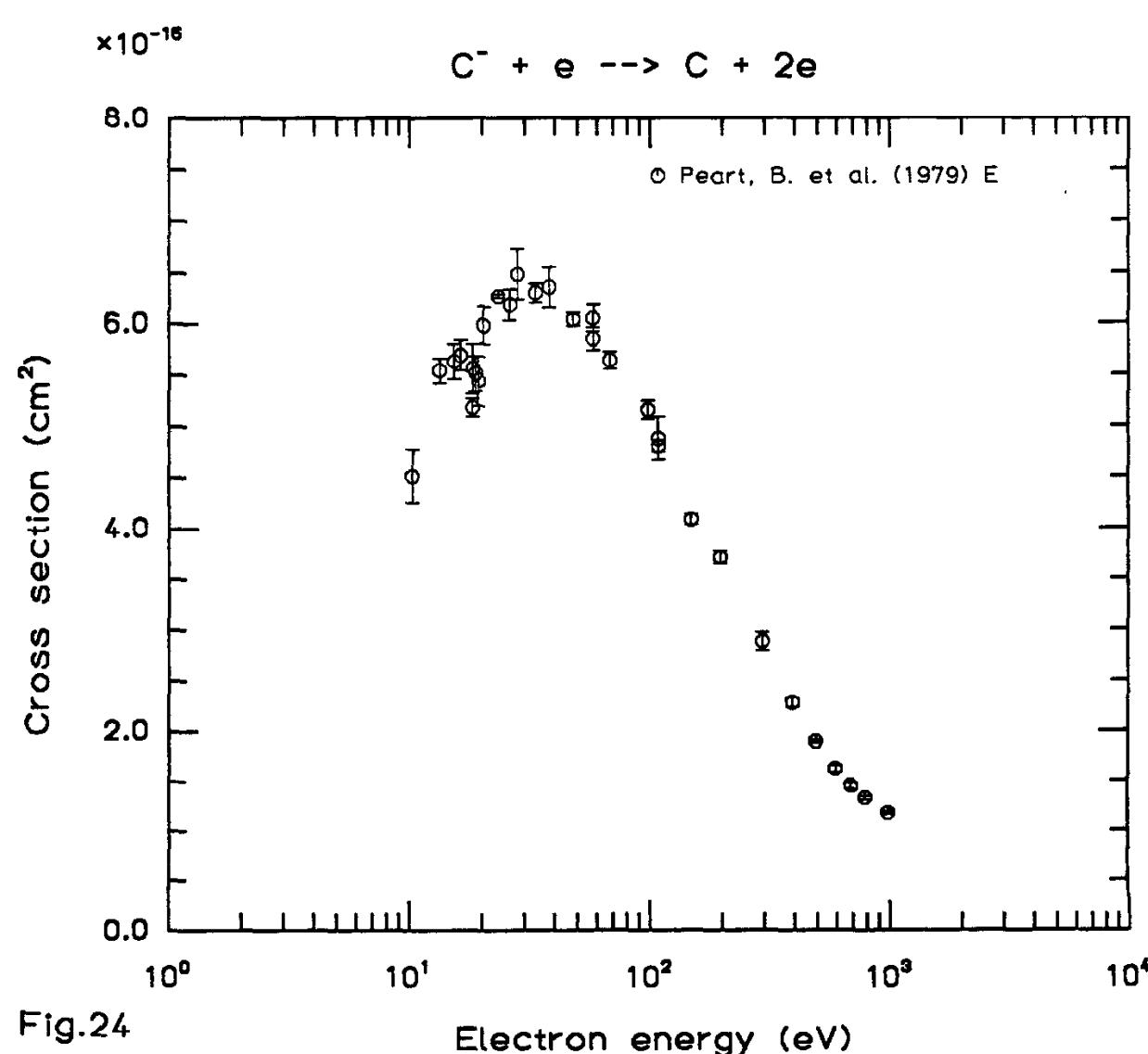


Fig.24

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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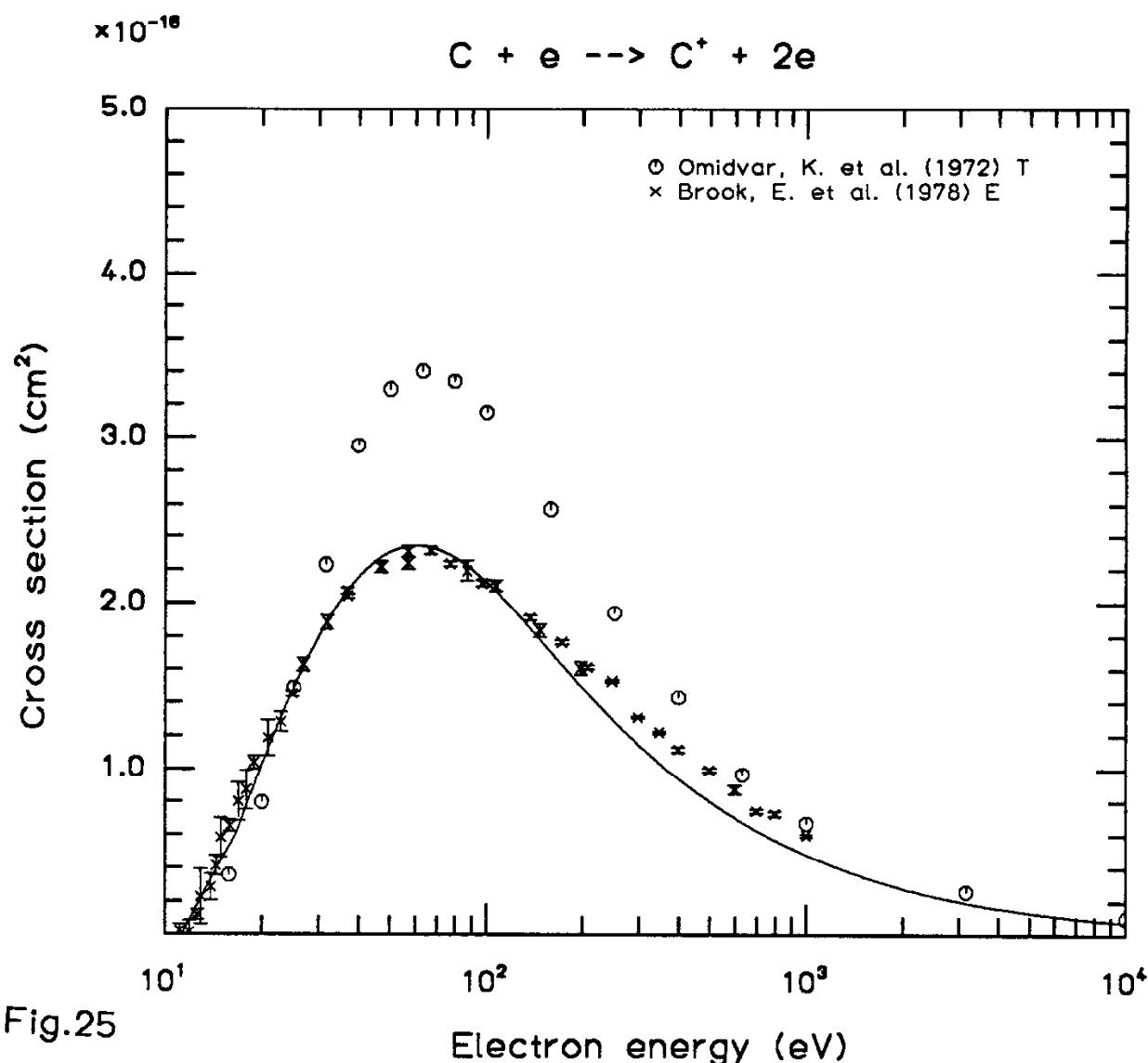


Fig.25

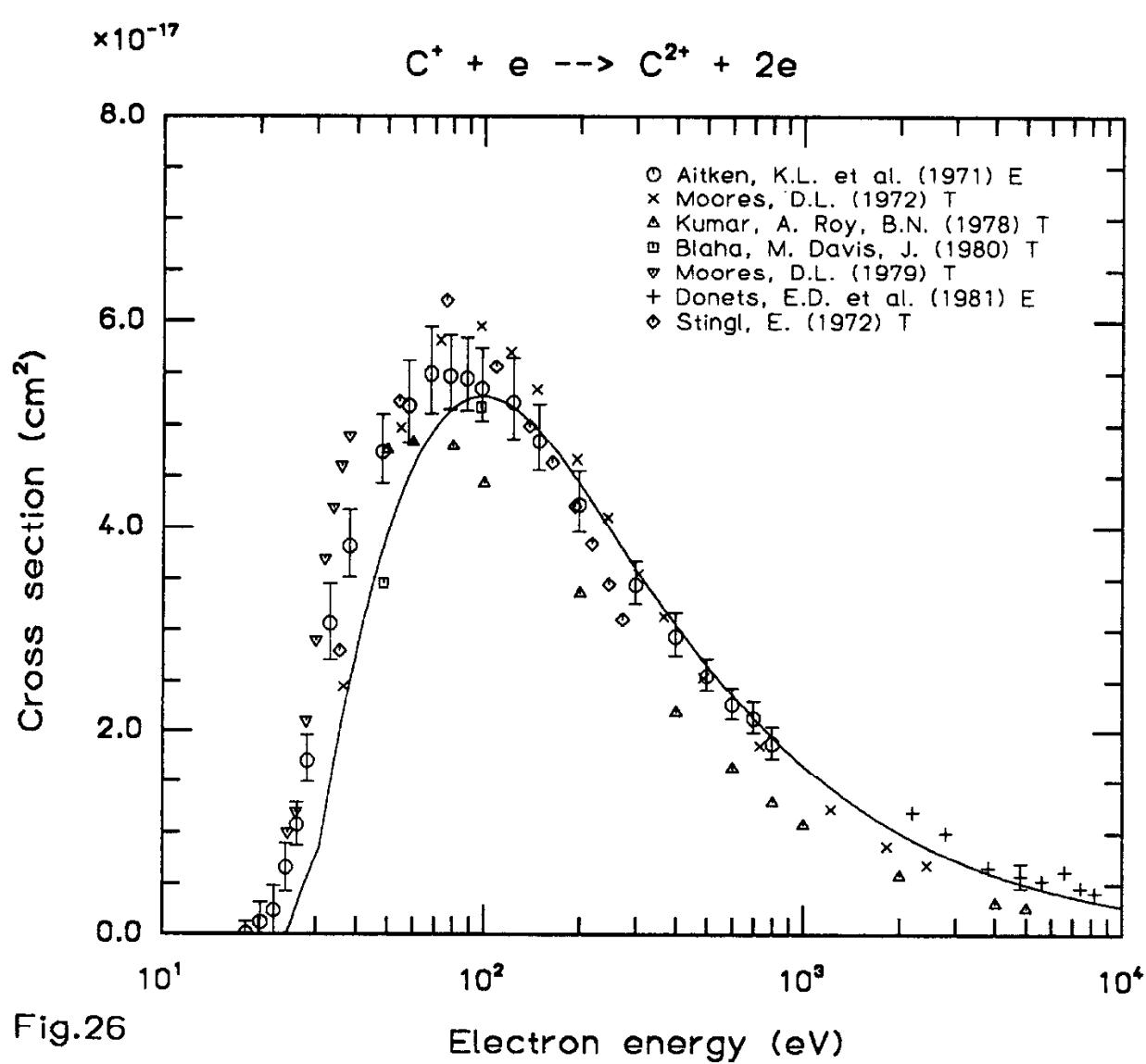


Fig.26

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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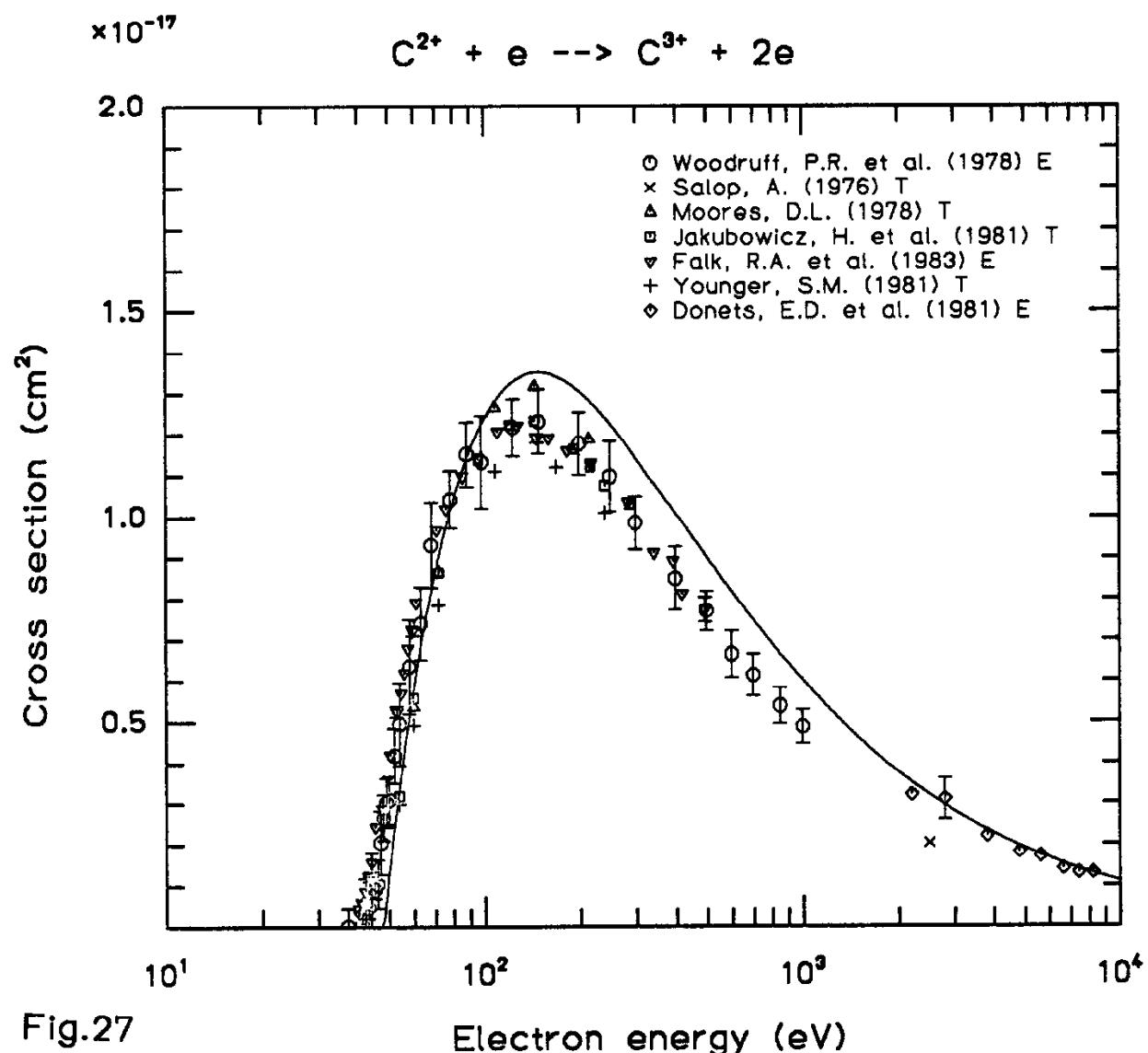


Fig.27

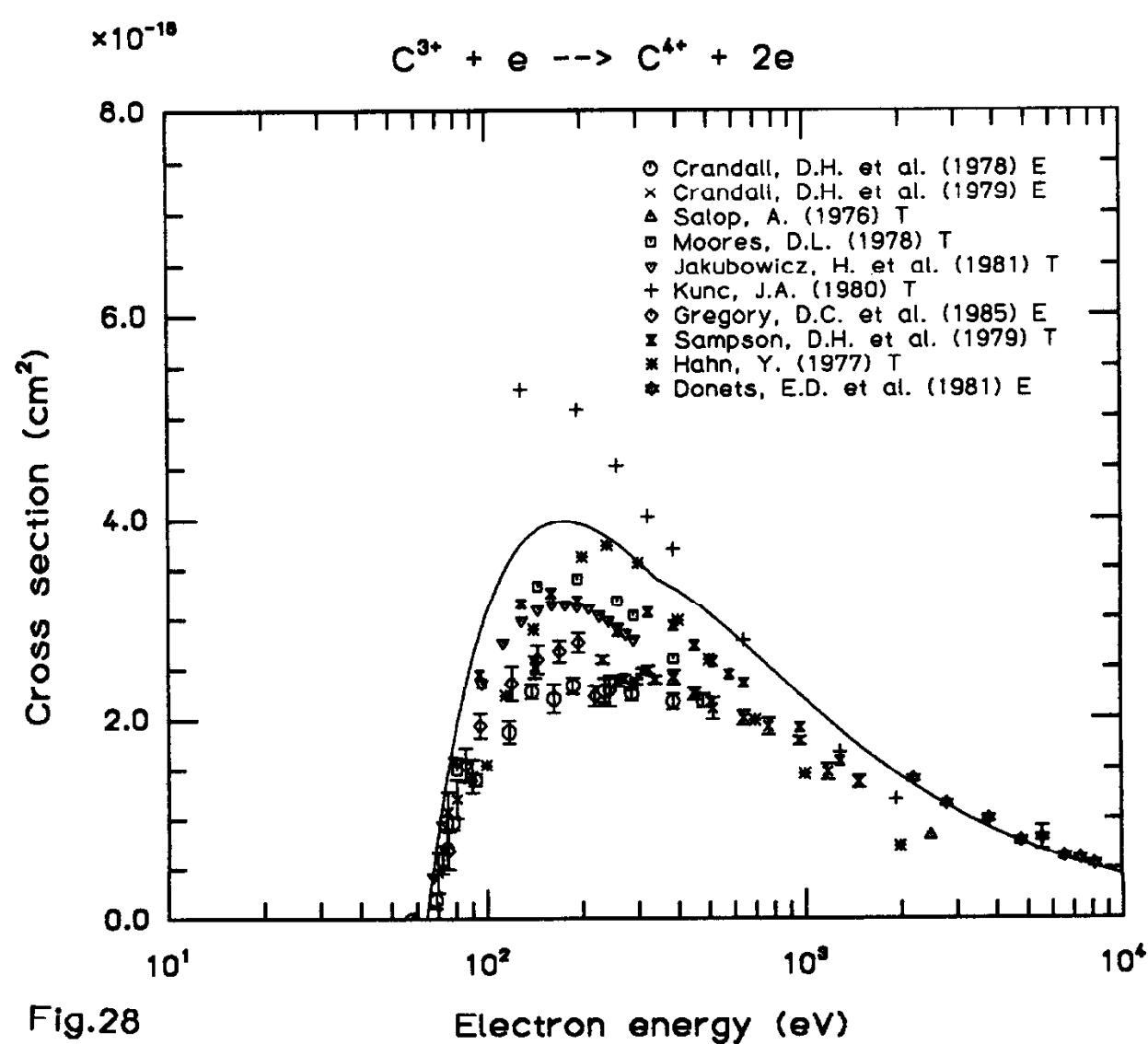


Fig.28

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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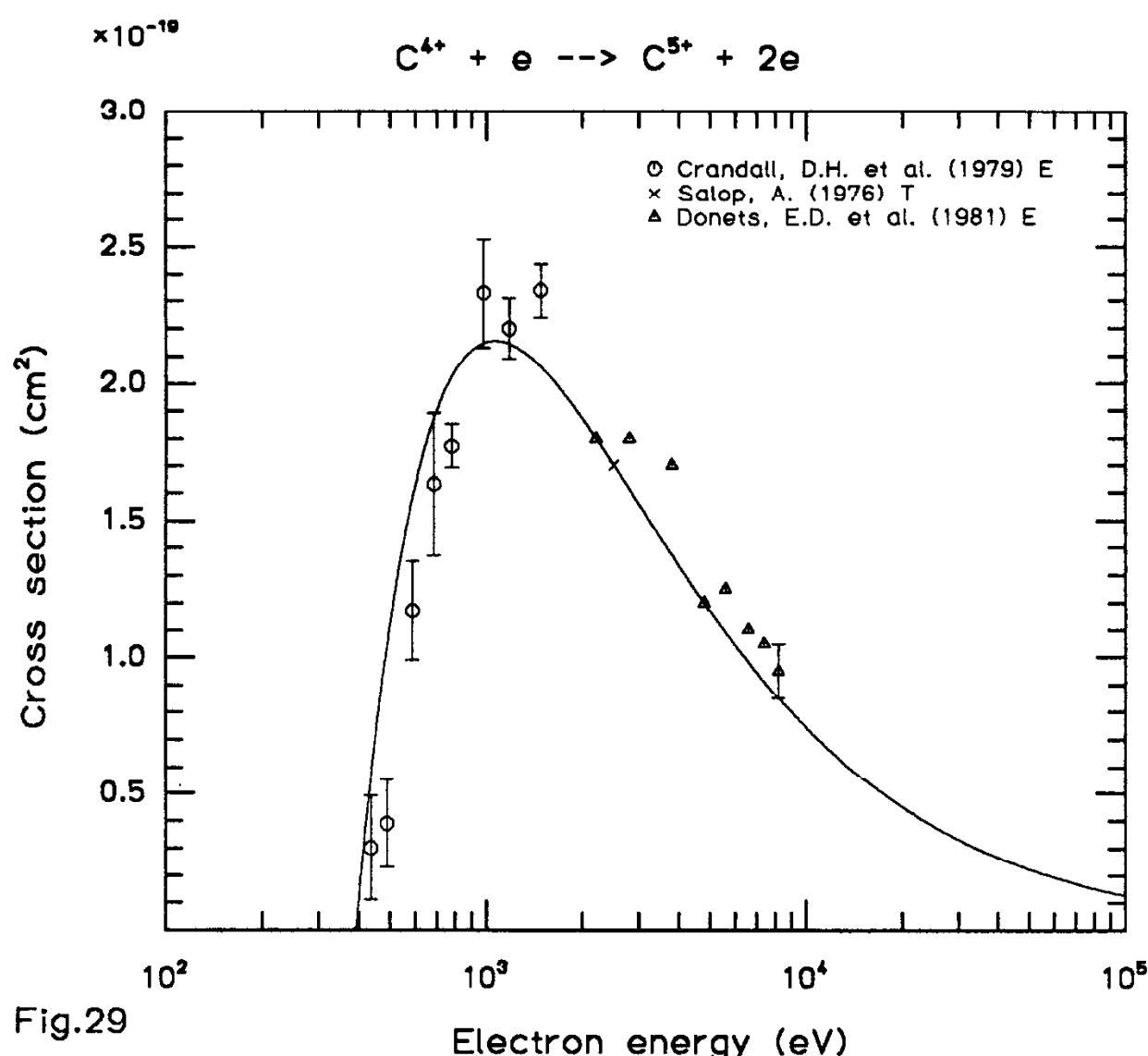


Fig.29

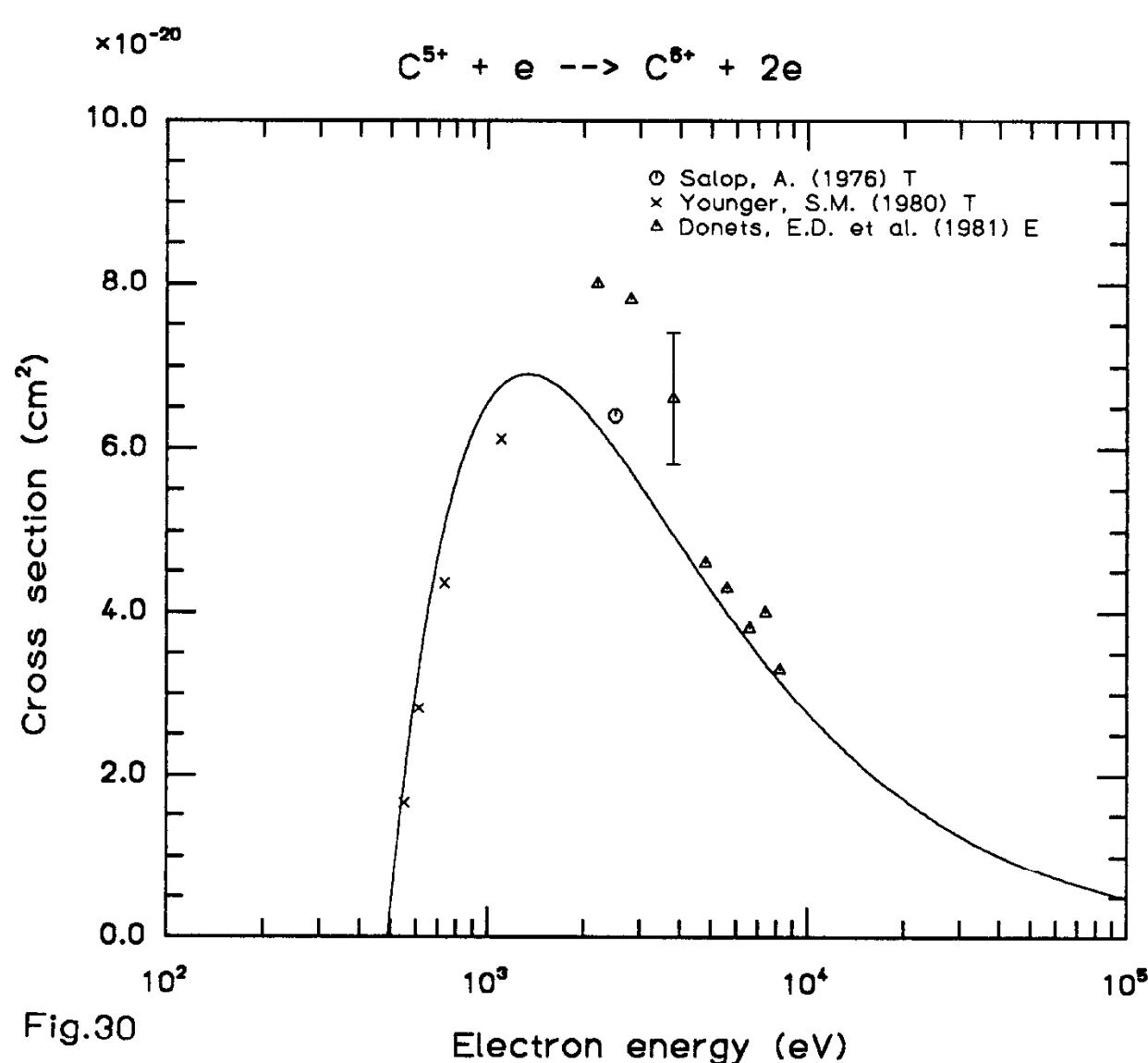


Fig.30

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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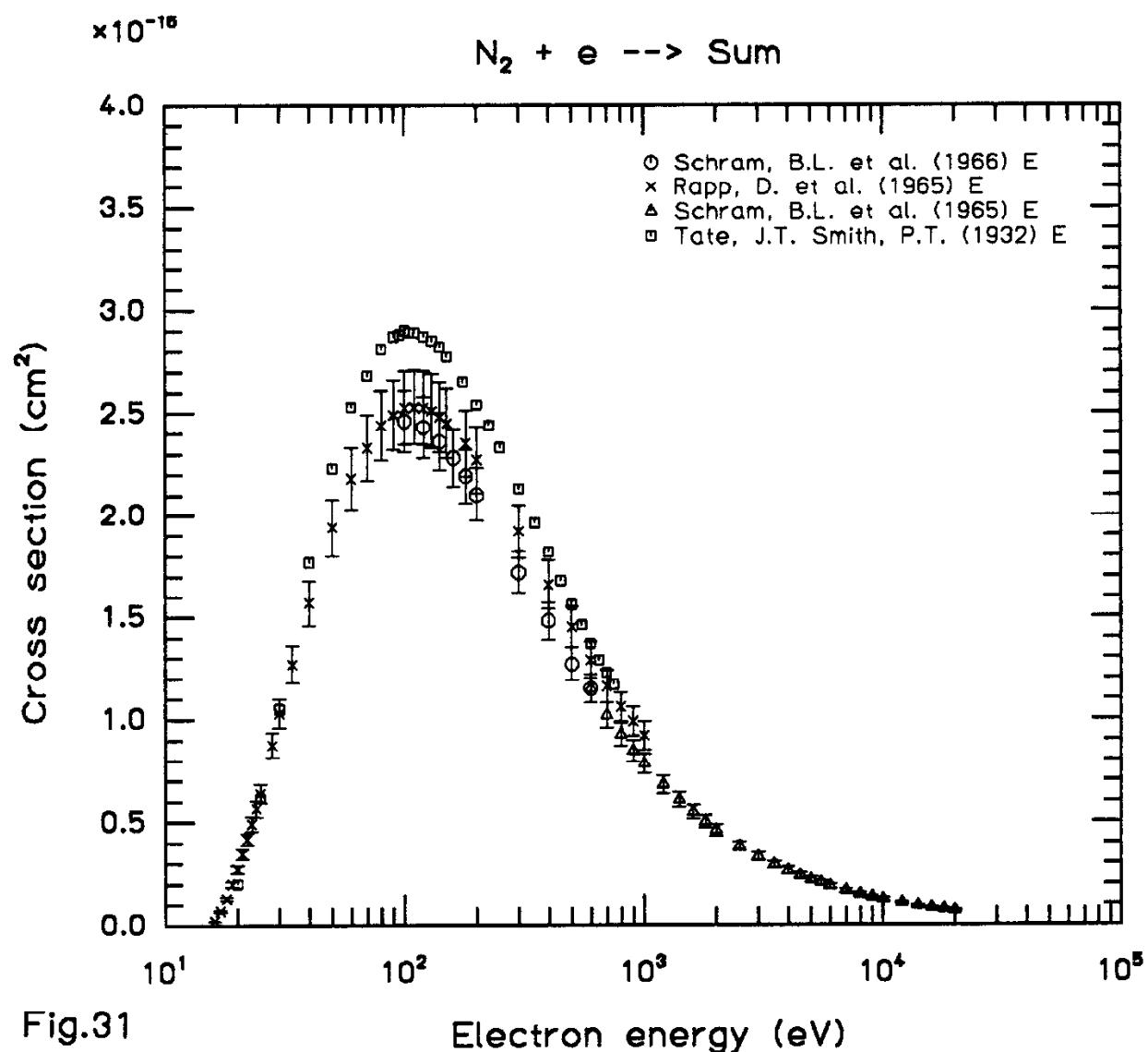


Fig.31

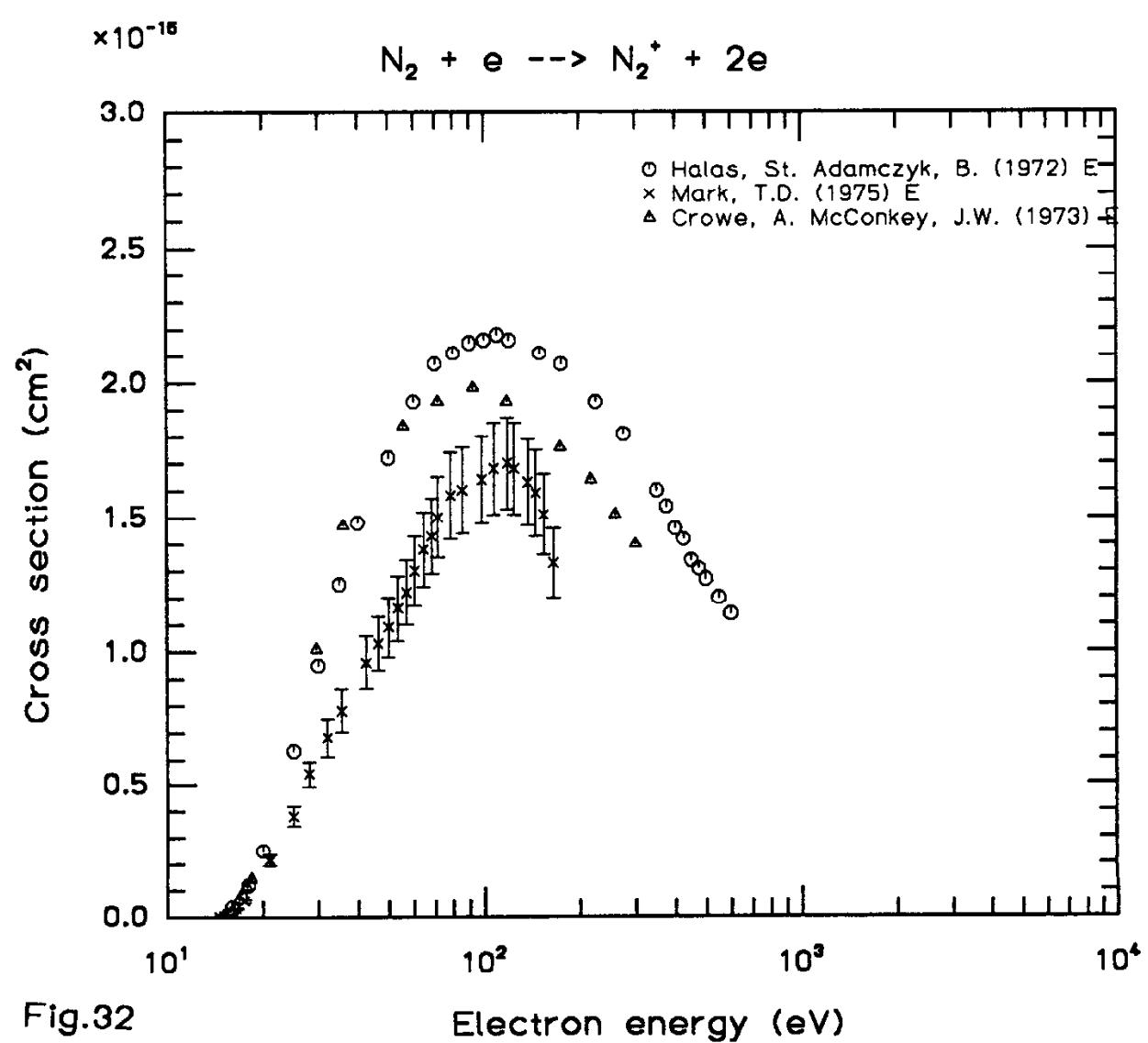


Fig.32

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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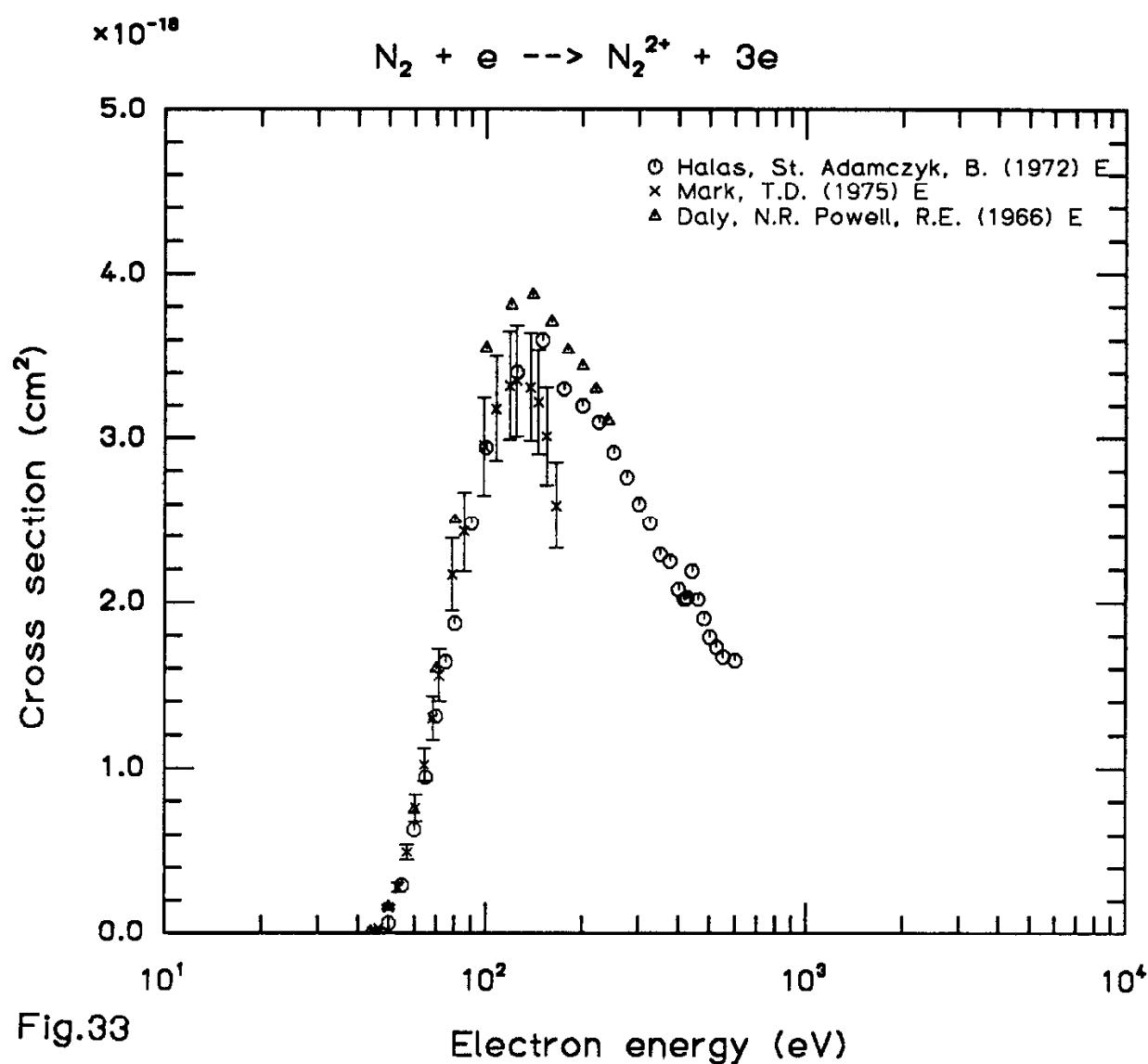


Fig.33

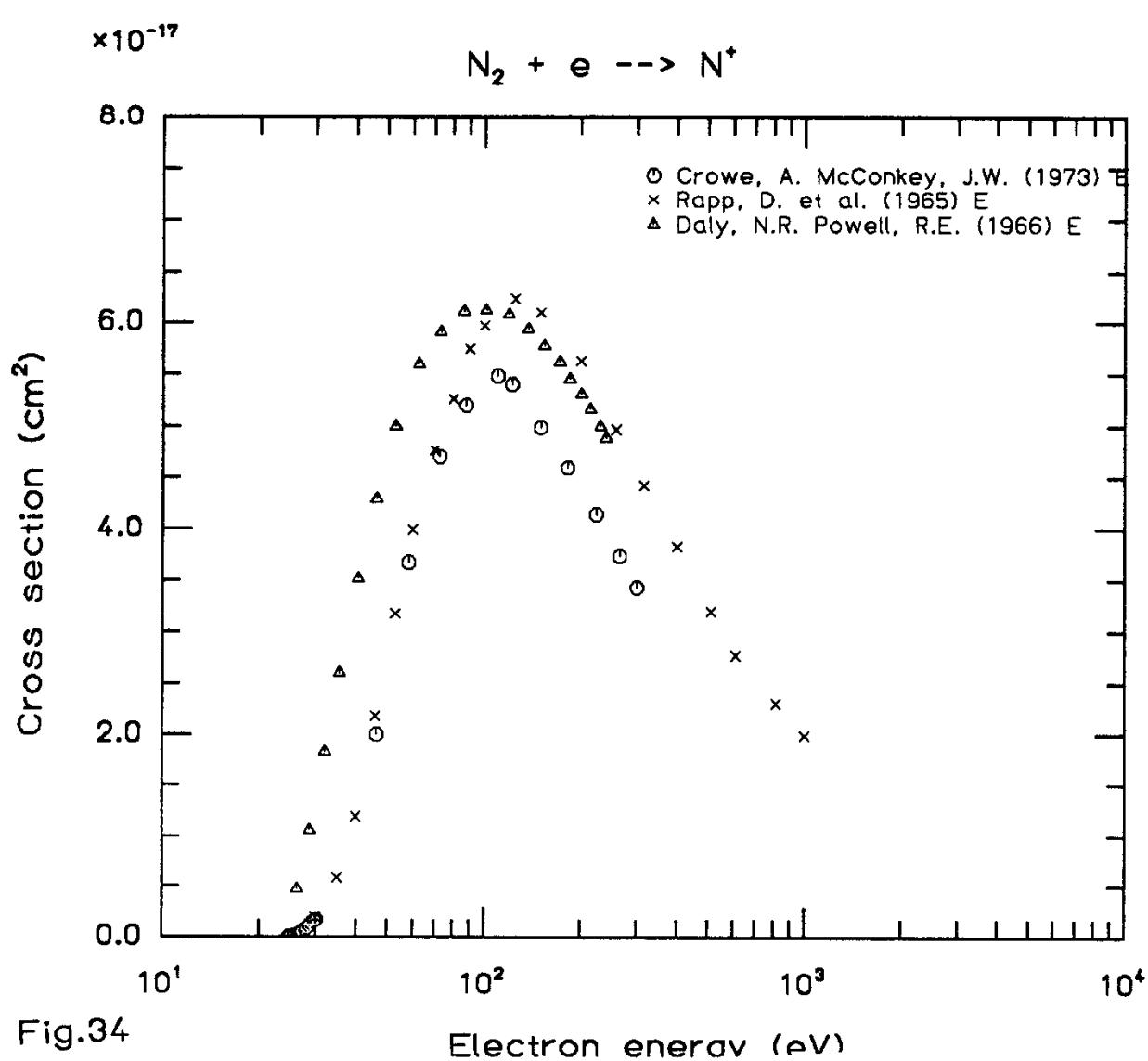
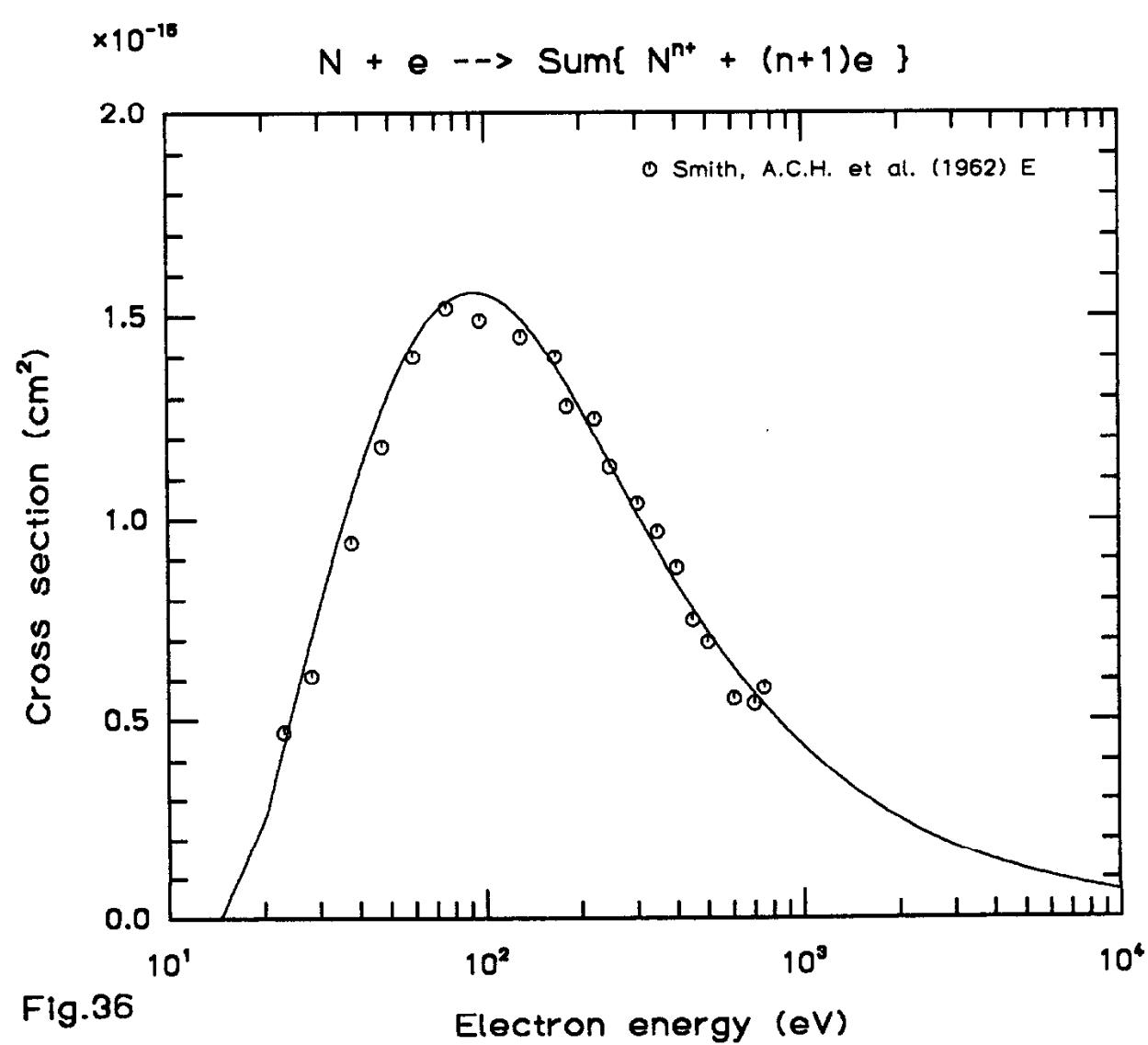
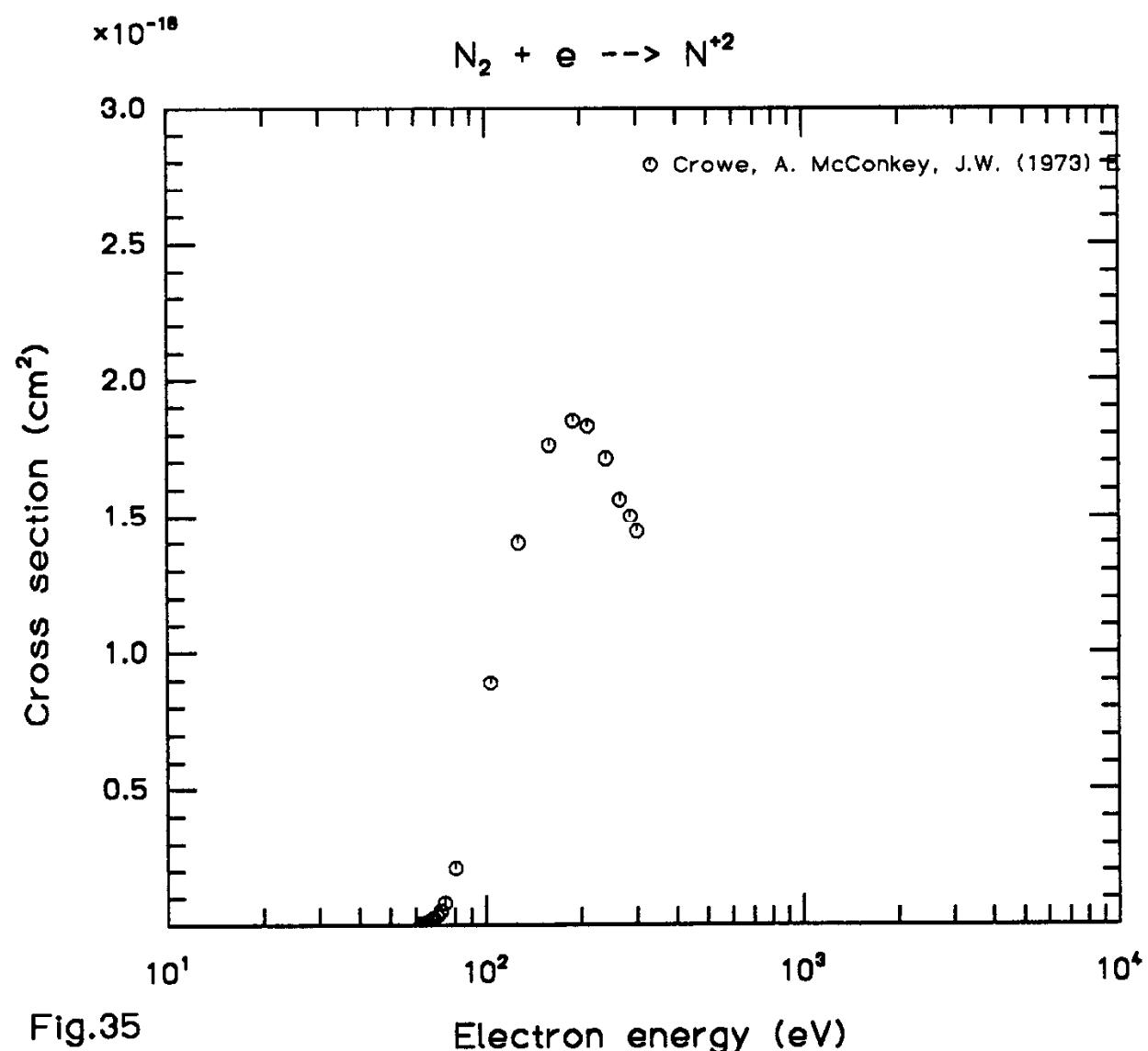


Fig.34

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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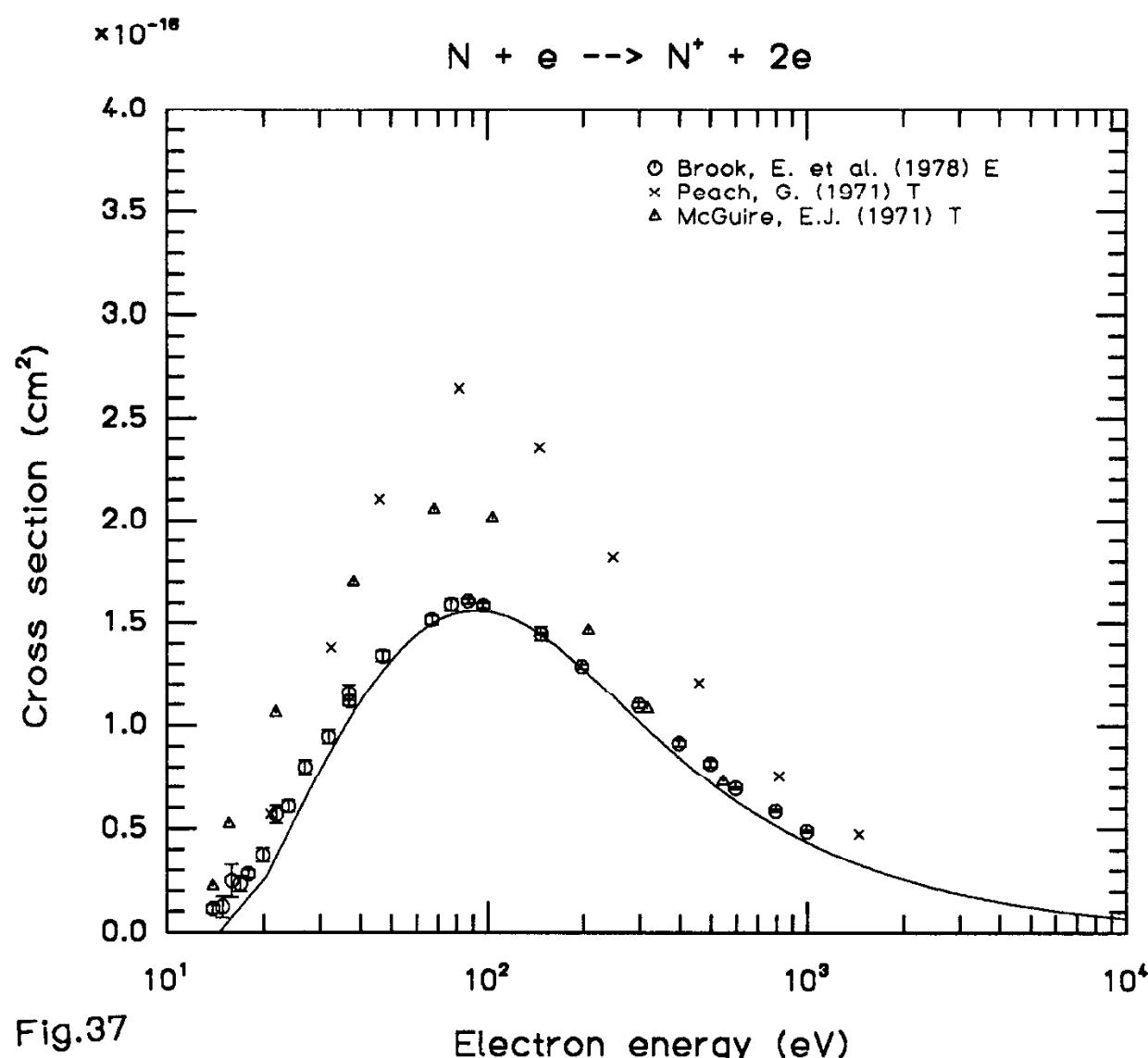


Fig.37

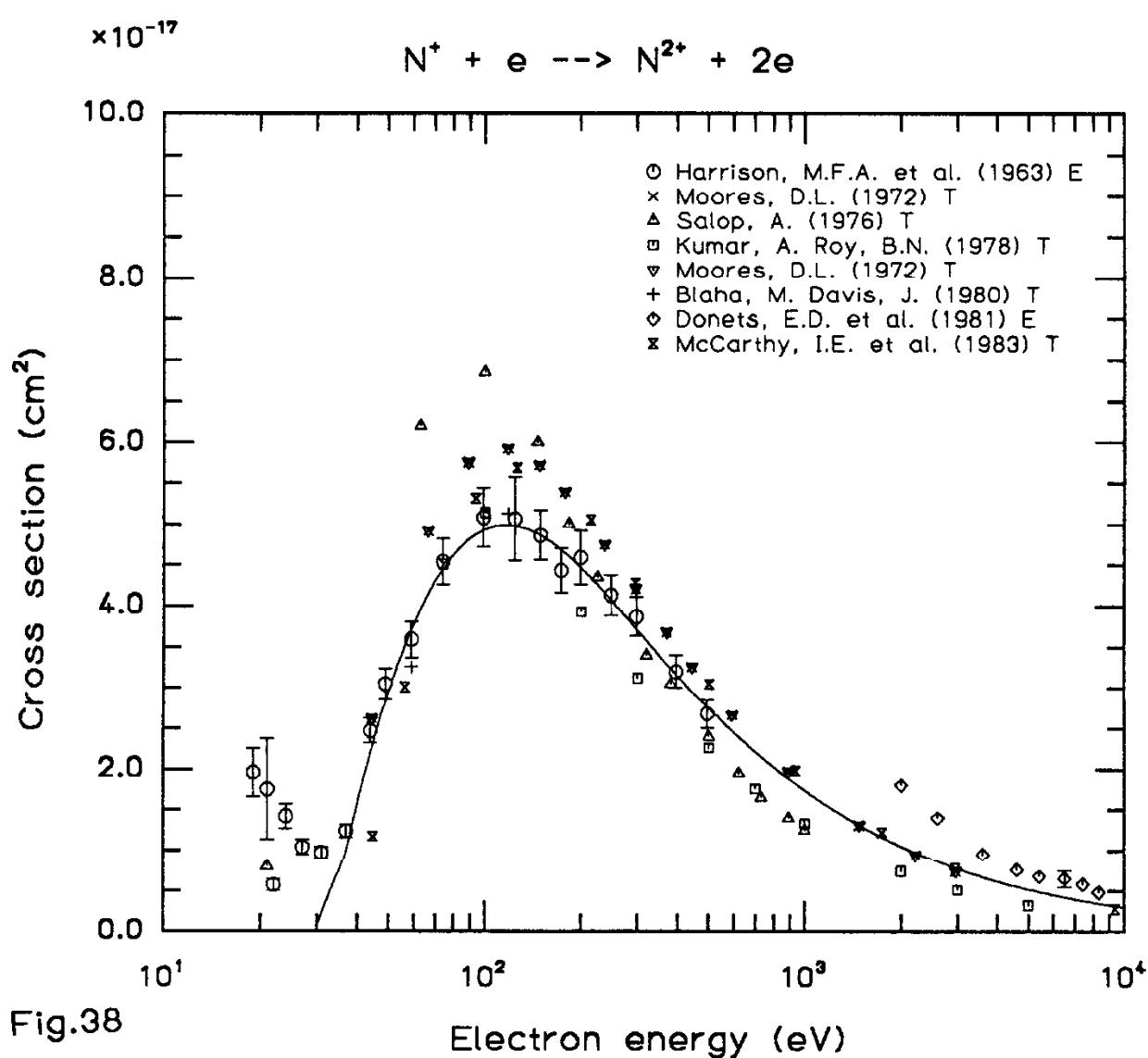


Fig.38

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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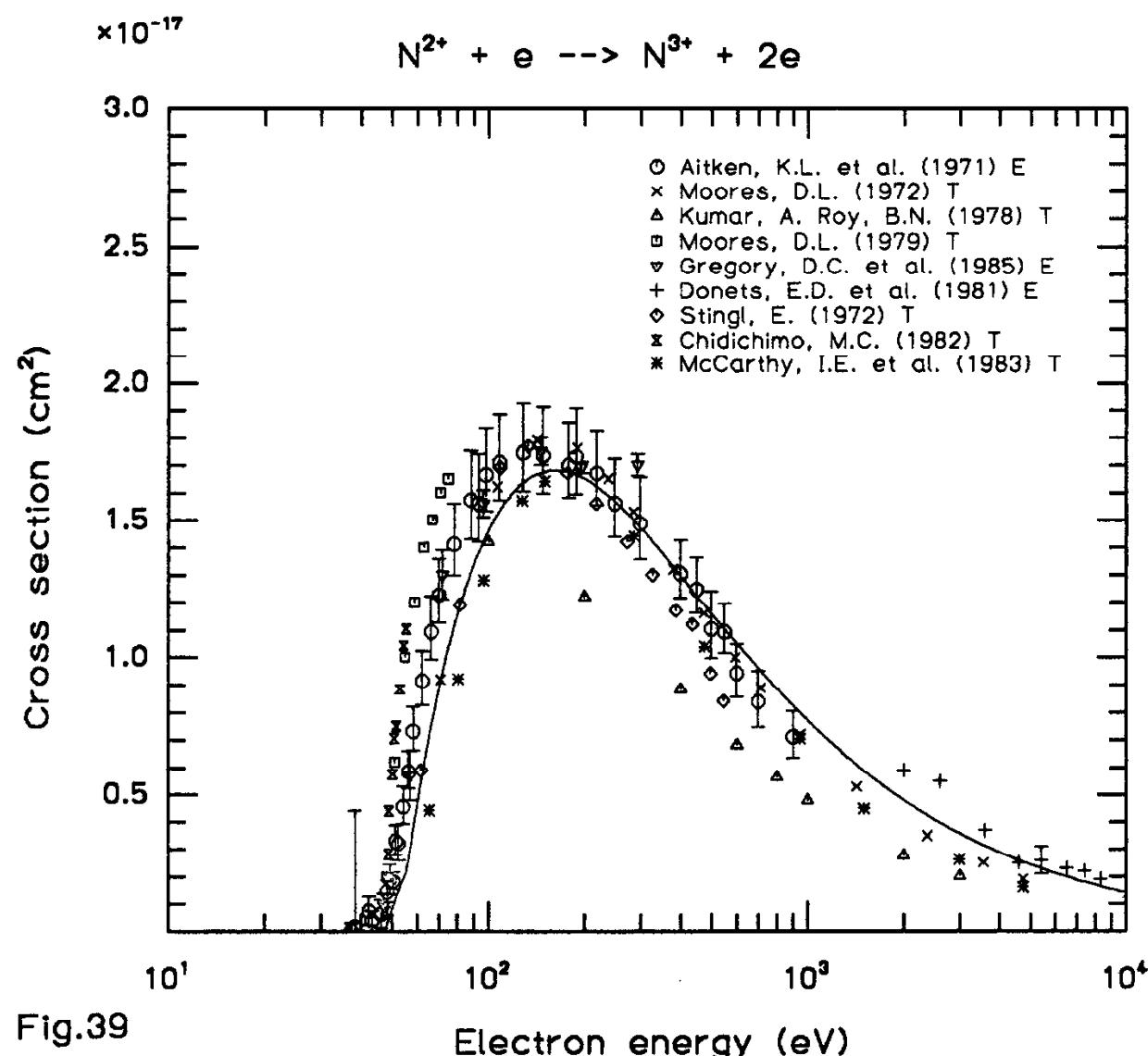


Fig.39

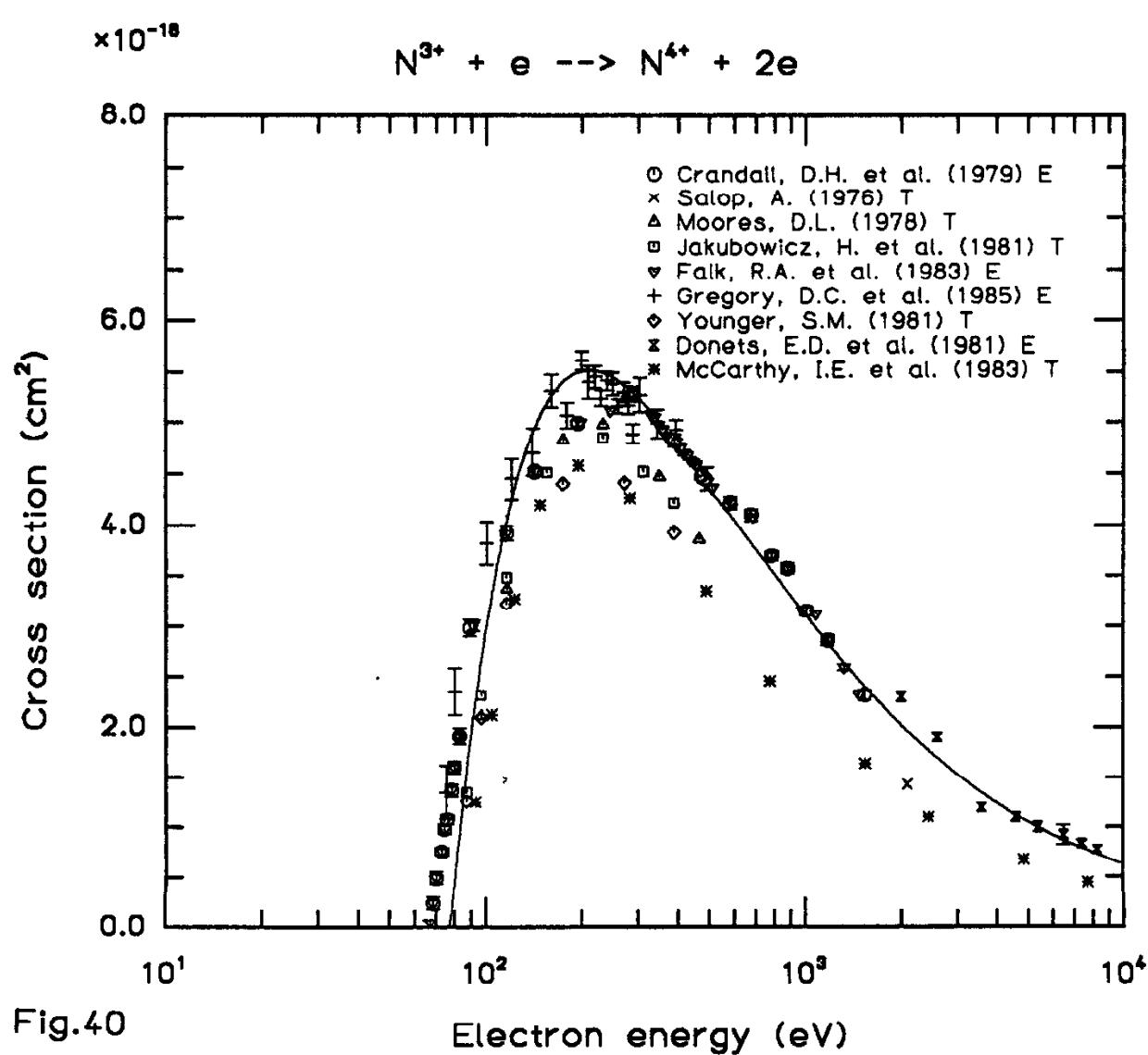


Fig.40

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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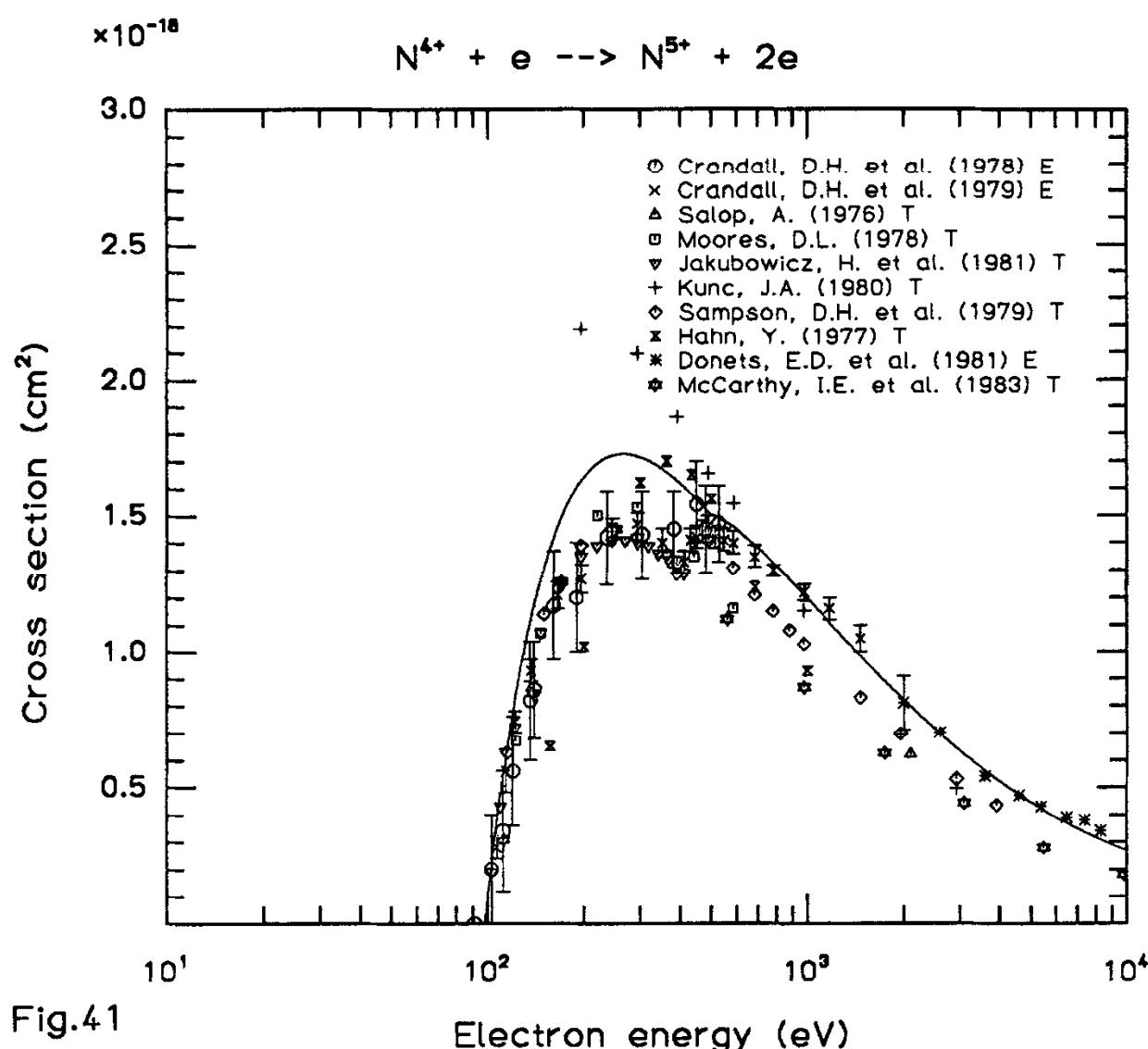


Fig.41

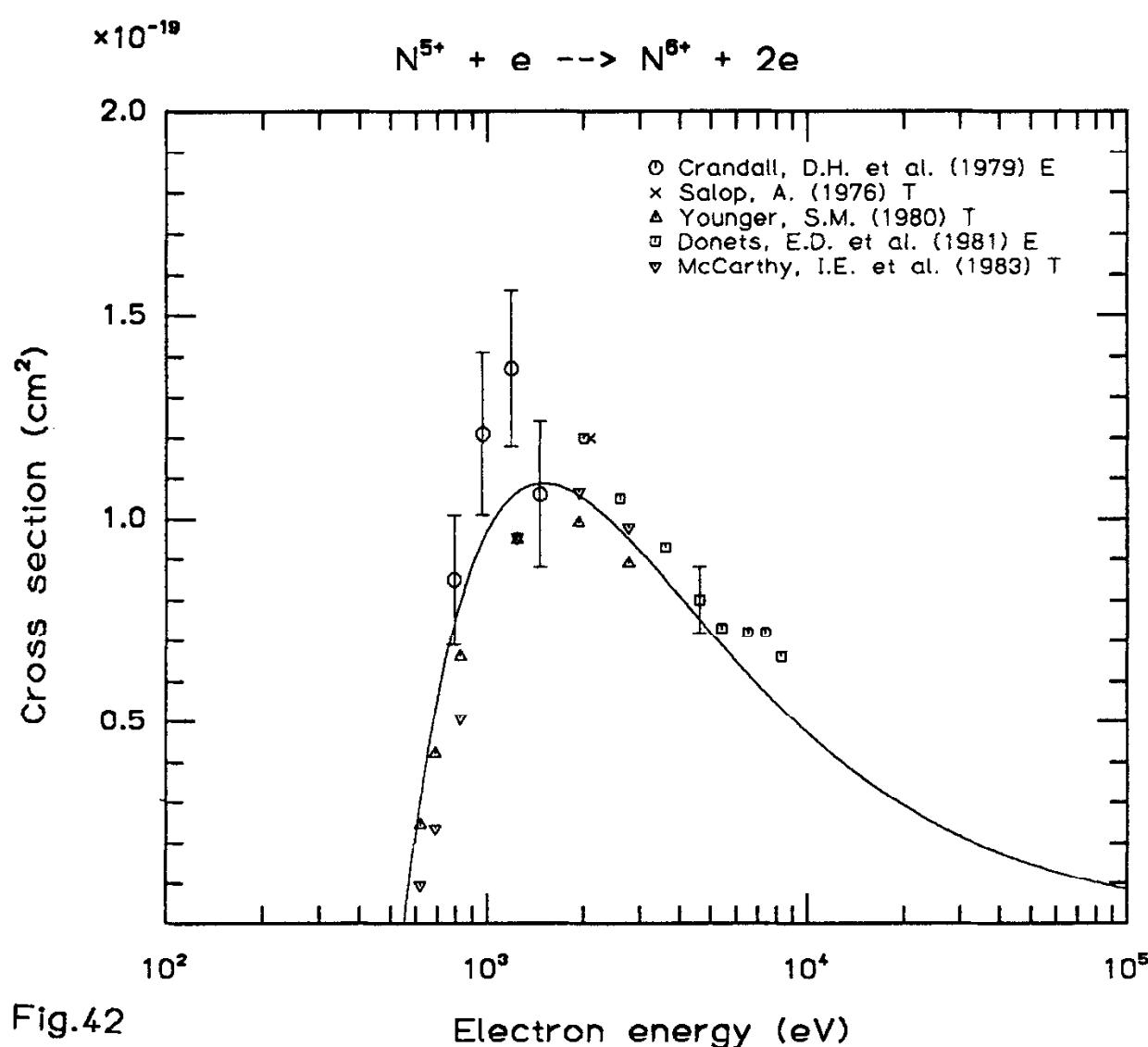


Fig.42

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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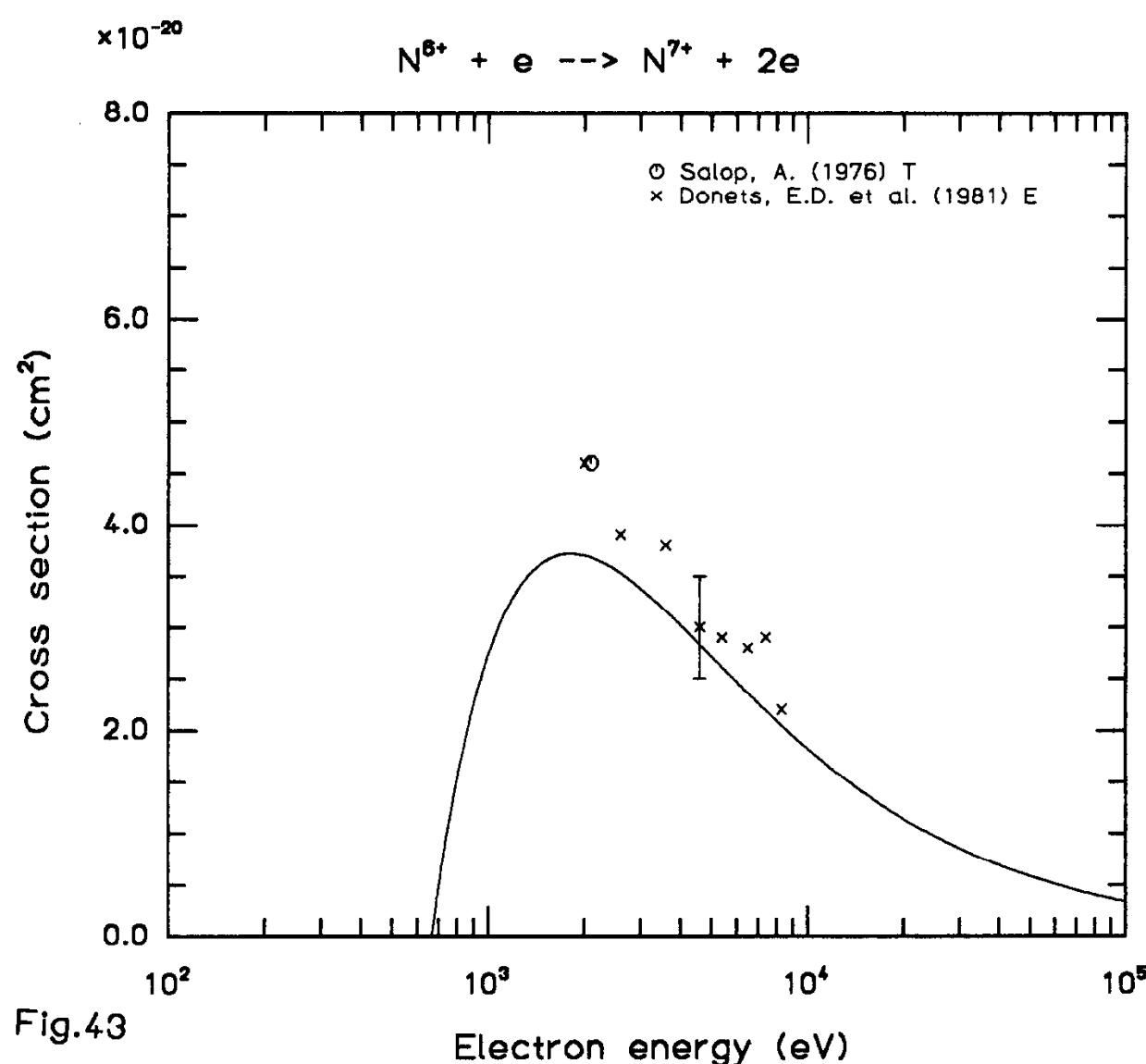


Fig.43

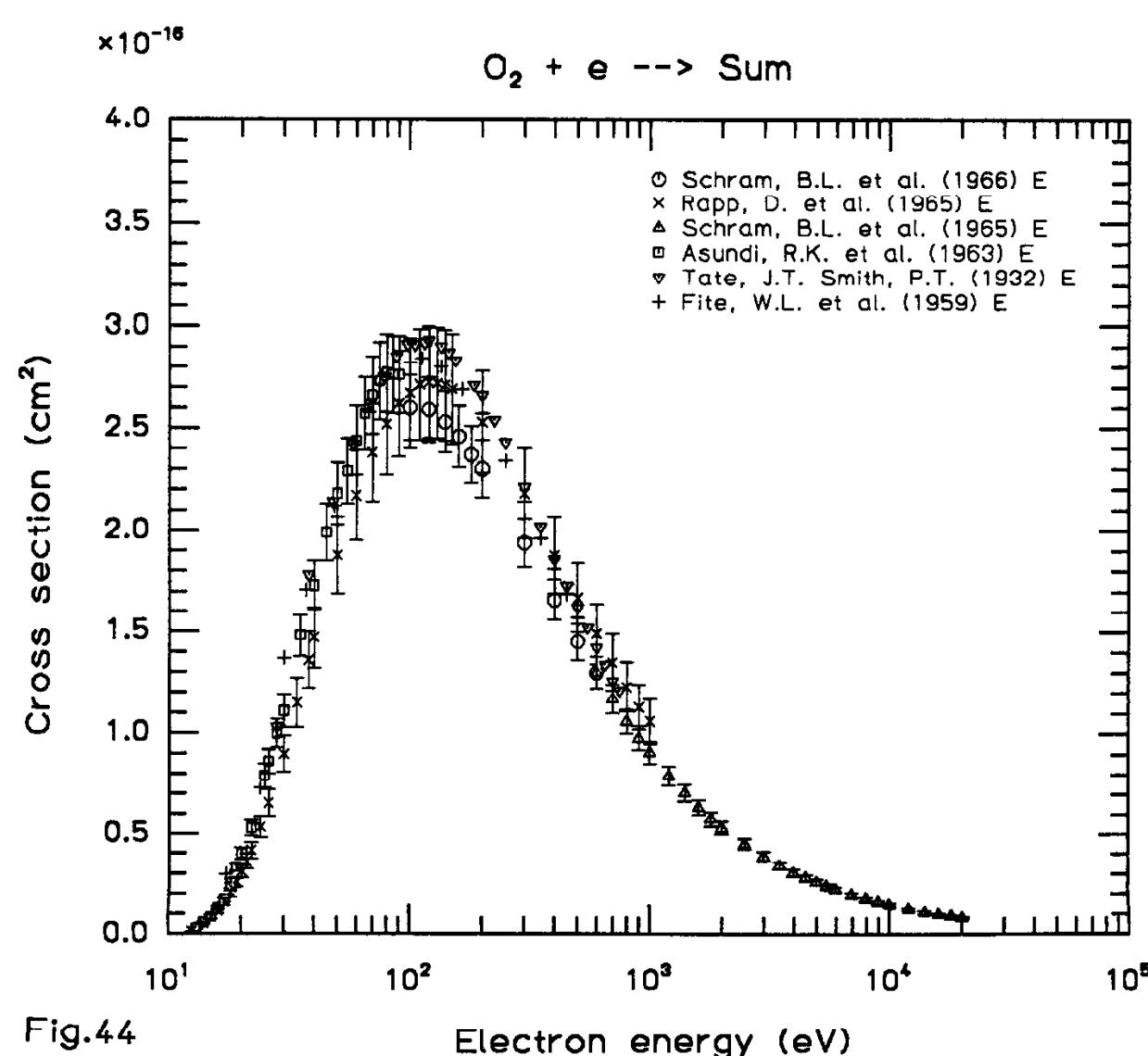


Fig.44

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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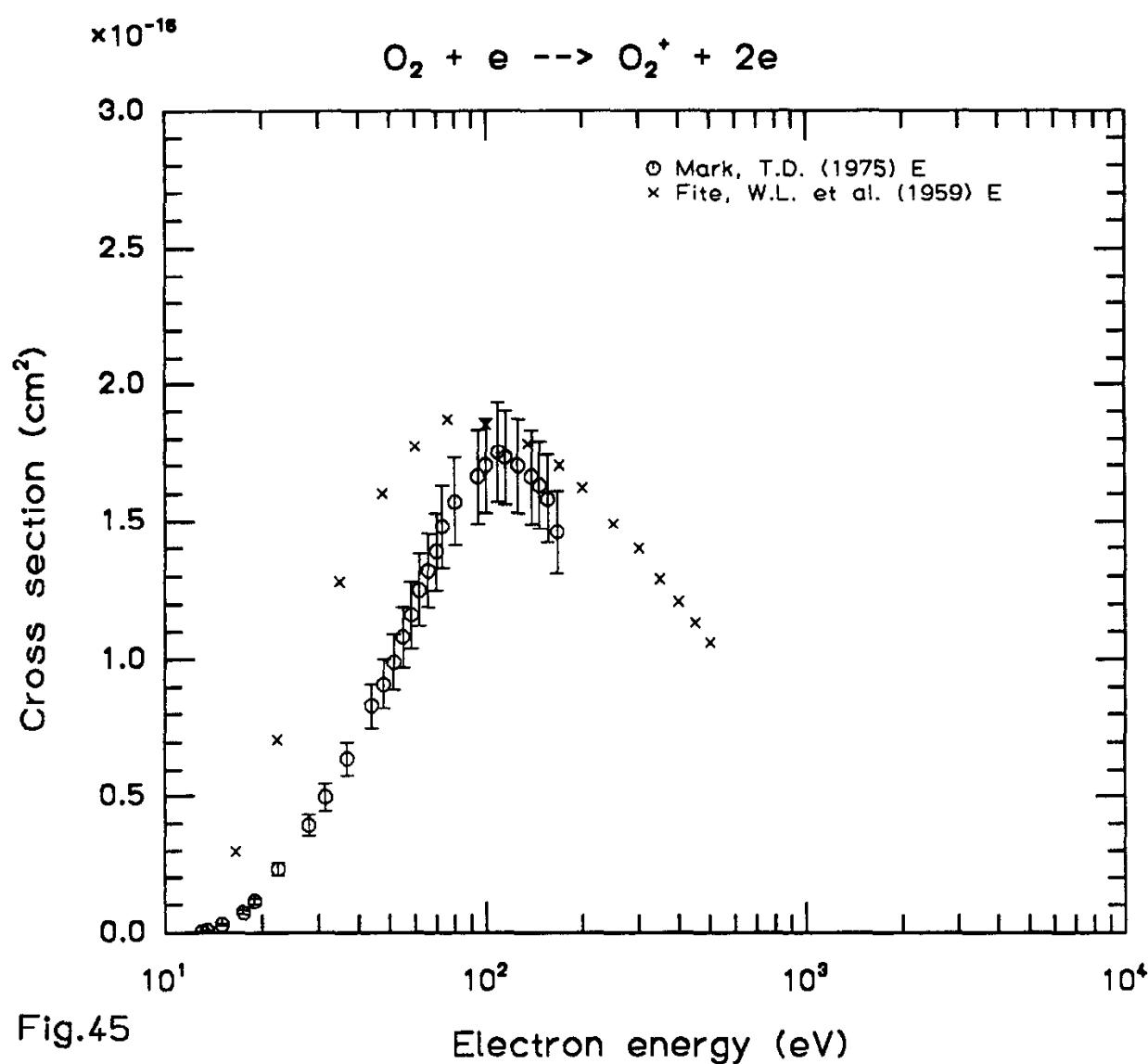


Fig.45

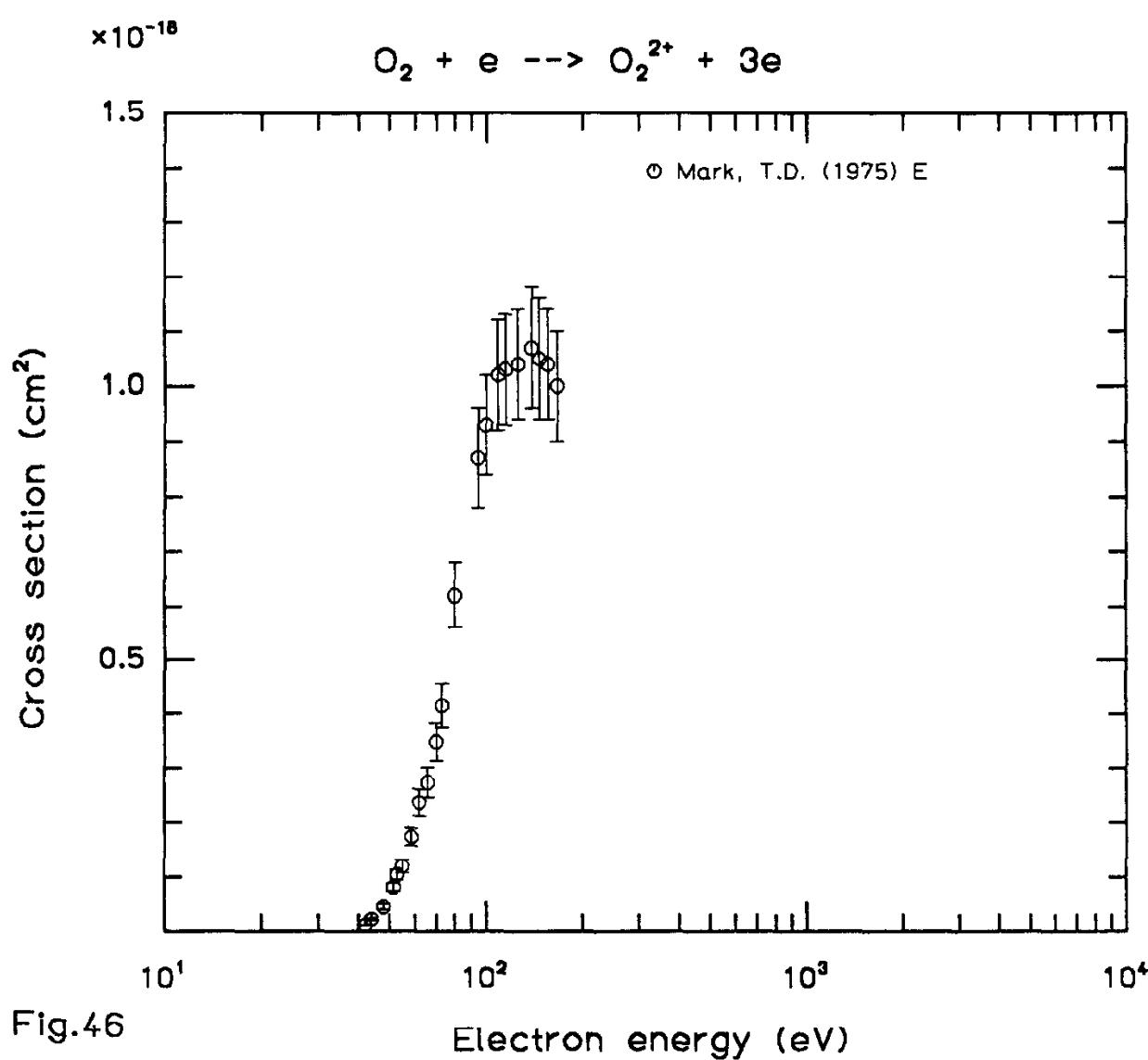


Fig.46

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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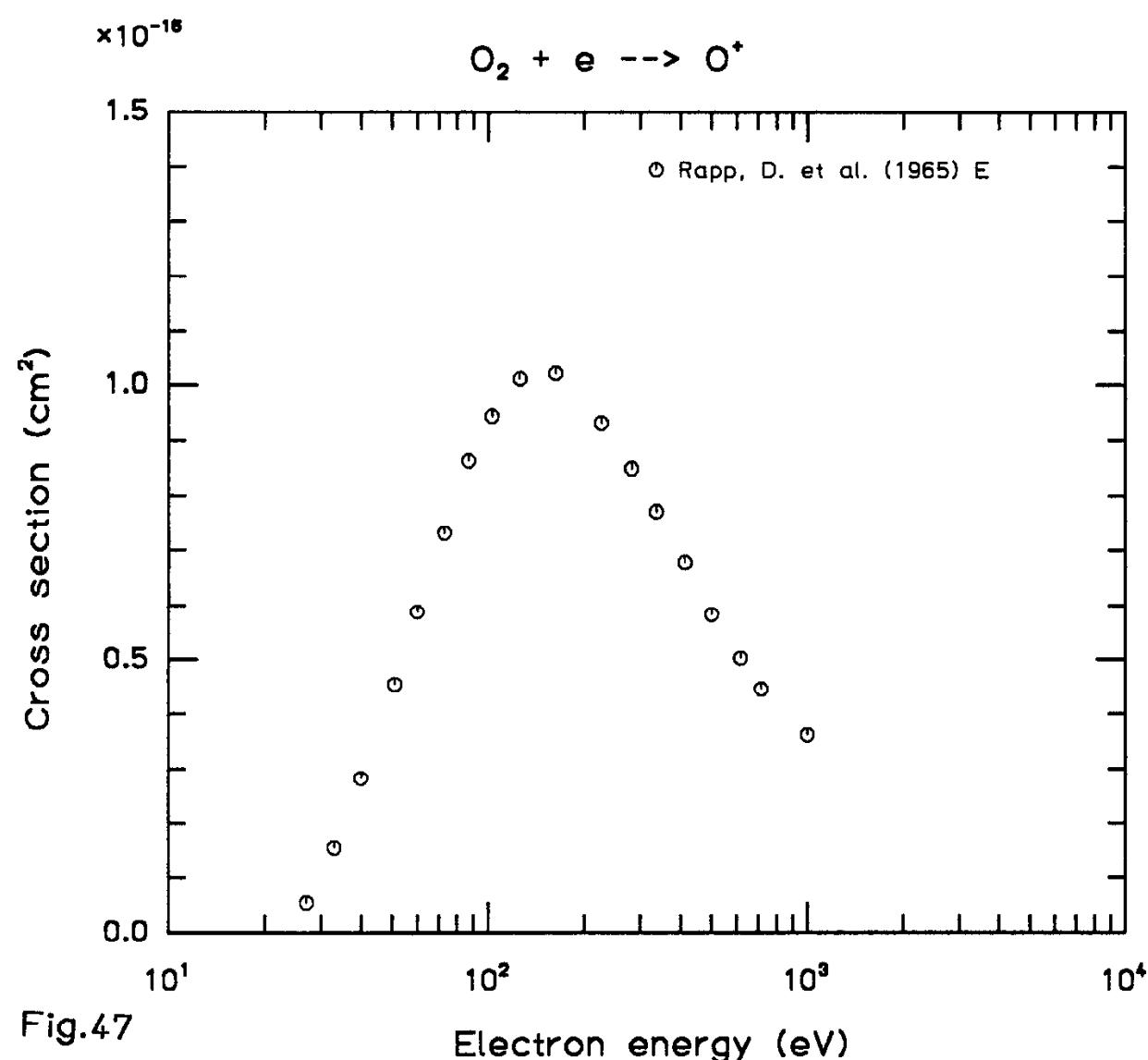


Fig.47

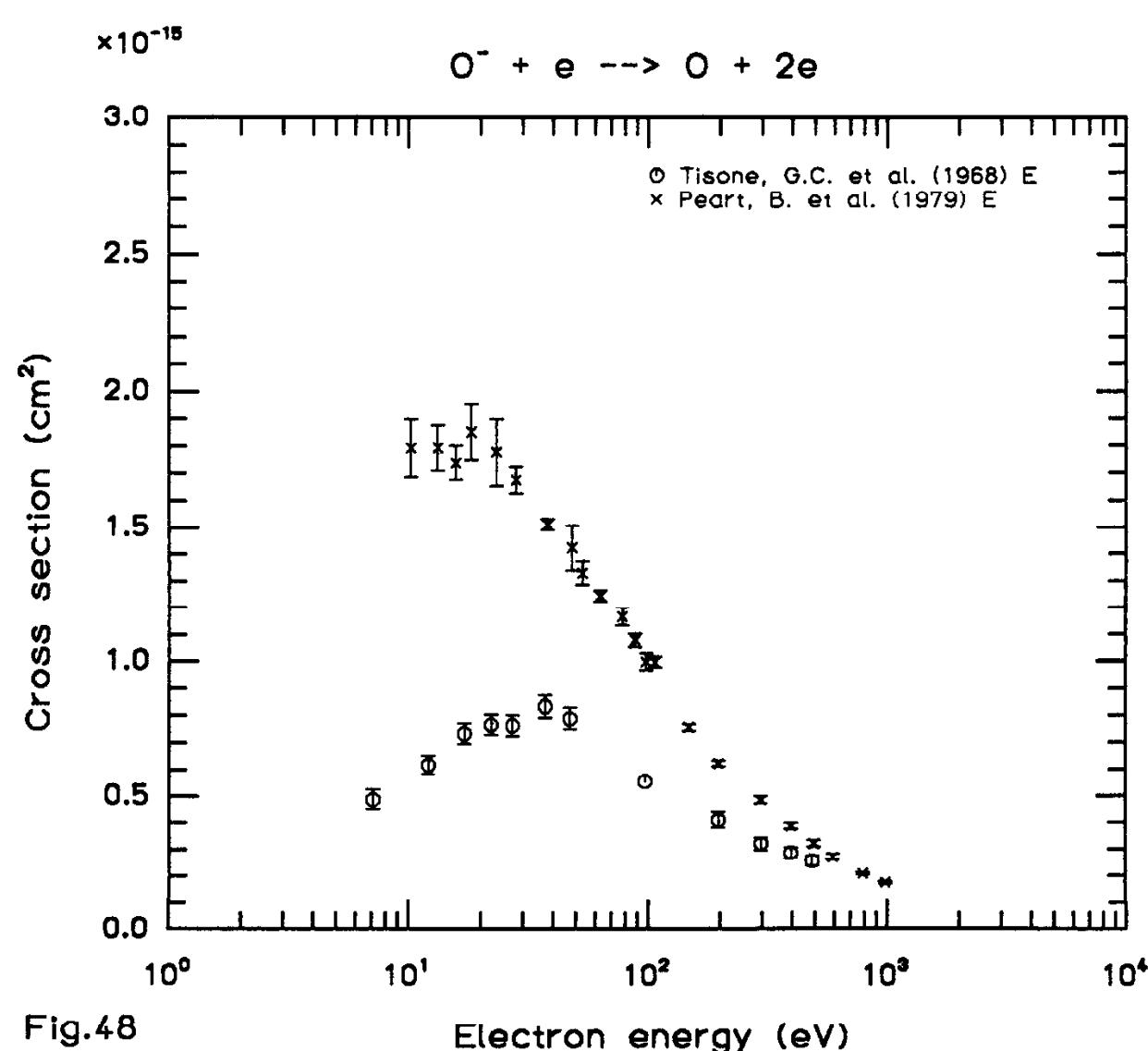


Fig.48

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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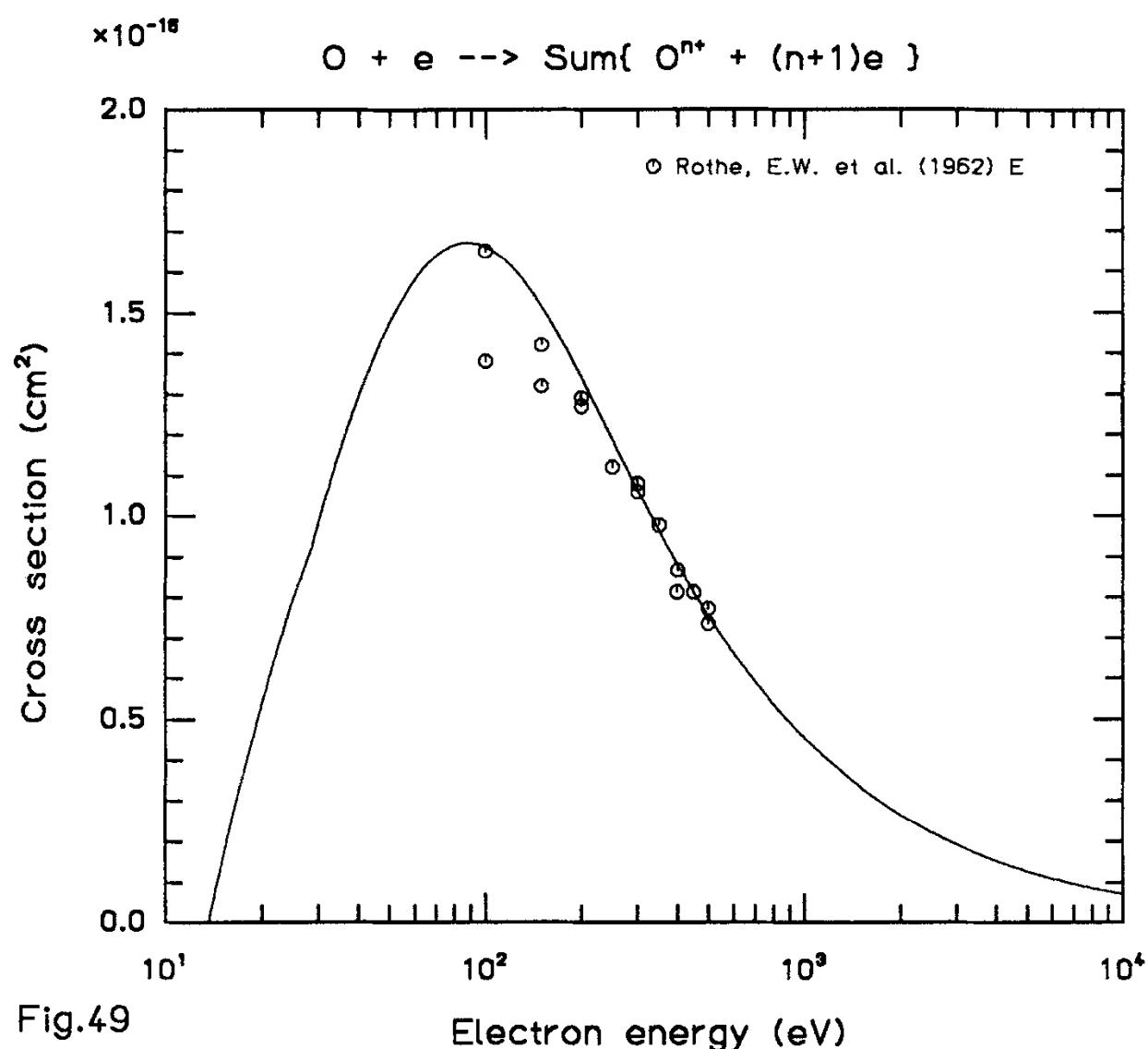


Fig.49

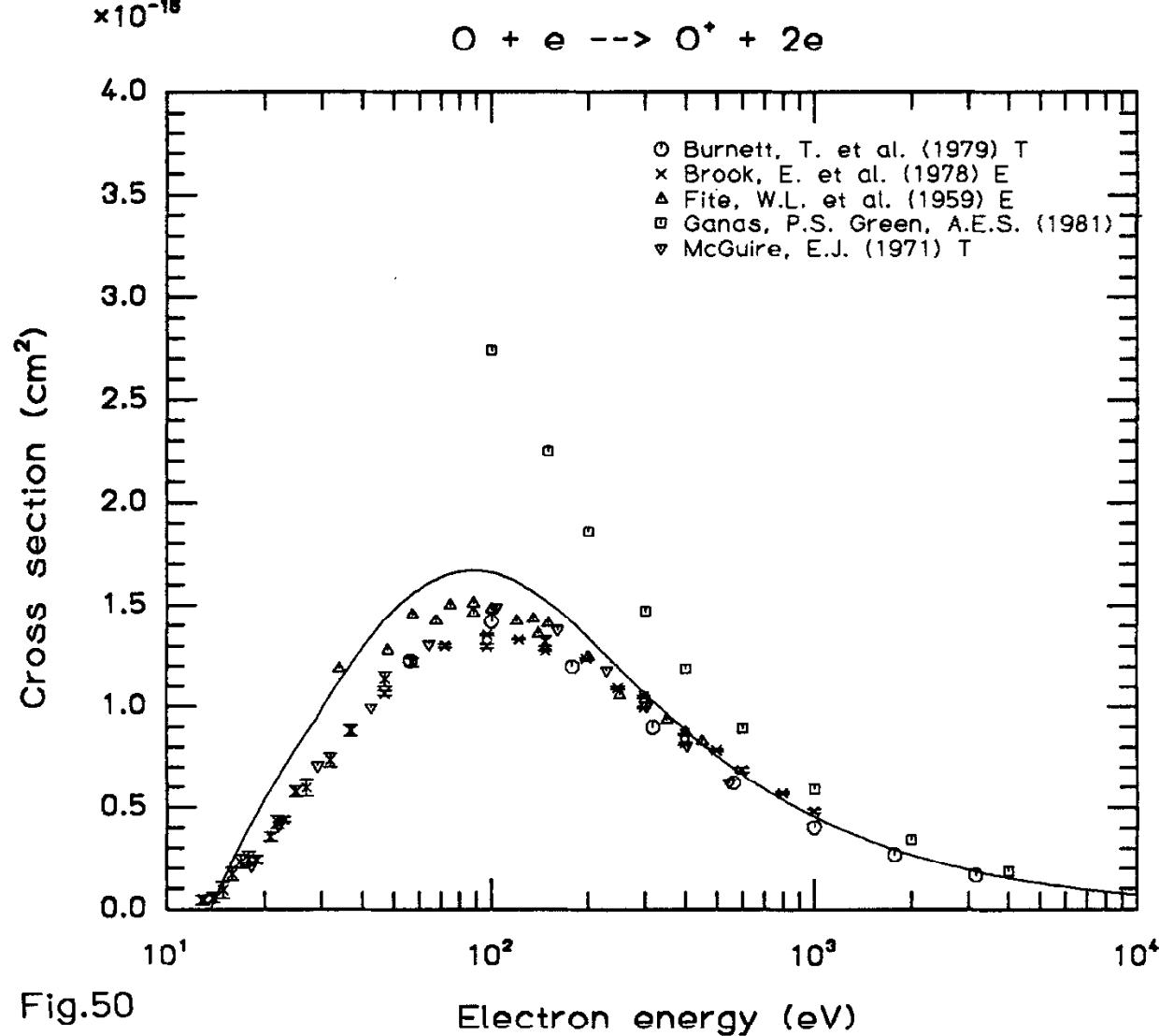


Fig.50

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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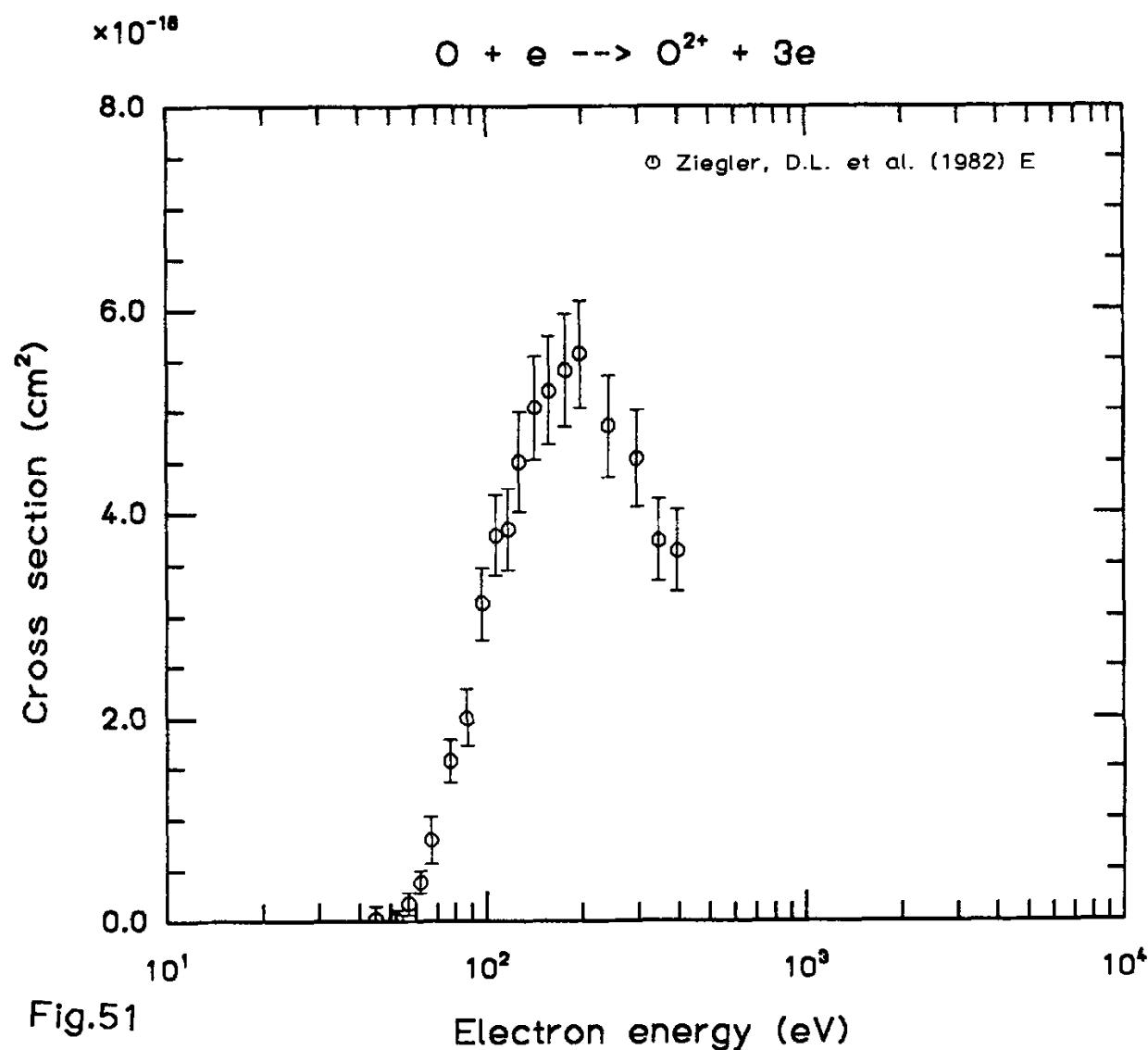


Fig.51

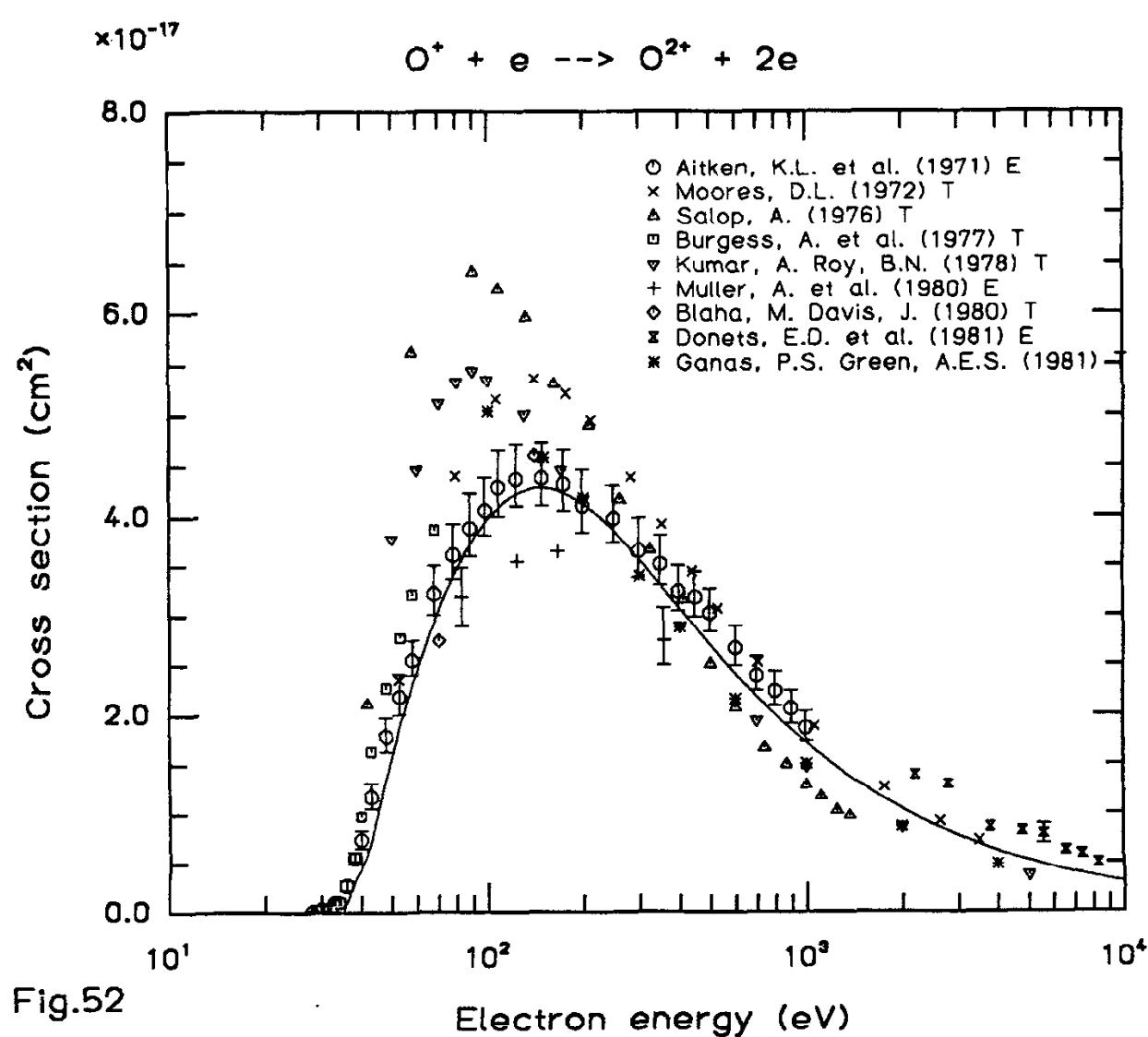


Fig.52

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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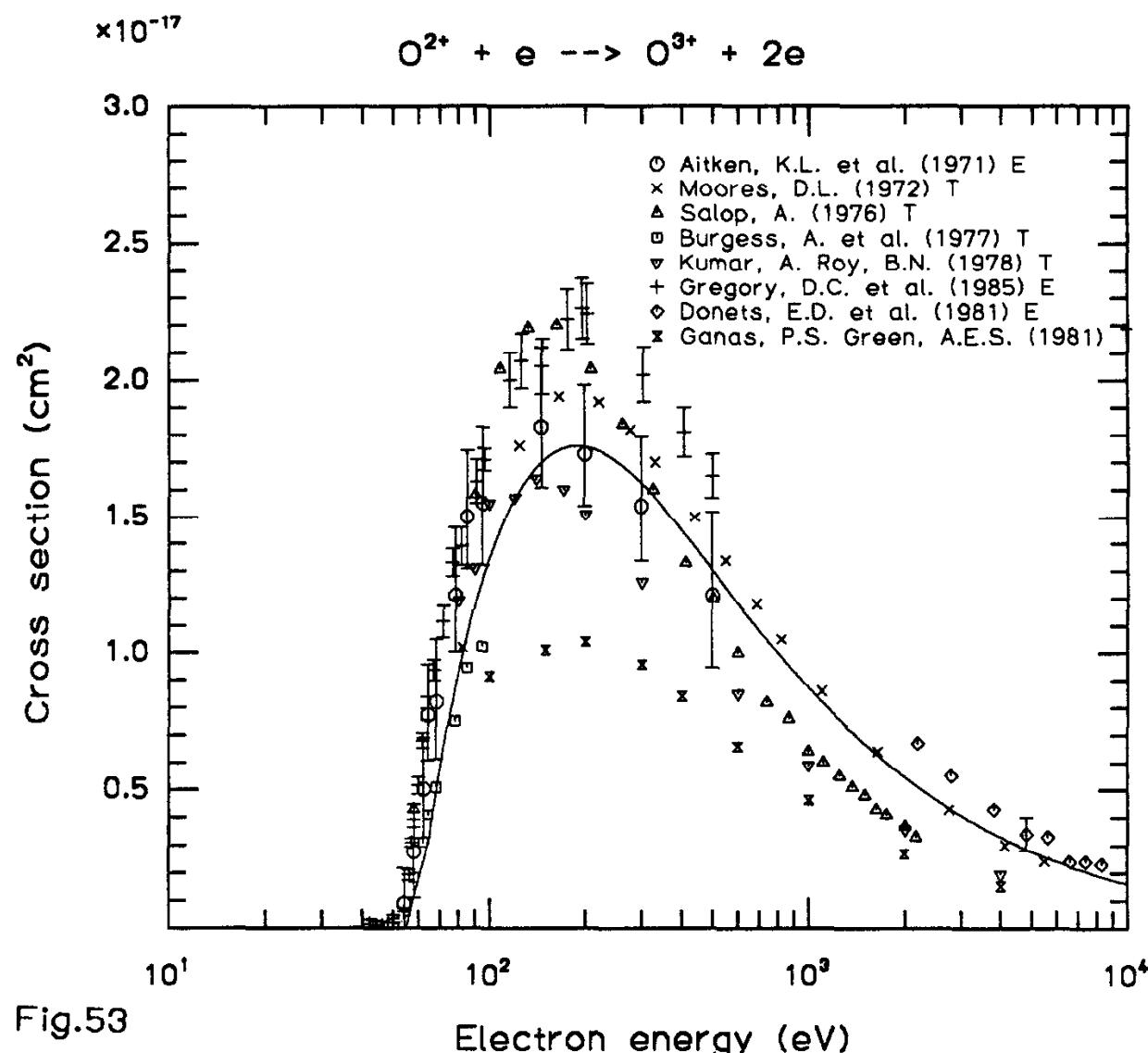


Fig.53

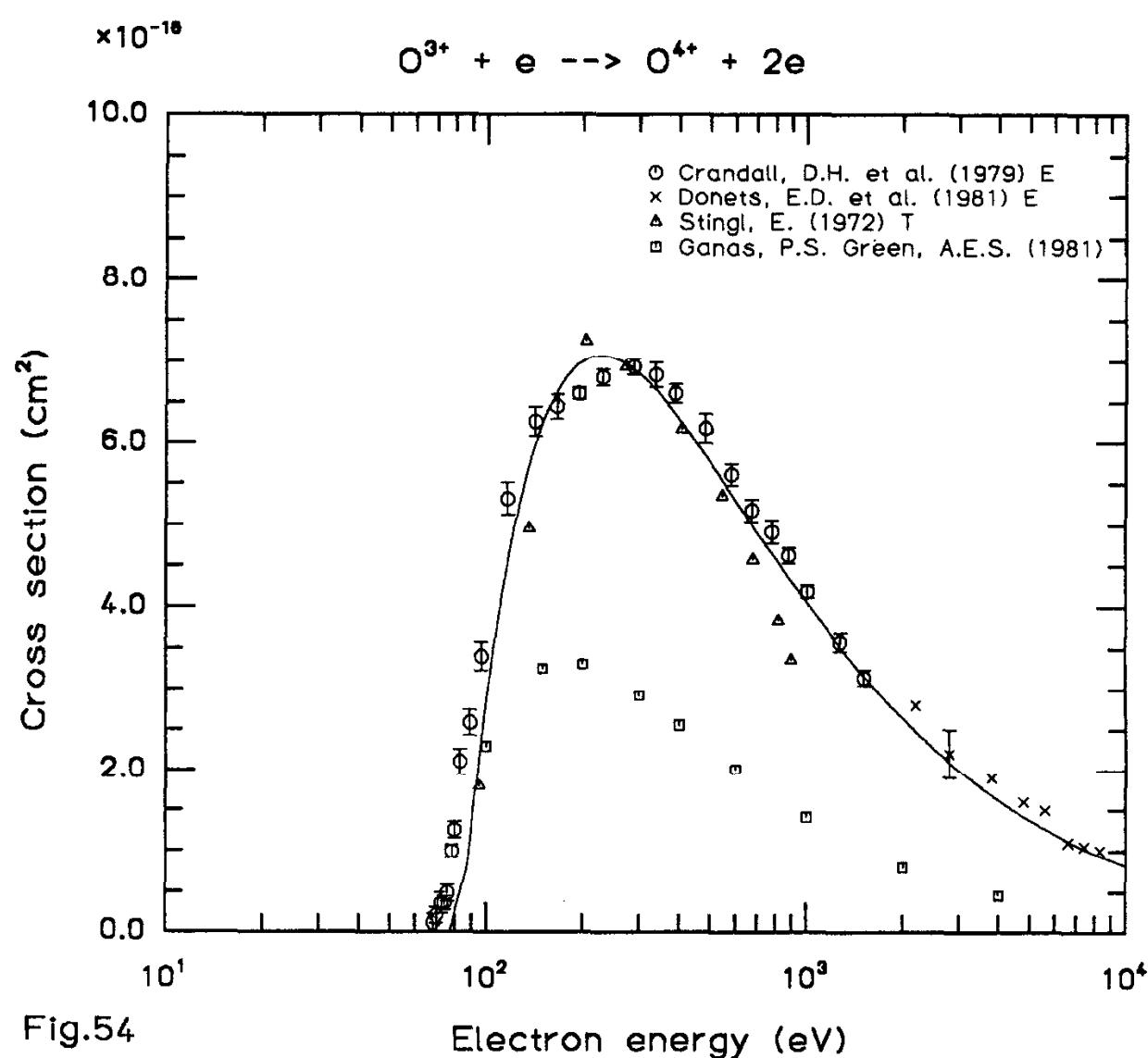
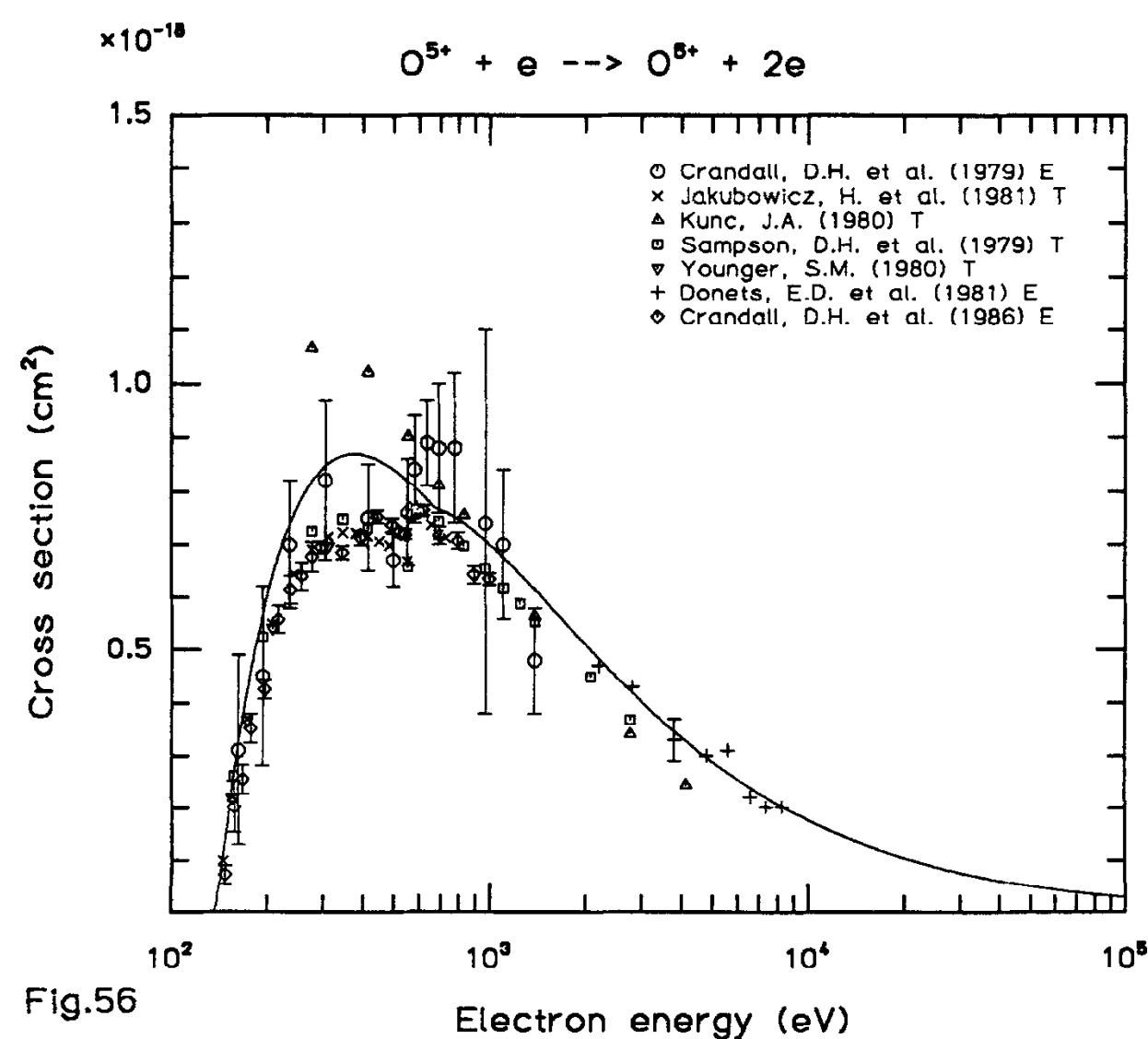
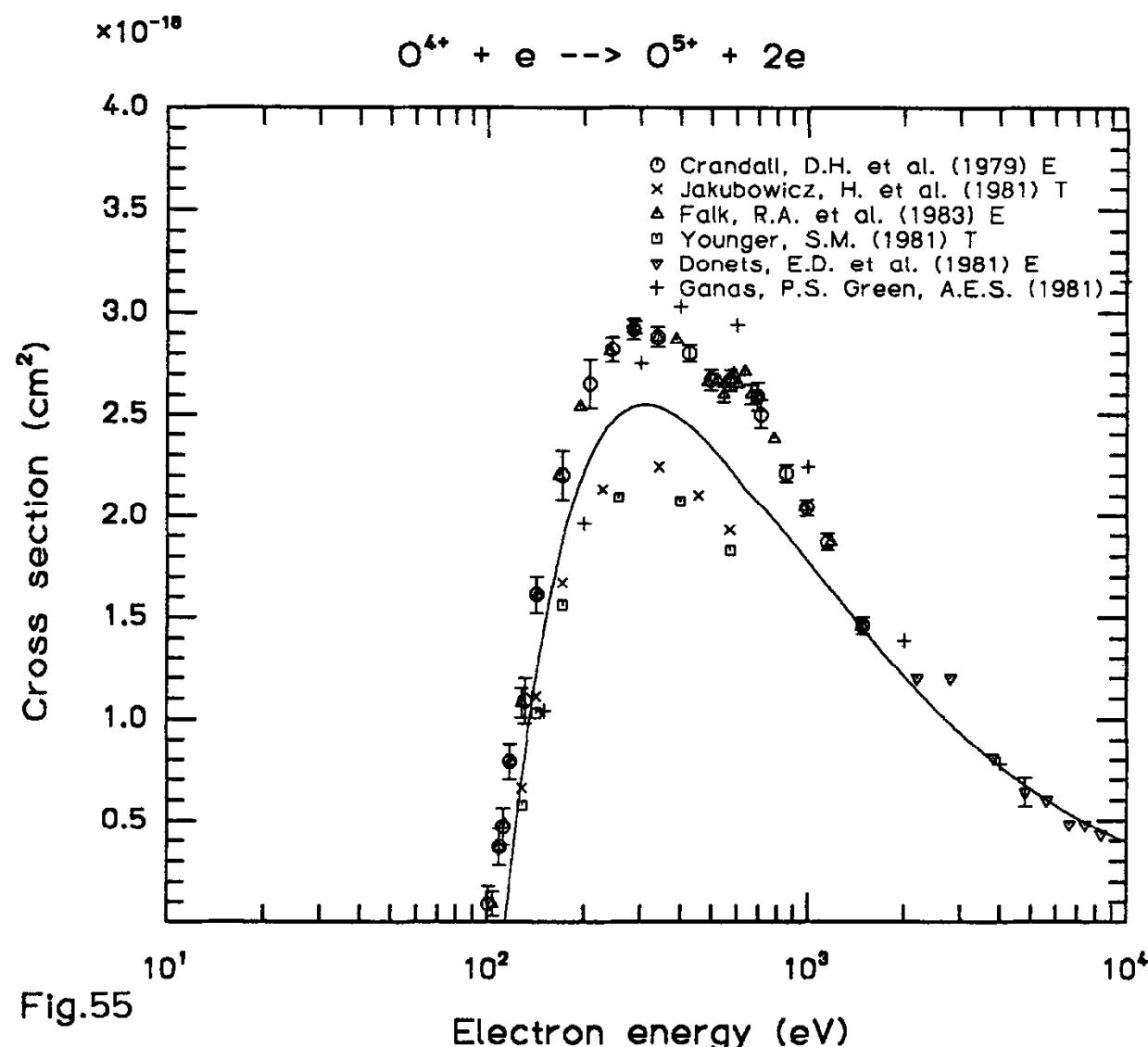
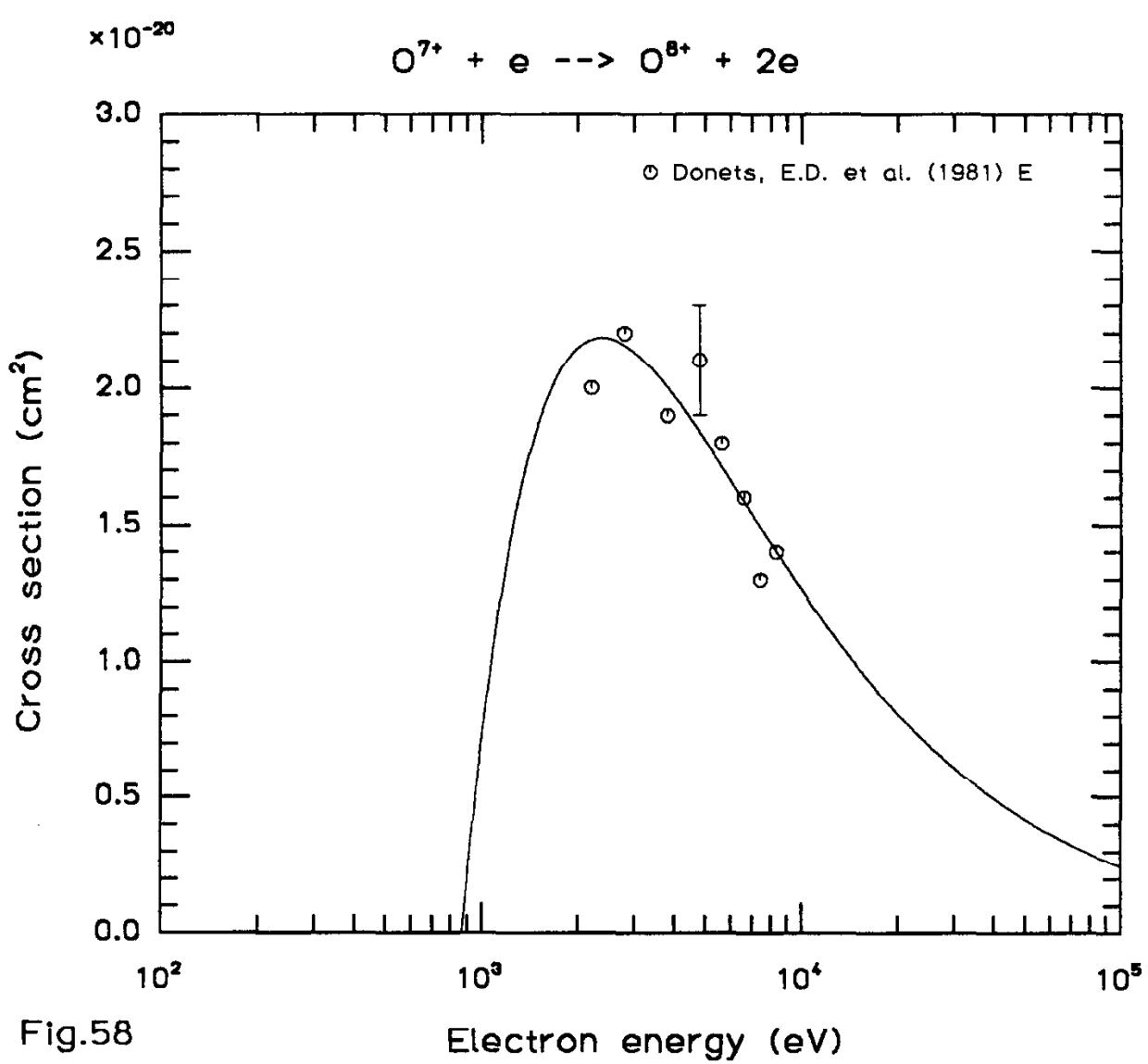
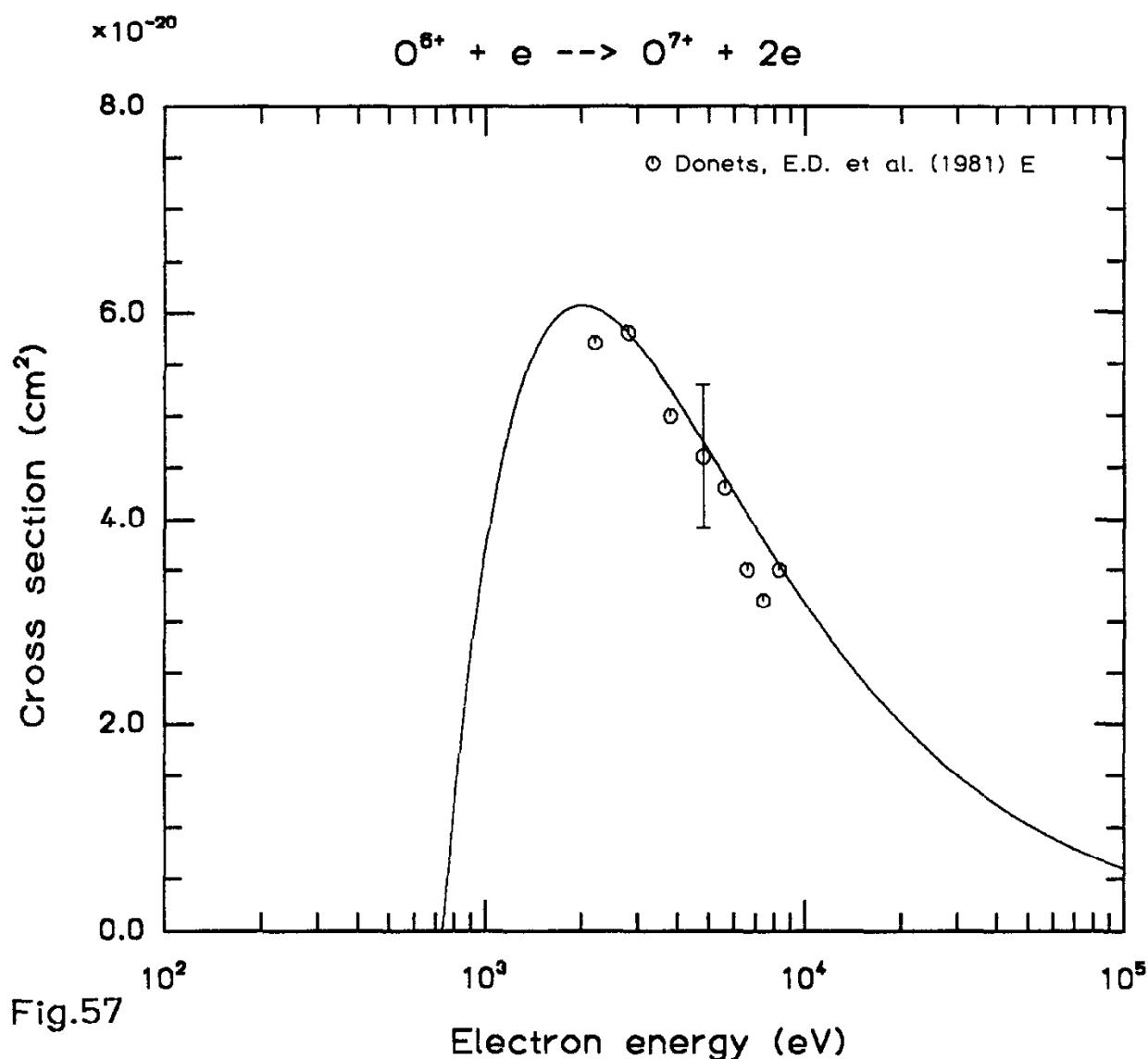


Fig.54

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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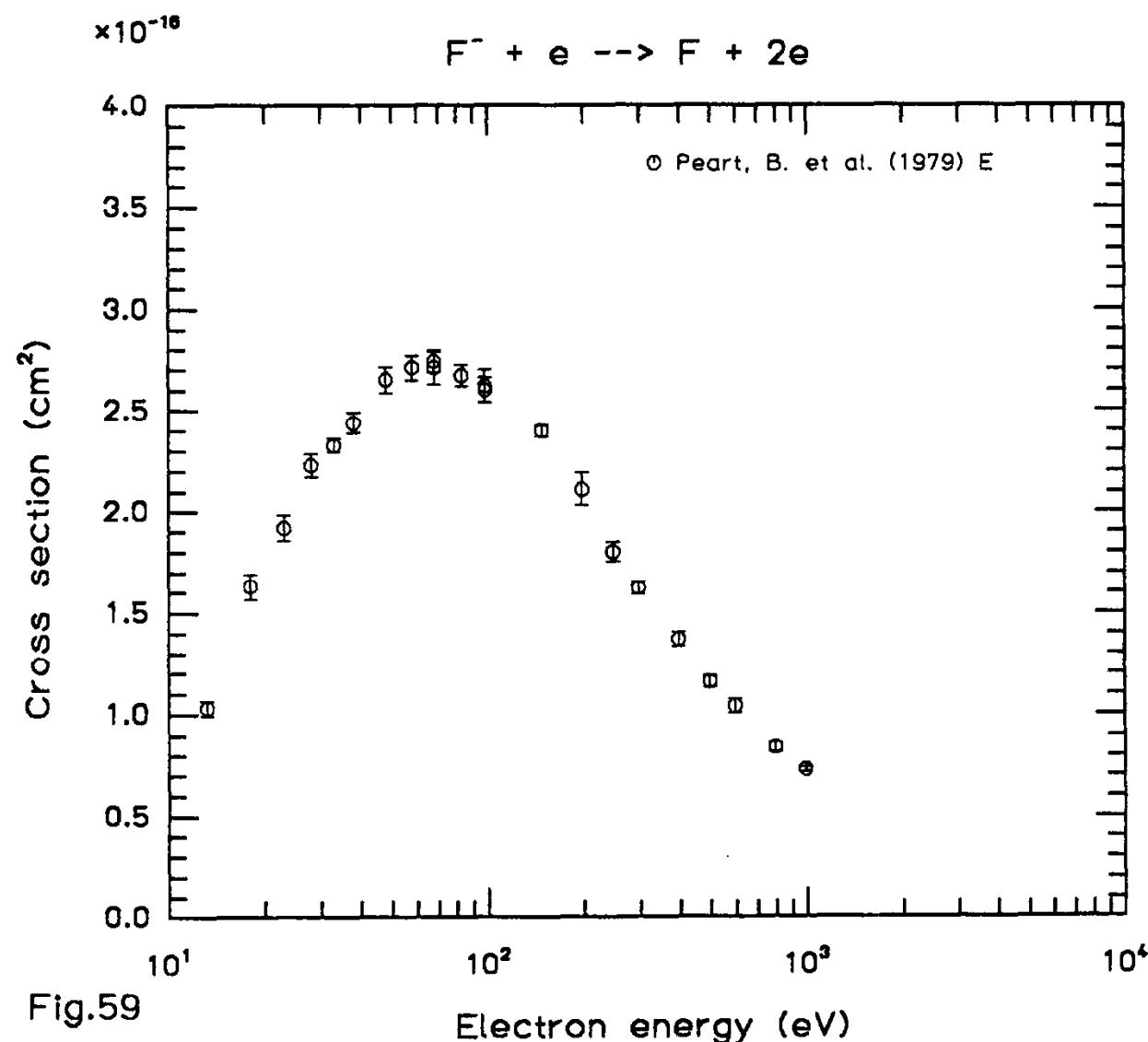


Fig.59

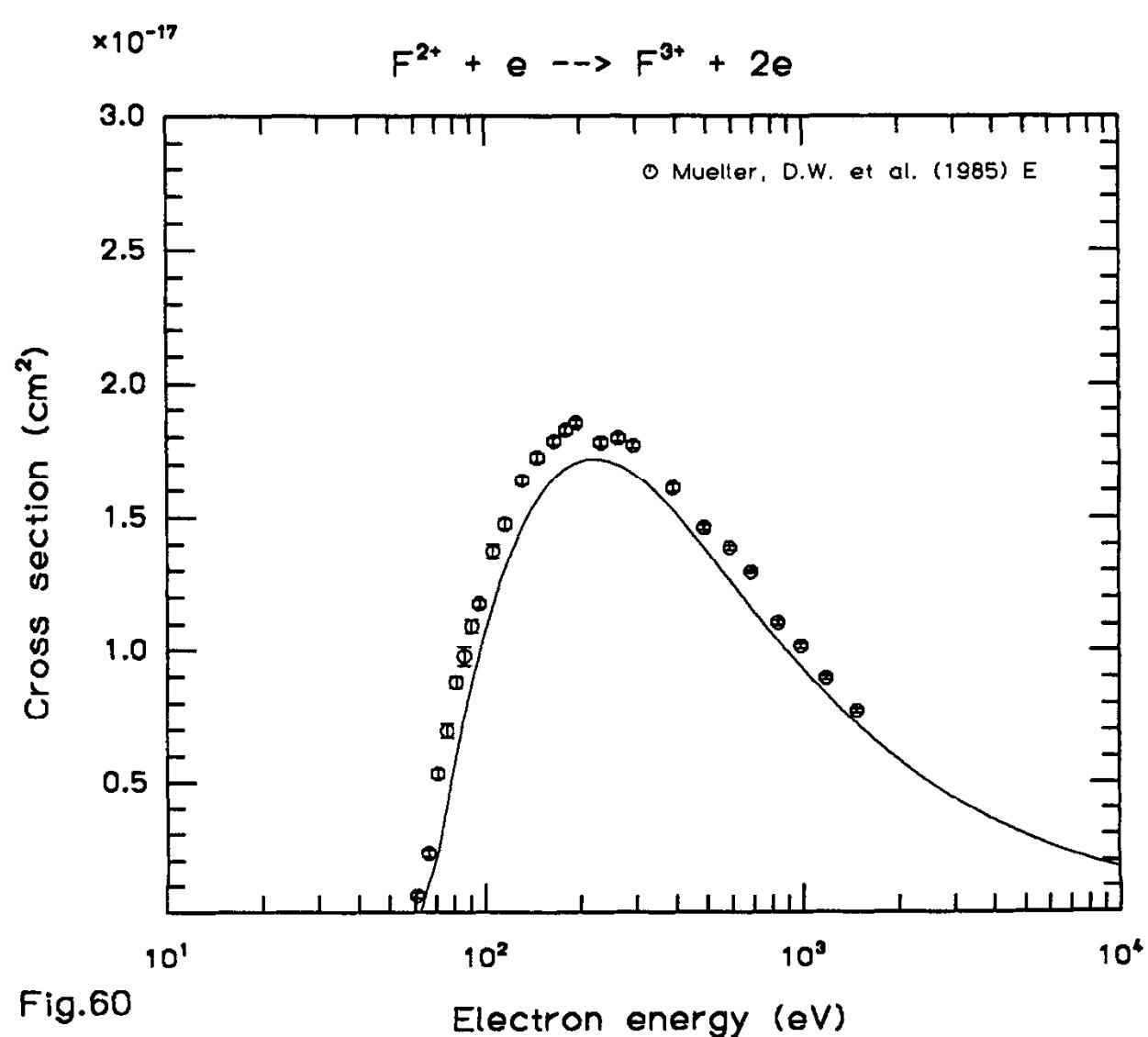


Fig.60

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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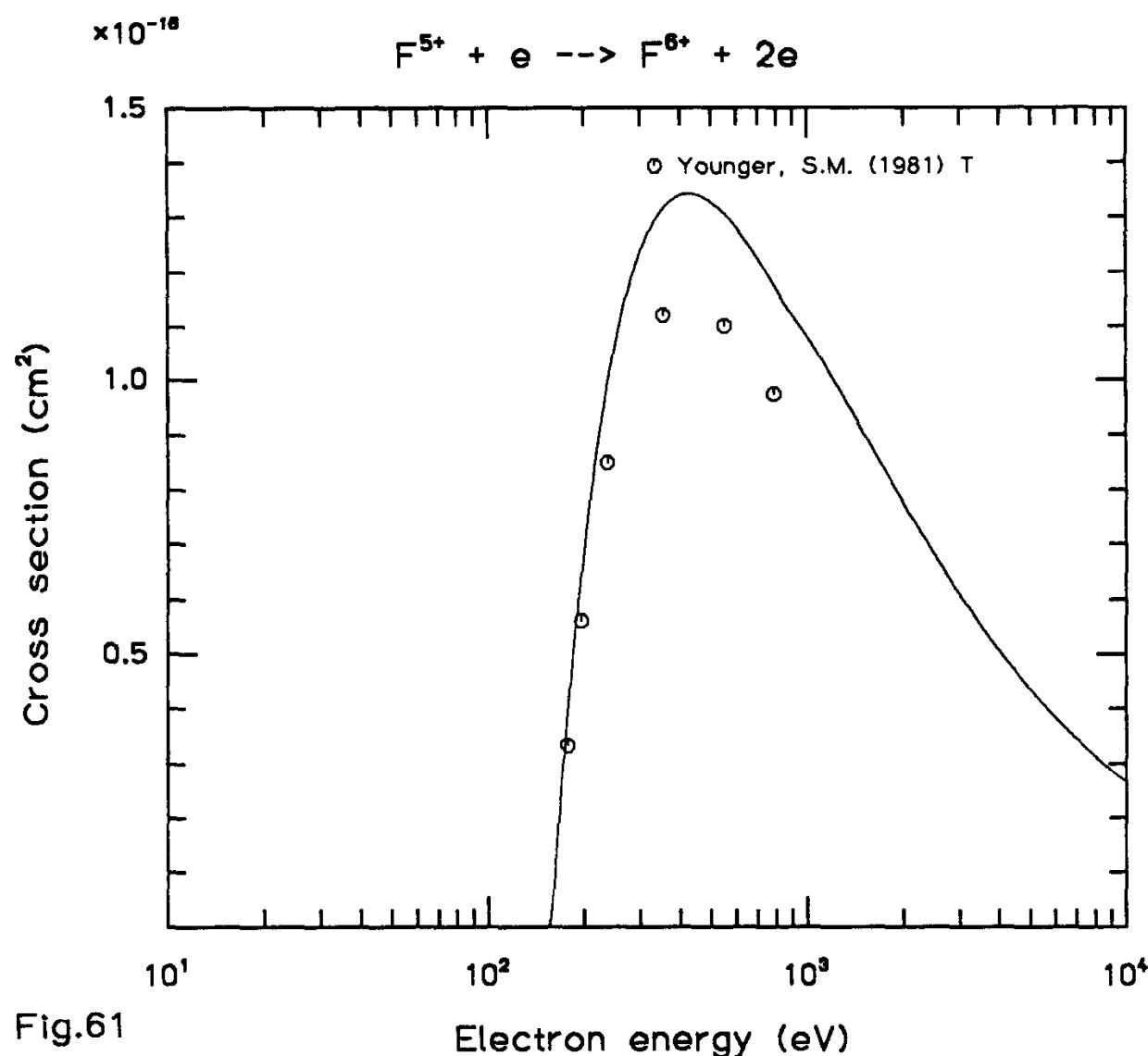


Fig.61

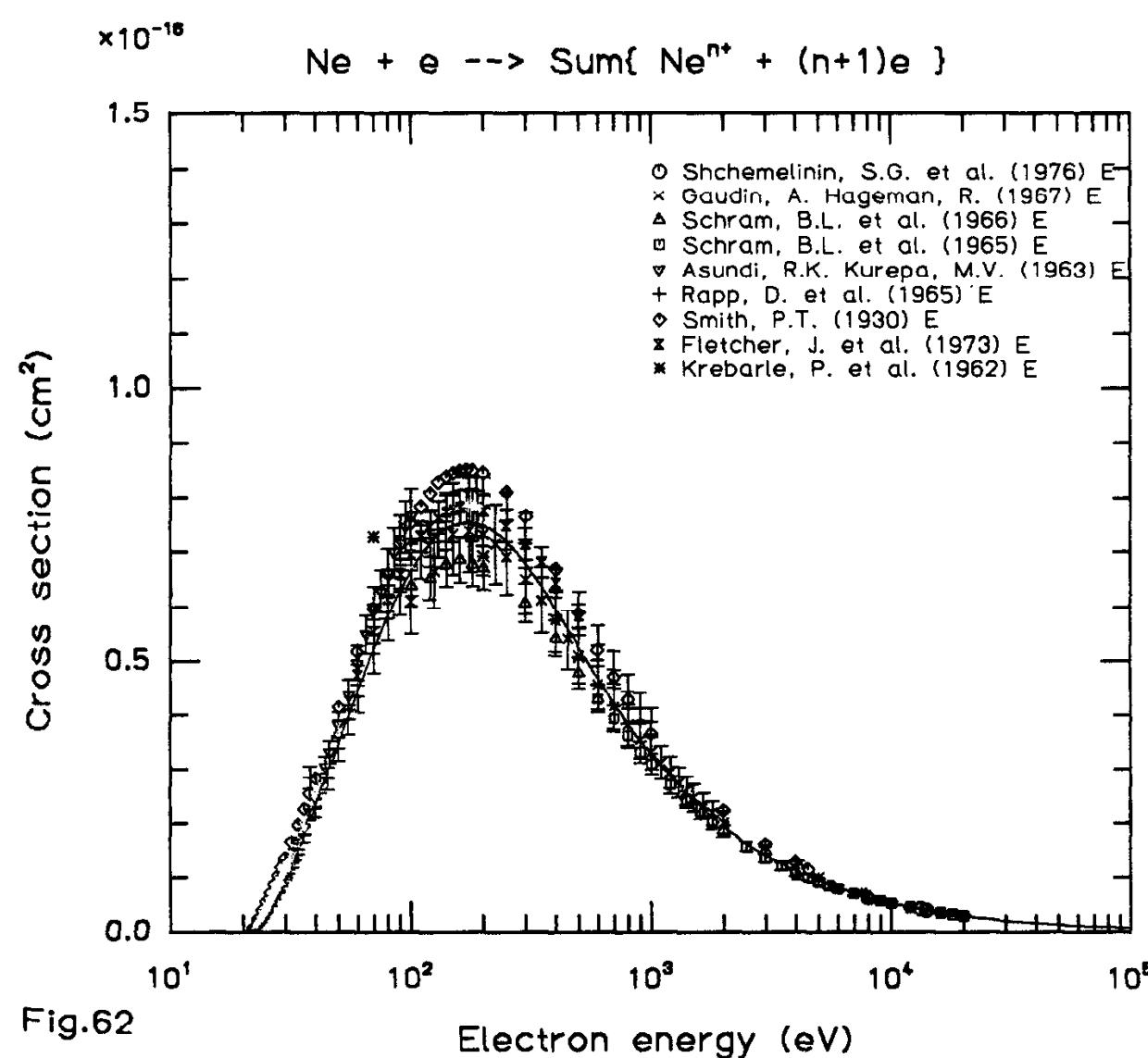


Fig.62

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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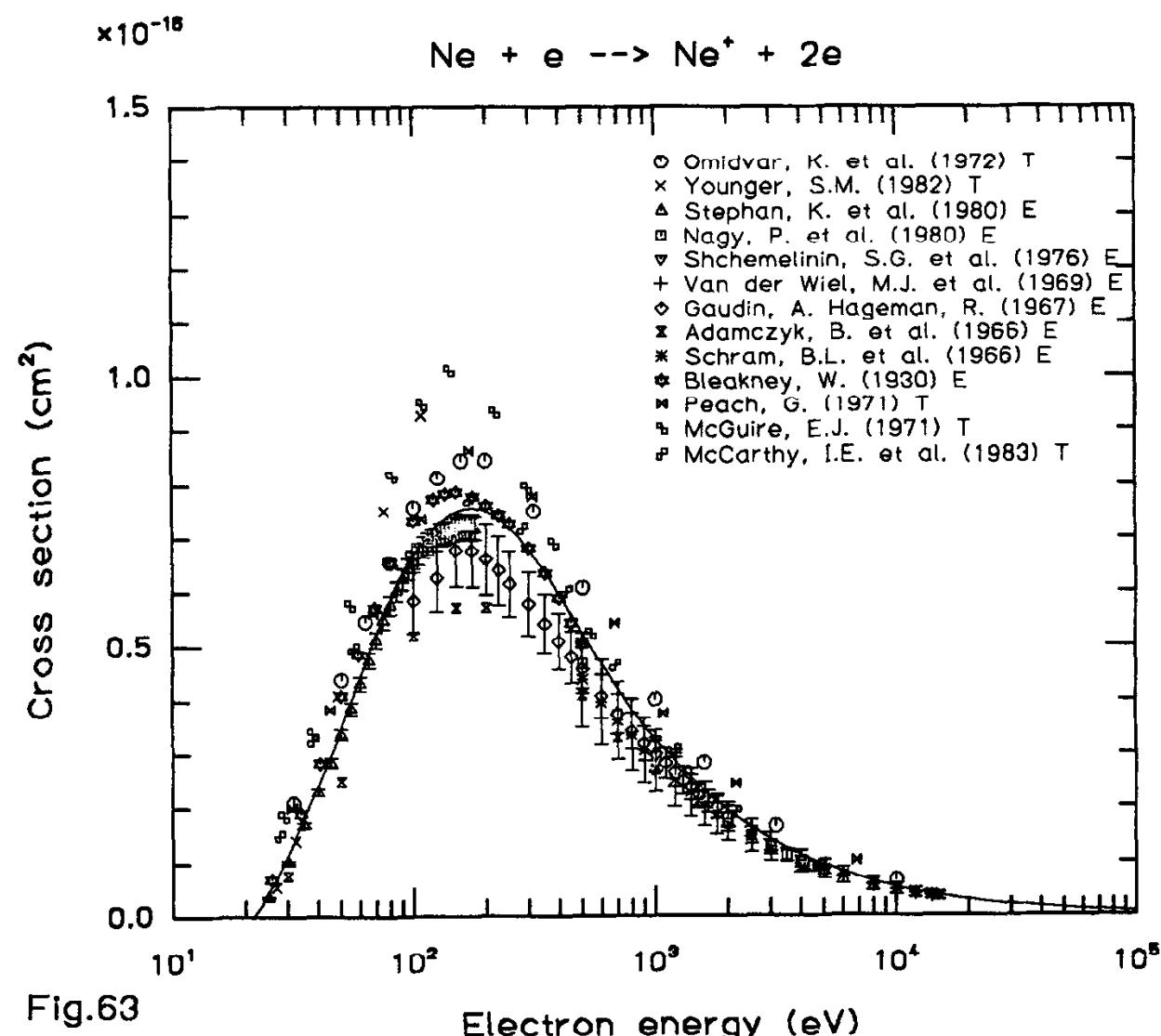


Fig.63

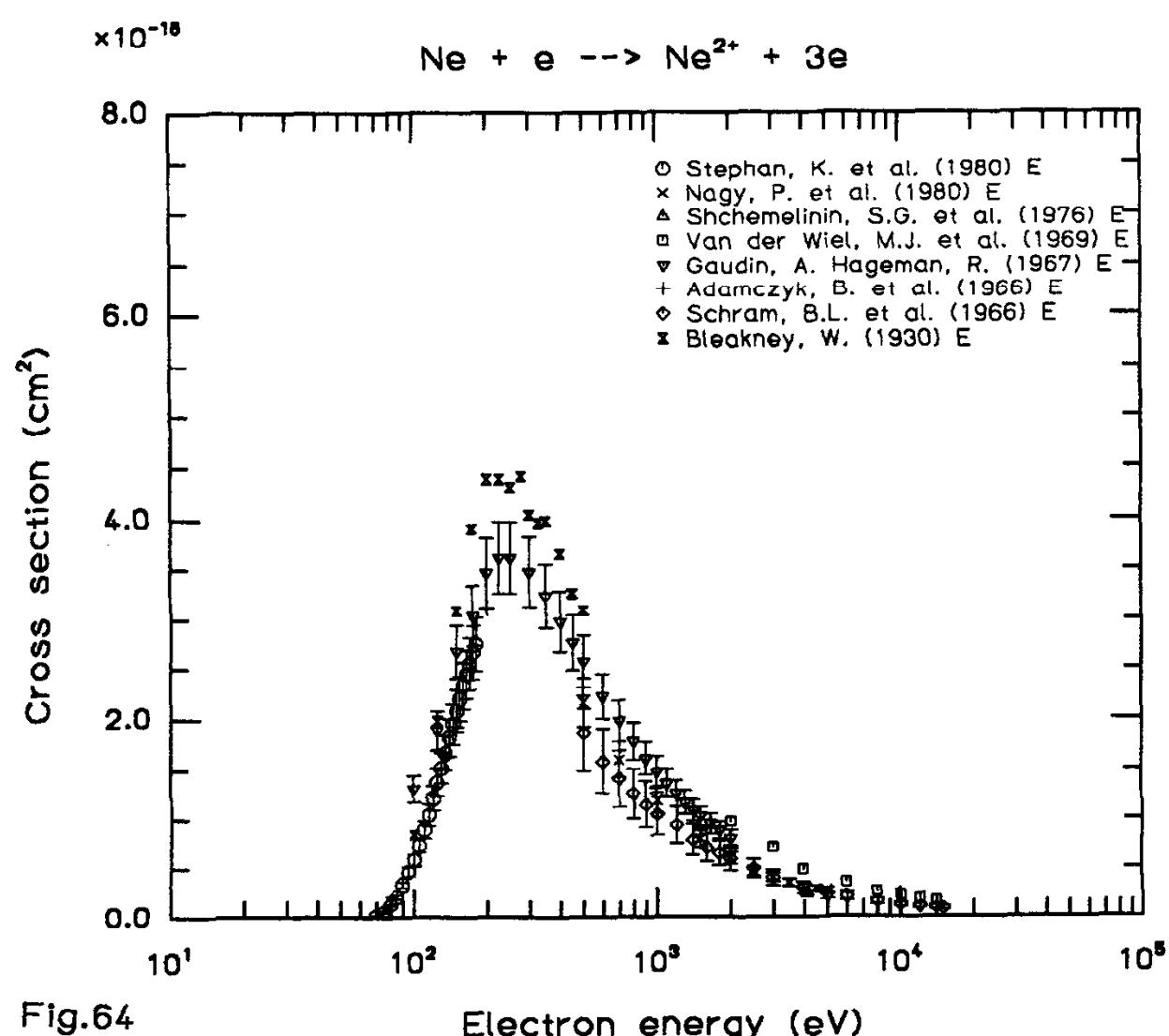


Fig.64

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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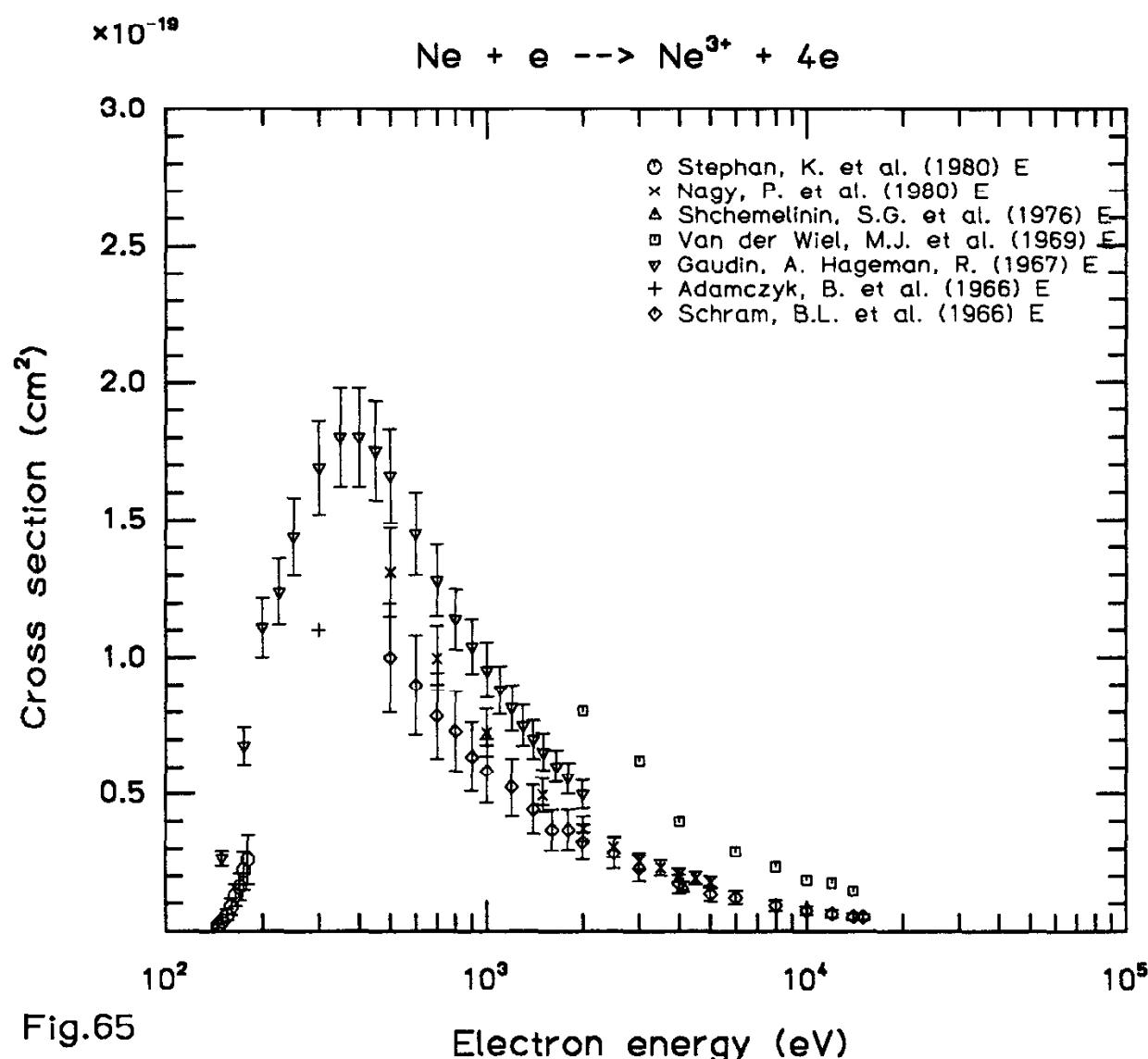


Fig.65

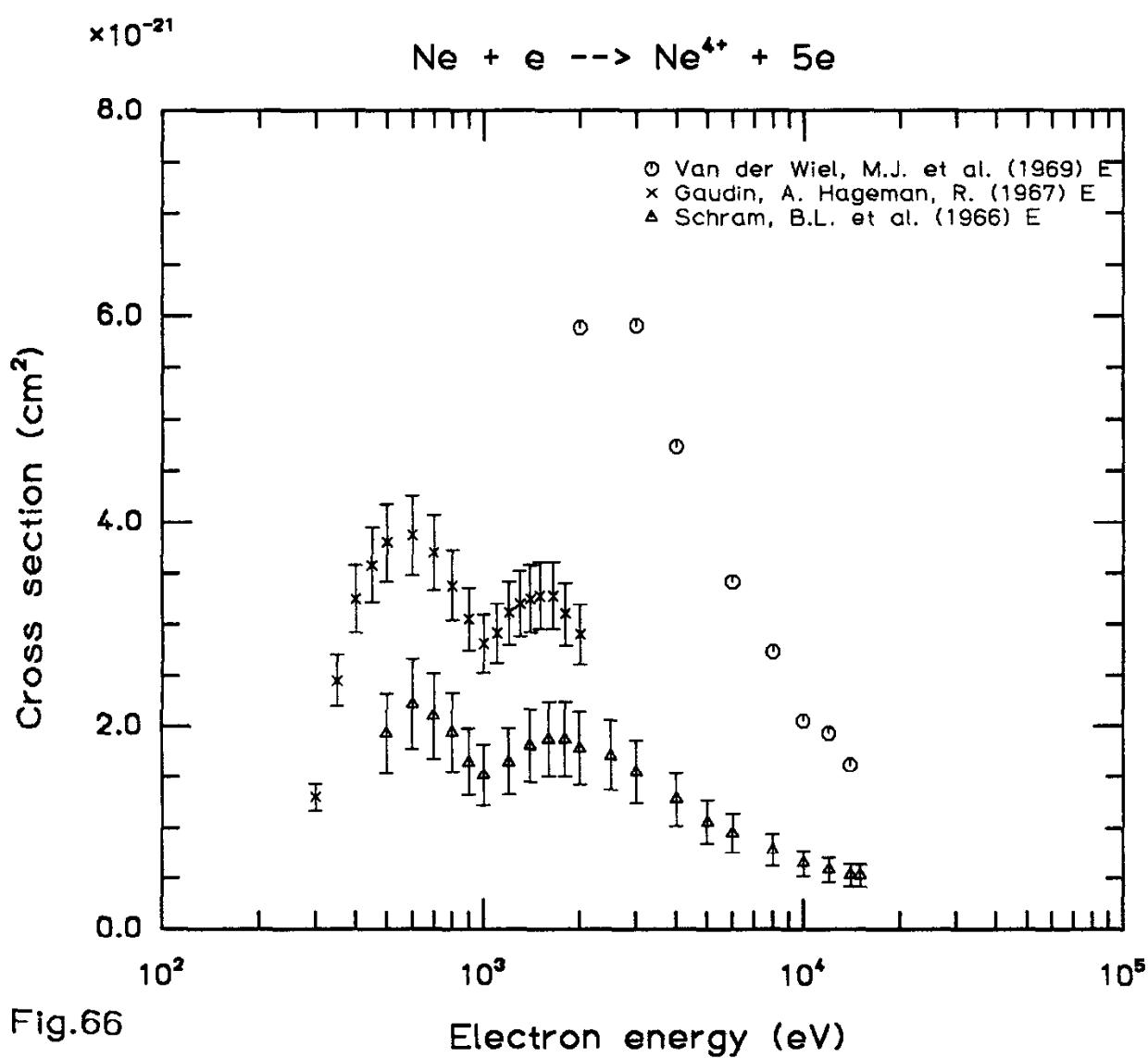


Fig.66

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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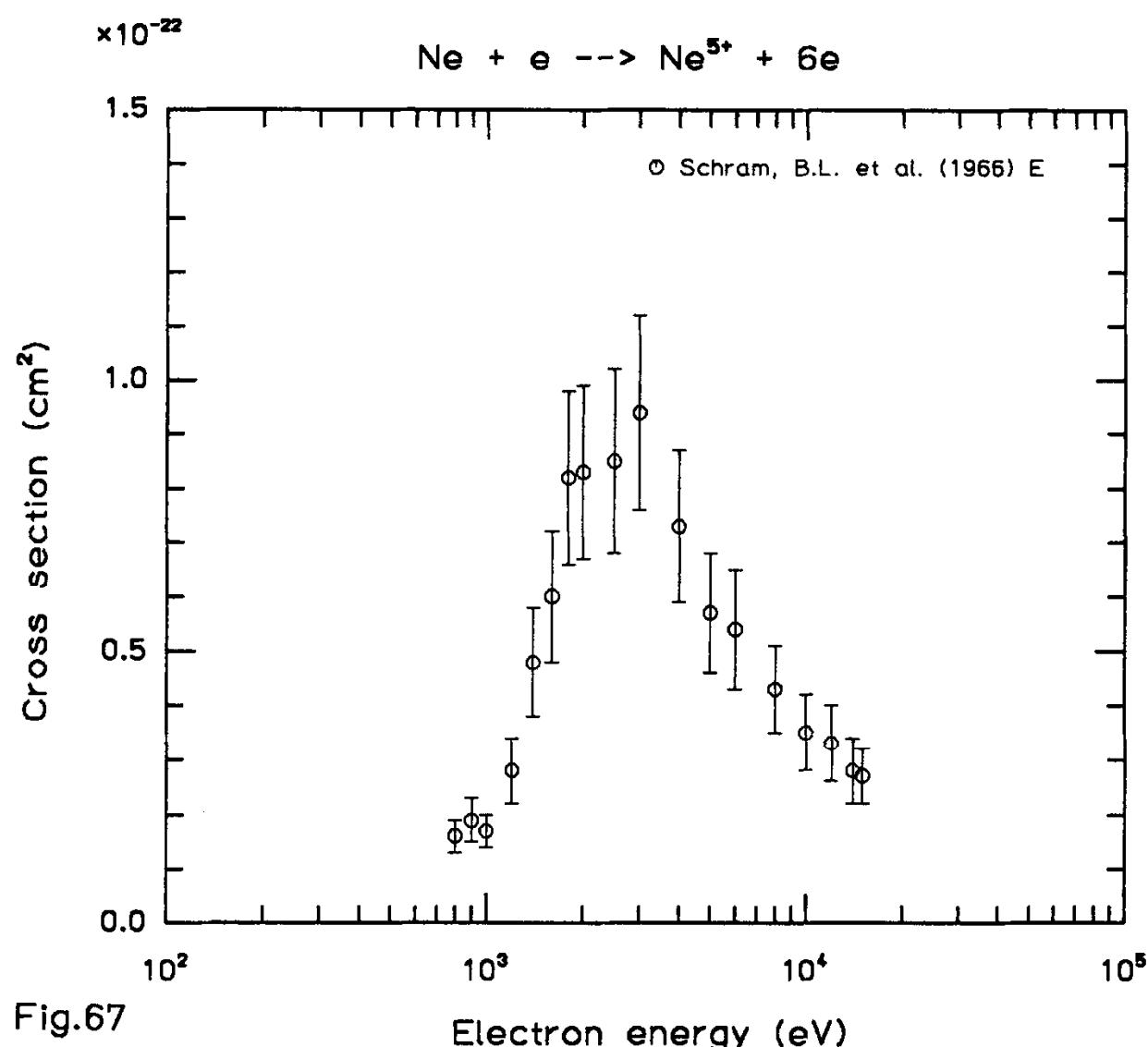


Fig.67

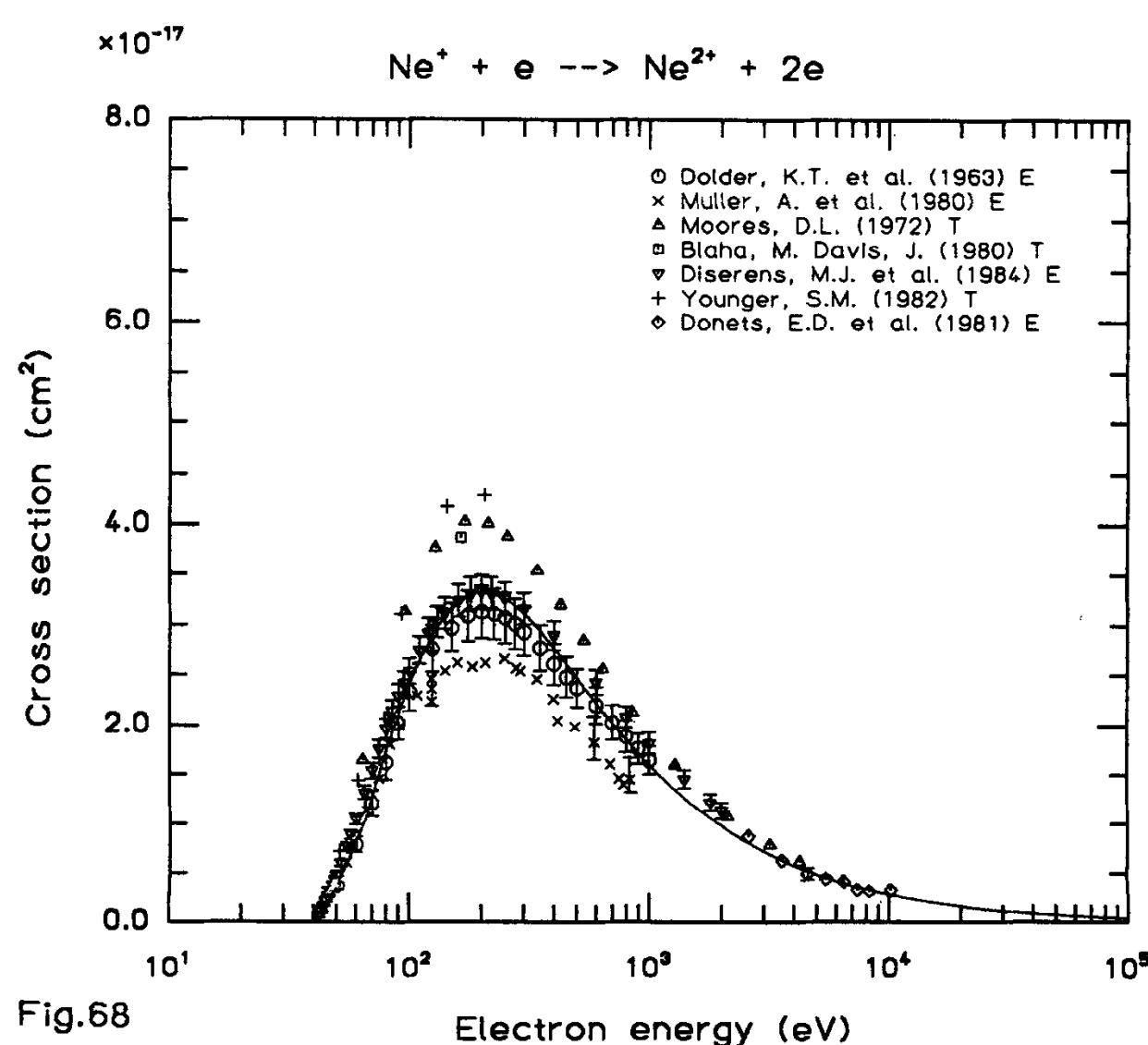


Fig.68

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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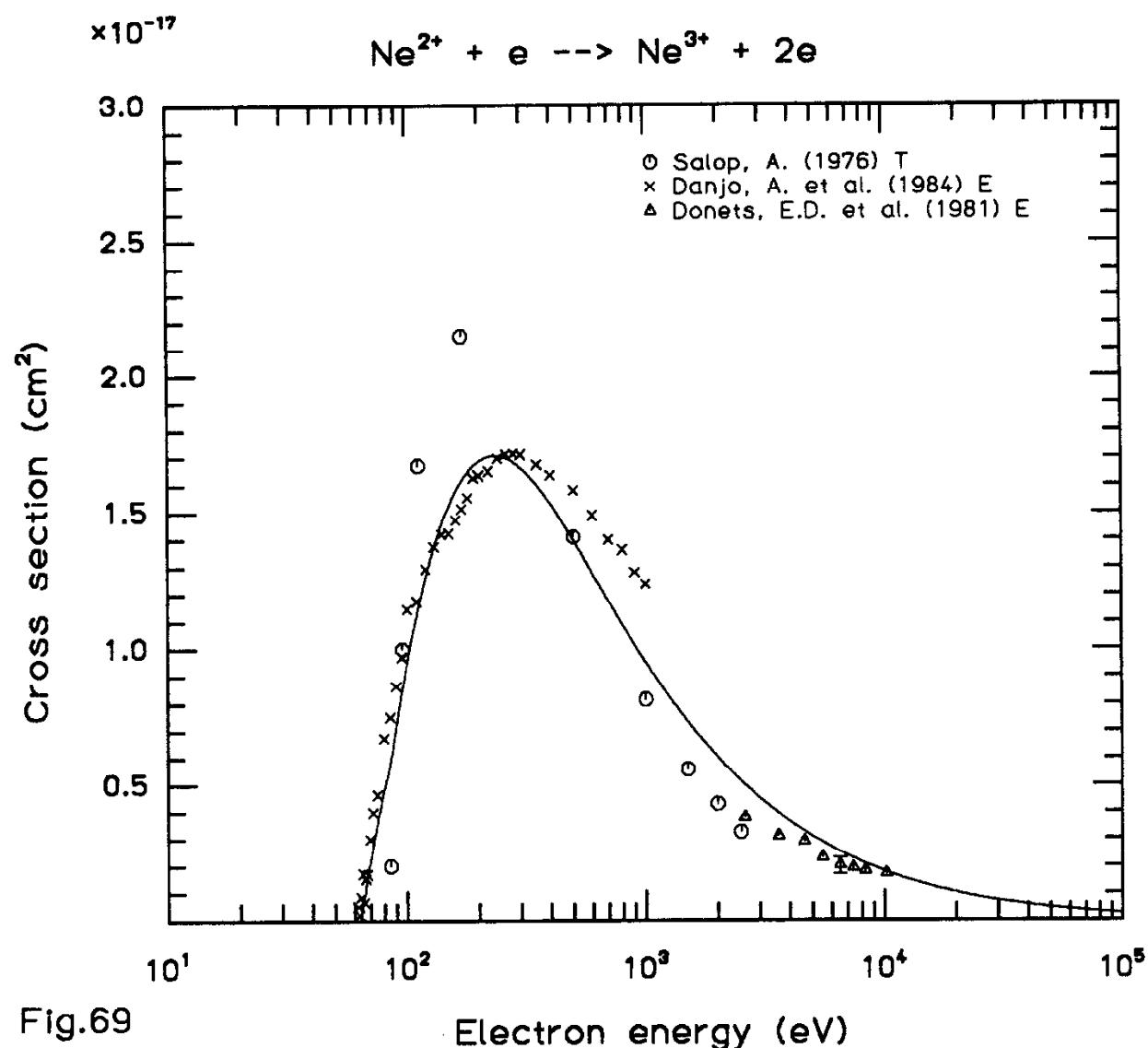


Fig.69

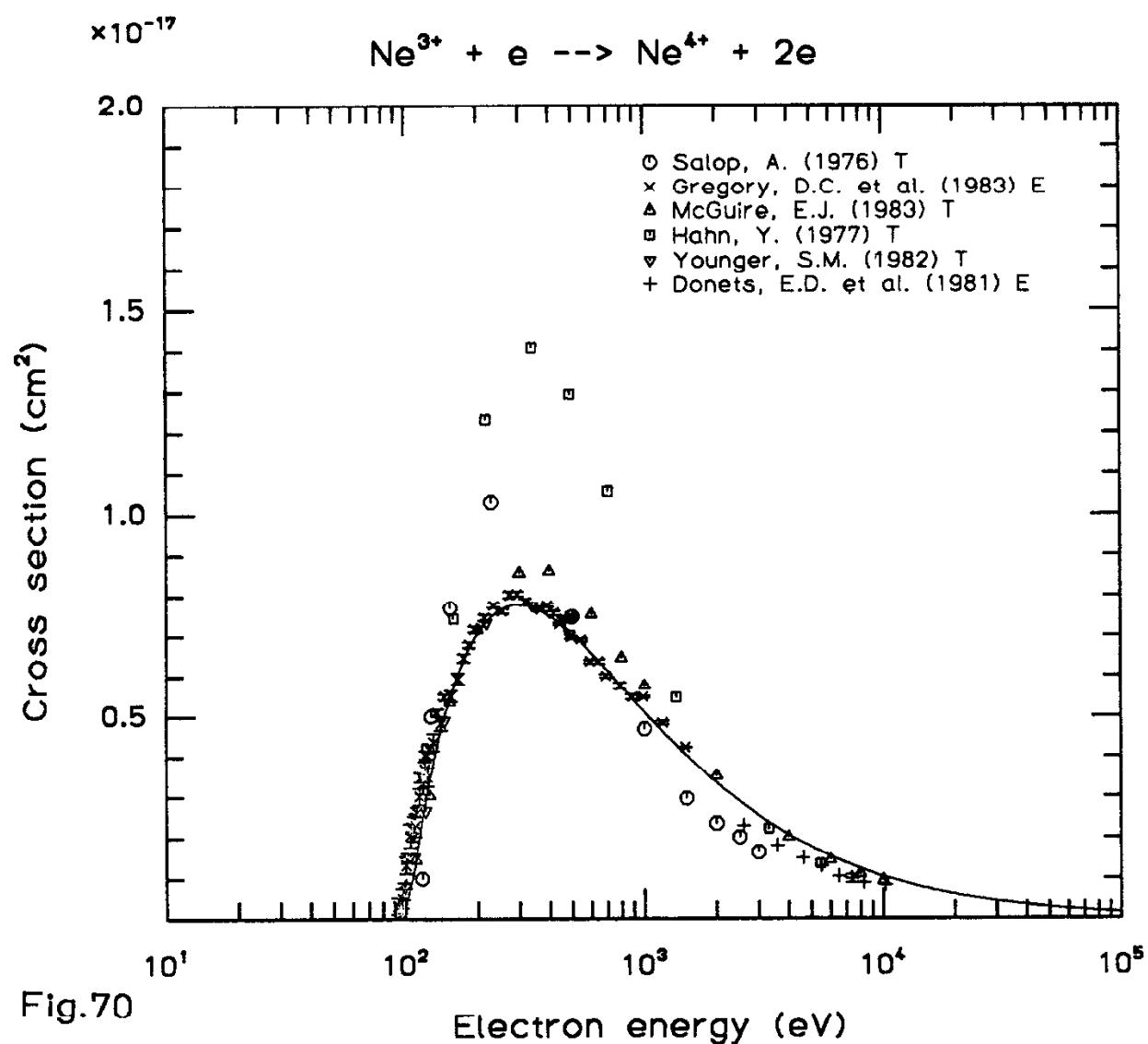


Fig.70

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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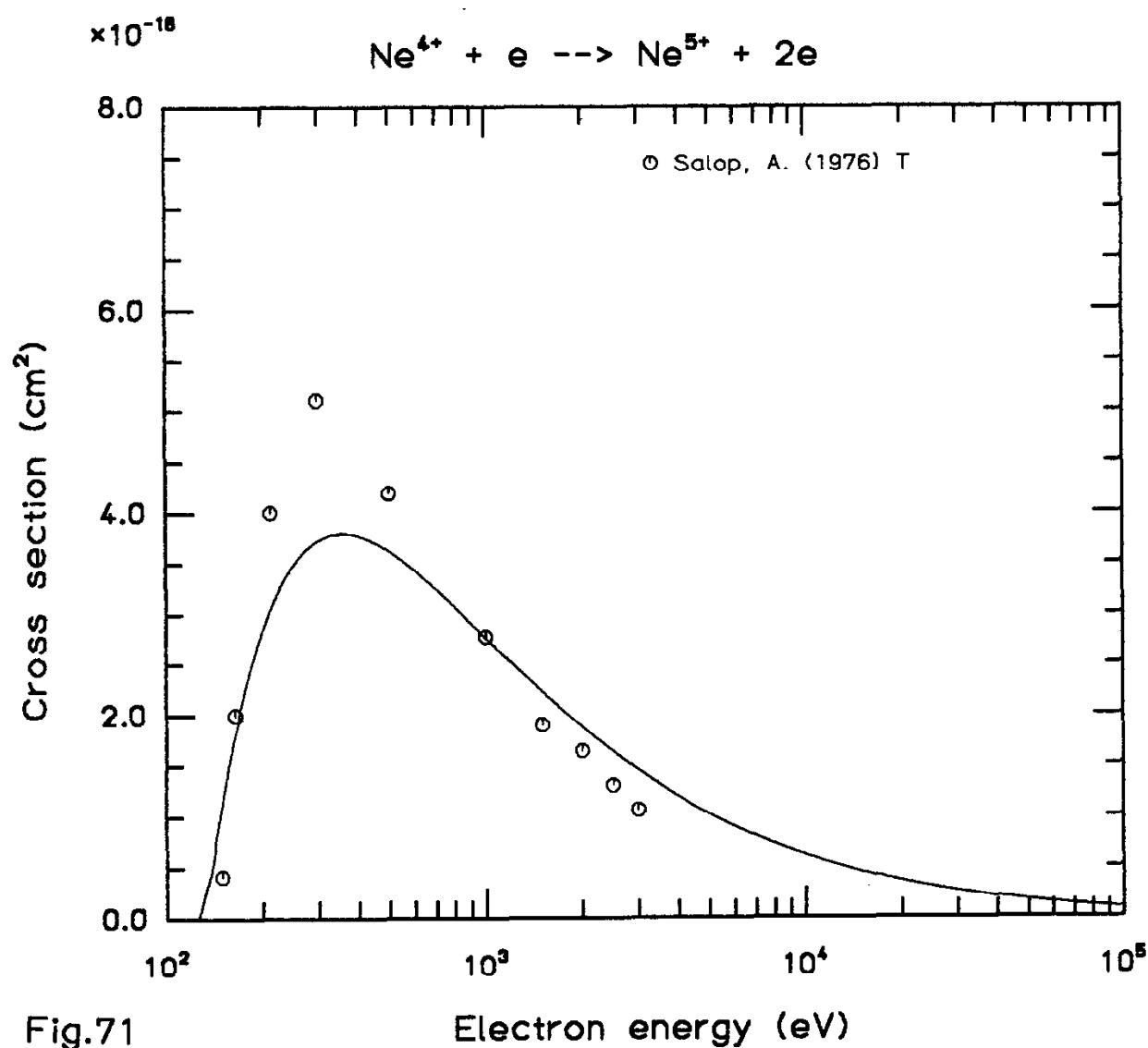


Fig.71

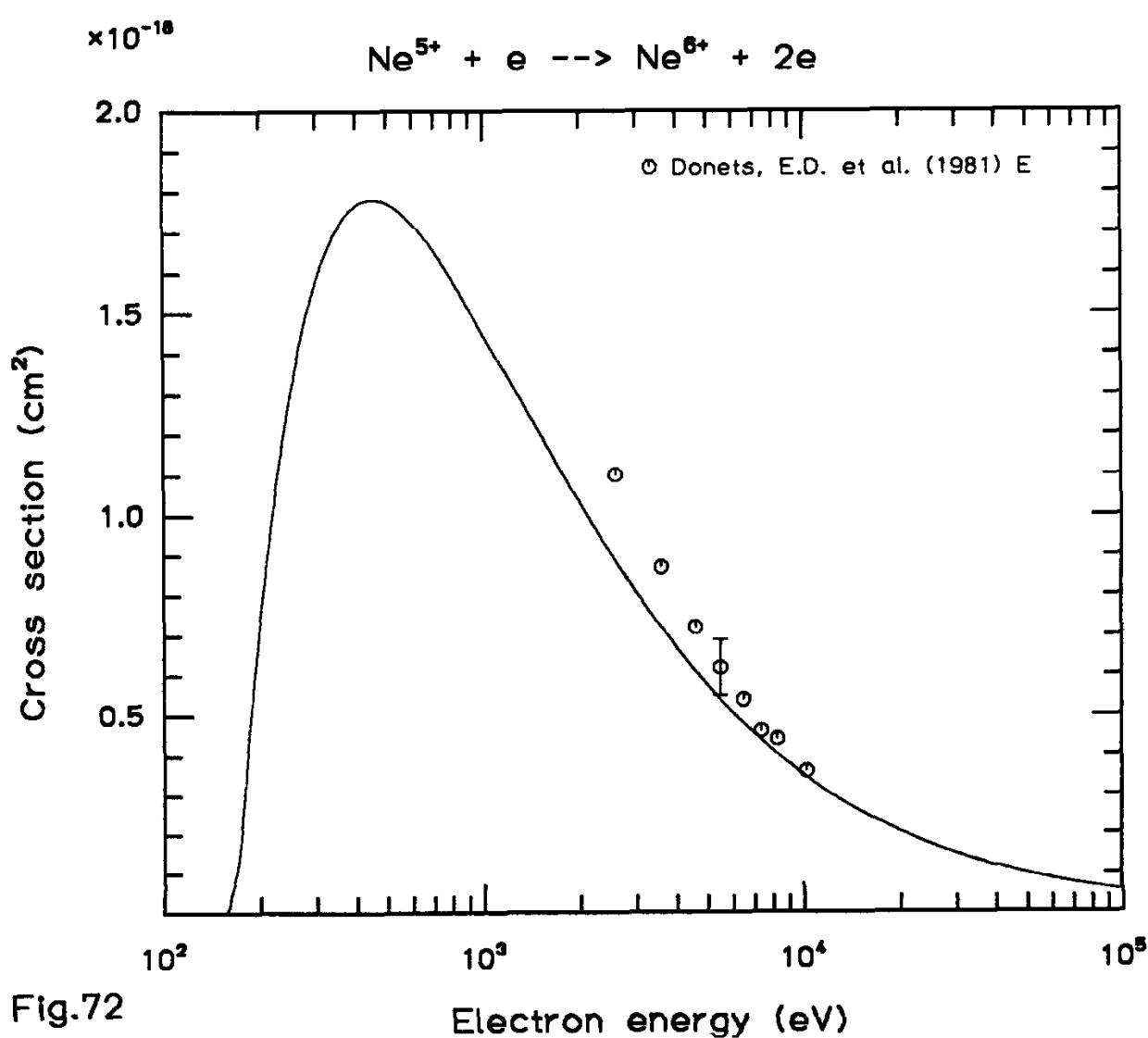


Fig.72

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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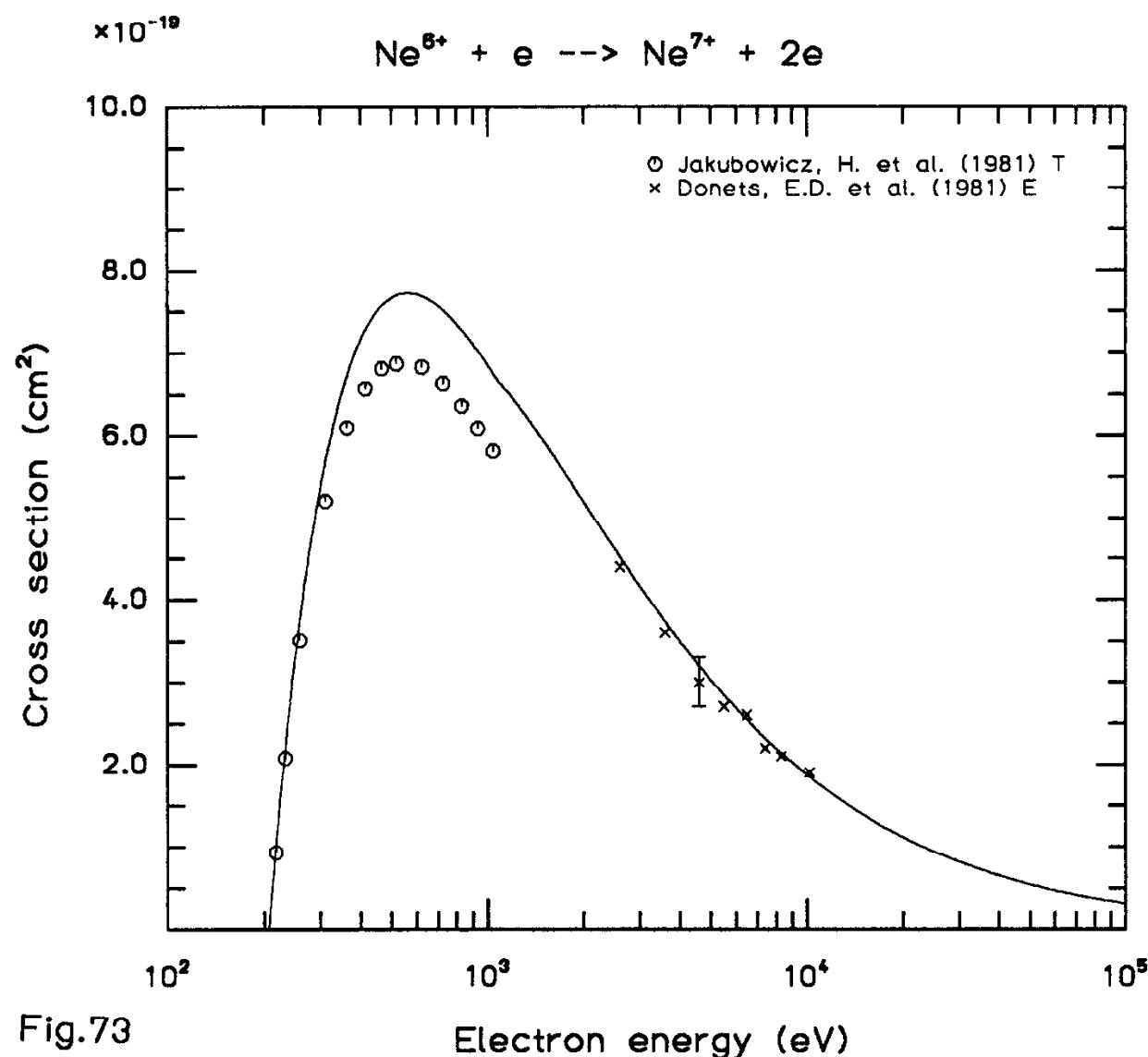


Fig.73

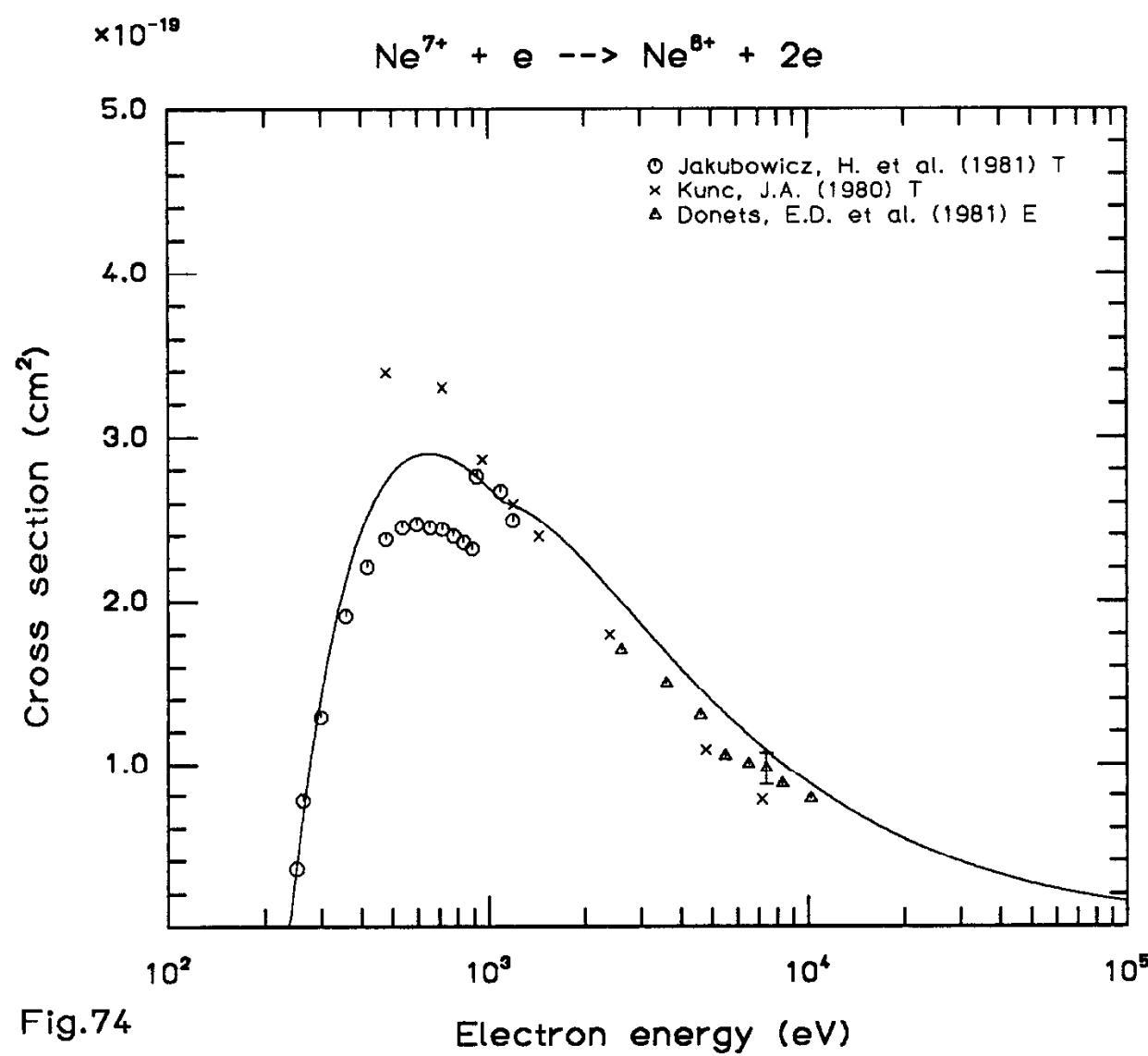
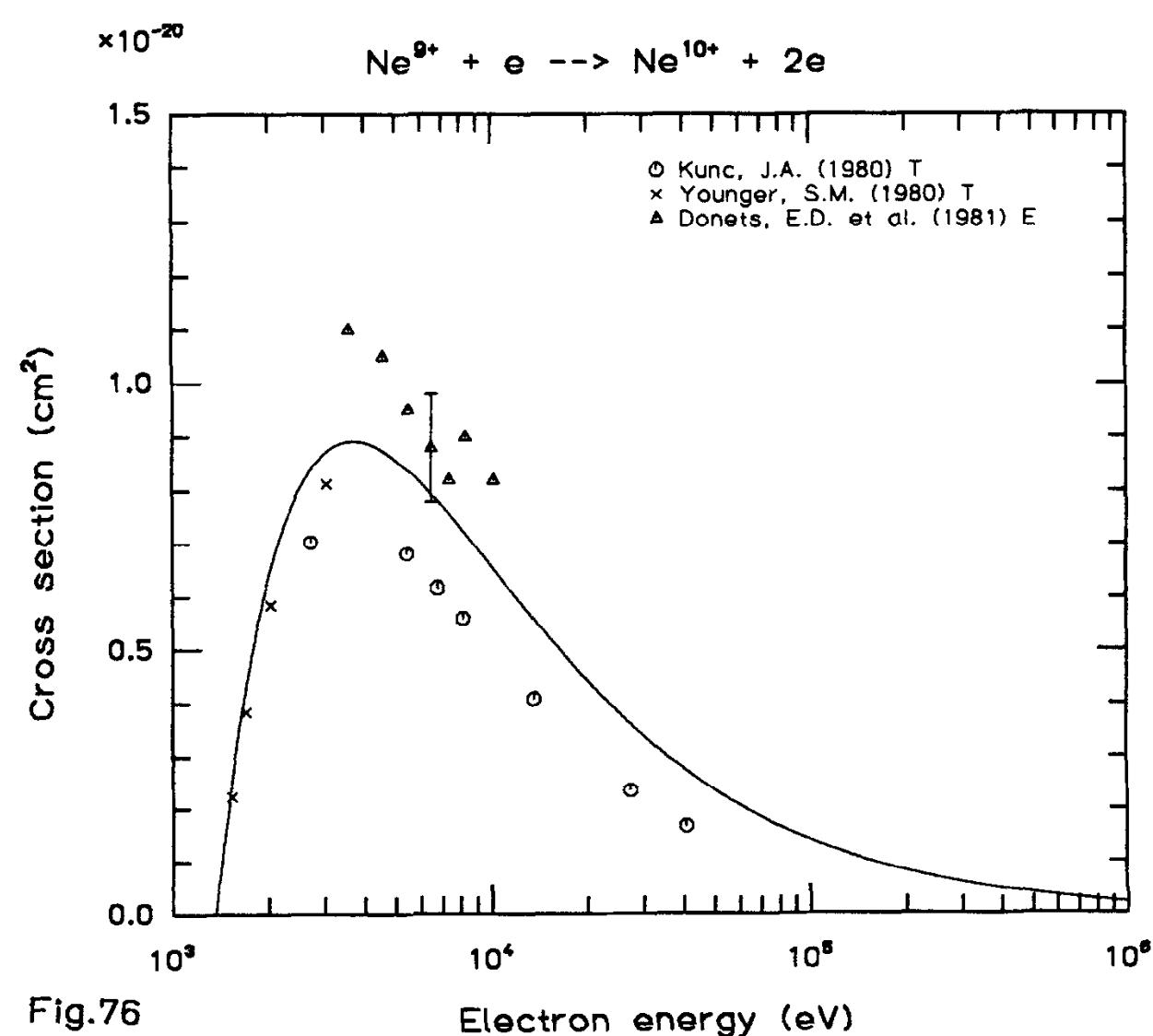
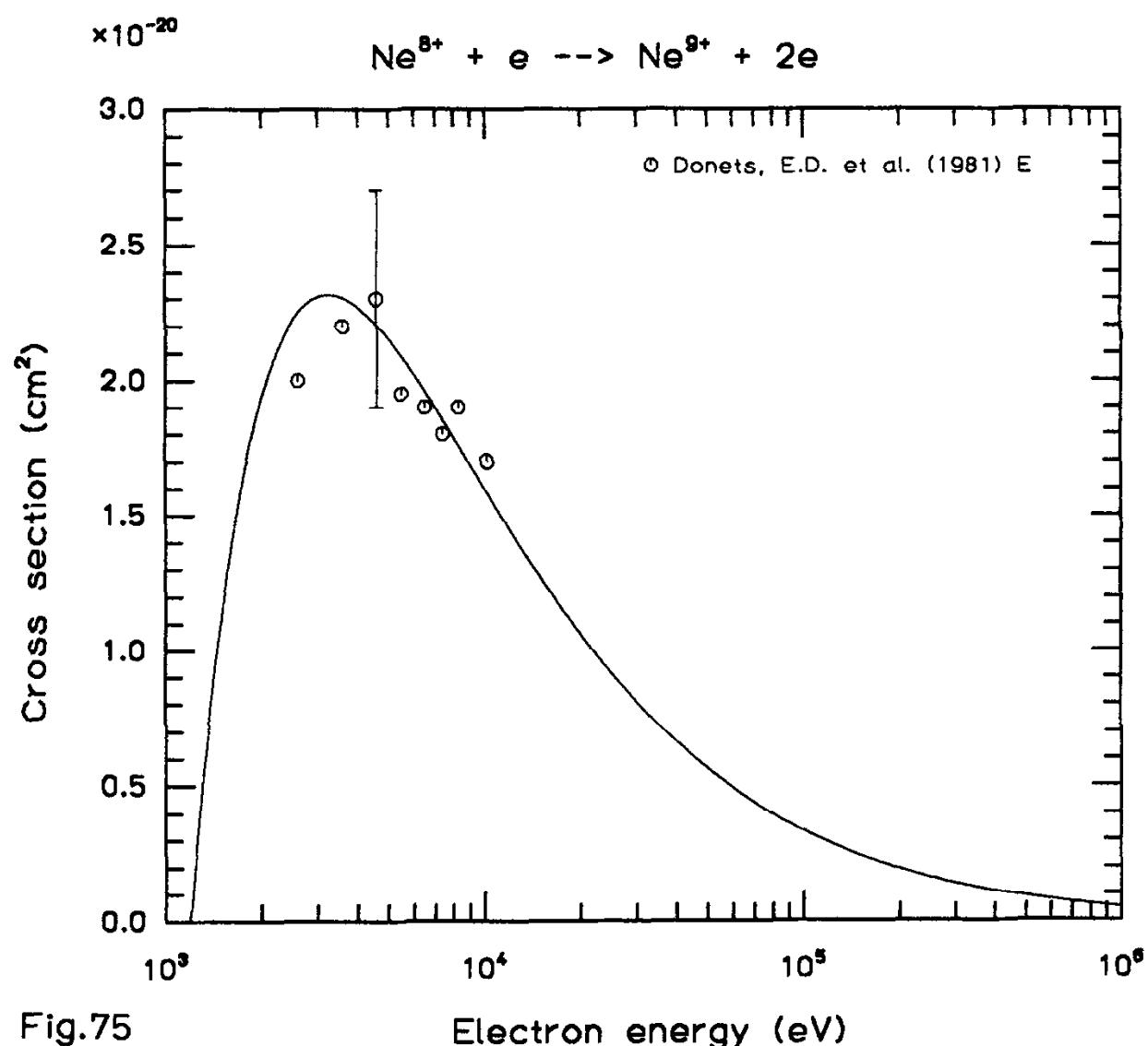


Fig.74

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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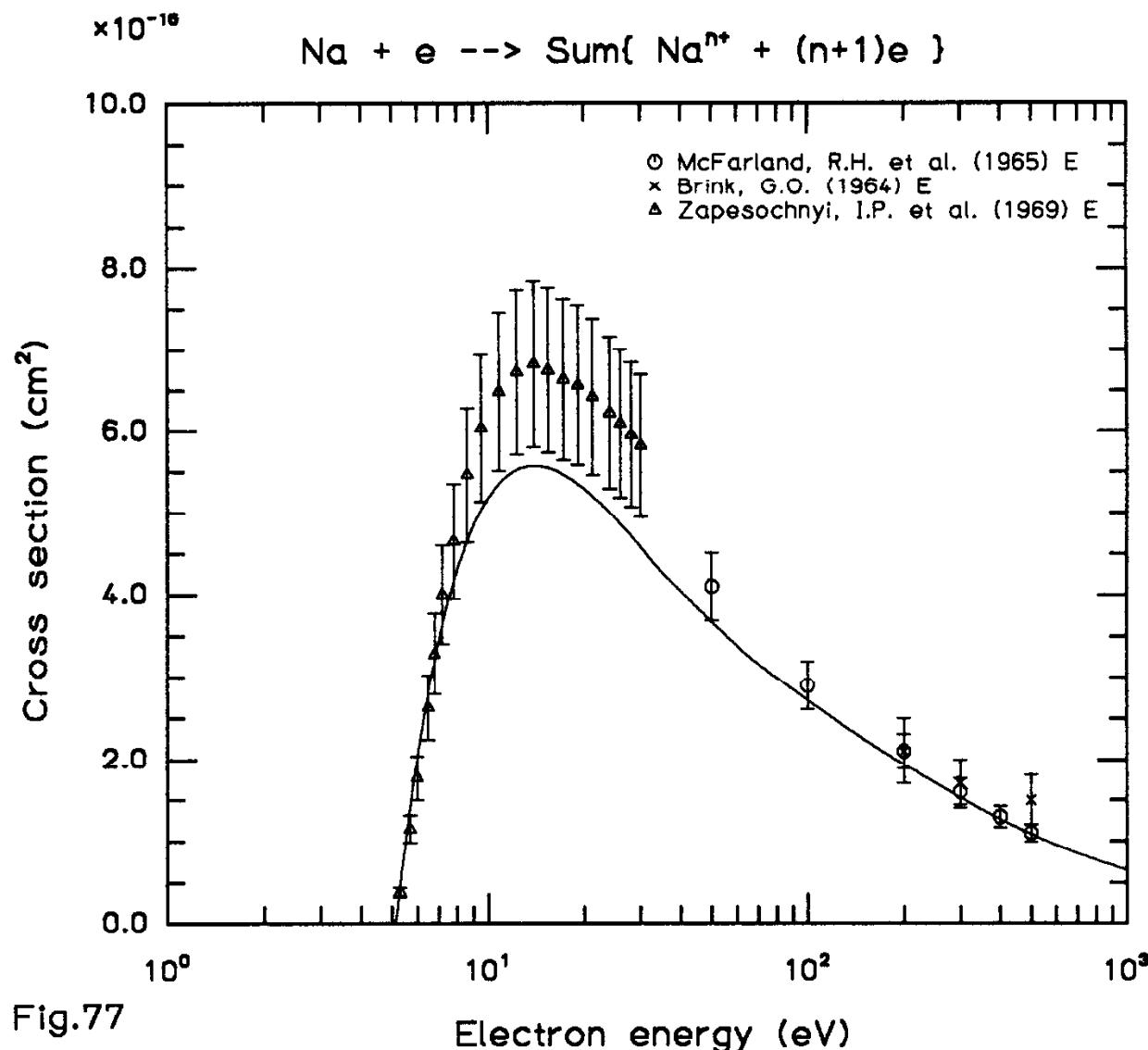


Fig.77

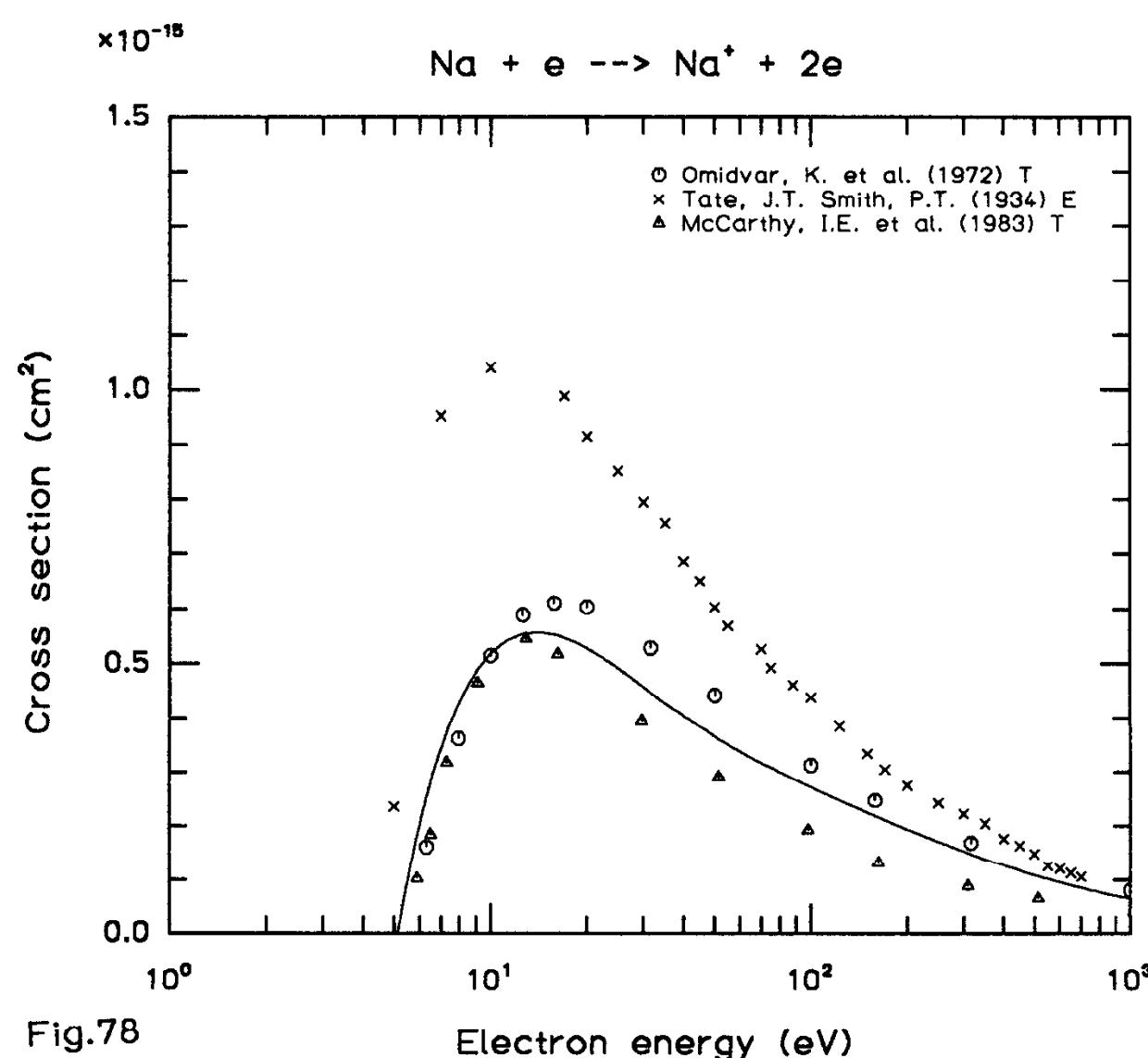


Fig.78

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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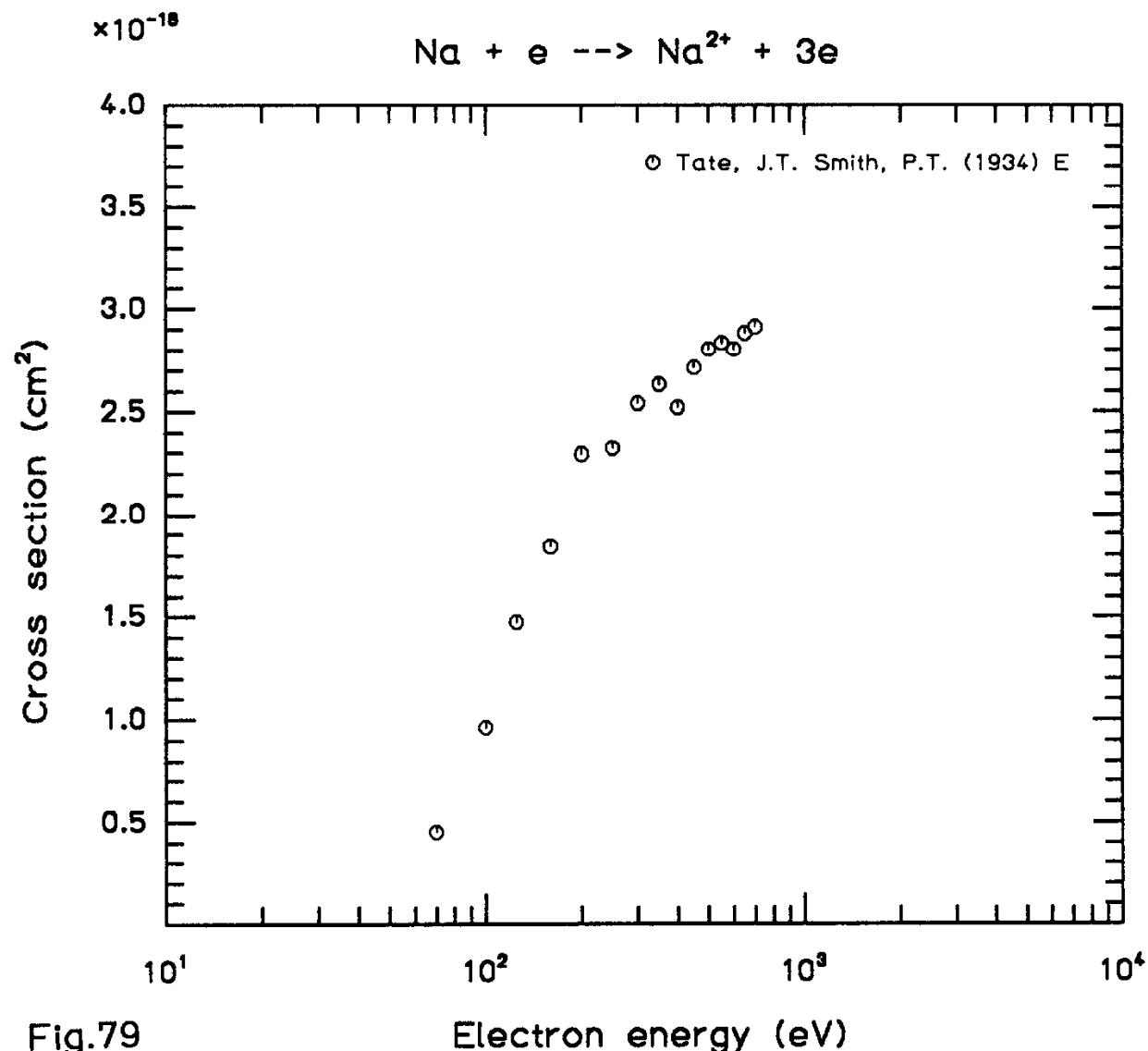


Fig.79

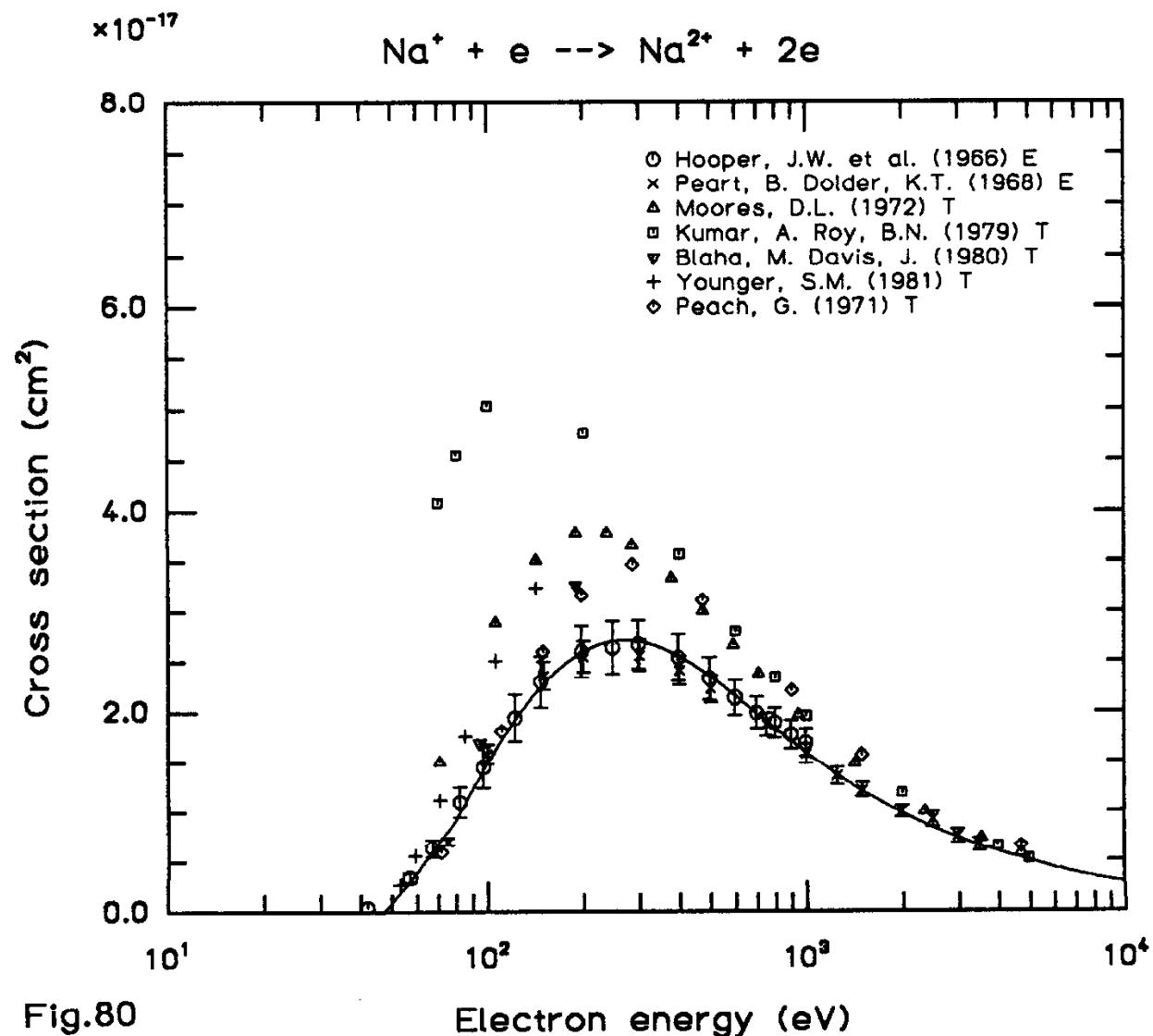


Fig.80

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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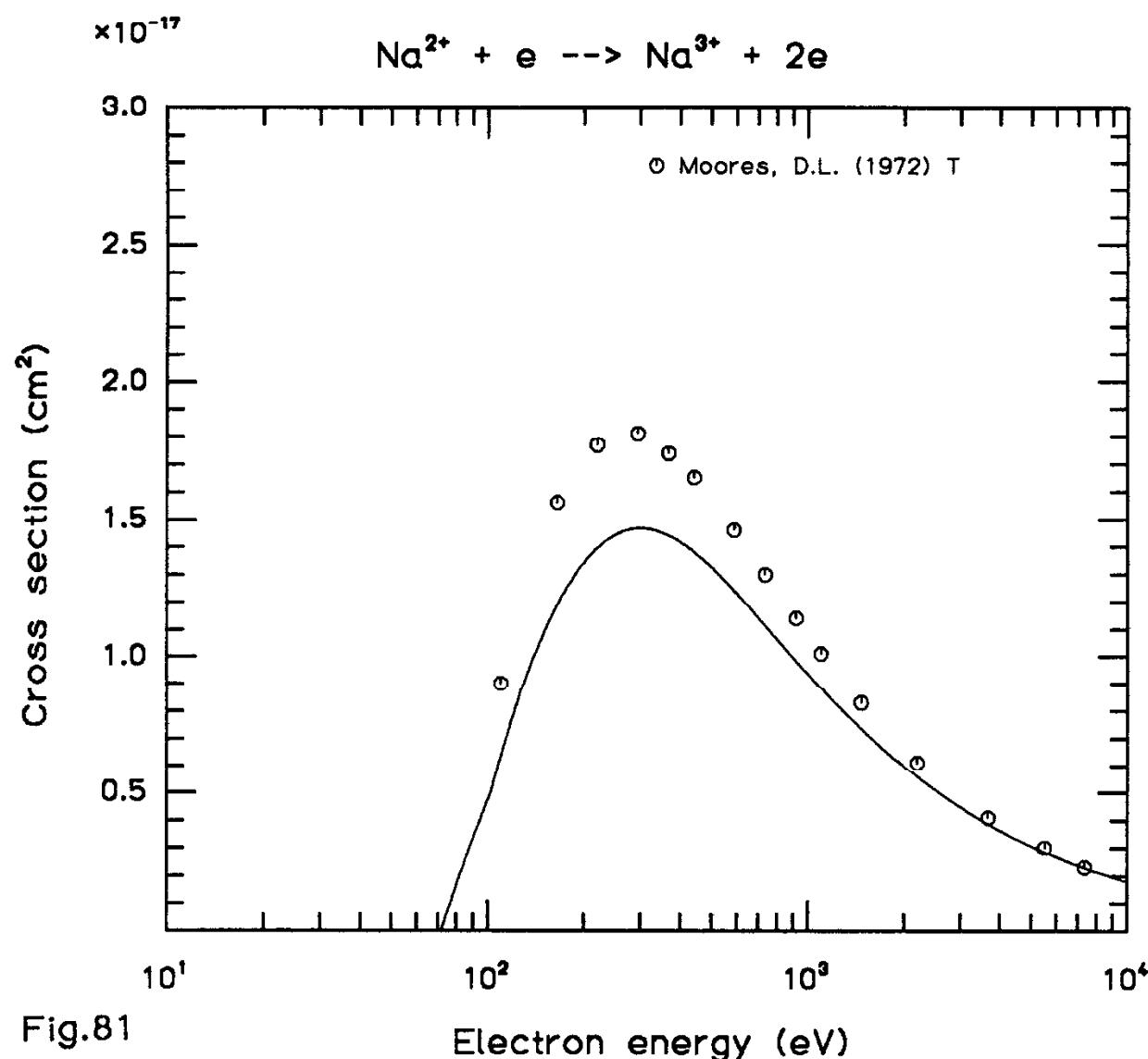


Fig.81

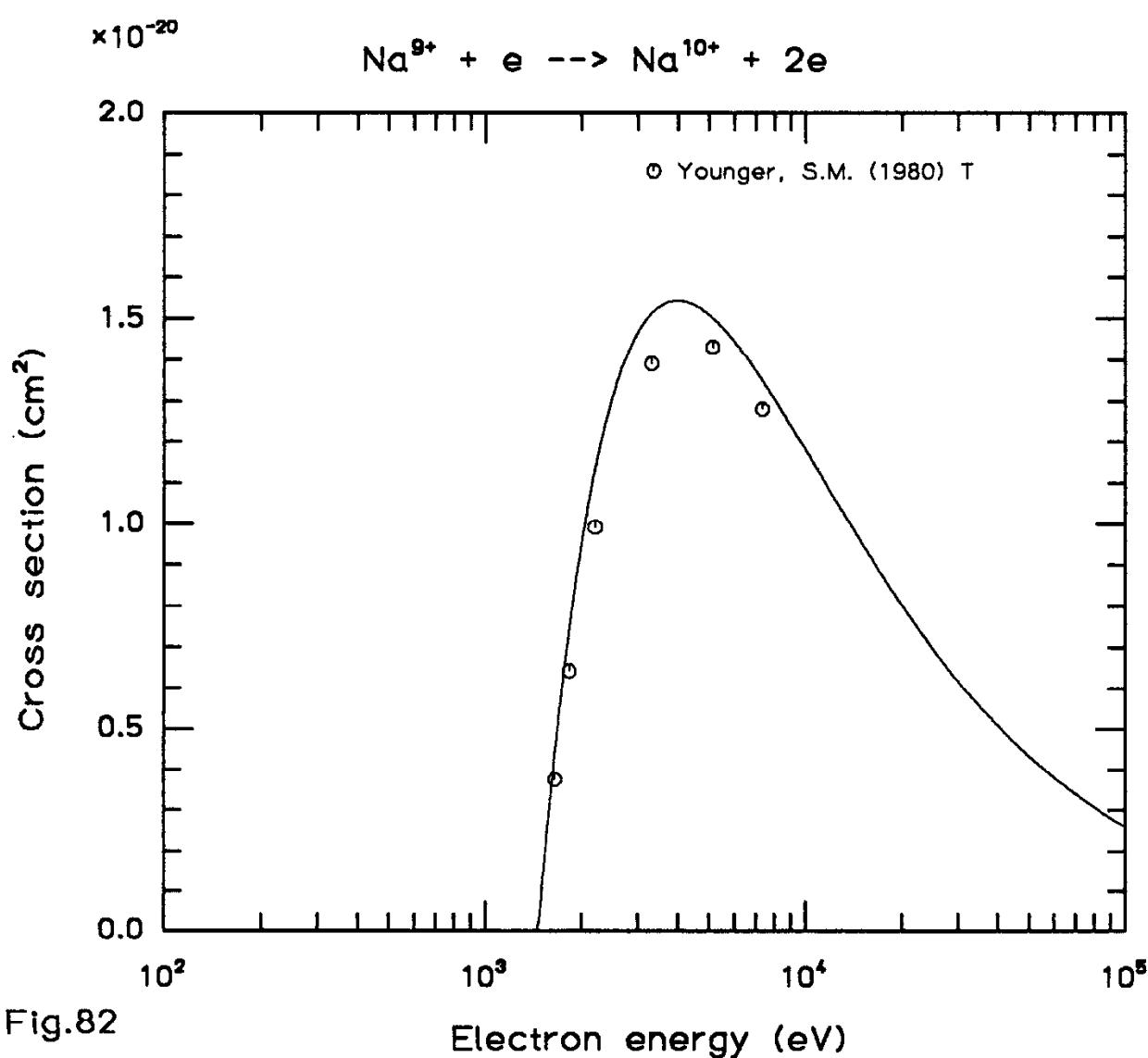
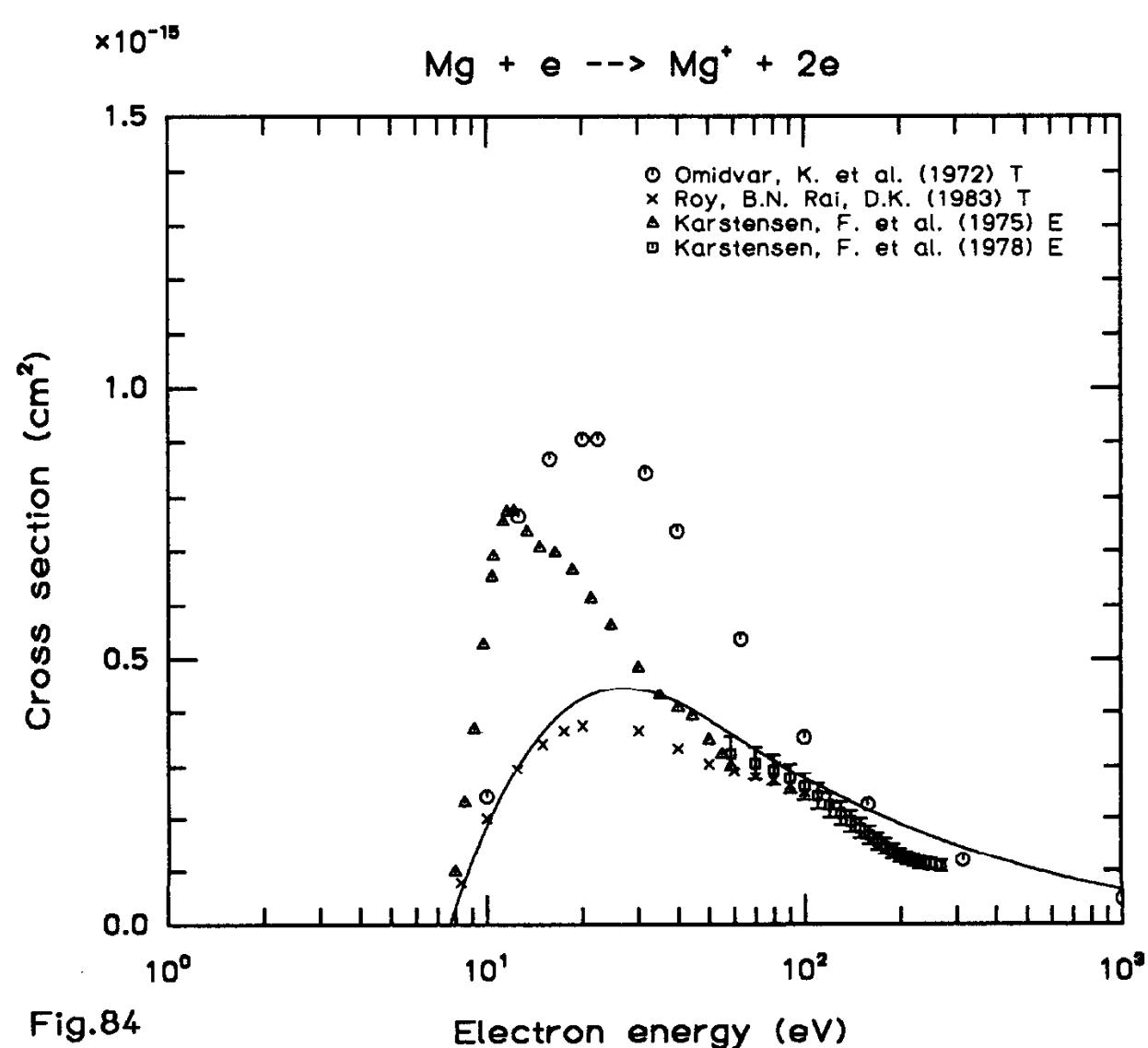
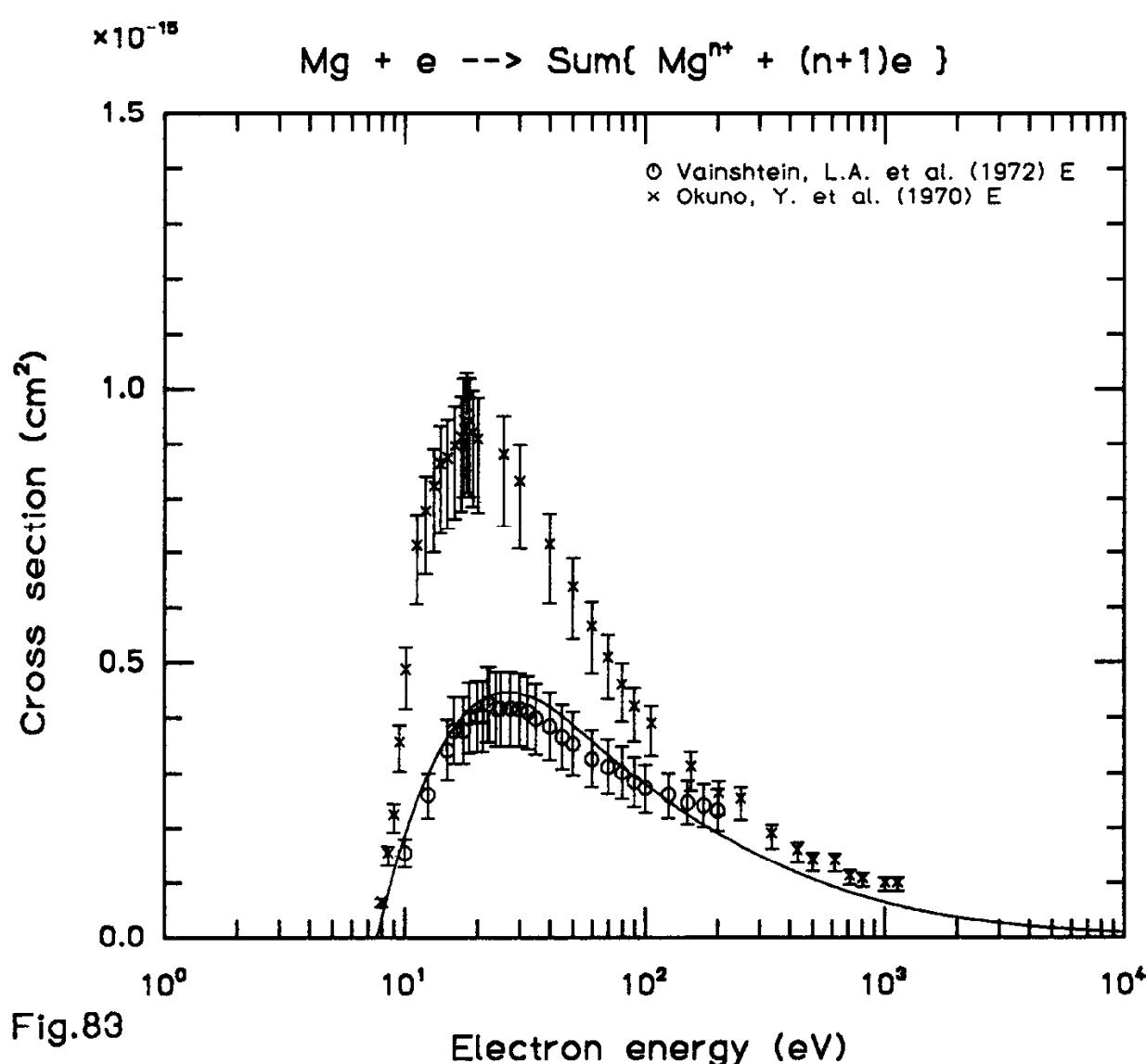


Fig.82

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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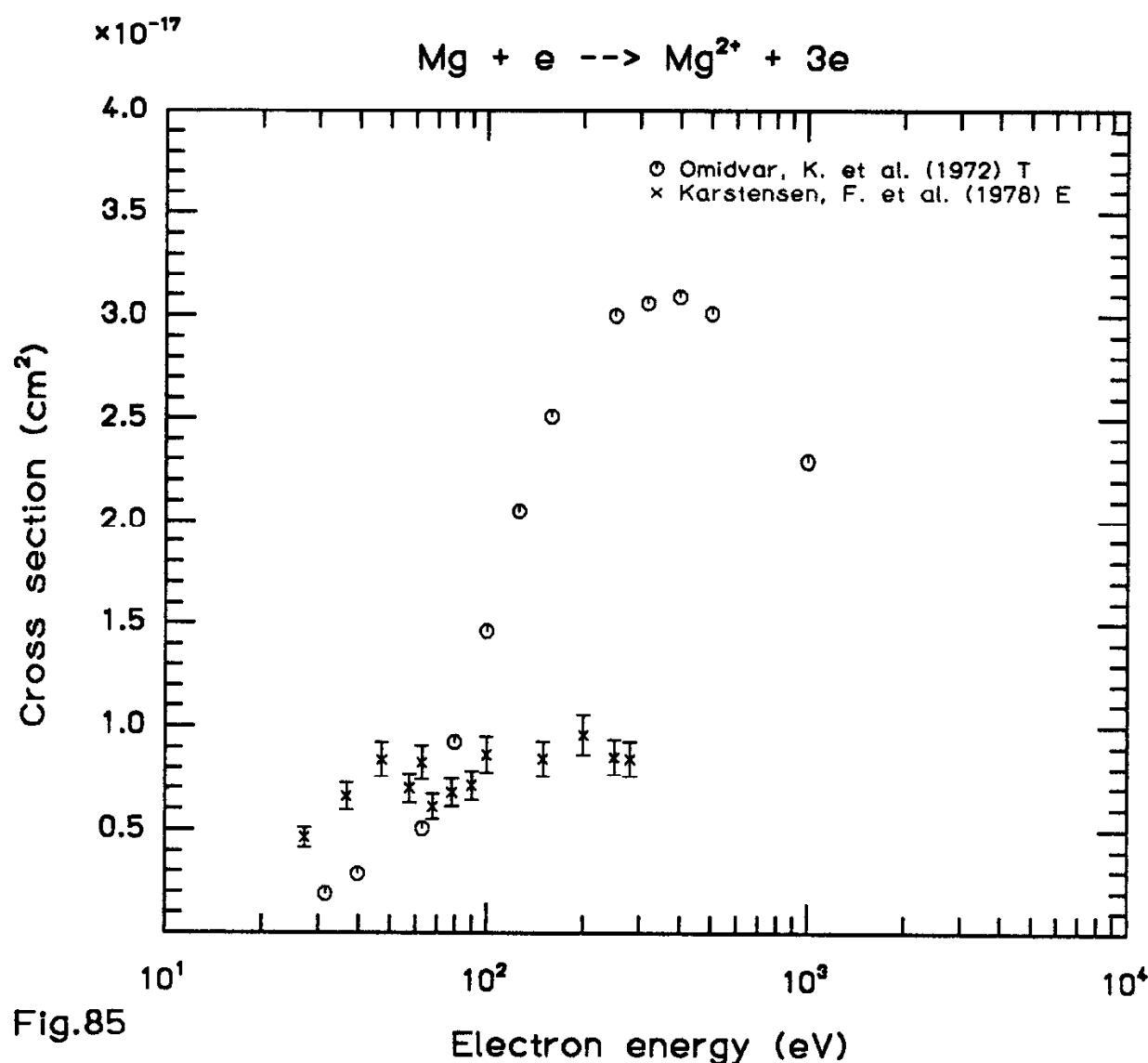


Fig.85

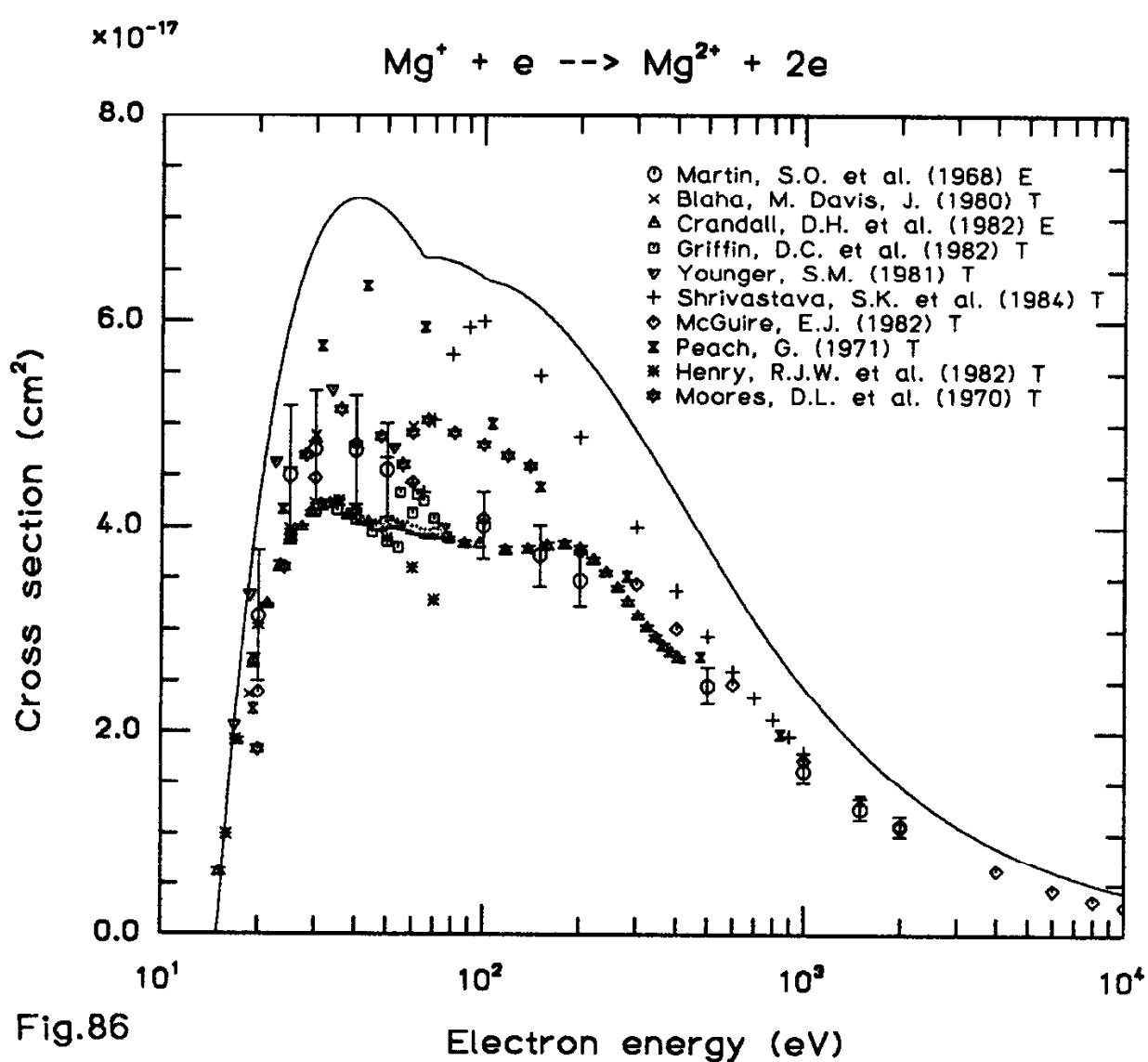


Fig.86

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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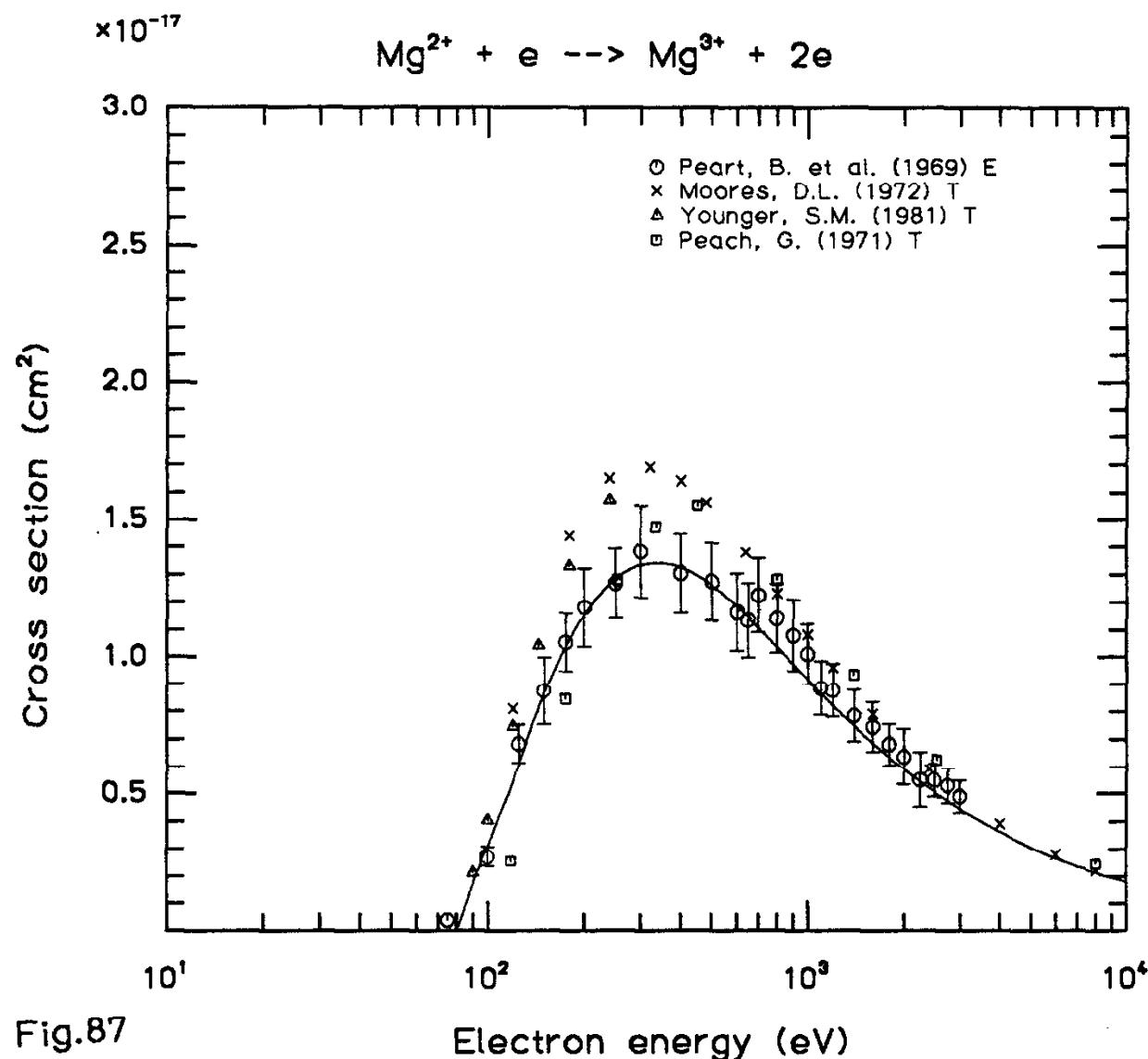


Fig.87

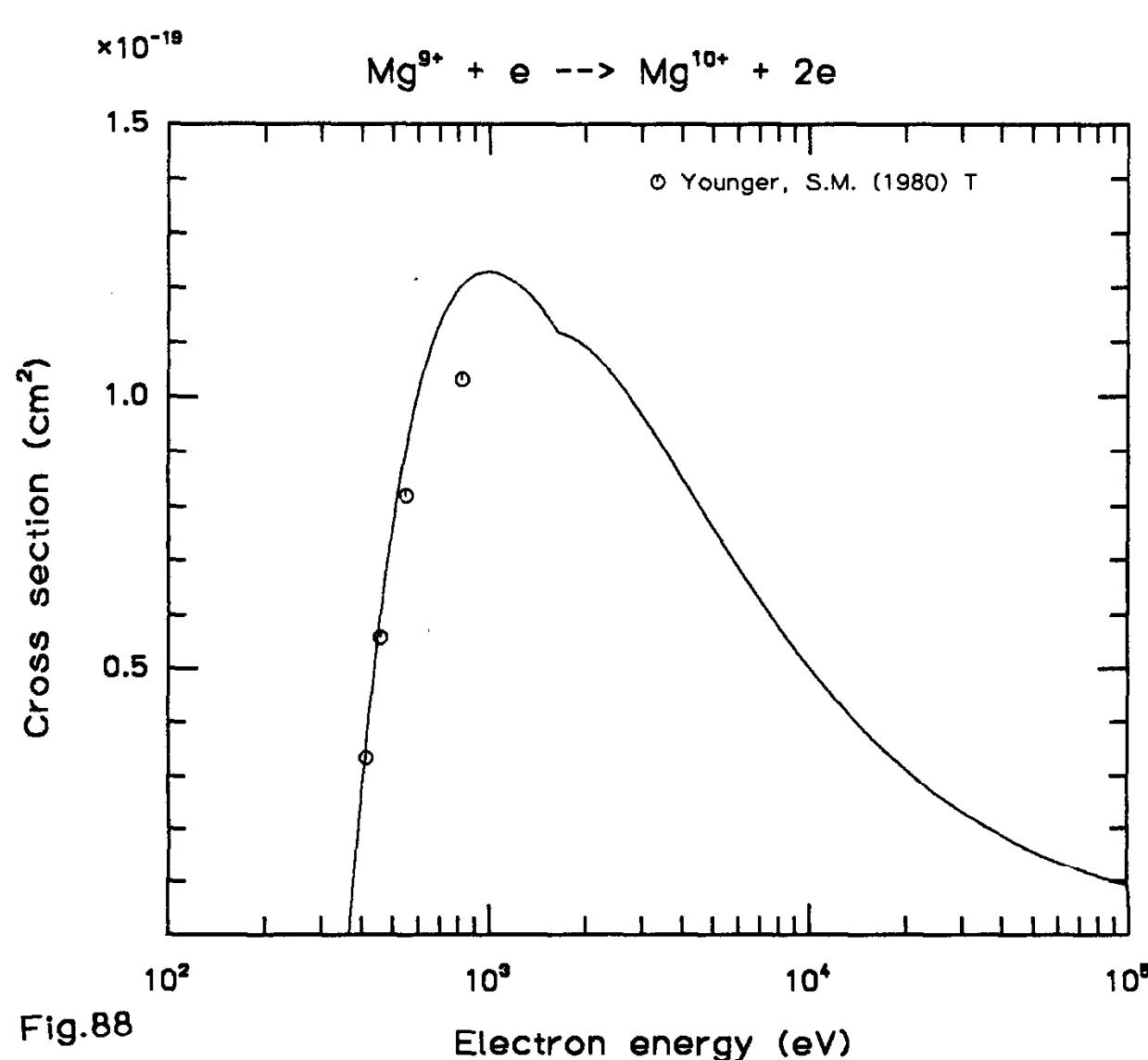


Fig.88

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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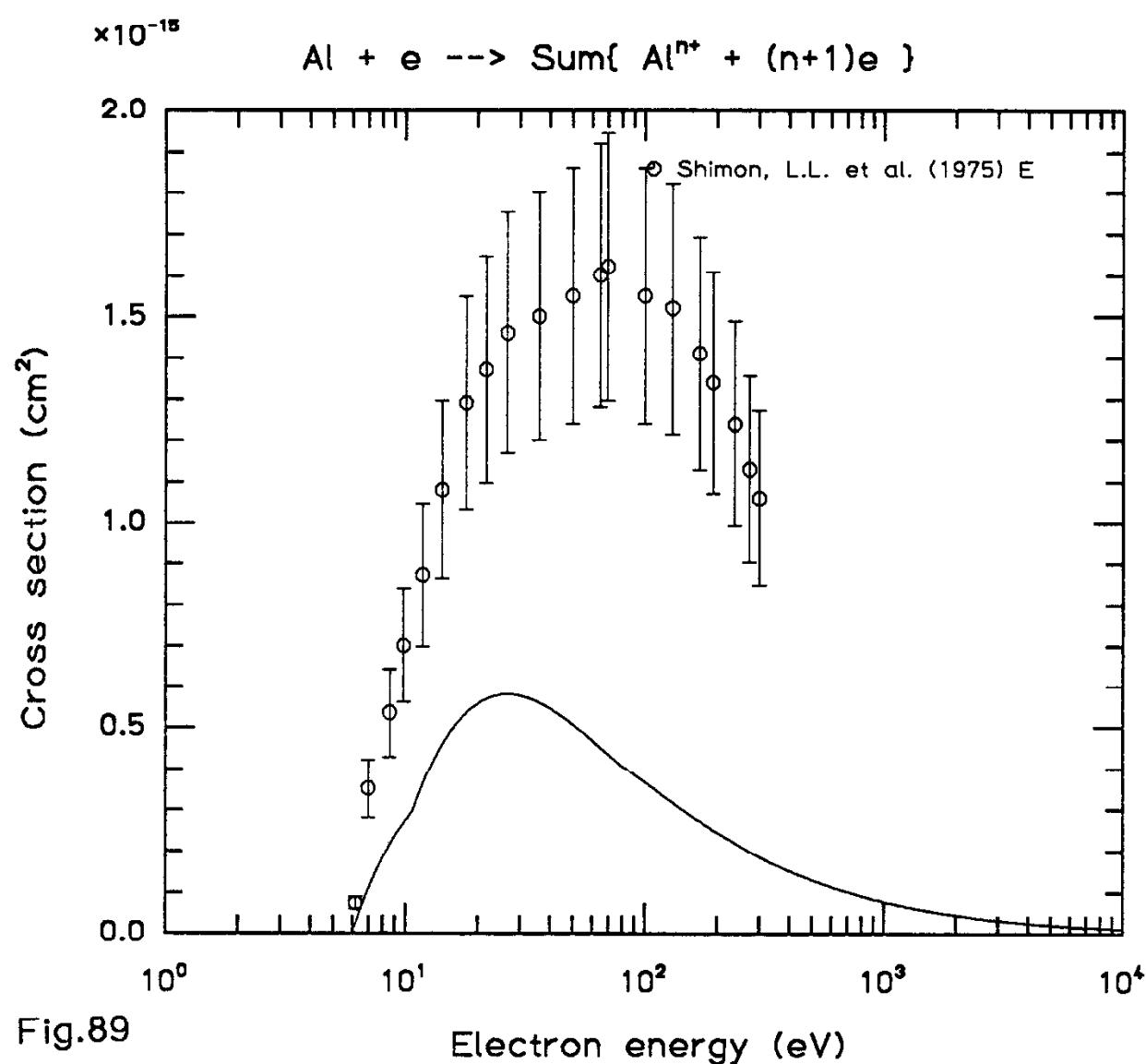


Fig.89

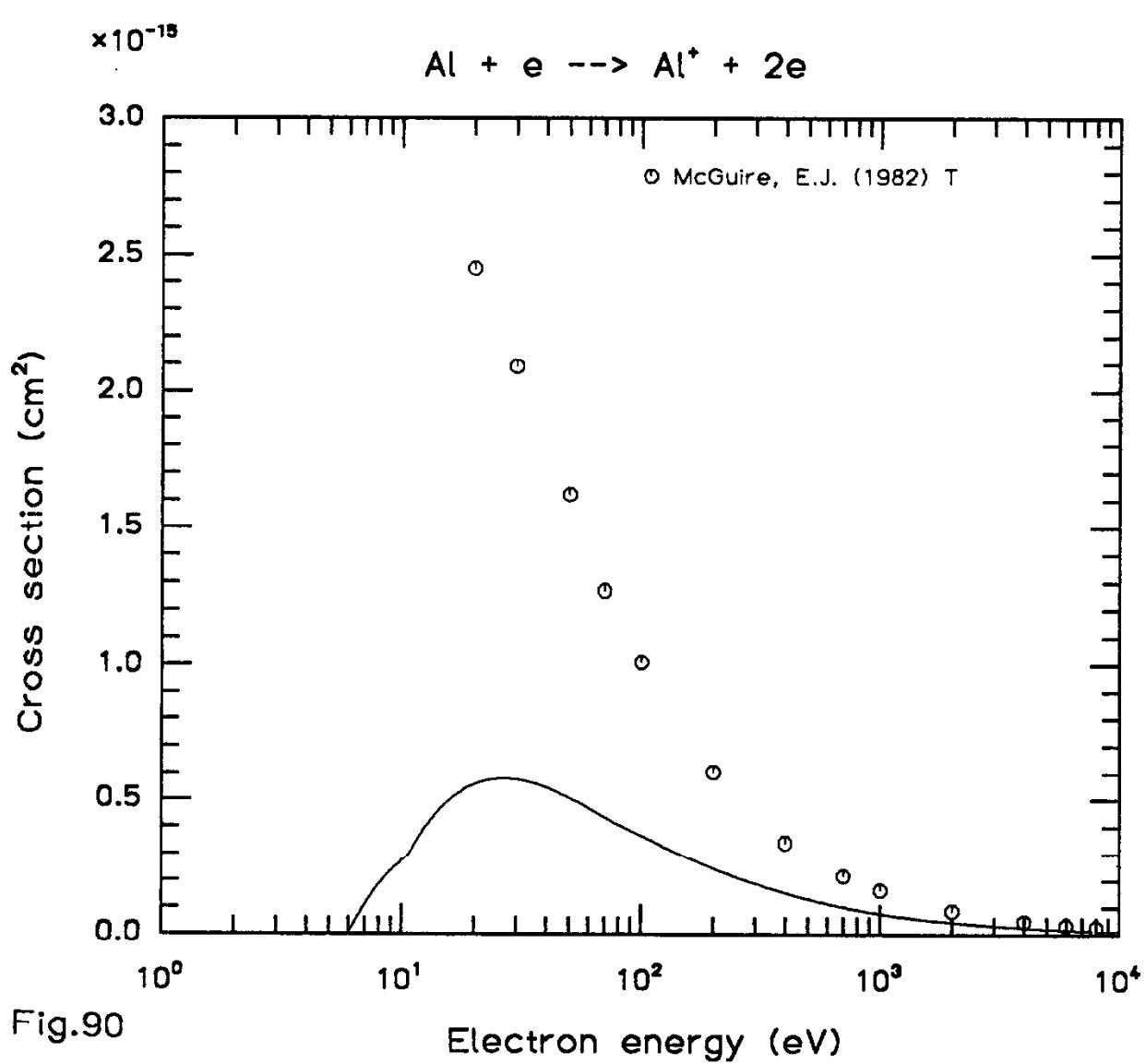


Fig.90

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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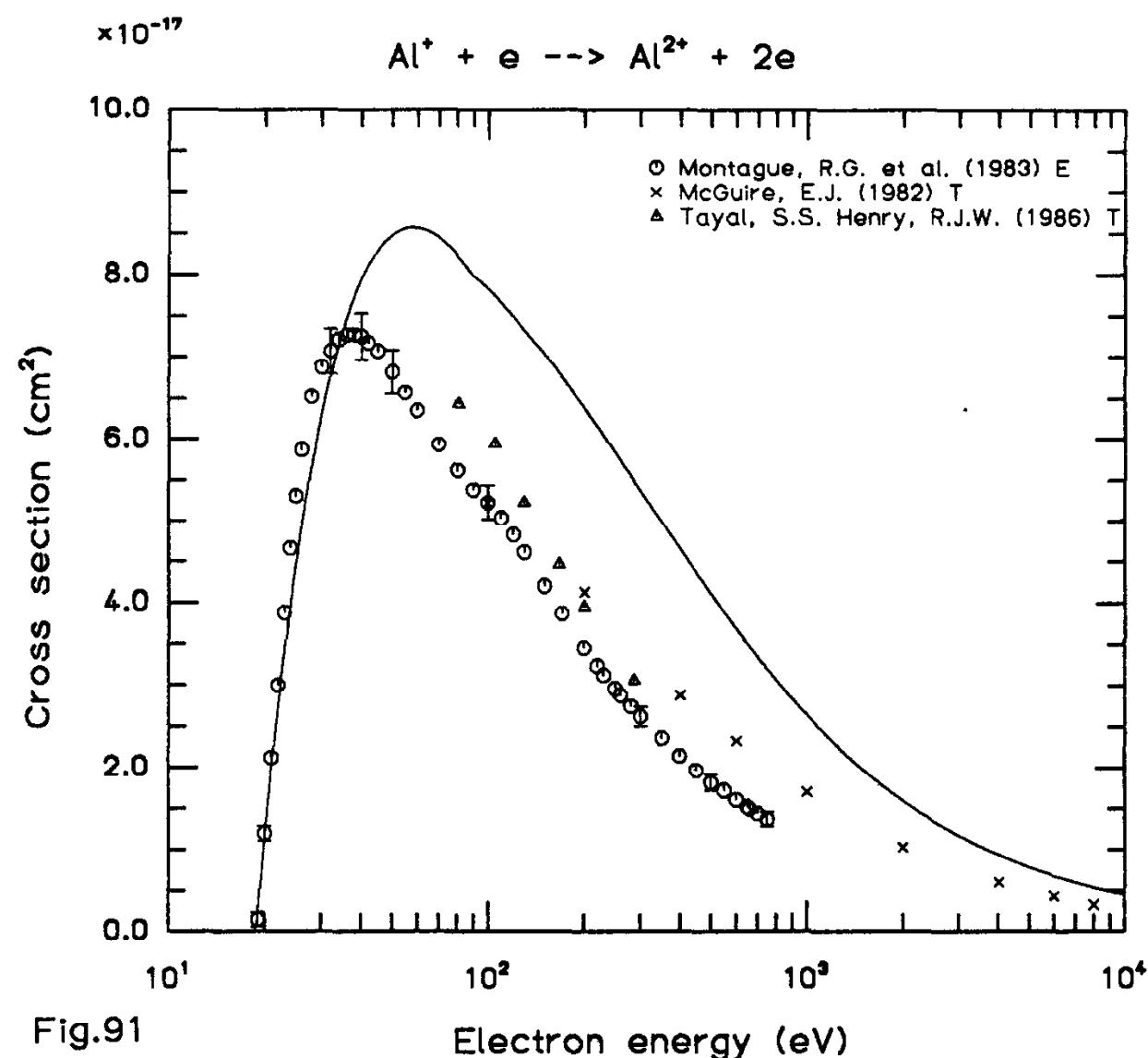


Fig.91

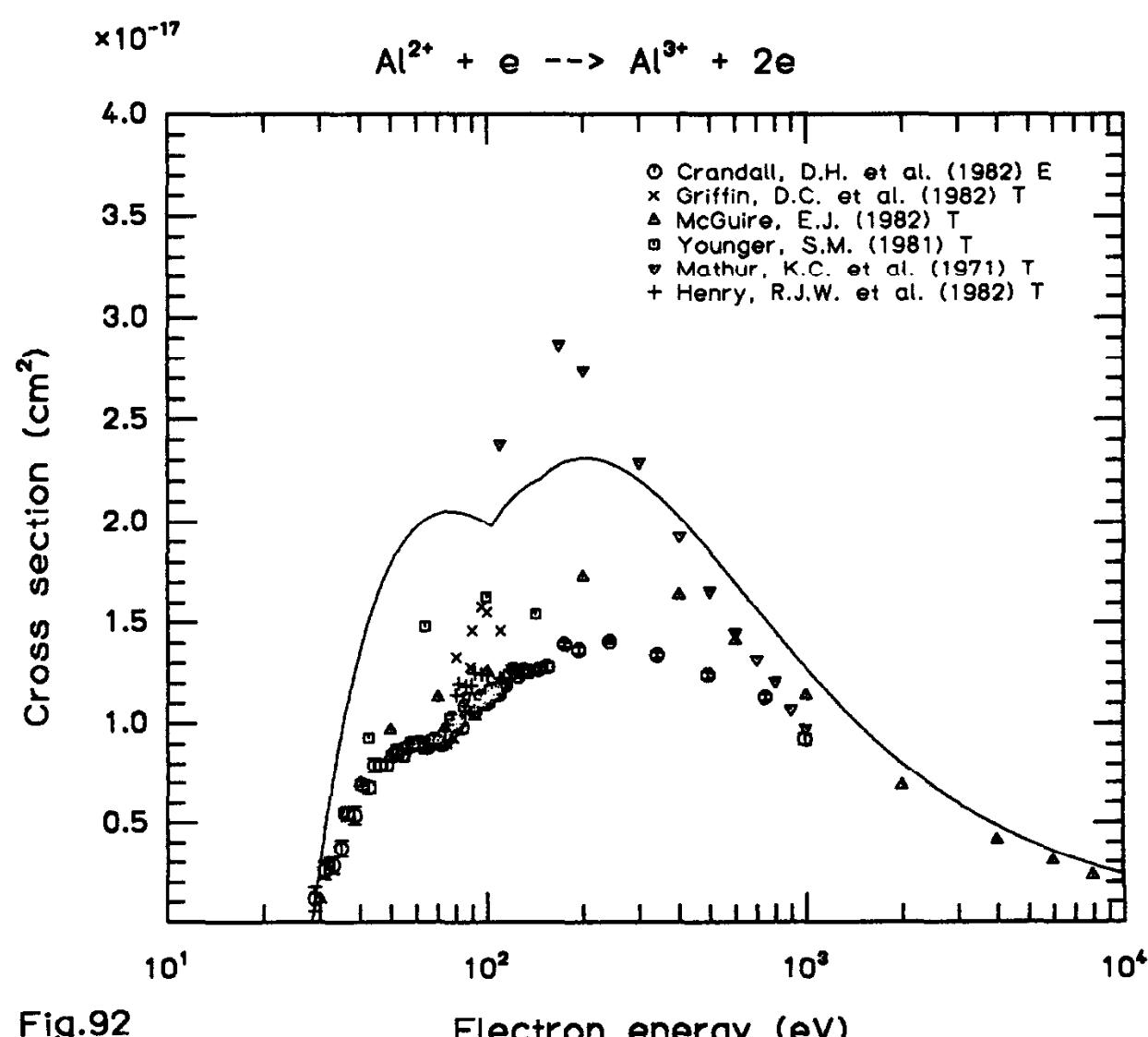


Fig.92

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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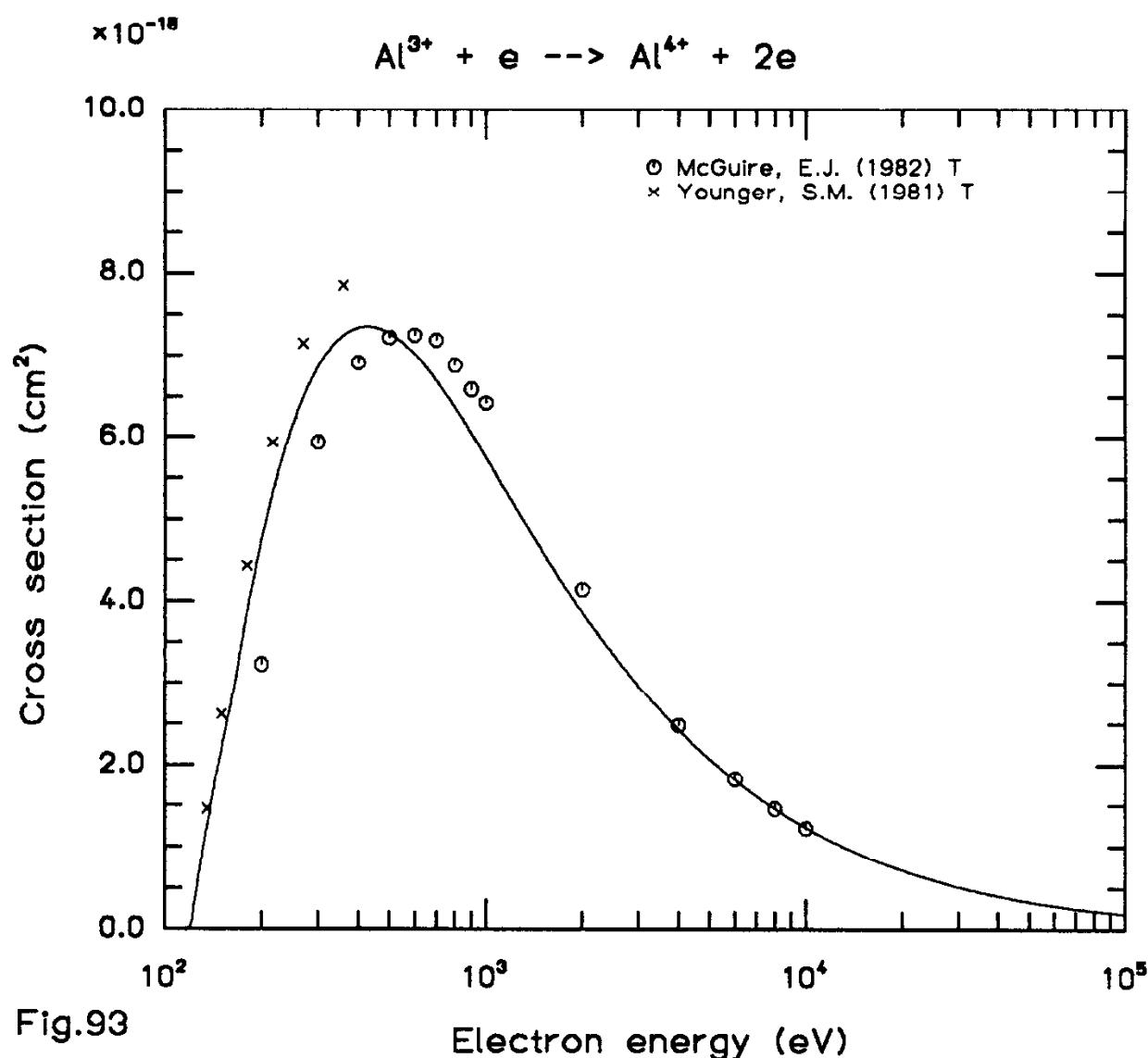


Fig.93

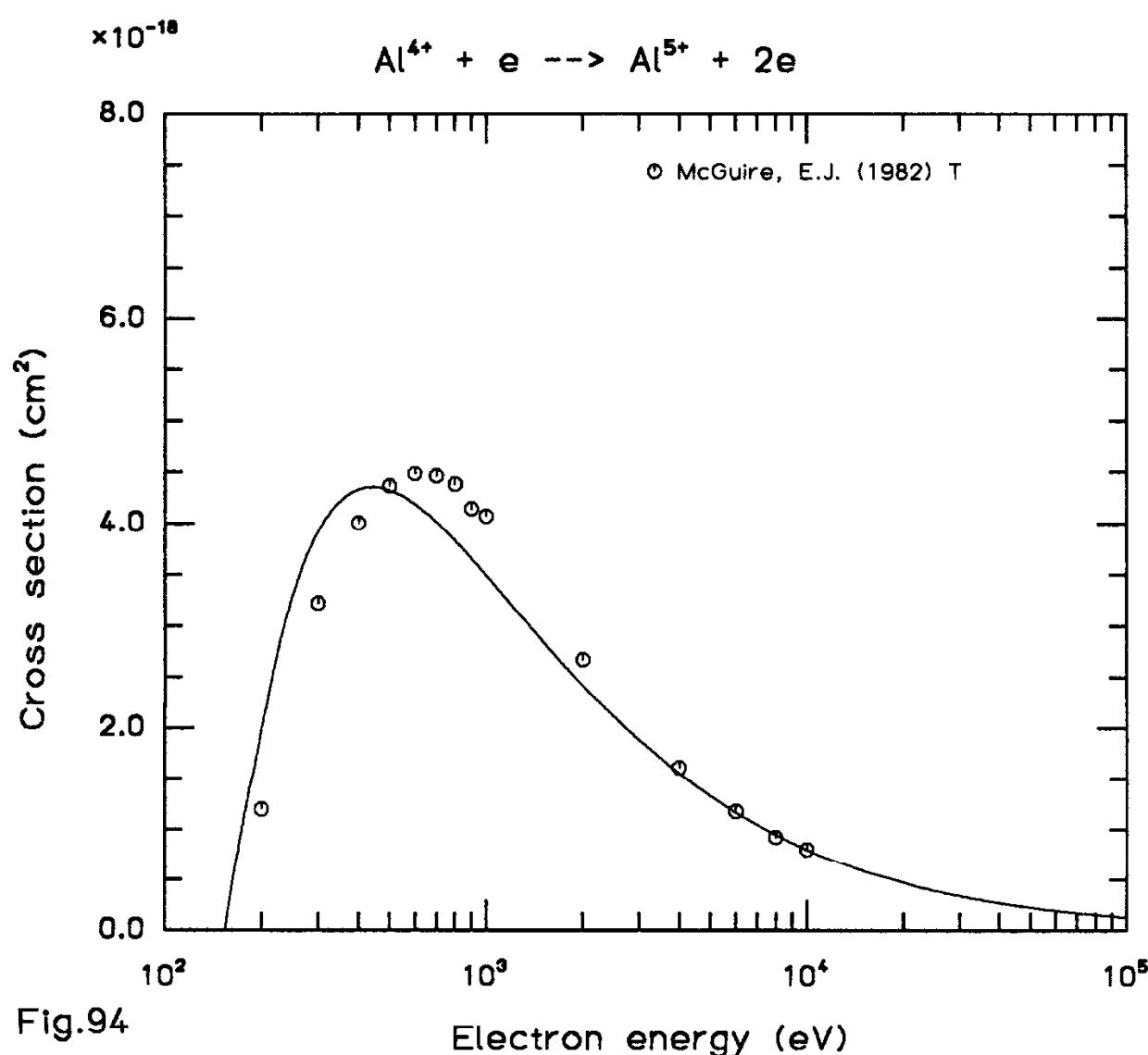


Fig.94

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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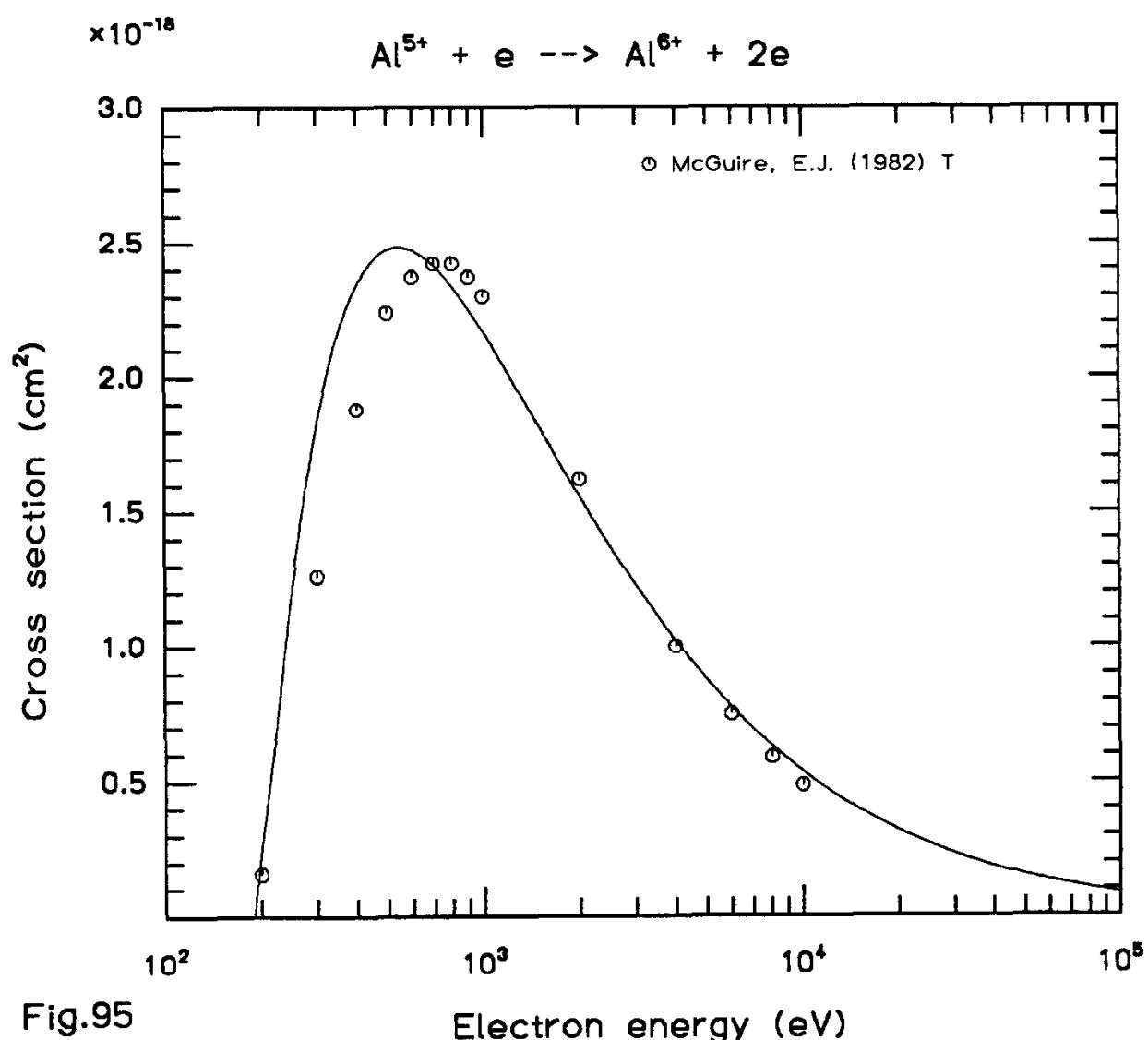


Fig.95

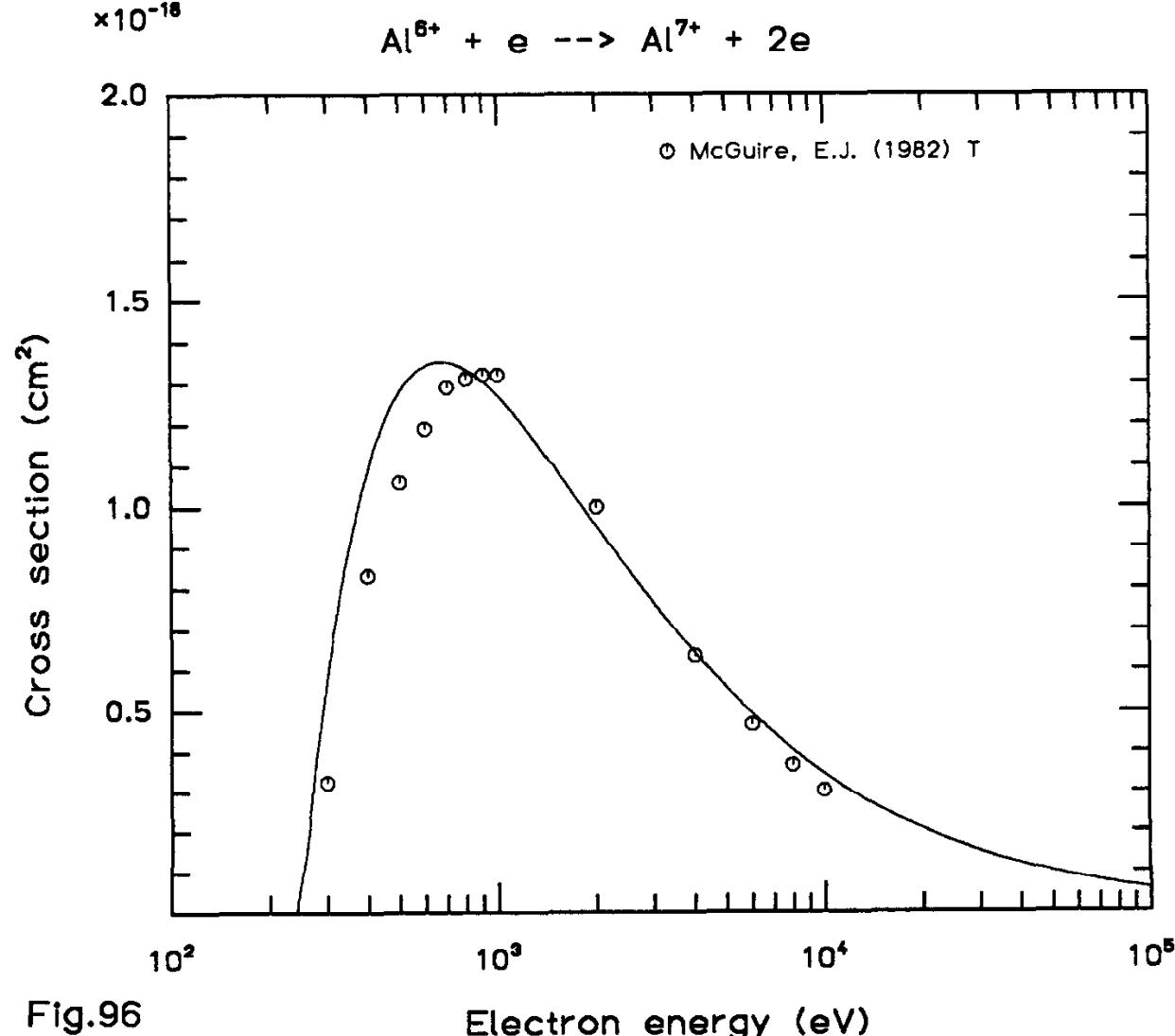


Fig.96

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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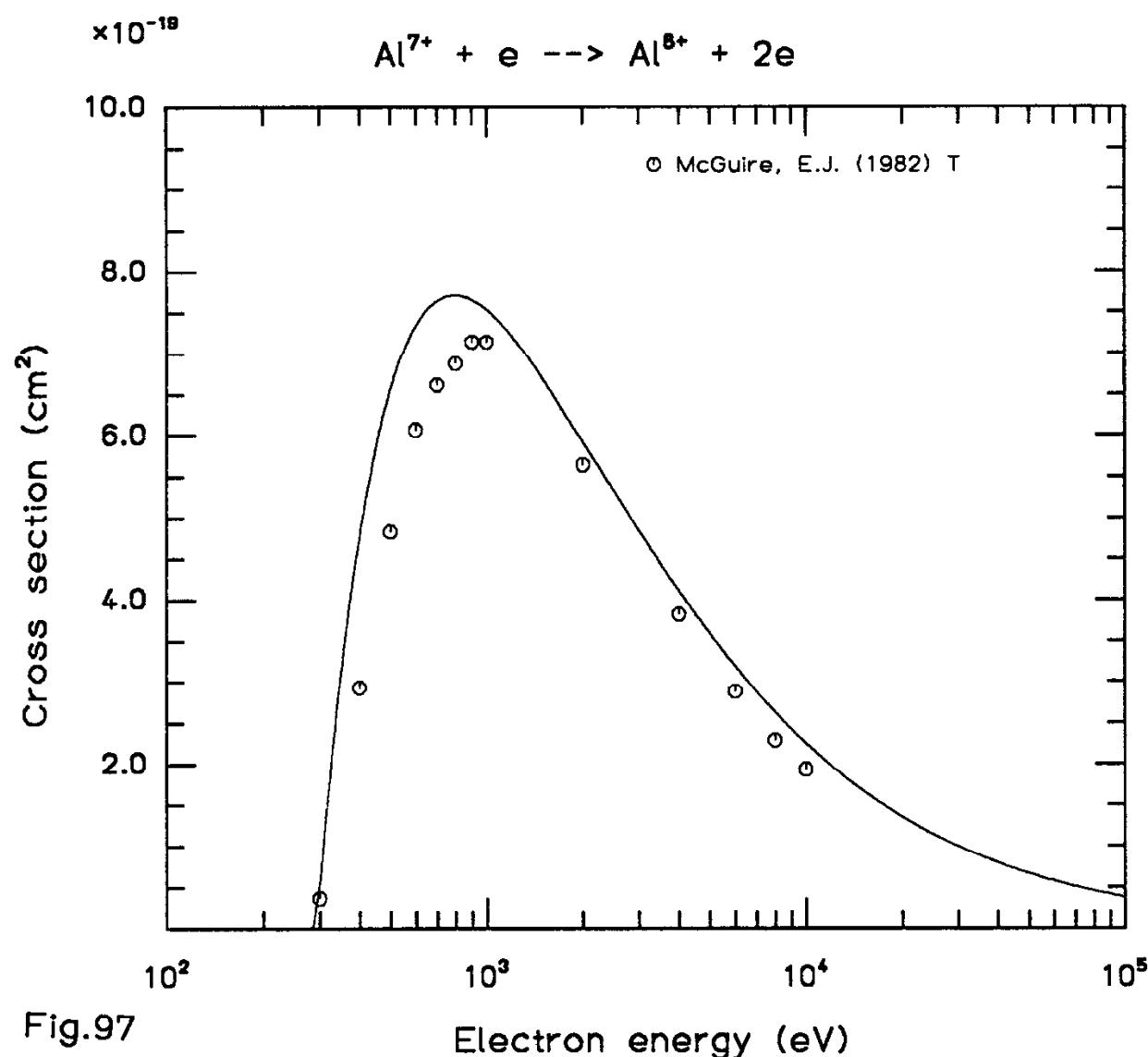


Fig.97

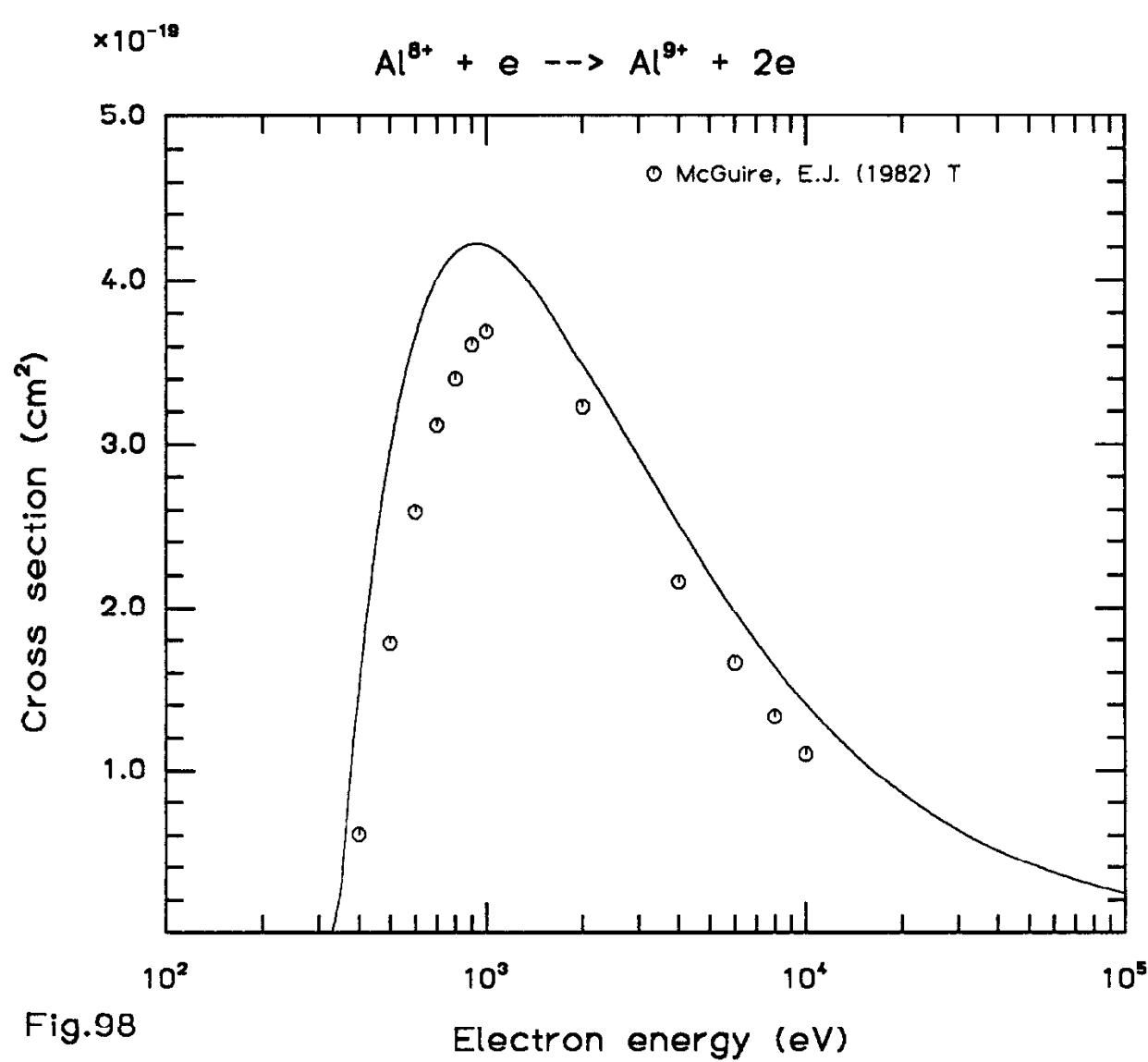


Fig.98

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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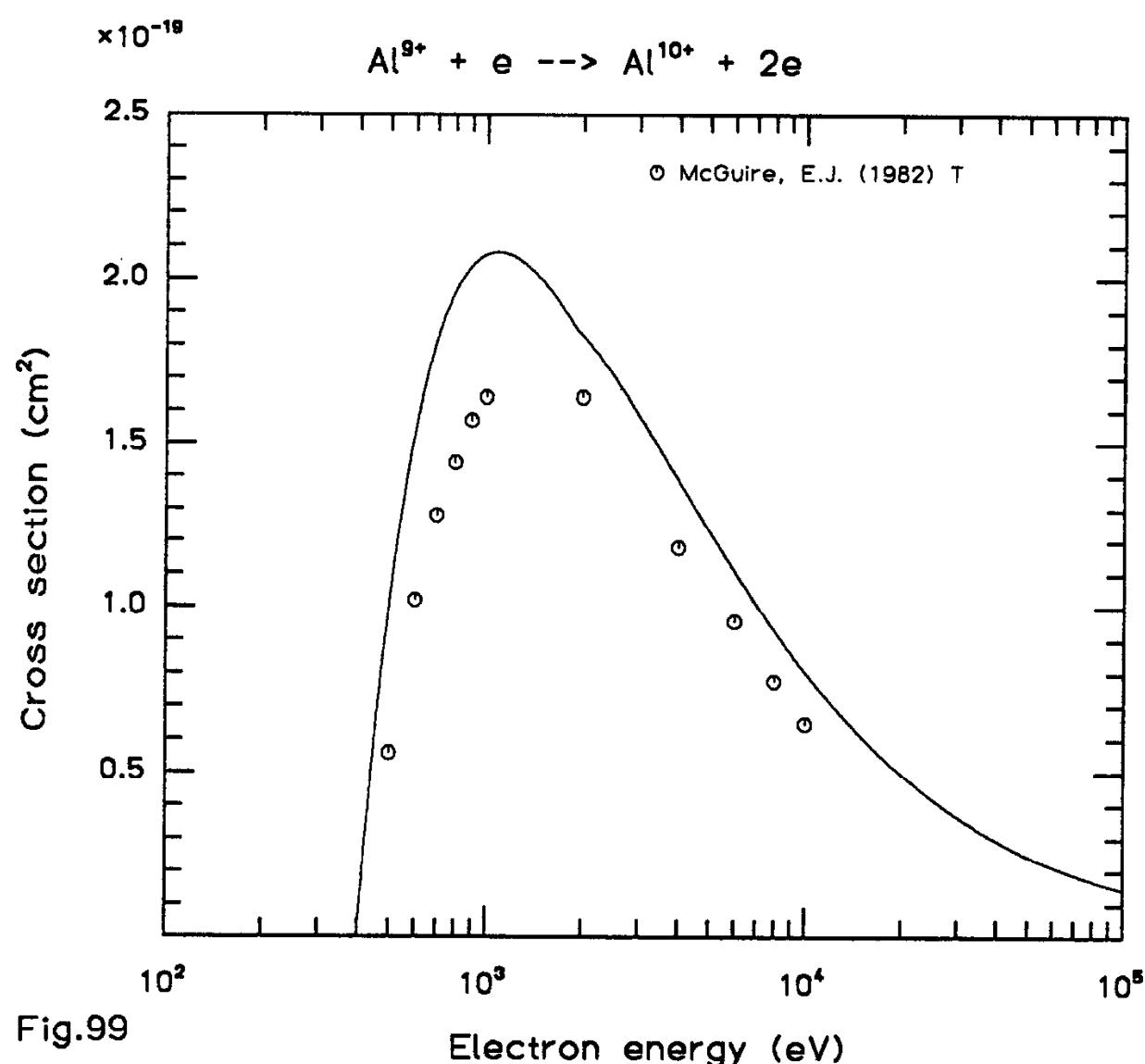


Fig.99

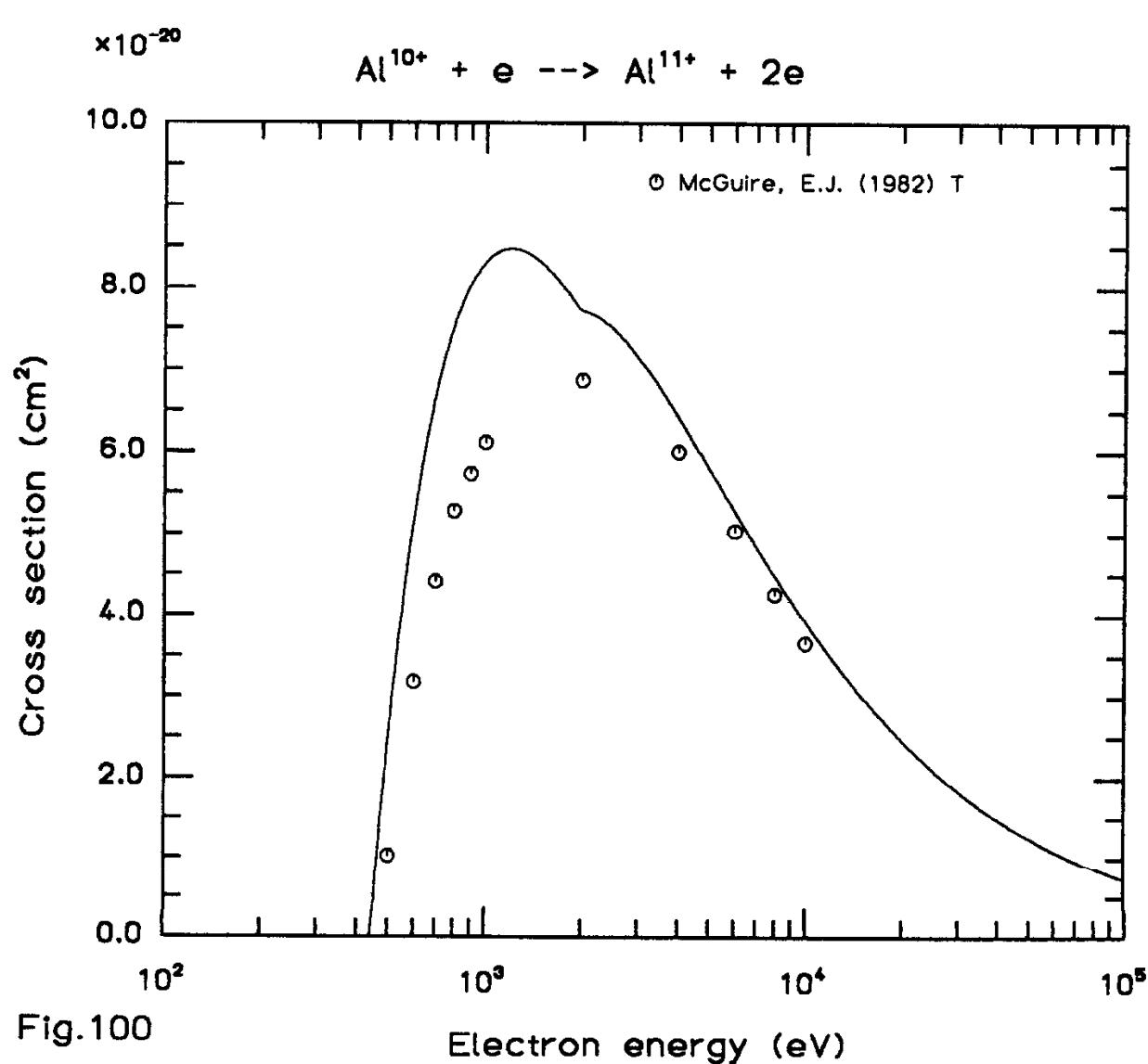


Fig.100

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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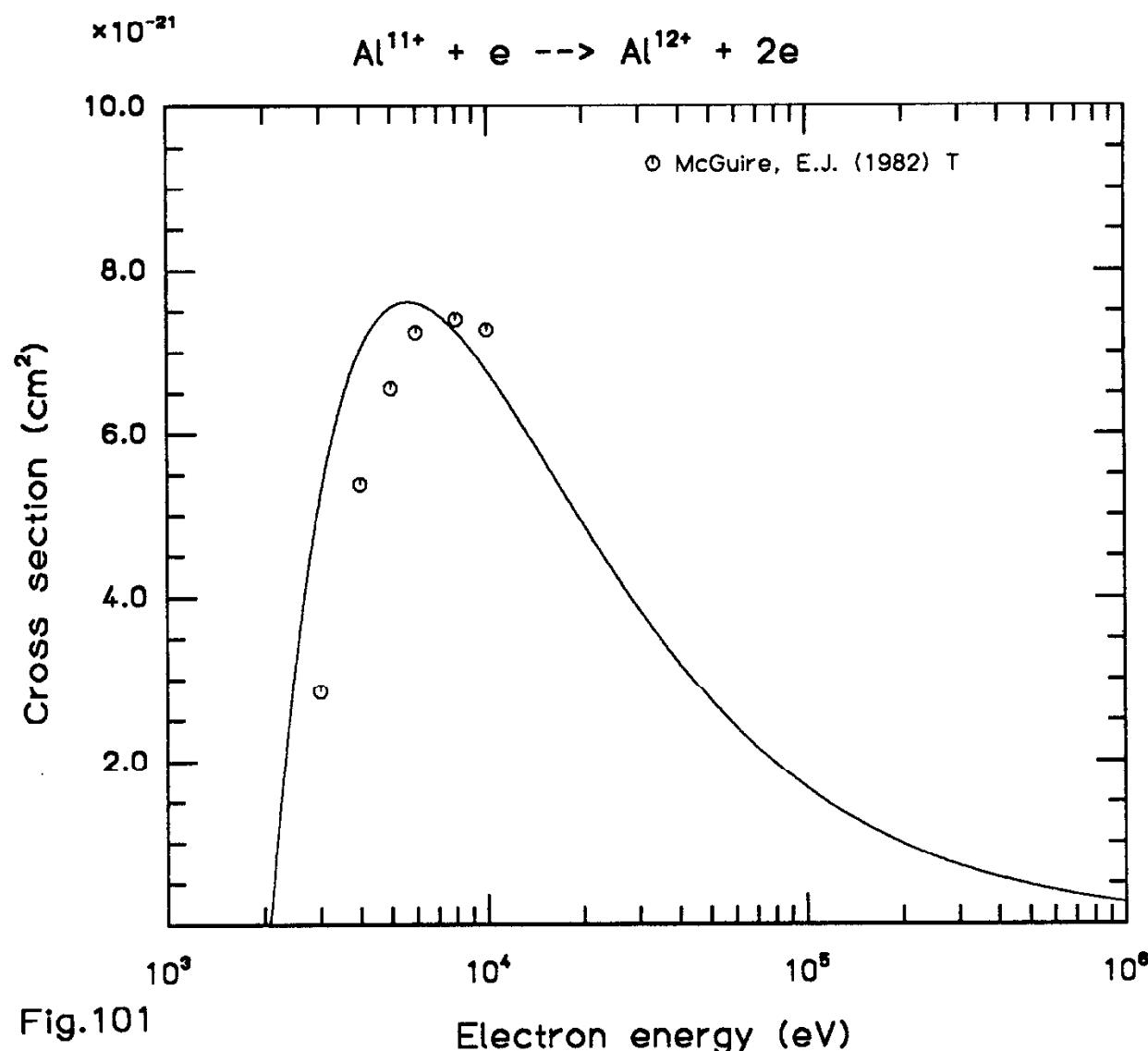


Fig.101

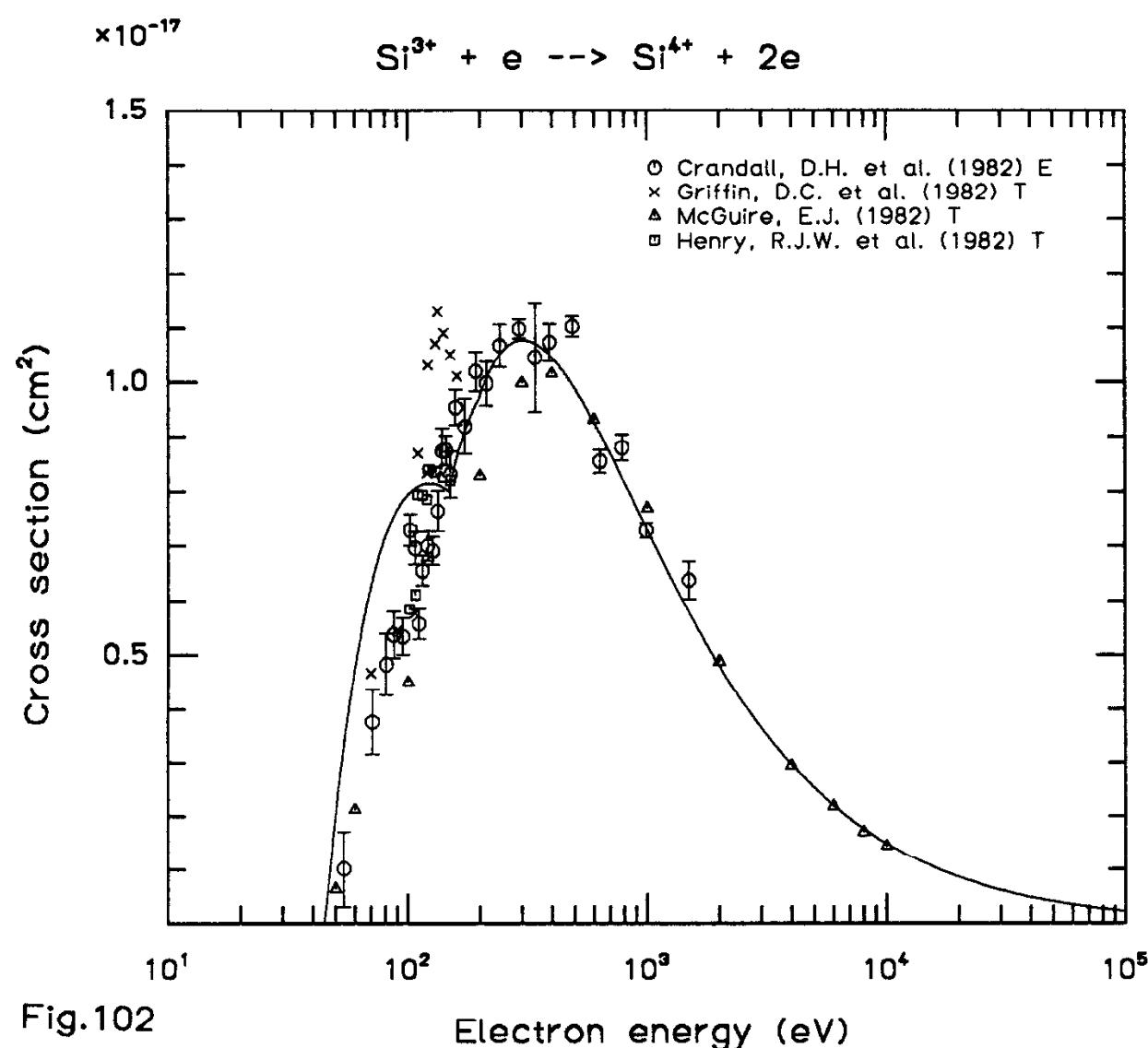
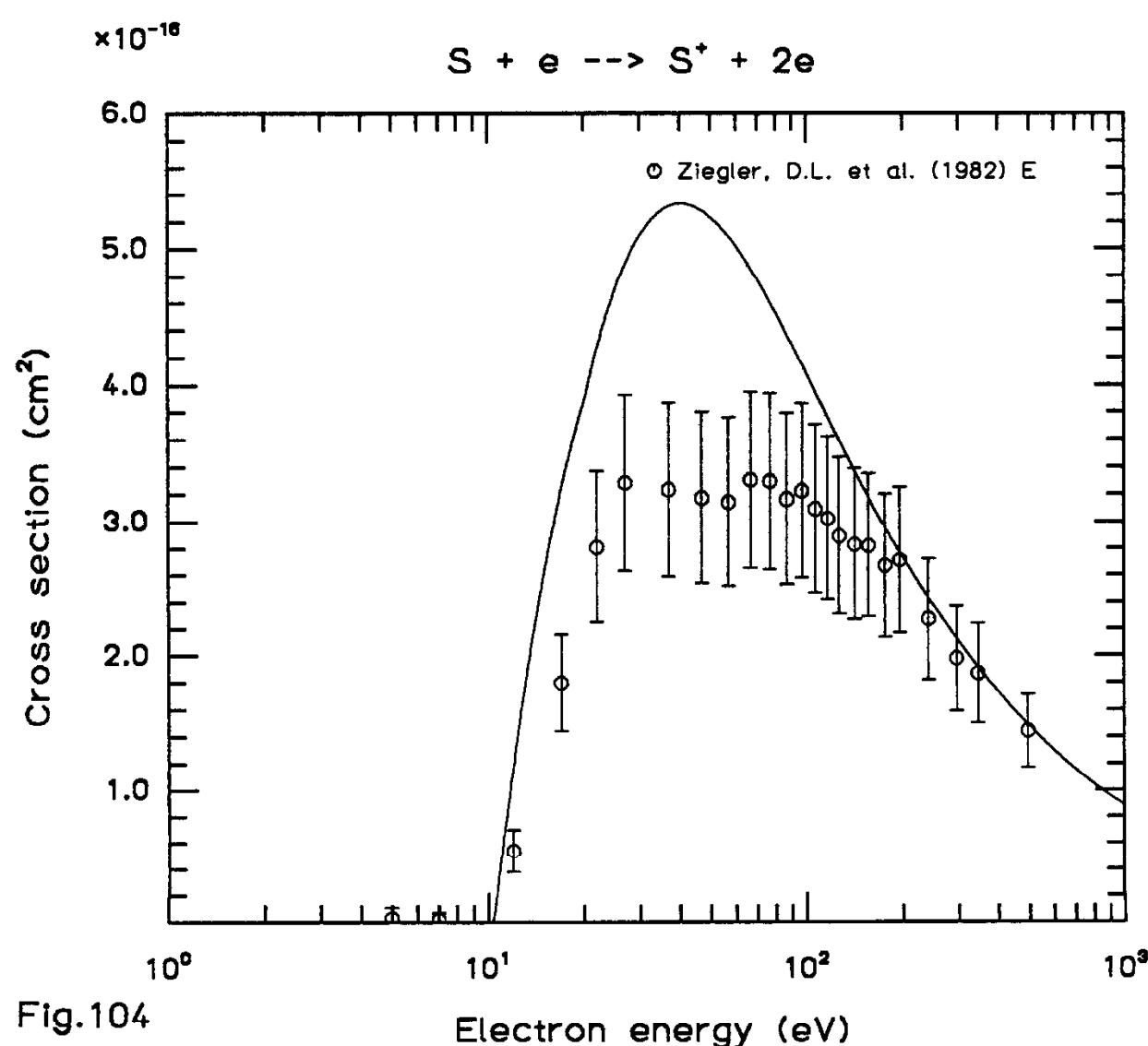
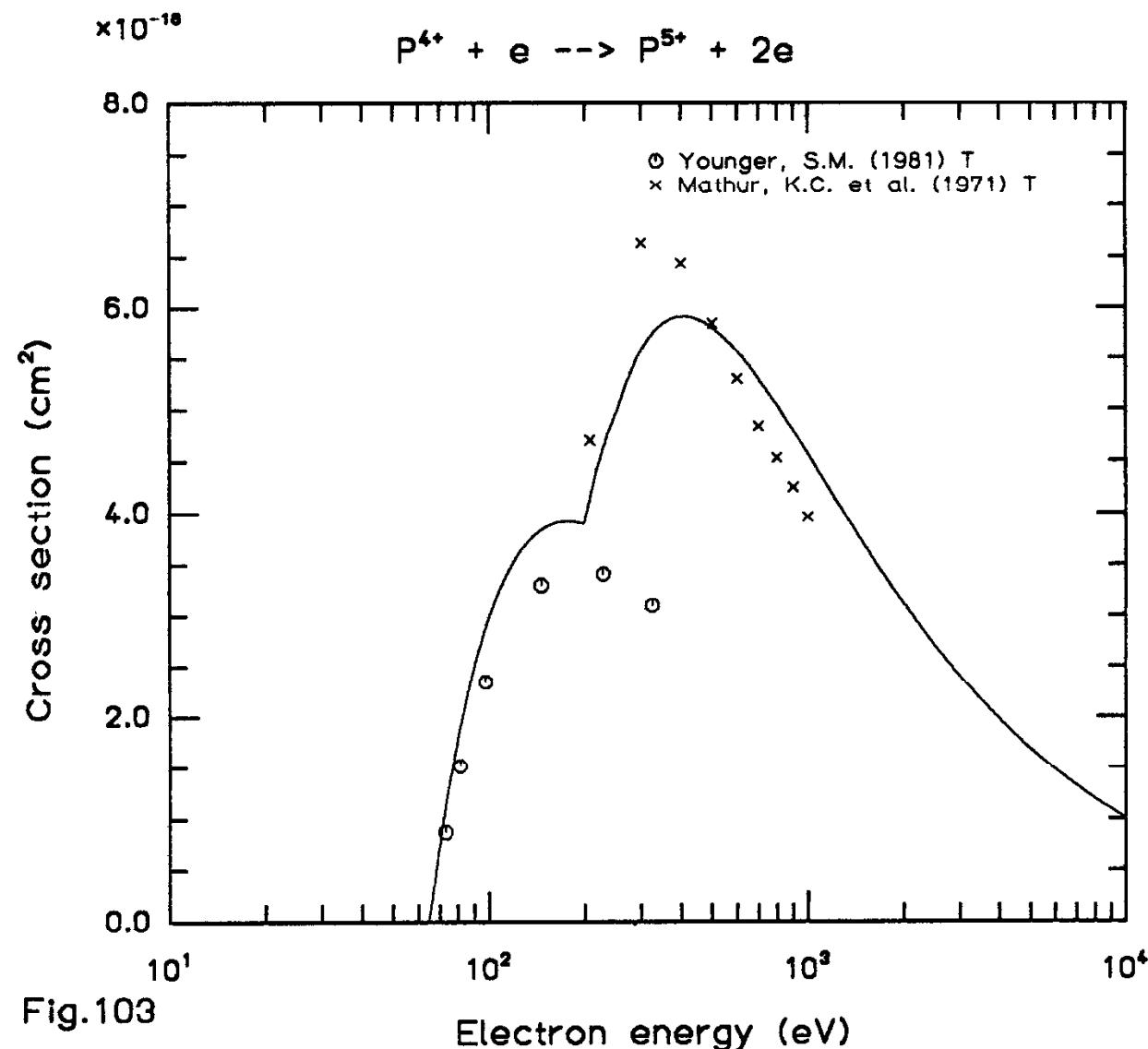


Fig.102

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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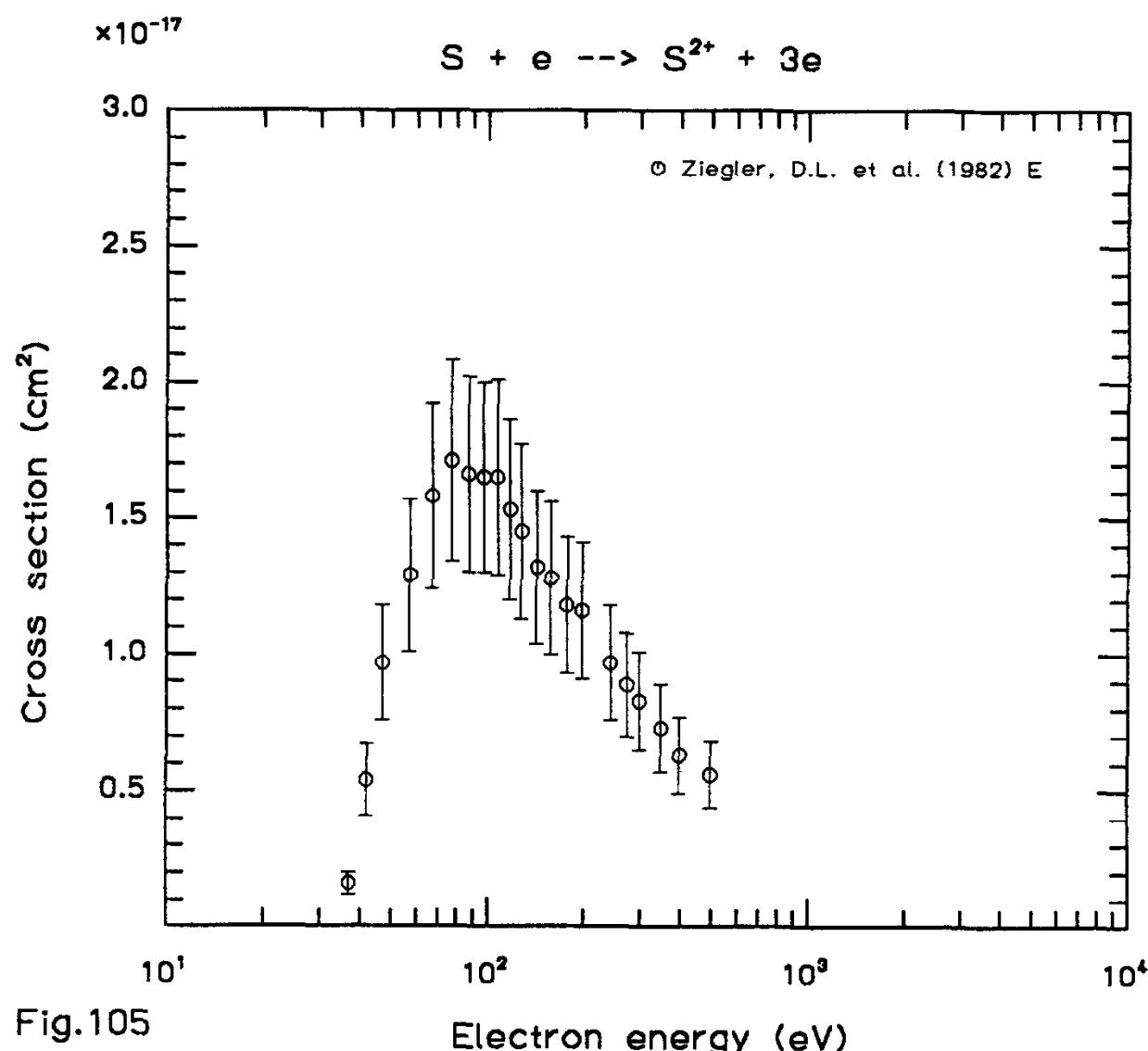


Fig.105

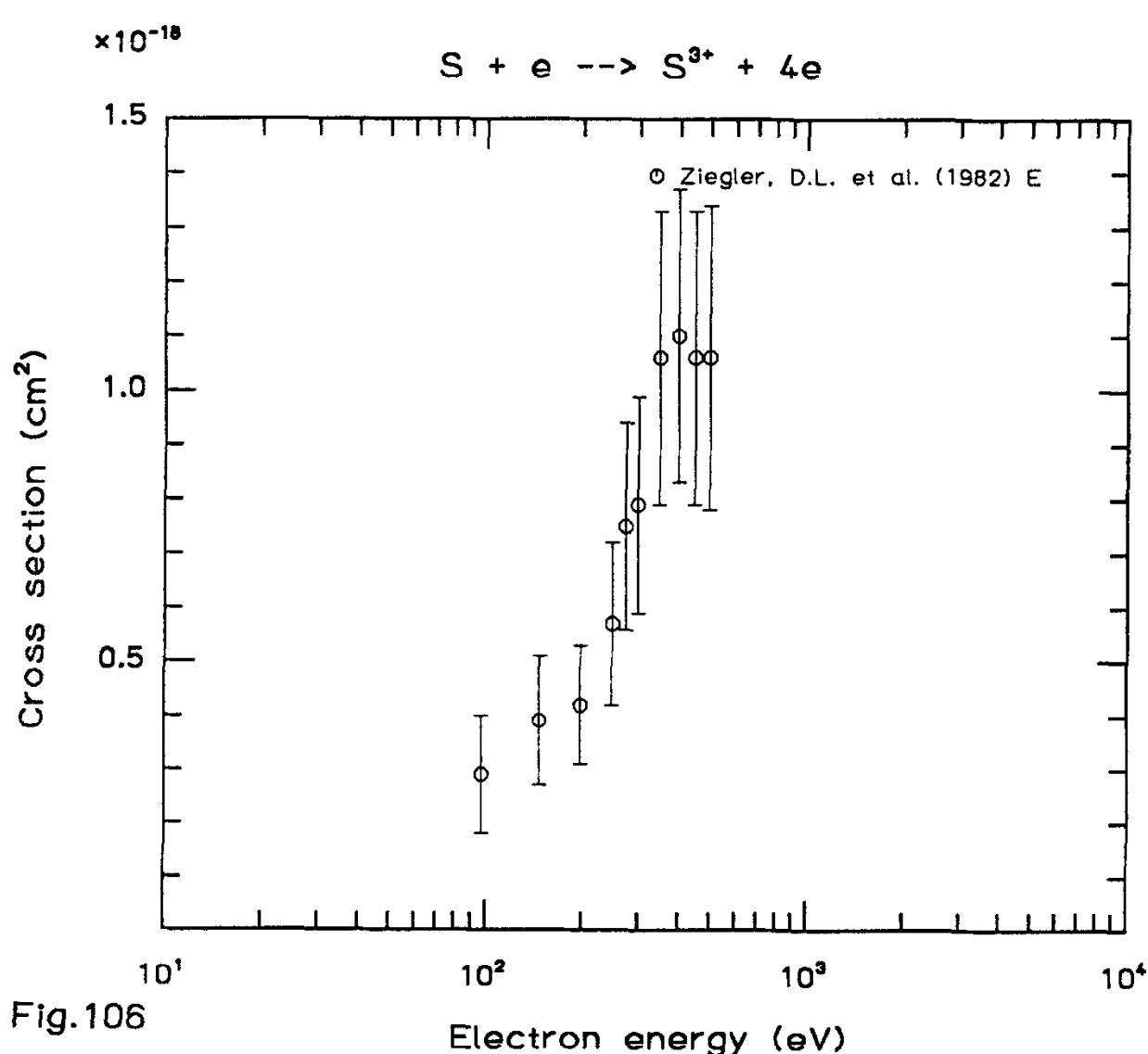


Fig.106

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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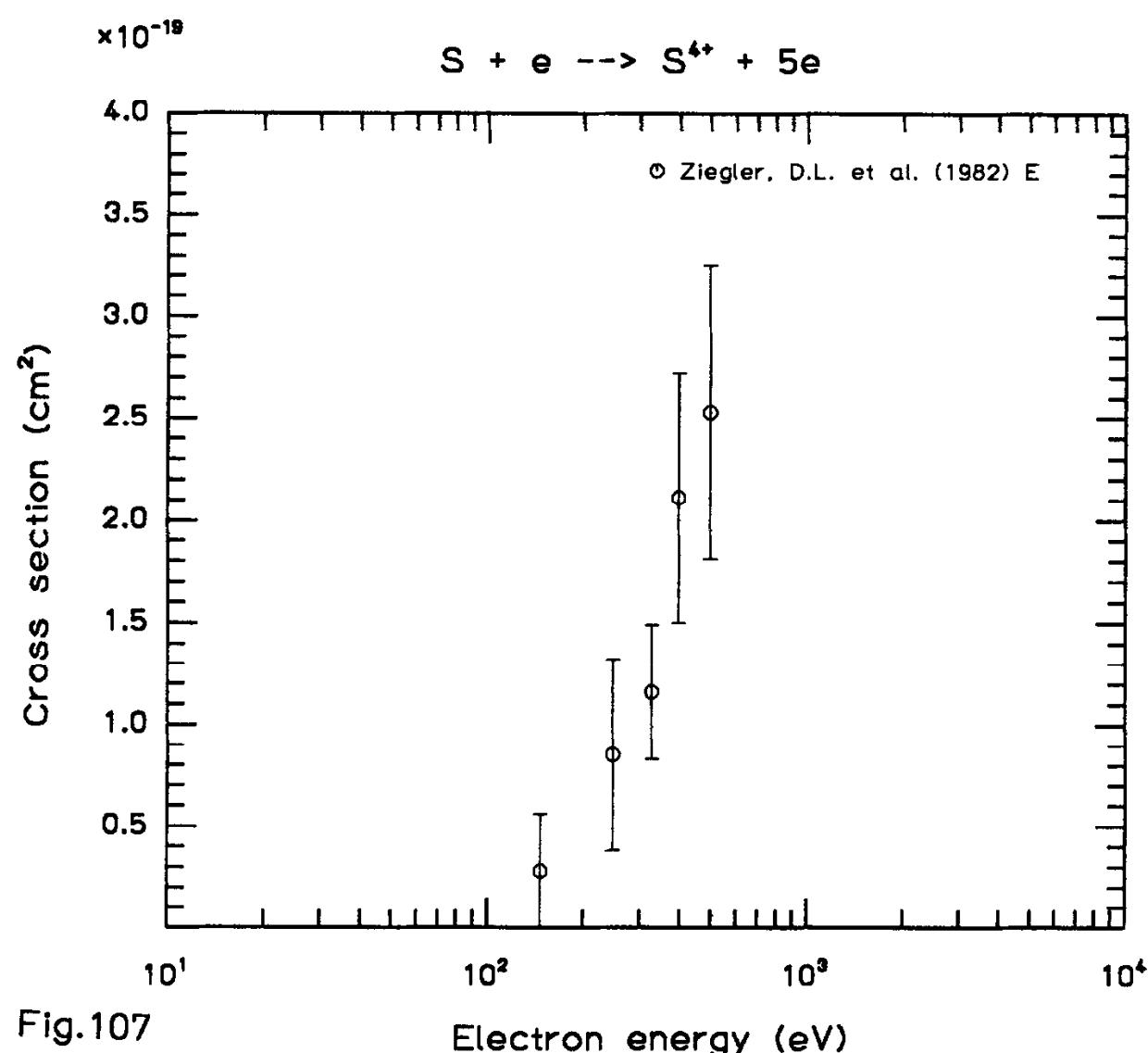


Fig.107

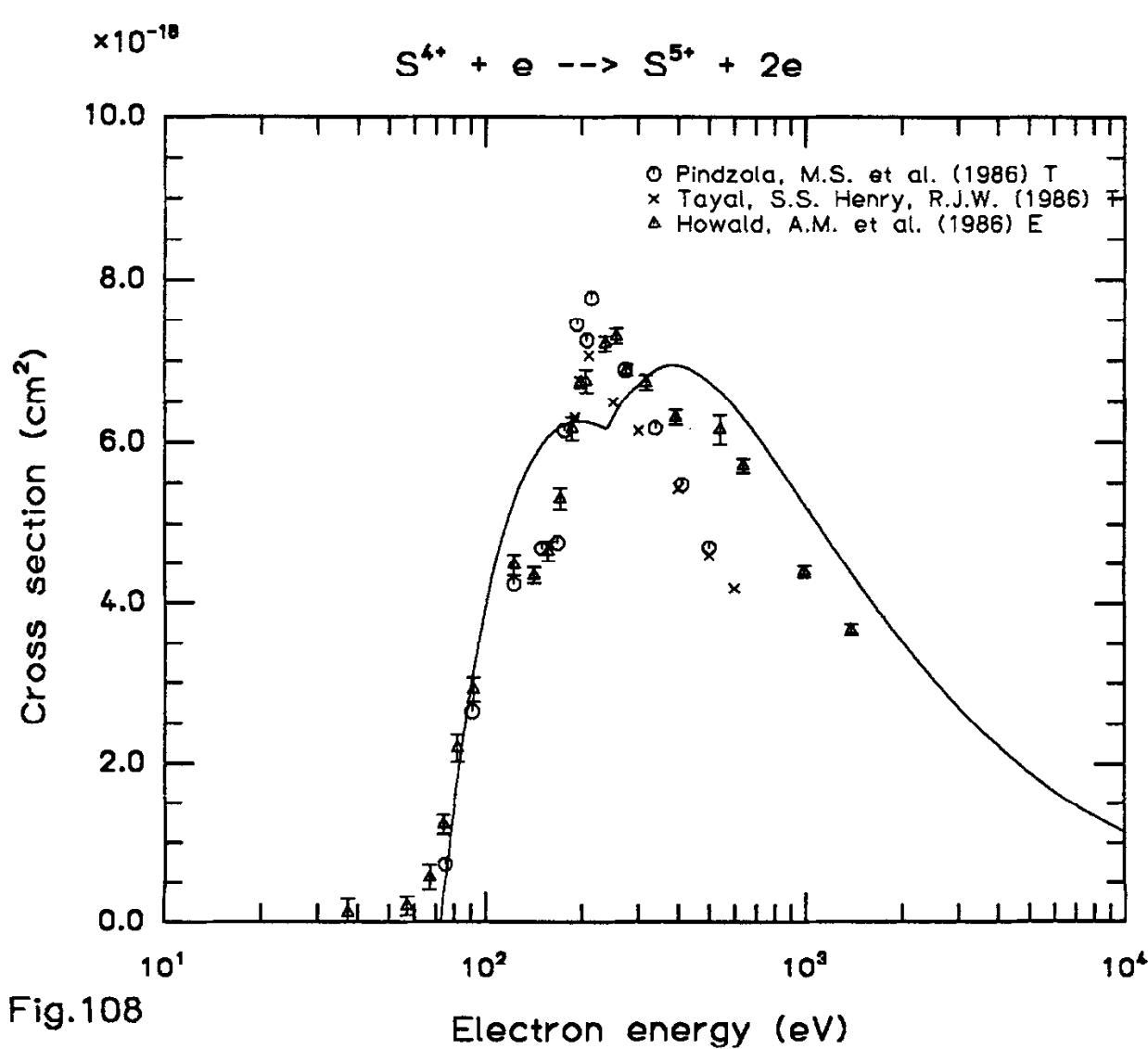


Fig.108

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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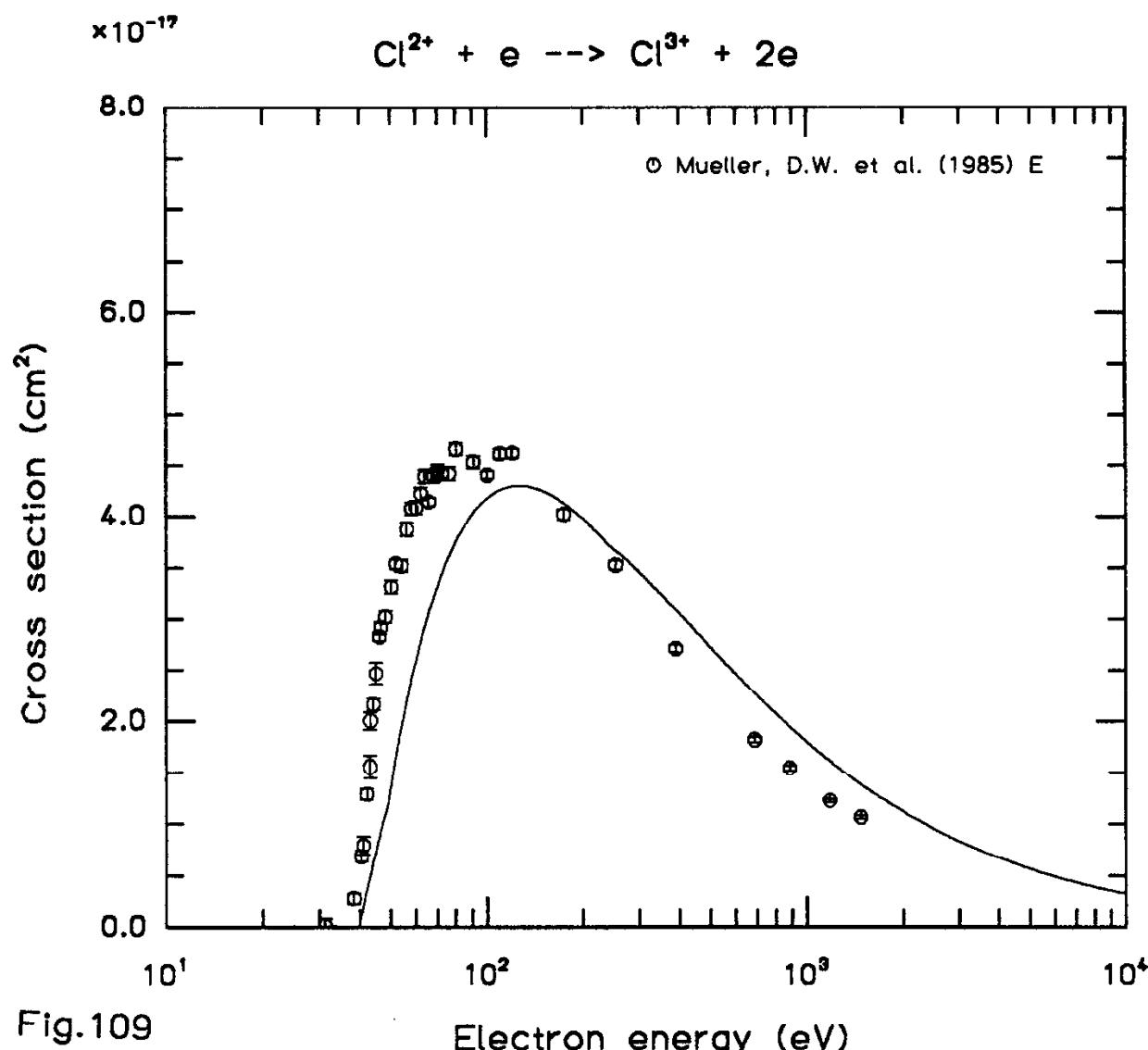


Fig.109

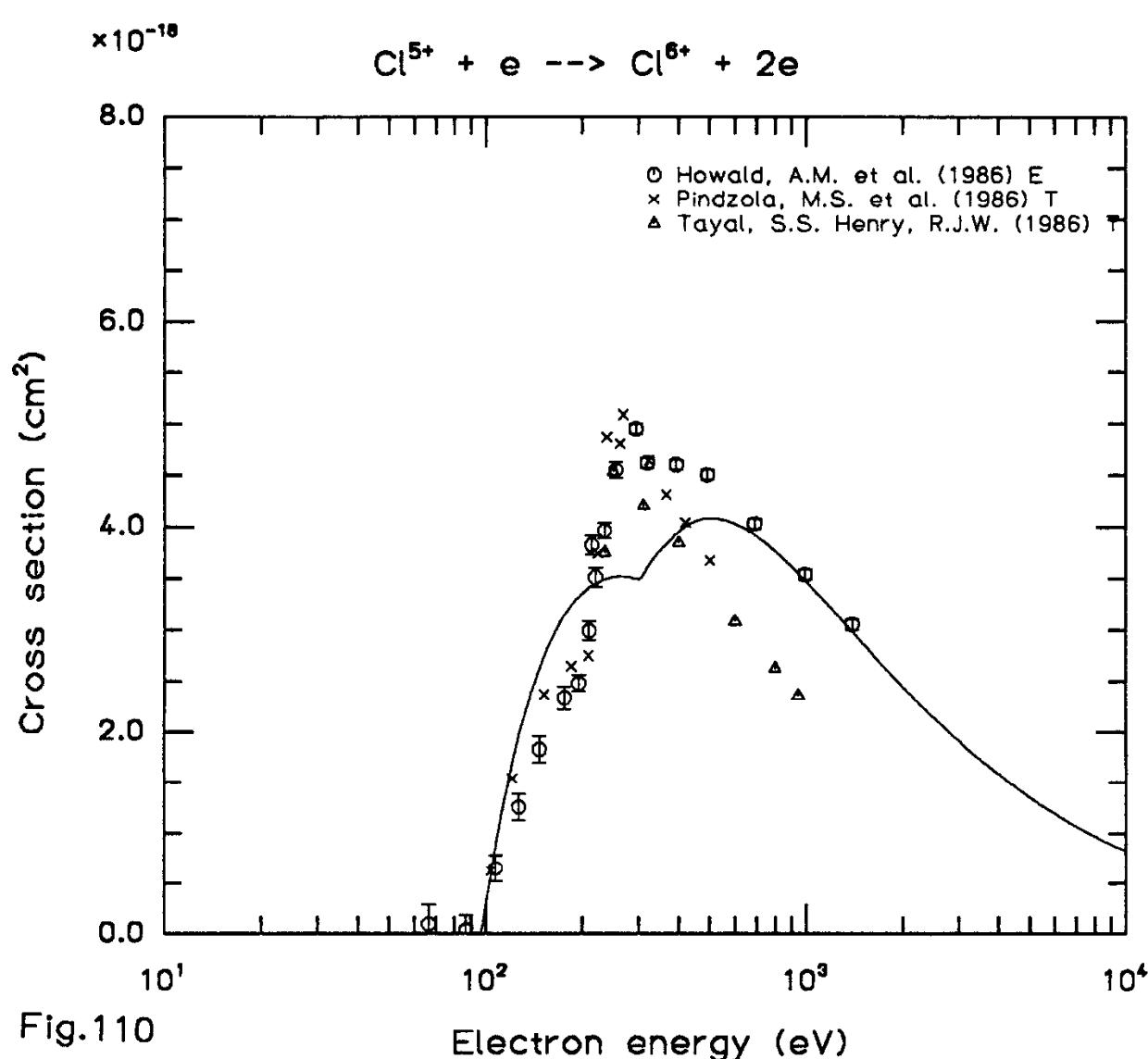
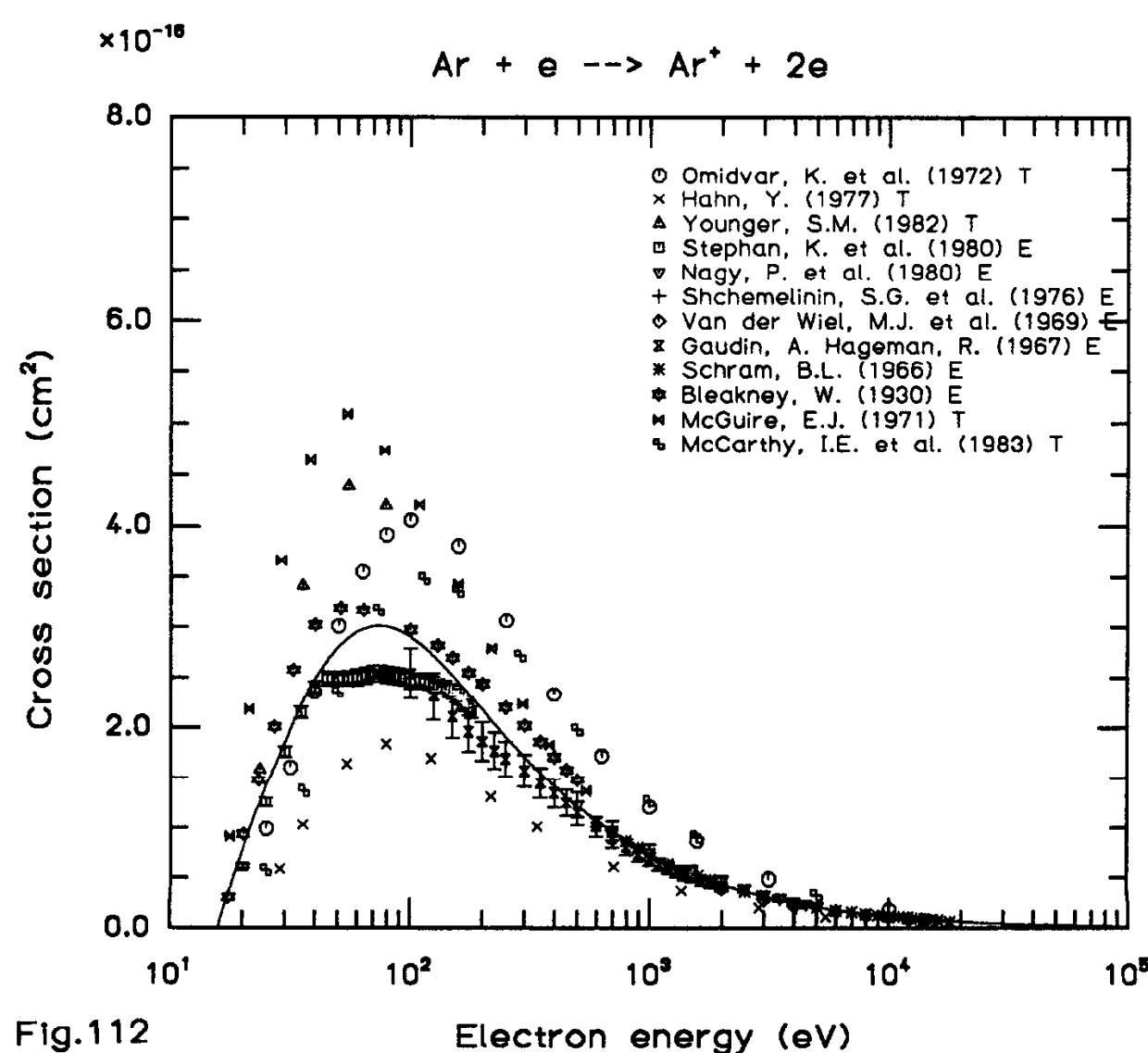
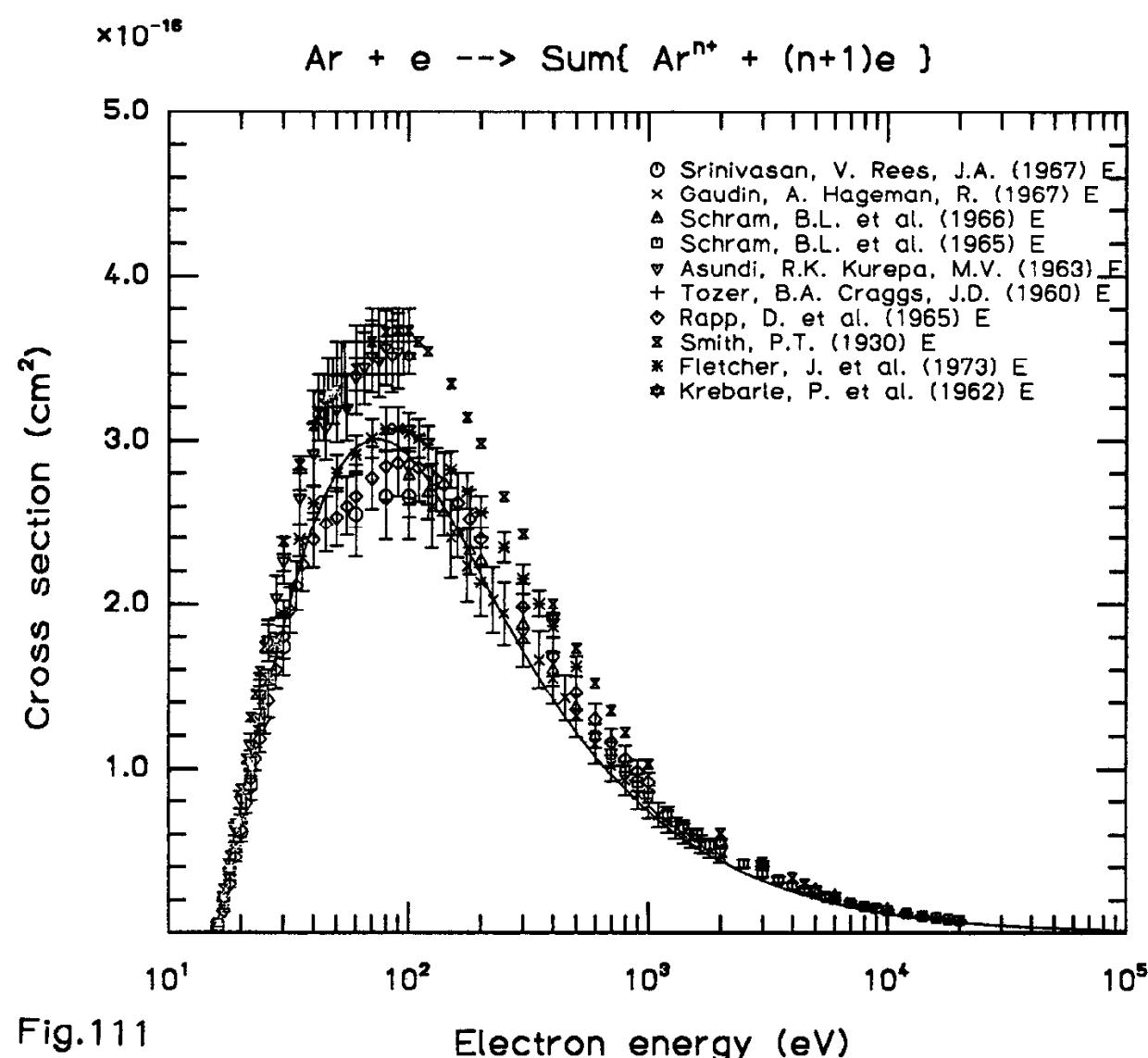


Fig.110

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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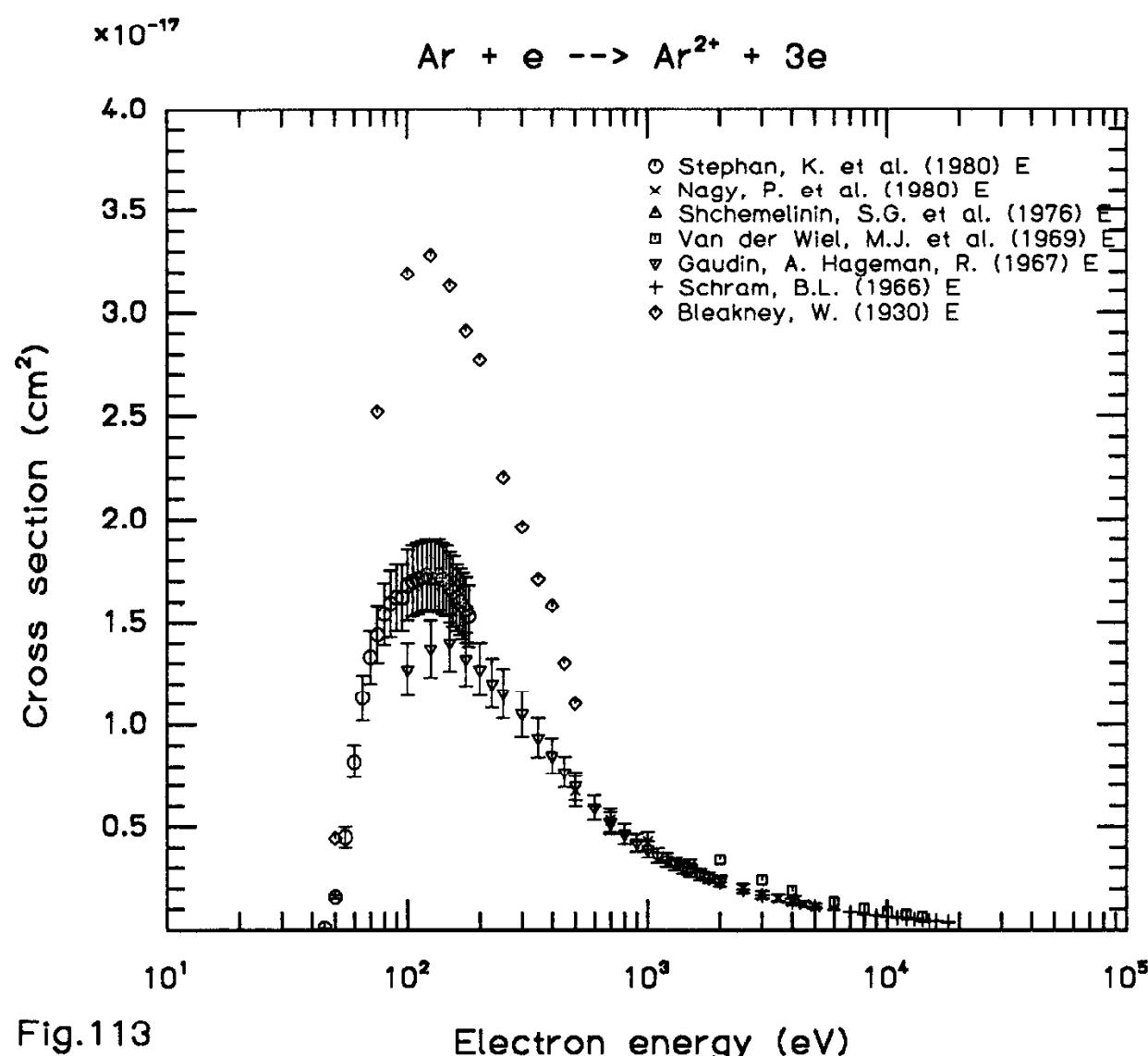


Fig.113

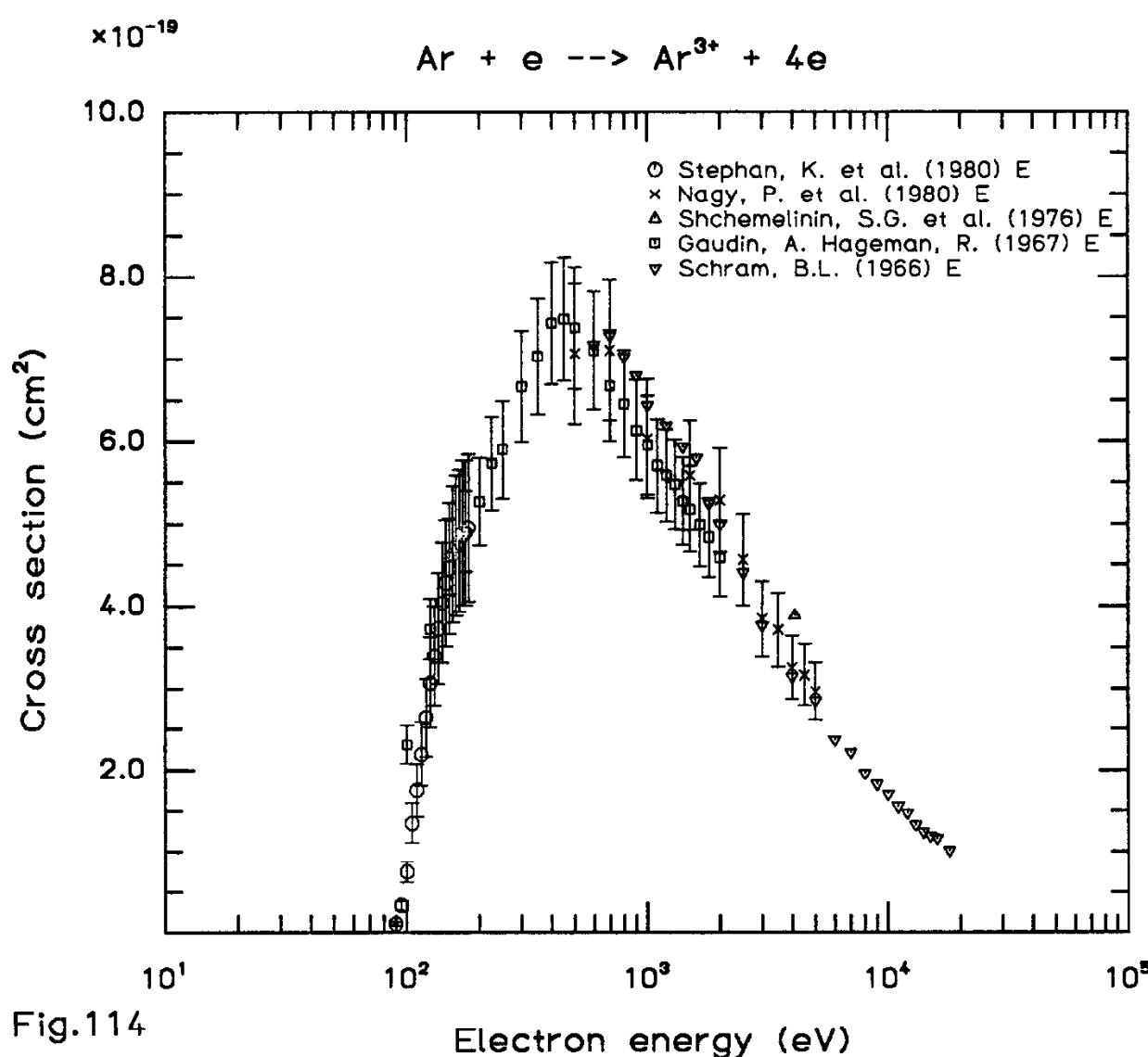


Fig.114

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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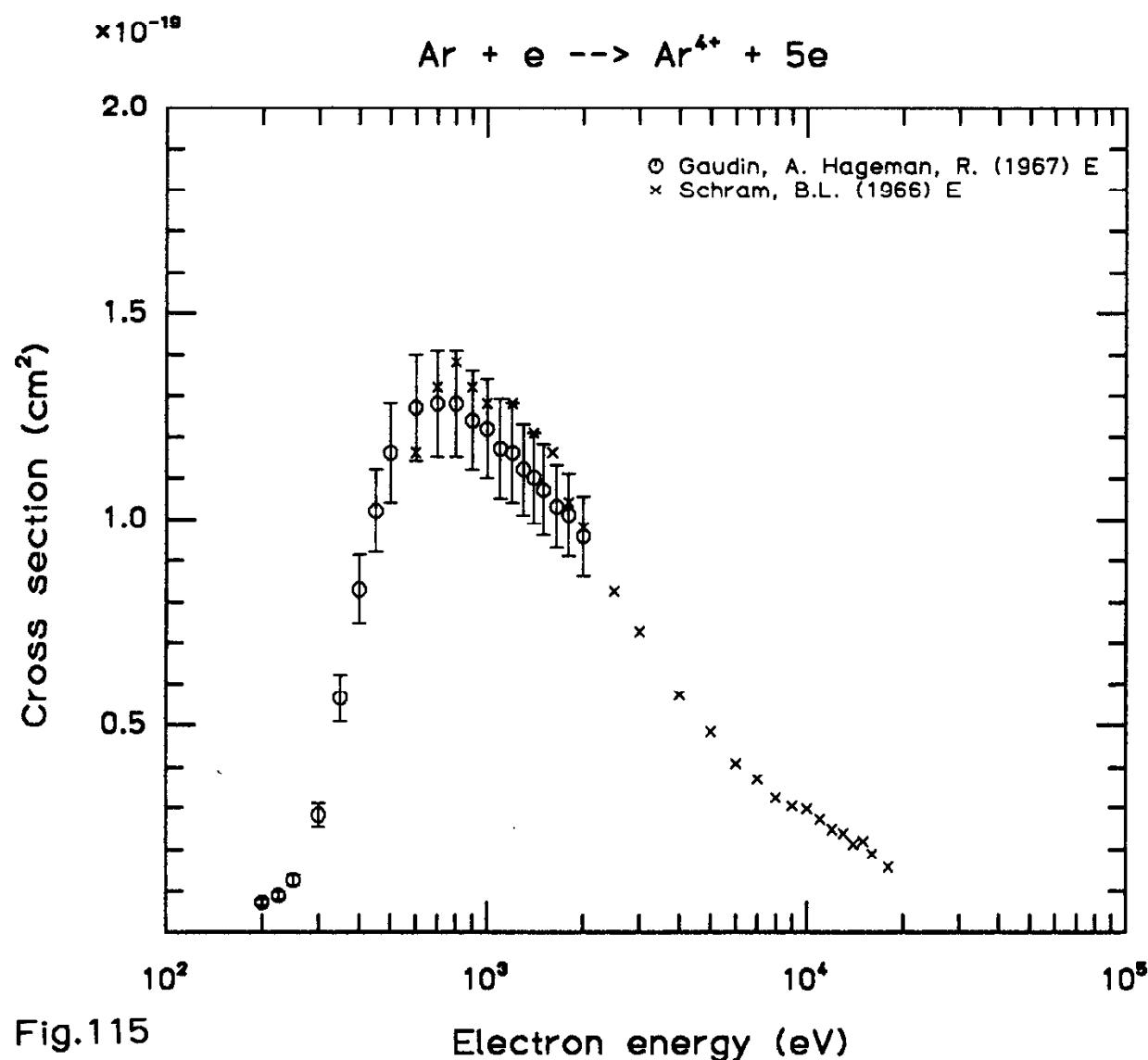


Fig.115

Electron energy (eV)

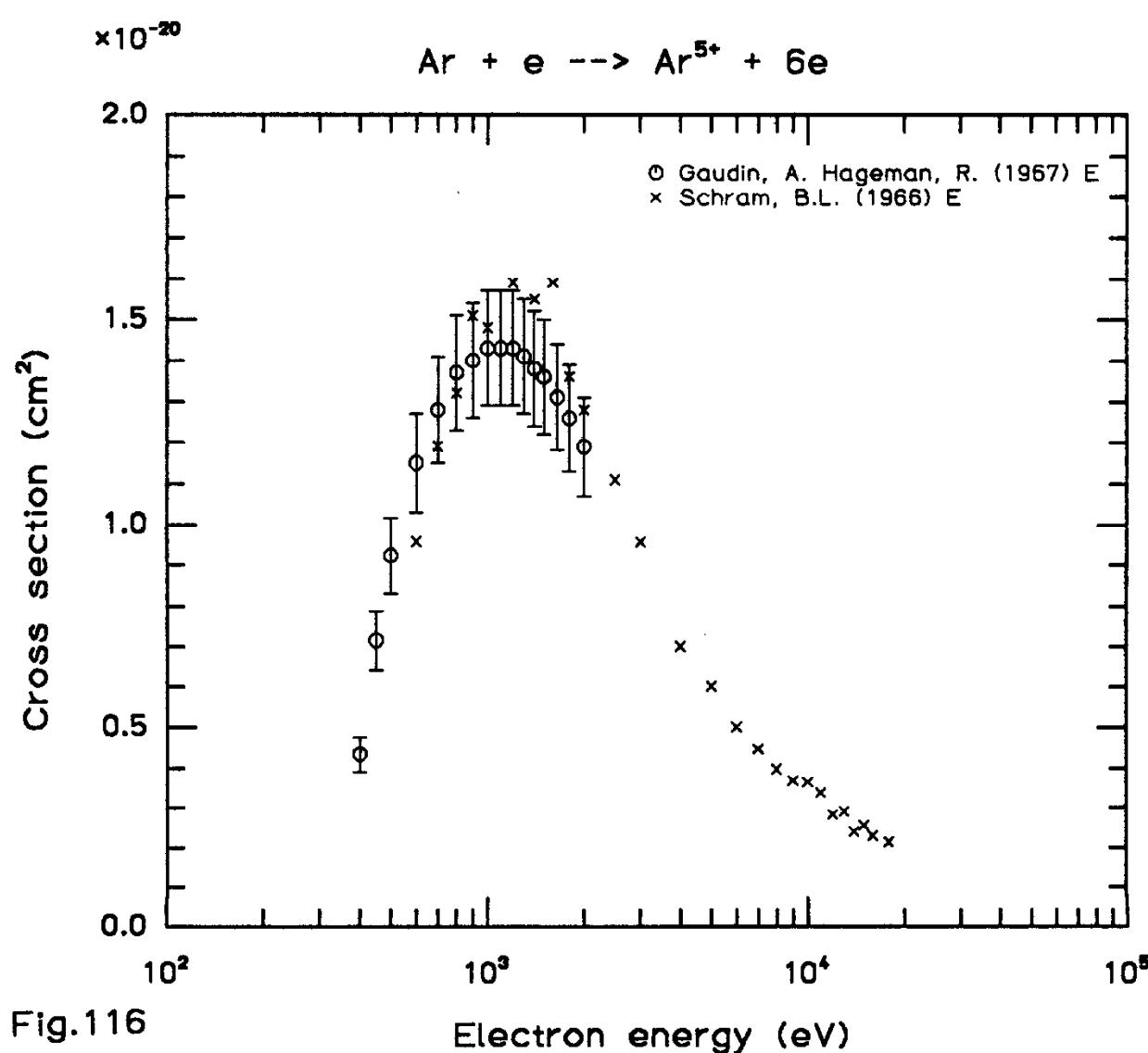


Fig.116

Electron energy (eV)

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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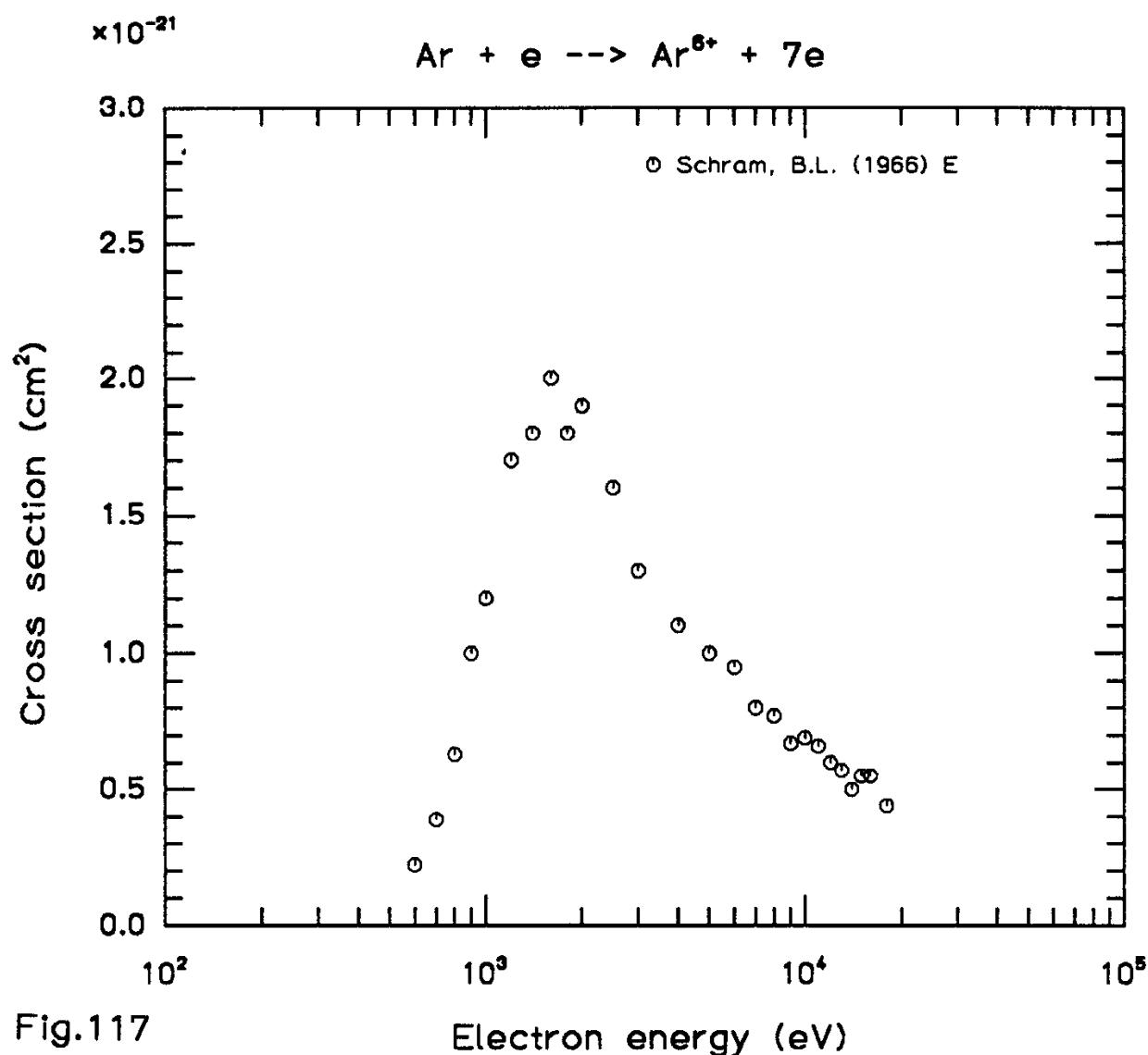


Fig.117

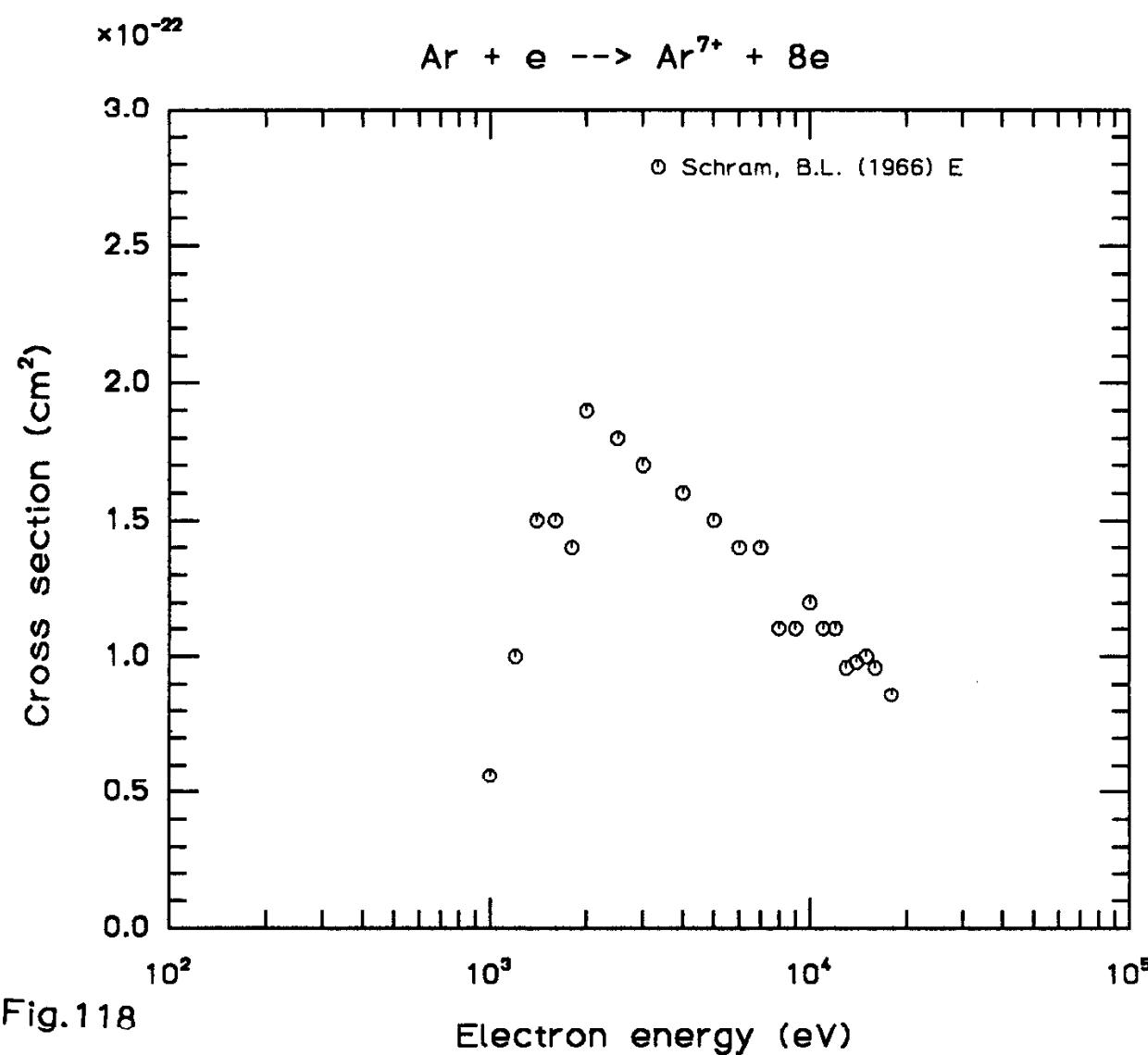


Fig.118

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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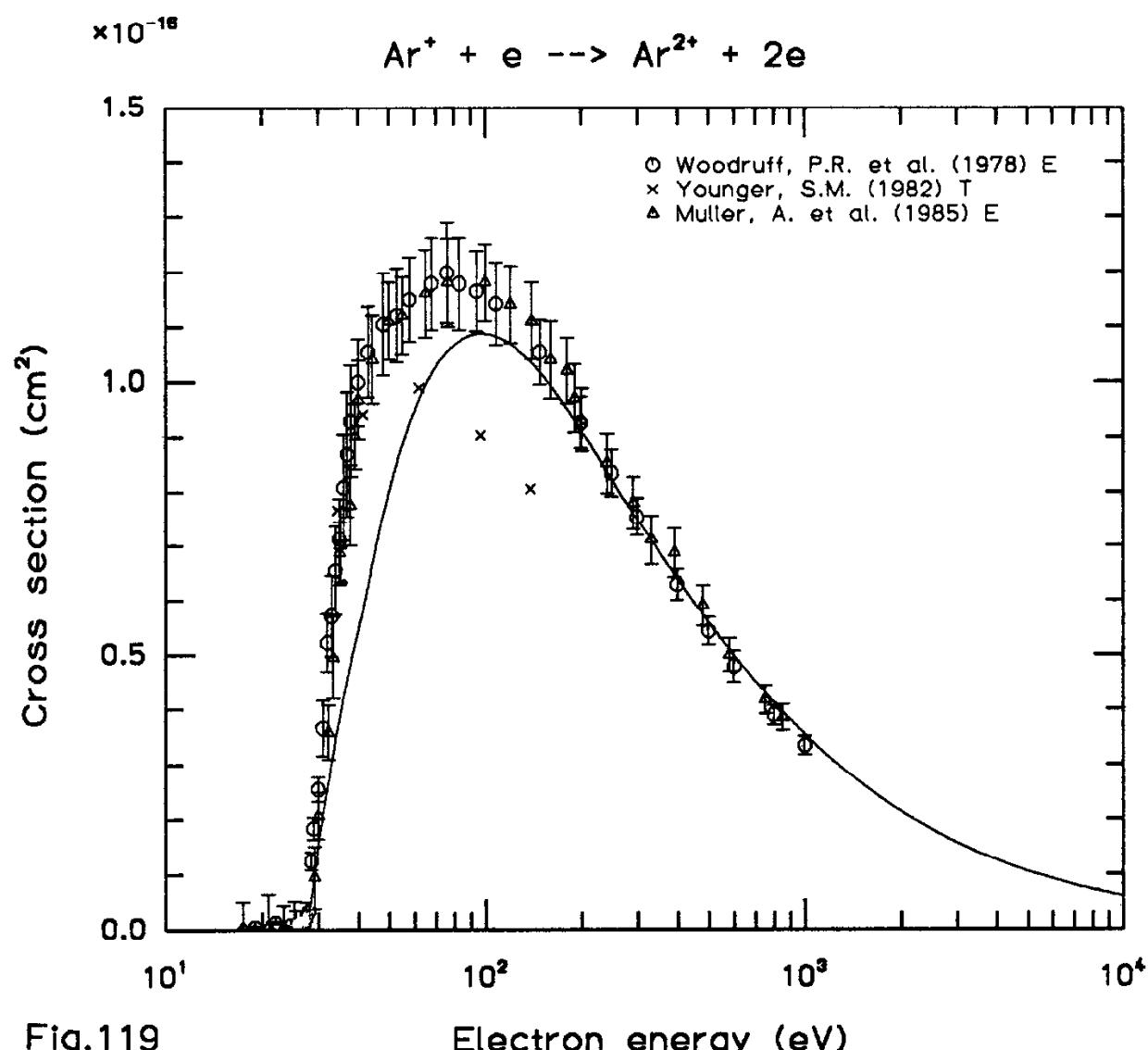


Fig.119

Electron energy (eV)

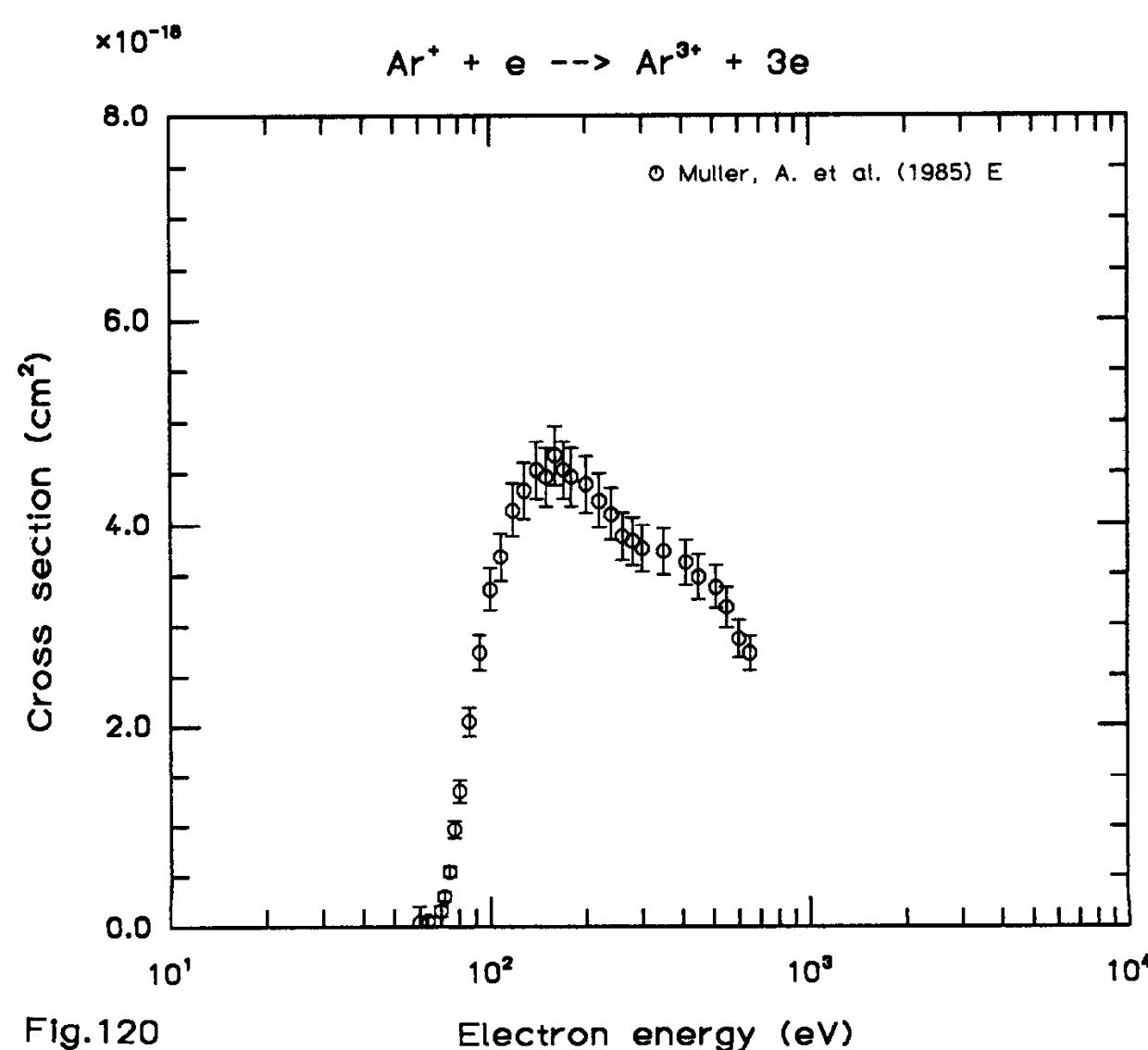


Fig.120

Electron energy (eV)

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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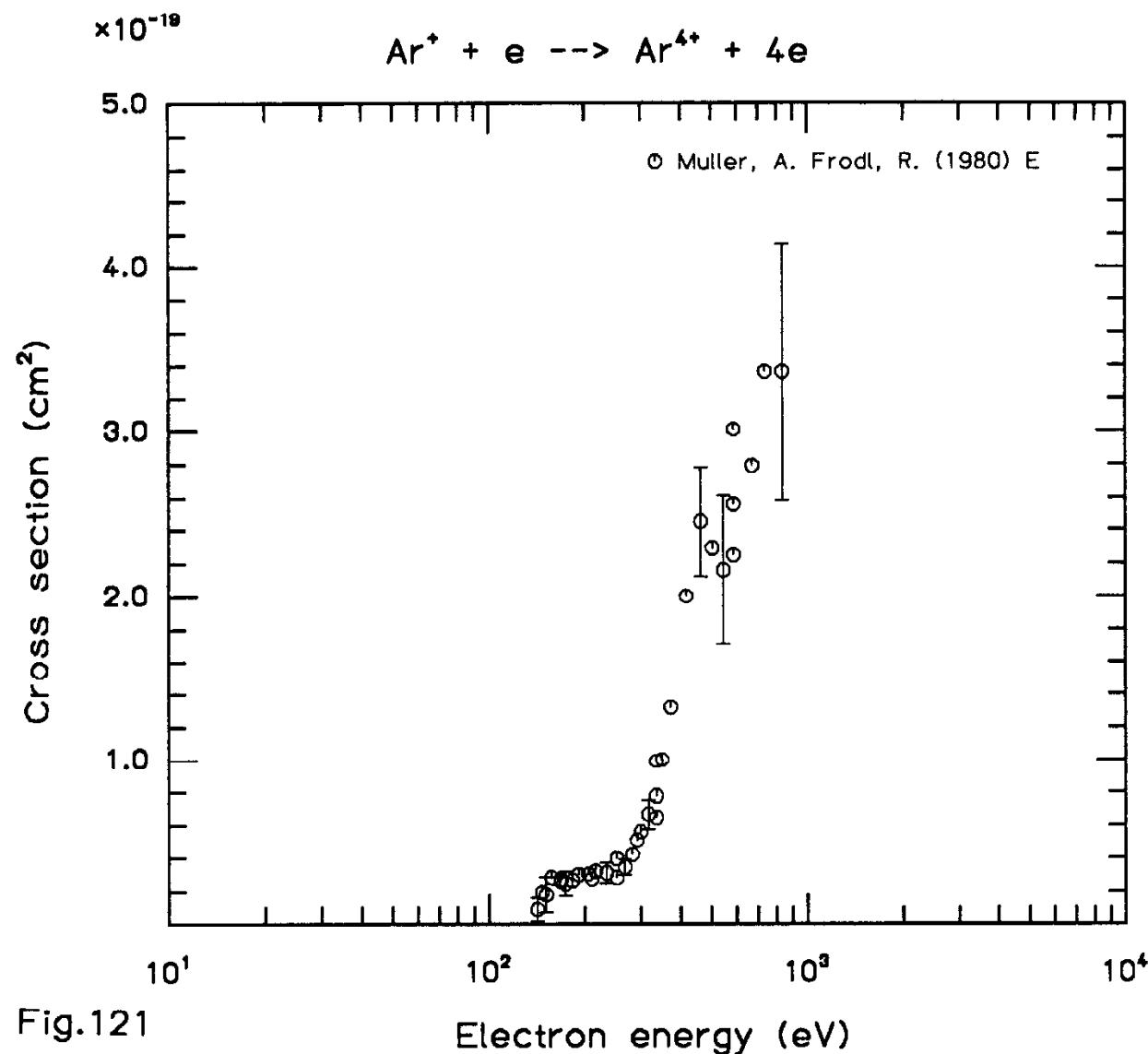


Fig.121

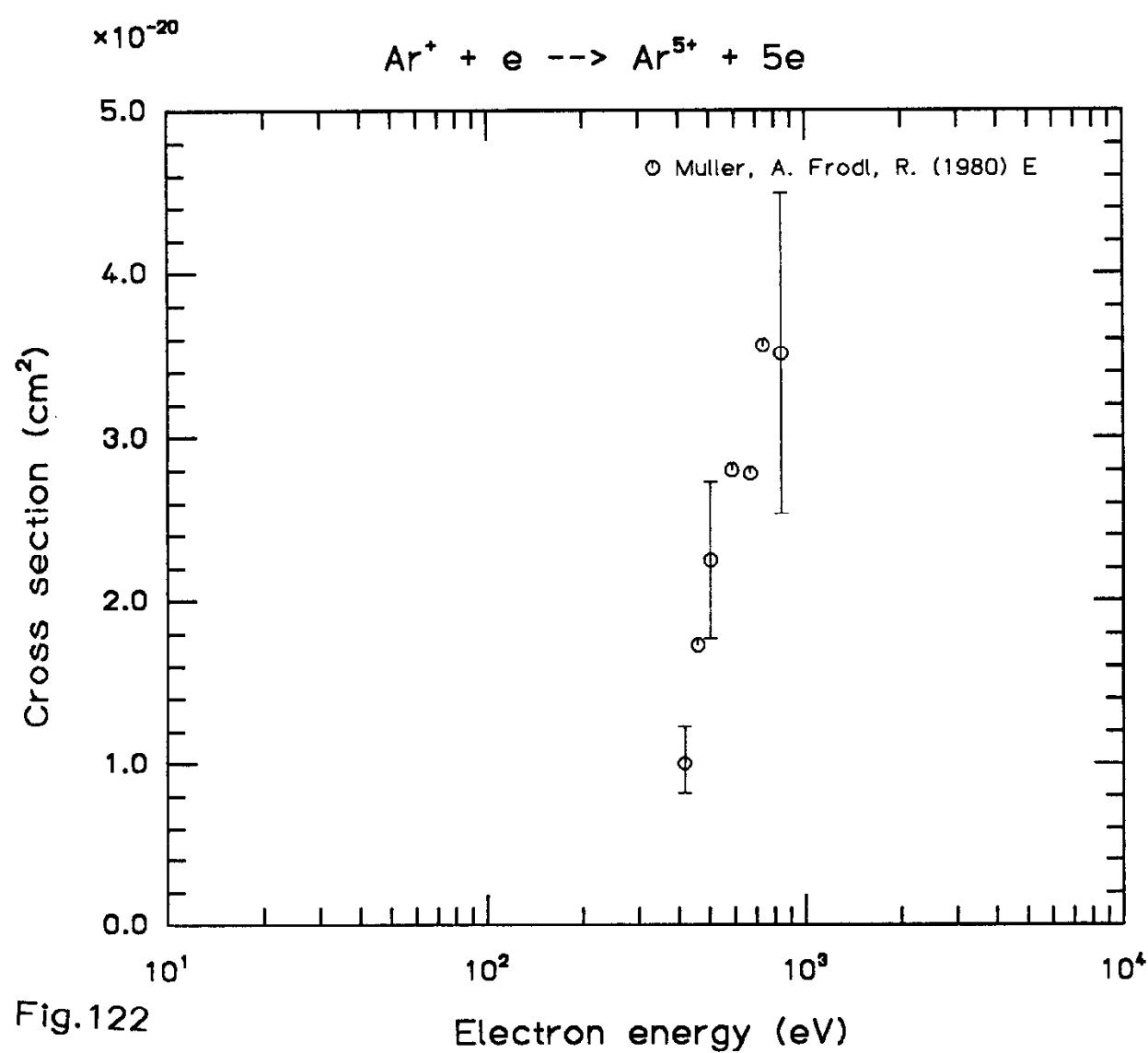


Fig.122

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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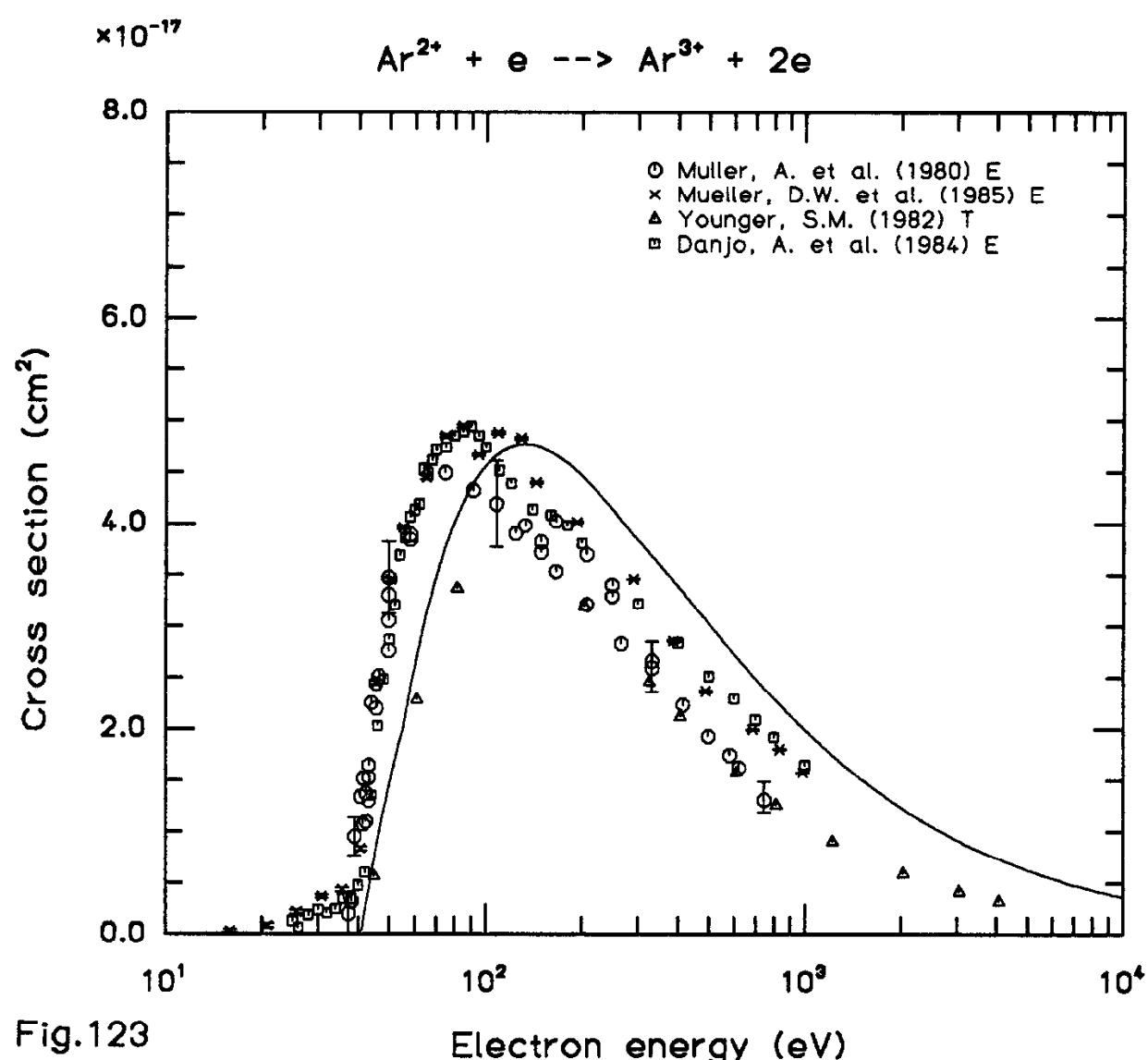


Fig.123

Electron energy (eV)

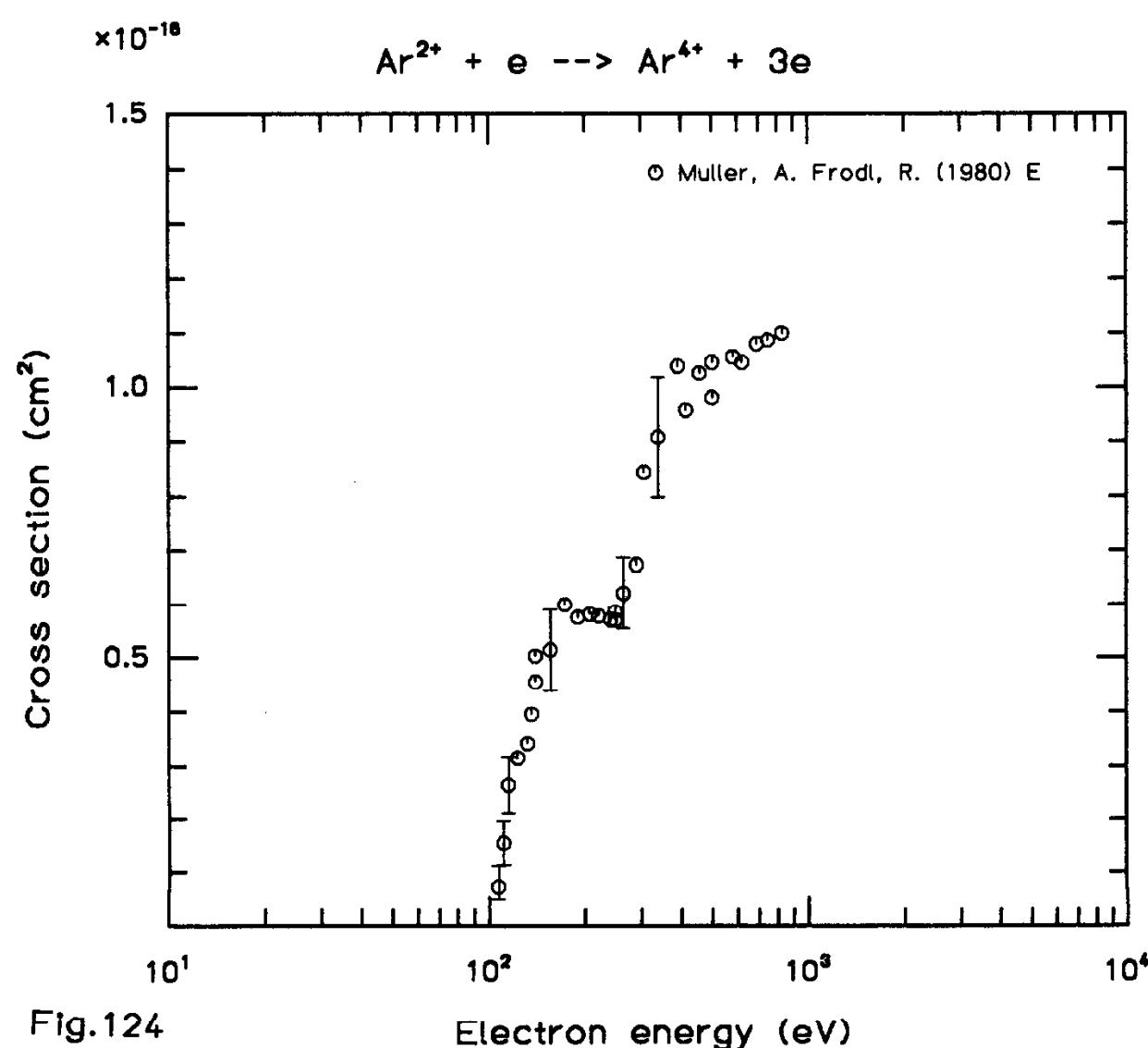


Fig.124

Electron energy (eV)

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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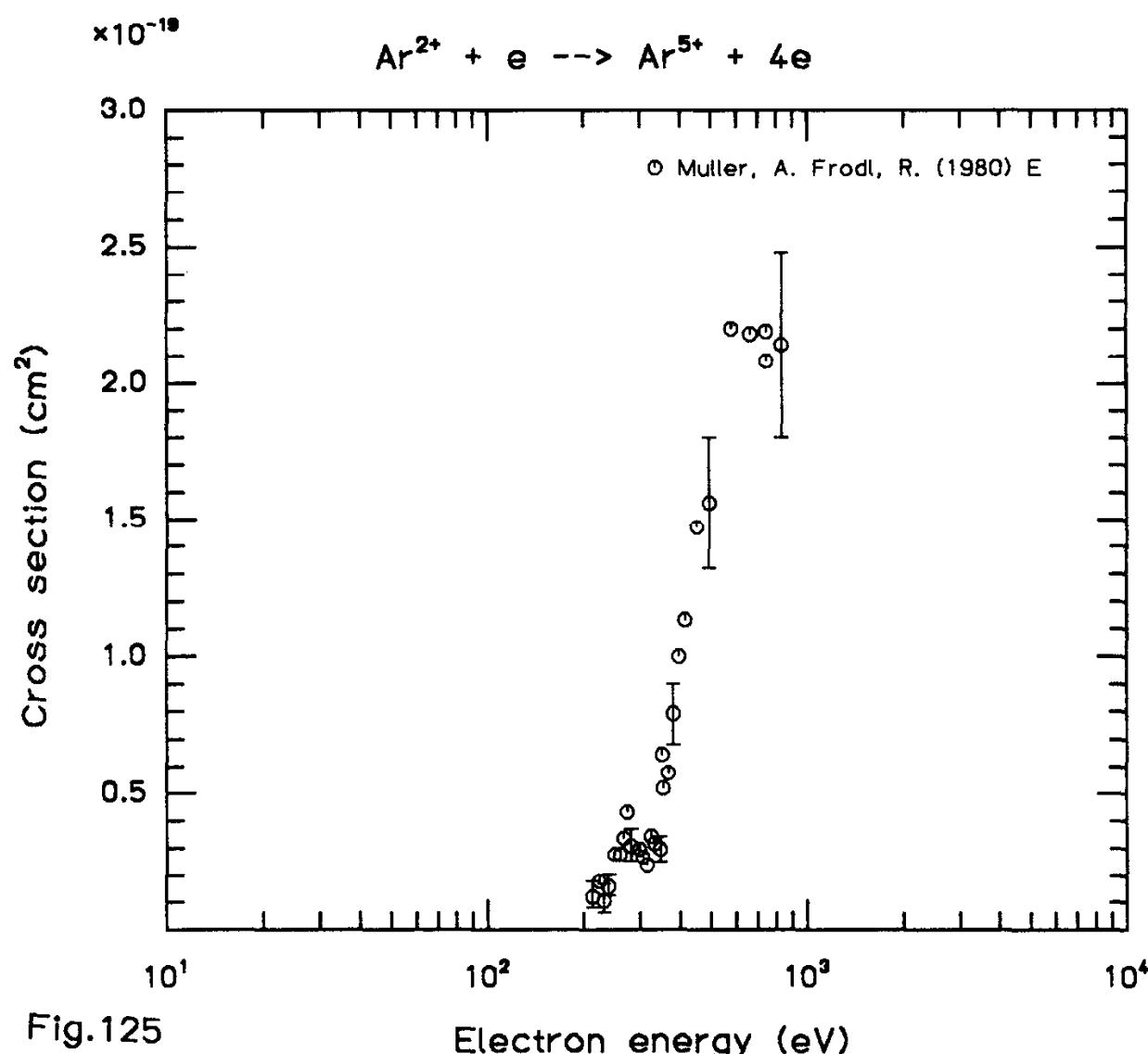


Fig.125

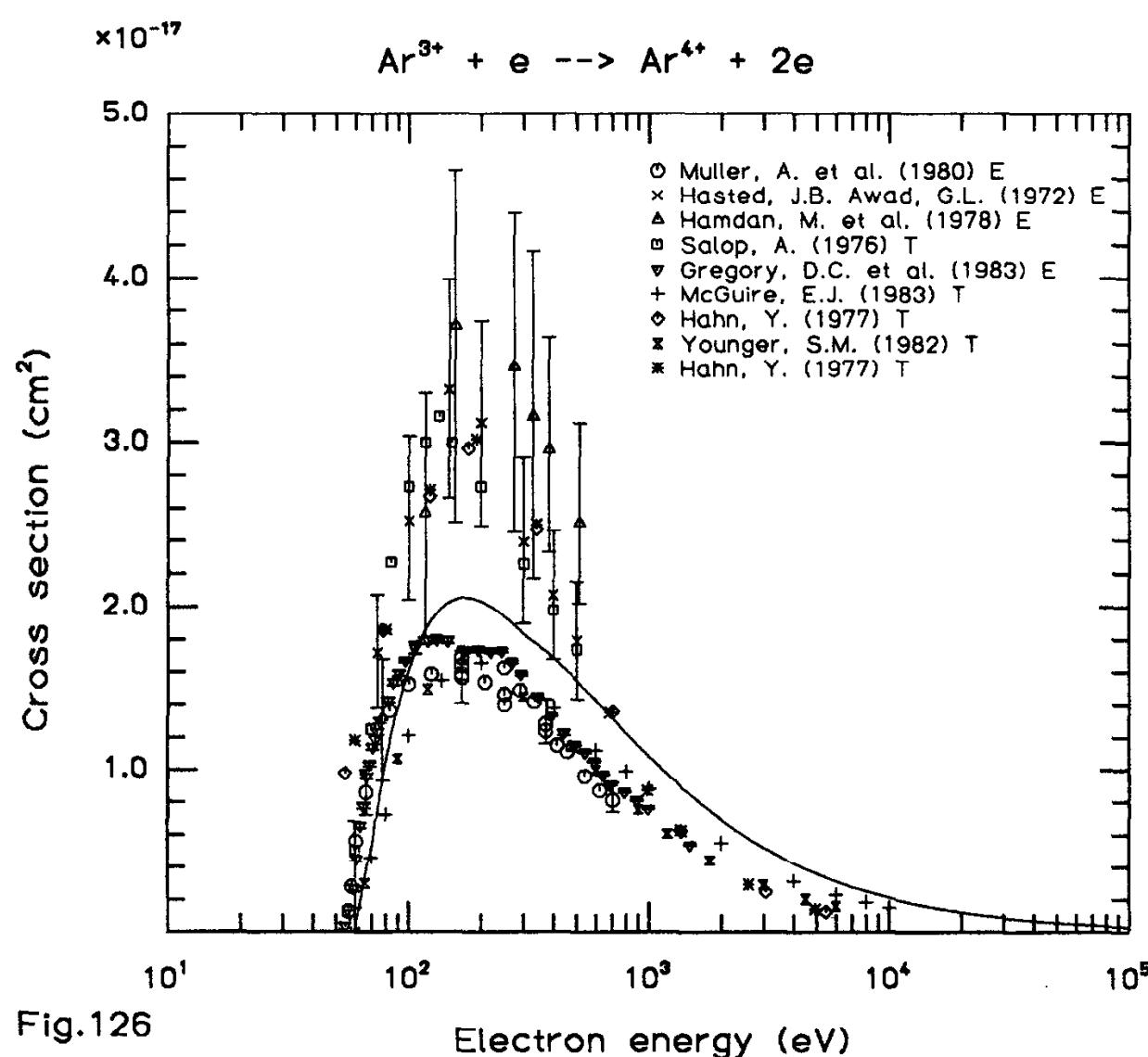


Fig.126

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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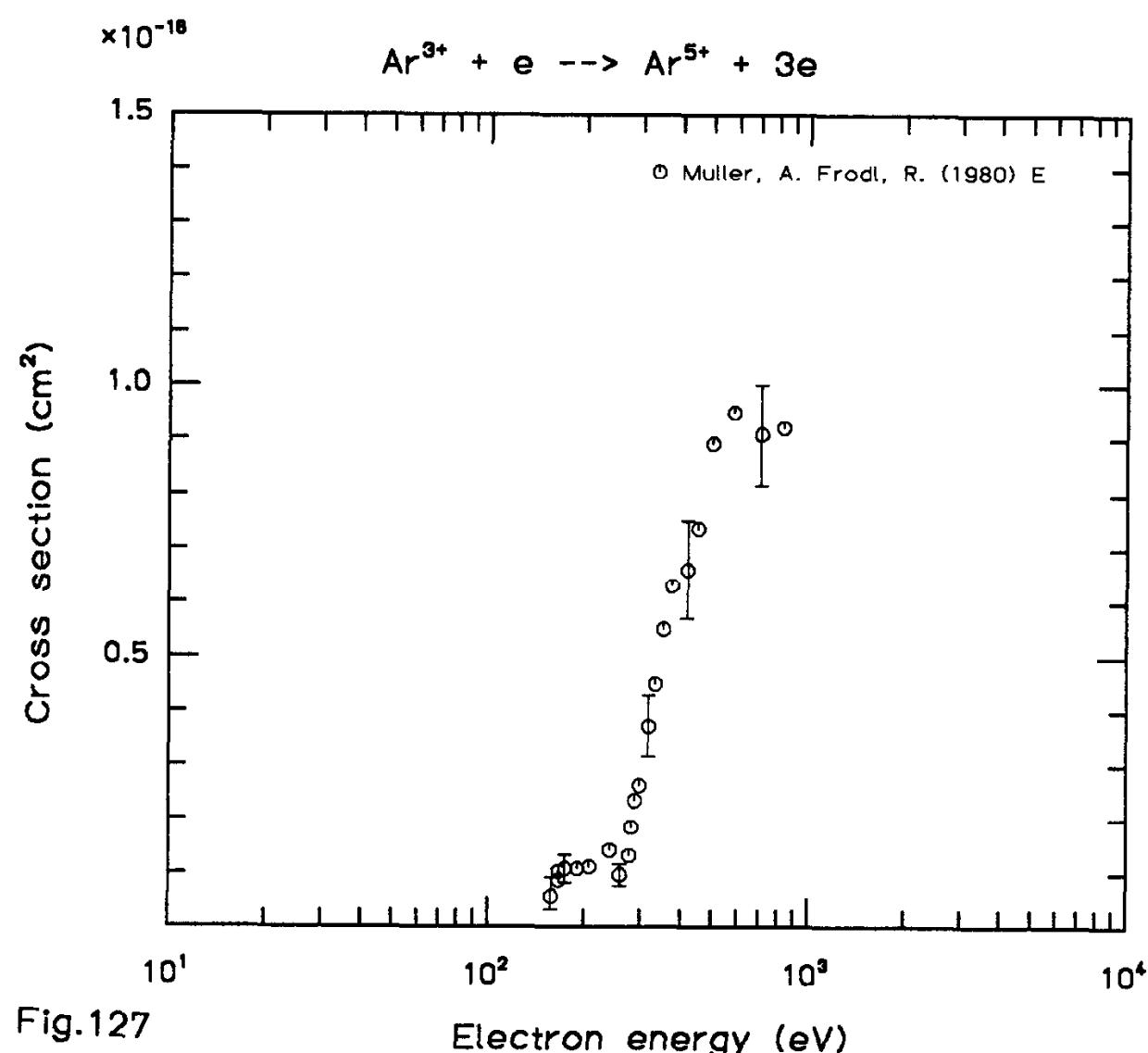


Fig.127

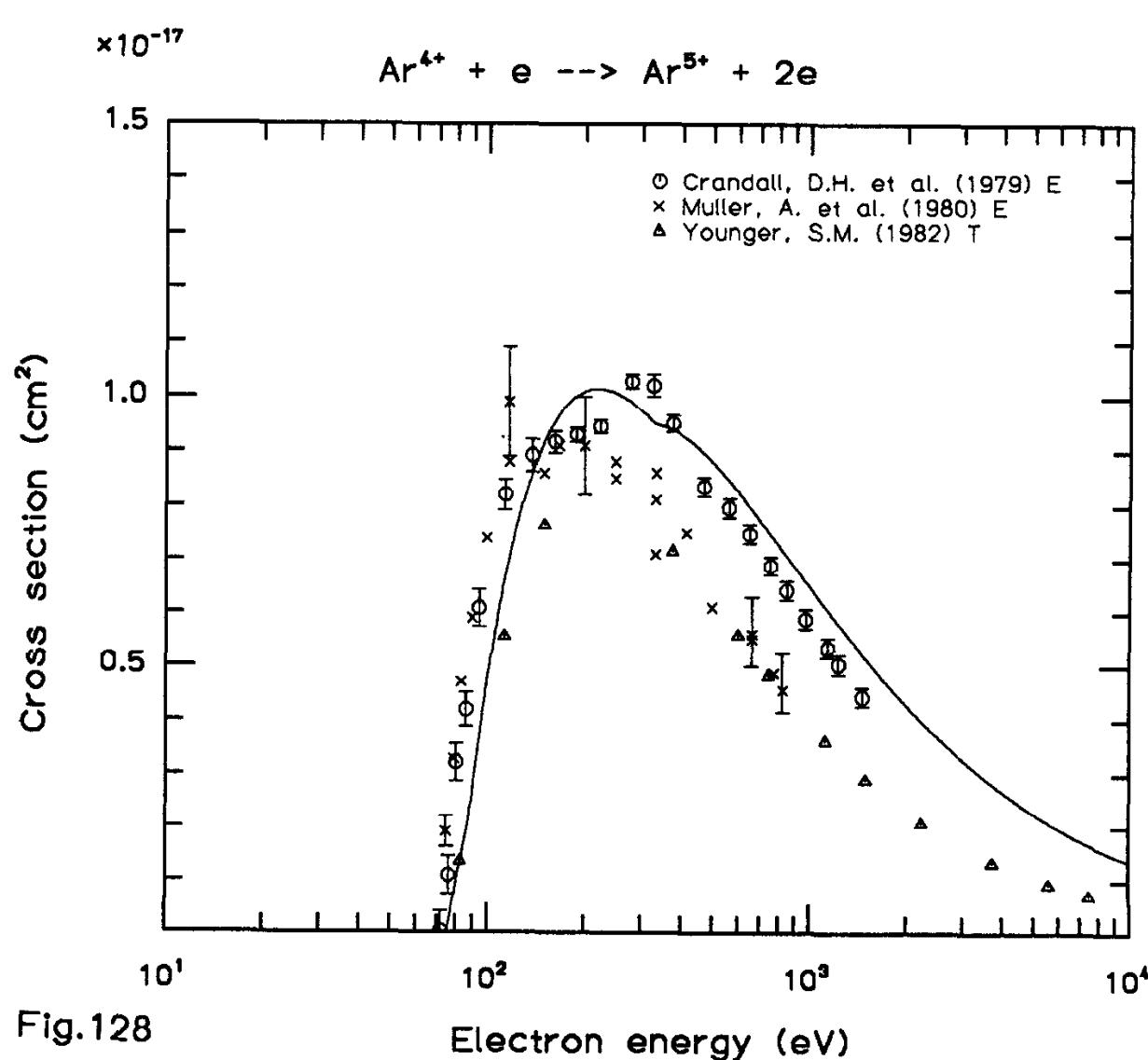


Fig.128

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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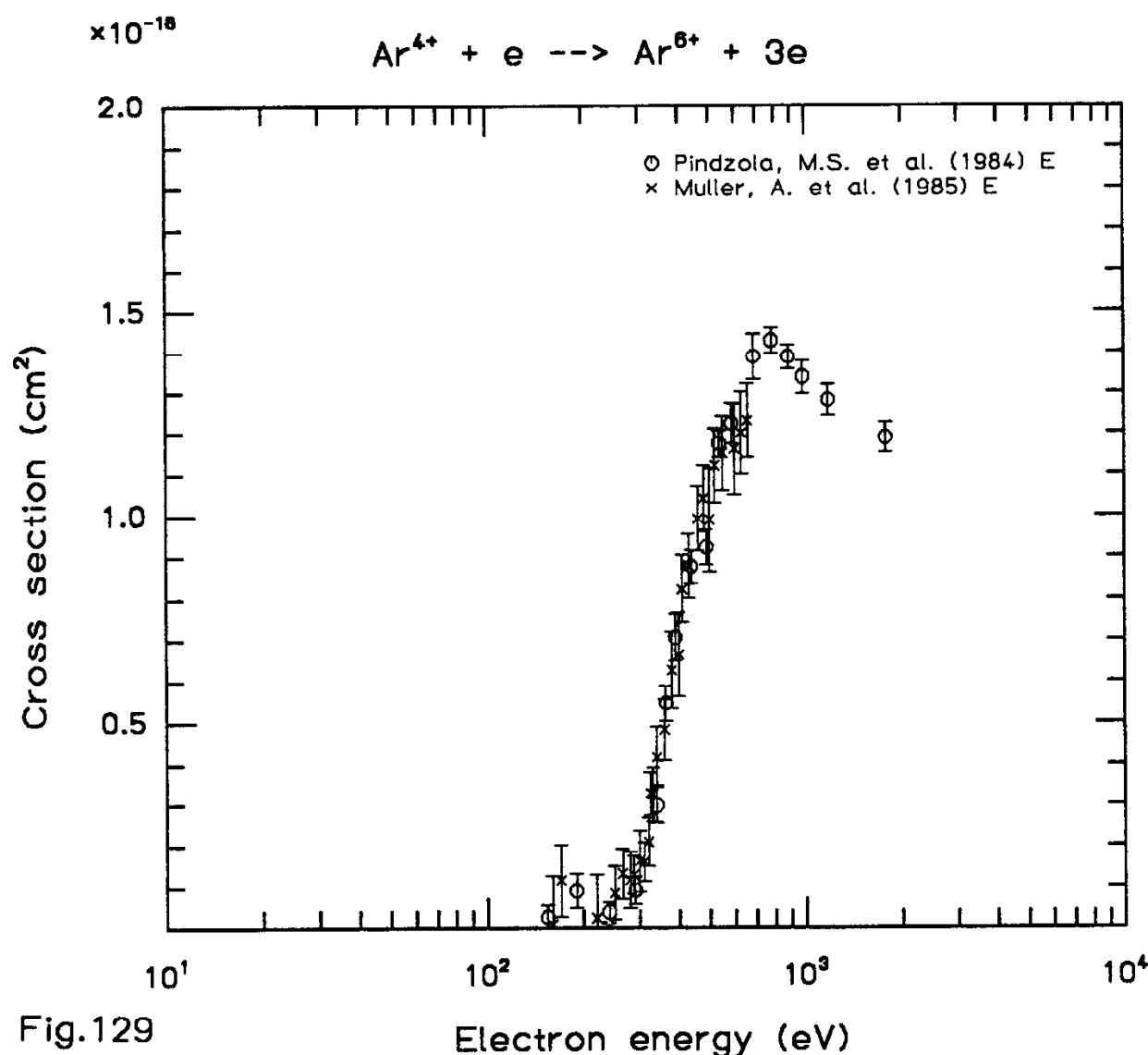


Fig.129

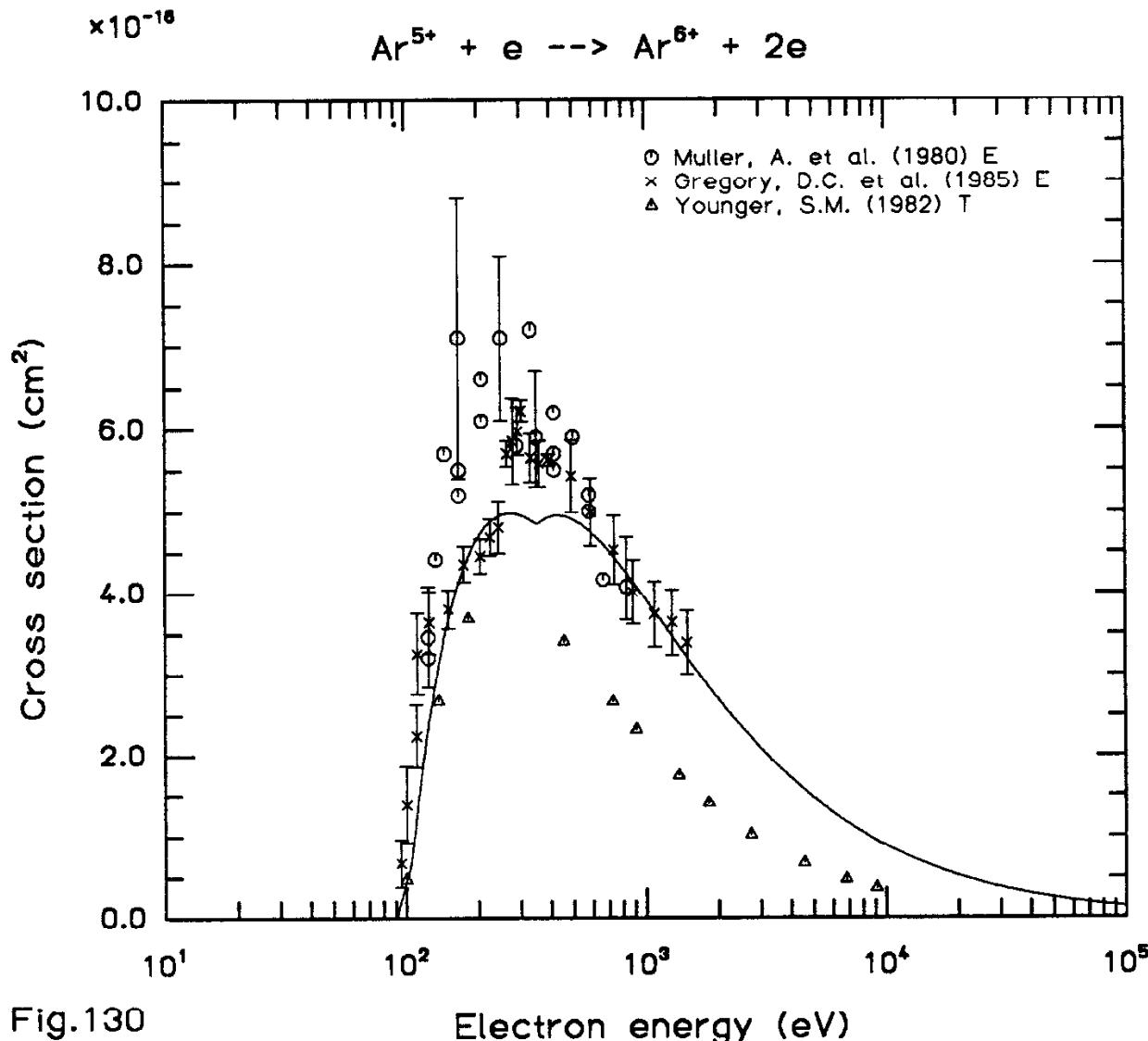


Fig.130

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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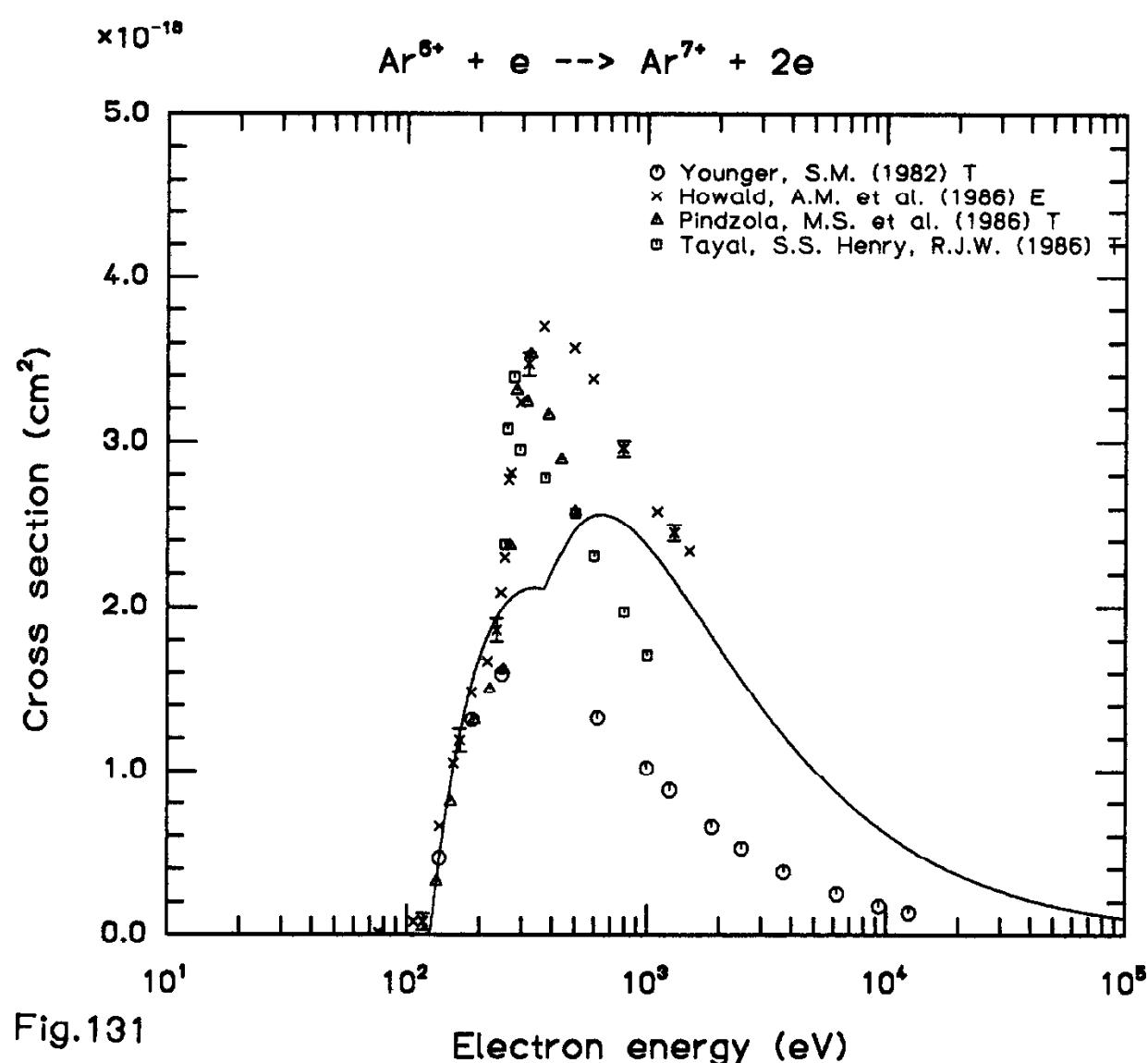


Fig.131

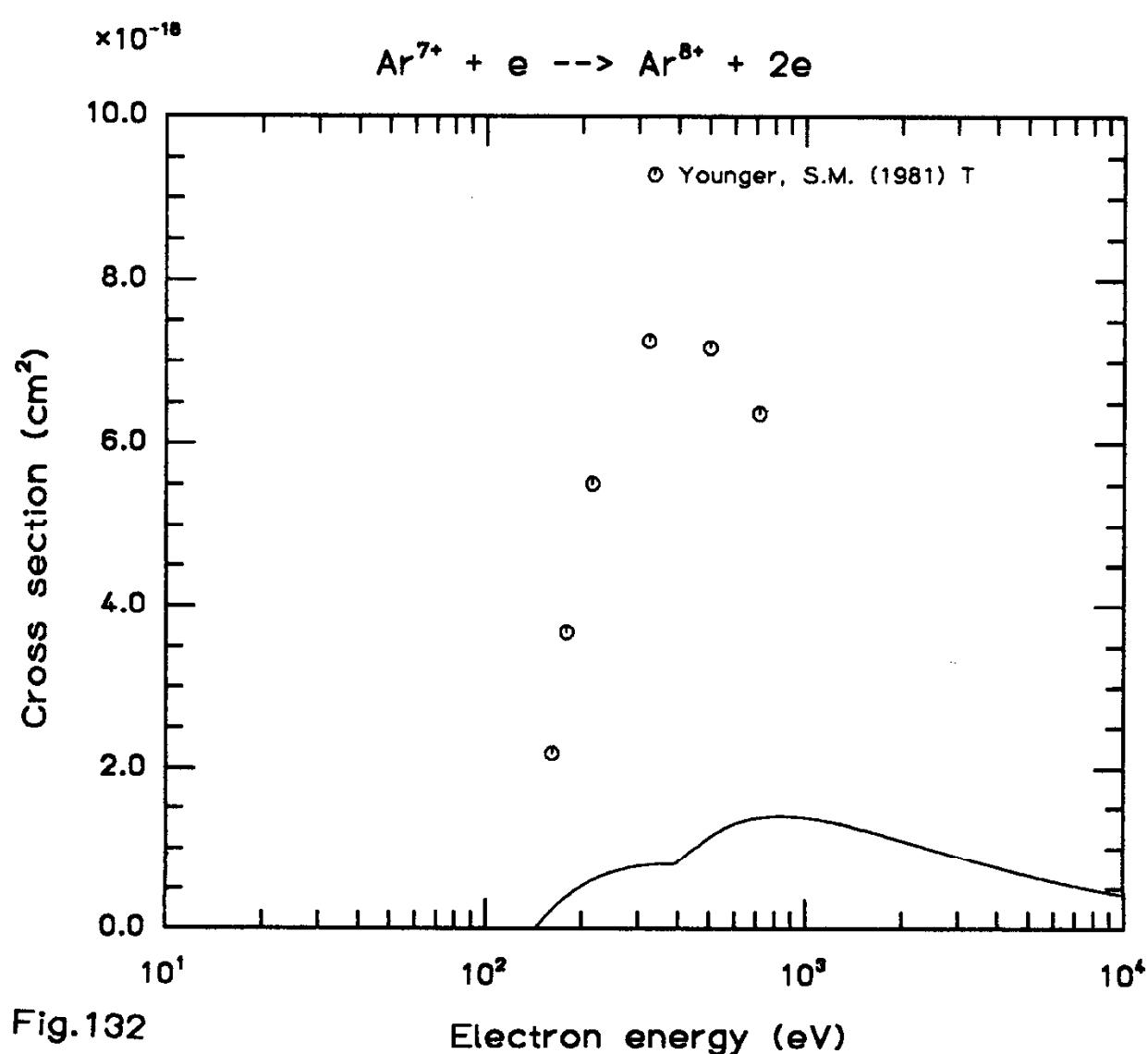


Fig.132

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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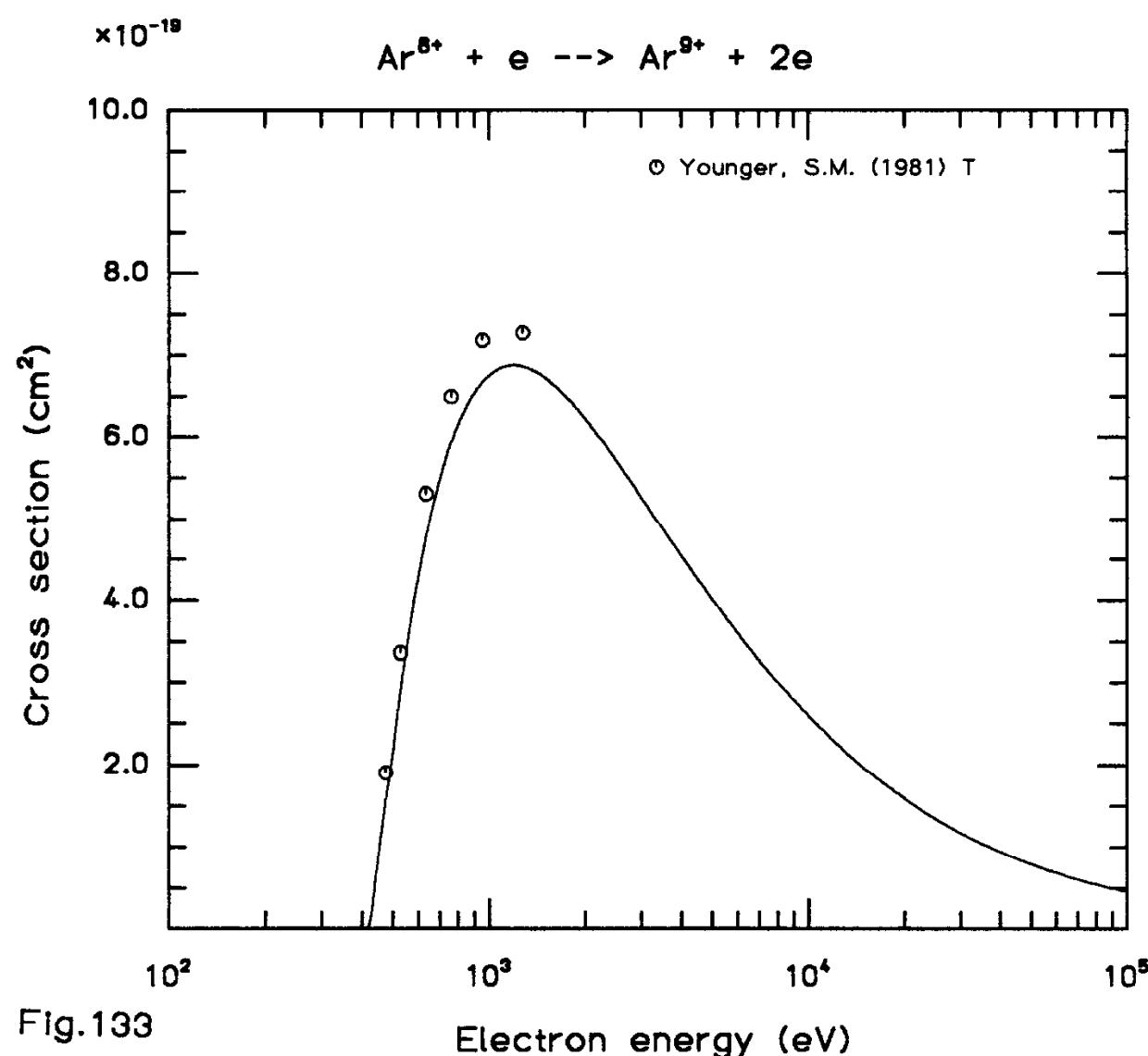


Fig.133

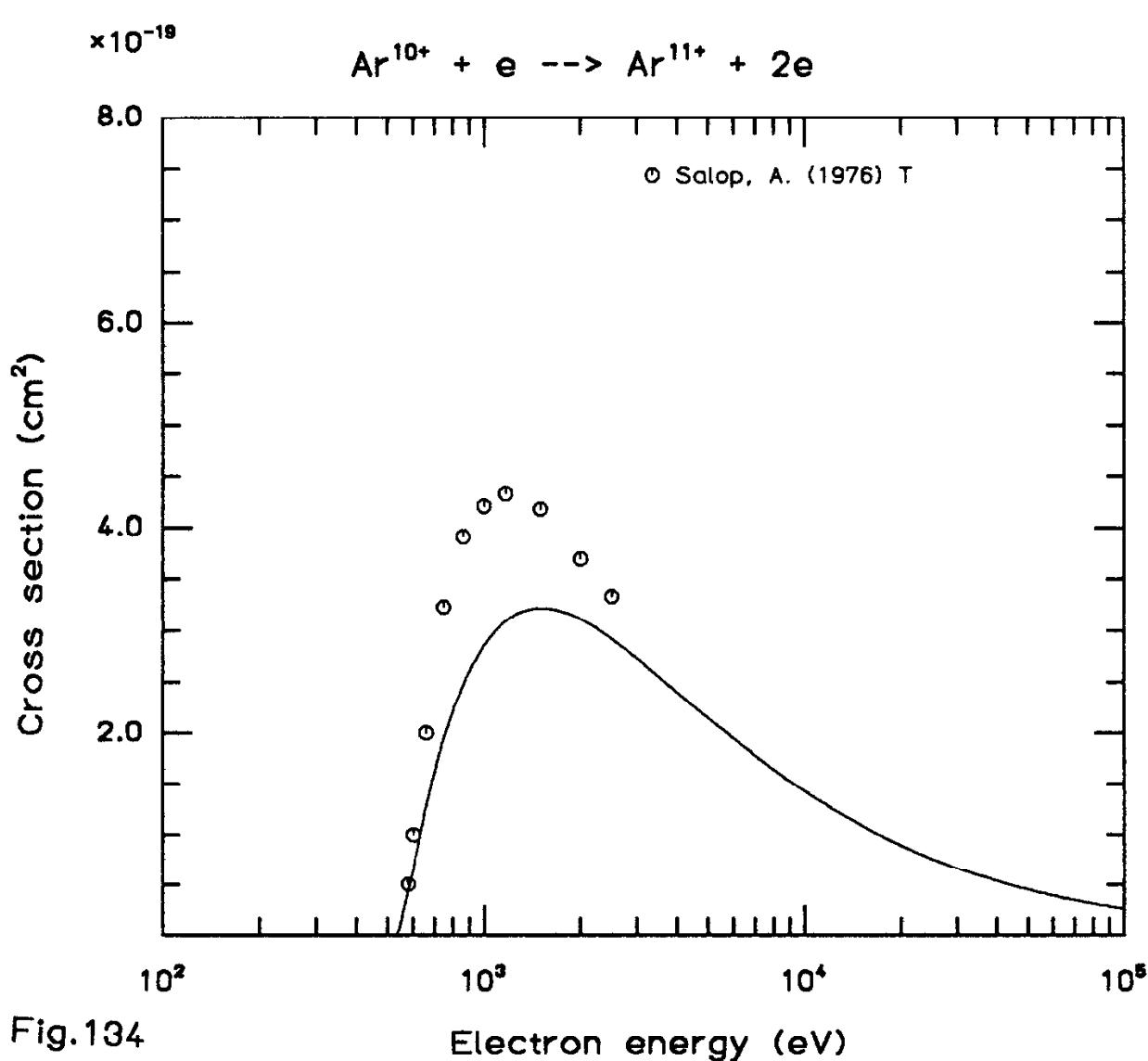
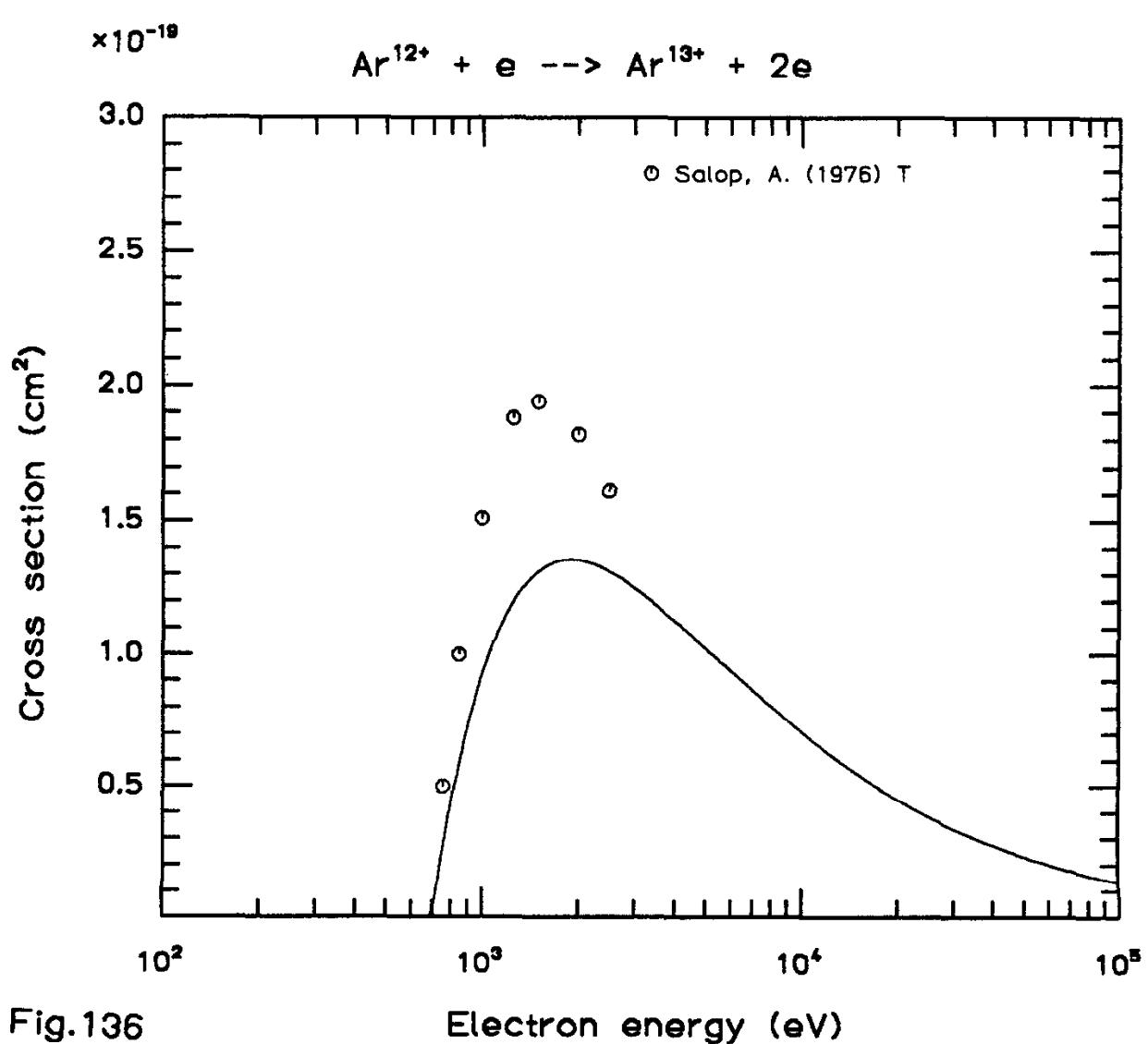
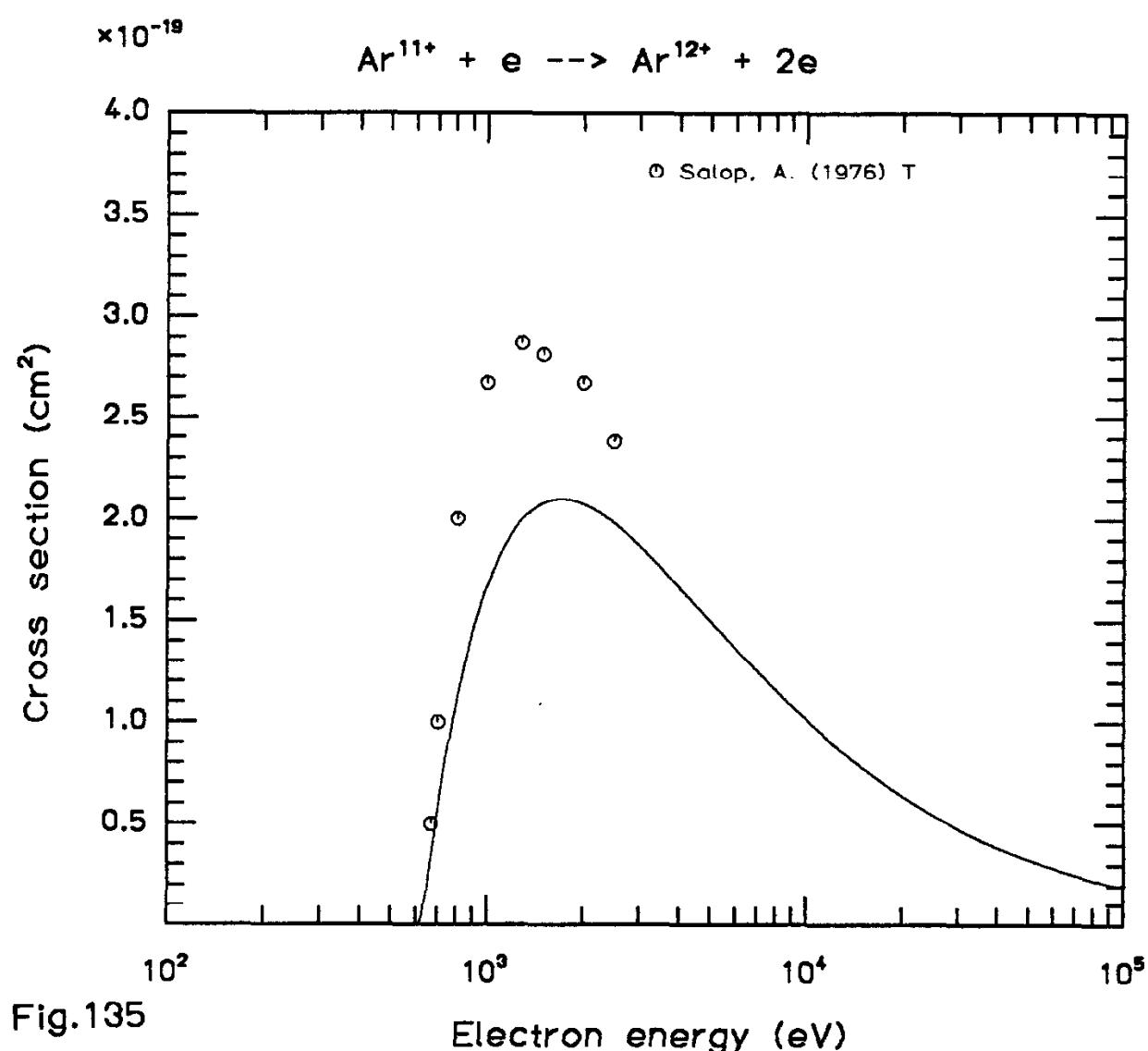


Fig.134

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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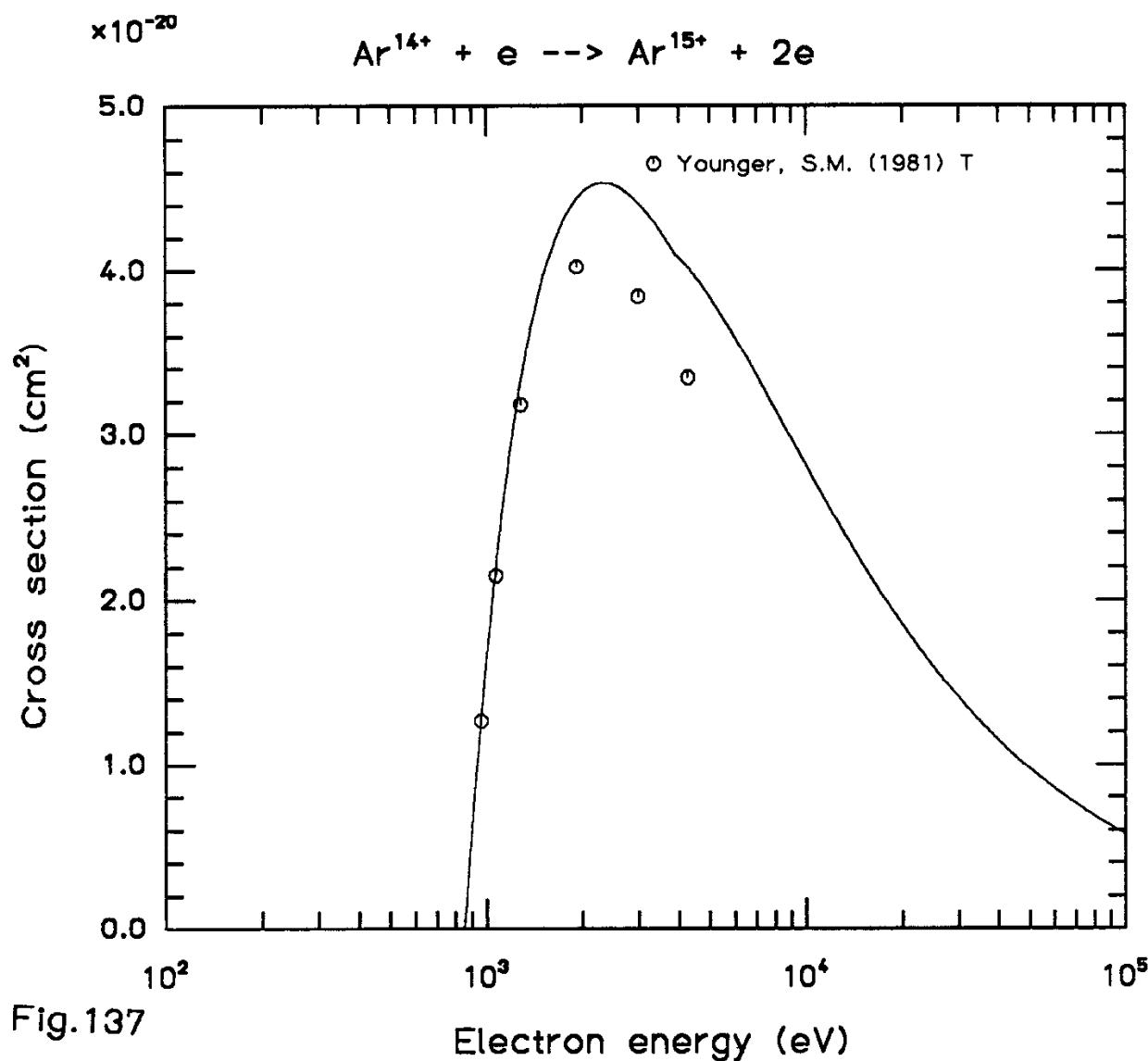


Fig.137

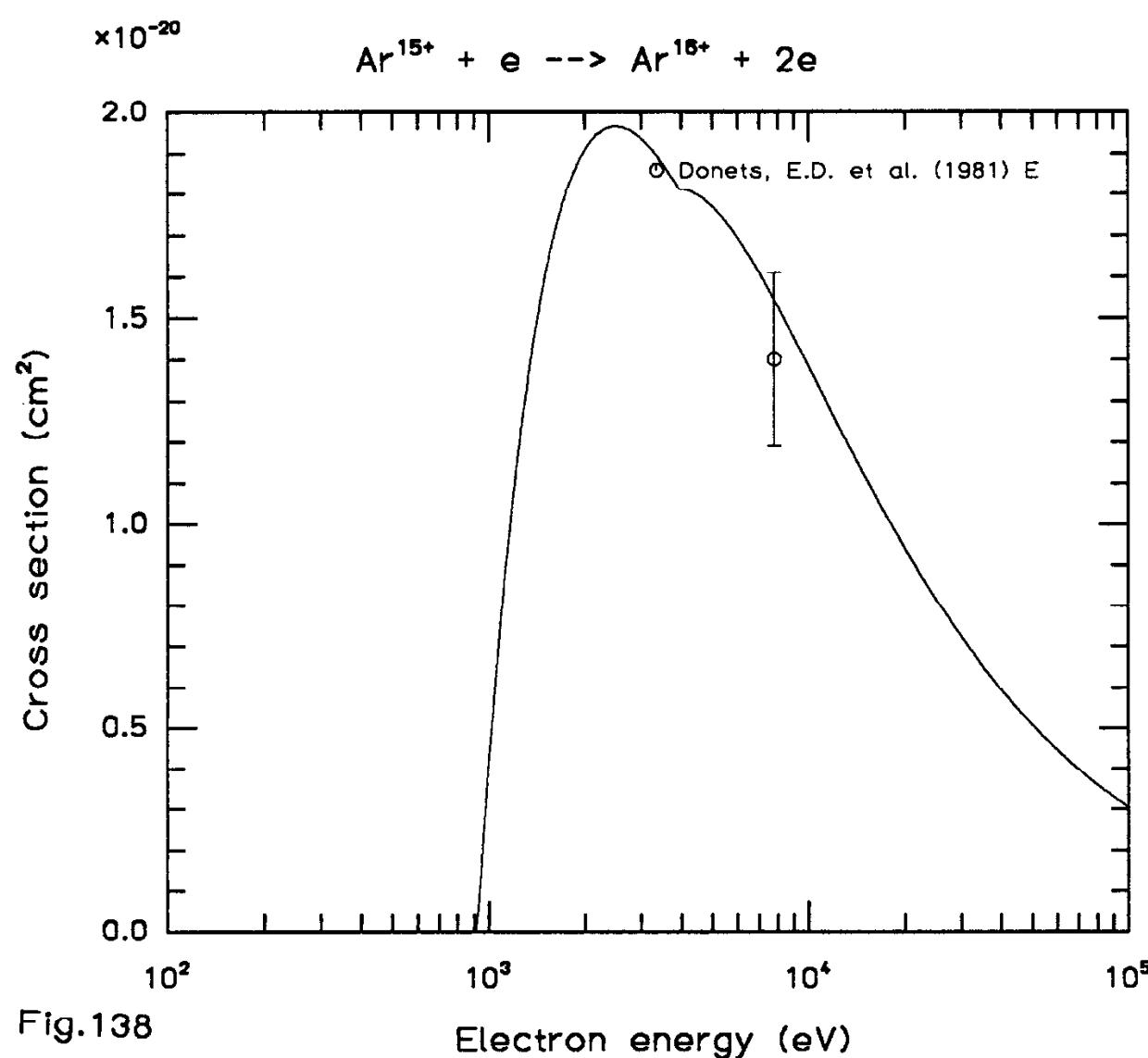
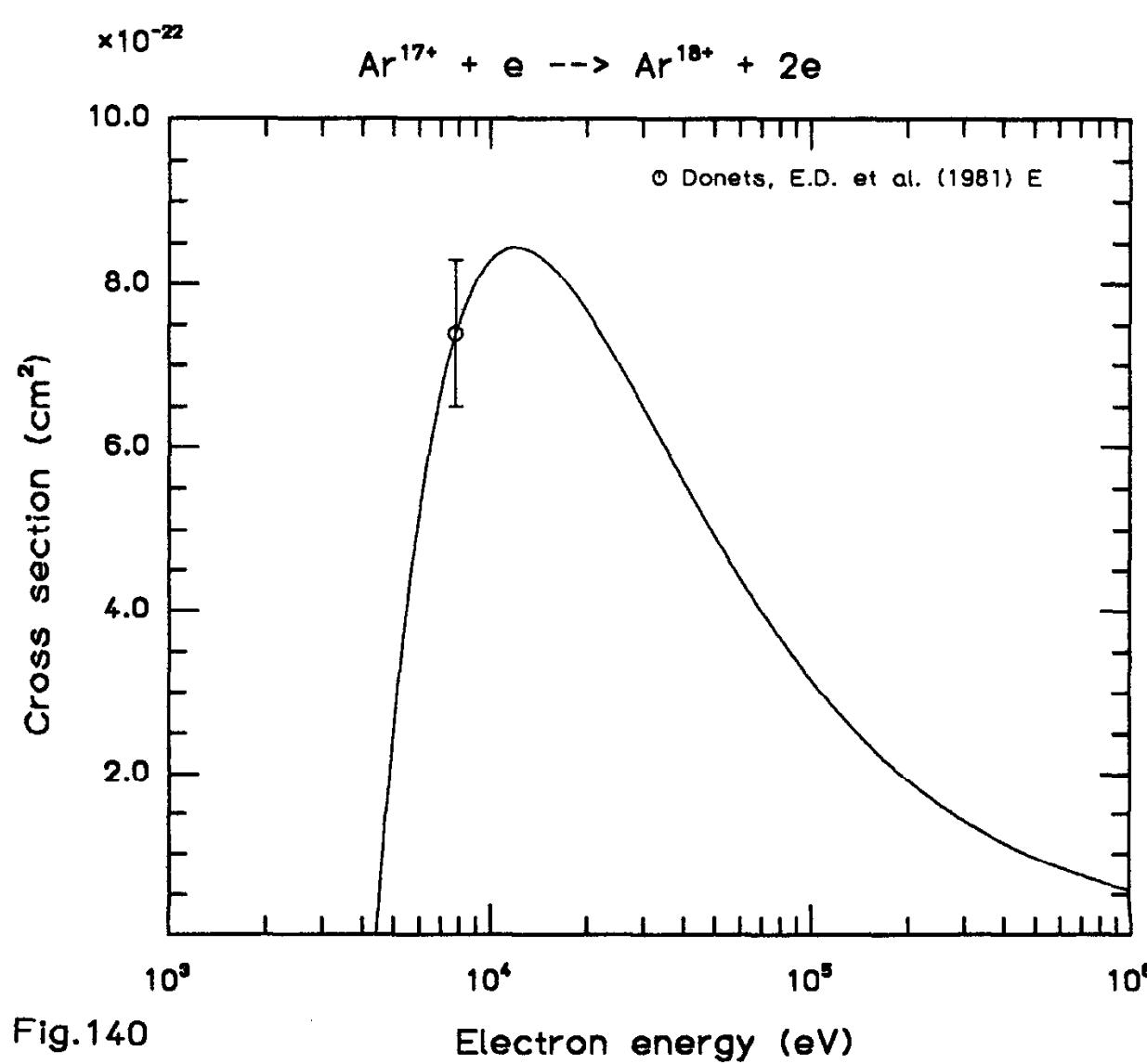
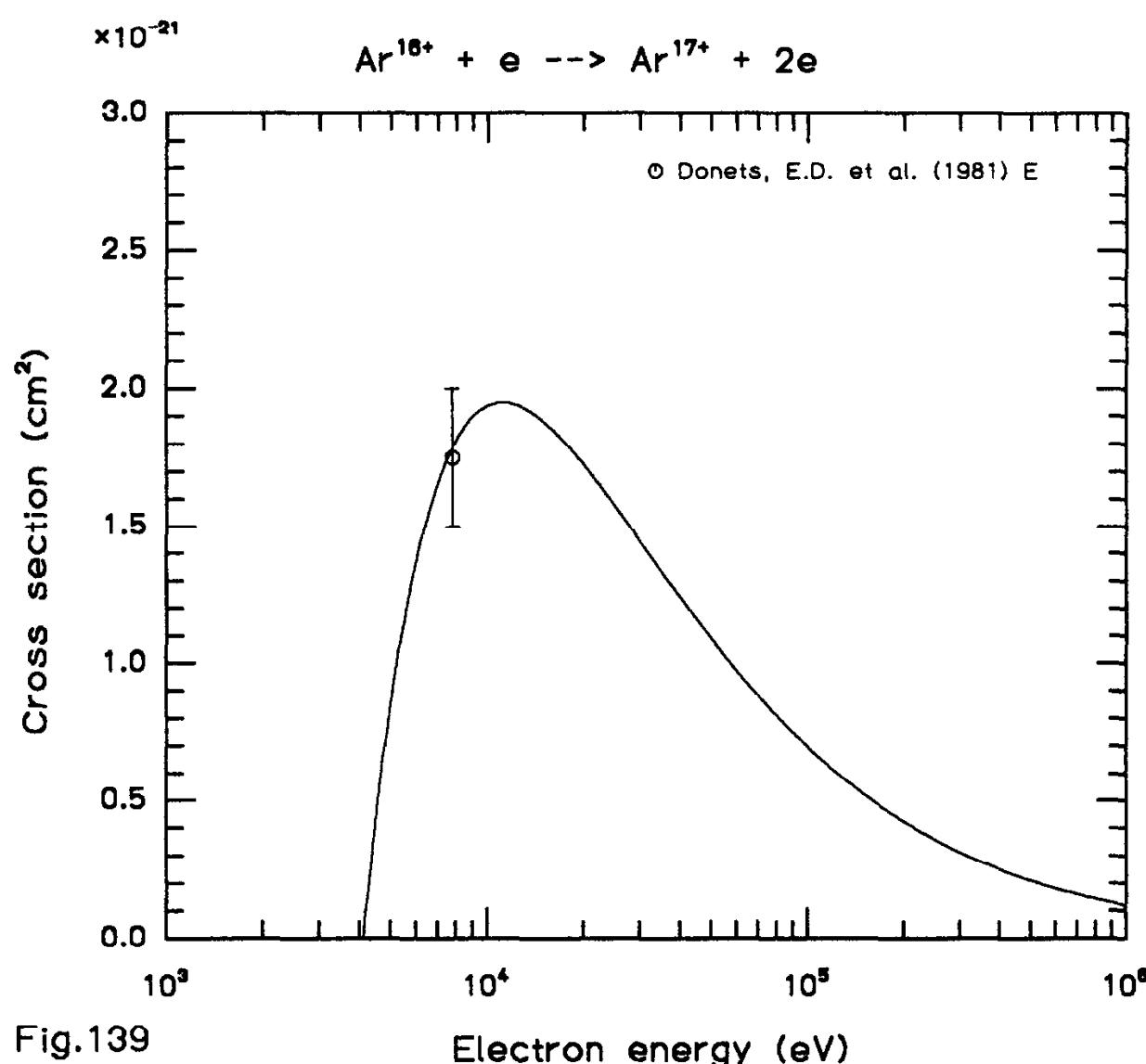


Fig.138

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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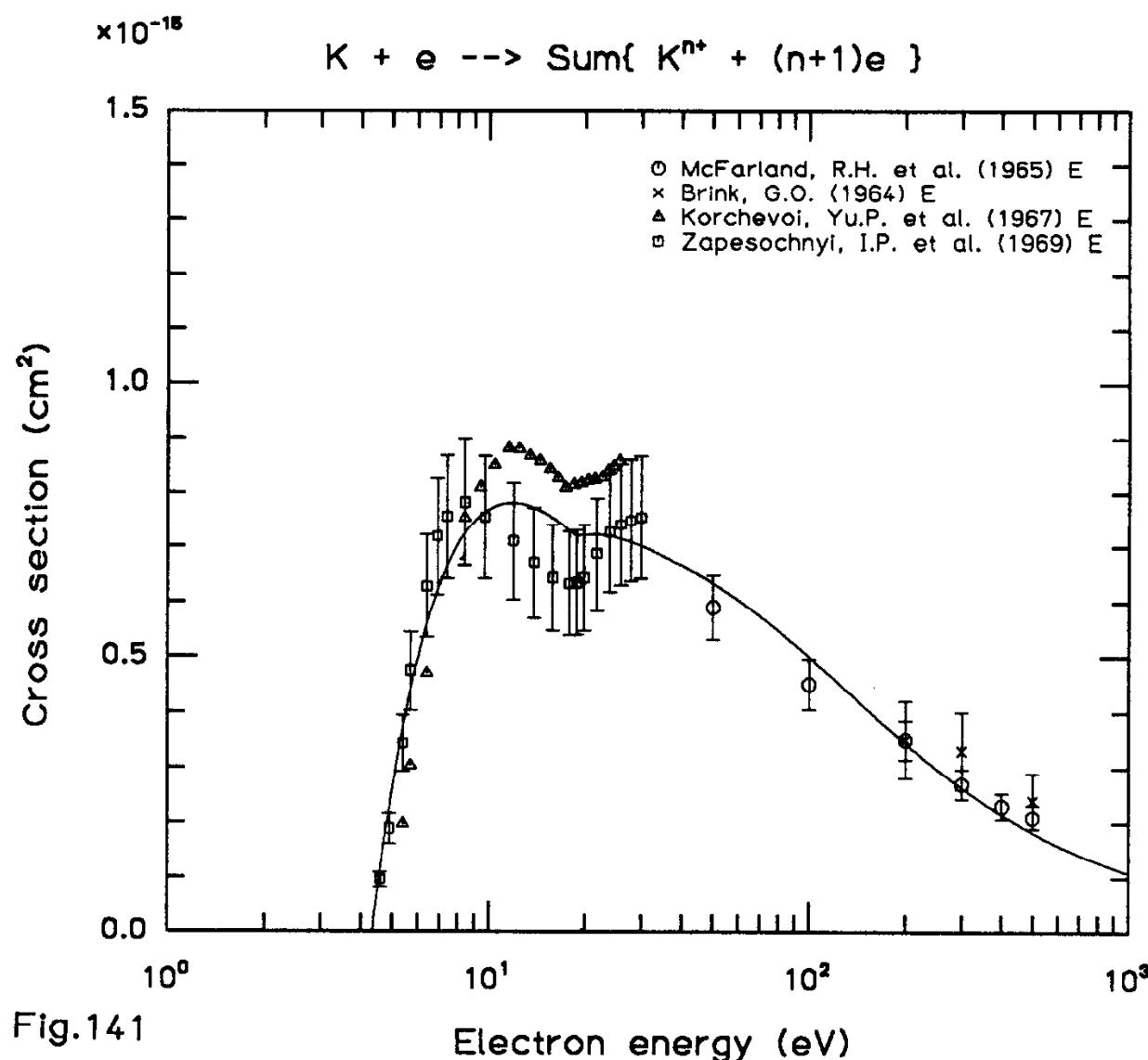


Fig.141

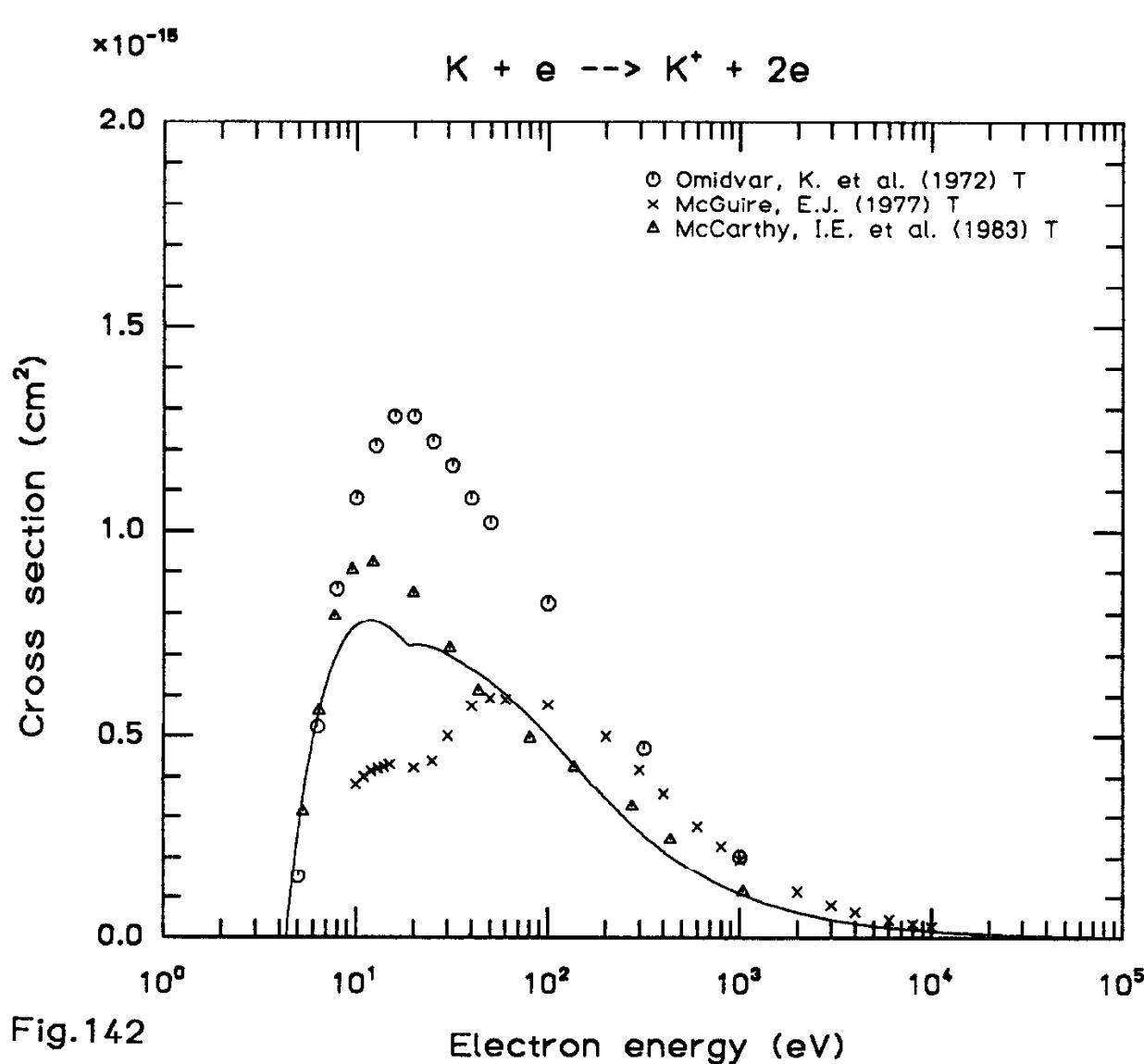
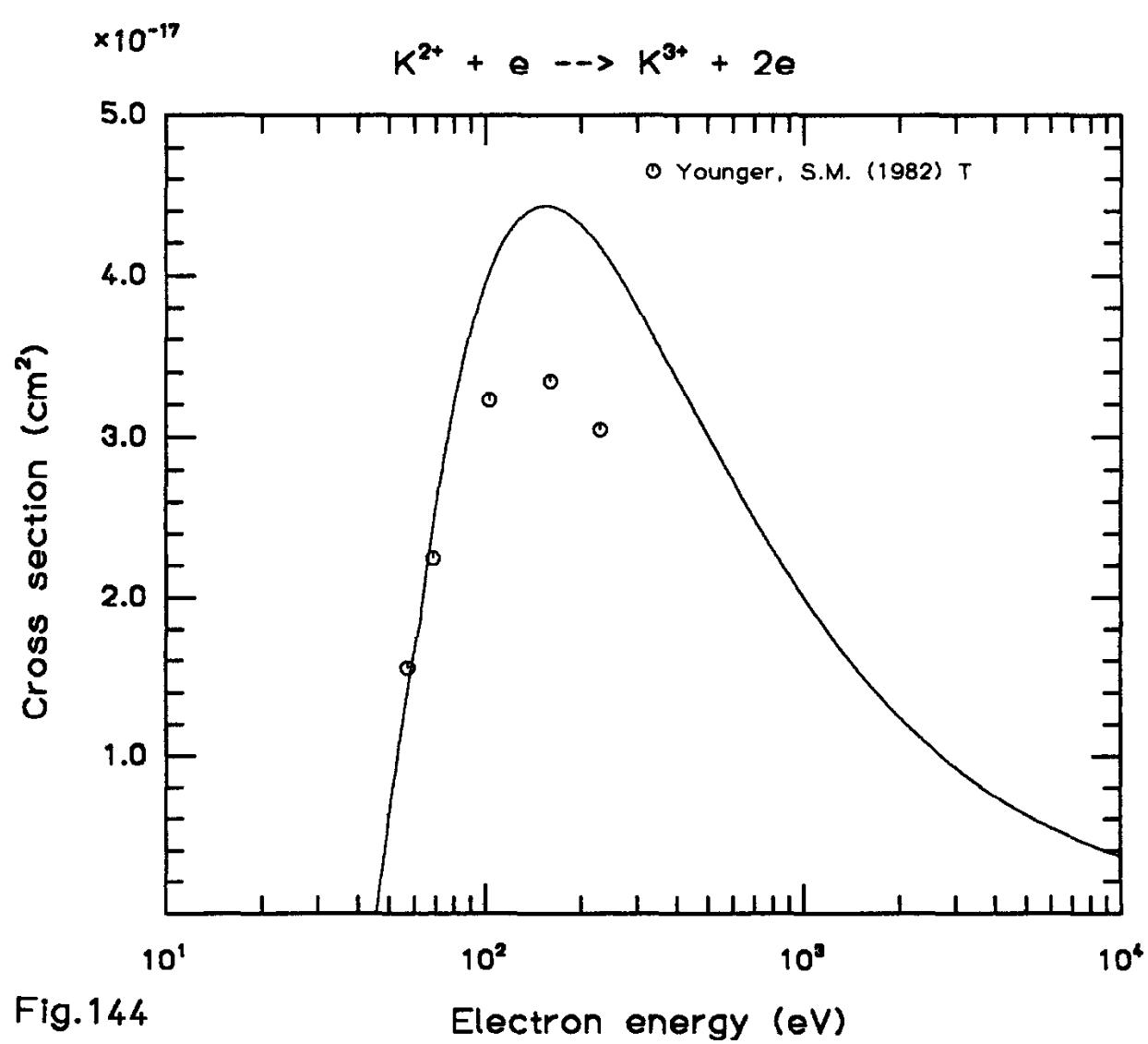
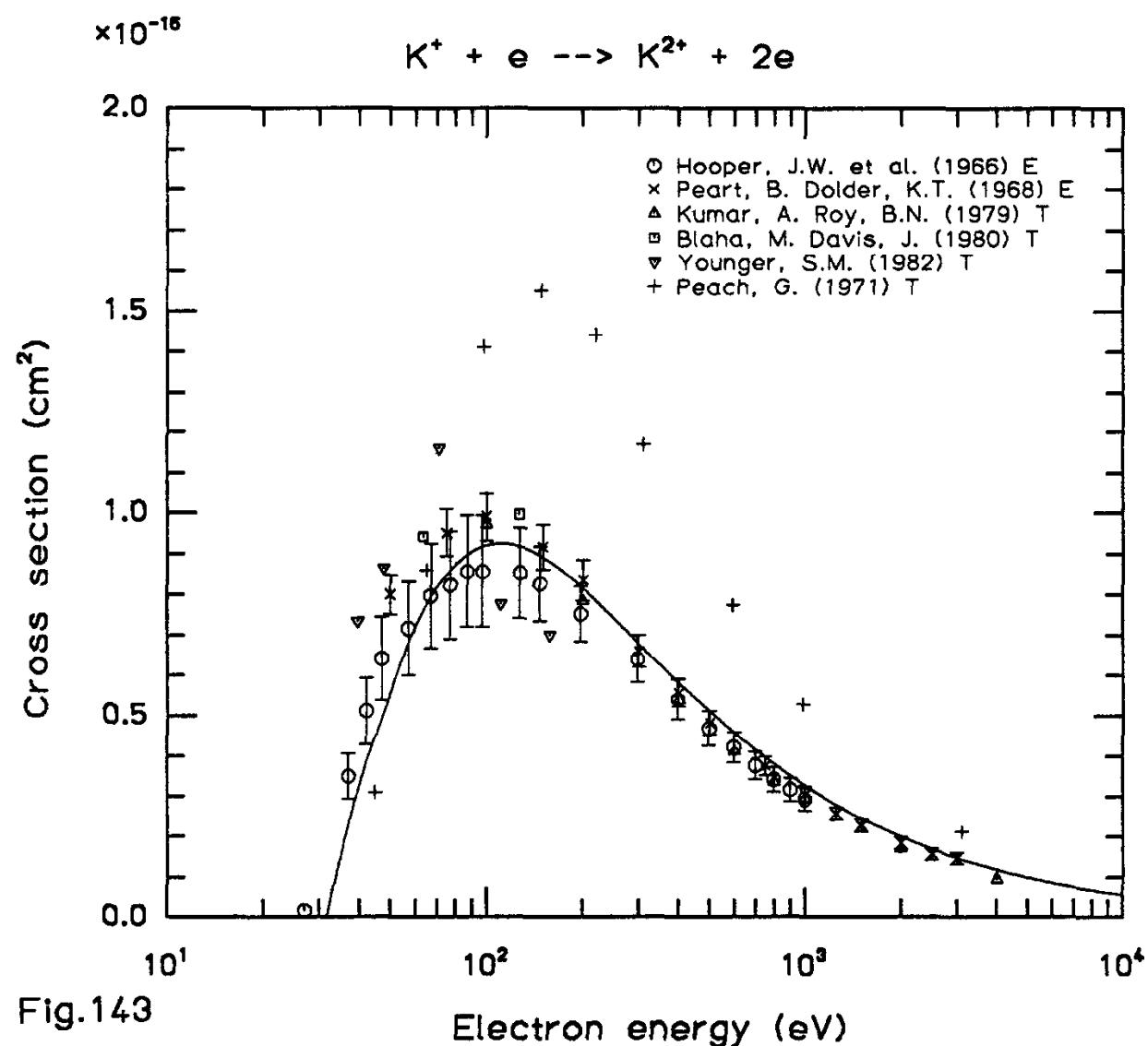


Fig.142

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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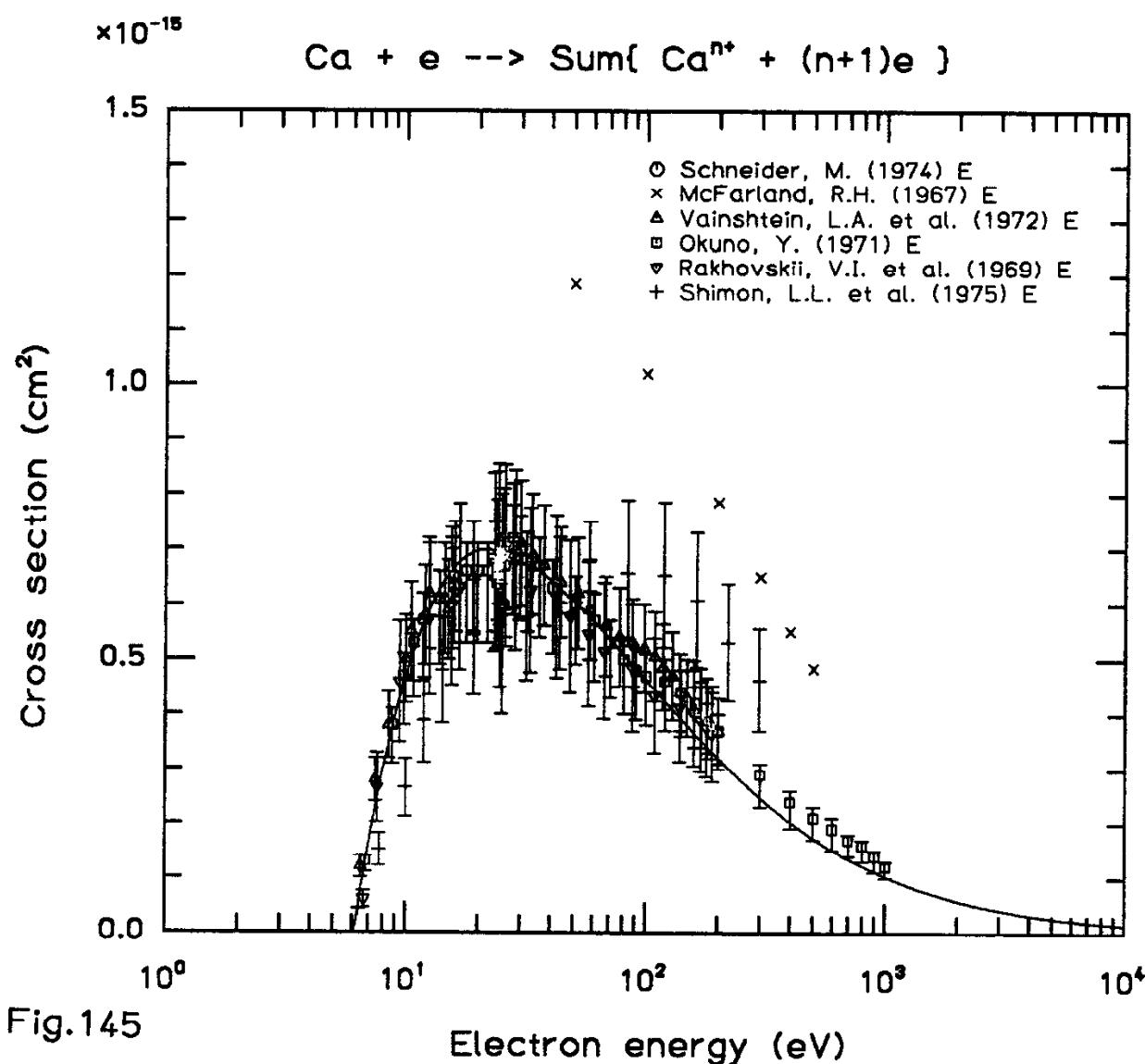


Fig.145

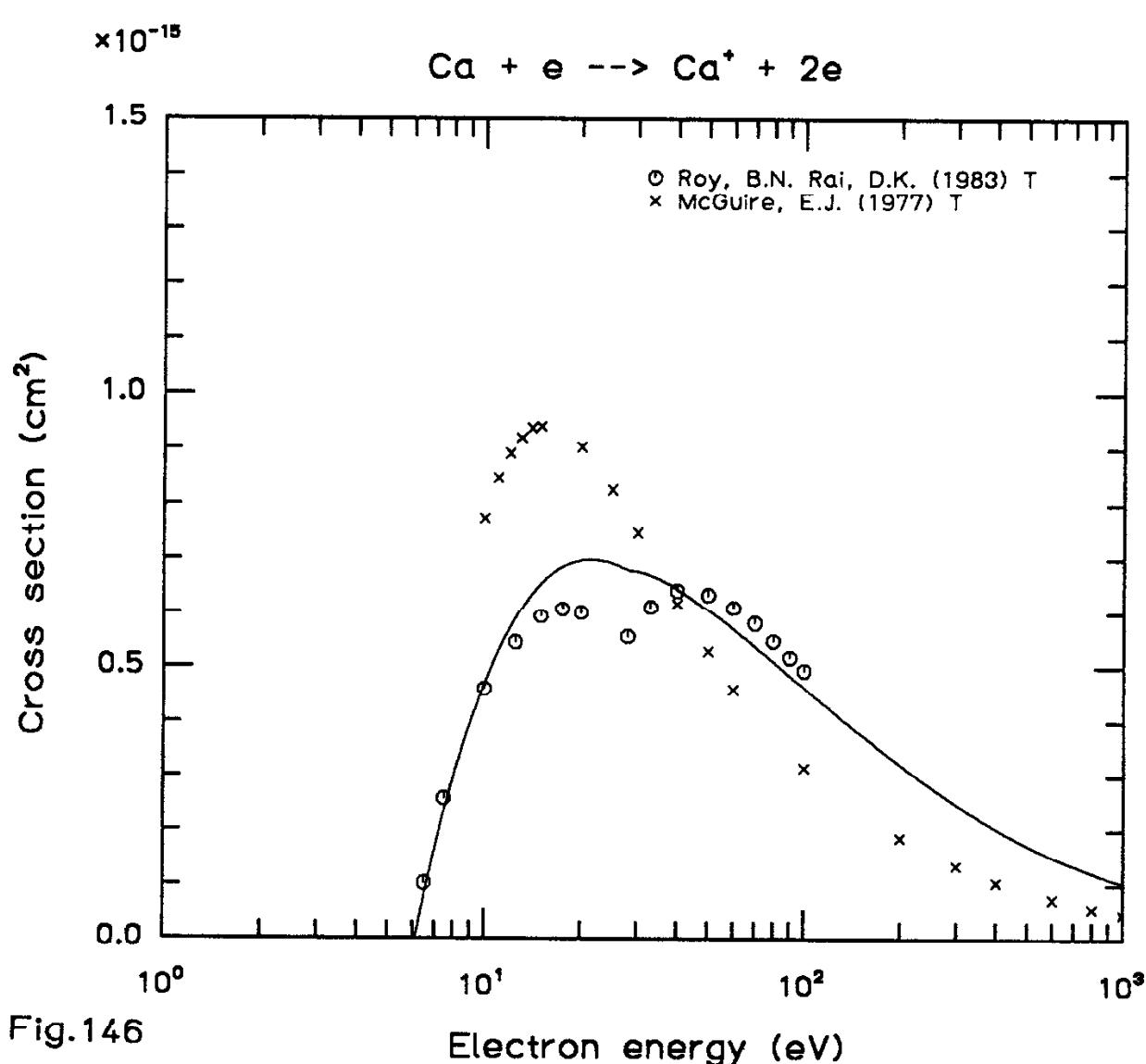


Fig.146

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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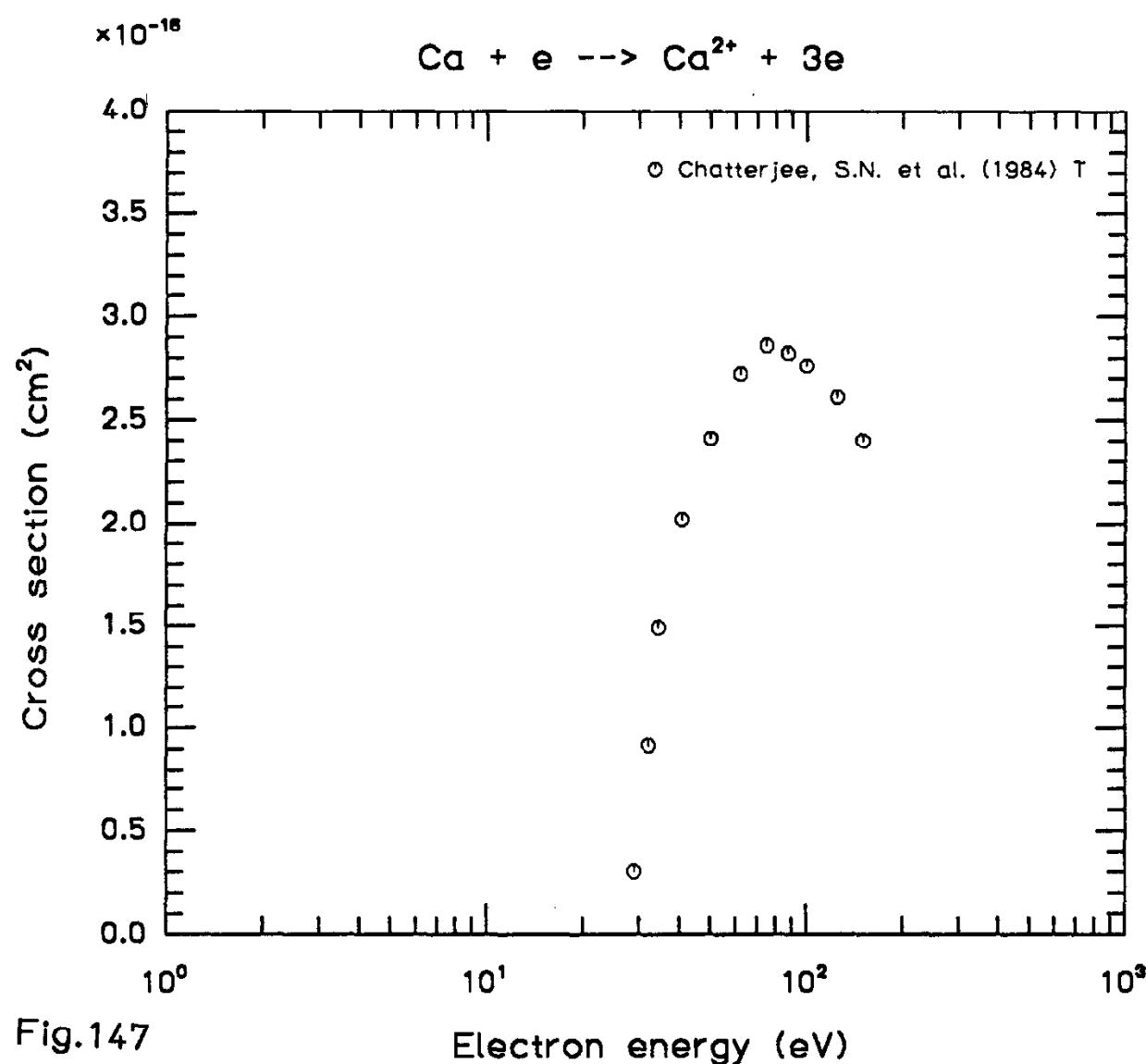


Fig.147

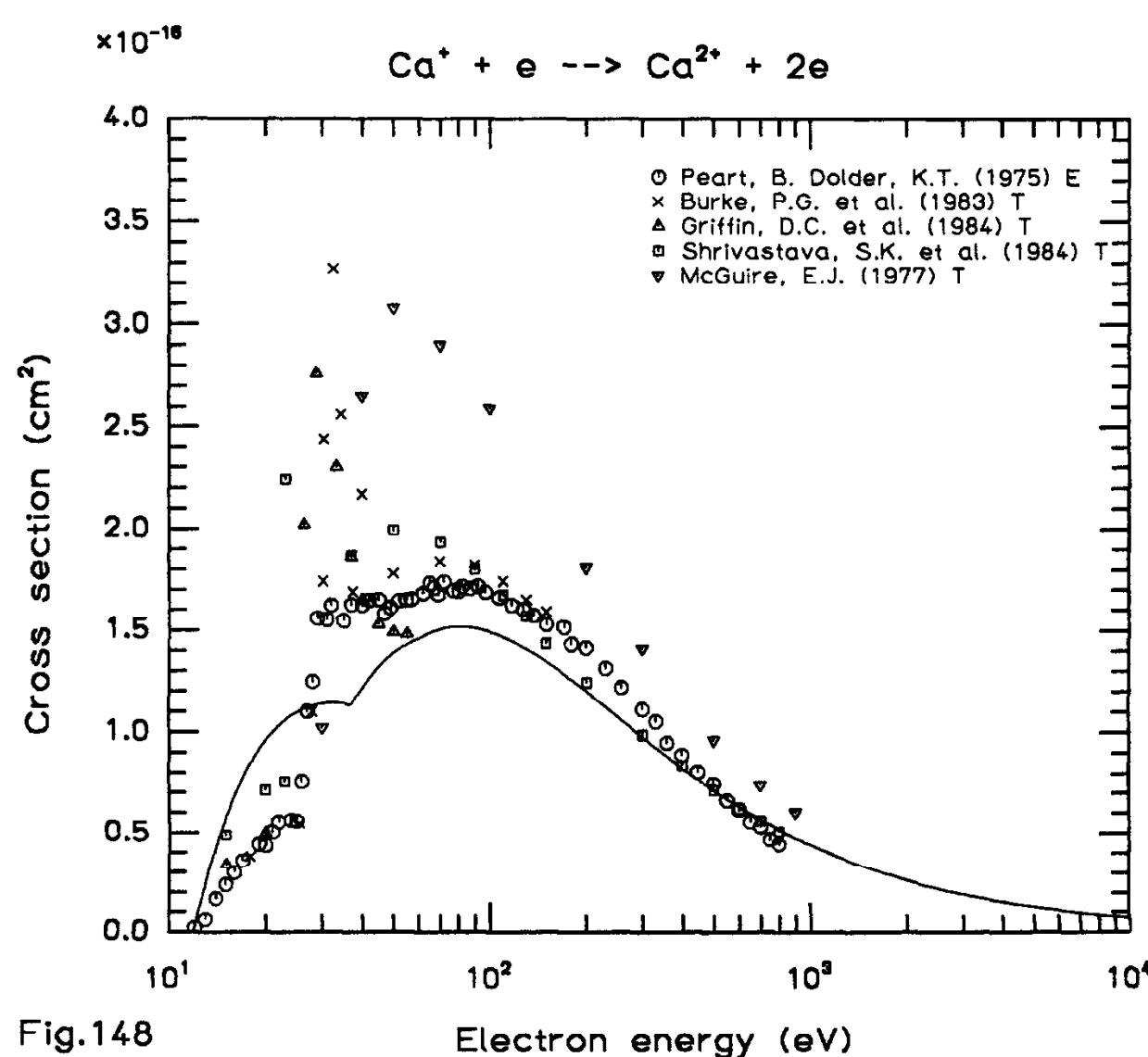
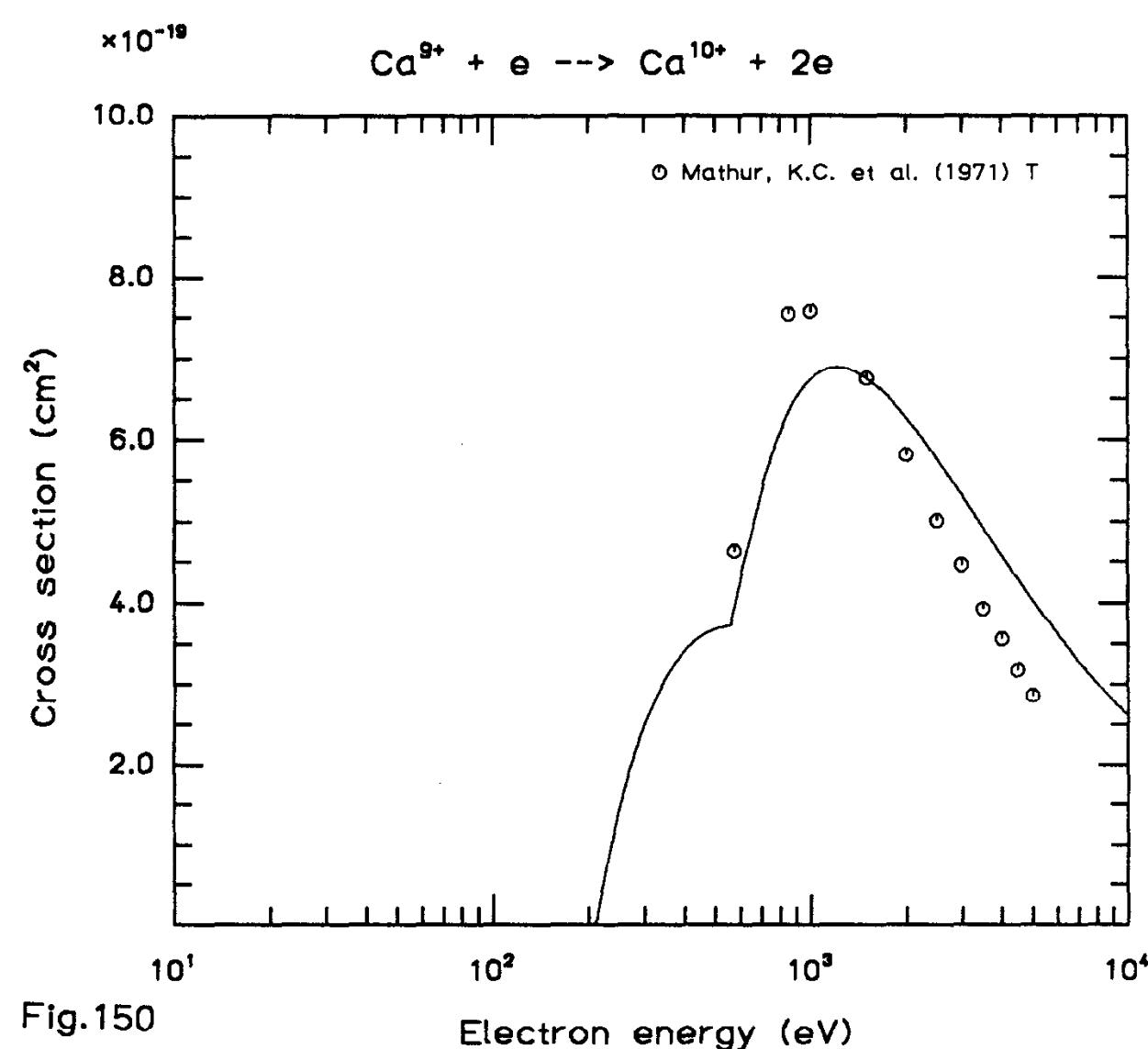
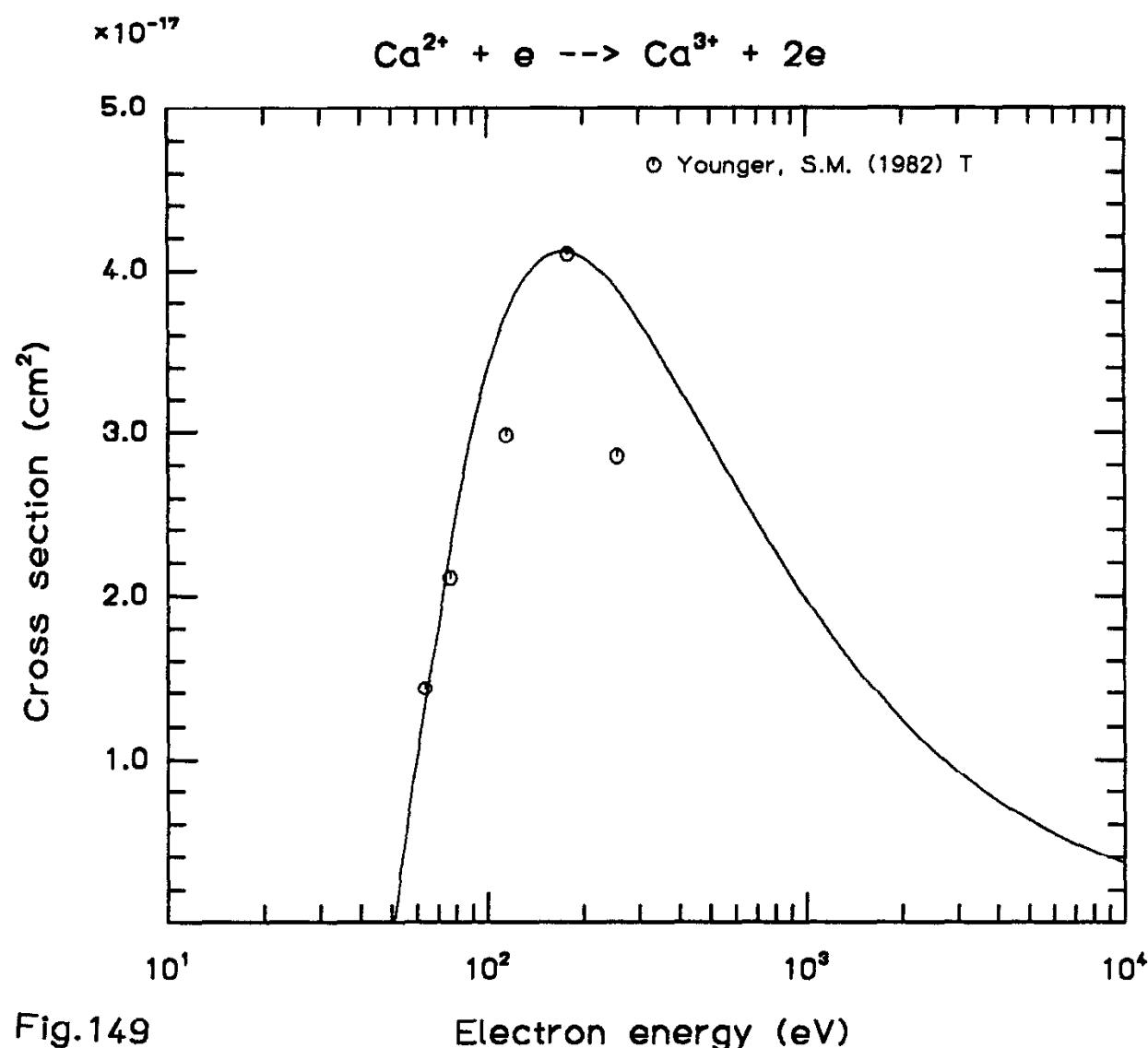


Fig.148

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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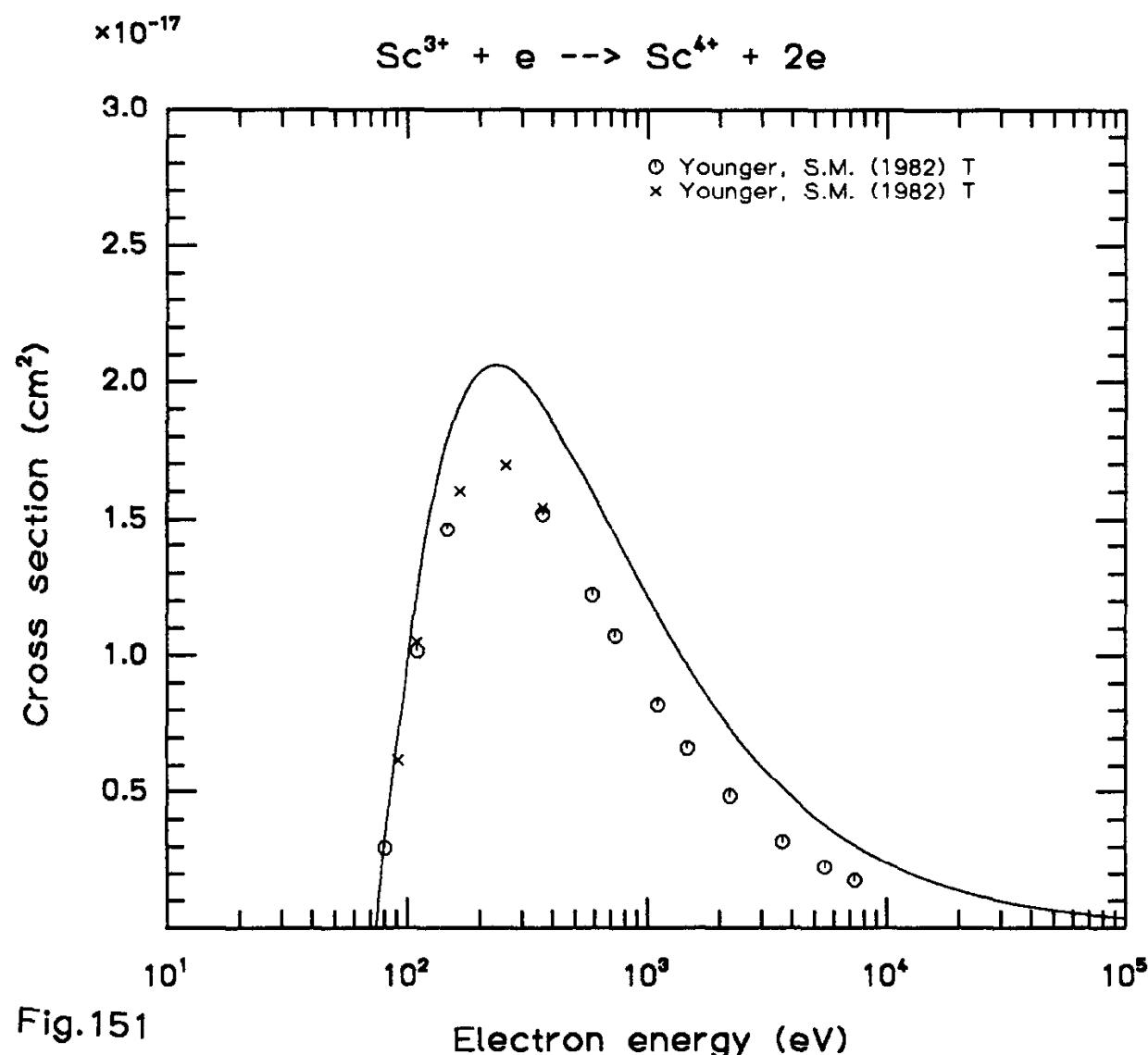


Fig.151

Electron energy (eV)

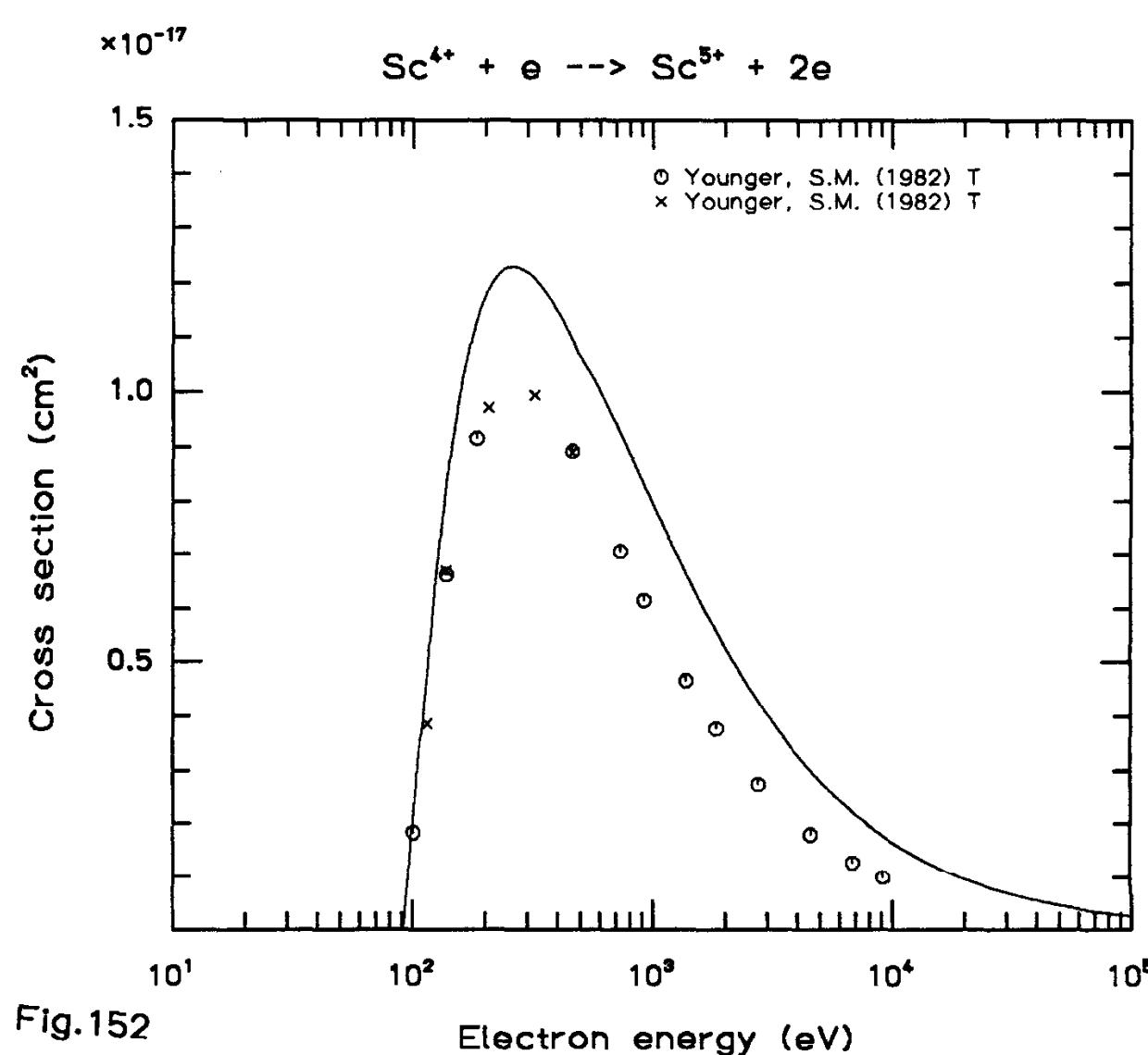


Fig.152

Electron energy (eV)

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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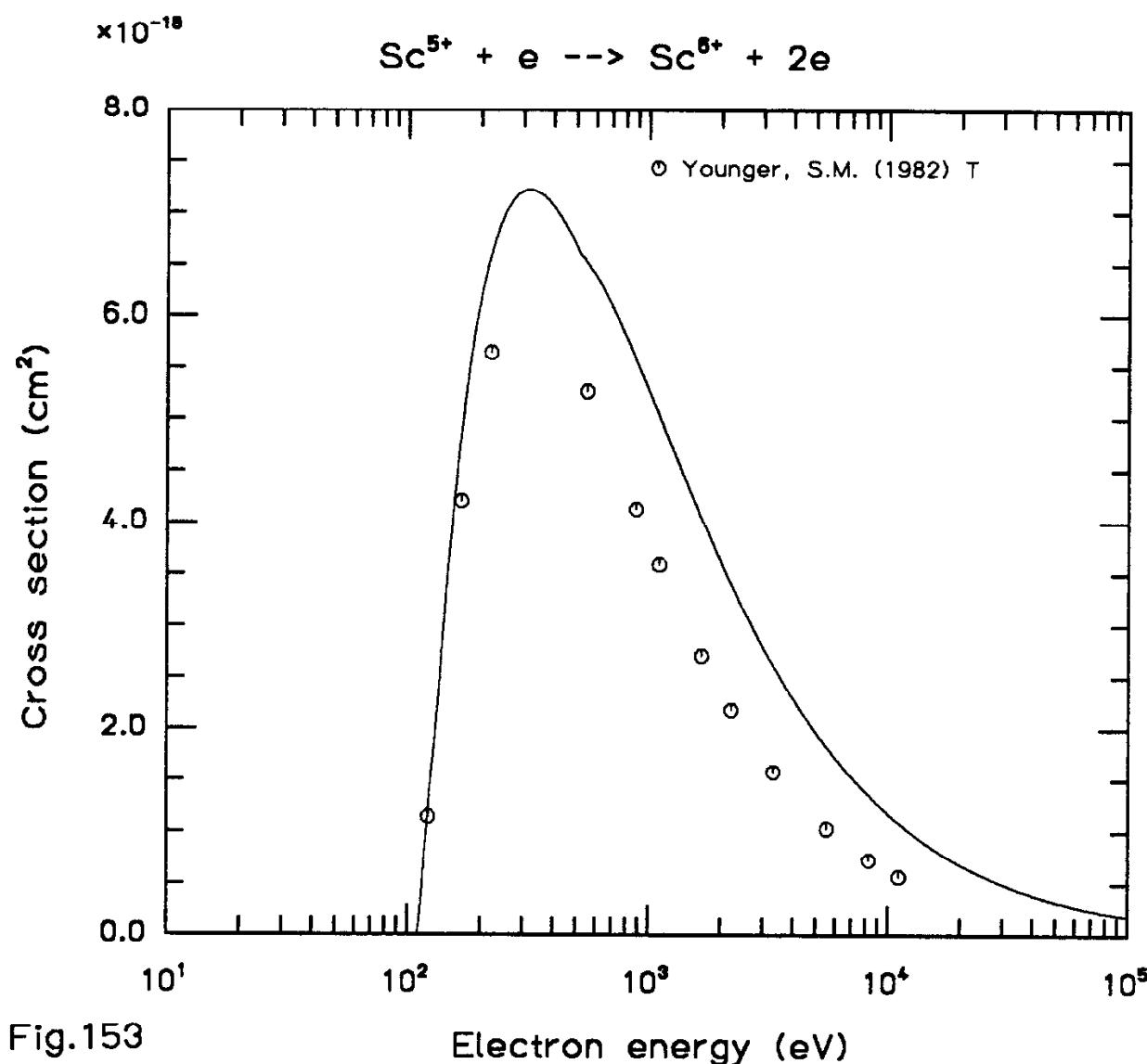


Fig.153

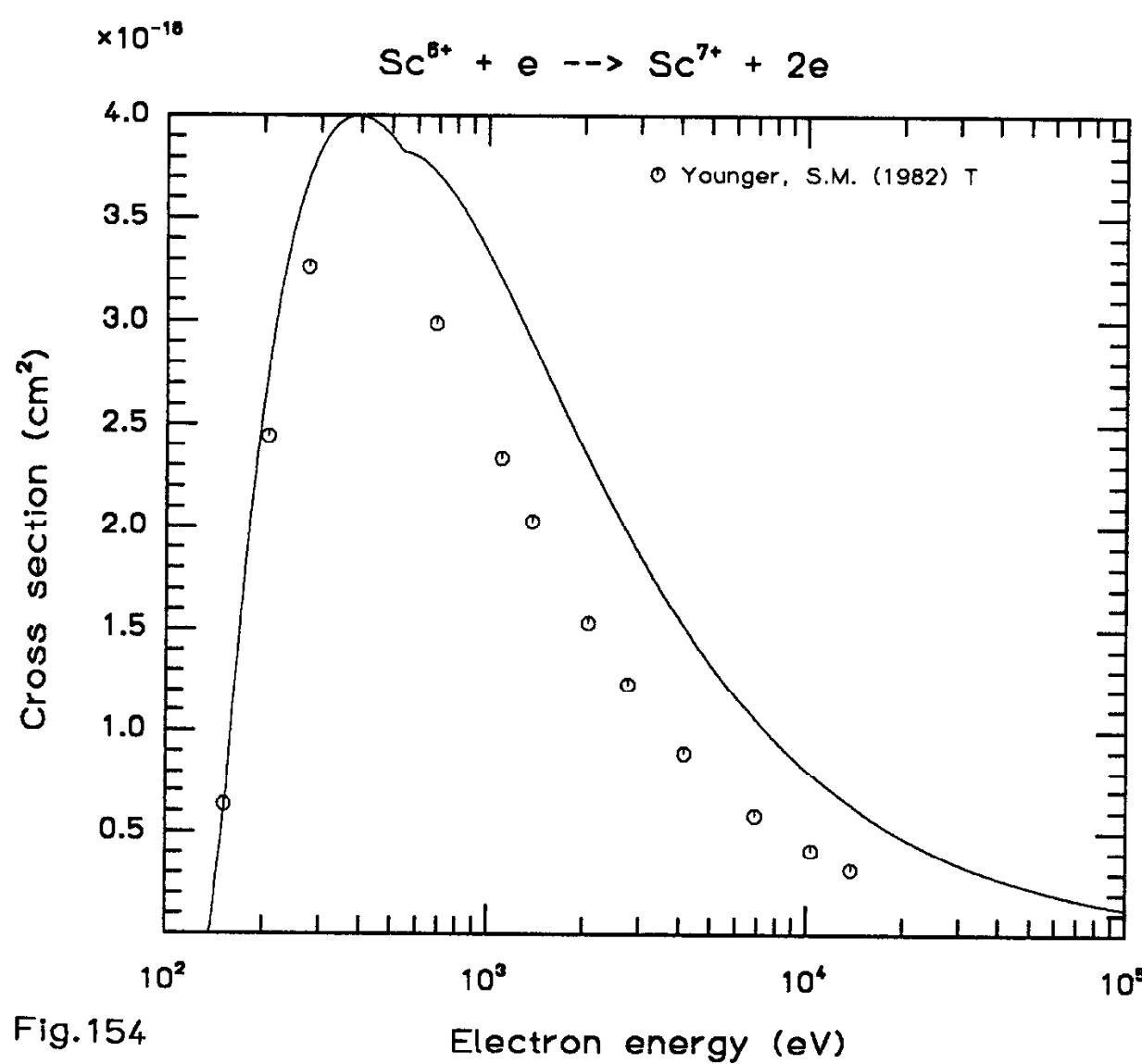


Fig.154

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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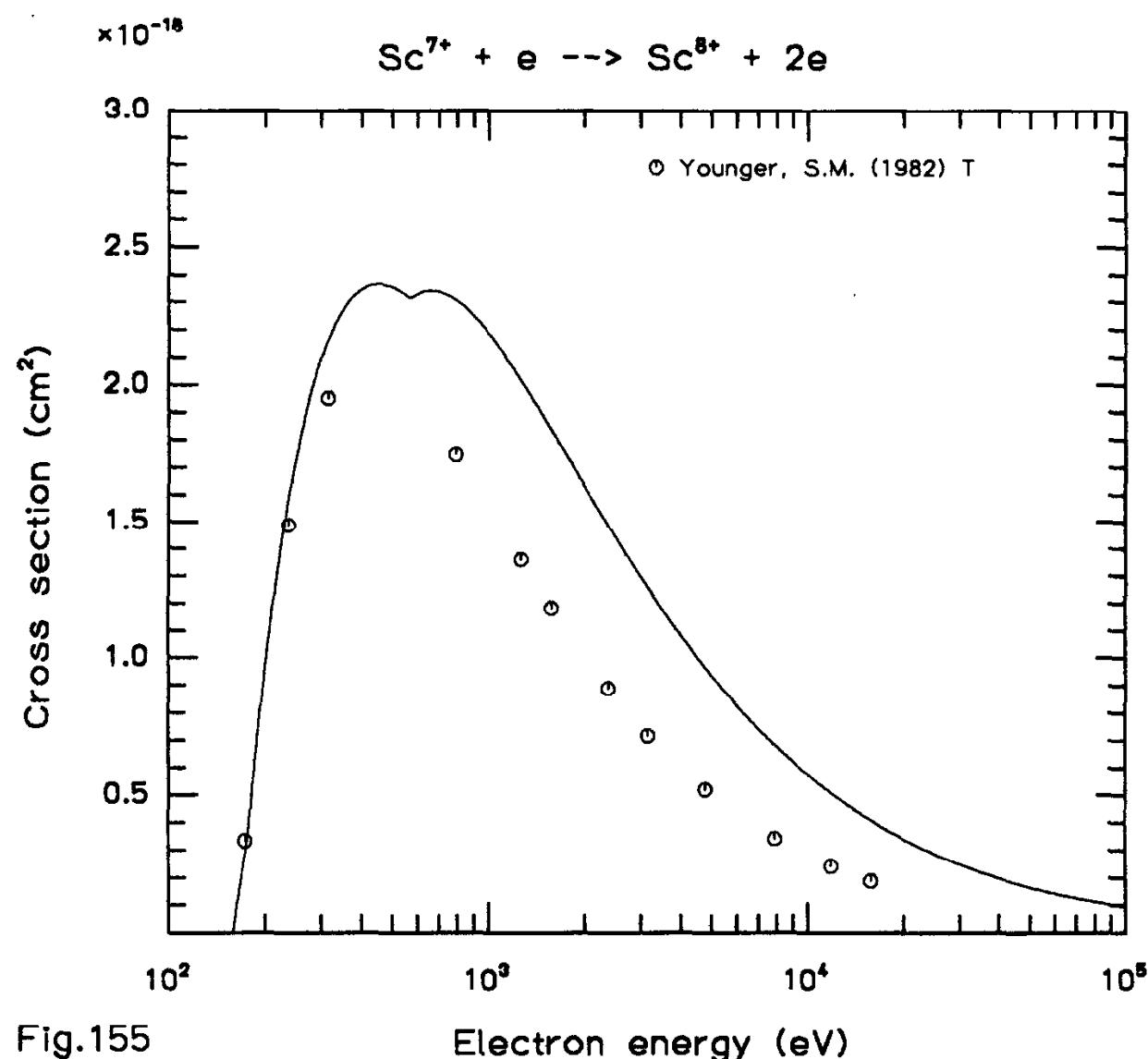


Fig.155

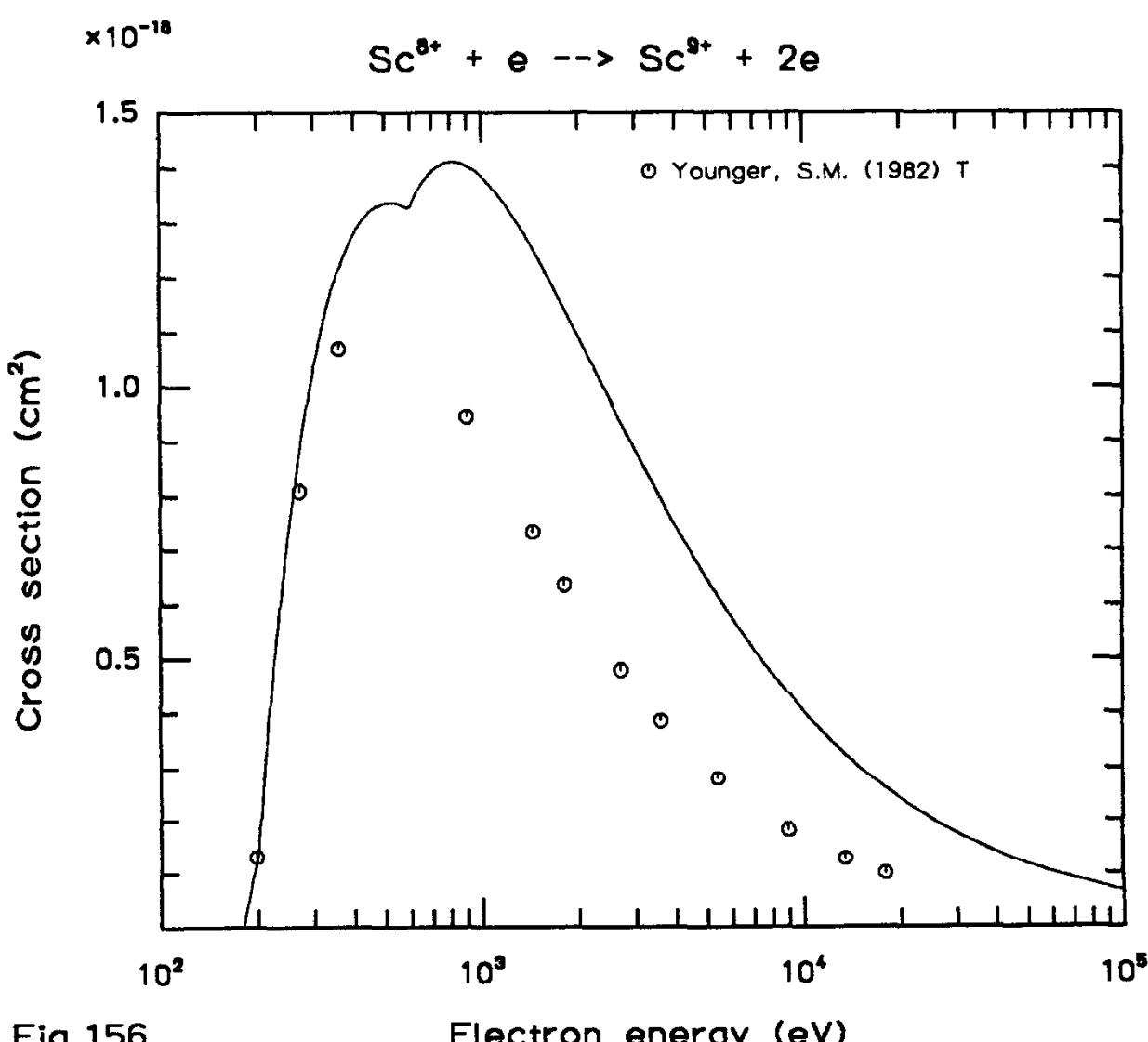


Fig.156

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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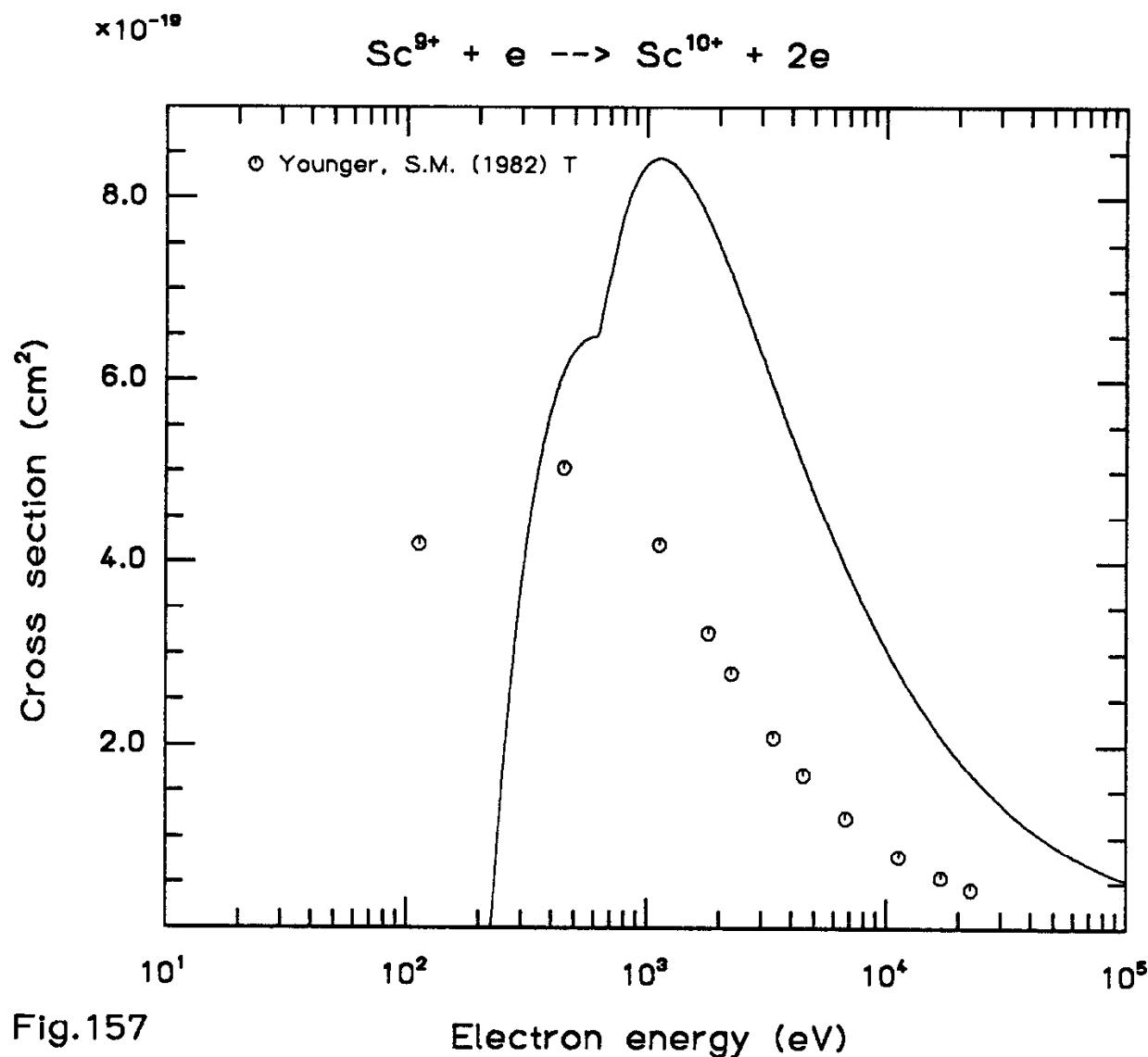


Fig.157

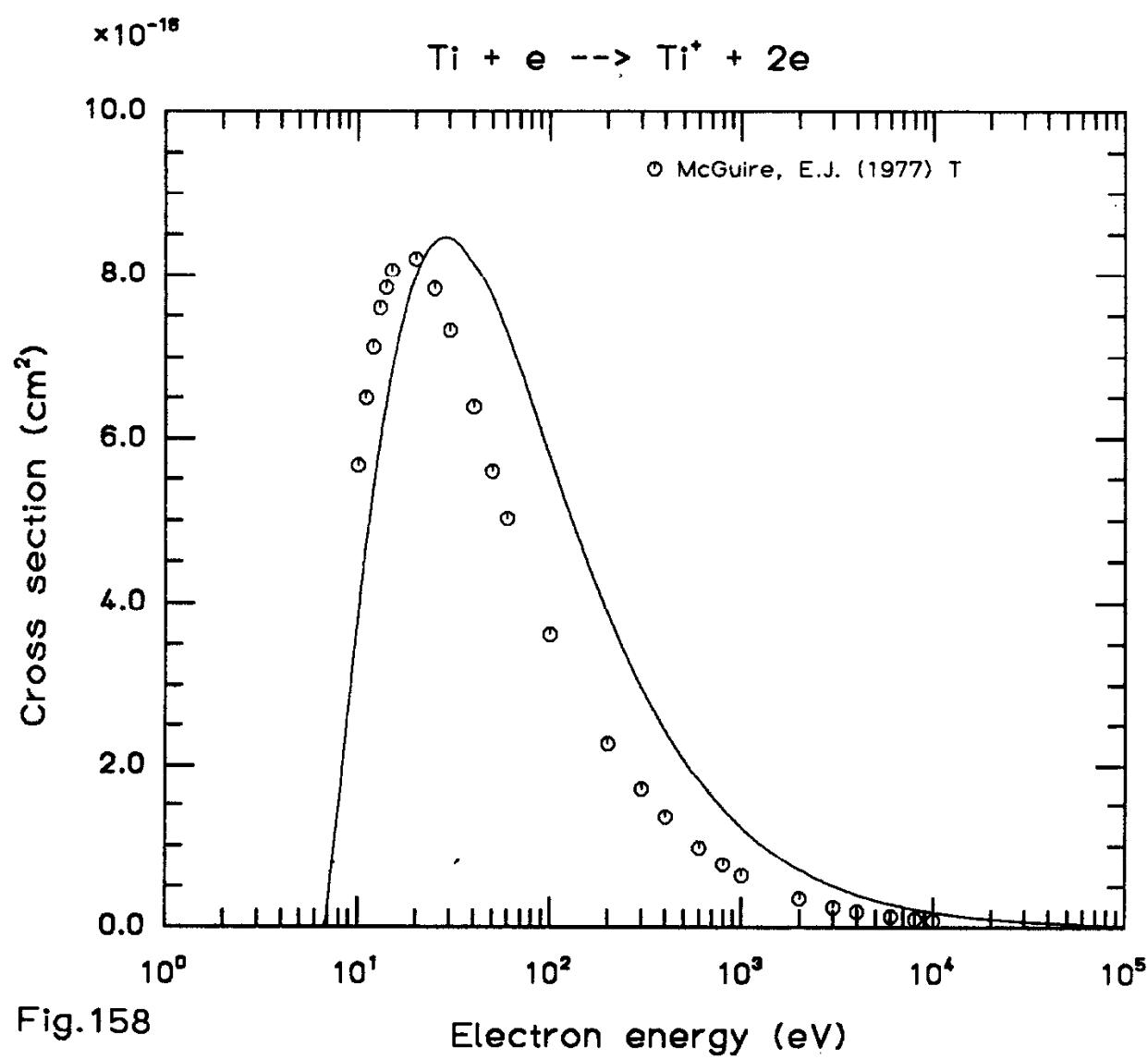


Fig.158

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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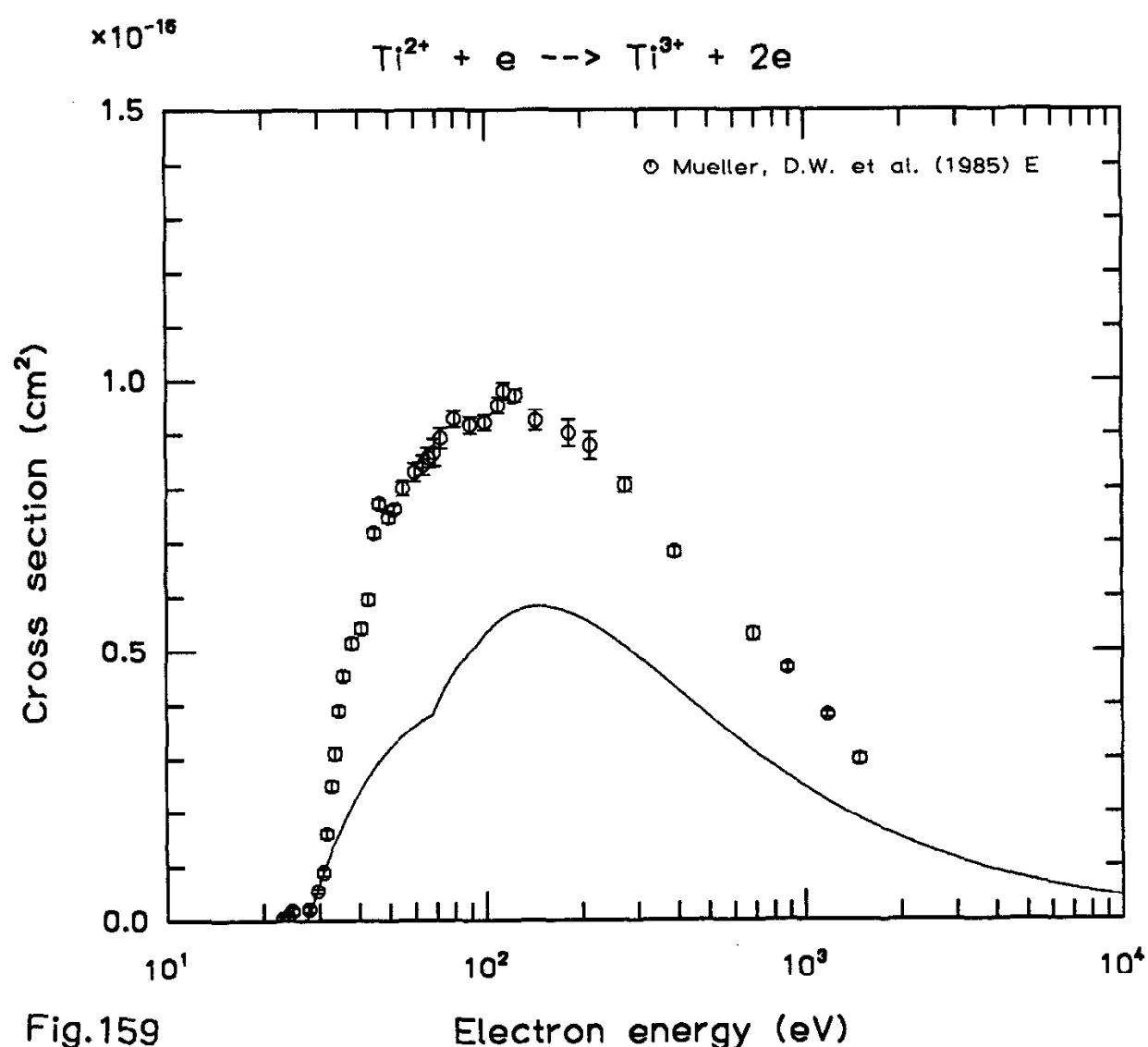


Fig.159

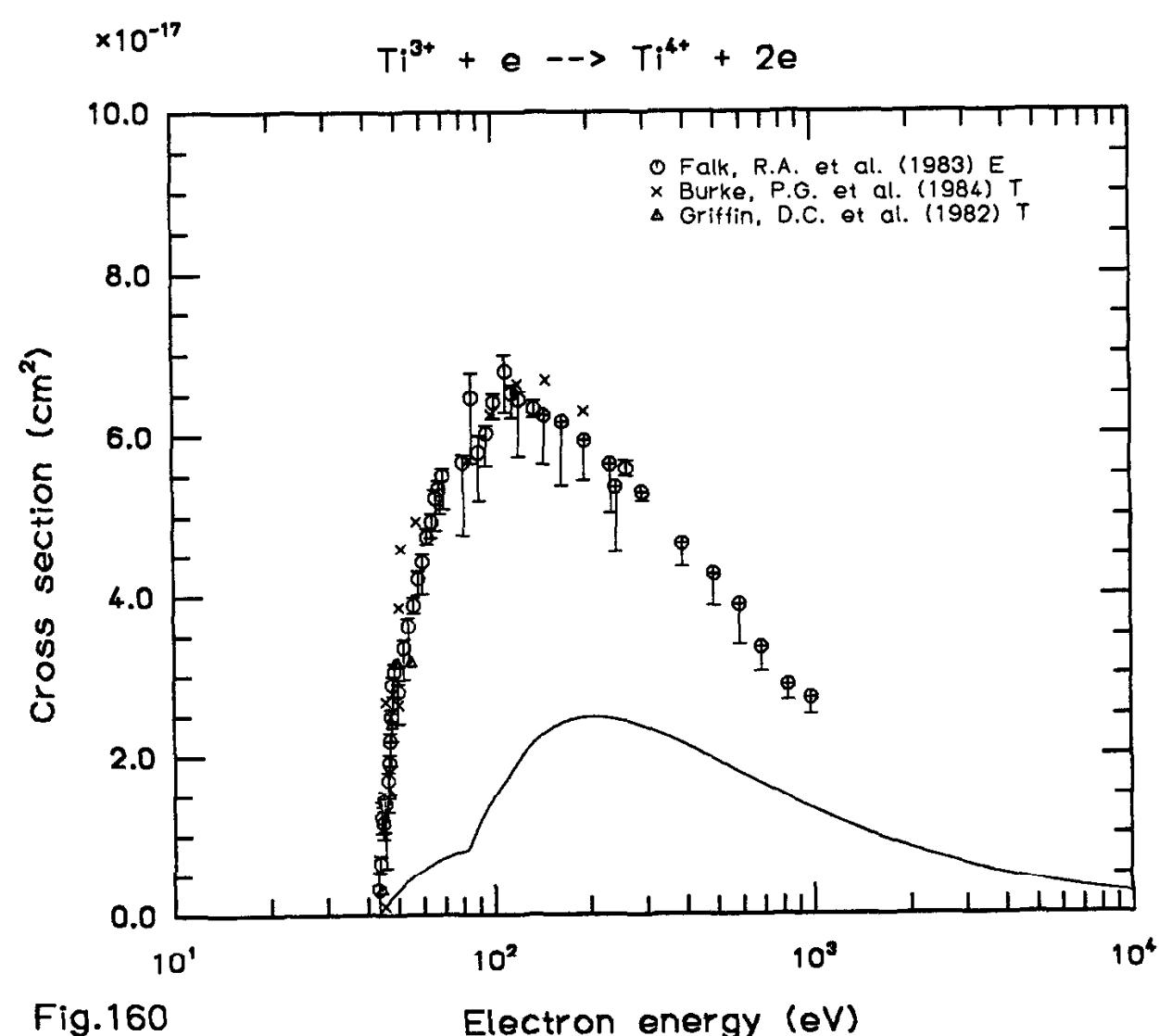
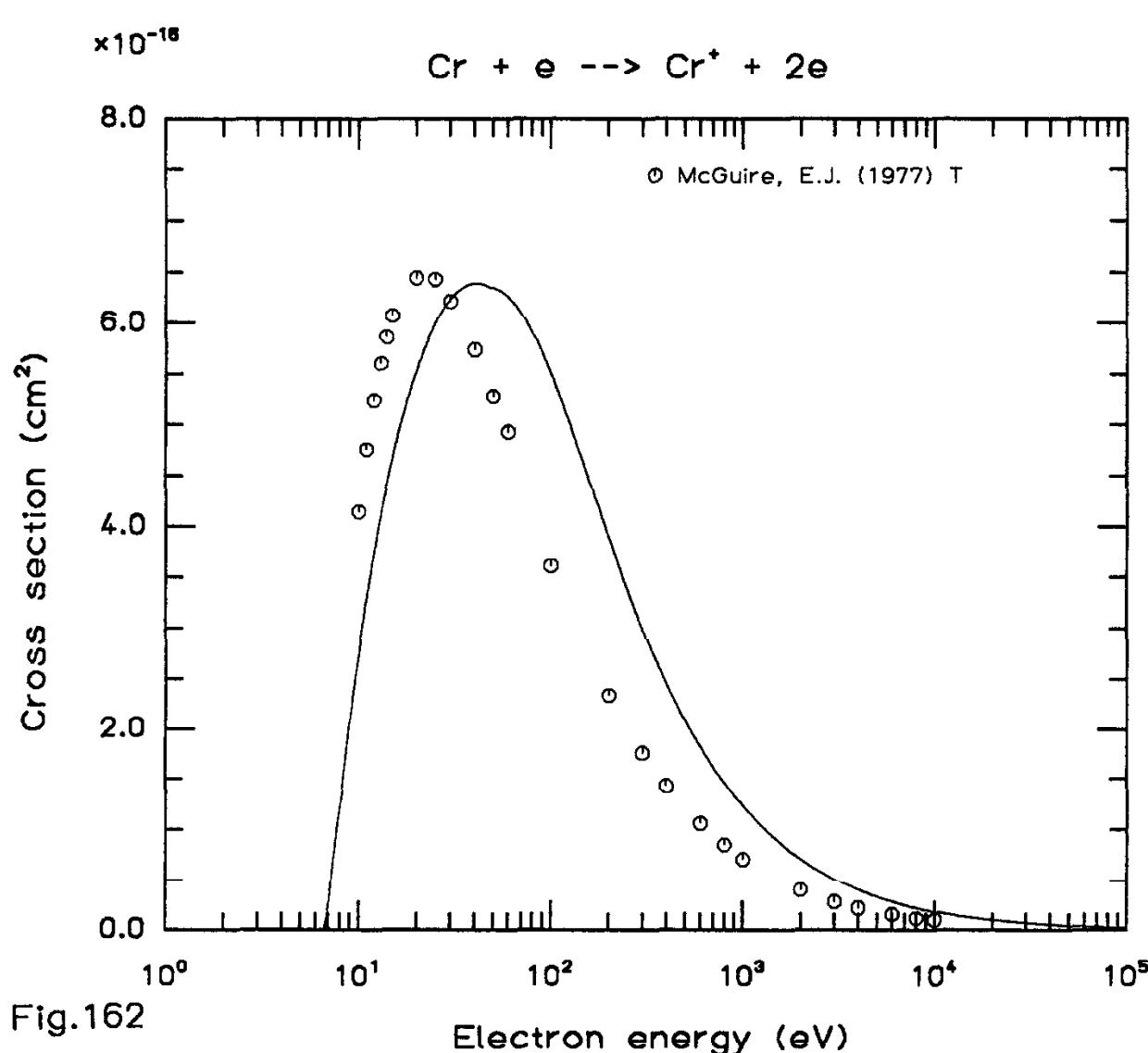
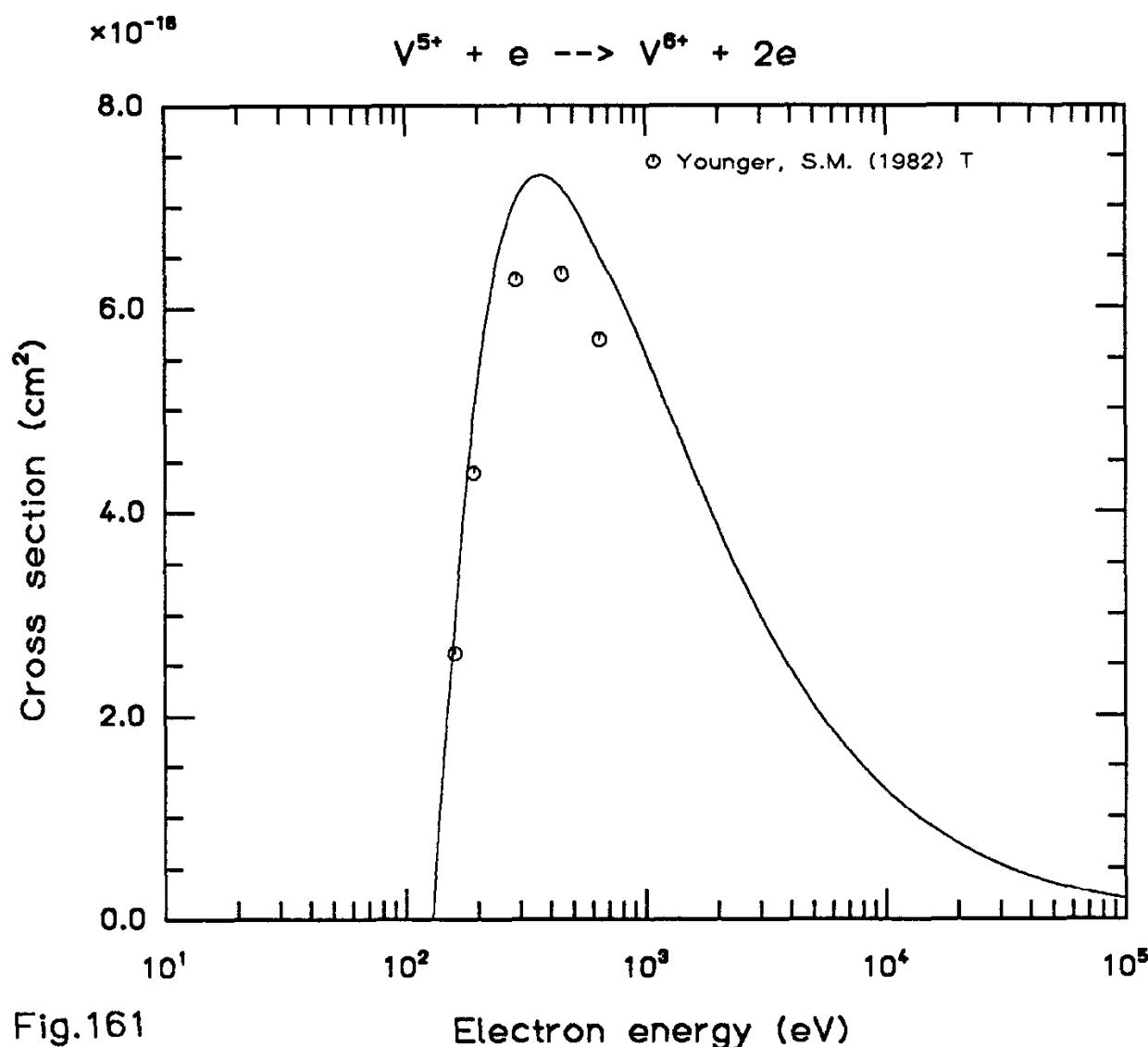


Fig.160

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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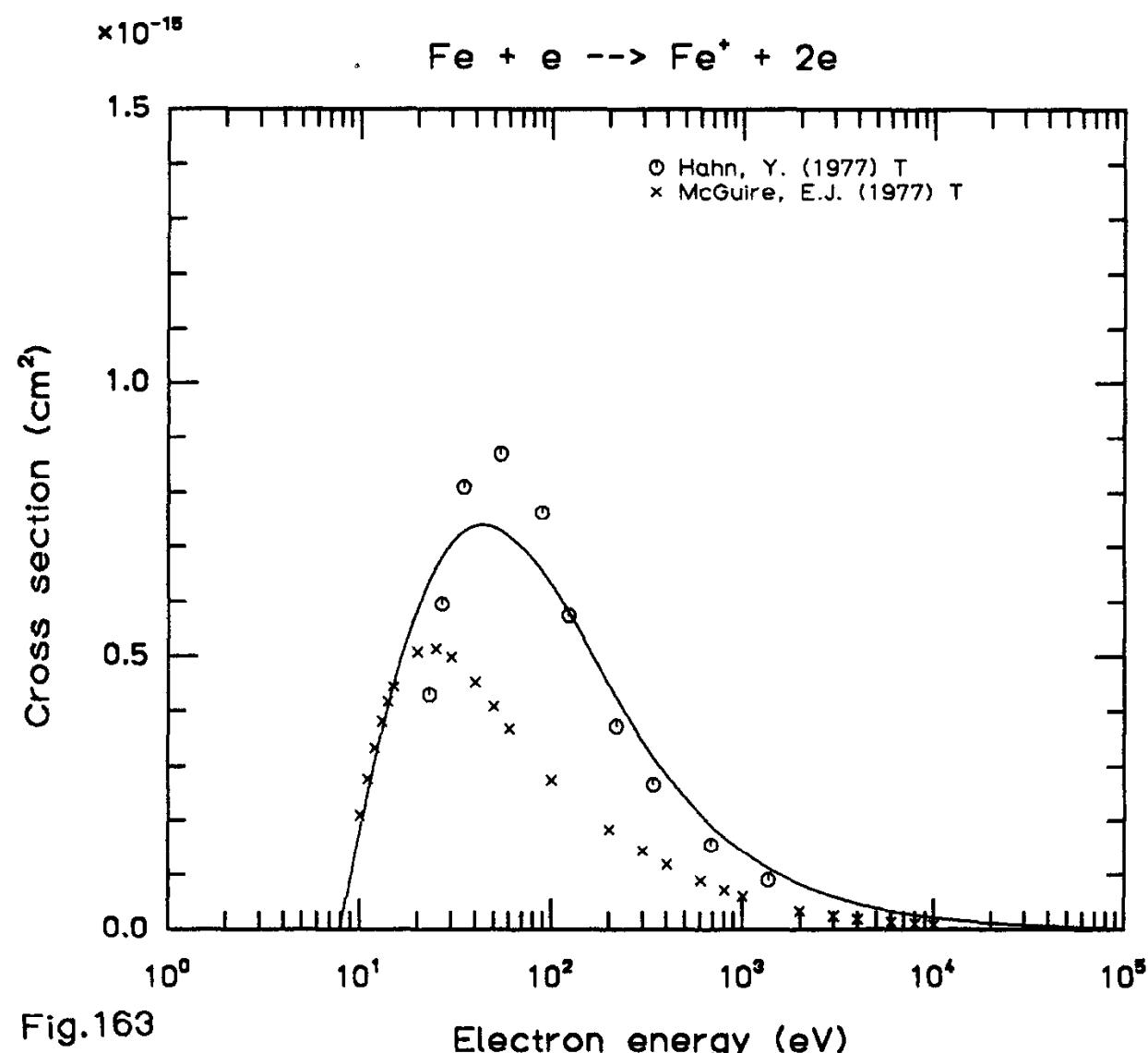


Fig.163

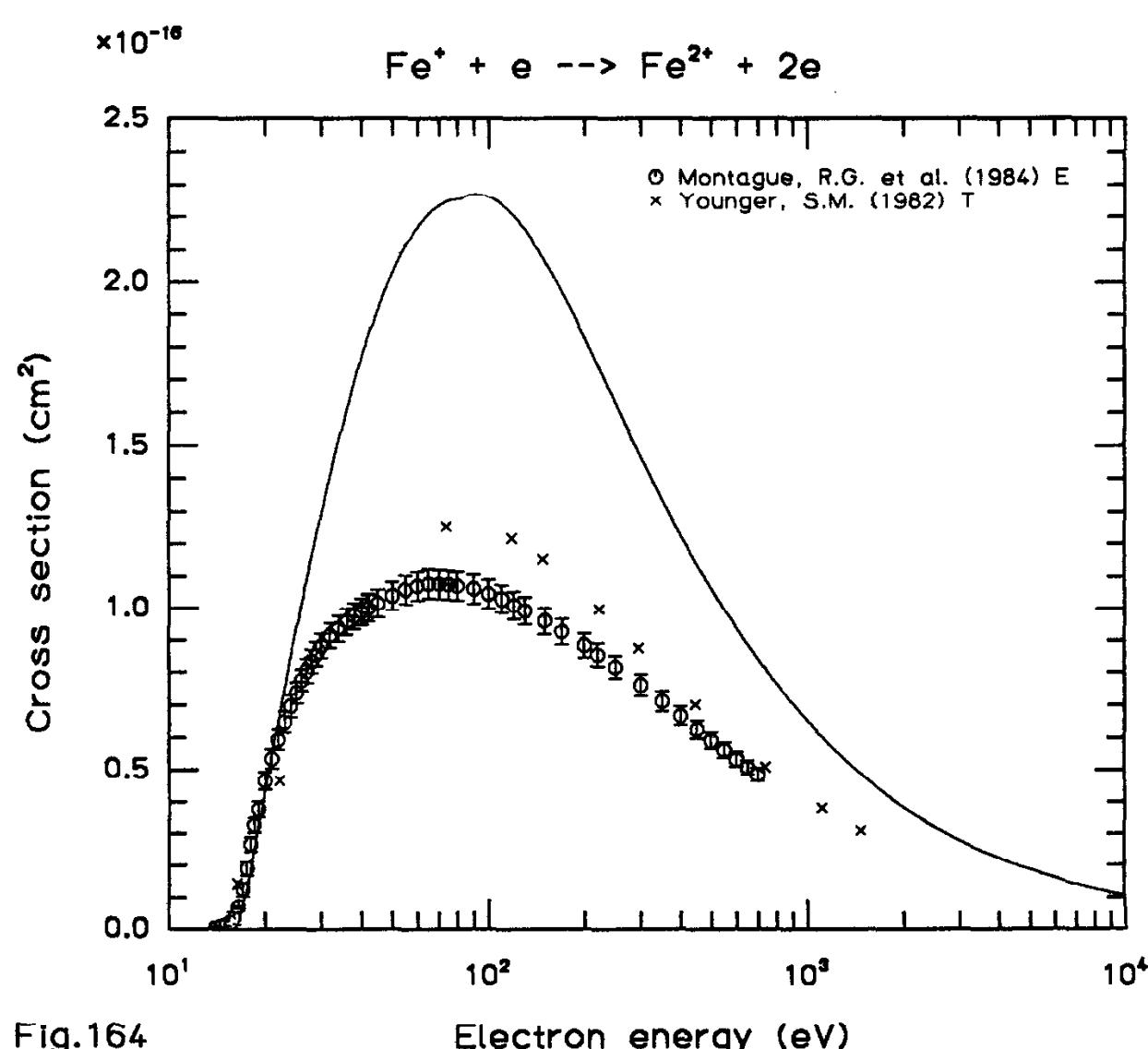


Fig.164

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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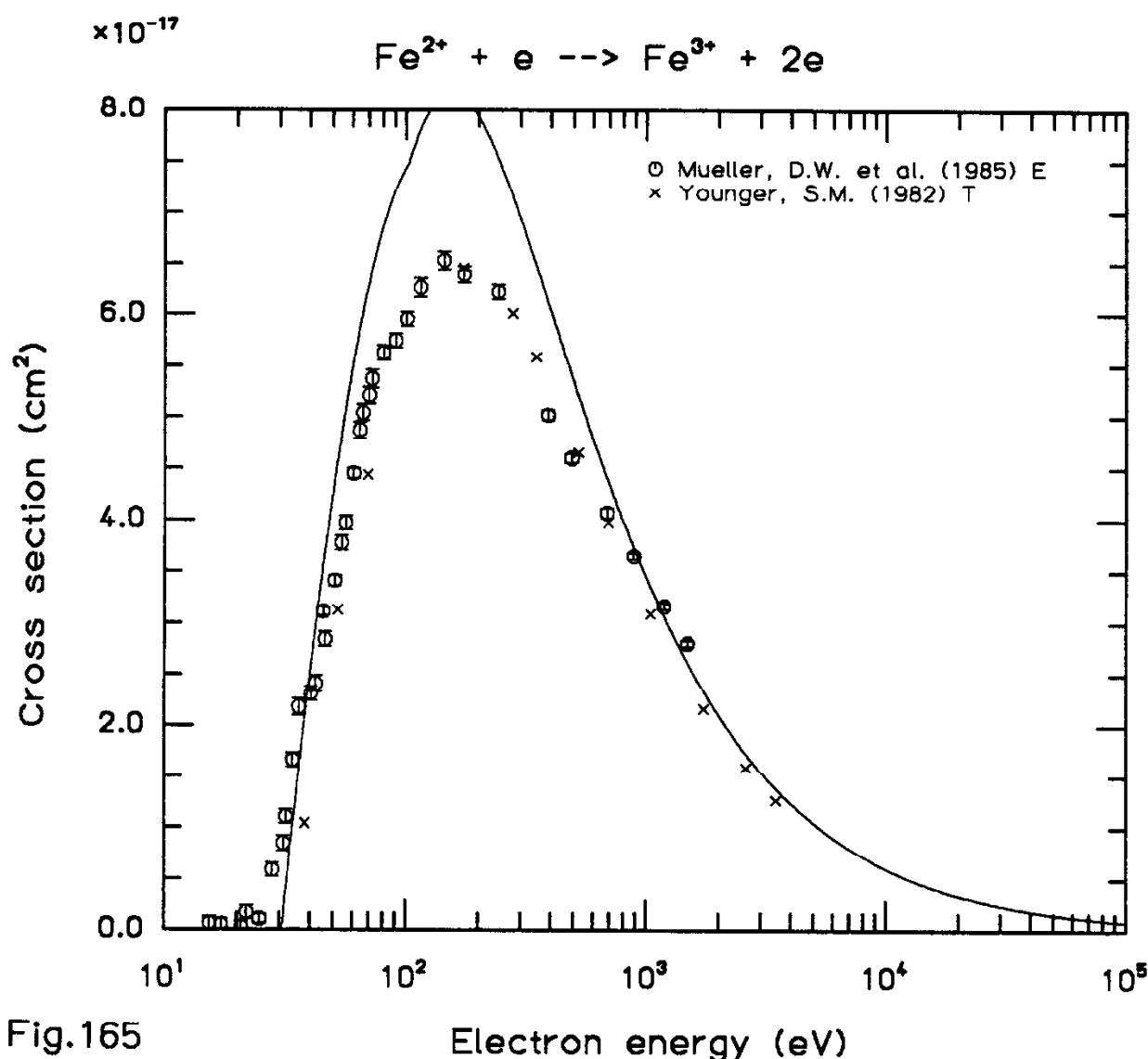


Fig.165

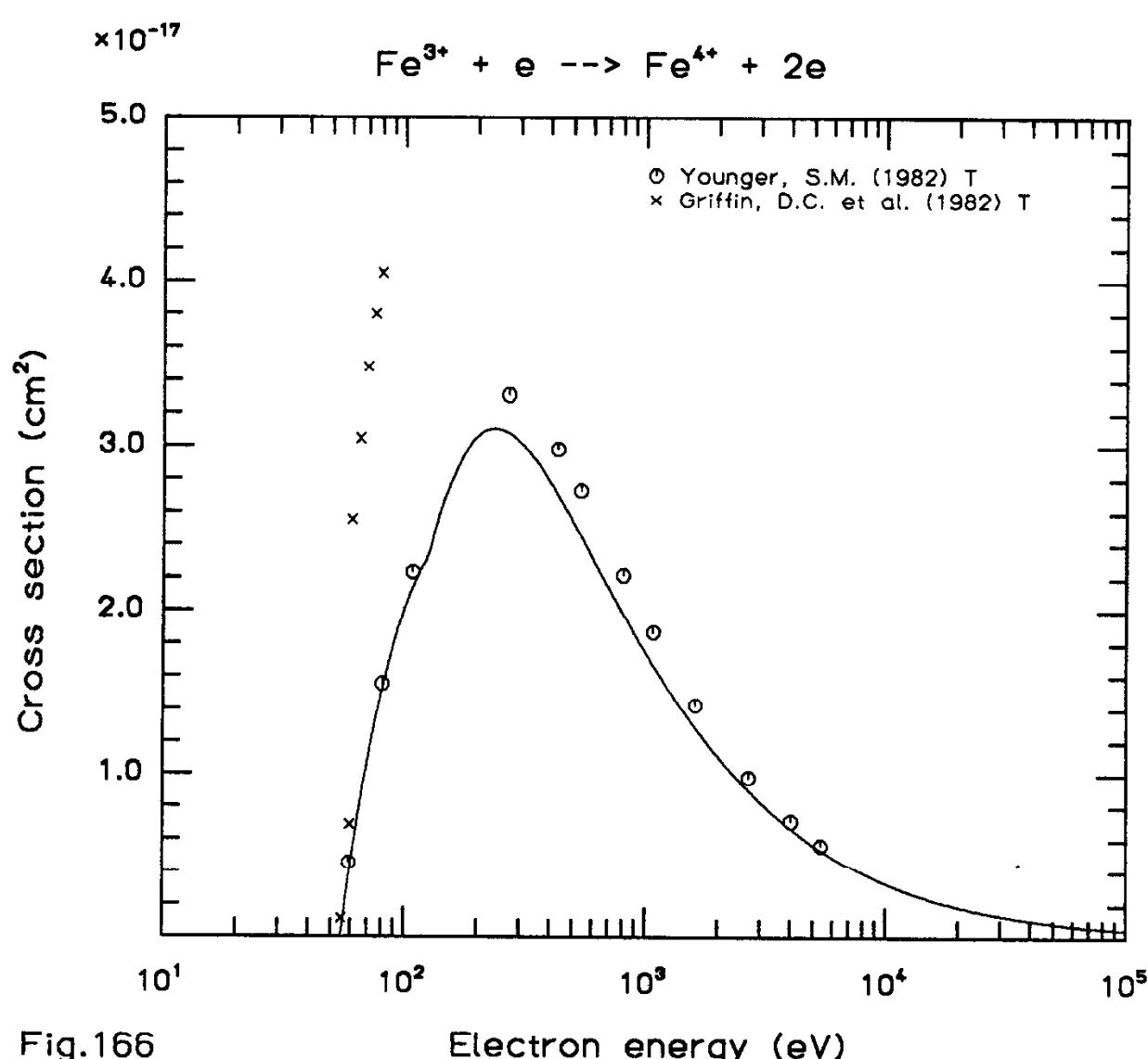


Fig.166

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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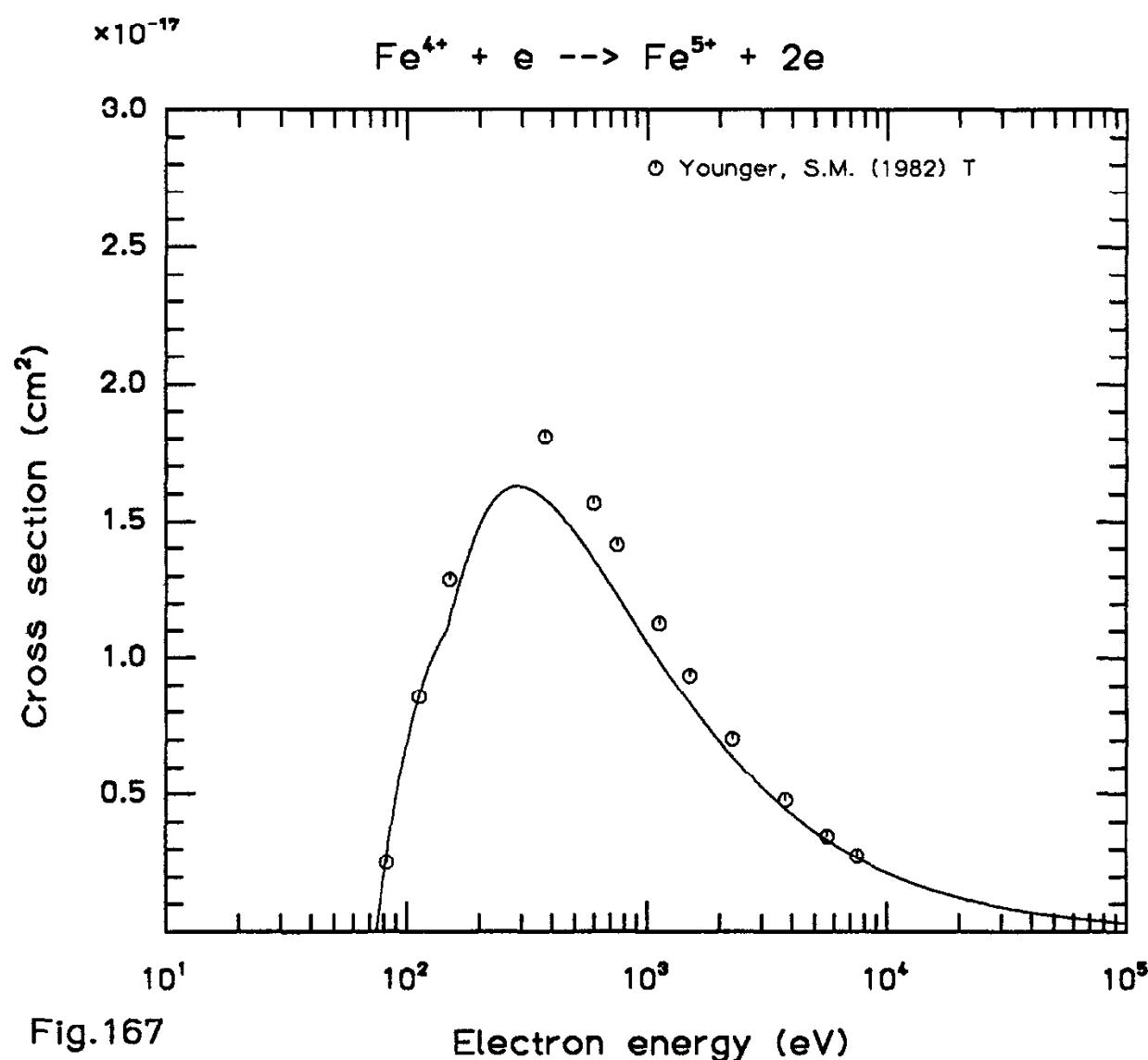


Fig.167

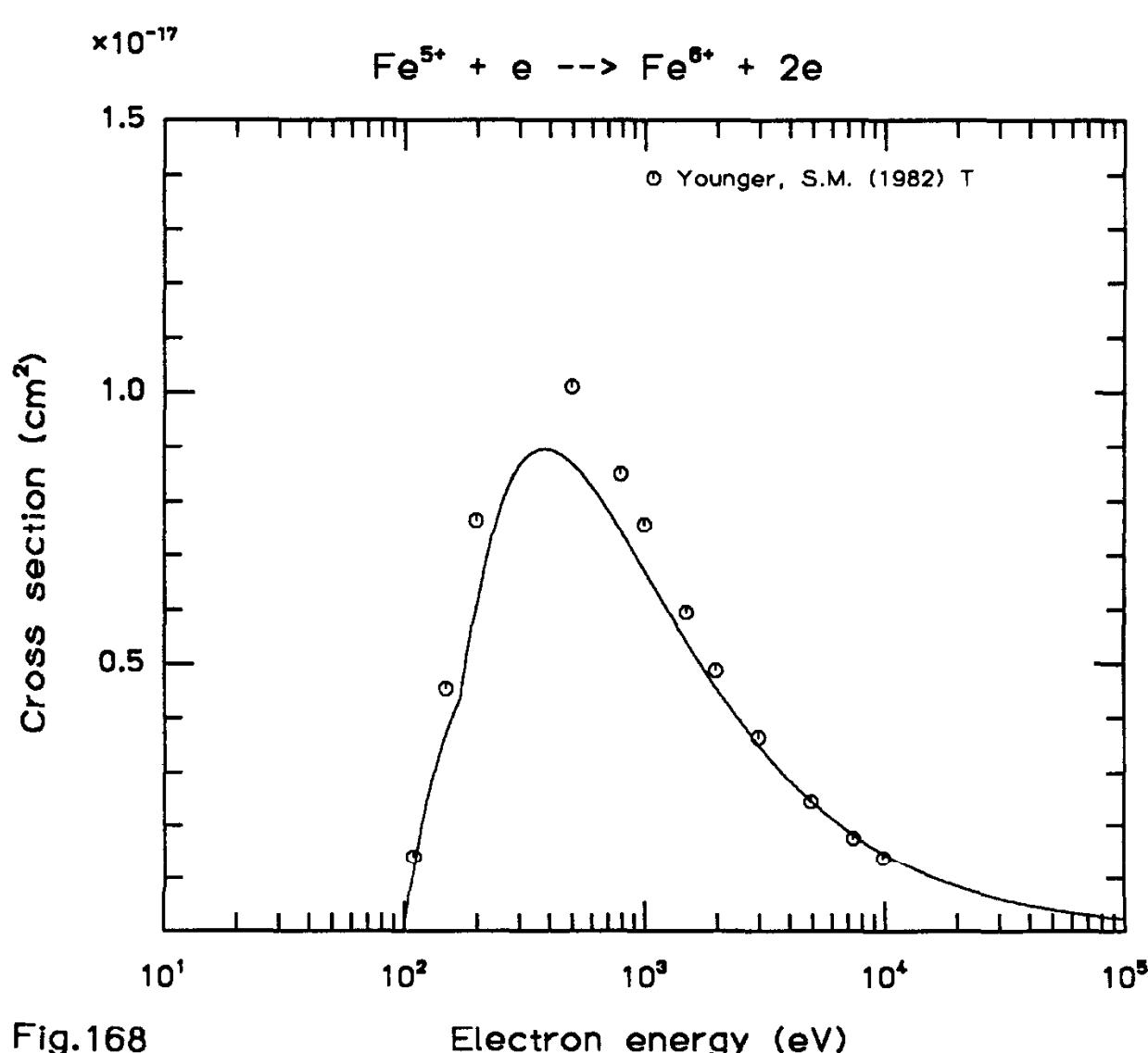


Fig.168

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
 See page 171 for Explanation of Figures

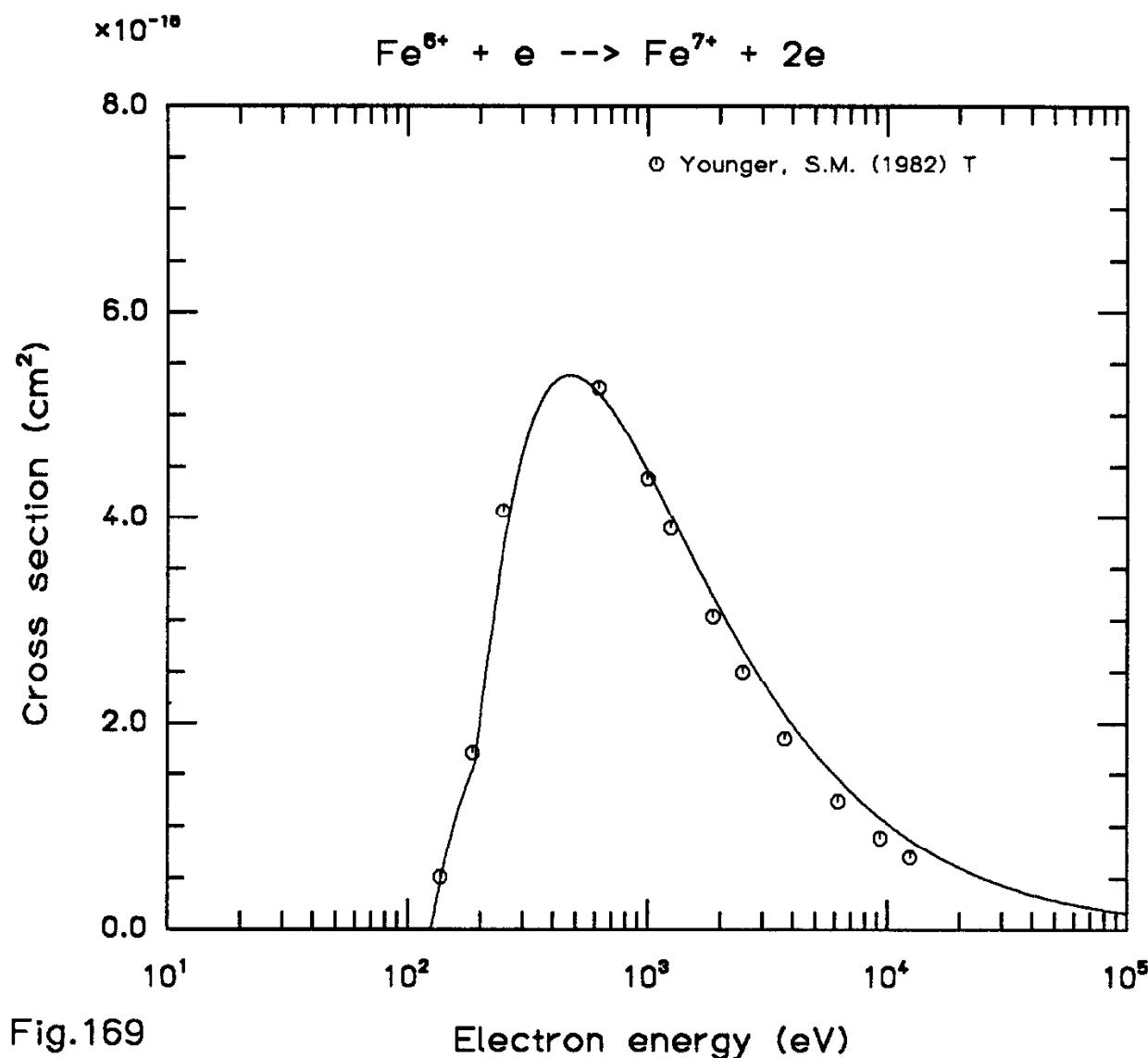


Fig.169

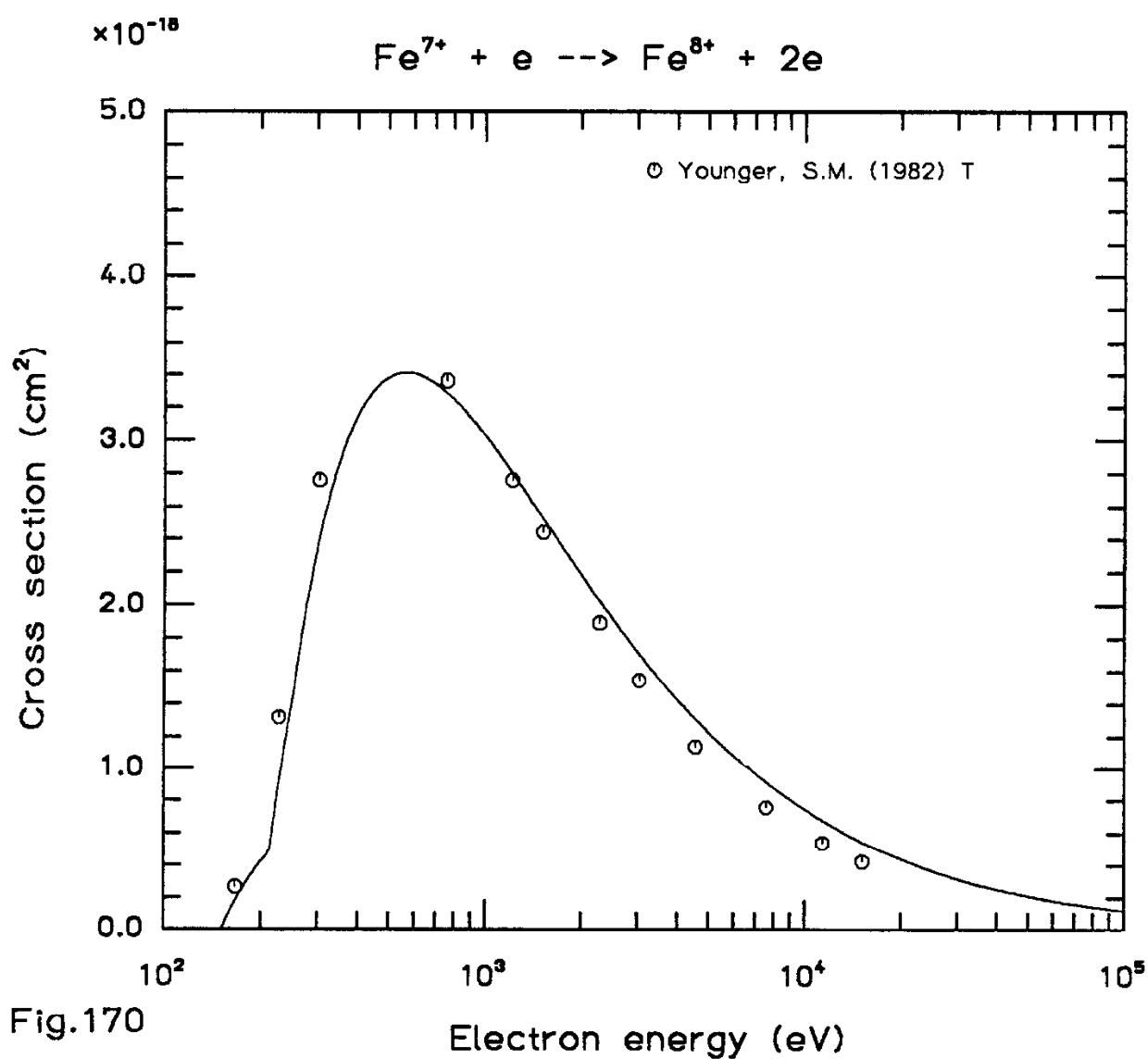


Fig.170

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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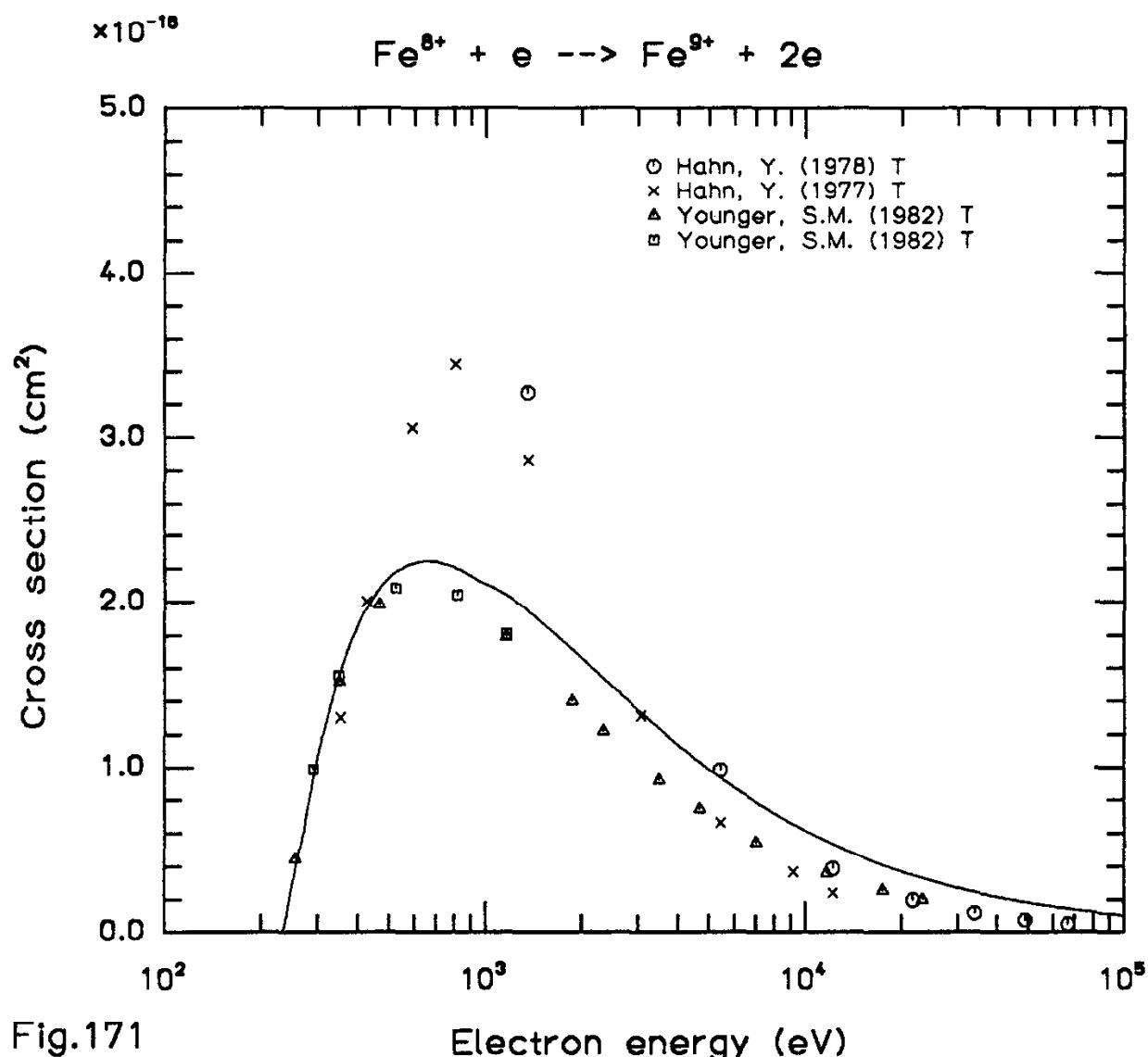


Fig.171

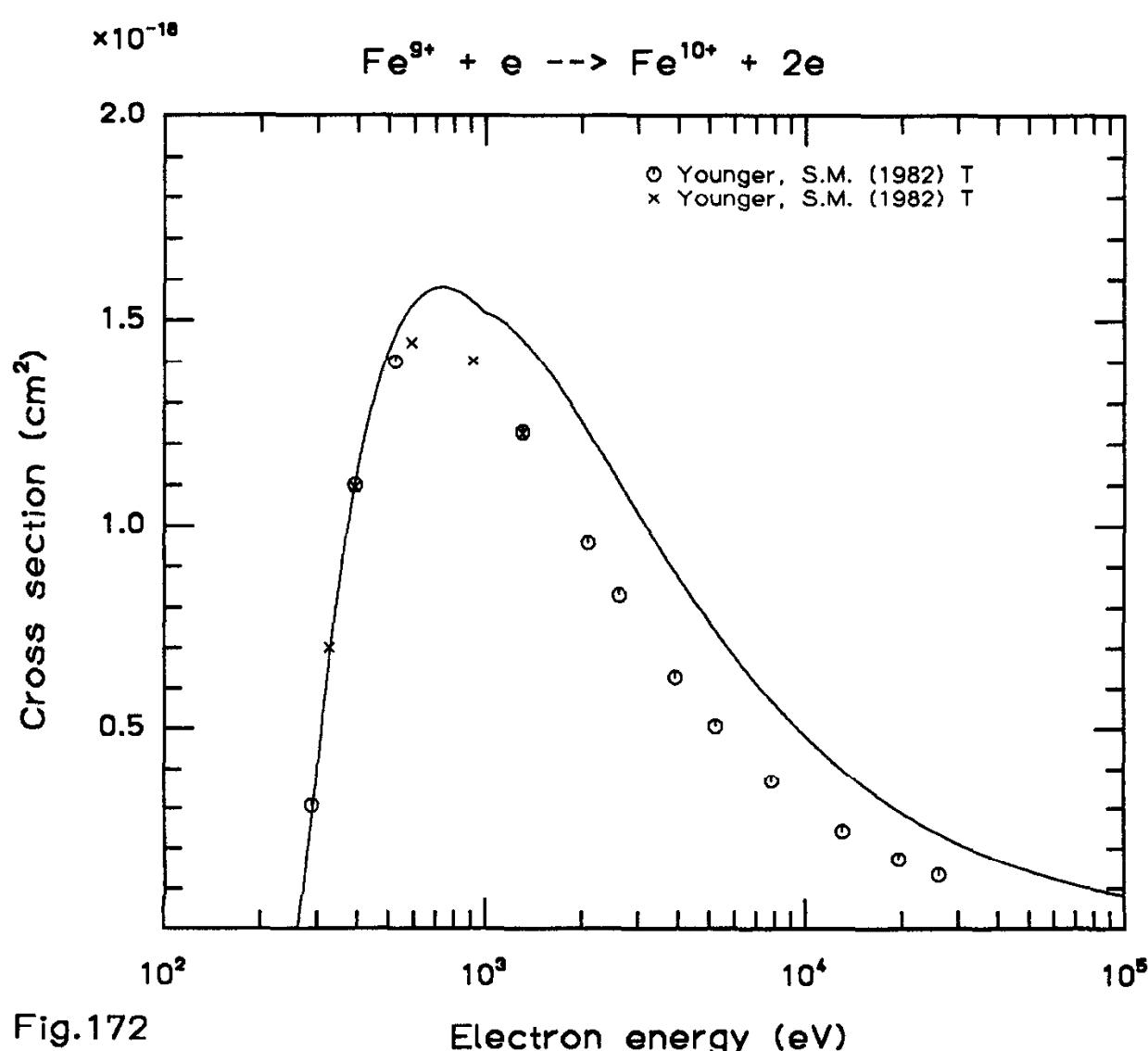


Fig.172

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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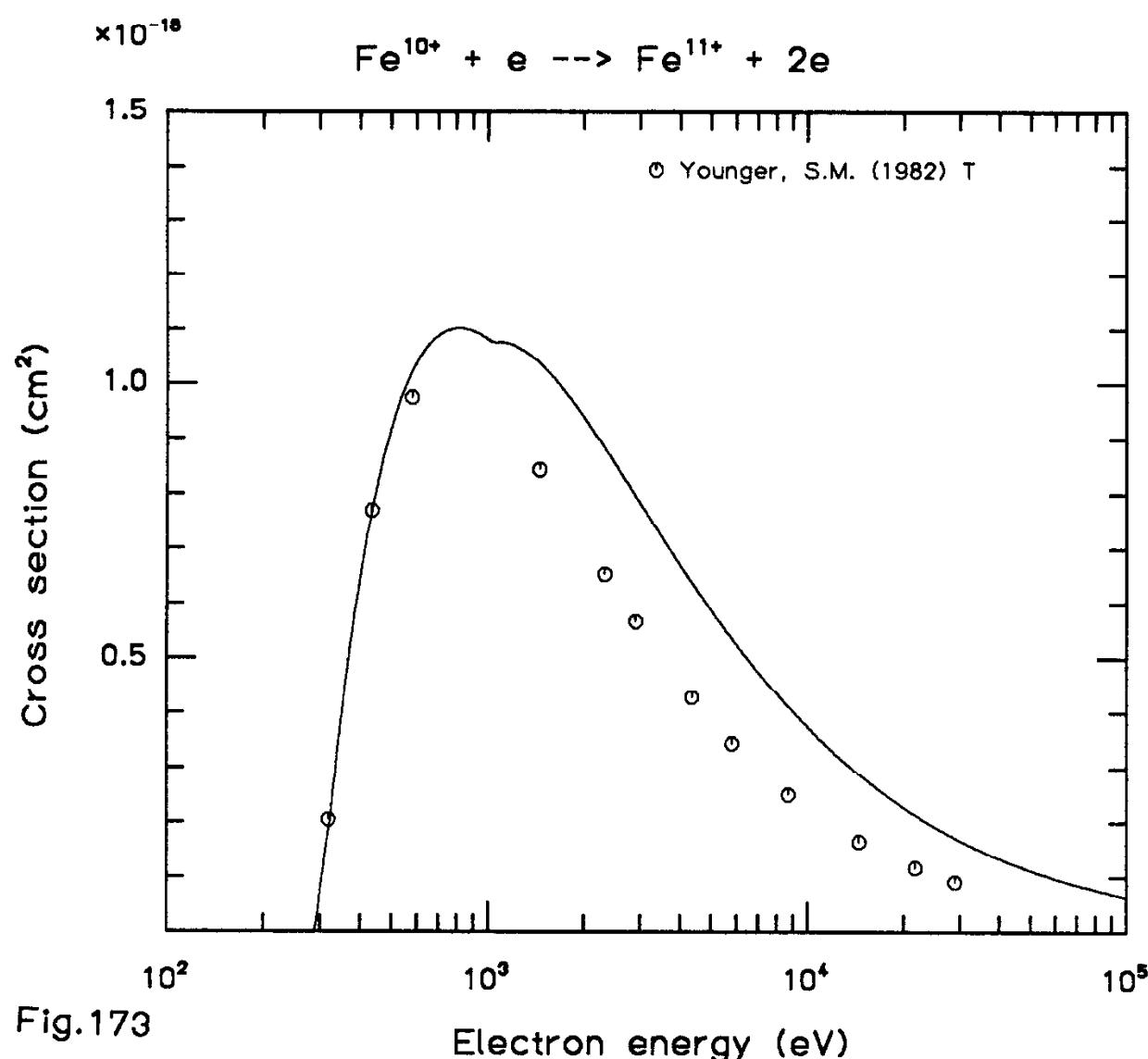


Fig.173

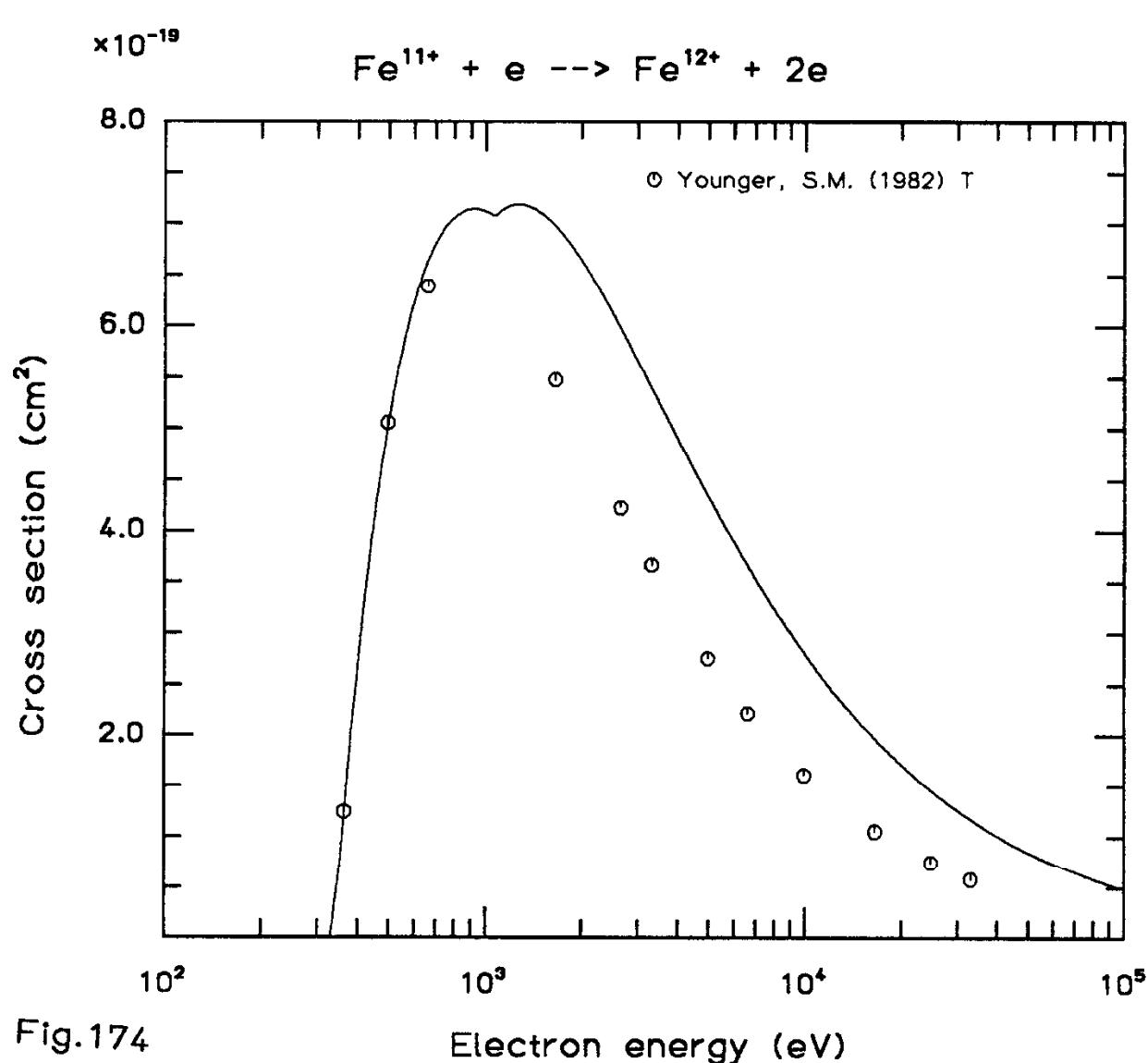


Fig.174

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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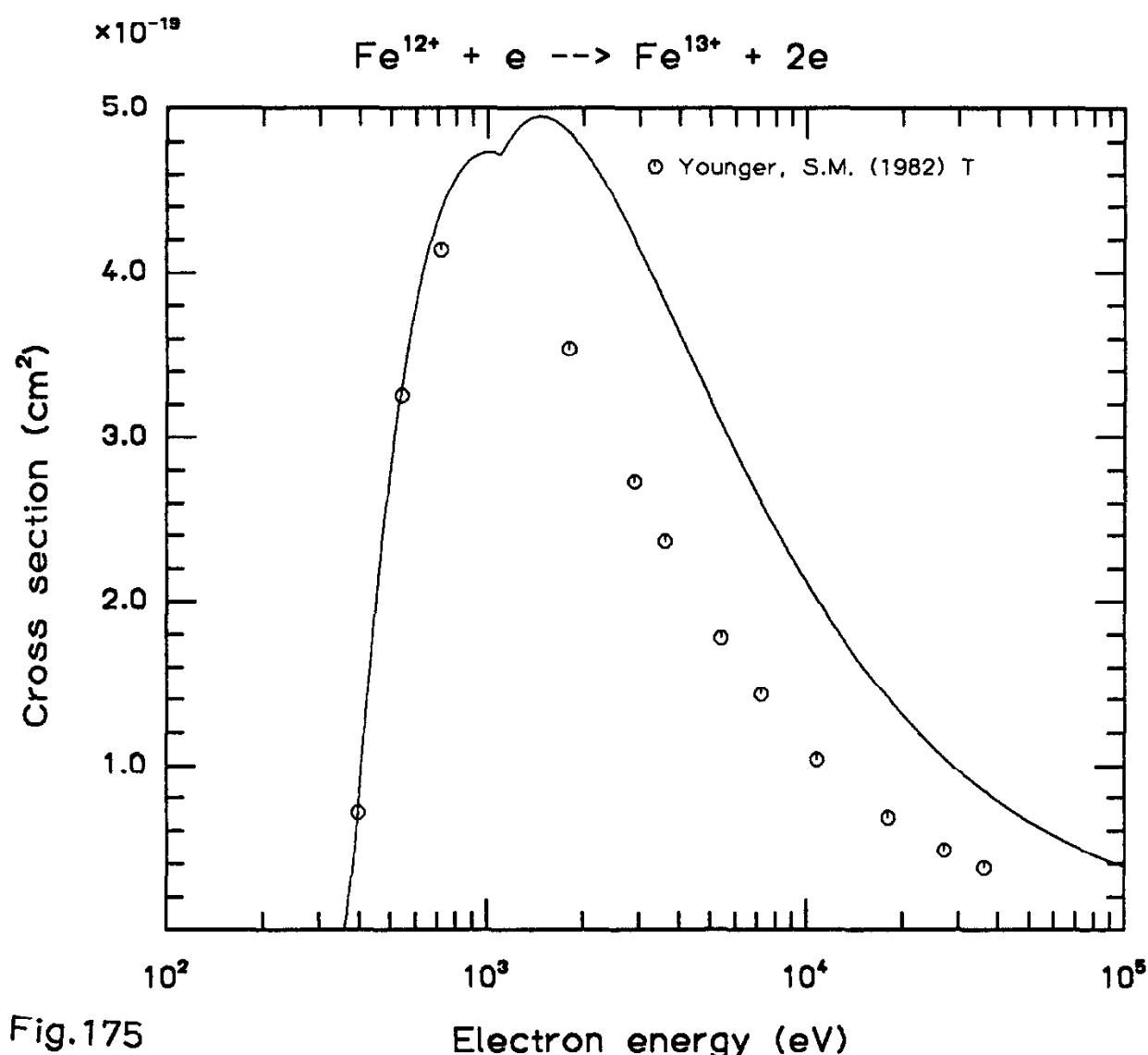


Fig.175

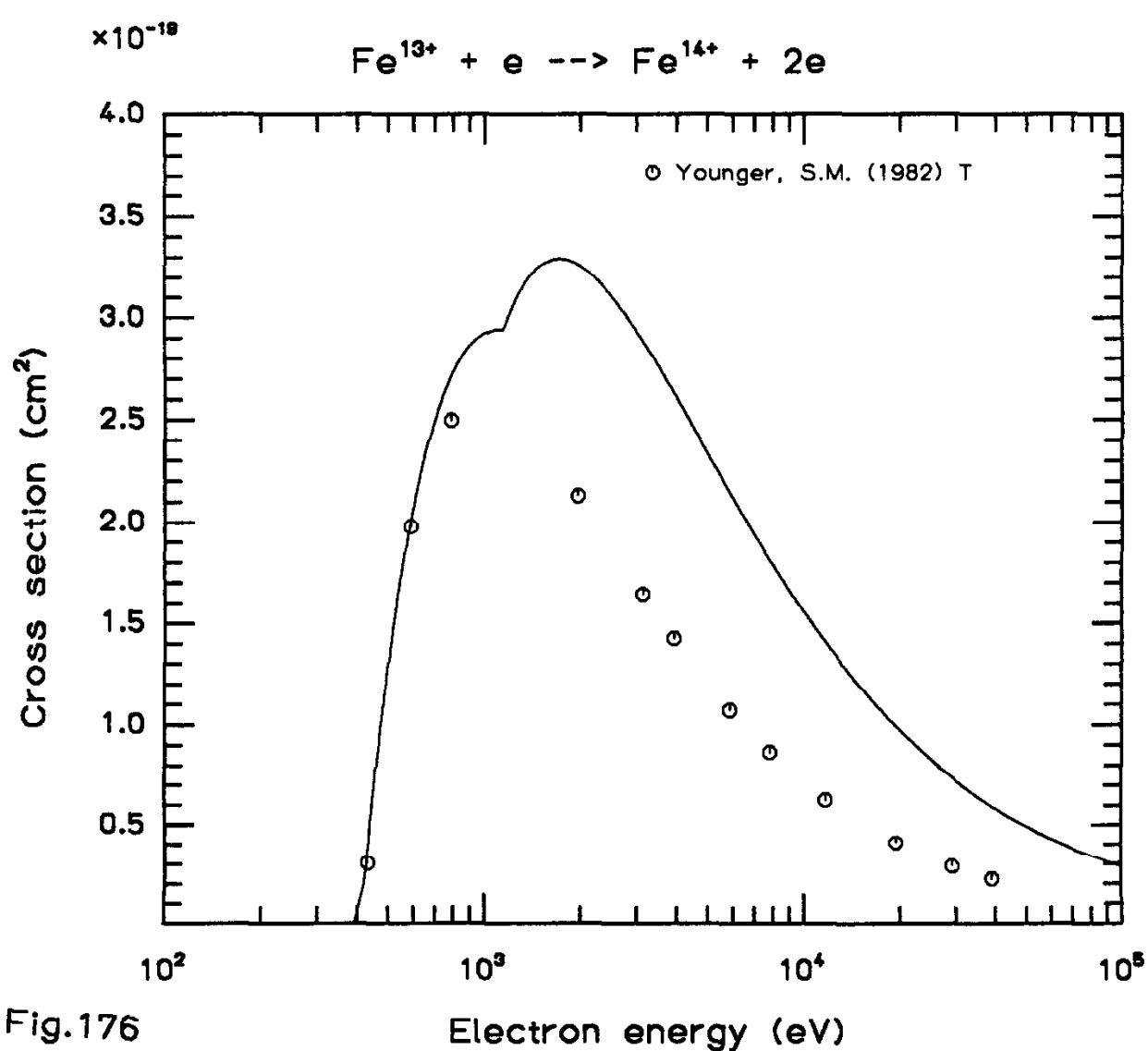


Fig.176

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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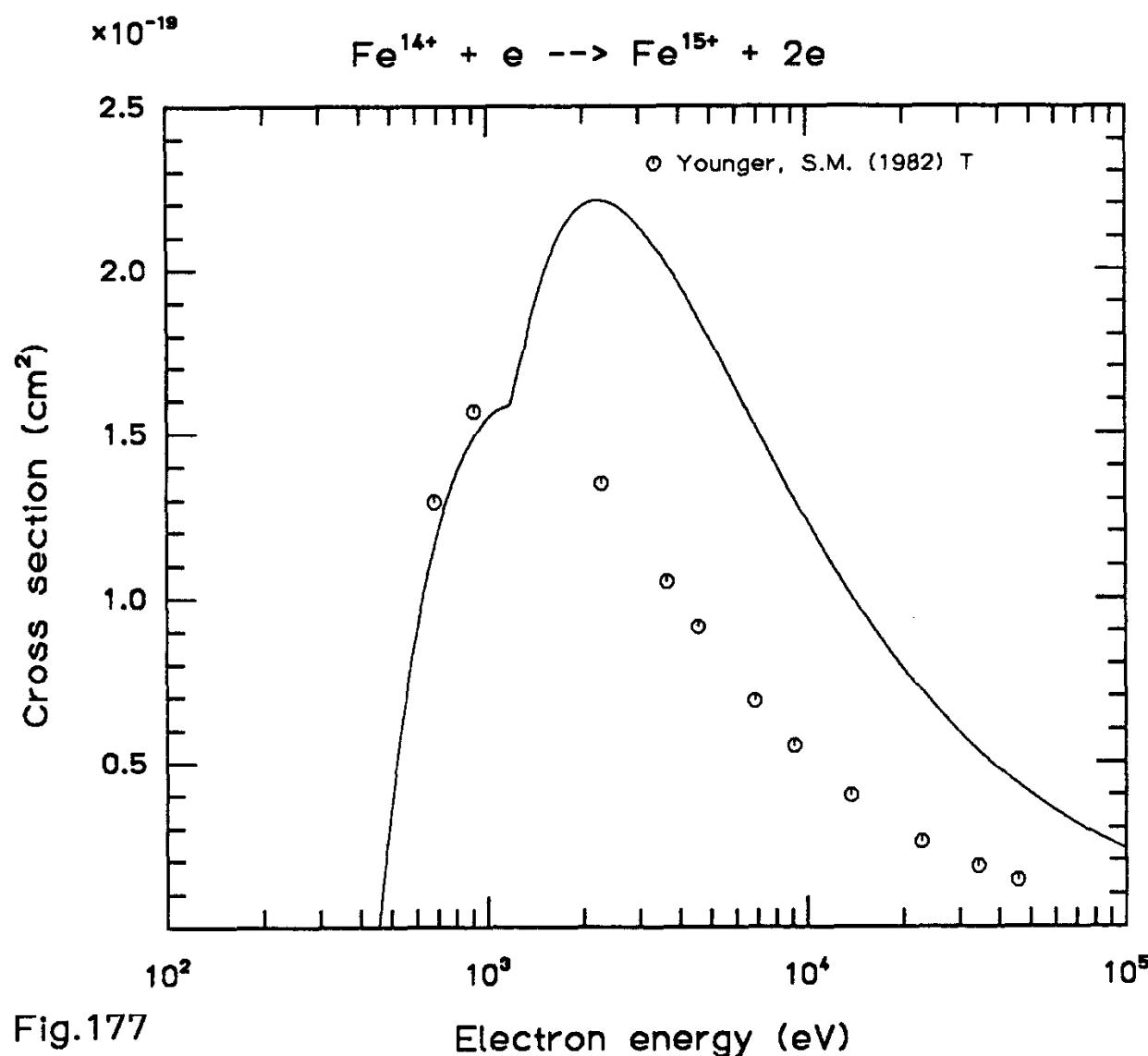


Fig.177

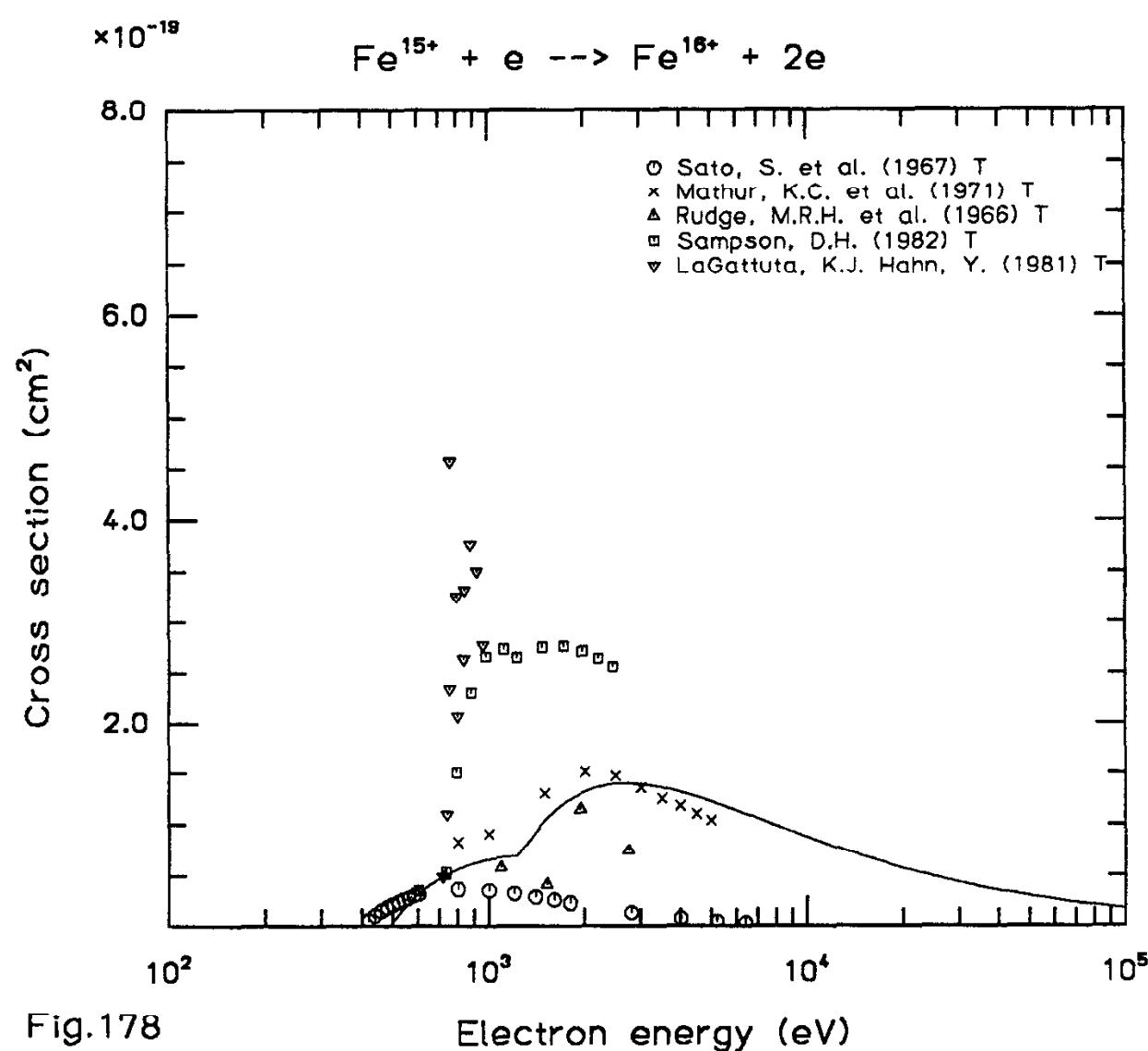


Fig.178

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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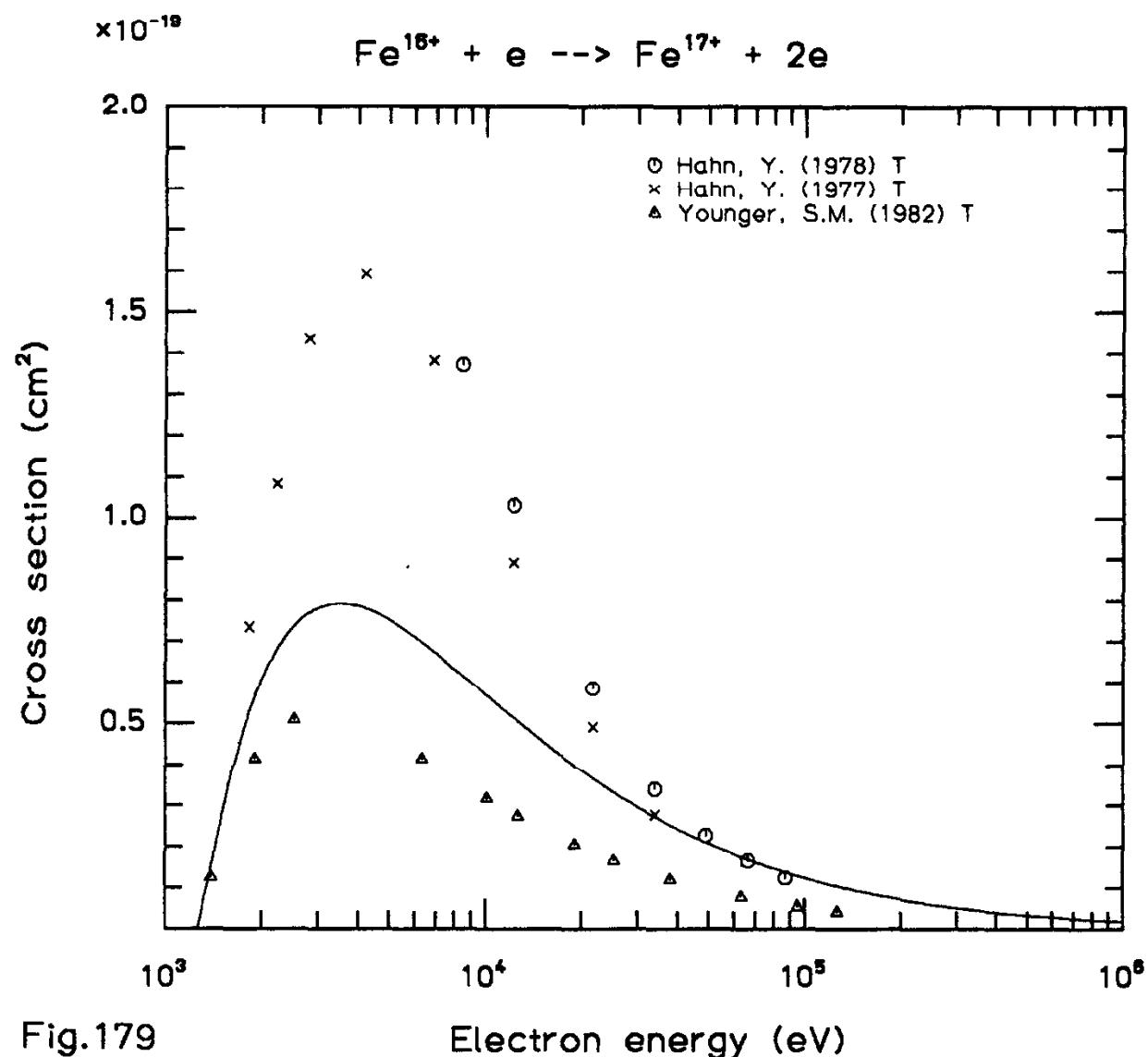


Fig.179

Electron energy (eV)

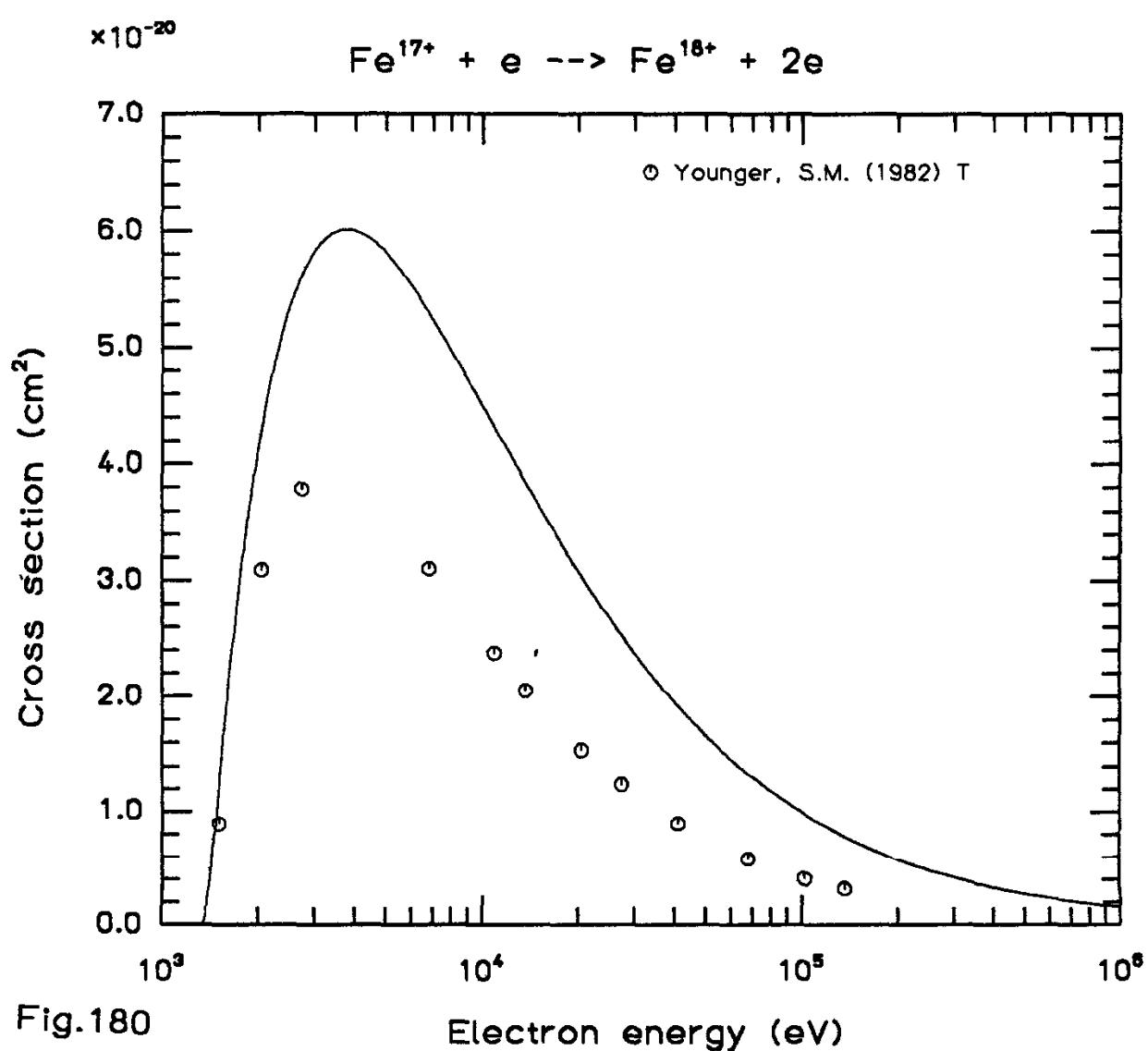


Fig.180

Electron energy (eV)

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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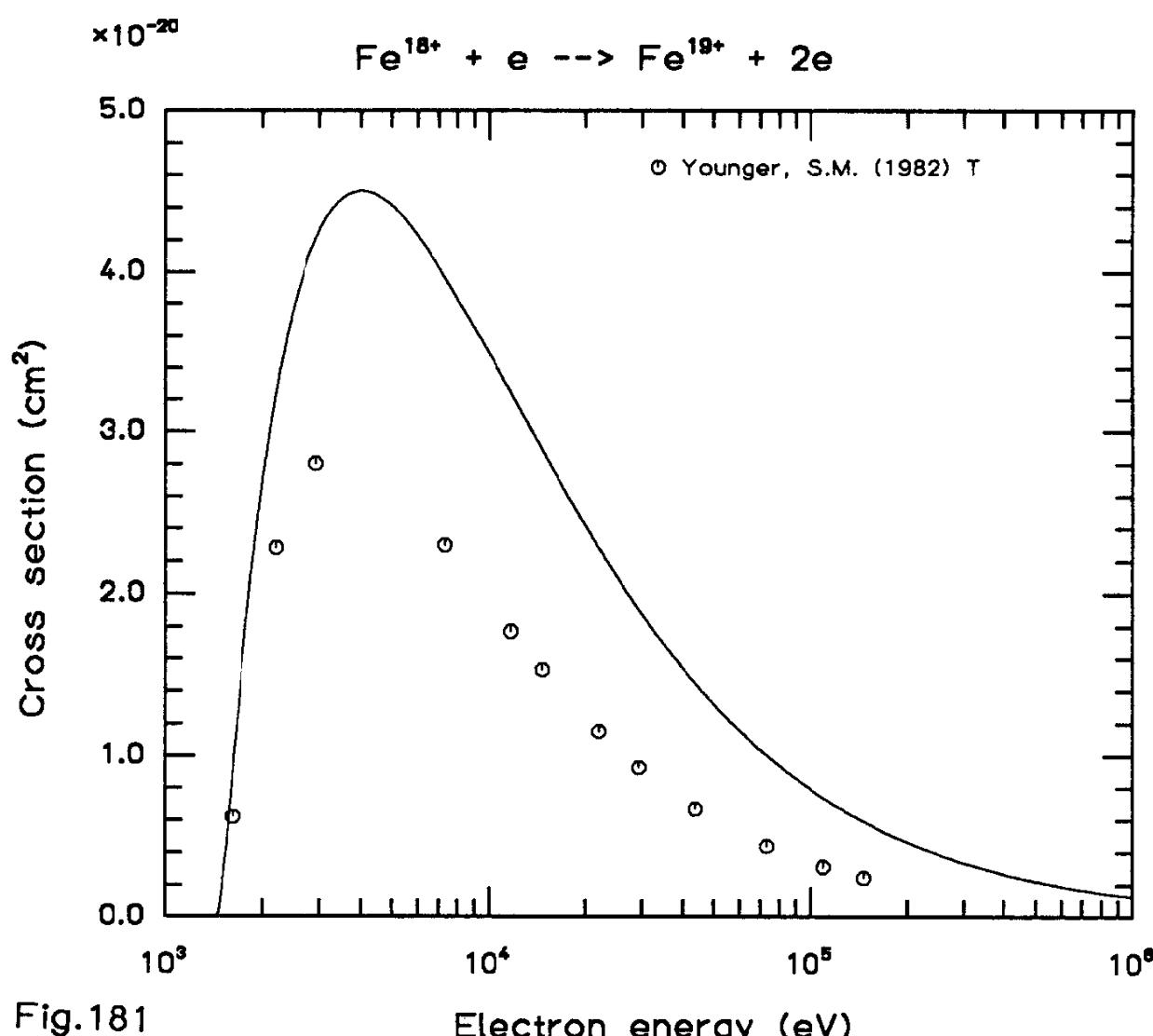


Fig.181

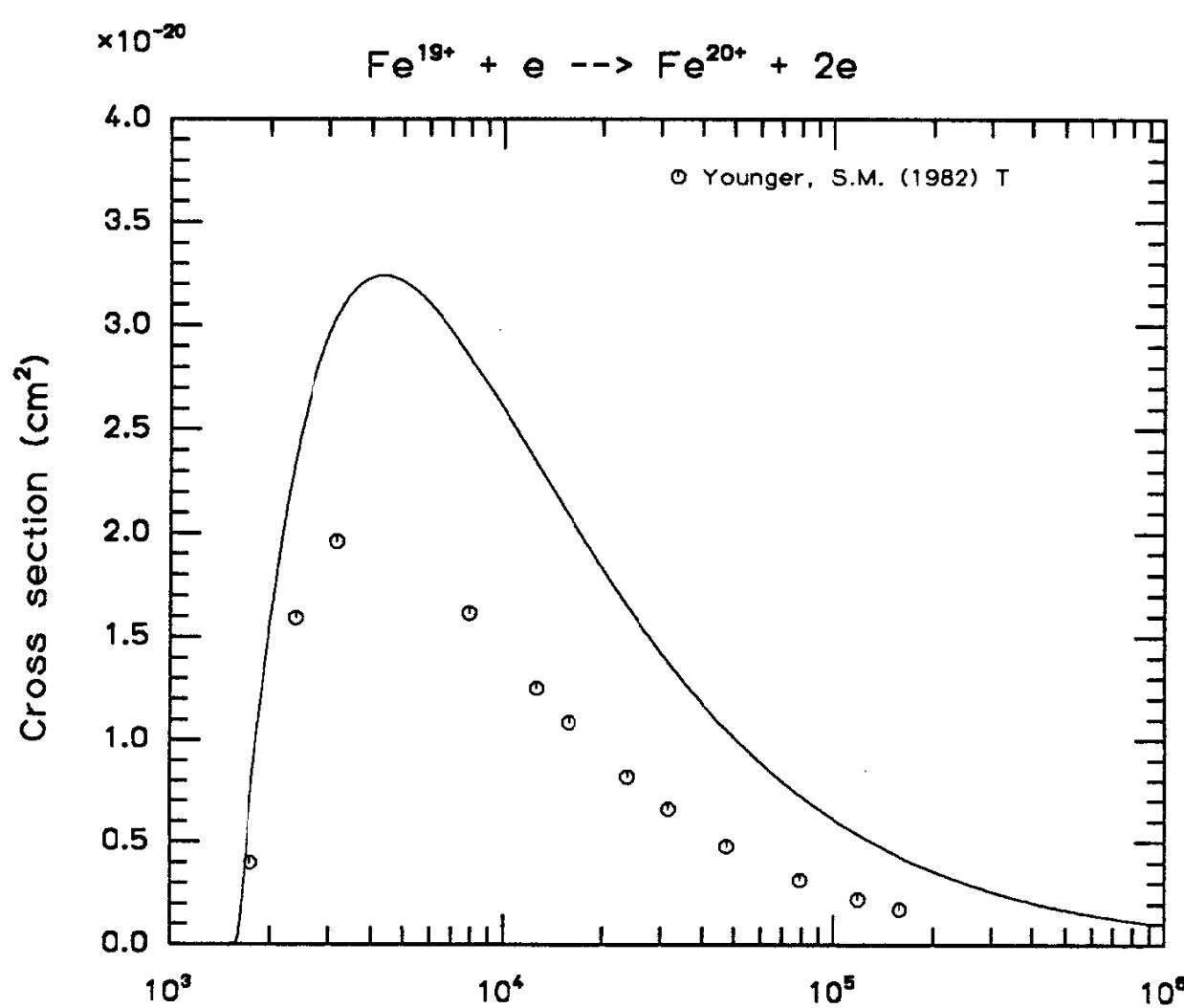
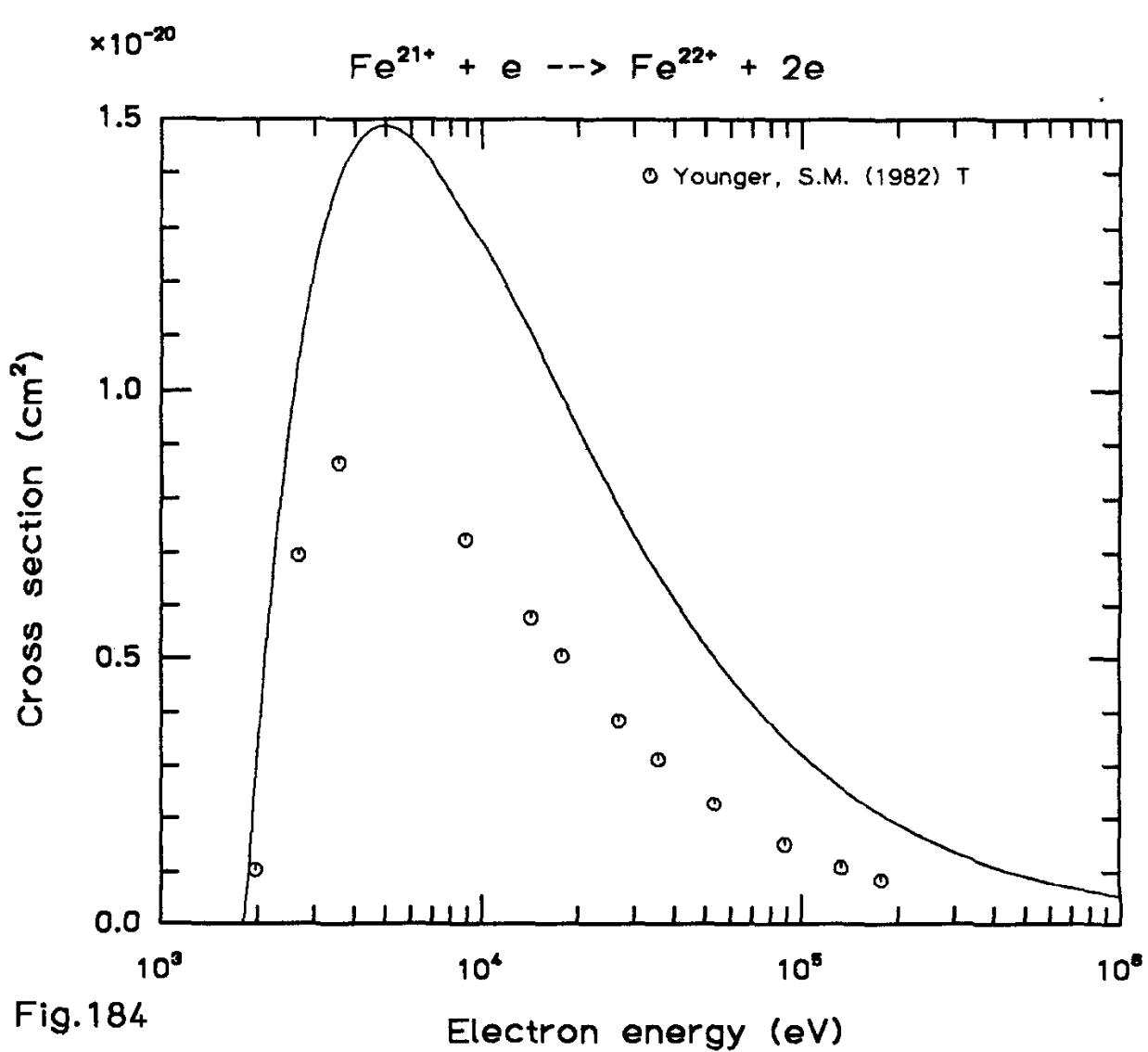
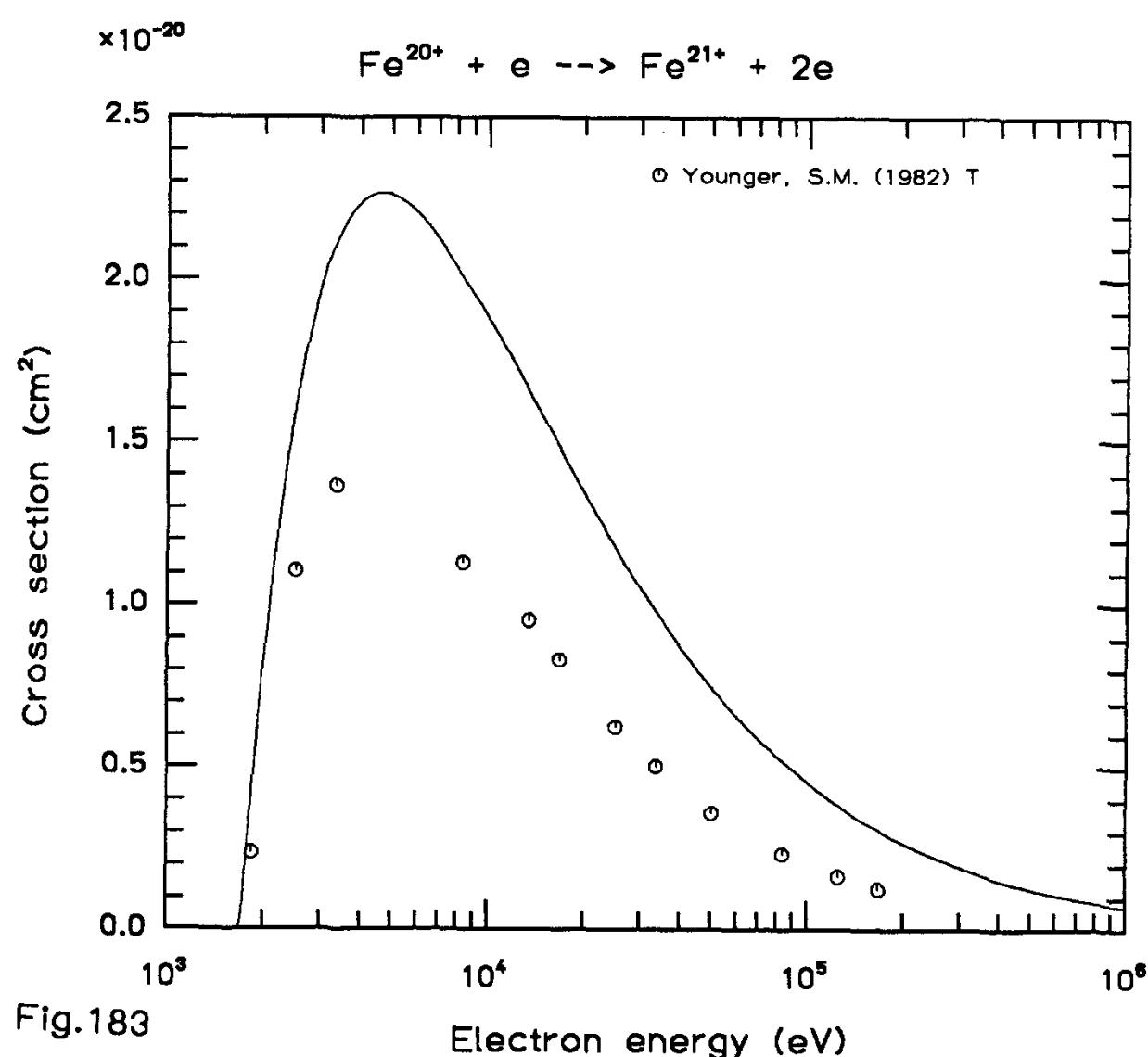


Fig.182

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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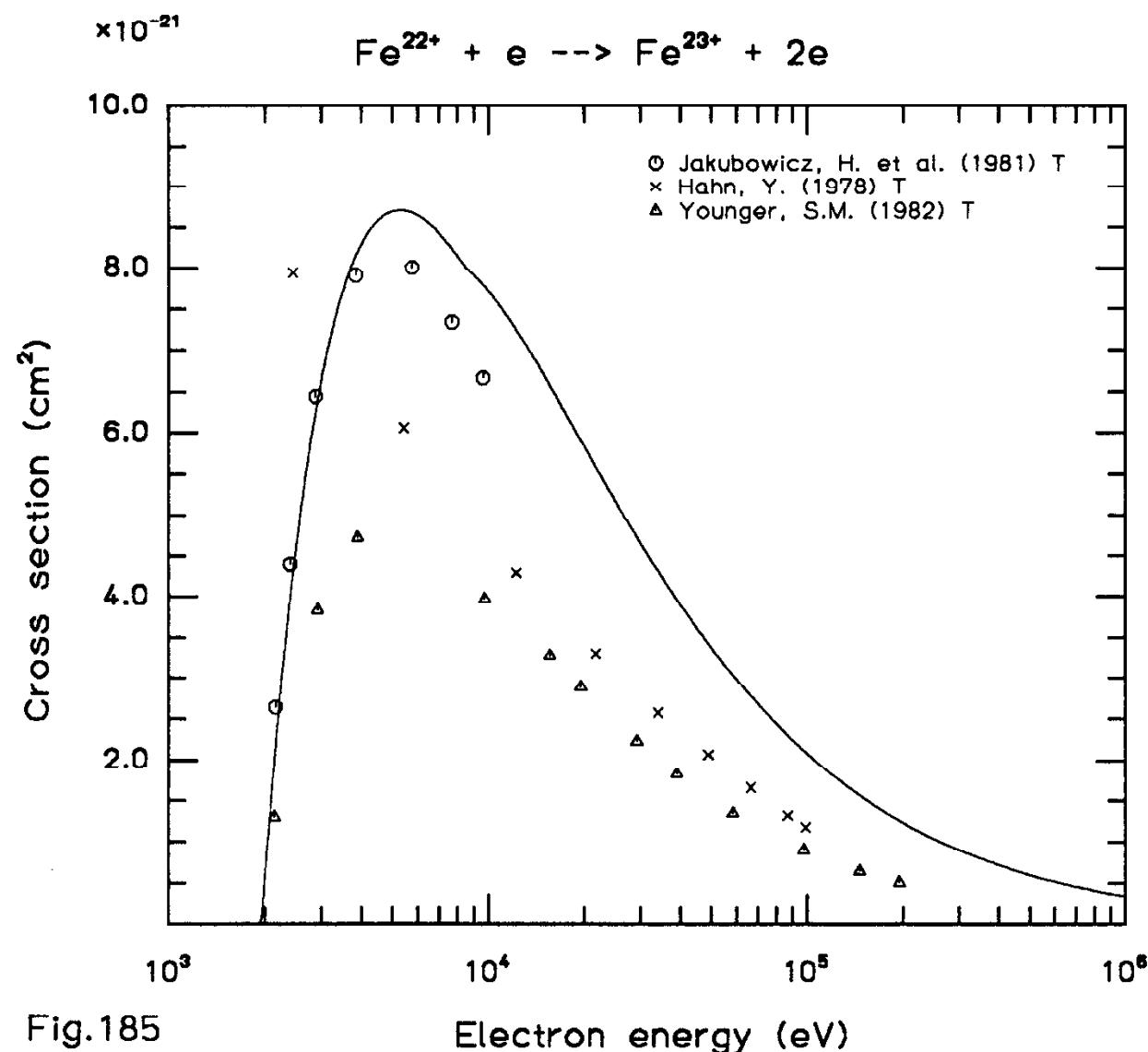


Fig.185

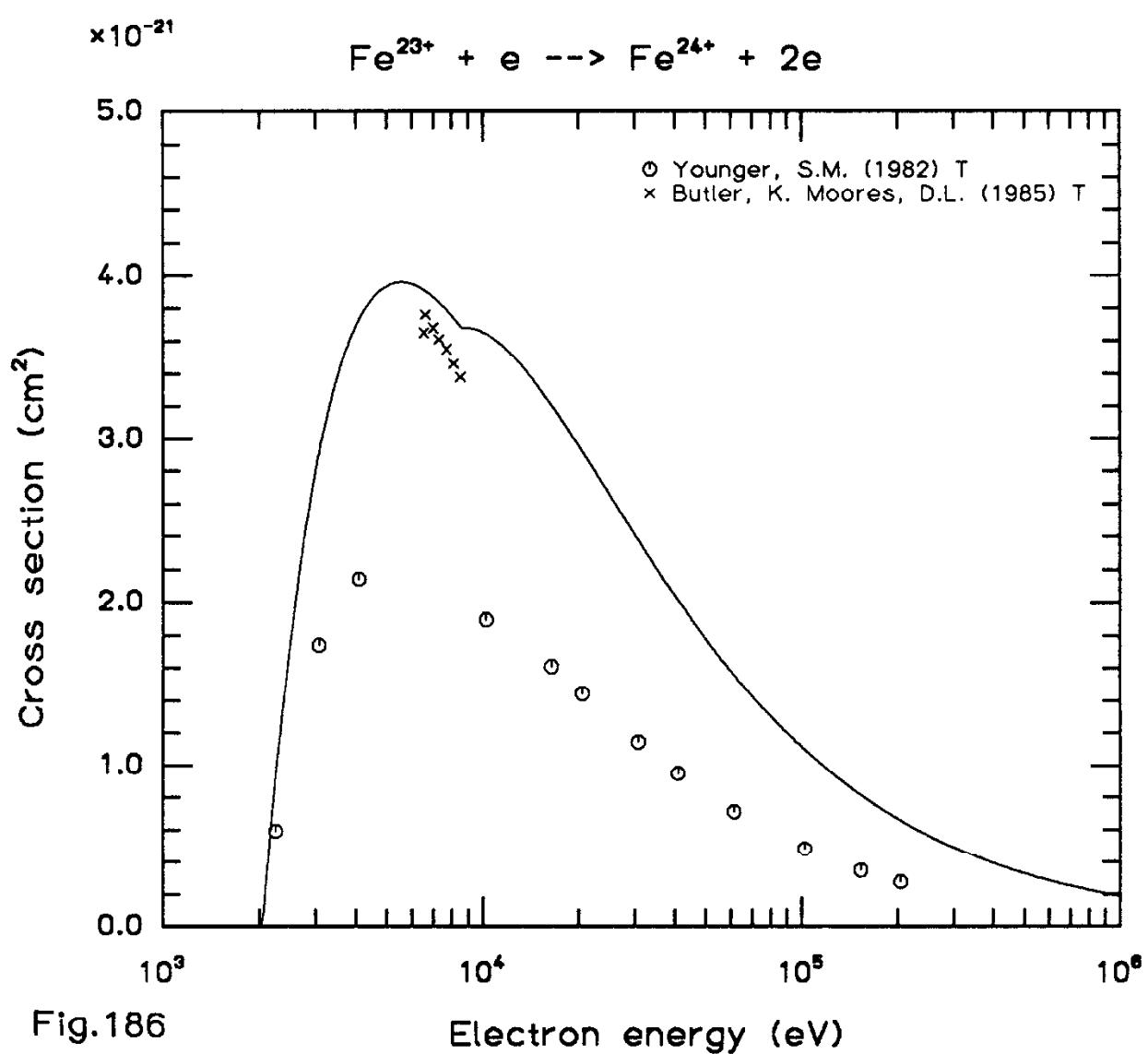


Fig.186

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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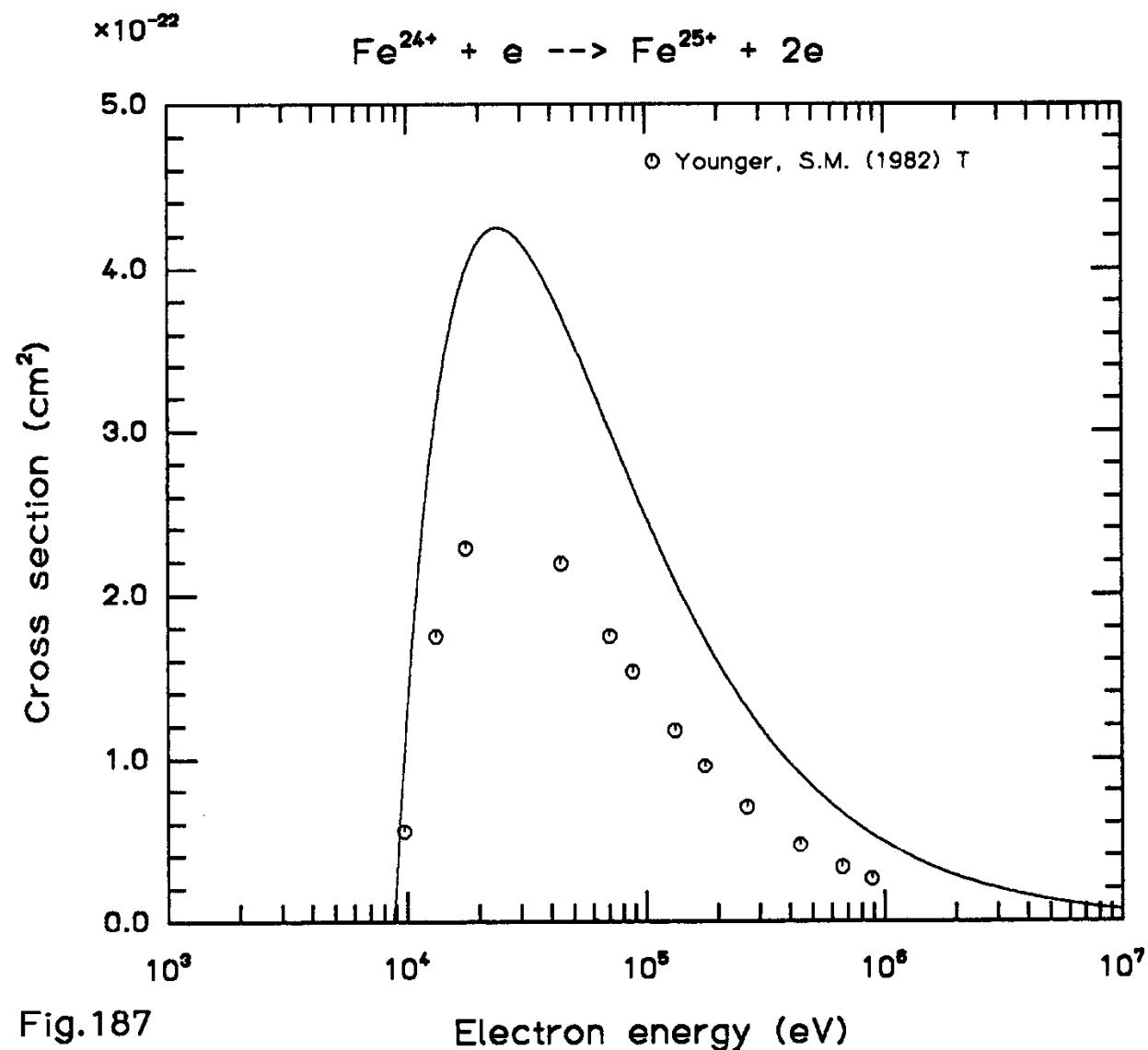


Fig.187

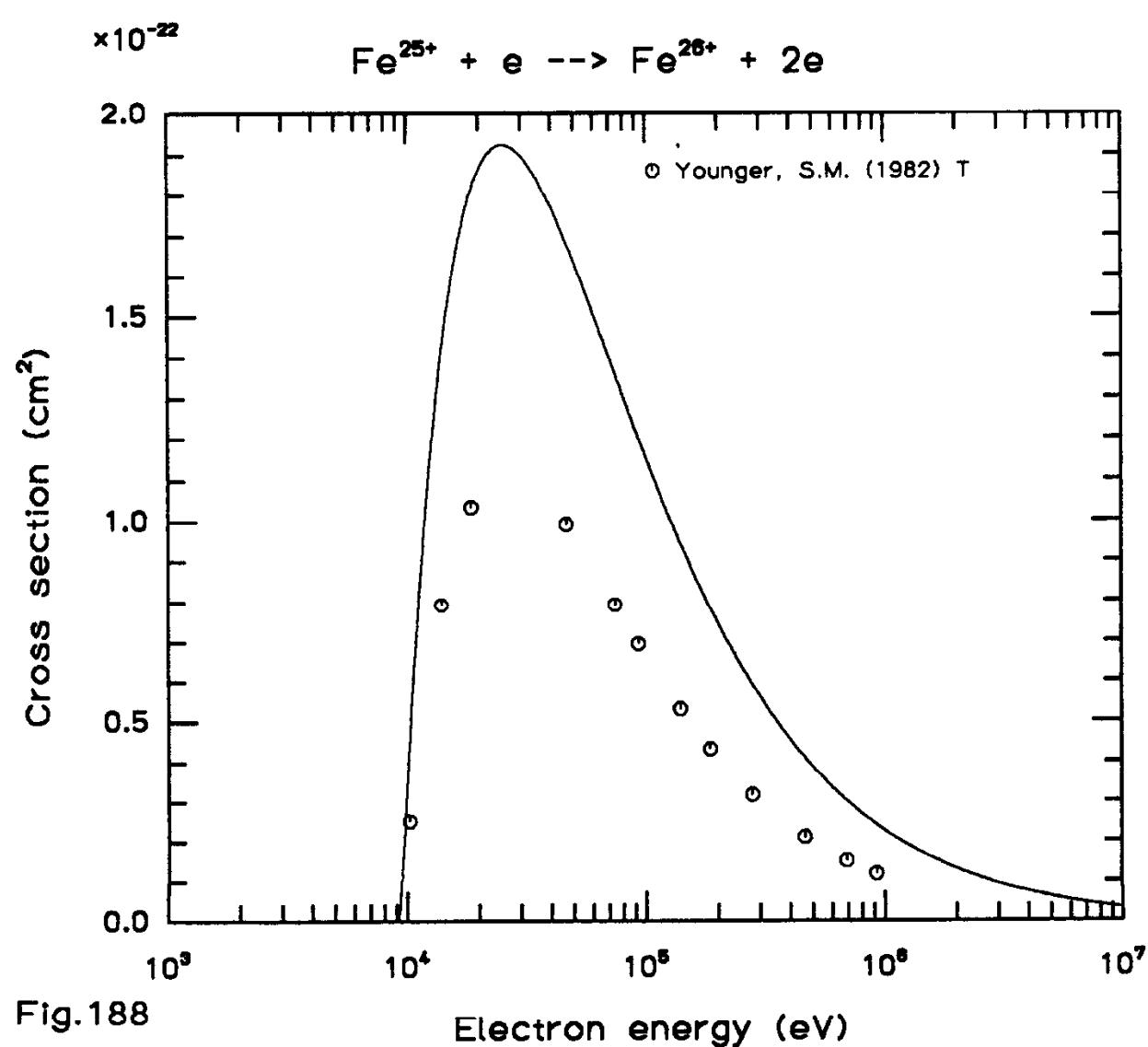


Fig.188

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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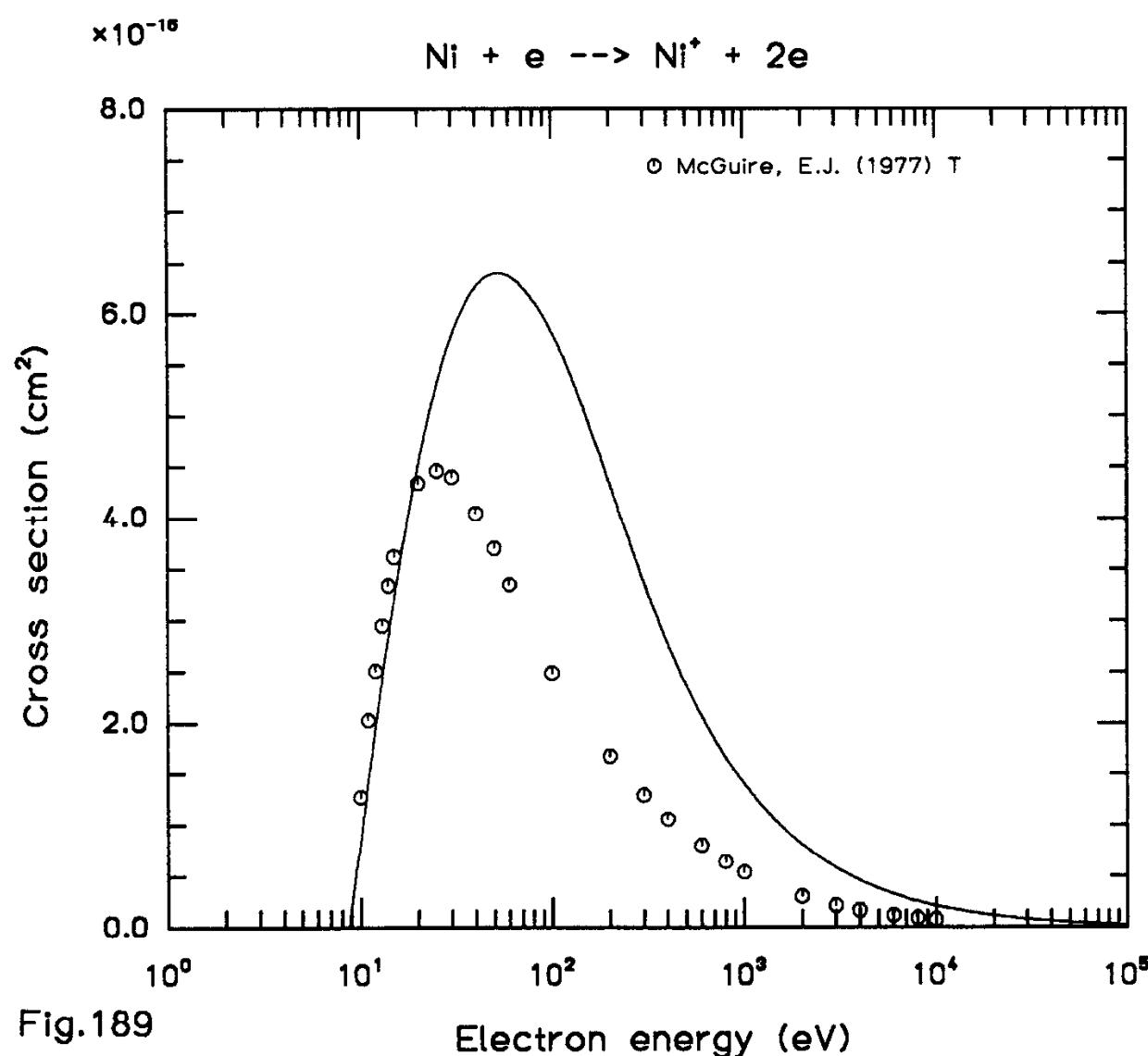


Fig.189

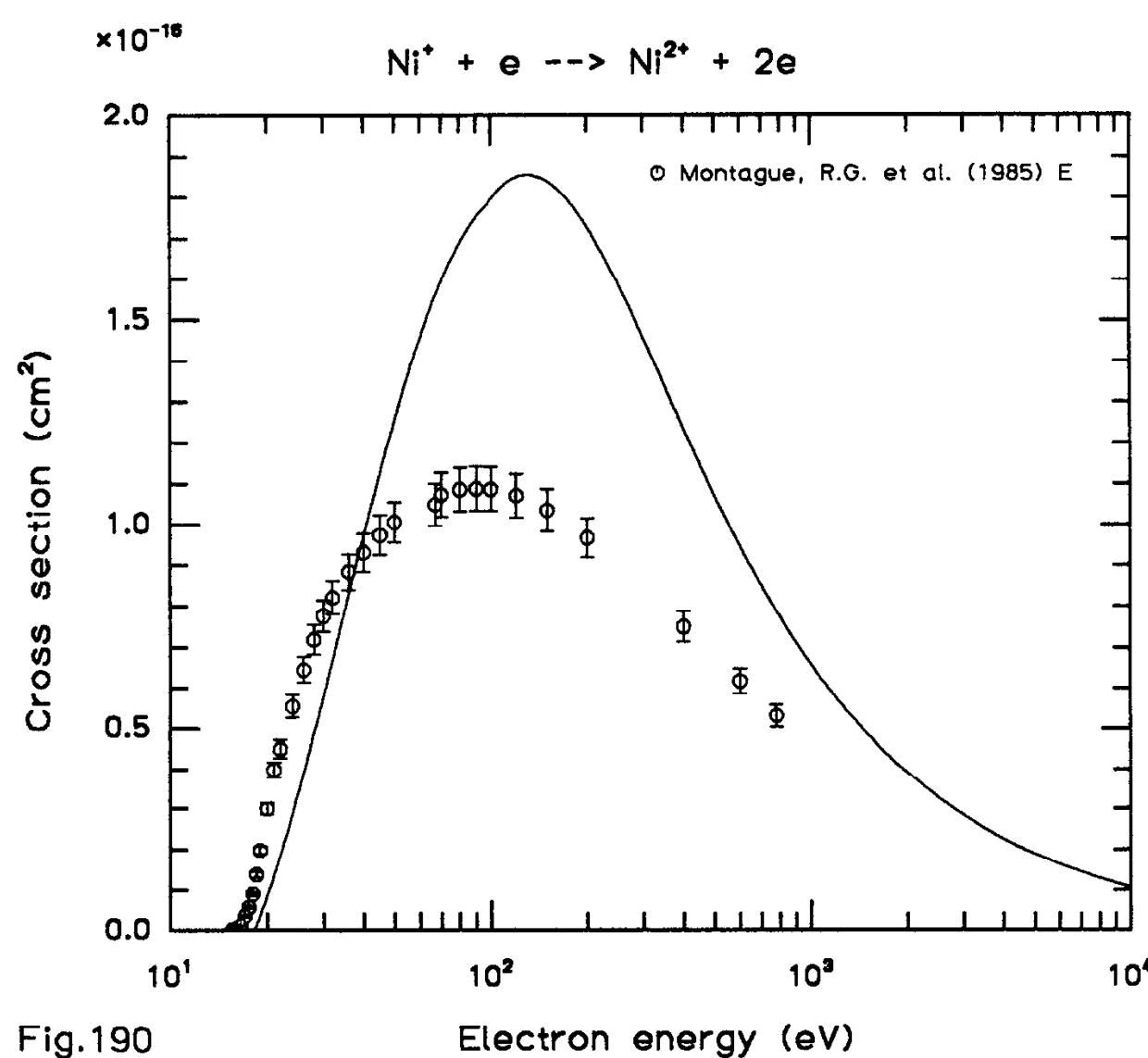


Fig.190

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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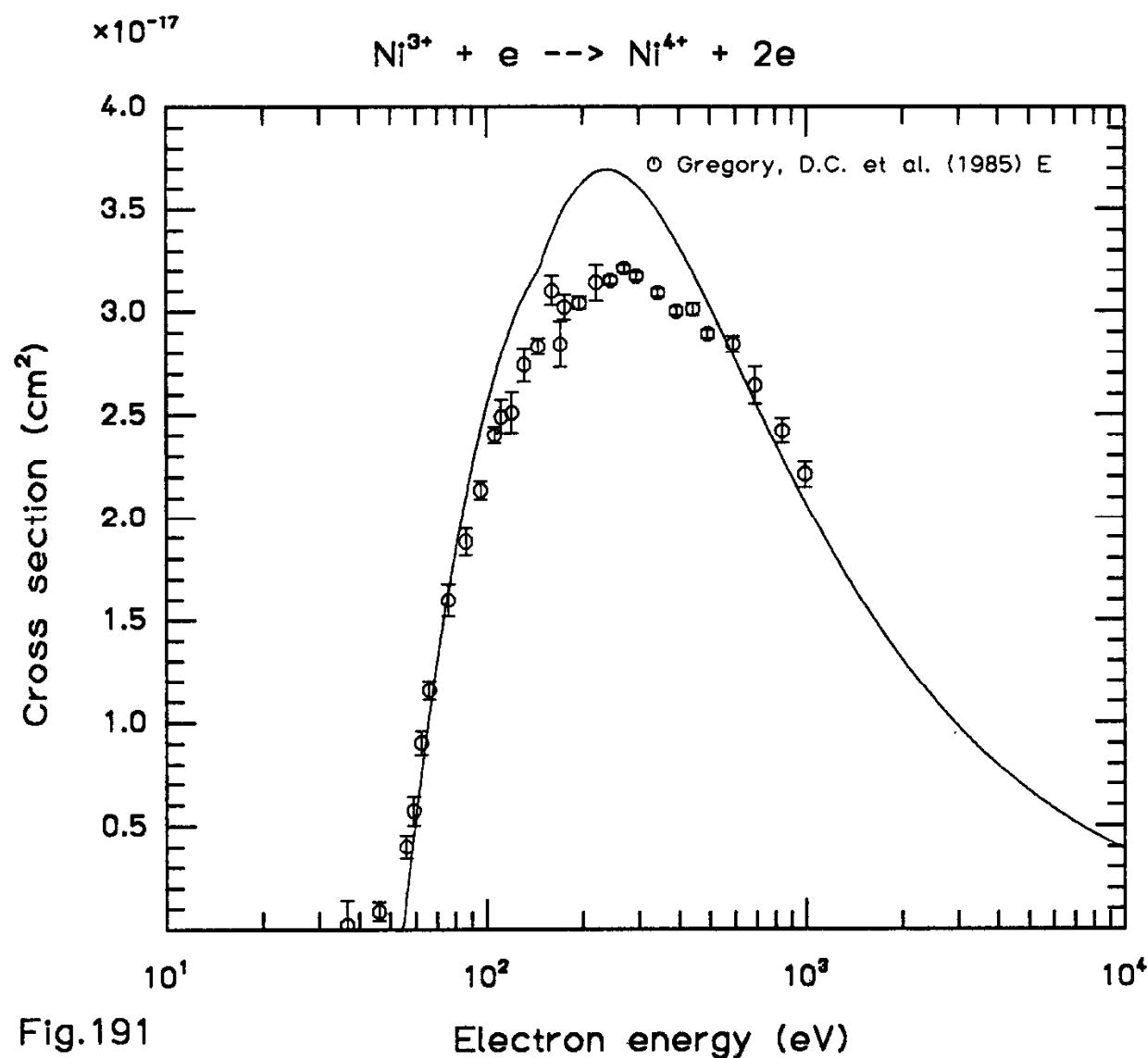


Fig.191

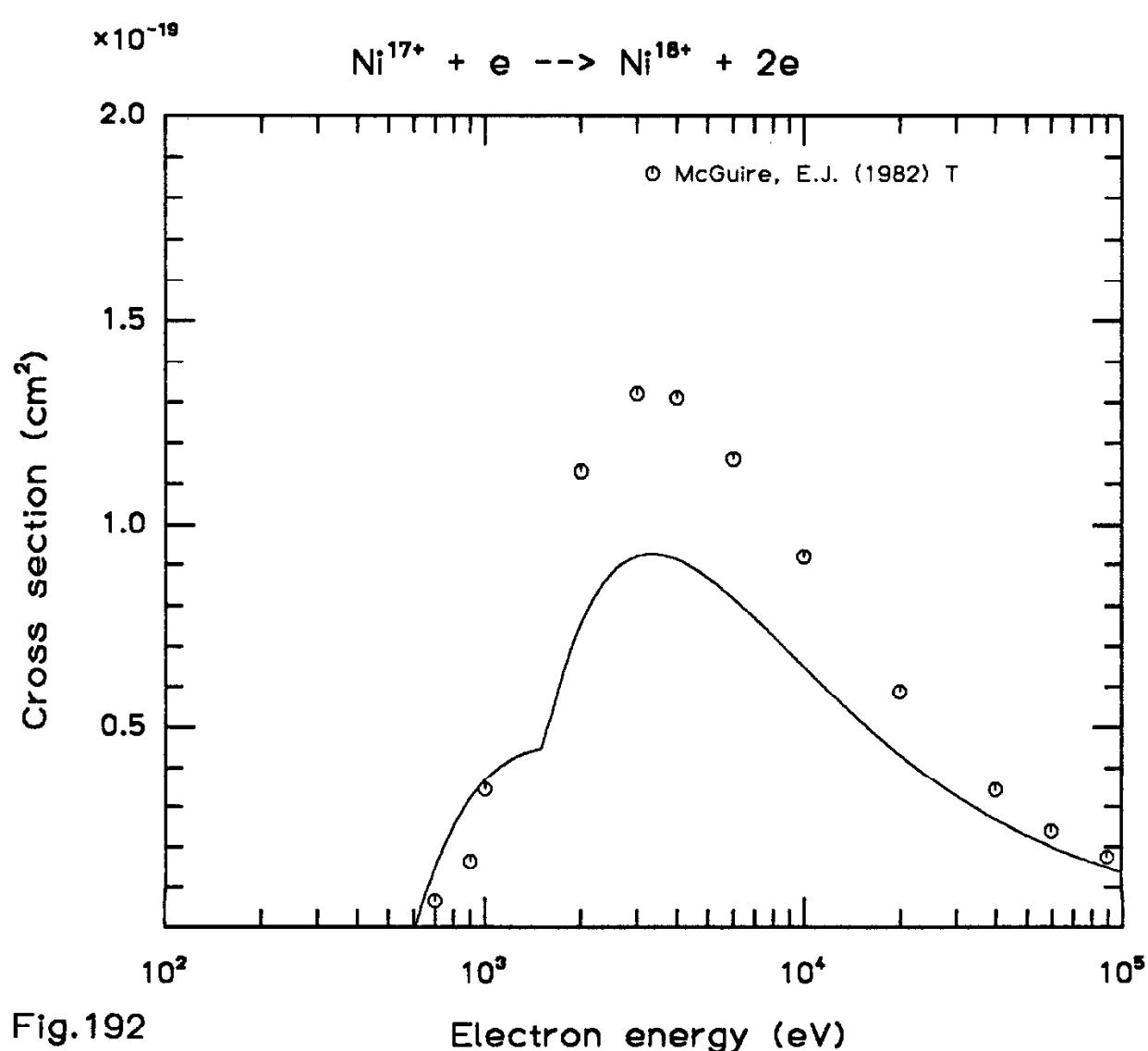


Fig.192

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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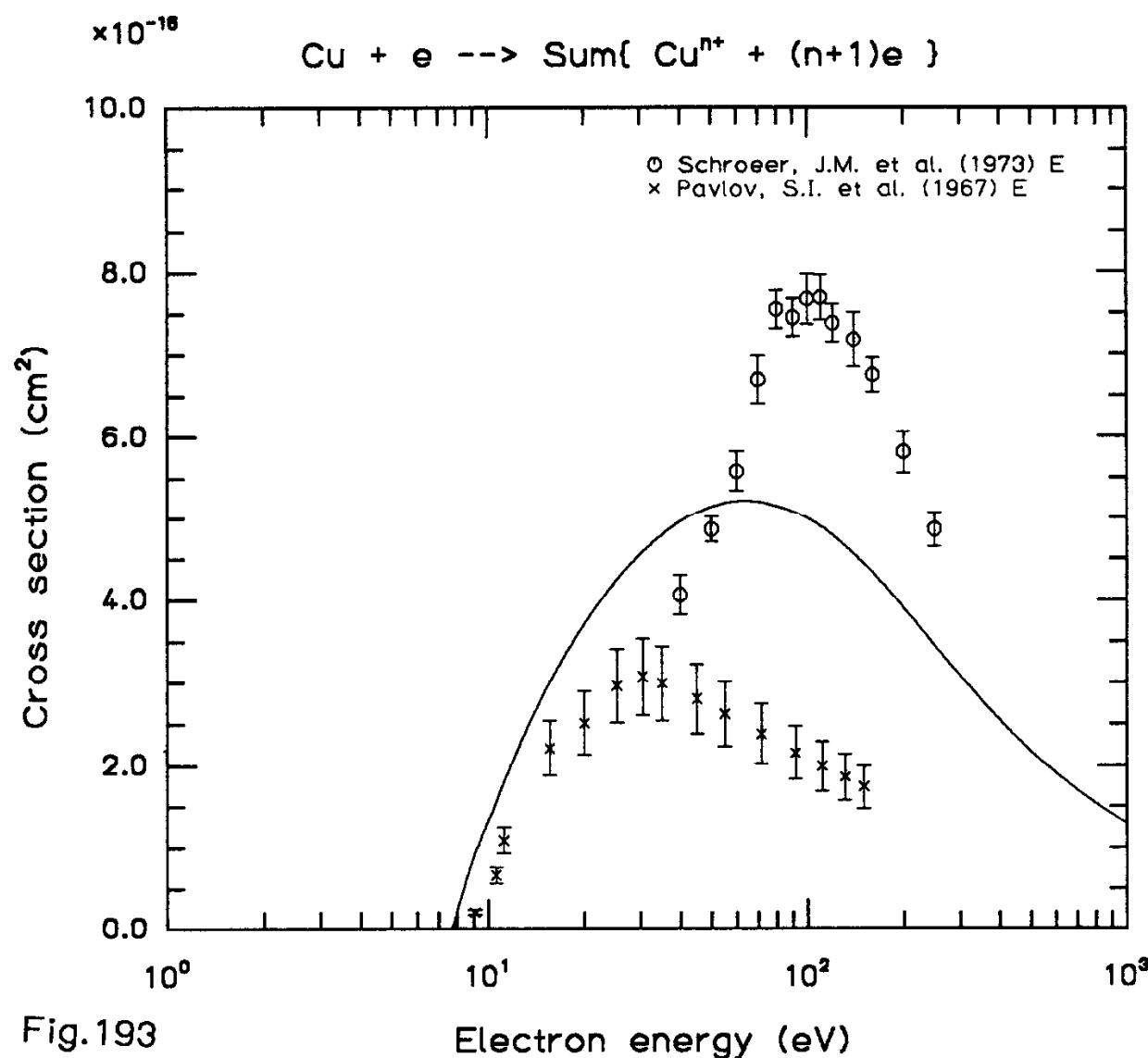


Fig.193

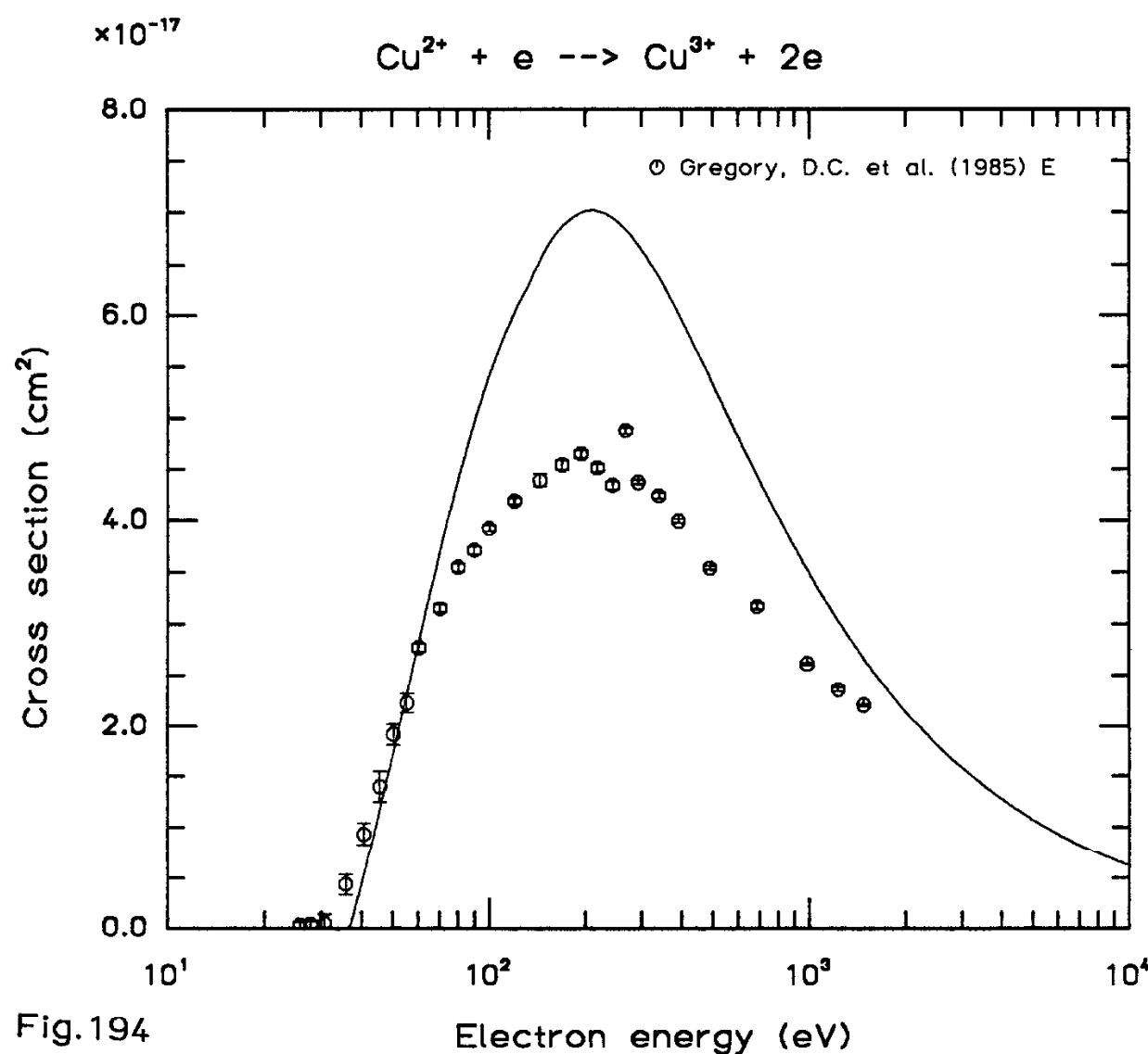


Fig.194

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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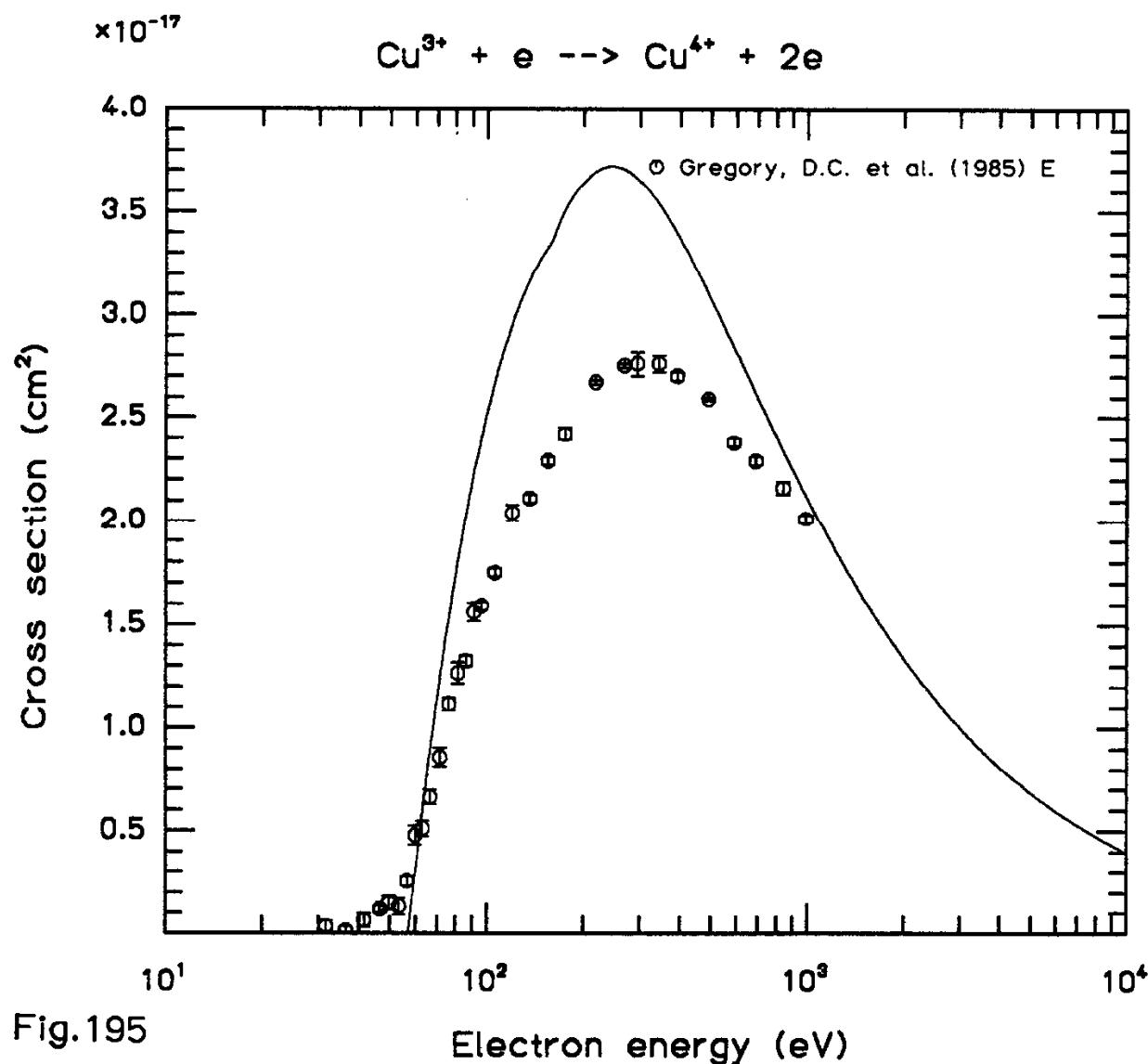


Fig.195

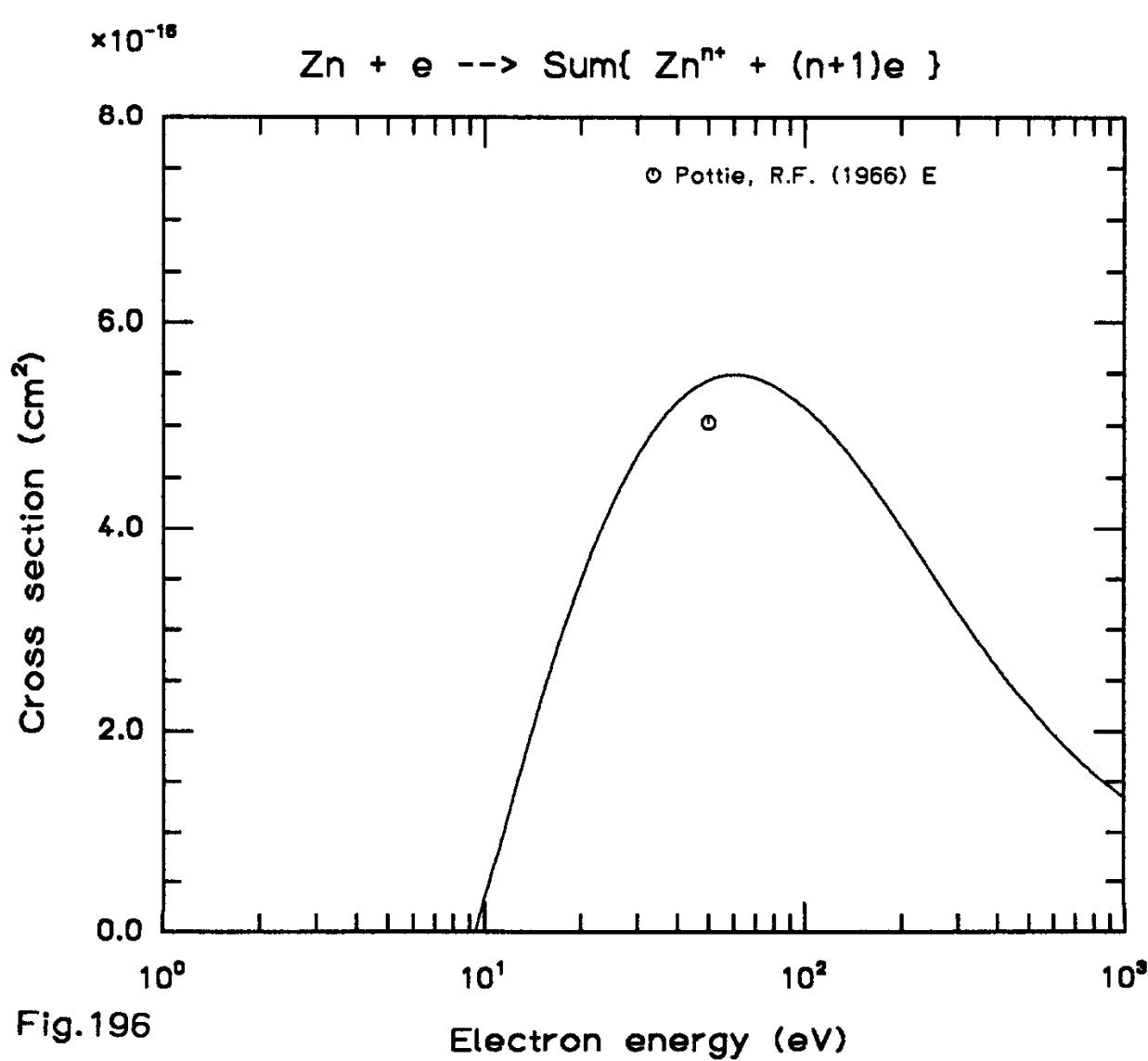


Fig.196

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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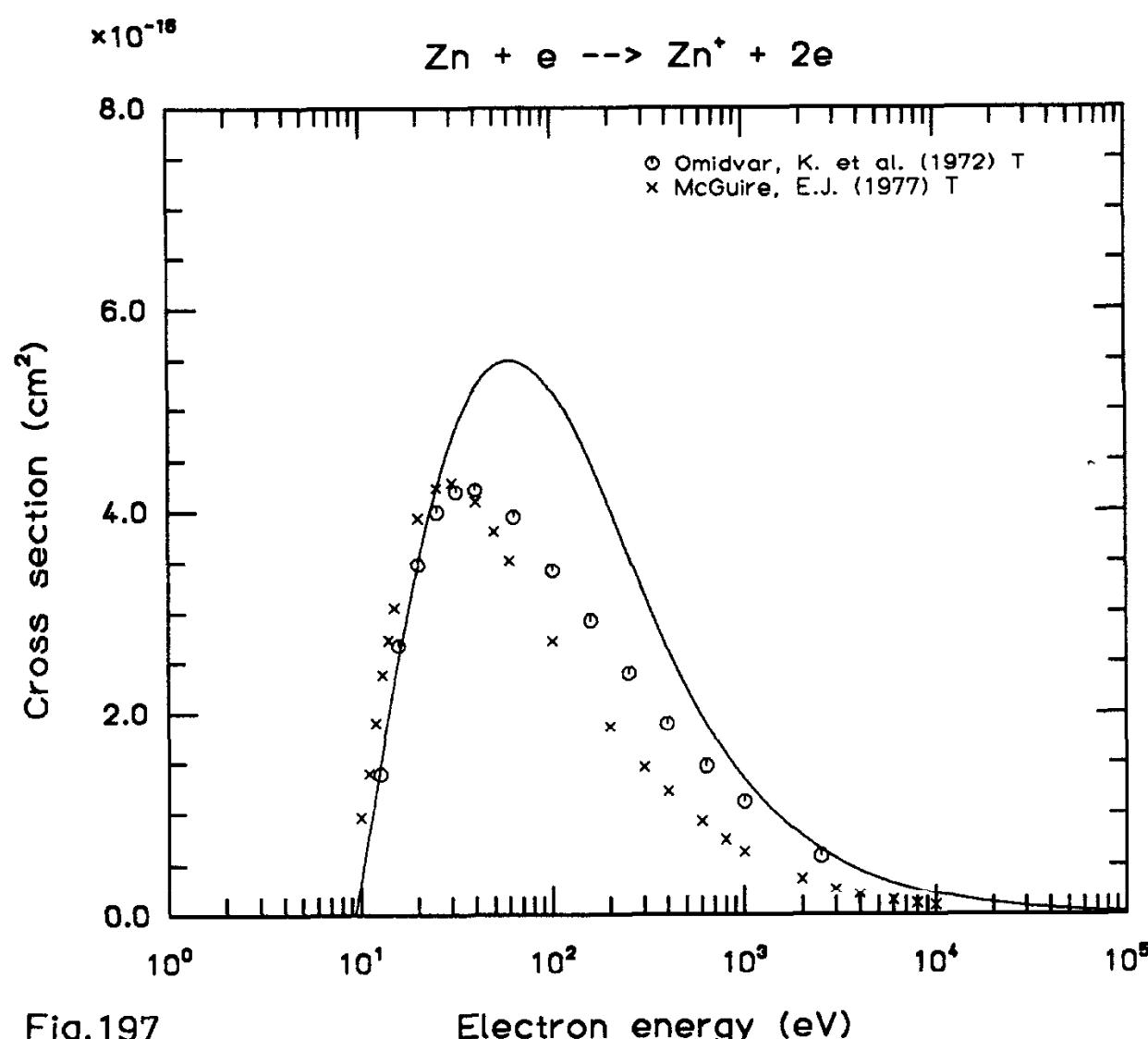


Fig.197

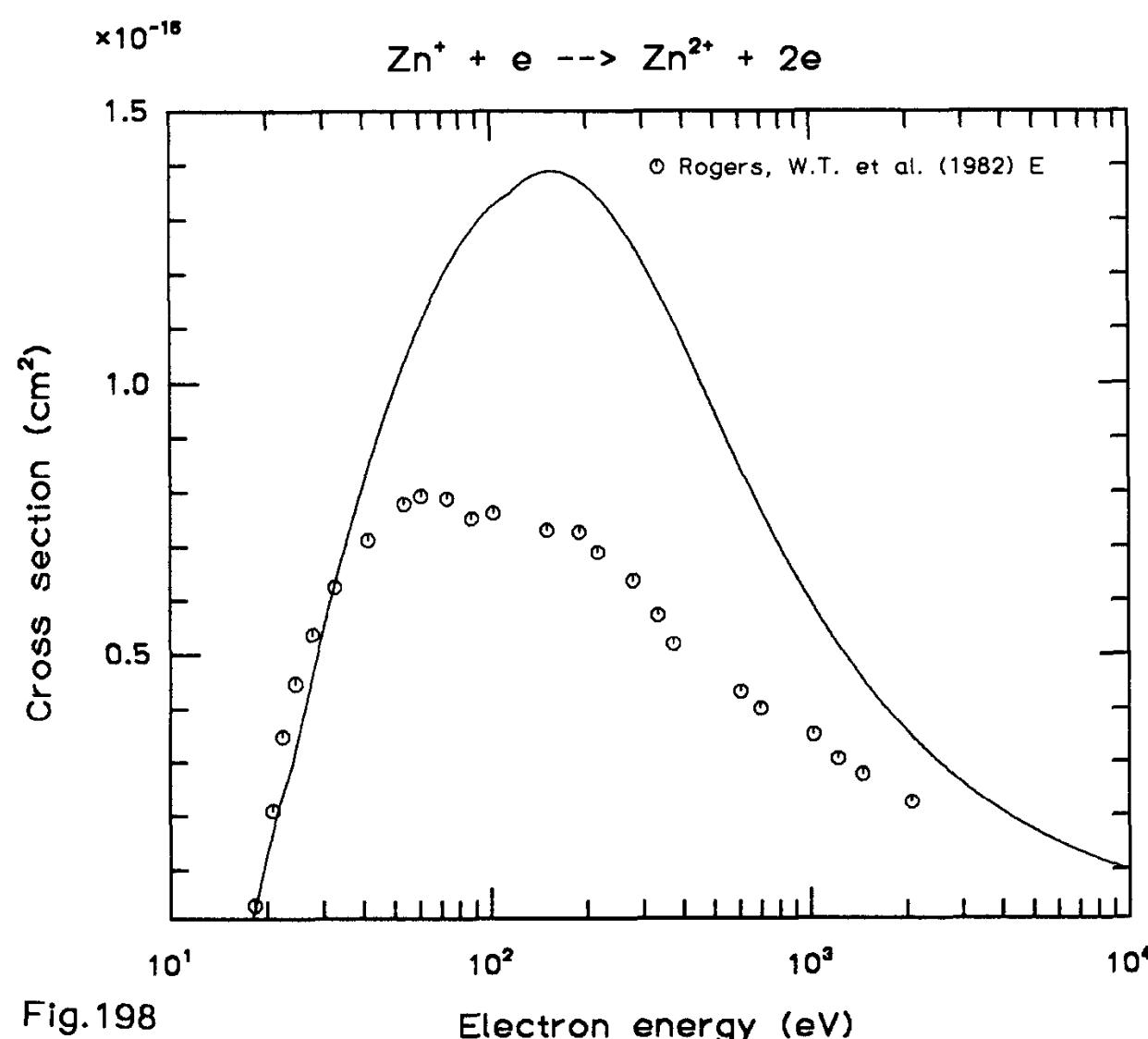


Fig.198

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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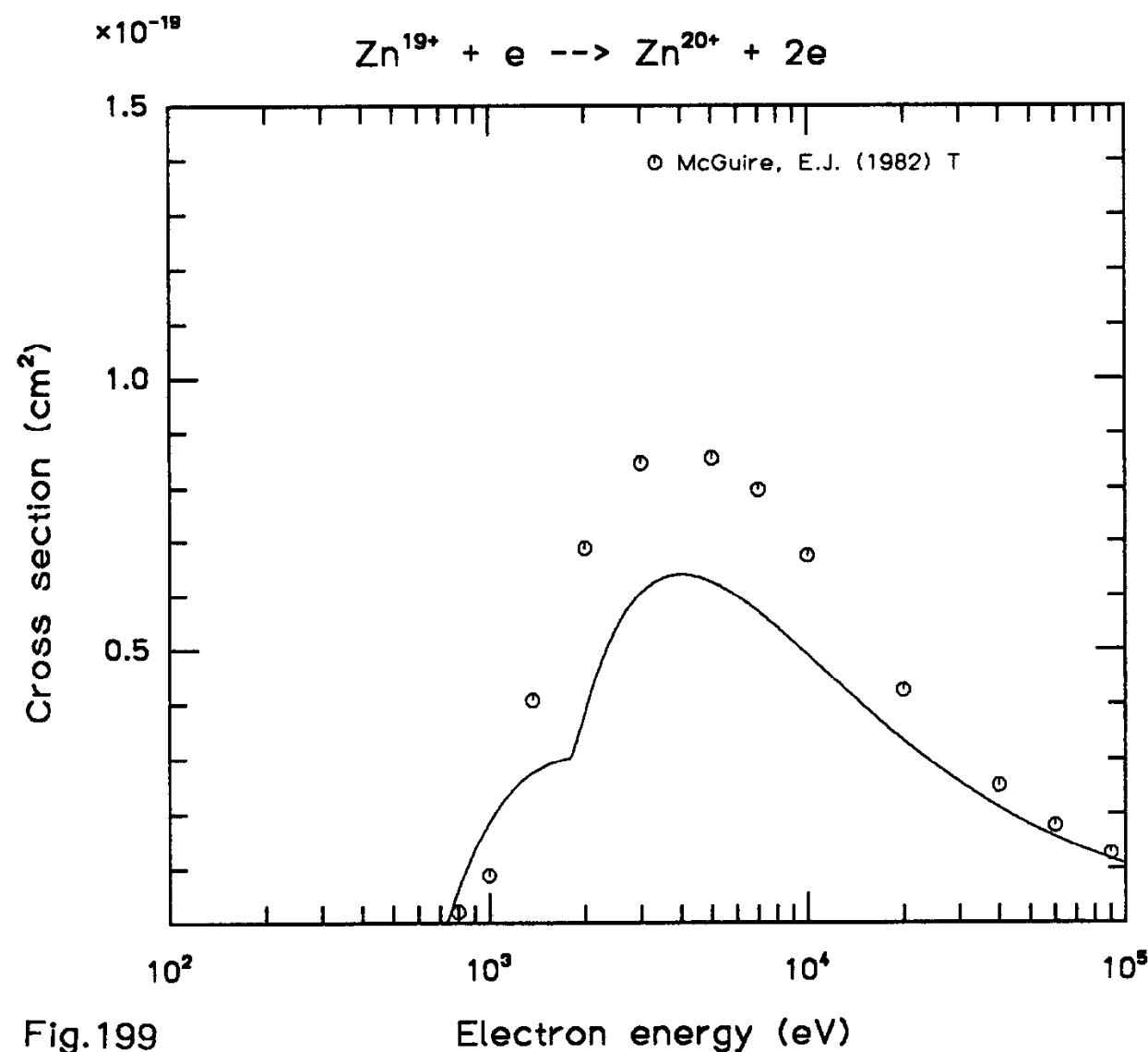


Fig.199

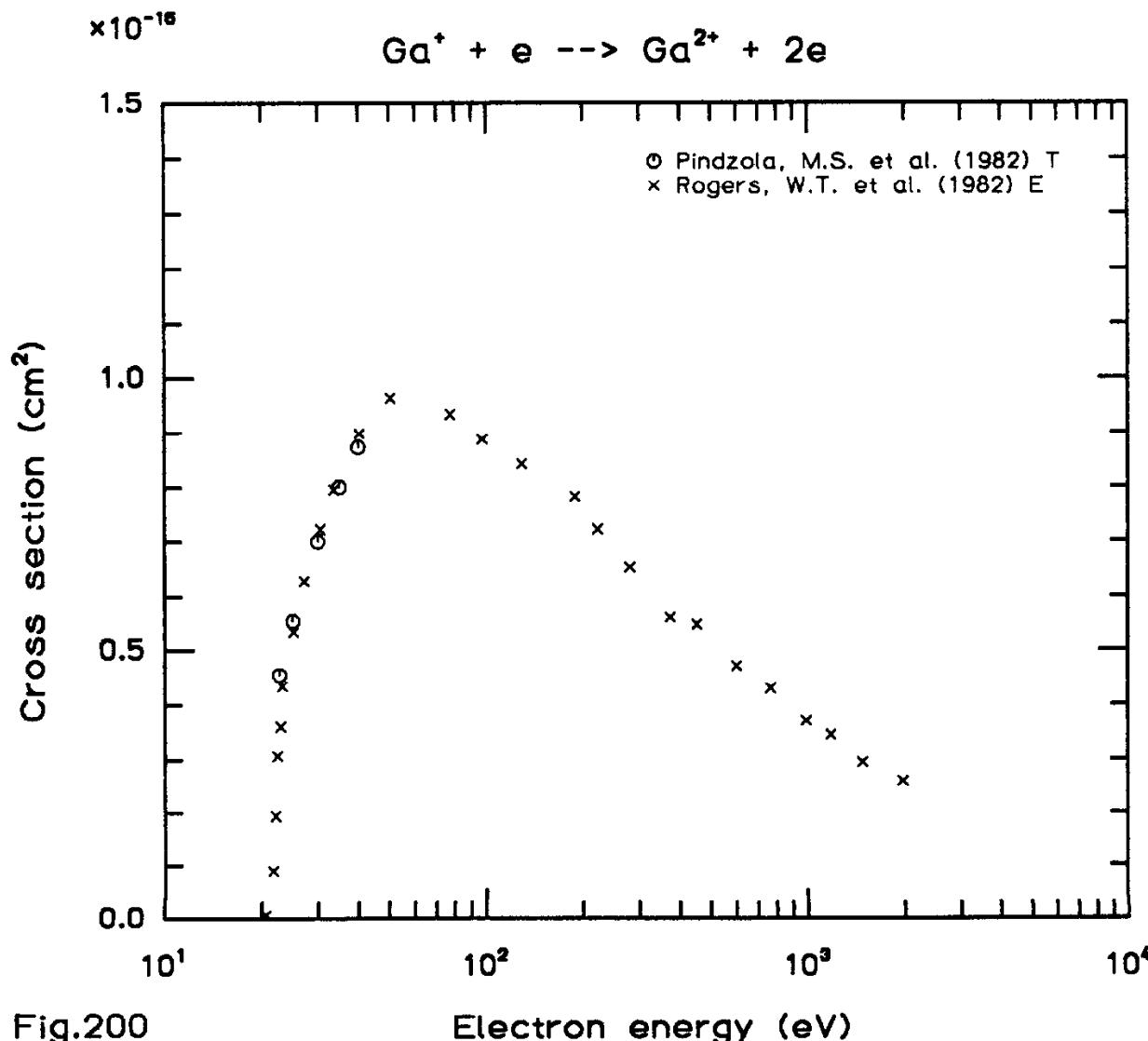


Fig.200

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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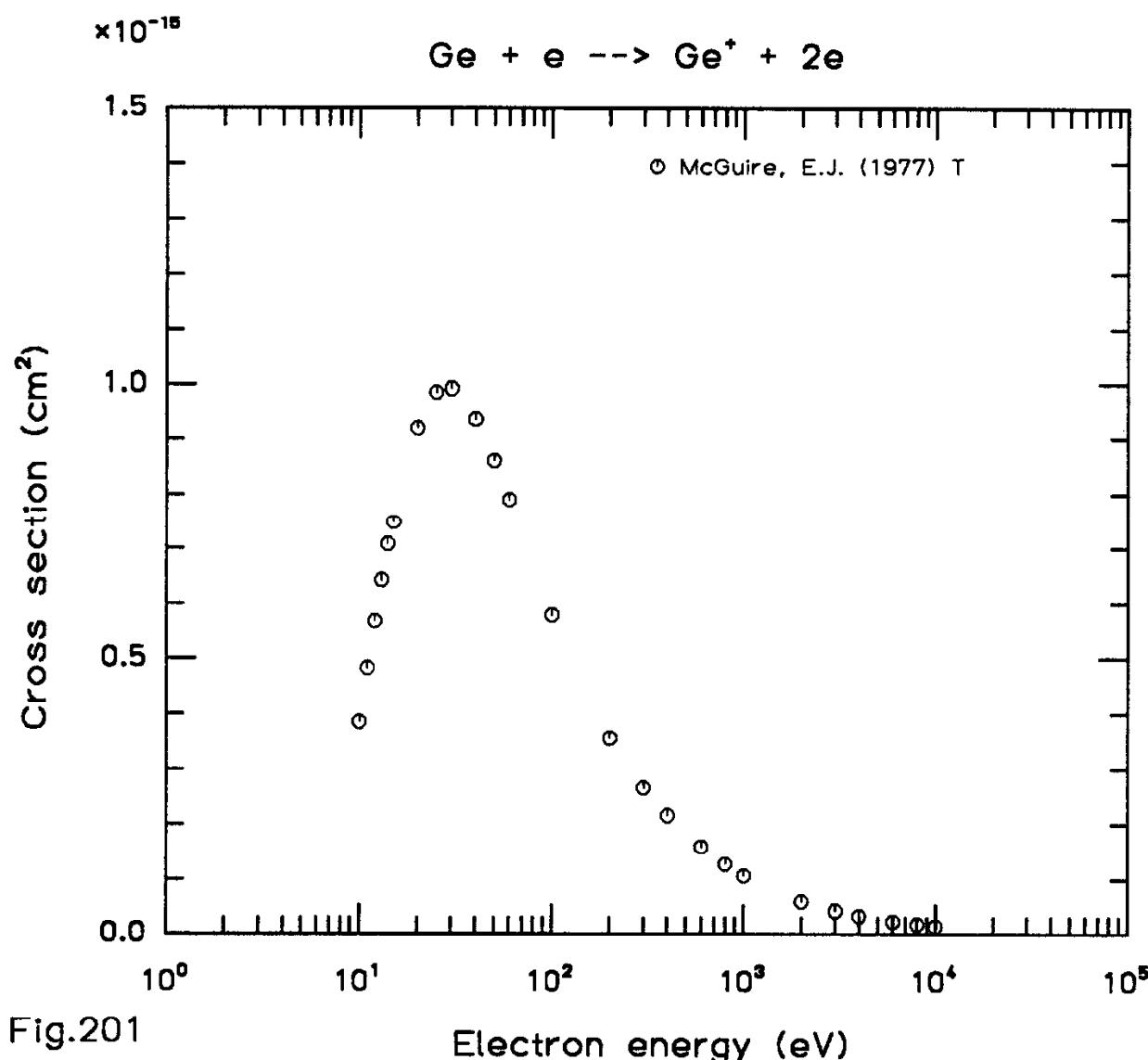


Fig.201

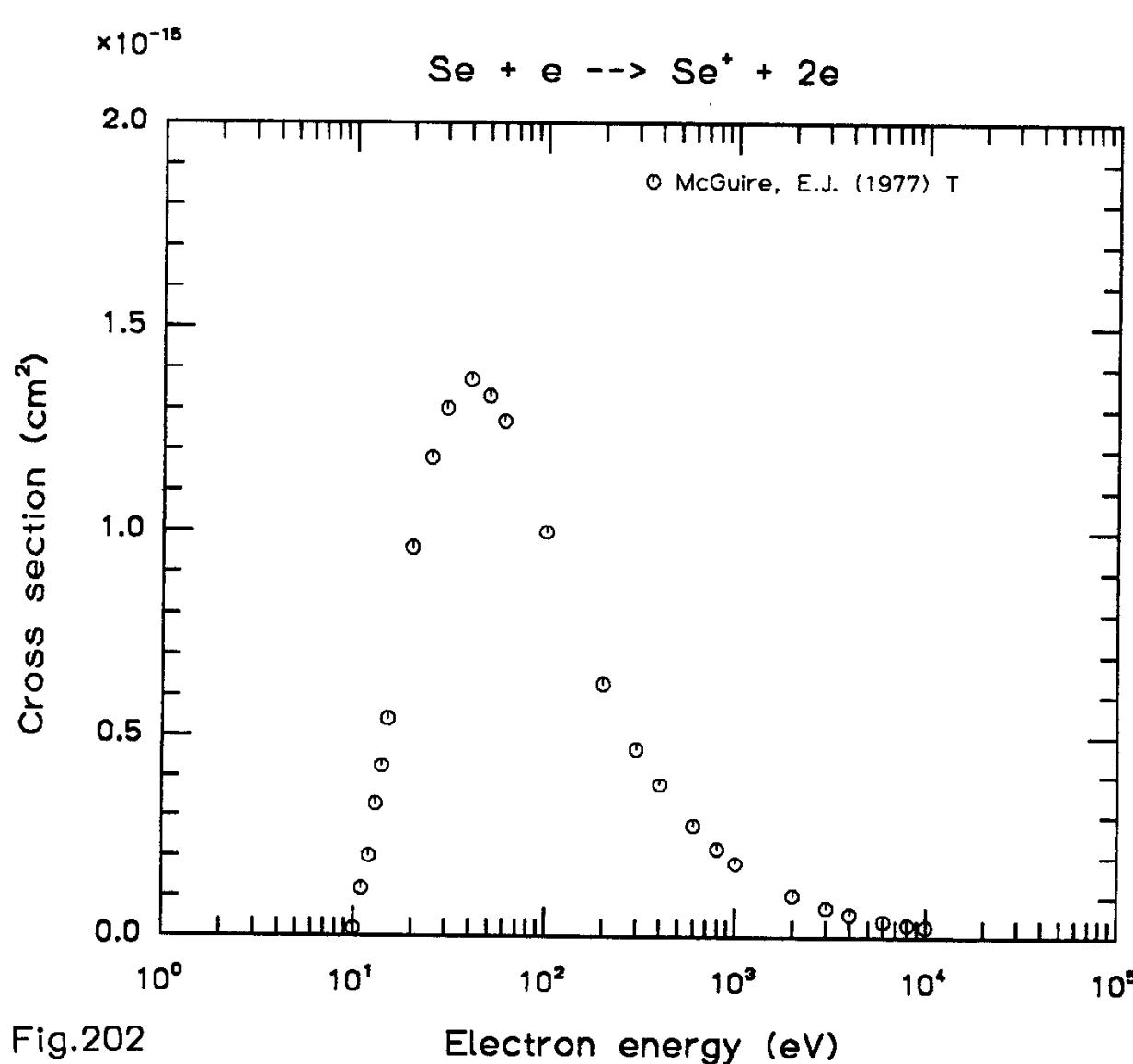


Fig.202

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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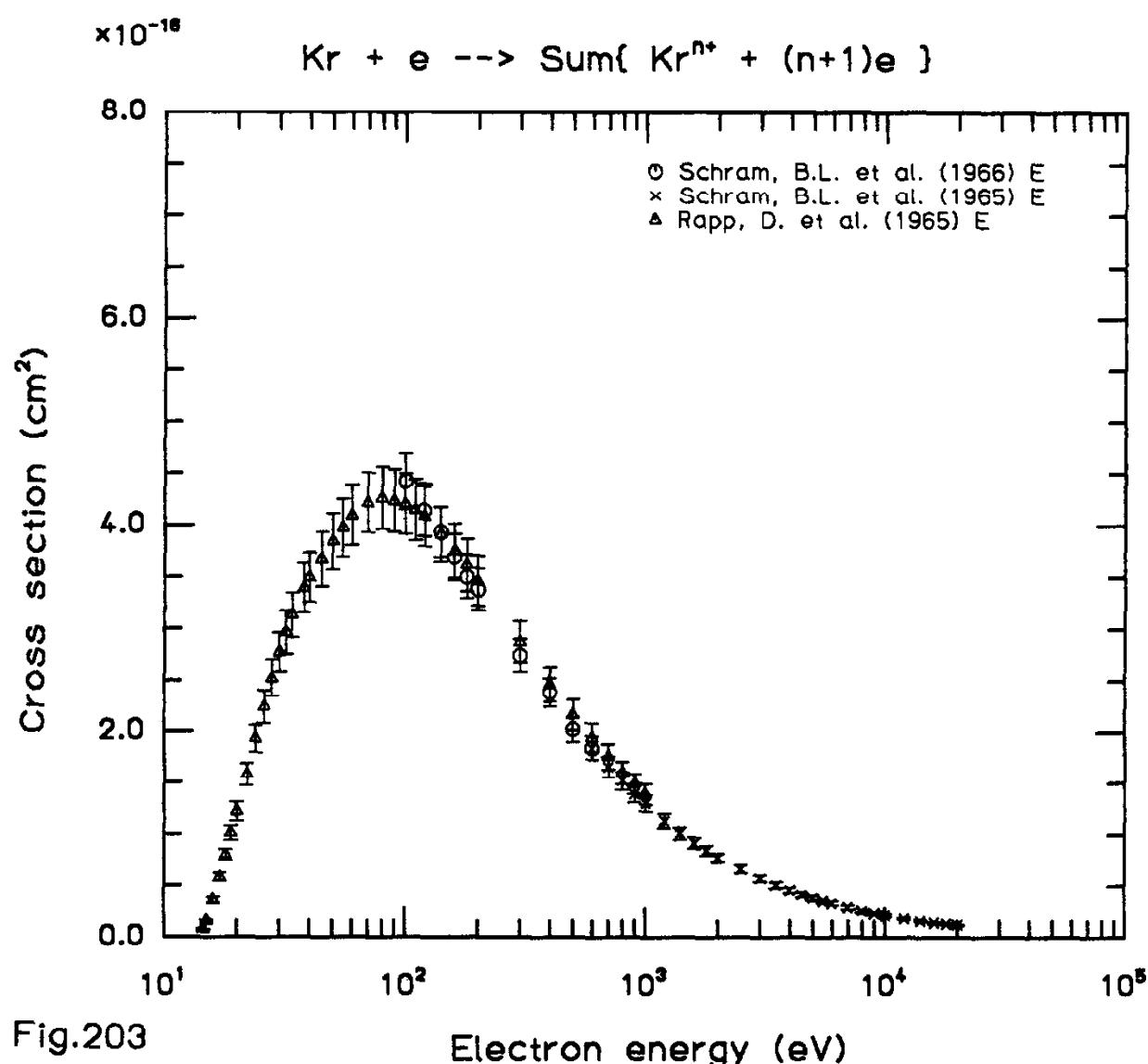


Fig.203

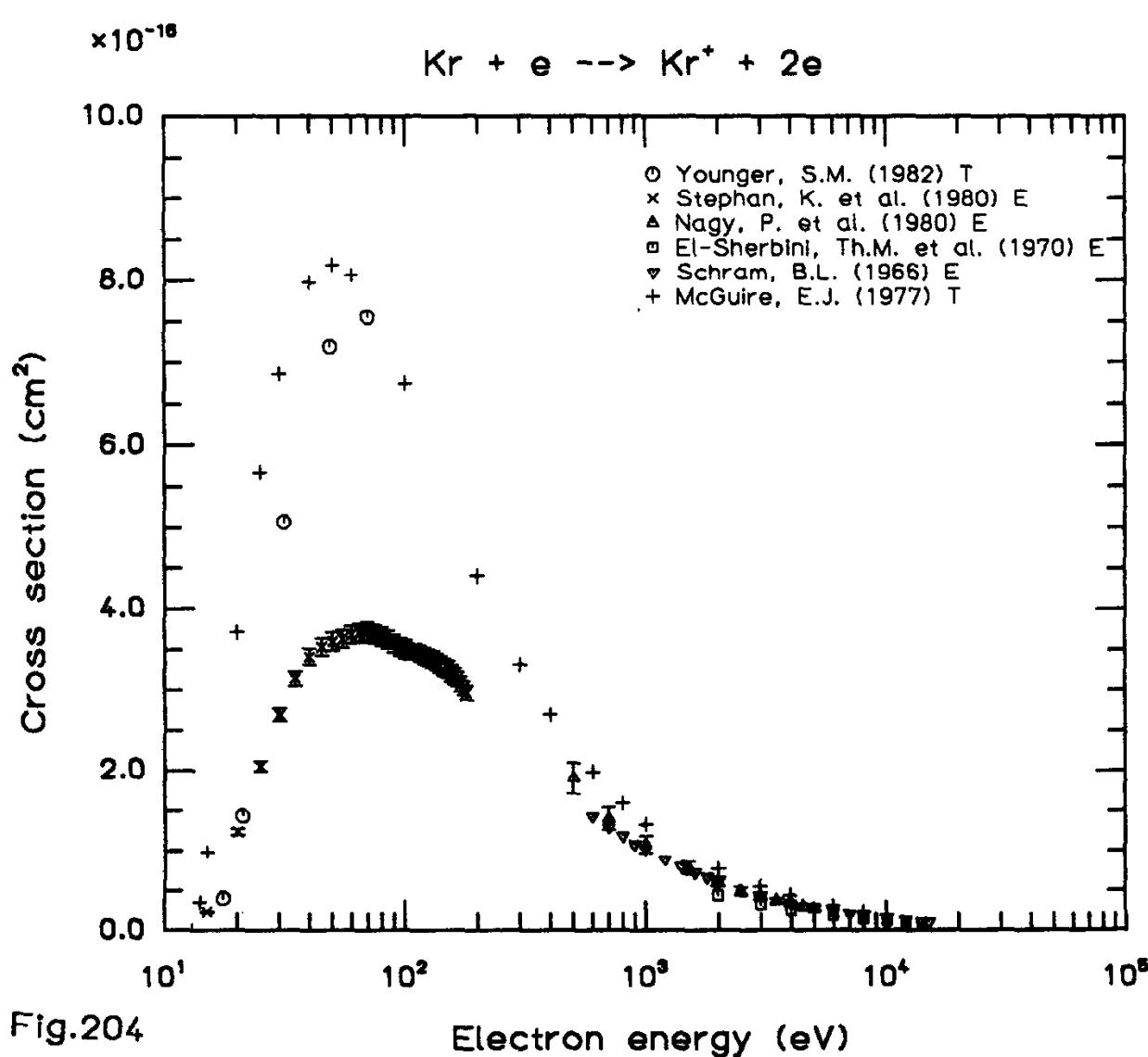


Fig.204

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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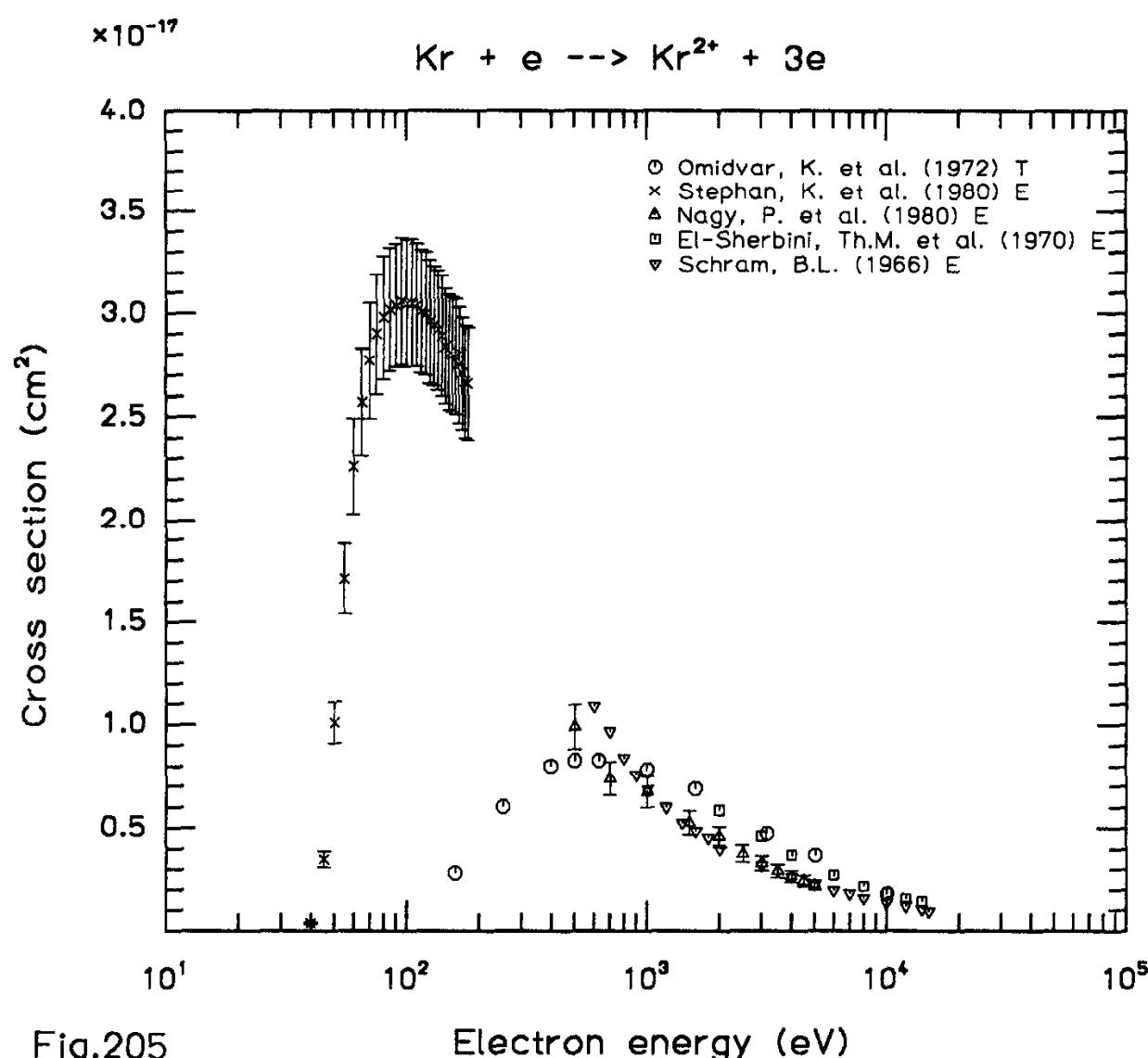


Fig.205

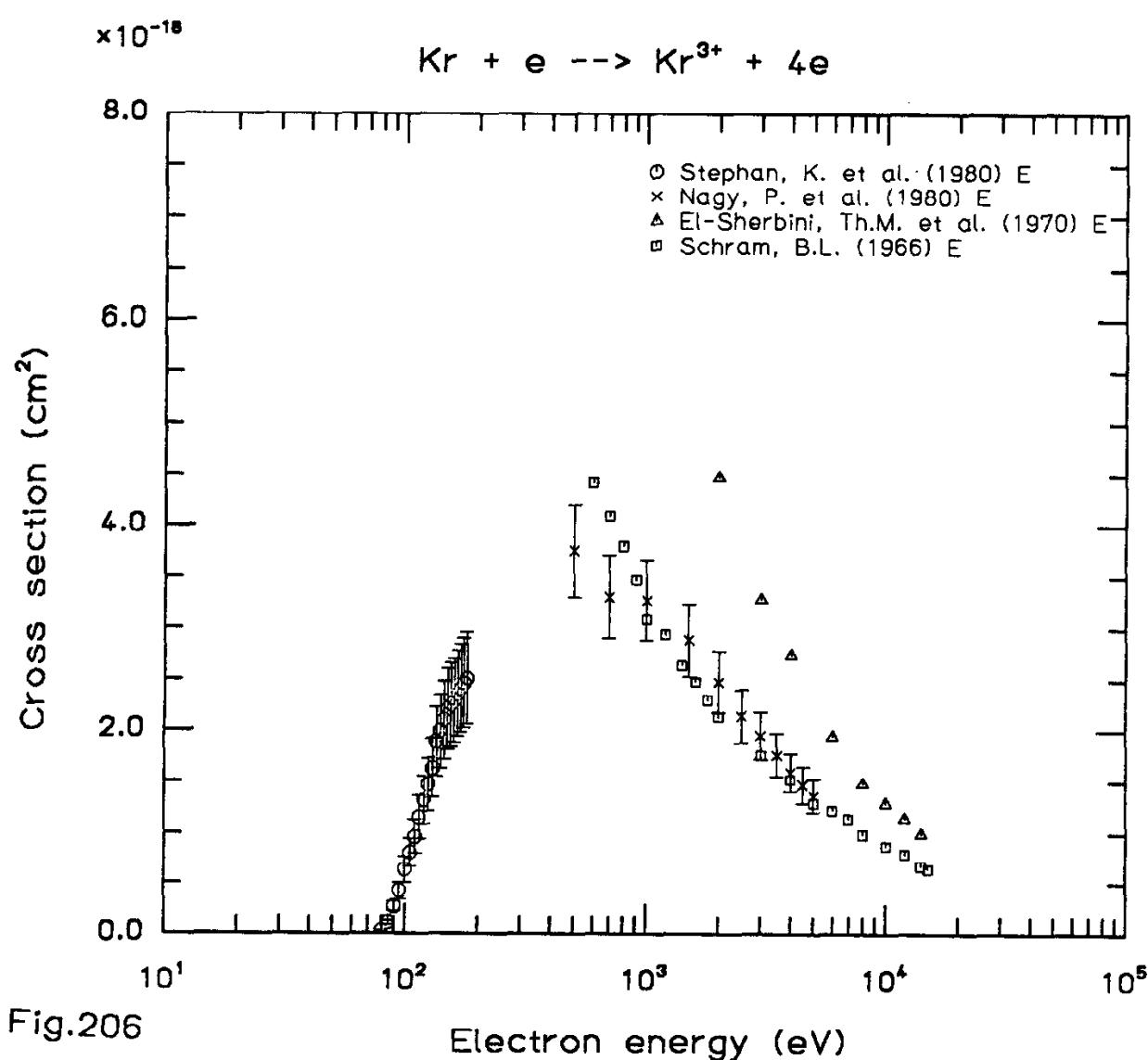


Fig.206

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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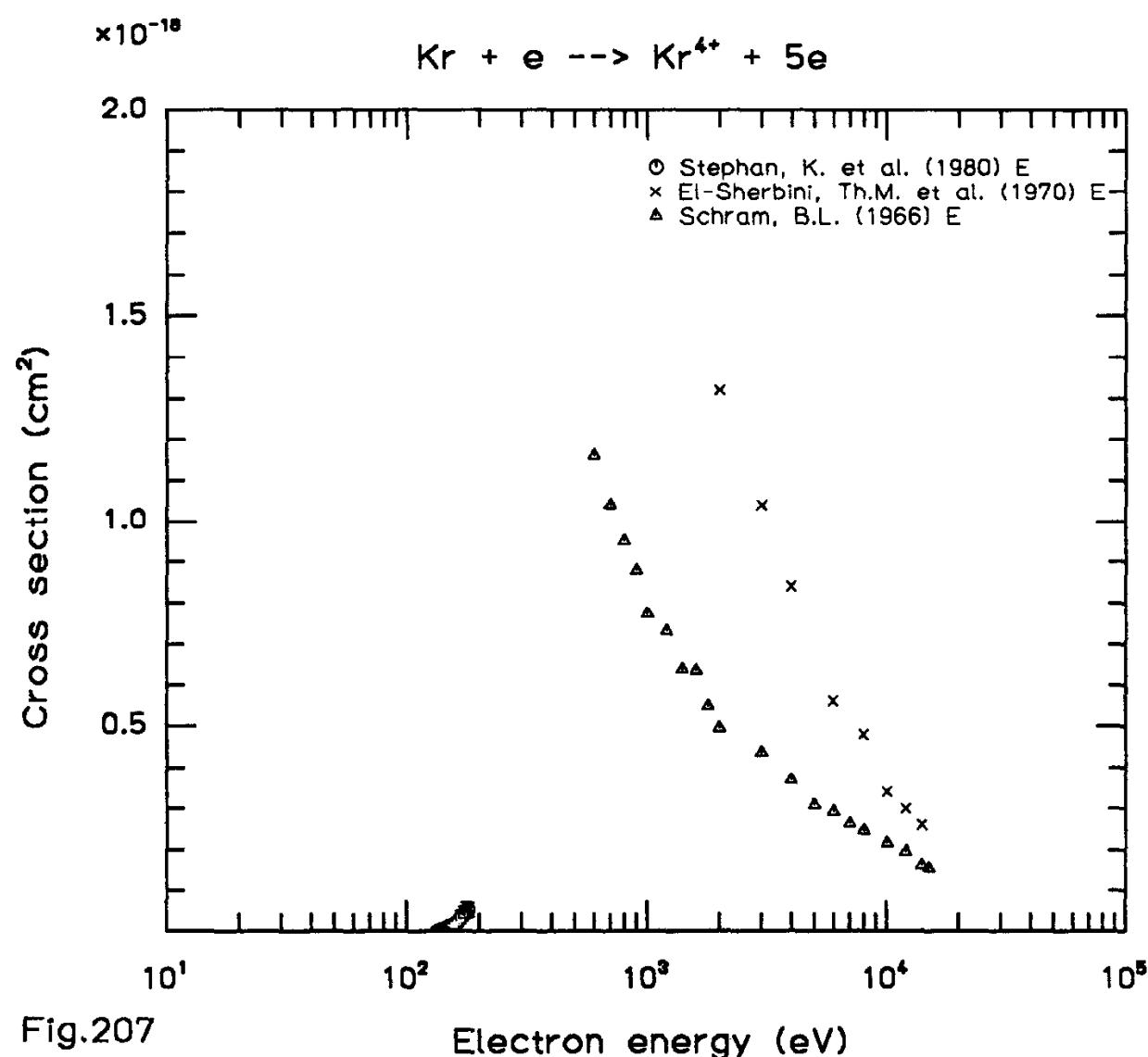


Fig.207

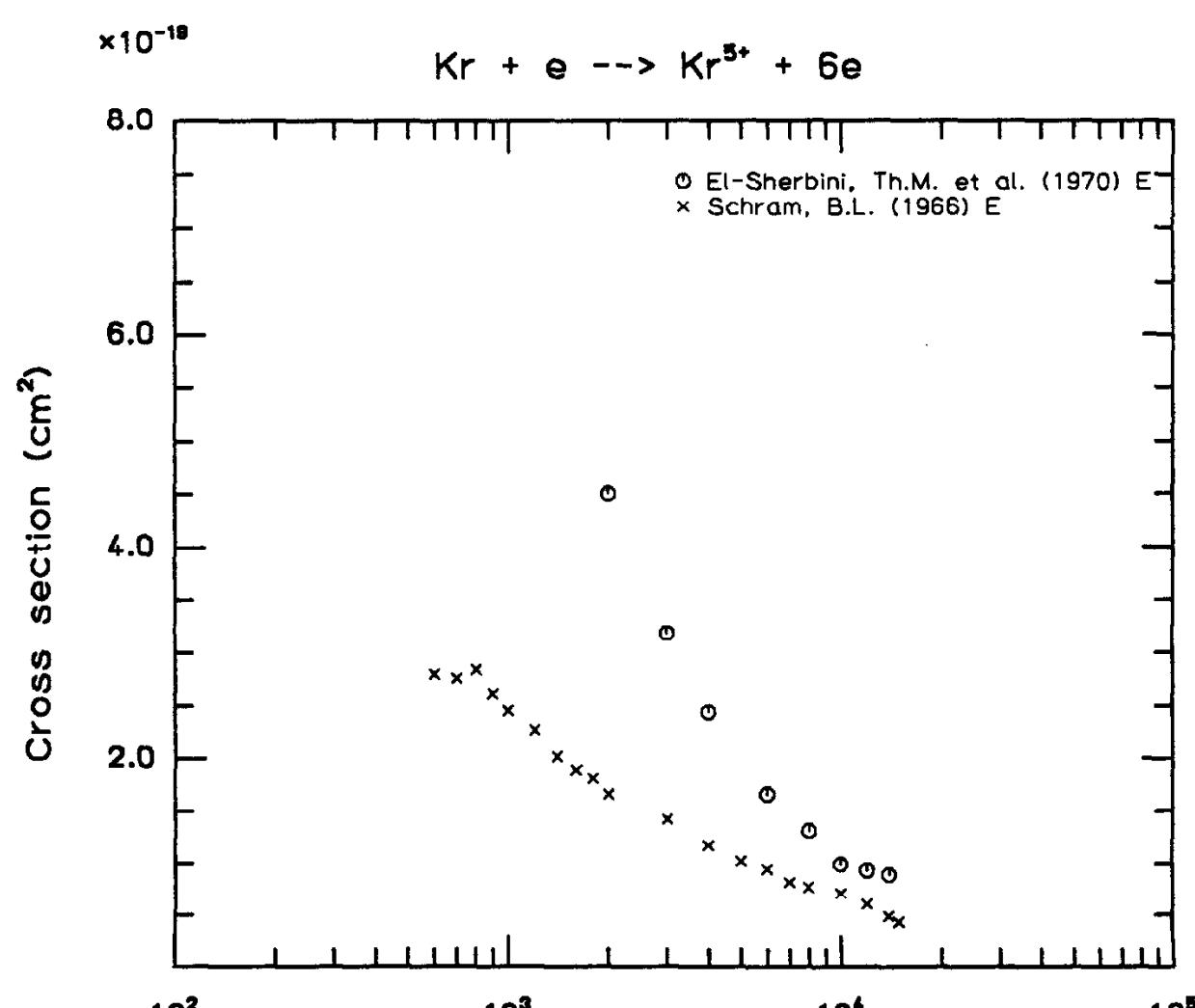


Fig.208

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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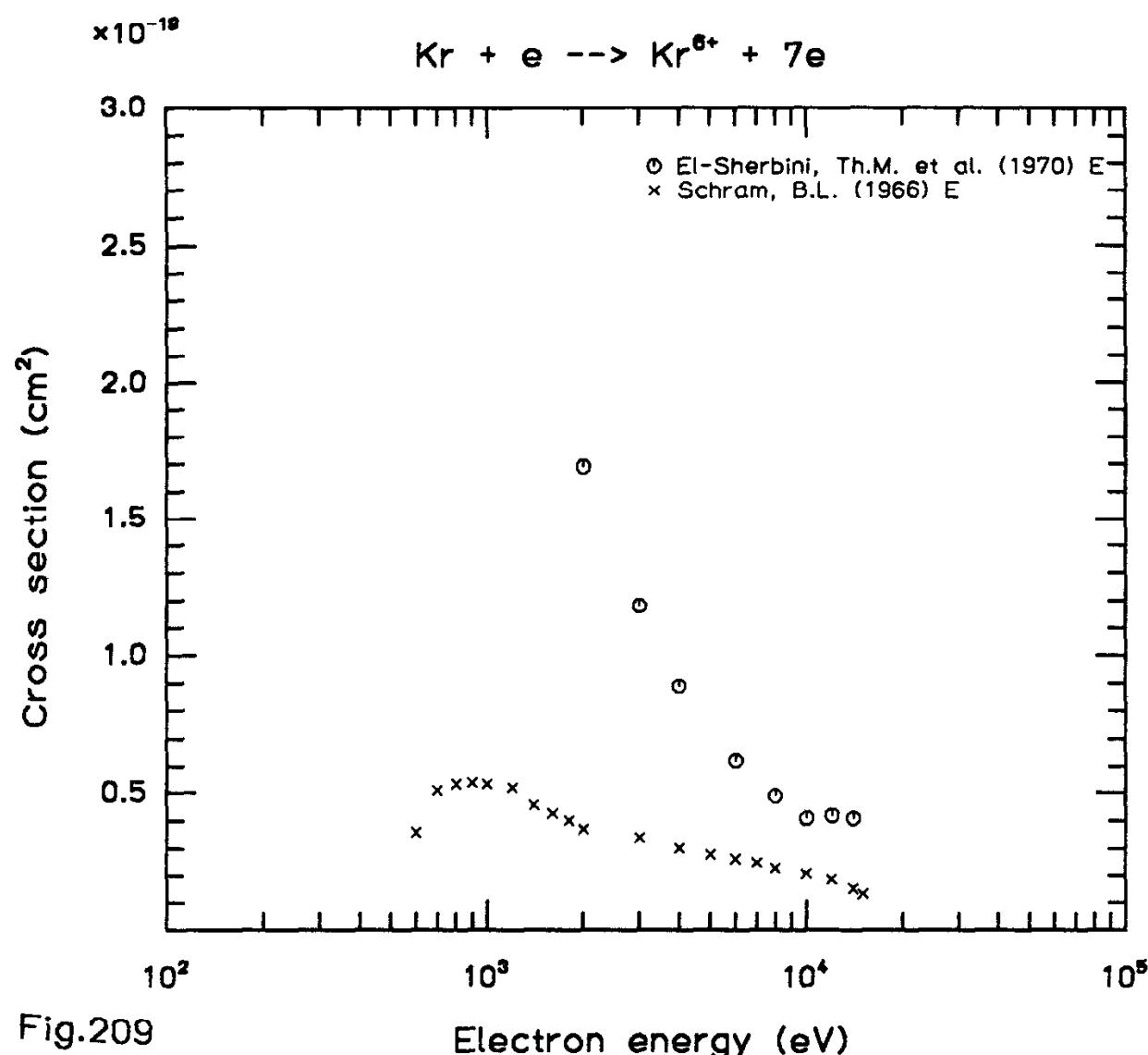


Fig.209

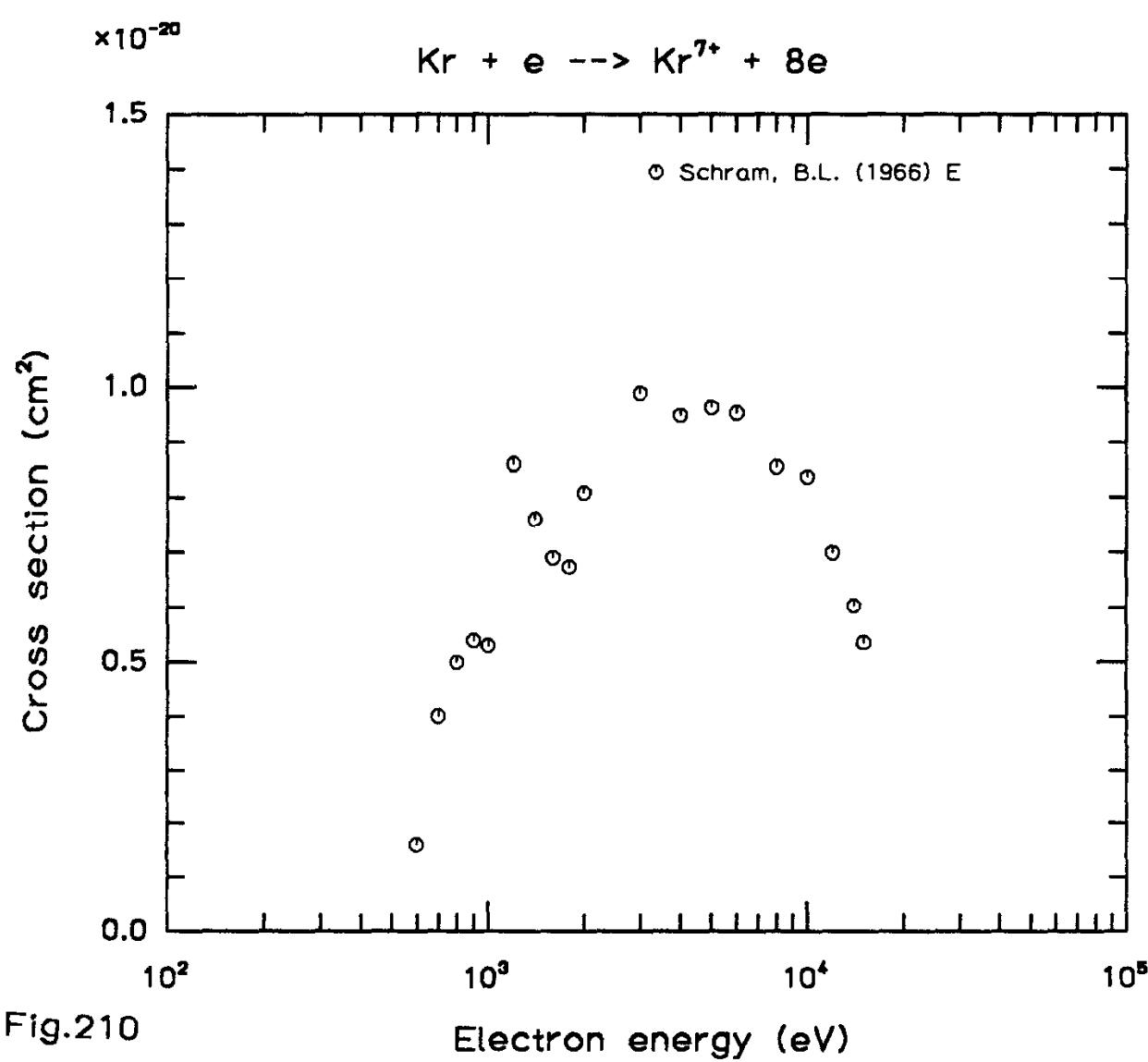
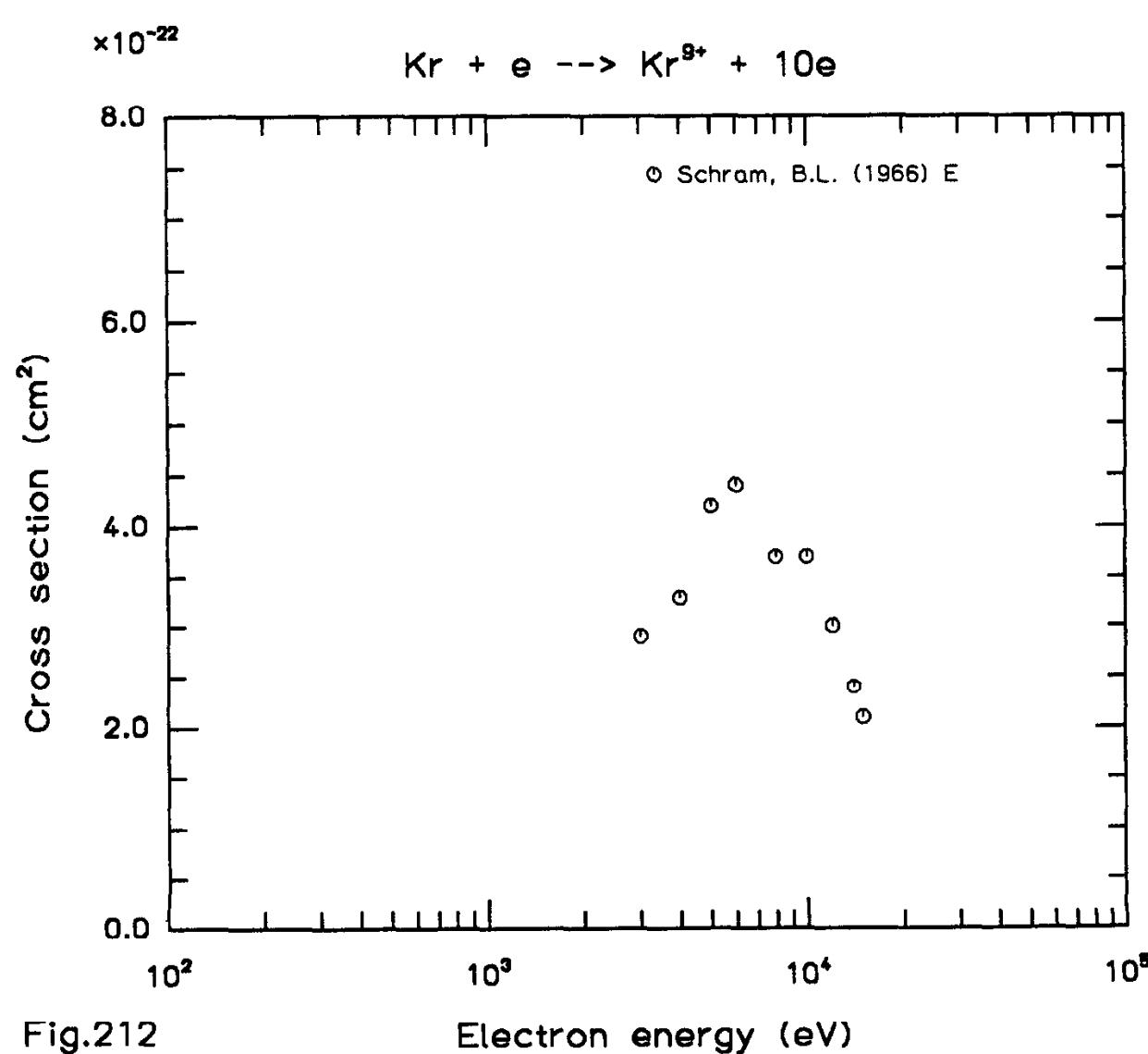
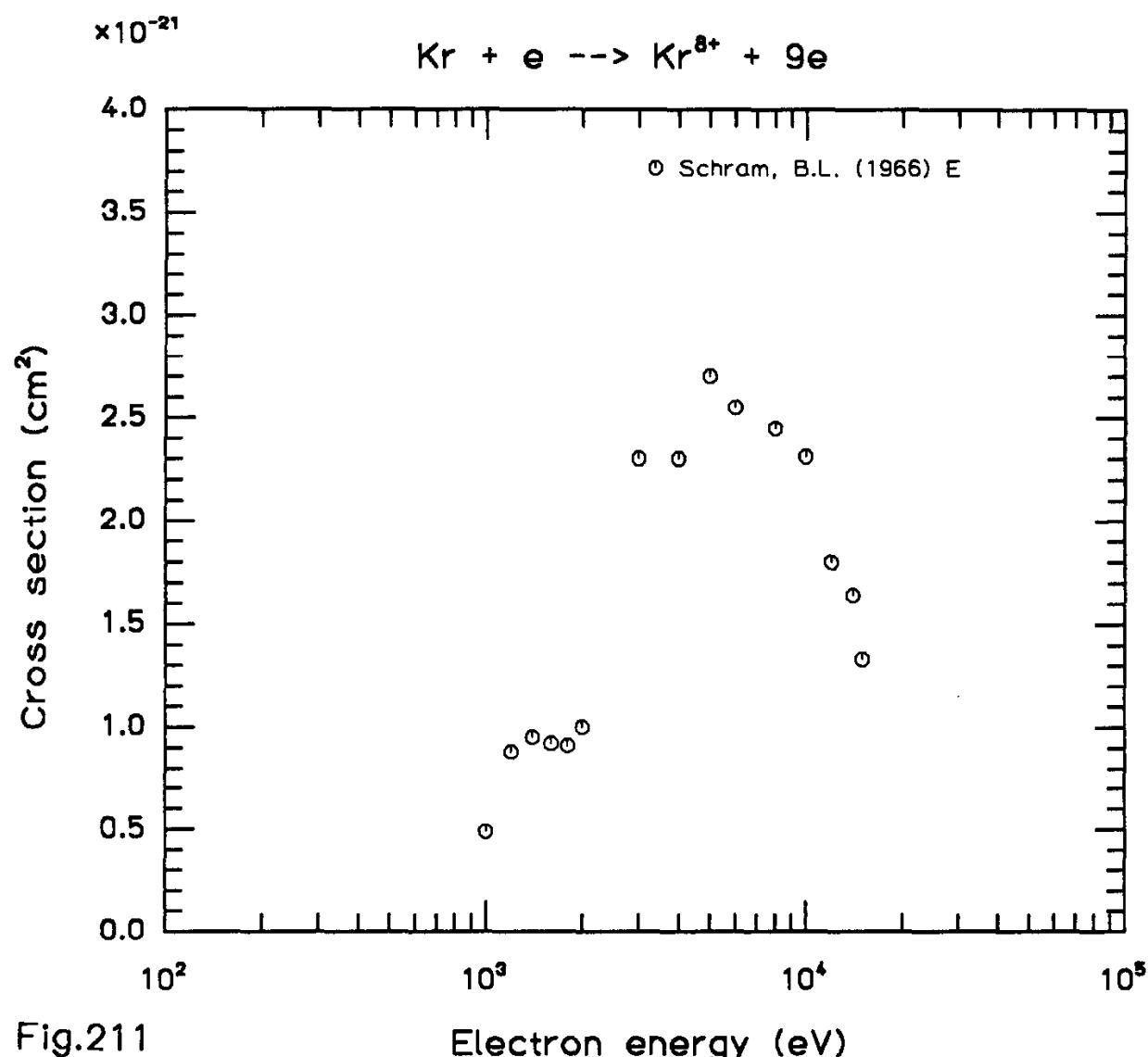


Fig.210

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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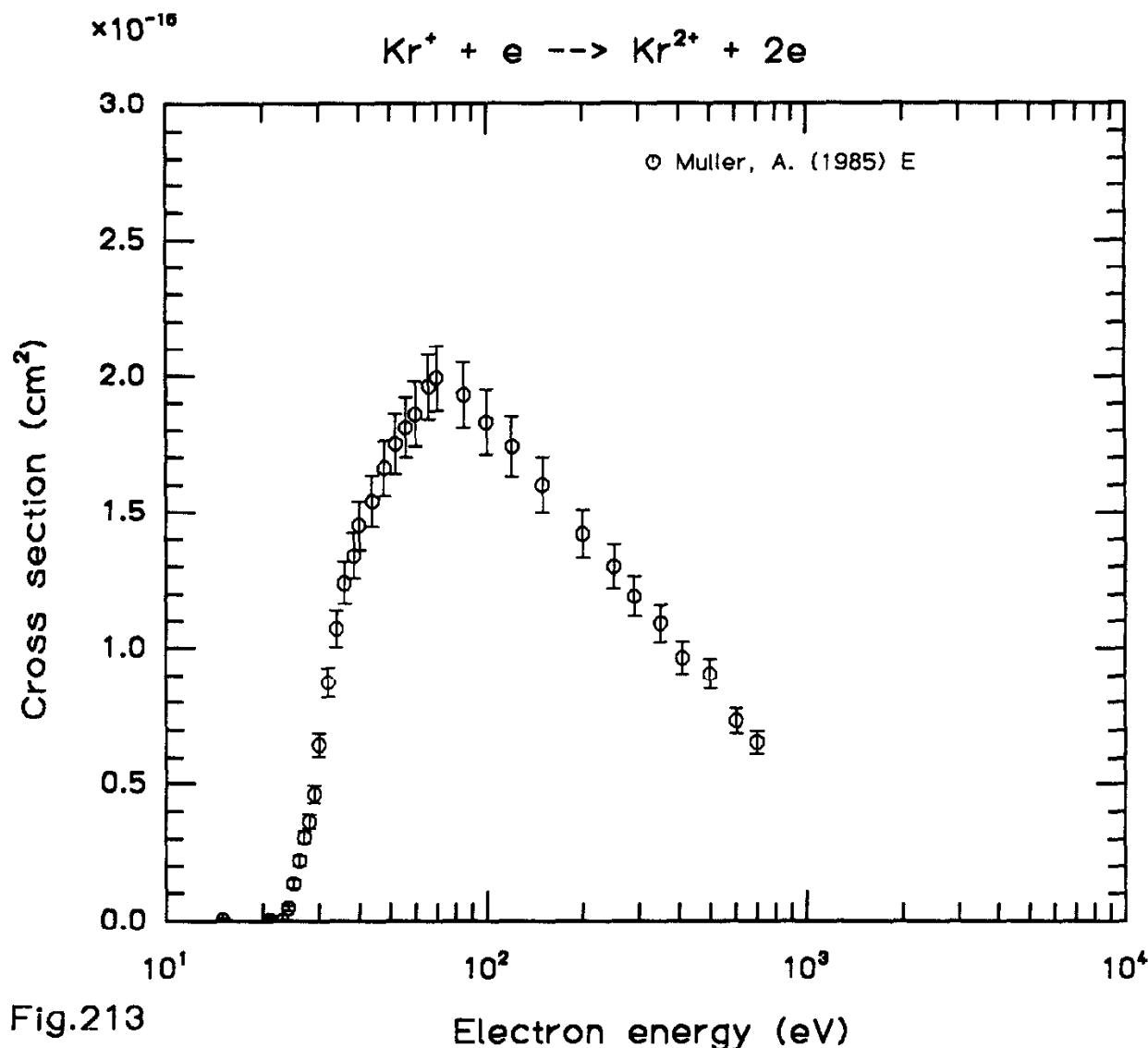


Fig.213

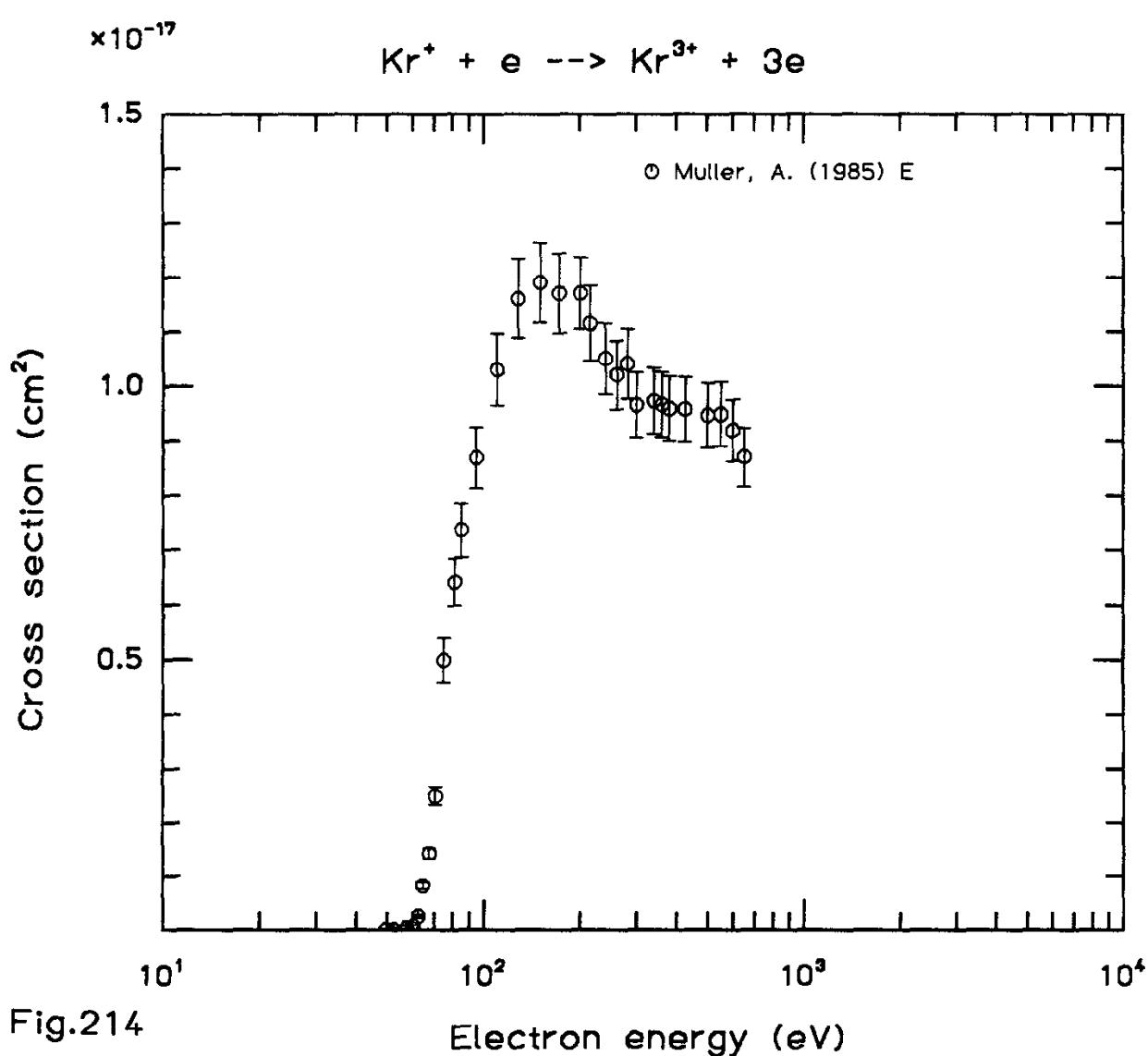


Fig.214

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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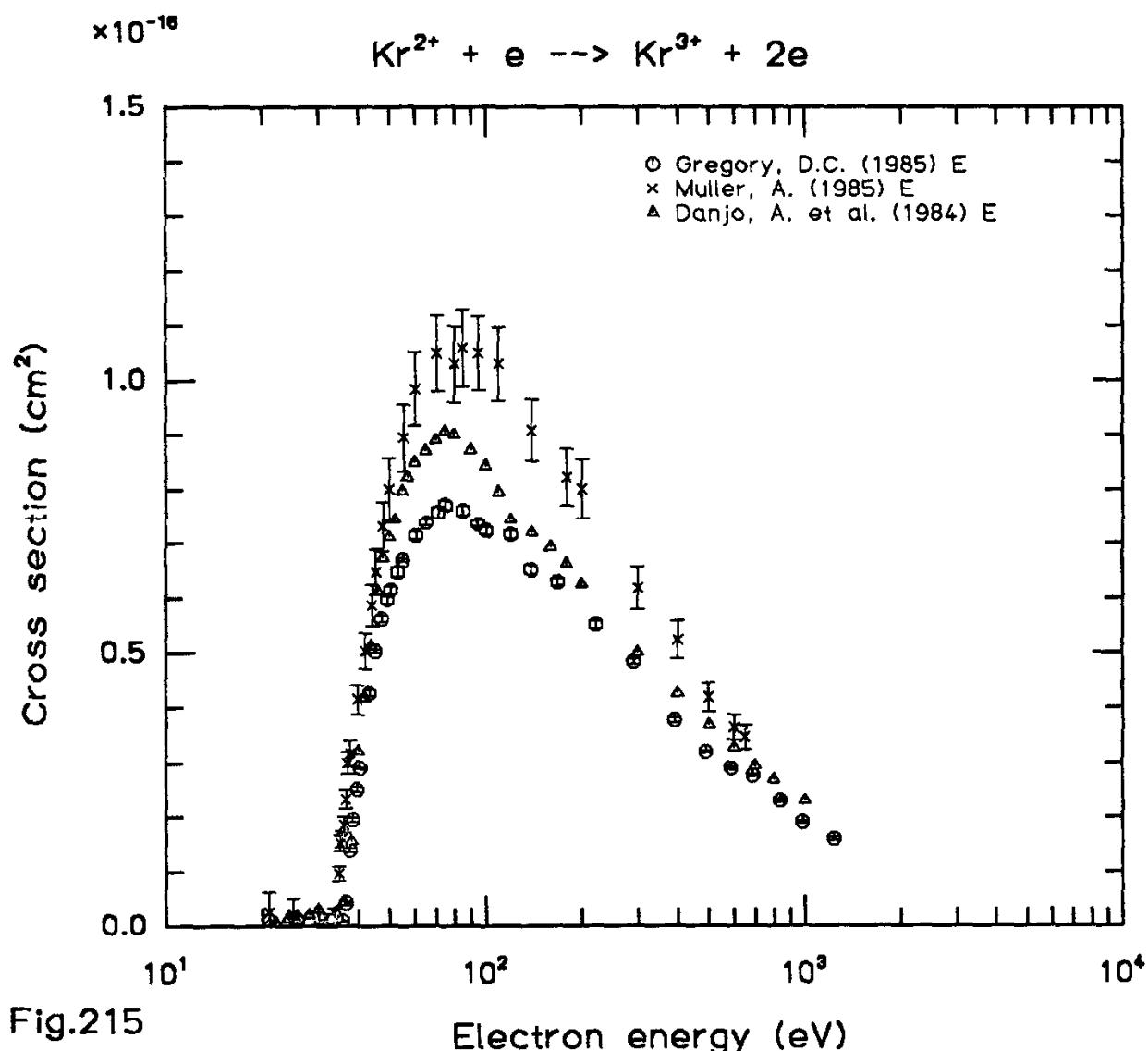


Fig.215

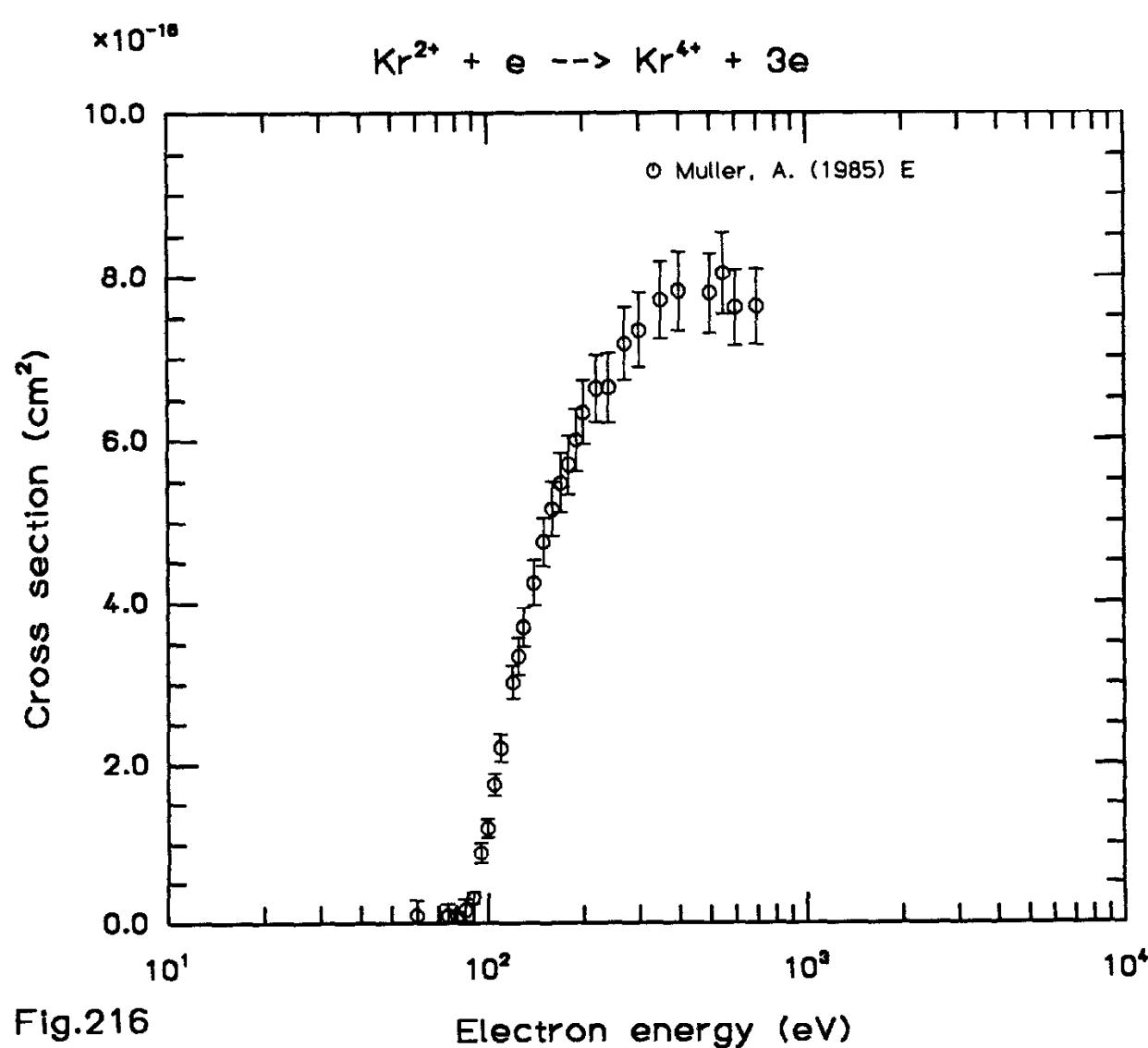


Fig.216

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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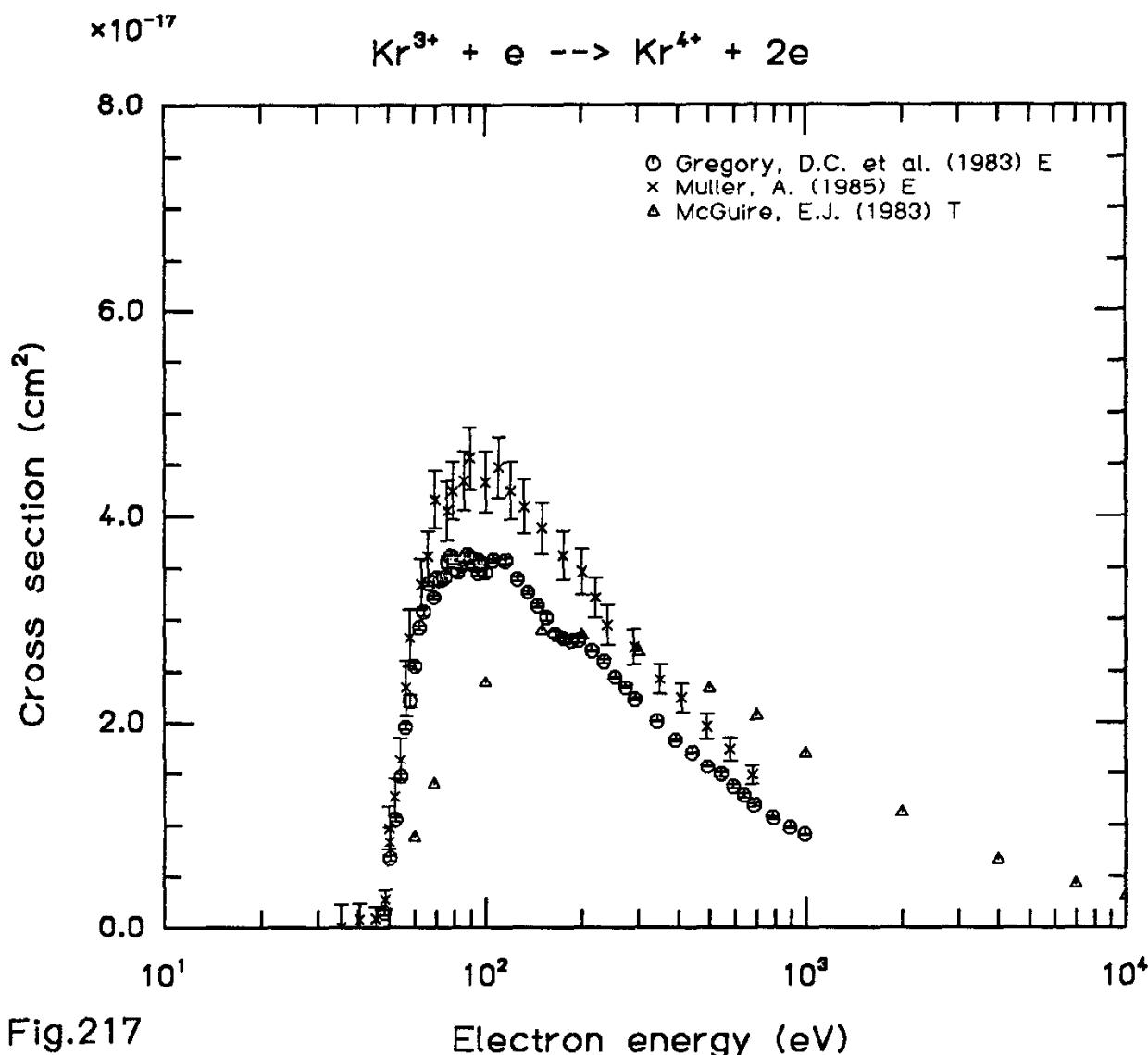


Fig.217

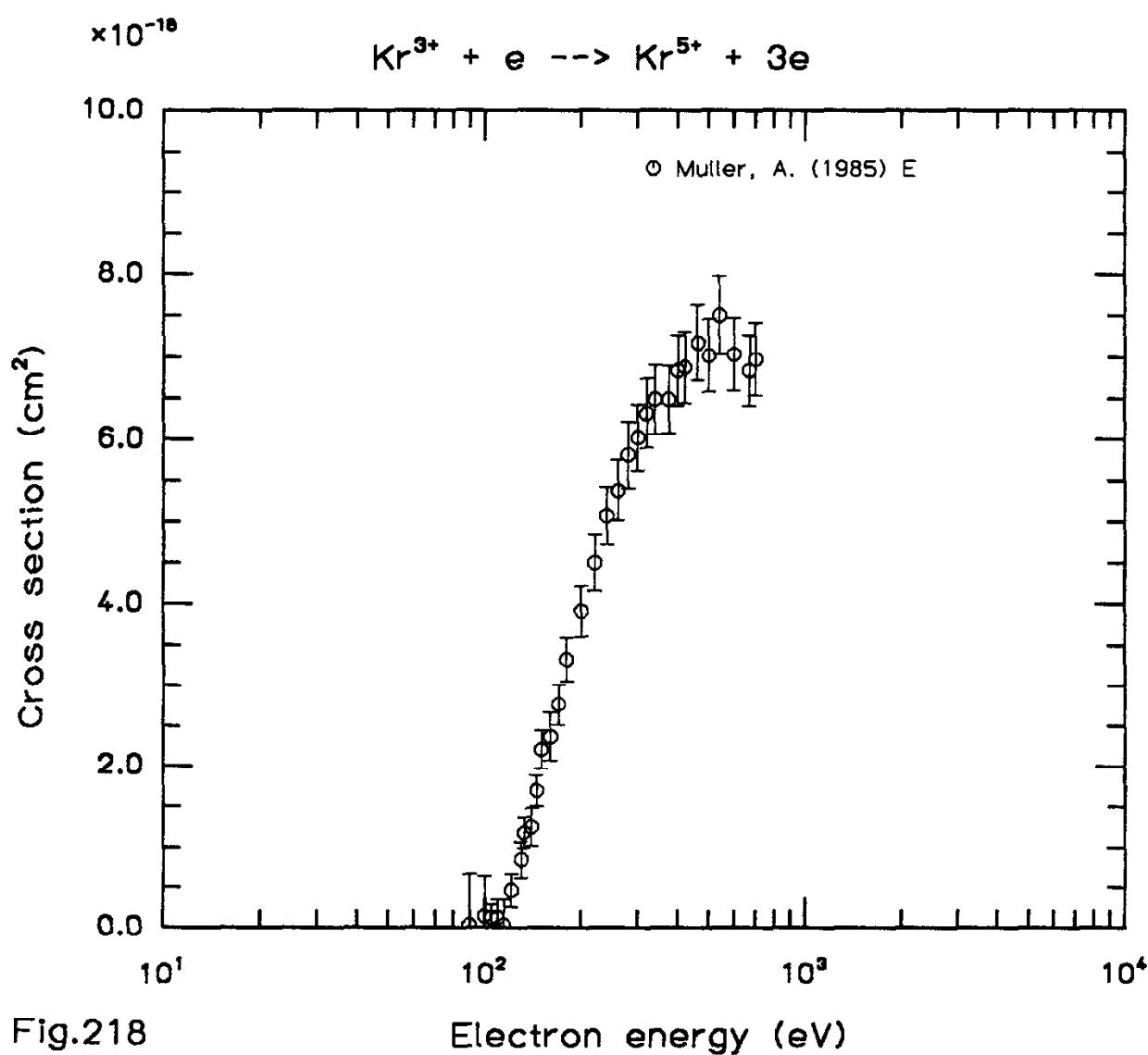


Fig.218

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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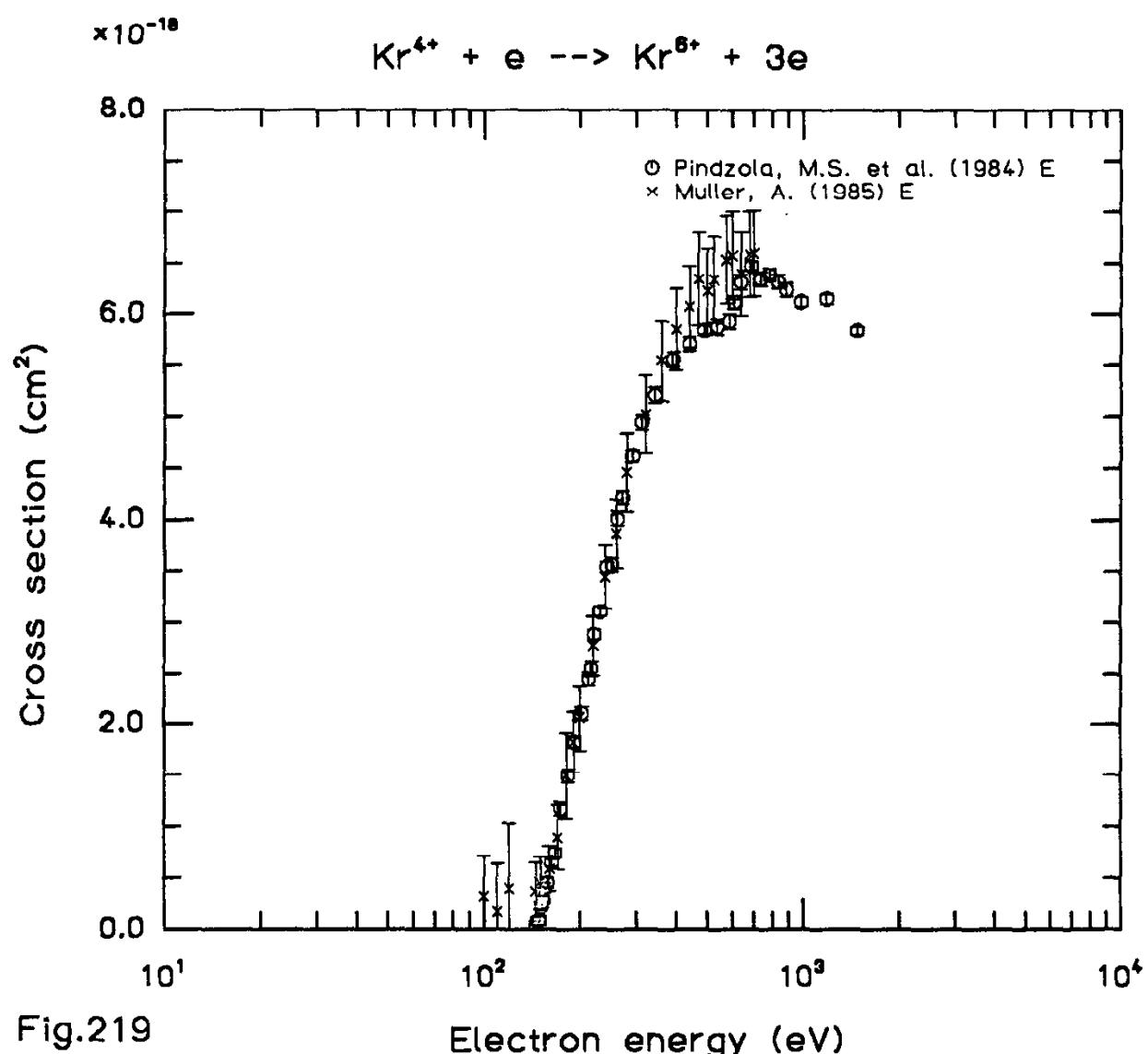


Fig.219

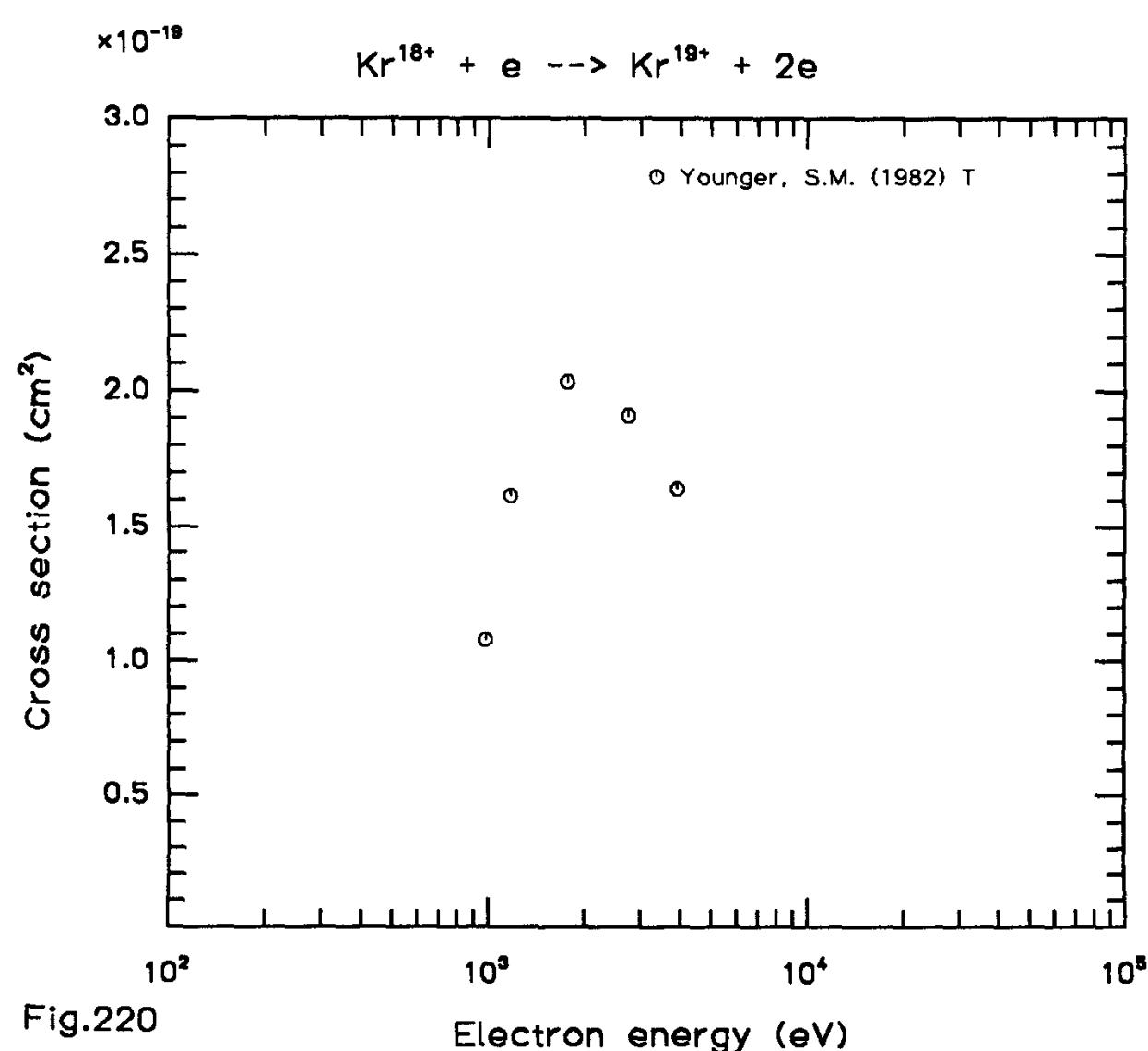


Fig.220

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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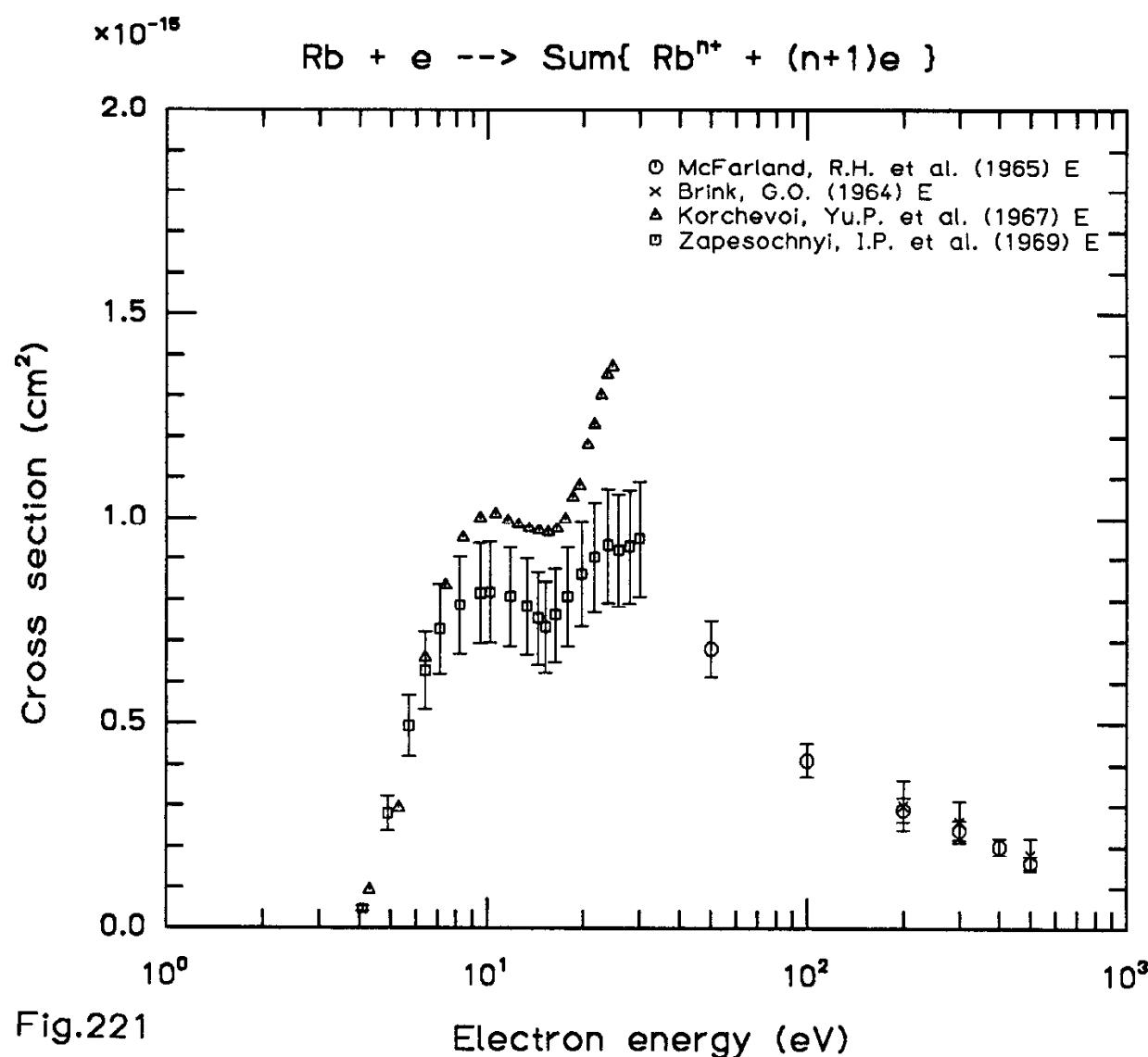


Fig.221

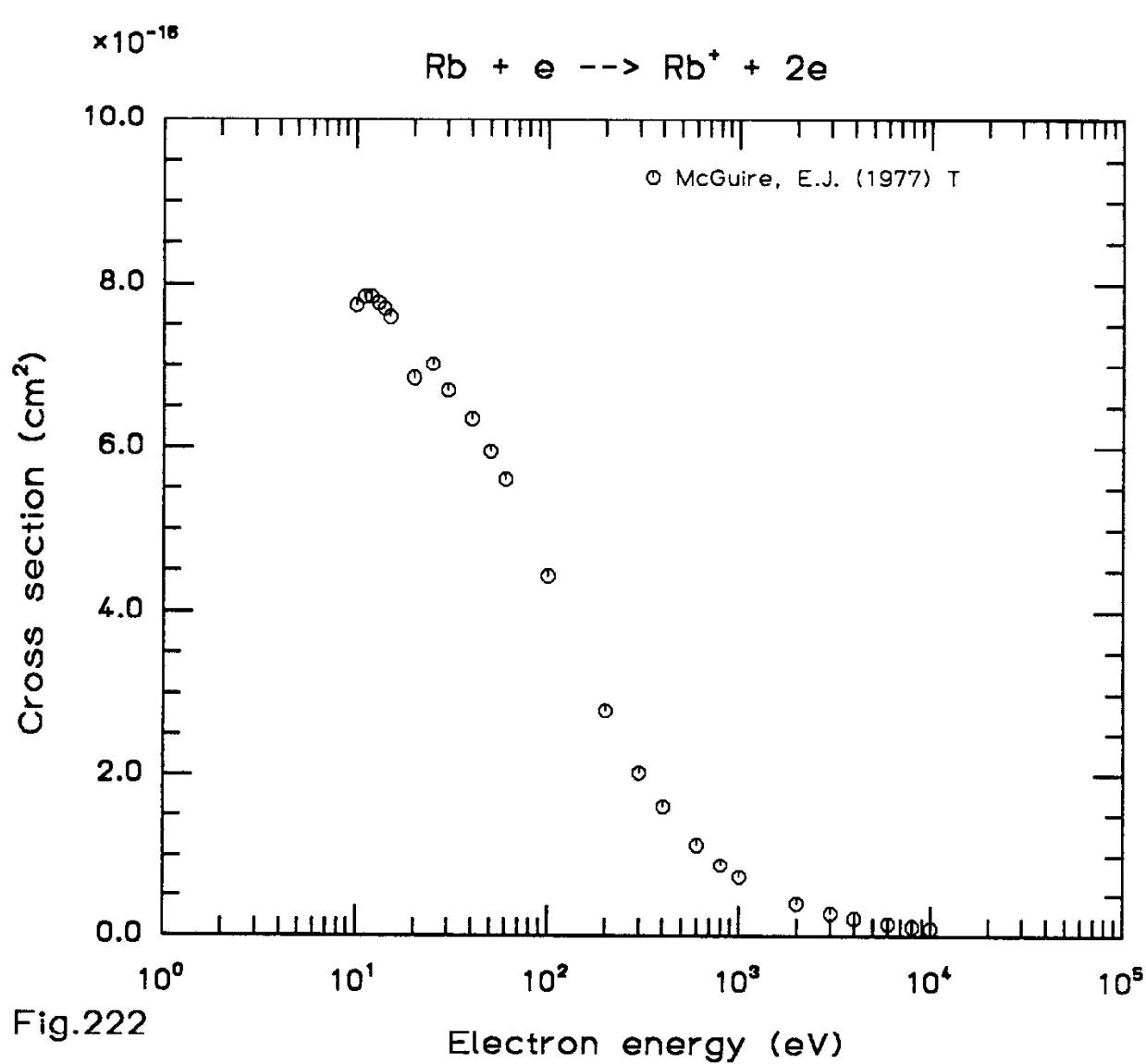


Fig.222

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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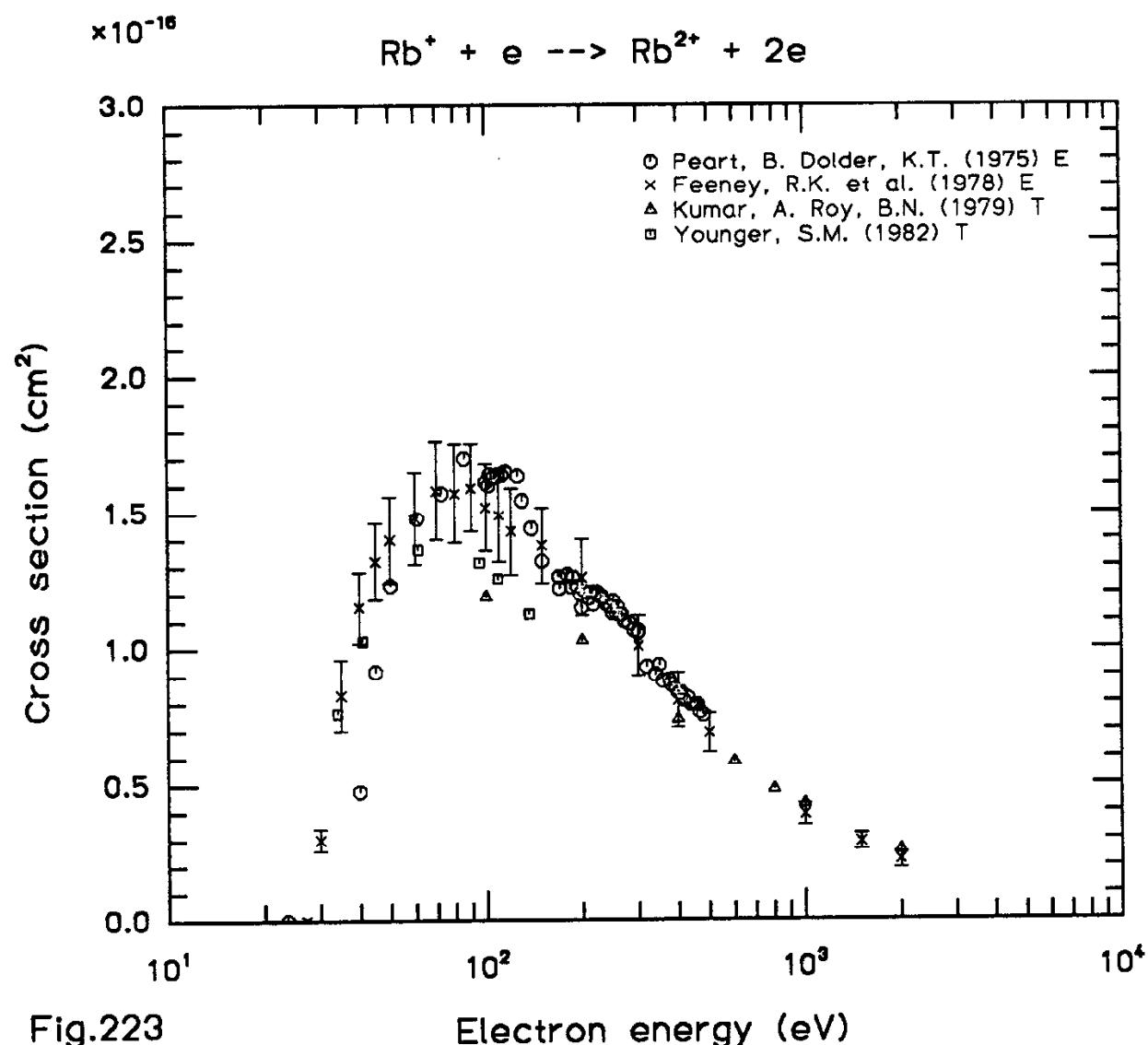


Fig.223

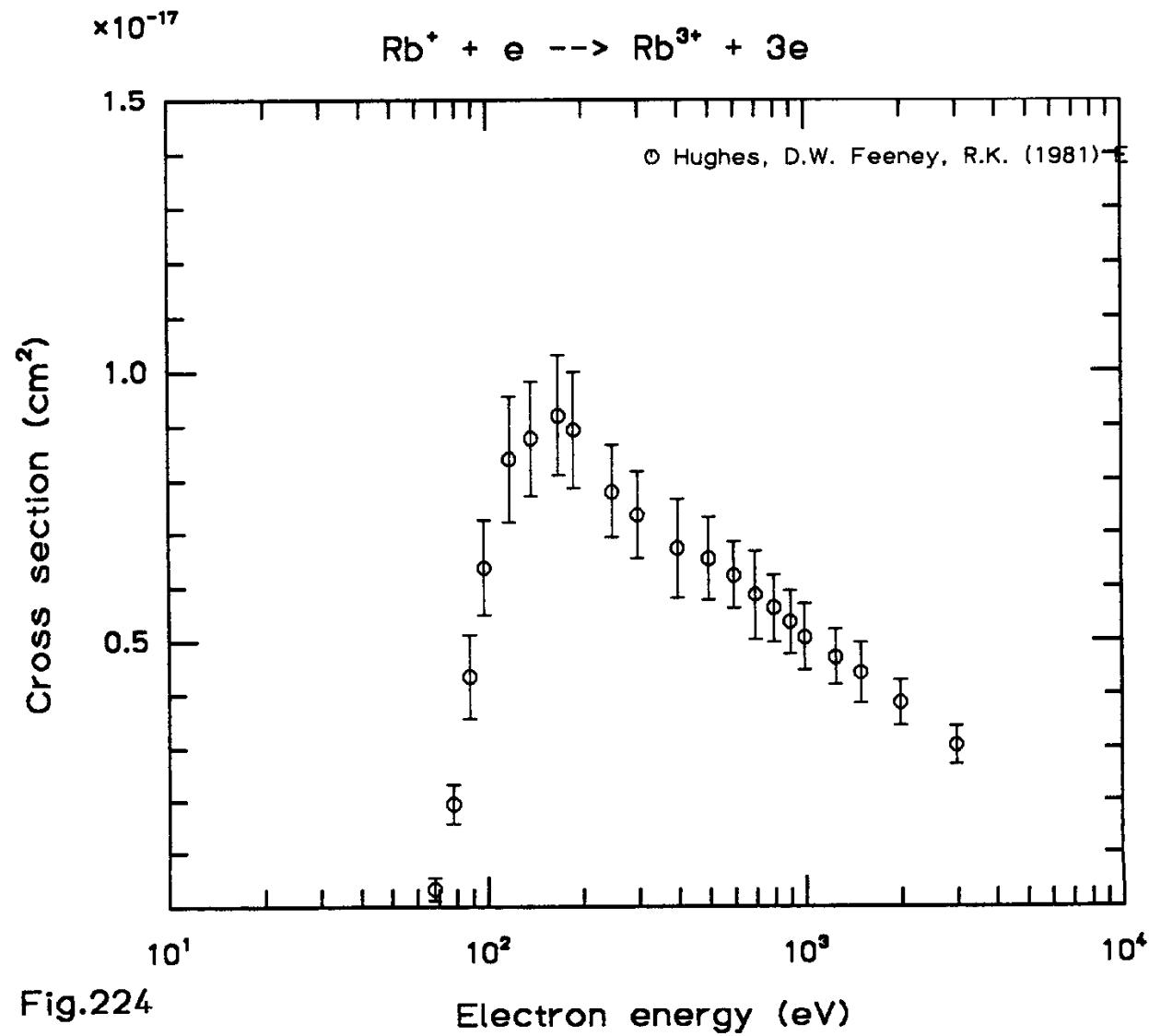


Fig.224

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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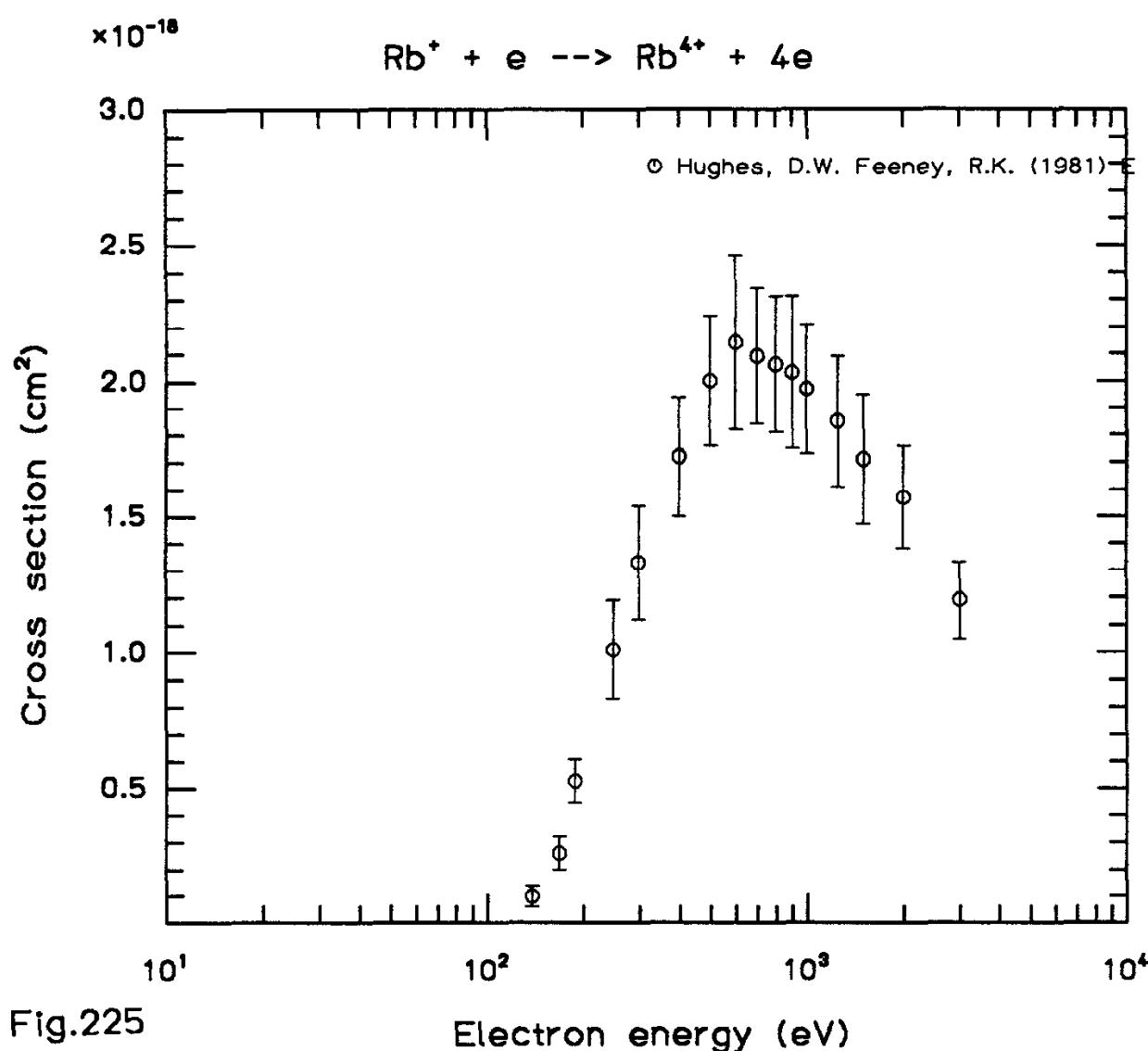


Fig.225

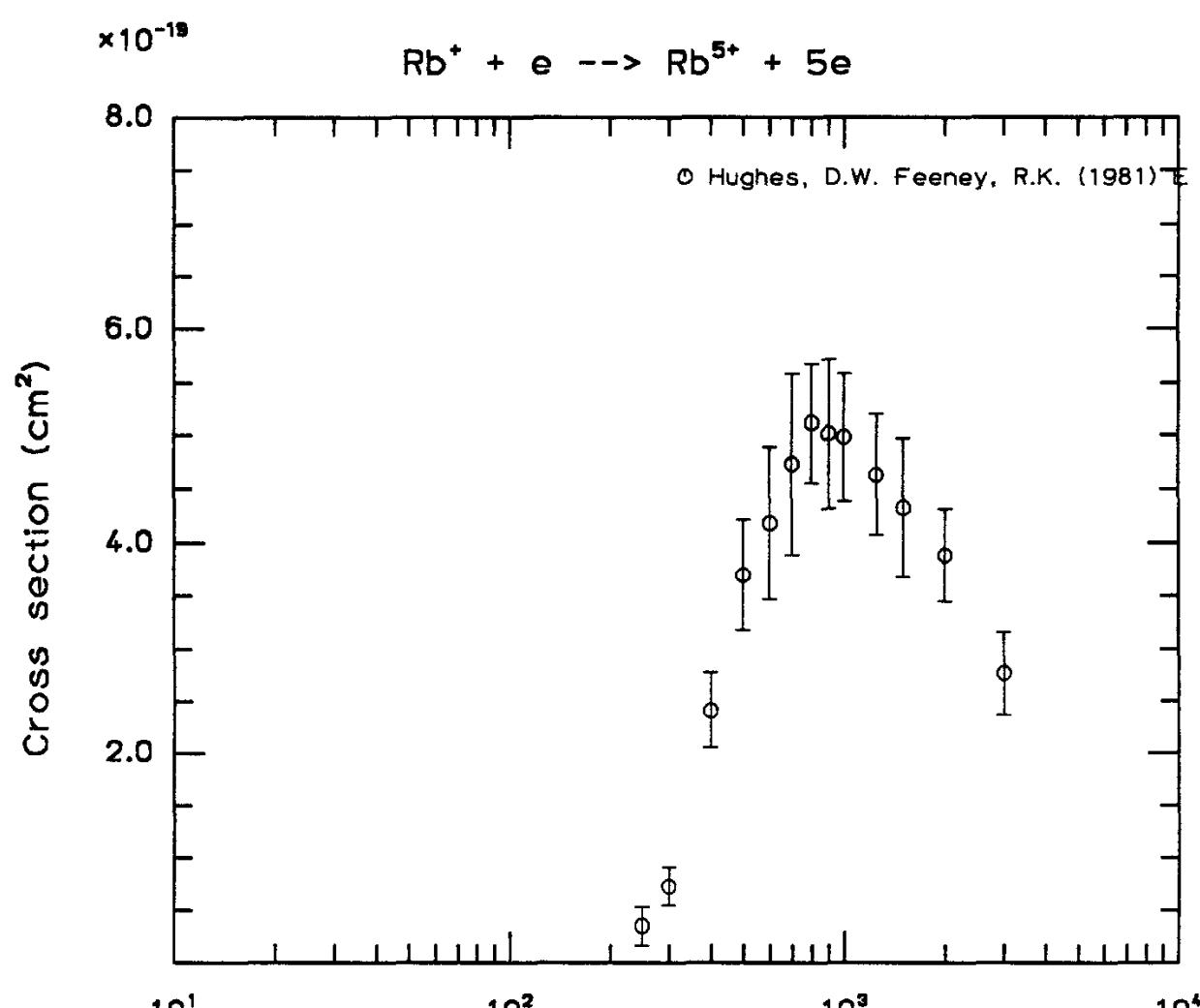


Fig.226

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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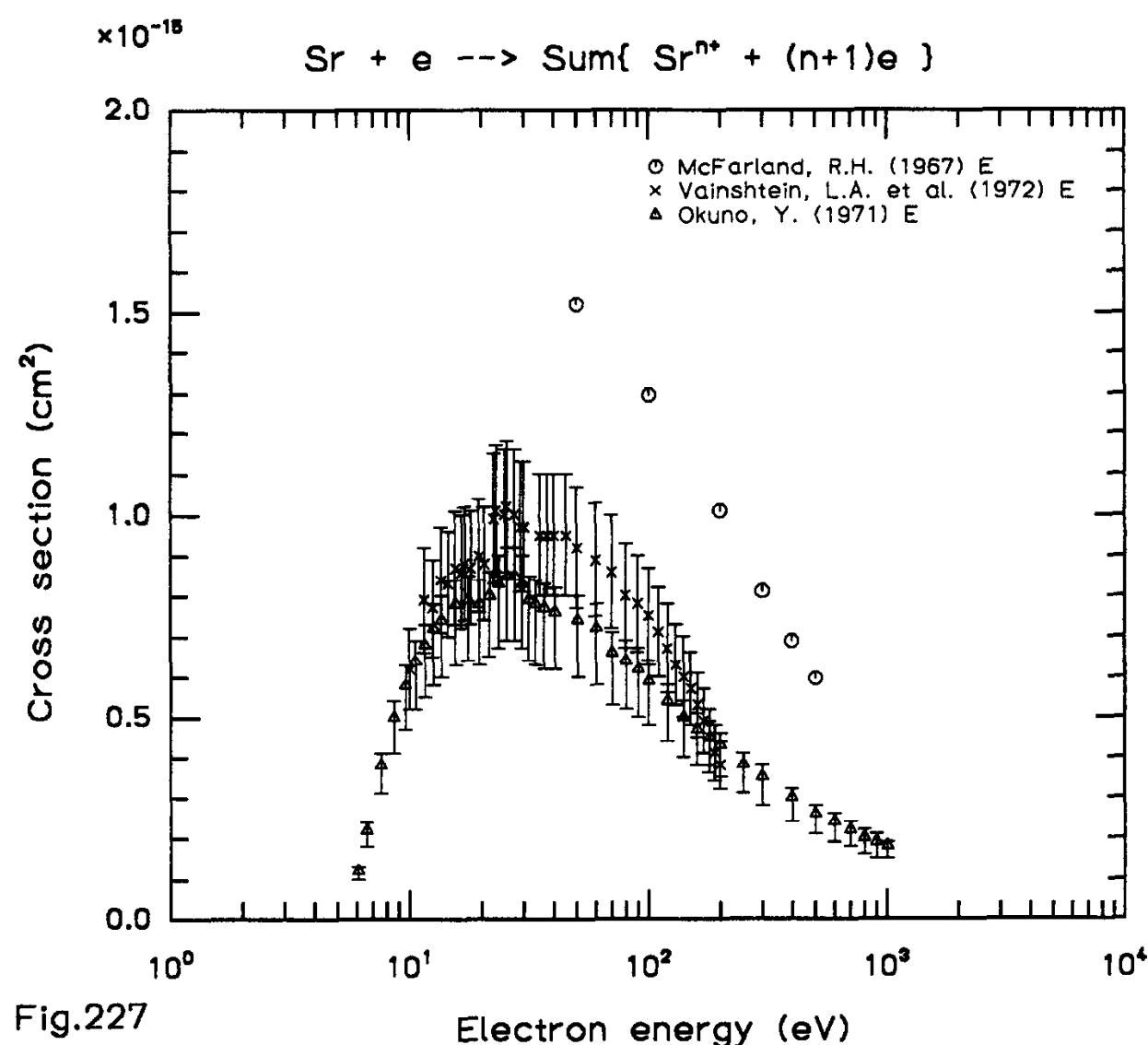


Fig.227

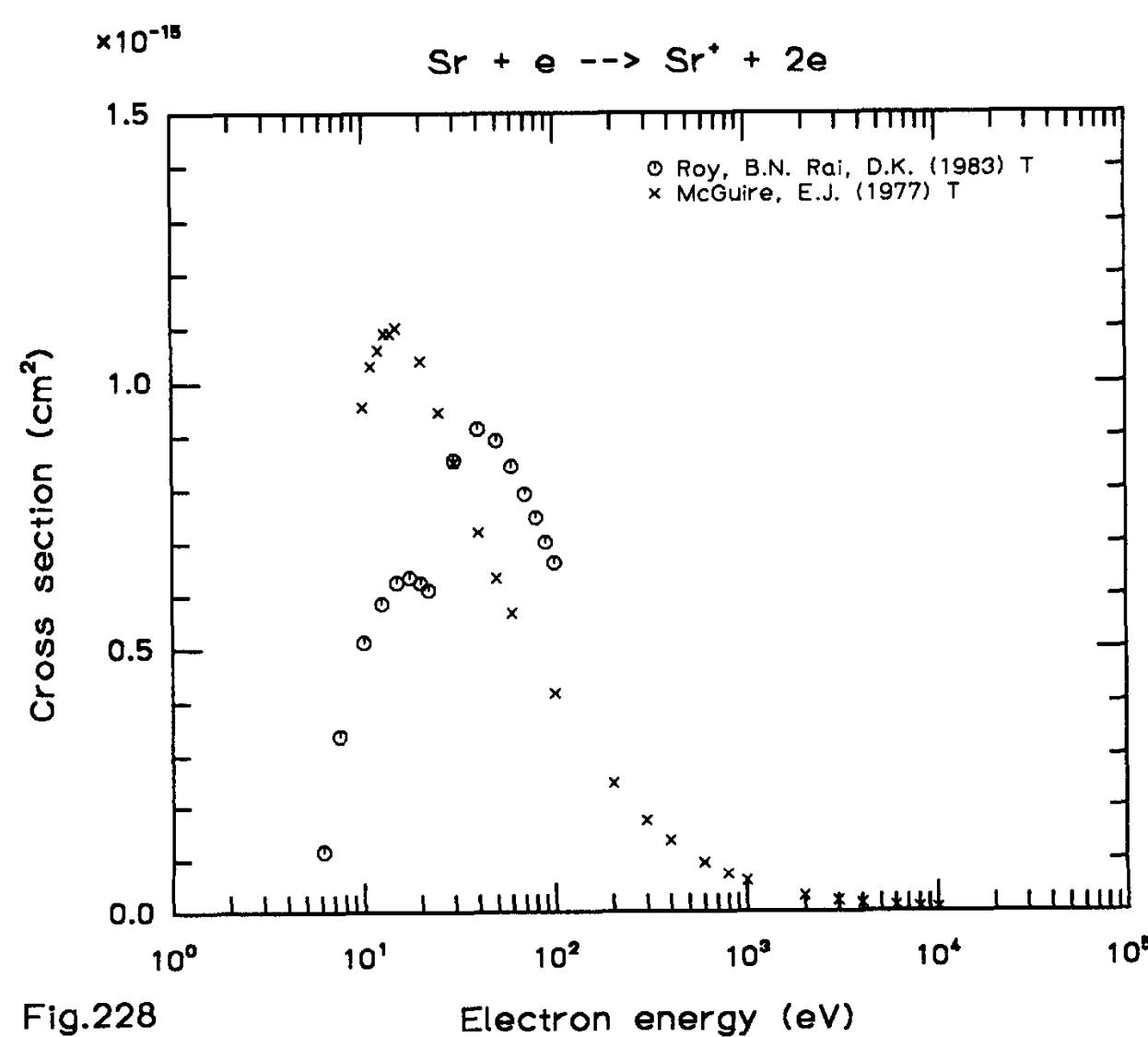


Fig.228

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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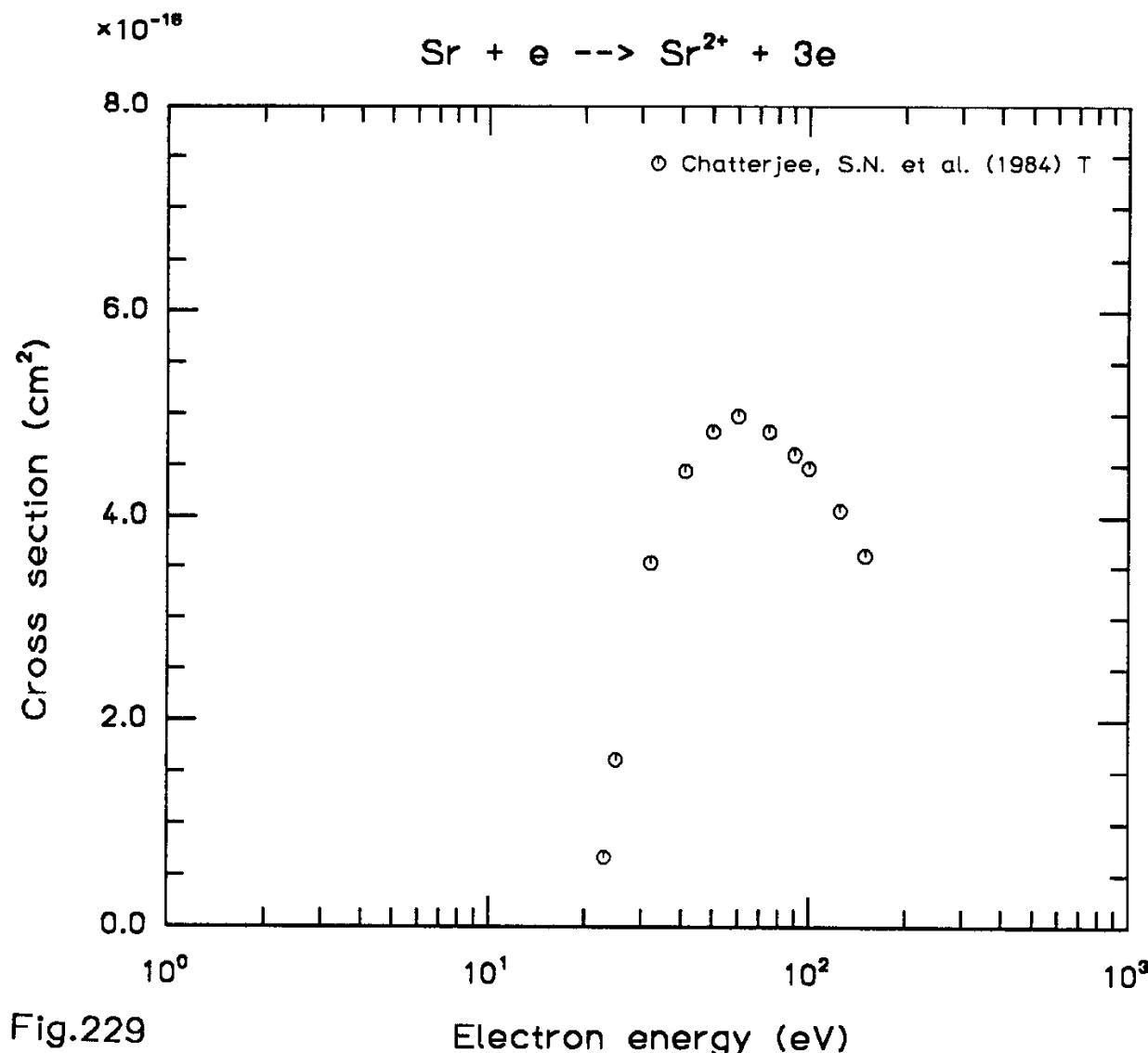


Fig.229

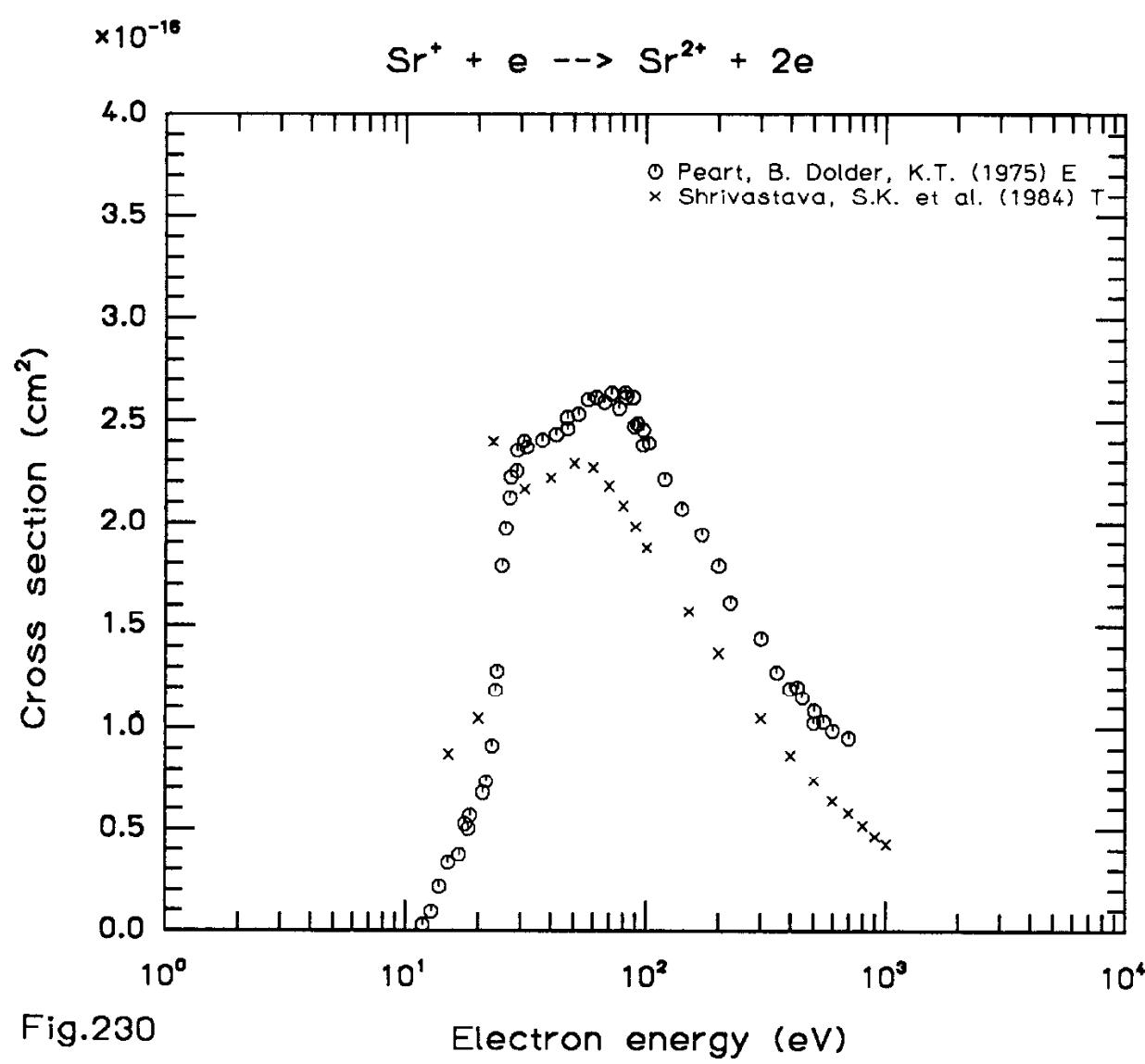
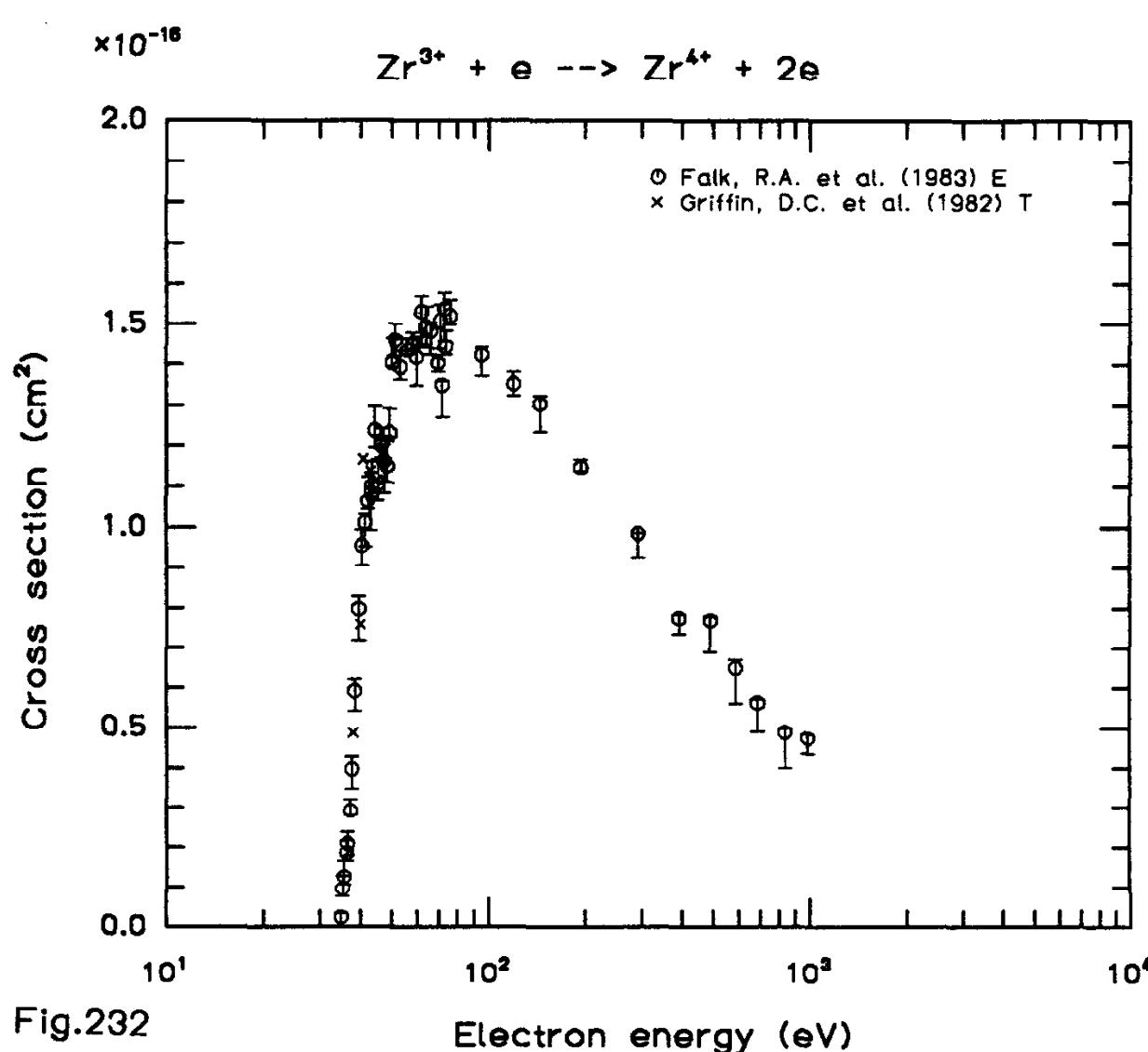
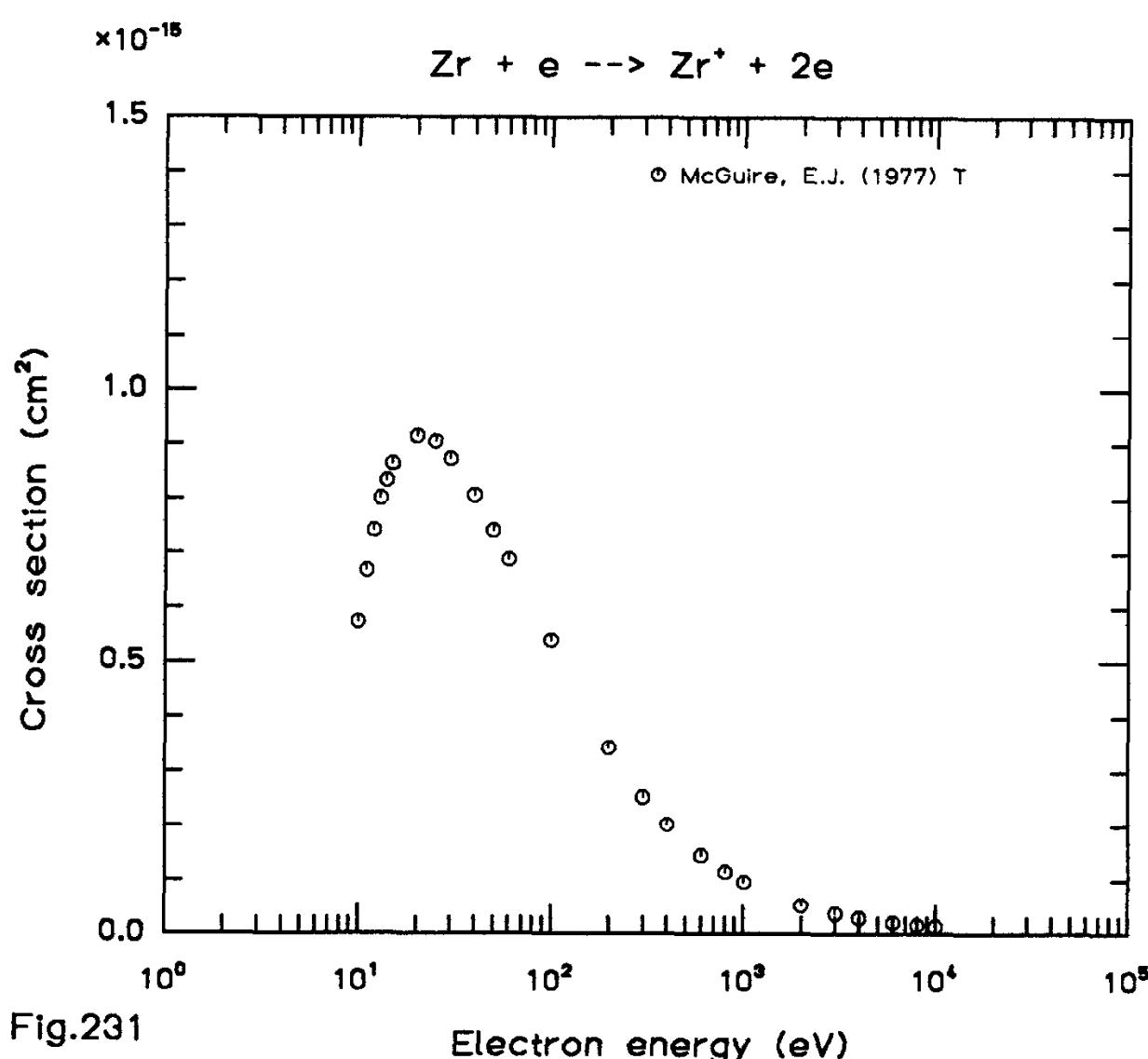


Fig.230

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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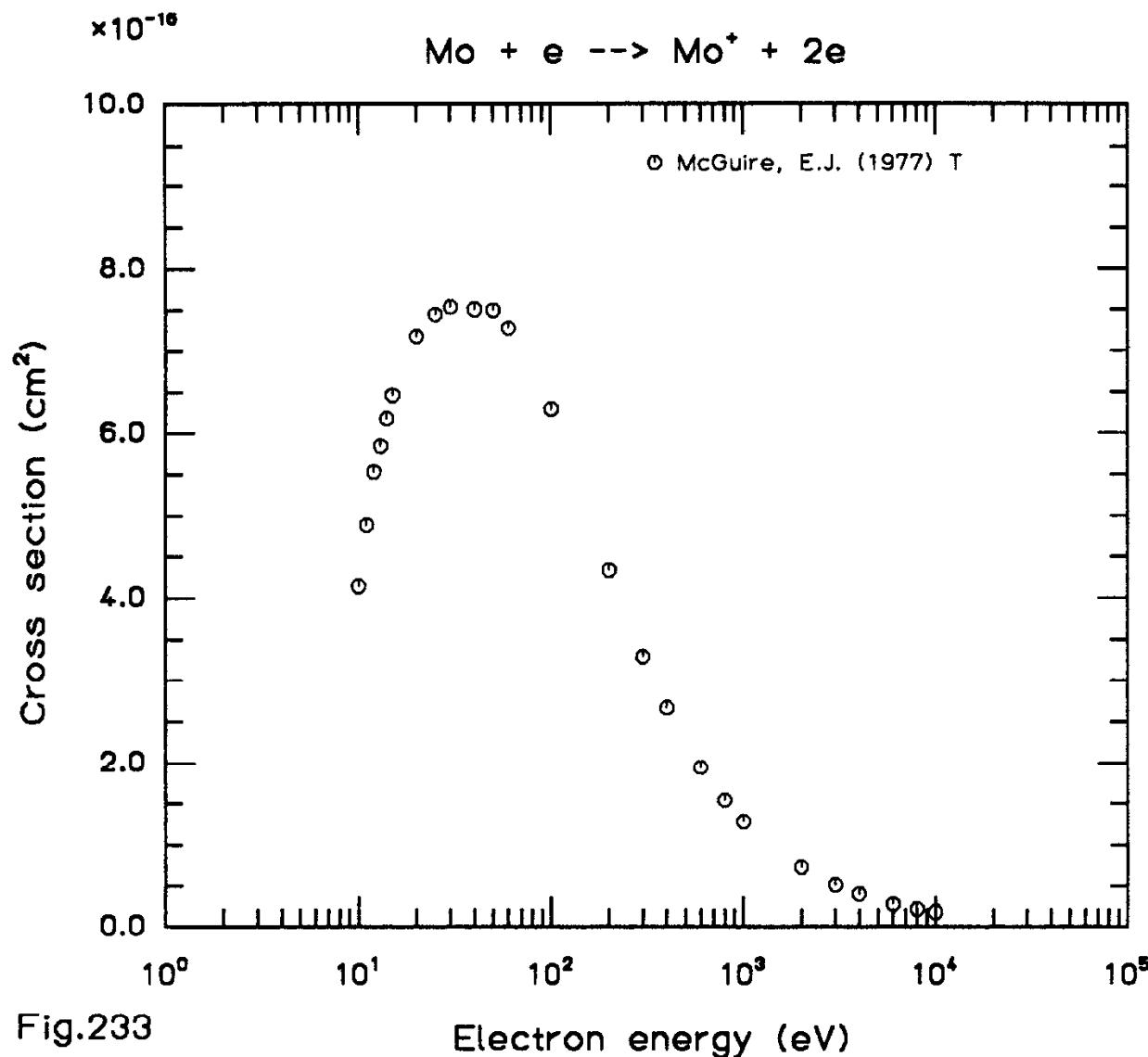


Fig.233

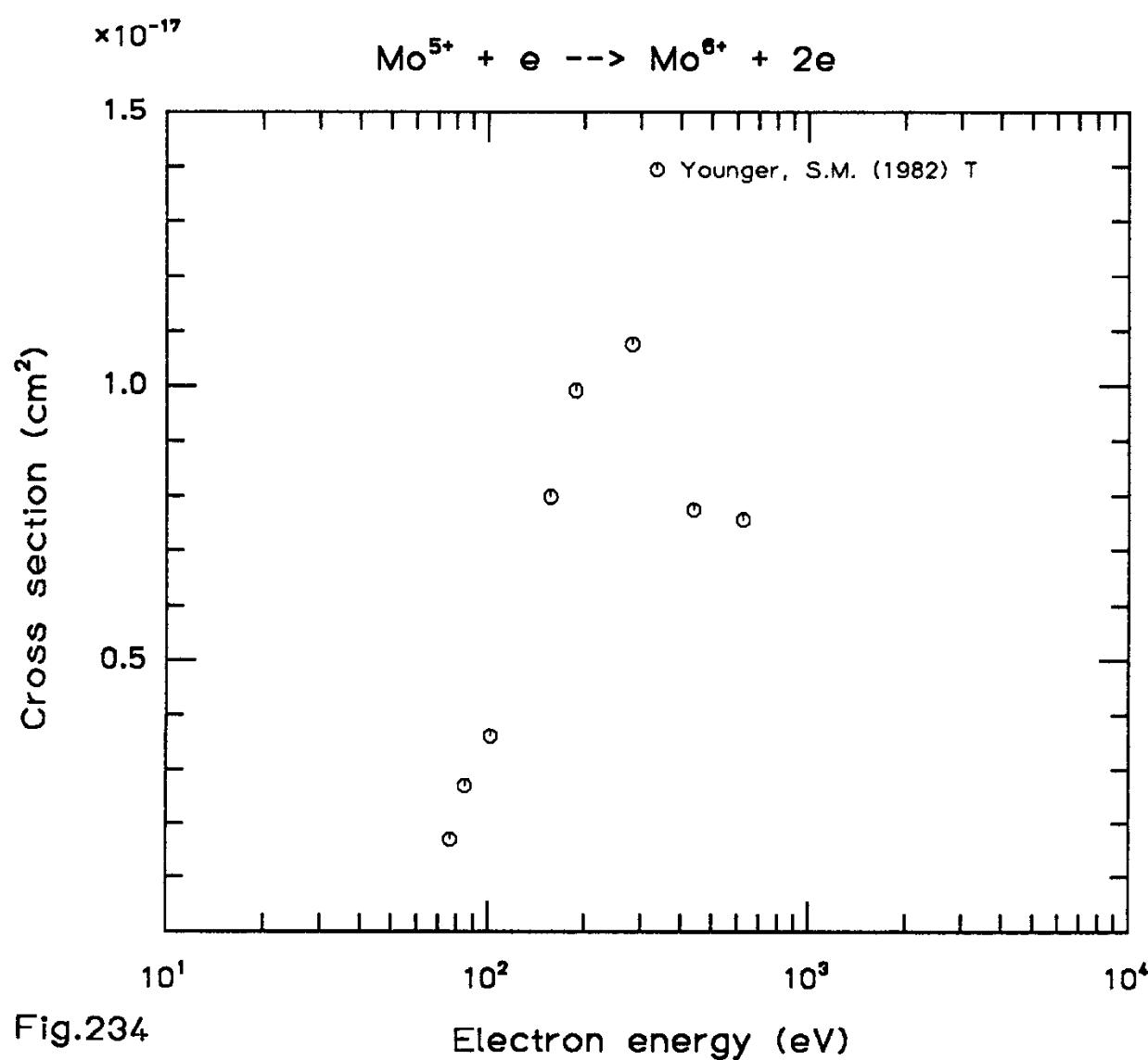


Fig.234

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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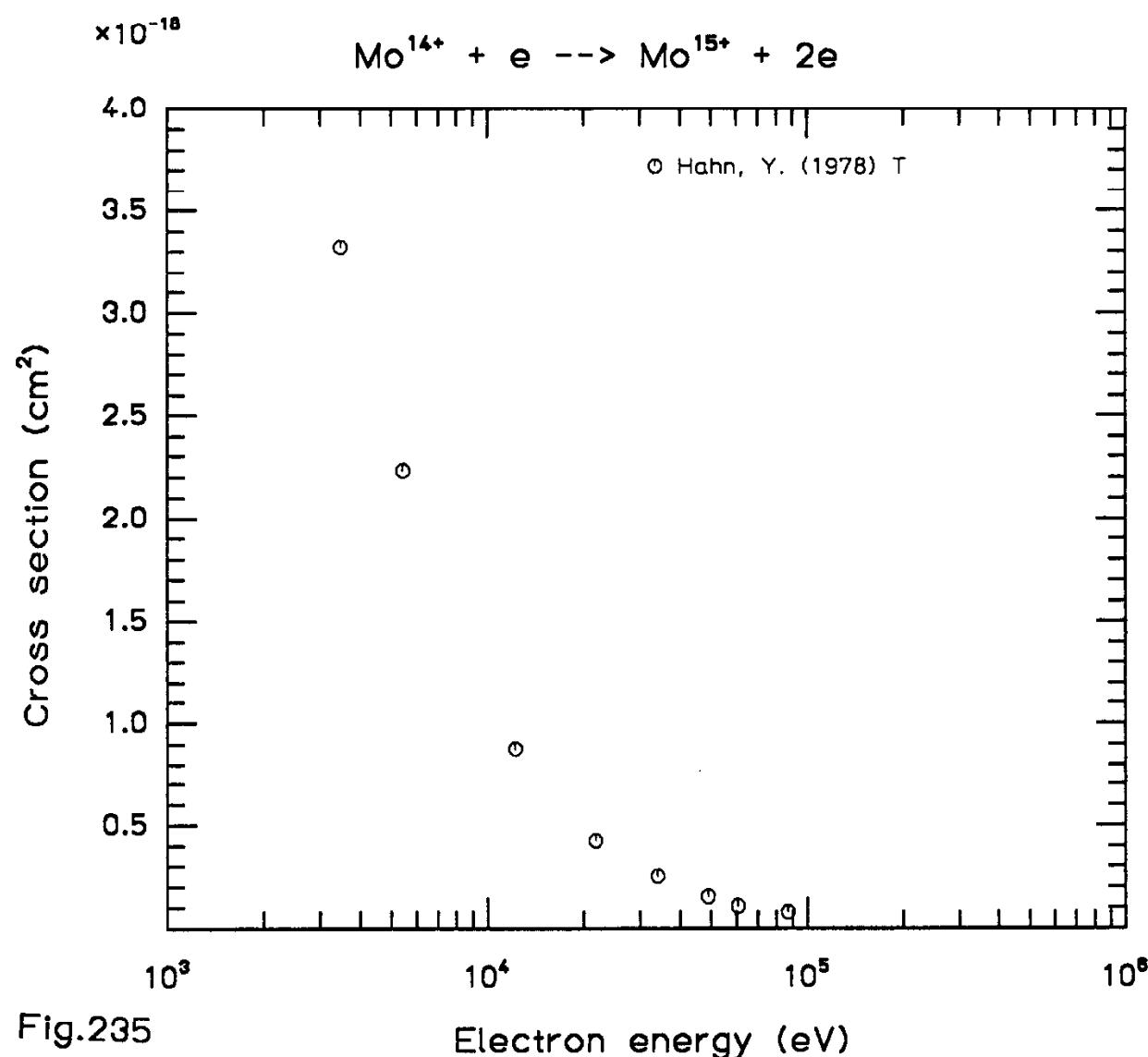


Fig.235

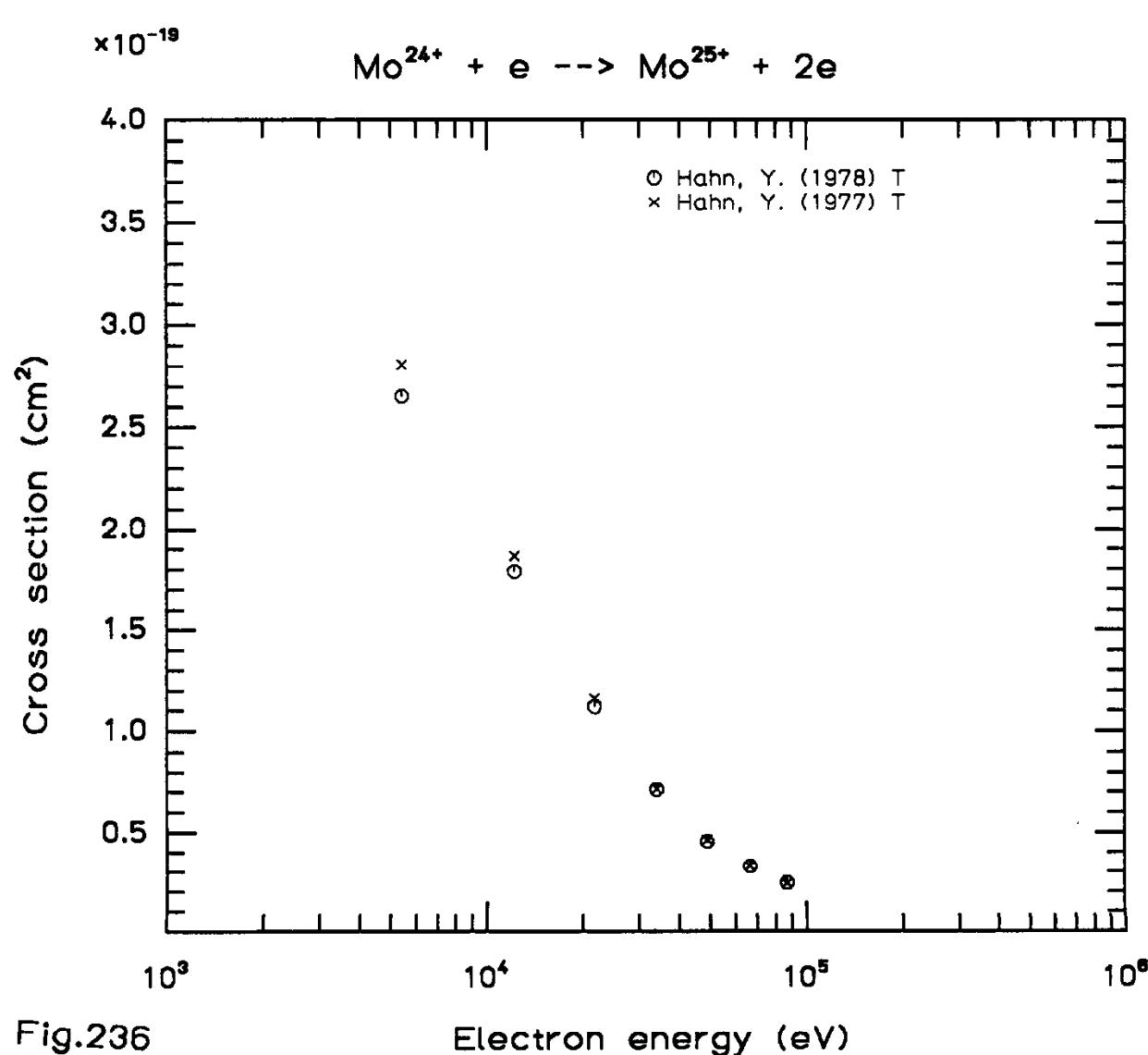


Fig.236

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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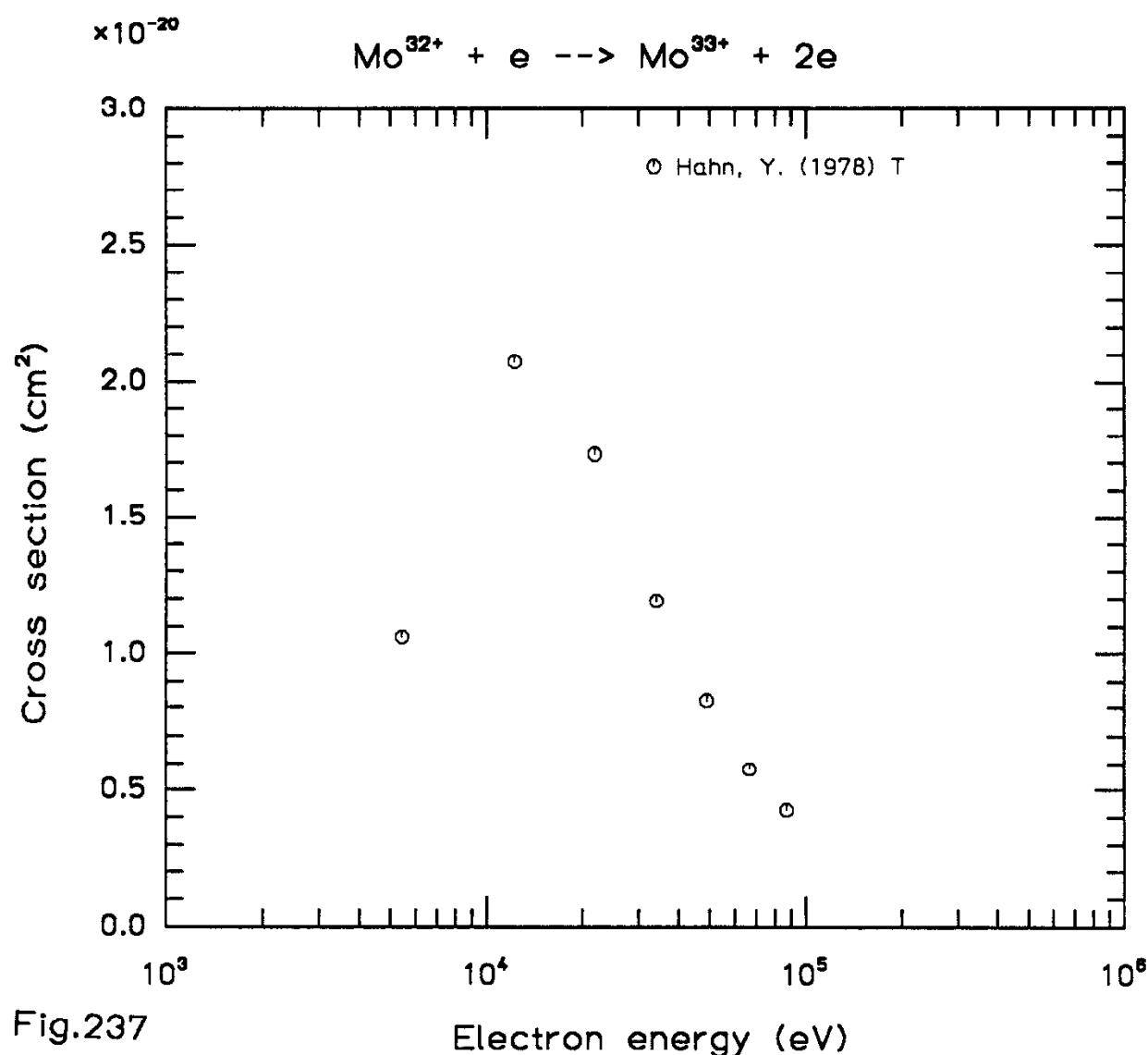


Fig.237

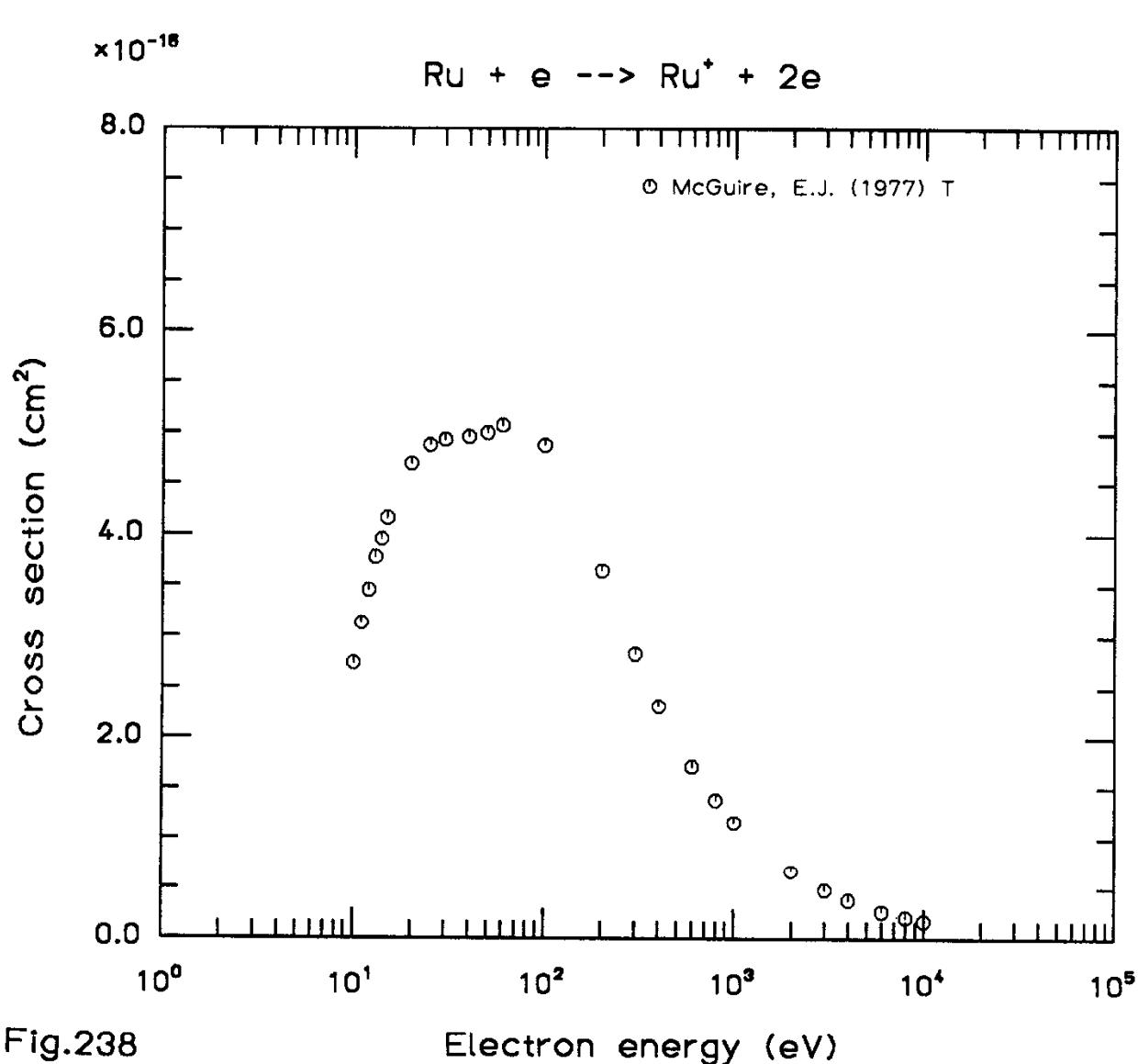


Fig.238

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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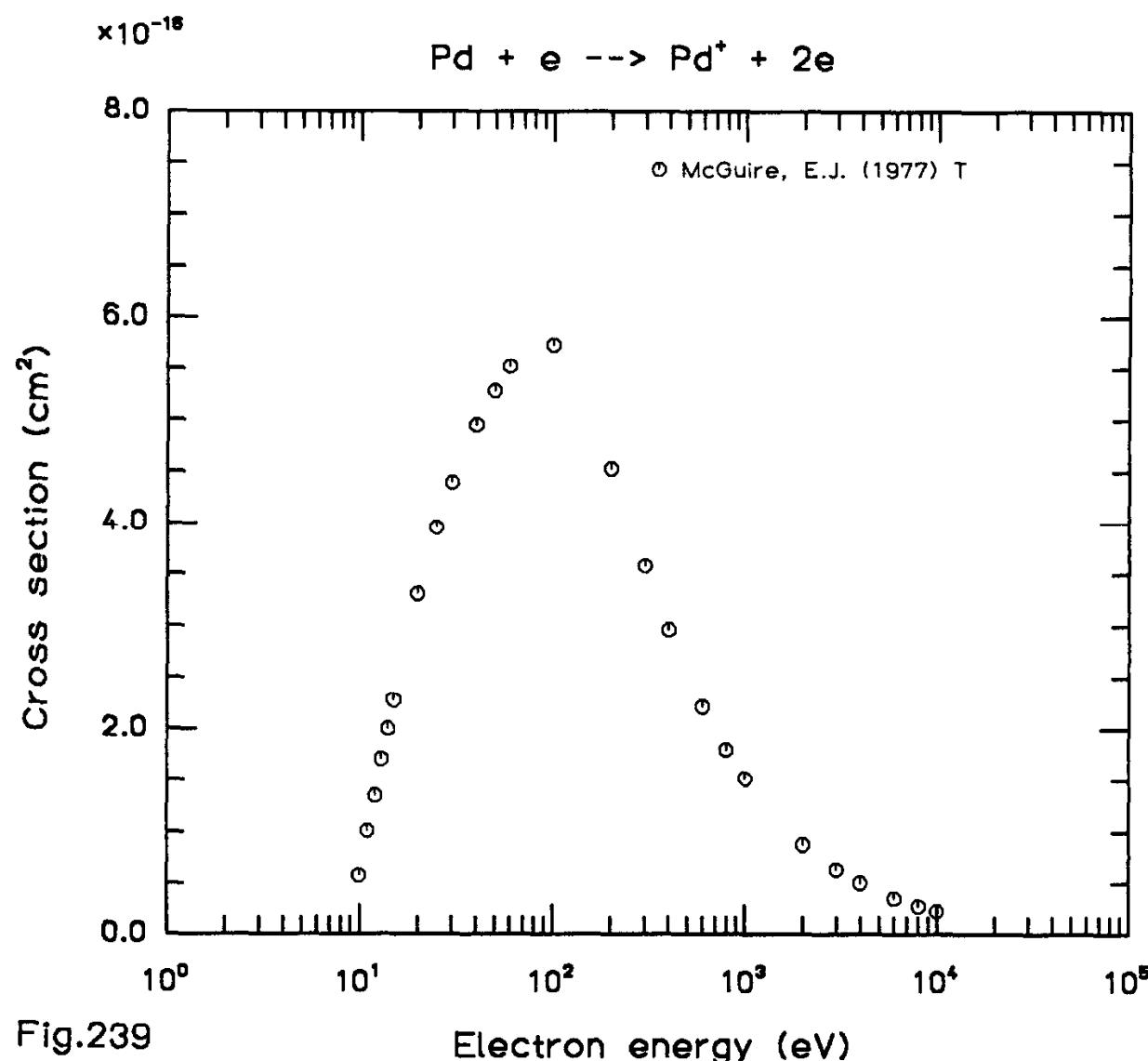


Fig.239

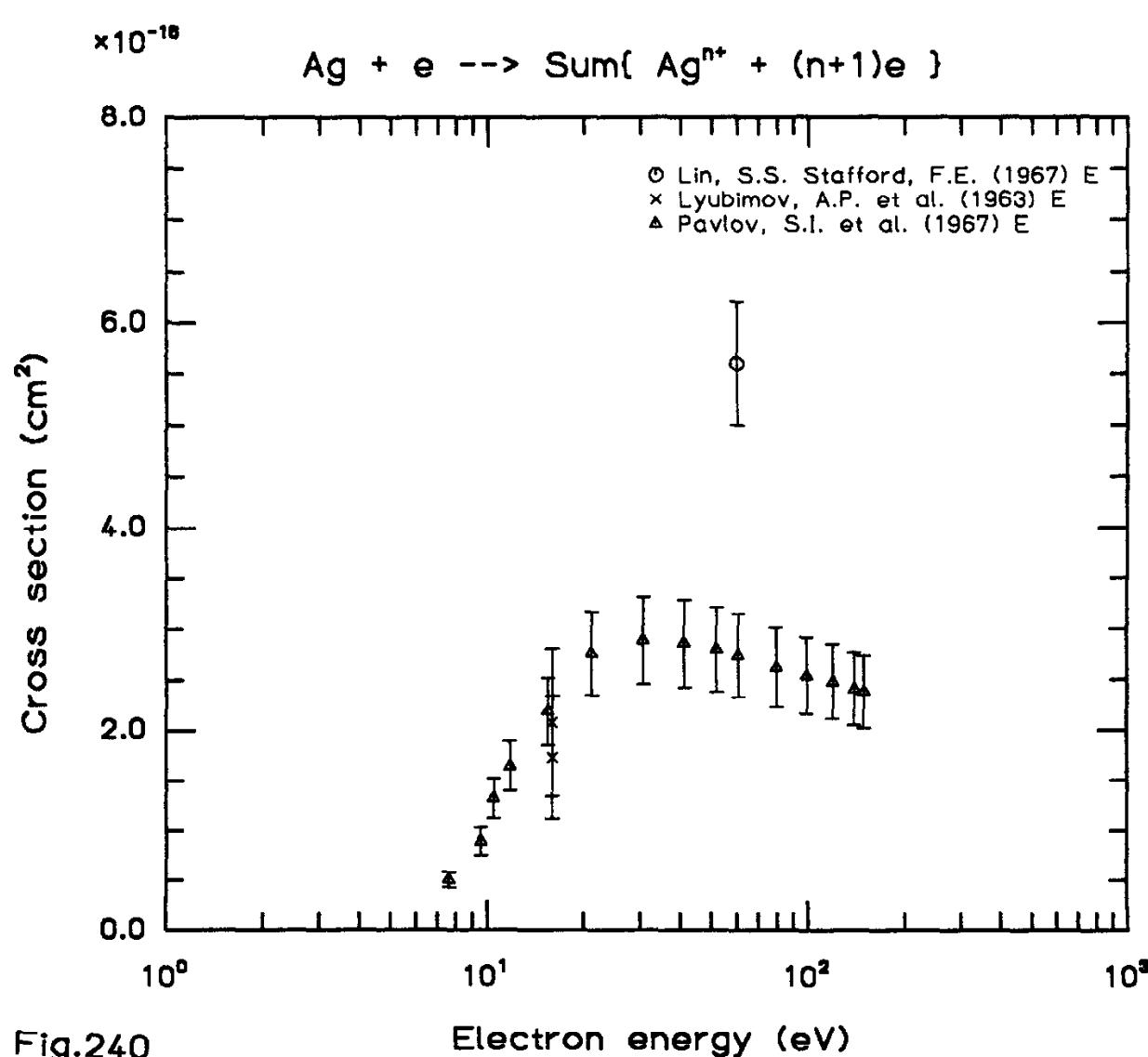


Fig.240

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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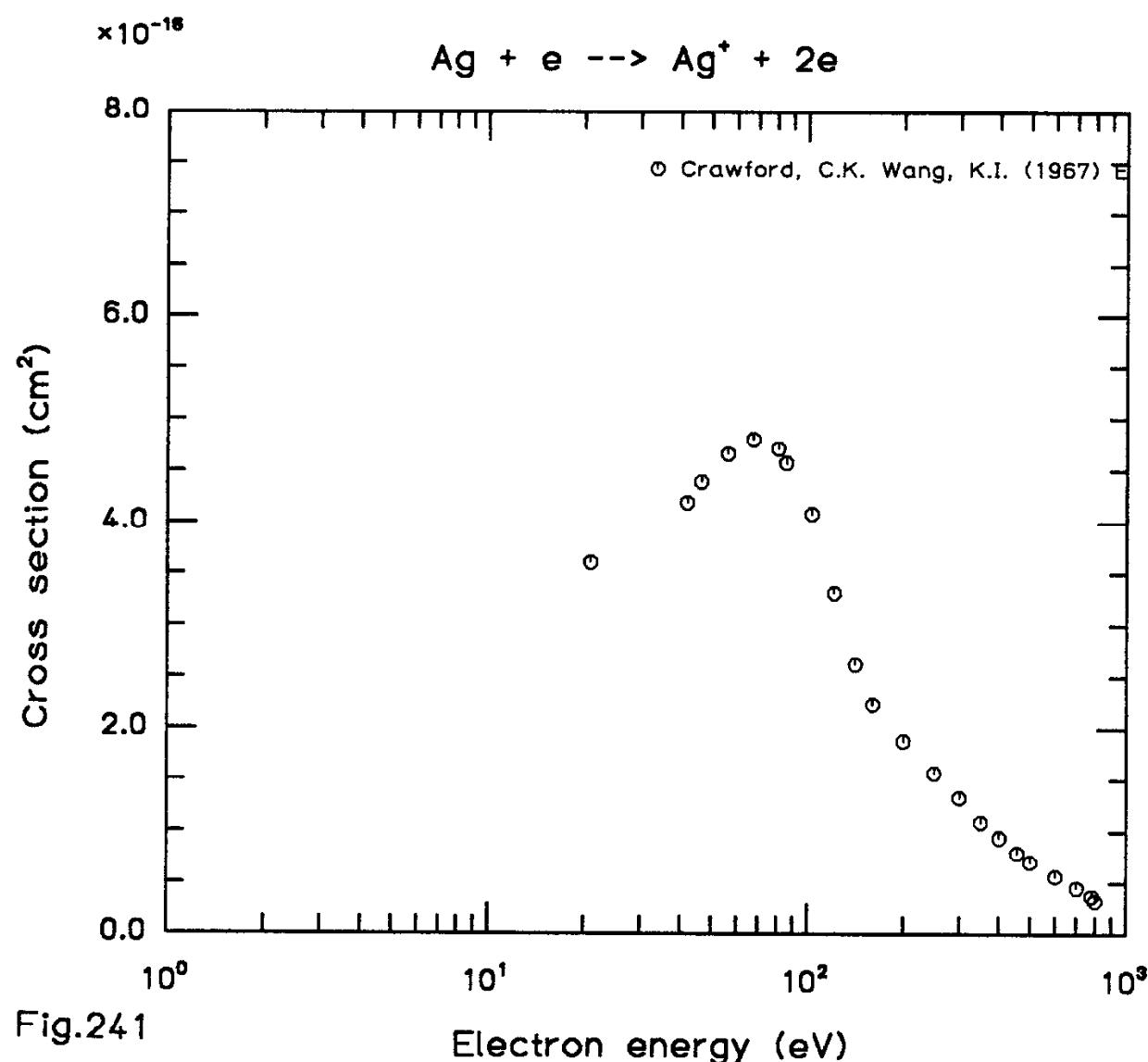


Fig.241

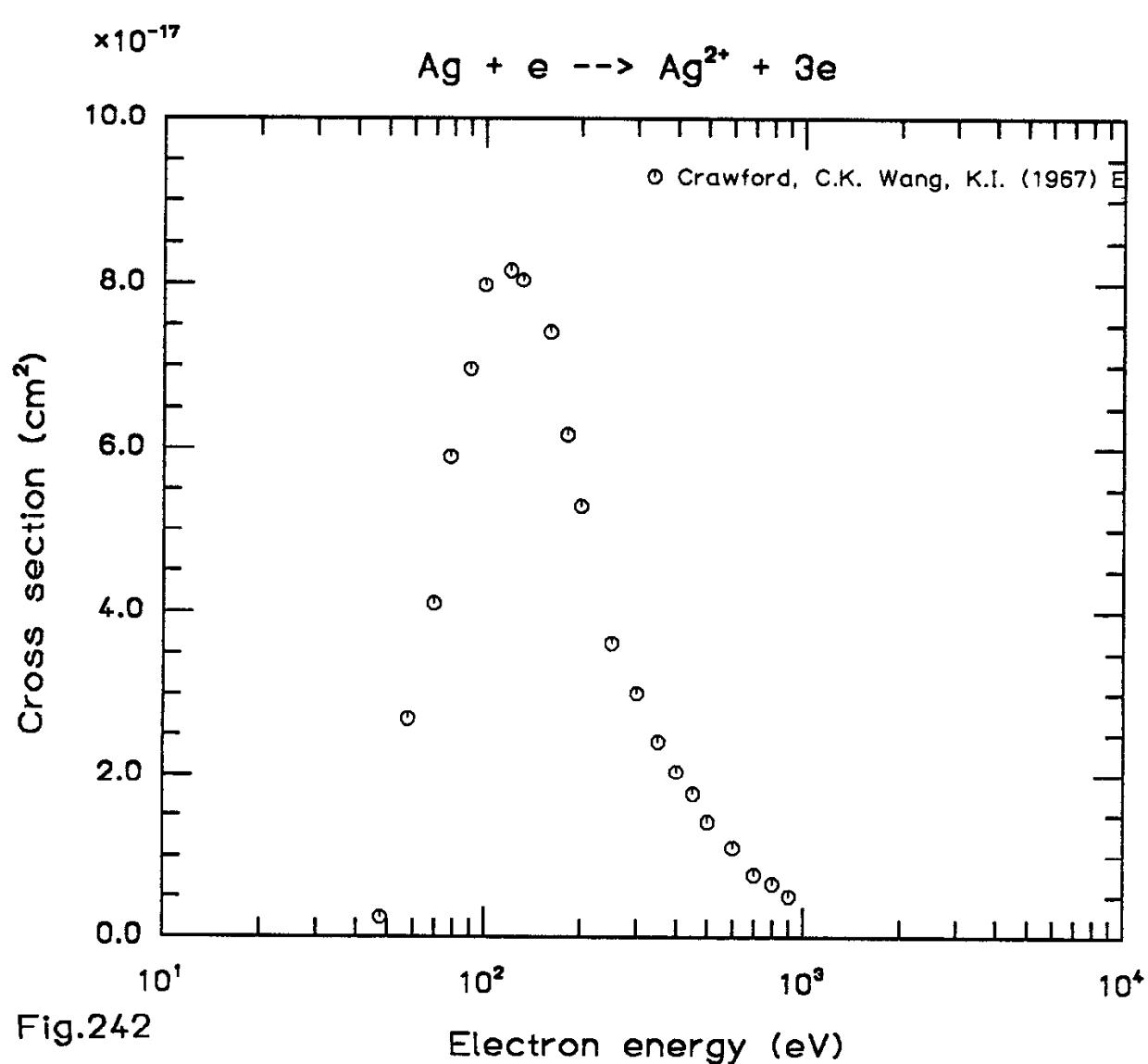


Fig.242

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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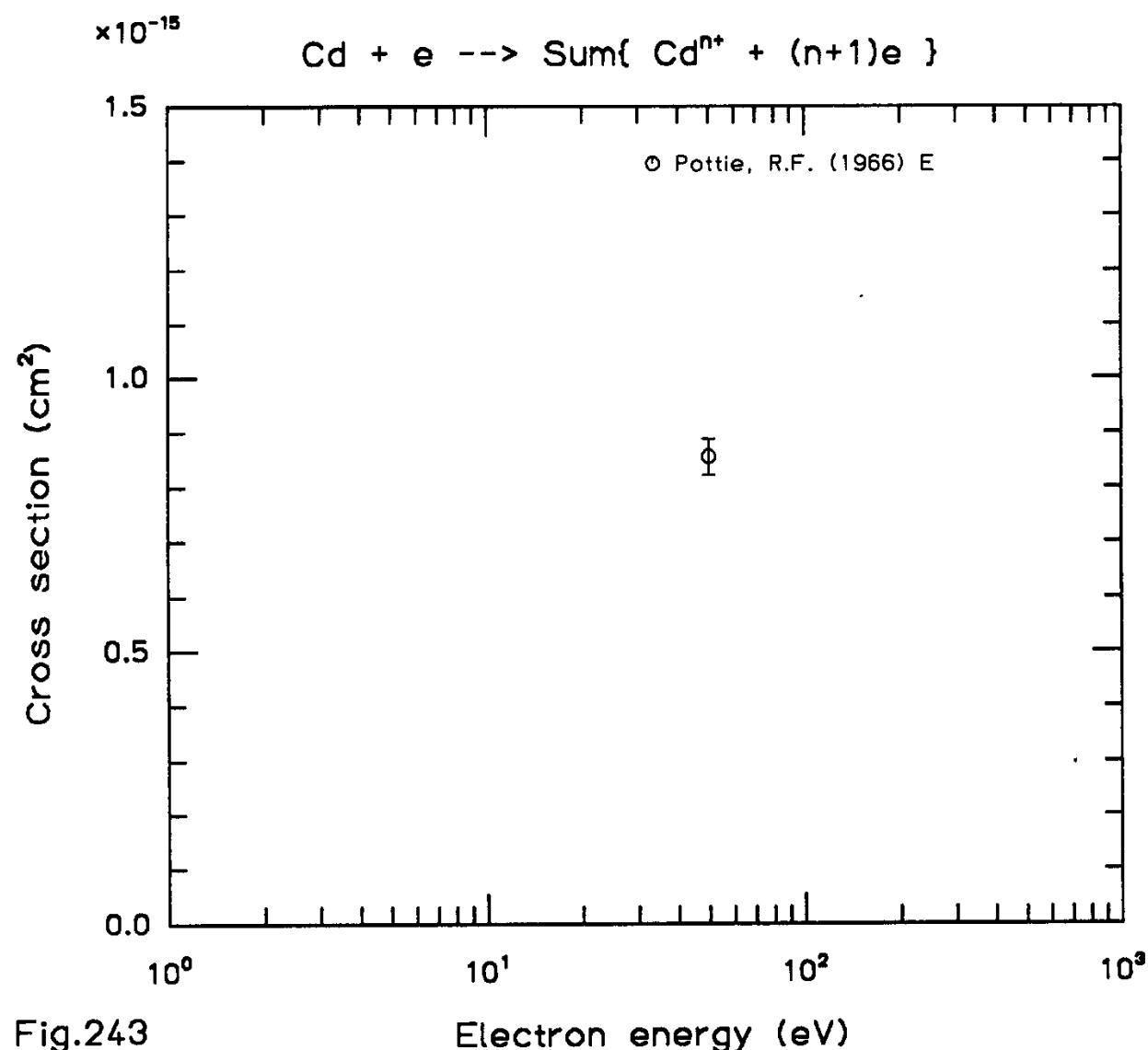


Fig.243

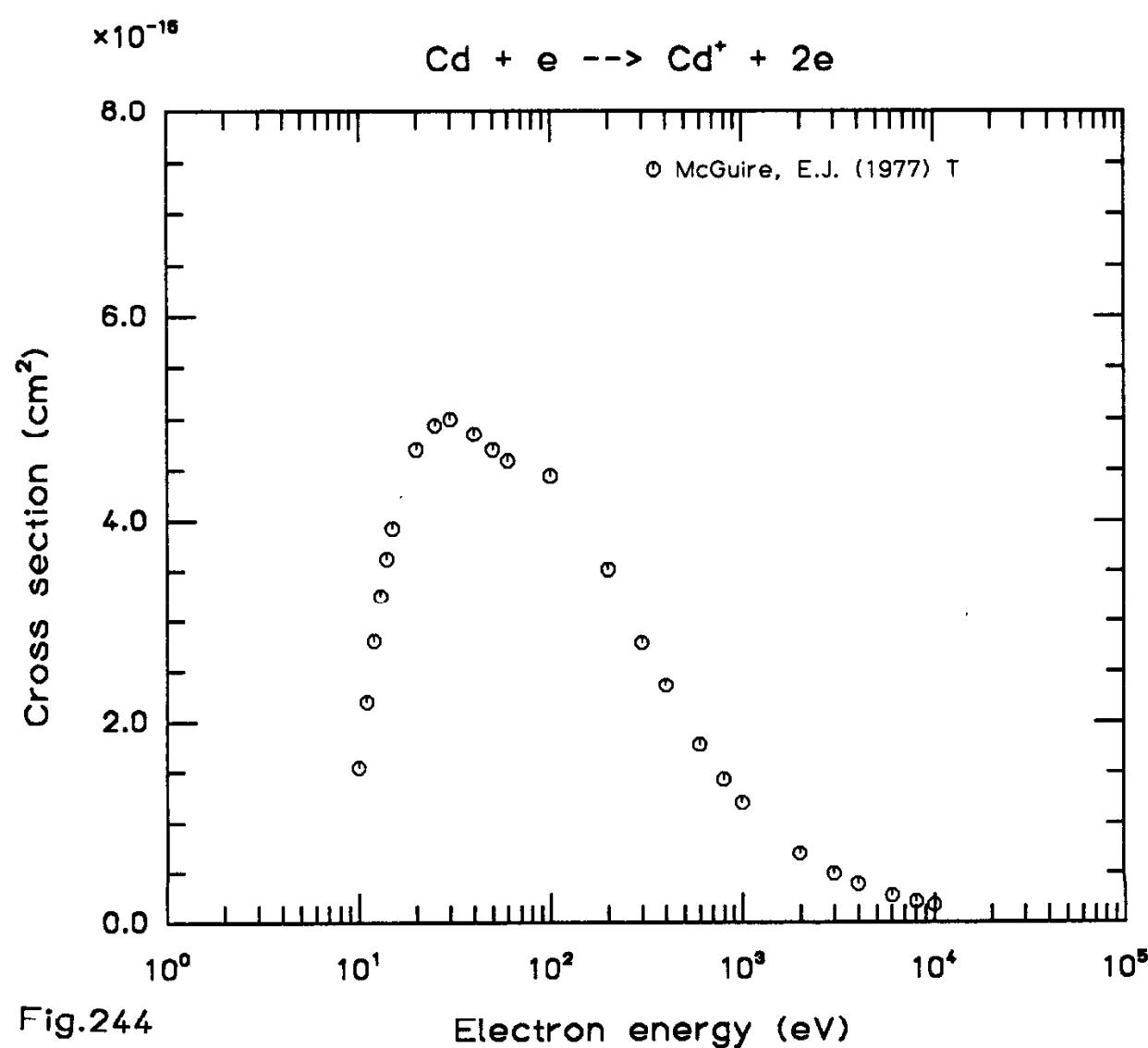


Fig.244

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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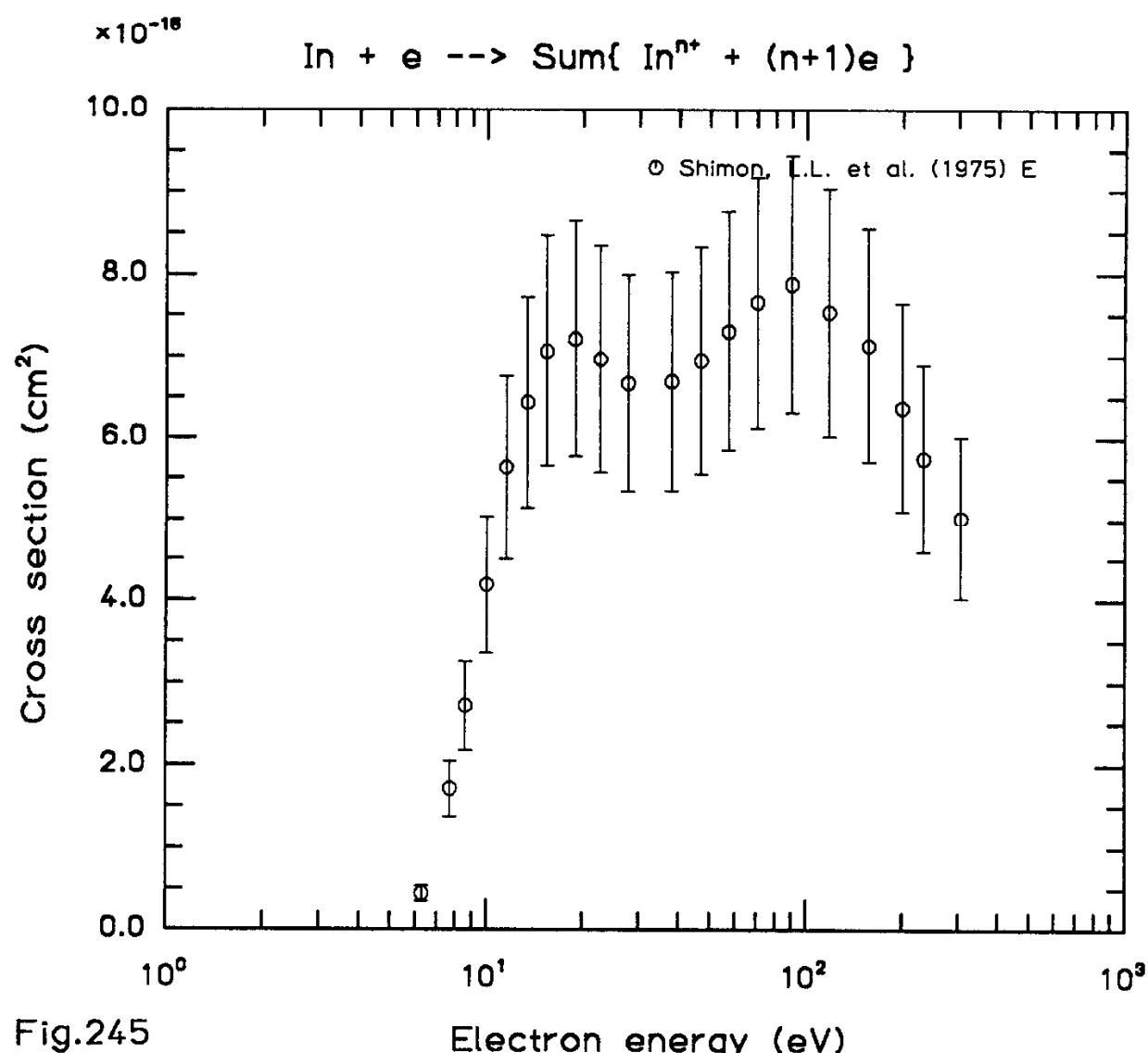


Fig.245

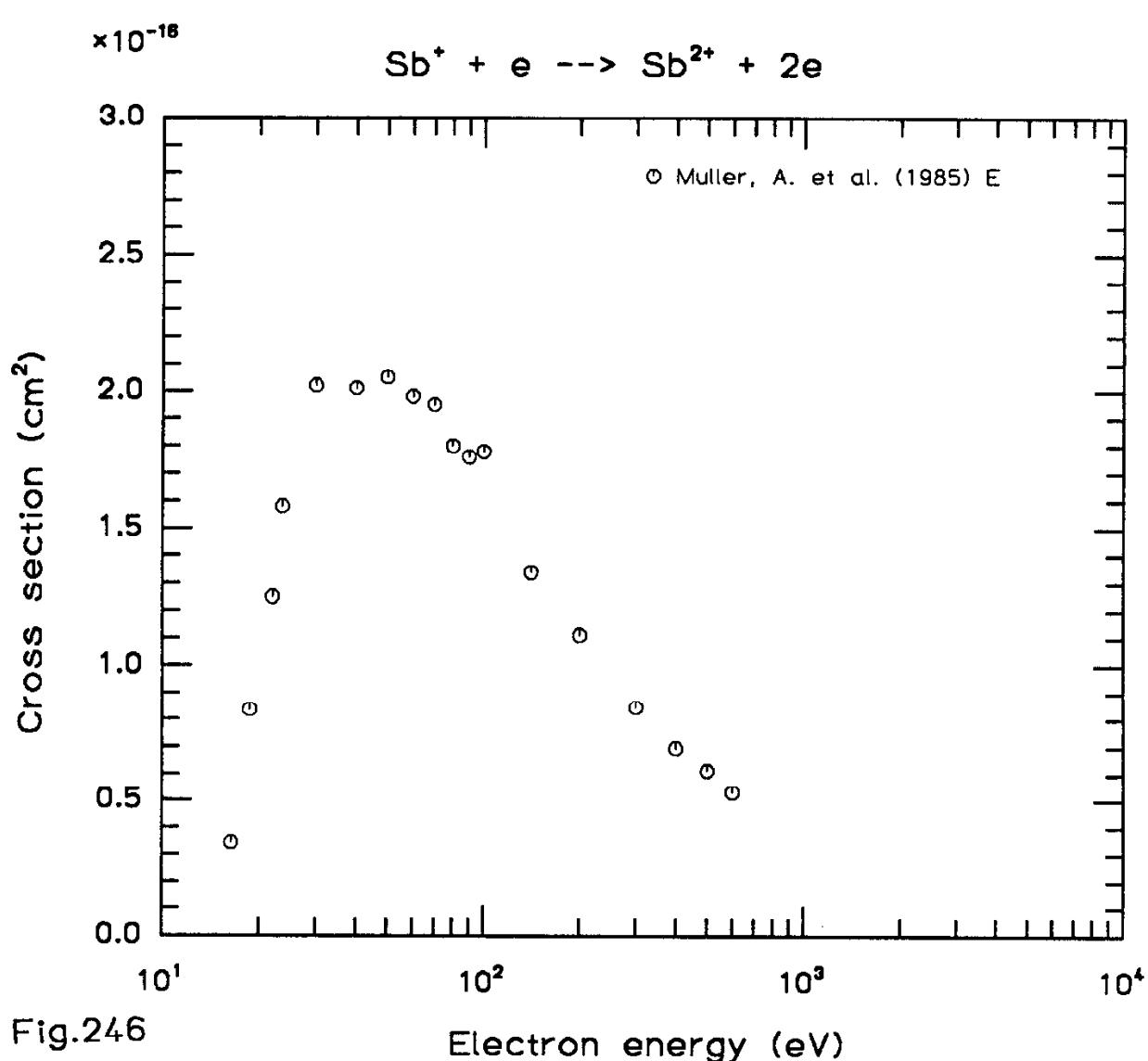
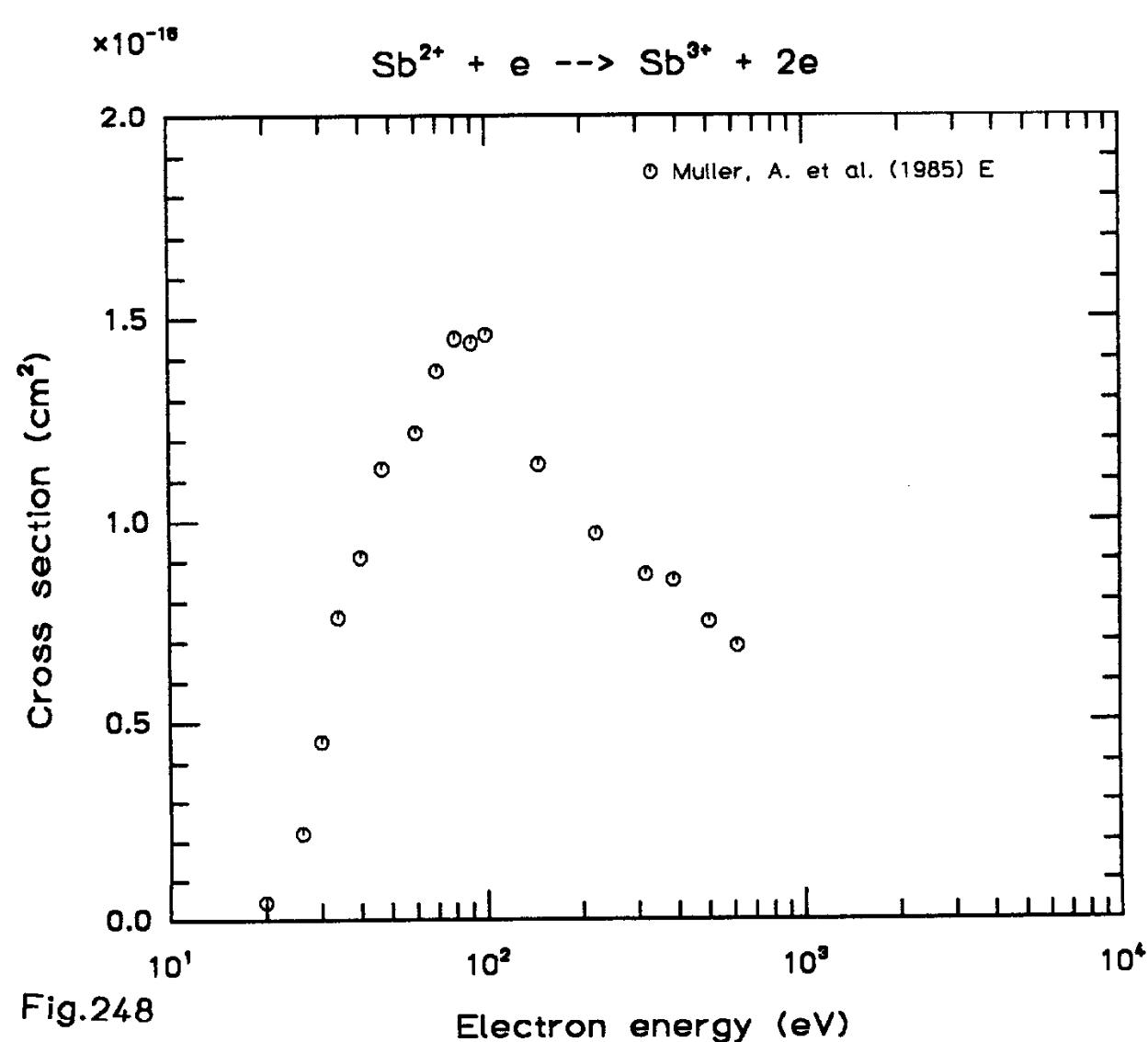
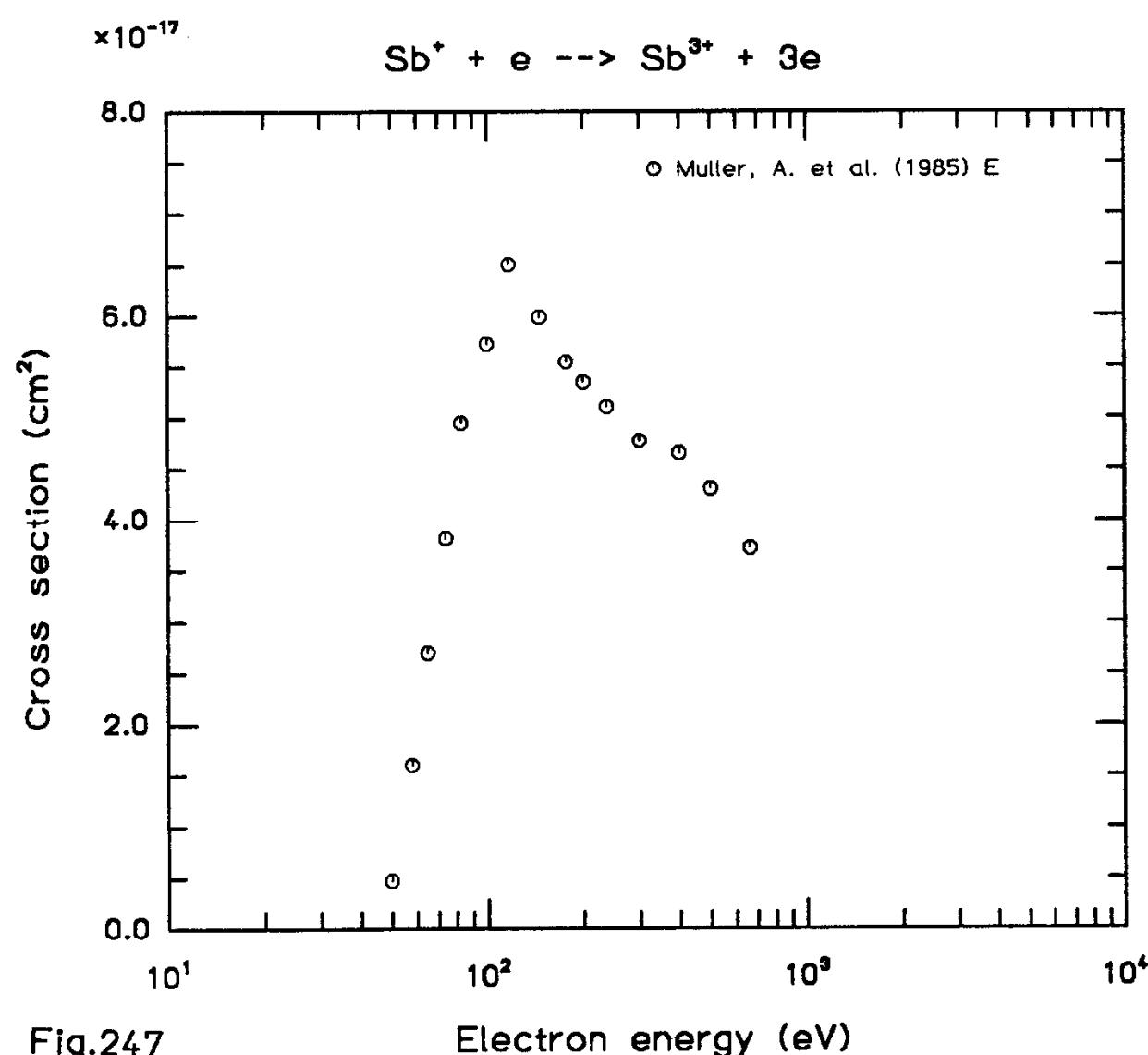
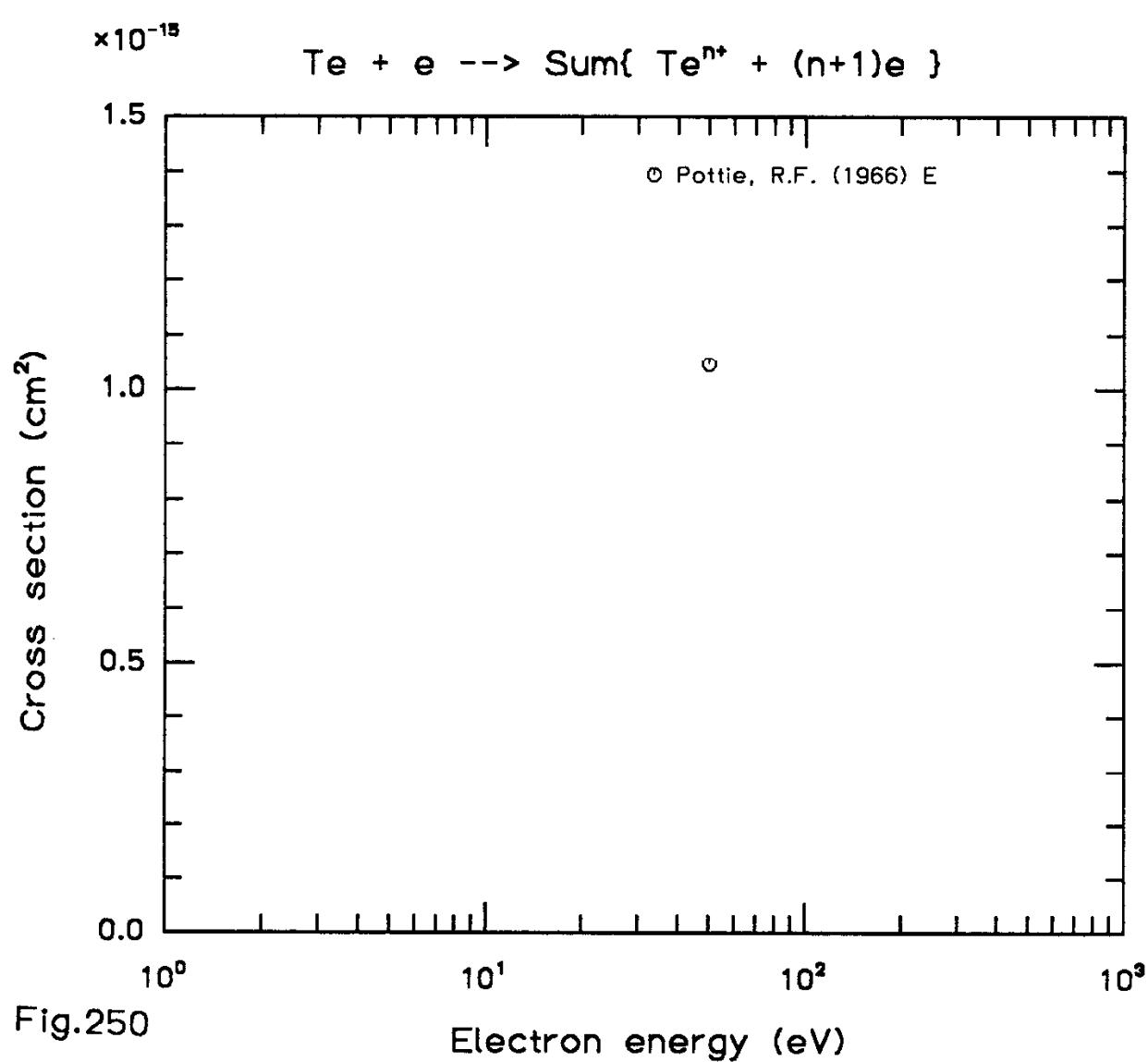
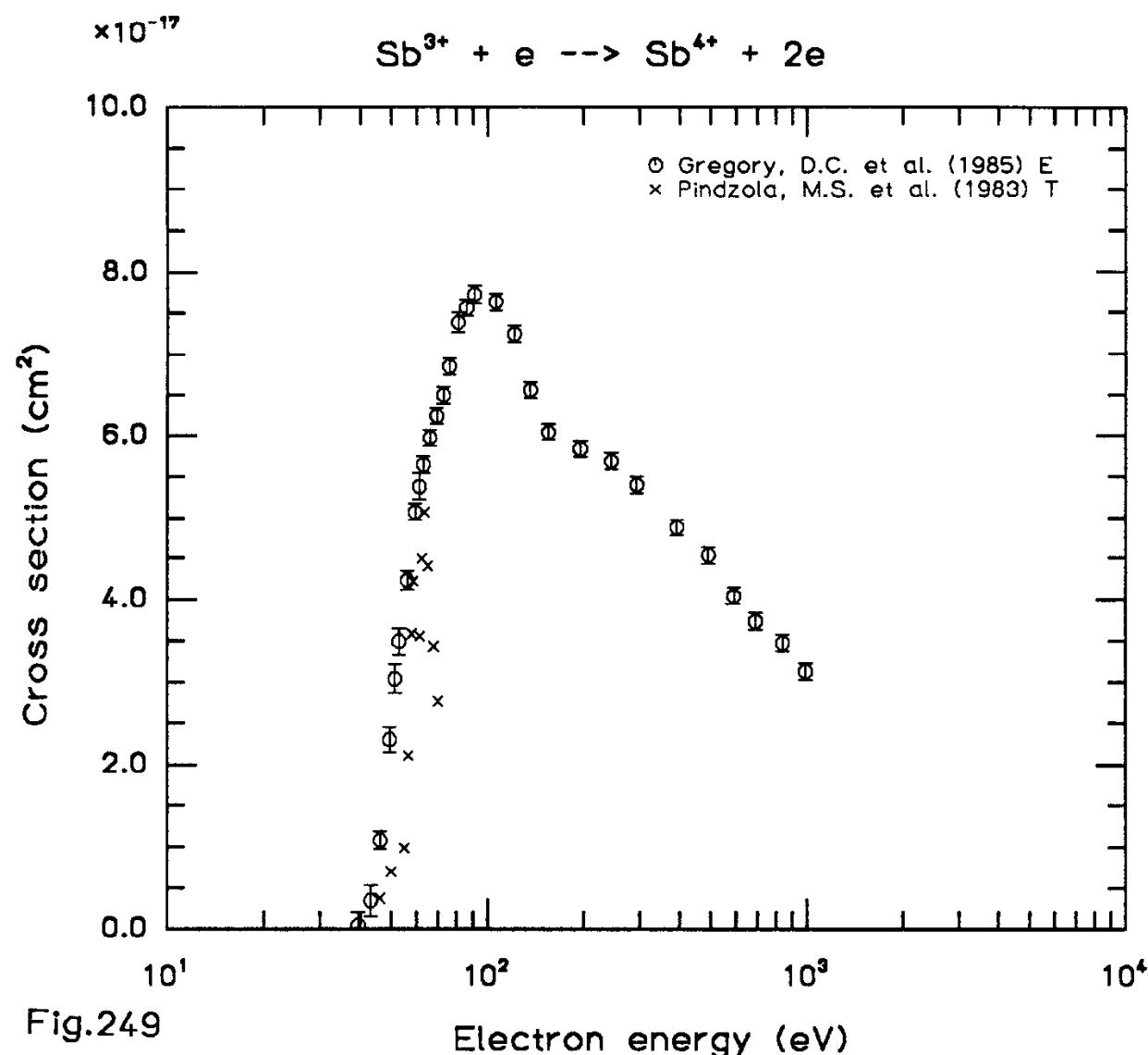


Fig.246

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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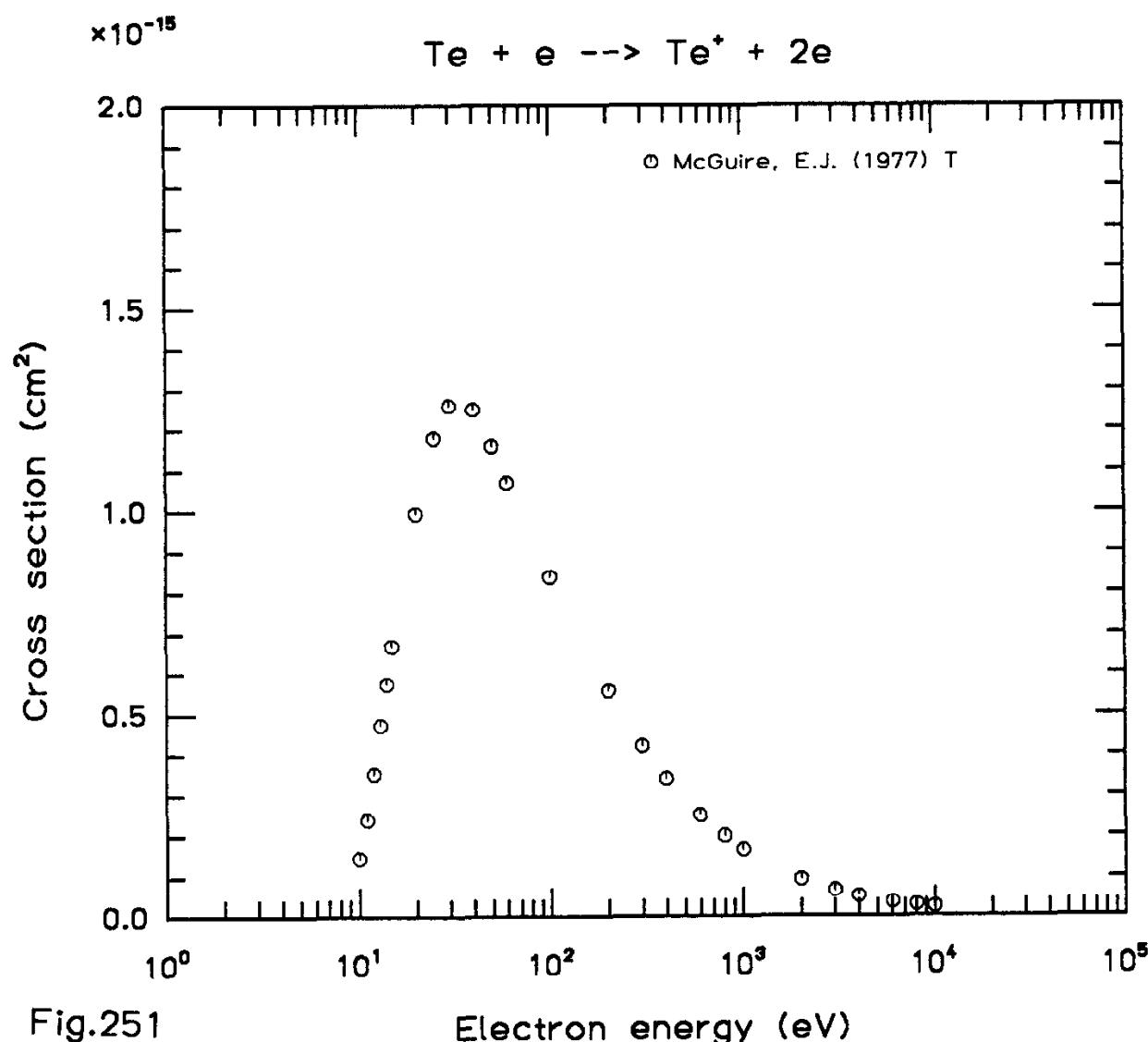


Fig.251

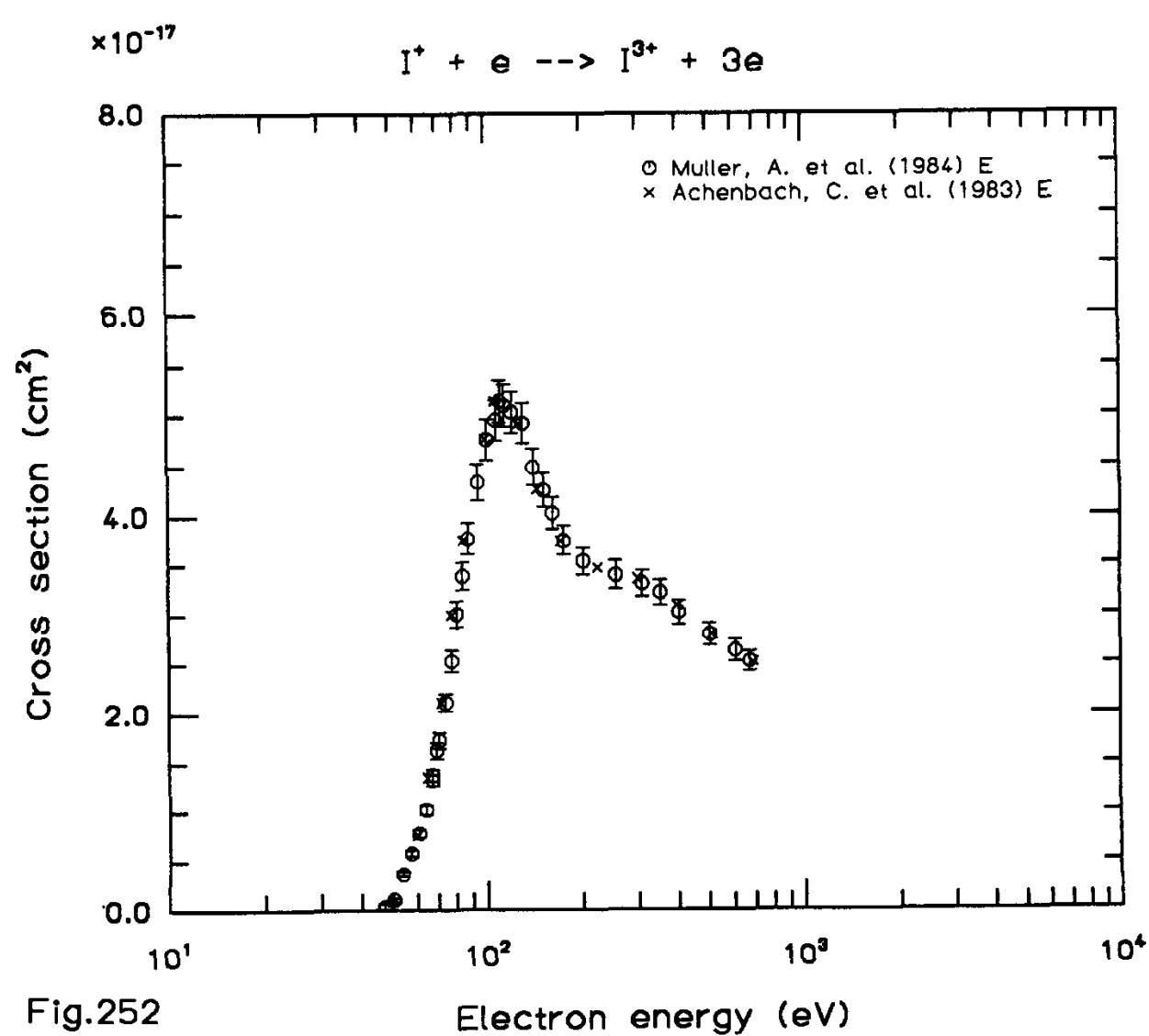


Fig.252

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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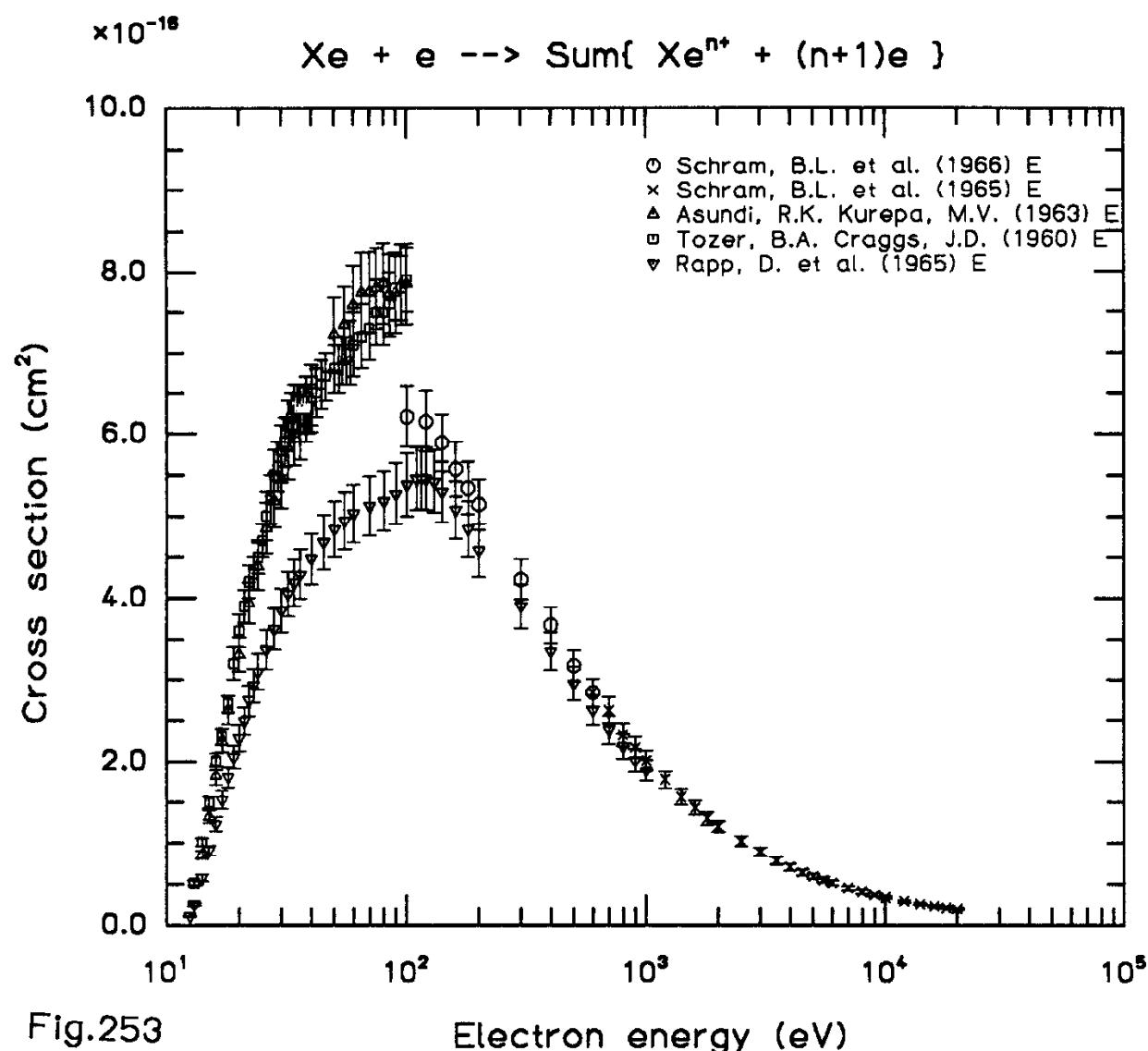


Fig.253

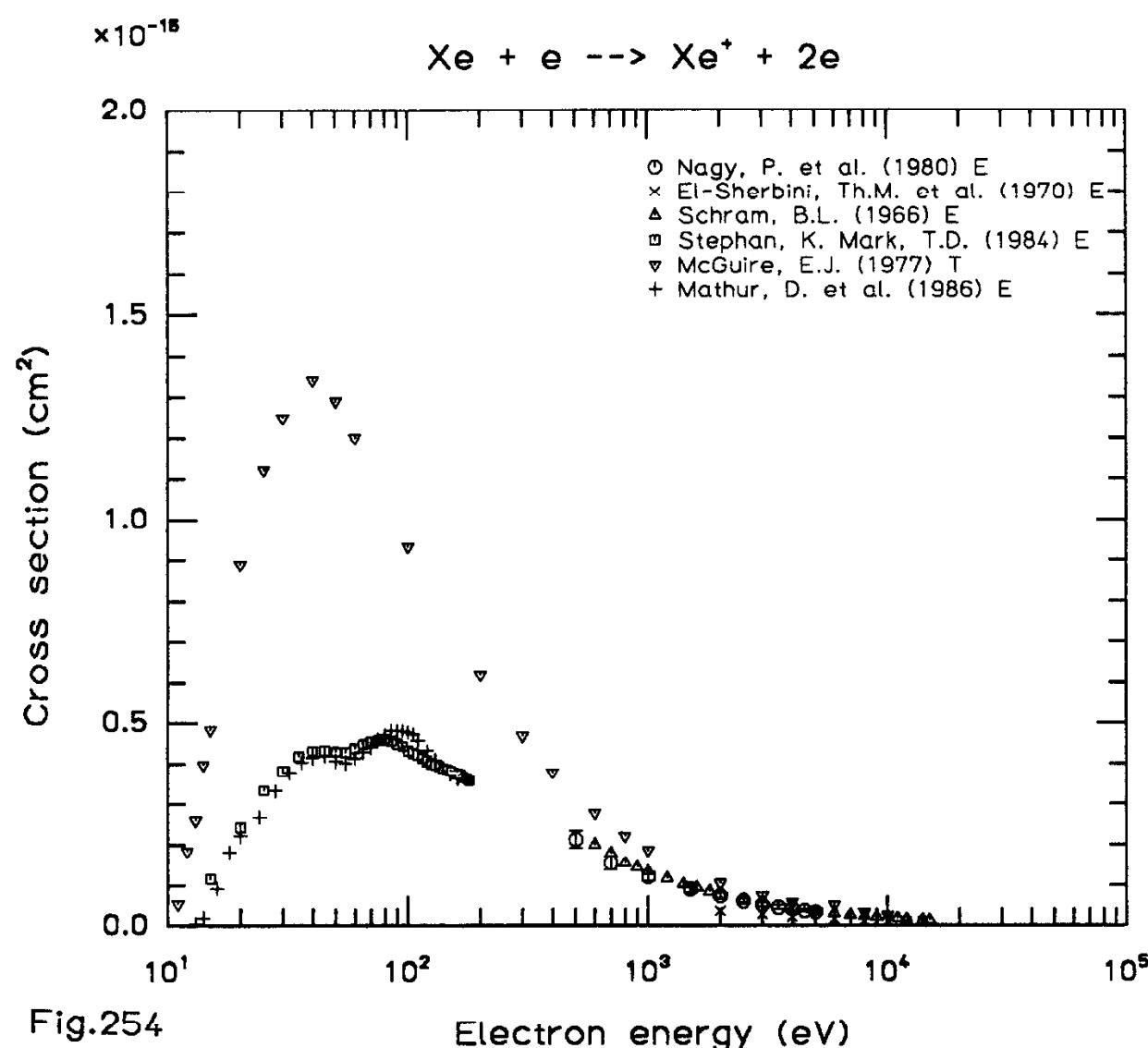


Fig.254

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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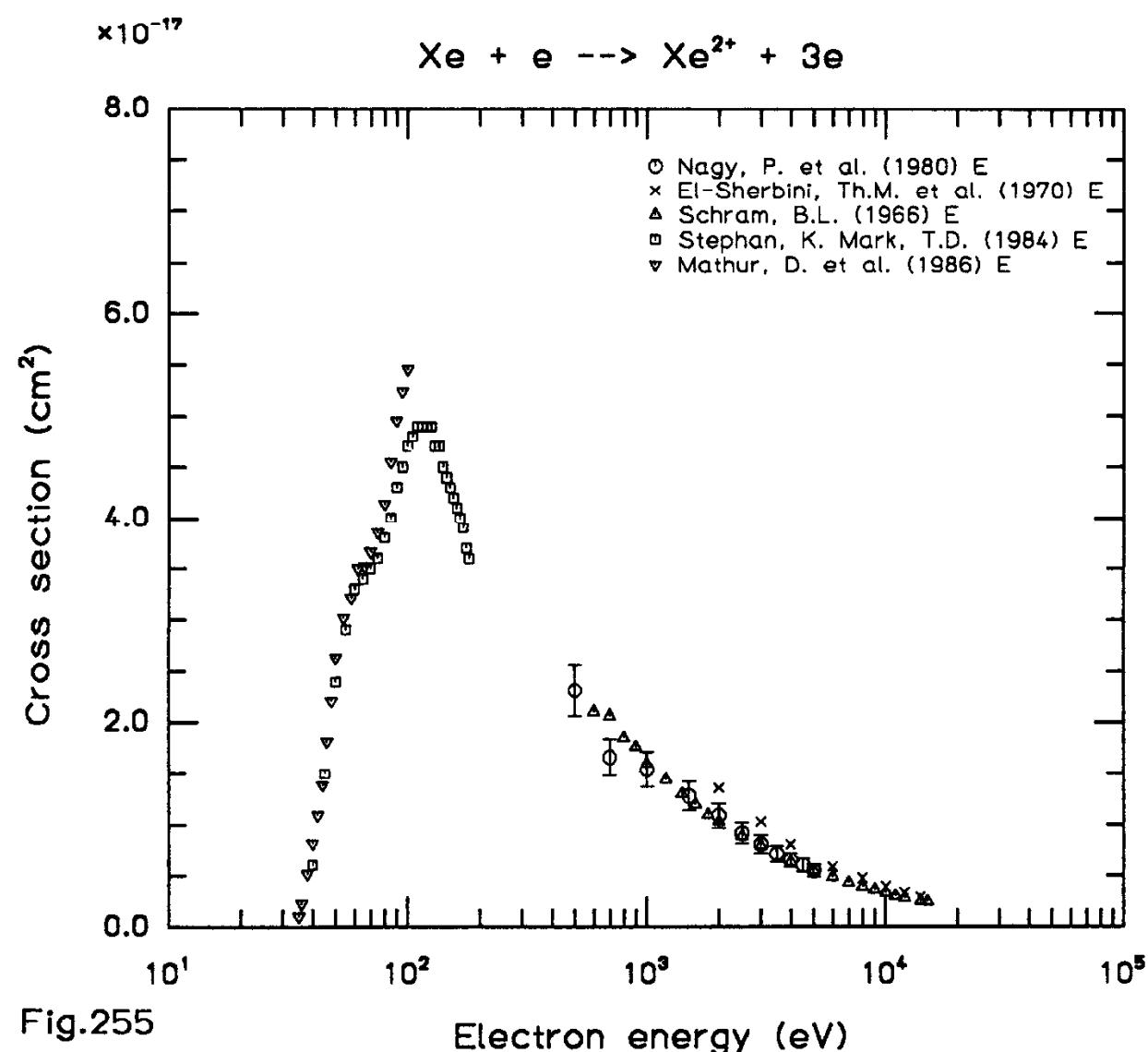


Fig.255

Electron energy (eV)

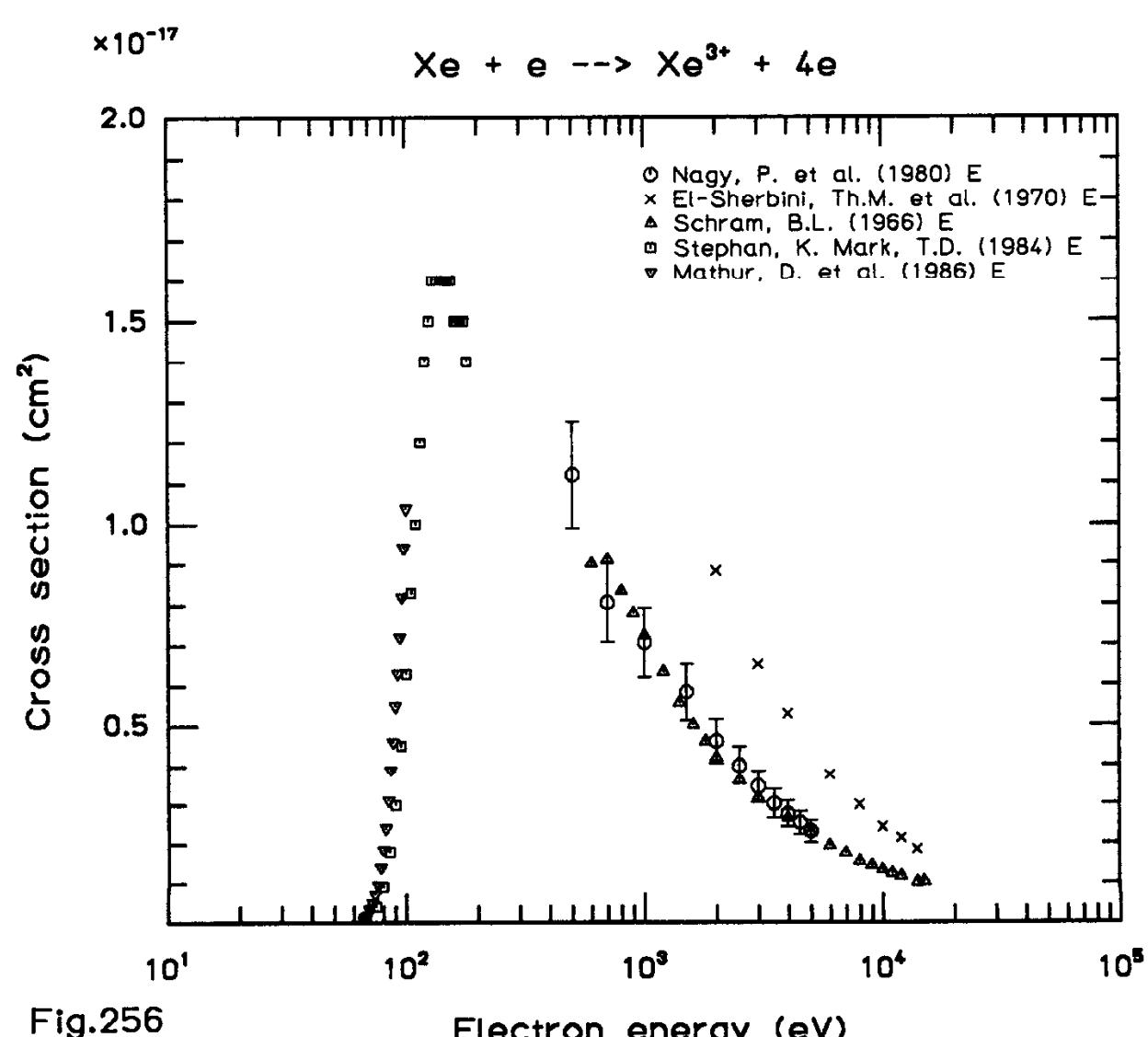


Fig.256

Electron energy (eV)

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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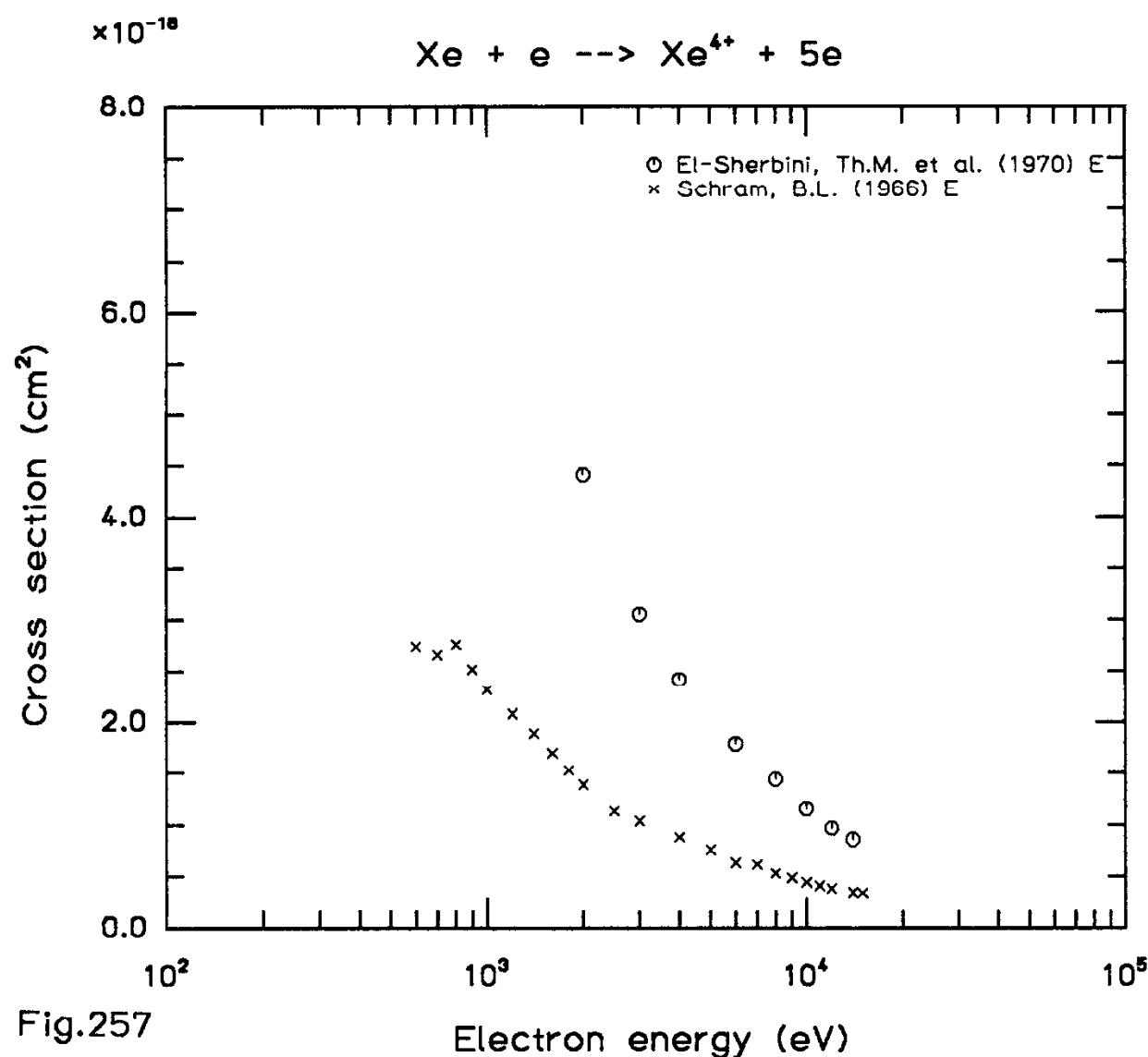


Fig.257

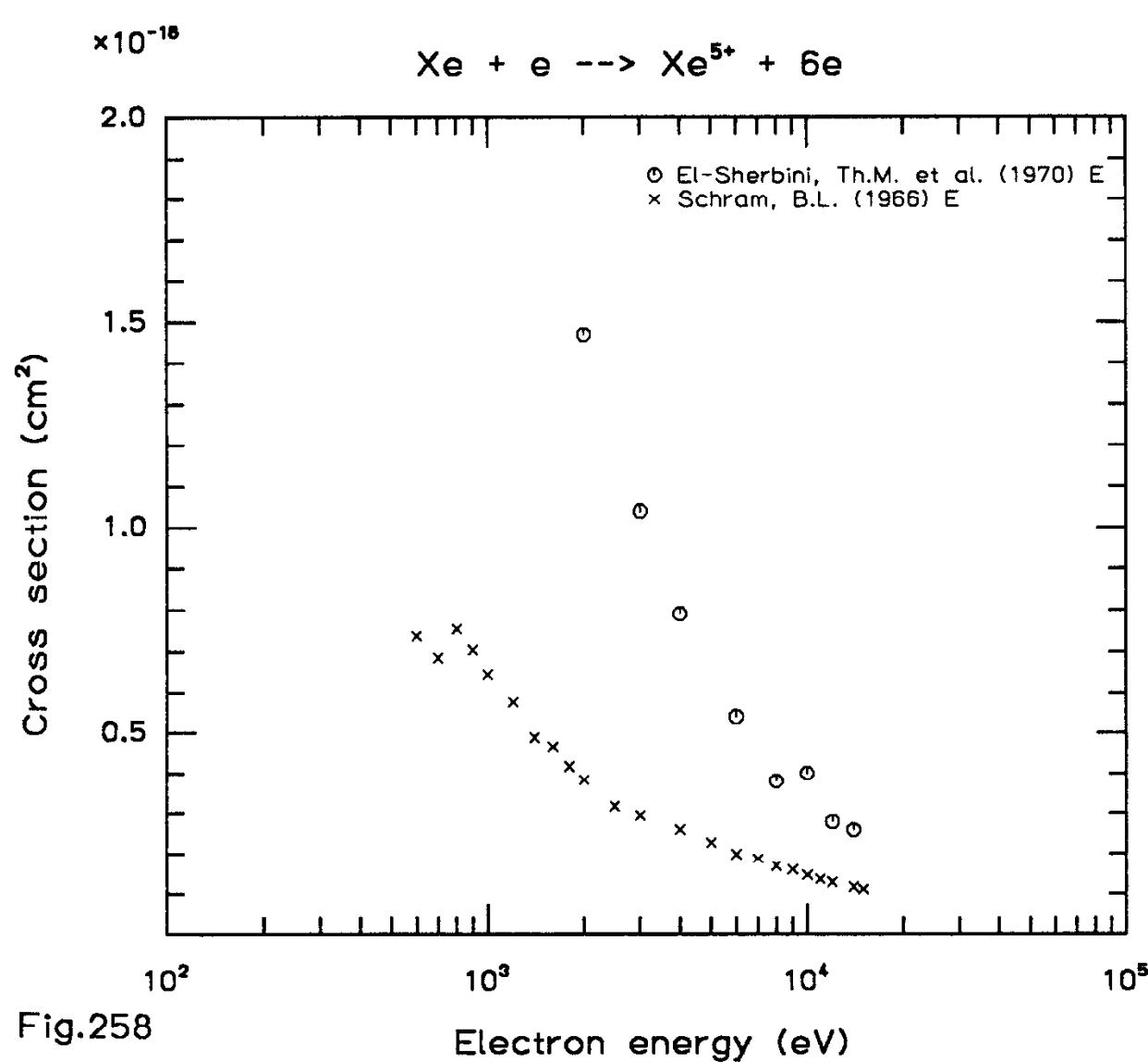


Fig.258

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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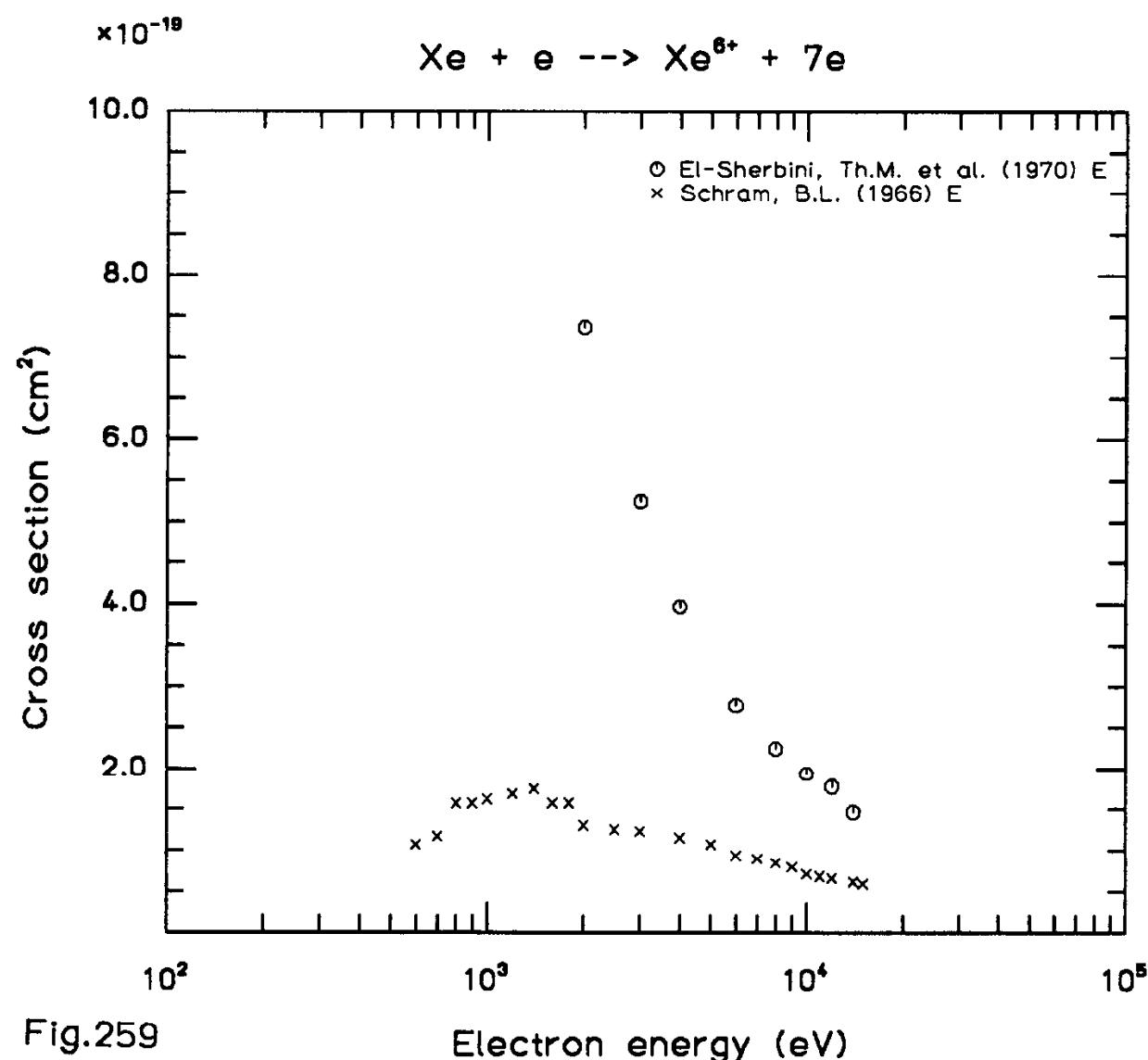


Fig.259

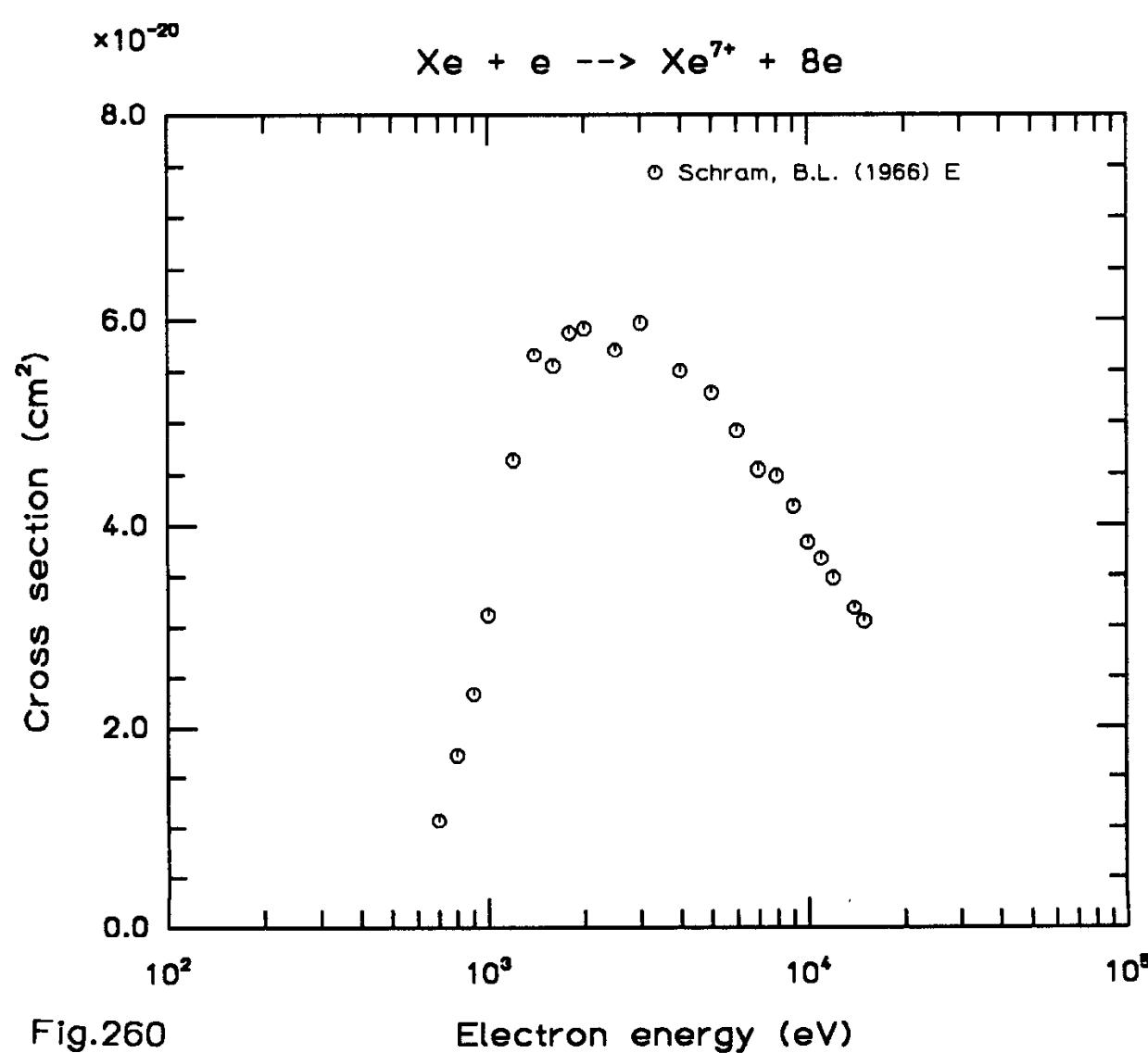


Fig.260

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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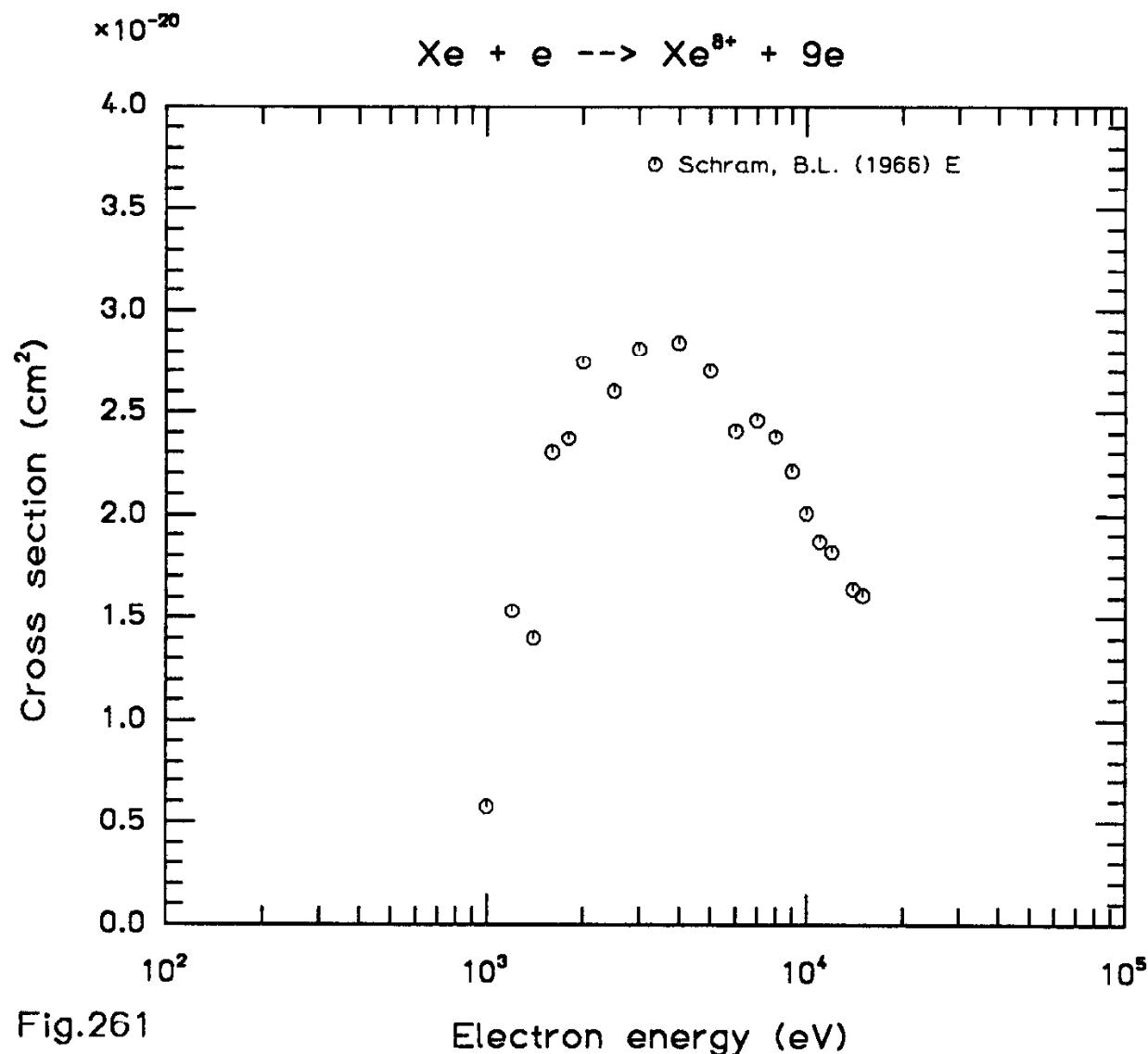


Fig.261

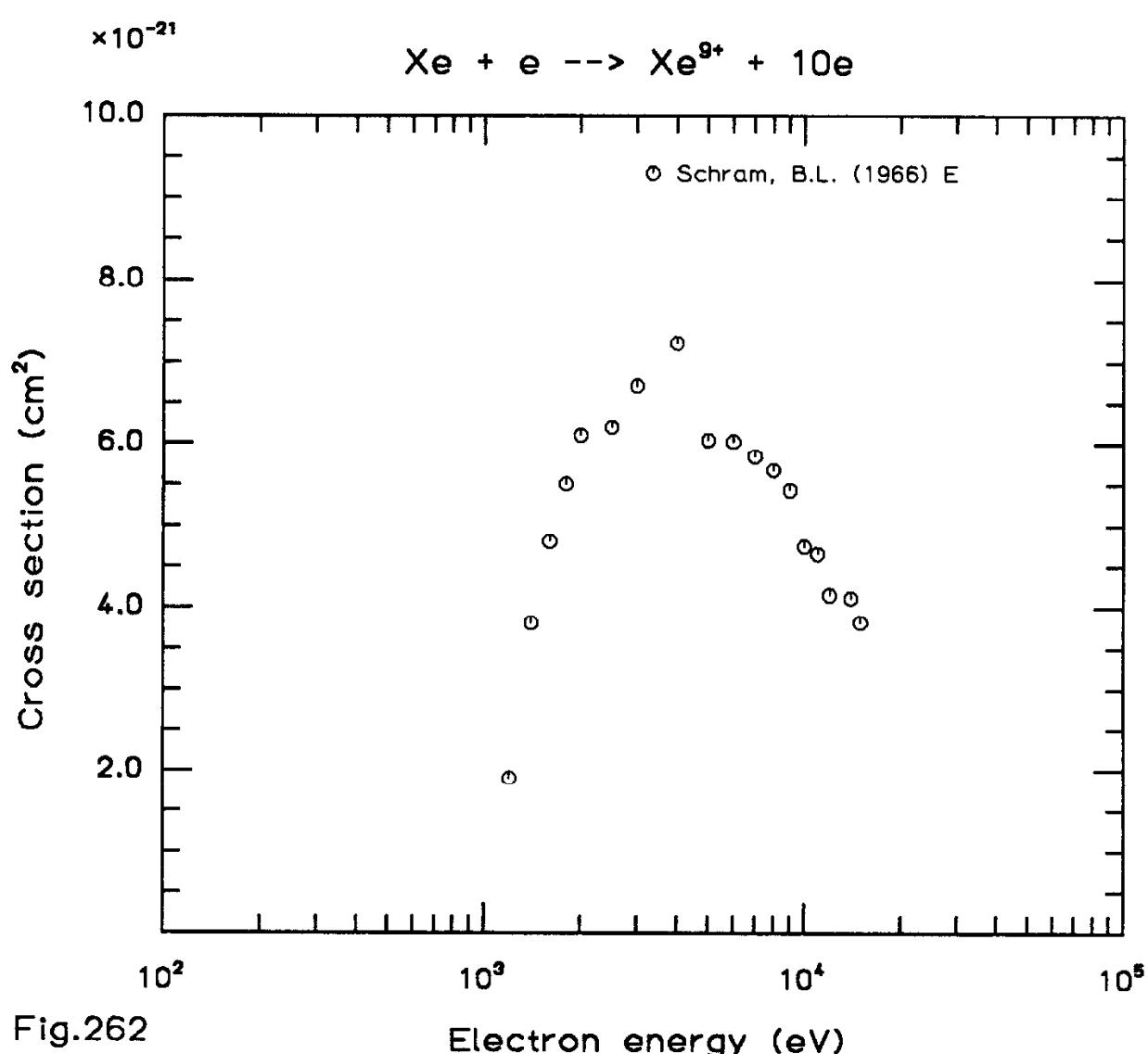


Fig.262

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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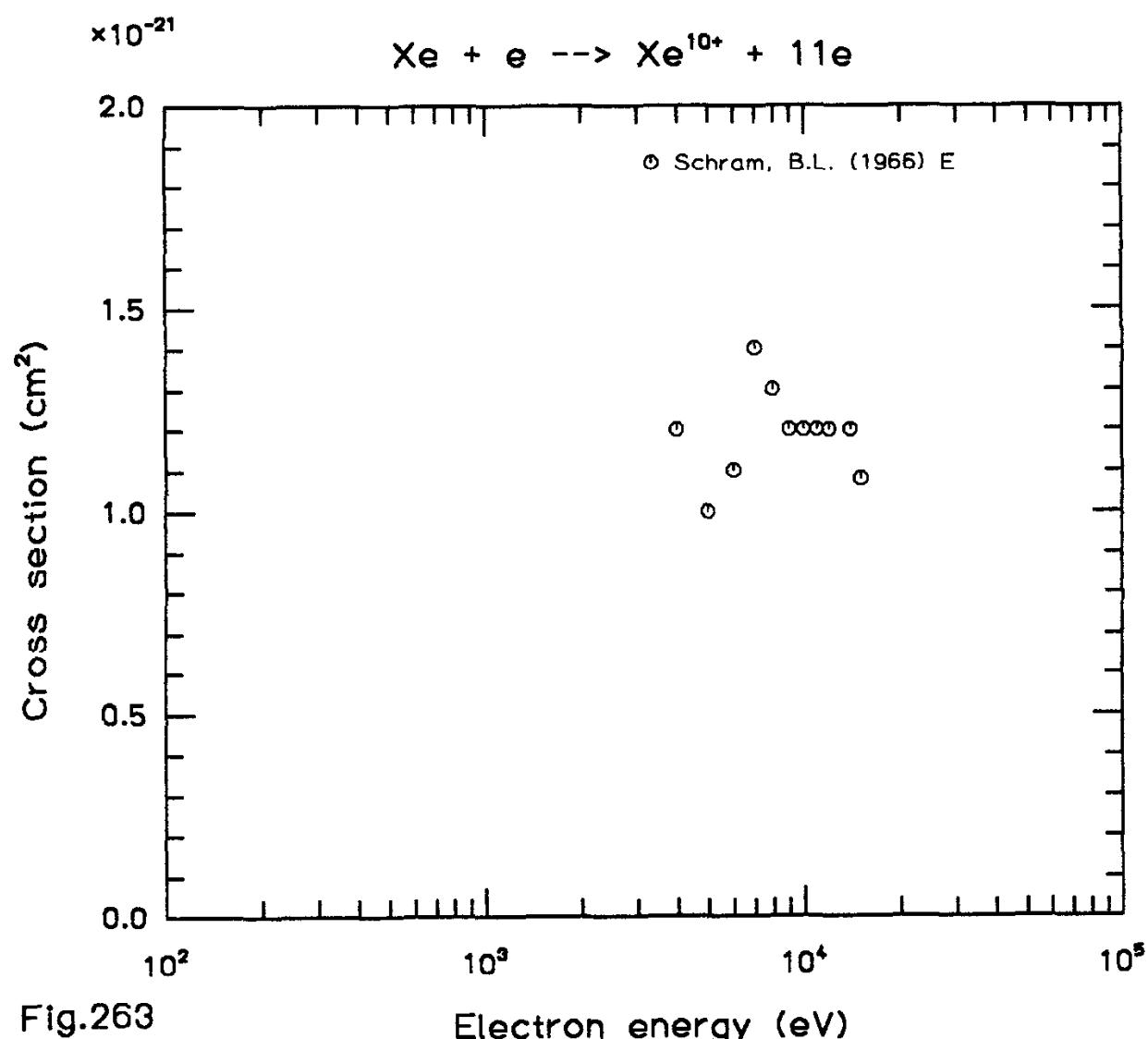


Fig.263

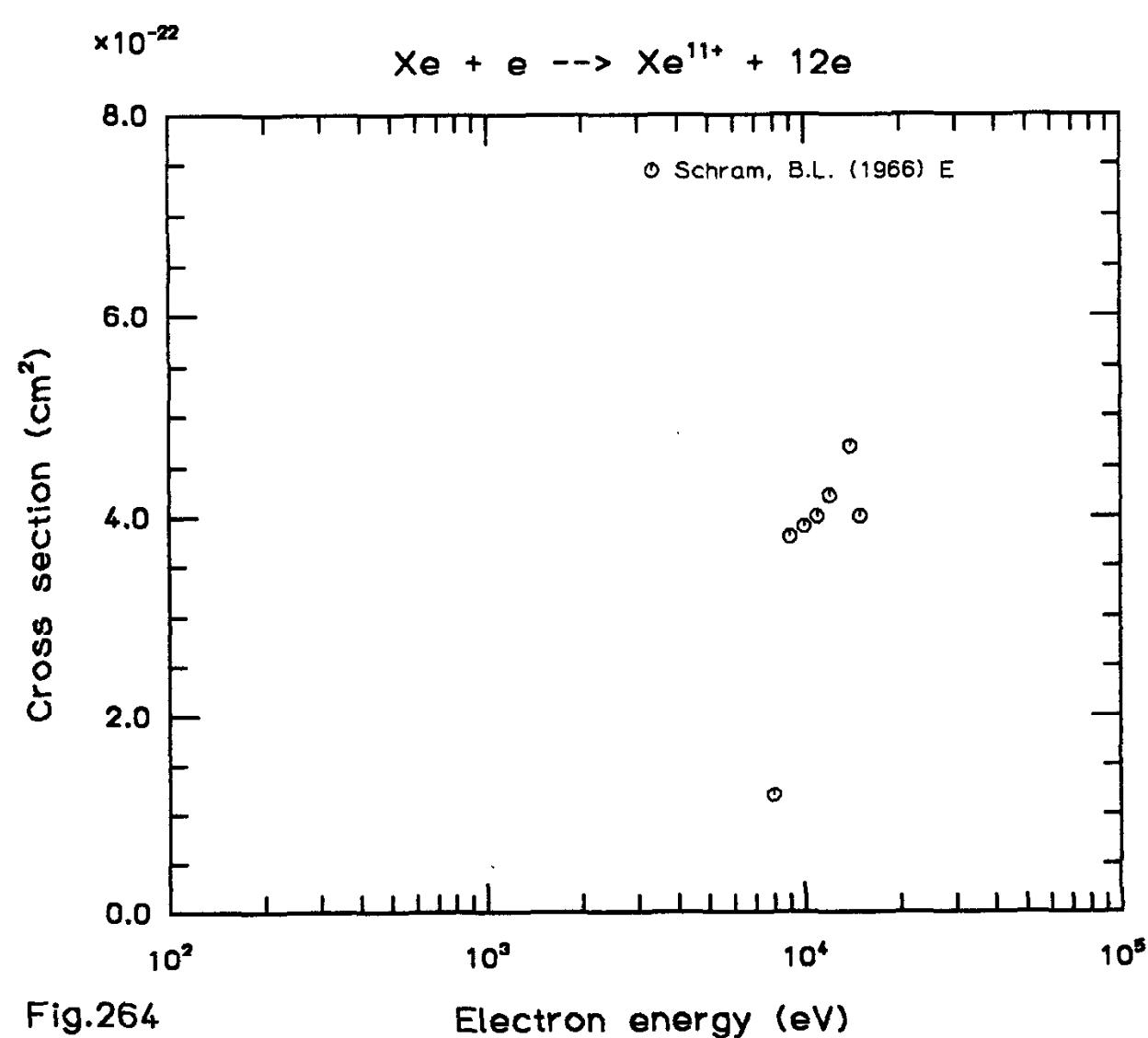


Fig.264

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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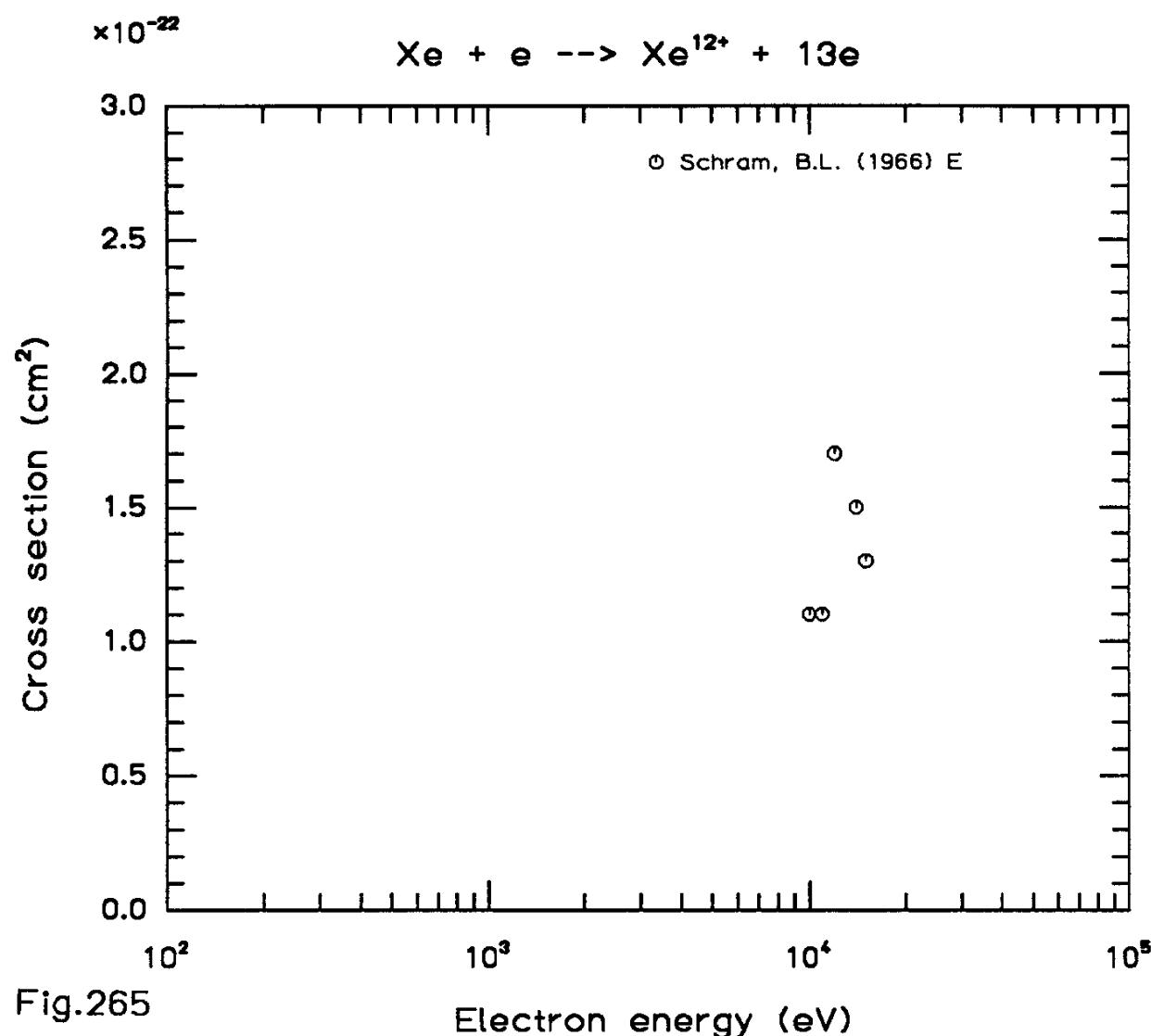


Fig.265

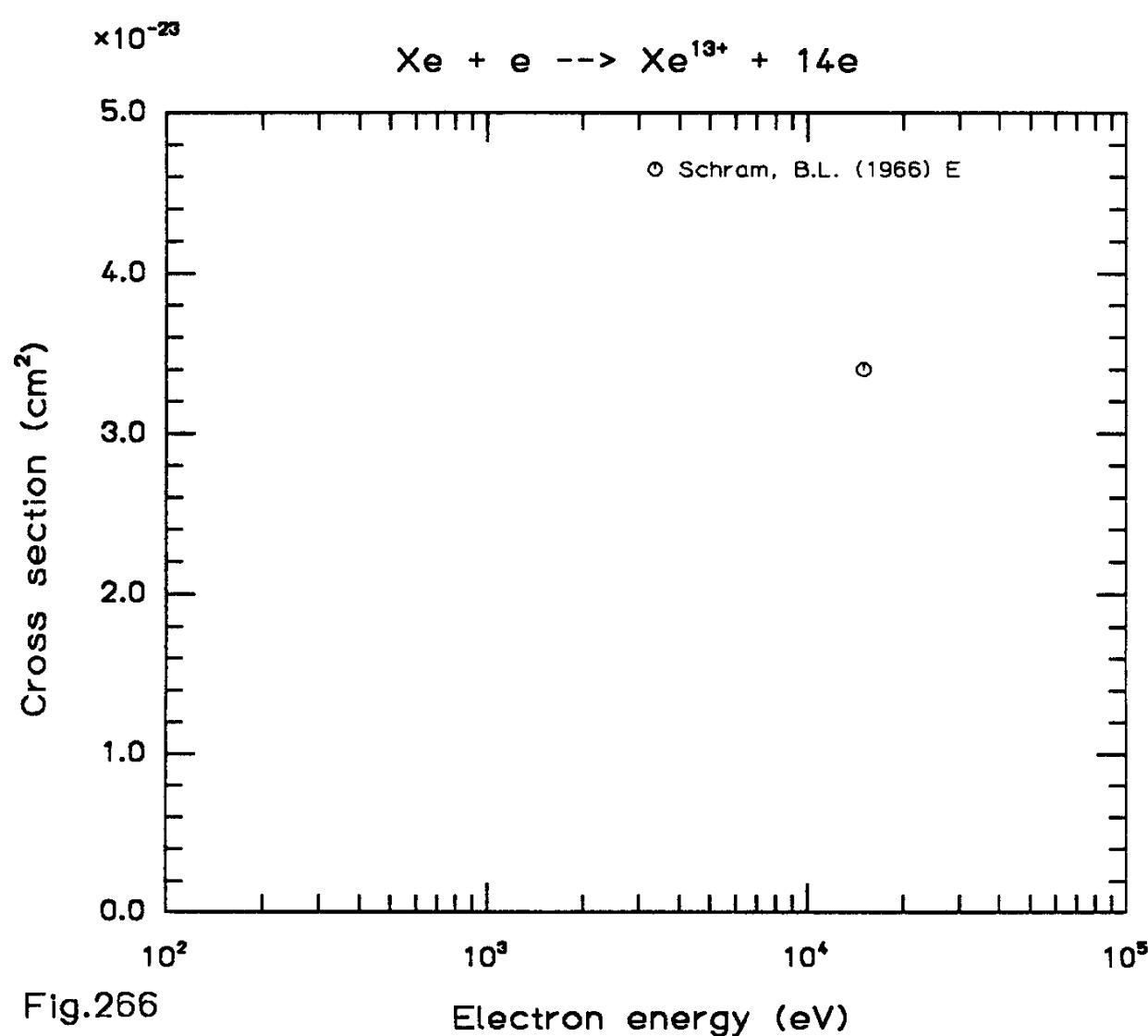


Fig.266

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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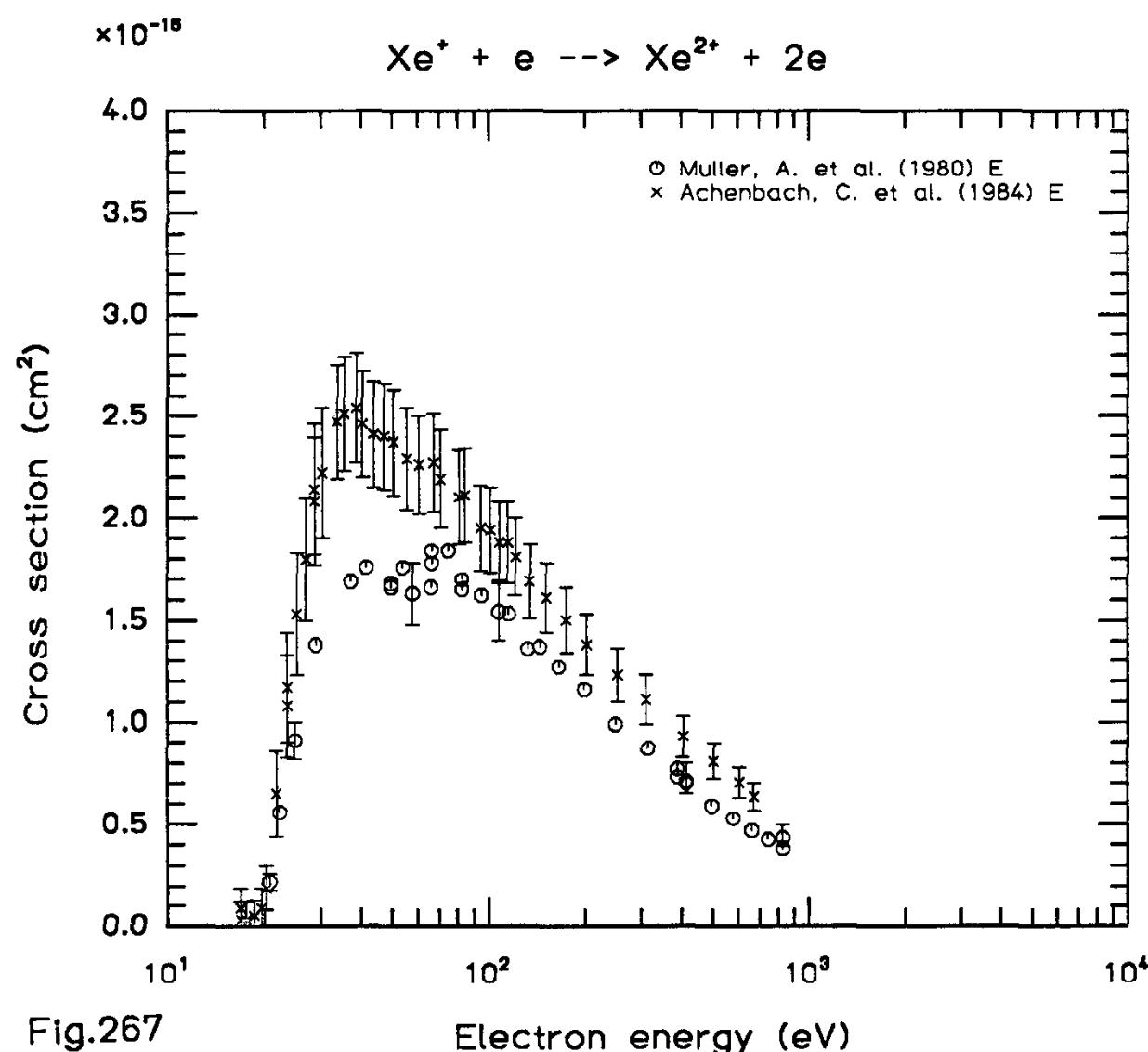


Fig.267

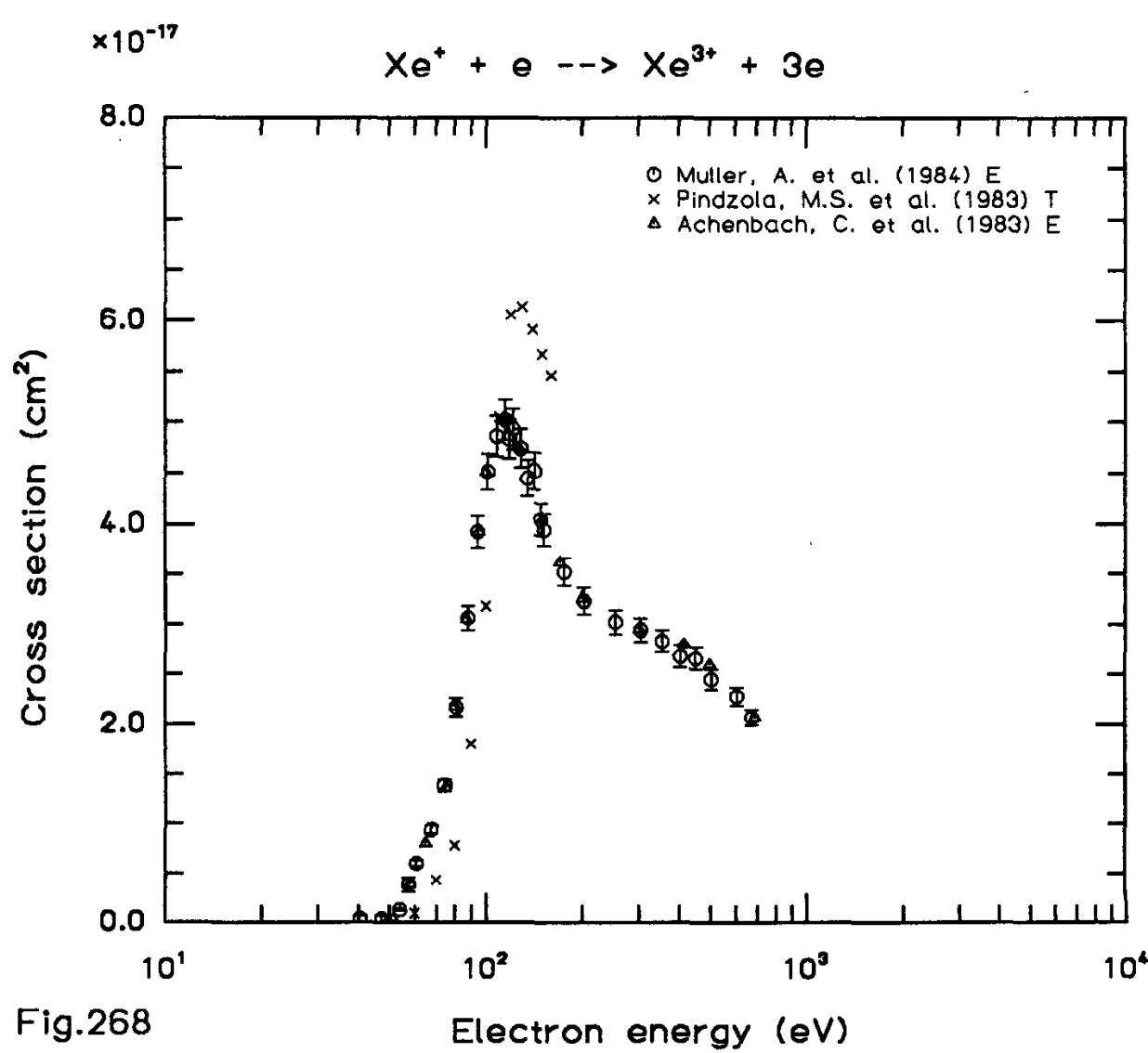


Fig.268

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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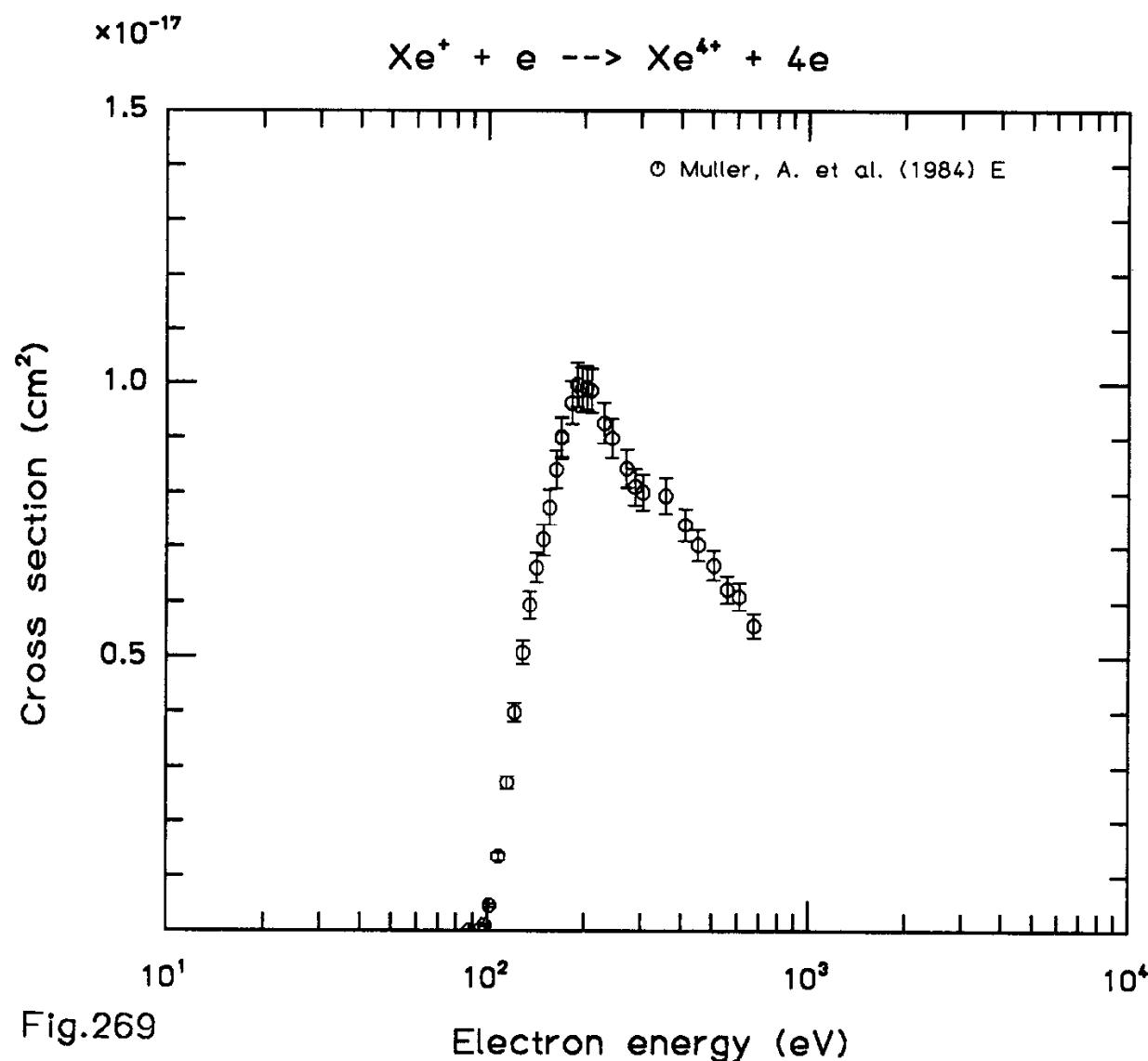


Fig.269

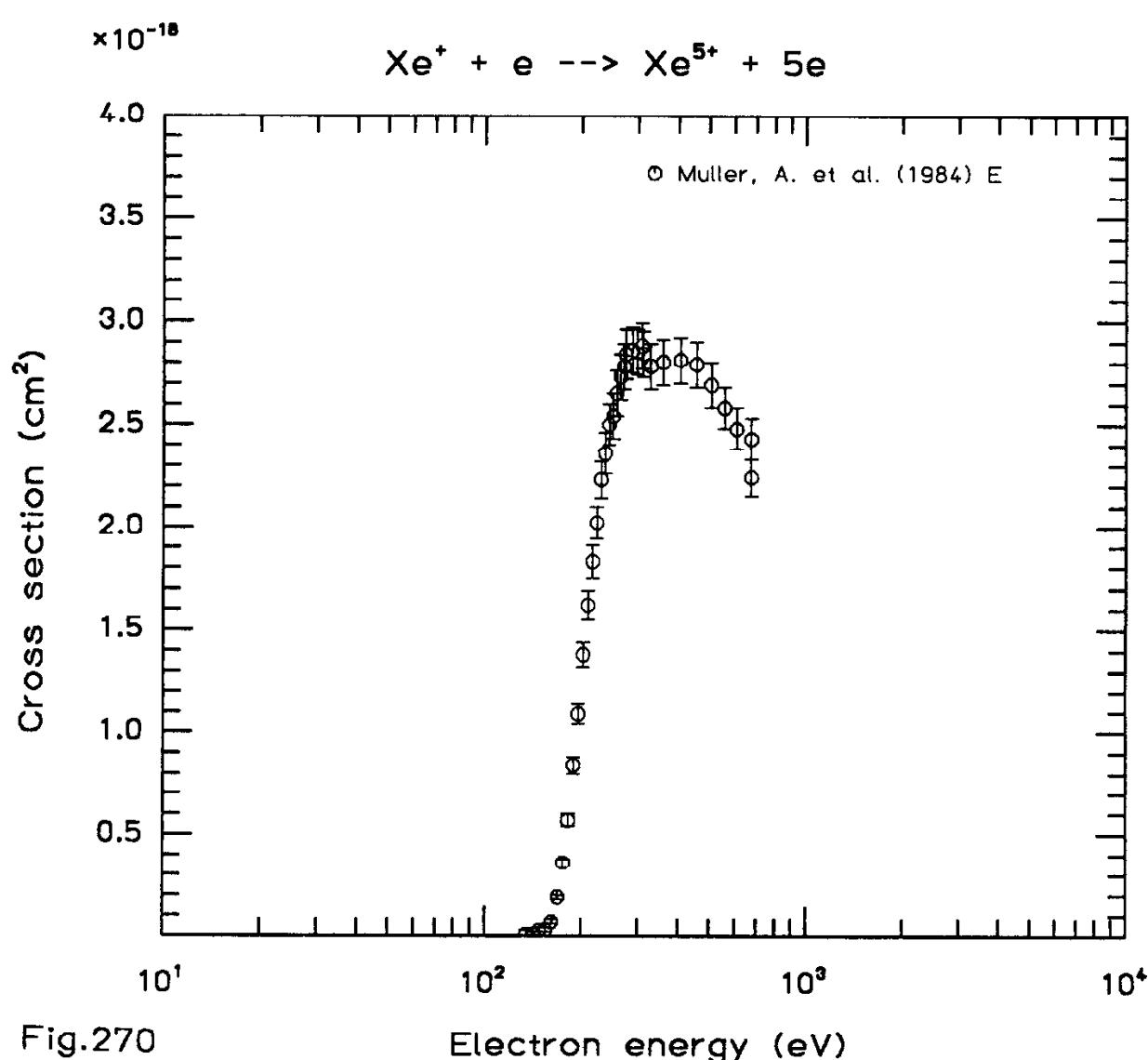


Fig.270

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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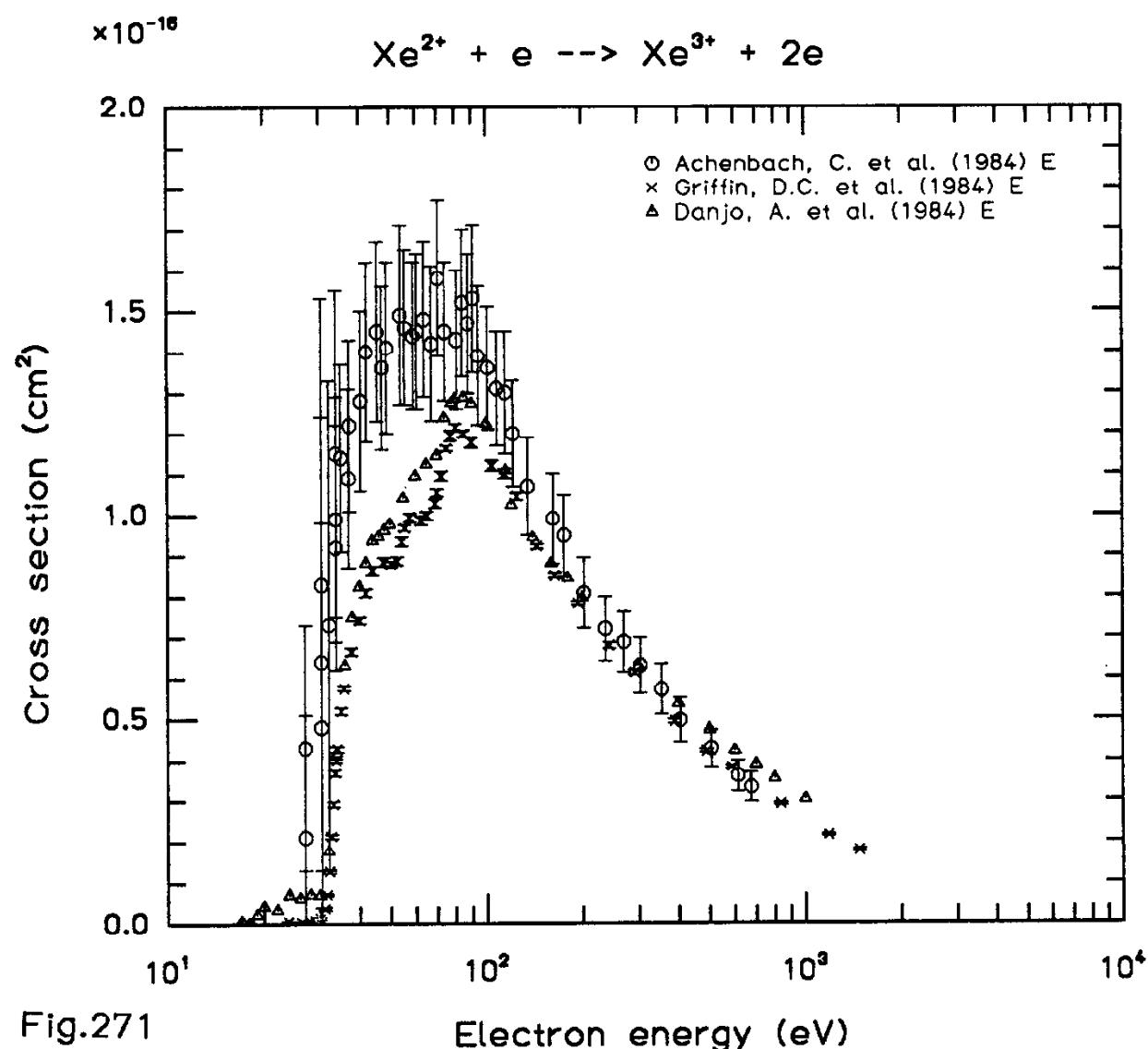


Fig.271

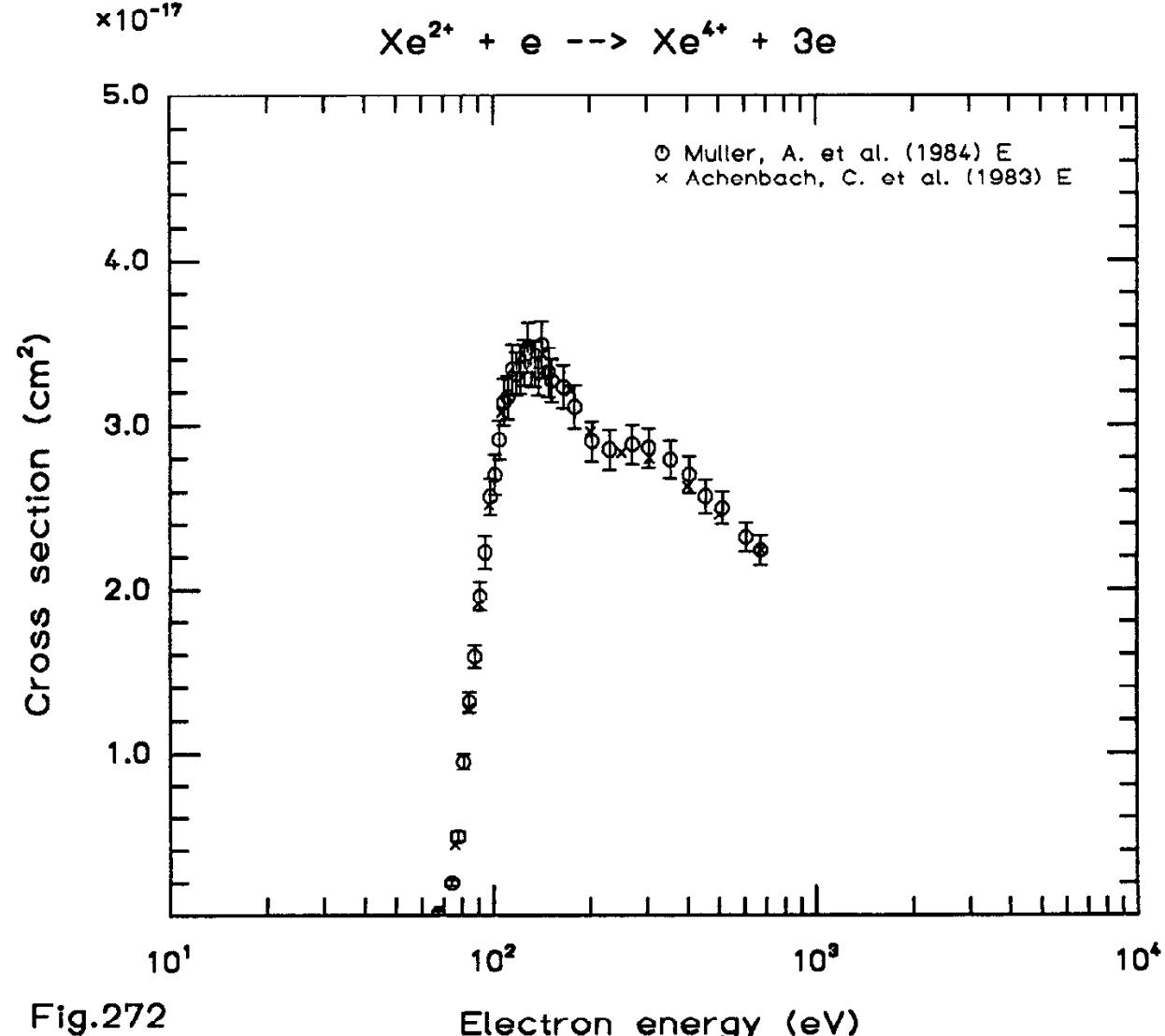


Fig.272

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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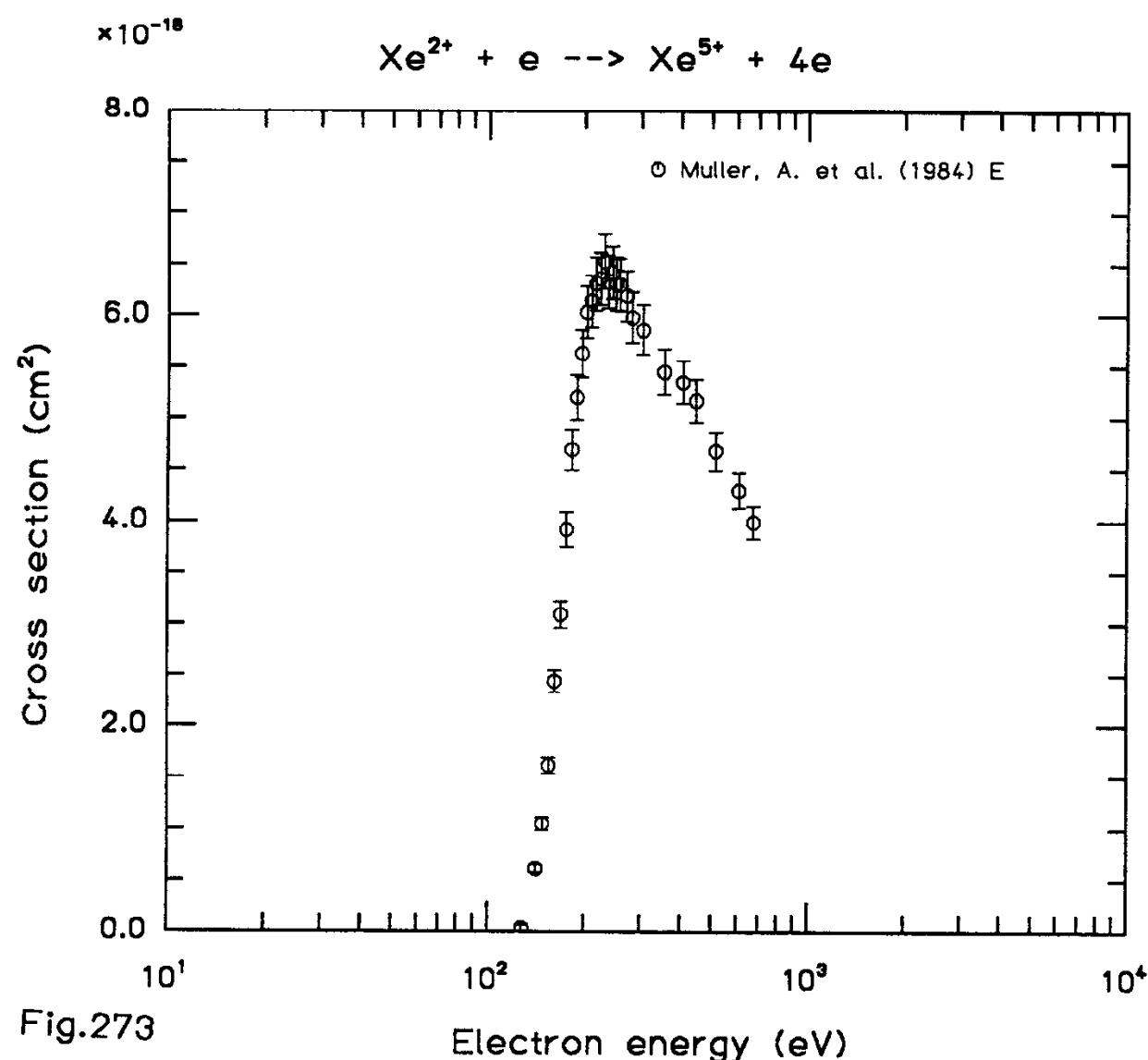


Fig.273

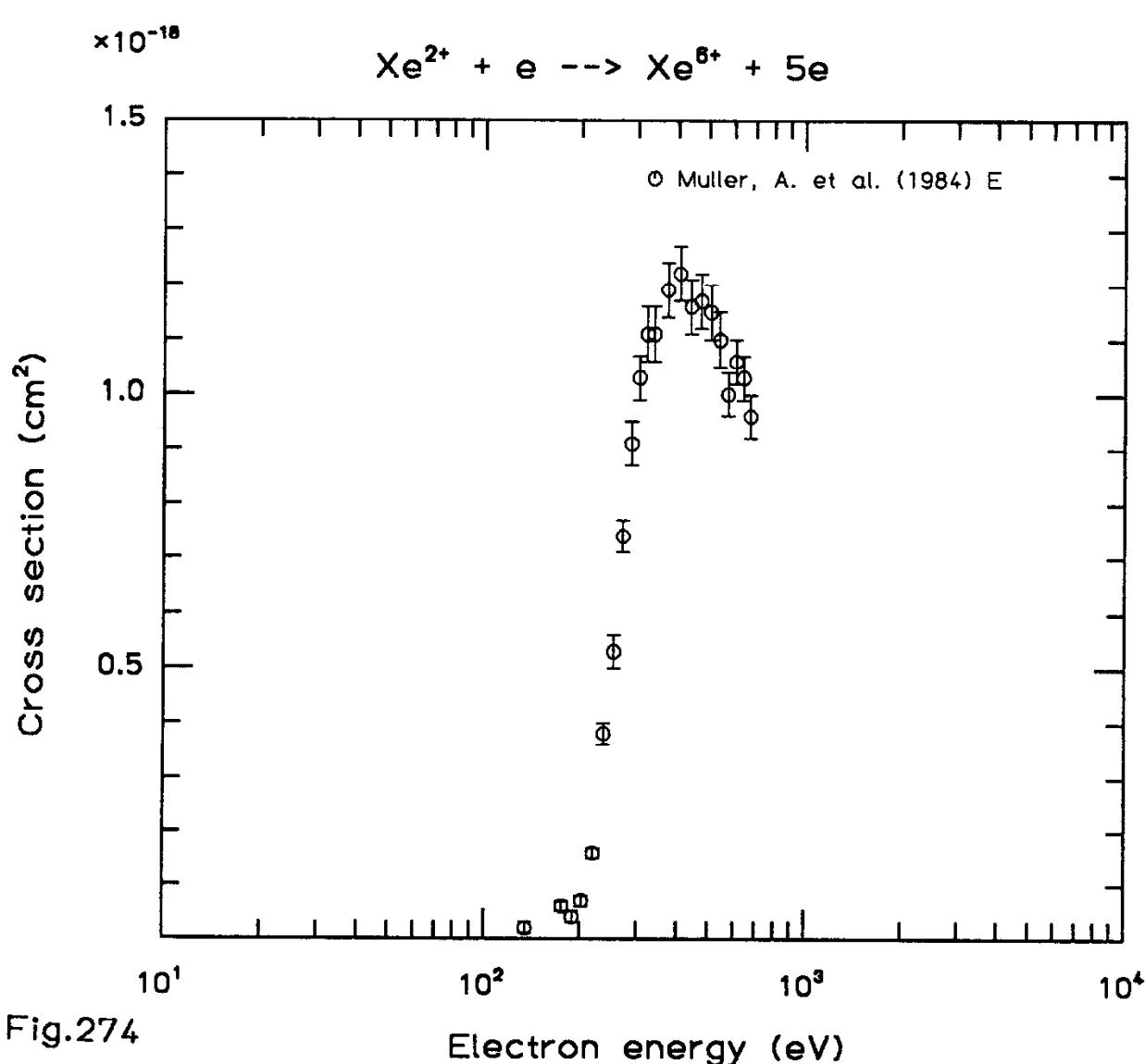


Fig.274

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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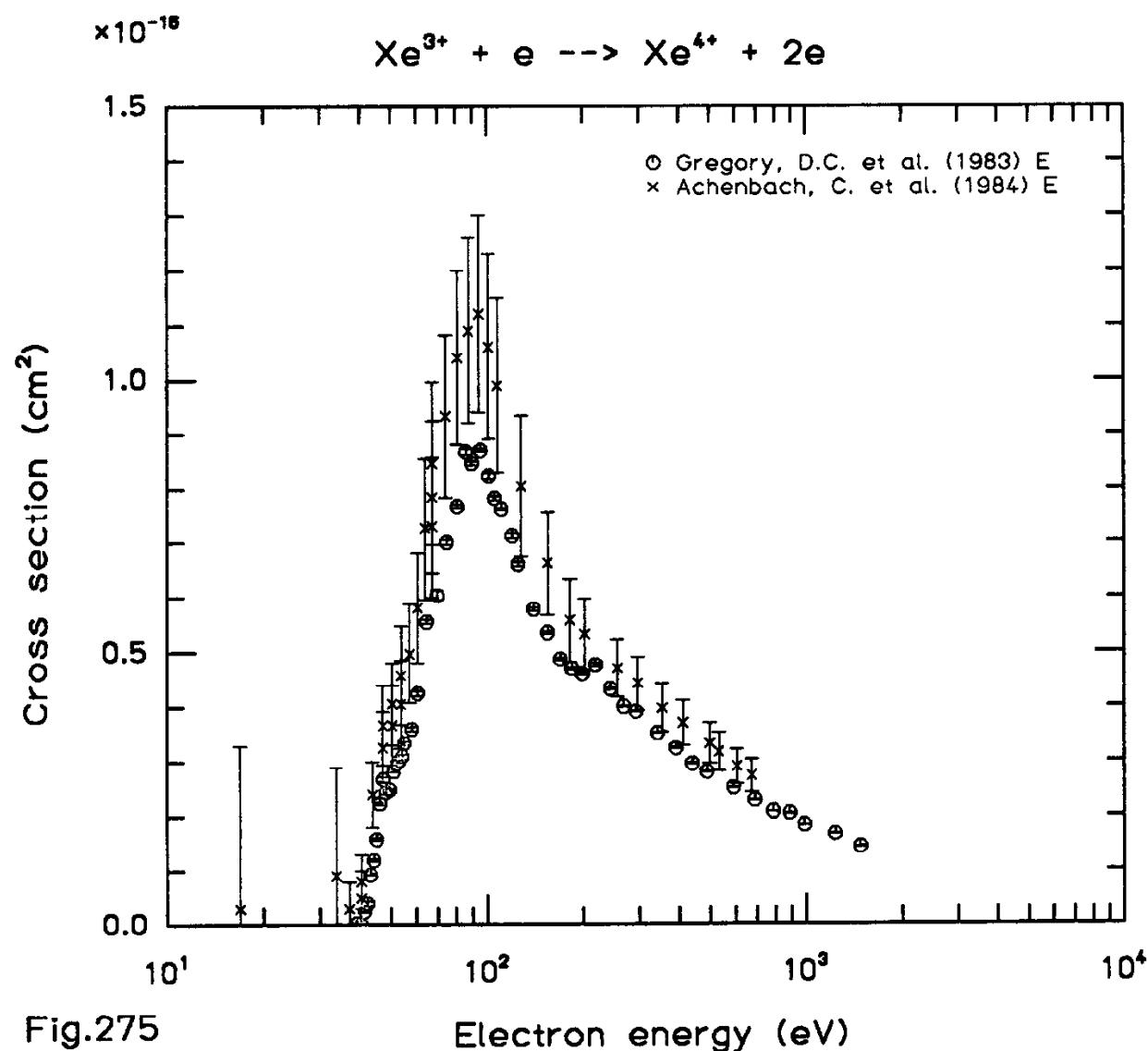


Fig.275

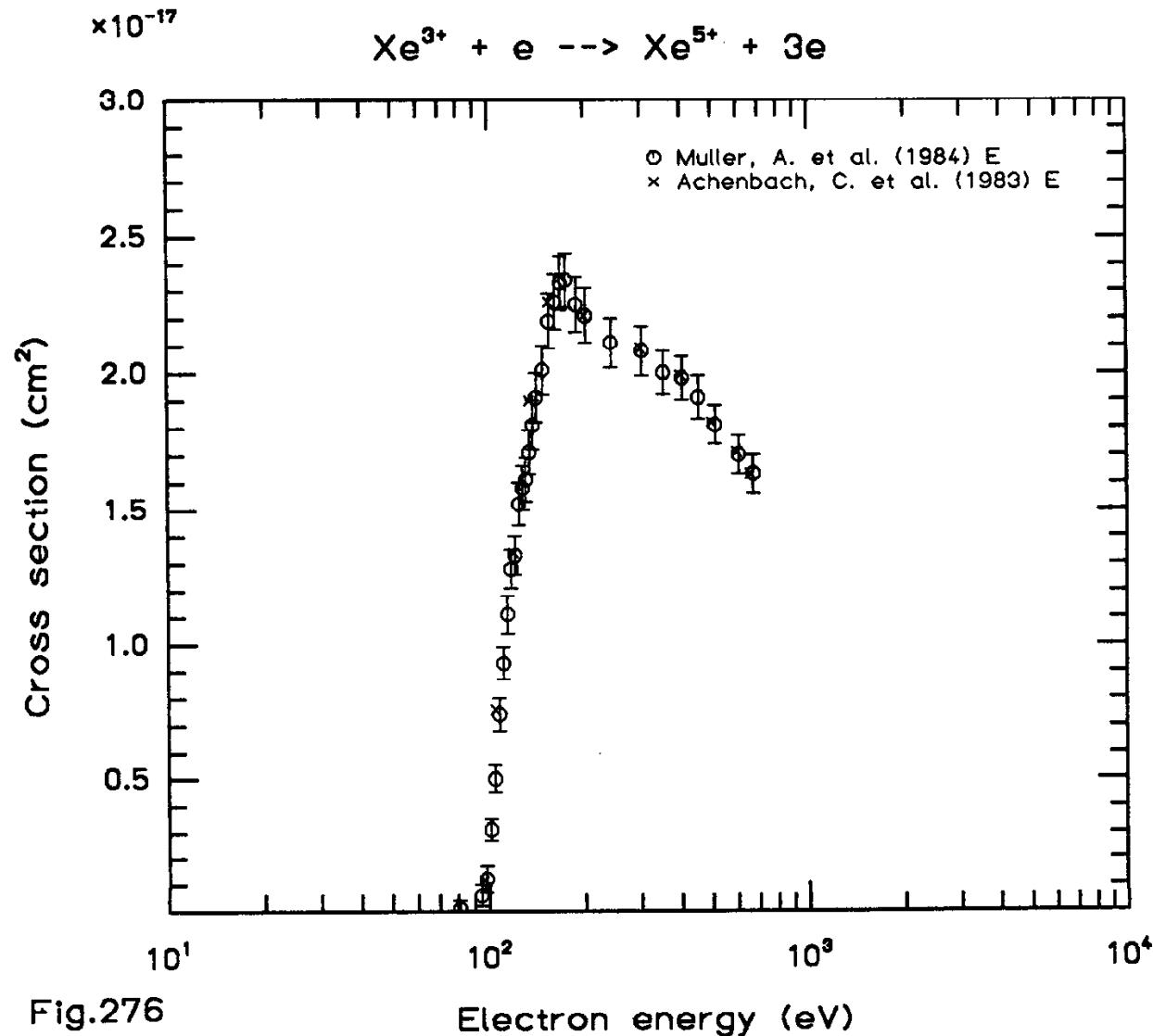
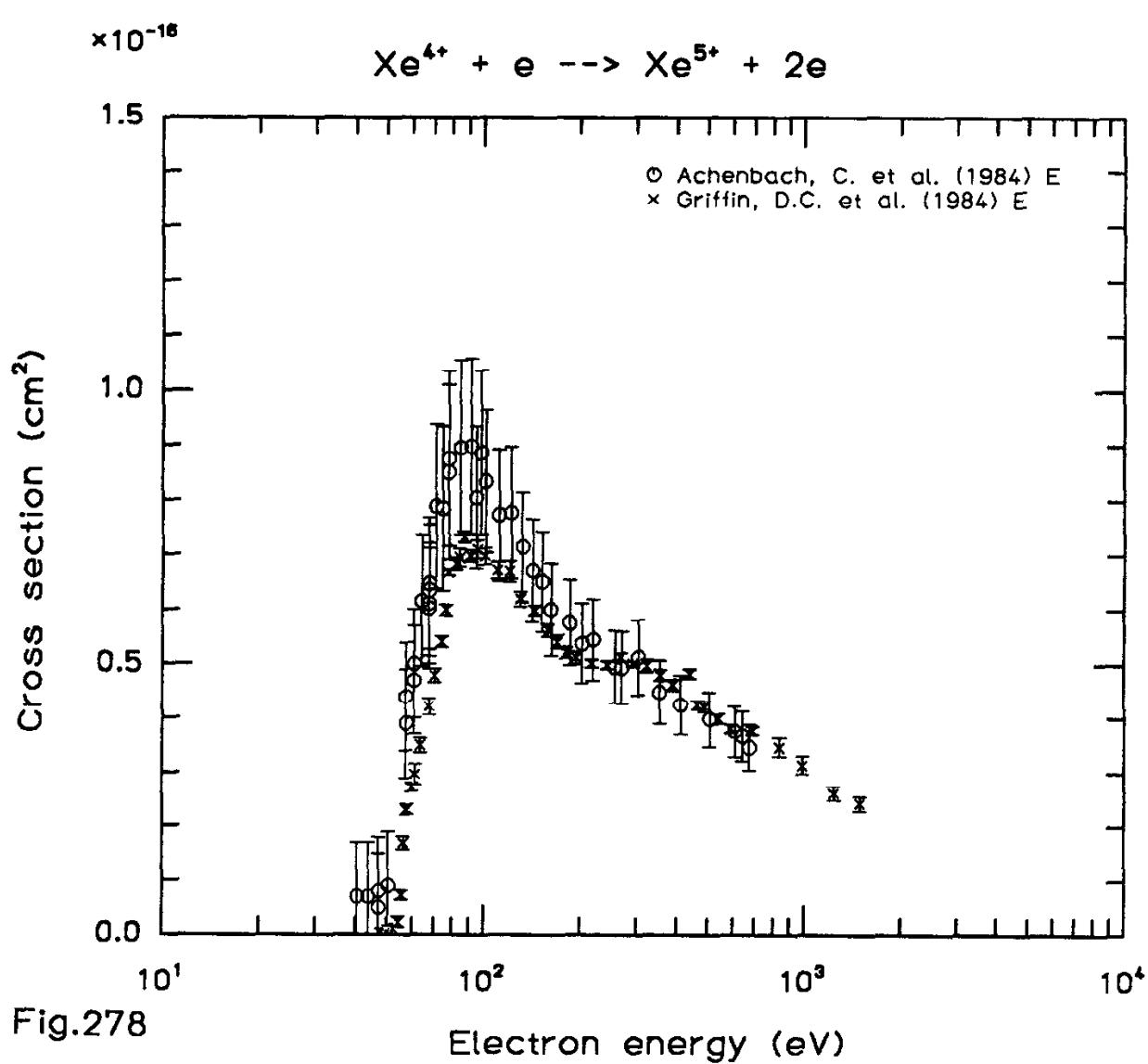
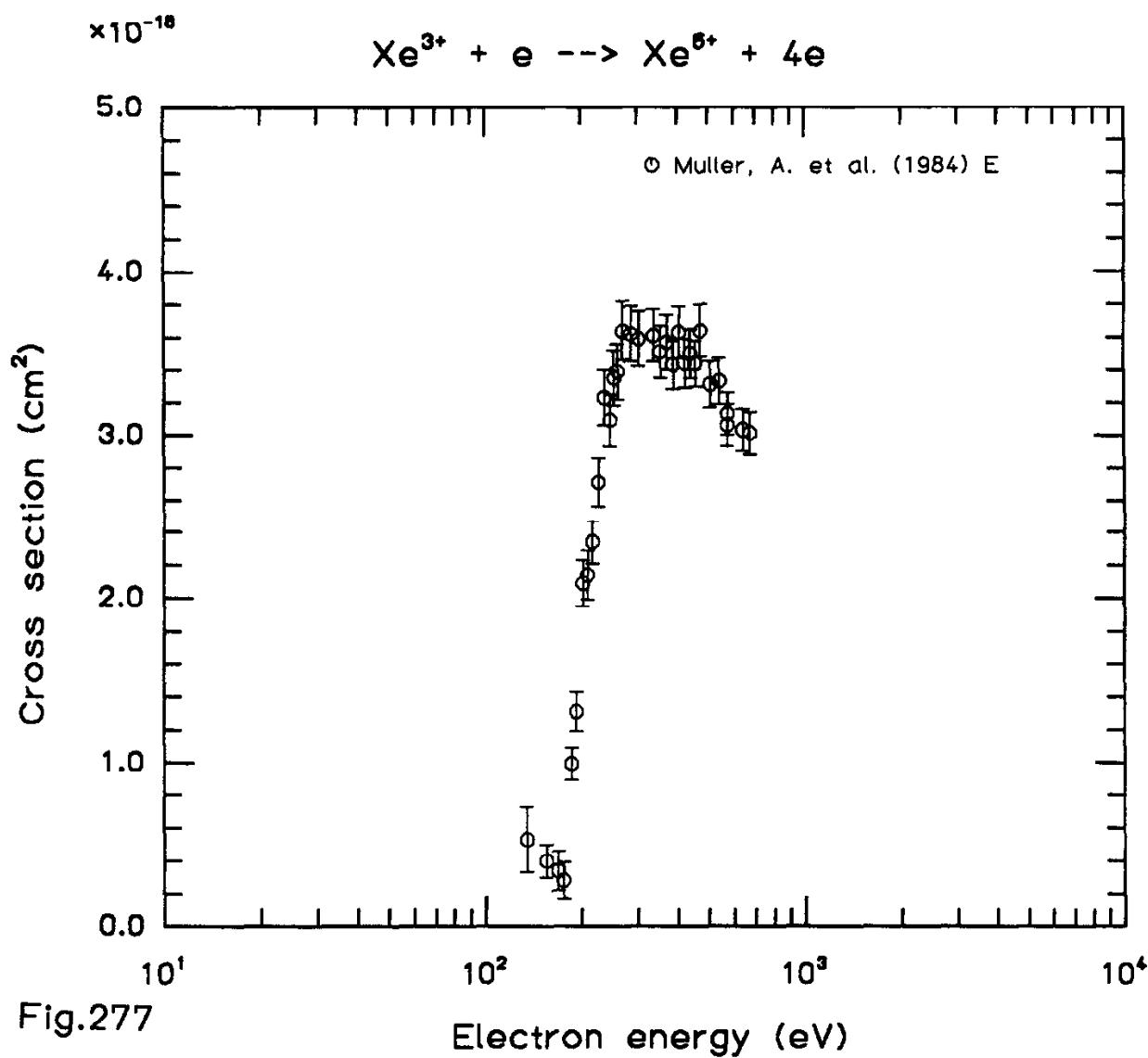


Fig.276

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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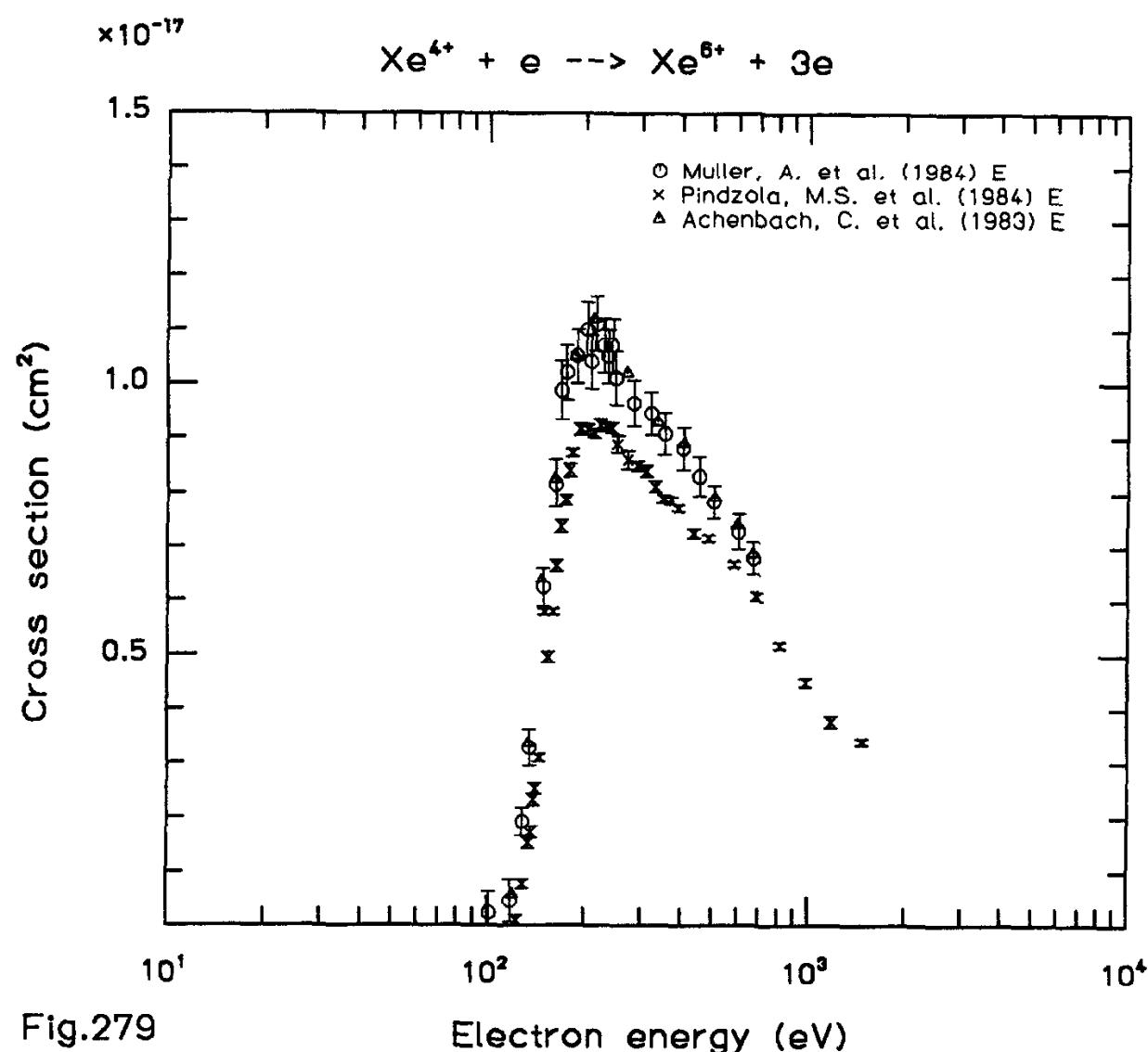


Fig.279

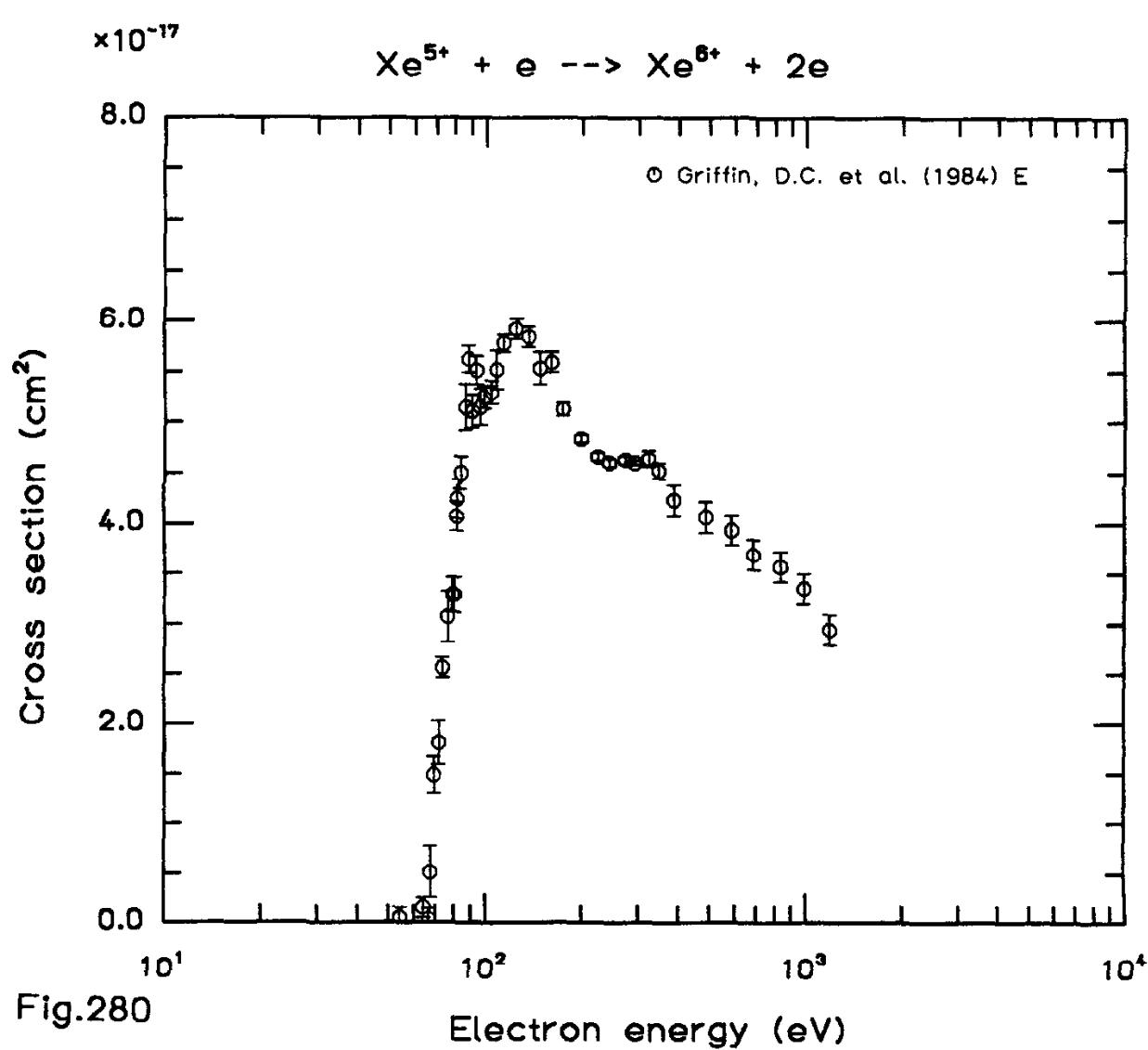


Fig.280

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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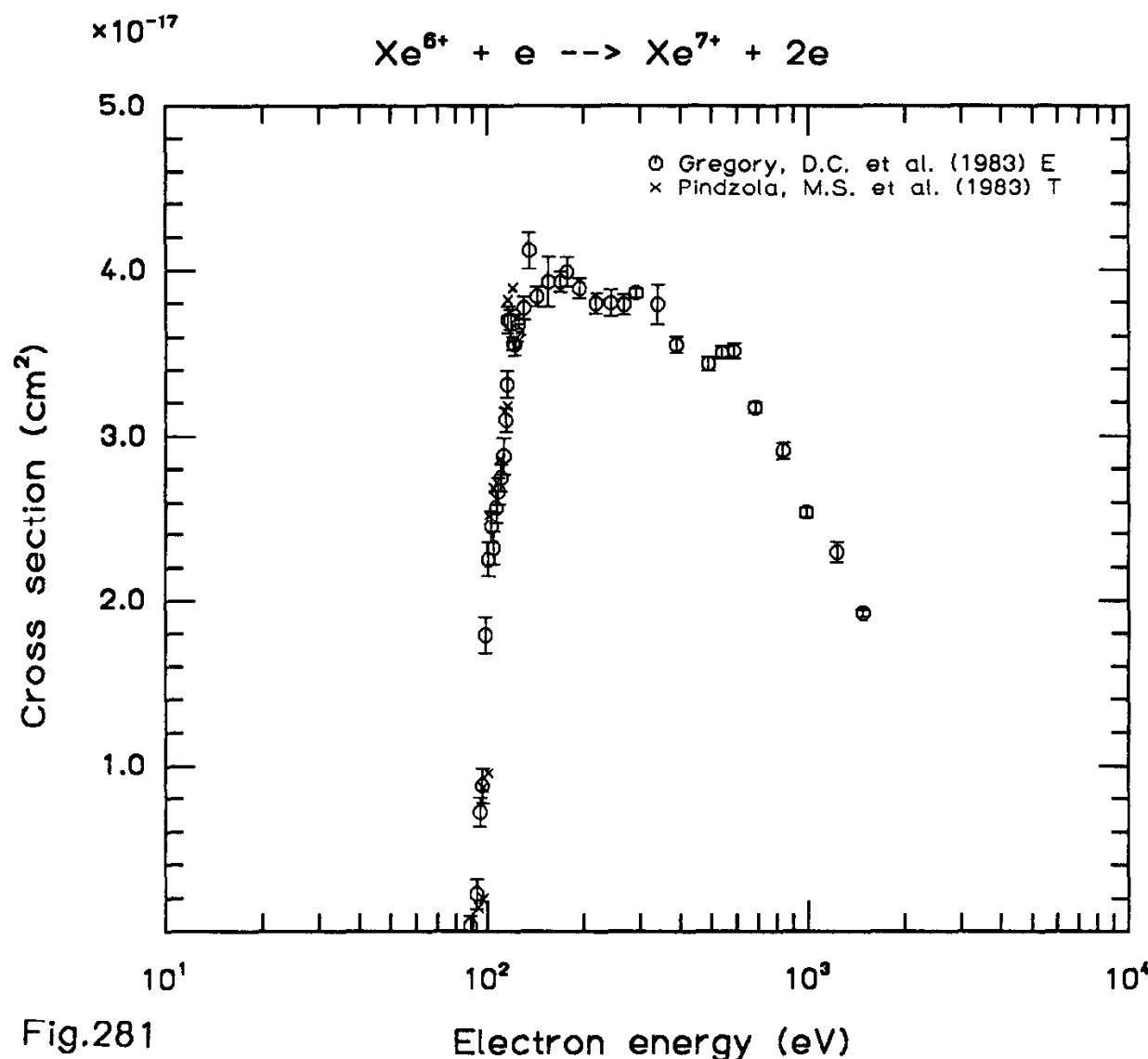


Fig.281

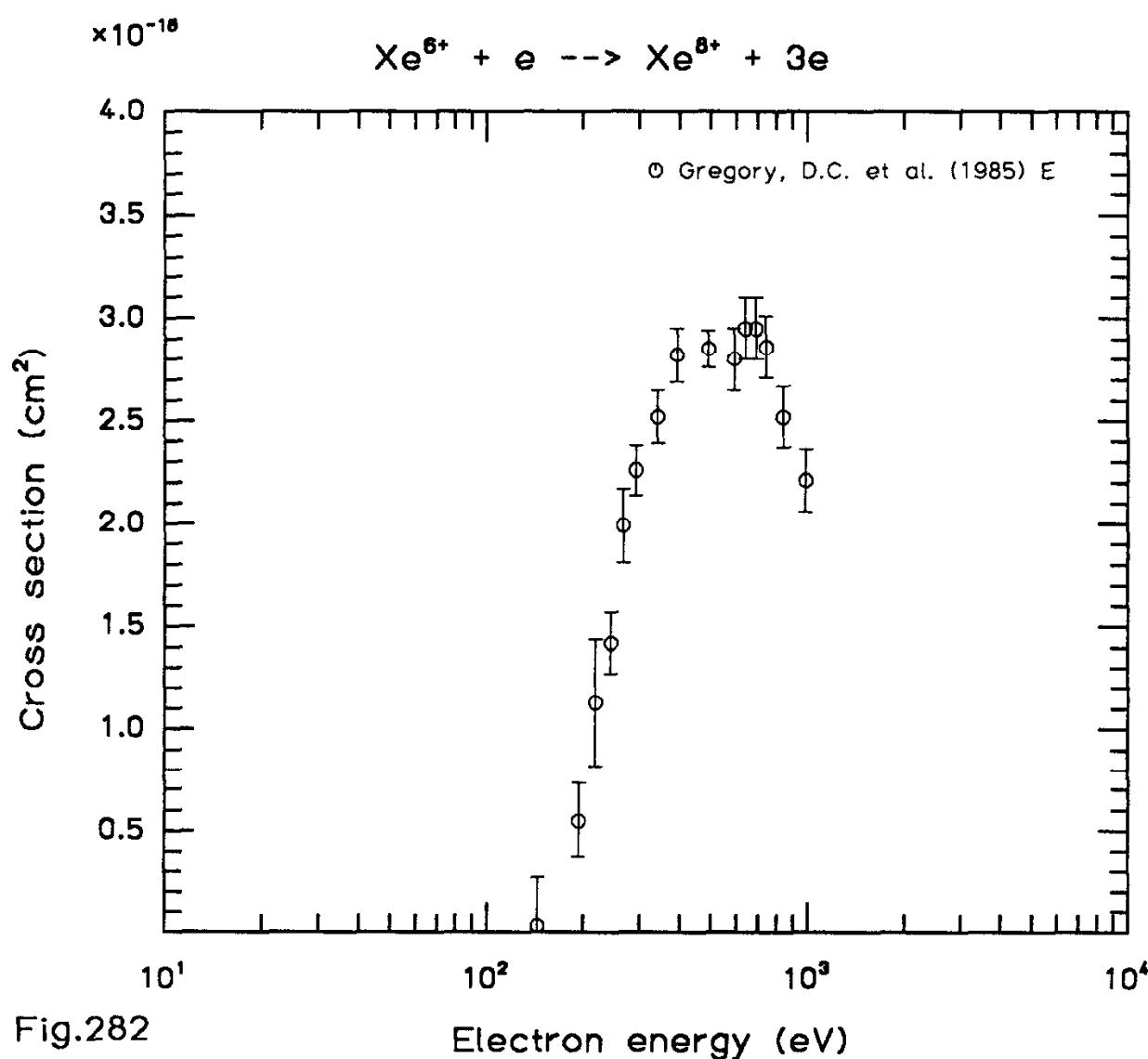


Fig.282

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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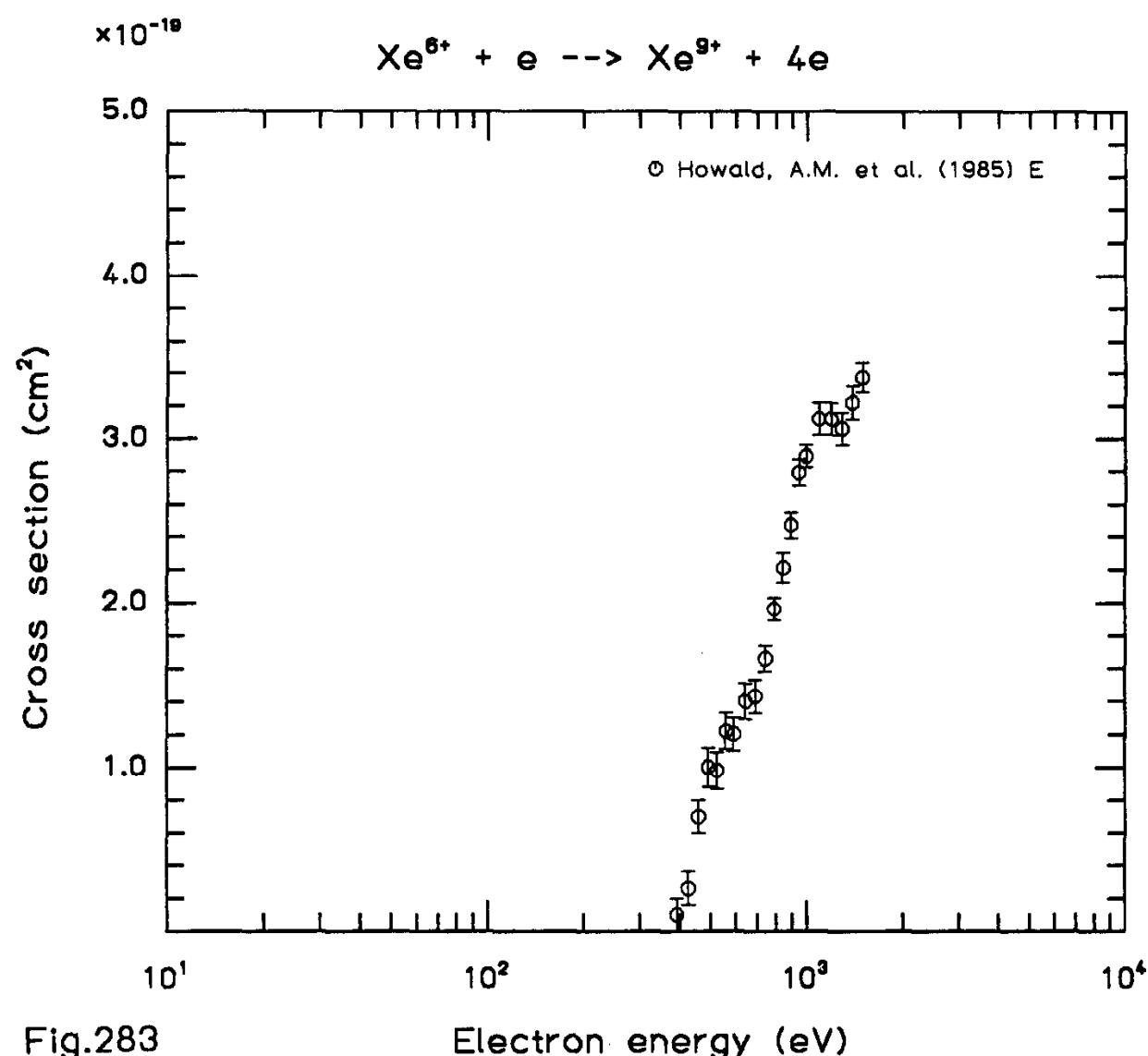


Fig.283

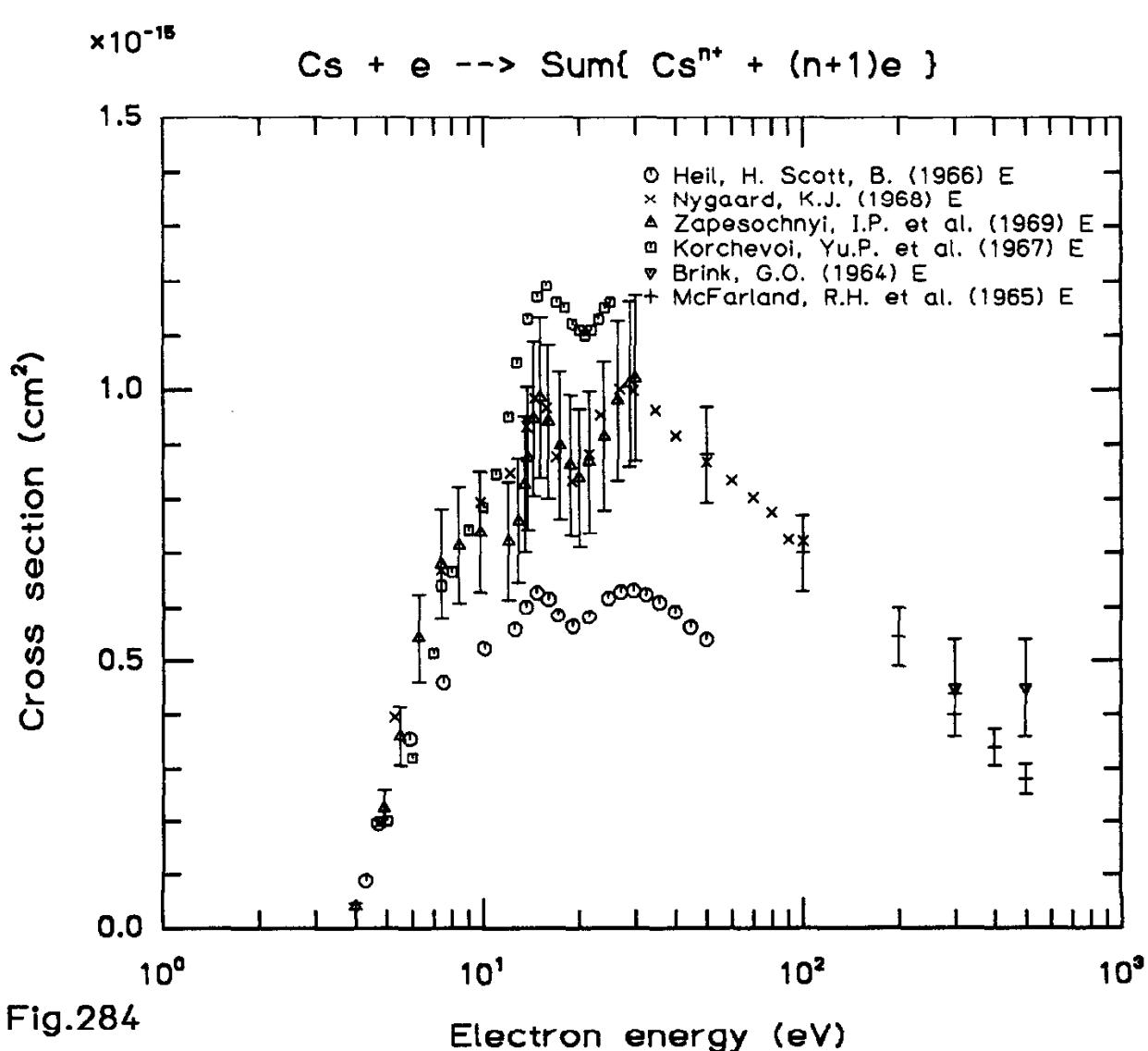


Fig.284

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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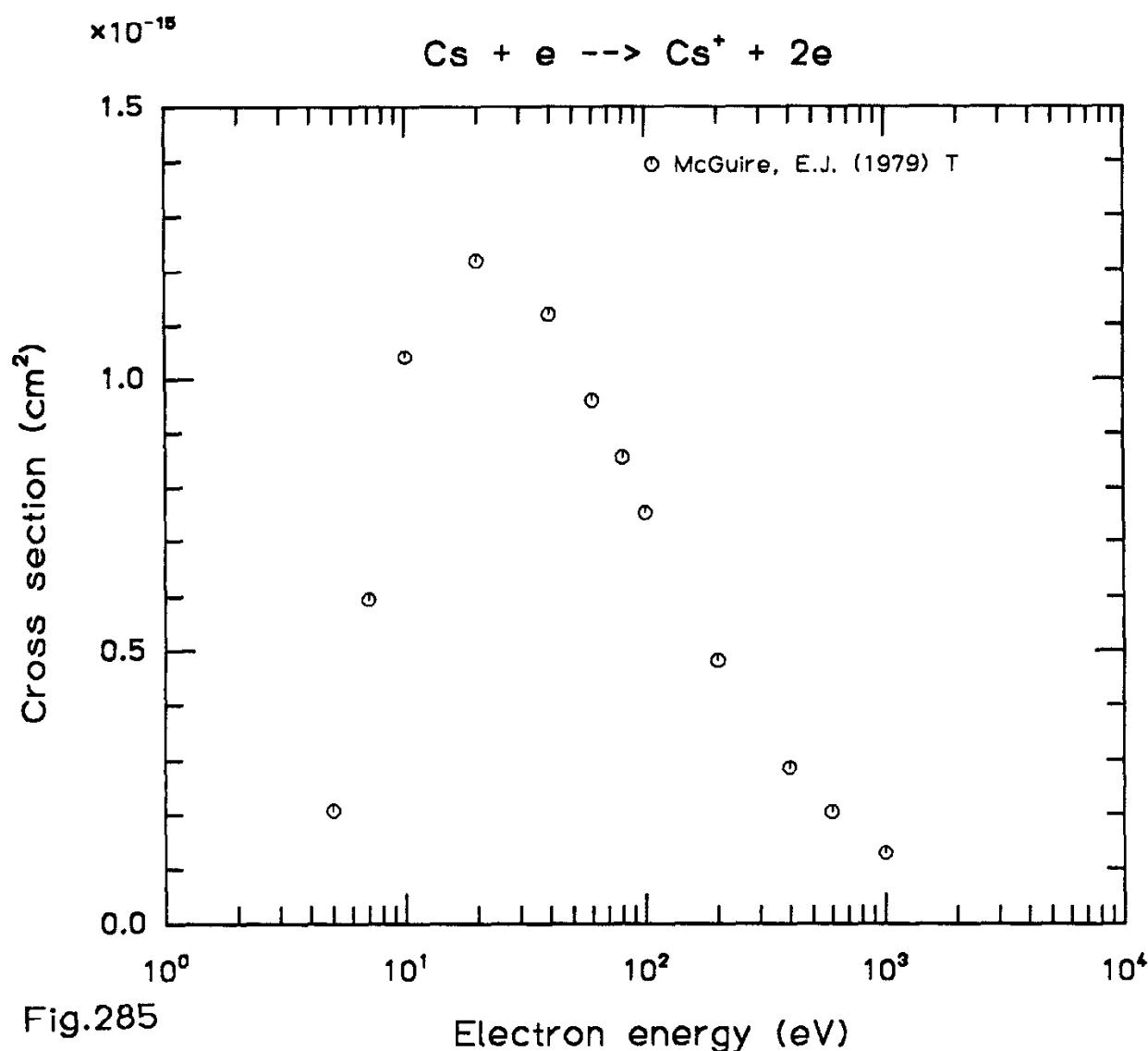


Fig.285

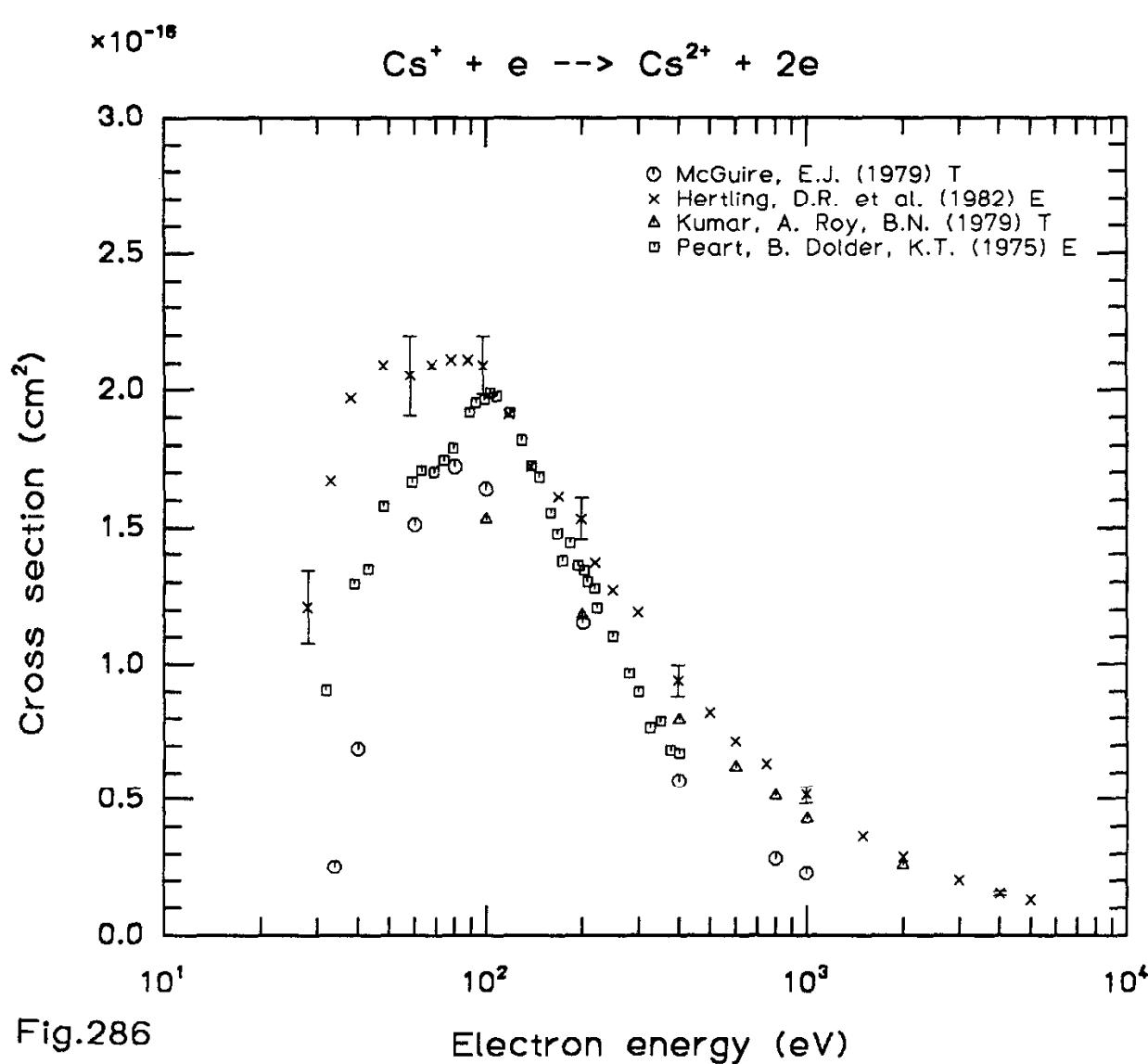


Fig.286

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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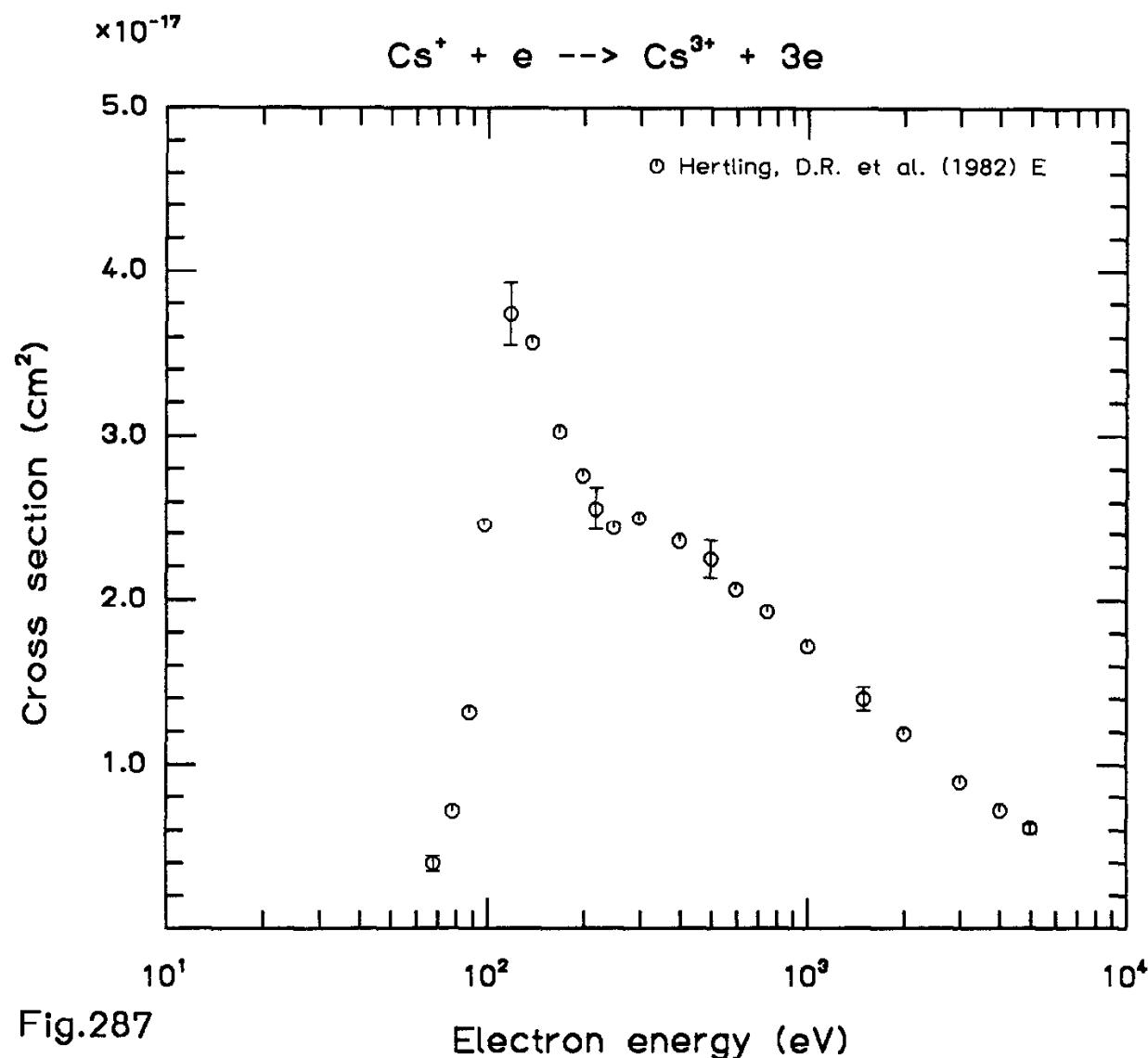


Fig.287

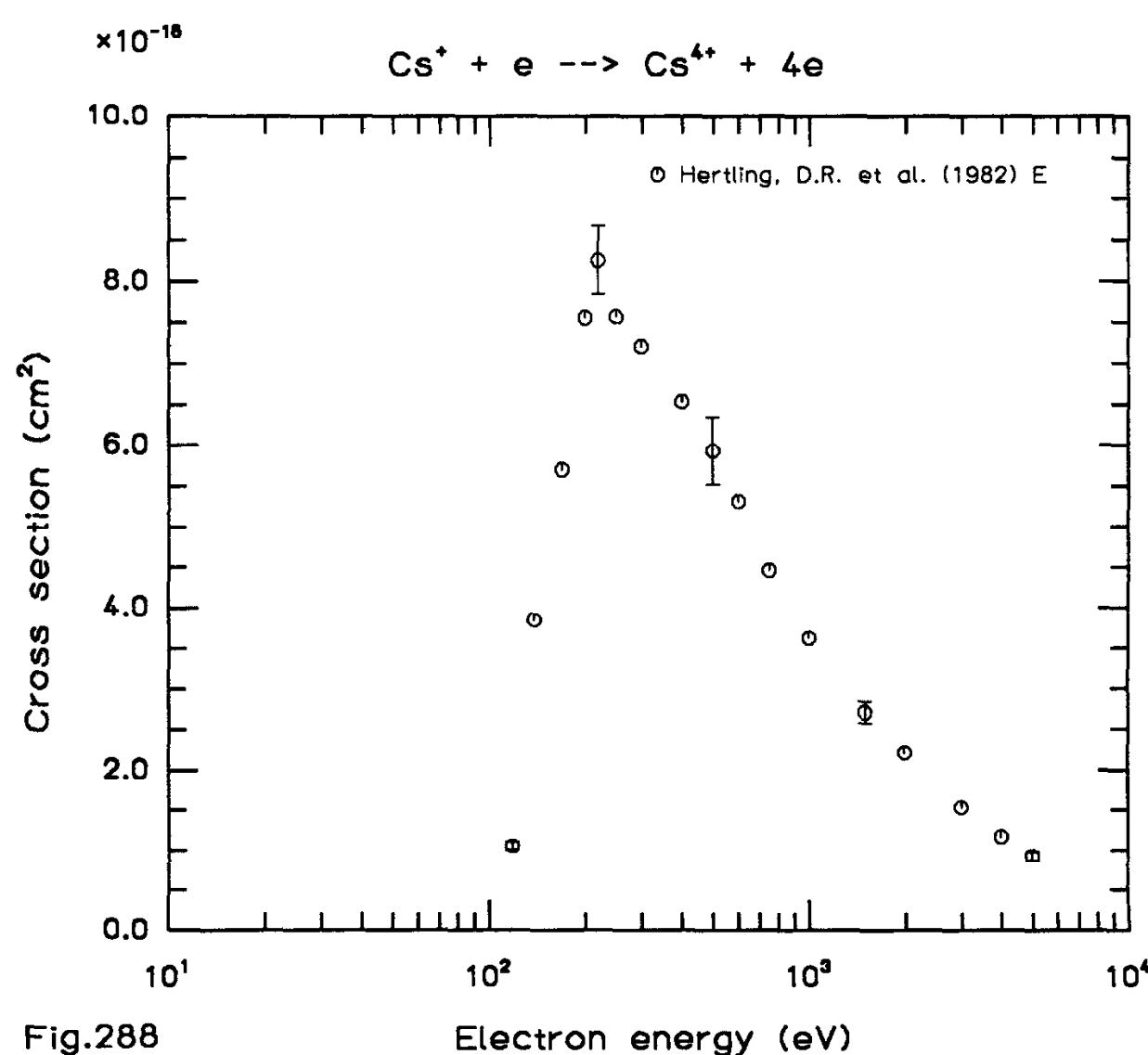


Fig.288

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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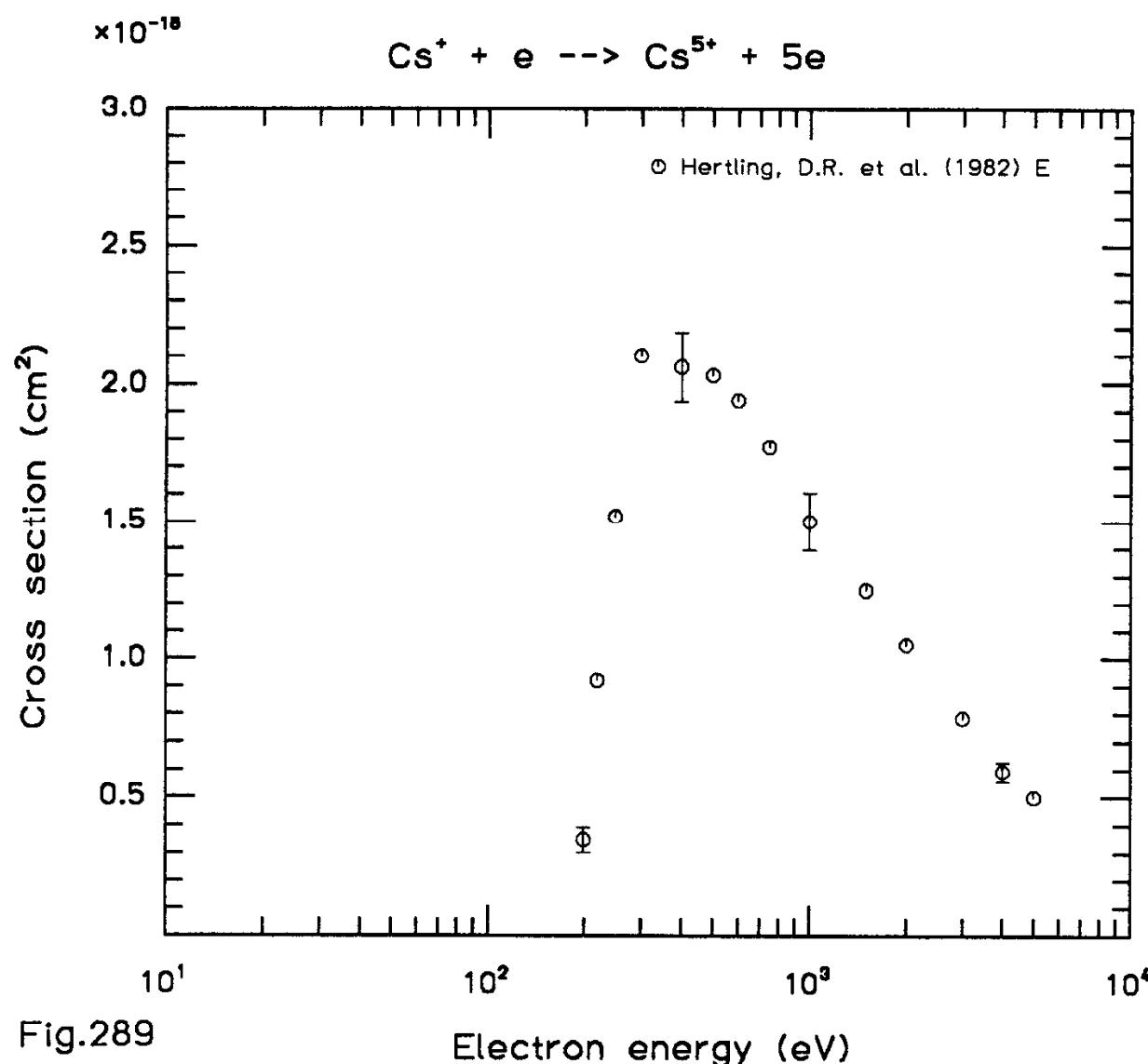


Fig.289

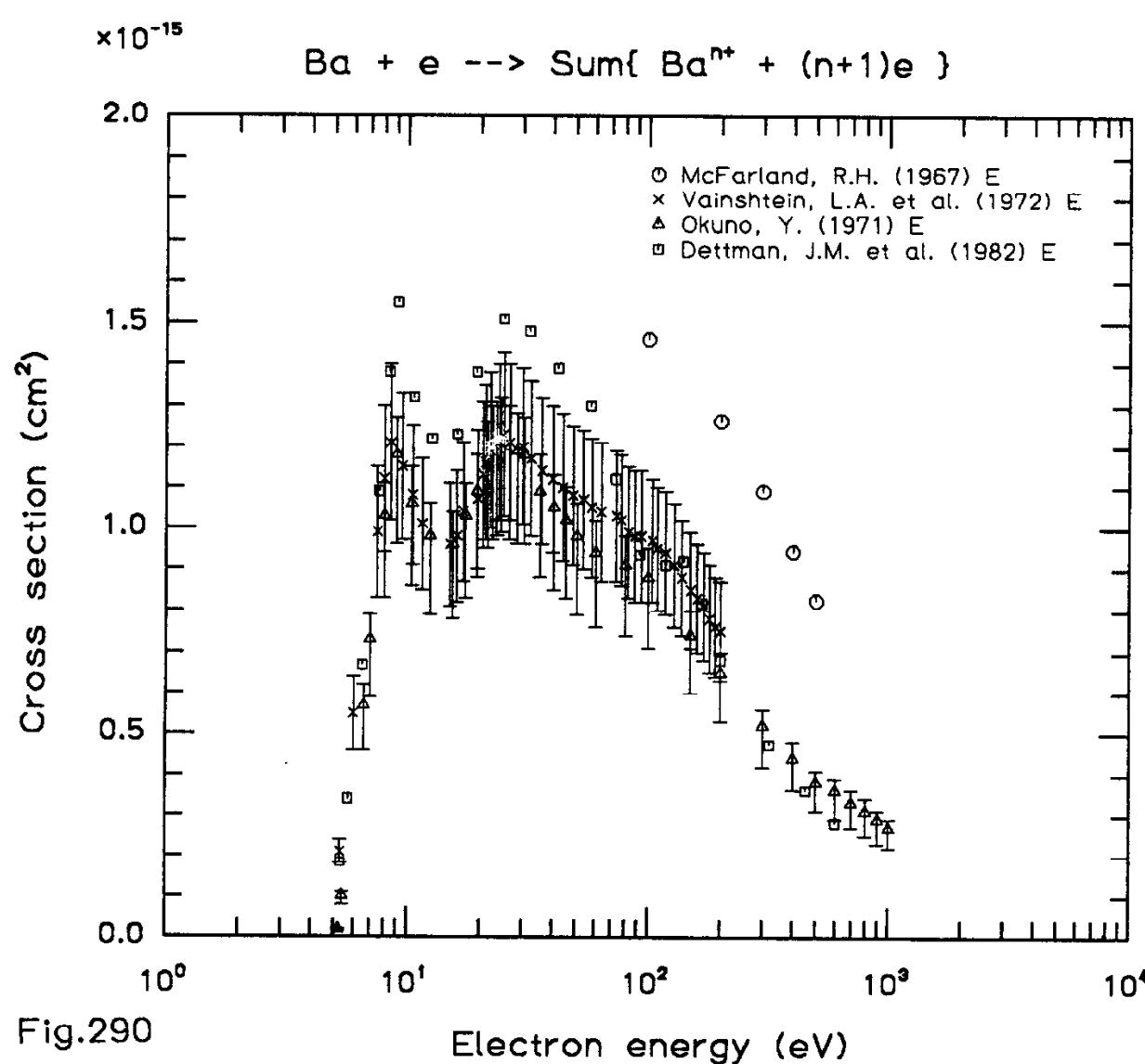


Fig.290

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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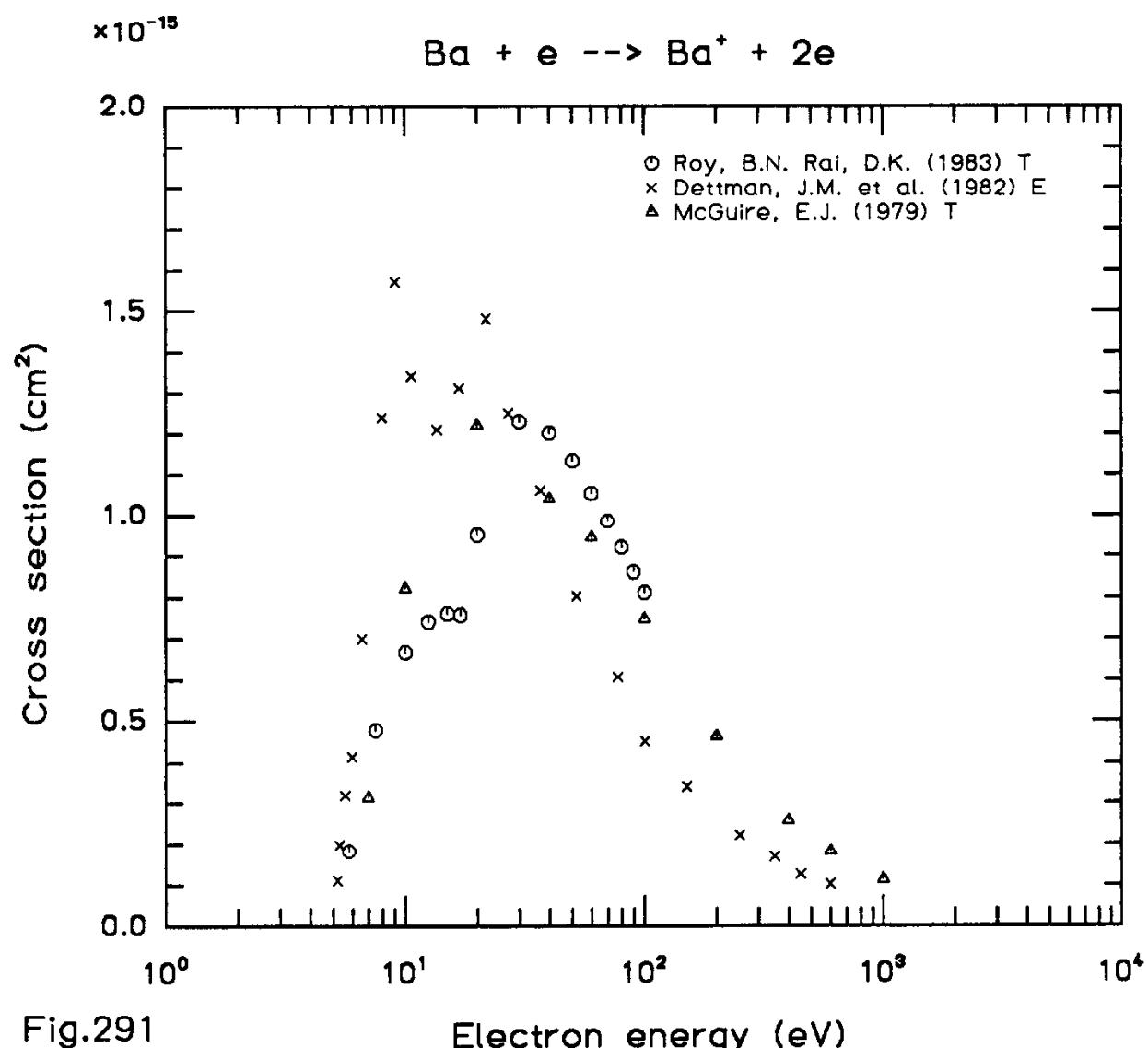


Fig.291

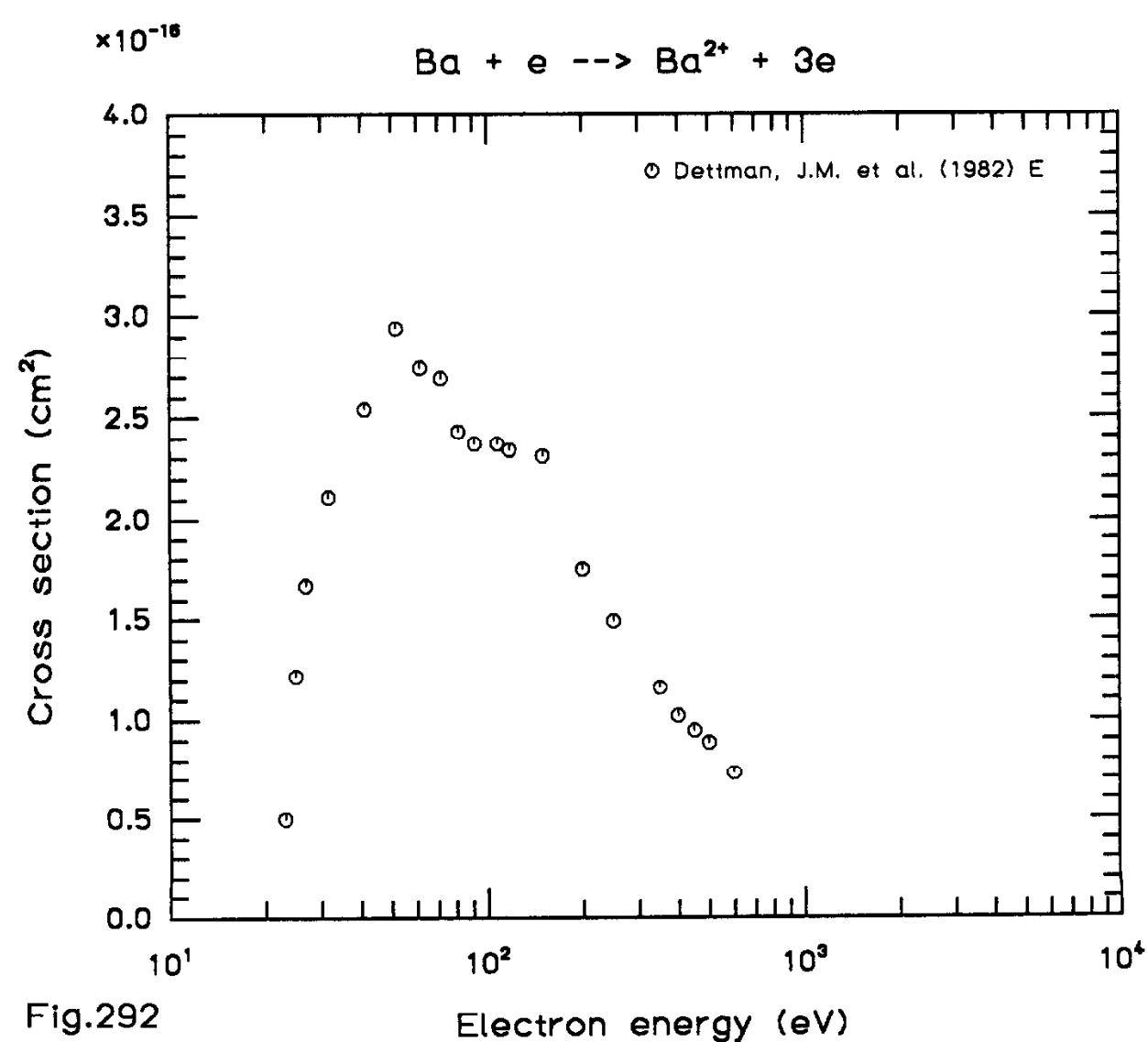


Fig.292

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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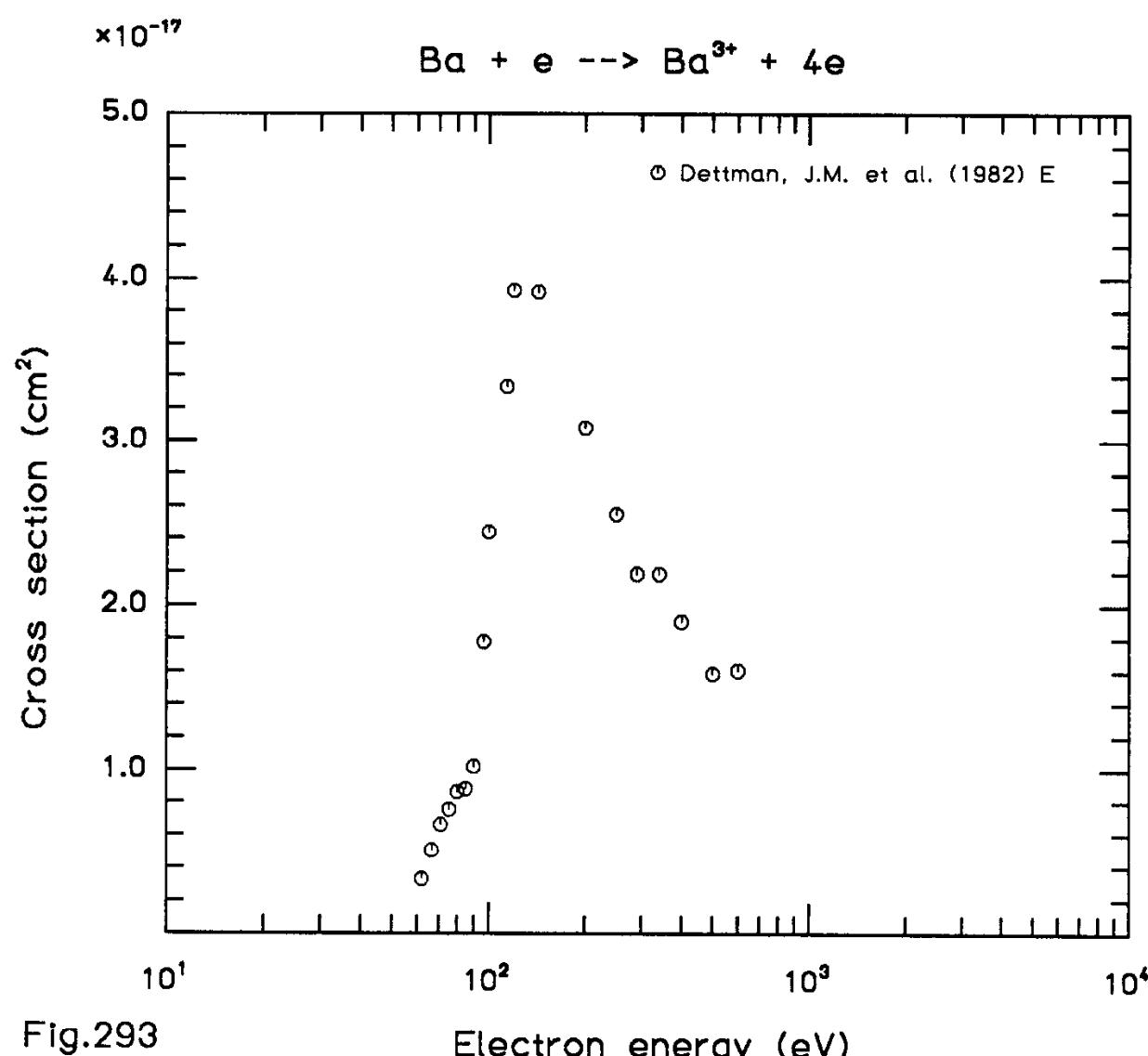


Fig.293

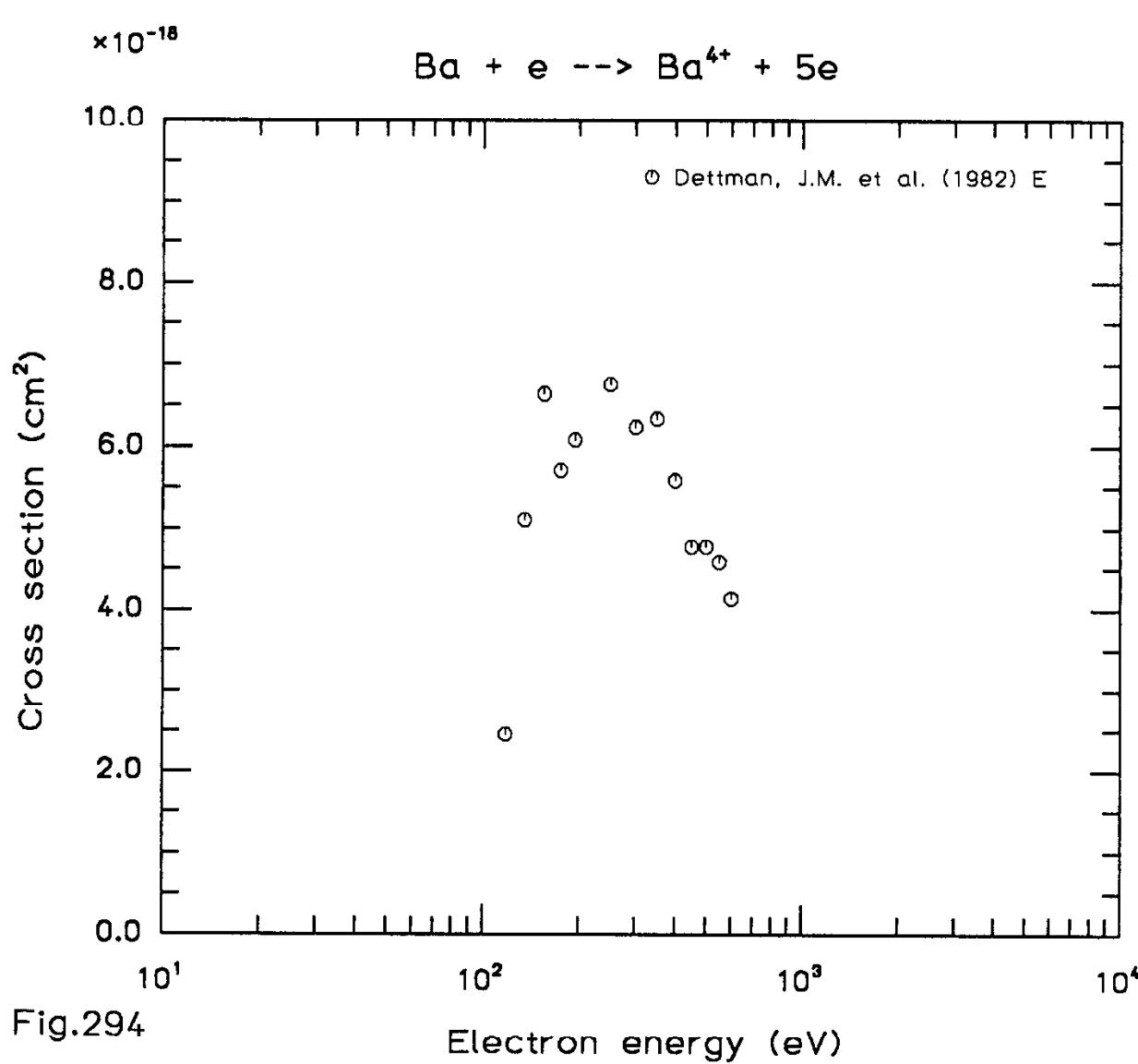


Fig.294

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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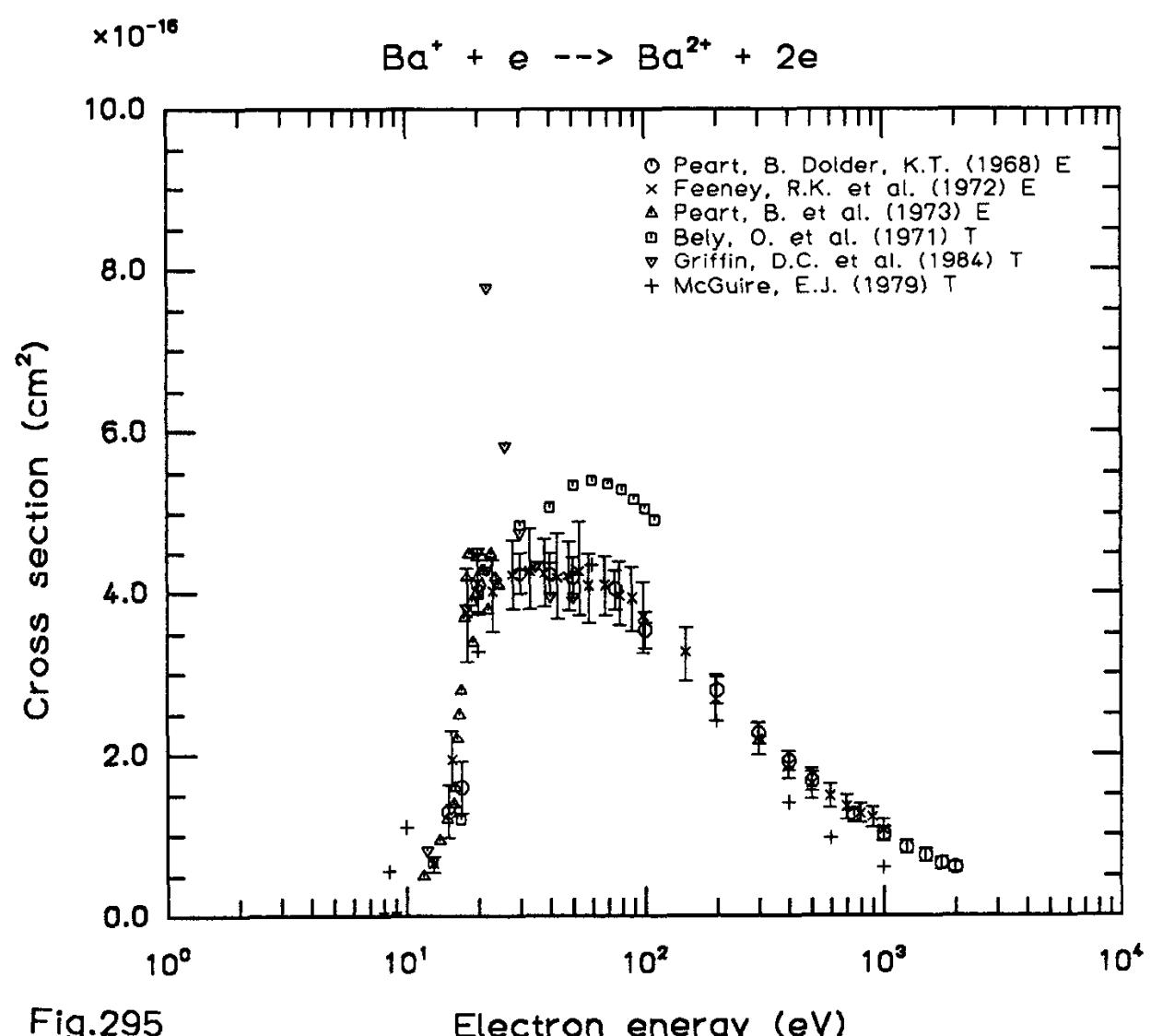


Fig.295

Electron energy (eV)

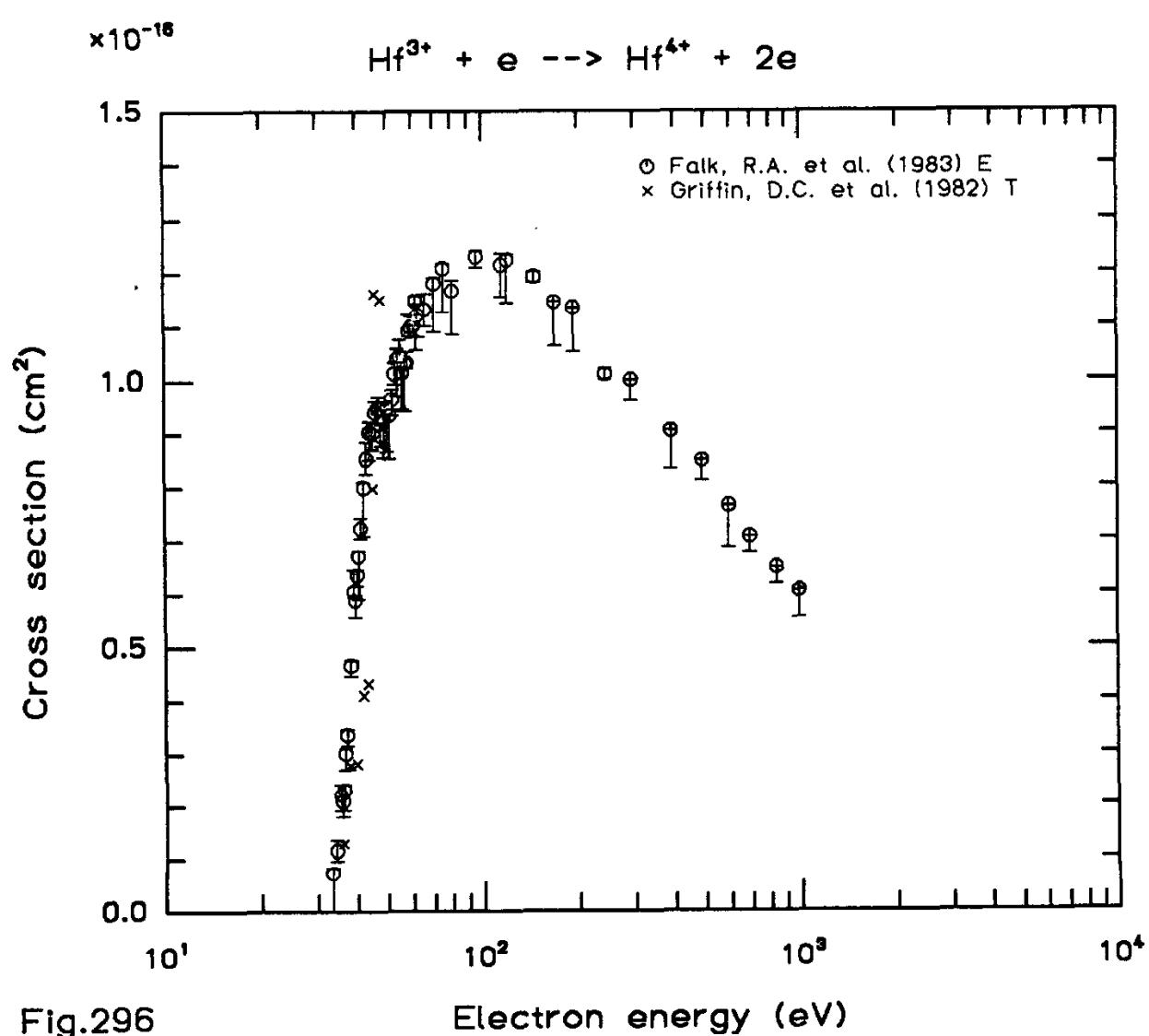


Fig.296

Electron energy (eV)

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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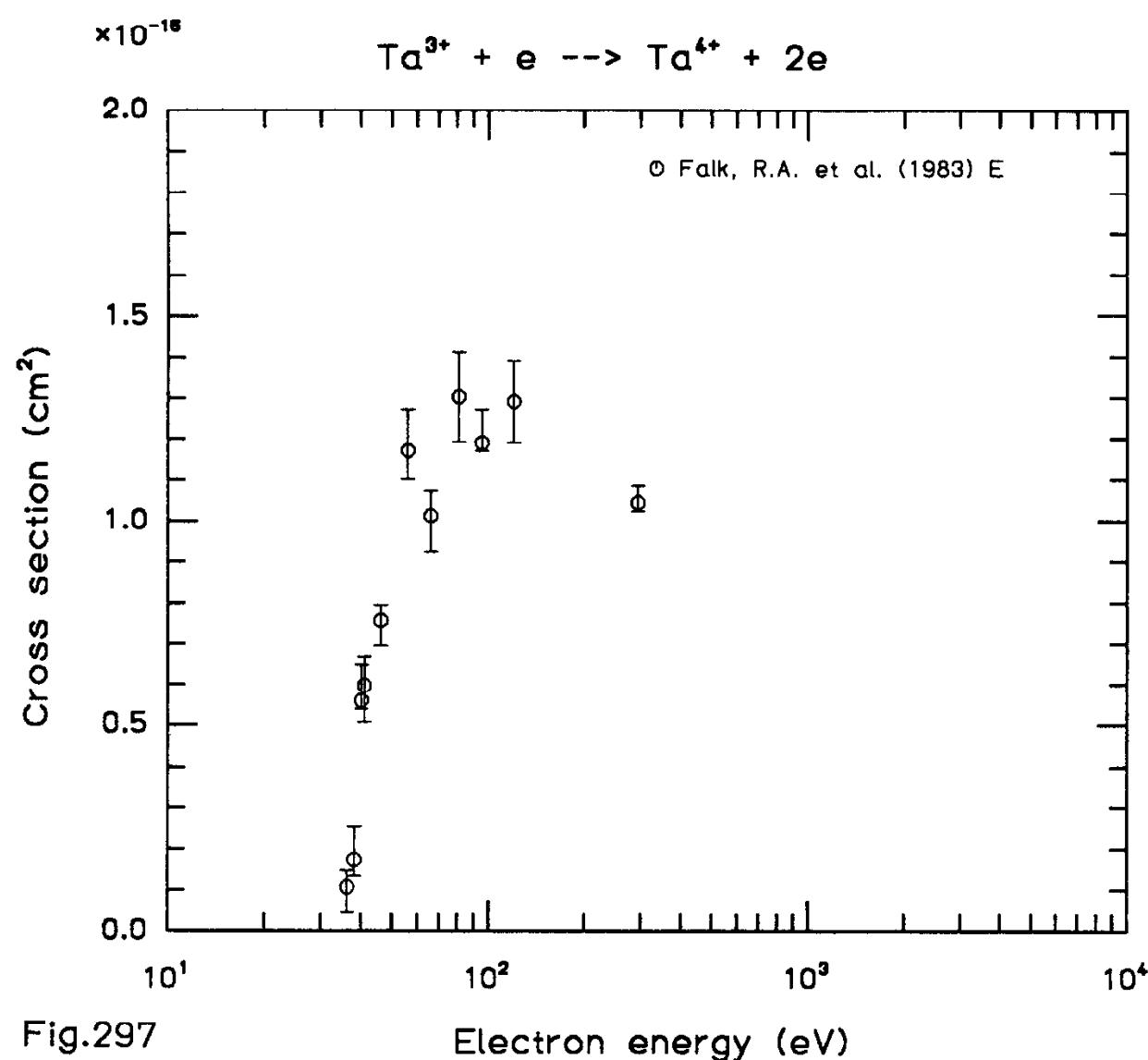


Fig.297

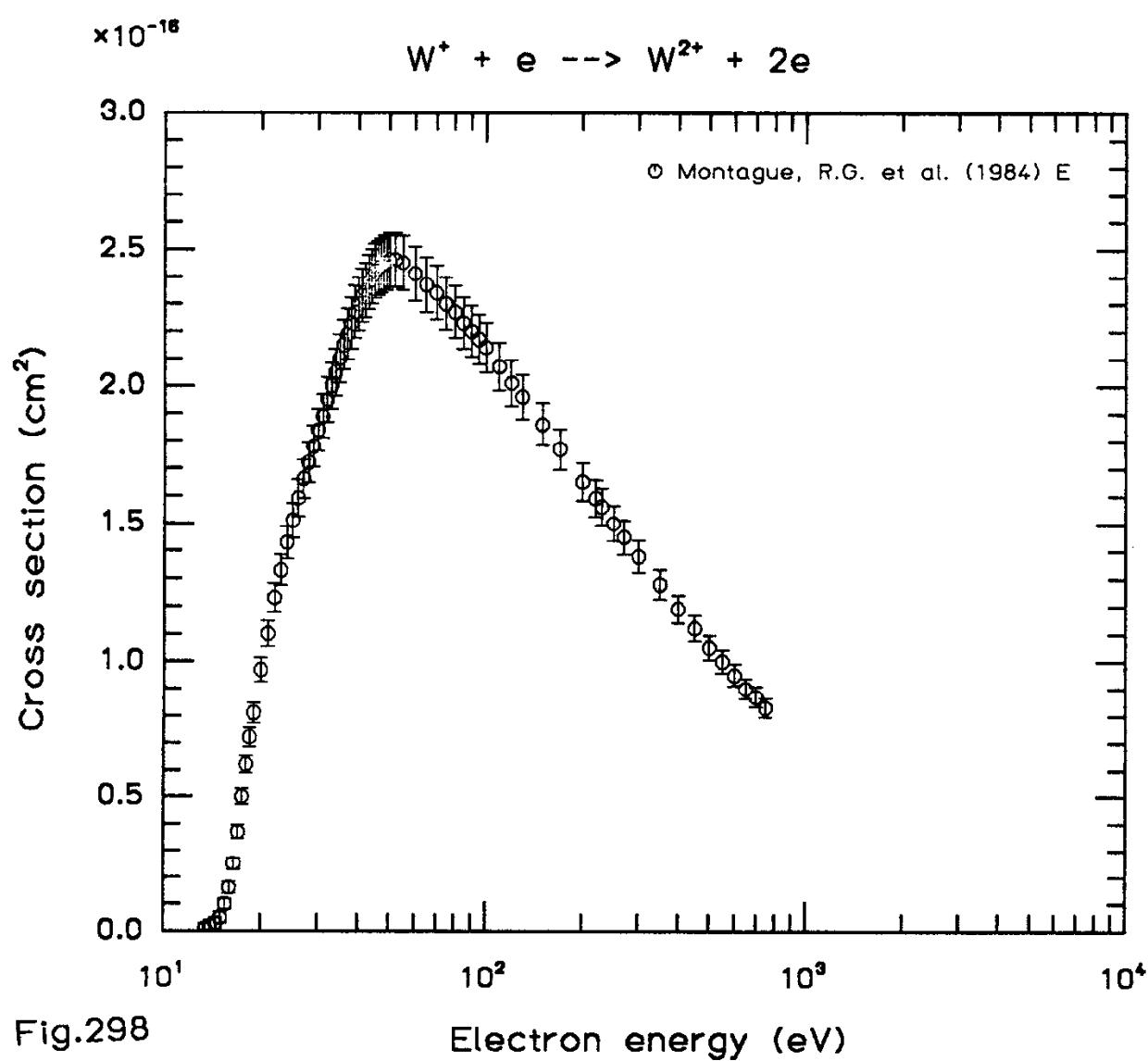


Fig.298

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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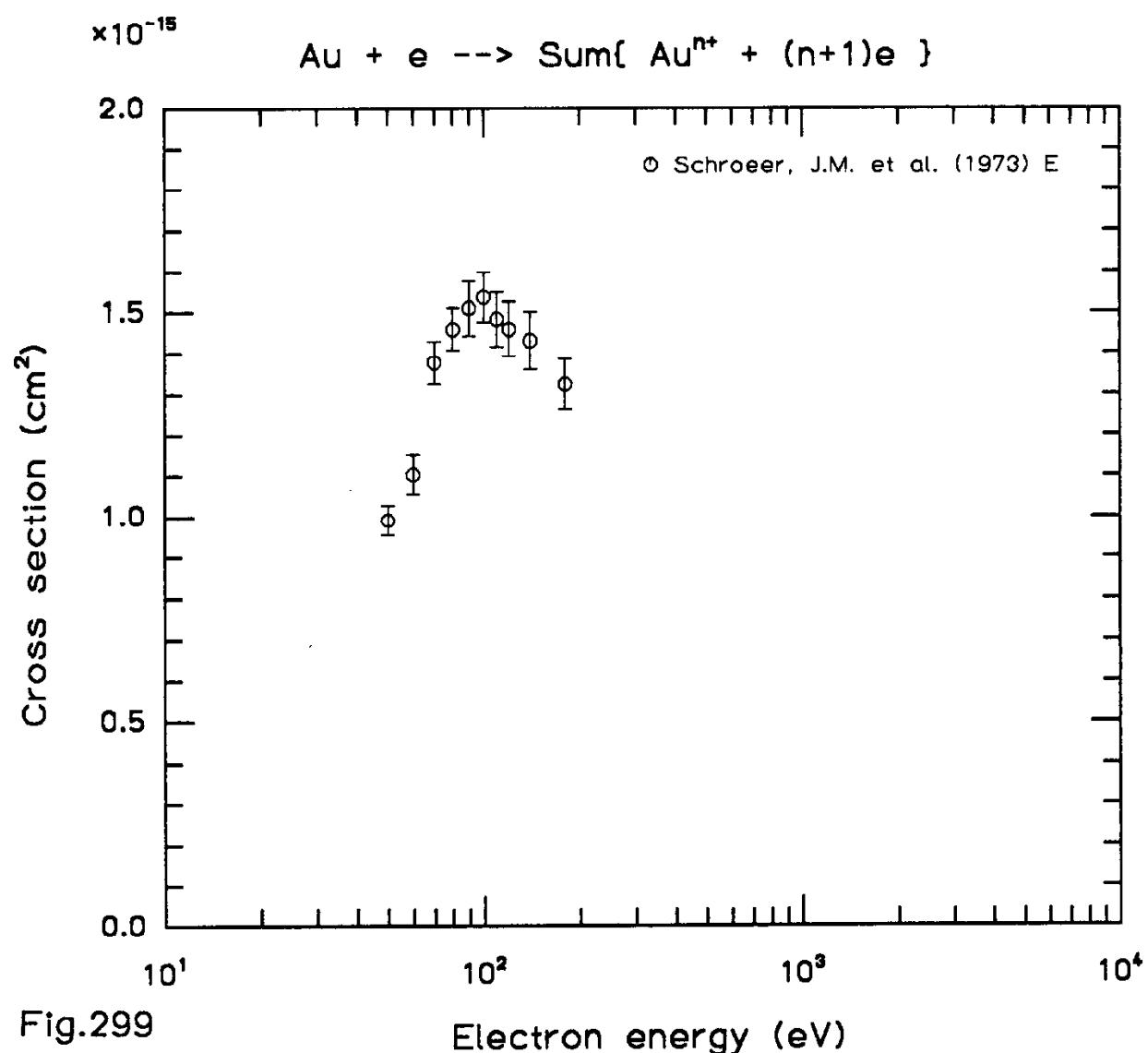


Fig.299

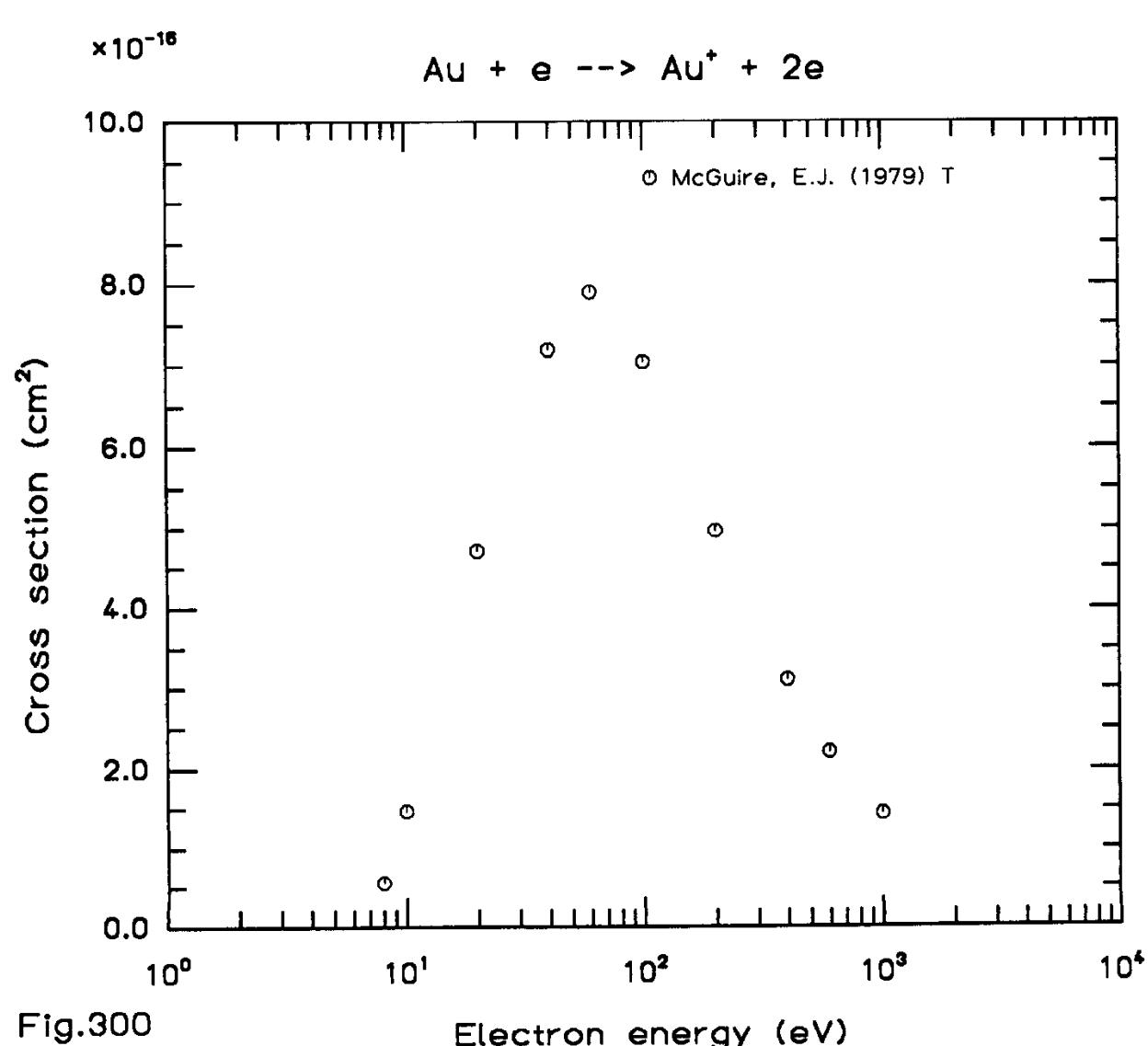


Fig.300

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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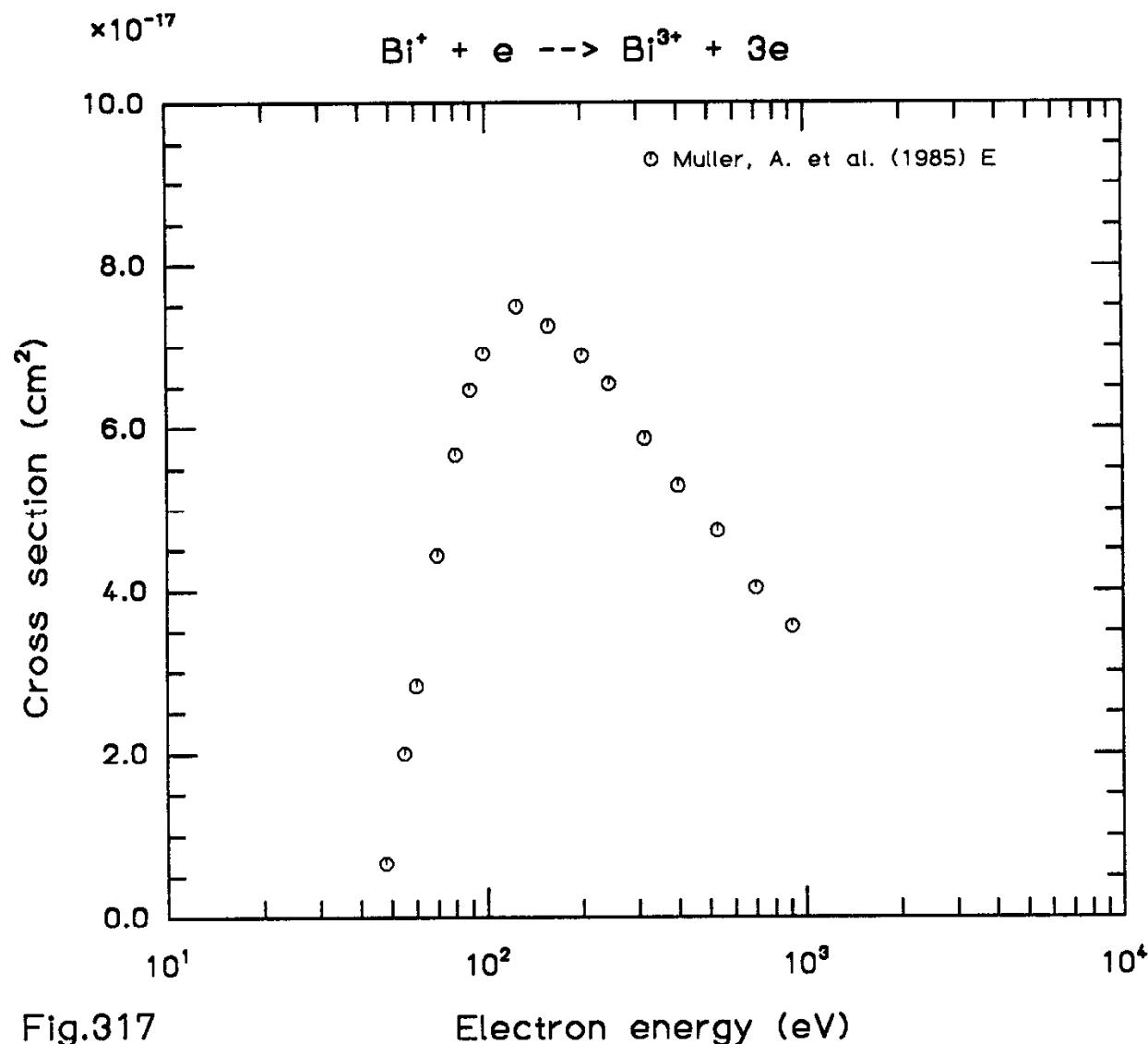


Fig.317

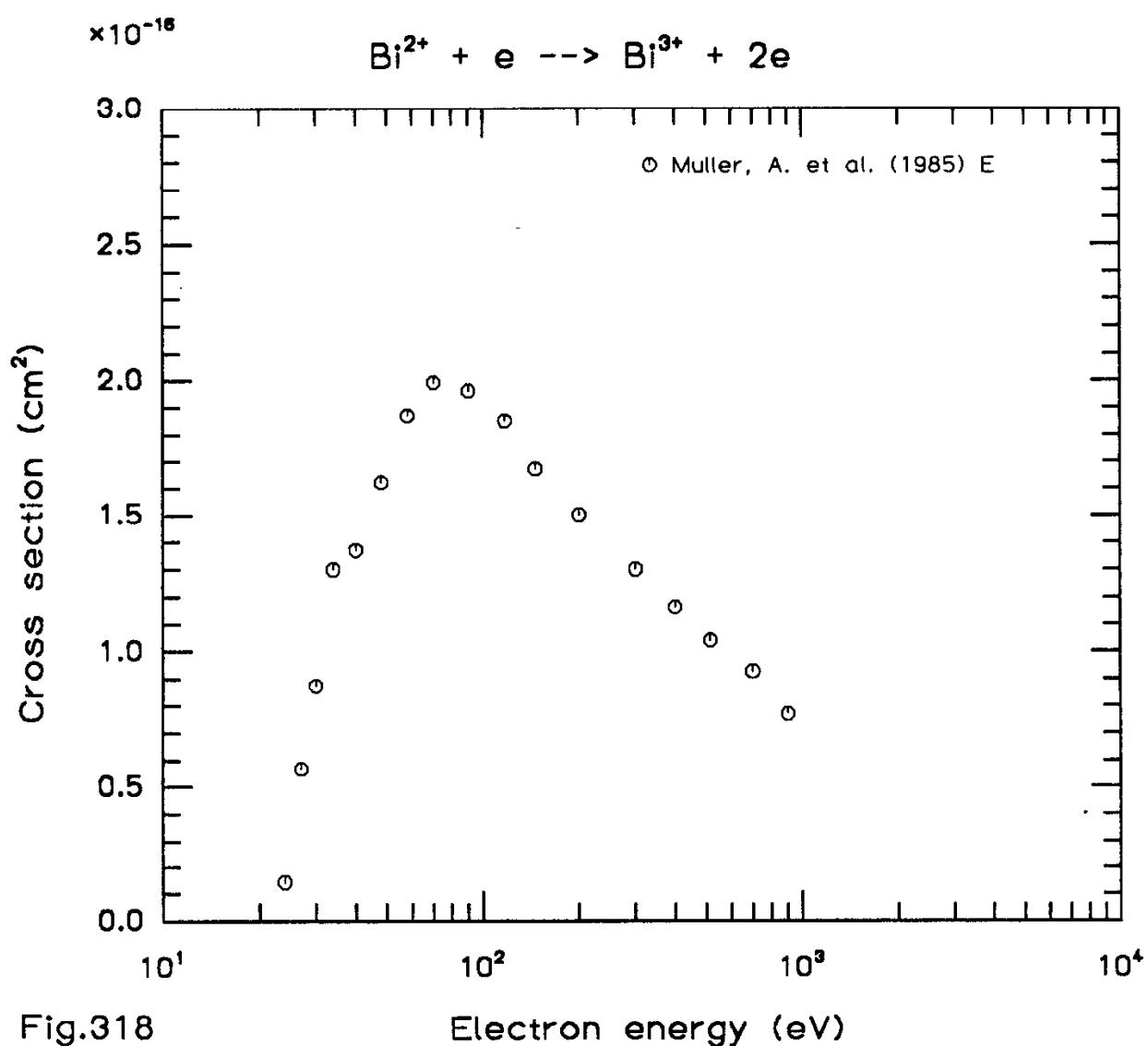


Fig.318

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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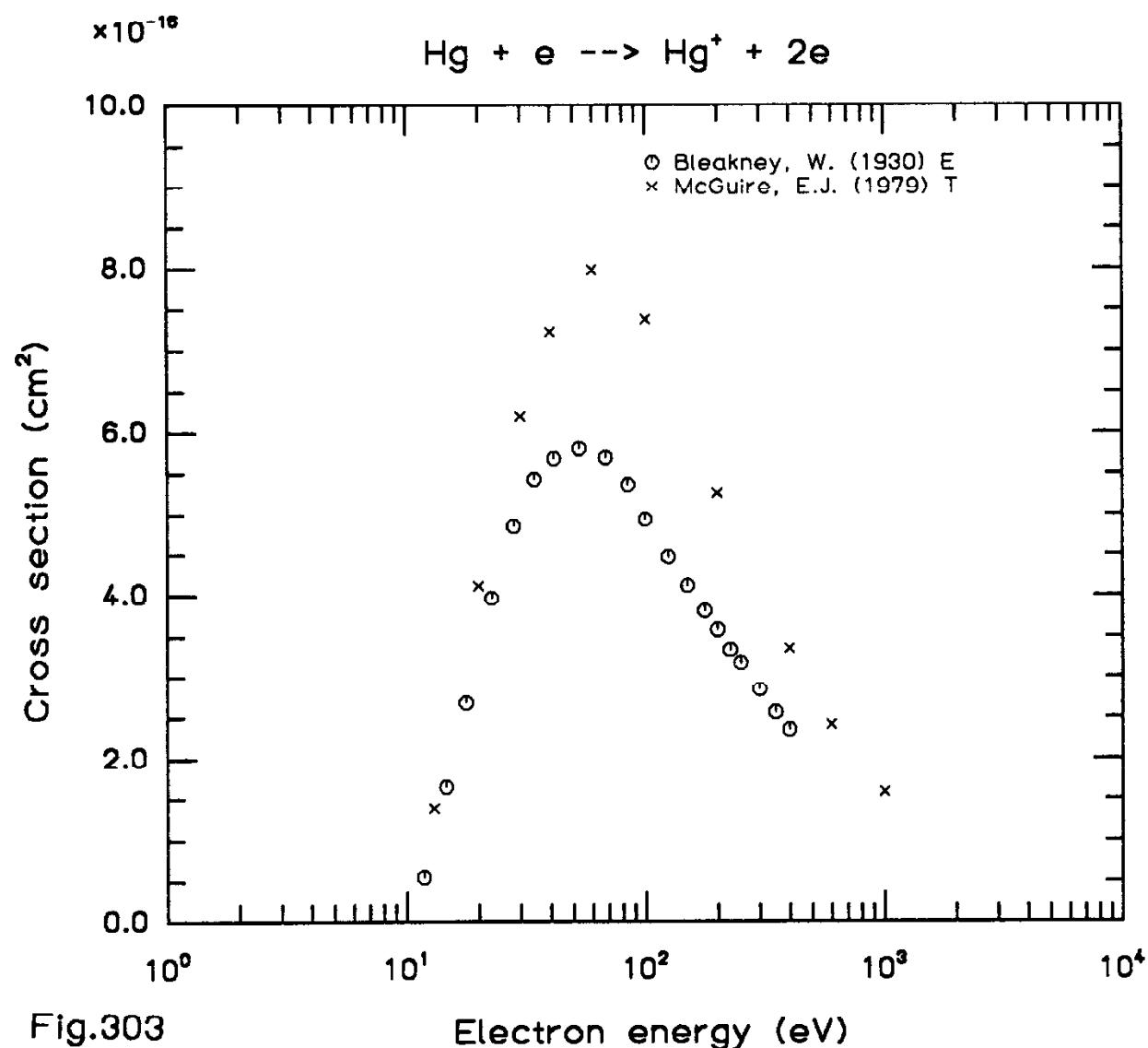


Fig.303

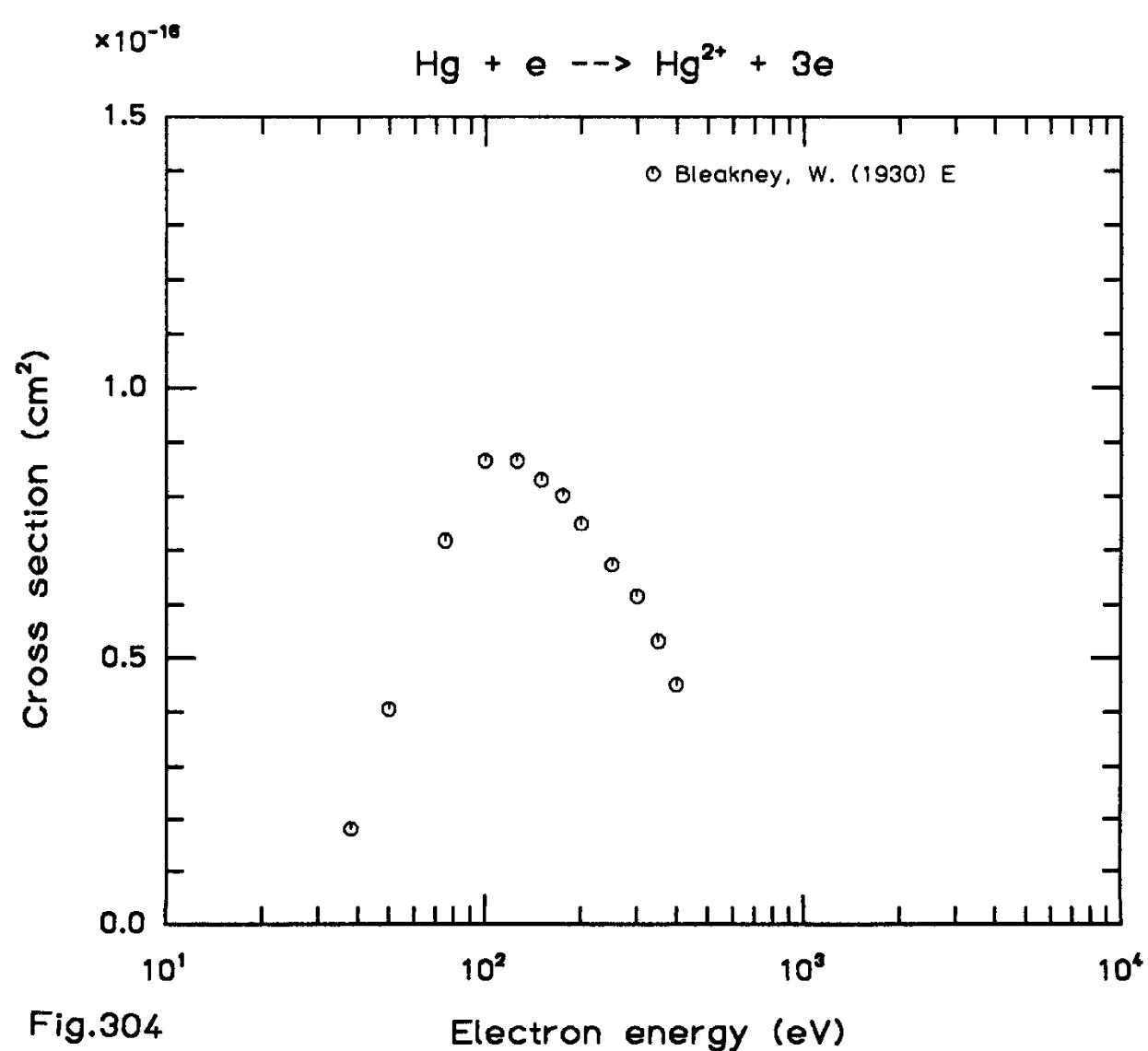


Fig.304

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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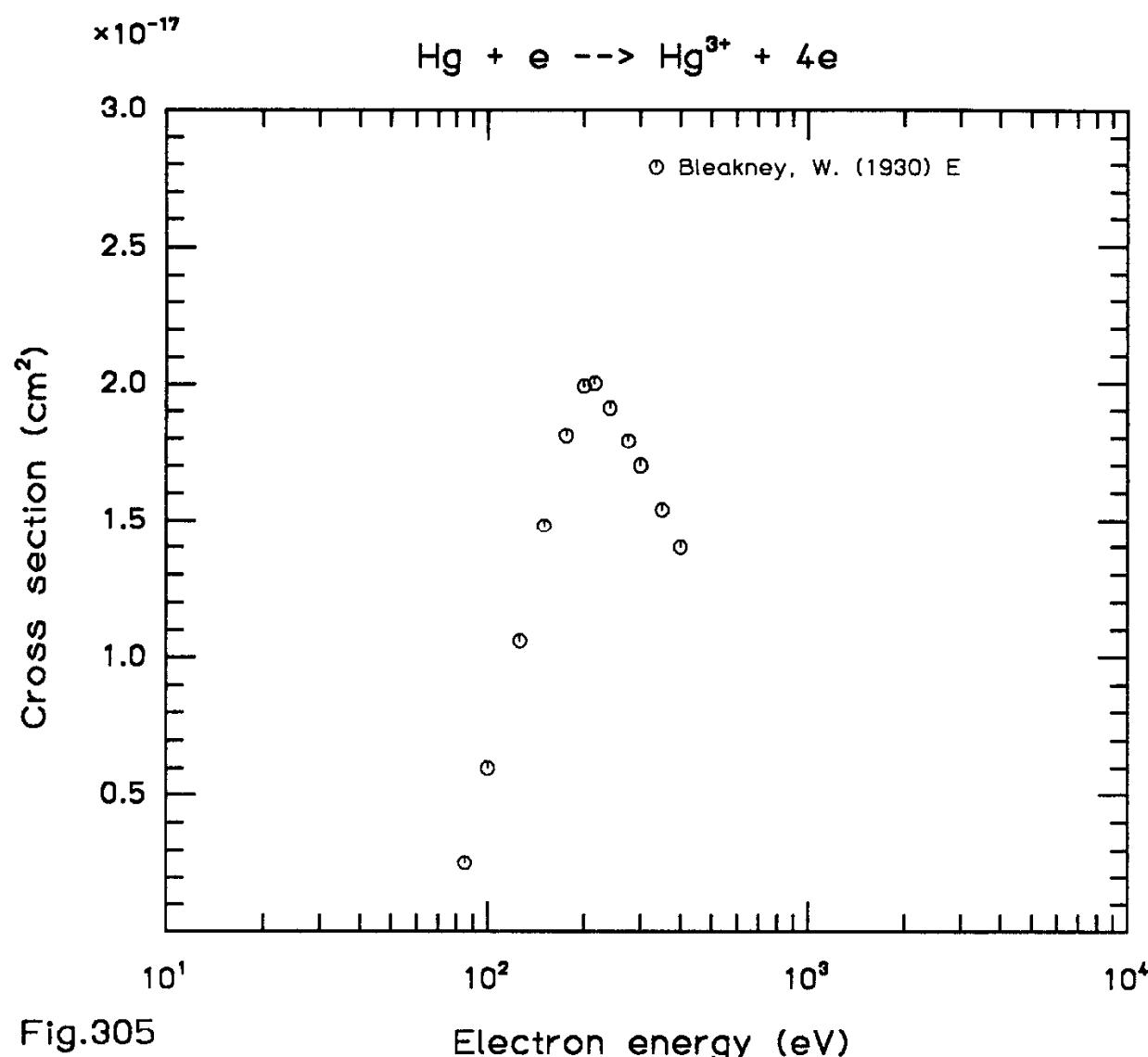


Fig.305

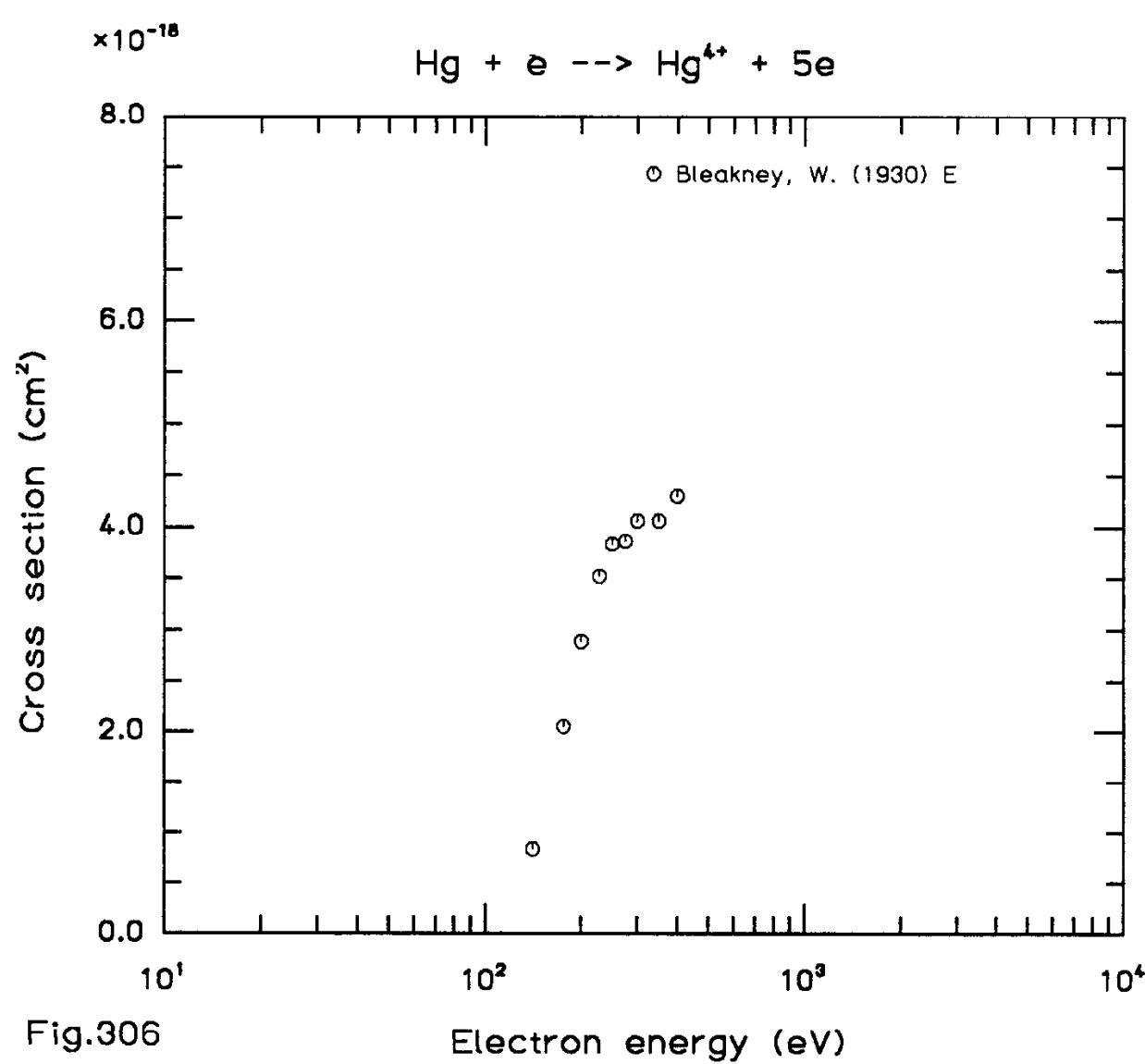
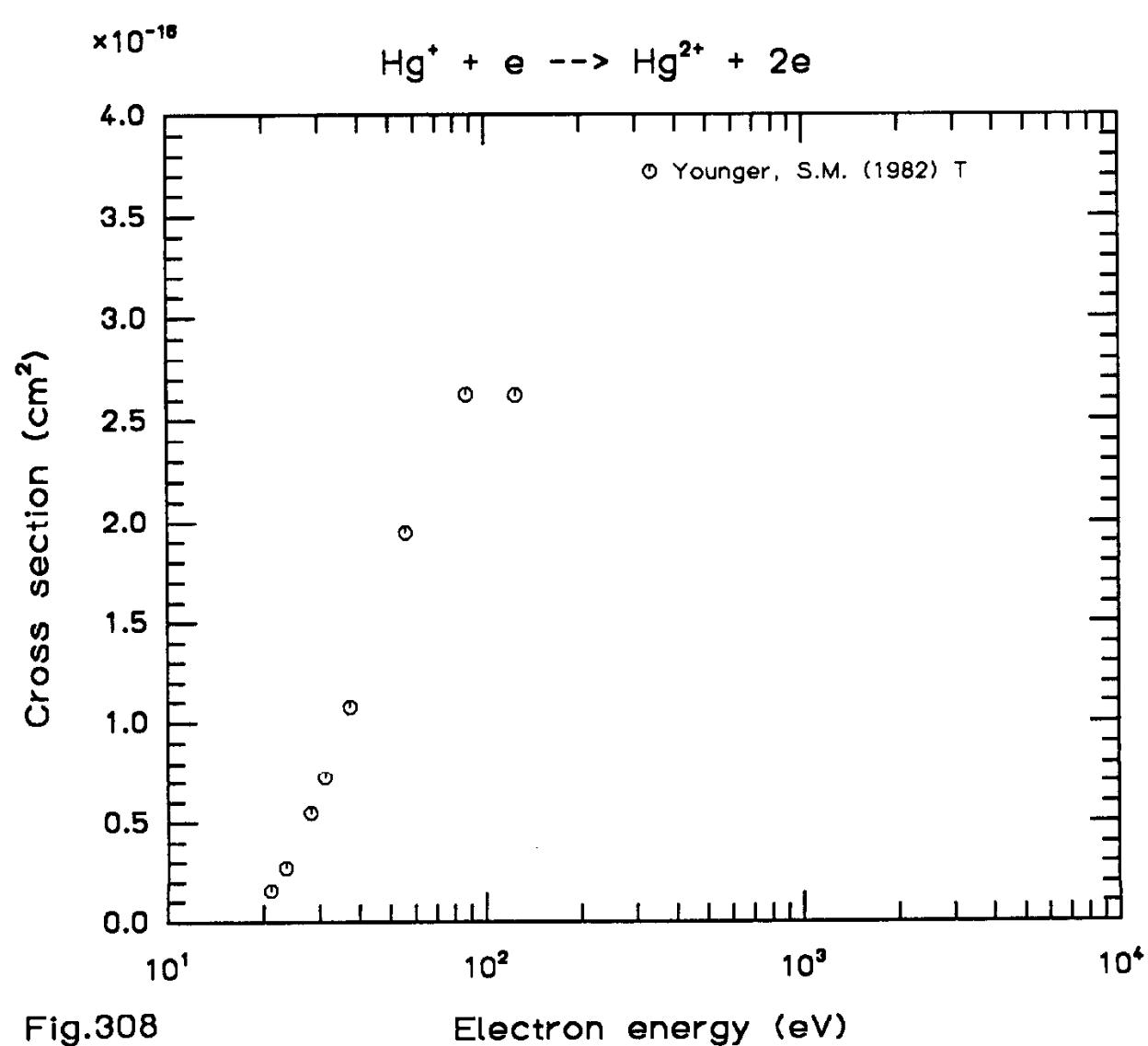
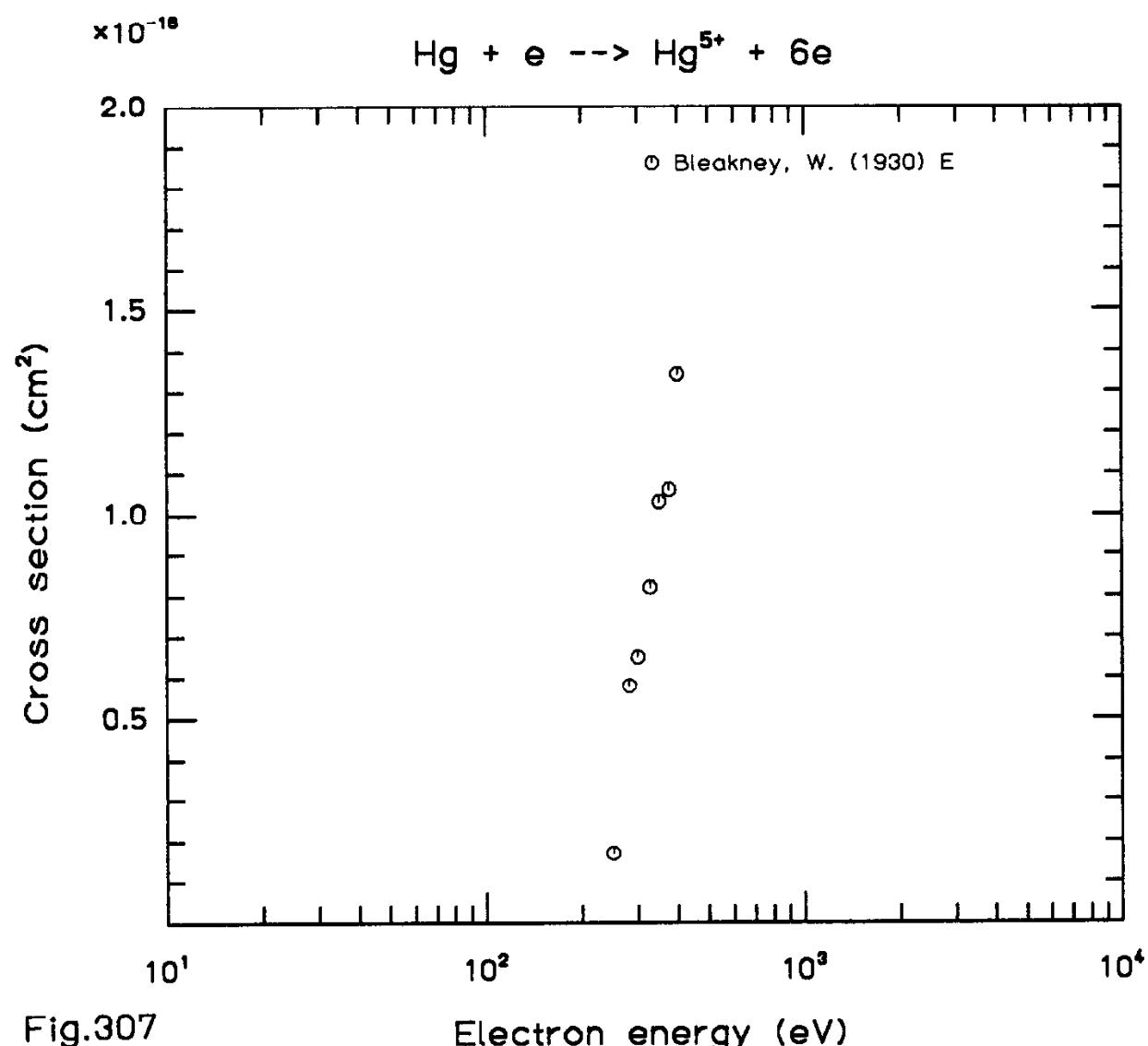


Fig.306

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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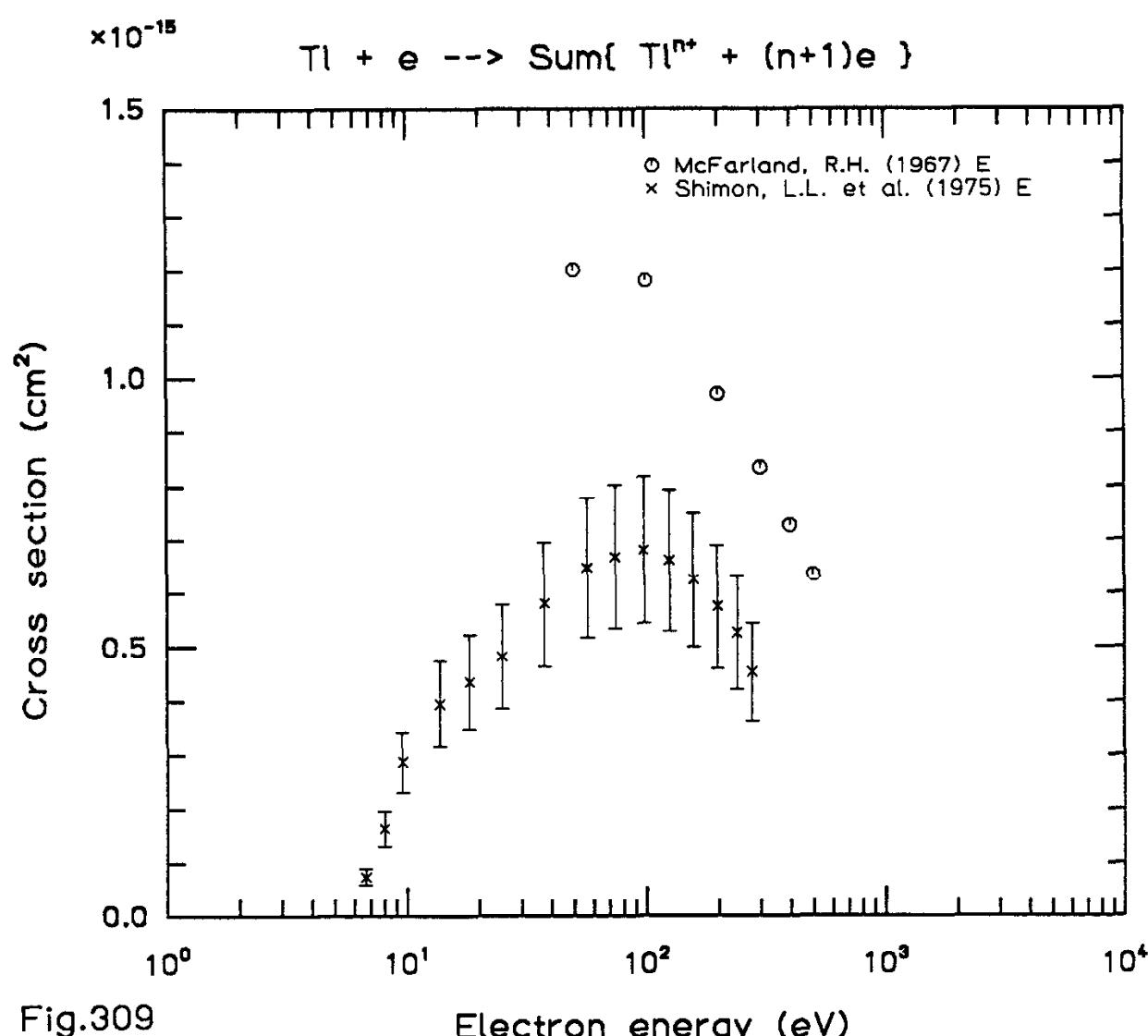


Fig.309

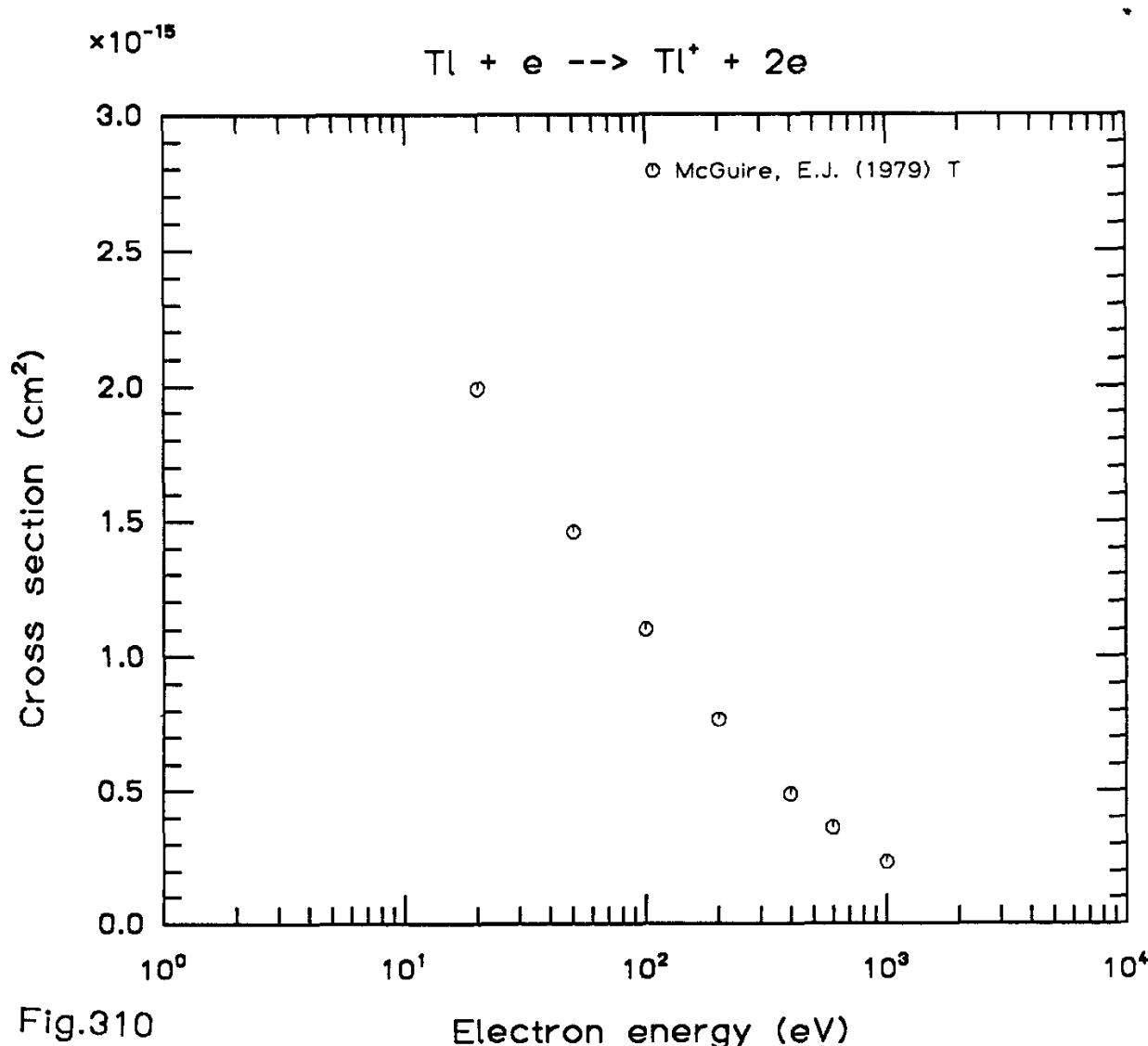


Fig.310

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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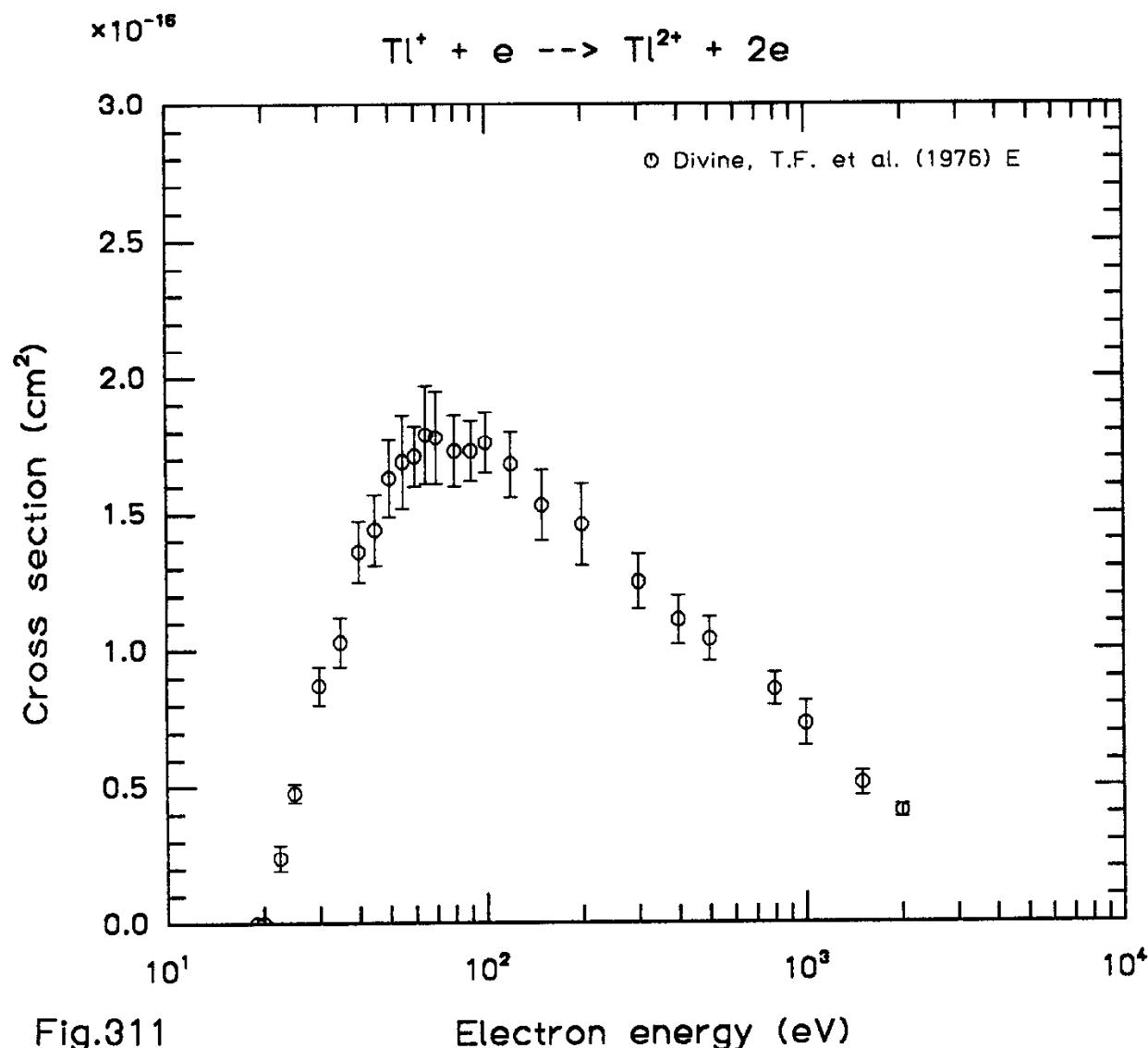


Fig.311

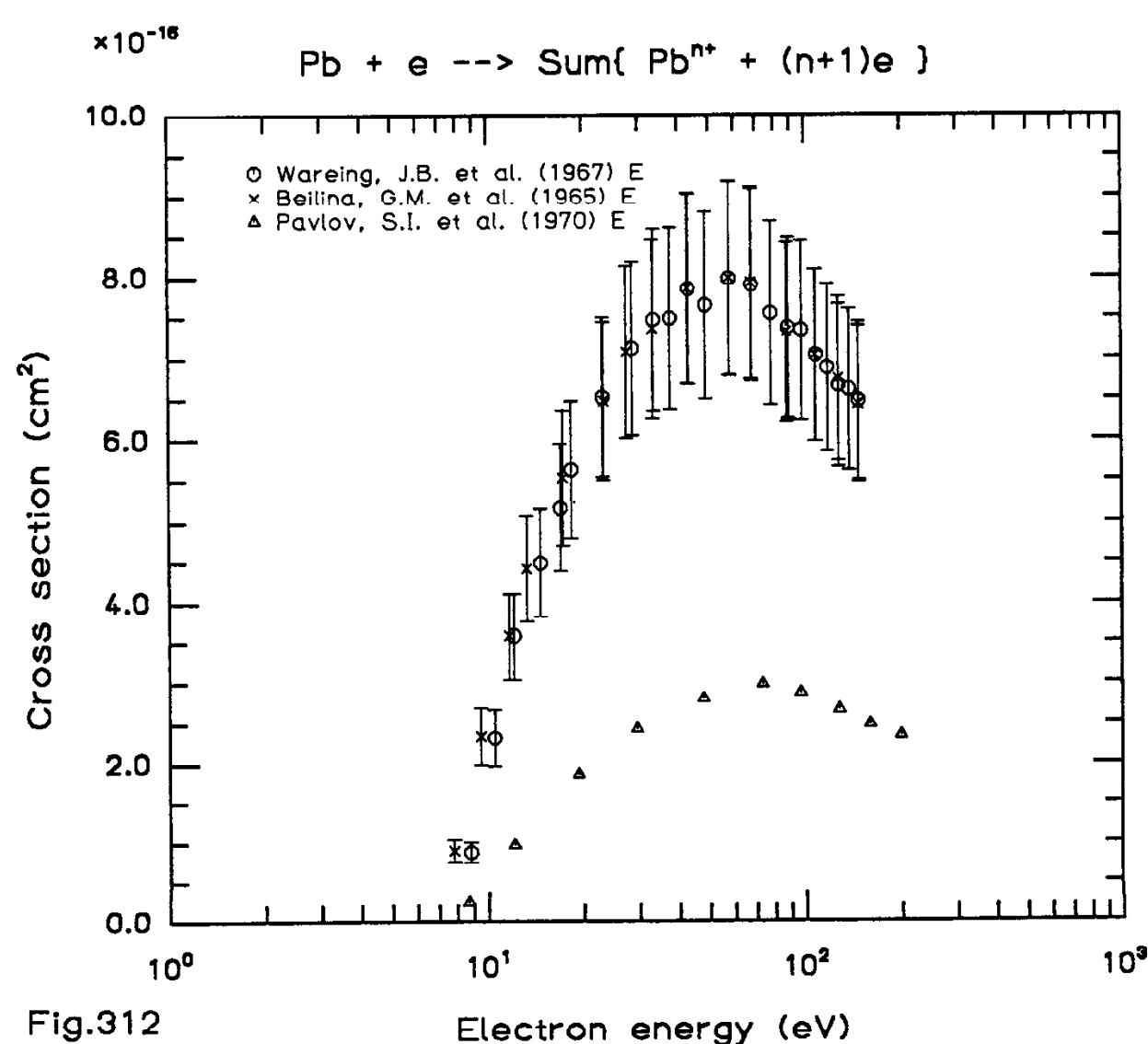


Fig.312

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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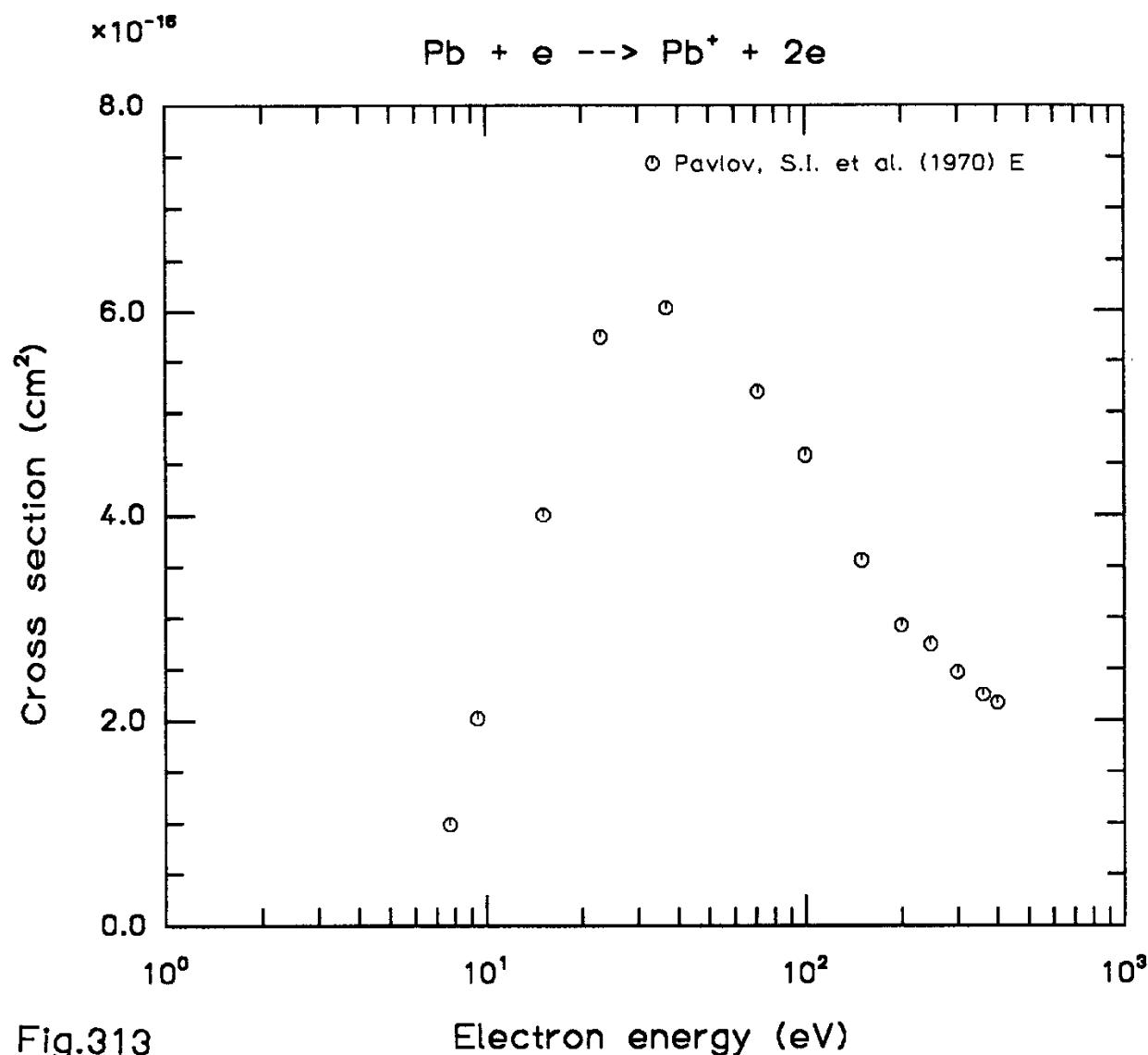


Fig.313

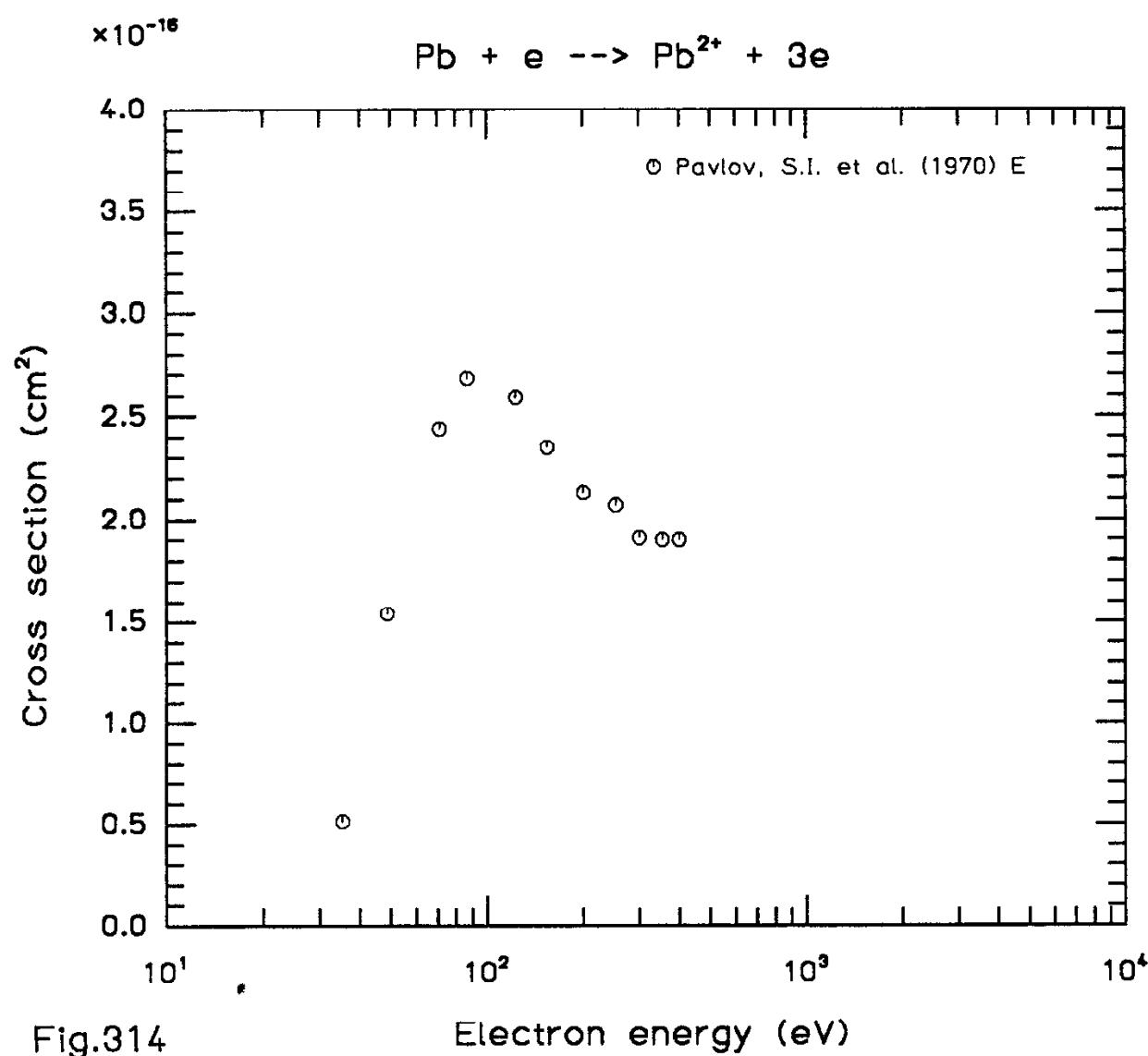
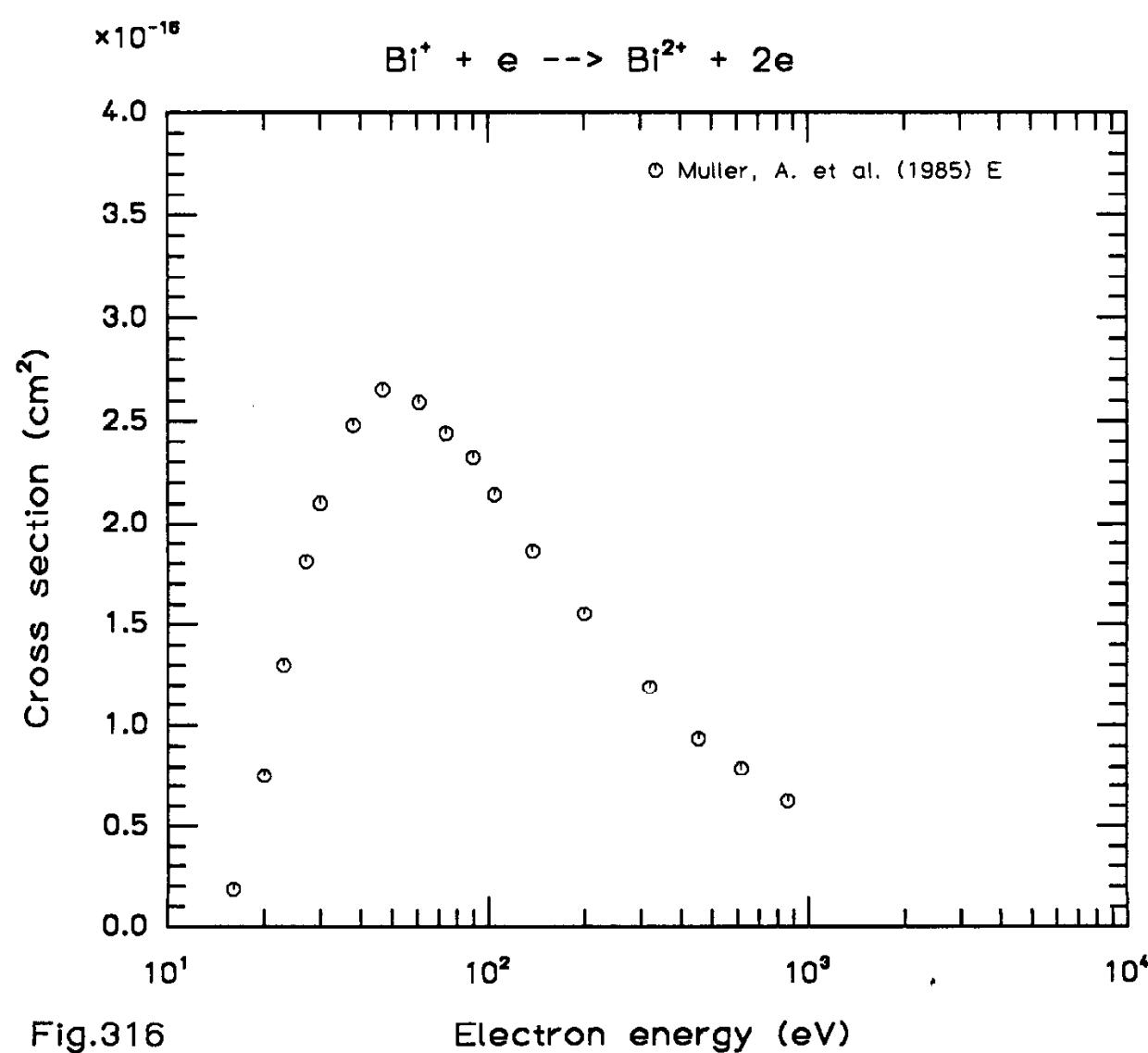
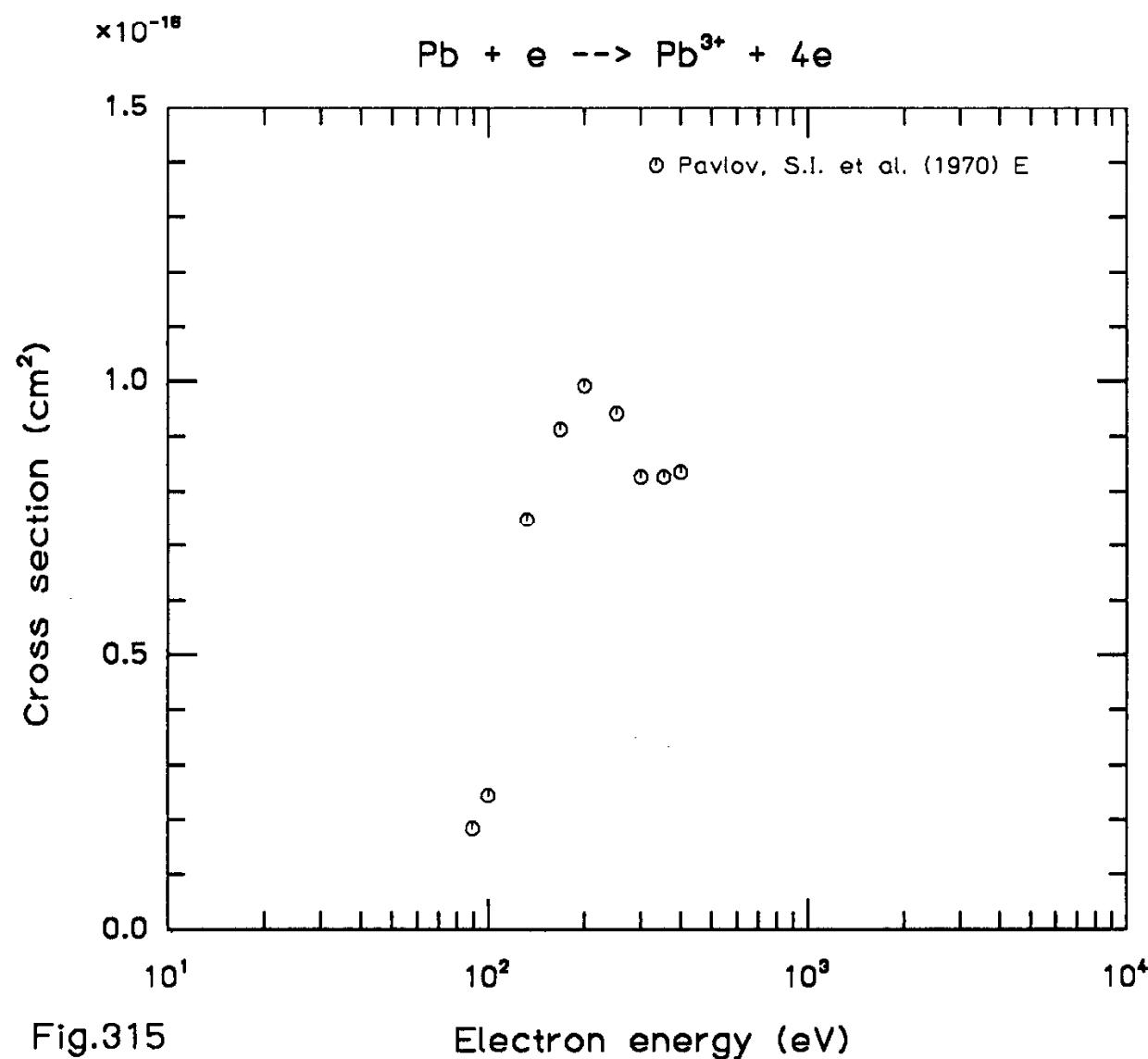


Fig.314

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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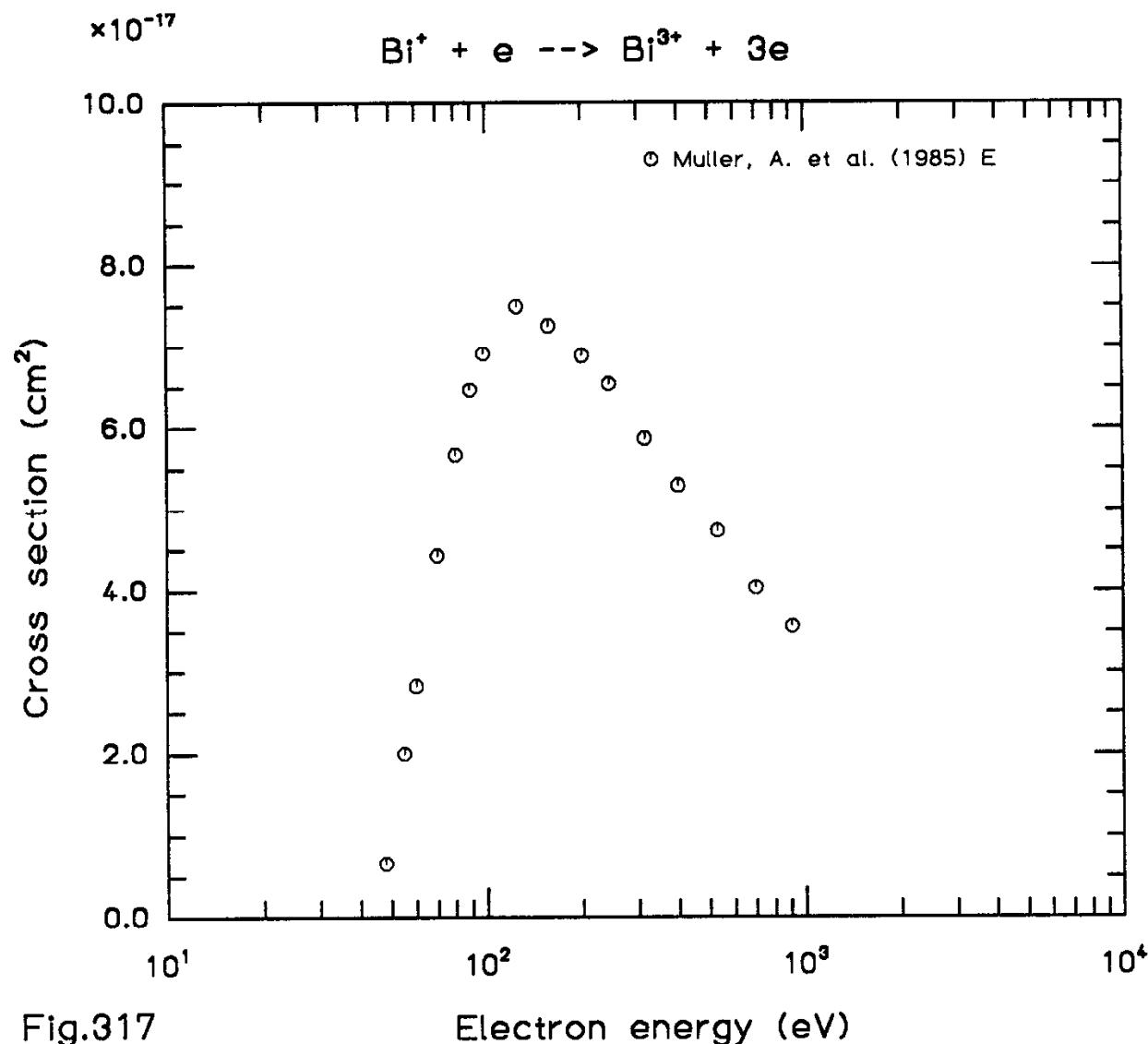


Fig.317

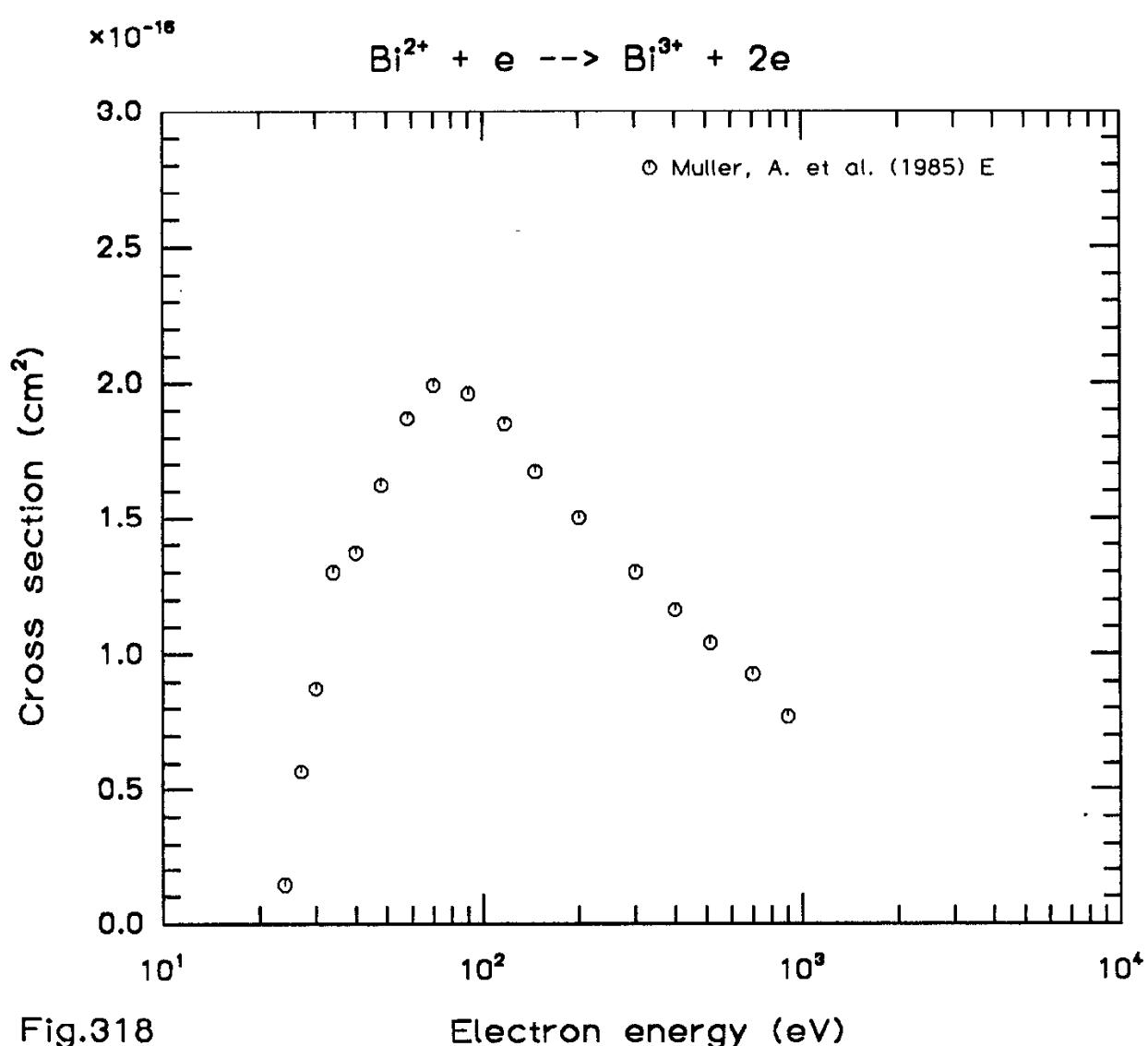
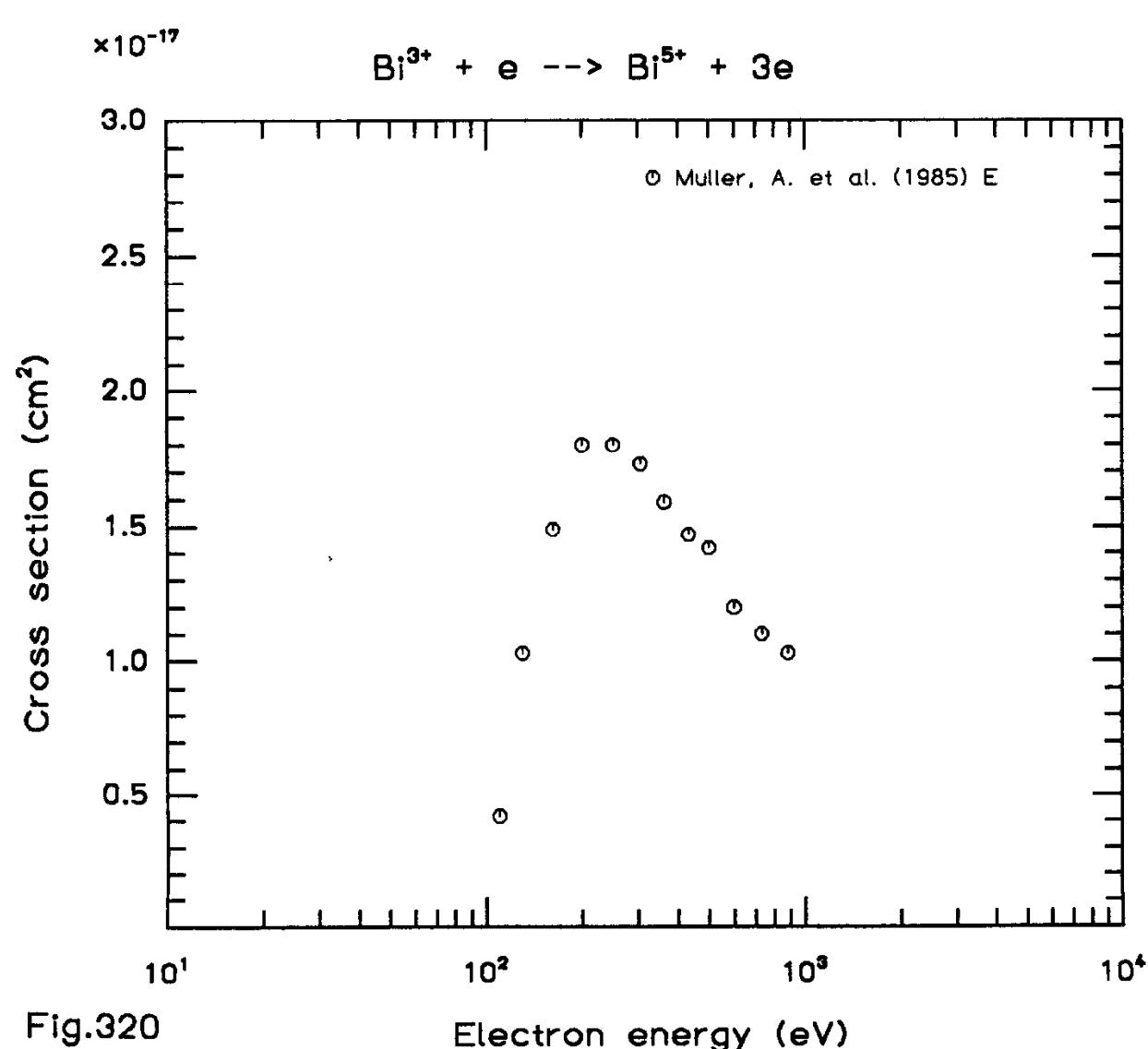
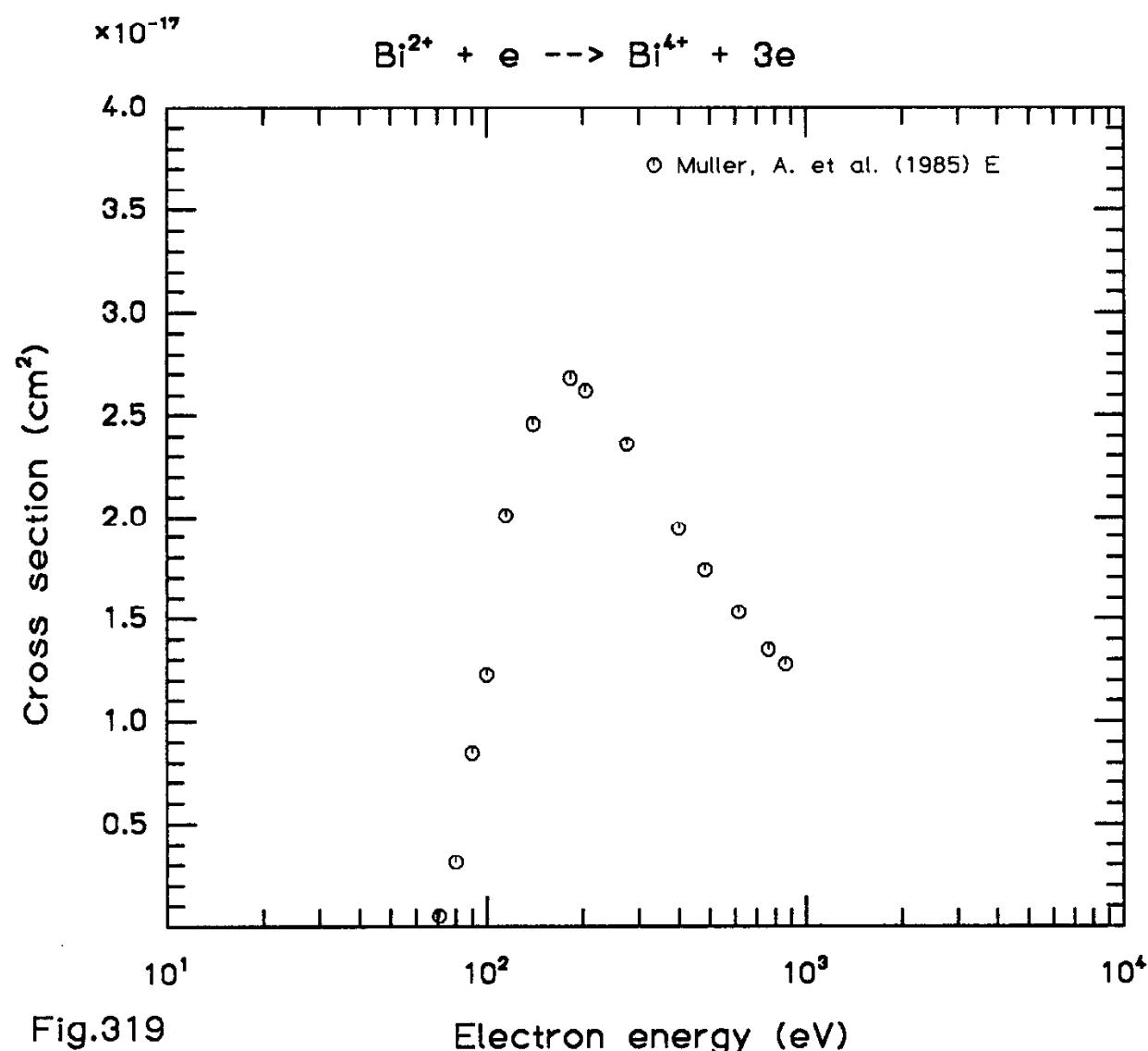


Fig.318

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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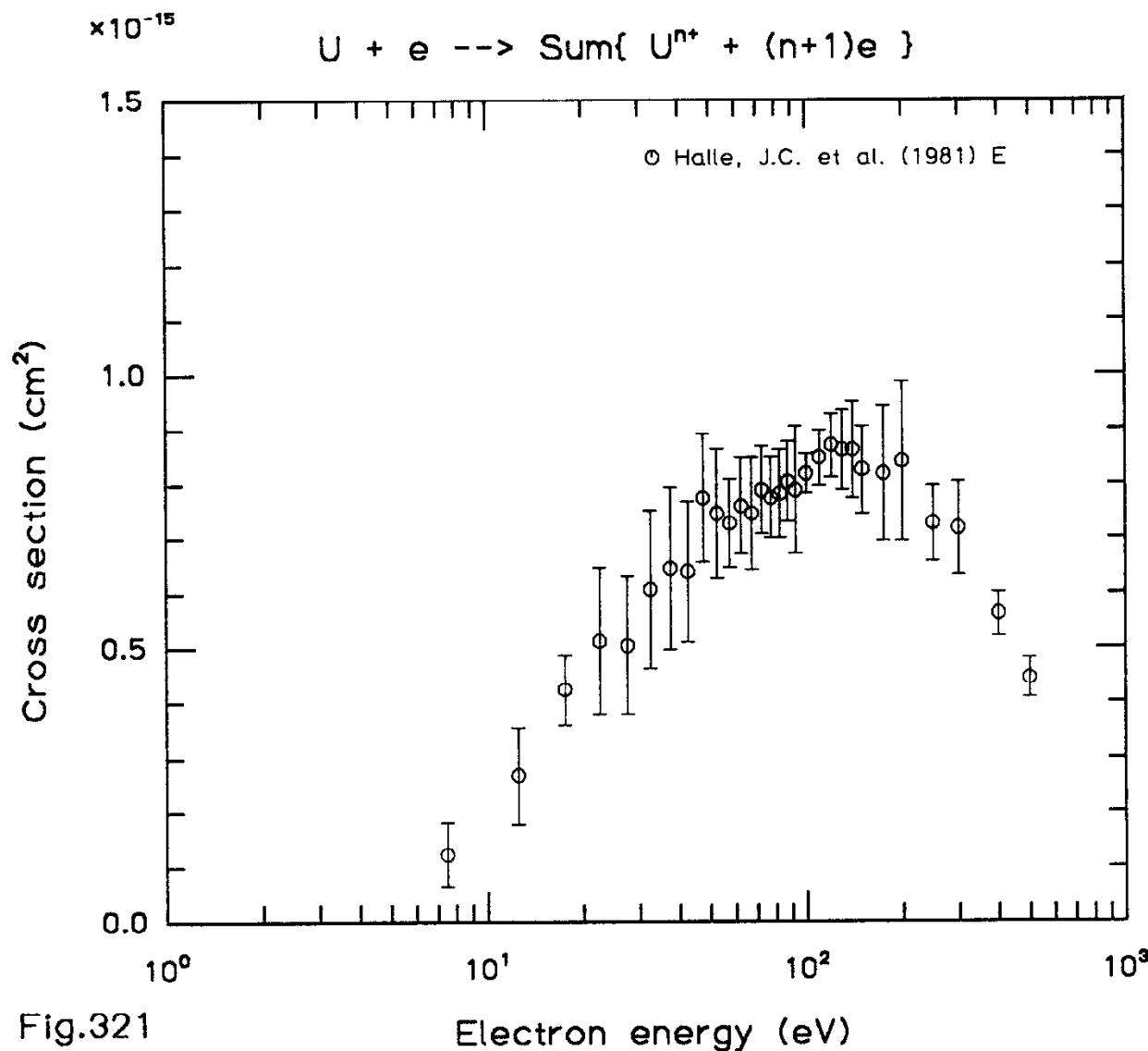


Fig.321

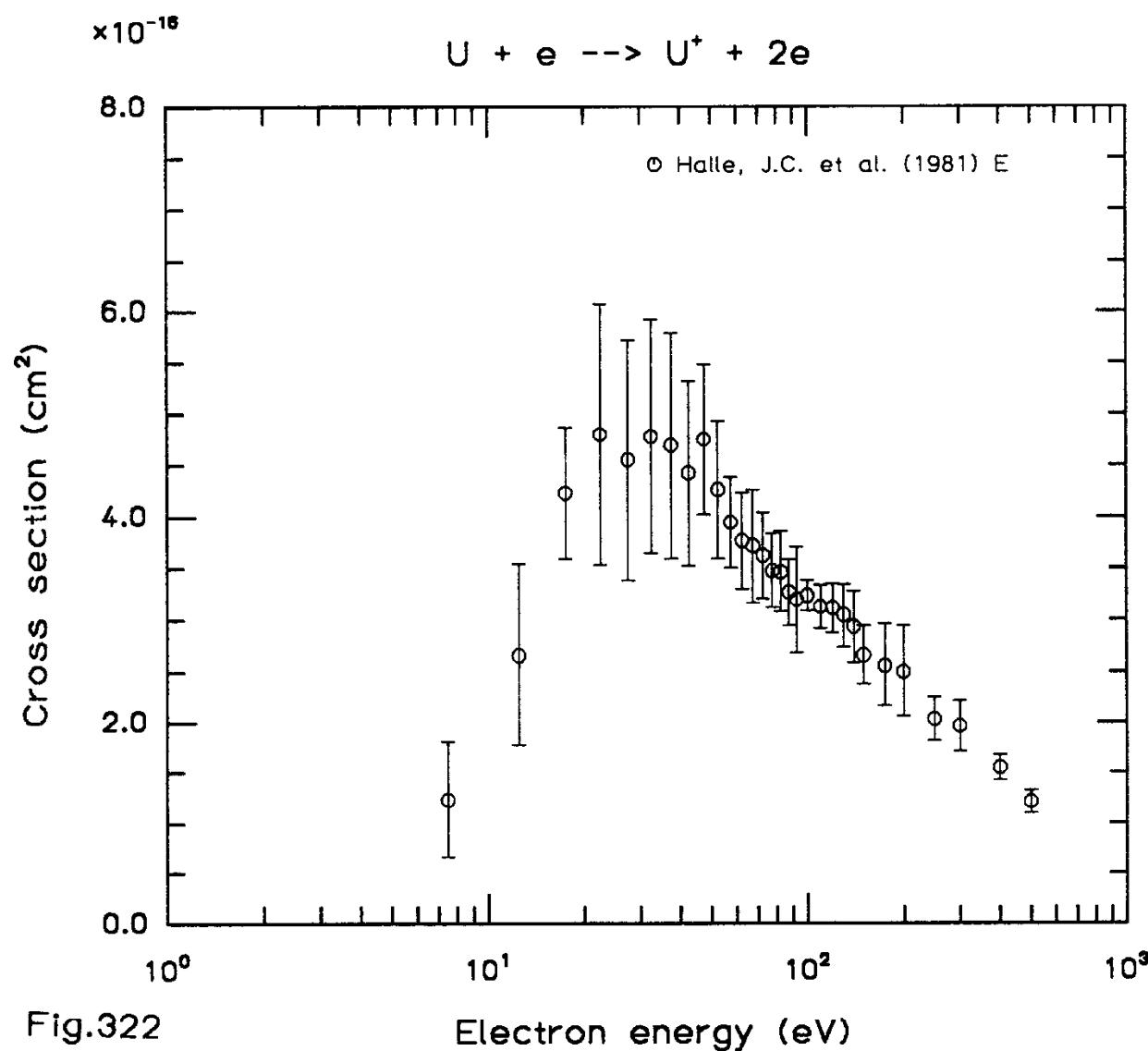


Fig.322

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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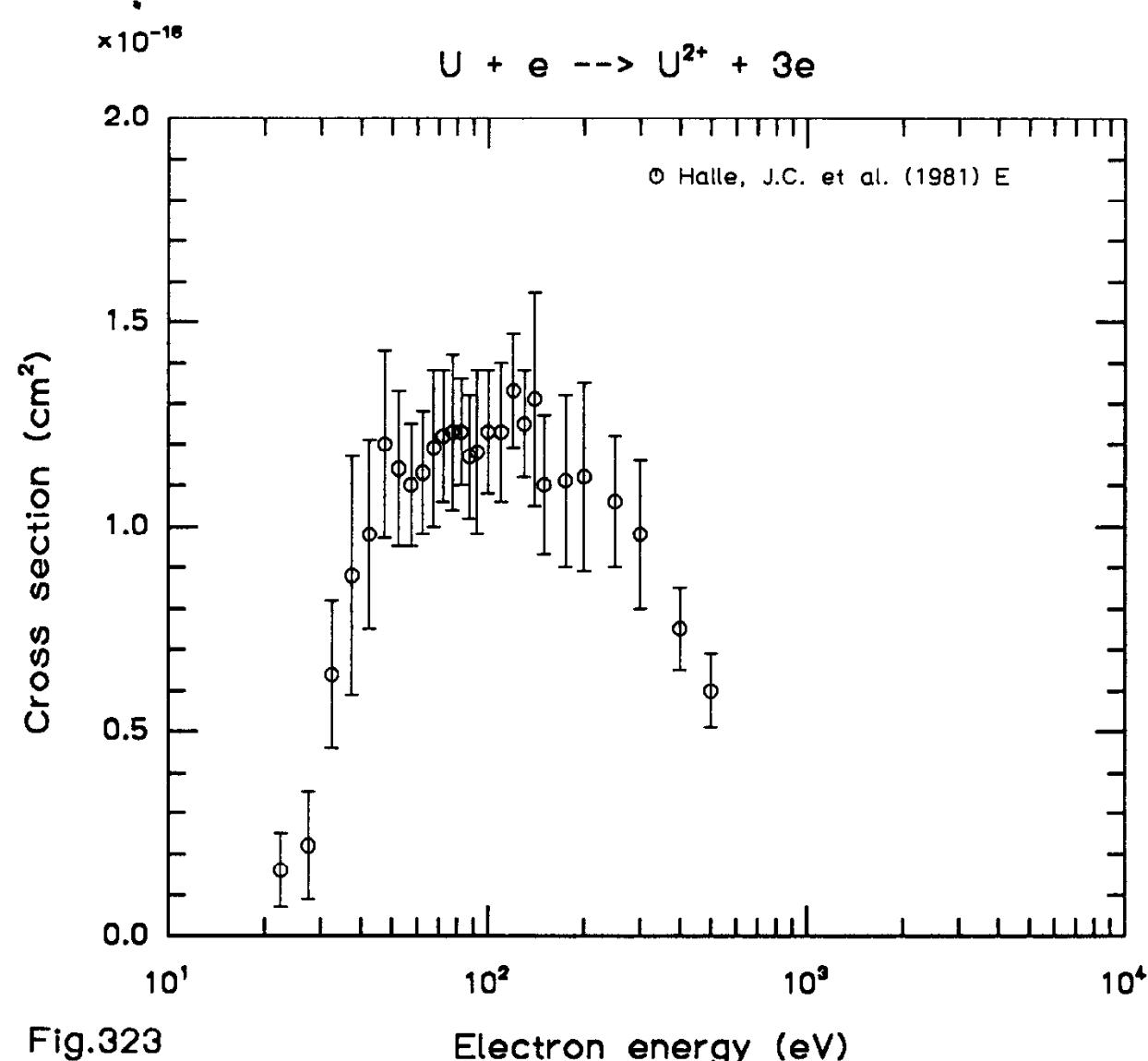


Fig.323

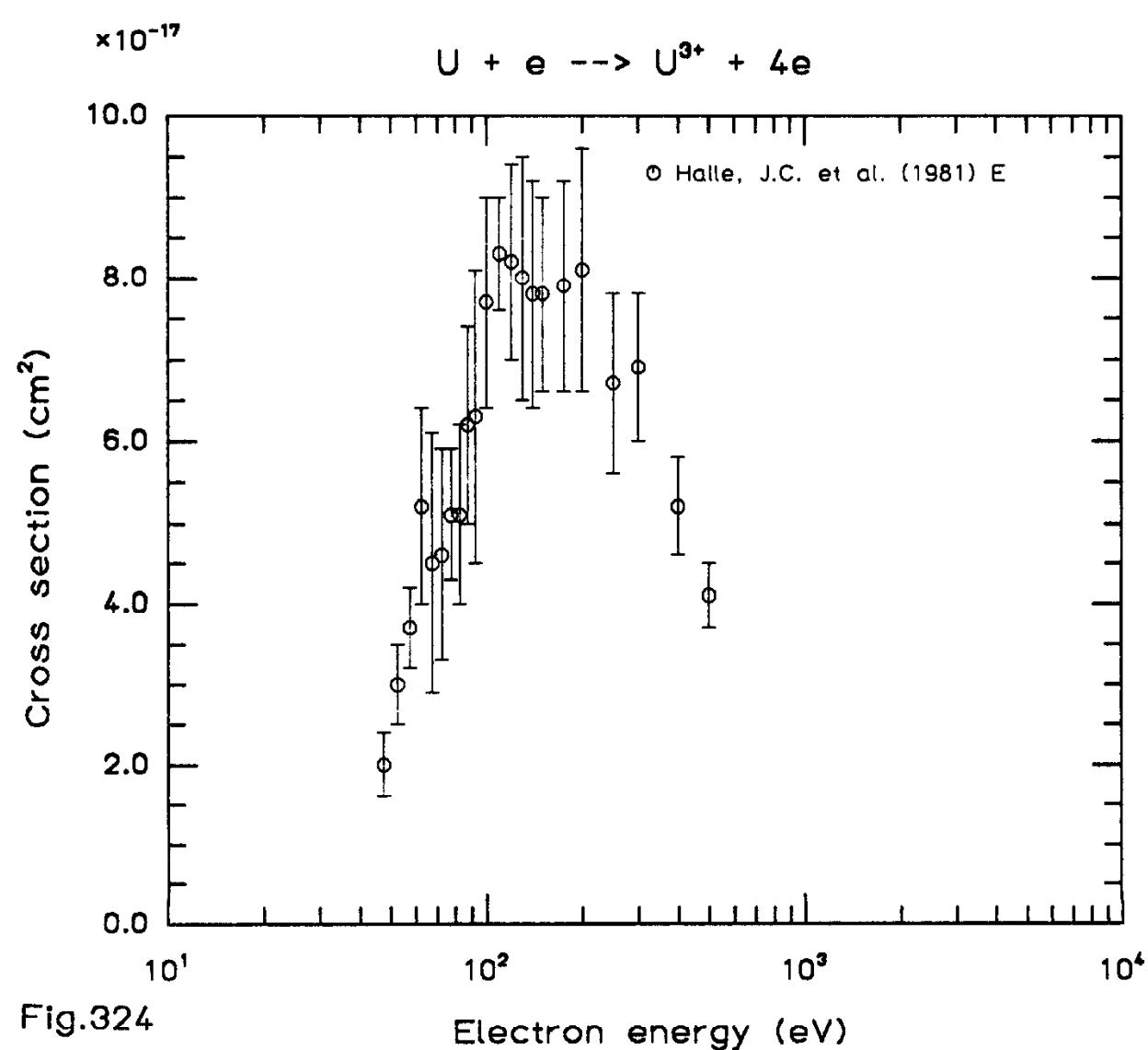


Fig.324

FIGURES 1-325. Ionization Cross Sections as a Function of Electron Impact Energy
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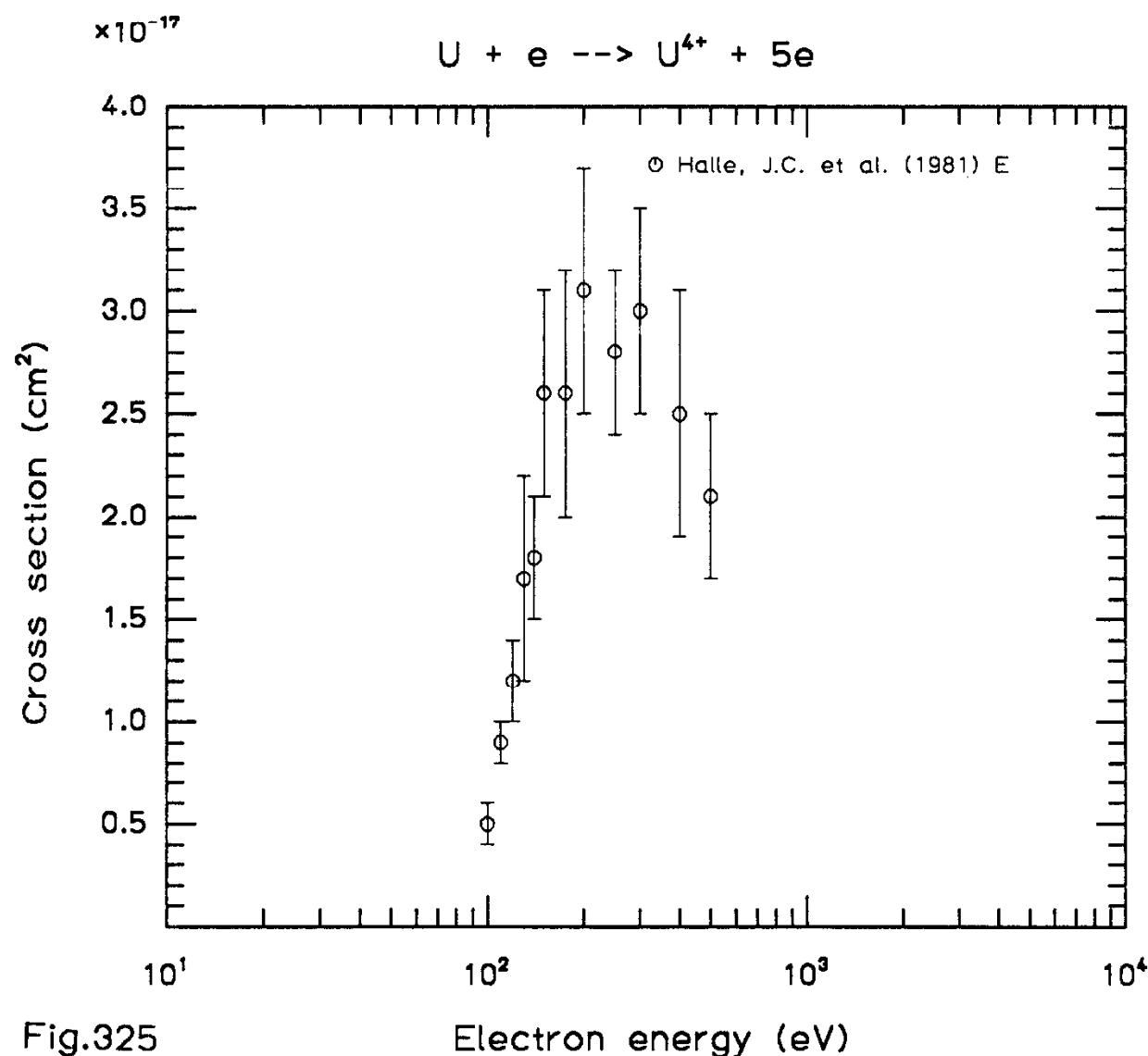


Fig.325