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Bibliography of Electron and Photon Cross Sections with Atoms and Molecules Published in the 20th Century
– Argon –

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Bibliography of Electron and Photon Cross Sections with Atoms and Molecules Published in the 20th Century

—— Argon ——*

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A bibliography of original and review reports of experiments or theories of electron and photon cross sections and also electron swarm data are presented for atomic or molecular species with specified targets. These works covered 17 atoms and 51 molecules. The present bibliography is only for argon (Ar). About 1,960 papers were compiled. A comprehensive author index is included. The bibliography covers the period 1921 through 2000 for Ar. Finally, author's recommended Ar electron collision cross section set is given in numerical tables.

Keywords : Ar atom, collision cross section, electron, elastic scattering, electronic excitation, ionization, photon, photoabsorption, photodissociation, photoexcitation, photoionization, electron swarm, drift velocity, diffusion coefficient, ionization coefficient, excitation and ionization energies, transition probability, lifetimes of excited states

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Introduction

History

This bibliography is the result of a continuing literature survey which was begun around 1970 and originally encompassed only electron collision cross section and electron swarm data. The organization responsible for undertaking this survey is Nagoya Institute of Technology, Nagoya. From 1994, the work continued to Gaseous Electronics Institute, Nagoya. In 1997, the collection of photon cross section references was begun. The search for references in both cases was retrospective and included all papers reporting measurements, calculations or reviews of such cross sections and electron swarm data.

Scope

This bibliography contains references to original research papers which report experiments or theoretical calculations of cross sections for electron and photon collisions with argon (Ar) atom. The review papers on this subject are also included.

Some argon cluster papers are included. Some conference reports, company or agency reports and Ph.D. thesis are included. Argon ion papers and positron collision papers are not included in principle.

Papers reporting the following data are included.

For electron collision cross sections :

1) elastic scattering
2) electronic excitation
3) ionization
4) grand total scattering (sum of elastic and inelastic cross sections)
5) metastable argon
6) electron swarm parameters (drift velocity, diffusion coefficient)
7) excitation and ionization coefficients

For photon collision cross section :

1) photoabsorption
2) photoexcitation and fluorescence
3) photodissociation
4) photoionization

For some related data :

1) excitation and ionization energies
2) transition probabilities
3) lifetimes of excited states
4) others

The energy range for electron cross section data is usually 0 -10 keV, but some higher electron energy papers are included. The wavelength range for photon cross section data is from microwaves to X-rays. Most papers are concerned with infrared, visible and ultraviolet ray region.

The bibliography includes the papers published in the 20^{th} century, from 1901 to 2000. But the oldest paper in this list is given by C. Ramsauer (1921). So for this argon bibliography, published papers from 1921 to 1999 are compiled in alphabetical order of the first author's surname of the paper. References published in 2000 and plus some old papers found very recently after compilation are added as "Addenda of References for Ar". In total, about 1,960 papers are compiled in the argon bibliography.

Organization

This report consists of four parts : introduction, the bibliography and its addenda, author index and an electron collision cross section set recommended by the author.

Bibliography

In this section the complete citation for all references are given. At first following classifications are shown :

E : Elastic collision
EX : electronic EXcitation
I : Ionization
ME: MEtastable argon
S : electron Swarm
O : Others (photon cross sections and others)

All author's initials and surname, journal name, volume, inclusive pages and year of publication are given as well as the title, and some additional information in the square bracket [ ]. E and T in the square bracket mean experiment and theory.

Author Index

In this section all authors are listed alphabetically by surname. After each author's name is a list of page numbers indicating which references he or she authored or coauthored.

Electron Collision Cross Section Set for Argon (Ar)

Electron collision cross section set of elastic, electronic excitation and ionization collision for argon recommended by the author are given by the tables. Final conclusions are given and detailed discussions are not shown here. Elastic total and elastic momentum transfer cross sections are obtained from author's recommended elastic differential cross sections. These values of the set are not final, in other words, tentative values.

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References for Ar (1900 - 1999)

(Argon)

[Inert gas, Noble gas]

E : Elastic collision, EX : Electronic excitation,
I : Ionization, QT : Grand total cross section,
ME : Metastable argon, S : Swarm, O : The others,
α : Ionization coefficient [ ] : Additional informations,
E : Exp., T : Theory.

The oldest paper in this list is given by C. Ramsauer (1921).

QT W. H. Aberth : Thesis, New York University, 1-57 (1963)
Measurement of total cross sections for the scattering of low energy electrons by argon and molecular oxygen and nitrogen. [E, Ar, O_2, N_2]

QT W. Aberth, G. Sunshine and B. Bederson : in Atomic Collision Processes, North-Holland, 3rd ICPEAC, London 53-58 (1964)
Absolute measurement of total cross sections for the scattering of low energy electrons by argon, nitrogen and oxygen.
[E, Ar, N_2, O_2; 1 - 25 eV]

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Ionization and breakdown in argon. [E, Ar; 15 - 3600 Td]

O M. Y. Adam, F. Wuilleumier, S. Krummacher, N. Sandner, V. Schmidt and W. Mehlhorn : J. Elect. Spectrosc. Relat. Phenom. 15, 211-224 (1979)
Recent progress in the study of photoionization processes of atomic species by electron spectroscopy using synchrotron radiation.
[E, $h\nu$, Ar, He, Xe, Pb]

O M. Y. Adam, P. Morin and G. Wendin : Phys. Rev. A31, 1426-1433 (1985)
Photoelectron satellite spectrum in the region of the 3s Cooper minimum of argon. [E, $h\nu$, Ar; 40 - 70 eV]

O D. L. Adams and W. Whaling : J. Opt. Soc. Am. 71, 1036-1038 (1981)
Argon branching ratios for spectral-intensity calibration.
[E, $h\nu$, Ar; 104 emission lines ; 2900 - 23000 A]

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Kinetics of slow electrons in an electron-beam pumped excimer laser.
[T, Ar, Xe, HCl]

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Modeling of an XeCl excimer laser excited by a fast electron beam.
[T, Ar

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On excitation temperature measurements in a plasma-jet, and transition probabilities for argon lines. [E, $h\nu$, Ar]

EX V. V. Afrosimov, Yu. S. Gordeev, V. M. Lavrov and S. G. Shchemelinin : Sov. Phys. JETP I 28, 821-825 (1969)・
Energy loss spectra of electrons colliding with inert gas atoms.
[E, Ne - Xe; 4 keV]

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A study of the ns^0np^6 ^1S states in the rare gas ions. [E, Ne - Xe]

E K. M. Aggarwal, N. Nath and C. S. G. K. Setty : Planet. Space Sci. 27, 753-768 (1979)・
Collision frequency and transport properties of electrons in the ionosphere. [T, Ar, He, H, N, O, N_2, O_2]

EX J. M. Ajello, G. K. James, B. Franklin and S. Howell : J. Phys. B23, 4355-4376 (1990)
Study of electron impact excitation of argon in the extreme ultraviolet : emission cross section of resonance lines of Ar I, Ar II.
[E, Ar; 104.8, 106.7 nm, 12 - 2000 eV]

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Auger energies of free atoms : Comparison between experiment and relativistic theory. [E and T, Ne - Xe, Na, K, Cs, Cu, Cd, Hg, etc.]

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Shake processes in Auger decay of resonatly excited states of rare gases.
[E, Ne - Xe]

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Angular distribution of emitted electrons in the decay of Ar $2p^{-1}4s$ states studied by high-resolution experiment. [E, Ar]

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Time of flight measurements of the ratio of radial diffusion coefficient and mobility for electron swarms in helium, argon, neon and krypton at high E/N. [E, He - Kr; E/N = 56.5 - 5650 Td for Ar]

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Electron swarms in mixtures of metal vapour and argon gas.
[T, Ar + (Na, K, Cs)]

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Calculated Born and four-state cross sections of low lying Ar levels excited by proton and electron impact. [T, Ar; 4s and 4p levels]

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Measurement of the drift velocity of electrons in an argon-nitrogen mixture using a gas scintillation drift chamber. [E, Ar + N_2]

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Electron rate coefficients in gases under non-uniform field and electron density conditions. [T, Ar, CO_2, N_2]

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Exchange of kinetic energy in a dense, weakly ionized, argon plasma.
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A spectroscopic method for the investigation of elastic scattering of slow electrons. [T, Ne - Xe, Cs; mainly for Ar]

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The contribution of long-range forces to low-energy phaseshifts.
[T, Ar, H]

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Mean for ionization cross sections of neutral beams by electrons with a Maxwellian velocity distribution. [T, He - Kr, H, H_2, D_2, N_2, O_2]

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Electron temperatures and mobilities in the rare gases. [T, He - Ar]

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Some measurements of electron drift velocities in compressed gases.
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Theorie der Streuung langsamer Elektronen an Atomen.
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Electron impact multiple ionization cross section of argon (σ_{n+}, n = 3 - 6). [E, Ar]

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Electron-impact ionization cross-section of argon (σ_{n+}, n = 7, 8).
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Multiple ionization of gases by collisions with electrons.
[E, Ar, Ne, He ; 90 - 3000 eV]

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On the cross section of low-energy electron collision on CH_4 and CO_2.
[T, Ar + CH_4, Ar + CH_4 + CO_2, etc. ; B. Eq.]

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Dependence of the transverse diffusion of drifting electrons on magnetic field. [E, Ar + CH_4]

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Many-electron correlations in photoabsorption in the M-shell of Ar.
[T, $h\nu$, Ar]

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Inelastic scattering of electrons by noble gas atoms.
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Cross section for the photoionization of noble-gas atoms with allowance for multielectron correlations. [T, $h\nu$, Ne - Xe]

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The role of many-electron correlations in fast electron-atom inelastic collisions. [T, Ar; 4 KeV]

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Elastic scattering of slow electrons and level shifts in Ar. [T, Ar]

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Intershell and intersubshell effects in photoionization of atoms.
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Many-electron correlations in scattering processes. [review]

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Inner-shell correlation in the inelastic scattering of fast electrons of the outer subshells in Ar and Xe. [T, Ar, Xe]

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Inter-shell correlations in the formation of singly charged ions near the Ar L-shell ionisation threshold. [T, Ar]

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Photoionization from the excited state of argon and xenon atoms.
[T, hν, Ar, Xe]

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Single-electron ionisation of Ar $3s^2$ subshell by slow electrons.
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Near-threshold effects in the ionization of atoms (the post-collision interaction). [T, Ar]

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Manifestation of restructuring of the electron shells in atoms in the course of ionization. [T, hν, Ar, Xe, Cs, Ba]

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Photoionizations of inner shells. [T, hν, Ar]

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The influence of "Two-electron－two-hole" excitations on the $3s^{-1}4p$ autoionization profile in Ar atoms. [T, hν, Ar]

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The photoelectron angular-distribution β parameter in the region of the $3s^{-1}4p$ resonance in Ar. [T, hν, Ar]

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On our ability to measure the singly ionised rare-gas spectroscopic factors using the (γ, e) and $(e, 2e)$ reactions. [T, Ar]

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Spectroscopic factor and the renormalization of interelectron interaction. [comments, Ar - Xe]

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Nonphysical characteristics of the photoionization cross section of internal shells. [T, hν, Ar - Xe, Cu, Hg]

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Many-electron effects in the absorption and emission of VUV radiation by atoms and ions. [T, hν, Ar, Xe, etc.]

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Multielectron correlations in the generalized oscillator strengths. [T, Ar, Ne, Xe]

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Analysis of orientation and alignment in electron impact excitation of heavy rare gases : the Ar 4s ^{1}P and ^{3}P case. [T, Ar; DCS of $^3P_1$, 16 eV]

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Hall effect and electron drift velocities in the plasma of the positive column. [E, He - Ar, N_2]

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Die Winkelabhangigkeit der Resonanzstreuung niederenergetischer Elektronen an He, Ne, Ar, und N_2. [E, He - Ar, N_2]

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Measurement of the free-free cross section of e^-- Ar scattering.
[E, Ar; 5 - 16 eV]

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Tables of interaction parameters for computation of Ohm's law coefficients in various gases. [T, Ar, Xe, He, CO_2, CO]

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Threshold double photoexcitation of argon with synchrotron radiation.
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Quantum theory of post-collision interaction in inner-shell photo-ionization : Final-state interaction between two continuum electrons.
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Radiationless resonant Raman scattering interpretation of argon photoion yields measured in coincidence with K-LL Auger decay. [T, $h\nu$, Ar]

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[review, general theory]

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[E, Ar_n]

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[E, hν, Ar; Ti:sapphire laser, 800 nm]]

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[T, Ar]

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[E, Ar, Kr, Xe; 140 - 4000 eV, error about 2 %]

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Lifetimes of some excited levels of Ar I. [E, Ar; fourteen levels]

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Electron Collision Cross Section Set for Argon (Ar)

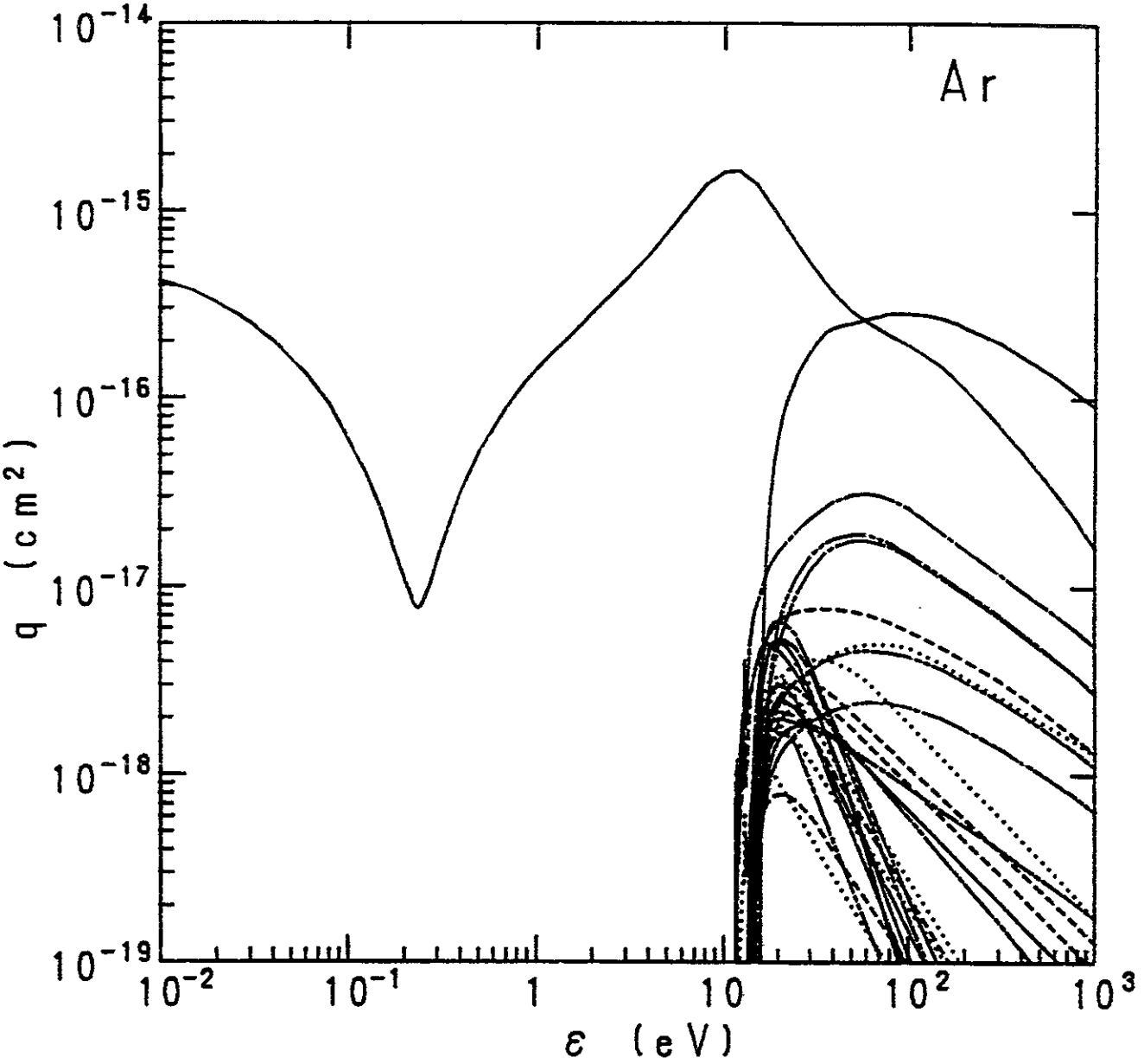

Figure 1. Electron collision cross section set for Ar.

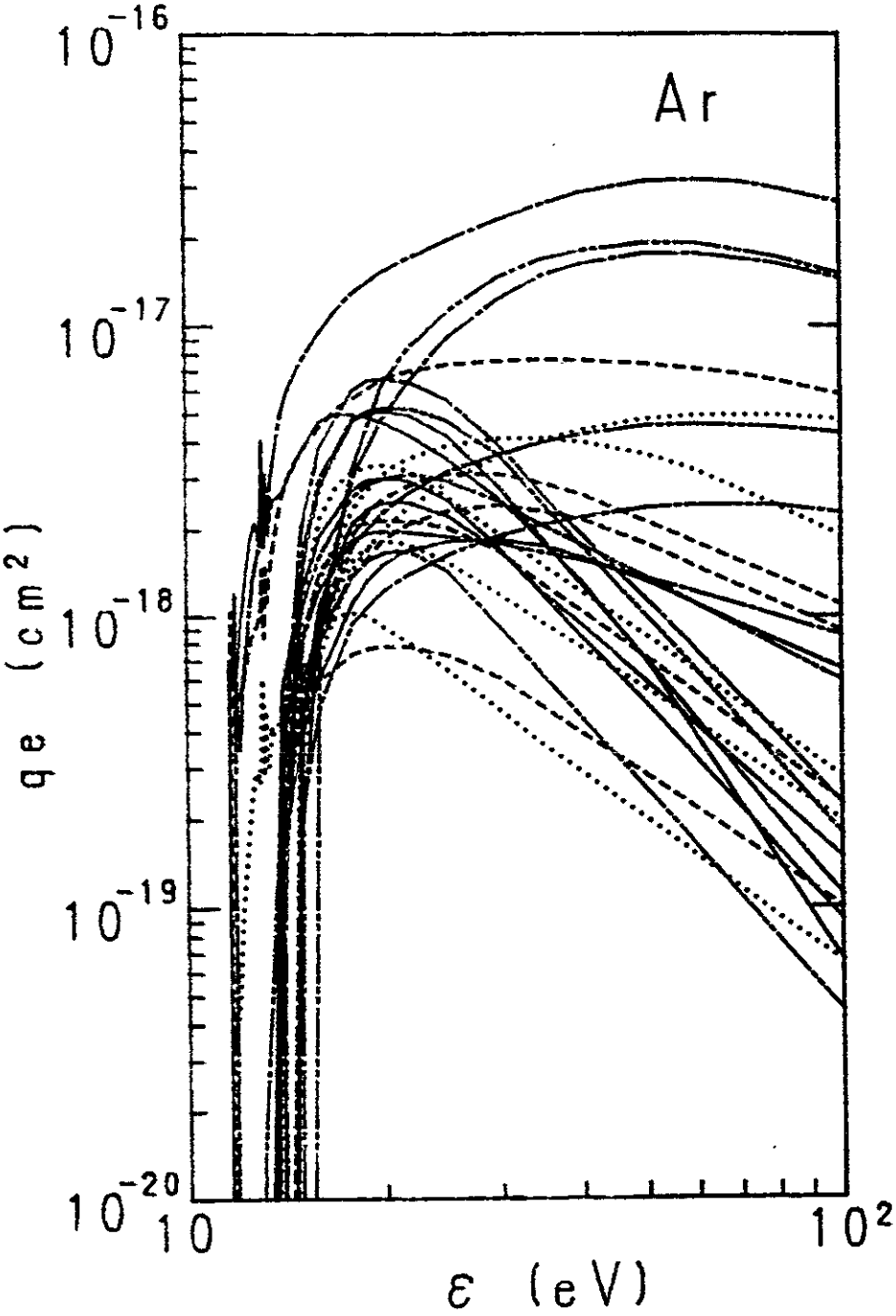

Figure 2. Electronic excitation cross sections for Ar.

Table 1. Energy levels of electronic excitation for Ar.

	Level No.			energy (eV)	Paschen notation	Designation
	This work	Chutjian	Eggarter			
					$1P_0$	$3p^6$
1	1	1	SM*	11.55	$1S_5$	$4s[3/2]_2$
2	2	2	S1**	11.62	$1S_4$	$4s[3/2]_1$
3	3	3	SM*	11.72	$1S_3$	$4s'[1/2]_0$
4	4	4	S1**	11.83	$1S_2$	$4s'[1/2]_1$
5	5	5		12.91	$2P_{10}$	$4p[1/2]_1$
6	6	6		13.08	$2P_9$	$4p[5/2]_3$
7	7	7		13.09	$2P_8$	$4p[5/2]_2$
8	8	8		13.15	$2P_7$	$4p[3/2]_1$
9	9	9		13.17	$2P_6$	$4p[3/2]_2$
10	10	10		13.27	$2P_5$	$4p[1/2]_0$
11				13.28	$2P_4$	$4p'[3/2]_1$
12	11	11	S4p	13.03	$2P_3$	$4p'[3/2]_2$
13	12	12		13.33	$2P_2$	$4p'[1/2]_1$
14	13	13		13.47	$2P_1$	$4p'[1/2]_0$
15	14	14		13.84	$3d_6$	$3d[1/2]_0$
16				13.86	$3d_5$	$3d[1/2]_1$
17	15	15		13.90	$3d_3$	$3d[3/2]_2$
18	16	16		13.98	$3d_4'$	$3d[7/2]_4$
19	17	17		14.01	$3d_4$	$3d[7/2]_3$
20	18	18		14.06	$3d_1''$	$3d[5/2]_2$
21				14.07	$2S_5$	$5s[3/2]_2$
22	19	19		14.10	$3d_1'$	$3d[5/2]_3$
23				14.09	$2S_4$	$5s[3/2]_1$
24	20	20		14.15	$3d_2$	$3d[3/2]_1$
25	21	21		14.21	$3S_1''''$	$3d'[5/2]_2$
26			S2	14.24	$3S_1'''$	$3d'[3/2]_2$
27	22	22		14.23	$2S_1''$	$3d'[5/2]_3$
28				14.24	$2S_3$	$5s'[1/2]_0$
29				14.25	$2S_2$	$5s'[1/2]_1$
30	23	23		14.30	$3S_1'$	$3d'[3/2]_1$
	24		S3	14.71		
	25		S4	15.20		

* SM : Sum of metastable states, 1 and 3.
** SI : Sum of 2 and 4 states.

Table 2. Electron collision cross section set for argon, recommended by the authour in 1992. qm is the elastic momentum transfer, qe of 1 to 25 are the electronic excitation, and qi is the ionization cross sections. I would like to improve these cross section values slightly.

ε (eV)	qm ($10^{-16}cm^2$)
0	6.30
0.01	4.20
0.012	4.00
0.015	3.69
0.02	3.20
0.025	2.80
0.03	2.48
0.035	2.20
0.04	1.98
0.05	1.59
0.06	1.32
0.08	0.913
0.10	0.599
0.125	0.391
0.15	0.255
0.175	0.162
0.20	0.108
0.225	0.0808
0.23	0.0781
0.235	0.0763
0.24	0.0765
0.245	0.0786
0.25	0.0816
0.275	0.103
0.3	0.139
0.35	0.216
0.4	0.310
0.5	0.507
0.6	0.690
0.7	0.888
0.8	1.07
0.9	1.25
1.0	1.42
1.2	1.70
1.5	2.09
2.0	2.84
2.5	3.56
3.0	4.31
4.0	5.78
5.0	7.68
6.0	9.71
8.0	13.7
10	16.1
12	16.4
15	13.7
20	9.30
25	6.68
30	5.16
40	3.59
50	2.90
60	2.54
80	2.14
100	1.91
120	1.71
150	1.46
200	1.12
250	0.873
300	0.713
400	0.518
500	0.397
600	0.315
800	0.219
1000	0.161
10000	0.00

ε (eV)	qe1 ($10^{-16}cm^2$)
11.55	0.00
11.60	0.00543
11.61	0.00643
11.62	0.00693
11.63	0.00704
11.64	0.00699
11.65	0.00623
11.66	0.00633
11.67	0.00663
11.68	0.00665
11.69	0.00633
11.70	0.00603
11.71	0.00573
11.72	0.00577
11.73	0.00586
11.75	0.00714
11.77	0.00815
11.80	0.00832
11.81	0.00840
11.84	0.0120
11.88	0.00681
11.90	0.00626
11.94	0.00644
12.0	0.00704
12.1	0.00889
12.2	0.0105
12.4	0.0150
12.6	0.0191
12.7	0.0204
12.74	0.0208
12.76	0.0210
12.8	0.0208
12.86	0.0196
12.90	0.0184
12.91	0.0183
12.94	0.0186
13.0	0.0222
13.05	0.0405
13.08	0.0267
13.10	0.0213
13.13	0.0184
13.16	0.0214
13.19	0.0262
13.21	0.0308
13.23	0.0221
13.24	0.0209
13.28	0.0197
13.3	0.0194
13.33	0.0191
13.36	0.0197
13.38	0.0206
13.40	0.0213
13.44	0.0220
13.48	0.0261
13.5	0.0245
13.52	0.0237
13.6	0.0251
14.0	0.0265
15.0	0.0369
16	0.0466
17	0.0500
18	0.0495
19	0.0482
20	0.0464
22	0.0418
25	0.0347
30	0.0253
35	0.0180
40	0.0132
50	0.00694
60	0.00375
70	0.00222
80	0.00141
100	0.000652
150	0.000170
175	0.000100
200	0.00

ε (eV)	qe2 ($10^{-16}cm^2$)
11.62	0.00
11.68	0.0104
11.70	0.00736
11.74	0.00568
11.76	0.00541
11.80	0.00499
11.81	0.00494
11.85	0.00490
11.90	0.00495
11.94	0.00500
12.00	0.00520
12.04	0.00530
12.1	0.00550
12.2	0.00570
12.4	0.00730
12.5	0.00790
12.6	0.00850
12.65	0.00860
12.7	0.00880
12.74	0.00900
12.8	0.00920
12.9	0.00970

13.00	0.0103
13.05	0.0147
13.08	0.0101
13.10	0.00940
13.13	0.00840
13.16	0.0103
13.20	0.0148
13.23	0.0139
13.25	0.0122
13.29	0.0112
13.30	0.0115
13.4	0.0138
13.5	0.0158
13.82	0.0219
14.0	0.0255
14.25	0.0292
14.5	0.0322
15.0	0.0373
16	0.0449
17	0.0520
18	0.0565
19	0.0608
20	0.0658
22	0.0700
25	0.0740
30	0.0760
35	0.0770
40	0.0765
50	0.0743
60	0.0715
70	0.0685
80	0.0650
100	0.0585
150	0.0480
200	0.0410
300	0.0320
400	0.0262
500	0.0222
800	0.0156
1000	0.0131
10000	0.00

ε (eV)	qe3 (10^{-16}cm^2)
11.72	0.00
11.75	0.000202
11.77	0.000420
11.80	0.000378
11.81	0.000400
11.84	0.000660
11.88	0.000431
11.90	0.000418
11.94	0.000473
12.00	0.000579
12.10	0.000837
12.20	0.00108
12.40	0.00174
12.60	0.00248
12.70	0.00276
12.74	0.00287
12.77	0.00291
12.80	0.00292
12.86	0.00282
12.90	0.00268
12.91	0.00265
12.94	0.00272
13.0	0.00332
13.05	0.00610
13.08	0.00407
13.10	0.00327
13.13	0.00282
13.16	0.00331
13.19	0.00406
13.21	0.00477
13.23	0.00344
13.24	0.00325
13.28	0.00310
13.3	0.00305
13.33	0.00301
13.36	0.00312
13.38	0.00330
13.40	0.00341
13.44	0.00354
13.48	0.00421
13.50	0.00399
13.52	0.00385
13.6	0.00396
14.0	0.00446
15.0	0.00641
16	0.00837
17	0.0100
18	0.0103
19	0.0100
20	0.00923
22	0.00800
25	0.00650
30	0.00475
35	0.00360
40	0.00290
50	0.00200
60	0.00149
70	0.00116
80	0.000930
100	0.000656
150	0.000339
200	0.000212
300	0.000110
317	0.000100
400	0.00

ε (eV)	qe4 (10^{-16}cm^2)
11.83	0.00
11.85	0.00770
11.90	0.00630
11.94	0.00493
12.00	0.00357
12.04	0.00340
12.1	0.00400
12.2	0.00570
12.4	0.00870
12.5	0.0106
12.6	0.0125
12.65	0.0133
12.7	0.0140
12.74	0.0145
12.8	0.0154
12.9	0.0167
13.0	0.0184
13.05	0.0266
13.08	0.0186
13.1	0.0174
13.13	0.0175
13.16	0.0192
13.2	0.0278
13.23	0.0261
13.25	0.0229
13.29	0.0213
13.3	0.0218
13.4	0.0265
13.5	0.0306
13.82	0.0432
14.0	0.0505
14.25	0.0580
14.5	0.0648
15.0	0.0757
16	0.0947
17	0.114
18	0.130
19	0.142
20	0.154
22	0.172
25	0.197
30	0.233
35	0.263
40	0.288
50	0.313
60	0.318
70	0.311
80	0.296
100	0.266
150	0.197
200	0.160
300	0.119
350	0.106
400	0.0963
500	0.0822
800	0.0580
1000	0.0490
10000	0.00

ε	qe5

Ar

(eV)	(10^{-16}cm^2)
12.91	0.00
13	0.000140
14	0.00300
15	0.00590
16	0.00870
18	0.0140
19	0.0156
20	0.0166
21	0.0169
22	0.0167
25	0.0145
30	0.00923
35	0.00625
40	0.00445
50	0.00252
60	0.00160
80	0.000780
100	0.000444
150	0.000160
180	0.000100
200	0.00

ε (eV)	qe6 (10^{-16}cm^2)
13.08	0.00
14	0.00550
15	0.0123
16	0.0190
18	0.0275
19	0.0294
20	0.0300
21	0.0298
22	0.0292
25	0.0255
30	0.0173
35	0.0119
40	0.00850
50	0.00500
60	0.00318
80	0.00157
100	0.000910
150	0.000340
200	0.000167
248	0.000100
300	0.00

ε (eV)	qe7 (10^{-16}cm^2)
13.09	0.00
14	0.00230
15	0.00520
16	0.00820
18	0.0138
20	0.0184
22	0.0211
25	0.0232
30	0.0243
35	0.0233
40	0.0218
50	0.0179
60	0.0149
80	0.0112
100	0.00892
150	0.00600
200	0.00450
300	0.00300
500	0.00179
800	0.00112
1000	0.000900
10000	0.00

ε (eV)	qe8 (10^{-16}cm^2)
13.15	0.00
14	0.00200
15	0.00560
16	0.00920
18	0.0156
19	0.0174
20	0.0181
21	0.0181
22	0.0176
25	0.0155
30	0.0120
35	0.00950
40	0.00780
50	0.00560
60	0.00425
80	0.00275
100	0.00198
150	0.00109
200	0.000710
300	0.000390
500	0.000181
740	0.000100
800	0.00

ε (eV)	qe9 (10^{-16}cm^2)
13.17	0.00
14	0.00360
15	0.00810
16	0.0124
18	0.0184
19	0.0194
20	0.0198
22	0.0196
25	0.0190
30	0.0179
35	0.0167
40	0.0157
50	0.0137
60	0.0122
80	0.0100
100	0.00860
150	0.00650
200	0.00535
300	0.00405
500	0.00280
800	0.00203
1000	0.00173
10000	0.00

ε (eV)	qe10 (10^{-16}cm^2)
13.27	0.00
14	0.00450
15	0.0107
16	0.0162
18	0.0260
19	0.0284
20	0.0298
22	0.0310
25	0.0295
30	0.0250
35	0.0207
40	0.0178
50	0.0138
60	0.0110
80	0.00780
100	0.00600
150	0.00370
200	0.00264
300	0.00164
500	0.000890
800	0.000510
1000	0.000390
10000	0.00

ε (eV)	qe11 (10^{-16}cm^2)
13.30	0.00
14	0.00155
15	0.00390
16	0.00620
18	0.0111
19	0.0134
20	0.0151
21	0.0162
22	0.0170
25	0.0182
30	0.0185
35	0.0176
40	0.0162
50	0.0133
60	0.0110

80	0.00820
100	0.00657
150	0.00435
200	0.00322
300	0.00212
500	0.00126
800	0.000780
1000	0.000630
10000	0.00

ε (eV)	qe12 ($10^{-16}cm^2$)
13.33	0.00
14	0.00200
15	0.00460
16	0.00600
18	0.00740
19	0.00770
20	0.00783
22	0.00780
25	0.00730
30	0.00611
35	0.00485
40	0.00395
50	0.00283
60	0.00216
80	0.00140
100	0.00100
150	0.000550
200	0.000360
300	0.000195
470	0.000100
500	0.00

ε (eV)	qe13 ($10^{-16}cm^2$)
13.48	0.00
14	0.00250
15	0.00800
16	0.0135
18	0.0235
19	0.0275
20	0.0307
21	0.0332
22	0.0352
25	0.0387
30	0.0411
35	0.0410
40	0.0400
50	0.0362
60	0.0317
80	0.0240
100	0.0190
150	0.0124
200	0.00920
300	0.00605
500	0.00355
800	0.00219
1000	0.00172
10000	0.00

ε (eV)	qe14 ($10^{-16}cm^2$)
13.84	0.00
14	0.00300
15	0.0205
16	0.0380
18	0.0600
19	0.0650
20	0.0660
22	0.0640
25	0.0560
30	0.0390
35	0.0265
40	0.0193
50	0.0115
60	0.00750
80	0.00385
100	0.00225
150	0.000890
200	0.000450
300	0.000175
380	0.000100
500	0.00

ε (eV)	qe15 ($10^{-16}cm^2$)
13.90	0.00
14	0.00150
15	0.0160
16	0.0300
18	0.0475
19	0.0510
20	0.0524
22	0.0520
25	0.0475
30	0.0360
35	0.0245
40	0.0176
50	0.0100
60	0.00640
80	0.00310
100	0.00177
150	0.000650
200	0.000315
300	0.000113
315	0.000100
500	0.00

ε (eV)	qe16 ($10^{-16}cm^2$)
13.98	0.00
14	0.000800
15	0.0140
16	0.0275
18	0.0470
19	0.0500
20	0.0508
22	0.0490
25	0.0420
30	0.0280
35	0.0185
40	0.0129
50	0.00700
60	0.00430
80	0.00197
100	0.00110
150	0.000370
200	0.000170
242	0.000100
300	0.00

ε (eV)	qe17 ($10^{-16}cm^2$)
14.01	0.00
15	0.00830
16	0.0143
18	0.0203
19	0.0213
20	0.0216
22	0.0214
25	0.0203
30	0.0168
35	0.0130
40	0.0105
50	0.00720
60	0.00540
80	0.00334
100	0.00230
150	0.00118
200	0.000730
300	0.000375
500	0.000160
660	0.000100
800	0.00

ε (eV)	qe18 ($10^{-16}cm^2$)
14.06	0.00
15	0.0105
16	0.0220
17	0.0283
18	0.0315
19	0.0328
20	0.0332
21	0.0326
22	0.0315

Ar

25	0.0260
30	0.0193
35	0.0152
40	0.0123
50	0.00860
60	0.00640
80	0.00405
100	0.00280
150	0.00146
200	0.000910
300	0.000475
500	0.000205
780	0.000100
800	0.00

ε (eV)	qe19 ($10^{-16}cm^2$)
14.09	0.00
15	0.00220
16	0.00500
18	0.00950
20	0.0123
22	0.0142
25	0.0164
30	0.0191
35	0.0208
40	0.0222
50	0.0239
60	0.0245
80	0.0243
100	0.0230
150	0.0200
200	0.0175
300	0.0140
500	0.0102
800	0.00750
1000	0.00640
10000	0.00

ε (eV)	qe20 ($10^{-16}cm^2$)
14.15	0.00
15	0.00400
16	0.00900
18	0.0175
20	0.0230
22	0.0270
25	0.0315
30	0.0362
35	0.0400
40	0.0425
50	0.0455
60	0.0460
80	0.0450
100	0.0430
150	0.0367
200	0.0316
300	0.0250
500	0.0180
800	0.0130
1000	0.0110
10000	0.00

ε (eV)	qe21 ($10^{-16}cm^2$)
14.21	0.00
15	0.00450
16	0.0110
18	0.0210
19	0.0235
20	0.0248
21	0.0250
22	0.0247
25	0.0225
30	0.0170
35	0.0122
40	0.00940
50	0.00595
60	0.00415
80	0.00233
100	0.00148
150	0.000660
200	0.000370
300	0.000163
385	0.000100
500	0.00

ε (eV)	qe22 ($10^{-16}cm^2$)
14.23	0.00
15	0.00400
16	0.00960
18	0.0190
19	0.0228
20	0.0255
22	0.0285
25	0.0310
30	0.0310
35	0.0290
40	0.0265
50	0.0215
60	0.0180
80	0.0138
100	0.0110
150	0.00760
200	0.00580
300	0.00395
500	0.00242
800	0.00157
1000	0.00127
10000	0.00

ε (eV)	qe23 ($10^{-16}cm^2$)
14.30	0.00
15	0.00320
16	0.00730
18	0.0145
20	0.0199
22	0.0240
25	0.0290
30	0.0355
35	0.0405
40	0.0440
50	0.0480
60	0.0495
80	0.0495
100	0.0477
150	0.0395
200	0.0330
300	0.0260
500	0.0192
800	0.0147
1000	0.0129
10000	0.00

ε (eV)	qe24 ($10^{-16}cm^2$)
14.71	0.00
15	0.00200
16	0.0100
18	0.0300
20	0.0480
22	0.0650
25	0.0910
30	0.124
35	0.150
40	0.165
50	0.178
60	0.178
80	0.165
100	0.146
150	0.112
200	0.0930
300	0.0690
500	0.0470
800	0.0330
1000	0.0280
10000	0.00

ε (eV)	qe25 ($10^{-16}cm^2$)
15.20	0.00
16	0.00900
18	0.0320
20	0.0630
22	0.0850

Ar

25	0.112	350	1.81
30	0.148	400	1.68
35	0.170	500	1.46
40	0.183	600	1.30
50	0.193	700	1.16
60	0.193	800	1.06
80	0.173	1000	0.916
100	0.152	10000	0.00
150	0.115		
200	0.0950		
300	0.0710		
500	0.0480		
800	0.0330		
1000	0.0270		
10000	0.00		

ε (eV)	qi ($10^{-16}cm^2$)
15.76	0.00
16	0.0202
17	0.134
18	0.294
19	0.460
20	0.627
21	0.787
22	0.933
23	1.06
24	1.18
25	1.30
26	1.41
28	1.60
30	1.80
32	1.96
34	2.11
36	2.24
38	2.33
40	2.39
42.5	2.45
45	2.49
50	2.53
55	2.60
60	2.66
65	2.73
70	2.77
75	2.82
80	2.84
85	2.85
90	2.86
100	2.85
120	2.81
130	2.76
150	2.68
160	2.62
180	2.52
200	2.39
250	2.17
300	1.98

2002. 12. 27.

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Atoms (17)		Molecules (51)			
A + e,	A + hν	M + e,		M + hν,	
He 2	2170 *	2 H_2, D_2	1850	5 CH_4	750
Ne 10	1140 *	N_2	2140	CF_4	390
Ar 18	1960	O_2	1690	CCl_4	210
Kr 36	790	CO	1190	CCl_2F_2	250
Xe 54	940	NO	850	CH_3Cl	90
				SiH_4	230
Li 3	450	F_2	170	SiF_4	140
Na 11	800	Cl_2	320	GeH_4	50
K 19	370	Br_2	130		
Rb 37	220	I_2	240		
Cs 55	370			6 C_2H_4	370
		HF	260	CH_3OH	240
O 8	390	HCl	320		
		HBr	190		
F 9	90	HI	100	7 SF_6	780
Cl 17	130				
		3 CO_2	1160	8 C_2H_6	260
Cu 29	180	H_2O	850	C_2F_6	150
Cd 48	210	O_3	480	Si_2H_6	70
Ba 56	320	N_2O	450		
Hg 80	600	NO_2	300	9 C_3H_6	120
		H_2S	270	C_2H_5OH	60
		SO_2	260		
		CS_2	240		
		OCS	240	11 C_3H_8	190
not final, but finished mostly				C_3F_8	100
		4 C_2H_2	390	12 C_4F_8	100
include electron swarm papers		NH_3	400	C_6H_6	240
		NF_3	110	C_6F_6	100
include review papers		BF_3	110		
		BCl_3	90	60 C_{60}	300
		PH_3	80		
		H_2CO	180	r + v	700

* He(Ne) + e only. Not include He(Ne) + hν papers.

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