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

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Bibliography of Electron and Photon Cross Sections

with Atoms and Molecules

Published in the 20th Century

—— Xenon ——*

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(Gaseous Electronics Institute)

A bibliographies 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 xenon (Xe). About 1180 papers were compiled. A comprehensive author index is included. The bibliography covers the period 1921 through 2000 for Xe. Finally, author's recommended Xe electron collision cross section set is given by number tables

Keywords : Xe 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 in around 1970 and originally encompassed only electron collision cross section and electron swarm data. The organization responsible for continuing 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 xenon (Xe) atom. The review papers on this subject are also included. Some xenon cluster papers are included. Some conference reports, company or agency reports and PhD thesis are added. Xenon ion papers and positron collision papers are not included in principle.

Papers of the following quantities are included.

For electron collision cross section :

- 1) elastic scattering
- 2) electronic excitation
- 3) ionization
- 4) grand total scattering (sum of elastic and inelastic cross sections)
- 5) metastable xenon
- 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 probability
- 3) lifetime of excited states
- 4) the others

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

The bibliography include the papers published in the 20th century, from 1901 to 2000. But oldest paper in this list is given by C. Ramsauer (1921). So for this xenon bibliography, published papers from 1921 to 1999 are compiled by alphabetical order of the first author's surname of the paper. And the references published in 2000 and plus some old papers found very recently after compilation are added as "Addenda of References for Xenon". Totally, about 1180 papers are compiled in the xenon bibliography.

Organization

This report consists of four parts : introduction, the bibliography and its addenda, author index and 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 xenon
S : electron Swarm
O : the Others (photon cross sections and the others)

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

Bibliography for Xe are divided into three parts :

Part 1.	1980 - 1999	p. 1 - 42
Part 2.	1921 - 1979	p. 43 - 76
Part 3.	Addenda of References (1)	1997 - 1999 p. 77 - 79
	Addenda of References (2)	published in 2000, plus some old papers p. 80 - 100
	Addenda of References (3)	p. 101 - 102

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. (Author Index of Addenda of References for Xe (2) is not complete and some selected authors are listed. I am sorry about it.)

Electron Collision Cross Section Set for Xenon (Xe)

Electron collision cross section set of elastic, electronic excitation and ionization collision for xenon 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. The author would like to improve this cross section set slightly.

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National Institute for Fusion Science, Toki
Institute for Molecular Science, Okazaki

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References for Xe (1980 - 1999)

(Xenon)

[Inert gas, Noble gas]

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

Some important papers published till 1979 are included in this part.

- E V. V. Afonin, Yu. M. Gapperin, V. L. Gurevich and A. Schmid : Phys. Rev. A36, 5729-5741 (1987)
Weak localization of electrons in a classical gas.
[T, general theory]
- O S. Aksela : J. Elect. Spectrosc. Relat. Phenom. 79, 247-252 (1996) .
High resolution electron spectroscopy of atoms and molecules.
[E, $h\nu$, Xe, Kr, He, H₂S]
- S N. L. Aleksandrov, I. V. Kochetov, D. Lo and A. P. Napartovich : J. Phys. D30, 2217-2222 (1997)
Negative differential conductivity of electrons in He - Xe mixtures.
[T, Xe + He; see N. L. Aleksandrov (1996), I. V. Kochetov (1998)]
- O M. Allan : J. Phys. B26, L73-L77 (1993)
Low energy electron impact spectra of the van der Waals clusters Xe₂ and Xe_n (n = 3, 4). [E, Xe₂, Xe₃, Xe₄]
- QT D. T. Alle, M. J. Brennan and S. J. Buckman : 18th ICPEAC, Aarhus 127-127 (1993) . Z
Total electron scattering cross sections for neon, nitrogen and xenon.
[E, Xe, Ne, N₂; 0.1 - 20 eV]
- O D. P. Almeida and C. F. L. Godinho : Nucl. Instrum. Meth. B114, 337-340 (1997).
Erratum 122, 167-167 (1997)
Integrated oscillator strengths for multiionization processes under the Bethe-Born formulation. [T, Ne - Xe]
- O Z. Altun, M. Kutzner and H. P. Kelly : Phys. Rev. A37, 4671-4678 (1988)
Photoionization of the 4d subshell of xenon. [T, $h\nu$, Xe]
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Manifestation of restructuring of the electron shells in atoms in the course of ionization. [T, $h\nu$, Xe, Ar, Cs, Ba]

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'Stripping' of the atom in bremsstrahlung. [T, Xe, La]
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The effect of atomic rearrangement on the photoionisation cross section for 3d subshells of the isoelectronic Xe series. [T, $h\nu$, Xe]
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Spectroscopic factor and the renormalization of interelectron interaction.
[comments, $h\nu$, Ar - Xe]
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Bull. Acad. Sci. USSR Phys. Ser. 50, No. 7, 19-25 (1986)
Nonphysical characteristics of the photoionization cross sections of internal shells. [T, $h\nu$, Ar - Xe, Cu, Hg]
- O M. Ya. Amusia and A. V. Korol : Nucl. Instrum. Meth. B79, 146-149 (1993) -
Recent developments of "polarizational" bremsstrahlung. [T, Xe, He, Ne]
- EX N. Anderson, J. W. Gallager and I. V. Hertel : Phys. Rep. 165, 1-188 (1988)
Collisional alignment and orientation of atomic outer shells. I.
Direct excitation by electron and atomic impact.
[review, He - Xe, H, Li, Na, K, Hg, Ba]
- ME E. A. Andreev and A. E. Bodrov : Chem. Phys. Lett. 109, 450-455 (1984) -
Inelastic scattering of low-energy electrons by metastable atoms.
[T, He - Xe, C, N, O]
- α T. Aoyama : Nucl. Instrum. Meth. A234, 125-131 (1985)
Generalized gas gain formula for proportional counters.
[T, Xe + CO₂, Ar + CH₄, etc.]
- O I. Arcon, A. Kodre, M. Stuhel and D. Glavic-Cindro : Phys. Rev. A51, 147-154 (1995)
Multielectron excitations in the L-subshell photoabsorption of xenon.
[E, $h\nu$, Xe]
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Quantum theory of post-collision interaction in inner-shell photoionization : Final-state interaction between two continuum electrons.
[T, $h\nu$, Xe, Ar]
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3d photoionization of Xe, Cs and Ba and the collapse of the 4f wavefunction. [E, $h\nu$, Xe, Cs, Ba]
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Highly charged inert-gas ions produced by nanosecond laser pulses.
[E, $h\nu$, Ar - Xe]

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Multiply charged ion produced in noble gases by a 1 ps laser pulse at $\lambda = 1053$ nm. [E, $h\nu$, Xe, He - Ar]
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A study of post-collision interaction effects in Kr 3d and Xe 4d near-threshold photoionization. [E, $h\nu$, Xe, Kr]
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Coplanar asymmetric (e, 2e) experiments on xenon 4p and 5p orbitals. [E, Xe]
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Observation of angle dependent postcollision interaction in the electron impact ionization of Xe 4d_{5/2}. [E, Xe; 1000 eV]
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Formation and decay of Xe 4d⁻¹ vacancies studied via electron-electron coincidence experiments. [E, Xe]
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Electron scattering of slow electrons from xenon atoms. [T, Xe; relativistic Hartree-Fock]
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L-subshell ionization cross sections of xenon by electron impact near threshold region. [E, Xe; 6 - 14 keV]
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Density dependence of electron mobility in dense gases. [T, He - Xe, H₂, N₂, O₂, CO₂; multiple-scattering approach]
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Effective collision frequency of electrons in noble gases. [T, He - Xe; assuming Maxwellian distribution]
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Resonantly enhanced multiphoton-ionization photoelectron spectroscopy of krypton and xenon : Experiment and theory. [E and T, $h\nu$, Xe, Kr]

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 Electron impact excitation of rare gases : Differential cross sections
 and angular correlation parameters for neon, argon, krypton and xenon.
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 Non-statistical branching ratios for excitation of $[np^5(n+1)s]^{1,3}P^o_{0,1,2}$
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 Threshold behaviour and resonances in the photoionization of atoms and
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 Double ionization of neutral atoms, positive and negative ions by
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Rate of deexcitation of the xenon $^3P_2(6s[11/2]_2)$ state by slow electrons
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Measurements using a pulsed electron beam and time scanning of radiation.
V : Xenon, $5p^56p$ levels. [E, Xe]
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Experimental xenon 4d photoionization cross sections in the 75 - 140-eV
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Satellite structure of the xenon valence shell by electron-momentum
spectroscopy. [E, Xe]

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Absolute differential cross sections of electrons elastically scattered by the rare gases. I. Small angle scattering between 200 and 700 eV. [E, He - Xe; 300 - 700 eV, 3 - 25°]
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High resolution electron impact excitation of negative ion resonances in Ne, Ar, Kr and Xe. [E, Ne - Xe]
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High-resolution electron impact excitation functions of metastable states of neon, argon, krypton and xenon. [E, Ne - Xe]
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Nonresonant above-threshold ionization by circularly polarized subpicosecond pulses. [E, $h\nu$, Xe; 140 fs]
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Details of electron correlation explored with VUV and soft X-radiation. [E, $h\nu$, Xe only]
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Angular distribution of decay electrons from the 6p resonance excitations in xenon. [E, $h\nu$, Xe]
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Author Index for Xe References

- J. Abdallah 21
T. Aberg 2, 33
M. Y. Adam 70
V. V. Afonin 1
V. V. Afrosimov 43
P. Agostini 39, 40
A. Aguirre 21
J. M. Ajello 43
T. Akahori 27
H. Aksela 32, 43, 77, 78
S. Aksela 1, 32, 43, 77, 78
N. L. Aleksandrov 1
S. Alitalo 77
M. Allan 1
D. T. Alle 1
L. J. Allen 7, 14, 24
D. P. Almeida 1, 10
S. H. Al-Shamma 43
Z. Altun 1
K. Amos 24
M. Ya. Amusia 2, 21, 43, 44, 72
M. Ya. Amus'ya 1, 43, 44
L. W. Anderson 24
N. Anderson 2
E. A. Andreev 2
A. Antonetti 39
T. Aoyama 2
I. Arcon 2
G. S. Argyropoulos 45
H. Ariola 48
G. B. Armen 2
L. Armstrong 12, 45, 65, 72
U. Arp 2
T. U. Arslanbekov 2
U. Asaf 31, 32
S. Asaoka 17
P. Ashley 78
G. Aspromallis 28
R. K. Asundi 45
V. M. Atrazhev 45
T. Auguste 3
L. Avaldi 3, 16, 31, 38, 78
N. B. Avdonina 2
B. Awe 3
M. Aydinol 3
A. Aymar 45
Y. Azuma 25, 33, 77
R. Ch. Baas 62
C. Badrinathan 26
A. Bagheri 3
S. Baier 20
P. Baille 3
F. A. Baiocchi 39
S. J. Bajic 3
G. S. Bajwa 46
K. L. Baluja 3
G. M. Bancroft 40
I. M. Band 2
M. S. Banna 5
K. Bartschat 4, 16, 41
A. K. Barua 45
B. Barzick 39, 40
V. I. Baskakov 45
R. C. Bass 45
A. K. Batabyal 45
W. E. Baylis 34
B. C. Beaty 13, 14, 66
C. E. Beckmann 21
K. Becker 4, 10, 26
U. Becker 4, 18, 23
M. J. M. Beerlage 22
C. Belenger 4
K. L. Beown 9
J. A. Beran 45
E. Berezhko 46
P. Berejny 4
N. B. Berezina 44
O. Berger 5, 27
H. P. Berg 5
K. Berkhan 33
N. Berrah 23
K. A. Berrington 28
D. Bessis 5, 16
H. Beutler 46
A. K. Bhattacharya 46
F. Biggs 68
J. Binder 23
W. K. Bischel 23
P. G. F. Bisling 19
H. J. Blaauw 46

H. E. Blackwell 46
 A. Blagoev 5
 A. B. Blagoev 5, 22
 C. Blanc 46
 Blanc 46
 H. Bluhme 78
 K. Blum 35
 D. P. Bochkova 5
 A. E. Bodrov 2
 A. J. H. Boerboom 70
 I. P. Bogdanova 5
 E. Bolduc 63
 J. J. Bolick 5
 P. Bolognesi 3
 R. A. Bonham 46, 75
 T. O. Bonifield 59
 C. Bordas 5
 D. Bordelon 21
 A. B. Borisov 5
 V. S. Borozdin 46
 M. Borst 5
 W. L. Borst 46
 C. Bottcher 15
 R. Boucique 19
 K. Boyer 5
 R. C. Bradford 60
 G. L. Braglia 47
 S. Braidwood 5
 S. W. Braidwood 6
 W. Brandt 47
 C. A. Brau 53
 P. Breger 39
 B. Brehm 47
 M. J. Brennan 1
 E. A. Briggs 56
 G. Brill 10
 C. E. Brion 6, 7, 47, 56, 77
 R. B. Brode 47
 J. E. Brolley 48
 J. P. Bromberg 6, 48
 I. K. Bronic 6
 H. L. Brooks 6
 G. S. Brown 33
 R. T. Brown 56
 S. C. Brown 67
 J. N. H. Brunt 6, 48, 68
 M. Brunger 5
 M. J. Brunger 6
 R. S. Brusa 6, 41
 W. Bruynooghe 19

I. A. Brytov 62
 S. J. Buckman 1, 6, 7, 14, 24, 48
 P. H. Bucksbaum 7, 19
 W. J. Buma 22
 C. J. Burkley 48
 J. F. Burns 48

 J. A. Cabrera 25
 A. A. Cafolla 40
 R. B. Cairns 48, 69
 C. D. Caldwell 7, 13, 40
 G. Caledonia 73
 R. Camilloni 3, 31, 38, 78
 J. Campos 25, 57
 M. Capitelli 24
 M. A. Cappelli 7
 C. -D. Carette 50
 J. -D. Carette 50, 69
 J. D. Carette 48
 T. A. Carlson 12, 48
 J. G. Carter 8, 18
 M. A. Casteel 45
 S. Cavalieri 77
 R. J. Cedolin 7
 R. J. Celotta 72
 R. E. Center 24
 J. P. Chambaret 39
 G. E. Chamberlain 60
 J. -S. Chang 3
 W. F. Chan 7
 T. N. Chang 7, 73
 J. M. Channing 42
 S. Chandra 49
 D. Charalambidis 7, 77, 79
 Y. Chatelus 7
 M. A. Chaudhry 7
 C. L. Chen 49
 M. H. Chen 33
 S. Chen 8
 Z. Chen 8, 28
 K. T. Cheng 8, 18, 19, 58
 V. K. Chernyatin 45
 M. Cheret 63
 N. A. Cherepkov 43, 44, 49
 I. V. Chernysheva 38
 L. V. Chernysheva 2, 43, 44
 N. K. Cherepkov 72
 C. Chiandusso 49
 M. I. Chibisov 63
 C. -Y. Chien 37

R. V. Chiflikyan 8
 Y. Chikahiro 38
 S. L. Chin 8, 37, 78
 P. D. Chopra 49
 L. G. Christophorou 8, 18
 A. Chutjian 43
 C. W. Clark 6
 J. D. Clark 10
 R. E. H. Clark 21
 E. M. Clarke 49
 A. Claude 3
 G. G. Cloutier 49
 L. L. Coatsworth 40
 K. Codling 49, 56, 71, 74
 J. H. Collins 49, 75
 J. Comer 9, 40
 A. R. Comeaux 64
 F. J. Comes 49, 50
 R. N. Compton 3, 54
 C. A. N. Conde 11, 31, 32, 35
 G. R. Cook 64
 J. P. D. Cook 8
 T. B. Cook 62
 D. R. Cooper 77
 G. Cooper 7
 J. Cooper 8, 71
 J. W. Cooper 50, 63
 R. Cooper 8, 50, 77
 M. Coreno 78
 M. C. Cornell 6
 J. J. Corr 8
 M. Coulombe 45
 W. L. Courchene 75
 P. L. Cowan 25
 H. L. Cox 46
 J. D. Craggs 61, 73
 M. Crance 9
 D. H. Crandall 15
 B. Crasemann 2, 33
 Z. Crljen 9
 D. T. Cromer 56
 A. Crowe 4, 40, 50, 75
 D. Cubric 9, 77
 F. J. Currell 36
 H. Czerwinski 35
 M. S. Dababneh 9
 P. Dabkiewicz 55
 C. Dal Cappello 9
 G. Dall'Armi 9
 N. R. Daly 50

H. Damany 9
 N. Damany 9
 A. Danjo 12, 28, 29, 35
 S. M. Datta 3
 V. A. Davidenko 50
 E. R. Davidson 6
 A. J. Davies 9
 G. Dawber 3, 16
 A. de Boer 39
 M. P. de Boer 9
 P. Defrance 4
 A. Degeilh 46
 M. R. De Haas 39
 F. J. de Heer 9, 19, 33, 39, 50,
 52, 57, 62, 70
 C. A. DeJoseph 10
 A. Delage 50
 C. A. de Lange 22
 F. de la Ripelle 50
 J. L. Delcroix 61
 A. Dellafiore 10
 N. B. Delone 10
 Ph. V. Demekhin 22
 V. F. Demekhin 35
 G. M. de' Munari 47, 50, 51
 L. Deng 10
 E. Dershem 51
 P. C. Deshmukh 10, 30
 R. D. Deslattes 25, 51
 T. A. De Temple 35
 H. Deutsch 10, 25
 M. Deutsch 10
 A. M. Devyatov 54, 74
 D. P. Dewangan 51
 C. Dezarnaud 10
 T. H. V. T. Dias 11, 31, 32, 35
 V. H. Dibeler 61
 M. A. Dillon 6
 D. Dill 51
 L. F. DiMauro 39
 T. Ditmire 77
 P. F. Dittner 15
 A. J. Dixon 51, 74
 V. V. Dmitrenko 11
 A. Dobay-Szegleth 51
 B. A. Dolgoshein 50
 G. G. Dolgov-Savelev 51
 M. Dondera 11
 A. Dorn 11
 J. D. Dow 72

J. P. Downing 9
 M. J. Druyvesteyn 52
 D. Dube 11
 A. I. Dudenko 22
 A. Dulcic 11
 M. Dummler 11
 A. J. Duncan 7, 18
 G. H. Dunn 25, 59
 F. B. Dunning 62, 69, 72
 J. Dunning-Davies 49
 T. L. Dutt 52
 J. Dutton 9, 45, 52
 C. Duzy 12
 M. J. Dyer 5

 C. R. Eaton 47
 P. J. Ebert 60
 J. E. Eden 21
 D. L. Ederer 52
 M. Edwards 12
 W. F. Egelhoff 12
 F. Egger 52, 63
 H. Egger 24
 F. Ehlotzky 20
 A. Ehresmann 77
 H. Ehrhardt 32
 W. B. Eissner 28
 J. H. D. Eland 30
 M. T. Elford 12
 R. L. Elgin 56
 A. Elliott 11
 K. Ellis 16
 Th. M. El-Sherbini 52
 S. B. Elston 52
 S. Emura 77
 P. Englander-Golden 31, 52, 68
 W. N. English 52
 R. Eramo 77
 A. P. Ershov 52
 F. Eschen 19
 T. Ester 12
 C. J. Evans 9
 M. Evans 79
 J. J. Ewing 24, 53

 I. I. Fabrikant 12, 34
 A. Fahlman 12, 40
 E. Fainelli 3
 T. Fairfield 5
 F. C. Farnoux 49, 75

O. Faucher 77
 H. Faxen 53
 R. Feder 3, 20
 D. Feldmann 12, 32
 Z. Felfli 12, 16, 28
 M. Felsmann 19
 P. V. Feltsan 53, 75, 76
 B. H. Feng 7
 J. Ferch 12
 L. J. Ferderber 60
 L. Ferrari 47
 C. M. Ferreira 13
 T. A. Ferrett 18
 F. H. Field 62
 H. H. Fielding 78
 D. Filipovic 12, 25
 L. Fini 77
 M. G. J. Fink 12
 C. D. Finney 53
 O. B. Firsov 63
 E. I. Fisher 69
 I. P. Flaks 66
 M. R. Flannery 13, 26, 63, 73
 M. G. Flemming 13
 J. Fletcher 6, 9
 V. Florescu 11
 S. N. Foner 53
 J. C. Fong 48
 J. T. Fons 13
 C. J. Fontes 13, 21
 C. Fotakis 7
 G. R. Fournier 53
 M. M. F. R. Fraga 13
 J. L. Franklin 62
 G. W. Fraser 13
 G. R. Freeman 13, 56
 R. R. Freeman 7
 R. S. Freund 39, 54, 71
 L. A. Fridkin 73
 H. Friedrich 19
 L. Fritsche 13, 15
 C. Fuchtbauer 54
 C. H. Fuller 69
 O. T. Fundingsland 67
 J. E. Furst 13, 14

 L. Gabba 51
 J. W. Gallagher 13, 14, 18
 P. S. Ganas 54
 P. Gangopadhyay 14

Yu. M. Gapperin 1
 C. Garcia-Rosales 14
 J. L. Gardner 69
 W. R. Garrett 10, 54
 A. Garscadden 28
 T. J. Gay 13, 14
 J. Geiger 54
 F. Gelebart 73
 S. Geltman 54
 E. V. George 56
 G. N. Gerasimov 54
 C. Gerth 78
 F. Giammanco 38
 F. A. Gianturco 14
 J. C. Gibson 7, 14
 G. Gibson 14
 F. Giusiano 50, 51
 D. Glavic-Cindro 2
 R. E. Gleason 59
 E. V. Gnatchenko 15, 38, 39
 C. F. L. Godinho 1
 H. C. Goldwire 69
 H. Gollisch 13
 A. Goodings 9
 Yu. S. Gordeev 43
 F. Gossler 54
 B. Gotz 33
 B. Granitza 15
 F. Grasso 54
 A. E. S. Green 15, 46, 54
 D. C. Gregory 15
 J. Gresser 7
 S. A. Gribovskii 62
 F. Grieser 50
 D. C. Griffin 15
 T. Yu. Grigor'eva 27
 J. T. Grissom 54
 R. Grisenti 41
 M. Gryzinski 54
 C. Guet 19
 F. Guillot 10
 S. S. Guk 54
 N. Gully 12
 X. Guo 7, 11, 15
 S. K. Gupta 55
 V. L. Gurevich 1
 Yu. K. Gus'kov 55
 T. Gustafsson 55
 H. Haberland 15

R. Haberland 15
 G. N. Haddad 69
 R. Haensel 55
 A. Haffad 5, 16
 H. D. Hagstrum 55
 U. Hahn 16
 R. I. Hall 3, 16
 S. Hallman 7
 P. Hammond 6, 8, 16, 29, 30, 31
 A. Hamnett 56
 W. Hanle 55
 G. C. Hanna 52
 G. F. Hanne 11, 16, 26, 27, 38
 P. Hansch 16, 77, 79
 J. E. Hansen 16
 R. K. Hanson 7
 P. W. Harland 38
 S. A. Harris 38
 A. G. Harrison 53, 55
 H. Harrison 48
 T. W. Hartquist 55
 K. Hasenburg 16
 J. B. Hasted 55
 Y. Hatano 36, 38
 T. Hayaishi 4, 17, 22
 M. Hayashi 17
 T. R. Hays 39
 H. Hda 9
 C. Heckenkamp 17
 D. W. O. Heddle 18, 49, 55
 P. A. Heimann 18, 24
 T. Heindorff 55
 U. Heinzmann 17, 55
 H. Helm 5, 56
 A. Henins 25
 B. L. Henke 56
 J. W. Hepburn 79
 J. Herbak 36
 U. Hergenbahn 18, 24
 R. R. Herm 74
 H. Hertz 56
 I. V. Hertel 2
 C. Herting 26, 27
 A. Heutz 78
 E. Hille 63
 D. Hils 26
 R. Hippler 7, 18, 26
 R. M. Hobson 3
 H. L. Hodges 73
 C. R. Hoffmann 56

J. Hofft 55
 D. Hofsaess 56
 D. M. P. Holland 56
 G. Holtkamp 18
 J. Holtsmark 53
 Q. Hong 78
 S. T. Hood 56
 A. N. Hopersky 77
 K. Hosaka 29
 H. Hotop 20, 30, 33
 R. G. Houlgate 74
 R. J. Howerton 56
 Y. F. Hsieh 9
 C. -W. Hsu 79
 D. X. Huang 40
 K. -N. Huang 18
 S. -S. Huang 56
 J. H. Hubbell 56
 B. A. Huber 23
 J. E. Hudson 38
 R. D. Hudson 48, 57
 R. E. Huffman 57
 H. J. Humpert 18
 J. Hurn 11
 J. M. Hurn 15
 M. H. R. Hutchinson 77
 H. A. Hyman 12, 18, 57

 I. T. Iakubov 19, 45
 K. Iemura 2
 V. S. Igropulo 57
 W. Ihra 19
 Y. Iketaki 19, 36
 K. Imre 28
 M. G. Inghram 74
 M. Inokuti 6, 60
 A. F. Ioffe 1
 H. Ishii 19
 F. A. Iskanderov 2
 K. Isoda 38
 G. Isoyama 17
 Y. Itikawa 28, 57
 K. Ito 25
 Y. Ito 77
 Iv. Ivanov 5
 V. A. Ivanov 19
 V. K. Ivanov 1, 2, 43, 44

 R. S. Jackson 63
 L. Jacques 19

R. H. Jansen 19, 57
 R. H. J. Jansen 9, 45, 50
 W. Jaskolski 19
 J. Jauhainen 77
 J. G. Jenkin 58
 E. Jimenez 57
 U. Johann 24
 T. L. John 58
 L. P. Johnson 58
 W. R. Johnson 8, 12, 18, 19, 30, 58
 A. E. Jonas 48
 D. G. C. Jones 43
 E. G. Jones 55
 L. R. Jones 56
 N. R. Jones 64
 R. R. Jones 19
 S. Jones 25
 K. Jost 19, 27
 K. Jung 32

 N. M. Kabachnik 18, 24, 46
 K. Kadota 58
 B. Kaemmerling 19
 Y. Kageyama 17
 K. Kameta 38
 J. Z. Kaminski 20
 B. Kammerling 20
 Y. Kaneko 58
 I. Kanik 21
 V. Kara 58, 78
 V. Karaivanov 58
 B. A. Karlin 25
 L. Karlsson 39
 W. L. Karras 29
 J. Karvonen 78
 G. Karwasz 36, 41
 G. P. Karwasz 6, 41
 J. Karwowski 19
 M. Kato 37
 T. Kato 37
 R. Kau 20
 W. E. Kauppila 9, 20
 S. Kaur 20
 P. A. Kazaks 58
 A. K. Kazansky 20
 G. Keitel 55
 H. P. Kelly 1, 20, 23
 P. C. Kemeny 58
 F. Kemper 3, 20
 D. J. Kennedy 58, 63

C. Kenty 58	R. Kollath 60, 68
H. G. Kerkhoff 4, 18	N. B. Kolokolov 22
J. Kessler 5, 11, 12, 14, 16, 20, 21, 27, 28, 38, 40, 53, 55, 58, 59	K. L. Kompa 33
J. W. Keto 59	A. A. Konkov 61
L. Kevan 45	A. V. Korol 2
M. A. Khakoo 8, 21, 30	A. I. Korotkov 22
S. P. Khare 21, 59	I. V. Kosinskaya 61
A. G. Kharpak 59	H. R. Koslowski 23
A. S. Kheifets 21	G. F. Koster 72
I. V. Kholin 33	N. Kouchi 38
A. L. Khomkin 59	K. Koura 22, 23
N. A. Khromov 22	T. Z. Kowalski 23
M. H. Kibel 59	T. Kraft 33
L. J. Kieffer 57, 59, 60	V. P. Krainov 10
K. P. Killeen 21	B. Krassig 19, 79
Y. -K. Kim 60	B. Kraus 33
Y. S. Kim 7	M. O. Krause 12, 13, 40
J. Kimman 23	M. Krauss 61
M. Kimura 6	V. D. Kravtsov 25, 78
G. C. King 3, 6, 12, 16, 34, 42, 48, 60, 68, 77	E. Krishnakumar 23
A. E. Kingston 60	S. Kroll 23
R. W. Kiser 60	P. Kruit 23
L. Kissel 35, 42	A. A. Kruithof 61
J. Kistemaker 70	M. Yu. Kuchiev 2, 23
B. Kivel 60	E. Kugler 55
A. Kivimaki 32, 77, 78	K. C. Kulander 5
R. Kizler 10	A. Kumar 61
T. Kjeldaas 53, 56	V. Kumar 35
D. Klar 20, 33	C. Kunz 55
H. Klar 18	V. A. Kupchenko 2
H. Kleinpoppen 7, 18, 26, 43	A. Kuppermann 75
W. Klemperer 54	S. E. Kupriyanov 61, 72
M. Klewer 22	M. Kupsch 4
L. E. Kline 29, 30	A. V. Kuralova 74
K. A. Klopovskii 22	M. V. Kurepa 45, 61
E. L. Klosterman 24	E. J. Kuster 58
H. Knudsen 78	G. Kutluk 2
P. Kobrin 75	N. N. Kutsina 41
J. Kobus 19	M. Kutzner 1, 23
I. V. Kochetov 1, 22	C. E. Kuyatt 61, 72
A. G. Kochur 22	A. A. Kuzovnikov 52
A. Kodre 2	T. Kylli 77
A. F. Kodre 33	G. Laaricchia 78
S. M. Koeckhoven 22	P. Lablanquie 78
H. A. Koehler 60	P. Laborie 61
F. Koike 17	B. M. Lagutin 23
T. Koizumi 22, 37	P. Lambropoulos 3, 14, 79
T. Kolar 15	F. W. Lampe 62
	O. L. Landen 37

N. F. Lane 29
 J. Lang 62
 B. Langer 4, 18, 23
 F. Laperriere 9
 P. Laporte 9
 G. Laricchia 78
 S. Larochelle 37
 S. F. J. Larochelle 78
 J. C. Larrabee 57
 C. J. Latimer 62
 Z. Z. Latypov 61
 P. Lavigne 8
 S. V. Lavrent'ev 35
 V. M. Lavrov 43
 S. A. Lawton 35, 52
 H. Lebius 23
 T. LeBrun 25
 R. C. G. Leckey 58
 L. R. LeClair 21, 23
 R. B. Ledingham 56
 J. S. Lee 75
 S. T. Lee 62
 E. S. Leherissey 71
 H. Lehrke 62
 J. Lei 78
 F. J. Leng 59
 R. E. Lent 56
 P. Lenz 33
 R. M. Lerner 56
 J. C. Levin 25
 L. A. Levin 24
 B. R. Lewis 62
 A. L'Huillier 24
 I. S. Li 44
 Y. Liang 37
 J. Liedtke 62
 J. Liesegang 58
 C. C. Lin 13, 24
 I. Lindau 40
 D. W. Lindle 18, 24
 I. M. Littlewood 6
 S. H. Liu 18
 D. Lo 1, 22
 B. Lohmann 18, 24
 L. A. Lompre 3, 24
 S. Longo 24
 J. Los 39
 J. Lower 11, 15
 J. J. Lowke 62
 Y. Lu 17

C. B. Lucas 59, 62
 J. Ludwig 32
 T. Luhmann 78
 T. S. Luk 14, 24
 A. P. Lukirskii 62
 A. V. Luk'yanova 22
 D. R. Lun 7, 14, 24
 S. Lundqvist 47
 D. R. Lunt 7
 H. O. Lutz 18
 B. F. J. Luyken 62
 A. V. Lyash 73
 C. J. MacCallum 68
 M. A. MacDonald 9, 16, 25
 K. Maciag 36
 R. G. A. R. MacLagan 38
 D. MacNair 73
 R. P. Madden 49
 D. H. Madison 4, 13, 25, 78
 K. Maeda 25
 B. Magel 77
 W. Mahler 23
 G. Mainfray 3, 24
 T. Makabe 62
 L. Malegat 78
 C. Malesset 46
 N. A. Malik 26
 D. D. Malyuta 74
 G. Mambriani 47, 50, 51
 L. J. Medhurst 18
 W. Mehlhorn 70
 J. Mehr 64
 L. Mei 30
 H. A. J. Meijer 33
 H. J. Meister 64
 G. Mentzel 77
 H. Merz 16
 C. Mette 26, 27
 P. H. Metzger 64
 E. Mevel 39
 S. R. Mielczarek 60, 61, 71
 B. Mielewska 42
 V. Mihkelsoo 27
 U. Mikkelsen 78
 A. Mikuni 17
 V. M. Mikyshkin 66
 D. Milathianaki 77
 P. M. Millet 4

D. L. Miller 72
 A. M. Millhouse 35
 B. -S. Min 27
 B. S. Min 36
 R. Minkowski 65
 T. M. Mishonov 5
 H. P. Mital 49
 J. D. Mitroy 8
 L. K. Mitryuhin 22
 S. Mizzi 31
 P. Mlidla 27
 B. Mobus 33
 C. B. O. Mohr 63
 B. L. Moiseiwitsch 65
 A. G. Molchanov 65
 E. Mollenkamp 27
 R. Mollenkamp 40
 S. P. Moller 78
 J. J. Monaghan 65
 P. Monot 3
 S. E. Moody 24
 C. E. Moore 65
 T. J. Moratz 29
 E. Morenzoni 78
 I. Mori 29
 T. Mori 17, 62
 T. Morioka 17
 Y. Morioka 17, 27
 K. Morita 36
 A. P. Moritts 5
 J. D. Morrison 51, 58, 65
 J. Morton 73
 H. R. Moustafa-Moussa 33, 70
 S. T. Manson 10, 26, 29, 58, 63, 65, 66
 C. Manus 3, 24
 P. Maragakis 79
 N. H. March 13
 V. S. Marchenko 25
 D. Margreiter 25
 B. Marinkovic 12, 25
 R. S. Marjoribanks 77
 T. D. Mark 10, 25, 35, 52, 56, 63
 P. Marmet 25, 63
 G. V. Marr 56
 A. R. Martin 63
 P. Martin 25
 J. D. Martinez 32
 M. Martins 78
 K. E. Martus 26
 Yu. V. Martynenko 63

N. J. Mason 26
 H. S. W. Massey 63
 S. Masui 26
 F. Matera 10
 M. Materazzi 77
 E. Mathieson 13
 D. Mathur 26
 T. Matila 77
 T. Matsuda 28, 29
 F. M. Matsunaga 63
 T. Matsuo 22, 37
 J. A. D. Matthew 41
 E. Matthias 62
 L. Mattsson 39
 D. V. Maxey 8
 R. Mayol 32
 J. Mazeau 78
 S. Mazevet 11, 15, 78
 S. F. Mazevet 11
 K. J. McCann 13, 63
 I. E. McCarthy 6, 8, 11, 15, 26, 51,
 62, 64, 73, 74, 77, 78
 M. McChesney 64
 J. W. McConkey 4, 8, 29, 30, 37, 41
 D. L. McCorkle 8
 E. W. McDaniel 26
 R. P. McEachran 7, 8, 11, 14, 16, 20,
 25, 26, 35, 40, 42
 S. P. McGlynn 32
 J. W. McGowan 64
 I. McGregor 18, 26
 D. R. A. McMahon 34
 A. McPherson 5
 J. Moxom 78
 A. Mozumder 28
 A. Msezane 65
 A. Z. Msezane 5, 8, 12, 16, 28
 I. A. Mukhitdinova 65
 T. Mukoyama 37, 77
 H. Muller 14, 28
 H. G. Muller 9, 23
 K. G. Muller 62
 R. Multari 3
 R. A. Multari 3
 E. Murakami 17

 T. Nagata 2
 R. Nagpal 28
 P. Nagy 28, 55
 M. Nakamura 17, 27

S. Nakazaki 28
 B. H. Nall 53
 A. P. Napartovich 1, 22
 U. Narain 49
 R. M. Nayak 59
 R. K. Nesbet 28
 K. F. Ness 12, 32
 H. Neu 65
 J. Neville 6, 77
 J. J. Neville 77
 W. R. Newell 26
 C. Y. Ng 79
 A. J. C. Nicholson 51, 65
 J. N. Nickel 28
 C. A. Nicolaides 15, 28
 A. Niehaus 66
 H. Nishimura 28, 29, 66
 Y. Nishimura 66
 C. J. Noble 51, 64, 74
 J. Noffke 13, 15
 E. Nomliste 32, 77
 L. D. Noordam 9
 K. -E. Norell 39
 C. Noren 29, 41
 G. L. Nyberg 59
 K. J. Nygaard 6

 B. Obst 78
 J. K. O'Connell 29
 T. Odaka 38
 I. Ogawa 22, 29
 G. L. Ogram 3
 G. N. Ogurtsov 66
 M. Ohnishi 37
 S. Ohtani 36, 66
 M. Ohwa 29
 K. Ohya 29
 K. Okuno 35
 L. A. R. Olsen 47
 T. F. O'Malley 66
 W. Ong 29, 66
 Y. Oono 66
 C. B. Opal 66
 V. N. Ostrovsky 20
 G. Otto 12
 J. W. Otvos 66
 P. Ozimba 12

 J. L. Pack 29, 30, 66
 B. D. Padalis 59

R. Padma 30
 S. C. Page 30
 D. Palfreyman 30
 K. Paludan 78
 C. Pan 30
 L. Pan 12
 V. E. Panchenko 51
 V. -F. Z. Papp 67
 L. Parcell 14
 L. A. Parcell 7, 14
 J. H. Parker 62
 F. A. Parpia 30
 P. K. Patel 77
 S. H. Patil 30
 P. A. Pavlov 67
 M. G. Payne 10
 V. Peet 27
 V. Pejcev 12, 25
 N. P. Penkin 27, 30
 F. M. Penning 52
 J. Peresse 67, 73
 A. A. Perov 61
 M. D. Perry 37
 W. Persson 16
 R. Peterkop 67
 W. K. Peterson 66
 G. Petite 40
 J. Petrakis 7
 D. Petring 12
 I. D. Petrov 20, 23, 30, 35
 N. I. Petrov 22
 S. Ya. Petrov 54
 S. Pfau 67
 A. V. Phelps 29, 30, 54, 66, 67
 B. A. Phillips 64
 C. K. Phodes 24
 M. N. Piancastelli 18
 F. M. J. Pichanick 52, 67
 M. S. Pindzola 15
 R. Ya. Pirogovskii 2
 P. Plessis 8, 30
 W. Poffel 33
 P. S. Pogrebnyak 38, 39
 V. Pol 9
 E. D. Poliakov 75
 A. Ya. Polischuk 30
 L. P. Polozova 61
 R. T. Poole 58
 Tc. K. Popov 5
 V. A. Popov 77

Yu. M. Popov	65	J. A. Rodriguez-Ruiz	14
L. E. Porter	48	V. I. Roldugin	45
R. H. Pratt	42	J. Rolke	6, 77
W. Prepejchal	68	S. L. Rolston	39
T. Prescher	4	A. S. Romanyuk	11
S. D. Price	30	S. J. Rose	77
A. S. Prikhodko	19	T. Rosel	32
K. C. Prince	78	R. A. Rosenberg	62, 75
M. Proulx	25	F. Rosicky	3, 20
A. Prytz	32	G. S. Rostovikova	68
V. Puech	31	H. Rottke	32
H. Pummer	24	A. C. Roy	9
J. E. Purcell	46	B. N. Roy	61, 69
P. H. Purdie	9	D. Roy	11, 48, 50, 69
		B. F. Rozsnyai	32
J. J. Quemener	63	M. -W. Ruf	33
		M. W. Ruf	66
L. L. Rabik	73	J. R. Rumble	13
P. J. B. M. Rachinhas	31	R. D. Rundel	69, 72
V. Radojevic	23, 30	K. Rupnik	32
D. K. Rai	69	J. Ruscheinski	33
W. Raith	34	O. P. Rustgi	69
A. T. Rakhimiv	22	A. Rutscher	67
P. Ramanantsizehena	7	P. M. Rutter	3
C. Ramsauer	67, 68		
J. A. Ramswell	78	K. Saeed	18
D. Rapp	31, 52, 68	O. -P. Sairanen	32
J. Rasch	31	M. Saissac	4
F. H. Read	6, 16, 30, 31, 34, 42, 48, 60, 68, 77	N. Saito	32
D. L. Redhead	60	Y. Sakai	32, 36
P. A. Redhead	68	Y. Salamero	4
J. A. Rees	61, 71	F. Salvat	32
R. M. Reese	61	E. Salzborn	4, 34
D. F. Register	28, 31	H. G. Salzer	49, 50
D. D. Reid	31	V. P. Samoilov	68, 69
R. F. Reilman	65	J. A. R. Samson	69
T. Reiners	15	L. Sanche	69
G. Reisfeld	31	N. Sandner	70
N. B. Rerezina	44	W. Sandner	32
K. Reyman	33	D. F. Sangster	50
C. K. Rhodes	5, 14	F. P. Santos	11, 31, 32
M. Richter	78	S. Sasaki	12
D. Riede	55	M. C. Sauer	8, 50
F. F. Rieke	68	R. V. Savvov	55
M. E. Riley	68	S. Sawada	32
D. E. Rio	15	N. N. Sazhina	33
E. J. Robinson	68	K. Schackert	70
R. E. Robson	32	F. Schafers	17, 55
J. M. Rocard	61	H. Schaffer	77
		M. Schaper	70

S. J. Schaphorst	33, 79	V. S. Shevera	67
K. -H. Schartner	33, 77	J. A. Shiavone	71
D. Schaupp	35	H. Shibata	37
I. Schechter	33	R. C. Shiell	79
H. Scheibner	67, 70	E. Shigemasa	17, 26, 35
M. Schein	51	K. Shima	22, 37
H. I. Schiff	49	H. Shimamori	34
H. Schmaranzer	33	I. Shimamura	34
A. Schmid	1	M. Shimbo	35
B. Schmidt	33	V. A. Shingarkina	38
E. Schmidt	4	K. Shinsaka	38
V. Schmidt	5, 19, 20, 28, 33, 70, 79	G. S. Shipp	46
A. Schmillen	55	D. A. Shirley	4, 18, 24, 62, 75
U. Schmitz	33	E. Shirakawa	22
H. Schmoranzer	77	B. Shizgal	34
R. I. Schoen	48	O. B. Shpenik	34, 41
D. G. Schofield	43	K. Siegbahn	39
S. Schohl	20, 33	J. E. Sienkiewicz	34, 36
G. Schonhense	17	T. Simon	27
H. Schroder	33, 79	M. de Simone	78
B. L. Schram	33, 70	F. Simon	12
P. Schreiber	55	J. A. Simpson	61, 67, 71
H. Schroder	33, 79	G. Sinapius	34
G. Schultz	7	L. T. Sin Fai Lam	31, 34
D. W. Schumacher	7, 19	P. Sinha	21
M. Schumacher	35	Yu. F. Skachkov	71
G. Schumpe	50	H. M. Skarsgard	56
J. Schutten	33, 70	A. Skutlartz	28
W. H. E. Schwarz	70	J. Slevin	35
H. Schwier	18	V. A. Slobodyanyuk	55
J. H. Scofield	70	J. H. Smart	9
P. Selles	78	F. Smend	35
I. A. Sellin	26	V. V. Smirnov	27, 30
J. Semke	16	Yu. M. Smirnov	46, 68, 69, 71
M. C. Sexton	48	S. J. Smith	33, 65
R. Shakeshaft	14, 33	K. Smith	71
S. A. Shannon	71	P. T. Smith	72
S. G. Shapiro	44, 72	R. A. Smith	77
Shardanand	71	A. N. Snegursky	12
D. A. Shaw	34	A. V. Snegursky	34, 41
S. G. Shchemelinin	43	K. Soejima	35
S. I. Sheftel'	1	E. Sokell	9
S. I. Sheftel	1, 43, 44	F. K. Soley	59
S. A. Sheinerman	1, 23, 44, 79	T. J. Sommerer	35
W. N. Shelton	71	S. V. Somov	50
Y. Shen	11, 15	B. Sonntag	4
O. B. Shepenik	12	R. Sorkina	27
A. Sherman	27	G. M. Sorokin	22
R. H. Sherman	48	S. H. Southworth	25, 75
V. P. Shevelko	4, 34	U. Sowada	39

L. T. Specht 35
 D. Spence 71
 N. Spinelli 38
 H. Sponer 65
 V. Srinivasan 71
 B. N. Srivastava 45
 R. Srivastava 20, 35
 S. K. Srivastava 23
 J. R. Stallcop 71
 A. F. Starace 18, 30, 69, 71
 G. S. Starikova 69
 V. N. Staroseltsev 50
 H. Statz 72
 A. D. Stauffer 8, 11, 16, 20, 26,
 31, 32, 35, 40, 42
 V. G. Stavros 78
 R. F. Stebbings 62, 69, 72
 G. Stefani 3, 31, 38
 T. S. Stein 9, 20
 K. Stephan 35, 56, 63
 D. P. Stevenson 66
 P. K. Stewart 9
 S. Stimson 79
 H. Stori 63
 G. Strakeljahn 12
 F. A. Stuber 72
 M. Stuhec 2
 K. P. Subramanian 35
 J. L. Subtil 9
 S. I. Suchkov 11
 N. V. Suetin 22
 V. L. Sukhorukov 20, 22, 23, 30,
 C. P. Sun 75
 T. Sunagawa 34
 G. A. Surskii 72
 E. Suzuki 36
 H. Suzuki 17, 19, 27, 32, 36, 66
 I. H. Suzuki 17, 32
 T. Y. Suzuki 36
 A. Svensson 12
 P. Swan 72
 J. R. Swanson 45, 65, 72
 C. A. Swarts 72
 J. A. Syage 36
 E. Szmola 36
 Cz. Szmytkowski 36
 A. Szoke 37
 D. Szostak 4, 18
 A. Takahashi 29

M. Takahashi 77
 C. Takayanagi 27
 K. Takayanagi 72
 T. Takayanagi 19, 27, 36, 37
 A. Talebpour 37, 78
 E. Tammé 27
 K. H. Tan 40
 Y. Tanaka 27, 57
 A. Tanchich 44
 A. R. Tancic 72
 X. Tang 3, 14
 C. L. Tange 72
 M. Tapernon 32
 V. D. Taranukhin 37
 S. M. Tarr 71
 J. T. Tate 72
 H. Tawara 4, 22, 29, 34, 37
 R. L. Taylor 73
 N. Terazawa 38
 P. J. O. Teubner 48, 62
 J. K. Theobald 48
 K. Thimm 55
 E. W. Thomas 26
 T. D. Thomas 43
 D. B. Thompson 77
 P. K. Tien 73
 I. S. Tilinin 37
 A. A. Tkachenko 15, 39
 T. Tochio 77
 D. Ton-That 73
 T. Tonuma 22, 37
 L. Torop 73
 B. A. Tozer 73
 C. J. Traeger 65
 S. Trajmar 21, 23, 28, 31, 37, 75
 T. Tran 21
 K. W. Trantham 14
 D. Tremblay 11
 A. Treshchalov 27
 D. N. Tripathi 69
 M. Tronc 10, 60
 M. B. Trzhaskovskaya 2
 J. Tulkki 2, 33
 A. D. Turnbull 64
 R. J. Tweed 73
 K. Ueda 25, 37
 T. Ueda 15
 A. Ugbabe 73
 E. Uggerhoj 78

M. Uhrig 38
 C. J. G. J. Uiterwaal 79
 M. Ukai 38
 S. Ushiroda 17
 D. B. Uskov 4
 N. N. Ustinovskii 33
 Z. M. Uteshev 11, 38

 C. Vallance 38
 P. J. M. van der Burgt 8
 W. van der Kaay 9, 50
 M. J. van der Wiel 22, 23, 52, 70, 73, 75
 P. van der Meulen 40
 A. F. J. van Raan 73
 T. van Tubergen 39
 L. D. Van Woerkom 7, 16, 77, 79
 G. R. Varton 7
 R. V. Vasil'eva 38
 H. Veenhuizen 39
 W. L. Veigele 56
 V. Veldre 67
 V. Ya. Veldre 73
 R. Velotta 38
 E. T. Verkhovtseva 15, 38, 39
 J. Viefhaus 23
 D. Villarejo 74
 A. M. Vlaicu 77
 Yu. M. Volkov 74
 L. M. Volkova 74
 F. Vollweiler 77
 A. von Engel 51
 A. V. Vorontsov 61
 R. E. Voshall 29, 30, 66
 L. Vriens 74
 D. A. Vroom 64, 74
 L. Vuskovic 12, 25, 31, 59

 J. T. Waber 74
 J. M. Wadehra 21, 31
 R. W. Wagennar 39
 K. H. Wagner 74
 A. L. Wahrhaftig 58
 K. Wakiya 19, 27, 36, 66
 W. Wakiya 36
 M. Walhourt 39
 D. W. Walker 74
 M. A. Walker 16, 77, 79
 T. E. H. Walker 74
 G. K. Walters 59
 H. R. J. Walters 3, 31, 32, 40, 41, 42, 51

F. Walther 19
 J. Wang 77
 S. Wang 21
 B. Wannberg 39
 J. S. Wark 77
 J. M. Warman 39
 T. Watabe 19, 27
 K. Watanabe 63
 M. Watanabe 17, 27
 T. Watanabe 74
 W. S. Watson 62
 R. Wehlitz 4, 18, 23
 E. Weigold 5, 6, 8, 11, 15, 51,
 62, 64, 73, 74, 78
 H. F. Weiss 64
 G. L. Weissler 46
 K. H. Welge 12, 32
 G. Wendin 9, 24, 74
 J. B. West 56, 71, 73, 74
 W. P. West 62
 H. -E. Wetzel 4
 M. Weyhreter 39, 40
 C. T. Whelan 3, 31, 32, 40, 41, 42
 M. G. White 75
 T. N. White 75
 M. A. Whitehead 15
 B. Whitfield 23, 40
 S. B. Whitfield 23, 40
 W. Wieme 19
 K. Wiesemann 23
 G. R. Wight 73, 75
 W. M. K. P. Wijayarathna 13, 14
 M. Wildberger 33
 J. F. Williams 26, 40, 50, 75
 W. Williams 75
 A. A. Wills 9, 40
 W. G. Wilson 34
 N. W. Winter 13
 R. E. Winters 49, 75
 A. Witte 39
 A. Wolcke 55
 B. Wolff 32
 T. C. Wong 75
 Y. H. Woo 75
 P. R. Woodruff 74
 M. C. Wrinn 15
 J. -Z. Wu 13
 J. Z. Wu 40
 W. Wubker 27, 40
 F. Wuilleumier 70, 75

D. Xenakis 79
 X. Xing 7

 S. Yagi 2
 A. Yagishita 2, 4, 17, 22, 26, 27, 35, 37
 V. E. Yakhontova 65, 67
 I. T. Yakubov 59
 H. Yamada 38
 B. Yang 39
 A. C. Yates 53, 75
 B. W. Yates 40
 A. W. Yau 3, 40
 V. A. Yavna 77
 C. Ye 22
 J. J. Yeh 40
 F. Yergeau 8, 40
 Y. Yoshinari 27
 S. N. Younger 15
 S. Y. Yousfi 41
 J. Yuan 41
 S. V. Yurgenson 5

 A. A. Zaidi 26
 I. Zakrzewski 41
 I. P. Zapesochnyi 67, 75, 76
 I. P. Zapesochny 75, 76
 B. Zauderer 75
 A. N. Zavilopulo 12, 34, 41
 A. Zecca 6, 41
 V. Zeman 41
 J. Y. Zhang 10
 X. Zhang 3, 32, 41, 42
 V. P. Zhdanov 76
 S. H. Zheng 26
 Y. Zheng 6, 77
 B. Zhou 42
 I. G. Zhukov 75, 76
 V. J. Zigman 42
 T. M. Zimkina 62
 P. Zimmermann 78
 O. A. Zinov'ev 74
 M. Zitnik 31
 R. J. Zollweg 76
 B. A. Zon 10, 42
 M. Zubek 12, 16, 42
 A. D. Zuev 38
 T. Zuo 42

Author Index of Addenda of References for Xe (2)

This author index is not complete
and some selected authors are listed.

T. Aberg 96	H. Damany 99
M. Y. Adam 97	N. Damany 98
H. Aksela 83, 87, 88, 93	G. Dawber 87
S. Aksela 83, 87, 88, 93	A. De Fanis 80
D. P. Almeida 80	Ph. V. Demekhin 82, 91
K. Amos 82	P. C. Deshmukh 95
M. Ya. Amusia 83, 84	H. Deutsch 86
M. Ya. Amusya 80	T. H. V. T. Dias 94
L. W. Anderson 80	J. D. Dow 98
G. B. Armen 84, 96	
L. Avaldi 80, 87	D. L. Ederer 86, 88
	A. Ehresmann 82
G. M. Bancroft 83, 84	J. H. D. Eland 86, 93
K. Bartschat 81, 83, 84	M. T. Elford 80
K. Becker 86	N. Embaye 80
U. Becker 95	
D. Bessis 92	I. I. Fabrikant 86
S. V. Bobashev 82	A. Fahlman 86, 87
J. B. Boffard 80	Z. Felfli 80, 92
P. Bolognesi 80	P. V. Feltsan 98
C. E. Brion 93	J. C. Fong 97
G. S. Brown 84, 85	R. R. Freeman 92
S. J. Buckman 80	J. R. Fuhr 81
P. H. Bucksbaum 92	
	G. Garcia 81, 87
R. Camilloni 80	W. R. Garrett 87
J. Campos 99	A. Garscadden 93
T. A. Carlson 85, 86, 87, 90	J. Geiger 98
R. J. Celotta 100	E. V. Gnatchenko 96
D. Charalambidis 96	A. N. Grum-Grzhimailo 81
M. H. Chen 84, 85, 96	X. Guo 87
Z. Chen 80, 84	T. Gustafsson 91
K. T. Cheng 85, 88, 89	
N. A. Cherepkov 85	H. Haberland 87
L. V. Chernysheva 80, 83, 84	R. I. Hall 82, 87
K. Codling 85, 100	M. Hanif 81
C. A. N. Conde 94	J. E. Hansen 87, 88, 99
J. P. Connerade 86	T. Hayaishi 81, 87, 88
G. Cooper 93	P. A. Hayes 83
J. W. Cooper 80, 86	U. Heinzmann 82, 88, 95
B. Crasemann 84, 85, 92, 96	U. Hergenbahn 81, 95
A. Crowe 87	D. M. P. Holland 88

R. G. Houlgate 100	M. A. MacDonald 82
K. -N. Huang 85, 88, 89	D. H. Madison 84
B. A. Huber 91	G. Mainfray 92
R. E. Huffman 99	G. N. Malovic 82
W. M. Huo 89	C. Manus 92
	P. Maragakis 96
M. Inokuti 81	T. D. Mark 86
K. Ito 82	E. Matthias 99
	R. P. McEachran 90
G. K. James 81	W. Mehlhorn 81, 94
A. Javan 100	B. Mobus 82
P. V. Johnson 81	Y. Morioka 87, 88
W. R. Johnson 85, 88, 89, 93	A. Mozumder 96
	A. Z. Msezane 80, 84, 92, 93
N. M. Kabachnik 81, 82, 89	E. Murakami 81, 87, 88
B. Kammerling 89	
I. Kanik 81, 87, 89	T. Nagata 95
S. Kaur 90	A. P. Napartovich 83
J. Kessler 90	C. Y. Ng 100
M. A. Khakoo 81, 87, 89	A. Niehaus 96
Y. -K. Kim 89	
G. C. King 80, 87	M. Outred 100
M. Kitajima 80, 81	P. Ozimba 80, 92
A. Kivimaki 81, 83	
H. Kleinpoppen 100	F. A. Parpia 93
A. Kobayashi 81	S. H. Patil 93
I. V. Kochetov 83	M. G. Payne 87
T. Kolar 87	W. Persson 83, 88, 93, 99
A. V. Korol 90	I. D. Petrov 82, 91
A. I. Korotkov 90	Z. Lj. Petrovic 82
H. R. Koslowski 91	M. N. Piancastelli 81
I. Koyano 80	E. D. Poliakoff 99
B. Krassig 89, 94	L. E. Porter 97
M. O. Krause 86, 87, 90	S. D. Price 93
C. Kunz 98	
H. Kust 81	P. J. B. M. Rachinhas 94
C. E. Kuyatt 100	V. Radojevic 93
	V. -F. Z. Rapp 100
P. Lablanquie 82, 86	T. Reiners 87
B. M. Lagutin 82, 91	M. Richter 82, 95
P. Lambropoulos 96	S. J. Rose 84
P. Laporte 99	R. A. Rosenberg 99
S. Larochelle 91	O. -P. Sairanen 83
J. C. Larrabee 99	N. Saito 80, 94
H. Lebius 91	J. A. R. Samson 94
S. T. Lee 99	F. P. Santos 94
J. C. Levin 84	F. Schafers 88
C. C. Lin 80	S. J. Schaphorst 94
D. W. Lindle 85, 86, 95	K. -H. Schartner 82
B. Lohmann 91	B. Schmidt 82
A. Lovell 82	V. Schmidt 86, 89, 94, 97

B. Schmidtke 82
H. Schmoranz 82, 91, 94
G. Schonhense 88, 94
H. Schroder 96
Shardanand 100
R. H. Sherman 97
V. S. Shevera 100
E. Shigemasa 87, 88
D. A. Shirley 95, 99
L. A. Shmaenok 82
O. B. Shpenik 86, 90
J. E. Sienkiewicz 82
A. E. Slattery 82
B. Sonntag 95, 96
A. A. Sorokin 82, 95
S. H. Southworth 95
R. Srivastava 90
A. F. Starace 88, 96
A. D. Stauffer 90, 94
M. Stuhec 80
V. L. Sukhorukov 82, 91
I. H. Suzuki 82, 94
T. Suzuki 100
N. Swanson 100

A. Talebpour 91
K. H. Tan 83
H. Tanaka 80
Y. Tanaka 98, 99
H. Tawara 96
J. K. Theobald 97
A. A. Tkachenko 96
D. Toffoli 82
S. Trajmar 87, 89
M. Tsukakoshi 100
J. Tulkki 81, 96

K. Ueda 80, 81
C. J. G. J. Uiterwaal 96
G. Ulm 82

E. T. Verkhovtseva 96
Ya. F. Verolainen 100
F. Vollweiler 82, 91

G. Wendin 92, 96, 97
J. B. West 85, 86, 88
J. E. West 100
M. G. White 99
S. B. Whitfield 84

W. Wieme 100
K. Wieseemann 91
J. F. Williams 83, 97
P. R. Woodruff 90, 100
F. Wuilleumier 94, 97

D. Xenakis 96

S. Yagi 87
A. Yagishita 81, 88, 95
B. W. Yates 85, 86
D. H. Yu 83, 97

I. P. Zapesochny 98, 100
A. N. Zaviolopulo 86
V. Zeman 83, 87
M. Zitnik 80
B. A. Zon 96
M. Zubek 87

Electron Collision Cross Section Set for Xenon (Xe)

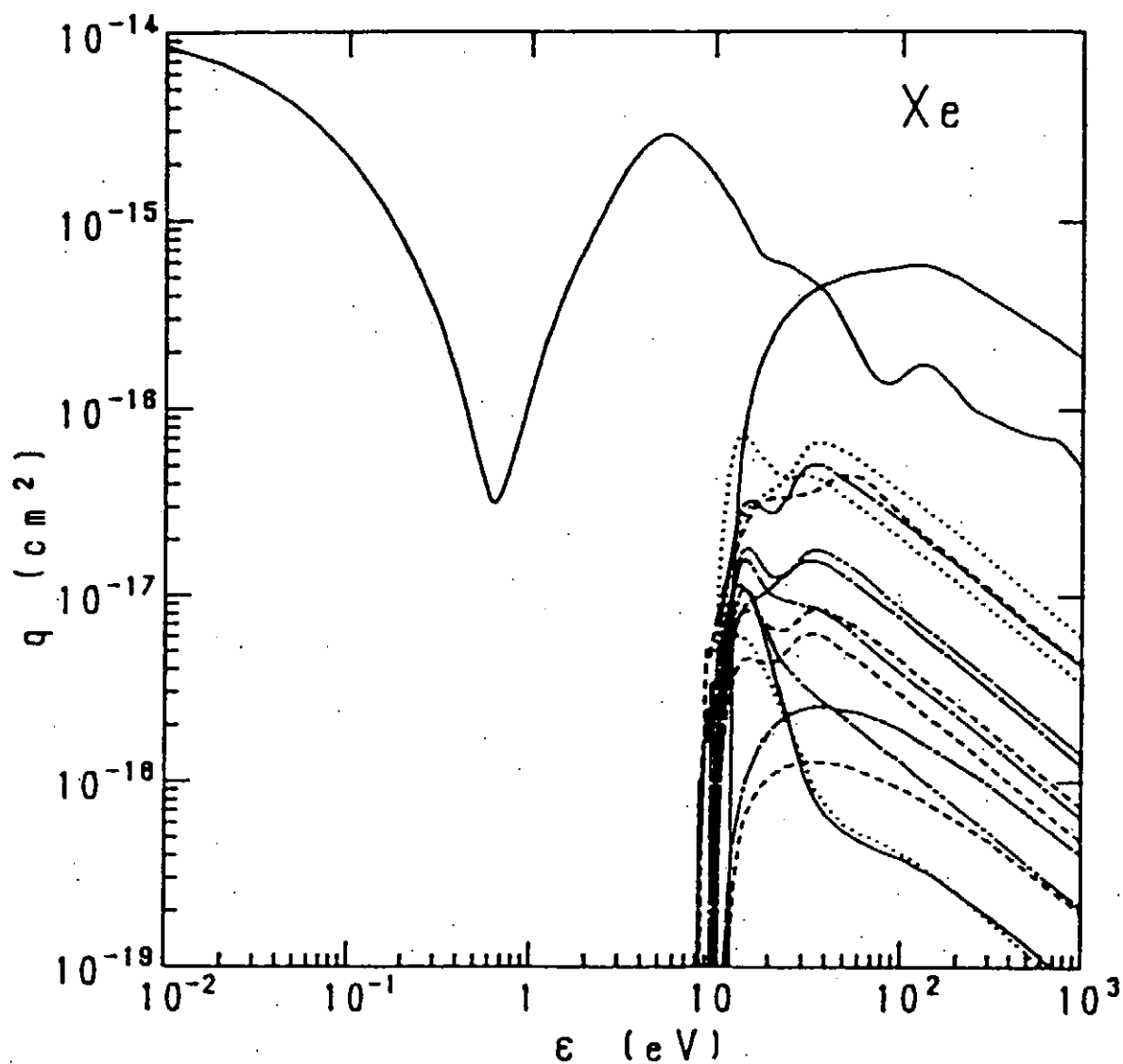


Figure 1. Electron collision cross section set for Xe.

Elastic momentum transfer cross section q_m . Electronic excitation cross sections $q_{e1} - q_{e14}$ divided into fourteen energy levels as shown in the next table. Total ionization cross section q_i . Detailed cross section values are shown in the following tables.

Important Energy Levels for Xenon

	Pachen notation	designation	energy (eV)	resolved feature	
0	P ₀	5p ⁶	0		
1	1s ₅	6s [3/2] ₂	8.315	Qe1	metastable state
	1s ₄	6s [3/2] ₁	8.437	Qe2	
	1s ₃	6s' [1/2] ₀	9.447	Qe3	metastable state
	1s ₂	6s' [1/2] ₁	9.570	Qe4	
5	2p ₁₀	6p [1/2] ₁	9.580	}	Qe5
	2p ₉	6p [5/2] ₂	9.686		
	2p ₈	6p [5/2] ₃	9.721	}	Qe6
	2p ₇	6p [3/2] ₁	9.789		
	2p ₆	6p [3/2] ₂	9.821	}	Qe7
10	3d ₆	5d [1/2] ₀	9.891		
	3d ₅	5d [1/2] ₁	9.917		
	2p ₅	6p [1/2] ₀	9.934		
	3d ₄ '	5d [7/2] ₄	9.943		
	3d ₃	5d [3/2] ₂	9.959	}	Qe8
15	3d ₄	5d [7/2] ₃	10.039		
	3d ₁ '	5d [5/2] ₂	10.158		
	3d ₁ '	5d [5/2] ₃	10.220		
	3d ₂	5d [3/2] ₁	10.401		
	2s ₅	7s [3/2] ₂	10.562	}	Qe12
20	2s ₄	7s [3/2] ₁	10.593		
	3p ₁₀	7p [1/2] ₁	10.902		
	3p ₉	7p [5/2] ₂	10.954		
	2p ₄	6p' [3/2] ₁	10.958		
	3p ₈	7p [5/2] ₃	10.969		
25	4d ₆	6d [1/2] ₀	10.972		
	4d ₅	6d [1/2] ₁	10.979		
	3p ₆	7p [3/2] ₂	10.996		
	4d ₃	6d [3/2] ₂	10.999		
	3p ₇	7p [3/2] ₁	11.008		
30	3p ₅	7p [1/2] ₀	11.015		
	4d ₄ '	6d [7/2] ₄	11.024		
	4d ₄	6d [7/2] ₃	11.038		
	2p ₃	6p' [3/2] ₂	11.055		
	4d ₁ '	6d [5/2] ₂	11.065		
35	2p ₂	6p [1/2] ₁	11.069		
	4d ₁ '	6d [5/2] ₃	11.101		
	2p ₁	6p' [1/2] ₀	11.141		
	4d ₂	6d [3/2] ₁	11.163		
39	3s ₅	8s [3/2] ₂	11.259	}	Qe13
74	4s ₅	9s [3/2] ₂	11.580	Qe14	
	2p ⁰ _{3/2} (Xe ⁺)		12.130		ionization potential

Cross Section Set for Xe

determined at 1990. 2. 24.

elastic momentum transfer cross section Q_m for xenon

ϵ (eV)	Q_m (10^{-16}cm^2)	ϵ (eV)	Q_m (10^{-16}cm^2)	ϵ (eV)	Q_m (10^{-16}cm^2)
0	131	1. 3	2. 77	35	4. 60
0. 001	123	1. 4	3. 38	40	4. 05
0. 0025	113	1. 6	4. 68	45	3. 40
0. 005	99. 0	1. 8	5. 98	50	2. 78
0. 01	84. 3	2	7. 39	55	2. 30
0. 02	67. 1	2. 2	8. 95	60	1. 95
0. 03	55. 7	2. 4	10. 6	65	1. 70
0. 04	47. 2	2. 6	12. 4	70	1. 52
0. 05	40. 8	2. 8	14. 3	75	1. 43
0. 06	35. 3	3	16. 1	80	1. 39
0. 08	27. 3	3. 3	18. 8	85	1. 38
0. 1	21. 5	3. 6	21. 1	90	1. 39
0. 12	17. 2	4	24. 1	95	1. 43
0. 16	11. 4	4. 4	26. 2	100	1. 50
0. 2	7. 79	4. 8	27. 7	110	1. 62
0. 24	5. 45	5	28. 3	120	1. 70
0. 28	3. 91	5. 2	28. 7	125	1. 73
0. 32	2. 87	5. 4	28. 8	130	1. 73
0. 35	2. 16	5. 6	28. 7	140	1. 71
0. 4	1. 47	6	28. 0	150	1. 65
0. 45	0. 970	6. 5	26. 8	200	1. 24
0. 5	0. 640	7	25. 5	220	1. 10
0. 55	0. 450	8	22. 5	250	0. 980
0. 6	0. 340	9	19. 5	300	0. 910
0. 62	0. 320	10	17. 0	400	0. 800
0. 64	0. 315	11	14. 9	500	0. 740
0. 66	0. 320	12	13. 1	600	0. 710
0. 7	0. 360	13	11. 6	700	0. 700
0. 75	0. 440	15	9. 04	750	0. 680
0. 8	0. 540	17	7. 10	800	0. 650
0. 9	0. 810	18	6. 55	1000	0. 490
1	1. 21	20	6. 12	2000	0.
1. 1	1. 66	25	5. 73	4000	0.
1. 2	2. 21	30	5. 11	8000	0.

error 3 - 5 %

Xenon 1

electronic excitation of $1s_5$

ε (eV)	q_{e1} (10^{-16}cm^2)	ε (eV)	q_{e1} (10^{-16}cm^2)
8.315	0.00	50	0.00540
8.35	0.00552	60	0.00480
8.4	0.0101	80	0.00420
8.5	0.00420	100	0.00384
8.6	0.00540	120	0.00348
8.7	0.00840	150	0.00312
8.8	0.0122	200	0.00252
8.9	0.0181	300	0.00192
9.0	0.0228	500	0.00132
9.07	0.0244	1000	0.000720
9.2	0.0176	10000	0.00

electronic excitation of $1s_4$

ε (eV)	q_{e2} (10^{-16}cm^2)	ε (eV)	q_{e2} (10^{-16}cm^2)
8.437	0.00	16	0.286
8.5	0.00115	17.5	0.316
8.6	0.00720	20	0.334
8.7	0.0130	22	0.338
8.8	0.0202	25	0.342
8.9	0.0288	30	0.352
9.0	0.0418	32	0.355
9.1	0.0533	35	0.370
9.2	0.0461	40	0.410
9.3	0.0446	45	0.430
9.4	0.0461	50	0.442
9.5	0.0490	55	0.440
9.6	0.0518	60	0.434
9.7	0.0562	70	0.390
9.8	0.0590	80	0.341
9.9	0.0619	100	0.270
10.0	0.0677	120	0.230
10.5	0.0840	150	0.190
11.0	0.101	200	0.151
12	0.137	300	0.110
13	0.175	500	0.0730
14	0.215	1000	0.0430
15	0.253	10000	0.00

error 30 - 50 %

electronic excitation of $1s_3$ electronic excitation of $1s_2$ and $2p_{10}$ electronic excitation of $2p_9$ and $2p_8$

ε (eV)	q_{e3} (10^{-16}cm^2)	ε (eV)	q_{e4} (10^{-16}cm^2)	ε (eV)	q_{e5} (10^{-16}cm^2)
9.447	0.00	9.570	0.00	9.686	0.00
9.52	0.00408	9.6	0.0202	10	0.0100
9.55	0.00756	9.62	0.0259	10.2	0.0180
9.59	0.00516	9.7	0.0144	10.5	0.0280
9.63	0.00780	9.8	0.0175	10.7	0.0350
9.68	0.00576	9.9	0.0230	11	0.0460
9.73	0.00504	10	0.0288	11.5	0.0660
9.78	0.00516	10.5	0.0550	12	0.0900
9.83	0.00780	11	0.0850	12.5	0.112
9.9	0.00924	11.5	0.117	13	0.135
9.94	0.00888	12	0.152	13.5	0.156
10.0	0.0102	12.5	0.191	14	0.171
10.25	0.0166	13	0.232	14.5	0.178
10.5	0.0220	13.5	0.267	15	0.180
10.75	0.0259	14	0.294	16	0.174
11	0.0312	14.5	0.312	17	0.160
11.5	0.0432	15	0.320	18	0.146
12	0.0516	16	0.322	20	0.126
12.5	0.0570	18	0.296	22	0.125
13	0.0600	20	0.276	25	0.135
14	0.0612	21	0.278	30	0.167
15	0.0576	22	0.287	32	0.173
16	0.0540	25	0.350	35	0.177
18	0.0432	27	0.420	40	0.170
20	0.0354	30	0.480	50	0.150
22	0.0270	32	0.500	60	0.132
25	0.0204	35	0.510	80	0.103
30	0.0134	40	0.490	100	0.0840
35	0.00912	50	0.420	120	0.0730
40	0.00756	60	0.370	150	0.0620
50	0.00588	80	0.300	200	0.0490
60	0.00528	100	0.250	300	0.0630
80	0.00468	120	0.220	500	0.0240
100	0.00408	150	0.180	1000	0.0140
120	0.00372	200	0.146	10000	0.00
150	0.00312	300	0.105		
200	0.00252	500	0.070		
300	0.00180	1000	0.0420		
500	0.00120	10000	0.00		
1000	0.000720				
10000	0.00				

error 30 - 50 %

electronic excitation
of $2p_7$ and $2p_6$

electronic excitation
of $3d_6$, $3d_5$, $2p_5$, $3d_4'$
and $3d_3$

electronic excitation
of $3d_4$

ε (eV)	q_{e6} (10^{-16}cm^2)	ε (eV)	q_{e7} (10^{-16}cm^2)	ε (eV)	q_{e8} (10^{-16}cm^2)
9.789	0.00	9.891	0.00	10.039	0.00
10	0.00400	10	0.0170	10.2	0.00600
10.2	0.00800	10.2	0.0560	10.5	0.0170
10.5	0.0150	10.5	0.120	10.7	0.0250
10.7	0.0200	10.7	0.160	11	0.0380
11	0.0270	11	0.225	11.2	0.0460
11.5	0.0390	11.2	0.275	11.5	0.0580
12	0.0490	11.5	0.347	12	0.0800
12.5	0.0590	12	0.472	12.5	0.101
13	0.0680	12.5	0.597	13	0.123
13.5	0.0750	13	0.672	13.5	0.141
14	0.0790	13.5	0.710	14	0.153
14.5	0.0820	14	0.720	14.5	0.157
15	0.0830	14.5	0.712	15	0.155
16	0.0810	15	0.697	15.5	0.151
17	0.0780	15.5	0.677	16	0.144
18	0.0750	16	0.652	18	0.118
20	0.0670	18	0.560	20	0.102
22	0.0640	20	0.494	22	0.0970
25	0.0660	22	0.450	25	0.0930
30	0.0790	25	0.430	30	0.0890
32	0.0820	30	0.450	35	0.0860
35	0.0840	35	0.430	40	0.0800
40	0.0820	40	0.400	50	0.0690
50	0.0740	50	0.340	60	0.0580
60	0.0660	60	0.296	80	0.0460
80	0.0530	80	0.240	100	0.0380
100	0.0440	100	0.200	120	0.0330
120	0.0380	120	0.173	150	0.0280
150	0.0320	150	0.148	200	0.0225
200	0.0260	200	0.118	300	0.0164
300	0.0190	300	0.0860	500	0.0110
500	0.0125	500	0.0580	1000	0.00640
1000	0.00730	1000	0.0340	10000	0.000
10000	0.00	10000	0.00		

error 30 - 50 %

electronic excitation of 3d'' electronic excitation of 3d₁' electronic excitation of 3d₂

ϵ (eV)	q_{e9} (10^{-16}cm^2)	ϵ (eV)	q_{e10} (10^{-16}cm^2)	ϵ (eV)	q_{e11} (10^{-16}cm^2)
10.158	0.00	10.220	0.00	10.401	0.00
10.2	0.00100	10.5	0.00300	10.6	0.0180
10.5	0.00900	10.7	0.00700	11	0.0550
10.7	0.0160	11	0.0120	11.2	0.0760
11	0.0250	11.2	0.0150	11.5	0.102
11.2	0.0310	11.5	0.0210	12	0.148
11.5	0.0410	12	0.0275	12.5	0.185
12	0.0570	12.5	0.0346	13	0.216
12.5	0.0730	13	0.0390	13.5	0.240
13	0.0870	13.5	0.0420	14	0.259
13.5	0.0990	14	0.0440	14.5	0.277
14	0.106	14.5	0.0453	15	0.290
14.5	0.108	15	0.0460	15.5	0.304
15	0.107	15.5	0.0460	16	0.315
15.5	0.104	16	0.0460	18	0.345
16	0.100	18	0.0430	20	0.370
18	0.0750	20	0.0430	22	0.390
20	0.0590	22	0.0440	25	0.440
22	0.0480	25	0.0510	30	0.600
25	0.0400	28	0.0590	32	0.640
30	0.0330	30	0.0610	35	0.670
35	0.0290	35	0.0630	40	0.660
40	0.0260	40	0.0590	50	0.600
50	0.0220	50	0.0500	60	0.530
60	0.0190	60	0.0440	80	0.430
80	0.0150	80	0.0350	100	0.360
100	0.0127	100	0.0290	120	0.320
120	0.0109	120	0.0250	150	0.270
150	0.00920	150	0.0210	200	0.218
200	0.00730	200	0.0170	300	0.158
300	0.00540	300	0.0123	500	0.105
500	0.00360	500	0.00820	1000	0.0600
1000	0.00210	1000	0.00480	10000	0.00
10000	0.00	10000	0.000		

error 30 - 50 %

electronic excitation of 2s ₅ - 4d ₂		electronic excitation of 3s ₅ -		electronic excitation of 4s ₅ -	
ε (eV)	q _{e12} (10 ⁻¹⁶ cm ²)	ε (eV)	q _{e13} (10 ⁻¹⁶ cm ²)	ε (eV)	q _{e14} (10 ⁻¹⁶ cm ²)
10.562	0.00	11.259	0.00	11.580	0.00
10.6	0.00300	11.5	0.00105	12	0.000900
11	0.0135	12	0.00255	12.5	0.00195
11.2	0.0188	12.5	0.00405	13	0.00300
11.5	0.0270	13	0.00525	13.5	0.00390
12	0.0420	13.5	0.00645	14	0.00495
12.5	0.0555	14	0.00750	14.5	0.00585
13	0.0675	14.5	0.00885	15	0.00660
13.5	0.0758	15	0.0102	15.5	0.00705
14	0.0825	15.5	0.0113	16	0.00765
14.5	0.0878	16	0.0122	18	0.00930
15	0.0900	18	0.0158	20	0.0105
15.5	0.0930	20	0.0186	22	0.0113
16	0.0945	22	0.0206	25	0.0122
18	0.101	25	0.0228	30	0.0128
20	0.110	30	0.0245	35	0.0128
22	0.119	35	0.0252	40	0.0126
25	0.134	40	0.0251	50	0.0123
27	0.144	50	0.0240	60	0.0114
30	0.153	60	0.0234	80	0.0102
32	0.155	80	0.0210	100	0.00915
35	0.153	100	0.0191	120	0.00840
40	0.147	120	0.0170	150	0.00735
50	0.128	150	0.0149	200	0.00615
60	0.111	200	0.0125	300	0.00480
80	0.0885	300	0.00975	500	0.00330
100	0.0750	500	0.00675	1000	0.00195
120	0.0645	1000	0.00405	10000	0.00
150	0.0540	10000	0.00		
200	0.0435				
300	0.0315				
500	0.0213				
1000	0.0123				
10000	0.00				

error 50 %

ionization cross sections Q_1 for xenon

ϵ (eV)	Q_1 (10^{-16} cm ²)	ϵ (eV)	Q_1 (10^{-16} cm ²)
12.130	0.00	45	4.87
12.5	0.105	50	5.09
13	0.247	55	5.23
13.5	0.409	60	5.34
14	0.570	65	5.40
14.5	0.751	70	5.46
15	0.931	75	5.50
15.5	1.09	80	5.51
16	1.25	85	5.60
17	1.56	90	5.63
18	1.82	95	5.69
19	2.06	100	5.76
20	2.30	105	5.80
21	2.54	110	5.88
22	2.76	115	5.87
23	2.96	120	5.87
24	3.14	125	5.88
25	3.29	130	5.85
26	3.41	135	5.80
27	3.55	140	5.76
28	3.70	145	5.71
29	3.82	150	5.63
30	3.92	160	5.48
31	4.02	170	5.36
32	4.11	180	5.23
33	4.21	190	5.10
34	4.28	200	5.02
35	4.36	250	4.37
36	4.43	300	3.96
37	4.48	500	2.97
38	4.55	700	2.43
39	4.61	1000	1.90
40	4.66	10000	0.00

error 10 %

elastic total cross sections Q_t for xenon

ε (eV)	Q_t (10^{-16} cm ²)	ε (eV)	Q_t (10^{-16} cm ²)
0.05	60.0	6	39.7
0.1	36.5	8	42.0
0.15	23.0	10	40.5
0.2	15.3	12	37.7
0.25	10.8	15	33.6
0.3	7.96	20	27.5
0.4	4.51	25	20.9
0.5	2.66	30	15.8
0.6	1.74	40	10.1
0.7	1.35	50	7.21
0.8	1.30	60	5.79
0.9	1.44	80	4.77
1	1.77	100	4.71
1.2	2.80	125	4.76
1.5	4.81	150	4.65
1.75	6.75	200	4.30
2	8.91	250	3.96
2.5	13.7	300	3.73
2.75	16.3	400	3.40
3	18.7	500	3.17
4	28.5	700	2.83
5	35.9	1000	2.30

error 5 %

comparison of Σq and Q_T for xenon

$$\Sigma q = q_t + \Sigma q_e + q_i$$

Q_T : grand total cross sections measured by experiments

ε (eV)	q_t	Σq_e	q_i (10^{-16} cm^2)	Σq	Q_T
10	40.5	0.15	0	40.7	38.8
12	37.7	1.40	0	39.1	37.4
15	33.6	2.41	0.93	36.9	35.6
20	27.5	2.09	2.30	31.9	33.3
25	20.9	2.15	3.29	26.3	27.0
30	15.8	2.53	3.92	22.3	19.8
40	10.1	2.58	4.66	17.34	14.9
50	7.21	2.34	5.09	14.64	13.0
60	5.79	2.10	5.34	13.23	12.0
80	4.77	1.69	5.51	11.97	11.1
100	4.71	1.40	5.76	11.87	10.7
150	4.65	1.02	5.63	11.30	10.0
200	4.30	0.82	5.02	10.14	9.5
300	3.73	0.60	3.96	8.29	8.1
500	3.17	0.40	2.97	6.54	6.4
1000	2.30	0.23	1.90	4.43	4.35

Numbers of References
on Electron and Photon Collisions
with Atoms and Molecules
published in the 20th Century

Atoms (17)			Molecules (51)					
A + e.		A + hν		M + e.		M + hν.		
He	2	2170 *	2	H ₂ , D ₂	1870	5	CH ₄	780
Ne	10	1140 *		N ₂	2240 ○			
Ar	18	1960 ○		O ₂	1700		CF ₄	390
Kr	36	1000		CO	1190		CCl ₄	210
Xe	54	1180 ○		NO	880		CCl ₂ F ₂	250
							CH ₃ Cl	90
Li	3	450		F ₂	190			
Na	11	800		Cl ₂	360		SiH ₄	230
				Br ₂	140		SiF ₄	140
K	19	370		I ₂	240		GeH ₄	50
Rb	37	220						
Cs	55	370		HF	260	6	C ₂ H ₄	370
				HCl	320		CH ₃ OH	240
O	8	390		HBr	200			
				HI	130	7	SF ₆	920 ○
F	9	90						
Cl	17	130	3	CO ₂	1240 ○			
						8	C ₂ H ₆	260
Cu	29	180		H ₂ O	900		C ₂ F ₆	150
Cd	48	210		H ₂ S	270		Si ₂ H ₆	70
Ba	56	340		O ₃	480			
				N ₂ O	450	9	C ₃ H ₆	120
Hg	80	600		NO ₂	300		C ₂ H ₅ OH	60
				SO ₂	260			
				CS ₂	260			
				OCS	280	11	C ₃ H ₈	190
not final, but							C ₃ F ₈	100
finished mostly			4	C ₂ H ₂	390			
						12	C ₄ F ₈	100
include electron				NH ₃	500		C ₆ H ₆	240
swarm papers				NF ₃	110		C ₆ F ₆	100
				BF ₃	110			
include				BCl ₃	90	60	C ₆₀	300
review papers				PH ₃	80			
				H ₂ CO	180		M _r + M _v	850

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

○ The bibliography was published already.

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