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

– Hydrogen Halide Molecules –

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

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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 hydrogen halide molecules (HF, HCl, HBr, HI). About 330 (HF), 420 (HCl) 220 (HBr) and 150 (HI) papers were compiled respectively. Comprehensive author indexes for each molecule are included. The bibliography covers the period 1903 through 2000 for HF-HI. Finally, author's comments for HBr electron collision cross sections are given.

Keywords : HF, HCl, HBr, HI molecules, collision cross sections, electron, elastic scattering, rotational, vibrational and electronic excitations, dissociation, ionization, photon, photoabsorption, photodissociation, photoexcitation, photoionization, electron swarm, drift velocity, diffusion coefficient, ionization coefficient, excitation and ionization energies, transition probabilities, 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 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, theoretical calculations or reviews and data compilations 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 hydrogen halide molecules HF, HCl, HBr, and HI. The review papers on this subject are also included. Some hydrogen halide molecule cluster papers are included. Some conference reports, company or agency reports and PhD thesis are included. Hydrogen halide molecules ion papers and positron collision papers are not included in principle.

Papers reporting the following data are included.

For electron collision cross section :

1) elastic scattering
2) rotational excitation
3) vibrational excitation
4) electronic excitation
5) dissociation
6) ionization
7) attachment
8) grand total scattering (sum of elastic and inelastic cross sections)
9) electron swarm parameters (drift velocity, diffusion coefficient)
10) 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 microwave to X-ray. Most papers are concerned with infrared, visible and ultraviolet ray region.

The bibliography includes the papers published in the 20th century, from 1901 to 2000. Oldest paper in this list is given by J. S. Townsed (1903) for HCl. Oldest papers for other hydrogen halide molecules are shown in each molecules. So for this bibliography, published papers from 1903 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 each Hydrogen Halide Molecule". In total, about 330 for HF, 420 for HCl, 220 for HBr and 150 for HI papers are compiled in the four hydrogen halide molecule bibliography.

Organization

This report consists of four parts : introduction, the bibliography and its addenda, author index, and some comments on electron collision cross sections.

Bibliography

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

E : Elastic collision
R : Rotational excitation
V : Vibrational excitation
EX : electronic EXcitation
D : Dissociation
I : Ionization
A : Attachment
ME : MEtastable molecules
S : electron Swarm
O : Others (photon cross sections and the others)

QT : grand Total cross section
(sum of elastic and inelastic
electron cross sections).
Q came from Querschnitt

All authors' 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.

Bibliographies for HF, HCl, HBr, and HI are divided into two parts :

HF

Part 1. 1924 - 1999 p. 1 - 22

Part 2. Addenda of References published in 2000, plus some old papers p. 23 - 28

HCl

Part 1. 1903 - 1999 p. 1 - 27

Part 2. Addenda of References published in 2000, plus some old papers p. 28 - 36

HBr

Part 1. 1913 - 1999 p. 1 - 17

Part 2. Addenda of References published in 2000, plus some old papers p. 18 - 23

HI

Part 1. 1916 - 1999 p. 1 - 11

Part 2. Addenda of References published in 2000, plus some old papers p. 12 - 14

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.

HF	p. 1 - 5
HCl	p. 1 - 7
HBr	p. 1 - 4
HI	p. 1 - 4

Each author index of four hydrogen halide molecules follows each bibliography.

Some Comments on Electron Collision Cross Sections for HBr

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Hydrogen Fluoride HF

References for HF, DF (1900 - 1999)

(Hydrogen fluoride)

[Hydrogen halide, Halogen acid]

E : Elastic collision,
V : Vibrational excitation,
D : Dissociation,
A : Attachment,
S : Swarm,
O : The others,

R : Rotatioal excitation,
EX : Electronic excitation,
I : Ionization,
QT : Grand total cross section,
α : Ionization coefficient,
[ ]: Additional information,
E : Exp., T : Theory.

The oldest paper in this list is given by J. Simons (1924).

A R. Abouaf and D. Teillet-Billy : 10th ICPEAC, Paris 2, 792-793 (1977)·
Electron attachment to polar molecules : Structure in the dissociative attachment cross sections for HCl, HBr, HF. [E, HF, HCl, HBr]

A R. Abouaf and D. Teillet-Billy : Chem. Phys. Lett. 73, 106-109 (1980a) K
Fine structure in the dissociative attachment cross sections for HBr and HF. [E, HF, HBr; 2 - 3.8 eV for HF]

A R. Abouaf and D. Teillet-Billy : J. Phys. B13, L275-L279 (1980b)
Predissociation of Feshbach resonances in hydrogen fluoride.
[E, HF; 10 - 15 eV, Feshbach resonance at 12.8 - 14 eV]

A R. Abouaf, D. Teillet-Billy, R. Azria and P. Girard : J. Phys. B18, 3017-3024 (1985)
Resonances in HF : H^- formation around 10 eV. [E, HF]

A N. G. Adams, D. Smith, A. A. Viggiano, J. F. Paulson and M. J. Henchman : J. Chem. Phys. 84, 6728-6731 (1986) K
Dissociative attachment reactions of electrons with strong acid molecules.
[E, HF - HI, HNO_3, H_2SO_4, etc.]

O J. R. Airey and I. W. M. Smith : J. Chem. Phys. 57, 1669-1676 (1972)
Quenching of infrared chemiluminescence : Rates of energy transfer from HF ($v \leqq 5$) to CO_2 and HF, and from DF ($v \leqq 3$) to CO_2 and HF.
[E, HF; $H + F_2 \rightarrow HF + F$, etc.]

E Y. Alhassid and B. Shao : Phys. Rev. A46, 3991-4002 (1992)·
R Algebraic eikonal approach to electron-molecule scattering. II.
V Rotational-vibrational excitations.
[T, HF, HCl, LiF; 0.63 - 10 eV for HF]

A M. Allan and S. F. Wong : J. Chem. Phys. 74, 1687-1691 (1981)○K
Dissociative attachment from vibrationally and rotationally excited HCl and HF. [E, HF, HCl; 300 - 1180 K]

O I. V. Andrianov and G. K. Paramonov : Phys. Rev. A59, 2134-2138 (1999)
Selective excitation of the vibrational-rotational states and dissociation of diatomic molecules by picosecond infrared laser pulses : Modeling for HF in the ground electronic state. [T, $h\nu$, HF]

R. Azria : in Physics of Electron and Atomic Collisions, 12th ICPEAC, Gatlinburg 557-567 (1982)
Electron molecule collision at low energy resonance and threshold phenomena. [review, HF, HCl, HBr, HI]

O R. F. W. Bader and G. A. Jones : Can. J. Chem. 41, 2251-2264 (1963)
The electron density distributions in hydride molecule. Ⅲ. Hydrogen fluoride. [T, HF]

O R. F. W. Bader and W. H. Henneker : J. Am. Chem. Soc. 88, 280-285 (1966)
The nature of the chemical bond in lithium hydride and hydrogen fluoride. [T, HF, LiH; Hartree-Fock charge distribution]

O R. A. Ballinger : Mol. Phys. 2, 139-157 (1959)
The electronic structure of hydrogen fluoride. [T, HF]

O M. S. Banna, B. E. Mills, D. W. Davis and D. A. Shirley : J. Chem. Phys. 61, 4780-4786 (1974)
X-ray photoemission molecular orbitals of hydrogen fluoride and the fluorinated methanes. [E, $h\nu$, HF, CH_4, CH_3F, CH_2F_2, CH_3F, CF_4]

O M. S. Banna and D. A. Shirley : J. Chem. Phys. 63. 4759-4766 (1975a)
Molecular photoelectron spectroscopy at 132.3 eV. The second-row hydrides. [E, $h\nu$, HF, H_2O, NH_3, CH_4, Ne]

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Molecular photoelectron spectroscopy at 132.3 eV. Methane, the fluorinated methanes and hydrogen fluoride.
[T, $h\nu$, HF, CH_4, CH_3F, CH_2F_2, CHF_3, CF_4]

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Variational calculations of vibrational-rotational properties of HF in the $X^1\Sigma^+$ and $B^1\Sigma^+$ electronic states. [T, HF]

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The ultra-violet spectrum of a diatomic hydride excited in hydrogen-potassium fluoride hollow-cathode discharges.
[E, H_2 + KF; HF as possible emitter]

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Direct observation of the effect of enhanced vibrational excitation on fragmentation in a mass spectrometer. [E, HF]

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Spectra of stimulated emission in the hydrogen-fluorine reaction process and energy transfer from DF to CO_2. [E, HF]

O A. D. Becke : Int. J. Quant. Chem. : Quant. Chem. Symp. 28, 625-632 (1994)
Thermochemical tests of a kinetic-energy dependent exchange-correlation approximation. [T, HF, Cl_2, SiH_4, etc.]

EX K. H. Becker : Comments At. Mol. Phys. 30, 261-284 (1994)
I Electron-impact ionization and dissociative excitation of halogen-containing molecules.
[comments, HF, SF_6, CF_2Cl_2, CF_4, HCl, HBr, CF_3H, CF_3Cl, etc.]

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A modified plane wave model for calculating UV photoionization cross-sections. [T, hν, HF, N_2, CO, H_2O, $(CN)_2$, etc.]

O C. F. Bender and E. R. Davidson : J. Chem. Phys. 47, 360-366 (1967)
Correlation energy and molecular properties of hydrogen fluoride.
[T, HF]

O C. F. Bender and E. R. Davidson : J. Chem. Phys. 49, 4989-4995 (1968)
Theoretical study of several electronic states of the hydrogen fluoride molecule. [T, HF]

O W. S. Benedict, B. W. Bullock, S. Silverman and A. V. Grosse : J. Opt. Soc. Am. 43, 1106-1113 (1953)
Infrared emission of the hydrogen-fluorine (H_2 - F_2) flame.
[E, hν, HF]

O J. Berkowitz, W. A. Chupka, P. M. Guyon, J. H. Holloway and R. Spohr : J. Chem. Phys. 54, 5165-5180 (1971a)
Photoionization mass spectrometric study of F_2, HF, and DF.
[E, hν, HF, DF, F_2; V_i of HF 16.00_7 eV and DF 16.03_0 eV]

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Experimental potential energy curves for $X^2\Pi$ and $^2\Sigma^+$ states of HF^+.
[E, hν, HF, DF]

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Ab initio CI calculation of the effects of Rydberg-valence mixing in the electronic spectrum of the HF molecule. [T, HF]

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Simple one-center calculation of breathing force constants and equilibrium internuclear distance for NH_3, H_2O, and HF. [T, HF, NH_3, H_2O]

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Vibrational contribution to molecular dipole polarizabilities.
[review, HF, HCl, DCl, HI, CO, NO, CH_4, SF_6, C_6H_6, etc. many molecules]

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The heat of dissociation of N_2 and the appearance potentials of some ions formed in F_2 and HF by electron impact. [, HF, F_2, N_2; from F.I.Vilesov]

S.W.Braiwood,M.J.Brunger,D.A.Konovalov and E.Weigold : J.Phys.B26,1655-1668 (1993)·
Electron momentum spectroscopy of the isoelectronic species hydrogen fluoride and neon. [E, HF, Ne; 1500 eV]

C.E.Brion and A.P.Hitchcock : J.Phys.B13,L677-L680 (1980)
Electron scattering experiments with hydrogen fluoride. [E, HF]

EX C.E.Brion : in Physics of Electronic and Atomic Collisions, 12th ICPEAC, Gatlinberg, North-Holland 579-593 (1982)·
Electron scattering at high and intermediate energies.— Quantitative measurements in molecular spectroscopy.
[E, HF, F_2, CO_2, CS_2, COS, N_2O, etc.]

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Mass spectrometric investigation of the anomalous behaviour of hydrogen fluoride in low-pressure scattering experiments.
[E, HF; 20 eV]

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Compilation of valence shell molecular photoelectron branching ratios as a function of energy. [compilation, HF, HCl, HBr, N_2, O_2, CO, NO, H_2O, NH_3, CH_4, CO_2, COS, CS_2, N_2O]

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Compilation of dipole oscillator strengths (cross sections) for the photoabsorption, photoionization and ionic fragmentation of molecules.
[compilation, hν, HF, NO, H_2, CO, N_2, O_2, HCl, HBr, H_2O, NH_3, CH_4, N_2O, CO_2, COS, CS_2, SF_6]

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Absolute oscillator strengths for photoabsorption and photoionization processes by fast electron impact.
[comments, HF, HBr, N_2, NO, CO_2, SO_2]

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Wirkungsquerschnitt und Molekelbau in der Pseudoedelgasreihe. Ne - HF - H_2O - NH_3 - CH_4.
[E, no exp. data for HF; data are mainly for H_2O and NH_3]

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Ionization and dissociation energies of HF and DF and their bearing on $D_0^0(F_2)$. [E, hν, HF, DF]

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Threshold peaks in electron scattering by HF and HCl. [T, HF, HCl]

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Transition probability and photoionisation cross section calculations for CH_4 and HF by one-centre expansion and Stieltjes technique.
[T, hν, HF, CH_4]

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Basis set and gauge dependence of ab initio radiative lifetimes for the $A^2\Sigma^+$ state of the HF^+ molecule. [T, HF]

O I.Cacelli : Chem.Phys.Lett.249,149-154 (1996)
Calculation of the photoabsorption of HF in the vacuum UV.
[T, hν, HF; 8 - 13 eV]

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Electric dipole moments for first- and second-row diatomic hydride molecules, AH. [T, HF, LiH, BeH, BH, CH, NH, OH]

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Electric structure of diatomic molecules. Ⅵ.A. Hartree-Fock wavefunctions and energy quantities for the ground states of the first-row hydrides, AH. [T, HF, LiH, BeH, BH, CH, NH, OH]

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Nonequilibrium dissociation of HF in electrical discharges : The role of vibrational excitation. [T, HF]

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Kinetics of dissociation processes in plasmas in the low and intermediate pressure range. [review, T, HF, H_2, N_2, O_2, CO, CO_2, NH_3, C_mH_n]

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Kinetics of dissociation processes in plasmas in the low and intermediate pressure range.
[review, T, HF, H_2, N_2, O_2, CO, CO_2, NH_3, CH_4, C_2H_4, C_2H_6, n-C_4H_{10}]

E M.Capitelli,R.Celiberto and M.Cacciatore : in Advances in Atomic, Molecular
V and Optical Physics, Vol.33, Academic 321-372 (1994)
EX Needs for cross sections in plasma chemistry.
I [review, HF, HCl, F_2, Cl_2, H_2, N_2, O_2, CO, CO_2, etc.]

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Absolute oscillator strengths for the photoabsorption and partial photoionisation of hydrogen fluoride. [E, hν, HF]

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Absolute dipole oscillator strengths for molecular and dissociative photoionization of hydrogen fluoride. [E, hν, HF; 15 - 60 eV]

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Theory of electron-molecules collisions by frame transformations. [general theory, hν, H_2]

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Angular distributions of resonantly scattered electrons in vibrational excitation of HF. [T, HF, HCl; 2 eV]

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Influence de l'autoabsorption et du gradient thermique sur la determination spectroscopiquee des temperatures locales d'une flamme fluor-hydrogene. [T and E, hν, HF]

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Determination de la temperature d'une flamme de diffusion methane-fluor au moyen du spectre de vibration-rotation de la molecule HF. [E, hν, HF]

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Kinetic energy of ions produced by photoionization of HF and F_2. [E, hν, HF, F_2; D_0(HF) = 5.91 or 5.87 eV]

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SCF-MO wave functions for the hydrogen fluoride molecule. [T, HF]

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The Franck-Condon principle and the ionization of molecules. [compilation, HF - HI, F_2 - I_2, H_2, N_2, O_2, CO, NO, CO_2]

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Ionization potentials of hydrogen fluoride and the ground-state of the HF^+ ion. [E, HF; V_i = 15.77 eV]

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Low energy electron-impact excitation of HF. [E, HF; 8.4 - 16.5 eV]

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Threshold and resonant feature in the vibrational excitation functions of hydrogen halides. [E, HF, HCl, HBr]

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Magnetic properties of hydrogen fluoride. I. Rotational moment. [T, HF]

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Calculated photoionization cross-sections and angular distributions for the isoelectronic series Ne, HF, H_2O, NH_3, and CH_4. [T, hν, HF, Ne, etc.]

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Magnetic properties and molecular quadrupole moment of HF and HCl by molecular-beam electric-resonance spectroscopy. [E, HF, HCl]

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A modified additivity rule for the calculations of electron impact ionization cross-section of molecules AB_n.
[T, HF, HCl, HBr, SF_6, CF_4, CCl_4, etc.]

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Molecular laser action in hydrogen and deuterium halides.
[E, HF - HBr, DF - DBr]

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Photoionization study of the dissociation energy of fluorine and the heat of formation of hydrogen fluoride. [E, hν, HF, F_2; D(HF) 5.74 eV]

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Negative ion mass spectrometry.
[review, HF, HCl, H_2, O_2, F_2, Cl_2, CO, NO, H_2O, N_2O, NO_2, CO_2, etc.]

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Electronic spectra of HF and F_2. [E, hν, HF, F_2]

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The electronic spectrum of HF. I. The $B^1\Sigma^+ - X^1\Sigma^+$ band system.
[E, hν, HF; 1480 - 2670 A]

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The electronic spectra of HCl and HF. [E, hν, HF, HCl]

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The structure of some simple molecules with long pair electrons.
[T, HF, H_2O, NH_3]

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The electronic structure of hydrogen fluoride. [T, HF]

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The low-lying states of hydrogen fluoride : Potential energy curves for the $X^1\Sigma^+$, $^3\Sigma^+$, $^3\Pi$, and $^1\Pi$ states. [T, HF]

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V Nuclear-excited Feshbach resonances in the electron scattering from HCl and HF. [E, HF, HCl]

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V Experiments on low-energy electron-molecule collisions.
[review, HF, HCl, H_2, N_2, CO, H_2O, CO_2, CH_4]

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Near threshold electron impact electronic excitation of molecules.
[comments, HF, HCl, N_2, Cl_2]

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Analytic properties of the S matrix for a simple model of fixed-nuclei electron-polar-molecule scattering. [T, HF, HCl, HBr]

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The influence of long-range interaction on the vibrational excitation of polar molecules by electron scattering. [T, HF, HCl]

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The influence of αr^{-s} potential on electron scattering by polar molecules.
[T, HF, LiF, CsF; 0 - 2 eV]

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Generalized quantum defect theory for electron scattering by polar molecules. [T, HF, H_2O, LiF, BeO, HCN]

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Frame transformation effective-range theory : Application to interaction of polar molecules with electrons. [T, HF, LiF,

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A Resonant R-matrix theory of inelastic processes in collisions of electrons with HF molecules. [T, HF]

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Calculated cross section for photoionization from the 1π and 3σ orbitals of hydrogen fluoride. [T, $h\nu$, HF]

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An empirical potential function of diatomic molecules.
[T, HF, H_2, I_2, N_2, O_2, CO, NO, OH]

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One-electron properties of several small molecules using near Hartree-Fock limit basis sets. [T, HF, HCl, N_2, CO, H_2O, H_2S, NH_3, PH_3]

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[T, HF - HBr]

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[T, HF, etc.]

Author Index for HF References

Hydrogen Chloride HCl

References for HCl, DCl (1900 - 1999)

(Hydrogen chloride, Hydrochloric acid)

[Hydrogen Halide, Halogen acid]

E : Elastic collision, R : Rotatioal excitation,
V : Vibrational excitation, EX : Electronic excitation,
D : Dissociation, I : Ionization,
A : Attachment, QT : Grand total cross section,
S : Swarm, α : Ionization coefficient,
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Author Index for HCl References

Hydrogen Bromide HBr

References for HBr, DBr (1900 - 1999)

(Hydrogen bromide)

[Hydrogen halide, Halogen acid]

E : Elastic collision,
V : Vibrational excitation,
D : Dissociation,
A : Attachment,
S : Swarm,
O : The others,

R : Rotatioal excitation,
EX : Electronic excitation,
I : Ionization,
QT : Grand total cross section,
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Hydrogen Iodide HI

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(Hydrogen iodide)

[Hydrogen halide, Halogen acid]

E : Elastic collision,
V : Vibrational excitation,
D : Dissociation,
A : Attachment,
S : Swarm,
O : The others,

R : Rotatioal excitation,
EX : Electronic excitation,
I : Ionization,
QT : Grand total cross section,
α : Ionization coefficient,
[ ]: Additional information,
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Some Comments on Electron Collision Cross Sections for HBr

We have determined the electron collision cross section set for HCl (Hayashi (1987)), assuming that all HCl molecules are in the ground state. This assumption is not true, so we do not like our cross section set of HCl.

As an example, we discuss the electron cross sections for HBr here. Experimental and theoretical studies on electron collision cross sections of HBr are summarized as follows :

On the study of electron scattering cross sections for HBr

grand total cross section Q_T

no work

elastic experiment

no data
(F. Linder 1977)

elastic theory

M. E. Riley	1975	
Y. Itikawa	1978	< 1 eV
E. Estrada	1984	general theory
S. Pozdneev	1988	
L. Malegat	B 1990	
R. Fandreyer	B 1993	0.1 - 11 eV
T. N. Rescigno	C 1996	0 - 10 eV, DCS
I. M. Smith	B 1998	

rotational excitation experiment and theory

no work

vibrational excitaion experiment

J. P. Ziesel	C	1975	○	
K. Rohr	B	1977a		DCS at 0.41 eV
K. Rohr	B	1978	○	th. - 7 eV for v = 0→1
R. Azria	B	1980		
S. Cvejanovic		1993		
A. -C. Sergenton		1999		0.3 - 2.7 eV
M. Cizek	P	2001	○	0 - 4 eV
G. P. Karwasz		2001		compilation
M. Cizek		2002		

vibrational excitation theory

F. A. Gianturco		1977		
H. Estrada		1984		
S. Pozdneev		1988		
F. Fandreyer	B	1993		th. - 4.5 eV
J. Horacek	P	1996		
J. Horacek		2000		
S. A. Pozdneev		2000		
M. Cizek	P	2001	○	0 - 4 eV

electronic excitation experiment

G. R. Mohlmann		1979		
P. A. Shaw	B	1984		1500 eV
S. Cvejanovic	B	1987		
K. England		1987		0.5 - 50 eV
K. England	B	1990	○	0.5 - 50 eV
K. H. Becker		1994		
D. Cubric	B	1994		

electronic excitation theory

T. N. Rescigno (V. McKoy)	C	1996		th. - 25 eV

ionization experiment

K. H. Becker	1994

ionization theory

H. Deutsch	1997

attachment experiment

H. Gutbier		1954		
D. C. Frost	C	1958		
I. S. Buchelnikova		1959		
L. G. Christophorou	C	1968a		
L. G. Christophorou	C	1968b		
K. G. Mothes		1972		
A. A. Christodoulides		1974		≦ 0.4 eV
O. H. Crawford	C	1974		
S. S. Nagra		1975		
J. P. Ziesel	C	1975	○	Br^- formation, 0 - 1.9 eV
R. Abouaf		1977		
N. A. Burdett		1977		
D. W. Trainor		1978		
R. Abouaf		1980		0.05 - 2 eV
R. Azria		1982		
Y. Le Coat	B	1982	○	H^- formation, 5 - 10 eV
N. G. Adams	C	1986		
D. Smith	B	1987		
W. C. Wang		1988a		
M. Cizek	P	2001	○	
G. P. Karwasz		2001		compilation
J. B. A. Mitchell		2001		
T. Speck		2001		

attachment theory

S. A. Pozdneev		1982
A. U. Hazi	B	1983
S. A. Pozdneev		1988
J. Horacek	P	1996
S. A. Pozdneev		2000
K. Houfek		2001
K. Houfek	P	2002

We need more experimental studies of cross sections and other processes, especially grand total cross section, elastic scattering cross section, ionization cross section and electron swarm parameters, for the determination of tentative and approximate cross section set for HBr.

We cannot determine the exact value of cross section set for molecules. The HBr molecules are always mixture of HBr(r) and HBr(v) at given experimental conditions. And cross section sets for HBr(r) and HBr(v) are different.

May We Measure the Exact Values of Electron Collision Cross Sections for Molecules by Beam and Swarm Experiments ?

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We cannot measure the exact values of DCS for molecules intrinsically. Of course, we can measure the approximate values of DCS for molecules, but can measure the exact values of DCS for atoms. The reason is very simple.

Target molecule M in both beam and swarm experiments consists of the mixture of different states :

$$M = M(g) + M(r_j) + M(v_i) + M_N$$

where $M(g)$, $M(r_j)$, $M(v_i)$ and M_N represent the completely ground state molecules, the rotationally excited molecules, the vibrationally excited molecules and the van der Waals clusters consisting of N molecules ($N \geqq 2$), respectively. Usually beam and swarm experiments are carried out at about 300 K. The concentration of $M(g)$ is small compared to $M(r_j)$ (except H_2 molecules) at 300 K. Then the molecule M is always mixture of $M(r_j)$ and $M(v_i)$, and the concentration of $M(r_j)$ and $M(v_i)$ changes with temperature. And electron collision cross section sets from elastic to inelastic collision processes for $M(r)$ and $M(v)$ are different each other. The target molecules M in the beam and swarm experiments are always mixtures of different molecules $M(r_j)$ and $M(v_i)$. In the case of H_2, the target gas consists of $M(g)$ and $M(r_j)$, especially $M(g)$ and $M(r_1)$ at 78 K.

Most clear change of cross sections of $M(r_j)$ and $M(v_i)$ will occur for triatomic molecules, CO_2, N_2O and so on. Triatomic molecules can change from linear to bend, or vice versa easily. The authors [1] have presented the different elastic momentum transfer cross sections q_{mr} and q_{mv} for $CO_2(r)$ and $CO_2(v)$, where they assumed that all other inelastic cross sections of $CO_2(r)$ and $CO_2(v)$ are practically the same. Then they have calculated the electron drift velocity W as a function of gas temperature T. When T increas, concentrations of $CO_2(v)$ increases, then W decreases with T at the same E/N, the electric field over the gas number density, around 50 Td.

We have a comment to the interesting and important paper of W. Johnstone, et al. [2]. They have measured the temperature dependence of elastic DCS for CO_2 at 4.0 eV. Unfortunitly, q_{mv} for $CO_2(v)$ at 4 eV is almost equal to q_{mr} for $CO_2(r)$ [1]. Then we propose the same experiments at about 3.4 eV for CO_2, because the temperature dependence of DCS seems to be very large there.

Winstead and McKoy [3] calculated the elastic DCS for $N_2O(g)$ at low electron energies and compare the experimental DCS data for $N_2O(r)$ + $N_2O(v)$ mixture at 300 K. We can see large discrepancy between them at lower than about 10 eV. We urge Winstead and Mckoy to calculate the DCS for $N_2O(v)$ and also $N_2O(r)$ for comparison. We can see the same discrepancy of DCS for CO_2 [4] [5] at low electron energies..

H_2 molecules have the famous long standing controversy in the vibrational excitation cross section [6]. A possible way to solve the problem may be as follows. At first, theoreticians calculate the q_{mg}, q_{mr}, q_{mv}, q_{rg}, q_{rr}, q_{rv}, q_{vg}, q_{vr}, and q_{vv} for $H_2(g)$, $H_2(r_1)$ and $H_2(v_1)$, as a function of electron energies. Using these data, we calculate the electron swarm parameters. From beam experiments, we cannot determine the values of q_{mg}, q_{mr}, q_{rg}, q_{rr} for $H_2(g)$ and $H_2(r_1)$ at the same time. It is clear that the threshold energies of q_r and q_v for $H_2(g)$ and $H_2(r_1)$ are different. Bhattacharyya. et al. [7] have shown that elastic integral cross sections Q_{tr} are larger than Q_{tg} for 20 to 200 eV for $H_2(g)$ and $H_2(r_1)$. We want the elastic DCS values for $H_2(g)$ and $H_2(r_1)$ at low electron energies lower than 10 eV. Swarm experiments also carried out in the mixtures of $H_2(g)$ and $H_2(r_1)$, except for para-$H_2(g)$ at 78 K (concentration of $H_2(g)$ is 99.3 %). We compare the experimental and calculated swarm parameters at given conditions.

Usually, theoreticians calculate the DCS for $M(g)$, not for $M(r_j)$ and $M(v_i)$, for most molecules. Theoretical studies involving the rotationally and vibrationally excited species are urgently required for many molecules. There is a interesting paper given by A. Jain [8].

If we have the cross section sets for excited inert gas clusters, we can calculate the electron swarm parameters of inert gases at high pressure and low temperature conditions. The concentration of the clusters for atoms and molecules are important at low temperature and high pressure conditions.

Most interesting temperature dependence occur for attachment cross sections q_a [9]-[13]. The values of non-dissociative q_{an} and dissociative q_{ad} are quite different for $M(r)$ and $M(v)$, and $M(r)$ and $M(v)$ have the definit and individual cross sections, independ on the temperature. Apparent temperature dependence of attachment cross section is caused through different concentration of the excited components $M(r)$ and $M(v)$ at different temperatures.

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2004. 2.12.

Numbers of References

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

Atoms (17)			Molecules (51)					
A + e, A + $h\nu$					M + e,	M + $h\nu$,		
He	2	2170 *	2	H_2, D_2	2200 ○	5	CH_4	800
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_2F_2	250
							CH_3Cl	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	330 ○	6	C_2H_4	370
				HCl	420 ○		CH_3OH	350
O	8	390		HBr	220 ○			
				HI	150 ○	7	SF_6	920 ○
F	9	90						
Cl	17	130	3	CO_2	1240 ○			
				H_2O	1200 ○	8	C_2H_6	260
Cu	29	180					C_2F_6	150
Cd	48	210		O_3	480		Si_2H_6	70
Ba	56	340		N_2O	450			
				NO_2	350	9	C_3H_6	120
Hg	80	600		H_2S	270		C_2H_5OH	60
				SO_2	290			
				CS_2	260			
				OCS	280	11	C_3H_8	190
							C_3F_8	100
			4	C_2H_2	390			
						12	C_4F_8	100
				NH_3	700		C_6H_6	240
				NF_3	110		C_6F_6	100
				BF_3	110			
				BCl_3	90	60	C_{60}	300
				PH_3	120			
				H_2CO	180		$M_r + M_v$	850

not final, but
finished mostly

include electron
swarm papers

include
review papers

* He(Ne) + e only. Not include He(Ne) + $h\nu$ papers.

○ The bibliography was published already.

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