Bibliography on Electron Collisions with Molecules: 
Rotational and Vibrational Excitations, 1980-2000

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RESEARCH REPORT
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Bibliography on electron collisions with molecules: rotational and vibrational excitations, 1980-2000

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Abstract
A list of papers reporting cross sections for electron-impact excitations of rotational and vibrational states of molecules is presented. The list includes both the theoretical and the experimental papers published in 1980-2000. An index by molecular species is provided at the end of the bibliography.

Keywords
bibliography, electron-molecule collision, rotational excitation, vibrational excitation

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INTRODUCTION

Electron-molecule collision is a fundamental process in a low-temperature plasma, which is of importance both in nature (e.g., ionospheres of the Earth and other planets) and in industry (e.g., gaseous electronics and plasma processing). The electron-molecule collision also plays a fundamental role in the interaction of radiation with matter. Thus the cross section data for the electron-molecule collision are needed in a wide field of applications.

One of the specific features of the electron-molecule interaction is the presence of the degree of nuclear motion of the molecule (i.e., rotation and vibration). Excitation of molecular rotation and vibration makes the electron-molecule collision very much different from the electron-atom collision, particularly in the region of low collision energy (say, below several tens of eV). For instance, the behavior of the slowing down of an electron in a molecular gas at the energies below the threshold of the electronic excitation of the molecule is mainly determined by the excitation of the molecular rotation and vibration.

In the present paper, a list is given of the papers reporting cross section data on the electron-impact excitations of rotational and vibrational states of molecules. In the case of rotational and vibrational excitations, particularly in the former, experimental data are not sufficiently available. The present paper, therefore, lists theoretical, as well as experimental, papers. For readers' convenience, a short description of the content of each paper follows the bibliographic information. Also the molecular species dealt with in each paper is clearly indicated. An index by molecular species is provided at the end of the paper.

The present list includes the papers published in 1980-2000. For the papers published before 1980, a similar but more general bibliography is available elsewhere.1-4)

EXPLANATION OF TABLES

Table I. Bibliography
Each paper is identified by a record number such as 80Chu1, where 80 means the year of publication (i.e., 1980) and Chu is the first three letters of the first author. The listing is arranged in the ascending order of the record number (i.e., the year and the first author). Each entry has the information

author(s)
journal name, volume, page and the year of publication

title

the name of the molecule(s), rotation or vibration (or both), experiment or theory (or both)
simple description of the content

In the description of the content, the following abbreviations are used:

CC close-coupling method
DCS differential cross section
DW distorted wave method
FNA fixed-nuclei approximation
FNO fixed-nuclear-orientation approximation
ICS integrated cross section
Th threshold

Table II. Index for rotational excitation

Papers reporting rotational cross section are indexed by molecular species. The letter in the parentheses after each record number indicates theoretical (T) or experimental (E) paper. The letter (R) means recommended cross sections given in the relevant paper.

Table III. Index for vibrational excitation

Papers reporting vibrational cross section are indexed by molecular species. The letter in the parentheses after each record number indicates theoretical (T) or experimental (E) paper. The letter (R) means recommended cross sections given in the relevant paper.

Acknowledgement

This bibliography has been planned through the discussion with Prof. Sang-Joon Kim of the Kyunghee University under the Core University Program on Energy Science and Engineering between Korea and Japan. I would like to appreciate his helpful comments on this publication.

References
2) J. W. Gallagher, J. R. Rumble and E. C. Beaty, Bibliography of Low Energy Electron and
Photon Cross Section Data (January 1975 through December 1977), NBS Special Publication 426, Suppl. 1 (NBS, 1979)


Table I. Bibliography

80Chu1
Electron impact cross sections for v=0→1 vibrational excitation in CO at electron energies of 3 to 100 eV
[CO, vib, experiment]
ICS and DCS at 3-100 eV

80Ond1
Comparison of local-exchange approximations for intermediate-energy electron-molecule differential cross sections
[N2, rot, theory]
rotational CC with model potential; DCS at 30 eV

80Ond2
State-to-state cross sections for elastic and inelastic electron scattering by N2 at 20-35 eV, including resonant
enhancement of vibrational excitation
[N2, rot, vib, theory]
rot: rotational CC with model potential; DCS at 25 eV; ICS at 20, 25 and 30 eV; vib: vibrational adiabatic and
rotational CC; ICS and DCS at 20, 25 and 30 eV

80Ond3
Quantum mechanical study of elastic scattering and rotational excitation of CO by electrons
[CO, rot, theory]
rotational CC with model potential; DCS at 10 eV

80Reg1
Elastic scattering and vibrational excitation of CO2 by 4, 10, 20 and 50 eV electrons
[CO2, vib, experiment]
ICS and DCS at 4-50 eV

80Roh1
Cross beam experiment for the scattering of low-energy electrons from methane
[CH4, vib, experiment]
DCS at 2 eV

80Thi1
Excitation of the asymmetric stretch mode of CO2 by electron impact
[CO2, vib, theory]
rotational CC and vibrational adiabatic; DCS at 10 eV

81Sah1
Rotational cross sections and rate coefficients for e-CO and e-HCN collisions under interstellar conditions
[CO, HCN, rot, theory]
rotational CC with a simple model potential; ICS at 0.0006-0.1 eV; rate coefficient for 5-100 K

81Sie1
Hybrid calculation of electron-polar-molecule scattering: Integrated and momentum-transfer cross sections for LiF
[LiF, rot, theory]
a hybrid method with the continuum multiple scattering method, the FNA, and the Born closure; ICS at 1-20 eV

81Tan1
Electron-impact cross sections for $v = 0 \rightarrow 1$ vibrational excitation of N$_2$ at electron energies of 3 to 30 eV
[N$_2$, vib, experiment]
ICS and DCS at 3-30 eV

81Thi1
Elastic scattering and rotational excitation of a polyatomic molecule by electron impact: Acetylene [C$_2$H$_2$, rot, theory]
rotational CC with model potential; ICS and DCS at 10 eV

81Thi2
Electron scattering by CO$_2$: Elastic scattering, rotational excitation, and excitation of the asymmetric stretch at 10 eV
impact energy
[CO$_2$, rot, vib, theory]
rotational CC and vibrational adiabatic with model potential; ICS and DCS at 10 eV

81Thi3
Improved calculation of the cross section for excitation of the asymmetric stretch of CO$_2$ by electron impact
[CO$_2$, vib, theory]
an improved version of 81Thi2

82Bha1
Elastic and rotational excitation of the nitrogen molecule by intermediate-energy electrons
[N$_2$, rot, theory]
FNA with an eikonal amplitude; ICS at 20-200 eV; DCS at 20, 30, and 50 eV

82Fell
Breakdown of the adiabatic-nuclear-rotation approximation for near-threshold e-H$_2$ collisions
[H$_2$, rot, theory]
validity of the FNA tested; ICS at 0.4-4 eV; DCS at 0.047, 0.1 and 1 eV

82Jun1
Rotational excitation of N$_2$, CO and H$_2$O by low-energy electron collisions
[N$_2$, CO, H$_2$O, rot, vib, experiment]
rot: for N$_2$, DCS at 2.22 and 2.47 eV; for CO, DCS at 1.8 and 2.1 eV; for H$_2$O, DCS at 2.14 and 6 eV; vib: for N$_2$, DCS at 2.47 eV; for CO, DCS at 1.8 eV

82Nor1
The multipole-extracted adiabatic-nuclei approximation for electron-molecule collisions
[CO, HCl, rot, theory]
a test of the multipole-extracted adiabatic-nuclei approximation (MEAN) method; for CO, ICS at 0.001-0.1 eV; for HCl, DCS at 11 eV

82Res1
Ab initio study of vibrational excitation of HF by low-energy electrons
[HF, vib, theory]
FNA; ICS at 0.5-5 eV

82Whi
Near-threshold vibrational excitation in electron-CO$_2$ collisions: A simple model
[CO$_2$, vib, theory]
FNA with vibrational CC; ICS at Th-1 eV

83Abu
Electron scattering by methane: Elastic scattering and rotational excitation cross sections calculated with ab initio interaction potentials
[CH$_4$, rot, theory]
rotational CC with model potential; DCS and ICS at 10 eV

83Bha
Elastic and rotational excitation of the oxgen molecule by intermediate-energy electrons
[O$_2$, rot, theory]
same as 82Bha, but for O$_2$

83Bur
Electron scattering by nitrogen molecules at intermediate energies
[N$_2$, vib, theory]
FNA; ICS at 20-30 eV

83Fab
Generalised quantum defect theory for electron scattering by polar molecules
[LiF, HF, rot, theory]
FNA and the effective range theory; ICS at 0.5-4 eV

83Had
Cross sections for electron-carbon monoxide collisions in the range 1-4 eV
[CO, vib, experiment]
ICS at 0.3-4 eV, from swarm experiment

83Jai1
Vibrational excitation of symmetric and bending modes of H$_2$O by slow electron impact
[H$_2$O, vib, theory]
FNA with model-exchange and model-polarization potential; ICS at 1-10 eV, DCS at 1-8 eV

83Jai2
Momentum transfer cross sections for the low-energy electron scattering by NH$_3$ molecules
[NH$_3$, rot, theory]
FNA with model-exchange and model-polarization potential; ICS at 0.01-10 eV

83Jai3
Rotational excitation of CH₄ and H₂O by slow electron impact
[CH₄, H₂O, rot, theory]
FNA with model-exchange and model-polarization potential; for CH₄, DCS at 5 and 10 eV, ICS at 1-15 eV; for H₂O, DCS at 2.14 and 6 eV, ICS at 1-10 eV, a comparison with experiment attempted

83Ond1
Calculation of the polarization potential for e-N₂ collisions
[N₂, vib, theory]
FNA with polarized-orbital method; ICS at 1.8-2.3 eV

83Pad1
Vibrationally elastic scattering of electrons by HCl
[HCl, rot, theory]
FNA with model-exchange and model-polarization potential; ICS at 0.01-10 eV

83Rum1
State-to-state differential and integral cross sections for vibrational-rotational excitation and elastic scattering of electrons by N₂ at 5-50 eV; Calculations using extended-basis-set Hartree-Fock wave functions
[N₂, vib, theory]
FNA; ICS at 5-50 eV

83Soh1
Threshold structures in the cross sections of low-energy electron scattering of methane
[CH₄, vib, experiment]
DCS at 0.3, 0.6 and 1 eV, also excitation function vs energy (Th-1.8 eV)

83Tan1
Vibrational excitation of CH₄ by electron impact: 3-20 eV
[CH₄, vib, experiment]
ICS and DCS at 3-20 eV

83Var1
Off-shell adiabatic nuclei theory of e–H₂ rotational excitation
[H₂, rot, theory]
the off-shell adiabatic nuclear theory; ICS at 0.05-0.5 ev; DCS at 0.05 and 0.5 eV

84Fel1
Scaled adiabatic-nuclear-rotation theory for near-threshold rotational excitation in electron-molecule scattering
[H₂, rot, theory]
a modified FNA; ICS at 0.04-0.5 eV

84Hal1
Electron impact excitation of H₂ (D₂). Resonance phenomena associated with the X₂Σ⁺ states of H₂⁺ in the 10 eV region
[H$_2$, vib, experiment]
ICS and DCS at 5 and 10 eV

84Jai1
Low-energy electron scattering by H$_2$S molecules: elastic, rotational and vibrational excitation
[H$_2$S, rot, vib, theory]
FNA with model-exchange and model-polarization potential; rot: ICS at 0.5-10 eV; vib: ICS at 0.5-7 eV, DCS at 2 and 3 eV, a large disagreement with experiment

84Mor1
Adiabatic approximations for the nuclear excitation of molecules by low-energy electron impact: Rotational excitation of H$_2$
[H$_2$, rot, theory]
test of FNA against rot CC with model-exchange and model-polarization potential; ICS at 0.05-6 eV, also DCS; the breakdown of the FNA shown near threshold

84Mor2
Validity of the adiabatic nuclei theory for vibrational excitation of molecules by electron impact: The e-H$_2$ system
[H$_2$, vib, theory]
test of the adiabatic nuclear theory; ICS at 0.7-4.5 eV, DCS at 0.7 eV

84Pad1
Ro-vibrational excitation of HCl by electron impact
[HCl, vib, theory]
the multipole-extracted adiabatic-nuclei approximation (MEAN) method; ICS at 0.4-4.5 eV

84Sta1
Complex optical potential model for electron-molecule scattering, elastic scattering, and rotational excitation of H$_2$ at 10-100 eV
[H$_2$, rot, theory]
rot CC with optical potential; ICS at 10-100 eV; DCS at 10, 40 and 100 eV

84Sur1
Rotational excitation of hydrogen molecules by electron and positron impact
[H$_2$, rot, theory]
a DW approximation with a model potential; ICS at Th-10 eV

84Var1
Threshold behaviour of rotational cross sections in e-H$_2$ scattering
[H$_2$, rot, theory]
an off-shell generalization of adiabatic nuclear model; ICS at 0.05-6 eV, DCS at 0.047 and 0.1 eV

85All1
Experimental observation of structures in the energy dependence of vibrational excitation in H$_2$ by electron impact in the $^2\Sigma_u^+$ resonance region
[H$_2$, vib, experiment]
ICS (relative) at the energy below 5 eV, resonance found for high-state excitation

85All2
Excitation of vibrational levels up to v=17 in N$_2$ by electron impact in the 0-5 eV region
[N$_2$, vib, experiment]
ICS (relative) for the excitation up to v=17

85Buc1
Vibrational excitation of D$_2$ by low energy electrons
[H$_2$, D$_2$, vib, experiment]
ICS at Th-10 eV, from swarm experiment

85Cur1
Elastic and inelastic scattering of electrons by methane and ethane
[CH$_4$, C$_2$H$_6$, vib, experiment]
DCS at 7.5-20 eV

85Est1
On the virtual-state effect in low-energy electron-CO$_2$ scattering
[CO$_2$, vib, theory]
a virtual state model for near-Th cross section

85Had1
Low energy electron collision cross sections for methane
[CH$_4$, vib, experiment]
ICS at Th-10 eV, from swarm experiment

85Jal1
Ab initio calculations of low-energy electron scattering by HCN molecules
[HCN, rot, theory]
FNA with exact-exchange and model-polarization potential; ICS at 0.001-0.1 eV; DCS at 3 eV

85Jer1
Energy-modified frame-transformation theory: Application to near-threshold rovibrational excitation of hydrogen molecules by electrons
[H$_2$, rot, vib, theory]
the energy-modified frame transformation theory; rot & vib; ICS at 0.6-10 eV, good agreement with experiment

85Koc1
Direct and resonant vibrational excitation of C$_2$H$_2$ by electron impact from 0 to 3.6 eV
[C$_2$H$_2$, vib, experiment]
ICS at 0.235-3.6 eV, DCS at 0.235-2.6 eV

85Koc2
Elastic electron scattering and vibrational excitation of CO$_2$ in the threshold energy region
[CO$_2$, vib, experiment]
DCS at 0.33, 0.53 and 1.05 eV, also excitation function near Th

85Lec1
Vibrationally elastic and inelastic (0→1) scattering of electrons by H2-a coherent renormalised multicentre potential
model approach
[H2, vib, theory]
FNA; ICS and DCS at 20-81 eV

85Mul1
Rotational excitation of CH4 by low-energy-electron collisions
[CH4, rot, vib, experiment]
rot: DCS at 0.5, 5, 7.5 and 10 eV; vib: DCS at 0.5 and 7.5 eV

85Mun1
Nuclear dynamics in resonant electron-molecule scattering beyond the local approximation: Vibrational excitation
and dissociative attachment in H2 and D2
[H2, vib, theory]
resonance theory; ICS at 1-6 eV

85Nis1
Differential cross sections of electron scattering from molecular hydrogen I. Elastic scattering and vibrational
excitation (X^1Σ^+ g^+, v =0→1)
[H2, vib, experiment]
ICS and DCS at 2.5-100 eV

85Nov1
Collisional cross sections of CCl2F2 and transport coefficients of CCl2F2 and N2-CCl2F2 mixtures
[CCl2F2, vib, experiment]
ICS at 0.1-10 eV, from swarm experiment

85Ond1
Rotational excitation of molecular nitrogen by electron impact
[N2, rot, theory]
FNA with model-exchange and model-polarization potential; partial differential equation approach; ICS at 0.01-3 eV,
showing resonant structure

85Soh1
Electron scattering from CO below resonance energy
[CO, vib, experiment]
ICS at 0.37-1.26 eV, DCS at 0.45 and 1.26 eV

86Ant1
Rotational branch analysis of the excitation of the fundamental vibrational modes of CO2 by slow electron collisions
[CO2, vib, experiment]
ICS and DCS at 2 and 3.8 eV
86Fuj1
Vibrational excitation cross sections for F₂ by electron impact

[F₂, vib, experiment]
ICS at 0.5-1.8 eV, DCS at 1.2 and 1.5 eV

86Huo1
Electron-nitrogen molecule collisions in high-temperature nonequilibrium air

[N₂, vib, theory]
FNA with the multichannel Schwinger variational method; rate coefficients at T= 0.1-5.0 eV

86Lee1
Electron-impact vibrational excitation rates in the flowfield of aeroassisted orbital transfer vehicles

[N₂, vib, theory]
resonance cross sections calculated and used to derive excitation rate coefficient

86Mor1
Resonant vibrational excitation of N₂ by low-energy electron impact

[N₂, vib, theory]
the R-matrix method; ICS (relative) for the resonance region

86Mor2
A first-order non-degenerate adiabatic theory for calculating near-threshold cross sections for rovibrational excitation of molecules by electron impact

[H₂, rot, theory]
the first-order non-degenerate adiabatic theory (FONDA); ICS at 0.04-8 eV

86Mor3
Investigation of parameter-free model polarization potentials for electron-molecule scattering calculations including the nuclear motion

[H₂, rot, vib, theory]
rot: rot CC with model-exchange and model-polarization potential; ICS at 0.08-10 eV, good agreement with experiment; vib: vibrational CC with a model polarization potential; ICS at 0.08-10 eV

86Ohm1
Boltzmann equation analysis of electron swarm behaviour in methane

[CH₄, vib, experiment]
ICS at Th-200 eV, from swarm experiment

86Soh1
Near-threshold vibrational excitation and elastic electron scattering from N₂

[N₂, vib, experiment]
ICS and DCS at 0.5, 1.0 and 1.5 eV

87Abd1
Calculating vibrational-excitation cross sections off the energy shell: A first-order adiabatic theory

[H₂, vib, theory]
the first-order adiabatic theory; ICS at 0.6-10 eV, DCS at 0.7 eV

87Gia1
Electron-methane scattering via a parameter-free model interaction
[CH₄, rot, theory]
FNA with model-exchange and model-polarization potential; ICS at 2-20 eV, DCS at 10 eV, a fairly good agreement with experiment

87Gil1
Electron scattering by nitrogen molecules
[N₂, vib, theory]
the R-matrix method; DCS at 3-30 eV

87Huo1
Schwinger multichannel study of the 2Πg shape resonance in N₂
[N₂, vib, theory]
the multichannel Schwinger variational method; ICS (relative) at Th-4 eV and absolute values of the peak cross section

87Jun1
Breakdown of the adiabatic-nuclei approximation in the rotational excitation of H₂ by very slow electrons
[H₂, rot, experiment]
DCS measured at 0.2 and 0.6 eV, showing breakdown of the FNA

87Kno1
Rovibrational threshold structures in the electron scattering from hydrogen halides
[HCl, vib, experiment]
DCS at 0.5 eV, also DCS (90°) vs energy (Th-5.5 eV)

87Mor1
Near-threshold rotational and vibrational excitation of H₂ by electron impact: Theory and experiment
[H₂, rot, vib, theory, experiment]
rot: rot CC with exact-exchange and model-polarization potential; ICS at 0.05-10 eV, a detailed comparison with swarm result; vib: ICS at 0.5-1.5 eV, from swarm experiment

87Soh1
Low-energy electron impact spectroscopy of OCS and CS₂
[OCS, CS₂, vib, experiment]
For OCS, ICS at 0.4-4 eV, DCS at 0.6, 3 and 4 eV; for CS₂, ICS and DCS at 0.3-5 eV

88Curt1
Electron swarm characteristic energies (Dr / μ) in tetrafluoromethane (CF₄) at low E/N
[CF₄, vib, experiment]
ICS at Th-2 eV, from swarm experiment

88Eng1
A study of the vibrational excitation of H₂ by measurements of the drift velocity of electrons in H₂-Ne mixtures
[H₂, rot, vib, experiment]
rot: ICS at 0.04-10 eV, from swarm experiment; vib: ICS at 0.5-15 eV, from swarm experiment

88Gia1
Rotational excitations and resonant behaviour in electron-molecule collisions
[CH₄, rot, theory]
same as 87Gia1; DCS at 0.5-20 eV

88Mal1
Resonant vibrational excitation of N₂ by electron impact in the 15-35 eV energy range
[N₂, vib, theory]
FNA with exact-exchange potential for the resonance symmetry; ICS at 16-35 eV, DCS (90°) compared with experiment, agreement is not good

88Mor1
Low-energy electron scattering by HF
[HF, vib, theory]
the R-matrix method; ICS at 0.5-2 eV

88Red1
Studies of the 2 eV shape resonance in N₂ using a two-dimensional scanning technique
[N₂, vib, experiment]
DCS (70°) at 2 eV for the excitations up to v=8

88Shy1
Vibrational-excitation cross sections of water molecules by electron impact
[H₂O, vib, experiment]
ICS and DCS at 2.2-20 eV

88Ste1
Elastic and inelastic e-CF₄ cross sections at low energies: fit to the experimental data
[CF₄, vib, experiment]
ICS at Th-4 eV, from swarm experiment

89Bre1
Cross sections for rotational excitation of CH₄ by 3-20 eV electrons
[CH₄, rot, theory]
FNA and the Schwinger multichannel variational method; DCS at 3-20 eV, some disagreement with experiment

89Bru1
Vibrational excitation of N₂ in the ²Π_g resonance region
[N₂, vib, experiment]
DCS at 2.1, 2.4 and 3.0 eV
89Dav1
Measurements of swarm parameters and derived electron collision cross sections in methane
[CH4, vib, experiment]
ICS at 0.16-200 eV, from swarm experiment

89Kno1
Near-threshold electron impact rovibrational excitation of HCl and HF
[HCl, HF, vib, experiment]
ICS at Th-5 eV, DCS at 0.5-1.5 eV

89Kno2
Electron impact rovibrational excitation close to threshold of the v=2 and v=3 levels of HF and HCl
[HF, HCl, vib, experiment]
same as 89Kno1, but for the excitation of v=2, 3

89Kur1
Electron collision cross sections for the monosilane molecule
[SiH4, vib, experiment]
ICS at Th-50 eV, from swarm experiment

89Rad1
Rotational and rovibrational excitation of HCl and HF by low-energy electron impact
[HF, HCl, rot, vib, experiment]
DCS measured at 0.5-10 eV

90Boe1
23, 1905 (1990)
Vibrational excitation of ethane by electron impact
[C2H6, vib, experiment]
ICS and DCS at 3-20 eV

90Bru1
Low energy electron scattering from H2
[H2, vib, experiment]
ICS and DCS at 1.5 eV

90Buc1
S. J. Buckman, M. J. Brunger, D. S. Newman, G. Snitcher, S. Alston, D. W. Norcross, M. A. Morrison, B. C. Saha,
Near-threshold vibrational excitation of H2 by electron impact: Resolution of discrepancies between experiment and
theory
[H2, vib, experiment, theory]
experiment: ICS at 1.5 eV, DCS at 1.2 eV; theory: vibrational CC with non-local exchange effect, good agreement
with the experiment

90Fur1
Electron-impact excitation of the normal vibrational modes of NH3 in the intermediate region (12-50 eV)
[NH3, vib, experiment]
DCS (relative) at 25 and 50 eV

90Gal1
A theory of low-energy electron impact excitation of dipole-allowed molecular vibrations. An application to acetylene, C₂H₂
[C₂H₂, vib, theory]
the Born approx.; DCS at 0.235 eV, also DCS(45°) vs energy

90Gal2
Low energy electron impact excitation of dipole allowed vibrations in CO and CO₂
[CO, CO₂, vib, theory]
the Born approx.; for CO, DCS at 0.45 eV, also DCS(12.5°, 90°) vs energy; for CO₂, DCS(39°, 54°) vs energy

90McN1
Low-energy electron-CH₄ collisions using exact exchange plus parameter-free polarization potential
[CH₄, rot, theory]
FNA with exact-exchange and model-polarization potential; DCS at 0.5-10 eV, good agreement with experiment for some cases, but poor agreement for others; ICS at 0.1-20 eV, no comparison with experiment

90Mor1
Low-energy electron scattering by HCl
[HCl, vib, theory]
the R-matrix method; ICS near Th

90Pir1
Elastic and inelastic e-C₂F₆ and e-C₃F₈ cross sections from swarm data
[C₂F₆, C₃F₈, vib, experiment]
ICS at 0.1-8 eV, from swarm experiment

90Sch1
Resonant vibrational excitation of H₂CO by low-energy electron impact
[H₂CO, vib, theory]
FNA and the Kohn variational method; ICS at 0.2-2 eV

90Sni1
Near-threshold vibrational excitation of HF by electron impact
[HF, vib, theory]
vibrational CC with exact-exchange and model-polarization potential; ICS at 0.5-1.4 eV, DCS at 0.49-1.1 eV

90Tan1
Elastic and vibrational differential cross sections for collisions of low- and intermediate-energy electrons with silane
[SiH₄, vib, experiment]
DCS at 2.15 and 5 eV

90Tra1
Simple procedure for including vibrational effects in the calculation of electron-molecule cross sections
[H₂, rot, theory]
a simple procedure proposed to include vibrational effects; ICS at 0.05-10 eV, better agreement with experiment

91Bru1
Elastic scattering and rovibrational excitation of H₂ by low-energy electrons
[H₂, vib, experiment]
ICS and DCS at 1-5 eV

91Fur1
Absolute vibrational differential cross sections of water vapor by 30 and 50 eV electron impact
[H₂O, vib, experiment]
DCS at 30 and 50 eV

91Gia1
Scattering of low-energy electrons from polyatomic targets: the water molecule example
[H₂O, rot, theory]
FNA with model-exchange and model-polarization potential; DCS at 2 and 6 eV, a fairly good agreement with experiment at 6 eV, but not at 2 eV

91Gia2
Ab initio model calculations to treat electron scattering from polar polyatomic targets: H₂S and NH₃
[H₂S, NH₃, rot, theory]
FNA with model-exchange and model-polarization potential; NH₃, ICS at 0.1-20 eV; H₂S, DCS at 1-30 eV

91Jai1
Theoretical study of low-energy electron-SiH₄ collisions using exact-exchange plus parameter-free polarization potential
[SiH₄, rot, theory]
FNA with exact-exchange and model-polarization potential; DCS at 0.5-20 eV

91Jai2
Effect of gas temperature on the rotational excitation of spherical top molecules (CH₄ and SiH₄) by low-energy electrons
[CH₄, SiH₄, rot, theory]
FNA with exact-exchange and model-polarization potential; DCS and ICS at 0.5-20 eV

91Men1
Algebraic-eikonal approach to the electron-molecule-collision process: Vibrational excitation and quadrupole interaction
[HF, HCl, vib, theory]
algebraic eikonal method; DCS at 20 eV

91Mor1
Low-energy electron scattering by CO
[CO, vib, theory]
the R-matrix method; ICS at 1-5 eV
91Mor2
Improved accuracy in adiabatic cross sections for low-energy rotational and vibrational excitation of molecules by 
electron impact
[H$_2$, rot, vib, theory]
the First Order Non-Adiabatic Theory (FONDA); rot: ICS at 0.05-10 eV, comparison with other calculations; vib: 
ICS at 0.5-10 eV, DCS at 0.7, 1.0 and 5 eV;

91Mor3
Use of numerical optimization algorithms to obtain cross sections from electron swarm data
[CH$_4$, vib, experiment]
ICS at Th-2 eV, from swarm experiment

91Rob1
Driving nuclei with resonant electrons: Ab initio study of (e+H$_2$)$^2$Σ$_u^+$
[H$_2$, vib, theory]
NNA with the formulation of Greene and Jungen; ICS at 0.3-5 eV

91Sch1
Measurement of near-threshold vibrational excitation of HCl by electron impact
[HCl, vib, experiment]
relative DCS (a sum of 0° and 180° scattering) at 0.3-4.5 eV

91Sch2
Anisotropic low energy electron collision cross sections for methane derived from transport coefficients
[CH$_4$, vib, experiment]
ICS at 0.16-3 eV, from swarm experiment

91Shy1
Vibrational excitation cross sections of methane by electron impact
[CH$_4$, vib, experiment]
ICS and DCS at 5-15 eV

92Boe1
Crossed-beam experiment for the scattering of low energy electrons from CF$_4$
[CF$_4$, vib, experiment]
DCS at 2 eV

92Bre1
Elastic electron scattering and rovibrational excitation of N$_2$ at low incident energies
[N$_2$, vib, experiment]
ICS at 1.5-5.0 eV, DCS at 2.1 and 3.0 eV

92Gan1
Electron impact cross-sections and cooling rates for methane
based on a review of cross section data, an empirical formula is given.

92Gao1
Vibrational excitation of H₂ by electron impact: An energy-dependent vibrational-frame-transformation approach
[H₂, vib, theory]
the multichannel quantum defect theory (MQDT); ICS at 1-5 eV

92Gul1
Resonant excitation of NH₃ by low energy electron impact: the ν₁,3 normal vibrational modes
[NH₃, vib, experiment]
DCS at 5.75 and 15 eV; also DCS(90°) vs energy (5-10 eV)

92Man1
Low-energy electron scattering from halomethanes: II. Direct and resonant vibrational excitation in e-CF₄ scattering
[CF₄, vib, experiment]
DCS at 5.5 and 7.5 eV; DCS(20°, 50°, 90°) vs energy (0.5-12 eV)

92Man2
Low-energy electron scattering from halomethanes: III. e-CF₃Cl
[CF₃Cl, vib, experiment]
DCS at 1.7, 5.5 and 8.2 eV

92Man3
Low-energy electron scattering from halomethanes: IV. e-CF₂Cl₂
[CCl₂F₂, vib, experiment]
DCS (90°) vs energy (0.5-10 eV)

92Mid1
Vibrational excitation in isoelectronic molecules by electron impact: CO and N₂
[CO, N₂, vib, experiment]
For CO, DCS at 20-50 eV; for N₂, DCS at 20, 30 and 50 eV

92Mot1
Vibrational excitation of methylamine by electron impact in the 4.5-30 eV energy range
[CH₃NH₂, vib, experiment]
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92Pfi1
Near-threshold rotational excitation in electron scattering by the HCl molecule
[HCl, rot, theory]
the variational R-matrix calculation with the Born closure; DCS and ICS at 0.5-10 eV; DCS at 1 eV agrees fairly well with experiment

92Thu1
Near-threshold rotational excitation in electron-polar molecule scattering
[HF, rot, theory]
the variational R-matrix method; DCS at 0.63 and 3.0 eV, a fairly good agreement with experiment

93Dav1
Vibrational excitation of ozone by electron impact
[O3, vib, experiment]
DCS at 6 eV

93Dil1
Elastic and vibrationally inelastic cross sections and energy loss spectra for electron collisions with GeH4
[GeH4, vib, theory, experiment]
DCS at 2 eV; DCS (40°, 60°, 90°, 120°) vs energy (1-4 eV)

93Gal1
A lowest-order theory of vibrational excitation of polyatomic molecules upon resonant electron impact. Vibrational excitation in CH3Cl
[CH3Cl, vib, theory]
analysis of resonant excitation; DCS at 3.5 and 5.5 eV

93Gul1
The scattering of low energy electrons from hydrogen sulphide
[H2S, vib, experiment]
DCS at 2 and 3 eV

93Joh1
Electron scattering from vibrationally excited carbon dioxide
[CO2, vib, experiment]
ICS for v=1→2, 1→0 at 4 eV

93Kan1
Total electron scattering and electronic state excitations cross sections for O2, CO, and CH4
[CO, CH4, vib, recommended]
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93Kha1
Differential electron scattering from acetylene - elastic scattering and vibrational excitation
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93Mor1
The importance of bound-free correlation effects for vibrational excitation of molecules by electron impact: a sensitivity analysis
[H2, vib, theory]
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93Res1
An ab initio treatment of near-threshold vibrational excitation of H2 by electron impact: new perspectives on
discrepancies between crossed-beam and swarm data
[H2, vib, theory]
consideration of non-adiabatic effect; ICS at 0.5-7.0 eV, DCS at 1, 2.5 and 5 eV

93Shy1
Vibrational-excitation cross sections of molecular oxygen by electron impact
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ICS and DCS at 5-15 eV

94Abo1
Low energy electron collisions on OCS, differential vibrational cross sections and S' production around 1 eV
[OCS, vib, experiment]
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94Boe1
Elastic and vibrational excitation cross sections for electron collision with propane
[C3H8, vib, experiment]
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94Bon1
Electron impact cross section data for carbon tetrafluoride
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94Dil1
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94Gre1
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FNA with exact-exchange and model-polarization potential; DCS at 6 eV, good agreement with experiment

94Kaz1
On the local theory of resonant inelastic collisions of slow electrons with carbon dioxide
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94Liu1
Electron energy deposition in carbon monoxide gas
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94Lun
Low-energy electron scattering from CH₄, C₂H₄ and C₂H₆
[CH₄, C₂H₄, C₂H₆, vib, experiment]
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94Map
Vibrational excitation of methane by electron impact
[CH₄, vib, experiment]
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94Sch
New experimental techniques in the study of electron swarms in gases and their impact on the determination of low energy electron scattering cross sections
[H₂, vib, experiment]
ICS at 0.5-2.3 eV, from swarm experiment

94Tak
Elastic scattering and vibrational excitation cross sections for electron collisions with C₂F₆
[C₂F₆, vib, experiment]
DCS at 5 eV; also excitation function vs energy (1-16 eV)

94Wea
Completion of a hybrid-theory calculation of the IIg resonance in electron-N₂ scattering
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vibrational CC; DCS at 1.5, 2.05 and 3 eV, good agreement with experiment

95All
Measurement of absolute differential cross sections for vibrational excitation of O₂ by electron impact
[O₂, vib, experiment]
energy-integrated ICS for the resonant excitation

95Alt
Calculation of integral cross sections for vibrationally inelastic electron-methane scattering
[CH₄, vib, theory]
FNA with non-adiabatic correction; ICS at Th-12 eV

95Gia
The Ramsauer minimum of methane
[CH₄, rot, theory]
FNA with exact-exchange interaction and dynamical correlation using the density functional theory; DCS at 0.2, 1.5 and 5.0 eV

95Gia2
Elastic scattering of electrons by methane molecules
[CH₄, rot, theory]
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95Got1
Rotational excitation of diatomic molecules at intermediate energies: absolute differential state-to-state transition
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[N2, CO, Cl2, HCl, rot, experiment]
DCS at 2-200 eV

95Hig1
Low-energy electron scattering by oxygen molecules: II. Vibrational excitation
[O2, vib, theory]
the R-matrix method; resonance cross section below 1 eV

95Joh1
Resonant vibrational excitation of carbon dioxide
[CO2, vib, experiment]
DCS (20°) vs energy (1-7 eV)

95Kut1
Rotational excitation of N2 and Cl2 molecules by electron impact in the energy range 0.01-1000 eV: Investigation of
excitation mechanisms
[N2, Cl2, rot, theory]
FNA with model-exchange and model-polarization potential; ICS at 0.001-1000 eV; rotational rainbow effects
discussed

95Moj1
Electron collisions with NO: elastic scattering and rovibrational (0→1,2,3,4) excitation cross sections
[NO, vib, experiment]
ICS and DCS at 7.5-40 eV

95Nak1
Drift velocity and longitudinal diffusion coefficient of electrons in CO2-Ar mixtures and electron collision cross
sections for CO2 molecules
[CO2, vib, experiment]
ICS at Th-100 eV, from swarm experiment

95Nis1
Electron-impact vibrational excitation of water molecules
[H2O, vib, theory]
FNA with model-exchange and model-polarization potential; ICS and DCS at 6-50 eV, a fairly good agreement with
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95Sun1
Detailed theoretical and experimental analysis of low-energy electron-N2 scattering
[N2, vib, experiment, theory]
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experiment, DCS at resonant peaks

96Boel
Vibrationally inelastic and elastic cross sections for e+NF\textsubscript{3} collisions
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96Borl
Determination of a set of electron impact cross sections in tetrafluoromethane consistent with experimental determination of swarm parameters
[\text{CF\textsubscript{4}, vib, experiment}]
ICS at Th-100 eV, from swarm experiment

96Chri
Electron interactions with CF\textsubscript{4}
[\text{CF\textsubscript{4}, vib, recommended}]
recommended data

96Danl
The separable representation of exchange in electron-molecule scattering: I. Elastic scattering and rotational excitation
[\text{H\textsubscript{2}, rot, theory}]
test of separable exchange model; ICS, 0.05-10 eV, DCS

96Gibl
Low energy electron scattering from CO: absolute cross section measurements and R-matrix calculations
[\text{CO, vib, theory, experiment}]
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96Gri1
Calculation of cross sections for rovibrational excitation of N\textsubscript{2} by electron impact
[N\textsubscript{2}, vib, theory]
the R-matrix method with non-adiabatic correction; ICS at 1.5-3.5 eV

96Horl
Calculation of cross sections for vibrational excitation and dissociative attachment in electron collisions with HBr and DBr
[HBr, vib, theory]
the non-local resonance model; ICS at Th-5 eV

96Kaz1
Calculation of the vibrational excitation cross sections for H\textsubscript{2}, HD, and D\textsubscript{2} molecules in collisions with slow electrons within the framework of nonstationary nonlocal theory
[H\textsubscript{2}, vib, theory]
a model of resonance excitation; ICS at Th-7 eV

96Nag1
Electron impact vibrational excitation cross sections of SiF$_4$

[SiF$_4$, vib, experiment]
ICS at Th-10 eV, from swarm experiment

96Nis1
Vibrationally elastic and inelastic scattering of electrons by hydrogen sulphide molecules

[H$_2$S, vib, theory]
FNO with vibrational CC with model-exchange and model-polarization potential; ICS and DCS at 6-50 eV

96Nob1
Resonant mechanisms in the vibrational excitation of ground state O$_2$

[O$_2$, vib, theory, experiment]
ICS at 4-15 eV; measured values compared with the R-matrix method calculation

96Ran1
Very low energy electron scattering in CO

[CO, rot, experiment]
ICS estimated with the experimental data on the backward cross sections and the Born approximation; 0.001-0.2 eV

96Shi1
Low energy electron scattering from CH$_3$Cl

[CH$_3$Cl, vib, experiment]
DCS at 3.2 and 5.5 eV, also DCS (100°) vs energy (1.5-8 eV)

96Vic1
Large vibrational excitation of N$_2$ by low-energy electrons

[N$_2$, vib, experiment]
ICS for v=0→8,9 at 2-4.5 eV

96You1
Boltzmann equation analysis of electron-molecule collision cross sections in water vapor and ammonia

[H$_2$O, NH$_3$, vib, experiment]
ICS at Th-10 eV, from swarm experiment

97Alv1
On the cross section of low-energy electron collisions on CH$_4$ and CO$_2$

[CO$_2$, CH$_4$, vib, experiment]
ICS at Th-10 eV, from swarm experiment

97Bun1
C. T. Bundschu, J. C. Gibson, R. J. Gulley, M. J. Brunger, S. J. Buckman, N. Sanna and F. A. Gianturco,
Low-energy electron scattering from methane
[CH₄, vib, theory, experiment]

ICS and DCS at 2.5-4 eV

97Chrl
Electron interactions with CCl₂F₂
[CCl₂F₂, vib, recommended]
recommended data

97Gial
Electron scattering from SO₂ molecules: elastic processes and rotational excitations
[SO₂, rot, theory]
FNA with exact-exchange and model-polarization potential; DCS at 1 and 30 eV; ICS at 1-30 eV

97Gia2
Calculation of rotationally inelastic processes in electron collisions with CO₂ molecules
[CO₂, rot, theory]
FNA with separable-exchange and model-polarization potential; DCS and ICS at 2-10 eV

97Majl
New survey of electron impact cross sections for photoelectron and auroral electron energy loss calculations
[N₂, O₂, vib, recommended]
recommended data; for N₂, ICS at 1.3-6 eV; for O₂, ICS at 1-30 eV

97Morl
Ultrasimple calculation of very-low-energy momentum-transfer and rotational-excitation cross sections: e-N₂ scattering
[N₂, rot, theory]
the modified effective range theory to provide cross section very near threshold

97Motl
Vibrational excitation of methane by 15 and 30 eV intermediate-energy electron impact
[CH₄, vib, experiment]
DCS at 15 and 30 eV

97Robl
Rotational and vibrational excitation of nitrogen by electron impact
[N₂, vib, theory]
FNO with vibrational CC; ICS at 0.29-10 eV

97Shil
Low-energy electron collision cross sections of ethane by electron swarm study
[C₂H₆, vib, experiment]
ICS at 0.1-100 eV, from swarm experiment

97Swel
Measurement of absolute differential cross sections for the vibrational excitation of molecular nitrogen by electron impact in the $^2 \Pi_g$ shape resonance region

[N$_2$, vib, experiment]
ICS and DCS at 1.9-2.6 eV (resonance region)

97Var1
Cross sections for rotational excitations of CH$_4$, SiH$_4$, GeH$_4$, SnH$_4$ and PbH$_4$ by electron impact

[CH$_4$, SiH$_4$, GeH$_4$, SnH$_4$, PbH$_4$, rot, theory]
FNA with the Schwinger multichannel variational method with pseudopotential (SMCPP); no polarization considered; DCS and ICS at 7.5-30 eV; DCS for CH$_4$ agrees fairly well with experiment, except in the forward direction

98Bru1
Differential cross sections for rovibrational ($\nu'=0\rightarrow1,2,3,4$) excitation of the electronic ground state of O$_2$ by electron impact

[O$_2$, vib, experiment]
ICS and DCS at 5-20 eV

98Gia1
Low-energy electron scattering from the water molecule: Angular distributions and rotational excitation

[H$_2$O, rot, theory]
FNA with exact-exchange and model-polarization potential; ICS at 2-50 eV; DCS at 2, 6, 30 and 50 eV

98Gia2
Angular distributions and rotational excitations for electron scattering from ozone molecules

[O$_3$, rot, theory]
FNA with exact-exchange and model-polarization potential; ICS at 3-20 eV

98Kim1
Mode dependence in vibrational excitation of CO$_2$ molecule by electron and positron impacts

[CO$_2$, vib, theory, experiment]
ICS at 2-8 eV, theory compared to experiment

98Tak1
Vibrational excitation of carbon dioxide by electron impact: symmetric and antisymmetric stretching modes

[CO$_2$, vib, theory]
FNO with vibrational CC; ICS and DCS at 4-50 eV

99Bor1
Boltzmann analysis of electron swarm parameters in CF$_4$ using independently assessed electron-collision cross sections

[CF$_4$, vib, experiment]
ICS at Th-100 eV, from swarm experiment

99Chr1
Electron interactions with Cl₂
[Cl₂, vib, recommended]

99Dai1
Electron energy deposition in a gas mixture of atomic and molecular hydrogen and helium
[H₂, vib, selected]
selected data

99Joh1
Differential electron scattering from the (010) excited vibrational mode of CO₂
[CO₂, vib, experiment]
excitation from the excited state; DCS at 3.8 eV

99Maz1
Inclusion of nonadiabatic effects in calculations on vibrational excitation of molecular hydrogen by low-energy electron impact
[H₂, vib, theory]
correction of non-adiabatic effect; ICS and DCS at 0.6-8 eV

99Maz2
Adiabatic treatments of vibrational dynamics in low-energy electron-molecule scattering
[H₂, vib, theory]
the energy-modified adiabatic phase matrix method; ICS and DCS at 0.5-10 eV

99Nat1
Elastic and rotationally inelastic cross sections for low-energy electron scattering by SO₂ molecules
[SO₂, rot, theory]
FNA and the Schwinger multichannel variational method with pseudopotential (SMCPP); no polarization taken considered; DCS and ICS at 5-30 eV; some disagreement with 97Gia1

99Shi1
Electron collisions with HCl: elastic scattering and rotational excitation
[HCl, rot, theory]
FNA with model-exchange and model-polarization potential; DCS at 5-30 eV, a fairly good agreement with experiment; ICS at 5-50 eV

99Tak1
Theoretical study of electron scattering from carbon dioxide: excitation of bending vibration
[CO₂, vib, theory]
FNO with vibrational CC; ICS and DCS at 2-50 eV

99Tan1
Total cross sections of electron and positron collisions with C₃F₈ and C₃H₈ molecules and differential elastic and vibrational excitation cross sections by electron impact on these molecules
[C₃F₈, C₃H₈, vib, theory, experiment]
DCS at 3, 6.5 and 9 eV

99Var1
Low-energy electron scattering by CF₄, CCl₄, SiCl₄, SiBr₄, and SiI₄
[CF₄, CCl₄, SiCl₄, SiBr₄, SiI₄, rot, theory]
FNA and the Schwinger multichannel variational method with pseudopotential (SMCPP); DCS and ICS at 7.5-30 eV

99Var2
Cross sections for rotational excitations of NH₃, PH₃, AsH₃, and SbH₃ by electron impact
[NH₃, PH₃, AsH₃, SbH₃, rot, theory]
FNA and the Schwinger multichannel variational method with pseudopotential (SMCPP); DCS and ICS at 7.5-30 eV; for NH₃, not much difference from 91Gia2

00Chr1
Electron interactions with SF₆
[SF₆, vib, recommended]
recommended data

00Elz1
Resonance phenomena in electron impact excitation of the fundamental vibrational modes of water
[H₂O, vib, experiment]
DCS at 7.5 eV

00Elz2
Excitation of vibrational quanta in water by electron impact
[H₂O, vib, experiment]
ICS and DCS at 6-20 eV

00Kaw1
Vibrational excitation of carbon oxysulfide molecules by positron and electron impacts
[OCS, vib, experiment, theory]
ICS at 1-8 eV; experimental data compared with the continuum multiple-scattering (CMS) calculation

00Kit1
Electron scattering from N₂O: absolute elastic scattering and vibrational excitation
[N₂O, vib, experiment]
ICS and DCS at 2.4 and 8.0 eV

00Kit2
Strong mode dependence of the 3.8-eV resonance in CO₂ vibrational excitation by electron impact
[CO₂, vib, theory, experiment]
ICS and DCS at 2-6 eV; experimental data compared with theory

00Map1
Vibrational excitation of ethane and ethene by electron impact
[C$_2$H$_4$, C$_2$H$_6$, vib, experiment]  
DCS at 3.2-15.4 eV

00Ser1  
Excitation of vibrational levels of HI up to v=8 by electron impact  
[H, vib, experiment]  
ICS (relativo) at Th-3 eV

00Ser2  
Excitation of vibrational levels of HF up to v=4 by electron impact  
[HF, vib, experiment]  
ICS (relative) near Th

00Zub1  
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[N$_2$, vib, experiment]  
DCS at 5 eV
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