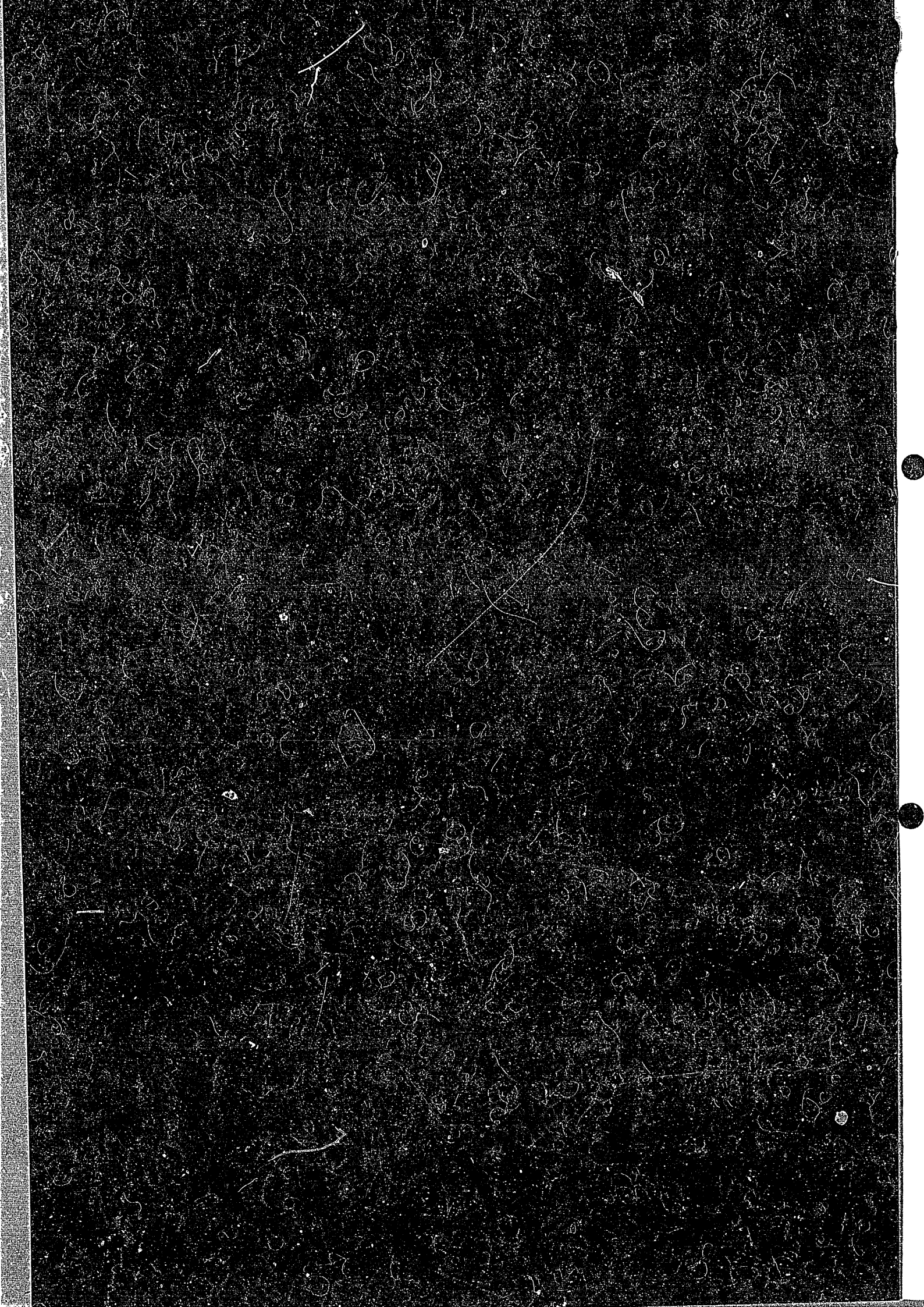# BIBLIOGRAPHY OF ELECTRON TRANSFER IN ION-ATOM COLLISIONS

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BIBLIOGRAPHY OF ELECTRON TRANSFER IN ION-ATOM COLLISIONS

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June 1986

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Abstract

    A bibliographic compilation is given of theoretical and experimental

investigations on electron transfer involving multiply charged ions with the

emphasis on their final state (n, ℓ) distributions. The references are

surveyed up to mid-1986. Each reference is accompanied with a short

description of the collision partners, their charge states, their energy

range and some important results.

Contents

Introduction

The charge transfer processes are attracting not only a number of atomic physicists because of the interest in basic research but also those in other fields such as astrophysics, accelerator development and fusion research because of a variety of their possible applications[1]. As one of the immediate applications of charge transfer, for example, the electron transfer processes involving hydrogen ions and atoms play a key role in production of intense neutral beam for heating plasmas in fusion research[2], [3].

More recently, multiply charged ions, present copiously in plasmas, have been found to play a crucial role in achieving high temperature plasmas for realization of nuclear fusion because the radiation loss from these multiply charged ions through electron capture followed by decay into the ground state with light emission becomes considerable amount of the input energy. Thus, total electron transfer cross sections have to be known to estimate the energy loss through such radiations[4]. It is now well known that the electron capture into multiply charged ions at low energies usually occurs into relatively highly excited states[1].

These radiations can also be used for diagnosing and monitoring the distribution of impurity ions in plasmas and for modelling and understanding the overall behavior of high temperature plasmas. For such purposes, it is prerequisite to have more detailed information of the final state distributions, so called (n, ℓ) distributions, in the electron-captured ions.

Some aspects on the (n, ℓ) distributions of multiply charged ions in charge transfer have been reviewed by Janev and Winter[5].

This bibliography is intended to supply more new information on the

investigations of electron transfer, in particular relevant to the (n, ℓ) distributions of the electron-captured multiply charged ions. In each reference, a short description is given on important parameters such as the collision partners, their charge states before and after electron transfer, the energy range, and some important results. To cover other references on the charge transfer, we include a copy of references appeared in our previous compilations[3, 4]. Only a few important references published before 1975 are listed in this bibliography.

Following this bibliography, we plan to compile theoretical and experimental numerical data on the (n, ℓ) distributions in electron transfer involving typical impurity ions, C^{q+} and O^{q+} ions in plasmas.

The authors would like to thank Dr. S. Ohtani and Dr. T. Kato for their useful suggestions and comments. Dr. T. Kato also helped computer-programming for bibliography and Miss M. Ohnishi made a list of the present bibliography. Their contribution was essential for the present compilation. During the course of compiling data, Oak Ridge National Laboratory Bibliographic Database and IAEA International Bulletin of Atomic and Molecular Data for Fusion were quite helpful in finding the references.

References

1. R.K. Janev, L.P. Presnyakov and V.P. Shevelko, Physics of Highly Charged Ions (Springer Verlag, 1985).

2. H. Tawara and A. Russek, Rev. Mod. Phys. 45 (1973) 178.

3. H. Tawara, Atomic Data and Nucl. Data Tables 22 (1978) 491.

4. H. Tawara, T. Kato and Y. Nakai, Atomic Data and Nucl. Data Tables 32 (1985) 235.

5. R.K. Janev and H. Winter, Phys. Reports 117 (1985) 265.

List of references of review papers

76R 1   Salzborn,E.
IEEE NS-23 (1976) 947-958
Charge exchange cross sections

78R 1   Basu,D. Mukherjee,S.C. Sural,D.P.
Phys. Reports 42 (1978) 145-234
Electron capture processes in ion-atom collisions

78R 2   Presnyakov,L.P.
Electronic and Atomic Collisions (ed. G.Watel, North-Holland)
(1978) 407-430
Charge exchange of highly charged ions in neutral atoms

79R 1   Belkic,Dz. Gayet,R. Salin,A.
Phys. Reports 56 (1979) 279-369
Electron capture in high-energy ion-atom collisions

79R 2   Shakeshaft,R. Spruch,L.
Rev. Mod. Phys. 51 (1979) 369-405
Mechanisms for charge transfer (or for the capture of any light
particle) at asymmetrically high impact velocities

81R 1   Janev,R.K. Presnyakov,L.P.
Phys. Reports 70 (1981) 1-107
Collision processes of multiply charged ions with atoms

82R 1   Barat,M.
Atomic Physics of Highly Ionized Atoms (ed. R.Marrus, Plenum Press)
(1982)
Charge exchange processes involving multicharged ions; the
quasi-molecular approach

82R 2   Briggs,J.S. Macek,J. Taulbjerg,K.
Comments At. Mol. Phys. 12 (1982) 1-17
Theory of asymmetric electron capture collisions

82R 3   Greenland,P.T.
Phys. Reports 81 (1982) 131
Electron capture by highly stripped ions

82R 4   Winter,H.
Comm. .At. Mol. Phys. 12 (1982) 165-195
Excitation of multiply charged ions by electron capture from lithium
and applications for plasma impurity ion transport studies

83R 1   de Heer,F.J.
Atomic and Molecular Physics of Controlled Thermonuclear Fusion
(ed. C.J.Joachain and D.E.Post, Plenum) (1983)
Experiments on electron capture and ionization by multiply charged ions

83R 2   Gallagher,J.W. Bransden,B.H. Janev,R.K.
J. Phys. Chem. Ref. Data 12 (1983) 873-890
Evaluated theoretical cross section data for charge exchange of
multiply charged ions with atoms.II. hydrogen atom-partially stripped
ion systems

83R 3   Janev,R.K. Hvelplund,P.
Comm. At. Mol. Phys. 12 (1983) 277-300
Electron capture into excited states in collisions of highly charged
ions with atoms; A theoretical and experimental challenge

83R 4   Janev,R.K. Bransden,B.H. Gallagher,J.W.
         J. Phys. Chem. Ref. Data 12 (1983) 829-872
         Evaluated theoretical cross section data for charge exchange of
         multiply charged ions with atoms. I. hydrogen atom-fully stripped ion
         systems

84R 1   Fritsch,W. Lin,C.D.
         Electronic and Atomic Collisions (ed. J.Eichler, J.V.Hertel and
         'N.Stolterfoht, North-Holland) (1984) 331-342
         Description of electronic processes in ion-atom collisions with
         two-center atomic orbital

84R 2   Janev,R.K. Gallagher,J.W.
         'J. Phys. Chem. Ref. Data 13 (1984) 1199-1249
         Evaluated theoretical cross section data for charge exchange of
         multiply charged ions with atoms II. non-hydrogenic target atoms

84R 3   Macek,J.
         Electronic and Atomic Collisions (ed. J.Eichler, I.V.Hertel and
         N.Stolterfoht, North-Holland) (1984) 317-330
         Review of electron capture in ion-atom collisions

85R 1   Barat,M.
         Nucl. Instr. Meth. in Phys. Res. B 9 (1985) 364-367
         Electron capture by low energy multicharged ions

85R 2   Janev,R.K. Winter,H.
         Phys. Reports 117 (1985) 265-387
         State-selected electron capture in atom-highly charged ion collisions

85R 3   Morgan,T.J. Olson,R.E. Schlachter,A.S. Gallagher,J.W.
         J. Phys. Chem. Ref. Data 14 (1985) 971-1040
         Charge transfer of hydrogen ions and atoms in metal vapors

List of references of experiments

68E 1   Belyaev,V.A. Brezhnev,B.G. Erostov,E.M.
Sov. Phys.-JETP 27 (1968) 924-926
Resonant charge transfer of low-energy carbon and nitrogen ions
$C^+ + C \rightarrow C + C^+; N^+ + N \rightarrow N + N^+$
merging beam technique
$6 \times 10^{-4} - 8 \times 10^{-3}$ keV/amu
total cross sections

69E 1   Lockwood,G.J.
Phys. Rev 187 (1969) 161-166
Charge transfer cross sections for H^+, Li^+ and Na^+ on N_2
$A^+ + N_2 \rightarrow A^0$ (A = H, Li, Na)
growth
0.2 - 100 keV/amu
total cross sections

70E 1   Cobic,B. Vujovic,M. Matic,M.
J. Phys. B 3 (1970) 660-666
A study of charge-changing collisions involving Mg^+, Fe^+ and Cu^+
in the energy range 5-30 keV
$A^+ + Ne, Kr, N_2 \rightarrow A^{2+}, A, A^-$ (A = Mg, Fe, Cu)
growth
0.08 - 1.25 keV/amu

70E 2   Lockwood,G.J.
Phys. Rev. A 2 (1970) 1406-1410
Total cross sections for charge transfer of noble-gas ions in N_2
$A^+ + N_2 \rightarrow A^0$ (A = He, Ne, Ar, Kr, Xe)
growth
0.07 - 20 keV/amu

70E 3   Winter,G.J.M. Bieman,D.J. van der Weg,W.F.
Phys. Letters 31A (1970) 170-171
Electron capture by multiply charged ions
$Ne^{q+} + Ar \rightarrow Ne^{(q-1)+}, Ne^{(q-2)+}$ (q=1-4)
growth + fitting
3 keV/amu

70E 4   Zwally,H.J. Koopman,D.W.
Phys. Rev. A 2 (1970) 1851-1861
Single-electron capture by C^{4+} in helium, neon and argon below 40 keV
$C^{4+} + He, Ne, Ar \rightarrow C^{3+}$
growth
0.03 - 3.3 keV/amu
total cross sections; spark source

71E 1   Zwally,H.J. Cable,P.G.
Phys. Rev. A 4 (1971) 2301-2304
Comparison of the Landau-Zener theory with measurements of electron
capture in $B^{3+} + He$ collisions
$B^{3+} + He \rightarrow B^{2+}(nl) + He^+$
E. energy-loss/gain, T. LZ
$3 \times 10^{-2} - 0.46$ keV/amu
total cross sections measured

73E 1   Kienle,P. Kleber,M. Povh,B. Diamond,R.M. Stephens,F.S. Grosse,E.
Maier,M.R. Proetel,D.
Phys. Rev. Letters 31 (1973) 1099-1102
Radiative capture and bremsstrahlung of bound electrons induced by
heavy ions
$A^{z+} + B \rightarrow A^{(z-1)+}(1s) + h\nu + B^+$ (A = N, Ne, Ar; B = He, Ne)

x-ray spectroscopy
7.2×10^3 - 1.8×10^4 keV/amu

73E 2   Lockwood,G.J.
Phys. Rev. A 7 (1973) 125-129
Total cross sections for charge transfer and stripping of Al, Cr and Er
ions in He and N_2
Al^+, Cr^+, Er^+, Er^{2+} + He, N_2 -> Al^0, Cr^0, Er^0, Er^{2+}, Er^+
growth
0.12 - 3.6 keV/amu
total cross section

74E 1   Macdonald,J.R. Cocke,C.L. Eidson,W.W.
-Phys. Rev. Letters 32 (1974) 648-651
Capture of argon K-shell electrons by 2.5 to 12 MeV protons
H^+ + Ar -> H^0 + $Ar^+(1s^{-1})$
x-ray coincidence
2500 - 12000 keV/amu

74E 2   Meyer,F.W. Anderson,L.W.
Phys. Rev. A 9 (1974) 1909-1915
Charge-exchange cross sections for Ne^+ and Ar^+ incident on Cs
Ne^+, Ar^+ + Cs -> Ne^0, Ar^0
growth
0.09 - 2.0 keV/amu

75E 1   Afrosimov,V.V. Leiko,G.A. Manaev,Yu.A. Panov,M.N.
Sov. Phys.-JETP 40 (1975) 661-666
Elementary processes of variation of particle charge states in He^{2+} -
He interaction
He^{2+} + He -> He^0 + He^{2+}; He^+ + He^+; He^{2+} + He^+ + e;
He^{2+} + He^{2+} + 2e; He^+ + He^{2+} + e
coincidence technique
0.25 - 25 keV/amu

75E 2   Bayfield,J.E. Khayrallah,G.A.
Phys. Rev. A 12 (1975) 869-875
Electron transfer in keV-energy $^4He^{++}$ collisions. III. Experimental
tests of the close-coupling calculations for $^4He^{++}$ - H(1s)
collisions
He^{2+} + H -> $He^+(2s)$ + H^+
Energy-loss/gain + field-quenching
1.75 - 36 keV/amu

75E 3   Chen,Y.H. Johnson,R.E. Humphris,R.R. Siegel,M.W. Boring,J.W.
J. Phys. B 8 (1975) 1527-1543
Differential scattering of He^{2+} from He
He^{2+} + He -> He^{2+} + He, He^+ + He^+
Translational energy method
5×10^{-2} - 1.5×10^{-1} keV/amu

75E 4   Klinger,H. Muller,A. Salzborn,E.
J. Phys. B 8 (1975) 230-238
Electron capture processes of multiply charged argon ions in argon at
energies from 10 to 90 keV
Ar^{q+} + Ar -> $A^{(q-i)+}$ (q=2-7; i=1-4)
growth method
0.25 - 2.25 keV/amu

75E 5   Meyer,F.W. Anderson,L.W.
Phys. Rev. A 11 (1975) 586-588

Charge-exchange cross sections for Kr^+ and Xe^+ incident on Cs
Kr^+, Xe^+ + Cs -> Kr^0, Xe^0
growth
0.012 - 0.34 keV/amu

75E 6   Muller,A. Klinger,H. Salzborn,E.
Phys. Letters 55A (1975) 11-12
Multiple-electron transfer to highly charged noble gas ions in single ion-atom collisions
Ar^{6+} + Ne, N_2, Ar, Kr, Xe -> Ar^{2+}
0.2 - 1.8 keV/amu

76E 1   Crandall,D.H. Olson,R.E. Shipsey,E.J. Browne,J.C.
Phys. Rev. Letters 36 (1976) 858-860
Single and double charge transfer in C^{4+} - He collisions
C^{4+} + He -> C^{3+}, C^{2+}
E. growth; T. MO
0.21 - 7.5 keV/amu

76E 2   Eisele,F.L. Nagy,S.W.
J. Chem. Phys. 65 (1976) 752-756
Attenuation and single electron charge-exchange cross sections of He^+ on He in the energy range 500 - 5000 eV
He^+ + He -> He^0
attenuation + condenser plate technique
0.125 - 1.25 keV/amu
total attenuation and charge changing cross section

76E 3   Goldbar,J. Mariella,R. Javan,A.
Appl. Phys. Letters 29 (1976) 96-98
Observation of one- and two-electron transfer from noble-gas atom to highly stripped carbon ions
C^{q+} + He, Ne, Ar -> $C^{(q-1)+}$, $C^{(q-2)+}$ (q=3-5)
growth
laser source

76E 4   Hird,B. Suk,H.C.
Phys. Rev. A 14 (1976) 928-936
Single-electron stripping cross sections of N_1^+ in Ne, Ar and Kr between 35 and 140 keV
N^+ + Ne, Ar, Kr -> N^0
2.5 - 10 keV/amu
total cross sections

76E 5   Hvelplund,P.
J. Phys. B 9 (1976) 1555-1565
Electron capture and loss by ground state and metastable Li^+ in helium and argon targets
$Li^+(1s^2)$ + He, Ar -> Li^0, $Li^{+*}(1s2s)$ + He, Ar -> $Li^+(1s^2)$; Li^{0*}
growth + attenuation methods
5.7 - 12.9 keV/amu
effect of metastable states

76E 6   Klinger,H. Muller,A. Salzborn,E.
J. Chem. Phys. 65 (1976) 3427-3430
Electron capture cross sections for multiply charge argon ions passing through nitrogen and krypton targets at energies from 10 to 110 keV
Ar^{q+} + N_2, Kr -> $Ar^{(q-i)+}$ (q=2-7 ; i=1-4)
0.25 - 2.75 keV/amu

76E 7   Latypov,Z.Z. Shaporenko,A.A.

Sov. Phys.-JETP 42 (1976) 986-988
Ionization and capture of electrons in collisions of Na^+ ions with Ne
atoms
$Na^+ + Ne \rightarrow Na + Ne^+$, $Na^+ + Ne^+ + e$
growth
0 - 0.02 keV/amu
total cross sections

76E 8 , Lindskog,J. Phil,J. Sjodin,R. Marelius,A. Sharma,K. Hallin,R.
Phys. Scripta 14 (1976) 100-104
Radiative electron capture by multiply ionized, chlorine atoms
$Cl^{q+} + C \rightarrow Cl^{(q-1)+}(1s) + h\nu + C^+$
x-ray spectroscopy
- 857-1714 keV/amu
solid target, angular distribution, energy shift

76E 9 Muller,A. Klinger,H. Salzborn,E.
J. Phys. B 9 (1976) 291-293
Role of metastable argon ions in Ar^{i+} + Ar charge-exchange collisions
$Ar^{2+} + Ar \rightarrow Ar^+$; $Ar^+ + Ar \rightarrow Ar^{2+}$
0.53, 0.9 keV/amu
effect of metastable beams

76E10 Muller,A. Salzborn,E.
Phys. Letters 59A (1976) 19-20
Single and double electron transfer in Ar^{i+} - He collisions
$Ar^{q+} + He \rightarrow Ar^{(q-i)+}$ (q=3-8 ; i=1,2)
0.075-1.75 keV/amu

76E11 Shah,M.B. Gilbody,H.B.
J. Phys. B 9 (1976) 1933-1941
Redetermination of cross sections for formation of metastable $He^+(2s)$
ions in fast collisions using an improved calibration procedure
$He^{2+} + B \rightarrow He^+(2s)$ (B = H, H_2, He, N_2, O_2, Ar Kr, K);
$He^+(1s) + B \rightarrow H^+(2s)$ (B = H_2, He, N_2, O_2, Ar, Kr)
ion chamber
3.3 - 20 keV/amu (He^{2+}); 2 - 10 keV/amu (He^+)

76E12 Shah,M.B. Gilbody,H.B.
J. Phys. B 9 (1976) 2685-2692
Electron capture, loss and de-excitation in collisions involving fast
metastable $He^+(2s)$ ions
$He^+(2s) + B \rightarrow He^0$, He^{2+} (B = H_2, He, N_2, O_2, Ar, Kr)
5 - 18.3 keV/amu

76E13 Sohval,A.R. Delvaille,J.P. Kalata,K. Kirby-Docken,K. Schnopper,H.W.
J. Phys. B 9 (1976) L25-29
Model for radiative electron capture: an interpretation of the line
width
$O^{8+} + B \rightarrow O^{7+}(1s) + h\nu + B^+$ (B = H_2, He, N_2, O_2, C_3H_8)
x-ray spectroscopy
1875 - 4062 keV/amu
line width

76E14 Sohval,A.R. Delvaille,J.P. Kalata,K. Schnopper,H.W.
J. Phys. B 9 (1976) L47-51
Cross section ratio for radiative electron capture to inner and outer
atomic shells
$O^{8+} + B \rightarrow O^{7+}(1s) + h\nu + B^+$ (B = H_2, N_2, He, O_2, C_3H_8)
x-ray spectroscopy
1875 - 4062 keV/amu

77E 1 Cocke,C.L. Gardner,R.K. Curnutte,B. Bratton,T. Saylor,T.K.
Phys. Rev. A 16 (1977) 2248-2255
K-shell capture by protons from O_2, N_2 and Ne
$H^+ + B \rightarrow H^0 + B^+(1s^{-1})$ (B = N, O, Ne)
Auger electron spectroscopy
750 - 5000 keV/amu

77E 2 Crandall,D.H.
Phys. Rev. A 16 (1977) 958-963
Electron transfer between He-like ions and He
B^{3+}, C^{4+}, N^{5+}, O^{6+} + He $\rightarrow$ B^{2+}, B^{1+}, C^{3+}, C^{2+}, N^{4+}, N^{3+}. O^{5+}, O^{4+}
growth
1.3 - 7.5 keV/amu
H-oven

77E 3 Eisele,F.L. Nagy,S.W.
J. Chem. Phys. 66 (1977) 883-885
Attenuation and single electron charge-exchange cross sections of He^+
on Ne and Ar in the 500 - 5000 eV energy range
$He^+ + Ne, Ar \rightarrow He^0$
attenuation + parallel plate technique
0.125 - 1.25 keV/amu
total attenuation and charge changing cross section

77E 4 Guffey,J.A. Ellsworth,L.D. Macdonald,J.R.
Phys. Rev. A 15 (1977) 1863-1870
X-ray cross sections in helium for electron capture to excited states
by bare nuclei with $5 \leq z_1 \leq 9$
B^{5+}, C^{6+}, N^{7+}, O^{8+}, F^{9+} + He $\rightarrow$ B^{4+}, C^{5+}, N^{6+}, O^{7+}, F^{8+} + He^+
x-ray spectroscopy
250 - 2300 keV/amu

77E 5 Meyer,F.W. Anderson,C.J. Anderson,L.W.
Phys. Rev. A 15 (1977) 455-462
Total charge-transfer cross sections for H^+, H_2^+, H_3^+, He^+,
N^+, N_2^+, Ne^+, Ar^+, Kr^+ and Xe^+ incident on Cs
$A^+ + Cs \rightarrow A^0$ (A = H, H_2, H_3, He, N, N_2, Ne, Ar, Kr, Xe)
0.23 - 160 keV/amu

77E 6 Muller,A. Salzborn,E.
Phys. Letters 62A (1977) 391-394
Scaling of cross sections for multiple electron transfer to highly
charged ions colliding with atoms and molecules
< 25 keV/amu
scaling law

77E 7 Schuch,R. Schmidt-Bocking,H. Tserruya,I.
J. Phys. B 10 (1977) 889-898
Radiative electron capture by ^{32}S ions
$S^{q+} + B \rightarrow S^{(q-1)+} + h\nu + B^+$ (B = Be, C, Ni)
x-ray spectroscopy
156-3594 keV/amu
solid targets; angular distribution; energy shift; width

77E 8 Spindler,E. Betz,H.D. Bell,F.
J. Phys. B 10 (1977) L561-564
Radiative electron capture and momentum distributions of target
electrons
$Cu^{q+} + Al \rightarrow Cu^{(q-1)+} + h\nu + Al^+$
x-ray spectroscopy

7031 keV/amu

77E 9   Suk,H.C. Guilband,A. Hird,B.
         Can. J. Phys. 55 (1977) 1594-1600
         Single electron capture by Ar^{2+} in Ne, Ar and Kr gases
         Ar^{2+} + Ne, Ar, Kr -> Ar^+
         growth
         1.27 - 4.8 keV/amu

77E10   Winter,H. Bloemen,E. de Heer,F.J.
         J. Phys. B 10 (1977) L453-457
         Electron capture into excited projectile states in collisions of 100
         keV Ne^{z+} (z=1,2,3,4) with He, H_2 and Ar
         Ne^{q+} + He -> $Ne^{(q-1)+}$ + He^+ (q=1-4)
         Photon emission spectroscopy
         5 keV/amu

77E11   Winter,H. Bloemen,E. de Heer,F.J.
         J. Phys. B 10 (1977) L599-605
         VUV radiation, slow ions and electrons produced in collisions of
         multiply charged Ne ions with He and Ar
         Ne^{q+} + He -> $Ne^{(q-1)+}$ + He^+ (q=1-4)
         Photon emission spectroscopy
         1.24 - 39.6 keV/amu

78E 1   Afrosimov,V.V. Basalaev,A.A. Panov,M.N. Leiko,G.A.
         JETP Letters 26 (1978) 537-539
         Electron capture in different electronic states by multiply charged
         Ar^{z+} ions in He atoms
         Ar^{q+} + He -> $Ar^{(q-1)+}$ + He^+ (q=3-7); Ar^{6+} + He -> Ar^{5+}(nl);
         Ar^{3+} + He -> Ar^{2+}(nl)
         energy gain spectroscopy
         0.1 - 0.5 keV/amu
         total one-electron capture cross sections; partial cross sections for
         Ar^{6+} and Ar^{3+}

78E 2   Berkner,K.H. Graham,W.G. Pyle,R.V. Schlachter,A.S. Stearns,J.W.
         Olson,R.E.
         J. Phys. B 11 (1978) 875-885
         Electron capture and impact ionization cross sections for partially
         stripped iron ions colliding with atomic and molecular hydrogen
         Fe^{q+}(q=9-25) + H, H_2 -> $Fe^{(q-1)+}$
         E. growth; T. CTMC method
         50 - 1200 keV/amu
         total cross sections

78E 3   Hinds,E.A. Novick,R.
         J. Phys. B 11 (1978) 2201-2207
         Precise resonant charge-transfer cross sections for He - He^+ between
         2 and 100 eV
         He^+ + He -> He + He^+
         attenuation method
         5×10^{-4} - 2.5×10^{-2} keV/amu
         total cross sections

78E 4   Maier,II.W.B. Stewart,B.
         J. Chem. Phys. 68 (1978) 4228-4232
         Electron transfer in collisions of doubly charged atomic ions with
         rare-gas atoms for primary-ion energies below 100 eV
         N^{2+}, O^{2+}, Ar^{2+}, Ar^{3+} + He -> N^+, O^+, Ar^+, Ar^{2+};
         He^{2+}, Ne^{2+}, Ar^{2+} + Ne -> He^+, Ne^+, Ar^+;

Ne^{2+}, Ar^+ + Ar -> Ne^+, Ar^+; Ar^{2+} + Kr -> Ar^+
$1x10^{-3}$ keV/amu
total cross sections

78E 5   Nutt,W.L. McCullough,R.W. Brady,K. Shah,M.B. Gilbody,H.B.
         J. Phys. B 11 (1978) 1457-1462
         Electron capture by He^{2+} ions in collisions with H and H_2 at impact
         energies below 10 keV
             He^{2+} + H, H_2 -> $He^+(\Sigma nl)$ + H^+, H_2^+
             furnace-target technique
             0.1 - 2.5 keV/amu

78E 6   Okuno,K. Koizumi,T. Kaneko,Y.
         Phys. Rev. Letters 40 (1978) 1708-1710
         Symmetric resonance double charge transfer in Kr^{2+} + Kr and
         Xe^{2+} + Xe systems
             A^{2+} + A -> A + A^{2+} (A = Kr, Xe)
             drift tube technique
             $5x10^{-7}$ - $2x10^{-4}$ keV/amu
             total cross section

78E 7   Pedersen,E.H. Mikkelsen,J.V. Vaaben,J. Taulbjerg,K.
         Phys. Rev. Letters 41 (1978) 1541-1544
         Interference effect in resonant double-charge transfer
             Mg^+; Mg^{2+} + Mg -> Mg; Mg^+, Mg^0
             E. growth; T. LZ
             0.05 - 42 keV/amu

78E 8   Shah,M.B. Gilbody,H.B.
         J. Phys. B 11 (1978) 121-131
         Electron capture and $He^+(2s)$ formation in fast He^{2+} - H and
         He^+ + H collisions
             He^{2+} + H, H_2 -> $He^+(2s,\Sigma nl)$ + H^+, H_2^+;
             He^+ + H -> $He^+(2s)$ + $H(\Sigma)$
             Photon emission spectroscopy + field-qunching
             1 - 100 keV/amu

78E 9   Suk,H.C. Guilband,A. Hird,B.
         J. Phys. B 11 (1978) 1463-1474
         Cross sections for electron capture by Ne^{2+} in He, Ne, Ar, Kr and Xe
             Ne^{2+} + He, Ne, Ar, Kr, Xe -> Ne^+
             2 - 10 keV/amu
             total cross section

78E10   Tanis,J.A. Shafroth,S.M.
         Phys. Rev. Letters 40 (1978) 1174-1177
         Target thickness dependence of radiative electron capture in heavy ion
         collisions
             Cl^{q+} + Cu -> $Cl^{(q-1)+}$ + $h\nu$ + Cu^+
             x-ray spectroscopy
             2285 keV/amu

78E11   Tawara,H. Richard,P. Gray,T.J. Newcomb,J. Jamison,K.A. Schmiedekamp,C.
         Hall,J.M.
         Phys. Rev. A 18 (1978) 1373-1380 ·
         Si K-shell ionization and electron transfer cross sections; solid targets
             F^{9+} + Si -> $F^{8+}(1s)$ + $Si^+(1s^{-1})$
             x-ray measurement
             400 - 2200 keV/amu

78E12   Tawara,H. Richard,P. Jamison,K.A. Gray,T.J.

J. Phys. B 11 (1978) L615-620
Experimental differentiation between electron excitation and electron capture by one electron (F^{8+}) ions in He
$$F^{8+} + He \rightarrow F^{7+} + He^{*}(1s)$$
x-ray spectroscopy
395 - 1840 keV/amu

78E13   Winter,H. El-Sherbini,Th.M. Bloemen,E. de Heer,F.J. Salop,A.
Phys. Letters 68A (1978) 211-214
A comparison between radiative and non-radiative de-excitation after electron capture by multiply charged ions
Ne^{q+} (q=1-4), Ar^{q+}(q=1-8) + B -> $Ne^{(q-1)+}$, $Ar^{(q-1)+}$
(B = He, Ne, Ar, Kr, Xe)
photon spectroscopy
5 keV/amu

79E 1   Adams,N.G. Smith,D. Grief,D.
J. Phys. B 12 (1979) 791-800
Single charge transfer reactions of the ground and metastable states of Xe^{2+} at 300 K
$Xe^{2+}(^3P, {}^1D_2, {}^1S_0)$ + B -> Xe^+ (B = H_2, N_2, O_2, CO_2, Ar, Xe)
selected ion drift tube technique
3×10^{-5} keV/amu
rate coefficient

79E 2   Beuhler,R.J. Friedman,L. Porter,R.F.
Phys. Rev. A 19 (1979) 486-494
Electron-transfer reactions of fast Xe^{n+} ions with Xe in the energy range 15 keV to 1.6 MeV
Xe^{q+} + Xe -> $Xe^{(q-1)+}$, $Xe^{(q-2)+}$, $Xe^{(q-3)+}$, $Xe^{(q-4)+}$, $Xe^{(q+1)+}$
growth
0.38 - 1.5 keV/amu

79E 3   Dowek,D. Krutein,J. Thielmann,V. Barat,M.
J. Phys. B 12 (1979) 2553-2563
Collision spectroscopy of open-shell systems I. C^+ - Ne collisions
$$C^+ + Ne \rightarrow C^0$$
energy loss spectroscopy
0.04 - 0.17 keV/amu
no absolute cross section

79E 4   El-Sherbini,T.M. Salop,A. Bloemen,E. de Heer,F.J.
J. Phys. B 12 (1979) L579-582
Target dependence of excitation resulting from electron capture in collisions of 200 keV Ar^{6+} ions with noble gases
Ar^{6+} + He, Ne, Ar, Kr, Xe -> Ar^{5+} + He^+, Ne^+, Ar^+, Kr^+, Xe^+
photon emission spectroscopy
5 keV/amu

79E 5   Gray,T.J. Richard,P. Gealy,G. Newcomb,J. Tawara,H.
IEEE NS-26 (1979) 1127-1129
X-ray production and electron transfer cross sections for 0.4 - 2.2 MeV/amu N, O, and F ions on Al
A^{z+} + Al -> $A^{(z-1)+}$ + $Al^*(1s^{-1})$
x-ray spectroscopy
400 - 2200 keV/amu

79E 6   Hill,J. Geddes,J. Gilbody,H.B.
J. Phys. B 12 (1979) L653-656
H^- formation in electron capture by 4 - 25 keV metastable hydrogen atoms in the inert gases

$H(2s) + B \rightarrow H^- + B^+$ (B = He, Ne, Ar, Kr)
growth
4 - 25 keV/amu

79E 7   Johnsen,R. Biondi,M.A.
Phys. Rev. A 20 (1979) 87-97
Thermal energy charge transfer quenching and association reactions of doubly charged ions in the rare gases
$A^{2+} + B \rightarrow A^+ + B^+$ (A, B = He, Ne, Ar, Kr, Xe)
drift tube mass-spectrometer
10^{-5} keV/amu
rate coefficient

79E 8   Jones,J.D.C. Lister,D.G. Twiddy,N.D.
J. Phys. B 12 (1979) 2723-2726
Charge transfer reaction rate coefficients for He^+ and Ne^+ with Ar at 300 K
He^+, Ne^+ + Ar $\rightarrow$ He^0, Ne^0 + Ar
selected-ion-flow tube technique
1×10^{-5} keV/amu
rate coefficient

79E 9   Kita,S. Inoue,H.
J. Phys. B 12 (1979) 2338-2349
Charge exchange reactions in collisions of Li^+ - Li
$Li^+ + Li(2s) \rightarrow Li(2s, 2p) + Li^+$
TOF spectroscopy
0.07 - 0.14 keV/amu

79E10   Loyd,D.H. Dawson,H.R.
Phys. Rev. A 19 (1979) 948-951
Electron capture into the n=3 states of hydrogen by proton impact on Co, Co_2 and N_2O
$H^+ + B \rightarrow H^0$ (3s, 3p, 3d)
photon spectroscopy
2.2 - 8.2 keV/amu

79E11   Morgan,T.J. Eriksen,F.J.
Phys. Rev. A 19 (1979) 1448-1456
Single- and double-electron capture by 1 - 100 keV protons in collisions with magnesium and barium
$H^+ + B \rightarrow H^0$, H^- (B = Ar, Mg, Ba)
growth
1 - 100 keV/amu

79E12   Morgan,T.J. Eriksen,F.
Phys. Rev. A 19 (1979) 2185-2191
Formation of metastable hydrogen atoms by charge exchange of fast protons in magnesium and barium
$H^+ + Ar, Mg, Ba \rightarrow H(2s)$
quenching technique
1.5 - 90 keV/amu

79E13   Morgan,T.J. Stone,J. Mayo,M. Kurose,J.
Phys. Rev. A 20 (1979) 54-57
D^- production by multiple electron transfer collisions in alkaline-earth metal vapors
$D^+ + B \rightarrow D^-$ (B = Mg, Ca, Sr, Ba)
equilibrium charge distribution
1.25 - 100 keV/amu

79E14   Muller,A. Achenbach,C. Salzborn,E.
        Phys. Letters 70A (1979) 410-412
        Dependence of the charge transfer between atoms and highly charged ions
        on the ionization potential of the atoms
            Xe^{10+} + He, Ne, Ar, Kr, Xe, Cd, Na, Cs -> Xe^{9+}
            0.75 keV/amu

79E15   Nagata,T.
        J. Phys. Soc. Japan 46 (1979) 1302-1306
        Charge changing collisions of atomic beams in alkali-metal vapors. II.
        total cross sections for one-electron capture by C^+, O^+, S^+ ions
        and C, O, S atoms
            A^+, A^0 + B -> A^0, A^- (A = H, C, O, S; B = Cs, K, Na)
            growth
            0.5 - 5 keV/amu (H^+); 0.015 - 0.15 keV/amu (S^+)
            total cross sections

79E16   Olsen,J.O. Andersen,T. Barat,M. Gaussorgues,Ch.C. Sidis,V. Pommier,J.
        Agusti,J. Andersen,N. Russek,A.
        Phys. Rev. A 19 (1979) 1457-1484
        Excitation and charge transfer in low-energy Na^+ - Ne collisions
            Na^+ + Ne -> Na^0 + Ne^+
            energy loss and photon spectroscopy
            0.01 - 0.52 keV/amu

79E17   Olsen,J.O. Vedel,K. Dahl,P.
        J. Phys. B 12 (1979) 929-944
        Differential cross sections for charge transfer and excitation in low
        energy Be^+ - He, Ne collisions
            Be^+ - He, Ne -> Be^0
            energy loss spectroscopy
            0.22 - 0.55 keV/amu
            angular dependence

79E18   Pradel,P. Spiess,G. Sidis,V. Kubach,C.
        J. Phys. B 12 (1979) 1485-1505
        Differential cross sections for the near-resonant charge-transfer
        process H^+ + Cs -> H(2s) + Cs^+ at low energies
            H^+ + Cs -> H(2s) + Cs^+
            E. Lyman line; T. CC
            0.025 - 0.1 keV/amu
            θ = 1-7

79E19   Rodbro,R. Pedersen,E.H. Cocke,C.L. MacDonald,J.R.
        Phys. Rev. A 19 (1979) 1936-1947
        Innershell electron capture by H^+, He^{2+} and Li^{3+} projectiles from
        CH_4, Ne and Ar
            A^{z+} + B -> $A^{(z-1)+}$ + $B^+(1s^{-1})$ (A = H, He, Li; B = CH_4, Ne, Ar)
            coincidence method
            400 - 3000 keV/amu

79E20   Rundel,R.D. Nitz,D.E. Smith,K.A. Geis,M.W. Stebbings,R.F.
        Phys. Rev. A 19 (1979) 33-42
        Resonant charge transfer in He^+ - He collisions studied with the
        merging-beams technique
            He^+ + He -> He + He
            merging-beams technique
            2.5×10^{-5} - 4.7×10^{-2} keV/amu
            total cross section

79E21   Sato,Y. Moore,J.H.

Phys. Rev. A 19 (1979) 495-503
Electron capture in N^{2+} - He and N^{2+} - Ne collisions
   N^{2+} + He, Ne -> N^+ + He^+, Ne^+
   energy loss spectroscopy   ·
   0.014 - 0.17 keV/amu

79E22   Sharma,S. Awod,G.L. Hasted,J.B. Mathur,D.
         J. Phys. B 12 (1979) L163-160
         Energy loss spectra of production ions in electron capture
            N^{2+} + B -> N^+ + B^+ (B = He, Ne, Ar)
            0.1 keV/amu
            energy loss spectra only; no cross sections

79E23   Tawara,H.
         Phys. Letters 71A (1979) 208-210
         On a scaling of electron capture by fully ionized heavy ions in light
         gas targets at low energies
            scaling for low MeV energy region

80E 1   Agacu,A. Oluwole,A.F.
         J. Phys. B 13 (1980) 1429-1432
         K - K^+ charge exchange cross section
            K^+ + i⁻ -> K^0 + K^+
            polarized K target
            3×10^{-5} keV/amu

80E 2   Andersen,T. Bisgaard,P. Pedersen,E.H.
         Phys. Rev. A 22 (1980) 818-821
         Formation of excited Mg^+ states in Mg^{++} - Mg collisions (20-500 keV)
            Mg^{2+} + Mg -> $Mg^+(3p)$ + $Mg^+(3p)$
            photon spectroscopy
            0.8 - 21 keV/amu

80E 3   Aubert,J. Bliman,S. Geller,R. Jacquot,B. van Houtte,D.
         Phys. Rev. A 22 (1980) 2403-2407
         Charge-changing collisions of argon ions on argon gas. one-electron
    ○   capture
            $Ar^{q+}(q=2-12)$ + Ar -> $Ar^{(q-i)+}$
            growth method
            (1-10)xq/M keV/amu
            ECR ion source

80E 4   Bayfield,J.E. Gardner,L.D. Gulkok,Y.Z. Saylor,T.K. Sharma,S.D.
         Rev. Sci. Instr. 51 (1980) 65-654
         Charge exchange measurements in helium using a double tandem
         accelerator-decelerator source of low energy highly stripped oxygen ions
            O^{q+} + He -> $O^{(q-1)+}$ + He^+ (q=5-8)
            15 - 100 keV/amu
            deceleration with two tandems

80E 5   El-Sherbini,T.M. Salop,A. Bloemen,E. de Heer,F.J.
         J. Phys. B 13 (1980) 1433-1449
         Excitation and ionization resulting from electron capture in Ar^{6+} +
         H_2 collisions at ion projectile energies of 200 - 1200 keV
            Ar^{6+} + H_2 -> Ar^{5+} + H_2^+, Ar^{5+} + H^+ + H, Ar^{6+} + H_2^+ + e^-
            photon emission spectroscopy
            5 - 30 keV/amu

80E 6   Huber,B.A.
         J. Phys. B 13 (1980) 809-818
         Charge transfer of Ar^{2+} in He, Ne and Ar

Ar^{2+} + He, Ne, Ar -> Ar^+, Ar^0
translational spectroscopy
0.06 - 0.1 keV/amu
cross sections for exothermic and endothermic channels

80E 7   Jones,J.D. Lister,D.G. Birkinshaw,K. Twiddy,N.D.
         J. Phys. B 13 (1980) 799-808
         Quasi-resonant charge transfer at thermal energies in the rare gases
         A^+ + A -> A + A^+ (A = Ne, Ar, Kr, Xe)
         selected ion-flow tube method
         3×10^{-5} keV/amu
         rate constant

80E 8   Matic,M. Sidis,V. Vujovic,M. Cobic,B.
         J. Phys. B 13 (1980) 3665-3676
         Near-resonant charge transfer in collisions of N^+ and O^+ ions with
         inert gases
         A^+, A^{++} + B -> A^0, A^{0*} (A = O, N; B = He, Ne, Ar, Kr, Xe)
         E. growth; T. Demkov model
         0.14 - 2.1 keV/amu

80E 9   Matsumoto,A. Tsurubuchi,S. Iwai,T. Ohtani,S. Okuno,K. Kaneko,Y.
         J. Phys. Soc. Japan 48 (1980) 567-574
         Single-electron capture into Ar^+ excited states in Ar^{2+} + Na
         collision below 12 keV I. Absolute measurement of emission
         cross-sections
         Ar^{2+} + Na -> $A^+(nl)$ + Na^+
         photon emission spectroscopy
         5×10^{-3} - 0.3 keV/amu

80E10   Matsumoto,A. Tsurubuchi,S. Iwai,T. Ohtani,S. Okuno,K. Kaneko,Y.
         J. Phys. Soc. Japan 48 (1980) 575-582
         Single-electron capture into Ar^+ excited states in Ar^{2+} + Na
         collisions below 12 keV II. Relative population distribution in Ar^+
         excited states
         Ar^{2+} + Na -> $Ar^+(nl)$ + Na^+ (nl=4p, 4p', 4d)
         E. photon emission spectroscopy; T. LZ
         5×10^{-3} - 0.3 keV/amu

80E11   McAfee,K.B. Hozack,R.S. Johnson,R.E.
         Phys. Rev. Letters 44 (1980) 1247-1250
         Σ oscillation and spin change during charge exchange in Ar^+ on Ar
         Ar^+ + Ar -> Ar + Ar^+
         crossed beam
         0.005 keV/amu

80E12   Meyer,F.W.
         J. Phys. B 13 (1980) 3823-3828
         Single electron capture and loss by H^+, H^0 and H^- in Cs vapor in
         the energy range 0.1 - 2.0 keV
         H^+ + Cs -> H^0
         growth
         0.1 - 2.0 keV/amu

80E13   Morgenstern,R. Niehaus,A. Zimmermann,G.
         J. Phys. B 13 (1980) 4811-4831
         Autoionizing states formed by electron capture in collisions of
         multiply charged Ne ions with He, H_2 and Xe
         Ne^+, Ne^{2+}, Ne^{3+} + He, H_2, Xe -> Ne, Ne^+, Ne^{2+} + He^{2+},
         H_2^{2+}, Xe^{2+} + e^-
         electron emission spectroscopy

$5 \times 10^{-2} - 5 \times 10^{-1}$ keV/amu

80E14   Nagata,T.
J. Phys. Soc. Japan 48 (1980) 2068-2075
Charge changing collisions of atomic beams in alkali-metal vapors. IV.
Total cross sections for single electron capture by H^+ ion and H(1s)
atom
$H^+ + B \rightarrow H^-$; $H^0(1s) + B \rightarrow H^-$ (B = Cs, Rb, K, Na)
growth
0.4 - 5 keV/amu
total cross sections

80E15   Panov,M.N.
Electronic and Atomic Collisions (eds. N.Oda and K.Takayanagi,
North-Holland, Amsterdam) (1980) 437
Electron capture into different excited states of multiply charged ions
$Ar^{6+} + He \rightarrow Ar^{5+}(nl) + He^+$

80E16   Rille,E. Winter,H.
J. Phys. B 13 (1980) L531-536
Excitation in electron capture collisions of Ne^{2+}(15-20 keV) with Xe
$Ne^{2+} + Xe \rightarrow Ne^+(nl) + Xe^+(nl)$
photon emission spectroscopy
0.74 - 2.5 keV/amu

80E17   Schlachter,A.S. Stalder,K.R. Stearns,J.W.
Phys. Rev. A 22 (1980) 2494-2509
D^- production by charge transfer of 0.3 - 10 keV D^+, D^0, and D^-
in cesium, rubidium and sodium vapor targets
$D^0 + Cs \rightarrow D^-$
growth
1.25 - 5 keV/amu
charge equilibrium fractions for Cs, Rb, Na

80E18   Shah,M.B. Geddes,J. Gilbody,H.B.
J. Phys. B 13 (1980) 4049-4058
Absolute cross sections for H(2s) formation in electron capture by
protons in gases   .
$H^+ + B \rightarrow H^0(2s) + B^+$ (B = He, Ne, N_2, O_2, Ar, H_2)
photon counting
12 - 18 keV/amu

80E19   Smith,D. Adams,N.G. Alge,E. Villinger,H. Lindinger,W.
J. Phys. B 13 (1980) 2787-2799
Reactions of Ne^{2+}, Ar^{2+}, Kr^{2+} and Xe^{2+} with the rare gases at
low energies
$A^{2+} + B \rightarrow A^+ + B^+$ (A = Ne, Ar, Kr, Xe; B = He, Ne, Ar, Kr, Xe)
selected ion-flow tube method
3×10^{-5} eV

80E20   Sofield,C.J. Cowern,N.E.B. Praper,J. Bridwell,L. Freeman,J.M.
Woods,C.J. Spencer-Harper,M.
Nucl. Instr. Meth. 170 (1980) 257-260
Charge-exchange cross sections of nearly fully stripped ^{16}O ions in
solid targets
$O^{q+} + B(solid) \rightarrow O^{(q-1)+}(q=7,8)$; $O^{(q+1)+}(q=6,7)$ (B = C, Al)
foil thickness dependence
2500 keV/amu

80E21   Tanis,J.A. Jacobs,W.W. Shafroth,S.M.
Phys. Rev. A 22 (1980) 483-495

Systematics of target and projectile K x-ray production and radiative capture for 20 - 80 MeV Cl^{q+} ions incident on 25 - 200 mg/cm^2 Cu targets

Cl^{z+} + Cu -> $Cl^{(z-1)+}$ + Hν + Cu$^+$

x-ray spectroscopy

571 - 2285 keV/amu

80E22   Thielmann,U. Krutein,J. Barat,M.
J. Phys. B 13 (1980) 4217-4232
Collisions spectroscopy of open-shell systems II. N$^+$ - Ne collisions

N$^+$ + Ne -> N^0

TOF-energy loss spectroscopy

0.036 - 0.14 keV/amu

energy loss spectra

80E23   Van Zyl,B. Rothwell,H.L. Neumann,H.
Phys. Rev. A 21 (1980) 730-737
Balmer-α and Balmer-β emission cross sections for H$^+$ + Ar collisions

H$^+$ + Ar -> H^0(3l, 4l)

photon spectroscopy

0.05 - 2.5 keV/amu

80E24   Varghese,S.L. Bissinger,G. Joyce,J.M. Laubert,R.
Nucl. Instr. Meth. 170 (1980) 269-273
The electron capture cross section of 1.5 - 3 MeV protons from carbon

H$^+$ + B -> H^0 (B = CH_4, C_2H_2, C_2H_4, C_2H_6, C_3H_6, C_4H_8)

growth

1500 - 3000 keV/amu

81E 1   Afrosimov,V.V. Basalaev,A.A. Gordeev,Yu.S. Donets,E.D. Zinov'ev,A.N.
Ovchinnikov,S.Yu. Panov,M.N.
Sov. Phys.-JETP Lett. 34 (1981) 316-318
X radiation accompanying electron capture by oxygen and carbon nuclei in molecular hydrogen

C^{6+}, O^{8+} + H_2 -> C^{5+}, O^{7+}

photon emission spectroscopy

0.6 - 8 keV/amu

81E 2   Barret,J.L. Leventhal,J.J.
Phys. Rev. A 23 (1981) 485-490
Selective formation of He$^+$(n=3) in He^{2+} - Li collisions

He^{2+} + Li -> He$^+$ (n=3)

photon spectroscopy

0.125 - 1.75 keV/amu

emission cross section

81E 3   Beyer,H.F. Mann,R. Folkmann,F.
J. Phys. B 14 (1981) L377-381
High-charge-low-velocity electron capture studied by x-ray line quenching

Ne^{8+}(1s2p $^3P_1$) + Ne -> Ne^{7+}

Kα x-ray observation

5.1×10^{-4} keV/amu

recoil ions

81E 4   Bloemen,E.W.P. Winter,H. Mark,T.D. Dijkkamp,D. Barends,D. de Heer,F.J.
J. Phys. B 14 (1981) 717-725
Absolute emission cross sections at 30.4 nm for e - He collisions and at 20.8 nm for Ne^{4+} - He collisions

e + He -> 2e + He$^+$ -> 2e + He$^+$ + hν;

$$Ne^{4+} + He \rightarrow Ne^{3+} + He^{*} \rightarrow Ne^{3+} + h\nu + He^{*}$$
photon emission spectroscopy
9.9 (Ne^{4+}-He) keV/amu

81E 5   Campbell,F.M. Browning,R. Latimer,C.J.
J. Phys. B 14 (1981) 1183-1195
Symmetric charge transfer in argon, krypton and xenon; the effect of
spin-orbit coupling studied using photoelectron-photoion coincidence
spectroscopy
$$A^{+}(^{2}P_{3/2,1/2}) + A \rightarrow A(^{1}S_{0}) + A^{+}(^{2}P_{3/2,1/2})$$
photoion-photoelectron coincidence
$1.25 \times 10^{-4} - 2.5 \times 10^{-2}$ keV/amu
cross section ratios for initial states ($^{2}P_{3/2}$ and $^{2}P_{1/2}$)

81E 6   Chetioui,A. Rozet,J.P. Briand,J.P. Stephan,C.
J. Phys. B 14 (1981) 1625-1638
K excitation and K-K transfer cross sections for intemediate-velocity
nearly symmetric collisions
$$Kr^{36+} + B \rightarrow Kr^{35}(1s) + B^{+}(1s^{-1}) \ (B = Ti, Mn, Ni, Cu, Zr, Ag)$$
x-ray spectroscopy
3614 keV/amu

81E 7   Cocke,C.L. Dubois,R. Gray,T.J. Justiniano,E.
IEEE NS-28 (1981) 1032-1035
Capture by highly-charged low-energy ions studied with a secondary
recoil ion source
$Ne^{q+}(q=2-6)$, $Ar^{q+}(q=2-10)$, $Kr^{q+}(q=2-10)$ + He $\rightarrow$ $Ne^{(q-1)+}$,
$Ar^{(q-1)+}$, $Kr^{(q-1)+}$
TOF
$(0.1-1.1)xq/M$ keV/amu
oscillation of cross section over q

81E 8   Cocke,C.L. DuBois,R. Gray,T.J. Justiniano,E. Can,C.
Phys. Rev. Letters 26 (1981) 1671-1674
Coincidence measurements of electron capture and ionization in
low-energy Ar^{q+} + (He, Ne, Ar, Xe) collisions
$Ar^{q+} + A \rightarrow Ar^{(q-1)+}$, $Ar^{(q-2)+} + A^{i+}$ (A = He, Ne, Ar, Xe; i=1-2)
coincidence technique
$(0.25-0.66)xq/M$ (keV/amu)
recoil ion source; total cross section

81E 9   Dillingham,T.R. McDonald,J.R. Richard,P.
Phys. Rev. A 24 (1981) 1237-1248
Ionization of one-electron ions and capture by bare and one-electron
ions of C, N, O and F on He
$A^{z+,(z-1)+} + He \rightarrow A^{(z-1)+}$, $A^{(z-2)+}$ (A = C, N, O, F)
growth
500 - 2500 keV/amu

81E10   Hall,J. Richard,P. Gray,T.J. Lin,C.D.
Phys. Rev. A 24 (1981) 2416-2419
Double K-shell-to-K-shell electron transfer in ion-atom collisions
$A^{z+} + Ti \rightarrow A^{(z-1)+}(1s)$, $A^{(z-2)+}(1s^{2}) + Ti^{+}(1s^{-1})$, $Ti^{2+}(1s^{-2})$;
(A = N, F, Mg, Al, Si, S)
x-ray yields
1500-6500 keV/amu (Si); 5000 keV/amu (others)

81E11   Hird,B. Ali,S.P.
J. Phys. B 14 (1981) 267-280
Electron transfer to Ar^{2+} from rare gas atoms
Ar^{2+} + He, Xe $\rightarrow$ Ar^{+}

1.5 - 5 keV

81E12   Hvelplund,P. Hangen,H.K. Knudsen,H. Andersen,L. Damsgaard,H. Fukusawa,F.
         Phys. Scripta   24   (1981)   40-42
         Electron capture into highly-lying Rydberg states in collisions between
         multiply charged ions and H_2
             $Au^{13+,15+} + H_2 \rightarrow Au^{12+,14+}$
         optical measurement
         100 keV/amu
         $\Delta n = 1$; dominant transitions; no cross section given

81E13   Justiniano,E. Cocke,C.L. Gray,T.J. DuBois,R.D. Can,C.
         Phys. Rev. A   24   (1981)   2953-2962
         Charge transfer and ionization in low energy Ar^{q+} + Ne collisions
             $Ar^{q+}(q=2-9) + Ne \rightarrow Ar^{(q-1)+}, Ar^{(q-2)+}, Ar^{(q-3)+} + Ne^{i+}$ (i=1-3)
         coincidence techinique
         $(0.1-1.1) \times q/M$ (keV/amu)
         recoil ion source; total cross section

81E14   Knudsen,H. Haugen,H.K. Hvelplund,P.
         Phys. Rev. A   23   (1981)   597-610
         Single-electron capture cross sections for medium-, and high-charged
         ions colliding with atoms
             $Au^{q+}(q=2-24)$, $O^{q+}(q=1-8)$ + He $\rightarrow Au^{(q-1)+}, O^{(q-1)+}$
         growth
         16.8 - 102 keV/amu (Au); 125 - 1000 keV/amu (O)
         scaling law

81E15   ·Mann,R. Folkmann,F. Beyer,H.F.
         J. Phys. B   14   (1981)   1161-1181
         Selective electron capture into highly stripped Ne and N target atoms
         after heavy ion impact
             $A^{q+} + B \rightarrow A^{(q-1)+}(n) + B^+$ (A = Ne^{8+}, Ne^{10+}, N^{5+};
         B = He, Ne, Ar, H_2, CH_4, NH_3)
         x-ray spectroscopy
         10^{-4} keV/amu
         recoil ions; no cross section

81E16   Nagata,T. Okamura,Y. Katoh,E. Mukoyama,Y.
         Phys. Letters   81A   (1981)   265-267
         Single-electron capture cross sections for 0.4-5.0 keV He^+ ions
         incident on alkali-vapor targets
             $He^+ + B \rightarrow He^0$ (B = Cs, Rb, K, Na)
         growth
         0.1 - 1.25 keV/amu

81E17   Seim,W. Muller,A. Salzborn,E.
         Z. Phys. A   301   (1981)   11-16
         On the population of metastable ionic states in electron-capture
         collisions
             A^{1+}, $A^{2+} + O_2 \rightarrow A^{2+}, A^{3+}$
         growth
         0.25 - 1.7 keV/amu
         met.stable state effect

81E18   Tanis,J.A. Shafroth,S.M. Willis,J.E. Clark,M. Swenson,J. Strait,E.N.
         Mowat,J.R.
         Phys. Rev. Letters   47   (1981)   828-831
         Simultaneous electron capture and excitation in S + Ar collisions
             $S^{q+} + Ar \rightarrow S^{(q-1)+}, S^{(q-2)+}$ (q=13-16)
         coincidence with K x-rays

2180 keV/amu

81E19   Tanis,J.A. Shafroth,S.M. Willis,J.E. Mowat,J.R.
         Phys. Rev. A 23 (1981) 366-370
         Radiative electron capture by Cl ions incident on C and Cu foils
             Cl^{z+} + C, Cu -> $Cu^{(z-1)+}$ + $h\nu$ + C^+, Cu^+
         x-ray spectroscopy
         1142 - 2285 keV/amu

81E20   Vane,C.R. Prior,M.H. Marrus,R.
         Phys. Rev. Letters 46 (1981) 107-110
         Electron capture by Ne^{10+} trapped at very low energies
             Ne^{10+} + Ne -> Ne^{9+}
         trapped ion
         3.5×10^{-4} - 2.25×10^{-3} keV/amu
         recoil ion + trapping; total cross sections

82E 1   Beyer,H.F. Mann,R. Folkmann,F.
         J. Phys. B 15 (1982) 1083-1088
         Electron capture by slow Ne^{8+} recoil ions
             Ne^{8+} + He, Ne, Ar, CH_4, Xe -> Ne^{7+}
         K-α x-ray observation
         recoil ion source; recoil energy

82E 2   Bissinger,G. Joyce,J.M. Lapicki,G. Laubert,R. Varghese,S.L.
         Phys. Rev. Letters 49 (1982) 318-322
         Failure of cross section additivity for electron capture from hydrogen
         gases to bound states of hydrogen ions
             H^+ + B -> H^0 (B = CH_4, C_2H_2, C_3H_6, C_4H_8)
         growth
         800 - 3000 keV/amu

82E 3   Bloemen,E. Dijkkamp,D. de Heer,F.J.
         J. Phys. B 15 (1982) 1391-1413
         Production of excited projectile states in collisions of 25-800 keV
         Ne^{z+} (z=1,2,3,4) with He, Ne and Ar
             Ne^{z+}(z=1,2,3,4) + He, Ne, Ar -> $Ne^{(z-1)+}$ + He^+, Ne^+, Ar^+
         photon emission spectroscopy
         1.24 - 39.6 keV/amu

82E 4   Brazuk,A. Winter,H.
         J. Phys. B 15 (1982) 2233-2244
         Excitation by electron capture in collisions of ground state and
         metastable Ne^{2+} with Xe at 40 keV
             Ne^{2+} + Xe -> $Ne^+(nl)$ + Xe^+
         photon emission spectroscopy
         2.0 keV/amu

82E 5   Bruch,R. Dube,L.J. Trabert,E. Heckmann,P.H. Raith,B. Brand,K.
         J. Phys. B 15 (1982) L857-862
         Electron capture to Rydberg states; C^{4+} in collisions with H_2
             C^{4+} + H_2, He -> $C^{3+}(nl)$ + H_2^+, He^+
         E. EUV; T. TA, CDW, first and second Born
         166 - 416 keV/amu

82E 6   Church,D.A. Holzscheiter,H.M.
         Phys. Rev. Letters 49 (1982) 643-646
         Charge transfer from atomic hydrogen to O^{2+} and O^{3+} ions with
         electron-volt energy
             O^{2+}, O^{3+} + H -> O^+, O^{2+}
         trapping technique

10^4 K
rate constant

82E 7   Dmitriev,I.S. Vorobiev,N.F. Zaikov,V.P. Konovalova,Zh.M. Nikolaev,V.S.
Teplova,Ya.A. Fainberg,Yu.A.
J. Phys. B 15 (1982) L351-355
Oscillations of the charge exchange cross sections and the average
equilibrium charge of helium ions
He^{2+}; He^+ + He, N_2, Ne, Ar -> He^+, He^0; He^0
growth
331 - 2070 keV/amu

82E 8   El-Sherbini,T.M. de Heer,F.J.
J. Phys. B 15 (1982) 423-438
Projectile excitation in the collisions of Ar^{q+}(q=1,2 and 3) with He
and Ne
Ar^{q+} + He, Ne -> Ar^+, Ar^2 (q=1-3)
photon emission spectroscopy
0.375 - 10 keV/amu

82E 9   Groh,W. Schlachter,A.S. Muller,A. Salzborn,E.
J. Phys. B 15 (1982) L207-212
Transfer ionization in slow collisions of He^{2+} ions in rare gases
He^{2+} + A -> He^+ + A^{i+} + (i-1)e
coincidence
1.88 - 8 keV/amu
charge fraction

82E10   Havener,C.C. Westerveld,W.B. Risley,J.S. Tolk,N.H. Tully,J.C.
Phys. Rev. Letters 48 (1982) 296-929
Observation of a large electric dipole moment produced in electron
transfer collisions of H^+ on He
H^+ + He -> H^0(n=3) + H^+
Balmer-alpha line observation
40 - 80 keV/amu
polarization as a function of electric field

82E11   Hegerberg,R. Elford,M.T. Skullerud,H.R.
J. Phys. B 15 (1982) 797-811
The cross section for symmetric charge exchange of Ne^+ in Ne at low
energies
A^+ + A -> A + A^+ (A = Ne, Ar)
drift tube method
1×10^{-4} - 1.25×10^{-3} keV/amu

82E12   Iwai,T. Kaneko,Y. Kimura,M. Kobayashi,N. Ohtani,S. Okuno,K. Takagi,S.
Tawara,H. Tsurubuchi,S.
Phys. Rev. A 26 (1982) 105-115
Cross sections for one-electron capture by highly stripped ions of B,
C, N, O, F, Ne and S from He below 1 keV/amu
A^{q+} + He -> $A^{(q-1)+}$ + He^+ (A = B, C, N, O, F, Ne, S; q = 1-9)
growth
0.44 - 1.11 keV/amu
total cross section

82E13   Kadota,K. Dijkkamp,D. van der Woude,R.L. de Boer,A. Yan,P.G.
de Heer,F.J.
J. Phys. B 15 (1982) 3275-3296
One-electron capture into excited states for He^{2+} - Li collisions in
the energy range of 15 - 150 keV
He^{2+} + Li -> He^+(nl) + Li^+

photon emission spectroscopy
4 - 40 keV/amu

82E14 Kadota,K. Dijkkamp,D. van der Woude,R. Yan,P.G. de Heer,F.J.
Phys. Letters 88A (1982) 135-139
Absolute cross sections for one-electron capture into the excited
projectile states in collisions between He^{2+}(15-150 keV) and Li atoms
He^{2+} + Li -> He^+(nl)
optical spectroscopy
3.75 - 37.5 keV/amu

82E15 Kambara,T. Awaya,Y. Hitachi,A. Kase,M. Kohno,I. Tonuma,T.
J. Phys. B 15 (1982) 3759-3767
X-ray from radiative electron capture induced by 110 MeV Ne ions
Ne^{10+} + H_2, He, CH_4, N_2, O_2, Ne -> Ne^{9+} + $h\nu$
x-ray spectroscopy
5500 keV/amu

82E16 Kamber,Y. Mathur,D. Hasted,J.B.
J. Phys. B 15 (1982) 2051-2059
Energy loss spectra of single electron capture products from Ar^{2+}
collisions with Ar, Kr, and Xe
Ar^{2+} + B -> Ar^+(nl) (B = Ar, Kr, Xe)
energy loss spectroscopy
0.013 keV/amu
no cross sections

82E17 Katayama,I. Berg,G.P.A. Hurlimann,W. Martin,S.A. Meissburger,J.
Oelert,W. Rogge,M. Romer,J.G.M. Tain,J. Styzen,B.
Phys. Letters 92A (1982) 385-388
Charge transfer reactions of ^{3}He in carbon at 68, 99 and 130 MeV
$^3He^{2+}$ + C -> He^+
foil thickness dependence
22000 - 43000 keV/amu

82E18 Kimura,M. Iwai,T. Kaneko,Y. Kobayashi,N. Matsumoto,A. Ohtani,S.
Okuno,K. Takagi,S. Tawara,H. Tsurubuchi,S.
J. Phys. B 15 (1982) L851-856
The (n,l) distributions in electron capture reactions for C^{3+}, N^{4+}
and O^{5+} ions colliding with He
A^{q+} + He -> $A^{(q-1)+}$ + He^+ (A^{q+}=C^{3+}, N^{4+}, O^{5+})
energy-loss/-gain spectroscopy
2.5×10^{-1} (C^{3+}), 2.85×10^{-1} (N^{4+}), 3.12×10^{-1} (O^{5+}) keV/amu

82E19 Kusakabe,T. Hanaki,H. Nagai,N. Kuroda,K. Maeda,N. Sakisaka,M.
Nucl. Instr. Meth. 198 (1982) 577-581
Ion-impact ion source applied to low energy charge-transfer collisions
He^{2+} + Ne -> He^+, He^0
growth
0.2 - 0.75 keV/amu

82E20 Mann,R. Cocke,C.L. Schlachter,A.S. Prior,M. Marrus,R.
Phys. Rev. Letters 49 (1982) 1329-1332
Selective final-state population in electron capture by low-energy
highly charged projectiles studied by energy-gain spectrocopy
Ne^{9+}, Ne^{10+} + He, Ne, Ar, Xe -> Ne^{8+}(n), Ne^{9+}(n)
energy-gain spectroscopy
0.025- keV/amu
crossing radius; n-distribution only

82E21 Matsumoto,A. Ohtani,S. Iwai,T.

J. Phys. B 15 (1982) 1871-1881
Experimental study of one-electron capture by ground and metastable
Ar^{2+} ions from Na at 1.5 keV
   $Ar^{2+}(^1D, {}^3P) + Na \rightarrow Ar^+ + Na^+$
   optical attenuation method
   3.75×10^{-2} keV/amu

82E22   McCullough,R.W. Goffe,T.V. Shaha,M.B. Lennon,M.O. Gilbody,H.B.
        J. Phys. B 15 (1982) 111-117
        Electron capture by He^{2+} and He^+ ions in lithium vapor
           He^{2+}, He^+ + Li $\rightarrow$ He^+, He^0
           growth
           1.7 - 200 keV/amu
           total cross section

82E23   Miethe,K. Dreiseidler,T. Salzborn,E.
        J. Phys. B 15 (1982) 3069-3084
        Charge transfer of hydrogen atoms in N_2 and in caesium vapor
           H + N_2, Cs $\rightarrow$ H^+, H^{0-}
           growth
           0.1 - 5 keV/amu
           scattering effect in cross sections (θ = 0.8, 2.6)

82E24   Murray,G.A. Stone,J. Mayo,M. Morgan,T.J.
        Phys. Rev. A 25 (1982) 1805-1807
        Single and double electron transfer in He^{2+} + Li collisions
           He^{2+} + Li $\rightarrow$ He^+, He^0
           total cross section

82E25· Nagata,T.
        Mass spectroscopy in Japan 30 (1982) 153-161
        Attenuation cross sections for single electron capture of proton in
        collision with alkali-atom targets
           H^+ + Cs, Rb, K, Na $\rightarrow$ H
           attenuation method
           0.3 - 5 keV/amu

82E26   Ohtani,S. Kaneko,Y. Kimura,M. Kobayashi,N. Iwai,T. Matsumoto,A.
        Okuno,K. Takagi,S. Tawara,H. Tsurubuchi,S.
        J. Phys. B 15 (1982) L533-535
        Observation of electron capture into selective state by fully stripped
        ions from He atom
           C^{6+}, O^{8+} + He $\rightarrow$ $C^{5+}(nl)$, $O^{7+}(nl)$ + He^+
           Energy-loss/gain spectroscopy
           0.45 keV/amu

82E27   Panev,G.S.
        Phys. Letters 91A ' (1982) 348-350
        Charge transfer in collisions of Mg^+ ions with Ca atoms
           Mg^+ + Ca $\rightarrow$ Mg + Ca^+
           crossed beam
           0.006 - 0.08 keV/amu
           total cross section

82E28   Pedersen,E.H. Folkmann,F. Pedersen,N.H.
        J. Phys. B 15 (1982) 739-762
        Differential cross sections for K-shell ionization and capture by H^+
        n $C(CH_4)$ and Ne
           H^+ + B $\rightarrow$ H + $B^+(1s^{-1})$ (B = C, Ne)
           Auger electron coincidence
           200 - 600 keV/amu (C), 500 - 1500 keV/amu (Ne)

impact parameter dependence

82E29   Pedersen,E.H. Pedersen,N.H.
         J. Phys. B 15 (1982) 2205-2220
         Differential cross sections for K-shell ionization and capture in
         asymmetric collisions; scaling properties
             $A^{z+} + B \rightarrow A^{(z-1)+} + B^{*}(1s)$ (A = H, He, Li; B = C, Ne, Ar)
             Auger electron coincidence
             200 keV/amu (C), 500 keV/amu(Ne), 1700 keV/mu (Ar)
             probability as a function of impact parameter

82E30   Pedersen,E.P. Loftager,P. Rasmussen,J.L.
         J. Phys. B 15 (1982) 4423-4436
         Electron capture in close collisions between protons and carbon (CH_4)
             $H^{+} + C \rightarrow H + C^{*}(1s^{-1})$
             Auger electron coincidence
             200 - 2000 keV/amu
             Impact parameter dependence

82E31   Richard,P. Pepmiller,P.L. Kawatsura,K.
         Phys. Rev. A 25 (1982) 1937-1942
         Electron excitation and capture in F^{8+} plus Ne collisions
             $F^{8+}(1s) + Ne \rightarrow F^{7+}$
             x-ray spectroscopy
             526 - 2100 keV/amu

82E32   Rille,E. Olson,R.E. Peacher,J.L. Blankenship,D.M. Kvale,T.J. Redd,E.
         Park,J.T.
         Phys. Rev. Letters 49 (1982) 1819-1821
         Isotope effect in electron-capture differential cross sections at
         intermediate energies
             $H^{+}, D^{+} + H, D \rightarrow H^{0}, D^{0}$
             E. growth with high temperature oven; T. CTMC
             40 keV/amu
             projectile dependence at small angles; no target isotope dependence;
             scaling law

82E33   Rille,E. Winter,H.
         J. Phys. B 15 (198?) 3489-3507
         State-selective and total one-electron capture in Ne^{q+} - Li
         collisions (q = 1,2; E $\leq$ 30q keV)
             $Ne^{q+} + Li \rightarrow Ne^{(q-1)+}(3l, 4l)$ (q=1,2)
             photon spectroscopy
             0.25 - 1.5 keV/amu (Ne^{+}; 1 - 3 keV/amu (Ne^{2+})
             total and partial cross sections

82E34   Tanis,J.A. Bernstein,E.M. Graham,W.G. Clark,M. Shafroth,S.M.
         Johnson,B.M. Jones,K.W. Meron,M.
         Phys. Rev. Letters 49 (1982) 1325-1328
         Resonant behavior in the projectile x-ray yield associated with
         electron capture in S + Ar collisions
             $S^{13+} + Ar \rightarrow S^{12+}$
             coincidence with x-ray
             2180 - 5000 keV/amu

82E35   Tawara,H. Richard,P. Kawatsura,K.
         Phys. Rev. A 26 (1982) 154-161
         Radiative electron-capture processes in zero-and one-electron heavy ion
         collisions with He
             $F^{8+}, F^{9+} + He \rightarrow F^{7+}, F^{8+} + He^{+} + h\nu$
             x-ray spectroscopy

82E36   Tsurubuchi,S. Iwai,T. Kaneko,Y. Kimura,M. Kobayashi,N. Matsumoto,A. Ohtani,S. Okuno,K. Takagi,S. Tawara,H.
J. Phys. B 15 (1982) L733-737
Two-electron capture into autoionising states of $N^{5+}(3l3l')$ and $O^{5+}(1s3l3l')$ in collisions of N^{7+} and O^{7+} with He
    N^{7+}, O^{7+} + He -> $N^{5+}(3l, 3l')$, $O^{5+}(1s3l3l')$ + He^{2+}
    Energy-loss/gain spectroscopy
    0.5 keV/amu (N^{7+}). 0.44 keV/amu (O^{7+})

83E 1   Afrosimov,V.V. Basalaev,A.A. Donets,E.D. Zinovev,A.N. Lozhkin,K.O. Panov,M.N.
JETP Letters 37 (1983) 24-27
Electron capture cross sections of nuclei and mutiply charged ions at hydrogen atoms
    A^{z+}, $A^{(z-1)+}$, $A^{(z-2)+}$ + H -> $A^{(z-1)+}$, $A^{(Z-2)+}$, $A^{(z-3)+}$,
    (A = C, N, O, Ne)
    growth
    0.47 - 5.2 keV/amu

83E 2   Afrosimov,V.V. Donets,E.D. Zinovev,A.N. Ovchinnikov,S.Y. Panov,M.N.
JETP Letters 38 (1983) 80-83
Cross sections for characteristic x-ray emission in collisions of C^{6+}, N^{6+}, N^{7+}, and O^{8+} ions with hydrogen
    C^{6+}, N^{6+}, N^{7+}, O^{8+} + H -> C^{5+}, N^{5+}, N^{6+}, O^{7+} $(2p-1s; \Sigma(np-1s))$
    x-ray observation
    0.47 - 7.5 keV/amu
    oven (dissociation 85%)

83E 3   Baptist,R. Bliman,S. Bonnet,J.J. Chauvet,G. Dousson,S. Hitz,D. Jacquot,B. Knystautas,E.J.
Phys. Lett. 93A (1983) 185-188
Radiative decay of lithium-like ions following charge exchange collisions of 60 keV O^{6+} ions with H_2
    O^{6+} + H_2 -> $O^{5+}(nl)$ + H_2^+
    photon emission spectroscopy
    3.75 keV/amu
    no cross sections given

83E 4   Bliman,S. Bonnefoy,M. Bonnet,J.J. Dousson,S. Fleury,A. Hitz,D. Jacquot,B.
Phys. Scripta T3 (1983) 63-67
Charge exchange collision experiments with highly charged ions-status report
    A^{z+} + He -> $A^{(z-1)+}$ (A = C, O, Ne); $Ar^{q+}(q=3-16)$ + D_2 -> $Ar^{(q-1)+}$
    growth
    2 - 5 keV/amu
    ECR source; total cross section and x-ray production cross section

83E 5   Bliman,S. Bonnet,J.J. Chauvet,G. Dousson,S. Hitz,D. Jacquot,B. Knystautas,E.J.
J. Phys. B 16 (1983) L243-245
Radiative decay of lithium-like ions following charge exchange collisions of 3 keV amu^{-1} C^{4+} ions with H_2
    C^{4+} + H_2 -> $C^{3+}(nl)$ + H_2^+
    photon emission spectroscopy
    3.3 keV/amu

83E 6   Bliman,S. Hitz,D. Jacquot,B. Harel,C. Salin,A.
J. Phys. B 16 (1983) 2849-2860

Charge exchange in the O^{8+} - He collisions at keV amu^{-1} energies
O^{8+} + He -> O^{7+}(n) + He$^+$, O^{6+}(n,n') + He^{2+}
· E. TOF; T. OEDM
0.9 - 5.3 keV/amu   ·

83E 7   Chetioui,A. Wohrer,K. Rozet,J.P. Jolly,A. Stephan,C. Belkic,Dz.
Gayet,A. Salin,A.
J. Phys. B 16 (1983) 3993-4003
State-to-state charge exchange cross sections in high-velocity
asymmetric and near-symmetric collisions of 400 MeV Fe^{26+} ions
Fe^{26+} + B -> Fe^{25+}(nl) + B$^+$(1s^{-1}) (B = He, N, Ar)
E. x-ray spectroscopy, T. continuum-distorted wave, strong-potential
Born, impulse
7000 keV/amu
x-ray (1s->np, nd)

83E 8   Church,D.A. Kenefick,R.A. Burns,W.S. Holmes,C.S.O.R. Huldt,S. Berry,S.
Breinig,M. Elston,S. Rozet,J.P. Sellin,I.A. Taylor,D. Thomas,B.
Phys. Rev. Letters 51 (1983) 1636-1639
Charge transfer to multicharged recoil ions in a Penning trap
Ne^{q+} + Ne -> $Ne^{(q-1)+}$ (q=2-6)
trapping method
q x 10^{-4} keV/amu
rate coefficients

83E 9   Cocke,C.L. Gray,T.J. Justiniano,E. Can.C. Waggoner,B. Varghese,S.L.
Mann,R.
Phys. Scripta T3 (1983) 75-78
Electron capture collisions involving low-energy highly stripped
projectiles
Ar^{q+} + He -> $Ar^{(q-1)+}$(q=3-6); Ne^{q+}(q=2-8) + He -> $Ne^{(q-1)+}$, $Ne^{(q-2)+}$;
Ar^{q+}(q=2-10) + Li -> $Ar^{(q-1)+}$
growth, energy gain spectroscopy
0.006 - 0.075 keV/amu
recoil ion; total cross section; n-distribution for Ne^{10+} + Xe

83E10   Damsgaard,H. Hangen,H.K. Hvelplund,P. Knudsen,H.
Phys. Rev. A 27 (1983) 112-116
Coincidence measurements of electron capture and target ionization in
multiply charged Au^{q+} + (He, Ne) collisions
Au^{q+} (q=5-21) + He, Ne -> $Au^{(q-1)+}$, $Au^{(q-2)+}$ + He^{r+}(r=1,2), Ne^{r+}(r=1-6)
coincidence
100 keV/amu

83E11   Dijkkamp,D. Brazuk,A. Drentje,A.G. de Heer,F.J. Winter,H.
J. Phys. B 16 (1983) L343-346
State-selective single-electron capture by 80 keV C^{4+} ions from He,
H_2 and Li
C^{4+} + He, H_2, Li -> C^{3+}(nl) + He$^+$, H_2^+, Li$^+$
photon emission spectroscopy
6.66 keV/amu

83E12   Gordeev,Yu.S. Dijkkamp,D. Drentje,A.G. de Heer,F.J.
Phys. Rev. Letters 50 (1983) 1842-1845
Electron capture into different (n,l) states in slow collisions of
C^{6+}, N^{6+}, O^{6+} and Ne^{6+} projectiles on He and H_2 targets
C^{6+}, N^{6+}, O^{6+}, Ne^{6+} + He -> C^{5+}(nl), N^{5+}(nl), O^{5+}(nl),
Ne^{5+}(nl) + He$^+$; N^{6+}, O^{6+} + H_2 -> N^{5+}(nl), O^{5+}(nl) + H_2^+,
photon emission spectroscopy
0.56 - 6.25 keV/amu

83E13   Groh,W. Muller,A. Schlachter,A.S. Salzborn,E.
J. Phys. B 16 (1983) 1997-2015
Transfer ionization in slow collisions of multiply charged ions with atoms
$A^{q+} + B \rightarrow A^{(q-k)+} + B^{i+} + (i-k)e$ {A=Ne (q=1-7) ; Ar(q=1-9) ;
Kr(q=1-12) ; Xe(q=1-15)}
coincidence
$(3-5)xq/M$ (keV/amu)
contribution of transfer ionization; charge fraction

83E14   Hall,J. Richard,P. Gray,T.J. Newcomb,J. Pemiller,P. Lin,C.D. Jones,K.
Johnson,B. Gregory,D.
Phys. Rev. A 28 (1983) 99-110
Systematics of single and double K-shell vacancy production in titanium
bombarded by heavy ions
$A^{z+} + Ti \rightarrow A^{(z-1)+}(1s) + Ti^{+}(1s^{-1});\ A^{(z-2)+}(1s^2) + Ti^{2+}(1s^{-2})$
(A = C, N, O, F, Mg, Si, S, Cl)
x-ray measurements
500 - 6500 keV/amu

83E15   Hanaki,H. Kusakabe,T. Nagai,N. Sakisaka,M.
J. Phys. Soc. Japan 52 (1983) 424-430
Electron capture of He^{2+} from gas target atoms at round a few keV
$He^{2+} + A \rightarrow He^{+}, He^{0}$ (A = Ne, Ar, Kr, Xe, N_2)
growth method
0.175 - 1.125 keV/amu
recoil ion source

83E16   Huber,B.A.
Phys. Scripta T3 (1983) 96-100
Energy gain and loss spectroscopy of charged changing collisions
between multiply charged ions and neutrals
$A^{q+} + B \rightarrow A^{(q-1)+}$ (A = Ne, Ar, Kr, Xe; B = H_2, He, Ar, Xe; q=2-6)
growth, energy gain spectroscopy
0.25 keV/amu
cross section vs. crossing radius

83E17   Huber,B.A. Kahlert,H.J.
J. Phys. B 16 (1983) 4655-4669
State-selective electron capture by $Ar^{2+}(^3P, ^1D, ^1S)$ ions in
He, Ne and Kr
$Ar^{2+} + He, Ne, Ar \rightarrow Ar^{+}$
translational energy spectroscopy
0.015 keV/amu
metastable beam fraction determined through beam attenuation

83E18   Hvelplund,P. Samsoe,E. Andersen,L.H. Haugen,H.G. Knudsen,H.
Physica Scripta T3 (1983) 176-181
Population of n,l states in electron-capture collisions between highly
charged, medium-velocity ions and H_2
$Au^{q+} + H_2 \rightarrow Au^{(q-1)+}(n) + H_2^{+}$ ($12 \leq q \leq 18$)
photon emission spectroscopy
100 keV/amu

83E19   Johnsen,R.
Phys. Rev. A 28 (1983) 1460-1468
Spectroscopic observations of the radiative charge transfer and
association of helium ions with neon atoms at thermal energy
$He^{+} + Ne \rightarrow He + Ne^{+} + h\nu$
selected ion drift tube technique
$3x10^{-5}$ keV/amu

rate coefficient

83E20   Kahlert,H.J. Huber,B.A. Wiesemann,K.
J. Phys. B 16 (1983) 449-459 .
Charge exchange and transfer ionisation in low-energy Ne^{2+} - Xe
collisions
   Ne^{2+} + Xe -> Ne^+ + Xe^+; Ne^+ + Xe^{2+} + e^-
   energy-loss/-gain spectroscopy
   10^{-2} keV/amu

83E21   Kamber,E.Y. Hasted,J.B.
J. Phys. B 16 (1983) 3025-3035
Single electron capture by Ar^{2+} and Ar^{3+} ions impacting helium
   Ar^{2+}, Ar^{3+} + He -> Ar^+, $Ar^{2+}(nl)$ + He^+ + ΔE
   energy loss spectroscopy
   0.0135, 0.03 keV/amu
   energy loss spectra

83E22   Knudsen,H. Hvelplund,P. Andersen,L.H. Bjornelund,S.
Phys. Scripta T3 (1983) 101-109
Experimental investigation of electron capture by highly charged ions
of medium velocities
   general analysis

83E23   Kuen,I. Stori,H. Howorka,F.
Phys. Rev. A 28 (1983) 119-126
Measurement of direct and charge exchange excitation cross sections in
in collisions of 1 - 800 eV (laboratory frame) He^+, Ne^+, Ar^+, Kr^+
and B^+ ions and of 1 - 3600 eV He^{2+}, Ne^{2+}, and Ar^{2+} ions with O_2
(wavelength region 2000 - 8000 A)
   A^+ + O_2 -> A^0 (A = He, Ne, Ar, Kr, B); A^{2+} + O_2 -> A^+
   (A = He, Ne, Ar)
   photon-spectroscopy
   1.2×10^{-5} - 0.45 keV/amu (A^+); 1.2×10^{-5} - 0.9 keV/amu (A^{2+})
   emission cross sections

83E24   Kusakabe,T. Hanaki,H. Nagai,N. Horiuchi,T. Konomi,I. Sakisaka,M.
Mem. Fac. Eng. Kyoto Univ. 45 (1983) 35-49
Charge transfer cross sections for multiply charged slow Ne, Ar, Kr and
Xe ions on various gas targets I. rare gas targets
   A^{q+} + B -> $A^{(q-k)+}$ + B^{k+} (A = Ne, Ar, Kr, Xe; q=2-11;
   B = He, Ne, Ar, Kr, Xe; k=1-5)
   growth
   0.15 - 3 keV/amu

83E25   Kusakabe,T. Nagai,N. Hanaki,H. Horiuchi,T. Sakisaka,M.
J. Phys. Soc. Japan 52 (1983) 4122-4128
Charge transfer cross sections for slow Ne^{2-5+} ions on He and H_2
   Ne^{q+} + B -> $Ne^{(q-k)+}$ + B^{k+} (q=2-5; B = He, H_2; k=1-2)
   growth
   0.15 - 3 keV/amu

83E26   Kusakabe,T. Hanaki,H. Nagai,N. Horiuchi,T. Sakisaka,M.
Phys. Scripta T3 (1983) 191-193
q-dependence of electron capture cross sections for slow Kr^{q+} and
Xe^{q+} ions on H_2 and He
   Kr^{q+}(q=2-9), Xe^{q+}(q=2-10) + H_2, He -> $Kr^{(q-k)+}$, Xe(q-k)+ (k=1-2)
   growth
   0.29 keV/amu
   total cross section

83E27   Lennon,M. McCullough,R.W. Gilbody,H.B.
         J. Phys. B 16 (1983) 2191-2204
         State-selective electron capture by C^{2+}, C^{3+}, N^{2+} and Ar^{2+} ions
         in rare gases
              C^{2+} + He, Ne, Ar -> C^+; N^{2+} + He, Ne -> N^+;
              Ar^{2+} + He, Ne -> Ar^+; C^{3+} + He -> C^{2+}
              energy-loss/-gain spectroscopy
              0.13 - 5 (C^{2+}); 5.7x10^{-2} - 0.57 (N^{2+}); 3.5x10^{-3} - 0.125
              (Ar^{2+}); 0.25 - 1.5 (C^{3+}) keV/amu

83E28   Lindinger,W.
         Phys. Scripta T3 (1983) 115-119
         Reactions of doubly charged ions at near thermal energies
              A^{2+} + B -> A^+ (A = He, C, O, Ne, Mg, Ar, Ca, Kr; B = He, Ne, Ar,
              Kr, Xe, Hg, H_2, N_2, O_2, NO, CO_2, SO_2, NO_2, NH_3, CH_4, C_2H_2)
              swarm method
              thermal energy
              rate coefficient - crossing radius

83E29   Matsumoto,A. Iwai,T. Kaneko,Y. Kimura,M. Kobayashi,N. Ohtani,S.
         Okuni,K. Takagi,S. Tawara,H. Tsurubuchi,S.
         J. Phys. Soc. Japan 52 (1983) 3291-3293
         Measurement of relative population between B^{2+}(2s) and B^{2+}(2p) in
         electron capture collision of B^{3+} with He
              B^{3+} + He -> B^{2+}(2s, 2p)
              energy-gain spectroscopy
              0.09 - 0.3 keV/amu
            · relative value

83E30   Matsumoto,A. Sano,T. Twai,T.
         J. Phys. Soc. Japan 52 (1983) 1173-1177
         Observation of N_2^* 3914 A band emission in collisions of singly-and
         doubly-charged Ar, Kr and Xe ions with N_2 at keV energies
              A^{q+} + N_2 -> $A^{(q-1)+}$ + N_2^+ ($B^2\Sigma u^+$) (A = Ar, Kr, Xe, q=1, 2)
              optical spectroscopy
              0.03 - 0.2 keV/amu
              relative emission cross section

83E31   Mayo,M. Stone,J.A. Morgan,T.J.
         Phys. Rev. A 28 (1983) 1315-1321
         Charge changing cross sections for 1 - 70 keV H^+ and H^0 in
         collisions with calcium and strontium metal vapors
              H^+(H^0) + Ca, Sr -> H^0, H^- (H^+, H^-)
              growth
              1 - 70 keV/amu

83E32   McCullough,R.W. Lennon,M. Wilkie,F.G. Gilbody,H.B.
         J. Phys. B 16 (1983) L173-176
         State-selective electron capture by N^{2+} ions in atomic hydrogen using
         collision spectroscopy
              N^{2+} + H -> N^+($2s2p^3$) $^3P^0$, $^3D^0$ + H^+
              energy-loss/-gain
              0.57 keV/amu

83E33   Mikoushkin,V.M. Ogurtsov,G.N. Flaks,I.P.
         J. Phys. B 16 (1983) L405-408
         Autoionisation in quasimolecular system formed in multiply charged
         ion-atoms collisions
              He^+, He^{2+}, Ne^{n+}, Ar^{n+} + Xe -> He, He^+, $Ne^{(n-1)+}$,
              $Ar^{(n-1)+}$ + Xe^{2+} + e (n=1,2,3)
              electron emission spectroscopy

1.25 - 7.5 (He^+, He^{2+}), 0.25 - 1.5 (Ne^{n+}), 0.125 - 0.75
(Ar^{n+}) keV/amu

83E34   Muller,A. Groh,W. Salzborn,E.   ·
         Phys. Rev. Letters 51 (1983) 107-109
         Statistical interpretation of transfer ionization in slow collisions of
         multiply charged ions with atoms
             Xe^{q+} + Xe -> $Xe^{(q-l)+}$ + Xe^{k+} + (k-i)e (q=3-15)
         statistical model for transfer ionization and multiple-ionization

83E35   Neil,P.A. Angel,G.C. Dunn,K.F. Gilbody,H.B.
         J. Phys. B 16 (1983) 2185-2190
         Charge transfer and ionization in H^+ - C^+ and H^+ - N^+ collisions
             H^+ + C^+, N^+ -> H^0 + C^{2+}, N^{2+}
         crossed beam technique
         65 - 470 keV/amu

83E36   Ohtani,S.
         Phys. Scripta T3 (1983) 110-114
         Recent activities at NICE Nagoya
             A^{q+} + He -> $A^{(q-1)+}$(n) + He^+ (A=C, N, O; q=3-8)
         energy gain spectroscopy
         1xq/M (keV/amu)
         total cross section vs. crossing radius

83E37   Okuno,K. Tawara,H. Iwai,T. Kaneko,Y. Kimura,M. Kobayashi,N.
         Matsumoto,A. Ohtani,S. Takagi,S. Tsurubuchi,S.
         Phys. Rev. A 28 (1983) 127-134
         Energy-spectroscopic studies of electron-capture processes by
         low-energy, highly stripped C, N, and O ions from He
             C^{4+}, C^{5+}, N^{5+}, N^{6+}, O^{6+} + He -> (single and double)
         electron transfer
         energy-loss/-gain spectroscopy
         0.33, 0.66 (C^{4+}); 0.41, 0.82 (C^{5+}); 0.36, 0.72 (N^{5+});
         0.43, 0.86 (N^{6+}); 0.37, 0.74 (O^{6+}) keV/amu
         n-distribution; no cross sections

83E38   Panov,M.N. Basalaev,A.A. Lozhkin,K.O.
         Phys. Scripta T3 (1983) 124-130
         Interaction of fully stripped, hydrogenlike and heliumlike C, N, O, Ne
         and Ar ion with H and He atoms and H_2 molecules
             Ar^{q+}(q=3-7) + He -> $Ar^{(q-1)+}$(nl) + He^+
         photon emission spectroscopy
         0.6 - 8 keV/amu

83E39   Peart,B. Rinn,K. Dolder,K.
         J. Phys. B 16 (1983) 2831-2835
         Measurements of cross sections for inelastic collisions between
         $^4He^+$ ions
             He^+ + He^+ -> He^0 + He^{2+}; He^+ + He^{2+} + e
         crossed beam
         7 - 29 keV/amu

83E40   Pedersen,E.H. Cocke,C.L. Rasmussen,J.L. Varghese,S.L. Waggoner,W.
         J. Phys. B 16 (1983) 1799-1804   ·
         Capture of Ar K-shell electrons by protons
             H^+ + Ar -> H + $Ar^+(1s^{-1})$
         x-ray coincidence
         1500 - 10000 keV/amu   ‑
         impact parameter dependence

83E41   Pedersen,E.H. Cocke,C.L. Stockli,M.
         Phys. Rev. Letters 50 (1983) 1910-1913
         Experimental observation of the Thomas peak in high velocity electron
         capture by protons from He
             $H^+ + He \rightarrow H^0$
             2820 - 7400 keV/amu
             angular distributions in Thomas peak

83E42   Phaneuf,R.A.
         Phys. Rev. A 28 (1983) 1310-1314
         Electron capture by slow Fe^{q+} ions from hydrogen atoms and molecules
             $Fe^{q+}(q=3-14) + H, H_2 \rightarrow Fe^{(q-1)+}$
             growth
             0.01 - 0.095 keV/amu
             total cross sections

83E43   Prior,M.H. Marrus,R. Vane,C.R.
         Phys. Rev. A 26 (1983) 141-150
         Electron capture by trapped Ne^{q+} ions at very low energies
             $Ne^{q+}(q=1-10) + Ne, Xe \rightarrow Ne^{(q-1)+}$
             trapping beam technique
             5×10^{-5} - 3.5×10^{-3} keV/amu
             trapped recoil ion

83E44   Rudd,M.E. DuBois,R.D. Toburen,L.H. Ratcliffe,C.A. Goffe,T.V.
         Phys. Rev. A 28 (1983) 3244-3257
         Cross sections for ionization of gases by 5 - 4000 keV protons and for
         ·electron capture by 5 - 150 keV protons
             $H^+ + B \rightarrow H^0$ (B = He, Ne, Ar, Kr, H_2, N_2, CO, O_2, CH_4, CO_2)
             condenser plate method
             5 - 150 keV/amu

83E45   Sakisaka,M. Hanaki,H. Nagai,N. Horiuchi,T. Konomi,I. Kusakabe,T.
         J. Phys. Soc. Japan 52 (1983) 716-717
         A statistical model for collisions of multiple electron transfer
             $Kr^{q+}(q=2-9) + Kr \rightarrow Kr^{(q-2)+} + Kr^{i+}$ (i=1-5)
             0.29 keV/amu
             multiple electron transfer

83E46   Schlachter,A. Stearns,J.W. Graham,W.G. Berkner,K.H. Pyle,R.V. Tanis,J.A.
         Phys. Rev. A 27 (1983) 3372-3374
         Electron capture for fast highly charged ions in gas targets;
         an empirical scaling rule
             300 - 8500 keV/amu
             total cross section; scaling law

83E47   Schuessler,H.A. Holder,C.H. Sing,O.
         Phys. Rev. A 28 (1983) 1817-1820
         Orbiting charge transfer cross sections between He^+ ions and cesium
         atoms at near-thermal ion-atom energies
             $He^+ + Cs \rightarrow He(1s^2, 1s2s, 1s2p)$
             trapped technique
             3.9×10^{-5} - 2.4×10^{-4} keV/amu

83E48   Shields,G.C. Moran,T.F.
         J. Phys. B 16 (1983) 3591-3601
         Single-and double-electron transfer reactions of ground and metastable
         state Ar^{2+} ions
             $Ar^{2+} + B \rightarrow Ar^+, Ar^0$ (B = O_2, N_2, CO, CO_2, CH_4, C_2H_6)
             TOF
             0.1 - 0.175 keV/amu

total cross section

83E49   Stevens,J. Petersen,R.S. Pollack,E.
         Phys. Rev. A 27 (1983) 2396-2402
         Electron capture in small-angle Ar^{2+} + Ar collisions
             Ar^{2+} + Ar -> Ar^+ (^2P) + $Ar^+(3s^23p^4nl)$
             energy loss/gain spectroscopy
             0.0725 keV/amu
             scattering angle 0-1; relative cross section

83E50   Terasawa,M. Gray,T.J. Hagmann,S. Hall,J. Newcomb,J. Pepmiller,P.
         Richard,P.
         Phys. Rev. A 27 (1983) 2868-2875
         Electron capture by and electron excitation of two-electron fluorine
         ions incident on helium
             $F^{7+}(1s2s\ ^3S)$ + He -> $F^{6+}(1s2s2p\ ^4P)$
             x-ray spectroscopy
             315 - 2100 keV/amu
             total cross section

83E51   Winter,H.
         J. Phys. B 16 (1983) L521-523
         Comments on "radiative decay of lithium-like ions following exchange
         collisions of 3 keV/amu C^{4+} with H_2"
             C^{4+} + H_2 -> $C^{3+}(nl)$
             VUV photon spectroscopy
             3 keV/amu

83E52   Winter,H.
         Phys. Scripta T3 (1983) 159-162
         Empirical state-selection rules for electron capture in low
         energy-ion-atom collisions
             Ne^+, Ne^{2+}, O^+ + Li -> Ne(nl), Ne^+(nl), O(nl) + Li^+
             energy-loss/gain spectroscopy
             7 - 25 keV/amu

83E53   Yan,P.G. van der Woude,R. Dijkkamp,D. de Heer,F.J.
         Phys. Scripta T3 (1983) 120-123
         Electron capture into excited states in collisions between multiply
         charged ions and atoms
             He^{2+}, C^{q+}, O^{q+}(q=1,2,3) + Li -> He^+, $C^{(q-1)+}$, $O^{(q-1)+}$(nl);
             C^{q+}, O^{q+} + H_2 -> $C^{(q-1)+}$, $O^{(q-1)+}$(nl)
             photon emission spectroscopy
             1 - 37.5 keV/amu

84E 1   Andersen,L.H. Frost,M. Hvelplund,P. Knudsen,H. Datz,S.
         Phys. Rev. Letters 52 (1984) 518-521
         Correlated two-electron effects in highly charged ion-atom collisions;
         transfer ionization and transfer excitation in 20-MeV Au^{15+} + He
         collisions
             Au^{15+} + He -> Au^{14+} + He^+; Au^{13+} + He^{2+}
             Electron emission spectroscopy coincidence with final projectile
             charge state
             3939.0 keV/amu

84E 2   Anholt,R. Andriamonje,S.A. Morenzoni,E. Stoller,Ch. Molitoris,J.D.
         Meyerhof,W.E. Borman,H. Xu,J.S. Xu,Z.Z. Rasmussen,J.O. Hoffmann,D.H.
         Phys. Rev. Letters 53 (1984) 234-237
         Observation of radiative capture in relativistic heavy ion-atom
         collisions
             A^{q+} + B -> $A^{(q-1)+}$ + $h\nu$ + B^+ (q = z, z-1; A = Xe, La, U;

B = Be-Ta)
x-ray spectroscopy
10^5 keV/amu
REC cross sections; angular districution

84E 3   Astner,G. Barany,A. Cederquist,H. Danared,H. Huldt,S. Hvelplund,P.
Johnson,A. Knudsen,H. Liljeby,L. Renfelt,K.G.
J. Phys. B 17 (1984) L877-883
Absolute cross sections for multielectron processes in low-energy
Ar^{q+} - Ar collisions as measured with a new technique
Ar^{q+} + Ar -> Ar^{r+} + Ar^{2+} + (r+s-q)e
TOF
0.45xq keV/amu
recoil ions

84E 4   Aumayr,F. Fehringer,M. Winter,H.
J. Phys. B 17 (1984) 4201-4211
Inelastic H^+ - Li(2s) collisions (2-20 keV); II. electron capture
into H(2p) and H(3l) subshells
H^+ + Li(2s) -> H(2p), H(3s, 3p, 3d)
photon spectroscopy
2 - 20 keV/amu

84E 5   Bahring,A. Hertel,I.V. Meyer,E. Schmidt,H.
Phys. Rev. Letters 53 (1984) 1433-1436
Polarization dependence of resonant charge transfer in low energy
collisions of Na^+ with laser-excited Na^*(3p)
Na^+ + Na^*(3s, 3p) -> Na(3s, 3p) + Na^+
E. photon spectroscopy; T. MO model calculation
0.045 - 0.075 keV/amu
polarization measured

84E 6   Baptist,R. Bonnet,J.J. Chauvet,G. Desclaux,J.P. Dousson,S. Hitz,D.
J. Phys. B 17 (1984) L417-421
Polarisation of light emitted after charge transfer from H_2 to C^{4+}
ions
C^{4+} + H_2 -> C^{3+}($3lm_l$) + H_2^+
photon emission spectroscopy
0.3 - 3 keV/amu

84E 7   Berkowitz,K. Zorn,J.C.
Phys. Rev. A 29 (1984) 611-616
Charge transfer into the metastable 2s level of hydrogen by protons
colliding with K and Na
H^+ + K, Na -> H(2s)
growth
0.5 - 2.5 keV/amu

84E 8   Boellaard,A.
FOM Institute for Atomic and Molecular Physics Report No.58.245
Electron capture into He^{2+} - Li collisions at 0.55 - 10.0 keV
He^{2+} - Li -> He^*(nl)
photon spectroscopy
0.138 - 2.5 keV/amu

84E 9   Bordenave-Montesquieu,A. Benoit-Cattin,P. Gleizes,A. Marrakchi,A.I.
Dousson,S. Hitz,D.
J. Phys. B 17 (1984) L127-131
Autoionisation of N^{5+}(nln'l') with n=2,3,4 and n'≥ n measured by
electron spectrometry in collisions of N^{7+} with He and H_2, at 4.9
keV amu^{-1}

N^{7+} + He, H_2 -> $N^{5+}(nln'l')$ + He^{2+}, H_2^{2+} (n=2,3,4; n'≥ n)
electron emission spectroscopy
4.9 keV/amu

84E10   Bordenave-Montesquieu,A. Benoit-Cattin,P. Gleizes,A. Marrakchi,A.I.
Dousoon,S. Hitz,D.
J. Phys. B 17 (1984) L223-227
Two-electron capture into autoionising configurations $N^{4+}(1snln'l')$
with n=2,3,4 and n'≥n, observed by electron spectrometory in
collisions of $N^{6+}(1s)$ with He and H_2, at 4.2 keVamu^{-1}
    N^{6+} + He, H_2 -> $N^{4+}(1snln'l')$ + He^{2+}, H_2^{2+} (n=2,3,4 ;n'≥ n)
    electron emission spectrosocpy
    4.2 keV/amu

84E11   Brazuk,A. Dijkkamp,D. Drentje,A.G. de Heer,F.J. Winter,H.
J. Phys. B 17 (1984) 2489-2505
Measurement of metastable fractions in multiply charged ion beams by
ion excitation in core-conserving electron capture
    C^{2+}, N^{3+}, O^{4+}, N^{2+} + Li -> C^+, N^{2+}, O^{3+}, N^+ + Li^+
    photon emission spectroscopy
    1.665 (C^{2+}), 1.43 (N^{3+}), 1.25 (O^{4+}), 1.43 (N^{2+}) keV/amu

84E12   Brazuk,A. Winter,H. Dijkkamp,D. Boellaard,A. de Heer,F.J. Drentje,A.G.
Phys. Lett. 101A (1984) 139-141
Absolute emission cross sections for detection of plasma impurity ions
with active neutral lithium beam diagnostics
    C^{q+}, O^{q+} + Li -> $C^{(q-1)+}$, $O^{(q'-1)+}$ + Li^+ (q = 3,4,5,6 ; q'= 4,5,6,7)
    photon emission spectroscopy
    1.66,2.5 (C^{q+} + Li); 1.25,1.88 (O^{q+} + Li) keV/amu

84E13   de Bruijn,D.P. Neuteboom,J. Sidis,V. Los,J.
Chem. Phys. 85 (1984) 215-231
A detailed experimental study of the dissociative charge exchange of
H_2^+ with Ar, Mg, Na and Cs targets at keV energies
    H_2^+ + B -> H_2^* (B = Ar, Mg, Na, Cs)
    growth
    0.75 - 3.75 keV/amu

84E14   Dijkkamp,D. Brazuk,A. Drentje,A.G. de Heer,F.J. Winter,H.
J. Phys. B 17 (1984) 4371-4385
Single-electron capture into $C^{3+}(n,l)$ subshells in C^{4+} - Li
collisions (20-80 keV)
    C^{4+} + Li -> $C^{3+}(nl)$ + Li^+ (n<=7)
    photon emission spectroscopy
    0.8 - 6.7 keV/amu

84E15   Dmitriev,I.S. Vorobev,N.F. Konovalova,Zh.M. Nikolaev,V.S.
Novozhilova,V.N. Teplova,Ya.A. Fainberg,Yu.A.
Sov. Phys. -JETP 57 (1984) 1157-1164
Loss and capture of electrons by fast ions and atoms of helium in
various media
    He^{2+}; He^+ + B -> He^+, He^0; He^0 (B = He, Ne, N_2, Sr)
    E. growth; T. modified OBK
    331 - 2070 keV/amu

84E16   DuBois,R.D.
Phys. Rev. Letters 52 (1984) 2348-2351
Electron production in collisions between light ions and rare gases;
The importance of the charge transfer and direct ionization channels
    H^+, He^+ + B -> H^0, He^0 + B^{i+} (B = Ne, Ar, Kr)
    coincidence between H^0, He^0 and B^{i+} ions

15 - 100 (H); 4 - 25 (He) keV/amu

84E17   DuBois,R.D. Giese,J.P. Cocke,C.L.
         Phys. Rev. A 29 (1984) 1079-1082
         Contribution of electron capture to 2p-vacancy production in
         p - Mg collisions
         $H^+ + Mg(2p) \rightarrow H^0 + Mg(2p^{-1})$; $H + Mg(2p^{-1})$
         growth
         25 - 80 keV/amu

84E18   Gould,H. Greiner,D. Lindstrom,P. Symons,T.J.M. Crawford,H.
         Phys. Rev. Letters 52 (1984) 180-183
         Electron capture by U^{91+} and U^{92+} and ionization of U^{90+} and U^{91+}
         U^{91+}, U^{92+} + B $\rightarrow$ U^{90+}, U^{91+} (B = C, Cu, Ta)
         growth method
         4×10^5 - 9.6×10^5 keV/amu

84E19   Graham,W.G. Berkner,K.H. Pyle,R.V. Schlachter,A.S. Stearns,J.W.
         Tanis,J.A.
         Phys. Rev. A 30 (1984) 722-728
         Charge transfer cross sections for multiply charge ions colliding with
         gaseous targets at energies from 310 keV/amu to 8.5 MeV/amu
         A^{q+} + B $\rightarrow$ $A^{(q-1)+}$, $A^{(q-2)+}$, $A^{(q+1)+}$ (A = C, Ar, Fe, Nb, Pb;
         q = 6-59; B = H_2, He, N_2, Ne, Ar, Xe)
         growth
         310- 8500 keV/amu
         total cross section

84E20   Hanaki,H. Kusakabe,T. Horiuchi,T. Konomi,I. Nagai,N. Yamaguchi,T.
         Sakisaka,M.
         Mem. Fac. Eng. Kyoto Univ. 46 (1984) 1-17
         Charge transfer cross sections for multiply charged slow Ne, Ar, Kr and
         Xe ions on various gas targets II. molecular gas targets
         A^{q+} + B $\rightarrow$ $A^{(q-k)+}$ + B^{k+} (A = Ne, Ar, Kr, Xe ; q=2-11 ;
         B = H_2, N_2, CO_2, CH_4, C_2H_6, C_3H_8 ; k=1-5)
         growth
         0.15 - 3 keV/amu

84E21   Heckman,V. Martin,S.J. Jakacky,J. Pollack,E.
         Phys. Rev. A 30 (1984) 2261-2263
         Electron capture in $H^+ + H_2$
         $H^+ + H_2 \rightarrow H(1s) + H_2^+(^2\Sigma g^+)$
         TOF method
         1 - 3 keV/amu
         probability as a function of scattered angle

84E22   Howald,A.M. Miers,R.E. Allen,J.S. Anderson,L.W. Lin,C.C.
         Phys. Rev. A 29 (1984) 1083-1087
         Charge-changing cross sections for 1 - 25 keV H(1s) incident on a
         Na-vapor target
         $H(1s) + Na \rightarrow H^+$, H^-
         growth
         1 - 25 keV/amu
         total cross section

84E23   Huber,B.A. Kahlert,H.J.
         J. Phys. B 17 (1984) L69-74
         On the importance of metastable $Ne^{2+}(^1D_2)$ ions in charge-changing
         Ne^{2+} - Xe collisions
         $Ne^{2+} + Xe \rightarrow Ne^+ + Xe^+$; $Ne^+ + Xe^{2+} + e^-$
         energy-loss-/-gain spectroscopy

2×10^{-2}, 5×10^{-2} keV/amu

84E24   Huber,B.A. Kahlert,H.J. Wiesemann,K.
J. Phys. B 17 (1984) 2883-2895
Study of electron capture reactions by means of double translational
spectroscopy
Ar^{3+}, Ar^{3+*} + Ar -> Ar^{2+*} + Ar^+
double translational spectroscopy
0.015 keV/amu

84E25   Iwai,T. Kaneko,Y. Kimura,M. Kobayashi,N. Matsumoto,A. Ohtani,S.
Okuno,K. Takagi,S. Tawara,H. Tsurubuchi,S.
J. Phys. B 17 (1984) L95-99
The dependence on Rc of cross sections for one-electron capture by
S^{11+}, S^{13+} and $Kr^{q+}(q=7-25)$ ions from He
S^{11+}, S^{13+}, $Kr^{q+}(q=7-25)$ + He -> S^{10+}, S^{12+}, $Kr^{(q-1)+}$ + He^+ + ΔE
translational energy spectroscopy
1xq/M keV/amu
total cross sections vs. crossing radius

84E26   Jolly,A. Wohrer,K. Chetioui,A. Rozet,J.P. Stephan,C. Dube,L.J.
J. Phys. B 17 (1984) 235-242
Total charge transfer cross sections for 400 MeV bare Fe^{26+} ions
colliding with He, N_2, Ne and Ar targets
Fe^{26+} + He, N_2, Ne, Ar -> Fe^{25+}
Lyman x-rays
7140 keV/amu
total cross section

84E27   Justiniano,E. Cocke,C.L. Gray,T.J. DuBois,R. Can,C. Waggoner,W.
Schuch,R. Schmidt-Bocking,H. Ingwersen,H.
Phys. Rev. A 29 (1984) 1088-1095
Total cross sections for electron capture and tranfer ionization by
highly stripped, slow Ne, Ar, Kr and Xe projectiles on helium
Ne^{q+}, Ar^{q+}, Kr^{q+}, Xe^{q+} + He -> $Ne^{(q-i)+}$, $Ar^{(q-i)+}$,
$Kr^{(q-i)+}$, $Xe^{(q-i)+}$ (i= 1-2)
(0.25 - 1.0)xq/M keV/amu
recoil ion sources; total cross sections

84E28   Kamber,E.Y. Brenton,A.G. Beynon,J.H.
J. Phys. B 17 (1984) 4919-4933
Single electron capture collisions of ground and metastable N^{2+*} ions
with atomic and molecular gases
N^{2+}, N^{2+*} + He, Ne, Ar, Kr, Xe, H_2, N_2 -> Ne^+
translational energy spectroscopy
0.43 keV/amu
no cross sections given

84E29   Kamber,E.Y. Hasted,J.B.
Vacuum 34 (1984) 63-65
Energy loss spectra for single electron capture in Ar^{3+} - He
collisions
Ar^{3+} - He -> Ar^{2+} + H^+ + ΔE
energy loss spectroscopy
0.03 keV/amu
no cross section

84E30   Kase,M. Kikuchi,A. Yagishita,A. Nakai,Y.
J. Phys. B 17 (1984) 671-677
Single and double-electron capture cross sections for Ne^+ in He, Ne
and Ar

Ne^{2+} + He, Ne, Ar -> Ne^+, Ne^0
growth
25 - 150 keV/amu
total cross section

84E31   Katayama,I. Berg,G.P.A. Hulimann,W. Martin,S.A. Meissburger,I.
Aelert,W. Rogge,M. Romer,J.G.M. Rain,J.L. Zemlo,L. Gaul,G.
J. Phys. B 17 (1984) L23-28
High energy electron capture and stripping in gas targets
$^3He^{2+}$ + N_2, Ne, Ar -> He
attenuation method
2×10^4 - 4×10^4 keV/amu

84E32   Kheyrandish,H. Armour,D.G. Jones,E.J.
Vacuum 34 (1984) 269-273
The measurement of charge transfer cross sections for a variety of ions
on air and argon
A^+ + B -> A (A = Sb, As, In, P, N_2, O_2, N, O, Ge, Cr, Fe;
B = air, Ar)
growth
0.08 - 2.9 keV/amu

84E33   McCullough,R.W. Wilkie,F.G. Gilbody,H.B.
J. Phys. B 17 (1984) 1373-1382
State-selective electron capture by slow C^{2+} and C^{3+} ions in atomic
hydrogen
C^{2+} + H -> C^+ + H^+; C^{3+} + H -> $C^{2+}((2s3s)^3S$,
$(2s3p)^3P^0$, $(2p)^2\ ^1S$, $(2p)^2\ ^1D)$ + H^+
energy-loss/gain spectroscopy
5×10^{-2} - 1.5 keV/amu

84E34 . Newcomb,J. Dillingham,T.R. Hall,J. Varghese,S.L. Pepmiller,P.L.
Richard,P.
Phys. Rev. A 29 (1984) 82-91
Electron capture by metastable projectiles on He and Ne
$F^{7+}(1s2s\ ^3S)$ + He, Ne -> F^{6+}
Auger electron
·315 - 789 keV/amu

84E35   Nielsen,E.H. Andersen,L.H. Barany,A. Cederquist,H. Hvelplund,P.
Knudsen,H. MacAdam,K.B. Sorensen,J.
J. Phys. B 17 (1984) L139-144
Energy-gain spectroscopy measurements of single-electron capture by
Ar^{6+} in Ne and Ar
Ar^{6+} + Ne, Ar -> $Ar^{5+}(nl)$
energy-gain spectroscopy
0.0025 - 0.025 keV/amu
total and partial cross section

84E36   Nikulin,V.K. Dijkkamp,D. Gordeev,Yu.S. Samoylov,A.V. de Heer,F.J.
J. Phys. B 17 (1984) L721-725
Electron capture into excited projectile states in 6 - 100 keV Ne^{4+} -
Ne collisions
Ne^{4+} + Ne -> $Ne^{3+}(2p^2, nl)$; $Ne^{2+}(2p^2, nl^2)$
0.25 - 6.25 keV/amu

84E37   Ohtani,S.
Electronic and Atomic Collisions (eds. Eichler,J. Hertel,I.V.
Stolterfoht,N. (North-Holland, Amsterdam)) (1984)
One-electron capture by highly stripped ions from helium atoms
C^{q+}, N^{q+}, O^{q+} + He -> $C^{(q-1)+}$, $N^{(q-1)+}$, $O^{(q-1)+}$ + He^+

energy-loss/-gain

84E38   Peterson,J.R. Bae,Y.K.
         Phys. Rev. A 30 (1984) 2807-2810
         Product states of H_3^+, H_2^+ and O_2^+ electron capture in Cs
         D_2^+; D_3^+; O_2^+ + Cs -> dissociative charge transfer
         energy analysis
         0.3 keV/amu

84E39   Roncin,P. Barat,M. Laurent,H. Pommier,J. Dousson,S. Hitz,D.
         J. Phys. B 17 (1984) L521-525
         Transfer ionization and two-electron capture processes in N^{6+} - He
         collisions at 3 - 34 keV energies
         Ne^{6+} + He -> Ne^{5+} (n=3,4)
         energy-gain spectroscopy
         0.1 keV/amu
         angular dependence of energy-gain spectra; contribution of
         two-electron capture and transfer ionization

84E40   Schmeissner,C. Cocke,C.L. Mann,R. Meyerhof,W.
         Phys. Rev. A 30 (1984) 1661-1671
         Energy-gain spectroscopy studies of electron capture from helium by
         slow multiply charged neon ions
         Ne^{q+} + He -> $Ne^{(q-1)+}$ (q=3-8)
         energy-loss/-gain
         3.5×10^{-3} - 2.6×10^{-2} keV/amu

84E41   Sorensen,J. Andersen,L.H. Hvelplund,P. Knudsen,H. Liljeby,L.
         Nielsen,E.H.
         J. Phys. B 17 (1984) 4743-4756
         Cross sections $\sigma(nl)$ for electron capture collisions between medium
         velocity, highly charged ions and molecular hydrogen
         Au^{q+} + H_2 -> $Au^{(q-1)+}(nl)$ + H_2^+ (q=12-18)
         photon emission spectroscopy
         100 keV/amu

84E42   Szucs,S. Karemera,M. Terao,M. Brouillard,F.
         J. Phys. B 17 (1984) 1613-1622
         Experimental study of the mutual neutralization of H^+ and H^-
         between 5 and 2000 eV
         H^+ + H^- -> H + H
         merging beam technique
         5×10^{-3} - 2 keV/amu

84E43   Tanis,J.A. Bernstein,E.M. Graham,W.G. Stockli,M.D. Clark,M.
         McFarland,R.H. Morgan,T.J. Berkner,K.H. Schlachter,A.S. Stearns,J.W.
         Phys. Rev. Letters 53 (1984) 2551-2554
         Resonant electron transfer and excitation in two- three- and four
         electron Ca^{q+} and V^{q+} ions colliding with helium
         Ca^{q+}(q=16-18), V^{q+}(q=19-21) + He -> $Ca^{(q-1)+}$, $C^{(q-1)+}$
         RTE
         2500 - 9000 (Ca), 3530 - 9000 (V) keV/amu

84E44   Tanis,J.A. Bernstein,E.M. Stockli,M.P. Graham,W.G. Berkner,K.H.
         Markevich,D.J. McFarland,R.H. Pyle,R.V. Stearns,J.W. Willis,J.E.
         Phys. Rev. A 29 (1984) 2232
         Correlations between charge-changing interactions and projectile $K\alpha$-
         x-ray emission in Ar + Xe collisions
         Ar^{q+} + Xe -> $Ar^{(q-1)+}$ (q=15, 16, 17)
         coincidence between x-rays and projectiles
         4000 - 4500 keV/amu

84E45   Tawara,H. Iwai,T. Kaneko,Y. Kimura,M. Kobayashi,N. Matsumoto,A.
              Ohtani,K. Takagi,S. Tsurubuchi,S.
              Phys. Rev. A 29 (1984) 1529-1532
              Energy-spectroscopy studies of electron-capture processes of
              low-energy, highly stripped F and Ne ions in collisions
                  $F^{q+} + He \rightarrow F^{(q-1)+} + He^{+}(q=6,7,8)$;
                  $Ne^{q+} + He \rightarrow Ne^{(q-1)+} + He^{+}$ (q=7,8,9)
                  energy-loss/gain spectroscopy
                  1xq/M keV/amu

84E46   Varghese,S.L. Waggoner,W. Cocke,C.L.
              Phys. Rev. A 29 (1984) 2453-2456
              Electron capture from lithium by protons and helium ions
                  H^{+}, He^{+}, $He^{2+} + Li \rightarrow H^{0}$, He^{0}, He^{+}
                  growth
                  0.257 - 3.85 (H), 0.06 - 2 (He) keV/amu

84E47   Waggoner,W. Cocke,C.L. Varghese,S.L. Stockli,M.
              Phys. Rev. A 29 (1984) 2457-2462
              Experimental cross sections for electron capture from lithium by slow,
              highly charged, rare-gas projectiles
                  Ne^{q+}, Ar^{q+}, Kr^{q+}, $Xe^{q+} + Li \rightarrow Ne^{(q-1)+}$, $Ar^{(q-1)+}$,
                  $Kr^{(q-1)+}$, $Xe^{(q-1)+}$ (q=2-10)
                  Li-oven
                    (0.1 - 1.0)xq/M keV/amu

84E48   Watts,M.F. Angel,G.C. Dunn,K.F. Gilbody,H.B.
              J. Phys. B 17 (1984) 1631-1635
              Charge transfer and ionization in collisions between Li^{+} ions
                  $Li^{+} + Li^{+} \rightarrow Li^{+} + Li^{2+} + e$; $Li^{0} + Li^{2+}$
                  crossed beam technique
                  0.053 - 0.24 keV/amu

84E49   Williams,I.D. Geddes,J. Gilbody,H.B.
               J. Phys. B 17 (1984) 1547-1558
              Electron capture, loss and excitation in collisions of H^{+}, H(1s),
              H(2s) and H^{-} in atomic oxygen
                  $H^{+} + B \rightarrow H^{0}$ (total, 2s); H(1s) + B $\rightarrow H^{+}$, H^{0}(2s), H^{-};
                  H(2s) + B $\rightarrow H^{+}$, H^{-} (B = O, O_2)
                  growth
                  2.5 - 25 keV/amu
                  Ir tube furnace

84E50   Wohrer,K. Chetioui,A. Rozet,J.P. Jolly,A. Stephan,C.
              J. Phys. B 17 (1984) 1575-1587
              K-K transfer cross sections in near-symmetric Fe^{26+} ion-atom
              collisions at intermediate velocity
                  $Fe^{26+} + B \rightarrow Fe^{25+}$(1s) + $B(1s^{-1})$ (B = Ar, Kr, Zr, Ag, Sn)
                  x-ray spectroscopy
                  7142 keV/amu

84E51   Woods,C.J. Sofield,C.J. Cowern,N.E.B. Murrell,M. Draper,J.
              J. Phys. B 17 (1984) 867-878
              Comparison of charge-changing cross sections in gaseous and solid
              targets
                  $C^{q+} + B \rightarrow C^{(q\pm i)+}$ (q=4-6 ; i=1,2 ; B= carbon foil, CH_4,
                  C_2H_6, C_2H_4, C_2H_2)
                  growth
                  3000 keV/amu

85E 1   Alvarez,I. Cisneros,C. Morales,A. Morgan,T.J.
Phys. Letters, 109A .(1985) 268-270
H^- formation in H^0 + Mg collisions
   H^0 + Mg -> H^-
   growth
   1.0 - 5.0 keV/amu

85E 2   Andrews,M.C. McDaniel,F.D. Duggan,J.L. Miller,P.D. Pepmiller,P.L.
Krause,H.F. Rosseel,T.M. Rayburn,L.A. Mehta,R. Lapicki,G.
Nucl. Instr. Meth. in Phys. Res. B 10/11 (1985) 186-189
M-shell electron capture and direct ionization of gold by 25 MeV carbon
and 32 MeV oxygen ions
   C^{6+}, O^{8+} + Au -> C^{5+}, O^{7+} + Au^+ $(3l^{-1})$
   x-ray coincidence
   2000 keV/amu

85E 3   Andriamonje,S. Chemin,J.F. Rofurier,J. Saboya,B. Schenrer,J.N.
Belkic,Dz. Gayet,R. Solin,A. Laurent,H. Schapira,J.P.
J. Physique 46 (1985) 349-353
Electron capture from the krypton M-shell by MeV protons
   H^+ + Kr -> H^0(1s) + $Kr^+(3l^{-1})$
   E. x-ray coincidence; T. CDW
   2000 - 3000 keV/amu

85E 4   Aumayr,F. Lakits,G. Husinsky,W. Winter,H.
J. Phys. B 18 (1985) 2493-2501
Inelastic H^+ - Li(2s) collisions (2-20 keV); III. electron capture
into the H(2s) subshell
   H^+ + Li(2s) -> H(2s)
   photon spectroscopy
   2 - 20 keV/amu

85E 5   Aumayr,F. Winter,H.
Phys. Rev. A 31 (1985) 67-71
Total single-electron capture cross sections for impact of H^+,
H_2^+, He^+, and Ne^+ (2-20 keV) on Li
   A^+ + Li(2s) -> A^0 (A = H, H_2, He, Ne)
   growth
   2 - 20 (H) keV/amu; 0.1 - 1 keV/amu
   total cross section

85E 6   Aumayr,F. Winter,H.
J. Phys. B 18 (1985) L741-746
Excitation by impact of He^+ (2-20 keV) on Li(2s)
   He^+ + Li(2s) -> He(total, 2p, 3p)
   photon spectroscopy
   0.5 - 5 keV/amu

85E 7   Bae,Y.K. Coggiola,M.J. Peterson,J.R.
Phys. Rev. A 31 (1985) 3627-3632
Charge transfer of 50 eV - 4 keV H^+, H_2^+, H_3^+, N^+ and
N_2^+ in Cs; absolute cross sections
   A^+ + Cs -> A^0 (A = H, H_2, H_3, N, N_2)
   attenuation method
   0.05 - 4 keV/amu (H); 0.025 - 0.28 keV/amu
   attenuation cross sections dominated by single electron capture

85E 8   Barany,A. Astner,G. Cederquist,H. Danard,H. Huldt,S. Hvelplund,P.
Johnson,A. Knudsen,H. Liljeby,L. Rensfelt,K.G.
Nucl. Instr. Meth. in Phys. Res. B 9 (1985) 397-399

Absolute cross sections for multi-electron processes in low energy Ar^q - Ar collisions; comparison with theory

$Ar^{q+} + Ar \rightarrow Ar^{(q-k)+} + Ar^{(k+n)+}$ (q=4-8 ; k=1-5 ; n=0-3)
coincidence technique
0.045xq keV/amu

85E 9   Bendahman,M. Bliman,S. Dousson,S. Hitz,D. Gayet,R. Hanssen,J. Harel,C.
Salin,A.
J. de Phys. 46 (1985) 561-572
Electron capture from atomic hydrogen by multiply charged ions in low
energy collisions
$A^{q+} + H \rightarrow A^{(q-1)+} + H^+$ (A = B, C, N, O, F, Ne ; q=4-10)
0.25 - 50 keV/amu
molecular calculation with translational factor

85E10   Bliman,S. Bonnet,J.J. Bordenave-Montesquieu,A. Dousson,S. Druetta,M.
Hitz,D. Mayo,M.
Nucl. Instr. Meth. in Phys. Res. B 9 (1985) 371-376
Radiative decay following low energy charge exchange collisions at the
AGRIPPA facility
Ne^{8+}, O^{8+}, $Al^{8+} + H_2$, $\rightarrow Ne^{7+}(nl)$, $O^{7+}(nl)$, $Al^{7+}(nl)$
x-ray, VUV photon spectroscopy
1.56 - 3.84 keV/amu
grazing incidence spectrometer; cystal spectrometer

85E11   Bonnet,J.J. Fleury,A.F. Bonnefoy,M. Politis,M.F. Chassevent,M.
Bliman,S. Dousson,S. Hitz,D.
J. Phys. B 18 (1985) L23-27
Electron capture into different (nl) states in slow collisions of
Ne^{8+} projectiles on He and H_2 targets
$Ne^{8+} + He, H_2 \rightarrow Ne^{7+}(nl) + He^+, H_2^+$
photon emission spectroscopy
1 - 4 keV/amu

85E12   Bordenave-Montesquieu,A. Benoit-Cattin,P. Gleizes,A. Marrakchi,A.I.
Dousson,S. Hitz,D.
Nucl. Instr. Meth. in Phys. Res. B 9 (1985) 389-391
Experimental cross sections for two-electron capture into nitrogen
autoionising states in N^{q+}(q=6,7) on He and H_2 collisions at 10.5 q keV
$N^{6+,7+} + H_2$, He $\rightarrow N^{4+,5+}$ (nl, n'l'), n=2,3,4
electron spectroscopy
0.75xq keV/amu

85E13   Bordenave-Montesquieu,A. Boenoit-Cattin,P. Gleizes,A. Dousson,S. Hitz,D.
J. Phys. B 18 (1985) L195-199
One-electron capture into Li-like autoionizing $N^{4+}(1s2ln'l')$
configurations by metastable $N^{5+}(1s2s\ ^3S)$ multicharged ions in
collisions with He and H_2, observed by electron spectroscopy at 3.4
keV/amu
$N^{5+} + He, H_2 \rightarrow N^{4+}$ (1s2ln'l')
electron spectroscopy
3.42 keV/amu

85E14   Brazuk,A. Winter,H. Dijkkamp,D. de Heer,F.J. Drentje,A.G.
Nucl. Instr. Meth. in Phys. Res. B 9 (1985) 442-447
Subshell-selective electron capture from lithium by slow multiply
charged ions
$C^{4+} + Li(2s) \rightarrow C^{4+}$ (n,l)
1.67 - 6.67 keV/amu

85E15   Can,C. Gray,T.J. Varghese,S.L. Hall,J.M. Tunnel,L.N.

Phys. Rev. A 31 (1985) 72-83
Electron-capture cross sections for low-energy highly charged neon and
argon ions from molecular and atomic hydrogen
   $Ne^{q+}(q=2-7)$, $Ar^{q+}(q=2-10)$ + H, H_2 -> $Ne^{(q-1)+}$, $Ar^{(q-1)+}$
H-oven
(0.4 - 1.25)xq/M keV/amu

85E16   Cederquist,H. Andersen,L.H. Barany,A. Hvelplund,P. Knudsen,H.
        Nielsen,E.H. Pedersen,J.O.K. Sorensen,J.
        J. Phys. B 18 (1985) 3951-3969
        State-selective single- and double-electron capture processes in slow
        C^{4+} + He, Ne, Ar and Xe collisions
           C^{4+} + Ne, Ar, Xe -> C^{3+} + Ne^+, Ar^+, Xe^+;
           C^{4+} + He, Ne -> C^{2+} + He^{2+}, Ne^{2+}
           energy-loss/-gain
           0.0416 keV/amu

85E17   Chetioui,A. Rozet,J.P. Vernhet,D. Wohrer,K. Bouisset,P. Tonati,A.
        Stephan,C.
        Nucl. Instr. Meth. in Phys. Res. A 240 (1985) 488-491
        Charge exchange process with low energy multicharged ions; n,l
        populations
           Al^{12+} + He, H_2 -> Al^{11+} (n,l)
           photon spectroscopy
           10xq/27 (keV/amu)
           Lyman spectra obsrved; Si(Li) used; relative intensities

85E18   Chetioui,A. Wohrer,K. Rozet,J.P. Vernhet,D. Stephan,C.
        Nucl. Instr. Meth. in Phys. Res. B 10/11 (1985) 134-137
        High velocity capture process in excited states of multicharged ions
           Ar^{18+} + N_2 -> Ar^{17+}(np); Fe^{26+} + He, N_2 -> Fe^{25+} (np)
           6250 keV/amu (Ar); 7140 keV/amu (Fe)
           n-distribution

85E19   Ciric,D. Brazuk,A. Dijkkamp,D. de Heer,F.J. Winter,H.
        J. Phys. B 18 (1985) 3629-3639
        State-selective electron capture in C^{3+} - H, H_2 collisions
        (0.7 - 4.6 $keVamu^{-1}$) studied by photon spectroscopy
           C^{3+} + H, H_2 -> C^{2+} + H^+, H_2^+
           photon emission spectroscopy
         • 0.7 - 4.6 keV/amu

85E20   Ciric,D. Dijkkamp,D. Vlieg,E. de Heer,F.J.
        J. Phys. B 18 (1985) L17-22
        Subshell-selective electron capture cross sections in collisions of
        He^{2+} and C^{4+} with atomic hydrogen
           C^{4+} + H -> C^{3+}(nl) + H^+ (n=3,4); He^{2+} + H -> He^+(2p) + H^+
           photon emission spectroscopy
           1 - 7 (C^{4+}-H), 1 - 10 (He^{2+}-H) keV/amu

85E21   Ciric,D. Dijkkamp,D. Vlieg,E. de Heer,F.J.
        J. Phys. B 18 (1985) 4745-4762
        Selective electron capture into He II (n,l) subshells in collisions of
        He^{2+} with atomic and molecular hydrogen
           He^{2+} + H, H_2 -> H^+ (n,l)
           photon spectroscopy
           1.25 - 10 keV/amu

85E22   Clark,M. Brandt,D. Swenson,J.K. Shafroth,S.M.
        Phys. Rev. Letters 54 (1985) 544-546
        Non-resonant electron transfer and projectile K-electron excitation in

ion-atom collisions
$Si^{11+} + He \rightarrow Si^{10+}$
growth
469 - 2940 keV/amu

85E23   Clark,M. Shafroth,S.M.
Nucl. Instr. Meth. in Phys. Res. B 10/11 (1985) 124-127
Resonant transfer and excitation(RTE) and non-resonant transfer and excitation(NTE) in Si^{11+} on He collisions
$Si^{11+} + He \rightarrow Si^{10+}$
coincidence with x-ray and charge changed projectile
535 - 3571 keV/amu

85E24   Coggiola,M.J. Bae,Y.K. Peterson,J.R.
Phys. Rev. A 32 (1985) 784-788
Single-electron-capture cross sections for 1-10 keV Li^+ ions in alkaline-earth vapors
$Li^+ + Mg, Ca, Sr, Ba \rightarrow Li^0$
attenuation method
0.14 - 1.4 keV/amu
total cross section

85E25   Cotte,P.H. Druetta,M. Martin,S. Denis,A. Desesquelles,J. Hitz,D. Dousson,S.
Nucl. Instr. Meth. in Phys. Res. B 9 (1985) 743-46
UV spectroscopy of charge exchange collisions between N^{5+} ions and H_2, He
$N^{5+} + H^2, He \rightarrow N^{4+}$ $(1s^2nl)$
UV spectroscopy
0.8 - 3.57 keV/amu

85E26   Dijkkamp,D. Boellaard,A. de Heer,F.J.
Nucl. Instr. Meth. in Phys. Res. B 9 (1985) 377-381
Single electron capture in slow He^{2+} - Li collisions
$He^{2+} - Li \rightarrow He^+ (n,l)$
VUV spectroscopy
0.55 - 10 keV/amu

85E27   Dijkkamp,D. Ciric,D. de Heer,F.J.
Phys. Rev. Letters 54 (1985) 1004-1007
Total capture and line-emission cross sections for C^{6+}, N^{7+}, O^{8+} - H collisions in the energy range
$C^{6+}, N^{7+}, O^{8+} - H \rightarrow C^{5+}(nl), N^{6+}(nl), O^{7+}(nl)$
VUV spectroscopy
3 - 7.5 keV/amu

85E28   Dijkkamp,D. Ciric,D. de Heer,F.J. Vlieg,E.
Nucl. Instr. Meth. in Phys. Res. B 9 (1985) 403-407
(n,l)-subshell electron capture cross sections in collisions of C^{4+}, N^{5+} and O^{6+} with atomic hydrogen
$C^{4+}, N^{5+}, O^{6+} + H \rightarrow C^{3+}(n,l), N^{4+}(n,l), O^{5+}(n,l)$
VUV spectroscopy
1 - 7 keV/amu

85E29   Dijkkamp,D. Ciric,D. Vlieg,E. de Boer,A. de Heer,F.J.
J. Phys. B 18 (1985) 4763-4793
Subshell-selective electron capture in collisions of C^{4+}, N^{5+}, O^{6+} with H, H_2 and He
$C^{4+}, N^{5+}, O^{6+} + B \rightarrow C^{3+}, N^{4+}, O^{5+} (nl)$
photon spectroscopy
0.5 - 12 keV/amu

85E30   Dijkkamp,D. Gordeev,Yu.S. Brazuk,A. Drentje,A.G. de Heer,F.J.
         J. Phys. B 18 (1985) 737-756
         Selective single-electron capture into (n,l) subshells in slow
         collisions of C^{6+}, N^{6+}, O^{6+} and Ne^{6+} with He, H_2, and Ar
           C^{6+}, N^{6+}, O^{6+}, Ne^{6+} + He -> C^{5+}(nl), N^{5+}(nl), O^{5+}(nl),
           Ne^{5+}(nl) + He^+ ; C^{6+}, N^{6+}, O^{6+} + H_2 -> C^{5+}(nl),
           N^{5+}(nl), O^{5+}(nl) + H_2^+ ; O^{6+} + Ar -> O^{5+}(nl) + Ar^+
           photon emission spectoscopy
           0.56 - 6.25 keV/amu

85E31   Druetta,M. Mayo,M. Bliman,S. Martin,S. Hitz,D. Dousson,S.
         Deresquelles,J.
         J. de Phys. Letters 46 (1985) L869-873
         Etude spectroscopique de la collision d'echange de charge entre Ne^{8+}
         et He
           Ne^{8+} + He -> Ne^{7+}, Ne^{6+}
           VUV spectrometer
           2.4 - 4 keV/amu
           emission cross section

85E32   Druetta,M. Mayo,M. Cotte,P.H. Martin,S. Dousson,S. Hitz,D. Tran Cong,K.
         Phys. Letters 108A (1985) 338-339
         Asolute cross sections for electron capture into (n,l) subshells of N
         VI by VUV spectroscopic study of the N^{6+} - He collision
           N^{6+} + He -> N^{5+} (n,l)
           VUV spectrometer
           4.2 keV/amu

85E33   DuBois,R.D.
         Phys. Rev. A 32 (1985) 3319-3323
         Charge transfer and ionization of lithium by protons and helium ions
           H^+, He^{2+}, He^+ + Li -> H^0, He^+, He^0
           growth
           15 - 200 keV/amu
           differentials in Li charge states

85E34   DuBois,R.D. Toburen,L.H.
         Phys. Rev. A 31 (1985) 3603-3611
         Electron capture by protons and helium ions from lithium, sodium and
         magnesium
           H^+, He^+ + B -> H^0, He^0; He^{2+} + B -> He^+, He^0
           (B = Li, Na, Mg)
           growth
           2 - 100 keV/amu (H); 1.3 - 66.7 keV/amu (He)

85E35   Graham,W.G. Berkner,K.H. Bernstein,E.M. Clark,M. McFarland,R.H.
         Morgan,T.J. Schlachter,A.S. Stearns,J.W. Stockli,M.P. Tanis,J.A.
         J. Phys. B 18 (1985) 2503-2508
         Charge state dependence of single electron capture and loss cross
         sections for highly stripped V ions in He at 8.55 MeV/amu
           V^{q+}(q=18-23) + He -> $V^{(q-1)+}$
           growth
           8550 keV/amu
           total cross sections

85E36   Hall,J. Richard,P. Pepmiller,P.L. Gregory,D.C. Miller,P.D. Moak,C.D.
         Jones,C.M. Alton,G.D. Bridwell,L.B. Sofield,C.J.
         Phys. Rev. A 33 (1985) 914-920
         Energy systematics of single-and double- K-shell vacancy production in
         titanium bombarded by chlorine ions

$Cl^{q+} + Ti \rightarrow Cl^{(q-1)+}, Cl^{(q-2)+} + Ti^{*}(1s^{-1}), Ti^{2+}(1s^{-2})$
x-ray spectroscopy
$7 - 15 \times 10^{3}$ keV/amu

85E37   Hippler,R. Faust,M. Wolf,R. Kleinpoppen,H. Lutz,H.O.
Phys. Rev. A 31 (1985) 1399-1404
Polarization studies of H(2p) charge-exchange excitation; $H^{+} + Ar$ collisions
$H^{+} + Ar \rightarrow H(2p) + Ar^{+}$
linear and circular polarizar
1.5 - 3 keV
polarization at scattering angle of 0.5 - 3.5

85E38   Huber,B.A. Kahlert,H.J.
J. Phys. B 18 (1985) 491-498
Vibrational excitation of H_2^{+} in electron capture collsions of Xe^{2+} and Ar^{3+} with H_2
$Xe^{2+} + H_2 \rightarrow Xe^{+} + H_2^{+}(\nu); Ar^{3+} + H_2 \rightarrow Ar^{2+}(nl) + H_2^{+}(\nu)$
energy-gain/-loss
4.6×10^{-5}, 2.3×10^{-4} (Xe^{2+}); 1.5×10^{-1}, 0.75 (Ar^{3+}) keV/amu

85E39   Hvelplund,P. Andersen,L.H. Barany,A. Cederquist,H. Heinemeier,J.
Knudsen,H. Macadam,K.B. Nielsen,E.H. Sorensen,J.
Nucl. Instr. Meth. in Phys. Res. B 9 (1985) 421-425
Energy-gain spectroscopy studies of state-selective electron capture for multiply charged Ar recoil ions; comparison with the extended classical barrier model
Ar^{q+} (q=6-10) + Ne, Ar, Xe $\rightarrow Ar^{(q-1)+}(nl)$
energy gain spectroscopy-energy defect
0.025 keV/amu

85E40   Jellen-Wutte,U. Schweinzer,J. Vanek,W. Winter,H.
J. Phys. B 18 (1985) L779-785
Scattering-angle-dependent translational energy spectroscopy for electron capture by double charged ions
$Ar^{2+}, Kr^{2+}, Xe^{2+} + He, Ne, Ar \rightarrow Ar^{+}, Kr^{+}, Xe^{+}$
translational energy spectroscopy
identification of various reaction channel

85E41   Jones,M.L. Doughty,B.M. Dillingham,T.R. Jones,T.A.
Nucl. Instr. Meth. in Phys. Res. B 10/11 (1985) 142-145
Electron capture by 20 - 150 keV protons on hydrogen gases
$H^{+} + CO, CH_4, C_2H_6, C_3H_8 \rightarrow H^{0}$
growth
20 - 150 keV/amu

85E42   Kamber,E.Y. Brenton,A.G. Beynon,J.H. Hasted,J.B.
J. Phys. B 18 (1985) 933-941
Single-electron capture spectra for collisions of O^{2+} on He, N_2 and H_2
$O^{2+} + He, N_2, H_2 \rightarrow O^{*+}(nl)$
translational spectroscopy
0.125 - 0.38 keV/amu

85E43   Kamber,E.Y. Hormis,W.G. Brenton,A.G. Hasted,J.B. Baynon,J.H.
J. Phys. B 18 (1985) 117-124
Double electron capture by Ar^{3+} from rare-gas atoms
$Ar^{3+} + He, Ne, Ar, Kr \rightarrow Ar^{+} + He^{2+}, Ne^{2+}, Ar^{2+}, Kr^{2+}$
enegy-loss/-gain
0.2 keV/amu

85E44 Lee,A.R. Williams,D.G. Butcher,E.C.
Phys. Letters 107A (1985) 218-220
Isotope effect in electron capture by protons into the 2s-state of hydrogen
$H^+ + H_2, D_2 \to H(2s)$
photon measurement
8 - 16 keV/amu
no isotope effect found

85E45 Lembo,L.J. Danzmann,K. Stoller,Ch. Meyerhof,W.E. Hansch,T.W.
Phys. Rev. Letters 55 (1985) 1874-1876
Observation of polarized optical radiation following electron capture into slow, highly ionized neon
$4 \text{ keV } Ne^{8+} + Na \to Ne^{7+}(nl)$
0.2 keV/amu

85E46 Maro,M. Hitz,D. Druetta,M. Dousson,S. Desclaux,J.P. Blimann,S.
Phys. Rev. Letters 54 (1985) 317-319
Spectroscopy of Al VIII produced by low energy charge changing collisions
$Al^{8+} + H_2 \to Al^{7+}$
optical spectroscopy
3 keV/amu

85E47 Mathur,D. Badrinathan,C. Rajgara,F.A. Rafeja,U.T.
J. Phys. B 18 (1985) 4795-4804
Electron capture collisions of $Kr^{2+}(^3P)$ in H_2
$Kr^{2+}(^3P) + H_2 \to Kr^+$
growth + energy loss sectroscopy
0.012 - 0.06 keV/amu

85E48 McAfee,K.B. Hozack,R.S.
Phys. Rev. A 32 (1985) 810-814
Charge and energy transfer in symmetric doubly charged Ar^{2+} + Ar collisions
$Ar^{2+}(^1S) + Ar \to Ar + Ar^{2+}(^3P)$
translational energy spectroscopy
0.006 keV/amu
energy spectra only

85E49 McDaniel,F.D. Toten,A. Bhalla,R.P. Lapicki,G.
Nucl. Instr. Meth. A24 (1985) 492-497
Carbon K-shell vacancy production and K-K electron capture cross sections for 0.4 - 1.5 MeV H^+ ions incident on CH_4 targets
$H^+ + C \to H(1s) + C^*(1s^{-1})$
Auger electron coincidence
400 - 1500 keV/amu

85E50 Meyer,F.W. Howald,A.M. Havener,C.C. Phaneuf,R.A.
Phys. Rev. Letters 54 (1985) 2663-2666
Observation of low-energy Z oscillations in total electron capture cross sections for bare projectiles colliding with H and H_2
$A^{z+} + H, H_2 \to A^{(z-1)+}$ (A = C, N, O, F, Ne)
growth
0.3 - 3.0 keV/amu
total cross section

85E51 Meyer,F.W. Howald,A.M. Havener,C.C. Phaneuf,R.A.
Phys. Rev. A 32 (1985) 3310-3318
Low-energy total electron capture cross sections for fully stripped and H-like projectiles incident on H and H_2

$A^{z+,(z-1)+} + H, H_2 \rightarrow A^{(z-1)+,(z-2)+}$ (A = C, N, O, F, Ne)
H-oven
0.18 - 8.5 keV/amu

85E52   Meyerhof,W.E. Anholt,R. Eichler,J. Gould,H. Munger,Ch. Alonso,J.
Thieberger,P. Wegner,H.E.
Phys. Rev. A 32 (1985) 3291-3301
Atomic collisions with relativisic heavy ions. III. electron capture
$Xe^{q+} + B \rightarrow Xe^{(q-i)+}$ (q=52-54 ; B=Be-Au ; i=1-3)
solid target
82000 - 200000 keV/amu

85E53   Nakamura,T. Kobayashi,N. Kaneko,Y.
J. Phys. Soc. Japan 54 (1985) 1743-1749
Ion-energy-loss spectroscopy of Kr^{2+}-He and -Ne collisions II.
one-electron capture processes
$Kr^{2+}(^3P, {}^1D_2, {}^1S_0) + He, Ne \rightarrow Kr^+$
energy-loss spectroscopy
0.006 - 0.018 keV/amu

85E54   Nielsen,E.H. Andersen,L.H. Barany,A. Cederquist,H. Heinemeier,J.
Hvelplund,P. Knudsen,H. MacAdam,K.B. Sorensen,J.
J. Phys. B 18 (1985) 1789-1808
Energy-gain spectroscopy of state-selective electron capture for
multiply charged Ar recoil ions
$Ar^{q+} + Ne, Ar, Xe \rightarrow Ar^{(q-i)+}$ (q=6-10)
energy-gain/-loss spectroscopy
1×10^{-2} - 5×10^{-2} keV/amu

85E55   Peart,B. Bennett,M.A. Dolder,K.
J. Phys. B 18 (1985) L439-444
New measurements of the mutual neutralization of H^+/H^- and
He^+/H^- ions
$H^+ + H^- \rightarrow H + H$; $He^+ + H^- \rightarrow He + H$
crossed beam technique
0.03 - 2 keV/amu (H^+); 0.1 - 3 keV/amu (He^+)

85E56   Phaneuf,R.A. Kimura,M. Sato,H. Olson,R.E.
Phys. Rev. A 31 (1985) 2914-2917
Electron capture by slow Al^{q+} ions colliding with hydrogen
$Al^{q+}(q=2-10) + H, H_2 \rightarrow Al^{(q-1)+}$
E. growth; T. MO expansion
0.02 - 0.12 keV/amu
total cross section; laser source

85E57   Puerta,J. Huber,B.A.
J. Phys. B 18 (1985) 4445-4453
Single electron capture by state-prepared Ar^{2+} projectiles in Ar
$Ar^{2+} + Ar \rightarrow Ar^+$
translational energy spectroscopy
0.01 keV/amu
metastable fraction

85E58   Puerta,J. Kahlert,H.J. Koslowski,H.R. Huber,B.A.
Nucl. Instr. Meth. in Phys. Res. B 9 (1985) 415-420
Single electron capture by state-selected multiply charged Ar^{q+} ions
(q=3,4)
$Ar^{3+,4+} + He, Ne, Ar, Kr \rightarrow Ar^{2+}, Ar^{3+}$
translational energy spectroscopy
0.02 keV/amu
forward angle (θ - 0 ± 0.7)

85E59   Rinn,K. Melchert,F. Salzborn,E.
J. Phys. B 18 (1985) 3783-3795
Measurements of charge transfer in H^+ - He^+ collisions
H^+ + He^+ -> H^0 + He^{2+}
crossed beam technique
8 - 100 keV/amu

85E60   Rozet,J.P. Chevallier,P. Legagneux-Piquema,P. Chetioui,A. Stephan,C.
J. Phys. B 18 (1985) 943-948
Capture cross sections in highly excited P sates of Ar^{17+} in high
velocity collisions of 250 MeV Ar^{18+} on N
Ar^{18+} + N_2 -> Ar^{17+} (np, $n \leq 10$)
x-ray spectroscopy
6250 keV/amu
$1/n^3$ distribution

85E61   Rudd,M.E. Goffe,T.V. Itoh,A.
Phys. Rev. A 32 (1985) 2128-2133
Ionization cross sections for 10 - 300 keV/U and electron capture cross
sections for 5 - 150 keV/U $^3He^{2+}$ ions in gases
He^{2+} + B -> He^+, He^0 (B = He, Ne, Ar, Kr, H_2, N_2, CO, O_2,
CH_4, CO_2, H_2O)
condenser plate
1.67 - 50 keV/amu
total cross section

85E62   Rudd,M.E. Itoh,A. Goffe,T.V.
Phys. Rev. A 32 (1985) 2499-2500
Cross sections for ionization, capture and loss for 5 - 450 keV He^+
on water vapor
He^+ + H_2O -> He^0; He^{2+}
condenser plate
1.25 - 112.5 keV/amu

85E63   Scheurer,J.N. Baker,O.K. Meyerhof,W.E.
J. Phys. B 18 (1985) L85-89
Large angle scattering and nuclear resonance effect in electron capture
in H^+ + C and H^+ + N collisions
H^+ + C, N -> H^0
350 - 1000 keV/amu (C), 1050 - 1065 keV/amu (N)
θ = 30, 150

85E64   Shafroth,S.M. Awaya,Y. Kase,M. Kambara,T. Kumagai,H. Nishida,M.
Shibata,H. Tawara,H.
Nucl. Instr. Meth. in Phys. Res. A 240 (1985) 546-548
Angular distribution of REC for Ar^{4+} on C at 1 MeV/amu
Ar^{q+} + C -> $Ar^{(q-1)+}$(1s) + $h\nu$ + C^+
x-ray spectroscopy
1000 keV/amu
angular distribution

85E65   Shah,M.B. Elliott,D.S. Gilbody,H.B.
J. Phys. B 18 (1985) 4245-4258
Ionization and charge transfer in collisions of H^+ and He^{2+} with
lithium
H^+, He^{2+} + Li -> H^0, He^+
growth method
22 - 2100 keV/amu
Li-oven

85E66   Tanis,J.A. Bernstein,E.M. Oglesby,C.S. Graham,W.G. Clark,M.
McFarland,R.H. Morgan,T.J. Stockli,M.P. Berkner,K.H. Schlachter,A.S.
Sterns,J.W. Johnson,B.M. Jones,K.W. Meron,M.
Nucl. Instr. Meth. in Phys. Res. B 10/11 (1985) 128-233
Resonant-transfer and excitation for highly charged ions
$(16 \leq z \leq 23)$ in collisions with helium
$$S^{13+}, Ca^{16+ - 18+}, V^{19+ - 21+} + He \rightarrow S^{12+}, Ca^{15+ - 17+}, V^{18+ - 20+} + He^+$$
coincidence
469 - 6250 (S); 2500 - 9000 (Ca); 3529 - 9020 (V) keV/amu

85E67   Tawara,H. Iwai,T. Kaneko,Y. Kimura,M. Kobayashi,N. Matsumoto,A.
Ohtani,K. Takagi,S. Tsurubuchi,S.
Nucl. Instr. in Phys. Res. B 9 (1985) 432-434
Electron capture in $I^{q+}(q=10-41) + He$ collisions at low energies
$$I^{q+}(q=10-41) + He \rightarrow I^{(q-1)+}$$
energy gain spectroscopy
0.08 - 0.3 keV/amu
cross sections vs. q and crossing radius

85E68   Tawara,H. Iwai,T. Kaneko,Y. Kimura,M. Kobayashi,N. Matsumoto,A.
Ohtani,S. Okuno,K. Takagi,S. Tsurubuchi,S.
J. Phys. B 18 (1985) 337-350
Electron capture processes of I^{q+} ions with very high charge state
$(41 \geq q \geq 10)$ in collisions with He atoms
$$I^{q+} + He \rightarrow I^{(q-1)+} + He^+ \quad (q=10-41)$$
energy-loss/gain
6×10^{-2} - 0.73 keV/amu

85E69   van Wijngaarden,A. Patel,J. Becker,K. Drake,G.W.F.
Phys. Rev. A 32 (1985) 2150-2157
Charge-exchange processes of hydrogen ions with Hg atoms at keV energies
$$H^+ + Hg \rightarrow H^0; \quad H^- + Hg \rightarrow H^0$$
growth
23.8 - 134.2 keV/amu

85E70   Varghese,S.L. Bissinger,G. Joyce,J.M. Laubert,R.
Phys. Rev. A 31 (1985) 2202-2209
Atomic total electron-capture cross sections from C^-, O^-, F^- and
S^- bearing molecular gases for -MeV/u H^+ and He^+ projectiles
$$H^+, He^+ + B = H^0, He^0 \quad (B = C^-, O^-, F^-, S^- \text{ compound gas})$$
growth
800 - 3000 keV/amu (H); 800 keV/amu (He)

85E71   Vernhet,D. Chetioui,A. Wohrer,K. Rozet,J.P. Piquemal,P. Hitz,P.
Dousson,S. Salin,A. Stephan,C.
Phys. Rev. A 32 (1985) 1256-1259
Alignment of Ne^{8+} n^1P states produced by collisions of Ne^{9+} with
H_2 at 4 keV/amu
$$Ne^{9+} + H_2 \rightarrow Ne^{8+} \quad (1snl)$$
4 keV/amu

85E72   Wilkie,F.G. Yousif,F.B. McCullough,R.W. Geddes,J. Gilbody,H.B.
J. Phys. B 18 (1985) 479-489
Total and state-selective capture by slow N^{2+} ions in atomic and
molecular hydrogen
$$N^{2+} + H \rightarrow N^+(2p^2) + H^+; \quad N^{2+} + H, H_2 \rightarrow N^+ + H^+, H_2^+$$
energy-gain/-loss
4.28×10^{-2} - 14.3 keV/amu

86E 1   Aumayr,F. Lakits,G. Winter,H.
Phys. Rev. A 33 (1986) 846-850

Electron capture from Li(2s) by doubly charged ions (5-40 keV)
A^{2+} + Li(2s) -> A^+ + Li^+ (A = N, Ne, Ar, Kr, Xe)
growth
0.04 - 2.9 keV/amu

86E 2   Bischof,G. Linder,F.
Z. Phys. D 1 (1986) 303-320
Crossed beam study of He^+ - O_2 charge transfer reactions in the
collision energy range 0.5 - 200 eV
He^+ + O_2 -> He + O + O^+
crossed beam technique
1.25×10^{-4} - 0.05 keV/amu

86E 3   Clark,M.W. Bernstein,E.M. Tanis,J.A. Graham,W.G. McFarland,R.H.
Morgan,T.J. Johnson,B.M. Jones,K.W. Meron,M.
Phys. Rev. A 33 (1986) 762-764
Electron capture and loss for 2.5 - 200 MeV S^{13+} + He collisions
S^{13+} + He -> S^{12+}, S^{14+}
growth
78 - 6250 keV/amu

86E 4   DuBois,R.D.
Phys. Rev. A 33 (1986) 1595-1601
Ionization and charge transfer in He^{2+} - rare gas collisions
He^{2+} + B -> He^+, He^0 + B^{I+} (B = He, Ne, Ar, Kr)
coincidence technique
3.75 - 50 keV/amu

86E 5   Graham,W.G. Bernstein,E.M. Clark,M.W. Tanis,J.A. Berkner,K.H.
Gohil,P. McDonald,R.J. Schlachter,A.S. Stearns,J.W. McFarland,R.H.
Morgan,T.J. Muller,A.
Phys. Rev. A 33 (1986) 3591-3594
Structure in the energy dependence of high energy electron capture
cross sections
Ca^{q+} + H_2 -> $Ca^{(q-1)+}$ (q=16-19)
growth method
2425 - 9200 keV/amu
two bumps near 200-300 MeV

86E 6   Hormis,W.G. Kamber,E.Y. Hasted,J.B.
Int. J. Mass Spectr. Ion Processes 69 (1986) 211-216
Differential N^{2+} - He collisions with capture
N^{2+} + He -> N^+
translational energy spectroscopy
0.07 keV/amu
no cross section

86E 7   Muller,A. Schuch,B. Groh,W. Salzborn,E. Beyer,H.F. Mokler,P.H.
Olson,R.E.
Rev. Rev. A 33 (1986) 3010-3017
Multiple electron capture and ionization in collisions of highly
stripped ions with Ar atoms
Fe^{q+}(q=5,10,12,15,20,25), U^{q+}(q=44) + Ar -> $Fe^{(q-i)+}$,
$U^{(q-i)+}$(i=0-4) + Ar^{r+}(r=1-4)
E. recoil ion-projectile ion coincidence ; T. CTMC
1400 keV/amu

86E 8   Liljeby,L. Astner,G. Barany,A. Cederquist,H. Danared,H. Huldt,S.
Hvelplund,P. Johnson,A. Knudsen,H. Rensfelt,K.G.
Phys. Scripta 33 (1986) 310-320
Absolute cross sections for multielectron processes in slow Ar^{q+} +

Ne, Ar, Kr collisions
$Ar^{q+} + B \rightarrow Ar^{r+} + B^{s+}$ (q=1-8 ; r=0-8 ; s=1-6 ; B=Ne, Ar, Kr)
TOF + coincidence
0.045xq keV/amu

86E 9   Rice,J.E. Marmar,E.S. Terry,J.L. Kallne,E. Kallne,J.
Phys. Re.. Letters 56 (1986) 50-53
Observation of charge-transfer population of high n-levels in Ar^{16+}
from neutral hydrogen in the ground and excited states in a Tokamak
plasma
$Ar^{17+} + H, H(n) \rightarrow Ar^{16+}$
photon spectroscopy
4×10^{-2} keV/amu (maxellian)

86E10   Ullrich,J. Bethge,K. Kelbch,S. Schadt,W. Schmidt-Bocking,H.
Stiebing,K.E.
J. Phys. B 19 (1986) 437-448
Absolute cross sections for projectile-charge-state-correlated multiple
ionisation processes in Ne - Ne collisions
$Ne^{q+} + Ne \rightarrow Ne^{r+} + Ne^{s+}$ (q=2, 3 ; r=1-6)
coincidence technique
75 - 360 keV/amu

86E11   Wilkie,F.G. McCullough,R.W. Gilbody,H.B.
J. Phys. B 19 (1986) 239-251
State-selective electron capture by slow C^{3+} and N^{3+} ions in H and
H_2
$C^{3+} + H \rightarrow C^{2+}(2s3d\ ^1D,^3D;\ 2s3p\ ^1P,^3P;\ 2s3s\ ^3S;\ 2p^2\ ^1S,^1D) + H^+$
translational energy spectroscopy + H-oven
0.125 - 1 keV/amu
only energy gain spectra for $C^{3+} + H_2$; $N^{3+} + H, H_2$ collisions

List of references of theories

54T 1   Bates,D.R. Moiseiwitsch,B.L.
Proc. Phys. Soc. 67 (1954) 805-812
Inelastic heavy particle collisions involving the crossing of potential
curves I; charge transfer from H atoms to Be^{2+}, Si^{2+} and Mg^{2+} ions
$A^{2+} + H \rightarrow A^{+} + H^{+}$ (A = Be, Si, Mg)
Landau-Zener model
1×10^{-2} - 10 keV/amu
total cross section

67T 1   Nikalaev,V.S.
Sov. Phys. -JETP 24 (1967) 847-857
Calculation of the effective cross sections for proton charge exchange
in collisions with multielectron atoms
modified OBK

71T 1   Olson,R.E. Smith,F.T. Bauer,E.
Appl. Optics 10 (1971) 1848-1855
Estimation of the coupling matrix elements for one-electron transfer
systems
H_{12} for Landau-Zener model

73T 1   Halpern,A.M. Law,J.
Phys. Rev. Letters 31 (1973) 4-6
K-vacancy creation by high Z heavy ion impact
$A^{z+} + Ar \rightarrow A^{(z-1)+} + Ar^{+}(1s^{-1})$ (A = H, C, N, O, F)

74T 1   Briggs,J.S. Dettmann,K.
Phys. Rev. Letters 33 (1974) 1123-1125
Radiative charge transfer from H atoms by fast ions
$H^{+} + H(1s) \rightarrow H(1s) + h\nu + H^{+}$
IP
analytic expressions at asymptotic region

74T 2   Piacentini,R.D. Salin,A.
J. Phys. B 7 (1974) 1666-1678
Molecular treatment of the He^{2+}-H collisions
$He^{2+} + H \rightarrow He^{+} + H^{+}$; $He^{+}(2s)$
PSS
0.25-12.5

75T 1   Halpern,A.M. Law,J.
Phys. Rev. A 12 (1975) 1776-1780
Full first Born approximation for innershell pickup in heavy ion
collisions
$A^{z+} + Ar \rightarrow A^{(z-1)+} + Ar^{+}(1s^{-1})$ (A = H, C, N, O, F)
first Born approximation
2500 - 12000 keV/amu (H), 1050 - 1800 keV/amu (C, N, O, F)

75T 2   Kleber,M. Jakubassa,D.H.
Z. Phys. A 252 (1975) 152-162
Radiative electron capture in heavy ion collisions
$A^{z+} + B^{(z-1)} \rightarrow A^{(z-1)+}(1s) + B^{z+} + h\nu$
IA
analytic formula

75T 3   McCarrol,R. Valiron,P.
Astron. & Astrophys. 44 (1975) 465-467
Electron capture by C^{2+} from interstellar atomic hydrogen
$C^{2+} + H \rightarrow C^{+} + H^{+}$
model potential method
no cross sections given

75T 4   Omidvar,K.
         Phys. Rev. A 12 (1975) 911-926
         Asymptotic form of the charge-exchange cross section in three-body
         rearrangement collisions
             $H^+ + H(1s) \rightarrow H(n) + H^+$
             first Born approximation
             scaling for any Z

75T 5   Presnyakov,L.P. Ulantsev,A.D.
         Sov. J. Quant. Electron. 4 (1975) 1320-1324
         Charge exchange between multiply charged ions and atoms
             $10^{-3} - 10^2$ keV/amu

76T 1   Blint,R.J. Watson,W.D. Christensen,R.B.
         Astrophys. J. 205 (1976) 634-637
         Calculation of the cross section for CIV - H charge exchange;
         significance for interstellar x-rays and cosmic-ray particles
             $C^{3+} + H \rightarrow C^{2+} + H^+$
             Landau-Zener model/two-state perturbation method
             $10^{-4} - 1.75 \times 10^{-3}$ keV/amu

76T 2   Chibisov,M.I.
         JETP Letters 24 (1976) 46-49
         Charge exchange and ionization in the collision of atoms and multiply
         charged ions

76T 3   Olson,R.E. Salop,A.
         Phys. Rev. A 14 (1976) 579-585
         Electron transfer between multicharged ions and neutral species
             $A^{z+} + B \rightarrow A^{(z-1)+}$ (z = 5 - 50, B = H, H_2, He, Ne, Kr, Xe)
             absorbing sphere model (Landau-Zener model)
             ≤ 0.2 keV/amu
             total cross section

76T 4   Omidvar,K. Golden,J.E. McGuire,J.H.
         Phys. Rev. A 13 (1976) 500-503
         Single electron Born approximations for charge transfer from
         multielectron atoms to protons
             $H^+ + He, Ar \rightarrow H + He^+(1s), Ar^+(1s^{-1})$
             Born approximation
             1000 - 12000 keV/amu

76T 5   Salop,A.
         Phys. Rev. A 13 (1976) 1321-1325
         Charge exchange between H(2s) and fully stripped carbon and nitrogen
         ions at low-keV impact energies
             $C^{6+}, N^{7+} + H(2s) \rightarrow C^{5+}$
             multichannel Landau-Zener model
             0.014 - 3.3 keV/amu
             weak energy-dependence

76T 6   Salop,A. Olson,R.E.
         Phys. Rev. A 13 (1976) 1312-1320
         Charge exchange between H(1s) and fully stripped heavy ions at low-keV
         impact energies
             $A^{z+} + H \rightarrow A^{(z-1)} + H$ (A = C, N, O, Ne, Si, Ar)
             multichannel Landau-Zener model
             0.01 - 3 keV/amu
             scaling ($Z^{3/2}$) law of total cross setion

77T 1   Belkic,Dz.
J. Phys. B 10 (1977) 3491
High-energy behaviour of the transition probabilities and total cross
sections for charge exchange
$H^+ + H(1s) \rightarrow H(nl) + H^+$
continuum intermediate state approximation
25 - 10000

77T 2   Belkic,Dz. Gayet,R.
J. Phys. B 10 '1977) 1911-1921
Electron capture from atomic hydrogen by fast protons and alpha
particles
$H^+ + H(1s) \rightarrow H(nl) + H^+$
CDW
$25 - 10^4$ keV/amu

77T 3   Belkic,Dz. Gayet,R.
J. Phys. B 10 (1977) 1923-1932
Charge exchange in fast collisions of H^+ and He^{2+} with helium
$H^+ + He(1s^2) \rightarrow H(1s, 2s, 2p, 3s, 3p, 3d, 4s) + He^+(1s)$;
$He^{2+} + He(1s^2) \rightarrow He^+ + He^+(1s)$
CDW
$25 - 10 \times 10^3$ keV/amu

77T 4   Belkic,Dz. McCarroll,R.
J. Phys. B 10 (1977) 1933-1943
Projectile charge dependence of electron capture cross sections
$A^{z+} + H \rightarrow A^{(z-1)+} + H^+$ (z = 1, 2, 4, 6, 8, 10, 20, 30) ;
$F^{9+} + H \rightarrow F^{8+}(nl) + H^+$
CDW
$500 - 5 \times 10^3$ keV/amu

77T 5   Bottcher,C.
J. Phys. B 10 (1977) L213-217
Charge transfer to highly stripped ions from hydrogen atoms
$A^{z+} + H(1s, 2s) \rightarrow A^{(z-1)+}(nl) + H^+$ (z=2-18)
0 - 225 keV/amu
only total cross sections given

77T 6   Bulter,S.E. Guberman,S.L. Dalgarno,A.
Phys. Rev. A 16 (1977) 500-507
Radiative charge transfer between H and C^{2+}, C^{3+} and N^{2+}
$C^{2+}, C^{3+}, N^{2+} + H \rightarrow C^+, C^{2+}, N^+ + H^+ + h\nu$
ab initio calculation
$10 - 10^5$ (K)

77T 7   Christensen,R.B. Watson,W.D. Blint,R.J.
Astrophys. J. 213 (1977) 712-715
Calculation of the cross section for N IV - H charge-exchange;
significance for the intercloud gas
$N^{3+} + H \rightarrow N^{2+} + H^+$
OBK, Landau-Zener approximation
$1 \times 10^{-6} - 5 \times 10^{-4}$ keV/amu

77T 8   Dewangan,D.P.
J. Phys. B 10 (1977) 1083
Electron capture in high-energy approximation
$H^+ + H(1s) \rightarrow H(1s, 2s, 2p_x, 2p_z) + H^+$
eikonal approximation
40 - 5000 keV/amu

77T 9   Harel,C. Salin,A.
        J. Phys. B. 10 (1977) 3511-3522
        Charge exchange in collisions of highly ionized ions and atoms
        $A^{q+} + H \rightarrow A^{(q-1)}(nl) + H^+$ ($A^{q+} = O^{8+}$, B^{5+}, Be^{4+})
        Impact parameter
        0.25 - 25 keV/amu

77T 10 Koyama,K. Ohtsuki,Y.H.
        Phys. Rev. B 15 (1977) 61-63
        Theory of radiative electron capture by channeled ions
        O^{8+} + Ag(single crystal) $\rightarrow$ $O^{7+}(1s)$ + $h\nu$ + Ag^+
        statistical model
        - 100 - 4000 keV/amu

77T 11 Lapicki,G. Losonsky,W.
        Phys. Rev. A 15 (1977) 896-905
        Electron capture from innershells by fully stripped ions
        $A^{z+} + B \rightarrow A^{(z-1)+} + B^+(1s^{-1})$
        scaling law

77T 12 Msezane,A.Z.
        Phys. Letters 59A (1977) 435-437
        Electron capture by completely stripped positive ions in collisions
        with atomis hydrogen
        $A^{z+} + H \rightarrow A^{(z-1)+} + H^+$
        semiclassical impact parameter method

77T 13 Olson,R.E. Salop,A.
        Phys. Rev. A 16 (1977) 531-541
        Charge transfer and impact-ionization cross sections for fully and
        partially stripped positive ions colliding with atomic hydrogen
        $A^{q+} + H \rightarrow A^{(q-1)+} + H^+$; $A^{q+} + H^+ + e$ ($A^{q+} = H^+$,
        He^{2+}, Li^{3+}, Be^{4+}, $B^{3+ - 5+}$, $C^{3+ - 6+}$, $N^{3+ - 7+}$, $O^{3+ - 8+}$,
        Ne^{10+}, Si^{14+}, Ar^{18+}, Fe^{26+}, Kr^{36+})
        CTMC
        37.5 - 200 keV/amu
        total cross sections

77T 14 Piacentini,R.D. Salin,A.
        J. Phys. B 10 (1977) 1515-1522
        Molecular treatment of He^{2+} - H collisons II
        $He^{2+} + H \rightarrow He^+ + H^+$; $He^+(2s)$
        PSS (MO)
        0.25 - 12.5 keV/amu

77T 15 Salop,A. Olson,R.E.
        Phys. Rev. A 16 (1977) 1811-1916
        Electron removal from atomic hydrogen by collisions with fully stripped
        carbon
        $C^{6+} + H(1s) \rightarrow C^{5+} + H^+$; $C^{6+} + H^+ + e$
        PSS (low energies), CTMC (high energy)
        0.05 - 500 keV/amu

77T 16 Shipsey,E.J. Brown,J.C. Olson,R.E.
        Phys. Rev. A 15 (1977) 2166-2172
        Theoretical charge-exchange total cross sections for B^{+3} + He and
        C^{+4} + He collisions
        $C^{4+} + He \rightarrow C^{3+} + He^+$, $C^{2+} + He^{2+}$; $B^{3+} + He \rightarrow B^{2+} + He$
        Impact-parameter classical-coupled equation
        0.25 - 25 keV/amu

77T17   Vaaben,J. Briggs,J.S.
         J. Phys. B 10 (1977) L521-526
         Charge transfer in C^{6+} - H(1s) collisions at low velocity
            C^{6+} + H(1s) -> C^{5+} + H^+
         MO basis calculation
         0.05 - 5 keV/amu

78T 1   Abramov,U.A. Baryshnikov,F.F. Lisita,V.S.
         JETP Letters 27 (1978) 464-467
         Change of intensity of spectral lines of multiply charged ions as a
         result of charge exchange with atomic hydrogen
            O^{8+} + H -> O^{7+} (nl)
         Analytic expression of l-distribution for slow and fast collisions,
         no cross section but distribution.

78T 2   Banyard,K.E. Moore,J.C.
         J. Phys. B 11 (1978) 3899
         Electron capture from H^- by fast alpha particles
            He^{2+} + $H^-(1s^2)$ -> $He^+(nl)$ + $H(n'l')$ (n,n'$\leq$ 2) ;
            μ^+ + $H^-(1s^2)$ -> $(\mu e)(1s)$ + $H(n'l')$
         CDW
         25- 2000 (He^{2+}), 90 - 9000 (μ^+) keV/amu

78T 3   Golden,J.E. McGuire,J.H. Omidvar,K.
         Phys. Rev. A 18 (1978) 2373
         Electron capture from atomic hydrogen into excited n, l levels of
         projectiles with Z_1; I
            p + H -> H(nlm) + p ; He^{2+} + H -> $He^+(nlm)$ + p ;
            Be^{4+} + H -> $Be^{3+}(nlm)$ + p ; O^{8+} + H -> $O^{7+}(nlm)$ + p
         full Born (Jackson-Schiff) ; BK
         100, 200 keV/amu

78T 4   Grozdanov,T.P. Janev,R.K.
         Phys. Letters 66A (1978) 191-194
         One-electron capture in slow collisions of highly charged ions with
         atoms
            $Ar^{6+,7+}$ + He, Ar -> $Ar^{5+,6+}$
         tunnelling model
         0.05 - 5 keV/amu
         Preferential n-values as a function of q and of targets. dependence
         on target ionization energy

78T 5   Grozdanov,T.P. Janev,R.K.
         Phys. Rev. A 17 (1978) 880-888
         Charge-exchange collisions of multiply charged ions with atoms
            A^{z+} + B -> $A^{(z-1)+}$ + B^+ (z = 5-40; B = H, Li, Na, K, Rb, Cs)
         tunnelling model
         0.002 - 500 keV/amu

78T 6   Lee,C.M.
         Phys. Rev. A 17 (1978) 566-569
         Radiative charge exchange process in high energy ion-atom collisions
            U^{36+} + B -> U^{35+} + $h\nu$ + B^+ (B = N, Ne, Ar, Kr);
            U^{q+} + Ne -> $U^{(q-1)+}$ + $h\nu$ + Ne^+ (q = 2, 36, 92)
         IA
         1×10^4 - 3×10^5 keV/amu

78T 7   Lin,C.D.
         J. Phys. B 11 (1978) L185-190
         Electron capture for ion-atom collisions at intermediate energies
            A^{z+} + B -> $A^{(z-1)+}$ + $B^+(1s^{-1})$ (A = C, N, O, F, Cl ;

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                B = Ne, Ar, Kr)
                two-state two-center AO
                1000 - 4500 keV/amu
                K-K transfer
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78T 8   Lin,C.D. Soong,S.C. Tunnell,L.N.
         Phys. Rev. A   17   (1978)   1646-1654
         Two-state atomic expansion methods for electron capture from
         multielectron atoms by fast protons
            $H^+ + B \to H + B^+$ (B = C, N, O, Ne, Ar)
            Two-state atomic expansion
            200 - 12000 keV/amu

78T 9   Moore,J.C. Banyard,K.E.
         J. Phys. B   11   (1978)   1613
         Continuum-distorted-wave calculations for electron capture from
         hydrogen negative ions by fast protons
            $H^+ + H^-(1s^2) \to H(nl) + H(n'l')$ (n, n'$\leq$ 2)
            CDW
            5 - 2000 keV/amu

78T10   Morrison,H.G. Opik,U.
         J. Phys. B   11   (1978)   473-492
         An impact-parameter method for heavy-particle collisions involving one
         electron I. Theory and sample results on H^+ - H and He^{2+} - H
         collisions
            $H^+ + H \to H(2s, 2p) + H^+$; $He^{++} + H \to He^+$
            modified close-coupling
            8, 25, 49, 60 (H^++H), 10, 18.33 (He^{++}+H) keV/amu

78T11   Olson,R.E.
         Phys. Rev. A   18   (1978)   2464-2469
         Electron-capture and impact-ionization cross sections for multiply
         charged ions colliding with helium
            H^+, He^{2+}, Li^{3+}, Be^{4+}, B^{5+}, C^{6+}, N^{7+}, O^8, + He $\to$
            H^0, He^+, Li^{2+}, Be^{3+}, B^{4+}, C^{5+}, N^{6+}, O^{7+} + He^+
            CTMC
            100 - 500 keV/amu

78T12   Olson,R.E. Shipsey,E.J. Browne,J.C.
         J. Phys. B   11   (1978)   699-708
         Charge transfer cross sections for B^{3+}, C^{4+} + H collisions
            B^{3+}, C^{4+} + H $\to$ B^{2+}, C^{3+} + H^+
            impact parameter PSS
            0.05 - 5 keV/amu
            total cross section, C^{4+} nearly constant, B^{3+} oscillatory

78T13   Ryufuku,H. Watanabe,T.
         Phys. Rev. A   18   (1978)   2005-2015
         Charge transfer in collisions of atomic hydrogen with O^{8+}, He^{2+} and H^+
            H^+, He^{2+}, O^{8+} + H $\to$ H^0, He^+, O^{7+} + H^+
            UDWA, absorption model, DWBA
            0.025 - 200 keV/amu
            total cross section

78T14   Shakeshaft,R. Spruch,L.
         J. Phys. B   11   (1978)   L457-463
         Possibility of observing the second Born contribution to electron
         capture at high impact velocities
            $A^{z+} + B^{(z-1)+} \to A^{(z-1)+}$
            second Born approximation

2.5x10⁴ - 8x10⁴ keV/amu

78T15   Shevelko,V.P.
        Z. Phys. A   287   (1978)   19-26
        One-electron capture in collisions of fast ions with atoms
        $H^+ + Cs, Cd, Ar \rightarrow H(nl)$; $F^{7+} + Ar \rightarrow F^{6+}(nl)$;
        $O^{3+,6+,8+} + He, N \rightarrow O^{2+,5+,7+}$
        Born approximation + close-coupling at low energies
        1 - 5x10⁴ keV/amu
        analytic expression

78T16   Shipsey,E.J. Redman,L.T. Browne,J.C. Olson,R.E.
        Phys. Rev. A   18   (1978)   1961-1966
        Electron-capture and ionization cross sections for collisions of He^{2+}
        with Li ; production of $He^+(3l)$ at low velocities
        $He^{2+} + Li \rightarrow He^+ + Li^+$
        PSS (low E), CTMC (high E)
        0.05 - 500 keV/amu
        preferential capture to $He^+(3l)$; total cross sections

78T17   Sidis,V. Kubach,C.
        J. Phys. B   11   (1978)   2687-2703
        Theoretical study of the elastic and charge exchange processes in H^+
        + Cs collisions
        $H^+ + Cs \rightarrow H^0$ (total, 2s, 2p)
        CC
        0.05 - 4.0 keV/amu

78T18   Winter,T.G. Lane,N.F.
        Phys. Rev. A   17   (1978)   66-79
        Electron transfer in collisions of He^{++} ions with H atoms at
        $^4He^{++}$ impact energies of 0.1-20.0 keV
        $He^{2+} + H \rightarrow He^+$
        PSS (20 MO)
        2.5x10⁻² - 5 keV/amu

79T 1   Abramov,V.A. Baryshnikov,F.F. Lisita,V.S.
        Sov. Phys. -JETP   47   (1979)   469-477
        Charge transfer between hydrogen atoms and the nuclei of multicharged
        ions with allowance for the degeneracy of the final states
        $C^{6+}, O^{8+} + H \rightarrow C^{5+}, O^{7+}$
        Landau-Zener model with rotation of nuclear axis
        total cross section; valid in v<1

79T 2   Banyard,K.F. Shirtcliffe,G.W.
        J. Phys. B   12   (1979)   3247-3256
        Electron capture from lithium and its ions by high-energy protons
        $H^+ + Li \rightarrow H(nl) + Li^+$ (1^1S, 2^1S, 2^3S) (n ≤ 2)
        CDW
        200 - 10000 keV/amu

79T 3   Bardsley,J.N. Cohen,J.S. Wadera,I.M.
        Phys. Rev. A   19   (1979)   2129-2130
        Resonant contributions to single charge transfer between He^{2+} and He
        $He^{2+} + He \rightarrow He^+ + He^+ + h\nu$
        quantum and JWKB
        10⁻⁷ - 10⁻² keV/amu

79T 4   Becker,R.L. Mackellar,A.D.
        J. Phys. B   12   (1979)   L345-350
        Classical four-body calculations of $He^+ + H$ and $H + H$ collisions

He* + H -> He^0
four-body CTMC
9 - 250 keV/amu

79T 5   Briggs,J.S. Taulbjerg,K.
         J. Phys. B 12 (1979) 2565-2573
         Charge transfer by a double-scattering mechanism involving target
         electrons
         ^{r} H* + He(1s^2) -> H(1s) + He^{2*} + e
         quantum mechanical description of Thomas peak
         asymptotic forms (v^{-11} a.u)

79T 6   Butler,S.E. Bender,C.F. Dalgarno,A.
         Astrophys. J. 230 (1979) L59-61
         Charge transfer of O^{2*} and Ne^{2*} with H
         O^{2*}, Ne^{2*} + H -> O*, Ne* + H*
         Landau-Zener
         10^{-5} keV/amu
         Thermal energy; rate coefficient

79T 7   Butler,S.E. Dalgarno,A.
         Astrophys. J. 234 (1979) 765-767
         Charge transfer between N* and H
         N* + H -> N + H*
         quantal distorted wave approximation
         10^{-5} - 10^{-2} keV/amu
         rate coefficient

79T 8   Chan,F.T. Eichler,J.
         Phys. Rev. Letters 42 (1979) 58-61
         Approximation scheme for electron capture into arbitrary principal
         shells of energetic bare projectiles
         A^{z*} + H -> A$^{(z-1)*}$(n) + H*
         eikonal approximation
         500 - 5000 keV/amu
         analytic expression for any n, normalized to OBK

79T 9   Chan,F.T. Eichler,J.
         Phys. Rev. A 20 (1979) 1841-1847
         Electron capture into arbitrary n, l levels of fast projectiles
         O^{8*} + He -> O^{7*}(nl) + He*; O^{8*} + H -> O^{7*}(nl) + H*;
         H* + H(1s) -> H(nl) + H*; H* + He -> H(nl) + He*
         eikonal-Brir.kman-Kramers
         100 (O^{8*}), 30 - 1000 (H*) keV/amu

79T10   Chan,F.T. Eichler,J.
         J. Phys. B 12 (1979) L305-308
         Charge exchange between H(2s) and enegetic projectiles
         A^{z*} + H(2s) -> A$^{(z-1)*}$ + H*
         eikonal approximation
         10 - 1000 keV/amu

79T11   Duman,E.L. Menshikov,L.I.
         Sov. Phys.-Dokl. 24 (1979) 116-117
         Radiative capture of an electron of a traget atom by multiply charged
         ions
             analytic cross sections

79T12   Duman,E.L. Menshikov,L.I. Smirnov,B.M.
         Sov. Phys.-JETP 49 (1979) 260-266
         Destruction of hydrogen atom by collisions with multiply charged ions

$A^{q+} + H \rightarrow A^{(q-1)+}(n,l) + H^+;\ A^{q+} + H^+ + e\ (A \gg 1)$
perturbation theory
Analytic expressions for electron capture $(v \ll e^2/h)$ and ionization $(v \gg Z^{1/2}e^2/h)$ in some cases (high Z).

79T13   Duman,E.L. Smirnov,B.M.
Sov. Phys.-J. Plasma Phys. 4 (1979) 650-652
Charge exchange of hydrogen atoms with multiply charged ions
$A^{z+} + H \rightarrow A^{(z-1)+} + H^+$ (z = 4 - 30)
Tunneling model
$1 - 10^2$ keV/amu

79T14   Eichler,J. Chan,F.T.
Phys. Rev. A 20 (1979) 104-112
Approach to electron capture into arbitrary principal shells of
energetic projectiles
$C^{6+} + H \rightarrow C^{5+}(n) + H^+$
eikonal approximation
50 - 500 keV/amu
Analytical expression scaled to OBK for any projectile-target
combination.

79T15   Ford,A.L. Reading,J.F. Becker,R.L.
J. Phys. B 12 (1979) 2905-2912
Charge transfer and ionization in collosions of 2.5 to 9 MeV protons
with argon
    target-centered basis expansion method
    2500 - 9000 keV/amu

79T16   Hatton,G.J. Lane,N.F. Winter,T.G.
J. Phys. B 12 (1979) L571-577
Charge transfer for He^{2+} on H using molecular bases with plane-wave
translational factors
$He^{2+} + H \rightarrow He^+(2s) + H^+$
MO close-coupling with plane-wave ETF
0.25 - 25 keV/amu

79T17   Kumar,A. Roy,B.N.
J. Phys. B 12 (1979) 2025-2030
Modified binary encounter calculations for electron capture from noble
gas atoms by He^+ ions II
$He^+ + B \rightarrow He^0$ (B = He, Ne, Ar, Kr, Xe)
modified BEA
20 - 250 keV/amu

79T18   Lin,C.D.
Phys. Rev. A 19 (1979) 1510-1516
Double K-shell electron capture for ion-atom collisions at intermediate
energies
$H^+ + He \rightarrow H^- + He^{2+};\ He^{2+} + He \rightarrow He + He^{2+};$
$A^{z+} + Ne \rightarrow A^{(z-2)+} + Ne^{2+}\ (1s^{-2})$
Two-state, Two-center AO
10 - 200 keV/amu (H), 50 - 250 keV/amu (He), 500 - 4000 keV/amu (F)

79T19   Lin,C.D. Tunnell,L.N.
J. Phys. B 12 (1979) L485-490
Subshell electron capture cross sections of argon atoms by protons
$H^+ + Ar \rightarrow H + Ar^+\ (nl^{-1})$ (n = 2, 3)
two-sate AO close-coupling
2 - 10000 keV/amu

79T20   McCarroll,R. Valiron,P.
         Astron. Astrophys. 78 (1979) 177-180
         Charge exchange of N^{3+} ions with atomic hydrogen in the interstellar
         gas
             N^{3+} + H -> N^{2+} + H^+
         molecular model/Landau-Zener model
         10^{-7} - 2×10^{-3} keV/amu

79T21   Moisewitsch,B.L. Stockman,S.G.
         J. Phys. B 12 (1979) L591-595
         Electron capture at relativistic energies
             H^+ + H(1s) -> H(1s) + H^+
         OBK with Dirac wave functions
         100 - 1000000 keV/amu
         total cross section with and without spin change

79T22   Moiseiwitsch,B.L. Stockman,S.G.
         J. Phys. B 12 (1979) L695-698
         Relativistic classical theory of electron capture
             H^+ + H(1s) -> H(1s) + H^+
         relativistic classical theory
         10^5 - 10^7 keV/amu

79T23   Morrison,H.G. Opik,U.
         J. Phys. B 12 (1979) L685-688
         Excitation and charge transfer to the 2s and 2p states in H^+ - H
         collisions in the energy range 49 to 125keV
             H^+ + H -> H(2s, 2p) + H^+
         modified close-coupling
         49 - 125 keV/amu

79T24   Mukherjee,S. Sil,N.C. Basu,D.
         J. Phys. B 12 (1979) 1259-1265
         Electron capture by protons from some hydrogen-like ions
             H^+ + He^+, Li^{2+} -> H + He^{2+}, Li^{3+}
         Coulomb-Born
         5 - 1000 (H^+) keV/amu

79T25   Omidvar,K.
         Phys. Rev. A 19 (1979) 65-71
         Scaling of cross sections for K-shell capture by high energy protons
         and alpha-particles from the multi-electron atoms
             H^+, He^{2+} + B -> H^0, He^+ + $B^+(1s^{-1})$ (B = H, He, Ar)
         scaling law

79T26   Ray,P.P. Saha,B.C.
         Phys. Letters 71A (1979) 415-419
         Electron capture in H^+ - H_2 collisions
             H^+ + H_2 -> H^0
         first Born approximation
         50 - 5000 keV/amu

79T27   Reading,J.F. Ford,A.L. Swafford,G.L. Fritchard,A.
         Phys. Rev. A 20 (1979) 130-144
         Innershell charge transfer in asymmetric ion-atom collisions
             A^{z+} + Cu -> $A^{(z-1)+}$ + $Cu^+(1s^{-1}, 2l^{-1})$ (A = He, C, O)
         HF
         6000 keV/amu

79T28   Roy,A. Ghosh,A.S.
         J. Phys. B 12 (1979) 99-104

The capture of electrons by fast protons from hydrogen atoms
$H^+ + H \rightarrow H(1s, 2s, 2p) + H^+$
fixed scatterer approximation (frozen target-second Born)
30 - 2000 keV/amu

79T29   Roy,B.N. Rai,D.K.
J. Phys. B 12 (1979) 2015-2030
Modified binary-encounter calculations for electron capture from
noble-gas atoms by protons I
$H^+ + B \rightarrow H^0$ (B = He, Ne, Ar, Kr, Xe)
modified BEA
10 - 500 keV/amu

79T30   Ryufuku,H. Watanabe,T.
Phys. Rev. A 19 (1979) 1538-1549
Charge transfer cross sections for collisions of Li^+, Be^{4+}, and
C^{6+} ions with atomic hydrogen
Li^{3+}, Be^{4+}, B^{5+}, $C^{6+} + H \rightarrow Li^{2+}$, Be^{3+}, B^{4+}, C^{5+}
UDWA
0.025 - 2000 keV/amu
total cross sections

79T31   Ryufuku,H. Watanabe,T.
Phys. Rev. A 20 (1979) 1828-1837
Total and partial cross sections for charge transfer in collisions of
multicharged ions with atomic hydrogen
Ne^{10+}, Si^{14+}, Ca^{20+}, $C^{6+} + H \rightarrow Ne^{9+}$, Si^{13+}, Ca^{19+}, $C^{5+} + H^+$
UDWA
0.025 - 2000 (Ne^{10+}), 0.025 - 5000 (Si^{14+}), 0.1 - 10 (Ca^{20+}) keV/amu
also H^+, He^{2+}, Li^{3+}, Be^{4+}, B^{5+}, C^{6+}, O^{8+}

79T32   Salop,A.
J. Phys. B 12 (1979) 919-928
The distribution of excitation resulting from electron capture in
stripped-ion-hydrogen-atom collisions
C^{6+}, O^{8+}, $B^{5+} + H \rightarrow C^{5+}(nl)$, $O^{7+}(nl)$, $B^{4+}(nl) + H^+$
CTMC
25 - 72 keV/amu
no cross section

79T33   Salop,A. Olson,R.E.
Phys. Letters 71A (1979) 407-410
Electron removal from atomic hydrogen by collisions with fully stripped
iron ions
$Fe^{26+} + H \rightarrow Fe^{25+} + H^+$; $Fe^{26+} + H^+ + e$
PSS (low energies); CTMC (high energies)
0.35 - 535 keV/amu

79T34   Salop,A. Olson,R.E.
Phys. Rev. A 19 (1979) 1921-1929
Electron removal from atomic hydrogen by collisions with fully stripped
oxygen ions
$O^{8+} + H \rightarrow O^{7+} + H^+$; $O^{8+} + H^+ + e$
impact parameter PSS (low energies); CTMC (high enegies)
0.06 - 300 keV/amu

79T35   Shakeshaft,R.
Phys. Rev. A 20 (1979) 779-786
Relativistic effects in electron capture from a hydrogenlike atom by a
fast-moving bare ion
H^+, $Ne^{10+} + H \rightarrow H(1s)$, $Ne^{9+}(1s)$

first Born with relativistic correction, Thomas model at relativistic energy
10000 - 10000000 keV/amu
Thomas peak - E^{-3}, first Born - E^{-1}, REC - E^{-1}

79T36   Sinha,C. Mukherjee,S. Sil,N.C.
J. Phys. B 12 (1979) 1391-1397
Electron capture in an arbitrary excited S state by protons passing through hydrogenic ions
$H^+ + X^{z+} \rightarrow H(ns) + X^{(z+1)+}$ ($X^{z+} = He^+$, Li^{2+}, C^{5+}, n=2, 3, 4, 6, ∞)
Coulomb-Born
50 - 400

79T37   Spruch,L. Shakeshaft,R.
Phys. Rev. A 19 (1979) 1023-1028
Classical cross section for charge transfer via "knock-on" capture from high Rydberg states at asymptotically high impact velocities
$A^{z+} + B^{(z-1)+}(1s) \rightarrow A^{(z-1)+} + B^{z+}$

79T38   Theisen,T.C. McGuire,J.H.
Phys. Rev. A 20 (1979) 1406-1408
Single and double electron capture in the independent electron approximation at high velocities
$He^{2+} + He \rightarrow He^+$, He^{0+}
Independent electron model with Bates-Born theory
25 - 250 keV/amu

79T39   Watson,W.D. Christensen,R.B.
Astrophys. J. 231 (1979) 627-631
Quantal calcualtions for charge transfer in collisions of C^{3+} and N^{3+} with H atoms
$A^{3+} + H \rightarrow A^{2+} + H^+$ (A = C, N)
quantal calculation/Landau-Zener model
$10^{-6} - 10^{-2}$ keV/amu

80T 1   Amundsen,P.A. Jakubassa,D.H.
J. Phys. B 13 (1980) L467-472
Charge transfer in asymmetric heavy ion collisions
$H^+ + B \rightarrow H^0 + B^+(1s^{-1})$ (B = C, Ne, Ar)
IA
200 - 6000 keV/amu
Impact parameter dependence of capture probabilities.

80T 2   Banyard,K.E. Shirtcliffe,G.W.
Phys. Rev. A 22 (1980) 1452-1454
Charge exchange between simple structured projectiles in high energy collisions
$H(1s) + H(1s) \rightarrow H^- + H^+$
continuum-intermediate-state approximation
2 - 90 keV/amu

80T 3   Becker,R.L. Ford,A.L. Reading,J.F.
J. Phys. B 13 (1980) 4059-4077
Contributions of multi-electron processes to innershell charge transfer and vacancy production; projectile charge dependence in collisions of bare nuclei with argon
He^{2+}, $C^{6+} + Ar \rightarrow He^+$, $C^{5+} + Ar^+(1s^{-1})$
CC
1000 - 5000 keV/amu
Z_p-scaling

80T 4   Bransden,B.H. Newby,C.W. Noble,C.J.
J. Phys. B 13 (1980) 42450-4255
Electron capture by fully stripped ions of helium, lithium, beryllium
and boron from atomic hydrogen
He^{2+}, Li^{3+}, Be^{4+}, B^{5+} + H -> He^+, Li^{2+}, Be^{3+}, $B^{4+}(nl)$ + H^+
CC (2-AO)
5 - 200 keV/amu

80T 5   Briggs,J.S. Dube,L.
J. Phys. B 13 (1980) 771-784
The second Born approximation to the electron transfer cross section
A^{z1+} + $B^{(z2-1)+}(n'l'm')$ -> $A^{(z1-1)+}(nlm)$ + B^{z2+}
second Born (approximate)

80T 6   Butler,S.E. Heil,T.G. Dalgarno,A.
Astrophys. J. 241 (1980) 442-447
Charge transfer of multiply charged ions with hydrogen and helium;
quantal calculations
A^{2+}, A^{3+} + H, He -> A^+, A^{2+} + H^+, He^+ (A = C, N, O, Ne)
quantal calculation
5×10^3 - 5×10^4 (K)
rate coefficient

80T 7   Butler,S.E. Dalgarno,A.
Astrophys. J. 241 (1980) 838-843
Charge transfer of multiply charged ions with hydrogen and helium;
Landau-Zener calculations
A^{q+} + B -> $A^{(q-1)+}$ + B^+ (A = C^{3+}, C^{4+}, N^{2+} - N^{4+}, O^{3+}, O^{4+},
Ne^{2+} - Ne^{4+}, Mg^{2+} - Mg^{4+}, Si^{3+}, Si^{4+}, S^{2+} - S^{4+},
Ar^{2+} - Ar^{4+}; B = H, He)
Landau-Zener model
10^{-5} - 4×10^{-3} keV/amu
rate coefficients

80T 8   Chamband,G. Launay,J.M. Levy,B. Mille,P. Roueff,E. Minh,F.T.
J. Phys. B 13 (1980) 4205-4216
Charge exchange and fine structure excitation in O - H^+ collisions
O^+ + H -> O + H^+; H^+ + $O(^3P_2)$ -> H^0 + O^+ ($^4S_{3/2}$)
CC
10 - 1000 K

80T 9   Crothers,D.S.F. Todd,N.R.
J. Phys. B 13 (1980) 547-563
Electron capture by slow Zn^{2+}, Cd^{2+}, B^{2+}, Mg^{2+} and C^{6+} ions
in H
Zn^{2+}, Cd^{2+}, B^{2+}, Mg^{2+}, C^{6+} + H
Phase-integral interpretation of the two-state exponential model
within IP
2.5×10^{-3} - 25 (Zn^{2+}, Cd^{2+}), 0.25 - 2.5×10^3 (B^{2+}),
400 - 1225 (Mg), 0 - 25 (C^{6+}) keV/amu

80T10   Crothers,D.S.F. Todd,N.R.
J. Phys. B 13 (1980) 2277-2294
One-electron capture by fast multiply charged ions in H; q^3 scaling
A^{q+} + H -> $A^{(q-1)+}$ + H^+
OBK, eikonal, CDW, CIS
1.3 - 250 keV/amu
q^3 scaling low

80T11   Datta,S. Mukherjee,S.C.
J. Phys. B 13 (1980) 539-546

Charge transfer in He^{2+} - H(1s) collisions
He^{2+} + H(1s) -> He^+(1s, 2s, 2p) + H^+
Coulomb-Born
25 - 2500 keV/amu

80T12   Eichler,J. Narumi,H.
Z. Phys. A 295 (1980) 209-214
On the classical-trajectory eikonal approximation for electron capture
into multicharged ions
He^{2+} + H(1s) -> H^+(1s) + H^+
Eikonal approximation
200 - 50000 keV/amu
General expression for 1s-1s transfer for any projectile-target
combination, normalized to OBK.

80T13   Gozdanov,T.P.
J. Phys. B 13 (1980) 3835-3847
Classical model for electron capture in collisions of highly charged,
fully stripped ions with hydrogen atoms
A^{z+} + H -> $A^{(z-1)+}$ + H^+ (z = 8, 10, 14, 18, 26, 36)
classical over-barrier model
0.5 - 100 keV/amu
total cross sections

80T14   Grozdanov,T.P. Janev,R.K.
J. Phys. B 13 (1980) L69-72
Electron capture in slow collsions of multiply charged ions with
hydrogen molecules
$Kr^{4+->7+}$ + H_2 -> $Kr^{3+->6+}$
tunnelling model
0.012 - 0.24 keV/amu
total cross section

80T15   Grozdanov,T.P. Janev,R.K.
J. Phys. B 13 (1980) 3431-3442
Two-electron capture in slow ion-atom collisions
He^{2+}, C^{4+} + He -> He^0, C^{2+} + He^{2+}
asymptotic Landau-Herring method
0.5 - 12 keV/amu
total cross section

80T16   Harel,C. Salin,A.
J. Phys. B 13 (1980) 785-789
Application of OEDM orbitals to many-electron systems; He^{2+}-He
collisions
He^{2+} + He -> He^+(n) + He^+(1s), He + He^{++} (n = 1, 2)
MO close-coupling
3.3 - 33 keV/amu

80T17   Jakubassa-Amundsen,D. H. Amundsen,P.A.
Z. Phys. A 297 (1980) 203-214
On the semiclassical impulse approximation for electron caputure in
asymmetric ion-atom collisions
H^+ + B -> H(1s) + B^+($1s^{-1}$) (B = C, N, O, Ne, Ar)
semiclassical impulse approximation
400 - 20000 keV/amu
angular distribution

80T18   Jakubassa-Amundsen,D.H. Amundsen,P.A.
Z. Phys. A 298 (1980) 13-19
Charge transfer in heavy ion collisions at relativistic velocities

impulse approximation

80T19   Lapicki,G. McDaniel,F.D.   ·
Phys. Rev. A 22 (1980) 1896-1905
Electron capture from K shell by fully stripped ions
    modified OBK with corrections
    scaling law

80T20   Lin,C.D. Tunnell,L.N.
Phys. Rev. A 22 (1980) 76-85
Improved atomic model for charge transfer in multielectron ion-atom
collisions at intermediate energies
    $H^+ + Ar \rightarrow H^0(1s) + Ar^+(1s^{-1})$; $H^+ + Ne$, $Kr \rightarrow H(1s) +$
    $Ne^+(2s^{-1}, 2p^{-1})$, $Kr^+(4s^{-1}, 4p^{-1})$; $F^{q+} + Ar \rightarrow F^{8+}(1s) + Ar^+(1s^{-1})$
    Two-center AO expansion method
    1 - 200 keV/amu (H); 1000 - 24000 keV/amu (F)

80T21   Macek,J.H. Shakeshaft,R.
Phys. Rev. A 22 (1980) 1441-1446
Second Born approximation with the Coulomb Green's function;
electron capture from hydrogen-like ions by a bare ion
    $H^+ + B^{(z-1)+}(1s) \rightarrow H(1s)$ (B = Ne, Ca)
    second Born approximation
    2500 - 10000 keV/amu

80T22   McCarroll,R. Valiron,P.
Electric and Atomic Collisions (North-Holland) (1980) 453- 456
Thermal charge exchange reaction with multicharged ions of
astrophysical interest; application to the N^{3+} - H system
    $N^{3+} + H \rightarrow N^{2+} + H^+$
    quantal calculation/Landau-Zener model
    $10^{-7} - 10^{-3}$ keV/amu

80T23   Moiseiwitsch,B.L. Stockman,S.G.
J. Phys. B 13 (1980) 2975-2981
Electron capture by charged particles at relativistic energies
    H^+, $Ne^{10+} + H(1s) \rightarrow H(1s)$, $Ne^{9+}(1s) + H^+$
    OBK with Dirac wave function
    10000 - 10000000 keV/amu
    analytic expression

80T24   Moiseiwitsch,B.L. Stockman,S.G.
J. Phys. B 13 (1980) 4031-4037
Non-orthogonality of atomic wave functions in electron capture at
relativistic energies
    $A^{z+} + B^{(z-1)+}(1s) \rightarrow A^{(z-1)+}(1s)$ (A = H, Ne, Ar; B = H, Cu)
    relativistic OBK
    $1 \times 10^6 - 1 \times 10^{37}$ keV/amu

80T25   Mukherjee,S. Sil,N.C.
J. Phys. B 13 (1980) 3421-3430
Ion-ion capture collisions in continuum distorted-wave approximation
    $H^+ + He^+$, Li^{2+}, Be^{3+}, $C^{5+} \rightarrow H(1s, 2s) + He^+$, Li^{3+}, Be^{4+}, C^{6+}
    CDW
    400 - 2000 keV/amu

80T26   Olson,R.E.
J. Phys. B 13 (1980) 483-492
Ion-Rydberg atom collisions cross sections
    $A^{q+} + B^{(z-1)+}(n) \rightarrow A^{(q-1)+}(n') + B^{z+}$ (q=1, 2, 5, 10 ; n=1, 2, 5, 10, 20)
    CTMC

80T27   Reading,J.F. Ford,A.L.
Phys. Rev. A 21 (1980) 124
K-shell hole production, multiple hole production, charge transfer and antisymmetry

80T28   Rivarola,R.D. Piancetini,R.D. Salin,A. Belkic,Dz.
J. Phys. B 13 (1980) 2601-2609
'The influence of the static potential in high energy K-shell electron . capture collisions
$H^+ + He(1s^2) \rightarrow H(1s) + He^*(1s)$
CDW
293 keV/amu

80T29   Roy,P.K. Saha,B.C. Sil,N.C.
J. Phys. B 13 (1980) 3401-3420
Formation of hydrogen atoms in arbitrary excited states by electron capture in p-H collision
$H^+ + H(1s) \rightarrow H(nlm) + H^+$
Born approx.; distorted-wave (Bassel-Gerjuoy) approx.;
time-dependent two-state(Band) approx.
25 - 4000 keV/amu

80T30   Ryufuku,H. Sasaki,K. Watanabe,T.
Phys. Rev. A 21 (1980) 745-750
Oscillatory behavior of charge transfer cross sections as a function of the charge of projectiles in low energy collisions
$A^{z+} + H \rightarrow A^{(z-1)+} + H^+$ ($A^{z+} = B^{2+}\text{-}B^{5+}$; $C^{3+}\text{-}C^{6+}$; $N^{3+}\text{-}N^{6+}$; $O^{3+}\text{-}O^{6+}$)
UDWA, classical barrier model
1 - 25 keV/amu
oscillation of cross sections at low energies

80T31   Saha,H.P. Maiti,N. Sil,N.C.
J. Phys. B 13 (1980) 327-342
Electron capture in the 3s level by proton and alpha-particle from atomic hydrogen
$H^+ + H \rightarrow H(3s) + H^+$, $He^{++} + H \rightarrow He^+(3s) + H^+$
Bates formula
25 - 800 (H^+), 6.25 - 200 (He^{++}) keV/amu

80T32   Shakeshaft,R.
Phys. Rev. Letters 44 (1980) 442-444
Innershell electron capture by a swift bare ion; second Born effects
$A^{z+} + B^{(z-1)+} \rightarrow A^{(z-1)+} + B^{z+}$
second Born approximation
Second and higher-order Born terms needed for innershell electron capture.

80T33   Winter,T.G. Hatton,G.
Phys. Rev. A 21 (1980) 793-807
Plane-wave-factor, molecular-state treatment of electron transfer in collisions of He^{2+} ions with H atoms
$He^{2+} + H \rightarrow He^+(nl) + H^+$
CC (3,4,10 MO) with ETF
0.25 - 17.5

81T 1   Borondo,F. Macias,A. Riera,A.
Phys. Rev. Letters 46 (1981) 420-423
Asymmetry effect in the nentralization reaction $H^+ + H^-$
$H^+ + H^- \rightarrow H(1s) + H(nl)$
semi-classical approach

0.1 - 100 keV/amu

81T 2   Bransden,B.H. Ermolaev,A.M. •
         Phys. Lett. 84A (1981) 316-318
         Charge exchange in He^{++} - Li collisions
         He^{2+} + Li -> $He^+(n)$ + Li^+
         CC (2-AO)
         1.25 - 16.0 keV/amu

81T 3   Bransden,B.H. Noble,C.J.
         J. Phys. B 14 (1981) 1849-1856
         Charge transfer in H^+ + He^+ and He^{2+} + H collisions
         H^+ + He^+ -> H + He^{2+}; He^{2+} + H -> He^+ + H
         Impact parameter
         0.5 - 50 keV/amu

81T 4   Burgdorfer,J.   •
         J. Phys. B 14 (1981) 1019-1034
         Angular momentum coherences in the differential capture amplitude in
         hydrogen
         H^+, He^{2+} + Ar -> H(1s, 2s, 2p, 3s), $He^+(1s, 2s, 2p_1, 3s)$
         Coulomb-Brinkman-Kramers approximation
         6000 keV/amu
         angular distribution; A^{z+} + $B^{(z-1)+}(1s)$ -> $A^{(z-1)+}(nlm)$

81T 5   Burgdorfer,J.
         Phys. Rev. A 24 (1981) 1736-1767
         Influence of the linear Stark effect on electron capture into fully
         stripped ions
         H^+ + H, He -> H(n=2) + H^+; O^{8+} + He -> $O^{7+}(n=2)$;
         C^{6+} + He -> $C^{5+}(n=2)$
         modified OBK
         50 - 400 keV/amu

81T 6   Casaubon,J.I. Piancentini,R.D. Salin,A.
         J. Phys. B 14 (1981) L297-299
         Charge exchange in low-energy Li^{3+} - H collisions
         Li^{3+} + H -> $Li^{2+}(nl)$ + H^+
         impact parameter molecular approximation
         1 - 5.7 keV/amu

81T 7   Christensen,R.B. Watson,W.D.
         Phys. Rev. A 24 (1981) 1331-1341
         Charge transfer in S^{2+} + H collisions at eV collision energies
         $S^{2+}(^3P)$ + H(1s) -> S^+ + H^+
         ab initio MO method
         10^{-3} keV/amu

81T 8   Crothers,D.S.F.   •   ⁾
         J. Phys. B 14 (1981) 1035-1040
         Continuum distorted waves; capture into the nth shell
         A^{z+} + H(1s) -> $A^{(z-1)+}(n)$ + H^+ (A = H, He, Li, Be, B, C)
         C.D.W
         130 keV/amu

81T 9   Crothers,D.S.F. Todd,N.R.
         J. Phys. B 14 (1981) 2251-2258
         Molecular treatment of charge-transfer in He^{2+} - H collisions
         He^{2+} + H -> $He^+(nl)$ + H^+
         CC(5-MO) with ETF
         0.5 - 6.0 keV/amu

81T10   Devi,K.R.S. Koonin,S.E.
Phys. Rev. Letters 47 (1981) 27-30
Mean-field approximation to P + He scattering
$H^+ + He \rightarrow H^0$
time-dependent Hartree-Fock method
4 - 100 keV/amu

81T11   Dube,L.J. Briggs,J.S.
J. Phys. B 14 (1981) 4595-4617
Systematics of the single and double electron scattering contribution
to charge exchange
$A^{z+} + B^{(z-1)+}(nlm) \rightarrow A^{(z-1)+}(n'l'm')$
first and second Born approximations
25 - 10000 keV/amu

81T12   Eichler,J.
Phys. Rev. A 23 (1981) 498-509
Eikonal theory of charge exchange between arbitrary hydrogenic states
of target and projectile
$A^{z+} + H(nl) \rightarrow A^{(z-1)+}(n'l') + H^+$ (A = H, He, Li, B, C, Fe)
eikonal approximation
10 - 3000 keV/amu

81T13   Fijiwara,K.
J. Phys. B 14 (1981) 3977-3986
Close-coupling calculation for electron capture by an alpha particle
from atomic hydrogen
$He^{2+} + H \rightarrow He^+(nlm) + H^+$
CC (19AO)
1.3 - 100 keV/amu

81T14   Ford,A.L. Reading,J.F. Becker,R.L.
Phys. Rev. A 23 (1981) 510-518
Innershell capture and ionization in collisions of H^+, He^{2+} and
Li^{3+} projectiles with neon and carbon
$A^{z+} + B \rightarrow A^{(z-1)+}(1s) + B^+(1s^{-1}, 2l^{-1})$ (A = H, He, Li; B =C, Ne)
target-centered basis expansion method
200 - 2000 keV/amu (C); 400 - 4000 keV/amu (Ne)

81T15   Gargaud,M. Hanssen,J. McCarroll,R. Valiron,P.
J. Phys. B 14 (1981) 2259-2276
Charge exchange with multiply charged ions at low energies; application
to the N^{3+}/H and C^{4+}/H systems
$N^{3+} + H \rightarrow N^{2+}(nl) + H^+$; $C^{4+} + H \rightarrow C^{3+}(nl) + H^+$
CC (MO)
7×10^{-7} - 7×10^{-3} (N^{3+}), 8×10^{-7} - 8×10^{-3} (C^{4+}) keV/amu

81T16   Gayet,R. Rivarola,R.D.R. Salin,A.
J. Phys. B 14 (1981) 2421-2427
Double electron capture by fast neuclei
$He^{2+} + He \rightarrow He^0$; $F^{9+} + Ar \rightarrow F^{7+}(1s^2)$
CDW
125 - 350 keV/amu (He); 1578 - 3263 keV/amu (F)

81T17   Green,T.A. Shipsey,E.J. Brown,J.C.
Phys. Rev. A 23 (1981) 546-561
Modified method of perturbed stationary states. III. Charge-exchange
cross-sections for C^{6+} - H collisions
$C^{6+} + H \rightarrow C^{5+}(n) + H^+$
CC (MO)

0.05- 30.0 keV/amu

81T18   Heil,T.G. Butler,S.E. Dalgarno,A.
        Phys. Rev. A 23 (1981) 1100-1109
        Charge transfer of multiply charged ions at thermal energies
        N^{2+} + H -> N^+ + H^+; C^{3+} + H -> C^{2+}(nl) + H
        CC (MO)
        1.4×10^{-6} - 5.8×10^{-4} (N^{2+}), 2.2×10^{-5} - 6.7×10^{-4} (C^{3+}) keV/amu

81T19   Ho,T.S. Lieber,M. Chan,F.T.
        Phys. Rev. A 24 (1981) 2925-2932
        Eikonal approximation of electron-capture cross sections in collisions
        of H-atoms with fast projectiles
        P + H -> H(nl) + P; C^{6+} + H -> C^{5+}(nl) + P;
        O^{8+} + H -> O^{7+}(nl) + P; Fe^{24+} + H -> Fe^{23+} + H^+
        eikonal approximation
        20 - 100 (P), 40 - 200 (others) keV/amu

81T20   Ho,T.S. Lieber,M. Chan,F.T. Omidvar,K.
        Phys. Rev. A 24 (1981) 2933-2945
        Eikonal approximation for charge transfer from a multielectron atom to
        fast projectiles
        H^+ + He, C, Ar, N_2, O_2 -> H; He^{2+} + He, C -> He^+;
        Li^{3+} + C, Ne -> Li^{2+}
        eikonal approximation
        500 - 10000 keV/amu

81T21   Ho,T.S. Umberger,D. Day,R.L. Lieber,M. Chan,F.T.
        Phys. Rev. A 24 (1981) 705-713
        Eikonal calculation of electron capture cross sections from an
        arbitrary nlm shell of a hydrogenic target into arbitrary n'l'm' shell
        of a fast bare projectile
        A^{z+} + $B^{(z-1)+}$(nlm) -> $A^{(z-1)+}$(n'l'm') + B^{z+}
        Eikonal, OBK
        20 - 200 keV/amu

81T22   Jakubassa-Amundsen,D.H.
        J. Phys. B 14 (1981) 2647-2656
        Semiclassical impulse approximation for L-shell electron capture in
        asymmetric heavy ion collisions
        H^+ + B -> H + B^+ ($2l^{-1}$) (B = Ne, Ar)
        semiclassical impulse approximation
        50 - 4000 keV/amu
        capture probability

81T23   Kimura,M. Thorson,W.R.
        Phys. Rev. A 24 (1981) 1780-1792
        Direct and charge-exchange excitation processes in H^+ - H(1s)
        collisions at 1 to 7 keV
        H^+ + H(1s) -> H(2s, 2p) + H^+
        MO with ETF
        1 - 7 keV/amu

81T24   Kimura,M. Thorson,W.R.
        Phys. Rev. A 24 (1981) 3019-3031
        Molecular-state study of He^{2+} + H(1s) and He^+ + He^+(1s) collisions
        He^{2+} + H(1s) -> He^+(total, 2l); H^+ + He^+(1s) -> H(1s; n=2)
        CC
        0.25 - 5 keV/amu

81T25   Kubach,C. Sidis,V.

Phys. Rev. A 23 (1981) 110-118
Theoretical study of near-resonant charge exchange collisions of H^+
with alkali atoms
$H^+ + B \rightarrow H^0(2s+2p)$ (B = Rb, K, Na)
CC
0.2 - 6 keV/amu

81T26   Ludde,H.J. Dreizler,R.M.
,J. Phys. B 14 (1981) 2191-2201
Direct and capture processes in proton-hydrogen scattering I. Pilot
study for bombarding energies of 2 and 8 keV
$H^+ + H \rightarrow H$(total, 2s, 2p) $+ H^+$
numerical solution of time-dependent Schroedinger equation
- 2 - 8 keV/amu

81T27   Macek,J. Taulbjerg,K.
Phys. Rev. Letters 46 (1981) 170-174
Correction to Zp/Zt expansions for electron capture
$H^+ + Ar \rightarrow H^0 + Ar^+(1s^{-1})$
second Born approximation
2000 - 15000 keV/amu

81T28   Macias,A. Riera,A. Yonez,M.
Phys. Rev. A 23 (1981) 2941-2949
Molecular treatment of $He^+ + H$ collisions
$He^+(1s) + H(1s) \rightarrow He(1s2p, {}^{1,3}P)$
MO with IP
0.125 - 7.25 keV/amu

81T29   Mandal,C.R. Datta,S. Mukherjee,S.C.
Phys. Rev. 24 (1981) 3044-3050
Charge-transfer cross sections for collisions of fast Li^{3+} ions with
atomic hydrogen
$Li^{3+} + H \rightarrow Li^{2+}$(1s, 2s, 2p, 3s, 3p, 3d) $+ H^+$
Coulomb-Born, Born
14.4 - 288 keV/amu

81T30   Olson,R.E.
Phys. Rev. A 24 (1981) 1726-1733
n, l distribution in $A^{q+} + H$ electron-capture collisions
$Z^{z+} + H \rightarrow Z^{(z-1)+} + H^+$ (Z = 1-20)
CTMC
50, 100 keV/amu

81T31   Presnyakov,L.P. Uskov,D.B. Janev,R.K.
Phys. Letters 84A (1981) 243-246
New analytic approach to the theory of charge exchange in atom-multiply
charged ion collisions
$A^{z+} + H \rightarrow A^{(z-1)+}(nl) + H^+$ (z = 5-15, 20, 30)
modified decay model
0.5 - 25 keV/amu
Analytic expression for l-distribution; q-oscillation; only total
cross sections given.

81T32   Shimakura,N. Inoue,H. Koike,F. Watanabe,T.
J. Phys. B 14 (1981) 2203-2214
Impact parameter treatment for Li^+-Li collisions using molecular
basis with electron translation factors
$Li^+ + Li \rightarrow Li(2s) + Li^+$
MO with ETF
0.015 - 0.14 keV/amu

differential in angle

81T33   Shipsey,E.J. Browne,J.C. Olson,R.E.
J. Phys. B 14 (1981) 869-880
Electron capture and ionization in C^{5+}, N^{5+}, O^{6+} + H collisions
C^{5+}, N^{5+}, O^{6+} + H -> C^{4+}, N^{4+}, O^{5+} + H^+
PSS (low velocities), CTMC (high velocities)
10^{-2} - 10^3 keV/amu
total cross sections

81T34   Sidis,V. Kubach,C. Fussen,D.
Phys. Rev. Letters 47 (1981) 1280-1284
Developments : the H^+ + H^- problem
H^+ + H^- -> $H^0(n)$ + H^0
IPM
0.02 - 10 keV/amu

81T35   Sidis,V. Kubach,C. Pommier,J.
Phys. Rev. A 23 (1981) 119-126
Systematic theoretical investigation of charge exchange in He^+ -
alkali-atom collisions
He^+ + B -> H(2s+2p) (B = Cs, Rb, K, Na)
CC
0.013-0.3 keV/amu

81T36   Simony,P.R. McGuire,J.H.
J. Phys. B 14 (1981) L737-741
Exact second Born calculations of 1s-1s electron capture in P + H
H^+ + H(1s) -> H(1s)
second Born approximation
10000, 50000 keV/amu
angular differential cross section

82T 1   Bienstock,S. Heil,T.G. Bottcher,C. Dalgarno,A.
Phys. Rev. A 25 (1982) 2850-2852
Charge transfer of C^{3+} ions in atomic hydrogen
C^{3+} + H -> $C^{2+}(2lnl')$ + H^+
CC (MO)
0.00083 - 0.416 keV/amu

82T 2   Bottcher,C. Heil,T.G.
Chem. Phys. Letters 86 (1982) 506-509
Low-energy charge exchange from hydrogen atoms by few-electron ions
Be^{4+}, B^{5+}, C^{6+} + H -> Be^{3+}, B^{4+}, C^{5+}; C^{4+}, C^{5+} + H -> C^{3+}, C^{4+}
fully quantal PSS
1.0×10^{-4} - 0.1 keV/amu
total cross section

82T 3   Bransden,B.H. Noble,C.J.
J. Phys. B 15 (1982) 451-455
Charge transfer in Li^{3+} + H collisions
Li^{3+} + H -> $Li^{2+}(nlm)$ + H^+
CC (8, 14, 20-AO)
1.4 - 200 keV/amu

82T 4   Briggs,J.S. Greenland,P.T. Kocbach,L.
J. Phys. B 15 (1982) 3085-3102
Differential cross sections for high energy electron capture in the
impulse approximation
H^+ + H, Ne -> H^0; Li^{3+} + Ne^{9+} -> Li^{2+}
impulse approximation

10000 keV/amu (H); 20000 keV/amu (Li)
angular differential cross sections

82T 5   Crothers,D.S.F. McCann,J.F.
Phys. Letters 92A (1982) 170-174
Continuum-distorted-wave capture into the n-th shell; l, m distribution
C^{6+} + H(1s) -> C^{5+}(nlm) + H^+
CDW

82T 6   Datta,S. Mandal,C.R. Mukherjee,S.C. Sil,N.C.
Phys. Rev. A 26 (1982) 2551-2566
Calculation of cross sections for electron capture by fast Li^{3+} ions
from atomic hydrogen in the continuum distorted wave approximation
- Li^{3+} + H -> Li^{2+}(1s, 2s, 2p, 3s, 3p, 3d)
CDW
100 - 1500 keV/amu

82T 7   Eichenauer,D. Grun,N. Scheid,W.
J. Phys. B 15 (1982) L17-20
Classical trajectory calculations of the differential cross sections
for charge transfer in H^+ - H collisions
H^+ + H(1s) -> H(1s)
CTMC
25, 60 keV/amu
angular differential cross sections

82T 8   Ermolaev,A.M. Noble,C.J. Bransden,B.H.
J. Phys. B 15 (1982) 457-470
Charge exchange between Cs^+ ions and related studies
Cs^+ + Cs^+ -> $Cs(5p^6$, nl) + $Cs^{2+}(5p^5)$ (nl=5d, 6s, 6p);
Li^+ + Li^+ -> $Li(1s^2$, nl) + Li^{2+} (n ≤ 3)
two-state AO close-coupling
4.5 - 75 keV/amu

82T 9   Ermolaev,A.M. Miraglia,J.E. Bransden,B.H.
J. Phys. B 15 (1982) L677-680
Ionization and charge exchange in collisions between Li^+ ions at
intermediate energies
Li^+ + Li^+ -> Li^0 + Li^{2+}; Li^+ + Li^{2+} + e
first Born approximation
5 - 1000 keV/amu

82T10   Ford,A.L. Reading,J.F. Becker,R.L.
J. Phys. B 15 (1982) 3257-3274
Coupled-channel calculations of ionization and charge transfer in
$p+Li^{+,2+}$ and transfer in $Li^{2+,3+}$ + H(1s)
Li^{2+}(1s) + H(1s) -> Li^+(1snl) + H^+ (n ≤ 3);
Li^{3+} + H(1s) -> Li^{2+}(nl) + H^+ (n ≤ 4)
perturbed one-and-a-half center
70, 86 - 400 keV/amu

82T11   Fritsch,W.
J. Phys. B 15 (1982) L389-392
Atomic orbital expansion description for slow ion-atom collisions;
a curved-line trajectory study
C^{6+} + H -> C^{5+}
atomic expansion method
0.1 - 1.0 keV/amu
total cross section

82T12   Fritsch,W. Lin,C.D.

Phys. Rev. A 26 (1982) 762-769
Excitation and charge transfer to 2s and 2p states in 1 - 20 keV
H^+ - H collisions
    H^+ + H -> H(2s, 2p)
    AO
    1 - 20 keV/amu

82T13   Fritsch,W. Lin,C.D.
J. Phys. B 15 (1982) 1255-1268
Close-coupling calculations for inelastic processes in intermediate
energy ion-atom collisions
    H^+ + $A^{(z-1)+}$ -> H + A^{z+} (A = H, He)
    two-center atomic orbital expansion method
    1.5 - 100 keV/amu

82T14   Fritsch,W. Lin,C.D.
J. Phys. B 15 (1982) L281-288
Electron transfer in Li^{3+} + H collisions at low and intermediate
energies
    Li^{3+} + H -> Li^{2+}(nl) + H^+ (n ≤ 3)
    AO close-coupling
    0.2 - 20 keV/amu

82T15   Green,T.A. Peek,J.M. Riley,M.E. Shipsey,E.J. Brown,J.C.
Phys. Rev. A 26 (1982) 1278-1282
Electron capture cross section for C^{6+} - H(1s) collisions at
electron-volt energies; a test of the Landau-Zener formula
    C^{6+} + H(1s) -> C^{5+}
    Landau-Zener + close-coupling
    3×10^{-4} - 2×10^{-2} keV/amu
    total cross section

82T16   Green,T.A. Riley,M.E. Shipsey,E.J. Brown,J.C.
Phys. Rev. A 26 (1982) 3668-3671
Semiclassical trajectory on C^{6+} - H charge exchange cross sections at
low energy
    C^{6+} + H -> C^{5+}
    semiclassical approximation
    3×10^{-3} - 1.3 keV/amu
    total cross section

82T17   Green,T.A. Shipsey,E.J. Brown,J.C.
Phys. Rev. A 25 (1982) 1364-1373
Modified method of perturbed stationary states. IV. Electron capture
cross sections for the reaction C^{6+} + H(1s) -> C^{5+}(nl) + H^+
    C^{6+} + H -> C^{5+}(nl) + H^+
    Close coupling; PSS (MO) with variationally optimized ETF
    1×10^{-3} - 2.25 keV/amu

82T18   Ho,T.S. Eichler,J. Lieber,M. Chan,F.T.
Phys. Rev. A 25 (1982) 1456-1461
Calculation of the differential cross section for electron capture in
fast ion-atom collisions
    H^+ + H(1s) -> H(nlm) + H^+
    optical eikonal approximation
    25 - 125 keV/amu
    angular differential for 1s->nlm capture

82T19   Ishihara,T. Tsuji,A.
Phys. Rev. A 26 (1982) 2987-2989
Eikonal approximation for electron capture into partially stripped

projectile ions
A^{q+} (q=1,2) + H -> $A^{(q-1)+}$(nl) (A = Li, C)
eikonal approximation
50 - 500 keV/amu
ratio to OBK

82T20   Kimura,M. Olson,R.E. Pascale,J.
         Phys. Rev. A 26 (1982) 1138-1141
       ᵣ Electron capture collisions of H^+ with ground-and excited state Na
         H^+ + Na(3s, 3p) -> H(2s, 2p)
         pseudo potential molecular-structure calculation with ETF
         0.1 - 10 keV/amu

82T21   ⁻Kimura,M. Olson,R.E. Pascale,J.
         Phys. Rev. A 26 (1982) 3113-3124
         Molecular treatments of electron capture by protons from the ground and
         excited states of alkali-metal atoms
         H^+ + B -> H^0(total; 2s, 2p) (B = Na, K, Rb, Cs)
         MO
         0.01 - 10.0 keV/amu
         total, 2s, 2p cross sections

82T22   Lin,C.D. Winter,T.G. Fritsch,W.
         Phys. Rev. A 25 (1982) 2395-2398
         Three-center atomic expansion method for ion-atom collisions
         H^+ + H(1s) -> H(1s) + H^+
         three-center atomic expansion
         2 - 25 keV/amu
         Charge transfer probability, no cross section except for 13.7, 9.90,
         7.8, 3.03 A^2 at 2, 5, 10 and 25 keV, respectively.

82T23   Ludde,H.J. Dreizler,R.M.
         J. Phys. B 15 (1982) 2703-2712
         Direct and capture processes in proton-hydrogen scattering. II. Total
         cross sections for bombarding energies of 1 to 50 keV
         H^+ + H(1s) -> H(nl) + H^+ (n ≤ 3)
         pseudo state close-coupling
         1 - 50 keV/amu

82T24   Ludde,H.J. Dreizler,R.M.
         J. Phys. B 15 (1982) 2713-2720
         Electron capture with He^{2+}, Li^{3+}, Be^{4+} and B^{5+} projectiles from
         atomic hydrogen
         He^{2+} + H -> He^+(nl) + H^+ (n ≤ 3);
         Be^{4+}, B^{5+} + H -> Li^{2+}, Be^{3+}, B^{4+} + H^+
         pseudo state close-coupling
         2 - 50 keV/amu

82T25   Macek,J. Alston,S.
         Phys. Rev. A 26 (1982) 250-270
         Theory of electron capture from a hydrogenlike ion by a bare ion
         A^{z+} + $B^{(z-1)+}$ -> $A^{(z-1)+}$ + B^{z+}
         strong potential Born approximation

82T26   Moiseiwitsch,B.L.
         J. Phys. B 15 (1982) 3103-3110
         Second Born approximation for electron capture at ultrahigh
         relativistic impact energies
         A^{z+} + $B^{(z-1)+}$ -> $A^{(z-1)+}$
         relativistic second Born approximation
         asymptotic formula (E^{-1})

82T27   Ohyama-Yamaguchi,T. Itikawa,Y.
         J. Phys. Soc. Japan 51 (1982) 2982-2988
         Charge transfer in collisions of Li^{3+} and Be^{4+} ions with atomic
         hydrogen at low impact energy
            Li^{3+}, Be^{4+} + H -> Li^{2+}, Be^{3+}
            PSS
            0.1 - 20 keV/amu
            total cross section

82T28   Olson,R.E.
         J. Phys. B 15 (1982) L163-167
         Electron capture and ionization in H^+, He^{2+} + Li collisions
            H^+, He^{2+} + Li -> H^0, He^+, (He^0) + Li^+, (Li^{2+});
            H^+, He^{2+} + Li^+ + e
            CTMC
            50 - 400 keV/amu

82T29   Olson,R.E. Kimura,M.
         J. Phys. B 15 (1982) 4231-4238
         Angular scattering in slow multiply charged ion atom collisions
            C^{6+} + H -> C^{5+}
            quantal
            0.25 - 225 keV/amu
            Total cross section as a function of scattering angles

82T30   Reading,J.F. Ford,A.L. Becker,R.L.
         J. Phys. B 15 (1982) 625
         One and a half centered calculations of ionization and charge transfer
         in H^+ ·- He^+ and He^{2+} + H collisions
            He^{2+} + H(1s) -> He^+(nl) + H^+ (n ≤ 5);
            H^+ + He^+(1s, 2s, 2p) -> H(1s) + He^{2+}
            perturbed one-and-a-half-center
            75.5 (He^{2+}); 20 - 400 (H^+) keV/amu

82T31   Rivarola,R.D. Miraglia,J.E.
         J. Phys. B 15 (1982) 2221-2232
         Comparison between the continuum distorted-wave and the second
         Born-Kramers approximations at high energies electron capture
            H^+ + H(1s) -> H(1s) + H^+
            CDW, second Born-Kramers approximations
            10000; 50000 keV/amu

82T32   Ryufuku,H.
         Phys. Rev. A 25 (1982) 720-736
         Ionization, excitation and charge transfer for impact of H^+, Li^{3+},
         B^{5+}, C^{6+} and Si^{14+} ions on atomic hydrogen
            H^+, Li^{3+}, B^{5+}, C^{6+}, Si^{14+} + H -> H^0, Li^{2+}, B^{4+}, C^{5+}, Si^{13+} + H^+
            UDWA
            0.01 - 5000 keV/amu

82T33   Salin,A.
         Phys. Letters 91A (1982) 61-63
         Charge exchange in Li^{3+} - H collisions
            Li^{3+} + H -> Li^{2+} + H^+
            OEDM
            1.29 - 50 keV/amu
            total cross section

82T34   Simony,P.R. McGuire,J.H. Eichler,J.
         Phys. Rev. A 26 (1982) 1337-1343

Exact second Born electron capture for P + He
$$P + He(1s^2) \rightarrow H(1s)$$
second Born approximation
1000 - 100000 keV/amu
angular differential cross sections

82T35   West,B.W. Lane,N.F. Coben,J.S.
         Phys. Rev. A 26 (1982) 3164-3169
       ʳ Radiative charge transfer in collisions of He^{2+} ions and ground state
         H atoms
         $$He^{2+} + H(1s) \rightarrow He^*(1s) + H^+ + h\nu$$
         optical potential method
         1×10^{-4} - 1 keV/amu

83T 1   Allan,R.J. Dickinson,A.S. McCarroll,R.
         J. Phys. B 16 (1983) 467-480
         Molecular treatment of charge exchange in H^+ + Li collisions
         $$H^+ + Li \rightarrow H (n=2)$$
         PSS
         0.03 - 15 keV/amu

83T 2   Alston,S.
         Phys. Rev. A 27 (1983) 2342-2357
         Theory of electron capture from a hydrogen-like ions by a bare ion;
         intermediate-state contributions to the amplitude
         $$H^+ + B \rightarrow H + B^+ (B = C, Ne, Ar)$$
         strong potential Born approximation
         100 - 20000 keV/amu

83T 3   Barany,A. Brandas,E. Elander,N. Rittby,M.
         Phys. Scripta T3 (1983) 233-235
         Resonances in low energy charge transfer between multiply charged ions
         and neutral atoms described with dilated Titchmarsch-Weyle theory
             Titchmarsch-Weyle theory
             quasi-molecule with polarization force; no cross sections given

83T 4   Bienstock,S. Heil,T.G. Dalgarno,A.
         Phys. Rev. A 27 (1983) 2741-2743
         Charge transfer of O^{3+} ions in collisions with atomic hydrogen
         $$O^{3+} + H \rightarrow O^{2+} + H^+$$
         CC (MO)
         0.000006 - 0.312 keV/amu

83T 5   Borondo,F. Macias,A. Riera,A.
         Chem. Phys. Letters 100 (1983) 63
         Asymmetry effect in H^+ + H^- neutralization application to the n=3
         pseudo crossing
         $$H^+ + H^- \rightarrow H + H(n=2, 3)$$
         MO with pseudo-crossing
         0.05 - 5 keV/amu

83T 6   Brandt,D.
         Phys. Rev. A 27 (1983) 1314-1318
         Resonant transfer and excitation in ion-atom collisions
         $$Si^{11+} + He \rightarrow Si^{10+}; \; S^{13+} + He, Ar \rightarrow S^{12+}$$
         IA

83T 7   Bransden,B.H. Noble,C.J. Chandler,J.
         J. Phys. B 16 (1983) 4191-4201
         Theoretical studies of the interaction of He^{2+} with H(1s) and H^+
         with He

$He^{2+} + H \rightarrow He^{+}(nl) + H^{+}$; $He^{+}(1s) + H^{+} \rightarrow He^{2+} + H(nl)$;
$He^{2+} + H \rightarrow He^{2+} + H^{*}(2s, 2p)$
CC (AO)
3.7 - 230 keV/amu

83T 8   Crothers,D.S.F.
Phys. Scripta T3 (1983) 236-240
Refined orthogonal variation-perturbation continuum-distorted-wave
treatment of $B^{z+} + H(1s) \rightarrow B^{(z-1)+}(nl) + H^{+}$ at intermediate velocity
for n, Z>>1
$A^{z+} + H(1s) \rightarrow A^{(z-1)+}(n) + H^{+}$ (A = 12-18, n = 9-16)
orthogonal variation-perturbation CDW
100 keV/amu
n-dependence

83T 9   Devi,K.R.S. Garcia,J.D.
J. Phys. B 16 (1983) 2837-2847
$He^{2+} + $ He collisions in time-dependent Hartree-Fock theory
$He^{2+} + He(1s^{2}) \rightarrow He^{+}$, He^{0}
time-dependent Hartree-Fock theory
7.5 - 37.5 keV/amu

83T10   Dickinson,A.S. McCarroll,R.
J. Phys. B 16 (1983) 459-466
Adiabatic switching factors in slow atomic collisions
$H^{+} + $ Li
MO with adiabatic switching factors
transition probabilities only

83T11   Errea,L.F. Mendez,L. Riera,A.
Phys. Rev.A 27 (1983) 3357-3360
Excitation and charge transfer in $He^{+} + $ H collisions. A molecular
approach including two electron translation factors
$He^{+} + H \rightarrow He^{0}$
common-translation-factor method
2.5, 6.5 keV/amu

83T12   Fritsch,W. Lin,C.D.
J. Phys. B 16 (1983) 1595-1603
Atomic orbital expansion study of electron capture in $H^{+} + $ Li and
$He^{2+} + $ Li collisions
$He^{2+} + Li \rightarrow He^{+}(nl) + Li^{+}$; $H^{+} + Li \rightarrow H(nl) + Li^{+}$
CC (40-AO)
0.5 - 20 (H^{+}), 0.1 - 2.0 (He^{2+}) keV/amu

83T13   Fritsch,W. Lin,C.D.
Phys. Scripta T3 (1983) 241-243
Atomic expansions for describing charge transfer in slow ion-atom
collisions
$H^{+} + H \rightarrow H(2s) + H^{+}$; Li^{3+}, $C^{6+} + H \rightarrow Li^{2+}$; $C^{5+} + H^{+}$
atomic expansion method
0.1 - 100 keV/amu
total cross section

83T14   Fritsch,W. Lin,C.D.
Phys. Rev. A 27 (1983) 3361-3364
Coupled-state calculations for excitation, charge transfer and
ionization in 1 - 75 keV proton-hydrogen atom collisions
$H^{+} + H \rightarrow H(2s, 2p)$
TSAE
1 - 75 keV/amu

83T15   Gorriz,M. Briggs,J.S. Alston,S.
         J. Phys. B 16 (1983) L665-670
         Strong potential Born theory of radiative electron capture
         Ne^{10+} + H -> Ne^{9+} + H^+ + $h\nu$
         strong potential Born approximation
         5625 keV/amu

83T16 ᶜ Grun,N. Scheid,W.
         J. Phys. B 16 (1983) L425-428
         Calculation of the impact parameter dependence of the charge exchange
         for Li^{3+} + H at 10.5 keV by the finite difference method
         Li^{3+} + H -> Li^{2+}
         finite difference method
         1.5 keV/amu
         P(b) dependent on magnetic substates (m=0, 1, 2)

83T17   Hardie,D.J.W. Olson,R.E.
         J. Phys. B 16 (1983) 1983-1996
         Charge transfer and ionization processes involving multiply charged
         ions in collision with atomic hydrogen
         X^{q+} + H -> $X^{(q-1)+}$ + H^+; X^{q+} + H^+ + e^- (X^{q+} = H^+, He^{2+}, C^{6+}, O^{8+})
         CTMC
         25, 50, 100 keV/amu
         total (E=25-200 keV/amu); partial (E=25-50 keV/amu)

83T18   Harel,C. Salin,A.
         J. Phys. B 16 (1983) 55-70
         Application of OEDM orbitals to many electron systems; He^+ - H
         collisions
         He^+ + H(1s) -> He($1s^2$, 1s2p)
         OEDM
         0.19 - 7.5 keV/amu
         total cross sections included

83T19   Heil,T.G. Butler,S.E. Dalgarno,A.
         Phys. Rev. A 27 (1983) 2365-2383
         Charge transfer of doubly charged and triply charged ions with atomic
         hydrogen at thermal energies
         A^{2+}, A^{3+} + H-> A^+, A^{2+} (A = C, N, O, Ne)
         MO
         10^{-5} - 10^{-4} keV/amu

83T20   Janev,R.K.
         Phys. Scripta T3 (1983) 208-221
         Excited states created in charge transfer collisions between atoms and
         highly charged ions
         A^{2+} + H -> $A^{(q-1)+}$(n,l) + H^+ (A = He, Li, Be, C, N, F, Ne, Na,
         Mg, Al, Si, S, Ar, Ca, Cr, Ni, Sr)
         Landau-Zener model with rotational transitions
         1 - 100 keV/amu
         review; general scaling for n and l distribution

83T21   Janev,R.K. Belic,D.S.
         Physica Scripta T3 (1983) 246-248
         Electron capture into excited states in H + Ar^{18+}, Kr^{36+} and
         Xe^{54+} charge transfer collisions
         Ar^{18+}, Kr^{36+}, Xe^{54+} + H -> Ar^{17+}(n), Kr^{35+}(n), Xe^{53+}(n) + H^+
         MLZ
         10^{-2} - 10^2 keV/amu

83T22   Janev,R.K. Belic,D.S. Bransden,B.H.
         Phys. Rev. A 28 (1983) 1293-1302
         Total and partial cross sections for electron capture in collisions of
         hydrogen atoms with fully stripped ions
             $A^{z+} + H \rightarrow A^{(z-1)+}(nl) + H^+$ (z = 5-54, A^{z+} fully stripped ion)
         0.03 - 80 keV/amu
         Multichannel Landau-Zener theory with rotational coupling included.

83T23   Kazanskii,A.K. Komarov,I.V.
         Sov. J.-Tech. Phys. 27 (1983) 1064-1067
         Charge exchange of C^{6+} and O^{8+} ions with hydrogen atoms; strong
         coupling calculation
             $C^{6+}, O^{8+} + H \rightarrow C^{5+}, O^{7+}$
         strong coupling
         0.25 - 4.0 keV/amu
         total cross section

83T24   Kimura,M. Sato,H. Olson,R.E.
         Phys. Rev. A 28 (1983) 2085-2090
         Molecular treatment of charge transfer in Li^+ + Ca collisions
             $Li^+ + Ca \rightarrow Li(2s, 2p) + Ca^+$
         PSS with ETF
         0.1 - 20 keV/amu

83T25   Kimura,M. Thorson,W.R.
         J. Phys. B 16 (1983) 1471-1480
         Molecular-state studies of charge transfer in Li^{3+} - H, Be^{4+} - H
         and B^{5+} - H collisions
             $Li^{3+}, Be^{4+}, B^{5+} + H \rightarrow Li^{2+}, Be^{3+}, B^{4+}$
         MO switching function
         1 - 15 keV/amu
         total cross section

83T26   Ludde,H.J. Dreizler,R.M.
         J. Phys. B 16 (1983) 1009-1015
         Direct and capture processes in proton-hydrogen scattering III.
         differential cross sections and charge exchange probabilities
             $H^+ + H \rightarrow H^0$ (1s, 2l)
         time-dependent Schroedinger equation
         1 - 2 keV/amu

83T27   Ludde,H.J. Dreizler,R.M.
         J. Phys. B 16 (1983) 3971-3981
         Method for the calculation of global probabilities for many electron
         systems
             $He^{2+} + He \rightarrow He^+, He^0$
         IP

83T28   Macias,A. Riera,A. Yanez,M.
         Phys. Rev. A 27 (1983) 213-219
         Excitation and charge transfer in He^+ + H collisions. A study of the
         origin dependence of calculated cross sections
             $He^+(1s) + H(1s) \rightarrow He(1s2p\ ^{1,3}P)$
         Impact parameter form . 'sm   .
         0.125 - 7.5 keV/amu

83T29   McCarroll,R. Valiron,P.
         Phys. Scripta T3 (1983) 226-232
         Charge exchange of highly charged ions at low energy
             $C^{4+} + H \rightarrow C^{3+}(nl) + H^+$; $N^{3+} + H \rightarrow N^{2+}(nl) + H^+$
         CC (MO)

$$8 \times 10^{-7} - 4 \times 10^{-2} \ (C^{4+}); \quad 7 \times 10^{-7} - 3.5 \times 10^{-2} \ (N^{3+}) \ keV/amu$$

83T30   McGuire,J.H. Eichler,J. Simony,P.R.
Phys. Rev. A 28 (1983) 2104-2112
Exact second Born calculations for electron capture for systems with
various projectile and target charges
$H^+ + H$, Be, C, O, Ne $\rightarrow H^0$; $He^{2+} + He \rightarrow He^+$; $Be^{4+} + Be \rightarrow$
Be^{3+}; $C^{6+} + C \rightarrow C^{5+}$; $O^{8+} + O \rightarrow O^{7+}$; $Ne^{10+} + Ne \rightarrow Ne^{9+}$
second Born approximation
10000 - 200000 keV/amu
angular distribution

83T31   Opradolce,L. Valiron,P. McCarroll,R.
J. Phys. B 16 (1983) 2017-2028
Single charge exchange in Ar^{6+} - He collisions
$Ar^{6+} + He \rightarrow Ar^{5+}(3s^2 nl) + He^+$
MO close-coupling (model potential)
0.12 - 1.2656 (4 states); 0.025 - 1.2656 (6 states) keV/amu

83T32   Presnyakov,L.P. Uskov,D.B. Janev,R.K.
Soviet J.-JETP 56 (1983) 525-531
Charge exchange in slow collisions of multiply charged ions with atoms
$A^{q+} + H_2 \rightarrow A^{(q-1)+} + H_2$ ($A = C^{6+}$, N^{7+}, O^{8+}, Ne^{10+}, Ar^{18+});
$C^{6+} + H \rightarrow C^{5+}$
decay model
0.1 - 20 keV/amu

83T33   Salin,A.
J. Phys. B 16 (1983) L661-664
Comments on adiabatic switching factors in slow atomic collisions

83T34   Sato,H. Kimura,M. Wetmore,A.E. Olson,R.E.
J. Phys. B 16 (1983) 3037-3044
Electron capture cross sections for TiH^{4+}
$Ti^{4+} + H \rightarrow Ti^{3+}(nl) + H^+$; $Ti^{3+} + H^+ \rightarrow Ti^{4+} + H(nl)$
Impact parameter PSS (MO) with ETF
0.1 - 10 keV/amu

83T35   Shields,G.A. Dalgarno,A. Sternberg,A.
Phys. Rev. A 28 (1983) 2137-2140
Line emission from charge transfer with atomic hydrogen at thermal
energies
$O^{3+}(2p) + H \rightarrow O^{2+}(2p3p, {}^1P, {}^3D_1)$
modelling
6.25×10^{-5} keV/amu
evaluation from astrophysical data

83T36   Shipsey,E.J. Green,T.A. Brown,J.C.
Phys. Rev. A 27 (1983) 821-832
Modified method of perturbed stationary states. V. Electron-capture
cross sections for the reaction $O^{8+} + H(1s) \rightarrow O^{7+}(n, l) + H^+$
$O^{8+} + H \rightarrow O^{7+}(nl) + H^+$ (n=4, 5, 6, 7, l=0 - n-1)
close coupling; PSS (MO) with variationally optimized ETF
13×10^{-3} - 34 keV/amu

83T37   Sidis,V. Kubach,C. Fussen,D.
Phys. Rev. A 27 (1983) 2431-2446
Ionic-covalent problem in the $H^+ + H^- \leftrightarrow H^* + H$ collisional
system
$H^+ + H^- \rightarrow\leftarrow H(nl) + H$
MO model

0.02 - 10 keV/amu

83T38   Tan,C.K. Lee,A.R.
         J. Phys. B 16 (1983) 1445-1459
         Electron capture into excited states of hydrogen
         $H^+ + H \rightarrow H(n) + H^+$ (n ≤ 4); $H^+ + He \rightarrow H(n) + He^+$ (n ≤ 5)

83T39   Taulbjerg,K. Briggs,J.S.
         J. Phys. B 16 (1983) 3811-3824
         Multiple scattering theory of electron capture in intermediate-to
         high-velocity collisions
            CDW method
            formulation only

84T 1   Aberg,T. Blomberg,A. Tulkke,J. Goscinski,O.
         Phys. Rev. Letters 52 (1984) 1207-1210
         Maximum entropy theory of recoil charge distributions in electron
         capture collisions
            maximum entropy theory

84T 2   Amundsen,P.A. Jakubassa-Amundsen,D.H.
         Phys. Rev. Letters 53 (1984) 222-225
         Charge transfer to a fast projectile in the presence of a nuclear
         resonance
            $H^+ + Ni, C \rightarrow H^0$
            strong potential Born approximation
            3110 - 3200 keV/amu (Ni); 350 - 550 keV/amu (C)

84T 3   Amundsen,P.A. Jakubassa-Amundsen,D.H.
         J. Phys. B 17 (1984) 2671-2686
         Charge transfer at large scattering angles in the strong-potential Born
         approximation
            $H^+ + C, Ni \rightarrow H(1s)$
            strong-potential Born approximation
            $3 \times 10^3 - 20 \times 10^3$ keV/amu
            angular distribution

84T 4   Andriamonje,S. Chemin,J.F. Roturier,J. Saboya,B. Schuerer,J.N. Gayet,R.
         Salin,A. Laurent,H. Aguer,P. Briand,J.P.
         Z. Phys. A 317 (1984) 251-265
         Production of projectile and target KX-rays by single and multiple
         electron capture in collisions of Si^{14+} and Si^{13+} ions with argon
         atoms at 4.5 and 5.5 MeV/amu
            $Si^{q+} + Ar \rightarrow Si^{(q-1)+}, Si^{(q-2)+}, Si^{(q-3)+}$ (q=14, 13)
            T. molecular model ; E. x-ray coincidence
            4000 - 5450 keV/amu

84T 5   Banyard,K.E. Shirtcliffe,G.W.
         Phys. Rev. A 30 (1984) 604-606
         Electron capture from hydrogen atoms by fast $Li^+(1s^2)$, $Li^{2+}(1s)$
         and Li^{3+} ions
            $Li^+(1s^2)$, $Li^{2+}(1s)$, $Li^{3+} + H \rightarrow Li(1s^2, nl)$, $Li^+(1s, nl)$, $Li^{2+}(nl)$
            continuum intermediate state approximation
            28 - 1428 keV/amu

84T 6   Bienstock,S. Dalgarno,A. Heil,T.G.
         Phys. Rev. A 29 (1984) 2239-2241
         Charge transfer of N^{3+} ions in collisions with atomic hydrogen
            $N^{3+} + H \rightarrow N^{2+}(nl,n'l'n''l'') + H^+$
            CC (MO) with unitarized, multichannel distorted-wave approximation
            0.278×10^{-3} - 5 keV/amu

84T 7   Bienstock,S. Heil,T.G. Dalgarno,A.
Phys. Rev. A 29 (1984) 503 - 508
Distorted-wave theory of heavy-particle collisions at intermediate
energies
C^{3+} + H -> C^{2+}(nl) + H^+; O^{2+} + H -> O^+(nl) + H^+
CC (MO)
0 - 5 keV/amu
Quantum-mechanical treatment in close-coupling and unitarized
distorted-wave approximation

84T 8   Bonnet,J.J.
Ann. Phys. Fr. 9 (1984) 629-639
Photon emission spectroscopy of lighly charged ions following low
energy charge exchange collilsions
review
classical one electron model; Landau-Zener model

84T 9   Bransden,B.H. Errolaev,A.M. Shingal,R.
J. Phys. B 17 (1984) 4515-4521
One-and two-electron models for electron capture by He^+ ions from
Li^0 at intermediate energies
He^+(1s) + Li(2s, 1s) -> He($1s^2$)
two-center AO
0.25 - 100 keV/amu

84T10   Burgdorfer,J. Dube,L.J.
Phys. Rev. Letters 52 (1984) 2225-2228
Multiple scattering approach to coherent excitation in electron-capture
collisions
H^+ + He -> H(n=3) + He^+
first Born approximation; multiple scattering theory (CDW)
9.4 - 500 keV/amu

84T11   Casaubon,J.I. Piancetini,R.D.
J. Phys. B 17 (1984) 1623-1630
Charge exchange by fully stripped lithium ions on metastable and ground
state. hydrogen atoms at low energies
Li^{3+} + H(1s), H(2s) -> Li^{2+}(nl)
OEDM + Landau-Zener method
0.02 - 2.57 keV/amu

84T12   Crothers,D.S.F. McCann,J.M.
J. Phys. B 17 (1984) L177-184
A second-order continuum distorted-wave theory of charge transfer at
high energy
H^+ + H(1s) -> H(1s)
second-order CDW
10000, 50000 keV/amu
angular differential cross sections

84T13   Datta,S. Mandal,C.R. Mukherjee,S.C.
Can. J. Phys. 62 (1984) 307-311
Charge transfer in H^+ - He^+(1s) collisions
H^+ + He^+(1s) -> H(1s, 2s, 2p, 3s, 3p, 3d) + He^{2+}
CIS
50 - 10000 keV/amu

84T14   Deco,G.R. Maidagan,J.M. Rivarola,R.D.
J. Phys. B 17 (1984) L707-711
Electron capture by proton and alpha particle impact on helium atoms

H^+, He^{2+} + $He(1s^2)$ -> $H(nl)$, $He^+(nl)$
symmetric eikonal approximation
25 - 1000 keV/amu (H); 25 - 2500 keV/amu (He)

84T15   Devi,K.R.S. Garcia,J.D.
Phys. Rev. A 30 (1984) 600-603
Coriolis coupling effects in time-dependent Hartree-Fock calculations
of ion-atom collisions
   He^{2+} + He -> He^+, He^0
time-dependent Hartree-Fock calculation
7.5, 62.5 keV/amu

84T16   Ermolaev,A.M.
J. Phys. B 17 (1984) 1069-1081
Charge transfer in collisions between protons and lithium atoms
   H^+ + H -> $H(nlm)$; H^+ + Li -> $H(nl)$
TCAE with translational factors
15 - 145 keV/amu (H); 0.5 - 109 keV/amu (Li)

84T17   Ermolaev,A.M. Bransden,B.H.
J. Phys. B 17 (1984) 1083-1092
Charge transfer in He^{2+} + Li collisions
   He^{2+} + Li -> $He^+(nl)$ + Li^+
CC (24-AO)
0.475 - 400 keV/amu

84T18   Feagin,J.M. Briggs,J.S. Reeves,T.M.
J. Phys. B 17 (1984) 1057-1068
Simultaneous charge transfer and excitation
   $A^{(z-1)+}$ + $B^{(z-1)+}$ -> $A^{(z-2)+}(nl, n'l')$ + B^{z+}
strong-potential Born approximation

84T19   Fritsch,W.
Phys. Rev. A 30 (1984) 1135-1138
Atomic-basis study of electron transfer in H^+ + Na and H^+ + K
collisions
   H^+ + Na, K -> $H^0(nl)$
atomic-orbital expansion method
0.2 - 20 keV/amu
total and partial cross section

84T20   Fritsch,W.
Phys. Rev. A 30 (1984) 3324-3327
Determination of high-n partial transfer cross sections in
bare-nucleus-hydrogen-atom collisions
   C^{6+}, N^{7+}, O^{8+} + H -> C^{5+}, N^{6+}, O^{7+} (n, l)
semi-classical close-coupling with AO basis
4 - 25 keV/amu
partial cross section (n, l)

84T21   Fritsch,W. Lin,C.D.
J. Phys. B 17 (1984) 3271-3278
Atomic-basis study of electron transfer into $C^{3+}(nl)$ orbitals in
C^{4+} + H and C^{4+} + Li collisions
   C^{4+} + H -> $C^{3+}(nl)$ + H^+; C^{4+} + Li -> $C^{3+}(nl)$ + Li^+
CC (AO)
0.1 - 20 keV/amu

84T22   Fritsch,W. Lin,C.D.
Phys. Rev. A 29 (1984) 3039-3051
Atomic-orbital-expansion studies of electron transfer in bare-nucleus Z

(Z=2, 4-8)-hydrogen-atom collisions
$Z^{Z+} + H \rightarrow Z^{(z-1)+}(nl) + H^+$ (Z=2, 4-8)
CC (AO)
0.133 - 25 keV/amu

84T23   Gerrat,J.
         Phys. Rev. A 30 (1984) 1643-1660
         R-matrix theory of charge transfer
             R-matrix theory
             formalisms

84T24   Ghosh,M. Datta,S. Mukherjee,S.C.
         Phys. Rev. A 30 (1984) 1307-1310
         Calculation of cross sections for electron capture between arbitrary
         hydrogenic states of target and projectile
             $H^+ + H(2l) \rightarrow H(3l') + H^+$
             continuum intermediate state approximation
             25 - 1000 keV/amu
             arbitrary (nlm)->(n'l'm')

84T25   Gonzales,A.D. Miraglia,J.E.
         Phys. Rev. A 30 (1984) 2292-2296
         Comparison between the mechanical and radiative electron capture
         processes at high energies
             $H^+ + H(1s), C^{5+}(1s), He(1s^2) \rightarrow H^0$
             CDW
             1000 - 200000 keV/amu

84T26   Grozdanov,T.P.
         Phys. Scripta 30 (1984) 194-197
         A model for final-state mixing following electron capture in slow
         collisions of fully stripped, multicharged ions and hydrogen atoms
             $C^{6+} + H(1s) \rightarrow C^{5+}(4l) + H^+$
             MO with Stark mixing
             0.05 - 20 keV/amu

84T27   Hanssen,J. Gayet,R. Hartel,C. Salin,A.
         J. Phys. B 17 (1984) L323-328
         Electron capture by C^{4+}, N^{5+} and O^{6+} from atomic hydrogen in the
         keV/amu energy range
             $C^{4+}, N^{5+}, O^{6+}(1s^2) + H \rightarrow C^{3+}, N^{4+}, O^{5+} + H^+$
             Molecular approximation
             0.25 - 25 keV/amu
             total cross section

84T28   Humphries,W.J. Moiseiwitsch,B.L.
         J. Phys. B 17 (1984) 2655-2669
         Relativistic second Born approximation for electron capture
             $H^+ + H(1s) \rightarrow H(1s) + H^+$
             relativistic second Born approximation
             $1 \times 10^3 - 1 \times 10^8$ keV/amu

84T29   Jakubassa-Amundsen,D.H. Hoppler,R. Betz,H.D.
         J. Phys. B 17 (1984) 3943-3949
         Radiative electron capture in fast ion-atom collisions
             $S^{16+} + C \rightarrow S^{15+}(1s)$
             E. x-ray spectroscopy; T. strong-potential Born approximation
             3900 keV/amu

84T30   Janev,R.K. Joachain,C.J. Nedelkovic,N.N.
         Phys. Rev. A 29 (1984) 2463-2478

Resonant electron transfer in slow collisions of protons with Rydberg hydrogen atoms
$H^+ + H(n) \rightarrow H(n) + H^+$ (n=10-50)
under-and over-barrier model
$10^{-5} - 10^{-2}$ keV/amu
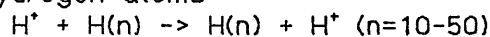
84T31   Janev,R.K. McDowell,M.R.C.
Phys. Letters 102A (1984) 405-408
Electron removal from H and He atoms in collisions with C^{q+}, N^{q+} and O^{q+} ions
$A^{q+} + H$, He $\rightarrow A^{(q-1)+} + H^+$, He^+; $A^{q+} + H^+$, $He^+ + e$
CTMC
50, 100 keV/amu
scaling for electron removal; total cross section

84T32   Kimura,M. Iwai,T. Kaneko,Y. Kobayashi,N. Matsumoto,A. Ohtani,S. Okuno,K. Takagi,S. Tawara,H. Tsurubuchi,S.
J. Phys. Soc. Japan 53 (1984) 2224-2232
Landau-Zener model calculations of one-electron capture from He atoms by highly stripped ions at low energies
C^{q+}, N^{q+}, O^{q+}, F^{q+}, Ne^{q+} (q=4-9), Kr^{q+} (q=10-25) + He $\rightarrow A^{(q-1)+}(n)$
multichannel Landau-Zener
1xq/M keV/amu
total and partial(n) cross sections

84T33   Kimura,M. Olson,R.E.
J. Phys. B 17 (1984) L713-719
Electron capture to (nl) states in collisions of C^{4+} and C^{6+} with He
$C^{4+} + He \rightarrow C^{3+}$, $C^{2+} + He$; $C^{6+} + He \rightarrow C^{5+}$, $C^{4+} + He$
PSS with ETF
20 keV/amu

84T34   Kocbach,L. Briggs,J.S.
J. Phys. B 17 (1984) 3255-3270
Theory of electron capture by fast projectiles scattered through large angles
$H^+ + Ne \rightarrow H^0$
IP
200 - 550 keV/amu
capture probabilities as a function of scattering angle

84T35   Larsen,O.G. Taulbjerg,K.
J. Phys. B 17 (1984) 4523-4542
Theory of electron capture by partially stripped ions in slow collisions with atomic hydrogen
$A^{6+} + H(1s) \rightarrow A^{5+}$ (A = Ar, Cr, Mg)
CC with ETF
0.015 - 4 keV/amu

84T36   Maidagan,J.M. Rivarola,R.D.
J. Phys. B 17 (1984) 2477-2487
A symmetric eikonal-type approximation for electron capture in ion-atom collisions
$H^+ + H(1s)$, He(1s) $\rightarrow$ H(1s); $H^+ + He^+(1s) \rightarrow$ H(1s)
symmetric eikonal approximation
500 - 100000 keV/amu
K-K total and partial (in angle) cross sections

84T37   Mandel,C.R. Datta,S. Mukherjee,S.C.
Phys. Rev A 30 (1984) 1104-1106
Electron capture from atomic hydrogen by fully stripped ions of Be^{4+},

B^{5+}, C^{6+}, N^{7+} and O^{8+} in the continuum intermediate-sate approximation

$A^{z+} + H \rightarrow A^{(z-1)+} + H^+$ (A = Be, B, C, N, O)
continuum-intermediate state approximation
47 - 1111 keV/amu
total cross sections

84T38   McDowell,M.R.C. Janev,R.K.
         J. Phys. B 17 (1984) 2295-2305
         Electron capture, ionisation and transfer-ionisation in fast Au^{q+} + He collisions
         Au^{q+} + He $\rightarrow$ $Au^{(q-1)+}$ + He^+; $Au^{(q-1)+}$ + He^{2+} + e^- (q = 6-25)
         CTMC
         20 - 300 keV/amu
         n-distribution

84T39   McGuire,J.H. Stockli,M. Cocke,C.L. Pedersen,E.H. Sil,N.C.
         Phys. Rev. A 30 (1984) 89-94
         Study of the Thomas peak in electron capture
         H^+ + H, He $\rightarrow$ H^0
         T. strong potential Born approximation; E. growth
         2820 - 3000 keV/amu
         H_2 instead of H in experiment; angular differential cross sections

84T40   Miraglia,J.E.
         Phys. Rev. A 30 (1984) 1721-1726
         Electron capture in asymmetric collisions
         H^+ + C(1s), O(1s) $\rightarrow$ H(1s)
         peaking impulse approximation
         200 - 4000 keV/amu

84T41   Morrison,H.G. Opik,U.
         J. Phys. B 17 (1984) 857-865
         An impact-parameter method for heavy-particle collisions involving one elctron. II. Attempts to improve the accuracy, and results on He^{2+} - H collisions
         H^+ + H, He $\rightarrow$ H(2s, 2p) + H^+, He^{2+}; He^{2+} + H $\rightarrow$ He^+(total, 2s, 2p) + H^+
         new impact-parameter method
         25 (H^+), 19.4, 25, 41,7, 50 (He^{2+}) keV/amu

84T42   Olson,R.E. Kimura,M. Sato,H.
         Phys. Rev. A 30 (1984) 1692-1696
         Molecular-state cross section calculations for H + Cs $\rightarrow$ $\leftarrow$ H^- + Cs^+
         H + Cs(6s, 6p, 5d) $\rightarrow$ H^- + Cs^+
         pseudo-potential molecular-structure calculation
         0.1 - 10 keV/amu

84T43   Presnyakov,L.P. Uskov,D.B.
         Sov. Phys. JETP 59 (1984) 515-522
         Ionization and charge exchange in atom collision with multicharged ion
         A^{q+} + H $\rightarrow$ $A^{(q-1)+}$(nl) + H^+; A^{q+} + H^+ + e (q $\geq$ 3)
         Keldysh quasi-classical method
         10 - 400 keV/amu·
         analytic expression for (n, l) distribution

84T44   Rittby,M. Elander,N. Brandas,E. Barany,A.
         J. Phys. B 17 (1984) L677-681
         Resonance structure in charge transfer cross sections; an application to the N^{3+} + H $\rightarrow$ N^{2+} + H^+ reaction
         N^{3+} + H $\rightarrow$ N^{2+}(3s) + H^+

10^{-8} - 10^{-3} keV/amu
rich resonance

84T45   Rivarola,R.D.
Phys. Rev. A   30   (1984)   1122-1124
Resonant electron capture in H^+ + H(1s) collisions
   H^+ + H(1s) -> H(1s)
   CDW
   10000 keV/amu

84T46   Rivarola,R.D. Salin,A.
J. Phys. B   17   (1984)   659-669
K-shell one-electron capture in asymmetric collisions at intermediate
and high energies
   H^+ + He^+, Ne^{9+}, Ar^{17+} -> H(1s); H^+ + He, C, Ne, -> H(1s)
   CDW
   400 - 20000 keV/amu
   differential (in angle) cross sections

84T47   Rivarola,R.D. Salin,A. Stockli,M.P.
J. Physique Letters   45   (1984)   L259-264
Differential electron-capture cross sections in high energy ion-atom
collisions; comparison of experiment and theory for the Thomas peak
   H^+ + H_2, He -> H^0
   CDW
   2820 - 7400 keV/amu

84T48   Salin,A.
J. de Physique   45   (1984)   671-680
Intrashell mixing following electron capture from atomic hydrogen
targets by slow ions. I - Fully stripped projectiles
   C^{6+} + H -> C^{5+}(4l) + H^+; O^{8+} + H -> O^{7+}(5l) + H^+;
   Ne^{10+} + H -> Ne^{9+}(6l) + H^+
   PSS
   1 - 16 keV/amu

84T49   Shimakura,N. Inoue,H. Watanabe,T.
J. Phys. B   17   (19' ')   '687-2694
Differential cross section, for Li^+ - Li collisions using molecular
bases; quantum effect
   Li^+ + Li'2s) -> Li(2s) + Li^+; Li(2p) + Li^+
   JWKB
   0.07 - 0.14 keV/amu
   angular distribution

84T50   Sidis,V. de Bruijn,D.P.
Chem. Phys.   85   (1984)   201-214
Theory of near-resonant charge exchange in atom-molecule collisions.
dissociate NRCE in the H_2^+ + Mg collision
   H_2^+ + Mg -> H_2^*
   IPM
   0.75 - 3.75 keV/amu

84T51   Spruch,l. Shakeshaft,R.
Phys. Rev. A   29   (1984)   2283-2285
Simple heuristic derivation of some charge transfer probabilities at
asymptotically high incident velocities

84T52   Stollberg,M.T. Lee,H.W.
Phys. Rev. A   29   (1984)   2448-2452
Charge transfer in low-energy collisions of He^{2+} and Li^{3+} with

various. neutral atoms

$He^{2+} + Li, Be, B, C, Na, Mg, K, Cs \rightarrow He^+(n)$;

$Li^{3+} + H, He, Li, Be, B, C, Ne, Na, Mg, K, Ar, Cs \rightarrow Li^{2+}(n)$

Landau-Zener model

0.05 - 5.18 keV/amu

84T53   Suzuki,H. Kajikawa,Y. Toshima,N. Ryufuku,H. Watanabe,T.

Phys. Rev. A 29 (1984) 525-528

Electron-capture cross sections from He in collision with bare nuclear ions

$A^{q+} + He \rightarrow A^{(q-1)+} + He^+$ (A = H^+, Li^{3+}, Be^{4+}, C^{6+}, O^{8+})

UDWA

$1 - 10^3$ keV/amu

total cross section

84T54   Suzuki,H. Toshima,N. Watanabe,T. Ryufuku,H.

Phys. Rev. A 29 (1984) 529-535

Exponential distorted-wave approximation for charge transfer in collisions of multicharged ions with atomic hydrogen

$A^{q+} + H \rightarrow A^{(q-1)+} + H^+$ (A = He^{2+}, Li^{3+}, Be^{4+}, B^{5+}, C^{6+})

exponential UDWA

0.1 - 1000 keV/amu

total cross section

84T55   Suzuki,R. Nakamura,H. Ishiguro,E.

Phys. Rev. A 29 (1984) 3060-3070

Semiclassical scattering theory based on the dynamical state representation; application to the Li^+ + Na and Li + Na^+ collisions

$Na^+ + Li(2s) \rightarrow Na(3s)$; $Li^+ + Na(3s) \rightarrow Li(2s, 2p) + Na^+$

semiclassical theory

0.25 - 5 keV/amu

84T56   Thorson,W.R. Choi,J.H.

Phys. Rev. A 30 (1984) 743-749

Long-range secondary couplings in X^{+z} - H(1s) charge transfer collisions

$A^{z+} + H(1s) \rightarrow A^{(z-1)+}(nl)$

molecular state CC + long-range dipole and quadruple coupling

15 - 20 keV/amu

no cross section given

84T57   Wada,K. Murai,T.

J. Phys. B 17 (1984) L363-367

Close-coupling calculation for charge transfer in Be^{4+} + H(1s) collisions at low energies

$Be^{4+} + H(1s) \rightarrow Be^{3+}$

CC (11)

0.1 - 25 keV/amu

84T58   Winter,T.G. Lin,C.D.

Phys. Rev. A 29 (1984) 567-582

Triple-center treatment of electron transfer and excitation in p - H collisions

$H^+ + H \rightarrow H^0(2s, 2p) + H^+$

triple-center AO

1.5 - 15 keV/amu

84T59   Yenen,O. Jaecks,D.H. Macek,J.

Phys. Rev. A 30 (1984) 597-599

Two-state charge transfer calculation in H^+ - H_2 collisions

$H^+ + H_2 \rightarrow H^0$

Demkov model
1 - 50 keV/amu

85T 1   Abramov,V.A. Lisitsa,V.S. Pigarov,A.Yu.
JETP Letters 42 (1985) 356-358
Changes in effective charge-exchange cross sections in a plasma
    enhancement of cross sections due to excited atoms in a plasma

85T 2   Allan,R.J. Hanssen,J.
J. Phys. B 18 (1985) 1981-1997
Quasimolecular treatment of Na - Na^+, Li - Li^+, Li - Na^+ and Na - Li^+ collisions with a common translation factor
    $Li^+ + Li(2s)$, $Na(3s) \rightarrow Li^0$; $Na^+ + Li(2s)$, $Na(3s) \rightarrow Na^+$
    CC with ETF
    0.06 - 3.4 keV/amu

85T 3   Anholt,R. Eichler,I.
Phys. Rev. A 31 (1985) 3505-3508
Eikonal calculations of electron capture by relativistic projectiles
    C^{6+}, Ne^{10+}, $Ar^{18+} + B \rightarrow C^{5+}$, Ne^{9+}, Ar^{17+} (B = Al-U)
    eikonal
    140000 - 2100000 keV/amu

85T 4   Burgdorfer,J.
Nucl. Instr. Meth. in Phys. Res. A240 (1985) 519-526
Final state angular momentum distributions in charge transfer collisions at high energies
    $A^{z+} + B(1s) \rightarrow A^{(z-1)+}(nlm) + B^+$
    Born, CDW, PCI, quasi-resonant over barrier model
    30 - 500 keV/amu

85T 5   Burgdorfer,J. Dube,L.J.
Phys. Rev. A 31 (1985) 634-640
Population of Rydberg states by electron capture in fast-ion-atom collisions
    $H^+ + H(1s) \rightarrow H(n=10, l, m) + H^+$
    CDW
    25 - 10000 keV/amu

85T 6   Chatterjee,L. Bhattacharyya,B.
Phys. Scripta 32 (1985) 504-506
Quantum electrodynamic study of electron capture by light stripped ions
    $Li^{3+} + H \rightarrow Li^{2+}$
    relativistic QED
    14 - 285 keV/amu

85T 7   Chatterjee,S.N. Roy,B.N.
J. Phys. B 18 (1985) 4283-4293
Modified BEA calculations of He^{2+} impact double electron capture cross sections of atoms
    $He^{2+} + He$, Li, Ar, Kr $\rightarrow He^0$
    BEA
    10 - 250 keV/amu

85T 8   Crothers,D.S.F.
J. Phys. B 18 (1985) 2879-2892
First-order continuum-distorted-wave double-scattering nlm transitions
    $A^{z+} + B^{(z-1)+}(1s) \rightarrow A^{(z-1)+}(nlm)$
    first-order CDW double scattering

85T 9   Crothers,D.S.F.

J. Phys. B 18 (1985) 2893-2906
Second-order continuum-distorted-wave double scattering nlm transitions
   $A^{z+} + B^{(z-1)+}(1s) \rightarrow A^{(z-1)+}(nlm)$
   second-order CDW double scattering

85T10   Crothers,D.S.F. McCann,J.F.
J. Phys. B 18 (1985) 2907-2913
Exact two-channel variational continuum distorted-wave theory; results
for symmetric resonant exchange
   $H^+ + H(1s) \rightarrow H(1s) + H^+$
   CDW, travelling AO
   1 - 500 keV/amu

85T11   Deco,G.R. Rivarola,R.D.
J. Phys. B 18 (1985) 2283-2293
A second-order symmetric eikonal approximaion for electron capture at
high energies
   $H^+ + H(1s) \rightarrow H(1s)$
   symmetric eikonal approximation, CDW
   500 - 200000 keV/amu

85T12   Dewangan,D.P. Eichler,J.
J. Phys. B 18 (1985) L65-69
Boundary conditions and the strong potential Born approximation for
electron capture
   strong potential Born approximation

85T13   Dube,L.J. Burgdorfer,J.
Nucl. Instr. Meth. in Phys. Res. B 9 (1985) 392-396
Electron capture into Rydberg states in collisions between multiply
charged ions and hydrogen
   $C^{6+} + H(1s) \rightarrow C^{5+}(nlm) + H^+$
   CDW, CDW-PCI
   25 - 900 keV/amu
   multiple scattering effect; partial cross section

85T14   Dube,L.J. Eichler,J.
J. Phys. B 18 (1985) 2467-2483
Structural and asymptotic properties of the eikonal approximation for
electron capture
   eikonal approximation
   formulation

85T15   Dube,L.J. Will,U. Bruch,R. Trabert,E. Heckmann,P.H.
Nucl. Instr. Meth. in Phys. Res. B 9 (1985) 408-412
Theory and experiment of electron capture in collisions of multiply
charged projectiles with light targets
   $C^{4+} + H_2, He \rightarrow C^{3+}(1s^2 nl)$
   T. CDW, B1; E. photon spectroscopy
   166 - 417 keV/amu

85T16   Eicher,J.
Phys. Rev. A 32 (1985) 112-121
Relativistic eikonal theory of electron capture
   $Ne^{10+} + B^{(z-1)+} \rightarrow Ne^{9+}(1s) + B^{z+}$
   relativistic eikonal
   10000 - 100000000 keV/amu
   analytic expression

85T17   Errea,L.F. Gomez-Llorente,J.M. Mendez,L. Riera,A.
Phys. Rev. A 32 (1985) 2158-2165

Practical criterion for the determination of translation factors. II.
Application to He^{2+} + H(1s) collisions
He^{2+} + H -> $He^+(nl)$ + H^+ .
CC (MO) with ETF
0.25 - 25 keV/amu

85T18   Errea,L.F. Mendez,L. Riera,A. Yonez,M. Hansen,J. Harel,C. Salin,A.
        J. de Physique 46 (1985) 719-726
        Charge exchange in Li^{2+}(1s) + H(1s) collisions. A molecular approach
        including two-electron translation factors
        Li^{2+}(1s) + H(1s) -> Li^+(1s2s), Li^+(1s2p), Li^+(total)
        8 MO expansion method with ETF
        0.5 - 25 keV/amu

85T19   Fritsch,W. Lin,C.D.
        Phys. Rev. A 31 (1985) 1164-1167
        Close-coupling study of K-shell vacancy production in near-symmetric
        collisions
        F^{8+} + Ne -> F^{7+} + $Ne^+(1s^{-1})$; S^{15+} + Ar -> S^{14+} + $Ar^+(1s^{-1})$
        modified AO
        231 - 520 keV/amu (F); 500 - 2800 keV/amu (S)

85T20   Gargaud,M. McCarroll,R.
        J. Phys. B 18 (1985) 463-477
        Charge transfer in low-energy collisions of N^{3+}, C^{4+} and N^{5+} with
        H and H_2
        N^{3+}, C^{4+}, N^{5+} + H, H_2 -> N^{2+}, C^{3+}, N^{4+} + H^+, H_2^+
        CC (MO)
        1.0 keV/amu

85T21   Gayet,R. Hanssen,J. Harel,C. Salin,A.
        Nucl. Instr. Meth. in Phys. Res. B 9 (1985) 413-414
        Electron capture from atomic hydrogen in the keV/amu energy range
        C^{4+}, N^{5+}, O^{6+} + H -> C^{3+}, N^{4+}, O^{5+} + H^+
        Molecular calculation
        0.25 - 25 keV/amu

85T22   Ghosh,M. Mandal,C R. Mukherjee,S.C.
        J. Phys. B 18 (1985) 3797-3804
        Single and double electron capture from lithium by fast alpha particles
        He^{2+} + Li -> $He^+(nl)$ + Li; He^0 + Li^{2+}
        CDW approximation
        200 - 500 keV/amu

85T23   Gorzdanov,T.P. Janev,R.K. Lazur,V.Yu.
        Phys. Scripta 32 (1985) 64-68
        Two-electron exchange in slow ion-atom collisions
        A^{2+} + A -> A + A^{2+} (A = Ne, Ar, Kr, Xe)
        asymptotic expansion
        3.8×10^{-3} - 0.25 keV/amu
        total cross section

85T24   Humphries,W.J. Moiseiwitsch,B.L.
        J. Phys. B 18 (1985) 1209-1222
        Third Born approximation for electron capture at relativistic energies
        A^{z+} + $B^{(z-1)+}$ -> $A^{(z-1)+}$ + B^{z+1}
        third Born approximation
        analytic expression; no cross sections given

85T25   Humphries,W.J. Moiseiwitsch,B.L.
        J. Phys. B 18 (1985) 2295-2301

Total cross sections for electron capture at relativistic energies
$A^{z+} + B^{(z-1)+}(1s) \rightarrow A^{(z-1)+}(1s) + B^{z+}$ (A = C, Ne, Ar;
B = Al, Cu, Ag)
relativistic second Born approximation
140000 - 1050000 keV/amu

85T26   Jakubassa-Amundsen,D.H.
        Z. Phys. A 322 (1985) 191-197
        Radiative electron capture accompanying resonant nuclear scattering
        $^{16}O^{8+}$, $^{20}Ne^{10+}$ + He $\rightarrow$ O^{7+}, Ne^{9+}
        1187 - 1250 keV/amu (O), 885 - 887 keV/amu (Ne)

85T27   Jakubassa-Amundsen,D.H.
        Phys. Rev. A 32 (1985) 2166-2174
        Nonadiabatic sliding model for rearrangement collisions
        $O^{8+} + C \rightarrow O^{7+} + C + h\nu$;
        $S^{16+} + Ne \rightarrow S^{15+} + Ne^+ + h\nu$ (REC)
        sliding model

85T28   Jakubassa-Amundsen,D.H. Amundsen,P.A.
        Phys. Rev. A 32 (1985) 3106-3108
        Exact relativistic second Born approximation for electron capture
          relativistic second Born approximation
          scaling at asymptotic region, $(\ln E)^2/E$

85T29   Jakubassa-Amundsen,D.H. Amundsen,P.A.
        J. Phys. B 18 (1985) 757-774
        Electron capture across a nuclear resonance in the strong potential
        Born approximation
        $H^+ + ^{22}Ne$, ^{28}Si,$^{58}Ni \rightarrow H^0$; $He^{2+} + ^{16}O$, ^{20}Ne, $^{28}Si \rightarrow He^+$
        strong potential Born approximation
        1000 - 5500 keV/amu

85T30   Janev,R.K. Nedeljkovic,N.N.
        J. Phys. B 19 (1985) 1809-1825
        Quasi-stationary spectrum of Rydberg atoms in the field of a highly
        charged ion
        $A^{z+} + B(n>>1) \rightarrow A^{(z-1)+} + B^+$ (A>>B)
        Tunneling theory

85T31   Kimura,M.
        Phys. Rev. A 31 (1985) 2158-2161
        Molecular-state treatment of excitation and charge transfer processes
        in $H^+ + He(1s^2)$ collisions
        $H^+ + He(1s^2) \rightarrow H(nl) + He^+(1s)$; $H^+ + He(1s, 2l)$
        MO expansion with IP
        1 - 30 keV/amu

85T32   Kimura,M.
        Phys. Rev. A 32 (1985) 802-809
        Charge transfer in ion-molecule collisions at keV energy region; Study
        of $H^{\cdot} + H_2$ collisions by the electron-traslational-factor-modified
        molecular-orbital-expansion method
        $H^+ + H_2 \rightarrow H(1s) + H_2$
        MO expansion with ETF
        0.2 - 20 keV/amu
        cross section ratios between H and H_2 targets

85T33   Kimura,M. Lin,C.D.
        Phys. Rev. A 31 (1985) 590-592
        Unified treatment of slow atom-atom and ion-atom collisions

$H^+ + He^+ \rightarrow H + He^{2+}$; $H^+ + He^{2+} + e$
MO (at inner region) + AO (at large nuclear distance)
2 - 5 keV/amu
no cross sections given for charge transfer

85T34   Kimura,M. Lin,C.D.
Phys. Rev. A 32 (1985) 357-1362
Unified treatment of slow atom-atom and ion-atom collisions. II.
Applications to $H^+ + H$ and $C^{6+} + H$ collisions
    $H^+ + H \rightarrow H + H^+$; $C^{6+} + H \rightarrow C^{5+} + H^+$
unified treatment (matching method)
1 - 15 (H), 0.1 - 10 (C^{6+}) keV/amu

85T35   Kimura,M. Olson,R.E.
J. Phys. B 18 (1985) 2729-2735
Electron capture in O^{8+} - He collisions
    $O^{8+} + He \rightarrow O^{7+} + He^+$
MO expansion with ETF
0.2 - 50 keV/amu
total cross section

85T36   Kimura,M. Olson,R.E.
Nucl. Instr. Meth. in Phys. Res. B 10/11 (1985) 207-213
Slow ion-atom collisions
    $H^+ + H \rightarrow H^0$; $He^{2+} + Li \rightarrow He^+$; $Ti^{4+} + H \rightarrow Ti^{3+}$;
    $C^{4+} + He \rightarrow C^{3+}$, C^{2+}; $C^{6+} + He \rightarrow C^{5+}(nl)$; $H^+ + Cs \rightarrow H^0$
MO
review; partial cross section for $C^{6+} + He \rightarrow C^{5+}(nl)$;
total cross section for others

85T37   Kimura,M. Olson,R.E.
Phys. Rev. A 31 (1985) 489-491
Electron capture in pseudo-two-electron systems; $Ar^{8+} + He$
    $Ar^{8+} + He \rightarrow Ar^{7+}(nl) + He^+$
PSS (MO) with two electron ETF
0 02 - 10 keV/amu

85T38   Kobayashi,K. Toshima,N. Ishihara,T.
Phys. Rev. A 32 (1985) 1363-1368
Eikonal approximation for proton-helium electron capture processes
    $H^+ + He \rightarrow H + He^+$
eikonal approximation
$10^2 - 10^4$ keV/amu
total and angle-differential cross sections

85T39   Kocbach,L. Taulbjerg,K.
J. Phys. B 18 (1985) L79-83
On the theory of electron capture from innershells in intermediate and
high-energy collisions
    IA
no absolute cross sections given

85T40   Macek,J.
J. Phys. B 18 (1985) L71-74
Treatment of divergent terms in the strong potential Born approximation
    strong potential Born approximation
modified Coulomb Green's function to avoid divergence

85T41   Martiarena,M.L. Garibott,C.R.
Phys. Letters 113A (1985) 307-310
Radiative electron capture to the continuum

radiative electron capture to continuum in H^+ + He; Ne^{10+} + He; Ar^{10+} + He
first Born
RECC spectra in Ne^{10+}, Ar^{17+} + He collisions

85T42   McCann,J.F.
J. Phys. B 18   (1985) L569-573
Contunuum distorted-wave theory of relativistic electron capture
    H^+ + H(1s) -> H(1s) + H^+; H^+ + B^{4+}(1s) -> H(1s) + B^{5+}
    relativistic CDW theory
    10^3 - 10^8 keV/amu

85T43   McDowell,M.R.C. Janev,R.K.
J. Phys. B 18   (1985) L295-301
Charge exchange and ionisation in collisions of fast partially stripped
ions of iron with hydrogen
    Fe^{q+} + H -> $Fe^{(q-1)+}$ + H^+; Fe^{q+} + H^+ + e (q=12-18)
    CTMC
    10 - 400 keV/amu
    Scaling laws for the cross sections as a function of q

85T44   McGuire,J.H.
J. Phys. B 18   (1985) L75-77
Non-orhtogonality in the strong potential Born approximation
    strong potential Born approximation

85T45   McGuire,J.H. Kletke,R.E. Sil,N.C.
Phys. Rev. A 32 (1985) 815-821
Strong-potential Born calculations for 1s-1s electron capture from
atoms by protons
    H^+ + B -> H + $B^+(1s^{-1})$ (B = H, He, C, Ne, Ar, Xe)
    strong potential Born approximation
    200 - 100000 keV/amu
    angle-differential cross sections

85T46   Miraglia,J.E.
Phys. Rev. A 32 (1985) 2702-2706
Radiative electron capture in proton-hydrogen collisions
    H^+ + H -> H^0 + H^+ + $h\nu$
    Born, CDW
    10 - 10^4 keV/amu

85T47   Miraglia,J.E. Garibotti,C.R. Gonzalez,A.D.
Phys. Rev. A 32 (1985) 250-253
Photon spectrum associated with radiative electron capture processes
    Ne^{10+} + He, Ne -> Ne^{9+}; Ar^{17+} + He -> Ar^{16+}
    first Born approximation
    7000 keV/amu (Ne), 7200 keV/amu (Ar)

85T48   Olson,R.E. Kimura,M.
Phys. Rev. A 32 (1985) 3092-3094
Molecular-state cross section calculations for H + Na -> <- H^- + Na^+
    H + Na -> H^- + Na^+; H^- + Na^+ -> H + Na (3s, 3p, 4s)
    pseudo potential MO
    0.1 - 5 keV/amu

85T49   Peach,G. Willis,S.L. McDowell,M.R.C.
J. Phys. B 18   (1985) 3921-3937
The classical theory of charge transfer and ionization processes in
collisions between complex atomic ions
    classical theory

general theory

85T50   Saha,G.C. Datta,S. Mukherjee,S.C.
         Phys. Rev. A 31 (1985) 3633-3638
         Electron capture from multielectron atoms by fast ions in the continuum
         intermediate-state approximation
             H^+ + C, N, O, Ne, Ar -> H^0
             continuum-intermediate-state approximation
             500 - 20000 keV/amu

85T51   Shingal,R. Bransden,B.H. Flower,D.R.
         J. Phys. B 18 (1985) 2485-2491
         Neutralization in H^+ + H^- collisions
             H^+ + H^- -> H(1s) + H(nl)
             two-center AO expansion method
             8 - 50 keV/amu

85T52   Sidorovich,V.A. Nikolaev,V.S. McGuire,J.H.
         Phys. Rev. A 31 (1985) 2193-2201
         Calculation of charge-changing cross sections in collisions of H^+,
         He^{2+} and Li^{3+} with He atoms
             A^{z+} + He -> $A^{(z-1)+}$(1s), $A^{(z-2)+}$(1s^2)
             independent-electron model
             25 - 4000 keV/amu
             also single and double ionization of He; ionization with electron
             capture into ground state

85T53   Stallcop,J.R. Partridge,H.
         Phys. Rev. A 32 (1985) 639-642
         N^+ - N long-range interaction energies and resonance charge exchange
             N^+ + N -> N + N^+
             self-consistent field method
             7×10^{-5} - 7×10^{-3} keV/amu

85T54   Stich,W. Ludde,H.J. Dreizler,R.M.
         J. Phys. B 18 (1985) 1195-1207
         TDHF calculations for two-electron systems
             H^+ + He(1s^2) -> H; He^{2+} + He(1s^2) -> He^+, He^0;
             Li^{3+} + He(1s^2) -> Li^{2+}; He^+(2s) + H(1s), He^+(2s) -> He
             TDHF
             7×10^{-5} - 7×10^{-3} keV/amu

85T55   Thylwe.K.E. Barany,A.
         Nucl. Instr. Meth. in Phys. Res. B 9 (1985) 435-437
         A semiclassical analysis of orbiting resonances in slow charge transfer
         processes
             N^{3+} + H -> N^{2+}
             semiclassical
             10^{-5} - 10^{-2} keV/amu
             total cross sections

85T56   Toepfer,A. Ludde,H.J. Jacob,B. Dreizler,R.M.
         J. Phys. B 18 (1985) 1969-1980
         Many-electron aspects in ion-atom collisions; 2p-2s vacancy transfer in
         the Ne^+ + Ne system
             Ne^+ + Ne -> Ne(2p) + Ne^+(2s)
             IP
             0.25 - 25 keV/amu

85T57   van Hemert,M.C. van Dishoeck,E.F. van der Hart,J.A. Koike,F.
         Phys. Rev. A 31 (1985) 2227-2243

Quantum-mechanical and impact-parameter treatment of He^{2+} - H collisions
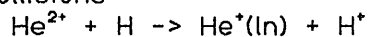
He^{2+} + H -> $He^+(ln)$ + H^+
CC (20-MO)
5×10^{-3} - 1.25×10^{-1} (quantum), 2.5×10^{-2} - 2.5 (semiclassical) keV/amu

85T58   Wada,K. Murai,T.
J. Phys. B 18 (1985) 4259-4269
Charge transfer in Be^{4+} + H(1s) collisions; convergence and oscillatory structure of the total cross sections
Be^{4+} + H(1s) -> Be^{3+}
MO close-coupling method
2.0 - 25.0 keV/amu

85T59   Willis,S.L. Peach,G. McDowell,M.R.C. Banerji,J.
J. Phys. B 18 (1985) 3939-3950
Charge transfer and ionization processes in collisions involving atoms and ions of hydrogen and helium
He^+ + H -> He + H^+; He^+ + H^+ + e;
He^+ + He^+ -> He + He^{2+}; He^+ + He^{2+} + e
classical theory

86T 1   Allan,R.J.
J. Phys. B 19 (1986) 321-334
Charge transfer in H^+ - Na^0 collisions; molecular orbital calculations
H^+ + Na(3s) -> H(nl) + Na^+
PSS with ETF

86T 2   Allan,R.J. Singal,R. Flower,D.R.
J. Phys. B 19 (1986) L251-256
Charge transfer in H^+ - Na(3p) collisions; a possible ultraviolet lase; mechanism
H^+ + Na(3p) -> H(nl) + Na^+
AO (>0.2 keV/amu) ; MO (<0.4 keV/amu)
0.02 - 10 keV/amu

86T 3   Bienstock,S. Dalgarno,A. Heil,T.G.
Phys. Rev. A 33 (1986) 2078-2080
Charge transfer in N^{2+} + H collisions at slow to intermediate velocities
N^{2+} + H -> N^+ + H^+
CC + UDWA
5.4×10^{-3} - 5.36 keV/amu

86T 4   Burgdorfer,J. Taulbjerg,K.
Phys. Rev. A 33 (1986) 2959-2969
Distorted-wave methods for electron capture in ion-atom collisions
A^{z+} + $B^{(z-1)+}$ -> $A^{(z-1)+}$ + B^{z+}
distorted-wave with strong potential Born ; CDW

86T 5   Errea,L.F. Mendez,L. Mo,O. Riera,A.
J. Chem. Phys. 84 (1986) 147-151
Nonadiabatic ionic-covalent transitions exponential-linear model for the charge exchange and neutralization reactions Na + H -> <- Na^+ + H^-
Na(3s) + H(1s) -> Na^+ + H^-; Na^+ + H^- -> Na(3s, 3p, 4s) + H(1s)
5 MO with ETF
0.16 - 5.0 keV/amu

86T 6   Fussen,D. Kubach,C.
J. Phys. B 19 (1986) L31-34
Theoretical study of mutual neutralization in H^+ - H^- collisions at low energy (0.02-20 eV)
$H^+ + H^- \rightarrow H + H(n=2, 3)$
quantum close-coupling treatment
2×10^{-5} - 2×10^{-2} keV/amu
n=3 dominant, particularly at low energies

86T 7   Horbatsch,M.
J. Phys. B 19 (1986) L193-198
Calculation of transfer ionization processes in ion-atom collisions
C^{6+}, O^{8+} + Ne $\rightarrow$ C^{5-3+}, O^{7-5+} + Ne (i=1-8)
quantum statistical time-dependent mean-field theory
1000 keV/amu

86T 8   Kimura,M. Chapman,S. Lane,N.F.
Phys. Rev. A 33 (1986) 1619-1625
Electron capture in Ar^+ + H_2 collisions in the keV energy regime
$Ar^+ + H_2 \rightarrow Ar^0 + H_2^+$
MO with ETF
7.5×10^{-3} - 0.25 keV/amu

86T 9   Ojha,P.C. Girardean,M.D. Gilbert,J.D. Straton,J.C.
Phys. Rev. A 33 (1986) 112-123
Fock-Tani transformation and a first-order theory of charge transfer
$H^+ + H(1s) \rightarrow H(1s) + H^+$
Fock-Tani transformation of second-quantized Hamiltonian
2 - 800 keV/amu
angular distribution

86T10   Shingal,R. Bransden,B.H. Ermolaev,A.M. Flower,D.R. Newby,C.W. Noble,C.J.
J. Phys. B 19 (1986) 309-320
Charge transfer in H^+ - Na^0 collisions; atoms orbital calculations
$H^+ + Na(3s) \rightarrow H(nl) + Na^+(n=1,2,3)$;
$Na^+ + H(1s) \rightarrow Na(3l) + H^+$ (l=0, 1, 2)
two-center expansion in travelling AO
0.5 - 20 keV/amu

86T11   Toshima,N. Watanabe,T.
Phys. Rev. A 33 (1986) 1382-1384
Simplified distorted-wave treatment for asymmetric electron capture processes
$A^{z+} + H(1s) \rightarrow A^{(z-1)+} + H^+$ (A = C, Ne)
DWBA
10^{-1} - 10^3 keV/amu

CROSS SECTIONS FOR CHARGE TRANSFER OF HYDROGEN BEAMS IN GASES AND VAPORS IN THE ENERGY RANGE 10 EV–10 KEV

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Cross sections are presented in graphical form for the charge transfer in various gases and vapors of hydrogen beams (H$^+$, H^0, and H$^-$) with laboratory energy ranging from 10 eV to 10 keV. This compilation is intended to be an addendum to a previous paper in Rev. Mod. Phys. 45, 179 (1973). The references have been covered through August 1978.

491

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CONTENTS

INTRODUCTION

It has been recognized that the charge-transfer processes of hydrogen beams play an important role in plasma physics, radiation physics, astrophysics, and particle accelerators. In plasma physics, especially in fusion reactor experiments, the injection of neutral hydrogen beams is one of the most promising methods for the effective trapping of ions into the toroidal plasma. These neutral beams are generally produced through electron capture by proton beams. Similarly, the production of intense negative hydrogen-ion beams is important because the injection of the negative-ion beam is also thought to be an effective method for ion trapping. The neutral particles escaping from the plasma contain some useful information on the plasma itself and can be used for diagnosing the plasma characteristics. For these purposes, data are required on the charge transfer of hydrogen beams, especially at energies lower than a few keV. There are some reviews[1-6] on these charge-transfer processes but the energy is generally limited from a few keV to some tens of MeV. Also, there are a number of measurements of the cross sections for charge transfer, but there is no systematic compilation of data at lower energies. In this paper, we compile in graphical form experimental data (up to August 1978) on the charge

transfer in various gases and vapors of protons (H^+), hydrogen atoms (H^0), and negative hydrogen ions (H^-) with incident energy between 10 and 10 000 eV. It is hoped that this compilation can be an addendum to our previous work.[6] Detailed discussions on the charge-transfer processes already have been given in some references.[1,6] Here only a short description is given. In hydrogen beams, the following charge-transfer processes take place (B is the target atom, B^+ and B^{2+} are the slow target ions, and e is a slow electron):

1. H^+ impact

$H^+ + B \rightarrow H^+ + B^+ + e$ $(\sigma_{11} \equiv \sigma_1^i)$: pure ionization

$\rightarrow H^0 + B^+$ (σ_{10}): one-electron capture

$\rightarrow H^- + B^{2+}$ (σ_{1-1}): two-electron capture

2. H^0 impact

$H^0 + B \rightarrow H^0 + B^+ + e$ $(\sigma_{00} \equiv \sigma_0^i)$: pure ionization

$\rightarrow H^+ + B + e$ (σ_{01}): one-electron stripping

$\rightarrow H^- + B^+$ (σ_{0-1}): one-electron capture

3. H^- impact

$H^- + B \rightarrow H^- + B^+ + e$ $(\sigma_{-1-1} \equiv \sigma_{-1}^i)$: pure ionization

$\rightarrow H^0 + B + e$ (σ_{-10}): one-electron stripping

$\rightarrow H^+ + B + 2e$ (σ_{-11}): two-electron stripping.
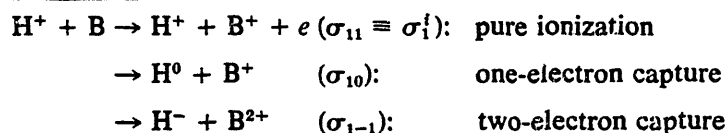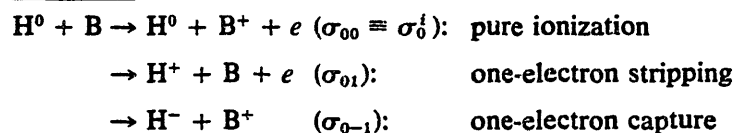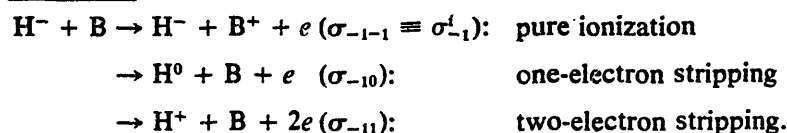
Here σ_{ij} denotes the cross section for the charge-transfer process from the initial charge state i to the final charge state j. σ_k^i means the ionization cross section for the incident ion with the charge state k.

To determine the cross section for the charge-transfer process, the following three methods are generally used: the attenuation, the growth, and the condenser methods. In the first two methods, only the fast beams are observed, neglecting the charge state of secondary slow ions. In the third method, the secondary slow ions and electrons are measured, neglecting the charge state of the incident projectiles after collision. Sometimes the equilibrium and retardation methods are also used.[6]

The cross sections which can be determined from various experimental methods for different incident ion beams are summarized in the following table:

Experimental Method	Incident Particle		
	H^+	H^0	H^-
Growth	$\sigma_{10}, \sigma_{1-1}$	$\sigma_{01}, \sigma_{0-1}$	$\sigma_{-10}, \sigma_{-11}$
Attenuation	$\sigma_{10} + \sigma_{1-1}$	$\sigma_{01} + \sigma_{0-1}$	$\sigma_{-10} + \sigma_{-11}$
Condenser			
Slow Ion	$\sigma_1^i + \sigma_{10} + 2\sigma_{1-1}$	$\sigma_0^i + \sigma_{0-1}$	σ_{-1}^i
Slow Electron	σ_1^i	$\sigma_0^i + \sigma_{01}$	$\sigma_{-1}^i + \sigma_{-10} + 2\sigma_{-11}$
Total Charge	$\sigma_{10} + 2\sigma_{1-1}$	$\sigma_{01} - \sigma_{0-1}$	$\sigma_{-10} + 2\sigma_{-11}$

493

In some methods, for example in the attenuation and condenser methods, the measured cross sections are not always those for a single process but those for the sum of two or more processes. However, in many collision processes, the cross sections for two-electron transfer processes are small, compared with those for single-electron transfer processes. It is important to consider the following points when these compiled data are used:

1. In some measurements by the condenser method, only slow-electron or ion-production cross sections (σ_-,σ_+) are determined. However, these cross sections are, in many cases, the sum of the ionization cross sections (σ^i) and the charge-transfer cross sections. It is possible to estimate the cross section for the charge-transfer processes from this measurement only when the ionization cross section is small. In some collisions such as $H^0 + Xe$, the slow-electron and ion-production cross sections are nearly equal (1–25 keV). In this case, it is not possible to determine the charge-transfer cross section without measuring both slow electrons and ions. For such cross sections, σ_- or σ_+ is shown to distinguish them from pure charge-transfer cross sections. In such cases, σ_- should be taken as an upper limit of the charge-transfer cross section σ_{01}.

2. In most measurements, no detailed description is given of the effect of scattering processes which becomes significantly important at energies lower than a few hundred eV. Due to the scattering loss of the beam charge-transferred in the collision, the observed cross sections may be too low, depending on the measuring geometry, as seen in the scattering of data at lower energies.

3. Some measurements have indicated that there is a finite difference (~5%) in the charge-transfer cross sections between H and D beams at energies less than 200 eV. This is thought to be due to the difference in scattering cross sections. However, more systematic measurements should be made before a definite conclusion on the difference is drawn from the observations.

4. Errors in the measured data are usually claimed to be 10%–20% for stable gas targets. However, for metal vapors, errors are often larger than those in gas targets.

References for the Introduction

1. S. K. Allison, Rev. Mod. Phys. **30**, 1137 (1958)

2. H. D. Betz, Rev. Mod. Phys. **44**, 465 (1972)

3. R. C. Dehmel, H. K. Chau, and H. H. Fleishmann, ATOMIC DATA **5**, 231 (1973)

4. H. H. Lo and W. L. Fite, ATOMIC DATA **1**, 305 (1970)

5. V. S. Nikolaev, Sov. Phys.–Usp. **8**, 269 (1965)

6. H. Tawara and A. Russek, Rev. Mod. Phys. **45**, 178 (1973)

EXPLANATION OF GRAPHS AND TABLES

Energy	Of incident beam; in keV on Graphs, in eV in Tables
Cross Section	Per target atom or molecule
σ_-, σ_+	Cross section for slow-electron, slow-ion production
Measurement Method	
A	Attenuation method
C	Condenser method
DC	Differential cross-section measurement
E	Equilibrium method
G	Growth method
MS	Mass-separation method
R	Retardation method

For details of methods, see Ref. 6

TABLE I. A List of Measurements of σ_{10}

Authors	Year	Energy range (eV)	Target	Method	Reference
Hasted	1951	10-800	Ar,Kr,Xe	C	37
Hasted	1952	100-1.000	Ar	C	38
Whittier	1954	4.000-70.000	H_2	A	88
Stedeford-Hasted	1955	100-40.000	H_2,He,Ne,Ar Kr,Xe	C	80
Stier-Barnett	1956	3.000-200.000	H_2,He,N_2,O_2, Ne,Ar	G+E	81
Gilbody-Hasted	1957	10-40.000	N_2,CO,NH_3	C	32
Curran et al.	1959	2.400-60.000	H_2	C	19
Gustaffson-Lindholm	1960	25-900	H_2,N_2,CO	MS	36
Cramer-Marcus	1960	4-400	D_2(D^+)	C	17
Cramer	1961	50-400	H_2	C	19
Stebbings et al.	1964	40-10.000	O_2,O	C	79
Gordeev-Panov	1964	1.000-40.000	H_2,N_2,Ar	C	34
Hollricher	1965	1.500-30.000	H_2,D_2	C	40
McClure	1966	2.000-117.000	H_2,H	G	51
Williams	1966	2.000-50.000	H_2,He,Ne,Ar Kr,Xe	G	89
Koopman	1967	70-1050	H_2,Ar,Kr,Xe	C	42
Cable	1967	180-460	H_2O	C	11
Futch-Moses	1967	4.000-50.000	Mg	G	31
Koopman	1968	40-1.500	N_2,O_2,CO_2,H_2O	C	43
Koopman	1968	100-1.500	CH_4,NH_3	C	44
McNeal-Clark	1969	1.000-25.000	N_2	C(σ_-,σ_+)	52
Becker-Scharman	1969	1.500-30.000	He-3,He-4	C	6
Schlachter et al.	1969	500-20.000	Cs	G	73
Berkner et al.	1969	5.000-70.000	Mg	G	7
Dagnac et al.	1970	2.000-60.000	H_2O	G+E	21
Coplan-Ogilvie	1970	30-500	H_2O,CO_2,NH_3	DC	15
Berkner et al.	1970	300-70.000	CO,CH_4,H_2O C_6F_{16}	C	8
Gruebler et al.	1970	1.000-20.000	Li,Na,K,Cs	G	35
Spiess et al.	1970	2.500	Cs	G	77
McNeal	1970	1.000-25.000	CO,CO_2,NH_3, CH_4	C(σ_-,σ_+)	54

See page 494 for Explanation of Graphs and Tables

TABLE I, continued

Authors	Year	Energy range (eV)	Target	Method	Reference
Spiess et al.	1972	500-3.000	Cs	G	78
Inoue	1972	150-8.000	K	G	41
Maier II	1972	0.5-100	Kr,Xe	C	47
Baragiolla	1973	7.500-40.000	Pb	G	9
Monnom et al.	1975	100-2.500	N_2,Ne,A	G	55
Morgan et al.	1976	1.250-25.000	Xe	G	56
Girnius et al.	1977	550-2.000	Rb	G	33 .

TABLE II. A List of Measurements of σ_{1-1}

Authors	Year	Energy range (eV)	Target	Method	Reference
Fogel et al.	1956	9.500-29.000	H_2,He,N_2,O_2, Ne,Ar	G	27
Fogel et al.	1959	5.000-50.000	H_2,He,Ne,Ar, Kr,Xe	G	30
Afrosimov et al.	1960	5.000-180.000	Ar	G	2
Kozlov et al.	1963	500-5.000	H_2,Ar,Kr	R	45
McClure	1963	6.000-50.000	H_2	G	48
Williams	1966	2.000-50.000	H_2,He,Ne,Ar, Kr,Xe	G	90
Futch-Moses	1967	4.000-50.000	Mg	G	31
Schlachter et al.	1969	500-20.000	Cs	G	73
Gruebler et al.	1970	1.000-20.000	Li,Na,K,Cs	G	35
Spiess et al.	1970	2.500	Cs	G	77
Baragiolla	1973	7.500-40.000	Pb	G	9
Cisneros et al.	1976	250-1.250	Cs	G	13
Morgan et al.	1976	1.250-25.000	Xe	G	56
Morgan et al.	1978	1.100-80.000	Mg	G	57

See page 494 for Explanation of Graphs and Tables

TABLE III. A List of Measurements of σ_{01}

Authors	Year	Energy range (eV)	Target	Method	Reference
Stier-Barnett	1956	3.000-200.000	H_2,He,N_2,O_2, Ne,Ar	G+E	81
Fogel et al.	1958	5.000-40.000	H_2,He,N_2,O_2, Ne,Ar,Kr,Xe	G	29
Curran-Donahue	1960	4.000-35.000	H_2	C+A	20
Donahue-Hushfar	1961	8.000-40.000	Ar,CO	C+A	24
Pilipenko-Fogel	1962	5.000-20.000	H_2,N_2,O_2,CO	G	63
Pilipenko-Fogel	1963	5.000-30.000	NO	G	64
Williams	1967	2.000-50.000	H_2,He,Ne,Ar,Kr, Xe	G	91
Futch-Moses	1967	4.000-50.000	Mg	G	31
McClure	1968	1.250-117.000	H_2	G	51
Schlachter et al.	1969	500-20.000	Cs	G	73
Berkner et al.	1969	5.000-70.000	Mg	G	7
Fleishmann-Young	1969	50-1.000	H_2,He,Ne,Ar	$C(\sigma_-)$	25
Fleishmann-Young	1969	50-800	N_2,O_2	$C(\sigma_-)$	24
McNeal-Clark	1969	1.000-25.000	N_2	$C(\sigma_-,\sigma_+)$	52
McNeal et al.	1970	1.000-25.000	H_2,He,O_2,Ne, Ar,Kr,Xe	$C(\sigma_-,\sigma_+)$	53
McNeal	1970	1.000-25.000	CO,CO_2,CH_4, NH_3	$C(\sigma_-,\sigma_+)$	54
Dagnac et al.	1970	2.000-60.000	H_2O	G+E	21
Barnett-Ray	1972	300-10.000	H_2,N_2	G	5
Baragiolla	1973	7.500-40.000	Pb	G	9
Dehmel et al.	1973	80-2.000	Ar,Kr,Xe,CO, CO_2,CH_4	$C(\sigma_-)$	22
Pradel et al.	1974	500-3.000	HI	G	66
Monnon et al.	1975	100-2.000	N_2,Ne,Ar	G	55
Noda	1976	200-5.000	H_2,N_2	G	60
Smith et al.	1976	250-5.000	H_2,He,N_2,O_2, CO,CO_2,CH_4	C	75
Cisneros et al.	1976	500-2.000	N_2	G	14
Morgan et al.	1976	1.250-25.000	Xe	G	56
Roussel et al.	1977	500-3.000	H_2,He,Ne,Ar, Kr,Xe	G	70
Van Zyl et al.	1977	250-5.000	Ar	C	86
Van Zyl et al.	1978	50-3.000	N_2,O_2	C	87

See page 494 for Explanation of Graphs and Tables

TABLE IV. A List of Measurements of σ_{0-1}

Authors	Year	Energy range (eV)	Target	Method	Reference
Stier-Barnett	1956	3.000-200.000	H_2,He,N_2,O_2, Ne,Ar	G+E	81
Curran-Donahue	1960	4.000-35.000	H_2	C	20
Donahue-Hushfar	1961	8.000-40.000	Ar,CO	C	24
Pilipenko-Fogel	1962	5.000-50.000	H_2,N_2,O_2,CO	G	63
Pilipenko-Fogel	1963	5.000-35.000	NO	G	64
McClure	1964	6.000-120.000	H_2	G	49
Williams	1967	2.000-50.000	H_2,He,Ne,Ar, Kr,Xe	G	91
Schlachter et al.	1969	500-20.000	Cs	G	73
Berkner et al.	1969	5.000-70.000	Mg	G	7
Spiess et al.	1970	2.500	Cs	G	77
Baragiolla	1973	7.500-40.000	Pb	G	9
Pradel et al.	1974	500-3.000	HI	G	66
Cinsneros et al.	1976	250-1.250	Cs	G	13
Morgan et al.	1976	1.250-25.000	Xe	G	56
Roussel et al.	1977	500-3.000	H_2,He,Ne,Ar, Kr,Xe	G	70
Van Zyl et al.	1978	50-3.000	N_2,O_2	C	87

See page 494 for Explanation of Graphs and Tables

TABLE V. A List of Measurements of σ_{-10}

Authors	Year	Energy range (eV)	Target	Method	Reference
Hasted	1952	100-2.500	He,Ne,Ar,Kr, Xe	C	38
Whittier	1954	4.000-70.000	H_2	A	88
Stedeford-Hasted	1955	100-40.000	He,Ne,Ar,Kr, Xe	C	80
Hasted-Smith	1956	10-2.700	H_2	C	39
Stier-Barnett	1956	4.000-300.000	H_2,He,N_2,O_2, Ne,Ar	G	81
Muschlitz et al.	1956	4-400	H_2	C	58
Muschlitz et al.	1957	4-400	H_2	C	59
Bailey et al.	1957	5-350	He,Ne,Ar	C	3
Pilipenko	1966	3.000-30.000	O_2,NO,CO	C	65
Bydin	1966	200-7.000	He,Ne,Ar,Kr,Xe	C	10
Williams	1967	2.000-50.000	H_2,He,Ne,Ar,Kr, Xe	G	92
Berkner et al.	1969	5.000-70.000	Mg	G	7
Spiess et al.	1970	2.500	Cs	G	77
Bailey et al.	1970	10-350	O_2	C	4
Leslie et al.	1971	2.000-30.000	Cs	G	46
Simpson-Gilbody	1972	4.000-30.000	H_2,He,Ar	A	74
Risley-Geballe	1974	200-10.000	H_2,He,N_2,O_2,Ar	A	68
Risley	1974	200-10.000	H_2,He,N_2,O_2,Ar	A	69
Champion et al.	1976	2-100	He,N_2,Ne,Ar	C	12
Morgan et al.	1976	1.250-25.000	Xe	G	56

TABLE VI. A List of Measurements of σ_{-11}

Authors	Year	Energy range (eV)	Target	Method	Reference
Fogel et al.	1957	5.000-40.000	H_2,He,N_2,O_2, Ne,Ar,Kr,Xe	G	28
Tisone et al.	1965	500-4.000	H_2	G	82,83
Williams	1967	2.000-50.000	H_2,He,Ne,Ar	G	92
Leslie et al.	1971	2.000-30.000	Cs	G	46
Morgan et al.	1976	1.250-25.000	Xe	G	56

See page 494 for Explanation of Graphs and Tables

REFERENCES FOR GRAPHS AND TABLES

1   V.V. Afrosimov, R.N. Ilin and N.V. Fedorenko, Soviet Phys.-Tech.
      Phys. $\underline{3}$, 2080 (1958)

2   V.V. Afrosimov, R.N. Ilin and E.A. Solovev, Soviet Phys.-Tech.
      Phys. $\underline{5}$, 661 (1960)

3   T.L. Bailey, C.J. May and E.E. Muschlitz, J. chem. Phys. $\underline{26}$, 1446
      (1957)

4   T.I. Bailey and P. Mahadevan, N. chem. Phys. $\underline{52}$, 179 (1970)

5   C.F. Barnett and J.A. Ray, Nucl. Fusion $\underline{12}$, 65 (1972)

6   M. Becker and A. Scharmann, Z. Naturforsch, $\underline{21a}$, 854 (1969)

7   K.H. Berkner, R.V. Pyle and J.W. Stearns, Phys. Rev. $\underline{178}$, 248 (1969)

8   K.H. Berkner, R.V. Pyle and J.W. Stearns, Nucl. Fusion $\underline{10}$, 145 (1970)

9   A. Baragiola and E.E. Salvattelli, Nucl. Instr. Meth. $\underline{110}$, 503 (1973)

10   Y.R. Bydin, Soviet Phys. -JETP $\underline{22}$, 762 (1966)

11   P.C. Cable, University of Maryland Tech. Note no. BN-499, 1967
      (unpublished)

12   R.L. Champion, L.D. Doverspike and S.K. Lam, Phys. Rev. A$\underline{13}$, 617
      (1976)

13   C. Cisneros, I. Alvarez, C.F. Barnett, and J.A. Ray, Phys. Rev.
      A$\underline{14}$, 76 (1976)

14   C. Cisneros, I. Alvarez, C.F. Barnett, and J.A. Ray, Phys. Rev.
      A$\underline{14}$, 84 (1976)

15   M.A. Coplan and K.W. Ogilvie, J. chem. Phys. $\underline{52}$, 4154 (1970)

16   W.H. Cramer and J.H. Simons. J. chem. Phys. $\underline{26}$, 1272 (1957)

17   W.H. Cramer and A.B. Marcus, J. chem. Phys. $\underline{32}$, 186 (1960)

18   W.H. Cramer, J. chem. Phys. $\underline{35}$, 836 (1961)

19   R. Curran, T.M. Donahue and W.H. Kasner, Phys. Rev. $\underline{114}$, 490 (1959)

20   R. Curran and T.M. Donahue, Phys. Rev. $\underline{118}$, 1233 (1960)

21   R. Dagnac, D. Blanc and D. Molina, J. Phys. B$\underline{3}$, 1239 (1970)

22   R.C. Dehmel, R. Merger, H.H. Fleishmann and M. Steinberg, J. chem.
      Phys. $\underline{58}$, 5111 (1973)

23   T.M. Donahue and F. Hushfar, Phys. Rev. $\underline{124}$, 138 (1961)

24   H.H. Fleishmann and R.A. Young, Phys. Letters $\underline{29A}$, 287 (1969)

25   H.H. Fleishmann and R.A. Young, Phys. Rev. $\underline{178}$, 254 (1969)

26   H.H. Fleishmann, C.F. Barnett and J.A. Ray, Phys. Rev. A$\underline{10}$, 569
      (1974)

27   I.M. Fogel and R.V. Mitin, Soviet Phys. -JETP $\underline{3}$, 334 (1956)

28   I.M. Fogel and V.A. Ankudinov and R.E. Slabospitskii, Soviet Phys.
      -JETP $\underline{5}$, 382 (1957)

29   I.M. Fogel, V.A. Ankudinov, D.V. Pilipenko and N.V. Topolia,
      Soviet Phys. -JETP $\underline{7}$, 400 (1958)

30   I.M. Fogel. R.V. Mitin, V.F. Kozlov and N.D. Romashko, Soviet Phys.
      -JETP $\underline{8}$, 390 (1959)

REFERENCES FOR GRAPHS AND TABLES

31   A.H. Futch and K.G. Morses, UCRL-70251 (1966)

32   H.B. Gilbody and J.B. Hasted, Proc. Roy. Soc. A238, 334 (1957)

33   R.J. Girnius, L.W. Anderson and E. Stabl, Nucl. Instr. Meth. 143, 505 (1977)

34   Y. Gordeev and M.N. Panov, Soviet Phys. -Tech. Phys. 9, 656 (1964)

35   W. Gruebler, P.A. Schmelzbach, E. Konig and P. Marmier, Helv. Phys. Acta 43, 254 (1970)

36   E. Gustaffson and E. Lindholm, Arkiv Fysik 18, 219 (1960)

37   J.B. Hasted, Proc. Roy. Soc. A205, 421 (1951)

38   J.B. Hasted, Proc. Roy. Soc. A212, 235 (1952)

39   J.B. Hasted and R.A. Smith, Proc. Roy. Soe. A235, 349 (1956)

40   O. Hollricher, Z. Phys. 187, 41 (1965)

41   N. Inoue, Nucl. Fusion 12, 130 (1972)

42   D.W. Koopman, Phys. Rev. 154, 79 (1967)

43   D.W. Koopman, Phys. Rev. 166, 57 (1968)

44   D.W. Koopman, J. chem. Phys. 49, 5203 (1968)

45   V.F. Kozlov, Y.M. Fogel and V.A. Stratienko, Soviet Phys. -JETP 17, 1226 (1963)

46   T.E. Leslie, K.P. Sarver and L.W. Anderson, Phys. Rev. A4, 408 (1971)

47   W.B. Maier II, Phys. Rev. A5, 1256 (1972)

48   G.W. McClure, Phys. Rev. 132 , 1636 (1963)

49   G.W. McClure, Phys. Rev. 134, A1226 (1964)

50   G.W. McClure, Phys. Rev. 148, 47 (1966)

51   G.W. McClure, Phys. Rev. 166, 22 (1968)

52   R.J. McNeal and D.C. Clark, J. Geophys. Res. 74, 5065 (1969)

53   R.J. McNeal, D.C. Clark and R.A. Klingberg, Phys. Rev. A2, 131 (1970)

54   R.J. McNeal, J. chem. Phys. 53, 4308 (1970)

55   G. Monnom, M. Eliot, J. Guidini and P.G. Valckx, C.R. Acad. Sci. Paris 281B, 425 (1975)

56   T.J. Morgan, K.H. Berkner, W.G. Graham, R.V. Pyle and J.W. Stearns, Phys. Rev. A14, 664 (1976)

57   T.J. Morgan and F. Eriksen, Phys. Letters 66A, 198 (1978)

58   E.E. Muschlitz, T.L. Bailey and J.H. Simons, J. chem. Phys. 24, 1202 (1956)

59   E.E. Muschlitz, T.L. Bailey and J.H. Simons, J. chem. Phys. 26, 711 (1957)

60   N. Noda, J. Phys. Soc. Japan 41, 625 (1976)

61   R.E. Olson, Phys. Letters 55A, 83 (1975)

62   R.E. Olson, IEEE NS-23, 971 (1976)

63   D.V. Pilipenko and Y.M. Fogel, Soviet Phys. -JETP 15, 646 (1962)

64   D.V. Pilipenko and Y.M. Fogel, Soviet Phys. -JETP 17, 1222 (1963)

REFERENCES FOR GRAPHS AND TABLES

65   D.V. Pilipenko, V.A. Gusev and Y.M. Fogel, Soviet Phys. -JETP 22, 965 (1966)

66   P. Pradel and F. Roussel, Nucl. Instr. Meth. 121, 111 (1974)

67   P. Pradel, F. Roussel, A.S. Schlachter, G. Spiess and V. Valance, Phys. Rev. A10, 797 (1974)

68   J.S. Risley and R. Geballe, Phys. Rev. A9, 2485 (1974)

69   J.S. Risley,   Phys. Rev. A10, 731 (1974)

70   F. Roussel, P. Pradel and G. Spiess, Phys. Rev. A16, 1854 (1977). See discussions on their previous data (ref. 67).

71   E.R. Salvatelli, G. Lantschner and W. Meckbach, J. Phys. B2, 772 (1969)

72   F. Schwirzke, Z. Phys. 157, 510 (1960)

73   A.S. Schlachter, R.J. Bjorkholm, D.H. Loyd, L.W. Anderson, W. Haeberli, Phys. Rev. 177, 184 (1960)

74   F.R. Simpson and H.B. Gilbody, J. Phys. B5, 1959 (1972)

75   K.A. Smith, M.D. Duncan, N.W. Geis and R.D. Rundel, J. Geophys. Res. 81, 2231 (1976)

76   W.S. Snow, R.D. Rundel and R. Geballe, Phys. Reg. 178, 228 (1969)

77   G. Spiess, A. Valance and P. Pradel, Phys. Letters 31A, 434 (1970)

78   G. Spiess, A. Valance and P. Pradel, Phys. Rev. A6, 746 (1972)

79   R.F. Stebbings, A.C.H. Smith and H. Ehrhardt, J. Geophys. Res. 69, 2349 (1964)

80   J.B.H. Stedeford and F.B. Hasted, Proc. Roy. Soc. A227, 466 (1955)

81   P.M. Stier and C.F. Barnett, Phys. Rev. 103, 896 (1956)

82   G.C. Tisone and L.M. Branscomb, Bull. Am. Phys. Soc. 9, 535 (1964)

83   G.C. Tisone and L.M. Branscomb, JILA report no.20, (1964)

84   V.N. Tuan, G. Gautherin and A.S. Schlachter, Phys. Rev. A9, 1242 (1974)

85   V.N. Tuan, A.S. Schlachter and G. Gautherin, Nucl. Instr. Meth. 114, 499 (1974)

86   B. Van Zyl, T.Q. Le, H. Neumann and R.C. Amme, Phys. Rev. A15, 1871 (1977)

87   B.Van Zyl, H. Neumann, T.Q. Le, and R.C. Amme, Phys. Rev. A18, 506 (1978)

88   A.C. Whittier, Can. J. Phys. 32, 275 (1954)

89   J.F. Williams and D.N.F. Dunbar, Phys. Rev. 149, 62 (1966)

90   J.F. Williams, Phys. Rev. 150, 7 (1966)

91   J.F. Williams, Phys. Rev. 153, 116 (1967)

92   J.F. Williams, Phys. Rev. 154, 9 (1967)

CROSS SECTIONS FOR ELECTRON CAPTURE AND LOSS BY POSITIVE IONS IN COLLISIONS WITH ATOMIC AND MOLECULAR HYDROGEN

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Experimental cross sections for electron capture and loss by atomic positive ions in collisions with atomic and molecular hydrogen targets are tabulated as a function of the incident energy of projectile ions and of their charge state. Literature up to mid-1984 has been covered. © 1985 Academic Press, Inc.

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235

CONTENTS

INTRODUCTION

Electron capture (more generally electron transfer) processes of highly ionized ions in collisions with atomic hydrogen are known to play an important role in high-temperature plasmas. In the peripheral region of high-temperature plasmas, the collisions of highly ionized ions with molecular hydrogen are also important. Therefore, the electron transfer data for both atomic and molecular hydrogen are required for the analysis and modeling of the behavior of edge plasmas. Theoretical investigations of these transfer processes and experimental data compilations have been the subject of a number of recent works.[1-7] Previously, data have been compiled for similar processes with hydrogen as the projectile.[8,9]

In this work, experimental numerical data are compiled for the following electron transfer processes involving atomic and molecular hydrogen targets:

electron capture $\quad A^{q+} + H \longrightarrow A^{(q-1)+} + H^+ \qquad$ (1)

$$A^{q+} + H_2 \longrightarrow A^{(q-1)+} + H_2^+ \qquad (2)$$

$$A^{q+} + H_2 \longrightarrow A^{(q-2)+} + 2H^+ \qquad (3)$$

electron loss $\qquad A^{q+} + H \longrightarrow A^{(q+i)+} + \sum H + ie \quad$ (4)

$$A^{q+} + H_2 \longrightarrow A^{(q+i)+} + \sum H_2 + ie.$$

$$(5)$$
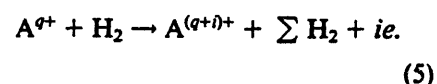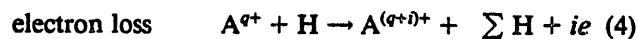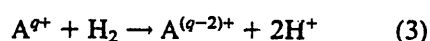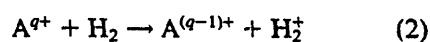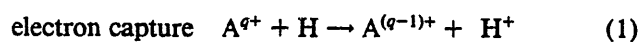
Here Σ indicates the summation over all the possible states including ionization, and i the number of electrons stripped from the projectile ion. Data for pure excitation processes of target atoms ($i = 0$) are not included in this work.

There are several methods for determining the cross sections for charge transfer.[8] In most cases, the cross sections are measured by detecting either the charge-changed projectile ions or the secondary ions and electrons. While molecular hydrogen targets are easily prepared, atomic hydrogen targets are generated through dissociation of thermal molecular hydrogen either in high-temperature furnaces or in high-frequency electric fields. At very low energies (<10 eV), the merging beam technique[10] is used.

Ratios of the cross sections of electron transfer processes in molecular and atomic hydrogen, that is,

$\sigma(H_2)/\sigma(H)$, are quite useful for many applications because experiments for atomic hydrogen are fairly difficult and so there still are insufficient such data. It has often been claimed that the above ratios are equal to 2, on the assumption that a molecular hydrogen simply consists of two identical atomic hydrogens. However, it should be noted that this has generally not been found to be the case. As discussed by Knudsen et al.,[11] at relatively high energies, the measured ratios for electron capture processes (1) and (2) converge toward a constant value which is larger than 2, and is dependent on projectile ions as follows:

$$\sigma(H_2)/\sigma(H) = 2.4 \quad \text{for protons}$$

$$= 3.3 \quad \text{for He}^{2+} \text{ ions}$$

$$= 3.8 \quad \text{for heavier ions.}$$

The above ratios for protons are known[12] to be quite consistent with theoretical values (2.4 ~ 2.8) by Tuan and Gerjuoy.[13] Still, there is no clear understanding of why the ratios change with projectile ions. Moreover, at low collision energies where the quasi-molecular formation plays a key role in the electron transfer processes, there seems to be no simple pattern in the ratios. According to our preliminary analysis, the ratios are strongly dependent on the energy defect in collision processes. For example, the ratios for electron capture by protons become zero at low energies because the charge transfer collisions with atomic hydrogen are resonance processes while those with molecular hydrogen are nonresonant. On the other hand, when the collisions with molecular hydrogen are quasi-resonant whereas those with atomic hydrogen are nonresonant, the ratios are found to reach values of more than 100 at low energies.

In contrast to the situation with electron capture, the ratios for electron loss processes are found to converge toward a constant value of 2 at high energies, though experimental data are still scarce.[14] Thus it appears that for electron loss processes, a hydrogen molecule can be assumed to be equivalent to two hydrogen atoms in high-energy collisions. However, similar to electron capture, there seems to be no simple pattern in the ratios in electron loss processes at lower energies.

In this compilation are included all the experimental data published up to mid-1984, except for those which seem to be obviously in error. Table I shows the ion–target combinations compiled; Tables II–V list the numerical data for the processes described by Eqs. (1)–(5).

These compilations are stored in a computer system called CHART (charge transfer) and data can be retrieved numerically as well as graphically through the on-line system in our Institute or through telephone line linkage from other institutions.

References

1. D. Basu, S. C. Mukherjee, and D. P. Sural, Phys. Rep. C 42, 145 (1978)

2. Dz. Belkic, R. Gayet, and A. Salin, Phys. Rep. 56, 279 (1979)

3. R. K. Janev and L. P. Presnyakov, Phys. Rep. 70, 1 (1981)

4. P. T. Greenland, Phys. Rep. 81, 131 (1982)

5. H. B. Gilbody, Advances in Atomic and Molecular Physics (Academic Press, New York, 1979), Vol. 15, p. 293

6. H. Tawara, T. Kato, and Y. Nakai, IPPJ-AM-30 (Institute of Plasma Physics, Nagoya University, Nagoya, 1983), updated version of IPPJ-AM-15 (1980) by Y. Kaneko, T. Arikawa, Y. Itikawa, T. Iwai, T. Kato, M. Matsuzawa, Y. Nakai, K. Okuno, H. Ryufuku, H. Tawara, and T. Watanabe

7. H. Tawara, T. Kato, and Y. Nakai, IPPJ-AM-28 (Institute of Plasma Physics, Nagoya University, Nagoya, 1983), updated version of IPPJ-AM-20 (1981) by Y. Kaneko, Y. Itikawa, T. Iwai, T. Kato, Y. Nakai, K. Okuno, and H. Tawara

8. H. Tawara and A. Russek, Rev. Mod. Phys. 45, 178 (1973). In this paper, the cross sections for diatomic molecules are given per atom, i.e., as one-half of the measured value.

9. H. Tawara, ATOMIC DATA AND NUCLEAR DATA TABLES 22, 491 (1978)

10. J. H. Newman, J. D. Cogan, D. L. Ziegler, D. E. Nitz, R. D. Rundel, K. A. Smith, and R. F. Stebbings, Phys. Rev. A 25, 2976 (1982)

11. H. Knudsen, H. K. Haugen, and P. Hvelplund, Phys. Rev. A 24, 2287 (1981)

12. "Cross Sections for Atomic Processes," IPPJ-DT-48 (Institute of Plasma Physics, Nagoya University, 1974), p. I-A1

13. T. F. Tuan and E. Gerjuoy, Phys. Rev. 117, 756 (1960)

14. P. Hvelplund and A. Andersen, Phys. Scripta 26, 370 (1982)

REFERENCES FOR TABLES

Abbe,J.-C. Adloff,J.-P.
    Bull.Soc.Chim.Fr. 6 1212 (1964)
    Sur les reaction d'ions positifs avec l'argon, l'azote et
    l'hygrogene

Afrosimov,A.A. Basalaev,A.A. Gordeev,Yu.S. Donets,E.D.
    Zoniv'ev,A.N. Ovchinnikov,S.Yu. Panov,M.N.
    Sov.Phys.-JETP Letters 34 316 (1981)
    X radiation accompanying electron capture by oxygen and
    carbon nuclei in molecular hydrogen

Afrosimov,V.V. Basalaev,A.A. Donets,E.D. Panov,N.N.
    Sov.Phys.-JETP Letters 31 600 (1980)
    Electron capture by multiply charged ions and nuclei of
    hydrogen molecule atoms

Afrosimov,V.V. B.salaev,A.A. Donets,E.D. Lozhkin,K.O. Panov,M.N.
    Sov.Phys.-JETP Letters 34 171 (1981)
    Processes involving the capture of an electron by the
    nuclei of atoms near helium atoms and hydrogen molecules at
    low energies

Afrosimov,V.V. Leiko,G.A. Mamaev,Yu.A. Panov,M.N.
    Sov.Phys.-JETP 29 648 (1969)
    Elementary processes of change of charge states in the
    interaction between protons and hydrogen molecules

Aldag,J.E. Peacher,J.L. Martin,P.J. Sutcliffe,V. George,J.
    Redd,E. Kvale,T.J. Blankenship,D.M. Park,J.T.
    Phys.Rev.A 23 1062 (1981)
    Angular differential and total cross sections for the
    excitation of atomic hydrogen to n=2 state by helium ions

Allison,S.K.
    Phys.Rev. 102 1041 (1956)
    Experimental cross sections for charge-changing collisions
    of He^+ and He^{++} ions traversing gases

Allison,S.K.
    Phys.Rev. 109 76 (1958)
    Double electron capture and loss by helium ions traversing
    gases

Allison,S.K. Cuevas,J. Garcia-Munoz,M.
    Phys.Rev. 120 1266 (1960)
    Experiments on charge-changing collisions of lithium and
    atomic beams

Alton,G.D. Bridwell,L.B. Lucas,M. Hoak,C.D. Miller,P.D.
    Jones,C.M. Kessel,Q.C. Antar,A.A. Brown,M.D.
    Phys.Rev.A 23 1073 (1981)
    Single and multiple electron loss cross section
    measurements from 20 MeV Fe^{4+} on thin gaseous targets

Alvarez,I. Cisneros,C. Barnett,C.F. Ray,J.A.
    Phys.Rev.A 13 1728 (1976)

Electron capture and stripping cross sections for Tl and K
ions and atoms in H_2

Baragiola,R.A. Nemirovsky,I.B.
    Nucl.Instr.Meth. 110 511 (1973)
    Cross sections for single and double electron capture from
    He^{++} on hydrogen, neon and argon

Barnett,C.F. Reynolds,H.K.
    Phys.Rev. 109 355 (1958)
    Charge exchange cross sections of hydrogen particles in
    gases at high energies

Barnett,C.F. Stier,P.M.
    Phy.Rev. 109 385 (1958)
    Charge exchange cross sections for helium ions in gases

Bayfield,J.E.
    Phys.Rev.Letters 20 1223 (1968)
    Electron capture into the metastable 2s state in collisions
    of protons with hydrogen atoms

Bayfield,J.E.
    Phys.Rev. 185 105 (1969)
    Measurement of the total cross section for charge transfer
    into the metastable state H (2s) for proton collisions with
    atomic hydrogen

Bayfield,J.E. Khayrallah,G.A. Koch,P.M.
    Phys.Rev.A 9 209 (1974)
    Production of fast highly excited atoms in proton
    collisions with atomic hydrogen and argon

Bayfield,J.E. Khayrallah,G.A.
    Phys.Rev.A 12 869 (1975)
    Electron transfer in keV energy $^4He^{2+}$ collisions

Bayfield,J.E. Khayrallah,G.A.
    Phys.Rev. 11 920 (1975)
    Electron transfer in keV-enegy $^4He^{++}$ atomic
    collisions.I.single and double electron transfer with He,
    Ar, H_2 and N_2

Belyaev,V.A. Brezhnev,B.G. Erastov,E.M.
    Sov.Phys.-JETP 25 777 (1967)
    Resonance charge exchange of protons and deuterons at low
    energies

Berkner,K.H. Graham,W.G. Pyle,R.V. Schlachter,A.S. Stearns,J.W.
    Phys.Lett. 62A 407 (1977)
    Single electron capture and loss cross sections for highly
    stripped Fe ions in hydrogen at 3.4 MeV/Nucleon

Berkner,K.H. Graham,W.G. Pyle,R.V. Schlachter,A.S. Stearns,J.W.
    Olson,R.E.
    J.Phys.B 11 875 (1978)
    Electron capture and impact-ionization cross sections for

REFERENCES FOR TABLES continued

partially stripped iron ions colliding with atomic and
molecular hydrogen

Berkner,K.H. Graham,W.G. Pyle,R.V. Schlachter,A.S. Stearns,J.W.
    Phys.Rev.A 23 2891 (1981)
    Electron capture, electron loss and impact ionization cross
    sections for 103- to 3400- keV/amu multicharged iron ions
    colliding with molecular hydrogen

Betz,H.D. Ryding,G. Wittkower,A.B.
    Phys.Rev.A 3 197 (1971)
    Cross sections for electron capture and loss by fast
    bromine and iodine ions traversing light gases

Betz,H.D. Wittkower,A.B.
    Phys.Rev.A 6 1485 (1972)
    Charge-changing cross sections of 5-25 MeV iodine ions in
    hydrogen and oxygen

Bliman,S. Aubert,J. Geller,R. Jacquot,B. van-Houtte,D.
    Phys.Rev.A 23 1703 (1981)
    Electron capture collisions at keV energies of multiply
    charged ions of carbon and argon with molecular deuterium

Burniaux,M. Brouillard,F. Jognaux,A. Govers,T.R. Szucs,S.
    J.Phys.B 10 2421 (1977)
    Merged-beams study of the charge exchange between He^{2+}
    ions and highly excited hydrogen atoms

Chambers.E.S.
    UCRL-14214 (1965)
    Neutralization of fast hydrogen ions colliding with H_2,
    CO, CH_4 and H2O molecules

Chong,Y.P. Fite,W.L.
    Phys.Rev.A 16 933 (1977)
    Cross section for the metastable H(2s) state in prote
    collisions with atomic hydrogen

Cramer,W.H.
    J.Chem.Phys. 35 836 (1961)
    Elastic and inelastic scattering of low-velocity H^+ and
    H^{2+} in hydrogen

Crandall,D.H. Mallory,M.L. Kocher,D.C.
    Phys.Rev.A 15 61 (1977)
    Charge exchange between multicharged ions of C, N and O and
    molecular hydrogen

Crandall,D.H. Phaneuf,R.A. Meyer,F.W.
    Phys.Rev.A 19 504 (1979)
    Electron capture by slow multicharged ions in atomic and
    molecular hydrogen

Crandall,D.H. Phaneuf,R.A. Meyer,W.
    Phys.Rev.A 22 379 (1980)

Electron capture by heavy multicharged ions from atomic
hydrogen at low velocities

Curran,R. Donahue,T.M. Kasner,W.H.
    Phys.Rev. 114 490 (1959)
    Charge transfer for protons in H_2

Curran,R. Donahue,T.M.
    Phys.Rev. 118 1233 (1960)
    Electron capture and loss by hydrogen atoms in molecular
    hydrogen

Datz,S. Lutz,H.O. Bridwell,L.B. Moak,C.D. Betz,H.D.
    Ellsworth,L.D.
    Phys.Rev.A 2 430 (1970)
    Electron capture and loss cross sections of fast bromine
    ions in gases

Desesquelles,J. Cao,G.D. Dufay,M.
    Compt.Rend. B262 1329 (1966)
    Etude de l'ionisation de quelques gaz par des ions
    acceleres H^+ et H_2^+

Dimov,G.I. Dudnikov,V.G.
    Sov.Phys.-Tech.Phys. 11 919 (1967)
    Cross sections for stripping of 1-MeV negative hydrogen
    ions in certain gases

El-Sherbini,Th.M. Salop,A. Bloemen,E. de-Heer,F.J.
    J.Phys.B 13 1433 (1980)
    Excitation and ionization resulting from electron capture
    in Ar^{6+} + H_2 collisions at ion projectile energies of
    200-1200 keV

Fite,W.L. Brackmann,R.T. Snow,W.M.R.
    Phys.Rev. 112 1161 (1958)
    Charge exchange in proton-hydrogen atom collisions

Fite,W.L. Smith,A.C. Stebbings,R.F.
    Proc.Roy.Soc.A 268 527 (1962)
    Charge transfer in collisions involving symmetric and
    asymmetric resonance

Fite,W.L. Stebbings,R.F. Hummer,D.G. Brackmann,R.T.
    Phys.Rev. 119 663 (1960)
    Ionization and charge transfer in proton-hydrogen atom
    collisions

Fogel',Ia.M. Ankudinov,V.A. Pilipenko,D.V. Topolia,N.V.
    Sov.Phys.-JETP 7 400 (1958)
    Electron loss and capture in collisions between fast
    hydrogen atoms and molecules of gases

Fogel',Ia.M. Krupnik,L.I. Safronov,B.G.
    Sov.Phys.-JETP 1 415 (1955)
    Capture of electrons and ionization by protons in hydrogen

REFERENCES FOR TABLES continued

Franzke,B.

GSI Report 80-3   225 (1980)

Charge change cross sections for 1.4 MeV/u Uranium in H_2
and N_2

Fussen,D. Claeys,W. Cornet,A. Jureta,J. Defrance,P.

J.Phys.B 15 L715 (1983)

Absolute total cross section measurement of ion pair
production in H (1s)-H (2s) collisions

Gardner,L.D. Bayfield,J.E. Koch,P.M. Kim,H.J. Stelson,P.H.

Phys.Rev.A 16 1415 (1977)

Experimental study of electron transfer in multiply charged
iron ion collisions with atomic hydrogen

Gardner,L.D. Bayfield,J.E. Koch,P.M. Sellin,I.A. Pegg,D.J.
Peterson,S. Mallory,K.L. Crandall,D.H.

Phys.Rev.A 20 766 (1979)

Electron-capture collision at keV energies of boron and
other multiply charged ions with atoms and molecules I, Ar,
H_2 and He

Gardner,L.D. Bayfield,J.E. Koch,P.M. Sellin,I.A. Pegg,D.J.
Peterson,R.S. Crandall,D.H.

Phys.Rev.A 21 1397 (1980)

Electron collisions at keV energies of boron and other
multiply charged ions with atoms and molecules. II. Atomic
hydrogen

Geddes,J. Hill,J. Gilbody,H.B.

J.Phys.B 14 4837 (1981)

Formation of excited hydrogen atoms in electron detachment
collisions by 3 - 25 keV H^- ions

Geddes,J. Hill,J. Shah,M.B. Goffe,T.V. Gilbody,H.B.

J.Phys.B 13 319 (1980)

Electron loss by 1-300 keV H^- ions in H and H_2

Gilbody,H.B. Dunn,K.F. Browning,R. Latimer,C.J.

J.Phys.B 3 1105 (1970)

Electron loss from fast metastable and ground state helium
atoms in passage through gaseous targets

Gilbody,H.B. Dunn,K.F. Browning,R. Latimer,C.J.

J.Phys.B 4 800 (1971)

Formation of metastable helium atoms by electron capture
during the passage of fast He^+ ions through gases

Gilbody,H.B. Ireland,J.V.

Proc.Roy.Soc.A 227 137 (1963)

Ionization of atomic hydrogen by protons in the energy
range 60 to 400 keV

Gilbody,H.B. Ryding,G.

Proc.Roy.Soc.A 291 438 (1966)

An experimental study of charge transfer in proton-atomic

hydrogen collisions at impact energies above 40 keV

Goffe,T.V. Shah,M.B. Gilbody,H.B.

J.Phys.B 12 3763 (1979)

One electron capture and loss by fast multiply charged
boron and carbon ions in H and H_2

Gordeev,Yu.S. Panov,M.N.

Sov.Phys.-Tech.Phys. 9 656 (1964)

Ionization and capture of electrons during collisions of
hydrogen ions with atoms and molecules of a gas

de-Heer,F.J. Huizenga,W. Kistemaker,J.

Physica 23 181 (1957)

Some experiments on electron capture, electron loss and
ionization

de-Heer,F.J. Schutten,J. Moustafa,H.

Physica 32 1766 (1966)

Ionization and electron capture cross sections for protons
incident on noble and diatomic gases between 10 and 140 keV

de-Heer,F.J. Schutten,J. Moustafa,H.

Physica 32 1973 (1966)

Ionization and electron capture for helium ions incident on
noble and diatomic gases between 10 and 150 keV

Hill,J. Geddes,J. Gilbody,H.B.

J.Phys.B 12 L341 (1979)

Improved measurements of cross sections for H(2s) formation
in electron capture by 1.5-25 keV protons in H and H_2

Hill,J. Geddes,J. Gilbody,H.B.

J.Phys.B 12 2875 (1979)

1s-2s excitation of fast hydrogen atoms in collisions with
atomic and molecular hydrogen

Hoffman,J.M. Miller,G.H. Lockwood,G.L.

Phys.Rev.A 25 1930 (1982)

Charge transfer of ground state C^+, N^+, and O^+ in
N_2 and H_2

Hollricher,O.

Z.Physik 187 41 (1965)

Umladung und Ionisation beim Durchgang von leichten und
schweren Wasserstoffionen durch leichten und schweren
Wasserstoff

Hopkins,F. Little,A. Cue,N.

Phys.Rev.A 14 1634 (1976)

Innershell Coulomb excitation in the collisions of few
electron F with H_2 and He

Houver,J.C. Fayeton,J. Barat,M.

J.Phys.B 7 1358 (1974)

Elastic and inelastic differential measurements for H^+ on
H collisions in the 250 eV - 2000 eV energy range

241

REFERENCES FOR TABLES continued

Houver,J.Ch. Fayeton,J. Abignoli,M. Barat,M.

Phys.Rev.Letters 28 1433 (1972)

Measurement of the differential cross section for H(n=2)

direct excitation in H^+-on-H collisions

Huber,B.A.

Z.Phys.A 299 307 (1981)

Electron capture by slow multiply charge Ar and Ne ions

from atomic hydrogen

Huber,B.A. Bumbel,A. Wiessmann,K.

J.Phys.E 16 145 (1983)

A high-density effusive target of atomic hydrogen

Huber,B.A. Kahlert,H.J.

J.Phys.B 13 L159 (1980)

Electron transfer from molecular hydrogen to multiply

charged Ar and Kr ions

Huber,B.A. Kahlert,H.J.

SFB 82-05-104 (1982)

Total cross sections for electron capture by multiply

charged ions in H, H_2 and He

Hummer,D.G. Stebbings,R.F. Fite,W.L.

Phys.Rev. 119 668 (1960)

Charge transfer and electron production in H^- + H

collisions

Hvelplund,P. Andersen,A.

Phys.Scripta 26 370 (1982)

Electron loss by fast He^+, H, He, H^- and He^-

projectiles in collisions with atomic and molecular hydrogen

Hvelplund,P. Andersen,A.

Phys.Scripta 26 375 (1982)

Electron capture by fast H^+, He^+ and He^{++} ions in

collisions with atomic and molecular hydrogen

Hvelplund,P. Haugen,H.K. Knudsen,H. Andersen,L. Damsgaard,H.

Fukusawa,F.

Phys.Scripta 24 40 (1981)

Electron capture into high-lying Rydberg states in

collisions between multiply charged ions and H_2

Hvelplund,P. Pedersen,E.H.

Phys.Rev.A 9 2434 (1974)

Single and double electron loss by fast helium atoms in

gases

Hvelplund,P. Pedersen,E.H.

J.Phys.B 9 491 (1976)

Electron capture by fast He^{2+} ions in gases

Itoh,A. Asari,M. Fukuzawa,F.

J.Phys.Soc.Japan 48 943 (1980)

Charge-changing collisions of 0.7-2.0 MeV helium beams in

various gases. I. electron capture

Jorgenson,T. Kuyatt,Jr.,C.E. Lang,W.W. Lorents,D.C. Sautter,C.A.

Phys.Rev. 140 A1481 (1965)

Measurements on charge-changing collisions involving

negative hydrogen, helium and oxygen ions

Kauppila,W.E. Teubner,P.J.O. Fite,W.L. Girnius,R.J.

Phys.Rev.A 2 1759 (1970)

Polarization of Lyman-alpha radiation produced by direct

excitation of hydrogen atoms by proton impact

Keever,W.C. Lockwood,G.J. Helbig,H.F. Everhart,E.

Phys.Rev. 166 68 (1968)

Measurements of close encounters in H-on-H, H-on-H_2 and

H^--on-H collisions

Kim,H.J. Hvelplund,P. Meyer,F.W. Phaneuf,R.A. Stelson,P.H.

Bottcher,C.

Phys.Rev.Letters 40 1635 (1978)

Observation of oscillations in the charge dependence of

total electron capture cross sections

Kim,H.J. Meyer,F.W.

Phys.Rev.Letters 44 1047 (1980)

Electron loss from highly excited states of H^0 in

collisions with N^{3+}

Kim,H.J. Meyer,F.W.

Phys.Rev.A 26 1310 (1982)

Electron removal from H^0 (n) in fast collisions with

multiply charged ions

Kim,K.J. Phaneuf,R.A. Meyer,F.W. Stelson,P.H.

Phys.Rev.A 17 854 (1978)

Single electron capture by multiply charged Si^{28} ions in

atomic and molecular hydrogen

Knudsen,H. Haugen,H.K. Hvelplund,P.

Phys.Rev.A 24 2287 (1981)

Single electron capture by highly charged ions colliding

with atomic and molecular hydrogen

Koch,P.M. Bayfield,J.E.

Phys.Rev.Letters 34 448 (1975)

Electron loss in low energy H^+ - H (high n) merged beam

collisions

Kondow,T. Girnius,R.J. Chang,Y.P. Fite,W.L.

Phys.Rev.A 10 1167 (1974)

Production of Lyman-alpha radiation in collisions of

protons and hydrogen atoms

Krasner,S.

Phys.Rev. 99 520 (1955)

Electron loss cross sections for helium atoms passing

through gases

REFERENCES FOR TABLES continued

Lichtenberg,W.J. Bethge,K. Schmidt-Bocking,H.

J.Phys.B 13 343 (1980)

Electron-loss cross sections for negative ions at high

energies

Lockwood,G.J.

Phys.Rev.A 9 1916 (1974)

Total cross sections for charge transfer for F^+ in H_2,

N_2, He, Ne and Ar

Lockwood,G.J. Everhart,E.

Phys.Rev. 125 567 (1962)

Resonant electron capture in violent proton-hydrogen atom

collisions

Lockwood,G.J. Miller,G.H. Hoffmann,J.M.

Phys.Rev.A 18 935 (1978)

Charge transfer of C^+, N^+ and O^+ in N_2 and H_2

Martin,P.J. Blankenship,D.M. Kvale,T.J. Redd,E. Peacher,J.L.

Park,J.T.

Phys.Rev.A 23 3357 (1981)

Electron capture at very small scattering angles from

atomic hydrogen by 25-125 keV protons

McClure,G.W.

Phys.Rev. 134 A1226 (1964)

Ionization and dissociation of fast H_2 molecules incident

on H_2 gas

McClure,G.W.

Phys.Rev. 148 47 (1966)

Electron transfer in proton-hydrogen atom collisions; 2-117

keV

McClure,G.W.

Phys.Rev. 166 22 (1968)

Ionization and electron transfer in collisions of two H

atoms; 1.25-117 keV

McCullough,R.W. Lennon,M. Wilkie,F.G. Gilbody,H.B.

J.Phys.B 16 L173 (1983)

State-selective electron capture by N^{2+} ions in atomic

hydrogen using collision spectroscopy

McCullough,R.W. Nutt,W.L. Gilbody,H.B.

J.Phys.B 12 4159 (1979)

One electron capture by slow doubly charged ions in H and

H_2

McCullough,R.W. Shah,M.B. Lennon,M. Gilbody,H.B.

J.Phys.B 15 791 (1982)

Electron loss by fast Li^- ions

Meyer,F.W. Phaneuf,R.A. Kim,H.J. Hvelplund,P. Stelson,P.H.

Phys.Rev.A 19 515 (1979)

Single-electron-capture cross sections for multiply charged

O, Fe, Mo, Ta, W, and Au ions incident on H and H_2 at

intermediate velocities

Moran,T.F. Conrads,H.

J.Chem.Phys. 58 3793 (1973)

Charge neutralization of He^+ ion beams

Moran,T.F. Mathur,B.P.

Phys.Rev.A 21 1051 (1980)

Charge transfer reactions of C^+, N^+ and O^+ ions with

H_2 and N_2

Morgan,T.F. Geddes,J. Gilbody,H.B.

J.Phys.B 6 2118 (1973)

Formation of H (2p) and H (2s) atoms in collisions of 2-26

keV protons with hydrogen atoms

Morgan,T.F. Geddes,J. Gilbody,H.B.

J.Phys.B 7 142 (1974)

Excitation of the 2s and 2p states of hydrogen in fast

collisions between hydrogen atoms

Morgan,T.J. Stone,J. Mayo,R.

Phys.Rev.A 22 1460 (1980)

H (2s) formation in H^+ - H and H-H collisions

Newman,J.H. Cogan,J.D. Ziegler,D.L. Nitz,D.E. Rundel,R.D.

Smith,K.A. Stebbings,R.F.

Phys.Rev.A 25 2976 (1982)

Charge transfer in H^+ - H and H^+ - D collisions within

the energy range 0.1 - 150 eV

Nutt,W.L. McCullough,R.W. Gilbody,H.B.

J.Phys.B 11 L181 (1978)

Electron capture by C^{2+} and Ti^{2+} ions in H and H_2

Nutt,W.L. McCullough,R.W. Brady,K. Shah,M.B. Gilbody,H.B.

J.Phys.B 11 1457 (1978)

Electron capture by He^{2+} ions in collisions with H and

H_2 at impact energies below 10 keV

Nutt,W.L. McCullough,R.W. Gilbody,H.B.

J.Phys.B 12 L157 (1979)

Electron capture by 0.1-13 keV C^+, N^+ and O^+ ions in

H and H_2

Olson,R.E. Salop,A. Phaneuf,P.A. Meyer,F.W.

Phys.Rev.A 16 1867 (1977)

Electron loss by atomic and molecular hydrogen in

collisions with $^3He^{2+}$ and $^4He^+$

Panov,M.N. Basalaev,A.A. Lozhkin,K.O.

Phys.Scripta T 3 124 (1983)

Interaction of fully stripped, hydrogenlike and heliumlike

C, N, O, Ne and Ar ions with H and He atoms and H^2

molecule

REFERENCES FOR TABLES continued

Park,J.T. Aldag,J.E. George,J.M.

Phys.Rev.Letters 34 1253 (1975)

Excitation of atomic hydrogen to the n=2 states by 15-200
keV protons

Park,J.T. Aldag,J.E. George,J.M. Peacher,J.L.

Phys.Rev.A 14 608 (1976)

Cross sections for excitation of atomic hydrogen to the
n=2, 3 and 4 states by 15-200 keV protons

Park,J.T. Aldag,J.E. George,J.M. Peacher,J.L.

Phys.Rev.A 15 508 (1977)

Differential energy-loss cross sections for ionization of
atomic hydrogen by 25-200 keV protons

Park,J.T. Aldag,J.E. Peacher,J.L. George,J.M.

Phys.Rev.Letters 40 1646 (1978)

Angular differential cross sections for excitation of
atomic hydrogen by 25-, 50- and 100 keV protons

Park,J.T. Aldag,J.E. Peacher,J.L. George,J.M.

Phys.Rev.A 21 751 (1980)

Angular differential cross sections for excitation of
atomic hydrogen to the n=2 level by proton impact

Pedersen,E.H. Heinemeier,J.

J.Phys.B 7 132 (1974)

Single-electron loss by fast (0.02-4 MeV) helium atoms in
H_2 and He gases

Pedersen,E.H. Heinemeier,J. Larsen,L. Mikkelsen,J.V.

J.Phys.B 13 1167 (1980)

Electron-loss cross sections for fast, metastable and
ground-state helium atoms in gases and metal vapours

Phaneuf,R.A.

IEEE NS-28 1182 (1981)

Production of high-Q ions by laser bombardment method

Phaneuf,R.A.

Phys.Rev.A 24 1138 (1981)

Electron capture in very slow C^{q+} + H collisions

Phaneuf,R.A.

Phys.Rev.A 28 1310 (1983)

Electron capture by slow Fe^{q+} ions from hydrogen atoms
and molecules

Phaneuf,R.A. Alvarez,I. Meyer,F.W. Crandall,D.H.

Phys.Rev.A 26 1892 (1982)

Electron capture in low-energy collisions of C^{q+} and
O^{q+} with H and H_2

Phaneuf,R.A. Meyer,F.W. McKnight,R.H. Olson,R.E. Salop,A.

J.Phys.B 10 L425 (1977)

Electron capture and impact ionization cross sections of
N^{q+} in atomic hydrogen

Phaneuf,R.A. Meyer,F.W. McKnight,R.H.

Phys.Rev.A 17 534 (1978)

Single electron capture by multiply charged ions of carbon,
nitrogen and oxygen in atomic and molecular hydrogen

Pillipenko,D.V. Fogel',Ia.M.

Sov.Phys.-JETP 15 646 (1962)

Electron capture and loss by fast hydrogen atoms passing
through molecular gases

Pivovar,L.I. Levchenko,Y.Z. Krivonosov,G.A.

Sov.Phys.-JETP 32 11 (1971)

Ionizing collisions and charge exchange for Li^+, Li^{2+}
and Li^{3+} ions in gases (0.2-2 MeV)

Pivovar,L.I. Tubaev,V.M. Novikov,M.T.

Sov.Phys.-JETP 14 20 (1962)

Electron loss and capture by 200-1500 keV helium ions in
various gases

Pivovar,L.I. Tubaev,V.M. Novikov,M.T.

Sov.Phys.-JETP 15 1035 (1962)

Electron capture by helium ions in various gases in the
300-1500 keV ebergy range

Puckett,L.J. Taylor,G.O. Martin,D.W.

Phys.Rev. 178 271 (1969)

Cross sections for ions and electron production in gases by
0.15-1.00-MeV hydrogen and helium ions and atoms

Ribe,F.L.

Phys.Rev. 83 1217 (1951)

Electron-capture cross sections for protons passing through
hydrogen gas

Roussel,F. Pradel,P. Spiess,G.

Phys.Rev.A 16 1854 (1977)

Electron capture, electron loss, and deexcitation of fast
$H(2^2S)$ and $H(1^2S)$ atoms in collisions with molecular
hydrogen and inert gases

Ryding,G. Betz,H.D. Wittkower,A.

Phys.Rev.Lett. 24 123 (1970)

Influence on ionic excitation in heavy-ion charge-changing
cross sections

Ryding,G. Wittkower,A.B. Gilbody,H.B.

Proc.Phys.Soc. 89 547 (1966)

A study of Lyman-alpha emission in charge transfer
collisions involving 40-200 keV protons

Schlachter,A.S.

IEEE NS-28 1039 (1981)

Collisions of highly stripped ions at MeV energies in gas
targets; charge transfer and ionization

REFERENCES FOR TABLES continued

Schlachter,A.S. Berkner,K.H. Graham,W.G. Pyle,R.V. Stearn,J.W.
Tanis,J.A.
Phys.Rev.A 24 1110 (1981)
Collisions of fast, highly stripped carbon, niobium and
lead ions with molecular hydrogen

Schrey,H. Huber,B.A.
J.Phys.B 14 3197 (1981)
Electron capture by slow multiply charged Mg, Al, Cs, Pb
and Bi ions from He, Ne, Kr and H_2

Schryber,U.
Helv.Phys.Acta.A 40 1023 (1967)
Elektroneneinfäng schneller Protonen in Gasen

Schwirzke,F.
Z.Physik 157 510 (1960)
Ionisierungs-und Umladequerschnitte von Wasserstoff-Atomen
und Ionen von 9 bis 60 keV in Wasserstoff

Seim,W. Muller,A. Salzborn,E.
Phys.Letters 80A 20 (1980)
Electron capture from atomic hydrogen by slow fully
stripped lithium ions

Seim,W. Muller,A. Wirkner-Bott,I. Salzborn,E.
J.Phys.B 14 3475 (1981)
Electron capture by Li^{i+} (i=2,3), N^{i+} and Ne^{i+}
(i=2,3,4,5) ions from atomic hydrogen

Shah,M.B. Gilbody,H.B.
J.Phys.B 7 630 (1974)
Charge transfer in He^{2+} - H collisions in the energy
range 6-60 keV

Shah,M.B. Gilbody,H.B.
J.Phys.B 7 256 (1974)
Formation of $He^+(2s)$ metastable ions in passage of 10-60
keV $^3He^{2+}$ ions through gases

Shah,M.B. Gilbody,H.B.
J.Phys.B 8 372 (1975)
Electron loss and collisional destruction of fast $He^+(2S)$
ions and application to a polarized ^3He ion source

Shah,M.B. Gilbody,H.B.
J.Phys.B 11 121 (1978)
Electron capture and He^+ (2s) formation in fast He^{2+} -H
and He^+ -H collisions

Shah,M.B. Gilbody,H.B.
J.Phys.B 14 2361 (1981)
Experimental study of the ionization of atomic hydrogen by
fast H^+ and He^{2+} ions

Shah,M.B. Gilbody,H.B.
J.Phys.B 14 2831 (1981)

Experimental study of the ionization of atomic hydrogen by
fast multiply charged ions of carbon, nitrogen and oxgen

Shah,M.B. Goffe,T.V. Gilbody,H.B.
J.Phys.B 10 L723 (1977)
Slectron loss by 35-1000 keV He^+ ions in collisions with
atomic and molecular hydrogen

Shah,M.B. Goffe,T.V. Gilbody,H.B.
J.Phys.B 11 L233 (1978)
Electron capture and loss by fast lithium ions in H and H_2

Sluyters,Th.J.M. de-Haas,E. Kistemaker,J.
Physica 25 1376 (1959)
Charge exchange, ionization and electron loss cross
sections in the energy range 5 to 24 keV

Smith,K.A. Duncan,M.D. Geis,M.W. Rundel,R.D.
J.Geophys.Res. 81 2231 (1976)
Measurement of electron loss cross sections for 0.25- to
5-keV hydrogen atoms in atmospheric gases

Stebbings,R.F. Fite,W.L. Hummer,D.G.
J.Chem.Phys. 33 1226 (1960)
Charge transfer between atomic hydrogen and N^+ and O^+

Stebbings,R.F. Young,R.A. Oxley,C.L. Everhardt,H.
Phys.Rev. 138 A1312 (1965)
Lyman-alpha production in H^+ - H (1s) collisions

Stedeford,J.B.H. Hasted,J.B.
Proc.Roy.Soc.(London) A227 466 (1955)
Further investigations of charge exchange and electron
detachment

Stier,P.M. Barnett,C.F.
Phys.Rev. 103 896 (1956)
Charge exchange cross sections of hydrogen ions in gases

Takagi,S. Ohtani,S. Kadota,K. Fujita,J.
Nucl.Instr.Meth. 213 539 (1983)
Collision experiment on highly ionized ions using vacuum
spark source

Takagi,S. Ohtani,S. Kadota,K. Fujita,J.
J.Phys.Soc.Japan 52 3759 (1983)
Cross sections for one-electron capture by highly stripped
ions of Be, B and C from H_2 and Ar below 10 keV

Toburen,L.H. Nakai,Y. Langley,R.A.
Phys.Rev. 171 114 (1968)
Measurement of high-energy charge-transfer cross sections
for incident protons and atomic hydrogen in various gases

Tonuma,T. Kohno,Y. Miyazawa,I. Yoshida,P. Karasawa,T.
Takahashi,T. Konno,S.
J.Phys.Soc.Japan 34 148 (1973)
Charge changing of energetic heavy ions in gases

REFERENCES FOR TABLES continued

Van-Zyl,B. Le-T,Q. Amme,R.C.

    Phys.Rev. 74 314 (1981)

    Charge-particle production in low-energy H + H_2 and H +
    He collisions and differential scattering calculations

Welsh,T.M. Berkner,K.H. Kaplan,S.N. Pyle,R.B.

    Phys.Rev. 158 85 (1967)

    Cross sections for electron capture by fast protons in
    H_2, He, N_2, and Ar

Williams,J.F.

    Phys.Rev. 153 116 (1967)

    Single-electron capture and loss cross sections for
    2-50-keV hydrogen atoms incident upon hydrogen and the
    inert gases

Williams,J.F. Dunbar,D.N.F.

    Phys.Rev. 149 62 (1966)

    Charge exchange and dissociation cross sections for H^{1+},
    H^{2+}, and H^{3+} ions of 2- to 50-keV energy incident upon
    hydrogen and the inert gases

Winter,H. Bloemen,E. de-Heer,F.J.

    Phys.Rev.B 10 L453 (1977)

    Electron capture into excited projectile states in
    collisions of 100 keV Ne^{2+} (z=1,2,3,4) with He, H_2, and
    Ar

Wirkner-Bott,I. Beim,W. Muller,A. Kester,P. Salzborn,E.

    J.Phys.B 14 3987 (1981)

    Electron capture by Li^{3+} and Li^{2+} ions in H_2 and He

Wittkower,A.B. Betz,H.D.

    J.Phys.B 4 1173 (1971)

    Charge changing cross-sections for heavy ions in complex
    molecules; the failure of an additive rule

Wittkower,A.B. Gilbody,H.B.

    Proc.Phys.Soc. 90 353 (1967)

    A study of the charge neutralization of fast He^+, Ar^+
    and Kr^+ ions during passage through gaseous targets

Wittkower,A.B. Levy,G. Gilbody,H.B.

    Proc.Phys.Soc. 90 581 (1967)

    Metastable atoms in fast helium beams

Wittkower,A.B. Levy,G. Gilbody,H.B.

    Proc.Phys.Soc. 91 306 (1967)

    An experimental study of electron loss during the passage
    of fast hydrogen atoms through atomic hydrogen

Wittkower,A.B. Levy,G. Gilbody,H.B.

    Proc.Phys.Soc. 91 862 (1967)

    Charge-changing collisions involving fast helium beams-the
    effect of a metastable atom component

Wittkower,A.B. Ryding,G. Gilbody,H.B.

    Proc.Phys.Soc. 89 541 (1966)

    An experimental study of charge transfer in proton-atomic
    hydrogen collisions using a furnace target method

Young,R.A. Stebbings,R.F. McGowan,J.W.

    Phys.Rev. 171 85 (1968)

    Lyman-alpha production and polarization in He^+ collisions
    with H and H_2

BIBLIOGRAPHY ON IONIZATION AND CHARGE TRANSFER PROCESSES IN ION-ION COLLISION

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Abstract

A bibliographic compilation is given on the experimental and theoretical investigations on the charge transfer and ionization processes in ion-ion collisions.

I. REVIEW ARTICLES

R.H. Neynaber
Advances in Atomic and Molecular Physics (Academic Press, 1960)
p. 57-108 (vol. 8)
Experiments with merging beams

M.F.A. Harrison
Methods of Experimental Physics (Academic Press, 1968) 7a, p. 95-115
Electron impact ionization and excitation of positive ions.

K.T. Dolder
Case Studies in Atomic Collision Physics 1, p.249-334 (North-Holland Publishing Co., 1969)
Experiments with colliding charged-particle beams.

J.T. Moseley, R.E. Olson, and J.R. Peterson
Case Studies in Atomic Physics (North-Holland Publishing Co., 1975) p. 1-45
Ion-ion mutual neutralization.

K.T. Dolder and B. Peart
Reports on Progress in Physics 39, p. 693-749 (1976)
Collisions between electrons and ions.

K.T. Dolder
Electronic and Atomic Collisions (Proc. XI-ICPEAC, North-Holland Publishing Co., 1980) p. 281-294
Collisions between charged particles.

K.T. Dolder
Atomic and Molecular Processes in Controlled Thermonuclear Fusion (ed. by M.R.C. McDowell and A.M. Ferendeci, Plenum Press, 1980) p. 348
Some experimental aspects of inelastic electron-atom collisions and collisions between charged particles.

H.B. Gilbody
Physics of Electronic and Atomic Collisions (North-Holland Publishing Co., 1982) p. 223
Collisions between positive ions

K.T. Dolder
Comments on Atomic and Molecular Physics 11, 211 (1982).
Ion-ion collisions

F. Brouillard (ed.)
Physics of Ion-Ion and Electron-Ion Collisions (Plenum Press, 1983)

II. EXPERIMENTAL WORKS

T. Sinda, C. Manus, and J. Guidi
Comptes Rendus 264, 755 (1967)
Etude des interactions inélastiques entre deux faisceaux d'ions.

$H_2^+ + N_2 \to H^+, H_2^0 + H^0$,
E=50 - 250 keV

R.D. Rundel, K.L. Aitken, and M.F.A. Harrison
J. Phys. B 2, 954 (1969)
A measurement of the cross section for charge exchange in $H^+ - H^-$ collisions.

$H^+ + H^- \to H + H$
E=0.25 - 10 keV(rel.)

T.D. Gaily and M.F.A. Harrison
J. Phys. B 3, L25 (1970)
A remeasurement of the cross section for charge exchange in $H^+ - H^-$ collisions.

$H^+ + H^- \to H + H$
E=0.6 - 4.0 keV (rel.)

T.D. Gaily and M.F.A. Harrison
J. Phys. B 3, 1098(1970)
A measurement of the charge exchange cross section in $He^+ - H^-$ collisions.

$He^+ + H^- \to He + H$
E=0.2 - 8.0 keV (rel)

R.E. Olson, J.R. Peterson, and J. Moseley
J. Chem. Phys. 53, 3391 (1970)
Ion-ion recombination total cross sections-atomic species.

$O^+ + O^- \to O + O : He^+ + D^- \to He + D$
$H^+ + H^- \to H + H$;
$N^+ + O^- \to N + O : He^+ + H^- \to He + H$
E=0.1 - 10,000 eV (rel.)

J. Moseley, W. Aberth, and J.R. Peterson
Phys. Rev. Letters 24, 435 (1970)
$H^- - H^-$ mutual neutralization cross section obtained with superimposed beams.

$H^+ + H^- \rightarrow H + H$
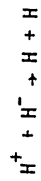
E = 0.15 - 300 eV (rel.)

W.H. Aberth and J.R. Peterson
Phys. Rev. A1, 158 (1970)
Ion-ion mutual neutralization cross sections measured by a superimposed beam technique.
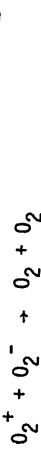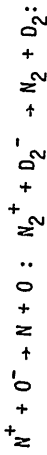
J.R. Peterson, W.H. Aberth, and J.T. Moseley
Phys. Rev. A3, 1651 (1971)
Ion-ion mutual neutralization cross sections measured by a superimposed beam technique. II.
$O_2^+ - O_2^-$, O_2^- - NO_2^- and $NO^+ - NO_2^-$.

$N^+ + O^- \rightarrow N + O$: $N_2^+ + D_2^- \rightarrow N_2 + D_2$;

$O_2^+ + O_2^- \rightarrow O_2 + O_2$

E=0.1 - 98 eV (rel.)

$O_2^+ + O_2^- \rightarrow O_2 + O_2$: $O_2^+ + NO_2^- \rightarrow O_2 + NO_2$

$NO^+ + NO_2^- \rightarrow NO + NO_2$
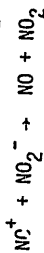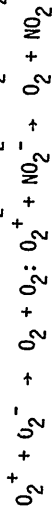
E=0.15 - 200 eV (rel.)

J. Weiner, M.B. Peatman, and R.S. Berry
Phys. Rev. A4, 1824 (1971)
Charge transfer in Na⁺ - O⁻ collisions at low relative energy

$Na^+ + O^- \rightarrow Na$ (3d → 3p; 3p → 3s; 4p → 3s)
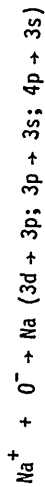
E=0.1 - 7 eV (rel.)

B. Peart, R. Grey, and K.T. Dolder
J. Phys. B 9, L369 (1976)
Measurements of cross sections for the mutual neutralization of H⁺ and H⁻ ions.

$H^+ + H^- \rightarrow H + H$
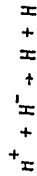
E = 20 - 3000 eV (rel.)

B. Peart, R. Grey, and K.T. Dolder
J.Phys. B 9, L373(1976)
Measurements of cross sections for the mutual neutralization of He⁺ and H⁻ ions.

$He^+ + H^- \rightarrow He + H$
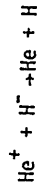
E = 35 - 4550 eV (rel.)

B. Peart, R. Grey, and K.T. Dolder
J.Phys. B, 9, 3047 (1976)
Measurements of cross sections for electron detachment from H⁻ ions by proton impact.

$H^+ + H^- \rightarrow H^+ + H + e$
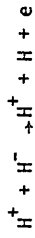
E = 1.49 - 35.2 keV (rel.)

J.B.A. Mitchell, K.F. Dunn, G.C. Angel, R. Browning, and H.B. Gilbody
J.Phys. B 10, 1897 (1977)
Ionization and charge transfer in fast H⁺ - He⁺ collisions using an interesting beam technique.

$H^+ + He^+ \rightarrow H + He^{2+}$ (coincidence); $H^+ + He^{2+} + e$
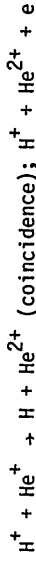
E = 72 - 402 keV (c.m.)

B. Peart, R. Grey, and K.T. Dolder
J.Phys. B 10, 2675 (1977)
Measurements of cross sections for the formation of He²⁺ ions by collisions between protons and He.

$H^+ + He^+ \rightarrow H + He^{2+}$
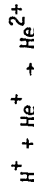
E = 2.98 - 28.5 keV (rel.)

B. Peart, D.M. Gee, and K.T. Dolder
J.Phys. B 10, 2683 (1977)
Measurements of cross sections for the formation of Mg²⁺ ions by collisions between protons and Mg.

$H^+ + Mg^+ \rightarrow Mg^{2+}$
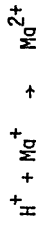
E = 0.98 - 44.5 keV (rel.)

G.C. Angel, k.F. Dunn, E.C. Sewell, and H.B. Gilbody
J.Phys. B 11, L49 (1978)
Ionization and charge transfer in fast H⁺ - He⁺ collisions : further measurements of improved accuracy.

$H^+ + He^+ \rightarrow He^{2+}$

E = 40 - 386 keV (c.m.)

G.C. Angel, E.C. Sewell, K.F. Dunn, and H.B. Gilbody
J.Phys. B 11, L297 (1978)
Charge transfer and ionization in fast H⁺ - He⁺ collision: further measurements using coincidence technique.

$H^+ + He^+ \rightarrow H + He^{2+}$; $H^+ + He^{2+} + e$
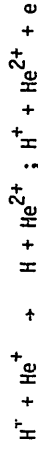
E = 60 - 182 keV (c.m.)

A. Jognaux, F. Brouillard, and S. Szucs
J.Phys. B 11, L669 (1978)
Charge exchange on low energy He^+ - He^{2+} collisions.

$$^3He^{2+} + {}^4He^+ \rightarrow {}^3He^+ + {}^4He^{2+}$$
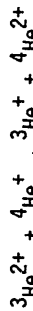
E = 10 - 1700 eV (rel.)

G. Poulaert, F. Brouillard, and W. Claeys
J.Phys. B 11, L671 (1978)
H_2^+ formation in low energy H^+ - H^- collisions.

$$H^+ + H^- \rightarrow H_2^+ + e$$

E = 0.001 - 3 eV (rel.)

B. Peart and R.A. Forrest
J.Phys. B 12, L23 (1979)
Measurements of cross sections for double charge transfer in collisions between H^+ and H^- ions.

$$H^+ + H^- \rightarrow H^- + H^+$$
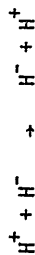
E = 44 - 570 eV (rel.)

K.F. Dunn, G.C. Angel, and H.B. Gilbody
J.Phys. B 12, L623 (1979)
An experimental study of charge transfer and ionization in Cs^+ - Cs collisions.

$$Cs^+ + Cs^+ \rightarrow Cs^{2+}$$

E = 40 - 280 keV (c.m.)

F. Brouillard, W. Claeys, G. Poulaert, G. Rahmat, and G. Van Wassenhove
J.Phys. B 12, 1253 (1979)
Double charge transfer in H^+ - H^- collisions.

$$H^+ + H^- \rightarrow H^- + H^+$$
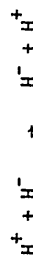
E = 30 - 200 eV (c.m.)

B. Peart, and K.T. Dolder
J.Phys. B 12, 4155 (1979)
Measurements of cross sections for charge exchange between $^4He^+$ and $^3He^{2+}$ ions.

$$^3He^{2+} + {}^4He^+ \rightarrow {}^3He^+ + {}^4He^{2+}$$

E = 0.1 - 20 keV (rel.)

E.C. Sewell, S.C. Angel, K.F. Dunn, and H.B. Gilbody
J.Phys. B 13, 2269 (1980)
Ionization and charge transfer in fast H^+ - Li^+ collisions.

$$H^+ + Li^+ \rightarrow Li^{2+}; \; H + Li^{2+} : \text{ deduce } H^+ + Li^{2+} + e$$

E = 62 - 350 keV (c.m.)

G.C. Angel, K.F. Dunn, P.A. Neil, and H.B. Gilbody
J.Phys. B 13, L391 (1980)
Charge transfer and ionization in Xe^+ - Xe^+ collisions.

$$Xe^+ + Xe^+ \rightarrow Xe^{2+}$$
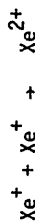
E = 38 - 303 keV (c.m.)

B. Peart, R.A. Forrest, and K. Dolder
J.Phys. B 14, L383 (1981)
Measurements of cross sections for charge transfer between Cs^+ ions.

$$Cs^+ + Cs^+ \rightarrow Cs + Cs^{2+}$$
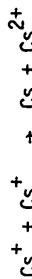
E = 28 - 68 keV (c.m.)

B. Peart, R.A. Forrest, and K. Dolder
J.Phys. B 14, L603 (1981)
Measurements of inelastic collisions between homonuclear ions: Na^+, K^+ and Rb^+.

$$Na^+ + Na^+ \rightarrow Na^{2+}$$
$$K^+ + K^+ \rightarrow K^{2+}$$
$$Rb^+ + Rb^+ \rightarrow Rb^{2+}$$
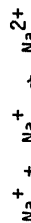
E = 19.3 - 87.6 keV (c.m.)

B. Peart, R.A. Forrest, and K. Dolder
J.Phys. B 14, 1655 (1981)
Measurements of inelastic collisions between Cs^+ ions.

$$Cs^+ + Cs^+ \rightarrow Cs^{2+}$$

E = 19 - 79 keV (c.m.)

B. Peart, R.A. Forrest, and K. Dolder

J.Phys. B 14, 3457 (1981)
Measurements of cross sections for the formation of $^7Li^{2+}$ by collisions between $^7Li^+$ ions.

$$^7Li^+ + {}^7Li^+ \rightarrow {}^7Li^{2+}$$
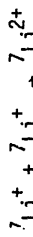
E = 19.3 - 87.6 keV (c.m.)

R.A. Forrest, B. Peart, and K. Dolder
J.Phys. B 15, L45 (1982)
Measurements of inelastic collisions between Tl^+ ions.

$$Tl^+ + Tl^+ \rightarrow Tl^{2+}$$

E = 33 - 92 keV (c.m.)

P.A. Neil, G.C. Angel, K.F. Dunn, and H.B. Gilbody
J.Phys. B 15, 4219 (1982)
Collisions between Cs^+ ions - a further experimental study.

$$Cs^+ + Cs^+ \rightarrow Cs^{2+}$$

E = 42 - 271 keV (c.m.)

B. Peart, K. Rinn and K. Dolder
J.Phys. B 16, 1461 (1983)
Measurements of charge transfer and $^4He^{2+}$ production in collisions between protons and $^4He^+$ ions.

$$H^+ + He^+ \rightarrow H + He^{2+} : He^{2+}$$
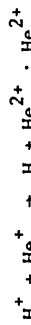
E = 14 - 67 keV (c.m.)

III. THEORETICAL WORKS

(see the explanation of the abbreviations for the models given in the last part of this section)

D.R. Bates and J.T. Lewis
Proc. Phys. Soc. A 68, 173 (1955)
Inelastic heavy particle collisions involving potential energy curves III. charge transfer from negative ions of atomic hydrogen to proton.

$$H^+ + H^-(1s^2) \rightarrow H(2s, 2p, 3s, 3p,3d) + H(1s)$$
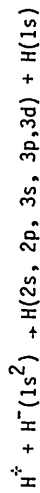
E = 10^{-1} - 10^4 eV

(LZ)

D.R. Bates and A.H. Boyd
Proc. Phys. Soc. 79, 710 (1962)
Effect of Coulomb repulsion between charged atomic systems on excitation and ionization cross sections.

$$He^{2+} + He^+ \rightarrow He^{2+} + He^+ \; (2s; 2p ; 2p_+)$$
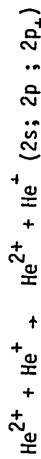
(FB)

D.R. Bates and A.H. Boyd
Proc. Phys. Soc. 80, 1301 (1962)
Effect on symmetrical resonance charge transfer cross sections of change in relative motion during encounter.

$$He^{2+} + He^+ \rightarrow He^+ + He^{2+}$$

E = 10 eV - 10^4 eV (rel.)

(FB)

R.E. Olson
J. Chem. Phys. 56, 2979 (1972)
Absorbing-sphere model for calculating ion-ion recombination total cross sections.

$$H^+ + H^- \rightarrow H + H: He^+ + D^- \rightarrow He + D:$$
$$H_2^+ + D^- \rightarrow H_2 + D: Na^+ + O^- \rightarrow Na + O: O^+ + O^- \rightarrow O + O:$$
$$N^+ + O^- \rightarrow N + O: O_2^+ + O^- \rightarrow O_2 + O:$$
$$N_2^+ + O^- \rightarrow N_2 + O: NO^+ + O^- \rightarrow NO + O$$
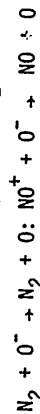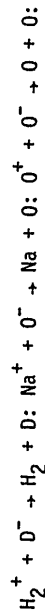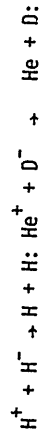
E = 10^{-2} - 10^2 eV, rate coefficient

V.P. Zhdanov and M.I. Chibisov
Fiz. Plasmy 3, 712 (1977): Sov.J.-Plasma Phys. 3, 406 (1977)
Charge exchange between protons and singly ionized metal atoms.

$$H^+ + A^+ \to H(1s) + A^{2+} \quad (A=Mg, Fe, Zn, Mo, Cd, W)$$

E=1 - 10^4 eV

(LZ)

R.E. Olson
J.Phys. B 11, L227(1978)
Ionization and charge transfer cross sections for H^+, $He^{2+} + He^+$:

$$H^+ + He^+ \to H^+ + He^{2+} + e; \; H + He^{2+}:$$

$$He^{2+} + He^+ \to He^{2+} + He^{2+} + e; \; He^+ + He^{2+}$$
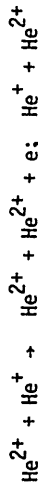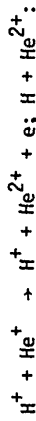
E=100 - 500 keV/amu

(CTMC)

D.S.F. Crother and N.R. Todd
J. Phys. B 11, L663(1978)
Response to Nikitin and Reznikov: Total cross sections for proton-Be charge transfer.

$$H^+ + Be^+ \to H + Be^{2+}$$
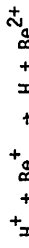
$E=10^2 - 10^7$ eV

(IP)

J.C. Moore and K.E. Banyard
J. Phys. B 11, 1613 (1978)
Continuum-distorted-wave calculation for electron capture from hydrogen negative ions by fast protons.

$$H^+ + H^- \to H(1s, 2s, 2p) + H(1s, 2s)$$
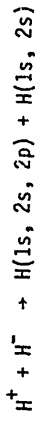
E=5 - 2000 keV

(CDW)

K.E. Banyard and J.C. Moore
Electron capture from H^- by fast alpha particles.
J. Phys. B 11, 3899 (1978)

$$He^{2+} + H^- \to He^+(1s, 2s, 2p) + H(1s, 2s)$$

E=500 - 8000 keV

(CDW)

(ASM-LZ)

R. Gayet, R.K. Janev, and A. Salin
J.Phys. B 6, 993 (1973)
Electron detachment from negative ions by charged particle collisions I. proton impact.

$$H^+ + H^- \to H + H$$

E = 1.56 - 400 keV

(CB)

K. Roy and S.C. Mukherjee
Phys. Rev. A 7, 130 (1973)
Charge transfer in $H^+ - H^-$ collisions.

$$H^+ + H^- \to H(2s, 2p, 2p_{+1})$$

E = 0.5 - 8 keV

(AE)

K. Fujiwara
J.Phys. Soc. Japan 41, 1350 (1976)
Coulomb-Born calculation of charge transfer cross sections of highly-ionized atoms.
Erratum; J. Phys. Soc. Japan 45, 1053 (1978)

$$H^+ + C^{1+} - 5+; \; O^{1+} - 7+; \; Fe^{7+}; \; Fe^{15+}; \; Fe^{23+}; \; Mo^{13+} \to H^0$$

E = 1 keV - 100 MeV

(CB)

V.P. Zhdanov
Sov. J.-Tech. Phys. 21, 117 (1976)
Resonance charge exchange in ion-ion collisions

$$He^{2+} + He^+ \to He^+ + He^{2+} : \; Li^{3+} + Li^{2+} \to Li^{2+} + Li^{3+} :$$
$$Be^{4+} + Be^{3+} \to Be^{3+} + Be^{4+} : \; B^{5+} + B^{4+} \to B^{4+} + B^{5+} :$$
$$C^{6+} + C^{5+} \to C^{5+} + C^{6+} : \; N^{7+} + N^{6+} \to N^{6+} + N^{7+}$$

E=0.01 - 10^4 eV

(IP)

K.L. Bell, A.E. Kingston, and P.J. Madden
J. Phys. B $\underline{11}$, 3977 (1978)
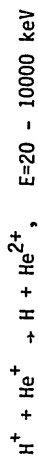Electron detachment from H^- ions by proton impact.

$$H^+ + H^- \rightarrow H^+ + H(1s) + e$$
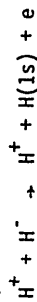
E=1.5 - 1000 keV

(FB)

M. Lal, A.N. Tripathi, and M.K. Srivastava
J. Phys. B $\underline{11}$, 4249 (1978)
Charge transfer cross sections for protons colliding with hydrogenic ions I.

$H^+ + He^+ \rightarrow H + He^{2+}$,   E=20 - 10000 keV

$H^+ + Li^{2+} \rightarrow H + Li^{3+}$,   E=50 - 10000 keV

$H^+ + Be^{3+} \rightarrow H + Be^{4+}$,   E=100 - 10000 keV

$H^+ + B^{4+} \rightarrow H + B^{5+}$,   E=200 - 10000 keV

$H^+ + C^{5+} \rightarrow H + C^{6+}$,   E=200 - 10000 keV

$H^+ + N^{6+} \rightarrow H + N^{7+}$,   E=200 - 10000 keV

$H^+ + O^{7+} \rightarrow H + O^{8+}$,   E=200 - 10000 keV

$H^+ + Fe^{25+} \rightarrow H + Fe^{26+}$,   E=1000 - 100000 keV
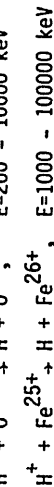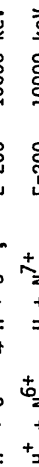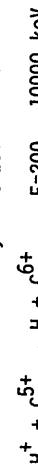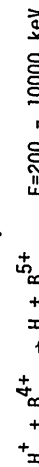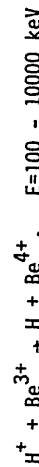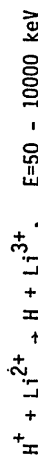
(CPB)

B.K. Janev and Z.M. Radulovic
Phys. Rev. A $\underline{17}$, 889 (1978)
Ion-ion recombination and ion-pair formation processes in alkali-hydrogen diatomic systems.

$Na^+ + H^- \rightarrow Na(3s, 3p, 3d, 4s, 4p) + H$, $E=10^{-2} - 5\times10^3$ eV(rel.)

$Cs^+ + H^- \rightarrow Cs(6s, 6p, 7s, 7p) + H$, $E=10^{-2} - 5\times10^3$ eV(rel.)

$M^+ + H^- \rightarrow M + H$ (M=Li, K, Rb), $E=10^{-1} - 10^3$ eV(rel.)
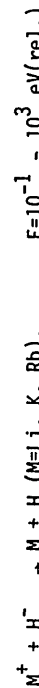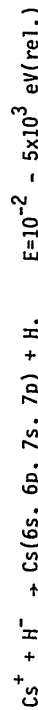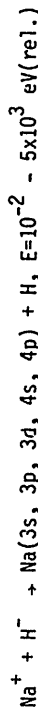
rate coefficient.

(LZ)

S. Mukherjee, K. Bhadra, N.C. Sil, and D. Basu
Phys. Letters $\underline{65A}$, 285 (1978)
Capture in proton-He collisions.

$$H^+ + He^+ \rightarrow H(1s) + He^{2+}$$

E = 40 - 100 keV

(CB)

V.P. Zhdanov and M.I. Chibisov
Sov. Phys. -Tech. Phys. $\underline{23}$, 532 (1978)
Effect of level degeneracy on charge exchange at a term pseudointersection.

$$H^+ + H^- \rightarrow H + H$$

E = 0.01 - 2519 eV

(LZ)

S. Mukherjee, N.C. Sil, and D. Basu
J.Phys. B $\underline{12}$, 1259 (1979)
Electron capture by protons from some hydrogen-like ions.

$$H^+ + He^+, Li^{2+} \rightarrow H(1s,2s) + He^{2+}, Li^{3+}$$
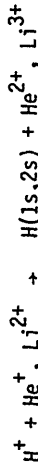
E = 5 - 1000 keV

(CB)

C. Sinha, S. Mukherjee, and N.C Sil
J.Phys. B $\underline{12}$, 1391 (1979)
Electron capture in an arbitrary excited state by protons passing through hydrogenic ions.

$$H^+ + A^{(z-1)+} \rightarrow H(n) + A^{Z+} \quad (A=He, Li, C; n=2 \sim \infty)$$
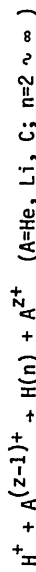
E = 50 - 400 keV

(CB)

K.E. Banyard, and G.W. Shirtcliffe
J.Phys. B $\underline{12}$, 3247 (1979)
Electron capture from lithium and its ions by high-energy protons.

$$H^+ + Li \rightarrow H(n\ell) + Li^{2+}; \; H^+ + Li^{2+} \rightarrow H(n\ell) + Li^{3+}$$
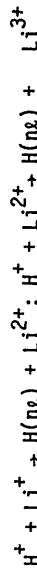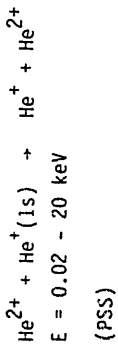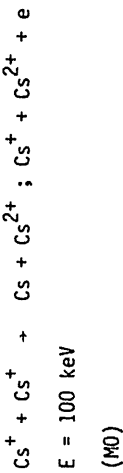
$(n\ell=1s,2s,2p)$

E = 200 - 10000 keV

(CDW)

A.S. Dickinson and D.J.W. Hardie
J.Phys. B $\underline{12}$, 4147 (1979)
Symmetric resonance charge transfer in $He^+(1s)$ - He^{2+} collisions.

$He^{2+} + He^{+}(1s) \rightarrow He^{+} + He^{2+}$

E = 0.02 - 20 keV

(PSS)

R.E. Olson
ANL-79-41 (1979) p.171
Charge changing cross sections for Cs⁺ + Cs⁺ collisions.

$Cs^{+} + Cs^{+} \rightarrow Cs + Cs^{2+}$; $Cs^{+} + Cs^{2+} + e$

E = 100 keV

(MO)

S Sramek, G. Gallup, and J. Macek
ANL-79-41 (1979) p.183
Preliminary estimate of heavy ion electron transfer cross sections.

$Ba^{+} + Ba^{+} \rightarrow Ba + Ba^{2+}$

E = 100 - 300 keV

(CC-MO)
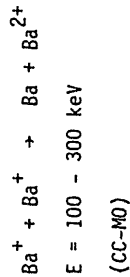
J. Macek
ANL-79-41 (1979) p.191
Charge exchange cross sections for the reaction

$Xe^{8+} + Xe^{8+} \rightarrow Xe^{9+} + Xe^{7+}$.

$Xe^{8+} + Xe^{8+} \rightarrow Xe^{9+} + Xe^{7+}$

E = 150 keV

(MO)
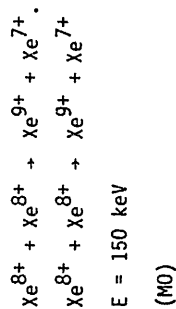
G. Das, R.C. Raffenetti, and Y.K. Kim
ANL-79-41 (1979) p.195
Low-lying state of $(Cs_2)^{++}$.

$Cs^{+} + Cs^{+} \rightarrow Cs + Cs^{2+}$; $Cs^{+} + Cs^{2+} + e$

(MO)
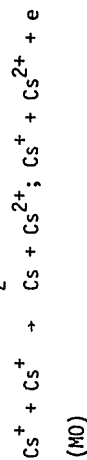
B.H. Choi, R.T. Poe, and T.K. Tang
ANL-79-41 (1979) p.201
Charge exchange between singly ionized helium ions.

$He^{+} + He^{+} \rightarrow He^{2+} + He$

E = 10 - 100 keV

(PWBA)
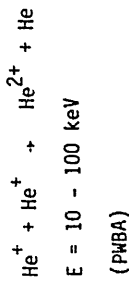
C. Sinha and N.C. Sil
Phys. Letters 71A, 201 (1979)
Charge transfer in proton-positive-ion collisions producing hydrogen atcms in any arbitrary p state.

$H^{+} + He^{+} \rightarrow H + He^{2+}$

E = 50 - 400 keV

(CB)
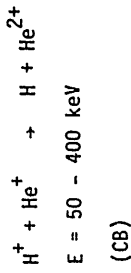
R.E. Olson
Phys. Letters 71A, 341 (1979)
Cross sections for alpha particles colliding with oxygen ions: Loss of alpha heating in Tokamak plasmas.

$He^{2+} + O^{3+} \rightarrow He^{2+} + O^{4+} + e$; $He^{+} + O^{4+}$
$He^{2+} + O^{4+} \rightarrow He^{2+} + O^{5+} + e$; $He^{+} + O^{5+}$
$He^{2+} + O^{5+} \rightarrow He^{2+} + O^{6+} + e$; $He^{+} + O^{6+}$

E = 0.25 - 1.0 MeV/amu

(CTMC)
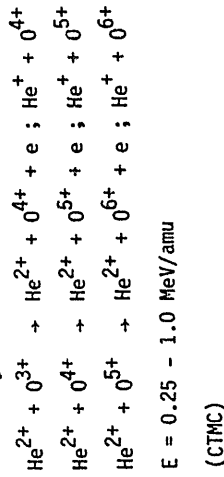
V.A. Bazylev and M.I. Chibisov
Sov. J.-Plasma Phys. 5, 327 (1979)
Charge exchange in collisions of multiply charged ions

$C^{6+} + O^{+} \rightarrow C^{5+} + O^{2+}$: $N^{7+} + C^{+} \rightarrow N^{6+} + C^{+}$
$N^{7+} + C^{2+} \rightarrow N^{6+} + C^{3+}$: $N^{7+} + N^{+} \rightarrow N^{6+} + N^{2+}$
$N^{7+} + O^{2+} \rightarrow N^{6+} + O^{3+}$: $O^{8+} + C^{+} \rightarrow O^{7+} + C^{2+}$
$O^{8+} + N^{3+} \rightarrow O^{7+} + N^{4+}$: $O^{8+} + O^{+} \rightarrow O^{7+} + O^{2+}$
$O^{8+} + O^{3+} \rightarrow O^{7+} + O^{4+}$
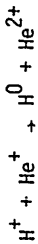
E=1 - 5 keV

(LZ)
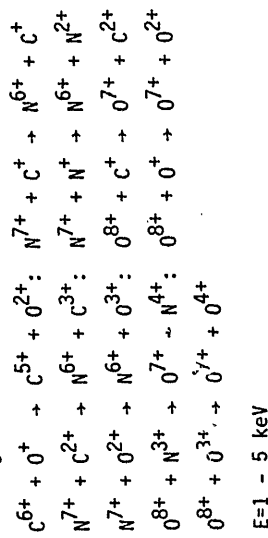
A.P. Hickman
J. Chem. Phys. 70, 4872 (1979)

Approximate scaling formula for ion-ion mutual neutralization rates. chemical reactions, rate constant

(LZ)

Dz. Belkic, G. Gayet, and A. Salin
Phys. Report 56, 279 (1979)
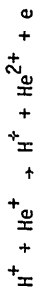Electron capture in high-energy ion-atom collisions

$H^+ + He^+ \rightarrow H^0 + He^{2+}$

E=30 - 450 keV

(CDW)

Dz. Belkic
J. Phys. D 13, L589 (1980)
Charge dependence of ionization cross sections.

$H^+ + He^+ \rightarrow H^+ + He^{2+} + e$

E=40 - 500 keV

(CDW)

S. Mukherjee and N.C. Sil
Ion-ion capture collisions in the continuum-distorted-wave approximation.

$H^+ + He^+ \rightarrow H(1s,2s) + He^{2+}$: $H^+ + Li^{2+} \rightarrow H(1s,2s) + Li^{3+}$

$H^+ + Be^{3+} \rightarrow H(1s,2s) + Be^{4+}$: $H^+ + C^{5+} \rightarrow H(1s,2s) + Be^{4+}$
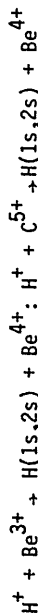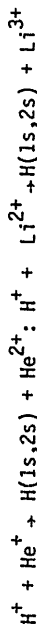
E=0.4 - 2.0 MeV

(CDW)

T.G. Winter, G.J. Hatton, and N.F. Lane
Phys. Rev. A22, 930 (1980)
Molecular-state treatment of collisions between protons and He^+ ions.

$H^+ + He^+ \rightarrow H + He^{2+}$: $H^+ + He^+ \rightarrow H^+ + He^+(2s, 2p_0, 2p_1)$
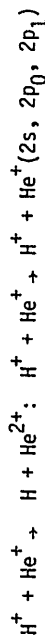
E=1.6 - 14 keV (c.m.)

(MO)

S.J. Sramek, J.H. Macek, and G.A. Gallup
Phys. Rev. A22, 1467 (1980)
Computed cross sections for electron transfer in $Ba^+ + Ba^+$ collisions.
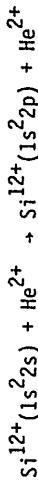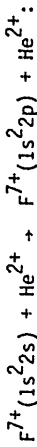
$Ba^+ + Ba^+ \rightarrow Ba + Ba^{++}$
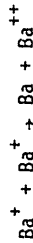
E=25 - 500 keV

(SLCT)

J.H. McGuire and P.R. Simony
Phys. Rev. A22, 2270 (1980)
Calculation of cross sections for 2s-2p excitation of one-electron ions by He^{2+} and He.
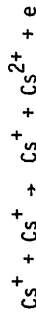
$F^{7+}(1s^22s) + He^{2+} \rightarrow F^{7+}(1s^22p) + He^{2+}$:

$Si^{12+}(1s^22s) + He^{2+} \rightarrow Si^{12+}(1s^22p) + He^{2+}$

E(F)=5 - 45 MeV; E(Si)=5 - 60 MeV

(PWBA)

R.E. Olson and B. Liu
J. Phys. B14, L279 (1981)
Interactions of Cs with Cs^+.

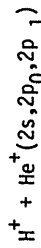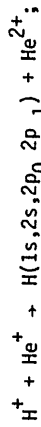$Cs^+ + Cs^+ \rightarrow Cs^+ + Cs^{2+} + e$

Molecular orbital energy level. Cross sections estimated.

(MO)

B.H. Bransden and C.J. Noble
J. Phys. B14, 1849 (1981)
Charge transfer in $H^+ + He$ and $He^{2+} + H$ collisions.

$H^+ + He^+ \rightarrow H(1s,2s,2p_0, 2p_1) + He^{2+}$;
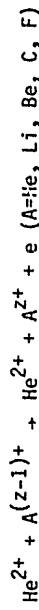
$H^+ + He^+(2s,2p_0,2p_1)$

E=3.725 - 227.5 keV

(TCAE)

J.H. McGuire, N. Stolterfoht, and P.R. Simony
Phys. Rev. A24, 97 (1981)
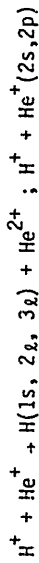Screening and antiscreening by projectile electrons in high velocity atomic collisions.

$He^{2+} + A^{(z-1)+} \rightarrow He^{2+} + A^{z+} + e$ (A=He, Li, Be, C, F)

E=10 - 10^4 keV/amu

(PWBA)

M. Kimura and W.R. Thorson
Phys. Rev. A24, 3019 (1981)
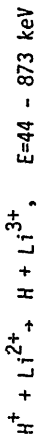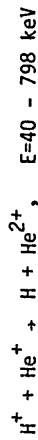
Molecular-state study of He^{2+} - H(1s) and H^+ - He^+(1s) collisions.

$$H^+ + He^+ \rightarrow H(1s, 2\ell, 3\ell) + He^{2+} \; ; \; H^+ + He^+(2s,2p)$$

E=1 - 20 keV

(CC - MO)

C. Sinha and N.C. Sil
Indian J. Pure and Appl. Phys. 20, 26 (1982)
A modified Coulomb-Born approximation and charge transfer in proton-positive ion collisions.

$$H^+ + He^+ \rightarrow H + He^{2+}, \qquad E=40 - 798 \text{ keV}$$
$$H^+ + Li^{2+} \rightarrow H + Li^{3+}, \qquad E=44 - 873 \text{ keV}$$
$$H^+ + C^5 \rightarrow H + C^{6+}, \qquad E=46 - 922 \text{ keV}$$
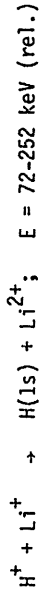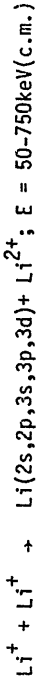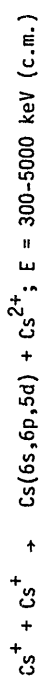$$H^+ + N^{6+} \rightarrow H + N^{7+}, \qquad E=47 - 933 \text{ keV}$$
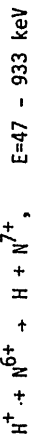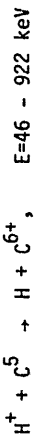
(MCB)

A.M. Ermolaev, J.E. Miraglia, and B.H. Bransden
J. Phys. B15, L677 (1982)
Ionization and charge exchange in collisions between Li^+ ions at intermediate energies.

$$Li^+ + Li^+ \rightarrow Li + Li^{2+} \; ; \; Li^+ + Li^{2+} + e$$
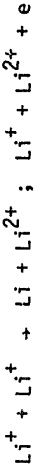
E = 5 - 1000 keV/amu

(FB)

A.M. Ermolaev, C.J. Noble, and B.H. Brandsden
J.Phy. B 15, 457 (1982)
Charge exchange between Cs^+ ions and related studies.

$$Cs^+ + Cs^+ \rightarrow Cs(6s,6p,5d) + Cs^{2+}; \quad E = 300\text{-}5000 \text{ keV (c.m.)}$$
$$Li^+ + Li^+ \rightarrow Li(2s,2p,3s,3p,3d)+ Li^{2+}; \quad E = 50\text{-}750 \text{keV(c.m.)}$$

$$H^+ + Li^+ \rightarrow H(1s) + Li^{2+}; \quad E = 72\text{-}252 \text{ keV (rel.)}$$

(TSAE)

J.F. Reading, A.L. Ford, and R.L. Becker
J.Phys. B 15, 625 (1982)
One-and a-half-centered calculations of ionization and charge transfer in $H^+ + He^+ + H$ collisions.

$$H^+ + He^+ (1s,2s,2p) \rightarrow H^+ + He^{2+} + e \; ; \; H(1s) + He^{2+}$$
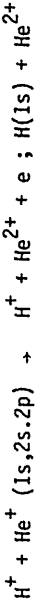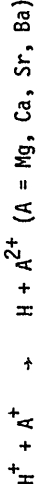
E = 20 - 485 keV

(OHCE, SCE)

W. Frisch and C.D. Lin
J.Phys. B 15, 1255 (1982)
Close coupling calculations for inelastic processes in intermediate energy ion-atom collisions.

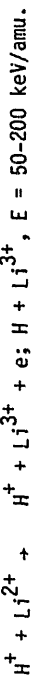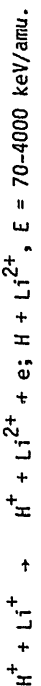$$H^+ + He^+ \rightarrow H + He^{2+}$$

E = 1.5 - 500 keV

(TCAE)

C. Sinha, S. Guha, and N.C. Sil
J.Phys. B 15, 1759 (1982)
Electron capture by protons in collisions with some alkali-like ions using a model potential approach.

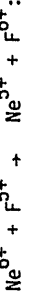$$H^+ + A^+ \rightarrow H + A^{2+} \quad (A = Mg, Ca, Sr, Ba)$$

E = 10 - 1000 keV

(CB)

A.L. Ford, J.F. Reading, and B.L. Becker
J.Phys. B 15, 3257 (1982)
Coupled-channel calculations of ionization and charge transfer in $p + Li^{+,2+}$ and transfer in $Li^{2+,3+}$ + H(1s) collisions.

$$H^+ + Li^+ \rightarrow H^+ + Li^{2+} + e; \; H + Li^{2+}, \quad E = 70\text{-}4000 \text{ keV/amu.}$$
$$H^+ + Li^{2+} \rightarrow H^+ + Li^{3+} + e; \; H + Li^{3+}, \quad E = 50\text{-}200 \text{ keV/amu.}$$

(OHCE,SCE)

R.K. Janev and D.S. Belic
J.Phys. B 15, 3479 (1982)
Quasi-resonant charge exchange collisions between multiply charged ions.

$$C^{2+} + B^+ \rightarrow C^+ + B^{2+} : He^{2+} + O^{2+} \rightarrow He^+(1s) + O^{3+} :$$
$$N^{3+} + C^{2+} \rightarrow N^{2+} + C^{3+}: C^{3+} + B^{2+} \rightarrow C^{2+} (2s2p) + B^{3+} :$$
$$O^{4+} + N^{3+} \rightarrow O^{3+} + N^{4+}: N^{4+} + C^{3+} \rightarrow N^{3+} (2s2p) + C^{4+}:$$
$$F^{5+} + O^{4+} \rightarrow F^{4+} + O^{5+}: O^{5+} + N^{4+} \rightarrow O^{4+} (2s2p) + N^{5+}:$$
$$Ne^{6+} + F^{5+} \rightarrow Ne^{5+} + F^{6+}:$$
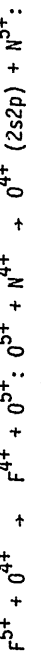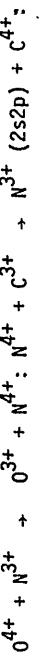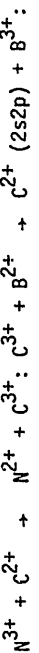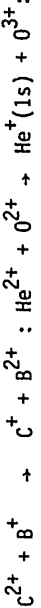
E = 0.1 - 100 keV (c.m.)

(RZD)

J.P. Maikagan, R.D. Piacentini, and R.D. Rivarola
Phys. Letters 88A, 128 (1982)
Differential cross sections for one-electron two center symmetric systems.

$A^{z+} + A^{(z-1)+} \rightarrow A^{(z-1)+} + A^z$ (A=He, Li, C, Ne)

E=25 keV/amu

(TSAE-VC)

R.K. Janev and D.S. Belic
Phys. Letters 89A, 190 (1982)
Double resonant charge exchange in ion-ion collisions.

$A^{z+} + A^{(z-2)+} \rightarrow A^{(z-1)+} + A^z$ (A=Li, Be, B, C, N, O, F, Ne)

E=threshold - 1 MeV

(IP)- scaling

T.G. Winter
Phys. Rev. A25, 697 (1982)
Electron transfer in p-He and He^{2+} - H collisions using Sturmian basis.

$H^+ + He^+ \rightarrow H + He^{2+}$

E= 4 - 120 keV (c.m.)

(CC-S)

J. Macek and S. Alston
Phys. Rev. A 26, 250 (1982)
Theory of electron capture from a hydrogenic ion by a bare ion.
erratum: Phys. Rev. A 27, 1708 (1983)

any ion (scaling)

(SPB)

M. Lal, M.K. Srivastava, and A.N. Tripathi
Phys. Rev. A26, 305 (1982)
Charge-transfer cross sections for particles colliding with hydrogenic ions.

$He^{2+} + A^{(z-1)+} \rightarrow He(1s,2s,2p)^+ + A^{z+}$ (A=He, Li, Be, C, Fe)

E=20 - 500000 keV

(CPB) - scaling

C. Sinha, S. Guha, P.K. Roy, and N.C. Sil
Phys. Rev. A 26, 2586 (1982)
Electron capture by protons passing through helium-like ions.

$H^+ + Li^+ \rightarrow H + Li^{2+}$

E=20 - 1000 keV

$H^+ + A^{(z-2)+} \rightarrow H + A^{(z-1)+}$ (A=Be, B, C, O),

E = 50 - 1000 keV

(CB, MCB)

J.E. Miraglia
J. Phys. B16, 1029 (1983)
Ion-atom single ionization at high and intermediate energies

$H^+ + He^+ \rightarrow H^+ + He^{2+} + e$

E=30 - 300 keV

(MCDW, MSA)

C.A. Falcon
J. Phys. B 16, 1793 (1983)
Charge exchange in low-energy $^3He^+ - {}^4He^{2+}$ collisions

$^3He^+ + {}^4He^{2+} \rightarrow {}^3He^{2+} + {}^4He^+$

E = 20-100 eV (c.m.)

(PSS)

Table 1 Ion-ion combinations investigated experimentally

P\T	H⁻	D⁻	He⁺	Li⁺	O⁻	Na⁺	Mg⁺	K⁺	Rb⁺	Xe⁺	Cs⁺	Tl⁺
H⁺	C,I D,R		C,I C,I	C,I C,I			C+I					
He⁺	C	C										
He²⁺			C									
Li⁺				C+I								
N⁺					C							
O⁺					C							
Na⁺					C	C+I						
K⁺								C+I				
Rb⁺									C+I			
Xe⁺										C+I		
Cs⁺											C+I C,I	
Tl⁺												C+I

Note the following notations (A^{q+}: projectile P; B^{p+} target T) :

C : $A^{q+} + B^{q+} \rightarrow A^{(q-1)+} + B^{(p+1)+}$ (single charge transfer)

D : $\rightarrow A^{(q-2)+} + B^{(p+2)+}$ (double charge transfer)

I : $\rightarrow A^{q+} + B^{(p+1)+} + e$ (ionization)

E : $\rightarrow A^{q+} + B^{p+*}$ (excitation)

R : $\rightarrow (AB)^{r+} + (q + p + r)e$ (recombination)

(C + I) in the table indicates that the sums of the cross sections for the processes (C) and (I) are measured.

Abbreviation for theoretical models used in calculation of the charge transfer and the ionization cross sections in ion-ion collisions

1. AE : atomic expansion method
2. ASM : absorbing-sphere model
3. CB : Coulomb-Born approximation
4. CC- : close-coupling model
    MO : molecular orbitals
    AO : atomic orbitals
    S : Sturmians
5. CDW : continuum distorted-wave approximation
6. CPB : Coulomb-projected Born approximation
7. CTMC : classical trajectory Monte Carlo method
8. FB : first Born approximation
9. IP : impact parameter method
10. LZ : Landau-Zener model
11. MCB : modified Coulomb-Born approximation
12. MCDW : modified continuum distorted-wave approximation
13. MO : molecular orbital model
14. MSA : multiple scattering approximation
15. OHCE : one-and-a-half centered expansion method
16. PSS : perturbed stationary state approximation
17. PWBA : plane-wave Born approximation
18. RZD : Rosen-Zener-Demkov model
19. SCE : single-centered expansion method
20. SLCT : straight line classical trajectory method
21. SPB : strong potential Born approximation
22. TCAE : two-center atomic expansion method
23. TSAE-VC : two-state atomic expansion method with variable charge

LIST OF IPPJ-AM REPORTS

IPPJ-AM-1*   "Cross Sections for Charge Transfer of Hydrogen Beams in Gases and Vapors in the Energy Range 10 eV–10 keV"

H. Tawara (1977) [Published in Atomic Data and Nuclear Data Tables 22, 491 (1978)]

IPPJ-AM-2*   "Ionization and Excitation of Ions by Electron Impact –Review of Empirical Formulae–"

T. Kato (1977)

IPPJ-AM-3   "Grotrian Diagrams of Highly Ionized Iron FeVIII-FeXXVI"

K. Mori, M. Otsuka and T. Kato (1977) [Published in Atomic Data and Nuclear Data Tables 23, 196 (1979)]

IPPJ-AM-4   "Atomic Processes in Hot Plasmas and X-Ray Emission"

T. Kato (1978)

IPPJ-AM-5*   "Charge Transfer between a Proton and a Heavy Metal Atom"

S. Hiraide, Y. Kigoshi and M. Matsuzawa (1978)

IPPJ-AM-6*   "Free-Free Transition in a Plasma –Review of Cross Sections and Spectra–"

T. Kato and H. Narumi (1978)

IPPJ-AM-7*   "Bibliography on Electron Collisions with Atomic Positive Ions: 1940 Through 1977"

K. Takayanagi and T. Iwai (1978)

IPPJ-AM-8   "Semi-Empirical Cross Sections and Rate Coefficients for Excitation and Ionization by Electron Collision and Photoionization of Helium"

T. Fujimoto (1978)

IPPJ-AM-9   "Charge Changing Cross Sections for Heavy-Particle Collisions in the Energy Range from 0.1 eV to 10 MeV I. Incidence of He, Li, Be, B and Their Ions"

Kazuhiko Okuno (1978)

IPPJ-AM-10   "Charge Changing Cross Sections for Heavy-Particle Collisions in the Energy Range from 0.1 eV to 10 MeV II. Incidence of C, N, O and Their Ions"

Kazuhiko Okuno (1978)

IPPJ-AM-11   "Charge Changing Cross Sections for Heavy-Particle Collisions in the Energy Range from 0.1 eV to 10 MeV III. Incidence of F, Ne, Na and Their Ions"

Kazuhiko Okuno (1978)

IPPJ-AM-12*   "Electron Impact Excitation of Positive Ions Calculated in the Coulomb-Born Approximation –A Data List and Comparative Survey–"

S. Nakazaki and T. Hashino (1979)

IPPJ-AM-13   "Atomic Processes in Fusion Plasmas — Proceedings of the Nagoya Seminar on Atomic Processes in Fusion Plasmas Sept. 5-7, 1979"

Ed. by Y. Itikawa and T. Kato (1979)

IPPJ-AM-14   "Energy Dependence of Sputtering Yields of Monatomic Solids"

N. Matsunami, Y. Yamamura, Y. Itikawa, N. Itoh, Y. Kazumata, S. Miyagawa, K. Morita and R. Shimizu (1980)

IPPJ-AM-15   "Cross Sections for Charge Transfer Collisions Involving Hydrogen Atoms"
              Y. Kaneko, T. Arikawa, Y. Itikawa, T. Iwai, T. Kato, M. Matsuzawa, Y. Nakai,
              K. Okubo, H. Ryufuku, H. Tawara and T. Watanabe (1980)

IPPJ-AM-16   "Two-Centre Coulomb Phaseshifts and Radial Functions"
              H. Nakamura and H. Takagi (1980)

IPPJ-AM-17   "Empirical Formulas for Ionization Cross Section of Atomic Ions for Elec-
              tron Collisions –Critical Review with Compilation of Experimental Data–"
              Y. Itikawa and T. Kato (1981)

IPPJ-AM-18   "Data on the Backscattering Coefficients of Light Ions from Solids"
              T. Tabata, R. Ito, Y. Itikawa, N. Itoh and K. Morita (1981) [Publisied in
              Atomic Data and Nuclear Data Tables 28, 493 (1983)]

IPPJ-AM-19   "Recommended Values of Transport Cross Sections for Elastic Collision and
              Total Collision Cross Section for Electrons in Atomic and Molecular Gases"
              M. Hayashi (1981)

IPPJ-AM-20   "Electron Capture and Loss Cross Sections for Collisions between Heavy
              Ions and Hydrogen Molecules"
              Y. Kaneko, Y. Itikawa, T. Iwai, T. Kato, Y. Nakai, K. Okuno and H. Tawara
              (1981)

IPPJ-AM-21   "Surface Data for Fusion Devices – Proceedings of the U.S–Japan Work-
              shop on Surface Data Review Dec. 14-18, 1981"
              Ed. by N. Itoh and E.W. Thomas (1982)

IPPJ-AM-22   "Desorption and Related Phenomena Relevant to Fusion Devices"
              Ed. by A. Koma (1982)

IPPJ-AM-23   "Dielectronic Recombination of Hydrogenic Ions"
              T. Fujimoto, T. Kato and Y. Nakamura (1982)

IPPJ-AM-24   "Bibliography on Electron Collisions with Atomic Positive Ions: 1978
              Through 1982 (Supplement to IPPJ-AM-7)"
              Y. Itikawa (1982) [Published in Atomic Data and Nuclear Data Tables 31,
              215 (1984)]

IPPJ-AM-25   "Bibliography on Ionization and Charge Transfer Processes in Ion-Ion
              Collision"
              H. Tawara (1983)

IPPJ-AM-26   "Angular Dependence of Sputtering Yields of Monatomic Solids"
              Y. Yamamura, Y. Itikawa and N. Itoh (1983)

IPPJ-AM-27   "Recommended Data on Excitation of Carbon and Oxygen Ions by Electron
              Collisions"
              Y. Itikawa, S. Hara, T. Kato, S. Nakazaki, M.S. Pindzola and D.H. Crandall
              (1983) [Published in Atomic Data and Nuclear Data Tables 33, 149 (1985)]

IPPJ-AM-28   "Electron Capture and Loss Cross Sections for Collisions Between Heavy
              Ions and Hydrogen Molecules (Up-dated version of IPPJ-AM-20)
              H. Tawara, T. Kato and Y. Nakai (1983) [Published in Atomic Data and
              Nuclear Data Tables 32, 235 (1985)]

IPPJ-AM-29   "Bibliography on Atomic Processes in Hot Dense Plasmas"
              T. Kato, J. Hama, T. Kagawa, S. Karashima, N. Miyanaga, H. Tawara,
              N. Yamaguchi, K. Yamamoto and K. Yonei (1983)

IPPJ-AM-30   "Cross Sections for Charge Transfers of Highly Ionized Ions in Hydrogen
              Atoms (Up-dated version of IPPJ-AM-15)"
              H. Tawara, T. Kato and Y. Nakai (1983) [Published in Atomic Data and
              Nuclear Data Tables 32, 235 (1985)]

IPPJ-AM-31   "Atomic Processes in Hot Dense Plasmas"
              T. Kagawa, T. Kato, T. Watanabe and S. Karashima (1983)

IPPJ-AM-32   "Energy Dependence of the Yields of Ion-Induced Sputtering of Monatomic
              Solids"
              N. Matsunami, Y. Yamamura, Y. Itikawa, N. Itoh, Y. Kazumata, S. Miyagawa,
              K. Morita, R. Shimizu and H. Tawara (1983) [Published in Atomic Data and
              Nuclear Data Tables 31, 1 (1984)]

IPPJ-AM-33   "Proceedings on Symposium on Atomic Collision Data for Diagnostics and
              Modelling of Fusion Plasmas, Aug. 29 – 30, 1983"
              Ed. by H. Tawara (1983)

IPPJ-AM-34   "Dependence of the Backscattering Coefficients of Light Ions upon Angle of
              Incidence"
              T. Tabata, R. Ito, Y. Itikawa, N. Itoh, K. Morita and H. Tawara (1984)

IPPJ-AM-35   "Proceedings of Workshop on Synergistic Effects in Surface Phenomena
              Related to Plasma-Wall Interactions, May 21 – 23, 1984"
              Ed. by N. Itoh, K. Kamada and H. Tawara (1984) [Published in Radiation
              Effects 89, 1 (1985)]

IPPJ-AM-36   "Equilibrium Charge State Distributions of Ions ($Z_1 \geqq 4$) after Passage
              through Foils – Compilation of Data after 1972"
              K. Shima, T. Mikumo and H. Tawara (1985)

IPPJ-AM-37   "Ionization Cross Sections of Atoms and Ions by Electron Impact"
              H. Tawara, T. Kato and M. Ohnishi (1985)

IPPJ-AM-38   "Rate Coefficients for the Electron-Impact Excitations of C-like Ions"
              Y. Itikawa (1985)

IPPJ-AM-39   "Proceedings of the Japan-U.S. Workshop on Impurity and Particle Control,
              Theory and Modeling, Mar. 12 – 16, 1984"
              Ed. by T. Kawamura (1985)

IPPJ-AM-40   "Low-Energy Sputterings with the Monte Carlo Program ACAT"
              Y. Yamamura and Y. Mizuno (1985)

IPPJ-AM-41   "Data on the Backscattering Coefficients of Light Ions from Solids (a
              Revision)"
              R. Ito, T. Tabata, N. Itoh, K. Morita, T. Kato and H. Tawara (1985)

IPPJ-AM-42   "Stopping Power Theories for Charged Particles in Inertial Confinement
              Fusion Plasmas (Emphasis on Hot and Dense Matters)"
              S. Karashima, T. Watanabe, T. Kato and H. Tawara (1985)

IPPJ-AM-43   "The Collected Papers of Nice Project/IPP, Nagoya"
              Ed. by H. Tawara (1985)
IPPJ-AM-44   "Tokamak Plasma Modelling and Atomic Processes"
              Ed. by T. Kawamura (1986)
IPPJ-ÁM-45   Bibliography of Electron Transfer in Ion-Atom Collisions
              H. Tawara, N. Shimakura, N. Toshima and T. Watanabe (1986)