```
%CSW changed from latex2.0.9 to latex2e (needed for usepackage-command)
%\documentstyle[12pt,epsf]{article}
\documentclass[12pt]{article}
\usepackage{epsf}

\oddsidemargin 0. true cm
\topmargin -1 true cm
\textheight 24 true cm
\textwidth 16 true cm
%CSW latex2html related commands, have no effect on
%CSW layout, style etc...
\usepackage{color}
\pagecolor{white}
\setcounter{secnumdepth}{1}
\usepackage{times}
%CSW that's it...
\begin{document}
\parindent 0pt
%titelpage
{\LARGE \bf \center
\vspace*{3truecm}

The data file AMJUEL: \\
Additional Atomic and Molecular Data for EIRENE
\vspace*{3truecm}

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%Post-box 1917 \\
FRG
\vspace{5truecm}

Version: \today
\vspace{3truecm}

Available via E-mail from d.reiter@fz-juelich.de
}
\tableofcontents
%ende titelpage
\newpage
\section{Introduction}
\subsection{Record:}
\begin{itemize}
\item update  6.12/94 \\
   Bor ionis. raten H.2, 2.5B0, 2.5B1 \\
                          Bor rec.   rates H.4, 2.3.5B0, 2.3.5B1 \\
 \item update  6.4/95 \\
  elast. revised, aus elrep.dat \\
 \item update  25.4/95 \\
  H.9, 3.1.8 verbessert   \\
 \item update 12. 1/96 \\
   Arg ionis. rates H.2, 2.18B0, 2.18B1   \\
   Arg rec.   rates H.4, 2.3.18B0, 2.3.18B1 \\
   Arg el.cool      H.8, 2.18B0, 2.18B1, H.11,2.18B0\\
   Be  el.cool      H.8, 2.4B0, 2.4B1, H.11,2.4B0\\
   B   el.cool      H.8, 2.5B0, 2.5B1, H.11,2.5B0\\
 \item update 12. 2/96 \\
   N ionis. rate H.2, 2.7B0 \\
 \item update  7. 3/96 \\
```

```
   He+ ionis. rate H.4, 2.2C \\
   He++ recomb. rate H.4, 2.3.2C \\
 \item update  17. 8/96 \\
   elast.rate H.3, 0.3T revised
 \item update   3. 9/96 \\
   ratios H.12 7.2a, 7.2b 2.0b, 2.0c\\
   ratios H.11 7.0 2.0a
 \item update   6. 9/96 \\
   H- cx multistep recombination, low proton energy, H.4  7.2.3a\\
   H- cx multistep ionisation, low proton energy, H.4  7.2.3b
 \item update   26.2/97 \\
   Corona H-ionisation rate from SOLXY: out, because:
   wrong, and never used anyway
(i.e. H.8 2.1.5G out).
 \item update   18.3/97 \\
  H.4 2.1.5FU, H.4 2.1.8FU (fujimoto rates) \\
  H.2 3.2.3  (only slow molecules) \\
  H.2 2.2.17
 \item update   28.7/97 \\
  H.3 3.2.3  = HYDHEL H.3 3.2.3(vs. Ebeam and Ti) + plus
  slow vibr. ex. molecules\\
  must be modified to account for Ebeam of vibr. excited
  molecules (scale cross section)\\
  H.4 2.2.5g, as 2.2.5 but vibr. distribution of H2 molecules
 \item update    8.8/97 \\
  H.2 2.10B0, 2.10B1 \\
  H.8 2.10B0, 2.10B1 \\
  H.11 2.10B0
 \item update   18.8/97 \\
  H.3 0.1D  0.2D, 0.3D 0.4D \\
 \item update    8.9/97 \\
  H.1 3.1.8R (Riviere) revised (better extrapolation to low energy) \\
  H.1 3.1.8S new (Schultz cx cross section) \\
  H.1 3.1.8M new (Schultz momentum transfer cross section) \\
  H.1 3.1.8J new (Janev cx cross section *2 = mom trans. x-section)\\
  H.1 3.1.8T new (Schultz cx cross section *2 = mom trans. x-section)\\
  note: 3.1.8M $\approx$ 3.1.8T within line-thickness
 \item update   23.9/97 \\
  H.2 2.6B0 strahl carbon data ionisation\\
  H.4 2.3.6B0 strahl carbon data recombination \\
  H.4 2.6A0 ADAS  carbon ionisation    \\
  H.4 2.3.6A0 ADAS  carbon recombination \\
  H.10 2.6A0 ADAS  carbon line radiation plus 11.3 per ionisation\\
                   (=electron cooling rate)\\
  H.10 2.3.6A0 ADAS  carbon line radiation due to recombination\\
                   (=electron cooling rate)\\
  H.12 2.6A0 ADAS  carbon line radiation per ionisation\\
  H.12 2.3.6A0 ADAS  carbon line radiation per recombination
 \item update   22.4/98 \\
  H.2  3.1.6FJ  Freeman and Jones ion impact ionisation, Ebeam=0.
 \item update   10.10/98 \\
  red. pop. coeff revised (n=2, n=3) and new ones (n=4, n=5)
  now all based on Fujimotos modifications to Johnson/Hinnov\\
  H.12 2.1.5  a,b,c,d  reduced pop. coeff, coupling to H ground state\\
  H.12 2.1.8  a,b,c,d  reduced pop. coeff, coupling to H+\\
  H.12 2.2.5  a,b,c,d  reduced pop. coeff, coupling to H2\\
  H.12 2.2.14 a,b,c,d  reduced pop. coeff, coupling to H2+\\
  H.12 7.2    a,b,c,d  reduced pop. coeff, coupling to H-\\
 \item update   20.1/99 \\
  H.12 2.2.5e Fulcher emissivity ($cm^3/s)$, coupling to H2\\
```

\item update   17.2/99 \\
 H.12 2.2.5g revised (because of low Te extrapolation)\\
 new format for plots for H.4, h2, h2fuji, h2fuji-vibr \\
 done for 2.2.5, 2.2.5g, 2.2.9, 2.2.11
\item update   10.4/99 \\
 Fujimoto He-col.rad model revised.\\
 Form.II   ionis.rate   H.4 2.3.9a, done \\
              elec. cooling rate H.10 2.3.9a, done \\
             $\delta_E/ionis$ H.12 2.3.9a, done \\
 Form.I ionisation.rates revised. \\
  K1$\rightarrow$ K10=K1-K12-K13 \\
  K2$\rightarrow$ K20=K2-K21-K23 \\
  K3$\rightarrow$ K30=K3-K31-K32 \\
              H.4 2.3.9b, 2.3.9c 2.3.9d redone \\
              (only 2.3.9b,K10, differs from earlier version)\\
              H.4 2.3.9e, 2.3.9f 2.3.9g redone \\
              (only 2.3.9f,K20, differs from earlier version)\\
              H.4 2.3.9h, 2.3.9i 2.3.9j redone \\
              (only 2.3.9j,K30, differs from earlier version)\\
\item update   2.7/99 \\
 Johnson Hinnov ionisation and recombination revised.\\
 all rates are now availabel for Ly-transparent (as in older versions)
 and (new) for Ly-opaque conditions. The labels for the opaque
 data have an additional "o". E.g.: H.4 2.1.5 (for transparent
 data for effective ionisation) and (new): H.4 2.1.5o (same process,
 but Lyman-opaque conditions). Same for: H.4 2.1.8 and (new) H.4 2.1.8o
\item update   2.7/99 \\
 During this update, an error in the Johnson Hinnov code was detected.
 It affects the rate H.10 2.1.8, at $T_e > 10 eV$. The slope of the
 effective electron cooling rate above this T_e was too steep.
 H.10 2.1.8 (and, correspondingly: H.12 2.1.8) have been corrected.
\item update   23.11/99 \\
 H.1, 3.1.6, Freeman and Jones ion impact ionisation cross section,
 for beam penetration runs.\\
 Figure H.12 2.2.5b corrected (was wrong figure).
\item update   3.2/00 \\
 new: ratio of population coeff. p(6)/p(1)\\
 H.12 7.2e added   \\
 H.12 2.2.14e added   \\
 H.12 2.2.5e added. Former 2.2.5e (Fulcher emissivity) is now:
                          2.2.5fl\\
 H.12 2.1.5e added. Former 2.1.5e (del-e) is now: 2.1.5de \\
 H.12 2.1.8e added. Former 2.1.8e (del-e) is now: 2.1.8de
\item update 23.5/00 \\
 H.12 2.2.5fl revised: labeling of n=2 triplet levels in fujimotos
 code corrected.
\item update 06.8/00 \\
 H.2 2.26B0 and H.2 2.26B1 added (ionisation rates for Iron).
\item update 26.12/00 \\
 H.1 (elastics: p + nobel gases).
\item update 21.01/01 \\
 error detected in H.1, 0.3D, 0.3V and 0.4D, 0.4V, fit coefficients\\
 for extrapolation wrong (different expression). Corrected.\\
 H.3 (elastics: p + nobel gases).\\
 Figures included/redone for all elastics H.1 0.1 -- 0.8, \\
 and same for H.3, $I_{0,0}$ and $I_{1,0}$
\item update 16.03/01 \\
 H.10 and H.12 added for 2.3.13a (He.rec.elec.cooling rates)\\
 Figures added, helraecr and helraecc
\item update 1.10/01 \\

```
  H.12  2.2.5fu added (to replace 2.2.5fl)
 \item update  1.11/01 \\
  H.12  2.2a, 2.2b, 2.2c 2.3.2a, 2.3.2b, 2.3.2c added \\
  Helium population coefficients, for states no. 6,7 and 10
 \item update  8.11/01 \\
  H.12  2.2c $\rightarrow$ 2.2d ,2.3.2c $\rightarrow$ 2.3.2d \\
  newly included: 2.2c, 2.2e,  2.3.2c,  2.3.2e
  Helium population coefficients, for states no. 8 and 16
 \item update  23.01/02 \\
  H.0  Potentials for elastic collision processes included\\
  fit-flag 1 (repulsive) and fit-flag 2 (Morse) introduced.
 \item update  13.03/04 \\
  3.1.8d: Langevin approximation for cx , for testing of internal consistency\\
  H.1:  3.1.8d done  \\
  H.3:  3.1.8d done   \\
  H.9:  3.1.8d done   \\
  H.3:  3.1.8o:  original fit from janev's springer 1987 book\\
  (only for reference purpose. don't use!)
 \item update  11.05/04 \\
  H.11  2.0a, 2.0b  redone, correct $E_{H2}=0.1$ eV\\
  H.11 7.0c renamed to H.11 7.0a\\
  H.12 2.0a, 2.0b and 2.0c fits and plots new, $E_{H2}=0.1$ eV\\
  H.4  2.2.5r, 2.2.5d, 2.2.5i fits and plots, MAR, MAD and MAI rate coef.\\
  H.3  3.2.3 new, $E_{H2}$ consistent for all H2(v) \\
  H.2  3.2.3 and 2.2.17 redone, $E_{H2}= 0.1$

\end{itemize}
\newpage
Additional atomic data fits, read by EIRENE

Format as HYDHEL DATEN \cite{kn:Janev}
or METHANE DATEN \cite{kn:Ehrhardt}.
\newpage

\subsection {Reading Data from AMJUEL}
Single parameter fits are identified by the character string
\begin{small}\begin{verbatim}
'p0' in case of H.0  (potential)
'a0' in case of H.1  (cross section)
'b0' in case of H.2  (rate coefficient vs. T-target)
'e0' in case of H.5
'h0' in case of H.8  (energy weighted rate coefficient vs. T-target)
'k0' in case of H.11
\end{verbatim}\end{small}
Format: E20.12

Double parameter fits are identified by the character string
'Index'


Data are transferred from a data file into the EIRENE code by
calls to subroutine SLREAC, listed below.

\begin{small}\begin{verbatim}
C
      SUBROUTINE SLREAC (IR,FILNAM,H123,REAC,CRC)
c
C  input
C    FILNAM: read a&m data from file filnam, e.g. AMJUEL, HYDHEL, METHAN, CONST
c    IR    : store data on eirene array CREAC(...,...,IR)
```

```
c    H123  : identifyer for data type in filnam, e.g. H.1, H.2, H.3, ...
c    REAC  : number of reaction in filnam, e.g. 2.2.5
c    CRC   : type of process, e.g. EI, CX, OT, etc
C  internal
C    ISW   <-- H123
C    IO    derived from ISW, initial value of 2nd index in CREAC
C  output
c    ISWR  : eirene flag for type of process  (1,2,...7)
c    CREAC : eirene storage array for a&m data CREAC(9,0:9,IR)
c    MODCLF: see below
c    DELPOT: ionisation potential (for H.10 data),
c            currently handeled in input.f. not nice!
c    IFTFLG: eirene flag for type of fitting expression ("fit-flag=...")
C            DEFAULTS: =2 FOR POTENTIAL (GEN. MORSE)
C                      =0 FOR ALL OTHERS (POLYNOM, DOUBLE POLYNOM)
c
C  READ A&M DATA FROM THE FILES INTO EIRENE ARRAY CREAC
C
C
C  OUTPUT (IN COMMON COMXS):
C    READ DATA FROM "FILNAM" INTO ARRAY "CREAC"
C    DEFINE PARAMETER MODCLF(IR) (5 DIGITS NMLKJ)
C    FIRST DEZIMAL  J           =1  POTENTIAL AVAILABLE
C                                   (ON CREAC(..,-1,IR))
C                   J           =0  ELSE
C    SECOND DEZIMAL K           =1  CROSS SECTION AVAILABLE
C                                   (ON CREAC(..,0,IR))
C                   K           =0  ELSE
C    THIRD  DEZIMAL L           =1  <SIGMA V> FOR ONE
C                                   PARAMETER E (E.G.
C                                   PROJECTILE ENERGY OR ELECTRON
C                                   DENSITY) AVAILABLE
C                                   (ON CREAC(..,1,IR))
C                               =2  <SIGMA V> FOR
C                                   9 PROJECTILE ENERGIES AVAILABLE
C                                   (ON CREAC(..,J,IR),J=1,9)
C                               =3  <SIGMA V> FOR
C                                   9 ELECTRON DENSITIES  AVAILABLE
C                                   (ON CREAC(..,J,IR),J=1,9)
C                   L           =0  ELSE
C    FOURTH DEZIMAL M               DATA FOR MOMENTUM EXCHANGE
C                                   TO BE WRITTEN
C    FIFTH  DEZIMAL N           =1  DELTA E FOR ONE PARAMETER E (E.G.
C                                   PROJECTILE ENERGY OR ELECTRON
C                                   DENSITY) AVAILABLE
C                                   (ON CREAC(..,1,IR))
C                               =2  DELTA E FOR
C                                   9 PROJECTILE ENERGIES AVAILABLE
C                                   (ON CREAC(..,J,IR),J=1,9)
C                               =3  DELTA E FOR
C                                   9 ELECTRON DENSITIES  AVAILABLE
C                                   (ON CREAC(..,J,IR),J=1,9)
C                   N           =0  ELSE
C
      USE PRECISION
      USE PARMMOD
      USE COMPRT
      USE COMXS
      USE PHOTON
```

```
      IMPLICIT NONE

      INTEGER,      INTENT(IN) :: IR
      CHARACTER(8), INTENT(IN) :: FILNAM
      CHARACTER(4), INTENT(IN) :: H123
      CHARACTER(9), INTENT(IN) :: REAC
      CHARACTER(3), INTENT(IN) :: CRC
C
      CHARACTER(11) :: REACSTR
      REAL(DP) :: CONST
      INTEGER :: I, IND, J, K, IH, I0P1, I0, IC, IREAC, ISW, INDFF,
     .           IFLG, INC, IANF
      CHARACTER(80) :: ZEILE
      CHARACTER(6) :: AMJUEL, HYDHEL, H2VIBR, SPECTR
      CHARACTER(7) :: METHANE
      CHARACTER(2) :: CHR
      CHARACTER(3) :: CHRL, CHRR
      LOGICAL :: LCONST,LGEMIN,LGEMAX
C
      LGEMIN=.FALSE.
      LGEMAX=.FALSE.
      ISWR(IR)=0
      CONST=0.
      CHR='l0'
      I0=0
C
      AMJUEL='AMJUEL'
      HYDHEL='HYDHEL'
      METHANE='METHANE'
      H2VIBR='H2VIBR'
      SPECTR='SPECTR  '
C
      IF (INDEX(CRC,'EI').NE.0.OR.
     .    INDEX(CRC,'DS').NE.0) ISWR(IR)=1
      IF (INDEX(CRC,'CX').NE.0) ISWR(IR)=3
      IF (INDEX(CRC,'II').NE.0.OR.
     .    INDEX(CRC,'PI').NE.0) ISWR(IR)=4
      IF (INDEX(CRC,'EL').NE.0) ISWR(IR)=5
      IF (INDEX(CRC,'RC').NE.0) ISWR(IR)=6
      IF (INDEX(CRC,'OT').NE.0) ISWR(IR)=7
C
      IF (INDEX(FILNAM,'AMJUEL').NE.0) THEN
        LCONST=.FALSE.
        OPEN (UNIT=29,FILE='AMJUEL')
      ELSEIF (INDEX(FILNAM,'METHAN').NE.0) THEN
        LCONST=.FALSE.
        OPEN (UNIT=29,FILE='METHANE')
      ELSEIF (INDEX(FILNAM,'HYDHEL').NE.0) THEN
        LCONST=.FALSE.
        OPEN (UNIT=29,FILE='HYDHEL')
      ELSEIF (INDEX(FILNAM,'H2VIBR').NE.0) THEN
        LCONST=.FALSE.
        OPEN (UNIT=29,FILE='H2VIBR')
      ELSEIF (INDEX(FILNAM,'SPECTR').NE.0) THEN
        LCONST=.FALSE.
        OPEN (UNIT=29,FILE='SPECTR')
      ELSEIF (INDEX(FILNAM,'PHOTON').NE.0) THEN
        LCONST=.FALSE.
        OPEN (UNIT=29,FILE='PHOTON')
      ELSEIF (INDEX(FILNAM,'CONST').NE.0) THEN
```

```
        LCONST=.TRUE.
      ELSE
        WRITE (6,*) ' NO SPECIFICATION FOR FILENAME IN REACTION CARD'
        WRITE (6,*) ' CHOOSE EITHER '
        WRITE (6,*) ' AMJUEL, METHAN, HYDHEL, H2VIBR, SPECTR '
        WRITE (6,*) ' OR '
        WRITE (6,*) ' CONST FOR ENTERING REACTION COEFFICIENTS VIA '
        WRITE (6,*) ' EIRENE INPUT-FILE '
        CALL EXIT
      ENDIF
C
      IF (H123(4:4).EQ.' ') THEN
        READ (H123(3:3),'(I1)') ISW
      ELSE
        READ (H123(3:4),'(I2)') ISW
      ENDIF
C
      IF (INDEX(FILNAM,'PHOTON').NE.0) THEN
        CALL READ_PHOTDBK (IR,REAC,ISW)
        RETURN
      END IF
C
      REACSTR=REPEAT(' ',11)
      IANF=VERIFY(REAC,' ')
      IREAC=INDEX(REAC(IANF:),' ')-1
      IF (IREAC.LT.0) IREAC=LEN(REAC(IANF:))
      REACSTR(2:IREAC+1)=REAC(IANF:IREAC+IANF-1)
C  ADD ONE MORE BLANK, IF POSSIBLE
      IREAC=IREAC+2

C  H.0
      IF (ISW.EQ.0) THEN
        CHR='p0'
        CHRL='pl0'
        CHRR='pr0'
        I0=-1
        MODCLF(IR)=MODCLF(IR)+1
        IFLG=0
C  DEFAULT POTENTIAL: GENERALISED MORSE
        IFTFLG(IR,IFLG)=2
C  H.1
      ELSEIF (ISW.EQ.1) THEN
        CHR='a0'
        CHRL='al0'
        CHRR='ar0'
        I0=0
        MODCLF(IR)=MODCLF(IR)+10
        IFLG=1
C  DEFAULT CROSS SECTION: 8TH ORDER POLYNOM OF LN(SIGMA)
        IFTFLG(IR,IFLG)=0
C  H.2
      ELSEIF (ISW.EQ.2) THEN
        CHR='b0'
        CHRL='bl0'
        CHRR='br0'
        I0=1
        MODCLF(IR)=MODCLF(IR)+100
        IFLG=2
C  DEFAULT RATE COEFFICIENT: 8TH ORDER POLYNOM OF LN(<SIGMA V>) FOR E0=0.
        IFTFLG(IR,IFLG)=0
```

```
C  H.3
      ELSEIF (ISW.EQ.3) THEN
        MODCLF(IR)=MODCLF(IR)+200
        I0=1
        IFLG=2
        IFTFLG(IR,IFLG)=0
C  H.4
      ELSEIF (ISW.EQ.4) THEN
        MODCLF(IR)=MODCLF(IR)+300
        I0=1
        IFLG=2
        IFTFLG(IR,IFLG)=0
C  H.5
      ELSEIF (ISW.EQ.5) THEN
        CHR='e0'
        CHRL='el0'
        CHRR='er0'
        I0=1
        MODCLF(IR)=MODCLF(IR)+1000
        IFLG=3
        IFTFLG(IR,IFLG)=0
C  H.6
      ELSEIF (ISW.EQ.6) THEN
        MODCLF(IR)=MODCLF(IR)+2000
        I0=1
        IFLG=3
        IFTFLG(IR,IFLG)=0
C  H.7
      ELSEIF (ISW.EQ.7) THEN
        MODCLF(IR)=MODCLF(IR)+3000
        I0=1
        IFLG=3
        IFTFLG(IR,IFLG)=0
C  H.8
      ELSEIF (ISW.EQ.8) THEN
        CHR='h0'
        CHRL='hl0'
        CHRR='hr0'
        I0=1
        MODCLF(IR)=MODCLF(IR)+10000
        IFLG=4
        IFTFLG(IR,IFLG)=0
C  H.9
      ELSEIF (ISW.EQ.9) THEN
        MODCLF(IR)=MODCLF(IR)+20000
        I0=1
        IFLG=4
        IFTFLG(IR,IFLG)=0
C  H.10
      ELSEIF (ISW.EQ.10) THEN
        MODCLF(IR)=MODCLF(IR)+30000
        I0=1
        IFLG=4
        IFTFLG(IR,IFLG)=0
C  H.11
      ELSEIF (ISW.EQ.11) THEN
        CHR='k0'
        CHRL='kl0'
        CHRR='kr0'
        I0=1
```

```
        IFLG=5
        IFTFLG(IR,IFLG)=0
C  H.12
      ELSEIF (ISW.EQ.12) THEN
        I0=1
        IFLG=5
        IFTFLG(IR,IFLG)=0
      ENDIF
C
      IF (LCONST) THEN
        IND=INDEX(REACSTR,'FT')
        IF (IND /= 0) THEN
          READ (REACSTR(IND+2:),*) IFTFLG(IR,IFLG)
        END IF

        IF (MOD(IFTFLG(IR,IFLG),100) == 10) THEN
C
C  READ ONLY ONE FIT COEFFICIENT FROM INPUT FILE
          READ (IUNIN,6664) CREAC(1,I0,IR)
        ELSE
C
C  READ 9 FIT COEFFICIENTS FROM INPUT FILE
          READ (IUNIN,6664) (CREAC(IC,I0,IR),IC=1,9)
        END IF
        RETURN
C
C  READ FROM DATA FILE
C
      ELSEIF (.NOT.LCONST) THEN
100     READ (29,'(A80)',END=990) ZEILE
c
c   loop to find begin of data, see subr. slreac.f in "file-handling"
c
        GOTO 100

1       READ (29,'(A80)',END=990) ZEILE
        IF (INDEX(ZEILE,H123).EQ.0) GOTO 1
C
2       READ (29,'(A80)',END=990) ZEILE
        IF (INDEX(ZEILE,'H.').NE.0) GOTO 990
        IF (INDEX(ZEILE,'Reaction ').EQ.0.or.
     .      INDEX(ZEILE,REACSTR(1:ireac)).EQ.0) GOTO 2
      ENDIF
C
C  SINGLE PARAM. FIT, ISW=0,1,2,5,8,11
      IF (ISW.EQ.0.OR.ISW.EQ.1.OR.ISW.EQ.2.OR.ISW.EQ.5.OR.ISW.EQ.8.OR.
     .    ISW.EQ.11) THEN
        IF (.NOT.LCONST) THEN
3         READ (29,'(A80)',END=990) ZEILE
          INDFF=INDEX(ZEILE,'fit-flag')
          IF (INDEX(ZEILE,CHR)+INDFF.EQ.0) GOTO 3
          IF (INDFF > 0) THEN
            READ (ZEILE((INDFF+8):80),*) IFTFLG(IR,IFLG)
            GOTO 3
          ENDIF
          IF (MOD(IFTFLG(IR,IFLG),100) == 10) THEN
            IND=INDEX(ZEILE,CHR(1:1))
            CREAC(:,I0,IR)=0._DP
            READ (ZEILE((IND+2):80),'(E20.12)') CREAC(1,I0,IR)
          ELSE
```

```
            DO 9 J=0,2
              IND=0
              DO 4 I=1,3
                IND=IND+INDEX(ZEILE((IND+1):80),CHR(1:1))
                READ (ZEILE((IND+2):80),'(E20.12)') CREAC(J*3+I,I0,IR)
4             CONTINUE
              READ (29,'(A80)',END=990) ZEILE
9           CONTINUE
          END IF
C
C  READ ASYMPTOTICS, IF AVAILABLE
C  I0P1=1 FOR CROSS SECTION
C  I0P1=2 FOR (WEIGHTED) RATE
          I0P1=I0+1
          IF (ISW.EQ.0) GOTO 12 ! NO ASYMPTOTICS FOR POTENTIALS
          IF (INDEX(ZEILE,CHRL).NE.0.AND.IFEXMN(IR,I0P1).EQ.0) THEN
            IND=0
            DO 5 I=1,3
              INC=INDEX(ZEILE((IND+1):80),CHR(1:1))
              IF (INC.GT.0) THEN
                IND=IND+INDEX(ZEILE((IND+1):80),CHR(1:1))
                READ (ZEILE((IND+3):80),'(E20.12)') FPARM(IR,I,I0P1)
              ENDIF
5           CONTINUE
            LGEMIN=.true.
            READ (29,'(A80)',END=990) ZEILE
          ENDIF
          IF (INDEX(ZEILE,CHRR).NE.0.AND.IFEXMX(IR,I0P1).EQ.0) THEN
            IND=0
            DO 7 I=4,6
              INC=INDEX(ZEILE((IND+1):80),CHR(1:1))
              IF (INC.GT.0) THEN
                IND=IND+INDEX(ZEILE((IND+1):80),CHR(1:1))
                READ (ZEILE((IND+3):80),'(E20.12)') FPARM(IR,I,I0P1)
              ENDIF
7           CONTINUE
            LGEMAX=.true.
            READ (29,'(A80)',END=990) ZEILE
          ENDIF
c
          if (lgemin.and.ifexmn(ir,I0P1).eq.0) then
            IND=INDEX(ZEILE,'=')
            READ (ZEILE((IND+2):80),'(E12.5)') rcmn(IR,I0P1)
            rcmn(ir,I0P1)=log(rcmn(ir,I0P1))
            ifexmn(ir,I0P1)=5
            READ (29,'(A80)',END=990) ZEILE
          endif
          if (lgemax.and.ifexmx(ir,I0P1).eq.0) then
            IND=INDEX(ZEILE,'=')
            READ (ZEILE((IND+2):80),'(E12.5)') rcmx(IR,I0P1)
            rcmx(ir,I0P1)=log(rcmx(ir,I0P1))
            ifexmx(ir,I0P1)=5
            READ (29,'(A80)',END=990) ZEILE
          endif
C
C  ANY OTHER ASYMPTOTICS INFO ON FILE?  SEARCH FOR Tmin, or Emin
          IF ((INDEX(ZEILE,'Tmin').NE.0.and.I0P1==2).or.
     .        (INDEX(ZEILE,'Emin').NE.0.and.I0P1==1)) then
            IND=INDEX(ZEILE,'n')
            READ (ZEILE((IND+2):80),'(E9.2)') rcmn(IR,I0P1)
```

```
            rcmn(ir,I0P1)=log(rcmn(ir,I0P1))
C  extrapolation from subr. CROSS
            if (I0P1.eq.1.and.iswr(ir).eq.1) ifexmn(ir,1)=1
            if (I0P1.eq.1.and.iswr(ir).eq.3) ifexmn(ir,1)=-1
            if (I0P1.eq.1.and.iswr(ir).eq.5) ifexmn(ir,1)=-1
C  extrapolation from subr. CDEF
C   ??      if (I0PT.eq.2) ifexmn(ir,1)=-1
            READ (29,'(A80)',END=990) ZEILE
          ENDIF
12        CONTINUE
C       ELSEIF (LCONST) THEN
C  NOTHING TO BE DONE
        ENDIF
C
C  TWO PARAM. FIT, ISW=3,4,6,7,9,10,12
      ELSEIF (ISW.EQ.3.OR.ISW.EQ.4.OR.ISW.EQ.6.OR.ISW.EQ.7.OR.
     .        ISW.EQ.9.OR.ISW.EQ.10.OR.ISW.EQ.12) THEN
        DO 11 J=0,2
16        READ (29,'(A80)',END=990) ZEILE
          INDFF=INDEX(ZEILE,'fit-flag')
          IF (INDEX(ZEILE,'Index')+INDFF.EQ.0) GOTO 16
          IF (INDFF > 0) THEN
            READ (ZEILE((INDFF+8):80),*) IFTFLG(IR,IFLG)
            GOTO 16
          ENDIF
          READ (29,'(1X)')
          IF (MOD(IFTFLG(IR,IFLG),100) == 10) THEN
            CREAC(:,:,IR)=0._DP
            READ (29,*) IH,CREAC(1,1,IR)
            EXIT
          ELSE
            DO 17 I=1,9
              READ (29,*) IH,(CREAC(I,K,IR),K=J*3+1,J*3+3)
17          CONTINUE
          END IF
11      CONTINUE
C   NO ASYMPTOTICS AVAILABLE YET
C
      ENDIF
C
      CLOSE (UNIT=29)
C
      RETURN
C
990   WRITE (6,*) ' NO DATA FOUND FOR REACTION ',H123,' ',REAC,
     .            ' IN DATA SET ',FILNAM
      WRITE (6,*) ' IR,MODCLF(IR) ',IR,MODCLF(IR)
      CLOSE (UNIT=29)
      CALL EXIT
991   WRITE (6,*) ' INVALID CONSTANT IN SLREAC. CONST= ',CONST
      WRITE (6,*) ' CHECK "REACTION CARDS" FOR REACTION NO. ',IR
      CLOSE (UNIT=29)
      CALL EXIT
6664  FORMAT (6E12.4)
      END
\end{verbatim}\end{small}
\newpage
\subsection{Types of Data, general prescriptions}
\subsubsection{H.0: interaction potentials}
\subsubsection{H.1: cross section vs. energy}
```

\subsubsection{H.2: rate coefficient vs. temperature (zero beam energy)}
\subsubsection{H.3: rate coefficient vs. temperature and energy}
\subsubsection{H.4: rate coefficient vs. temperature and density}
\subsubsection{H.5: momentum weighted rates vs. temperature}
\subsubsection{H.6: momentum weighted rates vs. temperature and energy}
\subsubsection{H.7: momentum weighted rates vs. temperature and density}
\subsubsection{H.8: energy weighted rates vs. temperature}
\subsubsection{H.9: energy weighted rates vs. temperature and energy}
\subsubsection{H.10: energy weighted rates vs. temperature and density}
Fits for $<\sigma \cdot v \cdot E> (n_e,T) \ [cm^3/s \cdot eV]$

E is the total energy loss for the electron or ion gas per collision event,
in eV.
These rates, therefore, if multiplied by the electron charge 1.6022 10^{-19},
are electron- or ion energy loss rates in Watt/cm^3.
Unless otherwise noted
these are total energy loss rate coefficients associated
with the particular process.
If such a process is an "effective process",
implicitly including fast transitions between excited
states of particles which are considered to be in a certain
(collisional radiative) equilibrium,
then these total effective rates include also line- and continuum
radiation losses, kinetic energy of
products (e.g. in case of dissociation processes) and
internal (potential) energy
differences between pre- and post collision particles,
but {\bf not} bremsstrahlung losses.

If the potential energy difference in a particular collision process
is negative, as, e.g., in recombination processes
or in electron impact de-excitation of metastables,
then this total energy loss rate
may become negative, for some values of the parameters,
and remain positive for others.
I.e., the coefficients may change sign within the parameter
range covered by the fit.
The fits in this database are, however, often given for the logarithm of the
rate coefficient. In such cases we have substracted the (negative) potential energy
contribution from these coefficients before fitting.

More generally, the fitted coefficients, therefore, read:

$<\sigma \cdot v \cdot E>_{fit} = <\sigma \cdot v \cdot E> - \Delta E_{subtr.} <\sigma \cdot v

with $\Delta E_{subtr.} $ specified for each particular rate coefficient below, together
with the fitting coefficients.

By default we have chosen $\Delta E_{subtr.} = 0.$ in this expression
for all processes in which the potential energy is
enhanced ("sub-elastic" processes, such as ionisation, excitation).

For the opposite case (recombination, collisional de-excitation, i.e., "super-elastic"
processes, we have chosen $\Delta E_{subtr.} = \Delta E_{pot}$

One can show with some boring algebra on the matrices which arise in collisional radiative
models that
with this particular choice of the substracted energy loss rate for collisional radiative
electron cooling rates
the remaining fitted expression $<\sigma \cdot v \cdot E>_{fit}$

turns out to be exactly the radiation energy loss rate
associated with a particular process.

In other words: the total effective electron cooling rate
is the sum of the effective
radiation energy loss rate
plus the effective potential energy loss rate, however, with the latter rate being simply
given as

$<\sigma \cdot v \cdot \Delta E_{pot}>_{effective} = \Delta E_{pot}
\cdot <\sigma \cdot v>_{effective}$

In this expression $<\sigma \cdot v>_{effective}$
is just the effective rate coefficient
for the process under consideration, i.e. the coefficient for the same process as given
in section H.4.
\newpage
\subsubsection{H.11: other data, e.g. reduced population coefficients}
\subsubsection{H.12: other data, e.g. reduced population coefficients}
\subsection{End of preface}
This next string is searched by EIRENE in subroutine SLREAC
to initialize search for a particular set of fit coefficients.

\bigskip
\begin{small}\begin{verbatim}
....
.   .
.   ##BEGIN DATA HERE##   .
.   .
....
\end{verbatim}\end{small}
\newpage
Generals
\newpage

\section{H.0 : Fits for Potentials}

\subsection{
Reaction 0.1T $ p + H (1s) \rightarrow p + H (1s) $ potential }
This potential is not yet implemented here. It is still explicitly
programmed in eirene, elastics.f. It is the first repulsive H_2^+
potential.

\begin{small}\begin{verbatim}
   fit-flag 1
   p0 0.000000000000D+00 p1 0.000000000000D+00 p2 0.000000000000D+00
   p3 0.000000000000D+00 p4 0.000000000000D+00 p5 0.000000000000D+00
   p6 0.000000000000D+00 p7 0.000000000000D+00 p8 0.000000000000D+00
\end{verbatim}\end{small}

\newpage

\subsection{
Reaction 0.2T $ p + He(1|1s) \rightarrow p + He (1|1s) $
potential }

Morse potential, see \cite{kn:Bachmann}

\begin{small}\begin{verbatim}

```
   fit-flag 2
   p0  2.000000000000D+00  p1  2.200000000000D+00  p2  0.850000000000D+00
   p3  1.455600000000D+00  p4  0.996990000000D+00  p5  1.995150000000D+00
   p6  0.000000000000D+00  p7 -1.500000000000D+00  p8  0.000000000000D+00
\end{verbatim}\end{small}


\newpage

\subsection{
Reaction 0.3T    $p + H_2 \rightarrow p + H_2 $ potential
}

Morse potential, see \cite{kn:Bachmann}
\begin{small}\begin{verbatim}
   fit-flag 2
   p0  2.700000000000D+00  p1  3.000000000000D+00  p2  1.000000000000D+00
   p3  2.835500000000D+00  p4  2.180380000000D+00  p5  3.490687000000D+00
   p6  0.000000000000D+00  p7 -2.025000000000D+00  p8  0.000000000000D+00
\end{verbatim}\end{small}


\newpage

\subsection{
Reaction 0.4T   $  He^+ + He \rightarrow He^+ + He $ potential
}

Morse potential, see \cite{kn:Bachmann}
\begin{small}\begin{verbatim}
   fit-flag 2
   p0  2.550000000000D+00  p1  2.350000000000D+00  p2  0.900000000000D+00
   p3  1.984200000000D+00  p4  1.399080000000D+00  p5  2.634500000000D+00
   p6  0.000000000000D+00  p7 -1.912500000000D+00  p8  0.000000000000D+00
\end{verbatim}\end{small}


\newpage

\subsection{
Reaction 0.5T   $ p + Ne \rightarrow p + Ne $ potential
}

\begin{small}\begin{verbatim}
   fit-flag 2
   p0  2.280000000000D+00  p1  2.680000000000D+00  p2  0.850000000000D+00
   p3  1.870900000000D+00  p4  1.387000000000D+00  p5  2.440200000000D+00
   p6  0.000000000000D+00  p7 -1.710000000000D+00  p8  0.000000000000D+00
\end{verbatim}\end{small}


\newpage

\subsection{
Reaction 0.6T   $ p + Ar \rightarrow p + Ar $ potential }

\begin{small}\begin{verbatim}
   fit-flag 2
   p0  4.040000000000D+00  p1  2.500000000000D+00  p2  0.860000000000D+00
   p3  2.475600000000D+00  p4  1.789200000000D+00  p5  3.273700000000D+00
```

```
   p6  0.000000000000D+00  p7 -3.030000000000D+00  p8  0.000000000000D+00
\end{verbatim}\end{small}


\newpage

\subsection{
Reaction 0.7T   $ p + Kr \rightarrow p + Kr $ potential }

\begin{small}\begin{verbatim}
   fit-flag 2
   p0  4.450000000000D+00  p1  2.500000000000D+00  p2  0.800000000000D+00
   p3  2.777900000000D+00  p4  2.007700000000D+00  p5  3.740600000000D+00
   p6  0.000000000000D+00  p7 -3.337500000000D+00  p8  0.000000000000D+00
\end{verbatim}\end{small}


\newpage

\subsection{
Reaction 0.8T   $ p + Xe \rightarrow p + Xe $ potential }

\begin{small}\begin{verbatim}
   fit-flag 2
   p0  6.750000000000D+00  p1  3.800000000000D+00  p2  1.080000000000D+00
   p3  3.288200000000D+00  p4  2.688400000000D+00  p5  3.843600000000D+00
   p6  0.000000000000D+00  p7 -5.062500000000D+00  p8  0.000000000000D+00
\end{verbatim}\end{small}


\newpage

\section{H.1 :  Fits for  \    $\sigma(E_{lab})$}\label{sect1}

\bigskip
Elastic collisions between neutral and charged particles,
Bachmann/Reiter (\cite{kn:Bachmann})
cross sections as function of $E_{lab}$,

$E_{lab} = m_{lab}/2 \cdot v^2$

$m_{lab}$ is the ion mass throughout

\subsection{
Reaction 0.1T $p + H (1s) \rightarrow p + H (1s) $ total cross
section}

\begin{small}\begin{verbatim}
   a0  0.000000000000D+00  a1  0.000000000000D+00  a2  0.000000000000D+00
   a3  0.000000000000D+00  a4  0.000000000000D+00  a5  0.000000000000D+00
   a6  0.000000000000D+00  a7  0.000000000000D+00  a8  0.000000000000D+00
  al0 -3.253031352541D+01 al1 -2.559032645641D-01 al2 -1.449996483552D-02
  ar0 -3.262937357400D+01 ar1 -8.719626183599D-02 ar2 -7.346647926269D-02
ELABMIN=   1.82060E 00 eV
ELABMAX=   1.82060E 00 eV
\end{verbatim}\end{small}



\subsection{
```

```
Reaction 0.1D    $ p + H (1s) \rightarrow p + H (1s)$  diff. cross
section}


\begin{small}\begin{verbatim}
   a0 -3.349115100108D+01  a1 -4.047040620920D-01  a2 -4.340959073105D-02
   a3 -5.224890973622D-03  a4 -1.019115858754D-04  a5 -3.314157761518D-06
   a6 -4.336259011986D-05  a7 -1.781020734395D-06  a8  1.220393550627D-06
  al0 -3.320677627738D+01 al1 -2.205942040112D-01 al2  0.000000000000D+00
  ar0 -2.753878563969D+01 ar1 -2.000000000000D+00 ar2  0.000000000000D+00
ELABMIN=  0.02000E 00 eV
ELABMAX=  2.00000E 02 eV
\end{verbatim}\end{small}


\subsection{
Reaction 0.1V    $p + H (1s) \rightarrow p + H (1s)$ visc. cross section
}



\begin{small}\begin{verbatim}
   a0 -3.353420922048D+01  a1 -3.522409780724D-01  a2 -3.587214262651D-02
   a3 -4.282561006823D-03  a4 -3.230618998917D-04  a5 -4.343173698940D-05
   a6 -1.753965583282D-05  a7 -4.580920664987D-07  a8  3.738689325195D-07
  al0 -3.330015157525D+01 al1 -1.992625366488D-01 al2  0.000000000000D+00
  ar0 -2.709329427260D+01 ar1 -2.000000000000D+00 ar2  0.000000000000D+00
ELABMIN=  0.02000E 00 eV
ELABMAX=  2.00000E 02 eV
\end{verbatim}\end{small}
Note: This elastic reaction should only be used, if the resonant charge
exchange differential cross section (and hence: diffusion cross section)
is reduced accordingly. The sum: elastic plus charge exchange transport
("diffusion"-) cross section should be twice the charge exchange total
cross section. The assumption of an exchange of identity (scattering
angle $\pi$ in the center of mass system) at charge exchange produces
that factor 2. Hence the need for a revised (smaller) charge exchange
scattering angle, if the elastic collision contribution is explicitly
added in.

\begin{figure} \label{0.1}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/elast01.ps}
\end{figure}
\newpage

\subsection{
Reaction 0.2T   $ p + He(1|1s) \rightarrow p + He (1|1s)$ total cross section
}



\begin{small}\begin{verbatim}
   a0 -3.357907136508D+01  a1 -9.811659406594D-02   a2  3.798308269292D-01
   a3 -1.259671949006D+00  a4 -4.473947519984D-02   a5  1.565182597363D+00
   a6 -1.203733922915D+00  a7  3.525830383820D-01   a8 -3.668922671043D-02
  al0 -3.355838377904D+01 al1 -2.845473342853D-01  al2 -1.351427675077D-02
  ar0 -3.706830076698D+01 ar1  4.204258692619D-01  ar2 -9.648359210100D-02
ELABMIN=  0.50810E 00 eV
ELABMAX=  2.94431E 01 eV
```

```
\end{verbatim}\end{small}

\subsection{
Reaction 0.2D    $p + He(1|1s) \rightarrow p + He (1|1s) $ diff. cross
section }


\begin{small}\begin{verbatim}
   a0 -3.425585328953D+01   a1 -8.999762959781D-01  a2 -3.434858124811D-01
   a3  1.549750110754D-02   a4  3.963555202866D-02  a5  3.343570605088D-04
   a6 -2.207534449376D-03   a7 -3.378852519380D-05  a8  4.224511209820D-05
  al0 -3.390101844960D+01  al1 -2.111706771112D-01 al2  0.000000000000D+00
  ar0 -3.034765152080D+01  ar1 -2.000000000000D+00 ar2  0.000000000000D+00
ELABMIN=  0.01250E 00 eV
ELABMAX=  1.25000E 02 eV
\end{verbatim}\end{small}


\subsection{
Reaction 0.2V   $ p + He(1|1s) \rightarrow p + He (1|1s) $ visc. cross
section }


\begin{small}\begin{verbatim}
  a0 -3.443725345071D+01   a1 -4.337427858507D-01  a2 -2.896488696126D-01
  a3 -6.451669335555D-02   a4  2.950009865269D-02  a5  5.752283385868D-03
  a6 -1.589840628629D-03   a7 -1.502468439244D-04  a8  3.151161681447D-05
 al0 -3.432276031579D+01  al1 -2.111706771112D-01 al2  0.000000000000D+00
 ar0 -2.978907423990D+01  ar1 -2.000000000000D+00 ar2  0.000000000000D+00
ELABMIN=  0.01250e 00 eV
ELABMAX=  1.25000e 02 eV
\end{verbatim}\end{small}


\begin{figure} \label{0.2}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/elast02.ps}
\end{figure}
\newpage

\subsection{
Reaction 0.3T    $p + H_2 \rightarrow p + H_2 $  total cross section
}


\begin{small}\begin{verbatim}
   a0 -3.452141819446D+01  a1  1.092015526305D+01  a2 -2.732690257819D+01
   a3  3.466297654768D+01  a4 -2.524607958646D+01  a5  1.092376446349D+01
   a6 -2.770065796605D+00  a7  3.796353200921D-01  a8 -2.168988142310D-02
  al0 -3.275286840950D+01 al1 -2.351764912137D-01 al2 -1.045602118569D-02
  ar0 -3.537275807146D+01 ar1  2.144573517210D-01 ar2 -4.643079956637D-02
ELABMIN=  1.55980E 00 eV
ELABMAX=  6.18164E 01 eV
\end{verbatim}\end{small}

\subsection{
Reaction 0.3D   $ p + H_2 \rightarrow p + H_2 $  diff. cross section
}
```

```
\begin{small}\begin{verbatim}
   a0 -3.318680874597D+01  a1 -3.580417289312D-01  a2 -2.274382376951D-01
   a3 -5.005702120342D-02  a4  2.369248748869D-02  a5  5.013459267775D-03
   a6 -1.357018742589D-03  a7 -1.393776090855D-04  a8  3.029808591929D-05
  al0 -3.319348529474D+01 al1 -1.726918000000D-01 al2  0.000000000000D+00
  ar0 -2.668769803274D+01 ar1 -2.000000000000D+00 ar2  0.000000000000D+00
ELABMIN=  0.01500E 00 eV
ELABMAX=  1.50000E 02 eV
\end{verbatim}\end{small}

\subsection{
Reaction 0.3V   $  p + H_2 \rightarrow p + H_2  $ visc. cross section
}


\begin{small}\begin{verbatim}
   a0 -3.362402037774D+01  a1 -2.337285826242D-01  a2 -5.404526201247D-02
   a3 -4.473235272373D-02  a4 -4.691524784882D-03  a5  3.121568334037D-03
   a6  4.229065229431D-04  a7 -6.739555319843D-05  a8 -7.756198335533D-06
  al0 -3.342235494450D+01 al1 -1.726917299089D-01 al2  0.000000000000D+00
  ar0 -2.658939177532D+01 ar1 -2.000000000000D+00 ar2  0.000000000000D+00
ELABMIN=  0.01500E 00 eV
ELABMAX=  1.50000E 02 eV
\end{verbatim}\end{small}


\begin{figure} \label{0.3}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/elast03.ps}
\end{figure}
\newpage


\subsection{
Reaction 0.4T   $  He^+ + He \rightarrow He^+ + He $  total cross section
}



\begin{small}\begin{verbatim}
   a0 -3.336949020454D+01  a1  4.374909804779D+00  a2 -1.517973301721D+01
   a3  2.345459194687D+01  a4 -1.969436659467D+01  a5  9.472303986781D+00
   a6 -2.604153028956D+00  a7  3.801132783280D-01  a8 -2.282922057203D-02
  al0 -3.291071330248D+01 al1 -2.416669402887D-01 al2 -9.821377921757D-03
  ar0 -3.664691925424D+01 ar1  4.752719886448D-01 ar2 -8.280792916138D-02
ELABMIN=  1.21220E 00 eV
ELABMAX=  6.46090E 01 eV
\end{verbatim}\end{small}

\subsection{
Reaction 0.4D    $He^+ + He \rightarrow He^+ + He$   diff. cross section
}


\begin{small}\begin{verbatim}
   a0 -3.332091557452D+01  a1 -3.823354679977D-01  a2 -2.666453887008D-01
   a3 -8.177418933677D-02  a4  2.593188019755D-02  a5  8.320863897668D-03
   a6 -1.649825718076D-03  a7 -2.491587647454D-04  a8  4.351897658362D-05
  al0 -3.302935901459D+01 al1 -1.115060000000D-01 al2  0.000000000000D+00
  ar0 -2.789589583796D+01 ar1 -2.000000000000D+00 ar2  0.000000000000D+00
```

```
ELABMIN=  0.02000E 00 eV
ELABMAX=  2.00000E 02 eV
\end{verbatim}\end{small}


\subsection{
Reaction 0.4V   $  He^+ + He \rightarrow He^+ + He $  visc. cross section
}



\begin{small}\begin{verbatim}
   a0 -3.379346231200D+01  a1 -1.740525006979D-01  a2 -8.091712353563D-02
   a3 -8.223847315134D-02  a4 -1.443276051210D-03  a5  6.530393601967D-03
   a6 -5.593294441844D-05  a7 -1.742244159818D-04  a8  1.068285383642D-05
  al0 -3.335648222384D+01 al1 -1.115060177785D-01 al2  0.000000000000D+00
  ar0 -2.751718958486D+01 ar1 -2.000000000000D+00 ar2  0.000000000000D+00
ELABMIN=  0.02000E 00 eV
ELABMAX=  2.00000E 02 eV
\end{verbatim}\end{small}


\begin{figure} \label{0.4}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/elast04.ps}
\end{figure}
\newpage

\subsection{
Reaction 0.5T   $ p + Ne \rightarrow p + Ne $ total cross
section }



\begin{small}\begin{verbatim}
   a0 -3.333282545037D+01    a1 -2.591757686627D-01    a2  5.905962318567D-02
   a3 -2.001826855775D-01    a4 -5.669049674832D-02    a5  3.137174515541D-01
   a6 -2.299821550060D-01    a7  6.688038706682D-02    a8 -6.994996779393D-03
  al0 -3.334100609281D+01   al1 -2.660471531811D-01   al2 -1.171591760471D-02
  ar0 -3.771378768853D+01   ar1  9.099449063061D-01   ar2 -1.337354731926D-01
ELABMIN=  0.62790E 00 eV
ELABMAX=  3.19973E 01 eV
\end{verbatim}\end{small}

\subsection{
Reaction 0.5D    $p + Ne \rightarrow p + Ne  $ diff. cross
section }


\begin{small}\begin{verbatim}
   a0 -3.397612223333D+01    a1 -7.944741087630D-01    a2 -3.200443973964D-01
   a3  2.143674395544D-02    a4  4.021546316704D-02    a5 -4.263678799110D-04
   a6 -2.276386458638D-03    a7 -3.001154820480D-06    a8  4.436110664443D-05
  al0 -3.344006570082D+01   al1 -1.264736732177D-01   al2  0.000000000000D+00
  ar0 -2.871071324009D+01   ar1 -2.000000000000D+00   ar2  0.000000000000D+00
ELABMIN=  0.01050E 00 eV
ELABMAX=  1.05000E 02 eV
\end{verbatim}\end{small}
```

```
\subsection{
Reaction 0.5V   $ p + Ne \rightarrow p + Ne  $ visc. cross
section }


\begin{small}\begin{verbatim}
   a0 -3.425296680643D+01    a1 -4.079254123231D-01    a2 -2.051623201200D-01
   a3 -4.669640022898D-02    a4  1.746802660208D-02    a5  4.241270429401D-03
   a6 -7.397954249705D-04    a7 -1.059957777533D-04    a8  1.168831982170D-05
  al0 -3.373988599214D+01   al1 -1.264736732177D-01   al2  0.000000000000D+00
  ar0 -2.849668424775D+01   ar1 -2.000000000000D+00   ar2  0.000000000000D+00
ELABMIN=  0.01050e 00 eV
ELABMAX=  1.05000e 02 eV
\end{verbatim}\end{small}



\begin{figure} \label{0.5}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/elast05.ps}
\end{figure}
\newpage



\subsection{
Reaction 0.6T   $ p + Ar \rightarrow p + Ar $ total cross
section }



\begin{small}\begin{verbatim}
   a0 -3.252771558768D+01    a1 -2.994313973955D-01    a2 -3.235294539387D-01
   a3  1.292660022245D+00    a4 -1.875728041457D+00    a5  1.314385161305D+00
   a6 -4.834707764434D-01    a7  8.976263360824D-02    a8 -6.639912411263D-03
  al0 -3.255656992304D+01   al1 -2.557987010452D-01   al2 -1.142012674223D-02
  ar0 -3.733310020910D+01   ar1  9.621654379319D-01   ar2 -1.332505124850D-01
ELABMIN=  1.00563E 00 eV
ELABMAX=  5.43280E 01 eV
\end{verbatim}\end{small}

\subsection{
Reaction 0.6D    $p + Ar \rightarrow p + Ar  $ diff. cross
section }


\begin{small}\begin{verbatim}
   a0 -3.300046179597D+01    a1 -5.241652502840D-01    a2 -2.862188345952D-01
   a3 -3.808042387800D-02    a4  2.731692136471D-02    a5  3.732186449899D-03
   a6 -1.323867831716D-03    a7 -9.428149507977D-05    a8  2.340068227020D-05
  al0 -3.200195937779D+01   al1  3.219272946637D-02   al2  0.000000000000D+00
  ar0 -2.798873683611D+01   ar1 -2.000000000000D+00   ar2  0.000000000000D+00
ELABMIN=  0.01025E 00 eV
ELABMAX=  1.02500E 02 eV
\end{verbatim}\end{small}

\subsection{
Reaction 0.6V   $ p + Ar \rightarrow p + Ar  $ visc. cross
section }
```

```
\begin{small}\begin{verbatim}
   a0 -3.344659528005D+01    a1 -2.316327281065D-01    a2 -7.902810934692D-02
   a3 -7.081702521173D-02    a4 -8.163451484200D-03    a5  5.173767719011D-03
   a6  8.930487483240D-04    a7 -1.149225205768D-04    a8 -2.179416064042D-05
  al0 -3.222949872234D+01   al1  3.219272946637D-02   al2  0.000000000000D+00
  ar0 -2.777200494194D+01   ar1 -2.000000000000D+00   ar2  0.000000000000D+00
ELABMIN=  0.01025e 00 eV
ELABMAX=  1.02500e 02 eV
\end{verbatim}\end{small}



\begin{figure} \label{0.6}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/elast06.ps}
\end{figure}
\newpage



\subsection{
Reaction 0.7T   $ p + Kr \rightarrow p + Kr $ total cross
section }



\begin{small}\begin{verbatim}
   a0 -3.217099198301D+01    a1 -2.966377676688D-01    a2 -2.616163755904D-01
   a3  1.046180820426D+00    a4 -1.532374878331D+00    a5  1.080443653930D+00
   a6 -3.994323904320D-01    a7  7.448807486523D-02    a8 -5.532560545765D-03
  al0 -3.219832641289D+01   al1 -2.577194242716D-01   al2 -1.156457632593D-02
  ar0 -3.656299611480D+01   ar1  7.386503642992D-01   ar2 -1.095842303625D-01
ELABMIN=  0.99496E 00 eV
ELABMAX=  5.69606E 01 eV
\end{verbatim}\end{small}

\subsection{
Reaction 0.7D    $p + Kr \rightarrow p + Kr  $ diff. cross
section }


\begin{small}\begin{verbatim}
   a0 -3.262831875045D+01    a1 -5.132763454362D-01    a2 -2.834710685102D-01
   a3 -4.303577717283D-02    a4  2.549874332091D-02    a5  4.067614437201D-03
   a6 -1.176633809631D-03    a7 -1.008012190920D-04    a8  1.995735768760D-05
  al0 -3.206995069647D+01   al1 -5.998480905376D-02   al2  0.000000000000D+00
  ar0 -2.770706826427D+01   ar1 -2.000000000000D+00   ar2  0.000000000000D+00
ELABMIN=  0.01011E 00 eV
ELABMAX=  1.01114E 02 eV
\end{verbatim}\end{small}

\subsection{
Reaction 0.7V   $ p + Kr \rightarrow p + Kr  $ visc. cross
section }


\begin{small}\begin{verbatim}
   a0 -3.308937458718D+01    a1 -2.158553767021D-01    a2 -6.932630020130D-02
   a3 -7.534625980338D-02    a4 -1.066481934150D-02    a5  5.423170191562D-03
```

```
   a6  1.055574923129D-03    a7 -1.193974259452D-04    a8 -2.508108481903D-05
  al0 -3.227537561040D+01   al1 -5.998480905376D-02   al2  0.000000000000D+00
  ar0 -2.750803302740D+01   ar1 -2.000000000000D+00   ar2  0.000000000000D+00
ELABMIN=  0.01011e 00 eV
ELABMAX=  1.01114e 02 eV
\end{verbatim}\end{small}


\begin{figure} \label{0.7}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/elast07.ps}
\end{figure}
\newpage


\subsection{
Reaction 0.8T   $ p + Xe \rightarrow p + Xe $ total cross
section }



\begin{small}\begin{verbatim}
   a0 -8.022745305889D+01    a1  1.563497534909D+02    a2 -2.198787103607D+02
   a3  1.720041600893D+02    a4 -8.202458014402D+01    a5  2.443504314279D+01
   a6 -4.445085155020D+00    a7  4.519723658716D-01    a8 -1.969077046350D-02
  al0 -3.273372765185D+01   al1 -1.978370734932D-01   al2 -7.780729379878D-03
  ar0 -3.529762555521D+01   ar1  2.820997908369D-01   ar2 -4.141441372472D-02
ELABMIN=  4.11282E 00 eV
ELABMAX=  1.22993E 02 eV
\end{verbatim}\end{small}

\subsection{
Reaction 0.8D    $p + Xe \rightarrow p + Xe  $ diff. cross
section }


\begin{small}\begin{verbatim}
   a0 -3.318665017785D+01    a1 -1.652711162673D-01    a2 -8.820446797035D-02
   a3 -4.031476436668D-02    a4  4.816376369566D-03    a5  2.865304171410D-03
   a6 -2.624353623005D-04    a7 -6.271242694944D-05    a8  6.709771809639D-06
  al0 -3.367397269144D+01   al1 -2.502739321615D-01   al2  0.000000000000D+00
  ar0 -2.275819247054D+01   ar1 -2.000000000000D+00   ar2  0.000000000000D+00
ELABMIN=  0.01008E 00 eV
ELABMAX=  1.00760E 03 eV
\end{verbatim}\end{small}

\subsection{
Reaction 0.8V   $ p + Xe \rightarrow p + Xe  $ visc. cross
section }


\begin{small}\begin{verbatim}
   a0 -3.353160943338D+01    a1 -1.556474053592D-01    a2 -3.165283483361D-02
   a3 -2.954761000116D-02    a4 -1.020213798216D-04    a5  1.787583845145D-03
   a6 -4.672186377936D-05    a7 -3.577368889534D-05    a8  2.586881672353D-06
  al0 -3.326401521314D+01   al1 -1.220855990887D-01   al2  0.000000000000D+00
  ar0 -2.266117187300D+01   ar1 -2.000000000000D+00   ar2  0.000000000000D+00
ELABMIN=  0.01008e 00 eV
ELABMAX=  1.00760e 03 eV
\end{verbatim}\end{small}
```

\begin{figure} \label{0.8}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/elast08.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.2.5
$ e + H_2 (X_g^+ S) \rightarrow . . . \rightarrow e + H(1s) + H(1s) $ }

Fit as given in \cite{kn:Janev} (given here only for reference purposes).
EIRENE uses fit as given in the unpublished preprint for
\cite{kn:Janev} in its default database.
This latter fit seems to be more plausible and has been put
into the file HYDHEL.
It is therefore recommended to read these
fit coefficients from the database HYDHEL, and not from here (AMJUEL).

\begin{displaymath}
 e + H_2 (X_g^+ S) \rightarrow e + H (b^3\Sigma^+_u , a^3\Sigma^+_g,
c^3\Pi_u)
             \rightarrow e + H(1s) + H(1s)
\end{displaymath}

\begin{small}\begin{verbatim}

   a0 -2.297914361380e+05   a1 5.303988579693e+05   a2 -5.316636672593e+05
   a3 3.022690779470e+05   a4 -1.066224144320e+05   a5 2.389841369114e+04
   a6 -3.324526406357e+03   a7 2.624761592546e+02   a8 -9.006246604428e+00
       Emin 1.08e+01   s(Emin) 1.00e-19   smax 2.92e-17   Error 5.62e-01
\end{verbatim}\end{small}
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\subsection{
Reaction 3.1.6FJ
$ p + H \rightarrow . . . \rightarrow p + e + p $ }

Freeman and Jones coefficients, transformed from the KeV to eV energy scale
E is the proton energy.

\begin{small}\begin{verbatim}
  a0 -5.607099441961D+02 a1 2.905103863403D+02 a2 -6.871403140568D+01
  a3 8.714435377189D+00 a4 -6.169007495812D-01 a5 2.294651604603D-02
  a6 -3.495444000000D-04 a7 0.000000000000D+00 a8 0.000000000000D+00

\end{verbatim}\end{small}
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```
\subsection{
Reaction 3.1.8R $  p + H(1s) \rightarrow H(1s) + p  $
}
Riviere cross section formula for charge exchange
(\cite{kn:Riviere}), fitted into
"Janev format"

\begin{small}\begin{verbatim}
  a0 -3.260293402651D+01  a1 -1.302091929244D-01  a2 -3.264584699247D-03
  a3 -2.837612246121D-03  a4  2.259716141071D-04  a5  3.105542152111D-04
  a6 -9.613308889191D-05  a7  1.043010252591D-05  a8 -3.944350620003D-07
  Max. rel. Error:    .7501 %
  Mean rel. Error:    .2304 %
\end{verbatim}\end{small}

\subsection{
Reaction 3.1.8S $  p + H(1s) \rightarrow H(1s) + p  $
}

D.Schultz cross section for charge exchange
fitted into "Janev format"


\begin{small}\begin{verbatim}
   a0 -3.296040048723D+01    a1 -9.877533792693D-02    a2  2.622855374688D-03
   a3 -3.210858385884D-03    a4 -2.175078820057D-04    a5  2.394562232339D-05
   a6  1.665865000000D-05    a7  0.000000000000D+00    a8  0.000000000000D+00
  ar0 -3.291743242047D+01   ar1 -1.358551000000D-01   ar2  0.000000000000D+00
ELABMAX=  2.00000E 01 eV
\end{verbatim}\end{small}
\subsection{
Reaction 3.1.8T $  p + H(1s) \rightarrow H(1s) + p  $
}
D.Schultz cross section for charge exchange *2
increase absolute coefficients by ln(2)

\begin{small}\begin{verbatim}
   a0 -3.226725330000D+01    a1 -9.877533792693D-02    a2  2.622855374688D-03
   a3 -3.210858385884D-03    a4 -2.175078820057D-04    a5  2.394562232339D-05
   a6  1.665865000000D-05    a7  0.000000000000D+00    a8  0.000000000000D+00
  ar0 -3.222428522000D+01   ar1 -1.358551000000D-01   ar2  0.000000000000D+00
ELABMAX=  2.00000E 01 eV
\end{verbatim}\end{small}

\subsection{
Reaction 3.1.8M $  p + H(1s) \rightarrow H(1s) + p  $
}
D.Schultz cross section for momentum exchange (elastic plus cx)
fitted into "Janev format"

\begin{small}\begin{verbatim}
   a0 -3.225844350904D+01    a1 -1.220948860470D-01    a2  7.214005848073D-03
   a3  5.997760021277D-04    a4 -1.060316696581D-03    a5 -7.487092727391D-05
   a6  3.824773000000D-05    a7  0.000000000000D+00    a8  0.000000000000D+00
  ar0 -3.221533966214D+01   ar1 -1.386002000000D-01   ar2  0.000000000000D+00
ELABMAX=  2.00000E 01 eV
\end{verbatim}\end{small}
\subsection{
Reaction 3.1.8J $  p + H(1s) \rightarrow H(1s) + p  $
}
```

Janev cross section for momentum exchange (cx*2)
increase absolute coefficients by ln(2)

\begin{small}\begin{verbatim}
   a0 -3.204809074000e+01   a1 -8.916456579806e-02   a2 -3.016990732025e-02
   a3 9.205482406462e-03   a4 2.400266568315e-03   a5 -1.927122311323e-03
   a6 3.654750340106e-04   a7 -2.788866460622e-05   a8 7.422296363524e-07
  al0 -3.225274882000D+01   al1 -1.713112000000D-01   al2 0.000000000000
ELABMIN=   0.10000E 00 eV
\end{verbatim}\end{small}

\begin{figure} \label{318RS}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/sigmacx.ps}
\end{figure}
\newpage
\subsection{
Reaction 3.1.8d $ p + H(1s) \rightarrow H(1s) + p $
}
For testing purposes:
Langevin cross section, sigma * vrel = const = 2e-8

\begin{small}\begin{verbatim}
   a0 -3.187171717171e 01   a1 -0.500000000000e-00   a2 0.000000000000e-00
   a3 0.000000000000e 00   a4 0.000000000000e 00   a5 0.000000000000e 00
   a6 0.000000000000e 00   a7 0.000000000000e 00   a8 0.000000000000e 00
\end{verbatim}\end{small}

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\section{H.2 : Fits for $<\sigma v> (T)$}\label{sect2}

\bigskip
Data from Freeman and Jones \cite{kn:Freeman},
for comparison with old cases.

Note: Maxwellian rate coefficients are taken for neutral particle energy = 0.0 eV
vs. temperature (electron or ion temp., resp.) of the Maxwellian f_{maxw}.
I.e. :

$<\sigma v> = \int dv_p \sigma(v_{p}) \cdot v_{p} \cdot
f_{maxw}(v_{p})top$

The ion impact rates can be scaled to different isotops and to finite
neutral particle temperatures T_n by evaluating the fits at an
effective temperature T_{eff} given by

$T_{eff} = \frac {M}{M_1} T_1 + \frac{M}{M_2} T_2 $

Here M is the mass of the ion as used in the Freeman/Jones rate coefficients,
M_1 and M_2 are the masses of the two isotops in the particular collision
process considered, and T_1 and T_2 are the two temperatures.

\bigskip

\subsection{
Reaction 2.1.5FJ $e + H (1s) \rightarrow e + H^+ + e$
}

```
\begin{small}\begin{verbatim}
   b0 -0.317385000000e+02    b1  0.114381800000e+02    b2 -0.383399800000e+01
   b3  0.704669200000e 00    b4 -0.743148620000e-01    b5  0.415374900000e-02
   b6 -0.948696700000e-04    b7  0.000000000000e-00    b8  0.000000000000e 00
\end{verbatim}\end{small}

\subsection{
Reaction 3.1.6FJ  $p + H(1s) \rightarrow H^+ + p + e$
}


\begin{small}\begin{verbatim}
   b0 -0.149086100000e+03  b1  0.759257500000e 02  b2 -0.220928100000e+02
   b3  0.390970900000e+01  b4 -0.440216800000e 00  b5  0.320904700000e-01
   b6 -0.149040900000e-02  b7  0.409415100000e-04  b8 -0.506977700000e-06
\end{verbatim}\end{small}

\subsection{
Reaction 3.1.8FJ  $p + H(1s) \rightarrow H(1s) + p  $
}


\begin{small}\begin{verbatim}
   b0 -0.184175600000e+02  b1  0.528295000000e 00  b2 -0.220047700000e+00
   b3  0.975019200000e-01  b4 -0.174918300000e-01  b5  0.495429800000e-03
   b6  0.217491000000e-03  b7 -0.253020600000e-04  b8  0.823075100000e-06
\end{verbatim}\end{small}

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\subsection{
Reaction 2.2.5
$e + H_2^1 (X_g^+ S ) \rightarrow . . .\rightarrow e + H(1s) + H(1s)$}


Fit as given in \cite{kn:Janev}.
      EIRENE uses fit as given in preprint for \cite{kn:Janev},
      unless otherwise specified, for the following process.
      This latter fit seems to be more plausible. Therefore, the
      preprint data are stored in file HYDHEL, whereas the original
      data from ref.\cite{kn:Janev} are given here in AMJUEL.



\begin{displaymath}
 e + H_2^1 (X_g^+ S ) \rightarrow e + H (b^3\Sigma^+_u , a^3\Sigma^+_g,
c^3\Pi_u)
             \rightarrow e + H(1s) + H(1s)
\end{displaymath}



\begin{small}\begin{verbatim}
   b0 -2.858072836568e+01    b1  1.038543976082e+01    b2 -5.383825026583e+00
   b3  1.950636494405e+00    b4 -5.393666392407e-01    b5  1.006916814453e-01
   b6 -1.160758573972e-02    b7  7.411623859122e-04    b8 -2.001369618807e-05
    Tmin 1.26e+00   <sv>(Tmin) 3.25e-12   <sv>max 3.82e-09   Error 1.07e-06
```

```
\end{verbatim}\end{small}
\begin{figure} \label{2.2.5.or}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/fig225.ps}
\end{figure}

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\subsection{
Reaction 2.2.17  $e + H_2 \rightarrow e + H_2(v) \rightarrow H + H^-$
}
Effective dissociative attachment rate.

$ <\sigma v>_{eff} = <\sigma v>_{H_2(\nu=0)} + \sum_{\nu=1}^{14}
<\sigma v>_{H_2(\nu)} \cdot pH_2(\nu) $

Vibrational distribution $pH_2(\nu,T_e)$ (vs. $T_e$) taken into
account. Only coupling
to $H_2$ ground state. No population of $H_2(\nu)$ from electronically
excited $H_2^*$, no radiative transitions between vibrational levels.
Assume: incident $H_2$ particle with 0.1 eV and $T_i = T_e$,
hence: density independent vibrational distribution and effective
rate.

Competing processes: see ion conversion, below, and contribution to
dissociation via vibrational states, i.e., enhanced transition into
repulsive triplett $^3b....$ state.

\begin{small}\begin{verbatim}
  b0 -2.278396332892D+01  b1  8.634828071751D-01  b2 -1.686619409809D+00
  b3  4.392288378207D-01  b4 -4.393128035945D-01  b5  2.640299048385D-01
  b6 -6.748601049114D-02  b7  7.753368735736D-03  b8 -3.328288267126D-04

  Max. rel. Error:  11.6159 %
  Mean rel. Error:   5.8452 %
\end{verbatim}\end{small}
\subsection{
Reaction 3.2.3   $p + H_2 \rightarrow H + H_2^+  $
}

  Effective ion conversion rate (charge exchange on $H_2$)

  $ <\sigma v>_{eff} = <\sigma v>_{H_2(\nu=0)} + \sum_{\nu=1}^{14}
<\sigma v>_{H_2(\nu)} \cdot pH_2(\nu) $

  Same vibrational distribution (as function of $T_e$) as above.
  Therefore:
  single parameter fit vs. $T_e$,
  since vibrational distribution does not depend upon density, $E_0$ is fixed
  (0.1 eV) and $T_p = T_e = T$.

\begin{small}\begin{verbatim}
  b0 -2.163099643422D+01  b1  3.206843053514D+00  b2 -3.369939911269D+00
  b3  1.290238400703D+00  b4 -3.988189754178D-01  b5  1.462287796966D-01
  b6 -3.524154596754D-02  b7  4.146324082808D-03  b8 -1.846022446828D-04

  Max. rel. Error:  10.2031 %
  Mean rel. Error:   6.3799 %

\end{verbatim}\end{small}
```

Competing process at low T: see above
\begin{figure} \label{3.2.3}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/ionconv1.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.2FJ $e + He(1|1S) \rightarrow e + He^+ + e$
}
Freeman and Jones rate for electron impact ionisation of helium atoms.

\begin{small}\begin{verbatim}
   b0 -0.445091700000e+02   b1 0.244298800000e+02   b2 -0.102571400000e+02
   b3 0.247093100000e+01   b4 -0.342636620000e 00   b5 0.250510000000e-01
   b6 -0.743867500000e-03   b7 0.000000000000e-00   b8 0.000000000000e 00
\end{verbatim}\end{small}

Data from impurity transport code "STRAHL" \cite{kn:Behringer}

All reaction data with label ..aB0 or ..aB1 are taken from that
reference. a is the nuclear charge number.

Ionisation Rate for neutral Helium Atoms

\subsection{
Reaction 2.2B0 $e + He \rightarrow e + He^+ + e $
}
\begin{small}\begin{verbatim}
   b0 -4.445750823378D+01   b1 2.505856927901D+01   b2 -1.196552488672D+01
   b3 3.715887422949D+00   b4 -7.729722462758D-01   b5 1.055704673374D-01
   b6 -9.047513943647D-03   b7 4.403714187787D-04   b8 -9.276447001487D-06

  Max. rel. Error: 0.4138 %
  Mean rel. Error: 0.1636 %
\end{verbatim}\end{small}

  Ionisation Rate for single charged Helium Ions

\subsection{
Reaction 2.2B1 $e + He^+ \rightarrow e + He^{++} + e$
}

\begin{small}\begin{verbatim}
   b0 -7.559669902889D+01   b1 5.464529470916D+01   b2 -2.644507121426D+01
   b3 8.159073714053D+00   b4 -1.694080618046D+00   b5 2.348225872648D-01
   b6 -2.073277438991D-02   b7 1.049056816265D-03   b8 -2.305310731172D-05

  Max. rel. Error: 0.9472 %
  Mean rel. Error: 0.5457 %

\end{verbatim}\end{small}

\begin{figure} \label{2.2B}

```
\epsfxsize=16truecm
\epsffile{Amjuel_PS/fig2_2B.ps}
\end{figure}
\newpage

 Ionisation Rates for neutral Beryllium Atoms

\subsection{
Reaction 2.4B0   $e + Be \rightarrow e + Be^+ + e $
}

\begin{small}\begin{verbatim}
  b0 -2.701191641765D+01    b1  9.882275334399D+00    b2 -4.581384174259D+00
  b3  1.463446005529D+00    b4 -3.282155444497D-01    b5  4.895458945839D-02
  b6 -4.558103660501D-03    b7  2.382205094374D-04    b8 -5.319547065990D-06

  Max. rel. Error:    .1411 %
  Mean rel. Error:    .0582 %

\end{verbatim}\end{small}

 Ionisation Rates for
 single charged Beryllium Ions

\subsection{
Reaction 2.4B1  $e + Be^+ \rightarrow e + Be^{++} + e $
}


\begin{small}\begin{verbatim}
  b0 -3.677989427190D+01    b1  1.855869089956D+01    b2 -8.843053626300D+00
  b3  2.708167857179D+00    b4 -5.651333671979D-01    b5  7.947570447499D-02
  b6 -7.160867067297D-03    b7  3.705422825861D-04    b8 -8.322700230771D-06

  Max. rel. Error:    .3962 %
  Mean rel. Error:    .2225 %

\end{verbatim}\end{small}

\begin{figure} \label{2.4B}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/beryi.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.5B0   $e + B \rightarrow e + B^+ + e $
}

 Ionisation Rates for neutral Boron Atoms


\begin{small}\begin{verbatim}
  b0 -2.652112807432D+01    b1  8.818502481012D+00    b2 -3.832208851779D+00
  b3  1.206778920817D+00    b4 -2.766330884306D-01    b5  4.255759023412D-02
  b6 -4.078840883672D-03    b7  2.185455019432D-04    b8 -4.985646766233D-06
\end{verbatim}\end{small}

\subsection{
Reaction 2.5B1   $e + B^+ \rightarrow e + B^{++} + e $
```

```
}

 Ionisation Rates for single charged Boron Ions


\begin{small}\begin{verbatim}
  b0 -4.420568125967D+01    b1  2.558429301929D+01    b2 -1.226766585830D+01
  b3  3.790617724445D+00    b4 -7.898969090461D-01    b5  1.094004163863D-01
  b6 -9.602179535698D-03    b7  4.812751663763D-04    b8 -1.045722639512D-05
\end{verbatim}\end{small}

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\subsection{
Reaction 2.6B0   $e + C \rightarrow e + C^+ + e  $
}

  Ionisation rate for neutral Carbon Atoms

  $<sigma*vrel>(Te)  (cm**3/s), C --> C^+$

\begin{small}\begin{verbatim}
  b0 -2.955122753053D+01  b1  1.180604026361D+01  b2 -5.438799573749D+00
  b3  1.750648117869D+00  b4 -3.946542606866D-01  b5  5.887749368990D-02
  b6 -5.469027807326D-03  b7  2.850693136991D-04  b8 -6.354758903485D-06

  Max. rel. Error:    .3712 %
  Mean rel. Error:    .1458 %

\end{verbatim}\end{small}
\subsection{
Reaction 2.6B1   $e + C^+ \rightarrow e + C^{++} + e  $
}

  Ionisation rate for Carbon Ions


\begin{small}\begin{verbatim}
  b0 -4.406752926798D+01  b1  2.464907506907D+01  b2 -1.157330396759D+01
  b3  3.619195611010D+00  b4 -7.853469883899D-01  b5  1.149856668829D-01
  b6 -1.070995852675D-02  b7  5.681198605329D-04  b8 -1.299242985961D-05

  Max. rel. Error:    .9478 %
  Mean rel. Error:    .4820 %

\end{verbatim}\end{small}
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\subsection{
Reaction 2.7B0   $e + N \rightarrow e + N^+ + e  $
}

  Ionisation rate for neutral Nitrogen Atoms
  (Bell et al., CLM-R216
```

```
  $<sigma*vrel>(Te)  (cm**3/s), N --> N^+$

\begin{small}\begin{verbatim}
  b0 -3.267927139870D+01  b1  1.487745850177D+01  b2 -7.393982038208D+00
  b3  2.552657836634D+00  b4 -6.031414732283D-01  b5  9.299608313666D-02
  b6 -8.862541230616D-03  b7  4.718778196780D-04  b8 -1.071093371002D-05

\end{verbatim}\end{small}
\begin{figure} \label{2.7B0}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/nitri.ps}
\end{figure}
\newpage


 Ionisation Rate for neutral Neon Atoms

\subsection{
Reaction 2.10B0   $e + Ne \rightarrow e + Ne^+ + e  $
}

\begin{small}\begin{verbatim}
  b0 -4.164979646286D+01  b1  2.217184105146D+01  b2 -1.042613793789D+01
  b3  3.175650981066D+00  b4 -6.293446783142D-01  b5  7.941711930007D-02
  b6 -6.140370720421D-03  b7  2.651559926489D-04  b8 -4.900429196295D-06

  Max. rel. Error:    .0200 %
  Mean rel. Error:    .0103 %

\end{verbatim}\end{small}

 Ionisation Rate for single charged Neon Ions

\subsection{
Reaction 2.10B1  $ e + Ne^+ \rightarrow e + Ne^{++} + e $
}

\begin{small}\begin{verbatim}
  b0 -6.100121276752D+01  b1  4.015006828838D+01  b2 -1.879440280294D+01
  b3  5.630907545903D+00  b4 -1.119573454119D+00  b5  1.458082247661D-01
  b6 -1.192136518944D-02  b7  5.544020624369D-04  b8 -1.117943418062D-05

  Max. rel. Error:    .1916 %
  Mean rel. Error:    .0814 %

\end{verbatim}\end{small}


\begin{figure} \label{2.10B0}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/neoni.ps}
\end{figure}

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\subsection{
Reaction 2.18B0   $e + Ar  \rightarrow e + Ar^+  + e$
}
```

```
  Ionisation Rate for neutral Argon Atoms

\begin{small}\begin{verbatim}
  b0 -3.330347417325D+01  b1  1.627861918393D+01  b2 -7.765170847889D+00
  b3  2.446384994382D+00  b4 -5.186581624286D-01  b5  7.184868450814D-02
  b6 -6.200405891186D-03  b7  3.018464732517D-04  b8 -6.325074170944D-06

  Max. rel. Error:    .1093 %
  Mean rel. Error:    .0503 %

\end{verbatim}\end{small}



\subsection{
Reaction 2.18B1   $e + Ar^+ \rightarrow e + Ar^{++} + e$
}

  Ionisation Rate for single charged Argon Ions

\begin{small}\begin{verbatim}
  b0 -4.577132769437D+01  b1  2.796761945871D+01  b2 -1.347073209993D+01
  b3  4.188634468306D+00  b4 -8.778893409977D-01  b5  1.220883796618D-01
  b6 -1.073976899816D-02  b7  5.386460788345D-04  b8 -1.169793339733D-05

  Max. rel. Error:    .3659 %
  Mean rel. Error:    .2214 %

\end{verbatim}\end{small}


\begin{figure} \label{2.18B}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/argi.ps}
\end{figure}
\newpage



\subsection{
Reaction 2.26B0   $e + Fe  \rightarrow e + Fe^+  + e$
}

  Ionisation Rate for neutral Iron Atoms

\begin{small}\begin{verbatim}
  b0 -2.457959373433D+01  b1  8.433391049230D+00  b2 -3.846892092374D+00
  b3  1.185976759143D+00  b4 -2.459329335625D-01  b5  3.266162856106D-02
  b6 -2.642594731066D-03  b7  1.182305727446D-04  b8 -2.237621366618D-06

  Max. rel. Error:    .0907 %
  Mean rel. Error:    .0450 %

\end{verbatim}\end{small}



\subsection{
Reaction 2.26B1   $e + Fe^+ \rightarrow e + Fe^{++} + e$
}
```

Ionisation Rate for single charged Iron Ions

```
\begin{small}\begin{verbatim}
  b0 -3.437574762141D+01  b1  1.685181764677D+01  b2 -7.911217139035D+00
  b3  2.442620345655D+00  b4 -5.072788444089D-01  b5  6.899131935535D-02
  b6 -5.866292819569D-03  b7  2.825378750379D-04  b8 -5.881378739141D-06

  Max. rel. Error:    .2106 %
  Mean rel. Error:    .1105 %


\end{verbatim}\end{small}


\begin{figure} \label{2.26B}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/fei.ps}
\end{figure}
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\section{H.3 : Fits for $<\sigma v> (E,T)$}\label{sect3}


\subsection{
Reaction 0.1T  $p + H(1s) \rightarrow  + H(1s)$
, elastic ,
$\  I_{0,0}$
}




\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
 T-Index:
        0   -1.823472394862D+01    1.043929094352D-01    3.385021298310D-02
        1    1.218869427323D-01   -8.071776515805D-02   -6.163024588310D-03
        2    2.183144859635D-02    6.947238019788D-03   -1.029753867911D-02
        3   -8.144414285471D-03    7.950619428888D-03    1.480212482573D-03
        4   -2.414158185489D-03   -1.610515523206D-03    1.147576632073D-03
        5    4.042335482230D-04   -3.333068266837D-04   -2.109287055048D-04
        6    6.684610364551D-05    1.395481729149D-04   -3.872093410396D-05
        7   -1.814826813629D-05   -1.589238118662D-05    1.137141330233D-05
        8    1.049993252610D-06    6.124957529757D-07   -6.966443729323D-07

        E-Index:     3                    4                    5
 T-Index:
        0   -2.048059867515D-03   -4.577324303045D-03    5.174052650323D-05
        1    8.404776509987D-03    5.448141329729D-04   -6.017991251450D-04
        2   -1.660137737426D-03    1.687354957150D-03    1.123876140912D-05
        3   -1.907814505083D-03    2.558232467687D-05    1.587671168547D-04
        4    5.801892116713D-04   -2.945348864215D-04   -2.556467005779D-05
        5    8.053144974289D-05    2.875034864587D-05   -9.746625582656D-06
        6   -5.043290334814D-05    1.493675458929D-05    3.216371174204D-06
        7    6.798870422148D-06   -3.269371275613D-06   -3.202325463122D-07
        8   -3.006730549005D-07    1.854263211106D-07    1.033863743276D-08

        E-Index:     6                    7                    8
 T-Index:
```

```
        0    2.673201510283D-04   -4.451268371503D-05    2.199498285047D-06
        1    3.536937592691D-05    9.054714466075D-06   -8.596768109209D-07
        2   -1.224423097417D-04    2.126181472934D-05   -1.100195177512D-06
        3   -2.858120151811D-05    1.112919746718D-06    4.374805864224D-08
        4    2.747846551451D-05   -4.380086290415D-06    2.202510674285D-07
        5   -6.360748557750D-07    3.783870577323D-07   -2.732689440408D-08
        6   -1.738436960565D-06    2.363371059212D-07   -1.072861195261D-08
        7    3.156490387804D-07   -5.006550452098D-08    2.526895478569D-09
        8   -1.655735806555D-08    2.801053970232D-09   -1.467609659450D-10

Max. rel. Error:   0.5284 %
Mean rel. Error:   0.0853 %
\end{verbatim}\end{small}
\begin{figure} \label{0.1T}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/bachr1.ps}
\end{figure}
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\subsection{
Reaction 0.1D  $p + H(1s) \rightarrow  + H(1s)$ ,
elastic, $\ I_{1,0}$
}

\begin{small}\begin{verbatim}
        E-Index:     0                   1                   2
 T-Index:
        0   -1.934778779385D+01    2.193162842747D-02   -5.787610534513D-04
        1    8.400121290584D-04   -5.025758478606D-02    9.405606314808D-03
        2   -1.072570686950D-02    1.258217951174D-02   -7.629292880371D-03
        3   -7.329656452946D-03    1.017355462044D-02   -2.212101744320D-03
        4   -1.548110966373D-03   -4.141816249813D-03    1.623377903131D-03
        5    8.780715214347D-05   -5.483013774324D-04    1.371503461028D-04
        6    6.351915617491D-05    4.711920962053D-04   -1.702351291260D-04
        7   -1.071915622348D-05   -7.653900655552D-05    2.828377077442D-05
        8    5.468789447600D-07    3.989227802803D-06   -1.457895095025D-06

        E-Index:     3                   4                   5
 T-Index:
        0   -9.555854995025D-03   -3.071069026823D-03    5.668304238739D-04
        1    1.213464571187D-02   -3.615417883123D-03   -8.289738887452D-04
        2   -3.222678509228D-03    2.181349883244D-03    1.491076548317D-04
        3   -4.530314087059D-03    1.707627243838D-03    3.285319171515D-04
        4    1.894095127078D-03   -8.173359548467D-04   -1.268607651578D-04
        5    2.806873100807D-04   -1.147859100868D-04   -2.036026302326D-05
        6   -2.386998803904D-04    9.947217842552D-05    1.676927171418D-05
        7    3.936468195914D-05   -1.609704117822D-05   -2.801579443731D-06
        8   -2.077060263537D-06    8.298532548793D-07    1.504259503231D-07

        E-Index:     6                   7                   8
 T-Index:
        0    1.023499873278D-04   -4.375997865613D-05    3.554762032992D-06
        1    4.794896057762D-04   -7.011568552117D-05    3.413857855011D-06
        2   -2.352460376261D-04    4.210499686989D-05   -2.314387560956D-06
        3   -2.365796504952D-04    3.759133611684D-05   -1.934588738006D-06
        4    1.083092577128D-04   -1.817871861306D-05    9.758474990215D-07
        5    1.584828965214D-05   -2.554030249359D-06    1.314431146313D-07
        6   -1.358046593907D-05    2.254690862488D-06   -1.202340694084D-07
        7    2.216781743757D-06   -3.678764178035D-07    1.970465840287D-08
```

```
        8   -1.154459633382D-07    1.906633038081D-08   -1.021379321893D-09

 Max. rel. Error:   2.5240
 Mean rel. Error:   0.4077
\end{verbatim}\end{small}

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\subsection{
Reaction 0.2T $ p + He(1s) \rightarrow p + He(1s) ,\  $
elastic, $ \  I_{0,0} $
}

\begin{small}\begin{verbatim}
        E-Index:     0                   1                   2
 T-Index:
        0   -1.934393021918D+01    6.563446707236D-02   -1.132533853318D-01
        1    1.301350106064D-01   -4.071555273225D-02    2.016906859537D-02
        2    1.828664127573D-02    1.460635793653D-02    6.745665311224D-03
        3   -1.572566883649D-02   -3.953675178715D-03    1.747850519967D-03
        4   -1.651243630315D-02   -2.847284094044D-04   -1.016420463987D-03
        5    1.536731193440D-03    5.204625005620D-04   -1.110404741405D-04
        6    1.407936221176D-03   -1.273303544933D-04    7.874267771795D-05
        7   -3.024575206489D-04    1.258652128299D-05   -9.943699290077D-06
        8    1.717075379788D-05   -4.489657191575D-07    3.942435517534D-07

        E-Index:     3                   4                   5
 T-Index:
        0   -2.108203840264D-02    5.126981927132D-02   -3.332060792240D-03
        1    4.145056754712D-03   -1.207683748654D-02    9.777916409735D-04
        2   -2.343836845279D-03   -2.643817205066D-03    4.122233549648D-04
        3    1.316616725294D-03   -3.328603688720D-04   -1.025202074732D-04
        4    2.115185323595D-04    3.305924890461D-04   -4.422649148500D-05
        5   -2.096646478748D-04    4.907753719257D-05    1.750257851569D-05
        6    3.694523090258D-05   -3.137559296212D-05   -2.054573401396D-06
        7   -2.076330117601D-06    3.934064976552D-06    7.117080375326D-08
        8    5.837947019108D-09   -1.543181228289D-07    1.142825149606D-09

        E-Index:     6                   7                   8
 T-Index:
        0   -5.396242466413D-03    1.236276138019D-03   -7.628885182442D-05
        1    1.273531852240D-03   -3.057392495993D-04    1.949879233267D-05
        2    2.238463116916D-04   -5.822708605029D-05    3.713522343609D-06
        3    3.644852940119D-05   -2.948705115200D-06    2.772902778994D-08
        4   -2.296832307757D-05    5.703124977270D-06   -3.560603032570D-07
        5   -7.404629231556D-06    8.730873892378D-07   -3.238131969596D-08
        6    3.004305767140D-06   -4.823864866020D-07    2.370653749977D-08
        7   -3.116821151336D-07    4.985170981511D-08   -2.366645009836D-09
        8    9.670471248063D-09   -1.366953072466D-09    5.308492125136D-11

 Max. rel. Error:  43.0372 %
 Mean rel. Error:   3.6615 %

\end{verbatim}\end{small}
\begin{figure} \label{0.2T}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/bachr2.ps}
\end{figure}
```

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\subsection{
Reaction 0.2D $ p + He(1s) \rightarrow p + He(1s) ,\  $
elastic, $ \  I_{1,0} $
}

\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
 T-Index:
        0   -2.038078616420D+01   -4.993496998398D-02    2.460551521383D-02
        1   -3.301657139332D-01   -3.084287321372D-02    1.554461839749D-02
        2   -1.250516030333D-01    3.495799299565D-02   -1.424614705786D-02
        3    6.328424290736D-03   -3.821208294684D-03   -1.623627120526D-03
        4    1.127524699096D-02   -2.410962290755D-03    1.757598241612D-03
        5   -1.287708708939D-03    4.847023005705D-04    9.455808977270D-05
        6   -6.368309748535D-04    4.413818051866D-05   -1.552922023412D-04
        7    1.421859797928D-04   -1.659744792044D-05    2.551798508100D-05
        8   -8.055939868827D-06    1.038460845033D-06   -1.289836231544D-06

        E-Index:     3                    4                    5
 T-Index:
        0   -1.517017165274D-02   -2.397648448576D-02    3.029365163804D-03
        1    3.040700264374D-02   -2.593835985009D-03   -3.146176415388D-03
        2   -9.657174093701D-03    7.433666067399D-03    4.191585645845D-04
        3   -2.321909525809D-03    7.614727149051D-04    2.681001889717D-04
        4    1.188908537635D-03   -1.115315269461D-03   -4.859218322237D-05
        5    3.089582619996D-05    7.699187722499D-06   -8.863762072239D-06
        6   -6.629197652130D-05    8.154996921696D-05    1.796356820001D-06
        7    9.800954064911D-06   -1.473582389149D-05    6.040382986474D-08
        8   -4.465334549154D-07    7.821310450330D-07   -1.548297648690D-08

        E-Index:     6                    7                    8
 T-Index:
        0    2.120043324652D-03   -5.206063712236D-04    3.229462400161D-05
        1    6.652125688558D-04   -2.834612166641D-05   -1.127219264426D-06
        2   -8.556829101842D-04    1.582340533265D-04   -8.789744795492D-06
        3   -1.226460004470D-04    1.517380199975D-05   -6.070841562603D-07
        4    1.341954089088D-04   -2.572769659598D-05    1.459166812937D-06
        5   -8.619326544178D-07    6.166331772717D-07   -5.093661426041D-08
        6   -9.360612397745D-06    1.830066731050D-06   -1.043424396036D-07
        7    1.676084936402D-06   -3.453407619810D-07    2.029350887316D-08
        8   -8.843599781403D-08    1.879251002731D-08   -1.123059892608D-09

 Max. rel. Error:   4.5211
 Mean rel. Error:   1.0118
\end{verbatim}\end{small}

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\subsection{
Reaction 0.3T  $p + H_2 \rightarrow  p + H_2 ,\ $  elastic,
$\  I_{0,0}$
}

\begin{small}\begin{verbatim}
```

```
       E-Index:     0                    1                    2
  T-Index:
       0   -1.850658754996D+01    7.211082264457D-02    2.881570478725D-02
       1    2.020169165482D-01   -6.382135800278D-02   -1.628749501583D-02
       2    2.598024510290D-02    1.330939790463D-02   -3.589374170071D-03
       3   -1.678447543630D-02    1.969680248144D-03    2.420309504140D-03
       4   -3.805013471382D-03   -8.538366688716D-04    1.219958125509D-04
       5    5.832875302941D-04    1.404105142335D-05   -1.373999872185D-04
       6    1.183272287480D-04    1.754003746153D-05    4.575214200943D-06
       7   -9.013768167130D-06   -1.593144865711D-06    2.703806954321D-06
       8   -7.237839929582D-07    1.856207389335D-08   -2.288152742189D-07

       E-Index:     3                    4                    5
  T-Index:
       0    2.824670772476D-03   -1.925459417470D-03   -3.785321033027D-04
       1    3.609681973946D-03    2.430555593258D-03   -5.689585982541D-04
       2   -2.973717962634D-03   -2.983530508154D-05    4.140245564780D-04
       3    1.164630658778D-04   -3.334041165620D-04   -1.688850581453D-05
       4    2.448727242148D-04    3.615934391216D-06   -2.949112340307D-05
       5   -3.662763983152D-05    2.253519645066D-05    4.135548971992D-06
       6   -4.332949346678D-06   -1.278290014948D-06    5.039287664347D-07
       7    1.185717497396D-06   -5.094274460491D-07   -1.239318519727D-07
       8   -6.264732541905D-08    4.920894679796D-08    5.881467421248D-09

       E-Index:     6                    7                    8
  T-Index:
       0    1.364568368798D-04    1.549425706176D-05   -6.618501118923D-06
       1   -1.393818486289D-04    6.326271239195D-05   -6.695217940204D-06
       2   -9.885614172244D-06   -3.254217622645D-05    4.703412615895D-06
       3    1.899933955654D-05   -1.395858712371D-06    6.819987383210D-08
       4    1.515103150938D-06    1.989212957512D-06   -3.032181942708D-07
       5   -1.527239138118D-06   -2.816863864732D-08    1.345210099656D-08
       6    3.182007050723D-08   -4.398423525407D-08    6.503053760354D-09
       7    3.952472363950D-08    8.350979668461D-10   -3.926411713518D-10
       8   -3.379572792986D-09    3.141592395102D-10   -2.459493010474D-11

  Max. rel. Error:   3.4420 %
  Mean rel. Error:   1.2045 %
  Ti: 0.01---1000, EB: 0.1---100
\end{verbatim}\end{small}

\begin{figure} \label{0.3T}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/bachr3.ps}
\end{figure}
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\subsection{
Reaction 0.3D  $p + H_2 \rightarrow  p + H_2 ,\ $  elastic,
$\  I_{1,0}$
}

\begin{small}\begin{verbatim}
       E-Index:     0                    1                    2
 T-Index:
       0   -1.919275366997D+01   -1.865238346305D-02    4.682617815803D-02
       1   -5.947780482087D-02   -5.971382726967D-02    5.854568958623D-03
       2   -9.004077564531D-02    3.225709371997D-02   -6.402554946956D-03
       3   -1.870459871354D-02   -1.438038218134D-03    2.190778358004D-03
```

```
        4    1.491376597764D-02   -1.614133948666D-03   -1.009422051586D-03
        5    9.563126960467D-04    3.707880488168D-04   -7.731975035804D-05
        6   -1.330077285945D-03   -5.353962725785D-05    1.351235395106D-04
        7    2.020583687196D-04    6.849923024482D-06   -2.550615695507D-05
        8   -9.277851726161D-06   -4.082429350941D-07    1.441579661485D-06

        E-Index:     3                    4                    5
 T-Index:
        0   -8.932266130300D-03   -2.903882752834D-02    3.477806471368D-03
        1    1.637194804434D-02   -3.291459604645D-04   -1.492225099738D-03
        2   -1.308998760658D-03    2.367849536658D-03   -2.633913429665D-04
        3   -2.828299306442D-04   -4.686890203582D-07    4.818941917867D-05
        4   -5.326505552258D-04    1.673303613736D-04    6.564947466483D-05
        5    2.493241008729D-05   -2.434562819338D-05   -5.585591947606D-06
        6    6.595946297185D-05   -2.509630806820D-05   -5.474903148493D-06
        7   -1.420945572125D-05    6.290869308799D-06    1.207885423899D-06
        8    8.431661832790D-07   -4.002257378192D-07   -7.135379893415D-08

        E-Index:     6                    7                    8
 T-Index:
        0    2.790218940150D-03   -6.908438427090D-04    4.338681573230D-05
        1    1.443370523034D-04    2.409850106077D-05   -2.849926680503D-06
        2   -1.712112384677D-04    4.233619961041D-05   -2.665571098691D-06
        3   -1.902274102571D-05    2.446426035585D-06   -9.693955463859D-08
        4   -2.847616427622D-05    3.578927723952D-06   -1.517016799547D-07
        5    4.669438326556D-06   -7.601170248698D-07    3.823110747713D-08
        6    3.257943960303D-06   -4.775908920414D-07    2.342435491722D-08
        7   -8.361574596535D-07    1.290522448864D-07   -6.505820743915D-09
        8    5.318078186713D-08   -8.385721089159D-09    4.277930018700D-10

 Max. rel. Error:   5.2866
 Mean rel. Error:   1.2591
\end{verbatim}\end{small}

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\subsection{
Reaction 0.4T  $He^+ + He \rightarrow He^+ + He ,\ $
 elastic, $\  I_{0,0}$
}

\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
 T-Index:
        0   -1.932287393135D+01   -6.254173654177D-02    7.946623543420D-02
        1    7.420452433663D-02   -1.124812231885D-02   -2.699799758379D-02
        2    4.578246117879D-02    5.807748349427D-03   -6.767337797049D-03
        3    9.376519610500D-03    3.743869063612D-03    1.935668442071D-03
        4   -1.232363387636D-02   -1.100675144650D-03    3.439916049619D-04
        5   -1.307054294818D-03   -8.910211076373D-05   -1.851109052007D-04
        6    1.118562583548D-03    5.617956521495D-05    4.722943119535D-05
        7   -1.434031268233D-04   -6.365356860650D-06   -7.103013883339D-06
        8    5.358989072610D-06    2.334269507353D-07    4.090109024266D-07

        E-Index:     3                    4                    5
 T-Index:
        0    8.838505558116D-02   -2.793201134092D-02   -9.954061526499D-03
```

```
        1   -1.884565424365D-02    1.123857510199D-02    1.596841699378D-03
        2   -2.495042935023D-03    1.439511185350D-04    2.861967025267D-04
        3   -2.047050990056D-03   -1.947991019023D-04    2.018359028340D-04
        4    7.434976678383D-04   -4.730384293613D-05   -6.250784297096D-05
        5    1.117168152610D-04    3.115251093953D-05   -1.325389437604D-05
        6   -5.881739628460D-05   -1.308533305864D-05    6.051250040246D-06
        7    6.666955388827D-06    2.380955160803D-06   -7.094040977952D-07
        8   -2.367498282831D-07   -1.427503775556D-07    2.786934787376D-08

        E-Index:     6                    7                    8
 T-Index:
        0    3.764403463819D-03   -3.408466490224D-04    6.412518246520D-06
        1   -1.389644457539D-03    2.161107270253D-04   -1.049187773127D-05
        2   -4.171591875990D-06   -1.196874977368D-05    1.094079145119D-06
        3   -1.598805546650D-05   -2.311078550298D-06    2.483893468689D-07
        4    1.280702702425D-05   -7.877322455546D-07    9.482501133602D-09
        5   -2.131389375108D-07    3.650222503579D-07   -2.688165319879D-08
        6    1.603031094261D-07   -1.683294115673D-07    1.140269704662D-08
        7   -1.056486811884D-07    3.540020523528D-08   -2.124298972987D-09
        8    9.141132772747D-09   -2.324505150923D-09    1.328831955405D-10

 Max. rel. Error:  45.6817
 Mean rel. Error:   5.1917
\end{verbatim}\end{small}

\begin{figure} \label{0.4T}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/bachr4.ps}
\end{figure}
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\subsection{
Reaction 0.4D  $He^+ + He \rightarrow He^+ + He ,\ $
 elastic, $\  I_{1,0}$
}

\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
 T-Index:
        0   -2.005856706409D+01   -2.416298567134D-02   -1.290643907647D-01
        1   -1.723033466633D-01   -2.876974997211D-02    6.358697996829D-02
        2   -8.480540790141D-02    2.121102722373D-02    1.060648053441D-03
        3   -1.583772608067D-02    2.831738365425D-04    3.604228124024D-04
        4    7.141918601934D-03   -2.712847139884D-03   -1.390046088713D-03
        5    1.050415524504D-03    3.514199969505D-04   -1.430457735837D-04
        6   -5.609743409859D-04    1.114910501595D-04    1.776137463792D-04
        7    5.528775780351D-05   -2.849479698839D-05   -2.957402039735D-05
        8   -1.298487796038D-06    1.744141312203D-06    1.511018855995D-06

        E-Index:     3                    4                    5
 T-Index:
        0   -7.609374902789D-02    2.051842775759D-02    6.700343984959D-03
        1    1.484173774740D-02   -1.259800535085D-02   -3.314345389346D-04
        2    7.437796246116D-03   -1.933320600619D-03   -8.197110013265D-04
        3    5.722003993817D-04    1.577284882295D-04   -1.165904265498D-04
        4   -7.836120750894D-04    5.279763008829D-04    7.329216329788D-05
        5   -8.871424676206D-05    1.610771935311D-06    9.934442032629D-06
        6    6.401396318081D-05   -5.184619145829D-05   -4.985193070868D-06
        7   -7.539210289621D-06    9.524059409052D-06    4.297672500003D-07
        8    2.529392826633D-07   -5.084304524420D-07   -5.932611004947D-09
```

```
       E-Index:     6                    7                    8
 T-Index:
        0   -2.466827019035D-03    2.195450363238D-04   -4.275624910534D-06
        1    9.943338501590D-04   -1.676144873446D-04    8.508217370560D-06
        2    3.610884437671D-04   -4.659019201525D-05    2.019277552554D-06
        3    1.134360853468D-05    9.293505569914D-07   -1.249357290876D-07
        4   -6.844730630933D-05    1.119496625366D-05   -5.759041144367D-07
        5   -1.298801064099D-06   -4.988842872544D-08    9.924160039487D-09
        6    6.074150104979D-06   -1.029965177536D-06    5.399132209393D-08
        7   -1.048375199655D-06    1.905679254148D-07   -1.033208843896D-08
        8    5.357991449124D-08   -1.021819231976D-08    5.659599344410D-10

 Max. rel. Error:   4.6006
 Mean rel. Error:   1.4030

\end{verbatim}\end{small}
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\subsection{
Reaction 0.5T  $p + Ne \rightarrow p + Ne ,\ $
 elastic, $\  I_{0,0}$
}

\begin{small}\begin{verbatim}
         E-Index:     0                    1                    2
  T-Index:
        0   -1.920759314942D+01   -5.203892840321D-02    6.256738740832D-02
        1    2.301174650324D-01    4.598103585536D-02   -4.529061500977D-02
        2   -2.844809537536D-03   -2.458775402853D-03    5.193663554519D-03
        3   -2.057818892403D-02   -7.174444135106D-03    1.007438682679D-03
        4   -1.247725873726D-02    1.478687710859D-03    3.953183188726D-04
        5    2.157436023407D-03    3.355091844482D-04   -8.112880498847D-05
        6    9.992078785249D-04   -1.437802559650D-04   -5.015798225079D-05
        7   -2.519290342081D-04    1.679868230149D-05    1.313639535025D-05
        8    1.528819949488D-05   -6.582462835809D-07   -8.420538426381D-07

         E-Index:     3                    4                    5
  T-Index:
        0    3.570384214557D-02   -2.599370622275D-02   -1.307788828471D-03
        1   -3.361904573721D-02    1.857018937894D-02    1.960502872244D-03
        2    4.605054021354D-03   -1.471661007966D-03   -3.978819729213D-04
        3    3.298168445875D-03   -9.406952560414D-04   -2.831787775281D-04
        4   -7.251750861538D-04   -7.779131291367D-05    8.979474917231D-05
        5   -1.832873740518D-04    7.101665930610D-05    1.518922775711D-05
        6    7.431587797692D-05    4.751928717840D-06   -9.288005671637D-06
        7   -8.355288839969D-06   -3.287000259239D-06    1.308988935499D-06
        8    3.123866169547D-07    2.487732705021D-07   -6.106353269941D-08

         E-Index:     6                    7                    8
  T-Index:
        0    3.079721700396D-03   -5.958055457558D-04    3.413526344209D-05
        1   -2.294912090837D-03    4.037290717482D-04   -2.198722138819D-05
        2    1.769972448752D-04   -2.083969105626D-05    8.333041368586D-07
        3    1.507107647921D-04   -2.125246166296D-05    9.847199659415D-07
        4   -7.898054427499D-07   -3.134863355412D-06    2.737318021218D-07
        5   -1.088302678431D-05    1.723721432651D-06   -8.713592846203D-08
```

```
         6    7.411456169336D-07    1.836531987751D-07   -2.021065290807D-08
         7    2.067606837134D-07   -9.097454398809D-08    6.730401523292D-09
         8   -2.086750507882D-08    6.592902645608D-09   -4.544772018004D-10
\end{verbatim}\end{small}


\begin{figure} \label{0.5T}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/bachr5.ps}
\end{figure}
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\subsection{
Reaction 0.5D  $p + Ne \rightarrow p + Ne ,\ $
 elastic, $\  I_{1,0}$
}

\begin{small}\begin{verbatim}
         E-Index:     0                    1                    2
  T-Index:
         0   -2.002574827025D+01   -9.486205506769D-03   -1.916286734818D-02
         1   -2.537906409600D-01    1.220589506641D-02   -4.405411696435D-03
         2   -1.492855002501D-01    2.319954090051D-04    1.263929021478D-02
         3    2.277262949762D-02   -4.830188456031D-03   -2.750452234840D-03
         4    1.454565132881D-02    1.634829233387D-03   -7.315594083272D-04
         5   -2.459106378105D-03    3.600089747182D-05    2.671541616531D-04
         6   -7.404449444601D-04   -9.641735194704D-05   -7.552824895881D-06
         7    1.859174611798D-04    1.571912622960D-05   -4.091377459615D-06
         8   -1.080632769187D-05   -7.917702265677D-07    3.295235267228D-07

         E-Index:     3                    4                    5
  T-Index:
         0    3.064150950343D-04    5.770565072378D-03   -1.288012249760D-03
         1   -9.350961151995D-03    2.046783521289D-03    1.263699863822D-03
         2    5.587555734861D-03   -3.892475694794D-03   -2.567575758703D-04
         3    3.929098223217D-04    4.312366386482D-04   -1.038820514086D-04
         4   -7.648388450741D-04    3.694752429370D-04    4.454311674256D-05
         5    9.309623048752D-05   -7.252696686113D-05   -1.552983373470D-06
         6    2.291515177534D-05   -9.054806193408D-06   -1.496738021147D-06
         7   -5.643860949550D-06    3.070565006104D-06    2.494317965158D-07
         8    3.263260078468D-07   -1.924412405804D-07   -1.206274348614D-08

         E-Index:     6                    7                    8
  T-Index:
         0   -6.056764332700D-04    1.841533150445D-04   -1.268081106690D-05
         1   -3.065943896812D-04    6.450450819580D-06    1.427066945930D-06
         2    4.415539725039D-04   -8.037605353389D-05    4.426529308029D-06
         3   -2.150818421027D-05    8.166836349571D-06   -6.038520579569D-07
         4   -5.066174985198D-05    9.122002151237D-06   -5.057086230537D-07
         5    7.660825723624D-06   -1.561716894668D-06    9.411992094619D-08
         6    1.670809775312D-06   -3.122277677479D-07    1.755858285560D-08
         7   -4.493868279400D-07    8.907923424961D-08   -5.237533360927D-09
         8    2.688180498679D-08   -5.445051092452D-09    3.250534258748D-10

\end{verbatim}\end{small}
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```
\subsection{
Reaction 0.6T  $p + Ar \rightarrow p + Ar ,\ $
 elastic, $\  I_{0,0}$
}

\begin{small}\begin{verbatim}
         E-Index:     0                    1                    2
  T-Index:
         0   -1.839897580907D+01    4.030184662143D-03    1.802460470789D-03
         1    2.037060320748D-01   -5.396105402336D-03   -7.769954287934D-04
         2    1.248391636263D-02    2.603532176725D-03   -3.227588765414D-04
         3    7.219811509122D-03   -4.061565358391D-04   -3.750257185540D-04
         4   -1.470827813902D-02    2.065674500382D-05    3.333229773836D-04
         5   -8.480842849852D-04   -4.796563627170D-05   -5.309221423582D-05
         6    1.475843994216D-03    2.151994248608D-05   -7.098388544357D-06
         7   -2.369733723824D-04   -3.291364962627D-06    2.359507987294D-06
         8    1.134634185229D-05    1.702489707640D-07   -1.506817496256D-07

         E-Index:     3                    4                    5
  T-Index:
         0    3.294800134968D-04    1.465250143471D-04    8.663294112725D-05
         1   -6.037520883955D-05   -7.833105742017D-04   -7.893554189454D-05
         2    2.800210419328D-04    7.133616427016D-04   -7.316301877565D-05
         3   -3.944497369254D-04    1.428880614656D-07    6.395999790794D-05
         4    1.035484083951D-04   -1.259450451777D-04   -6.254483715556D-06
         5    2.614410225361D-05    2.546750118822D-05   -5.673820883686D-06
         6   -1.539637991363D-05    2.130859838243D-06    1.919659151259D-06
         7    2.333187328954D-06   -9.290655798117D-07   -2.320465866922D-07
         8   -1.174046627783D-07    6.235484198986D-08    1.001839767228D-08

         E-Index:     6                    7                    8
  T-Index:
         0    6.685225434320D-07   -4.106232974060D-06    2.723608800669D-07
         1    7.183376311050D-05   -7.472067446331D-06    1.322655803936D-07
         2   -7.138077909744D-05    1.620936024346D-05   -9.673898950970D-07
         3   -1.770621609979D-06   -2.727090501391D-06    2.643852072903D-07
         4    1.305037799181D-05   -2.175685933563D-06    1.088658237035D-07
         5   -2.138483570591D-06    6.604985427235D-07   -4.569211762479D-08
         6   -4.041031701627D-07   -3.355268537350D-09    2.937036162249D-09
         7    1.213582669967D-07   -1.417846453379D-08    4.992956309007D-10
         8   -7.672622548871D-09    1.110090107209D-09   -5.119220753399D-11
\end{verbatim}\end{small}


\begin{figure} \label{0.6T}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/bachr6.ps}
\end{figure}
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\subsection{
Reaction 0.6D  $p + Ar \rightarrow p + Ar ,\ $
 elastic, $\  I_{1,0}$
}

\begin{small}\begin{verbatim}
         E-Index:     0                    1                    2
  T-Index:
         0   -1.902636300376D+01    3.001140234133D-03   -5.268608243610D-03
         1   -1.190527528568D-01   -9.553336489669D-03    8.838025019236D-03
```

```
         2   -1.730087103659D-01    4.587817497859D-03   -1.385574331019D-03
         3   -1.555030094420D-04   -6.909759775226D-05   -2.299454149526D-03
         4    1.652235885356D-02   -2.381913347984D-04    8.373956786709D-04
         5   -8.324171609940D-04   -2.293808078785D-05    5.460206572452D-05
         6   -1.029303844386D-03    2.488294466911D-05   -6.512005353386D-05
         7    1.906300286920D-04   -3.895517435876D-06    1.038339787073D-05
         8   -9.787840807784D-06    1.909716194883D-07   -5.237600871611D-07

         E-Index:     3                    4                    5
  T-Index:
         0   -3.745428185818D-03    1.799497927500D-03    3.198330217071D-04
         1    3.207879804088D-03   -4.594149568994D-03    3.457996925194D-06
         2    7.517190218616D-04    1.585823173330D-03   -2.165980750364D-04
         3   -1.236341581941D-03    6.255302087543D-04    7.892735992329D-05
         4    2.230976227599D-04   -3.347480301314D-04    5.331115058296D-06
         5    7.233602681294D-05   -4.639425388458D-06   -6.590740254953D-06
         6   -3.100626413849D-05    2.210113950523D-05    1.029508831544D-06
         7    3.988838107824D-06   -3.769212293593D-06   -4.076159591930D-08
         8   -1.769431052019D-07    1.950084020747D-07   -1.116568059624D-09

         E-Index:     6                    7                    8
  T-Index:
         0   -2.403744917992D-04    2.279983724758D-05   -1.931788624409D-08
         1    4.912047383164D-04   -9.410833593792D-05    5.088836276642D-06
         2   -1.484255933008D-04    3.868365832252D-05   -2.534300688720D-06
         3   -6.764773601651D-05    1.041550065999D-05   -5.033712296102D-07
         4    3.231656107374D-05   -6.733195279376D-06    4.029898146395D-07
         5    9.314900214037D-07    5.580215548355D-08   -1.063413052225D-08
         6   -2.175492032074D-06    4.036437533899D-07   -2.288971303250D-08
         7    3.569143181296D-07   -7.087085127829D-08    4.174797773877D-09
         8   -1.803893978156D-08    3.691585310844D-09   -2.208748178924D-10

\end{verbatim}\end{small}
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\subsection{
Reaction 0.7T  $p + Kr \rightarrow p + Kr ,\ $
 elastic, $\  I_{0,0}$
}

\begin{small}\begin{verbatim}
         E-Index:     0                    1                    2
  T-Index:
         0   -1.804373557904D+01    1.559321831821D-03    1.404133353439D-03
         1    2.031777449493D-01   -2.592160804293D-03   -1.467585847319D-03
         2    9.686882765703D-03    1.516696535508D-03    3.516527725030D-05
         3    8.643169704852D-03   -2.293872602067D-04    2.022613761542D-04
         4   -1.424299843875D-02   -3.467610803097D-05    2.405799623813D-05
         5   -1.048137401376D-03   -1.163533423390D-05   -4.664386608096D-05
         6    1.430609919337D-03    1.091497123198D-05    1.254896476704D-05
         7   -2.194259131788D-04   -1.955482471322D-06   -1.369663518077D-06
         8    1.009389168927D-05    1.086879702977D-07    5.472917240108D-08

         E-Index:     3                    4                    5
  T-Index:
         0    3.120877691343D-04   -1.817512879035D-04    4.117059852657D-05
         1    1.242877797139D-04    9.112376503933D-05   -1.233416285351D-04
```

```
         2   -1.573876413696D-04    2.563895433480D-04    4.138546015912D-05
         3   -1.420956386480D-04   -1.528253798614D-04    2.912014736234D-05
         4    9.590594342402D-05    5.645092477734D-07   -1.535634290988D-05
         5   -6.142656580682D-06    1.596912487433D-05    1.203913423509D-07
         6   -5.141525041188D-06   -4.044272726929D-06    9.881486025146D-07
         7    1.084914594786D-06    3.915011722907D-07   -1.811507168253D-07
         8   -6.255863642133D-08   -1.333876245529D-08    9.821435035614D-09

         E-Index:     6                     7                     8
  T-Index:
         0    2.839905184310D-05   -6.378458873924D-06    3.184713992614D-07
         1   -1.279935281113D-05    8.614723298861D-06   -6.786954072347D-07
         2   -2.600699325895D-05    2.200678327510D-06   -2.925585047627D-09
         3    1.312098730964D-05   -3.454115928930D-06    2.098391843619D-07
         4    9.219516369433D-07    4.847045590986D-07   -4.845129241580D-08
         5   -1.422113360703D-06    2.351780708953D-07   -1.060289207166D-08
         6    2.602916257409D-07   -8.197279350456D-08    5.265588912826D-09
         7   -1.502708544211D-08    9.287156417397D-09   -6.890608304608D-10
         8    4.565464331790D-11   -3.636906385821D-10    3.037183480051D-11
\end{verbatim}\end{small}


\begin{figure} \label{0.7T}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/bachr7.ps}
\end{figure}
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\subsection{
Reaction 0.7D  $p + Kr \rightarrow p + Kr ,\ $
 elastic, $\  I_{1,0}$
}

\begin{small}\begin{verbatim}
         E-Index:     0                     1                     2
  T-Index:
         0   -1.865545505448D+01   -2.224653891670D-03    3.512510248126D-03
         1   -1.067068862517D-01   -2.372607771064D-03   -2.528011293662D-03
         2   -1.793062289927D-01    3.411244442908D-03   -5.757528343672D-04
         3   -3.949316377716D-03   -9.122323825167D-04    7.332721562736D-04
         4    1.720673370392D-02   -8.376797069854D-05   -5.923952768477D-05
         5   -5.292205338392D-04    5.171588105599D-05   -6.998516881937D-05
         6   -1.123585474018D-03   -1.123489868132D-06    2.209356688942D-05
         7    1.995670109878D-04   -1.062124014473D-06   -2.542259189383D-06
         8   -1.005942932112D-05    8.744976036870D-08    1.047152545942D-07

         E-Index:     3                     4                     5
  T-Index:
         0    5.208166935036D-04   -1.718161556721D-03    1.592709184582D-04
         1    4.342669746539D-04    6.205372491923D-04   -2.512144246616D-04
         2   -6.548561119095D-04    7.557892819154D-04    8.655880993873D-05
         3   -1.170727706000D-06   -4.588074844111D-04    3.617188469585D-05
         4    1.148785626919D-04    2.681963226773D-05   -2.204300778275D-05
         5   -1.734332538201D-05    3.427749154446D-05    3.700519676902D-07
         6   -4.518652819335D-06   -9.660892785904D-06    1.410244055501D-06
         7    1.243519343884D-06    1.011493440280D-06   -2.646219750940D-07
         8   -7.777508674647D-08   -3.800858381217D-08    1.452395343502D-08

         E-Index:     6                     7                     8
  T-Index:
```

```
         0    1.760192998914D-04   -4.823181012443D-05    3.283695269304D-06
         1   -5.953843658876D-05    2.746473855990D-05   -2.212169538346D-06
         2   -8.109653911492D-05    1.104868697474D-05   -4.181441820322D-07
         3    4.537025011410D-05   -1.035893652496D-05    6.333257556842D-07
         4   -1.525645889670D-06    1.261725358435D-06   -1.056714078118D-07
         5   -3.440639370908D-06    6.338548661992D-07   -3.391092703214D-08
         6    8.551857146979D-07   -2.188109556451D-07    1.399325047660D-08
         7   -7.894576610417D-08    2.545593595077D-08   -1.763312508912D-09
         8    2.520441766028D-09   -1.046876612281D-09    7.719196237445D-11

\end{verbatim}\end{small}
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\subsection{
Reaction 0.8T  $p + Xe \rightarrow p + Xe ,\ $
 elastic, $\  I_{0,0}$
}

\begin{small}\begin{verbatim}
         E-Index:     0                    1                    2
  T-Index:
         0   -1.837022175444D+01    1.966234873272D-01   -8.045525227882D-02
         1    1.805905055691D-01   -9.802945396045D-02    3.544388629813D-03
         2    3.047012359914D-02    6.128643067258D-03   -4.012918398972D-03
         3   -6.923416688779D-03    5.221800119943D-03    4.204812055154D-03
         4   -3.195025138086D-04   -1.316526854062D-03    6.034285640091D-04
         5   -1.935784557781D-04   -7.420136378842D-05   -4.344482793235D-04
         6   -1.933096968862D-04    9.094117569189D-05    5.180202859895D-06
         7    7.175836632929D-05   -1.543061104752D-05    1.174663734921D-05
         8   -5.568595272341D-06    8.358080592792D-07   -9.761323315864D-07

         E-Index:     3                    4                    5
  T-Index:
         0   -4.848631362553D-02    4.750879899677D-02    5.610953213302D-04
         1    1.612499614172D-02   -5.523987597225D-03   -9.460219395869D-04
         2    6.794095254509D-04   -9.895305035946D-04   -2.861258121115D-05
         3   -1.150110473980D-03   -7.631572145165D-04    1.776787179903D-04
         4    3.981780177076D-04   -1.483284811460D-04   -3.107860031349D-05
         5    6.891189917320D-06    1.027084520227D-04   -1.030852624977D-05
         6   -3.951029440916D-05    7.160419132800D-06    4.694154796307D-06
         7    8.033492283600D-06   -4.946108320253D-06   -6.642328462598D-07
         8   -4.761690151100D-07    3.755070632999D-07    3.283487948208D-08

         E-Index:     6                    7                    8
  T-Index:
         0   -5.413232395756D-03    1.094586062581D-03   -6.392041039556D-05
         1    7.755701996850D-04   -1.315661918085D-04    7.128051226064D-06
         2    1.645431285623D-04   -3.499826315853D-05    2.119997135712D-06
         3    3.410974410072D-05   -1.133727004658D-05    7.517805454064D-07
         4    1.782649548441D-05   -2.411600549323D-06    1.058674617194D-07
         5   -7.065840257206D-06    1.628340574934D-06   -9.783727086764D-08
         6   -1.830471247020D-06    2.273687191682D-07   -9.553571528267D-09
         7    6.407304183785D-07   -1.061766307764D-07    5.519134501912D-09
         8   -4.447805281256D-08    7.735214914952D-09   -4.130970468715D-10
\end{verbatim}\end{small}
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\begin{figure} \label{0.8T}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/bachr8.ps}
\end{figure}

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\subsection{
Reaction 0.8D  $p + Xe \rightarrow p + Xe ,\ $
 elastic, $\  I_{1,0}$
}

\begin{small}\begin{verbatim}
         E-Index:     0                    1                    2
  T-Index:
         0   -1.897424529930D+01    6.759221376448D-02    2.831656966128D-02
         1    7.880568783648D-02   -1.013433977091D-01   -4.803501715713D-04
         2   -2.211004195406D-02    2.780616010153D-02   -9.803026089070D-03
         3   -1.881720757004D-02    7.288240524563D-03    3.622352023952D-03
         4    1.881626843867D-03   -3.506478495212D-03    1.038874766045D-04
         5    1.555723381321D-03   -6.488785021639D-05   -3.629668747278D-04
         6   -2.155563511636D-04    1.904734853680D-04    9.263791323244D-05
         7   -1.309212493163D-05   -2.940905387089D-05   -9.735247959278D-06
         8    2.085088015611D-06    1.405276321600D-06    3.784816393936D-07

         E-Index:     3                    4                    5
  T-Index:
         0   -1.132739367386D-02   -1.136836207882D-02    1.644151842499D-03
         1    1.616595589060D-02   -6.630385050040D-04   -1.261647418326D-03
         2   -3.466486887128D-03    2.154814681750D-03    6.929992653084D-05
         3   -1.469864494259D-03   -3.263588910597D-04    1.619007714736D-04
         4    5.655409965690D-04   -6.761053529597D-05   -3.542760579601D-05
         5    7.812054156187D-06    5.307617978533D-05   -6.584683292245D-06
         6   -2.696200061727D-05   -1.593650897407D-05    3.272732707082D-06
         7    4.097153412890D-06    2.165559988365D-06   -4.226732919171D-07
         8   -1.941951920917D-07   -1.068579438469D-07    1.856975994299D-08

         E-Index:     6                    7                    8
  T-Index:
         0    9.347764278165D-04   -2.260015561966D-04    1.349778327834D-05
         1    2.184449544252D-04   -4.870473229076D-06   -6.585679719393D-07
         2   -1.768547787859D-04    3.062903702294D-05   -1.606726635371D-06
         3   -5.383734875328D-06   -3.242779246901D-06    2.887563512048D-07
         4    8.898390092703D-06   -5.828977975784D-07    2.514867221936D-09
         5   -2.668417682123D-06    6.656669113253D-07   -4.118906229906D-08
         6    9.467025678674D-07   -2.778964165257D-07    1.810797219300D-08
         7   -1.603923367792D-07    4.412968572947D-08   -2.823552915243D-09
         8    9.066091691589D-09   -2.353837415803D-09    1.478176477260D-10
\end{verbatim}\end{small}

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\subsection{
Reaction 3.1.8  $ p + H(1s) \rightarrow H(1s) + p   $
}

 Charge exchange between protons and hydrogen
 atoms. Cross section: Janev  3.1.8, improved fit
```

$ <sigma*vrel>$(Ti,Ebeam) (cm**3/s)

\begin{small}\begin{verbatim}

T-Index:	E-Index: 0	1	2
0	-1.831670498376D+01	1.650239332070D-01	5.025740610454D-02
1	2.143624996483D-01	-1.067658289373D-01	-5.304993033743D-03
2	5.139117192662D-02	9.536923957409D-03	-1.306075129405D-02
3	-9.896180369559D-04	6.315097684976D-03	2.655464630308D-03
4	-2.495327546080D-03	-1.265503371044D-03	7.569269700468D-04
5	-2.417046684097D-05	-6.945512319613D-05	-2.956984088728D-04
6	1.177406072793D-04	3.698501620365D-05	3.424317896619D-05
7	-1.483036457978D-05	-3.348172574417D-06	-1.527018819072D-06
8	5.351909441226D-07	9.728230870242D-08	1.676354786072D-08

T-Index:	E-Index: 3	4	5
0	5.288358515136D-03	-2.437122342843D-03	-4.461891214720D-04
1	8.289383645942D-03	-9.698773663345D-05	-4.470180279338D-04
2	-1.033166370333D-03	1.280464204775D-03	-8.453294908907D-05
3	-1.365781346175D-03	-1.859939123743D-04	1.237942304972D-04
4	2.756946036257D-04	-1.107375149384D-04	-7.217379426085D-06
5	2.318277483195D-05	3.704494397140D-05	-6.066558692480D-06
6	-9.815693511794D-06	-4.285719813022D-06	1.169257650609D-06
7	8.362050692462D-07	2.058392726953D-07	-7.463594884928D-08
8	-2.237567830699D-08	-3.081685803820D-09	1.450862501121D-09

T-Index:	E-Index: 6	7	8
0	1.731631548110D-04	-1.588434781959D-05	4.482291414386D-07
1	7.944326905066D-05	-5.303688417551D-06	1.235167254501D-07
2	-3.040874906105D-05	4.747888095498D-06	-1.923953750574D-07
3	-1.588253432932D-05	6.603560345800D-07	-1.970606344918D-09
4	5.769971321188D-06	-6.717311113584D-07	2.440961351104D-08
5	-4.951573401626D-07	1.437520597154D-07	-6.998724470004D-09
6	-4.968953461875D-10	-1.618948982477D-08	9.440094842562D-10
7	5.924370389093D-10	1.078208689229D-09	-6.619767848464D-11
8	4.434231893204D-11	-3.324377862622D-11	1.935019679501D-12

 Max. rel. Error: 1.1026 %
 Mean rel. Error: 0.3105 %

\end{verbatim}\end{small}
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\subsection{
Reaction 3.1.8o $ p + H(1s) \rightarrow H(1s) + p $
}
original fit from janev's springer book 1987
in hydhel.tex now there is the improved fit (see above), leading to better
energy balance with tracklength estimators and the energy weighted rate (below)

\begin{small}\begin{verbatim}

T Index	E Index 0	1	2
0	-1.829079581680e+01	1.640252721210e-01	3.364564509137e-02
1	2.169137615703e-01	-1.106722014459e-01	-1.382158680424e-03

```
     2      4.307131243894e-02  8.948693624917e-03 -1.209480567154e-02
     3     -5.754895093075e-04  6.062141761233e-03  1.075907881928e-03
     4     -1.552077120204e-03 -1.210431587568e-03  8.297212635856e-04
     5     -1.876800283030e-04 -4.052878751584e-05 -1.907025662962e-04
     6      1.125490270962e-04  2.875900435895e-05  1.338839628570e-05
     7     -1.238982763007e-05 -2.616998139678e-06 -1.171762874107e-07
     8      4.163596197181e-07  7.558092849125e-08 -1.328404104165e-08

    E Index         3                   4                   5
  T Index
     0      9.530225559189e-03 -8.519413589968e-04 -1.247583860943e-03
     1      7.348786286628e-03 -6.343059502294e-04 -1.919569450380e-04
     2     -3.675019470470e-04  1.039643390686e-03 -1.553840717902e-04
     3     -8.119301728339e-04  8.911036876068e-06  3.175388949811e-05
     4      1.361661816974e-04 -1.008928628425e-04  1.080693990468e-05
     5      1.141663041636e-05  1.775681984457e-05 -3.149286923815e-06
     6     -4.340802793033e-06 -7.003521917385e-07  2.318308730487e-07
     7      3.517971869029e-07 -4.928692832866e-08  1.756388998863e-10
     8     -9.170850253981e-09  3.208853883734e-09 -3.952740758950e-10

    E Index         6                   7                   8
  T Index
     0      3.014307545716e-04 -2.499323170044e-05  6.932627237765e-07
     1      4.075019351738e-05 -2.850044983009e-06  6.966822400446e-08
     2      2.670827249272e-06  7.695300597935e-07 -3.783302281524e-08
     3     -4.515123641755e-06  2.187439283954e-07 -2.911233951880e-09
     4      5.106059413591e-07 -1.299275586093e-07  5.117133050290e-09
     5      3.105491554749e-08  2.274394089017e-08 -1.130988250912e-09
     6     -6.030983538280e-09 -1.755944926274e-09  1.005189187279e-10
     7     -1.446756795654e-10  7.143183138281e-11 -3.989884105603e-12
     8      2.739558475782e-11 -1.693040208927e-12  6.388219930167e-14

     Error  8.88e-04 (B)
\end{verbatim}\end{small}

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\subsection{
Reaction 3.1.8d $ p + H(1s) \rightarrow H(1s) + p   $
}

 Langevin approximation: sigma v = const = 2e-8


\begin{small}\begin{verbatim}
        E-Index:     0                   1                   2
 T-Index:
        0   -1.772753356000D+01    0.000000000000D 00    0.000000000000D 00
        1    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00
        2    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00
        3    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00
        4    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00
        5    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00
        6    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00
        7    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00
        8    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00
```

```
       E-Index:     3                    4                    5
 T-Index:
       0    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00
       1    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00
       2    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00
       3    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00
       4    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00
       5    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00
       6    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00
       7    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00
       8    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00

       E-Index:     6                    7                    8
 T-Index:
       0    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00
       1    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00
       2    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00
       3    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00
       4    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00
       5    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00
       6    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00
       7    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00
       8    0.000000000000D 00    0.000000000000D 00    0.000000000000D 00

 Max. rel. Error:   0.0000 %
 Mean rel. Error:   0.0000 %

\end{verbatim}\end{small}
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\subsection{
Reaction 3.2.3  $  p + H_2(\nu) \rightarrow H + H_2^+  $
}
  Effective ion conversion (Charge exchange on $H_2$)
  as function of $T_p$ (from Janev,\cite{kn:Janev}).

  vibrational distribution $H2(v)$ is density independent, assume: $T_e = T_p = T$

  hence: function of $E_{beam} = E_{H2}$ and T
\begin{small}\begin{verbatim}
       E-Index:     0                    1                    2
  T-Index:
       0   -9.645230885771D+03   -3.312562293674D+03   -4.642008863875D+02
       1    9.635139317586D+02    1.431209981817D+02   -1.623113446476D+01
       2   -3.238552524703D+02   -1.045021110299D+02   -1.247030415569D+01
       3   -7.958948816096D+01   -1.564243498893D+01   -8.126692776267D-01
       4    1.795249783907D+01    4.608298344746D+00    3.409881486918D-01
       5    3.327095557246D+00    3.248359051912D-01   -2.959384898339D-02
       6   -4.996203651405D-01   -7.156952880369D-02    1.244172796212D-03
       7   -1.042737933528D-01   -2.286145982917D-02   -1.923616091088D-03
       8    7.531901795379D-03    9.800034496803D-04   -2.725923286539D-05

       E-Index:     3                    4                    5
  T-Index:
       0   -3.341516413973D+01   -1.253133090148D+00   -1.969917158282D-02
       1   -5.063990966680D+00   -4.479998578191D-01   -1.834077278807D-02
       2   -6.865550615891D-01   -1.928755581441D-02   -4.268078616899D-04
       3    2.143166881350D-02    3.497082036304D-03    1.578307875059D-04
```

```
        4   -2.095566222471D-04   -7.255924192706D-04   -3.707123917753D-06
        5   -4.145707357196D-03   -7.361702041078D-05    5.249460348237D-06
        6    4.659917001708D-04    3.904853189629D-06   -6.450609749607D-07
        7   -6.403548983914D-05    7.574816575503D-07    7.494387755209D-08
        8   -9.947192276480D-06   -5.919454475128D-07   -1.962353959902D-08

        E-Index:     6                    7                    8
  T-Index:
        0    6.484329142648D-05    3.673451315592D-06   -9.872104337110D-09
        1   -3.261356373574D-04   -8.929589681768D-07    2.353018979277D-08
        2   -4.544184994978D-06    5.951797088816D-07    1.949475247030D-08
        3    5.690389745524D-06    1.553911576456D-07    1.720385042997D-09
        4    3.068887469389D-07   -5.270953529262D-08   -1.818374530299D-09
        5    2.757680430193D-07    1.117682102273D-08    2.740369015702D-10
        6    3.398565803833D-08    2.670966708170D-09    3.346957195127D-11
        7   -1.467276797896D-09   -9.460129351949D-11   -1.542043001723D-13
        8   -9.289671920073D-10   -4.157042085906D-11   -7.220730215109D-13

  Max. rel. Error:  12.4260 %
  Mean rel. Error:   5.1714 %

\end{verbatim}\end{small}
\begin{figure} \label{3.2.3b}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/ionconv3.ps}
\end{figure}
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\subsection{
Reaction 3.3.1  $  p + He \rightarrow H + He^+  $
}


\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
  T-Index:
        0   -3.777393171216D+01    1.034570822224D+00    5.500659259212D-01
        1    9.354555314272D+00   -1.691165109278D+00   -7.450052207738D-01
        2   -4.235897398162D+00    1.383244831625D+00    3.396734449323D-01
        3    1.350058534401D+00   -6.640009322644D-01   -2.562301717488D-02
        4   -2.418149537330D-01    1.946040141373D-01   -2.712202677247D-02
        5    1.747617790690D-02   -3.507141422752D-02    9.840686949146D-03
        6    7.868843917720D-04    3.782419535260D-03   -1.470034129542D-03
        7   -1.857520833749D-04   -2.234371833506D-04    1.049668682077D-04
        8    7.419442223475D-06    5.549545840266D-06   -2.941631374324D-06

        E-Index:     3                    4                    5
  T-Index:
        0    4.271707093128D-02   -5.858821491798D-02    1.392666257426D-02
        1    1.174092828553D-02    1.114511012703D-01   -2.954831571871D-02
        2   -6.307600501935D-02   -6.111443567710D-02    2.198175535806D-02
        3    3.966559773589D-02    9.770353095467D-03   -6.712723502770D-03
        4   -1.172231175354D-02    2.197390583445D-03    6.399497506338D-04
        5    1.999302843269D-03   -1.106397155875D-03    9.894710667600D-05
        6   -2.070618270598D-04    1.765303992000D-04   -2.889915777541D-05
        7    1.226009237337D-05   -1.292057629192D-05    2.493401272590D-06
        8   -3.182522175779D-07    3.665898328329D-07   -7.535980089596D-08

        E-Index:     6                    7                    8
```

```
  T-Index:
         0   -1.826013734833D-03    1.338360116582D-04   -4.094793119826D-06
         1    3.221947627445D-03   -1.596959700477D-04    2.851937035822D-06
         2   -2.959465078436D-03    1.811254083073D-04   -4.188871522474D-06
         3    1.199132836096D-03   -9.257540264113D-05    2.685063664954D-06
         4   -2.155848545229D-04    2.170199383545D-05   -7.480430374938D-07
         5    1.197406032871D-05   -2.356790229752D-06    1.014622773664D-07
         6    1.233468768851D-06    8.575083472581D-08   -6.548641344013D-09
         7   -1.868672214120D-07    3.144081097677D-09    1.518680425956D-10
         8    6.598419439525D-09   -2.255951200310D-10    7.165455179223D-13

\end{verbatim}\end{small}
  Max. rel. Error:  28.3918 %
  Mean rel. Error:   1.3778 %

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\subsection{
Reaction 3.3.6a  $ p + He^*(1s2s|1S) \rightarrow H^*(2s) + He^+(1s) $
}


\begin{small}\begin{verbatim}
         E-Index:     0                    1                    2
  T-Index:
         0   -2.547454346557D+01    4.128640321938D-01    1.681364689904D-01
         1    2.925159193919D+00   -4.482539906582D-01   -1.510618145526D-01
         2   -2.632374609849D-01    1.498243646661D-01    4.224863000625D-02
         3   -3.665347937696D-02   -4.030592366279D-03   -6.024374907107D-03
         4    1.186624566602D-02   -7.264454630020D-03    1.759741131185D-03
         5   -7.743098120973D-04    1.549566023754D-03   -5.251712659531D-04
         6   -6.048032854477D-05   -1.303138256507D-04    7.489465754264D-05
         7    9.567845819569D-06    4.491545385436D-06   -4.865196018372D-06
         8   -3.240997611305D-07   -3.791720988961D-08    1.182380927243D-07

         E-Index:     3                    4                    5
  T-Index:
         0    4.770799895182D-02   -4.589820198321D-03   -3.381658191835D-03
         1    5.782833798276D-04    1.062966905109D-02   -1.000814684417D-03
         2   -1.379424993966D-02   -4.799947755285D-03    2.003286792299D-03
         3    3.861551147569D-03    8.428413708310D-04   -6.216316421045D-04
         4   -5.418286557573D-04   -2.942217454245D-05    7.238789629847D-05
         5    1.074828795860D-04   -1.693095034492D-05   -1.682620078098D-06
         6   -1.905146446763D-05    3.627851762042D-06   -3.555921820186D-07
         7    1.601618148499D-06   -3.021602782205D-07    3.224220197809D-08
         8   -4.832611082122D-08    9.163386368269D-09   -8.754524349299D-10

         E-Index:     6                    7                    8
  T-Index:
         0    7.216467750187D-04   -5.367354341527D-05    1.404882131093D-06
         1   -1.026211922836D-04    1.753943422756D-05   -6.292768990258D-07
         2   -2.604060260416D-04    1.473506727808D-05   -3.094165446584D-07
         3    1.074723588583D-04   -7.721788090796D-06    2.030369344275D-07
         4   -1.611312475612D-05    1.369478220738D-06   -4.100428990113D-08
         5    1.009293380060D-06   -1.149043918048D-07    4.074816429488D-09
         6   -1.512787587046D-08    5.066369422287D-09   -2.328387385602D-10
         7   -7.878569805292D-10   -1.445940103849D-10    8.580766309466D-12
         8    2.044140116707D-11    3.044550460011D-12   -1.768485828956D-13
```

```
\end{verbatim}\end{small}
  Max. rel. Error:   7.6526 %
  Mean rel. Error:   1.0667 %

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\subsection{
Reaction 3.3.6b   $p + He^*(1s2s|3S) \rightarrow H^*(2s) + He^+(1s) $
}

\begin{small}\begin{verbatim}

         E-Index:     0                    1                    2
  T-Index:
         0   -3.143965131590D+01    6.213651065042D-01    1.902530458816D-01
         1    5.052041699363D+00   -7.148284765635D-01   -1.237588528705D-01
         2   -1.123510624616D+00    5.432613921547D-01    8.782764771787D-02
         3    5.348600593230D-01   -2.975038694390D-01   -7.480657433556D-02
         4   -2.135986381612D-01    1.005463096676D-01    3.217845093386D-02
         5    4.690491969254D-02   -1.984365278750D-02   -6.930272101671D-03
         6   -5.582187291915D-03    2.224271972399D-03    7.806801953220D-04
         7    3.414974814001D-04   -1.311003795110D-04   -4.398645721299D-05
         8   -8.438843692321D-06    3.153343412371D-06    9.747101004706D-07

         E-Index:     3                    4                    5
  T-Index:
         0    6.905094039815D-02    2.031144550828D-03   -5.216959360609D-03
         1   -3.733697369694D-02   -4.284814988611D-04    8.393728104870D-03
         2   -6.508591153825D-02    1.088127433701D-02   -1.741996511515D-03
         3    6.989130699630D-02   -1.052805212797D-02   -1.083666162584D-03
         4   -2.714253969913D-02    4.258559341854D-03    4.082988867720D-04
         5    5.298275385423D-03   -9.198385408429D-04   -1.481408240559D-05
         6   -5.526051789225D-04    1.111995316138D-04   -9.733079909866D-06
         7    2.923449260993D-05   -7.085139465779D-06    1.368541840554D-06
         8   -6.120199563565D-07    1.849580238681D-07   -5.378697856092D-08

         E-Index:     6                    7                    8
  T-Index:
         0    6.870508923626D-04   -2.653292731940D-05    1.208474130385D-08
         1   -1.989364522591D-03    1.753792411592D-04   -5.477952397515D-06
         2    3.431473662601D-04   -3.592640513827D-05    1.335701974095D-06
         3    4.316290417315D-04   -4.061169944387D-05    1.281804690424D-06
         4   -1.790232068370D-04    1.771568491253D-05   -5.843104467181D-07
         5    2.117076885890D-05   -2.256441586648D-06    7.622251547211D-08
         6    2.956849458181D-07    6.754190895102D-09   -4.412084334419D-10
         7   -2.054349022277D-07    1.712307554998D-08   -5.567694760593D-10
         8    9.859620416969D-09   -8.710088226618D-10    2.871802269066D-11

  Max. rel. Error:  34.6091 %
  Mean rel. Error:   1.4428 %
\end{verbatim}\end{small}

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\section{H.4 :  Fits for $<\sigma v> (n_e,T)$}\label{sect4}
```

```
\subsection{
Reaction 2.1.5   $H + e \rightarrow H^+ + 2e $}

   Effective hydrogenic ionisation rate. Data: L.C.Johnson

\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
  T-Index:
        0   -3.292647100524D+01    1.293481375348D-02    5.517562508468D-03
        1    1.423977672396D+01   -1.173143955186D-02    1.063440108279D-03
        2   -6.519438729039D+00   -7.189825749516D-03    9.247377414923D-04
        3    2.009996151806D+00    1.275979740638D-02   -4.693479616874D-03
        4   -4.289594424073D-01   -5.340866322754D-03    2.324582357388D-03
        5    6.047834607038D-02    9.624900593359D-04   -4.182981184259D-04
        6   -5.304737965836D-03   -7.854872454067D-05    2.735823803201D-05
        7    2.606946949696D-04    2.317442253442D-06    5.148890779990D-08
        8   -5.467903073834D-06    6.077380038450D-09   -4.712893073569D-08

        E-Index:     3                    4                    5
  T-Index:
        0   -7.853816321645D-04    1.436128501544D-04   -3.883750282085D-07
        1   -1.600053527730D-03    1.136554639958D-05    5.177662275946D-05
        2    2.037026745547D-03   -3.668717204076D-04    5.368630315837D-06
        3   -2.389224140310D-05    1.358069915666D-04   -1.454897555460D-05
        4   -3.217228075879D-04    6.660581406632D-06    2.396531874534D-06
        5    7.957230182146D-05   -7.447042563915D-06    1.849155263575D-07
        6   -5.915348564130D-06    8.666302868477D-07   -6.115514821045D-08
        7   -7.144182523188D-09   -2.540194754187D-08    4.097857835689D-09
        8    1.086858755070D-08   -3.448417246175D-10   -8.714183216468D-11

        E-Index:     6                    7                    8
  T-Index:
        0   -1.489774355194D-06    1.416361431167D-07   -3.890932078762D-09
        1   -7.947999902838D-06    4.508505683240D-07   -8.952614093357D-09
        2    3.713958914062D-06   -3.125764373429D-07    7.451213220623D-09
        3    4.212031496989D-08    5.506044670830D-08   -1.852677638893D-09
        4   -1.785208321244D-07    6.095649574151D-10    1.470204228549D-10
        5    1.618233640838D-08   -8.182928298434D-10    4.835789623340D-12
        6    1.075473174260D-09    4.118000674849D-11   -1.089323091222D-12
        7   -2.048657335774D-10    3.027916374251D-12    1.155854020410D-14
        8    8.023660696154D-12   -2.396518500447D-13    2.173645280354D-15

  Max. rel. Error:    .8487 %
  Mean rel. Error:    .2419 %
\end{verbatim}\end{small}
\begin{figure} \label{2.1.5}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hydi1_tr.ps}
\end{figure}
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\subsection{
Reaction 2.1.5o  $H + e \rightarrow H^+ + 2e $, Ly-opaque}


   Effective hydrogenic ionisation rate. Data: L.C.Johnson, Ly-opaque

\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
```

```
  T-Index:
        0   -2.842625123610D+01    3.816926440645D-02   -2.093090374769D-02
        1    1.212167851020D+01   -8.864661558973D-02    2.578404580790D-02
        2   -6.815821411657D+00    1.136458676986D-01   -3.209328253150D-02
        3    2.625844925126D+00   -7.176672848153D-02    2.221528694064D-02
        4   -6.666700835468D-01    2.362874407172D-02   -7.539637780701D-03
        5    1.063576010855D-01   -4.303004854934D-03    1.340877575599D-03
        6   -1.019791186281D-02    4.388098086177D-04   -1.289968813905D-04
        7    5.357498344762D-04   -2.353712235761D-05    6.392439908462D-06
        8   -1.183601163067D-05    5.183054638931D-07   -1.286865471654D-07

        E-Index:     3                    4                    5
  T-Index:
        0    1.173278205549D-02   -3.195307082806D-03    4.891090254225D-04
        1   -1.125027025423D-02    3.132061119992D-03   -5.478419611750D-04
        2    7.428129132200D-03   -1.359196323415D-03    2.455552537690D-04
        3   -3.813499462891D-03    3.488231091499D-04   -5.136595197719D-05
        4    1.139599698461D-03   -5.231484976569D-05    3.851106631395D-06
        5   -1.830544200085D-04    3.418266263749D-06    2.695420674804D-07
        6    1.595087521180D-05   -5.244682697928D-08   -4.069155577999D-08
        7   -7.334538727835D-07    7.314879444968D-09   -1.321258886395D-09
        8    1.468328421917D-08   -8.136369296580D-10    2.036456697308D-10

        E-Index:     6                    7                    8
  T-Index:
        0   -3.972967626237D-05    1.591035727928D-06   -2.476205052687D-08
        1    4.881508340119D-05   -2.055128753437D-06    3.275823973472D-08
        2   -2.356276122712D-05    1.024674585628D-06   -1.635599873170D-08
        3    5.236557713321D-06   -2.300633304095D-07    3.500516071428D-09
        4   -4.712865883416D-07    2.015344675266D-08   -2.228472576727D-10
        5   -1.533579453796D-09    2.312045651251D-10   -2.651886075183D-11
        6    6.001489992879D-10   -5.139558636314D-11    3.525452470540D-12
        7    3.249620872276D-10   -1.169248684183D-11    1.979747513777D-14
        8   -2.321096956876D-11    9.053581287584D-13   -1.015243451999D-14

  Max. rel. Error:   1.6436 %
  Mean rel. Error:    .4360 %
\end{verbatim}\end{small}
\begin{figure} \label{2.1.5o}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hydi1_op.ps}
\end{figure}
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\subsection{
Reaction 2.1.5FU $H + e \rightarrow H^+ + 2e $
}


   Effective hydrogenic ionisation rate

   Data: T.Fujimoto

\begin{small}\begin{verbatim}

        E-Index:     0                    1                    2
  T-Index:
        0   -3.248798455435D+01   -1.583576809722D-02    3.285869028504D-02
        1    1.424356612437D+01    3.175029518444D-02    9.606950348085D-03
        2   -6.722904294064D+00    4.311446813618D-02   -2.517427976955D-02
```

```
        3    2.266387333083D+00   -9.789489154775D-02    5.398109574433D-02
        4   -5.931032360416D-01    5.124097312852D-03    3.699994176386D-03
        5    1.147920872414D-01    2.742313837002D-02   -2.245028749822D-02
        6   -1.483888171383D-02   -1.067834175877D-02    8.438148198729D-03
        7    1.108218446771D-03    1.512053921582D-03   -1.194919283060D-03
        8   -3.555502249894D-05   -7.478079715366D-05    5.942458049742D-05

        E-Index:     3                    4                    5
  T-Index:
        0   -1.240528813529D-02    2.664717037630D-03   -3.172375040535D-04
        1   -2.494745880098D-02    8.399542503117D-03   -1.240998629473D-03
        2    4.815970486999D-03   -2.748969584392D-05   -7.686346500535D-05
        3   -4.390792820575D-03   -2.086950993749D-03    5.027328234775D-04
        4   -4.380199678034D-03    1.398919656687D-03   -2.054931337082D-04
        5    6.429720925359D-03   -8.561752691155D-04    5.612593457460D-05
        6   -2.298070192939D-03    2.749935201803D-04   -1.349056109137D-05
        7    3.264168032303D-04   -3.911785463154D-05    1.907055599407D-06
        8   -1.641075826954D-05    2.005118242687D-06   -1.030101387433D-07

        E-Index:     6                    7                    8
  T-Index:
        0    2.088404138696D-05   -6.733740099320D-07    8.002700070910D-09
        1    9.260868887035D-05   -3.436780257491D-06    5.047722022714D-08
        2    8.948973512616D-06   -4.156485988583D-07    7.088252652411D-09
        3   -4.517190827248D-05    1.853907927399D-06   -2.898869496139D-08
        4    1.546565080680D-05   -5.798096560424D-07    8.582946406760D-09
        5   -1.548036225269D-06   -1.023827139183D-09    5.794387210244D-10
        6   -2.662642186574D-08    2.413742483983D-08   -5.794076415255D-10
        7    5.992772728045D-09   -3.561389436748D-09    8.487681187766D-11
        8    2.615441399307D-10    1.580071599787D-10   -3.961679583726D-12

  Max. rel. Error:   3.2257 %
  Mean rel. Error:   1.1182 %

\end{verbatim}\end{small}
\begin{figure} \label{2.1.5FU}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hydi1FU.ps}
\end{figure}
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\subsection{
  Reaction 2.1.8  $ p + electron(s) \rightarrow H(1s) + ...$
}

   Effective hydrogenic recombination rate
   Data: L.C.Johnson, radiative + three-body contribution


\begin{small}\begin{verbatim}

        E-Index:     0                    1                    2
  T-Index:
        0   -2.855728479302D+01    3.488563234375D-02   -2.799644392058D-02
        1   -7.664042607917D-01   -3.583233366133D-03   -7.452514292790D-03
        2   -4.930424003280D-03   -3.620245352252D-03    6.958711963182D-03
        3   -5.386830982777D-03   -9.532840484460D-04    4.631753807534D-04
        4   -1.626039237665D-04    1.888048628708D-04    1.288577690147D-04
        5    6.080907650243D-06   -1.014890683861D-05   -1.145028889459D-04
```

```
       6    2.101102051942D-05    2.245676563601D-05   -2.245624273814D-06
       7   -2.770717597683D-06   -4.695982369246D-06    3.250878872873D-06
       8    1.038235939800D-07    2.523166611507D-07   -2.145390398476D-07

       E-Index:     3                    4                    5
  T-Index:
       0    1.209545317879D-02   -2.436630799820D-03    2.837893719800D-04
       1    2.709299760454D-03   -7.745129766167D-04    1.142444698207D-04
       2   -2.139257298118D-03    4.603883706734D-04   -5.991636837395D-05
       3   -5.371179699661D-04    1.543350502150D-04   -2.257565836876D-05
       4   -1.634580516353D-05   -9.601036952725D-06    3.425262385387D-06
       5    5.942193980802D-05   -1.211851723717D-05    1.118965496365D-06
       6   -2.944873763540D-06    1.002105099354D-06   -1.291320799814D-07
       7   -9.387290785993D-07    1.392391630459D-07   -1.139093288575D-08
       8    7.381435237585D-08   -1.299713684966D-08    1.265189576423D-09

       E-Index:     6                    7                    8
  T-Index:
       0   -1.886511169084D-05    6.752155602894D-07   -1.005893858779D-08
       1   -9.382783518064D-06    3.902800099653D-07   -6.387411585521D-09
       2    4.729262545726D-06   -1.993485395689D-07    3.352589865190D-09
       3    1.730782954588D-06   -6.618240780594D-08    1.013364275013D-09
       4   -4.077019941998D-07    2.042041097083D-08   -3.707977721109D-10
       5   -4.275321573501D-08    3.708616111085D-10    7.068450112690D-12
       6    7.786155463269D-09   -2.441127783437D-10    3.773208484020D-12
       7    5.178505597480D-10   -9.452402157390D-12   -4.672724022059D-14
       8   -6.854203970018D-11    1.836615031798D-12   -1.640492364811D-14

  Max. rel. Error:   6.8962 %
  Mean rel. Error:    .5559 %


\end{verbatim}\end{small}
\begin{figure} \label{2.1.8}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hydr1_tr.ps}
\end{figure}
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\subsection{
  Reaction 2.1.8o $ p + electron(s) \rightarrow H(1s) + ...$ Ly-opaque
}

   Effective hydrogenic recombination rate
   Data: L.C.Johnson, radiative + three-body contribution
   Lyman opaque


\begin{small}\begin{verbatim}
       E-Index:     0                    1                    2
  T-Index:
       0   -2.959696621207D+01   -2.370057688281D-01    2.485234780243D-01
       1   -2.261509350573D+00   -3.916834765592D-01    4.175284638738D-01
       2   -4.674937331875D-01   -5.569001933269D-03    1.424684098594D-02
       3    2.507869795516D-01    2.497608379269D-02   -3.407068292654D-02
       4    2.069706780864D-02   -6.227904899439D-03    7.567752788769D-03
       5   -2.504106136665D-02    5.231970346733D-03   -4.961906824405D-03
       6    4.740060719354D-03   -1.583429487117D-03    1.485117205295D-03
       7   -3.716199599046D-04    1.790096302797D-04   -1.687816759412D-04
       8    1.078074419507D-05   -6.889626133438D-06    6.523611088216D-06
```

```
       E-Index:     3                    4                    5
  T-Index:
       0   -9.938245216461D-02    1.980881578608D-02   -2.122222479009D-03
       1   -1.818480115491D-01    3.961587768727D-02   -4.770502751429D-03
       2   -7.573368055249D-03    2.345252431484D-03   -3.903412960562D-04
       3    1.848151065349D-02   -4.874151697039D-03    6.859699832287D-04
       4   -3.519012590703D-03    7.900468003264D-04   -9.404610318098D-05
       5    1.530766046402D-03   -1.980846746944D-04    7.679462128899D-06
       6   -4.566472727887D-04    6.072295908223D-05   -2.912042904116D-06
       7    5.315093984335D-05   -7.528931894689D-06    4.568686753692D-07
       8   -2.087698447004D-06    3.070917297414D-07   -2.078805542480D-08

       E-Index:     6                    7                    8
  T-Index:
       0    1.218203616198D-04   -3.464708585003D-06    3.763195232065D-08
       1    3.183363649173D-04   -1.099361683574D-05    1.532076900830D-07
       2    3.495619343912D-05   -1.549589929805D-06    2.649470795327D-08
       3   -5.207997134901D-05    2.003342466410D-06   -3.056485646618D-08
       4    5.971364301743D-06   -1.910514915873D-07    2.423960414424D-09
       5    5.127742944183D-07   -5.042762997588D-08    1.117985320964D-09
       6   -6.966012349475D-08    1.046266371637D-08   -2.448127591728D-10
       7   -4.197741084618D-09   -6.390754230254D-10    1.836925499320D-11
       8    4.554850332229D-10    1.165730429588D-11   -4.891755053806D-13

  Max. rel. Error:  21.7976 %
  Mean rel. Error:   8.2471 %

\end{verbatim}\end{small}
\begin{figure} \label{2.1.8o}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hydr1_op.ps}
\end{figure}
\newpage

\subsection{
  Reaction 2.1.8FU $ p + electron(s) \rightarrow H(1s) + ...$
}

   Effective hydrogenic recombination rate
   Data: T.Fujimoto, radiative + three-body contribution


\begin{small}\begin{verbatim}

       E-Index:     0                    1                    2
  T-Index:
       0   -2.859173412090D+01   -1.661007811717D-03    1.800123869432D-02
       1   -7.727897152963D-01   -7.185510516868D-03   -6.664735116824D-03
       2    2.731740252417D-04    1.841463674641D-02   -1.042796032026D-02
       3   -9.412381843177D-03   -8.325885755900D-03    6.197039066476D-03
       4    1.564398998662D-03   -1.001077253771D-03    1.281843907383D-03
       5   -3.875231655429D-04    8.967038573752D-04   -9.737851139343D-04
       6    5.743703850623D-05   -5.709392754051D-05    7.831607832493D-05
       7   -3.896462887932D-06   -1.728485488993D-05    1.504835319823D-05
       8    8.168921109996D-08    1.789661999688D-06   -1.723007265214D-06

       E-Index:     3                    4                    5
  T-Index:
       0   -5.901319721407D-03    1.008884427267D-03   -7.666468567133D-05
```

```
        1    1.025718155555D-03   -2.371359765453D-05   -2.379761249077D-05
        2    3.793816747821D-03   -5.381919535018D-04    2.996223783421D-05
        3   -2.288446843140D-03    3.612389570540D-04   -2.632269904386D-05
        4   -3.969582319908D-04    5.662371262429D-05   -3.470227226116D-06
        5    3.466635482442D-04   -5.542034883238D-05    4.167611128622D-06
        6   -2.931850335332D-05    4.165929395282D-06   -1.833910759412D-07
        7   -5.498262806478D-06    1.109375120018D-06   -1.305413093317D-07
        8    6.441246925770D-07   -1.229576937590D-07    1.308011799197D-08

        E-Index:     6                    7                    8
  T-Index:
        0    1.997734434786D-06    5.093156468064D-08   -2.546978246800D-09
        1    3.017661441193D-06   -1.459838627412D-07    2.519490281465D-09
        2    3.746085786687D-07   -9.615385988357D-08    2.492563949079D-09
        3    6.689181198740D-07    1.133271905873D-08   -5.680616540286D-10
        4    1.907348094032D-08    6.472160529017D-09   -1.931397945496D-10
        5   -1.201431943086D-07   -7.335510423575D-10    6.808738180475D-11
        6   -8.594650668059D-09    9.039128783831D-10   -1.825430199313D-11
        7    8.728480804730D-09   -2.967440451300D-10    3.804314675048D-12
        8   -7.784991698470D-10    2.376732432651D-11   -2.798033819072D-13

  Max. rel. Error:   4.0868 %
  Mean rel. Error:    .3058 %

\end{verbatim}\end{small}
\begin{figure} \label{2.1.8FU}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hydr1FU.ps}
\end{figure}
\newpage


\subsection{
  Reaction 2.1.8a  $p + e \rightarrow H(1s) + h\nu $
}

   Effective hydrogenic recombination rate
   Data: L.C.Johnson, radiative contribution only


\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
 T-Index:
        0   -2.861779556590D+01   -1.786166918005D-02    6.391553337864D-04
        1   -7.251997071478D-01    3.210966054964D-03    4.550251497787D-03
        2   -1.735023322687D-02   -3.112517426840D-03    1.077863345492D-03
        3   -3.557752804131D-03    1.558966107388D-03   -1.037331531958D-03
        4   -2.777882255016D-04   -9.329932857673D-05    1.096331766957D-04
        5    2.060295404466D-05   -1.283711654633D-04    7.312311894769D-05
        6    1.593238392469D-05    3.705503401064D-05   -2.407235857913D-05
        7   -2.116580756634D-06   -3.854172456142D-06    2.662392026941D-06
        8    7.665990100168D-08    1.400789118322D-07   -1.008951470934D-07

        E-Index:     3                    4                    5
 T-Index:
        0   -4.509415260040D-04    7.095459017274D-05   -5.660309928918D-06
        1   -1.882306456891D-03    3.983133042462D-04   -4.851835293564D-05
        2   -2.616958968739D-04    5.459332810644D-05   -8.635308675130D-06
        3    2.817237174744D-04   -4.407815167942D-05    4.646017350681D-06
        4   -4.567488387292D-05    8.495787235165D-06   -7.261076273040D-07
```

```
       5   -1.064805149480D-05   -1.498776433806D-07    1.199087596048D-07
       6    4.915213917257D-06   -3.346609397503D-07   -4.912753691671D-09
       7   -6.120846201882D-07    5.663728215333D-08   -1.474221162308D-09
       8    2.495214914834D-08   -2.678484130657D-09    1.170138331019D-10

       E-Index:     6                    7                    8
 T-Index:
       0    1.160186631232D-07    7.564986067995D-09   -2.969815025786D-10
       1    3.404834497087D-06   -1.280839994482D-07    1.982839967575D-09
       2    8.383106368091D-07   -4.133352004945D-08    7.872491728981D-10
       3   -3.365654551356D-07    1.428350791171D-08   -2.522153346435D-10
       4    2.326992940046D-08    2.208089550616D-10   -1.989979386039D-11
       5   -5.668079133507D-09   -1.018554043516D-10    7.766578964142D-12
       6    1.302393677822D-09   -3.169013613822D-11   -1.783762758524D-13
       7   -7.373095178045D-11    4.314457229158D-12   -4.791677504810D-14
       8   -1.588254701759D-13   -1.226345218681D-13    2.329402447113D-15

 Max. rel. Error:   2.5215 %
 Mean rel. Error:   0.1955 %


\end{verbatim}\end{small}
\begin{figure} \label{2.1.8a}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hydr1a.ps}
\end{figure}
\newpage

\subsection{
  Reaction 2.1.8b  $p + e + e \rightarrow H(1s) + e$
}

   Effective hydrogenic recombination rate
   Data: L.C.Johnson, three-body contribution only



\begin{small}\begin{verbatim}
       E-Index:     0                    1                    2
 T-Index:
       0   -3.138669506796D+01    2.558074094965D-01    7.547564538159D-02
       1   -1.417925704352D+00   -1.066708008069D-01    8.912699543671D-02
       2   -3.966595205668D-02    1.064506076088D-01   -9.185507688379D-02
       3   -2.739310162323D-03    1.071195586887D-02   -1.158499493255D-02
       4    1.342474842019D-03   -1.404239147230D-02    1.282799910712D-02
       5   -3.784959334108D-05    2.130406018949D-03   -1.795433974878D-03
       6   -2.481473746256D-05   -2.906534460063D-05    4.381082887635D-07
       7    3.022022778586D-06   -1.227016198396D-05    1.250237920569D-05
       8   -1.059584647842D-07    5.895982135096D-07   -5.420516699864D-07

       E-Index:     3                    4                    5
 T-Index:
       0   -3.195165302392D-02    5.993840007093D-03   -6.049665420516D-04
       1   -3.076861794558D-02    5.170778601878D-03   -4.681886539105D-04
       2    3.233942643372D-02   -5.730070151158D-03    5.639470554955D-04
       3    4.028223463613D-03   -6.775275129877D-04    5.927342203251D-05
       4   -4.343906483582D-03    7.330672175437D-04   -6.737562862785D-05
       5    5.739582951694D-04   -9.301568592793D-05    8.339289670874D-06
       6    4.646781534504D-06   -9.443082582766D-07    4.567269449835D-08
       7   -4.231117608526D-06    6.309570737001D-07   -4.235798707450D-08
```

```
        8    1.668808712577D-07   -2.180052385585D-08    1.047870711900D-09

        E-Index:     6                    7                    8
 T-Index:
        0    3.390872601321D-05   -9.817548467947D-07    1.135964925849D-08
        1    2.260490762610D-05   -5.312960958760D-07    4.417913806532D-09
        2   -3.105931750375D-05    8.954284624235D-07   -1.053605286933D-08
        3   -2.695731962799D-06    5.604944938198D-08   -3.081951853519D-10
        4    3.406464134420D-06   -8.840559993869D-08    9.088416616843D-10
        5   -4.195355464733D-07    1.130977058144D-08   -1.314879735454D-10
        6    3.574490849965D-09   -4.342693823216D-10    1.186584611296D-11
        7    7.775072659869D-10    4.164660123508D-11   -1.575223043337D-12
        8    2.251635634963D-11   -3.743444984134D-12    9.336979510479D-14

 Max. rel. Error:   6.0738 %
 Mean rel. Error:   0.8731 %



\end{verbatim}\end{small}
\begin{figure} \label{2.1.8b}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hydr1b.ps}
\end{figure}
\newpage


\subsection{
Reaction 2.2.5    $e + H_2   \rightarrow e + H + H  $
}

H2 multi-step model

 Data: Sawada/Fujimoto ,\cite{kn:Sawada}

$  H(1), H_2, H_2^+, H^+ $ transported


$H_2$ is in vibrational ground state, and the electronic levels
in the molecules as discussed in \cite{kn:Sawada} are taken into
account.


\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
 T-Index:
        0   -2.748251723699D+01    5.245554722385D-04   -2.978103958861D-04
        1    1.032713102402D+01   -4.288853521030D-04   -4.899568733097D-04
        2   -5.042872981718D+00    2.836621770958D-03   -3.043912367565D-03
        3    1.608638174175D+00   -1.261120000328D-03    1.887422712154D-03
        4   -4.314430346833D-01   -8.545622758573D-04    7.288308305238D-04
        5    9.436567726730D-02    3.330555462733D-04   -3.941114594575D-04
        6   -1.384992697339D-02    5.154637596963D-06    2.704571960637D-05
        7    1.132016190295D-03   -1.288164830284D-05    7.769128981290D-06
        8   -3.842014088368D-05    1.171737695451D-06   -9.017007769431D-07

        E-Index:     3                    4                    5
 T-Index:
        0   -2.360275829176D-07    2.352410977770D-05   -4.997866180134D-06
        1    4.986004995584D-04   -1.488915435909D-04    2.064670043755D-05
```

```
        2    1.292894496252D-03   -2.905449411133D-04    3.788502709678D-05
        3   -9.327238099803D-04    2.128634474527D-04   -2.509788157193D-05
        4   -2.484715070595D-04    4.842155320136D-05   -6.186008058267D-06
        5    1.711527657525D-04   -3.637820737985D-05    4.163286478680D-06
        6   -2.084393307530D-05    5.401855723043D-06   -6.247464789742D-07
        7   -1.221455182210D-06   -3.231445161484D-09    9.993216378891D-09
        8    2.476534052706D-07   -3.367686347533D-08    2.869160964443D-09

        E-Index:     6                    7                    8
 T-Index:
        0    4.276219304407D-07   -1.656742885479D-08    2.414039859152D-10
        1   -1.483657661440D-06    5.231689914639D-08   -7.056262049968D-10
        2   -2.892758625724D-06    1.174418148176D-07   -1.927933996765D-09
        3    1.553010173585D-06   -4.703323705313D-08    5.371568383284D-10
        4    5.102144895277D-07   -2.321199392340D-08    4.255457918971D-10
        5   -2.597547413556D-07    8.256194712004D-09   -1.040875802194D-10
        6    3.214084295485D-08   -5.485492350310D-10   -2.766340477990D-12
        7    1.346287938920D-10   -7.497501425175D-11    2.502198014796D-12
        8   -1.931319268617D-10    9.102276313210D-12   -1.872646131609D-13

 Max. rel. Error:   1.7118 %
 Mean rel. Error:   0.4517 %

\end{verbatim}\end{small}
\begin{figure} \label{2.2.5}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hydh2d2.ps}
\end{figure}
\newpage


\subsection{
Reaction 2.2.5r   $p + H_2   \rightarrow H + H + H  $
}

H2 multi-step model, MAR rate coefficient, H2+ condensed

 Data: Sawada/Fujimoto ,\cite{kn:Sawada}

$  H(1), H_2, H^+ $ transported, $H_2^+$ in QSS with $H_2$, $E_{H2}=0.1$ eV


$H_2$ is in vibrational distribution as fct. of $T_e$


\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
  T-Index:
        0   -2.191302446846D+01    2.201979359177D-02   -5.084127804366D-02
        1    2.515287131029D+00   -1.951782673829D-03    1.210559594877D-02
        2   -3.739165027129D+00   -5.039990032868D-03    5.156475880767D-02
        3    1.460287495804D+00   -1.902427777619D-02   -2.653691460740D-03
        4   -3.613420054183D-01   -9.136720216773D-03   -4.776315047524D-03
        5    1.022097226981D-01    1.430112787487D-02   -2.068159413388D-03
        6   -2.326509820253D-02   -4.698557490053D-03    1.350601458627D-03
        7    2.755718181169D-03    6.183157753063D-04   -2.180157674348D-04
        8   -1.245440617856D-04   -2.916396705941D-05    1.131212737957D-05

        E-Index:     3                    4                    5
  T-Index:
```

```
        0    2.725675449247D-02   -6.821140812496D-03    8.984277627487D-04
        1   -1.056465122608D-02    3.268414282907D-03   -4.770499814477D-04
        2   -3.005896796044D-02    7.117618884301D-03   -8.640595844451D-04
        3    8.718387627078D-03   -3.083275129564D-03    4.690013186619D-04
        4    2.274299170449D-03   -8.429380778242D-05   -5.166724308864D-05
        5   -8.581335425960D-04    2.018790326947D-04   -9.377832906111D-06
        6    9.091464941954D-06   -3.214048434350D-05    2.476622604418D-06
        7    1.640987010283D-05    1.594693278851D-06   -1.857150815035D-07
        8   -1.227368784843D-06   -6.059729362682D-09    4.830770876395D-09

        E-Index:     6                    7                    8
  T-Index:
        0   -6.471300739878D-05    2.392339469853D-06   -3.542871296534D-08
        1    3.555893312434D-05   -1.316695158693D-06    1.915346495446D-08
        2    5.696582068003D-05   -1.943708118398D-06    2.693231032650D-08
        3   -3.587259258804D-05    1.355091397789D-06   -2.009854793386D-08
        4    7.313297805130D-06   -3.673160516940D-07    6.439394992510D-09
        5   -6.689618689827D-07    6.721794871158D-08   -1.490826423672D-09
        6    4.829313987833D-08   -1.004736504929D-08    2.534364634180D-10
        7   -4.842242342991D-09    9.541230138142D-10   -2.466137348591D-11
        8    2.201416000842D-10   -3.685384915056D-11    9.608086847565D-13

  Max. rel. Error:  12.2399 %
  Mean rel. Error:   5.5197 %


\end{verbatim}\end{small}
\begin{figure} \label{2.2.5mar}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/mar.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.2.5d   $p + H_2   \rightarrow p + H + H  $
}

H2 multi-step model, MAD rate coefficient, H2+ condensed

 Data: Sawada/Fujimoto ,\cite{kn:Sawada}

$  H(1), H_2, H^+ $ transported, $H_2^+$ in QSS with $H_2$, $E_{H2}=0.1$ eV


$H_2$ is in vibrational distribution as fct. of $T_e$


\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
  T-Index:
        0   -2.305748927979D+01    5.724038174456D-02   -5.615862094751D-02
        1    5.292904264798D+00   -1.292700263854D-01    3.199290063730D-02
        2   -4.589002200888D+00    1.035141485454D-01    4.245746723064D-02
        3    1.282553627472D+00    8.228634639144D-03   -6.982329836971D-02
        4   -5.768335357015D-02   -4.231280575573D-02    4.520570788253D-02
        5   -1.762738366359D-02    1.754153736792D-02   -1.333930685945D-02
        6   -6.220461405830D-04   -2.841940983105D-03    1.674562107704D-03
        7    6.413295998688D-04    1.777701087291D-04   -5.286124278229D-05
        8   -4.623793560750D-05   -2.110102637934D-06   -2.826184196637D-06
```

```
        E-Index:     3                    4                    5
  T-Index:
        0    2.580537345185D-02   -5.187638531338D-03    5.591824235916D-04
        1   -1.411097510416D-03   -1.861670137347D-03    3.728807776936D-04
        2   -2.833978655627D-02    6.680453562388D-03   -7.508030455334D-04
        3    2.197499638706D-02   -2.786872754376D-03    1.536533061795D-04
        4   -9.850360398006D-03    5.824809680428D-04    2.282005339391D-05
        5    2.328857648314D-03   -4.906664256889D-05   -9.488057748931D-06
        6   -1.644016839248D-04   -2.447100861104D-05    2.465487188700D-06
        7   -1.933715475610D-05    7.307909083302D-06   -5.218713324203D-07
        8    2.372770563877D-06   -5.341529037052D-07    3.931259348181D-08

        E-Index:     6                    7                    8
  T-Index:
        0   -3.282931512925D-05    9.814853142975D-07   -1.164322982242D-08
        1   -3.011576633244D-05    1.138828160076D-06   -1.667604512176D-08
        2    4.303656667760D-05   -1.201510983254D-06    1.269878029776D-08
        3   -1.336438693130D-06   -1.902010802533D-07    5.308752951539D-09
        4   -3.734435698157D-06    1.331754413945D-07   -1.412895213605D-09
        5    1.096115694138D-07    3.997691612605D-08   -1.319357291444D-09
        6    1.527860379159D-07   -2.055626589064D-08    5.202352548656D-10
        7   -1.441930896339D-08    2.541011510181D-09   -6.500006263746D-11
        8   -7.928979184194D-11   -9.515229004763D-11    2.697745453159D-12

  Max. rel. Error:  11.3558 %
  Mean rel. Error:   5.3396 %


\end{verbatim}\end{small}
\begin{figure} \label{2.2.5mad}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/marmad.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.2.5i   $p + H_2   \rightarrow p + p + H  $
}

H2 multi-step model, MAI rate coefficient, H2+ condensed

 Data: Sawada/Fujimoto ,\cite{kn:Sawada}

$  H(1), H_2, H^+ $ transported, $H_2^+$ in QSS with $H_2$, $E_{H2}=0.1$ eV


$H_2$ is in vibrational distribution as fct. of $T_e$


\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
  T-Index:
        0   -4.373131541734D+01    6.718149393827D-01   -3.867837685625D-01
        1    2.174689987798D+01   -1.191104354839D+00    7.378457372332D-01
        2   -1.162182756359D+01    7.756604222360D-01   -4.321461052143D-01
        3    1.837003210284D+00   -1.537238550557D-01    8.022138313912D-02
        4    8.791715928275D-01   -6.293664899458D-02    2.407530624100D-02
        5   -4.701697036505D-01    4.136103649916D-02   -1.573783289950D-02
        6    9.146891578771D-02   -9.230394630199D-03    3.397451000676D-03
        7   -8.352940909550D-03    9.482379346865D-04   -3.411244141755D-04
```

```
       8    2.983980601563D-04   -3.758192682764D-05    1.332532546790D-05

       E-Index:     3                    4                    5
  T-Index:
       0    1.350532623779D-01   -2.606290252421D-02    2.960623240635D-03
       1   -2.337897758691D-01    4.249920373347D-02   -4.710792852313D-03
       2    1.244024912859D-01   -1.991554109544D-02    2.092199411332D-03
       3   -2.768133389852D-02    3.798880238692D-03   -3.638596889044D-04
       4    4.582163407263D-04   -2.026711273229D-04    1.801057292473D-05
       5    1.179264114144D-03   -1.870608178594D-05   -1.181360244394D-06
       6   -2.827540980953D-04    8.280496335764D-07    8.876306183255D-07
       7    2.896154172252D-05    2.341967770730D-07   -1.335324508242D-07
       8   -1.146002829775D-06   -1.521564259490D-08    5.973795729243D-09

       E-Index:     6                    7                    8
  T-Index:
       0   -1.932912896769D-04    6.651475974023D-06   -9.311652407600D-08
       1    3.059747667206D-04   -1.054165293122D-05    1.478357492460D-07
       2   -1.374611007871D-04    4.927217261940D-06   -7.245875668840D-08
       3    2.590722791448D-05   -1.080909364087D-06    1.850940055128D-08
       4   -1.952361813207D-06    1.287993215397D-07   -3.006990415615D-09
       5    1.194038887873D-07   -1.002354431841D-08    3.112143515737D-10
       6   -3.422331996712D-08    3.799710153845D-10   -6.935765606162D-12
       7    4.289635494443D-09    5.061843256637D-11   -2.503981294990D-12
       8   -1.601724546314D-10   -5.336350859656D-12    1.956601576452D-13

  Max. rel. Error:   3.7214 %
  Mean rel. Error:   1.4562 %


\end{verbatim}\end{small}
\begin{figure} \label{2.2.5mai}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/marmadmai.ps}
\end{figure}
\newpage


\subsection{
Reaction 2.2.5g   $e + H_2   \rightarrow e + H + H  $
}

H2 multi-step model,
data: Sawada/Fujimoto/Greenland.
$  H(1), H_2, H_2^+, H^+ $ transported (slow species).
The $H_2(\nu)$ are in vibrational equilibrium
(depends only upon $T_e$), and the electronic levels
in the molecules as discussed in \cite{kn:Sawada} are taken into
account. CX losses from vibr. distribution are computed assuming $T_e =
T_i$, and an energy of $H_2$-Beam  = 0.1 eV.
\begin{small}\begin{verbatim}
       E-Index:     0                    1                    2
  T-Index:
       0   -2.702372540584D+01   -3.152103191633D-03    5.990692171729D-03
       1    1.081756417479D+01   -1.487216964825D-02    1.417396532101D-02
       2   -5.368872027676D+00    5.419787589654D-03   -1.747268613395D-02
       3    1.340684229143D+00    1.058157580038D-02   -3.446019122786D-03
       4   -1.561644923145D-01   -3.847438570333D-03    3.571477356851D-03
       5   -1.444731533894D-04   -3.194532513126D-04   -2.987368098475D-04
       6    2.117693926546D-03    2.679309814780D-04   -1.037559373832D-04
```

```
       7   -2.143738340207D-04   -3.539232757385D-05    1.909399233821D-05
       8    6.979740947331D-06    1.462031952352D-06   -8.858634506391D-07

       E-Index:     3                    4                    5
  T-Index:
       0   -3.151252835426D-03    7.457309144890D-04   -9.238664007853D-05
       1   -4.689911797083D-03    7.180338663163D-04   -5.502798587526D-05
       2    9.532963297450D-03   -2.196705622859D-03    2.611447288152D-04
       3   -7.032769815599D-04    4.427959286553D-04   -7.370484189164D-05
       4   -1.103305795473D-03    1.476712517858D-04   -8.461162952132D-06
       5    2.092094838648D-04   -4.339352509941D-05    4.009328699469D-06
       6    7.297053580368D-06    1.454171585421D-06   -2.251616910293D-07
       7   -3.819368125069D-06    3.754063159414D-07   -2.441872829462D-08
       8    2.099830142707D-07   -2.606862169776D-08    2.039813579349D-09

       E-Index:     6                    7                    8
  T-Index:
       0    6.222557542845D-06   -2.160024578659D-07    3.028755759836D-09
       1    1.983066081752D-06   -2.207639762507D-08   -2.116339335271D-10
       2   -1.695536960581D-05    5.737375510694D-07   -7.940900078995D-09
       3    5.746786010618D-06   -2.182085196303D-07    3.264045809897D-09
       4    9.757111870171D-08    8.130014050833D-09   -2.234996157750D-10
       5   -1.762651912129D-07    3.357860444624D-09   -1.857322587267D-11
       6    9.191700327811D-09   -2.052366968228D-11   -3.567738654108D-12
       7    1.437490161488D-09   -6.172308568891D-11    1.104905484620D-12
       8   -1.113483084607D-10    3.859777100010D-12   -5.909099891913D-14

  Max. rel. Error:  11.6439 %
  Mean rel. Error:   2.6169 %
\end{verbatim}\end{small}
\begin{figure} \label{2.2.5g}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/green4.ps}
\end{figure}
\newpage


\subsection{
Reaction 2.2.9  $  e + H_2       \rightarrow 2e + H_2^+  $
}



\begin{small}\begin{verbatim}
       E-Index:     0                    1                    2
  T-Index:
       0   -3.574773783577D+01    3.470247049909D-01   -9.683166540937D-02
       1    1.769208985507D+01   -1.311169841222D+00    4.700486215943D-01
       2   -8.291764008409D+00    1.591701525694D+00   -5.814996025336D-01
       3    2.555712347240D+00   -8.625268584825D-01    2.612076696684D-01
       4   -5.370404654062D-01    2.375816996323D-01   -4.165908778170D-02
       5    7.443307905391D-02   -3.322214182214D-02   -2.351235556666D-03
       6   -6.391785721973D-03    1.862554278190D-03    1.540632467396D-03
       7    3.001729098239D-04    3.497202259366D-05   -1.742029226138D-04
       8   -5.607182991432D-06   -5.779550092391D-06    6.495742927455D-06

       E-Index:     3                    4                    5
  T-Index:
       0    1.959576276250D-03    2.479361119190D-03   -1.196632952666D-04
       1   -5.521175478827D-02   -2.689651616933D-03    7.308915874002D-04
```

```
       2    9.160898084105D-02   -4.770789631868D-03    1.994775632224D-05
       3   -3.686525285376D-02    1.945480608139D-03   -3.690918356665D-05
       4    1.732469114063D-03    3.693513203529D-04   -4.931268184607D-05
       5    1.723053881691D-03   -2.096625925098D-04    1.358575558294D-05
       6   -3.547150770477D-04    1.392157055273D-05    1.047463944093D-06
       7    2.296551698214D-05    2.357520372192D-06   -5.306085513950D-07
       8   -3.040011333889D-07   -2.361542565281D-07    3.655056080262D-08

       E-Index:     6                    7                    8
  T-Index:
       0   -1.862956119592D-05    1.669867158509D-06   -3.673736278200D-08
       1   -2.920560755694D-05   -3.148831240316D-07    2.514856386324D-08
       2   -7.511552245648D-06    1.089689676313D-06   -2.920863498031D-08
       3    4.836340453567D-06   -4.165748666929D-07    9.265898224345D-09
       4    2.727501534044D-06   -1.081027384449D-07    2.420509440644D-09
       5   -1.041586202167D-06    6.928574330531D-08   -1.746656185835D-09
       6    1.513510667993D-08   -9.915499708242D-09    3.298173891188D-10
       7    2.223137028418D-08    3.340169309800D-10   -2.560542889504D-11
       8   -1.771478792301D-09    1.334615260635D-11    6.831564719957D-13

  Max. rel. Error:   3.1001 %
  Mean rel. Error:    .4740 %

\end{verbatim}\end{small}
\begin{figure} \label{2.2.9}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hydh2i.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.2.10  $ e + H_2  \rightarrow e + H + H^+  $
}

\begin{small}\begin{verbatim}

       E-Index:     0                    1                    2
  T-Index:
       0   -3.793749300315D+01   -3.333162972531D-01    1.849601203843D-01
       1    1.280249398154D+01    1.028969438485D+00   -3.271855492638D-01
       2   -3.778148553140D+00   -1.415561059533D+00    2.928509524911D-01
       3    2.499987501522D-01    1.032922656537D+00   -1.580288004759D-01
       4    2.480574522949D-01   -4.372934216955D-01    6.448433196301D-02
       5   -9.960628182831D-02    1.092652428162D-01   -1.782307798975D-02
       6    1.709129400742D-02   -1.574889001363D-02    2.865310743302D-03
       7   -1.435304503973D-03    1.203823111704D-03   -2.350465388313D-04
       8    4.808639828229D-05   -3.761591649539D-05    7.490531472388D-06

       E-Index:     3                    4                    5
  T-Index:
       0   -8.803945197107D-02    2.205180180735D-02   -2.852568161901D-03
       1    1.305597441611D-01   -3.408439821910D-02    4.591924060066D-03
       2   -7.425165688158D-02    2.028424685287D-02   -3.042376564749D-03
       3    9.934702707539D-03   -2.450845732158D-03    5.716646876513D-04
       4    1.229222932630D-03   -9.281410519553D-04    5.946235618034D-05
       5    1.192181214757D-04    2.310636556641D-04   -2.492990725967D-05
       6   -1.700396064727D-04   -1.502644504654D-06    3.297869416435D-07
       7    2.507288189894D-05   -3.077975735212D-06    3.748299687254D-07
       8   -1.077314971617D-06    1.950247963978D-07   -2.569729600929D-08
```

```
       E-Index:     6                    7                    8
  T-Index:
       0    1.942314738448D-04   -6.597388255594D-06    8.798544848606D-08
       1   -3.167471002157D-04    1.070920193931D-05   -1.408139742113D-07
       2    2.279124955373D-04   -8.197224564797D-06    1.130682076163D-07
       3   -5.339115778704D-05    2.135848413694D-06   -3.072223247387D-08
       4   -8.758032156912D-08   -7.270955072707D-08    1.100087131523D-09
       5    1.217600444191D-06   -3.624263301602D-08    6.139167092128D-10
       6    6.572135289627D-10    4.269190108005D-10   -3.666090917669D-11
       7   -2.613600078122D-08    8.263175463927D-10   -8.509179497022D-12
       8    1.804377780165D-09   -6.031847199601D-11    7.416020205748D-13

  Max. rel. Error:   1.2041 %
  Mean rel. Error:    .4804 %
\end{verbatim}\end{small}
\begin{figure} \label{2.2.10}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hydh2d1.ps}
\end{figure}
\newpage



\subsection{
Reaction 2.2.11   $e + H_2^+      \rightarrow 2e + H^+ + H^+ $
}


\begin{small}\begin{verbatim}
       E-Index:     0                    1                    2
 T-Index:
       0   -3.708803769397D+01    9.784233987341D-02   -7.200361272130D-03
       1    1.561780529774D+01   -1.673256230592D-02    2.743322772895D-02
       2   -6.874406034117D+00   -7.782929961315D-03   -6.888773684846D-03
       3    2.010540060675D+00   -3.226785148562D-03   -6.181192193854D-03
       4   -3.614768906120D-01    3.710098881765D-03    2.045814599796D-03
       5    2.956861321735D-02   -5.524443504504D-04   -2.457951062112D-05
       6    9.662490252868D-04   -1.548556801431D-04    1.417215042439D-05
       7   -3.543571865464D-04    4.662969089421D-05   -1.471117766355D-05
       8    1.827109843671D-05   -3.179895716088D-06    1.432429412413D-06

       E-Index:     3                    4                    5
 T-Index:
       0    6.496843022778D-03   -1.420590818760D-03    1.703620321164D-04
       1   -1.026956102747D-02    1.999561527383D-03   -2.043607814503D-04
       2    2.306107197863D-03   -4.029222834436D-04    3.932152471491D-05
       3    2.388146990238D-03   -5.018901320009D-04    5.520233512352D-05
       4   -8.523935993991D-04    1.751295192861D-04   -1.944203941844D-05
       5    3.433179945503D-05   -1.450208898992D-06   -2.447566480782D-07
       6   -6.444863591678D-06   -1.566028729499D-06    4.152486680818D-07
       7    5.235585096328D-06   -5.779667826854D-07    2.139729421817D-08
       8   -5.141065080107D-07    7.734387173369D-08   -6.163336831045D-09

       E-Index:     6                    7                    8
 T-Index:
       0   -1.160738946400D-05    4.148222302162D-07   -6.007853385325D-09
       1    1.084177127603D-05   -2.671800995803D-07    2.093182411476D-09
       2   -2.094907364150D-06    5.682907060010D-08   -6.320752545610D-10
       3   -3.080798536641D-06    7.864770315002D-08   -6.357395371638D-10
       4    1.138888354831D-06   -3.256303793266D-08    3.501794038444D-10
```

```
        5    1.375679100044D-08    4.863880510459D-10   -3.004374374556D-11
        6   -2.855068942744D-08    6.081804811000D-10    9.512865901179D-13
        7   -3.656048425230D-10    3.759866326965D-11   -1.486151370215D-12
        8    3.128313515842D-10   -1.061842444216D-11    1.771099769640D-13

 Max. rel. Error:   1.0209 %
 Mean rel. Error:   0.3164 %

\end{verbatim}\end{small}
\begin{figure} \label{2.2.11}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hydh2p0.ps}
\end{figure}
\newpage



\subsection{
Reaction 2.2.12 $  e + H_2^+   \rightarrow  e + H + H^+  $
}



\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
 T-Index:
        0   -1.793443274600D+01   -4.932783688604D-02    1.039088280849D-01
        1    2.236108757681D+00   -2.545406018621D-02   -1.160421006835D-01
        2   -3.620018994703D-01    6.721527680150D-02    1.564387124002D-02
        3   -4.353922258965D-01   -3.051033606589D-02    3.512861172521D-02
        4    1.580381801957D-01    2.493654957203D-03   -1.601970998119D-02
        5    1.697880687685D-02    2.106675963900D-03    4.521983358170D-04
        6   -1.521914651109D-02   -7.527862162788D-04    9.095551479381D-04
        7    2.406276368070D-03    9.971361856278D-05   -1.760978402353D-04
        8   -1.219469579955D-04   -4.785505675232D-06    9.858840337511D-06

        E-Index:     3                    4                    5
 T-Index:
        0   -4.375935166008D-02    9.196691651936D-03   -1.043378648769D-03
        1    4.407846563362D-02   -8.192521304984D-03    8.200277386433D-04
        2   -4.939045440424D-03    4.263195867947D-04    1.034216805418D-05
        3   -1.179504564265D-02    2.091772760029D-03   -1.991100044575D-04
        4    5.346709597939D-03   -8.711870134835D-04    7.542066727545D-05
        5   -3.017151690655D-04    6.209239389357D-05   -7.598119096817D-06
        6   -2.372576223034D-04    3.018561480848D-05   -1.365255868731D-06
        7    4.877659148871D-05   -6.477358351729D-06    3.541106430252D-07
        8   -2.779210878533D-06    3.720379996058D-07   -2.110289928486D-08

        E-Index:     6                    7                    8
 T-Index:
        0    6.600342421838D-05   -2.198466460165D-06    3.004145701249D-08
        1   -4.508284363534D-05    1.282824614809D-06   -1.474719350236D-08
        2   -3.975028601900D-06    2.322116289258D-07   -4.381217154470D-09
        3    1.018080238045D-05   -2.597941866088D-07    2.524118386011D-09
        4   -3.410778344979D-06    7.120460603822D-08   -4.412295474522D-10
        5    5.523273241689D-07   -2.130508249251D-08    3.319099650589D-10
        6   -4.604769733903D-08    5.867910270430D-09   -1.357779142836D-10
        7    1.309772899670D-09   -8.072907334230D-10    2.074669430611D-11
        8    3.753875073646D-11    4.024906665497D-11   -1.075990572574D-12
```

```
 Max. rel. Error:  15.8263 %
 Mean rel. Error:   3.9031 %

\end{verbatim}\end{small}
\begin{figure} \label{2.2.12}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hydh2p1.ps}
\end{figure}
\newpage



\subsection{
Reaction 2.2.14  $ e + H_2^+    \rightarrow H + H  $
}



\begin{small}\begin{verbatim}
        E-Index:     0                   1                   2
 T-Index:
        0   -1.664335253647D+01    8.953780953631D-02   -1.056411030518D-01
        1   -6.005444031657D-01    4.063933992726D-02   -4.753947846841D-02
        2    4.494812032769D-04    7.884508616595D-05    3.688007562485D-04
        3    1.632894866655D-04    3.108116177617D-04   -3.521552580917D-04
        4   -7.234142549752D-05   -1.316311320262D-03    1.643509328764D-03
        5   -1.504085050039D-05    1.315865970237D-04   -1.025653773999D-04
        6    1.113923667684D-05    2.711411525392D-05   -8.495922363727D-05
        7   -1.843926162250D-06   -1.663674537499D-06    1.308069926896D-05
        8    9.864173150662D-08   -2.212261708468D-07   -4.431749501051D-07

        E-Index:     3                   4                   5
 T-Index:
        0    4.477000808690D-02   -9.729945434357D-03    1.174456882002D-03
        1    2.188304031377D-02   -5.201085606791D-03    6.866340394051D-04
        2   -4.659255785539D-04    1.907115980400D-04   -3.434324710145D-05
        3   -2.233169775063D-04    1.869415236037D-04   -4.329991211511D-05
        4   -6.412764282779D-04    1.048891053765D-04   -7.018555173322D-06
        5    5.310324781249D-05   -1.831888048039D-05    3.423755373077D-06
        6    4.026487801017D-05   -6.289324474240D-06    1.911447036702D-07
        7   -7.324021449032D-06    1.431739868187D-06   -1.085644779665D-07
        8    3.270530731011D-07   -7.282085521177D-08    6.578253567957D-09

        E-Index:     6                   7                   8
 T-Index:
        0   -7.987743820637D-05    2.842957892768D-06   -4.104508608435D-08
        1   -5.059940013116D-05    1.930213882205D-06   -2.963966822809D-08
        2    3.067651560323D-06   -1.325689465590D-07    2.212493073620D-09
        3    4.465256901322D-06   -2.136296167564D-07    3.873085368404D-09
        4    4.776213235854D-08    1.380537343974D-08   -4.199397846492D-10
        5   -3.303384352061D-07    1.551627097700D-08   -2.809391819541D-10
        6    3.638198230235D-08   -3.235540606394D-09    7.605442050634D-11
        7    1.143164983367D-09    2.151595003971D-10   -7.052562220005D-12
        8   -1.925258267827D-10   -4.217474167519D-12    2.364754029318D-13

 Max. rel. Error:   3.3331 %
 Mean rel. Error:   0.3010 %
```

```
\end{verbatim}\end{small}
\begin{figure} \label{2.2.14}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hydh2p2.ps}
\end{figure}
\newpage



\subsection{
Reaction 2.3.9a  $e + He(1|1S) \rightarrow  e + He^+ + e $
}
Helium multi-step model, here ionization

 Fujimoto Formulation II (only ground level transported, no metastables
 kept explicit), \cite{kn:Fujimoto}



\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
  T-Index:
        0   -4.227118452798D+01    1.294554451998D-01   -8.433979538052D-02
        1    2.411668100975D+01   -8.121999208281D-02    4.052570160482D-02
        2   -1.203181133667D+01   -3.998282970932D-03   -2.819919193060D-03
        3    3.829444688521D+00    2.546414073266D-02    2.654490306111D-03
        4   -7.945839257175D-01   -1.493597874850D-02   -1.018320076497D-03
        5    1.054334178555D-01    4.338821244147D-03   -1.483560478208D-04
        6   -8.578643565653D-03   -6.689202603525D-04    9.084162487421D-05
        7    3.886232727181D-04    5.180805123476D-05   -1.125453787291D-05
        8   -7.487575233223D-06   -1.582977433740D-06    4.413792107083D-07

        E-Index:     3                    4                    5
  T-Index:
        0    4.910721979375D-02   -1.454047282438D-02    2.178105605879D-03
        1   -2.367924962508D-02    8.488392041366D-03   -1.452752408581D-03
        2   -1.904887727240D-03   -2.390948585334D-04    1.844484422285D-04
        3    1.087493205419D-03   -4.469192206896D-04    3.715538155590D-05
        4    2.821927325759D-04    3.269264854581D-05   -5.937518354028D-06
        5   -6.901574689672D-05    6.350490312899D-06   -4.414167358057D-07
        6   -4.184111347149D-06    1.153919327151D-07    3.797435455934D-08
        7    1.536214841434D-06   -1.632601398517D-07    8.948177075796D-09
        8   -7.832095176637D-08    9.586974774950D-09   -6.739076170810D-10

        E-Index:     6                    7                    8
  T-Index:
        0   -1.657512355348D-04    6.161429564793D-06   -8.910615590909D-08
        1    1.170902182939D-04   -4.410479245308D-06    6.297315949647D-08
        2   -1.972728027860D-05    7.779440219801D-07   -1.033814145233D-08
        3   -1.595144154431D-06    6.311039124056D-08   -1.485989166680D-09
        4    4.714656637197D-07   -2.433462923993D-08    5.307423532159D-10
        5    1.266603603049D-08    8.049435558339D-10   -3.807796193572D-11
        6   -4.123383037275D-09    1.095960078746D-10   -5.109801608123D-14
        7   -1.853674996294D-10    1.342166707999D-14    1.184569645146D-14
        8    2.565598443992D-11   -4.994625098807D-13    4.124048804450D-15

  Max. rel. Error:   1.4966 %
  Mean rel. Error:    .1241 %
```

```
\end{verbatim}\end{small}
\begin{figure} \label{2.3.9a}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/helia.ps}
\end{figure}
\newpage


 Fujimoto Formulation I (ground level and 2 meta-stable levels transported)

\subsection{
Reaction 2.3.9b  $e + He(1|1S) \rightarrow e + He^+ + e  $
}


\begin{small}\begin{verbatim}



       E-Index:     0                    1                    2
  T-Index:
       0   -4.465926038712D+01    2.779089377769D-01   -1.924882766567D-01
       1    2.525835077281D+01   -3.615923725584D-01    1.317375998510D-01
       2   -1.209203690110D+01    2.546508612886D-01   -4.865271188617D-02
       3    3.800524426932D+00   -1.050334429568D-01    1.534747997056D-02
       4   -8.039502806290D-01    2.383460807262D-02   -2.453115299067D-03
       5    1.113782505171D-01   -2.736570987242D-03   -1.204111477713D-04
       6   -9.620115283603D-03    1.170152671250D-04    8.499825475516D-05
       7    4.684217843660D-04    2.993567258600D-06   -9.064004864288D-06
       8   -9.803749599678D-06   -2.872558504737D-07    3.052211397578D-07

       E-Index:     3                    4                    5
  T-Index:
       0    8.206249637969D-02   -1.857913019533D-02    2.303280474362D-03
       1   -3.756327901158D-02    7.553859741475D-03   -9.078039556264D-04
       2    3.019270415903D-03    6.079717185636D-05   -1.971883028916D-05
       3   -1.216174535037D-04   -1.789202918039D-04    2.652901470795D-05
       4    1.469571845580D-04   -3.672662632973D-05    3.283809863879D-06
       5    1.895504949459D-05    9.915856648703D-06   -1.080542155973D-06
       6   -1.228789754131D-05   -2.775942493726D-07    3.600949456643D-08
       7    1.331783826572D-06   -3.482200586084D-08    3.023300632995D-09
       8   -4.228344440471D-08    1.047078160211D-09   -7.325236965794D-11

       E-Index:     6                    7                    8
  T-Index:
       0   -1.557492713615D-04    5.412603196390D-06   -7.592974771773D-08
       1    6.285196169828D-05   -2.363737361863D-06    3.748123629849D-08
       2   -1.284093049142D-06    2.768704515392D-07   -9.149600770688D-09
       3   -7.430360191467D-07   -7.771887920734D-08    3.535086119528D-09
       4   -3.318791946233D-07    3.208524419469D-08   -1.011210049359D-09
       5    5.266320143919D-08   -3.383189536291D-09    1.132832454025D-10
       6    3.748617077019D-09   -1.897621201127D-10   -6.405513953940D-13
       7   -7.781196082881D-10    4.279614523560D-11   -6.119815491934D-13
       8    2.391497281895D-11   -1.495486439356D-12    2.587685854804D-14

  Max. rel. Error:   1.3886 %
  Mean rel. Error:    .1520 %

\end{verbatim}\end{small}
\begin{figure} \label{2.3.9b}
```

```
\epsfxsize=16truecm
\epsffile{Amjuel_PS/helib.ps}
\end{figure}
\newpage


\subsection{
Reaction 2.3.9c  $e + He(1|1S) \rightarrow e + He(2|1S) $
}



\begin{small}\begin{verbatim}

        E-Index:     0                    1                    2
  T-Index:
        0   -4.046178452435D+01    2.793780023801D-02   -2.636827236275D-02
        1    2.021782349890D+01   -8.168151009006D-02    6.137459348454D-02
        2   -9.976409627529D+00    7.203017486249D-02   -4.594744469839D-02
        3    3.121941621264D+00   -3.252368776384D-02    1.838136188172D-02
        4   -6.605740116932D-01    7.971710032974D-03   -3.491501531484D-03
        5    9.314429433629D-02   -1.237053221067D-03    3.539330238278D-04
        6   -8.331619915042D-03    1.280998359531D-04   -2.164671094364D-05
        7    4.255343291630D-04   -7.951439218420D-06    7.965320643996D-07
        8   -9.415940442146D-06    2.158374132954D-07   -1.212346927674D-08

        E-Index:     3                    4                    5
  T-Index:
        0    9.966974050192D-03   -1.925058189572D-03    2.074618402408D-04
        1   -1.789108699037D-02    2.499301042347D-03   -1.708164459820D-04
        2    1.099110619333D-02   -1.123236352791D-03    2.768319881512D-05
        3   -4.067150951400D-03    4.169742301105D-04   -1.424941738587D-05
        4    5.821208934666D-04   -4.623802427724D-05    8.865908638099D-07
        5   -1.693003577039D-05   -2.195524273463D-06    2.451445678475D-07
        6   -3.496132235049D-06    7.607387051093D-07   -2.643851478727D-08
        7    4.015715517122D-07   -6.690887808842D-08    2.045934897132D-09
        8   -1.496923652893D-08    2.594682285097D-09   -1.399655571965D-10

        E-Index:     6                    7                    8
  T-Index:
        0   -1.262053793968D-05    4.055587151672D-07   -5.348263576276D-09
        1    4.628208806209D-06    2.791547274449D-08   -2.554662311089D-09
        2    3.397787872961D-06   -2.546734368181D-07    5.048596843802D-09
        3   -7.637600844108D-07    7.190678272390D-08   -1.515996656096D-09
        4    1.543470779365D-07   -1.154851629261D-08    2.413115266566D-10
        5   -1.466182203352D-08    7.285294206745D-10   -1.706462195600D-11
        6   -1.132975723190D-09    6.492076232833D-11   -3.972506213491D-13
        7    1.178546445834D-10   -6.482775463755D-12    5.122149685044D-14
        8    2.346036357946D-12   -3.268745663823D-14    1.995604762061D-15

  Max. rel. Error:   1.9207 %
  Mean rel. Error:    .5914 %



\end{verbatim}\end{small}
\begin{figure} \label{2.3.9c}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/helic.ps}
\end{figure}
```

```
\newpage

\subsection{
Reaction 2.3.9d $ e + He(1|1S) \rightarrow e + He(2|3S) $
}



\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
  T-Index:
        0   -3.886266644950D+01    7.019809942099D-04   -4.884086339705D-03
        1    1.929521258283D+01   -2.357936604103D-02   -1.328300789738D-02
        2   -9.046404053855D+00    8.666192442035D-02    5.474654335859D-02
        3    2.673018107253D+00   -1.398928491802D-01    3.218710988103D-03
        4   -5.548107653535D-01    7.465434423573D-02   -1.179392922571D-02
        5    7.774830542594D-02   -1.905817901709D-02    3.638331146570D-03
        6   -6.848256427157D-03    2.528446995280D-03   -4.700217870527D-04
        7    3.400854043835D-04   -1.673888466652D-04    2.614365787435D-05
        8   -7.262673007156D-06    4.357192276102D-06   -4.506225745622D-07

        E-Index:     3                    4                    5
  T-Index:
        0    4.394808572685D-03   -1.302054032826D-03    1.826711561551D-04
        1    1.082410659623D-03    8.797507874605D-04   -1.904140538432D-04
        2   -2.932730590755D-02    5.819861355501D-03   -6.211677015176D-04
        3    7.586337950327D-03   -1.674705131468D-03    1.745859315455D-04
        4    2.158501813724D-04    7.916139470987D-05   -6.470261758484D-06
        5   -2.830357834958D-04    2.090178740450D-05   -2.905940657585D-06
        6    2.610671874389D-05   -7.317822457225D-07    2.937506973332D-07
        7    9.223198907867D-07   -4.349863908454D-07    1.893279869199D-08
        8   -1.418436717966D-07    3.344143189525D-08   -2.438361820942D-09

        E-Index:     6                    7                    8
  T-Index:
        0   -1.338147384862D-05    4.944420378156D-07   -7.274738213340D-09
        1    1.572144633422D-05   -5.949713883471D-07    8.661413444821D-09
        2    3.751189894835D-05   -1.205285676422D-06    1.596181856159D-08
        3   -1.072392282940D-05    3.817775426074D-07   -5.941731934892D-09
        4    5.703111011170D-07   -4.610054978455D-08    1.257685434225D-09
        5    1.376224572390D-07    3.158742833521D-09   -2.256374221221D-10
        6   -2.123916588197D-08   -1.342964777517D-10    2.534904955517D-11
        7    2.438015393047D-11    2.825944427401D-11   -1.724540860429D-12
        8    8.609576897508D-11   -2.649053786615D-12    6.205443362599D-14

  Max. rel. Error:   4.7040 %
  Mean rel. Error:   1.6362 %



\end{verbatim}\end{small}
\begin{figure} \label{2.3.9d}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/helid.ps}
\end{figure}
\newpage
\subsection{
Reaction 2.3.9e  $e + He(2|1S) \rightarrow e + He(1|1S) $
}
```

\begin{small}\begin{verbatim}

```
       E-Index:     0                    1                    2
  T-Index:
       0   -1.206284357030D+01   -9.395741200722D-01    8.941559006967D-02
       1    1.001413279976D-01    1.092169776728D-01    1.368198258579D-01
       2    7.586400083695D-02   -3.795422777009D-03   -4.592861987024D-02
       3   -6.305941229397D-02   -1.344397679189D-02    5.918300497317D-03
       4    1.769150254942D-02    3.790811280315D-03   -6.656861914400D-06
       5   -2.649142451670D-03   -4.390182739385D-04   -1.378634631707D-04
       6    2.286216360493D-04    1.421107391865D-05    2.727632307001D-05
       7   -1.081890897336D-05    1.614465895521D-06   -2.798379357036D-06
       8    2.194368384994D-07   -1.169587182544D-07    1.178226546132D-07

       E-Index:     3                    4                    5
  T-Index:
       0    2.236104074143D-02   -6.491279005972D-03    6.949727832958D-04
       1   -5.565930009734D-02    1.010402473629D-02   -1.046827564504D-03
       2    1.258334121198D-02   -1.876085557457D-03    1.902110155531D-04
       3    6.956902121898D-04   -2.605824960044D-04    1.950702712776D-05
       4   -5.678513919575D-04    9.916918467853D-05   -5.461700671234D-06
       5    9.155083108892D-05   -9.582108792123D-06   -4.823548954286D-08
       6   -8.973643720110D-06    5.015822067600D-07    4.733355630355D-08
       7    7.315416774742D-07   -6.070951170683D-08    2.496749755159D-09
       8   -3.205208905129D-08    4.211868482308D-09   -4.146419126420D-10

       E-Index:     6                    7                    8
  T-Index:
       0   -3.798849551595D-05    1.060426073614D-06   -1.221792772705D-08
       1    6.343654833533D-05   -2.081812227589D-06    2.840825118625D-08
       2   -1.235336841503D-05    4.391737031475D-07   -6.361146384328D-09
       3   -2.609090338780D-07   -2.035332888490D-08    5.697468968308D-10
       4    9.584672975523D-09    7.522667390232D-09   -1.643595153340D-10
       5    4.899977333096D-08   -2.232347489472D-09    2.900728952005D-11
       6   -4.956007021108D-09    1.036072591263D-10    5.476491421305D-13
       7   -2.464346448050D-10    1.983186245349D-11   -4.977113923684D-13
       8    3.334367936705D-11   -1.585718526609D-12    2.983699805655D-14

  Max. rel. Error:   1.4647 %
  Mean rel. Error:    .6179 %
```

\end{verbatim}\end{small}
\begin{figure} \label{2.3.9e}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/helie.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.3.9f $e + He(2|1S) \rightarrow e + He^+ + e $
}

\begin{small}\begin{verbatim}

```
       E-Index:     0                    1                    2
  T-Index:
       0   -2.041118707850D+01    2.064277904192D-01   -2.301314111088D-01
       1    4.734415747558D+00   -2.552828703588D-01    2.342297501453D-01
       2   -2.031119990372D+00    1.324170464675D-01   -4.709002494788D-02
       3    6.371388191840D-01   -6.485323499659D-02   -1.318105876403D-02
       4   -1.606102572000D-01    3.031094673577D-02    4.353315277834D-03
       5    2.869498856933D-02   -8.594657926314D-03    1.245406154419D-04
       6   -3.217835269221D-03    1.298813772998D-03   -1.446399013109D-04
       7    1.992406567281D-04   -9.756034343132D-05    1.558038205391D-05
       8   -5.162497860818D-06    2.873135417997D-06   -5.121082856413D-07

       E-Index:     3                    4                    5
  T-Index:
       0    1.064846554112D-01   -2.384946202844D-02    2.875360842310D-03
       1   -1.009365349705D-01    2.154424500834D-02   -2.450397986314D-03
       2    1.965251665219D-02   -4.861043898033D-03    5.741139338224D-04
       3    6.274439358726D-03   -5.336599826346D-04    6.766527255195D-06
       4   -2.730895337646D-03    2.879856399739D-04   -8.539443051056D-06
       5    3.376848227155D-04   -2.761034449494D-05   -1.226863119476D-06
       6   -1.429851963639D-05    8.564331543394D-07    2.266756951926D-07
       7    1.313034465605D-07   -1.155540500016D-07    8.907397769803D-09
       8   -9.429070218568D-09    1.043211307579D-08   -1.547549446017D-09

       E-Index:     6                    7                    8
  T-Index:
       0   -1.875978041743D-04    6.245347035980D-06   -8.331988072406D-08
       1    1.492018825102D-04   -4.569691982094D-06    5.506673096644D-08
       2   -3.190474508863D-05    7.544465168586D-07   -4.738153009264D-09
       3   -4.524848313611D-07    1.101272889478D-07   -3.647448463620D-09
       4    1.327453253122D-07   -2.364732558216D-08    8.985219510628D-10
       5    1.509448581903D-07   -1.051090322975D-09   -1.035749496501D-10
       6   -1.493652619657D-08   -1.728825755255D-10    1.851526257919D-11
       7   -1.266737591814D-09    1.032899830898D-10   -2.632477381331D-12
       8    1.383817472027D-10   -6.759540208869D-12    1.300020937903D-13

  Max. rel. Error:   3.1668 %
  Mean rel. Error:    .5043 %


\end{verbatim}\end{small}
\begin{figure} \label{2.3.9f}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/helif.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.3.9g $ e + He(2|1S) \rightarrow e + He(2|3S) $
}




\begin{small}\begin{verbatim}


       E-Index:     0                    1                    2
  T-Index:
```

```
       0   -1.511346543847D+01   -8.315548974761D-03    1.043755302803D-03
       1    2.080755731664D-02   -1.438655344675D-02    3.050387143129D-02
       2   -1.559881223335D-01   -4.819070749165D-03    5.469768725333D-03
       3    3.593311746308D-02   -3.264350393911D-03   -2.797070666582D-03
       4   -7.539069188132D-03    2.816838207584D-03    1.209358979731D-04
       5    1.249554266705D-03   -6.865425821712D-04    4.394712468238D-05
       6   -1.346691563985D-04    7.711126608572D-05   -3.761880439834D-06
       7    8.141009386823D-06   -4.262318558331D-06   -5.160666241730D-08
       8   -2.101701177702D-07    1.010890135509D-07    3.792122360486D-09

       E-Index:     3                    4                    5
  T-Index:
       0    2.642487583410D-03   -1.141726366943D-03    1.946543332558D-04
       1   -1.854158470475D-02    4.594389089735D-03   -5.599959861484D-04
       2    2.070413057149D-04   -3.457506453968D-04    4.738780926722D-05
       3    8.235312574359D-04   -9.572690868675D-05    8.428282893341D-06
       4   -1.330419686348D-04    1.899203210608D-05   -1.396220087820D-06
       5    1.494981666075D-05   -3.053826052126D-06    2.132092797921D-07
       6   -2.368299001887D-06    4.919560666227D-07   -3.450359185228D-08
       7    2.216347288940D-07   -4.134834676754D-08    2.800553268281D-09
       8   -5.585637013718D-09    9.462594289102D-10   -4.980912274284D-11

       E-Index:     6                    7                    8
  T-Index:
       0   -1.635057730275D-05    6.698344020218D-07   -1.065235099548D-08
       1    3.560438313422D-05   -1.132594240133D-06    1.422148875942D-08
       2   -2.442018698579D-06    4.281026474337D-08    5.902980719683D-11
       3   -6.289242286208D-07    2.809710863001D-08   -4.986421098936D-10
       4    5.944783491030D-08   -1.403317455776D-09    1.466091168551D-11
       5   -2.812985305069D-09   -2.643823395694D-10    7.873039688058D-12
       6    3.288755762988D-10    5.309244160943D-11   -1.497810114810D-12
       7   -2.188207542114D-11   -4.594641184965D-12    1.274835520030D-13
       8   -1.490478001851D-12    2.101409635615D-13   -4.858731679885D-15

  Max. rel. Error:   3.2971 %
  Mean rel. Error:    .9554 %



\end{verbatim}\end{small}
\begin{figure} \label{2.3.9g}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/helig.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.3.9h  $e + He(2|3S) \rightarrow e + He(1|1S) $
}


\begin{small}\begin{verbatim}


       E-Index:     0                    1                    2
  T-Index:
       0   -1.830459498604D+01    1.680944192322D-01   -1.907710632311D-01
       1    1.261631206881D+00   -3.697196539108D-01    3.033207775574D-01
       2   -6.559878055182D-01    3.061935618408D-01   -1.782153223733D-01
       3    1.697614445868D-01   -1.342126595676D-01    5.676221077284D-02
```

```
        4   -3.176415719557D-02    3.126025766778D-02   -1.011584147746D-02
        5    3.950262828345D-03   -3.455627026606D-03    6.079929754617D-04
        6   -2.881881569143D-04    1.125950976085D-04    5.069359855193D-05
        7    1.022634571062D-05    7.797965660632D-06   -7.903959237155D-06
        8   -1.046204166475D-07   -5.060676841045D-07    2.672428957821D-07

        E-Index:     3                    4                    5
  T-Index:
        0    7.870000493965D-02   -1.578049324901D-02    1.693793556658D-03
        1   -1.021849055299D-01    1.773149558150D-02   -1.726009071069D-03
        2    4.310244321027D-02   -5.236106415441D-03    3.417399063180D-04
        3   -8.861603178392D-03    3.398799078845D-04    4.431709264967D-05
        4    1.152839986316D-03    9.136542557803D-06   -9.999842824089D-06
        5   -1.259483668399D-05   -8.845662317330D-06    8.897275861513D-07
        6   -1.194283431812D-05    8.912124314893D-07   -4.132333818961D-08
        7    7.631517909210D-07    5.811563274232D-08   -6.834989323422D-09
        8   -3.354009675567D-09   -6.847471248575D-09    6.066678972621D-10

        E-Index:     6                    7                    8
  T-Index:
        0   -9.871776235813D-05    2.943212020081D-06   -3.527779579573D-08
        1    9.567692855718D-05   -2.834877407571D-06    3.493434187484D-08
        2   -1.237776471579D-05    2.515470587336D-07   -2.566899239887D-09
        3   -4.572811804993D-06    1.335801462225D-07   -8.926601447859D-10
        4    3.785048727116D-07    1.570413745481D-08   -7.805586685406D-10
        5    3.807398587262D-08   -7.209735737750D-09    2.098640072212D-10
        6   -2.405215414685D-09    4.468725637555D-10   -1.423750029854D-11
        7   -9.649173073383D-12    1.030982426102D-11   -1.042452128502D-13
        8   -2.881700207187D-12   -1.158584840686D-12    2.909357590574D-14

  Max. rel. Error:   6.5233 %
  Mean rel. Error:   1.8951 %

\end{verbatim}\end{small}
\begin{figure} \label{2.3.9h}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/helih.ps}
\end{figure}
\newpage



\subsection{
Reaction 2.3.9i $ e + He(2|3S) \rightarrow e + He(2|1S) $
}


\begin{small}\begin{verbatim}


        E-Index:     0                    1                    2
  T-Index:
        0   -1.745844276703D+01    8.157573269596D-02   -8.846137669182D-02
        1    7.481807449876D-01   -8.855888981396D-02    6.895575898405D-02
        2   -4.821059764779D-01    4.679324654447D-02   -3.297751569188D-02
        3    1.178180871789D-01   -6.059351136561D-03    6.707641671282D-03
        4   -1.832266433398D-02   -3.019133239406D-03   -4.072864365252D-06
        5    1.619689578381D-03    1.226840796832D-03   -1.633059618549D-04
        6   -5.423530837755D-05   -1.774072691416D-04    1.112445681671D-05
        7   -1.967026987940D-06    1.153537885107D-05    9.730921470847D-07
```

```
       8    1.471829150856D-07   -2.811554762172D-07   -8.690862477419D-08

       E-Index:     3                    4                    5
  T-Index:
       0    3.729534986051D-02   -7.748150218997D-03    8.681073774233D-04
       1   -2.009477611517D-02    2.695260975948D-03   -1.670023006117D-04
       2    7.266340675294D-03   -5.231546959702D-04   -1.405113747904D-05
       3   -1.185084843308D-03   -7.521294935444D-06    1.345383423264D-05
       4   -3.463344438708D-06    2.717377734542D-05   -3.273238480292D-06
       5    5.881112042281D-06   -3.089656478315D-06    4.514505533598D-07
       6    6.093509408469D-06   -8.020661101230D-07    1.087961936931D-08
       7   -1.135225653662D-06    1.679703656220D-07   -7.767824389490D-09
       8    5.404365621466D-08   -8.134516470380D-09    4.439057728063D-10

       E-Index:     6                    7                    8
  T-Index:
       0   -5.326368279955D-05    1.687247391834D-06   -2.160318603760D-08
       1    3.273035637060D-06    9.077935253350D-08   -3.430880317364D-09
       2    3.581367863934D-06   -1.600203938605D-07    2.265889575361D-09
       3   -7.627838979440D-07    1.599025715771D-09    4.761644881308D-10
       4    1.521655610951D-08    1.078364608775D-08   -3.386106465918D-10
       5   -8.083755569905D-09   -1.161692326935D-09    4.153576692338D-11
       6    2.280605076008D-09   -9.703614416875D-11    8.269006530832D-13
       7   -1.272866644000D-10    1.985460981397D-11   -4.226560743702D-13
       8    1.412497774809D-13   -8.003922930542D-13    1.975681079140D-14

  Max. rel. Error:   1.8916 %
  Mean rel. Error:    .4888 %


\end{verbatim}\end{small}
\begin{figure} \label{2.3.9i}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/helii.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.3.9j  $e + He(2|3S) \rightarrow e + He^+ + e $
}



\begin{small}\begin{verbatim}


       E-Index:     0                    1                    2
  T-Index:
       0   -2.055363233340D+01    4.495119087580D-01   -5.238622256836D-01
       1    5.210334391329D+00   -2.968974679742D-01    2.779506719390D-01
       2   -2.250469356935D+00    7.010500442526D-02   -1.213577735853D-01
       3    5.852050404826D-01    8.921407862649D-02    4.101964952741D-03
       4   -9.522800090383D-02   -6.623026789339D-02    1.426598675675D-02
       5    8.361746435674D-03    1.876265413172D-02   -4.938987966830D-03
       6   -2.082000823695D-04   -2.653612987499D-03    7.235705862418D-04
       7   -1.971223241071D-05    1.866108873151D-04   -5.008080286294D-05
       8    1.129438144977D-06   -5.204161575593D-06    1.341100873190D-06

       E-Index:     3                    4                    5
  T-Index:
```

```
        0    2.389768266075D-01   -5.282830816524D-02    6.225525677663D-03
        1   -9.544309562602D-02    1.574089888139D-02   -1.373029882004D-03
        2    3.981143589359D-02   -5.552464406897D-03    4.010663176656D-04
        3   -6.610103528390D-03    9.857909449549D-04   -6.826906017552D-05
        4   -7.969610821575D-04   -1.713086806983D-05    3.192882264529D-06
        5    4.727105277550D-04   -1.892061941621D-05    5.709120517813D-07
        6   -6.875356963100D-05    2.067400657772D-06   -4.852278760689D-08
        7    4.145701518111D-06   -3.688167910326D-09   -5.119123986569D-09
        8   -8.570742834160D-08   -5.179756344998D-09    4.745066997076D-10

        E-Index:     6                    7                    8
  T-Index:
        0   -3.959446131986D-04    1.281892887943D-05   -1.658021134736D-07
        1    6.228002425783D-05   -1.303442479359D-06    8.322300537481D-09
        2   -1.588204879114D-05    3.456291200468D-07   -3.614686328664D-09
        3    3.402964809821D-06   -1.409141853759D-07    2.865103804351D-09
        4   -3.264060374187D-07    2.446519428773D-08   -6.273758803879D-10
        5   -3.265134644505D-08    8.398689087309D-10    1.744587191452D-12
        6    1.231197186211D-08   -8.532974556790D-10    1.733410572003D-11
        7   -1.110937956560D-09    9.978997213312D-11   -2.217674451730D-12
        8    3.268128548473D-11   -3.678837719391D-12    8.560132404451D-14

  Max. rel. Error:   7.0831 %
  Mean rel. Error:   2.2103 %


\end{verbatim}\end{small}
\begin{figure} \label{2.3.9j}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/helij.ps}
\end{figure}
\newpage


\subsection{
Reaction 2.3.13a  $e + He^+(1s) \rightarrow He(1S) + ...  $
}

Helium multi-step model, here recombination

 Fujimoto Formulation II (only ground level transported, no metastables kept
explicit), \cite{kn:Fujimoto}


\begin{small}\begin{verbatim}

        E-Index:     0                    1                    2
  T-Index:
        0   -2.872754373123D+01   -6.171082987797D-03    2.414548639597D-02
        1    1.564233603544D+00   -3.972220721457D-02   -4.466712599181D-02
        2   -6.182140631482D+00    1.626641668186D-01    3.366589582541D-02
        3    5.459428677778D+00   -1.700323494998D-01   -1.540106384088D-02
        4   -2.128115924661D+00    7.233939709414D-02    5.819196258503D-03
        5    4.373730373037D-01   -1.574917019835D-02   -1.456253436544D-03
        6   -4.972257208732D-02    1.866175274689D-03    2.047337498511D-04
        7    2.967287371427D-03   -1.147811325052D-04   -1.460813593905D-05
        8   -7.271204747116D-05    2.874049670122D-06    4.124421172202D-07

        E-Index:     3                    4                    5
  T-Index:
```

```
        0   -7.188662067622D-03    9.481268604767D-04   -1.958887458637D-05
        1    1.247359158796D-02   -1.660591942878D-03    6.019181402025D-05
        2   -7.413737965595D-03    1.220189896183D-03   -9.505295724750D-05
        3    9.524545793262D-04   -8.734341535385D-05   -2.796027477899D-06
        4   -7.655935845761D-05   -1.837949067050D-05    4.725789832980D-06
        5    4.772491845078D-05   -1.827059132463D-06   -6.941163292710D-08
        6   -1.004438052808D-05    7.590734865850D-07   -6.771179147667D-08
        7    7.422385993164D-07   -3.281946488134D-08    2.164459880579D-09
        8   -1.689203971933D-08   -9.071172814458D-10    1.844295219334D-10

        E-Index:     6                    7                    8
  T-Index:
        0   -5.507786383328D-06    4.358288686930D-07   -9.503272091010D-09
        1    3.800156798817D-06   -3.377807793756D-07    6.828447501225D-09
        2    4.459492214068D-06   -1.552772441333D-07    2.866586118879D-09
        3    4.561981097438D-07    4.940311502014D-09   -6.525725010760D-10
        4   -3.997782411860D-07    1.036731541123D-08   -3.373845712183D-11
        5    2.716740135949D-08   -1.143121626264D-09    1.295139027087D-11
        6    1.218720257518D-09    6.787024479540D-11   -2.432253541918D-12
        7    1.113868237282D-10   -1.513922678655D-11    3.951084520871D-13
        8   -2.055023511556D-11    1.101902611511D-12   -2.206082129473D-14

  Max. rel. Error:  16.4494 %
  Mean rel. Error:   3.2360 %
\end{verbatim}\end{small}
\begin{figure} \label{2.3.13a}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/helra.ps}
\end{figure}
\newpage
\subsection{
Reaction 2.3.13b  $e + He^+(1s) \rightarrow He(1|1S) + h\nu$
}

 Fujimoto Formulation I (ground level and 2 meta-stable levels transported)


\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
  T-Index:
        0   -2.932450239883D+01   -1.725214936087D-02    4.209507397331D-02
        1    1.368459463821D+00   -7.548584212824D-02   -3.321889449021D-02
        2   -5.057940093488D+00    2.531332526084D-01   -1.925988688740D-02
        3    4.437755591817D+00   -2.369773678428D-01    2.411850401784D-02
        4   -1.704236205062D+00    9.630485149239D-02   -6.971157814419D-03
        5    3.430644471030D-01   -2.061167258227D-02    7.487855629993D-04
        6   -3.809452269361D-02    2.434745940239D-03   -1.722706965522D-06
        7    2.218026788496D-03   -1.502211895379D-04   -5.165559630643D-06
        8   -5.301589276464D-05    3.780661493099D-06    2.647213620732D-07

        E-Index:     3                    4                    5
  T-Index:
        0   -1.843883199649D-02    4.330069861940D-03   -5.571398183907D-04
        1    2.246769961570D-02   -6.920109284335D-03    1.034704067336D-03
        2   -1.562041938975D-03    2.844891620769D-03   -5.840417169956D-04
        3   -6.245247150004D-03    1.707788608782D-04    8.828047075521D-05
        4    2.150122229030D-03   -1.997306644340D-04    2.987453868437D-06
        5   -2.352870835454D-04    2.321396939441D-05   -1.669051074965D-06
        6   -1.929788529702D-06    1.001774243168D-06    7.435769683477D-08
        7    1.999043007214D-06   -3.211502011021D-07    8.114609805127D-09
```

```
        8   -9.897241177277D-08    1.504658532546D-08   -5.883462440247D-10

        E-Index:     6                    7                    8
  T-Index:
        0    4.006413547865D-05   -1.488766590351D-06    2.211904689519D-08
        1   -8.066726007499D-05    3.137222500010D-06   -4.796687278784D-08
        2    5.166332348737D-05   -2.133727041895D-06    3.362146796114D-08
        3   -1.099721749926D-05    5.014979395019D-07   -8.105197770220D-09
        4    4.904814231191D-07   -2.358575243153D-08    2.498171028400D-10
        5    1.745034668357D-07   -1.128396994326D-08    2.586295673609D-10
        6   -3.342032519922D-08    2.451263340785D-09   -5.477602284810D-11
        7    2.414625764231D-09   -2.022906627308D-10    4.590099192405D-12
        8   -6.465233005227D-11    6.181507714121D-12   -1.430061439345D-13

  Max. rel. Error:  15.0191 %
  Mean rel. Error:   3.1731 %

\end{verbatim}\end{small}
\begin{figure} \label{2.3.13b}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/helrb.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.3.13c $ e + He^+(1s) \rightarrow He(2|1S) + h\nu$
}

\cite{kn:Fujimoto}. Here: effective recombination into metastable level
$(2|1S)$.

\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
  T-Index:
        0   -3.290594969157D+01    5.936377204270D-01   -5.786568026984D-01
        1    1.289118555318D+00   -7.322821510173D-01    5.216313908016D-01
        2   -4.581116130605D+00    4.359234826400D-01   -1.879684009591D-01
        3    3.975023080430D+00   -1.135607337249D-01   -2.093787195291D-02
        4   -1.511744296191D+00    9.273954721890D-03    3.091151170807D-02
        5    3.006694544045D-01   -7.098672020828D-04   -6.524345786670D-03
        6   -3.291282273842D-02    4.674323034046D-04    3.252758528411D-04
        7    1.885862263038D-03   -7.894912660673D-05    3.023350709086D-05
        8   -4.430501809351D-05    3.801909601518D-06   -2.522313594898D-06

        E-Index:     3                    4                    5
  T-Index:
        0    2.219812747147D-01   -4.301992587218D-02    4.645717376756D-03
        1   -1.469524854136D-01    1.758178948996D-02   -6.553480315101D-04
        2    4.156489474989D-02   -1.653580474529D-03   -5.740235177360D-04
        3    4.449510483711D-03   -7.099391762833D-04    1.140482945563D-04
        4   -6.447934562370D-03    5.521339815402D-04   -1.215385049113D-05
        5    1.190208632381D-03   -8.535844740287D-05    1.100343069640D-06
        6    7.662178711899D-06   -1.003394753061D-05    9.133676744341D-07
        7   -1.693836511335D-05    2.998300023499D-06   -2.134268520285D-07
        8    1.008933043477D-06   -1.637662372864D-07    1.194860574397D-08

        E-Index:     6                    7                    8
  T-Index:
        0   -2.827549938027D-04    9.098967864743D-06   -1.204212130817D-07
        1   -3.911503234413D-05    3.838699392781D-06   -8.432388008514D-08
```

```
         2    8.252435318894D-05   -4.174329959264D-06    7.461274593602D-08
         3   -1.015903498277D-05    4.067368927608D-07   -5.956193776494D-09
         4   -1.743597814483D-06    1.504881645494D-07   -3.516856295239D-09
         5    3.283228084253D-07   -2.777357769656D-08    6.855090395029D-10
         6   -3.246510016651D-08    1.021166636920D-09   -2.826061022812D-11
         7    5.448904749550D-09    1.026064555133D-11   -1.372295711583D-12
         8   -3.572199625876D-10    1.353028569150D-12    7.810473188768D-14

  Max. rel. Error:  12.8697 %
  Mean rel. Error:   4.3370 %



\end{verbatim}\end{small}
\begin{figure} \label{2.3.13c}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/helrc.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.3.13d  $e + He^+(1s) \rightarrow He(2|3S) + h\nu $
}


\begin{small}\begin{verbatim}
         E-Index:     0                   1                   2
  T-Index:
         0   -2.956247006586D+01    4.857379877013D-01   -4.698385090723D-01
         1    2.226655583858D+00   -5.008925977592D-01    4.409072277517D-01
         2   -8.386271074322D+00   -6.680555751755D-02    1.358293373473D-01
         3    7.802551872732D+00    1.513454163302D-01   -2.382523353494D-01
         4   -3.176066118073D+00   -2.915513853670D-02    8.389442053277D-02
         5    6.790403187679D-01   -8.583336134054D-03   -8.339355078342D-03
         6   -8.005018693268D-02    3.501616009283D-03   -8.108811483383D-04
         7    4.936833057738D-03   -4.038202701566D-04    1.917972012272D-04
         8   -1.245931475232D-04    1.550754095349D-05   -8.944775549284D-06

         E-Index:     3                   4                   5
  T-Index:
         0    1.816491812551D-01   -3.584007722558D-02    4.008582628581D-03
         1   -1.490076771833D-01    2.428208422290D-02   -2.197248681202D-03
         2   -4.192264845130D-02    6.681287810863D-03   -3.474715517406D-04
         3    7.034251548002D-02   -9.653541471324D-03    3.950052472624D-04
         4   -2.594911934917D-02    3.785834072023D-03   -1.721024156646D-04
         5    3.100772841149D-03   -5.641898835295D-04    3.146400786804D-05
         6    1.226453809803D-04    9.772361084934D-06   -1.220791337288D-06
         7   -4.737671071626D-05    4.334084847132D-06   -1.862385782715D-07
         8    2.364380548912D-06   -2.583267263336D-07    1.313403535033D-08

         E-Index:     6                   7                   8
  T-Index:
         0   -2.562289391561D-04    8.707904177549D-06   -1.215806872260D-07
         1    1.109906018249D-04   -2.900632901582D-06    3.027934182965D-08
         2   -1.076950834118D-05    1.529234802310D-06   -3.663757563702D-08
         3    2.408158683211D-05   -2.450750101163D-06    5.482201735529D-08
         4   -8.229247133546D-06    9.351454862581D-07   -2.147970339341D-08
         5    1.022459855218D-06   -1.480508733520D-07    3.599099499020D-09
         6   -8.112983260770D-08    1.090170350156D-08   -2.777349026055D-10
         7    6.415033848685D-09   -3.093185955060D-10    7.625408371264D-12
```

```
        8   -2.624838999683D-10   -6.850467836445D-13    5.598594440202D-14

  Max. rel. Error:  21.5948 %
  Mean rel. Error:   5.8841 %

\end{verbatim}\end{small}
\begin{figure} \label{2.3.13d}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/helrd.ps}
\end{figure}
\newpage



\subsection{
Reaction 2.2C $e + He^+ \rightarrow He^{++}  + e  + e $
}
  Ionisation Rates for singly charged helium ions

  COLRAD (McWriter), hydrogen-like approximation

$ <sigma*vrel>(Te,ne) $(cm**3/s)

\begin{small}\begin{verbatim}
        E-Index:     0                   1                   2
  T-Index:
        0   -7.504895618885D+01    2.201465463709D-02   -5.069769253639D-03
        1    5.475513292431D+01   -5.417589714886D-02    3.775044165759D-02
        2   -2.693028880068D+01    3.774947998557D-02   -2.411882491817D-02
        3    8.660359434783D+00   -1.764877195580D-02    7.243690204418D-03
        4   -1.955813859940D+00    8.202168146805D-03   -3.070056924124D-03
        5    3.098090672677D-01   -2.771730559069D-03    1.297834186151D-03
        6   -3.271260113212D-02    5.325112160328D-04   -2.929485587655D-04
        7    2.050483088051D-03   -5.190809564237D-05    3.145856505861D-05
        8   -5.719259025474D-05    2.004313708534D-06   -1.292078319547D-06

        E-Index:     3                   4                   5
  T-Index:
        0    3.915543748345D-03   -1.031132793821D-03    1.654691798718D-04
        1   -1.633041262280D-02    3.459931210677D-03   -4.194602018842D-04
        2    8.989971506710D-03   -1.829622573856D-03    2.164276869595D-04
        3   -1.273168299077D-03    1.763624435402D-04   -2.479535228702D-05
        4    9.752207930721D-05    6.251121832296D-05   -6.640018325938D-06
        5   -1.296242864408D-04   -8.805176355814D-06    1.717983972172D-06
        6    4.563001069981D-05   -1.836358658149D-06   -6.237635823497D-08
        7   -5.886932297134D-06    4.277584502763D-07   -1.234530993035D-08
        8    2.657229485598D-07   -2.298984920724D-08    9.125550698905D-10

        E-Index:     6                   7                   8
  T-Index:
        0   -1.471360785546D-05    6.823504501535D-07   -1.247427417560D-08
        1    2.861803302953D-05   -1.036298188456D-06    1.553321018673D-08
        2   -1.391926980686D-05    4.512942119697D-07   -5.904011561947D-09
        3    1.882628114227D-06   -6.323064673756D-08    8.275404429978D-10
        4    1.952370344224D-07    1.751264412799D-09   -1.622640470420D-10
        5   -5.793682625805D-08   -1.220451186228D-09    7.819729115572D-11
        6    1.020925549512D-09    4.417455780936D-10   -1.689115024159D-11
        7    4.669160272059D-10   -4.606556580267D-11    1.506577519668D-12
        8   -2.598750073326D-11    1.464529452448D-12   -4.669913022501D-14
```

```
  Max. rel. Error:    .3141 %
  Mean rel. Error:    .1103 %

\end{verbatim}\end{small}
\begin{figure} \label{2.2C}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/heli.ps}
\end{figure}
\newpage


\subsection{
Reaction 2.6A0 $e + C \rightarrow C^+  + 2e $
}
  Ionisation Rates for singly charged carbon,
  ADAS 93

$ <sigma*vrel>(Te,ne) $(cm**3/s)
\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
  T-Index:
        0   -2.971457639565D+01    1.107810794514D+00   -4.929092425558D-01
        1    1.499806652944D+01   -2.549991583370D+00    9.026830825116D-01
        2   -7.145949073329D+00    6.664487958895D-01   -1.727631701810D-01
        3    2.340511256186D+00   -1.160562412201D-01    1.411445363827D-02
        4   -5.249343322780D-01    2.135356892092D-02   -1.638667443530D-03
        5    7.562193210612D-02   -2.918522374196D-03    1.286365870759D-04
        6   -6.679478578836D-03    3.000723261637D-04   -1.608459495742D-05
        7    3.270945618657D-04   -1.883054084198D-05    1.732029469888D-06
        8   -6.675613055770D-06    4.142784144247D-07   -3.486309036661D-08

        E-Index:     3                    4                    5
  T-Index:
        0    1.300116911300D-01   -2.066054730760D-02    2.042310400958D-03
        1   -1.879920996407D-01    2.431269610957D-02   -2.004879563783D-03
        2    2.797274709016D-02   -2.903521270254D-03    1.995997150157D-04
        3   -5.971983093427D-04   -7.377767439216D-05    1.267367125997D-05
        4    6.910190376581D-05   -5.464445143303D-06    5.674562003155D-07
        5   -7.001250033151D-07    7.855848854211D-07   -8.856533728232D-08
        6    4.049976855256D-07   -2.088187353775D-08   -6.089302275674D-09
        7   -1.675345958159D-07    1.579162356473D-08   -6.994965968869D-10
        8    2.814990023664D-09   -2.947061589979D-10    2.418389203250D-11

        E-Index:     6                    7                    8
  T-Index:
        0   -1.198777580517D-04    3.797623457774D-06   -5.001748956830D-08
        1    1.013724485054D-04   -2.844335907618D-06    3.386548334244D-08
        2   -8.259361032307D-06    1.731145419218D-07   -1.270740802103D-09
        3   -1.039751082795D-06    4.599752398553D-08   -7.953804201299D-10
        4    1.653887367244D-08   -3.425776625948D-09    8.586728657030D-11
        5   -4.099151298763D-09    5.982763605144D-10   -1.370643938638D-11
        6    1.485858394226D-09   -8.987472676089D-11    1.616606601615D-12
        7   -1.867411789486D-11    2.235327393834D-12   -3.862181485750D-14
        8   -1.188451034508D-12    4.216699821614D-14   -9.477595087316D-16

  Max. rel. Error:   1.2246 %
  Mean rel. Error:    .2748 %
\end{verbatim}\end{small}
\begin{figure} \label{2.6A0}
\epsfxsize=16truecm
```

```
\epsffile{Amjuel_PS/carbi.ps}
\end{figure}
\newpage

Data from impurity transport code "STRAHL", \cite{kn:Behringer}

  Recombination Rates for single charged Helium Ions

\subsection{
Reaction 2.3.2B0  $e + He^+ \rightarrow He + h\nu$
}

\begin{small}\begin{verbatim}
         E-Index:     0                    1                    2
  T-Index:
         0   -2.898866818182D+01   -3.068735204957D-02    7.818231657785D-02
         1    1.816504622984D+00   -1.996644882484D-01   -2.022934910684D-01
         2   -5.957620306977D+00    5.564226839342D-01    2.720939045109D-01
         3    4.883356392367D+00   -5.504736532364D-01   -1.589729887673D-01
         4   -1.785690784875D+00    2.554161096465D-01    4.391044966362D-02
         5    3.443976158874D-01   -6.304562647473D-02   -6.048646045521D-03
         6   -3.666670180913D-02    8.499875301084D-03    4.080124220783D-04
         7    2.042474095540D-03   -5.896220272289D-04   -1.226466093436D-05
         8   -4.653873125342D-05    1.644314326566D-05    1.520073468241D-07

         E-Index:     3                    4                    5
  T-Index:
         0   -4.360289476744D-02    1.088616122909D-02   -1.442780146671D-03
         1    1.057079914763D-01   -2.358570776702D-02    2.968485844589D-03
         2   -1.235076579967D-01    2.248324096678D-02   -2.497067848696D-03
         3    6.635551763548D-02   -9.269476706908D-03    8.089219419856D-04
         4   -1.831174182029D-02    1.752848228102D-03   -7.418643102963D-05
         5    2.905705534546D-03   -1.678595996471D-04   -7.790745301776D-06
         6   -2.926914092439D-04    1.437277876918D-05    1.085106848461D-06
         7    1.894207582471D-05   -1.612501983994D-06    6.632343028157D-08
         8   -5.989406850464D-07    8.425772893569D-08   -8.367921447451D-09

         E-Index:     6                    7                    8
  T-Index:
         0    1.043554466513D-04   -3.878190225512D-06    5.783675088058D-08
         1   -2.149050424333D-04    8.207356509792D-06   -1.268150915732D-07
         2    1.779838048026D-04   -7.127873717134D-06    1.175164928521D-07
         3   -5.675497459272D-05    2.589770454486D-06   -4.902088171680D-08
         4    5.561292499931D-06   -4.363201173962D-07    1.122814678532D-08
         5    2.465992165628D-07    5.016603759447D-08   -1.901239672341D-09
         6   -4.188299784450D-09   -8.149167953030D-09    2.753349347791D-10
         7   -1.167337552792D-08    1.023904862606D-09   -2.578964505694D-11
         8    8.321169431770D-10   -4.756050161152D-11    9.973991458967D-13

  Max. rel. Error:  16.6458 %
  Mean rel. Error:   6.0389 %

\end{verbatim}\end{small}
\begin{figure} \label{2.3.2B0}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/helir1.ps}
\end{figure}
\newpage
  Recombination Rates for double charged Helium Ions
```

```
\subsection{
Reaction 2.3.2B1  $e + He^{++} \rightarrow He^+ + h\nu$
}


\begin{small}\begin{verbatim}
         E-Index:     0                    1                    2
  T-Index:
         0   -2.689730745452D+01   -4.189774474235D-02    3.907009691550D-02
         1   -6.433874222932D-01    3.299308672728D-02   -2.112564779272D-02
         2   -1.779312827872D-02   -2.784310132407D-02    3.756334628555D-03
         3   -2.941208629331D-03    2.348797955174D-02   -3.603044725903D-03
         4   -1.097079440712D-04   -1.041386945451D-02    2.110484002085D-03
         5    3.627190561298D-05    2.454594288891D-03   -5.469934610104D-04
         6   -2.051498433274D-06   -3.182066464328D-04    7.445181597104D-05
         7    9.049897913059D-08    2.153132862082D-05   -5.311099451965D-06
         8   -2.589196837551D-09   -5.949628493511D-07    1.570204824882D-07

         E-Index:     3                    4                    5
  T-Index:
         0   -1.856976066463D-02    4.225395376848D-03   -5.189796861077D-04
         1    9.361575704851D-03   -2.096884296496D-03    2.460978351345D-04
         2   -1.500786464745D-05   -5.281337256827D-05    1.822688274176D-05
         3   -1.199741248527D-04    7.729105625058D-05   -1.292571216711D-05
         4   -1.215394704492D-04    8.835563507260D-07    2.346139078670D-07
         5    3.717841775232D-05   -4.659128130528D-07    2.336659134693D-08
         6   -4.784046635653D-06   -1.879150864927D-07    3.484666707655D-08
         7    3.629533941682D-07    1.916572317480D-08   -4.026763260489D-09
         8   -1.317789208085D-08   -1.808855222707D-10    9.539953463992D-11

         E-Index:     6                    7                    8
  T-Index:
         0    3.509533525807D-05   -1.228955181999D-06    1.739986570439D-08
         1   -1.534423152274D-05    4.789360346264D-07   -5.852399019136D-09
         2   -2.723344400799D-06    1.665540778802D-07   -3.521640501579D-09
         3    1.408094932910D-06   -7.805738049487D-08    1.598423694616D-09
         4   -8.824848629130D-08    8.227207653809D-09   -2.131061531618D-10
         5    2.250976512907D-10   -4.235527036624D-10    1.550066068535D-11
         6   -2.041471088674D-09    8.365367756013D-11   -1.652661621540D-12
         7    2.600592567487D-10   -9.155241214856D-12    1.419133004850D-13
         8   -6.933726687326D-12    2.503906957552D-13   -3.798372386466D-15

  Max. rel. Error:   4.5211 %
  Mean rel. Error:   0.3321 %

\end{verbatim}\end{small}
\begin{figure} \label{2.3.2B1}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/helir2.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.3.2C   $\  e + He^{++} \rightarrow  He^+ + h\nu$
}

\begin{small}\begin{verbatim}
         E-Index:     0                    1                    2
  T-Index:
        0   -2.689214714131D+01    3.841692092650D-02   -2.151460046121D-02
```

```
        1   -7.416684284021D-01   -5.199553857553D-02    3.438416388654D-02
        2    1.549811628148D-02    1.921849237497D-02   -8.089751449111D-03
        3   -5.022643137206D-03    1.540629050827D-03   -7.848453879802D-03
        4   -2.966821161678D-03   -1.893539924742D-03    4.846354316088D-03
        5    1.716018223894D-03    6.468052386412D-06   -9.304158014361D-04
        6   -4.229257398810D-04    1.430545146021D-04    2.720980715002D-05
        7    4.855298100008D-05   -2.713103018793D-05    1.061403221125D-05
        8   -2.091379921301D-06    1.529918299298D-06   -8.819776625245D-07

        E-Index:     3                    4                    5
  T-Index:
        0    1.113251929355D-02   -2.612008568492D-03    3.555115960397D-04
        1   -1.649709408021D-02    3.745035825507D-03   -4.770050113400D-04
        2    5.051466915107D-03   -1.400888615025D-03    1.945119633833D-04
        3    2.248785870746D-03   -1.593097934071D-04   -1.072827330359D-05
        4   -1.751184149675D-03    2.311213551980D-04   -1.261592043312D-05
        5    3.966217825812D-04   -5.599522857044D-05    3.206357069410D-06
        6   -2.835692554212D-05    3.986381335434D-06   -1.237526859045D-07
        7   -1.563313372280D-06    2.625959470738D-07   -3.940819818057D-08
        8    2.172325347358D-07   -3.473325519567D-08    3.579469680317D-09

        E-Index:     6                    7                    8
  T-Index:
        0   -2.731753894771D-05    1.106668461341D-06   -1.811175295207D-08
        1    3.368532716741D-05   -1.237223053047D-06    1.842374272400D-08
        2   -1.349677736259D-05    4.458107763508D-07   -5.616195641425D-09
        3    1.549801888675D-06   -4.466672928817D-08    1.764795248975D-10
        4    2.970110443204D-07   -7.035453496351D-09    1.847001891274D-10
        5   -7.282619416548D-08    9.859256161271D-10   -1.965913679526D-11
        6   -6.579575377692D-09    3.713367646234D-10   -4.389109805641D-12
        7    2.919813070386D-09   -9.345142710166D-11    1.091816211559D-12
        8   -2.087578972278D-10    6.033495076188D-12   -6.834858440297D-14

  Max. rel. Error:    .2915 %
  Mean rel. Error:    .0363 %


\end{verbatim}\end{small}
\begin{figure} \label{2.3.2C}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/helr.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.3.4B0  $e + Be^+ \rightarrow Be + h\nu$
}


\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
 T-Index:
        0   -2.725929462038D+01   -1.296055365219D-01    2.245292514899D-02
        1    1.598632576296D+00    1.302182159333D-04   -2.924508048254D-02
        2   -7.069733638623D-02    1.301621002137D-02    1.388489192201D-02
        3   -2.067343201215D-01    1.279607652398D-02   -8.226493898105D-03
        4    2.796219393914D-02   -1.144848913448D-02    3.649484551890D-03
        5    5.780534740910D-03    3.235328959441D-03   -7.482336928187D-04
        6   -1.791370907134D-03   -4.230924884959D-04    5.874787455135D-05
        7    1.653534958925D-04    2.595221480786D-05   -2.868950341068D-08
```

```
       8   -5.311684839816D-06   -5.924897096316D-07   -1.331690294260D-07

       E-Index:     3                    4                    5
 T-Index:
       0   -1.244235177506D-02    3.352082223981D-03   -4.750321394261D-04
       1    1.419746473600D-02   -4.100011934711D-03    6.269202287880D-04
       2   -4.288663227065D-03    1.247934273073D-03   -2.322360688726D-04
       3    2.497646037590D-04    4.417198058647D-05    1.716710307904D-05
       4    2.490565857171D-05   -6.848577114910D-05    3.867029384089D-06
       5   -2.697562238180D-05    1.387239687374D-05   -4.925211191787D-07
       6    1.287864123306D-05   -2.354269427799D-06    3.073587970762D-08
       7   -1.972411742335D-06    2.825061118192D-07   -7.702743784611D-09
       8    9.449990775297D-08   -1.322880879849D-08    5.884617340207D-10

       E-Index:     6                    7                    8
 T-Index:
       0    3.617661866105D-05   -1.399725603339D-06    2.156930157877D-08
       1   -5.003180914560D-05    1.985020029777D-06   -3.097413546292D-08
       2    2.077646031907D-05   -8.667756318377D-07    1.374149193674D-08
       3   -2.600090567970D-06    1.170403862720D-07   -1.712303962785D-09
       4   -4.054013167812D-08    3.807690920711D-09   -2.098135936009D-10
       5   -7.568193559820D-09   -9.343144402500D-10    6.008228504862D-11
       6    6.869621840242D-09   -1.575414388099D-10   -3.255005891524D-12
       7   -5.010735365600D-10    2.217617931435D-11   -5.017068152436D-14
       8    2.010217590918D-12   -5.523345073293D-13    4.450782184771D-15

 Max. rel. Error:   6.2699 %
 Mean rel. Error:   1.0385 %

\end{verbatim}\end{small}
\begin{figure} \label{2.3.4B0}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/beryr1.ps}
\end{figure}
\newpage
\subsection{
Reaction 2.3.4B1  $e + Be^{++} \rightarrow Be^+ + h\nu$
}

\begin{small}\begin{verbatim}
       E-Index:     0                    1                    2
 T-Index:
       0   -2.728409454363D+01   -1.241811114602D-01    1.328174994693D-01
       1   -2.299481340923D+00    1.889049385273D-01   -2.096802695556D-01
       2    4.885685671195D+00   -2.008764876827D-01    1.648701897617D-01
       3   -5.251357791035D+00    1.631486837681D-01   -7.503508975743D-02
       4    2.543387065980D+00   -7.665832661210D-02    1.818184962498D-02
       5   -6.269100539052D-01    1.928103605570D-02   -2.110079141475D-03
       6    8.249496717063D-02   -2.610043486921D-03    7.049607917706D-05
       7   -5.541301207997D-03    1.802133911336D-04    5.702189021974D-06
       8    1.496309096538D-04   -4.989437255700D-06   -3.793346968439D-07

       E-Index:     3                    4                    5
 T-Index:
       0   -5.910214948004D-02    1.285989947336D-02   -1.526818134096D-03
       1    7.862010247287D-02   -1.449011071235D-02    1.461947439599D-03
       2   -5.176172885669D-02    7.317236286761D-03   -5.006068297333D-04
       3    2.174133611107D-02   -2.589246910885D-03    1.224743194508D-04
       4   -5.098247822369D-03    5.664018911361D-04   -2.623256825779D-05
       5    5.566735359374D-04   -5.584858194143D-05    3.211048838419D-06
```

```
       6   -1.070413228691D-05   -3.231789926435D-07   -9.263670040464D-08
       7   -2.513802136711D-06    4.313606598236D-07   -1.345931063116D-08
       8    1.390196607821D-07   -2.084300790388D-08    8.301747763811D-10

       E-Index:     6                    7                    8
 T-Index:
       0    1.005202819403D-04   -3.444000702166D-06    4.788161890026D-08
       1   -8.097933215082D-05    2.286740613012D-06   -2.544219441065D-08
       2    1.209066466730D-05    2.327109476167D-07   -1.143146298073D-08
       3    1.794422803392D-06   -3.537707361735D-07    8.456876614023D-09
       4   -2.156876176312D-07    6.001245421502D-08   -1.405872631137D-09
       5   -1.162693902875D-07    2.839971828955D-09   -4.787146737233D-11
       6    2.652307178112D-08   -1.756949577531D-09    3.793381075708D-11
       7   -2.115315858957D-09    1.781987654521D-10   -3.982036996716D-12
       8    6.140791320298D-11   -5.995928373217D-12    1.365597034534D-13

 Max. rel. Error:  19.0670 %
 Mean rel. Error:   6.8000 %


\end{verbatim}\end{small}
\begin{figure} \label{2.3.4B1}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/beryr2.ps}
\end{figure}
\newpage
\subsection{
Reaction 2.3.5B0 $ e + B^+ \rightarrow B + h\nu $
}


\begin{small}\begin{verbatim}
       E-Index:     0                    1                    2
 T-Index:
       0   -2.918956305904D+01    3.267550103394D-02   -4.823066950210D-02
       1    8.901372275414D-01   -3.397383703545D-01    1.289852726858D-01
       2    3.343506939285D+00    2.282515642460D-01   -9.103783258930D-02
       3   -3.008679922076D+00   -5.388342232412D-02    2.167553199906D-02
       4    1.112964165086D+00    1.260534666317D-03   -7.052258987157D-04
       5   -2.245854583458D-01    1.232228819204D-03   -1.977243930068D-04
       6    2.569483673112D-02   -1.483676372126D-04   -3.653164425984D-05
       7   -1.563882824177D-03    2.300571590825D-06    1.068539912027D-05
       8    3.933351235932D-05    2.450506888590D-07   -5.790374711265D-07

       E-Index:     3                    4                    5
 T-Index:
       0    1.084235624678D-02    4.281860869234D-05   -3.006985941012D-04
       1   -3.793909504492D-02    4.214381437312D-03    5.910871725608D-06
       2    2.943514986182D-02   -4.396644202855D-03    2.457154873853D-04
       3   -7.736046881343D-03    1.441634147933D-03   -1.205002465319D-04
       4    3.041197053727D-04   -1.227481836109D-04    1.626382262962D-05
       5    1.177319584913D-04   -1.388326649605D-05    3.987367591191D-07
       6   -2.705344470187D-06    1.266769783662D-06   -1.190611163202D-07
       7   -2.136704633704D-06    2.158430175622D-07   -1.198466851774D-08
       8    1.462074438369D-07   -1.888327232304D-08    1.358886807026D-09

       E-Index:     6                    7                    8
 T-Index:
       0    3.913363201372D-05   -1.987487775013D-06    3.630009838447D-08
       1   -3.407335594737D-05    2.302780682573D-06   -4.724118588530D-08
```

```
        2    3.689509356594D-06   -8.271291751691D-07    2.110278755964D-08
        3    3.252526057299D-06    7.531658549775D-08   -3.753147142803D-09
        4   -7.584147771365D-07    5.617754775370D-09    2.618328829288D-10
        5    1.169505739833D-09    4.403213913778D-10   -2.082516311551D-11
        6    6.928958657672D-09   -2.614080202244D-10    3.949718599255D-12
        7    2.061339771948D-10    7.658743006289D-12   -2.294692069099D-13
        8   -5.021219740097D-11    7.599476609801D-13   -1.699102278262D-15

 Max. rel. Error:  15.7065 %
 Mean rel. Error:   2.2281 %

\end{verbatim}\end{small}
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\subsection{
Reaction 2.3.5B1  $e + B^{++} \rightarrow B^+ + h\nu$
}

\begin{small}\begin{verbatim}
        E-Index:     0                   1                   2
 T-Index:
        0   -2.696271008275D+01   -7.423987167527D-02    3.571997357107D-02
        1    2.025499561046D+00   -2.017543096490D-01    3.889732429633D-02
        2   -4.525788140577D-01    1.968460159120D-01   -6.412952427778D-02
        3   -3.570127232580D-01   -7.677034125200D-02    2.458200773053D-02
        4    2.176453653579D-01    1.757254624302D-02   -4.002911937506D-03
        5   -5.551419899407D-02   -2.867264920419D-03    3.695449702619D-04
        6    7.441747604883D-03    3.370916489954D-04   -3.534397855198D-05
        7   -5.097962423085D-04   -2.392639746135D-05    3.307875064213D-06
        8    1.405770163082D-05    7.241258048176D-07   -1.324815003798D-07

        E-Index:     3                   4                   5
 T-Index:
        0   -1.957405255310D-02    4.910268684892D-03   -6.464476031989D-04
        1   -5.508972762098D-03   -4.103038628528D-04    1.902830434350D-04
        2    1.585484361226D-02   -2.177399186175D-03    1.563169407076D-04
        3   -4.639868259732D-03    6.167716090045D-04   -4.549330605404D-05
        4    4.476991372525D-05    2.476330393040D-05   -4.315071827987D-06
        5    1.274740751517D-04   -2.134889461534D-05    1.854544233927D-06
        6   -1.479662046092D-05    1.581279654885D-06   -5.641458092706D-08
        7    3.704493921569D-07    4.734791626350D-08   -1.455285738785D-08
        8    1.013413641304D-08   -5.639914715196D-09    8.778548005120D-10

        E-Index:     6                   7                   8
 T-Index:
        0    4.608213097181D-05   -1.682328343662D-06    2.462552849920D-08
        1   -1.936931659635D-05    8.242354232962D-07   -1.278778364027D-08
        2   -5.717563499079D-06    1.159226451051D-07   -1.577559627995D-09
        3    1.710077304240D-06   -4.608894528959D-08    1.034076249492D-09
        4    4.279304514899D-07   -1.372870923770D-08    1.655700973007D-11
        5   -1.249051804766D-07    3.972618831455D-09   -2.392056598119D-11
        6    3.662805039340D-09   -1.410127247126D-10   -5.284190509036D-13
        7    8.814048276934D-10   -2.379651723043D-11    3.923946846891D-13
        8   -5.221503829879D-11    1.455883950215D-12   -1.921453513095D-14

 Max. rel. Error:   7.5135 %
 Mean rel. Error:   2.0952 %

\end{verbatim}\end{small}
```

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\subsection{
Reaction 2.3.6B0  $e + C^{+} \rightarrow C + h\nu$
}
 Recombination Rates for single
 charged Carbon Ions, STRAHL DATA

\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
  T-Index:
        0   -2.923411311232D+01    1.678337974062D-01   -1.269890700218D-01
        1   -1.749378923698D+00   -5.867508813696D-01    3.397276446168D-01
        2    6.127446343098D+00    3.513770163224D-01   -3.131110083174D-01
        3   -4.441560794072D+00   -3.036137429391D-02    1.289084037863D-01
        4    1.527841448611D+00   -3.932152302666D-02   -2.579185039826D-02
        5   -2.957532224524D-01    1.516783137012D-02    2.555395039340D-03
        6    3.288049698838D-02   -2.329750940307D-03   -1.325353309286D-04
        7   -1.958690224903D-03    1.660871088628D-04    6.019220191601D-06
        8    4.844127251791D-05   -4.535654544518D-06   -2.688488538169D-07

        E-Index:     3                    4                    5
  T-Index:
        0    2.720437652981D-02   -1.111631011430D-03   -3.480216080173D-04
        1   -6.886574322654D-02    3.439645295541D-03    5.751243071725D-04
        2    6.328287422211D-02   -4.081409017151D-03   -2.359905542867D-04
        3   -2.671202258246D-02    2.108719776241D-03   -7.726681822181D-06
        4    5.571312305715D-03   -4.818176068215D-04    1.334742280902D-05
        5   -6.449949817748D-04    5.958291545901D-05   -1.609837915859D-06
        6    5.723823810059D-05   -6.760386887666D-06    1.723115899471D-07
        7   -4.762486550175D-06    7.317966975006D-07   -3.186790226580D-08
        8    2.051810131854D-07   -3.486630219212D-08    2.049817590722D-09

        E-Index:     6                    7                    8
  T-Index:
        0    5.022696584875D-05   -2.548461445798D-06    4.576047167523D-08
        1   -8.585218474052D-05    4.198580036578D-06   -7.219262965042D-08
        2    4.464512662440D-05   -2.122412913024D-06    3.430797320366D-08
        3   -6.790151469405D-06    2.960526415072D-07   -3.591611206495D-09
        4   -8.898179366602D-08    2.113053977058D-08   -8.335017960966D-10
        5    1.948025779931D-08   -3.879062320437D-09    1.297193866948D-10
        6    1.158556735339D-08   -6.938508364472D-10    1.200809450653D-11
        7   -9.678693700555D-10    1.166071387136D-10   -2.726800105081D-12
        8   -8.574281546240D-13   -4.129172667888D-12    1.141324130890D-13

  Max. rel. Error:  20.1006 %
  Mean rel. Error:   2.5839 %


\end{verbatim}\end{small}
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\subsection{
Reaction 2.3.6A0  $e + C^{+} \rightarrow C + h\nu$
}
 Recombination Rates for single
 charged Carbon Ions, ADAS 93
```

```
\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
  T-Index:
        0   -2.386015899408D+01   -3.910955838564D+00    1.552770970883D+00
        1   -5.659678700923D+00    3.273571762123D+00   -1.226359264263D+00
        2    5.390501265589D+00   -2.355302777087D-01   -5.195368951742D-02
        3   -3.714328835667D+00    3.628845439540D-01   -2.200031489025D-02
        4    1.135859606525D+00   -1.186644208284D-01    5.551341663448D-03
        5   -1.869372950502D-01    1.628631987628D-02    6.410015500816D-04
        6    1.780826701298D-02   -1.478766722313D-03   -8.533991517766D-05
        7   -9.287327719634D-04    9.071133960815D-05   -1.095758224111D-06
        8    2.035725216911D-05   -2.414914230400D-06    1.597295024608D-07

        E-Index:     3                    4                    5
  T-Index:
        0   -3.450187675134D-01    4.712272970491D-02   -4.042671286872D-03
        1    2.600531850861D-01   -3.341908339155D-02    2.682578223051D-03
        2    1.011059953763D-02   -1.169563926566D-03    6.667572788661D-05
        3    3.526377986446D-03   -3.427847110389D-04    1.835504781865D-05
        4   -8.838264136732D-04    8.565268990423D-05   -1.066175819677D-06
        5   -8.593821289931D-05    5.272524686958D-06   -1.224520162331D-06
        6    2.660975471746D-06    1.089822895916D-06   -2.890683271478D-09
        7    1.203297067573D-06   -2.099731716273D-07    6.174132427111D-09
        8   -4.421659538874D-08    4.310876850464D-09    2.079113580150D-10

        E-Index:     6                    7                    8
  T-Index:
        0    2.122032361962D-04   -6.207489360202D-06    7.739602341370D-08
        1   -1.336715470333D-04    3.811224434825D-06   -4.747119054140D-08
        2    1.856735987460D-06   -3.458187396125D-07    9.391749990270D-09
        3   -2.365613863260D-06    2.014784469522D-07   -5.309278460907D-09
        4    2.407496723541D-07   -4.228290011762D-08    1.385165315494D-09
        5    3.962428233835D-08    4.764982812388D-09   -2.132127641260D-10
        6   -8.202254054789D-10   -4.541903480422D-10    2.006990579325D-11
        7    2.277931530317D-10    3.545967143036D-12   -6.419790552377D-13
        8   -4.192645662630D-11    1.557121980135D-12   -1.271691932014D-14

  Max. rel. Error:   7.2475 %
  Mean rel. Error:   1.9064 %


\end{verbatim}\end{small}
\begin{figure} \label{2.3.6A0}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/carbr.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.3.10B0   $e + Ne^+ \rightarrow  Ne + h\nu$
}

 Recombination Rates for single
 charged Neon Ions

\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
 T-Index:
        0   -2.950007003885D+01    3.491651842120D-01   -4.526729152358D-01
```

```
        1   -6.520457077063D-01    7.213904325098D-02    3.658011914091D-01
        2   -2.555722669669D+00   -7.475436856707D-01    9.738719342931D-02
        3    3.661205101651D+00    5.765147468133D-01   -1.604649380940D-01
        4   -1.748125063014D+00   -2.102066448685D-01    6.321986952859D-02
        5    4.075296845781D-01    4.352555184156D-02   -1.311266215655D-02
        6   -5.084544478774D-02   -5.232558963021D-03    1.582205007651D-03
        7    3.267745768343D-03    3.392758114186D-04   -1.046424800738D-04
        8   -8.515144644683D-05   -9.147101439320D-06    2.913148029419D-06

        E-Index:     3                    4                    5
 T-Index:
        0    1.822526019576D-01   -3.440093707612D-02    3.365607055965D-03
        1   -1.925738935529D-01    4.196008186724D-02   -4.824821656521D-03
        2    2.722985240177D-02   -9.973812872134D-03    1.461560737391D-03
        3    1.878485303345D-02   -1.385285413951D-03    9.295164050536D-06
        4   -7.774293016035D-03    7.843935223543D-04   -5.991856389796D-05
        5    1.332124081154D-03   -1.033638922199D-04    8.612183709508D-06
        6   -1.337988184391D-04    5.636490415762D-06   -4.121413995158D-07
        7    8.230405845512D-06   -1.571454512161D-07    3.845854426768D-09
        8   -2.383823550795D-07    4.365491330109D-09    2.073873285125D-12

        E-Index:     6                    7                    8
 T-Index:
        0   -1.720328845594D-04    4.174907414363D-06   -3.433683135382D-08
        1    3.088521584980D-04   -1.043623699368D-05    1.452433604004D-07
        2   -1.188366580476D-04    5.102874363441D-06   -8.840074619382D-08
        3    1.172576233056D-05   -9.701778130960D-07    2.315053595109D-08
        4    1.480911313552D-06    7.311631221035D-08   -3.231110770367D-09
        5   -3.779888128247D-07    1.120723303371D-09    2.214485537742D-10
        6    2.901125564163D-08   -7.405559613471D-10    1.446032893388D-12
        7   -1.213848594721D-09    7.298790343151D-11   -1.305351788753D-12
        8    3.400354319444D-11   -2.737297017901D-12    6.063188511756D-14

 Max. rel. Error:  54.9736 %
 Mean rel. Error:   6.6709 %

\end{verbatim}\end{small}
\begin{figure} \label{2.3.10B0}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/neonr1.ps}
\end{figure}
\newpage
\subsection{
Reaction 2.3.10B1   $e + Ne^{++}\rightarrow  Ne^+ + h\nu$
}


 Recombination Rates for double
 charged Neon Ions

\begin{small}\begin{verbatim}

        E-Index:     0                    1                    2
 T-Index:
        0   -2.764720323935D+01   -1.955655877647D-01    1.671527355799D-01
        1    1.118894063339D+00    3.129124651555D-01   -1.009059388068D-01
        2   -5.807229758743D+00   -4.303560193277D-01    5.147902079014D-02
        3    5.906119436289D+00    2.908074868726D-01   -3.504756895839D-02
        4   -2.486369699756D+00   -1.066677872724D-01    1.675054599333D-02
        5    5.400218712330D-01    2.285969690928D-02   -4.685542119686D-03
```

```
       6   -6.423019855816D-02   -2.860087284730D-03    7.328508385727D-04
       7    3.984332639562D-03    1.927287799126D-04   -5.887153870896D-05
       8   -1.009911047233D-04   -5.380432470580D-06    1.881736675497D-06

       E-Index:     3                   4                   5
 T-Index:
       0   -7.260114126178D-02    1.583009936797D-02   -1.898589530133D-03
       1    3.746533708965D-02   -8.655894421673D-03    1.099661830628D-03
       2   -6.718805346046D-03    1.999612428280D-03   -3.290996365052D-04
       3   -4.526057371154D-04   -1.450332583776D-05    6.267094921401D-05
       4    4.734615609031D-04   -1.872293739068D-04    1.215375414502D-06
       5   -1.215606626036D-05    5.132159918071D-05   -2.379109789101D-06
       6   -2.422737859678D-05   -4.568253290882D-06    2.259728294625D-07
       7    3.940458387139D-06    2.917180971670D-08    6.379283743551D-09
       8   -1.800023588704D-07    9.209746135240D-09   -1.047238386420D-09

       E-Index:     6                   7                   8
 T-Index:
       0    1.268000506338D-04   -4.414136321690D-06    6.233135264975D-08
       1   -7.507106502001D-05    2.542756842488D-06   -3.303898330923D-08
       2    2.397963779263D-05   -6.716878731698D-07    3.568810796685D-09
       3   -6.220521674696D-06    1.257734260178D-07    2.204442932049D-09
       4    9.599983583142D-07   -1.352244273881D-08   -1.106786869688D-09
       5   -1.008039023067D-07    1.880168166012D-09    2.080209442599D-10
       6    1.781190939483D-08   -6.447382343471D-10   -1.518762965124D-11
       7   -2.457175556170D-09    9.557839810920D-11    1.286224146698D-14
       8    1.179856275948D-10   -4.471022550637D-12    3.079250396313D-14

 Max. rel. Error:  21.1204 %
 Mean rel. Error:   6.0132 %

\end{verbatim}\end{small}
\begin{figure} \label{2.3.10B1}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/neonr2.ps}
\end{figure}
\newpage
\subsection{
Reaction 2.3.18B0  $ \  e + Ar^+ \rightarrow  Ar + h\nu $
}

  Recombination Rates for single
  charged Argon Ions

\begin{small}\begin{verbatim}
       E-Index:     0                   1                   2
  T-Index:
       0   -2.961523714505D+01   -3.466294797008D-01    3.739734228058D-01
       1   -9.700717663678D-01    3.174213911999D-01   -2.690300717347D-01
       2    2.733587493672D-01   -3.157221881515D-01    6.974859201463D-02
       3   -2.623209601735D-01    2.934758215827D-01   -5.501202052884D-02
       4    1.121844963088D-01   -1.406901237239D-01    3.460910634739D-02
       5   -2.608050847276D-02    3.514232816083D-02   -9.818421888710D-03
       6    3.353322712511D-03   -4.716045851013D-03    1.375466865468D-03
       7   -2.241669321389D-04    3.232299270856D-04   -9.397908348434D-05
       8    6.083901388792D-06   -8.888872233070D-06    2.502839044441D-06

       E-Index:     3                   4                   5
  T-Index:
       0   -1.677610771210D-01    3.629620906444D-02   -4.200257817954D-03
```

```
        1    1.288420244186D-01   -3.161715324237D-02    4.057456599586D-03
        2   -1.580414272181D-02    5.471732050209D-03   -8.980424488739D-04
        3   -9.482732378151D-04    4.606867303099D-04    7.340402374160D-06
        4   -1.908249918710D-03   -8.498577198828D-05    9.702094170437D-06
        5    8.582053824339D-04   -2.071529296492D-05   -1.272108567719D-07
        6   -1.258112651082D-04    1.949277321810D-06    2.643262514781D-07
        7    7.448923978325D-06    2.740906796410D-07   -7.103042442755D-08
        8   -1.383359038597D-07   -2.541568324398D-08    4.131280999373D-09

        E-Index:     6                    7                    8
  T-Index:
        0    2.648330614117D-04   -8.569045126425D-06    1.113597041124D-07
        1   -2.773372679142D-04    9.588925395704D-06   -1.320334721938D-07
        2    6.859512197435D-05   -2.469218146406D-06    3.413301196731D-08
        3   -3.175389000213D-06    1.354114675747D-07   -1.709524073729D-09
        4   -1.895926857712D-07   -4.275832820919D-09    1.814552488433D-10
        5   -7.124015966833D-08    7.365306362028D-09   -1.907511087995D-10
        6   -3.822283871117D-09   -9.046050010004D-10    3.169432383695D-11
        7    3.382667208777D-09   -1.902820234583D-11   -1.500255342391D-12
        8   -2.249462681920D-10    4.358044610945D-12   -5.630369486130D-16

  Max. rel. Error:  21.9156 %
  Mean rel. Error:   2.3347 %

\end{verbatim}\end{small}
\begin{figure} \label{2.3.18B0}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/argr1.ps}
\end{figure}
\newpage
\subsection{
Reaction 2.3.18B1   $\  e + Ar^{++} \rightarrow  Ar^+ + h\nu$
}

  Recombination Rates for double
  charged Argon Ions

\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
  T-Index:
        0   -2.772725546092D+01   -1.964508067762D-01    2.324627102422D-01
        1   -6.978601807006D-01   -3.079561336369D-02   -2.145381507914D-02
        2   -1.450309406042D-01    1.046307484649D-01   -4.369629888000D-02
        3    7.260838315993D-02   -3.466094766036D-02   -7.255991015237D-04
        4   -2.582804347800D-02    1.815351628023D-03    6.871280269968D-03
        5    5.160665923838D-03    1.395970098141D-03   -2.114054789289D-03
        6   -5.799496412067D-04   -3.699751917053D-04    3.252016165358D-04
        7    3.420248521929D-05    3.736066138991D-05   -2.707472572922D-05
        8   -8.205975768535D-07   -1.373593769853D-06    9.391881125204D-07

        E-Index:     3                    4                    5
  T-Index:
        0   -1.121363406353D-01    2.586067808011D-02   -3.210690057370D-03
        1    1.781324636009D-02   -4.150064170275D-03    4.491490678296D-04
        2    1.565988829654D-02   -4.208889079256D-03    6.472110597204D-04
        3   -1.979769358644D-04    6.722846983901D-04   -1.476650287912D-04
        4   -1.629081885435D-03    7.839217315971D-05    5.746848866889D-06
        5    3.607110982734D-04   -3.524282842463D-06   -1.878125337156D-06
        6   -4.180965183796D-05   -2.409133311107D-06    5.593232200934D-07
        7    3.500759466355D-06    1.374491446170D-07   -3.705743160513D-08
```

```
        8   -1.463187124936D-07    4.107894379819D-09    1.824159518664D-10

        E-Index:     6                     7                     8
  T-Index:
        0    2.193249820474D-04   -7.757566204730D-06    1.108985082330D-07
        1   -2.393877794814D-05    5.679271788812D-07   -3.900827694763D-09
        2   -5.394011848597D-05    2.272796732271D-06   -3.777889093261D-08
        3    1.363319474233D-05   -5.936164719619D-07    9.957385133643D-09
        4   -6.009177241892D-07    1.485983255077D-08   -3.099011150065D-11
        5    1.007709629207D-08    8.232051597397D-09   -2.668448723973D-10
        6   -1.251252096167D-08   -1.153506022137D-09    4.325526291510D-11
        7    5.438054847774D-10    1.039015370714D-10   -3.543703207540D-12
        8    4.191847861623D-11   -5.007688195721D-12    1.309659229521D-13

  Max. rel. Error:  25.0141 %
  Mean rel. Error:   1.9704 %

\end{verbatim}\end{small}
\begin{figure} \label{2.3.18B1}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/argr2.ps}
\end{figure}
\newpage

\subsection{
Reaction 7.2.3a   $\  p + H^{-} \rightarrow  H + H$
}
  CX multistep recombination rate for $H^-$ ions,
  Fujimoto/Greenland

  Rate p + $H^- \rightarrow H + H^*$ followed by $H^* \rightarrow H(1)$

$ <sigma*v_{rel}>(T_e,n_e) (cm^3/s)$

Assume low energy of projectile, and $T_e = T_i$

\begin{small}\begin{verbatim}
        E-Index:     0                     1                     2
  T-Index:
        0   -1.689958613546D+01    2.585744512612D-02   -4.686058886696D-02
        1   -2.291609419576D-01   -7.308669313857D-02    8.026450702663D-02
        2    1.985329309562D-02   -2.271915845401D-03    1.013150305465D-02
        3    9.335837612306D-03    1.940829247492D-02   -1.992436991578D-02
        4    1.274574464426D-02   -4.822705953574D-03    3.849091485289D-03
        5    6.703617821754D-05   -9.004234876962D-04    8.849378349781D-04
        6   -1.257626989088D-03    5.664394784455D-04   -4.641403305892D-04
        7    2.143146360234D-04   -8.759670668366D-05    6.870805919223D-05
        8   -1.055257190060D-05    4.534231154329D-06   -3.511193788754D-06

        E-Index:     3                     4                     5
  T-Index:
        0    2.783090963627D-02   -7.632532843253D-03    1.085802222613D-03
        1   -3.179931081947D-02    5.991317696040D-03   -5.871102728042D-04
        2   -7.665175186294D-03    2.338311935887D-03   -3.495775753988D-04
        3    7.562723625654D-03   -1.383486553056D-03    1.312159196963D-04
        4   -9.809012705807D-04    7.206316383106D-05    6.590267910811D-06
        5   -3.385082738926D-04    6.471915664128D-05   -6.470171411523D-06
        6    1.363632807418D-04   -1.749346463036D-05    7.921553956947D-07
        7   -1.881395512243D-05    2.083985898491D-06   -4.519745275052D-08
        8    9.460759194167D-07   -1.020671934750D-07    1.979047631004D-09
```

```
        E-Index:     6                    7                    8
  T-Index:
        0   -8.207858543758D-05    3.104412856772D-06   -4.620092607790D-08
        1    3.016923733239D-05   -7.586463970517D-07    7.057170530864D-09
        2    2.704414829412D-05   -1.036583389529D-06    1.557135399293D-08
        3   -6.364505526831D-06    1.407100013451D-07   -9.161724411190D-10
        4   -1.307923657976D-06    7.021087772566D-08   -1.273285686180D-09
        5    3.277081480654D-07   -7.368093284028D-09    4.421035861257D-11
        6    2.513159248864D-08   -3.275941085164D-09    7.645460625694D-11
        7   -8.474594238605D-09    6.284551825135D-10   -1.286885689482D-11
        8    4.224643120915D-10   -3.020714806008D-11    6.063697380552D-13

  Max. rel. Error:   3.9185 %
  Mean rel. Error:    .8358 %
\end{verbatim}\end{small}
\begin{figure} \label{7.2.3a}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hmrc.ps}
\end{figure}
\newpage

\subsection{
Reaction 7.2.3b   $\  p + H^{-} \rightarrow  H + H^+ + e$
}

  CX multistep ionisation rate for $H^-$ ions,
  Fujimoto/Greenland

  Rate p + $H^- \rightarrow H + H^*$ followed by $H^* \rightarrow H^+
+e$

$ <sigma*v_{rel}>(T_e,n_e) (cm^3/s)$
Assume low energy of projectile, and $T_e = T_i$

\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
  T-Index:
        0   -3.274751900307D+01    1.057109882504D+00   -8.936901963508D-02
        1    1.604364842644D+00   -1.443109013749D-01    1.690533561576D-01
        2   -7.816918130743D-01   -2.347361292060D-02    4.110952732043D-02
        3    2.395855753688D-01   -6.225540264519D-03   -1.648340850103D-03
        4   -6.556183790944D-02    4.215744601773D-03   -5.158760778343D-03
        5    1.464056022876D-02    1.270403269646D-03   -4.113415659065D-04
        6   -2.005780385646D-03   -6.931866278069D-04    5.791932384301D-04
        7    1.351852833727D-04    9.974060967641D-05   -1.007826533755D-04
        8   -3.213694947420D-06   -4.842567965660D-06    5.499350977553D-06

        E-Index:     3                    4                    5
  T-Index:
        0    5.963774892179D-02   -1.702424731143D-02    2.492510251845D-03
        1   -7.269114856144D-02    1.475128760240D-02   -1.576111811381D-03
        2   -1.917643639943D-02    4.250362970515D-03   -5.006480814748D-04
        3    2.559005592403D-03   -7.827230301860D-04    1.032116238563D-04
        4    2.182664832818D-03   -4.362834212868D-04    4.796239157842D-05
        5   -1.302027880766D-04    6.841880878738D-05   -1.115072314234D-05
        6   -1.596744401866D-04    1.954996935015D-05   -1.003883795535D-06
        7    3.380175590789D-05   -5.420183814352D-06    4.639212731224D-07
        8   -2.014293356639D-06    3.530358683241D-07   -3.357354573423D-08
```

```
        E-Index:     6                    7                    8
  T-Index:
        0   -1.896429554903D-04    7.099452532840D-06   -1.035390330350D-07
        1    9.008386861560D-05   -2.597536463108D-06    2.959396612904D-08
        2    3.247080991945D-05   -1.092816190101D-06    1.487371133735D-08
        3   -6.835395361797D-06    2.246468887242D-07   -2.922890851123D-09
        4   -2.971183195114D-06    9.679461487234D-08   -1.285746705358D-09
        5    8.686111262624D-07   -3.285937217133D-08    4.841910477727D-10
        6    1.279981835033D-09    1.620449645136D-09   -3.963462453441D-11
        7   -2.133892365496D-08    4.870897474908D-10   -4.178822635795D-12
        8    1.771731050820D-09   -4.887892950672D-11    5.520042005157D-13

  Max. rel. Error:   4.4461 %
  Mean rel. Error:   1.9743 %
\end{verbatim}\end{small}
\begin{figure} \label{7.2.3b}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hmio.ps}
\end{figure}
\newpage


\section{H.5 :Fits for $<\sigma \cdot v \cdot momentum> (T) $}

to be written

\section{H.6 :Fits for $<\sigma \cdot v \cdot momentum> (E,T) $ }


to be written

\section{H.7 :Fits for $<\sigma \cdot v \cdot momentum> (n_e,T) $ }

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\section{H.8 :Fits for $<\sigma \cdot v \cdot E_{kin}> (T) \ [cm^3/s
\cdot eV]$}

$E_{kin}$ is the kinetic Energy of the impacting electron or ion in eV.
The energy weighted rate is a function of temperature [eV] of the
impacting electron or ion

\subsection{
Reaction 2.2.14   $e + H_2^+(v) \rightarrow H(1s) + H^*(n)   (v=0-9, n \ge 2) $
}



\begin{small}\begin{verbatim}
   h0 -1.682072926000e+01    h1  3.964351525300e-01    h2 -2.501012514300e-11
   h3  1.066503238000e-11    h4  2.724261514100e-12    h5 -2.120710160500e-12
   h6  4.248055273200e-13    h7 -3.653955751100e-14    h8  1.187177640600e-15

\end{verbatim}\end{small}
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```

```
\subsection{
Reaction 2.2B0                    11/94 update
}

\begin{small}\begin{verbatim}

  h0 -3.294427070846D+01  h1  2.058485983359D+01    h2 -1.018663912043D+01
  h3  3.072113276309D+00  h4 -6.121540418115D-01    h5  8.135920959426D-02
  h6 -6.956871247682D-03  h7  3.454933903445D-04    h8 -7.541153102380D-06
\end{verbatim}\end{small}

\subsection{
Reaction 2.2B1                    11/94 update
}


\begin{small}\begin{verbatim}
  h0 -5.355348236978D+01    h1  4.009715623653D+01    h2 -1.981585158765D+01
  h3  6.148719835529D+00    h4 -1.288397616745D+00    h5  1.817351838759D-01
  h6 -1.642324160178D-02    h7  8.519919601377D-04    h8 -1.917188865674D-05
\end{verbatim}\end{small}

\begin{figure} \label{e2.2B}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/fige2_2B.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.4B0                     1/96 update
}

  Electron cooling rates for neutral
  Beryllium Atoms

 $<de*sigma*vrel>(T_e)  (eV*cm**3/s), Be  \rightarrow Be^*$

\begin{small}\begin{verbatim}
  h0 -1.600797819812D+01  h1  4.801721310374D+00  h2 -2.546377115756D+00
  h3  7.688590079004D-01  h4 -1.502880642117D-01  h5  1.910668947476D-02
  h6 -1.528566911077D-03  h7  6.997210970692D-05  h8 -1.398145303385D-06

  Max. rel. Error:    .1477 %
  Mean rel. Error:    .0376 %

\end{verbatim}\end{small}


\subsection{
Reaction 2.4B1                     1/96 update
}

  Electron cooling rates for single
  charged Beryllium Ions

 $<de*sigma*vrel>(T_e)  (eV*cm**3/s), Be^+ \rightarrow Be^{+*} $

\begin{small}\begin{verbatim}
  h0 -1.570117098474D+01  h1  3.492073280813D+00  h2 -1.988895527002D+00
```

```
  h3  6.770887182178D-01  h4 -1.567537912034D-01  h5  2.416405226747D-02
  h6 -2.343329470312D-03  h7  1.280666147623D-04  h8 -2.989849097428D-06

  Max. rel. Error:    .1400 %
  Mean rel. Error:    .0783 %

\end{verbatim}\end{small}

\begin{figure} \label{2.4Bl}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/beryl.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.5B0                    1/96 update
}

 Electron cooling rates for neutral
 Boron Particles

$ <de*sigma*vrel>(T_e)  (eV*cm**3/s), B   \rightarrow B^* $


\begin{small}\begin{verbatim}
  h0 -1.854307390504D+01    h1  6.477147013729D+00    h2 -3.012265953316D+00
  h3  7.443204571714D-01    h4 -9.875163519457D-02    h5  4.879302715434D-03
  h6  3.317004129594D-04    h7 -5.135297123379D-05    h8  1.774782835741D-06
\end{verbatim}\end{small}

\subsection{
Reaction 2.5B1                    1/96 update
}

 Electron cooling rates for single
 charged Boron Particles

 $<de*sigma*vrel>(T_e)  (eV*cm**3/s), B^+ \rightarrow B^{+*} $


\begin{small}\begin{verbatim}
  h0 -2.025375436381D+01    h1  8.540697000676D+00    h2 -4.378249188138D+00
  h3  1.324025185106D+00    h4 -2.627439468179D-01    h5  3.472998074572D-02
  h6 -2.959016392102D-03    h7  1.467662520364D-04    h8 -3.204537616409D-06
\end{verbatim}\end{small}

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\subsection{
Reaction 2.6B0                    1/98 update
}

 Electron cooling rates for neutral
 Carbon Particles

$ <de*sigma*vrel>(T_e)  (eV*cm**3/s), C   \rightarrow C^* $
```

```
\begin{small}\begin{verbatim}
  h0 -2.710584143898D+01  h1  1.171618970490D+01  h2 -5.312348774769D+00
  h3  1.667697028647D+00  h4 -3.652915272670D-01  h5  5.292698010012D-02
  h6 -4.778582112683D-03  h7  2.424218757774D-04  h8 -5.267817054083D-06

  Max. rel. Error:    .3085 %
  Mean rel. Error:    .0783 %

\end{verbatim}\end{small}

\subsection{
Reaction 2.6B1                     1/98 update
}

 Electron cooling rates for single
 charged Carbon Particles

 $<de*sigma*vrel>(T_e)  (eV*cm**3/s), C^+ \rightarrow C^{+*} $


\begin{small}\begin{verbatim}
  h0 -2.182881258910D+01  h1  8.721441032283D+00  h2 -3.874718527697D+00
  h3  9.883761525498D-01  h4 -1.611584081736D-01  h5  1.774337558846D-02
  h6 -1.355435656870D-03  h7  6.703143691651D-05  h8 -1.588682523808D-06

  Max. rel. Error:   1.0056 %
  Mean rel. Error:    .3730 %

\end{verbatim}\end{small}

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\subsection{
Reaction 2.10B0                   1/96 update
}

  Electron cooling rates for neutral and single
  charged Neon Particles
 $<de*sigma*vrel>(T_e)  (eV*cm**3/s), Ne  \rightarrow  Ne^*$

\begin{small}\begin{verbatim}
  h0 -3.296011717683D+01  h1  2.090175238087D+01  h2 -1.260497269687D+01
  h3  4.703674520432D+00  h4 -1.084256841690D+00  h5  1.545011409578D-01
  h6 -1.329678439752D-02  h7  6.349448203560D-04  h8 -1.293944291911D-05

  Max. rel. Error:    .0768 %
  Mean rel. Error:    .0448 %


\end{verbatim}\end{small}


\subsection{
Reaction 2.10B1                   1/96 update
}

  Electron cooling rates for neutral and single
  charged Neon Particles
```

```
 $ <de*sigma*v-rel>(T_e)  (eV*cm**3/s), Ne^+ \rightarrow Ne^{+*} $

\begin{small}\begin{verbatim}
  h0 -4.016425730032D+01  h1  2.721204153637D+01  h2 -1.284168864085D+01
  h3  3.355303591105D+00  h4 -4.850926860273D-01  h5  3.324128846263D-02
  h6 -7.385513932230D-05  h7 -1.193933246957D-04  h8  4.774152004995D-06

  Max. rel. Error:    .3700 %
  Mean rel. Error:    .2182 %

\end{verbatim}\end{small}

\begin{figure} \label{2.10l}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/neonl.ps}
\end{figure}
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\subsection{
Reaction 2.18B0                   1/96 update
}

  Electron cooling rates for neutral and single
  charged Argon Particles
 $<de*sigma*vrel>(T_e)  (eV*cm**3/s), Ar  \rightarrow Ar^* $

\begin{small}\begin{verbatim}
  h0 -3.045268909292D+01  h1  1.604228101358D+01  h2 -7.521359142337D+00
  h3  2.315576669299D+00  h4 -4.783176799904D-01  h5  6.444351575406D-02
  h6 -5.402184742604D-03  h7  2.552505450397D-04  h8 -5.189111527652D-06

  Max. rel. Error:    .0340 %
  Mean rel. Error:    .0128 %

\end{verbatim}\end{small}


\subsection{
Reaction 2.18B1                   1/96 update
}

  Electron cooling rates for neutral and single
  charged Argon Particles
 $ <de*sigma*vrel>(T_e)  (eV*cm**3/s), Ar^+ \rightarrow Ar^{+*} $

\begin{small}\begin{verbatim}
  h0 -4.165898540334D+01  h1  2.608109647112D+01  h2 -1.166949407607D+01
  h3  3.280473403465D+00  h4 -6.113171083108D-01  h5  7.504889391247D-02
  h6 -5.828589448772D-03  h7  2.593634229260D-04  h8 -5.035811848208D-06

  Max. rel. Error:    .0697 %
  Mean rel. Error:    .0288 %

\end{verbatim}\end{small}

\begin{figure} \label{2.18Bl}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/argl.ps}
\end{figure}
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```

```
\section{H.9 :Fits for $<\sigma \cdot v \cdot E_{kin}> (E,T) \ [cm^3/s
\cdot eV]$}

\subsection{
Reaction 3.1.8   $p + H(1s)  \rightarrow  H(1s) + p $
}
$E_{kin}$ is the kinetic energy of the impacting electron or ion in eV.
The energy weighted rate is a function of electron (or ion) temperature
[eV]  and of the impacting neutral particle kinetic energy E [eV]

\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
 T-Index:
        0   -1.777579549728D+01    1.009523650881D-01    4.654228527844D-02
        1    1.275231758810D+00   -9.644906009036D-02   -2.211669235384D-02
        2    4.530160377165D-02    2.342045574729D-02   -9.203651373424D-03
        3   -5.955369019980D-03    3.554165401021D-03    5.687922583665D-03
        4   -1.979653552345D-03   -2.139061718958D-03   -5.015782273336D-05
        5    1.387089441785D-04    2.267300682383D-04   -4.035280214497D-04
        6    9.252160306969D-05    1.040699979357D-05    8.704096952722D-05
        7   -1.432658980502D-05   -2.945710692553D-06   -7.300036168036D-06
        8    5.659366058900D-07    1.274167039318D-07    2.222526255554D-07

        E-Index:     3                    4                    5
 T-Index:
        0    1.086931313538D-02   -2.594201995447D-03   -7.731266223508D-04
        1    8.467481122042D-03    1.412559491188D-03   -7.442507107710D-04
        2   -4.737882712502D-03    1.276905220752D-03    2.370696675146D-04
        3   -1.107407133685D-03   -5.709773444309D-04    1.803637598216D-04
        4    6.785109655871D-04   -6.025307354437D-05   -5.642411701218D-05
        5   -5.545614797192D-05    6.129382543768D-05   -3.599116584649D-06
        6   -9.853811706993D-06   -1.141186867496D-05    2.733706713304D-06
        7    1.708575489575D-06    8.872884700942D-07   -3.140831827282D-07
        8   -6.988406373694D-08   -2.556421038443D-08    1.135791478659D-08

        E-Index:     6                    7                    8
 T-Index:
        0    2.413613977749D-04   -2.132300538605D-05    6.057223635716D-07
        1    9.518302025258D-05   -4.753012706978D-06    7.069997192010D-08
        2   -1.000952289205D-04    1.059536089242D-05   -3.696859736968D-07
        3   -1.512070888533D-05    5.360958997427D-08    2.773215541900D-08
        4    1.500712819446D-05   -1.393253051164D-06    4.521246252095D-08
        5   -1.937812763003D-06    3.059696948703D-07   -1.282436081613D-08
        6   -9.308661633534D-08   -1.924954958807D-08    1.274653104848D-09
        7    2.993136285588D-08   -4.094687301095D-10   -4.251053762140D-11
        8   -1.386563064570D-09    5.641978567123D-11   -1.151564989100D-13

 Max. rel. Error:   1.2514 %
 Mean rel. Error:   0.2865 %
\end{verbatim}\end{small}

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\subsection{
Reaction 3.1.8d  $p + H(1s)  \rightarrow  H(1s) + p $
}
```

E_{kin} is the kinetic energy of the impacting electron or ion in eV.
The energy weighted rate for the Langevin approximation is
3/2 kT * 2e-8

\begin{small}\begin{verbatim}

T-Index:	E-Index: 0	1	2
0	-1.732206846000D+01	0.000000000000D 00	0.000000000000D 00
1	1.000000000000D+00	0.000000000000D 00	0.000000000000D 00
2	0.000000000000D 00	0.000000000000D 00	0.000000000000D 00
3	0.000000000000D 00	0.000000000000D 00	0.000000000000D 00
4	0.000000000000D 00	0.000000000000D 00	0.000000000000D 00
5	0.000000000000D 00	0.000000000000D 00	0.000000000000D 00
6	0.000000000000D 00	0.000000000000D 00	0.000000000000D 00
7	0.000000000000D 00	0.000000000000D 00	0.000000000000D 00
8	0.000000000000D 00	0.000000000000D 00	0.000000000000D 00

T-Index:	E-Index: 3	4	5
0	0.000000000000D 00	0.000000000000D 00	0.000000000000D 00
1	0.000000000000D 00	0.000000000000D 00	0.000000000000D 00
2	0.000000000000D 00	0.000000000000D 00	0.000000000000D 00
3	0.000000000000D 00	0.000000000000D 00	0.000000000000D 00
4	0.000000000000D 00	0.000000000000D 00	0.000000000000D 00
5	0.000000000000D 00	0.000000000000D 00	0.000000000000D 00
6	0.000000000000D 00	0.000000000000D 00	0.000000000000D 00
7	0.000000000000D 00	0.000000000000D 00	0.000000000000D 00
8	0.000000000000D 00	0.000000000000D 00	0.000000000000D 00

T-Index:	E-Index: 6	7	8
0	0.000000000000D 00	0.000000000000D 00	0.000000000000D 00
1	0.000000000000D 00	0.000000000000D 00	0.000000000000D 00
2	0.000000000000D 00	0.000000000000D 00	0.000000000000D 00
3	0.000000000000D 00	0.000000000000D 00	0.000000000000D 00
4	0.000000000000D 00	0.000000000000D 00	0.000000000000D 00
5	0.000000000000D 00	0.000000000000D 00	0.000000000000D 00
6	0.000000000000D 00	0.000000000000D 00	0.000000000000D 00
7	0.000000000000D 00	0.000000000000D 00	0.000000000000D 00
8	0.000000000000D 00	0.000000000000D 00	0.000000000000D 00

Max. rel. Error: 0.0000 %
Mean rel. Error: 0.0000 %
\end{verbatim}\end{small}

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\subsection{
Reaction 3.3.1 $ p + He \rightarrow H + He^+ $
}

\begin{small}\begin{verbatim}

T-Index:	E-Index: 0	1	2
0	-3.445873460852D+01	8.326134682590D-01	1.933054122941D-01
1	7.061207340144D+00	-1.313817435577D+00	-2.022008463051D-02
2	-1.736559910607D+00	9.850170907730D-01	-2.150416408177D-01

```
         3    2.831856629788D-01   -4.245131595514D-01    1.739383391445D-01
         4    2.241285385641D-02    1.103647192643D-01   -6.088038032579D-02
         5   -2.212724523621D-02   -1.746079083640D-02    1.145240838422D-02
         6    4.425243772505D-03    1.637736454226D-03   -1.204202849751D-03
         7   -3.781548873891D-04   -8.345178061307D-05    6.671405376586D-05
         8    1.193024795969D-05    1.774873395657D-06   -1.517888839586D-06

         E-Index:     3                    4                    5
  T-Index:
         0    6.873661138878D-02   -2.530594845507D-02    3.637744786711D-03
         1   -1.061062949296D-01    4.412103967546D-02   -3.685824519445D-03
         2    6.376880737273D-02   -1.785764179094D-02    1.574503264024D-03
         3   -2.171235372363D-02   -3.103258502378D-04   -7.908060831688D-05
         4    5.072440380901D-03    1.643836342594D-03   -1.585285238384D-04
         5   -8.662593688148D-04   -3.914961081124D-04    5.595248036912D-05
         6    1.004763175634D-04    3.863654089420D-05   -8.367160814608D-06
         7   -6.737998131918D-06   -1.587918693338D-06    6.003371579626D-07
         8    1.916686027968D-07    1.615498260138D-08   -1.693306893859D-08

         E-Index:     6                    7                    8
  T-Index:
         0   -4.698314268303D-04    4.502855041540D-05   -1.724119064743D-06
         1   -4.081552915490D-04    7.523889576611D-05   -3.020854867113D-06
         2    1.755019472132D-04   -3.622077917093D-05    1.578825987882D-06
         3    8.820311155289D-05   -1.096383895966D-05    4.077966484815D-07
         4   -4.325767085415D-05    7.303630284565D-06   -3.055052941782D-07
         5    3.995980258215D-06   -1.053387214627D-06    4.789068581038D-08
         6    4.989305627062D-07    4.799823908148D-09   -9.771077724410D-10
         7   -1.009348152873D-07    8.912440158402D-09   -3.117095091366D-10
         8    4.438767986041D-09   -4.806081198001D-10    1.835893653264D-11

  Max. rel. Error:  13.4603 %
  Mean rel. Error:   0.9308 %



\end{verbatim}\end{small}

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\subsection{
Reaction 3.3.6a $   p + He^*(2|1S) \rightarrow H^*(2s) + He^+(1s) $
}


\begin{small}\begin{verbatim}
         E-Index:     0                    1                    2
  T-Index:
         0   -2.397668404788D+01    3.159485036283D-01    1.251349908668D-01
         1    3.791127359443D+00   -3.761884787063D-01   -1.201611289430D-01
         2   -3.031005464839D-01    1.547966958268D-01    3.418807730147D-02
         3   -2.042285843152D-02   -1.849518757027D-02   -2.705500175969D-03
         4    9.317257534521D-03   -3.497722978839D-03    5.266899471936D-04
         5   -4.841929631711D-04    1.244615194159D-03   -3.264196261141D-04
         6   -9.483126811734D-05   -1.399032118750D-04    6.356897513547D-05
         7    1.241207591818D-05    6.987980280667D-06   -4.975196671014D-06
         8   -4.191666003951D-07   -1.299861951387D-07    1.392550743313D-07
```

```
        E-Index:     3                    4                    5
  T-Index:
        0    3.856067365269D-02   -2.026573130919D-03   -2.759136201694D-03
        1   -6.229570032866D-03    7.539673693629D-03    3.228125296776D-05
        2   -1.117399758747D-02   -3.402440317662D-03    1.301470355832D-03
        3    4.346233632875D-03    2.577875598472D-04   -4.359935280851D-04
        4   -6.346015739054D-04    1.053315422043D-04    3.920000120015D-05
        5    6.551645356748D-05   -2.376485094163D-05    1.685178990397D-06
        6   -8.200597026708D-06    1.844480677683D-06   -3.712741557353D-07
        7    7.170567793961D-07   -5.326280408650D-08    9.229946485903D-09
        8   -2.381772742595D-08    2.014368954375D-10    2.686050437848D-10

        E-Index:     6                    7                    8
  T-Index:
        0    5.281724050161D-04   -3.697200097287D-05    9.237548925974D-07
        1   -2.159762940362D-04    2.275443392926D-05   -7.099802232376D-07
        2   -1.482835634810D-04    6.952989686416D-06   -1.085642522433D-07
        3    7.949763771555D-05   -5.715813906994D-06    1.481611026493D-07
        4   -1.214272931648D-05    1.128632380175D-06   -3.510270530142D-08
        5    5.986765602098D-07   -9.526271005415D-08    3.781185514127D-09
        6    4.147212027299D-09    4.109065328207D-09   -2.316799675035D-10
        7   -6.505709803163D-11   -1.612579446392D-10    9.811627985408D-12
        8   -4.990895417628D-11    5.743415083193D-12   -2.467665429406D-13

  Max. rel. Error:   6.2499 %
  Mean rel. Error:   0.8870 %


\end{verbatim}\end{small}

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\subsection{
Reaction 3.3.6b  $  p + He^*(2|3S) \rightarrow H^*(2s) + He^+(1s)$
}


\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
  T-Index:
        0   -2.956696212252D+01    5.281567610030D-01    1.525645856454D-01
        1    5.608996254071D+00   -5.554651091960D-01   -8.310107491980D-02
        2   -5.586148730643D-01    2.869596240969D-01    2.693533782880D-02
        3    8.445222522903D-02   -9.885450333344D-02   -2.375836603441D-02
        4   -4.080969150629D-02    2.380017857884D-02    1.216452673035D-02
        5    1.109225928721D-02   -3.788861207335D-03   -2.898997798061D-03
        6   -1.454903843517D-03    3.686204124267D-04    3.488800425650D-04
        7    9.246654975855D-05   -1.956645015230D-05   -2.070012209875D-05
        8   -2.304179941047D-06    4.310780137920D-07    4.810780135493D-07

        E-Index:     3                    4                    5
  T-Index:
        0    5.501159994270D-02    5.231877282834D-03   -5.104807314720D-03
        1   -3.503708291156D-02   -6.194296661419D-03    8.545246673022D-03
        2   -2.619680827152D-02    9.409111065614D-03   -3.292720454900D-03
        3    3.066491792837D-02   -6.421108100188D-03    1.185509375312D-04
        4   -1.125547411729D-02    2.175569508209D-03    9.073341073380D-05
        5    2.024041838757D-03   -4.121003738472D-04    7.128259787760D-06
```

```
        6   -1.907412735028D-04    4.489456337277D-05   -6.215149457584D-06
        7    8.849836285624D-06   -2.639451182160D-06    7.576420403373D-07
        8   -1.534752844870D-07    6.492509343847D-08   -2.852852143477D-08

        E-Index:     6                    7                    8
  T-Index:
        0    6.537231707620D-04   -2.747946210980D-05    1.809150198692D-07
        1   -1.763283177626D-03    1.440173210330D-04   -4.252159818280D-06
        2    6.322499969920D-04   -5.569656379195D-05    1.811409365339D-06
        3    9.910404393999D-05   -1.096951926860D-05    3.556184138250D-07
        4   -7.195067291013D-05    7.772807797383D-06   -2.677198674596D-07
        5    8.134485110505D-06   -1.024492516657D-06    3.813168247354D-08
        6    4.630863375819D-07   -1.150736736272D-08   -2.200040624310D-10
        7   -1.265796349526D-07    9.977170726720D-09   -2.923241327427D-10
        8    5.638328877632D-09   -4.845499350959D-10    1.514129155630D-11

  Max. rel. Error:   6.1811 %
  Mean rel. Error:   0.6136 %

\end{verbatim}\end{small}



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\section{H.10 :Fits for $<\sigma \cdot v \cdot E> (n_e,T) \
[cm^3/s \cdot eV]$}

$E_{kin}$ is the kinetic Energy of the impacting electron or ion in eV.

\subsection{
Reaction 2.1.5  $ e + H \rightarrow H^+ + 2e $
}



\begin{small}\begin{verbatim}

        E-Index:     0                    1                    2
  T-Index:
        0   -2.508124023824D+01    1.734108135759D-02   -1.891777149512D-02
        1    9.961634412423D+00   -1.573307884566D-02    1.843734255418D-02
        2   -4.776180166264D+00    2.970917601727D-04   -3.807758859655D-03
        3    1.630713043514D+00    3.457819922651D-03   -1.182846239993D-03
        4   -3.862246458538D-01   -1.354707016609D-03    5.758335877954D-04
        5    5.908348117252D-02    2.467671779140D-04   -9.707776439937D-05
        6   -5.502149035570D-03   -2.550039601080D-05    9.186912710069D-06
        7    2.825693139758D-04    1.479374192570D-06   -5.357992990165D-07
        8   -6.126373636033D-06   -3.768914931663D-08    1.516539648383D-08

        E-Index:     3                    4                    5
  T-Index:
        0    7.823415079914D-03   -1.631549805821D-03    1.886435723148D-04
        1   -7.526506973636D-03    1.445482212534D-03   -1.430089553311D-04
        2    2.108820285359D-03   -4.156648351099D-04    3.407098816806D-05
        3   -1.066332982000D-05    2.942499095980D-05   -8.976235585729D-07
        4   -6.053903755468D-05   -4.227285712967D-07   -2.352473868493D-09
        5    7.784473195273D-06    7.205874145075D-07   -9.883252326876D-08
        6   -5.442048934307D-07   -8.990161485463D-08    8.933475010389D-09
```

```
       7    4.797758886682D-08   -1.637030558354D-09    5.735798106880D-10
       8   -2.404105327023D-09    3.753206693445D-10   -6.002003170733D-11

       E-Index:     6                    7                    8
  T-Index:
       0   -1.224700235983D-05    4.170427242828D-07   -5.775556894342D-09
       1    7.221376553657D-06   -1.633748217561D-07    1.028215793306D-09
       2   -8.300185166679D-07   -2.671730459566D-08    1.140062425575D-09
       3   -3.006283377398D-07    2.400198464058D-08   -4.901297252541D-10
       4    4.544140153285D-08   -2.854579885273D-09    3.868612101415D-11
       5    2.577124843878D-09   -1.007675407273D-10    6.215200297376D-12
       6   -1.937960153333D-10    1.664413123118D-11   -9.521242149750D-13
       7   -6.978042599136D-11    1.836020981290D-12    1.884922171479D-14
       8    5.011156979547D-12   -1.641995819473D-13    1.257296690473D-15

  Max. rel. Error:    .4678 %
  Mean rel. Error:    .2498 %


\end{verbatim}\end{small}
\begin{figure} \label{2.1.5i}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hydli1_tr.ps}
\end{figure}
\newpage
\subsection{
Reaction 2.1.5o $ e + H \rightarrow H^+ + 2e $  Ly-opaque}


Ditto, all Lyman lines (and continuum) opaque


\begin{small}\begin{verbatim}



       E-Index:     0                    1                    2
  T-Index:
       0   -2.431395592098D+01   -2.395941007384D-01    2.591565194903D-01
       1    1.113429718187D+01    1.849722545279D-01   -2.423728103974D-01
       2   -6.654446687338D+00    2.195366491981D-02    6.179888393756D-02
       3    2.747075059275D+00   -6.901300857989D-02    1.006521130909D-02
       4   -7.372137934626D-01    2.943069908340D-02   -7.829953302392D-03
       5    1.227074461193D-01   -6.057176837025D-03    1.694081601397D-03
       6   -1.216484938923D-02    6.701189895777D-04   -1.793079853259D-04
       7    6.566484532457D-04   -3.779995638455D-05    8.950721046575D-06
       8   -1.483802107723D-05    8.441118380444D-07   -1.530047985372D-07

       E-Index:     3                    4                    5
  T-Index:
       0   -1.087825788137D-01    2.304158174814D-02   -2.708007727528D-03
       1    9.801393644159D-02   -1.946235514182D-02    2.079309382971D-03
       2   -2.979923286006D-02    5.913142010781D-03   -5.549143094821D-04
       3    1.702193123225D-03   -6.298136767386D-04    4.093195127037D-05
       4    6.752425702279D-04    2.856788083851D-05   -7.732295592583D-07
       5   -1.621646872661D-04   -2.526799196487D-06    2.543500809367D-07
       6    1.506237912301D-05    4.384573257407D-07   -1.137888186554D-08
       7   -4.568263582843D-07   -5.697388918232D-08   -1.072747527249D-09
       8   -6.560997301392D-09    3.141908302488D-09    3.111434993423D-12
```

```
        E-Index:     6                    7                    8
  T-Index:
        0    1.777247119352D-04   -6.080187141189D-06    8.438023009891D-08
        1   -1.231134698172D-04    3.827948966411D-06   -4.895455818239D-08
        2    2.684044174965D-05   -6.633266274667D-07    6.895128780616D-09
        3   -4.598542858756D-09   -5.542757391998D-08    9.032937294372D-10
        4   -3.124180764582D-07    1.188861911457D-08    1.649196327692D-11
        5    1.826904076362D-08    4.273639168838D-10   -5.875558984747D-11
        6   -4.163110915594D-09    3.345977887826D-11    5.495071058936D-12
        7    6.106046869680D-10   -2.063138694762D-11   -9.709542597057D-16
        8   -2.241669215814D-11    9.998773490453D-13   -9.539526341658D-15

  Max. rel. Error:   2.4939 %
  Mean rel. Error:    .6828 %

\end{verbatim}\end{small}
\begin{figure} \label{2.1.5io}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hydli1_op.ps}
\end{figure}
\newpage

\subsection{
  Reaction 2.1.8  $p + electron(s)  \rightarrow H(1s) + ....$
}

   effective electron cooling rate due to rad.+three-b. recombination
   potential energy loss 13.6*(eff-rec.rate) still needs to be
   subtracted (may render the loss negative, i.e., turn it into a gain)
   Hence: the quantitity given here happens to be the radiation loss.

\begin{small}\begin{verbatim}

        E-Index:     0                    1                    2
  T-Index:
        0   -2.589374312060D+01   -6.009166210069D-03    1.344053651580D-02
        1   -7.200626698498D-01   -2.331360193865D-02    1.271471891444D-02
        2    1.661484666745D-02    1.772769952301D-02   -1.424886103594D-02
        3    3.502647662984D-03    1.361236801099D-03   -2.044757453549D-03
        4    4.991543964404D-04   -1.488083475886D-03    1.715465346946D-03
        5   -4.169287459210D-04    3.290537768840D-05   -9.071162586692D-05
        6    6.947265413566D-05    4.141652153718D-05   -3.440885706672D-05
        7   -4.976973887663D-06   -4.597628903794D-06    4.228338478163D-06
        8    1.352447813992D-07    1.298225568141D-07   -1.235886550564D-07

        E-Index:     3                    4                    5
  T-Index:
        0   -4.253727306252D-03    8.278102981647D-04   -8.052584782094D-05
        1   -4.884504230079D-03    6.641130375794D-04   -3.742148364520D-05
        2    6.090473982805D-03   -1.176971915488D-03    1.231132798913D-04
        3    3.651002250233D-04    3.537638276233D-06   -9.588255868825D-06
        4   -5.939085281080D-04    9.746375288671D-05   -7.718327324859D-06
        5    4.212511427706D-05   -9.046542545395D-06    9.361897045939D-07
        6    1.025910458536D-05   -1.286001954285D-06    6.230197379424D-08
        7   -1.337170391458D-06    1.790918755084D-07   -9.223488177985D-09
        8    3.813621172574D-08   -4.472350183176D-09    8.841921964691D-11

        E-Index:     6                    7                    8
  T-Index:
        0    4.112465057498D-06   -9.120123611956D-08    4.348069969762D-10
```

```
       1   -3.230243835655D-07    1.028999877616D-07   -2.619274627156D-09
       2   -6.882807794469D-06    1.909871253140D-07   -2.042975332082D-09
       3    1.156883184011D-06   -5.473919858586D-08    9.513634275736D-10
       4    2.531287396860D-07   -4.893558620829D-10   -9.642905929415D-11
       5   -4.489659983751D-08    9.398133961039D-10   -7.447977789416D-12
       6    3.348892041368D-10   -1.500889176513D-10    4.451964535623D-12
       7   -8.099406688438D-11    2.552730001764D-11   -7.119172481272D-13
       8    2.118934358596D-11   -1.649223972224D-12    3.731416769611D-14

  Max. rel. Error:   7.0717 %
  Mean rel. Error:    .6696 %


\end{verbatim}\end{small}
\begin{figure} \label{2.1.8r}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hydlr1_tr.ps}
\end{figure}
\newpage

\subsection{
  Reaction 2.1.8o $p + electron(s) \rightarrow H(1s) + ....$ Ly-opaque
}

   effective electron cooling rate due to rad.+three-b. recombination
   potential energy loss 13.6*(eff-rec.rate) still needs to be
   subtracted (may render the loss negative, i.e., turn it into a gain)
   Hence: the quantitity given here happens to be the radiation loss.

\begin{small}\begin{verbatim}



       E-Index:     0                   1                   2
  T-Index:
       0   -2.626461971500D+01   -1.141522828006D-01    1.076393602102D-01
       1   -8.898849653304D-02   -3.942292858703D-01    4.197250110873D-01
       2   -4.795279065913D-01   -1.335489318623D-01    1.698162748512D-01
       3   -6.457641001473D-02    4.613800494941D-02   -6.378456442460D-02
       4    6.800392305050D-02    2.637589098726D-02   -2.927766641228D-02
       5   -7.780596827160D-03   -1.696354616404D-03    4.101919602398D-03
       6   -9.252420142124D-04   -2.153234057341D-03    1.724087525894D-03
       7    2.115742192807D-04    3.847511359996D-04   -3.531396348434D-04
       8   -9.909336050813D-06   -1.829769520002D-05    1.745121101762D-05

       E-Index:     3                   4                   5
  T-Index:
       0   -3.951176865624D-02    7.434448907130D-03   -7.651735363726D-04
       1   -1.819873891755D-01    3.954265794034D-02   -4.746673604459D-03
       2   -7.777618558640D-02    1.791770402443D-02   -2.265419802670D-03
       3    3.368756666920D-02   -8.588159967647D-03    1.161221464744D-03
       4    1.215210455092D-02   -2.536449841814D-03    2.949052179931D-04
       5   -2.853313172787D-03    8.331295381374D-04   -1.219354343653D-04
       6   -3.889280715498D-04    1.445906496031D-05    5.400239087927D-06
       7    1.117507761644D-04   -1.626382515941D-05    1.138105849294D-06
       8   -5.935692251130D-06    9.750922276399D-07   -8.514634639125D-08

       E-Index:     6                   7                   8
  T-Index:
       0    4.256550578560D-05   -1.183957210565D-06    1.267430439071D-08
```

```
        1    3.160257175597D-04   -1.090132407225D-05    1.518762884136D-07
        2    1.597834560300D-04   -5.867107114568D-06    8.703048627852D-08
        3   -8.476482397035D-05    3.148378986370D-06   -4.661383263216D-08
        4   -1.945865547958D-05    6.794359168371D-07   -9.714166652574D-09
        5    9.388539733773D-06   -3.625759741848D-07    5.530677587059D-09
        6   -7.463824586159D-07    3.657036916983D-08   -6.329837178101D-10
        7   -3.277550512167D-08   -2.762994890889D-11    1.306756395427D-11
        8    4.007910080852D-09   -9.447800370353D-11    8.488148236190D-13

  Max. rel. Error:  26.2822 %
  Mean rel. Error:   8.6945 %

\end{verbatim}\end{small}
\begin{figure} \label{2.1.8ro}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hydlr1_op.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.3.9a $e + He \rightarrow He^+(1s) + 2e$
}

   effective electron cooling rate due to ionisation of Helium atoms

\begin{small}\begin{verbatim}
        E-Index:     0                   1                   2
  T-Index:
        0   -3.535258393674D+01   -3.428249311738D-02    6.378071832382D-02
        1    1.981855871044D+01    4.854482688892D-02   -5.088928946831D-02
        2   -9.334355651224D+00   -4.524206463148D-02    2.103002869692D-02
        3    2.800314250410D+00    2.474350787980D-02   -6.012991773715D-03
        4   -5.489088598705D-01   -7.339538872774D-03    7.783071302508D-04
        5    6.902095610357D-02    1.234159378604D-03    2.989745411104D-05
        6   -5.342940069130D-03   -1.223169549107D-04   -1.500790305823D-05
        7    2.313175089975D-04    6.966436907981D-06    8.944962909810D-07
        8   -4.279800193256D-06   -1.815466669910D-07   -2.282174576618D-09

        E-Index:     3                   4                   5
  T-Index:
        0   -2.849818870377D-02    6.041903480645D-03   -6.864532165560D-04
        1    1.732110218818D-02   -2.781419068092D-03    2.244804771683D-04
        2   -4.463941003028D-03    2.900917070658D-04    2.482449118881D-05
        3    8.918009845745D-04   -2.616249899141D-05   -6.885545577757D-06
        4   -4.483274558979D-05    1.900991581685D-06   -9.747171692727D-07
        5   -3.040906203340D-05    2.951386149372D-06    7.592185107575D-08
        6    5.253922160283D-06   -4.468905893926D-07    7.483496971361D-09
        7   -1.712024596447D-07   -9.782015167261D-09    2.499416349949D-09
        8   -6.972920569943D-09    2.607191494540D-09   -2.870919514967D-10

        E-Index:     6                   7                   8
  T-Index:
        0    4.251155616815D-05   -1.351759350582D-06    1.728801977101D-08
        1   -8.875290574348D-06    1.399429819761D-07   -1.389778740510D-10
        2   -4.278064413224D-06    2.040570181783D-07   -3.324224092217D-09
        3    7.013616309712D-07   -2.570063437935D-08    3.573487194914D-10
        4    1.349829568374D-07   -5.815812094637D-09    6.686532777575D-11
        5   -1.805060230413D-08    3.156859219121D-10    1.071168697340D-11
        6   -9.777558713428D-10    1.770619394125D-10   -6.050995244427D-12
        7    4.731973382221D-11   -1.845161957843D-11    6.011070143230D-13
```

```
       8    8.059675146168D-12    3.704316808942D-13   -1.713225271579D-14

  Max. rel. Error:   1.8148 %
  Mean rel. Error:    .1839 %

\end{verbatim}\end{small}
\begin{figure} \label{2.3.9aer}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/heliaecr.ps}
\end{figure}
\newpage


\subsection{
Reaction 2.3.13a $He^+(1s) + electron(s) \rightarrow   He(1|1S)+ ...$
}
Helium multi-step model, here recombination

 Fujimoto Formulation II (only ground level transported, no metastables
 kept explicit), \cite{kn:Fujimoto}.
 The quantitity given here happens to be the radiation loss.
 The loss of potential energy still needs to be substracted to make
 this a total electron energy loss (or gain) rate.



\begin{small}\begin{verbatim}

       E-Index:     0                   1                   2
  T-Index:
       0   -2.538377692766D+01   -4.826880987619D-02    6.796575967310D-02
       1    2.472758419513D+00    1.668058989207D-01   -1.265192781981D-01
       2   -8.864417999957D+00   -1.882326730037D-01    1.194028674310D-01
       3    8.394970578944D+00    8.397993216045D-02   -5.796972813740D-02
       4   -3.465864794112D+00   -1.572684180220D-02    1.398192327776D-02
       5    7.479071085372D-01    5.997666028811D-04   -1.614053457119D-03
       6   -8.863575102304D-02    1.901540166344D-04    6.941090299375D-05
       7    5.484926807853D-03   -2.510359436743D-05    1.123735445147D-06
       8   -1.388441945179D-04    9.141995596700D-07   -1.168915890330D-07

       E-Index:     3                   4                   5
  T-Index:
       0   -2.401710021390D-02    4.130156138736D-03   -3.494803122018D-04
       1    2.938171777028D-02   -2.216525055070D-03   -1.261523686946D-04
       2   -2.382836629119D-02    1.134820469638D-03    1.782113978272D-04
       3    1.158600348753D-02   -7.504743150582D-04   -2.602911694939D-05
       4   -2.700181027443D-03    1.902304157269D-04   -1.534387905925D-06
       5    2.620866439317D-04   -1.103039382799D-05   -4.215447554819D-07
       6   -3.042043168371D-06   -1.677907209787D-06    2.153652742395D-07
       7   -9.198494797723D-07    2.058851315121D-07   -1.866416375894D-08
       8    3.485370731777D-08   -5.086412415216D-09    3.674153797642D-10

       E-Index:     6                   7                   8
  T-Index:
       0    1.345025100540D-05   -1.323917127568D-07   -2.551716207606D-09
       1    2.701401918133D-05   -1.370446267883D-06    2.313673787201D-08
       2   -2.305554399898D-05    9.430294093180D-07   -1.305188423829D-08
       3    4.568209602293D-06   -1.458110560501D-07    9.826599911934D-10
       4   -1.032060079260D-07   -1.355858638619D-08    5.917279771473D-10
       5   -9.926133276192D-09    4.148813674084D-09   -1.207867670158D-10
```

```
       6   -6.354480058307D-09   -1.223103792568D-10    5.543057946730D-12
       7    7.564835556537D-10   -1.622993472948D-11    2.428986170198D-13
       8   -1.621809988343D-11    6.737654534264D-13   -1.678705755876D-14

  Max. rel. Error:  22.6665 %
  Mean rel. Error:   8.4662 %
\end{verbatim}\end{small}
\begin{figure} \label{2.3.13aer}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/helraecr.ps}
\end{figure}
\newpage

\subsection{
  Reaction 2.6A0  $e + C  \rightarrow C^+   + 2e $
}
electron cooling rate due to ionisation of C atoms [eV * cm**3/s]
ADAS 93

\begin{small}\begin{verbatim}

       E-Index:     0                   1                   2
  T-Index:
       0   -1.541340319198D+01   -4.635323668693D+00    1.424306255525D+00
       1    6.871565603800D+00    3.062312115608D-02    1.785653882692D-02
       2   -2.581732757825D+00   -1.272125958091D-01    3.493561583728D-02
       3    4.800945236897D-01    9.573076930006D-02   -2.511071760242D-02
       4   -3.221877058224D-02   -1.391798645331D-02    2.175585061019D-03
       5   -8.242753615795D-03    1.145594247121D-03    3.885428995621D-05
       6    2.099340312561D-03   -1.276880024615D-04   -4.884605861642D-06
       7   -1.795437092836D-04    1.389068259360D-05   -1.113237444693D-06
       8    5.520442022231D-06   -6.375114106630D-07    9.859364572176D-08

       E-Index:     3                   4                   5
  T-Index:
       0   -2.158652670331D-01    1.412329738807D-02    1.168676999154D-04
       1   -1.094056812899D-02    3.136700005660D-03   -3.963442307288D-04
       2   -5.370773139210D-03    2.974489768572D-04   -1.432652388384D-05
       3    3.687719429910D-03   -2.848608239928D-04    1.690331087319D-05
       4   -1.746771988767D-04   -3.294582308635D-06    8.485083720382D-07
       5   -1.528532398519D-05    1.555056417236D-06   -5.074853324543D-08
       6    6.205604777862D-08    1.558979315126D-07   -1.140737345155D-08
       7    1.652357272442D-07   -1.003365245229D-08   -1.633709577156D-09
       8   -1.163642679910D-08    2.003281042296D-10    1.350639090685D-10

       E-Index:     6                   7                   8
  T-Index:
       0   -6.658345040546D-05    3.254244791032D-06   -5.053767538668D-08
       1    2.266757015103D-05   -5.406980202349D-07    3.681457471642D-09
       2    1.906448581780D-06   -9.658075171996D-08    7.628999658428D-10
       3   -6.509994237871D-07   -1.483571537540D-08    1.479901251703D-09
       4   -1.063260940363D-07    1.336948585246D-08   -5.357328879289D-10
       5    2.810998774881D-09   -8.868420910603D-10    4.953950208308D-11
       6    9.322775355772D-10   -5.119114288255D-11   -2.546806508137D-13
       7    1.240247466159D-10    1.352672081064D-12   -1.036766300560D-13
       8   -1.122860695875D-11    2.002505887771D-13    1.458669917591D-15

  Max. rel. Error:   9.7643 %
  Mean rel. Error:   3.1877 %
```

\end{verbatim}\end{small}
\begin{figure} \label{2.6il}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/carbil.ps}
\end{figure}
\newpage

\subsection{
  Reaction 2.3.6A0 $C^+ + electron(s) \rightarrow C   + ... $
}
electron cooling rate due to recombination of C+ ions [eV * cm**3/s]
ADAS 93 (must substract: 11.3 eV per recombination).
Hence: the quantitity given here happens to be the radiation loss only.

\begin{small}\begin{verbatim}

E-Index:	0	1	2
T-Index:			
0	-3.449331531577D+01	9.258971812737D+00	-4.304690527938D+00
1	-4.179856306879D+00	4.719723714161D+00	-1.109771079252D+00
2	2.311733850808D+00	-2.370285434332D+00	1.216699592702D+00
3	1.806779837905D+00	-1.398234905586D+00	8.251852305561D-02
4	-8.032014606781D-01	6.243519059852D-01	-7.917711523053D-02
5	1.301554943312D-01	-9.725337184215D-02	9.508579166285D-03
6	-1.242233736267D-02	8.700165808817D-03	-5.616784271834D-04
7	7.954435301193D-04	-5.273273516585D-04	4.271193045387D-05
8	-2.500391513086D-05	1.626059504628D-05	-2.107306577342D-06

E-Index:	3	4	5
T-Index:			
0	1.092764777565D+00	-1.657866594525D-01	1.542303956967D-02
1	1.775353255679D-02	2.925284499345D-02	-4.933757846201D-03
2	-2.172778536056D-01	1.779079567056D-02	-5.919155623354D-04
3	6.930042877150D-03	-9.404827643211D-04	1.001550181383D-04
4	7.717002987717D-03	-8.219046168773D-04	3.450097852128D-05
5	-9.044019514499D-04	1.495651404294D-04	-9.330495889321D-06
6	4.344451591441D-05	-1.310415385953D-05	8.765092218798D-07
7	-3.990191176291D-06	7.319258744806D-07	-2.097979773124D-08
8	2.278134731858D-07	-1.867601250526D-08	-8.878768861855D-10

E-Index:	6	7	8
T-Index:			
0	-8.596236746746D-04	2.630726640545D-05	-3.398545538061D-07
1	3.628156323586D-04	-1.299989445086D-05	1.856398634322D-07
2	-1.839176473763D-06	5.227710471502D-07	-7.972639217563D-09
3	-1.421063531104D-05	9.098399911722D-07	-1.924615837222D-08
4	3.127888270655D-06	-3.185873097827D-07	7.374750430973D-09
5	-3.945898698541D-07	5.543052440997D-08	-1.361067307243D-09
6	5.284131939957D-08	-6.565852326841D-09	1.587125861820D-10
7	-6.267687595428D-09	5.231170570451D-10	-1.155780084007D-11
8	2.974065900351D-10	-1.882199061890D-11	3.774990290039D-13

  Max. rel. Error: 8.2940 %
  Mean rel. Error: 3.7511 %

\end{verbatim}\end{small}
\begin{figure} \label{2.3.6rl}
\epsfxsize=16truecm

```
\epsffile{Amjuel_PS/carbrl.ps}
\end{figure}
\section{H.11: Other single polynomial fits}

\subsection{
Reaction 2.2B0   $ <de>(T_e) \ [eV], He \rightarrow He^* $
}

  Electron cooling for neutral and single
  charged Helium Particles, per collision [eV]

\begin{small}\begin{verbatim}
  k0  1.151324376008D+01  k1 -4.473761205167D+00  k2  1.778986582799D+00
  k3 -6.438551868755D-01  k4  1.608511765799D-01  k5 -2.421866396738D-02
  k6  2.091573687632D-03  k7 -9.493936758931D-05  k8  1.736942898336D-06

\end{verbatim}\end{small}


\subsection{
Reaction 2.4B0  $  <de>(T_e)  \ [eV], Be \rightarrow Be^*$
}

  Electron cooling rates for neutral and single
  charged Beryllium Particles

\begin{small}\begin{verbatim}
  k0  1.100391045815D+01  k1 -5.081216135395D+00  k2  2.036662223616D+00
  k3 -6.960133333130D-01  k4  1.785218452743D-01  k5 -2.998205644075D-02
  k6  3.046320376267D-03  k7 -1.693432568467D-04  k8  3.950464677598D-06

\end{verbatim}\end{small}
\subsection{
Reaction 2.5B0   $ <de>(T_e) \ [eV], B \rightarrow B^* $
}

 Electron cooling rates for neutral and single
 charged Boron Particles

\begin{small}\begin{verbatim}

  k0  7.978054620918D+00    k1 -2.341359084919D+00    k2  8.199491879599D-01
  k3 -4.624629728853D-01    k4  1.778831014506D-01    k5 -3.767862190039D-02
  k6  4.410579417779D-03    k7 -2.699007579966D-04    k8  6.760485583089D-06

\end{verbatim}\end{small}
\begin{figure} \label{2.5ll}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/HeBeB_il.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.6B0   $ <de>(T_e) \ [eV], C \rightarrow C^* $
}

 Electron cooling rates for neutral and single
 charged Carbon Particles

\begin{small}\begin{verbatim}
```

```
  k0  2.424802725729D+00  k1 -1.797396036147D-10  k2  4.241484716257D-10
  k3 -3.759898635828D-10  k4  1.631442515076D-10  k5 -3.838557439876D-11
  k6  4.998205410921D-12  k7 -3.385835399169D-13  k8  9.309847584952D-15

  Max. rel. Error:    .0000 %
  Mean rel. Error:    .0000 %


\end{verbatim}\end{small}

\subsection{
Reaction 2.10B0   $ <de>(T_e) \ [eV], Ne \rightarrow Ne^* $
}

 Electron cooling rates for neutral and single
 charged Neon Particles

\begin{small}\begin{verbatim}
  k0  1.059049152999D+01  k1 -5.769454465431D+00  k2  2.125621468764D+00
  k3 -6.517811286454D-01  k4  1.883422085531D-01  k5 -3.905034526242D-02
  k6  4.823070375814D-03  k7 -3.148120306333D-04  k8  8.365625760942D-06

  Max. rel. Error:    .9028 %
  Mean rel. Error:    .5524 %

\end{verbatim}\end{small}


\subsection{
Reaction 2.18B0  $  <de>(T_e) \ [eV], Ar \rightarrow Ar^*$
}

  Electron cooling rates for neutral and single
  charged Argon Particles

\begin{small}\begin{verbatim}

  k0  2.760009940033D+00  k1  0.000000000000D+00  k2  0.000000000000D+00
  k3  0.000000000000D+00  k4  0.000000000000D+00  k5  0.000000000000D+00
  k6  0.000000000000D+00  k7  0.000000000000D+00  k8  0.000000000000D+00

  Max. rel. Error:    .0000 %
  Mean rel. Error:    .0000 %

\end{verbatim}\end{small}

\begin{figure} \label{2.18ll}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/CNeAr_il.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.0a   Ratio $H_2^+/H_2,$ only from CX on $H_2(v)$
}
(coll. model for vibr. excitation, Greenland, Reiter, \cite{kn:Green})

Assumptions:
```

```
$E_{H2} = 0.1$ eV, $T_i = T_e$, vibrational distribution with
no coupling to B,C states,
hence: independent of $n_e$

\begin{small}\begin{verbatim}
  k0 -5.281428900665D+00  k1  3.115995571855D+00  k2 -3.690629726865D+00
  k3  1.448918180601D+00  k4 -3.928689243481D-01  k5  1.236809448625D-01
  k6 -2.877121006548D-02  k7  3.391113110854D-03  k8 -1.521565312043D-04

  Max. rel. Error:   9.3977 %
  Mean rel. Error:   5.6685 %
\end{verbatim}\end{small}

\subsection{
Reaction 2.0b   Ratio $H_2^+/H_2,$ only from CX on $H_2(v=0)$
}
(coll. model for vibr. excitation, Greenland, Reiter, \cite{kn:Green})
same as 2.0a, but cx (ion conversion) only from vibr. ground state

\begin{small}\begin{verbatim}
  k0 -8.061954078771D+00  k1  2.475896585902D+00  k2 -2.933737852849D+00
  k3  1.492083638260D+00  k4 -3.461597813263D-01  k5  3.266006392880D-02
  k6  1.357009637322D-03  k7 -5.021441756376D-04  k8  2.737802193621D-05

  Max. rel. Error:   1.3369 %
  Mean rel. Error:    .8127 %

\end{verbatim}\end{small}

\begin{figure} \label{2.0a}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/ratioH11_2ab.ps}
\end{figure}

\newpage

\subsection{
Reaction 7.0a      Ratio $H^-/H_2, H_2: $ from DA on $H_2(v)$
}


  (coll. model for vibr. excitation, Greenland, Reiter, \cite{kn:Green})
  Ratio of densities: $n_{H^-}/n_{H_2}$

\begin{small}\begin{verbatim}
  k0 -6.001820741967D+00  k1  1.247273997745D+00  k2 -2.753387653632D+00
  k3  2.274419556537D-01  k4  1.148400271668D-02  k5  8.614331916062D-02
  k6 -3.482537437480D-02  k7  4.822974299102D-03  k8 -2.291190247346D-04

  Max. rel. Error:  23.4821 %
  Mean rel. Error:  10.7677 %
\end{verbatim}\end{small}

\subsection{
Reaction 7.0b      Ratio $H^-/H_2, H_2: $ only from DA on $H_2(v=0)$
}


  (Dissociative attachment only from ground vibrational state
 molecules \cite{kn:Green})
```

```
  Ratio of densities: $n_{H^-}/n_{H_2}$

\begin{small}\begin{verbatim}
  k0 -1.608434690479D+01  k1  2.105039374877D+00  k2 -2.553803267076D+00
  k3  7.038135447597D-01  k4 -6.586584264400D-02  k5 -2.548302462129D-03
  k6  2.922944743984D-04  k7  8.800611380131D-05  k8 -7.939105674896D-06

  Max. rel. Error:   3.3989 %
  Mean rel. Error:   1.0220 %
\end{verbatim}\end{small}


\begin{figure} \label{7.0}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/ratio7.ps}
\end{figure}

\newpage

\section{H.12: Other double polynomial fits}

\subsection{
Reaction 2.1.5a  $H + e \rightarrow H^+ + 2e $, Ratio H(3)/H(1)
}

\begin{small}\begin{verbatim}


        E-Index:     0                    1                    2
  T-Index:
        0   -3.082877684472D+01    9.740982428834D-01    2.693447564427D-02
        1    1.187030265272D+01    1.968338090648D-02   -2.495504765088D-02
        2   -5.889482037865D+00   -8.737684945730D-03    9.951688266911D-03
        3    2.017399399792D+00   -1.014609925009D-02    1.040081859210D-02
        4   -5.303360302839D-01    3.297808176838D-03   -2.712205422397D-03
        5    1.080451047951D-01    9.673290806118D-04   -1.096708705743D-03
        6   -1.555010466762D-02   -5.167168286670D-04    4.637911190482D-04
        7    1.327158680898D-03    7.389473703435D-05   -5.797555862425D-05
        8   -4.872105203992D-05   -3.537584073064D-06    2.453443334473D-06

        E-Index:     3                    4                    5
  T-Index:
        0   -9.004934091051D-03    1.222843687947D-03   -5.210804049741D-05
        1    1.123130855030D-02   -2.651909936461D-03    3.534709147248D-04
        2   -5.241271640755D-03    1.372483328336D-03   -1.917275090304D-04
        3   -3.478025606446D-03    5.572774095384D-04   -4.848784231802D-05
        4    8.454526208306D-04   -1.362168127545D-04    1.306146151315D-05
        5    3.872258199271D-04   -6.353971343367D-05    5.417022322731D-06
        6   -1.380893374707D-04    1.849429028886D-05   -1.166761555949D-06
        7    1.440341699187D-05   -1.290902554237D-06   -4.889963932464D-09
        8   -4.745956710582D-07    5.546604517157D-09    7.579547673173D-09

        E-Index:     6                    7                    8
  T-Index:
        0   -2.739765256223D-06    2.927097984040D-07   -6.646459819509D-09
        1   -2.632450715422D-05    9.987762315441D-07   -1.501421276021D-08
        2    1.441627470961D-05   -5.481720522735D-07    8.264009775214D-09
        3    2.416915703008D-06   -6.658457254421D-08    8.215818515744D-10
        4   -7.772290534634D-07    2.655224800515D-08   -3.968977724198D-10
        5   -2.470245979511D-07    5.722044899754D-09   -5.443566855045D-11
```

```
       6    2.955124264492D-08    3.184408123607D-11   -8.216232831023D-12
       7    7.390396686250D-09   -4.052521721349D-10    6.720841155202D-12
       8   -8.635578634097D-10    3.738695038824D-11   -5.757075610089D-13

  Max. rel. Error:   3.7804 %
  Mean rel. Error:   1.3368 %


\end{verbatim}\end{small}
\begin{figure} \label{2.1.5a}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hn3fu.ps}
\end{figure}

\newpage
\subsection{
Reaction 2.1.5b  $H + e \rightarrow H^+ + 2e$, Ratio H(2)/H(1)
}


\begin{small}\begin{verbatim}

       E-Index:     0                    1                    2
  T-Index:
       0   -2.888782240542D+01    9.694042304562D-01    4.613129045722D-02
       1    9.909537514500D+00   -4.163537878599D-02    2.444011013342D-02
       2   -4.942743781185D+00    1.230545313063D-02   -1.289174377763D-02
       3    1.715668267417D+00    3.034149311755D-02   -1.837812030403D-02
       4   -4.508004155190D-01   -1.136449435241D-02    7.857406065923D-03
       5    9.042516000563D-02   -2.874540451423D-03    1.787805444265D-03
       6   -1.280973933282D-02    1.947546784046D-03   -1.325209820376D-03
       7    1.084341450206D-03   -3.175349945580D-04    2.227323600480D-04
       8   -3.974359134401D-05    1.688199339120D-05   -1.209472946500D-05

       E-Index:     3                    4                    5
  T-Index:
       0   -2.216757216719D-02    5.067711671376D-03   -6.212032986616D-04
       1   -5.092551836572D-03    4.080645015829D-04   -5.739581031596D-06
       2    4.174980751883D-03   -5.559754475561D-04    2.207616832672D-05
       3    3.719122644080D-03   -2.039974521144D-04   -2.170634046629D-05
       4   -1.818309410916D-03    1.348196284756D-04    7.621772971297D-06
       5   -4.049163510078D-04    3.839701084642D-05   -1.182790529172D-06
       6    3.200749637228D-04   -3.075854301471D-05    4.485031199179D-07
       7   -5.559573928329D-05    5.656373947352D-06   -1.236115053324D-07
       8    3.100021285561D-06   -3.323560174565D-07    9.896407186442D-09

       E-Index:     6                    7                    8
  T-Index:
       0    4.172445968364D-05   -1.439572350231D-06    1.978486731178D-08
       1   -6.441112682031D-07    1.766524953307D-08    4.500335193180D-11
       2    1.604359947467D-06   -1.668549821257D-07    3.956288361818D-09
       3    3.319046346231D-06   -1.530562339677D-07    2.467744887550D-09
       4   -1.742105663717D-06    9.539025646066D-08   -1.764749848063D-09
       5   -3.224230256996D-08    2.293257666191D-09   -2.626033062059D-11
       6    1.187820950781D-07   -7.725204735890D-09    1.455730327605D-10
       7   -1.829679294498D-08    1.312011360384D-09   -2.576831583186D-11
       8    8.003219743811D-10   -6.578827971726D-11    1.343525928267D-12

  Max. rel. Error:   5.0202 %
  Mean rel. Error:    .9593 %
```

```
\end{verbatim}\end{small}
\begin{figure} \label{2.1.5b}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hn2fu.ps}
\end{figure}

\newpage
\subsection{
Reaction 2.1.5c  $H + e \rightarrow H^+ + 2e$, Ratio H(4)/H(1)
}


\begin{small}\begin{verbatim}
```

E-Index:	0	1	2
T-Index:			
0	-3.121459339796D+01	8.335828009713D-01	2.325042085123D-01
1	1.250950592132D+01	9.112878380113D-03	-5.491646502669D-02
2	-6.229984587067D+00	-1.938627422961D-02	1.621303063286D-02
3	2.142105600364D+00	3.084489232048D-02	-3.147946146487D-03
4	-5.615155300856D-01	-5.885518785970D-03	-1.131771898094D-03
5	1.127449459065D-01	-6.211271050025D-03	3.856805502108D-03
6	-1.590343046823D-02	2.950230045038D-03	-1.748272049931D-03
7	1.333705010633D-03	-4.583201098446D-04	2.858630200307D-04
8	-4.836027605927D-05	2.417569815070D-05	-1.585276481393D-05

E-Index:	3	4	5
T-Index:			
0	-1.096388203376D-01	2.434624647621D-02	-2.848412091044D-03
1	2.972045500915D-02	-6.752777629102D-03	7.907482466413D-04
2	-6.819605362801D-03	1.639046907231D-03	-2.316409264833D-04
3	-4.981563534979D-03	1.797076203455D-03	-2.547644660956D-04
4	2.277414510956D-03	-7.295707497520D-04	1.047093315160D-04
5	-9.720154554360D-04	1.201895430371D-04	-7.956678504065D-06
6	3.838584264558D-04	-3.212460389716D-05	-8.181068284295D-08
7	-6.739012881651D-05	6.684315041032D-06	-1.703080933280D-07
8	4.013119711268D-06	-4.619672863742D-07	2.215787076654D-08

E-Index:	6	7	8
T-Index:			
0	1.789669578362D-04	-5.712451213773D-06	7.267386885023D-08
1	-5.078726612521D-05	1.694110618282D-06	-2.296731891384D-08
2	1.859544292047D-05	-7.663932535000D-07	1.248233937322D-08
3	1.790413918002D-05	-6.225635876900D-07	8.589352663796D-09
4	-7.734966472367D-06	2.868598630187D-07	-4.235795995646D-09
5	2.942004754571D-07	-6.030861909870D-09	5.715848860621D-11
6	1.721805311242D-07	-9.730371684031D-09	1.730299677672D-10
7	-1.655594650506D-08	1.235894145239D-09	-2.408500349383D-11
8	2.731478375019D-11	-3.750344543532D-11	9.061707694269D-13

```
  Max. rel. Error:   3.6808 %
  Mean rel. Error:   1.2901 %


\end{verbatim}\end{small}
\begin{figure} \label{2.1.5c}
\epsfxsize=16truecm
```

```
\epsffile{Amjuel_PS/hn4fu.ps}
\end{figure}

\newpage
\subsection{
Reaction 2.1.5d  $H + e \rightarrow H^+ + 2e$, Ratio H(5)/H(1)
}


\begin{small}\begin{verbatim}


       E-Index:     0                    1                    2
  T-Index:
       0   -3.126718125624D+01    9.282945460974D-01    1.070213380676D-01
       1    1.281374709913D+01    3.573873112144D-02   -4.872701879146D-02
       2   -6.380408105491D+00   -1.144110981890D-03   -4.680598150266D-05
       3    2.191577061685D+00   -5.161589020256D-03    6.439656957369D-03
       4   -5.751755938054D-01    1.676622419964D-03   -1.568501026478D-03
       5    1.157406495600D-01    1.486290009897D-04   -1.404765081110D-04
       6   -1.631671197369D-02   -2.016003370833D-04    1.639222741263D-04
       7    1.362647208936D-03    3.901702147732D-05   -3.141140575728D-05
       8   -4.908854946631D-05   -2.325049769834D-06    1.888930116590D-06

       E-Index:     3                    4                    5
  T-Index:
       0   -5.984835557747D-02    1.574482420977D-02   -2.152803383431D-03
       1    2.122340688681D-02   -4.335261058803D-03    4.511000731668D-04
       2    4.899399906199D-04   -1.730051136321D-04    2.045111743029D-05
       3   -2.595193985854D-03    5.083896758770D-04   -5.001475048416D-05
       4    5.235042780927D-04   -8.901350181088D-05    8.437562876296D-06
       5    1.953433357615D-05    3.171136646292D-06   -1.281135706652D-06
       6   -3.782479181914D-05    2.829273502486D-06    1.645529677700D-07
       7    7.810730453019D-06   -7.640509497691D-07    9.357372398314D-09
       8   -4.970298877362D-07    5.607762235203D-08   -2.232480288100D-09

       E-Index:     6                    7                    8
  T-Index:
       0    1.533450613139D-04   -5.416190220272D-06    7.503092506245D-08
       1   -2.514757812007D-05    7.098607959133D-07   -7.948198678409D-09
       2   -4.780097207035D-07   -3.664829135622D-08    1.435704784493D-09
       3    2.378856833473D-06   -4.662729327187D-08    1.885707833825D-10
       4   -4.722754735716D-07    1.525662957088D-08   -2.277373255316D-10
       5    1.539182389681D-07   -7.795475709363D-09    1.408203935795D-10
       6   -3.844013350899D-08    2.070018927471D-09   -3.568996816514D-11
       7    3.398945819263D-09   -2.120439941817D-10    3.643140818164D-12
       8   -6.095037813579D-11    6.718495301125D-12   -1.229967242093D-13

  Max. rel. Error:   2.8664 %
  Mean rel. Error:   1.0041 %

\end{verbatim}\end{small}
\begin{figure} \label{2.1.5d}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hn5fu.ps}
\end{figure}

\newpage
\subsection{
Reaction 2.1.5e  $H + e \rightarrow H^+ + 2e$, Ratio H(6)/H(1)
```

}

\begin{small}\begin{verbatim}

```
        E-Index:     0                    1                    2
  T-Index:
        0   -3.118788806329D+01    1.051705868661D+00   -6.954764617920D-02
        1    1.300365034969D+01    5.806024278787D-02   -7.054107872877D-02
        2   -6.464611656902D+00   -3.350148712230D-02    3.809632279775D-02
        3    2.198690942590D+00   -1.651116960139D-02    1.248202030331D-02
        4   -5.762198964354D-01    8.782966049217D-03   -7.253814512300D-03
        5    1.190459835777D-01    7.937734220940D-04   -3.032198147605D-04
        6   -1.758172528529D-02   -8.425168421647D-04    4.935184501531D-04
        7    1.540671110406D-03    1.322737632505D-04   -7.161027491097D-05
        8   -5.782468318198D-05   -6.483373521666D-06    3.088146690349D-06

        E-Index:     3                    4                    5
  T-Index:
        0    2.612329534702D-02   -3.911384137475D-03    1.474794675693D-04
        1    3.209814487839D-02   -7.336538391803D-03    8.838327301328D-04
        2   -1.663574690203D-02    3.667522832624D-03   -4.409479869479D-04
        3   -3.600008781362D-03    5.273464947078D-04   -4.137511227236D-05
        4    2.434417487959D-03   -4.385057360151D-04    4.589037396076D-05
        5   -6.693627833492D-05    4.755833322780D-05   -8.654363224389D-06
        6   -8.020637279277D-05   -2.254322145665D-06    1.858918078917D-06
        7    9.120131097155D-06    1.138969748088D-06   -3.791832116704D-07
        8   -1.704370060355D-07   -1.258928004543D-07    2.744344149529D-08

        E-Index:     6                    7                    8
  T-Index:
        0    9.191757017392D-06   -7.898231632650D-07    1.514512376570D-08
        1   -5.779085565904D-05    1.935287412436D-06   -2.603161887414D-08
        2    2.975048782418D-05   -1.054940416948D-06    1.523660684271D-08
        3    1.553774051571D-06   -1.704433673171D-08   -2.016881015852D-10
        4   -2.785668187173D-06    9.065547432614D-08   -1.223436753078D-09
        5    7.303664535216D-07   -2.952279140710D-08    4.597194098628D-10
        6   -1.970736415814D-07    8.619751903229D-09   -1.383868509607D-10
        7    3.596045684588D-08   -1.495930494169D-09    2.332244458469D-11
        8   -2.357827363714D-09    9.371149524100D-11   -1.424213663602D-12

  Max. rel. Error:   5.6136 %
  Mean rel. Error:   1.7770 %
```

\end{verbatim}\end{small}
\begin{figure} \label{2.1.5e}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hn6fu.ps}
\end{figure}

\newpage
\subsection{
Reaction 2.1.5t $ H + e \rightarrow H^+ + 2e$, Ratio H(tot)/H(1)
}

\begin{small}\begin{verbatim}

```
        E-Index:     0                    1                    2
  T-Index:
```

```
          0    9.999989080920D-01    6.569869814870D-04   -6.526259178085D-04
          1   -6.684079057216D-06   -1.624733380895D-03    1.517116722391D-03
          2    2.553992642225D-05    9.833706477844D-04   -8.771533719662D-04
          3   -2.462557791473D-05   -2.342847322381D-04    2.116654525863D-04
          4    1.062360801108D-05    2.225391064535D-05   -2.995563308037D-05
          5   -2.399855499712D-06    2.478808045973D-06    1.242643822457D-06
          6    2.951154702233D-07   -7.469982004941D-07    1.518536644908D-07
          7   -1.871893412626D-08    5.751651874704D-08   -1.380451507029D-08
          8    4.796659338151D-10   -1.452959768161D-09    2.101916949778D-10

          E-Index:     3                    4                    5
    T-Index:
          0    2.446820545529D-04   -4.633538453818D-05    4.889372584120D-06
          1   -5.196975095555D-04    8.835186629866D-05   -8.286820244724D-06
          2    2.694565448733D-04   -3.889200026191D-05    2.928290705068D-06
          3   -5.533211626824D-05    5.123221852559D-06   -1.729804749149D-08
          4    8.273895035263D-06   -6.797808694765D-07   -1.060219799928D-08
          5   -5.874504858843D-07    4.859497595281D-08    1.114394044002D-09
          6    7.883226202848D-09   -1.005021139591D-09   -2.177196303683D-10
          7   -9.799681363679D-10    4.054138156358D-10   -2.970144566810D-11
          8    1.213701692902D-10   -3.377976381012D-11    3.362497319640D-12

          E-Index:     6                    7                    8
    T-Index:
          0   -2.917482144379D-07    9.209996969945D-09   -1.195587997940D-10
          1    4.378814547750D-07   -1.223407550017D-08    1.405657502664D-10
          2   -1.169351655337D-07    2.258524229896D-09   -1.460715455401D-11
          3   -2.426972326758D-08    1.404805094637D-09   -2.540724522759D-11
          4    3.476416204584D-09   -1.330157773056D-10    1.424915474012D-12
          5   -8.129340876771D-11   -1.183776577049D-11    5.125710307402D-13
          6    5.313468965034D-12    1.675867714679D-12   -6.770309443179D-14
          7    1.619425683239D-12   -1.268121213878D-13    3.934356277466D-15
          8   -1.798937732279D-13    6.521970562366D-15   -1.251030581090D-16

\end{verbatim}\end{small}
\begin{figure} \label{2.1.5t}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hydic.ps}
\end{figure}

\newpage

\subsection{
Reaction 2.1.5de  $ H + e \rightarrow H^+ + 2e, \   <de> \ [eV]$}


\begin{small}\begin{verbatim}

          E-Index:     0                    1                    2
    T-Index:
          0    7.845107077886D+00   -4.158388629994D-02    2.060681712432D-02
          1   -4.270502285463D+00    9.505957771815D-02   -7.673602080150D-02
          2    1.726068286328D+00   -4.522519386379D-02    5.154287556942D-02
          3   -3.652415321353D-01   -5.349008403944D-03   -1.089345117269D-02
          4    3.713344797329D-02    9.550154852851D-03   -1.137782108759D-03
          5   -1.816044037023D-04   -2.867587202499D-03    8.354453807701D-04
          6   -3.430690631609D-04    3.909898872586D-04   -1.337503951808D-04
          7    3.098356603724D-05   -2.559885625243D-05    9.077886701887D-06
          8   -8.899184097510D-07    6.519466167972D-07   -2.268251226270D-07
```

```
      E-Index:     3                    4                    5
  T-Index:
        0   -8.052322446345D-03    1.361616907232D-03   -1.426513742220D-04
        1    2.563880114503D-02   -3.821401798942D-03    2.937551907788D-04
        2   -1.720715317463D-02    2.290689977061D-03   -1.253606753443D-04
        3    4.775945182204D-03   -6.467228312794D-04    2.975489992699D-05
        4   -3.721823938539D-04    7.419831565375D-05   -3.809552723616D-06
        5   -8.073915024648D-05    3.196729352202D-06   -4.577796946576D-08
        6    1.863239051629D-05   -1.462457758789D-06    6.102229658187D-08
        7   -1.331114942698D-06    1.094119960469D-07   -4.763060764998D-09
        8    3.160102832021D-08   -2.366622776376D-09    9.028757163018D-11

      E-Index:     6                    7                    8
  T-Index:
        0    9.199187026673D-06   -3.626126425744D-07    6.526649455096D-09
        1   -1.081310544107D-05    1.291895685695D-07    1.068484717217D-09
        2   -1.280245967862D-08    2.592986543781D-07   -7.113378488276D-09
        3    8.057527653614D-07   -1.189385405932D-07    2.982171776258D-09
        4   -9.060932716087D-08    1.580536007694D-08   -4.320760123314D-10
        5   -5.069290362681D-10   -2.785729865499D-10    1.593762976817D-11
        6    2.554338381631D-10   -9.890935002552D-11    1.770328452101D-12
        7   -9.336950682103D-12    8.093464288205D-12   -1.767574119215D-13
        8    1.044083905543D-12   -2.066392792622D-13    4.436324698144D-15

  Max. rel. Error:    .4629 %
  Mean rel. Error:    .0970 %

\end{verbatim}\end{small}
\begin{figure} \label{2.1.5li2}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hydli2_tr.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.1.5o  $ H + e \rightarrow H^+ + 2e, \   <de> \ [eV]$ Ly-opaque}

Lyman opaque

\begin{small}\begin{verbatim}



      E-Index:     0                    1                    2
  T-Index:
        0    4.257426092590D+00   -2.648139307081D-01    2.747475375517D-01
        1   -1.580642905913D+00    1.856918325247D-01   -1.887867610999D-01
        2    9.487720032428D-01   -4.334108248024D-02    4.027363438413D-02
        3   -3.653667544231D-01    1.938361132039D-03   -1.064922255960D-03
        4    9.142288235830D-02    6.321600657670D-04   -1.359591518986D-04
        5   -1.446402551044D-02   -2.277509541327D-04   -1.939963902602D-05
        6    1.384901599216D-03    4.074186530390D-05    1.262940841492D-06
        7   -7.297260412218D-05   -3.278960026730D-06    5.700992619392D-08
        8    1.620578859074D-06    9.263823594567D-08    1.592211120194D-09

      E-Index:     3                    4                    5
  T-Index:
        0   -1.211356030412D-01    2.685695232533D-02   -3.317777605290D-03
        1    8.363647099141D-02   -1.868059156820D-02    2.327504355627D-03
        2   -1.875679395058D-02    4.434521459505D-03   -5.945647526149D-04
```

```
        3    7.959030639825D-04   -2.528345636722D-04    5.007272230577D-05
        4    5.074526064710D-06   -3.035134696595D-06   -2.203465100709D-06
        5    2.365267620753D-05   -2.398473162099D-06    3.489675236875D-07
        6   -3.631085495565D-06    4.137564902109D-07   -2.971694422141D-08
        7    2.493062937307D-07   -3.179509396878D-08    1.585728061318D-09
        8   -9.298947595442D-09    1.468230792208D-09   -9.887260958280D-11

        E-Index:     6                    7                    8
  T-Index:
        0    2.278436663051D-04   -8.091967627921D-06    1.156866070535D-07
        1   -1.605612738266D-04    5.703707563566D-06   -8.131849775947D-08
        2    4.346897926519D-05   -1.605515516330D-06    2.346223121561D-08
        3   -4.662162321782D-06    1.981562216998D-07   -3.155996422050D-09
        4    3.653404338885D-07   -1.942106127435D-08    3.499018522662D-10
        5   -3.942216779052D-08    2.001379932680D-09   -3.673145766979D-11
        6    1.954467664699D-09   -8.738736712781D-11    1.665200022479D-12
        7   -2.359672833575D-11   -4.475930371767D-13    7.240045137258D-15
        8    2.798900106658D-12   -1.040603787711D-14   -5.219184133080D-16

  Max. rel. Error:    .4321 %
  Mean rel. Error:    .0858 %

\end{verbatim}\end{small}
\begin{figure} \label{2.1.5li2o}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hydli2_op.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.1.8a  $H^+ + e \rightarrow H(1s) + ...$,  Ratio $H(3)/H^+$
}

\begin{small}\begin{verbatim}


        E-Index:     0                    1                    2
  T-Index:
        0   -3.026567737773D+01    1.152583719426D+00   -1.626038509544D-01
        1   -8.879460687468D-01   -5.351933360860D-02    4.426984905627D-02
        2   -2.779342631813D-02    6.030457249067D-03    1.515441331512D-03
        3   -1.196375890811D-02   -2.871588085187D-03    2.404285503458D-04
        4    1.822980963695D-03   -1.575168978328D-06    8.405772103417D-04
        5   -2.196477309909D-04    5.066260303625D-04   -5.971643097799D-04
        6    3.323843511157D-05   -1.520492801515D-04    1.281232614617D-04
        7   -1.697007294106D-06    1.825841763069D-05   -1.220563921933D-05
        8   -5.916439943353D-08   -8.242186020597D-07    4.677827163183D-07

        E-Index:     3                    4                    5
  T-Index:
        0    7.198684018769D-02   -1.490875604355D-02    1.619553420918D-03
        1   -1.852578901204D-02    3.331452439870D-03   -2.948572788751D-04
        2   -9.056841023031D-04    3.563549006757D-04   -5.590965690725D-05
        3   -8.226476286514D-05    2.960920971970D-05   -8.086208258569D-06
        4   -3.464740688021D-04    5.922304252082D-05   -4.850028146748D-06
        5    2.105198711062D-04   -3.609362517850D-05    3.423756972171D-06
        6   -3.517980076344D-05    4.427958188863D-06   -2.493221748446D-07
        7    2.198069639127D-06   -6.705985847102D-09   -4.128988875743D-08
        8   -4.300266775823D-08   -1.512563397687D-08    4.068624995447D-09
```

```
      E-Index:     6                    7                    8
  T-Index:
        0   -9.269115359815D-05    2.618073045777D-06   -2.835709536455D-08
        1    1.169406889954D-05   -1.253572620552D-07   -1.886947676134D-09
        2    4.196575697004D-06   -1.482582457939D-07    1.946426380509D-09
        3    9.143236603084D-07   -4.362855429636D-08    7.452885416070D-10
        4    2.164045324446D-07   -6.474547723428D-09    1.156823417385D-10
        5   -1.851415491252D-07    5.487390918519D-09   -7.088510716926D-11
        6    4.694709505540D-10    5.338069108949D-10   -1.542307935794D-11
        7    5.373013388538D-09   -2.844239825756D-10    5.516973870161D-12
        8   -4.168331974260D-10    2.004403028395D-11   -3.695127505869D-13

  Max. rel. Error:   4.5193 %
  Mean rel. Error:    .9402 %

\end{verbatim}\end{small}
\begin{figure} \label{2.1.8ra}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hpn3fu.ps}
\end{figure}
\newpage



\subsection{
Reaction 2.1.8b  $H^+ + e \rightarrow H(1s) + ...$,  Ratio $H(2)/H^+$
}

\begin{small}\begin{verbatim}


      E-Index:     0                    1                    2
  T-Index:
        0   -3.115038577088D+01    9.264747680865D-01    1.116069825638D-01
        1   -8.266322399304D-01   -5.055344435832D-03   -5.172879304080D-03
        2   -1.958933034940D-02    1.996587961213D-02   -1.406505755991D-02
        3   -1.098097104386D-02   -8.026613963832D-03    2.384792377395D-03
        4    2.240953060530D-03    6.216308441596D-04    4.708126181720D-04
        5   -4.287502766451D-04    1.030957503524D-03   -8.066658779253D-04
        6    2.695143837765D-05   -3.813692505803D-04    2.807631048773D-04
        7    4.431006229058D-06    4.875879498318D-05   -3.657593211279D-05
        8   -4.836943342929D-07   -2.119652719791D-06    1.615837004793D-06

      E-Index:     3                    4                    5
  T-Index:
        0   -4.999361806664D-02    1.110692800547D-02   -1.318266873039D-03
        1   -2.471719625656D-04    2.512113939106D-04   -4.782708408420D-05
        2    6.003957672996D-03   -1.118685805994D-03    1.071846833065D-04
        3    2.913902175387D-04   -3.137930614752D-04    6.113629942161D-05
        4   -3.710502524841D-04    1.004704612837D-04   -1.265344424602D-05
        5    1.874529789965D-04   -9.988538268116D-06   -1.920784234786D-06
        6   -6.603768771619D-05    4.665491245671D-06    3.297381117360D-07
        7    9.282643997639D-06   -9.265752285496D-07    1.709073955313D-08
        8   -4.302365964264D-07    5.056403909495D-08   -2.595051961188D-09

      E-Index:     6                    7                    8
  T-Index:
        0    8.540286307962D-05   -2.815699854432D-06    3.675943603675D-08
        1    3.802889409563D-06   -1.453090712874D-07    2.181183016555D-09
        2   -5.066273468359D-06    9.656495668618D-08   -2.071395871695D-10
```

```
       3   -5.318038556138D-06    2.186221742805D-07   -3.426977855059D-09
       4    7.996838066338D-07   -2.418791195391D-08    2.661640394733D-10
       5    3.024841319851D-07   -1.543862403318D-08    2.709969256279D-10
       6   -6.616004144573D-08    3.369760494944D-09   -5.636580218277D-11
       7    3.122103721669D-09   -1.967871537035D-10    3.230724672289D-12
       8    3.213236793835D-11    1.140062879563D-12   -1.343611820864D-14

  Max. rel. Error:   3.9289 %
  Mean rel. Error:    .5704 %

\end{verbatim}\end{small}
\begin{figure} \label{2.1.8rb}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hpn2fu.ps}
\end{figure}
\newpage



\subsection{
Reaction 2.1.8c  $H^+ + e \rightarrow H(1s) + ...$,  Ratio $H(4)/H^+$
}

\begin{small}\begin{verbatim}


       E-Index:     0                   1                   2
  T-Index:
       0   -2.953191910521D+01    9.871472575458D-01    8.335595020148D-03
       1   -9.556069945203D-01   -3.479296508982D-02    3.951762140637D-02
       2   -3.712742175485D-02    3.782567517335D-02   -3.658223474024D-02
       3   -9.582306874061D-03   -1.030473600466D-02    8.044191938471D-03
       4    1.337505622469D-03    3.261828837170D-04    5.825308847532D-04
       5   -2.564587290898D-04    1.167215404726D-04   -2.625484568114D-04
       6    1.083049171042D-04    2.603250284906D-05   -2.172994325710D-05
       7   -1.652237169896D-05   -8.358946327039D-06    9.583200142966D-06
       8    7.926514417410D-07    5.226431312203D-07   -6.190692135710D-07

       E-Index:     3                   4                   5
  T-Index:
       0    1.287791418429D-02   -6.337729479020D-03    1.170329931626D-03
       1   -2.556830678726D-02    7.040128215489D-03   -9.992314993605D-04
       2    1.632735440252D-02   -3.401365727621D-03    3.765651076870D-04
       3   -3.131290915260D-03    5.532459754610D-04   -4.812308414974D-05
       4   -3.168083167077D-04    7.594919813871D-05   -9.295628844487D-06
       5    1.297679885878D-04   -2.681169439239D-05    2.486736935154D-06
       6    2.967532719536D-06   -1.552348470032D-07    9.914557379237D-08
       7   -3.107547721696D-06    5.261339241776D-07   -6.078003254539D-08
       8    2.129711932150D-07   -3.682886859964D-08    3.943673329206D-09

       E-Index:     6                   7                   8
  T-Index:
       0   -1.003471065764D-04    4.052095946656D-06   -6.254934022483D-08
       1    7.419247879214D-05   -2.738645028702D-06    3.973261293345D-08
       2   -2.252802392381D-05    6.849333710573D-07   -8.279262117799D-09
       3    1.952561489849D-06   -2.606240633525D-08   -1.668491146428D-10
       4    6.041299678217D-07   -1.989967163130D-08    2.616873567872D-10
       5   -9.162513063487D-08    2.197291562634D-10    3.883962188438D-11
       6   -1.959030711680D-08    1.270158481004D-09   -2.671947435341D-11
       7    4.857708161457D-09   -2.162490178679D-10    3.822243417577D-12
```

```
       8   -2.753763204013D-10    1.095025653423D-11   -1.798235585379D-13

  Max. rel. Error:   3.8778 %
  Mean rel. Error:    .7384 %


\end{verbatim}\end{small}
\begin{figure} \label{2.1.8rc}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hpn4fu.ps}
\end{figure}
\newpage



\subsection{
Reaction 2.1.8d  $H^+ + e \rightarrow H(1s) + ...$,  Ratio $H(5)/H^+$
}

\begin{small}\begin{verbatim}


       E-Index:     0                   1                   2
  T-Index:
       0   -2.896620907578D+01    8.263162726911D-01    2.453412310701D-01
       1   -1.020472386996D+00    6.774681712067D-02   -9.359887389995D-02
       2   -3.909076727301D-02    9.233229043428D-03   -6.811898776723D-03
       3   -8.108346091837D-03   -1.114009915066D-02    7.784902980212D-03
       4    1.019109955231D-03    2.143186124447D-03   -7.445628503896D-04
       5   -3.832012105835D-04    7.665209835422D-04   -6.615105657343D-04
       6    2.074862770456D-04   -4.323660314654D-04    3.084220743425D-04
       7   -3.467034971602D-05    7.046871983203D-05   -5.074193286238D-05
       8    1.826483263765D-06   -3.843166437506D-06    2.864841439776D-06

       E-Index:     3                   4                   5
  T-Index:
       0   -1.095918159657D-01    2.352340764192D-02   -2.606799746665D-03
       1    3.777179622766D-02   -7.435824927042D-03    7.370730125395D-04
       2    5.541316826680D-03   -1.652672599440D-03    2.451627952732D-04
       3   -3.103060845765D-03    6.334549501483D-04   -7.027215944854D-05
       4   -4.194692950067D-06    5.637881977255D-05   -1.207354069047D-05
       5    2.344290799663D-04   -4.452581583360D-05    4.741482394533D-06
       6   -8.589872787033D-05    1.127548136764D-05   -6.664466414066D-07
       7    1.398275288859D-05   -1.748270612401D-06    8.910652633496D-08
       8   -8.177688767346D-07    1.076944846317D-07   -6.310685093478D-09

       E-Index:     6                   7                   8
  T-Index:
       0    1.550006217168D-04   -4.720230271207D-06    5.795820807765D-08
       1   -3.773216809044D-05    9.378701533392D-07   -8.638031636714D-09
       2   -1.885289195306D-05    7.183528697382D-07   -1.073414499710D-08
       3    4.215222394060D-06   -1.276305499861D-07    1.520731912855D-09
       4    1.096969913038D-06   -4.657703480617D-08    7.564520027104D-10
       5   -2.779296405890D-07    8.321497480007D-09   -9.899754662843D-11
       6    6.572553261299D-09    8.982707823537D-10   -2.633081356088D-11
       7    6.037786936012D-10   -2.111950717307D-10    5.235642212608D-12
       8    6.366831945852D-11    8.080764312523D-12   -2.351015375046D-13

  Max. rel. Error:   5.3024 %
  Mean rel. Error:    .9480 %
```

```
\end{verbatim}\end{small}
\begin{figure} \label{2.1.8rd}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hpn5fu.ps}
\end{figure}
\newpage



\subsection{
Reaction 2.1.8e  $H^+ + e \rightarrow H(1s) + ...$,  Ratio $H(6)/H^+$
}

\begin{small}\begin{verbatim}

       E-Index:     0                    1                    2
  T-Index:
       0   -2.853134339900D+01    1.025762058140D+00    4.820359378086D-02
       1   -1.057384296999D+00   -1.367338116022D-02   -3.351784927664D-02
       2   -4.357129898325D-02   -7.394478242994D-03    2.206668060201D-02
       3   -1.022068439636D-02    8.205900215515D-03   -9.593969669623D-03
       4    2.240869860862D-03   -2.398078272359D-03    2.119411722051D-03
       5   -2.845620700011D-04    1.159424639874D-04   -6.688436690039D-05
       6    1.056461895367D-04    6.774788436258D-05   -6.199652445552D-05
       7   -1.924352018053D-05   -1.263343934006D-05    1.111364886603D-05
       8    1.083397517395D-06    6.663341827792D-07   -5.889621084106D-07

       E-Index:     3                    4                    5
  T-Index:
       0   -3.882358720615D-02    1.237087286269D-02   -1.764105210919D-03
       1    2.391618457883D-02   -7.152556397423D-03    9.907047976258D-04
       2   -1.040668635206D-02    2.383766498799D-03   -2.822620365202D-04
       3    3.186917464795D-03   -4.976528642770D-04    3.877389269379D-05
       4   -5.566686572310D-04    5.664600566222D-05   -5.658026509008D-07
       5    2.276886525280D-06    2.992207488831D-06   -6.105459843829D-07
       6    1.913273349345D-05   -2.523727510933D-06    1.167652225992D-07
       7   -3.255526057721D-06    4.051238507748D-07   -1.532222680198D-08
       8    1.737855470748D-07   -2.223530055553D-08    9.525747219138D-10

       E-Index:     6                    7                    8
  T-Index:
       0    1.262454385864D-04   -4.469205240312D-06    6.250167666694D-08
       1   -6.978776837879D-05    2.446946729997D-06   -3.400752053390D-08
       2    1.791903200774D-05   -5.823791297469D-07    7.631403828079D-09
       3   -1.446134439476D-06    1.918944143993D-08    6.658988931422D-11
       4   -2.818155986041D-07    1.813752401935D-08   -3.433445792332D-10
       5    5.203793299428D-08   -2.092865649431D-09    3.247676557005D-11
       6    2.465131736062D-09   -3.635425072620D-10    8.132197656808D-12
       7   -8.118597627154D-10    7.842131310409D-11   -1.656179057643D-12
       8    3.184540505918D-11   -3.747826185419D-12    8.214908508402D-14

  Max. rel. Error:   2.9379 %
  Mean rel. Error:    .6634 %


\end{verbatim}\end{small}
\begin{figure} \label{2.1.8re}
\epsfxsize=16truecm
```

```
\epsffile{Amjuel_PS/hpn6fu.ps}
\end{figure}
\newpage


\subsection{
Reaction 2.1.8t  $H^+ + e \rightarrow H(1s) + ...$, Ratio $H(tot)/H^+$
}

\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
 T-Index:
        0   -2.235624329253D+01    9.763145521833D-01    1.918330680061D-02
        1   -1.439934055420D+00   -2.519401923047D-02    3.585508737762D-03
        2    1.060215606120D-03   -1.118872464044D-03    1.720136583820D-03
        3    2.244412354881D-03   -6.704475990451D-04   -6.699472886502D-04
        4    5.982736693346D-05    1.208170153071D-06    1.246488800870D-04
        5   -8.466861405156D-05    3.561208397089D-05   -1.494745309621D-05
        6    1.175099184836D-05   -4.822515840160D-06    7.839022932286D-07
        7   -7.023031296681D-07    2.948938110645D-07   -5.225388371277D-08
        8    1.609249642095D-08   -8.845142466159D-09    3.899049823853D-09

        E-Index:     3                    4                    5
 T-Index:
        0   -4.691259242713D-03    6.288351029702D-04   -5.107818695069D-05
        1   -3.606855133841D-04    2.098139498792D-05    4.491184999788D-07
        2   -5.631447161500D-04    1.107941690049D-04   -1.324767192387D-05
        3    3.084892726230D-04   -6.392879662268D-05    7.279340567526D-06
        4   -4.311535218313D-05    7.637892784584D-06   -7.417970337062D-07
        5    6.008386349890D-07    3.291652198945D-07   -7.214543918759D-08
        6    3.310641902198D-07   -9.636153557710D-08    1.224666378778D-08
        7   -4.418889088947D-09   -5.755172852233D-10    2.933776480728D-10
        8   -1.417759796908D-09    4.224902609944D-10   -6.257737712706D-11

        E-Index:     6                    7                    8
 T-Index:
        0    2.511251181976D-06   -6.877740736899D-08    8.022672312302D-10
        1   -1.748905208728D-07    1.096079038665D-08   -2.309525766240D-10
        2    9.284121363830D-07   -3.520965065456D-08    5.652221180618D-10
        3   -4.730061277373D-07    1.650428248605D-08   -2.440356698087D-10
        4    4.087003980074D-08   -1.104737352197D-09    9.985107172732D-12
        5    6.581760780626D-09   -3.342177330708D-10    7.477370951765D-12
        6   -9.009824883694D-10    4.485057352449D-11   -1.092334989093D-12
        7   -2.513282999634D-11    7.402108547860D-14    3.356083702441D-14
        8    4.562227755580D-12   -1.394585520243D-13    9.622937037320D-16

 Max. rel. Error:   3.0878 %
 Mean rel. Error:   0.2211 %

\end{verbatim}\end{small}
\begin{figure} \label{2.1.8rt}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hydrc.ps}
\end{figure}
\newpage



\subsection{
  Reaction 2.1.8de $p + electron(s) \rightarrow H(1s) + ...   <de>+13.6 \ [eV] $
```

```
}

  electron energy loss (radiative) due to one effective recombination.
  13.6 eV (ionisation potential) has to be
  subtracted, which may render the total electron loss negative, i.e., make it a gain.

\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
  T-Index:
        0    2.663320096798D+00   -1.320386526088D-03    1.077306300916D-03
        1    4.637834318618D-02   -1.588463528038D-03    2.002995590656D-03
        2    2.179688109388D-02    1.227809616939D-03   -1.372294046856D-03
        3    8.786631426209D-03   -8.960302716704D-05    1.595966734727D-04
        4    6.391144224017D-04    2.610866249230D-05   -3.057989576708D-05
        5   -4.028137479647D-04   -2.206121470336D-05    1.483985932596D-05
        6    4.407284278429D-05    4.822704225043D-06   -2.708391040884D-06
        7   -1.800630823030D-06   -4.268416439260D-07    2.054565282375D-07
        8    1.754888057605D-08    1.379566556295D-08   -5.693253510115D-09

        E-Index:     3                    4                    5
  T-Index:
        0   -5.652833135835D-04    1.291803029485D-04   -1.699440271234D-05
        1   -8.658936631663D-04    1.964776542360D-04   -2.511974119325D-05
        2    6.323096825415D-04   -1.469986402797D-04    1.904694837642D-05
        3   -8.033905958159D-05    1.847264603217D-05   -2.183101421945D-06
        4    8.826444477631D-06   -8.527003617234D-07   -4.498496855396D-08
        5   -3.285199837204D-06    2.353573666059D-07    8.214927216612D-09
        6    4.944231739776D-07   -1.901239754277D-08   -2.018685643310D-09
        7   -2.517818591922D-08   -2.272219519599D-09    5.459755052746D-10
        8    2.382569427426D-10    2.097919770643D-10   -3.284308598067D-11

        E-Index:     6                    7                    8
  T-Index:
        0    1.256679592455D-06   -4.984258926618D-08    8.057248636970D-10
        1    1.824600710728D-06   -6.979835386906D-08    1.089009846784D-09
        2   -1.386974537374D-06    5.315788264477D-08   -8.319075356138D-10
        3    1.356888246299D-07   -4.132215086182D-09    4.756405284626D-11
        4    1.409300591671D-08   -9.388481841524D-10    2.040334695881D-11
        5   -1.910545503689D-09    8.669945377667D-11   -1.226004969587D-12
        6    9.160202016183D-11    7.808665752604D-12   -3.711189374604D-13
        7   -2.036170999640D-11   -8.641575595254D-13    4.579180281382D-14
        8    1.467413391747D-12    1.092457646878D-14   -1.442948963740D-15

  Max. rel. Error:    .3337 %
  Mean rel. Error:    .1540 %

\end{verbatim}\end{small}
\begin{figure} \label{2.1.8lr2}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hydlr2_tr.ps}
\end{figure}
\newpage



\subsection{
  Reaction 2.1.8o $p + electron(s) \rightarrow H(1s) + ... <de>+13.6 \ [eV] $
  Ly-opaque
}
```

electron energy loss (radiative) due to one effective recombination.
13.6 eV (ionisation potential) has to be
subtracted, which may render the total electron loss negative, i.e., make it a gain.

\begin{small}\begin{verbatim}

E-Index:	0	1	2
T-Index:			
0	3.332760890904D+00	2.276467542533D-02	-3.375104085272D-02
1	2.095607992432D+00	2.149640996135D-01	-2.163109435324D-01
2	-7.718235594111D-03	5.342318925152D-02	-3.826264614382D-02
3	-2.796028848568D-01	-5.076194843679D-02	4.211090303923D-02
4	4.114054656028D-02	1.167368824693D-03	-2.634010977122D-03
5	1.379031566337D-02	4.766103150116D-03	-3.140405264654D-03
6	-4.442827387044D-03	-1.168245938217D-03	8.103728635753D-04
7	4.466408723499D-04	1.067947114632D-04	-7.426869611152D-05
8	-1.550852684757D-05	-3.448224819513D-06	2.365214591310D-06

E-Index:	3	4	5
T-Index:			
0	1.533294583406D-02	-2.993999791570D-03	2.625217527284D-04
1	8.513801946679D-02	-1.708115211759D-02	1.908032465874D-03
2	9.848556553690D-03	-1.198540836499D-03	7.289210776603D-05
3	-1.343364231895D-02	2.197734625605D-03	-2.020807399429D-04
4	1.540828008778D-03	-3.888233553638D-04	5.009886243915D-05
5	6.669070177773D-04	-4.301617499659D-05	-3.131696299090D-06
6	-1.953437642437D-04	1.957310765780D-05	-4.682020227901D-07
7	1.819420479360D-05	-1.913117253436D-06	6.213331827001D-08
8	-5.704392451980D-07	5.826373961407D-08	-1.634950425947D-09

E-Index:	6	7	8
T-Index:			
0	-7.802660138687D-06	-1.578343346285D-07	8.885318650802D-09
1	-1.191827223971D-04	3.886108418638D-06	-5.149798003444D-08
2	-1.886829891317D-06	-4.065327740691D-09	7.815045054601D-10
3	1.049475835680D-05	-2.854931151940D-07	3.138820449657D-09
4	-3.454361952343D-06	1.217245343098D-07	-1.725312803637D-09
5	5.905901174405D-07	-3.001019530996D-08	5.223614921536D-10
6	-5.627862273723D-08	4.147493653191D-09	-8.140380486253D-11
7	3.646425627446D-09	-3.215059278414D-10	6.559359042393D-12
8	-1.392555515521D-10	1.101965822929D-11	-2.192243607759D-13

Max. rel. Error: 17.4151 %
Mean rel. Error: 7.1827 %

\end{verbatim}\end{small}
\begin{figure} \label{2.1.8lr2o}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hydlr2_op.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.2a $e + He \rightarrow He^* + ... $ Ratio He(6)/He(1)
}

3^1S state
reduced population coefficients, formulation II,

Coupling to groundstate.

For 728 nm line: $\rightarrow 2^1P$, A(6,4)=1.810629e7, dE=1.7023 eV

\begin{small}\begin{verbatim}

E-Index:	0	1	2
T-Index:			
0	-4.311315252344D+01	1.068788324945D+00	4.607816591604D-01
1	2.227727400968D+01	2.533246784559D-02	-4.171642913247D-01
2	-1.092526995496D+01	-3.147570844629D-02	1.875310957896D-01
3	3.455212456083D+00	-1.389486107084D-02	-4.063899942293D-02
4	-7.374015718678D-01	2.242933213868D-02	-2.420756303296D-03
5	1.038623596715D-01	-8.572063066145D-03	3.324173037175D-03
6	-9.192956530427D-03	1.455904553910D-03	-6.673595425546D-04
7	4.616742167799D-04	-1.160328883781D-04	5.534829062629D-05
8	-1.001260661416D-05	3.542757576830D-06	-1.685458944344D-06

E-Index:	3	4	5
T-Index:			
0	-2.288516993884D-01	4.934442752394D-02	-5.604584821093D-03
1	1.615799989993D-01	-2.658923546753D-02	2.208439837134D-03
2	-6.250400889583D-02	7.917685175679D-03	-4.072650465024D-04
3	1.516486061778D-02	-1.624326286753D-03	3.323367272941D-05
4	-1.576970797070D-03	2.296103941475D-04	-2.793441980969D-06
5	-2.351628215299D-04	-3.805995868992D-06	-3.856178638492D-07
6	7.622121272510D-05	-2.414972618793D-06	3.145956146766D-08
7	-6.623209681071D-06	1.396329196910D-07	1.644463329342D-08
8	1.880631768107D-07	2.036496093646D-09	-1.449219917820D-09

E-Index:	6	7	8
T-Index:			
0	3.438226618132D-04	-1.077128821245D-05	1.352276198706D-07
1	-9.431672141577D-05	1.862180588113D-06	-1.132114188246D-08
2	4.546258048294D-06	2.365213157088D-07	-4.976268161753D-09
3	2.722186667141D-06	-9.017760018097D-08	-4.904178184171D-10
4	-4.152461824776D-07	-6.241223808031D-09	8.068574923944D-10
5	6.209519268505D-08	1.441911748739D-09	-1.316978098635D-10
6	-3.356847387494D-09	-3.697594587912D-11	7.240088197508D-12
7	-9.792067155585D-10	2.164943531687D-11	-2.800778214544D-13
8	8.944524915556D-11	-2.169200058693D-12	1.817590942107D-14

Max. rel. Error: 4.7466 %
Mean rel. Error: 1.8012 %

\end{verbatim}\end{small}
\begin{figure} \label{2.2a}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/he2.2a.ps}
\end{figure}
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\subsection{
Reaction 2.2b $e + He \rightarrow He^* + ... $ Ratio He(7)/He(1)
}

3^3S state,

reduced population coefficients, formulation II,
Coupling to groundstate.

For 706 nm line: $\rightarrow 2^3P$, A(7,5)=2.76441e7, dE =1.75437 eV

\begin{small}\begin{verbatim}

E-Index:	0	1	2
T-Index:			
0	-4.007960997971D+01	9.034446644096D-01	1.165111771540D-01
1	2.144863586125D+01	1.947485468069D-01	-1.301067140494D-01
2	-1.062424949389D+01	-2.036865355513D-01	1.502619709740D-01
3	3.274440069862D+00	6.002917850635D-02	-4.500559725551D-02
4	-6.910270587692D-01	-5.778030255527D-03	6.133919377226D-03
5	9.696455049644D-02	-3.615838261304D-04	-5.591761507584D-04
6	-8.558419026409D-03	1.372863071237D-04	3.079519906206D-05
7	4.299591264600D-04	-1.352177886718D-05	1.363347413015D-06
8	-9.396794815079D-06	5.081568411364D-07	-1.918622684719D-07

E-Index:	3	4	5
T-Index:			
0	-2.597504506357D-02	1.439511190742D-04	5.735113536484D-04
1	-1.134174339750D-03	8.934529257747D-03	-1.672264590109D-03
2	-2.435598894352D-02	2.959994394968D-04	2.087336754163D-04
3	5.473014417323D-03	9.912931702266D-05	-3.121815866488D-05
4	-1.569913055752D-04	-1.068830646003D-04	5.591339866244D-06
5	3.468442843104D-05	-7.773486473364D-06	2.269135973852D-06
6	-1.109174473451D-05	3.766577588319D-06	-4.517137662136D-07
7	1.823956910222D-07	-1.482530106434D-07	6.084462068041D-09
8	4.597529153937D-08	-7.085546973595D-09	1.411547564036D-09

E-Index:	6	7	8
T-Index:			
0	-7.136082319245D-05	3.362863636423D-06	-5.629721496083D-08
1	1.290346463406D-04	-4.579314176342D-06	6.164974848265D-08
2	-1.619346650396D-05	3.859684910385D-07	-1.226364851070D-09
3	-4.970042343218D-07	1.575739269032D-07	-4.434371121129D-09
4	4.546393179958D-07	-4.580471294432D-08	1.080771415075D-09
5	-1.879528911353D-07	6.906966394218D-09	-1.112570278287D-10
6	1.591625909374D-08	3.622976767180D-11	-6.002477025919D-12
7	1.509097136492D-09	-1.196127739728D-10	2.320887234439D-12
8	-1.631586971717D-10	7.893728865910D-12	-1.311109499334D-13

Max. rel. Error: 5.3070 %
Mean rel. Error: 1.9605 %

\end{verbatim}\end{small}
\begin{figure} \label{2.2b}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/he2.2b.ps}
\end{figure}
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\subsection{
Reaction 2.2c $e + He \rightarrow He^* + ... $ Ratio He(8)/He(1)
}

3^1P state,
reduced population coefficients, formulation II,
Coupling to groundstate.

For 501 nm line: $\rightarrow 2^1S$, A(8,2)=1.35143E7, dE = 2.47126 eV

\begin{small}\begin{verbatim}

E-Index:	0	1	2
T-Index:			
0	-4.653397136053D+01	1.061565404274D+00	1.538213466570D-01
1	2.341040126523D+01	-2.338924405778D-01	-1.620037152343D-01
2	-1.139498311209D+01	3.614149800761D-01	1.852266870603D-02
3	3.614773239756D+00	-2.470591133234D-01	1.639517537700D-02
4	-7.802147409864D-01	9.652798837959D-02	-1.139696161330D-02
5	1.129731936040D-01	-2.211800736270D-02	3.415302206693D-03
6	-1.046003037564D-02	2.894859026350D-03	-5.216830627677D-04
7	5.566146923182D-04	-1.990551598260D-04	3.914361279505D-05
8	-1.287797826551D-05	5.559558313857D-06	-1.141508901494D-06

E-Index:	3	4	5
T-Index:			
0	-4.960776358631D-02	3.721007453372D-03	4.129592286060D-04
1	7.079138649586D-02	-1.107648995898D-02	7.955218807596D-04
2	-2.002227448100D-02	2.516435028232D-03	-8.077169032818D-05
3	4.996213760875D-03	-6.235419082909D-04	5.622895177211D-06
4	-8.188564258666D-04	1.489938947126D-04	-1.639651945413D-06
5	5.788680997946D-06	-1.848630429871D-05	-2.817393417179D-07
6	1.476821784698D-05	1.555280785423D-06	2.630583281095D-08
7	-1.461225058243D-06	-1.566386546423D-07	1.078484737480D-08
8	3.755714180141D-08	8.635247245624D-09	-9.744421400623D-10

E-Index:	6	7	8
T-Index:			
0	-7.595441650236D-05	3.938916077091D-06	-6.904203416831D-08
1	-2.492979564442D-05	1.479965187751D-07	5.129381943121D-09
2	-3.279337614319D-06	2.317424648906D-07	-3.212001663062D-09
3	1.149833159917D-06	-1.744164295894D-09	-1.271403337443D-09
4	-1.099736125961D-07	-1.622513539030D-08	7.323542946653D-10
5	6.181107684745D-08	1.189086401587D-09	-1.030873863310D-10
6	-8.335949262711D-09	5.417107113342D-11	6.544932959532D-12
7	-2.073967263488D-10	1.158671282787D-11	-4.346356593657D-13
8	4.965186141757D-11	-1.582356159149D-12	2.463828951285D-14

Max. rel. Error: 4.4334 %
Mean rel. Error: 1.0452 %

\end{verbatim}\end{small}
\begin{figure} \label{2.2c}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/he2.2c.ps}
\end{figure}
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\subsection{
Reaction 2.2d $e + He \rightarrow He^* + ... $ Ratio He(10)/He(1)

```
}

  $3^1D$ state,
  reduced population coefficients, formulation II,
  Coupling to groundstate.

  For 667 nm line: $\rightarrow 2^1P$, A(10,4)=6.27547e7, dE = 1.8561 eV

\begin{small}\begin{verbatim}


        E-Index:     0                    1                    2
  T-Index:
        0   -4.387462178720D+01    1.297729348975D+00    2.171426368859D-01
        1    2.231897245990D+01   -7.254021696102D-02   -2.818676964157D-01
        2   -1.103840904811D+01    8.933431516828D-03    1.084333935229D-01
        3    3.439678364969D+00    8.110861039861D-03   -1.419780536561D-02
        4   -7.194379330234D-01   -7.617376918719D-03   -7.804052035737D-04
        5    9.977541313333D-02    2.492457513616D-03    4.151471795535D-04
        6   -8.744899237837D-03   -3.818311009548D-04   -5.656979814142D-05
        7    4.364458313084D-04    2.772577703683D-05    4.646402252581D-06
        8   -9.420938125153D-06   -7.681794402039D-07   -1.810036079763D-07

        E-Index:     3                    4                    5
  T-Index:
        0   -1.227267686184D-01    2.684569500768D-02   -3.084104019669D-03
        1    1.283426585873D-01   -2.558157078407D-02    2.736593361910D-03
        2   -4.640225933795D-02    8.670127027232D-03   -8.320926095332D-04
        3    6.159942757994D-03   -1.210673774922D-03    1.034347467373D-04
        4    2.605016526459D-04    3.287984864674D-05   -4.952370009630D-06
        5   -1.787934297272D-04    7.093030346467D-06    1.042617033617D-06
        6    2.864168088776D-05   -1.737189312029D-06   -1.314488727944D-07
        7   -2.630470520737D-06    2.699291231064D-07   -6.034998122757D-09
        8    1.046366140500D-07   -1.472124741829D-08    9.766999701447D-10

        E-Index:     6                    7                    8
  T-Index:
        0    1.927330419368D-04   -6.192457335223D-06    8.013020564099D-08
        1   -1.625900542113D-04    5.035250553353D-06   -6.326313962119D-08
        2    4.258487531484D-05   -1.078934966891D-06    1.012644792468D-08
        3   -3.461954139324D-06   -8.569915050105D-09    2.035476745628D-09
        4   -6.887941807259D-08    2.782454606073D-08   -8.823571239501D-10
        5   -7.282533905038D-08   -7.826443302463D-10    9.734519877427D-11
        6    1.515466306533D-08   -2.609983592228D-10   -5.766562927060D-12
        7   -2.777752615430D-10   -1.005417881311D-12    5.711155616810D-13
        8   -4.089947705610D-11    1.537624472911D-12   -3.487131096914D-14

  Max. rel. Error:   4.2913 %
  Mean rel. Error:   1.0561 %


\end{verbatim}\end{small}
\begin{figure} \label{2.2d}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/he2.2d.ps}
\end{figure}
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\subsection{
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```
  Reaction 2.2e $e + He \rightarrow He^* + ... $ Ratio He(16)/He(1)
}

  $4^1D$ state,
  reduced population coefficients, formulation II,
  Coupling to groundstate.

  For 492 nm line: $\rightarrow 2^1P$, A(16,4)=1.95062E7, dE = 2.5183 eV

\begin{small}\begin{verbatim}

        E-Index:     0                    1                    2
  T-Index:
        0   -4.471883009004D+01    1.379902734939D+00   -1.588304426869D-02
        1    2.301803742916D+01   -4.112391837175D-01    4.020010647943D-02
        2   -1.142290678089D+01    2.325073124471D-01   -2.363867774084D-02
        3    3.584520289665D+00   -9.292301814148D-02    1.399795303239D-02
        4   -7.588759927163D-01    2.769660867165D-02   -5.996411152428D-03
        5    1.071981413506D-01   -5.846876265058D-03    1.730779175387D-03
        6   -9.623807639587D-03    7.555908490695D-04   -2.665737696024D-04
        7    4.938446976776D-04   -5.141246970493D-05    1.928578993317D-05
        8   -1.097930969158D-05    1.395884806885D-06   -5.127774120276D-07

        E-Index:     3                    4                    5
  T-Index:
        0    1.102005327143D-03   -2.776453047428D-03    5.951669267394D-04
        1   -7.083881196314D-03    3.184653460498D-03   -5.939046552980D-04
        2    2.183867697930D-04   -5.291800815389D-04    1.705675041358D-04
        3    1.229903491947D-04   -5.697630240547D-05   -2.236164784844D-05
        4    4.993998679121D-05    7.400566057679D-05   -3.844211220285D-06
        5   -1.193787781320D-04   -6.321252008286D-06    5.997152437237D-07
        6    2.840484021461D-05   -8.190964593875D-07    3.074212731682D-08
        7   -2.172661190110D-06    5.852557117498D-08    9.693636966803D-10
        8    4.622655761109D-08    2.165754381744D-09   -5.193903473398D-10

        E-Index:     6                    7                    8
  T-Index:
        0   -5.438344417754D-05    2.323368482605D-06   -3.790056253508D-08
        1    4.958874975704D-05   -1.935263751082D-06    2.888456240999D-08
        2   -1.624226089828D-05    6.305375766051D-07   -8.706585722074D-09
        3    2.531455667103D-06   -7.702409620971D-08    4.463396284857D-10
        4    5.210309715124D-08   -6.836232292167D-09    2.958879358471D-10
        5   -1.506763120215D-08    1.252708957129D-09   -4.685561440635D-11
        6   -3.582721370055D-09    8.034963393881D-11    9.950344146148D-13
        7    7.970509295800D-12   -1.219308703370D-12   -3.005051437224D-14
        8    3.149843951988D-11   -9.361514367135D-13    1.191949633363D-14

  Max. rel. Error:   3.6319 %
  Mean rel. Error:   1.2457 %



\end{verbatim}\end{small}
\begin{figure} \label{2.2e}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/he2.2e.ps}
\end{figure}
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\subsection{
  Reaction 2.3.2a $e + He^+ \rightarrow He^* + ... $ Ratio He(6)/He$^+$
}

  $3^1S$ state
  reduced population coefficients, formulation II,
  Coupling to He$^+$.

  For 728 nm line:  $\rightarrow 2^1P$, A(6,4)=1.810629e7, dE=1.7023 eV

\begin{small}\begin{verbatim}


        E-Index:     0                    1                    2
  T-Index:
        0   -3.216150314541D+01    1.017126728848D+00    2.503192212525D-01
        1    2.472997234218D+00   -6.604244815764D-01    4.447853197254D-01
        2   -7.273641530992D+00    6.512267559345D-01   -3.697133484751D-01
        3    6.312899128558D+00   -3.221127513661D-01    1.407336611903D-01
        4   -2.475271968793D+00    9.628490082958D-02   -3.860831119148D-02
        5    5.141511842314D-01   -1.679217364205D-02    6.622911077550D-03
        6   -5.911906094824D-02    1.521368851222D-03   -4.758101424176D-04
        7    3.565096703678D-03   -5.540747253127D-05   -4.988643158537D-06
        8   -8.814835329708D-05    1.000054107875D-07    1.442316009145D-06

        E-Index:     3                    4                    5
  T-Index:
        0   -1.573779795630D-01    4.193259536500D-02   -5.714327145825D-03
        1   -1.373512721569D-01    2.642773580772D-02   -3.333243832771D-03
        2    8.180617352023D-02   -1.194178092608D-02    1.504343740838D-03
        3   -1.575910145395D-02   -4.261270008957D-04    1.160434934873D-04
        4    4.321891266732D-03    1.535428208875D-04   -5.462458572233D-05
        5   -1.141504489899D-03    1.088062290891D-04   -6.933905317108D-06
        6    9.243986342244D-05   -1.491809640805D-05    1.546659340673D-06
        7    4.349712967453D-06   -5.545082995129D-07    3.861187877207D-08
        8   -5.722874156419D-07    9.632513971858D-08   -9.509739163118D-09

        E-Index:     6                    7                    8
  T-Index:
        0    4.136519317417D-04   -1.509799360230D-05    2.184621419674D-07
        1    2.515045346534D-04   -1.007775905926D-05    1.635743918463D-07
        2   -1.333316361152D-04    6.445989555292D-06   -1.234698479875D-07
        3    2.714541315649D-06   -8.940705316636D-07    2.952675110887D-08
        4    2.756655915997D-06    6.165051309359D-08   -5.082966020137D-09
        5    3.178875894924D-07   -2.390667896507D-08    8.828419978172D-10
        6   -7.331886684615D-08    2.614867580638D-09   -7.330106832639D-11
        7   -4.023931989434D-09    1.812490590825D-10   -1.428342946112D-12
        8    6.381564120008D-10   -2.352182090998D-11    3.197916618777D-13

  Max. rel. Error:  23.9646 %
  Mean rel. Error:   6.2722 %


\end{verbatim}\end{small}
\begin{figure} \label{2.3.2a}
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\epsffile{Amjuel_PS/he2.3.2a.ps}
\end{figure}
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```
\subsection{
  Reaction 2.3.2b $e + He^+ \rightarrow He^* + ... $ Ratio He(7)/He$^+$
}

  $3^3S$ state,
  reduced population coefficients, formulation II,
  Coupling to He$^+$.

  For 706 nm line: $\rightarrow 2^3P$, A(7,5)=2.76441e7, dE =1.75437 eV

\begin{small}\begin{verbatim}


        E-Index:     0                    1                    2
  T-Index:
        0   -3.021804030158D+01    1.130848334651D+00   -1.073740464502D-01
        1    3.523368969674D+00   -5.478378025513D-01    6.458417120865D-01
        2   -8.974598355857D+00    3.778216418622D-01   -5.081928217917D-01
        3    7.635897546212D+00   -9.147403628179D-02    1.662078021034D-01
        4   -3.000303742731D+00   -9.002194876928D-03   -1.863105119205D-02
        5    6.285699508085D-01    9.416908796340D-03   -3.038866915586D-03
        6   -7.304205616620D-02   -1.989766581715D-03    1.144474905838D-03
        7    4.453488758391D-03    1.821308292697D-04   -1.240908829743D-04
        8   -1.113155471497D-04   -6.266781207601D-06    4.673905317880D-06

        E-Index:     3                    4                    5
  T-Index:
        0    4.970170535549D-02   -1.165239967844D-02    1.510313083106D-03
        1   -2.735061111112D-01    5.462012224337D-02   -5.869531956065D-03
        2    2.064807405621D-01   -3.532912576039D-02    3.081608767454D-03
        3   -7.412844397846D-02    1.064378821100D-02   -5.813109620435D-04
        4    1.464638881441D-02   -1.982598876641D-03    5.279445200867D-05
        5   -1.322561156054D-03    2.390586823075D-04   -8.306640146040D-06
        6   -3.560089264490D-05   -1.201538636649D-05    1.411823544331D-06
        7    1.602474940002D-05   -6.171115568805D-07   -8.146917989801D-08
        8   -8.353650874253D-07    6.599657419719D-08    2.416556483484D-10

        E-Index:     6                    7                    8
  T-Index:
        0   -1.081306838597D-04    3.980420063002D-06   -5.865611960494D-08
        1    3.455835282567D-04   -1.051504918041D-05    1.297001161406D-07
        2   -1.414786677129D-04    3.275747814089D-06   -3.119868249308D-08
        3    1.147245647095D-06    8.409794703428D-07   -1.823740755654D-08
        4    6.867272943685D-06   -4.730788976909D-07    8.026049328029D-09
        5   -7.306589669632D-07    5.266691013685D-08   -8.117214675526D-10
        6   -6.030271577709D-08    1.815641913753D-09   -4.671055888097D-11
        7    1.133396885188D-08   -5.820505536000D-10    1.163064737956D-11
        8   -3.847614776613D-10    2.391347375446D-11   -4.850942377843D-13

  Max. rel. Error:  23.6466 %
  Mean rel. Error:   6.3388 %


\end{verbatim}\end{small}
\begin{figure} \label{2.3.2b}
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\epsffile{Amjuel_PS/he2.3.2b.ps}
\end{figure}
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\subsection{
  Reaction 2.3.2c $e + He^+ \rightarrow He^* + ... $ Ratio He(8)/He$^+$
}

  $3^1P$ state,
  reduced population coefficients, formulation II,
  Coupling to He$^+$.

  For 501 nm line: $\rightarrow 2^1S$, A(8,2)=1.35143E7 dE = 2.47126 eV

\begin{small}\begin{verbatim}

        E-Index:     0                    1                    2
  T-Index:
        0   -3.445572948968D+01    1.137519254060D+00   -1.204158609891D-01
        1    2.775136339237D+00   -4.487673567858D-01    4.037515904078D-01
        2   -9.482806590562D+00    5.618314205781D-01   -3.914168608519D-01
        3    8.753415720243D+00   -3.569019076961D-01    1.753910146247D-01
        4   -3.577960912550D+00    1.343719586718D-01   -5.423186626416D-02
        5    7.706325166736D-01   -2.952144452037D-02    1.111018961085D-02
        6   -9.158735526626D-02    3.628637458935D-03   -1.291959720425D-03
        7    5.693572104634D-03   -2.288531778507D-04    7.302736513118D-05
        8   -1.447822452674D-04    5.723900429738D-06   -1.455648868887D-06

        E-Index:     3                    4                    5
  T-Index:
        0    5.518321955152D-02   -1.275404675701D-02    1.567946643590D-03
        1   -1.505032740194D-01    3.105545096940D-02   -3.891527004898D-03
        2    1.175987658408D-01   -2.021206967023D-02    2.440969566947D-03
        3   -3.667084372893D-02    2.854422446911D-03   -1.660305334064D-04
        4    9.559862125182D-03   -9.162545378146D-05   -8.032611295151D-05
        5   -2.147001210922D-03    7.977007897719D-05    8.625984135551D-06
        6    2.735972256964D-04   -1.938645862420D-05    6.853343303742D-07
        7   -1.532878284339D-05    1.233959442253D-06   -9.081746795921D-08
        8    2.445107599088D-07   -1.001706708366D-08    1.073020722799D-09

        E-Index:     6                    7                    8
  T-Index:
        0   -1.004500270631D-04    3.178038428972D-06   -3.936121532969D-08
        1    2.854040739913D-04   -1.113667661675D-05    1.772401326973D-07
        2   -1.919209138406D-04    8.352922848971D-06   -1.483995437185D-07
        3    1.763502677889D-05   -1.312005258433D-06    3.373289875724D-08
        4    5.629040165925D-06   -5.258717216470D-08   -3.151242886886D-09
        5   -7.699661573237D-07    7.542813546822D-09    5.034382828487D-10
        6   -3.749930108264D-08    3.406483389911D-09   -1.104413275874D-10
        7    7.612336214085D-09   -4.287524304739D-10    9.944501803630D-12
        8   -1.818784682827D-10    1.208359092107D-11   -2.808344024957D-13

  Max. rel. Error:  25.0250 %
  Mean rel. Error:   6.9230 %


\end{verbatim}\end{small}
\begin{figure} \label{2.3.2c}
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\epsffile{Amjuel_PS/he2.3.2c.ps}
\end{figure}
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\subsection{
  Reaction 2.3.2d $e + He^+ \rightarrow He^* + ... $ Ratio He(10)/He$^+$
}

  $3^1D$ state,
  reduced population coefficients, formulation II,
  Coupling to He$^+$.

  For 667 nm line: $\rightarrow 2^1P$, A(10,4)=6.27547e7, dE = 1.8561 eV

\begin{small}\begin{verbatim}


        E-Index:     0                    1                    2
  T-Index:
        0   -3.192508131204D+01    7.730604480077D-01    3.913705333191D-01
        1    2.828623875238D+00    3.043166975331D-01   -5.394294436435D-01
        2   -1.094286352161D+01    4.449752413106D-01    5.999182478623D-02
        3    1.052099366893D+01   -7.603297466416D-01    3.020794746641D-01
        4   -4.404840999690D+00    3.789883977105D-01   -1.864822739530D-01
        5    9.659859829733D-01   -8.886124374969D-02    4.574019828906D-02
        6   -1.164625241195D-01    1.078353226216D-02   -5.432191040269D-03
        7    7.324584132923D-03   -6.529437247704D-04    3.049402440492D-04
        8   -1.880391228394D-04    1.553160134143D-05   -6.266500198751D-06

        E-Index:     3                    4                    5
  T-Index:
        0   -1.895103722167D-01    4.458135648534D-02   -5.670836879252D-03
        1    3.196979542189D-01   -7.857255265840D-02    9.520006805526D-03
        2   -2.102789422795D-01    6.659906282329D-02   -8.539428018247D-03
        3    1.669978165448D-02   -2.112215942331D-02    3.118385995004D-03
        4    2.327397267002D-02    1.834729531187D-03   -4.527735068892D-04
        5   -7.557858145939D-03    1.796130918335D-04    2.396527075095D-05
        6    8.888503829029D-04   -2.025043121277D-05   -2.255417061932D-06
        7   -3.985563239078D-05   -2.090429714735D-06    4.928756876729D-07
        8    3.268393543240D-07    2.036815496667D-07   -2.933925056569D-08

        E-Index:     6                    7                    8
  T-Index:
        0    3.963745460112D-04   -1.424905218920D-05    2.052965619067D-07
        1   -6.049392469505D-04    1.923558499837D-05   -2.397863109992D-07
        2    5.302906384868D-04   -1.548203816799D-05    1.630918993190D-07
        3   -1.871228014319D-04    4.525444542407D-06   -2.484052167901D-08
        4    2.215031871253D-05   -3.969555753912D-09   -1.502410481834D-08
        5    5.050715387567D-07   -1.944403098333D-07    6.132124950693D-09
        6   -1.681357574652D-07    2.937982495017D-08   -8.509572249650D-10
        7   -8.155554263527D-09   -1.366419067606D-09    4.898820258533D-11
        8    1.198416940460D-09    5.339525486382D-12   -9.014052780522D-13

  Max. rel. Error:  28.7561 %
  Mean rel. Error:   8.5118 %


\end{verbatim}\end{small}
\begin{figure} \label{2.3.2d}
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\epsffile{Amjuel_PS/he2.3.2d.ps}
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\subsection{
  Reaction 2.3.2e $e + He^+ \rightarrow He^* + ... $ Ratio He(16)/He$^+$
}

  $4^1D$ state,
  reduced population coefficients, formulation II,
  Coupling to He$^+$.

  For 492 nm line: $\rightarrow 2^1P$, A(16,4)=1.95062E7, dE = 2.5183 eV

\begin{small}\begin{verbatim}


        E-Index:     0                    1                    2
  T-Index:
        0   -3.188482573905D+01    8.610245311120D-01   -7.871637904226D-02
        1    9.933879030912D-01    2.266459651326D+00   -9.472857315400D-01
        2   -7.486546162203D+00   -3.150308486050D+00    1.212822565689D+00
        3    7.834652212756D+00    1.901758352641D+00   -6.605089155304D-01
        4   -3.347990149324D+00   -6.248586863904D-01    2.007495980841D-01
        5    7.366886873864D-01    1.190475683473D-01   -3.602551009154D-02
        6   -8.864057763980D-02   -1.309846016686D-02    3.760565403015D-03
        7    5.555256683180D-03    7.711297791954D-04   -2.099326142463D-04
        8   -1.421052566331D-04   -1.878580877217D-05    4.822799528233D-06

        E-Index:     3                    4                    5
  T-Index:
        0    1.007691814520D-01   -3.094881651282D-02    4.360394656253D-03
        1    1.590010861827D-01   -1.031249533204D-02   -2.061971584679D-04
        2   -2.039503541069D-01    1.940627970159D-02   -1.269842997337D-03
        3    9.150327990878D-02   -6.639386857171D-03    3.547850561263D-04
        4   -2.342313204830D-02    1.172376176842D-03   -2.311168366669D-05
        5    3.768569485892D-03   -1.588304810091D-04   -2.066241218916D-07
        6   -3.706654458246D-04    1.841194915725D-05   -4.050823848900D-07
        7    1.996960560623D-05   -1.358423173826D-06    7.836592920988D-08
        8   -4.433571946131D-07    4.149590065641D-08   -3.556757547808D-09

        E-Index:     6                    7                    8
  T-Index:
        0   -3.145292638212D-04    1.131115258763D-05   -1.610863865001D-07
        1    6.454814129154D-05   -3.308023119594D-06    5.784207966726D-08
        2    6.690737638410D-05   -2.294961757856D-06    3.201017904975D-08
        3   -2.521266112731D-05    1.253726502750D-06   -2.225943158869D-08
        4    3.096507943757D-06   -2.590646481613D-07    5.452184158491D-09
        5   -2.280634231739D-07    3.149850598031D-08   -6.947518389720D-10
        6    3.729749615530D-08   -2.770965878183D-09    4.800254654826D-11
        7   -4.762215328192D-09    1.745304400761D-10   -1.658813624438D-12
        8    2.026923384162D-10   -5.318966772198D-12    2.100743151512D-14

  Max. rel. Error:  37.7911 %
  Mean rel. Error:   6.9227 %



\end{verbatim}\end{small}
\begin{figure} \label{2.3.2e}
\epsfxsize=16truecm
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\epsffile{Amjuel_PS/he2.3.2e.ps}
\end{figure}
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\subsection{
  Reaction 2.3.9a  $He + e \rightarrow He^+(1s) + 2e   <de> \ [eV] $
}

  electron energy loss (radiative plus potential) due to one effective ionisation.

\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
  T-Index:
        0    6.833598031940D+00   -2.581591750171D-01    3.002724552043D-01
        1   -3.963803034848D+00    1.083742817806D-01   -2.185819272140D-01
        2    2.340984418775D+00    7.960301860904D-02   -2.380541593246D-02
        3   -8.720605342433D-01   -2.187065734893D-02    4.335409780587D-02
        4    2.151914370389D-01   -2.025747886335D-02   -6.222418098960D-03
        5   -3.480057305671D-02    1.039843241545D-02   -1.466657569917D-03
        6    3.519085971631D-03   -1.896269271396D-03    4.723390036919D-04
        7   -2.005331697724D-04    1.550021181454D-04   -4.460430898110D-05
        8    4.890032176597D-06   -4.783948237900D-06    1.434239402361D-06

        E-Index:     3                    4                    5
  T-Index:
        0   -1.562968002089D-01    3.804132257792D-02   -4.819950771068D-03
        1    1.380891687214D-01   -3.493851885048D-02    4.336864850281D-03
        2   -2.233168326792D-02    8.567898287243D-03   -1.135198845537D-03
        3   -9.017359555794D-03    4.146449794934D-04    2.229593440360D-05
        4    2.872369142740D-03   -3.563116903860D-04    2.183046296448D-05
        5   -1.004362351325D-04    2.650562392977D-05   -1.006835018389D-06
        6   -4.170965146914D-05    1.520955505512D-06   -1.199396957406D-07
        7    4.727045263171D-06   -1.341691381461D-07   -9.067558155258D-09
        8   -1.408579120961D-07   -2.631952383725D-09    1.504095408373D-09

        E-Index:     6                    7                    8
  T-Index:
        0    3.251351974739D-04   -1.108119967409D-05    1.502088801630D-07
        1   -2.788751037407D-04    8.919934156922D-06   -1.121476666732D-07
        2    6.881062206346D-05   -1.901589536293D-06    1.850790588779D-08
        3   -1.237210702996D-06   -5.350049703101D-08    2.614670721314D-09
        4   -8.649474896814D-07    2.477033243810D-08   -3.749285231265D-10
        5   -7.916173274377D-08    7.346267688694D-09   -1.619067607087D-10
        6    2.102619442307D-08   -1.402551865343D-09    3.013612509314D-11
        7    2.537560484891D-10    3.296713149429D-11   -1.211004021082D-12
        8   -1.050110011758D-10    2.672317014529D-12   -1.734344850181D-14

  Max. rel. Error:   4.8670 %
  Mean rel. Error:    .4586 %

\end{verbatim}\end{small}
\begin{figure} \label{2.3.9aec}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/heliaecc.ps}
\end{figure}
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\subsection{
```

Reaction 2.3.13a $e + He^+(1s) \rightarrow   He(1|1S)+ h\nu <de> \
[eV]$ }

  electron energy loss (radiative plus potential) due to one effective
recombination.

\begin{small}\begin{verbatim}

```
       E-Index:     0                    1                    2
  T-Index:
       0    3.433913136981D+00   -4.838690601594D-03   -3.012005651151D-03
       1    3.571941963713D-01    1.366702629693D-01    4.305394970015D-03
       2   -1.878217847962D+00   -2.687159886881D-01    3.681576112685D-02
       3    2.424802386624D+00    1.668555927113D-01   -1.489289566691D-02
       4   -1.167489860199D+00   -3.968312198499D-02   -5.806242392586D-03
       5    2.785216165202D-01    2.794413323851D-03    3.748295131357D-03
       6   -3.549870765089D-02    3.061971808105D-04   -6.964994225616D-04
       7    2.325006625009D-03   -5.536285155093D-05    5.514149047897D-05
       8   -6.167011906326D-05    2.237779310326D-06   -1.602672918010D-06

       E-Index:     3                    4                    5
  T-Index:
       0    4.897530083159D-03   -1.501012076471D-03    1.946127138348D-04
       1   -2.542692753033D-02    8.618718418466D-03   -1.155324896611D-03
       2    4.404690243381D-03   -4.417465105562D-03    6.541649981092D-04
       3    5.027112091534D-03    2.212796313573D-04   -6.372305615527D-05
       4   -1.157260624154D-03    9.661422893980D-05   -7.830966474304D-06
       5   -7.990778489925D-05   -5.166337856831D-06    5.389604603452D-07
       6    3.596656976635D-05    1.433564986542D-07    1.512821193564D-08
       7   -2.512892127544D-06   -2.280106015151D-07    1.957605446858D-08
       8    3.299538986852D-08    1.871390766422D-08   -1.821480547627D-09

       E-Index:     6                    7                    8
  T-Index:
       0   -1.279526998241D-05    4.198553031308D-07   -5.453125267641D-09
       1    7.588474563611D-05   -2.435602148969D-06    3.048074124737D-08
       2   -4.062514764122D-05    1.126080643711D-06   -1.084879079455D-08
       3    1.646788579650D-06    1.017675408347D-07   -3.909525540561D-09
       4    1.221818458812D-06   -7.525537630546D-08    1.491574341448D-09
       5   -5.819508932994D-08    1.849145077320D-09   -1.280524821596D-12
       6   -1.800399945032D-08    1.587416635024D-09   -3.976884843047D-11
       7    1.171329251871D-09   -1.635594061798D-10    4.324427772952D-12
       8    1.868229185881D-11    4.166329792374D-12   -1.347143462455D-13

  Max. rel. Error:  22.5154 %
  Mean rel. Error:   7.8340 %
```

\end{verbatim}\end{small}
\begin{figure} \label{2.3.13aec}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/helraecc.ps}
\end{figure}
\newpage

\subsection{
  Reaction 2.6A0 $C + e \rightarrow C^+   + 2e <de> [eV] $
}

electron energy loss (radiative+potential) due to one effective ionisation.

\begin{small}\begin{verbatim}

E-Index:	0	1	2
T-Index:			
0	9.498032398433D+00	-1.819265937462D+00	5.796344005492D-01
1	-2.316370818977D+00	-1.912413251967D+00	5.639266856065D-01
2	2.320704120275D+00	7.593550209141D-01	-2.384731751044D-01
3	-1.423469978730D+00	-3.888330744867D-02	1.868782289925D-02
4	4.441710451586D-01	-1.408402765701D-02	4.609271425672D-04
5	-8.198134345687D-02	3.816981348123D-03	-1.201041388569D-04
6	9.025343419623D-03	-5.956250281350D-04	3.460685141518D-05
7	-5.421408064934D-04	5.242557410997D-05	-5.660290060134D-06
8	1.358691589766D-05	-1.845719396806D-06	2.798854323430D-07

E-Index:	3	4	5
T-Index:			
0	-9.876225428908D-02	7.923470670427D-03	-1.889758400029D-04
1	-7.502544061825D-02	4.301133626753D-03	1.263821297128D-04
2	3.513874434013D-02	-2.722831770062D-03	5.261936992701D-05
3	-2.516467231041D-03	1.815314237493D-04	-3.776094914794D-07
4	-5.595871698878D-05	1.172374862061D-05	-1.427876732685D-06
5	-9.049612725058D-06	-2.823320281538D-07	1.856100050999D-07
6	8.873065193751D-07	-1.786247323757D-07	6.579947427433D-09
7	2.934330556330D-07	5.202583801575D-09	-2.631835360203D-09
8	-2.439978518785D-08	7.004344333195D-10	1.000272415897D-10

E-Index:	6	7	8
T-Index:			
0	-1.022904037358D-05	5.840788152953D-07	-6.375736799139D-09
1	-3.427310072061D-05	1.885339856267D-06	-3.505352276047D-08
2	6.880039401864D-06	-4.536973415974D-07	7.687829752307D-09
3	-3.936336799962D-07	-1.180564243948D-08	1.277731900255D-09
4	-4.740152838620D-08	1.512393664320D-08	-5.903109943091D-10
5	-1.544365666000D-09	-1.278608019932D-09	6.083549010546D-11
6	2.900458497992D-11	4.157695298962D-12	-1.518435981756D-12
7	1.539892599330D-10	-6.042934507312D-13	-4.298624172985D-14
8	-9.023325396014D-12	1.668395598922D-13	7.457156257137D-16

Max. rel. Error: 10.0848 %
Mean rel. Error: 3.3383 %

\end{verbatim}\end{small}
\begin{figure} \label{2.3.6il1}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/carbil1.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.3.6A0 $C^+ + e \rightarrow C + ... <de>+11.3 \ [eV] $
}

electron energy loss (radiative) due to one effective recombination.
For the total electron energy loss, 11.3 eV (potential) have to be
subtracted, which may render the loss negative, i.e., make it a gain.

\begin{small}\begin{verbatim}

	E-Index: 0	1	2
T-Index:			
0	6.453628189480D+00	-3.411959121202D+00	1.027601643412D+00
1	5.566257359499D+00	-2.827487978046D+00	1.323581114195D+00
2	7.023144782419D-02	-8.719987617388D-01	2.676321249963D-01
3	-1.612434026349D-01	1.081834795086D-01	-7.116653339183D-02
4	6.539562167664D-02	4.139385617180D-02	2.769162614331D-03
5	-2.206442445551D-02	-7.840262448517D-03	-9.995675347671D-04
6	2.871920422343D-03	8.502276174927D-04	1.251507934880D-04
7	-1.549156846628D-04	-6.373587175654D-05	-3.129721638855D-06
8	3.278924523113D-06	1.670923171850D-06	8.554676549572D-08

	E-Index: 3	4	5
T-Index:			
0	-1.501284760092D-01	9.016194688684D-03	2.238571380263D-04
1	-3.322262917492D-01	4.865809696737D-02	-4.343709230425D-03
2	-2.643011608926D-02	5.658846165674D-04	1.413672739471D-04
3	7.688215878015D-03	-5.493080299892D-04	3.497209232351D-05
4	5.691532547205D-04	-1.149074252290D-04	4.807423173738D-06
5	5.044633066348D-05	4.715897395507D-06	-9.154583868877D-08
6	-1.234952236991D-05	-9.240109636586D-08	4.248634746180D-08
7	3.335538428637D-07	2.604300994523D-08	-3.070635332640D-09
8	-3.205409357745D-08	4.814828405950D-09	-5.332849014591D-10

	E-Index: 6	7	8
T-Index:			
0	-5.983556406852D-05	2.938264102004D-06	-4.865346084259D-08
1	2.324145347640D-04	-6.832076246100D-06	8.466507036184D-08
2	-1.468227303594D-05	5.744169024370D-07	-8.237111069147D-09
3	-2.064808887243D-06	7.798853036278D-08	-1.206248775248D-09
4	2.193418042952D-07	-1.995457258897D-08	3.575861953373D-10
5	-4.818418728971D-08	2.776256710020D-09	-3.694099060448D-11
6	-2.045420857293D-10	-3.406586578331D-11	-7.204537382726D-13
7	1.097056113387D-11	2.734596577436D-12	2.335553372556D-14
8	3.762885118005D-11	-1.334245563205D-12	1.722914980319D-14

Max. rel. Error: 9.9451 %
Mean rel. Error: 4.6015 %

\end{verbatim}\end{small}
\begin{figure} \label{2.3.6lr1}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/carbrl1.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.2.5a $ H_2 + e \rightarrow .....+ H(3), \ $
Ratio $H(3)/H_2 $
}
Multi-step hydrogenic population coefficients
Data: T.Fujimoto
Ratio of population coefficients: p(3)/nH2

\begin{small}\begin{verbatim}

	E-Index: 0	1	2

```
 T-Index:
        0   -3.843232308973D+01    9.866136797620D-01   -7.630767164474D-04
        1    1.763737135501D+01   -7.268396239737D-02    1.044914850159D-01
        2   -9.102596461463D+00    6.283138055344D-02   -7.375751509571D-02
        3    3.044087169667D+00   -4.582914429668D-02    4.001305352976D-02
        4   -6.799512263137D-01    2.529525369912D-02   -1.619747297605D-02
        5    1.021208740284D-01   -9.089155747301D-03    4.651977381511D-03
        6   -1.027903716284D-02    1.911308645888D-03   -8.844096702821D-04
        7    6.460492607832D-04   -2.089424506198D-04    9.480996308587D-05
        8   -1.923319726365D-05    9.093882674319D-06   -4.196010732530D-06

        E-Index:     3                    4                    5
 T-Index:
        0    8.463761770878D-03   -3.668738045523D-03    6.470552634326D-04
        1   -5.045692652261D-02    1.145016084229D-02   -1.370891627120D-03
        2    2.874156352094D-02   -5.093075324948D-03    4.483604397328D-04
        3   -1.247549414985D-02    1.733717971265D-03   -1.065732952139D-04
        4    3.883454673035D-03   -4.379243673277D-04    2.751938724811D-05
        5   -7.719439518973D-04    4.105848834550D-05   -9.791293810522D-07
        6    1.045477116614D-04    4.536233386087D-06   -1.259893630895D-06
        7   -9.553834264468D-06   -1.115019494878D-06    2.363713809533D-07
        8    4.237208860211D-07    5.589085089129D-08   -1.252796449945D-08

        E-Index:     6                    7                    8
 T-Index:
        0   -5.551234542034D-05    2.284493199758D-06   -3.621267376539D-08
        1    8.882007338293D-05   -2.941321182498D-06    3.890740158619D-08
        2   -1.885697574083D-05    2.852269978935D-07    8.496957677236D-10
        3    1.618515118726D-06    9.254848831070D-08   -2.858249742968D-09
        4   -1.329060444185D-06    5.670350444090D-08   -1.228700843631D-09
        5    2.901690837726D-07   -2.818973160122D-08    7.385401732551D-10
        6    2.538253614744D-08    3.282804098763D-09   -1.212274570019D-10
        7   -1.107068687207D-08   -5.725981536387D-12    7.272031033863D-12
        8    7.329111895115D-10   -1.221514806869D-11   -8.661756397302D-14

 Max. rel. Error:   3.0327 %
 Mean rel. Error:   1.0280 %

\end{verbatim}\end{small}
\begin{figure} \label{2.2.5a}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/h2n3fu.ps}
\end{figure}
\newpage
\subsection{
Reaction 2.2.5b  $H_2 + e \rightarrow .....+H(2)   , \  $
Ratio $H(2)/H_2 $
}

 Ratio of population coefficients: p(2)/nH2

 Multi-step hydrogenic population coefficients
 Data: T.Fujimoto


\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
 T-Index:
        0   -3.709244791220D+01    9.687241476053D-01    3.742262659150D-02
        1    1.669985823625D+01   -1.746089790847D-02    2.153832458702D-02
```

```
       2   -8.309237048353D+00    3.381127410703D-02   -3.556201387754D-02
       3    2.657739315672D+00   -8.512812279243D-03    1.196655088860D-02
       4   -6.132396646504D-01   -2.552858621025D-03    1.194454859764D-04
       5    1.101743243476D-01    1.097984176326D-03   -4.977907148307D-04
       6   -1.475653262109D-02   -4.324624980123D-05   -1.194492163554D-07
       7    1.224129849314D-03   -1.978420677869D-05    1.695927041869D-05
       8   -4.446691780917D-05    1.813978843455D-06   -1.455738811700D-06

       E-Index:     3                    4                    5
 T-Index:
       0   -1.651081799644D-02    3.565764257714D-03   -4.174591391487D-04
       1   -1.090577226038D-02    2.794096310833D-03   -3.908538558075D-04
       2    1.407590381030D-02   -2.699474372936D-03    2.742035615058D-04
       3   -5.055672344660D-03    9.440106236031D-04   -8.615580226180D-05
       4    3.664276773773D-04   -1.108403409912D-04    1.373091515639D-05
       5    1.084866241578D-04   -9.612225065207D-06   -3.739409418091D-07
       6   -5.135563052511D-06    1.895456383045D-06   -1.588469158937D-07
       7   -3.814928055218D-06    2.731245678489D-07    1.634952517283D-09
       8    3.749880009743D-07   -3.989523167029D-08    1.603033939474D-09

       E-Index:     6                    7                    8
 T-Index:
       0    2.688883877617D-05   -8.884834785320D-07    1.159228215260D-08
       1    2.999154465824D-05   -1.175608698972D-06    1.820253115424D-08
       2   -1.469100393011D-05    3.734482260499D-07   -3.177600597413D-09
       3    3.725098060685D-06   -5.918174922608D-08   -6.433645161998D-11
       4   -9.325142355108D-07    3.763485456338D-08   -7.145755570016D-10
       5    1.704997971383D-07   -1.376296741989D-08    3.514893200953D-10
       6   -1.145517528846D-08    1.898641500278D-09   -5.838483361781D-11
       7    1.312392622432D-10   -1.035003695410D-10    4.030531144035D-12
       8   -2.253655572832D-11    2.072693141970D-12   -9.944952208106D-14

 Max. rel. Error:   1.9631 %
 Mean rel. Error:   0.6656 %


\end{verbatim}\end{small}
\begin{figure} \label{2.2.5b}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/h2n2fu.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.2.5c  $H_2 + e \rightarrow .....+H(4)   , \  $
Ratio $H(4)/H_2 $
}

 Ratio of population coefficients: p(4)/nH2

 Multi-step hydrogenic population coefficients
 Data: T.Fujimoto

\begin{small}\begin{verbatim}

       E-Index:     0                    1                    2
  T-Index:
       0   -3.912344526943D+01    9.262202059006D-01    9.389410302438D-02
       1    1.756197573185D+01   -4.343762540494D-02    6.126434071800D-02
       2   -8.886628104138D+00    2.119621111180D-02   -2.656188467734D-02
```

```
       3    3.057910637954D+00   -1.535881342701D-03    2.932875657740D-03
       4   -7.835206514361D-01   -1.389945765942D-03    1.255399530700D-03
       5    1.580308696978D-01    1.928352522209D-04   -3.543899525036D-04
       6   -2.353640097896D-02    4.031200319945D-05    2.846252498973D-05
       7    2.128743508257D-03   -8.795964786784D-06   -1.512497781432D-06
       8   -8.285077032772D-05    4.111725894460D-07    1.270837350725D-07

       E-Index:     3                   4                   5
  T-Index:
       0   -4.264954883585D-02    9.104064233267D-03   -9.991876289465D-04
       1   -3.242966270346D-02    8.357146835162D-03   -1.147734080465D-03
       2    1.227590202063D-02   -2.719431170815D-03    3.144838167343D-04
       3   -1.186497869383D-03    1.497138310345D-04    3.644078028099D-06
       4   -5.552975953317D-04    1.352074320357D-04   -1.821378482602D-05
       5    1.750515375163D-04   -3.621530587129D-05    3.319095280981D-06
       6   -2.248136922616D-05    4.496488473333D-06   -2.595976205911D-07
       7    2.265470434041D-06   -4.927085512215D-07    3.240824081247D-08
       8   -1.404975048998D-07    3.246838389464D-08   -2.985897409147D-09

       E-Index:     6                   7                   8
  T-Index:
       0    5.646131117170D-05   -1.541734784320D-06    1.563548973536D-08
       1    8.491836730798D-05   -3.177470024031D-06    4.698887012882D-08
       2   -1.909003815732D-05    5.644098554224D-07   -6.240476308631D-09
       3   -2.108751238830D-06    1.449614494660D-07   -3.025489423066D-09
       4    1.329682209766D-06   -4.835654939859D-08    6.736536866134D-10
       5   -1.024702456679D-07   -1.838064127165D-09    1.096804376213D-10
       6   -1.383903232721D-08    1.811451752221D-09   -4.443051906110D-11
       7    8.783996080897D-10   -1.570045781133D-10    3.895723973541D-12
       8    9.149043474391D-11    1.200102594315D-12   -7.103779862531D-14

  Max. rel. Error:   5.8311 %
  Mean rel. Error:   2.4005 %


\end{verbatim}\end{small}
\begin{figure} \label{2.2.5c}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/h2n4fu.ps}
\end{figure}
\newpage
\subsection{
Reaction 2.2.5d  $H_2 + e \rightarrow .....+H(5)   , \  $
Ratio $H(5)/H_2 $
}

 Ratio of population coefficients: p(5)/nH2

 Multi-step hydrogenic population coefficients
 Data: T.Fujimoto


\begin{small}\begin{verbatim}

       E-Index:     0                   1                   2
  T-Index:
       0   -3.951411187905D+01    9.845720830236D-01    2.965188823982D-02
       1    1.754222947805D+01    8.247738158426D-03   -1.272102756074D-02
       2   -8.876801014058D+00    4.901299958077D-03   -5.280618932755D-03
       3    3.072154572289D+00   -1.530726569770D-03    2.607605517865D-03
```

```
       4   -7.853999520176D-01   -2.345612983161D-03    2.701173976139D-03
       5    1.567509317981D-01    8.814896942982D-04   -1.049815583642D-03
       6   -2.318325485784D-02   -7.993944555387D-05    7.600898233240D-05
       7    2.098355270569D-03   -3.387024520670D-06    9.244162752622D-06
       8   -8.207983816964D-05    5.528578997147D-07   -1.019716004446D-06

       E-Index:     3                   4                   5
  T-Index:
       0   -1.988697872409D-02    5.937630704750D-03   -8.791623431456D-04
       1    5.501038151489D-03   -8.566607598092D-04    2.183252927157D-05
       2    2.314980071502D-03   -5.478894140036D-04    7.109825032007D-05
       3   -1.396561346251D-03    3.325686900420D-04   -3.809967071864D-05
       4   -1.125294104660D-03    2.296369788655D-04   -2.539533631356D-05
       5    4.447398821903D-04   -9.021186699180D-05    9.582338741375D-06
       6   -2.411443826400D-05    2.990412729672D-06   -5.900509921306D-08
       7   -5.982892783306D-06    1.671607281419D-06   -2.370199152045D-07
       8    5.706608511575D-07   -1.455207707019D-07    1.922725997681D-08

       E-Index:     6                   7                   8
  T-Index:
       0    6.453161013676D-05   -2.282669216724D-06    3.113968814246D-08
       1    5.326208461631D-06   -4.221360253600D-07    8.838098533169D-09
       2   -4.628672509606D-06    1.314409444715D-07   -1.108256720247D-09
       3    1.973863091768D-06   -3.710162944512D-08    2.441617394808D-11
       4    1.549890921198D-06   -4.822256530984D-08    5.795655841101D-10
       5   -5.224195972980D-07    1.313051592940D-08   -1.087986680607D-10
       6   -2.099205652655D-08    1.716078063896D-09   -3.742956025175D-11
       7    1.822822435371D-08   -7.148600246211D-10    1.095760653021D-11
       8   -1.375709745925D-09    5.028096539680D-11   -7.253832666784D-13

  Max. rel. Error:   5.8770 %
  Mean rel. Error:   2.4838 %



\end{verbatim}\end{small}
\begin{figure} \label{2.2.5d}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/h2n5fu.ps}
\end{figure}

\newpage
\subsection{
Reaction 2.2.5e  $H_2 + e \rightarrow .....+H(6)   , \  $
Ratio $H(6)/H_2 $
}

 Ratio of population coefficients: p(6)/nH2

 Multi-step hydrogenic population coefficients
 Data: T.Fujimoto


\begin{small}\begin{verbatim}


       E-Index:     0                   1                   2
  T-Index:
       0   -3.976375830432D+01    1.080938475473D+00   -1.041552669840D-01
       1    1.755396272137D+01    1.997928889454D-02   -1.798710059345D-02
```

```
        2   -8.859630135249D+00   -2.504982400656D-02    2.543100868921D-02
        3    3.076066110143D+00   -7.835891215709D-03    3.545212479895D-03
        4   -7.843523260590D-01    5.646209832689D-03   -3.561003903809D-03
        5    1.561553501837D-01    7.187156275750D-04   -5.963069173321D-04
        6   -2.332414342207D-02   -7.250674775397D-04    5.042502000331D-04
        7    2.152674655984D-03    1.218456761872D-04   -8.096427977714D-05
        8   -8.602048471984D-05   -6.415059271451D-06    4.107777281787D-06

        E-Index:     3                    4                    5
  T-Index:
        0    4.597090039926D-02   -9.342295727179D-03    9.308478102486D-04
        1    7.525111338364D-03   -1.729122256079D-03    1.982524112989D-04
        2   -1.066061134667D-02    2.308937441320D-03   -2.749941500007D-04
        3   -3.509536109581D-05   -2.051879002933D-04    4.063170393346D-05
        4    8.140229792921D-04   -8.180427544392D-05    3.613298743897D-06
        5    1.757400200541D-04   -2.144818777523D-05    7.661627732789D-07
        6   -1.279018270105D-04    1.377362109836D-05   -4.685940627108D-07
        7    1.925404378767D-05   -1.822283216087D-06    2.708967643411D-08
        8   -9.154258157002D-07    7.217533878534D-08    1.433836277468D-09

        E-Index:     6                    7                    8
  T-Index:
        0   -4.990551313939D-05    1.412124656401D-06   -1.686977249955D-08
        1   -1.100090823914D-05    2.783571526155D-07   -2.545786068789D-09
        2    1.844047875979D-05   -6.611108809876D-07    9.857959406283D-09
        3   -3.580865956702D-06    1.526795464151D-07   -2.489702863615D-09
        4   -5.514937069176D-08    1.282783100756D-09   -7.929654586724D-11
        5    7.413860626664D-08   -7.230260739451D-09    1.670076436316D-10
        6   -2.752310640534D-08    2.519485275718D-09   -5.096968024103D-11
        7    6.897900227166D-09   -4.409727389145D-10    7.792707281870D-12
        8   -5.340626613072D-10    2.786970513377D-11   -4.532087311135D-13

  Max. rel. Error:   7.8110 %
  Mean rel. Error:   3.3876 %

\end{verbatim}\end{small}
\begin{figure} \label{2.2.5e}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/h2n6fu.ps}
\end{figure}

\newpage
\subsection{
Reaction 2.2.5fl $H_2 + e \rightarrow .....+H2(n=3,Triplet)$}

Ratio $H2(n=3, Triplet)/H_2/n_e*2/9*2E7 $

 Fulcher emissivity, $cm^3/s$

 Multi-step hydrogenic molecule population coefficients
 Data: T.Fujimoto

\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
  T-Index:
        0   -3.504557850421D+01    9.344698340987D-02   -1.262393982454D-01
        1    1.265185253675D+01    3.464589180343D-01   -1.897206206043D-01
        2   -5.915984508527D+00   -4.770835779343D-01    2.383409770393D-01
        3    1.567639302331D+00    3.390100280427D-01   -1.091189901772D-01
        4   -2.590628281288D-01   -1.393257670314D-01    3.068867791726D-02
```

```
        5    2.135659024123D-02    3.392916031088D-02   -5.998734336944D-03
        6    2.067218294860D-04   -4.798473917584D-03    7.772903414015D-04
        7   -1.751915106668D-04    3.619887562438D-04   -5.646895975370D-05
        8    9.203730354946D-06   -1.119572886551D-05    1.591317926643D-06

        E-Index:     3                    4                    5
  T-Index:
        0    5.877352224633D-02   -1.302261116596D-02    1.540680462958D-03
        1    5.862703454732D-02   -1.095188520145D-02    1.183240573644D-03
        2   -6.570429435087D-02    1.114775452853D-02   -1.070181983249D-03
        3    1.814682024195D-02   -2.295511323493D-03    1.728358529303D-04
        4   -1.552484350393D-03    1.648565252382D-05   -2.120282511290D-06
        5   -1.441720545043D-04    3.491712665534D-05    3.814455169266D-06
        6    5.391904676009D-05   -6.544745167097D-06   -9.545517784441D-07
        7   -7.783493080968D-06    1.329842208929D-06   -2.466307689654D-08
        8    4.941214511748D-07   -1.119035840584D-07    1.039673602122D-08

        E-Index:     6                    7                    8
  T-Index:
        0   -1.002500011070D-04    3.343404484895D-06   -4.450494173734D-08
        1   -7.027920699731D-05    2.111151704919D-06   -2.487468982378D-08
        2    5.325609368599D-05   -1.188266988002D-06    7.422508082261D-09
        3   -3.839135008823D-06   -1.858093262988D-07    7.490073429227D-09
        4   -7.719566036043D-07    9.893554038792D-08   -2.773366208727D-09
        5   -4.033028965823D-07    4.648379959066D-09    2.007004276332D-10
        6    1.065338439445D-07   -2.602264223322D-09   -2.414058704987D-12
        7   -9.313819595092D-10   -9.979867907432D-11    5.230579069087D-12
        8   -7.005564197388D-10    3.183343414621D-11   -6.155115004501D-13

  Max. rel. Error:   2.1244 %
  Mean rel. Error:    .5558 %

\end{verbatim}\end{small}
\begin{figure} \label{2.2.5fl}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/h2fulch.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.2.5fu $H_2 + e \rightarrow .....+H2(n=3,Triplet)$}

Ratio $H2(n=3, Triplet)/H_2*2/9 $

upper Fulcher population coefficient. A$_{Fulch}$=2.53E7

 Multi-step hydrogenic molecule population coefficients
 Data: K.Sawada, T.Fujimoto
\begin{small}\begin{verbatim}

        E-Index:     0                    1                    2
  T-Index:
        0   -3.349174061267D+01    1.107380092037D+00   -1.655827681081D-01
        1    1.284047976186D+01   -1.213122026237D-02   -6.132056368717D-02
        2   -6.413764746315D+00    1.053962121929D-01   -6.058203471496D-02
        3    1.913028024117D+00    2.514347072348D-02    3.181942687879D-02
        4   -3.712816383722D-01   -8.695525483414D-02    1.678189635748D-02
        5    3.960600799571D-02    4.074080534020D-02   -1.134082769478D-02
        6   -1.052874219789D-03   -8.083345350383D-03    2.128448882617D-03
        7   -1.785154627634D-04    7.388146670979D-04   -1.479827212239D-04
```

```
       8    1.236983575407D-05   -2.548553348211D-05    2.434481214858D-06

       E-Index:     3                    4                    5
  T-Index:
       0    9.081831153858D-02   -2.155176531205D-02    2.687110630298D-03
       1    5.251600630207D-02   -1.395960837597D-02    1.788290996793D-03
       2    6.456727187820D-03    1.595488379837D-03   -4.162388909601D-04
       3   -1.416086355652D-02    2.228765748284D-03   -1.755681970258D-04
       4    4.890801701257D-05   -2.528675286395D-04    2.362149977157D-05
       5    1.378478247903D-03   -1.216867717338D-04    1.169258210331D-05
       6   -2.022364242066D-04    9.143064899344D-06   -7.499679999777D-07
       7   -4.302790819505D-06    3.693903982739D-06   -4.071669440599D-07
       8    1.444361088193D-06   -3.875548036922D-07    4.187131100236D-08

       E-Index:     6                    7                    8
  T-Index:
       0   -1.837187135024D-04    6.451571682807D-06   -9.069754757405D-08
       1   -1.202871787507D-04    4.089730888930D-06   -5.549056353363D-08
       2    3.510814616606D-05   -1.292366561720D-06    1.769955642393D-08
       3    8.265012930924D-06   -2.411216153218D-07    3.359929241882D-09
       4   -1.058500206157D-06    2.788248190313D-08   -3.444629946902D-10
       5   -8.243859256275D-07    3.097729075561D-08   -4.709916834130D-10
       6    7.676056442394D-08   -3.719597774226D-09    6.637415766552D-11
       7    2.100981276615D-08   -5.378074189405D-10    5.316692027152D-12
       8   -2.402222996167D-09    7.235773530136D-11   -8.965563401217D-13

  Max. rel. Error:   3.6274 %
  Mean rel. Error:   1.3835 %

\end{verbatim}\end{small}
\begin{figure} \label{2.2.5fu}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/h2fu.ps}
\end{figure}

\newpage
\subsection{
Reaction 2.2.14a $ H_2^+ + e \rightarrow ...+ H(3) , \  $
Ratio $H(3)/H_2^+ $
}

 Multi-step hydrogenic population coefficients
 Data: T.Fujimoto

 Ratio of population coefficients: p(3)/nH2+


\begin{small}\begin{verbatim}
       E-Index:     0                    1                    2
 T-Index:
       0   -1.722688127458D+01    1.153283206758D+00   -1.683858517653D-01
       1   -6.130457183836D-01    1.914093897035D-01   -2.119334228080D-01
       2   -3.288796872020D-02   -2.400733485492D-02    2.404651735462D-02
       3    1.011296840186D-02   -1.550958978732D-02    1.584315646622D-02
       4    1.661600971350D-02    4.557160690820D-03   -3.973908011295D-03
       5   -1.332921799914D-03    1.037539779315D-05    6.731975412111D-05
       6   -1.279967875089D-03   -2.589228947175D-04    1.486622411070D-04
       7    2.677167178361D-04    5.420325237257D-05   -3.368818743134D-05
       8   -1.506445178315D-05   -3.499465420549D-06    2.352582612122D-06
```

```
       E-Index:     3                    4                    5
 T-Index:
       0    6.918918524329D-02   -1.429478386078D-02    1.613571468557D-03
       1    9.109177794808D-02   -2.007505252911D-02    2.472425643895D-03
       2   -9.020252068955D-03    1.671217936164D-03   -1.647723170945D-04
       3   -6.589011823707D-03    1.468052024984D-03   -1.881996632423D-04
       4    1.324545590207D-03   -2.271138929258D-04    2.197082919209D-05
       5   -2.225087720532D-05   -3.948031909877D-06    2.183242092156D-06
       6   -2.359201102735D-05    5.994534813816D-07    8.163420117561D-08
       7    5.871647174879D-06   -7.017526293806D-08   -7.321361270638D-08
       8   -4.869333174029D-07    2.666937131278D-08    2.907495025800D-09

       E-Index:     6                    7                    8
 T-Index:
       0   -9.996182392999D-05    3.143558308195D-06   -3.894902873796D-08
       1   -1.710731264281D-04    6.171658058460D-06   -8.994609018799D-08
       2    8.489265493722D-06   -2.013488013000D-07    1.438802569384D-09
       3    1.372284113113D-05   -5.221176658885D-07    7.993094218338D-09
       4   -1.193452426271D-06    3.308071890623D-08   -3.519685687680D-10
       5   -2.896287982222D-07    1.562000946898D-08   -3.009928452053D-10
       6    1.559281307950D-09   -6.451643409471D-10    1.995316529751D-11
       7    7.478573101616D-09   -2.883419180345D-10    3.944931881913D-12
       8   -4.438182202186D-10    2.053419620687D-11   -3.291110119780D-13

 Max. rel. Error:   3.5492 %
 Mean rel. Error:   1.1008 %


\end{verbatim}\end{small}
\begin{figure} \label{2.2.14a}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/h2pn3fu.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.2.14b $ H_2^+ + e \rightarrow ...+ H(2) , \   $
Ratio $H(2)/H_2^+  $
}

 Multi-step hydrogenic population coefficients
 Data: T.Fujimoto

 Ratio of population coefficients: p(2)/nH2+

\begin{small}\begin{verbatim}

       E-Index:     0                    1                    2
  T-Index:
       0   -1.893340627587D+01    9.384468043754D-01    6.845844295054D-02
       1   -6.928605971087D-01   -8.026687490301D-02    9.467107255600D-02
       2   -2.281426599901D-02    2.469204550924D-02   -2.484665906437D-02
       3    7.477602038370D-02    2.032608947899D-02   -2.519725182225D-02
       4    1.800864421577D-02   -6.090658281624D-03    7.017163446504D-03
       5   -7.998916722808D-03   -9.279887714293D-05    2.698897287206D-04
       6   -3.810034520682D-04   -2.106056251267D-05   -1.953567231400D-05
       7    2.854892030780D-04    4.128701336617D-05   -4.250413339334D-05
       8   -2.071857549683D-05   -4.001420432076D-06    4.379705502021D-06

       E-Index:     3                    4                    5
```

```
  T-Index:
        0   -3.000866490557D-02    6.301221120024D-03   -7.121426054946D-04
        1   -4.166524495938D-02    8.977392904028D-03   -1.051153710461D-03
        2    9.033528728860D-03   -1.517598590401D-03    1.263880354474D-04
        3    1.162950470259D-02   -2.606098938264D-03    3.140565339454D-04
        4   -3.000019054211D-03    6.218383225871D-04   -6.912762960613D-05
        5   -2.042942399126D-04    6.121533276155D-05   -8.909019790621D-06
        6    3.395544918660D-05   -1.198646949905D-05    1.803522408198D-06
        7    1.505473503739D-05   -2.586687292054D-06    2.484264221846D-07
        8   -1.726884062383D-06    3.360010725821D-07   -3.628922644305D-08

        E-Index:     6                    7                    8
  T-Index:
        0    4.370331341973D-05   -1.366214208274D-06    1.690062454965D-08
        1    6.808364131429D-05   -2.298331729242D-06    3.151517460256D-08
        2   -4.822206870495D-06    5.000680158777D-08    8.129482308185D-10
        3   -2.070880988429D-05    7.034167608369D-07   -9.610489042355D-09
        4    4.193160605355D-06   -1.303566995266D-07    1.616380399841D-09
        5    6.656671628061D-07   -2.464877011413D-08    3.582951420528D-10
        6   -1.317043941884D-07    4.601629603901D-09   -6.103803830641D-11
        7   -1.416917248903D-08    4.608792938645D-10   -6.675661118338D-12
        8    2.234037377054D-09   -7.375120969117D-11    1.017886320572D-12

  Max. rel. Error:  10.9817 %
  Mean rel. Error:   4.1166 %


\end{verbatim}\end{small}
\begin{figure} \label{2.2.14b}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/h2pn2fu.ps}
\end{figure}
\newpage

\subsection{
Reaction 2.2.14c $ H_2^+ + e \rightarrow ...+ H(4) , \   $
Ratio $H(4)/H_2^+  $
}

 Multi-step hydrogenic population coefficients
 Data: T.Fujimoto

 Ratio of population coefficients: p(4)/nH2+


\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
  T-Index:
        0   -1.676331978580D+01    9.080085441987D-01    1.147906180602D-01
        1   -6.109051309024D-01   -8.294588654086D-03    1.632432484919D-02
        2   -2.909737666296D-02    5.624264669551D-03   -1.197286367681D-02
        3    7.623264778786D-03   -9.078213947581D-04    5.223194421632D-03
        4    1.521423403054D-02    1.676511919497D-03   -2.501873457928D-03
        5   -9.030920815279D-04   -1.632212690782D-03    1.351745824791D-03
        6   -1.243913874997D-03    5.018902795712D-04   -3.645436069304D-04
        7    2.498705414219D-04   -6.291439776017D-05    4.327516333116D-05
        8   -1.382134054195D-05    2.822461526917D-06   -1.872083205062D-06

        E-Index:     3                    4                    5
  T-Index:
```

```
        0   -5.270106237531D-02    1.127860512722D-02   -1.245143403573D-03
        1   -1.096202696457D-02    3.286907157227D-03   -4.917565920190D-04
        2    7.584360997821D-03   -2.062094702685D-03    2.791821975336D-04
        3   -3.449375282404D-03    8.838838532938D-04   -1.095438324110D-04
        4    1.102143471476D-03   -2.160129746705D-04    2.129894386269D-05
        5   -3.962453758917D-04    5.313919176171D-05   -3.533864379468D-06
        6    9.622258500169D-05   -1.184926396450D-05    7.911742891778D-07
        7   -1.107791453066D-05    1.379188891744D-06   -1.041402141388D-07
        8    4.704345845794D-07   -5.961078067778D-08    4.961931789364D-09

        E-Index:     6                    7                    8
  T-Index:
        0    7.175810811923D-05   -2.069167769109D-06    2.363328371263D-08
        1    3.752753236914D-05   -1.408607567442D-06    2.070687771858D-08
        2   -1.963835974805D-05    6.884652898708D-07   -9.525997813634D-09
        3    7.004585234319D-06   -2.213148187150D-07    2.720461054725D-09
        4   -1.080619499451D-06    2.598412251320D-08   -2.157639142592D-10
        5    1.153292411062D-07   -1.686998701330D-09    9.600285735482D-12
        6   -3.457481362906D-08    1.132144357690D-09   -1.987071178818D-11
        7    5.897518730021D-09   -2.354087236528D-10    4.278831126984D-12
        8   -3.227509261038D-10    1.380778939747D-11   -2.522987941747D-13

  Max. rel. Error:   3.2596 %
  Mean rel. Error:   1.2619 %

\end{verbatim}\end{small}
\begin{figure} \label{2.2.14c}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/h2pn4fu.ps}
\end{figure}
\newpage


\subsection{
Reaction 2.2.14d $ H_2^+ + e \rightarrow ...+ H(5) , \   $
Ratio $H(5)/H_2^+  $
}

 Multi-step hydrogenic population coefficients
 Data: T.Fujimoto

 Ratio of population coefficients: p(5)/nH2+

\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
  T-Index:
        0   -1.644185145736D+01    1.012436644382D+00    6.786438608987D-03
        1   -6.098791364927D-01    5.430488667435D-02   -7.847894120730D-02
        2   -2.950068702716D-02   -3.373771077709D-02    3.289895028745D-02
        3    6.754065058068D-03    7.451626213157D-03   -3.969682127389D-03
        4    1.537038416857D-02    4.118426250990D-03   -4.555083248726D-03
        5   -9.947711516605D-04   -1.833979398896D-03    1.801381990375D-03
        6   -1.192700661337D-03    3.791226761015D-05   -3.145634625643D-05
        7    2.404465554223D-04    5.021181230894D-05   -5.066197038660D-05
        8   -1.326828264262D-05   -4.564492434807D-06    4.606059092522D-06

        E-Index:     3                    4                    5
  T-Index:
        0   -1.636359203529D-02    6.460968901937D-03   -1.074723144885D-03
        1    3.737579519968D-02   -8.178265373295D-03    9.193848105982D-04
```

```
        2   -1.134088065312D-02    1.754362025677D-03   -1.242294410730D-04
        3    1.576874933190D-04    2.391978264795D-04   -5.252636585235D-05
        4    1.826529292073D-03   -3.545645854345D-04    3.657837147066D-05
        5   -6.662982315176D-04    1.215614803183D-04   -1.209604459175D-05
        6    1.450525549912D-05   -3.710641046768D-06    5.511118540490D-07
        7    1.829155353709D-05   -3.170388065293D-06    2.866743369560D-07
        8   -1.697317371127D-06    3.048871380215D-07   -2.932146588732D-08

        E-Index:     6                    7                    8
  T-Index:
        0    8.419235123864D-05   -3.153526630862D-06    4.581163952178D-08
        1   -5.560014479351D-05    1.725272054044D-06   -2.159304879239D-08
        2    3.243207880260D-06    3.071703458548D-08   -2.031512439383D-09
        3    4.543948082974D-06   -1.784049810861D-07    2.642282279507D-09
        4   -2.037354098418D-06    5.743682572167D-08   -6.369815462623D-10
        5    6.745084225490D-07   -1.997093162477D-08    2.459303044047D-10
        6   -4.734113162030D-08    2.110906778108D-09   -3.702822546028D-11
        7   -1.322386162924D-08    2.686441115973D-10   -1.341741119398D-12
        8    1.518492393831D-09   -3.921390964093D-11    3.853896510803D-13

  Max. rel. Error:   3.3950 %
  Mean rel. Error:   1.2048 %

\end{verbatim}\end{small}
\begin{figure} \label{2.2.14d}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/h2pn5fu.ps}
\end{figure}
\newpage


\subsection{
Reaction 2.2.14e $ H_2^+ + e \rightarrow ...+ H(6) , \   $
Ratio $H(6)/H_2^+  $
}

 Multi-step hydrogenic population coefficients
 Data: T.Fujimoto

 Ratio of population coefficients: p(6)/nH2+

\begin{small}\begin{verbatim}

        E-Index:     0                    1                    2
  T-Index:
        0   -1.622999065239D+01    1.114789960848D+00   -1.520045539695D-01
        1   -6.128088795544D-01    4.799590905456D-02   -6.226002600050D-02
        2   -2.843662556626D-02   -2.981491981788D-02    3.771158615252D-02
        3    9.040540246117D-03   -5.376296672908D-03    2.724387350634D-03
        4    1.488157339780D-02    4.117070101509D-03   -3.845342947354D-03
        5   -1.100892809269D-03    6.973802180775D-05    2.700981820011D-04
        6   -1.154443469425D-03   -2.746343562656D-04    1.329065248252D-04
        7    2.372720363390D-04    4.450995037612D-05   -2.399096395388D-05
        8   -1.321939690927D-05   -2.168171198227D-06    1.138090912890D-06

        E-Index:     3                    4                    5
  T-Index:
        0    6.454947459361D-02   -1.251452482400D-02    1.176116823129D-03
        1    3.120222040133D-02   -7.656737664171D-03    9.697768241674D-04
        2   -1.714743824449D-02    3.730164832607D-03   -4.245864266326D-04
```

```
        3   -7.284121072944D-04    1.754857033177D-04   -2.833588922766D-05
        4    1.501531035131D-03   -3.095442801682D-04    3.552383842276D-05
        5   -1.870097557763D-04    4.709088535767D-05   -5.863892714562D-06
        6   -1.824639804367D-05   -6.062961769823D-07    4.017509350696D-07
        7    4.371493229928D-06   -2.114447008583D-07   -3.261214899093D-08
        8   -1.889513057698D-07    3.153827435466D-09    2.672896065823D-09

        E-Index:     6                    7                    8
  T-Index:
        0   -5.801776455917D-05    1.436236089573D-06   -1.386191157402D-08
        1   -6.554993759673D-05    2.252572465958D-06   -3.097271363753D-08
        2    2.617269803427D-05   -8.313443339779D-07    1.069290183120D-08
        3    2.404364824295D-06   -9.739423966586D-08    1.496981935094D-09
        4   -2.266688480662D-06    7.510316070422D-08   -1.007253682698D-09
        5    3.929720894592D-07   -1.368756170273D-08    1.948330325484D-10
        6   -4.284044640046D-08    1.967059565426D-09   -3.388443373389D-11
        7    5.152899170025D-09   -2.667100015865D-10    4.835046441176D-12
        8   -3.370174839133D-10    1.633061281105D-11   -2.854661230035D-13

  Max. rel. Error:   3.0278 %
  Mean rel. Error:   1.1252 %

\end{verbatim}\end{small}
\begin{figure} \label{2.2.14e}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/h2pn6fu.ps}
\end{figure}
\newpage

 Multi-step hydrogenic population coefficients
 Data: T.Fujimoto, P.T. Greenland

 Ratio of population coefficients: p(3)/nH-

\subsection{
Reaction 7.2a $ H^- + p \rightarrow ...+ H(3) , \   $
Ratio $H(3)/H^- $
}

\begin{small}\begin{verbatim}

        E-Index:     0                    1                    2
  T-Index:
        0   -1.698348739110D+01    1.121505448583D+00   -1.562056461483D-01
        1   -1.986622381979D-01   -2.318217689253D-02    1.896031486639D-02
        2   -3.050975728615D-03   -3.329699545201D-02    3.779763018328D-02
        3    1.002499912290D-02    1.045462457960D-02   -9.650053061780D-03
        4   -6.398953884751D-04    1.441395323793D-03   -1.689635207883D-03
        5   -7.711075007663D-05   -1.265328413655D-03    1.172945655383D-03
        6   -2.049983387516D-05    2.044766998421D-04   -1.600026196636D-04
        7    6.408878869927D-06   -7.052533095200D-06    1.334460994662D-07
        8   -3.926518102708D-07   -4.161804947648D-07    7.965715911231D-07

        E-Index:     3                    4                    5
  T-Index:
        0    7.384423345663D-02   -1.696804365272D-02    2.090058776152D-03
        1   -3.664162784606D-03   -4.356306374247D-04    2.146755452836D-04
        2   -1.612181968354D-02    3.403282708663D-03   -3.903169292552D-04
        3    3.237264411283D-03   -4.804144315515D-04    2.972541984716D-05
        4    7.163905079239D-04   -1.561640485896D-04    1.914209762341D-05
```

```
       5   -4.120367467656D-04    7.008894220942D-05   -6.189441302916D-06
       6    5.033444502959D-05   -7.181438176276D-06    4.108056332733D-07
       7    1.170985498327D-06   -4.690125988575D-07    8.503464517525D-08
       8   -3.594245312260D-07    7.814690334520D-08   -9.611375720209D-09

       E-Index:     6                    7                    8
  T-Index:
       0   -1.399195453462D-04    4.756587306459D-06   -6.422505400847D-08
       1   -2.514789071754D-05    1.212290889597D-06   -2.106280292156D-08
       2    2.457727782342D-05   -7.941349227263D-07    1.025519706079D-08
       3   -1.694973729097D-07   -5.142251421864D-08    1.423052870937D-09
       4   -1.305410385352D-06    4.544728618553D-08   -6.246887421462D-10
       5    2.736219149295D-07   -4.974014655394D-09    1.101207197277D-11
       6    1.974698869452D-09   -1.016713293612D-09    2.621621803143D-11
       7   -7.763141441637D-09    3.392374094524D-10   -5.632384756330D-12
       8    6.750917451519D-10   -2.475979110847D-11    3.641741567554D-13

  Max. rel. Error:   3.9821 %
  Mean rel. Error:   1.1463 %


\end{verbatim}\end{small}
\begin{figure} \label{7.2a}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hmn3fu.ps}
\end{figure}
\newpage


\subsection{
Reaction 7.2b $ H^- + p \rightarrow ...+ H(2) , \  $
Ratio $H(2)/H^- $
}
 Multi-step hydrogenic population coefficients
 Data: T.Fujimoto, P.T. Greenland

 Ratio of population coefficients: p(2)/nH-

\begin{small}\begin{verbatim}

       E-Index:     0                    1                    2
  T-Index:
       0   -1.926343612010D+01    9.700693610120D-01    3.086732967457D-02
       1   -1.496546124174D-01   -1.162600124695D-02    2.092625890254D-02
       2    1.400659517460D-02   -1.908809713587D-03    4.474825228504D-03
       3    3.712727041944D-02   -3.993957797149D-03   -4.541915418960D-04
       4    1.113294261028D-02    1.611302161934D-03   -5.800693212819D-04
       5   -2.330535554138D-03    9.558196184261D-04   -6.770389256165D-04
       6   -7.776821303119D-04   -4.777860585666D-04    3.191698603955D-04
       7    1.906239407094D-04    6.855600321265D-05   -4.406502657234D-05
       8   -1.086976945156D-05   -3.231539920350D-06    1.960565560845D-06

       E-Index:     3                    4                    5
  T-Index:
       0   -1.026100449251D-02    1.333365556163D-03   -4.164574430779D-05
       1   -1.057668991857D-02    2.292243771977D-03   -2.438392602831D-04
       2   -3.880343783906D-03    1.355446874959D-03   -2.254517664957D-04
       3    1.729089007572D-03   -5.825182714335D-04    8.058493209277D-05
       4    3.161122491789D-05   -4.291165076538D-06    3.882643863521D-06
       5    1.355992925800D-04   -1.875746974531D-06   -2.072988238143D-06
```

```
       6   -7.101794671976D-05    5.892592961569D-06   -1.070175076067D-07
       7    9.542955450383D-06   -7.940664442729D-07    2.114115776211D-08
       8   -3.805705631298D-07    2.128669195423D-08    9.157761577608D-10

       E-Index:     6                    7                    8
  T-Index:
       0   -4.925686587468D-06    4.112831538264D-07   -8.777239592815D-09
       1    1.320368718562D-05   -3.516108767654D-07    3.593691259527D-09
       2    1.896658591425D-05   -7.769484207076D-07    1.231580177702D-08
       3   -5.398656503144D-06    1.737911735033D-07   -2.130553272068D-09
       4   -6.162993739156D-07    3.529468645256D-08   -6.926859162458D-10
       5    2.283983783682D-07   -9.387255029589D-09    1.353162447593D-10
       6   -5.193261748972D-09   -8.326872653843D-12    8.362383797066D-12
       7   -2.705240932212D-10    5.067994995276D-11   -2.001347795107D-12
       8   -1.122561005445D-10    1.928570020702D-12    3.288397756094D-14

  Max. rel. Error:   4.1304 %
  Mean rel. Error:    .7570 %



\end{verbatim}\end{small}
\begin{figure} \label{7.2b}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hmn2fu.ps}
\end{figure}
\newpage

 Multi-step hydrogenic population coefficients
 Data: T.Fujimoto, P.T. Greenland

 Ratio of population coefficients: p(4)/nH-

\subsection{
Reaction 7.2c $ H^- + p \rightarrow ...+ H(4) , \  $
Ratio $H(4)/H^- $
}

\begin{small}\begin{verbatim}


       E-Index:     0                    1                    2
  T-Index:
       0   -2.969108713736D+01    1.931658904309D+00    7.005369877806D-02
       1    8.583491624134D-01   -8.544233834909D-02    9.904671957939D-02
       2   -3.327946567475D-01    1.355262241947D-02   -1.899077114113D-02
       3    8.772623007048D-02   -4.247217004031D-03    6.314342474404D-03
       4   -2.582394435391D-02    1.090757038295D-03   -1.202894310870D-03
       5    6.746292673873D-03   -3.228772733572D-04    1.070577412178D-04
       6   -1.132324670043D-03    6.889983086344D-05   -6.086331074514D-07
       7    1.006838799981D-04   -5.193593477524D-06   -2.845251555754D-06
       8   -3.599766107118D-06    3.508499294249D-08    3.027924280383D-07

       E-Index:     3                    4                    5
  T-Index:
       0   -2.422134716752D-02    3.199185442634D-03   -6.987784095340D-05
       1   -4.450036905348D-02    9.670609772772D-03   -1.101676052891D-03
       2    8.393372221366D-03   -1.661524835400D-03    1.641367406906D-04
       3   -2.639744634139D-03    5.083813172965D-04   -5.282312671120D-05
       4    3.818974330343D-04   -6.097846279683D-05    6.274556790674D-06
```

```
       5    9.032592725060D-06   -6.659380541156D-06    8.007827323926D-07
       6   -7.241191756806D-06    1.656854215049D-06   -1.498873287066D-07
       7    1.401115633607D-06   -2.121062436653D-07    1.534383868464D-08
       8   -1.101496052033D-07    1.593127950555D-08   -1.277557055555D-09

       E-Index:     6                    7                    8
  T-Index:
       0   -1.803884638427D-05    1.309228115068D-06   -2.572694262914D-08
       1    6.597236559178D-05   -1.961355019834D-06    2.274461149865D-08
       2   -8.182135682187D-06    1.912043686849D-07   -1.561456368451D-09
       3    3.184968943859D-06   -1.061178779633D-07    1.506697376442D-09
       4   -4.432073749742D-07    1.802283140716D-08   -2.998106690730D-10
       5   -3.770998670281D-08    7.419022111792D-10   -5.644157060356D-12
       6    7.339285822808D-09   -2.538540703677D-10    5.059927143765D-12
       7   -7.934859405533D-10    3.738687857068D-11   -8.858974656396D-13
       8    7.567293625031D-11   -3.326379990558D-12    6.790144662322D-14

  Max. rel. Error:   4.0429 %
  Mean rel. Error:   1.7450 %


\end{verbatim}\end{small}
\begin{figure} \label{7.2c}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hmn4fu.ps}
\end{figure}
\newpage

 Multi-step hydrogenic population coefficients
 Data: T.Fujimoto, P.T. Greenland

 Ratio of population coefficients: p(5)/nH-

\subsection{
Reaction 7.2d $ H^- + p \rightarrow ...+ H(5) , \  $
Ratio $H(5)/H^- $
}

\begin{small}\begin{verbatim}


       E-Index:     0                    1                    2
  T-Index:
       0   -3.043880324651D+01    2.037032074318D+00   -5.086322906145D-02
       1    1.011406665313D+00   -6.365628088545D-02    7.087018763490D-02
       2   -4.732792128048D-01   -1.434223357911D-02    1.444177153118D-02
       3    1.440745315416D-01    3.264873576448D-03    1.234505116701D-04
       4   -4.082830889986D-02    1.991190906181D-03   -2.756435764540D-03
       5    9.541548408277D-03   -9.069208554478D-04    6.996980010317D-04
       6   -1.454117847671D-03    1.551884580262D-04   -5.857488300427D-05
       7    1.198928707328D-04   -1.400228251698D-05    6.473439676219D-07
       8   -4.030214875087D-06    6.097512779644D-07    4.415255128121D-08

       E-Index:     3                    4                    5
  T-Index:
       0    2.509733144867D-02   -6.315994199856D-03    8.827794491945D-04
       1   -2.975345239990D-02    5.983399626204D-03   -6.277759777604D-04
       2   -5.166305865235D-03    9.106705396634D-04   -8.761725049017D-05
       3   -1.123250849126D-03    4.288583660416D-04   -6.890481712127D-05
       4    1.147789672027D-03   -2.316365246467D-04    2.543759697649D-05
```

```
       5   -1.993228761853D-04    2.517330858438D-05   -1.247794740929D-06
       6    9.762118554856D-06   -3.741044970390D-07   -9.913305397062D-08
       7    2.196741015054D-07    6.182578609139D-08   -2.188081446861D-08
       8   -1.180565156491D-09   -1.449312603808D-08    3.350274299704D-09

       E-Index:     6                    7                    8
  T-Index:
       0   -6.942768316956D-05    2.730469037199D-06   -4.155159141638D-08
       1    3.369864501513D-05   -8.510546585606D-07    7.531215060388D-09
       2    4.914337425208D-06   -1.501058689051D-07    1.891596830989D-09
       3    5.529304847315D-06   -2.178898125651D-07    3.358437789658D-09
       4   -1.555058635679D-06    4.945103866119D-08   -6.348990139489D-10
       5   -1.032098974250D-08    3.032884418381D-09   -7.544164802502D-11
       6    1.356968032839D-08   -6.737882205239D-10    1.229312195398D-11
       7    2.266731611803D-09   -9.840633948791D-11    1.532952032542D-12
       8   -3.079193750552D-10    1.282055029730D-11   -2.003506603284D-13

  Max. rel. Error:   3.6382 %
  Mean rel. Error:   1.4968 %

\end{verbatim}\end{small}
\begin{figure} \label{7.2d}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/hmn5fu.ps}
\end{figure}
\newpage

 Multi-step hydrogenic population coefficients
 Data: T.Fujimoto, P.T. Greenland

 Ratio of population coefficients: p(6)/nH-

\subsection{
Reaction 7.2e $ H^- + p \rightarrow ...+ H(6) , \  $
Ratio $H(6)/H^- $
}

\begin{small}\begin{verbatim}



       E-Index:     0                    1                    2
  T-Index:
       0   -3.067097488487D+01    2.133892956222D+00   -1.858785381782D-01
       1    1.107995704752D+00   -7.267316900367D-02    8.619894154229D-02
       2   -5.345011110243D-01   -3.782902464706D-02    3.756478330674D-02
       3    1.764954640174D-01   -1.032649676351D-02    6.464524722712D-03
       4   -5.202491523226D-02    9.880352020439D-03   -7.493150468782D-03
       5    1.098049582592D-02    6.531384081385D-04   -4.330923663414D-04
       6   -1.298474536154D-03   -1.099967577090D-03    7.673435067944D-04
       7    6.641085066002D-05    1.987746890586D-04   -1.359755033628D-04
       8   -6.055672527870D-07   -1.099732061179D-05    7.398032652292D-06

       E-Index:     3                    4                    5
  T-Index:
       0    9.184112431405D-02   -2.187443850319D-02    2.732957962088D-03
       1   -3.580517565764D-02    6.746409669729D-03   -6.444562044629D-04
       2   -1.526915092790D-02    3.195158804825D-03   -3.642351248993D-04
       3   -1.591669787688D-03    2.306297194231D-04   -2.527875779410D-05
       4    2.344024954832D-03   -3.904912867153D-04    3.759207667760D-05
```

```
       5    8.191445720958D-05    3.579949470965D-07   -1.520984760597D-06
       6   -2.001600190074D-04    2.348421586345D-05   -1.161204797043D-06
       7    3.467501043759D-05   -3.909320595026D-06    1.690954968052D-07
       8   -1.839785030150D-06    1.966330012309D-07   -6.837510677821D-09

       E-Index:     6                    7                    8
  T-Index:
       0   -1.868296143542D-04    6.535291194065D-06   -9.119318650851D-08
       1    3.052346096314D-05   -6.246714758968D-07    3.118274317587D-09
       2    2.310260448654D-05   -7.637664587365D-07    1.022317615231D-08
       3    1.917516778339D-06   -7.990930597360D-08    1.329300639507D-09
       4   -2.089962077496D-06    6.184502696051D-08   -7.491029220022D-10
       5    1.631598610791D-07   -6.823070866810D-09    1.018157208247D-10
       6    1.519122575792D-09    1.768275307240D-09   -4.254302334326D-11
       7    2.544277095276D-09   -4.245685956755D-10    9.325245214987D-12
       8   -3.147128047635D-10    2.969365004153D-11   -6.059328354768D-13

  Max. rel. Error:   4.5793 %
  Mean rel. Error:   1.9756 %

\end{verbatim}\end{small}
\begin{figure} \label{7.2e}
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\end{figure}
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\subsection{
Reaction 2.0a Ratio $H_2^+/H_2$, from electr. impact only
}

 Multi-step hydrogenic density ratios
 Data: T.Fujimoto, P.T. Greenland


  Ratio H2+ to H2 density
  (coll.rad model, Sawada/Fujimoto/Greenland)

  only contribution from  EI on H2*


\begin{small}\begin{verbatim}
       E-Index:     0                    1                    2
  T-Index:
       0   -1.929803964240D+01    2.097006502950D-01   -1.100904809661D-01
       1    1.727612905933D+01   -4.662670859833D-01    8.567341672326D-02
       2   -8.438025952533D+00    6.115179297110D-01   -1.153478632323D-01
       3    2.883389908864D+00   -4.286361930144D-01    6.596018559458D-02
       4   -7.403401021470D-01    1.809442086665D-01   -1.864042138902D-02
       5    1.387371448471D-01   -4.879175895909D-02    4.430141421894D-03
       6   -1.746217632264D-02    8.151856339270D-03   -1.015594807894D-03
       7    1.287561948974D-03   -7.544209459715D-04    1.374937928555D-04
       8   -4.136061327089D-05    2.914443517923D-05   -7.106408217685D-06

       E-Index:     3                    4                    5
  T-Index:
       0    4.477781641551D-02   -9.060826089295D-03    1.170547725039D-03
       1   -6.827368520293D-03   -3.618060467670D-03    6.852659500488D-04
       2    1.993457166448D-02    1.643837202714D-04   -3.516424328964D-04
       3   -1.341784022457D-02    1.582201264314D-03   -7.056994955968D-05
```

```
        4    1.875666968084D-03   -2.978688155916D-04    2.721069163086D-05
        5    1.476743155802D-04   -3.955049388000D-05    2.382368688632D-06
        6    6.205132641268D-06    7.210178682186D-06   -6.812476857444D-07
        7   -1.222677896703D-05    8.247029259344D-07   -5.043186962921D-08
        8    1.041267499432D-06   -1.158374992604D-07    9.052478729563D-09

        E-Index:     6                    7                    8
  T-Index:
        0   -8.893455666588D-05    3.479454987799D-06   -5.361512296401D-08
        1   -4.473404420068D-05    1.209602016239D-06   -1.069974187479D-08
        2    3.207886028645D-05   -1.101305933603D-06    1.299192188737D-08
        3    4.431489645883D-07    2.326874797653D-08    1.068518137706D-10
        4   -1.428413713222D-06    4.845148645034D-08   -8.048035605554D-10
        5   -5.790867265229D-08   -6.986008432331D-10    4.535659079263D-11
        6    3.277446170025D-08   -8.583517963518D-10    9.700723935742D-12
        7    2.025920058300D-09   -3.655728430701D-11    8.337869178540D-14
        8   -4.280094258996D-10    1.063115935764D-11   -1.030790224273D-13

  Max. rel. Error:   1.8077 %
  Mean rel. Error:    .3852 %

\end{verbatim}\end{small}
\begin{figure} \label{h12_2.0a}
\epsfxsize=16truecm
\epsffile{Amjuel_PS/ratioH12_2a.ps}
\end{figure}

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\subsection{
Reaction 2.0b Ratio $H_2^+/H_2$, from EI plus CX on $H_2(v=0)$
}

 Multi-step hydrogenic density ratios
 Data: T.Fujimoto, P.T. Greenland


  Ratio H2+ to H2 density
  (coll.rad model, Sawada/Fujimoto/Greenland)

  only contribution from  EI on H2*  and from CX on H2(v=0)


\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
  T-Index:
        0   -8.073335051460D+00    6.423193640255D-03   -8.948271203923D-03
        1    1.653303173229D+00   -2.467726829997D-02    2.781981866915D-03
        2   -2.823571725913D+00    4.179798625064D-02   -3.843754761904D-02
        3    3.990452244578D+00    3.234966368980D-02    1.652438305320D-02
        4   -1.928017324234D+00   -5.924941119276D-02    2.747810096639D-03
        5    4.270719810226D-01    3.111963342548D-02   -5.375451827926D-03
        6   -4.448144242484D-02   -7.757664930424D-03    2.077957627729D-03
        7    1.689930248766D-03    9.331136287171D-04   -3.275780863917D-04
        8    1.023775315217D-05   -4.333393780782D-05    1.830671388026D-05

        E-Index:     3                    4                    5
  T-Index:
        0    4.582288903630D-03   -1.133062383784D-03    1.472017794904D-04
        1    2.885192609023D-03   -9.313120366375D-04    1.193603851194D-04
        2    1.457779901878D-02   -2.689882985994D-03    2.781888663389D-04
```

```
        3   -1.096201612859D-02    1.873511746692D-03   -1.169697988538D-04
        4    5.081237207186D-03   -1.022266662048D-03    5.028620238286D-05
        5   -1.087834901368D-03    3.309186604685D-04   -2.068184308171D-05
        6   -4.372642244363D-05   -3.372497244723D-05    2.250956728263D-06
        7    4.092745909295D-05   -2.274671467977D-06    2.463960054850D-07
        8   -3.393709830706D-06    3.905523509303D-07   -3.774892100311D-08

        E-Index:     6                    7                    8
  T-Index:
        0   -1.037336914709D-05    3.752297970376D-07   -5.454015313711D-09
        1   -7.537317404876D-06    2.293533267915D-07   -2.631009817091D-09
        2   -1.566116716437D-05    4.383284185329D-07   -4.647720359472D-09
        3    3.575003652413D-07    2.295739667060D-07   -6.354279184897D-09
        4    1.852056305253D-06   -2.235055431776D-07    5.044313531628D-09
        5   -1.431641793698D-07    4.978742338393D-08   -1.196745758163D-09
        6    4.433372743456D-08   -7.031624330495D-09    1.525402495797D-10
        7   -2.449746761192D-08    1.051457900024D-09   -1.574612982461D-11
        8    2.386870809793D-09   -7.721695858310D-11    9.552566353384D-13

  Max. rel. Error:  20.6614 %
  Mean rel. Error:   8.5812 %

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\subsection{
Reaction 2.0c   Ratio $H_2^+/H_2$ from EI plus CX on $H_2(v)$}

 Multi-step hydrogenic density ratios
 Data: T.Fujimoto, P.T. Greenland


  Ratio H2+ to H2 density
  (coll.rad model, Sawada/Fujimoto/Greenland)
  contribution from CX on H2(v) and EI on H2*


Should be larger than corresponding H11 ratio for contrib. from cx alone.
Slightly violated due to fitting problem near 1-2 eV

\begin{small}\begin{verbatim}
        E-Index:     0                    1                    2
  T-Index:
        0   -5.179118614571D+00    1.286086917362D-02   -1.247224025136D-02
        1    2.724390078109D+00    2.834163745797D-02   -3.864050364482D-02
        2   -4.386686018740D+00   -2.926061072808D-02    2.894878695435D-02
        3    2.264569877939D+00    1.815438259403D-02   -1.085596419844D-02
        4    7.274238145138D-02   -8.711469240181D-03    1.228482582919D-03
        5   -3.332379782334D-01    3.737790746246D-03   -2.689540529741D-04
        6    9.526327139861D-02   -1.046333532366D-03    2.549358736065D-04
        7   -1.096455316607D-02    1.457992401832D-04   -5.912048929304D-05
        8    4.636081955869D-04   -7.621573981592D-06    3.973565261183D-06

        E-Index:     3                    4                    5
  T-Index:
        0    4.533679343348D-03   -8.361635510932D-04    8.553044625491D-05
        1    1.706652099436D-02   -3.663038423578D-03    4.202564138138D-04
```

```
        2   -9.446648200804D-03    1.518996106179D-03   -1.265997327758D-04
        3    3.413100865417D-03   -5.414461499166D-04    5.583904028460D-05
        4   -2.783712092681D-04    4.118527168273D-05   -1.416596336268D-05
        5   -7.626065770945D-05    3.568228589947D-05   -1.406315371249D-06
        6   -3.059560467433D-05   -3.460893323989D-06    4.064186524949D-07
        7    1.303239138604D-05   -1.086383020673D-06    6.161003040376D-08
        8   -1.046764002685D-06    1.291713097220D-07   -9.932517910526D-09

        E-Index:     6                    7                    8
  T-Index:
        0   -4.999715093023D-06    1.571098567732D-07   -2.060813085997D-09
        1   -2.662584829521D-05    8.795062121815D-07   -1.182222955604D-08
        2    5.854399926391D-06   -1.486122653306D-07    1.689012430939D-09
        3   -3.494312204501D-06    1.176151828469D-07   -1.631239647294D-09
        4    1.434270108351D-06   -5.449461807998D-08    6.856555143001D-10
        5   -3.197342970575D-08   -4.539301068809D-10    9.975543797298D-11
        6   -3.342848157445D-08    2.469622408760D-09   -6.675572336239D-11
        7    2.239916154599D-10   -2.455363614572D-10    7.954115052237D-12
        8    3.412487324650D-10    1.748563436447D-12   -2.514652180013D-13

  Max. rel. Error:  18.5554 %
  Mean rel. Error:   8.9531 %

\end{verbatim}\end{small}
\begin{figure} \label{2.0c}
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\epsffile{Amjuel_PS/ratioH12_2bc.ps}
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\section{Appendix}
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\begin{thebibliography}{99}
\bibitem{kn:Ehrhardt}  A.B.Ehrhardt, W.D.Langer, PPPL 2477 (1987)
\bibitem{kn:Janev} R.K. Janev et al.  Springer Series on Atoms+Plasmas,
                   Vol 4, 1987
\bibitem{kn:Riviere} A.C.Riviere, Nucl.Fus. 11 (1971), p363
\bibitem{kn:Mahn} C.Mahn, V.Welge, IPP 2/239, June 1978
\bibitem{kn:Reiter91c} Reiter, D., Eckstein, W., Giesen, G., Belitz,
                    H.J.,
                    Database for recycling and penetration of neutral
                    helium atoms in the boundary of a fusion plasma,
                    J\"ul-2605 (1991)
\bibitem{kn:Sawada} Sawada,K.,  Fujimoto,T., J.Appl.Phys.78 (5), (1995)
                    ,p2913
\bibitem{kn:Bell}  Bell et al.,"Atomic and molecular data for fusion, part I:
recommended cross sections and rates for electron ionisation of light atoms and ions"
 report CLM-R 216, UKAEA Culham, 1982
\bibitem{kn:Bachmann}  Bachmann, P., Reiter, D., Contrib. Plas. Phys.
                       35, (1995), 1, pp45
\bibitem{kn:Green} Greenland, T., Reiter, D.,
                    The Role of Molecular Hydrogen in Plasma
                    Recombination
                    J\"ul-3258 (1996)
\bibitem{kn:Behringer} Behringer, K., STRAHL code and ADAS 89
\bibitem{kn:Schultz} Schultz, D. in "Atomic and Molecular Processes in Fusion
                     Edge Plasmas", ed.: Janev, R.K., Plenum Press, New York, 1995
\bibitem{kn:Freeman} Freeman, Jones, Culham report
\bibitem{kn:Fujimoto} Fujimoto, He-col.rad. model
 \end{thebibliography}
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