MODULE 5
Charge exchange and beam emission spectroscopy. Modelling emitter populations, beam stopping and analysing spectra

Demonstration script

Hugh Summers, Martin O'Mullane and Alessandra Giunta

July 19, 2013

Contents

1 Demo (a) Looking at basic charge exchange and ion impact cross-section data 3

1.1 Demo (a-1) Figures 4
1.2 Demo (a-2) IDL procedure 7
1.3 Demo (a-2) Figures 8
1.4 Demo (a-3) IDL procedure 12
1.5 Demo (a-3) Figures 14

2 Demo (b) Obtaining charge exchange receiver populations driven by beams 16

2.1 Demo (b-1) Figures 17
2.2 Demo (b-2) IDL procedure 19
2.3 Demo (b-2) Figures 20

3 Demo (c) Obtaining beam stopping and beam coefficients 22

3.1 Demo (c-1) IDL procedure 24
3.2 Demo (c-1) datasets 27
3.2.1 adf26_h1.pass 27
3.2.2 adf26_c6.pass 29
3.2.3 adf21_h1.pass 30
3.2.4 adf21_c6.pass 32
3.3 Demo (c-2) IDL procedure 35
3.4 Demo (c-2) datasets 35
3.4.1 /bme10#h/bme10#h_h1.dat 35
3.4.2 /bme10#h/bme10#h_c6.dat 37
3.5 Demo (c-3) procedure 40
3.6 Demo (c-3) Figures 43

4 Demo (d) Looking at Stark multiplet emission for the H-beam 46
4.1 Demo (d-1) procedure 47
4.2 Demo(d-1) Figures 49

1 Demo (a) Looking at basic charge exchange and ion impact cross-section data

```
------------------------------
DEMO A: Looking at basic charge exchange and ion impact cross-section data
------------------------------
PURPOSE: Looking at ion impact and charge exchange data. Furthermore a comparison between
ionisation and charge exchange reactions is shown.

Ion-atom impact cross sections are collected in the adf02 files, which provide
data for different reactions.

Selective Charge Exchange (CX) cross sections are stored in the adf01 data files, while ad
state selective charge exchangecross sections for partially stripped receivers.
Thermally averaged total chiarge exchange rate coefficients are given by adf14 files. They
Maxwellian averages over the receiver and donor temperatures.

EXAMPLE: The adf02 for ion-atom cross section selected for this demo is the
following:
/home/adas/adas/adf02/sia#h/sia#h_j99#h.dat

Three reactions have been chosen with corresponding blocks:
1) total charge exchange (cx) transfer: H+0 impact Li+3 -> Li+2
   block=3
2) ionisation: Li+3 target H+0 -> H+
   block=13
3) excitation: Li+3 target H+0 -> H(n=2)
   block=28

Isotopic mass number of primary specie (deuterium has been chosen)=2
Isotopic mass number of secondary specie (lithium)=7

Two adf01s for CX are selected for this demo:
1) Oxygen:  O8+ + H(is) -> O7+ + H+
   /home/adas/adas/adf01/qcx#h0/qcx#h0_old#o8.dat
   For nl-resolved cross section the chosen quantum numbers are:
   n=5, l=1.

2) Lithium: Li3+ + H(1s) -> Li2+ + H+
  /home/adas/adas/adf01/ext#h0/arf07#3/ext#h0_arf07#li3.dat
   For nl-resolved cross section the chosen quantum numbers are:
   n=3, l=0.

For the comparison between charge exchange and electron impact rate coefficients
the following reactions are considered:
1) IONISATION: H+e -> H+ + e + e  electron impact rate from adf11
   /home/adas/adas/adf11/scd12/scd_h.dat
   Two electron density values are selected: 1.e10 cm-3 and 1.e14 cm-3
2) CHARGE EXCHANGE: H + H+ -> H+ + H+  cx rate from
```

```
a) adf14
   /home/adas/adas/adf14/tcx#h0/tcx#h0_h.dat
   Two cases are shown: - no beam -> when the temperature of receiver (Tr) is equal to
   the temperature of donor (Td) and both are equal to the electron temperature
   (Te).
   - cold beam -> Tr = Te and Td = 3 eV
b) cx cross section in the adf24 format,converted into cx rate by ceevth.pro
   The adf24 used is the following:
   /home/adas/adas/adf24/scx#h0/scx#h0_ornl#h1.dat
```

```
DEMO a1: Extract and graph adf02 data interactively with ADAS302
1.Look at the selected adf02 for specifying the blocks corresponding
  to the reactions.
2.Use ADAS302 with the interactive ADAS window for the selected species,
  selecting different reactions (e.g. cx, ionisation, excitation).
3.Compare the different cross sections.
 (output files: demo_a_1_cx.ps, demo_a_1_ion.ps, demo_a_1_exc.ps)

DEMO a2: Extract adf01 data with ADAS301, use read_adf01.pro offline
1. Use ADAS301 with the interactive windows for O and Li
   (outputs: demo_a_2_oxygen.ps, demo_a_2_oxygen_nl.ps,
    demo_a_2_lithium.ps,demo_a_2_lithium_nl.ps).
2. Using the command line:
   a) Use rea_adf01.pro to read the selected adf01 files.
   b) Find the indices corresponding to the n and l specified.
   c) Plot total and selective cx cross sections as a function of energy (eV/amu).
Program: demo_a_2.pro
Output file: demo_a_2.ps

DEMO a3: Comparison between ion impact/cx and electron impact reactions
1. Use read_adf11.pro to read the selected ionisation rate coefficients adf11 for H.
2. Use read_adf14.pro to read thermal cx rate coefficients.
3. Use read_adf24.pro to read the cx cross sections adf24.
4. Use ceevth.pro to produce cx rate for H from adf24 data.
5. Compare the results (adf11 with adf14 and output of ceevth.pro)
Program: demo_a_3.pro
Output file: demo_a_3.ps
```

1.1 Demo (a-1) Figures

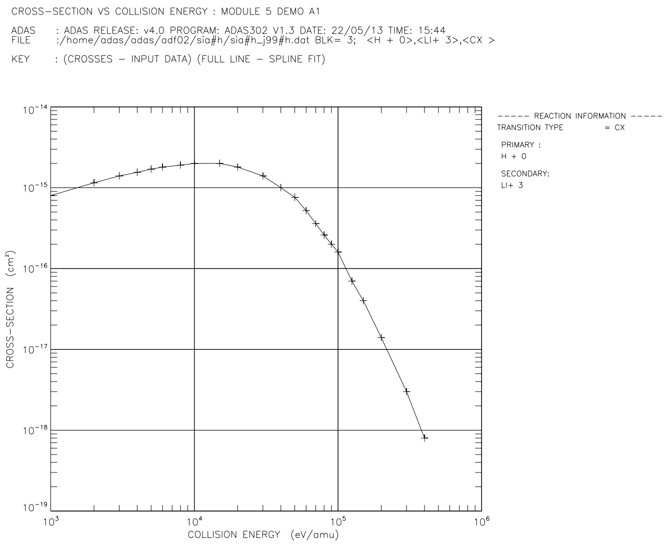

Figure 1: demo_a/demo_a_1_cx.pdf

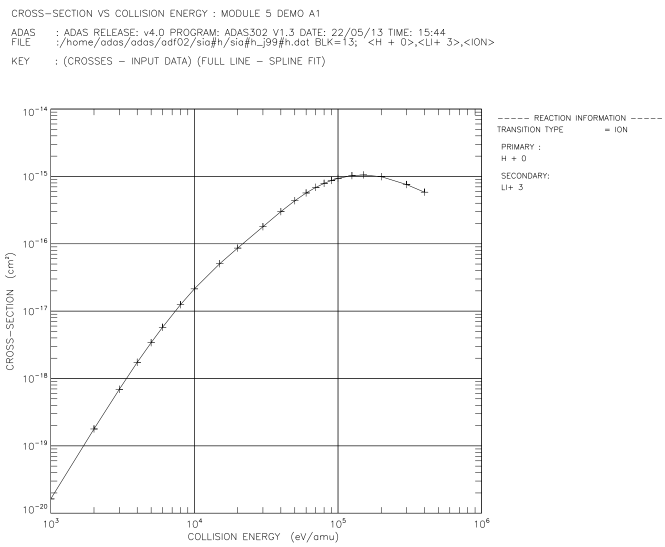

Figure 2: demo_a/demo_a_1_ion.pdf

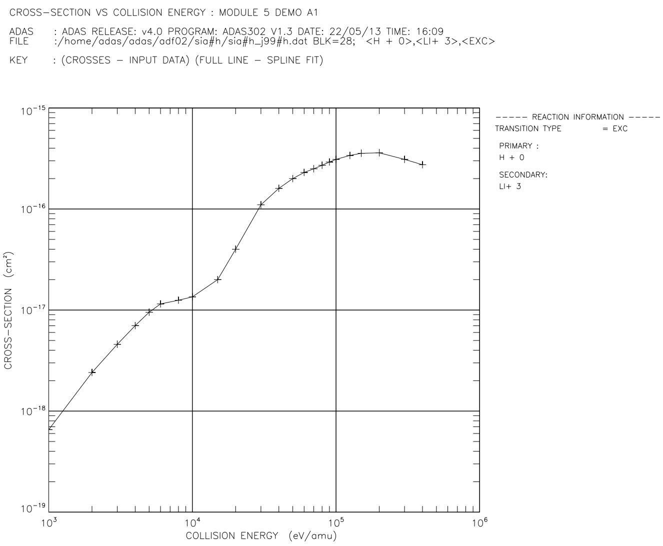

Figure 3: demo_a/demo_a_1_exc.pdf

1.2 Demo (a-2) IDL procedure

```
pro demo_a_2
;Use read_adf01.pro to read selctive charge exchange cross section
;for O8+ + H(1s) -> O7+ + H+
;and for Li3+ + H(1s) -> Li2+ + H+


adf01_o='/home/adas/adas/adf01/qcx#h0/qcx#h0_old#o8.dat'
adf01_li='/home/adas/adas/adf01/ext#h0/arf07#3/ext#h0_arf07#li3.dat'


;Use read_adf01.pro to read the selected adf01 for O+8 and Li+3
read_adf01,file=adf01_o,fulldata=cx_o
read_adf01,file=adf01_li,fulldata=cx_li

;specity principal and angular quantum numerbers for oxygen
n_o=5
l_o=1
;find the index corresponding to n=5 and l=1 (l-resolved) for oxygen
index_o=i4idfl(n_o,l_o,/idl_index)

;specity principal and angular quantum numerbers for lithium
n_li=3
l_li=0
;find the index corresponding to n=3 and l=0 (l-resolved) for lithium
index_li=i4idfl(n_li,l_li,/idl_index)

loadct,3
;Plot total and selective cx cross sections as a function of energy (eV/amu)
set_plot,'ps'
device, /isolatin1, font_index=8
device, bits=8, filename='demo_a_2.ps',         $
        font_size = 14, xsize=18.0, ysize=16.0, $
        yoffset=7.0, /color
device, /helvetica

plot_oo,cx_o.enrgya,cx_o.sigta,xrange=[5.e3,5.e5],yrange=[1.e-17,1.e-14],$
        title='Total and selective CX cross sections',$
        xtitle='ENERGY (eV/amu)',ytitle='CROSS-SECTION (cm!u2!n)'
oplot,cx_o.enrgya,cx_o.sigta,psym=1
oplot,cx_o.enrgya,cx_o.sigla[*,index_o],line=1


plots,cx_li.enrgya,cx_li.sigta,color=120
plots,cx_li.enrgya,cx_li.sigta,color=120,psym=1
plots,cx_li.enrgya,cx_li.sigla[*,index_li]>1.e-17,color=120,line=1


xyouts,0.63,0.9,'O!u8+!n + H!u0+!n -> O!u7+!n + H!u1+!n',/normal
```

```
xyouts,0.63,0.85,'Li!u3+!n + H!u0+!n -> Li!u2+!n + H!u1+!n',color=120,/normal

xyouts,0.73,0.6,'total',/normal
xyouts,0.47,0.7,'total',color=120,/normal

xyouts,0.2,0.6,'n=5 l=1',/normal
xyouts,0.43,0.3,'n=3 l=0',color=120,/normal

device, /close
set_plot,'X'
!p.font=-1


end
```

1.3 Demo (a-2) Figures

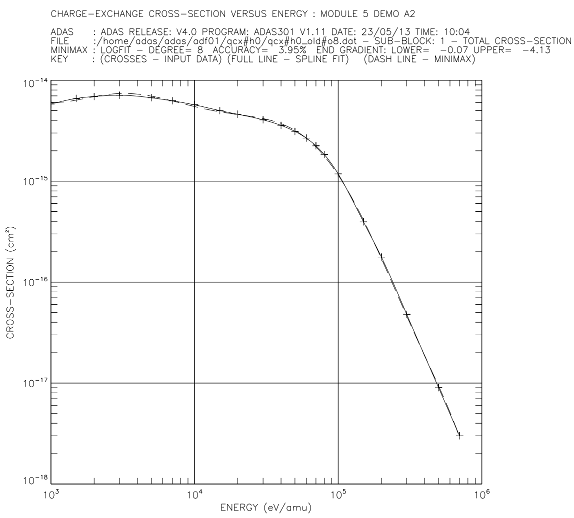

Figure 4: demo_a/demo_a_2_oxygen.pdf

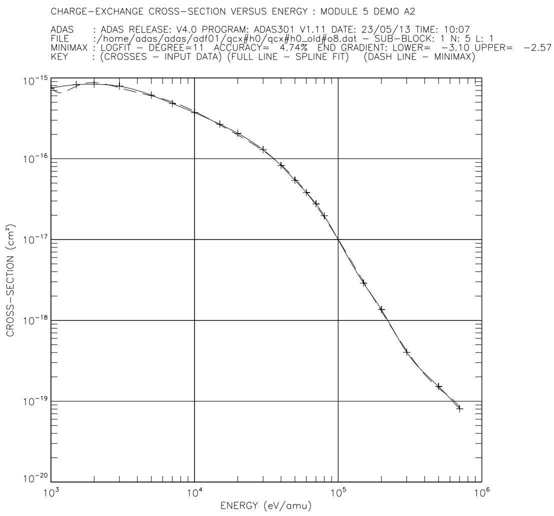

Figure 5: demo_a/demo_a_2_oxygen_nl.pdf

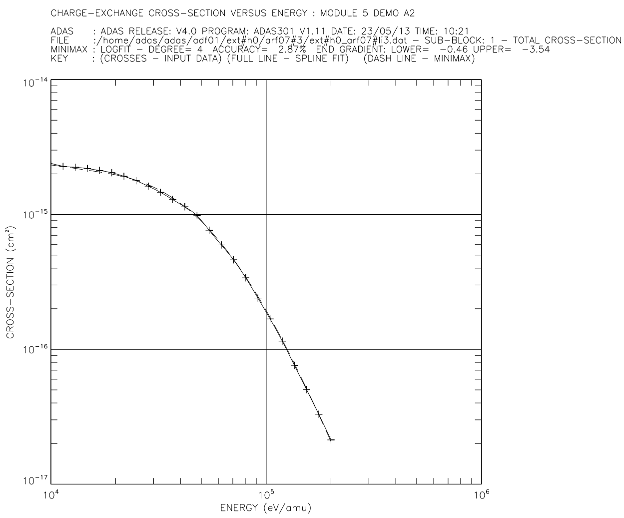

Figure 6: demo_a/demo_a_2_lithium.pdf

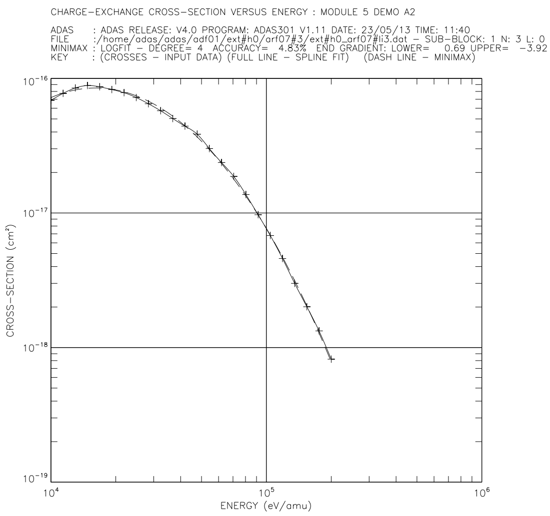

Figure 7: demo_a/demo_a_2_lithium_nl.pdf

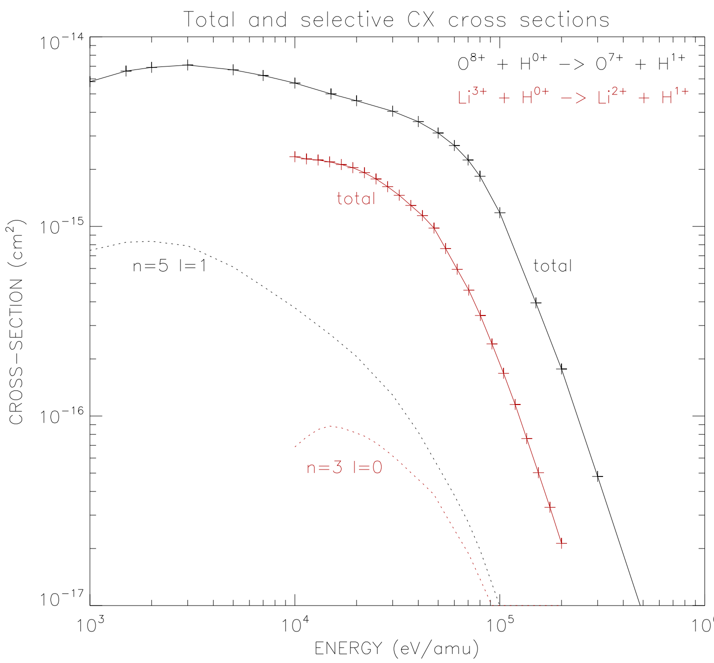

Figure 8: demo_a/demo_a_2.pdf

1.4 Demo (a-3) IDL procedure

```
pro demo_a_3
;Compare electron impact excitation vs thermal CX for H.
;Contrast the ORNL red book rates against forming the double
;Maxwellian with the ceevth.pro library routine.

;define electron temperature range
itval =30
te=adas_vector(low=1., high=1000., num=itval)

;Ionisation rates from adf11 for two different electron densities

file_scd = '/home/adas/adas/adf11/scd12/scd12_h.dat'

read_adf11, file=file_scd, class='scd', iz0=1, iz1=1, $
            te=te, dens=fltarr(itval)+1e10, data=scd_10

read_adf11, file=file_scd, class='scd', iz0=1, iz1=1, $
            te=te, dens=fltarr(itval)+1e14, data=scd_14


;Thermal CX rates from adf14
;Note isotope is hydrogen, not deuterium, H + H+

adf14='/home/adas/adas/adf14/tcx#h0/tcx#h0_h.dat'

;use read_adf14.pro to read the selected adf14
;case of temperature of receiver=temp.of donor=electron temp.
read_adf14, file=adf14, block=1, t_rec=te, t_don=te, $
            m_rec = 1.0, m_don=1.0, data=tcx_eq
;case of temperature of receiver=electron temp. and temp.of donor=3eV
read_adf14, file=adf14, block=1, t_rec=te, t_don=fltarr(itval)+3.0, $
            m_rec = 1.0, m_don=1.0, data=tcx_3


;Form H CX rate from the adf24 cross section
adf24='/home/adas/adas/adf24/scx#h0/scx#h0_ornl#h1.dat'

read_adf24, file=adf24, fulldata=all

eng = reform(all.teea[*,0])   ; block 1
sig = reform(all.scx[*,0])
ind = where(eng GT 0.0)       ; remove zeros
eng = eng[ind]
sig = sig[ind]

amdon   = 1.0001              ; Hydrogen as before
amrec   = 1.0001
catyp   = 'tt'
```

```
iextyp  = 2

te_comp = [3, 7, 10, 100, 500]

;use ceevth.pro to produce cx rate for H
ceevth, amdon   = amdon,   $
        amrec   = amrec,   $
        catyp   = catyp,   $
        iextyp  = iextyp,  $
        enin    = eng,     $
        sgin    = sig,     $
        enout   = te_comp, $
        rcout   = cx_rate

; Plot the results
set_plot,'ps'
device, /isolatin1, font_index=8
device, bits=8, filename='demo_a_3.ps',         $
        font_size = 14, xsize=18.0, ysize=16.0, $
        yoffset=7.0, /color
device, /helvetica

xmin = 1
xmax = 1000
ymin = 1e-9
ymax = 1e-7

plot_oo, [xmin, xmax], [ymin, ymax], /nodata, $
         xtitle = 'Temperature (eV)', $
         ytitle = 'Rate coefficient (cm!u3!n s!u-1!n)'

oplot, te, scd_10
oplot, te, scd_14, linestyle=2


loadct,3
oplot, te, tcx_eq, color=120
oplot, te, tcx_3, linestyle=1, color=120

loadct,1
oplot, te_comp, cx_rate, psym=5, color=120

plots, 3.8, 4.5e-8, psym=5, color=120
xyouts, 4.7, 4.2e-8, 'rate from ceevth.pro', color=120

loadct,3
xyouts, 1.2, 7e-9, 'H + H!u+!n CX', color=120
xyouts, 10.0, 3e-9, 'H + e ionisation'

xyouts,70.,2.e-9,'N!de!n=10!u10!n cm!u-3!n'
```

```
plots,[300.,600.],[2.e-9,2.e-9]
xyouts,70.,1.5e-9,'N!de!n=10!u14!n cm!u-3!n'
plots,[300.,600.],[1.5e-9,1.5e-9],line=2

plots, [1.5,3.8],[8.e-8,8.e-8], color=120
xyouts, 4.7, 8.e-8, 'T!dr!n=T!dd!n=T!de!n', color=120
plots, [1.5,3.8],[6.e-8,6.e-8], color=120, line=1
xyouts, 4.7, 6.e-8, 'T!dr!n=T!de!n, T!dd!n=3 eV', color=120


device, /close
set_plot,'X'
!p.font=-1

end
```

1.5 Demo (a-3) Figures

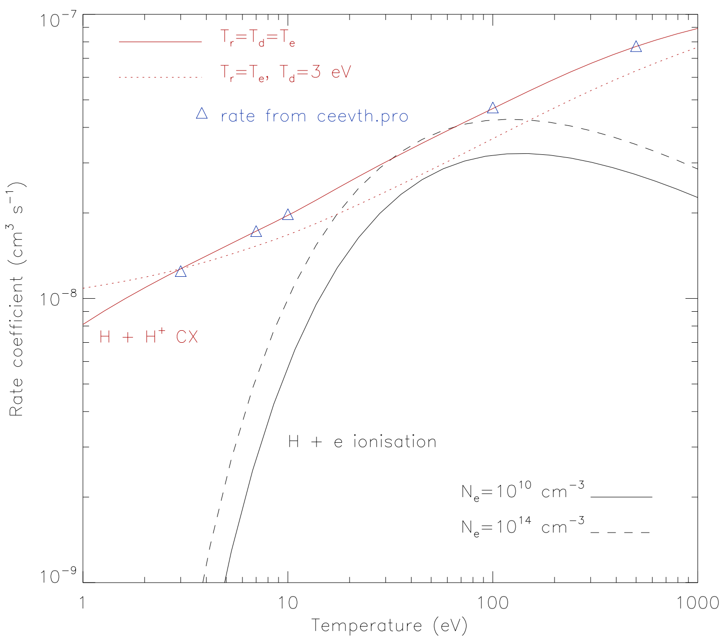

Figure 9: demo_a/demo_a_3.pdf

2 Demo (b) Obtaining charge exchange receiver populations driven by beams

```
------------------------------
DEMO B: Obtaining charge exchange receiver populations driven by beams
------------------------------
PURPOSE: Produce and analyse charge exchange effective emission coefficients
associated by a particula donor.

The charge exchange effective emission coefficients are produced by ADAS306 (in
the j-resolved case) and stored in the adf12 format. This format is read and
analysed by ADAS303.

EXAMPLE: For this demo C VI n=8-7 at 5290.7 Ang. has been chosen.
The adf12 selected are the following:
- adf12 for n=1 is : /home/adas/adas/adf12/qef93#h/qef93#h_c6.dat
- adf12 for n=2 is : /home/adas/adas/adf12/qef97#h/qef97#h_en2_kvi#c6.dat

The plasma parameters are:
Ion temperature (eV): 1.e3
Ion density(cm-3): 1.e13
Effective charge: 2.0
Magnetic field (Tesla): 3.0


DEMO b1: Examine adf12 data with ADAS303 interactively.
1. Use ADAS303 with interactive windows.
(Output files: demo_b_1_interactive_n1.ps, demo_b_1_interactive_n2.ps)

DEMO b2: Examine adf12 using read_adf12.pro.
1. Define plasma parameters.
2. Use read_adf12.pro fro n=1 and n=2
3. Plot the effective emission coefficients as a function of beam energy.
4. Compare the results withe the interactive run.
Program: demo_b_2.pro
Output files: demo_b_2.ps
```

2.1 Demo (b-1) Figures

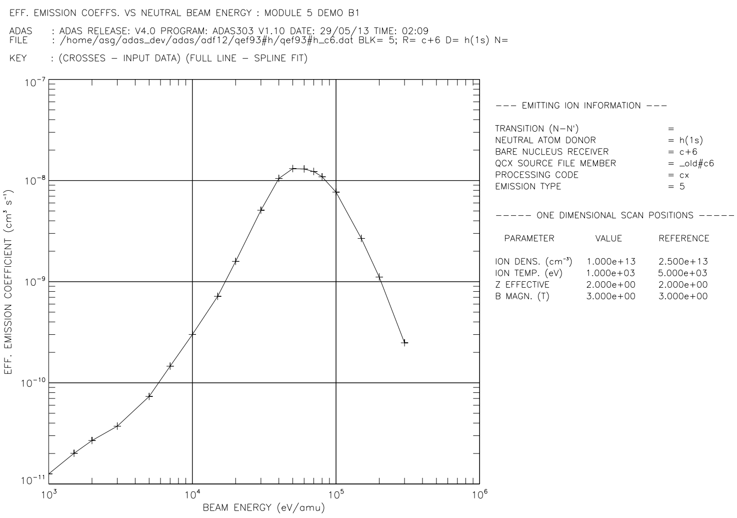

Figure 10: demo_b/demo_b_1_interactive_n1.pdf

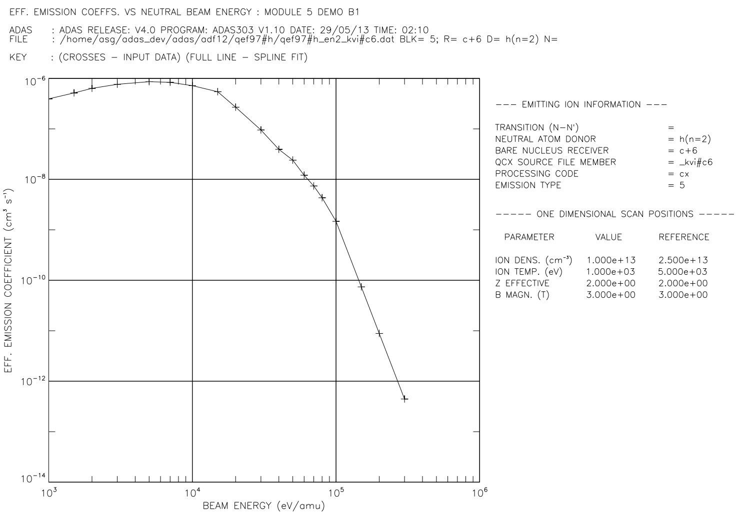

Figure 11: demo_b/demo_b_1_interactive_n2.pdf

2.2 Demo (b-2) IDL procedure

```
pro demo_b_2
;Use read_adf12.pro to read adf12 files for C5+ with different donors:
;- D in n=1
;- D in n=2


;Plasma and beam conditions
ein    = adas_vector(low=2e3, high=1e5, num=100)
dion   = 1.e13
tion   = 1.e3
zeff   = 2.0
bmag   = 3.0

;n=1 and n=2 adf12 files for CVI(n=8-7) 5290.7 Ang.

adf12_n1 = '/home/adas/adas/adf12/qef93#h/qef93#h_c6.dat'
read_adf12, file=adf12_n1, block=5,                      $
            tion=tion, dion=dion, zeff=zeff, bmag=bmag,  $
            ein=ein, data=data_n1

adf12_n2 = '/home/adas/adas/adf12/qef97#h/qef97#h_en2_kvi#c6.dat'
read_adf12, file=adf12_n2, block=5,                      $
            tion=tion, dion=dion, zeff=zeff, bmag=bmag,  $
            ein=ein, data=data_n2

;Plot the effective emission coefficients as a function of beam energy.
set_ plot,'ps'
device, /isolatin1, font_index=8
device, bits=8, filename='demo_b_2.ps',        $
        font_size = 14, xsize=14.0, ysize=16.0, $
        yoffset=7.0, /color
device, /helvetica
plot_oo, ein, data_n1, xtitle='Energy (eV/amu)', $
                     ytitle='Effective emission coefficient (cm!u3!n s!u-1!n)', $
                     yrange=[1.e-11,1.e-5]
oplot, ein, data_n2, linestyle=2

xyouts, 2.3e3,8e-11, 'D(n=1)'
xyouts, 4.e3,3e-7, 'D(n=2)'
xyouts,0.4,0.9,'C VI (n=8-7) 5290 Ang.',/normal

device, /close
set_plot,'X'
!p.font=-1

end
```

2.3 Demo (b-2) Figures

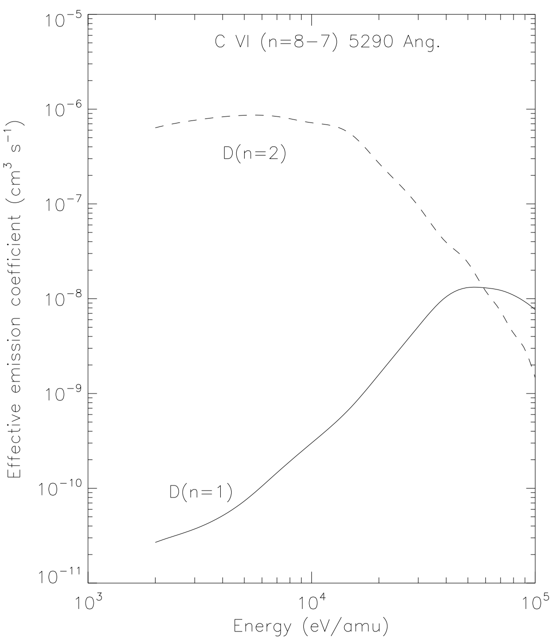

Figure 12: demo_b/demo_b_2.pdf

3 Demo (c) Obtaining beam stopping and beam coefficients

```
------------------------------
DEMO C: Obtaining beam stopping and beam coefficients
------------------------------
PURPOSE: Compute the populations (excited population structure, effecive
ionisation and recombination) for hydrogen atoms or hydrogenic ions in a plasma
with impurities using a bundle-n approximation and tabulate beam stopping and
beam emission coefficients.

Starting from an adf01 (selecting cx cross section) and an adf18 (cross-referencing data -
beam emission and stopping coefficients in the adf21 and adf22 formats are shown by ADAS30

EXAMPLE: The input files for ADAS310 used for this demo are the following:
- adf01: /home/adas/adas/adf01/qcx#h0/qcx#h0_e2p#h1.dat
- adf18: /home/adas/adas/adf18/p310_a17/bndlen_exp#h0.dat

The beam emission and beam stopping coefficients are calculated for D1+ and C6+ plasmas.
Plasma parameters are defined in the script demo_d_1.pro.

The output files from ADAS310 in the adf26 and adf21 formats are:
- for D1+: adf26_h1.pass, adf21_h1.pass
- for C6+: adf26_c6.pass, adf21_c6.pass

These are the input file for the ADAS312 ru, which gives the following outputs:
- adf22 for D1+: ./bme10#h/bme10#h_h1.dat
- adf22 for C6+: ./bme10#h/bme10#h_c6.dat

COMMENTS: Note that for H beams a bundle-n modelling is suitable (ADAS310),while for He be


DEMO c1: Processing  H-beam stopping and emission with ADAS310
1. Define parameters for run_adas310.pro.
2. Use run_adas310.pro for calculating beam emission coefficients and
   stopping coefficients.
3. Write adf21 and adf26 files.
Program: demo_c_1.pro
Output files: adf26_h1.pass, adf26_c6.pass, adf21_h1.pass, adf21_c6.pass

DEMO c2: Convert adf26 to adf22 using ADAS312
1. Create a directory called "bme10#h".
2. Use run_adas312.pro to produce beam emission coefficients for D1+ and C6+.
Program: demo_c_2.pro
Input files: adf26_h1.pass, adf26_c6.pass
Output files: /bme10#h/bme10#h_h1.dat, /bme10#h/bme10#h_c6.dat

DEMO c3: Examine adf22 with ADAS304 and use read_adf21.pro and read_adf22.pro
1. Using ADAS304 with interactive windows:
```

```
  a) Run ADAS304 interactively, taking the adf22 stored locally.
  b) Plot emission coefficients for a pure D1+ plasma and a pure C6+ plasma.
 (Output files: demo_d_3_beam_emission_h.ps, demo_d_3_beam_emission_c.ps)
2. Using read_adf21.pro and read_adf22.pro with command line:
  a) Use read_adf22.pro to read the adf22 stored locally.
  b) Plot emission coefficients for a pure D1+ plasma and a pure C6+ plasma
     at different densities.
  c) Compare the results with the interactive outputs.
  d) Use read_adf21.pro to read beam stopping coefficients
     for D1+ and C6+ plasmas.
  e) Plot a surface of beam stopping coefficients as a function of beam
     energy and density.
  f) Compare beam stopping coefficients for a pure D1+ plasma and a plasma
     with D1+ and a 2% concentration of C6+.
  Program: demo_c_3.pro
  Output files: demo_c_3_emission.ps, demo_c_3_stopping.ps
```

3.1 Demo (c-1) IDL procedure

```
pro demo_c_1
;Use run_adas310.pro to make an adf21 (stopping coefficients for an H
;beam) and an adf26 tabulation over a wide range of densities and beam
;energies(which is needed to make and adf22 for beam
;emission coefficients) for H+1 and C+6

;Input files for run_adas310.pro
adf18  = '/home/adas/adas/adf18/p310_a17/bndlen_exp#h0.dat'
adf01  = '/home/adas/adas/adf01/qcx#h0/qcx#h0_e2p#h1.dat'

iz0    = 1           ; Nuclear charge of beam species
iz1    = 0           ; Recombining ion charge
ts     = 8617.00     ; Radiation field temperature (ev)
wdil   = 0.00000     ; External radiation field dilution factor
cion   = 1.00000     ; Multiplier of ground level e-impact ionisation rate
cpy    = 1.00000     ; Multiplier of ground level e-impact excitation rate
wdpi   = 1.0e+08     ; External radiation field dilution factor photo-ionisation
bsim   = 1.00000     ; Beam species isotope mass
nip    = 2           ; Range of delta n for impact parameter cross sections
intd   = 3           ; Order of maxwell quadrature for cross sections
iprs   = 1           ; Beyond nip - 0 van regemorter, 1 percival-richards
ilow   = 1           ; Access special low level data
ionip  = 1           ; Include ion impact collisions
nionip = 4           ; Delta n for ion impact excitation cross sections
ilprs  = 1           ; Lodge-percival-richards or vainshtein default
ivdisp = 1           ; Use of beam energy in calculation of cross section


; 1-110, make sure nrep is below 110 to avoid negative F's

nmin  = 1
nmax  = 110
nrep  = [ 1,  2,  3,  4,  5,  6,  7, 8, 9, 10, 11, 12, 15, 20, $
         30, 40, 50, 60, 70, 80, 90, 100]


;define a density and temperature arrays
dens = adas_vector(low=1e8, high=1e18, num=24)

denp = fltarr(24) + 1.0

te   = [100.000,  200.000,   300.000,   500.000,   600.000,   700.000, $
        800.000,  900.000,   1000.00,   2000.00,   3000.00,   5000.00, $
        6000.00,  7000.00,   8000.00,   9000.00,   10000.0,   20000.0, $
        30000.0,  50000.0]

tp   =  te
```

```
bmeng = [ 5.000E+03, 1.000E+04, 1.500E+04, 2.000E+04, 2.500E+04, 3.000E+04, 3.500E+04, $
          4.000E+04, 4.500E+04, 5.000E+04, 5.500E+04, 6.000E+04, 6.500E+04, 7.000E+04, $
          7.500E+04, 8.000E+04, 8.500E+04, 9.000E+04, 9.500E+04, 1.000E+05, 1.050E+05, $
          1.100E+05, 1.150E+05, 1.200E+05, 1.250E+05]

;Reference values
tref  = 2000.0
dref  = dens[11]
bref  = 6.5e4
bdens = 1.0e7

;Define ion features: H+1, C+6
z_list = [1, 6]
m_list = [1.0, 12]
n_list = ['h1', 'c6']

for j = 0, n_elements(z_list)-1 do begin

   print, 'Generating...' + n_list[j]
   izimp = z_list[j]
   amimp = m_list[j]
   frimp = 1.0D0

;Use run_adas310.pro to calculate adf21 and adf26
   if izimp EQ 1 then denp_in = dens else denp_in = denp   ; Different for Hydrogen

   run_adas310, iz0    = iz0,    $
                iz1    = iz1,    $
                adf18  = adf18,  $
                adf01  = adf01,  $
                ts     = ts,     $
                wdil   = wdil,   $
                cion   = cion,   $
                cpy    = cpy,    $
                wdpi   = wdpi,   $
                bsim   = bsim,   $
                nip    = nip,    $
                intd   = intd,   $
                iprs   = iprs,   $
                ilow   = ilow,   $
                ionip  = ionip,  $
                nionip = nionip, $
                ilprs  = ilprs,  $
                ivdisp = ivdisp, $
                izimp  = izimp,  $
                amimp  = amimp,  $
                frimp  = frimp,  $
                nmin   = nmin,   $
                nmax   = nmax,   $
                nrep   = nrep,   $
```

```
                te     = te,     $
                tp     = tp,     $
                dens   = dens,   $
                denp   = denp_in,$
                bmeng  = bmeng,  $
                tref   = tref,   $
                dref   = dref,   $
                bref   = bref,   $
                bdens  = bdens,  $
                log    = log,    $
                adf21  = 'adf21_'+n_list[j]+'.pass', $
                adf26  = 'adf26_'+n_list[j]+'.pass'


endfor

end
```

3.2 Demo (c-1) datasets

3.2.1 adf26_h1.pass

```
1


 EFFECTIVE CONTRIBUTION TABLE FOR ION PRINCIPAL QUANTUM SHELL POPULATIONS IN THERMAL PLASMA


   Generated by run_adas310  Z0 = 1.00E+00               Z1 = 1.00E+00

    TRAD = 1.00E+08 K        TE = 2.32E+07 K             TP = 2.32E+07 K
       W = 0.00E+00          NE = 1.00E+08 CM-3          NP = 1.00E+08 CM-3

      EH = 5.00E+03 EV/AMU   NH = 1.00E+07 CM-3        NH/NE = 1.00E-01   FLUX = 9.78E+14 CM-2 SEC-1


 CHARGE EXCHANGE OFF : N1/N+ = 1.20636E-09  RECOMB COEFF = 1.44370E-16 CM+3 SEC-1   IONIZ COEFF = 1.19674E-07 CM+3 SEC-1

 CHARGE EXCHANGE ON  : N1/N+ = 5.07543E-01  RECOMB COEFF = 6.07398E-08 CM+3 SEC-1   IONIZ COEFF = 1.19674E-07 CM+3 SEC-1


    I    N             F1             F2             F3           B(CHECK)       B(ACTUAL)      NN/(BN*N+)
    1    1          0.00000E+00    3.23307E+09    1.36023E+19    1.36027E+18    1.36027E+18    3.73131E-19
    2    2          3.77374E+09    3.67088E+00    7.29101E+10    9.20635E+09    9.20635E+09    1.48493E-18
    3    3          1.56414E+09    2.67814E+00    4.78802E+10    5.58189E+09    5.58189E+09    3.33793E-18
    4    4          1.09994E+09    2.32591E+00    1.00100E+10    1.55926E+09    1.55926E+09    5.93213E-18
    5    5          8.69960E+08    2.13763E+00    3.07331E+09    7.48874E+08    7.48874E+08    9.26753E-18
    6    6          7.02215E+08    2.01525E+00    1.18814E+09    4.75218E+08    4.75218E+08    1.33441E-17
    7    7          6.38332E+08    1.92564E+00    5.35483E+08    3.77529E+08    3.77529E+08    1.81619E-17
    8    8          5.89970E+08    1.85360E+00    2.68896E+08    3.26325E+08    3.26325E+08    2.37209E-17
    9    9          5.49073E+08    1.79067E+00    1.46075E+08    2.93286E+08    2.93286E+08    3.00211E-17
   10   10          5.12139E+08    1.73306E+00    8.42682E+07    2.68360E+08    2.68360E+08    3.70626E-17
   11   11          4.94781E+08    1.70356E+00    5.30325E+07    2.56426E+08    2.56426E+08    4.48452E-17
   12   12          4.59388E+08    1.64894E+00    3.36139E+07    2.36521E+08    2.36521E+08    5.33690E-17
   13   15          3.20687E+08    1.44505E+00    9.65185E+06    1.63728E+08    1.63728E+08    8.33876E-17
   14   20          1.26779E+08    1.17233E+00    1.35438E+06    6.44813E+07    6.44813E+07    1.48243E-16
   15   30          2.02429E+07    1.02717E+00    1.62966E+05    1.02905E+07    1.02905E+07    3.33543E-16
   16   40          4.89611E+06    1.00653E+00    3.57972E+04    2.48857E+06    2.48857E+06    5.92963E-16
   17   50          1.55678E+06    1.00207E+00    1.08745E+04    7.91221E+05    7.91221E+05    9.26503E-16
   18   60          5.87660E+05    1.00078E+00    3.99779E+03    2.98664E+05    2.98664E+05    1.33416E-15
   19   70          2.43975E+05    1.00032E+00    1.62790E+03    1.23992E+05    1.23992E+05    1.81594E-15
   20   80          1.02940E+05    1.00014E+00    6.72652E+02    5.23150E+04    5.23150E+04    2.37184E-15
   21   90          3.82958E+04    1.00005E+00    2.40014E+02    1.94618E+04    1.94618E+04    3.00186E-15
   22  100          5.97491E+03    1.00001E+00    2.55108E+01    3.03608E+03    3.03608E+03    3.70601E-15


                                             BN = F1*(N1/N+) + F2 + F3*(NH/NE)
                                             N1 = POPULATION OF GROUND STATE OF ION
                                             N+ = POPULATION OF GROUND STATE OF NEXT IONISATION STAGE
                                             NN = POPULATION OF PRINCIPAL QUANTUM SHELL N OF ION
                                             BN = SAHA-BOLTZMANN FACTOR FOR PRINCIPAL QUANTUM SHELL N
                                             EH = NEUTRAL HYDROGEN BEAM ENERGY
                                              W = RADIATION DILUTION FACTOR
                                             Z0 = NUCLEAR CHARGE
                                             Z1 = ION CHARGE+1


 NIP    =  2     INTD  =  3     IPRS  =  1     ILOW  =  1     IONIP =  1     NIONIP=  4     ILPRS =  1     IVDISP=  1
 ZEFF  = 1.0     TS  =  1.00D+08     W   =  0.00D+00     CION  =1.0     CPY =1.0     W1  =  1.00D+08     ZIMP  = 0.0 (  0.00D+00)
1


 EFFECTIVE CONTRIBUTION TABLE FOR ION PRINCIPAL QUANTUM SHELL POPULATIONS IN THERMAL PLASMA


   Generated by run_adas310  Z0 = 1.00E+00               Z1 = 1.00E+00

    TRAD = 1.00E+08 K        TE = 2.32E+07 K             TP = 2.32E+07 K
```

W = 0.00E+00 NE = 2.72E+08 CM-3 NP = 2.72E+08 CM-3

EH = 5.00E+03 EV/AMU NH = 1.00E+07 CM-3 NH/NE = 3.68E-02 FLUX = 9.78E+14 CM-2 SEC-1

CHARGE EXCHANGE OFF : N1/N+ = 1.20494E-09 RECOMB COEFF = 1.44278E-16 CM+3 SEC-1 IONIZ COEFF = 1.19739E-07 CM+3 SEC-1

CHARGE EXCHANGE ON : N1/N+ = 1.86491E-01 RECOMB COEFF = 2.23303E-08 CM+3 SEC-1 IONIZ COEFF = 1.19739E-07 CM+3 SEC-1

I	N	F1	F2	F3	B(CHECK)	B(ACTUAL)	NN/(BN*N+)
1	1	0.00000E+00	1.18723E+09	4.99800E+18	1.83756E+17	1.83756E+17	1.01492E-18
2	2	3.77015E+09	3.66585E+00	7.29093E+10	3.38359E+09	3.38359E+09	4.03900E-18
3	3	1.55969E+09	2.67192E+00	4.78787E+10	2.05111E+09	2.05111E+09	9.07916E-18
4	4	1.09402E+09	2.31763E+00	1.00078E+10	5.71959E+08	5.71959E+08	1.61354E-17
5	5	8.61886E+08	2.12636E+00	3.07028E+09	2.73612E+08	2.73612E+08	2.52077E-17
6	6	6.91108E+08	1.99951E+00	1.18426E+09	1.72424E+08	1.72424E+08	3.62960E-17
7	7	6.22372E+08	1.90297E+00	5.30925E+08	1.35586E+08	1.35586E+08	4.94005E-17
8	8	5.66427E+08	1.82004E+00	2.63792E+08	1.15332E+08	1.15332E+08	6.45210E-17
9	9	5.14238E+08	1.74092E+00	1.40729E+08	1.01075E+08	1.01075E+08	8.16575E-17
10	10	4.64629E+08	1.66533E+00	7.95062E+07	8.95722E+07	8.95722E+07	1.00810E-16
11	11	4.43672E+08	1.63119E+00	5.06610E+07	8.46032E+07	8.46032E+07	1.21979E-16
12	12	3.90259E+08	1.55182E+00	3.16133E+07	7.39419E+07	7.39419E+07	1.45164E-16
13	15	2.19032E+08	1.30490E+00	8.35559E+06	4.11546E+07	4.11546E+07	2.26814E-16
14	20	6.70459E+07	1.09155E+00	9.63736E+05	1.25389E+07	1.25389E+07	4.03220E-16
15	30	9.95771E+06	1.01345E+00	1.13632E+05	1.86120E+06	1.86120E+06	9.07236E-16
16	40	2.35270E+06	1.00316E+00	2.49380E+04	4.39674E+05	4.39674E+05	1.61286E-15
17	50	7.40186E+05	1.00099E+00	7.57556E+03	1.38317E+05	1.38317E+05	2.52009E-15
18	60	2.77744E+05	1.00037E+00	2.78514E+03	5.19000E+04	5.19000E+04	3.62892E-15
19	70	1.14814E+05	1.00015E+00	1.13416E+03	2.14545E+04	2.14545E+04	4.93937E-15
20	80	4.82228E+04	1.00006E+00	4.68667E+02	9.01133E+03	9.01133E+03	6.45142E-15
21	90	1.77809E+04	1.00002E+00	1.67250E+02	3.32312E+03	3.32312E+03	8.16507E-15
22	100	2.58867E+03	1.00000E+00	1.78030E+01	4.84418E+02	4.84418E+02	1.00803E-14

BN = F1*(N1/N+) + F2 + F3*(NH/NE)
N1 = POPULATION OF GROUND STATE OF ION
N+ = POPULATION OF GROUND STATE OF NEXT IONISATION STAGE
NN = POPULATION OF PRINCIPAL QUANTUM SHELL N OF ION
BN = SAHA-BOLTZMANN FACTOR FOR PRINCIPAL QUANTUM SHELL N
EH = NEUTRAL HYDROGEN BEAM ENERGY
W = RADIATION DILUTION FACTOR
Z0 = NUCLEAR CHARGE
Z1 = ION CHARGE+1

NIP = 2 INTD = 3 IPRS = 1 ILOW = 1 IONIP = 1 NIONIP= 4 ILPRS = 1 IVDISP= 1
ZEFF = 1.0 TS = 1.00D+08 W = 0.00D+00 CION =1.0 CPY =1.0 W1 = 1.00D+08 ZIMP = 0.0 (0.00D+00)
1

EFFECTIVE CONTRIBUTION TABLE FOR ION PRINCIPAL QUANTUM SHELL POPULATIONS IN THERMAL PLASMA

Generated by run_adas310 Z0 = 1.00E+00 Z1 = 1.00E+00

TRAD = 1.00E+08 K TE = 2.32E+07 K TP = 2.32E+07 K
W = 0.00E+00 NE = 7.41E+08 CM-3 NP = 7.41E+08 CM-3

EH = 5.00E+03 EV/AMU NH = 1.00E+07 CM-3 NH/NE = 1.35E-02 FLUX = 9.78E+14 CM-2 SEC-1

CHARGE EXCHANGE OFF : N1/N+ = 1.20281E-09 RECOMB COEFF = 1.44141E-16 CM+3 SEC-1 IONIZ COEFF = 1.19836E-07 CM+3 SEC-1

CHARGE EXCHANGE ON : N1/N+ = 6.83959E-02 RECOMB COEFF = 8.19632E-09 CM+3 SEC-1 IONIZ COEFF = 1.19836E-07 CM+3 SEC-1

I	N	F1	F2	F3	B(CHECK)	B(ACTUAL)	NN/(BN*N+)
1	1	0.00000E+00	4.35029E+08	1.83303E+18	2.47379E+16	2.47379E+16	2.76490E-18
2	2	3.76477E+09	3.65825E+00	7.29071E+10	1.24140E+09	1.24140E+09	1.10033E-17

```
   3    3          1.55298E+09    2.66243E+00    4.78747E+10    7.52301E+08    7.52301E+08    2.47340E-17
   4    4          1.08489E+09    2.30477E+00    1.00023E+10    2.09186E+08    2.09186E+08    4.39571E-17
   5    5          8.48879E+08    2.10808E+00    3.06233E+09    9.93868E+07    9.93868E+07    6.86724E-17
   6    6          6.72236E+08    1.97241E+00    1.17418E+09    6.18241E+07    6.18241E+07    9.88800E-17
   7    7          5.93201E+08    1.86106E+00    5.19299E+08    4.75806E+07    4.75806E+07    1.34580E-16
   8    8          5.20641E+08    1.75414E+00    2.51360E+08    3.90019E+07    3.90019E+07    1.75772E-16
   9    9          4.46152E+08    1.64310E+00    1.28948E+08    3.22551E+07    3.22551E+07    2.22457E-16
  10   10          3.77770E+08    1.54120E+00    7.03891E+07    2.67878E+07    2.67878E+07    2.74634E-16
  11   11          3.46421E+08    1.49330E+00    4.51569E+07    2.43032E+07    2.43032E+07    3.32303E-16
  12   12          2.83793E+08    1.40198E+00    2.76968E+07    1.97840E+07    1.97840E+07    3.95464E-16
  13   15          1.29182E+08    1.18054E+00    6.81864E+06    8.92755E+06    8.92755E+06    6.17902E-16
  14   20          3.19573E+07    1.04383E+00    6.64381E+05    2.19472E+06    2.19472E+06    1.09848E-15
  15   30          4.53750E+06    1.00617E+00    7.68456E+04    3.11384E+05    3.11384E+05    2.47155E-15
  16   40          1.05718E+06    1.00143E+00    1.68550E+04    7.25355E+04    7.25355E+04    4.39386E-15
  17   50          3.30482E+05    1.00045E+00    5.12058E+03    2.26737E+04    2.26737E+04    6.86539E-15
  18   60          1.23557E+05    1.00017E+00    1.88274E+03    8.47722E+03    8.47722E+03    9.88615E-15
  19   70          5.09416E+04    1.00007E+00    7.66751E+02    3.49554E+03    3.49554E+03    1.34561E-14
  20   80          2.13355E+04    1.00003E+00    3.16871E+02    1.46454E+03    1.46454E+03    1.75754E-14
  21   90          7.82329E+03    1.00001E+00    1.13101E+02    5.37607E+02    5.37607E+02    2.22438E-14
  22  100          1.08761E+03    1.00000E+00    1.20652E+01    7.55505E+01    7.55505E+01    2.74615E-14


                                             BN = F1*(N1/N+) + F2 + F3*(NH/NE)
                                             N1 = POPULATION OF GROUND STATE OF ION
                                             N+ = POPULATION OF GROUND STATE OF NEXT IONISATION STAGE
                                             NN = POPULATION OF PRINCIPAL QUANTUM SHELL N OF ION
                                             BN = SAHA-BOLTZMANN FACTOR FOR PRINCIPAL QUANTUM SHELL N
                                             EH = NEUTRAL HYDROGEN BEAM ENERGY
                                              W = RADIATION DILUTION FACTOR
                                             Z0 = NUCLEAR CHARGE
                                             Z1 = ION CHARGE+1

 NIP   =  2     INTD  =  3     IPRS  =  1     ILOW  =  1     IONIP =  1     NIONIP=  4     ILPRS =  1     IVDISP=  1
 ZEFF  = 1.0    TS  =  1.00D+08     W   =  0.00D+00     CION  =1.0     CPY =1.0     W1  =  1.00D+08     ZIMP  = 0.0 (  0.00D+00)
1
    ...........................

                                             BN = F1*(N1/N+) + F2 + F3*(NH/NE)
                                             N1 = POPULATION OF GROUND STATE OF ION
                                             N+ = POPULATION OF GROUND STATE OF NEXT IONISATION STAGE
                                             NN = POPULATION OF PRINCIPAL QUANTUM SHELL N OF ION
                                             BN = SAHA-BOLTZMANN FACTOR FOR PRINCIPAL QUANTUM SHELL N
                                             EH = NEUTRAL HYDROGEN BEAM ENERGY
                                              W = RADIATION DILUTION FACTOR
                                             Z0 = NUCLEAR CHARGE
                                             Z1 = ION CHARGE+1


 NIP   =  2     INTD  =  3     IPRS  =  1     ILOW  =  1     IONIP =  1     NIONIP=  4     ILPRS =  1     IVDISP=  1
 ZEFF  = 1.0    TS  =  1.00D+08     W   =  0.00D+00     CION  =1.0     CPY =1.0     W1  =  1.00D+08     ZIMP  = 0.0 (  0.00D+00)

C---------------------------------------------------------------------
C
C  Code      : run_adas310
C  Producer  : Alessandra Giunta
C  Date      : 27/05/13
C
C---------------------------------------------------------------------
```

3.2.2 adf26_c6.pass

```
1



 EFFECTIVE CONTRIBUTION TABLE FOR ION PRINCIPAL QUANTUM SHELL POPULATIONS IN THERMAL PLASMA


   Generated by run_adas310  Z0 = 1.00E+00               Z1 = 1.00E+00

    TRAD = 1.00E+08 K        TE = 2.32E+07 K             TP = 2.32E+07 K
```

```
      W = 0.00E+00          NE = 1.00E+08 CM-3           NP = 1.00E+00 CM-3

     EH = 5.00E+03 EV/AMU   NH = 1.00E+07 CM-3        NH/NE = 1.00E-01   FLUX = 9.78E+14 CM-2 SEC-1

 CHARGE EXCHANGE OFF : N1/N+ = 1.53030E-09  RECOMB COEFF = 1.44336E-16 CM+3 SEC-1   IONIZ COEFF = 9.43188E-08 CM+3 SEC-1

 CHARGE EXCHANGE ON  : N1/N+ = 6.43981E-01  RECOMB COEFF = 6.07395E-08 CM+3 SEC-1   IONIZ COEFF = 9.43188E-08 CM+3 SEC-1
```

I	N	F1	F2	F3	B(CHECK)	B(ACTUAL)	NN/(BN*N+)
1	1	0.00000E+00	4.10125E+09	1.72588E+19	1.72594E+18	1.72594E+18	3.73131E-19
2	2	3.12743E+09	3.66905E+00	7.29100E+10	9.30501E+09	9.30501E+09	1.48493E-18
3	3	1.30553E+09	2.67589E+00	4.78799E+10	5.62873E+09	5.62873E+09	3.33793E-18
4	4	9.26108E+08	2.32297E+00	1.00095E+10	1.59735E+09	1.59735E+09	5.93213E-18
5	5	7.79429E+08	2.13388E+00	3.07305E+09	8.09243E+08	8.09243E+08	9.26753E-18
6	6	6.98798E+08	2.01056E+00	1.18790E+09	5.68803E+08	5.68803E+08	1.33441E-17
7	7	6.34125E+08	1.91983E+00	5.35176E+08	4.61882E+08	4.61882E+08	1.81619E-17
8	8	5.84756E+08	1.84640E+00	2.68472E+08	4.03419E+08	4.03419E+08	2.37209E-17
9	9	5.42440E+08	1.78147E+00	1.45495E+08	3.63871E+08	3.63871E+08	3.00211E-17
10	10	5.02788E+08	1.72002E+00	8.34769E+07	3.32134E+08	3.32134E+08	3.70626E-17
11	11	4.79956E+08	1.68280E+00	5.20095E+07	3.14283E+08	3.14283E+08	4.48452E-17
12	12	4.35230E+08	1.61510E+00	3.23641E+07	2.83516E+08	2.83516E+08	5.33690E-17
13	15	2.65677E+08	1.36899E+00	8.18657E+06	1.71910E+08	1.71910E+08	8.33876E-17
14	20	8.16708E+07	1.11095E+00	5.33217E+05	5.26478E+07	5.26478E+07	1.48243E-16
15	30	1.08689E+07	1.01460E+00	5.50221E+04	7.00487E+06	7.00487E+06	3.33543E-16
16	40	2.38810E+06	1.00319E+00	1.11508E+04	1.53901E+06	1.53901E+06	5.92963E-16
17	50	7.10059E+05	1.00095E+00	3.18844E+03	4.57585E+05	4.57585E+05	9.26503E-16
18	60	2.53500E+05	1.00034E+00	1.11267E+03	1.63361E+05	1.63361E+05	1.33416E-15
19	70	9.93969E+04	1.00013E+00	4.28977E+02	6.40537E+04	6.40537E+04	1.81594E-15
20	80	3.86460E+04	1.00005E+00	1.63567E+02	2.49047E+04	2.49047E+04	2.37184E-15
21	90	1.17210E+04	1.00002E+00	4.71438E+01	7.55382E+03	7.55382E+03	3.00186E-15
22	100	-1.35648E+03	9.99998E-01	-8.99322E+00	-8.73445E+02	-8.73445E+02	3.70601E-15

```
                                              BN = F1*(N1/N+) + F2 + F3*(NH/NE)
                                              N1 = POPULATION OF GROUND STATE OF ION
                                              N+ = POPULATION OF GROUND STATE OF NEXT IONISATION STAGE
                                              NN = POPULATION OF PRINCIPAL QUANTUM SHELL N OF ION
                                              BN = SAHA-BOLTZMANN FACTOR FOR PRINCIPAL QUANTUM SHELL N
                                              EH = NEUTRAL HYDROGEN BEAM ENERGY
                                               W = RADIATION DILUTION FACTOR
                                              Z0 = NUCLEAR CHARGE
                                              Z1 = ION CHARGE+1
..............................
                                              BN = F1*(N1/N+) + F2 + F3*(NH/NE)
                                              N1 = POPULATION OF GROUND STATE OF ION
                                              N+ = POPULATION OF GROUND STATE OF NEXT IONISATION STAGE
                                              NN = POPULATION OF PRINCIPAL QUANTUM SHELL N OF ION
                                              BN = SAHA-BOLTZMANN FACTOR FOR PRINCIPAL QUANTUM SHELL N
                                              EH = NEUTRAL HYDROGEN BEAM ENERGY
                                               W = RADIATION DILUTION FACTOR
                                              Z0 = NUCLEAR CHARGE
                                              Z1 = ION CHARGE+1

 NIP    =  2     INTD  =  3     IPRS  =  1     ILOW  =  1     IONIP =  1     NIONIP=  4     ILPRS =  1     IVDISP=  1
 ZEFF  = 6.0    TS  =  1.00D+08     W   =  0.00D+00     CION  =1.0     CPY =1.0     W1  =  1.00D+08     ZIMP  = 6.0 (  1.01D+12)

C-------------------------------------------------------------------
C
C  Code      : run_adas310
C  Producer  : Alessandra Giunta
C  Date      : 27/05/13
C
C-------------------------------------------------------------------
```

3.2.3 adf21_h1.pass

```
    1 /SVREF=9.132E-08 /SPEC=H  /DATE=27/05/13 /CODE=ADAS310
-------------------------------------------------------------------------------
```

```
   25   24 /TREF=2.000E+03
--------------------------------------------------------------------------------
 5.000E+03 1.000E+04 1.500E+04 2.000E+04 2.500E+04 3.000E+04 3.500E+04 4.000E+04
 4.500E+04 5.000E+04 5.500E+04 6.000E+04 6.500E+04 7.000E+04 7.500E+04 8.000E+04
 8.500E+04 9.000E+04 9.500E+04 1.000E+05 1.050E+05 1.100E+05 1.150E+05 1.200E+05
 1.250E+05
 1.000E+08 2.720E+08 7.410E+08 2.020E+09 5.480E+09 1.490E+10 4.060E+10 1.110E+11
 3.010E+11 8.190E+11 2.230E+12 6.060E+12 1.650E+13 4.490E+13 1.220E+14 3.320E+14
 9.050E+14 2.460E+15 6.700E+15 1.820E+16 4.960E+16 1.350E+17 3.670E+17 1.000E+18
--------------------------------------------------------------------------------
 1.197E-07 1.212E-07 1.190E-07 1.156E-07 1.116E-07 1.074E-07 1.032E-07 9.897E-08
 9.500E-08 9.127E-08 8.795E-08 8.493E-08 8.236E-08 8.009E-08 7.816E-08 7.651E-08
 7.505E-08 7.380E-08 7.268E-08 7.167E-08 7.077E-08 6.993E-08 6.917E-08 6.846E-08
 6.781E-08
 1.197E-07 1.213E-07 1.191E-07 1.157E-07 1.117E-07 1.075E-07 1.032E-07 9.902E-08
 9.506E-08 9.133E-08 8.800E-08 8.499E-08 8.241E-08 8.015E-08 7.821E-08 7.656E-08
 7.510E-08 7.384E-08 7.273E-08 7.172E-08 7.081E-08 6.998E-08 6.921E-08 6.851E-08
 6.786E-08
 1.198E-07 1.214E-07 1.192E-07 1.158E-07 1.118E-07 1.076E-07 1.033E-07 9.911E-08
 9.514E-08 9.141E-08 8.808E-08 8.506E-08 8.248E-08 8.022E-08 7.828E-08 7.663E-08
 7.517E-08 7.391E-08 7.279E-08 7.179E-08 7.088E-08 7.004E-08 6.928E-08 6.858E-08
 6.792E-08
 1.200E-07 1.215E-07 1.193E-07 1.159E-07 1.119E-07 1.077E-07 1.034E-07 9.923E-08
 9.526E-08 9.152E-08 8.819E-08 8.517E-08 8.259E-08 8.032E-08 7.838E-08 7.672E-08
 7.527E-08 7.401E-08 7.289E-08 7.188E-08 7.097E-08 7.013E-08 6.937E-08 6.866E-08
 6.801E-08
 1.202E-07 1.217E-07 1.195E-07 1.161E-07 1.121E-07 1.079E-07 1.036E-07 9.940E-08
 9.542E-08 9.168E-08 8.834E-08 8.531E-08 8.273E-08 8.046E-08 7.852E-08 7.686E-08
 7.540E-08 7.413E-08 7.301E-08 7.200E-08 7.109E-08 7.026E-08 6.949E-08 6.878E-08
 6.813E-08
 1.204E-07 1.220E-07 1.198E-07 1.164E-07 1.123E-07 1.081E-07 1.039E-07 9.964E-08
 9.566E-08 9.190E-08 8.856E-08 8.552E-08 8.293E-08 8.065E-08 7.871E-08 7.704E-08
 7.558E-08 7.431E-08 7.319E-08 7.218E-08 7.126E-08 7.042E-08 6.965E-08 6.895E-08
 6.829E-08
 1.207E-07 1.223E-07 1.201E-07 1.167E-07 1.127E-07 1.085E-07 1.042E-07 1.000E-07
 9.601E-08 9.225E-08 8.889E-08 8.584E-08 8.324E-08 8.095E-08 7.900E-08 7.733E-08
 7.586E-08 7.458E-08 7.345E-08 7.244E-08 7.152E-08 7.067E-08 6.990E-08 6.919E-08
 6.853E-08
 1.211E-07 1.227E-07 1.207E-07 1.173E-07 1.133E-07 1.091E-07 1.048E-07 1.006E-07
 9.660E-08 9.282E-08 8.945E-08 8.639E-08 8.377E-08 8.147E-08 7.950E-08 7.782E-08
 7.634E-08 7.505E-08 7.391E-08 7.289E-08 7.196E-08 7.111E-08 7.033E-08 6.961E-08
 6.895E-08
 1.216E-07 1.234E-07 1.214E-07 1.181E-07 1.142E-07 1.100E-07 1.058E-07 1.015E-07
 9.754E-08 9.375E-08 9.037E-08 8.730E-08 8.466E-08 8.235E-08 8.037E-08 7.867E-08
 7.717E-08 7.588E-08 7.472E-08 7.369E-08 7.275E-08 7.189E-08 7.110E-08 7.037E-08
 6.970E-08
 1.223E-07 1.243E-07 1.224E-07 1.193E-07 1.154E-07 1.114E-07 1.072E-07 1.030E-07
 9.897E-08 9.519E-08 9.181E-08 8.873E-08 8.609E-08 8.376E-08 8.177E-08 8.006E-08
 7.855E-08 7.724E-08 7.607E-08 7.502E-08 7.407E-08 7.320E-08 7.240E-08 7.166E-08
 7.098E-08
 1.233E-07 1.255E-07 1.238E-07 1.209E-07 1.172E-07 1.132E-07 1.091E-07 1.050E-07
 1.010E-07 9.730E-08 9.393E-08 9.086E-08 8.822E-08 8.589E-08 8.388E-08 8.216E-08
 8.064E-08 7.932E-08 7.815E-08 7.708E-08 7.612E-08 7.524E-08 7.442E-08 7.367E-08
 7.298E-08
 1.246E-07 1.271E-07 1.258E-07 1.231E-07 1.197E-07 1.159E-07 1.119E-07 1.079E-07
 1.040E-07 1.003E-07 9.700E-08 9.395E-08 9.132E-08 8.900E-08 8.700E-08 8.527E-08
 8.375E-08 8.242E-08 8.123E-08 8.016E-08 7.918E-08 7.828E-08 7.746E-08 7.670E-08
 7.599E-08
 1.265E-07 1.295E-07 1.286E-07 1.263E-07 1.232E-07 1.197E-07 1.160E-07 1.121E-07
 1.084E-07 1.048E-07 1.015E-07 9.850E-08 9.591E-08 9.361E-08 9.162E-08 8.991E-08
 8.839E-08 8.706E-08 8.586E-08 8.478E-08 8.380E-08 8.289E-08 8.205E-08 8.127E-08
 8.055E-08
 1.293E-07 1.329E-07 1.326E-07 1.308E-07 1.282E-07 1.251E-07 1.217E-07 1.182E-07
 1.146E-07 1.112E-07 1.081E-07 1.052E-07 1.027E-07 1.004E-07 9.848E-08 9.679E-08
 9.529E-08 9.398E-08 9.279E-08 9.171E-08 9.072E-08 8.980E-08 8.895E-08 8.816E-08
 8.742E-08
 1.335E-07 1.380E-07 1.385E-07 1.375E-07 1.356E-07 1.332E-07 1.303E-07 1.272E-07
 1.241E-07 1.210E-07 1.181E-07 1.153E-07 1.129E-07 1.108E-07 1.089E-07 1.073E-07
 1.059E-07 1.046E-07 1.034E-07 1.024E-07 1.014E-07 1.005E-07 9.958E-08 9.878E-08
 9.802E-08
 1.392E-07 1.444E-07 1.457E-07 1.455E-07 1.445E-07 1.429E-07 1.409E-07 1.385E-07
 1.360E-07 1.335E-07 1.310E-07 1.286E-07 1.265E-07 1.246E-07 1.230E-07 1.215E-07
 1.202E-07 1.190E-07 1.180E-07 1.170E-07 1.160E-07 1.151E-07 1.143E-07 1.135E-07
 1.127E-07
```

```
 1.446E-07 1.499E-07 1.515E-07 1.519E-07 1.516E-07 1.507E-07 1.495E-07 1.480E-07
 1.462E-07 1.443E-07 1.424E-07 1.405E-07 1.389E-07 1.373E-07 1.360E-07 1.348E-07
 1.337E-07 1.327E-07 1.318E-07 1.310E-07 1.302E-07 1.294E-07 1.286E-07 1.279E-07
 1.272E-07
 1.479E-07 1.530E-07 1.548E-07 1.554E-07 1.555E-07 1.551E-07 1.544E-07 1.534E-07
 1.521E-07 1.507E-07 1.492E-07 1.477E-07 1.463E-07 1.451E-07 1.440E-07 1.430E-07
 1.421E-07 1.413E-07 1.406E-07 1.399E-07 1.392E-07 1.385E-07 1.378E-07 1.372E-07
 1.366E-07
 1.494E-07 1.544E-07 1.562E-07 1.570E-07 1.572E-07 1.570E-07 1.566E-07 1.558E-07
 1.548E-07 1.536E-07 1.523E-07 1.510E-07 1.498E-07 1.487E-07 1.477E-07 1.469E-07
 1.461E-07 1.454E-07 1.448E-07 1.441E-07 1.435E-07 1.429E-07 1.422E-07 1.416E-07
 1.411E-07
 1.500E-07 1.550E-07 1.568E-07 1.576E-07 1.578E-07 1.578E-07 1.574E-07 1.567E-07
 1.559E-07 1.547E-07 1.536E-07 1.523E-07 1.512E-07 1.501E-07 1.492E-07 1.484E-07
 1.477E-07 1.471E-07 1.464E-07 1.458E-07 1.452E-07 1.446E-07 1.440E-07 1.435E-07
 1.429E-07
 1.503E-07 1.552E-07 1.570E-07 1.578E-07 1.581E-07 1.581E-07 1.578E-07 1.571E-07
 1.563E-07 1.552E-07 1.540E-07 1.528E-07 1.517E-07 1.507E-07 1.498E-07 1.490E-07
 1.483E-07 1.477E-07 1.471E-07 1.465E-07 1.459E-07 1.453E-07 1.447E-07 1.442E-07
 1.436E-07
 1.504E-07 1.553E-07 1.571E-07 1.579E-07 1.582E-07 1.582E-07 1.579E-07 1.572E-07
 1.564E-07 1.553E-07 1.542E-07 1.530E-07 1.519E-07 1.509E-07 1.500E-07 1.493E-07
 1.485E-07 1.479E-07 1.473E-07 1.468E-07 1.462E-07 1.456E-07 1.450E-07 1.444E-07
 1.439E-07
 1.504E-07 1.553E-07 1.571E-07 1.579E-07 1.582E-07 1.582E-07 1.579E-07 1.573E-07
 1.565E-07 1.554E-07 1.543E-07 1.530E-07 1.520E-07 1.510E-07 1.501E-07 1.493E-07
 1.486E-07 1.480E-07 1.474E-07 1.468E-07 1.463E-07 1.457E-07 1.451E-07 1.445E-07
 1.440E-07
 1.504E-07 1.553E-07 1.571E-07 1.579E-07 1.582E-07 1.582E-07 1.579E-07 1.573E-07
 1.565E-07 1.554E-07 1.543E-07 1.531E-07 1.520E-07 1.510E-07 1.501E-07 1.494E-07
 1.487E-07 1.480E-07 1.475E-07 1.469E-07 1.463E-07 1.457E-07 1.451E-07 1.446E-07
 1.440E-07
-------------------------------------------------------------------------------
   20 /EREF=6.500E+04 /NREF=6.060E+12
-------------------------------------------------------------------------------
 1.000E+02 2.000E+02 3.000E+02 5.000E+02 6.000E+02 7.000E+02 8.000E+02 8.966E+02
 1.000E+03 2.000E+03 3.000E+03 5.000E+03 6.000E+03 7.000E+03 8.000E+03 8.966E+03
 1.000E+04 2.000E+04 3.000E+04 5.000E+04
-------------------------------------------------------------------------------
 1.082E-07 1.076E-07 1.056E-07 1.021E-07 1.006E-07 9.942E-08 9.836E-08 9.745E-08
 9.658E-08 9.132E-08 8.852E-08 8.530E-08 8.418E-08 8.325E-08 8.245E-08 8.176E-08
 8.109E-08 7.639E-08 7.308E-08 6.821E-08
-------------------------------------------------------------------------------

C-------------------------------------------------------------------
C
C  Code      : run_adas310
C  Producer  : Alessandra Giunta
C  Date      : 27/05/13
C
C-------------------------------------------------------------------
```

3.2.4 adf21_c6.pass

```
    6 /SVREF=1.781E-07 /SPEC=C  /DATE=27/05/13 /CODE=ADAS310
-------------------------------------------------------------------------------
   25   24 /TREF=2.000E+03
-------------------------------------------------------------------------------
 5.000E+03 1.000E+04 1.500E+04 2.000E+04 2.500E+04 3.000E+04 3.500E+04 4.000E+04
 4.500E+04 5.000E+04 5.500E+04 6.000E+04 6.500E+04 7.000E+04 7.500E+04 8.000E+04
 8.500E+04 9.000E+04 9.500E+04 1.000E+05 1.050E+05 1.100E+05 1.150E+05 1.200E+05
 1.250E+05
 1.000E+08 2.720E+08 7.410E+08 2.020E+09 5.480E+09 1.490E+10 4.060E+10 1.110E+11
 3.010E+11 8.190E+11 2.230E+12 6.060E+12 1.650E+13 4.490E+13 1.220E+14 3.320E+14
 9.050E+14 2.460E+15 6.700E+15 1.820E+16 4.960E+16 1.350E+17 3.670E+17 1.000E+18
-------------------------------------------------------------------------------
 9.432E-08 1.141E-07 1.231E-07 1.285E-07 1.325E-07 1.366E-07 1.408E-07 1.452E-07
 1.499E-07 1.548E-07 1.598E-07 1.648E-07 1.700E-07 1.750E-07 1.800E-07 1.848E-07
 1.894E-07 1.938E-07 1.981E-07 2.020E-07 2.056E-07 2.090E-07 2.123E-07 2.154E-07
 2.184E-07
 9.439E-08 1.142E-07 1.232E-07 1.286E-07 1.326E-07 1.367E-07 1.409E-07 1.453E-07
 1.500E-07 1.549E-07 1.598E-07 1.649E-07 1.700E-07 1.751E-07 1.801E-07 1.849E-07
 1.895E-07 1.939E-07 1.981E-07 2.021E-07 2.057E-07 2.091E-07 2.123E-07 2.154E-07
```

2.184E-07
9.448E-08 1.143E-07 1.233E-07 1.287E-07 1.327E-07 1.368E-07 1.409E-07 1.454E-07
1.501E-07 1.549E-07 1.599E-07 1.650E-07 1.701E-07 1.752E-07 1.802E-07 1.850E-07
1.896E-07 1.940E-07 1.982E-07 2.022E-07 2.058E-07 2.092E-07 2.124E-07 2.155E-07
2.185E-07
9.462E-08 1.144E-07 1.234E-07 1.288E-07 1.328E-07 1.369E-07 1.411E-07 1.455E-07
1.502E-07 1.551E-07 1.600E-07 1.651E-07 1.702E-07 1.753E-07 1.803E-07 1.851E-07
1.897E-07 1.941E-07 1.984E-07 2.023E-07 2.059E-07 2.093E-07 2.125E-07 2.156E-07
2.186E-07
9.479E-08 1.146E-07 1.236E-07 1.289E-07 1.330E-07 1.371E-07 1.412E-07 1.457E-07
1.504E-07 1.552E-07 1.602E-07 1.653E-07 1.704E-07 1.755E-07 1.804E-07 1.852E-07
1.899E-07 1.943E-07 1.985E-07 2.025E-07 2.061E-07 2.095E-07 2.127E-07 2.158E-07
2.188E-07
9.502E-08 1.148E-07 1.238E-07 1.292E-07 1.332E-07 1.373E-07 1.414E-07 1.459E-07
1.506E-07 1.554E-07 1.604E-07 1.655E-07 1.706E-07 1.757E-07 1.807E-07 1.855E-07
1.901E-07 1.945E-07 1.987E-07 2.027E-07 2.063E-07 2.097E-07 2.129E-07 2.160E-07
2.190E-07
9.532E-08 1.151E-07 1.241E-07 1.294E-07 1.335E-07 1.376E-07 1.417E-07 1.462E-07
1.509E-07 1.557E-07 1.607E-07 1.658E-07 1.709E-07 1.760E-07 1.810E-07 1.858E-07
1.904E-07 1.949E-07 1.991E-07 2.031E-07 2.067E-07 2.101E-07 2.133E-07 2.164E-07
2.194E-07
9.571E-08 1.155E-07 1.244E-07 1.298E-07 1.339E-07 1.379E-07 1.421E-07 1.466E-07
1.513E-07 1.562E-07 1.612E-07 1.663E-07 1.714E-07 1.765E-07 1.815E-07 1.864E-07
1.910E-07 1.955E-07 1.997E-07 2.037E-07 2.074E-07 2.108E-07 2.140E-07 2.172E-07
2.202E-07
9.623E-08 1.160E-07 1.250E-07 1.304E-07 1.344E-07 1.385E-07 1.427E-07 1.472E-07
1.519E-07 1.568E-07 1.619E-07 1.670E-07 1.722E-07 1.773E-07 1.824E-07 1.872E-07
1.919E-07 1.964E-07 2.007E-07 2.047E-07 2.084E-07 2.119E-07 2.152E-07 2.183E-07
2.214E-07
9.691E-08 1.168E-07 1.257E-07 1.311E-07 1.352E-07 1.393E-07 1.435E-07 1.481E-07
1.528E-07 1.578E-07 1.629E-07 1.681E-07 1.733E-07 1.785E-07 1.837E-07 1.886E-07
1.934E-07 1.979E-07 2.023E-07 2.064E-07 2.101E-07 2.136E-07 2.170E-07 2.202E-07
2.233E-07
9.781E-08 1.179E-07 1.269E-07 1.322E-07 1.363E-07 1.405E-07 1.448E-07 1.494E-07
1.543E-07 1.593E-07 1.645E-07 1.698E-07 1.752E-07 1.805E-07 1.857E-07 1.908E-07
1.957E-07 2.004E-07 2.048E-07 2.090E-07 2.129E-07 2.165E-07 2.199E-07 2.232E-07
2.264E-07
9.902E-08 1.194E-07 1.285E-07 1.340E-07 1.381E-07 1.423E-07 1.467E-07 1.515E-07
1.565E-07 1.618E-07 1.671E-07 1.726E-07 1.781E-07 1.836E-07 1.890E-07 1.943E-07
1.994E-07 2.042E-07 2.089E-07 2.133E-07 2.173E-07 2.210E-07 2.246E-07 2.281E-07
2.315E-07
1.006E-07 1.215E-07 1.310E-07 1.366E-07 1.407E-07 1.451E-07 1.496E-07 1.546E-07
1.598E-07 1.653E-07 1.710E-07 1.767E-07 1.825E-07 1.883E-07 1.939E-07 1.995E-07
2.048E-07 2.100E-07 2.149E-07 2.195E-07 2.238E-07 2.278E-07 2.316E-07 2.354E-07
2.389E-07
1.028E-07 1.246E-07 1.347E-07 1.405E-07 1.447E-07 1.492E-07 1.539E-07 1.591E-07
1.646E-07 1.704E-07 1.764E-07 1.825E-07 1.887E-07 1.949E-07 2.009E-07 2.069E-07
2.126E-07 2.182E-07 2.235E-07 2.285E-07 2.331E-07 2.375E-07 2.417E-07 2.457E-07
2.497E-07
1.062E-07 1.291E-07 1.396E-07 1.456E-07 1.500E-07 1.547E-07 1.597E-07 1.652E-07
1.711E-07 1.774E-07 1.840E-07 1.906E-07 1.973E-07 2.040E-07 2.105E-07 2.170E-07
2.233E-07 2.294E-07 2.353E-07 2.409E-07 2.460E-07 2.508E-07 2.555E-07 2.600E-07
2.644E-07
1.109E-07 1.339E-07 1.443E-07 1.504E-07 1.551E-07 1.601E-07 1.654E-07 1.714E-07
1.779E-07 1.847E-07 1.918E-07 1.990E-07 2.063E-07 2.134E-07 2.206E-07 2.276E-07
2.345E-07 2.412E-07 2.477E-07 2.538E-07 2.594E-07 2.648E-07 2.699E-07 2.749E-07
2.798E-07
1.152E-07 1.373E-07 1.473E-07 1.534E-07 1.583E-07 1.636E-07 1.693E-07 1.757E-07
1.825E-07 1.898E-07 1.973E-07 2.049E-07 2.125E-07 2.201E-07 2.276E-07 2.350E-07
2.422E-07 2.494E-07 2.562E-07 2.627E-07 2.687E-07 2.744E-07 2.799E-07 2.853E-07
2.905E-07
1.179E-07 1.390E-07 1.487E-07 1.548E-07 1.598E-07 1.653E-07 1.712E-07 1.777E-07
1.848E-07 1.923E-07 2.001E-07 2.079E-07 2.156E-07 2.234E-07 2.311E-07 2.387E-07
2.461E-07 2.534E-07 2.605E-07 2.672E-07 2.734E-07 2.792E-07 2.849E-07 2.904E-07
2.958E-07
1.191E-07 1.397E-07 1.493E-07 1.553E-07 1.604E-07 1.660E-07 1.719E-07 1.786E-07
1.858E-07 1.934E-07 2.012E-07 2.091E-07 2.170E-07 2.248E-07 2.325E-07 2.402E-07
2.478E-07 2.552E-07 2.623E-07 2.691E-07 2.753E-07 2.813E-07 2.870E-07 2.926E-07
2.980E-07
1.196E-07 1.400E-07 1.495E-07 1.556E-07 1.607E-07 1.662E-07 1.722E-07 1.789E-07
1.862E-07 1.938E-07 2.017E-07 2.096E-07 2.175E-07 2.253E-07 2.331E-07 2.408E-07
2.484E-07 2.558E-07 2.630E-07 2.698E-07 2.761E-07 2.820E-07 2.878E-07 2.934E-07
2.989E-07
1.198E-07 1.401E-07 1.496E-07 1.556E-07 1.608E-07 1.663E-07 1.724E-07 1.791E-07

```
 1.863E-07 1.940E-07 2.018E-07 2.098E-07 2.177E-07 2.255E-07 2.333E-07 2.410E-07
 2.486E-07 2.561E-07 2.633E-07 2.701E-07 2.764E-07 2.823E-07 2.881E-07 2.937E-07
 2.992E-07
 1.199E-07 1.402E-07 1.496E-07 1.557E-07 1.608E-07 1.664E-07 1.724E-07 1.791E-07
 1.864E-07 1.940E-07 2.019E-07 2.098E-07 2.177E-07 2.256E-07 2.334E-07 2.411E-07
 2.487E-07 2.562E-07 2.634E-07 2.702E-07 2.765E-07 2.824E-07 2.882E-07 2.938E-07
 2.994E-07
 1.199E-07 1.402E-07 1.496E-07 1.557E-07 1.608E-07 1.664E-07 1.724E-07 1.791E-07
 1.864E-07 1.940E-07 2.019E-07 2.098E-07 2.178E-07 2.256E-07 2.334E-07 2.411E-07
 2.487E-07 2.562E-07 2.634E-07 2.702E-07 2.765E-07 2.825E-07 2.882E-07 2.939E-07
 2.994E-07
 1.199E-07 1.402E-07 1.496E-07 1.557E-07 1.608E-07 1.664E-07 1.724E-07 1.791E-07
 1.864E-07 1.940E-07 2.019E-07 2.099E-07 2.178E-07 2.256E-07 2.334E-07 2.412E-07
 2.488E-07 2.562E-07 2.634E-07 2.702E-07 2.765E-07 2.825E-07 2.883E-07 2.939E-07
 2.994E-07
--------------------------------------------------------------------------------
   20 /EREF=6.500E+04 /NREF=6.060E+12
--------------------------------------------------------------------------------
 1.000E+02 2.000E+02 3.000E+02 5.000E+02 6.000E+02 7.000E+02 8.000E+02 8.966E+02
 1.000E+03 2.000E+03 3.000E+03 5.000E+03 6.000E+03 7.000E+03 8.000E+03 8.966E+03
 1.000E+04 2.000E+04 3.000E+04 5.000E+04
--------------------------------------------------------------------------------
 1.927E-07 1.924E-07 1.905E-07 1.872E-07 1.859E-07 1.847E-07 1.838E-07 1.830E-07
 1.822E-07 1.781E-07 1.767E-07 1.761E-07 1.764E-07 1.768E-07 1.774E-07 1.780E-07
 1.787E-07 1.858E-07 1.925E-07 2.029E-07
--------------------------------------------------------------------------------

C-------------------------------------------------------------------
C
C  Code      : run_adas310
C  Producer  : Alessandra Giunta
C  Date      : 27/05/13
C
C-------------------------------------------------------------------
```

3.3 Demo (c-2) IDL procedure

```
pro demo_c_2
;Use run_adas312.pro to make an adf22 (Beam emission coefficients)
;from an adf26 for H+1 and C+6

;Define ion features: H+1, C+6
z_list = [1, 6]
n_list = ['h1', 'c6']

for j = 0, n_elements(z_list)-1 do begin
  run_adas312, adf26='adf26_'+n_list[j]+'.pass', nlow=2, nup=3,$
               outfile='./bme10#h/bme10#h_' + n_list[j] + '.dat'

endfor

end
```

3.4 Demo (c-2) datasets

3.4.1 /bme10#h/bme10#h_h1.dat

```
    1 /ECREF=3.647E-09 /SPEC=H  /DATE=27/05/13 /CODE=ADAS312
-------------------------------------------------------------------------------
   25   24 /TREF=2.000E+03
-------------------------------------------------------------------------------
 5.000E+03 1.000E+04 1.500E+04 2.000E+04 2.500E+04 3.000E+04 3.500E+04 4.000E+04
 4.500E+04 5.000E+04 5.500E+04 6.000E+04 6.500E+04 7.000E+04 7.500E+04 8.000E+04
 8.500E+04 9.000E+04 9.500E+04 1.000E+05 1.050E+05 1.100E+05 1.150E+05 1.200E+05
 1.250E+05
 1.000E+08 2.720E+08 7.410E+08 2.020E+09 5.480E+09 1.490E+10 4.060E+10 1.110E+11
 3.010E+11 8.190E+11 2.230E+12 6.060E+12 1.650E+13 4.490E+13 1.220E+14 3.320E+14
 9.050E+14 2.460E+15 6.700E+15 1.820E+16 4.960E+16 1.350E+17 3.670E+17 1.000E+18
-------------------------------------------------------------------------------
 2.304E-09 2.677E-09 3.080E-09 3.475E-09 3.838E-09 4.161E-09 4.443E-09 4.684E-09
 4.890E-09 5.063E-09 5.208E-09 5.327E-09 5.426E-09 5.507E-09 5.574E-09 5.628E-09
 5.673E-09 5.710E-09 5.739E-09 5.763E-09 5.782E-09 5.797E-09 5.808E-09 5.817E-09
 5.824E-09
 2.298E-09 2.671E-09 3.073E-09 3.468E-09 3.832E-09 4.155E-09 4.437E-09 4.678E-09
 4.885E-09 5.058E-09 5.203E-09 5.321E-09 5.421E-09 5.502E-09 5.569E-09 5.624E-09
 5.668E-09 5.705E-09 5.734E-09 5.758E-09 5.778E-09 5.792E-09 5.804E-09 5.813E-09
 5.819E-09
 2.288E-09 2.661E-09 3.063E-09 3.458E-09 3.822E-09 4.146E-09 4.428E-09 4.670E-09
 4.876E-09 5.050E-09 5.195E-09 5.314E-09 5.414E-09 5.495E-09 5.561E-09 5.617E-09
 5.661E-09 5.698E-09 5.728E-09 5.752E-09 5.771E-09 5.786E-09 5.797E-09 5.806E-09
 5.812E-09
 2.273E-09 2.646E-09 3.048E-09 3.444E-09 3.808E-09 4.132E-09 4.415E-09 4.657E-09
 4.864E-09 5.038E-09 5.183E-09 5.303E-09 5.403E-09 5.484E-09 5.551E-09 5.606E-09
 5.651E-09 5.688E-09 5.718E-09 5.742E-09 5.762E-09 5.777E-09 5.788E-09 5.797E-09
 5.804E-09
 2.254E-09 2.626E-09 3.028E-09 3.423E-09 3.787E-09 4.112E-09 4.396E-09 4.638E-09
 4.846E-09 5.021E-09 5.167E-09 5.287E-09 5.388E-09 5.469E-09 5.537E-09 5.592E-09
 5.637E-09 5.675E-09 5.705E-09 5.729E-09 5.749E-09 5.764E-09 5.775E-09 5.785E-09
 5.791E-09
 2.228E-09 2.599E-09 2.999E-09 3.393E-09 3.758E-09 4.083E-09 4.367E-09 4.611E-09
 4.820E-09 4.995E-09 5.142E-09 5.263E-09 5.365E-09 5.447E-09 5.515E-09 5.571E-09
 5.617E-09 5.655E-09 5.685E-09 5.710E-09 5.730E-09 5.745E-09 5.757E-09 5.766E-09
 5.773E-09
 2.193E-09 2.558E-09 2.955E-09 3.347E-09 3.710E-09 4.035E-09 4.320E-09 4.565E-09
 4.776E-09 4.953E-09 5.102E-09 5.224E-09 5.327E-09 5.411E-09 5.480E-09 5.537E-09
 5.583E-09 5.622E-09 5.653E-09 5.679E-09 5.699E-09 5.715E-09 5.727E-09 5.737E-09
 5.744E-09
 2.141E-09 2.496E-09 2.884E-09 3.270E-09 3.629E-09 3.953E-09 4.238E-09 4.484E-09
 4.697E-09 4.876E-09 5.027E-09 5.152E-09 5.257E-09 5.343E-09 5.414E-09 5.473E-09
 5.521E-09 5.561E-09 5.593E-09 5.620E-09 5.642E-09 5.659E-09 5.672E-09 5.683E-09
```

```
5.691E-09
2.062E-09 2.396E-09 2.767E-09 3.139E-09 3.490E-09 3.809E-09 4.092E-09 4.339E-09
4.553E-09 4.735E-09 4.889E-09 5.017E-09 5.125E-09 5.214E-09 5.288E-09 5.350E-09
5.400E-09 5.443E-09 5.478E-09 5.506E-09 5.530E-09 5.548E-09 5.563E-09 5.576E-09
5.585E-09
1.931E-09 2.227E-09 2.566E-09 2.912E-09 3.245E-09 3.553E-09 3.831E-09 4.076E-09
4.292E-09 4.476E-09 4.634E-09 4.766E-09 4.878E-09 4.972E-09 5.050E-09 5.116E-09
5.170E-09 5.217E-09 5.255E-09 5.287E-09 5.313E-09 5.335E-09 5.353E-09 5.367E-09
5.379E-09
1.707E-09 1.938E-09 2.219E-09 2.520E-09 2.818E-09 3.104E-09 3.369E-09 3.608E-09
3.822E-09 4.008E-09 4.169E-09 4.306E-09 4.424E-09 4.523E-09 4.607E-09 4.679E-09
4.739E-09 4.791E-09 4.835E-09 4.872E-09 4.903E-09 4.929E-09 4.951E-09 4.970E-09
4.986E-09
1.345E-09 1.483E-09 1.681E-09 1.909E-09 2.150E-09 2.392E-09 2.627E-09 2.846E-09
3.048E-09 3.229E-09 3.388E-09 3.526E-09 3.647E-09 3.751E-09 3.840E-09 3.918E-09
3.984E-09 4.042E-09 4.092E-09 4.136E-09 4.173E-09 4.205E-09 4.233E-09 4.257E-09
4.278E-09
8.827E-10 9.378E-10 1.051E-09 1.196E-09 1.361E-09 1.537E-09 1.716E-09 1.891E-09
2.057E-09 2.211E-09 2.349E-09 2.473E-09 2.583E-09 2.680E-09 2.765E-09 2.840E-09
2.906E-09 2.965E-09 3.016E-09 3.061E-09 3.101E-09 3.136E-09 3.167E-09 3.195E-09
3.219E-09
4.841E-10 5.014E-10 5.597E-10 6.416E-10 7.400E-10 8.495E-10 9.658E-10 1.083E-09
1.199E-09 1.308E-09 1.409E-09 1.501E-09 1.584E-09 1.658E-09 1.725E-09 1.785E-09
1.838E-09 1.886E-09 1.929E-09 1.967E-09 2.001E-09 2.032E-09 2.058E-09 2.083E-09
2.104E-09
2.424E-10 2.480E-10 2.773E-10 3.210E-10 3.754E-10 4.383E-10 5.074E-10 5.793E-10
6.514E-10 7.211E-10 7.865E-10 8.470E-10 9.024E-10 9.528E-10 9.985E-10 1.040E-09
1.077E-09 1.111E-09 1.142E-09 1.169E-09 1.193E-09 1.215E-09 1.234E-09 1.252E-09
1.268E-09
1.158E-10 1.165E-10 1.300E-10 1.513E-10 1.790E-10 2.121E-10 2.495E-10 2.895E-10
3.305E-10 3.708E-10 4.093E-10 4.454E-10 4.788E-10 5.096E-10 5.377E-10 5.635E-10
5.869E-10 6.082E-10 6.274E-10 6.448E-10 6.604E-10 6.745E-10 6.871E-10 6.985E-10
7.088E-10
5.113E-11 5.029E-11 5.572E-11 6.494E-11 7.734E-11 9.253E-11 1.101E-10 1.292E-10
1.492E-10 1.692E-10 1.885E-10 2.068E-10 2.239E-10 2.398E-10 2.544E-10 2.680E-10
2.804E-10 2.917E-10 3.020E-10 3.114E-10 3.199E-10 3.275E-10 3.345E-10 3.408E-10
3.465E-10
2.074E-11 2.008E-11 2.212E-11 2.578E-11 3.079E-11 3.702E-11 4.431E-11 5.233E-11
6.079E-11 6.932E-11 7.763E-11 8.557E-11 9.304E-11 1.000E-10 1.065E-10 1.125E-10
1.180E-10 1.231E-10 1.277E-10 1.319E-10 1.358E-10 1.393E-10 1.424E-10 1.453E-10
1.479E-10
7.946E-12 7.630E-12 8.384E-12 9.767E-12 1.168E-11 1.407E-11 1.689E-11 2.000E-11
2.330E-11 2.663E-11 2.990E-11 3.302E-11 3.597E-11 3.874E-11 4.131E-11 4.369E-11
4.589E-11 4.792E-11 4.978E-11 5.148E-11 5.302E-11 5.442E-11 5.570E-11 5.687E-11
5.794E-11
2.974E-12 2.847E-12 3.124E-12 3.640E-12 4.355E-12 5.250E-12 6.307E-12 7.477E-12
8.719E-12 9.978E-12 1.121E-11 1.239E-11 1.351E-11 1.456E-11 1.553E-11 1.644E-11
1.728E-11 1.805E-11 1.876E-11 1.940E-11 1.999E-11 2.053E-11 2.102E-11 2.146E-11
2.187E-11
1.098E-12 1.050E-12 1.152E-12 1.342E-12 1.605E-12 1.936E-12 2.327E-12 2.760E-12
3.219E-12 3.685E-12 4.142E-12 4.581E-12 4.995E-12 5.384E-12 5.746E-12 6.083E-12
6.394E-12 6.681E-12 6.944E-12 7.184E-12 7.403E-12 7.603E-12 7.784E-12 7.951E-12
8.103E-12
4.045E-13 3.864E-13 4.239E-13 4.937E-13 5.909E-13 7.127E-13 8.566E-13 1.016E-12
1.185E-12 1.357E-12 1.526E-12 1.688E-12 1.840E-12 1.984E-12 2.117E-12 2.242E-12
2.357E-12 2.462E-12 2.560E-12 2.648E-12 2.729E-12 2.803E-12 2.870E-12 2.931E-12
2.988E-12
1.489E-13 1.422E-13 1.560E-13 1.817E-13 2.175E-13 2.623E-13 3.153E-13 3.741E-13
4.364E-13 4.997E-13 5.618E-13 6.214E-13 6.777E-13 7.305E-13 7.798E-13 8.256E-13
8.679E-13 9.068E-13 9.427E-13 9.753E-13 1.005E-12 1.032E-12 1.057E-12 1.080E-12
1.100E-12
5.467E-14 5.222E-14 5.727E-14 6.671E-14 7.984E-14 9.630E-14 1.158E-13 1.373E-13
1.602E-13 1.835E-13 2.062E-13 2.281E-13 2.488E-13 2.682E-13 2.863E-13 3.031E-13
3.186E-13 3.330E-13 3.461E-13 3.581E-13 3.691E-13 3.790E-13 3.881E-13 3.964E-13
4.040E-13
--------------------------------------------------------------------------------
   20 /EREF=6.500E+04 /NREF=6.060E+12
--------------------------------------------------------------------------------
1.000E+02 2.000E+02 3.000E+02 5.000E+02 6.000E+02 7.000E+02 8.000E+02 8.966E+02
1.000E+03 2.000E+03 3.000E+03 5.000E+03 6.000E+03 7.000E+03 8.000E+03 8.966E+03
1.000E+04 2.000E+04 3.000E+04 5.000E+04
--------------------------------------------------------------------------------
4.168E-09 4.242E-09 4.211E-09 4.108E-09 4.058E-09 4.012E-09 3.970E-09 3.933E-09
3.895E-09 3.647E-09 3.510E-09 3.341E-09 3.284E-09 3.237E-09 3.198E-09 3.167E-09
```

```
 3.138E-09 2.996E-09 2.957E-09 2.952E-09
--------------------------------------------------------------------------------
C
C
C  ADAS file type : adf22 (bme)
C  Source file    : adf26_h1.pass
C
C  A-VALUE        : 4.413E+07 S-1
C
C
C
C  CODE     : ADAS312
C  PRODUCER : Alessandra Giunta
C  DATE     : 27/05/13
C
C-------------------------------------------------------------------------------
```

3.4.2 /bme10#h/bme10#h_c6.dat

```
    6 /ECREF=2.407E-09 /SPEC=C  /DATE=27/05/13 /CODE=ADAS312
--------------------------------------------------------------------------------
   25   24 /TREF=2.000E+03
--------------------------------------------------------------------------------
 5.000E+03 1.000E+04 1.500E+04 2.000E+04 2.500E+04 3.000E+04 3.500E+04 4.000E+04
 4.500E+04 5.000E+04 5.500E+04 6.000E+04 6.500E+04 7.000E+04 7.500E+04 8.000E+04
 8.500E+04 9.000E+04 9.500E+04 1.000E+05 1.050E+05 1.100E+05 1.150E+05 1.200E+05
 1.250E+05
 1.000E+08 2.720E+08 7.410E+08 2.020E+09 5.480E+09 1.490E+10 4.060E+10 1.110E+11
 3.010E+11 8.190E+11 2.230E+12 6.060E+12 1.650E+13 4.490E+13 1.220E+14 3.320E+14
 9.050E+14 2.460E+15 6.700E+15 1.820E+16 4.960E+16 1.350E+17 3.670E+17 1.000E+18
--------------------------------------------------------------------------------
 1.923E-09 1.985E-09 2.036E-09 2.096E-09 2.216E-09 2.389E-09 2.609E-09 2.869E-09
 3.150E-09 3.438E-09 3.721E-09 3.990E-09 4.257E-09 4.533E-09 4.818E-09 5.111E-09
 5.406E-09 5.689E-09 5.950E-09 6.197E-09 6.439E-09 6.680E-09 6.920E-09 7.160E-09
 7.400E-09
 1.916E-09 1.978E-09 2.029E-09 2.089E-09 2.209E-09 2.382E-09 2.602E-09 2.863E-09
 3.143E-09 3.431E-09 3.714E-09 3.983E-09 4.250E-09 4.526E-09 4.812E-09 5.105E-09
 5.399E-09 5.682E-09 5.943E-09 6.190E-09 6.432E-09 6.673E-09 6.913E-09 7.153E-09
 7.393E-09
 1.906E-09 1.969E-09 2.020E-09 2.079E-09 2.200E-09 2.373E-09 2.593E-09 2.853E-09
 3.134E-09 3.421E-09 3.705E-09 3.974E-09 4.241E-09 4.517E-09 4.802E-09 5.095E-09
 5.390E-09 5.672E-09 5.934E-09 6.181E-09 6.423E-09 6.664E-09 6.904E-09 7.144E-09
 7.384E-09
 1.893E-09 1.956E-09 2.007E-09 2.067E-09 2.187E-09 2.361E-09 2.581E-09 2.841E-09
 3.122E-09 3.409E-09 3.692E-09 3.961E-09 4.228E-09 4.504E-09 4.790E-09 5.083E-09
 5.377E-09 5.660E-09 5.921E-09 6.168E-09 6.410E-09 6.651E-09 6.891E-09 7.131E-09
 7.371E-09
 1.874E-09 1.938E-09 1.990E-09 2.050E-09 2.171E-09 2.344E-09 2.564E-09 2.824E-09
 3.105E-09 3.392E-09 3.675E-09 3.944E-09 4.211E-09 4.487E-09 4.772E-09 5.065E-09
 5.359E-09 5.642E-09 5.903E-09 6.150E-09 6.392E-09 6.633E-09 6.873E-09 7.113E-09
 7.352E-09
 1.848E-09 1.914E-09 1.966E-09 2.026E-09 2.148E-09 2.321E-09 2.540E-09 2.800E-09
 3.081E-09 3.368E-09 3.650E-09 3.919E-09 4.186E-09 4.461E-09 4.746E-09 5.038E-09
 5.332E-09 5.614E-09 5.875E-09 6.122E-09 6.363E-09 6.603E-09 6.843E-09 7.083E-09
 7.322E-09
 1.812E-09 1.878E-09 1.931E-09 1.993E-09 2.114E-09 2.286E-09 2.506E-09 2.764E-09
 3.044E-09 3.330E-09 3.611E-09 3.879E-09 4.144E-09 4.418E-09 4.702E-09 4.993E-09
 5.285E-09 5.566E-09 5.826E-09 6.071E-09 6.311E-09 6.550E-09 6.789E-09 7.027E-09
 7.265E-09
 1.758E-09 1.823E-09 1.878E-09 1.941E-09 2.061E-09 2.233E-09 2.450E-09 2.706E-09
 2.983E-09 3.266E-09 3.545E-09 3.809E-09 4.072E-09 4.342E-09 4.622E-09 4.910E-09
 5.198E-09 5.475E-09 5.731E-09 5.972E-09 6.209E-09 6.445E-09 6.681E-09 6.916E-09
 7.151E-09
 1.674E-09 1.733E-09 1.793E-09 1.857E-09 1.976E-09 2.144E-09 2.357E-09 2.608E-09
 2.878E-09 3.154E-09 3.425E-09 3.683E-09 3.939E-09 4.202E-09 4.474E-09 4.754E-09
 5.034E-09 5.302E-09 5.550E-09 5.784E-09 6.014E-09 6.244E-09 6.472E-09 6.701E-09
 6.929E-09
 1.535E-09 1.577E-09 1.645E-09 1.713E-09 1.830E-09 1.990E-09 2.191E-09 2.429E-09
 2.684E-09 2.944E-09 3.199E-09 3.441E-09 3.683E-09 3.931E-09 4.187E-09 4.449E-09
 4.712E-09 4.963E-09 5.195E-09 5.414E-09 5.629E-09 5.844E-09 6.058E-09 6.273E-09
 6.486E-09
 1.305E-09 1.313E-09 1.390E-09 1.465E-09 1.574E-09 1.716E-09 1.893E-09 2.101E-09
 2.324E-09 2.550E-09 2.772E-09 2.984E-09 3.196E-09 3.414E-09 3.638E-09 3.866E-09
```

```
 4.093E-09 4.310E-09 4.510E-09 4.699E-09 4.886E-09 5.072E-09 5.258E-09 5.444E-09
 5.629E-09
 9.596E-10 9.304E-10 1.010E-09 1.085E-09 1.176E-09 1.286E-09 1.421E-09 1.579E-09
 1.746E-09 1.915E-09 2.082E-09 2.244E-09 2.407E-09 2.574E-09 2.744E-09 2.916E-09
 3.087E-09 3.249E-09 3.398E-09 3.540E-09 3.680E-09 3.821E-09 3.961E-09 4.101E-09
 4.240E-09
 5.736E-10 5.338E-10 5.964E-10 6.557E-10 7.189E-10 7.891E-10 8.732E-10 9.716E-10
 1.076E-09 1.180E-09 1.284E-09 1.388E-09 1.492E-09 1.599E-09 1.708E-09 1.817E-09
 1.924E-09 2.026E-09 2.121E-09 2.212E-09 2.301E-09 2.391E-09 2.480E-09 2.570E-09
 2.659E-09
 2.877E-10 2.590E-10 2.953E-10 3.314E-10 3.680E-10 4.066E-10 4.520E-10 5.049E-10
 5.607E-10 6.172E-10 6.744E-10 7.323E-10 7.915E-10 8.519E-10 9.133E-10 9.746E-10
 1.035E-09 1.093E-09 1.147E-09 1.200E-09 1.252E-09 1.304E-09 1.356E-09 1.408E-09
 1.460E-09
 1.337E-10 1.158E-10 1.323E-10 1.506E-10 1.696E-10 1.893E-10 2.123E-10 2.389E-10
 2.671E-10 2.959E-10 3.254E-10 3.558E-10 3.869E-10 4.187E-10 4.511E-10 4.835E-10
 5.155E-10 5.467E-10 5.767E-10 6.057E-10 6.342E-10 6.625E-10 6.909E-10 7.193E-10
 7.480E-10
 6.028E-11 4.895E-11 5.525E-11 6.334E-11 7.215E-11 8.145E-11 9.225E-11 1.047E-10
 1.180E-10 1.317E-10 1.457E-10 1.602E-10 1.751E-10 1.903E-10 2.058E-10 2.213E-10
 2.368E-10 2.520E-10 2.667E-10 2.811E-10 2.951E-10 3.090E-10 3.229E-10 3.368E-10
 3.510E-10
 2.566E-11 1.949E-11 2.169E-11 2.494E-11 2.862E-11 3.255E-11 3.713E-11 4.240E-11
 4.805E-11 5.387E-11 5.985E-11 6.604E-11 7.237E-11 7.881E-11 8.538E-11 9.201E-11
 9.862E-11 1.051E-10 1.115E-10 1.177E-10 1.237E-10 1.297E-10 1.357E-10 1.417E-10
 1.478E-10
 1.022E-11 7.449E-12 8.222E-12 9.463E-12 1.089E-11 1.244E-11 1.423E-11 1.631E-11
 1.853E-11 2.083E-11 2.318E-11 2.561E-11 2.810E-11 3.063E-11 3.322E-11 3.582E-11
 3.843E-11 4.100E-11 4.351E-11 4.595E-11 4.834E-11 5.070E-11 5.305E-11 5.543E-11
 5.786E-11
 3.887E-12 2.777E-12 3.055E-12 3.517E-12 4.055E-12 4.636E-12 5.314E-12 6.096E-12
 6.936E-12 7.802E-12 8.690E-12 9.608E-12 1.055E-11 1.150E-11 1.247E-11 1.346E-11
 1.444E-11 1.541E-11 1.636E-11 1.728E-11 1.818E-11 1.907E-11 1.996E-11 2.086E-11
 2.178E-11
 1.451E-12 1.029E-12 1.130E-12 1.301E-12 1.500E-12 1.716E-12 1.968E-12 2.259E-12
 2.572E-12 2.894E-12 3.224E-12 3.566E-12 3.914E-12 4.269E-12 4.631E-12 4.997E-12
 5.362E-12 5.723E-12 6.076E-12 6.420E-12 6.755E-12 7.086E-12 7.417E-12 7.751E-12
 8.093E-12
 5.351E-13 3.782E-13 4.152E-13 4.781E-13 5.516E-13 6.311E-13 7.240E-13 8.311E-13
 9.463E-13 1.065E-12 1.187E-12 1.312E-12 1.441E-12 1.571E-12 1.705E-12 1.839E-12
 1.974E-12 2.107E-12 2.237E-12 2.364E-12 2.487E-12 2.609E-12 2.731E-12 2.854E-12
 2.980E-12
 1.970E-13 1.391E-13 1.526E-13 1.758E-13 2.028E-13 2.321E-13 2.662E-13 3.056E-13
 3.480E-13 3.917E-13 4.365E-13 4.827E-13 5.300E-13 5.780E-13 6.270E-13 6.766E-13
 7.261E-13 7.751E-13 8.230E-13 8.695E-13 9.150E-13 9.599E-13 1.005E-12 1.050E-12
 1.096E-12
 7.251E-14 5.117E-14 5.616E-14 6.467E-14 7.461E-14 8.538E-14 9.796E-14 1.125E-13
 1.281E-13 1.441E-13 1.606E-13 1.776E-13 1.950E-13 2.127E-13 2.308E-13 2.490E-13
 2.672E-13 2.852E-13 3.029E-13 3.200E-13 3.367E-13 3.532E-13 3.697E-13 3.864E-13
 4.035E-13
 2.662E-14 1.878E-14 2.061E-14 2.374E-14 2.739E-14 3.134E-14 3.596E-14 4.128E-14
 4.700E-14 5.290E-14 5.895E-14 6.520E-14 7.159E-14 7.807E-14 8.470E-14 9.140E-14
 9.809E-14 1.047E-13 1.112E-13 1.175E-13 1.236E-13 1.297E-13 1.357E-13 1.418E-13
 1.481E-13
--------------------------------------------------------------------------------
   20 /EREF=6.500E+04 /NREF=6.060E+12
--------------------------------------------------------------------------------
 1.000E+02 2.000E+02 3.000E+02 5.000E+02 6.000E+02 7.000E+02 8.000E+02 8.966E+02
 1.000E+03 2.000E+03 3.000E+03 5.000E+03 6.000E+03 7.000E+03 8.000E+03 8.966E+03
 1.000E+04 2.000E+04 3.000E+04 5.000E+04
--------------------------------------------------------------------------------
 2.894E-09 2.929E-09 2.889E-09 2.791E-09 2.746E-09 2.706E-09 2.670E-09 2.637E-09
 2.606E-09 2.407E-09 2.307E-09 2.192E-09 2.155E-09 2.125E-09 2.101E-09 2.082E-09
 2.065E-09 1.981E-09 1.960E-09 1.970E-09
--------------------------------------------------------------------------------
C
C
C  ADAS file type : adf22 (bme)
C  Source file    : adf26_c6.pass
C
C  A-VALUE        : 4.413E+07 S-1
C
C
C
```

```
C  CODE     : ADAS312
C  PRODUCER : Alessandra Giunta
C  DATE     : 27/05/13
C
C-------------------------------------------------------------------------------
```

3.5 Demo (c-3) procedure

```
pro demo_c_3
;Use read_adf22.pro to read beam emission coefficients.
;Use read_adf21.pro to read beam stopping coefficient (adf21.pass).
;Plot the D-alpha emission coefficients in a pure D+ and pure C6+ plasma

;Conditions

ieval=50
te=2000.0
energy=adas_vector(low=1e3, high=1e5, num=ieval)
dens=[1e8, 1e12,  1e15]
idval =n_elements(dens)

file_d='./bme10#h/bme10#h_h1.dat'
file_c='./bme10#h/bme10#h_c6.dat'

;Read data at fixed Te, for different densities s a function of beam energy
data_d = fltarr(ieval,idval)
data_c = fltarr(ieval,idval)

for id=0,idval-1 do begin

   read_adf22, files=file_d, fraction=[1.0], te=fltarr(ieval)+te,     $
               dens=fltarr(ieval) + dens[id], energy=energy, data=tmp
   data_d[*,id] = tmp

   read_adf22, files=file_c, fraction=[1.0], te=fltarr(ieval)+te,     $
               dens=fltarr(ieval) + dens[id], energy=energy, data=tmp
   data_c[*,id] = tmp
endfor


;Plot D and C side by side with same y-axis
set_plot,'ps'
device, /isolatin1, font_index=8
device, bits=8, filename='demo_c_3_emission.ps',         $
        font_size = 14, xsize=20.0, ysize=16.0, $
        yoffset=7.0, /color
device, /helvetica

energy_kev = energy / 1000.0

xmin=1
xmax=100
ymin=0
ymax=6
```

```
plot_oi, [xmin, xmax], [ymin, ymax], /nodata, ystyle=1, $
         position=[0.07, 0.09, 0.5, 0.95], $
         title='D!u+!n plasma',$
         xtitle = 'Beam Energy (keV/amu)', $
         ytitle = 'D!7a!3 emission coefficient (10!u-9!n ph cm!u3!n s!u-1!n)'


for id = 0, idval-1 do oplot, energy_kev, data_d[*,id]/1e-9,line=id

plots,[1.3,3.],[5.7,5.7]
xyouts,3.1,5.7,'10!u8!n cm!u-3!n'
plots,[1.3,3.],[5.3,5.3],line=1
xyouts,3.1,5.3,'10!u12!n cm!u-3!n'
plots,[1.3,3.],[4.9,4.9],line=2
xyouts,3.1,4.9,'10!u14!n cm!u-3!n'


plot_oi, [xmin, xmax], [ymin, ymax], /nodata, ystyle=1, $
         title='C!u6+!n plasma',$
         position=[0.55, 0.09, 0.95, 0.95], /noerase, $
         xtitle = 'Beam Energy (keV/amu)'

for id = 0, idval-1 do oplot, energy_kev, data_c[*,id]/1e-9, line=id


device, /close
set_plot,'X'
!p.font=-1


;Use read_adf21.pro to read adf21.pass produced in demo_d_1 and
;compare pure D+1 and D+1 + 2% of C6+

idval  = 24
ieval  = 20
te     = 2000.0
dens   = adas_vector(low=1e12, high=1e15, num=idval)
energy = adas_vector(low=5e3, high=1.2e5, num=ieval)
files  = ['adf21_h1.pass', $
          'adf21_c6.pass' ]

data_d  = fltarr(ieval, idval)
data_dc = fltarr(ieval, idval)

for id = 0, idval-1 do begin
   ; D+ only
   read_adf21, files=files[0], fraction=[1.0], te=fltarr(ieval)+te,     $
               dens=fltarr(ieval) + dens[id], energy=energy, data=tmp
   data_d[*,id] = tmp
```

```
   ; D+ and C6+
   read_adf21, files=files, fraction=[0.98, 0.02], te=fltarr(ieval)+te, $
               dens=fltarr(ieval) + dens[id], energy=energy, data=tmp
   data_dc[*,id] = tmp

endfor

energy_kev =energy/1000.0
loadct,3

;Plot total beam stopping coefficient as a function of energy and
;density
;for pure D1+ and D1+ and 2% C6+
set_plot,'ps'
device, /isolatin1, font_index=8
device, bits=8, filename='demo_c_3_stopping.ps',         $
        font_size = 14, xsize=20.0, ysize=16.0, $
        yoffset=7.0, /color
device, /helvetica

surface, data_d, energy_kev, dens, /ylog,charsize=1.3,color=120,$
           xrange=[5,120], yrange=[1e12, 1e15], zrange=[6e-8,1.6e-7],$
           xtitle='log(Beam energy) (keV/amu)', $
           ytitle='log(Density) (cm!u-3!n s!u-1!n)', $
           ztitle = 'Stopping coefficient (cm!u3!n s!u-1!n)'

surface, data_dc, energy_kev, dens, /ylog,charsize=1.3,/noerase,$
           xrange=[5,120], yrange=[1e12, 1e15], zrange=[6e-8,1.6e-7],$
           xtitle='log(Beam energy) (keV/amu)', $
           ytitle='log(Density) (cm!u-3!n s!u-1!n)', $
           ztitle = 'Stopping coefficient (cm!u3!n s!u-1!n)'

xyouts,0.7,0.9,'D!u1+!n only',color=120,/normal
xyouts,0.7,0.85,'D!u1+!n and 2% C!u6+!n',/normal

device, /close
set_plot,'X'
!p.font=-1


end
```

3.6 Demo (c-3) Figures

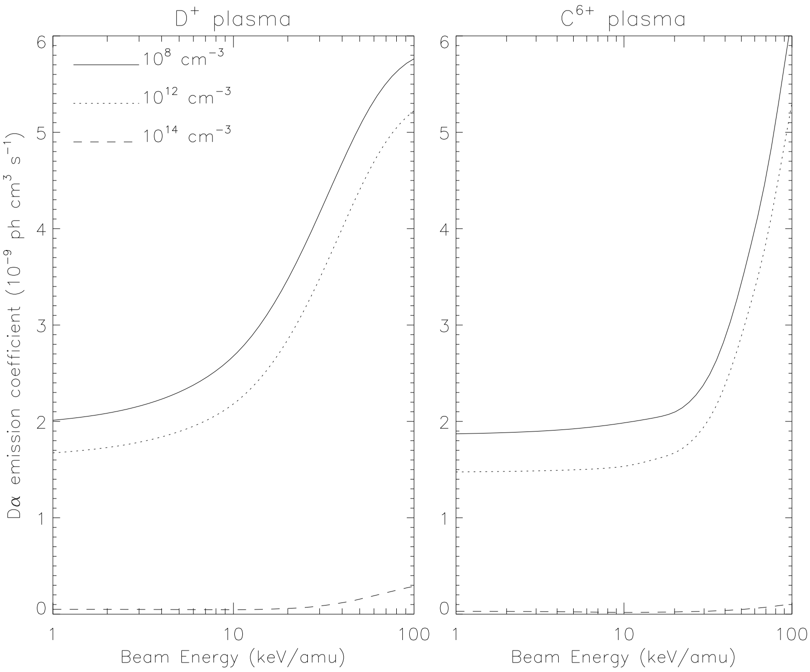

Figure 13: demo_c/demo_c_3_emission.pdf

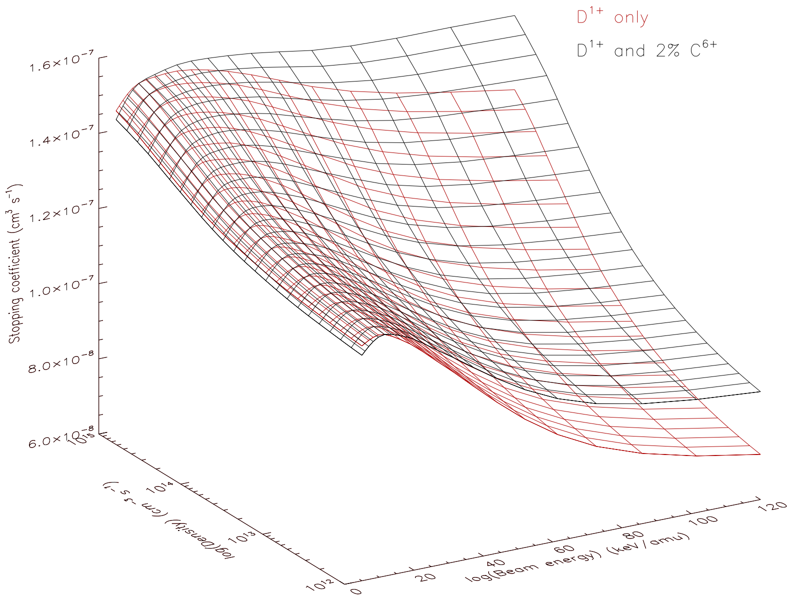

Figure 14: demo_c/demo_c_3_stopping.pdf

4 Demo (d) Looking at Stark multiplet emission for the H-beam

```
------------------------------
DEMO D: Looking at Stark multiplet emission for the H-beam
------------------------------
PURPOSE: Look at the hydrogen Stark feature as components and as a Doppler
broadened feature.

EXAMPLE: For this demo a deuterium beam and a deuterium plasma are considered.

Beam details are the following:
H beam mass (deuterium): 2.0
Energy: 78.0e3e V/amu
Temperature:  10.0 eV
Density: 1.00e10 cm-3
Direction cosines for velocity components: x = 0.0, y = 0.0, z = 1.0

Plasma details are the following:
H plasma mass (deuterium): 2.0
Temperature: 4440.0 eV
Density: 2.49e13 cm-3
Effective charge: 2.0

Magnetic field details are the following:
Value: 3.3915 Tesla
Direction cosines for components: x = 0.788, y = 0.788, z = 0.0


Electric field details are the following:
Value: 0.0000 Volts
Direction cosines for components: x = 1.000, y = 1.000, z = 0.0

Viewing line of sight details are the following:
Direction cosines for components: x = 0.8701, y = -0.047, z = 0.4905
Specific sigma polarisation: 1.0
Specific pi polarisation:1.0

H Balmer alpha line is chosen:
n_lower=2
n_upper=3


DEMO d1: Working offline with adas305_get_stark.pro
1. Define beam, plasma, magnetic, electric and observed line of sight details.
2. Use adas305_get_stark.pro to get Stark and Doppler-broadened features for
   D(n=3-2).
3. Plot Stark line emission and Doppler broadening.
Program: demo_d.pro
```

Output file: demo_d.ps

4.1 Demo (d-1) procedure

```
pro demo_d
;Use adas305_get_stark.pro to calculate the D(n=3-2) Stark manifold.

;Set all parameters

;Beam details: H beam mass -> 2 for deuterium; energy in eV/amu, te in eV,
;density in cm-3, dc_X,dc_y,dc_z are velocity component directions
beam   = {mass : 2.0, energy : 78.0e3, te : 10.0, density : 1.00e10, $
          dc_x : 0.0, dc_y : 0.0, dc_z : 1.0}

;Plasma details
plasma = {mass : 2.0, te : 4440.0, density : 2.49e13, zeff : 2.0}

;Magnetic field details
bfield = {value : 3.3915, dc_x : 0.788, dc_y : 0.788, dc_z : 0.0}

;Electric field details
efield = {value : 0.0000, dc_x : 1.000, dc_y : 1.0000, dc_z : 0.0000}

;Viewing line of sight details
obs    = {dc_x : 0.8701, dc_y : -0.047, dc_z : 0.4905, sigma : 1.0, pi : 1.0}

;Number of pixels
npix     = 360


;Use adas305_get_stark.pro to get the wavelength components of stark feature
;together with the associated emission and the emission Doppler-bradened on to
;the wavelength grid
adas305_get_stark,  beam          = beam,          $
                    plasma        = plasma,        $
                    bfield        = bfield,        $
                    efield        = efield,        $
                    obs           = obs,           $
                    n_lower       = 2,             $
                    n_upper       = 3,             $
                    wave_comp     = wave_comp,     $
                    emiss_comp    = emiss_comp,    $
                    wave_min      = wave_min,      $
                    wave_max      = wave_max,      $
                    npix          = npix,          $
                    adf22         = adf22,         $
                    emiss_doppler  = emiss_doppler, $
                    wave_doppler   = wave_doppler,  $
                    /doppler,/auto_wave



;Plot Stark line emission and Doppler broadening for D(n=3-2)
loadct,3
set_plot,'ps'
device, /isolatin1, font_index=8
device, bits=8, filename='demo_d.ps',         $
        font_size = 14, xsize=18.0, ysize=16.0, $
        yoffset=7.0, /color
device, /helvetica

plot, wave_comp, emiss_comp,/nodata, $
      title='Beam Balmer !7a!3 Stark manifold',xmargin=[12,3],$
      xtitle='Wavelength (A)', $
      ytitle = 'Intensity /ion (Photon cm!u-2!n s!u-1!n)'
for i = 0, n_elements(wave_comp)-1 do oplot,[wave_comp[i],wave_comp[i]],[0,emiss_comp[i]]
plots, wave_doppler, emiss_doppler,color=120

xyouts,6524.,8.e12,'Stark emission components'
xyouts,6520.,1.1e13,'Doppler-broadened emission',color=120

device, /close
set_plot,'X'
```

```
!p.font=-1

end
```

4.2 Demo(d-1) Figures

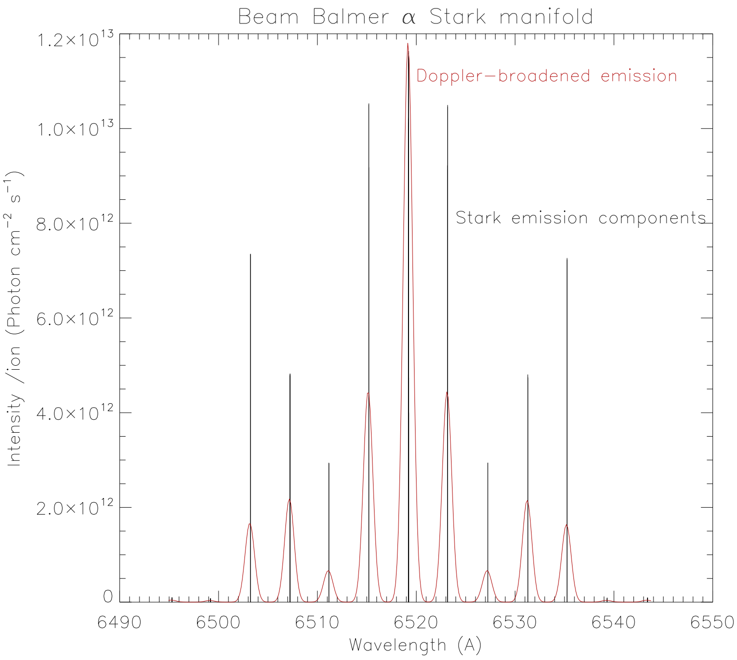

Figure 15: demo_d/demo_d.pdf