MODULE 6
Advanced charge exchange plasma receiver and beam donor modelling - the current state.

Demonstration script

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July 19, 2013

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1 Demo (a) Using universal charge exchange cross-section data

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DEMO A: Using universal charge exchange cross-section data
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PURPOSE: To prepare an adf01 data file for a specific ion from universal
z-scaled charge exchange (CX) cross-section data, collected in the adf49 data
format.
The adf01 data files provide state selective CX data.
The adf49 data files give, at the present, the universal scaled CX cross-section
for H(n=1) and H(n=2) donors


EXAMPLE: This demo shows how to produce an adf01 from the universal scaled CX
data for W51+ with H(n=1) donor.
This can be done using either ADAS315 interactively or run_adas315.pro from the
IDL comman line.
The adf49 input file is /home/adas/adas/adf49/arf07#h0_n1.dat.
The element chosen is Tungsten: iz0=74
The ionisation stage W51+: iz1=51


DEMO a1: Extract adf01 data for an ion from adf49
         with interactive ADAS315
1. Use ADAS315 interactively.
Sample of output file: adf01_w51_interactive.pass

DEMO a2: Extract adf01 using run_adas315.pro
1. Define iz0 and iz1.
2. Define the adf49 for H(n=1) as donor.
3. Use run_adas315.pro to produce the adf01.
Program: demo_a_2.pro
Sample of output file: adf01_w51.pass
```

1.1 Demo (a) IDL procedures

1.1.1 Demo (a-2) demo_a_2.pro

Use IDL procedure *run_adas315.pro* for tungsten.

```
pro demo_a_2
;Use run_adas315.pro for W, receiver z0=74, donor z1=51
iz0=74
iz1=51

adf49='/home/adas/adas/adf49/arf07#h0_n1.dat'

;Define energy array in eV/amu
energy=adas_vector(low=0.01e3,high=100.e3,num=20)

;Use run_adas315.pro
run_adas315,iz0=iz0,iz1=iz1,energy=energy,adf49=adf49,adf01='adf01_w51.pass'

end
```

1.2 Demo (a) Tables and datasets

1.2.1 Demo (a-1) demo_d/adf01_w51_interactive.pass

```
W +51     H + 0 (1)  / receiver, donor (donor state index)    /         /
    9                / number of energies
   17                / nmin
   40                / nmax
              0.01      0.02      0.05      0.10      0.20      0.50      1.00      2.00      5.00 / energies         (keV/amu)
             80.90     58.62     45.27     31.04     14.88      9.94     19.34     16.68     11.76 / alpha
          4.97E-14 4.97E-14 4.97E-14 4.97E-14 4.97E-14 4.97E-14 4.97E-14 4.97E-14 4.97E-14 / total xsects.    (cm2)
  n  l  m                                                                                      / partial xsects.  (cm2)
 17       3.85E-16 3.23E-16 3.75E-16 5.08E-16 6.57E-16 9.25E-16 1.22E-15 1.60E-15 2.59E-15
 18       2.56E-15 2.39E-15 2.55E-15 2.89E-15 3.20E-15 3.77E-15 4.37E-15 4.75E-15 5.73E-15
 19       7.90E-15 7.64E-15 7.67E-15 7.85E-15 7.96E-15 8.28E-15 8.59E-15 8.42E-15 8.39E-15
 20       1.30E-14 1.27E-14 1.23E-14 1.20E-14 1.17E-14 1.11E-14 1.06E-14 1.00E-14 9.11E-15
 21       1.32E-14 1.30E-14 1.25E-14 1.21E-14 1.16E-14 1.08E-14 1.01E-14 9.47E-15 8.33E-15
 22       8.67E-15 9.03E-15 9.03E-15 8.77E-15 8.51E-15 8.10E-15 7.73E-15 7.41E-15 6.56E-15
 23       3.29E-15 3.72E-15 4.07E-15 4.18E-15 4.31E-15 4.48E-15 4.59E-15 4.72E-15 4.47E-15
 24       6.30E-16 7.87E-16 1.01E-15 1.18E-15 1.40E-15 1.67E-15 1.85E-15 2.22E-15 2.51E-15
 25       5.57E-17 7.66E-17 1.25E-16 1.84E-16 2.72E-16 3.95E-16 4.77E-16 7.49E-16 1.14E-15
 26       2.58E-18 4.18E-18 9.45E-18 1.86E-17 3.63E-17 6.78E-17 9.08E-17 2.00E-16 4.56E-16
 27       1.05E-19 2.73E-19 9.28E-19 2.26E-18 5.87E-18 1.21E-17 1.54E-17 4.93E-17 1.75E-16
 28       4.96E-21 2.99E-20 1.68E-19 4.51E-19 1.45E-18 2.83E-18 3.04E-18 1.36E-17 7.27E-17
 29       2.62E-22 3.54E-21 3.24E-20 1.27E-19 4.25E-19 8.67E-19 8.55E-19 4.93E-18 3.58E-17
 30       1.53E-23 4.53E-22 6.62E-21 4.27E-20 1.49E-19 3.59E-19 3.99E-19 2.57E-18 2.21E-17
 31       9.86E-25 6.21E-23 1.43E-21 1.49E-20 8.07E-20 2.18E-19 2.85E-19 1.83E-18 1.63E-17
 32       6.95E-26 9.08E-24 3.23E-22 5.39E-21 5.91E-20 1.75E-19 2.54E-19 1.53E-18 1.29E-17
 33       5.32E-27 1.41E-24 7.68E-23 2.01E-21 4.18E-20 1.37E-19 2.26E-19 1.28E-18 1.02E-17
 34       4.42E-28 2.32E-25 1.91E-23 7.74E-22 2.64E-20 9.52E-20 1.71E-19 9.55E-19 7.52E-18
 35       3.95E-29 4.04E-26 4.94E-24 3.06E-22 1.69E-20 5.23E-20 1.19E-19 6.66E-19 5.39E-18
 36       3.78E-30 7.38E-27 1.33E-24 1.25E-22 1.10E-20 3.77E-20 8.37E-20 4.75E-19 3.92E-18
 37       3.87E-31 1.42E-27 3.71E-25 5.20E-23 7.24E-21 2.85E-20 6.33E-20 3.58E-19 2.92E-18
 38       4.22E-32 2.84E-28 1.07E-25 2.22E-23 4.82E-21 2.17E-20 4.88E-20 2.75E-19 2.20E-18
 39       4.88E-33 5.95E-29 3.21E-26 9.70E-24 3.24E-21 1.66E-20 3.29E-20 1.85E-19 1.65E-18
 40       5.97E-34 1.30E-29 9.92E-27 4.33E-24 2.20E-21 1.28E-20 1.99E-20 1.20E-19 1.21E-18
    9                / number of energies
   17                / nmin
   40                / nmax
             10.00     15.00     20.00     25.00     30.00     35.00     40.00     45.00     50.00 / energies         (keV/amu)
              8.99      8.69     10.17      9.99      9.04      7.26      5.55      4.60      4.41 / alpha
          4.97E-14 4.87E-14 4.70E-14 4.50E-14 4.39E-14 4.28E-14 4.13E-14 3.99E-14 3.81E-14 / total xsects.    (cm2)
  n  l  m                                                                                      / partial xsects.  (cm2)
 17       2.48E-15 2.26E-15 4.41E-16 4.18E-16 4.08E-16 3.98E-16 3.88E-16 3.92E-16 3.92E-16
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 18        4.88E-15 4.28E-15 9.51E-16 1.09E-15 1.00E-15 9.66E-16 9.27E-16 9.22E-16 9.01E-16
 19        7.09E-15 6.19E-15 1.59E-15 1.78E-15 1.59E-15 1.53E-15 1.46E-15 1.43E-15 1.38E-15
 20        8.01E-15 7.05E-15 2.28E-15 2.26E-15 2.02E-15 1.93E-15 1.85E-15 1.79E-15 1.69E-15
 21        7.59E-15 6.82E-15 2.98E-15 2.69E-15 2.40E-15 2.29E-15 2.20E-15 2.10E-15 1.97E-15
 22        6.40E-15 5.93E-15 3.67E-15 3.19E-15 2.86E-15 2.72E-15 2.60E-15 2.47E-15 2.30E-15
 23        4.86E-15 4.74E-15 4.18E-15 3.63E-15 3.26E-15 3.08E-15 2.94E-15 2.78E-15 2.59E-15
 24        3.31E-15 3.55E-15 4.38E-15 3.81E-15 3.43E-15 3.22E-15 3.06E-15 2.91E-15 2.72E-15
 25        2.05E-15 2.51E-15 4.24E-15 3.70E-15 3.36E-15 3.13E-15 2.96E-15 2.83E-15 2.66E-15
 26        1.19E-15 1.70E-15 3.89E-15 3.41E-15 3.13E-15 2.90E-15 2.74E-15 2.62E-15 2.48E-15
 27        6.65E-16 1.13E-15 3.44E-15 3.05E-15 2.86E-15 2.66E-15 2.50E-15 2.38E-15 2.25E-15
 28        3.79E-16 7.54E-16 2.96E-15 2.69E-15 2.59E-15 2.42E-15 2.27E-15 2.15E-15 2.02E-15
 29        2.30E-16 5.11E-16 2.51E-15 2.36E-15 2.34E-15 2.22E-15 2.07E-15 1.95E-15 1.83E-15
 30        1.51E-16 3.56E-16 2.10E-15 2.06E-15 2.12E-15 2.04E-15 1.90E-15 1.79E-15 1.69E-15
 31        1.07E-16 2.51E-16 1.73E-15 1.79E-15 1.91E-15 1.87E-15 1.75E-15 1.66E-15 1.59E-15
 32        7.89E-17 1.78E-16 1.41E-15 1.54E-15 1.71E-15 1.70E-15 1.61E-15 1.55E-15 1.49E-15
 33        5.90E-17 1.27E-16 1.13E-15 1.32E-15 1.50E-15 1.52E-15 1.47E-15 1.43E-15 1.39E-15
 34        4.40E-17 9.27E-17 8.91E-16 1.10E-15 1.29E-15 1.34E-15 1.33E-15 1.31E-15 1.28E-15
 35        3.29E-17 6.92E-17 6.83E-16 8.98E-16 1.09E-15 1.17E-15 1.19E-15 1.18E-15 1.16E-15
 36        2.47E-17 5.29E-17 5.09E-16 7.07E-16 9.05E-16 1.01E-15 1.05E-15 1.06E-15 1.05E-15
 37        1.87E-17 4.09E-17 3.75E-16 5.43E-16 7.38E-16 8.60E-16 9.26E-16 9.47E-16 9.45E-16
 38        1.43E-17 3.21E-17 2.77E-16 4.14E-16 5.93E-16 7.27E-16 8.08E-16 8.41E-16 8.46E-16
 39        1.13E-17 2.57E-17 2.08E-16 3.17E-16 4.71E-16 6.07E-16 7.03E-16 7.47E-16 7.56E-16
 40        8.95E-18 2.05E-17 1.60E-16 2.44E-16 3.72E-16 5.03E-16 6.09E-16 6.63E-16 6.74E-16
   2               / number of energies
  17               / nmin
  40               / nmax
             75.00   100.00                                                                 / energies         (keV/amu)
              2.58     2.17                                                                 / alpha
          2.87E-14 2.18E-14                                                                 / total xsects.    (cm2)
  n  l  m                                                                                   / partial xsects.  (cm2)
 17        3.31E-16 2.81E-16
 18        6.85E-16 5.53E-16
 19        9.79E-16 7.56E-16
 20        1.17E-15 8.66E-16
 21        1.36E-15 9.81E-16
 22        1.62E-15 1.15E-15
 23        1.86E-15 1.32E-15
 24        1.96E-15 1.42E-15
 25        1.91E-15 1.42E-15
 26        1.78E-15 1.34E-15
 27        1.63E-15 1.24E-15
 28        1.49E-15 1.13E-15
 29        1.38E-15 1.04E-15
 30        1.29E-15 9.72E-16
 31        1.22E-15 9.27E-16
 32        1.16E-15 8.87E-16
 33        1.09E-15 8.44E-16
 34        1.02E-15 7.96E-16
 35        9.49E-16 7.49E-16
 36        8.82E-16 7.05E-16
 37        8.20E-16 6.65E-16
 38        7.64E-16 6.28E-16
 39        7.14E-16 5.94E-16
 40        6.67E-16 5.62E-16
  -1   -1
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1.2.2 Demo (a-1) demo_d/adf01_w51_interactive.pass

```
W +51      H + 0 (1)  / receiver, donor (donor state index)    /        /
   9               / number of energies
  17               / nmin
  40               / nmax
              0.01     0.02     0.03     0.04     0.07     0.11     0.18     0.30     0.48 / energies         (keV/amu)
             80.90    64.40    52.44    46.21    44.07    31.01    14.98    14.09     9.98 / alpha
          4.97E-14 4.97E-14 4.97E-14 4.97E-14 4.97E-14 4.97E-14 4.97E-14 4.97E-14 4.97E-14 / total xsects.    (cm2)
  n  l  m                                                                                   / partial xsects.  (cm2)
 17        3.85E-16 3.33E-16 3.21E-16 3.54E-16 4.33E-16 5.32E-16 6.36E-16 7.64E-16 9.13E-16
 18        2.56E-15 2.42E-15 2.38E-15 2.49E-15 2.71E-15 2.95E-15 3.16E-15 3.40E-15 3.75E-15
 19        7.90E-15 7.70E-15 7.60E-15 7.63E-15 7.76E-15 7.88E-15 7.95E-15 8.03E-15 8.26E-15
 20        1.30E-14 1.28E-14 1.26E-14 1.23E-14 1.21E-14 1.19E-14 1.17E-14 1.15E-14 1.12E-14
 21        1.32E-14 1.31E-14 1.29E-14 1.26E-14 1.23E-14 1.20E-14 1.17E-14 1.13E-14 1.08E-14
 22        8.67E-15 8.95E-15 9.10E-15 9.07E-15 8.91E-15 8.72E-15 8.54E-15 8.35E-15 8.12E-15
 23        3.29E-15 3.60E-15 3.86E-15 4.03E-15 4.13E-15 4.20E-15 4.30E-15 4.39E-15 4.48E-15
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24        6.30E-16 7.38E-16 8.54E-16 9.70E-16 1.09E-15 1.22E-15 1.37E-15 1.54E-15 1.66E-15
25        5.57E-17 6.94E-17 8.80E-17 1.14E-16 1.50E-16 1.96E-16 2.58E-16 3.39E-16 3.92E-16
26        2.58E-18 3.58E-18 5.22E-18 8.11E-18 1.31E-17 2.08E-17 3.31E-17 5.33E-17 6.72E-17
27        1.05E-19 2.05E-19 3.97E-19 7.57E-19 1.42E-18 2.64E-18 5.15E-18 9.87E-18 1.21E-17
28        4.96E-21 1.81E-20 5.49E-20 1.32E-19 2.70E-19 5.41E-19 1.23E-18 2.67E-18 2.87E-18
29        2.62E-22 1.74E-21 8.15E-21 2.47E-20 5.43E-20 1.55E-19 3.55E-19 8.55E-19 8.86E-19
30        1.53E-23 1.81E-22 1.29E-21 4.87E-21 1.16E-20 5.22E-20 1.23E-19 3.21E-19 3.65E-19
31        9.86E-25 2.04E-23 2.19E-22 1.02E-21 2.60E-21 1.82E-20 6.60E-20 1.77E-19 2.20E-19
32        6.95E-26 2.47E-24 3.92E-23 2.24E-22 6.13E-22 6.60E-21 4.85E-20 1.30E-19 1.75E-19
33        5.32E-27 3.20E-25 7.41E-24 5.15E-23 1.51E-22 2.47E-21 3.45E-20 9.19E-20 1.35E-19
34        4.42E-28 4.41E-26 1.48E-24 1.24E-23 3.90E-23 9.50E-22 2.17E-20 5.96E-20 9.37E-20
35        3.95E-29 6.45E-27 3.09E-25 3.13E-24 1.05E-23 3.76E-22 1.39E-20 3.91E-20 5.15E-20
36        3.78E-30 9.97E-28 6.75E-26 8.20E-25 2.91E-24 1.53E-22 9.00E-21 2.60E-20 3.72E-20
37        3.87E-31 1.62E-28 1.54E-26 2.23E-25 8.42E-25 6.39E-23 5.90E-21 1.75E-20 2.81E-20
38        4.22E-32 2.78E-29 3.66E-27 6.29E-26 2.52E-25 2.73E-23 3.92E-21 1.19E-20 2.13E-20
39        4.88E-33 4.99E-30 9.05E-28 1.83E-26 7.78E-26 1.20E-23 2.63E-21 8.16E-21 1.64E-20
40        5.97E-34 9.38E-31 2.32E-28 5.52E-27 2.48E-26 5.34E-24 1.78E-21 5.66E-21 1.26E-20
  9                / number of energies
 17                / nmin
 40                / nmax
              0.78     1.27     2.07     3.36     5.46     8.86    14.38    23.36    37.93 / energies         (keV/amu)
              9.55    18.35    16.55    14.32    11.31     9.78     8.40    10.07     6.19 / alpha
          4.97E-14 4.97E-14 4.97E-14 4.97E-14 4.97E-14 4.96E-14 4.88E-14 4.57E-14 4.19E-14 / total xsects.    (cm2)
 n  l  m                                                                                 / partial xsects.  (cm2)
17        1.10E-15 1.35E-15 1.62E-15 2.02E-15 2.65E-15 2.36E-15 2.42E-15 4.19E-16 3.90E-16
18        4.16E-15 4.54E-15 4.76E-15 5.15E-15 5.74E-15 4.84E-15 4.53E-15 1.12E-15 9.37E-16
19        8.53E-15 8.59E-15 8.41E-15 8.34E-15 8.32E-15 7.20E-15 6.41E-15 1.85E-15 1.48E-15
20        1.08E-14 1.04E-14 1.00E-14 9.53E-15 9.01E-15 8.20E-15 7.20E-15 2.36E-15 1.88E-15
21        1.03E-14 9.88E-15 9.44E-15 8.89E-15 8.23E-15 7.76E-15 6.90E-15 2.82E-15 2.24E-15
22        7.86E-15 7.60E-15 7.40E-15 7.05E-15 6.50E-15 6.53E-15 5.93E-15 3.35E-15 2.65E-15
23        4.55E-15 4.62E-15 4.73E-15 4.70E-15 4.47E-15 4.90E-15 4.68E-15 3.81E-15 2.99E-15
24        1.77E-15 1.95E-15 2.24E-15 2.46E-15 2.56E-15 3.28E-15 3.45E-15 3.99E-15 3.12E-15
25        4.35E-16 5.48E-16 7.66E-16 9.93E-16 1.21E-15 1.97E-15 2.39E-15 3.86E-15 3.02E-15
26        7.79E-17 1.16E-16 2.08E-16 3.36E-16 5.02E-16 1.09E-15 1.59E-15 3.53E-15 2.80E-15
27        1.28E-17 2.20E-17 5.23E-17 1.07E-16 2.02E-16 5.79E-16 1.03E-15 3.14E-15 2.55E-15
28        2.53E-18 4.75E-18 1.47E-17 3.72E-17 8.74E-17 3.15E-16 6.77E-16 2.74E-15 2.33E-15
29        7.07E-19 1.44E-18 5.37E-18 1.59E-17 4.43E-17 1.84E-16 4.54E-16 2.38E-15 2.13E-15
30        3.17E-19 6.99E-19 2.82E-18 9.07E-18 2.77E-17 1.19E-16 3.14E-16 2.05E-15 1.96E-15
31        2.18E-19 5.04E-19 2.00E-18 6.54E-18 2.04E-17 8.35E-17 2.21E-16 1.76E-15 1.80E-15
32        1.90E-19 4.43E-19 1.67E-18 5.29E-18 1.61E-17 6.22E-17 1.57E-16 1.49E-15 1.65E-15
33        1.65E-19 3.89E-19 1.40E-18 4.27E-18 1.26E-17 4.69E-17 1.13E-16 1.25E-15 1.49E-15
34        1.23E-19 2.93E-19 1.04E-18 3.17E-18 9.32E-18 3.52E-17 8.31E-17 1.02E-15 1.34E-15
35        7.86E-20 2.08E-19 7.25E-19 2.25E-18 6.70E-18 2.62E-17 6.23E-17 8.18E-16 1.18E-15
36        5.56E-20 1.47E-19 5.18E-19 1.62E-18 4.90E-18 1.96E-17 4.76E-17 6.31E-16 1.04E-15
37        4.20E-20 1.11E-19 3.90E-19 1.21E-18 3.64E-18 1.47E-17 3.67E-17 4.77E-16 9.05E-16
38        3.23E-20 8.55E-20 2.99E-19 9.24E-19 2.74E-18 1.12E-17 2.88E-17 3.59E-16 7.81E-16
39        2.51E-20 6.04E-20 2.02E-19 6.62E-19 2.06E-18 8.69E-18 2.31E-17 2.73E-16 6.70E-16
40        1.96E-20 3.75E-20 1.31E-19 4.56E-19 1.54E-18 6.74E-18 1.86E-17 2.10E-16 5.70E-16
  2                / number of energies
 17                / nmin
 40                / nmax
             61.58   100.00                                                              / energies         (keV/amu)
              3.47     2.17                                                              / alpha
          3.36E-14 2.18E-14                                                              / total xsects.    (cm2)
 n  l  m                                                                                 / partial xsects.  (cm2)
17        3.64E-16 2.81E-16
18        7.93E-16 5.53E-16
19        1.18E-15 7.56E-16
20        1.43E-15 8.66E-16
21        1.67E-15 9.81E-16
22        1.96E-15 1.15E-15
23        2.23E-15 1.32E-15
24        2.34E-15 1.42E-15
25        2.29E-15 1.42E-15
26        2.14E-15 1.34E-15
27        1.95E-15 1.24E-15
28        1.76E-15 1.13E-15
29        1.61E-15 1.04E-15
30        1.49E-15 9.72E-16
31        1.40E-15 9.27E-16
32        1.32E-15 8.87E-16
33        1.24E-15 8.44E-16
34        1.16E-15 7.96E-16
35        1.07E-15 7.49E-16
```

36		9.90E-16	7.05E-16
37		9.13E-16	6.65E-16
38		8.39E-16	6.28E-16
39		7.70E-16	5.94E-16
40		7.03E-16	5.62E-16
-1	-1		

2 Demo (b) Obtaining charge exchange driven 'bn' populations and emissivities

```
------------------------------
DEMO B: Obtaining charge exchange driven 'bn' populations and emissivities
------------------------------
PURPOSE: To provide charge exchange (CX) populations and emissivities performing
bundle-n population c alculations.

The use of ADAS316 has been described in Demo b of Module 2. The plot produced
by running ADAS316 interacively show the different contribution to the
population structure: 1. excitation part, driven from the ground state of
recombined receiver (fI*n1/n+); 2. recombination part, driven from free
electron capture by the recombining receiver (fII); 3. charge exchange part,
driven by neutral beam CX capture (fIII*nH/ne). This last parf fIII allows one
to build up the CX line emissivity coefficients.
ADAS316 provides the CX effective emission coefficients in the format adf12 and
the feature photon emissivity coefficients (FPEC) in the format adf40.


EXAMPLE: For this demo, the input file for ADAS316 population calculation is
adf25_bn#74_w61_n1.dat for W61+.
Following  Demo a1 an adf01 for W61+ is produced: w61_n1.dat.
This is the input for deriving the adf12 and adf40 using ADAS316 interactively.
For producing the adf40 data files the number of pixels and wavelength range
must be defined. The values chosen for this demo are the following:
- pixel: 500
- min wave: 3000
- max wave: 5000

COMMENTS: Note that the adf01, w61_n1.dat, has been produced using ADAS315 and
it is called within the file adf25_bn#74_w61_n1.dat.



DEMO b1: Examine the structure of adf25/a25_p316 drivers
1. Open adf25_bn#74_w61_n1.dat and examine the file.
Sample of file: adf25_bn#74_w61_n1.dat, w61_n1.dat

DEMO b2: Prepare adf12 and adf40 data for an ion with ADAS316
1. Use ADAS316 interactively.
2. Define pixel number and wavelength range.
3. Generate adf12 and adf40 and look at them.
Samples of output file: adas316_plot_w61.ps, adas316_adf12.pass,
                        adas316_adf40.pass
```

2.1 Demo (b) Figures

2.1.1 Demo (b-2) demo_b/adas316_plot_w61.pdf

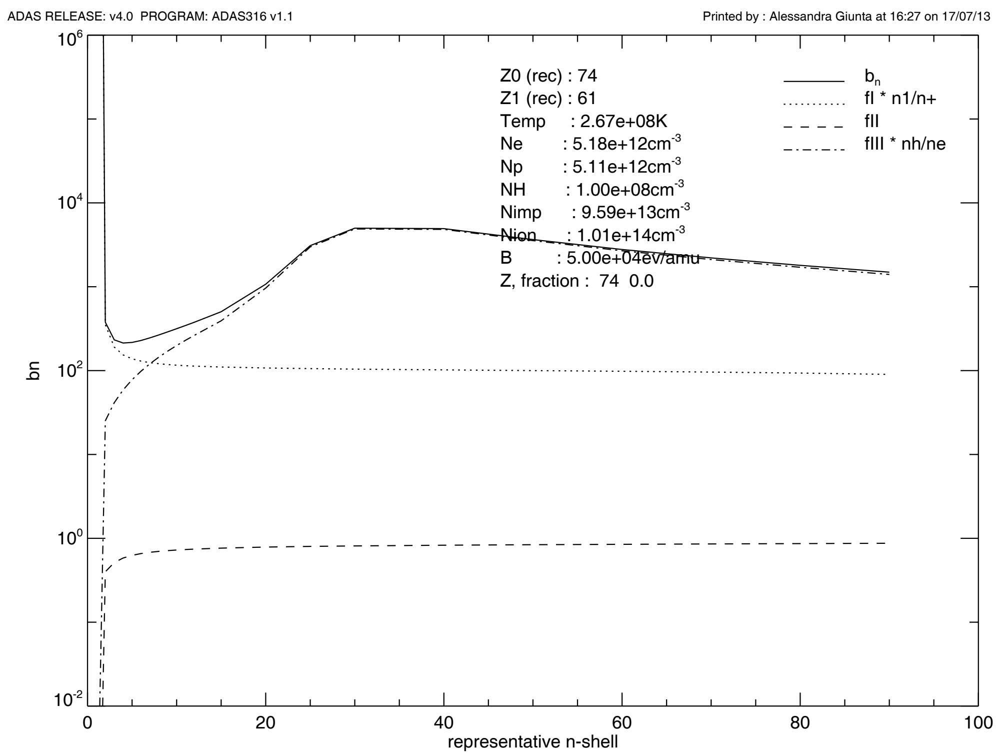

Figure 1:

2.2 Demo (b) Tables and datasets

2.2.1 Demo (b-1) demo_b/adf25_bn#74_w61_n1.dat

```
receiver ion parameters
-----------------------
z0       :          74
z1       :          61
outfmt   : adf40
exfile   : /home/adas/adas/adf18/p310_a17/bndlen_exp#h0.dat
cxfile   : /home/asg/adas_modules/module_6/demo_b/w61_n1.dat

plasma density parameters
-------------------------
ndens    :           1
id_ref   :           1
densa    :  1.01E+14
denpa    :  0.00E+00
denimpa  :  0.00E+00
deniona  :  1.01E+14

plasma temperature parameters
-----------------------------
ntemp    :           5
it_ref   :           3
tea      :  2.67E+08  2.67E+08  2.67E+08  2.67E+08  2.67E+08
tpa      :  2.67E+08  2.67E+08  2.67E+08  2.67E+08  2.67E+08
timpa    :  2.67E+08  2.67E+08  2.67E+08  2.67E+08  2.67E+08
tiona    :  2.67E+08  2.67E+08  2.67E+08  2.67E+08  2.67E+08

plasma zeff parameters
----------------------
nzef     :           3
iz_ref   :           2
zefa     :  1.00E+00  2.00E+00  3.00E+00

neutral beam donor parameters
-----------------------------
nbeam    :          13
ib_ref   :           9
bmena    :  1.00E+04  1.50E+04  2.00E+04  2.50E+04  3.00E+04  3.50E+04  4.00E+04
         :  4.50E+04  5.00E+04  5.50E+04  6.00E+04  6.50E+04  7.00E+04
denha    :  1.00E+08  1.00E+08  1.00E+08  1.00E+08  1.00E+08  1.00E+08  1.00E+08
         :  1.00E+08  1.00E+08  1.00E+08  1.00E+08  1.00E+08  1.00E+08
bmfra    :  1.00E+00  1.00E+00  1.00E+00  1.00E+00  1.00E+00  1.00E+00  1.00E+00
         :  1.00E+00  1.00E+00  1.00E+00  1.00E+00  1.00E+00  1.00E+00

plasma impurity parameters
--------------------------
nimp     :           1
im_ref   :           1
zimpa    :  7.40E+01
amimpa   :  1.35E+02
frimpa   :  1.00E-05

control parameters - radiation
------------------------------
ts       :  1.00e+08
w        :  0.00e+00
w1       :  1.00e+08

control parameters - collisions
-------------------------------
cion     :  1.00e+00
cpy      :  1.00e+00
nip      :           0
intd     :           3
iprs     :           1
ilow     :           1
ionip    :           0
nionip   :           2
ilprs    :           1
ivdisp   :           0
```

```
representative level parameters
-------------------------------
nmin     :           1
nmax     :         110
imax     :          22
nrep     :    1    2    3    4    5    6    7    8    9   10   11   12   15   20
         :   25   30   40   50   60   70   80   90
wbrep    :  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
         :  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
         :  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
jdef     :           1
def      :  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
         :  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
         :  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00

dielectronic recombination parameters
-------------------------------------
jcor     :           4
cor      :  5.00E-02  3.00E-01  7.00E-01  9.00E-01
jmax     :           1
epsil    :  7.50E-01
fij      :  0.00E+00
wij      :  0.00E+00

c---
```

2.2.2 Demo (b-1) demo_b/w61_n1.dat

```
W +61     H + 0 (1)  / receiver, donor (donor state index)    /        /
    9               / number of energies
   20               / nmin
   45               / nmax
               0.01      0.02      0.05      0.10      0.20      0.50      1.00      2.00      5.00 / energies         (keV/amu)
              83.35     59.91     45.20     42.70     15.33      9.73      8.99     16.58     11.92 / alpha
           5.99E-14 5.99E-14 5.99E-14 5.99E-14 5.99E-14 5.99E-14 5.99E-14 5.99E-14 5.99E-14 / total xsects.    (cm2)
  n  l  m                                                                                   / partial xsects.  (cm2)
 20        1.15E-15 1.02E-15 1.11E-15 1.37E-15 1.63E-15 2.11E-15 2.66E-15 3.17E-15 4.44E-15
 21        4.44E-15 4.20E-15 4.34E-15 4.71E-15 5.02E-15 5.69E-15 6.49E-15 6.76E-15 7.60E-15
 22        9.92E-15 9.60E-15 9.51E-15 9.61E-15 9.63E-15 9.82E-15 1.01E-14 9.79E-15 9.57E-15
 23        1.41E-14 1.38E-14 1.33E-14 1.30E-14 1.26E-14 1.20E-14 1.15E-14 1.08E-14 9.89E-15
 24        1.40E-14 1.38E-14 1.33E-14 1.29E-14 1.24E-14 1.16E-14 1.08E-14 1.02E-14 9.04E-15
 25        9.98E-15 1.03E-14 1.03E-14 9.96E-15 9.65E-15 9.12E-15 8.61E-15 8.25E-15 7.35E-15
 26        4.75E-15 5.26E-15 5.61E-15 5.66E-15 5.71E-15 5.73E-15 5.67E-15 5.72E-15 5.35E-15
 27        1.37E-15 1.65E-15 1.98E-15 2.19E-15 2.43E-15 2.71E-15 2.84E-15 3.20E-15 3.37E-15
 28        2.24E-16 2.94E-16 4.18E-16 5.42E-16 7.08E-16 9.11E-16 9.99E-16 1.36E-15 1.78E-15
 29        2.02E-17 2.87E-17 5.17E-17 8.47E-17 1.37E-16 2.20E-16 2.61E-16 4.61E-16 8.23E-16
 30        1.25E-18 2.15E-18 5.26E-18 1.10E-17 2.30E-17 4.57E-17 5.66E-17 1.35E-16 3.50E-16
 31        7.40E-20 2.08E-19 7.45E-19 1.85E-18 4.87E-18 1.06E-17 1.19E-17 3.90E-17 1.49E-16
 32        4.81E-21 2.91E-20 1.69E-19 4.55E-19 1.43E-18 3.08E-18 2.91E-18 1.26E-17 6.82E-17
 33        3.41E-22 4.34E-21 4.03E-20 1.17E-19 4.81E-19 1.10E-18 9.40E-19 5.00E-18 3.59E-17
 34        2.62E-23 6.87E-22 1.00E-20 3.15E-20 1.81E-19 4.76E-19 4.45E-19 2.66E-18 2.26E-17
 35        2.18E-24 1.15E-22 2.60E-21 8.81E-21 9.17E-20 2.71E-19 3.03E-19 1.86E-18 1.68E-17
 36        1.95E-25 2.02E-23 7.01E-22 2.56E-21 6.40E-20 2.06E-19 2.59E-19 1.53E-18 1.35E-17
 37        1.86E-26 3.74E-24 1.96E-22 7.67E-22 5.00E-20 1.72E-19 2.40E-19 1.34E-18 1.12E-17
 38        1.90E-27 7.25E-25 5.69E-23 2.38E-22 3.56E-20 1.32E-19 2.07E-19 1.12E-18 8.93E-18
 39        2.05E-28 1.47E-25 1.70E-23 7.62E-23 2.36E-20 9.45E-20 1.57E-19 8.47E-19 6.75E-18
 40        2.36E-29 3.09E-26 5.27E-24 2.51E-23 1.59E-20 5.42E-20 1.13E-19 6.16E-19 5.03E-18
 41        2.86E-30 6.78E-27 1.68E-24 8.53E-24 1.08E-20 4.08E-20 8.28E-20 4.57E-19 3.80E-18
 42        3.65E-31 1.55E-27 5.49E-25 2.97E-24 7.38E-21 3.17E-20 6.41E-20 3.54E-19 2.93E-18
 43        4.89E-32 3.65E-28 1.85E-25 1.06E-24 5.10E-21 2.51E-20 5.16E-20 2.83E-19 2.29E-18
 44        6.89E-33 8.91E-29 6.38E-26 3.89E-25 3.56E-21 1.99E-20 4.18E-20 2.10E-19 1.78E-18
 45        1.01E-33 2.25E-29 2.26E-26 1.46E-25 2.50E-21 1.59E-20 3.40E-20 1.43E-19 1.36E-18
    9               / number of energies
   20               / nmin
   45               / nmax
              10.00     15.00     20.00     25.00     30.00     35.00     40.00     45.00     50.00 / energies         (keV/amu)
               9.09      7.99     10.66     10.34      9.04      7.23      5.67      4.68      4.28 / alpha
           5.99E-14 5.89E-14 5.72E-14 5.50E-14 5.33E-14 5.23E-14 5.06E-14 4.90E-14 4.71E-14 / total xsects.    (cm2)
  n  l  m                                                                                   / partial xsects.  (cm2)
 20        3.83E-15 3.70E-15 7.02E-16 5.11E-16 4.80E-16 4.60E-16 4.25E-16 4.05E-16 3.96E-16
 21        6.23E-15 5.75E-15 1.26E-15 1.15E-15 1.01E-15 9.62E-16 8.77E-16 8.26E-16 7.95E-16
 22        8.09E-15 7.27E-15 1.94E-15 1.80E-15 1.55E-15 1.45E-15 1.32E-15 1.24E-15 1.17E-15
 23        8.73E-15 7.81E-15 2.68E-15 2.27E-15 1.95E-15 1.81E-15 1.66E-15 1.54E-15 1.44E-15
```

```
 24        8.28E-15 7.48E-15 3.39E-15 2.65E-15 2.28E-15 2.11E-15 1.94E-15 1.79E-15 1.66E-15
 25        7.18E-15 6.59E-15 4.03E-15 3.08E-15 2.66E-15 2.45E-15 2.25E-15 2.07E-15 1.90E-15
 26        5.73E-15 5.42E-15 4.51E-15 3.54E-15 3.06E-15 2.81E-15 2.58E-15 2.36E-15 2.16E-15
 27        4.20E-15 4.21E-15 4.76E-15 3.89E-15 3.39E-15 3.10E-15 2.83E-15 2.58E-15 2.37E-15
 28        2.84E-15 3.12E-15 4.72E-15 4.03E-15 3.53E-15 3.21E-15 2.92E-15 2.67E-15 2.45E-15
 29        1.79E-15 2.21E-15 4.45E-15 3.93E-15 3.48E-15 3.14E-15 2.84E-15 2.60E-15 2.40E-15
 30        1.07E-15 1.53E-15 4.03E-15 3.67E-15 3.30E-15 2.97E-15 2.68E-15 2.45E-15 2.27E-15
 31        6.33E-16 1.04E-15 3.54E-15 3.34E-15 3.06E-15 2.76E-15 2.48E-15 2.27E-15 2.10E-15
 32        3.81E-16 7.17E-16 3.05E-15 3.00E-15 2.80E-15 2.56E-15 2.29E-15 2.08E-15 1.92E-15
 33        2.41E-16 5.02E-16 2.59E-15 2.66E-15 2.56E-15 2.36E-15 2.12E-15 1.91E-15 1.76E-15
 34        1.63E-16 3.61E-16 2.18E-15 2.36E-15 2.33E-15 2.18E-15 1.96E-15 1.77E-15 1.62E-15
 35        1.18E-16 2.65E-16 1.82E-15 2.08E-15 2.12E-15 2.03E-15 1.83E-15 1.64E-15 1.51E-15
 36        8.93E-17 1.96E-16 1.50E-15 1.83E-15 1.92E-15 1.88E-15 1.70E-15 1.54E-15 1.42E-15
 37        6.94E-17 1.46E-16 1.23E-15 1.59E-15 1.74E-15 1.73E-15 1.58E-15 1.44E-15 1.34E-15
 38        5.39E-17 1.10E-16 1.00E-15 1.38E-15 1.56E-15 1.57E-15 1.46E-15 1.34E-15 1.27E-15
 39        4.18E-17 8.43E-17 8.06E-16 1.18E-15 1.37E-15 1.40E-15 1.33E-15 1.24E-15 1.18E-15
 40        3.24E-17 6.55E-17 6.41E-16 9.92E-16 1.20E-15 1.24E-15 1.21E-15 1.14E-15 1.09E-15
 41        2.52E-17 5.16E-17 5.05E-16 8.16E-16 1.02E-15 1.09E-15 1.09E-15 1.05E-15 1.00E-15
 42        1.96E-17 4.09E-17 3.92E-16 6.55E-16 8.58E-16 9.50E-16 9.70E-16 9.48E-16 9.18E-16
 43        1.54E-17 3.28E-17 3.03E-16 5.16E-16 7.10E-16 8.21E-16 8.62E-16 8.54E-16 8.35E-16
 44        1.23E-17 2.69E-17 2.35E-16 4.05E-16 5.81E-16 7.03E-16 7.61E-16 7.68E-16 7.57E-16
 45        1.00E-17 2.24E-17 1.84E-16 3.20E-16 4.72E-16 5.95E-16 6.68E-16 6.90E-16 6.86E-16
   2               / number of energies
  20               / nmin
  45               / nmax
            75.00   100.00                                                          / energies         (keV/amu)
             2.64     2.17                                                          / alpha
         3.63E-14 2.78E-14                                                          / total xsects.    (cm2)
  n  l  m                                                                           / partial xsects.  (cm2)
 20        2.72E-16 2.02E-16
 21        5.00E-16 3.57E-16
 22        6.96E-16 4.76E-16
 23        8.28E-16 5.46E-16
 24        9.41E-16 6.04E-16
 25        1.09E-15 6.90E-16
 26        1.26E-15 7.94E-16
 27        1.40E-15 8.86E-16
 28        1.46E-15 9.34E-16
 29        1.43E-15 9.30E-16
 30        1.35E-15 8.91E-16
 31        1.25E-15 8.33E-16
 32        1.16E-15 7.71E-16
 33        1.08E-15 7.15E-16
 34        1.01E-15 6.68E-16
 35        9.52E-16 6.34E-16
 36        9.05E-16 6.08E-16
 37        8.62E-16 5.85E-16
 38        8.18E-16 5.61E-16
 39        7.73E-16 5.34E-16
 40        7.27E-16 5.06E-16
 41        6.82E-16 4.79E-16
 42        6.40E-16 4.54E-16
 43        6.00E-16 4.31E-16
 44        5.64E-16 4.10E-16
 45        5.30E-16 3.90E-16
   -1   -1
```

2.2.3 Demo (b-2) demo_b/adas316_adf12.pass

```
  333
E=w   W= 3140.86 D=h(1s) R=w+61  N=30-29   F=#74_w61_n1 M=cx   isel=   1
  7.96D-08                                                     qefref
  5.00D+04  2.30D+04  1.01D+14  2.00D+00  3.00D+00             parmref
        13         5         1         3         1             nparmsc
  1.00D+04  1.50D+04  2.00D+04  2.50D+04  3.00D+04  3.50D+04   ener
  4.00D+04  4.50D+04  5.00D+04  5.50D+04  6.00D+04  6.50D+04
  7.00D+04
  1.34D-08  2.44D-08  7.97D-08  8.36D-08  8.45D-08  8.37D-08   qener
  8.22D-08  8.07D-08  7.96D-08  7.70D-08  7.32D-08  6.91D-08
  6.51D-08
  2.30D+04  2.30D+04  2.30D+04  2.30D+04  2.30D+04             tiev
  7.96D-08  7.96D-08  7.96D-08  7.96D-08  7.96D-08             qtiev
  1.01D+14                                                     densi
```

```
  7.96D-08                                                    qdensi
  1.00D+00  2.00D+00  3.00D+00                                zeff
  1.55D-06  7.96D-08  4.09D-08                                qzeff
  3.00D+00                                                    bmag
  7.96D-08                                                    qbmag
E=w   W= 3471.35 D=h(1s) R=w+61  N=31-30   F=#74_w61_n1 M=cx   isel=   2
  7.58D-08                                                    qefref
  5.00D+04  2.30D+04  1.01D+14  2.00D+00  3.00D+00            parmref
        13         5         1         3         1            nparmsc
  1.00D+04  1.50D+04  2.00D+04  2.50D+04  3.00D+04  3.50D+04   ener
  4.00D+04  4.50D+04  5.00D+04  5.50D+04  6.00D+04  6.50D+04
  7.00D+04
  9.13D-09  1.77D-08  7.08D-08  7.72D-08  7.94D-08  7.91D-08   qener
  7.79D-08  7.66D-08  7.58D-08  7.34D-08  6.99D-08  6.61D-08
  6.24D-08
  2.30D+04  2.30D+04  2.30D+04  2.30D+04  2.30D+04            tiev
  7.58D-08  7.58D-08  7.58D-08  7.58D-08  7.58D-08            qtiev
  1.01D+14                                                    densi
  7.58D-08                                                    qdensi
  1.00D+00  2.00D+00  3.00D+00                                zeff
  1.48D-06  7.58D-08  3.89D-08                                qzeff
  3.00D+00                                                    bmag
  7.58D-08                                                    qbmag
   . .
C-------------------------------------------------------------------------------
C  Wavelength ranges:
C
C     wvmin(A)    wvmax(A)
C     --------    --------
C     3000.00     5000.00
C
C     emis_thres =   1.00D-12
C
C
C  Effective coefficient list:
C
C     isel    type      ion       transition   wavln.(A)   emis. rank
C     ----    ----      ---       ----------   ---------   ----------
C       1.   cx.emis.  w +60      n = 30- 29    3140.86         1
C       2.   cx.emis.  w +60      n = 31- 30    3471.35         2
. . .
C     332.   cx.emis.  w +60      n =110- 86    4657.80       319
C     333.   cx.emis.  w +60      n =110- 87    4948.75       315
C
C
C  Bundle-n population code parameters:
C
C    nip   =  0     intd  =  3     iprs  =  1     ilow  =  1
C    ionip =  0     nionip=  2     ilprs =  1     ivdisp=  0
C    cion  = 1.0    cpy   = 1.0
C
C    ts(K)   =  1.00D+08     w       =  0.00D+00     w1      =  1.00D+08
C
C    zimp(1) =  7.40D+01     amimp(1)=  1.35D+02     frimp(1)=  1.00D-05
C
C
C  adf25 file : /home/asg/adas_modules/module_6/demo_b/adf25_bn#74_w61_n1.dat
C  Code       : adas316
C  Producer   : Alessandra Giunta
C  Date       : 18/06/13
C
C-------------------------------------------------------------------------------
```

2.2.4 Demo (b-2) demo_b/adas316_adf40.pass

```
    1    /w :60 feature photon emissivity coefficients/
-------------------------------------------------------------------------------
    1    1    1    1    1    1    1    1    1    1    1    1    1    1
    1    1    1    1    1    1    1    1    1    1    1    1    1    1
    1    1    1    1    1    1    1    1    1    1    1    1    1    1
    1    1    1    1    1    1    1    1    1    1    1    1    1    1
    1    1    1    1    1    1    1    1    1    1    1    1    1    1
    1    1    1    1    1
```

```
--------------------------------------------------------------------------------
//#01/p00/ 00/p01/ 01/p02/ 02/p03/ 03/p04/ 04/p05/ 05/p06/ 06/p07/ 07/p08/ 08/
      p09/ 09/p10/ 10/p11/ 11/p12/ 12/p13/ 13/p14/ 14/p15/ 15/p16/ 16/p17/ 17/
      p18/ 18/p19/ 19/p20/ 20/p21/ 21/p22/ 22/p23/ 23/p24/ 24/p25/ 25/p26/ 26/
      p27/ 27/p28/ 28/p29/ 29/p30/ 30/p31/ 31/p32/ 32/p33/ 33/p34/ 34/p35/ 35/
      p36/ 36/p37/ 37/p38/ 38/p39/ 39/p40/ 40/p41/ 41/p42/ 42/p43/ 43/p44/ 44/
      p45/ 45/p46/ 46/p47/ 47/p48/ 48/p49/ 49/p50/ 50/p51/ 51/p52/ 52/p53/ 53/
      p54/ 54/p55/ 55/p56/ 56/p57/ 57/p58/ 58/p59/ 59/p60/ 60/p61/ 61/p62/ 62/
      p63/ 63/p64/ 64/p65/ 65/p66/ 66/p67/ 67/p68/ 68/p69/ 69/p70/ 70/p71/ 71/
      p72/ 72/p73/ 73/p74/ 74/
--------------------------------------------------------------------------------
   500      1    1 /pl=01:ss=60:pp= 1:lz=60:hz=60/type=chexc/ispb = 1/isel =    1
  3000.00000  5000.00000
 1.01E+14
 2.30E+04
 3.34E-16 1.09E-11 5.49E-11 6.25E-11 1.84E-09 6.89E-10 1.70E-10 8.21E-11
 4.66E-11 9.19E-11 9.39E-11 6.39E-11 4.24E-11 4.20E-11 5.17E-14 8.91E-16
 3.72E-11 2.31E-10 3.22E-11 8.11E-13 2.51E-10 9.27E-11 1.48E-11 1.31E-08
 9.72E-09 2.35E-11 2.20E-10 5.33E-11 7.27E-10 5.55E-11 2.76E-09 6.45E-09
 1.52E-09 2.58E-10 2.05E-08 6.14E-08 4.23E-10 2.00E-11 1.97E-10 2.71E-10
 2.45E-10 3.99E-09 5.76E-10 1.43E-10 4.87E-11 1.30E-11 4.74E-11 3.67E-10
 1.17E-09 1.03E-11 1.57E-10 4.38E-11 2.14E-11 2.13E-11 1.86E-11 3.36E-12
 1.54E-10 1.86E-10 2.25E-11 2.16E-13 1.24E-10 9.15E-11 1.76E-11 6.11E-14
 1.77E-11 1.92E-11 1.12E-10 1.08E-10 4.77E-10 3.42E-10 5.23E-11 6.09E-10
 8.99E-11 4.25E-12 5.67E-10 7.06E-10 1.42E-10 1.39E-11 4.16E-16 1.57E-11
 3.94E-10 9.35E-10 1.44E-09 4.24E-12 1.18E-10 4.42E-11 1.19E-10 8.11E-09
 1.99E-08 9.44E-10 5.36E-12 2.24E-13 1.09E-09 4.20E-09 3.91E-10 3.22E-11
 1.63E-10 1.14E-11 1.41E-10 7.89E-11 1.04E-10 3.49E-11 4.49E-11 8.12E-12
 9.82E-11 2.34E-11 2.84E-11 8.50E-14 5.05E-12 2.44E-11 5.70E-10 6.74E-10
 3.11E-10 3.02E-13 1.80E-17 1.47E-12 3.49E-10 5.23E-08 2.36E-08 8.37E-10
 1.70E-10 2.11E-13 1.34E-11 1.87E-11 5.78E-14 9.79E-16 4.50E-12 1.66E-11
 2.24E-13 6.27E-12 1.34E-10 1.87E-09 7.01E-10 1.90E-10 4.70E-11 1.30E-13
 2.36E-11 2.76E-11 1.04E-10 5.75E-11 1.12E-09 1.90E-10 1.52E-12 2.73E-17
 2.65E-13 9.39E-11 5.82E-09 5.11E-09 1.89E-11 1.59E-10 5.77E-11 4.21E-14
 2.90E-11 6.17E-10 4.57E-10 1.31E-09 1.64E-08 1.22E-09 1.09E-13 9.64E-11
 2.72E-10 3.52E-12 2.32E-12 1.26E-10 7.97E-10 1.60E-10 5.99E-12 3.38E-11
 1.11E-10 5.69E-11 1.19E-10 4.87E-11 2.43E-10 8.16E-11 2.81E-11 3.89E-12
 1.76E-11 2.42E-11 8.82E-12 6.16E-15 2.02E-13 5.83E-11 6.32E-10 1.37E-09
 2.42E-11 6.26E-15 5.72E-17 3.71E-12 3.28E-10 1.04E-09 6.30E-11 3.37E-12
 1.85E-11 1.13E-10 4.97E-12 2.34E-11 3.85E-10 1.45E-10 4.44E-10 2.51E-10
 2.82E-11 2.13E-10 7.54E-10 2.65E-09 1.97E-10 3.04E-08 4.05E-08 3.34E-10
 4.58E-09 2.20E-09 5.53E-11 6.27E-10 2.55E-10 1.36E-10 9.55E-12 1.88E-11
 2.66E-13 2.49E-13 5.32E-11 5.49E-11 7.31E-13 1.84E-11 5.86E-12 5.29E-15
 0.00E+00 4.35E-17 1.92E-11 6.73E-09 1.04E-08 1.60E-10 2.39E-11 1.92E-10
 6.18E-11 1.97E-11 6.96E-11 7.76E-11 1.42E-09 3.27E-10 1.67E-11 7.69E-10
 6.72E-10 1.59E-10 9.29E-12 5.06E-12 4.66E-10 3.67E-10 7.18E-11 8.91E-11
 1.04E-10 1.94E-12 5.19E-17 2.95E-16 1.59E-12 2.05E-11 1.30E-10 1.04E-10
 5.39E-11 4.85E-11 3.60E-13 1.13E-10 6.40E-10 2.14E-09 8.44E-10 1.59E-12
 1.64E-13 3.37E-11 5.89E-11 6.79E-11 1.90E-11 1.12E-10 2.23E-10 5.92E-11
 4.33E-10 4.88E-09 7.00E-10 1.94E-11 5.81E-11 5.12E-12 1.07E-13 1.26E-11
 1.24E-11 9.81E-14 6.34E-16 3.79E-12 6.51E-11 5.76E-11 3.15E-10 4.13E-11
 2.33E-10 1.87E-10 5.58E-12 9.91E-10 2.07E-09 1.14E-10 8.75E-13 5.56E-11
 4.10E-11 9.70E-11 2.97E-10 2.81E-08 3.77E-08 6.03E-10 2.69E-09 1.21E-08
 8.14E-10 1.45E-11 8.47E-13 3.73E-11 4.21E-11 3.25E-11 5.78E-10 2.47E-10
 1.17E-10 3.75E-11 5.21E-11 2.41E-12 4.27E-16 0.00E+00 0.00E+00 0.00E+00
 6.24E-14 1.72E-10 2.16E-09 4.94E-10 6.94E-12 3.26E-15 0.00E+00 0.00E+00
 1.66E-14 1.71E-11 1.07E-10 1.12E-11 2.94E-11 3.02E-10 2.56E-10 8.63E-11
 4.47E-11 6.14E-11 3.85E-11 3.37E-11 2.18E-09 3.63E-09 3.57E-10 2.91E-11
 3.24E-12 3.07E-10 6.83E-10 4.50E-11 9.15E-11 1.15E-09 2.76E-10 3.86E-11
 9.59E-11 3.69E-11 1.10E-11 1.23E-10 2.76E-11 5.13E-14 3.26E-19 0.00E+00
 1.80E-14 3.68E-11 5.02E-10 1.71E-10 2.30E-12 4.55E-16 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 4.37E-18 1.92E-13 3.83E-11 1.23E-10 4.04E-11 5.52E-11
 6.59E-11 2.95E-11 4.65E-11 2.03E-11 6.84E-11 2.67E-09 1.08E-08 1.06E-09
 1.07E-10 1.65E-09 8.16E-10 1.17E-10 7.78E-11 8.18E-13 2.25E-13 8.30E-11
 3.68E-10 6.08E-11 7.75E-11 9.06E-12 9.77E-15 3.58E-14 3.93E-10 2.75E-08
 3.30E-08 1.06E-09 5.55E-10 5.83E-11 3.10E-11 4.37E-13 1.64E-16 2.88E-12
 4.21E-10 9.32E-10 5.04E-10 3.79E-09 8.18E-10 3.48E-11 2.44E-11 1.63E-10
 4.59E-10 1.28E-10 7.12E-11 2.06E-11 1.10E-13 1.11E-17 1.25E-13 1.56E-11
 3.28E-11 1.66E-12 8.00E-16 1.45E-13 4.19E-11 1.73E-10 2.76E-11 1.92E-10
 1.17E-10 5.35E-11 1.33E-10 4.22E-11 3.71E-12 6.30E-11 2.93E-11 2.47E-13
 1.67E-17 1.29E-18 8.65E-14 4.37E-11 3.10E-10 1.81E-10 8.14E-11 3.67E-12
 3.07E-11 4.61E-11 3.66E-10 1.72E-09 2.70E-10 5.60E-12 1.48E-14 2.08E-14
 6.27E-12 3.08E-11 1.87E-11 4.46E-10 3.69E-10 1.08E-10 8.22E-11 2.77E-11
 3.25E-09 8.79E-09 7.20E-10 8.21E-13 1.20E-14 2.65E-11 7.75E-10 9.47E-10
```

```
 1.03E-10 1.51E-12 3.03E-11 2.31E-11 4.45E-13 6.72E-12 1.33E-10 7.92E-11
 1.50E-12 4.06E-11 2.86E-10 2.72E-10 2.16E-09 2.27E-09 8.53E-11 4.72E-11
 6.54E-11 1.47E-11 1.93E-13 1.03E-11 9.59E-11 6.20E-11 1.38E-12 6.86E-16
 1.43E-12 1.21E-10 2.77E-10 2.22E-11
C-------------------------------------------------------------------------------
C  Wavelength ranges:
C
C     wvmin(A)    wvmax(A)
C     --------    --------
C     3000.00     5000.00
C
C     emis_thres =   1.00D-12
C
C
C
C  Bundle-n population code parameters:
C
C    nip   =  0     intd  =  3     iprs  =  1     ilow  =  1
C    ionip =  0     nionip=  2     ilprs =  1     ivdisp=  0
C    cion  = 1.0    cpy   = 1.0
C
C    ts(K)   =  1.00D+08     w       =  0.00D+00     w1      =  1.00D+08
C
C    zimp(1) =  7.40D+01     amimp(1)=  1.35D+02     frimp(1)=  1.00D-05
C
C
C  adf25 file : /home/asg/adas_modules/module_6/demo_b/adf25_bn#74_w61_n1.dat
C  Code       : adas316
C  Producer   : Alessandra Giunta
C  Date       : 18/06/13
C
C-------------------------------------------------------------------------------
```

3 Demo (c) Comparing active W emission to bremsstrahlung background

```
------------------------------
DEMO C: Comparing active W emission to bremsstrahlung background
------------------------------
PURPOSE: To generate active spectrum and continuum for W and compare the emission.
This is a proper application of ADAS tools (use of ADAS316 to produce  the feature
photon emissivity coefficients (FPEC) in the adf40 format, in order to generate the
spectrum).
The emissivity due to spectral lines is given by the FPEC times the fractional
abundances at equilibrium, as calulated by ADAS405.
The continuum emission is calculated by the routine
/home/adas/adas/idl/adaslib/atomic/continuo.pro

EXAMPLE: This demo consists of three main points:
1. Set up the plasma environment: define temeprature and density profiles, beam
   position and establish the relevant ionisation stages.
   The data (distance along line of sight, electron temperature
   and electron density) come from an ITER scenario (H-mode).
   For calculating which ionisation stage occurs in the region defined
   by the beam, ADAS405 is used. This calculate the ionisation balance
   at equilibrium for W. The input files are the adf11 specidief by year 50.

2. Make adf40 for W. The input file is in the adf25 format.
   This is made using as input the adf01 generated
   for W51+ to W71+, as described in Demo a, and the adf25 template
   bn_cxs_template.dat.
   ADAS316 is used to create the adf40 (See Demo b).
   The directories created locally (adf01, adf25 and adf40) contain
   the data produced by this demo:
   a)   ./adf01/w/
       w51_n1.dat  w55_n1.dat  w59_n1.dat  w63_n1.dat  w67_n1.dat  w71_n1.dat
       w52_n1.dat  w56_n1.dat  w60_n1.dat  w64_n1.dat  w68_n1.dat
       w53_n1.dat  w57_n1.dat  w61_n1.dat  w65_n1.dat  w69_n1.dat
       w54_n1.dat  w58_n1.dat  w62_n1.dat  w66_n1.dat  w70_n1.dat
   b)   ./adf25/a25_p316/bn#74
       bn#74_w51_n1.dat  bn#74_w57_n1.dat  bn#74_w63_n1.dat  bn#74_w69_n1.dat
       bn#74_w52_n1.dat  bn#74_w58_n1.dat  bn#74_w64_n1.dat  bn#74_w70_n1.dat
       bn#74_w53_n1.dat  bn#74_w59_n1.dat  bn#74_w65_n1.dat  bn#74_w71_n1.dat
       bn#74_w54_n1.dat  bn#74_w60_n1.dat  bn#74_w66_n1.dat
       bn#74_w55_n1.dat  bn#74_w61_n1.dat  bn#74_w67_n1.dat
       bn#74_w56_n1.dat  bn#74_w62_n1.dat  bn#74_w68_n1.dat

   c)   ./adf40/w
       fpec_w51_n1.dat  fpec_w57_n1.dat  fpec_w63_n1.dat  fpec_w69_n1.dat
       fpec_w52_n1.dat  fpec_w58_n1.dat  fpec_w64_n1.dat  fpec_w70_n1.dat
       fpec_w53_n1.dat  fpec_w59_n1.dat  fpec_w65_n1.dat  fpec_w71_n1.dat
       fpec_w54_n1.dat  fpec_w60_n1.dat  fpec_w66_n1.dat
```

```
    fpec_w55_n1.dat  fpec_w61_n1.dat  fpec_w67_n1.dat
    fpec_w56_n1.dat  fpec_w62_n1.dat  fpec_w68_n1.dat
```

```
3.  Generate the active emission using the adf40 produced in point 2
    and the continuum emission. .The active emission is generated combining
    the adf40 FPEC with the frantional abundances at equilibrium
    computed by ADAS405.
    The continuum emission is calculated by the routine continuo.pro
```

```
DEMO c1: Explore implications of plasma conditions on choice
         of tungsten stages
1. Specify distance alond line of sight, electron temperature and density.
2. Identify the temperature where the beam exists.
3. Use run_adas405.pro to establish the ionisation stages of W
   which occur in that region.
Program: demo_c_1.pro
Sample of output files:demo_c_1_temp_dens.ps, demo_c_1_frac.ps

DEMO c2: Generate adf40 W active emission with run_adas316
1. Use read_adf25.pro to read the adf25 template.
2. Set up the input value for the new adf25 and the adf01 to be used.
3. Use write_adf25.pro to write the adf25 to be used as input for the ADAS316 run.
4. Use run_adas316.pro to produce the adf40.
Program: demo_c_2.pro
Sample of output files: files contained in the adf01, adf25 and adf40 directories
created locally.

DEMO c3: Construct active spectrum by combining adf40 with
         ionisation balance and generate continuum spectrum
         with ADAS routine continuo.pro
1. Define plasma condintions (temperature and density).
2. Set up the adf40 (W51+ to W71+).
3. Use run_adas405.pro for calculatin the fractgional abundances for W.
4. Use read-adf40.pro to read data from adf40
   (W line emission, called active emission in the program).
5. Build up the active emission mutiplying FPEC from
   adf40 times the fractional abundances.
6. Integrate the emission over beam size.
7. Plot the integrated active emission as a function of wavelength.
8. Use continuo.pro to calculate the continuum emission
   and ingrate along the line of sight.
9. Plot the active integrated emission and continuum integrated
   emission as a function of wavelength.
Program: demo_c_3.pro
Sample of output files: demo_c_3_active.ps, demo_c_3_compare.ps
```

3.1 Demo (c) Figures

3.1.1 Demo (c-1) demo_c/demo_c_1_frac.pdf

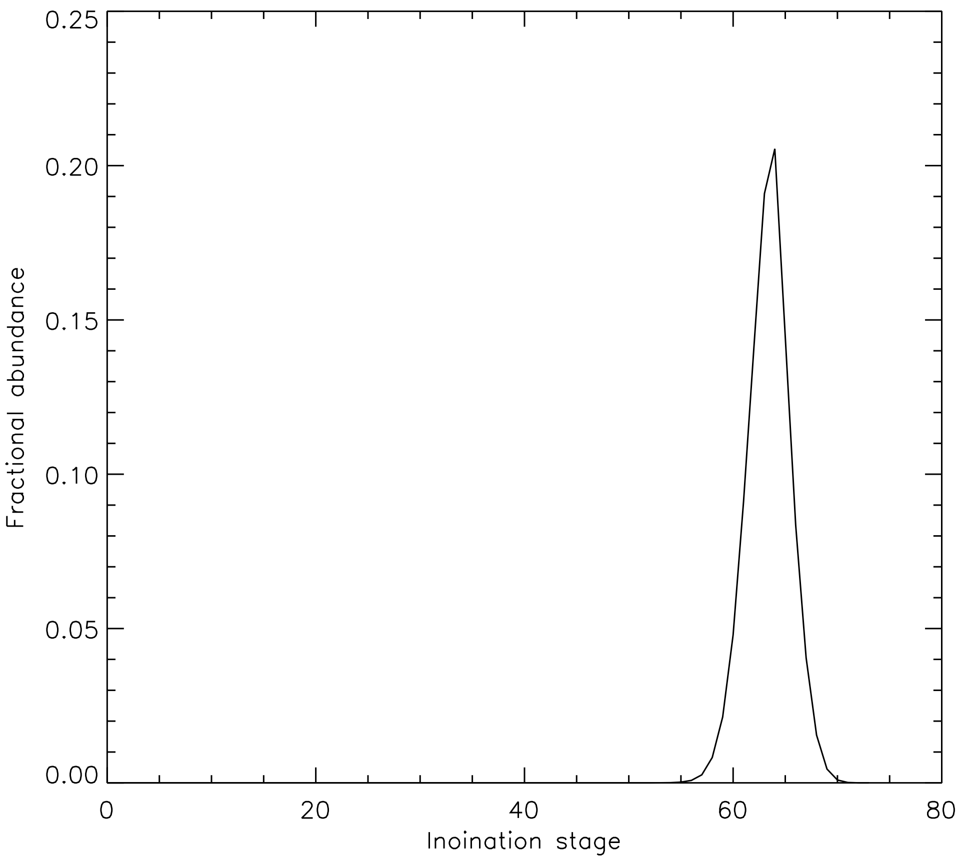

Figure 2:

3.1.2 Demo (c-1) demo_c/demo_c_1_temp_dens.pdf

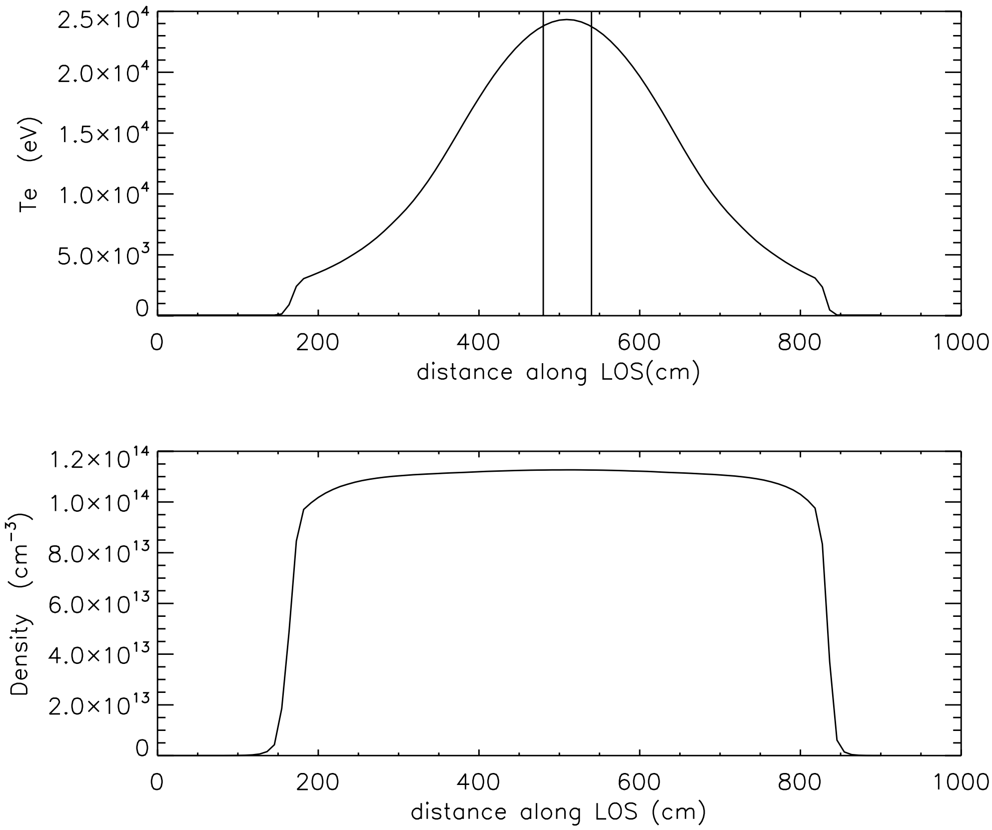

Figure 3:

3.1.3 Demo (c-3) demo_c/demo_c_3_active.pdf

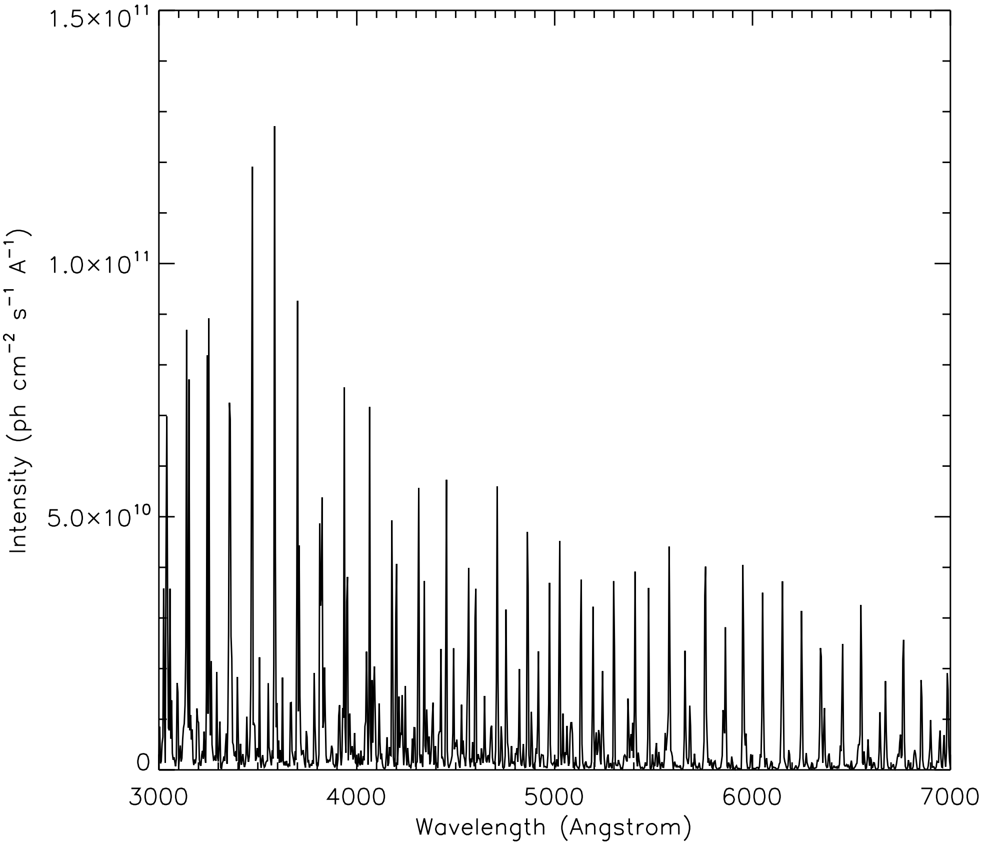

Figure 4:

3.1.4 Demo (c-3) demo_c/demo_c_3_compare.pdf

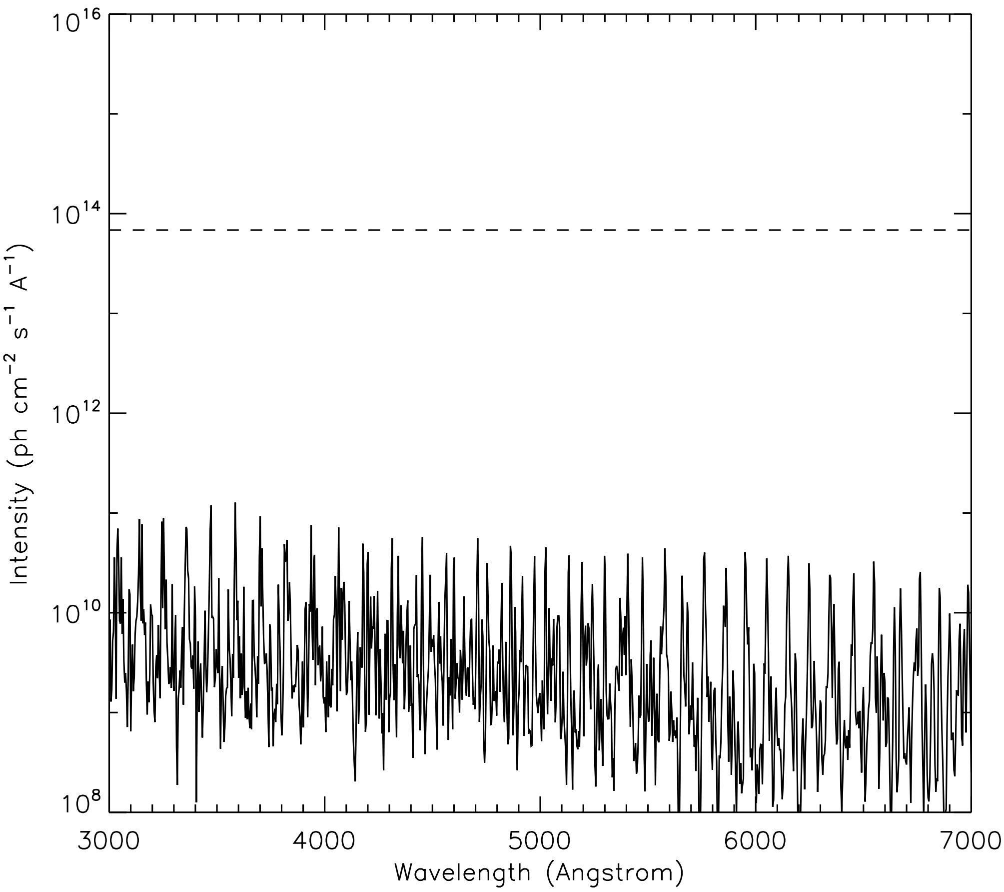

Figure 5:

3.2 Demo (c) IDL procedures

3.2.1 Demo (c-1) demo_c_1.pro

```
pro demo_c_1

; Data from ITER scenario 2 (H-mode)

d = [  0.0000e+00,  9.0909e+00,  1.8182e+01,  2.7273e+01,  3.6364e+01,  $
       4.5455e+01,  5.4545e+01,  6.3636e+01,  7.2727e+01,  8.1818e+01,  $
       9.0909e+01,  1.0000e+02,  1.0909e+02,  1.1818e+02,  1.2727e+02,  $
       1.3636e+02,  1.4545e+02,  1.5455e+02,  1.6364e+02,  1.7273e+02,  $
       1.8182e+02,  1.9091e+02,  2.0000e+02,  2.0909e+02,  2.1818e+02,  $
       2.2727e+02,  2.3636e+02,  2.4545e+02,  2.5455e+02,  2.6364e+02,  $
       2.7273e+02,  2.8182e+02,  2.9091e+02,  3.0000e+02,  3.0909e+02,  $
       3.1818e+02,  3.2727e+02,  3.3636e+02,  3.4545e+02,  3.5455e+02,  $
       3.6364e+02,  3.7273e+02,  3.8182e+02,  3.9091e+02,  4.0000e+02,  $
       4.0909e+02,  4.1818e+02,  4.2727e+02,  4.3636e+02,  4.4545e+02,  $
       4.5455e+02,  4.6364e+02,  4.7273e+02,  4.8182e+02,  4.9091e+02,  $
       5.0000e+02,  5.0909e+02,  5.1818e+02,  5.2727e+02,  5.3636e+02,  $
       5.4545e+02,  5.5455e+02,  5.6364e+02,  5.7273e+02,  5.8182e+02,  $
       5.9091e+02,  6.0000e+02,  6.0909e+02,  6.1818e+02,  6.2727e+02,  $
       6.3636e+02,  6.4545e+02,  6.5455e+02,  6.6364e+02,  6.7273e+02,  $
       6.8182e+02,  6.9091e+02,  7.0000e+02,  7.0909e+02,  7.1818e+02,  $
       7.2727e+02,  7.3636e+02,  7.4545e+02,  7.5455e+02,  7.6364e+02,  $
       7.7273e+02,  7.8182e+02,  7.9091e+02,  8.0000e+02,  8.0909e+02,  $
       8.1818e+02,  8.2727e+02,  8.3636e+02,  8.4545e+02,  8.5455e+02,  $
       8.6364e+02,  8.7273e+02,  8.8182e+02,  8.9091e+02,  9.0000e+02   ]

te =   [ 5.0000e+01,  5.0000e+01,  5.0000e+01,  5.0000e+01,  5.0000e+01,  $
         5.0000e+01,  5.0000e+01,  5.0000e+01,  5.0000e+01,  5.0000e+01,  $
         5.0000e+01,  5.0000e+01,  5.0000e+01,  5.0000e+01,  5.0000e+01,  $
         5.0000e+01,  5.0947e+01,  1.3802e+02,  8.9934e+02,  2.4124e+03,  $
         3.0462e+03,  3.2800e+03,  3.5272e+03,  3.7913e+03,  4.0776e+03,  $
         4.3872e+03,  4.7341e+03,  5.1028e+03,  5.4936e+03,  5.9293e+03,  $
         6.4070e+03,  6.9345e+03,  7.5085e+03,  8.1055e+03,  8.7299e+03,  $
         9.4337e+03,  1.0205e+04,  1.1033e+04,  1.1930e+04,  1.2889e+04,  $
         1.3882e+04,  1.4895e+04,  1.5920e+04,  1.6921e+04,  1.7885e+04,  $
         1.8818e+04,  1.9700e+04,  2.0513e+04,  2.1264e+04,  2.1951e+04,  $
         2.2557e+04,  2.3085e+04,  2.3523e+04,  2.3869e+04,  2.4125e+04,  $
         2.4280e+04,  2.4333e+04,  2.4284e+04,  2.4134e+04,  2.3878e+04,  $
         2.3532e+04,  2.3092e+04,  2.2558e+04,  2.1946e+04,  2.1253e+04,  $
         2.0491e+04,  1.9666e+04,  1.8767e+04,  1.7811e+04,  1.6826e+04,  $
         1.5803e+04,  1.4753e+04,  1.3717e+04,  1.2713e+04,  1.1744e+04,  $
         1.0820e+04,  9.9907e+03,  9.2201e+03,  8.5092e+03,  7.8700e+03,  $
         7.2528e+03,  6.6671e+03,  6.1215e+03,  5.6368e+03,  5.1965e+03,  $
         4.7808e+03,  4.3867e+03,  4.0308e+03,  3.6993e+03,  3.3895e+03,  $
         3.0920e+03,  2.3507e+03,  4.7135e+02,  5.4887e+01,  5.0000e+01,  $
         5.0000e+01,  5.0000e+01,  5.0000e+01,  5.0000e+01,  5.0000e+01   ]
```

```
dens = [1.2644e+10,  1.0410e+10,  1.0000e+10,  1.0000e+10,  1.0000e+10,  $
        1.0000e+10,  1.0920e+10,  1.3384e+10,  1.6654e+10,  2.5761e+10,  $
        4.0784e+10,  7.1152e+10,  1.3571e+11,  2.7752e+11,  6.3022e+11,  $
        1.5611e+12,  4.2606e+12,  1.8577e+13,  4.8794e+13,  8.4619e+13,  $
        9.7046e+13,  9.9647e+13,  1.0178e+14,  1.0352e+14,  1.0492e+14,  $
        1.0609e+14,  1.0699e+14,  1.0780e+14,  1.0845e+14,  1.0896e+14,  $
        1.0940e+14,  1.0977e+14,  1.1006e+14,  1.1031e+14,  1.1052e+14,  $
        1.1073e+14,  1.1090e+14,  1.1104e+14,  1.1118e+14,  1.1133e+14,  $
        1.1145e+14,  1.1157e+14,  1.1167e+14,  1.1180e+14,  1.1194e+14,  $
        1.1207e+14,  1.1215e+14,  1.1223e+14,  1.1232e+14,  1.1240e+14,  $
        1.1248e+14,  1.1254e+14,  1.1258e+14,  1.1261e+14,  1.1264e+14,  $
        1.1265e+14,  1.1266e+14,  1.1266e+14,  1.1264e+14,  1.1261e+14,  $
        1.1258e+14,  1.1254e+14,  1.1248e+14,  1.1240e+14,  1.1232e+14,  $
        1.1222e+14,  1.1215e+14,  1.1207e+14,  1.1193e+14,  1.1178e+14,  $
        1.1166e+14,  1.1155e+14,  1.1144e+14,  1.1130e+14,  1.1115e+14,  $
        1.1100e+14,  1.1086e+14,  1.1067e+14,  1.1045e+14,  1.1023e+14,  $
        1.0994e+14,  1.0958e+14,  1.0916e+14,  1.0864e+14,  1.0795e+14,  $
        1.0711e+14,  1.0608e+14,  1.0475e+14,  1.0302e+14,  1.0064e+14,  $
        9.7578e+13,  8.3379e+13,  3.6986e+13,  6.0841e+12,  1.4363e+12,  $
        3.9416e+11,  1.1876e+11,  3.7860e+10,  1.4183e+10,  1.0000e+10   ]


set_plot,'ps'
device, /isolatin1, font_index=8
device, bits=8, filename='demo_c_1_temp_dens.ps',  $
        font_size = 14, xsize=18.0, ysize=16.0, $
        yoffset=7.0, /color;
device, /helvetica


!p.multi = [0,1,2]

; Plot plasma temperature

plot, d, te, xtitle='distance along LOS(cm)', ytitle='Te  (eV)'


; show location of beam volume

oplot, [480, 480], [!y.crange[0], !y.crange[1]]
oplot, [540, 540], [!y.crange[0], !y.crange[1]]

; plot density

plot, d, dens, xtitle='distance along LOS (cm)', ytitle='Density  (cm!u-3!n)'

!p.multi = 0

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

```
!p.font=-1



; Find Te where beam exists

print, te[i4indf(d,480):i4indf(d,540)]


; Establish which ionisation stages of tungsten occur in this region
; Equilibrium ionisation balance for W with central ADAS year 50 set

te   = 24.0e3
dens = 1.01e14

run_adas405, uid='adas', year=50, elem='w', te=te, dens=dens, frac=frac


set_plot,'ps'
device, /isolatin1, font_index=8
device, bits=8, filename='demo_c_1_frac.ps',  $
        font_size = 14, xsize=18.0, ysize=16.0, $
        yoffset=7.0, /color;
device, /helvetica

plot, indgen(74), frac.ion,xtitle='Ionination stage',  $
      ytitle='Fractional abundance'

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


end
```

3.2.2 Demo (c-2) demo_c_2.pro

```
pro demo_c_2

;generate the adf40 for W
spawn, 'pwd', res
root =res[0]

te   = 23.0e3
tp   = te
dens = 1.01e14

z_low  = 51
z_high = 71
```

```
iz     = indgen(z_high-z_low+1) + z_low
n_z    = n_elements(iz)

npix  = [1000]
wvmin = [3000]
wvmax = [7000]

adf25 = 'bn_cxs_template.dat'

read_adf25, file=adf25, fulldata=all_25


for j = 0, n_z-1 do begin

  izr = iz[j]

  print, 'Processing stage ' + string(izr)

  all = all_25

  all.iz1 = izr
  all.cxfile = root + '/adf01/w/w' + string(izr, format='(i2.2)') + '_n1.dat'
  all.densa  = dens
  all.denpa  = 0.0
  all.denimpa = 0.0
  all.deniona = dens

  all.tea   = te * 11605.0
  all.tpa   = tp * 11605.0
  all.timpa = te * 11605.0
  all.tiona = tp * 11605.0

  all.zimpa  = 74.0
  all.amimpa = 135.0
  all.frimpa = 1.0e-5

  adf25  = root + '/adf25/a25_p316/bn#74/bn#74_w' +  $
                  string(izr, format='(i2)') + '_n1.dat'
  write_adf25, outfile=adf25, fulldata=all

  adf40 = root + '/adf40/w/fpec_w' + string(izr, format='(i2.2)') + '_n1.dat'

  run_adas316, adf25=adf25, adf40=adf40, $
               npix = npix, wvmin=wvmin, wvmax=wvmax


endfor


end
```

3.2.3 Demo (c-3) demo_c_3.pro

```
PRO demo_c_3

; Local plasma conditions of beam plasma intersection

te   = 20.0e3
dens = 1.01e14


; Set of CX adf40 emission

adf40  = file_search('adf40/w/fpec*.dat', count=nfiles)
z_low  = 51
z_high = 71
iz     = indgen(z_high-z_low+1) + z_low
n_z    = n_elements(iz)


; Equilibrium ionisation balance for W with central ADAS year 50 set

run_adas405, uid='adas', year=50, elem='w', te=te, dens=dens, frac=frac


; Construct the spectrum from adf40 and multiply by fractional abundance
; Note that adas316 generated adf40 at the reference Te/Ne/Eb condition
; ie there is no ability to interpolated to different plasma conditions.

npix  = 1000
wmin  = 3000.0
wmax  = 7000.0
wave  = adas_vector(low=wmin, high=wmax, num=npix, /linear)
delta = wave[1] - wave[0]


emiss_active = fltarr(npix)                ; Cumulative spectrum

k = 0
for iz = z_low, z_high do begin

   read_adf40, file=adf40[k], fulldata=all

   emiss_active = emiss_active + frac.ion[0,iz] * all.fpec / delta
               ; fPECs are /pixel, we need /Angstrom

   k += 1

endfor

; Integrate the emission over beam size - assume an ITER DNB of 2MW power,
```

```
; 50keV/amu energy and height of 45cm   - assume a W concentration of 1e-5

conc  = 1.0e-5
nbeam = 6.0e8
hbeam = 45.0

emiss_active_int = emiss_active * nbeam * (conc * dens) * hbeam


set_plot,'ps'
device, /isolatin1, font_index=8
device, bits=8, filename='demo_c_3_active.ps',  $
        font_size = 14, xsize=18.0, ysize=16.0, $
        yoffset=7.0, /color;
device, /helvetica

plot, wave, emiss_active_int,$
         xtitle='Wavelength (Angstrom)', $
         ytitle = 'Intensity (ph cm!u-2!n s!u-1!n A!u-1!n)',$
         xmargin=[12,3]

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

; Calculate the continuum emission from H only using ITER reference scenario 2
; and a vertical line of sight. The plasma profiles along the LOS are

d = [  0.0000e+00,  9.0909e+00,  1.8182e+01,  2.7273e+01,  3.6364e+01,  $
       4.5455e+01,  5.4545e+01,  6.3636e+01,  7.2727e+01,  8.1818e+01,  $
       9.0909e+01,  1.0000e+02,  1.0909e+02,  1.1818e+02,  1.2727e+02,  $
       1.3636e+02,  1.4545e+02,  1.5455e+02,  1.6364e+02,  1.7273e+02,  $
       1.8182e+02,  1.9091e+02,  2.0000e+02,  2.0909e+02,  2.1818e+02,  $
       2.2727e+02,  2.3636e+02,  2.4545e+02,  2.5455e+02,  2.6364e+02,  $
       2.7273e+02,  2.8182e+02,  2.9091e+02,  3.0000e+02,  3.0909e+02,  $
       3.1818e+02,  3.2727e+02,  3.3636e+02,  3.4545e+02,  3.5455e+02,  $
       3.6364e+02,  3.7273e+02,  3.8182e+02,  3.9091e+02,  4.0000e+02,  $
       4.0909e+02,  4.1818e+02,  4.2727e+02,  4.3636e+02,  4.4545e+02,  $
       4.5455e+02,  4.6364e+02,  4.7273e+02,  4.8182e+02,  4.9091e+02,  $
       5.0000e+02,  5.0909e+02,  5.1818e+02,  5.2727e+02,  5.3636e+02,  $
       5.4545e+02,  5.5455e+02,  5.6364e+02,  5.7273e+02,  5.8182e+02,  $
       5.9091e+02,  6.0000e+02,  6.0909e+02,  6.1818e+02,  6.2727e+02,  $
       6.3636e+02,  6.4545e+02,  6.5455e+02,  6.6364e+02,  6.7273e+02,  $
       6.8182e+02,  6.9091e+02,  7.0000e+02,  7.0909e+02,  7.1818e+02,  $
       7.2727e+02,  7.3636e+02,  7.4545e+02,  7.5455e+02,  7.6364e+02,  $
       7.7273e+02,  7.8182e+02,  7.9091e+02,  8.0000e+02,  8.0909e+02,  $
       8.1818e+02,  8.2727e+02,  8.3636e+02,  8.4545e+02,  8.5455e+02,  $
       8.6364e+02,  8.7273e+02,  8.8182e+02,  8.9091e+02,  9.0000e+02   ]

te =   [ 5.0000e+01,  5.0000e+01,  5.0000e+01,  5.0000e+01,  5.0000e+01,  $
```

```
         5.0000e+01,  5.0000e+01,  5.0000e+01,  5.0000e+01,  5.0000e+01,  $
         5.0000e+01,  5.0000e+01,  5.0000e+01,  5.0000e+01,  5.0000e+01,  $
         5.0000e+01,  5.0947e+01,  1.3802e+02,  8.9934e+02,  2.4124e+03,  $
         3.0462e+03,  3.2800e+03,  3.5272e+03,  3.7913e+03,  4.0776e+03,  $
         4.3872e+03,  4.7341e+03,  5.1028e+03,  5.4936e+03,  5.9293e+03,  $
         6.4070e+03,  6.9345e+03,  7.5085e+03,  8.1055e+03,  8.7299e+03,  $
         9.4337e+03,  1.0205e+04,  1.1033e+04,  1.1930e+04,  1.2889e+04,  $
         1.3882e+04,  1.4895e+04,  1.5920e+04,  1.6921e+04,  1.7885e+04,  $
         1.8818e+04,  1.9700e+04,  2.0513e+04,  2.1264e+04,  2.1951e+04,  $
         2.2557e+04,  2.3085e+04,  2.3523e+04,  2.3869e+04,  2.4125e+04,  $
         2.4280e+04,  2.4333e+04,  2.4284e+04,  2.4134e+04,  2.3878e+04,  $
         2.3532e+04,  2.3092e+04,  2.2558e+04,  2.1946e+04,  2.1253e+04,  $
         2.0491e+04,  1.9666e+04,  1.8767e+04,  1.7811e+04,  1.6826e+04,  $
         1.5803e+04,  1.4753e+04,  1.3717e+04,  1.2713e+04,  1.1744e+04,  $
         1.0820e+04,  9.9907e+03,  9.2201e+03,  8.5092e+03,  7.8700e+03,  $
         7.2528e+03,  6.6671e+03,  6.1215e+03,  5.6368e+03,  5.1965e+03,  $
         4.7808e+03,  4.3867e+03,  4.0308e+03,  3.6993e+03,  3.3895e+03,  $
         3.0920e+03,  2.3507e+03,  4.7135e+02,  5.4887e+01,  5.0000e+01,  $
         5.0000e+01,  5.0000e+01,  5.0000e+01,  5.0000e+01,  5.0000e+01   ]

dens = [1.2644e+10,  1.0410e+10,  1.0000e+10,  1.0000e+10,  1.0000e+10,  $
        1.0000e+10,  1.0920e+10,  1.3384e+10,  1.6654e+10,  2.5761e+10,  $
        4.0784e+10,  7.1152e+10,  1.3571e+11,  2.7752e+11,  6.3022e+11,  $
        1.5611e+12,  4.2606e+12,  1.8577e+13,  4.8794e+13,  8.4619e+13,  $
        9.7046e+13,  9.9647e+13,  1.0178e+14,  1.0352e+14,  1.0492e+14,  $
        1.0609e+14,  1.0699e+14,  1.0780e+14,  1.0845e+14,  1.0896e+14,  $
        1.0940e+14,  1.0977e+14,  1.1006e+14,  1.1031e+14,  1.1052e+14,  $
        1.1073e+14,  1.1090e+14,  1.1104e+14,  1.1118e+14,  1.1133e+14,  $
        1.1145e+14,  1.1157e+14,  1.1167e+14,  1.1180e+14,  1.1194e+14,  $
        1.1207e+14,  1.1215e+14,  1.1223e+14,  1.1232e+14,  1.1240e+14,  $
        1.1248e+14,  1.1254e+14,  1.1258e+14,  1.1261e+14,  1.1264e+14,  $
        1.1265e+14,  1.1266e+14,  1.1266e+14,  1.1264e+14,  1.1261e+14,  $
        1.1258e+14,  1.1254e+14,  1.1248e+14,  1.1240e+14,  1.1232e+14,  $
        1.1222e+14,  1.1215e+14,  1.1207e+14,  1.1193e+14,  1.1178e+14,  $
        1.1166e+14,  1.1155e+14,  1.1144e+14,  1.1130e+14,  1.1115e+14,  $
        1.1100e+14,  1.1086e+14,  1.1067e+14,  1.1045e+14,  1.1023e+14,  $
        1.0994e+14,  1.0958e+14,  1.0916e+14,  1.0864e+14,  1.0795e+14,  $
        1.0711e+14,  1.0608e+14,  1.0475e+14,  1.0302e+14,  1.0064e+14,  $
        9.7578e+13,  8.3379e+13,  3.6986e+13,  6.0841e+12,  1.4363e+12,  $
        3.9416e+11,  1.1876e+11,  3.7860e+10,  1.4183e+10,  1.0000e+10   ]

nd     = n_elements(d)

; call continuo with 100 pixels and integrate along LOS

nw     = 100
wave_c = adas_vector(low=wmin, high=wmax, num=nw)

continuo, wave_c, te, 1, 1, contff_d, contin_d
```

```
emiss_cont = contin_d * (rebin(reform(dens, 1, nd), nw, nd))^2.0
        ; nb this inflates dens along wavelength

emiss_cont_int = dblarr(nw)

for j = 0, nw-1 do emiss_cont_int[j] = int_tabulated(d, emiss_cont[j,*], /double)




; Compare the contributions by plotting the results on one graph

xmin = wmin
xmax = wmax
ymin = min([emiss_active_int, emiss_cont_int], max=ymax)
ymin = 1e8
ymax = 1e15

set_plot,'ps'
device, /isolatin1, font_index=8
device, bits=8, filename='demo_c_3_compare.ps',  $
        font_size = 14, xsize=18.0, ysize=16.0, $
        yoffset=7.0, /color;
device, /helvetica

plot_io, [xmin, xmax], [ymin, ymax], /nodata, $
         xtitle = 'Wavelength (Angstrom)', $
         ytitle = 'Intensity (ph cm!u-2!n s!u-1!n A!u-1!n)'


oplot, wave_c, emiss_cont_int, line=2, thick=5
oplot, wave, emiss_active_int


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



END
```

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) Figures

4.1.1 Demo (d-1) demo_d/demo_d.pdf

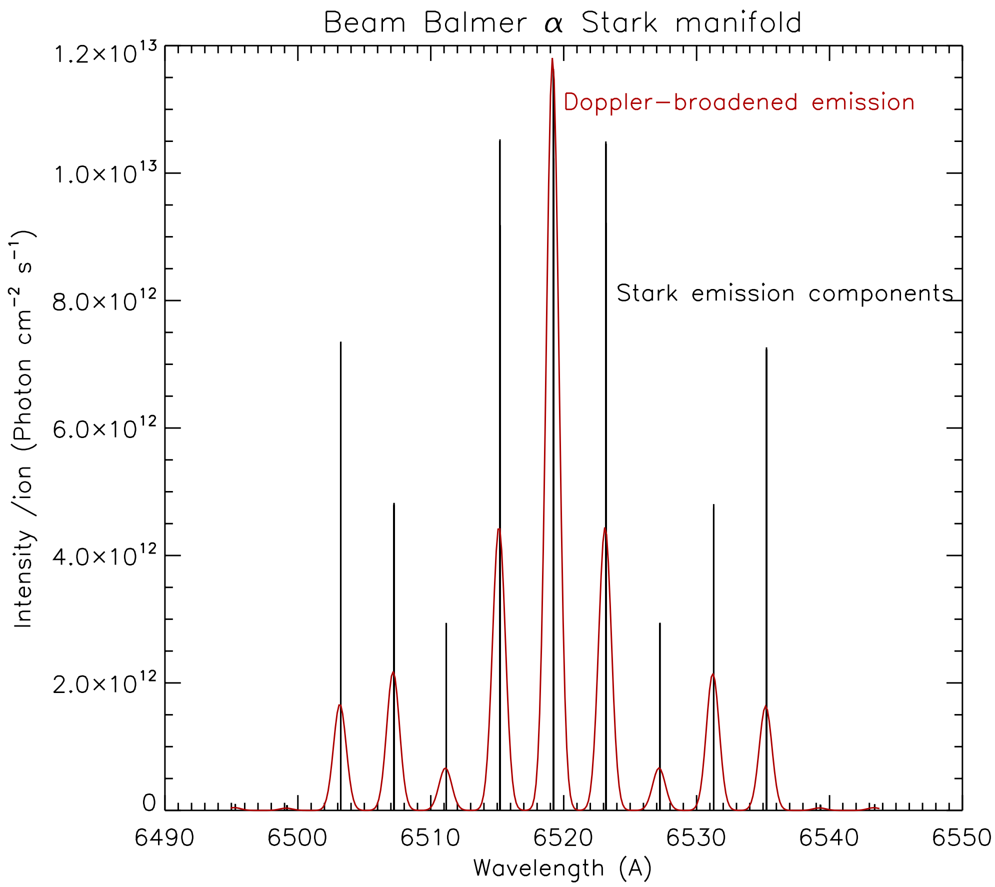

Figure 6:

4.2 Demo (d) IDL procedures

4.2.1 Demo (d-1) demo_d/demo_d.pro

```
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
```