

Differential Emission Measure (DEM) analysis

- One of the most widely used methods available for the interpretation of astronomical spectral lines is the Differential Emission Measure (DEM) technique.
- Although this method is less familiar in spectroscopic studies of fusion plasma, it can be applied to determine impurity concentration, impurity variation in time and impurity influx in fusion.

What is DEM

Intensity of spectral line of optically thin plasma:

$$I_{j \rightarrow k} = \frac{A(Z)}{4\pi} \int G_{j \rightarrow k}(T_e) \Phi(T_e) dT_e$$

DEM

A realistic study of line emission through DEM requires:

• **Measurements**

⇒

$I_{j \rightarrow k}$

• **Atomic model**

⇒

$$\left\{ \begin{array}{l} G_{j \rightarrow k}(T_e) = A_{j \rightarrow k} \frac{N_H}{N_e} \sum_{\rho=1}^{M_Z} F_{j\rho}^{(exc)} \frac{N_\rho}{N_{TOT}} \\ \Phi(T_e) dT_e \propto N_e^2 dV \end{array} \right.$$

Requirements for a DEM analysis

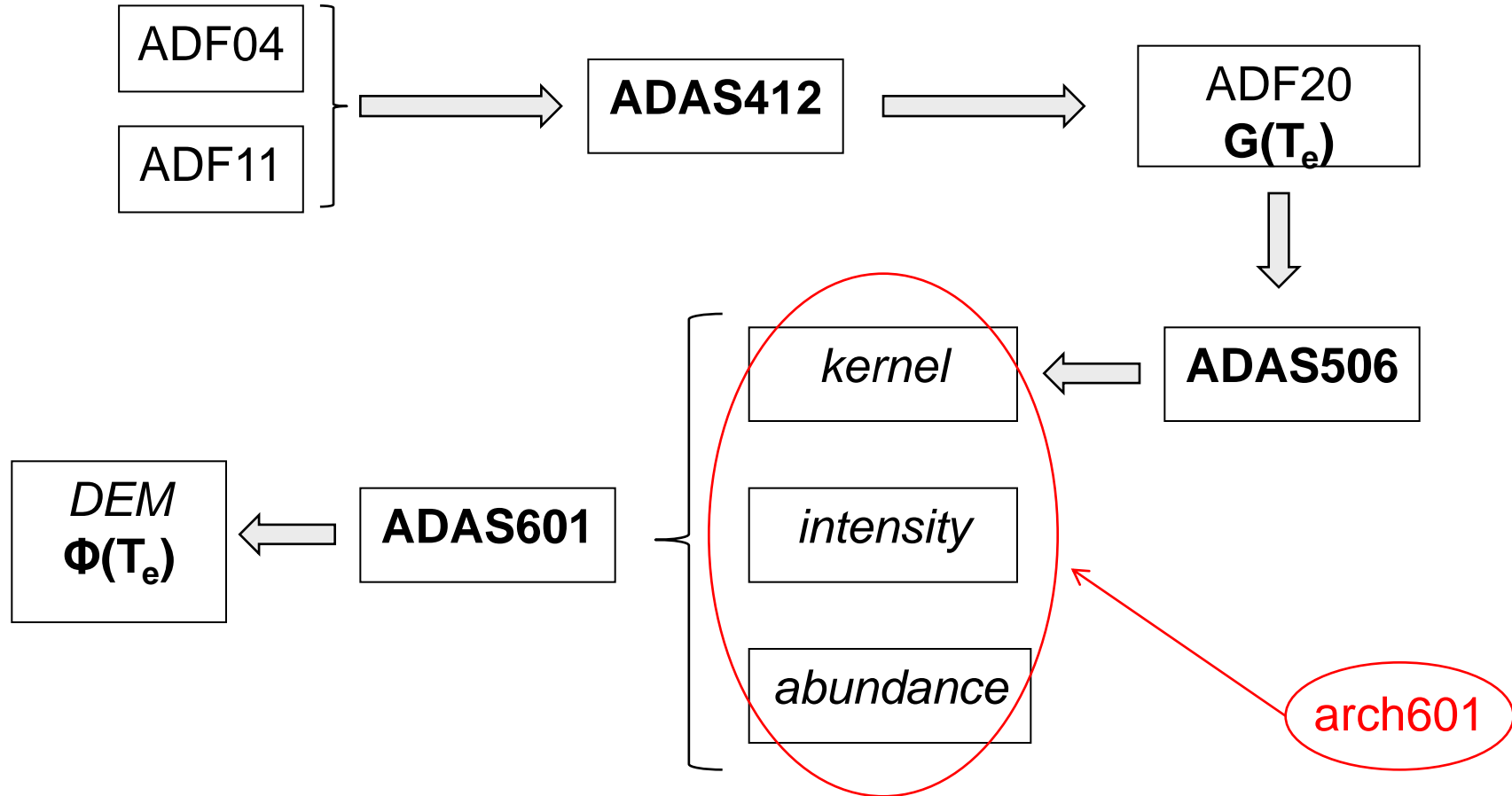
ADAS601: DEM estimated by *data adaptive smoothing approach*, using the integral inversion algorithm of Thompson (1990, 1991).

Input data

$$I_i = \frac{A(Z)}{4\pi} \int_{T_1}^{T_2} G_i(T) \Phi(T) dT$$

- Set of observed intensities I_i
 - Elemental abundances $A(Z)$
 - Contribution functions $G_i(T)$
- $i = 1, 2, \dots, m$

Scheme of DEM analysis in ADAS



Generating ADF20

- Code ADAS412 allows the calculation of $G(\text{Te})$ functions and collects them in the ADF20 format.
- It does this by carrying out the excited population calculation from an ADF04 dataset in the manner of ADAS205 and generating an ionisation balance from ADF11 datasets in the manner of ADAS405. Finally it assembles the $G(\text{Te})$ functions.

ADAS412 input

ADAS 412 INPUT

Input Specific Ion File

Data Root:

Edit Path Name

..

mom97_ls#c0.dat

mom97_ls#c1.dat

mom97_ls#c2.dat

mom97_ls#c3.dat

mom97_ls#c4.dat

Data File

mom97_ls#c5.dat

mom97_n#c5.dat

Select Ionisation and Recombination Datasets

Data Root:

Edit Path Name

Data Year.: Element:

select adf04

select adf11

ADAS412 processing

ADAS412 PROCESSING OPTIONS

Title for Run

Data File Name: /home/asg/adas_dev/adas/adf04/adas#6/mom97_ls#c4.dat

adf11 year:96 Element:c

Model Data

| | Electron Temperature (Log(K)) | Electron Density (cm ⁻³) | NH/NE Ratio |
|-------|-------------------------------|--------------------------------------|-------------|
| INDEX | | | |
| 1 | 4.000E+00 | 1.000E+11 | 1.610E+00 |
| 2 | 4.050E+00 | 8.310E+10 | 1.430E+00 |
| 3 | 4.100E+00 | 7.340E+10 | 1.330E+00 |
| 4 | 4.150E+00 | 7.080E+10 | 1.240E+00 |
| 5 | 4.200E+00 | 6.310E+10 | 1.170E+00 |
| 6 | 4.250E+00 | 5.620E+10 | 1.100E+00 |

Ionisation balance

Density independent Density dependent

Select Transitions By: Indices Wavelengths

| | | |
|----|---------|------------|
| 1 | 1s2 | (1)S(0.0) |
| 2 | 1s1 2s1 | (3)S(1.0) |
| 3 | 1s1 2s1 | (1)S(0.0) |
| 4 | 1s1 2p1 | (3)P(4.0) |
| 5 | 1s1 2p1 | (1)P(1.0) |
| 6 | 1s1 3s1 | (3)S(1.0) |
| 7 | 1s1 3s1 | (1)S(0.0) |
| 8 | 1s1 3p1 | (3)P(4.0) |
| 9 | 1s1 3p1 | (3)D(7.0) |
| 10 | 1s1 3d1 | (1)D(2.0) |
| 11 | 1s1 3p1 | (1)P(1.0) |
| 12 | 1s1 4s1 | (3)S(1.0) |

Transitions

| INDEX | Upper Level | Lower Level | Assigned wavelength |
|-------|-------------|-------------|---------------------|
| 1 | 3 | 1 | |
| 2 | 9 | 1 | |
| 3 | 15 | 1 | |
| 4 | 16 | 1 | |
| 5 | 23 | 1 | |

Wavelength Max. (Å): Wavelength Min. (Å): Highest Level Included

Edit the processing options data and press Done to proceed

select T_e , N_e
and N_H/N_e

select
wavelength
range

select
transitions

ADAS412 output

ADAS412 OUTPUT OPTIONS

Data File Name: /home/asg/adas_dev/adas/adf04/adas#6/mom97_ls#c4.dat

Browse Comments

Graphical Output

Graph Title: Contribution function

Select Device

Post-Script

Post-Script

HP-PGL

HP-GL

Explicit Scaling

X-min: X-max:

Y-min: Y-max:

Enable Hard Copy Replace

File Name: goft.ps

Text Output Replace Default File Name

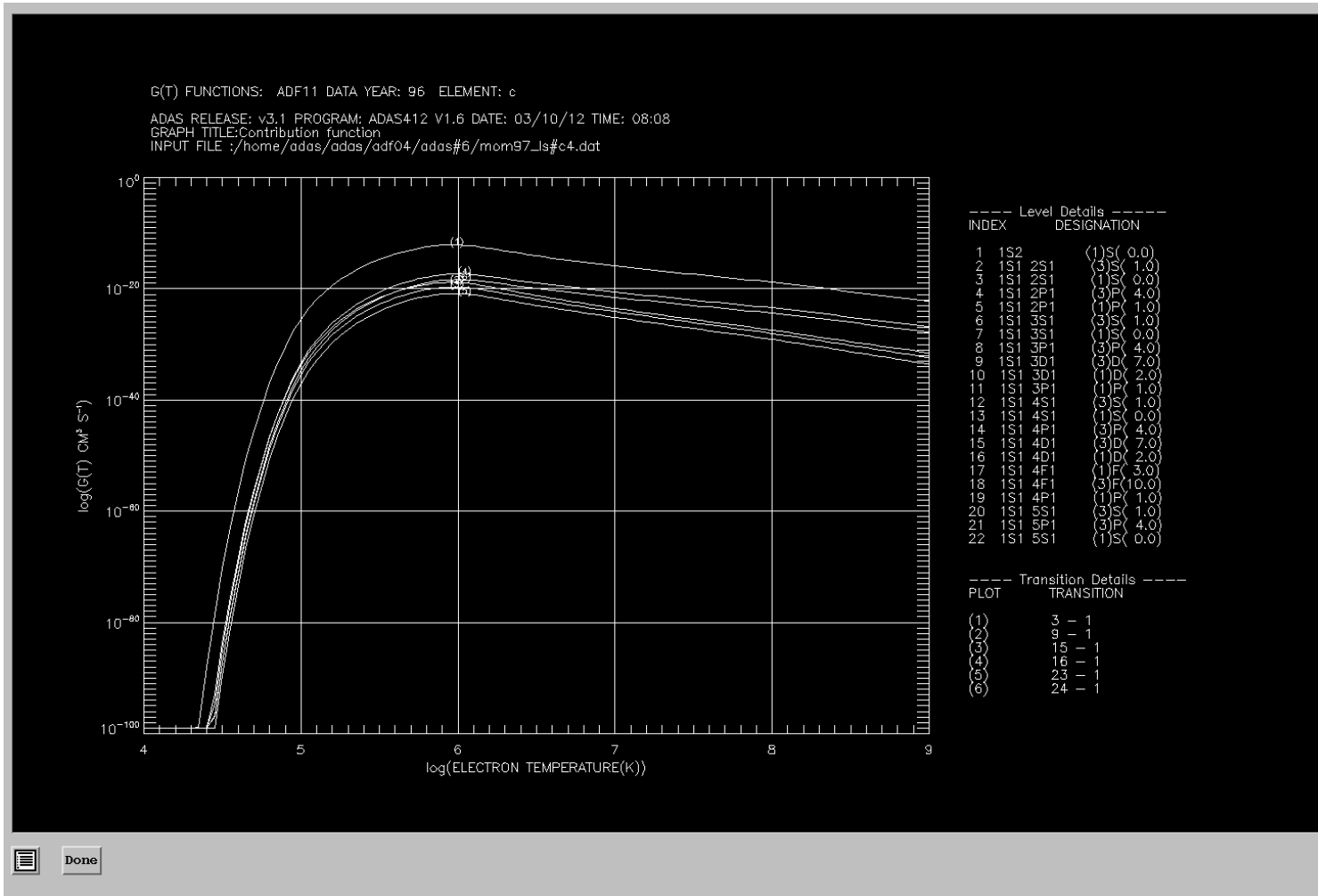
File Name: goft.pass

Cancel Done

graph
output
choices

ADF20

ADAS412 graph



Example of ADF20

```

+ 4 /NLEVELS= 11/NKNOTS= 94/NLINES= 6/

SOURCE FILES:
IONISATION BALANCE DATA - /ADAS/adas/adf11.<>cd85#c.dat
SPECIFIC ION FILE DATA - /ADAS/adas/adf04/helike/helike_wjd92#c.dat

PROCESSING CODE          DATE          USER IDENTIFIER
-----
GOFT V2.0                18-Jul-96        Alessandro Lanzafame

ENERGY LEVEL INDEXING
-----
INDX   CODE          S L IJ
-----
  1    1S2           1(0) 0.0
  2    1S1 2s1       3(0) 1.0
-----
 10    1S1 3D1       1(2) 2.0
 11    1S1 3F1       1(1) 1.0
-----

PLASMA MODEL (FINITE DENSITY IONISATION BALANCE =YES)
-----
TE (K)   NE (CM-3)   P (KCM-3)   NH/NE   TIME (S)   LOG(TE)   LOG(NE)   LOG(P)
-----
2.24D+04 1.00D+10  2.24D+14  1.03D+00  -----  4.35  10.00  14.35
-----
8.91D+08 1.00D+10  8.91D+18  8.27D-01  -----  8.95  10.00  18.95
1.00D+09 1.00D+10  1.00D+19  8.27D-01  -----  9.00  10.00  19.00

TABLE OF G(T) VALUES (CM3 S-1) FOR C V
-----
TRANS INDEX      1      2      3      4      5      6      7      8      9      10
APPROX WLENGTH  260.2  271.9  227.2  248.7  267.3  247.3  0.0    0.0    0.0    0.0
SPECTR WLENGTH  0.000  0.000  0.000  0.000  0.000  0.000  0.000  0.000  0.000  0.000
TRANSITION       4- 6    5- 7    2- 8    4- 9    5-10   3-11   0- 0    0- 0    0- 0    0- 0
LOG(TE (K))
-----
 5.60  3.366D-15  8.406D-16  5.233D-15  5.167D-15  7.630D-16  1.869D-16  0.000D+00  0.000D+00  0.000D+00  0.000D+00
 5.65  9.269D-15  2.409D-15  1.483D-14  1.443D-14  2.075D-15  5.426D-16  0.000D+00  0.000D+00  0.000D+00  0.000D+00
-----
 5.90  1.757E-13  5.660D-14  3.243D-13  2.902D-13  3.772D-14  1.383D-14  0.000D+00  0.000D+00  0.000D+00  0.000D+00
 5.95  1.993D-13  6.748D-14  3.789D-13  3.325D-13  4.279D-14  1.683D-14  0.000D+00  0.000D+00  0.000D+00  0.000D+00
-----

TRANSITION LIST FOR C V
-----
IND  TRANSITION  APP. WVL. (A)  EXACT WVL. (A)  LOWER ST.  UPPER ST.
-----
 1   4 - 6        260.2         0.0            3(1) 4.0       3(0) 1.0
 2   5 - 7        271.9         0.0            1(1) 1.0       1(0) 0.0
 3   2 - 8        227.2         0.0            3(0) 1.0       3(1) 4.0
 4   4 - 9        248.7         0.0            3(1) 4.0       3(2) 7.0
 5   5 - 10       267.3         0.0            1(1) 1.0       1(2) 2.0
 6   3 - 11       247.3         0.0            1(0) 0.0       1(1) 1.0

```

energy levels

plasma model:
 $N_e = \text{const.}$ or
 $T_e N_e = P_e = \text{const.}$

contribution functions versus T_e

line specification

Creating the collection file (kernel)

- Code ADAS506 interrogates G(Te) files of the type ADF20.
- It gives the collection file (archived in ARCH601) which is composed of blocks of data for each spectrum line. This is one of the input for the differential emission measure analysis performed by ADAS601.

ADAS506 input

ADAS 506 INPUT

Input Dataset

Data Root

Edit Path Name

Data File

..
gft95#he_al#c4_n1e10.dat
gft95#he_al#c4_n1e11.dat
gft95#he_al#c4_n1e12.dat
gft95#he_al#c4_n1e8.dat
gft95#he_al#c4_n1e9.dat
gft95#he_al#c4_pl10.dat
gft95#he_al#c4_pl14.dat
gft95#he_al#c4_pl15.dat
gft95#he_al#c4_p3e14.dat
gft95#he_al#c4_p3e15.dat

select
ADF20

ADAS506 processing

ADAS506 PROCESSING OPTIONS

Title for Run

Data File Name: /home/adas/adas/adf20/gft95#he/gft95#he_al#c4_p1e15.dat

Number of Transitions : 6
Number of Index Energy levels : 11

Polynomial Fitting

Fit Polynomial value % :

Select Transition

| TRANSITION INDEX | LOWER LEVEL INDEX DESIGNATION | UPPER LEVEL INDEX DESIGNATION | APPROXIMATE WAVELENGTH | SPECTROSCOPIC WAVELENGTH |
|------------------|-------------------------------|-------------------------------|------------------------|--------------------------|
| 3 | 2 1s1 2s1 (3)S(1.0) | 8 1s1 3p1 (3)P(4.0) | 227.200 | 0.000 |
| 1 | 4 1s1 2p1 (3)P(4.0) | 6 1s1 3s1 (3)S(1.0) | 260.200 | 0.000 |
| 2 | 5 1s1 2p1 (1)P(1.0) | 7 1s1 3s1 (1)S(0.0) | 271.900 | 0.000 |
| 3 | 2 1s1 2s1 (3)S(1.0) | 8 1s1 3p1 (3)P(4.0) | 227.200 | 0.000 |
| 4 | 4 1s1 2p1 (3)P(4.0) | 9 1s1 3d1 (3)D(7.0) | 248.700 | 0.000 |

Select Temperatures for output files

Output Electron Temperatures

| INDEX | output | input |
|-------|-----------|-----------|
| 1 | 2.240E+04 | 2.240E+04 |
| 2 | 2.510E+04 | 2.510E+04 |
| 3 | 2.820E+04 | 2.820E+04 |
| 4 | 3.160E+04 | 3.160E+04 |

Temperature Units: Kelvin

select line

Select output T_e

ADAS506 output

ADAS506 OUTPUT OPTIONS

Data File Name: /home/adas/adas/adf20/gft95#he/gft95#he_al#c4_p1e15.dat [Browse Comments](#)

Graphical Output

Graph Title:

Select Device

Post-Script

Post-Script

HP-PCL

HP-GL

Explicit Scaling

X-min: X-max:

Y-min: Y-max:

Enable Hard Copy Replace

File Name:

Text Output Replace

File Name:

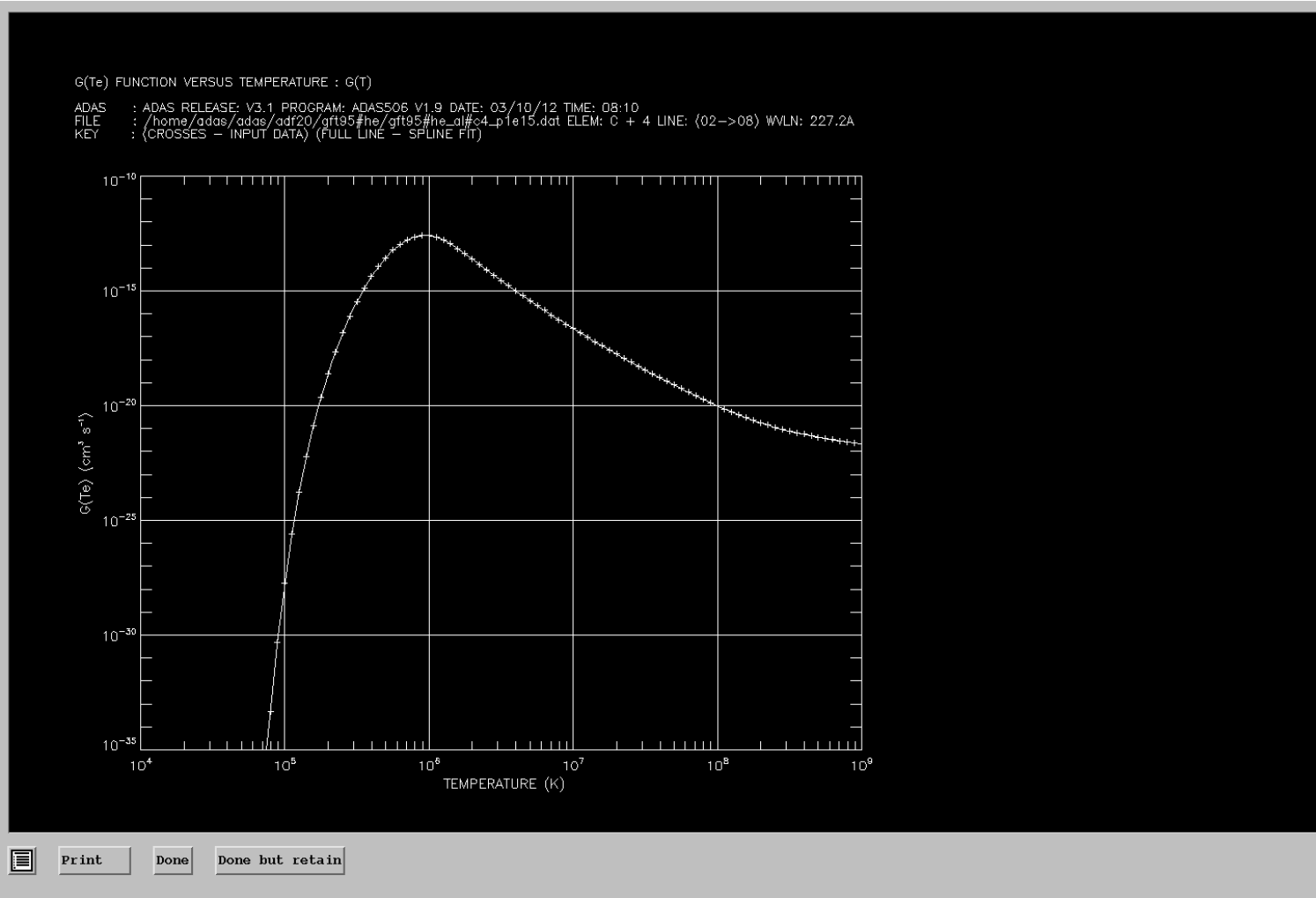
Collection File Replace

File Name:

graphical
setup

creating
collection file for
archiving in
ARCH601

ADAS506 graph



Example of collection file (kernel)

```
FE+10 /ITRANS= 14/NTEMP= 88/APPWAV= 308.500/SPWAV= 308.515/  
/home95/acl/adas/adf20/gft95#s/gft95#s_al#fe10_nle10.dat  
4.65 4.70 4.75 4.80 4.85 4.90 4.95 5.00 5.05 5.10 5.15 5.20 5.25 5.30 5.35 5.40 5.45 5.50 5.55 5.60 5.65 5.70 5.75  
1.0000E-99 2.5650E-98 6.9770E-87 8.4490E-77 6.0270E-68 3.3460E-60 1.8910E-53 1.3540E-47 1.5400E-42 3.6250E-38 2.304  
FE+12 /ITRANS= 22/NTEMP= 84/APPWAV= 311.600/SPWAV= 311.552/  
/home95/acl/adas/adf20/gft95#si/gft95#si_al#fe12_nle10.dat  
4.85 4.90 4.95 5.00 5.05 5.10 5.15 5.20 5.25 5.30 5.35 5.40 5.45 5.50 5.55 5.60 5.65 5.70 5.75 5.80 5.85 5.90 5.95  
1.0000E-99 2.5190E-97 3.3010E-86 1.7300E-76 4.9700E-68 1.1270E-60 2.9150E-54 1.1890E-48 1.0270E-43 2.3140E-39 1.622  
MG+ 7 /ITRANS= 13/NTEMP= 90/APPWAV= 311.800/SPWAV= 311.772/  
/home95/acl/adas/adf20/gft95#b/gft95#b_al#mg7_nle10.dat  
4.55 4.60 4.65 4.70 4.75 4.80 4.85 4.90 4.95 5.00 5.05 5.10 5.15 5.20 5.25 5.30 5.35 5.40 5.45 5.50 5.55 5.60 5.65  
1.0000E-99 2.3230E-96 1.9580E-85 1.0250E-75 4.5730E-67 1.9330E-59 8.4180E-53 5.1930E-47 6.4010E-42 1.9340E-37 1.680  
MG+ 7 /ITRANS= 11/NTEMP= 90/APPWAV= 313.700/SPWAV= 313.743/  
/home95/acl/adas/adf20/gft95#b/gft95#b_al#mg7_nle10.dat  
4.55 4.60 4.65 4.70 4.75 4.80 4.85 4.90 4.95 5.00 5.05 5.10 5.15 5.20 5.25 5.30 5.35 5.40 5.45 5.50 5.55 5.60 5.65  
1.0000E-99 4.6340E-96 3.8750E-85 2.0130E-75 8.9200E-67 3.7460E-59 1.6210E-52 9.9460E-47 1.2200E-41 3.6700E-37 3.177  
SI+ 7 /ITRANS= 13/NTEMP= 91/APPWAV= 314.300/SPWAV= 314.356/  
/home95/acl/adas/adf20/gft95#n/gft95#n_al#si7_nle10.dat  
4.50 4.55 4.60 4.65 4.70 4.75 4.80 4.85 4.90 4.95 5.00 5.05 5.10 5.15 5.20 5.25 5.30 5.35 5.40 5.45 5.50 5.55 5.60  
1.0000E-99 1.0000E-99 5.2670E-90 1.0810E-79 1.5450E-70 1.9730E-62 2.4700E-55 3.1930E-49 5.6070E-44 2.0290E-39 2.069  
MG+ 7 /ITRANS= 14/NTEMP= 90/APPWAV= 315.000/SPWAV= 315.015/  
/home95/acl/adas/adf20/gft95#b/gft95#b_al#mg7_nle10.dat  
4.55 4.60 4.65 4.70 4.75 4.80 4.85 4.90 4.95 5.00 5.05 5.10 5.15 5.20 5.25 5.30 5.35 5.40 5.45 5.50 5.55 5.60 5.65  
1.0000E-99 1.1770E-95 9.9210E-85 5.1910E-75 2.3170E-66 9.7930E-59 4.2640E-52 2.6310E-46 3.2430E-41 9.7970E-37 8.512  
SI+ 7 /ITRANS= 9/NTEMP= 91/APPWAV= 316.200/SPWAV= 316.218/  
/home95/acl/adas/adf20/gft95#n/gft95#n_al#si7_nle10.dat  
4.50 4.55 4.60 4.65 4.70 4.75 4.80 4.85 4.90 4.95 5.00 5.05 5.10 5.15 5.20 5.25 5.30 5.35 5.40 5.45 5.50 5.55 5.60  
1.0000E-99 1.0000E-99 1.0430E-89 2.1240E-79 3.0120E-70 3.8220E-62 4.7610E-55 6.1270E-49 1.0720E-43 3.8700E-39 3.937  
MG+ 7 /ITRANS= 12/NTEMP= 90/APPWAV= 317.000/SPWAV= 317.028/  
/home95/acl/adas/adf20/gft95#b/gft95#b_al#mg7_nle10.dat  
4.55 4.60 4.65 4.70 4.75 4.80 4.85 4.90 4.95 5.00 5.05 5.10 5.15 5.20 5.25 5.30 5.35 5.40 5.45 5.50 5.55 5.60 5.65  
1.0000E-99 2.9510E-96 2.4680E-85 1.2820E-75 5.6800E-67 2.3850E-59 1.0320E-52 6.3340E-47 7.7690E-42 2.3370E-37 2.023  
MG+ 6 /ITRANS= 27/NTEMP= 93/APPWAV= 319.000/SPWAV= 319.018/  
/home95/acl/adas/adf20/gft95#c/gft95#c_al#mg6_nle10.dat  
4.40 4.45 4.50 4.55 4.60 4.65 4.70 4.75 4.80 4.85 4.90 4.95 5.00 5.05 5.10 5.15 5.20 5.25 5.30 5.35 5.40 5.45 5.50  
1.0000E-99 4.6500E-99 5.8970E-88 4.5910E-78 2.8670E-69 1.9290E-61 1.8370E-54 3.0770E-48 9.4210E-43 5.3860E-38 7.297  
SI+ 7 /ITRANS= 5/NTEMP= 91/APPWAV= 319.800/SPWAV= 319.839/  
/home95/acl/adas/adf20/gft95#n/gft95#n_al#si7_nle10.dat  
4.50 4.55 4.60 4.65 4.70 4.75 4.80 4.85 4.90 4.95 5.00 5.05 5.10 5.15 5.20 5.25 5.30 5.35 5.40 5.45 5.50 5.55 5.60  
1.0000E-99 1.0000E-99 1.7740E-89 3.5680E-79 5.0070E-70 6.2910E-62 7.7670E-55 9.9100E-49 1.7210E-43 6.1670E-39 6.233
```

line
specification

ADF20 source

Performing DEM

- Given a set of observed spectral line intensities, $G(\text{Te})$ functions and elemental abundances, ADAS601 evaluates an estimate for the differential emission measure in temperature.
- The output consists of a graphical display of the DEM as a function of electron temperature and a text file which includes also a list of the lines used for the integral inversion and the ratios between reconstructed and observed spectral intensities.

ADAS601 input

select abundance

select intensity

select kernel

ADAS 601 V1.8 - BETA

File Temperature Weight Smoothing Noise Plot Run

Abundance file: /home/asg/adas/arch601/abundance/abundance_thesis/test_ab/abund.osinecfe2_maarcas

Intensity file: /home/asg/adas/arch601/intensity/intensity_thesis/new_intensity_op_s_c_e_abtest_ciii1176_fex184_oiv7

Kernel file: /home/asg/adas/arch601/kernel/kernel_thesis/kernel_thesis_newgft_si_p4e15.dat

No of Temperature Points: 100 Tmin: 1.0000e+04 Tmax: 1.0000e+07

Step in Log(T): 3.0303e-02 Log(T-min): 4.0000e+00 Log(T-max): 7.0000e+00

Smoothing: automatic Noise variance: 2.0525e-02

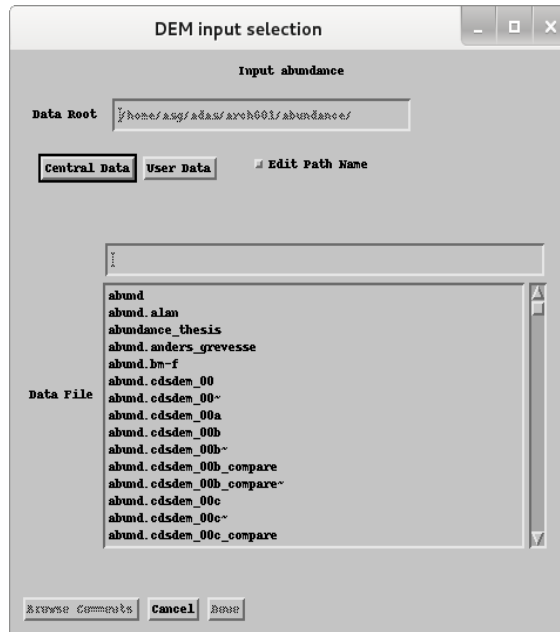
weight: from intensity data file

status: ready

perform the inversion or the abundance analysis

Selection of abundance

select
abundance



Examples of abundance input file

| | |
|----|------|
| H | 12.0 |
| HE | 10.9 |
| C | 8.59 |
| N | 8.00 |
| O | 8.89 |
| NE | 8.08 |
| NA | 6.93 |
| MG | 7.90 |
| AL | 7.00 |
| SI | 7.65 |
| S | 7.27 |
| AR | 6.58 |
| CA | 7.00 |
| FE | 7.67 |
| NI | 6.84 |

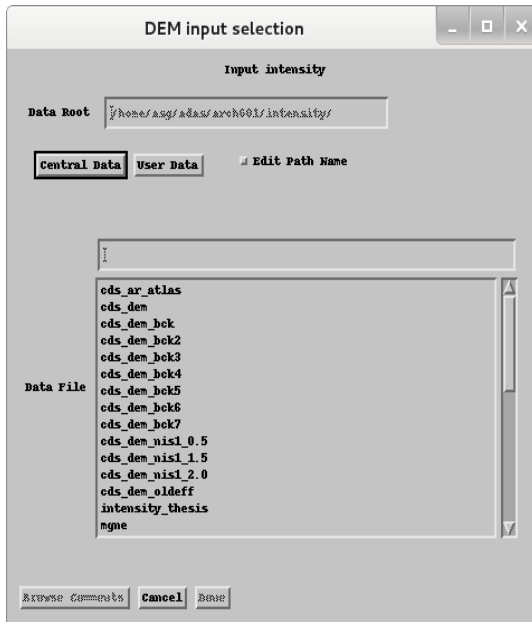
logarithmic scale:
 $A(H)=\log N(H)=12$
 $A(E)=\log N(E)=$
 $\log[N(E)/N(H)]+12$

| | |
|----|-----------|
| H | 1.000E+00 |
| K | 2.790E-07 |
| Na | 4.250E-06 |
| Al | 6.300E-06 |
| Ca | 4.540E-06 |
| Cr | 1.000E-06 |
| Ti | 1.780E-07 |
| Mg | 7.940E-05 |
| Ni | 3.650E-06 |
| Fe | 6.740E-05 |
| Si | 7.420E-05 |
| Zn | 8.010E-08 |
| S | 2.080E-05 |
| P | 2.750E-07 |
| C | 2.570E-04 |
| Cl | 1.200E-07 |
| O | 5.480E-04 |
| N | 6.470E-05 |
| Ar | 2.310E-06 |
| Ne | 8.830E-05 |
| He | 6.310E-02 |

Selection of intensity

select
intensity

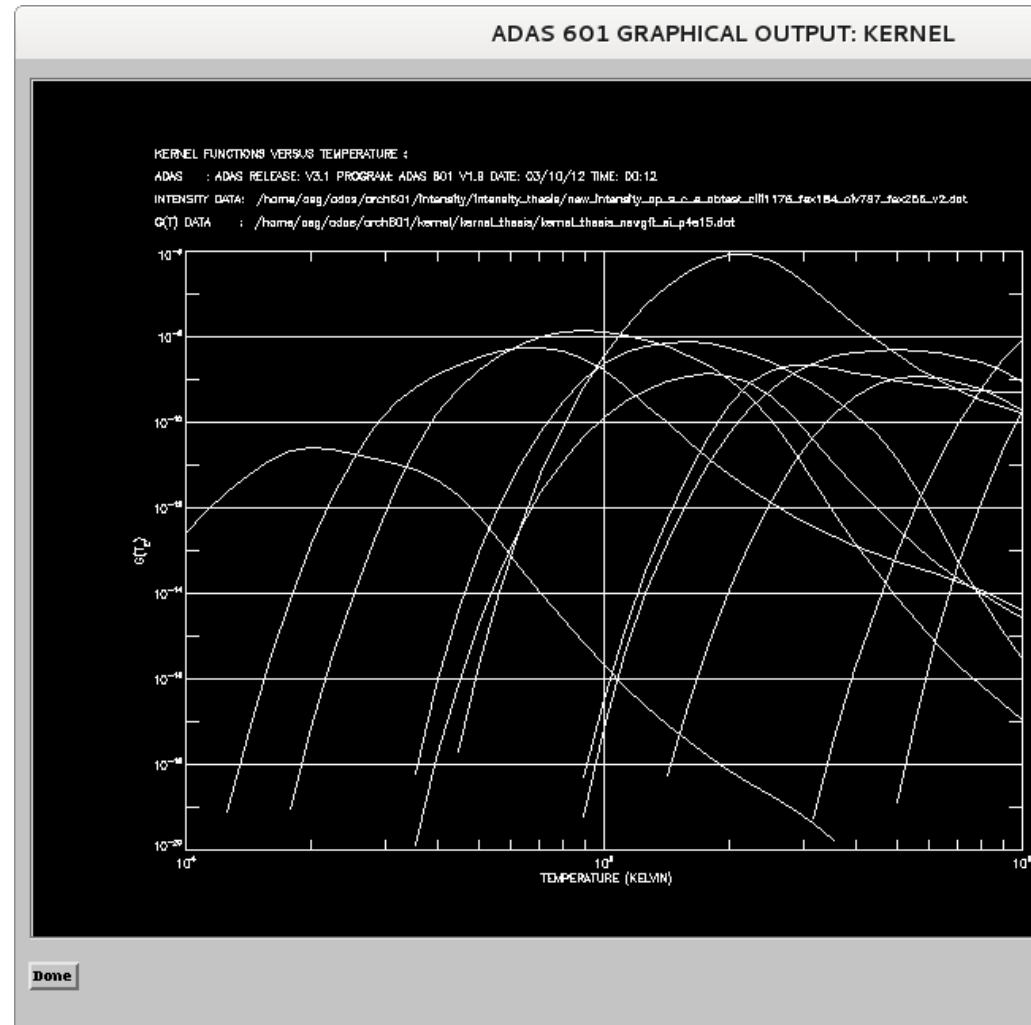
Examples of intensity input file



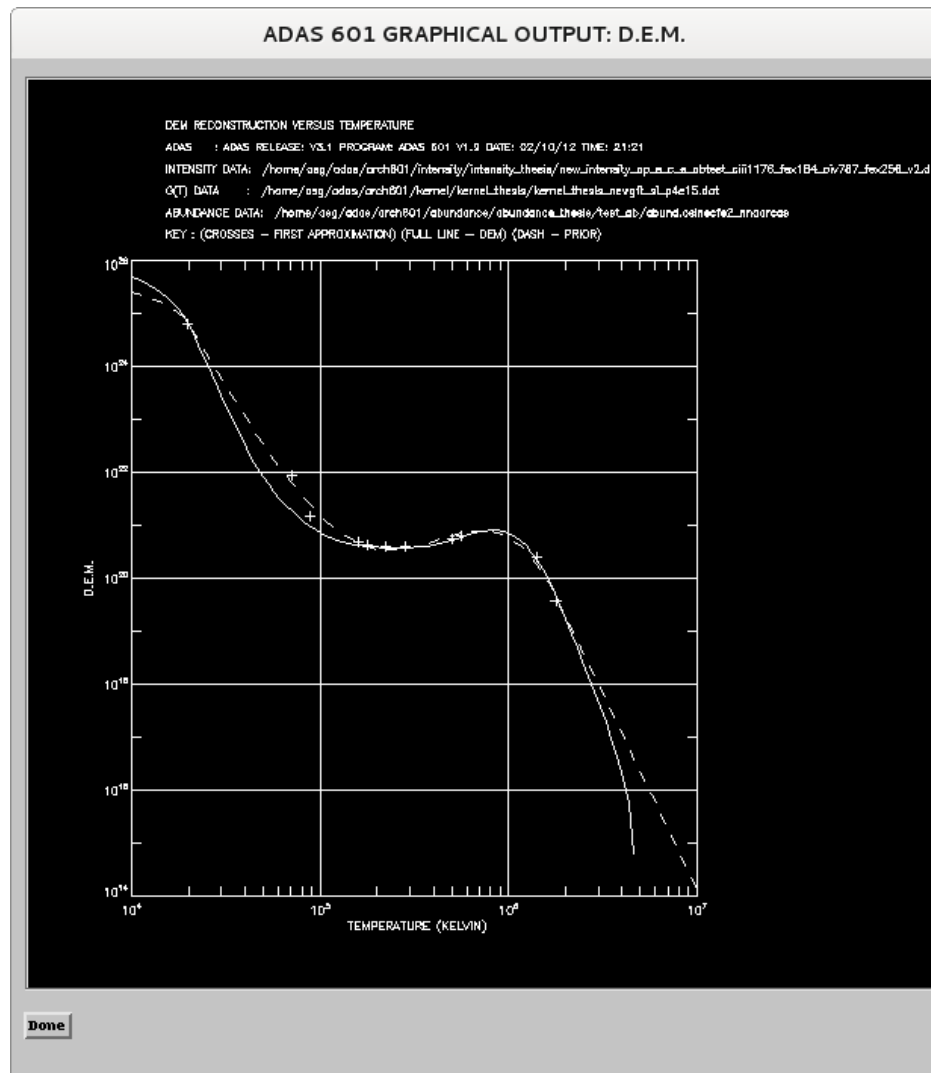
| | spectr. | wavelength | configuration | configuration | G-in | blnd | observed wavelength | observed intensity | uncert. |
|---|---------|------------|--|---------------|------|------|------------------------|-----------------------|------------|
| ----- ----- ----- ----- ----- ----- ----- ----- ----- ----- | | | | | | | | | |
| | | | | | | | | | |
| \UNITS=COUNTS/SEC/PIX | | | | | | | | | |
| 0 +2 | N | 599.598 | \$2s^22p^2w^1D {2}-2s2p^3w^1D {2} | | 18 | 0 | 599.611 | 1.2596e+00 | 3.3676e-02 |
| Ne+3 | E | 543.886 | \$2s^22p^3w^4S {3/2}-2s^22p^4w^4P_{5/2} | | 12 | 0 | 543.941 | 3.2397e-01 | 8.4847e-03 |
| 0 +4 | N | 629.732 | \$2s^2w^1S {0}-2s2p^w^1P_{1} | | 3 | 0 | 629.817 | 1.1295e+01 | 1.9724e-01 |
| Ne+4 | E | 359.375 | 2s^22p^2s \$^3SPs_2s-\$2s2p^3s \$^3SSs_1s\$ | | 30 | 0 | 359.357 | 8.0133e-02 | 4.1755e-03 |
| Ne+6 | E | 561.720 | 2s2p^w^3P_{7/2}-2p^2w^3P_{2} | | 11 | 0 | 561.754 | 3.2164e-01 | 1.9390e-02 |
| Ca+9 | E | 557.759 | \$3s^w^2S_{1/2}-3p^w^2P_{3/2} | | 2 | 0 | 557.810 | 6.4224e-01 | 1.5114e-02 |
| 0 +3 | N | 555.263 | \$2s^22p^w^2P_{3/2}-2s2p^2w^2P_{1/2} | | 12 | 0 | 555.319 | 9.6139e-01 | 2.6456e-02 |
| Si+8 | E | 341.950 | 2s^22p^2s \$^3SPs_0s-\$2s2p^3s \$^3SDs_1s\$ | | 13 | 0 | 341.933 | 1.0600e-01 | 5.5169e-03 |
| Si+11 | E | 520.662 | \$2s^w^2S_{1/2}-2p^w^2P_{1/2} | | 1 | 0 | 520.755 | 2.1358e-02 | 5.2103e-03 |
| 0 +2 | N | 525.797 | 2s^22p^2w^1D {2}-2s2p^3w^1P_{1} | | -25 | 0 | 525.855 | 6.8039e-01 | 1.2309e-02 |
| 0 +3 | N | 553.329 | \$2s^22p^w^2P_{1/2}-2s2p^2w^2P_{3/2} | | -13 | 0 | 553.405 | 8.9942e-01 | 2.4394e-02 |
| 0 +3 | N | 554.076 | \$2s^22p^w^2P_{1/2}-2s2p^2w^2P_{1/2} | | -11 | 0 | 554.143 | 1.6043e+00 | 8.0473e-02 |
| Al+7 | E | 328.230 | 2s^22p^2s \$^3SPs_2s-\$2s2p^3s \$^3SPs_1s\$ | | -19 | 3 | | | |
| Fe+13 | K | 334.178 | \$3s^23p^s \$^2SDs_{1/2}\$-\$3s3p^2s \$^2SDs_{3/2}\$ | | -6 | 0 | | | |
| Fe+11 | O | 338.263 | 3s^23p^3s \$^2SDs_{5/2}\$-\$3s3p^4s \$^2SDs_{5/2}\$ | | -23 | 0 | 338.298 | 1.7945e-02 | 4.3500e-03 |
| Ca+6 | K | 339.965 | 3s^23p^2s \$^3SPs_1s-\$3s^23p3d \$^3SDs_2s\$ | | -159 | 0 | | | |
| Fe+10 | O | 341.113 | 3s^23p^4s \$^3SPs_2s-\$3s3p^5s \$^3SPs_1s\$ | | -6 | 0 | 341.163 | 6.5387e-02 | 3.9576e-03 |
| Ca+6 | K | 342.394 | 3s^23p^2s \$^3SPs_2s-\$3s^23p3d \$^3SDs_3s\$ | | -173 | 0 | | | |
| Si+8 | E | 344.954 | 2s^22p^2s \$^3SPs_1s-\$2s2p^3s \$^3SDs_1s\$ | | -14 | 4 | 345.092 | 2.6861e-01 | 1.1433e-02 |
| ----- ----- ----- ----- ----- ----- ----- ----- ----- ----- | | | | | | | | | |

Lines used for
the integral
inversion

ADAS601 kernel graph



ADAS601 DEM graph



Example of DEM text output

```

ADAS RELEASE: v3.1 PROGRAM: ADAS 601 V1.9 - BETA DATE: 07/08/12 TIME: 10:52
***** TABULAR OUTPUT FROM INTEGRAL INVERSION - PROGRAM: ADAS 601 V1.9 - BETA - DATE: 07/08/12 *****

INTENSITY DATA FILE NAME: /home/asg/adas/arch601/intensity/intensity_thesis/new_intensity_op_s_c_e_abtest_cii1176_fex184_oiv787_fex256_v2.dat
KERNEL DATA FILE NAME: /home/asg/adas/arch601/kernel/kernel_thesis/kernel_thesis_newgft_si_pls15.dat
ABUNDANCE DATA FILE NAME: /home/asg/adas/arch601/abundance/abundance_thesis/test_ab/abund.osinecfe2_nnaarcas

CONSTANT VARIANCE = 0.24283086
SMOOTHING PARAMETER = 3.1511096

----- SINGLE LINES -----
ION SPECTROSCOP. PEAK RECONSTR. OBSERVED RECONSTR. OBSERVED EPS SIG DEV
WAVELENGTH TEMP INTENSITY INTENSITY QFR INTENSITY INTENSITY
log(T) erg/cm2/s erg/cm2/s ph/cm2/s ph/cm2/s

Si+ 1 1309.276 4.30 131.890 131.889 1.000 8.693e+12 8.693e+12 9.172e+11 8.777e+10 8.531e-09
C + 2 1174.933 4.85 46.364 46.395 0.999 2.742e+12 2.744e+12 7.195e+11 4.849e+10 3.302e-04
-----
Si+ 6 275.667 5.75 2.814 2.776 1.013 3.905e+10 3.853e+10 3.237e+09 2.297e+09 1.230e-02
Fe+11 193.509 6.15 43.185 43.276 0.998 4.207e+11 4.216e+11 2.690e+10 4.240e+09 1.075e-02
Si+11 520.662 6.25 3.702 3.663 1.011 9.704e+10 9.600e+10 6.093e+09 2.725e+09 3.548e-02
-----

CHISQUARE = 2.93811
NUMBER OF TRANSITION USED FOR THE INTEGRAL INVERSION = 11

----- PREDICTED INTENSITIES -----
ION SPECTROSCOP. PEAK RECONSTR. OBSERVED RECONSTR. OBSERVED DEV
WAVELENGTH TEMP INTENSITY INTENSITY QFR INTENSITY INTENSITY
log(T) erg/cm2/s erg/cm2/s ph/cm2/s ph/cm2/s

C + 1 1334.532 4.45 1478.155 1114.748 1.326 9.930e+13 7.489e+13 1.179e+02
C + 2 1174.933 4.80 46.364 46.395 0.999 2.742e+12 2.744e+12 3.302e-04
C + 3 787.711 5.15 92.726 75.372 1.230 3.677e+12 2.989e+12 6.216e+00
Ne+ 7 770.409 5.75 104.051 96.682 1.076 4.035e+12 3.750e+12 5.470e+01
O + 2 525.797 4.95 18.463 23.685 0.780 4.887e+11 6.269e+11 1.542e+02
O + 4 629.732 5.30 457.300 401.595 1.139 1.450e+13 1.273e+13 5.096e+01
Ar+ 6 585.754 5.50 5.736 5.325 1.077 1.691e+11 1.570e+11 3.692e-02
Ar+ 7 526.496 5.55 0.130 0.697 0.187 3.445e+09 1.847e+10 8.268e+00
-----

DIFFERENTIAL EMISSION MEASURE
N TEMP DEM N TEMP DEM N TEMP DEM N TEMP DEM N TEMP DEM

1 1.00e+04 2.17e+26 11 2.01e+04 3.91e+24 21 4.04e+04 3.62e+22 31 8.11e+04 1.11e+21 41 1.63e+05 3.77e+20
2 1.07e+04 1.46e+26 12 2.15e+04 2.56e+24 22 4.33e+04 2.19e+22 32 8.70e+04 9.51e+20 42 1.75e+05 3.65e+20
3 1.15e+04 9.85e+25 13 2.31e+04 1.66e+24 23 4.64e+04 1.34e+22 33 9.33e+04 8.23e+20 43 1.87e+05 3.59e+20
4 1.23e+04 6.63e+25 14 2.48e+04 1.06e+24 24 4.98e+04 8.41e+21 34 1.00e+05 7.19e+20 44 2.01e+05 3.59e+20
5 1.32e+04 4.45e+25 15 2.66e+04 6.75e+23 25 5.34e+04 5.46e+21 35 1.07e+05 6.34e+20 45 2.15e+05 3.62e+20

```

lines used for the inversion

Ratios between reconstructed and observed intensities

set of reconstructed intensities

DEM versus T_e