

5. Ionisation and emission, part I

- Ionisation

- » Studying the temperature and density dependent ionisation balance in more detail
- » Analysing the make-up of $G(\text{Te}, \text{Ne})$ emission functions
- » Setting up a personal collection of $G(\text{Te}, \text{Ne})$

Ionisation and emission, part I (contd.)

- The ionisation balance is often a weakness in the theoretical input.
- Code ADAS405 is provided for examining and contrasting ionisation balances as a function of T_e and N_e .
- It has also capability for examining radiated power and the ingredients of $G(T_e(h), N_e(h))$ functions

Ionisation and emission, part I (contd.)

- Improved precision and study of ionisation balance necessitates consideration of the following issues:
 - » *Relaxation time constants*
 - » *Metastable populations*
 - » *Density dependence*
- Only an introduction is possible here

Ionisation and emission, part I (contd.)

- The ingredients are stored in central adas data classes *adf11* and *adf15*
 - » *adf11* contains collisional- radiative coefficients (acd, scd, plt,prb etc.) stored by year number and element.
 - » They may be stage to stage or metastable resolved and are density dependent
 - » *adf15* contains emissivity coefficients (pec) (density dependent & metastable resolved)

Ionisation and emission, part I (contd.)

- Start ADAS405 as follows
 - » *Move to ADAS series 4*
 - » *Click button for ADAS405*
- ADAS405 has the standard sequential three screen structure, namely *file selection, processing options & output options* screens

Ionisation and emission, part I (contd.)

- File selection

- » *This is more complex than usual. The top part selects the adf11 data for an element.*
- » *The lower part identifies a 'script' file for an element*
- » *The script file spells out the way each line emission function is to be assembled from pec parts (excitation parts, different metastables, recombination parts etc)*

ADAS405 Input

ADAS405 INPUT

Enter details of the iso-nuclear master files to be analysed :-

Select iso-nuclear master collisional-dielectronic classes : a)

Radiated power filter (blank for none) : b)

Member prefix (blank for none) :

Year of data : Select directory branch :

Default year (if required) : c)

Iso-electronic sequence symbol :

Type of master files : Specify partial type code :

Display data set availability d)

Input Line and Analysis Selection File :-

Data root

Edit Path Name

Data File

```
..
NULL
test_c
```

e)

f)

ADAS405 Input (contd.)

Class selection and file availability :-

Class	Year	Element	Member Power		Type	USER DATA		DEFAULT DATA (93)	
			Prefix	Filter		Selected	Availability	Used	Available
acd	93	c			Rpartial	YES	YES	no	YES
scd	93	c			Rpartial	YES	YES	no	YES
ccd	93	c			Rpartial	no	no	no	no
prb	93	c			Rpartial	YES	YES	no	YES
prc	93	c			Rpartial	no	no	no	no
qcd	93	c			Rpartial	YES	YES	no	YES
xcd	93	c			Rpartial	YES	YES	no	YES
plt	93	c			Rpartial	YES	YES	no	YES

All requested files available from user data sets.

Ionisation and emission, part I (contd.)

- Processing options
 - » Temperatures and densities are entered for a model atmosphere.
 - » A choice may be made of which script line to display.

ADAS405 Processing

ADAS405 PROCESSING OPTIONS

Title for Run

Script file : /disk2/adas/adas/scripts405/test_c

Browse Comments

Data file information :-

Selected master file element : C

Selected master classes : ACD, SCD, PRB, QCD, XCD, PLT

Enter isotope information :-

Enter element isotope mass number (amu) :

Enter hydrogen isotope mass number (amu) :

Select spectral line for analysis :-

Number of listed lines in script file : 2

LINE INDEX	RADIATING ION CHARGE	NUMBER OF COMPONENTS	TITLE AND WAVELENGTH
1	0	4	CI 1561
1	0	4	CI 1561
2	1	2	CII 904

Enter Output Temperature/ Density data

Index	Temperatures		Densities	
	Electron Output values	Hydrogen Output values	Electron Output values	Hydrogen Output values
1	1.000E+00	1.000E+00	1.000E+12	1.000E+11
2	2.000E+00	2.000E+00	1.000E+12	2.000E+11
3	5.000E+00	5.000E+00	1.000E+12	5.000E+11
4	1.000E+01	1.000E+01	1.000E+12	1.000E+12

Temperature Units : eV Density Units : cm⁻³

Edit Table

Default Temperature/Density values Clear Table

Edit the processing options data and press Done to proceed

Cancel Done

Ionisation and emission, part I (contd.)

- Output options

- » *Graphing of the ionisation balance, the radiated power functions or the chosen emission function may be selected.*

- » *An output file of the $G(Te(h), Ne(h))$ functions identified in the script file may be produced.*

ADAS405 Output

ADAS405 OUTPUT OPTIONS

Script file : /disk2/adas/adas/scripts405/test_c

Browse Comments

Graphical Output

Graph Title

Fractional abundance plot
 Power function plot
 Contribution function plot

Fractional abundance plot :-

Explicit Scaling

X-min : X-max :
Y-min : Y-max :

Enable Hard Copy Replace

File name :

Select Device
Post-script
Post-script
HP-PCL
HP-GL

Text Output Replace

File name :

Goft Passing File Append Replace

File name :

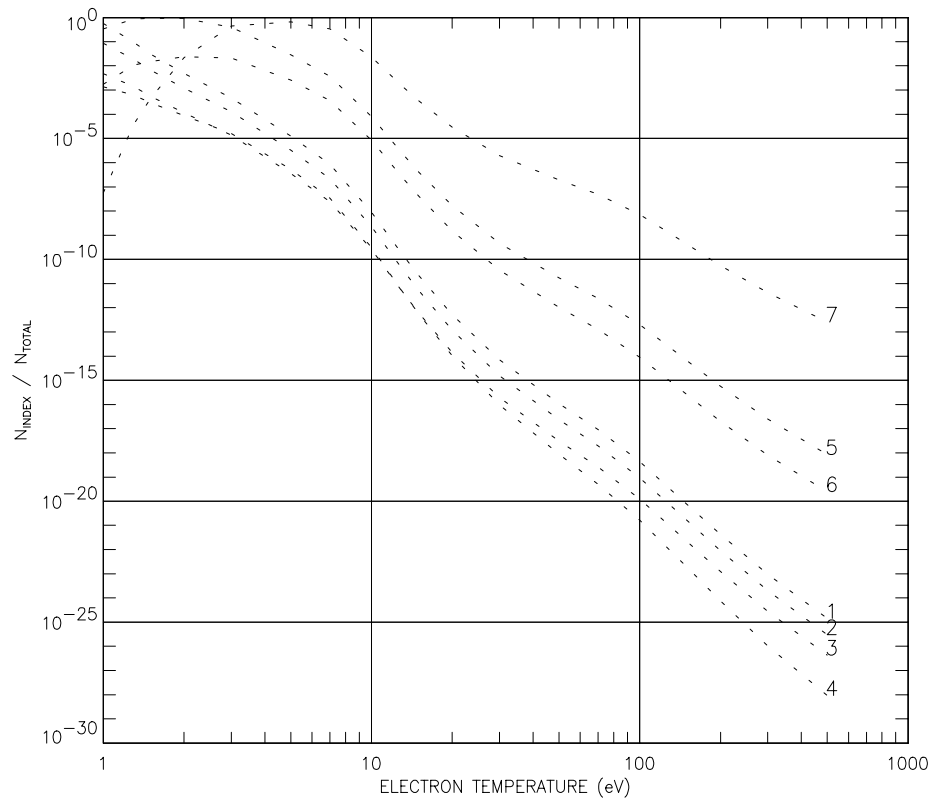
Cancel Done

a) b) c) d) e)

ADAS405 graph

ION FRACTION VS. ELECTRON TEMPERATURE: DEMONSTRATION

ADAS : ADAS RELEASE: ADAS93 V1.6 PROGRAM: ADAS405 V1.4 DATE: 17/07/96 TIME: 07:44
 FILE : /disk2/summers/adas/scripts405/test_c SPECIES: CARBON YEAR: 93 DEFAULT YEAR: 93
 KEY : (DASH LINE - PARTIAL)



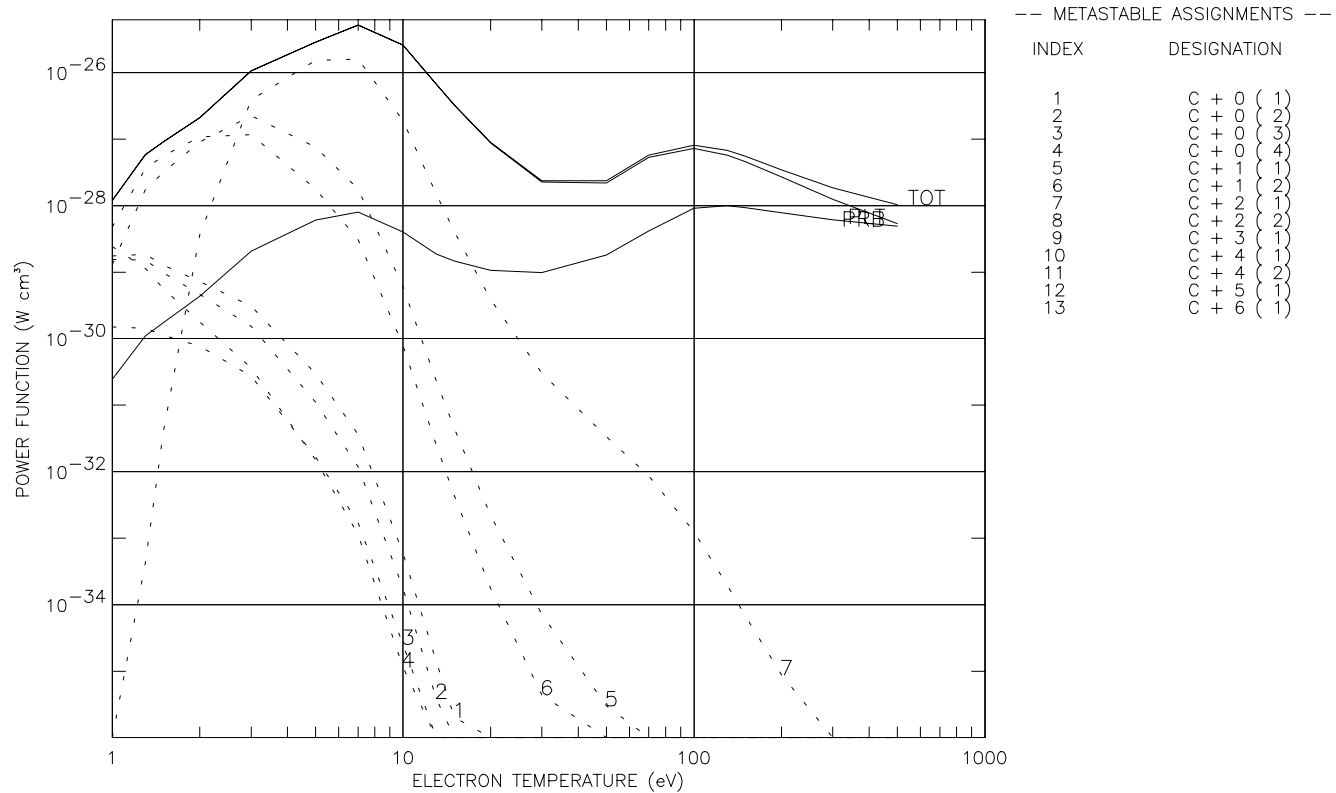
-- METASTABLE ASSIGNMENTS --

INDEX	DESIGNATION
1	C + 0 (1)
2	C + 0 (2)
3	C + 0 (3)
4	C + 0 (4)
5	C + 1 (1)
6	C + 1 (2)
7	C + 2 (1)
8	C + 2 (2)
9	C + 3 (1)
10	C + 4 (1)
11	C + 4 (2)
12	C + 5 (1)
13	C + 6 (1)

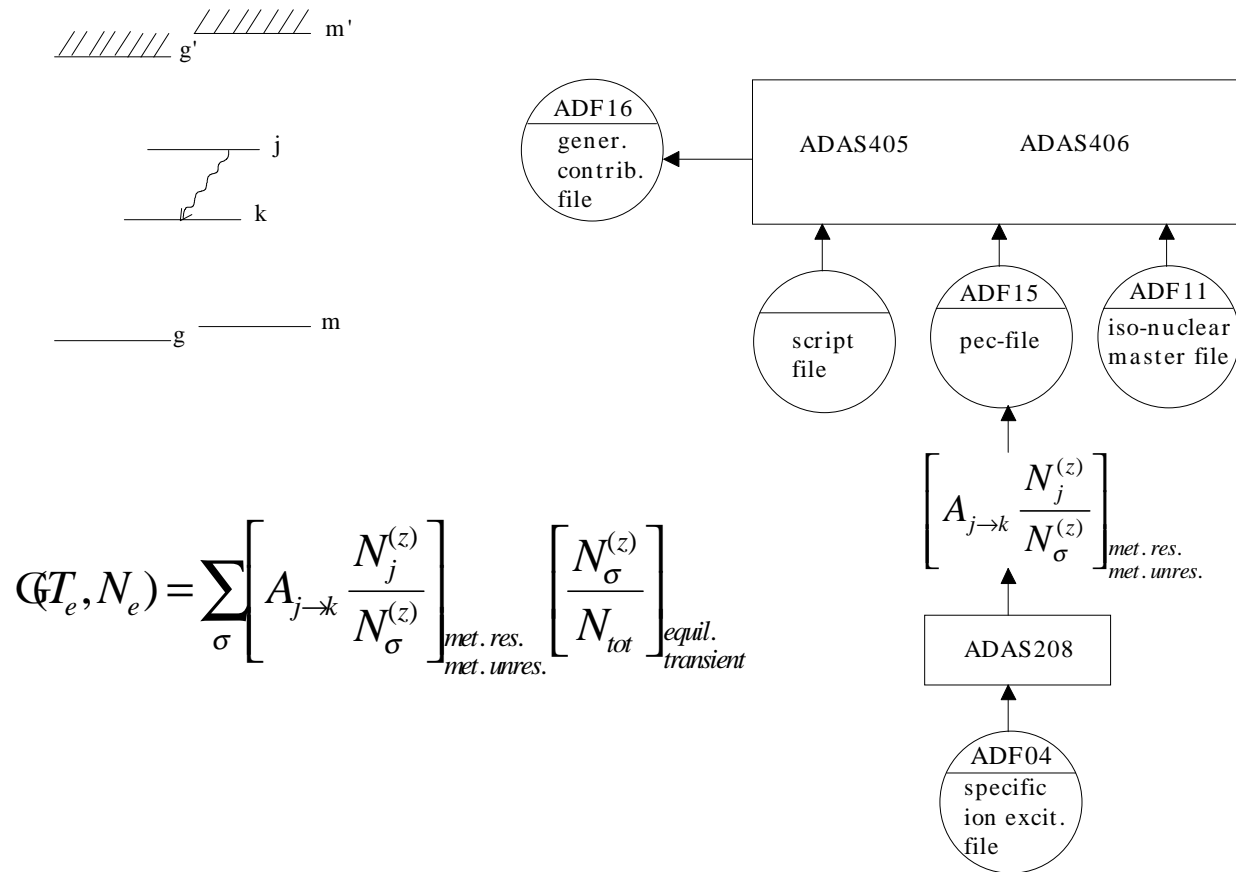
ADAS405 graph

POWER FUNCTION VS. ELECTRON TEMPERATURE: DEMONSTRATION

ADAS : ADAS RELEASE: ADAS93 V1.6 PROGRAM: ADAS405 V1.4 DATE: 17/07/96 TIME: 07:44
 FILE : /disk2/summers/adas/scripts405/test_c SPECIES: CARBON YEAR: 93 DEFAULT YEAR: 93
 KEY : (FULL LINE - TOTAL) (DASH LINE - PARTIAL)



G(Te, Ne) functions



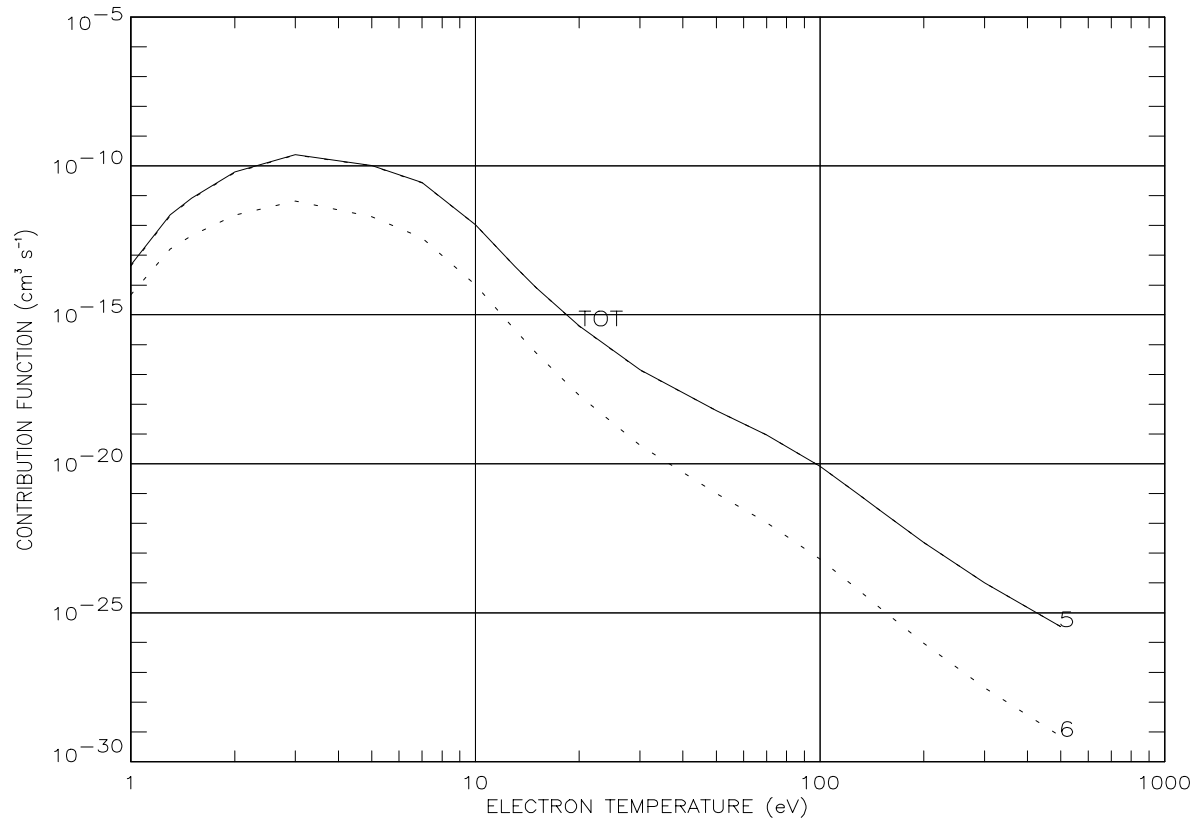
G(Te,Ne) functions (contd.)

- Two-dimensional G(Te,Ne) functions and line ratios from different ionisation stages are beyond the scope of this first tutorial.
 - » *Codes ADAS208 and ADAS409 will provide a full capability*

ADAS405 graph

CONTRIBUTION FUNCTION VS. ELECTRON TEMPERATURE: DEMONSTRATION

ADAS : ADAS RELEASE: ADAS93 V1.6 PROGRAM: ADAS405 V1.3 DATE: 11/07/96 TIME: 16:53
 FILE : /disk2/summers/adas/scripts405/test_c SPECIES: CARBON YEAR: 93 DEFAULT YEAR: 93
 KEY : (FULL LINE - TOTAL) (DASH LINE - PARTIAL)



-- METASTABLE ASSIGNMENTS --

INDEX	DESIGNATION
5	C + 1 { 1 }
6	C + 1 { 2 }

-- SPECTRUM LINE SPECIFICATION --

TITLE = CII 904A
 SELECT NO. = 2
 COMPONENTS = 2

-- COMPONENT PARAMETERS --

IC	IZ	IM	IP	IF	INDX
1	1	1	3E	2	5
2	1	2	25E	2	6

Ionisation and emission, part I (contd.)

- The most basic ADAS calculation of stage to stage ADF11 datasets for an element uses codes ADAS407 and ADAS408.
- ADAS407 processes mass produced ADF04 files for an element, extracting approximate form parameters (ADF03).
- ADAS408 uses ADF03 parameters to generate the ADF11 datasets.

Ionisation and emission, part I (contd.)

- File selection

- » *This is a simple selection of an atomic parameter file of type ADF03 for an element.*
- » *Martin O'Mullane ('mm') is our expert on producing these for heavy elements.*
- » *Data sets with the code 'vm' (Van Maanen) come from the original JET baseline production.*

ADAS408 Input

ADAS408 INPUT

Input Dataset

Data root /export/home/adas/adas/adf03/ ▼

Central data User data Edit Path Name

atompars/atompars_vm#c.dat ▼

Data File:

- ...
- atompars_ms#b.dat
- atompars_ms#be.dat
- ...

Browse Comments Cancel Done

a) b) c)

Ionisation and emission, part I (contd.)

- Processing options

- » *Te and Ne ranges must be set up. ADAS408 forces an equally spaced logarithmic grid.*
- » *Radiated power coeffs. produced include line power ('plt') and recom./Brems. power ('prb'). The effect of filter can be imposed.*
- » *Simple cut-off or Be/Si filters are allowed. The output file naming includes the filter spec.*

ADAS408 Processing

The screenshot shows the 'ADAS408 PROCESSING OPTIONS' dialog box. It contains several input fields and sections for configuring the processing options. Annotations a) through g) point to specific elements:

- a) Points to the 'Browse Comments' button.
- b) Points to the 'Please input mass information :-' section.
- c) Points to the 'Please input soft X-ray filter information :-' section.
- d) Points to the 'Current filter name : ft1232' text.
- e) Points to the 'Please enter electron temperature and density limits for scans' section.
- f) Points to the 'Temperature Units' section.
- g) Points to the 'Electron Density (cm-3)' section.

ADAS408 PROCESSING OPTIONS

Title for Run

Data File Name : /export/home/adas/adas/adf03/atompars/atompars_vm#c.dat

Please input mass information :-

Input element symbol : C

Impurity element isotopic mass :

Neutral hydrogen isotopic mass:

Please input soft X-ray filter information :-

Use a simple cut-off energy ?

Beryllium thickness (microns)

Silicon thickness (cm)

Current filter name : ft1232

Please enter electron temperature and density limits for scans

Electron Temperature (eV)	Temperature Units	Electron Density (cm-3)
Lower limit : <input type="text" value="1.0E+00"/>	<input type="checkbox"/> eV	Lower limit : <input type="text" value="1.0E+10"/>
Upper limit : <input type="text" value="1.0E+03"/>	<input type="checkbox"/> Kelvin	Upper limit : <input type="text" value="1.0E+15"/>
No. of temps. : <input type="text" value="11"/>		No. of dens. : <input type="text" value="11"/>

(Note : equal logarithmic scaling of temperatures and densities is used)

Ionisation and emission, part I (contd.)

- Output options

- » *ADF11 data are stored by 'year number'.*
- » *A year number tends to be used for an approximation (eg. baseline unresolved '89' ; advanced resolved '93', '96')*
- » *ADAS consortium members are also allocated decades (Garching '10', JET '20')*
- » *A template file naming is built from the year number and the power filter.*

ADAS408 Output

ADAS408 OUTPUT OPTIONS

Data File Name : /export/home/adas/adas/adf03/atompars/atompars_vm#c.dat

Please enter the year number for master passing files (two-digits)

Passing file template :

Text Output Replace

File Name :

a)

b)

c)