

ADAS206: Specific z excitation - process total and specific line power

The program calculates the total radiated power coefficient in spectrum line emission from excited levels of an ion, driven by excitation from the metastable levels of the ion, as a function of density and temperature. It also calculates the radiated power coefficient in a single identified spectrum line.

Background theory:

The program is functionally very similar to ADAS205. It uses all the population theory of ADAS205 with an extension to include the radiated power. Thus consider ions X^{+z} of the element X . The adjacent ionisation stages are X^{+z+1} and X^{+z-1} . Let the levels of the ion X^{+z} be separated into the metastable levels X_{σ}^{+z} , indexed by Greek indices, and excited levels X_i^{+z} , indexed by Roman indices. The collective name metastable states as used here includes the ground state. The driving mechanisms considered for populating the excited levels X_i^{+z} are excitation from the metastable levels X_{σ}^{+z} and recombination from the ground level of the adjacent ion X_1^{+z+1} . The dominant population densities of the ions in the plasma are those of the levels X_{σ}^{+z} and X_1^{+z+1} , denoted by N_{σ} and N_1^{+} respectively. They, or at least their ratios are assumed known from a dynamical ionisation balance. The other dominant population densities in the plasma are the electron density N_e , the proton density N_p and the neutral hydrogen density N_H . The excited populations, denoted by N_i , are assumed to be in a quasi-static equilibrium with respect to the dominant populations.

It has been shown in the theory of ADAS205 that the ordinary populations are given by

$$N_j = \sum_{\sigma=1}^M F_{j\sigma}^{(exc)} N_e N_{\sigma} + F_j^{(rec)} N_e N_1^{+} + F_j^{(CX)} N_H N_1^{+} \quad 3.6.1$$

The low level line power coefficient associated with the metastable σ is then

$$P_{LT,\sigma} = \sum_{i,j} \Delta E_{ij} A_{j \rightarrow i} F_{j\sigma}^{(exc)} \quad 3.6.2$$

where ΔE_{ij} is the $j \rightarrow i$ transition energy, $A_{j \rightarrow i}$, is the spontaneous emission coefficient and $F_{j\sigma}^{(exc)}$ is the component of the population of the j th ordinary level associated with the metastable.

At zero density, the total low level line power coefficient is simply the transition energy weighted sum of all the collisional excitations from the ground level

$$\begin{aligned} P_{LT,1}(N_e = 0) &= \sum_i \Delta E_{i1} q_{1 \rightarrow i}^{(e)} \\ &= \text{Lim}_{N_e \rightarrow 0} P_{LT,1} \end{aligned} \quad 3.6.3$$

since the metastable populations $\sigma \neq 1$ vanish.

Consider the special case when the ion is treated as though it has only a single metastable level (the ground level) although there are in fact other metastables treated as ordinary levels.

Since the equilibrium solution for the metastable populations (see equation 3.5.7) may be written as

$$N_{\sigma} \equiv F_{\sigma}^{(exc)} N_1 + F_{\sigma}^{(rec)} N_e N_1^{+} + F_{\sigma}^{(CX)} N_H N_1^{+} \quad 3.6.4$$

then the total low level line power coefficient, $P_{LT,1}$, is

$$P_{LT,1} = \sum_{\sigma} P_{LT,\sigma} (F_{\sigma}^{(exc)} + \Delta E_{\sigma 1} A_{\sigma \rightarrow 1}) \quad 3.6.5$$

This coefficient is with reference to the ground population N_1 . However the stage population N_{tot} is closely given by

$$N_{tot} = \sum_{\sigma=1}^M N_{\sigma} \quad 3.6.6$$

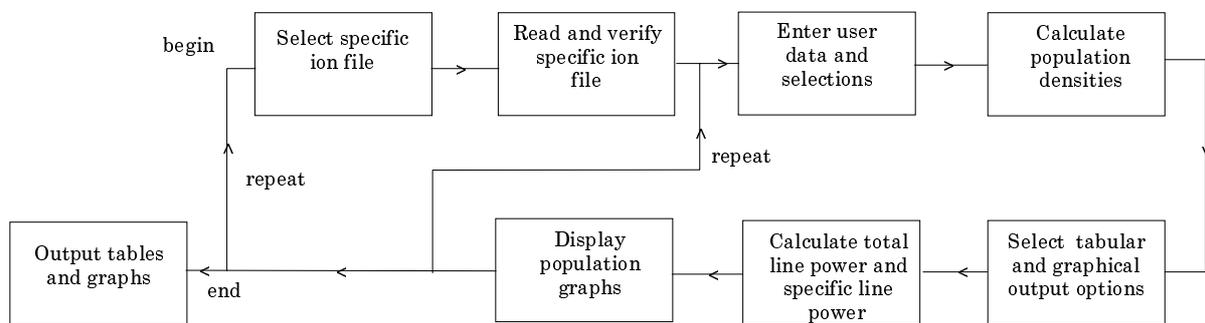
Therefore in treatment of low level line power when only stage abundances are considered, but metastables are in fact present, it is appropriate to re-normalise $P_{LT,1}$ and give instead the coefficient

$$P_{LT,1}(N_1 / N_{tot}) \quad 3.6.7.$$

Program steps:

These are summarised in fig. 3.6.

Figure 3.6

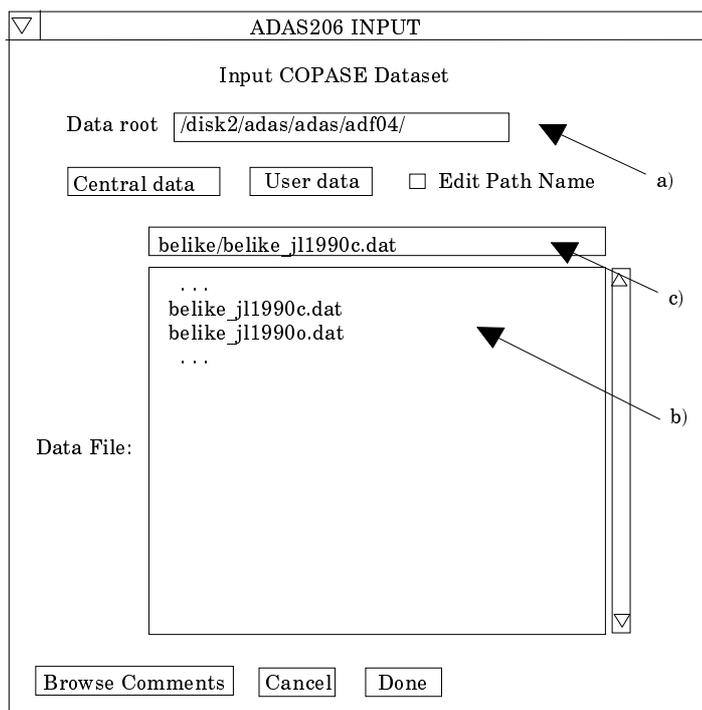


Interactive parameter comments:

Initiate ADAS, move to the series 2 menu and click on the sixth button to activate ADAS206.

The **file selection window** has the appearance shown below

1. Data root a) shows the full pathway to the appropriate data subdirectories. Click the *Central Data* button to insert the default central ADAS pathway to the correct data type. The appropriate ADAS data format for input to this program is *adf04* ('specific ion files'). Click the *User Data* button to insert the pathway to your own data. Note that your data must be held in a similar file structure to central ADAS, but with your identifier replacing the first *adas*, to use this facility.
2. The Data root can be edited directly. Click the *Edit Path Name* button first to permit editing.
3. Available sub-directories are shown in the large file display window b). Scroll bars appear if the number of entries exceed the file display window size.
4. Click on a name to select it. The selected name appears in the smaller selection window c) above the file display window. Then its sub-directories in turn are displayed in the file display window. Ultimately the individual datafiles are presented for selection. Datafiles all have the termination *.dat*.
5. Once a data file is selected, the set of buttons at the bottom of the main window become active.
6. Clicking on the *Browse Comments* button displays any information stored with the selected datafile. It is important to use this facility to find out what is broadly available in the dataset. The possibility of browsing the comments appears in the subsequent main window also.
7. Clicking the *Done* button moves you forward to the next window. Clicking the *Cancel* button takes you back to the previous window



The **processing options window** has the appearance shown below.

8. At the top of the window, an appropriate *Title for Run* may be entered. Note that name of the *adf04* file selected for analysis is given immediately below this. Also the *Browse Comments* button is present allowing scrutiny again of the comments section of the *adf04* file.
9. Plasma temperatures and densities for the population calculation are required. The information on these and the facility for entering temperature and density data are given in the sub-window at b). Click on the appropriate button at a) to display the temperature or density information.
10. In both cases the further operations are the same. For the *Densities* sub-window, click on the *Edit Table* button to open up the table editor. The data entry techniques and operations of Table Editor have been described previously. Note that altering units (which must be done with the Table Editor window activated) interprets the entered values in the selected units. It **does not convert** values already typed in. *Default densities* may be entered by clicking the appropriate button. The default values are inserted in reduced units for ADAS206. Note that the ion density, neutral hydrogen density to electron density ratio, N_H/N_e and $z+1$ ($\equiv z1$) ionisation stage density to z ionisation stage density, $N(z_1)/N(z)$, are **only used if** such collisional data is present in the input *adf04* file. The ion density and ratio vectors are specified at each electron density so they must be of the same length as the electron density vector. That is a model is specified.
11. The *Temperatures* table is handled in like manner. Note that unlike the density case, there is a set of input electron temperatures from the selected *adf04* file. The output electron temperatures are independent of the electron densities so that final calculated populations are obtained at points of a two-dimensional temperature/ density grid.
12. The Metastable State *Selections* button c) pops up a window indexing all the energy levels. Activate the buttons opposite levels which you wish treated as metastables.
13. The basic power calculation uses the populations of the set of levels present in the *adf04* file. Some improvement may be made by extrapolating to higher levels. Chose at d) a level above which an extrapolation correction is to be added in. This means that each contributions to the power from a level above the designated one will be enhanced by a correction. No extrapolation is an option.

14. In the output paper.txt file, a tabulation of power coefficient ratios is given. The ratio may be formed by using the power coefficient at zero density as the denominator or the power coefficient at the lowest entered density. Make the appropriate choice at e). Also at e) choose whether the power coefficient is to be normalised to the ground state population to the whole stage population. This option is only available when a single metastable (namely the ground state) is selected at c).

ADAS206 PROCESSING OPTIONS

Title for Run:

Data File Name: /disk2/adas/adas/adf04/belike/belike_jl1990c.dat

Nuclear Charge: 24 Ion Charge: 0

Metastable States

2s2(1S)	(1)S(0.0)
2s2p(3P)	(3)P(4.0)

Select extrapolation for power

2s2(1S) (1)S(0.0)

2s2p(3P) (3)P(4.0)

Densities

Index	Electron Densities	Ion Densities	NH/NE Ratio	N(Z1)/N(Z)
1	1.000E-03	0.0	0.0	0.0
2
3
4
5

Density Units : Reduced

Line power ratios : density type for denominator

Single metastable : normalise line power to the total stage population

Select Electron Impact Transition of Specific Line

TRANSITION INDEX	LOWER LEVEL INDEX	DESIGNATION	UPPER LEVEL INDEX	DESIGNATION
1	1	2s2(1S) (1)S(0.0)	2	2s2p(3P) (3)P(4.0)
1	1	2s2(1S) (1)S(0.0)	2	2s2p(3P) (3)P(4.0)
1	1	2s2(1S) (1)S(0.0)	3	2s2p(1P) (1)P(1.0)

Reaction Selection

Proton Impact Collisions

Scale Proton Impact for Zeff

Enter Z-effective for Collisions:

Ionisation Rates

Neutral H Charge Exchange

Free Electron Recombination

15. The power coefficient for a particular radiative transition may be selected. Click on the required transition at f). A file of format *adf11* will be available for output for this specific line power if requested.
16. Various processes, supplementary to the primary electron excitation collisions and bound-bound radiative transitions, are activated as desired by clicking on the appropriate buttons g). As for ADAS205, these only have an effect if such data is present in the *adf04* file, with the exception of *Ionisation Rates*. This activates ionisation out of excited states and is obtained by an internal calculation of these rates in the Burgess-Chidichimo approximation. **Warning**-ionisation should **not** be switched on if you have included auto-ionising levels in your *adf04* dataset.
17. Proton collisions may be present in the *adf04* file. If so, these rate coefficients may be scaled to represent a mixture of other charged projectiles with a mean Z-effective e).

The **output options window** has the appearance shown below. It follows the familiar form but with the added option of creating two output files.

18. Click on the button *Graphics* to obtain the sub-window for graphical output settings. Click the button *Text* to obtain the sub-window for text and other file output. This is also shown below.

19. In the first case, the button *Graphical Output* a) is activated to obtain display of graphs. Select the temperature at which you wish populations graphed at b).

20. Default graph scaling may be over-riden. Click the button for *Explicit Scaling* and enter the required x and y axes limits.

21. To allow printing of hard copy of graphs, click the button *Enable Hard Copy*. Note the selection of graphic output device is made at c). The *Select Device* is chosen by clicking on a device in the lower window and the selection is displayed in the upper window.

22. In the *Text* sub-window, the *Text Output* file may be selected as usual.

23. The *Contour File* button d) should be activated to write the passing file for use by the diagnostic line ratio program ADAS207. This is as for ADAS205. There is no arrangement for permanent storage of such files which reside only in a user's file space and are generally prepared for temporary immediate use. Usually in ADAS we store such temporary 'passed files' in a *pass* sub-library. You should create this at the first level within the adas database as

/...../<uid>/adas/pass

By default ADAS206 sends the contour file to

/...../<uid>/adas/pass/contour.pass

24. The *Total Line Power File* button e) and the *Specific Line Power File* button f) should be activated to write the appropriate passing files. They are of data format *adf11* and can be used in ionisation/recombination applications of ADAS series 4 programs. The Default file names are respectively

/...../<uid>/adas/pass/plt206.pass

/...../<uid>/adas/pass/pls206.pass

d) Text Output Replace
File Name :

e) Contour File Replace
File Name :

f) Total Line Power File Replace
File Name :

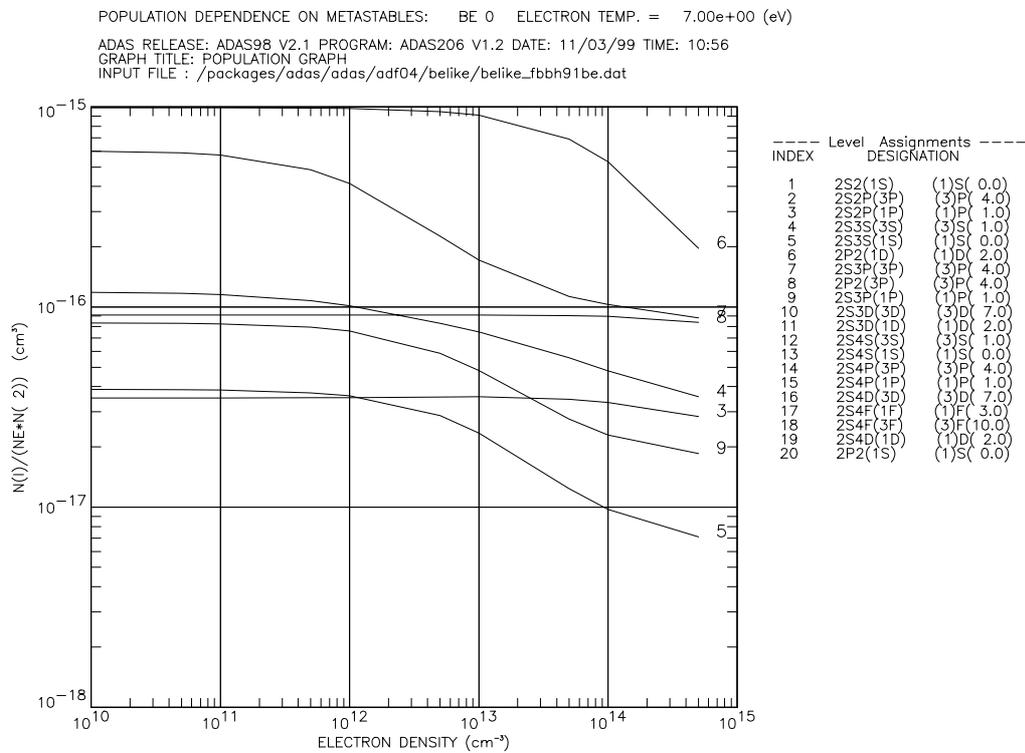
Specific Line Power File Replace
File Name :

25. Click *Done* to display the population graphs. Note that the *Escape to Menu* icon may be clicked to return directly to the series 2 menu.

Illustration:

The output from the program is shown for neutral beryllium Be^{+0} . The specific ion file is assembled from the R-matrix calculations of Fon et al. (1991). The graphical output is of populations as a function of density as for ADAS205.

Figure 3.6a



The tabular output is given in fig. 3.6.

Table 3.6.

ADAS RELEASE: ADAS98 V2.1 PROGRAM: ADAS206 V1.2 DATE: 11/03/99 TIME: 10:56
 ***** TABULAR OUTPUT FROM LINE POWER CALCULATION PROGRAM: ADAS206 - DATE: 11/03/99 *****

INPUT COPASE FILE NAME: /packages/adas/adas/adf04/belike/belike_fbbh91be.dat

ION	NUCLEAR CHARGE (Z0)	RECOMBINING ION CHARGE (Z1)	----- IONIZATION POTENTIAL ----- (wave number <cm-1>)	(rydbergs)
BE+ 0	4	1	75192.	0.6852023

----- ENERGY LEVELS -----						
INDEX	CONFIGURATION	(2S+1)L(J)	-- ENERGY RELATIVE TO LEVEL 1 -- (wave number <cm-1>)	(rydbergs)	ENERGY RELATIVE TO IONISATION POTENTIAL (wave number <cm-1>)	(rydbergs)
1	2S2(1S)	(1)0(0.0)	0.	0.0000000	75192.	0.6852023
2	2S2P(3P)	(3)1(4.0)	21980.	0.2002969	53212.	0.4849054
3	2S2P(1P)	(1)1(1.0)	42565.	0.3878816	32627.	0.2973206
19	2S4D(1D)	(1)2(2.0)	68781.	0.6267799	6411.	0.0584224
20	2P2(1S)	(1)0(0.0)	77870.	0.7096052	-2678.	-0.0244029

-- INPUT COPASE FILE TEMPERATURES: (TE=TP=TH) --			
INDEX	(kelvin)	(eV)	(reduced)
1	5.00D+03	4.31D-01	5.00D+03
2	1.00D+04	8.62D-01	1.00D+04
3	2.00D+04	1.72D+00	2.00D+04
4	5.00D+04	4.31D+00	5.00D+04
5	1.00D+05	8.62D+00	1.00D+05
6	2.00D+05	1.72D+01	2.00D+05
7	5.00D+05	4.31D+01	5.00D+05
8	1.00D+06	8.62D+01	1.00D+06

INPUT COPASE FILE INFORMATION:

NUMBER OF ELECTRON IMPACT TRANSITIONS = 57
 NUMBER OF PROTON IMPACT TRANSITIONS = 0
 NUMBER OF CHARGE EXCHANGE RECOMBINATIONS = 0
 NUMBER OF FREE ELECTRON RECOMBINATIONS = 0

METASTABLE INFORMATION:

NUMBER OF ORDINARY LEVELS = 18
 NUMBER OF METASTABLES = 2

----- METASTABLE DETAILS -----			
METASTABLE INDEX	ENERGY LEVEL INDEX	DESIGNATION	
1	1	2S2(1S)	(1)S(0.0)
2	2	2S2P(3P)	(3)P(4.0)

LOWER INDEX BOUND FOR PROJECTION = 21
 SPECIFIC LINE POWER - SELECTED ELECTRON IMPACT TRANSITION (11-01): 2S3D (1)D(2.0) - 2S2 (1)S(0.0)
 SPECIFIC LINE POWER - DIRECT LINE POWER LOSS = 1.2797D-41 ergs sec-1

OUTPUT PLASMA PARAMETERS:

NUMBER OF TEMPERATURES = 8
 NUMBER OF DENSITIES/RATIOS = 10

INDEX	-----TEMPERATURES (UNITS: eV) -----			INDEX	DENSITIES (UNITS: cm-3)		----- RATIOS -----	
	ELECTRON <TE>	PROTON <TP>	NEUTRAL HYDROGEN <TH>		ELECTRON <NE>	PROTON <NP>	NH/NE	N(Z+1)/N(Z)
1	4.308D-01 *	4.308D-01 #	4.308D-01 #	1	1.000D+10	0.000D+00 #	0.000D+00 #	0.000D+00 #
2	8.617D-01	8.617D-01 #	8.617D-01 #	2	5.000D+10	0.000D+00 #	0.000D+00 #	0.000D+00 #
3	1.723D+00	1.723D+00 #	1.723D+00 #	3	1.000D+11	0.000D+00 #	0.000D+00 #	0.000D+00 #
4	4.308D+00	4.308D+00 #	4.308D+00 #	4	5.000D+11	0.000D+00 #	0.000D+00 #	0.000D+00 #
5	7.000D+00	7.000D+00 #	7.000D+00 #	5	1.000D+12	0.000D+00 #	0.000D+00 #	0.000D+00 #
6	1.723D+01	1.723D+01 #	1.723D+01 #	6	5.000D+12	0.000D+00 #	0.000D+00 #	0.000D+00 #
7	4.308D+01	4.308D+01 #	4.308D+01 #	7	1.000D+13	0.000D+00 #	0.000D+00 #	0.000D+00 #
8	8.617D+01 *	8.617D+01 #	8.617D+01 #	8	5.000D+13	0.000D+00 #	0.000D+00 #	0.000D+00 #
				9	1.000D+14	0.000D+00 #	0.000D+00 #	0.000D+00 #
				10	5.000D+14	0.000D+00 #	0.000D+00 #	0.000D+00 #

KEY: * = WARNING - TEMPERATURE OUT OF RANGE
 - EXTRAPOLATION REQUIRED
 # = PARAMETER NOT USED IN CALCULATIONS
 NOTE: NH/NE = NEUTRAL HYDROGEN DENSITY / ELECTRON DENSITY
 N(Z+1)/N(Z) = STAGE ABUNDANCIES

PROTON IMPACT COLLISIONS - NOT INCLUDED
 IONIZATION RATES - NOT INCLUDED
 NEUTRAL HYDROGEN CHARGE EXCHANGE - NOT INCLUDED
 FREE ELECTRON RECOMBINATION - NOT INCLUDED

TABULATED TOTAL EQUILIBRIUM LINE POWER RATIOS REPRESENT THE RATIO TO THE ZERO DENSITY LINE POWER

TABLE KEY:

 NE = ELECTRON DENSITY
 TE = ELECTRON TEMPERATURE
 I = ENERGY LEVEL INDEX
 IMET = METASTABLE INDEX
 IORD = ORDINARY LEVEL INDEX

NUMBER OF PROTON IMPACT COLLISIONS INCLUDED = 0
 NUMBER OF FREE ELECTRON RECOMBINATIONS INCLUDED = 0
 NUMBER OF CHARGE EXCHANGE RECOMBINATIONS INCLUDED = 0

LINE POWER PARAMETERS:

THETA = REDUCED TEMPERATURES (kelvin/Z1**2)
 RHO = REDUCED DENSITIES (cm-3/Z1**7)
 Z1 = RECOMBINING ION CHARGE

PL = LINE POWER COEFFICIENT USED AS DENOMINATOR FOR CALCULATING LINE POWER RATIOS (ergs cm3 sec-1)
 PL0 = ZERO DENSITY LINE POWER ARISING FROM EXCITATIONS ONLY FROM THE GROUND LEVEL (ergs cm3 sec-1)
 PLA1 = DIRECT LINE POWER LOSS FROM METASTABLE (ergs sec-1)
 PLBA = HIGH N PROJECTED POWER BASED ON EXCITATIONS FROM METASTABLE TO LEVELS Z1 UPWARDS (ergs cm3 sec-1)

NE(CM-3)= 1.0000E+10 5.0000E+10 1.0000E+11 5.0000E+11 1.0000E+12 5.0000E+12 1.0000E+13 5.0000E+13

EQUILIBRIUM METASTABLE POPULATION DEPENDENCE ON DENSITY AT TE=4.31E-01 EV=5.00E+03 KELVIN PL0 =4.3163D-21

IMET	I	1	2	3	4	5	6	7	8	9
1	1	1.0000E+00								
2	2	1.6044E-02	1.6044E-02	1.6044E-02	1.6044E-02	1.6044E-02	1.6044E-02	1.6045E-02	1.6045E-02	1.6047E-02

POPULATION AND POWER DEPENDENCE ON DENSITY AND METASTABLE 1

PLA1 = 0.0000D+00		PLBA = 0.0000D+00								
IORD	I	1	2	3	4	5	6	7	8	9
1	3	1.1286E-11	5.6428E-11	1.1285E-10	5.6411E-10	1.1278E-09	5.6239E-09	1.1211E-08	5.4706E-08	
2	4	1.1494E-12	5.7437E-12	1.1479E-11	5.7063E-11	1.1338E-10	5.4695E-10	1.0665E-09	4.9218E-09	
3	5	7.8897E-13	3.9417E-12	7.8754E-12	3.9050E-11	7.7294E-11	3.5743E-10	6.5544E-10	2.0698E-09	
17	19	8.1722E-16	4.3565E-15	9.2036E-15	5.4184E-14	1.1601E-13	7.3410E-13	1.9203E-12	2.6932E-11	
18	20	2.7375E-18	1.3689E-17	2.7380E-17	1.3702E-16	2.7434E-16	1.3835E-15	2.7963E-15	1.5095E-14	
-LINE PWR-										
TOTAL		5.3601D-24	5.3599D-24	5.3597D-24	5.3582D-24	5.3563D-24	5.3412D-24	5.3231D-24	5.1923D-24	
SPECIFIC		2.6033D-66	2.5823D-66	2.5770D-66	2.8021D-66	3.2463D-66	7.4246D-66	1.2457D-65	3.2431D-65	

POPULATION AND POWER DEPENDENCE ON DENSITY AND METASTABLE 2

PLA1 = 1.3402D-14		PLBA = 0.0000D+00								
IORD	I	1	2	3	4	5	6	7	8	9
1	3	4.6622E-09	2.3310E-08	4.6618E-08	2.3300E-07	4.6579E-07	2.3208E-06	4.6230E-06	2.2506E-05	
2	4	4.3592E-10	2.1793E-09	4.3577E-09	2.1757E-08	4.3443E-08	2.1493E-07	4.2536E-07	1.9952E-06	
3	5	3.4161E-10	1.7068E-09	3.4105E-09	1.6930E-08	3.3558E-08	1.5673E-07	2.9013E-07	9.4886E-07	
17	19	2.9356E-16	9.5843E-15	4.7715E-14	2.3175E-12	1.2195E-11	4.5765E-10	1.8734E-09	2.7280E-08	
18	20	3.8755E-14	1.9377E-13	3.8754E-13	1.9375E-12	3.8744E-12	1.9348E-11	3.8635E-11	1.9079E-10	
-LINE PWR-										
TOTAL		2.2277D-21	2.2265D-21	2.2262D-21	2.2250D-21	2.2237D-21	2.2141D-21	2.2035D-21	2.1400D-21	
SPECIFIC		2.8110D-62	2.8162D-62	2.8227D-62	2.8706D-62	2.9253D-62	3.2650D-62	3.5370D-62	3.9331D-62	

...
 ...

***** TOTAL EQUILIBRIUM LINE POWER COEFFICIENT/RATIO *****

TOTAL EQUILIBRIUM LINE POWER COEFFICIENT NORMALISATION = M

NE (CM-3)	1.00D+10	5.00D+10	1.00D+11	5.00D+11	1.00D+12	5.00D+12	1.00D+13	5.00D+13	1.00D+14
TE (EV)									
4.31D-01	4.11D-23	4.11D-23	4.11D-23	4.11D-23	4.10D-23	4.09D-23	4.07D-23	3.95D-23	3.83D-23
8.62D-01	1.56D-20	1.56D-20	1.56D-20	1.56D-20	1.56D-20	1.54D-20	1.53D-20	1.47D-20	1.43D-20
1.72D+00	2.84D-19	2.84D-19	2.84D-19	2.84D-19	2.84D-19	2.83D-19	2.82D-19	2.75D-19	2.70D-19
4.31D+00	1.69D-18	1.69D-18	1.69D-18	1.69D-18	1.69D-18	1.70D-18	1.70D-18	1.71D-18	1.72D-18
7.00D+00	2.89D-18	2.89D-18	2.89D-18	2.89D-18	2.90D-18	2.91D-18	2.92D-18	2.98D-18	3.01D-18
1.72D+01	5.29D-18	5.29D-18	5.29D-18	5.30D-18	5.30D-18	5.33D-18	5.36D-18	5.52D-18	5.64D-18
4.31D+01	6.52D-18	6.52D-18	6.52D-18	6.53D-18	6.53D-18	6.57D-18	6.61D-18	6.83D-18	7.02D-18
8.62D+01	6.16D-18	6.16D-18	6.17D-18	6.17D-18	6.17D-18	6.21D-18	6.24D-18	6.43D-18	6.61D-18

TOTAL EQUILIBRIUM LINE POWER RATIO TABLE WITH REDUCED PARAMETERS - RATIO TO THE ZERO DENSITY LINE POWER

Z1	THETA	PL	RHO=	1.00D+10	5.00D+10	1.00D+11	5.00D+11	1.00D+12	5.00D+12	1.00D+13
	5.00D+03	4.32D-21		0.010	0.010	0.010	0.010	0.010	0.009	0.009
	1.00D+04	7.23D-20		0.216	0.216	0.216	0.215	0.215	0.214	0.212
	2.00D+04	2.91D-19		0.976	0.976	0.976	0.976	0.976	0.972	0.968
1	5.00D+04	9.41D-19		1.795	1.795	1.795	1.797	1.798	1.805	1.810
	8.12D+04	1.48D-18		1.952	1.952	1.953	1.955	1.957	1.967	1.976
	2.00D+05	2.57D-18		2.060	2.061	2.061	2.063	2.065	2.078	2.090
	5.00D+05	3.21D-18		2.033	2.033	2.034	2.035	2.037	2.049	2.062
	1.00D+06	3.14D-18		1.964	1.964	1.964	1.965	1.967	1.977	1.988

***** SPECIFIC EQUILIBRIUM LINE POWER COEFFICIENT/RATIO *****

SPECIFIC EQUILIBRIUM LINE POWER COEFFICIENT NORMALISATION = M

NE (CM-3)	1.00D+10	5.00D+10	1.00D+11	5.00D+11	1.00D+12	5.00D+12	1.00D+13	5.00D+13	1.00D+14
TE (EV)									
4.31D-01	4.54D-64	4.54D-64	4.55D-64	4.63D-64	4.73D-64	5.31D-64	5.80D-64	6.64D-64	6.22D-64
8.62D-01	3.02D-60	3.03D-60	3.03D-60	3.10D-60	3.16D-60	3.51D-60	3.74D-60	3.99D-60	3.83D-60
1.72D+00	1.51D-58	1.51D-58	1.52D-58	1.56D-58	1.59D-58	1.76D-58	1.84D-58	1.88D-58	1.84D-58
4.31D+00	8.82D-58	8.83D-58	8.86D-58	9.16D-58	9.51D-58	1.10D-57	1.15D-57	1.20D-57	1.24D-57
7.00D+00	1.18D-57	1.18D-57	1.18D-57	1.24D-57	1.30D-57	1.59D-57	1.72D-57	1.89D-57	2.01D-57
1.72D+01	1.39D-57	1.39D-57	1.40D-57	1.49D-57	1.62D-57	2.22D-57	2.54D-57	3.14D-57	3.56D-57
4.31D+01	1.10D-57	1.11D-57	1.12D-57	1.22D-57	1.35D-57	2.10D-57	2.56D-57	3.63D-57	4.34D-57
8.62D+01	7.90D-58	7.93D-58	7.99D-58	8.79D-58	9.92D-58	1.66D-57	2.11D-57	3.25D-57	3.98D-57

SPECIFIC EQUILIBRIUM LINE POWER RATIO TABLE WITH REDUCED PARAMETERS - RATIO TO THE LINE POWER FOR LOWEST OF THE INPUT DENSITIES

Z1	THETA	PL	RHO=	1.00D+10	5.00D+10	1.00D+11	5.00D+11	1.00D+12	5.00D+12	1.00D+13
	5.00D+03	4.54D-64		1.000	1.002	1.004	1.022	1.042	1.171	1.279
	1.00D+04	3.02D-60		1.000	1.002	1.005	1.025	1.047	1.164	1.238
	2.00D+04	1.51D-58		1.000	1.002	1.005	1.030	1.055	1.166	1.216
1	5.00D+04	8.82D-58		1.000	1.002	1.005	1.039	1.079	1.243	1.309
	8.12D+04	1.18D-57		1.000	1.001	1.005	1.050	1.105	1.347	1.455
	2.00D+05	1.39D-57		1.000	1.002	1.007	1.077	1.168	1.603	1.828
	5.00D+05	1.10D-57		1.000	1.003	1.010	1.102	1.226	1.903	2.319
	1.00D+06	7.90D-58		1.000	1.004	1.011	1.112	1.256	2.102	2.676

***** EQUILIBRIUM POPULATIONS *****

LEVEL = 1 - EQUILIBRIUM POPULATION

NE (CM-3)	1.00D+10	5.00D+10	1.00D+11	5.00D+11	1.00D+12	5.00D+12	1.00D+13	5.00D+13	1.00D+14
TE (EV)									
4.31D-01	1.00D+00								
8.62D-01	1.00D+00								
1.72D+00	1.00D+00								
4.31D+00	1.00D+00								
7.00D+00	1.00D+00								
1.72D+01	1.00D+00								
4.31D+01	1.00D+00								
8.62D+01	1.00D+00								

LEVEL = 20 - EQUILIBRIUM POPULATION

NE (CM-3)	1.00D+10	5.00D+10	1.00D+11	5.00D+11	1.00D+12	5.00D+12	1.00D+13	5.00D+13	1.00D+14
TE (EV)									
4.31D-01	6.25D-16	3.12D-15	6.25D-15	3.12D-14	6.24D-14	3.12D-13	6.23D-13	3.08D-12	6.06D-12
8.62D-01	2.80D-11	1.40D-10	2.80D-10	1.40D-09	2.80D-09	1.40D-08	2.80D-08	1.39D-07	2.77D-07
1.72D+00	3.51D-09	1.75D-08	3.51D-08	1.76D-07	3.51D-07	1.76D-06	3.54D-06	1.80D-05	3.64D-05
4.31D+00	3.43D-08	1.72D-07	3.43D-07	1.72D-06	3.44D-06	1.73D-05	3.50D-05	1.86D-04	3.93D-04
7.00D+00	5.47D-08	2.73D-07	5.47D-07	2.74D-06	5.49D-06	2.78D-05	5.65D-05	3.14D-04	6.99D-04
1.72D+01	8.19D-08	4.10D-07	8.20D-07	4.11D-06	8.26D-06	4.27D-05	8.87D-05	5.74D-04	1.45D-03
4.31D+01	7.18D-08	3.59D-07	7.19D-07	3.62D-06	7.31D-06	3.92D-05	8.48D-05	6.75D-04	1.93D-03
8.62D+01	5.80D-08	2.90D-07	5.82D-07	2.93D-06	5.93D-06	3.22D-05	7.08D-05	6.00D-04	1.77D-03

Notes: