CHIANTI

An Astrophysical Database for Emission Line Spectroscopy

CHIANTI TECHNICAL REPORT No. 14

The CHIANTI total dielectronic recombination rate files (drparams)

Version 1.0, 17 November 2017, Peter Young

1 Overview

This document describes the format for the CHIANTI drparams file, which contains the parameters used to compute the total dielectronic recombination coefficient for an ion.

Sect. 2 describes the format of the drparams file, and Sect. 3 describes the IDL routine that reads the file and computes the recombination rate.

Note that for CHIANTI the ion name *always corresponds to the recombining ion*, so the `o_6.drparams` file contains data for the recombination of O VI to form O V.

2 File format

The files that contain the fitting parameters for the dielectronic recombination rate coefficients have the suffix "drparams", and the formats for these files are given in Table 1. There are two types of fitting formula used for dielectronic recombination rate coefficients. Type 1 is due to Arnaud & Raymond (1992) and writes the rate coefficient, α^{DR} as

$$\alpha^{\mathrm{DR}}(T) = T^{-3/2} \sum_i c_i \exp(-E_i/T) \tag{1}$$

where c_i and E_i are the fitting parameters. Arnaud & Raymond (1992) considered a sum over four terms, but later work considered larger sums. For CHIANTI we allow up to 9 terms in the sum.

The second type of fitting formula is originally due to Shull & van Steenberg (1982), and is given by

$$\alpha^{\mathrm{DR}}(T) = A T^{-3/2} \exp(-T_0/T) \left[1 + B \exp(-T_1/T)\right] \tag{2}$$

where the fitting parameters are A, B, T_0 and T_1.

3 The IDL routine recomb_rate.pro

The routine `recomb_rate.pro` returns the *total* (dielectronic + radiative) recombination rate for the specified ion. It is called as

```
IDL> rate = recomb_rate ( ion_name, temp )
```

where `ion_name` is the name of the *recombining* ion in the CHIANTI format (e.g., 'fe_13' for Fe XIII, and `temp` is an array of temperatures.

The dielectronic component of the rate is returned by the routine `ch_diel_recomb.pro`, which is called as

```
IDL> dr_rate = ch_diel_recomb ( ion_name, temp )
```

For clarity, if the ion is given as 'o_6', then the returned rate will be for O^{5+} ions recombining to form O^{4+}.

Table 1: Data formats for the drparams files.

Type	Line	Format	Parameter
1	1	i5	Transition type (1)
	2	i5	Atomic number
		i5	Spectroscopic number (e.g., 13 for "XIII")
		9e12.4	Parameters E_i from Eq. 1
	3	i5	Atomic number
		i5	Spectroscopic number (e.g., 13 for "XIII")
		9e12.4	Parameters c_i from Eq. 1
2	1	i5	Transition type (2)
	2	i5	Atomic number
		i5	Spectroscopic number (e.g., 13 for "XIII")
		e12.4	Parameter A from Eq. 2
		e12.4	Parameter B from Eq. 2
		e12.4	Parameter T_0 from Eq. 2
		e12.4	Parameter T_1 from Eq. 2

References

Arnaud, M., & Raymond, J. 1992, ApJ, 398, 394

Shull, J. M., & van Steenberg, M. 1982, ApJS, 48, 95