
CHIANTI

An Astrophysical Database for Emission Line Spectroscopy

CHIANTI TECHNICAL REPORT No. 9

The radiative loss function

Ver. 1.2, 11-Aug-2017, Peter Young

Ver. 1.1, 8-Aug-2017, Peter Young

Ver. 1.0, 4-Apr-2016, Peter Young

The radiative loss function, $Q(T)$, is defined through the expression (see, e.g., Priest, 2014)

$$L_r = N_e N_H Q(T) \quad (1)$$

where L_r is the radiative loss, i.e., the energy lost per unit volume per unit second by radiation, N_e and N_H are the electron number densities of electrons and hydrogen, respectively.

Note that in astrophysics $Q(T)$ is often referred to as the radiative cooling curve and denoted by $\Lambda(T)$.

1 CHIANTI calculation

The radiative loss function is calculated by CHIANTI using the routine `rad_loss.pro`:

```
IDL> rad_loss, temp, loss_rate
```

which will assume a constant density of $N_e = 10^{10} \text{ cm}^{-3}$ and ask the user to select an abundance data-set and an ionization equilibrium file. Note that the temperature (`temp`) is not an input, it is only an output. Its values are taken from the ionization equilibrium file. Options exist to vary the density, or to assume a constant pressure.

The routine takes about 10 minutes to run, mainly due to the calculation of bound-bound radiative losses.

A plot of the radiative loss function is shown in Figure 1, which was computed with CHIANTI 8 (Del Zanna et al., 2015) with the `sun_photospheric_2011_caffau.abund` abundance file, the CHIANTI ion balance file, and a constant density of 10^{10} cm^{-3} .

1.1 Changing the temperature range

To change the temperature range for which the radiative loss function is defined, it is necessary to create a new ionization balance file. The example below shows how to create a new file covering the temperature range $\log T = 3.0$ to 5.0 at 0.02 dex intervals:

```
IDL> ltemp=findgen(101)/50.+3.0
IDL> make_ioneq_all,10.^ltemp,outname='new.ioneq'
```

Now when you call `rad_loss` you will be able to choose the new ion balance file from the widget menu.

2 Individual components

For the computation of the radiative losses, `rad_loss.pro` calls out to three other routines: `bb_rad_loss.pro`, `fb_rad_loss.pro` and `ff_rad_loss.pro` for bound-bound, free-bound and free-free radiative losses, respectively. (Note that losses due to two-photon emission are neglected.)

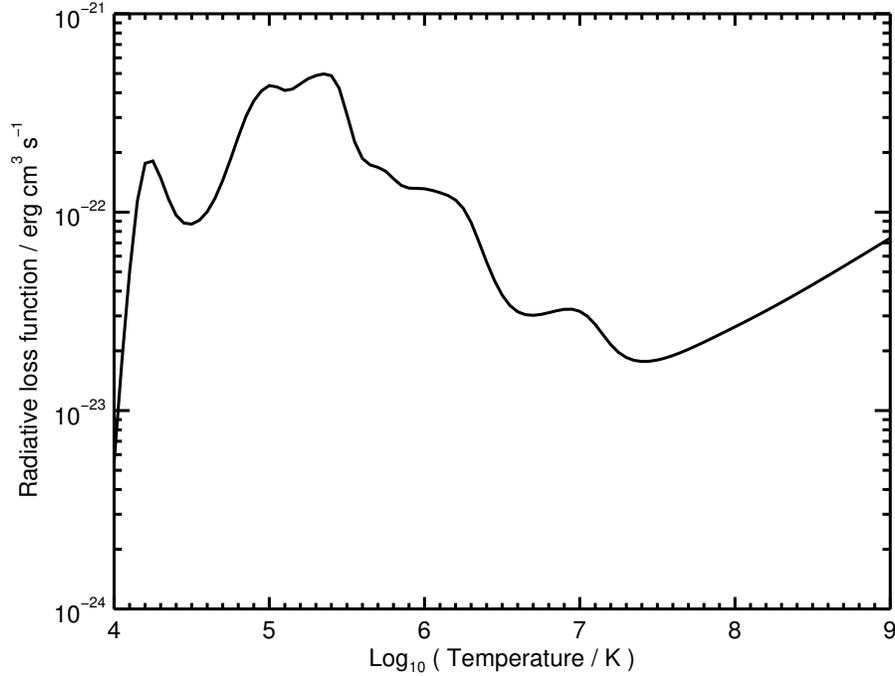


Figure 1: The radiative loss function computed with CHIANTI 8.

```
IDL> ff_rad_loss, temp, ff
IDL> fb_rad_loss, temp, fb
IDL> bb_rad_loss, temp, bb
```

For the bound-bound losses, a constant pressure or constant density across the temperature range can be specified. The default is a constant density of 10^{10} cm^{-3} .

The bound-bound losses for a single ion (or a subset of ions) can be computed by using the `sngl_ion=` keyword, for which ions can be specified in the CHIANTI format, e.g., 'o_6' for O VI.

References

- Del Zanna, G., Dere, K. P., Young, P. R., Landi, E., & Mason, H. E. 2015, *A&A*, 582, A56
- Priest, E. 2014, *Magnetohydrodynamics of the Sun* (Cambridge: Cambridge University Press)

A Document history

Ver. 1.2, 11-Aug-2017. Added Sect. 1.1.

Ver. 1.1, 8-Aug-2017. Updated following revisions to the rad_loss routines.