Installing the COMPTB model for XSPEC

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Procedure to install the COMPTB model, whose detailed description is reported in R. Farinelli, L. Titarchuk, A. Paizis, F. Frontera, *A new comptonization model for weakly magnetized, accreting neutron stars in low-mass X-ray binaries*, 2008, ApJ, 680, 602.

In order to run COMPTB, it is required:

- The source code of XSPEC v.12 or higher
- The model source code and description files

1 Compiling and installing COMPTB

To compile COMPTB, you must first choose the directory in which you want to put the source code of the model (xscomptb.c) and the model description file (comptb.dat). Let us call this directory, e.g., */home/username/comptb*. **IMPORTANT**: you must have writing rights to the directory, as the local model model library file libcomptb.so and some additional object files will be produced there.
Thus first cd to */home/username/comptb*. To compile the model:

- Run XSPEC from shell
- From XSPEC prompt type:

XSPEC12> *initpackage comptb comptb.dat /home/username/comptb*
XSPEC12> *lmod comptb /home/username/comptb*

Alternatively, you can put the above two command lines in a file, e.g., init.xcm and then, from the XSPEC prompt type:

XSPEC12> *@/home/username/comptb/init.xcm*

If compilation works successfully, you should find the shared library file **libcomptb.so** in the directory */home/username/comptb*.
Remember however that even if the compilation of the model worked successfully, you have to reload the model library every time you run XSPEC. In order to avoid that, go into $HOME/.xspec directory (which is automatically created for each user at first XSPECrunning), edit (or newly if it does not exist) the file xspec.rc, and add the line *lmod comptb /home/username/comptb*.

It is also worth pointing out that when you run XSPEC in batch mode, reading of the $HOME/.xspec/xspec.rc file is skipped. Thus if for example you want to load some spectra and the best-fit model (with COMPTB) you cannot just give the command

> xspec - data.xcm model.xcm

but rather the following command
> xspec - load_comptb.xcm data.xcm model.xcm

where the file load_comptb.xcm, as xspec.rc, contains the line
lmod comptb /home/username/comptb.

2 Model parameters

The COMPTB parameters for XSPEC fitting are the following:

- $kT_{\rm s}$: temperature of the seed photons
- γ: index of the seed photon spectrum

$$s(E) \equiv C_N \frac{E^{\gamma-1}}{e^{E/kT_{\rm s}}-1}. \tag{1}$$

  By default it is $\gamma = 3$, so that s(E) is just the blackbody spectrum, while for $\gamma \neq 3$ it somewhat reproduces a *modified* blackbody.

- α: energy index of the Comptonization spectrum.
- δ: bulk parameter, which gives the relative contribution of bulk over thermal Comptonization, defined as

$$\delta \equiv \frac{< E_{\rm bulk} >}{< E_{\rm th} >} = \frac{(1-\ell)}{\Theta \dot{m}}, \tag{2}$$

where $\ell \equiv L/L_{\rm Edd}$, $\Theta \equiv kT_{\rm e}/m_e c^2$ and $\dot{m} \equiv \dot{M}/\dot{M}_{\rm Edd}$. Note that when $\delta = 0$, a pure thermal Comptonization spectrum holds.

- $kT_{\rm e}$: temperature of the electrons

- log(A): *illuminating factor*, which gives the relative fraction of the soft (non up-scattered) seed photons to the Comptonized ones. The analytical shape of the emerging model spectrum is

$$F(E) = \frac{C_N}{A+1}[BB(E) + A \times BB(E_0) * G(E, E_0)]. \qquad (3)$$

where the second term is the square bracket represents convolution of the seed photon spectrum with the system Green's function $G(E, E_0)$. The normalization C_N is chosen in such a way that for $A \rightarrow 0$ the model reduces to the standard BBODY model of XSPEC.

For any problem and suggestions contact me:

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