The Sherwood simulation suite: guide to the public data

James S. Bolton, University of Nottingham
Version 1: 09/2017

This brief document contains a guide to the publicly available mock Lyman-α forest spectra drawn from the Sherwood simulation suite. The simulations are described in detail in the Sherwood overview paper (**Bolton et al. 2017, MNRAS, 464, 897**), and were performed with `P-Gadget-3`, an updated and extended version of the publicly available `Gadget-2` code (Springel et al. 2005, MNRAS, 364, 1105). An open access copy of the Sherwood overview paper is available on the arXiv preprint repository, at *https://arxiv.org/abs/1605.03462*.

The spectra are drawn from two of the hydrodynamical simulations described in Bolton et al. (2017): the $40 - 2048$ model at $2 \leq z \leq 7$, and the $80 - 1024$ model at $0 \leq z \leq 2$. Please refer to Bolton et al. (2017) for a technical description of the simulations (particularly Section 2), and please also cite this paper when using these data.

Two zipped tarballs containing the mock Lyman-α forest spectra are available for download:

spectra_40_2048.tar.gz (approx. 974 Mb)
spectra_80_1024.tar.gz (approx. 792 Mb)

Each tarball contains a directory housing a number of binary files, with each file containing a set of Lyman-α forest spectra at a single redshift. The files follow the naming convention *tauH1_lya_zX.X.dat*, where *X.X* gives the redshift of the spectra. Table 1 gives the internal structure of each file. The convention used to identify the sight-line positions within the simulation volume(s) is illustrated in Fig. 1.

For the high resolution $40-2048$ model, there are a total of 26 files, with outputs every $\Delta z = 0.2$ for $2 \leq z \leq 7$. The lower resolution $80 - 1024$ model has 21 files, with outputs every $\Delta z = 0.1$ for $0 \leq z \leq 2$. Each file contains a total of 5000 sight-lines with 2048 pixels. The sight-lines are drawn parallel to each of the simulation box axes (x, y and z) on regularly spaced grids of 50^2, 40^2 and 30^2, respectively. Note that all the simulated sight-lines are periodic (i.e. the first and last pixel in each sight-line join smoothly on to one another).

A very basic IDL code that can be used to read the spectra is also provided on the Sherwood website:

read_spectra.tar.gz (approx 4 Kb)

A brief guide to operation is given in the header of *read_spectra.pro*. For each output redshift, the routine plots one of the sight-lines and returns its position within the simulation volume. It also computes the effective optical depth of the Lyman-α forest and returns the hydrogen photo-ionisation rate, $\Gamma_{\rm HI}$, used in the simulation. In both models $\Gamma_{\rm HI}(z)$ corresponds to the ultraviolet background model for star-forming galaxies and quasars from Haardt & Madau, 2012, ApJ, 746, 125 (see figure 8 and table 3 in that paper).

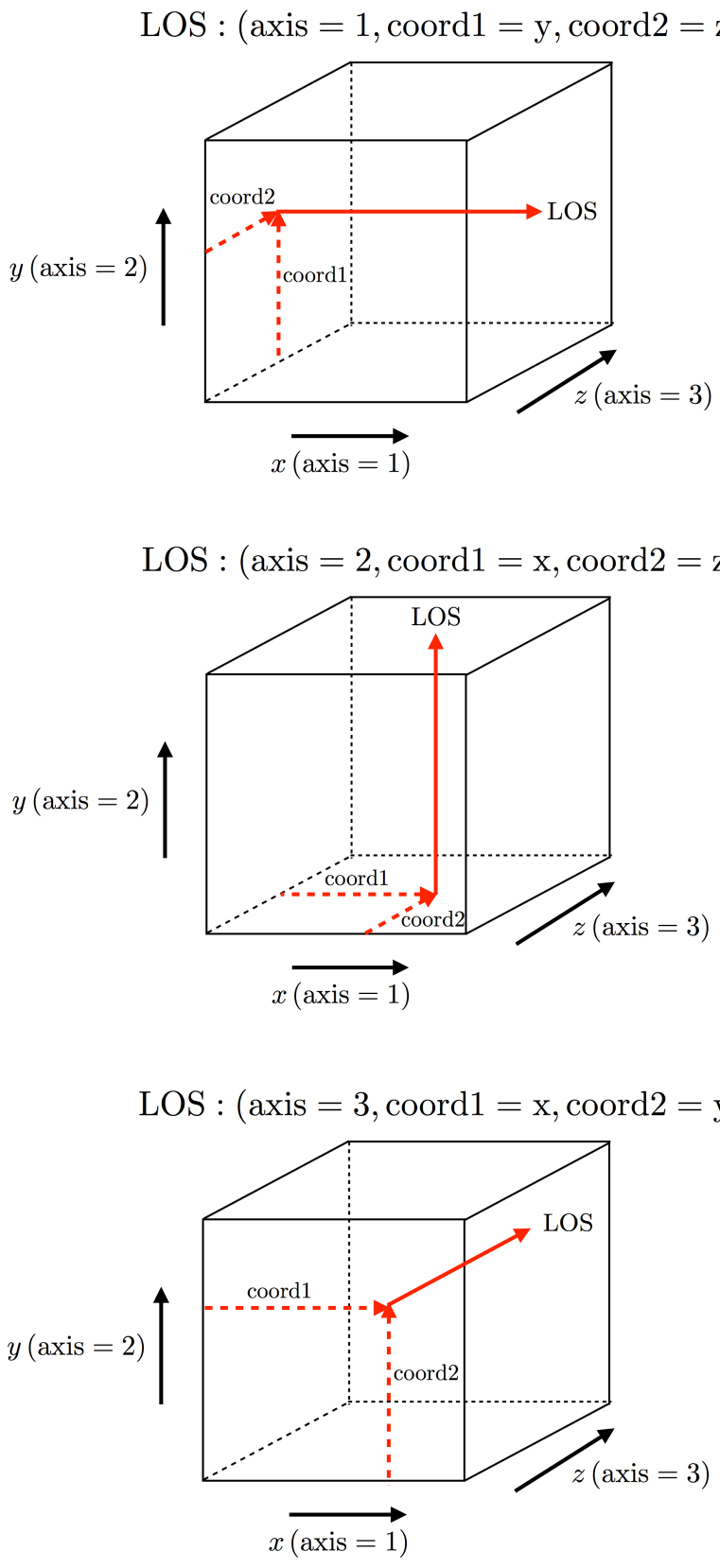

Figure 1: Convention used to identify the positions of Lyman-α forest sight-lines within the simulation volume(s). The sight-lines (solid red arrows in the figure, labelled LOS) are always drawn parallel to the box boundaries in either the x (top panel), y (middle panel) or z (bottom panel) direction. The variable *axis* describes the direction along which the sight-line is drawn ($x = 1$, $y = 2$, $z = 3$). The variables *coord1* and *coord2* (red dashed arrows) give the position of each sight-line in the plane perpendicular to the sight-line direction, in units $h^{-1}\,\mathrm{ckpc}$.

Variable	Type	Size (bytes)	Comment
npix	long	4	Number of pixels in each sight-line
nlos	long	4	Number of sight-lines in file
ztime	float	4	Redshift of mock spectra
omegaM	float	4	Matter density, $\Omega_{\rm m}$
omegaL	float	4	Vacuum energy density, Ω_{Λ}
omegab	float	4	Baryon density, $\Omega_{\rm b}$
hubble	float	4	Hubble constant, $h = H_0/100\,{\rm km\,s^{-1}\,Mpc^{-1}}$
boxsize	float	4	Simulation box size, $\rm h^{-1}\,ckpc$
axis[nlos]	long	4*nlos	Sight-line axis ($x = 1$, $y = 2$, $z = 3$). See Fig. 1.
coord1[nlos]	float	4*nlos	Sight-line coordinate, $\rm h^{-1}\,ckpc$. See Fig. 1.
coord2[nlos]	float	4*nlos	Sight-line coordinate, $\rm h^{-1}\,ckpc$. See Fig. 1.
pixels[npix]	float	4*npix	Pixel positions along axis, $\rm h^{-1}\,ckpc$
tau[npix*nlos]	float	4*npix*nlos	Ly-α optical depths

Table 1: Data structure for the binary files containing the mock Lyman-α forest spectra.