Simulated eROSITA Sky

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Abstract

We present a Monte-Carlo simulation framework providing a mock-up of the eROSITA telescope. The simulation can be used to investigate the eROSITA view of the X-ray sky, to analyse characteristic instrument properties, and to provide test data for the development of analysis software. For a demonstration of these powerful capabilites we show an example of a simulated survey observation of a field populated with galaxy clusters and AGN.

We use realistic input data for the simulation providing elaborate source models. The distribution of galaxy clusters is based on energy-resolved light cone images from a cosmological hydrodynamical simulation (Roncarelli et al. 2006). The AGN sample consists of a mixture of unobscured, Compton thin, and Compton thick sources at different redshifts (according to Gilli et al. 2007), accounting for the observed X-ray luminosity function.

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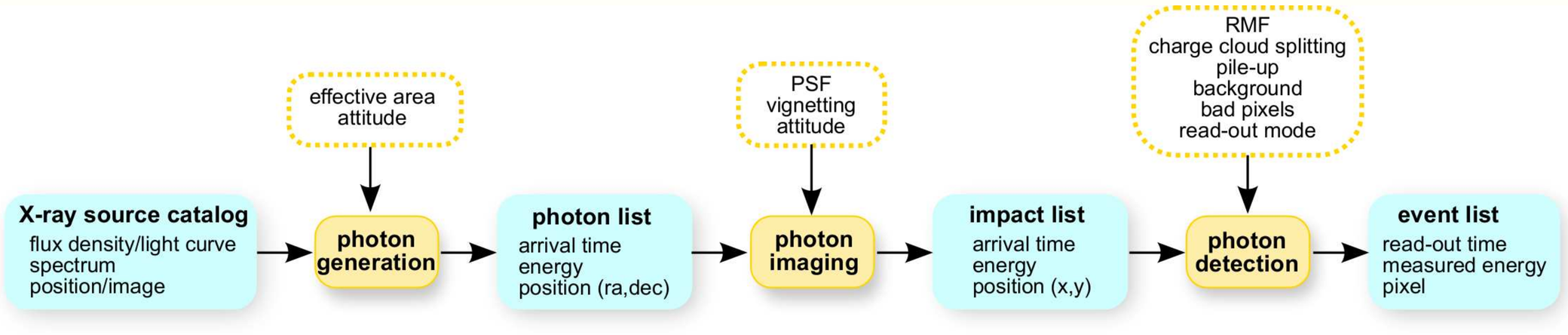
Simulation Software

We have developed a generic simulation software for X-ray telescopes with pixelized detectors. The software package is written in C and implements a common interface by using the APE/PIL library for parameter input and standard FITS files for data access. It contains models for different instruments such as the framestore pn-CCDs of eROSITA, and it can be easily extended for other detectors. For instance we can also simulate *ATHENA*, *LOFT*, or the EPIC-pn camera on *XMM-Newton*.

The simulation is set up as a pipeline of the relevant tasks such as the generation of a sample of X-ray photons, the imaging process in a Wolter telescope, and the photon detection by the respective detector. Individual tools in this pipeline can be replaced easily to adjust the simulation to different missions. The instrument characteristics like the mirror and detector properties are defined by standard calibration files, such as the PSF or RSP.



The software can simulate observations of different kinds of astronomical X-ray sources which are defined according to the SIMPUT file format described below.

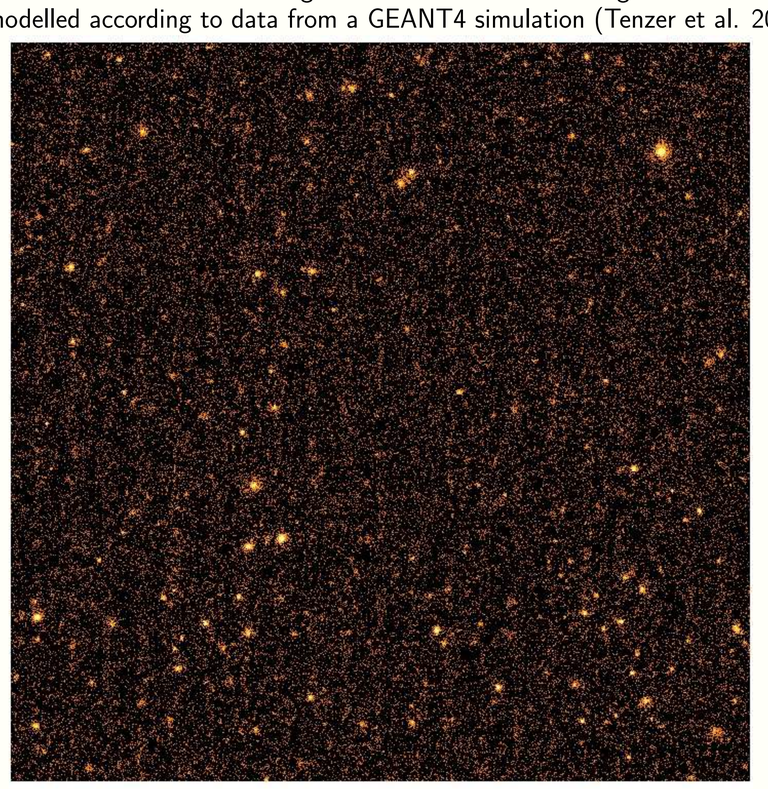
In order to provide fast and easy access to the simulation software we are developing a web interface for simulations of eROSITA.

SIMPUT File Format

The SIMulation inPUT (SIMPUT) file format can be used to define sources for input of simulations of astronomical observations. Each source file contains a catalog with one or multiple sources, which are described by specific properties such as position, brightness, energy spectrum, as well as optional characteristics such as time variability, polarization, and spatial extent.
The file format defines a common basis to exchange data between different software packages and scientific groups. It was developed in particular for the simulation of X-ray telescopes, but can also be used in different wavelength domains.

Light Cone Simulations

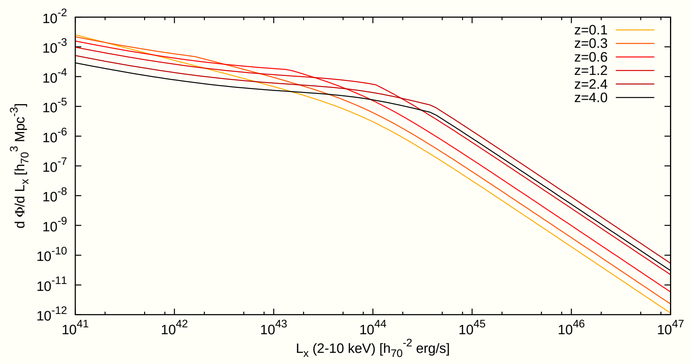
In order to investigate the imaging capabilities of eROSITA during the all-sky survey, we have simulated observations of small $3.6° \times 3.6°$ fields of the sky populated with galaxy clusters and AGN. The cluster input data are provided by F. Pace and M. Roncarelli in the form of 2-dimensional surface brightness maps in 146 energy bins covering an energy range from 0.2–10 keV with a resolution of 50 eV and 100 eV, respectively. The composition of the AGN input catalog is described in the box on the right-hand side. Detector background due to cosmic ray protons is modelled according to data from a GEANT4 simulation (Tenzer et al. 2010).



Simulated image of a light cone located at the survey equator after 4 years of all-sky survey.

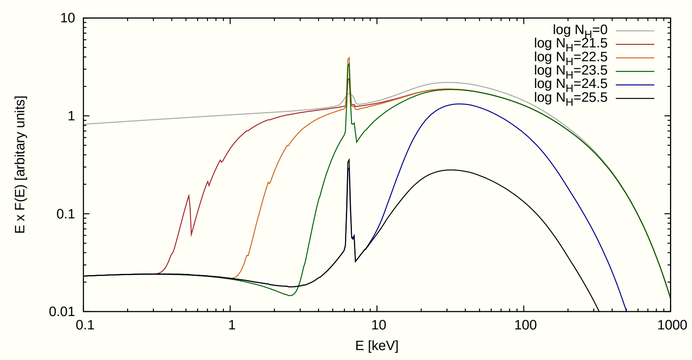
AGN Catalog

For virtual observations as described on the left-hand side we have developed a program which generates a source catalog in the SIMPUT file format filled with AGN. To achieve this, the light-cone up to a given redshift is filled with point sources according to distributions as measured in real observations. Thereby, spatial density and intrinsic luminosity are correlated with distance, a fact that is commonly described by the X-ray Luminosity Function (XLF) (Ueda et al. 2003).



The XLF for various values of redshift as used for our simulation.

The "raw" central engines are then built into realistic environments, each consisting of a dust torus and a reflecting accretion disk. This results in a broad variety of X-ray spectra. The single parameters such as column density and spectral index are set randomly with probabilities taken from recent publications (Gilli et al. 2007). The initially generated intrinsic luminosity is then absorbed and converted into the brightness as seen on earth, before the sources are stowed in the catalog.



Different spectra for AGN as used in this program.

References & Acknowledgments

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