cdfs-sim, cdfs-extract, LFtools, griddetect
new software tools for XMM-Newton and other missions

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With the increasing size and complexity of data in modern astrophysics, software is playing a major role among the astronomer's tools. The public availability of code, and a free software license are keys to allow a faster advancement of science, and to guarantee the reproducibility of published results.

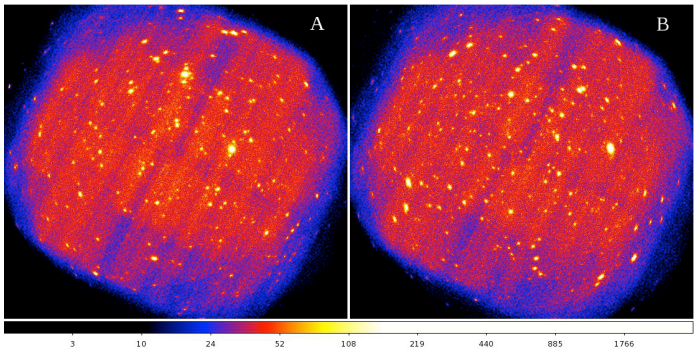
Here I present a collection of programs which I have been developing as part of my research, which are being successfully used by different groups for their publications (XMM-CDFS, Stripe-82, XXL, Cosmos, Atlas), and which I have publicly released as free software. While currently tuned to XMM-Newton, all of them are extensible to other missions.

cdfs-sim

a simulator of X-ray astronomical observations.

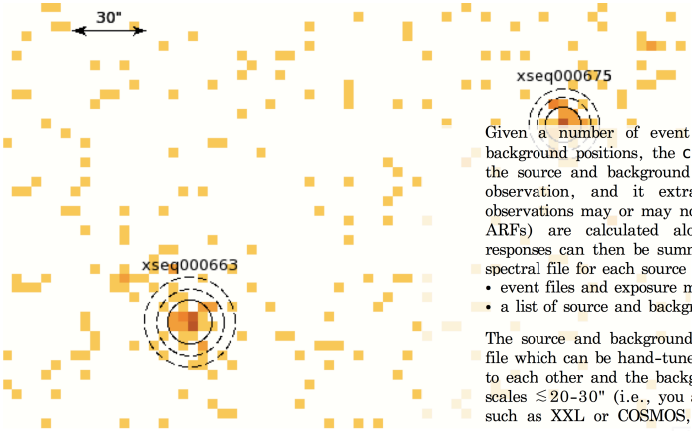
It can simulate an arbitrary set of point sources and reproduce the XMM-Newton background; the product is an event file which can be analysed with SAS.
It can be extended to work with Chandra and Athena. The only assumptions are that a library of position-dependent PSFs is available, that the effective area of the telescope and detector is known, and that an exposure map is provided to account for vignetting and eventual chip gaps. A background map can be used to account for the instrumental component.
Features:
- produces event files, to be analysed with common X-ray data analysis software;
- supports an arbitrary number of point sources;
- arbitrary spectra can be assigned to the sources;
- calculates the most appropriate PSF for each source, according to position and energy, by interpolating from the PSF library (for XMM, it is the latest CCF);
- reproduces the correct balance of background components (cosmic, particle and residual soft protons, each of which has its own spatial distribution).

Already used by:
- XMM-CDFS: Ranalli et al. 2013; Finoguenov et al. 2014 (submitted)
- Stripe82: LaMassa et al. 2014



A simulation compared to the real image, from the XMM-CDFS survey
Can you tell which is the simulation and which is the real one?

A: real; B: simulation



cdfs-extract & autoregions

extract spectra and aperture photometry for multiple sources in multiple XMM-Newton observations

Given a number of event files and a list of source and background positions, the `cdfs-extract program` checks if the source and background are in the field of view of any observation, and it extracts products accordingly. The observations may or may not overlap. Responses (RMFs and ARFs) are calculated along with spectra. Spectra and responses can then be summed if needed, producing a single spectral file for each source and each camera. All you need is:
- event files and exposure maps
- a list of source and background positions.

The source and background positions are specified in a text file which can be hand-tuned. If the sources are not too close to each other and the background has no large variations on scales $\lesssim$20-30" (i.e., you are dealing with a shallow survey such as XXL or COSMOS, rather than deep like CDFS or Lockman Hole) then the sources and background positions can be automatically generated. The `autoregions` program computes extraction regions yielding the highest signal/noise ratio, and excludes overlapping areas from the extraction regions.

Already used by:
- XMM-CDFS: Ranalli et al. 2013; Georgantopoulos et al. 2013; Falocco et al. 2013; Castelló-Mor et al. 2014; Comastri et al. (in preparation)
- XMM-XXL: in preparation (Pacaud, Paltani, Ramos, Ranalli, et al.)
- XMM-Atlas: Ranalli et al., in preparation
- XMM-COSMOS: Lanzuisi et al., in preparation

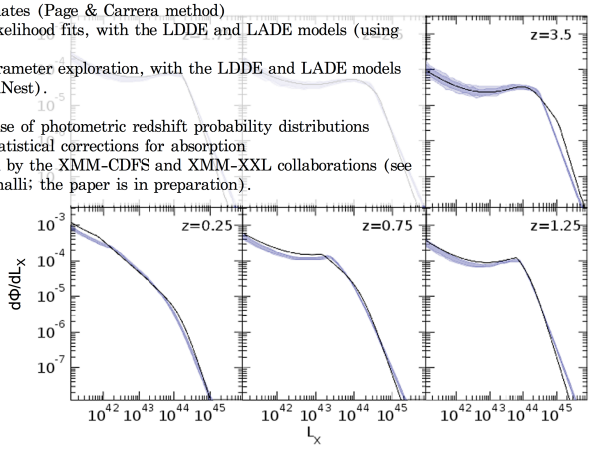
LFtools

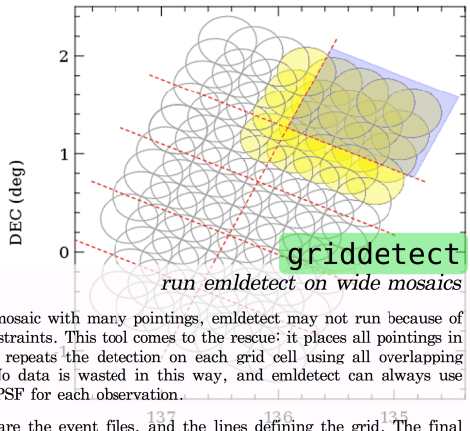
a set of programs to compute luminosity functions

Given a catalogue, an area curve, and (optionally) the photo-z probability distributions, it computes luminosity functions:
- binned estimates (Page & Carrera method)
- maximum likelihood fits, with the LDDE and LADE models (using Minuit)
- Bayesian parameter exploration, with the LDDE and LADE models (using MultiNest).

Strong points:
- makes full use of photometric redshift probability distributions
- can apply statistical corrections for absorption

Currently used by the XMM-CDFS and XMM-XXL collaborations (see talk by P. Ranalli; the paper is in preparation).





griddetect

run emldetect on wide mosaics

On a wide mosaic with many pointings, emldetect may not run because of memory constraints. This tool comes to the rescue: it places all pointings in a grid, and repeats the detection on each grid cell using all overlapping pointings. No data is wasted in this way, and emldetect can always use the correct PSF for each observation.

The inputs are the event files, and the lines defining the grid. The final product is the merged catalogue from all cells.

Currently used by XMM-Atlas (P. Ranalli ,in preparation).

All info on my website:
members.noa.gr/piero.ranalli
(including a PDF version of this poster)