Max-Planck-Institute for Extraterrestrial Physics

Applying the BSS algorithm to eROSITA simulated datasets

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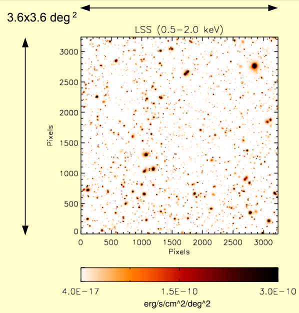
The Background-Source separation (BSS) algorithm [1], [2] is a general, powerful and flexible Bayesian technique for the detection and characterization of both point-like and extended astronomical objects. The BSS technique does **not** *censor* data for background estimation and the commonly used *p-values* are replaced by a measure of probability. Point-like and extended sources are detected on the original image data providing for a proper propagation of uncertainties of estimates. The current status of the feasibility study for applying the BSS algorithm to the *e*ROSITA mission [3] is reported. For more details on the *e*ROSITA mission: *See poster H. Brunner et al.*

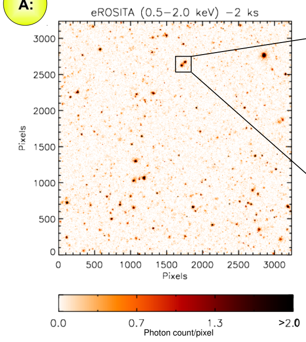


Cosmological hydrodynamical simulations of galaxy clusters and light-cones [4], [5], [6] have been developed to provide the Large-Scale Structure (LSS) input for the *e*ROSITA image and event simulations.

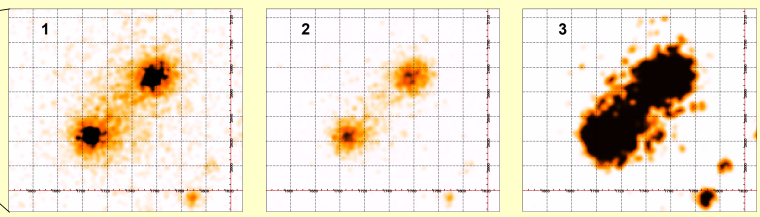
On the left-hand side, the LSS is shown for the 0.5-2.0 keV energy band. The simulated image accounts for a redshift range of 0.1-2.0 and covers a sky view of 3.6x3.6 deg^2 with a pixel resolution of 4 arcsec.

The *e*ROSITA simulations are created employing the LSS, an observed AGN population, a model for the raytracing simulated *e*ROSITA PSF and a background model for the planned L2 orbit [7], [8]. In Panel **A**, the *e*ROSITA simulated image in the 0.5-2.0 keV energy band is shown for 2 ks of observing time.

A:



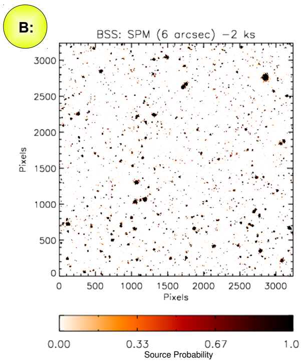
eROSITA photon count image: BSS SPM (4 arcsec): BSS SPM (6 arcsec):



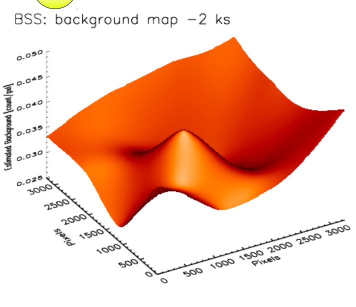
Details on detection of two galaxy clusters with the BSS algorithm.
Panel 1: zoom in to *e*ROSITA photon count image as shown in Panel A. The image is smoothed with a Gaussian kernel of 2 arcsec.
Panels 2,3: source probability maps in output from the BSS algorithm at 4 and 6 arcsec resolutions, respectively.

The BSS algorithm allows one to analyze the detection of clusters and their substructures employing a multi-resolution analysis. The brightest X-ray emissions of the clusters are detected at higher resolutions, while the dimmest hot diffuse emission in which the two clusters are embedded is detected at lower resolutions. Note that the diffuse emission connecting the two clusters is visible in panel 2 .

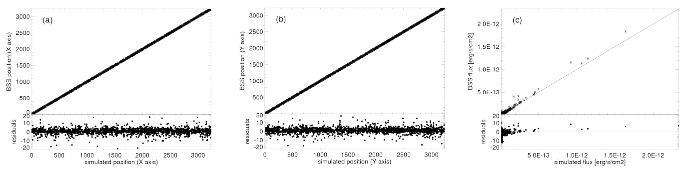
B:



C:



D:



A: *e*ROSITA simulated photon count image for 2 ks of observing time. The exposure time is assumed to be constant on the whole field of view. The image is scaled and smoothed in order to enhance the sources. The original scale of this image is in the range (0-54) counts per pixel.

The BSS algorithm is a new source detection method based on Bayesian Probability theory combined with a mixture-model technique. The algorithm allows one to estimate the background and its uncertainties and to detect celestial sources jointly. The new approach deals directly with the statistical nature of the data.
Results of the BSS algorithm are: source probability maps (SPMs) in a multi-resolution analysis, a background map and a catalog of detected sources including source positions and fluxes.

B: Example of SPM from the BSS algorithm. The displayed SPM is obtained with a resolution of 6 arcsec. The image provides probabilities of source detection. At this resolution, point-like and extended sources are visible.

C: Background map from the BSS algorithm. The background (amplitude) map is resulting from modeling the background rate with a 2D spline combined with the satellite's exposure time. Since the exposure time is chosen constant for this simulated dataset, the background map is dominated by the simulated background plus effects due to the presence of the simulated sources, both for the LSS and for the AGN population.
The displayed background map is obtained employing 16 supporting points.

D: Comparison of the estimated source positions and fluxes versus the positions and fluxes of simulated point-like sources with fluxes above 1.0e-14 erg/s/cm^2.

References:

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