The Background-Source Separation algorithm
– *feasibility studies for the eROSITA mission*

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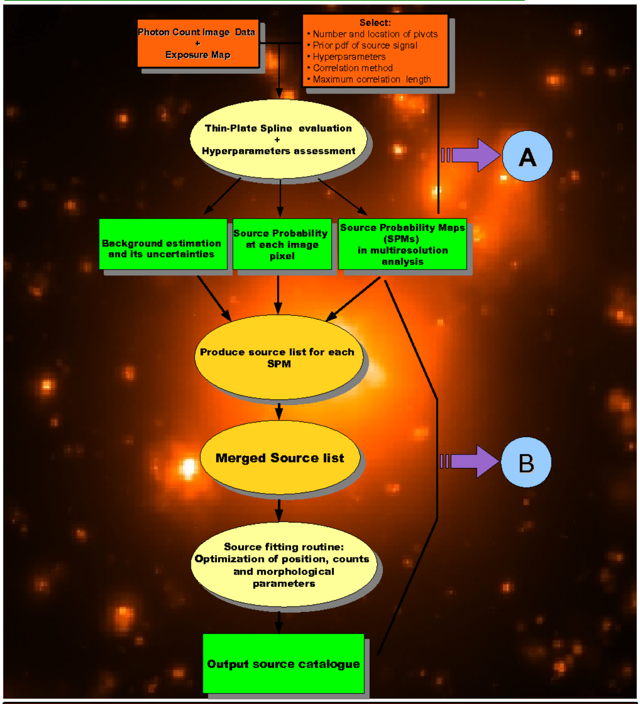
Abstract: The Background-Source separation (BSS) algorithm [1], [2] is a general, powerful and flexible Bayesian technique for the detection and characterization of both point-like and extended astronomical objects. The BSS technique does *not censor* data for background estimation and source detection. The commonly used *p-values* are replaced by a measure of probability. Point-like and extended sources are detected simultaneously 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 eROSITA mission [3] is reported. For more details on the eROSITA mission: *See poster H. Brunner et al.*

The BSS Algorithm



Flow chart illustrating the Background-Source Separation algorithm.

A: background estimation and source detection algorithm
The two orange boxes in the upper row represent the input information. The output information is provided by the green boxes in the lower row.

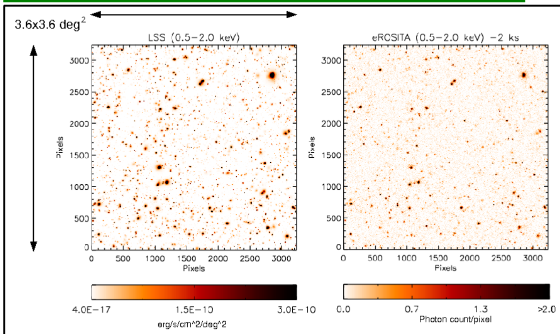
B: source characterization algorithm
The input information for source characterization are: the output information from part **A**, exposure map and photon count image data. The generated catalogue is in FITS standard.

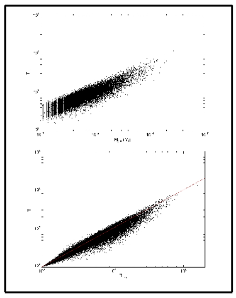
The BSS algorithm is capable to: preserve Poisson statistics, detect faint sources and large variety of source morphologies, provide a reliable background model, include the exposure map without corrupting the statistics.

The advantages of the BSS algorithm are: Joint background estimation and source detection; Proper propagation of uncertainties of experimental measurements; Parameters entering the models are estimated from the data; Point-like and extended sources are detected independent of their morphology and kind of background; Cope with steep gradients in the data; Multi-resolution and multi-band analyses; Applicable to large data volumes, e.g. surveys.

Artificial data are currently under investigation to test the BSS technique and other methods.

The data





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.

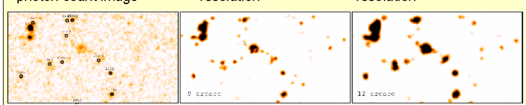
On the left-hand side, the LSS is shown for the 0.5-2.0 keV energy band. The simulated image accounts for a redshift range of 0.1-2.0 and covers a sky view of 3.6x3.6 deg² with a pixel resolution of 4 arcsecs.

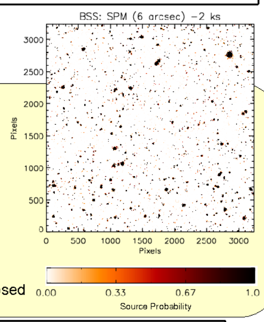
Center, the *e*ROSITA simulated image in the 0.5-2.0 keV energy band is shown for 2 ks of observing time. The *e*ROSITA simulations are created employing the LSS, an observed AGN population, a model for the raytracing simulated *e*ROSITA PSF and a background model for the planned L2 orbit [7], [8]. See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

On the right-hand side, **Upper plot:** Spectroscopic-like temperature as a function of the gas mass of the clusters. Temperature units in K, while masses in solar masses. **Lower plot**: Spectroscopic-like temperature as a function of the mass-weighted temperature. Both plots refer to the complete cosmological box at z=0.

Results

eROSITA photon count image | SPM at 8 arcsec resolution | SPM at 12 arcsec resolution





SPMs at several resolutions are used to detect faint and extended sources.
The analysis of SPMs allows one to separate point-like from extended sources.
On the eROSITA photon count image, the regions of simulated AGNs are superposed for fluxes larger than 1.35e-14 erg/s/cm² (~5σ)

References:
[1] Guglielmetti F. et al. MNRAS, **396**, 165-190 (2009)
[2] http://edoc.ub.uni-muenchen.de/12732/
[3] Predehl, P. et al. SPIE, 7732, 77320U (2010); doi:10.1117/12.856577
[4] Pace, F. et al. A&A, **483**, 389 (2008)
[5] Roncarelli, M. et al. MNRAS, **368**, 74-84 (2006)
[6] Borgani, S. et al. MNRAS, **348**, 1078 (2004)
[7] http://www.sternwarte.uni-erlangen.de/~schmid/download/schmid_{e}rosita.pdf
[8] http://mediatum.ub.tum.de/node?id=1007262

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