Digging deeper: Towards a catalogue of detections from stacked XMM-Newton observations

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Expanding 3XMM source detection to overlapping observations

About one third of the sky area covered by the XMM-Newton X-ray telescopes was observed more than once. The XMM-Newton Survey Science Centre Consortium SSC has generated catalogues of individual detections in all publicly available XMM-Newton observations and published the most recent incarnation 3XMM-DR7 on June 1. To achieve ultimate sensitivity in repeatedly observed regions of the XMM-Newton sky, we have now developed a new standardized approach to source detection on images of multiple pointings, making use of a maximum likelihood fitting procedure as for 3XMM. Source parameters are derived from stacks of the empirical point spread function per involved instrument, energy band, and off-axis position illustrated on the left. The method has entered the Science Analysis System SAS as a new task. It aims at higher detection reliability and improved source parameters and will be used to publish a catalogue of stacked detections.

Testing stacked source detection on “pseudo-mosaics”

In order to investigate the performance of our stacking method, we construct “pseudo-mosaics” by splitting long observations into artificial sub-exposures and performing source detection on each sub-exposure and on their stack. As intended, more and fainter sources are detected in the stacks than in the individual sub-exposures, the detection likelihood increases, and the source parameters are determined with higher precision. Because of statistical effects, combining a long with a short observation may result in a loss of detections anyhow. A systematic analysis of stacks with different exposure time ratios reveals an increase in total detection likelihood from about 40% on, when using all three instruments and five energy bands.

A proto-catalogue of detections in largely overlapping observations

For our first proto-catalogue, we have selected full-frame observations with a minimum overlap of 80% in area, low background and more than 99% usable chip area. 736 individual observations, grouped into 278 stacks, match the selection criteria. We detect about 26 000 unique sources, an increase of at least 5% over the joined detections of individual pointings before disregarding non-overlapping off-axis areas and spurious detections. The proto-catalogue shows that the new approach yields higher sensitivity, improved source parameters and likely fewer spurious detections.

The full catalogue of detections from overlapping pointings will be processed and made available soon. It will be based on the same set of OBS_Ids as 3XMM-DR7, selecting observations in full-frame mode only with reasonably low background level which overlap by 20% or more in area, and comprise order of 1800 fields.

Detection reliability: matching our proto-catalogue with unique sources in 3XMM. Those not recovered by stacked detection are more probably spurious than matching ones. Stack flags are set automatically only, 3XMM flags after additional visual screening.