The second Swift-XRT point source catalogue: 2SXPS

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Summary

We will shortly be publishing the second *Swift*-XRT Point Source Catalogue: 2SXPS. This catalogue covers 3,790 square degrees on the sky: twice as much as the earlier 1SXPS catalogue and nearly 3.5 times that of 3XMM-DR8.

Analysis was carried out over the 0.3-10 keV energy range and in three sub-bands. A total of ~213,000 unique point sources were detected, 75% of which have no counterpart in the *Rosat*, *XMM-Newton* or *Chandra* catalogues. Various products, detailed below, are available for the sources.

We have improved the source detection system over that used in 1SXPS, in particular, we are now able to model and so mitigate the impact of stray light, which otherwise gives rise to spurious detections. Stray light affects all X-ray optics and will be a particular concern for *Athena*, thus our ability to treat it within the source detection process is of especial interest looking ahead.

Catalogue contents

2SXPS contains all Photon Counting mode *Swift*-XRT observations with at least 50-s of cleaned data, up to August 2018. The summary characteristics are:

Number of observations:	**129,155**
Unique sky coverage:	**3,800 sq deg**
Exposure time used:	**267 Ms**
Number of detections:	**1.1 million**
Number of unique sources:	**213,700**
Median source flux: (0.3–10 keV)	**4.2×10^{-14} erg cm^{-2} s^{-1}**

For comparison, 3XMM-DR8 covers 1089 sq deg on the sky, with a median source flux of 2.2×10^{-14} erg cm^{-2} s^{-1} (0.2–12 keV): the smaller effective area of XRT is counterbalanced by the lower background level.

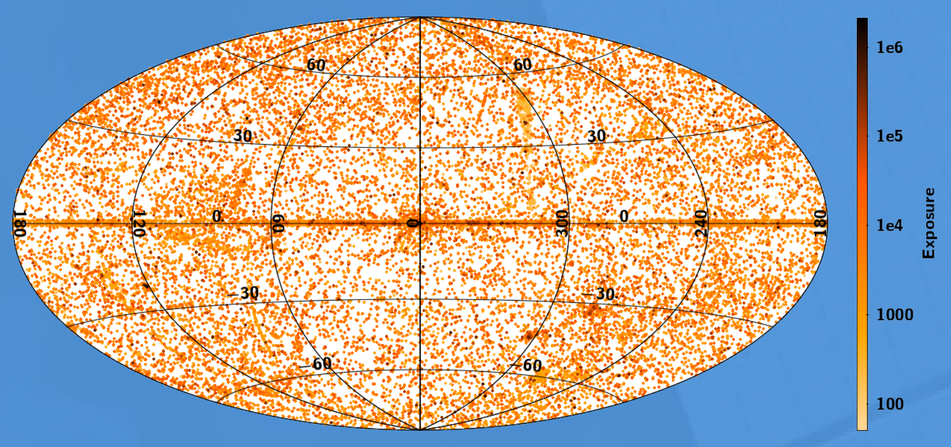

Fig. 1. The locations of fields in 2SXPS, in Galactic coordinates. Coverage is relatively uniform, with the exception of excesses around the Galactic plane, centre and the SMC, where specific observing campaigns have been targetted.

For each source the catalogue contains the position, a flux in 4 energy bands, and two hardness ratios per detection, as well as time series and (where available) spectra.

We are in the final phases of verification: the catalogue will soon be available via:

https://www.swift.ac.uk/2SXPS

Stray Light Modelling

Stray light is an artifact of Wolter-I X-ray optics: X-rays just outside the telescope's field of view undergo a single reflection which directs them onto the camera; this produces a series of concentric rings (one per mirror shell). These can give rise to spurious source detections.

The effective area of such single-reflection features is known (Fig. 2) so its occurrence can to some degree be predicted from X-ray catalogues and affected fields flagged: this was the approach used in 1SXPS.

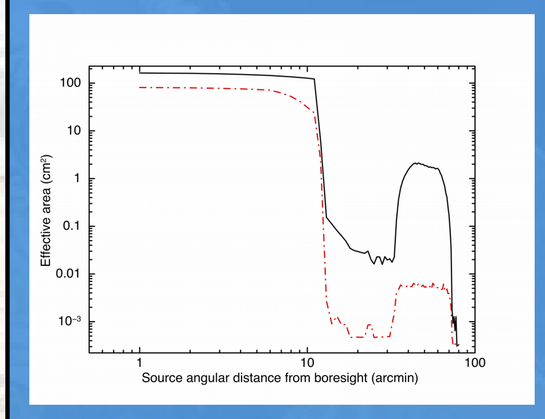

Fig. 2. The effective area of XRT as a function of off-axis angle, for the whole CCD (black) or a PSF-sized region (red). The field of view has radius 12'; the area around 30'-70' off-axis is due to stray light.

For 2SXPS, we have developed an analytical model of the stray light. For fields where stray light was expected, we fitted this model to the data as part of the background map creation. As shown below, this accurately reproduces the stray light, and so reduces the number of spurious detections in such fields. Such an approach will be important for *Athena* as the large effective area means that significant background structure is expected due to stray light.

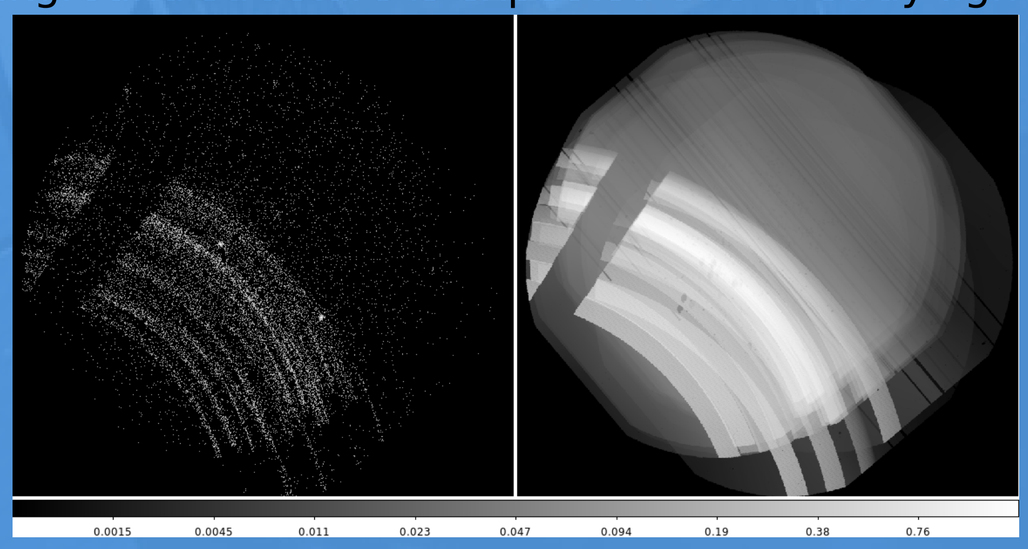

Fig. 3. An example dataset (l) and background map (r) of an observation contaminated with stray light. The intensity variation through the ring's thickness is not currently modelled but the positions and intensities are reproduced well.