The Palermo Swift-BAT Hard X-ray Catalogue: Results after 54 months of sky survey

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The Burst Alert Telescope (BAT: 14-150 keV) on board of Swift is mainly devoted to the monitoring of a large fraction of the sky (50%-80% per day) for the occurrence of Gamma Ray Bursts. This provides the opportunity for a substantial gain of our knowledge of the Galactic and extragalactic sky in the hard X-ray domain. Using a dedicated software we produced the First Palermo Swift-BAT hard X-ray catalogue (Cusumano et al. 2009, arXiv:0906.4788) from the analysis of the first 39 months of BAT survey data. This catalogue contains a list of 754 identified hard X-ray sources.
Here we present the **Second Palermo Swift-BAT hard X-ray catalogue** (http://bat.ifc.inaf.it), obtained from the analysis of the data relative to the first 54 months of the Swift mission and including 1049 identified high-energy sources (62.5% extragalactic objects, 22.5% Galactic objects, 15% known X-ray emitters whose nature has not been determined yet).

The software

We developed a code (Segreto et al 2009, A&A submitted) for efficient data processing of the Swift-BAT survey data. The software has been optimized for the direct production of all-sky mosaics on an equi-area spherical grid. To reduce systematic errors we performed an accurate in-flight calibration of the instrument, producing an improved description of the mask pattern, time-dependent pixel equalization maps, boresight misalignment and energy dependent off-axis count rate correction.

The 54 months catalogue

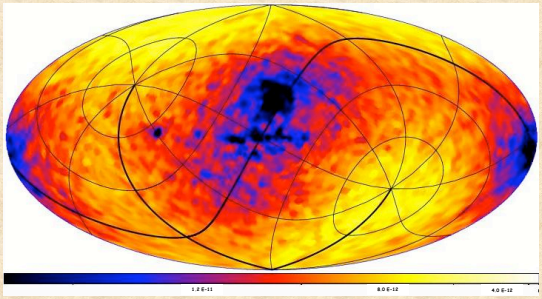
We created all-sky maps in three energy bands: 14-150 keV, 14-70 keV, 14-30 keV and performed a blind search with a detection threshold of 4.8 σ. After merging the three detection lists **we obtain a final number of 1259 detections**.

Identification strategy

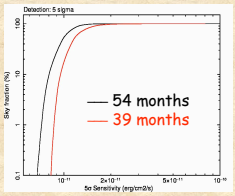
In order to identify the detection excesses, we have applied three different strategies.

1. The position of each excess was cross-correlated with the First Palermo Swift-BAT catalogue. **This allowed the identification of 745 sources**.
2. We have searched for bright sources in the Swift-XRT archival observations covering the sky position of the remaining BAT excesses (514). A source detected inside a 6.3' error circle was associated with the BAT excess if its count rate was above 5 x 10^{-3} c/s. In the few cases where more than one source was within the BAT error circle, we selected the hardest one. A similar method was applied to field observations of Chandra, XMM-Newton, SAX, ASCA and Rosat. **With this strategy we identify 185 sources** with ~1% of expected spurious associations.
3. We cross-correlated the remaining excesses (329) with selected SIMBAD catalogues (Cataclysmic Variables, High mass X-ray binaries, Low mass X-ray binaries, Seyfert galaxies, Blazars, QSOs), with the BZCat (Massaro et al. 2009, A&A, 495, 691) and with the ROSAT Bright and Faint sources catalogues (Voges et al. 1999, A&A, 349, 389). To validate the association we require a distance between the catalogue source and the BAT excess lower than 4.2' (except for the QSOs and ROSAT Faint catalogue sources, for wich we restricted the distance to 2'). **With this strategy we identify 119 sources** with ~5% of expected spurious associations.

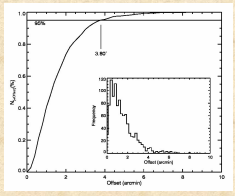
The final catalogue contains 1049 sources with an associated counterpart.



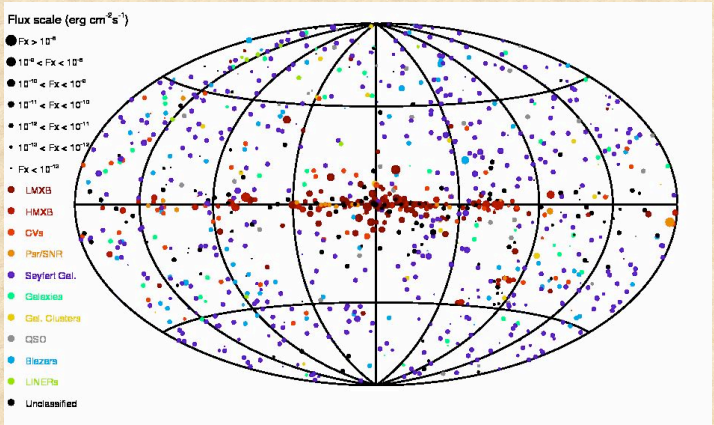
The limiting flux map in galactic Aitoff projection with the ecliptic coordinates grid superimposed. The minimum detection limiting flux is not fully uniform on the sky: the Galactic center and the ecliptic plane are characterized by a worse sensitivity due to high contamination from intense Galactic sources and to the observing constraints of the Swift spacecraft. The highest flux sensitivity is achieved near the ecliptic poles.



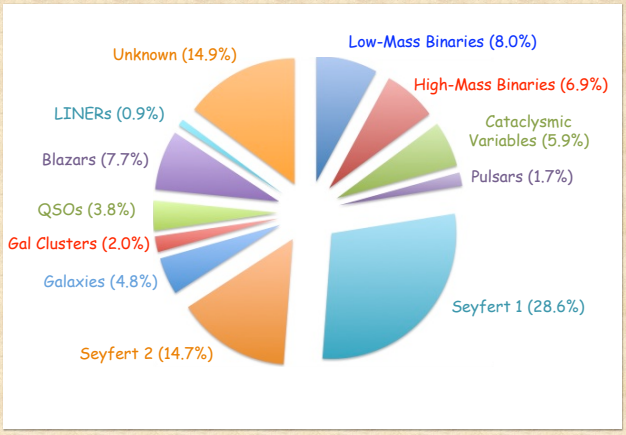
Fraction of the sky covered by the survey as a function of the detection limiting flux for a detection threshold of 4.8 σ.



The integrated distribution of the position offset of the BAT sources with respect to the associated counterpart: 95% of the sources have an offset lower than ~3.8 arcmin. The inset shows the differential distribution of the offset.



Distribution of the 1049 sources of the **Second Palermo Swift-BAT catalogue,** colour-coded according to the object class, with the size of the symbol proportional to the 14-150 keV flux



The distribution of the 1049 sources associated with a counterpart, among the different classes. "Unknown" includes unclassified X-ray sources. For the 210 BAT detections without any association, we are planning a follow-up campaign with Swift XRT.