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THE AKARI FIR ALL-SKY POINT SOURCE CATALOGUES: IMPROVEMENT ACTIVITIES

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ABSTRACT

The first version of the *AKARI* far-infrared All-Sky Bright Source Catalogue (BSC ver.1) was released to public in March 2010. It has been widely used for various astrophysical researches. We are continuing efforts to produce the next edition. The new version is expected to be improved in accuracy and reliability, as well as its volume. Many improvements to the next version are in progress. The time-line signal is being re-examined throughout the entire data processing. Correction processes for signal linearity and detector responsivity, and procedure for masking signal anomaly are revised. The source extraction process is further tuned and operating parameters will be optimized. These bring better reliability of the source detection and possibly an increase of source numbers. The position accuracy is expected to be improved. Systematic position error seen around the Galactic plane will also be corrected. We also plan to deliver the Faint Source Catalogue version 1.

Key words: infrared: survey; infrared: catalogues; methods: data analysis

1. THE AKARI FIR BRIGHT SOURCE CATALOGUE

One of the key objectives of the *AKARI* mission is to carry out an all-sky survey in the mid- and far-infrared wavelengths and to construct point source catalogues. *AKARI* achieved 16 months survey with liquid helium and scanned more than 96% of the entire sky twice or more at the far-infrared (FIR) bands with the Far-Infrared Surveyor (FIS; 50-180 μm; Kawada et al. 2007). The first version of the FIR All-Sky Bright Source Catalogue (BSC version 1) contains 427,071 sources measured at four FIR bands centred at 65, 90, 140, and 160 μm (Yamamura et al., 2010). The BSC version 1 has been in public since March 2010 and been widely used in the various fields of astronomy and astrophysics. We continue efforts to improve the catalogues in reliability and completeness as well as accuracy of flux and position measurements. FIR Faint Source Catalogue, which provides data for fainter sources than the BSC at high-visibility regions, is also planned to be produced. We report the current status of those activities.

2. IMPROVEMENTS

Since the release of the BSC version 1, we are continuing various kinds of efforts to produce the next edition, which will be improved in accuracy, reliability, and completeness. In this section, we describe the current status and activities for data processing improvements.

2.1. Pipeline processes

Each pixel of the FIS detectors generates time-series signal along the scan path on the sky. They are processed independently in most cases through various pipeline modules to form a contiguous dataset with uniform quality for source extraction and photometry processes.

- *Responsivity correction :*
  Responsivity of the detector significantly varies during observations. Its correction is essentially important for reliable measurement. There were some data which were not sufficiently corrected or not usable due to inadequate correction. In the revised program, we consider non-uniform quality among detector pixels and applied better interpolation methods so that more stable correction is enabled. We also reconstruct flat data in order to get homogeneous signals between pixels. Furthermore, slight but real long-term decay of the responsivity was found. It will also be corrected in the next version.

- *Dark subtraction :*
  Dark levels are affected by the responsivity fluctuations. However, the dark subtraction process was performed before the responsivity correction because it did not have satisfactory accuracy in the previous version. As a result of improvement of responsivity correction, the order of processing has been changed, in such a way that it provides more appropriate sequence.

- *Ramp curve correction :*
  The detector signal which is integrated in the readout circuit (namely, *ramp curve*) does not offer an output proportional to incoming flux. The ramp curve correction to bring linear relation is being revised and the correction range has been increased. This revision makes it possible to correct very bright sources which have been abandoned before, as well as to make more precise correction.

- *Deglitching :*
  Invalid signals (glitches) which are caused by charged particle hits should be masked as bad data. The deglitcher module distinguishes that kind of signal, and set a flag there. However, it sometimes picks up a real source signal as a glitch. We are trying to make improvement which raises the detection accuracy of glitch. It is expected that more glitch signals are removed and real source signals are retrieved.

2.2. Source extraction process

Revision of the source extraction process is also under way. We are trying to optimize some operating parameters and reconsider some processing methods. We are continuing test processes. Details of source detection and photometry algorithms with a dedicated software SUSSEXtractor are described in Savage et al. (2007).

Source detection is carried out by source candidate extraction process followed by confirmation process. Optimization for threshold parameters in these processes leads to an increase of faint sources. The threshold values are uniform in the version 1, but tuning to suit for each band would bring about a significant improvement. To provide better flux measurement and position accuracy, Point Response Function (PRF) fitting method is being considered. Process using processing image with finer grid has been also tested. This makes it possible to determine more precise source position. Adding background level estimation is also under consideration to measure more reliable point source flux.

3. CHARACTERISTIC INVESTIGATION

In parallel with the improvements, various investigation work has been performed to understand the characteristics of the catalogues including the current version (BSC version 1). In this section we describe the results of the investigation.

3.1. Non-flat source detection on the all-sky map

It is realized that there is non-flatness in the detected source distribution and it shows an artificial pattern on the all-sky map. The non-flat feature is related to scan density. The source detection and confirmation processes are performed under an identical condition. In the low-visibility regions, a probability to be confirmed becomes higher for a dark source and becomes lower for a bright source under the same condition. This is substantial and unavoidable, so that it is important to give a quantitative understanding.

3.2. Comparison with IRAS catalog

From the result of cross-match between *AKARI* and *IRAS* point source catalogue, most of the *IRAS* 60 μm sources are identified with the *AKARI* sources. Some of very bright sources do not have counterpart due to saturation in the *AKARI* measurement. The matching rate for faint sources also decreases due to *IRAS* non-detection. On the other hand, cross-matched *IRAS* 100 μm sources are less than 60 μm sources, and some IRAS 100 μm sources shows significant flux differences compared with the *AKARI*. It is concluded that the different resolution or the high background level produces such discrepancies. In the high background regions such as the Galactic plane, or for the sources with an extended component such as nearby galaxies, *AKARI* and *IRAS* are often inconsistent.

3.3. Position dispersion and the systematic error

The position accuracy of the detected source is evaluated to be around 6 arcsec (1 σ) for the BSC version 1 (See Yamamura et al. 2010), and will be improved in the next version. The dispersion of the positions is statistically-distributed, but slight systematic displacement was found. In the catalogue of version 1, the detected positions are systematically shifted by roughly 1 arcsec. This discrepancy does not depend on the source position on the sky, object type, nor flux level. The reason has not been understood yet. It is under investigation.

3.4. Data sampling time problem

Recently, small positional shift along in-scan direction was found in the Galactic plane data which are obtained with special readout mode for bright regions. According to the investigation, it is caused by the data sampling time displacement in the raw data. This may blur a composite image and affect photometry and position of a detected source. Shift length of time has been almost

estimated quantitatively. The data processing for the next version is carried out taking account of it.

4. FAINT SOURCE CATALOGUE

In addition to the revision of the BSC, the Faint Source Catalogue (FSC) is also planned to be produced. In the FSC production process, data redundancy is used to improve the detection limit instead of detection reliability by confirmation. Great increase of source numbers in the high-visibility regions near the ecliptic poles has been recognized in a test processing. Data verification and evaluation works are in progress.

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