# *AKARI* All-Sky Point Source Catalogues — Characteristics, Improvements, and Prospects —

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## ABSTRACT

*AKARI* carried out an all-sky survey with two onboard instruments; the Infrared Camera (IRC) and the Far-Infrared Surveyor (FIS). The first version of the catalogues, the FIS Bright Source Catalogue (FIS-BSC) and the IRC Point Source Catalogue (IRC-PSC) were released publicly in March 2010. The *AKARI* All-Sky catalogues are superior to the previous all-sky infrared catalogues by *IRAS* significantly in spatial resolution, sensitivity, and wavelength coverage. We present the specifications of the *AKARI* catalogues and their characteristics by comparing with other infrared source catalogues. We continue efforts to improve the *AKARI* catalogues in reliability and completeness as well as accuracy of flux and position measurements. FIS Faint Source Catalogue, which provides fainter sources than the BSC at the high-visibility regions, is also planned to be produced. We report the current status of improvement works and prospects for the future.

## 1. THE *AKARI* SATELLITE: MISSION AND OBSERVATIONS

*AKARI* (*ASTRO-F*) is the second Japanese space mission for infrared astronomy with the participation of ESA (Murakami et al. 2007). *AKARI* satellite was launched by a M-V rocket on February 22, 2006 (JST). The satellite has a 68.5 cm telescope cooled down to 6 K by liquid helium and mechanical coolers, and two scientific instruments, namely the Infrared Camera (IRC; 1.8–26.5 $\mu$m; Onaka et al. 2007) and the Far-Infrared Surveyor (FIS; 50–180 $\mu$m; Kawada et al. 2007). *AKARI* had two observational modes; pointed observations and all-sky survey. One of the key objectives of the *AKARI* mission is to carry out an all-sky survey in the mid- and far-infrared wavelengths. *IRAS* (Infrared Astronomical Satellite, launched in 1983 by USA, UK, and the Netherlands; Neugebauer et al. 1984) carried out the first all-sky survey at four infrared wavelengths and provided catalogs of infrared sources. The *AKARI* All-Sky Survey is expected to surpass the *IRAS* survey with the higher spatial resolution, better sensitivity, and broader wavelength coverage. During the 16-months operation period with the liquid helium, *AKARI* scanned more than 96 per cent of the entire sky.

## 2. THE *AKARI* ALL-SKY POINT SOURCE CATALOGUES

The first version of the *AKARI* All-Sky point source catalogues have been in public since March 2010 and been widely used in the various fields of astronomy and astrophysics.

Figure 1 shows an all-sky distribution of the point sources in the catalogues. The IRC Point Source Catalogue (IRC-PSC) version 1 provides positions and fluxes for 870,973 sources measured at mid-infrared wavelengths centered at 9 and 18 $\mu$m (Ishihara et al. 2010). The detection limit for point sources are 50 mJy for the 9 $\mu$m and 130 mJy for the 18 $\mu$m band, respectively. The FIS Bright Source Catalogue (FIS-BSC) version 1 contains data of 427,071 sources measured at four far-infrared wavelength bands centered at 65, 90, 140, and 160 $\mu$m (Yamamura et al. 2011).

Specification of the catalogues is summarized in Table 1. FITS and text format catalogue data file and the release note can be downloaded from the *AKARI* site[1]. They are also available from *AKARI* Catalogue Archive Server (CAS[2]; Yamauchi et al. 2011) with various data search services including matching with other databases.

## 3. CATALOGUE CHARACTERISTICS

The *AKARI* point source catalogues detected much more sources than the *IRAS* point source catalog in any wavelength bands (Figure 2).

The distribution of the sources is different at different band. In 9 and 18 $\mu$m, the extra sources that *AKARI* newly detected are mostly below the *IRAS*'s detection limit, while at 90 $\mu$m *AKARI* detected more sources in any flux range. It is explained that higher spatial resolution of *AKARI* resolves sources in the crowded areas, such as the Galactic plain and molecular clouds. It is also true for nearby galaxies. *AKARI* extracted more sources from the spiral arms.

Table 2 shows the result of cross-match between *IRAS* and *AKARI* catalogues. Almost 90 per cent of the *AKARI* sources have counterpart in the *IRAS* catalogue. The matching rate decreases in the high and low flux ranges, due to saturation in the *AKARI* measurement or non-detection in the *IRAS* catalog, respectively.

[1] http://www.ir.isas.jaxa.jp/AKARI/Observation/
[2] http://darts.isas.jaxa.jp/astro/akari/

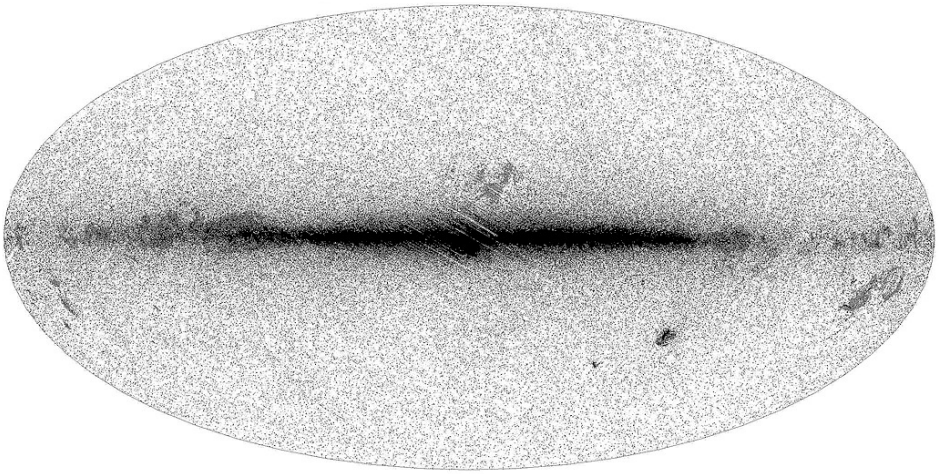

**Figure 1.** All-Sky distribution of the infrared sources based on the *AKARI* catalogues. Mid- and Far-infrared objects are shown together in the Galactic coordinates.

**Table 1.** *AKARI* All-Sky Point Source Catalogues

| | IRC PSC ver.1 | | FIS BSC ver.1 | | | |
|---|---|---|---|---|---|---|
| Band [$\mu$m] | 9 | 18 | 65 | 90 | 140 | 160 |
| Num. of sources | 844,649 | 194,551 | 29,336 | 373,819 | 117,994 | 36,646 |
| (total) | (870,973) | | (427,071) | | | |
| Detect. Lim. [mJy] | 50 | 130 | 3200 | 550 | 3800 | 7500 |
| Photo. Accur. [%] | 5 ~ 20 | 7 ~ 20 | ~ 20 | | | |
| Spatial Res. [arcsec] | ~ 7 | | 40 ~ 70 | | | |
| Pos. Uncertainty [arcsec] | 1 ~ 3 | | ~ 6 | | | |

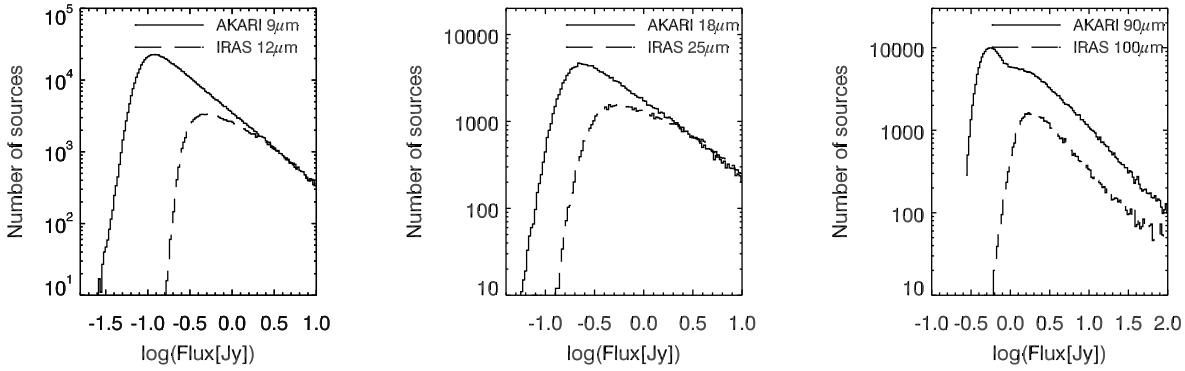


**Figure 2.** Comparison of flux number count plot between *AKARI* and *IRAS*. *AKARI* detected fainter source and increased the number of detected sources.

Care should be taken for the flux comparison between *AKARI* and *IRAS*. The ratios of the *AKARI* 90 $\mu$m flux to the *IRAS* 100 $\mu$m flux of cross-identified sources seem to be divided into two groups. This pattern is not obvious in the comparison of *AKARI* 90 $\mu$m to the *IRAS* 60 $\mu$m (Figure 3). The *IRAS* Point Source Catalog contains flags for the information of background radiation. A certain correlation between the background levels and the flux ratios of $F_{90}/F_{100}$ is found. Interstellar dust emission (cirrus component) is typically peaked around 100 $\mu$m, so it contributes to the FIR

**Table 2.** *AKARI* vs. *IRAS*; FIR sources number and cross-matched rate.

| Flux (*AKARI*90) [Jy] | *IRAS*(60) | Identified | Rate (%) | *IRAS*(100) | Identified | Rate (%) |
|---|---|---|---|---|---|---|
| $0.1 \leq F < 1$ | 18890 | 12072 | 63.9 | 1315 | 208 | 15.8 |
| $1 \leq F < 10$ | 9176 | 7997 | 87.2 | 33743 | 12650 | 37.5 |
| $10 \leq F < 100$ | 594 | 547 | 92.1 | 1278 | 1062 | 83.1 |
| $100 \leq F < 1000$ | 56 | 25 | 44.6 | 62 | 38 | 61.3 |
| $1000 \leq F$ | 7 | 1 | 14.3 | 11 | 1 | 9.1 |
| Total | 28723 | 20642 | 71.9 | 36409 | 13959 | 38.3 |

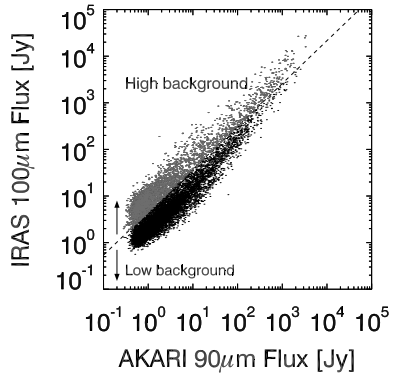


**Figure 3.** Flux correlation between *AKARI* 90 $\mu$m and *IRAS* 100 $\mu$m.

100 $\mu$m band flux significantly, especially near the Galactic plane. Since the beam sizes of the *AKARI* and *IRAS* detectors are significantly different, it is possible that *IRAS* grabbed more background radiation together with a point source and caused higher flux. This conspicuous discrepancy between the catalogues is needed to be examined in detail in the future.

## 4. FUTURE PLAN

As described in detail in Yamamura et al. (this volume), *AKARI* Far-infrared Bright Source Catalogue (BSC) is planned to be updated. Software development and data verification works continue. The revised version is expected to have better completeness, reliability, and accuracy compared to the current version. For this purpose, data reduction processes such as detector responsivity correction and dark subtraction have been re-investigated and applied to the scan data. Also, a problem of the current version, which very bright sources are removed out due to misidentification as cosmic-ray hits, will be fixed. In the source extraction process, optimization of operation parameters will improve the reliability of the detection. More accurate measurements of position and flux measurements will be implemented. Moreover, background information will be considered in the flux measurement.

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 has been obtained in the high-visibility regions near the ecliptic poles, in a test processing. Data verification and evaluation work is undergoing.

*AKARI* is a JAXA project with the participation of ESA.

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