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A SOURCE EXTRACTION METHOD FOR THE AKARI MID-IR FAINT SOURCE CATALOGUE

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ABSTRACT

We plan to produce a faint source catalogue from the AKARI mid-infrared (IR) all-sky diffuse maps. In the publicly-available AKARI mid-IR point source catalogue (PSC), sources were extracted from single-scan images, and confirmed by using the other scan images. By stacking multiple scan images, we can detect fainter sources which are not listed in the PSC. We optimized the source extraction process using a $6^\circ \times 6^\circ$ area around the star-forming region, Cepheus B. Then, we divided the all-sky data into three seasonal images, and checked the positions and the fluxes of the detected sources on the images. As a result, our new source extraction method works well; 90% of the sources are also identified in the WISE catalogue. In this method, we obtain the detection limit twice deeper than that of the PSC. The number of sources increases by a factor of 2, as compared with the PSC.

Key words: methods:data analysis; technique:photometric; stars:formation

1. INTRODUCTION

We plan to produce a faint source catalogue from the AKARI/IRC 9 and 18 μm mid-infrared all-sky survey data. The publicly-available point source catalogue (PSC; Ishihara et al., 2010) contains reliable but relatively bright sources, because point sources were extracted from single scan images. We plan to extract fainter sources by stacking all the scan images. In this case, however, it is difficult to confirm the detected sources, because there are no independent measurements. In this work, we optimized the parameters in the source extraction process and established a source confirmation method.

2. METHOD

We extracted point sources from the images made by stacking all the scan images. A source is identified, if contiguous pixels with the number of $N_{\rm pix}$ have signal values higher than a *threshold*, by using Source Extractor ver 2.8.6 (Bertin & Arnouts, 1996). In order to confirm the detected sources, we divided the stacked image into the three seasonal images, and checked the positions and the fluxes of the sources on each image. If they are consistent among the seasonal images, we take them as confirmed sources.

Table 1
The detection limit and the number of detected sources.

		PSC	This work
9 μm	Detection limit (4σ) (Jy)	0.12	0.06
	Number of sources	2439	4106
18 μm	Detection limit (4σ) (Jy)	0.22	0.12
	Number of sources	704	1190

We optimized the parameters in the source extraction process ($N_{\rm pix}$, *threshold*) using the star-forming region Cepheus B as a test field. We varied the *threshold* from 2σ to 5σ, and $N_{\rm pix}$ from 2 to 5 pixels. Figure 1a shows the flux distributions of the detected sources with $(N_{\rm pix}, threshold) = (2, 4)$ and $(2, 2)$. The flux bin which contains the largest number of sources is regarded as the

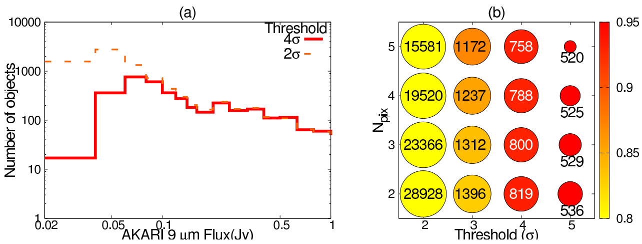

Figure 1. (a) Flux distributions of the detected sources in the 9 μm band with $N_{\rm pix} = 2$. The solid and dashed histograms indicate the sources detected with *threshold* $= 4\sigma$ and 2σ, respectively. (b) The fraction of the confirmed sources and the number of detected sources in the 9 μm band. The fraction of the confirmed sources is indicated by the color scale, while the number of sources is indicated by the size of the circle with the values.

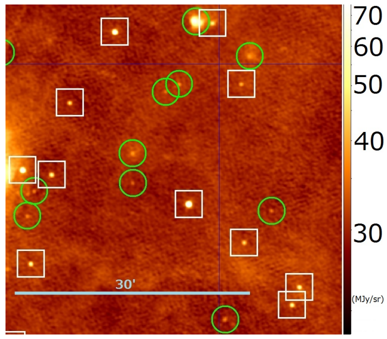

Figure 2. AKARI 9 μm image in the star-forming region, Cepheus B, made by stacking all the scan images. The field size is about $45' \times 45'$, centered at $(\alpha, \delta) = (347^\circ\!.3, 61^\circ\!.3)$. The squares indicate the PSC sources, while the circles indicate the sources newly detected on this work.

detection limit. We searched for the parameters which maximize the fraction of the confirmed sources and the number of detected sources.

3. RESULTS

Figure 1b summarizes the fraction of the confirmed sources and the number of the sources extracted for each parameter set. Based on the figure 1b, we adopted *threshold* $= 4\sigma$ and $N_{\rm pix} = 2$ as the optimized parameter set. The area of $N_{\rm pix} = 2$ is almost equivalent to the PSC sizes in the 9 and 18 μm bands. The detection limit and the number of sources extracted with the optimized parameters are summarized in Table 1. The detection limit is about twice deeper than that of the PSC, which is reasonable considering the number of stacked images. The number of detected sources is about twice larger than that of the PSC in both 9 and 18 μm bands which is smaller than expected from the 3-dimensional uniform distribution (i.e., $2^{1.5}$), probably due to the nature of the test field (Cepheus B). Figure 2 shows the distributions of the PSC sources and the newly detected sources for part of the Cepheus B region. Such faint sources not listed in the PSC are detected in this work.

4. DISCUSSION

We evaluated the reliability and the completeness of the detected sources, using the WISE catalogue (Wright et al., 2010). The reliability is defined as the number of the sources identified with WISE to that of the detected sources. The completeness is defined as a ratio of the number of the detected sources to that of the sources whose fluxes are higher than the WISE detection limit. We cross-identified the AKARI 9 and 18 μm sources with the WISE 12 and 22 μm sources, respectively. Figure 3 shows a plot between the fluxes in the AKARI 9 μm and the WISE 12 μm bands. Our cross-identifications are reliable because most of the sources show reasonable colors of stars for these bands. The small scatter may indicate objects having red continua or silicate features. Figure 4 shows the reliability and the completeness of the detected sources as a function of the flux. The reliability reaches $\sim$90% for sources brighter than the detection limit, while the completeness is lower than $\sim$90% at $<$0.5 Jy. It is because the 12 μm extended sources included in the WISE catalogue tend to be excluded in our list.

5. SUMMARY

We plan to make a faint source catalogue from the AKARI 9 and 18 μm all-sky survey data by stacking all the scan images. We extracted point sources on the stacked images and confirmed them on the three seasonal images. The parameters for the source extraction process were optimized to maximize the fraction of the confirmed sources and the number of detected sources. We carried out this study in the Cepheus B region as a test field. By applying the optimized parameters, we obtain the detection limit and the number of the detected sources twice better than those of the PSC. The reliability reaches $\sim$90% for sources brighter than the detection limit, based on the WISE catalogue.

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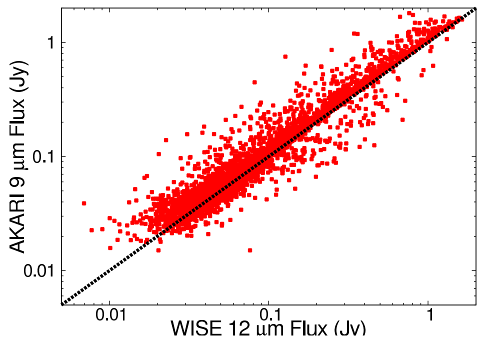

Figure 3. AKARI 9 μm fluxes versus the WISE 12 μm fluxes for the cross-identified sources. Solid line indicates the locus of stars assuming the Rayleigh-Jeans law.

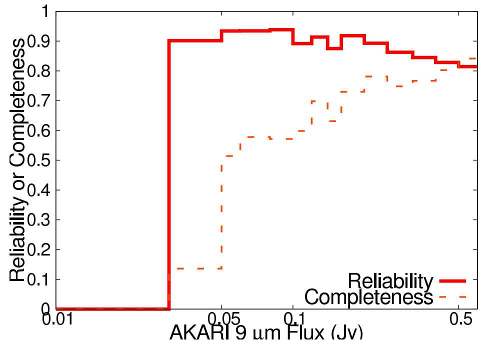

Figure 4. Reliability (solid line) and completeness (dashed line) in the AKARI 9 μm band as a function of the flux. The WISE 12 μm sources are used as references.

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