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Full length article

The IRAS PSC/FSC Combined Catalogue

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ABSTRACT

Optical identifications of a few thousands of IRAS sources showed that IRAS Point Source and IRAS Faint Source catalogues (PSC and FSC, respectively) contain many quasars and active galactic nuclei, late-type stars, planetary nebulae, variables, etc. To increase the efficiency of using IRAS PSC and FSC, which contain a lot of common sources, one needs a joint catalogue of all IRAS point sources with improved data based on both catalogues. However, cross-correlation of the catalogues is not so easy, as the association of many sources is relative, and not always it is obvious, whose source from one catalogue corresponds to the other one in the second catalogue. This problem exists in case of using standard cross-correlation tools like VizieR. Therefore, we have created a tool for cross-matching astronomical catalogues and we have applied it to IRAS PSC and FSC. Using this tool we have carried out identifications with a search radius corresponding to 3 σ of errors for each source individually rather than a standard radius for all sources. As a result, we obtained 73,770 associations. We showed that in case of cross-correlation of these catalogues by VizieR, we had to take 161.95 arcseconds radius not to lose any association; however, in this case a lot of false associations appear for many sources. In addition, we have made cross-correlations with AKARI-IRC, AKARI-FIS and WISE catalogues. As a result we created a catalogue with high positional accuracy and with 17 photometric measurements from 1.25 to 160 μm range, providing a detailed catalogue for IRAS point sources.

1. Introduction

Optical identification of IRAS sources revealed that IRAS Point Source Catalogue (PSC) and Faint Source Catalogue (FSC) contain many quasars and other active galactic nuclei (AGN), late-type stars, planetary nebulae (PN), variables, etc. To be able to effectively use the IRAS catalogues containing many common sources, it is desirable to have a joint catalogue of all IRAS point sources with improved data on the basis of both databases. However, the cross-correlation of catalogues is a tricky task, since many associations of sources are relative and it is not always clear what sources from one database coincide with another database.

To study the IR point sources we took IRAS PSC and FSC catalogues. They were created in 1986 (IRAS PSC) and 1989 (IRAS FSC), and provide information of fluxes at wavelengths 12, 25, 60 and 100 μm. IRAS PSC contains 245,889 sources and IRAS FSC contains 173,044 sources at galactic latitude $|b| > 10°$.

Each source in these catalogues has coordinate errors. We did a cross-correlation between IRAS PSC and FSC and considered errors for each source; we took those identifications having positional errors between the sources not exceeding 3σ (which corresponds to 99.73% probability). For that, in frame of the Armenian Virtual Observatory (ArVO), we created a software through which we made cross-correlations (Knyazyan et al., 2011). To obtain information about fluxes in other IR bands we did cross-correlation using the same method with AKARI-IRC All-Sky Survey Point Source Catalogue (Ishihara et al., 2010), AKARI-FIS All-Sky Survey Bright Source Catalogue (Yamamura et al., 2010) and used VizieR for WISE catalogue (Wright et al. 2012) having very accurate positions. We give in Table 1 the main characteristics of the catalogues IRAS-PSC, IRAS-FSC, AKARI-IRC, AKARI-FIS and WISE, including the number of sources.

WISE also gives 2MASS point source JHK data (Cutri et al., 2003), given in Table 1 WISE photometric bands.

Though IRAS sensitivity is much smaller than that of WISE and may also be worse than that of AKARI (however, AKARI fluxes are not always reliable), IRAS provides data for longer wavelengths absent in WISE; this is especially useful for extragalactic studies. That is why IRAS data still remains helpful.

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2213-1337/

Table 1
Main characteristics of IRAS-PSC, IRAS-FSC, AKARI-IRC, AKARI-FIS and WISE catalogues.

Catalogues	IRAS-PSC	IRAS-FSC	AKARI-IRC	AKARI-FIS	WISE
Year	1986	1989	2010	2010	2012
Wavebands (μm)	12, 25, 60, 100	12, 25, 60, 100	9, 18	65, 90, 140, 160	3.4, 4.6, 11.6, 22.6, 1.25, 1.65, 2.17
Wavelengths (μm)	8–120	8–120	6.7–25.6	50–180	2.6–28
Resolution (″)	40	20	0.3	0.8	0.5
Sensitivity (Jy)	0.25, 0.25, 0.4, 1.0	0.1–0.5	0.05, 0.12	∼0.55	0.00008–0.006
Sky area	All-sky	$\|b\| > 10°$	All-sky	All-sky	All-sky
Coverage (%)	96	83	94	98	99
Source number	245,889	173,044	870,973	427,071	563,921,584

Having the Combined Catalogue, we can in the future provide answers to many questions associated with these sources.

2. Cross-correlation of IRAS-PSC and IRAS-FSC

In catalogues IRAS-PSC and IRAS-FSC, for each source we have positional errors given as Minor and Major axes, which relate to the orientation of the satellite during the observations. For cross-correlations, we used Major and average axes positional errors for each object. We created a software through which we made cross-correlations. This software allows considering positional errors for each source individually and we have taken identifications having coordinate differences between counterparts not exceeding 3σ (calculated using both sigmas from PSC and FSC). As a result, we obtained 73,770 identifications when using the Major axes and 72,777 when using the average errors. To avoid losing identifications, finally we build our Catalogue using identification with Major axes.

Some sources have two or more associations. For these sources we take associations using the following criteria:

(1) the first (nearest by distance) association is taken, if the second one (and others) is 3 times farther than the first one (these are the best identifications and we call them Category 1). We have 58,296 (79%) such associations.
(2) in case of positional ambiguity (when the genuine association is not clear as in Category 1), we take those associations having close fluxes (coincidence within 20%) and quality flags indicating the same nature of objects. We call them Category 2 associations and we have 10,488 (14%) such cases.
(3) the first (nearest by distance) association is taken, if the second one (and others) is 2 times farther than the first one (weaker criterion giving worst identifications). We call them Category 3 associations and we have 4901 (7%) such cases.

We are left with 85 worse associations, which also may be regarded as genuine ones with weaker criteria.

We have built a distribution of the number of objects from distances of their identifications. Fig. 1 shows that the majority of identified objects have limited distance and we have derived by interpolation with polynomial fit that 73.4 arcsec should be taken as the radius of reliable associations. Bin size is 25 arcsec.

We calculated the positional errors root mean square (rms) between IRAS-PSC and IRAS-FSC. For this, we calculated the rms for all sources in IRAS-PSC and for sources with the module of galactic latitude more than ten (because for all sources in IRAS-FSC $|b| > 10°$). For identifications with the Major axes we obtained $\langle \mathrm{rms} \rangle = 50.14''$, and $\langle \mathrm{rms} \rangle = 53.98''$, respectively. For the average axes errors we obtain for all objects $\langle \mathrm{rms} \rangle = 31.07''$, and for $|b| > 10°$ sources, $\langle \mathrm{rms} \rangle = 33.96''$. So in average higher galactic latitude sources in IRAS-PSC have larger errors; this may be connected with the fact that they contain more galaxies with smaller fluxes and hence worse positions.

To verify our data, we have made cross-correlations using VizieR with search radius $3 * \langle \mathrm{rms} \rangle$ (thus 161.95″ for Major axis errors and 101.87″ for average axes errors). Cross-correlations of catalogues with a list of targets are used. As a result, for the Major axes errors we have lost 319 real identifications and added 350 false identifications, having in total 73,801 identifications compared to 73,770 when using our software. And for the average axes errors we have lost 238 real identifications and added 621 false identifications, having in total 73,160 identifications compared to 72,777 when using our software.

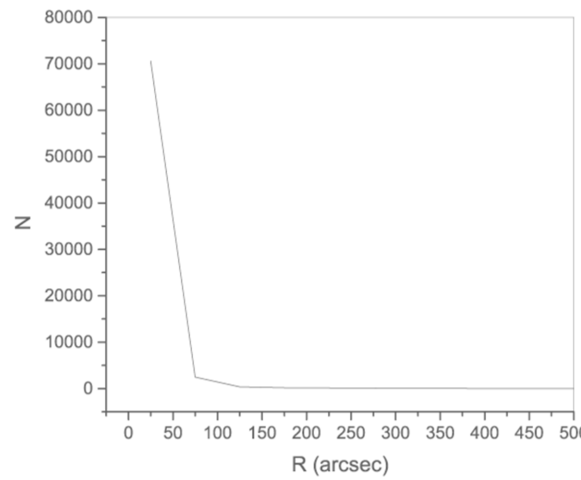

Fig. 1. Distribution of the number of sources by distances of their identifications (IRAS-PSC and IRAS-FSC).

For cross-correlations with IRAS catalogues most astronomers use search radius 60″. However, as we see from the comparison and analysis of these identification tools, if we take 60″ for cross-correlations, then we lose many genuine associations.

3. Calculation and improvement of positions and fluxes

Given that there are 73,770 common sources from IRAS-PSC and IRAS-FSC, the IRAS PSC/FSC Combined Catalogue contains 345,163 sources. This is the number of IRAS all-sky survey point sources (not counting the Serendipitous Sky Survey, IRAS-SSC, Kleinmann et al., 1986). As mentioned, 73,770 sources have data from both IRAS-PSC and IRAS-FSC. To ensure the reliability of our identifications, we give in Fig. 2 a comparison of the fluxes of these common sources from IRAS-PSC and IRAS-FSC. At 12, 25 and 60 μm fluxes very well coincide, however for 100 μm (and for some sources also at 60 μm) we see larger deviations probably due to poor flux measurements at 60 and 100 μm, especially in IRAS-PSC. The discrete limits on the diagrams appear due to flux limits in PSC catalogue at 12, 25, 60 and 100 μm (0.25, 0.25, 0.40 and 1.00 mJy respectively) and in FSC at 100 μm (1.00 mJy).

For 73,770 common sources from the new IRAS PSC/FSC Combined Catalogue, we calculated the best coordinates using statistical weights K_{PSC} and K_{FSC} for PSC and FSC positions, respectively, using formulae 1 and 2.

$$K_{PSC} = \frac{A^2}{A^2 + B^2} \tag{1}$$

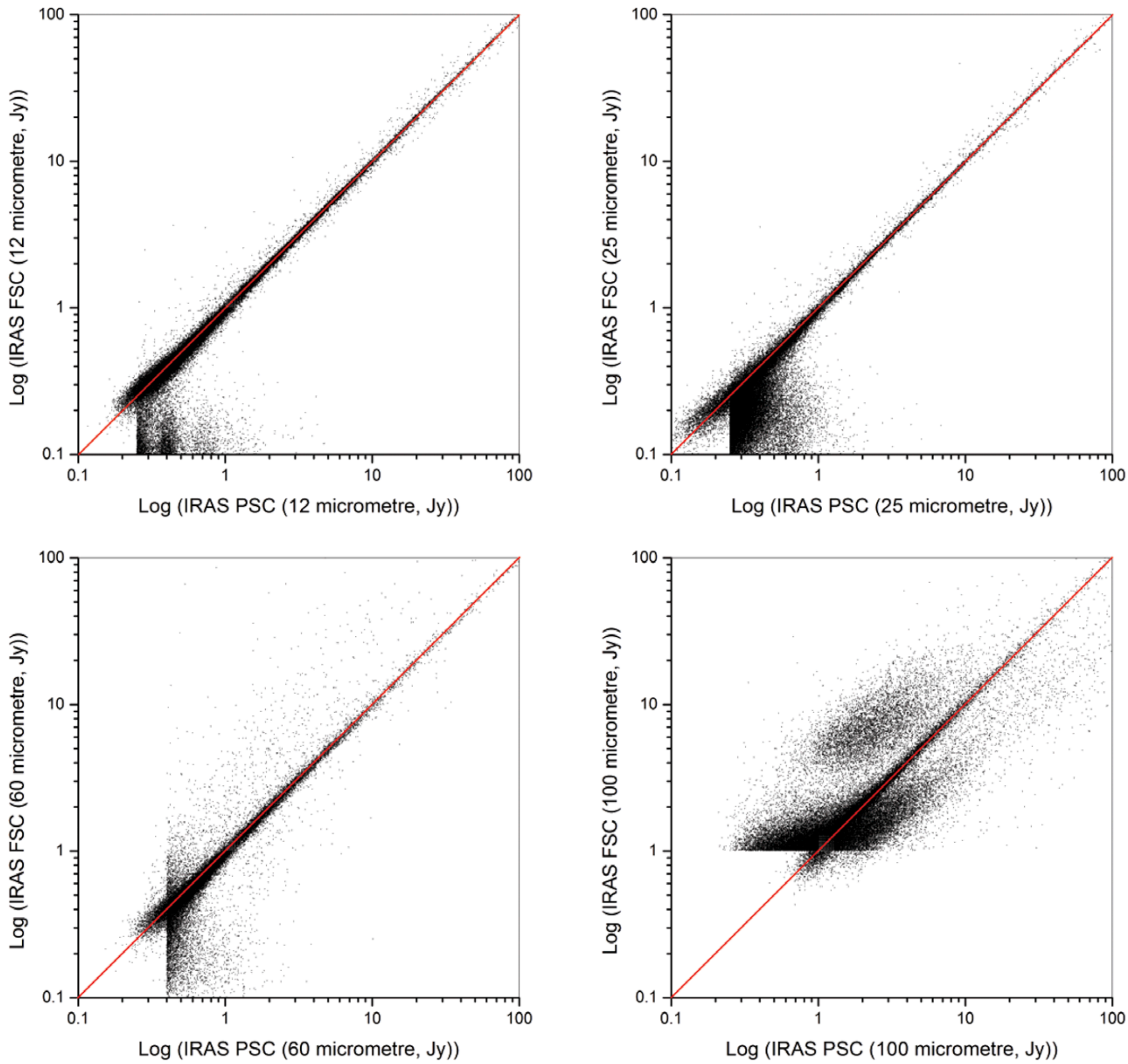

Fig. 2. Comparison of fluxes for associated sources from IRAS-PSC and IRAS-FSC from 12 to 100 μm.

$$K_{FSC} = \frac{B^2}{A^2 + B^2} \tag{2}$$

where A is the mean positional rms in IRAS-FSC and B is the mean positional rms in IRAS-PSC.

We calculate the best coordinates α_{best} and δ_{best} using formulae 3 and 4.

$$\alpha_{best} = K_{PSC} * \alpha_{PSC} + K_{FSC} * \alpha_{FSC} \tag{3}$$

$$\delta_{best} = K_{PSC} * \delta_{PSC} + K_{FSC} * \delta_{FSC} \tag{4}$$

where α_{PSC}, δ_{PSC}, α_{FSC} and δ_{FSC} are corresponding coordinates of IRAS-PSC and IRAS-FSC.

Having the best coordinates we calculated the errors α_e and δ_e for the 73,770 common sources from the IRAS PSC/FSC Combined Catalogue using formulae 5 and 6.

$$\alpha_e = \sqrt{\frac{((\alpha_{best} - \alpha_{PSC}) * \cos\delta)^2 + ((\alpha_{best} - \alpha_{FSC}) * \cos\delta)^2}{2}} \tag{5}$$

$$\delta_e = \sqrt{\frac{(\delta_{best} - \delta_{PSC})^2 + (\delta_{best} - \delta_{FSC})^2}{2}} \tag{6}$$

where α_e is the error of α and δ_e is the error of δ.

For 73,770 common sources we give improved Minor and Major axes errors of coordinates calculated using formulas 7 and 8.

$$Major = \sqrt{\frac{1}{\left(\frac{1}{Major_{PSC}}\right)^2 + \left(\frac{1}{Major_{FSC}}\right)^2}} \tag{7}$$

$$Minor = \sqrt{\frac{1}{\left(\frac{1}{Minor_{PSC}}\right)^2 + \left(\frac{1}{Minor_{FSC}}\right)^2}}. \tag{8}$$

For these 73,770 common sources we use fluxes (at 12, 25, 60 and 100 μm) from IRAS-FSC, because they are better measured and have less errors.

4. Cross-correlation of IRAS PSC/FSC with AKARI-IRC and AKARI-FIS

Using our cross-correlation software and the same methods as for building the Combined IRAS PSC/FSC, we carried out cross-correlations of IRAS PSC/FSC with AKARI-IRC and AKARI-FIS using the best positions for 73,770 common sources.

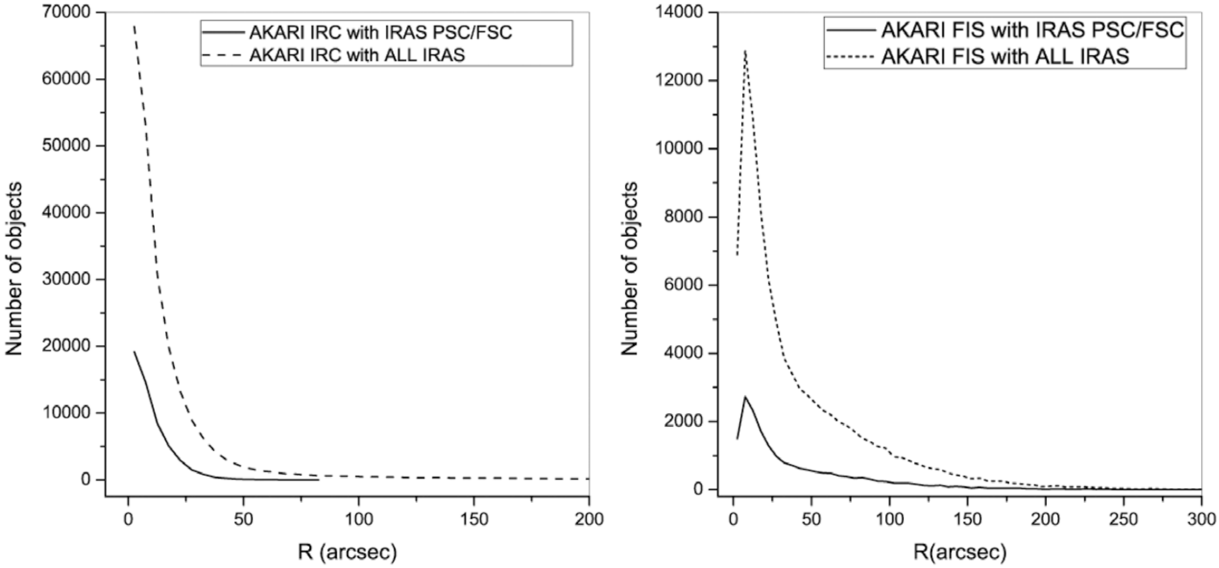

Fig. 3. Distribution of the number of objects by their positional distances between AKARI-IRC, AKARI-FIS and IRAS.

With this software, we took for each source as real associations only those having positional distance between the sources not exceeding 3σ of individual errors.

As a result, we obtained 225,165 identified sources from AKARI-IRC and 90,946 ones from AKARI-FIS. There are sources having two or more identifications; we select the appropriate identification with the same criteria as in case of building the IRAS PSC/FSC Combined Catalogue.

In Fig. 3 we have built the distribution of the number of sources for AKARI-IRC and AKARI-FIS by positional distances between AKARI sources and IRAS common 73,770 sources and all IRAS sources.

From the AKARI-IRC catalogue, we have fluxes at 9 and 18 μm, and the AKARI-FIS catalogue gives fluxes for 65, 90, 140 and 160 μm. For comparison of IRAS and AKARI fluxes we use 12, 25, 60 and 100 μm fluxes from IRAS and 9, 18, 65 and 90 μm fluxes from AKARI, which are more or less close to IRAS. The comparison of these fluxes is given in Fig. 4. These fluxes better coincide for IRAS 12 and AKARI 9 μm, and more or less for IRAS 25 and AKARI 18 μm. We see larger errors for IRAS 60 and AKARI 65 μm and there is no match for IRAS 100 and AKARI 90 μm. By comparison with some other data, particularly with Spitzer (at 24 μm), we conclude that AKARI catalogues have large flux errors, especially at larger wavelengths. However, cross-matching with AKARI catalogues provided very reliable coordinates compared to IRAS ones.

5. Cross-correlation of IRAS PSC/FSC with WISE

Cross-correlation of IRAS PSC/FSC with WISE allows us complement the photometric data for IRAS sources, particularly fluxes at 3.35, 4.6, 11.6 and 22.1 μm, as well as JHK 1.25, 1.65 and 2.17 μm (2MASS) also given in WISE. In order to make cross-correlation with WISE we again refined the IRAS PSC/FSC coordinates; they were taken in the following order: (1) AKARI-IRC when available, (2) AKARI-FIS when available and in case AKARI-IRC were absent, (3) improved coordinates for IRAS PSC/FSC common sources, (4) IRAS FSC, and (5) IRAS PSC (Table 2).

Due to large number of entries in WISE, cross-correlation was not possible with our software. That was why we made the cross-correlation using VizieR and the following criteria: (1) with a search radius of 3″ with coordinates from AKARI-IRC, (2) with a search radius of 15″ with coordinates from AKARI-FIS, (3) with a search radius of 20″ with coordinates from IRAS PSC/FSC, and (4) with a search radius of 30″ with coordinates from IRAS PSC or IRAS FSC.

As a result, out of 345,163 sources from the IRAS PSC/FSC Combined Catalogue, only 240 do not have identifications in WISE. We now have 17 photometric bands with IR fluxes ranging from 1.25 to 160 μm.

In all used catalogues, photometric measurements are given in fluxes, and only in WISE they are in magnitude units. To be able to compare the fluxes, we have transformed magnitudes to fluxes in Jy using formula 9 for 2MASS fluxes and formula 10 for WISE fluxes.

$$F_{\upsilon} = C * 2.512^{-F_m} \tag{9}$$

$$F_{\upsilon} = D * 10^{\frac{-F_m}{2.5}} \tag{10}$$

where F_{υ} and $-F_m$ are fluxes accordingly in units of "Jy" and "mag", and C and D are constants (zero points) which are given in Table 3.

We have built the distribution of flux differences between the IRAS PSC/FSC 12 and WISE 11.6 μm (Fig. 5). Though the scatter is very large, the figure shows that there is no systematic shift in IRAS data and they may be taken into account for rough calculations (slight systematic shift may be due to difference in IRAS and WISE photometric bands, 12 μm compared to 11.6 μm). Most probably, large differences should be related not only to large measurement errors, but also to the existence of some variable sources.

We group identified WISE sources into 3 categories:

(1) Best identifications. These have similar fluxes at 11.6 and 12 μm and having identification distance no more than 1σ and the distance of the second identification is more than 3σ,
(2) Reliable identifications. They have similar fluxes at 11.6 and 12 μm and identification distance no more than 3σ,
(3) Probable identifications. They have similar fluxes at 11.6 and 12 μm and identification distance greater than 3σ.

There are 173,804 sources in the first category, 134,244 in the second category and 36,875 ones in the third category. We consider identifications in the third category questionable.

WISE coordinates compared to IRAS and AKARI have very high accuracy, so for our joint catalogue of IRAS PSC/FSC, the coordinates are taken in the following order:

(1) coordinates from WISE (for the first and the second category of identifications) (typical accuracy <1″),
(2) coordinates from AKARI/IRC (typical accuracy <1″),
(3) coordinates from AKARI/FIS (typical accuracy <1″),
(4) improved IRAS PSC/FSC coordinates (typical accuracy 15″),
(5) coordinates from IRAS FSC (typical accuracy 20″),
(6) coordinates from IRAS PSC (typical accuracy 40″).

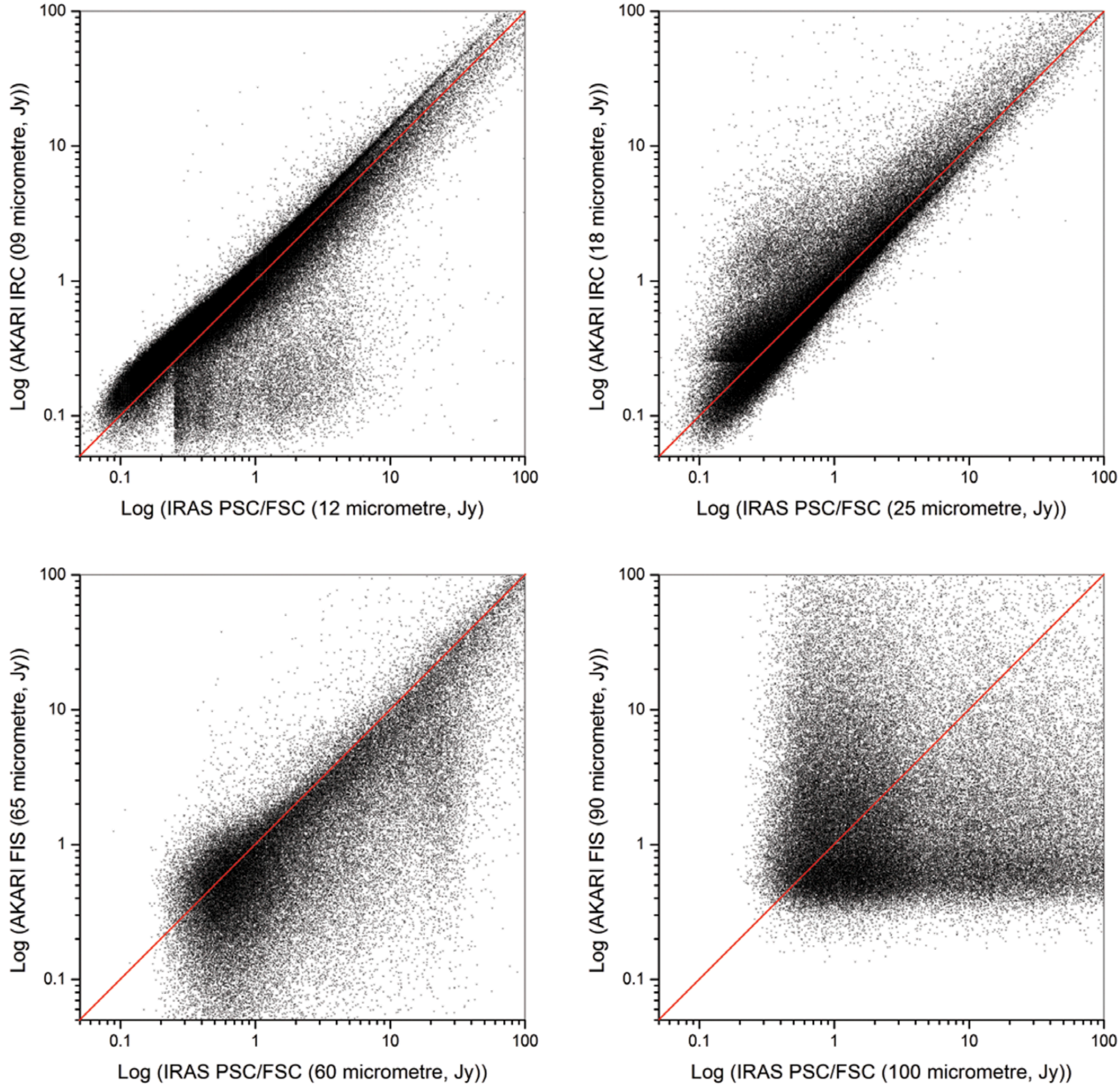

Fig. 4. Comparison of fluxes from AKARI and IRAS.

Table 2
Number and typical accuracy of coordinates in IRAS PSC/FSC taken from each cross-correlated catalogue to match with WISE sources.

Catalogues	IRAS-PSC	IRAS-FSC	IRAS PSC/FSC	AKARI-IRC	AKARI-FIS
Number of sources	39,138	31,073	14,332	225,165	35,455
Typical accuracy (″)	40	20	15	0.3	0.8

Table 3
Photometric zero points for calculation of fluxes in 2MASS and WISE catalogues.

2MASS C constants			WISE D constants			
Jmag 1.25 μm	Hmag 1.65 μm	Kmag 2.17 μm	W1mag 3.35 μm	W2mag 4.6 μm	W3mag 11.6 μm	W4mag 22.6 μm
1594	1020	666.7	305.54	171.782	31.674	8.363

6. Classification of objects

For our IRAS PSC/FSC Combined Catalogue we give the probability of classification for each source into "star" or "galaxy". For this purpose we used fluxes and quality flags from IRAS and other catalogues. If IRAS source is confidently identified with AKARI-IRC and there is no match in AKARI-FIS, then in all probabilities the object is a star, and if an IRAS source is detected in AKARI-FIS without a record in AKARI-IRC, then in all probabilities the object is a galaxy. For brighter sources, when all records are available, we use the IR colours, i.e. we follow the change of the flux from shorter to longer wavelengths; in case of a decrease it is a high probability star and in case of an increase it is a high probability galaxy. We can in fact estimate the type of all sources based on IRAS flux and quality flag data,

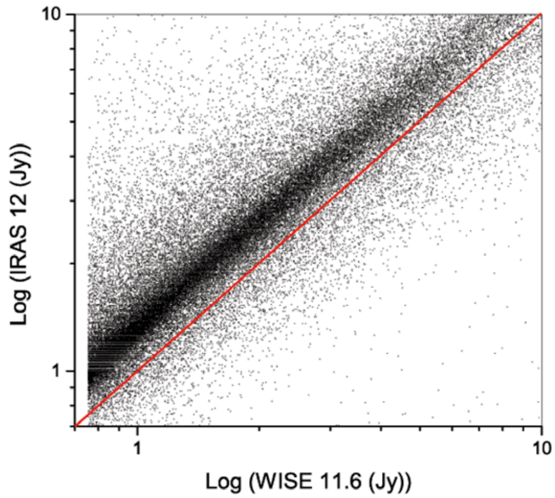

Fig. 5. Comparison of IRAS PSC/FSC 12 μm and WISE 11.6 μm fluxes.

as well as on AKARI and WISE/2MASS measurements. If all data show the same type of object, then we give it as a genuine one, and if there is a ambiguity, we give the most probable type with a flag.

A better classification using all data for these sources will be made in further works, including cross-correlations with existing catalogues of QSOs, active galaxies, bright galaxies and stars, late-type stars, variable stars, nebulae, etc.

In Fig. 6, for a possible star and a galaxy we built spectral energy distributions (SED) based on our collected data from NIR 2MASS JHK to FIR IRAS and AKARI. The star is IRAS 00012 + 7614 = IRAS F00012 + 7614 and the galaxy is IRAS F00041-3446. These sources were chosen as examples because they are very typical for stars and galaxies. The star is TYC 4492-1689-1 (V = 10.43) and the source chosen as a galaxy is also the radiosource NVSS J000639-342943.

7. The IRAS PSC/FSC Combined Catalogue

For the IRAS PSC/FSC Combined Catalogue, we have not only combined sources from IRAS-PSC and IRAS-FSC but also collected corresponding better data from AKARI and WISE catalogues. Numbers of sources found in all catalogues are given in Table 4.

IRAS sources found in WISE are especially useful to have accurate NIR/MIR fluxes for these sources, which may be IR galaxies based on IRAS longer wavelength measurements.

The IRAS PSC/FSC Combined Catalogue is available electronically at VizieR database and contains the following data:

IRAS-PSC data

Column 1: IRAS-PSC source name
Column 2: RAJ2000 (h:m:s)
Column 3: DEJ2000 (d:m:s)
Column 4: RAJ2000 (deg.)
Column 5: DEJ2000 (deg.)
Column 6: Uncertainty ellipse Major axis
Column 7: Uncertainty ellipse Minor axis
Column 8: Uncertainty ellipse Position Angle (PA)
Column 9: Average non-colour corrected flux density, 12 μm
Column 10: Average non-colour corrected flux density, 25 μm
Column 11: Average non-colour corrected flux density, 60 μm
Column 12: Average non-colour corrected flux density, 100 μm
Column 13: Quality flags 1–3 (flux density quality) for 12 μm
Column 14: Quality flags 1–3 (flux density quality) for 25 μm
Column 15: Quality flags 1–3 (flux density quality) for 60 μm
Column 16: Quality flags 1–3 (flux density quality) for 100 μm

IRAS-FSC data

Column 17: IRAS-FSC source name
Column 18: RAJ2000 (h:m:s)
Column 19: DEJ2000 (d:m:s)
Column 20: RAJ2000 (deg.)
Column 21: DEJ2000 (deg.)
Column 22: Uncertainty ellipse Major axis
Column 23: Uncertainty ellipse Minor axis
Column 24: Uncertainty ellipse Position Angle (PA)
Column 25: Average non-colour corrected flux density, 12 μm
Column 26: Average non-colour corrected flux density, 25 μm
Column 27: Average non-colour corrected flux density, 60 μm
Column 28: Average non-colour corrected flux density, 100 μm
Column 29: Quality flags 1–3 (flux density quality) for 12 μm
Column 30: Quality flags 1–3 (flux density quality) for 25 μm
Column 31: Quality flags 1–3 (flux density quality) for 60 μm
Column 32: Quality flags 1–3 (flux density quality) for 100 μm

IRAS PSC/FSC Combined Catalogue data

Column 33: The best PSC/FSC RAJ2000 (deg.)
Column 34: The best PSC/FSC DEJ2000 (deg.)
Column 35: Flag for combined coordinate
Column 36: Positional error for RAJ2000
Column 37: Positional error for DEJ2000
Column 38: Uncertainty ellipse Major axis
Column 39: Uncertainty ellipse Minor axis
Column 40: Uncertainty ellipse Position Angle (PA)
Column 41: Distance between PSC and FSC (r)
Column 42: Relative distance K (in fractions of σ)
Column 43: Average non-colour corrected flux density, 12 μm
Column 44: Average non-colour corrected flux density, 25 μm
Column 45: Average non-colour corrected flux density, 60 μm
Column 46: Average non-colour corrected flux density, 100 μm
Column 47: Flag for flux
Column 48: Classification (type: star or galaxy)

AKARI-IRC

Column 49: AKARI-IRC source name (HHMMSSs + DDMMSS)
Column 50: RAJ2000 (deg.)
Column 51: DEJ2000 (deg.)
Column 52: Major axis of position error ellipse
Column 53: Minor axis of position error ellipse
Column 54: Position Angle (PA) of Major axis
Column 55: Distance (r) (IRAS PSC/FSC to AKARI IRC)
Column 56: Relative distance K (in fractions of σ) (IRAS PSC/FSC to AKARI IRC)

Column 57: Flux density in AKARI/S9W filter
Column 58: Flux density in AKARI/L18W filter
Column 59: Flux error in S9W
Column 60: Flux error in L18W
Column 61: Flux quality flags 0–3 for S9W (values are either 3(good quality) or 0 (not observed))
Column 62: Flux quality flags 0–3 for L18W (values are either 3(good quality) or 0 (not observed))
Column 63: Radius of source extent in S9W
Column 64: Radius of source extent in L18W

AKARI-FIS

Column 65: AKARI-FIS source name (HHMMSSs + DDMMSS)
Column 66: RAJ2000 (deg.)
Column 67: DEJ2000 (deg.)
Column 68: Positional error
Column 69: Distance (r) (IRAS PSC/FSC to AKARI FIS)

(*continued on next page*)

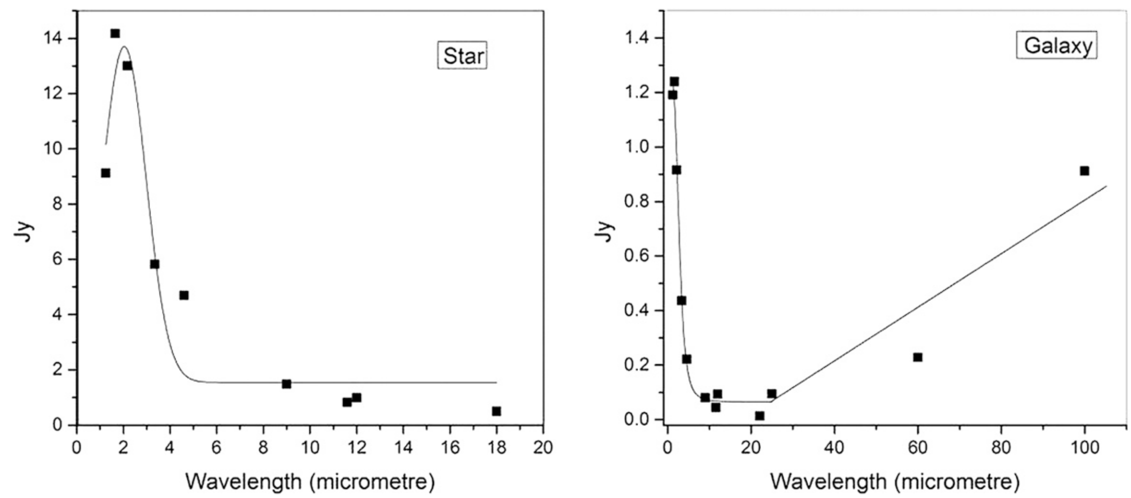

Fig. 6. "Star" (IRAS 00012 + 7614 = IRAS F00012 + 7614) and "Galaxy" (IRAS F00041-3446) SEDs based on 2MASS, WISE, AKARI and IRAS photometric data.

Table 4
Number of identified sources in IRAS, AKARI and WISE catalogues.

IRAS-PSC 1988	IRAS-FSC 1989	IRAS PSC/FSC 2014	AKARI-IRC 2010	AKARI-FIS 2010	WISE 2012
245,889	173,044	345,163	225,165	90,946	344,923

Column 70: Relative distance K (in fractions of σ) (IRAS PSC/FSC to AKARI FIS)
Column 71: Flux density in N60
Column 72: Flux density in WIDE-S
Column 73: Flux density in WIDE-L
Column 74: Flux density in N160
Column 75: Uncertainty in N60
Column 76: Uncertainty in WIDE-S
Column 77: Uncertainty in WIDE-L
Column 78: Uncertainty in N160
Column 79: Quality flags 0–3 for N60
Column 80: Quality flags 0–3 for WIDE-S
Column 81: Quality flags 0–3 for WIDE-L

WISE

Column 82: WISE All-Sky Release Catalogue name, based on J2000 positional designation
Column 83: Right ascension (J2000)
Column 84: Declination (J2000)
Column 85: Right ascension (J2000) (deg.)
Column 86: Declination (J2000) (deg.)
Column 87: Semi-major axis of the error ellipse
Column 88: Semi-minor axis of the error ellipse
Column 89: Position Angle (PA) of the error ellipse
Column 90: Distance (r) between IRAS PSC/FSC and WISE
Column 91: 2MASS J magnitude Red values corresponding to upper limits ($S/N < 2$) (1.25 μm) (mag)
Column 92: 2MASS J magnitude Red values corresponding to upper limits ($S/N < 2$) (1.25 μm) (Jy)
Column 93: 2MASS H magnitude Red values corresponding to upper limits ($S/N < 2$) (1.65 μm) (mag)
Column 94: 2MASS H magnitude Red values corresponding to upper limits ($S/N < 2$) (1.65 μm) (Jy)
Column 95: 2MASS Ks magnitude Red values corresponding to upper limits ($S/N < 2$) (2.17 μm) (mag)
Column 96: 2MASS Ks magnitude Red values corresponding to upper limits ($S/N < 2$) (2.17 μm) (Jy)
Column 97: WISE W1 magnitude Red values corresponding to upper limits ($S/N < 2$) (3.35 μm) (mag)
Column 98: WISE W1 magnitude Red values corresponding to upper limits ($S/N < 2$) (3.35 μm) (Jy)
Column 99: WISE W2 magnitude Red values corresponding to upper limits ($S/N < 2$) (4.6 μm) (mag)
Column 100: WISE W2 magnitude Red values corresponding to upper limits ($S/N < 2$) (4.6 μm) (Jy)
Column 101: WISE W3 magnitude Red values corresponding to upper limits ($S/N < 2$) (11.6 μm) (mag)
Column 102: WISE W3 magnitude Red values corresponding to upper limits ($S/N < 2$) (11.6 μm) (Jy)
Column 103: WISE W4 magnitude Red values corresponding to upper limits ($S/N < 2$) (22.1 μm) (mag)
Column 104: WISE W4 magnitude Red values corresponding to upper limits ($S/N < 2$) (22.1 μm) (Jy)
Column 105: Mean error on 2MASS J magnitude
Column 106: Mean error on 2MASS H magnitude
Column 107: Mean error on 2MASS Ks magnitude
Column 108: Mean error on W1 magnitude (3.35 μm)
Column 109: Mean error on W2 magnitude (4.6 μm)
Column 110: Mean error on W3 magnitude (11.6 μm)
Column 111: Mean error on W4 magnitude (22.1 μm)
Column 112: [0,3] Distance separating the positions of the WISE source and associated 2MASS-PSC source
Column 113: Flag for identification (IRAS PSC/FSC 12 μm, WISE 11.6 μm)
Column 114: Category of identification (1—Best, 2—Reliable, 3—Probable)

Best coordinates

Column 115: RAJ2000 (deg.)
Column 116: DEJ2000 (deg.)
Column 117: Glon best
Column 118: Glat best
Column 119: Best coordinate flag (source catalogue)

8. Summary and results

We have created a software through which we made cross-correlations with search radius for each source individually based on its positional error, taking only those associations having positional distance between sources not exceeding 3σ.

We have created the IRAS PSC/FSC Combined Catalogue to show the efficiency of the software and to have a joint IRAS catalogue for further statistical studies and investigations of individual sources. IRAS PSC/FSC contains 345,163 sources, including 73,770 common ones from both catalogues (IRAS-PSC and IRAS-FSC). We calculated the improved coordinates for these 73,770 sources, as well as individual positional errors based on shifts of IRAS-PSC and IRAS-FSC positions. We also have calculated improved Minor and Major axes coordinates errors.

For all sources of IRAS-FSC the module of galactic latitudes is more than ten ($|b| > 10°$). Cross-correlations between the IRAS-PSC and IRAS-FSC showed that 28,379 sources from IRAS-PSC with $|b| > 10°$ do not have identification in IRAS-FSC, which should not happen as IRAS-FSC is deeper. The reasons for this could be: (1) these entries have very poor quality fluxes and are not reliable sources, so they are not included in IRAS-FSC, (2) these are variable objects, and (3) these are false sources (cirruses; they are not detected in 12 and 25 μm and in 60 and 100 μm they are given with upper limits of fluxes).

We have shown that in case of the cross-correlations of IRAS-PSC and IRAS-FSC catalogues with VizieR, not to lose any associations, we need to take a search radius of $161.95''$. With the VizieR cross-correlation system, we also have proved that our software works satisfactorily.

With the same software we complemented our Combined Catalogue with more IR fluxes from AKARI and WISE catalogues. Thus we have 17 IR fluxes in the range from 1.25 to 160 μm: 4 from IRAS, 6 from AKARI, 4 from WISE and 3 from 2MASS.

For our IRAS PSC/FSC Combined Catalogue we give the probability of classifying each source into star or galaxy.

We show that AKARI-IRC covers 85% and AKARI-FIS covers 26% of the IRAS PSC/FSC Combined Catalogue, which underlines the shallow depth of AKARI data.

For the IRAS PSC/FSC Combined Catalogue we refined coordinates using WISE, AKARI-IRC, AKARI-FIS and improved coordinates from IRAS PSC/FSC.

In the future, we are going to carry out the following studies:

(1) a thorough classification of these objects using data from SDSS,
(2) building SEDs of these objects in the IR range to understand what types of SEDs have stars and galaxies and if it is possible to classify star and galaxies using IR SEDs,
(3) having X-ray (ROSAT, Chandra, XMM), optical (SDSS) and radio (FIRST, NVSS, GB6) data, we will try to understand how IR fluxes relate to optical, X-ray and radio fluxes, which IR sources are bright radio and X-ray sources and what it involves.

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Further reading

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