Far-infrared observations of extragalactic objects measured with ISOPHOT in mini-map mode

Attila Moór, Péter Ábrahám, Csaba Kiss, Szilárd Csizmadia

Konkoly Observatory, Budapest, Hungary

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1 Introduction

The mini-map observing mode was one of the most efficient ways of obtaining point source photometry with the ISOPHOT C100 and C200 detectors. It was also the mode used for FCS calibration observations. C100 mini-maps are typically 3x3 raster maps performed in satellite coordinate system centered on the source. In the recommended and most frequently used configuration $\Delta M = \Delta N = 46''$ (one detector pixel) in combination with an odd number of raster steps in both directions. For the C200 detector the usual configuration was $\Delta M = \Delta N = 92''$ together with an even number of raster steps. For a discussion of the special features and advantages of this observing mode see our report "Far-infrared observations of normal stars measured with ISOPHOT in mini-map mode" (Moór et al. 2003; hereafter Report I).

In Report I we described the recalibration of the mini-map mode and compiled a catalogue including recalibrated fluxes of 555 measurements of 229 normal stars. In the present work we (1) collect 774 far-infrared mini-map measurements of 325 extragalactic objects; (2) reprocess them following the scheme developed in Report I; and (3) compile a catalogue from the sample. The results are available as a Highly Processed Data Product (HPDP) in the ISO Data Archive.

2 Data-base of extragalactic objects observed in mini-map mode

In order to create a database of extragalactic objects we searched the ISO Archive for observations according to the following criteria:

- AOT P22 and P99 rasters with raster step numbers of $2 \leq \mathrm{M} \leq 7$ and $2 \leq \mathrm{N} \leq 7$ for the C100 and $2 \leq \mathrm{M} \leq 6$ and $2 \leq \mathrm{N} \leq 6$ for the C200 detector array;
- raster step sizes in the range $20'' - 70''$ for the C100, and $40'' - 100''$ in the case of the C200 detector;
- keywords : elliptical galaxies, normal galaxies, compact galaxies, quasars, active galactic nuclei, BL Lac objects, irregular galaxies, galaxy formation, starburst galaxies or the target of the observation is classified as an extragalactic object based on its Simbad code for object type;

This query resulted in 579 TDT numbers including 774 mini-maps. These measurements belong to 66 different proposals.

3 Data processing

In the course of processing we followed basically the data reduction scheme as documented in details in Report I. Deviations from this scheme are listed below:

3.1 Drift correction

A mini-map measurement lasts typically 400-500 sec, and on this timescale slow baseline variations, called 'long term drift' may not be negligible. The drift is usually positive, i.e. the signal increases with time even in the case of constant illumination.

The drift introduces some uncertainty in the estimate of the background signal, and the magnitude of the effect depends on the pixel number (for more details see Report I). In order to correct for artifacts related to drift we used the same method as in the case of reduction of normal stars (see Report I), but we performed this correction at the SRD - rather than the SCP - level.

3.2 New FCS default responsivities

The ISOPHOT instrument hosts two Fine Calibration Sources (FCSs) which were used as photometric standards to monitor the time evolution of the PHT-P and PHT-C detector responsivities. The two devices were identical and could be operated independently. Each ISOPHOT AOT (except PHT40) contained at least one FCS measurement which can be used to calculate the actual responsivity of the given detector. If an FCS measurement proves to be inadequate to determine the detector responsivity, the default responsivity can be used. The default responsivity is a function of the orbital phase and originally was determined by averaging many responsivity measurements from the whole mission (assumed that it does not vary from revolution to revolution). Since the response value derived from an individual FCS measurement depends on the signal processing, we determined new orbit dependent default responsivities based on our previous HPDP products.

3.3 Using the new measured beam profiles

In the course of flux extraction and check for point/extended nature of the object we used the new measured beam profile - developed in the framework of a collaboration between the Konkoly Observatory and the ISOPHOT Data Centre - instead of the old theoretically predicted profile (Herbstmeier et al., 1998) or the footprint fractions established by Laureijs (1999).

4 Notes

The observation of MCG-06-30-015 (TDT : 63900208, C100) was interrupted after the second raster step. Due to this fact only two pixels (Pix. 7 and Pix. 4) observed the source and their data stream contains only two points. Therefore we had to deviate from our general scheme and we extracted flux using the following steps: 1) the photometric results of individual pixels (each data stream contains one off-source and one on-source observation) were derived; 2) empirical correction for the given pixels was applied; 3) final flux density value was calculated as the average of the two fluxes.

5 Error budget

In the catalogue the flux uncertainties (see Table 2 - Field 15) were derived as a standard deviation of the nine (C100) or four (C200) independent pixel fluxes (for details see Report I).

In order to get a feeling about the typical flux uncertainties we also quantified the standard deviations on the basis of our study for normal stars (for details see Report I). On the normal stars sample the standard deviations of the measured flux vs. predicted flux residuals, computed after the empirical correction, were determined as follows: at low flux level a constant value independent of the source flux was assumed while at high fluxes the uncertainty was expressed as a fraction of the source's flux density, in percentage. At 60, 90 and 170μm suitable number of faint measurements were found for a reliable estimate of low level constant error value. At the other wavelengths the present normal star database turned out to be insufficient to determine such an error.

Detector	Filters	Constant error component [mJy]	Multiplicative error component [%]
C1	C50,C70,C100,C105	-	<7
C1	C60,C90	15	<7
C2	C120,C150,C180,C200	-	<10
C2	C160	35	<7

Table 1: Error budget

6 Description of the catalogue

Column	Field	Unit	Description
(1)	Object name		SIMBAD compatible name. Filled if a compact source from SIMBAD can be associated with the ISOPHOT target without doubt.
(2)	Object type		Standard SIMBAD code for object type
(3)	ISO name		Target name as given by the original ISO proposer
(4)	TDTNUM_ON		The 8-digit TDTNUM of the on-source observation
(5)	On_ Meas.		Index of the on-source measurement within TDTNUM_ ON
(6)	RA(2000)		RAh, RAm, RAs of the ISOPHOT position
(7)	Dec(2000)		DECd, DECm, DECs of the ISOPHOT position
(8)	Detector		ISOPHOT detector (C1 or C2 for C100 and C200)
(9)	Wavelength	[micron]	Nominal wavelength of the ISOPHOT filter
(10)	Aperture	[arcsec]	Square aperture for C100 (43.5 arcsec) and C200 (89.4 arcsec) detectors
(11)	Epoch		Epoch of the observation
(12)	TDTNUM_ OFF		The 8-digit TDTNUM of the off-source observation
(13)	Off_Meas.		Index of the off-source measurement within TDTNUM_OFF
(14)	Flux density	[Jy]	Flux density of the source. In case of a point source the measured flux is corrected for the size of the point spread function. In case of an extended source it corresponds to the integrated brightness. No colour correction applied.
(15)	Flux uncertainty	[Jy]	Flux uncertainty. No colour correction applied.
(16)	Background	[MJy/sr]	Background surface brightness. No colour correction applied.
(17)	Detection	[sigma]	The significance level of the source being detected above the background.
(18)	Object size		Indicates if the object is point-like (P) or extended (E)
(19)	Quality		Quality of the observation R1 – Standard processing according to the scheme described in the report. R2 – Minimap performed in astronomical (rather than satellite) coordinate system R3 – ISOPHOT position differs from SIMBAD position by more than 10” R4 – Suspected ISO pointing problem R5 – Only one FCS is available R6 – No useful FCS is available, default FCS is used R7 – Archive quality mark R8 – Not enough data points to perform drift correction R9 – Fitting smooth baseline to the data points failed, drift correction (partly/completely) omitted R10 – Observation was carried out at the very beginning or at the very end of orbit Reduced photometric reliability at orbital phase lesser than 0.2 or greater than 0.8 R11 – A large increase in the proton flux from the Sun was observed R12 – Non-stabilised target signal R13 – Measured flux was out of the empirically calibrated range

Table 2: Description of the catalogue

References

Herbstmeier, U., 1998, ”ISOPHOT Footprint Tables Explanatory Supplement”

Laureijs, R.J., 1999, ”Point spread function fractions related to the ISOPHOT C100 and C200 arrays”, ISO Data Center, Villafranca

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