YET ANOTHER INFRARED ARCHIVE: RELEASE OF THE INFRARED TELESCOPE IN SPACE (IRTS) ARCHIVE DATA

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ABSTRACT

The IRTS data archive has been in public since 2002. IRTS surveyed about 7 per cent of the whole sky with four instruments, which covered from 1.4 to 700 μm. Presently the archive includes the near- and mid-infrared low resolution spectral catalogues of point sources, and image maps in five wavelength bands in the far-infrared. The point source catalogues contains over 14 000 (near-infrared) and 500 (mid-infrared) sources. The majority of detected sources are late-type stars. These large samples of uniform spectra are especially useful for statistical studies of infrared properties of stars. The far infrared image maps are obtained for the 158 μm [C II] line, and continuum bands at 155, 250, 400, and 700 μm. Radiation from the diffuse interstellar components has been studied with these data. More data products will be available in a few year time-scale. The IRTS data can be accessed via ISAS's data archive service *DARTS*, *URL: http://www.darts.isas.ac.jp/*.

Key words: Surveys: IRTS – Infrared: stars – Infrared: ISM

1. The IRTS Mission

Infrared Telescope in Space (IRTS) is the first Japanese space infrared mission (Murakami et al. 1996). IRTS was on board of the Space Flyer Unit (SFU) satellite, and launched in 1995 March 18 by the NASDA's H-II rocket. Survey observations were carried out from March 30 to April 24. About 7 per cent of the whole sky was covered in two stripes (Figure 1); one (*North-scan*) scanned along the Galactic plane through near the Galactic Center, and the other (*South-scan*) observed high-galactic latitude region. SFU was retrieved by the Space Shuttle Endeavor in early 1996. Post-mission calibration measurements of the instruments were carried out and included in the calibration procedures (e.g., Murakami et al. 2002).

IRTS was equipped with a cooled 15-cm telescope and four scientific instruments, namely: The *Near-Infrared Spectrometer* (NIRS), the *Mid-Infrared Spectrometer* (MIRS), the *Far-Infrared-Line Mapper* (FILM), and the *Far-Infrared Photometer* (FIRP). The specifications of the instruments are summarized in Table 1.

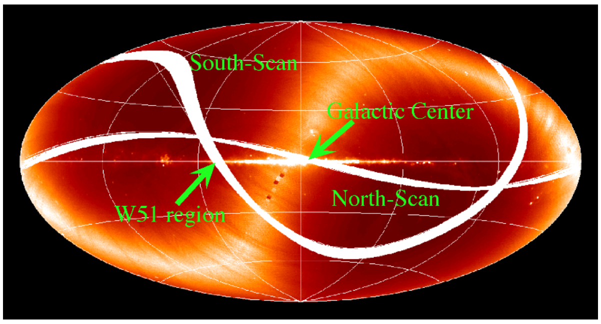

Figure 1. The IRTS scan area is overlaid on the COBE/DIRBE 12 μm image in Galactic coordinates. IRTS scanned along two stripes: North-scan *went through near the galactic center, and* South-scan *observed high-galactic latitude region. Total surveyed area is about 7 per cent of the whole sky.*

Table 1. Specifications of the IRTS focal-plane instruments.

	Wavelength (μm)	Detector	Resolution ($\lambda/\Delta\lambda$)	FOV (arcmin^2)
NIRS	1.4–2.5, 2.9–4.0	2×12-ch InSb	12–33	8×8
MIRS	4.5–11.7	32-ch Si:Bi	20–30	8×8
FILM	63([O I]), 158([C II]), 155, 160 (cont.)	Ge:Ga, stressed-Ge:Ga	400 (lines) 130 (cont.)	8×13
FIRP	150, 250, 400, 700	0.3 K bolometer	3	30ϕ

The large field-of-view (FOV) of the instruments has an advantage for observations of diffuse radiation. Interstellar and interplanetary gas and dust (Okumura et al. 1996; Makiuti et al. 2002; Ootsubo et al. 2000) as well as cosmic background radiation (Matsumoto et al. 1996) are the main targets of IRTS. In addition, the NIRS and the MIRS detected many point sources (Yamamura et al. 1996). The spectra provide information of the molecular and dust bands in the wavelengths masked by the Earth's atmosphere.

2. The NIRS Point Source Catalogue

The NIRS is a low-resolution grating spectrometer that covers the wavelength ranges of 1.4–2.5 and 2.9–4.0 μm by a pair of 12 channel InSb detector arrays. Each detector pixel observes a fixed wavelength, so that the spectrum of the sky is continuously provided. The product of the NIRS observation currently available is the NIRS Point Source Catalogue (NIRS PSC, Tanaka et al. in preparation). The first version of the catalogue contains spectra of 14,223 objects confirmed by at least two detections. The catalogue is complete down to 6–7 mag (approximately 1 Jy, Figure 2). The accuracy of the flux is typically 5 per cent. Details of the NIRS calibration procedure are described in Murakami et al. (2002).

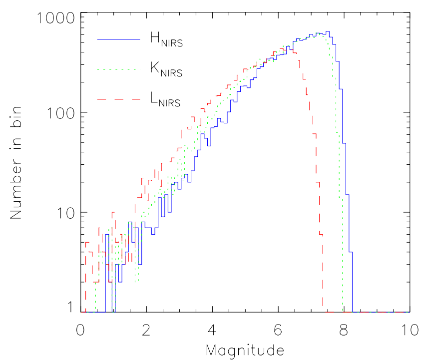

Figure 2. Magnitude–number diagram of the NIRS PSC at three wavelength channels closest to H, K, and L-band, respectively. The NIRS PSC is complete down to 6–7 mag.

The majority of sources are late-type stars; some of them show molecular absorption bands of H_2O, CO, C_2H_2, and HCN. These molecular features are indicators of chemical composition of the stars (Figure 4). Classification of the spectra using the 'key wavelength' of the features is attempted (Tanaka et al. in preparation). Figure 3 shows that M, S, and C type stars are clearly identified on the diagrams. The results of the classification of the best quality 4020 stars are listed in Table 2.

The NIRS PSC is extremely useful for studies of infrared properties of the stars. Matsuura et al. (1999) reported unexpected detections of H_2O bands in the early M-type stars. The IRTS/NIRS data are also used for galactic distribution of evolved star and their contribution to the mass circulation in the Galaxy (LeBertre et al. 2001).

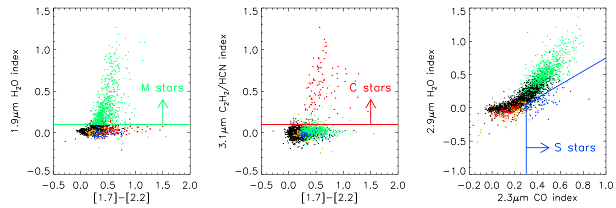

Figure 3. Color-magnitude diagrams of the NIRS point sources at different 'key wavelengths'. M-type and C-type stars are characterized by their H_2O and C_2H_2/HCN molecular absorption bands. S-type stars are defined as that they do show deep CO absorption but little or no H_2O absorption band (Tanaka et al. in preparation).

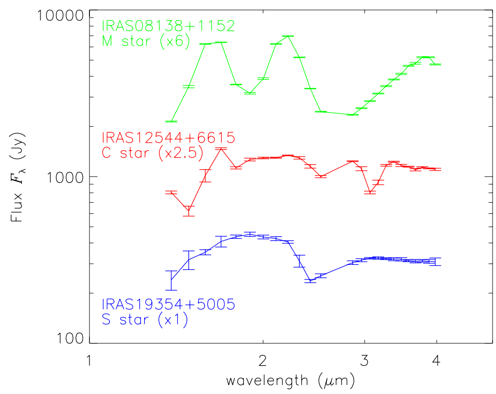

Figure 4. The typical NIRS spectra of M, C, and S-type stars, which are classified in the diagrams shown in Figure 3.

Table 2. Preliminary classification of the NIRS point sources with high-quality.

	Spectral indices	# of objects (out of 4020)
M star	w/ 1.9 μm H_2O	853
C star	w/ 3.1 μm C_2H_2/HCN	91
S star	w/ 2.3 μm CO and w/o 2.9 μm H_2O	62
UIR objects	w/ 3.3 μm band	6
Other red objects		1166
Earlier type stars		1842

3. The MIRS Point Source Catalogue

The MIRS is a 32-channel grating spectrometer observing a wavelength range between 4.5 and 11.7 μm simultaneously. The spectral resolution is $\Delta\lambda$ =0.23–0.36 μm. As the NIRS did, the MIRS detected a number of point sources. Many of the detected sources are mass-losing stars. It also detects the reflection nebula NGC 7023 and a few H II regions, which exhibit the UIR features. One asteroid, 01 Ceres, was observed by the MIRS for a several times and was used for the flux calibration (see, Cohen et al. 1998). The overview of the MIRS flux calibration procedures is explained in Onaka et al. (2002). The completeness level of the MIRS PSC is 10–20 Jy for the entire wavelength range (Figure 5).

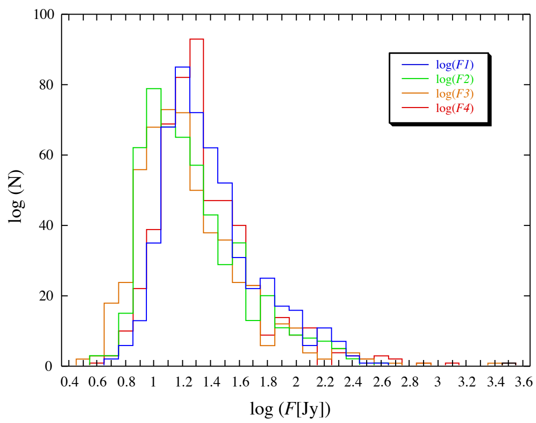

Figure 5. Flux–number diagram of the MIRS point sources at four wavelengths bands, in 4.6–6.2(F1), 6.4–8.0(F2), 8.2–9.8(F3), and 10.0–11.6(F4), respectively. The MIRS PSC contains the sources with the flux down to 10–20 Jy.

The MIRS detected about one thousand point sources. The MIRS Point Source Catalogue version 1.0 contains 536 sources with relatively good quality. The objects are classified into five groups on the two-color diagram made from representative wavelengths at 5, 8, and 10 μm (Yamamura et al. 1996). Figure 6 shows the NIRS+MIRS spectra of representative objects. Stars earlier than K-type show almost featureless spectra. As the star becomes later, H_2O around 6 μm and SiO fundamental band at 8 μm start to appear. In carbon stars C_3 at 5.3 μm and 7 μm C_2H_2/HCN band are clearly seen. These molecular bands are dimmed as dust emission becomes stronger. H II regions are characterized by their UIR bands at 6.2, 7.7–8.6, and 11.3 μm. MIRS detected many red objects with the blackbody-like spectra of $\sim$ 300 K. Almost all of them are space debris, except one asteroid, Ceres.

Although the number of sample is not as large as the NIRS PSC, the MIRS PSC provides very unique data of mid-infrared spectra of bright objects, especially in the wavelengths inaccessible from the ground.

4. The FILM Image Maps

The FILM is a grating spectrometer to observe the [C II] 158 μm and [O I] 63 μm line emissions as well as the far-infrared continuum emission at 155 and 160 μm. The stressed Ge:Ga detectors of the FILM performed very well, and provided high and stable (after corrected) sensitivity data. Distributions of carbon ions and cold dust in high Galactic latitude regions have been investigated using the FILM data (Makiuti et al. 2002; Okumura et al. 1996).

Image maps of the two highest performance channels, the [C II] 158 μm line and the 155 μm continuum intensities are released. The image maps are composed from the scan strip data (an aperture size of $8' \times 13'$) projected onto a $4'$ grid image plane. One image map covers 12.8×12.8 deg^2 with slight overlap with the adjacent images. No additional destriping after image reconstruction was applied. For each region four kinds of data are provided; a raw co-add intensity map, an intensity map in which small void pixels are filled by interpolation, an error map which indicates statistical errors of the scan data at each pixel, and a map of the number of samplings participating on each pixel. The images are distributed in the FITS format. The calibration procedures are described in the explanatory documents attached to the data.

Figure 7 shows the intensity maps of the galactic plane around the H II region, W51. By comparing the 155 μm intensity with the IRAS 100 μm intensity, dust temperature is derived and is also plotted.

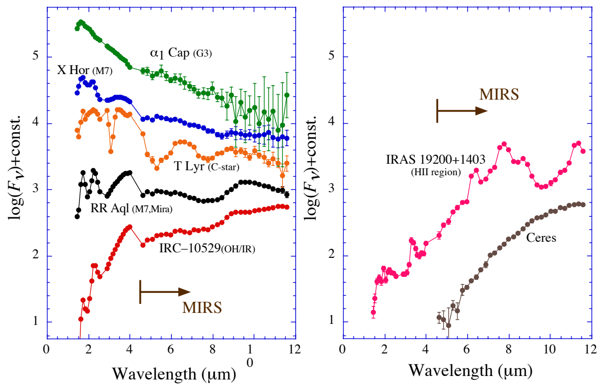

Figure 6. Examples of NIRS+MIRS spectrum of representative objects observed by the MIRS.

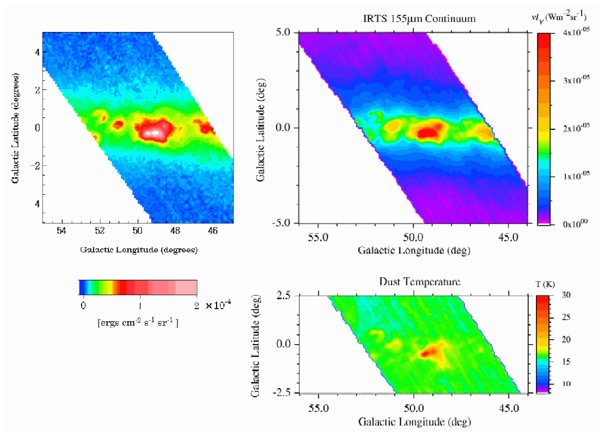

Figure 7. The W51 region image maps by the continuum and [C II] channels of the FILM. The color temperature derived from the FILM 155 μm continuum channel and the IRAS 100 μm are shown in the bottom.

5. THE FIRP Image Maps

The FIRP carried out broad-band photometry in four far-infrared wavelengths (150, 250, 400, 700 μm) operated simultaneously. The wavelength coverage of the FIRP extends beyond that of the COBE/DIRBE. The spatial resolution is also slightly better (0.5 deg). Unfortunately the system was not stable enough and some part of the data were suffered by large noises. The image maps are composed only from high-quality data in the similar manner with the FILM maps. The grid size of the maps are 8′. A raw co-add map and a sample number map are provided for each region. The 250 μm band have the best signal to noise ratio (comparable or slightly better than the COBE/DIRBE). Figure 8 shows the W51 region observed in the three channels.

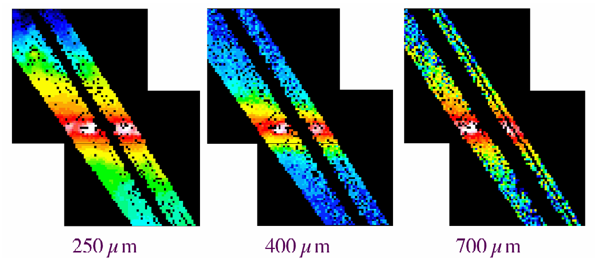

Figure 8. Image maps of the W51 region in the three channels of the FIRP.

Thanks to its unique wavelength coverage, the FIRP traces very cold dust in the galaxy (Hirao et al. 1996).

6. THE IRTS DATA ARCHIVE

The IRTS data archive system is developed as a part of ISAS's space science data archive system, *DARTS* (Data ARchive and Transmission System; *http://www.darts.isas.ac.jp/*). A simple Web interface allows the users to search, browse, and retrieve data interactively. The full data set of each product can be downloaded. Explanatory and related documents are also served. Inquires about the data are addressed to `irts_help@ir.isas.ac.jp`.

The data will be also available from IPAC.

7. FUTURE PLAN

The data reduction activity of the IRTS still continues. Calibrated time-line data of the FILM and the FIRP will be available in near future, for those who wish more detailed analysis. Image maps of the NIRS and the MIRS survey will be released in years time scale. They are valuable especially for studies of dust and UIR bands (e.g. Onaka et al. 2000), and Zodiacal light (Ootsubo et al. in preparation).

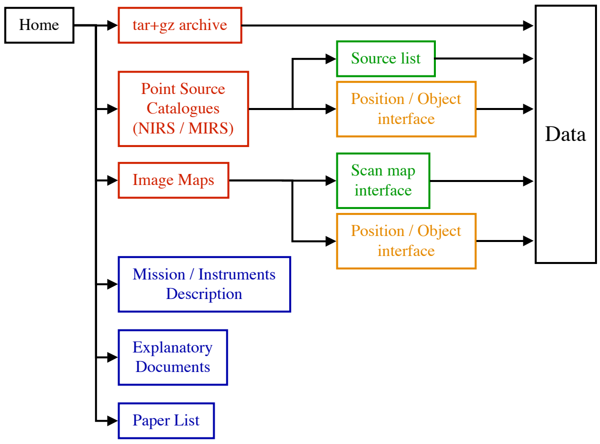

Figure 9. The structure and access flow of the IRTS data archive Web interface. Users can browse individual data by searching with object name / position or on the object list / scan map. The full data set of each product can also be retrieved in the tar+gz format.

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