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DATA REDUCTION OF AKARI/IRC SPECTROSCOPIC OBSERVATIONS

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ABSTRACT

AKARI performed about 10,000 spectroscopic observations with the Infrared Camera (IRC) during its mission phase. These IRC observations provide unique spectroscopic data at near- and mid-infrared wavelengths for studies of the next few decades because of its high sensitivity and unique wavelength coverage. In this paper, we present the current status of the activity for improving the IRC spectroscopic data reduction process, including the toolkit and related data packages, and also discuss the goal of this project.

Key words: infrared: general; methods: data analysis; space vehicles; catalogs; surveys;

1. INTRODUCTION

The Infrared Camera (IRC; Onaka et al. 2007) is one of the two instruments on board the AKARI satellite (Murakami et al., 2007), which was operated at near- to mid-infrared wavelengths. IRC has capability of spectroscopy as well as wide-field deep imaging (F. Egusa, et al. in this volume), in addition to the All-Sky Survey observations. Spectroscopic observations (Ohyama et al., 2007) were carried out with the specified position parameters as (see Fig.3 in Onaka et al. 2007):

- Slit position:
  - Ns (common of NIR and MIR-S): $5'' \times 0.8'$
  - Nh (high resolution of NIR): $3'' \times 1'$
  - Ls (MIR-L): $7'' \times 0.4'$
- Point source aperture:
  - Np (NIR): $1' \times 1'$
- Slitless position (approximately $10' \times 10'$ each):
  - Nc (NIR, MIR-S)
  - Lc (MIR-L)

where the spectral coverage of each channel is 1.8–5.5 μm for prism mode in NIR and 2.5–5.0 μm for grism mode in NIR, 4.6–9.2 μm for SG1 in MIR-S and 7.2–13.4 μm for SG2 in MIR-S, and 17.5–26.5 μm for LG2 in MIR-L, respectively.

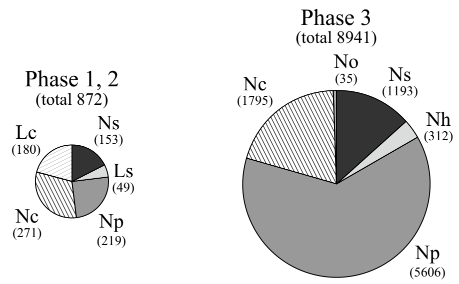

Figure 1. Fraction of the position parameters for spectroscopic observations with AKARI/IRC. Note that there are two other modes of spectroscopy: IRC64 (for PV2) and IRC02 (for the LSLMC program; Shimonishi et al. 2013), and that the parameter “No” in Phase 3 is for the test observations.

IRC spectroscopic observations were performed 872 times with NIR, MIR-S, and MIR-L before the liquid helium cryogen was exhausted (Phase 1 and 2), and 8941 times only with NIR at temperatures below < 50 K during the warm mission phase until the performance of the on-board cyro-cooler seriously degraded in February 2010 (Phase 3; Onaka et al. 2012).

Figure 1 shows the fraction of the position parameters specified for the targeted observations, which were

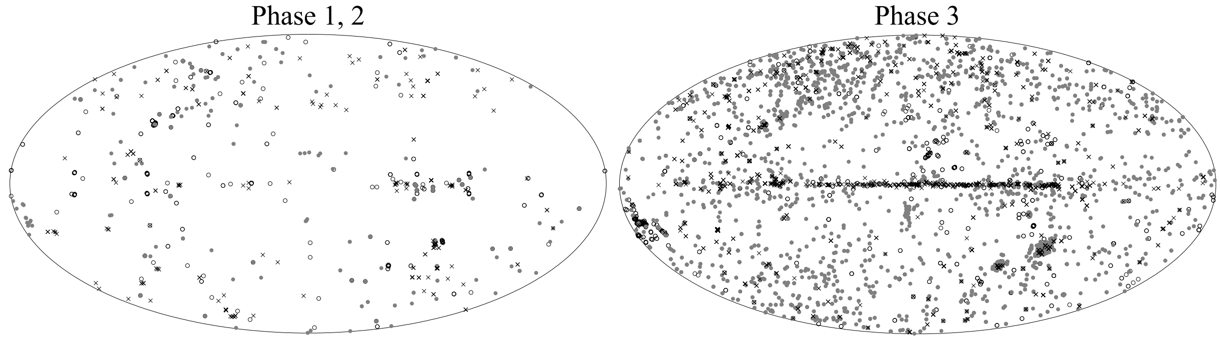

Figure 2. Distribution of the targets of spectroscopic observations with AKARI/IRC in the galactic coordinates. The black crosses, gray filled circles, and black open circles denote the observations specified at the slit positions (Ns, Nh, and Ls), the point source aperture (Np), and the slitless positions (Nc and Lc), respectively.

given by observers in the target lists. It shows that 25% of spectroscopic observations in Phase 1,2 and 63% in Phase 3 were executed at the Np position, while 52% in Phase 1,2 and 20% in Phase 3 were for the slitless mode. It should be noted that all slit and slitless data were obtained simultaneously in any of the spectroscopic observations regardless of the specified position parameters. Figure 2 shows the spatial distribution of the targets for the spectroscopic observations. It is found that especially in Phase 3 many slit observations were made around the galactic plane, and that Np observations were performed over the all-sky including the Large and Small Magellanic Clouds.

2. ISSUES CONCERNING THE REDUCTION TOOLKIT

All data mentioned above are already open to the public via the Data ARchives and Transmission System (DARTS)[1] at ISAS/JAXA, and the official data reduction toolkit mostly written in the IDL is also provided[2]. However, the current version of the toolkit has been developed for a small set of the data and may not provide the best results for general use. To make the best use of spectroscopic data and provide a consistent dataset ready for the scientific purpose, a homogeneous, robust data reduction process is needed. We have recognized several issues to be investigated and fixed concerning the reduction toolkit as follows:

Reconfiguring the toolkit structure
Current toolkit is separated into two by Phase 1,2 and Phase3, while that for Phase 3 already includes the function for both phases. There are also some versions of the toolkit customized by expert users and some of them are useful for general purposes. It is useful to merge them into a single toolkit.

Revising the toolkit
Revising the spectral image stacking, removing artificial background pattern (column pulldown, muxbleed, ghost image, periodic noise variation in the sensitivity of the detectors, etc), improving absolute wavelength calibration (especially for prism mode) are being planned. The revised flux calibration procedure taking account of the 2nd order light contamination in the 4.5–5.0 μm range for grism mode (S. Baba, et al., in this volume) will also be included.

Stacking multi pointing observations
In Phase 3 observations, it was strongly recommended to make redundant observations (with at least three independent pointings, especially in the second half of Phase 3) to obtain better quality data because the number of hot pixels in the detector was dramatically increased. Thus the data reduction process for multi pointing observations needs to be prepared. A subroutine to stack exposure frames taken at different pointings have already been developed independently (T. Shimonishi, private communication) and will be applied to produce a legacy archive.

Revising algorithm for source extraction
Sometimes the toolkit fails to extract the object position not only on the reference image but also on the spectral image, which uses the daofind method for target detection. The process needs to be revised to make it as robust as possible. Handling dense source regions like near the galactic plane is another issue to be taken care of.

[1] `http://darts.jaxa.jp/ir/akari/pointing.html.`
[2] `http://www.ir.isas.jaxa.jp/ASTRO-F/Observation/DataReduction/IRC/.`

Reduction of data with the severe conditions

Not a small number of observations were done with severe conditions; significant background pattern, too faint sources (typically, < 1 mJy), detection on the edge of the detector, or severe blending of sources. These data must be treated individually with care.

3. CONCLUDING REMARKS

After fixing the issues mentioned above, preparing the appropriate data archive system and documentation, consistent and comprehensive data reduction is being executed to provide legacy archive data for the future astronomical research. The reduced data products will be delivered to the science community by March 2016.

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