AKARI data reduction and archive project

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The AKARI mission AKARI data processing activity

Science highlight

The AKARI Mission









Feb. 21, 2006 ~ Nov. 24, 2011

2nd generation All-Sky Survey Deep imaging / Spectroscopy in pointed observation













170 litter liquid Helium + Mechanical cooler (two-stage Stirling cooler)

Lifetime = 550 days

After liq. He boil-off

Cooling only with the mechanical cooler



AXA ST

- φ 685 mm, F/6.1, Ritchey-Chretien
- Silicon carbide mirror

50–180 µm



(Far-Infrared Surveyor) FIS



 $IRC \text{ (Infrared Camera)} \\ 1.8-26 \ \mu\text{m}$





Photometric & Spectroscopic Capabilities





AKARI Operation history

	Feb. 21, 2006 Launch		
Checkout	Apr. 14, 2006 Ap.Lid Open Checkout & Performance Verification		
Phase 1	(FIS) All-Sky Survey: 1st priority		
(~180 days)	LS+Some MP Pointed Obs Nov. 10, 2006		
Phase 2	MP + OT Pointed Obs.		
$(\sim 300 \text{ days})$	Supplemental (FIS) survey		
2nd PV	Aug. 26, 2007 LHe boil-off	He holding time 550 days	
Phase 3	June 1, 2008 only NIR in operation MP + OT pointed Obs.		
Maintenance	- Feb. 15, 2010 Cryo-cooler degradation/recovery		
	Nov. 24, 2011 Satellite power-off		









- All-Sky survey in mid- and far-IR
 - Total 6 bands: 9, 18, 65, 90, 140, & 160 μm
 - Sky converge better than 96 %
- Thousands of pointed observations
 - Deep imaging (9 bands in near- & mid-IR + 4 bands in far-IR)
 - Spectroscopy (especially unique in 2-5 µm band)
 - LMC & NEP survey in near- & mid-IR



9 μm, 18 μm, **90 μm**







9 μm, 18 μm, **90 μm**

		MIR	FIR	
	Wavelength (µm)	9, 18	65, 90, 140, 160	
	Number of sources	870,973	427,071	
	Detection limit	50 & 130 mJy	3.2, 0.55, 3.8, 7.5 Jy	
	Flux uncertainty	5-20 %	20 ~ 30 %	2
	Spatial resolution	~7 arcsec	~1 arcmin	a history
	Position uncertainty	1–3 arcsec	~6 arcsec	



Other large area surveys

- North Ecliptic Pole (NEP) region survey (near/ mid-IR with the IRC)
 - NEP-Deep (Murata et al. 2013, A&A, accepted; Takagi et al. 2012, A&A, 537, A24)
 - NEP-Wide (*Kim et al. 2012, A&A, 548, A29*)
 - Catalogues become public on March 15, 2013
- Large Magellanic Cloud survey (near/mid-IRC with the IRC)
 - Point source catalogue (660,000 sources observed at 3, 7, 11, 15, 24 µm)

Public release on 2012 Nov. 13 (*Kato et al. 2012, AJ, 144, 179; Ita et al. 2008, PASJ, 60, S435*)

 Spectroscopic catalogue (1757 sources) Public release on 2013 Jan. 7 (*Shimonishi et al. 2013, AJ, 145, 32*)





NIR Spectra Catalog



Shimonishi et al. 2013, AJ, 145, 32

Careful treatment of overlapping spectra

A total of 1757 spectra extracted



AKARI asteroid catalog (AcuA)



13/10/08

AKARI data processing activity



- Reconstructed from AKARI satellite project in April 2013
- Five years project
 - 3 yrs for data processing + 2 yrs for maintenance
- Goal: to provide science ready data to the community
 - Revised version Bright Source Catalogue (FIS)
 - Faint Source Catalogues (IRC, FIS)
 - All-Sky image maps (IRC, FIS)
 - Uniformly processed image data from pointed observations (IRC, FIS)
 - Uniformly processed spectral data (IRC, FIS)

Mid-IR All-Sky Diffuse Map













Products under construction

Product name	Description	Priority	Public Release
FIS Bright Source Catalogue Ver.2	Revision of the FIS BSC. Accuracy and reliability will be improved. Single-scan photometric database and scan density data will also be available.	1	Mar. 2015
FIS Faint Source Catalogue Ver.1	The catalogue improves detection limit in the high-visibility regions.	1	June 2015
FIS All-SKy image maps	All-Sky image maps in the four FIS bands (65, 90, 140, 160 μ m).	2	Mar. 2016
IRC Faint Source Catalogue	The catalogue improves detection limit in the high-visibility regions.	1	Mar. 2016
IRC All-SKy Image Maps	All-Sky image maps in the two IRC bands (9 & 18 μ m).	2	Mar. 2016
Asteroid Catalogue ver.2	Additional 1000 asteroids supplemental to the Ver.1 are expected.	5	Mar. 2016
FIS Slow-scan Atlas	Processed image data of individual FIS Slow-scan mapping observations.	4	Mar. 2016
FIS FTS data	Processed imaging-spectroscopic data-set observed with the Fourier Transform Spectrometer (FTS) of the FIS.	5	Sep. 2015
IRC Pointed Observation Images	Processed imaging (photometric) observation data of the IRC. Individual observation data will be processed separately. No mosaicing will be applied.	4	Mar. 2016
IRC Slow-scan Atlas	Processed image data of individual IRC Slow-scan mapping observations.	4	Sep. 2015
IRC Slit spectroscopy Data	Spectra taken with the IRC spectroscopic mode with slit (and point source aperture mask).	4	Mar. 2016
IRC Slitless spectroscopy Data	Spectra taken with the IRC spectroscopic mode on the imaging field with the objective grism/prism.	5	Mar. 2016

Science Highlight



Mapping observations of Chamaeleon

- Mapping observations of the Chamaeleon molecular clouds
- SED fitting of warm (22 K) and cold (12 K) dust with spatial resolution of 0.04 pc
- Gravitational fragmentation of the cold HI cloud likely created the molecular clouds



Ikeda et al., 2012, ApJ, 745, 48



NIR spectroscopy of L and T dwarfs

Good/moderate spectra are taken for 20 objects.

First complete NIR wavelength coverage of brown dwarfs.

Spectral evolution from L to T is consistent with that was predicted from Unified Cloudy Model (Tsuji 2002)

Molecular bands of H_2O , CH_4 , CO_2 (!), CO are found.

Yamamura, et al., 2010; Sorahana & Yamamura 2012









Izumiura et al., 2011, A&A 528, A29

Cosmic star formation history at 0<z<2.2 all revealed by AKARI



TR huminosity density by star-forming galaxies. Results from this work is plotted with triangles at z=0.0082. The red, blue and orange

Probing star formation in ultraluminous infrared galaxies using AKARI near-infrared spectroscopy **AKARI/IRC NIR Grism** Kenichi Yano (Univ. of Tokyo, ISAS/JAXA) spectroscopy Takao Nakagawa, Naoki Isobe, Mai shirahata (ISAS/JAXA)

Systematic observations of the hydrogen recombination line Br α (4.05 μ m) on nearby (z < 0.3) 51 ultraluminous infrared galaxies (ULIRGs)

$Br\alpha$ line

- less affected by dust extinction than H α or Pa α lines
- in the wavelength range unique to AKARI (2.5-5.0 μ m) -
- in the wavelength range unique to AKARI (2.5-5.0 μ m) direct measure of ionizing photons, tracing OB stars \Rightarrow star formation rates (SFRs) were derived quantitatively



even in dusty ULIRGs



Comparing SFRs with total infrared luminosities

- investigate the energy sources of ULIRGs
- active galactic nuclei (AGN) and/or star formation



estimated from SFRs (derived from Brα line)

The contribution of star formation to the total IR luminosities are qunantitatively different among the optical classifications.

Detection of H α emission from z>3.5 submillimetre galaxies with AKARI-FUHYU spectroscopy





First detections of H α at z > 3 for submillimetre galaxies

Broad H α lines confirming two HzRGs are quasars

Confirmation of binary quasar in 4C60.07

Dust obscuration in the SMGs of ~10 at z~3.5





Chris Sedgwick, Stephen Serjeant and Chris Pearson on behalf of the FUHYU mission program (MNRAS submitted)

Near-Infrared Diffuse Spectrum

- NIR diffuse sky spectrum (1.8-5.3um) is studied and catalog is released
 - Zodiacal light (ZL) Tsumura et al. 2013a
 - Detection of high temperature component (~300K) of the zodiacal thermal emission
 - It implies the existence of sub-micron size interplanetary dust around the Earth
 - Diffuse Galactic Light (DGL) Tsumura et al. 2013b
 - Good correlation between 3.3um PAH in DGL and 100um dust emission was confirmed.
 - We first obtained the DGL spectrum at general interstellar space in this wavelengths.
 - Extragalactic Background Light (EBL)
 - Excess emission from the integrated light of galaxies was confirmed.
 - New data in two decades by COBE/DIRBE and IRTS



Example of the spectrum and its Separation into each components



Tsumura et al. 2013c

EBL spectrum obtained by AKARI