

Cosmic Infrared Background Observations with MIRIS

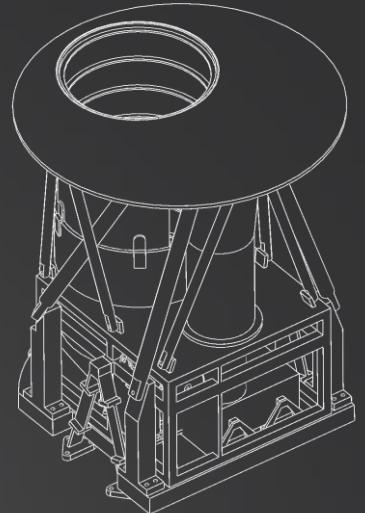
Woong-Seob Jeong^{1,2}

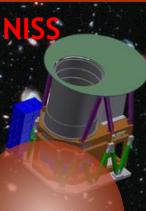
&

MIRIS Team

¹ Korea Astronomy and Space Science Institute, Korea

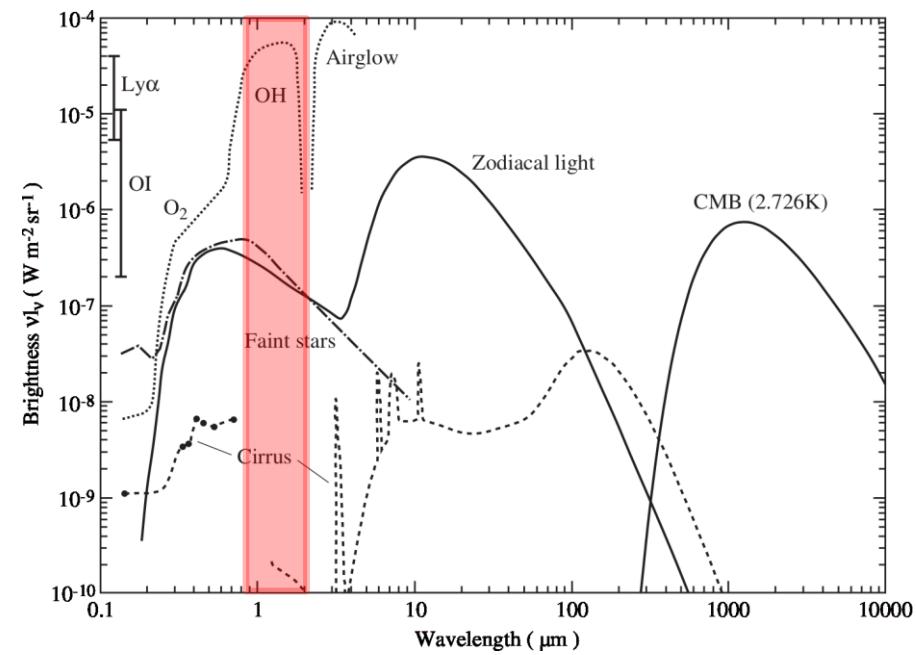
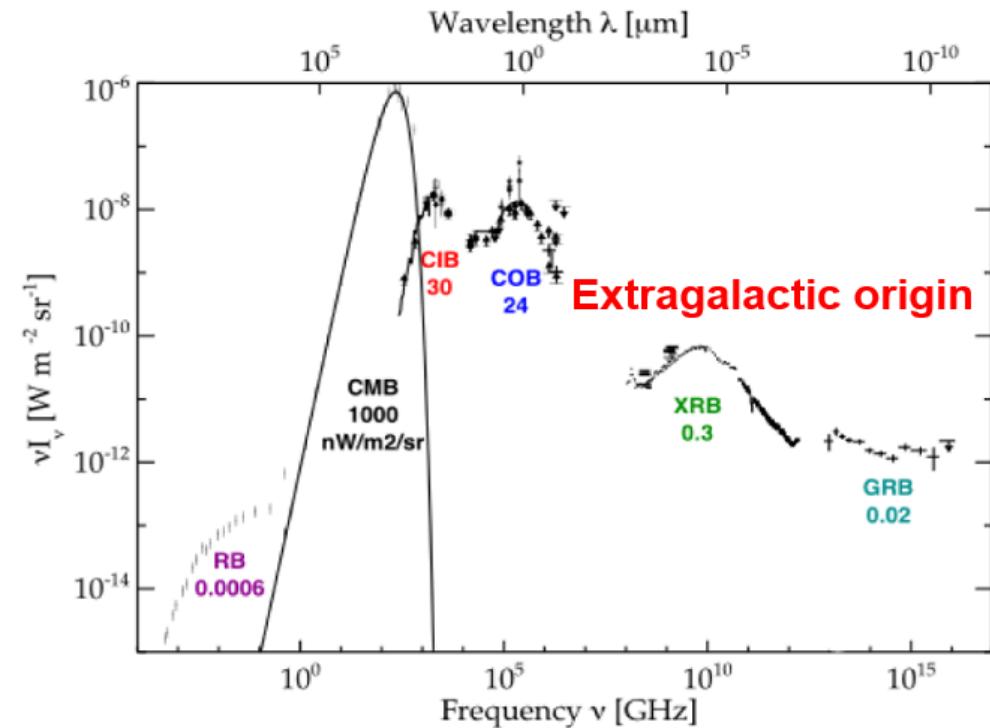
² Korea University of Science & Technology, Korea





Energy Budget of Background

- Dominant contribution from CMB ($\sim 95\%$)
→ Evidence of Big Bang
- Other contribution: **extragalactic origin?**



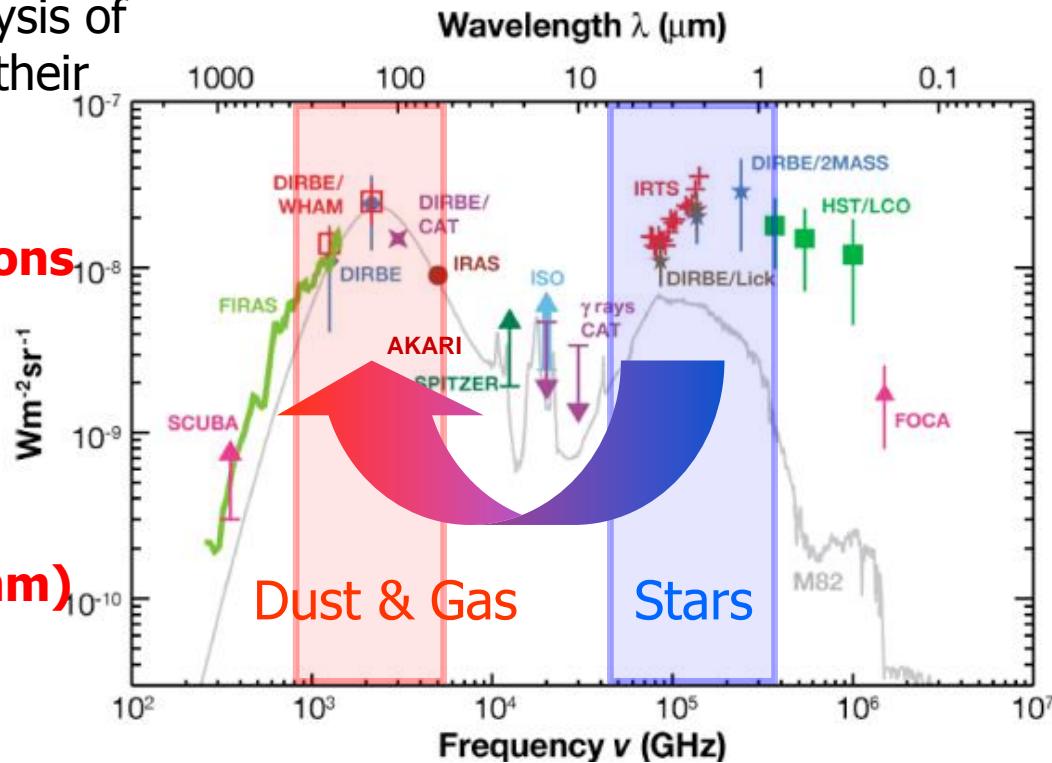


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Importance of IRB

- **IR background:** detailed analysis of distant galaxy populations and their formation & evolution
→ Can study only with **space observations**

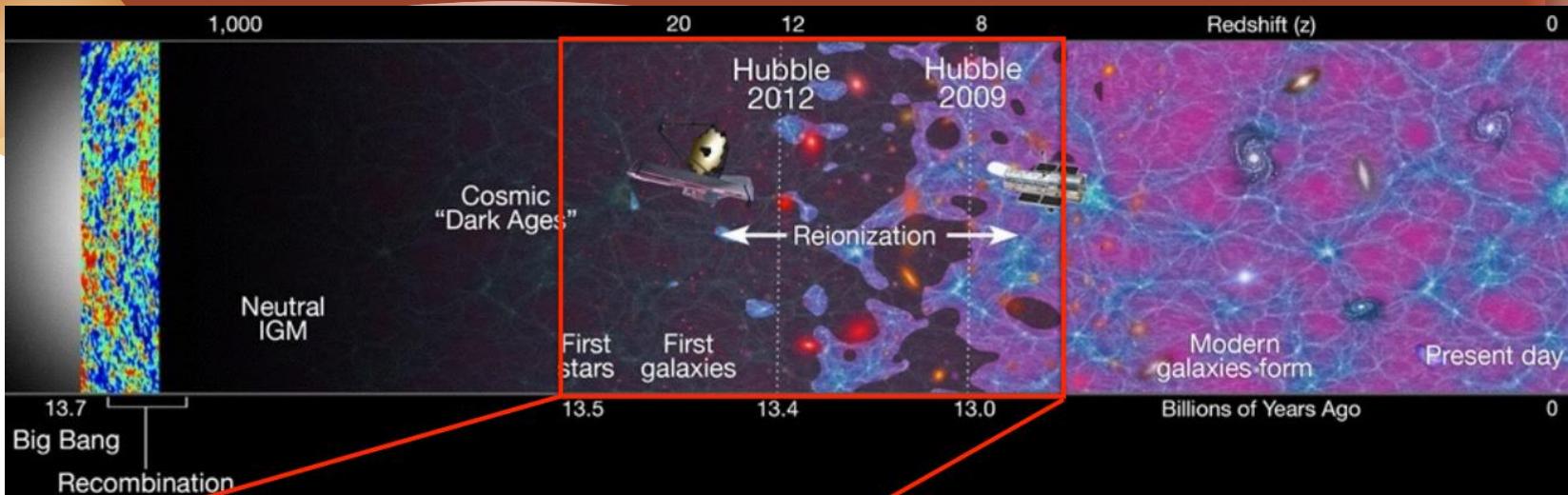
- **Cosmic Near-Infrared Background**
- **Cosmic Far-Infrared (sub-mm) Background**



- More than a half of energy is hidden and processed by dust.
- Myriad of luminous IR galaxies in the early Universe
→ **Significant portion of galaxies' light from far-IR and sub-mm**

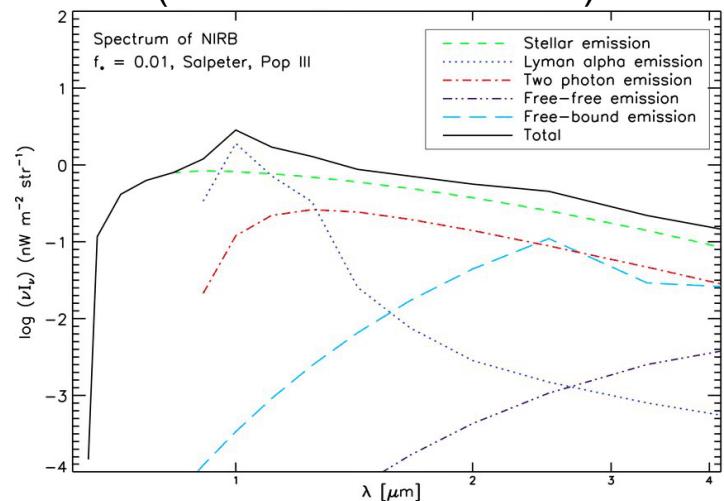


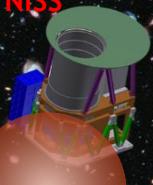
CIB from Reionization



- $z \sim 20 \sim 5$: reionization era
- Possible contributing sources
 - First stars →
 - **Star-forming galaxies**
 - **Black holes**
 - ...

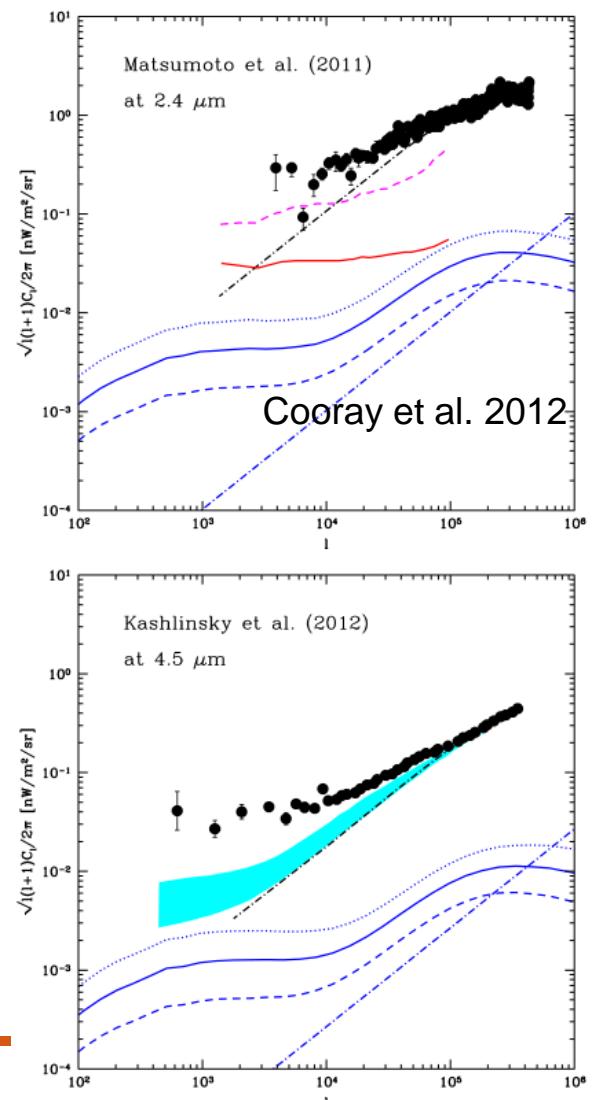
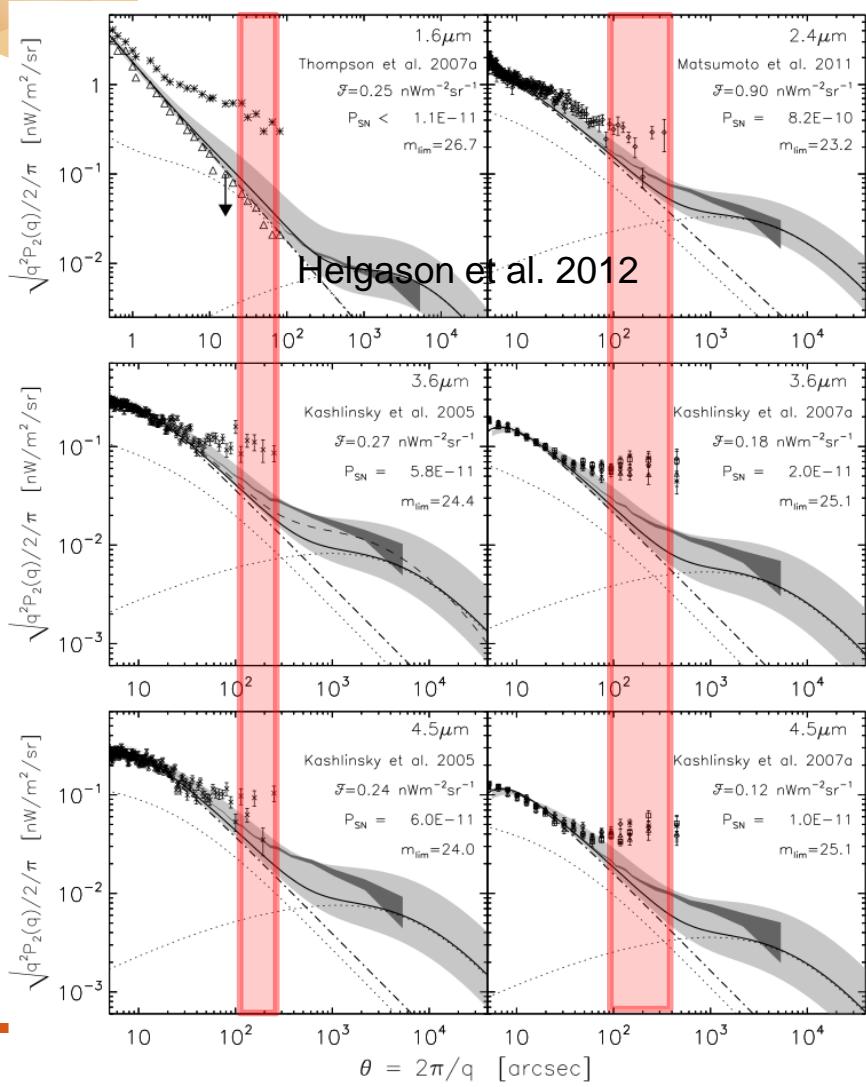
Model prediction
(Fernandez et al. 2010)

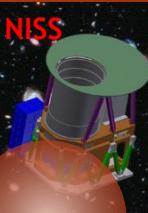




CIB from Foreground galaxies

- Shot noise, Model prediction \leftrightarrow Observation of fluctuation



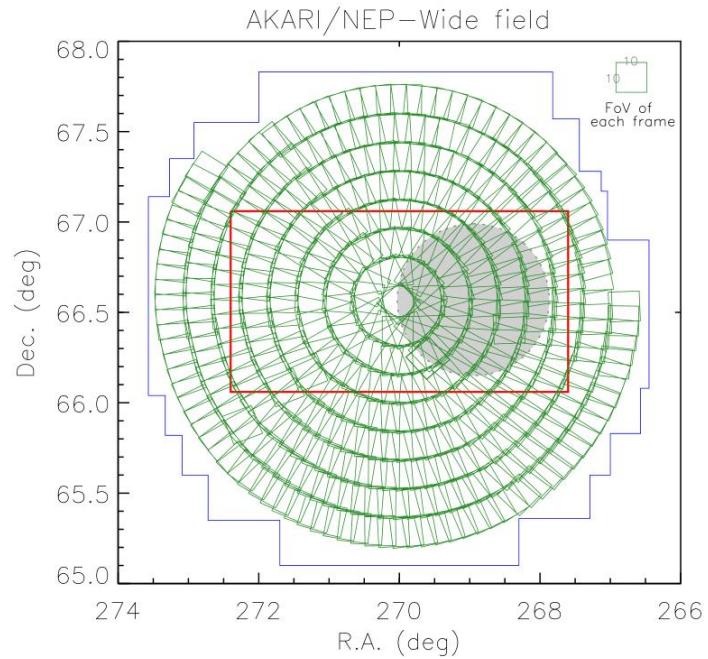


MIRIS Data for CIB Study

Wide band filter images (I & H bands)

- NEP Monitoring field: 1 FoV – 3.67 x 3.67 deg. (MP)
- NEP, SGP, NGP: 10x10 deg. (MP)
- Observations of Dark cloud (OT): 3 regions

Fully covered by MIRIS
(Monitoring field)

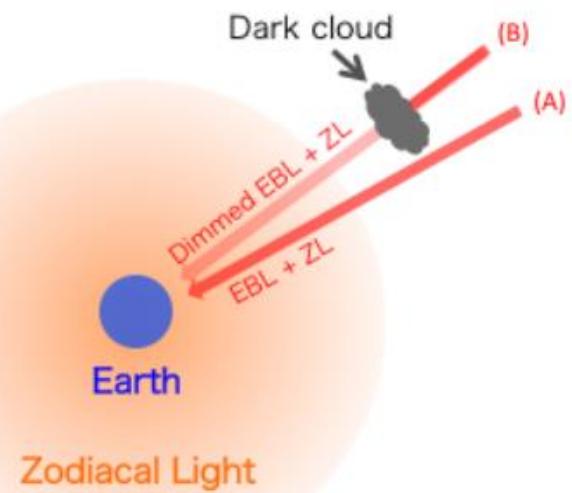
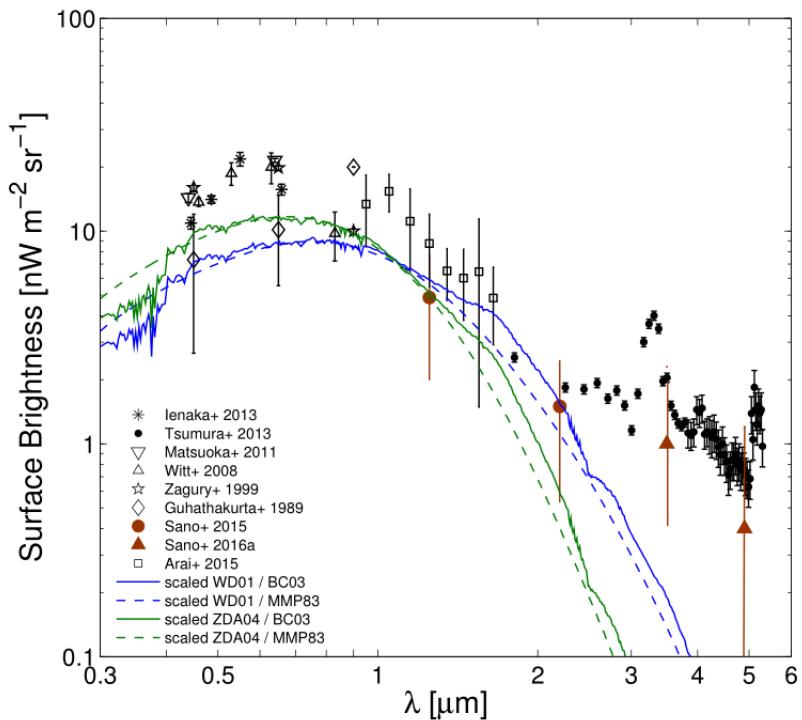


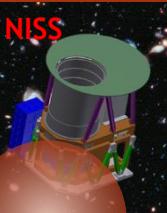


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Study of DGL

- Scattered emission from interstellar dust
- Foreground in the EBL measurements
- Dark cloud method: (A) – (B)





Data Reduction

○ Calibration

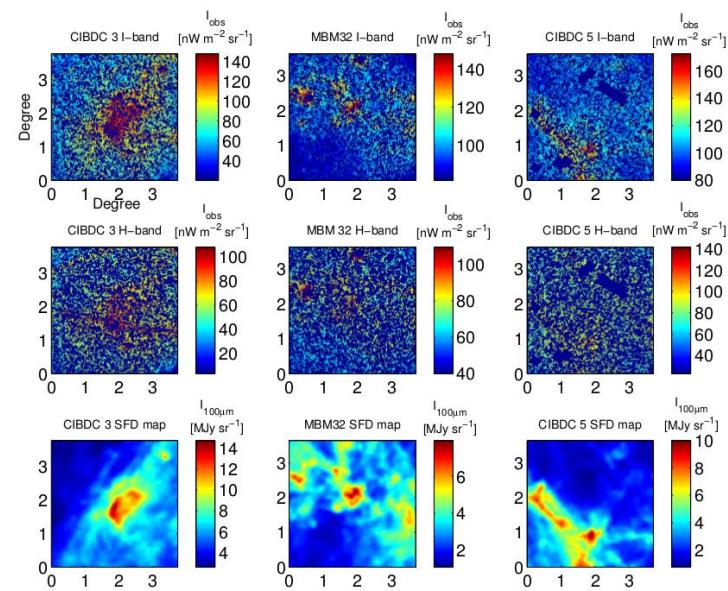
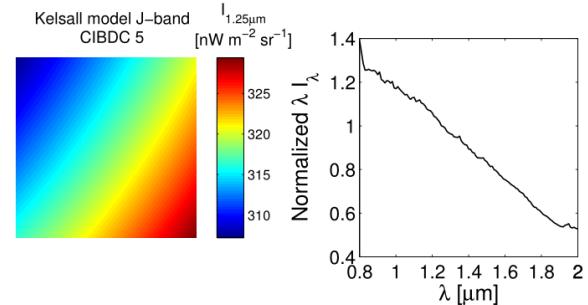
- I band: $11.83 \pm 0.34 \text{ nW/m}^2/\text{sr}$
- H band: $6.02 \pm 0.11 \text{ nW/m}^2/\text{sr}$

○ Point source masking

○ Removal of the gradient of ZL

- Kelsall model @ I & H bands

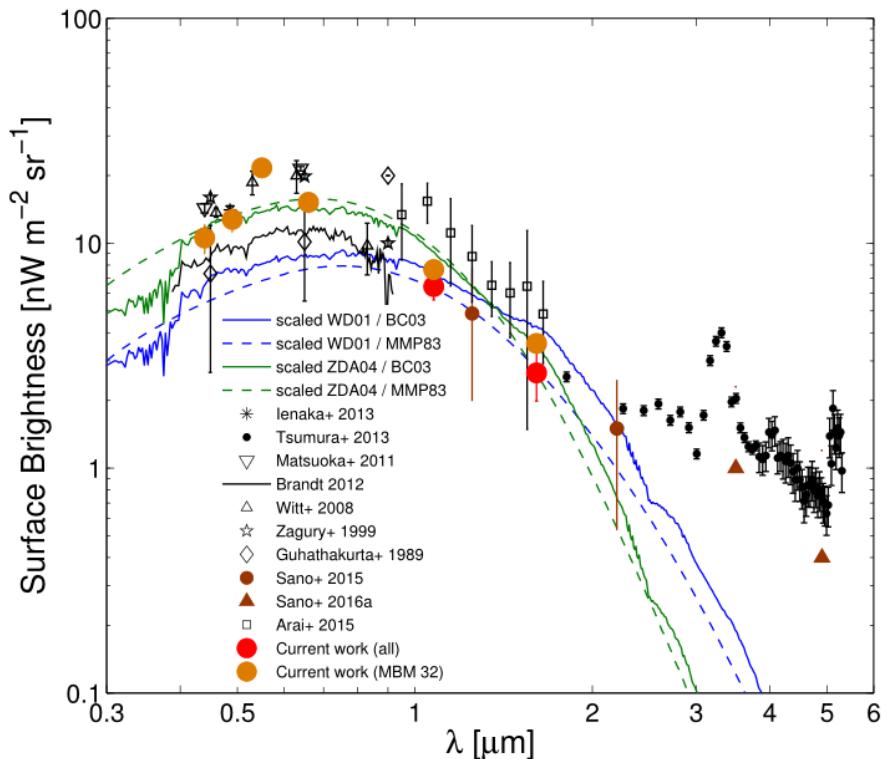
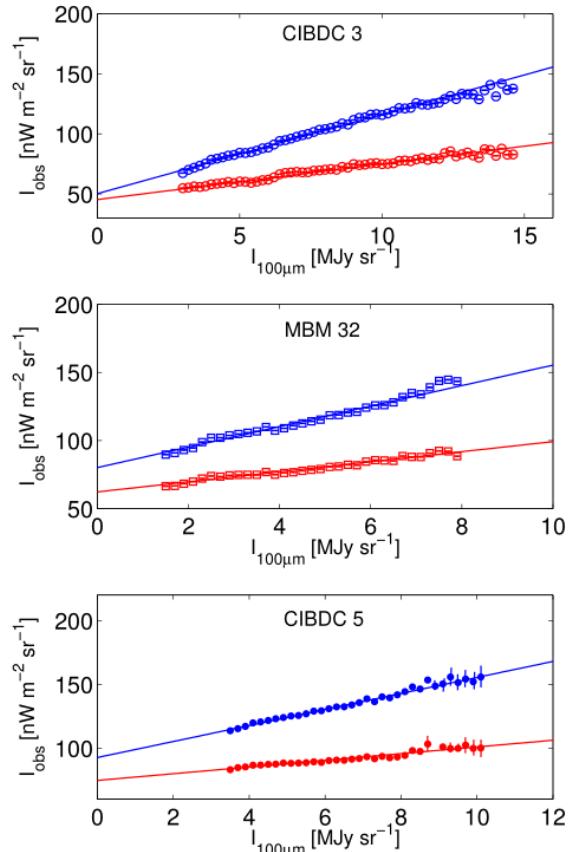
○ Smoothing of the images





DGL & EBL with Dark Cloud Regions

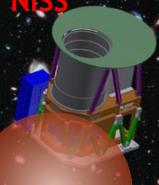
- Diffuse Galactic light and EBL with high-latitude dust clouds in I and H bands (submitted)



Onishi, Matsuura & Jeong et al. 2016,
ApJ, submitted



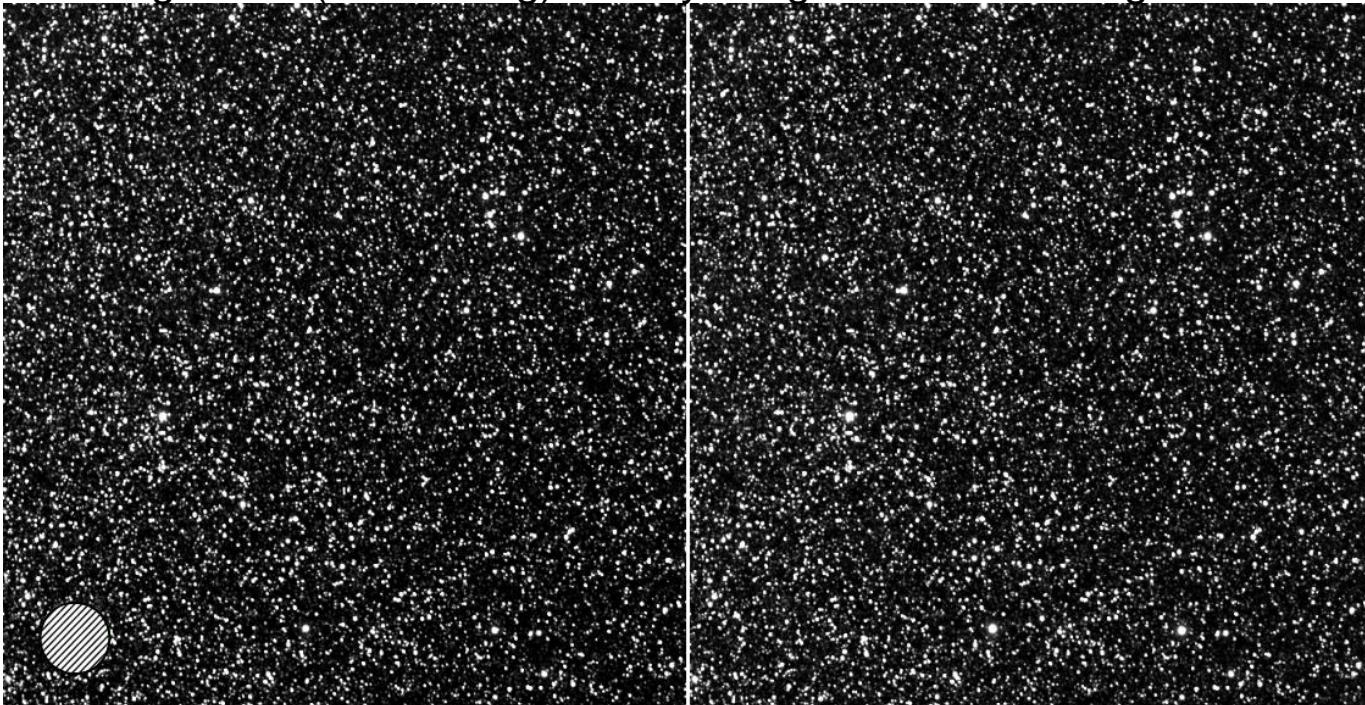
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CIB: NEP Wide Field

- Fluctuation of the near-IR extragalactic background light (EBL)

Large Area (10×10 deg) Survey Image of the NEP Region





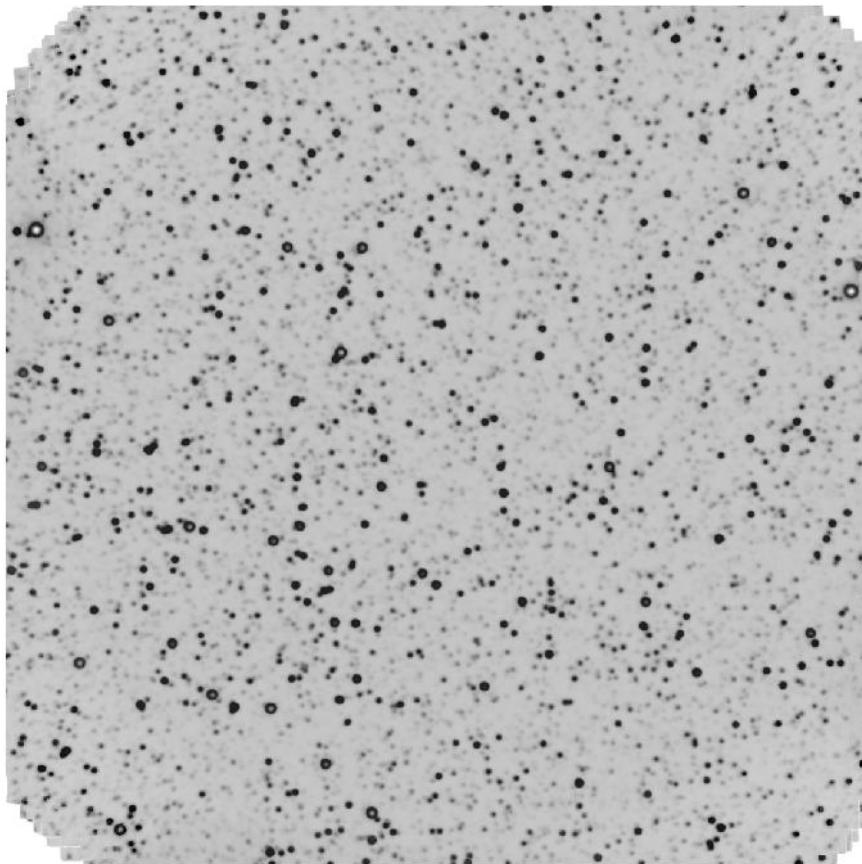
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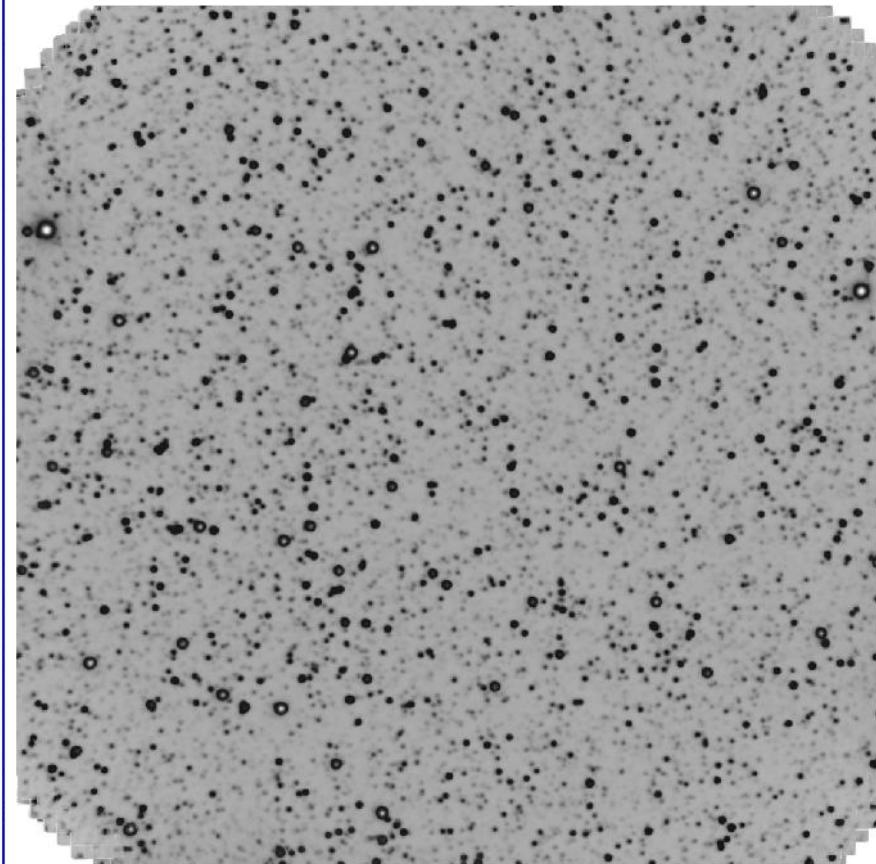
NEP Monitoring Field

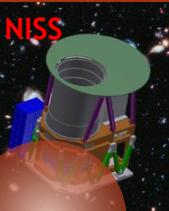
- Total observation time: > 10 hrs exposure

I band



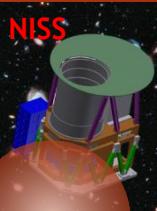
H band





Under the Analysis of Data

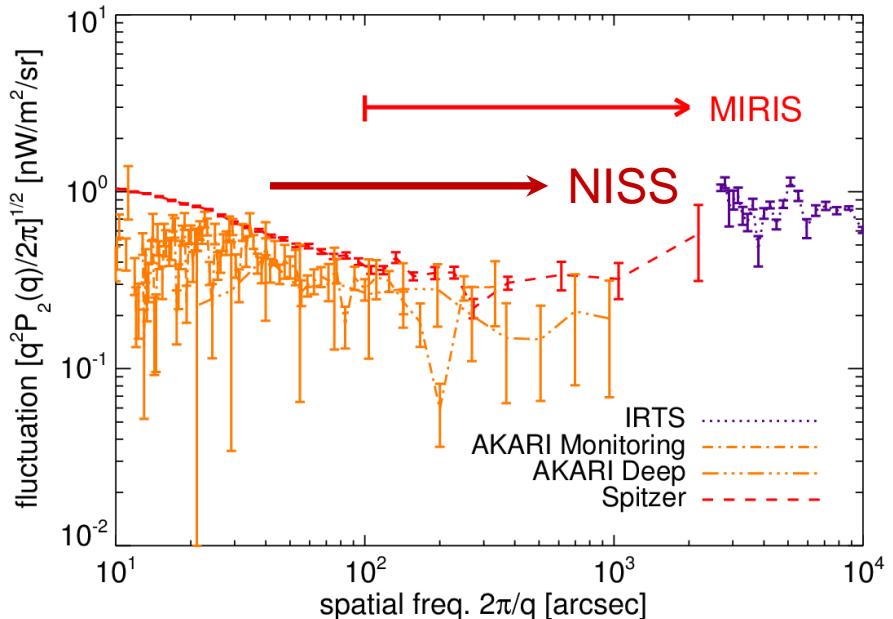
- PSF: not Gaussian shape
 - Pointing stability, Optical PSF
- Variation of background
 - Stray light: earth & sun
 - Intrinsic variation: transient effect, long-term var.
- Dark subtraction
- ...



CIB Fluctuation

- Large-scale fluctuation of CIB
- NEP Region
 - AKARI observation
 - MIRIS: large scales > 3 deg.
 - NISS: medium scales but, continuous

- CIB fluctuation @ $\sim 2\mu\text{m}$
 - IRTS: Matsumoto et al. 2005, 2015
 - AKARI: Matsumoto et al. 2012, Seo et al. 2015
 - Spitzer: Kashlinsky et al. 2012

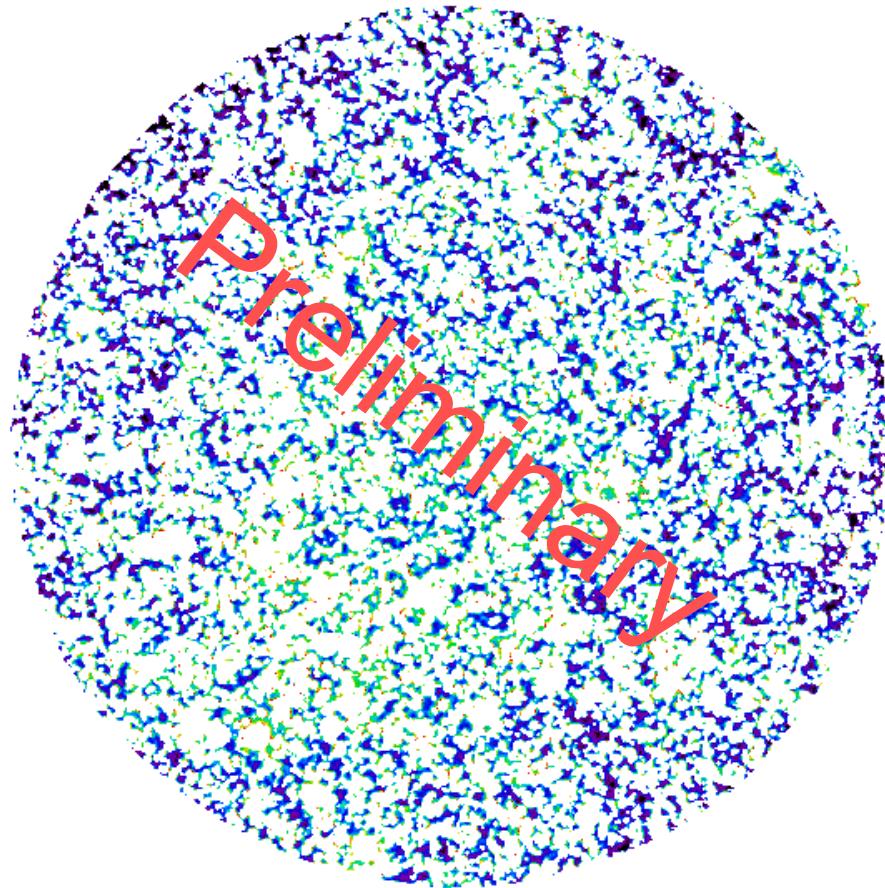




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Measured Fluctuation from MIRIS

- MIRIS Monitoring field
- Significant fluctuation
 - Under the investigation
 - I & H bands
- Need to revise for reduction of artifacts





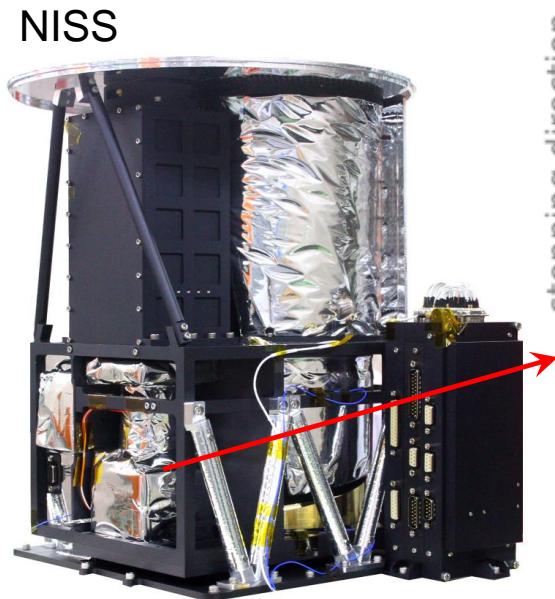
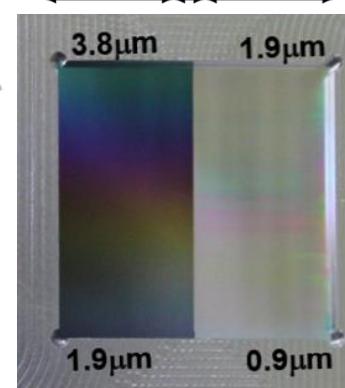
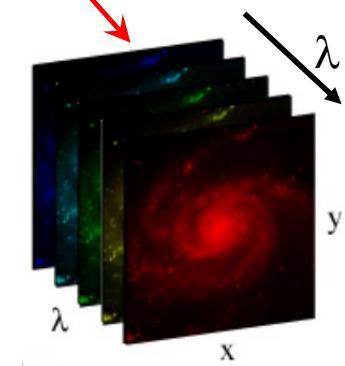
NISS: Near-IR Imaging Spectrometer onboard NEXTSat-1 (2017)

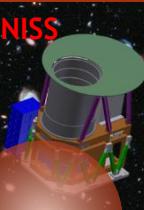
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- Wavelength range: $0.9 \sim 3.8\mu\text{m} \rightarrow 2.5\mu\text{m}$ ($R \sim 20$)
- Array format: 1024×1024 , FoV: $\sim 2 \text{ deg.} \times 2 \text{ deg.}$ ($15''\text{resol.}$)
- 15cm aperture, Imaging & Low-Resolution Spectroscopy ($R \sim 20$),
Sensitivity ~ 17 AB mag. – spectrophotometric survey area $\sim 150 \text{ deg}^2$



NEXTSat-1

stepping direction
↑2LVFs
Passive (180K) &
active cooling (80K)290mm(L) × 270mm(W) × 400mm(H)
14kg



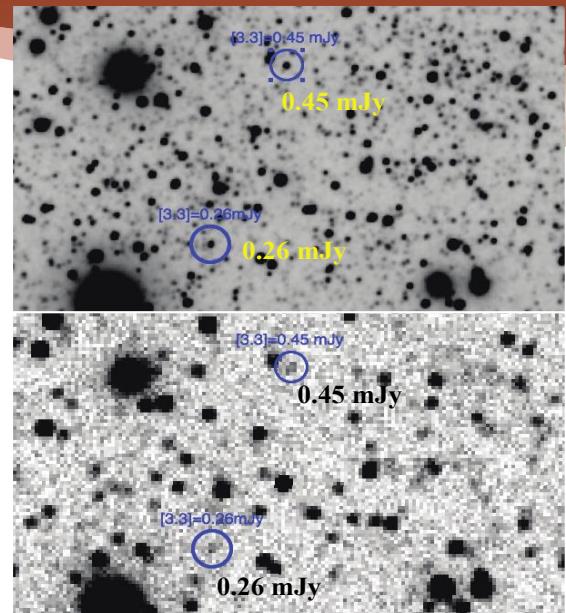
NISS Science Cases

- Near-IR Imaging Spectroscopy
 - Large Nearby galaxies / Clusters of galaxies
 - Star-forming regions
 - Cosmic Near-Infrared Background

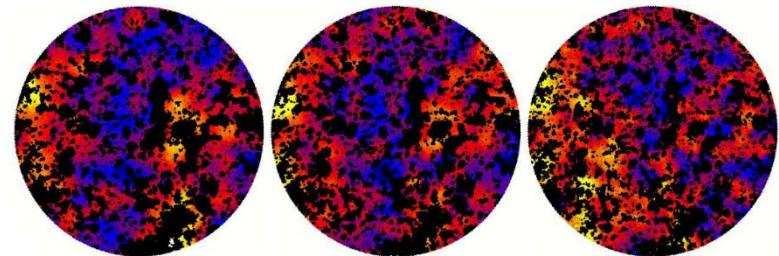
λ (μm)	line	Type
1.26, 1.64	[Fe II]	Emission
1.875	Paα	Emission
1.96	[Si IV]	Emission
2.212	H₂ 1-0 S(1)	Emission
3.05	H ₂ O Ice	Absorption
3.3	PAH	Emission

Near-infrared spectral lines

WISE



Detections of WISE galaxies

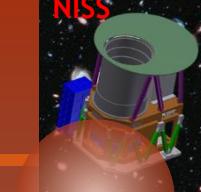


Matsumoto, Seo, Jeong et al. 2011



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Summary



○ CIB Study with MIRIS

- Monitoring field of NEP: huge data sets
 - Peak spatial scale of CIB
- Large area survey (10×10 deg.): NEP, SGP, NGP
 - Large-scale structure (> 3 deg.) of CIB

○ NISS (2017)

- Imaging spectroscopic capability
 - Source of Origin for CIB?
- Launch: end of 2017