Hα search in the Cosmic Infrared Background with SPiCA/MCS

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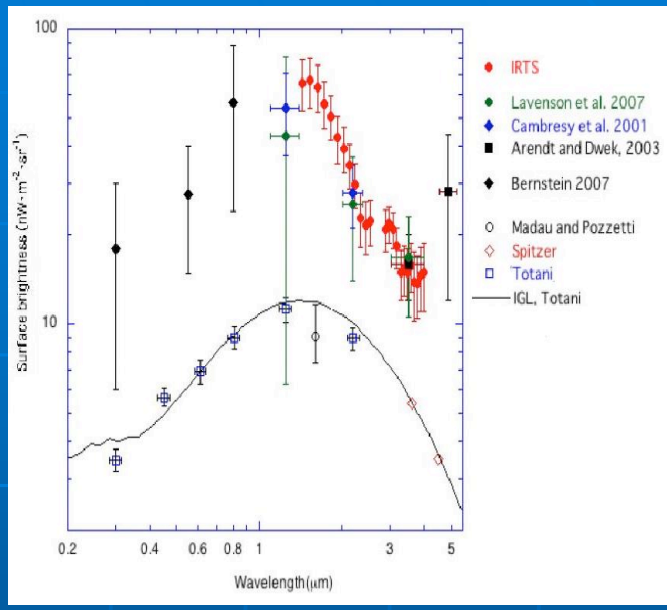
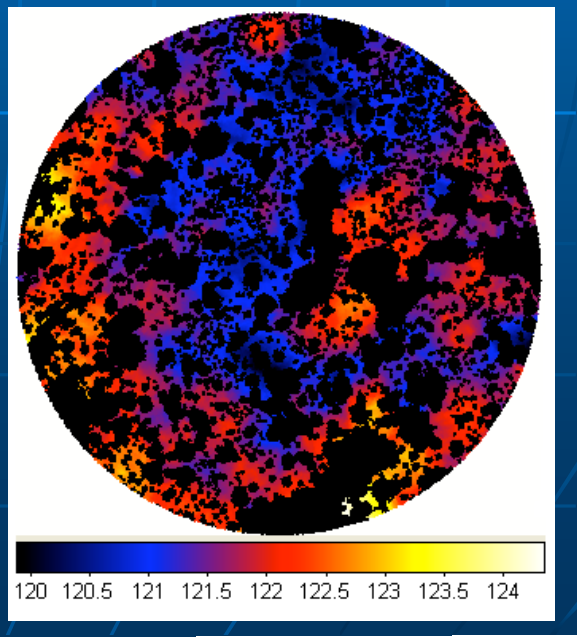
Cosmic Infrared Background (CIB)

- CIB excess at near-infrared
  - Many direct measurements from space (COBE/DIRBE, IRTS, CIBER/LRS)
  - Peak at ~1.6um?
  - Lyman-α from z~12? or foreground subtraction error?



- Large scale fluctuation of CIB
  - Recent results from Spitzer and AKARI
  - Zodiacal light (zody) is too smooth to explain this fluctuation
  - Fluctuation at the re-ionization era?



Matsumoto+(2010)

What is the origin of CIB?

Lyα from z~12?

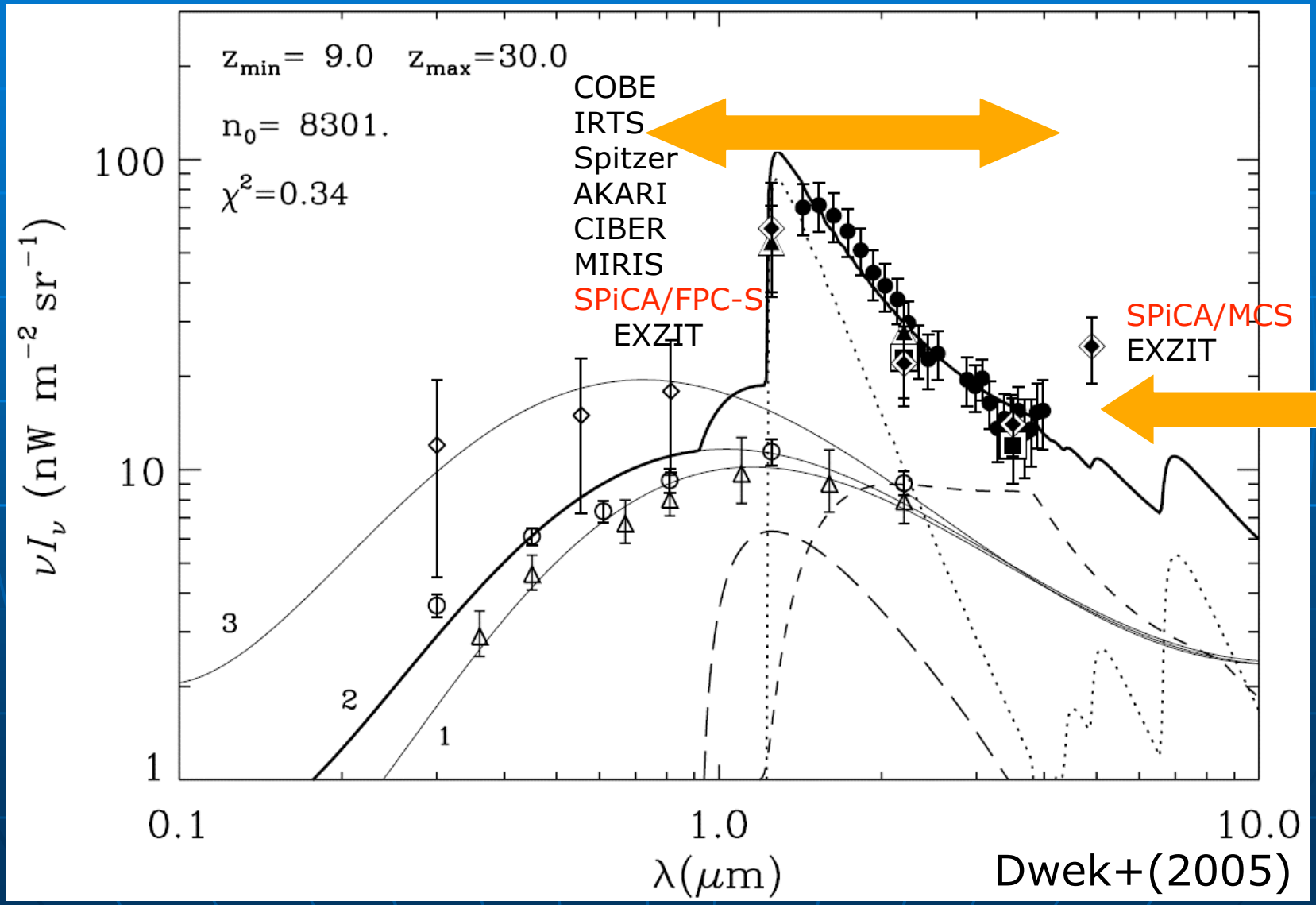
- Clear peak at 1.6um was detected with CIBER (but it's still preliminary)
- CIB fluctuation cannot be explained by the smoothness of zody and suggests high level of CIB (Pyo+ 2010, Matsumoto+ 2010)

Foreground error?

- Zody intensity is several times higher than CIB and it's difficult to determine the absolute brightness of zody.
- Intergalactic absorption of TeV γ-ray from blazers suggests low level of CIB. (Aharonian+ 2006)

Hα survey can settle this problem!

CIB spectrum in NIR and MIR



Suggestion for CIB science with SPiCA/MCS

- Spectroscopy at ~8.5um for search of CIB-Hα with MCS-LRS-S
  - Hα appears at ~8.5um if the 1.6um peak in CIB is related to Lymanα at z~12.
  - Estimated signal is almost same as photon noise of zody (600sec, 1 pointing, 1σ)
- Large area survey for search of CIB-Hα fluctuation at ~8.5um with MCS-WFC-S
  - Coordinated observation with FPC-S
  - It can be also used for HAE and HAB survey at z=12
  - Large area survey (>100 arcmin2) with a narrow-band filter (R>20) is suggested.

Can Hα be detected with SPiCA?

- Detection limit of MCS-LRS (600sec, 1σ)
  - 7.3uJy @7.5um (fact sheet) → ~4nW/m2/sr
- Estimated brightness (νI_ν@8μm)
  - Zody 3000 nW/m2/sr
  - CIB Hα ~5 nW/m2/sr (~1/10 of Ly-α Dwek+(2005))
  - Galactic ~2 nW/m2/sr + PAH
- Estimated photon number (600sec, R~50)
  - Zody 7×10^{5} → Photon noise = 800
  - CIB Hα 1100

S/N~1 at 1 pointing for 600 sec !

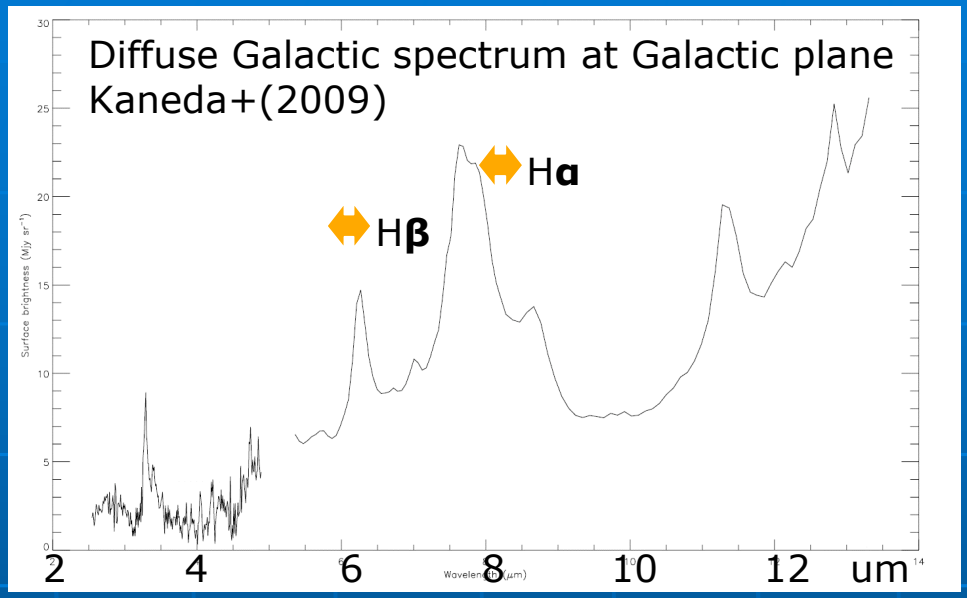
Strategy for CIB spectroscopy

- Different Ecliptic/Galactic latitude is required for foreground separation
  - Determination accuracy of 0.1% is required for zody spectrum
    → Ecliptic latitude dependance of zody
  - Galactic PAH also appears at ~8um
    → PAH intensity can be estimated from the other bands
    → PAH intensity is correlated to 100um intensity
    → observation at low cirrus region (cf. Lockman hole)
  - Hβ also appears at 6um (~1/3 of Hα) but PAH is also there too

>3 region are required for foreground separation
(high-β & low cirrus region, low-β for zody, low-b for Galactic)

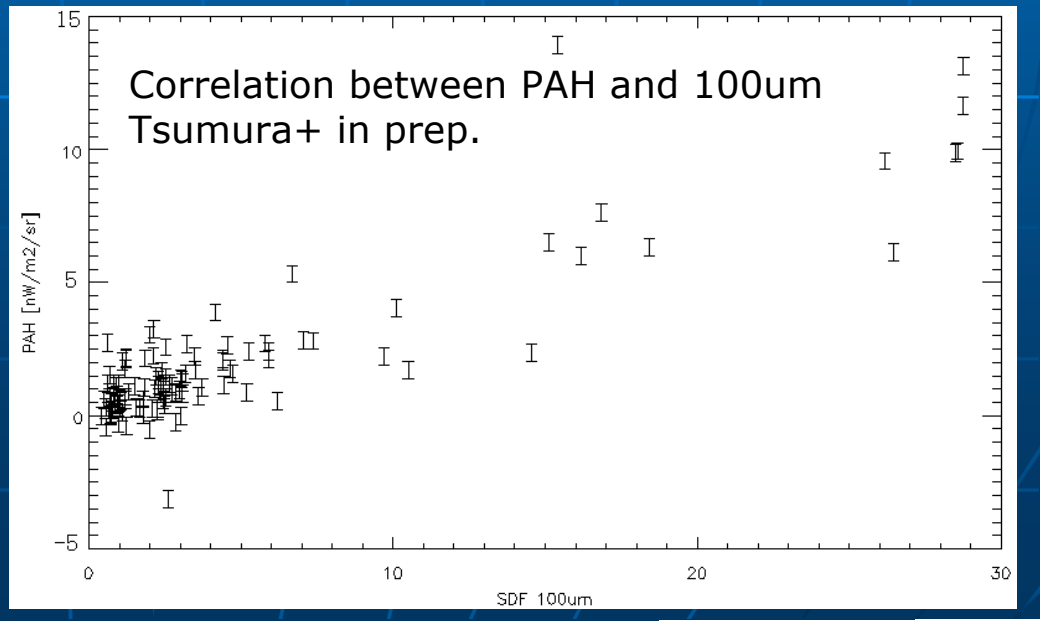
- Collaboration with NIR spectroscopy with FPC-S LVF filter
  - Coordinated observation and direct comparison

Foreground Galactic diffuse spectrum



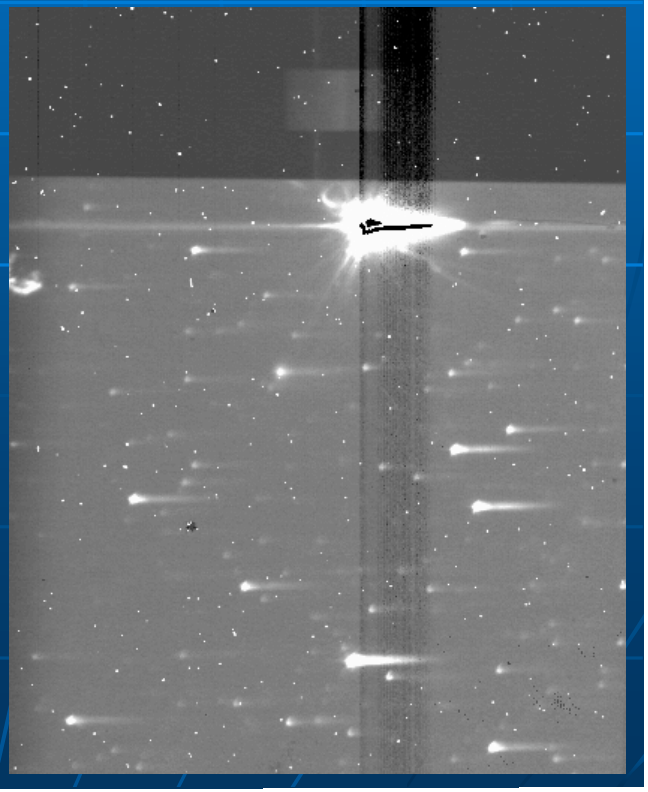
- PAH appears at almost same wavelength as Hα and Hβ
- We can estimate 8um PAH intensity from other PAH bands.

- Correlation between PAH intensity and 100um intensity
- AKARI confirmed this correlation even at high Galactic latitude
  (Tsumura+ in prep.)



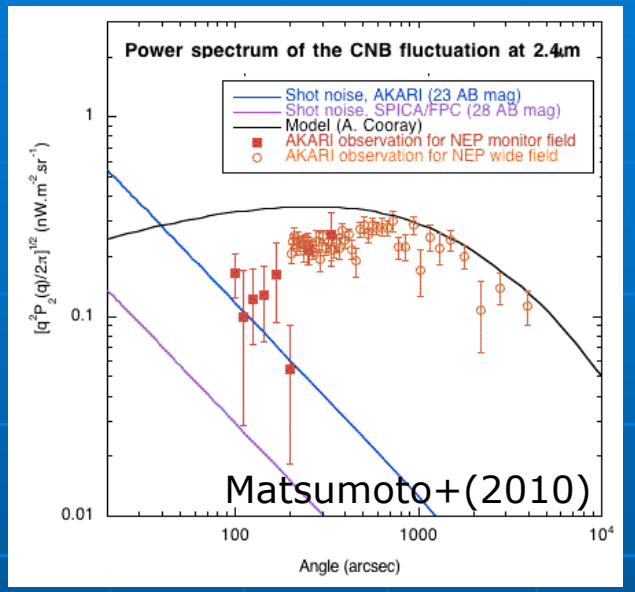
Advantage to JWST

- Large slit for diffuse spectroscopy
  - JWST/MIRI: 0.6”×5”
    (3uJy at 10σ, 10000sec, 7.5um)
  - SPiCA/MCS-LRS:1.4”×2.5’
    (7.3uJy at 1σ, 600sec, 7.5um)
- No Contamination from imaging region
  - Different mode between imaging and spectroscopy with MCS
  - Lesson from diffuse spectroscopy with AKARI/IRC
  - JWST has both imaging and spectroscopy region on the same array



Wide field survey for CIB-Hα fluctuation with MCS-WFC

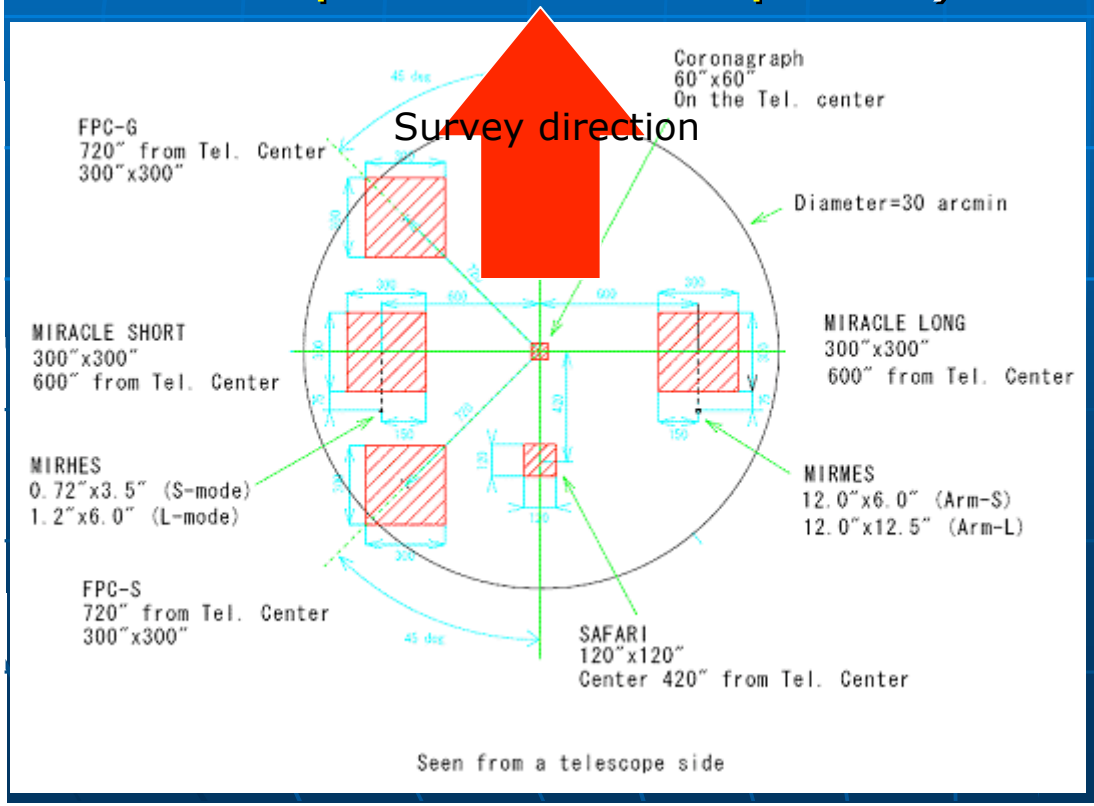
- Wide field survey (>100 arcmin^2)
  - CIB fluctuation peak at ~15arcmin
  - 15arcmin ~ 5Mpc at z~12
  - Galactic cluster size ~5Mpc
- Filter Suggestion
  - R=20 ~ Δz=0.5 ~ d=500Mpc
    (Same R with FPC-S)
  - R=100 ~ d=100Mpc —> >2deg^2 survey
  - It also can be used for HAE/HAB survey at z~12
- Coordinated survey with FPC-S
  - Correlation search between Ly-α and Hα fluctuation in CIB
- Large FOV is great advantage to JWST!
  - MCS-WFC: 5×5 arcmin^2
  - JWST-MIRI: 1.3×1.7 arcmin^2



Synergy from Coordinated survey

- Large area survey
  (For example: 2×2 deg)
- FPC-S and MCS can be operated at the same time!

(Modification of the filter wheel position is required)



- Spectroscopy and narrow-band imagings

FPC-S:

spec: LVF-2(1.4-2.8um)

imaging: z, H, K

MCS:

spec: LRS-S (5-26um)

Imaging:7um (for PAH)

8.5um (R=20)

9um (for Silicate)

and/or

8.5um (R=20)

8um (R=5)

Yellow: new suggested filter

Summary

- MCS-LRS-S is strongly required for our study!
  - Hα in CIB appears at ~8.5um if 1.5um peak is related to Lyman-α at z~12
  - SPiCA MCS-LRS-S can compete against JWST for diffuse spectroscopy
- Modification of filter wheel position is also required!
  - Coordinated large-area survey with MCS and FPC-S
- A new filter is suggested (8.5um, R~20)
  - Fluctuation analysis for CIB-Hα