Thermal Infrared Observation using Adaptive Secondary Mirror (ASM)

Hiroshi TERADA

(Subaru Telescope)

Talk Contents

- *Ground-based Thermal IR w/AO*
- *Subaru Thermal IR w/AOs*
- *Subaru Thermal IR w/ASM*

Ground based Thermal IR Observation

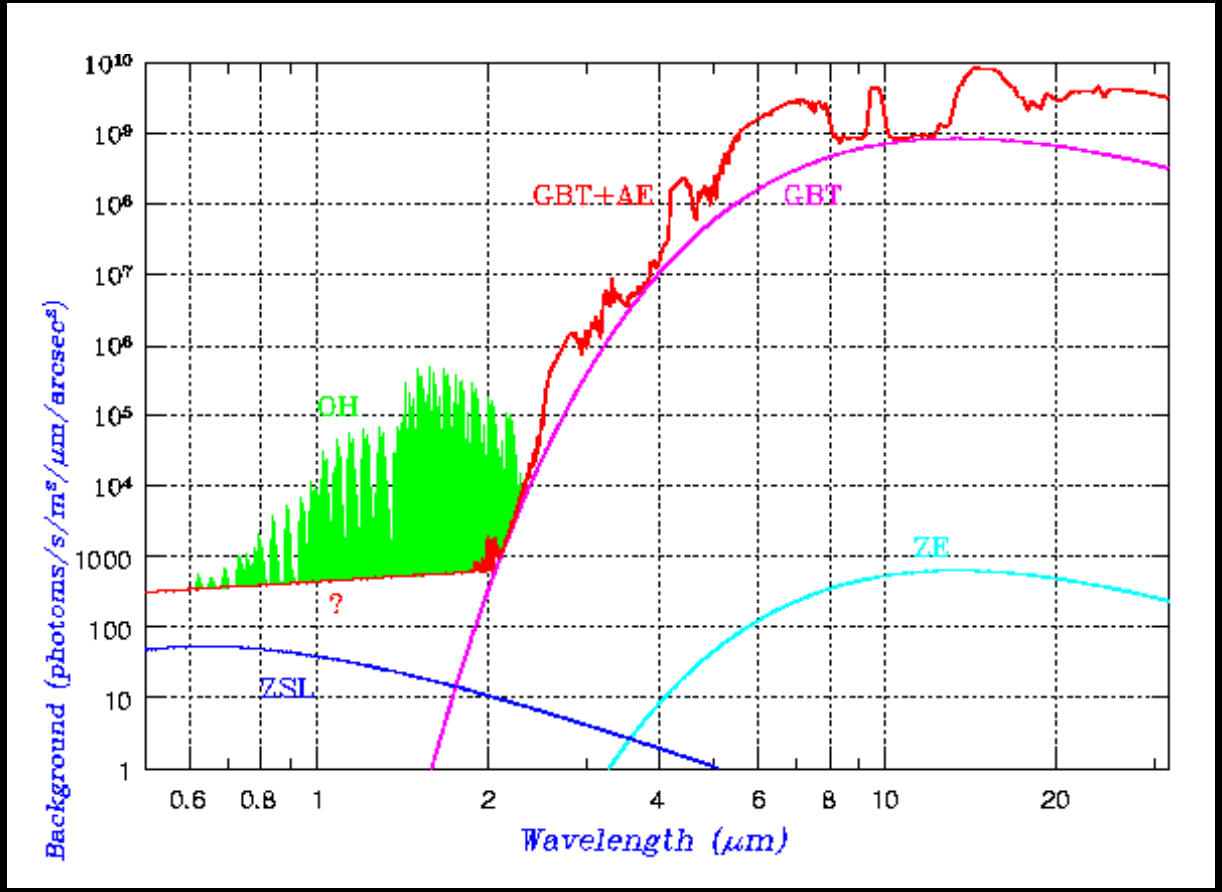
Background Emissions

1-2um

OH emission lines

>2um

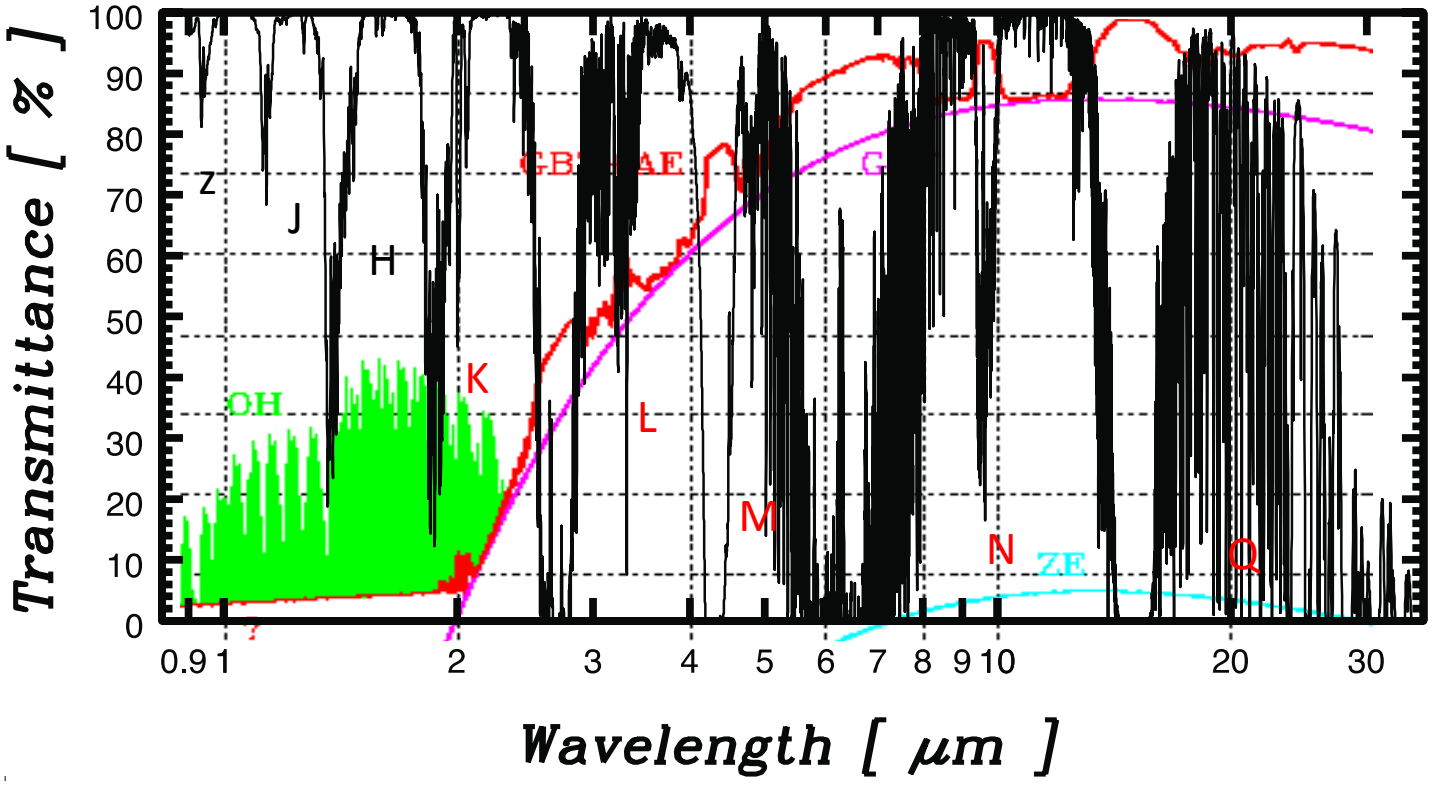
Thermal Radiation (from Sky and Ambient)



http://www.kusastro.kyoto-u.ac.jp/~iwamuro/LECTURE/OBS/atmos.html

Ground based Thermal IR Observation

Atmospheric Transmission

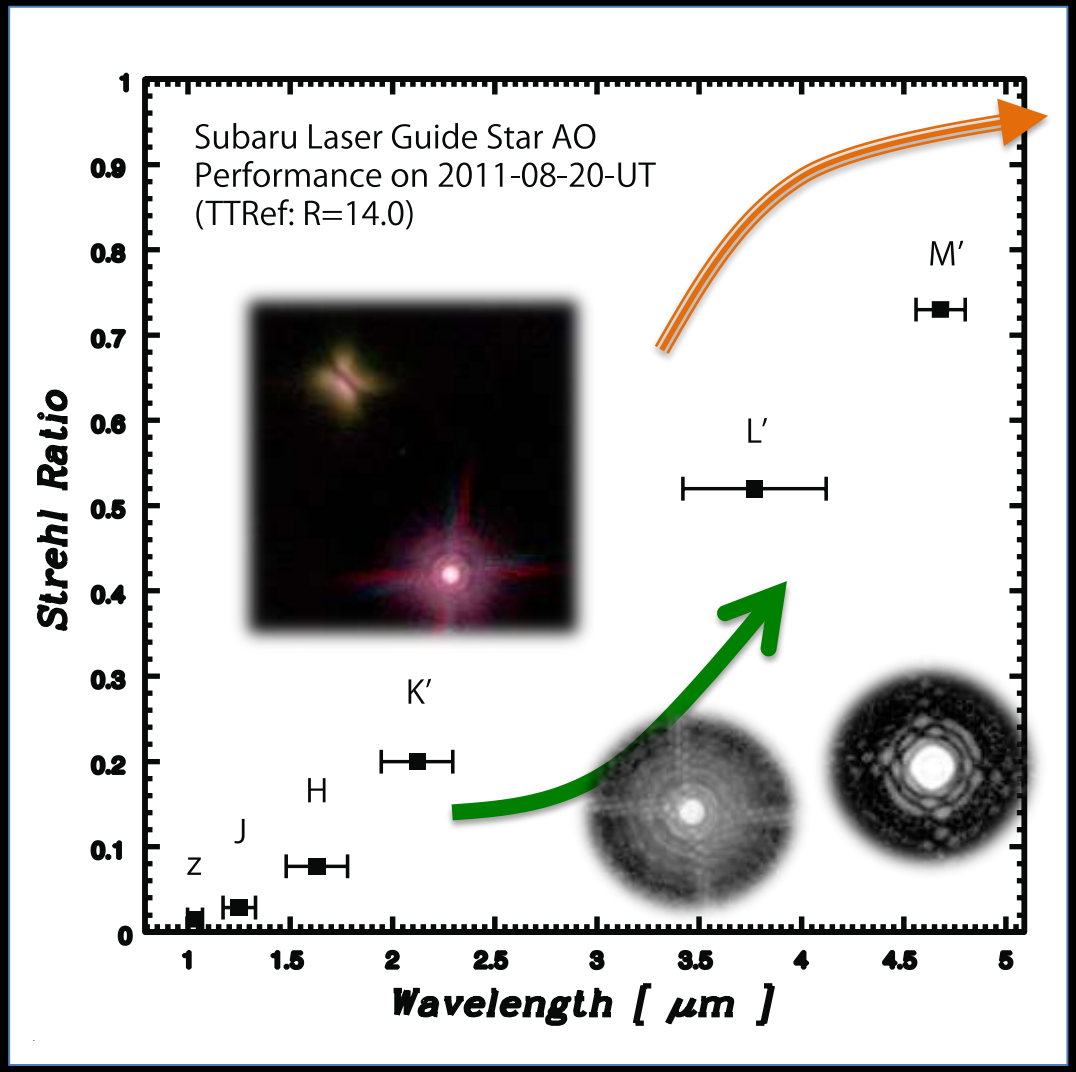


AO Observation @ Thermal IR

Performance in General

- ✓ *Higher Background*
- ✓ *Longer wavelength*
  - *-> Better correction*
  - *-> Covering wider FOV (angle ∝λ(1.2))*

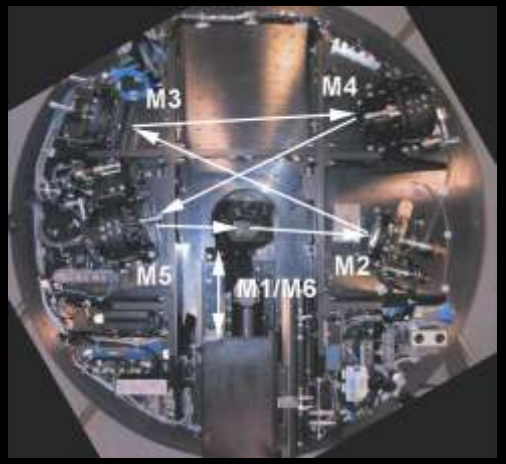
- ❖ *Image Quality Good Enough @ Mid-IR under Natural Seeing? (seeing ∝λ(-0.2))*

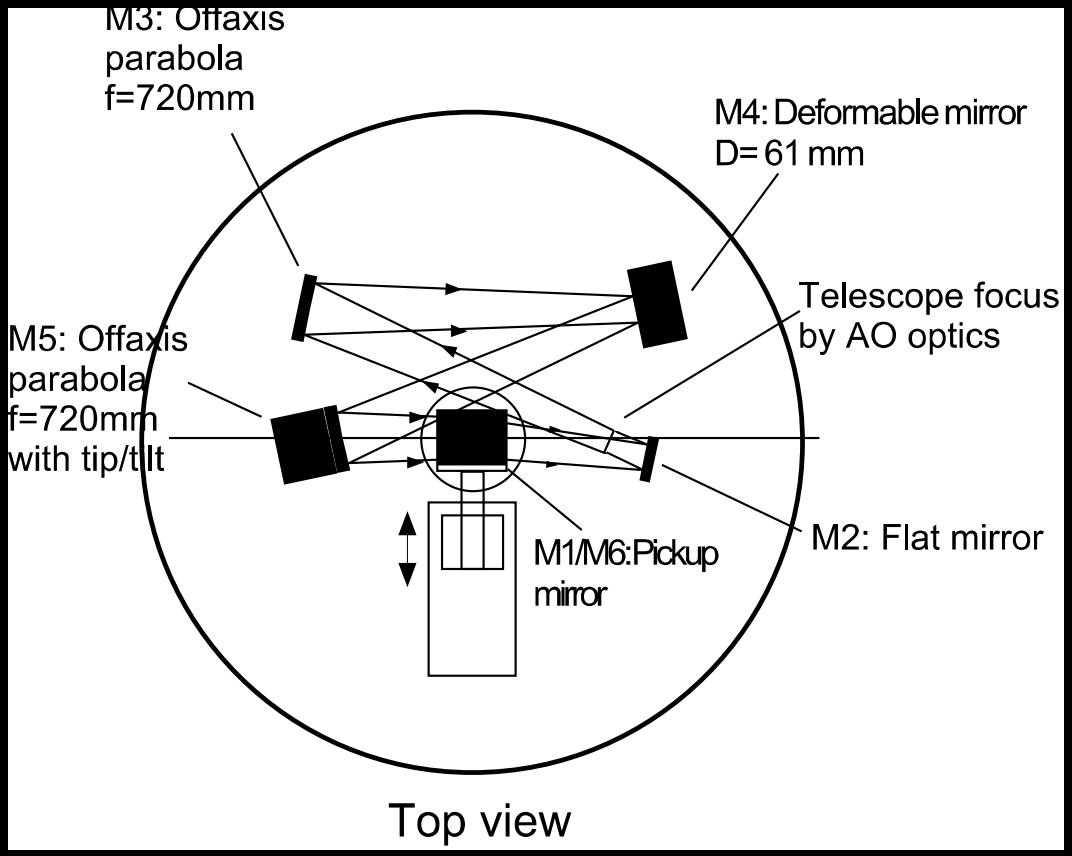


Subaru AO Observation

1st Generation AO (AO36)

AO36@Subaru Cassegrain focus





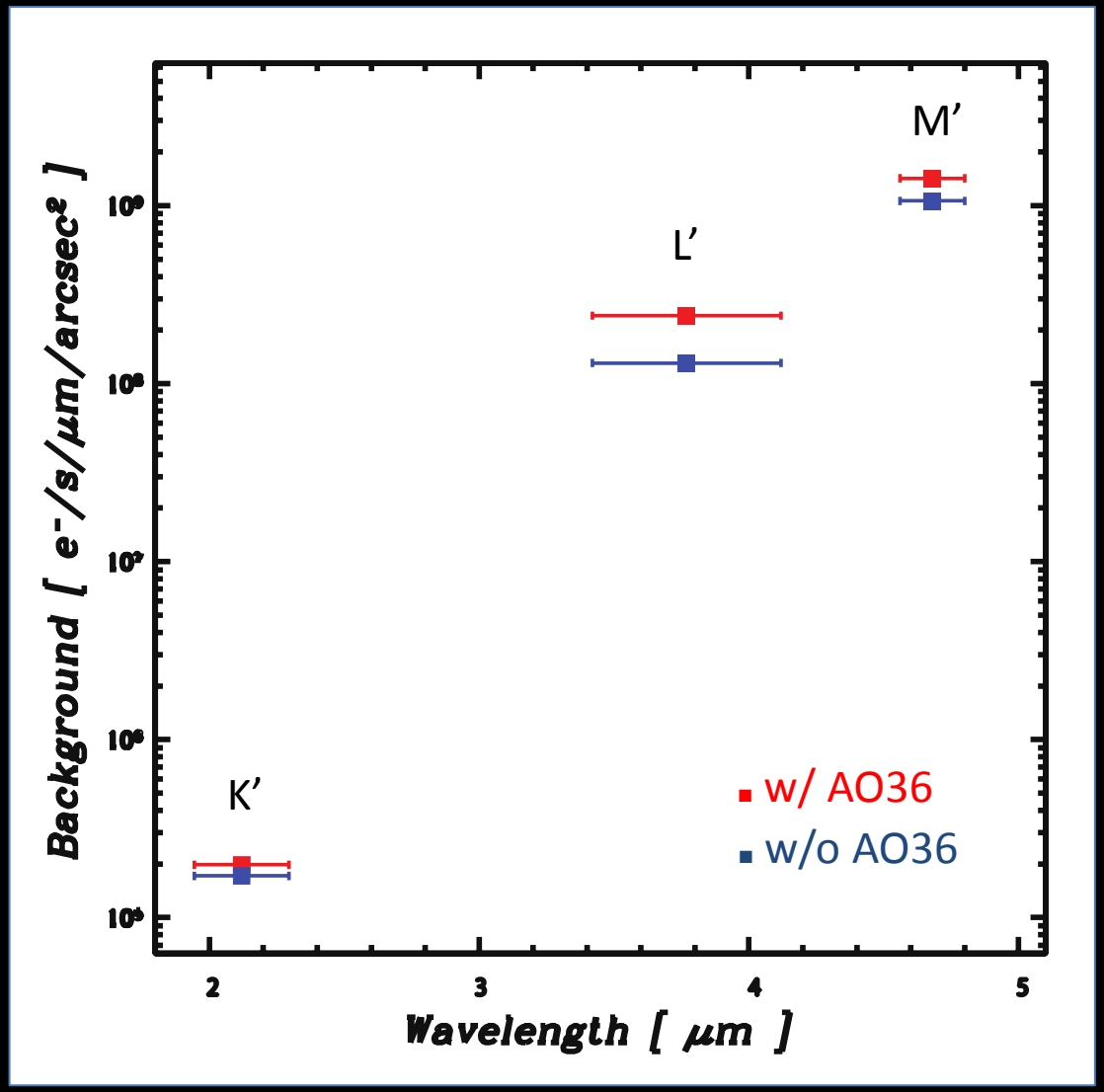
IRCS

CIAO

Beam Splitter: COLD n instrument

Subaru AO Observation

1st Generation AO (AO36)



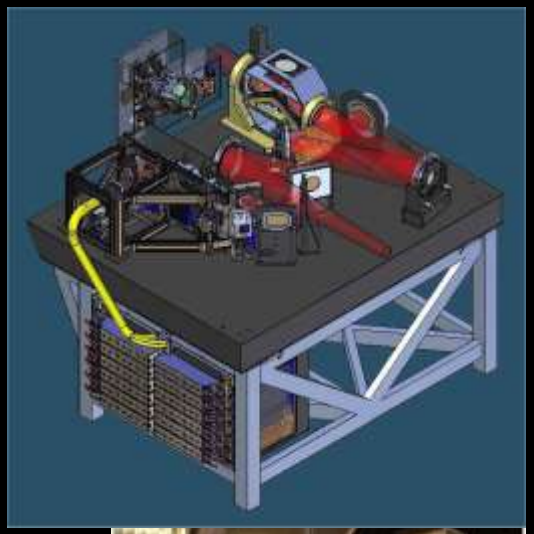
Background increase w/AO36 from w/o AO36	
K'	-0.08 mag
L'	-0.33 mag
M'	-0.16 mag

Hiroshi TERADA @ Subaru Telescope

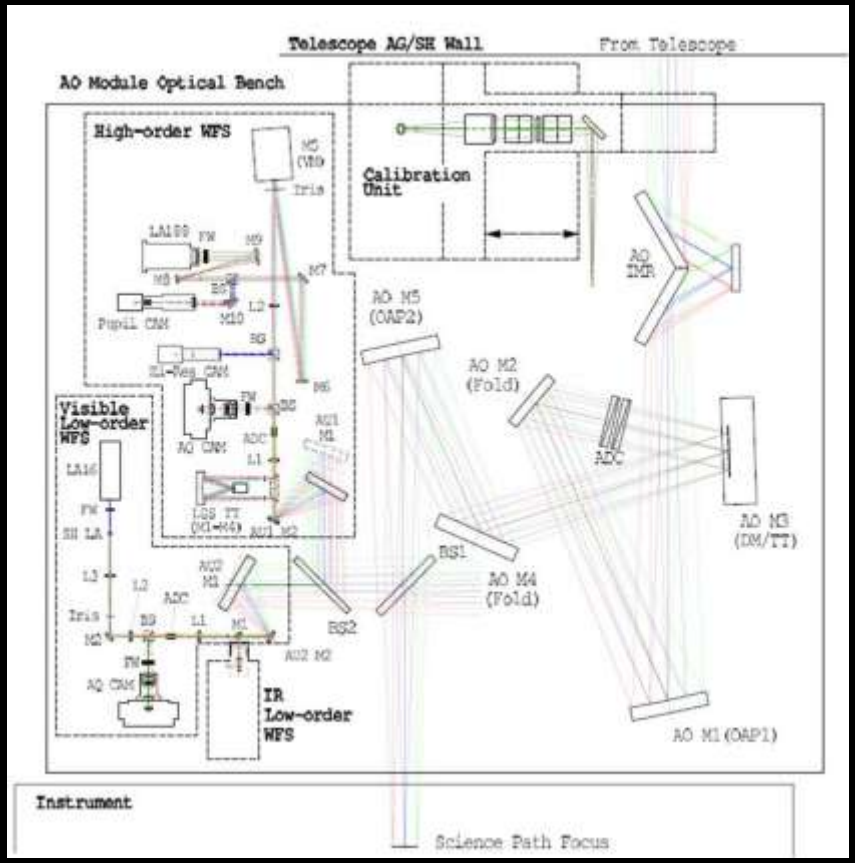
Subaru AO Observation

2nd Generation AO (LGS/AO188)

AO188 @ Subaru Infrared Nasmyth



IRCS

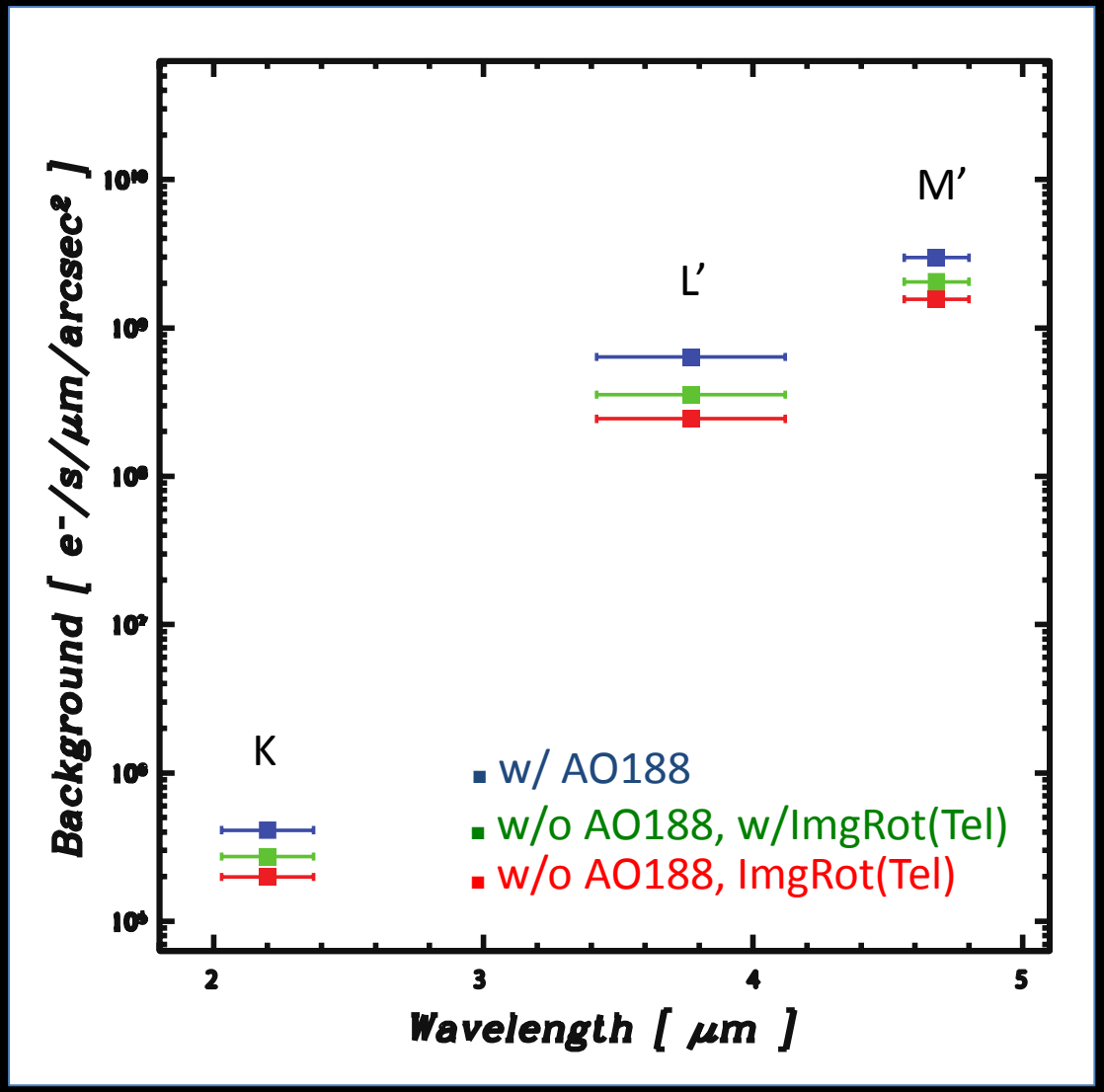


Beam Splitter: WARM outside instrument

Image Rotator: On AO188

Subaru AO Observation

2nd Generation AO (LGS/AO188)



Background increase w/AO188 from w/o AO188,ImgRot	
K	-0.39 mag
L'	-0.52 mag
M'	-0.35 mag

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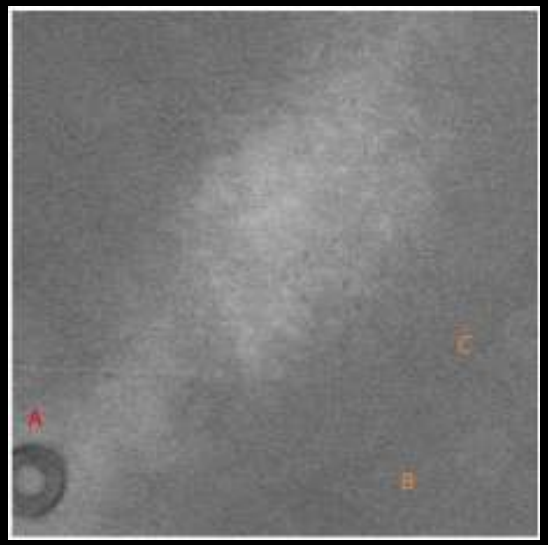
Subaru AO Observation

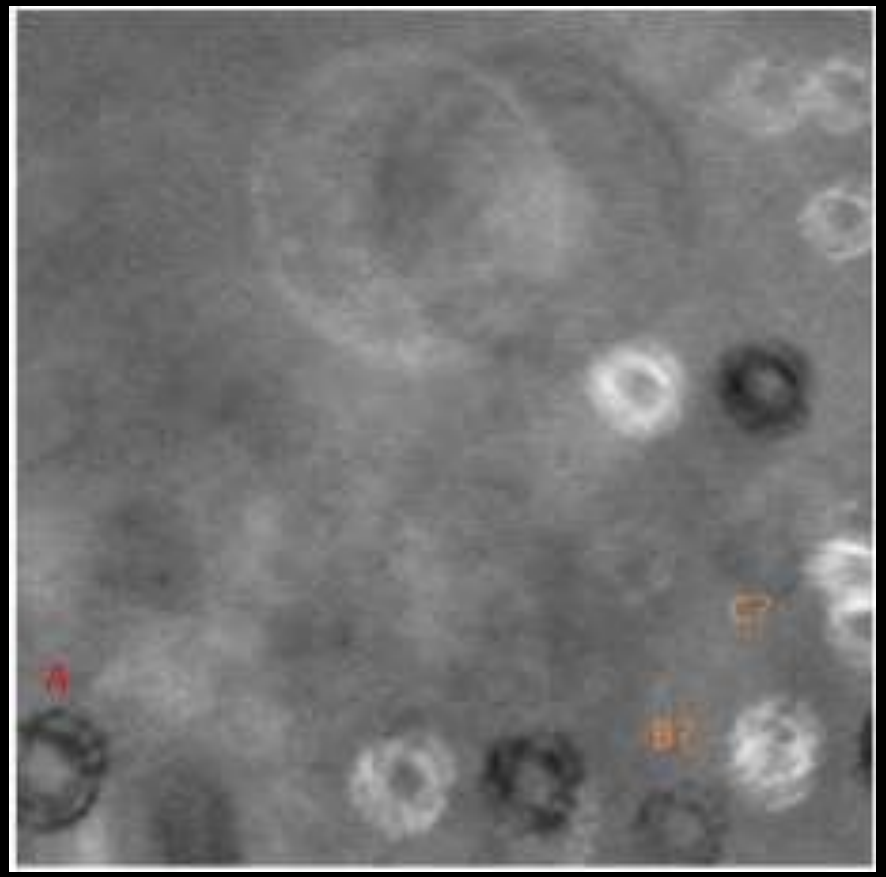
2nd Generation AO (LGS/AO188)

One More Thing…

- ✓ *Warm dust / Coating defect on Optical Surface*



Cf. Current



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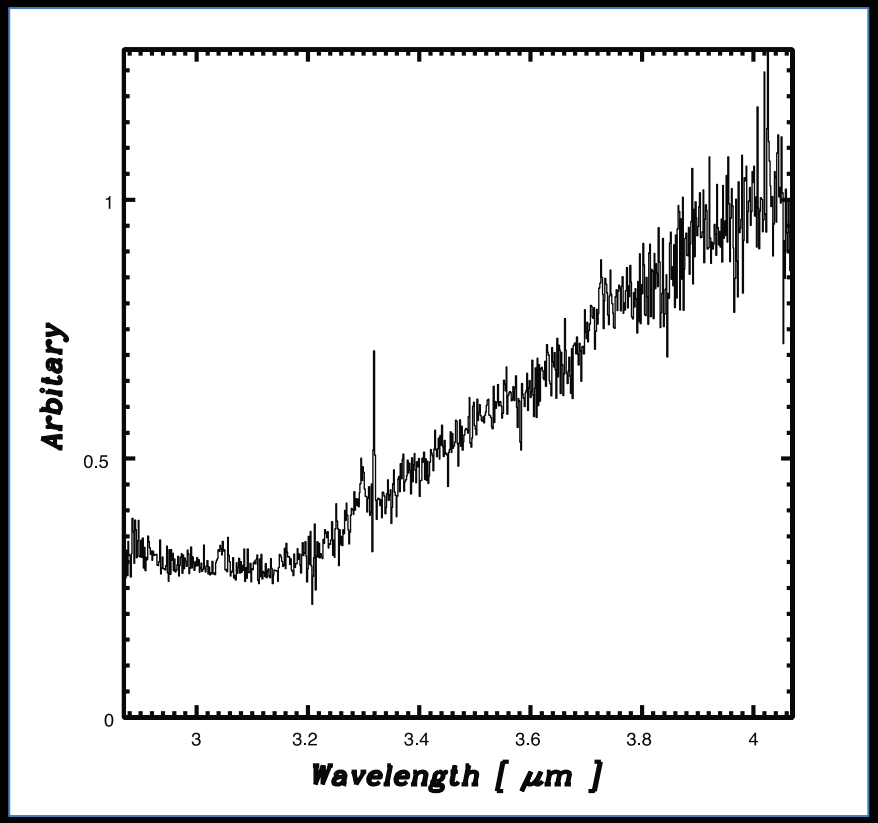
Subaru AO Observation

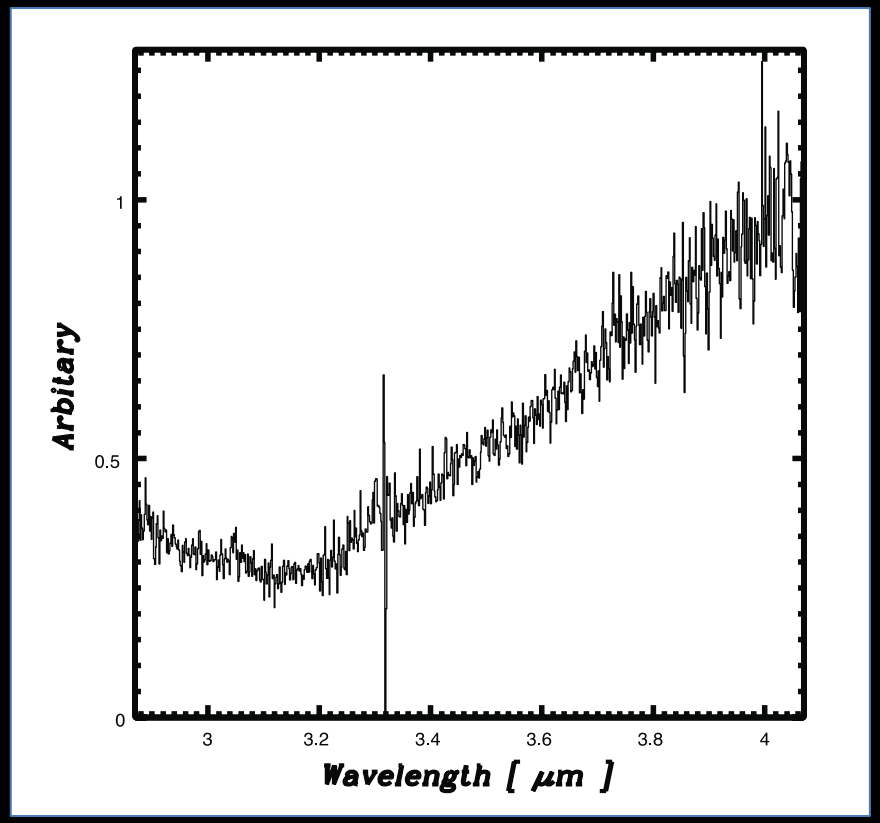
w/ and w/o AO188 L-band Observation

L-band Low-resolution Spectroscopy

Slit width: 0”.45 / 90sec * 24 = *2160sec*



Slit width: 0”.225 / 50sec * 20 = *1000sec*



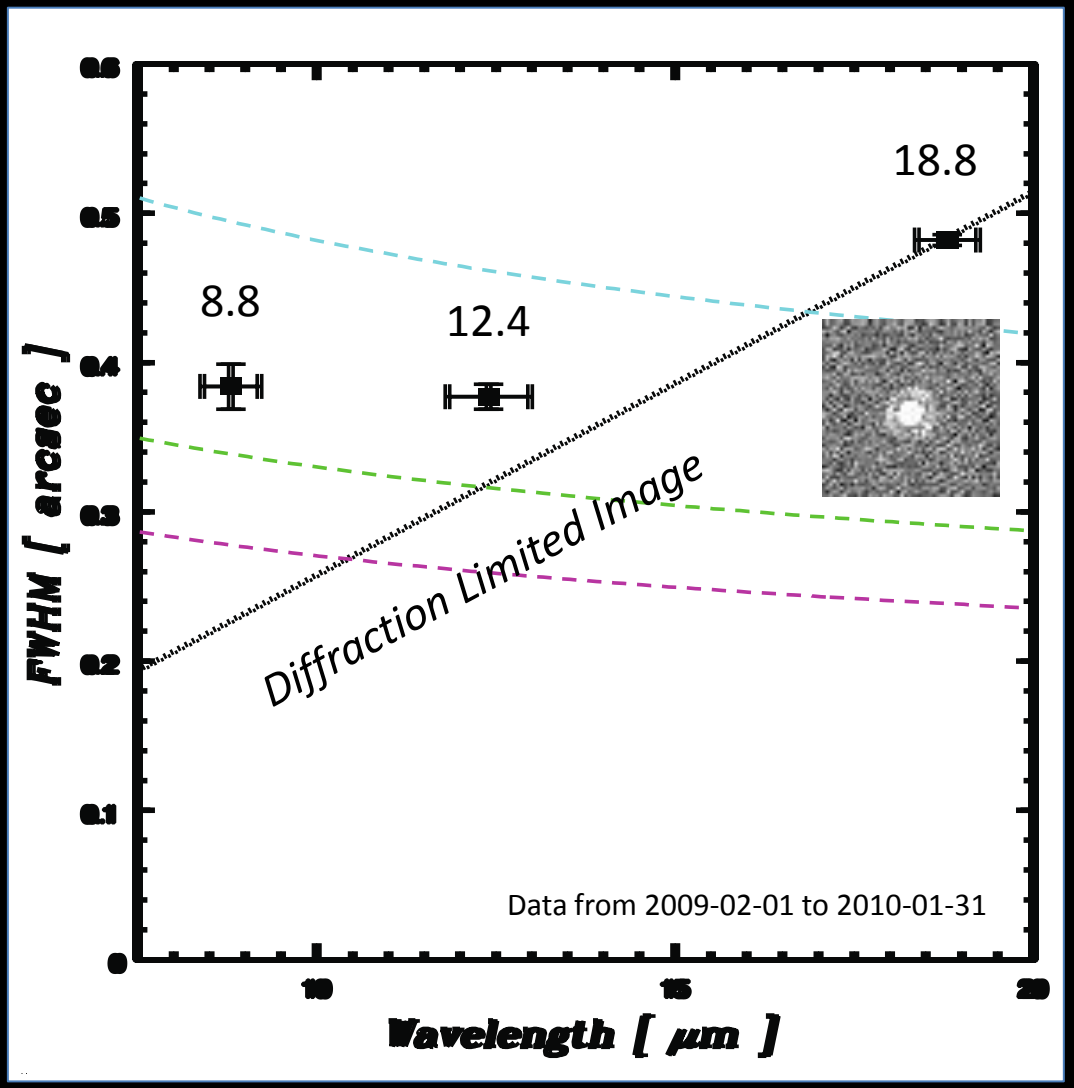
✓ *Comparable S/N w/ half an exposure time*

Hiroshi TERADA @ Subaru Telescope

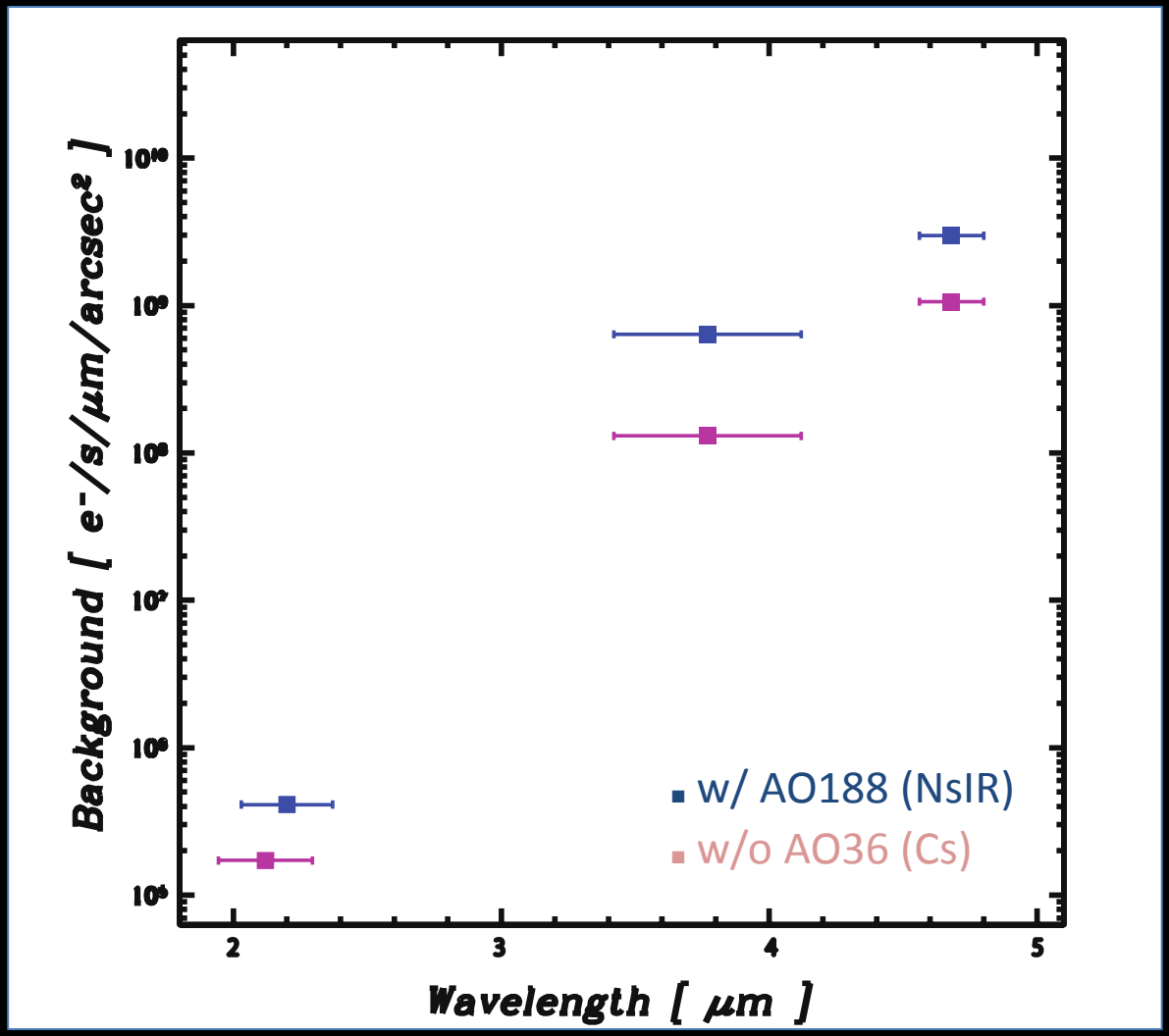
Subaru Mid-IR Observation

COMICS @ Subaru Cassegrain

- ✓ *Close to Diffraction Limited Image in N-band*
- ✓ *Stable Diffraction Limited Image in Q-band*
- ✓ *Technically Challenging for ASM Chopping*



Subaru Low Background
Thermal IR Observation



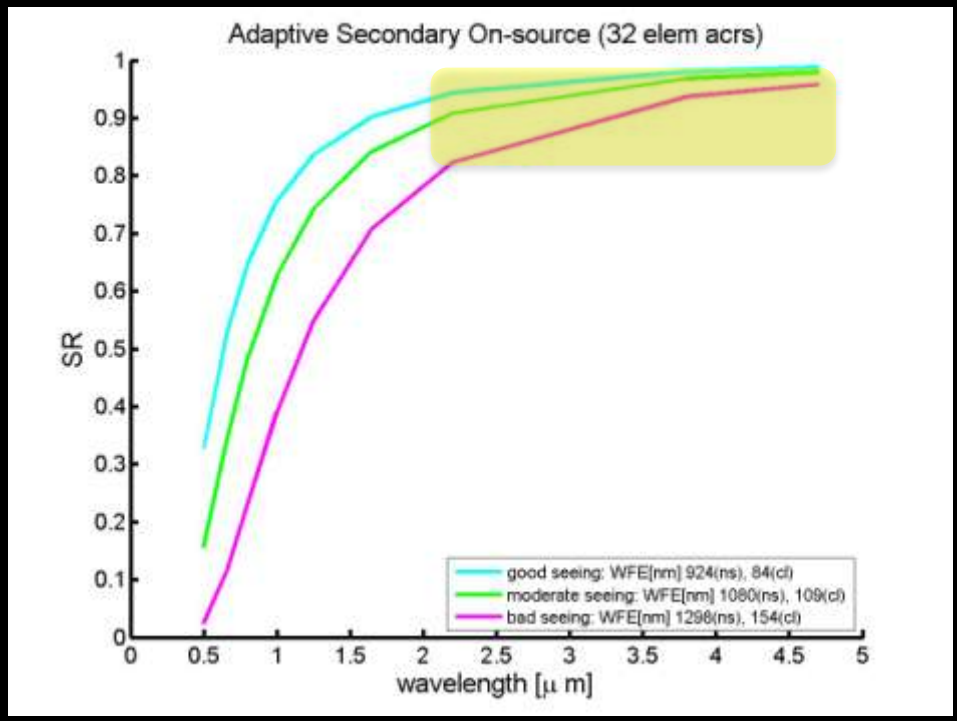
ASM / Cs

Background decrease from [NsIR] AO188 to [Cs]	
K/K’	+0.46 mag
L’	+0.86 mag
M’	+0.56 mag

Low Background Observation @ Thermal IR w/ ASM

On-source mode

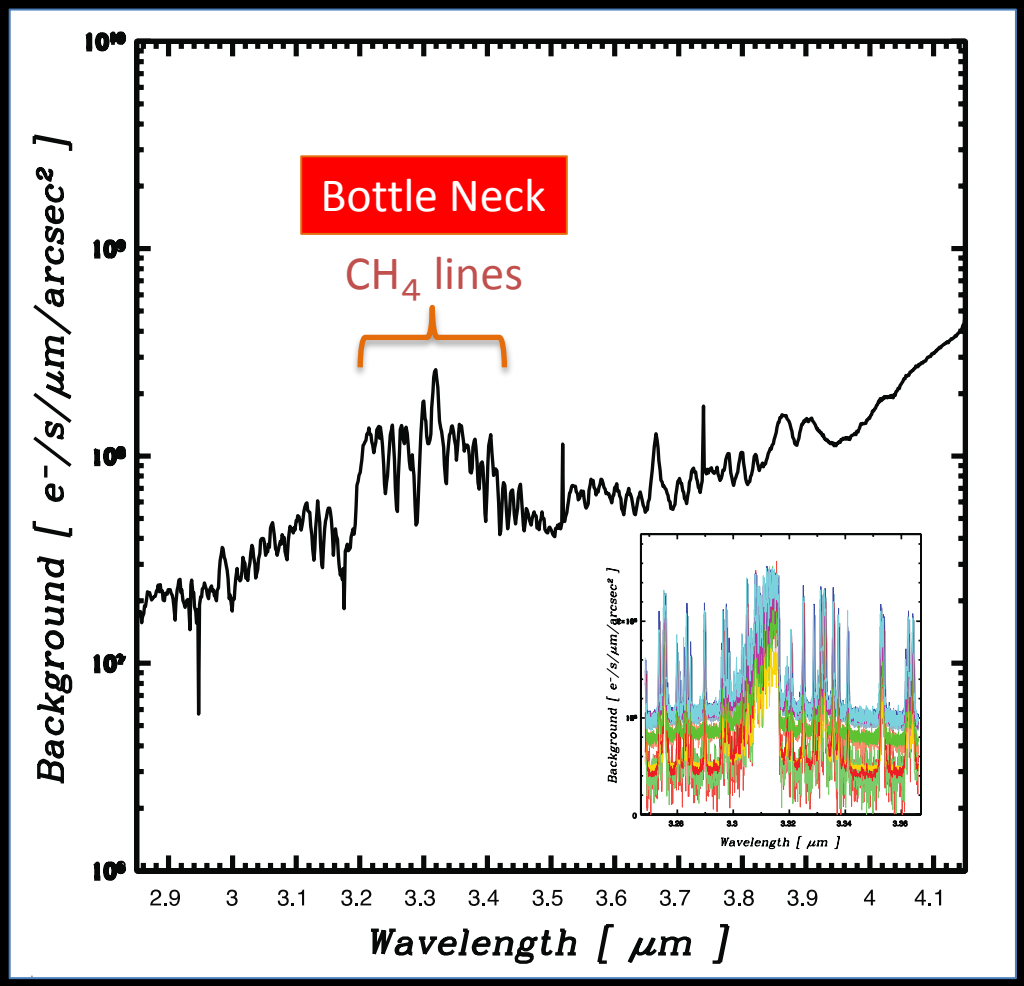
- *Strehl > 0.8 in any case*
- *Sensitivity improvement for all background-limit observations.*
- *Concept Examples:*
  - *IFU @ >3um*
    (currently not existing)
  - *Wider FOV @ L', M'-bands*
    Isoplanatic angle: $\theta_0 \propto \lambda^{(1.2)}$
    L': 30" * (3.77/2.2)^(1.2) ~ 57"
    M': 30" * (4.68/2.2)^(1.2) ~ 74"

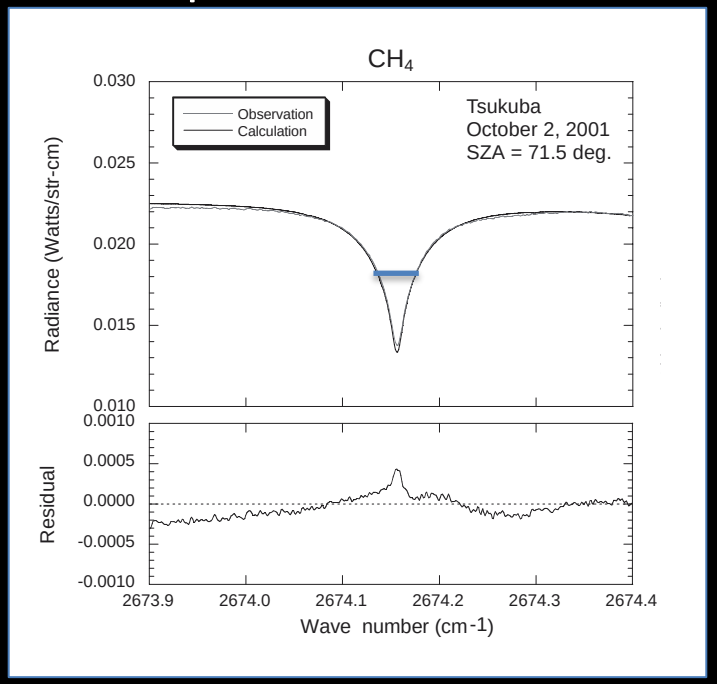


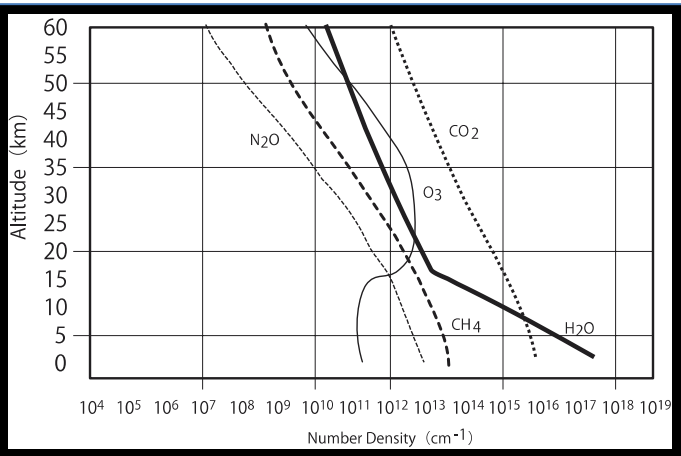
from GLAO Simulation by Oya

H2RG (5.5um cut-off)
30mas/pix => 1'x1'
40mas/pix => 1.3'x1.3'

Even Lower Background @ Ls?
Possible Removal of CH_4





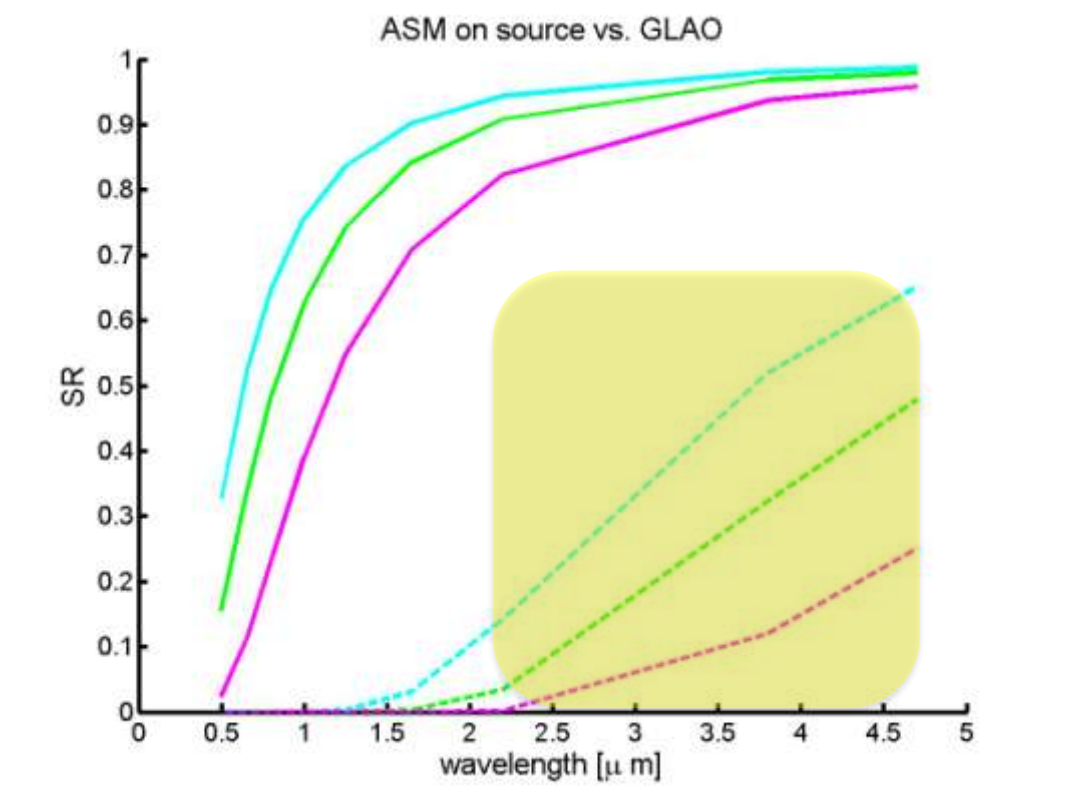


http://www.nies.go.jp/kanko/tokubetu/sr52/sr52.pdf

Low Background Observation @ Thermal IR w/ ASM

GLAO mode

Better performance than < 2um

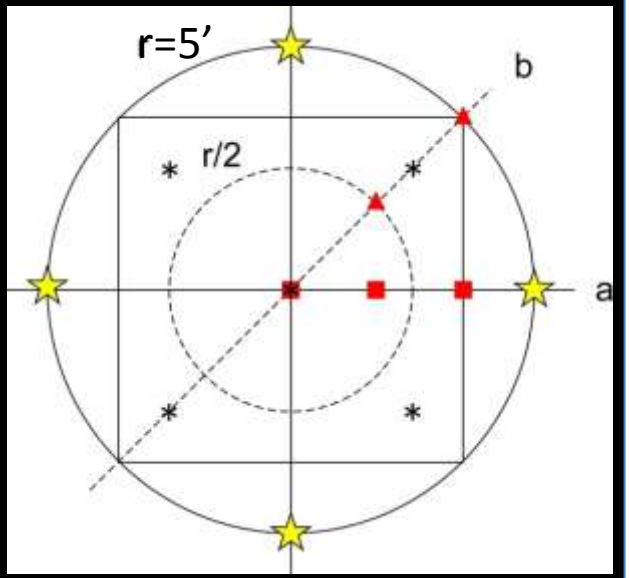


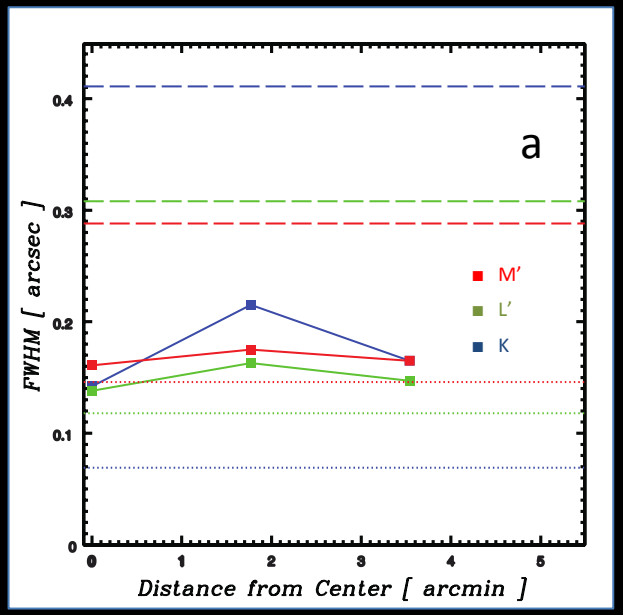
from GLAO Simulation by Oya

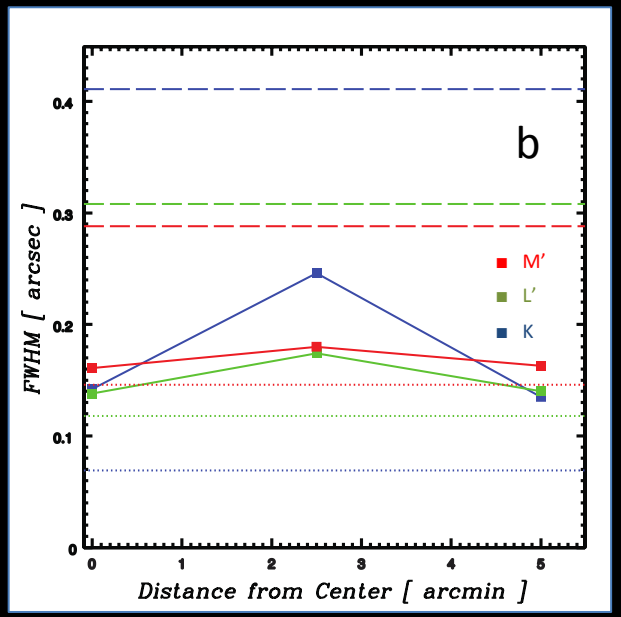
Low Background Observation @ Thermal IR w/ ASM

GLAO mode

- *Close to Diffraction Limited Image @ L'&M' over Diameter~10'*
  - ⇒ *Multi Object AO can be realized in this mode..*
  - ⇒ *Not Widest FOV, but Patrol type Instrument..*







Under average natural seeing

Low Background Observation @ Thermal IR w/ ASM

MOAO mode

- *ASM benefitial as Woofer? -> No.*
- *Anyway additional optics is needed…*
  - ➔ *Negative.*

Summary

- ✧ *Good AO performance (>2-3um)*
- ✧ *AO additional optics => S/N Down >2um*

  # AO sharp image => S/N Up in the end.
- ✧ *ASM => no degradation in background.*
- ✧ *MIR band may not need AO.*
- ✧ *Great On source performance (32x32 ASM)*

  => Benefit for All the Thermal IR Obs.
- ✧ *Good GLAO performance*

  => Patrol covering Wide FOV.