Current status of Japanese activities for astronomy in Antarctica

Takashi Ichikawa & Japanese Consortium

(Chair) Nakai, N., Seta M. (Tsukuba Univ.)
Ichikawa, T., Okano, S., Sakamoi, T. (Tohoku Univ.)
Taguchi, M. (Rikyou Univ.)
Takato, N., Uraguchi, H., Iye, M. (NOAJ)
Kurita, M. (Nagoya Univ.)
Motoyama, H. (NIPRJ)

& collaborators

THz Radio Telescope

2m Infrared Telescope
Astronomical sites in Antarctica

- Dome F (3810m)
- Dome A (4040m)
- Dome C (3250m)
- South Pole (2835m)
- Syowa Station

1000km
A long way to Dome Fuji

Dome Fuji

 ARP2
 Mizuho
 Showa base

 Novolazarevskaya

 Sydney (AU)
 Fremantle

 Japan

 Cape Town (South Africa)
 Shirase
 Japan

 Basler Turbo (BT67)

 IL76

 2006/11/09

 2007/02/16
Japan has one of best astronomical sites on earth

Clear sky (photometric day > ~85%)
Low and stable humidity (PWV < 0.6mm)
Low temperature (-70°C in winter)
Good seeing above boundary layer
weak wind

According to model atmosphere, the surface boundary layer at Dome Fuji is expected to be thinnest in Antarctic inland

The seeing above boundary layer (~30m) is ~0.3"-0.4" (λ =0.5μm) in winter at Dome C

Agabi+ (2005)
Lawrence+ (2006)

At Dome Fuji, it is ~0.3"-0.4" at ~20m or above (?)

Better seeing in the daytime

Swain & Gallee (2006)
Advantages of Antarctica (1)

High transmittance

<table>
<thead>
<tr>
<th></th>
<th>altitude</th>
<th>temperature</th>
<th>PW</th>
</tr>
</thead>
<tbody>
<tr>
<td>blue</td>
<td>Dome Fuji</td>
<td>3810m</td>
<td>-70°C</td>
</tr>
<tr>
<td>red</td>
<td>Mounakea</td>
<td>4200m</td>
<td>0°C</td>
</tr>
</tbody>
</table>

Transmittance in THz

THz Windows are only available in Antarctica
Advantages of Antarctica (2)

Low sky background

<table>
<thead>
<tr>
<th></th>
<th>altitude</th>
<th>temperature</th>
<th>PW</th>
</tr>
</thead>
<tbody>
<tr>
<td>blue</td>
<td>Dome Fuji</td>
<td>-70°C</td>
<td>0.2mm</td>
</tr>
<tr>
<td>red</td>
<td>Mounakea</td>
<td>0°C</td>
<td>1.0mm</td>
</tr>
</tbody>
</table>

Near-Infrared

Mid-Infrared

Far-Infrared
Comparison with Subaru for 2.5m Antarctic Telescope

1 hour integration with S/N=5\sigma for pint source

\[\log f (\mu Jy)\]

\[\lambda (\mu m)\]

- Mauna Kea (Subaru)
- Dome Fuji (2.5m)

3.4\mu m'

SPIZER 1.6\mu Jy @ 3.6\mu m
Subaru+MOIRCS

Ichikawa et al. (2005)

2m telescope in Antarctica

performance in near-infrared
1:1

Cost
100 : 1

Kurita et al. (2005)

Ultra light weight mount
MOIRCS High Redshift Galaxy Survey
In GOODS region

28 hour integration
Widest and Deepest High-Redshift Galaxy Survey

\( \sim 2\text{m telescope} + (K_{\text{dark}}, 3.4\mu\text{m}) \text{ camera} \)

Survey area (arcmin\(^2\))

Depth \((K_{AB}, 5\sigma)\)

AIR-FOX

UKIDSS

VISTA
Advantages of Antarctica (3). Polar night

Transit identification of long-period extra-solar planets

Probability of chance for multiple observation of transit (1-year monitoring)

Transit observation with molecule band

CH₄, H₂O, CO₂
Dome Fuji station
National Institute of Polar Research

220GHz radio meter

2006/2007 first deployment of instruments for site test

3810m (0.6atm)

SODAR
Transmittance in 220GHz band

Seta+ 2009

Very stable than Atakama in summer
However, higher transmittance than Atakama in the best days
Turbulence strength

Dome Fuji

Dome C

AASTINO
Diurnal variation of turbulence strength

Dome C
Aristidi + 2005
Vibration

±3 G on the roof of snow vehicle

25 G on a sledge
Pilot studies with small telescopes

40cm Infrared telescope
  J, K_{dark} Camera
  AIR-C
  for seeing, transmittance, sky background

30cm THz telescope
  for transmittance and its stability
AIR-T-40
40 cm Antarctic Infra-Red Telescope
+ remote control (under developing)

Specs for the environment at $-80^\circ$C
Operation at Hokkaido Rikybetsu, the coldest place in Japan (2008/2) by Murata et al.

- Operation at -23°C without any problems except note PC
- Operation by wind power
Jungflau in Swiss

◆ 3580m
◆ -37°C

Seta et al.
AIR-C3

\[ K_{\text{dark}} (2.4 \, \mu m) \]
\[ 3.4 \, \mu m \]
\[ L' (3.8 \, \mu m) \]

Lundock+ (2008)
Infrared Astronomy by Japanese group

AIR-FOX

Antarctic InfraRed astronomy at dome Fuji Observatory eXplorer

AIR-T-40 Antarctic InfraRed Telescope (40cm)
AIR-C1 Antarctic InfraRed Camera 1
AIR-C3 Antarctic InfraRed Camera (3 bands)
AIR-T-200 Antarctic InfraRed Telescope (2m)

AIR-Solar Antarctic InfraRed Solar telescope (40cm)
AIR-HET10 Antarctic InfraRed Heterodyne Spectrograph (10μm)
AIR-Trans Antarctic InfraRed Transit telescope etc.

< 500 M yen (Telescope & Instruments) + NIPRJ (logistics)
Collaboration with Australia group at Dome Fuji

Engine module

Dome A

Storey+
Seeing measurement by DIMM

Okita+
Seeing measurement by anemometer

Kurita et al.
Current status and future plan

2005/12 started the discussion with NIPR
2006/2 first observations for astronomical test
    SODAR
    220GHz radio meter
2009/12-2010/2
    first step on Dome Fuji by a Japanese astronomer
    transmittance by handy infrared spectrograph
    transmittance by 200GHz radiometer
2010/12-2011/2
    deployment of 40cm-infrared and 30cm-THz telescopes
    at Dome Fuji
2010-2014 Construction of overnight facilities by NIPR
2011-2012 deployment of PLATO-Fuji by collaboration with UNSW
    Observations with small telescope over winter
    (remote operation)
2014?- Construction of large telescope(?)