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30-micron band observations at TAO - from miniTAO/MAX38 to TAO/MIMIZUKU -

Takafumi Kamizuka[1*], MIYATA, Takashi[1], SAKO, Shigeyuki[1], NAKAMURA, Tomohiko[2], ASANO, Kentaro[1], UCHIYAMA, Mizuho[1], OKADA, Kazushi[1]

[1]Institute of Astronomy, the University of Tokyo, [2]Department of Astronomy, the University of Tokyo

TAO (The University of Tokyo Atacama Observatory; P.I. Y. Yoshii) is the observatory which we are constructing in the Atacama Desert of northern Chile. The site is one of the best places for ground-based infrared observations owing to its low-PWV (Precipitable Water Vapor) environment provided by the high altitude (5,640 m) and the dry climate of the site. The environment eases atmospheric absorption, and new atmospheric windows are opened. 30-micron band (wavelength: 30?40 microns) is one of the new windows. The band is suitable to observe thermal emission from cold dust. Some unique dust bands like crystalline silicate band or 30-micron band (MgS, FeS) are also observable. Therefore, 30-micron observations can be utilized to investigate the dust evolution in the cold environment (e.g. outer region of protoplanetary disks) or origin of some specific dust grains. In addition, TAO has a 6.5-m telescope. It will provide opportunities to investigate these issues with unprecedented spatial resolution.

To verify the capability of 30-micron observations at TAO, a pilot 1.0-m telescope named miniTAO was constructed on the site. Pilot observations have been conducted from 2009. A mid-infrared instrument named MAX38 on the miniTAO telescope has been developed and used to take 30-micron images. Although the aperture diameter of the telescope is only 1.0 m, the 30-micron images of MAX38 have nearly highest spatial resolution so far in the band (˜8 arcsec; Asano et al. 2012). The detailed distribution of the cold dust around dying stars like Luminous Blue Variable (eta Car; Nakamura 2012) and Planetary Nebula (Mz 3; Asano et al. in prep.) revealed by MAX38 gave new findings related to their mass-loss and dust formation events. Usefulness of 30-micron observations at TAO has been confirmed by these results.

For the TAO 6.5-m telescope, a mid-infrared instrument named MIMIZUKU has been developed. Its main characteristics are wide wavelength coverage, high spatial resolution, and capability of simultaneous multi-field observation. The wavelength coverage of MIMIZUKU ranges from 2 to 38 microns. It enables comprehensive understanding of objects composed of hot dust (visible in short-wavelength mid-infrared band), cold dust (visible in 30-micron band), and heating source like star (visible in near-infrared band). In the wavelengths longer than 8 microns, MIMIZUKU achieves diffraction-limited image. It will provide the highest spatial resolution in the 30-micron band for a few decades. This will be a powerful tool in the next generation to investigate cold dust distributions. The capability of simultaneous multi-field observation is realized by a mechanism called Field-Stacker. It picks up two different fields separated by < 25 arcmin and combines them onto one detector field. Using this function, we can observe a science target and reference object simultaneously, and calibration unaffected by atmospheric variability is realized. It improves photometric accuracy and spectrum quality. High brightness/spectroscopic accuracy allow us to detect weak changes caused by dust formation/destruction events. Investigation of such events, which are currently difficult to observe, is expected to be realized by MIMIZUKU.

The MIMIZUKU is planned to be installed to the Subaru telescope as a P.I. instrument in 2014. After scientific verification test, it will be provided for open-use programs until the construction of TAO is completed. At the Subaru telescope, the 30-micron band cannot be used because of the strong atmospheric absorption. Around 2019, the MIMIZUKU will be transferred and installed to the TAO telescope. The exploration in the 30-micron band will be opened from this time.

In this presentation, the results of the MAX38 pilot observations are reviewed, and the current development status of MIMIZUKU is reported.

Keywords: TAO, 30-micron band, mid-infrared, MAX38, MIMIZUKU, dust