Mid-infrared Monitoring Camera and Spectrograph MIMIZUKU on the TAO 6.5-m Telescope

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The university of Tokyo is currently building a new infrared observatory with a 6.5-m telescope, the university of Tokyo Atacama Observatory (TAO; PI: Y. Yoshii), in the Atacama Desert in Chile. The site is located at the summit of Co. Chajnantor of which altitude is 5640 m. This high altitude and dry climate effectively reduce Precipitable Water Vapor (PWV; 0.38 mm at 10 percentile) and increase the transparency of the atmosphere in the infrared. Then, at the site, we can make observations in bands which are usually impossible to use from ground-based observatories due to the atmospheric water vapor absorption (e.g. around 2.7 microns; 25 –40 microns). For observing in these unique atmospheric windows, we are developing an infrared camera and spectrograph named "Mid-Infrared Multi-field Imager for gaZing at the UnKnown Universe" (MIMIZUKU; PI: T. Miyata) as the first generation mid-infrared instrument for TAO.

MIMIZUKU has a wide wavelength coverage from 2 to 38 microns by having three optical channels named NIR, MIR-S, and MIR-L covering 2 –5.3, 6.8 –26, and 24 –38 microns, respectively. This capability enables us to observe thermal emission from dust grains with a wide range of temperature (> 70 K) and emission from their heating source without time-consuming instrument exchange. Another important feature is precise calibration capability of atmospheric transmittance. In ground-based mid-infrared observations, we have to observe not only target objects but also reference stars to correct atmospheric transmittance to get absolute flux. In conventional observations, we observe them separately for this calibration because it is difficult to observe them in one field due to the sparse distribution of the reference stars. However, this method is affected by the temporal variation of atmospheric transmittance, and it has been difficult to ensure photometric accuracies better than 10% or get smooth spectra corrected for the atmospheric absorption lines. MIMIZUKU has a unique optical device called "Field Stacker" (FS) for the solution of this problem. FS is placed on the telescope focal plane and combine two arbitral fields, where the target and calibrator exist, into one field so as to observe them simultaneously. This capability cancels the temporal variation of the atmospheric transmittance and improves photometric accuracy to a few percent. These capabilities enable us to open the window of time-domain astronomy in the infrared, which has not been challenged well. Such monitoring capability is beneficial for studying dust formation process in time-variable sources like supernovae, novae, and evolved stars. By monitoring such sources, we can investigate the timing of the dust formation and the chemical composition of the newly formed dust. Such information will give us new insights for the study of origin of material in space.

The first light of MIMIZUKU on the TAO telescope is planned in 2019 after the completion of the telescope in the early 2019. Before this first light, we will have commissioning observation on the Subaru telescope. The first light on Subaru is scheduled in July 2018, and MIMIZUKU has been transported from Japan to Hawaii. After the arrival at Hawaii in October 2017, we had an evaluation test of MIMIZUKU. In this test, we evaluated the specifications of the MIR-S channel, which will be used in the first light on Subaru. The results show that the optics can achieve diffraction-limited images in a wavelength range longer than 8 microns. Enough throughputs larger than 19 and 5 electrons/photons were confirmed for the imaging and spectroscopic modes, respectively. These results suggest that MIMIZUKU can achieve sensitivities equivalent to the other mid-infrared instruments on the ground-based 8-m telescopes.

In this conference, we will report the current status and latest specifications of MIMIZUKU and introduce sciece cases using MIMIZUKU.

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