Design and status of a near-infrared multi-object spectrograph for the TAO 6.5-m Telescope

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1. TAO PROJECT & NIR ASTRONOMY

The University of Tokyo Atacama Observatory (TAO) is a project to construct a 6.5m infrared-optimized telescope at the summit of Co. Chajnantor (5,640m altitude) in Atacama Desert, Chile (PI: Yuzuru Yoshii). Thanks to the dry climate and high altitude at the TAO site, high atmospheric transmittance is expected in near-infrared (NIR) wavelengths. Infrared spectrograph for the TAO 6.5m telescope, SWIMS (Simultaneous-color Wide-field Infrared Multi-object Spectrograph), has capabilities of wide-field imaging and multi-object spectroscopy (MOS) for a wide spectral range from 0.9-2.5 µm at a time using a dichroic mirror placed in the collimated beam. Taking advantage of the site, SWIMS enables us to obtain various redshifted spectral features (emission lines and continuum breaks) simultaneously under same observational conditions (weather, telescope, and the instrument), as shown in Figure 2.

2. SPECIFICATION OF SWIMS

The most remarkable feature of SWIMS is NIR two-band simultaneous (imaging or MOS) observations (0.9-1.4 and 1.4-2.5 µm) using a dichroic mirror.

- We are planning to carry out commissioning and early science observations on the Subaru Telescope at Hawaii before the construction of the TAO 6.5m telescope.

- Part of the initial design of the instrument is optimized for the Subaru.

The full FoV at the Nasmyth focus of the TAO 6.5m telescope (g = 6.6) is covered by four HAWAII-2GR arrays with 0.1' pixel sampling. During the commissioning phase on the Subaru, two arrays are installed on each channel, which covers 6.8 x 3.4 with 0.10 pixel.

3. OPTICS

The SWIMS optics is currently optimized for the Subaru Telescope (Figure 4 and Table 2). A dichroic mirror is placed in the collimated beam for simultaneous color observations. All of the components are placed on a optical bench (1400 x 920mm), and cooled down below 80K. Expected performances are shown in Figure 5 and 7. Good image qualities are achieved, and image distortions are negligible across the FoV.

Collimator Unit:
- Currently optimized for the Subaru Telescope
- Re-optimized by replacing the first three lenses when mounted on the TAO

Field lens: ϕ216mm, CaF2

Camera Unit:
- Two channels: optimized for λ≈0.9-1.5 µm (blue) and λ≈1.4-2.5 µm (red)
- Detectors:
  - HAWAII-2GR array with 2.5 µm cutoff
  - SIDECAR ASICs for readout
- Two array covers 6.8 x 3.4 with 0.10 pixel

The SWIMS consists of two dichroic mirrors and a grating. The dichroic mirrors divide the wavelength spectrum for blue (0.9-1.5 µm) and red (1.4-2.5 µm) channels. The grating disperses the light, and the dichroic mirrors reflect it to the appropriate detectors. The SWIMS has two dichroic mirrors, one for blue and one for red. The dichroic mirrors are placed in the collimated beam of the collimator unit. The dichroic mirrors divide the wavelength spectrum for blue (0.9-1.5 µm) and red (1.4-2.5 µm) channels.

4. MULTI-OBJECT SLIT UNIT

The design of the MOS unit of SWIMS is based on MORiCS’ on the Subaru Telescope, which is a mature technology and refined to be operative at the Nasmyth focus of the TAO 6.5m telescope.

- Neodymium magnets are used to hold a slit mask on the focal plane as well as to stock the mask at the carousel.
- A slit mask holder is designed to hold a cylindrical curved mask sheet to compensate for the curved focal plane of the telescopes, especially for the TAO 6.5m telescope.

5. SCHEDULE

By July 2010 Details of design, optics, mechanics and MOS to be completed.
2011 Dewar, MOS and detectors to be delivered.
2012 Installation and assembly of the components to be delivered.
2013 Transported to Subaru, and First Light.

References