Status report of 1.5m Kanata Telescope

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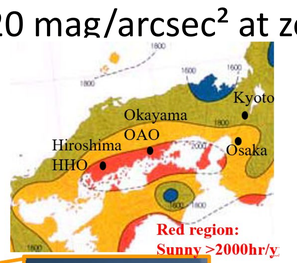
~ Receiving valuable assistance from Dr. Hiroshi Akitaya (Chiba Institute of Technology), Mahito Sasada (Science Tokyo), Ryosuke Itoh (BAO), Yousuke Utsumi, Hidehiko Nakaya (NAOJ) in operations ~

1. Site and telescope objectives

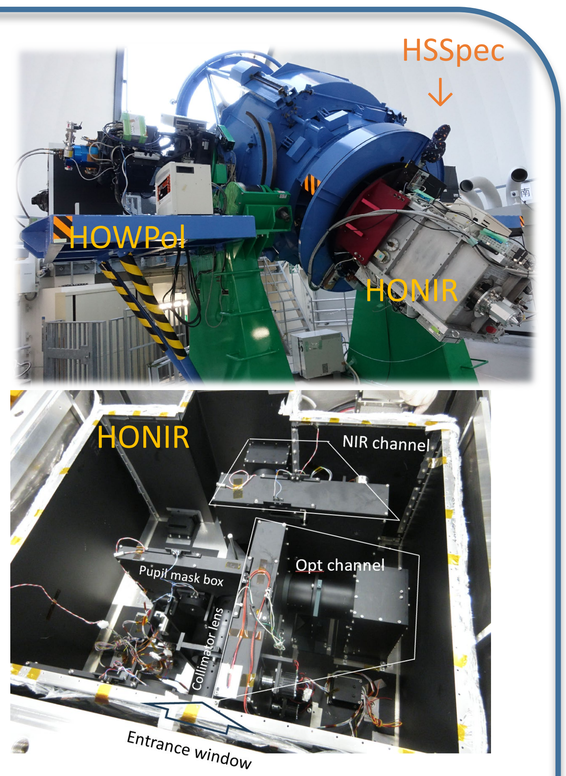
Established in 2006 and operated by Hiroshima University, the Higashi-Hiroshima Observatory is located just 25 minutes by car from the campus at an altitude of 503 m. The site offers favorable observing conditions, with ~40% of nights being clear, a median natural seeing of ~1.2”, and dark-sky brightness of R = 19–20 mag/arcsec² at zenith.

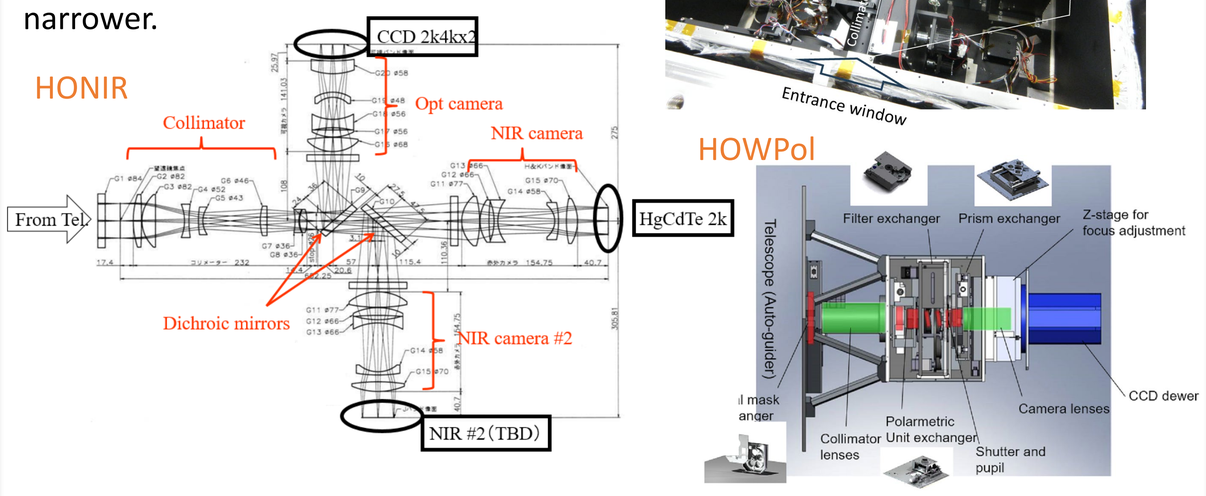


The 1.5 m Kanata telescope is a highly maneuverable system capable of slewing at 6 deg/s in azimuth. It has instruments at the Cassegrain and two Nasmyth foci, with a movable tertiary mirror enabling switching between them in under 20 seconds. Originally designed for high-energy transient follow-up, it aligns well with multi-messenger and time-domain astronomy. The instruments are also specifically designed and operated for optimal performance in transient object observations.

2. Instruments

HONIR (Hiroshima Optical and Near-InfraRed Camera) is a rare, permanently mounted instrument capable of simultaneous optical and dual NIR observations across imaging, spectroscopy, and polarimetric modes. It has proven especially effective for monitoring the polarization of rapidly fading transients. The field of view is about $10' \times 10'$. In polarimetry mode, we usually use a focal mask to avoid an overlap between ordinary and extraordinary rays and the FoV becomes narrower.





HOWPol (Hiroshima One-shot Wide-field POLarimeter) is an optical imaging polarimeter permanently installed at the Nasmyth focus. It offers imaging, long-slit spectroscopy, and polarimetric imaging modes, covering a wide field of view of 15’ arcminute diameter. Additionally, it features a single-exposure polarimetric mode that is effective for observing astronomical objects exhibiting rapid variability on timescales shorter than a minute. This mode has proven particularly valuable in polarimetric observations of the very early afterglows of several gamma-ray bursts.

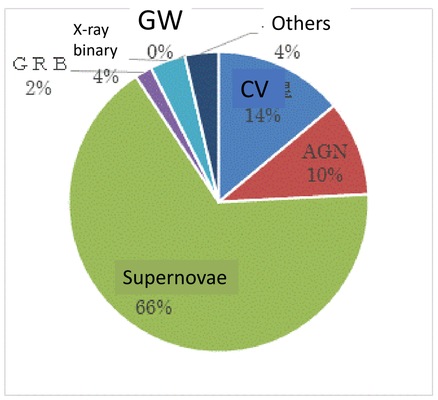
HONIR Item	HONIR Specification
Detector	HPK 2k4k CCD / Raytheon 2k2k MCT(Virgo)
Field of view	$10' \times 10'$
Imaging	B, V, Rc, Ic, z’, Y, ND1, oc / Y, J, H, Ks, H_2, ND1, oc
Spectroscopy	Grism (R=440@V – 800@z’) / Grism IR-short (R=630@J), IR-long (R=570@H – 440@J)
Polarimetry	Super-achromatic half-wave plate (SiO2+MgF2), Wollaston prism (YLF, rutile)
Limiting magnitude	R(Vega)=20.2mag (600 sec exp., S/N=10), 18.9 mag (60 sec exp., S/N=10) Ks(Vega)=16.1mag (600 sec exp., S/N=10), 14.3 mag (60 sec exp., S/N=10)

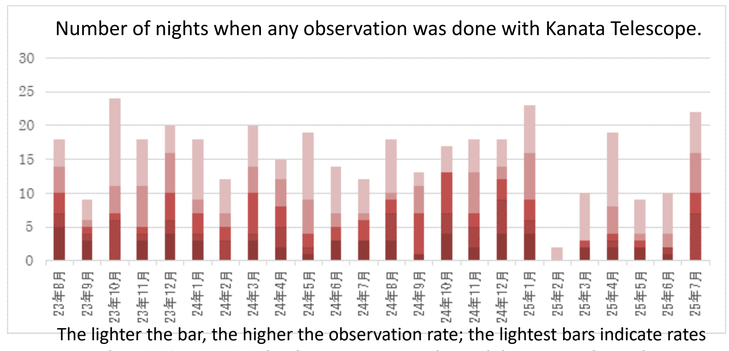
HOWPol Item	HOWPol Specification
Detector	HPK 2k4k CCD × 2
Field of view	$15'$ *diameter*
Imaging	B, V, Rc, Ic, z’, ND1, oc
Spectroscopy	Grism (R~400; 400-900nm)
Polarimetry	Achromatic half-wave plate (SiO2+MgF2), Wollaston prism (YLF, rutile)
Limiting magnitude	B(Vega)=18.7mag (100 sec exp., S/N=10), V(Vega)=19.5 mag (100 sec exp., S/N=10), R(Vega)=19.7 mag (100 sec exp., S/N=10), I(Vega)=19.0 mag (50 sec exp., S/N=10)

On the opposite side of the Nasmyth focus where HOWPol is attached, the optical system on an optical bench of the High-speed Spectrograph (HSSpec) is mouted. Recently, a near UV camera system was newly installed in front of the optcal system by the team in Chiba Institute of Technology.

3. Status of Observation and Operation

Since the beginning of its operations in 2006, the Kanata telescope has focused on multi-wavelength coordinated observations of transient objects in conjunction with X-ray and gamma-ray detections. This policy remains fundamentally unchanged today. Based on extended monitoring of explosive phenomena and similar targets, the telescope continues to conduct follow-up observations of newly discovered transients. Figure 1 presents a pie chart showing the distribution of observation time by object category for targets observed with the Kanata telescope over the past year.





The lighter the bar, the higher the observation rate; the lightest bars indicate rates exceeding 80%. In 2025 Feb, observations were limited due to a prolonged issue with the wireless communication system controlling the dome.

(Left) Figure 1: Category of the objects observed with Kanata Telescope in 2024 Aug-2025 Jul.
(Right) Figure 2: Number of nights when any observation was done with Kanata Telescope.

Figure 2 shows the monthly variation in the number of observation nights. The lighter the color of each bar, the clearer the skies were on those nights. On average, approximately 200 nights are observed per year, with a mean total exposure time of just under 3 hours per night.

Table 1 shows recent records of multi-messenger astronomical objects.
As a notable achievement in MM astronomy, the Kanata telescope played a key role in identifying the counterpart TXS 0506+056 associated with the IceCube-170922 event in 2017. However, according to statistics from the past two years (since October 2023), the number of observations promptly conducted in response to IceCube alerts has been limited, with only 3 cases recorded.

In response to gravitational wave alerts, our strategy is to observe GL galaxies within the localization error region for events located within 150 Mpc that involve neutron stars or are likely to leave behind a remnant. During the O4 observing run, we conducted follow-up observations for two such alerts, but no variable sources were detected.

Table 1: Recent observational records of Kanata Telescope for MM astronomy objects

Object category	2023 Apr – 2025 Nov observation status
IceCube alerts	3 alerts (Observed only central field for 230512, only central field for 231004, 4 BROS objects for 240424) No optical counterpart was identified.
GW alerts	2 alerts (Observed 6 GL galaxies for S240422ed, 12 GL galaxies for S251112cm) No optical counterpart was identified.
Gamma-ray bursts	13 alarts (GRB 20230420, 20230427, 20230805, 20230821, 20230902, 20231117A, 20240531, 20231030A, 20241030B, 20241216A, 20250128, 20250430, 20250706) No optical counterpart was identified.

Currently, most of these observations—except for GRBs—are not fully automated; they are executed only after the observer gives some form of green sign. (In the case of GRBs alone, ongoing exposures are interrupted and observations are forcibly and automatically triggered.) In the future, we aim to robotize the telescope and instruments to achieve full automation.

4. Other Unique Observations with Kanata Telescope

Using the imaging polarimetry mode of HONIR, we proceed an optical and NIR polarimetric survey for several regions near the Galactic plane, young stellar clusters and molecular clouds. For example, it would explore the distance-dependent magnetic field structure within the Galactic disk.

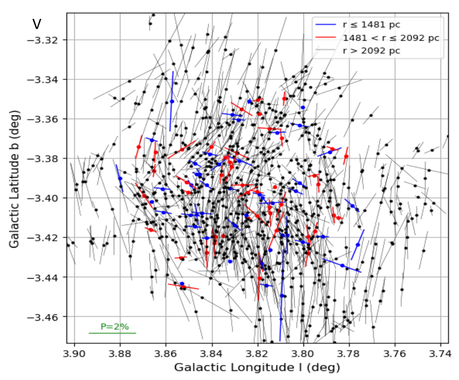


Figure 3: Polarization vectorial map of stars around V4444 Sgr.

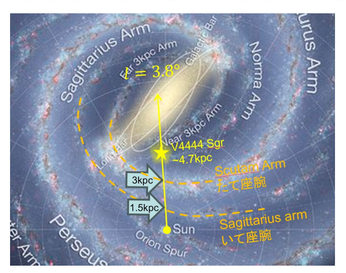


Figure 4: Line of sight toward V4444 Sgr and spiral arm structuire.

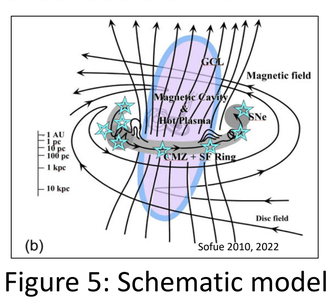


Figure 5: Schematic model of magnetic fields around the Galactic center.