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Part I

研究論文

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Polarimetric observations of asteroids of different taxonomic classes from Lulin Observatory in Taiwan

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ABSTRACT

Polarimetric measurements are a powerful tool in studying compositions and structures of dust layers of asteroids and other solar system objects. A pilot project was carried out using the Triple Range Imager and Polarimeter (TRIPOL) on Lulin 1-m (LOT) telescope at Lulin Observatory to obtain instrument characteristics essential to polarimetric diagnostics of asteroids. A comparison of the TRIPOL results with previous work from the measurements of a number of standard unpolarized, polarized stars, and 29 main-belt asteroids with known taxonomic types (B-, C-, S-, and M-type) shows that a long-term program of polarimetric observations of asteroids has a promising prospect at Lulin Observatory.

1. Introduction

Polarimetric observations can produce unique information on the surface properties of asteroids and other atmosphereless bodies in the solar system. This was known since the asteroid polarimetry work of Dollfus (1971), Zellner et al. (1974), and Dollfus and Zellner (1979) that linear polarization of the reflected light from the asteroidal surfaces would vary as a function of the phase angle (α) between the directions to the Sun and to the observer as viewed from the observation target itself. The opposition effect at small phase angle and negative linear polarizations of asteroids from photometric and polarimetric observations can be explained in terms of the light scattering processes in the surface regolith layers of porous structure - according to theoretical modelling and laboratory simulations as reviewed by Muinonen et al. (2002) and Shkuratov et al. (2002). In general terms, the scattered light fluxes can be separated in the perpendicular direction ($I_{\perp}$) and the parallel direction ($I_{\|}$) with respect to the scattering plane. Therefore, in asteroidal polarimetry, the observational results are described in terms of the polarization degree $\propto (I_{\perp}\text{-}I_{\|})/(I_{\perp}+I_{\|})$ parameter corresponding to the portion of the electromagnetic wave which is polarized. Within a certain range of phase angle from zero to α_0, called the branch of negative polarization, $P_r < 0$. For $\alpha > \alpha_0$, $P_r > 0$. Different taxonomic types of asteroids have distinct phase-polarization curves that are beneficial for geometrical albedo determination (Belskaya et al., 2005, 2015; Cellino et al., 2015a).

On the basis of the asteroidal polarimetric survey at CASLEO, Argentina, Gil-Hutton (2007), Gil-Hutton and Canada-Assandri (2011), Gil-Hutton and Canada-Assandri (2012) published their observational results of various types of asteroids ranging from the M-, S-, to C-types. Another important concerted effort has come from the Calern asteroid polarimetric survey as reported in Devogèle et al. (2017). It is noteworthy that polarimetric measurements were recently applied to two Near Earth Objects (NEOs): (101 955) Bennu (Cellino et al., 2018) and (3200) Phaethon (Devogèle et al., 2018) to provide key mission-critical information on their physical properties in preparation for their respective space exploration missions (i.e., NASA's OSIRIS-REx and JAXA's DESTINY-Plus).

In spite of its usefulness and versatility, the progress in asteroidal polarimetry has been slow, as mentioned by Devogèle et al. (2017), because of the lack of dedicated instruments and survey programs. In this paper, we report on a new initiative to establish a long-term program in asteroidal polarimetry to contribute to this critical task at Lulin Observatory. The instrument used is called Triple Range Imager and Polarimeter (Sato et al., 2019) or TRIPOL that will be introduced in Section 2. In Section 3, we will describe the practical steps in determining instrument polarization and stability. Our first results will be presented in Section 4 to be followed by a summary.

2. Instrument description

TRIPOL is a compact instrument capable of simultaneous optical

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Time-series and Phase-curve Photometry of the Episodically Active Asteroid (6478) Gault in a Quiescent State Using APO, GROWTH, P200, and ZTF

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Abstract

We observed the episodically active asteroid (6478) Gault in 2020 with multiple telescopes in Asia and North America and found that it is no longer active after its recent outbursts at the end of 2018 and the start of 2019. The inactivity during this apparition allowed us to measure the absolute magnitude of Gault of $H_r = 14.63 \pm 0.02$, $G_r = 0.21 \pm 0.02$ from our secular phase-curve observations. In addition, we were able to constrain Gault's rotation period using time-series photometric lightcurves taken over 17 hr on multiple days in 2020 August, September, and October. The photometric lightcurves have a repeating $\lesssim$0.05 mag feature suggesting that (6478) Gault has a rotation period of $\sim$2.5 hr and may have a semispherical or top-like shape, much like the near-Earth asteroids Ryugu and Bennu. The rotation period of $\sim$2.5 hr is near the expected critical rotation period for an asteroid with the physical properties of (6478) Gault, suggesting that its activity observed over multiple epochs is due to surface mass shedding from its fast rotation spin-up by the Yarkovsky–O'Keefe–Radzievskii–Paddack effect.

Unified Astronomy Thesaurus concepts: Asteroids (72); Asteroid dynamics (2210); Main belt asteroids (2036)

Supporting material: machine-readable tables

1. Introduction

Active asteroids produce comet-like tails and comae that can be driven by many different types of forces different from the comets themselves (Jewitt et al. 2015). While sublimation of water ice is a primary driver for activity in "typical" comets, the $\sim$20 known (so far) active asteroids in the main belt seem to lose mass via a wider array of physical effects such as collisions (e.g., Snodgrass et al. 2010), rotational instabilities (e.g., Jewitt et al. 2013), and thermal fracture (e.g., Jewitt et al. 2019a). We can assess the physics of a particular active asteroid's activity via observations over long time baselines that assess the object's photometric and morphological development. As more and more active asteroids are discovered, it is vital to continuously monitor these objects and determine the frequency of the various phenomena in the main belt.

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A Carbon/Oxygen-dominated Atmosphere Days after Explosion for the "Super-Chandrasekhar" Type Ia SN 2020esm

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Abstract

Seeing pristine material from the donor star in a type Ia supernova (SN Ia) explosion can reveal the nature of the binary system. In this paper, we present photometric and spectroscopic observations of SN 2020esm, one of the best-studied SNe of the class of "super-Chandrasekhar" SNe Ia (SC SNe Ia), with data obtained −12 to +360 days relative to peak brightness, obtained from a variety of ground- and space-based telescopes. Initially misclassified as a type II supernova, SN 2020esm peaked at $M_B = -19.9$ mag, declined slowly ($\Delta m_{15}(B) = 0.92$ mag), and had particularly blue UV and optical colors at early times. Photometrically and spectroscopically, SN 2020esm evolved similarly to other SC SNe Ia, showing the usual low ejecta velocities, weak intermediate-mass elements, and the enhanced fading at late times, but its early spectra are unique. Our first few spectra (corresponding to a phase of $\gtrsim$10 days before peak) reveal a nearly pure carbon/oxygen atmosphere during the first days after explosion. This composition can only be produced by pristine material, relatively unaffected by nuclear burning. The lack of H and He may further indicate that SN 2020esm is the outcome of the merger of two carbon/oxygen white dwarfs. Modeling its bolometric light curve, we find an ^{56}Ni mass of $1.23^{+0.14}_{-0.14}\ M_\odot$ and an ejecta mass of $1.75^{+0.32}_{-0.20}\ M_\odot$, in excess of the Chandrasekhar mass. Finally, we discuss possible progenitor systems and explosion mechanisms of SN 2020esm and, in general, the SC SNe Ia class.

Unified Astronomy Thesaurus concepts: Supernovae (1668); White dwarf stars (1799)

Supporting material: data behind figure, machine-readable tables

1. Introduction

Observations of type Ia supernovae (SNe Ia) first showed that the expansion of the universe is accelerating (Riess et al. 1998; Perlmutter et al. 1999). SNe Ia are also key to measuring the local expansion rate (Riess et al. 2016; Freedman et al. 2019), and those measurements differ from inferences from early universe probes that may indicate unaccounted physics in the current cosmological model (Freedman 2021). While there is strong observational evidence that SNe Ia result from the thermonuclear explosion of a degenerate carbon/oxygen white dwarf (WD) star in a binary system (Bloom et al. 2012), details of the progenitor system and explosion are poorly constrained (Maoz et al. 2014).

The peak luminosity of most SNe Ia correlates strongly with their decline rate (or light-curve width, parameterized with their magnitude decline from peak to 15 days after, Δm_{15}; Phillips 1993) and color (Riess et al. 1996). By observing the brightness, decline rate, and color of an SN Ia, one can infer its relative distance, which in turn, can be used to constrain cosmological parameters (e.g., Scolnic et al. 2018; Jones et al. 2019). The width–luminosity relation (WLR) can be explained as all SNe Ia having a similar ejecta mass with varying amounts of radioactive ^{56}Ni (Kasen & Woosley 2007), which sets the peak luminosity. Alternatively, the total ejecta mass may be the primary factor that causes differences in ^{56}Ni and luminosity (Goldstein & Kasen 2018). Moreover, SNe Ia are characterized by maximum-light spectra that lack hydrogen and helium emission features, but have prominent absorption features from

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AT 2019qyl in NGC 300: Internal Collisions in the Early Outflow from a Very Fast Nova in a Symbiotic Binary*†

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Abstract

Nova eruptions, thermonuclear explosions on the surfaces of white dwarfs (WDs), are now recognized to be among the most common shock-powered astrophysical transients. We present the early discovery and rapid ultraviolet (UV), optical, and infrared (IR) temporal development of AT 2019qyl, a recent nova in the nearby Sculptor Group galaxy NGC 300. The light curve shows a rapid rise lasting $\lesssim 1$ day, reaching a peak absolute magnitude of $M_V = -9.2$ mag and a very fast decline, fading by 2 mag over 3.5 days. A steep dropoff in the light curves after 71 days and the rapid decline timescale suggest a low-mass ejection from a massive WD with $M_{\rm WD} \gtrsim 1.2\,M_\odot$. We present an unprecedented view of the early spectroscopic evolution of such an event. Three spectra prior to the peak reveal a complex, multicomponent outflow giving rise to internal collisions and shocks in the ejecta of an He/N-class nova. We identify a coincident IR-variable counterpart in the extensive preeruption coverage of the transient location and infer the presence of a symbiotic progenitor system with an O-rich asymptotic-giant-branch donor star, as well as evidence for an earlier UV-bright outburst in 2014. We suggest that AT 2019qyl is analogous to the subset of Galactic recurrent novae with red-giant companions such as RS Oph and other embedded nova systems like V407 Cyg. Our observations provide new evidence that internal shocks between multiple, distinct outflow components likely contribute to the generation of the shock-powered emission from such systems.

Unified Astronomy Thesaurus concepts: Novae (1127); Symbiotic binary stars (1674); Recurrent novae (1366); White dwarf stars (1799); Asymptotic giant branch stars (2100); Spectroscopy (1558)

Supporting material: data behind figure, machine-readable tables

1. Introduction

Novae are a class of cataclysmic variables (CVs) whose eruptions are the result of a thermonuclear runaway (TNR) on the surface of a white dwarf (WD) accreting hydrogen-rich material from a nondegenerate companion (Gallagher & Starrfield 1978). Novae are among the most common explosive thermonuclear transients (e.g., Darnley et al. 2006; Shafter 2017;

* This paper includes data gathered with the 6.5 m Magellan Telescopes located at Las Campanas Observatory, Chile.

† Based on observations made with the NASA/ESA Hubble Space Telescope, obtained from the data archive at the Space Telescope Science Institute. STScI is operated by the Association of Universities for Research in Astronomy, Inc., under NASA contract NAS 5-26555.

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HO Puppis: Not a Be Star, but a Newly Confirmed IW And-type Star

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Abstract

HO Puppis (HO Pup) was considered as a Be-star candidate based on its γ Cassiopeiae-type light curve, but lacked spectroscopic confirmation. Using distance measured from Gaia Data Release 2 and the spectral-energy-distribution fit on broadband photometry, the Be-star nature of HO Pup is ruled out. Furthermore, based on the 28,700 photometric data points collected from various time-domain surveys and dedicated intensive-monitoring observations, the light curves of HO Pup closely resemble those of IW And-type stars (as pointed out by Kimura et al.), exhibiting characteristics such as a quasi-standstill phase, brightening, and dips. The light curve of HO Pup displays various variability timescales, including brightening cycles ranging from 23 to 61 days, variations with periods between 3.9 days and 50 minutes during the quasi-standstill phase, and a semiregular ∼14 day period for the dip events. We have also collected time-series spectra (with various spectral resolutions), in which Balmer emission lines and other spectral lines expected for an IW And-type star were detected (even though some of these lines were also expected to be present for Be stars). We detect Bowen fluorescence near the brightening phase, and that can be used to discriminate between IW And-type stars and Be stars. Finally, despite only observing for four nights, the polarization variation was detected, indicating that HO Pup has significant intrinsic polarization.

Unified Astronomy Thesaurus concepts: Dwarf novae (418); Be stars (142); Sky surveys (1464); Time series analysis (1916)

Supporting material: machine-readable table

1. Introduction

Be phenomena are the photometric and spectroscopic variability seen in the main-sequence luminous rapid rotators, known as Be stars, with a luminosity class III−V. In recent years, we have studied the evolutionary effect on the formation of Be stars in open clusters (Yu et al. 2015, 2016, 2018) using the Palomar Transient Factory (Law et al. 2009) and the intermediate Palomar Transient Factory (iPTF; Kulkarni 2013). The Zwicky Transient Facility (ZTF; Bellm et al. 2019; Graham et al. 2019; Masci et al. 2019) came after iPTF, and its improved data can extend our investigation on the variability of Be stars (Ngeow et al. 2019), especially for the Be stars and Be-star candidates at the faint end ($m > 13$ mag), which were largely excluded from previous works (e.g., in Labadie-Bartz et al. 2017). Together with accompanying time-series spectroscopic data, we have a new opportunity to explore the fundamental time-domain nature of Be stars.

Here we report the photometric characteristics of HO Puppis (HO Pup, $\alpha_{J2000} = 7^h33^m54\overset{s}{.}18$, $\delta_{J2000} = -15°45'38\overset{''}{.}28$) as a result of our investigations of the variability of Be stars with ZTF. HO Pup is listed as a Be star in the SIMBAD database (Manek 1997) and hence is included in our list of Be-star candidates, in which the classification is based on its γ Cassiopeiae (GCAS) type variability recorded by Samus et al. (2017)—a class of variable stars that exhibit eruptive irregular variability that is not easily classified further. Some early literature even suggested that HO Pup was a possible type Ia supernova with V-band photometry varying between 12.7 mag and 14.2 mag (Kukarkin et al. 1971). As presented in Figure 1, two highly unusual ∼2.5 mag dips of HO Pup were observed by ZTF in 2017 November. In the r band, the ZTF data cover the full brightness minimum of the two dips at 16 mag from near the minimum to maximum brightness within two days because of the high-cadence sampling. These two events were also witnessed by the All-Sky Automated Survey for Supernovae (ASAS-SN, Shappee et al. 2014; Kochanek et al. 2017). In addition to these two events recorded by ZTF and ASAS-SN, we have found more dips based on the literature and archival data since 2009 (see Section 2). It is very unusual to observe these dips with amplitudes of ∼2.5 mag in typical Be stars, and hence HO Pup caught our attention and merits further investigation.

The variability behavior of HO Pup was also considered as a special type of cataclysmic variable (CV). The ASAS-SN light curve of HO Pup was discussed in a recent work by Kimura et al. (2020a). In their study, HO Pup was classified as a dwarf nova (DN) with a unique heartbeat-like oscillation in its

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Millimeter-sized Dust Grains Surviving the Water-sublimating Temperature in the Inner 10 au of the FU Ori Disk

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Abstract

Previous observations have shown that the $\lesssim$10 au, $\gtrsim$400 K hot inner disk of the archetypal accretion outburst young stellar object, FU Ori, is dominated by viscous heating. To constrain dust properties in this region, we have performed radio observations toward this disk using the Karl G. Jansky Very Large Array in 2020 June–July, September, and November. We also performed complementary optical photometric monitoring observations. We found that the dust thermal emission from the hot inner disk mid-plane of FU Ori has been approximately stationary and the maximum dust grain size is $\gtrsim$1.6 mm in this region. If the hot inner disk of FU Ori, which is inward of the 150–170 K water snowline, is turbulent (e.g., corresponding to a Sunyaev & Shakura viscous $\alpha_t \gtrsim 0.1$), or if the actual maximum grain size is still larger than the lower limit we presently constrain, then as suggested by the recent analytical calculations and the laboratory measurements, water-ice-free dust grains may be stickier than water-ice-coated dust grains in protoplanetary disks. Additionally, we find that the free–free emission and the Johnson *B*- and *V*-band magnitudes of these binary stars were brightening in 2016–2020. The optical and radio variability might be related to the dynamically evolving protostellar- or disk-accretion activities. Our results highlight that the hot inner disks of outbursting objects are important laboratories for testing models of dust grain growth. Given the active nature of such systems, to robustly diagnose the maximum dust grain sizes, it is important to carry out coordinated multiwavelength radio observations.

Unified Astronomy Thesaurus concepts: Interstellar dust processes (838); Dust continuum emission (412)

1. Introduction

In theoretical studies about interstellar dust-grain growth (e.g., Ossenkopf 1993; Ormel et al. 2009; Wada et al. 2009; Okuzumi et al. 2012; Banzatti et al. 2015; Pinilla et al. 2017; Vorobyov et al. 2018, 2020; Molyarova et al. 2021) and the interpretation of the observations of (sub)millimeter dust spectral indices (e.g., Zhang et al. 2015), it has been conventional to assume or to conjecture that water-ice-coated dust grains are stickier than water-ice-free grains. It has been generally believed that grown dust with maximum grain sizes ($a_{\max}$) greater than 1 mm (e.g., chondrules, pebbles) tend to form outside of the water snowline ($T \sim 150$–170 K; e.g., Pollack et al. 1994). It has also been considered that in the inner, higher temperature regions of protoplanetary disks, grown dust will likely fragment back down to smaller sizes when water ice is sublimated (e.g., Banzatti et al. 2015; Cieza et al. 2016; Pinilla et al. 2017).

These assumptions used to be supported by the results of earlier laboratory experiments (e.g., Gundlach et al. 2011; Gundlach & Blum 2015 and references therein). However, they are inconsistent with analytical calculations (e.g., Kimura et al. 2015). An open issue related to this is how to form rocky planets or asteroids that are deficient in water.

Growing modern laboratory experimental results conversely suggested that water-ice-free dust grains are stickier or at least as sticky as the water-ice-coated ones (Gundlach et al. 2018; Musiolik & Wurm 2019; Steinpilz et al. 2019; Pillich et al. 2021). Gundlach et al. (2018) pointed out that the inconsistency between the modern and the earlier experimental results (e.g., Gundlach et al. 2011) may be because the ice-coated dust samples in the earlier experiments were thermally processed due to the imperfect low-temperature operational techniques. If this is indeed the case, then grown dust may be prone to form inward rather than outward of the water snowline in protoplanetary disks (for some related discussion see Molyarova et al. 2021; Musiolik 2021; Pinilla et al. 2021 and references therein). Since the laboratory dust samples do not necessarily have the same composition and morphology

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Final Moments. I. Precursor Emission, Envelope Inflation, and Enhanced Mass Loss Preceding the Luminous Type II Supernova 2020tlf

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Abstract

We present panchromatic observations and modeling of supernova (SN) 2020tlf, the first normal Type II-P/L SN with confirmed precursor emission, as detected by the Young Supernova Experiment transient survey. Pre-SN activity was detected in *riz*-bands at −130 days and persisted at relatively constant flux until first light. Soon after discovery, "flash" spectroscopy of SN 2020tlf revealed narrow, symmetric emission lines that resulted from the photoionization of circumstellar material (CSM) shed in progenitor mass-loss episodes before explosion. Surprisingly, this novel display of pre-SN emission and associated mass loss occurred in a red supergiant (RSG) progenitor with zero-age main-sequence mass of only 10–12 $M_{\odot}$, as inferred from nebular spectra. Modeling of the light curve and multi-epoch spectra with the non-LTE radiative-transfer code CMFGEN and radiation-hydrodynamical code HERACLES suggests a dense CSM limited to $r \approx 10^{15}$ cm, and mass-loss rate of $10^{-2}\,M_{\odot}$ yr^{-1}. The luminous light-curve plateau and persistent blue excess indicates an extended progenitor, compatible with an RSG model with $R_{\star} = 1100\,R_{\odot}$. Limits on the shock-powered X-ray and radio luminosity are consistent with model conclusions and suggest a CSM density of $\rho < 2 \times 10^{-16}$ g cm^{-3} for distances from the progenitor star of $r \approx 5 \times 10^{15}$ cm, as well as a mass-loss rate of $\dot{M} < 1.3 \times 10^{-5}\,M_{\odot}$ yr^{-1} at larger distances. A promising power source for the observed precursor emission is the ejection of stellar material following energy disposition into the stellar envelope as a result of gravity waves emitted during either neon/oxygen burning or a nuclear flash from silicon combustion.

Unified Astronomy Thesaurus concepts: Core-collapse supernovae (304); Type II supernovae (1731); Supernovae (1668); Massive stars (732); Stellar mass loss (1613)

Supporting material: data behind figure, machine-readable table

1. Introduction

The behavior of massive stars in their final years of evolution is almost entirely unconstrained. However, we can probe these terminal phases of stellar evolution prior to the core-collapse of massive stars $>8\,M_{\odot}$ by understanding the composition and origin of the high-density, circumstellar material (CSM) surrounding these stars at the time of explosion (Smith 2014).

[20] NASA Einstein Fellow.

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Revealing a New Black Widow Binary 4FGL J0336.0+7502

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Abstract

We report on the discovery of a promising candidate for a black widow (BW) millisecond pulsar binary, 4FGL J0336.0+7502, which shows many pulsar-like properties in the 4FGL-DR2 catalog. Within the 95% error region of the LAT source, we identified an optical counterpart with a clear periodicity at $P_{\rm orb} = 3.718178(9)$ hr using the Bohyunsan 1.8 m Telescope, the Lulin One-meter Telescope, the Canada–France–Hawaii Telescope, and Gemini-North. At the optical position, an X-ray source was marginally detected in the Swift/X-Ray Telescope archival data, and the detection was confirmed by our Chandra/ACIS DDT observation. The spectrum of the X-ray source can be described by a power-law model of $\Gamma_x = 1.6 \pm 0.7$ and $F_{0.3-7\,{\rm keV}} = 3.5^{+1.2}_{-1.0} \times 10^{-14}$ erg cm^{-2} s^{-1}. The X-ray photon index and the low X-ray-to-γ-ray flux ratio (i.e., $<1\%$) are both consistent with that of many known BW pulsars. There is also a hint of an X-ray orbital modulation in the Chandra data, although the significance is very low (1.3σ). If the pulsar identity and the X-ray modulation are confirmed, it would be the fifth BW millisecond pulsar binary that showed an orbitally modulated emission in X-rays.

Unified Astronomy Thesaurus concepts: High energy astrophysics (739); Gamma-ray sources (633); Compact binary stars (283); Millisecond pulsars (1062); X-ray sources (1822)

Supporting material: data behind figure

1. Introduction

The Fermi Large Area Telescope (LAT) has been observing the MeV/GeV γ-ray sky since 2008 June. With the 10 years of data taken between 2008 and 2018, 5064 sources are detected in the Fermi-LAT 10-Year Point Source Catalog (4FGL-DR2; Abdollahi et al. 2020; Ballet et al. 2020). While a major portion of the cataloged sources are known systems (e.g., active galaxies, pulsars, etc.), about one-fourth of them are unidentified at other wavelengths. Other than active galaxies, many of these unidentified γ-ray sources are believed to be pulsar systems.

There have been multiwavelength searching campaigns conducted for new candidates of γ-ray pulsars from the list of the unidentified Fermi-LAT sources (e.g., Hui et al. 2015; Braglia et al. 2020). Machine-learning techniques were also applied on the classification for pulsars based on only the γ-ray properties recently (e.g., Saz Parkinson et al. 2016; Luo et al. 2020; Hui et al. 2020). These efforts have led to at least a dozen candidates for further radio/γ-ray pulsation searches. Many of these candidates could be associated with two special pulsar classes, black widow (BW) and redback (RB), which are millisecond pulsars in compact binaries (the orbital periods are often less than a day). Besides the compact orbits, the two classes are characterized by the very low-mass companions (i.e., 0.1–0.4 $M_\odot$ for RBs and $<0.1 M_\odot$ for BWs; Chen et al. 2013; Roberts 2013) ablated by the strong radiations that originate from the primary pulsars. The radiation would also heat up the tidally locked companion one-sided, and this so-called pulsar heating effect can result in orbital modulations in the optical bands (see, e.g., Romani & Sanchez 2016; Yap et al. 2019 for the details), although exceptions exist (e.g., 3FGL J0212.1+5320 that does not show any observable pulsar heating effect; Li et al. 2016). Some recently discovered BW/RB candidates include 3FGL J0954.8−3948 (Li et al. 2018), 4FGL J2333.1−5527 (Swihart et al. 2020), 4FGL J0935.3+0901 (Wang et al. 2020), 4FGL J0407.7−5702 (Miller et al. 2020), and 4FGL J0940.3−7610 (Swihart et al. 2021; see the Table 3 of Hui & Li 2019 and the references therein for more candidates).

In this paper, we present a multiwavelength study for 4FGL J0336.0+7502, which is a new BW MSP candidate identified by our unidentified Fermi-LAT sources observing campaign. The study includes (i) the Fermi-LAT γ-ray properties of 4FGL J0336.0+7502 (Section 2); (ii) optical photometric observations taken by the Bohyunsan 1.8 m Telescope, the Lulin One-meter Telescope (LOT), the Canada–France–Hawaii Telescope (CFHT), and Gemini-North (Section 3); (iii) Swift/X-Ray Telescope (XRT) and Chandra/ACIS-S X-ray observations (Section 4); and (iv) a discussion for 4FGL J0336.0+7502 based on its multiwavelength properties (Section 5).

2. Gamma-Ray Properties

4FGL J0336.0+7502 is a bright γ-ray source (detection significance of 31.1σ) located at a Galactic latitude of $b = 15.5°$ (Ballet et al. 2020). It was first discovered in γ-rays by Fermi-LAT as 1FGL J0334.2+7501 in the 1FGL catalog (Abdo et al. 2010), and was subsequently cataloged in 2FGL, 3FGL, and 4FGL(-DR2) (Nolan et al. 2012; Acero et al. 2015; Abdollahi et al. 2020; Ballet et al. 2020). In 4FGL-DR2 (using data taken from 2008 August to 2018 August), 4FGL J0336.0+7502 was classified as a steady source on a yearly timescale with a variability index[4] of 9.8. The average γ-ray flux in 100 MeV–100 GeV is $F_\gamma = (7.4 \pm 0.5) \times 10^{-12}$ erg cm^{-2} s^{-1} that is among the top 30% of all 4FGL-DR2 sources. According to

[4] A source with a variability index greater than 18.48 has a less than 1% chance to be stable.

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The dual nature of blazar fast variability: Space and ground observations of S5 0716+714

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ABSTRACT

Blazar S5 0716+714 is well-known for its short-term variability, down to intraday time-scales. We here present the 2-min cadence optical light curve obtained by the *TESS* space telescope in 2019 December–2020 January and analyse the object fast variability with unprecedented sampling. Supporting observations by the Whole Earth Blazar Telescope Collaboration in *B*, *V*, *R*, and *I* bands allow us to investigate the spectral variability during the *TESS* pointing. The spectral analysis is further extended in frequency to the UV and X-ray bands with data from the *Neil Gehrels Swift Observatory*. We develop a new method to unveil the shortest optical variability time-scales. This is based on progressive de-trending of the *TESS* light curve by means of cubic spline interpolations through the binned fluxes, with decreasing time bins. The de-trended light curves are then analysed with classical tools for time-series analysis (periodogram, autocorrelation, and structure functions). The results show that below 3 d there are significant characteristic variability time-scales of about 1.7, 0.5, and 0.2 d. Variability on time-scales $\lesssim 0.2$ d is strongly chromatic and must be ascribed to intrinsic energetic processes involving emitting regions, likely jet substructures, with dimension less than about 10^{-3} pc. In contrast, flux changes on time-scales $\gtrsim 0.5$ d are quasi-achromatic and are probably due to Doppler factor changes of geometric origin.

Key words: galaxies: active – BL Lacertae objects: general – BL Lacertae objects: individual: S5 0716+714 – galaxies: jets.

1 INTRODUCTION

Blazars, including BL Lac objects (BL Lacs) and flat-spectrum radio quasars (FSRQ) form a class of active galactic nuclei characterized by extreme and unpredictable emission variability at all frequencies on a wide range of time-scales. In the optical band, small (up to tenths of mag) intraday flux variations usually overlap on larger (up to several mag) brightness changes on weeks-years scales, likely revealing different physical mechanisms at work. The distinctive feature of blazars is that most of the radiation we observe is produced in a relativistic plasma jet pointing towards us. This causes blueshift of the observed radiation with respect to the emitted one, contraction of the variability time-scales, and flux enhancement by some power of the Doppler factor $\delta = [\Gamma(1-\beta\cos\theta)]^{-1}$, which depends on both the bulk Lorentz factor $\Gamma = (1-\beta^2)^{-1/2}$ (i.e. on the bulk velocity $\beta = v/c$ of the emitting plasma) and the viewing angle θ (i.e. the angle between the velocity vector and the line of sight). Even small changes of θ can produce large flux variations, and at least part of the blazar variability can likely be due to geometric effects, as in the twisting inhomogeneous jet model proposed by Raiteri et al. (2017) to explain the multifrequency long-term behaviour of the FSRQ CTA 102. In the model by Camenzind & Krockenberger (1992) instead, rotating plasma bubbles in the jet can produce lighthouse effect and consequently quasi-periodic oscillations (QPOs). Other variability mechanisms involve intrinsic energetic processes, like particle injection or acceleration due to shock waves (e.g. Blandford & Königl 1979; Marscher & Gear 1985; Sikora et al. 2001), turbulence (Marscher 2014; Pollack, Pauls & Wiita 2016), or instabilities that occur in the accretion disc and propagate into the jet, giving rise to QPOs (e.g. King et al. 2013). Search for periodicities in blazar (and AGN) light curves at all wavelengths have led to a variety of results (e.g. Lainela et al. 1999; Raiteri et al. 2001; Gierliński et al. 2008; Ackermann et al. 2015;

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The complex variability of blazars: time-scales and periodicity analysis in S4 0954+65

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ABSTRACT

Among active galactic nuclei, blazars show extreme variability properties. We here investigate the case of the BL Lac object S4 0954+65 with data acquired in 2019–2020 by the *Transiting Exoplanet Survey Satellite* (*TESS*) and by the Whole Earth Blazar Telescope (WEBT) Collaboration. The 2-min cadence optical light curves provided by *TESS* during three observing sectors of nearly 1 month each allow us to study the fast variability in great detail. We identify several characteristic short-term time-scales, ranging from a few hours to a few days. However, these are not persistent, as they differ in the various *TESS* sectors. The long-term photometric and polarimetric optical and radio monitoring undertaken by the WEBT brings significant additional information, revealing that (i) in the optical, long-term flux changes are almost achromatic, while the short-term ones are strongly chromatic; (ii) the radio flux variations at 37 GHz follow those in the optical with a delay of about 3 weeks; (iii) the range of variation of the polarization degree and angle is much larger in the optical than in the radio band, but the mean polarization angles are similar; (iv) the optical long-term variability is characterized by a quasi-periodicity of about 1 month. We explain the source behaviour in terms of a rotating inhomogeneous helical jet, whose pitch angle can change in time.

Key words: galaxies: active – BL Lacertae objects: general – BL Lacertae objects: individual: S4 0954+65 – galaxies: jets.

1 INTRODUCTION

Blazars are active galactic nuclei that show extreme variability properties. They include flat-spectrum radio quasars, generally showing broad emission lines in their spectra, and (almost) featureless BL Lac objects. Blazar emission mostly comes from a relativistic plasma jet that is oriented closely to the line of sight. As a consequence, the flux is Doppler beamed and boosted, and time-scales are shortened. Blazar variability is unpredictable. Some objects show almost continuous activity, while others undergo extreme outburst events after periods of almost constant emission. Variability time-scales range from years down to hours, likely implying that different mechanisms are at work, both of intrinsic (i.e. energetic) and extrinsic (i.e. geometric) nature.

The *Transiting Exoplanet Survey Satellite* (*TESS*; Ricker et al. 2015) that was launched in 2018, though dedicated to the discovery of exoplanets, gives us the possibility to study the short-term blazar variability with extremely dense sampling. Therefore, we proposed a number of bright blazars for *TESS* observations in cycles 2, 3, and 4. Some of these *TESS* blazar observations were supported by ground-based monitoring by the Whole Earth Blazar Telescope[1] (WEBT) Collaboration (e.g. Villata et al. 2002, 2004, 2006, 2008; Raiteri

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[1] http://www.oato.inaf.it/blazars/webt/

Part II

工作報告

觀測時數統計 (2003-2021)

林宏欽、蕭翔耀、林啟生、侯偉傑

鹿林天文台自 2002 年 9 月開始人員常駐，2003 年鹿林一米望遠鏡 (LOT) 上線，開始有正式觀測時數紀錄，可供瞭解鹿林長期的天氣狀況。表 1 為 2003-2021 共 19 年的統計結果，鹿林天文台年平均觀測時數為 1547.16 小時。由圖 1(b) 可將一年可分為四個觀測季:

- 最佳觀測季：10-12 月。
- 次佳觀測季：1-3 月。
- 最差觀測季：4-6 月。4 月開始進入雨季，5-6 月受梅雨影響，天氣最差
- 次差觀測季：7-9 月。主要受颱風及西南氣流影響，天氣變化大。此外夏季晝長夜短，每晚可觀測時間比冬季為短。

Table 1: 每月觀測時數統計 (2003-2021)

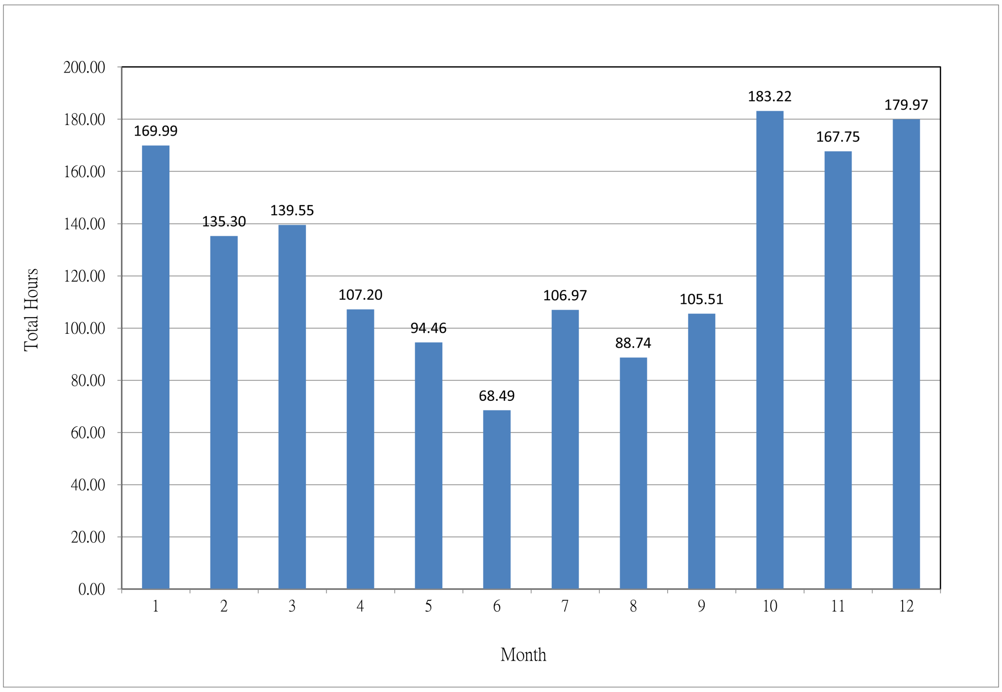
	月份												
	1	2	3	4	5	6	7	8	9	10	11	12	Total
2003	78.75	142.5	147.5	126.5	129.75	24	222.5	137.75	142	149.25	166.5	271.5	1738.5
2004	125	145.98	163	110.5	106.25	133	48	142	116	219.75	214.5	232.45	1756.43
2005	163.25	94.75	143	144.75	136.25	45	167.75	76	129.25	210.25	216.25	129	1655.5
2006	129	149	126.05	86.8	59.5	39.3	91.57	111.65	60.05	150.6	71.75	132	1207.27
2007	127.32	128.55	116.4	53.75	106.6	54	128.88	56.6	69.55	172.63	160.55	261.09	1435.92
2008	179	118.25	138.5	85.25	98.25	37	88.4	118.95	59.8	191.38	152.55	211.17	1478.5
2009	234.52	165.7	146.75	71.8	167.4	81.75	76.6	6.8[1]	0[1]	175.6	175.8	169.8	1472.52
2010	206.9	100.6	181.3	75.8	86.05	26.5	99.85	98.3	109.95	139.8	163.65	169.65	1458.35
2011	90.8	123.8	75.9	151.45	56.6	61.5	81.75	97.9	90.1	136.95	87.2	115.25	1169.2
2012	113.42	64.88	168.23	32.75	74.3	35.15	106.4	35.7	117.35	214.51	93.81	132.21	1188.71
2013	153.58	183.63	134.26	55.83	41.02	80.14	88.05	72.2	107.84	200.57	136.1	86	1339.22
2014	269.62	109.8	78.7	135.95	32.4	33.7	114.65	110.9	134.39	232.33	166.15	137.3	1555.89
2015	188.55	131.65	111.1	124	64.2	146.9	87.45	45.1	93.25	145.4	197.05	161.2	1495.85
2016	75.4	60.25	72.8	82.9	86.05	114.05	123.95	61	42.85	142.2	171.85	193.27	1226.57
2017	160.85	105.3	96.4	86.9	84.55	76.1	105.25	139.9	128.2	187.8	134.55	156.7	1462.5
2018	110.4	66.7	173.7	125.7	190.7	70.35	80.65	50.35	93.45	142.05	148.15	170.05	1422.25
2019	196.3	136.35	124	124.35	39.1	56.55	77.35	58.2	137.45	193.75	200.29	180.2	1523.89
2020	234.4	191.1	121.35	98.75	88.35	137.9	102.5	78.3	82.28	163.82	185.65	125.44	1609.84
2021	227.78	197.37	167.98	125.74	87.16	13.8[2]	90.4	71.08	116.42	132.21	129.6	202.8	1562.34
Average*	169.99	135.30	139.55	107.20	94.46	68.49	106.97	88.74	105.51	183.22	167.75	179.97	1547.16

* Average 為扣除最高及最低值後取平均

[1] 2009 年因受莫拉克颱風八八風災影響，自八月八日起至十月初約 2 個月期間道路中斷並停電，無法觀測。所以 2009 年八、九月觀測時數很少，甚至為 0。

[2] 2021 年 6 月雷擊造成圓頂故障，約有 20 日無法觀測。

(a) 年平均觀測時數統計圖 (2003-2021)



(b) 月平均觀測時數統計圖 (2003-2021)

Figure 1: 2003-2021 觀測時數統計圖

LOT 觀測研究計畫統計 (2021)

鹿林天文台一米望遠鏡 (LOT) 觀測研究計畫時間安排以 4 個月為一個觀測期，一年分為三期 (A = 1-4 月、B = 5-8 月、C = 9-12 月)，其中字母 E、R 和 *R 分別為天文觀測教學、國內研究計畫與國際合作計畫，而大型計畫 EDEN 亦為國際合作計畫。

2021 年的觀測計畫如 2所示，觀測教學有 9 個，佔 20%。國內研究計畫有 21 個，佔 48%。國際合作計畫有 14 個，佔 32%。

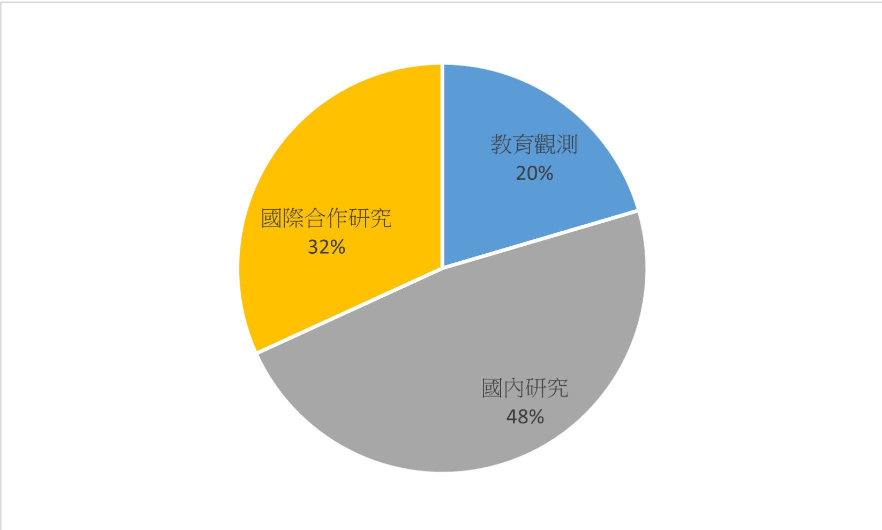


Figure 2: LOT 計畫比例圓餅圖 (2021)

LOT2021A Semester (01 January – 30 April, 2021)

Dear PI, your contact email is included in this announcement such that the PI for ToO programs can contact you in case of ToO triggers. Please let me know if you want your email to be removed. Thanks!
(Programs with “ * ” denotes the program has international CoI, this is used for statistics counting only.)

Education Program:

E01 – Acquiring a Training Data Set for Course “Advanced Astronomical Observations”
P.I.: Daisuke Kinoshita (kinoshita@astro.ncu.edu.tw)

E02 – A Training Program for Undergraduate Students in NTNU
P.I.: Yu-Chi Cheng (ycc312@g.ncu.edu.tw)

Large Program:

EDEN – Exo-earth Discovery and Exploration Network
PI: W-P Chen (wchen@astro.ncu.edu.tw)

Research Program:

*R01 – Calibrating the griz-Band PLZ Relations using RR Lyrae in Globular Clusters
P.I.: Chow-Choong Ngeow (cngeow@astro.ncu.edu.tw)

*R02 – Lulin Supernova Program
P.I.: Yen-Chen Pan (ycpan@astro.ncu.edu.tw)

R03 – Test of Lucky-Imaging Technique on LOT with a Cooled-CMOS Camera
P.I.: Yang-Peng Hsieh (m1089002@gm.astro.ncu.edu.tw)

*R04 – Joint X-ray, Optical, and Radio Monitoring towards a Pre-main Sequence Star
P.I.: Hauyu Baobab Liu (hyliu@asiaa.sinica.edu.tw)

*R05 – Survey of the Synchronous Binary Asteroids in the Solar System
P.I.: Polińska Magdalena (polinska@amu.edu.pl)

R06 – Detecting Polarization Associated with Stellar Flares
P.I.: Chen-Yen Hsu (pandaangela915@gmail.com)

*R07 – Hunting for Barbarians at Lulin
P.I.: Kang-Shian Pan (m989005@astro.ncu.edu.tw)

R08 – The Study of the Dust to Gas Ratio in Long- and Short-Period Comets
P.I.: Zhong-Yi Lin (zylin@astro.ncu.edu.tw)

R09 – Investigation of Surface Homogeneity of (596) Scheila
P.I.: Zhong-Yi Lin (zylin@astro.ncu.edu.tw)

R10 – The Spectral Variations in Superflare Phases of G- and M-type Stars
P.I.: Chia-Lung Lin (m1059006@gm.astro.ncu.edu.tw)

R11 – Taxonomical Classification of Dynamically Unstable Asteroids in the Outer Main Asteroid Belt
P.I.: Yu-Chi Cheng (ycc312@g.ncu.edu.tw)

LOT2021B Semester (01 May – 31 August, 2021)

Dear PI, your contact email is included in this announcement such that the PI for ToO programs can contact you in case of ToO triggers. Please let me know if you want your email to be removed. Thanks!
(Programs with " * " denotes the program has international CoI, this is used for statistics counting only.)

Education Program:

E01 – Astro Summer Camp 2021 Students Training with LOT
P.I.: Chow-Choong Ngeow (cngeow@astro.ncu.edu.tw)

E02 – Practical Class of "Fundamentals of Observational Astronomy"
P.I.: Albert Kong (akong@phys.nthu.edu.tw)

E03 – Hands-on Class of "Introduction to Astrophysics"
P.I.: Chin-Ping Hu (cphu0821@cc.ncue.edu.tw)

E04 – Acquiring a Training Data Set for Course "Advanced Astronomical Observations"
P.I.: Daisuke Kinoshita (kinoshita@astro.ncu.edu.tw)

Large Program:

EDEN – Exo-earth Discovery and Exploration Network
PI: W-P Chen (wchen@astro.ncu.edu.tw)

Research Program:

R01 – Variable Stars in Globular Clusters: Complement to ZTF with LOT
P.I.: Chow-Choong Ngeow (cngeow@astro.ncu.edu.tw)

*R02 – Lulin Supernova Program
P.I.: Yen-Chen Pan (ycpan@astro.ncu.edu.tw)

R03 – Follow-up Observations of Low-Mass X-ray Transients in Outbursts
P.I.: Albert Kong (akong@phys.nthu.edu.tw)

R04 – Testing Lucky-Imaging Technique On the Core of Globular Cluster M3
P.I.: Yang-Peng Hsieh (m1089002@gm.astro.ncu.edu.tw)

R05 – The Study of the Dust to Gas Ratio in Long- and Short-Period Comets
P.I.: Zhong-Yi Lin (zylin@astro.ncu.edu.tw)

R06 – Taxonomical Classification of Dynamically Unstable Asteroids in the Outer Main Asteroid Belt
P.I.: Yu-Chi Cheng (ycc312@g.ncu.edu.tw)

R07 – Deep Hα Imaging of Planetary-mass Objects: Toward Accretion Rate Monitoring
P.I.: Ya-Lin Wu (yalinwu@ntnu.edu.tw)

*R08 – International Observing Campaign on Binary Main-Belt Comet 288P/2006 VW139
P.I.: Yu-Chi Cheng (ycc312@g.ncu.edu.tw)

*R09 – Hunting for Barbarians at Lulin
P.I.: Kang-Shian Pan (m989005@astro.ncu.edu.tw)

R10 – The Spectral Variations in Superflare Phases of G- and M-type Stars
P.I.: Li-Ching Huang (lchuang@astro.ncu.edu.tw)

LOT Semester 2021C
(01 September - 31 December, 2021)

Education Program:

E01 - Practical Class of "Observational Astronomy”
PI: Albert Kong (akong@phys.nthu.edu.tw)

E02 - Student Training for NTHU’s “Fundamentals of Observational Astronomy” Course
PI: Shih-Ping Lai (slai@phys.nthu.edu.tw)

E03 - A Training Program for Undergraduate Astronomical Observation Course in NTNU
PI: Yueh-Ning Lee (ynlee@ntnu.edu.tw)

Large Program:

EDEN - Exo-earth Discovery and Exploration Network
PI: Wen-Ping Chen (wchen@astro.ncu.edu.tw)

Research Program:
(Programs which have international CoIs are marked with *)

*R01 - Lulin Supernova Program
PI: Yen-Chen Pan (ycpan@astro,ncu.edu.tw)

R02 - Variable Stars in Globular Clusters: Complement to ZTF with LOT
PI: Chow-Choong Ngeow (cngeow@astro.ncu.edu.tw)

*R03 - Global Polarization Monitoring of Blazars
PI: Wen-Ping Chen (wchen@astro.ncu.edu.tw)

R04 - Polarization during Magnetic Flares of Red Dwarfs
PI: Wen-Ping Chen (wchen@astro.ncu.edu.tw)

*R05 - The Nature of Unidentified Fermi Objects
PI: Albert Kong (akong@phys.nthu.edu.tw)

R06 - The study of the dust to gas ratio in long- and short-period comets
PI: Zhong-Yi Lin (zylin@astro.ncu.edu.tw)

R07 - Testing Lucky-Imaging Technique On the Core of Globular Cluster M15
PI: Yang-Peng Hsieh (m1089002@gm.astro.ncu.edu.tw)

R08 - The Spectral Variations in Superflare Phases of G- and M-type Stars
PI: Chia-Lung Lin (m1059006@gm.astro.ncu.edu.tw)

R09 - Return of the Near-Earth Asteroid (155140) 2005 UD
PI: Daisuke Kinoshita (kinoshita@astro.ncu.edu.tw)

R10 - Monitoring Accretion onto a Planetary-mass Companion

PI: Ya-Lin Wu (yalinwu@ntnu.edu.tw)

R11 - Taxonomical Classification of Dynamically Unstable Asteroids in the Outer Main Asteroid Belt

PI: Yu-Chi Cheng (ycc312@g.ncu.edu.tw)

工作報告 (2021)

具體工作

1. LOT 主鏡清洗 (2020)
2. LOT 光軸調整
3. LOT Operation Cheat-Sheet
4. Tripol-II 濾鏡鎖緊維修報告
5. Tripol 濾鏡無法定位維修報告
6. 雷擊勘災報告
7. LWT 淋雨事件與處置
8. 網站更新

LOT 主鏡清洗

20201030
林宏欽、蕭翔耀、侯偉傑

LOT 觀測時會有落塵掉在主鏡上，反射率會因累積的灰塵增加而下降。日常雖有使用高壓氣體噴槍清掃，但日久還是有許多無法移除的灰塵及髒汙，需使用清洗的方式來去除。

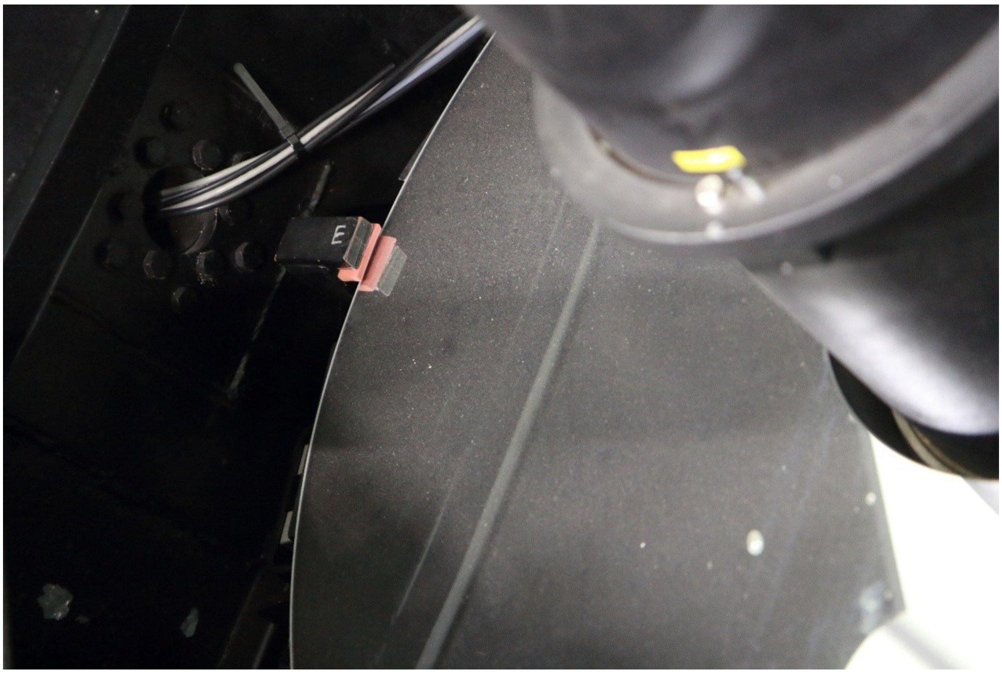


Fig. 1

為避免清洗時的水流到望遠鏡其他結構，需要先在主鏡以外的地方先做好防水作業。注意主鏡清洗不能用乾式擦拭，因紙或布與灰塵的摩擦會使鏡面刮花。清洗步驟如下：

1. 先將紙巾邊用純水噴濕邊貼到鏡面再直接掀起，先將大部分的灰塵沾起來。注意不可用摩擦方式擦拭，因為鏡面上還有許多灰塵，此步驟約重複三到四次。
2. 在鏡面上噴上用純水稀釋的專用低泡沫清潔劑，然後用濕紙巾貼上拖行，不可額外向鏡面施力，只用紙巾吸附在鏡面上的力即可。重複數次，這步驟可以移除剩下的灰塵。
3. 鏡面上若留有一些污漬，先噴上稀釋清潔劑後再使用濕紙輕輕擦拭，注意不可以太用力，若清不掉就留著，以防太用力使鏡面刮花
4. 重複步驟 2 一次，但改用純水。
5. 將整個鏡片噴上高純度酒精，去除鏡面的殘水並避免留下水漬，注意酒精有危險性，需戴口罩並嚴禁煙火。清除防水布及吸水紙巾，確定望遠鏡各部全乾後裝回儀器。

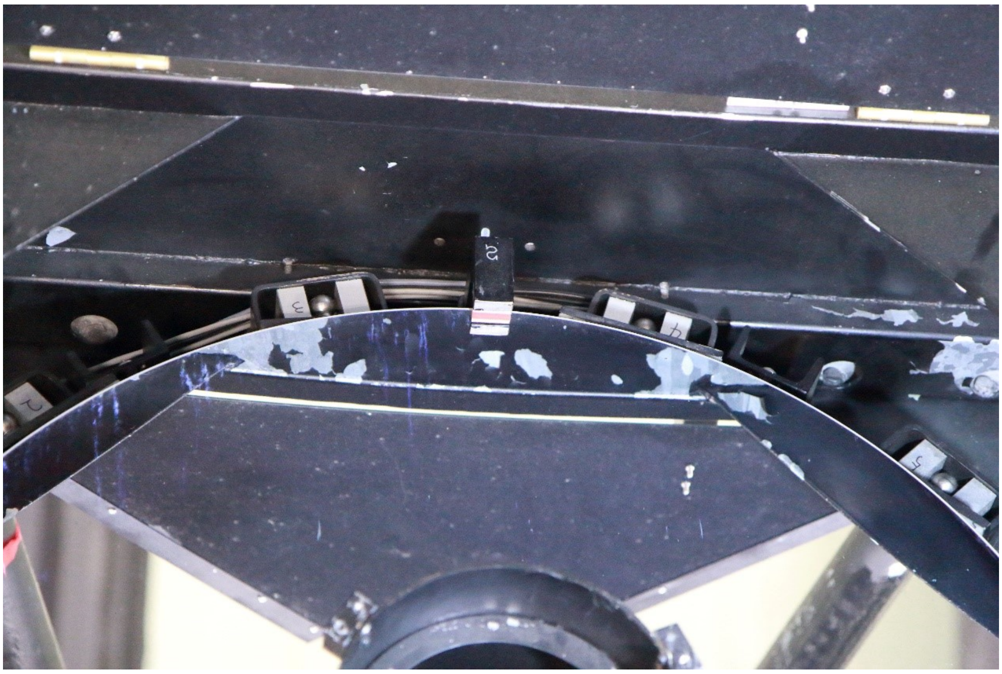


Fig. 2

LOT 光軸調整

20210128
林宏欽、林啟生、蕭翔耀、侯偉傑

LOT 因光軸偏移星點變形，影響觀測資料品質，需重新調整光軸。首先將目鏡座接上雷射光軸准直器，鬆開調焦座軌道螺絲。利用三角支架支撐目鏡座，調整三角支架高度並觀察雷射在次鏡上的位置。次鏡中央有作標記，調整三角支架高度讓雷射對準中央標記，之後將調焦座軌道螺絲鎖上，過程中要邊觀察雷射位置是否變動邊做修正。

利用環形雷射檢查雷射同心圓於主鏡的投影是否與主鏡同心，若不同心需調整次鏡上的螺絲 (Fig. 1)。一次調整一個位置，每個位置有兩個螺絲，注意調整時需一鬆一緊推拉兩顆螺絲同時進行，直到雷射環與主鏡同心。

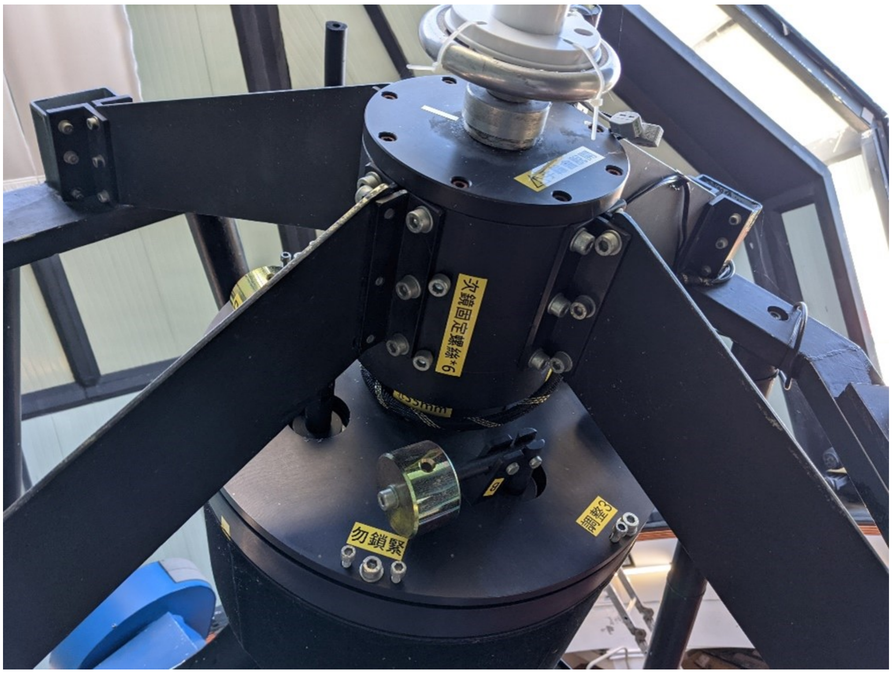


Fig. 1

將望遠鏡指向平場布幕，檢查屏幕上的雷射環 (一次反射與二次反射) 是否同心。若不同心則調整主鏡後面三個調整旋鈕 (Fig. 2)，調整完後要檢查底部支撐重錘，確定確實向上抵住主鏡。

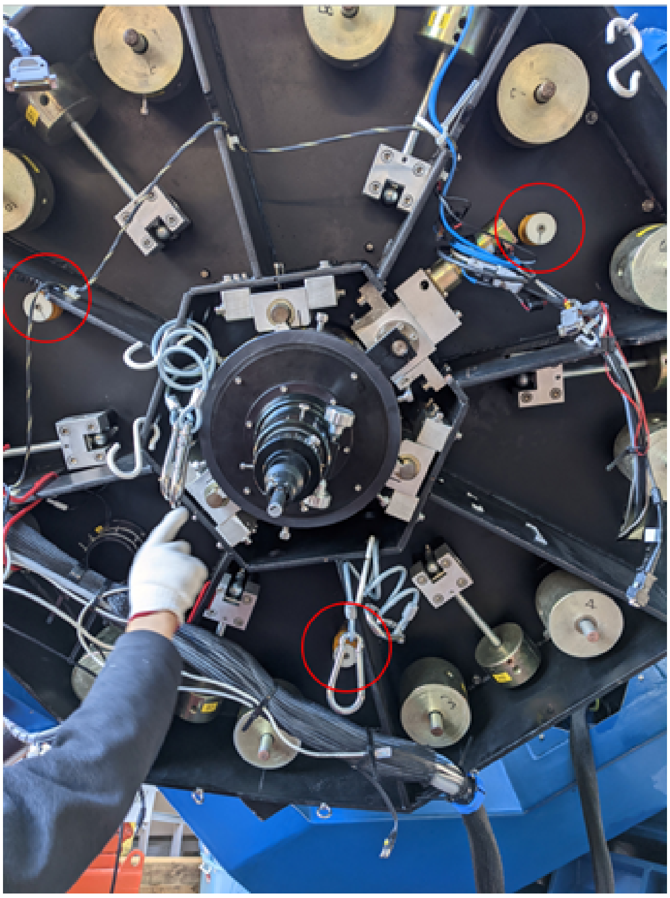
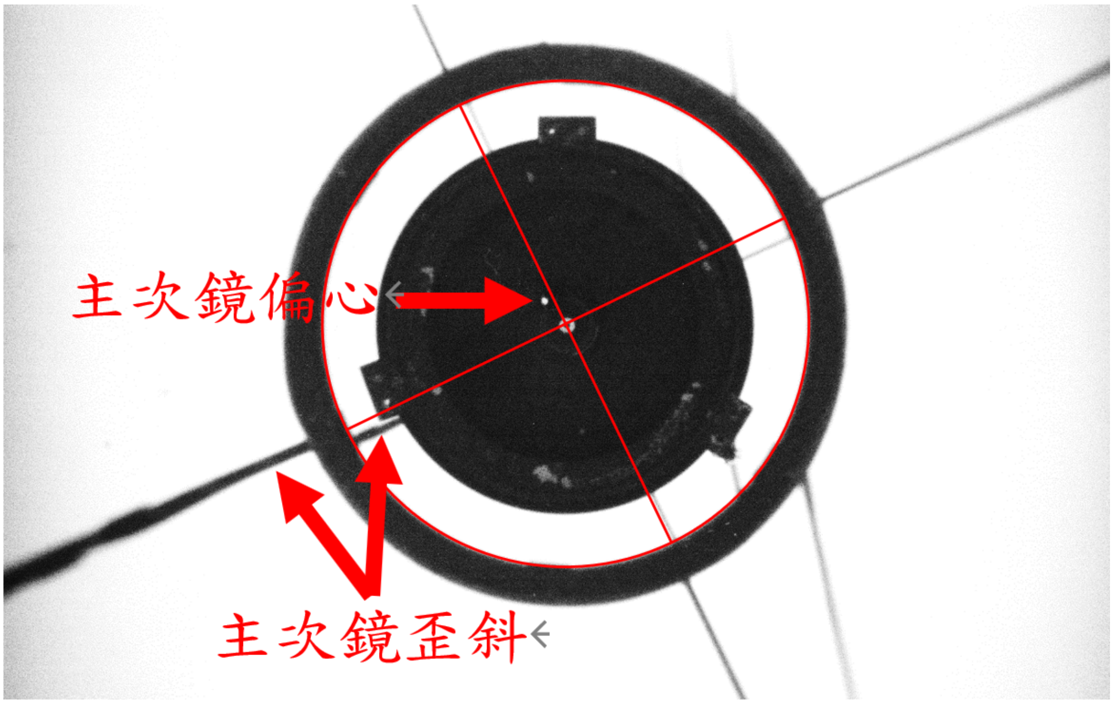
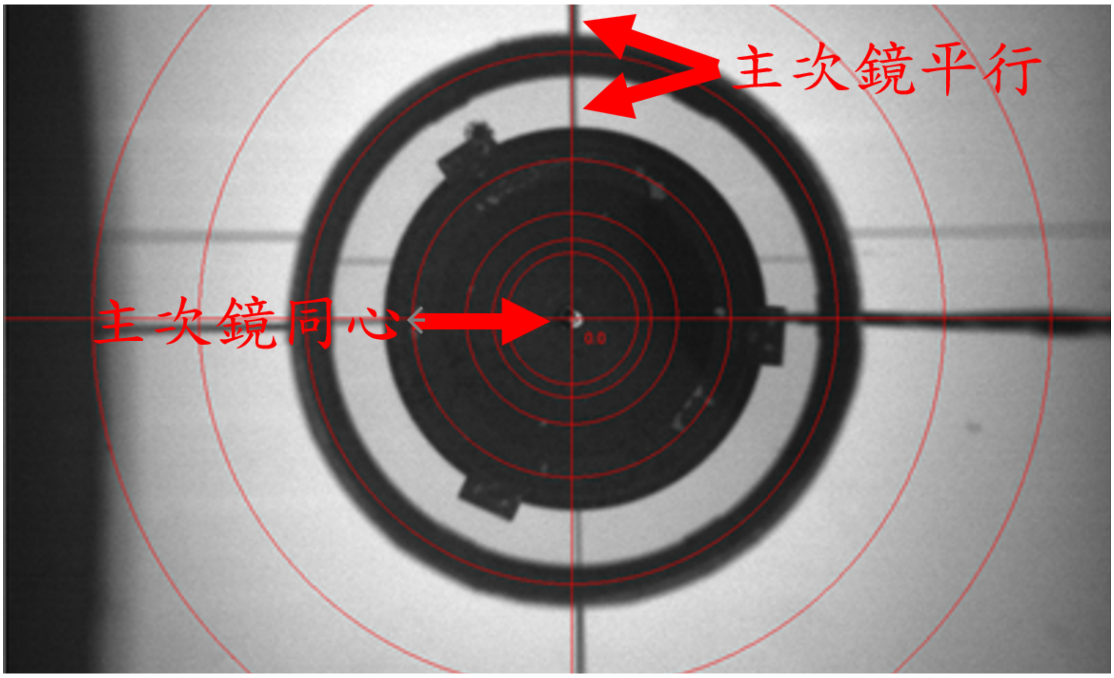


Fig. 2



(a) 調整前



(b) 調整後

Fig. 3

調整後實際拍攝，用 CCDInspector 軟體解析場星結果如下：

Min FWHM = 1.31”
Min FWHM = 1.31”
Max FWHM = 1.36”
Curvature = 9%
Tilt in X = -0.0”
Tilt in Y = -0.0”
Collimation = 0.9”
Star Used : 520

最佳星點約 FWHM 1”，恢復到以往之性能。

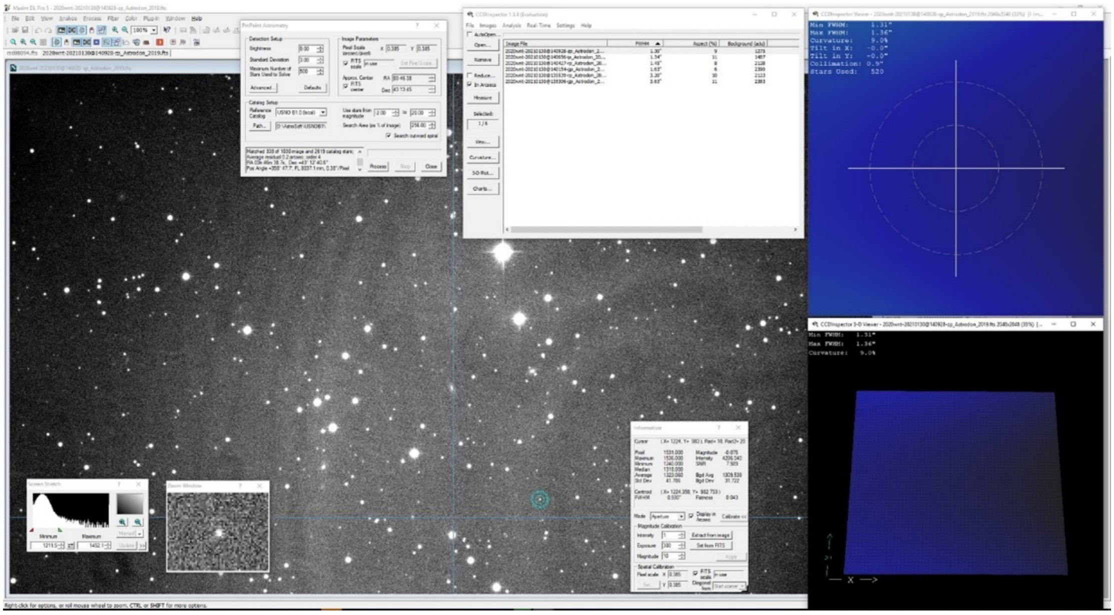


Fig. 4

LOT Operation Cheat-Sheet (2021-Feb-15)

Hauyu Baobab Liu 呂浩宇 (ASIAA), Natsuko Izumi 泉奈都子 (ASIAA)

技術指導: 木下大輔 (NCU), 林啓生 (Lulin Observatory)

Sofia camera: FOV–$13'.08 \times 13'.08$; $0''.39$/pixel; CCD counts: <50 k is usable (ideally <30 k)

Versions:
beta: 2021-Feb-15

Starting up (15 mins after sunset [exact sunset time can be checked with google])

Initiating the software environment (skip this step if the applications/software have been launched by the previous observer) **The order is important. Please strictly follow it.**

1. Find ”FocusMax” icon in the Windows XP toolbar (looks like a yellow coffee cup with something red inside). Click it.
   In the FocusMax panel, click the ”system” tab in the bottom. Then find the ”Connect” button in the ”Focuser” section and then click it.
2. In the Windows XP toolbar, find the MaxImDL icon (looks like a white telescope next to a moon). Launch it.
3. In the MaxImDL panel, click the ”View” tab, and then click ”Camera Control Window”.
   In the Camera control window panel, click the ”Setup” tab, and then click ”Connect” on the upper right corner. In the ”Coolers” section, click ”on”.
4. In the MaxImDL panel, click the ”View” tab, and then click ”Observatory control window”.
   In the ”Observatory” panel, click the ”Setup” tab and then find the ”Dome” section, then click ”Connect”.
5. After going through steps 1–4, the ”ACP Observatory Control Software” panel will be launched automatically.
   Click the ”Camera” tab and then click ”Connect” if it is not yet connected.
   Find the ”Script” Section. Click ”Select the Script” and choose ”AcquireImages.js”. Click the other box in the ”Script” section and then click ”JSscript”.
6. In the Windows XP toolbar, find ”Lulin.sky” and launch it (looks like s dark blue ball with a ”S” on it).
7. In the FocusMax panel, click the ”System” tab, in the ”Camera” section, choose ”MaxImDL” to permit automatically focusing.

If the applications/software have been launched by the (previous) observer:

1. Switch on all monitors (4 in total)
2. Unlock the dome [twist the red button clockwise] (see Figure 1) and then push the ”open” button.
3. Unlock the telescope controller [twist the red button clockwise].
4. After the dome is fully opened, on the autoslew panel (see Figure 1), click the ”Telescope” tab and open the cover of the telescope.
5. On the autoslew panel (see Figure 2), click the button on the left of the ”Earth icon” to enable tracking stars.
6. Create the directory ”LOTYYYYMMDD”, and then create a ”flat” directory under LOTYYYYMMDD. May also create a ”PIname” directory (e.g., ”hyliu”) to store the data taken on the target source(s).

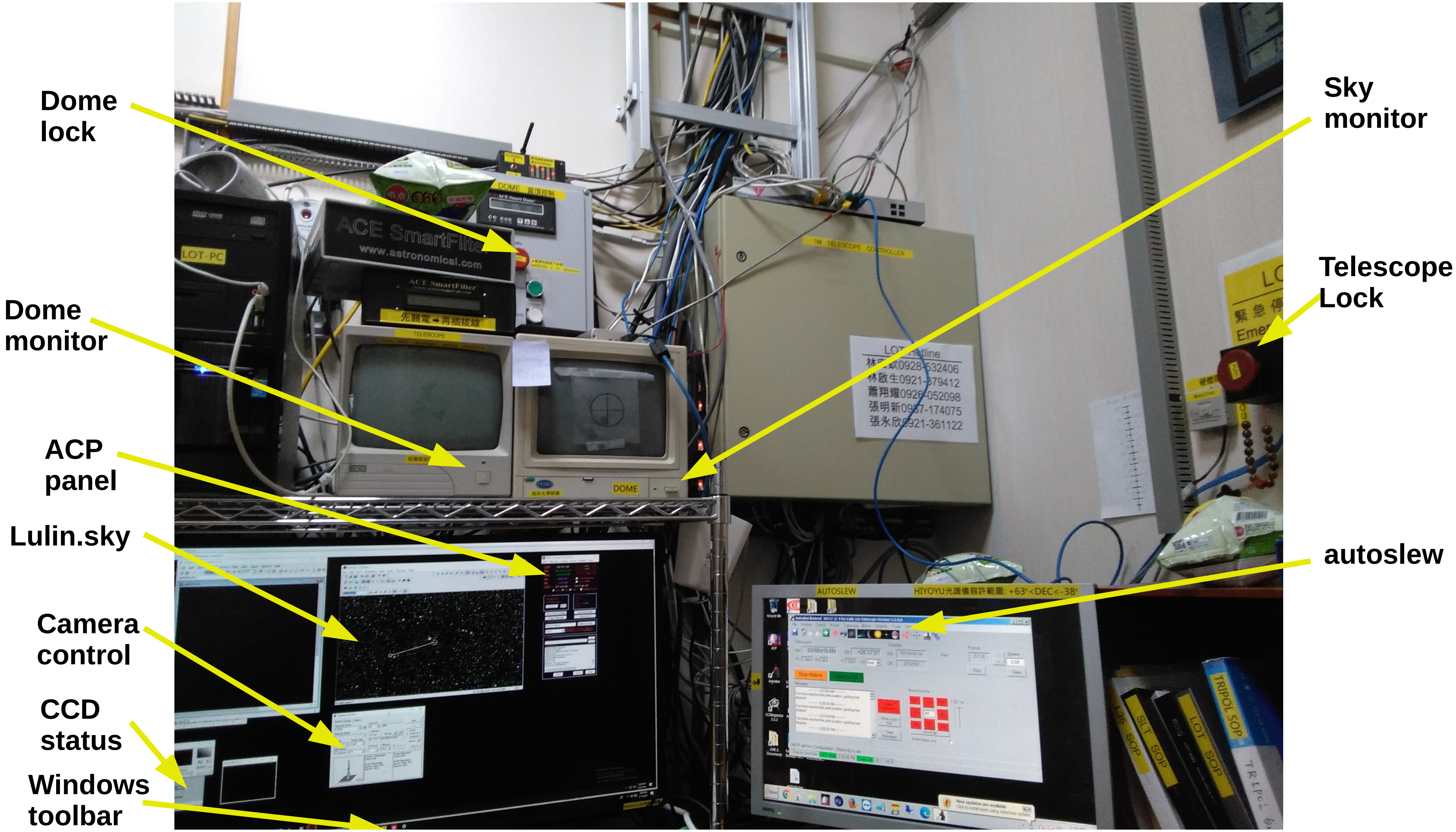


Figure 1: LOT control room configuration.

Flat field [take sky flat as far as the weather allows]

Sky flat during sunset

Starting from the band with low quantum efficiency, and then gradually move to those which are more sensitive (e.g., U− >Hα− >B− >V− >R− >I). During the sunrise, the order opposite to that for the sunset.

1 On the camera control panel, check ”continuous” to start testing the integration time (usually it is set to 5-10 seconds).

2 Once the count fall to the range of 10k–30k (for I band, slightly higher than 30k is acceptable), check ”autosave” and then set to take 5–10 flat field images for each band. Then click ”start”.
When each integration is finished, click the ”W” button on the autoslew panel to offset the telescope pointing a bit, to avoid having some stars always at the same locations in the flat field images.

3 Remember to book-keep (on your own notebook) the integration time used for the flat field images. We need to take the corresponding dark images.

4 Move on to calibrate focus.

Sky flat during sunrise

Starting from the band with high quantum efficiency, and then gradually move to those which are less sensitive (I− >R− >V− >B− >Hα− >U). During the sunset, the order opposite to that for the sunrise. We can start taking the flat field about 1 hour before sunrise (i.e. about 30 min after the twilight).

1 Make preparations

- Move the telescope to a little west from the zenith using the Lulin.sky (i.e. azimuth: ∼70–80 deg, direction: west) because sunlight comes from the east.
- Set telescope-moving to a higher speed in the Move-Controles on the autoslew panel to allow shifting the telescope pointing with sufficient angular offset when the taking sky-flat field (Usual: $\sim 0.01^{\circ}$/s?, Sky flat: $\sim 0.15^{\circ}$/s).
- Prepare Autosave Setup (it is recommended to prepare several slots with different exposure times (e.g. 5, 15, 60 seconds)).

2 On the camera control panel, check “Continuous” to start testing the integration time (e.g. 60 seconds).

3 Once the count becomes more than 1000 ADU, check autosave (use prepared autosave setup) and click start.
When each integration is finished, click the ”W” button on the autoslew panel to offset the telescope pointing a bit, to avoid having some stars always at the same locations in the flat field images.

- It is recommended to start from long exposure time and then decrease the exposure time as the CCD counts increase.
- It is also recommended to take many data even if the CCD counts are low (∼ 1k) or large (∼ 40k), just in case. We can remove the data which has too low or too large CCD counts during post-processing.

Autosave Setup

We can save and load the Autosave Setup in the Camera Control. It is useful for taking flat field, dark, and bias.

1 Click “Autosave” on the Camera Control panel to set parameters (e.g. Autosave Filenames, Type, Filter, Suffix, Exposure time, Binning, Repeat).

- Can not use the same Suffix in the sequence.
- If check “Same Repeat Count for All” in the “option”, the number of repeats becomes the same for all slots.
- if check “Group by slot” in the “option”, move to the next slot after all observations of the previous slot are finished (i.e. finish all repeat).

2 Click “Apply” => “OK” on the Autosave Setup.

3 We can save the sequence using “Save Sequence As...” in the “option” (It is useful for taking the flat field, dark, and bias).
We can load the saved sequence file from “Load Sequences...” in the “option”.

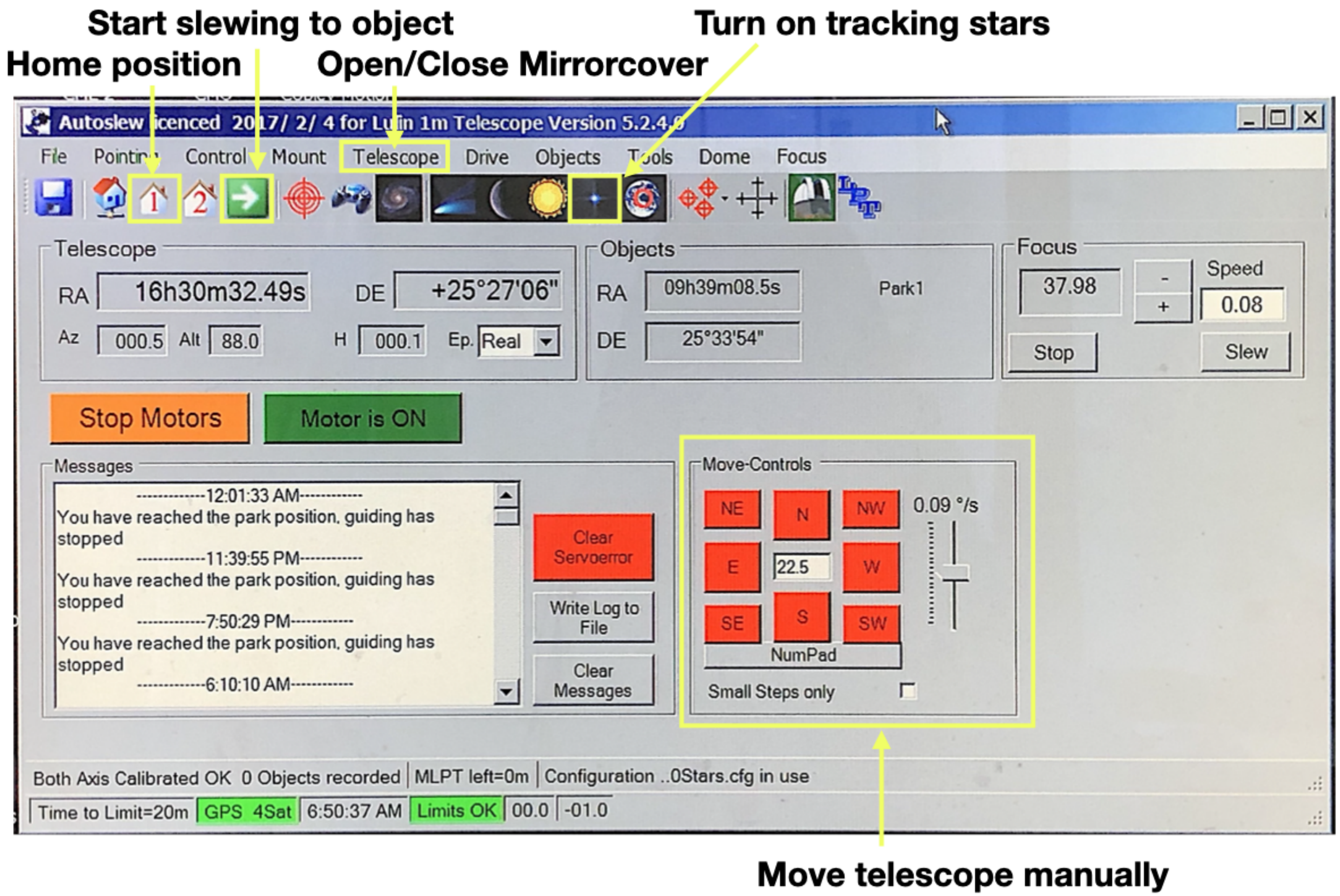


Figure 2: The Autoslew panel.

Dome flat with a illuminated screen

1) Use two small light sources (Source A1, Source A2; see Figure 3)

1 Walk up to the dome and switch on the Source A1 and A2 (Figure 3).

- Source A1: We can adjust the light intensity (The intensity should be minimum (labeling, minimum: E, maximum: F) when the light is turned on and off).
- Source A2: on/off only.
- Shed light on the floor (Do not shed light on the screen for domeflat).

2 Walk back to the control room and slew the telescope to the domeflat position (the position of telescope faced the screen) manually, using Move-Controls on the autoslew panel (check by our eyes in the sky monitor, e.g. Figure 4).

3 On the camera control panel, check “Single” to start testing the integration (exposure) time.

- Typical exposure time is 5 – 60 sec ??
- If we want to keep the error of about 1%, please keep the CCD counts of 10-30k.
- If it is difficult to adjust the time, go to the dome and adjust the light intensity of Source 1.

4 On the control panel, check “autosave”, set to take 5–10 flat field with the adjusted exposure time (do not forget to click “Apply” => “OK” after the setting), and then click “start”.

5 Remember to book-keep the exposure time used for the flat field images. We need to take the corresponding dark images.

6 Move on to calibrate focus.

2) Use one big light source (Source B)

1 Slew the telescope to the domeflat position (Az: 92.7, El: 21.0). First, use Lulin.sky to slew the telescope around the position roughly. Second, use Move-Controls to slew the telescope to the position correctly. Finally, lock the telescope.

2 Walk up to the dome taking with the black remote controller (Figure 5) and prepare the Source B (Figures 3, 6).

2.1 Change the plug (white -> blue) of the socket of the Source B (Figure 6).

2.2 Turn on the compact monitor (plug in the socket-> press the A1 button of the remote controller, Figure 5).

2.3 Hung a rope of the Source B down (Figure 6).

2.4 Turn on the switch (switch 1 and 2) and adjust the height of the Source B using the up-down switch (Figure 7).

∗ When adjusting the height, please check the compact monitor (adjust the height to the white circle be in the center of the compact monitor, Figure 5).

3 Walk back to the control room.

4 On the camera control panel, check “Single” to start testing the integration (exposure) time.

- Use the black remote controller to adjust the light intensity (e.g. Table 1)
- If we want to keep the error of about 1%, please keep the CCD counts of 10–30k.

5 On the control panel, check “autosave”, set to take 5–10 flat field with the adjusted exposure time (do not forget to click “Apply” => “OK” after the setting), and then click “start”.

6 Remember to book-keep the exposure time used for the flat field images. We need to take the corresponding dark images.

7 Move on to calibrate focus.

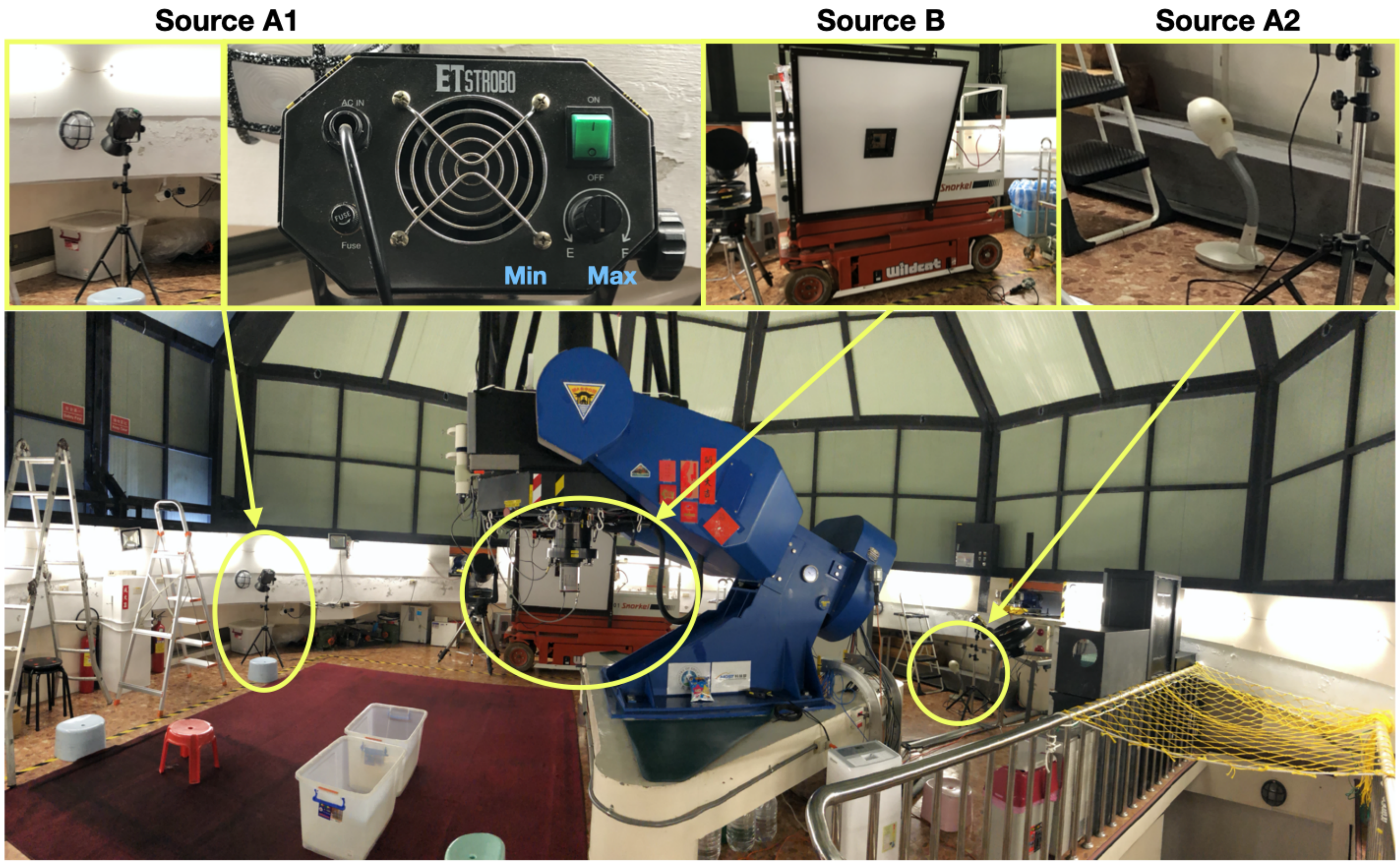


Figure 3: LOT dome configuration.

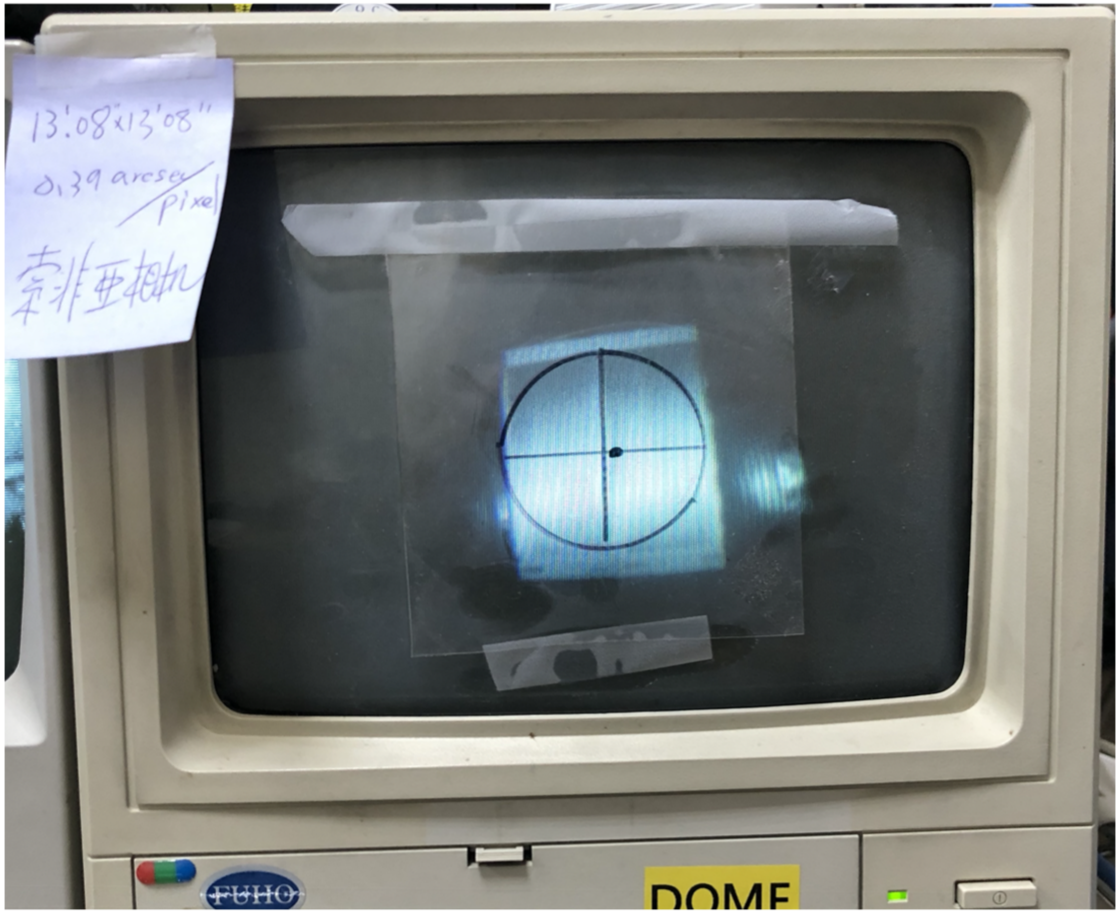


Figure 4: Example of the sky monitor during the observation of the flat (dome) field.

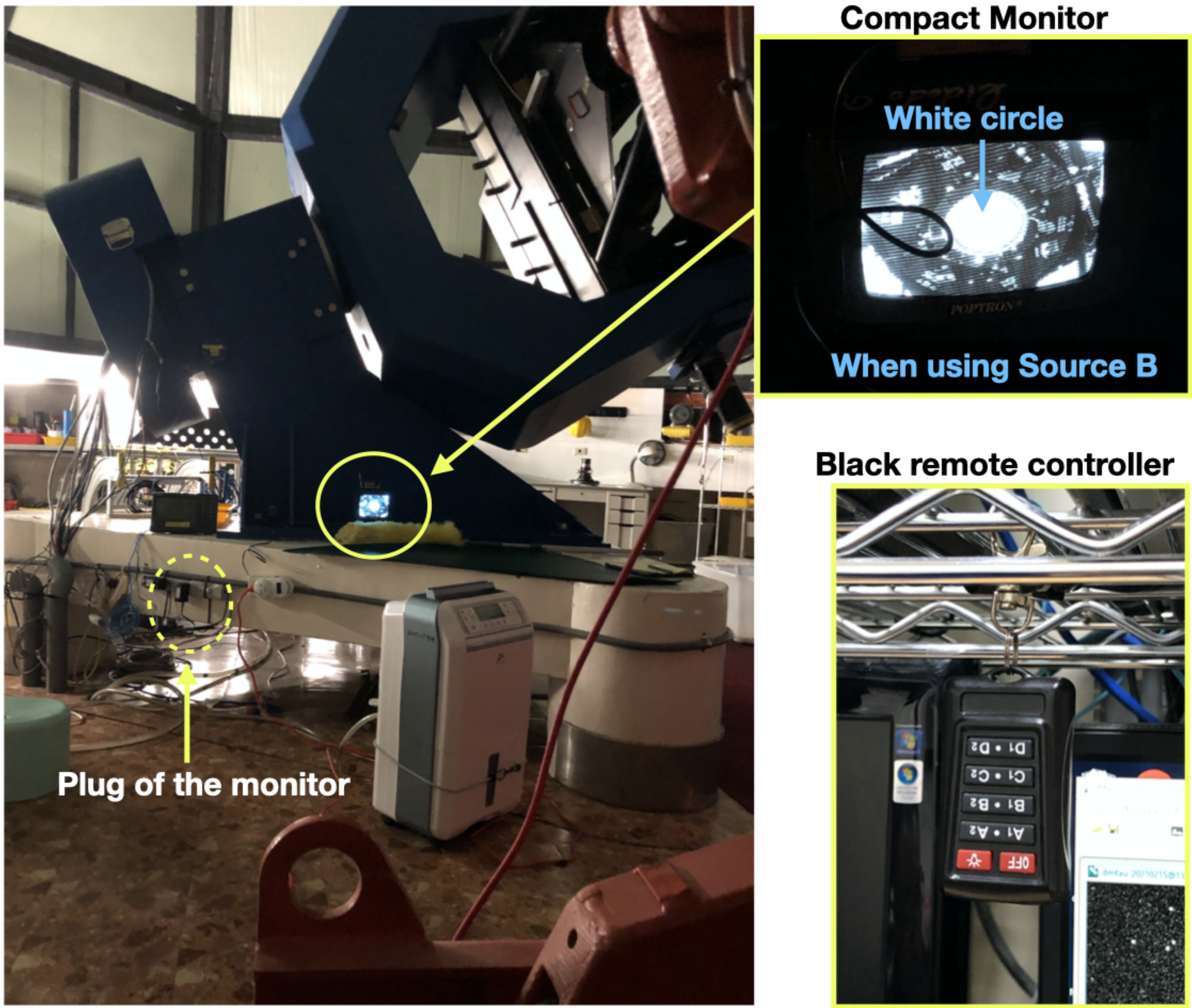


Figure 5: Compact monitor in the dome and black remoto controller

Figure 6: Source B configuration

Table 1: Example of the combination of the button of the remote controller, filter, and exposure time.

Button	Filter	Exposure time	CCD counts
B1	B	10 sec	$\sim$ 12-13 k
	V	5 sec	$\sim$ 25 k
	R	5 sec	$\sim$ 35 k
	gp	5 sec	$\sim$ 21 k
	rp	5 sec	$\sim$ 20 k
B1+C1	zp	90 sec	$\sim$ 14 k
C1	ip	2 sec	$\sim$ 30 k

Figure 7: Controller of the Source B and example of the adjusted height of the Source B.

Observing target source with a script

On the ACP panel, click "RUN" and choose the script for a certain project.

Remember to book-keep the integration time used for all bands for all target sources. We need to take the corresponding dark images.

We can in principle analyze the stars observed with less than 50k counts. But we should keep track of the counts on the major target source, and try to make it around or less than 30k. Otherwise, it may saturates (>50k) once the seeing is improved. We need to abort the script and edit the integration time if the source is saturating.

The system can dynamically solve and calibrate the pointing, which however can cost very significant overhead. Given the large FOV of the Sofia camera, if the science case is only for one single star, it might not be worthy of doing this. To **disable** this function, find the ACP panel and click the "preference" tab. Then click "disable autocenter".

We can manually, roughly calibrate the pointing with the following steps:

1 On the camera control panel, set 1 second integration time with Binning$\times$4.

2 On the Lulin.sky panel, click the location where we are going to correct to, and then click the "green telescope" icon to slew to it. Iterate this a few times until the target source is very close to the center of the field.

3 On the Lulin.sky panel, click again on the target source star. On the "Object information" panel, click "sync".

4 On the autoslew panel, click the "Mount" tab, and then click "set new home position".

We always need to make WCS correction in the post-processing.

Focus Do this before any target source observations

For observing target source with a scrip:

1 Start running the script first, wait for the system to slew the telescope to the target source and finish switching to the first filter.

2 "Abort" the script.

3 On the Lulin.sky panel, look for a star which is in between 9 to 10 magnitudes (cannot use brighter stars to avoid saturation), and then click the "green-telescope" icon to manually slew to it.

4 Click the Windows XP toolbar, find and click the focus-icon, which looks like a coffee cup.

5 In the popped-up panel, click "focus" to allow calibrating focus automatically. Under typical observing condition, we may achieve a FWHM of $1''$–$1.5''$.

For manually observing the target source:

1 On the Lulin.sky panel, click the "orientation" tab, enter the coordinate of the target source and then click "slew" to slew to it.

2 On the camera control panel, pick a filter.

3 Following the steps [3]-[5] for the observations (on target sources) using scripts.

Finishing up (can take flat field before doing this)

1. On the autoslew panel, click the [1] and [=>] icons. *NEVER click the [2] and [home] icons.
2. On the autoslew panel, click the "Telescope" tab and close the telescope cover. Wait for 30 seconds (i.e., until the cover of the telescope is fully closed to avoid dust and water drops from the dome).
3. Push the red buttons to lock the dome and telescope controls.
4. Move on the take "dark" images [Need to go through all the integration times which have been used for the flat and science observations].

An example of target source script (a TXT file with arbitrary filename)

*lines start with ”;” are comment lines, which will be ignored by the interpreter.

This script will loop over the target source ”DM Tau”, a nearby reference position ”ref”, and another reference position ”Terada” which cover some brighter comparison stars (saturate easily). It is switching between the B, V, and I bands. The ”ref” field is observed as often as the ”DM Tau” field using exactly the same integration time, while the ”Terada” field is observed less frequently and with reduced integration time. The line ”#SETS 1000” will make the loop repeated 1000 times.

In the lines specifying the observing fields, the source name, R.A., and Decl. needs to be separated by <tab> instead of <space>. Be careful with this!

```
#DIR D:LOTdata\LOT20210209\hyliu
; interval used (book keep): 120, 60, 30, 20, 15, 10, 5

; times to repeat the loop (set to an arbitrary large number)
#SETS 1000

; Below is one full loop
#COUNT 1
#BINNING 1
#FILTER B_319144
#INTERVAL 120
dmtau   04:33:48.734    18:10:09.974
ref     04:34:12.0985   18:18:49.700

#INTERVAL 20
terada  04:33:19.12     18:10:43.9

#COUNT 1
#BINNING 1
#FILTER V_319142
#INTERVAL 30
dmtau   04:33:48.734    18:10:09.974
ref     04:34:12.0985   18:18:49.700

#INTERVAL 5
terada  04:33:19.12     18:10:43.9

#COUNT 1
#BINNING 1
#FILTER I_10349
#INTERVAL 10
dmtau   04:33:48.734    18:10:09.974
ref     04:34:12.0985   18:18:49.700

#INTERVAL 5
terada  04:33:19.12     18:10:43.9


#COUNT 1
#BINNING 1
#FILTER B_319144
#INTERVAL 120
dmtau   04:33:48.734    18:10:09.974
ref     04:34:12.0985   18:18:49.700

#COUNT 1
#BINNING 1
#FILTER V_319142
#INTERVAL 30
dmtau   04:33:48.734    18:10:09.974
ref     04:34:12.0985   18:18:49.700

#COUNT 1
#BINNING 1
#FILTER I_10349
#INTERVAL 10
dmtau   04:33:48.734    18:10:09.974
ref     04:34:12.0985   18:18:49.700
```

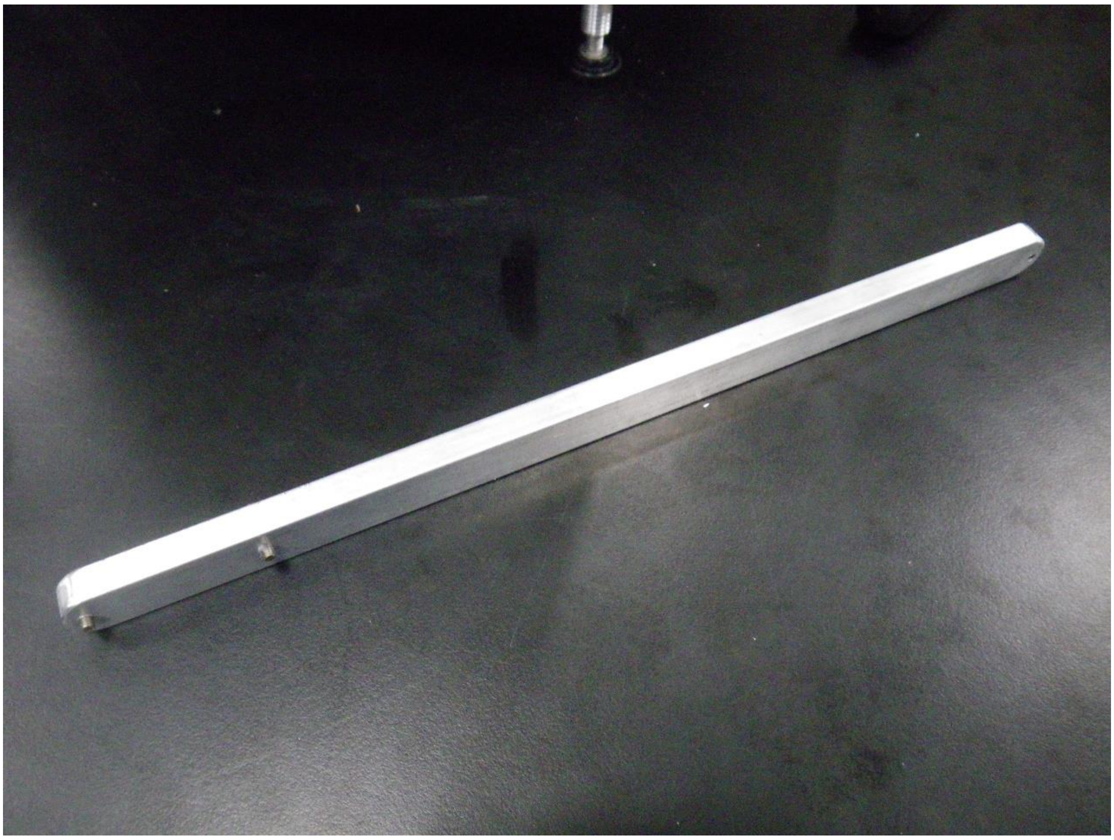
Tripol-II 濾鏡鎖緊維修報告

張永欣 2021/05/06

Tripol-II 第一片旋轉濾鏡，確實鬆動，以棉花棒輕觸，可以感覺到鏡片約有 1mm 的前後移動空間，非常鬆，目前已經已用特製板手鎖緊。

特殊扳手：

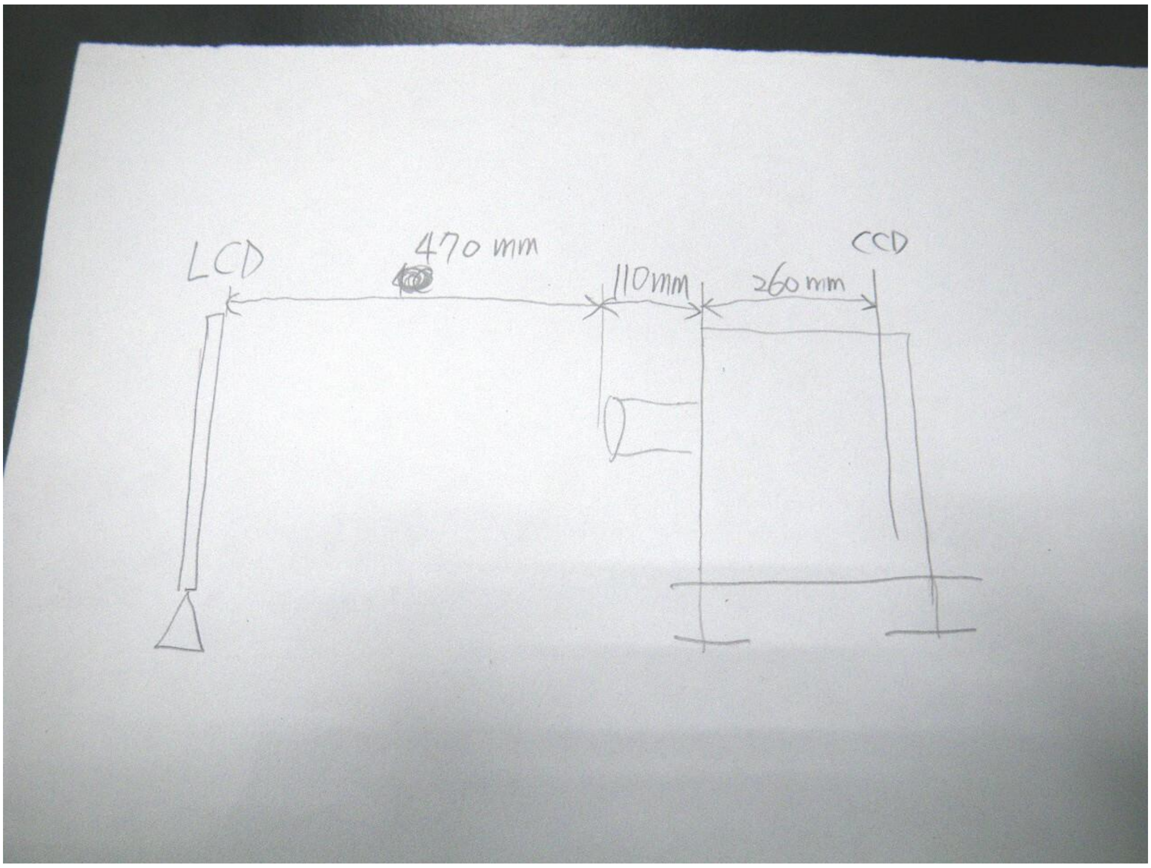
一開始以 L 型內六角扳手施作，但是非常不好施力，也不知道是否有鎖到足夠緊度，所以必須製作特製扳手，在狹小空間嵌入直徑 3mm 相距 40mm 的兩個洞，扳手如圖一。



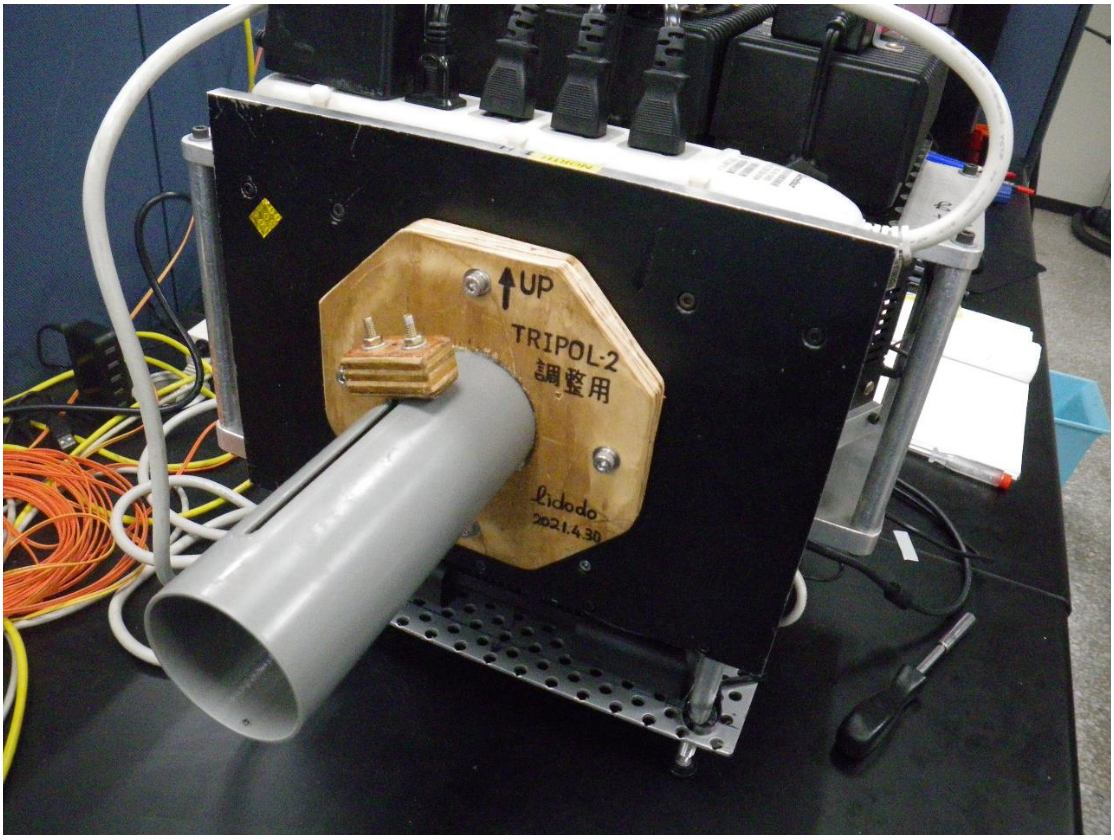
圖一：Tripol-II 專用特殊扳手

微距鏡頭：

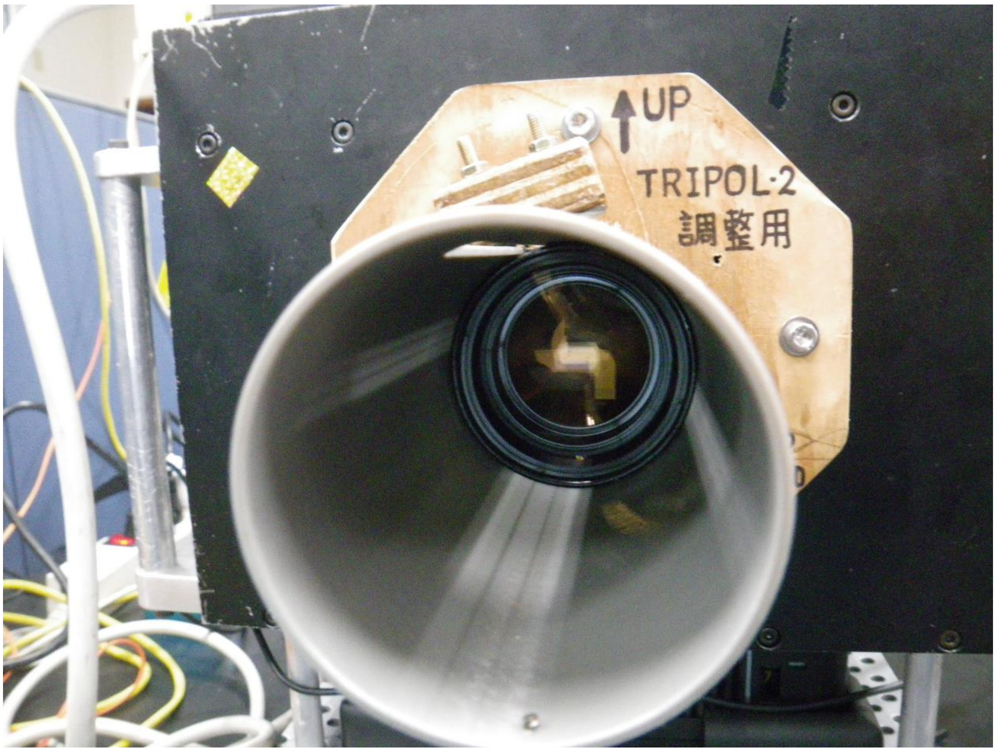
在實驗桌上以近距離拍攝 LCD 成像十字作為調整三台 CCD 的對準，必須製作一個 Tripol 專用微距鏡，根據先前的實驗的光學圖（如圖二），設計一個可以鎖在 Tripol-II 光學接面的鏡頭，然後可以調焦，完成如圖三，就可以很方便的在實驗室做光學調整了。



圖二：近距離成像焦距



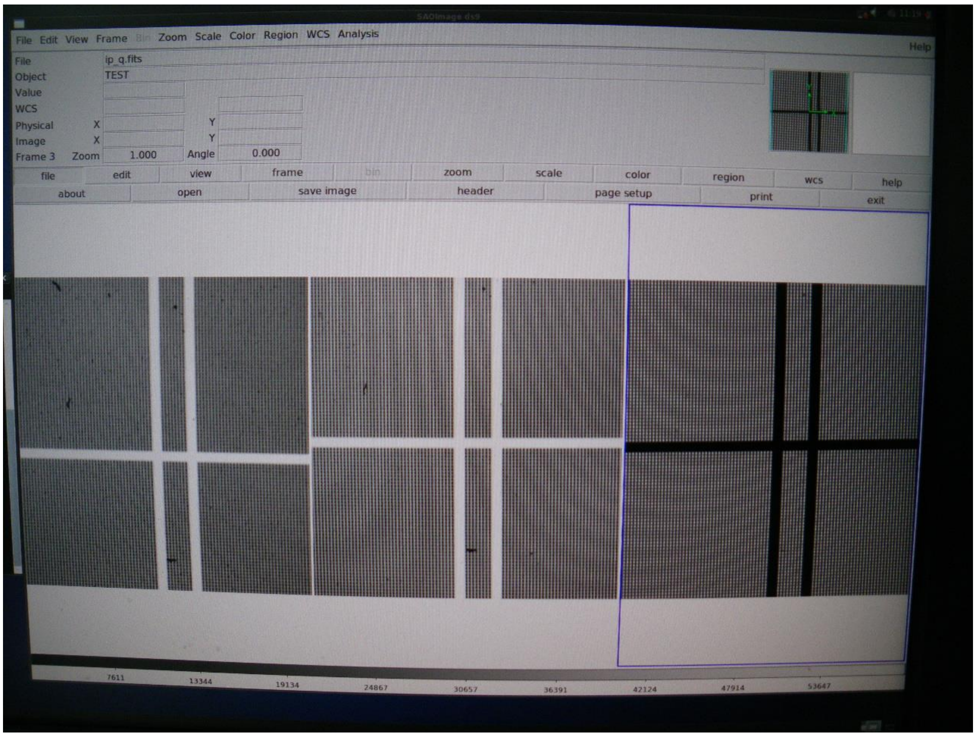
圖三：安裝在 Tripol-II 上的樣子



圖四：焦距 240mm 的影印機鏡頭

濾鏡鎖緊之後的測試：

最先進行調焦，相對於山上使用的焦點位置，R、I 相機有再稍微移動；然後嘗試以 G-相機影像為準調整 R、I 相機，R 相機必須墊高 2mm，但是空間受到限制，勉強上升後，會致使相機傾斜，反而更糟糕，所以嘗試後又鎖回原位，不再更動，完成的影像如圖五。



圖五：測試成像位置

濾鏡相位的調整：

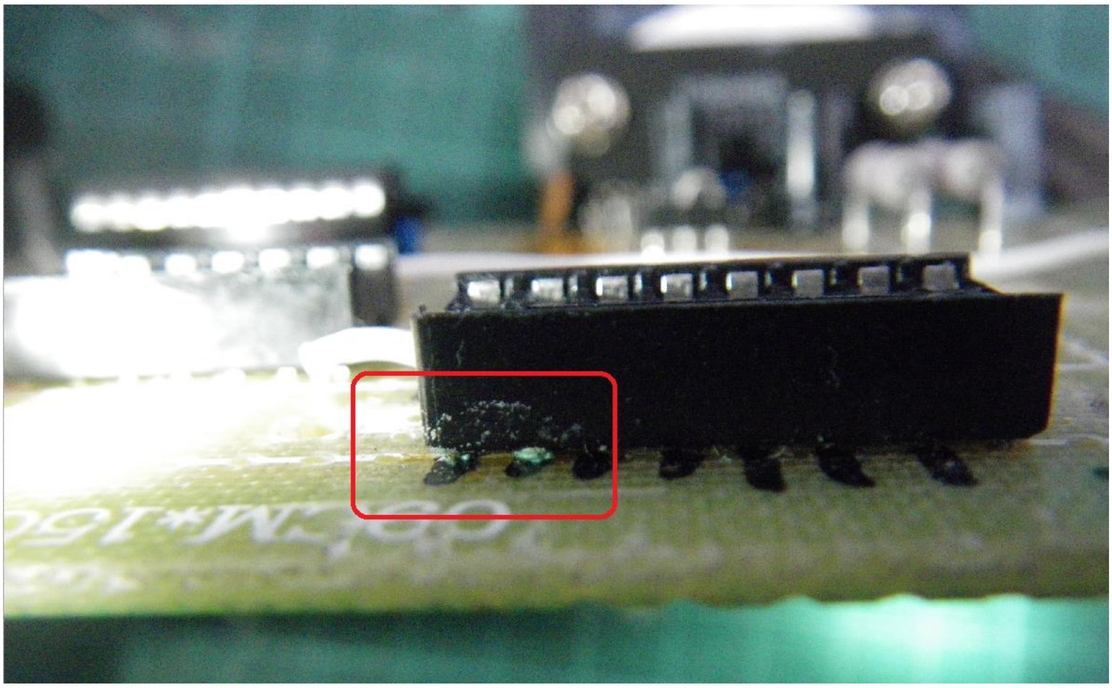
鎖緊濾鏡之後，測試旋轉濾鏡調整的方式，發現濾鏡是在一套筒內，用前後各一片螺旋壓板夾住固定，然後套筒再鎖在旋轉機構上，旋鬆套筒時反而濾鏡壓板會先被旋出，這樣不容易確認濾鏡相位的角度，所以決定不調整，恢復鎖緊之後再測試影片，如 Email 附件 IMGP0062.AVI。

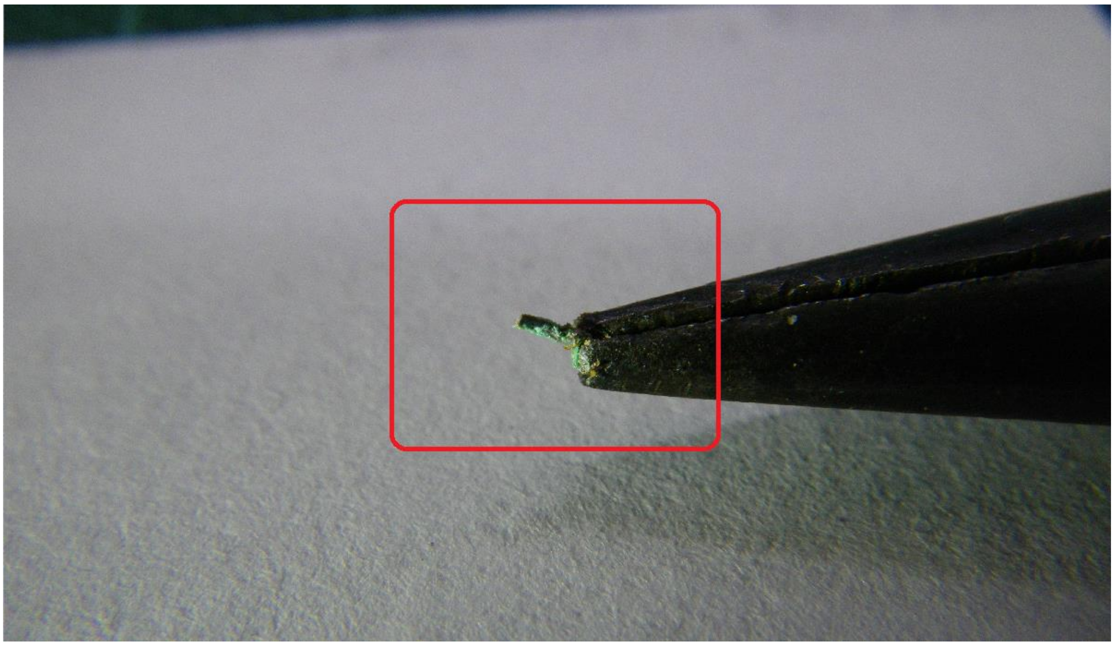
Tripol-II 濾鏡無法定位維修報告

張永欣

2021/05/11

Tripol-II 旋轉濾鏡盤無法歸零定位，經多項檢查，發現外接訊號連接座針腳，因電解腐蝕斷腳，接觸不良，造成訊號時有時無。





經更換腳座之後，狀況解決。

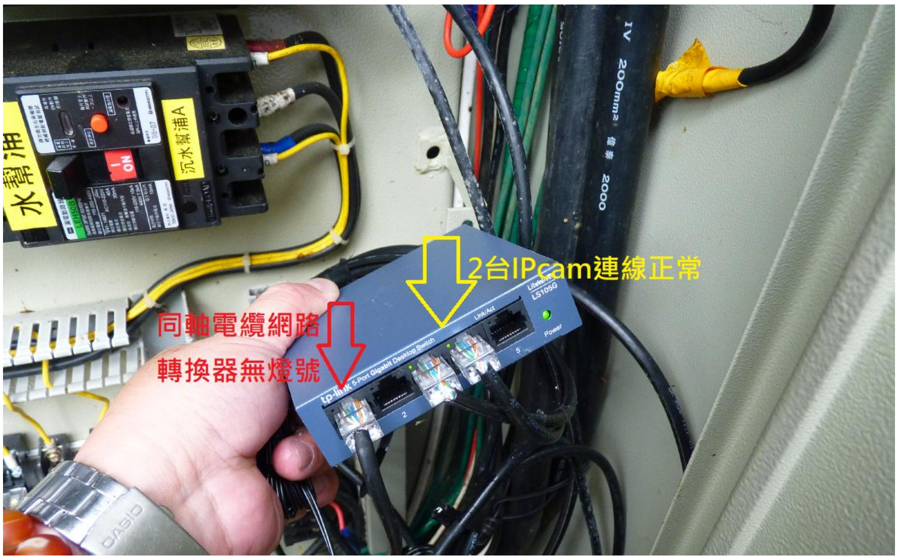
2021/06/15-18 鹿林天文台雷擊勘災報告

張永欣

雷擊發生時間 2021/06/12　16:43

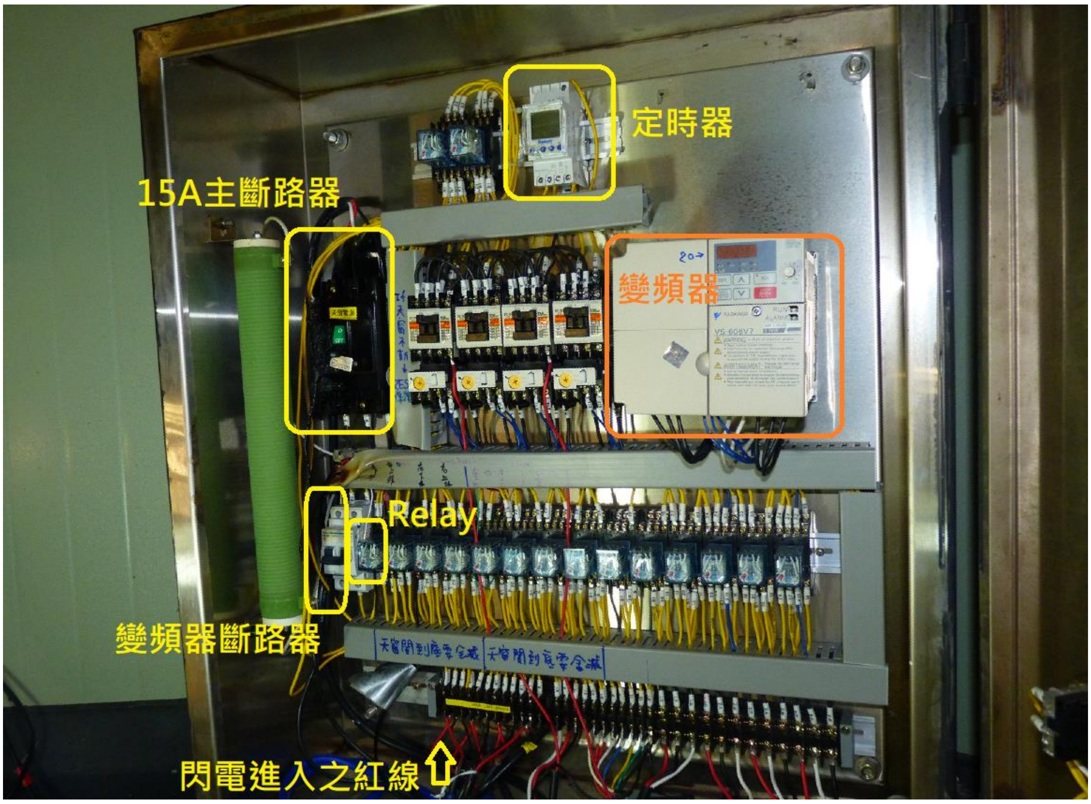
6/15

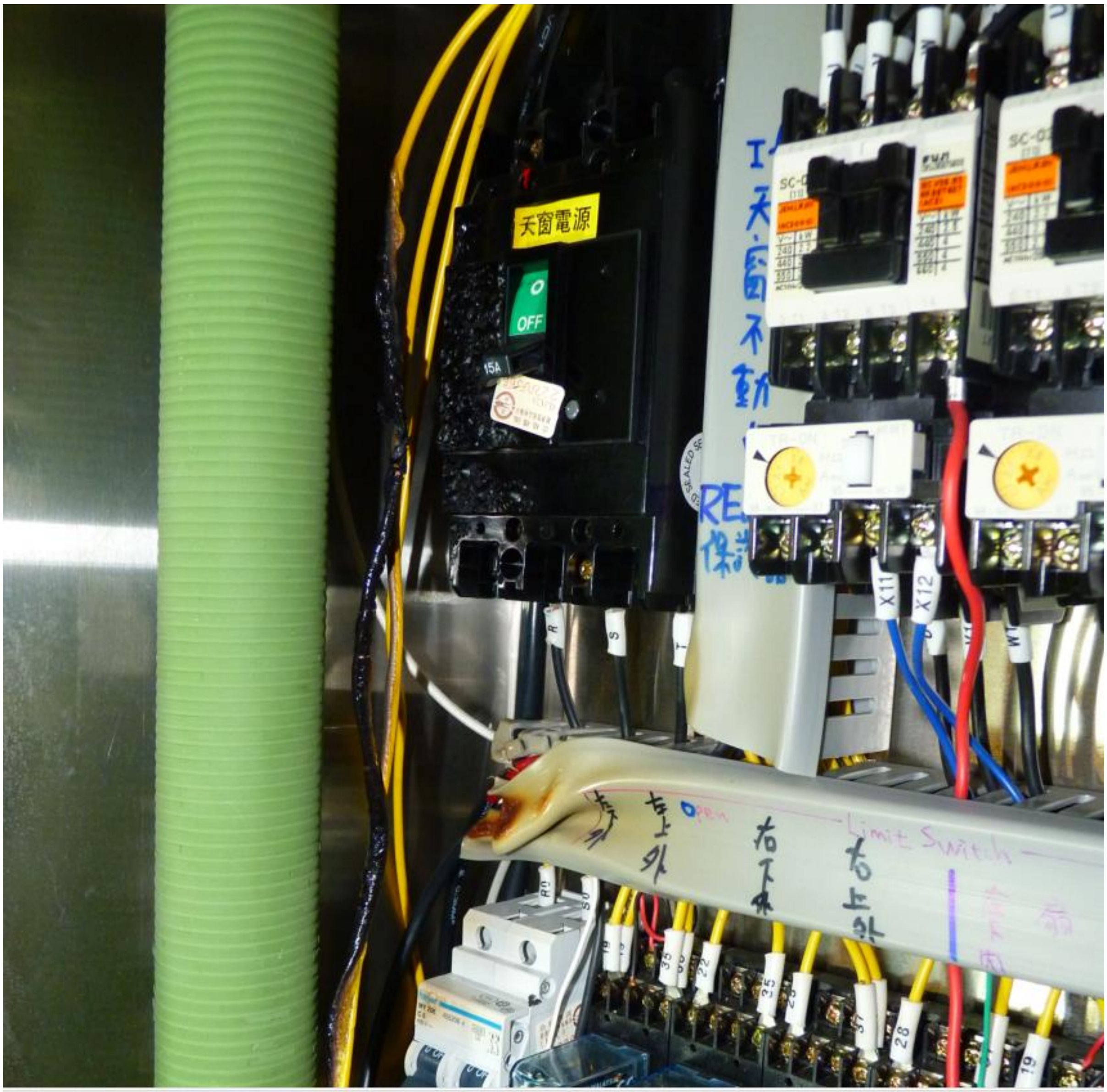
抵達山下停車場，首先檢查山下的 IPcma 與網路，測試結果 2 台 IPcam 的網頁都連得上，IPcam 是正常的；RJ45 轉同軸電纜網路傳輸器，連結燈號沒有閃，所以山下到山上之間的網路不通，斷電重置也一樣。



到達山上後，首先可看到雷電打到置於 LOT 圓頂上的氣象儀，風速計、風向計爆開飛走了，然後電流侵入到圓頂門軌道（左下外）的極限開關，開關供電為 AC-220V 的 R 相，然後高壓電沿著電纜之 R 相紅色線一路進入控制開關箱。

紅黑電纜之 R 相紅線進入開關箱接點後轉為標示 R1 之黃色線，控制電路由左下方白色電源斷路器之 R0、S0 配對電源供給 AC-220V，所以主要破壞是 R 相、S 相之間的放電，首先燒毀 Relay-1（最左側第 1 顆），接著箱體中間最上方控制斷電的白色定時器，然後定時器接出 S1 黃色線經過本開關箱黑色 15A 主斷路器前方時，與主斷路器及下方的控制電路白色斷路器 R 相間放電，造成 S1 黃色線與路徑上之明顯火燒痕跡。





SLT 圓頂一開始症狀為可以開門不能關門，旋轉也正常，但是開門的功能時有時無，強制按下開門、關門的電磁閥，動作都正常，所以研判是 Relay 做動不良，再量測供電給 Relay 的直流電源供應器，電壓僅有 4.8V，與標示規格 12V 不一樣，所以確定是 12V 電源供應器損壞，更換上新的 12V 電源供應器之後，圓頂正常運作。

6/16

上午圓頂的機電廠商抵達天文台，一同檢查 LOT 圓頂電路並測試，供電且圓頂緊急停止開關解除後，圓頂在無任何指令狀況下立即開始旋轉，所以圓頂旋轉馬達變頻器是正常的，但是無法停止旋轉，只能切斷電源停止，後查出是控制室內 ACE SmartDome 控制器損壞，內部短路錯誤訊號所致，斷開 SmartDome 控制器與圓頂 PLC 控制器間接線後恢復正常。

中午我們更換 LOT 圓頂上的 2 顆斷路器，拆掉定時器，供電給開關門變頻器，變頻器顯示狀態 F00，而非設定的狀態 F30，按下開、關門鈕，均無動作反應，研判變頻器損壞。

下午進行 LOT、SLT 的錄影監視系統檢查：

LOT 主機損毀 5 個 Port + 3 台攝影機。

SLT 主機損毀 6 個 Port + 6 台攝影機（含舊型 1 台）

6/17

拆下數台損壞之攝影機，檢查內部機板狀況，換上 2 台全新的備用攝影機，更改 DVR 內部設定，將損壞的 Port 移出，改為 IPcam 的輸入，未損壞的攝影機改到正常的 Port 繼續錄影監視。

檢查 LWT 側的 DVR 以及連往山下的網路轉換器：網路轉換器燈號不正常，斷電重置也一樣，可能網路轉換器組毀損；LWT 主機損毀 2 個 Port + 2 台攝影機

6/18

為補強另一備用監視器的檔案儲存，於 TAOS#B 內增設一台 320GB 的網路硬碟（NAS），將過去 3 個月錄影備份至 NAS。

新監視系統損壞統計：

13 個實體 Port。

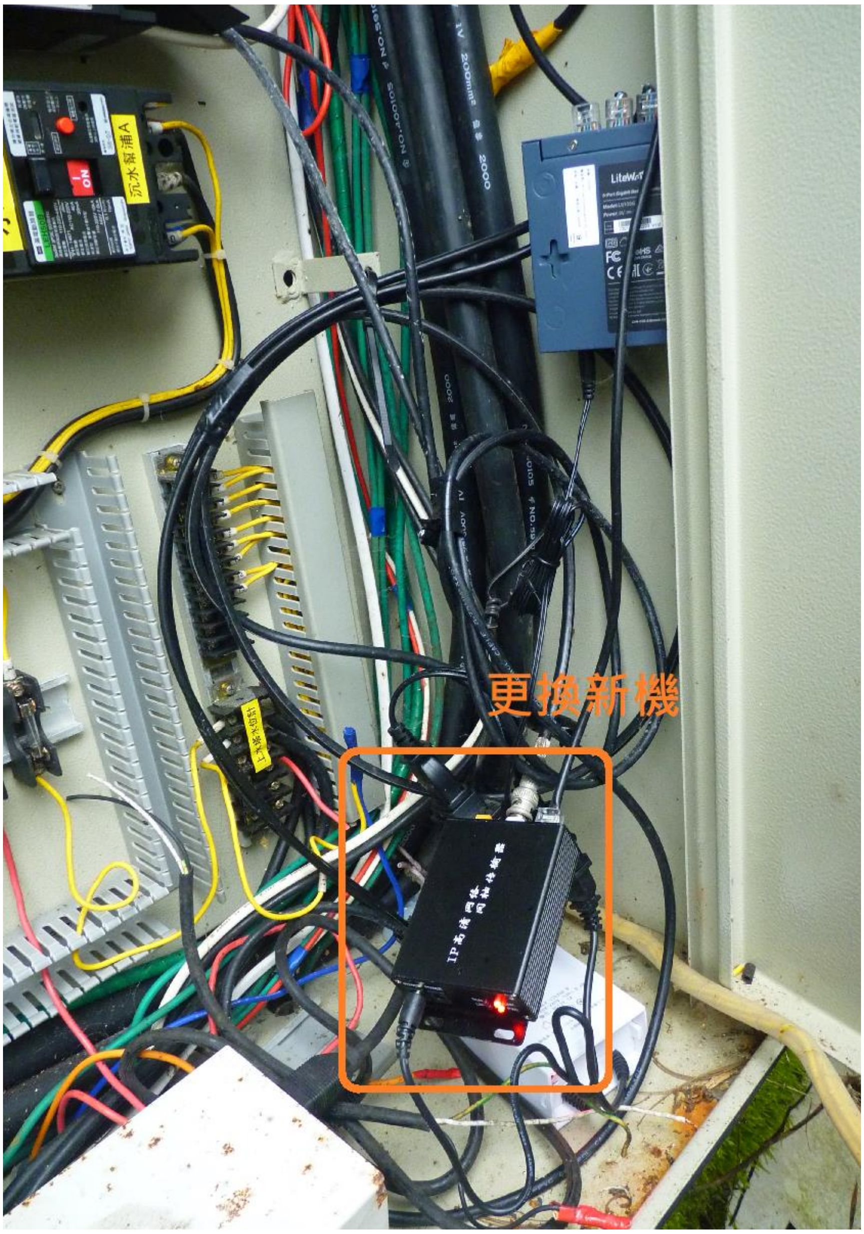
11 台攝影機。

1 組同軸電纜網路傳輸器。

5 組 12V 電源供應器。

2021/09/06 監視系統損壞維修

首先恢復山上與山下同軸電纜網路，更新一組轉換器。



考量受損攝影機數量較多，新攝影機單價較高，所以採用更換攝影機主機板以及無受損的BNC 接口維修，暫時恢復外部區域 90%的攝影機，另外新增一台 16 埠無硬碟主機，作為監看器擴增使用及備用機。

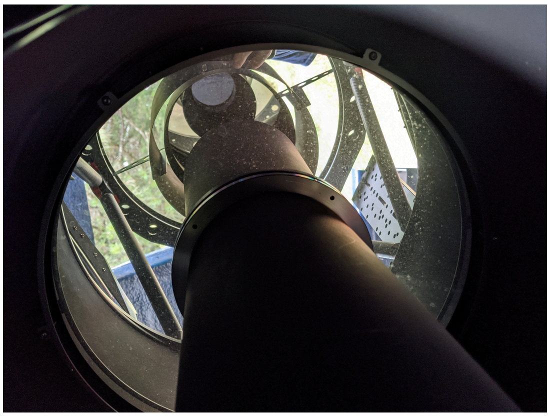
LWT 淋雨事件與處置

林宏欽、蕭翔耀、侯偉傑

2021 年 8 月初連日大雨，同仁日常巡邏時發現 LWT 圓頂內積水，望遠鏡有淋水。調閱監視設備後發現是圓頂於 7 日上午 4 點因不明原因自動開啟，約 30 分鐘後關閉。當時雨量不小，造成 OSRC16 望遠鏡主次鏡淋雨、修正鏡鏡片組、赤道儀進水，望遠鏡上 USB Hub 與電腦鍵盤等周邊設備淋水故障。

處置

周邊設備更換後電腦可正常運作。赤道儀蓋板打開後將水清除，並更換控制面板後可與電腦連線且運作正常。將鏡片上的水用吹風機吹後發現鏡面有髒汙 (Fig. 1(a))，無法使用高壓空氣吹除，最後決定清洗鏡片。將 CCD 與濾鏡盤拆下檢查，並沒有積水或是水痕，且運作正常。但望遠鏡上的修正鏡組積水，且是積在鏡片間 (Fig. 1(b))，無法直接排除，最後拆回控制中心做進一步處理。



(a) 鏡面髒汙

(b) 修正鏡進水

Fig. 1

鏡面清洗

步驟與 2021 年初清洗 LOT 主鏡步驟相似。

1. 相將主鏡中間管子包住，將鏡筒指向低於水平面，讓之後噴上的水可以流出望遠鏡，在主鏡下方舖上抹布接水 (Fig. 2)。
2. 將噴濕的紙巾蓋上主鏡後掀起，先沾起部分灰塵，重複數次。
3. 噴上中性清潔劑後將紙巾蓋上鏡面拖行，清除水漬與帶走大部分灰塵，注意不可向鏡面施力。
4. 用清水再施作一次，以清除殘留清潔劑。高純度酒精去除鏡面殘水。酒精不可噴到次鏡中心標記，此為調整光軸用的標記，碰到酒精會溶掉。

Fig. 2

修正鏡進水排除

鏡組進水後無法正常排出，且透鏡亦需要清潔，必須將鏡組拆除一一清理。

1. 鏡組拆除需要使用特殊工具對準 Fig. 1(b) 中黑色內環上的兩個洞，然後旋開。為了鎖回時緊度與拆開前相同，必須先將內外環做記號，鬆開後鏡片邊緣與外環也做上記號。

2. 透鏡共有三片，第一、二片移除後將水倒出，鏡面用吹風機吹乾，然後用拭鏡筆、酒精棉片擦除髒汙。清理透鏡不要使用酒精等溶劑，透鏡邊邊為避免內反射的黑色塗料 (Fig. 3)，若使用溶劑可能會將塗料洗掉。

3. 鏡面清潔後對著拆除時做的記號裝回，然後鎖緊。

4. 這次將鏡片鎖回時因為環境濕度高，導致鎖回的鏡片組內部又結露。因拆除不易，試著不拆除使用鎢絲燈加熱去除 (Fig. 4)，最後成功去除結露，且再次降溫也沒有再結露。

未來預防方案

這次事件後查明應為天文台附近打雷，造成圓頂控制系統接收到假訊號而打開。為避免再次發生類似事件訂定以下方案：

1. 將圓頂控制系統電源接至網路電源控制器，在觀測結束後將電源關閉，觀測前再打開。如此一來因為沒有供電，若再次打雷產生假訊號圓頂也不會打開。

2. 每日巡邏各望遠鏡兩次，駐站助理與觀測助理分別於上午與下午巡一次。若有未來發現如積水、望遠鏡姿態不良、望遠鏡結露等異狀才能及時處理。

Fig. 3

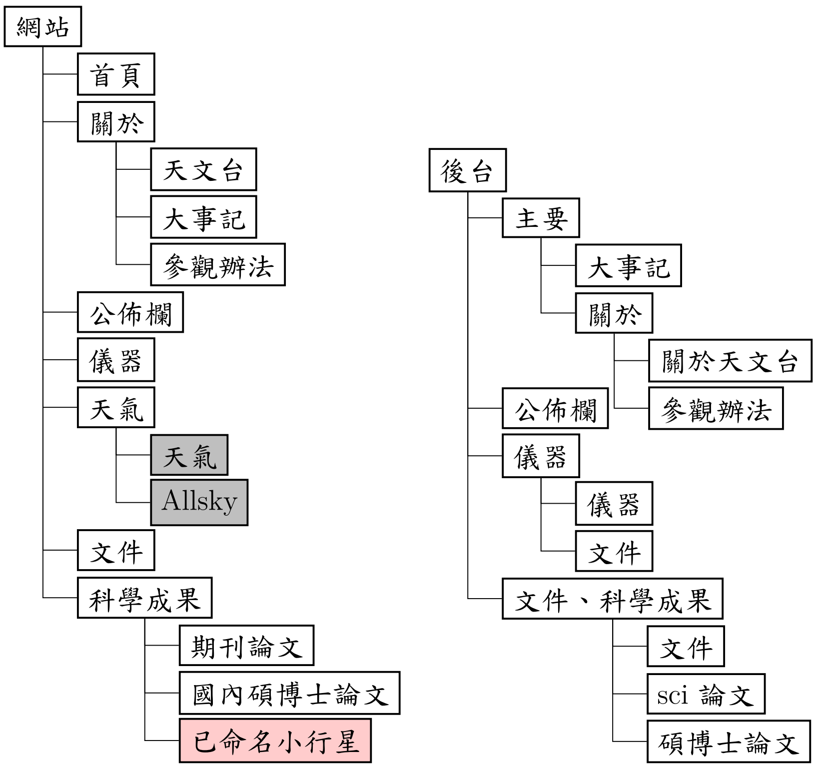
Fig. 4

鹿林網站更新

侯偉傑

鹿林舊網站原架設於天文台伺服器中，但因山區網路不穩定，不適合供山下使用者長期瀏覽，後來將網站移至中央大學天文所伺服器。但網站移植後許多功能變得無法編輯，只剩首頁新聞處可以更新，製作舊網站的助理已經離職，無法修復。而最常使用的天氣頁面雖然可用，但容易因電腦系統更新、停電造成資料不連續等等因素影響，而此頁面的背景是由 python2 編寫，與現今主流 python3 語法有異，不易維護。因上述種種原因決定製作新的網站。

新網站由 python3 與 django 製成，網站結構如圖 1(a) ，天氣與 Allsky 頁面由伺服器自動更新，已命名小行星為維基百科連結 (亦為鹿林助理編輯管理)。其餘頁面須於後台 (圖 1(b)) 管理，其中儀器與期刊論文管理較須說明。



(a) 網頁導覽結構圖　　(b) 網頁後台結構圖

Fig. 1.

儀器

儀器中有”儀器”與”檔案”兩個管理介面。

- 儀器可以使用樹狀結構來分層 (圖 2)，例如：LOT → LISA → CCD。

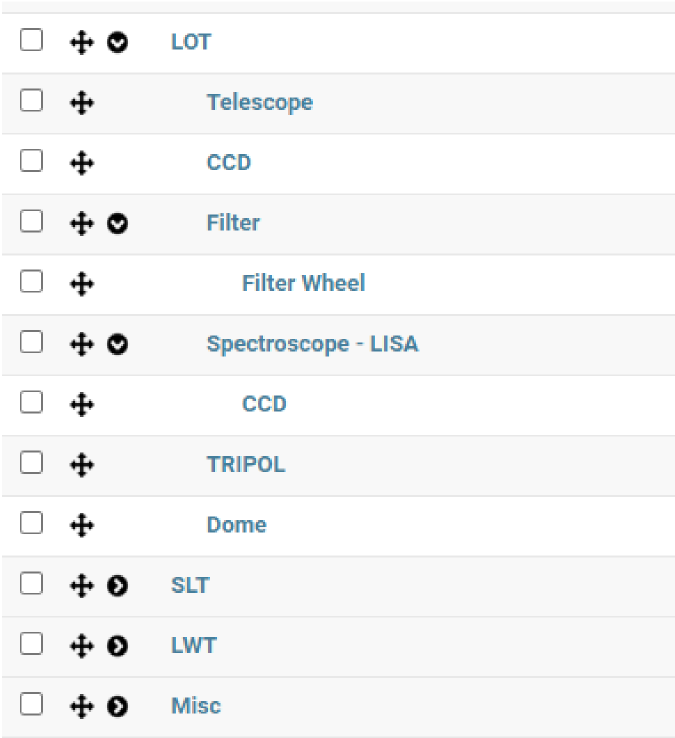


Fig. 2. 鹿林網頁儀器管理結構

- 選單中的項目左側都有拖曳圖示，新增項目後可以選擇項目的所屬儀器或順序，此順序與網頁顯示順序相同。
- 此樹狀結構的第一層會放置在導覽列中的儀器下拉選單中，其餘則是顯示在各個第一層儀器的頁面。

設定好儀器之後，再到檔案頁面新增檔案，並選擇所屬儀器即可。檔案的順序會依上傳時間排列，無法更換。

期刊論文

期刊論文 (圖 3) 的作者與發表期刊等有特定格式，獲取正確格式並上傳的操作步驟如下：

1. 先至 ADS 搜尋論文名稱並選擇論文。
2. 進入論文的摘要介面後點選左側的 ‘Export Citation’。
3. Select Export Format 選擇 Custom Format，Enter Custom Format 輸入 %T\n%3.3l, %Q (%Y)\n%u，點擊 Apply。
4. 輸出的第一、二、三行分別對應到鹿林網頁新增論文的 Title, Author publish, Ads 網址。
5. 選擇出版年份後儲存即可。

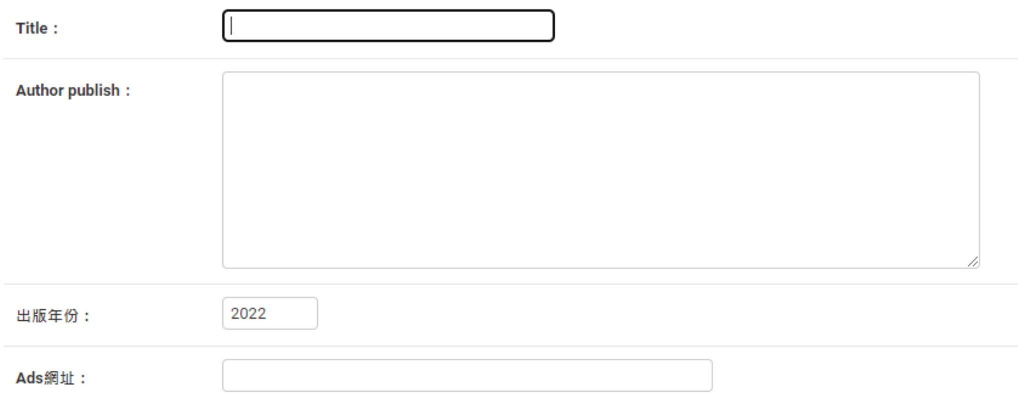


Fig. 3. 鹿林網頁期刊論文上傳欄位

科學成果

Scientific Papers

標題、作者、期刊名稱、卷期、起 (迄) 頁數、(月份/年)
Title, authors, journal, volume, first page, (year/month)

Earth and Planetary

1. Time-series and Phase-curve Photometry of the Episodically Active Asteroid (6478) Gault in a Quiescent State Using APO, GROWTH, P200, and ZTF, Purdum J., Lin Z.-Y., Bolin B., et al., AAS Division of Planetary Science meeting #53, id. 309.02. Bulletin of the American Astronomical Society, Vol. 53, No. 7 e-id 2021n7i309p02 (10/2021)

2. Polarimetric observations of asteroids of different taxonomic classes from Lulin Observatory in Taiwan, Pan K.-S., Ip W.-H., Planetary and Space Science, Volume 212, article id. 105412. (03/2022)

Solar and Stellar Astrophysics

3. A Carbon/Oxygen-dominated Atmosphere Days after Explosion for the "Super-Chandrasekhar" Type Ia SN 2020esm, Dimitriadis G., Foley R. J., Arendse N., et al., The Astrophysical Journal, Volume 927, Issue 1, id.78, 16 pp. (03/2022)

4. AT 2019qyl in NGC 300: Internal Collisions in the Early Outflow from a Very Fast Nova in a Symbiotic Binary, Jencson J. E., Andrews J. E., Bond H. E., et al., The Astrophysical Journal, Volume 920, Issue 2, id.127, 23 pp. (10/2021)

5. HO Puppis: Not a Be Star, but a Newly Confirmed IW And-type Star, Lee C.-D., Ou J.-Y., Yu P.-C., et al., The Astrophysical Journal, Volume 911, Issue 1, id.51, 18 pp. (04/2021)

6. Millimeter-sized Dust Grains Surviving the Water-sublimating Temperature in the Inner 10 au of the FU Ori Disk, Liu H. B., Tsai A.-L., Chen W. P., et al., The Astrophysical Journal, Volume 923, Issue 2, id.270, 20 pp. (12/2021)

High Energy Astrophysical Phenomena

7. Fast-transient Searches in Real Time with ZTFReST: Identification of Three Optically Discovered Gamma-Ray Burst Afterglows and New Constraints on the Kilonova Rate, Andreoni I., Coughlin M. W., Kool E. C., et al., The Astrophysical Journal, Volume 918, Issue 2, id.63, 16 pp. (09/2021)

8. Final Moments. I. Precursor Emission, Envelope Inflation, and Enhanced Mass Loss Preceding the Luminous Type II Supernova 2020tlf, Jacobson-Galán W. V., Dessart L., Jones D. O., et al., The Astrophysical Journal, Volume 924, Issue 1, id.15, 25 pp. (01/2022)

9. Investigation of the correlation patterns and the Compton dominance variability of Mrk 421 in 2017, MAGIC Collaboration, Acciari V. A., Ansoldi S., et al., Astronomy & Astrophysics, Volume 655, id.A89, 36 pp. (11/2021)

10. Revealing a New Black Widow Binary 4FGL J0336.0+7502, Li K.-L., Jane Yap Y. X., Hui C. Y., et al., The Astrophysical Journal, Volume 911, Issue 2, id.92, 7 pp. (04/2021)

11. The dual nature of blazar fast variability: Space and ground observations of S5 0716+714, Raiteri C. M., Villata M., Carosati D., et al., Monthly Notices of the Royal Astronomical Society, Volume 501, Issue 1, pp.1100-1115 (02/2021)

12. The complex variability of blazars: time-scales and periodicity analysis in S4 0954+65, Raiteri C. M., Villata M., Larionov V. M., et al., Monthly Notices of the Royal Astronomical Society, Volume 504, Issue 4, pp.5629-5646 (07/2021)

Progress Reports

1. Joint X-ray, Optical, and Radio Monitoring towards a Pre-main Sequence Star

Joint X-ray, Optical, and Radio Monitoring towards a Pre-main Sequence Star

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Abstract In 2019, we performed 3 epochs of Karl G. Jansky Very Large Array (JVLA) radio observations towards the transition disk DM Tau at the best possible angular resolutions. We found that the spatial distributions of the ionized gas appeared different from night to night. Compared with the optical *VRI* bands monitoring observations, our tentative hypothesis is that the ionizing photons may be emanated from the large cold spots around the magnetic north and south poles of the host Class II/III protostar, which may be beamed. Due to the spinning of the host protostar, the beams of ionizing photons are scanning through the disk like a lighthouse. We had been awarded the dedicated, joint JVLA and XMM-Newton observations for 8 consecutive dates in 2021 to monitor the spatial distribution of ionized gas and the high energy activities of the spots over one full period of the stellar spin. To maximize the science return of this joint JVLA and XMM-Newton campaign which were scheduled for February 08–15, 2021[1], we conducted the complementary optical monitoring observations from a few ground-based observatories including the LOT 1-m telescope. Our aim was to improve our understanding of disk mass dispersal and photo-chemistry.

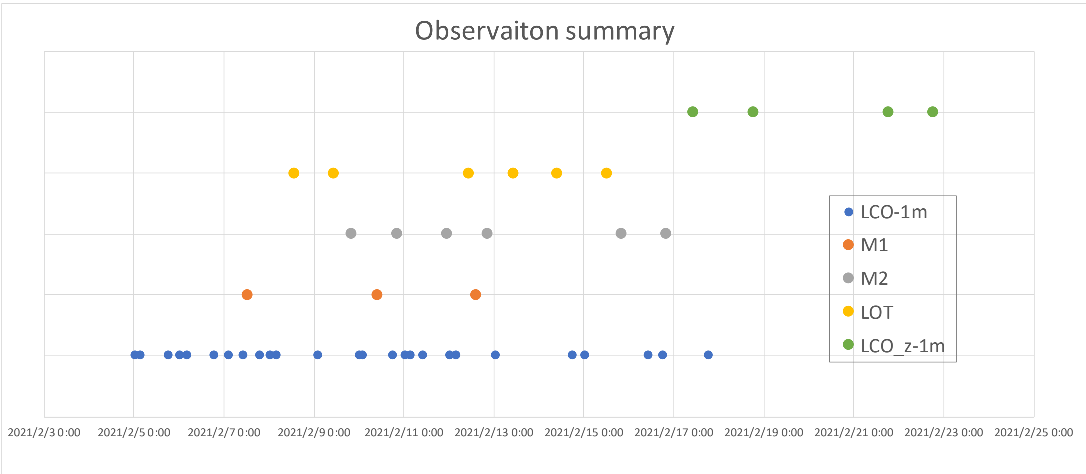

Figure 1: A summary of the OIR monitoring observations during the joint JVLA and XMM-Newton radio+X-ray campaign.

1 The JVLA+XMM-Newton+OIR Campaign

We coordinated several ground-based optical telescopes including the LOT to minimize the sampling gaps in the time domain that can be caused by the LST coverages of individual of these telescopes and by weather/technical downtime. The LOT observations were operated

[1]This occurred to be overlapping with the Chinese New Year Holidays. We deeply thank Prof. 木下大輔, Mr. 林啓生, and other Lulin staff who assisted our operation during this time period.

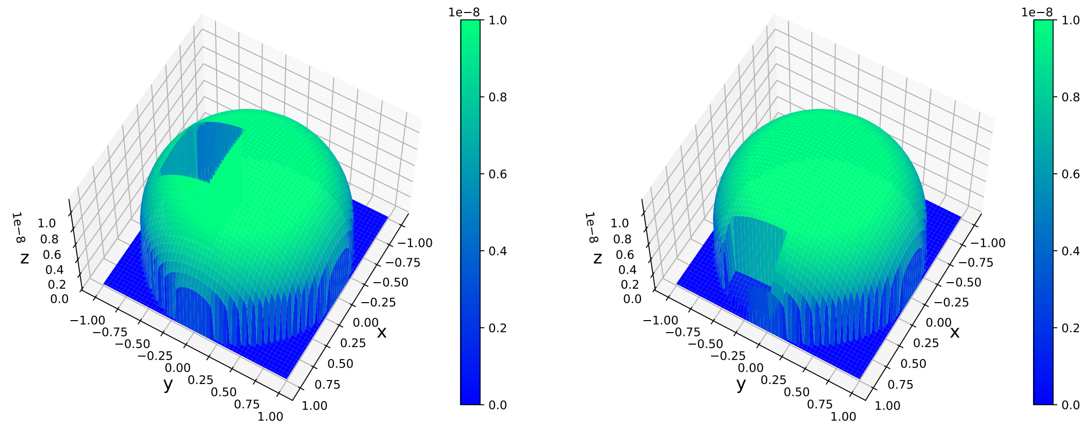

Figure 2: A visualization (preliminary) of the model for the DM Tau host protostar which is populated with cold spot(s).

by HBL and NI; YT was in charge of all the other optical observatories in this campaign. Those other optical observations included (1) the Las Cumbres Observatory (LCO) One-meter Telescopes that are located at four different sites in the world (URL) which took photometric *gp*, *rp*, *ip*, and *zs* bands observations, (2) the OAO/MuSCAT1 1.88-m telescope in Okayama, Japan which took g, r, and z bands observations, and (3) the TCS/MuSCAT2 1.52-m telescope in Tenerife, Spain which took g, r, i, and z bands observations. These optical observations are summarized in Figure 1. More about the LOT observations are given as follows.

We successfully carried out LOT photometric observations in the early half-night for six nights. The LOT observations employed the Johnson *VRI* filters and used the SOPHIA 2048B CCD which can simultaneously cover a large number of comparison stars in its wide field of view, which is advantageous for our time-domain studies. We took sky flat whenever was possible. As a byproduct of our operation, we produced an English version document for the operations of the LOT photometric observations which can be shared to the other non-Chinese-speaking colleagues.

2 Spot Modeling

We are in the progress of analyzing these optical observations. For a quantitative understanding, YT has been constructing a model of the DM Tau host protostar that is populated with cold spots. A visualization of the model is provided in Figure 2. The model self-consistently evaluated the limb darkening coefficients. We employed the Markov chain Monte Carlo (MCMC) method to optimize the modeling parameters including the stellar and spot surface temperatures, stellar rotational period, the radius, latitude, and inclination of the spot, etc.

Figure 3 shows an example of the comparison between our model and parts of our *VRI* bands observations. The model satisfyingly reproduced the photometric fluctuations on 5–10 days timescales while the actual DM Tau observations present richer longer and shorter duration flares. These flaring activities may be related to the magnetic activities around the spots.

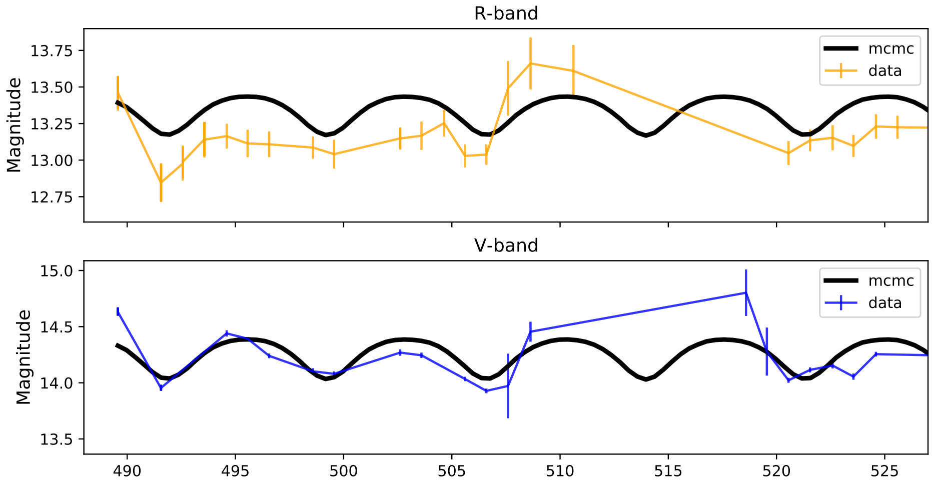

Figure 3: A comparison of the our spot model (black) with parts of the ground-based optical monitoring observations on DM Tau (preliminary).

3 Upcoming Work

We expect the spot modeling to be accomplished by the summer of 2022. By the time this report is submitted, we are also progressing on processing the JVLA data. We will soon move on to work on the X-ray data. We anticipate that a preliminary summary of the observations at the radio, optical, and X-ray bands can be accomplished before the end of 2022. These observations will be a part of the Ph.D. thesis of YT at the Graduate Institute of Astrophysics at the National Taiwan University.

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The Astronomer's Telegram

1. Outburst of comet 29P/Schwassmann-Wachmann 1, Lin Z.-Y., Ip W.-H., Lin C.-S., et al., The Astronomer's Telegram, No. 14323 (2021)

2. Cometary Activity on Asteroid 2005 XR132 Observed at Lulin Observatory, Cheng Y.-C., Hou W.-J., Ip W.-H., The Astronomer's Telegram, No. 14522 (2021)

3. A major outburst of comet 29P/Schwassmann-Wachmann 1, Lin Z.-Y., Ip W.-H., The Astronomer's Telegram, No. 14943 (2021)

4. An outburst of Comet 4P/Faye, Lin Z.-Y., Kelley M. S. P., Ip W.-H., The Astronomer's Telegram, No. 14967 (2021)

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29 Apr 2022; 09:44 UT

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Outburst of comet 29P/Schwassmann-Wachmann 1

ATel #14323; ***Zhong-Yi Lin (IANCU)), Wing-Huen Ip (IANCU),Chi-Sheng Lin (IANCU), Hsiang-Yao Hsiao (IANCU), Wei-Jie Hou(IANCU), Hung-Chin Lin(IANCU)***
*on **15 Jan 2021; 08:50 UT***
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Credential Certification: Zhong-Yi Lin (zylin@astro.ncu.edu.tw)

Subjects: Optical, Comet

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We report that an outburst of comet 29P/Schwassmann-Wachmann 1 was detected by using the images acquired with the SLT (16â Ritchey-Chretien telescope) at Lulin observatory. The outburst was observed to begin on 2021 January 14 with its brightness in V-band suddenly increasing by ~1.6 mag (from 16.6 mag to 15.0 mag), as measured through a 5.6 arcsec (10,000 km) aperture. Although the outburst event was relatively smaller than our previously reported last November (Atel #14207), the duration of two outbursts is consistent with Trigo-Rodriquezâ™s results (2008) who concluded that the average outburst rate is 7.3 events per year. Now, the central nuclear region was quite concentrated (https://www.astro.ncu.edu.tw/people/zylin/29P_202101.html) and the brightness might be increasing from time to time. Follow-up observations of comet 29P/S-W 1 is highly recommended.

Monitoring images of comet 29P/S-W 1

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13164 Possible Fragmentation of Comet 29P/Schwassmann-Wachmann 1
13110 Outburst of Comet 29P/Schwassmann-Wachmann
12994 Outburst of Comet 29P/Schwassmann-Wachmann 1

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Cometary Activity on Asteroid 2005 XR132 Observed at Lulin Observatory

ATel #14522; ***Yu-Chi Cheng (NTNU-PHYS), Wei-Jie Hou (IANCU), and Wing-Huen Ip (IANCU)***

*on **7 Apr 2021; 13:54 UT***
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Credential Certification: Yu-Chi Cheng (ycc312@g.ncu.edu.tw)

Subjects: Optical, Request for Observations, Asteroid, Comet, Solar System Object

We discover a tail-like structure along the anti-solar direction of the asteroid 2005 XR132 with the Lulin One-meter Telescope (LOT) in Taiwan. The cometary activity is clearly shown in our four individual 480s R-band images under the bin 2 readout mode taken on April 5 and 6. No background stars or galaxies are seen along the pathway of 2005 XR132 in the Pan-STARRS 1 stacked r' image. The position angle of the weak tail ranges from 0 to 60 degree, with 11 arcsec in length. The integrated brightness within a photometric aperture of 4 pixels in radius is R~19.7 mag (calibrated by the USNO B1 catalog). Our syndynes-synchrones simulation indicate that 2005 XR132 has been ejecting dust particles since ~100 days ago. The images, the reference frame, and the dust simulation can be found at http://140.115.34.237/XR132_LOT.png . Follow-up observations are required to clarify the nature of this transient object. This work is based on the observations made with Lulin 1-m telescopes at Lulin Observatory (MPC code: D35), operated by Institute of Astronomy, NCU, Taiwan.

Observing images of asteroid 2005 XR132

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A major outburst of comet 29P/Schwassmannâ“Wachmann 1

ATel #14943; ***Zhong-Yi Lin (IANCU), Wing-Huen Ip (IANCU)***
*on **29 Sep 2021; 10:08 UT***
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Subjects: Optical, Comet

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We report that a major outburst of comet 29P/Schwassmannâ“Wachmann 1 was detected by the R-band images obtained with the SLT at Lulin observatory (https://www.astro.ncu.edu.tw/people/zylin/29P_202109.html). The outburst was observed to begin on 2021 September 25 with its brightness suddenly increasing by ~1.0 mag. as measure through a 6.3 arcsec aperture. The brightness keeps brightening from 14.87 mag (Sep. 25) to 12.44 mag (Sep. 28) and the coma with a star-like shape is getting bigger and bigger. The outburst event was larger than that report in August 2021 (Atel#14898). Photometry of the image was all measure with the same radius and calibrated to PS1 catalog.

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An outburst of Comet 4P/Faye

ATel #14967; ***Zhong-Yi Lin (IANCU), Michael S. P. Kelley (U. Maryland), Wing-Huen Ip (IANCU)***

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Subjects: Optical, Comet

Tweet

We report the discovery of an outburst of comet 4P/Faye from SLT (40cm telescope) at Lulin Observatory and Zwicky Transient Facility (ZTF) at Palomar Observatory. The outburst was observed to begin on 2021 August 26 with its brightness suddenly increasing by ~ 1.0 mag (Johonson-Cousins R filter, effective central wavelength 634.9nm, FWHM 106.56 nm) within 4 days, as measured through a radius of 10,000 km. Ten days after the outburst, with comet 4P/Faye near perihelion, the brightness appeared to have returned to a quiescent level that was brighter by 0.4 mag than that measured before the outburst. ZTF images taken September 4 through 16 show a slow moving cloud of debris traveling in the anti-solar direction. Photometry was calibrated to the PS1 catalogue and measured with the same aperture radius (10,000 km).

[**Telegram Index**]

Bulletin of the American Astronomical Society

1. Establishing the population of asteroids located wholly inside the orbit of Venus, Bolin B., Ip W.-H., Masci F., et al., AAS Division of Planetary Science meeting #53, id. 107.01. Bulletin of the American Astronomical Society, Vol. 53, No. 7 e-id 2021n7i107p01 (10/2021)

2. Physical Properties and Origin of Active Outer Main-belt Asteroid 2005 XR_{132}, Cheng Y.-C., Bolin B. T., Kelley M., AAS Division of Planetary Science meeting #53, id. 110.05. Bulletin of the American Astronomical Society, Vol. 53, No. 7 e-id 2021n7i110p05 (10/2021)

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1. The discovery and characterization of 2020 AV2, the first known asteroid in the class of inner-Venus asteroids, Bolin B. T., Ip W.-H., Masci F. J., et al., 15th Europlanet Science Congress 2021, held virtually, 13-24 September 2021 id. EPSC2021-156 (09/2021)

2. The outbursts of comet 29P/SW-1 and C/2020 R4 (ATLAS), Lin Z.-Y., Kelly M. S. P., Ip H.-W., 15th Europlanet Science Congress 2021, held virtually, 13-24 September 2021. id. EPSC2021-448 (09/2021)

Transient Name Server AstroNote

1. Kinder follow-up observations of AT 2021gca (ZTF21aapkbav), Chen T. W., Yang S., Pan Y. C., et al., Transient Name Server AstroNote 2021-92 (03/2021)

GRB Coordinates Network

1. GRB 210928A: Kinder SLT-40cm optical limits, Chen T.-W., Yang S., Evans P., et al., GRB Coordinates Network, Circular Service, No. 30918 (10/2021)

其他成果

國內合作計畫

1. 愛因斯坦培植計畫 RIFT：全自動觀測緻密星瞬變事件，監測緻密天體。

RIFT（愛因斯坦培植計畫）

RIFT（愛因斯坦培植計畫；計畫主持人：成大物理系李君樂助理教授）為全台第二大口徑（五十公分）的研究型望遠鏡（若包括以教育為主的天文台在內，則為第五大），旨在研究在重力波、微中子和高能電磁波觀測中發現的緻密星瞬變事件。這些瞬變現象通常發生得毫無預警，且只維持短暫時間。為了捕捉到這些訊號，RIFT 被設計成全自主機械式望遠鏡。未來一旦發現新的瞬變事件，RIFT 將接收通知，並立刻自動把望遠鏡轉向指定位置，進行快速準確的光學觀測。RIFT 也會重點監測近 300 個有趣的緻密星系統，其中包括已知的黑洞及中子星等，以查察它們有否出現任何瞬變現象。透過對緻密星瞬變事件進行深入研究，李教授及其研究團體將更了解事件發生的原理以及輻射機制。整個系統已經進入測驗階段，預計將在 2022 年暑期作初步起動。

國際合作計畫

台灣位處太平洋西側，由於廣大的太平洋上（橫跨 6 個時區）只有夏威夷有天文台，對於觀測隨時間變化的天文現象或是全球不同經度的天文台（甚至太空望遠鏡）針對特定天體的聯合觀測，鹿林天文台扮演舉足輕重的角色。多年來鹿林天文台積極參與國際合作計畫，與各國天文台建立良好合作模式，並取得優良成果。這一年我們參與的幾個主要國際合作計畫如下：

1. 全球蠍虎 BL 類星體聯合觀測計畫（The Whole Earth Blazar Telescope - GLAST-AGILE Support Program, WEBT-GASP）：監測活躍星系核，藉此研究黑洞與噴流的性質。

2. 史維基瞬變探測器計畫（Zwicky Transient Facility, ZTF）：將天文研究推進到時間加上空間的 4D 階段，可望對可見光時域天文學作出重大的科學貢獻。

3. 伊甸園觀測網（Exoearth Discovery and Exploration Network, EDEN）：搜尋鄰近太陽之 M 型恆星可能位於適居區內的系外行星。

4. 年輕超新星巡天計畫 (Young Supernova Experiment) ：使用 Pan-STARRS telescopes 在 ZTF 天區進行巡天，藉由兩者之間經度的差距來探測瞬變天體早期的演化。

團體參觀及教學觀測

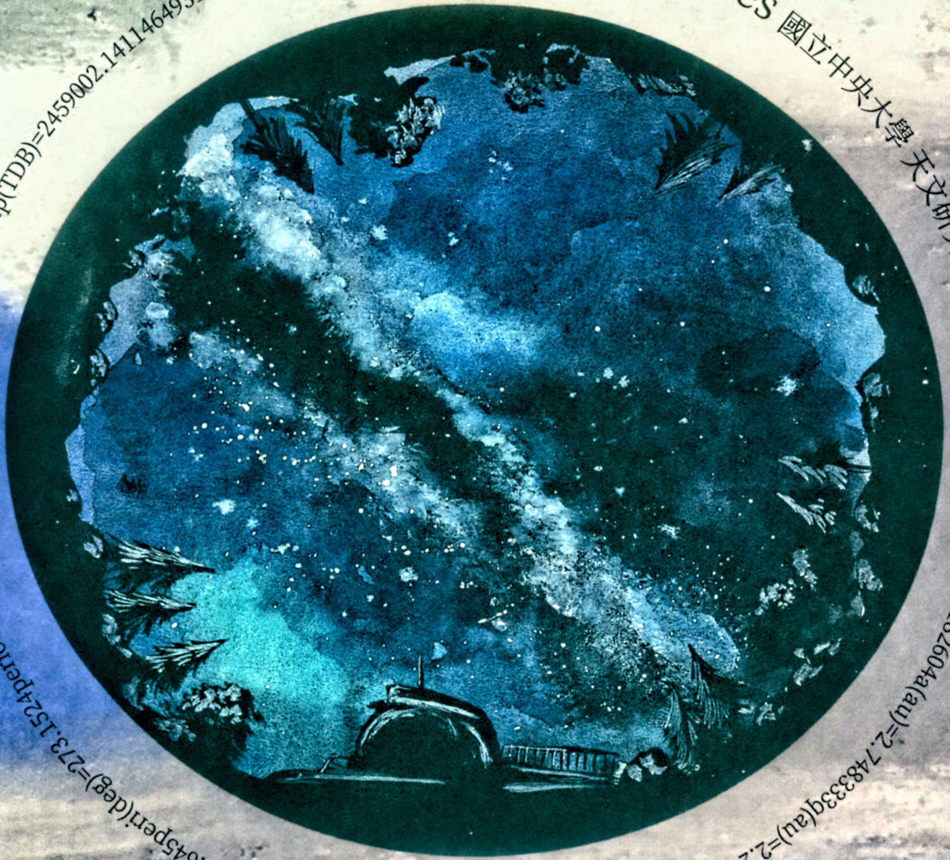
日期	單位	人數
1 月 16 日	高雄美國學校	15
1 月 27 日	環保署前署長張祖恩署長一行	30
1 月 27 日 3 月 1 日	因疫情暫停參觀	
3 月 13 日	中山醫學大學天文社	12
4 月 9 日	中大吳副校長一行	28
4 月 9 日	中大 EMBA 團	14
5 月 1 日	中正大學通識中心	20
5 月 2 日 11 月 1 日	因疫情暫停參觀	
11 月 15 日	仁和國小	20
11 月 28 日	西湖國小	23
12 月 4 日	台北天文館	49
12 月 5 日	新竹高中天文社	24

人文中大書系①

小行星的故事

李瑞騰　主編

Asteroid Stories 國立中央大學 天文研究所鹿林天文台Lulin145523e= 0.182604a(au)=2.748333q(au)=2.246475Q(au)= 3.25019node(deg)=345.2109M(deg)=359.645peri(deg)=273.1524period(days)=1664.18785n(deg/day)= 0.216322tp(TDB)=2459002.141146493121(2020-Jun-01.64114649)



國立中央大學人文研究中心　編印

Part III

新聞報導

彰顯臺灣美好價值　中央大學《小行星的故事》新書發表

發布日期： 2021-03-08　文／秘書室

中央大學《小行星的故事》新書發表，實踐人文關懷與永續發展，彰顯臺灣美好價值。陳薏安攝

中央大學於鹿林前山設有全國最高的天文台，除科學研究成果亮麗之外，在小行星的觀測上成果也相當豐碩。近期出版了獨一無二的《小行星故事》新書，內容收錄了 40 顆小行星命名的故事，期讓更多人認識宇宙天文的奧秘，實踐人文關懷與永續發展，彰顯出臺灣美好價值。

中央大學校長周景揚表示，探索星空是人類與生俱來的天性，中央大學 1992 年在國內首創天文研究所，1999 年在玉山國家公園的鹿林前山設立了鹿林天文台，規模雖不大，但藉由參與許多大型的國際計畫，展現出媲美世界知名天文台的科學成果。此書的發表，希望讓更多人了解天體的運行，認識鹿林天文台的運作，乃至於我們島上眾多美好。

在臺灣天文學發展史上，中央大學鹿林天文台締造了許多的紀錄，包括首度發現超新星、鹿林彗星（C/2007 N3）、近地小行星（2007 NL1）等，同時在小行星的觀測成果豐碩，從 2002 年發現第一顆小行星以來，迄今已發現超過 800 顆，是亞洲發現小行星最活躍的地方。

中央大學天文研究所葉永烜院士說，根據國際天文學聯合會的規定，其中得到確認的，便可以由發現者予以命名。中央大學小行星的命名，主要希望能彰顯出台灣價值，包括名城勝景（如桃園、台東、玉山、合歡山和雪霸等），仁人

義士（如慈濟、鄭崇華、溫世仁和陳樹菊等），文采風流（如雲門、陳其寬、鄧雨賢和鍾理和等），以及與中央大學密切相關者（如羅家倫、劉兆漢、李國鼎、馮元楨和蔡文祥等）。一方面表達感恩之意，另一方面希望得以後世永流傳。

「此書，可視為中大『特產』。」中央大學人文研究中心主任李瑞騰說，他帶著學生寫作團隊，經過將近一年的籌備和編寫，每一顆小行星除了提供天文學基本資料，更重要是關於命名的緣由。他認為，命名是一種人文的活動，是人文與科學的相互對話，也是人間向星空的呼喚，希望藉由此書的發表，再次彰顯這些人物與事蹟所代表的價值和意義！

中央大學《小行星的故事》新書發表，左至右：中央大學天文所黃崇源所長、天文所葉永烜院士、中央大學周景揚校長、人文研究中心李瑞騰主任、天文所陳文屏教授。陳薏安攝

中央大學小行星的命名，涵蓋名城勝景、仁人義士、文采風流，以及與中央大學密切相關者，期能彰顯台灣的美好。陳薏安攝

發現世外桃源　2021 中央大學十景出爐

發布日期： 2021-09-13

中央大學於 106 週年校慶舉辦 2021 中大十景票選活動，今(9/13)舉辦揭曉記者會，並於入選十景之一的聽松台合影。陳薏安攝。

中央大學被譽為桃園市的「世外桃源」，並設有全國最高的鹿林天文台，享有「最高學府」之美名。為提升優質學府形象，強化特色領域印象，中大 106 週年校慶選出新的中大十景，從前門到後門，校內到校外，依序是：中大路、聽松台、總圖書館、中正圖書館、百花川、大禮堂、中大湖、友好之櫻、太遙中心接收站和鹿林天文台。

中央大學在秘書室主辦，藝文中心、人文研究中心和學生會協辦下，推動新一波校園景點票選及命名活動。此次票選活動，吸引千人參與投票，希望凝聚教職員生及校友對學校之認同感與向心力，同時不斷與時俱進、推陳出新。

新十景票選，帶來了新氣象。新入列的景點包括聽松台、大禮堂、中正圖書館、友好之櫻、太遙中心接收站和鹿林天文台等六個，展現出中大獨一無二的特色。另外，中大路、中大湖、百花川、總圖書館等四個舊景點持續名列榜中，在中大人心目中歷久彌新、屹立不搖。

其中聽松台、大禮堂都是中央大學全新完工的特色建築。聽松台可眺望中大前門遠方美景，飽覽旖旎風光。教學研究綜合大樓之大禮堂，外型採獨特的「松

果」造型，表達深厚的知識內涵。而由國家文藝獎得主陳其寬校友規劃設計中正圖書館也入選。深受民眾喜愛的中大湖畔旁友好之櫻，也成為中大吸睛的「嬌」點。

另一大亮點是，中大的特色領域也入列。擁有 13 米碟型大天線的太遙中心資源衛星接收站，運用前瞻的科技，守護我們的國土和家園，成為中央大學深具特色地標。而海拔 2,862 公尺的鹿林前山，中央大學設有全國最高的鹿林天文台，使得中央大學享有「最高學府」之美名，不但是中大卓越的代表象徵，更是台灣邁向世界舞台的重要地標。

中央大學校長周景揚表示，中大堪稱全國最優美的大學校園，深具人文氣質，此次透過十景票選活動，可凝聚中大人認同感和向心力，實屬難得。中大走過百年風華，在臺深耕近一甲子，優美的校園是中大最珍貴的資產，希望透過此次出爐的十景，讓學生們更有機更深入每個角落，也期待校友們多回母校走走，感受中大與時俱進的新風貌。

中央大學人文研究中心李瑞騰主任則分析，新入選的六景，可略分三組，太遙中心接收站和鹿林天文台入選，顯示尖端科技已成為中大校園新人文景觀。中正圖書館和大禮堂入選，說明古老的歷史和嶄新的綠意在中大校園可以並存，互動而雙美。聽松台和友好之櫻入選，蘊含「動植皆文」，意味著人物我和諧共好。整體來說，2021 中大十景存在著一種向外部、更高更遠發展的新動向！

2021 中央大學十景出爐，現場嘉賓雲集。左起事務組吳雅婷技正、藝文中心陳文逸主任、人文研究中心李瑞騰主任、許協隆國際長、王文俊教務長、吳瑞賢副校長、周景揚校長、中大學術基金會蔣偉寧董事長、台聯大顏上堯系統副校長、周立德主任秘書、文學院林文淇院長、學務處周毓芳秘書。陳薏安攝。

中大湖於本次票選活動中獲得最高票，也是許多中大師生及校友心中最具代表性的景點。駱主安攝。

2021 超級血月　天文所研究生捕捉天文奇景

發布日期： 2021-05-28　文／天文所、秘書室

中央大學天文所研究生譚瀚傑透過事先估算，巧妙結合中大 13 米碟型大天線，捕捉到這難得的天文與太空同框奇景。照片譚瀚傑提供

睽違 24 年天文奇景，錯過要再等 12 年的「超級血月」5 月 26 日晚間登場，中央大學天文所碩士班研究生譚瀚傑透過單眼相機，巧妙結合中大全國最大的 13 米碟型天線，捕捉到這難得的天文與太空同框奇景。因逢年度最大滿月，也是今年最大的月全食，紅銅色的大滿月，讓他在臉書寫下「宇宙如是之觀，何等壯麗恢弘」之驚嘆！

他透過事前的計算，發現此次月全食現象，恰好可以與中央大學太空及遙測研究中心的 13 米天線相輝映。因此在月全食發生的時間，來到太遙中心西北方向 300 米外的田間，當處於「食甚」階段的月球，自下而上穿過高聳的 13 米天線時，他迅速按下快門，而有了這張彌足珍貴的照片。

譚瀚傑說，月食期間，月球的暗面呈現紅色，是因為雖然大多數的陽光無法照射在處於地球本影的月亮上，但波長最長的紅光，仍然有機會經過地球，靠近地平線的大氣折射作用，照射在月面上。因此從地球上看，此時的月球呈現紅銅色。這項天文奇景也提醒我們，因有地球大氣的保護，包括人類在內的萬千生靈，得以寄居在這顆美麗的藍色星球之上。月全食中的紅月亮，既是地球大氣的傑作，也是生命奇跡的見證！

中央大學天文研究所所長黃崇源表示，月亮繞著地球的軌道是橢圓形，如果滿

月正好發生在月球離地球最近的時候，這時月亮看起來會特別大，被稱為「超級月亮」。月全食時，月亮因反射穿透地球大氣的紅光，看起來像紅色的血月，如果「超級月亮」時又發生「月全食」，則是「超級血月」，這是非常難得的機會。

天地人正能量　阿里山、日月潭和蘭潭小行星通過命名

發布日期： 2021-05-20　文／天文所、秘書室

國際天文學聯合會（IAU）近期公告以台灣小學和著名風景區命名的小行星，其中三顆為中央大學鹿林天文台所發現。林宏欽攝

國際天文學聯合會（IAU）近期公告以台灣小學和著名風景區命名的小行星，其中三顆為中央大學鹿林天文台所發現，分別是編號 321131 的 Alishan（阿里山）、編號 300286 的 Zintun（日月潭），以及編號 300150 的 Lantan（蘭潭）。中央大學期許在疫情嚴峻之下，能為台灣帶來一些好消息與正能量！

中央大學天文研究所表示，天時、地利和人和，是小行星能否成功發現的三要素，「阿里山」、「日月潭」及「蘭潭」三顆小行星也正代表了天地人。中大日期出版的《小行星故事》專書，就是希望彰顯出臺灣美好價值。疫情日益嚴峻之際，更可看出宇宙無比浩瀚，人類何其渺小。但如果能夠重視教育，團結合作，一定能夠克服任何困難。

阿里山位於台灣中部嘉義和南投之間的旅遊風景區，阿里山以日出、雲海、晚霞、森林和小鐵路聞名於世，合稱阿里山五大奇景。Zintun 是日月潭的邵族名，位於台灣中部，海拔 748 公尺，是台灣唯一的天然大湖；拉魯島的南部形狀像新月一樣，北部形狀像太陽，因此得名日月潭。

台 18 線阿里山公路及台 21 線新中橫公路，沿途景觀優美壯麗、生態豐富，串起阿里山與日月潭兩大國際級景點，其中包括阿里山國家風景區、日月潭國家風景區和玉山國家公園。公路交接處最高點的玉山國家公園塔塔加地區，可將

台灣第一高山玉山美景盡收眼底，正是中央大學鹿林天文台的所在地，也是發現小行星的地方。

人文嘉義、天文蘭潭。蘭潭國小是「嘉義市天文協會」的基地，30 多年來推動自然科學與天文教育，2020 嘉義市日環食活動掀起台灣天文熱潮，讓許多人親眼目睹這個台灣百年難得一見的天文奇景。嘉義市天文協會並與林務局嘉義林區管理處長期合作在阿里山國家森林遊樂區開展天文生態活動，深耕嘉義地區天文教育。

蘭潭國小是「嘉義市天文協會」的基地，長期推動自然科學與天文教育不遺餘力。照片蘭潭國小提供

蘭潭小行星」躍上天際　臺灣首顆以小學命名的小行星

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適逢蘭潭國小創校 48 週年校慶，在貴賓眾星雲集中，正式發表「蘭潭」小行星高掛天際。左起第五位依序為中央大學周景揚校長、嘉義市黃敏惠市長、蘭潭國小邱榮輝校長。照片陳薏安攝。

蘭潭國小為嘉義市天文協會的起始與發展基地，學校與協會相輔相成，師生與志工熱心奉獻，30 多年推動自然科學與天文教育不遺餘力。今年為蘭潭國小 48 週年校慶，國立中央大學特將鹿林天文台所發現的第 300150 號小行星命名為「蘭潭」(Lantan)」。這是臺灣首次以小學命名的小行星，除了肯定蘭潭國小於天文教育的貢獻，更做為最特別的生日禮物，意義別具。

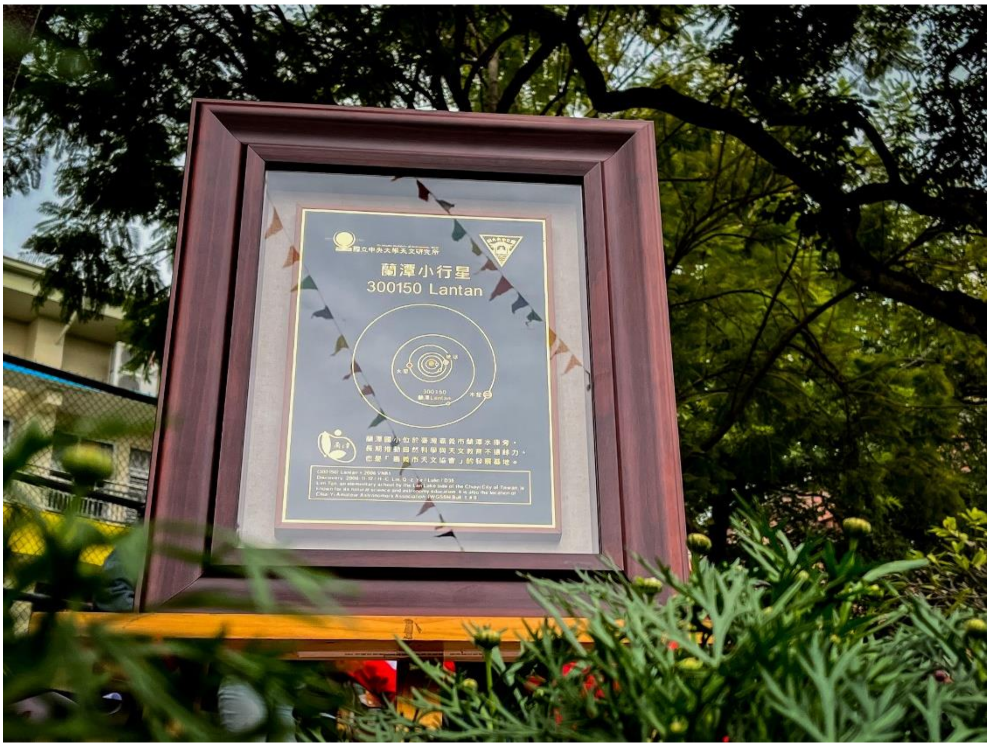
為了實現使嘉義成為天文最普及的地區之願景，嘉義市天文協會在民國 100 年成立嘉義市科學志工隊，與多校合作晨光天文活動計畫，讓天文種子在地紮根，遍地開花。蘭潭國小校內設有天文台、星象廳、百萬天幕等設施，從幼稚園到國小六年級都有天文課，用星光點亮孩子的科學熱情和人生態度。

中央大學表示，「蘭潭」小行星為 2006 年 11 月 12 日由鹿林天文台林宏欽及現在美國馬里蘭大學的葉泉志博士共同發現，大小約在 1-3 公里之間。蘭潭小行星繞行太陽一圈 5.72 年（軌道週期），離太陽最近時（近日點）為 3.91 億公里，最遠時（遠日點）為 5.67 億公里。。

中央大學校長周景揚肯定蘭潭國小對於天文教育向下扎根的貢獻。他指出，中大擁有全國海拔最高的鹿林天文台，以及全國最大的天文望遠鏡，為國內天文觀測的重鎮。同時在小行星的觀測成果豐碩，從 2002 年發現第一顆小行星以來，迄今已發現超過 800 顆，是亞洲發現小行星最活躍的地方。

蘭潭國小於 12 月 25 日舉行創校 48 週年校慶。今年也同時是嘉義市天文協會成立 34 週年及嘉義市科學志工隊成立 10 週年。當日蘭潭小行星恰好運行到人馬座，位置正在太陽旁邊，將在正上方照耀此天文教育與科普推廣的完美組合，期望繼續將「人文嘉義、天文蘭潭」之精神延續下去。

蘭潭國小學生獻上精彩的舞蹈演出，慶祝蘭潭小行星正式命名。照片陳薏安攝。



中央大學將鹿林天文台所發現的第 300150 號小行星命名為「蘭潭」(Lantan)，同時也是臺灣首次以小學命名的小行星。照片陳薏安攝。