

國立臺灣師範大學 天文與重力中心

Center of Astronomy and Gravitation, National Taiwan Normal University

[近地太空與太陽系探索－任務概念、設計、開發和部署] 工作坊

A Workshop on **Geospace and Solar System Exploration**

– Mission Concept, Design, Development, and Deployment

(GaSSE2026)

Day 1 (2026 Apr. 14, Tue)

10:00 - 11:00 Peaceful Space Exploration - Near and Far (Plenary talk)

Wing Ip (NCU)

It has often been observed that the planning of several major space missions in the 1980s—most notably the multinational spacecraft fleet sent to study **Halley's Comet** and the later **Cassini–Huygens mission**—was closely connected with the globalization of space science. During the later years of the Cold War, scientific communities around the world were actively seeking opportunities for peaceful cooperation, and space exploration provided a natural arena in which such collaboration could flourish. It is therefore worth reflecting on whether that historical moment has already passed or whether a comparable era of cooperative exploration may yet lie ahead.

The following narrative proceeds from the assumption that the spirit of peaceful collaboration in space science will ultimately endure, regardless of the fluctuations of contemporary geopolitical circumstances. As a starting point, we briefly recount the historical development of cometary exploration, culminating in the landmark achievements of the **Rosetta mission**. Building on this legacy, one may envision a new generation of missions. In particular, a **Stardust mission**–like sample-return mission to an **Interstellar Object** could be conceived, taking advantage of the technological and organizational experience gained through the joint **Comet Interceptor mission** led by **European Space Agency** and **Japan Aerospace Exploration Agency**.

Such a mission concept would also help set the stage for an even more ambitious objective: a **Halley's Comet** sample-return mission timed for its next perihelion passage in 2061. By that time, it is conceivable that initiatives such as the **Tiangong Kaiwu (天工開物) project** of the **China National Space Administration** may have matured, articulating a broader space economy in which asteroid resource utilization plays an important role.

Beyond technological progress alone, projects of this scale could profoundly deepen our understanding of the origin of the Solar System and stimulate the emergence of new interdisciplinary perspectives—perhaps even shaping a field that might be described as comparative exoplanetology. The central question we must therefore ask ourselves is not merely what discoveries may come, but how we can prepare scientifically, technologically, and institutionally to help bring these possibilities into reality.

11:20 – 11:50 Introduction of Synthetic Aperture Radar Design

Evan Hsu 許耀文(TASA)

11:50 – 12:20 From Algorithms to the Sky: System Design and Verification Strategies for Synthetic Aperture Radar

Chiung-Shen Ku 古瓊昇 (NTUT), Cheng-Yen Chiang (NTUT), Yang-Lang Chang (NTUT)

This presentation explores the comprehensive lifecycle of Synthetic Aperture Radar (SAR) development, bridging the gap between fundamental electromagnetic theory and cutting-edge hardware implementation. Synthetic Aperture Radar is a sophisticated form of radar used to create two-dimensional images or three-dimensional reconstructions of objects, utilizing the motion of the radar antenna over a target region to provide finer spatial resolution than conventional stationary beam-scanning radars. To accurately predict system performance, we employ a high-fidelity simulation framework that combines Physical Optics (PO) with the Shooting and Bouncing Rays (SBR) method. This hybrid approach allows for the precise modeling of SAR echo signals, which is subsequently validated against real-world data from existing systems using corner reflectors to ensure the simulated returns maintain authentic physical characteristics. Once the echo signals are acquired, the focus shifts to the computational core of the system, where specialized algorithms process raw data into high-resolution imagery. This transition involves detailed strategies for handling different classes of targets, specifically distinguishing between deterministic targets, such as ships, aircraft, and vehicles, and random (stochastic) targets that represent cluttered or complex environments. Finally, moving beyond traditional discrete circuit assemblies, we discuss modern system design strategies that leverage Integrated Circuit (IC) design and RF System-on-Chip (RFSoc) technology. By integrating high-speed data converters and programmable logic onto a single chip, these strategies significantly reduce form factor and power consumption while enhancing the real-time processing capabilities required for modern airborne and spaceborne SAR applications.

Keywords: Synthetic Aperture Radar (SAR), RF System-on-Chip (RFSoc), Physical Optics (PO), Shooting and Bouncing Rays (SBR), System Integration

13:30 – 14:00 Conceptual Mission Design of a Space Telescope CubeSat with MBSE

Chien-Hsien Lin 林建賢 (TASA)

This small example study proposes the mission requirements, concept of operations (ConOps), and preliminary design of a small space telescope hosted on a 16U CubeSat by using MBSE (Model-based System Engineering) method to provide traceable description from mission needs and establish system architecture. From the very first beginning is to have a trade-off analysis of mission objectives in this such astronomy observation on a CubeSat platform. The science objectives focus on photometry and low-resolution imaging of astronomical targets toward bright stars and galaxies, and explicitly trade capability against CubeSat constraints in SWaP, pointing stability, and thermal control. To balance scientific return and engineering risk, the payload baseline could adopt a visible/near-ultraviolet (NUV)-centric configuration. The mission orbit is assumed to a 500-600 km LEO by rideshare launch service. The observation duty is driven by the visibility window in orbital eclipse cycles, target list scheduling, and transient events. The ConOps covers end-to-end activities including ground planning, on-orbit operation, data downlink, and calibration/health monitoring. The satellite preliminary design allocates at least 8U out of 16U volume to the payload to maximize the aperture of telescope for observation efficiency. The MBSE model organizes requirements, conceptual architecture, functions, and interfaces to maintain end-to-end traceability, providing a shared baseline for further design, V&V planning, and mission risk management in subsequent phases.

14:00 – 14:30 A Control Framework for CubeSat Rendezvous and Proximity Operation Using Electric Propulsion

Frank Lin 林柏川 (Rapidtek)

CubeSat missions have increasingly shifted from academic demonstrations to commercially driven space programs. In the private sector, engineering decisions are shaped not only by technical performance, but also by schedule pressure, cost constraints, supply-chain limitations, and limited team resources.

This talk presents an ongoing CubeSat mission developed by a private company in Taiwan, highlighting how mission objectives are translated into practical engineering decisions under real-world constraints. The presentation introduces the mission background and overall system architecture, emphasizing how design choices are influenced by delivery timelines, component availability, and operational considerations rather

than idealized designs.

Key challenges encountered during the program are discussed from a system engineering perspective, including requirement prioritization, subsystem trade-offs, communication and attitude control constraints, integration and testing under tight schedules, and coordination across small, multi-role teams. The focus is placed on how risks are identified, managed, and accepted throughout the development cycle.

By sharing lessons learned from this ongoing mission, the talk aims to provide industry-relevant insights for engineers and managers involved in small satellite programs. The experience from Taiwan's private space sector serves as a practical case study of how commercial CubeSat missions are executed in emerging space industries.

14:30 – 15:00 Sharing Experience in CubeSat Payload Development

Shiuanhal Shiu 許軒豪 (Liscotech Co., Ltd.), Liscotech R&D department (Liscotech Co., Ltd.)

Liscotech focuses on the design and development of CubeSat payloads. This talk shares our practical experience in advancing optical remote sensing payloads from basic imaging to on-orbit edge AI processing. Through collaborations with National Cheng Kung University and National Taiwan University of Science and Technology, we present the development journey of the IRIS-A/B and Liliium-1/2 payload series.

The IRIS-A payload focuses on reliable Earth imaging to support satellite attitude verification and system health monitoring; IRIS-B payload advances to disaster detection, integrating FPGA platforms with edge AI for on-orbit real-time inference of debris flows and landslides. Liliium-1 payload achieves low-power FPGA based on-orbit AI image enhancement using unsupervised Zero-DCE HDR models to improve contrast and detail retention under varying illumination; Liliium-2 significantly boosts performance with NVIDIA Orin NX and advanced FPGA, attaining 5 m ground sample distance while supporting cloud screening, real-time object recognition like ships/vehicles, and insight-prioritized downlink for bandwidth optimization.

We also briefly touch upon the potential extension of these payload technologies to lunar missions. The development experience from this series may offer some reference and inspiration for intelligent optical remote sensing in Taiwan's geospace and solar system exploration efforts.

15:00 – 15:30 Introduction of Tensor Tech and its Spacecraft Motion Control Solutions

Sam Lee 李尚融 (Tensor Tech)

Tensor Tech advances spacecraft motion control through high-efficiency ADCS technologies, with a focus on variable-speed Control Moment Gyroscopes (CMGs). Compared with conventional reaction wheel systems, its CMG architecture delivers significantly higher torque-to-power performance in a compact form, enabling enhanced satellite agility, faster maneuvering, and improved pointing precision. These innovations expand the operational capabilities of next-generation spacecraft and accelerate market adoption of advanced attitude control solutions.

15:50 – 16:20 Compact Ionospheric Probes Onboard PEARL CubeSats

Chi-Kuang Chao 趙吉光 (NCU), Chi-Kuang Chao, Wei-Rong Huang, Jann-Yenq Liu

PEARL (Propagation Experiment using kurz-Above-band radio in Low earth orbit) CubeSats developed by National Central University (NCU) for educational training/scientific research. Two of them (PEARL-1C and PEARL-1H) were launched into a sun-synchronous orbit at 520 km altitude around 1030 local time sector by SpaceX Transporter-9 rideshare mission from Vandenberg Space Force Base on 11 November 2023. A Compact Ionospheric Probe (CIP) customized for CubeSat dimension was installed onboard PEARL-1C to monitor global ionospheric space weather conditions resulting in space communication disruption and navigation outage. The CIP is an all-in-one in-situ ion sensor also developed by NCU to measure ionospheric ion concentration, velocity, and temperature alternatively like its predecessor, Advanced Ionospheric Probe, onboard FORMOSAT-5 satellite. In this presentation, some observations derived from the CIP measurements will be presented. Even though, PEARL-1C was re-entry on 9 December 2025, next mission, PEARL-1A and PEARL-1B, equipped with CIP will also be introduced for space weather/climate study and scheduled to launch 2026Q2.

16:20 – 16:50 Sweet Success in Space: How TASA's ONGLAISAT is Redefining 6U Capabilities
Bandy Shang 商婕柔 (TASA), Chen-Yu Chan (TASA)

The ONGLAISAT (ONboard Globe-Looking And Imaging Satellite) project represents a landmark achievement in international space collaboration, uniting the expertise of the Taiwan Space Agency (TASA) in high-resolution payloads with the advanced satellite bus engineering of the University of Tokyo's Intelligent Space Systems Laboratory (ISSL) and ArkEdge Space. Initiated through a 2019 MOU, the project successfully navigated the challenges of the global pandemic to move from payload shipment in 2022 to final integration and environmental testing in 2023. This mission serves as a critical pathfinder for TASA's future remote sensing instruments (RSI), designed to validate three core in-house technologies within a compact 6U framework: a high-precision Korsch-type telescope, a sensitive Time Delay Integral (TDI) CMOS sensor, and efficient JPEG 2000 image compression management.

The mission reached a historic milestone on December 8, 2024, when the satellite was launched from the International Space Station (ISS) via the J-SSOD#30 deployer. Since its deployment, ONGLAISAT has achieved 100% of its mission goals, successfully quantifying the optical characteristics of its payload in the harsh space environment. Most notably, the satellite demonstrated a Ground Sampling Distance (GSD) of 2.4 meters, establishing the best-in-class performance for a 6U CubeSat to date. By completing this mission at an accelerated pace, the team has not only proven the viability of high-pointing performance for miniaturized satellites but has also provided a validated technological foundation for TASA's next generation of high-resolution Earth observation constellations.

16:50 – 17:20 Solar Wind Interaction with the Magnetospheres of Earth, Mercury, and Our Moon
Shu-Hua Lai 賴淑華 (NCU), Zhi-Jieng Wu (NCU), Kaiti Wang (TKU), Ya-Hui Yang (NCU)

Physical dynamics and processes within planetary magnetospheres driven by interactions with the solar wind are key observational targets of planetary exploration missions. Understanding energy and momentum transfer during solar wind-magnetosphere interactions, therefore, requires high-resolution measurements, multi-satellite conjunction observations, and comprehensive theoretical modeling. Using magnetohydrodynamic (MHD) simulations constrained by observations, we demonstrate that nonlinear fast-mode plane waves associated with Kelvin–Helmholtz instability (KHI) at planetary magnetopauses provide an efficient pathway for energy transport into the inner magnetosphere. Based on MESSENGER measurements, observational evidence for KHI-induced nonlinear fast-mode plane waves is identified through the construction of KHI wave-steepening directions. Furthermore, by combining observations and simulations, we present the first evidence that KHI-induced plane waves can account for the long-standing problem of shock-like external magnetic enhancements observed above the lunar surface, even at altitudes up to 800 km. This KHI-driven mechanism provides a universal explanation for external magnetic enhancements above weakly magnetized bodies across the Solar System (e.g., our Moon and Mars). In parallel, we are initiating a framework for a global lunar magnetic field model to produce a next-generation prototype and establish an integrated lunar surface magnetic field platform (UI), supporting future studies of the lunar magnetosphere, ionosphere, paleomagnetism, and polar in-situ magnetic field observations. Beyond boundary instabilities at magnetopauses, solar wind-magnetosphere interactions can also be fundamentally changed under extreme upstream conditions. In this context, extremely low-Mach-number solar wind events are examined using data from the Helios and Parker Solar Probe (PSP) missions. We find that such events are primarily driven by exceptionally low plasma densities associated with compound transient solar wind structures. Under these extreme conditions, planetary bow shocks may weaken or even disappear, directly exposing magnetospheres to the solar wind. Such interactions may substantially modify magnetospheric responses and potentially trigger magnetic storm activity even under persistently northward interplanetary magnetic field (IMF) conditions. Collectively, these results identify a previously underexplored observational domain of solar wind-magnetosphere coupling that can be investigated by current and future planetary and lunar missions.

Day 2 (2026 Apr. 15, Wed)

10:00 – 11:00 Juno Results: Comparing the Gas and Ice Giants (Plenary talk)

Scott J. Bolton (SwRI)

Juno has transformed our view of Jupiter through major discoveries about its interior structure, origin, and evolution; atmospheric dynamics and composition; magnetic dynamo; and polar magnetosphere. Results from the Juno investigation of Jupiter have challenged our understanding of Jupiter's origin and evolution. As the archetype of giant planets, the study of Jupiter provides knowledge needed to understand the origin of our own solar system and the planetary systems being discovered around other stars. Jupiter uniquely informs us about the origin of our own planetary system. The mass of Jupiter's heavy element core and the abundance of heavy elements in the atmosphere discriminate among models for giant planet formation. Measurements by Juno of Jupiter's gravity field suggest Jupiter's core is diffuse, extended and contains compositional gradients. These new results require new models of Jupiter's formation and evolution. Juno results Jupiter's interior is low metallicity, potentially solar or even sub-solar. This is in contrast with its atmosphere which indicates an enriched metallicity of 3-4x compared to solar abundances. Additionally, Juno's results have revolutionized our understanding of the Jupiter's atmospheric dynamics, polar magnetosphere, aurora, subsurface characteristics of Jupiter's moons Io, Europa and Ganymede as well as how tidal forces drive Io's volcanic activity.

Exploring the outer solar system is essential for understanding the formation and evolution of our solar system and the exoplanetary systems now being discovered throughout the galaxy. Key information on the history of our solar system is encoded in the characteristics, composition, and dynamics of the giant planets, satellite systems, magnetospheres and ring/dust environments that reside in the region within and beyond the asteroid belt. Exploration of giant planet interiors and atmospheres provide ground truth on how composition across the solar system evolved with time. How tidal forces create ocean and volcanic worlds, and potentially habitability is a fundamental question requiring outer solar system exploration. The role of disks and dust in the formation of planetary systems is ubiquitous throughout the universe. The ice giants are distinctively different from gas giants and terrestrial planets, and similar type planets appear to be common in exoplanetary systems. The origin of giant is theorized to be related to the growth of massive embryos (many Earth masses of ice and rock) within the solar nebula, with a gas-rich envelope arising naturally from the need to establish hydrostatic equilibrium between planet and surrounding nebula. Recent exoplanet discoveries suggest that there are many planets elsewhere that, like Neptune and Uranus, have a hydrogen rich gaseous envelope, possibly because they formed when a gaseous nebula was still present (as is assumed to be the case for Uranus and Neptune in our solar system). The ice giants are important targets for future exploration as they are distinctively different from gas giants and terrestrial planets. They are mostly up of heavy elements by mass but contain appreciable hydrogen and helium by molecular number. Their origin is thought to follow that of the gas giants -- growth of massive embryos (many Earth masses of ice and rock) within the solar nebula, with a gas-rich envelope arising naturally from the need to establish hydrostatic equilibrium between planet and surrounding nebula. Recent exoplanet discoveries suggest that there are many planets elsewhere that, like Neptune and Uranus, have a hydrogen-rich gaseous envelope, evidently because they formed while a gaseous nebula was present, as must have been the case for our ice giants. The ice giants potentially represent the most common type of exoplanet.

A summary of Juno's results relevant to Jupiter's formation and evolution will be presented along with a discussion of theoretical implications on Jupiter, and giant planets both within our solar system and beyond.

11:00 – 11:20 Surface Deposition of Icy Dust Entrained in Europa's Plumes

Wei-Ling Tseng 曾瑋玲 (NTNU), Ian-Lin Lai (NCU), Hsiang-Wen Hsu (U. of Colorado, USA), Wing-Huen Ip (NCU), and Jong-Shinn Wu (TASA)

Europa's icy surface and subsurface ocean make it a prime astrobiology target. The characteristics of outgassing plumes remain poorly understood. We use Direct Simulation Monte Carlo simulations to model Europa's water vapor plumes across varying gas production rates and initial velocities. In addition, our hybrid model reveals that gas drag has a significant influence on dust particle behavior: submicron particles (0.001–0.1 μm) disperse widely, whereas larger grains (0.1–10 μm) tend to deposit locally near the source.

At high production rates ($>10^{29}$ H₂O s⁻¹), gas drag dominates over initial ejection velocities, fundamentally controlling the dust plume morphology and surface deposition patterns. These results illuminate surface-subsurface exchange processes and will support the interpretation of forthcoming JUICE and Europa Clipper mission data.

11:20 – 11:40 Europa’s Ice Shell Thickness: Estimates from Thermal Evolution Models

Frederic Deschamps 戴夏飛 (ASIES), Ji-Ching Chen (ASIES), Wen-Pin Hsieh (ASIES)

Europa’s radial structure consists of a thin ice shell overlying a subsurface ocean and a large solid core. The thickness of the outer ice shell is strongly related to Europa’s thermal and geological histories. Estimates of this thickness range from a few kilometers to several tens of kilometers, with values deduced from the analysis of surface geological features being on the lower end (a few kilometers and less), and values predicted by modelling thermal evolution being on the upper end (up to a few tens of kilometers). Here, we model the thermal evolution of Europa’s ice shell using a parameterized convection approach that explicitly accounts for the release of heat (assumed to have a tidal origin) within this shell. We explore changes in the thickness of this ice shell depending on several parameters, including the bulk ice viscosity, amount of tidal heating, and ocean composition. We further consider possible cyclical variations in the amount of tidal heating in response to changes in the eccentricity of Europa’s orbit. Our calculations show that ice shell thickness is mostly influenced by both the ice bulk viscosity and tidal heating. While significant in absence of tidal heating, the ocean composition has no or few influence when tidal heating is accounted for. Interestingly, for dissipated tidal heat and viscosity around 1 TW and 10¹⁴ Pa·s, respectively, which are within the expected range of values for these parameters, our calculations predict an ice shell thickness in the range 15-45 km and, at the top of this shell, and a stagnant lid around 10 km in thickness, in agreement with recent estimates from impact basin morphology. Our calculations further indicate that a 10% change in orbital eccentricity may trigger variations in the ice shell thickness of approximately 15 km, which further helps to reconcile estimates based on geological features and modelled thermal history.

11:40 – 12:00 How Do the Saturnian Rings Stay Bright and Young?

Ian-Lin Lai 賴彥霖 (NCU), W.-L. Tseng (NTNU), W.-H. Ip (NCU)

The Saturnian rings are the largest and brightest in the Solar System, composed primarily of countless icy particles ranging from micrometers to several meters in size. More than 95% of their mass consists of water ice, while the remaining fraction is non-icy material delivered by continuous micrometeoroid bombardment. These exogenic impacts gradually darken and chemically modify the rings, suggesting that they should have lost their brightness over time. Based on this contamination rate, the rings’ age has been estimated to be ~400 million years. In contrast, the continuous transport of water from Enceladus acts as a counterprocess to this darkening. Enceladus ejects roughly 300 kg s⁻¹ of water vapor from its south-polar plumes, forming an extended neutral torus that dynamically interacts with Saturn’s rings. In this scenario, the ongoing water supply from Enceladus sustains ring brightness and may lead to an underestimation of the rings’ age.

12:00 – 12:30 The MRT Project: Looking for Moons and Rings in Taiwan

Melaine Saillenfest (LTE, Paris Obs)

Discovering rings around exoplanets is among the next major milestones of extra-solar exploration. Yet, despite technical feasibility with existing instruments, no Saturn-like exoring has been confirmed to date. While part of the explanation is observational biases, the absence of detection also comes from our profound lack of knowledge about what are rings, how they form, and what are their lifetimes. With the MRT project, we aim to answer these questions from the perspective of rings demographics in the Solar System. The existence of ring systems around small Solar System bodies gives us the opportunity of gathering many instances of rings, enabling statistical studies of their properties and natural evolution processes. To do so, the MRT project will run a network of telescopes dedicated to stellar occultations distributed across Taiwan’s territory, while benefiting from theoretical advances brought by the companion French project WRAPS: Where do Rings Appear in Planetary Systems?

Day 3 (2026 Apr. 16, Thu)

10:00 – 11:00 The JUper ICy moons Explorer: Science and Mission Overview (Plenary talk)

Paul Hartogh (MPS)

JUICE (JUper ICy moons Explorer) is the first large mission in the Cosmic Vision 2015-2025 programme. The spacecraft was launched on April 2023 and will arrive at the Jupiter system in July 2031. The primary science goals of JUICE are to characterize the Jovian icy satellites, studying their surfaces, interiors and atmospheres, to unveil their history and internal structures, and to assess the emergence of habitable environments in their internal oceans. During the Jupiter orbital tour, the spacecraft will run an extensive characterization of the Jupiter system, including the planet's atmosphere, its magnetosphere and the ring system. JUICE will focus most of its observations of the Jovian planet during 62 close passes (perijoves), leaving wide periods of time in which the planet's atmosphere will be observed less frequently, or at a poorer spatial resolution. Different from Juno, JUICE will not focus on the deep atmosphere, but try to constrain better the middle and upper atmosphere and the coupling between the layers. For the first time, simultaneous wind and temperature measurements from an orbiting satellite will be performed in the middle atmosphere in order to constrain its general circulation.

The last part of the presentation will focus on one of the remote sensing instruments on JUICE, the submillimetre wave instrument (SWI). SWI stands for an innovative instrumental concept with tunable heterodyne receivers and a telescope movable in azimuth and elevation, applied for the first time in a deep space mission. The instrumental and scientific objectives, as well as results from first observations will be presented.

11:00 – 11:30 The Gamma-ray Transients Monitor (GTM) onboard Formosat-8B and its Science Topics

Hsiang-Kuang Chang 張祥光 (NTHU)

The Gamma-ray Transients Monitor (GTM) is a science payload of Formosat-8B (FS-8B) for monitoring Gamma Ray Bursts (GRBs) and other transients, such as magnetar bursts and solar flares, in the energy band from 50 keV to 2 MeV. GTM consists of two identical modules located on two opposite sides of FS-8B, a Taiwanese remote sensing satellite. Each module has four sensor units facing different directions to cover half of the sky. The two modules will then cover the whole sky, including the direction occulted by the Earth. Each sensor unit is composed of a GAGG scintillator array (50 mm × 50 mm × 8 mm) to be readout by SiPM with 16 pixel-channels. Based on different flux levels detected by different sensor units, the direction of the GRB event can be determined. GTM will enhance the sky coverage of contemporary missions and provide independent event localization measurement. Spectral analysis and polarization-state determination for bright GRBs can be conducted with GTM data. GTM is expected to detect about 50 GRBs per year. The GTM flight model has been integrated to FS-8B satellite bus. The launch is expected in late 2026. The Gamma-ray Polarimeter and Monitor (GPM) is a similar instrument to fly on FS-8D. Different from GTM, there are 6 sensor units in each GPM module, which form a cube to enhance polarization measurement capability by catching more Compton events. GPM flight model delivery to TASA is expected in September 2027. FS-8D is scheduled to launch in late 2028. When operating together, GTM and GPM can boost localization performance with the method of arrival time difference.

11:30 – 12:00 Power Transmission of Whistlers in the Lunar Ionosphere

Kai-Ti Wang 汪愷悌 (TKU), Zhan-Rong Hsu (TKU), Jacob Bortnik (UCLA), Ya-Hui Yang (NCU)

The power transmission ratio of lunar whistlers propagating upward from the surface to 100 km high at frequencies below 10 Hz is investigated for the first time. This parameter is solved using full wave equations incorporating collisional effects from dominant ions and neutral species in the lunar ionosphere at temperatures of 150 K and 400 K in the lunar crustal field environment. The results show that increasing wave frequencies lead to decreasing power transmission ratios. This trend is consistent with the satellite observations near the Moon, which predominantly detect peak wave intensities at lower frequencies. In addition, stronger magnetic field intensities and larger angles between the field and the surface result in an increase in power transmission ratios. This finding is also consistent with the increased detection of waves in regions with higher field intensities and the more frequent occurrence rate of broadband whistlers linked to larger angles. When the temperature increases, the power transmission ratio increases, consistent with the higher occurrence rates of broadband whistlers at regions with smaller solar zenith angles. Incorporating the Doppler shift effect from solar wind on the observed wave frequency, the selenographic distribution of power transmission ratios exceeding -3 dB within the instrumentally detectable frequency range shows a

heightened northern–southern asymmetry, aligning with the established patterns of wave intensities and occurrence rates. The preference to measure harmonic whistlers at lower altitudes can be attributed to the attenuation of the higher-frequency component at higher altitudes. The fact that the intensities of left-hand polarized components are more pronounced is also consistent with this attenuation trend with increasing frequency. We will also discuss how these results vary when the densities and field strengths change.

12:00 – 12:30 Spacecraft-Plasma Interactions: From Kinetic Physics to Mission Design (online)

Chun-Sung Jao 饒駿頌 (NCHC)

As geospace exploration moves toward smaller platforms and more sensitive instrumentation, the interaction between a spacecraft and its environment becomes a primary driver of mission success. Phenomena such as surface charging, sheath formation, and wake dynamics can significantly distort in-situ measurements and impact operational stability. This presentation explores the fundamental physics of these interactions, focusing on the critical role of Particle-in-Cell (PIC) simulations. While traditional analytical models provide a baseline, kinetic treatments are essential to capture non-Maxwellian distributions and complex geometries that simplified theories often overlook. By translating these physical insights into concrete design guidance, it is possible to move plasma considerations from post-launch anomaly analysis to the early mission concept phase. This approach ensures both hardware robustness and the collection of high-fidelity scientific data for the geospace missions.

13:30 – 14:00 Taiwan-India Lunar Dust Analysis (TILDA) Mission Concept

Ying Liao 廖瑩 (NTUT), Yi-Hsuan Li (NTHU), Ian-Lin Lai (NCU), Hao-En Chang (Astrobotic), Bo-Chuan Lin (Rapidtek), Kang-Shian Pan (Academia Sinica), Inbisat Yousuf Nath (CUKmr), Nikhil Riyaz (Hexeia), Ratnesh Mishra (IDYM Foundation)

We propose a 12U CubeSat mission concept TILDA (Taiwan-India Lunar Dust Analysis) for investigating the poorly understood lunar dust environment, particularly in the polar regions, and its relationship to the lunar sodium exosphere. Lunar dust, formed by meteoroid impacts and space weathering, provides good constraints on the high-latitude meteoroid flux and the associated burial rate of bound ejecta and thus critical for understanding the long-term evolution of volatiles in lunar polar regions. The mission aims to fill this knowledge gap by identifying the size, velocity, and spatial distribution of dust particles in the low-altitude polar regions, monitoring sodium exosphere emissions, and establishing a correlation between the two. It will also demonstrate the technological capabilities of miniaturized dust detectors. The TILDA spacecraft will carry a piezoelectric dust detector (PDD) and an optical monochrome CMOS camera, ECAM-N50, and is expected to be deployed to a 100-kilometer circular lunar polar orbit around 2028, with an expected operation of approximately 360 days. This collaboration between Taiwanese and Indian entities, with an estimated total cost of approximately US\$19 million, aims to advance scientific understanding and support future lunar exploration, such as the Artemis program.

14:00 – 14:30 The Role of Magnetic Field Measurements in Taiwan's Lunar Exploration

Ya-Hui Yang 楊雅惠 (NCU), Yu-Shiang Chao (NCU), You-Min Chen (NCU), Yi-Yun Lai (NCU), Chi-Kuang Chao (NCU), Ping-Yu Chang (NCU), Kaiti Wang (TKU), Shu-Hua Lai (NCU), Peter Chi (UCLA), Pei-Ying Lin (NTNU), Wei-Ling Tseng (NTNU), and Jann-Yeng Liu (NCU)

The Moon is a planetary object characterized by the absence of a global magnetic field with a main dipole component but is found to have local crustal magnetization referred as magnetic anomalies. The interaction between solar wind and crustal magnetic fields can form mini-magnetospheres leading to the abundant electromagnetic waves at anomaly regions. In-situ exploration of lunar magnetic anomalies is therefore crucial for characterizing magnetic field turbulence near the lunar surface, evaluating the shielding efficiency of mini-magnetospheres under varying solar wind conditions, and investigating the Moon's internal geological structure to better understand the origin of its remnant magnetism. Lunar Vector Magnetometer (LVM) developed by National Central University is proposed to install on the Outer Space Exploration-Lunar Lander #1 (OSE-LL1) conducted by the Taiwan Space Agency (TASA). To achieve the scientific objectives, LVM consists of a deployable boom, a data logger, and three identical tri-axial fluxgate magnetometers. Continuous magnetic field measurements with a Normal mode will be conducted to investigate the internal geological structure of the Moon by geomagnetic bathymetry. Additionally, one of the sensors will operate in Burst mode measurements to study space weather events. In this talk, we will present a review of lunar magnetic field measurements, our recent progress in lunar science research, and the LVM development.

14:30 – 15:00 Measurement of Plasma on the Lunar Surface

Jocelyn Chang 張滋芳 (NCKU)

The team from National Cheng Kung University (NCKU) have successfully made the All-Sky Electrostatic Analyzer (A-ESA) which is a scientific payload that will be mounted on a lunar rover. The payload is composed of an electrostatic analyzer on the top, and an MCP assembly, power supply units and electronics are located under it. The science payload has the entrance scanning deflectors and the inner scanning deflectors. The entrance of A-ESA is electrically scanned within $\sim 90^\circ$ in vertical direction, i.e. A-ESA has hemi-spherical field of view (FOV). The operation of the A-ESA includes two modes: working mode and survival mode. The working mode cycles through four stages: idle stage, health data acquisition stage, scientific data acquisition stage, and data transmission stage. When the payload is operating in observation mode, the collection of science data is divided into 8 parts in horizontal direction and 6 parts in vertical direction. And it generates 16 energy levels via sweeping high voltage. Therefore it is capable of observing the variations of plasma environment on the Moon. It will measure the plasma distribution function and charged particle energy in hemi-sphere space on the lunar surface.

15:00 – 15:30 The Lunar Gravitational-wave Antenna (online)

Jan Harms (GSSI, Italy)

Gravitational-wave (GW) observations with the Virgo and LIGO detectors have revolutionized astronomy and physics. With more than 300 detections today, we can start to study in greater detail the properties of black holes and their distribution in our Universe. The observation of the merger of two neutron stars in 2017 has led to the greatest astronomical campaign in human history with numerous publications dedicated to its study. Despite these outstanding achievements, the field is only in its infancy, and new revolutionary instruments are underway like the space-based LISA mission or the proposed Einstein Telescope and Cosmic Explorer. Even with these detectors online one day, GW detectors will only observe a small portion of all possibly detectable GW sources in our Universe, and researchers have started to develop new detector concepts to further extend the scientific reach of GW detectors. Among these concepts is the Lunar Gravitational-wave Antenna (LGWA). The Moon itself acts like an antenna to GWs by starting to ring like a bell when a GW passes. A transducer needs to be built to read out the vibrations of the Moon. The Moon provides close to ideal conditions for LGWA, and it might well be the only place in our solar system where a detector like LGWA can ever be realized.

15:50 – 16:50 The Comet Interceptor Mission – Visiting a Pristine World (Plenary talk)

Satoshi Kasahara (U Tokyo)

Introduction: Comet Interceptor is the first Fast (F-class) mission in ESA's Cosmic Vision program. Its goal is the first in situ investigation of a long-period comet. Comet Interceptor (Spacecraft A or S/C A) will carry two deployable probes, allowing multipoint investigations of the target. Probe B1 is contributed by JAXA and probe B2 by ESA. The mission will be launched in late 2028 or early 2029 on an Ariane 6 towards the Sun-earth Lagrange point L2. Comet Interceptor is the first rapid response mission, waiting in space for its target comet to appear.

Science Objectives: All space missions to comets so far have visited short-period comets (SPCs). Comet Interceptor will, for the first time, target a long-period comet (LPC), ideally a dynamically new one. The mission will investigate the processes of planetesimal formation by evaluating which of the phenomena observed by previous missions, particularly during the rendezvous of Rosetta with Comet 67P, are primordial and which have developed during the many perihelion passages of those SPCs. Specifically, the objectives of Comet Interceptor are:

- 1) Comet Nucleus Science - What is the surface composition, shape, morphology, and structure of the target object?
- 2) Comet Environment Science - What is the composition of the coma, its connection to the nucleus (activity) and the nature of its interaction with the solar wind?

Mission Profile: After launch and transfer to L2, Comet Interceptor will wait for its target comet. In the unlikely case that no suitable LPC is found, the target will be selected from a list of SPCs. The comet encounter will take place near earth' orbit (between 0.9 and 1.2 AU from the sun). The duration of the waiting time

(typically a few years) and of the transfer to encounter (typically between several months and a few years) depend on the target. In the last two days before the fast flyby (velocity between 10 km/s and 70 km/s) the probes will be released from S/C A and pass by the target at nominal closest approach distances of 1000 km for S/C A, 850 km for probe B1 and 400 km for probe B2. The data from the probes are transferred to S/C A by an intersatellite link, and up to 6 months after the flyby are reserved for data downlink from S/C A to earth.

Payload: The instrumentation of Comet Interceptor is:

Spacecraft A:

- Comet Camera (CoCA): Visible high-resolution imager, 4 colour filters
- Multispectral InfraRed Molecular & Ices Sensor (MIRMIS): IR Imaging spectrometer, 0.9 – 25 μm
- Mass Analyzer for Neutrals in a Coma (MANiaC): Mass Spectrometer, mass/charge range up to ~ 1000
- Dust, Fields, and Plasma (DFP-A) instrument suite: dust detector, magnetometer, plasma instrument measuring electric fields and plasma density and temperature, ion and energetic neutral atoms spectrometer, and electron spectrometer.

Probe B1:

- Hydrogen Imager (HI): Ly α imager
- Plasma Suite (PS): Magnetometer and Ion Mass Spectrometer
- Narrow Angle Camera (NAC) and Wide Angle Camera (WAC): NAC for high-resolution nucleus imaging, WAC for Coma imaging.

Probe B2:

- Entire Visible Sky (EnVisS): All-sky imager with polarimetric capability
- Optical Periscope for Comets (OPIC): Visible Imager for science and navigation
- Dust, Fields, and Plasma (DFP-B2): Dust detector and magnetometer.

Conclusions: The Comet Interceptor mission provides various firsts:

- 1) First mission to an LPC
- 2) First multipoint investigation of a comet with three spacecraft
- 3) First rapid response mission

16:50 – 17:20 Multi-disciplinary Innovations to Solar System Origins – Our Journey to the Mission-Returned Samples

Hsien Shang 尚賢 (ASIAA), AstroLab Team

The AstroLab project is built upon a consortium of cutting-edge multi-disciplinary platforms for discoveries of our Solar System Origins. It aims to understand the delicate structures of extraterrestrial materials. With the arrival of Ryugu particles to Taiwan last year, our Team has been developing new, innovative techniques for these materials for the state-of-the-art instruments. Moving across the traditional boundaries of Astrophysics, we transform small primitive grains in meteorites as a proxy to probe deep into the dust content of the Solar System preserved from the first million years. We outline our new journey to the precious fresh samples from the Dawn of our Solar System.

17:20 – 17:40 Tentative Detection of Cyclopropenyldiene in Comets

Yo-Ling Chuang 莊幼玲 (ASIAA), Yi-Jehng KUAN (NTNU), Steven CHARNLEY (NASA)

We present the tentative detection of the ring molecule cyclopropenyldiene ($c\text{-C}_3\text{H}_2$) in the comae of comets. Our observations targeted three short-period comets—73P/Schwassmann–Wachmann 3, 17P/Holmes, and 103P/Hartley 2—as well as two Oort Cloud comets, C/2007 N3 (Lulin) and C/2012 F6 (Lemmon). These observations were conducted using the Arizona Radio Observatory Submillimeter Telescope (SMT) and the Atacama Large Millimeter/submillimeter Array (ALMA). We detected $c\text{-C}_3\text{H}_2$ in three of the observed comets, with estimated molecular production rates ranging from $(0.2\text{--}3.8) \times 10^{25}$ molecules s^{-1} . The $c\text{-C}_3\text{H}_2/\text{H}_2\text{O}$ mixing ratios were found to be between 0.01% and 0.19%. Analysis of both single-dish and interferometric data suggests that the presence of $c\text{-C}_3\text{H}_2$ in these comets is transient and spatially extended. This distribution pattern implies that the molecule is not primarily released directly from the nucleus but is instead produced through the decomposition of organic dust particles in the coma. These findings provide

new insights into the complex chemical processes occurring in cometary environments and highlight the potential role of organic dust in the formation of small carbon-based ring molecules in space.

Day 4 (2026 Apr. 17, Fri)

10:00 – 10:30 Taiwanese Contributions to the VERTECS Project

Tetsuya Hashimoto 橋本哲也 (NCHU), Tomotsugu Goto (NTHU), Kei Sano (Kyutech), Vignesh V. V. Rao (NCHU), Cossas Keng-Wei Wu (NTHU), Yu-An Chen (NTHU), Howard Jhe-Hao Chuang (NCHU), Yuki Hirose (Kwansei Gakuin University), Matsuura Shuji (Kwansei Gakuin University), Niimura Kohji (Tokyo City University), Tsumura Kohji (Tokyo City University), Tomoki Wada (NCHU), Ryo Hashimoto (Kwansei Gakuin University)

Previous observations have revealed that the near-infrared extragalactic background light (EBL) significantly exceeds the integrated light from galaxies. The source of this excess light remains unidentified, posing a major question in observational astronomy. Since objects in the early and local universe exhibit distinct emission spectra in optical wavelengths, precise optical observation can reveal the origin of the excess light. To this end, we are developing the optical Extragalactic background Radiation Exploration by CubeSat (VERTECS) mission to pinpoint the origin of the optical EBL. In 2025, the VERTECS collaboration, including Taiwanese members, successfully prepared an engineering model of the satellite, followed by a flight model. At each stage, we have passed critical mission reviews by the committee. Both of these models have also passed rigorous tests performed at Kyutech facility, including vibration test at various frequencies, thermal vacuum test, and communication/data transferring test. In this presentation, we will present Taiwan's contributions, which include (i) Development of the Taiwanese X-band Downlink Software and (ii) Development of the distortion correction software. These Taiwanese contributions, at the same time, offered Taiwanese students an invaluable talent cultivation/exchange opportunity to work at Kyutech, which has developed the largest number of nano satellites among the academic institutes in the world.

10:30 – 10:50 Black Hole Imaging with Space Missions

Hung-Yi Pu 卜宏毅 (NTNU)

Since 2017, the Event Horizon Telescope (EHT) has imaged black holes on horizon scales using a global network of radio telescopes, achieving angular resolutions of ~ 20 microarcseconds. Further improvements in resolution require extending interferometric baselines beyond the Earth, motivating the use of space-based radio telescopes. This talk reviews planned and proposed space missions for black hole imaging and their potential to advance horizon-scale astrophysics.

10:50 – 11:10 Magnetic-Confinement Effects in a Superconducting Electron Cyclotron Resonance Discharge Chamber

Shiang-Yi Han 韓相宜 (TKU)

Electron Cyclotron Resonance (ECR) plasmas provide efficient collisionless electron heating through resonant wave-particle interactions. In conventional ECR discharge chambers employing permanent or normal-conducting magnets, plasma performance is often constrained by limited magnetic field strength, broad resonance regions, and significant cross-field transport leading to enhanced wall losses. These effects restrict the achievable electron temperature and density, particularly under high-power operation.

This work investigates the plasma confinement and transport properties of a superconducting ECR discharge chamber, in which strong and spatially tailorable magnetic fields are employed to modify the fundamental loss mechanisms. The use of superconducting coils enables precise control of the ECR layer location and magnetic mirror ratio, resulting in localized resonant heating and enhanced confinement of energetic electrons. A zero-dimensional particle and energy balance model is formulated to quantify the relative contributions of ionization, wall losses, and axial plasma outflow as functions of magnetic field strength and topology.

The analysis indicates that increased electron magnetization significantly suppresses cross-field transport, effectively reducing wall-interaction losses and altering the steady-state electron energy distribution. These

results suggest that superconducting magnetic confinement introduces a distinct plasma regime for ECR discharges, bridging features of conventional ECR sources and magnetically confined plasmas. The implications for high-density plasma generation and fundamental ECR transport physics are discussed.

11:10 – 11:30 ALMASOP: Nested Morphological and Kinematic Structures of Outflows Revealed in SiO and CO Emission

Chun-Fan Liu 劉君帆 (ASIAA), Hsien Shang (ASIAA), Doug Johnstone (NRC Herzberg Astronomy and Astrophysics), Tsung-Han Ai (ASIAA/NCU), et al.

The Atacama Large Millimeter/submillimeter Array Survey of Orion Planck Galactic Cold Clumps (ALMASOP) reveals complex nested morphological and kinematic features of molecular outflows through the CO ($J = 2-1$) and SiO ($J = 5-4$) emission. We characterize the jet and outflow kinematics of the ALMASOP sample in four representative sources (HOPS 10, 315, 358, and G203.21-11.20W2) through channel maps and position-velocity diagrams (PVDs) parallel and transverse to the outflow axes. The combined CO and SiO emission exhibits the coexistence of the conventional extremely high-velocity jets and shell-like low-velocity cavity walls and new features. More complex, nested bubble-like and filamentary structures in the images and channel maps, triangleshaped regions near the base of the parallel PVDs, and regions composed of rhombus/oval shapes in the transverse

PVDs are also evident. Such features find natural explanations within the bubble structure of the unified model of jet, wind, and ambient medium. The reverse shock cavity is revealed on the PVD base regions, and other features naturally arise within the dynamic postshock region of magnetic interaction. The finer nested shells observed within the compressed wind region reveal previously unnoticed shocked emission between the jet and the

conventional large cavity walls. These pseudopulse-produced filamentary features connect to the jetlike knotty blobs, creating an impression of episodicity in mass ejection. SiO emission is enhanced downstream of the reverse shock boundary, with jetlike excitation conditions. Combined, these observed features reveal the extended structures induced by the magnetic interplay between a jet-bearing magnetized wide-angle wind and its ambient magnetized surrounding medium.

11:30 – 11:50 Chemical Composition of Ceres' Exosphere

Hsien-Ju Tsai 蔡顯如 (NTNU), Yi-Jehng Kuan, Yo-Ling Chuang

Ceres is a dwarf planet in the Asteroid Belt, a leftover of primordial Solar System formation. Dawn Space Mission reported the probable existence of a subsurface relict ocean in Ceres' upper mantle, which is brine-rich. Salty water may be deposited onto Ceres' surface from impact craters (Nathues et al., 2020). Diurnal haze was discovered in the Occator crater in Ceres' daytime, likely responsible for Ceres' exosphere (Thangjam et al., 2016). We thus conducted high spatial resolution (at $\sim 0.1''$) spectral observations of molecular species, e.g., CS, HCN, HC₃N, and KCl, on Ceres using the ALMA array in Band 7. Our preliminary results indicate that molecular species detected in Ceres' exosphere are in the southern hemisphere primarily and are associated with surface craters, such as the Occator crater, the largest crater on Ceres, and the Urvara crater, the 3rd-largest on Ceres.

11:50 – 12:10 High-temperature Events in Solar Nebula Recorded by Ca-Al-rich Inclusion and Wark-Lovering Rim

Tsung-Lin Wu 吳宗霖 (NTNU), Yung-Hsin Liu (ASIES), Der-Chuen Lee (ASIES), Hsien Shang (ASIAA), Yueh-Ning Lee (NTNU)

Calcium-Aluminum rich inclusion (CAI) is the earliest mineral assemblages that condense and solidify from high-temperature gas left from the formation of the Sun. CAI can be found in carbonaceous chondrites, which are 'undifferentiated' meteorites with a composition similar to the Sun and the solar nebula. By analyses the mineralogical, chemical and isotope compositions of these CAI, we can understand the evolution of early solar system. Most CAI experienced multiple melting and shock events, forming a unique layered structure called the Wark-Lovering rim (W-L rim). We can observe this feature in many CAIs, indicating significant and non-accidental events after forming the CAIs. Therefore, we select CAIs from the Allende meteorite for mineralogical, petrographic, and oxygen isotope composition analyses to investigate the complete thermal history of the CAIs and outer W-L rim. Our experiment results show that various oxygen isotope signatures

in the CAI and WL rim of sample A3-8, especially spinel and hibonite, are rich in ^{16}O . At the same time, fassaite is ^{16}O -poor relatively, and the same types of minerals show similar oxygen isotope abundance wherever they are distributed in A3-8. In our work, we try to explain isotopic variation in A3-8 and discuss several possible mechanisms. So far, the corresponding mechanisms and local astrophysical conditions still needed to be further investigated

12:10 – 12:30 Investigation of Calcium Dust in the Interstellar Medium

Ya-Yu Chu 朱雅妤 (ASIAA), Sascha Zeegers (ASIAA), Hsien Shang (ASIAA), Chi-Liang Chen (NSRRC), Mau-Tsu Tang (NSRRC), Ming-Jye Wang (ASIAA), Yun-Liang Soo (NTHU), Elisa Costantini (SRON), Ioanna Psaradaki (ESTEC), Daniele Rogantini (U. of Chicago), and H. Mutschke (AIU)

Calcium is one of the most abundant elements in the solar system. In the interstellar medium, calcium is highly depleted from the gas phase and most likely completely locked up in dust particles. However, the chemical composition and structure of Ca-bearing dust in the ISM remain to be determined. Considering that cosmic dust is dominated by silicon, carbon, and oxygen, calcium in the ISM is thought to bind with these elements and be present in several solid-state species. Unfortunately, we have little to no observational proof of this. We investigate calcium dust in the ISM using high-resolution X-ray spectroscopy. Three low mass X-ray binaries are chosen as the background sources, and we study the extinction along several sight lines. The X-rays provide a direct method to explore the absorption and scattering properties of the interstellar dust. Thus, we measure the X-ray

absorption spectra of possible calcium-bearing dust analogs at the National Synchrotron Radiation Research Center, NSRRC, in Taiwan. Several X-ray binaries are chosen as background light sources to study cosmic X-ray interactions, including both absorption and scattering, with interstellar dust. To investigate the intervening interstellar medium along various lines of sights, we selected sources with a large column density. We combine laboratory measurements and astronomical observations from the Chandra telescope using SPEX software. Additionally, we employ simulations with the XRISM telescope to achieve enhanced resolution and more effective coverage in the lower X-ray energy range.

Eventually, we compare the real observational data with that obtained from the recently launched XRISM telescope. Through this project, we aim to characterize the chemical composition of calcium-bearing dust using X-ray absorption fine structure as a diagnostic tool for future studies on the dust cycle in the solar system and the ISM.

12:30 – 12:50 The Four Seasons of Mercury's Sodium Tail

Chen-Yen Hsu 許溱謙 (NCU), Ian-Lin Lai (NCU), Wing-Huen Ip (NCU)

Mercury has an elongated and tenuous sodium exosphere that extends into a comet-like tail, which is observable with ground-based telescopes. At Lulin Observatory, we employed a small telescope equipped with a narrow-band sodium filter to monitor Mercury's sodium tail. We found a dependence of the sodium tail on Mercury's true anomaly angle (TAA). We detected a bright sodium tail during outbound phases, while during inbound phases, the tail seemed to be "absent". This asymmetry is consistent with earlier findings, the "non-detection" cases reported by Schmidt et al. (2010), which we confirm occurred during inbound orbital phases. In addition, Potter & Killen (2008) suggested that solar radiation pressure can exert asymmetric acceleration on particles depending on Mercury's orbital direction. To further investigate this phenomenon, we conducted numerical simulations on Mercury's sodium exosphere, trying to explain this observed scenario and particle dynamics on Mercury. This study can also be applied to objects which have such emissions, and provide diagnostic context for the upcoming BepiColombo observations of Mercury's volatile environment.

Posters

Data Downlink Pipeline for the VERTECS X-Band Ground Station

Jhe-Hao Chuang (NCHU), Keng-Wei Wu (NTHU), Yu-An Chen (NTHU), Tetsuya Hashimoto (NCHU), Tomotsugu Goto (NTHU), Tomoki Wada (NCHU), Kei Sano (Kyutech), Ryo Hashimoto (Kwansei Gakuin University), Abdulla Hil Kafi (Kyutech), Shotaro Yamasaki (NCHU), Vignesh V. V. Rao (NCHU)

The Visible Extragalactic background Radiation Exploration by CubeSat (VERTECS) is a 6U nano-satellite designed to measure the optical Extragalactic Background Light (EBL) to probe the cosmic star formation history. The raw image data is transmitted via X-Band during limited satellite visibility passes, making packet loss inevitable. As one of the Taiwanese contributions, we developed a fully automated data downlink pipeline that continuously monitors incoming binary files, identifies missing packets by comparing received Packet Sequence Counts (PSC) against expected totals, and applies adaptive handling: complete files are compiled directly into FITS format; partial receptions are compiled with zero-padding and cached for merging with future retransmitted data; severely incomplete files are flagged for full-file retransmission. The pipeline generates structured CSV reports that specify exact missing PSC ranges for retransmission scheduling, and a standalone command encoding tool (CRC-16/X-25) was additionally developed for laboratory testing. Validation using Engineering Model (EM) test data demonstrates successful FITS image reconstruction and correct identification of missing segments. The software is designed for deployment across multiple VERTECS ground stations to ensure consistent, science-ready data for EBL analysis.

Estimation of Bad Pixels in the EM Detector of the VERTECS Cube Satellite

Vignesh V. V. Rao (NCHU), Tetsuya Hashimoto (NCHU), Yuki Hirose (Kwansei Gakuin University), Tomotsugu Goto (NTHU), Matsuura Shuji (Kwansei Gakuin University), Niimura Kohji (Tokyo City University), Kei Sano (Kyutech), Tsumura Kohji (Tokyo City University), Cossas Wu (NTHU), Yu-An Chen (NTHU), Howard Chuang (NCHU)

The Extragalactic Background Light (EBL) represents the integrated extragalactic radiation accumulated from the early Universe to the present epoch. Measuring the EBL is therefore a key observational constraint on the cosmic star formation history. However, EBL has an infrared excess from the integrated galaxy light with an unknown origin. The possible scenarios for the mysterious excess include first stellar objects in the early Universe and intra-halo light in the local Universe. The two scenarios predict significantly different EBLs in optical, where the EBL is poorly explored due to some technical difficulties, such as Zodiacal light subtraction etc. To this end, the VERTECS 6U nano-satellite is designed to measure the EBL in optical. Because the EBL signal is extremely faint and diffuse, achieving robust low surface brightness photometry requires rigorous detector calibration, particularly reliable identification of defective pixels in the EM detector. Our pipeline uses dark and flat-field calibration exposures to identify and mask bad pixels in the EM detector. Bad pixels are detected using an annulus-based local statistics method: for each pixel, background values are sampled within an annular neighborhood to estimate the local distribution while minimizing sensitivity to large-scale gradients. Pixels deviating by more than $\pm 5\sigma$ from the local mean are classified as hot or cold outliers and flagged. A binary defect mask (0 for bad pixels, 1 for good pixels) is applied to science frames to suppress the systematics, improve image uniformity, and strengthen the reliability of EBL measurements.

Three-Dimensional Simulation of the Observational Frequency Range of Lunar Whistlers

Chi-Ying Lu (TKU), Kaiti Wang (TKU), Li-An Wang (TKU)

Recent lunar exploration missions have highlighted the importance of pre-mission scientific payload planning. Predicting expected observational parameters along a spacecraft's orbit can significantly improve payload design and mission preparation. This study aims to establish the observable frequency range of electromagnetic whistler-mode waves from the lunar surface up to an altitude of 200 km, providing a quantitative reference for future lunar orbiter missions. Global lunar surface magnetic field models and magnetic field observations at 200 km altitude from the Kaguya (SELENE) spacecraft are used to construct a three-dimensional magnetic field distribution. Based on these magnetic field

strengths, the electron cyclotron frequency is calculated as the theoretical upper limit of whistler-mode wave frequencies, while the lower bound is estimated using assumed ion cyclotron frequencies for different ion species. Since whistler-mode waves propagate upward on the lunar dayside, their observed frequencies are influenced by Doppler shifts from the solar wind speed. To evaluate this effect, Doppler-shifted frequency distributions are simulated under solar wind speeds ranging from 200 km/s to 950 km/s. The results will provide quantitative information on the expected frequency range of whistlers in lunar orbit, which is beneficial to scientific payload design and mission operation planning under varying solar wind conditions.

Reveal the devil in the detail: Nano-scale secondary ion mass spectrometry (Nano-SIMS)

Silver Sung-Yun Hsiao (ASIAA), Der-Chuen Lee (ASIES), Hsien Shang (ASIAA)

Nano-meter-scale secondary ion mass spectrometry (nanoSIMS) has been used for frontier researches in many field including geoscience, biology, material science and planetary science. It can analyze the lateral distributions of elements and/or their stable isotopes by very high spatial resolution (down to 50 nm per pixel). We can analyze polished solid sample (such as meteorite or stalagmite) and also thin slides which were cut by microtome or focused ion beam(FIB). Welcome to contact us for interdisciplinary research collaboration.