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[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

Day 1 (2025 Feb 10, Mon)

10:00 - 11:00 The Distant Past and Far Future of the Saturnian System (Plenary talk)
Wing Ip (NCU)

Saturn is unique in the sense that it has a massive ring system, a number of mid-sized icy satellites like Tethys, Dione and Rhea not found in other planets, a gas spawning small moon called Enceladus, a captured large KBO called Phoebe, a half-face moon with a huge circum-equatorial mountain ridge called Iapetus, and then Titan with its methane seas hidden by a thick atmosphere. How have they formed and evolved together and separately, and what will happen in future? This might be a story that Thucydides would have liked. Let us begin......

11:20 - 11:50 On the age of Saturn's rings, and a possible future mission to Saturn's rings
Ryuki Hyodo (ELSI, SpaceData)

In this talk, I will first present a long-standing debate regarding the age of Saturn's rings. NASA Cassini observations indicate that Saturn's rings appear remarkably clean, consisting of approximately 95% water ice by mass. Based on the hypothesis that micrometeoroids can pollute the rings over time, the age of Saturn's rings has been estimated to be around 100–400 million years (e.g., Kempf et al., 2023, Science Advances). However, a recent study found that the rings may possess mechanisms that resist pollution (Hyodo et al., 2024, Nature Geoscience). The rings could be billions of years old with this pollution resistance mechanism. I will explain these differing arguments in detail.

Secondly, I will introduce a potential mission to study Saturn's rings. The concept involves a spacecraft designed to fly much closer to the rings than NASA's Cassini mission achieved. Although this mission is still in the conceptual study phase, I will discuss what type of mission we should pursue following the successful Cassini mission.

11:50 -12:20 An investigation of Io's dynamical atmosphere with SMA's broadband observations
Wei-Ling Tseng (NTNU), Rong-Ting Hsu (NTNU), Ting-Yu Lin (NTHU), Sheng-Yuan Liu (ASIAA),
Mark Gurwell (CfA, USA), Ian-Lin Lai (NCU), Baobab Liu (NSYSU)

Io, the most volcanically active body in the Solar System, possesses a dynamic atmosphere shaped by volcanic eruptions and the sublimation of surface frost. Utilizing the Submillimeter Array (SMA), we conducted high-resolution observations of Io's atmosphere to investigate its variability and thermal structure. Data collected over three nights in 2022 identified 22 rotational lines of SO_2 within the 336-364 GHz range, allowing for improved constraints on gas temperatures and column densities. Observations indicated that the SO_2 emissions on the dayside were primarily driven by frost sublimation, consistent with previous studies, and exhibited equatorial bands and longitudinal asymmetries. Gas temperatures ranged from 240 to 270 K, and SO_2 column densities were estimated to be (2-3) × 10^{15} cm^{-2}. Radiative transfer modeling, which incorporated an isothermal profile and gas turbulence—possibly associated with volcanic lava lakes—provided insights into atmospheric dynamics. This study establishes a robust framework for analyzing Io's atmospheric processes and lays the groundwork for future investigations into its complex interactions with Jupiter's environment.

13:40 - 14:10 The Criticality of System Engineering in Space Program
Dan-Kai Liu (NASA/JPL)

The presenter will discuss the critical role of Systems Engineering in aerospace, emphasizing its significance in achieving mission success. Systems Engineering is the backbone of the entire mission lifecycle—from mission scenarios and requirements development to implementation, verification, and validation (V&V) and operations.

With the advent of Model-Based Systems Engineering (MBSE) and tools like SysML, Systems Engineering is evolving into a well-defined engineering discipline. This transformation enhances precision, traceability, and efficiency, enabling system engineers to systematically model, analyze, and manage complex systems. These capabilities are essential to address the growing challenges of modern aerospace missions.

14:10 – 14:40 The Current Development of Space Laser Optical Communication (OCT)
Liang-Tang Chen (TASA)

To meet the demands of next-generation communication development, Taiwan has actively invested in the research and development of free-space laser communication technology. Laser communication systems are widely used for satellite signal links and data transmission, demonstrating their importance in the future communication field. In the development of satellite laser communication systems, the most critical task is to ensure that the system design and implementation comply with the relevant standards set by the Space Development Agency (SDA) of the United States, ensuring compatibility with international standards and technological foresight.

To further enhance domestic laser communication technology, Taiwan is dedicated to independent R&D, focusing on the development of comprehensive communication systems spanning Low Earth Orbit (LEO) to LEO, LEO to Geostationary Orbit (GEO), and satellite-to-ground station links. This research also encompasses ultra-high precision satellite tracking, highly weather-resistant ground station systems, and low-latency, high-bandwidth transmission technologies. These systems have progressively undergone initial validation and testing.

Moreover, considering the potential challenges of free-space laser communication in practical applications, such as satellite platform jitter, external environmental interference, and atmospheric attenuation, Taiwan has also concentrated on the development of vibration-resistant designs, precise beam alignment technologies, and adaptive optical systems. These efforts aim to ensure the stability and reliability of communication systems.

14:40 – 15:10 The challenges of commercial lunar missions
Hao-En Julian Chang (Astrobotic)

In the recent years, humanity's growing interest in lunar exploration has sparked a new wave of space missions that aim to reach the moon. Unlike before, a large number of these missions are designed and owned by commercial companies instead of large government entities. While this increasing trend towards commercialization of space has facilitated the revitalization of global space industry by driving up competition to make space more accessible to the world, the challenges of getting to the moon are hardly ignored. In fact, the uptick in commercial lunar missions is often overshadowed by the number of mission failures that may have occurred at various phases of their missions. The underwhelming success rate of lunar missions to date speaks to the enormous challenges involved in architecting a spacecraft robust enough to withstand the adverse environments of space. Amongst the wide-ranging failure modes, the loss of propulsion systems is commonly identified as the root cause of these mission failures. Considering that the fundamental technology in spacecraft propulsion systems is largely unchanged from the heyday of the Apollo Program, then why is it that this seemingly mature technology still causes so much headache for space engineers? This talk will go over in greater details on the design vulnerability of a hypergolic propulsion system, which is the predominant choice of engine systems for lunar spacecrafts.

15:10 – 15:30 Application of Plasma Simulation in Studying the Interaction Between Space Plasma and Spacecraft/Scientific Payload: A Case Study with the Multi-Needle Langmuir Probe
Chun-Sung Jao (National Cheng Kung University), Wojciech J. Miloch (University of Oslo),
Yohei Miyake (Kobe University, Kobe, Japan)

To explore the Sun-Earth environment, space plasma research relies on two primary approaches:

ground-based observations and in-situ measurements. In particular, in-situ measurements are conducted using scientific payloads carried by moving platforms such as sounding rockets or satellites. However, a moving spacecraft can disturb the local plasma environment, potentially affecting the measurement results. Over several decades, numerical simulations have proven to be effective tools for designing space missions and scientific payloads, as well as for understanding the interactions between flying objects and the surrounding plasma. In this presentation, we use the multi-needle Langmuir probe (m-NLP) instrument as an example to demonstrate how plasma simulations can be applied to study these interactions.

16:00 – 16:30 A Mission Design for GNSS Remote Sensing Constellation in Taiwan
Yung-Fu Tsai (TASA)

Triton program is the first global navigation satellite system reflectometry (GNSS-R) mission in Taiwan which carries a Taiwan Space Agency (TASA) in-house built GNSS-R receiver. In a GNSS reflectometry (GNSS-R) mission, the reflected signals can be processed to form delay Doppler maps (DDMs) so that the various geophysical parameters of Earth's surface, such as roughness, ocean wind speed, and soil moisture can be retrieved. Furthermore, GNSS radio occultation (GNSS-RO) has been demonstrated its tremendous usage in atmospheric soundings by retrieving the temperature, pressure, and water vaper from the bending angle of GNSS signal while passing through the atmosphere. The most successful mission is FORMOSAT-3/COSMIC, launched in 2006, and co-developed by Taiwan and the United States. Owing to the success, the follow-on mission, FORMOSAT-7/ COSMIC-2, was launched in 2019 and also a Taiwan-USA cooperation 6 satellites constellation mission.

The GNSS-RO/R mission is poised to be the next advancement in Taiwan's GNSS remote sensing capabilities, aiming to gather both atmospheric and ocean surface roughness data simultaneously to improve severe weather predictions. This presentation outlines the conceptual design for the GNSS-RO/R mission, detailing the architecture and development methodology for the payload system, which utilizes TASA's proprietary technology. The discussion concludes with insights on future GNSS-RO/R mission roadmaps and developments.

16:30 – 17:00 A novel concept to prolong the forecasting time of space weather HENON Project
Gilbert Pi (Charles University)

HEliospheric ponNeer for sOlar and interplanertary threats defeNce (HENON) is an innovative project. The primary purpose is to test the stability of the Sun-Earth distant retrograde orbit (DRO). Extending space weather forecasts has become a hot topic nowadays. DRO is a novel solution for setting up a solar wind monitor with a distance much farther than L1. The Space Physics Laboratory at Charles University is also involved in the HENON project and is responsible for providing the plasma detector.

Day 2 (2025 Feb 11, Tue)

10:00 – 11:00 OSIRIS-REx Returned a Piece of the Early Solar System (Plenary talk)
Jason P. Dworkin (NASA Goddard Space Flight Center)

NASA's robotic Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer (OSIRIS-REx) asteroid sample return mission seeks answers to the questions that are central to the human experience: Where did we come from? What is our destiny? Asteroids, the leftover debris from the solar system formation process, can address these questions and teach us about the history of the solar system. OSIRIS-REx launched in September 2016, arrived at carbonaceous B-type near-Earth asteroid Bennu in December 2018, studied the asteroid then collected >120g of surface rocks in October 2020, and delivered it to Earth in September 2023, where the international science team began to study them. These samples are now available for investigations, they provide a pristine record of the chemical processes that occurred in the early solar system prior to the origin of life.

11:00 – 11:30 Introducing AstroLab: from Cutting-edge Multi-disciplinary Innovations to Solar System Origins
Hsien Shang (ASIAA) and the Astrolab Team

The AstroLab project is built upon a consortium of cutting-edge instrumental platforms. It aims to understand the delicate structures and components carried in extraterrestrial materials. In particular, the team is developing new, innovative sample-mounting techniques for these materials based on those previously developed for condensed matter physics. Moving across the traditional boundaries of disciplines in Physical sciences and 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.

11:30 – 12:00 The Surface-Bounded Lunar Exosphere

Ian-Lin Lai (IANCU), C.-Y. Hsu (IANCU), Z.-Y. Lin (IANCU), W.-H. Ip (IANCU)

The Moon's extremely rarefied atmosphere allows gas molecules and atoms to move across the lunar surface in collisionless, ballistic trajectories without interacting with other species. As a result, gas-surface interactions play a critical role in shaping the lunar exosphere. These interactions are determined by processes such as source generation, loss, and recycling, leading to distinct behaviors for each species in the surface-bound exosphere. As a result, these dynamics significantly impact the structure, distribution, and diurnal variations of the lunar exosphere. In this study, I will present a detailed analysis of the behavior of gas species such as helium (He), argon (Ar), sodium (Na), and radon (Rn) within the lunar exosphere.

12:00 - 12:20 Studies on Mercury's Dynamic Sodium Exosphere: Simulations and Observations

Chen-Yen Hsu (IANCU), Ian-Lin Lai (IANCU), S. Fatemi (Umeå University), Wing-Huen Ip (NCU)

Mercury's sodium exosphere is highly dynamic, responding to both solar and interplanetary conditions. The variability in its structure arises from complex interactions between the solar wind, Mercury's surface, and its magnetospheric environment. Solar wind events and meteoroid impacts play pivotal roles in shaping these dynamics. We investigate how solar wind conditions influence sodium production and transport in Mercury's exosphere through particle simulations. Focusing on a high-speed stream (HSS) event, we analyze morphological changes in sodium distributions during different phases of the event. Our results reveal a correlation between the relative flux of sodium in Mercury's northern and southern cusps and the IMF Bx component, while the overall production rate is modulated by Bz. Meteoroid impacts also significantly contribute to the variability of Mercury's exosphere by releasing neutral sodium atoms, which are subsequently ionized by solar radiation or through charge exchange with solar wind particles. These newly formed pickup ions are transported and influenced by Mercury's dynamic magnetosphere, which is strongly shaped by solar wind conditions. Our simulations demonstrate how ions produced during meteoroid impact events can be transported and energized, leading to the production of energetic neutral atoms (ENAs) through charge exchange processes. These ENAs provide crucial observational signatures of Mercury's exosphere-magnetosphere interactions and are detectable by spacecraft instrumentation. To bridge these simulations with observations, we conduct ground-based monitoring of Mercury's sodium tail at Lulin Observatory in preparation for the upcoming BepiColombo mission. By imaging and analyzing Mercury's sodium tail under varying solar wind conditions, we aim to complement in situ measurements from BepiColombo. This combined approach of modeling, simulation, and observation not only enhances our understanding of Mercury's unique environment but also contributes to the interpretation of the mission's findings, offering new insights into the interplay between solar wind dynamics, meteoroid impacts, and Mercury's exosphere.

13:30 – 14:30 Science Drivers for Cometary Sample Return (Plenary talk)

Steven Charnley (NASA Goddard Space Flight Center)

Comets are the least processed bodies in the solar system and so returned samples can provide invaluable information about the formation of the Solar System and the interstellar molecular cloud from which it formed. Analysis of samples from cometary nuclei in terrestrial laboratories will provide unprecedented insights into their composition, especially that related to organic molecules, isotopologues, and to their possible role in providing water and prebiotic molecules to the early Earth. In this talk, I will summarize what is currently known of the chemistry of comets and identify important scientific targets for a sample return mission.

Mumma, M. J. Charnley, S.B. (2011), Annu. Rev. Astron. Astrophys., 49, 471.

14:30 – 15:00 History, current status, and future plan of Taiwan meteorological satellite missions
Wen-Hao Yeh (TASA)

With the advent of Global Navigation Satellite System (GNSS), the GNSS signal is not only used for positioning and navigation, and is possible to explore the Earth environment by using GNSS signal. The most popular applications of space based GNSS signal are radio occultation (RO) and reflectometry (GNGG-R).

RO technique began to be developed in the end of 20 century for the Earth atmosphere and ionosphere observations. The most famous RO satellite missions are FORMOSAT-3/COSMIC (F3/C) and FORMOSAT-7/COSMIC-2 (F7/C2). F3/C was a constellation satellite mission contains 6 satellites and was launched in 2006 with the cooperation between Taiwan and USA. F3/C satellites receive horizontal propagating GPS signal for RO and provide around 2500 atmospheric pressure, temperature, and moisture profiles and around 2000 ionospheric electron density profile per day. Due to success of F3/C, the follow-on mission, F7/C2, was launched in 2019. F7/C2 also a Taiwan-USA cooperation mission with 6 satellites constellation. F7/C2 satellites not only receive GPS but also GLONASS and Galileo signal and provide around 6500 atmospheric and around 4500 ionospheric profiles per day.

GNSS-R technique began to be developed from the early 21 century and use the Earth surface reflected GNSS signal to retrieve the Earth surface parameters, such like ocean surface wind speed, soil moisture, sea ice presence, etc. In recent times, many satellite missions has been launched for GNSS-R. On October 9th, 2023, the first Taiwan-built meteorological satellite, Triton, was launched for GNSS-R mission. Triton represents the culmination of efforts by TASA in collaboration with over 20 Taiwanese companies, with domestic engineering and manufacturing accounting for 82% of the entire satellite project. The mission payload, GNSS-R receiver, is used to receive the ocean surface reflected GPS signal for ocean surface wind speed measurement.

In this report, the history of F3/C, F7/C2, and Triton will be introduced first. Then explain the illustration for the principle of RO and GNSS-R and show the benefit of RO and GNSS-R meteorological measure for weather and climate. Followed by the conclusions and the plan of future meteorological satellite mission.

15:00 – 15:30 Responses of the upper atmosphere to the gravitational force of the relative positions between the Sun, the Moon, and the Earth
Jann Yenq Tiger Liu (CAPE, DSSE, and CSRSR at National Central University), Tsung Yu Wu (CAPE at National Central University), Chi-Yen Lin (CAPE and DSSE at National Central University)

The semidiurnal (12.42 h) and semimonthly (14.76 days) lunar tides have been well-known by fishermen for several centuries. The gravitational force of the relative positions between the Sun, the Moon, and the Earth results in two symmetrical tidal bulges (double bulges) appearing at equatorial latitudes directly under and opposite the Moon. Ionospheric GNSS (Global Navigation Satellite System) radio occultation soundings reveal the global three-dimensional structures and dynamics of the double bulges of Earth's upper atmospheric lunar tides for the first time. The double-bulge amplitude of ionospheric F2-peak height hmF2, lagging the sublunar or antipodal point by about 2–3 h, is about 3–5 km at the equator and 1.5–2.0 km at ± 35° magnetic latitude. It is found that when the sublunar point is near 0° latitude, the double-bulge amplitude of hmF2 reaches approximately 8–10 km at the equator, implying the declination effects play an important role. The electron density further depicts global three-dimensional plasma flows in the ionosphere. Meanwhile, the most prominent feature in the ionosphere is the equatorial ionization anomaly (EIA), which is characterized by two enhanced plasma crests at low latitudes straddling the magnetic equator. Global ionosphere maps of total electron content are analyzed to see how the ionospheric EIA crests respond to changes in lunar phases. The results show that the EIA crests exhibit prominent semimonthly lunar tides with 14.77-day period. Appearance times of the EIA crests on new/full moon (first/third quarter) lead (lag) those on the associated average by about 20–40 min, while the EIA crests move the furthest poleward during new/full moon and equatorward during first/third quarter with the delays of about 2–5 days. These indicate that the lunar phase can significantly modulate the ionospheric EIA.

16:00 – 16:30 Exploring the Oceanity of the Dwarf Planet Ceres

Yo-Ling Chuang (ASIAA)

Ceres, a key target of NASA's Dawn mission, is known to possess a warm, volatile-rich interior containing liquid water. The discovery of aliphatic organic matter on this aqueously altered body suggests the potential for extensive prebiotic synthesis, making Ceres an object of considerable interest in the study of primitive solar system bodies and astrobiology. Observations by the Dawn mission of surface water ice, hazes, and organic compounds indicate the presence of an exosphere, likely formed through mechanisms such as solar wind sputtering, cryovolcanism, and thermal sublimation, which release materials into space. Consequently, the molecular composition of the exosphere provides critical insights into the surface chemistry of Ceres.

To explore this further, we used the Atacama Compact Array to search for spectral emissions within Ceres' molecular exosphere. Preliminary findings suggest the tentative detection of molecular emissions from sodium chloride (NaCl) and potassium chloride (KCl). These chloride detections imply the presence of salt-bearing water ice on Ceres' surface, likely originating from substantial subsurface reservoirs of salty liquid water. If confirmed, the identification of NaCl and KCl would offer indirect but compelling evidence for the existence of significant subsurface saline water reservoirs on Ceres. Additionally, the detection of chlorides enables the measurement of chlorinity in these reservoirs, a critical factor in advancing our understanding of Ceres' origins and its potential oceanic characteristics.

16:30 – 17:00 Spacecraft missions of planetary gravity
Ben Chao (ASIES)

Gravitation is the most dominant force in the universe. We shall review the W's of what, who, where, when, and how of the classical Newtonian gravity. The key is the orbital dynamics; we shall highlight its principles and applications in spacecraft explorations of the solar system as well as in understanding of planetary physics based on our knowledge about the planet Earth.

Day 3 (2025 Feb 12, Wed)

10:00 – 11:00 Europa Clipper Science and Mission Overview (Plenary talk)
Robert Pappalardo (Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA) and the Europa Clipper Science Team

NASA's Europa Clipper spacecraft was successfully launched on 14 October 2024. The mission's overarching science goal is to explore Europa to investigate its habitability. The mission will characterize Europa's ice shell and ocean, study its composition, investigate its geology, and search for and characterize any current activity, including possible plumes. The spacecraft is on a Mars-Earth Gravity Assist (MEGA) trajectory and then will enter Jupiter orbit in April 2030. Beginning March 2031, Europa Clipper will collect science data while flying past Europa multiple times at closest approach distances of typically 100 – 25 km altitude.

The mission's objectives will be addressed using an advanced suite of complementary instruments. The remote sensing payload consists of the Europa Ultraviolet Spectrograph (Europa-UVS), Europa Imaging System (EIS), Mapping Imaging Spectrometer for Europa (MISE), Europa Thermal Imaging System (E-THEMIS), and Radar for Europa Assessment and Sounding: Ocean to Near-surface (REASON). The *in-situ* instruments are the Europa Clipper Magnetometer (ECM), Plasma Instrument for Magnetic Sounding (PIMS), SUrface Dust Analyzer (SUDA), and MAss Spectrometer for Planetary EXploration (MASPEX). Gravity and Radio Science (G/RS) will be achieved using the spacecraft's telecommunication system, and valuable scientific data for Radiation Monitoring (RadMon) will be collected by engineering sensors.

The Europa Clipper team is documenting the mission, science plans, and instruments in a topical collection of the journal *Space Science Reviews*. The science team has begun science observation planning for the selected tour to detail the science observation strategy. ESA's JUpiter ICy moons Explorer (JUICE) spacecraft is expected to be in the Jovian system at the same time, and the two science teams have begun informal collaborations to consider synergistic science opportunities. This presentation will provide the most current information on the mission and its science.

11:00 – 11:30 Submillimeter Spectral Study of an Icy Ocean World
Yi-Jehng Kuan (NTNU/CAG)

Surface organics were found on Solar-System icy worlds, such as Ceres, Europa, Ganymede, Callisto, Enceladus, Titan, and Triton. Many of these icy bodies may contain putative subsurface oceans and are the most promising places for harboring life in our Solar System. Identification of key molecular species and trace compounds in the plumes is thus critical to constrain theories for the internal constitution and composition of subsurface oceans and to investigate whether icy moons are life-sustainable as the plumes would contain the most original composition of subsurface oceans. Submm spectral observations of Jovian icy moons were thus carried out; findings of neutral gas molecules detected will be presented, and their possible origins will be discussed.

11:30 – 11:50 A Numerical Simulation of the Neutral Atmospheric outflow and Loss Processes of the Jovian Moon, Europa
Meng Tse Yang (NCU), Wing-Huen Ip (NCU), Ian-Lin Lai (NCU), Hua-Shan Shih (NCU),
Chen-Yen Hsu (NCU)

From its close flyby observations of the Jovian Moon, Europa, the JUNO mission made the important discovery that the hydrogen molecular production rate can be constrained to be 4.5±2.4×10^26 H2/s and hence a production rate of 2.2±1.2×10^26 O2/s for the oxygen molecules from radiolysis of H2O ice at the surface layer (Szalay et al., 2024, Nature Astronomy, 8, 567-576). It was also reported that the H2 loss is driven by a nonthermal outflow that might be generated by Europa's interaction with the Jovian magnetosphere. On the basis of our previous work (Ip, 1996, Icarus, 120, 317; Ip et al., 1998, Geophys. Res. Lett. 25, 829-832), the electron impact ionization, charge exchange, Joule's heating, and ion pickup processes are examined by coupling a simple MHD flow model with an atmospheric model according to the JUNO measurements. This theoretical treatment will allow new insight to the intriguing surface atmosphere-magnetosphere interaction (SAMI) at Europa that is to be visited by the Europa Clipper spacecraft of NASA.

13:00 – 13:30 Gamma-ray Transients Monitor (GTM) onboard Formosat-8B
Hsiang-Kuan Chang (NTHU)

The Gamma-ray Transients Monitor (GTM) is a secondary science payload of Formosat-8B (FS-8B) for monitoring Gamma Ray Bursts (GRBs) and other transients 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. Its flight model has gone through all required environmental tests successfully and was delivered to Taiwan Space Agency (TASA) in September 2023. On-ground calibration is being conducted. The launch is expected in 2026.

13:30 – 14:00 Revealing the Origin of the Excess Optical Extragalactic Background Light:
The VERTECS CubeSat Mission
Tomo Goto (NTHU), Tetsuya Hashimoto (NCHU), Kei Sano (Kyutech) and the VERTECS collaboration

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. The key to solving this question is observation in optical. Since objects in the early and local universe exhibit distinct emission spectra in optical wavelengths, precise optical observation can pinpoint the origin of the excess light.

However, accurate measurements of the optical EBL necessitate a space telescope to avoid the emission from the Earth's atmosphere. To this end, we are developing a 6U CubeSat, the Visible Extragalactic background RadiaTion Exploration by CubeSat (VERTECS) mission to pinpoint the origin of the optical EBL. Because of its large field of view (36 deg2), VERTECS is more sensitive than the Hubble Space Telescope for EBL. We aim to constrain the optical EBL to a statistical error of 1σ < 1.0 nW/m2/sr, which will be the most accurate EBL measurement in optical wavelength. VERTECS is a collaboration project between NCHU/NTHU and Japanese institutes including Kyutech. Taiwanese members contribute to critical parts of the mission, (i) developing the data acquisition software, and (ii) downloading the X-band data with the help of CSRSR.

14:00 – 14:20 Modelling Pseudodisk Structures in Star Forming Envelopes using the GPU code Astaroth

Miikka S. Väisälä (ASIAA), Hsien Shang (ASIAA),
Daniele Galli (INAF–Osservatorio Astrofisico di Arcetri),
Susana Lizano (Instituto de Radioastronomía y Astrofísica, UNAM), Ruben Krasnopolsky (ASIAA)

Pseudodisks form out of the gravitational collapse of a cloud core leading to star formation. It is a disk-like toroidal structure created primarily by magnetic forces during gravitational collapse, seen as a larger envelope surrounding a much smaller protostellar disk.

We have developed a GPU code, Astaroth, to compute magnetohydrodynamics (MHD) problems with GPUs. Astaroth is uniquely efficient and proven to to work in massively parallel systems, like LUMI Supercomputer and Frontier. Astaroth is also a general GPU computation engine that can be used beyond our special focus in MHD, and is available free and open source.

To apply the power of Astaroth to start formation problems, we developed a model for a pseudodisk, as it provides a good test case to the new code. This is computed using a sixth-order finite difference method with shock viscosity scheme and GPU friendly sink particle method.

We can demonstrate the classical pseudo-disk case well, with a high order method showing good promise for resolving sharp pinch angles of magnetic field in the collapsing system. We also see evidence of infall shock structured created by pseudodisk itself. We also look into performance and scaling, as GPU performance provides several benefits, and how we can use the existing model to approach more complicated future challenges in star formation.

14:20 – 14:40 Characterizing the Physical Properties of T Tauri Stars with Multiband Optical Photometry and Spectroscopy from Multiple Facilities

Chia-Lung Lin (NCU), Wing-Huen Ip (NCU), Yao Hsiao (NCU), Tzu-Heng Chang (NCU),
Yi-han Song (NAOC), and A-Li Luo (NAOC)

We analyze 16 classical T Tauri stars (CTTSs) using data from LAMOST, TESS, ASAS-SN, ZTF, and Pan-STARRS, investigating their spectral properties, photometric variations, and mass accretion rates. All 16 stars exhibit Hα emission, with an average mass accretion rate of $1.76 \times 10^{-9} M_{\odot}\,\mathrm{yr}^{-1}$. Notably, DL Tau and Haro 6-13 display mass accretion bursts captured simultaneously by TESS, ASAS-SN, and/or ZTF, reaching peak rates of $2.5 \times 10^{-8}\ M_{\odot}\mathrm{yr}^{-1}$ and $2.0 \times 10^{-10}\ M_{\odot}\mathrm{yr}^{-1}$, respectively. Thirteen flares are detected, revealing significantly higher flare activity in CTTSs than in solar-type or young low-mass stars, with strong flares dominating their activity. Moreover, by comparing variability classes, we find that transitions, such as from stochastic (S) to bursting (B) or from quasi-periodic symmetric to quasi-periodic dipping, may occur on timescales of 1.6–4 years. Our study also emphasize the value of designing future programs that leverage collaboration between dedicated satellites and multi-survey data to maximize the scientific impact and advance YSO research.