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Jose Silva	Planetary Atmospheres Group, IBS

Mesoscale gravity waves at multiple levels on Venus clouds

Atmospheric gravity waves are a ubiquitous feature of planetary atmospheres. They are expected to have a sizeable contribution to mesoscale atmosphere dynamics, playing a role in the energy and momentum budget that powers several weather systems. Multiple studies have observed gravity waves at several wavelength ranges on Venus, mapping their activity throughout the cloud deck. These efforts have been coupled with modelling work that reproduces some of these structures, tapping into both their forcing mechanisms as well as the influence they have on atmospheric circulation. Despite the incremental insight brought by each of these efforts in understanding this phenomenon in the context of Venus' atmosphere, some gaps in our knowledge persist. It is still uncertain how much influence these waves have on the upper cloud superrotation and their role in the vertical distribution of angular momentum. Furthermore, the multitude of wave characteristics across different altitude levels of Venus and the detection of stationary features relative to surface topography provide clues to the vertical atmospheric circulation across the cloud deck and the impact of surface topography on the atmosphere. Hence, knowledge of the distribution of these structures and their variability with time becomes important to interpret other behaviours in the Venusian atmosphere, as well as enhancing our comprehension of gravity waves. The goal of this talk is to present recent efforts in characterising these structures, particularly at the mesoscale level, with data from Venus Express - VIRTIS and Akatsuki's UVI, IR1, IR2 and LIR instruments. Our efforts shall concentrate not only on gravity waves as an interesting atmospheric feature but also their role in the wider context of atmospheric planetary science.

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Jaeheung PARK	Korea Astronomy and Space Science institute

Magnetic signatures of plasma irregularities in the Martian topside ionosphere

Plasma irregularities are known to drive currents in the direction perpendicular to the background magnetic field and along iso-density contours. When the background magnetic field has negligible curvature, magnetic signals of the currents tend to compensate for plasma pressure irregularities. That is, magnetic field gets intensified inside plasma depletion, and vice versa, so that the total (magnetic and plasma) pressure is balanced across irregularity boundaries. In the Earth's ionosphere, it was observed that the climatological distributions of the plasma irregularities and magnetic field perturbations agree with each other, and the latter is often used as a stand-alone proxy for the former. As for the Martian ionosphere, while the latter has also been used as a substitute for the former, extensive evidence for the correlation between the two is still lacking. In this presentation, we directly compare the climatological behavior of plasma density irregularities and magnetic field perturbations, both of which are observed by the Mars Atmosphere and Volatile EvolutioN (MAVEN) from 2014 to 2023 at altitudes below 500 km. The results indicate significant mismatch between the spatial distributions of plasma and magnetic field irregularities at Mars. Strong inhomogeneity of the background magnetic field at Mars, as it has no Earth-like internal dynamo, is suspected to incur apparent intensity modulation of the magnetic perturbations coming from plasma irregularities.

3

Lucy Wright	University of Bristol

Seasonal variation of Titan's stratospheric tilt

Lucy Wright, Nicholas A. Teanby, Patrick G. J. Irwin, Conor A. Nixon, Joshua S. Ford

Titan, the largest moon of Saturn, is the only moon in our Solar System with a substantial atmosphere. Titan's stratosphere is in superrotation, a phenomenon known to also exist in the atmospheres of Venus, Jupiter, and Saturn. Titan's stratosphere rotates about an axis offset by approximately 4 degrees from Titan's solid-body rotation axis [1]. However, the mechanism causing this offset is not yet understood. The tilted axis has been determined previously through temperature retrievals [1, 2], composition retrievals [3, 4], and by analysis of images of stratospheric haze [5, 6, 7] and polar clouds [8]. We independently determine the magnitude and direction of the stratospheric tilted axis, from temperature and composition maps at a higher spatial resolution than in previous studies. This is achieved by inverting low-spectral-resolution (FWHM~14.5 cm-1) mid-infrared spectra (580—1500 cm-1) acquired with a nadir viewing geometry by Cassini's Composite Infrared Spectrometer (CIRS) [9, 10], which observed Titan for almost half a Titan year (2004—2017). We use the Non-linear Optimal Estimator for MultivariatE Spectral AnalySIS (NEMESIS) [11] radiative transfer and retrieval tool for our inversions [12]. Titan's obliquity is approximately 27 degrees, therefore Titan experiences strong seasonal variation. Here, in addition to determining an average stratospheric tilt, we investigate the seasonal evolution of the tilted axis from Titan Northern mid-winter (2004) to Northern Summer solstice (2017). This has not previously been studied and takes advantage of the excellent spatial and temporal coverage of the underused CIRS low-spectral-resolution dataset. Quantifying the tilt of the stratospheric rotation axis provides insight into the dynamics responsible for the offset and the mechanisms that drive superrotating atmospheres in general.

References: [1] Achterberg et al., 2008b [2] Achterberg et al., 2011 [3] Teanby et al., 2010 [4] Sharkey et al., 2020 [5] Roman et al., 2009 [6] Kutsop et al., 2022 [7] Vashist et al., 2023 [8] West et al., 2016 [9] Flasar et al., 2004 [10] Nixon et al., 2019 [11] Irwin et al., 2008 [12] Wright et al., 2024

4

Seonghwan Kim	Sejong University

Aerothermal Analysis of Heatshield Ablation for Carbon and Silicon Carbide Surface

Re-entry vehicles entering the atmosphere at hypersonic speeds generate a high-temperature shock layer. Thermochemical nonequilibrium phenomena such as excitation, vibration, dissociation, and recombination of molecules in the high-temperature shock layer. At this point, the highly reactive dissociated atoms(N, O) reached the surface of the re-entry vehicle due to the high flow velocity causing surface chemical reactions that lead to chemical heating. The re-entry vehicle uses a heatshield to protect the payload inside the re-entry vehicle from the extreme environment. Heatshields vary depending on the re-entry environment, the trajectory of the vehicle, and the materials used. Therefore, to design an efficient heatshield, it is necessary to predict the heating amount considering the material properties and flow environment. In this study, analysis is performed on the orbital re-entry experiment(OREX) flight[1], an Earth re-entry capsule, through a coupled simulation between a material response and a thermochemical nonequilibrium flow. Different surface chemistries are applied assuming a carbon surface for the nose of the capsule and a silicon carbide surface for the shoulder. A finite surface chemistry model[2-4] and an equilibrium surface chemistry model are applied to the carbon surface, and simulation results show that different physical behaviors depend on surface chemistry, which affects the difference in composition mass fraction and heat flux. When applying equilibrium surface chemistry to the silicon carbide surface, it shows the transition from passive oxidation to active oxidation as the wall temperature increases.

5

Tae Woong Jeong	Sejong University

Analysis of Surface Radiative Heating of Titan Space Vehicle Based on Thermochemical Nonequilibrium Modeling

Because the Titan atmospheric vehicle is exposed to an extremely heated environment when entering Titan's atmosphere, it is important to accurately predict the amount of heating applied to the probe's surface through rigorous Computational Fluid Dynamic(CFD) analysis. In the shock layer created ahead of the probe, a substantial quantity of is generated, and electrically excited applies extreme radiative heating to the surface. Therefore, when examining the surface heating of the probes, it is essential to take into account not only the convective heat flux but also the radiative heat flux. In this study, the surface radiative heat flux is calculated through flow-radiation coupling analysis. This is because it is challenging to satisfy the local thermodynamic equilibrium condition in regions where particle collisions are limited during the entry trajectory of the Titan probe. As a result, there is a need for the exchange of information between the flow field and radiation field. The probe used in this study is the Genesis sample return capsule model, and the Dragonfly trajectory is selected as the model's entry route to Titan. For flow field analysis, two-dimensional axisymmetric calculation is performed, and a two-temperature model and finite chemical reaction rate are applied to consider thermochemical non-equilibrium phenomena. As a thermochemical non-equilibrium model, the Kim and Jo model and model are considered, and calculations are performed by modeling the vibrational energy relaxation time, vibrational energy loss ratio, and chemical reaction rate coefficient differently between the two models. When calculating radiative heat flux, cases where the electronic energy distribution of particles follows the Boltzmann distribution and cases where it follows the non-Boltzmann distribution are analyzed separately, and the non-Boltzmann radiation field analysis is performed using the QSS assumption. Through this study, it is confirmed that the Boltzmann radiative heat flux is over-predicted compared to the non-Boltzmann radiative heat flux in relatively low-density areas, and the main contributing factor to this discrepancy is identified as the and radiation systems.

6

Joshua Ford	University of Bristol

Limb-darkening approximation analysis for atmospheric retrievals on Titan

In 2017 Cassini finished its 13-year mission, completing 127 close flybys of Saturn's largest moon, Titan. Cassini's Composite Infrared Spectrometer (CIRS) captured 8.4 million spectra in the thermal infrared (7 - 1000 μm) [1], allowing Titan's atmospheric temperature and gas abundances to be retrieved. While much of this data has been analysed there are still uncertainties in our understanding, for example the abundance and vertical profiles of minor atmospheric species. Many gases exhibit emission lines that are so weak they are hidden amongst the noise, so robust detections are challenging. The current method to search for weak spectral features is to average many spectra, however this loses geometric information and causes systematic bias by including a wide range of emission angles that are not well represented by the average geometry, limiting fitting accuracy. Here we present a new technique based on limb-darkening approximations to increase SNR while keeping key geometric information. Limb-darkening/limb-brightening is an effect whereby the limb of a planet/star is darker/brighter than the centre due to increasing optical depth. This is regularly used to study stars and exoplanet transits. However as shown by [2] limb-darkening can be applied to planetary atmospheres in the visible/near-infrared to improve SNR, random errors, computational efficiency and robustness. In this study, we show that by applying an adapted stellar limb-darkening function [3] to synthetic and observed CIRS IR Titan spectra, we can increase the SNR substantially. By fitting the atmospheric radiance over emission angles 0° – 60°, a parameterised function can be retrieved for each wavelength. This allows re-construction of the spectra accounting for geometrical variations and improves fit quality. Using this method we can approach the theoretical noise floor of the CIRS instrument. To test this analysis, we produce synthetic spectra to extreme accuracy and retrieve CO2 using NEMESIS [4] to compare against literature.

7

Weixiong Zhao	Anhui Institute of Optics and Fine Mechanics, Chinese Academy of Sciences

Development of high-resolution VIPA Spectrometer and its potential application in atmospheric and planetary chemistry

High-resolution broadband spectroscopy plays a vital role in high-precision measurements of atmospheric composition. In this presentation, we report the development of a high-resolution CCD spectrometer based on the virtually imaged phase arry (VIPA) technique. By using a thin glass plate and a reflective grating, a two-dimensional cross-dispersion was realized. Wide spectral coverage and high resolution are achieved in a simple structure. In the visible light band, the achievable single frame spectral coverage is 15 nm with a spectral resolution of about 1.4 pm ($R \geq 500000$). By rotating the grating, wider spectral coverage from 620 to 700 nm can be realized. In the near-infrared light band, a spectral resolution of about 4.5 pm ($R \geq 300000$) is achieved in the spectral range from 1260 to 1500 nm. The design of the VIPA spectrometer and a simple spectrogram model for high-precision spectral calibration will be presented. Further potential applications of the spectrometer in atmospheric and planetray chemistry will be discussed.

8

Yosheph Yang	Kangwon National University

Aerothermal and Material Coupling for Mars Reentry Environment

Predicting an accurate aerothermodynamic flow properties in Mars-entry vehicles requires a coupling simulation with the material response analysis. Unlike the Earth re-entry analysis, Mars entry analysis does not exhibit significant number of studies concerning the coupling between aerothermodynamic flow and material response analysis. The present study aims to investigate a preliminary coupling study between flow and material response for Mars-entry vehicles for a zero angle of attack assumption. Two-temperature model of Park is used to model the thermochemical nonequilibrium flow. Equilibrium ablation model for carbon-based material is used to model the material response. The coupling is also compared with the results that are solely obtained from a simple non-catalytic wall boundary condition. The comparison between these two approaches focuses on quantities such as surface wall heat flux, pressure, and temperature condition, highlighting the differences and benefits of the coupled analysis approach.

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LASANY ARFIN KUNJA	Chungnam National University

Radiation environment on the surface of the Moon and two-layers habitation model to protect future astronauts from radiation

The moon is the most plausible candidate for extraterrestrial life because it is the second most often observed celestial body after Earth. The radiation that arises from the combination of GCR (Galactic Cosmic Rays), SPE (Solar Particle Events), and Albedo radiation on the Moon's surface. The primary sources of radiation are GCR, Solar Energetic Particles, and radiation from Lunar Radioactive Elements (22Na, 24Na, 26Al, 54Mn, and 56Co). Underneath the surface of the Moon, this primary radiation will be directed upwards and form secondary radiation. These strong particles can spread out into the lunar surface after striking and produce an immense amount of secondary radiation, secondary radiation is just as significant as primary radiation. Lunar regolith has a highly possible potential to offer sufficient shielding for long-term space missions that protect future astronauts from radiation. Several studies have shown that Geo-Polymar shielding from lunar regolith may be achieved with a small amount (in our case, only 10 cm), and this will lower the amount of unnecessary effort required to transfer building materials to the Moon. We chose some hydrogen-rich materials to assist lunar regolith for protection from radiation because of the outstanding performance of this model showed in our previous study on the surface of Mars. For testing the efficiency of the combined regolith and chosen material model, we ran a Monte Carlo simulation of the adsorbed dose to compare various hydrogen-rich materials. The GEANT-4-based simulations were carried out in MULLASSIS, which is integrated within the SPENVIS system. Furthermore, data was generated in an independent second approach using the OLTARIS. For our two-layer model, between all materials under examination, LiH performed the best, outperforming Kevlar, aluminum, Mylar, polystyrene, and polypropylene by 15%, 14%, 11%, 8%, and 4%, respectively. This model successfully worked under the radiation environment of the Moon.

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HOU CHENGZE	The University of Tokyo

Mesoscale Dynamics Related to an Elongated Cloud over Tharsis Montes on Mars

This study explores the atmospheric dynamics around Tharsis Montes on Mars, particularly focusing on the elongated cloud formation over Arsia Mons, during a specific season of the Martian year (300 to 320 Ls). We used a regional mesoscale model beginning with idealized simulations horizontal wind profiles represented by polynomial functions and simplified mountain models to replicate the expected atmospheric conditions, establishing a method for predicting cloud formation from the perspective of fluid dynamics, notably for the occurrence of strong updrafts by hydraulic jumps around the “head” of the Arsia Mons Elongated Cloud (AMEC). Key findings reveal that wind velocity and the presence of high, flat-topped mountains significantly influence hydraulic jump events, which are also altitude-dependent. The study extends these methods to realistic Martian terrain and initial conditions generated by a General Circulation Model (GCM), highlighting the interaction between different volcanoes in this region, and replicating conditions seen in idealized simulations. However, challenges like numerical instability in modeling Arsia Mons's steep terrain are noted, despite improvements from increased vertical resolution. Overall, this research explored the dynamical mechanisms crucial for forming the head of AMEC and the atmospheric prerequisites for cloud elongation, enhancing the understanding of mountainous cloud formations on extraterrestrial planets and informing future Mars observations and studies.

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Nikolay Vedenkin	KAIROSPAC Co., Ltd.

12U BUS for CLOVE project

In a collaborative effort between the Institute for Basic Science (IBS) and KAIROSPACE, the possibility of designing a 12U micro satellite platform, designated as CLVB, has been explored to enable comprehensive observation of Venus as part of the Venus Long-Term Variability Tracking Project (CLOVE). This conceptual platform aims to integrate a payload provided by IBS along with additional parameters specified by the customer, facilitating extensive scientific exploration of Venus.
The estimated design objectives for the CLVB platform include maximizing observation coverage by evaluating the platform's potential to capture data across various geographical locations and environmental conditions on Venus. Optimizing observation parameters involves assessing the platform's ability to adjust resolution, frequency, and duration to achieve optimal data collection, meeting specific research objectives and maximizing scientific output.
Ensuring platform compatibility is crucial, focusing on the platform's ability to support advanced observational instruments and sensors necessary for studying Venus. Efficient data transmission and storage are also key, with estimates of the platform's capabilities to ensure seamless communication with ground stations and adequate storage for retaining observation data.
Cost-effective implementation is analyzed to understand the potential cost-effectiveness of developing, deploying, and maintaining the CLVB platform, ensuring that mission objectives can be met within allocated resources. Mission sustainability is evaluated by examining the platform's reliability, resilience to environmental factors, and longevity to support continuous observation of Venus over an extended period.
Through this cooperative effort, the possibility of designing the CLVB micro satellite platform represents a significant step towards advancing our capability to observe and study Venus. This platform aims to provide valuable insights and data to the scientific community, enhancing our understanding of Venus's long-term variability.

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Tatsuro Iwanaka	The University of Tokyo

Retrieval of the Venusian Cloud-top Sulfur Dioxide from Akatsuki UV Images

The horizontal distribution of clouds in the Venusian atmosphere is an essential factor influencing the solar energy absorbed by Venus. The cloud layer reflects about 75% of the solar energy (Taylor & Grinspoon, 2009) and controls the energy input to Venus. Understanding how sulfur dioxide, the precursor of clouds, is transported from the lower to the cloud top, where the cloud particles are formed from sulfur dioxide photochemistry, is one of the essential subjects for understanding the Venusian climate system. Akatsuki has continuously taken images of the Venusian disk at multiple wavelengths from the orbit. Retrieving the sulfur dioxide distribution from these data sets and monitoring its variation would help understand dynamical processes at meso- to planetary-scales that induce the transport of sulfur dioxide. Images at 283 nm, a strong absorption band of sulfur dioxide, taken by Akatsuki also reflect the effects of sulfuric acid aerosols, the unidentified UV absorber, and carbon dioxide, making interpretation difficult. Therefore, we developed a method to retrieve only sulfur dioxide from 283 nm images using additional images simultaneously taken at 365 nm. We estimated the amount of sulfur dioxide at the cloud top from about 15,000 pairs of both images taken in 2016 to 2022 to obtain the mean distribution of sulfur dioxide on the local time-latitude coordinates. The mean value is 80 to 200 ppb at the cloud top on the dayside, within the range of the previous study (Belyaev et al., 2012). The distribution has a single peak in the afternoon, qualitatively consistent with the result of a Venus GCM with photochemistry (Stolzenbach et al., 2023). The enhancement of sulfur dioxide in the afternoon is attributed to the vertical transport of sulfur dioxide induced by thermal tides based on the wave structures reproduced by the Venus GCM by Takagi et al. (2018).

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Hyeonju Kang	Planetary Atmosphere Group, IBS

Characterization of small-scale UV contrasts at Venus's cloud top level

Venus is covered by 20-km thick clouds which reflect solar photons effectively. Near the cloud top level, there are small-scale dark markings caused by ultraviolet (UV) absorbers, such as the SO2 gas and an unknown absorber(s). While the vertical distribution of SO2 gas abundance is relatively well understood, that of the unknown absorbers is still controversial. In order to characterize the relative vertical distribution of the unknown absorber, compared to that of the SO2 gas, we analyzed phase angle dependences of small-scale (37.16 ~ 83.23 km/pix) contrasts at 283 and 365 nm. 283 and 365-nm absorptions are mainly related to the abundances of the SO2 gas and the unknown absorbers, respectively. We used images observed by the ultraviolet imager (UVI) on board the Akatsuki spacecraft, a total of ~25,000 global images acquired in 2016-2021 at both channels. We find clear phase angle dependences at the two channels, implying that the abundance of UV absorbers decreases with increasing altitudes. We recognize a considerable wavelength difference between the two channels, and a temporal variation of UV contrasts appeared to be likely dominant over local time dependence. Further studies will be able to utilize our results to quantify the vertical distribution of the unknown absorber.

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Sumit Roy Pronoy	Shahjalal University of Science and Technology

Do low metallicity multiple-star system contain giant planets? Large exoplanet relation with stellar Metallicity around G class star

We used updated parameters for stars and planets from the NASA Exoplanet Archive to investigate the relationship between the radius of massive exoplanets orbiting G-class stars and the metallicity of their host stars. For planets with radii greater than 6 Earth radii, we found a probable inverse relationship between radius and stellar metallicity, which becomes stronger with declining metallicity and increasing planet size, particularly in multiple star systems. Our small data set (around 95) shows a low R-squared value (0.07) and a low P-value (0.006). We separated the data for the radial velocity and transit methods of planet detection. For the radial velocity method, the slope value and P-value are -2.19 and 0.028, respectively, and there is only one data point with an uncertainty value among the 65 data points. This suggests that the observed inverse exponential relationship may not be fully explained by observational biases alone. However, more accurate data will be needed for further confirmation.

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Seungyeol Lee	Chungbuk National University

Thermal decomposition of Murchison CM2 carbonaceous chondrite: Implications of space weathering processes for sample return missions

We have undertaken a multidisciplinary study of the thermal decomposition of Murchison CM2 carbonaceous chondrite as an analog to metamorphic process that may have occurred on carbonaceous asteroids. The pre- and post-heated Murchison powders were analyzed using X-ray diffraction, thermal and evolved gas analysis, visible-near-infrared spectroscopy, micro- to nanoscale analyses included scanning and transmission electron microscopy. Mineralogical analyses of the unheated Murchison samples identified fine-grained serpentine, rounded Mg-rich serpentine (chrysotile-type), platy Fe-rich serpentine (cronstedtite-type), tochilinite, tochilinite-cronstedtite intergrowths, olivine, pyroxene, iron-nickel sulfides, magnetite, potassium iron-nickel sulfide, calcite, gypsum, apatite, Cr-bearing spinel, and chromite. The tochilinite shows the contorted morphology, mainly showing (002) lattice fringes of ~5.4 Å spacing and the identification of a new twinning relationship on the (032) plane. In response to thermal effects, serpentine group minerals are converted into mixtures of sub-μm olivine and pyroxene grains with similar Mg/Mg+Fe ratios as the precursor. Tochilinite breakdown forms troilite, magnetite, and minor Fe-Ni metal aggregates via amorphization. The thermal processing of Murchison carbonaceous chondrite produces distinctive micron and submicron structures that correspond to the breakdown of key minerals. These findings will be useful for understanding the thermal history of carbonaceous asteroids and for analyzing samples returned from ongoing missions to primitive asteroids (101955) Bennu and (162173) Ryugu.

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Chang min Lee	Korea Aerospace University

Analysis of S-band and X-band Data Links for Venus Observation CLOVE Mission

This paper analyzes the performance of S-band and X-band data links in a Venus observation mission using low Earth orbit (LEO) small satellites. It proposes a bit rate that satisfies the conditional link margin and data transmission volume.
This paper analyzes RF communication data links during Venus observation missions using small low Earth orbit (LEO) satellites. The subject of this study is the CLOVE mission, promoted by the Institute for Basic Science (IBS) / Planetary Atmosphere Group (PAG), which aims to observe the long-term variability of Venus. This paper proposes effective data link design methods using S-band (24GHz) and X-band (812GHz) communication bands, which are commonly used in small satellites, to ensure the stable transmission of scientific data collected from Venus to ground stations.

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Young-Soo KIM	Green Optics Co., Ltd.

Optical Payloads and Ground Telescopes Development at Green Optics

Ground telescopes have been produced for Astronomy, and optical payloads are being developed mainly for Remote Sensing, such as sea monitoring, land use, atmospheric observations, and greenhouse gas detections at Green Optics Co. Ltd. Hyper-spectral imagers (HSIs) in visible and short-wave infra-red bands are being devised together with Acousto-Optic Tunable Filter (AOTF). The HSIs would be attached to the International Space Station (ISS) for remote sensing. In this poster, development history of optical payloads and telescopes are presented.

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Minbae Kim	Institute for Basic Science

The path-tracing simulation of SurfCam/GrainCams light field camera system for lunar surface exploration

The SurfCam is being developed to understand the microscopic lunar surface structures, called the fairy castle structure, composed of grains with an average size of about a few ten microns. It is designed as a microscopic light-field camera (LFC) and one of the camera instrument packages in GrainCams, a candidate payload of NASA's Commercial Lunar Payload Services (NASA/CLPS). The light-field camera system allows for obtaining depth maps and 3D images of lunar surface structures on a scale of tens of microns by capturing a 4D light field. This camera system can be achieved by adding a micro-lens array (MLA) between the main optics and the sensor in a typical camera system. The Cycles render engine, a physically-based path-tracing (one of the ray-tracing types) renderer of Blender 3D software, helps to simulate realistic light-field images. We performed path-tracing simulations by configuring SurfCam's optics and creating test objects to confirm depth estimation results in Blender 3D. In this study, we present the results of simulated images and analyze results based on the current SurfCam design.

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Ashimananda Modak | Planetary Atmospheres Group, IBS

Absorption characteristics of the Unknown absorber as seen by HST-STIS instruments

Venus atmosphere is known to produce unknown chemical compounds which absorb efficiently the solar radiation in the ultraviolet and visible part of the spectrum. The presence of the absorption was detected by the spacecraft and ground based observations both in the cloud images and reflected spectra. The characterization of these absorbers is an important part towards understanding Venus' atmospheric chemistry and dynamics due to their vast distribution in the Planet's clouds.

In this work we investigate the reflected spectra of Venus clouds using the observations of Space Telescope Imaging Spectrograph (STIS) onboard Hubble Space Telescope (HST). The observations were obtained by using a long slit and two gratings G230LB and G430L. Wavelength spans for these gratings are 200 – 300 and 350 – 550 nm respectively. Previous studies suggest the absorption center of the unknown absorbers at 340 nm with an FWHM of 140 nm. This means the observation of G430L covers the longer side of absorption of the unknown absorbers while the observations of G230LB covers the shorter side of the absorption. In addition, the absorption lines of SO and SO2 are present in the G230LB observation which may overlap with the absorption of those unknown absorbers.

Our goal here is to separate such absorptions and characterize the absorption of the unknown absorbers using an RT model. For the purpose we built a retrieval routine to use the optimal estimation method for the retrieval of SO, SO2 and to characterize the total absorption of the unknown absorbers.

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ChanHee Jeong | Korea Aerospace University

Data link analysis for Venus observation mission CLOVE-Sat

This paper analyzes the performance of S-band and X-band data links in a Venus observation mission using low Earth orbit small satellites. It proposes bit rates that satisfy conditional link margin and data transmission volume.

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Dhanraj sitaram Warjurkar	Independent Researcher

Trajectory Optimization for the Hilda Group of Asteroid & Comet's Mining Missions

The Hilda Group of Asteroid & Comet might become key in the future development of mining and space industry. Their exploitation would give access to a huge amount of minerals and metals that could be used to create an "in-space manufacturing industry" and that could be used also to support deep space missions and stations through in situ resource utilization. However, a deep knowledge of mineralogical composition and dynamic distribution of these bodies would be required in order to attain these achievements. The successful mining of Hilda asteroids and comets entails a multi-step process: firstly, the identification and confirmation of viable targets; secondly, either the retrieval of these targets or the deployment of mining teams to them; thirdly, the extraction of materials from the targets; and finally, the transportation of these materials back to Earth or other designated destinations. This work try to shed light to the matters of what Hilda should be considered in a mining project, what orbital parameters are going to influenced energetic cost required to reach them and how transfer trajectories could be optimized. A few Hilda have been analysed through different methods, employing an straightforward resolution of Lambert's Problem. The "leitmotif" of the work is, however, Hilda's accessibility and energy cost in terms of Δv of their transfer trajectories, which is one of the preceding parameters.