등록 및 교통 안내

1. 등록

회원의 등록비는 150,000원이며, 학생회원과 정회원 중 석.박사 과정(전일제) 학생은 70,000원입니다. 사전등록을 하신 회원은 등록자 명부에 서명 후 학회보, 명찰, 등록비 영수증(계산서)을 수령하시기 바랍니다.

2. 회원 가입

회원가입을 원하시는 분은 학회 홈페이지에서 회원가입신청 후 입회원서를 인쇄하여 추천인(2인) 서명을 받아 학회 사무국으로 송부하여 주시고 입회비와 연회비는 학회계좌로 송금하여 주시기 바랍니다.

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3. 발표자료 준비

구두발표: 발표자료는 파워포인트 파일로 준비하시기 바랍니다.

포스터발표: 포스터 발표는 4월 24일(수) 14시까지 지정된 장소에 게시하고, 26일(금) 10시에 수거하여 주시기 바랍니다. 집중 발표 시간에 발표자는 자신의 포스터 앞에서 회원들의 질문에 답할 수 있도록 준비해 주시기 바랍니다. 포스터를 부착하지 않거나 학회 종료 후 수거하지 않은 회원은 추후 학회발표가 제한될 수 있습니다(2006년 3차 이사회 결정).

4. 발표장

발표형식	구분	분과명
구두발표	Convention Lakai Ballroom	-Invited Talk -Sun/Space Environment I, II, III,IV
	Convention Sandpine Room	-Special Session Space Environment Payloads -Special Session NEXTSat-1 / KSEM I, II -Solar System & Space Exploration
	Reception 1F Han Song	-Special Session KPLO -Space Technology & Application I, II, III
포스터 발표	Convention Lobby	우주기술, 우주응용, 우주천문 태양 및 우주환경, 태양계 및 우주탐사, 기타

5. 교통

가. 주소
강원도 강릉시 해안로 536(안현동 89-87) T. 1644-3001

나. 찾아오시는 길
▶자가용 이용
-서울 : 약 2시간 30분 소요
-대전 : 약 2시간 50분 소요

▶시외, 고속버스 이용
-서울(경부) <-> 강릉 버스터미널(2시간 40분 소요)
- 동서울 <-> 강릉 버스터미널(2시간 40분 소요)
- 대전복합터미널 <->강릉 버스터미널(3시간 20분 소요)

▶KTX 이용
-서울역 <-> 강릉역 (2시간 소요)

▶강릉 시내버스 이용
-강릉터미널 -> 라카이 샌드파인 : 202번 (40여분 소요)
-강릉역 -> 라카이 샌드파인 : 202번,313번 (50여분 소요)

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2019 KSSS SPRING CONFERENCE PROGRAM

April 24 (Wed.)	11:00~	Registration Open : Convention Lobby				
	13:30~13:40	Opening Ceremony : Lakai Ballroom				
	13:40~14:10	**Invited Talk I** **Room : Lakai Ballroom** **Chair : Gi Hyuyk Choi (KARI)** **Dr. Cheol Ho, Lim (President, KARI)** **Korea's Plan for Space Development including Space Exploration and Space Science**				
	14:10~14:20	Coffee Break				
	Room	**Convention Lakai Ballroom**		**Convention Sandpine Room**		**Reception 1F Han Song**
	Session I	**Sun & Space Environment I Chair : Jae-Ok Lee (KASI)**		**Special Session Space Environment Payloads Chair : Joo Hyeon Kim (KARI)**		**Special Session KPLO Chair : Ho Jin (KHU)**
	14:20~14:35	I-1-1	Miyashita Yukinaga	I-2-1	Geuk Nam Kim	I-3-1	Minsup Jeong
	14:35~14:50	I-1-2	Jaejin Lee	I-2-2	Seunguk Lee	I-3-2	Bongkon Moon
	14:50~15:05	I-1-3	Sang-Yun Lee	I-2-3	Wonyong Han	I-3-3	ByungWook Jeong
	15:05~15:20	I-1-4	Junhyun Lee	I-2-4	Kwangsun Ryu	I-3-4	Young-Rok Kim
	15:20~15:35	I-1-5	SungJun Noh	I-2-5	Jongdae Sohn	I-3-5	Jo Ryeong Yim
	15:35~15:50	I-1-6	Wooyeon Park	I-2-6	Hee-Eun Kim	I-3-6	Eunhyeuk Kim
	15:50~16:00	Coffee Break					
	16:00~16:30	**Invited Talk II** **Room : Lakai Ballroom** **Chair : Young-Sil Kwak (KASI)** **Dr. Kyungin Kang (Director, NRF)** **National Space Development Plan and Current Status of Space Program**					
	16:30~16:40	Photo Time					
	16:40~17:30	Society Subcommittee Meeting					
	17:30~20:00	Banquet : Lakai Ballroom / 우주개발성과 소개(30분)					

	Room	Convention Lakai Ballroom		Convention Sandpine Room		Reception 1F Han Song	
April 25 (Thu.)	Session Ⅱ	Sun & Space Environment Ⅱ Chair : Jaejin Lee (KASI)		Special Session NEXTSat-1 / KSEM Ⅰ Chair : Jo Ryeong Yim (KARI)		Space Technology & Application Ⅰ Chair : Eun Jung Choi (KASI)	
	09:30~09:45	II-1-1	Jongchul Chae	II-2-1	Bongkon Moon	II-3-1	jin choi
	09:45~10:00	II-1-2	Yeon-Han Kim	II-2-2	Go Woon Na	II-3-2	Sung-Soo Jang
	10:00~10:15	II-1-3	Kyuhyoun Cho	II-2-3	Seung-hyuk Shin	II-3-3	Goo-Hwan Shin Ⅰ
	10:15~10:30	II-1-4	Jae-Ok Lee	II-2-4	Chan Haeng Lee	II-3-4	Goo-Hwan Shin Ⅱ
	10:30~10:45	II-1-5	Juhyung Kang	II-2-5	Ji hyeon Yoo	II-3-5	Hae Jin Choi
	10:45~11:00	II-1-6	Hannah Kwak	II-2-6	Kyoung-Min Roh	II-3-6	Gi-Hyuyk Choi
	11:00~11:10	Coffee Break					
	11:10~11:40	**Invited Talk Ⅲ Room : Lakai Ballroom Chair : Kwangsun Ryu (SaTReC)** **Dr. Kyung-Suk Cho (Vice President, KASI)** **KASI contributions to the BBSO/GST and NASA space solar missions**					
	11:40~13:10	Lunch					
	13:10~14:40	**Poster Session**					
	Session Ⅲ	Sun & Space Environment Ⅲ Chair : Byung-Kyu Choi (KASI)		Special Session NEXTSat-1 / KSEM Ⅱ Chair: Young-Joo Song(KARI)		Space Technology & Application Ⅱ Chair: Jeong-Han Kim(KOPRI)	
	14:40~14:55	III-1-1	Seheon Jeong	III-2-1	Bongkyu Park	III-3-1	Byoung-Sun Lee
	14:55~15:10	III-1-2	Jong-Min Choi	III-2-2	Woohyeong Seol	III-3-2	Tae-yong Yang
	15:10~15:25	III-1-3	Woo Kyoung Lee	III-2-3	Eojin Kim	III-3-3	Jong-Won Lee
	15:25~15:40	III-1-4	Changsup Lee	III-2-4	Hoonkyu Seo	III-3-4	Chang Ho Woo
	15:40~15:55	III-1-5	Wonseok Lee	III-2-5	Dae-Young Lee	III-3-5	Junseok Hong
	15:55~16:10	III-1-6	Khan-Hyuk Kim	III-2-6	Sang-Yun Lee	III-3-6	Jong-Kyun Chung
	16:10~16:20	Coffee Break					
	16:20~16:50	**Invited Talk Ⅳ Room : Lakai Ballroom Chair : Yeon-Han Kim (KASI)** **Prof. Yong-Jae Moon (Kyunghee Univ.)** **Application of deep learning to astronomical and space science data**					

	Room	Convention Lakai Ballroom		Convention Sandpine Room		Reception 1F Han Song	
April 26 (Fri.)	Session Ⅳ	Sun & Space Environment Ⅳ Chair: WooKyoung Lee(KASI)		Solar System & Space Exploration Chair : Bongkon Moon (KASI)		Space Technology & Application Ⅲ Chair : Jong-Kyun Chung (KASI)	
	09:30~09:45	IV-1-1	JaeHee Park	IV-2-1	Joo Hyeon Kim	IV-3-1	Jeoung Heum Yeon
	09:45~10:00	IV-1-2	Jong Kil Lee	IV-2-2	Joo Hee Lee	IV-3-2	Dong-Hyo Sohn
	10:00~10:15	IV-1-3	JeongHeon Kim	IV-2-3	Pureum Kim	IV-3-3	Byung-Kyu Choi
	10:15~10:30	IV-1-4	Su In Moon	IV-2-4	Dukhang Lee	IV-3-4	Jeong Heum Im
	10:30~10:45	IV-1-5	Hosik Kam	IV-2-5	Younkyu Kim	IV-3-5	Jaewoo Kim

Poster Session

2019. 4. 25.(Thu.) 13:10 ~ 14:40

Area	No	Author	Area	No	Author
Space Tech.	P-1	Woo Yong Kang	Space Tech.	P-32	Jeong Heum Im
	P-2	Chi Ho Kang		P-33	Sung Soo Jang
	P-3	In Hoi Koo		P-34	Jong Hyub Jun
	P-4	Dong Gyu Kim		P-35	Ok Chul Jung
	P-5	Dong Oh Kim		P-36	Seung Won Cho
	P-6	Young Yun Kim		P-37	Chang Kwon Cho
	P-7	Eui Keun Kim		P-38	Dong Seok Chae
	P-8	Ju Hyun Kim		P-39	Jung Su Choi
	P-9	Joon sung Kim		P-40	Yun Goo Huh
	P-10	Hyung Wan Kim	Space Appl.	P-41	Hwan Chun Myung
	P-11	Hye-Won Kim		P-42	Jong Euk Park
	P-12	Hui-Kyung Kim		P-43	Seok Bae SeoI
	P-13	Keun Joo Park		P-44	Seok Bae SeoII
	P-14	Sung Woo Park		P-45	Jeoung Heum Yeon
	P-15	Sung Wook Park		P-46	Jong Tae Lee
	P-16	Su Hyun Park	Space Astro.	P-47	Min Ji Jeong
	P-17	Young Woong Park	Sun & Space Env.	P-48	Ryun Young Kwon
	P-18	Jong Seok Park		P-49	Keun Chan Park
	P-19	Jong Oh Park		P-50	Ho Sub Song
	P-20	Jin Hyung Park		P-51	Jun Ho Shin
	P-21	Su Wan Bang		P-52	Hee Eun Wang
	P-22	Myung Jin Baek		P-53	Kang Woo Yi
	P-23	Jae Min Shin		P-54	Sang Woo Lee
	P-24	Hyun Kyu Shin		P-55	Ju Hun Rhee
	P-25	Sang Il Ahn		P-56	Gyeon Gbok Jo
	P-26	Seung Eun Yang		P-57	Kyung Eun Choi
	P-27	Tae Bong Oh		P-58	Kyu Cheol Choi
	P-28	Sung Hyun Woo		P-59	Young bae Ham
	P-29	Ju Woo	Solar System & Space Expl.	P-60	Seung Hee Son
	P-30	Seo Rim Lee		P-61	Young Joo Song
	P-31	Hye Jin Yi	Miscellaneous	P-62	Chul Kang

Abstracts

April 24(Wed)

Lakai Ballroom

■ Invited Talk I
Session Chair: Gi-Hyuyk Choi (KARI)

13:40 [IS-I]

Korea' s Plan for Space Development including Space Exploration and Space Science

Cheol Ho Lim

Korea Aerospace Research Institute

Korea' s the most urgent and important space program is the development of domestically and ingeniously designed KSLV-2 which is capable of launching 1.5t satellite into the low earth orbit(LEO). The 75t main was successfully tested in November 2018 and the first launch of KSLV-2 will be planned in 2021. For the continuous advancement of launch vehicle technology, after 3 times of test launches ('21-' 25), industry will enter the stage of launch vehicle mass production ('26-' 30). Simultaneously KARI will develop small launch vehicle which could be able to launch 500kg satellite into LEO economically ('26-' 30). After that KARI will develop large launch vehicle ('30-' 40) for launching geosynchronous satellite. Several various satellites such as nano satellite, micro/small and medium satellites are going to be developed to monitor national emergency and environments including ocean, weather, agricultural land, forest and to provide GPS services. Also it is required to monitor precisely Korean peninsula at all times and to give early warning. KARI will develop lunar orbiter by '20 to acquire and verify space exploration technologies. Next step will be sending lunar lander by ' 30 and asteroid sample return mission by '35. The Korean ingenious Satellite Positioning System (KPS) will be established by '34. For the establishment of ecosystem of space industries, government and KARI will bring up various players, develop key technologies, improve R&D management system and strengthen international cooperation. To bring up industries and create new jobs, it is encouraged to enlarge industrial participation and converge technologies such as space with energy, construction and IT technologies.

Lakai Ballroom

■ I-1 Sun&Space Environment I
Session Chair: Jae-Ok Lee (KASI)

14:20 [I-1-1]

An auroral streamer that emerged between the auroral poleward boundary and onset arc before substorm initial brightening

Yukinaga Miyashita[1], Akimasa Ieda[2], Shinobu Machida[2], Vassilis Angelopoulos[3]

[1]*Korea Astronomy and Space Science Institute*
[2]*Institute for Space-Earth Environmental Research, Nagoya University, Japan*
[3]*Department of Earth, Planetary, and Space Sciences, University of California, Los Angeles, USA*

While a lot of equatorward moving auroral streamers that emerged at the auroral poleward boundary and were related to distant magnetotail reconnection have been reported previously, those that emerged between the auroral poleward and equatorward boundaries and were related to near-Earth reconnection have scarcely been reported. Time History of Events and Macroscale Interactions during Substorms (THEMIS) ground-based all-sky imagers, however, observed that a clear equatorward moving auroral streamer emerged between the auroral poleward boundary and the equatorward substorm onset arc and arrived at the onset arc before initial brightening. Simultaneously a THEMIS spacecraft observed a tailward moving plasmoid in the near-Earth magnetotail, indicating that magnetic reconnection occurred earthward of this spacecraft. We suggest that this auroral streamer possibly corresponds to an earthward flow generated by near-Earth reconnection

14:35 [I-1-2]

The method of measureing electron microburst spatial scale

Jaejin Lee and SNIPE Team

Korea Astronomy and Space Science Institute,

The electron microbursts are the phenomena of energetic electron precipitation on the auroral oval, the duration is less than 1 second. The electron microbursts have been observed by balloon and spacecraft experiments since the 1960s and are deduced to be generated by the chorus waves. Even a large number of observations have been made, the spatial scales of microbursts are still unknown. If the spatial scale of the microbursts is measured, we can also estimate the spatial scale of chorus waves and the size of plasma instability at the equatorial region. Because measuring the spatial

scale of microbursts is crucial for understanding magnetospheric plasma physics, four CubeSats named SNIPE mission will be launched in 2020 to observe small scale plasma structures like microbursts. In order to measure the electron precipitation, two solid-state telescopes are installed on each spacecraft. In this presentation, we show the time scale of microbursts is about 300 msec from STSAT-1 observation, similar to the scale of chorus waves. In addition, If the four spacecraft observe the microbursts at different positions, how the spatial scale could be estimated would be discussed. Interestingly, this issue is related to the old mathematical problem, Buffon's needle problem. From this problem, we can calculate the correlation factors of microbursts observed at different positions for the microburst spatial scale and spacecraft distance.

14:50 [I-1-3]
Particle-in-cell and Weak Turbulence Simulations of Plasma Emission

Sang-Yun Lee[1], Luiz F. Ziebell[2], Peter H. Yoon[3,4,5], Rudi Gaelzer[2], Ensang Lee[3]

[1]*Satellite Technology Research Center, KAIST*
[2]*Instatuto de Fisica, UFRGS, Brazil*
[3]*Space Science Research, Kyung Hee University*
[4]*Institute for Physical Science and Technology, University of Maryland, USA*
[5]*Korea Astronomy and Space Science Institute*

The plasma emission process, which is the mechanism for solar type II and type III radio burst phenomena, is studied using particle-in-cell (PIC) and weak turbulence (WT) simulation methods. Plasma emission starts from the solar flare-associated electron beam exciting Langmuir and ion-acoustic turbulence, and subsequent partial conversion of beam energy into radiation energy by nonlinear processes. WT theory is efficient but based on some assumption. Therefore it is necessary to compare the WT theory with PIC simulation, which we do for the first time with numerical solutions of WT theory and a 2-dimensional electromagnetic PIC simulation. We found that WT theory is qualitatively valid comparing to the PIC simulation, although some discrepancies are also found.

15:05 [I-1-4]
Analysis of narrow band structures of H+, He+ and O+ ions in the plasmaspheric region

Junhyun Lee, Ensang Lee, and Khan-hyuk Kim

School of space research, Kyung Hee University

Using the measurements from the Helium Oxygen Proton Electron (HOPE) instrument onboard the Van Allen Probes (VAP) satellites, we report narrow band structures of ions in the energy-time spectrogram observed in the plasmaspheric region. These narrow band structures are identified in the 0.1 - 20 keV energy range for all ion species. As the satellite moves away from the earth in the plasmasphere, the energy of the peak flux gradually decreases. In most cases of the band structures, the nose-like structure with a wider energy band is observed in the preceding orbit. The band structures of heavy ions are formed closer to the earth than the proton, similar to the nose-like structures. A statistical survey of the spatial distribution of band structures near the equatorial plane shows that the band structures of all ion species occur more frequently around dusk inside L = 4. The energy of the band structure is largest at noon and decreases as the magnetic local time (MLT) increases. The similarity of characteristics between nose-like structures and narrow band structures suggests that the narrow band structures are formed from the loss of ions in the nose-like structures with different lifetimes at different energies and locations.

15:20 [I-1-5]
Spatial distribution of ion anisotropy and its implications in the inner magnetosphere

Sung-Jun Noh, Dae-Young Lee

Chungbuk National University

The anisotropy parameter which is derived for the first time by Kennel and Petschek [1966] is an important parameter to describe EMIC wave excitation mechanisms in classical linear perturbation theory. The anisotropy parameter is different from both temperature moment anisotropy and pitch angle anisotropy in the case of non Maxwellian distribution. Though the statistical research of EMIC waves or pitch angle distribution of the ions were reported in a number of literature, a quantitative investigation about the spatial distribution of the ion anisotropy has not been carried out until now. In this study, we rigorously calculate the Kennel-Petschek anisotropy parameter using the ion (H+, He+, O+) observations during the Van Allen Probes mission era. Then we figure out how the spatial distributions of the anisotropy are different by their energy and species. We discuss implications of the results.

15:35 [I-1-6]
Development the Dst index prediction algorithm 24 hours ahead using empirical model and neural network with geosynchronous orbit magnetic field data

Wooyeon Park[1,2], Jaejin Lee[1], Kyung-Chan Kim[3], Yu Yi[2], Miyashita Yukinaga[1]

[1]*Korea Astronomy and Space Science Institute*
[2]*Chungnam national University*
[3]*Daegu University*

Geomagnetic fields are disturbed by solar wind conditions, and geomagnetic indices such as Dst index and Kp index are commonly used to know how much these are disturbed. For space craft operations and power facilities, geomagnetic indices prediction is important. Korea Meteorological Administration (KMA) develop KSEM (Korea Space wEather Monitor) payload on GEO-KOMPSAT 2A (GK-2A) satellite for the space weather operation. We use Solar wind parameters, proton density, bulk speed, interplanetary magnetic field, Also we tried to use geosynchronous orbit magnetic field data of KSEM payload. We develop the algorithm to estimate geomagnetic indices with a combination of two techniques, empirical model and artificial neural network. Algorithms predict 1 hour to 24 hours Dst index in advance. We compare between the neural network model and the neural network model with the empirical model. We will show results of performances of two algorithms.

Sandpine Room

■ I-2 Special Session
Space Environment Payloads
Session Chair: Joo Hyeon Kim (KARI)

14:20 [I-2-1]
Development of the formation flying CubeSat system for CANYVAL-C mission

Geuk-Nam Kim, Dae-Eun Kang, Jihye Son, Taeyang Lee, Soobin Jeon, Namgyu Kim, Yeon-Gyu Park, Sang-Young Park

Department of Astronomy, Yonsei University, Seoul

CANYVAL-C(CubeSat Astronomy NASA and Yonsei using Virtual ALignment for Coronagraph) mission is aimed to take images solar corona via the formation flying of two CubeSats. CANYVAL-C consists of 1U CubeSat with visible camera and 2U CubeSat with occulter. Currently, the systems of two CubeSats have been designed. It is ready to integrate components of each subsystem with the flight software. Differential atmospheric drag area control and rendezvous maneuvers will keep their formation. To get the solar corona image in the mission mode, two CubeSats should be aligned with respect to Sun precisely. The relative navigation system is composed of GPS data and inter-satellite link. Through the numerical simulation and FEM analysis, it is verified that the system satisfies the required performance and constraints. The flight software and the ground system is under development with end-to-end test. In this research, we will present the current status of the system development for CANYVAL-C mission.

14:35 [I-2-2]
Initial Results of Performance Tests of Three-axes Fluxgate Magnetometer for Space Science Research Developed in Chungbuk National University

Seunguk Lee[1], Sung-Jun Noh[1], Cheong-Rim Choi[1], Kyung-In Kang[2], Gi-Hong Rue[3], Joonsung Kim[1], Hyunhwa Lee[1], Dooyoung Choi[1], Daeyoung Lee[1]

[1]*Chungbuk National University*
[2]*Satellite Technology Research Center, KAIST*
[3]*YeungJin University*

Chungbuk National University has been developing a fluxgate magnetometer for high-precision measurement of magnetic field for space science research. The ultimate goal is to achieve high-standard specifications such as a noise level of a few to hundreds of at 1 Hz. As the development is about to be completed, various tests of the performance have been conducted. Currently, we have confirmed quality of the design structure and basic operation ability of the assembled three axes fluxgate magnetometer. Most importantly, the linearity and noise tests, which are essential indicators of performance, have been undertaken. We have also completed the design and operation tests of the feed-back circuit which is critical to improve fluxgate performance. We plan to install the finally-tested magnetometer on the ground within this year, and we expect continuous upgrades thereafter.

14:50 [I-2-3]
MIRIS Infrared Space Telescope with Science Results

Wonyong Han[1,4], Junghyun Pyo[1], Il-Joong Kim[1], Woong-Seob Jeong[1,4], Dae-Hee Lee[1,4], Bongkon Moon[1], Youngsik Park[1], Sung-Joon Park[1], Won-Kee Park[1], Dukhang Lee[1], Young-Soo Jo[1], Kwang-Il Seon[1], Yosuke Onishi[2,3], Takao Nakagawa[3], Toshio Matsumoto[1,3]

[1]*Korea Astronomy and Space Science Institute*
[2]*Department of Physics, Tokyo Institute of Technology*
[3]*Institute of Space and Astronautical Science, JAXA*
[4]*University of Science and Technology, Korea*

MIRIS(Multi-purpose Infrared Imaging System) is the first astronomical purpose infrared space telescope in Korea developed by KASI in collaboration with SaTReC, KARI and ISAS/JAXA, as the main payload of the Korean science and technology satellite, STSAT-3. It was launched in 2013, and the space observations were made for Galactic plane survey with the Pa-α line(1.88 μm), together with for cosmic infrared background investigation at high Galactic latitude using I and H band. The infrared observational data has been processed and analyzed since its launch, and scientific results were published

recently in ApJ Supplement Series and PASJ following the MIRIS article introduced in the Nature Astronomy. System configuration of the MIRIS is briefly presented with recent science results, and possible future sciences are discussed for researchers who are interested in MIRIS infrared data,

15:05 [I-2-4]
Development and Test Results of Prototype Plasma Prove for Cubesat Constellations

Kwangsun Ryu[1], Hui-kuan Fang[2], K.-I. Oyama[3], Hunkyu Seo[1], Seong-Ho Rhee[4], Dongsu Kang[4], Sun Mie Park[5]

[1]*Satellite Technology Research Center, KAIST*
[2]*Institute of Space and Plasma Sciences, NCKU, Taiwan*
[3]*International Center for space weather study and education, Kyushu University, Japan*
[4]*Dream Spaceworld Ltd.*
[5]*Korea Academy of Science*

While the DC LP (Langmuir probe) is widely used for plasma measurements in space missions, it is not suitable for tiny satellites or Cubesats, since it is difficult to get accurate electron density (Ne) and electron temperature (Te) with the DC LP because of the contamination on both satellite surface and the electrode, and a lack of conductive surface area of the tiny satellite. As an effort to design a Cubesat constellation mission for space plasma observation, a prototype of AC type plasma probe was developed. The principle of the AC type plasma probe is based on the ETP (electron temperature probe) in which the AC voltage with fixed frequency is imposed to dual half-cylinder conducting probes. The time-varying frequency signal is imposed and the impedance change is detected by the AC filter circuit. Based the characteristics of the plasma upper hybrid resonance, the electron density and temperature can be derived without further calibration or inter-calibration with other satellite probes, once the magnetic field around the satellite position is known. The development and initial test results of the prototype of the AC type plasma probe and its possible applications are introduced.

15:20 [I-2-5]
Development of the Qualification Model (QM) for scientific instruments for Small scale magNetospheric Ionospheric Plasma Experiments (SNIPE) mission

Jongdae Sohn, Jaejin Lee, Junga Hwang, Young-Sil Kwak, Jaeheung Park, Uk-Won Nam, and Won-Kee Park

Korea Astronomy and Space Science Institute, Rep. of Korea

In this time, we report the progress of the Qualification Model (QM) for scientific instruments onboard the Korea Astronomy and Space Science Institute satellite-1 (KASISat-1) for Small scale magNetospheric Ionospheric Plasma Experiments (SNIPE) mission. The SNIPE mission consist of four 6 Unit nanosatellites, which have a sun-synchronous orbit at an altitude of 500 - 600 km [TBD]. It has plans to launch the KASISat-1 in the second half of 2020 to understand the spatial and temporal variation of micro-scale plasma structures on the topside ionosphere. The SNIPE mission have scientific targets such as electron microbursts, plasma trough, polar cap patches, bubbles/blobs, field aligned current and EMIC waves. It is equipped with scientific instruments to measure the geophysical phenomena. The SNIPE payload is comprised of three Small but Powerful Space Weather Instruments: the Solid State Telescopes (SST), the Langmuir Probe (LP), the 3 Axis Fluxgate Magnetometer (MAG). The SST will measure electrons in the range of 100 keV - 400 keV [TBD] with the geometrical factor (G = 0.02 cm2 sr) in parallel and perpendicular directions to the geomagnetic field. The LP will measure the density from 2x103/cm3 to 5x106/cm3 [TBD] for ionospheric thermal electrons. The MAG will measure Magnetic field of ± 50,000 nT [TBD] with the noise amplitude (FWHM = 1 nT).

15:35 [I-2-6]
First Results from the LP Instrument in the Instrument for the Study of Space Storms (ISSS) payload onboard NEXTSat-1

Hee-Eun Kim[1], Ensang Lee[1], Kyoungwook Min[2], Kwangsun Ryu[3], Sang-Yun Lee[3], Junchan Lee[4], Juneseok Kang[1]

[1]*School of Space Research, Kyung Hee University*
[2]*Department of Physics, KAIST*
[3]*Satellite Technology Research Center, KAIST*
[4]*Korea Advanced Institute of Science and Technology*

The instruments for the study of space storms (ISSS) is a science payload onboard the next generation small satellite-1 (NEXTSat-1), which has a sun-synchronous orbit with an altitude of about 575 km. The ISSS payload has two space radiation detectors and three space plasma detectors. The disk-type Langmuir probe (LP) instrument is one of the space plasma detectors included in the ISSS payload. LP measures density ($10^3 - 2\times10^6 cm^{-3}$) and temperature ($560 - 58{,}000\,K$) of ionospheric thermal electrons. We have developed an algorithm to pre-process and analyze the characteristics of the current-voltage (I-V) curve obtained from the LP instrument. In this study, we present a brief report on the results of the initial observations from the LP instrument. The quality of the observation data is discussed. Also, we present verification of the obtained electron density and temperature data by comparing simulation results for the LP instrument.

Han Song

■ I-3 Special Session KPLO
Session Chair: Ho Jin (KHU)

14:20 [I-3-1]
Opposition surge depending on grain size of lunar surface

Minsup Jeong[1], Young-Jun Choi[1,3], Sungsoo S. Kim[2]

[1]*Korea Astronomy and Space Science Institute*
[2]*Kyung Hee University*
[3]*University of Science and Technology*

Moon surface shows the brightening at the small phase angle. This phenomenon called as opposition surge. It implies that the Moon has considerably a rough surface. the opposition surge is affected by various physical properties of the surface such as roughness, albedo, and grain size. To understand the grain size effect to the opposition surge, we analyse the data with phase angles of less than 5 degrees from Lunar Reconnaissance Orbiter Wide Angle Camera (LRO WAC) and the grain size data from polarimetry. We find that the correlation between the grain size and opposition effect.

14:35 [I-3-2]
Space environment test of qualification model in the PolCam payload for Korea Pathfinder Lunar Orbiter (KPLO) mission

Bong-Kon Moon[1], Min-Seob Jeong[1], Kyoung-In Kang[2], Bon-Ju Koo[2], Min-Kyoung Lee[3], Eun-Jin Cho[3], Seung-Cheol Bang[1], Sung-Joon Park[1], Young-Jun Choi[1,3]

[1]*Korea Astronomy and Space Science Institute*
[2]*Satellite Technology Research Center, KAIST*
[3]*University of Science and Technology*

The Korea Astronomy and Space Science Institute is developing PolCam (Polarimetric Camera), a payload of Korea Pathfinder Lunar Orbiter (KPLO). PolCam is a polarizing camera that images the lunar surface with a 10-degree wide field of view at an altitude of about 100 km. This paper presents the results of the space environment test for PolCam's qualification model. The space environmental tests mainly consist of vibration test, shock test, and thermal vacuum test, and each test was performed based on the KPLO environmental test specification. The rigidity of the payload structure and the stability of the optical system were confirmed through the vibration test and the shock test, and it was confirmed that the function of the payload unit was normally operated through the thermal vacuum test. In conclusion, the PolCam qualification model has passed the space environment test, and the process of the space environment test and the detailed result are presented.

14:50 [I-3-3]
Test results of the KMAG Flight Model

Byungwook Jeong[1], Hyojeong Lee[1,3], Seungah Lee[1], Jehyuck Shin[1], Seongwhan Lee[1,3], Mangyu Lee[1], Ho Jin[1,2]

[1]*School of Space Research, Kyung Hee University*
[2]*Department of Astronomy & Space Science, Kyung Hee University*
[3]*Intorule Inc.*

KMAG (KPLO MAGnetometer) is one of scientific payloads in KPLO (Korea Pathfinder Lunar Orbiter). The scientific objective of KMAG is to measure the magnetic field on the lunar surface and around near moon space. The KMAG consists of FCE (Fluxgate magnetometer Control Electronics) unit and MAG (MAGnetometer) unit. At this moment, KMAG is now on the delivery stage after finishing Flight Model test. KMAG FM (Flight Model) was completed environmental tests and the long-term function test. From all tests, we confirmed to comply the requirements for the MAG data and system status. In this paper, we present final function results and MAG performances.

15:05 [I-3-4]
Orbit prediction error analysis in lunar capture phase with lunar orbit insertion maneuvers for the Korea Pathfinder Lunar Orbiter mission

Young-Rok Kim, Young-Joo Song, Jonghee Bae, Su-Jin Choi, Jae-ik Park, Donghun Lee

Korea Aerospace Research Institute

Lunar orbit insertion (LOI) maneuver is the most critical burn procedure for delivering lunar orbiter into its mission orbit. For successful lunar capture of a lunar orbiter, the performance of the first LOI burn is essential. In this study, orbit determination (OD) and orbit prediction (OP) error analysis in the first LOI maneuver was performed for Korea Pathfinder Lunar Orbiter (KPLO) mission. Because the OP accuracy at LOI maneuver time directly affects burn performance, the uncertainty of predicted orbital states was mainly investigated for successful burn implementation. For the OP uncertainty analysis at LOI maneuver time, the last tracking time was limited to one or two days before burn execution. For orbit accuracy assessments, predicted true anomaly uncertainty at maneuver time was calculated. This study provides a guideline of mission operation in the lunar capture phase of KPLO.

15:20 [I-3-5]
Design Concept of Image Calibration and Analysis Subsystem for Korea Pathfinder Lunar Orbiter

Jo Ryeong Yim, GwangSoo Shin, Dong-Gyu Kim

Korea Aerospace Research Institute

Korea Aerospace Research Institute(KARI) is developing the first Lunar Orbiter in Korea, Korea Pathfinder Lunar Orbiter (KPLO). One of the main instruments developed by KARI is Lunar Terrain Imager(LUTI). Image Calibration and Analysis Subsystem(ICAS) means a LUTI image processing pipeline system. The main functions for ICAS is 1) to receive LUTI image data from the Payload Storage Server, 2) to generate Level Products by performing geometric and radiometric calibration, and 3) to transfer the Level Products for archiving and public distribution. The calibration work for LUTI images will be performed by the KARI image calibration team. In LUTI images, the criteria of Level Product is defined in accordance with the PDS4 Data Standards. As a result of the preliminary design, it was decided to use ISIS3 software for image processing of LUTI, a specialized digital image processing software package developed by the USGS for NASA. The ISIS3 is also used for Narrow Angle Camera(NAC) image processing of Lunar Reconnaissance Orbiter (LRO), which is very similar to LUTI. In order to use ISIS3 software, KPLO ancillary data must be provided in the form of SPICE kernels, which are closely related to geometrical correction of LUTI images. In this paper, the function of ISIS3 and the design concept of ICAS will be covered in detail.

15:35 [I-3-6]
Korea Pathfinder Lunar Orbiter Mission: Development Status of Science Instruments

Eunhyeuk Kim, Seok-Weon Choi

Korea Aerospace Research Institute

Korea Pathfinder Lunar Orbiter (KPLO) mission, a first space exploration mission beyond the earth orbits of Korea is approaching to finalize the system design. KPLO will host 6 instruments; 5 science instruments and 1 technology demonstration instrument, DTNPL. The 5 scicence instruments of KPLO are 1) Lunar Terrain Imager (LUTI), 2) Wide-angle Polarimetric Camera (PolCam), 3) KPLO Magnetometer (KMAG), 4) KPLO Gamma-Ray Spectrometer (KGRS), and 5) ShadowCam. All instruments of KPLO have completed critical design reiview (CDR) and flight model of the instruments will be delivered. We will shortly report the development status of science instruments of KPLO.

Lakai Ballroom

■ Invited Talk II
Session Chair: Young-Sil Kwak (KASI)

16:00 [IS-II]
Science and Real-Time Observations with the 2024 Interstellar Mapping and Acceleration Probe (IMAP) Mission
KASI contributions to the BBSO/GST and NASA space solar missions

Kyung-Suk Cho[1,2]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*

From 2004, the Korea Astronomy and Space Science Institute (KASI) participated in the construction of 1.6 m Goode Solar Telescope (GST) with NJIT. The first experience was to develop the Fast Imaging Solar Spectrograph (FISS) with the SNU group and the softwares for the correlation tracker system and the high-order adaptive optics systems of GST. In 2010, KASI extended its scientific focus to space observations. As a part of the activity, KASI made an agreement with NASA and started initial setup of the data system to store, use, and disseminate the Solar Dynamic Observatory (SDO) data for Asian region. Since 2017, KASI and NASA have been developing a solar coronagraph system, which is expected to be installed on the International Space Station (ISS). For the purpose of technical demonstration, we will perform a stratospheric balloon experiment in 2019 September. In this talk, I will introduce KASI's contributions to the ground solar telescope and the space solar missions of NASA in the past 15 years.

16:30~16:40 Photo Time

April 25(Thu)

Lakai Ballroom

■ II-1 Sun&Space Environment II
Session Chair: Jaejin Lee (KASI)

09:30 [II-1-1]
Photospheric Resonator Model of Three-minute Umbral Oscillations

Jongchul Chae, Juhyung Kang

Seoul National University

The velocity oscillations observed in the chromosphere of sunspot umbrae look like a resonance in that their power spectra are sharply peaked around a period of about 3 minutes. What resonance leads to the observed 3 minute oscillations? To find an answer to this question, we have investigated the behavior of the acoustic waves that are driven by the motion of a piston at the lower boundary, and propagate in an nonisothermal atmosphere that consists of the lower layer (photosphere) where temperature rapidly decreases with height and the upper layer (chromosphere) where temperature slowly increases with height. We have obtained the following results: 1) the lower layer (photosphere) acts as a resonator of acoustic waves. The bottom end is established by the piston, and the top end, by the reflection at the interface between the two layers. 2) The top end partially reflects and partially transmits acoustic waves of frequencies around the acoustic cutoff frequency at the temperature minimum. 3) The resonance occurs at one frequency around this cutoff frequency, and its frequency is mainly determined by the distance between the driving position and the temperature minimum. The power spectrum of velocity oscillation observed in the chromosphere can be fairly well reproduced by this model.

09:45 [II-1-2]
The GST observation of small loop activities above the sunspot light bridge in NOAA AR 12673

Yeon-Han Kim[1], Yan Xu[3], Vasyl Yurchyshyn[2], Su-Chan Bong[1], Eun-Kyung Lim[1], Heesu Yang[1], Kwangsu Ahn[2], Young-Deuk Park[1], Phillip R. Goode[2]

[1]*Korea Astronomy and Space Science Institute*
[2]*Big Bear Solae Observatory, USA*
[3]*Center for Solar-Terrestrial Research, USA*

The active region NOAA AR 12673 is the most flare productive active region in the solar cycle 24. On 2017 September 07, it produced an X1.3 flare, three M-class, and several C-class flares. We successfully observed several C-class flares from 16:50 UT to 22:00 UT using the 1.6m Goode Solar Telescope (GST; formerly NST) at Big Bear Solar Observatory (BBSO). Interestingly, we observed the active region in He I D3 and 10830 lines simultaneously. The data shows several interesting features: (1) small loop activities occurred above the sunspot light bridge (LB); (2) the loop looks bright in 10830 and dark in D3 respectively; (3) all SDO AIA images show the same bright loop as 10830 data (4) in 10830, loop activity starts from 21:05 UT and ends around 21:23 UT then is followed by flare brightening; (5) from the SDO HMI, the light bridge is located along the polarity inversion line of the sunspot. Based on the observed features, we suggest that the small loop activity above the sunspot light bridge is a miniature of large scale filament eruption associated with two-ribbon flares.

10:00 [II-1-3]
Source of the internally excited umbral three-minute oscillations

Kyuhyoun Cho, Jongchul Chae

Seoul National University

We propose the evidence for the internal excitation of the three-minute umbral oscillations. We investigate the umbral velocity oscillation data observed by the Fast Imaging Solar Spectrograph (FISS) of 1.6 m Goode solar Telescope (GST) at the Big Bear Solar Observatory (BBSO). The umbral velocity oscillations were observed by the Fe I 5435 Å line which is a magnetically insensitive line formed at the temperature minimum region. As a result, we found several oscillation patterns that are supposed to be generated by internal excitations, not external origins in the 2-4 minute filtered velocity oscillation data. Their characteristics are well consistent with our expectations which are the positions of the oscillation centers, short time scale, and small size. Moreover, we found spatially and temporally associated umbral dots below the oscillation centers. The identified umbral dots show vigorous morphological and dynamical changes which can be interpreted as small-scale magnetoconvection inside the sunspot. In addition, we inferred the depth of the oscillation source using the propagation speed of the horizontal apparent waves. The results indicate that the sources are located at about 2000 km below the photosphere. Our results support that the magnetoconvection associated with umbral dots can generate the three-minute umbral oscillations and give us a clue about the internal structure of the sunspot.

10:15 [II-1-4]
Study on the origin of white light plasma blobs formed in post-CME current sheets:

I. outward-moving post-CME blobs by LASCO-C2

Jae-Ok Lee[1], Kyung-Suk Cho[1], Kyung-Sun Lee[2], Il-Hyun Cho[3]

[1]*Korea Astronomy and Space Science Institute*
[2]*Center for Space Plasma and Aeronomic Research, University of Alabama in Huntsville(UAH)*
[3]*Department of Astronomy & Space Science, Kyung Hee University*

It is generally believed that outward-moving plasma blobs along the post-CME rays (post-CME blobs) observed by LASCO-C2 form within the heights from 1.0 to 2.0 solar radii. Even though the COronal Solar Magnetism Observatory (COSMO) K-coronagraph (K-Cor) produce white-light corona structures from 1.0 to 3.0 solar radii with high spatial resolution (5.5 arcsec/pixel) and temporal cadence (15sec), there are no comprehensive investigations on the formation heights of post-CME blobs by using LASCO-C2 with K-Cor. In this study, we investigate the post-CME blobs observed on 2017 September 10 from 17:11 UT to 20:20 UT, which are the K-Cor observation time. We use LASCO-C2 and K-Cor data and make their intensity and running difference images in order to determine the observational heights of post-CME blobs. By using the observed times of post-CME blobs and their heights, we make the time-height plot of post-CME blobs. By examining the time-height plot, we find that there are only 2 post-CME blobs in LASCO-C2 FOV while 8 outward-moving plasma blobs above the tips of post-CME rays as well as 32 outward-moving plasma blobs in the post-CME rays are detected in K-Cor FOV. Among 8 outward-moving plasma blobs above the tips of post-CME rays, only 2 blobs might be associated with the 2 post-CME blobs in LASCO-C2 FOV and their formation heights are below or near the 1.93 and 1.79 solar radii, respectively. Our results demonstrate the origin of post-CME blobs by LASCO-C2 and leave the question why the other blobs can not propagate into the interplanetary space.

10:30 [II-1-5]
The Physical Nature of Spiral Wave Patterns Observed in Sunspots

Juhyung Kang[1], Jongchul Chae[1], Valery M. Nakariakov[2,3], Kyuhyoun Cho[1], Hannah Kwak[1], Kyeore Lee[1]

[1]*Seoul National University*
[2]*University of Warwick*
[3]*Kyung Hee University*

Recent observational works have reported the Spiral wave patterns occurred in umbrae of sunspots, but the nature of this has remained elusive. Here we reveal that the spiral wave patterns can be generated in an untwisted and non-rotating magnetic cylinder. We investigate the one and two-armed spiral wave patterns occurred in a pore by using Doppler velocity maps. The periods of these are about 160 seconds, and the durations are about 5 minutes. In our theoretical model, the spiral wave patterns can be formed by the source located 1600 km below the photosphere in untwisted and non-rotating magnetic flux tube of cylindrical geometry. The one-armed spiral wave pattern is produced by the m=0 sausage and m=1 kink modes, and the two-armed spiral pattern is formed by the m=0 sausage and m=2 fluting modes.

10:45 [II-1-6]
A collapsing granule and the excitation of oscillations

Hannah Kwak, Jongchul Chae

Seoul National University

We present a collapsing granule and associated oscillations in the photosphere and chromosphere. Our observations were carried out using the Fast Imaging Solar Spectrograph and the TiO 7057Å Broadband Filter Imager of the 1.6 meter Goode Solar Telescope of Big Bear Solar Observatory. Our main findings are as follows: (1) In the photospheric TiO images, we found a granule which becomes dark compared to neighboring granules and collapses within several minutes. (2) Above the dark granule, a downflow of 0.7 km/s is identified in the photosphere. (3) After the downflow, oscillations of velocity occur in the photospheric and chromospheric layers. (4) The dominant period of the oscillations is close to 4.5 minutes in both of the layers but slightly shorter in the chromosphere. Based on our results, we suggest that impulsive collapse of a granule can generate acoustic waves in the solar quiet region.

Sandpine Room

■ II-2 Special Session NEXTSat-1/KSEM I
Session Chair: Jo Ryeong Yim (KARI)

09:30 [II-2-1]
Structural and thermal analysis result of LEO-DOS payload for the NEXTSat-2

Bong-Kon Moon[1], Uk-Won Nam[1], Won-Ki Park[1], Jeong-Hyun Pyo[1], Jeong-A Hwang[1], Jae-Jin Lee[1], Jong-Dae Son[1], Sung-Hwan Kim[2], Seong-Jun Ye[3]

[1]*Korea Astronomy and Space Science Institute*
[2]*Cheongju University*
[3]*Seoul University*

The Korea Astronomy and Space Science Institute is developing a low-Earth orbit space radiation dosimeter (LEO-DOS) for the science payload of NEXTSat-2, which will be launched around 2021. The scientific missions of LEO-DOS payload are to

create a global map of charged particles and neutron equivalent doses on orbit, to study the cosmic radiation environment based on the measurement data, to study cosmic radiation changes in the solar activity minimum, and to verify the human impact weight by energetic neutrons. All structures and detectors of LEO-DOS are being developed with domestic technology. As the satellite payload basically has to withstand the vibrating environment of the launcher, the LEO-DOS payload is designed to maintain sufficient rigidity in consideration of such launch environment. NEXTSat-2 has a temperature variance of a 100-minute cycle as it travels through the Earth's orbit at an altitude of about 600 km. However, the LEO-DOS payload must maintain a room temperature environment in order to keep the performance of the detector in this temperature change environment. The concept of thermal design for this was applied and the thermal design results were confirmed to be well maintained at room temperature. We present the structure and thermal analysis results of the LEO-DOS structure.

09:45 [II-2-2]
Early operation of Korean Space Environment Monitor (KSEM) onboard GEO-KOMPSAT-2A and the preliminary result of KSEM Particle Detector (PD)

Go Woon Na, Jongho Seon, Kyu-Sung Chae, Yuchul Shin, Ju Woo, Woohyeong Seol, Chanhaeng Lee, Sungmin Pak, Seunghyuk Shin

School of Space Research, Kyung Hee University

Korean Space Environment Monitor (KSEM) is the first instrument in Korea to observe the space weather of the near-Earth environment in a geostationary orbit over Korea. KSEM consists of three sets of two particle detectors, a satellite charging monitor, and a set of four magnetometers. The particle detectors simultaneously measure the distribution of charged particles in the energy range of 100 keV to 2 MeV for electrons and 100 keV to 12 MeV for ions, respectively, over the six different viewing angles. KSEM was mounted on second Korean geostationary satellite GEO-KOMPSAT-2A (GK2A) which was launched in December 2018. The in-orbit test for KSEM has been performed since January 4, 2019. The initial activations of KSEM were successfully executed. The commissioning of particle detectors (PD) was also completely performed. We will provide a summary of the early operation activities and commissioning results of PD with comparison with data from other missions to attempt a preliminary assessment of the validity.

10:00 [II-2-3]
Understanding of the radiation shielding using Geant4-based simulation

Seung-hyuk Shin, Sungmin Pak, Yuchul Shin, Jongho Seon

School of Space Research, Kyung Hee University

The charged particle detectors for investigating the space environment are exposed to energetic particles which can damage electronics and contaminate data. Adjusting the thickness of the instruments is one of the methods to protect it from energetic radiation. The directional thickness distribution from the center of the detectors was calculated using Geant4-based Sector Shielding Analysis Tool (SSAT). The analysis of penetrating particles is essential to confirm the physical interaction of the devices. Through the particle simulation by using Geant4, the position and energy of detected particles incident from all directions were computed. This presentation summarizes the results of two simulations and confirms unprotected areas of the instruments.

10:15 [II-2-4]
In-orbit test results of KSEM SOSMAG on board GEOKOMPSAT-2A

Chanhaeng Lee[1], Go Woon Na[1], Kyusung Chae[1], Jongho Seon[1], Hans-Ulrich Auster[2], Christian Strauch[3], Werner Magnes[4], David Fischer[4]

[1]*School of Space Research, Kyung Hee University, Korea*
[2]*Technical University of Braunschweig, Germany*
[3]*Magson GmbH, Germany*
[4]*Austrian Academy of Sciences, Austria*

Service Oriented Spacecraft MAGnetometer (SOSMAG) is a magnetometer measuring the Earth magnetic field ranging from ±64,000 nT around the geostationary orbit. SOSMAG consists of 4 sensors, an electronic box and a deployable boom. A couple of Anisotropic Magneto-Resistance (AMR) sensors are located inside the body of the satellite to remove the magnetic noise from other electronics. The other sensors, FluxGate magnetometer Out (FGO) and FluxGate magnetometer In (FGI), measure magnetic fields on the deployed boom. The first operation of SOSMAG in space including basic health check and boom deployment was performed January 4th, 2019 and instrument parameter upload was performed on February 26th, 2019. The tests were successfully completed and it was confirmed that SOSMAG samples magnetic field vectors that are comparable to the previous findings from other space missions.

10:30 [II-2-5]
Initial report of energetic particle observations by the High Energy Particle Detector (HEPD) onboard the Next Generation Small Satellite-1 (NEXTSat-1)

Ji-Hyeon Yoo[1], Kwang-Sun Ryu[2], Young-Soo Jo[3], Eo-Jin Kim[2], Seunguk Lee[1], Dae Young Lee[1], Jongdae Sohn[3], Kyoung-wook Min[4], Junchan Lee[4], Gyeongbok Jo[5], Yu Yi[5], Gowoon Na[6], Jongho Seon[6], Kyung-In Kang[2] and Goo-Hwan

Shin[2]

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[4]*Korea Advanced Institute of Science and Technology*
[5]*Department of Astronomy and Space Science, Chungnam National University*
[6]*School of Space Research, Kyung Hee University*

The High Energy Particle Detector (HEPD) is one of the instruments onboard the Next Generation Small Satellite-1 (NEXTSat-1) which was launched in December 2018. The HEPD measures particles which precipitate from the inner magnetosphere into the Earth's atmosphere, allowing to understand source and loss mechanisms of the radiation belt and ring current particles. The HEPD consists of three telescopes corresponding to 0°, 45° and 90° to the local magnetic field. And each telescope has two solid-state detectors (SSDs). The HEPD measures electrons and protons in the energy range of 0.35 to 2MeV and 3 to 20MeV, respectively. It has a spectral resolution of about 10% at 1MeV and a time resolution of 32Hz. Since the launch of NEXTSat-1, initial operation of this spacecraft has continued. Of these instruments, Space Radiation Detectors (SRDs) including the HEPD and the Medium Energy Particle Detector (MEPD) have been operating in the subauroral region. In this presentation, we first briefly report on initial operation of NEXTSat-1 and introduce the data of the HEPD through quick look data samples. We also introduce plans for the distribution and the handling of the HEPD data.

10:45 [II-2-6]
Performace comparison of KOMPSAT-5 Precision Orbit Dermination with GRACE

Kyoung-Min Roh[1], Yoola Hwang[2], Sung-Moon Yoo[1]

[1]*Korea Astronomy and Space Science Institute*
[2]*Electronics and Telecommunications Research Institute*

The Korean Multipurpose Satellite-5 (KOMPSAT-5) launched on Aug. 22, 2013 was equipped with a global positioning system (GPS) receiver for precision orbit determination. Even though the GPS receiver of KOMPSAT-5 shares the same heritage as the BlackJack receiver installed in Gravity Recovery and Climate Experiment (GRACE) satellite, KOMPSAT-5 has lower orbital position accuracy (~10 cm) compared with GRACE (2-3 cm). The reduced-dynamic and kinematic methods were used to determine the orbital positions of KOMPSAT-5 and GRACE satellites to investigate the effects due to thesatellite operation and design on the quality of GPS observations dominating on the orbital position accuracy. The results were analyzed in terms of the number of observations and their special distribution, GPS signal quality, and orbital position accuracies. The results showed that the frequent attitude maneuvers of KOMPSAT-5 affect the quality of the GPS signals and solutions obtained from the kinematic method compared with those determined from the reduced-dynamic method. The patch GPS antenna installed in KOMPSAT-5 and its position resulted in more erratic measurement residuals compared with the choke ring antenna of GRACE by 140%. The results showed that the accuracy of precision orbit determination is dependent on the hardware design and operational strategy of the satellite as well as the use of a high-performance GPS receiver.

Han Song

■ II-3 Space Technology & Application I
Session Chair: Eun Jung Choi (KASI)

09:30 [II-3-1]
Analysis of close approach event between KOREASAT 5 and IGSOs using optical tracking data of OWL-Net

Jin Choi, Jung Hyun Jo, Hong-Suh Yim, Eun-Jung Choi, Dong-Goo Roh, Myung-Jin Kim, Sooyoung Kim, Jiwoong Yu, Jang-Hyun Park, Sungki Cho

Korea Astronomy and Space Science Institute

KOREASAT 5 is domestic GEO (Geostationary Earth Orbit) satellite operated at 113 degrees east longitude. KOREASAT 5A and PALAPA D are located near the station keeping box of KOREASAT 5. In this research, we analyzed close approach event between KOREASAT 5 and IGSO (Inclined Geosynchronous Orbit) satellite, Raduga 1-4. Raduga 1-4 is inactive and drifted along the longitudinal direction. On Dec. 23 2018, Raduga 1-4 close approached to KOREASAT 5 for less than few km. The close approach event was analyzed using TLEs (Two Line Elements), and estimated orbit using optical tracking data of OWL-Net. Test observations for OWL-Net optical tracking data verification were also performed for QZS-3. The verification results was utilized for the orbit estimation of KOREASAT 5 and Raduga 1-4.

09:45 [II-3-2]
The Design Concept of PMAD (Power Management and Distribution) for Korean SSPS (Space Solar Power Satellite)

Sung-Soo Jang

Korea Aerospace Research Institute

Since 1970s, NASA has been studied on wireless power transmission of abundant solar energy in space to the ground. The basic concept of Space

Solar Power Satellite (SSPS) converts solar energy into electrical energy in space, then it transmits electrical energy to the ground through the wireless power transmission with microwave or laser. In recent, the NASA plans to test 10MW solar power generation systems in the 2020s, and Japan has considered commercial operation of 1GW solar power generation satellites in the 2030s.
This paper investigates the design concept of a power management system for ultra – high voltage power conversion and power transmission, which should be considered for generation of gigawatt – class energy in space and transmission to the ground. In particular, this paper introduced the basic design concept for the power management system of Korean SSPS system.

10:00 [II-3-3]

A Development Progress of Solar Array for Localization in Korea for Low Earth Orbit

Goo-Hwan SHIN[1], Dong-Guk KIM[1], Im-Hyu SHIN[1], Won-Ho CHA[1], Tae-Seong JANG[1], Jeong-Ki SEO[1], Se-Jin KWON[1], Hu-Seung LEE[2], Soo-Hyun KIM[3], Jeong-Sik KIM[3], Jin-Hyung JEON[3], Hiroyuki TOYOTA[4]

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A 30W solar array is under development in KAIST to verify its performance in orbit such as the low earth orbit and also its main mission is localization of the solar array here in Korea. After verifying in orbit for that, the solar array shall be applied in Korean space program according to its long term space program in Korea. Current solar array will be about minimum 30W at 25° C with AM0 conditions and it will be verified by NEXTSat-2 program. It has so many requirements for developing here in Korea such as temperature, orbit, operational mode, radiation effects an so on. Thus, in this study, we proposed the requirements for verifying in space, which shall have all the requirements to check in space and analyze its data.

10:15 [II-3-4]

Localization of Space Solar Array Design about 300W for Low Earth Orbit

Goo-Hwan SHIN[1], Dong-Guk KIM[1], Im-Hyu SHIN[1], Won-Ho CHA[1], Tae-Seong JANG[1], Jeong-Ki SEO[1], Se-Jin KWON[1], Hu-Seung LEE[2], Soo-Hyun KIM[3], Jeong-Sik KIM[3], Jin-Hyung JEON[3], Hiroyuki TOYOTA[4]

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Solar array is a crucial parts for performing the spacecraft by photo-voltaic effects in space during the sunlight. The required power shall be generated from the solar array according to the power and energy budget. Also, its technology shall be imported from the overseas because the solar array shall not be provided by the manufacturer or supply. For this reason, the government proposed the need for technology development to avoid a technical subordination from the space advanced country in 2017. As part of this reason, the solar array development was kicked off to in 2017, thus KAIST is developing the QM solar array about 300W power for space applications. In this study, we proposed the current development progress in order to share the solar array.

10:30 [II-3-5]

Limitations of using high resolution satellite imagery for maritime Search and Rescue System

Hae-Jin Choi, Eun-Kyou Kim, Sun-Hee Woo

Korea Aerospace Reach Institute

In 2016, the method of using high resolution satellite images for the marine SAR(Search & Rescue) system was re-emerged with the accident of the Stella Daisy, which took place in South Atlantic Ocean. In general, the satellite image was not utilized for the SAR application because it was sensitive to weather conditions (such as clouds) and it took a long time to revisit the target. Currently, the most critical role in the marine SAR is Cospas-Sarsat program which provides rescue alarms and location information to the ICAO(International Civil Aviation Organization) and the IMO(International Maritime Organization). With the growth of small satellite constellation services, it was being planned to provide an entire earth images in a day. This made us rethink whether or not the high resolution satellite imagery could be utilized in the maritime SAR system. The technical limitations were studied based on the KOMPSAT images and future directions of technology were discussed.

10:45 [II-3-6]

The Vertical Distribution of Physical Properties and Chemical Species in the Upper Atmosphere Between 20 ~ 200km Altitude Range in the Northern Mid Latitude

Gi-Hyuk Choi, Joo-Hee Lee

Korea Aerospace Research Institute

Recently sub-orbital spaceship 'SpaceShip 2' ready to operation and from US Airforce' s X-37B unmanned space plane has been being operating since 2010. And other more orbital and sub orbital space planes are prepared for operation. Korea' s 3rd Space Promotion Basic

Plan announced February 2018, it says that asteroid sample return mission will be conducted in 2035. KARI also is started re-entry study from 2019. So it is required to get to know the vertical distribution of physical properties and chemical species between 20-200km altitudes because it is very important for design of re-entry vehicle and its thermal protection system. Usually in the upper atmosphere pressure decreased exponentially with altitude. During the Stratosphere between 20-50km temperature rises with altitude because of ozone heating. In the Mesosphere 50-90km temperature decrease again and it leads to fluid dynamic unstability. So there are many dynamic phenomenon such as tidal motions, gravity waves and planetary waves. Usually the re-entry objects have maximum heating between 70-90km altitude. Above 90km it is called Lower Thermosphere and Ionosphere where atmospheric molecules begin to dissociate into ions and electrons. And there are many energetic phenomenon occur such as aurora, airglow and sola wind/cosmic ray and atmospheric molecules/atoms interactions. We should understand and get the information of all these phenomenon for design and operation of re-entry vehicle. For these purpose, in this study we will show the fundamental information of the upper atmosphere.

Lakai Ballroom

■ Invited Talk III
Session Chair: Kwangsun Ryu (SaTReC)

11:10 [IS-III]
KASI contributions to the BBSO/GST and NASA space solar missions

Kyung-Suk Cho[1,2]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*

From 2004, the Korea Astronomy and Space Science Institute (KASI) participated in the construction of 1.6 m Goode Solar Telescope (GST) with NJIT. The first experience was to develop the Fast Imaging Solar Spectrograph (FISS) with the SNU group and the softwares for the correlation tracker system and the high-order adaptive optics systems of GST. In 2010, KASI extended its scientific focus to space observations. As a part of the activity, KASI made an agreement with NASA and started initial setup of the data system to store, use, and disseminate the Solar Dynamic Observatory (SDO) data for Asian region. Since 2017, KASI and NASA have been developing a solar coronagraph system, which is expected to be installed on the International Space Station (ISS). For the purpose of technical demonstration, we will perform a stratospheric balloon experiment in 2019 September. In this talk, I will introduce KASI's contributions to the ground solar telescope and the space solar missions of NASA in the past 15 years.

13:10~14:40 Poster Session

Lakai Ballroom

■ III-1 Sun&Space Environment III
Session Chair: Byung-Kyu Choi (KASI)

14:40 [III-1-1]
Estimation of ionospheric foF2 and hmF2 by applying convolution neural network method to one-year Jeju ionogram dataset

Se-Heon Jeong[1], Yong Ha Kim[1], YoungSil Kwak[2], JongYeon Yun[3]

[1]*Chungnam National University*
[2]*Korea Astronomy and Space science Institute*
[3]*Korea Space Weather Center (KSWC), Jeju, Korea*

The ionosphere has been monitored by ionosondes world-widely for a long time. An ionosonde produces an ionogram that displays radio echoes in the frequency-range plane. The trajectory of echoes in this plane can be read either manually or automatically scaled to extract ionospheric parameters, such as foF2 (peak frequency of the F2 layer), hmF2 (peak height of the F2 layer), and other ionospheric parameters. We trained a convolution neural network (CNN) model by using a Jeju (33.43°N, 126.30°E) ionogram dataset with manually scaled hmF2s and foF2s. Then, hmF2s and foF2s estimated by the CNN model are compared with those of auto-scaling program, ARTIST, for the entire year Jeju ionogram dataset of 2012. The comparison shows that auto-scaled foF2s and hmF2s have higher correlation and smaller root mean square error (RMSE) from the manually scaled values than those of the CNN model. However, the CNN model is able to estimate reasonable hmF2s and foF2s from ionograms (4718 ionograms) that cannot be treated by the auto-scaling program. The CNN model foF2s and hmF2s have RMSEs of 1.28 MHz and 28.6 km, and correlation coefficients of 0.91 and 0.80, respectively. Thus, we conclude that the CNN method can be used for extracting the ionospheric parameters from ionograms more robustly than the auto-scaling program.

14:55 [III-1-2]
Distribution of broad plasma depletions in the equatorial F region observed by the C/NOFS satellite and SWARM satellite

Jong-Min Choi[1], Young-Sil Kwak[1], Hyosub Kil[2], Jaeheung Park[1], Woo Kyoung Lee[1], Yong Ha Kim[3], and Jae-Jin Lee[1]

[1]*Korea Astronomy and Space Science Institute, Daejeon, South Korea*
[2]*The Johns Hopkins University Applied Physics Laboratory, Laurel Maryland, USA*
[3]*Chungnam National University, Daejeon, South Korea*

Broad plasma depletions (BPDs) represent bubble-like plasma depletions in the equatorial F region whose longitudinal widths (> 5 degree) are greater than those of regular bubbles. Their occurrence in satellite observations is understood in terms of the uplift of the ionosphere; BPDs occur when satellites pass through the bottomside of bubbles. However, a merger of bubbles is also suggested as the cause of BPDs. We investigate the origin of BPDs by examining the occurrence climatology of BPDs and its association with vertical plasma motion. Our preliminary results derived from the C/NOFS observations in 2008-2012 show that BPDs occur more frequently during lower solar activity, during higher magnetic activity, and at lower altitudes. BPDs during solar maximum and minimum show different behavior. BPDs occur frequently at premidnight and during the equinoxes and December solstices during solar maximum, whereas BPDs occur predominantly at postmidnight and during the June solstices. The occurrence rates of post-midnight BPDs are positively correlated with AE index and are inversely correlated with 10.7 cm solar radio flux. Low solar activity creates favorable conditions for generating BPDs by thinning the F region thickness. At the solar minimum, the density of the F region bottomside changes significantly even with slight altitude shifts, which can be recognized as a BPDs. When a geomagnetic disturbance occurs, the eastward electric field can be enhanced at the equatorial F region and the entire F layer can move upward. On the other hand, the latitudinal scale of BPD has not yet been reported. Therefore, in this presentation, the results of the latitudinal spatial scale obtained by analyzing SWARM satellite data will be also introduced.

15:10 [III-1-3]
Distribution of sporadic E layer seen by CHAMP GPS radio occultation data

Woo Kyoung Lee[1,2] and Hyosub Kil[3]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*
[3]*Johns Hopkins University Applied Physics Laboratory*

We investigates the distribution of sporadic E layer (Es) by analyzing the GPS radio occultation data provided by CHAMP satellite in 2002-2008. Es is a thin transient ionospheric layer with high electron density occurring at 80-130km altitude and has been suggested as an important source of medium-scale traveling ionospheric disturbances (MSTIDs) in middle latitudes. However, few studies have reported on how they are connected in global view. In this study, we examine the causal linkage between Es and MSTIDs by comparing global distributions of Es and MSTIDs retrieved from CHAMP satellite observations in season, longitude and local time. Finally, we discuss possible role of Es in the creation of MSTIDs.

15:25 [III-1-4]
Comparative study on mesospheric winds and temperature measured by Fabry-Perot interferometer and meteor radar at King Sejong Station, Antarctica

Changsup Lee[1], Geonhwa Jee[1], Qian Wu[2], Jeong-Han Kim[1], Yong Ha Kim[3]

[1]*Korea Polar Research Institute, Korea*
[3]*High Altitude Observatory, NCAR, USA*
[2]*Chungnam National University, Korea*

Neutral winds and temperature in the mesosphere and lower thermosphere (MLT) have been simultaneously observed by Fabry-Perot interferometer (FPI) and meteor radar (MR) at King Sejong Station (KSS), Antarctica from 2017. The simultaneous optical and radar observations for the neutral atmosphere in the MLT region provide us with an excellent opportunity of discussing inherent discrepancies between two wind measurement techniques based on temporal and spatial range of sampling area. Furthermore, since Antarctic peninsula has been well known for strong wave activities such as orographic gravity waves, the observations from these two instruments can be used to reveal the characteristics of neutral atmospheric responses to the waves in the MLT region. Using these observations, the neutral winds are compared at two airglow layers of 87 km and 97 km. The responses of Neutral winds and temperature in the MLT to the geomagnetic effects are also considered in this study.

15:40 [III-1-5]
Estimation of neutral atmospheric temperatures at the turnaround altitudes (80 and 97 km) of meteor diffusion profiles observed from a meteor radar

Wonseok Lee[1], Yong Ha Kim[1], Hosik Kam[1,2]

[1]*Chungnam National University*
[2]*Korea Polar Research Institute*

Most of meteors are ablated in the mesosphere and lower thermosphere (MLT) and their trails decay by the ambipolar diffusion, which is dependent on the neutral atmospheric temperature and pressure (density). However, above the altitude of 95 km and below the altitude of 84 km, the decay process of meteor trail is no longer dominated by the ambipolar diffusion. At the upper altitude, geomagnetic field hinders the diffusion of meteor trail, whereas at the lower altitude three-body attachment reactions distort the diffusion of

meteor trail. As a result, the diffusion profiles of meteors have turnaround altitudes around 80 (lower) and 97 (upper) km. The turnaround altitudes can be easily derived by using the quadratic fit to diffusion profiles observed by the meteor radar at King Sejong Station (62.22° S, 58.78° W). We found that the turnaround altitudes vary with seasons and match well to a constant pressure level (log10Plower = −2.14 ± 0.08, log10Pupper = −3.48 ± 0.05). If we can estimate the ambipolar diffusion coefficient at these two altitudes, the Einstein relation allows us to calculate the temperatures. By selecting the meteor radar echoes in height range where ambipolar diffusion is dominant, we determine the slope from a profile of log diffusion coefficient and extend this slope to turnaround heights to obtain the ambipolar diffusion coefficient. Using this method, we estimate the neutral atmospheric temperatures, which are on average within 8.8 (lower turnaround altitude) and 8.7 % (upper turnaround altitude) from TIMED/SABER temperatures at 80 and 97 km during 2014 − 2016. We discuss assumptions involved and uncertainties in the estimated temperatures.

15:55 [III−1−6]
Statistical analysis of ULF waves observed at the Moon by Lunar Prospector

Khan−Hyuk Kim, Seul−Min Baek, and Ho Jin

School of Space Research, Kyung Hee University

We have studied the statistical properties of ultra low frequency (ULF) waves using Lunar Prospector (LP) magnetometer data obtained at ~100−km altitude from the lunar surface during the period from 20 February 1998 to 31 December 1998. The ULF waves at LP orbit are mostly identified as transverse oscillations in the frequency band of ~10−50 mHz. The wave detection rate was high in the region of the solar zenith angle less than 90° and above the strong magnetic anomalies (e.g., Marginis and South Pole Aitken) on the dayside. We also found a pronounced morning−afternoon asymmetry in the wave detection rate. The detection rate in the prenoon sector is high when the interplanetary magnetic field (IMF) is directed along the Parker spiral. However, the morning−afternoon asymmetry is less significant for the interval of an ortho−Parker spiral IMF orientation. These observations indicate that the ULF waves observed at LP are driven by solar wind interaction with lunar magnetic anomalies.

Sandpine Room

■ III-2 Special Session NEXTSat-1/KSEM II
Session Chair: Young-Joo Song (KARI)

14:40 [III−2−1]
GEO−KOMPSAT−2A Transfer and Drift Orbit Maneuver Planning and Assessment

Bong−Kyu Park, Sang−Wook, Jae−Dong Choi

Korea Aerospace Research Institute

COMS(Communication, Ocean and Meteorological Satellite) launched in 2010 has exceeded its 7 years of mission lifetime. To replace the meteorological mission of COMS, GEO−KOMPSAT−2A had been launched and successfully injected into Ariane 5 standard transfer orbit in 5th of December 2018. After 5 LAE(Liquid Apogee Engine) burns, GK2A entered drift orbit at a drift rate of 1.4 deg/day at longitude of 119 deg. E. Through additional 5 small station acquisition maneuvers including one North maneuver and 4 East maneuvers, the GK2A arrived at the target operational orbit which is 128.25 deg. E geostationary orbit in 20th of December 2018. For successful satellite injection into target operational orbit, precise orbit planning, maneuver and orbit determination is essential. For GK2A orbit analysis and assessment, the FOCUSLEOP developed by GMV Spain for commercial purpose, has been accommodated into GK2A ground system in offline based. Using FOCUSLEOP, KARI has performed maneuver planning, orbit determination and LAE calibration for next maneuvers. This paper introduces the orbit maneuver planning and assessment process and results performed for GK2A LEOP.

14:55 [III−2−2]
The In−Orbit Test Results of KSEM CM for Monitoring of Spacecraft Charging

Woohyeong Seol, Jongho Seon, Kyusung Chae, Go Woon Na, Ju Woo, Chanhaeng Lee

School of Space Research, Kyung Hee University

Charging Monitor (CM), one of the sensors in Korean Space Environment Monitor (KSEM), measures the electron flux to monitor the spacecraft charging. CM can be used to detect the space weather such as the trapped electron flux in the magnetosphere and the changes in solar activity. CM is designed to measure the electrons above 700 keV within the range of −3 to +3 pA/cm^2 due to aluminum shielding of 1 mm thickness. The output data is expressed as −100 ~ +100 pA, because of the radius of the detection plate is 3.25 cm. CM shows the change of the electron flux according to the position in the in−orbit test. This study presents the electrical design of the CM and the results of the initial operation.

15:10 [III−2−3]
Operation Concepts of the Instrument for the Study of Space Storms (ISSS) payload onboard NEXTSat−1 during commissioning phase

Eojin Kim[1], Kwangsun Ryu[1], Kyoungwook Min[2],

Hoonkyu Seo[1], Young-Soo Jo[3], Jongdae Sohn[3], Gowoon Na[4], Chol Lee[1], Sung-Og Park[1], Son-Goo Kim[1]

[1]*Satellite Technology Research Center, KAIST*
[2]*Department of Physics, KAIST*
[3]*Korea Astronomy and Space Science Institute*
[4]*School of Space Research, Kyung Hee University*

The Next generation small satellite-1 (NEXTSat-1) was successfully launched in December 2018 into the low earth (~ 575 km) sun-synchronous orbit. The Instruments for the Study of Space Storms(ISSS) onboard NEXTSat-1 is an instrument suite consisting of two packages of radiation (High Energy Particle Detector, Medium Energy Particle Detector) and plasma detectors(Langmuir Probe, Retarding Potential Analyzer and Ion Drift Meter). The main goals of ISSS are to understand the space storm effect on the polar region, precipitating radiation belt particles and also mid-low latitude ionospheric disturbances.
For the ISSS operation, appropriate attitude control and well-structured operation scenarios is required. In this presentation, we introduce the operation concepts of ISSS during commissioning phase of NEXTSat-1.

15:25 [III-2-4]

Launch and early operation result of Medium Energy Particle Detector in the range of 20 keV to 400 keV aboard NEXTSat-1

Hoonkyu Seo[1], Eojin Kim[1], Kwangsun Ryu[1], Goohwan Shin[1], Jangsoo Chae[1], Ju Woo[2], Woohyeong Seol[2], Chanhaeng Lee[2], Hyunsang Lee[2], Go Woon Na[2], Jongho Seon[2], Kyungwook Min[3], Jongdae Sohn[4]

[1]*Satellite Technology Research Center, KAIST*
[2]*School of Space Research, Kyung Hee University*
[3]*Department of Physics, KAIST*
[4]*Korea Astronomy and Space Science Institute*

Medium Energy Particle Detector (MEPD) measures energy distribution of electrons, protons, and neutrals in the range of 20 keV to 400 keV. MEPD consits of two identical telescopes placed with orthogonal field-of-views for the detection of charged particles in terms of different pitch angles. Each telescope utilizes an electrostatic field to distinguish suprathermal and energetic particles. MEPD is a subset instrument of Instrument for the Study of Space Storm (ISSS) abroad Next Generation Small Satellite-1 (NEXTSat-1). NEXTSat-1 is a sun-synchronous orbit satellite at an altitude of 575 km launched on December 4th, 2018. This research presents a brief specification of the instrument and observation results during the early operation period.

15:40 [III-2-5]

Promising topics for research using energetic particle observations by the High Energy Particle Detector (HEPD) onboard the Next Generation Small Satellite-1 (NEXTSat-1)

Dae-Young Lee

Department of Astronomy and Space Science, Chungbuk National University

The High Energy Particle Detector (HEPD) is one of the two instruments of Space Radiation Detectors instrument package onboard the Next Generation Small Satellite-1 (NEXTSat-1) which was launched in December 2018. The HEPD consists of three telescopes corresponding to 0°, 45° and 90° to the local magnetic field. The HEPD measures electrons and protons in the energy range of 0.35 to 2MeV and 3 to 20MeV, respectively. It has a spectral resolution of about 10% at 1MeV and a time resolution of 32Hz. Since the launch of NEXTSat-1, the Space Radiation Detectors have been operating in the subauroral region. The HEPD measures particles which arrive at low altitude from the inner magnetosphere, mostly the outer radiation belt and ring current region. In this presentation, I will introduce selected science topics which may be promising for research using the HEPD particle data. This will include research topics that can use not only HEPD observations but also related observations by other satellites in the magnetosphere such as GK2-A, RBSP, ERG.

15:55 [III-2-6]

Data Reproducing Simulation of Langmuir Probe and Retarded Potential Analyzer for ISSS payload

Sang-Yun Lee[1], Kwangsun Ryu[1], Ensang Lee[2], Kyung-Wook Min[3], Hee-Eun Kim[2], Eojin Kim[1]

[1]*Satellite Technology Research Center, KAIST*
[2]*School of Space Research, Kyung Hee University*
[3]*Department of Physics, KAIST*

The next generation small satellite-1 (NEXTSat-1) launched on Dec. 2018 including the Instrument for the Study of Space Storms (ISSS). The Langmuir Probe (LP) and the Retarded Potential Analyzer (RPA) compose the ISSS and analyze the characteristics of electrons and ions, respectively. The plasma current with sweeping voltage is obtained as an I-V curve to measure plasma parameters by the instruments. The temperature and density of the multi-component ions and electrons can be obtained by fitting the I-V curve with the theoretical equations. We conducted simple test particle simulations to reproduce I-V curve. The simulation make possible to analyze the each ion and electron current, separately.

Han Song

■ III-3 Space Technology & Application II
Session Chair: Jeong-Han Kim(KOPRI)

14:40 [III-3-1]
Frozen Orbit of the Low Earth Prograde Motion Satellite

Byoung-Sun Lee[1,2], Yoola Hwang[1]

[1]*Electronics and Telecommunications Research Institute*
[2]*University of Science and Technology*

A frozen orbit is characterized as the altitude variation of a satellite passing through a specific latitude on Earth is minimized. In the frozen orbit, the mean eccentricity oscillates within a specific value with respect to the mean argument of perigee. Frozen orbits of the sun-synchronous imaging satellite have been studied by many authors and applied to the observations of the Earth's land, ocean, and atmosphere.
In this paper, a frozen orbit of the low Earth prograde motion satellite was analyzed. The mean eccentricity of the frozen orbit was calculated for a mean altitude of 500 km and an inclination of 45 degrees taking into account J2 and J3 terms of the Earth. Variations of mean eccentricity and argument of perigee were derived for long-term orbital motion of one year. Geodetic altitude changes of the satellites passing through the Earth's latitude were compared for the case of frozen and non-frozen orbits. It has been found that the frozen eccentricity value representing the minimum eccentricity changes in long-term orbital motion is smaller than the frozen eccentricity calculated using only J2 and J3 terms.

14:55 [III-3-2]
Characteristics of equatorial morning overshoot observed by the Swarm contstellation

Yong-Tae Yang[1], Jaeheung Park[1,2], Young-Sil Kwak[1,2]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*

In this paper we investigate the altitudinal and longitudinal variations of electron temperature at equatorial latitudes and compare our results with other observations. The rapid increase of electron temperature in the early morning period at the low-latitude and equatorial region is well known ionospheric phenomenon called the morning overshoot. Electron temperature and density data used in this study were obtained from the Langmuir probe on board the Swarm constellation which is in near polar orbit at two different altitudes of 470 km and 520 km with three identical satellites. Based on the data set between 2013 and 2019, we studied the electron temperature and density in terms of local time, season, latitude, longitude, and magnetic activity. To see the altitudinal difference of electron temperature and density, we also use the data from Floating Potential Measurement Unit (FPMU) on board International Space Station which is in low-earth orbit at an altitude of 400 km. We confirm the morning overshoot, where electron temperature has a maximum at the dip latitude and decreases gradually with increasing latitude in all seasons. But the amplitude of morning overshoot electron temperature is not uniform over season and longitude. Lastly, the response of ionospheric electron temperature to geomagnetic activity shows anticorrelation.

15:10 [III-3-3]
Analysis on combustion experiment utilizing parabolic flight for a cool flame research

Jong-Won Lee[1], Won-Sik Nam[2], Youn-Kyu Kim[1], Joo-Hee Lee[1], Seul-Hyun Park[2]

[1]*Korea Aerospace Research Institute*
[2]*Chosun University*

Korea Aerospace Research Institute (KARI) has developed combustion experiment system for a cool flame research in microgravity environment. The combustion experiment system was loaded on a reduced-gravity aircraft (so-called, parabolic flight campaign) at Zero-G corporation in the United States and droplet combustion experiment was conducted under microgravity environment.
Through this parabolic flight campaign, we were able to simulate a microgravity environment for about 20 seconds per each parabolic flight, and we have successfully carried out 38 times among the total of 60 times combustion experiments. During an analysis of these experiments, we have found the expected cool flame phenomenon from several experimental cases. And we are still analyzing all the experimental cases thoroughly.
In this paper, the experimental process and environment of the aircraft will be presented based on the experience of parabolic flight experiment. Also, the cool flame phenomenon obtained from an experiment analysis will be introduced.

15:25 [III-3-4]
Parallel propagating linear waves in arbitrarily degenerate quantum electron plasma

Chang-Ho Woo[1], Min ho Woo[2], Cheongrim Choi[3], Kyoung-Wook Min[1]

[1]*Department of Physics, KAIST, Daejeon, Korea*
[2]*National Fusion Research Institute, Daejeon, Korea*
[3]*Department of Astronomy and space science, Chungbuk National University, Cheongju, Korea*

In recent years, quantum plasma has been much studied for its possible application to ultra-small electronic devices, warm dense matter and exotic astrophysical objects such as white dwarfs and neutron stars. In the present paper, we investigate the quantum effects in the parallel propagating linear waves for finite temperature quantum electron plasma. The dispersion relations of electrostatic and electromagnetic (L and R) waves are derived using a quantum Vlasov equation for a Fermi-Dirac distribution. The results are compared to those of classical plasma with the same temperature. For example, it is seen that the anomalous dispersion region of the lower R wave branch decreases as the degeneracy decreases. We also present the dispersion relations in an analytical form for some limiting cases.

15:40 [III-3-5]

Characteristics of Ionospheric scintillation in GNSS signals measured at Arctic and Antarctic Sites of KOPRI

Junseok Hong[1,2], Yong Ha Kim[1], Jong-Kyun Chung[2], Jeong-Han Kim[3]

[1]*Chungnam National University*
[2]*Korea Astronomy and Space Science Institute*
[3]*Korea Polar Research Institute*

It is well known that the ionosphere is main error source for Global Navigation Satellite System (GNSS) communication. At high latitudes, various ionospheric phenomena, such as auroral activity and fast flow of plasma convection, can disturb GNSS signals, resulting in scintillation in the received signals and even loss of signal lock that eventually leads to socioeconomic impacts. Korea Polar Research Institute (KOPRI) and Korea Astronomy and Space Science Institute (KASI) have operated the ionospheric scintillation monitors at four high latitude sites (Jang Bogo and King Sejong in Antarctic, Dasan and Kiruna in Arctic) to observe the ionospheric scintillation activities since 2014. We statistically analyzed the scintillation indices ($\sigma\varphi$, S4) measured by CASES at these sites according to geomagnetic activity, season, local time and signal type. Occurrence rate of phase scintillation ($\sigma\varphi$) is clearly greater at L2 signal (1227.60 MHz) than L1 signal (1575.42 MHz), and also during high geomagnetic activity (kp>2) than low geomagnetic activity (kp<2). The occurrence rate shows not only obvious seasonal and daily variations, but also characteristic spatial distributions in terms of azimuth angle. In this presentation, we will report the results of statistical analysis for the occurrence rate of scintillation indices, and discuss the related mechanisms.

15:55 [III-3-6]

Ionospheric Studies through quality evaluation of GPS L1/L2 signals at Chuuk in Micronesia

Jong-Kyun Chung[1], Junseok Hong[1,2], Sung-Moon Yoo[1], Jeong-Han Kim[3]

[1]Korea Astronomy and Space Science Institute
[2]*Chungnam National University*
[3]*Korea Polar Research Institute*

KASI CHUK GNSS permanent site (geographical position: 7.5 ° N, 151.9 ° E; geomagnetic latitude: 0.4 °) is located at the trough of equatorial ionospheric anomaly (EIA) region. It is considered as optimal position for the influence of the GNSS signal propagation on ionosphere. KASI built a new GPS ionospheric scintillation monitoring system at Chuuk in October 2018. This is expected to increase our understanding of electrodynamics in the EIA trough region. In this study, we present the results of quality evaluation analysis of GPS L1/L2 signals and discuss the causes of it. Based on the results, the observational strategy of the KISS (Korea Ionospheric Scintillation Sites) network will be established.

Lakai Ballroom

■ Invited Talk IV
Session Chair: Yeon-Han Kim (KASI)

16:20 [IS-IV]

Application of deep learning to astronomical and space science data

Yong-Jae Moon

School of Space Exploration, Kyung Hee University

Multi-wavelength observations become very popular in astronomy and space science. Even though there are some correlations among different sensor images, it is not easy to translate from one to the other one. In this talk, we apply a deep learning method for image-to-image translation, based on conditional generative adversarial networks (cGANs), to scientific images. To examine the validity of the method for scientific data, we consider several different types of pairs: (1) Generation of stack images from single SDSS images, (2) Generation of SDO/EUV images from SDO/HMI magnetograms, (3) Generation of farside magnetograms from STEREO/EUVI images, (4) Generation of EUV & X-ray images from Carrington sunspot drawing, and (5) Generation of solar magnetograms from Ca II images. It is very impressive that AI-generated ones are quite consistent with actual ones. We will discuss several scientific application of such an image translation method scuh as the sunspot evolution from backside to frontside. In addition, we apply the convolution neural network to the forecast of solar flares and find that our method is better

than the conventional methods. Our study also shows that the forecast of solar proton flux profiles using Long and Short Term Memory method is better than the autoregressive method. We will also discuss several applications such as denoising and super-resolution for scientific research.

April 26(Fri)

Lakai Ballroom

■ IV-1 Sun&Space Environment IV
Session Chair: Woo Kyoung Lee(KASI)

09:30 [IV-1-1]
A statistical study of Pi2 pulsations observed in the upper ionosphere using Swarm magnetic field data

Jae-Hee Park[1], Khan-Hyuk Kim[1], Junga Hwang[2]

[1]*School of Space Research, Kyung Hee University, Gyeonggi, South Korea.*
[2]*Korea Astronomy and Space Science Institute, Daejeon, South Korea.*

The properties of Pi2 pulsations observed in the upper ionosphere are studied using magnetic field data acquired by the Swarm-A spacecraft in low Earth orbit (LEO) and at the low-latitude Bohyun ground station (BOH, L = 1,3) for January 2014-Jun 2015. From time intervals when Swarm-A was on the nightside (magnetic local time (MLT) = 1800-0600 hrs) and the BOH station was near midnight (MLT = 2100-0300 hrs), we identified 621 Pi2 events in the horizontal H component of the BOH data. For each event we examine the coherence between the horizontal H component on the ground and the Bx (radial) azimuthal By (azimuthal), or Bz (compressional) components at Swarm-A. Out of 621 events, the Bx-H high coherence (> 0.7) events are ~6%, the By-H high coherence events are ~3%, and the Bz-H high coherence events are ~25%. The ground-satellite high coherence events occurred when the spacecraft was located within a magnetic latitude range of ±50° . Using the ground-satellite high coherence events, we examined the latitudinal structure of the relative amplitude and phase of the ionospheric Pi2 pulsations detected at Swarm-A. Confirming previous observations at LEO, we found that the ionospheric Pi2 pulsations are characterized by symmetric odd mode standing oscillations in the north-south direction, having a node for Bx oscillation and an antinode for Bz oscillation, respectively, at the equator. This indicates that the source of ionospheric Pi2 pulsations is the plasmaspheric resonance.

09:45 [IV-1-2]
Improve radiation belt distribution algorithm performance using VAP electron flux accompany GOES-13 electron flux.

Jong-kil Lee[1,3], Jae-jin Lee[1], Kyung-chan Kim[2]

[1]*Korea Astronomy and Space Science Institute*
[2]*Daegu University*
[3]*University of Science and Technology*

The distribution of the radiation belt through the MPF algorithm has been shown in previous studies up to L * = 1 ~ 7. In this study, we use VAP MAGEIS data from 1.2 to 6 Re to reinforce GOES-13 electron flux (L * = 7) at a single location as initial input value. To convert this data to PSD (Phase Space Density), we calculated the time and flux. The space between 6 and 7 was filled using interpolation. The results of MPF algorithm using only GOES-13 and the result of algorithm that added VAP data are compared with measured data and the results are shown.

10:00 [IV-1-3]
Estimation of Regional Ionosphere by Assimilating Ionosonde Data into SAMI2 model

JeongHeon Kim[1], YongHa Kim[1], Nicholas Ssessanga[1], SeHeon Jeong[1], Su-In Moon[1], YoungSil Kwak[2], JongYeon Yun3

[1]*Chungnam National University*
[2]*Korea Astronomy and Space science Institute*
[3]*Korea Space Weather Center (KSWC), Jeju, Korea*

This paper explains an algorithm of estimating the regional ionosphere at mid-latitude by assimilating ionosonde measured data into a first principle physics-based model. It has been known that the first principle model suffers from the lack of information on the input drivers, such as neutral winds and compositions in the background thermosphere. In this study, equivalent meridional winds and electron density scale factors were derived from the F2 peak heights (hmF2) and densities (NmF2) measured at Jeju site (33.43N° , 126.30 E°) and then were used as inputs of a first principle model, SAMI2-CNU. SAMI2-CNU is an in-house revised version of the 2-dimensional ionosphere model (SAMI2), developed at Naval Research Laboratory (Huba et al., 2000; Kim et al., 2016). As a pilot study, we calculated a 2-dim ionosphere on the 127 deg meridional plane on a geo-magnetically quiet day each season with the derived inputs that were updated every 15 minutes with the measured hmF2 and NmF2 at Jeju. The model with the derived inputs predicts the next 15 minute hmF2s and NmF2s reasonably close to measured values at Jeju, Icheon (37.14 N° , 127.54 E°) and Okinawa (26.68 N° , 128.15 E°) (sites near the same meridional plane), showing a superior

performance, compared to the original SAMI2 and the International Reference Ionosphere (IRI) 2016 model. Thus, this study demonstrates that a physic model, SAMI2-CNU, can be used as a nowcast model of the regional mid-latitude ionosphere by assimilating ionosonde data in near-real time.

10:15 [IV-1-4]
Forecasting ionospheric F2 layer parameters over Jeju station using artificial neural network

SuIn Moon[1], YoungHa Kim[1], JeongHeon Kim[1], SeHeon Jeong[1], YongSil Kwak[2], JongYeon Yun[3], Wooyeon Park[1,2]

[1]*Chungnam National University*
[2]*Korea Astronomy and Space Science Institute*
[3]*Korea Space Weather Center (KSWC), Jeju Korea*

The ionospheric conditions have been continuously monitored by worldwide network of ionosondes. Ionosonde measurements can provide the major ionospheric parameters that represent the ionospheric conditions, such as the peak density and height of the F2 layrer (NmF2 and hmF2). Numerous efforts, either theoretical or empirical, have been made to predict these ionospheric parameters, but have achieved only very limited success. In this study, using artificial neural network (ANN) method, we attempted to predict the ionospheric parameters over Jeju ionosonde station (126.30°E, 33.43°N), operated by Korean Space Weather Center (KSWC). The input elements in the ANN model include date, hour, solar activity indices (sunspot number and F10.7 solar flux), and geomagnetic activity index (Ap). The model is designed to predict hourly NmF2s and hmF2s for the current time and next 24 hours. We trained the model with a 7 year (2009 - 2015) dataset of Jeju, and tested it with a 2016 dataset. The model performance was evaluated with a root mean square error (RMSE) and correlation coefficient between measured and predicted values. Thus far, the best performance model consists of 7 input elements, 45 hidden neurons, and 25 outputs. The best NmF2 model performs with an RMSE of 1.44*10^5 cm-3 and a correlation coefficient of 0.91 and the best hmF2 model predicts with an RMSE of 23 km and a correlation coefficient of 0.82.

10:30 [IV-1-5]
Comparison between wind blocking fields and propagating directions of mesospheric gravity waves observed over King Sejong Staion, Antarctica

Hosik Kam[1,2], Yong Ha Kim[1], Jeong-Han Kim[2], Takuji Nakamura[3,4], Masaki Tsutsumi[3,4], Yoshihiro Tomikawa[3,4], Masaru Kogure[3], Septi Perwitasari[3]

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[3]*National Institute of Polar Research, Tachikawa, Japan*
[4]*Department of Polar Science, SOKENDAI (The Graduate University for Advanced Studies), Tachikawa, Japan*

We analyzed mesospheric gravity waves in OH airglow images observed during 2012- 2016 by an all-sky camera at King Sejong Station (KSS; 62° S, 58° W), Antarctica. Using a new method of 2D image analysis recently developed by Matsuda et al. (2014), we obtained power spectra of horizontal phase velocity from the image sequence of total 107 image windows. We found from total power spectrum density that wave activity is maximized during winter, as is previously known. We also derived wind blocking fields from MERRA2 reanalysis data for the altitudes 10 - 64 km and from KSS meteor radar data for 80 - 90 km. By comparing the dominant propagating direction of short period gravity waves with the wind blocking field, we found a significant anti-correlation between wind blocking fields and dominant propagating direction of gravity waves except fall season, indicating wind filtering effects. The finding is the direct evidence of wind filtering effects observed in the mesosphere for the first time. During fall, the wind blocking fields below ~40 km are not matched with the dominant propagating directions. Thus, we suggest that mesospheric gravity waves observed by the all-sky camera during fall were generated above ~40 km (upper stratosphere and lower mesosphere), probably due to secondary waves. This exception will open up theoretical questions in middle atmosphere dynamic research area.

Sandpine Room

■ IV-2 Solar System & Space Exploration
Session Chair: Bongkon Moon (KASI)

09:30 [IV-2-1]
COSMOGRAPHIA as a visualization tool for KPLO Mission

Joo Hyeon Kim, Jo Ryeong Yim, Young-Rok Kim, Dong-Gyu Kim

Korea Aerospace Research Institute

Korea Pathfinder Lunar Orbiter(KPLO) is the first Korean space exploration program with the public interest.
KPLO operation rendering information such as trajectory, orientation, and maneuvering operation will be provided to KPLO Deep Space Ground System for the KPLO mission in order to support the overall KPLO mission, that the information will be created based on the SPICE Kernels of the spacecraft.
We expect that the visualization of the rendering

supports the spacecraft' s operation and gives the briefing on the mission for the public.
We investigate the availability of Cosmographia as the visualization tool for KPLO.
The Cosmographia is a visualization program for space exploration missions in order to render the orbit and trajectory of solar system objects and spacecrafts which is developed by JPL/NAIF.
In this presentation, we give a demonstration of Cosmographia using arbitrary SPICE Kernels for KPLO mission.
We appreciate the members of JPL/NAIF Team and their collaborators for COSMOGRAGPHIA and SPICE Kernel development and supports.

09:45 [IV-2-2]

Conceptual Design of ECLSS CO2 Removal System for Manned Space Exploration

J.H. Lee, Y.K. Kim, J.W. Lee, G.H. Choi

Korea Aerospace Research Institute

Habitation facilities such as International Space Station (ISS) and Soyuz spacecraft will provide a safe place for astronauts as they travel into space, and life support system is essential to survival inside a space habitat. Environmental Control and Life Support System (ECLSS) on the ISS provide pure oxygen, absorb carbon dioxide (CO2), and manage all vaporous gases and liquids from the astronauts themselves. And these ECLSS requires systems such as air recovery/management system, water recycles/ management system, and waste management system. Especially, air recovery/management system must supply oxygen and remove carbon dioxide from the atmosphere.
This presentation will introduce the conceptual design of carbon dioxide removal system related to the development of a ECLSS ground-based model supported by the Korea Aerospace Research Institute (KARI).

10:00 [IV-2-3]

Impulsive trajectory optimization to asteroids using parallel monotonic basin hopping

Pureum Kim, Sang-Young Park

Yonsei University

With many missions to asteroids coming up, there is an increasing need to optimize trajectories to such asteroids. As a global optimization algorithm, the monotonic basin hopping (MBH) method has been proven to be well-suited for trajectory optimization. It has also been found that a parallel version of MBH can speed up the optimization process. The MBH algorithm tries to find the global minimum by searching for local minima in the neighborhood of the current best solution, in the hopes that there might be a better local minimum nearby. One important factor affecting the efficiency of MBH is the scale of the neighborhood; it should not be too big nor too small. We will present a novel method of automatically determining an appropriate neighborhood size without any prior input. The MBH algorithm is utilized to obtain trajectories of multiple gravity-assist with one deep space maneuver (MGA-1DSM). Using the parallel version of MBH, a software is developed for optimizing impulsive trajectories to a user-specified asteroid. The results are analyzed in the studies.

10:15 [IV-2-4]

Conceptual Thermal Design of neoPASCAL: a Network of Landed Spacecraft on Mars

Dukhang Lee[1,2], Thomas Young[2], Hugh Podmore[2], John Moores[2], Young-Jun Choi[1,4], Regina Lee[2]

[1]*Korea Astronomy and Space Science Institute*
[2]*York University*
[3]*Honeywell Aerospace*
[4]*University of Science and Technology*

NeoPASCAL is a network of compact landed spacecraft on Mars which aim to validate Mars General Circulation Models (GCMs) by measuring the diurnal variations in surface pressure. As a modern revision of the original Pascal mission proposed in 1996, neoPASCAL has much smaller size and mass and consequent more number of stations by using miniaturized commercial off-the-shelf (COTS) electronic components and satellite platforms (i.e., Boardsat and CubeSat platforms). Establishment of an optimized neoPASCAL thermal design is critical due to the presence of extreme thermal environments and low insolation especially observed at high latitudes in winter. In this paper, we discuss the feasibility of the neoPASCAL thermal design and the scientific capabilities of the network mission.

10:30 [IV-2-5]

ECLSS(Environmental Control & Life Support System) Conceptual design for the Manned Space Application

Younkyu Kim, Jongwon Lee, Joohee Lee

Korea Aerospace Research Institute

For the space exploration and the human beings' advance into space, the manned space program like the space station missions was implemented for several years. Furthermore, recently the manned Mars exploration program is in the spotlight among the space application agencies. To operate the pressurized module which is fundamental structure for the habitation module being resided for human beings, the ECLSS(Environmental Control & Life Support System) development is indispensable and important for manned space program in Korea. This study is for some parts of the ECLSS conceptual design, which study includes the system requirements analysis as the several DRM(Design Reference Mission) such as manned lunar & mars missions, manned space structure

like ISS, etc. and ECLSS system configuration study including its subsystem's functional requirements and technological architecture study. The ECLSS consists of several subsystems; PCS(Pressure Control System), ARS(Atmosphere Revitalization System), THC(Temperature & Humidity Control System), FDS(Fire Detection & Emergency Management System), WRM(Portable Water Recovery & Management System), and WMS(Waste Management and Collection System)

Han Song

■ IV-3 Space Technology & Application III
Session Chair: JONG-KYUN CHUNG(KASI)

09:30 [IV-3-1]
Development of proto-type model Silicon Carbide telescope structure for space application

Jeoung-Heum Yeon, Won-Beom Lee, Sang-Soon Yong

Korea Aerospace Research Institute

Proto-type model of Silicon Carbide (SiC) mirror and telescope structure is developed for space application. SiC has high dimensional stability with respect to temperature and high thermal conductivity for easy thermal control. It has also high specific stiffness for good light weighting. SiC is outstanding material for the space application. In this research, medium size SiC mirror and its supporting SiC structure is developed. The design, analysis and test reults will be described.

09:45 [IV-3-2]
Changes of crustal strain-rate of Korean Peninsula before and after a megathrust earthquake

Dong-Hyo Sohn[1], Sun-Cheon Park[2], Won-Jin Lee[3], Byung-Kyu Choi[1], Pil-Ho Park[1]

[1]*Korea Astronomy and Space Science Institute*
[2]*Korea Meteorological Administration*
[3]*National Institute of Environmental Research*

We investigated the crustal movement rates in the Korean Peninsula before and after the 2011 Tohoku-Oki earthquake. According to the GPS analysis, the co-seismic deformation by this earthquake on the Korean Peninsula was about 5 cm in eastern site and about 1 cm in western side. Because the amount of crustal deformation in the eastern region is larger than that in the western region, the east-west extension of the Korean Peninsula may be occurred. In the present study, we used data observed from a GPS network in the Korean Peninsula to calculate crustal movement rates. In addition, analysis of the strain-rate changes over time is performed by using GPS data during a period of 7 years before and after the megathrust earthquake. Before the 2011 earthquake, it appears that there si a low strain-rate, but it tended to expand north-south part and compress east-west part. In 2011, however, the east-west expansion is observed apparently across the country. In the following year, it is relatively unstable dut to the aftermath of the earthquake. Since 2013, the movement rates have been low in most unit triangle networks. For some triangulations, different forms were derived from adjacent unit triangle network. We suggest that the surrounding environment and data quality of the station could not good efficiently. They can affect an accuracy of the coordinates and their velocities for the GPS station.

10:00 [IV-3-3]
The fast-traveling SAWs triggered by the 2017 North Korean missile

Byung-Kyu Choi[1], Jun-Seok Hong[1,2]

[1]*Korea Astronomy and Space Science Institute*
[2]*Chungnam National University*

The Hwasong-15 (H-15), an intercontinental ballistic missile developed by North Korea, was launched at approximately 18:17 UT on 28 November 2017. It was reported that the H-15 missile reached an altitude of approximately 4,500 km and traveled a distance of nearly 960 km from its launch site. We use GPS/GLONASS measurements obtained from the Korean GNSS network (KGN) to observe ionospheric total electron content (TEC) disturbances to the H-15 missile launch. The fast-traveling shock acoustic waves (SAWs) towards the southeast over South Korea were observed ~ 5-10 minutes after the missile launch. Its velocity was approximately 2.3 km/s which is much faster than velocities typically reported in previous studies. The vertical component of the H-15 missile was generally stronger than the horizontal one due to a trajectory of high altitude. Nevertheless, it also had a fast horizontal velocity. Our results suggest that the second-stage performance of the H-15 missile could be very powerful.

10:15 [IV-3-4]
System Operation Test Plan for Low Earth Orbit Satellite

Jeong-Heum Im

Korea Aerospace Research Institute

KARI (Korea Aerospace Research Institute) is developing a 500kg class medium-sized low earth orbit satellite. It is equiped with an electro-optical camera payload and it will provide 0.5m resolution panchromatic earth observation images from a 500km altitude of sun synchronous orbit. This paper describes the system operation test plan for ETB (Electrical

Testbed) satellite verification model. The purpose of system operation test are to verify overall system operation procedure from the moment when the satellite is separated from the launch vehicle until it conducts its normal operation such as imaging mission after the completion of each unit activation checkout. To cope with various situation including abnormal cases which is expected on orbit, three cases are prepared for the test. The first one is solar array deployment success case. The second case is solar array deployment failure case and the last is the case that a fail-over occurs during in orbit activation checkout. RTCS (Relative timed command sequence) to be activated right after satellite' s separation from the launch vehicle will be also verified during this test.

10:30 [IV-3-5]
ON THE EXISTENCE OF TETRAHEDRAL SOLUTION TO THE FOUR-BODY PROBLEM ON RELATIVE COORDINATE

Jaewoo Kim

Hankuk Academy of Foreign Studies

It is well known that the three-body problem has few analytical solutions in certain symmetrical constraints; the Lagrangian triangular solution is one of them. This triangular solution has been revisited by R.Broucke and H.Lass in 1971, concerning three relative position vectors pointing from one mass to another. This paper proposes a significant advance to the method, extended to four arbitrary masses on the vertices of a tetrahedron. The research provides a geometrical proof that under such constraint, only homothetic solution is possible which agrees with the conclusion brought by §371 of Wintner (1941).

Abstracts-Poster

April 25(Thu) 13:10~14:40

[P-1] Star tracker test results analysis using dynamic signal simulating device

Woo-Yong Kang, Kwang Yeal Back

Korea Aerospace Research Institute

The STA(Star Tracker Assembly) is a sensor that determines the attitude of the satellite and is a key component of the satellite attitude control system. Therefore, during the satellite development phase, various tests are carried out on the function and performance of the STA using ground support equipment. One of these test is to check the performance of the STA for various situations of maneuvering of the satellite. This paper describes the configuration of the STA dynamic signal simulation device and the dynamic test results.

[P-2] GK2A NMSC Ground System Implementation

Chiho KANG, Tae-Bong Oh, In-Hoi Koo, Durk-Jong PARK, Hyunsu Lim, Jinhyung Park, Jun-Young Bok

Korea Aerospace Research Institute

GEO-KOMPSAT 2A (GK2A) is the satellite system developed under the charge of Korea Aerospace Research Institute (KARI), which aims to continue meteorological observation mission of the Communication, Ocean and Meterological Satellite (COMS) and monitor weather and climate phenomena with enhanced performances in both time, resolution and accuracy. The ground system for GK2A meteorological operation is designed to be deployed in two local sites, which is located at KARI and National Meterological Satellite Center (NMSC) respectively. Both KARI and NMSC ground systems have been designed to have same constituents and functionalities. But the SOC ground system will be mainly used for GK2A satellite operation and the NMSC ground system will play a main role in service operation to general users. We address the overview and the current status of NMSC ground system which has been implemented since 2014.

[P-3] Performance Improvement of X-Band Onboard Antenna Tracking Parameter File Generation Software

In-Hoi Koo

Korea Aerospace Research Institute

In order to obtain high-resolution images from satellite operation, it is necessary to accurately track the ground station during X-band contact by satellite's onboard X-band antenna.
To drive the satellite's onboard antenna, a Tracking Parameter File (TPF) must be created using TPF Generation S/W on the ground and then sent to the satellite. To reduce the angular rate of satellite's onboard antenna in motion. TPF Generation S/W generates the TPF using the concept of virtual ground stations. This concept takes into account the maximum satellite antenna rotation angle that can communicate with the central target Ground Station without loss of signals.
In this paper, the algorithm improvement on the selection of virtual ground station and the resulting performance improvement are described.

[P-4] Requirements and Operation Concepts for Lunar Terrain Imager Target Management Subsystem of KPLO Deep Space Ground System

Dong-Gyu Kim

Korea Aerospace Research Institute

Korea Pathfinder Lunar Orbiter(KPLO) is the first Korean Lunar Exploration Program and Lunar Terrain Imager(LUTI) of KPLO is an electro-optical camera system which has a capability to provide high resolution lunar images for future landing mission and it will also gather images for other science missions. In order to support the overall LUTI mission, KPLO Deep Space Ground System(KDGS) needs to know which target area should be observed by LUTI and the detailed observation information should be delivered to KDGS using a proper interface for LUTI mission planning and image processing. The LUTI mission progress and image processing status should be monitored and reported to update LUTI mission planning policy and KPLO operation concepts. These functions will be considered as LUTI target management and there need to be a dedicated configuration item to conduct these function, LUTI Target Management Subsystem (LTMS).
We have studied and identified required functions for LTMS and derived the operation concepts of it. LTMS will gather target area information from LUTI user groups and establish Lunar GIS database. It will share the LUTI image acquisition progress to them. Mission Planning Subsystem (MPS) will generate LUTI imaging plans and Image Calibration and Analysis Subsystem (ICAS) will process the LUTI raw data to make a high level products. MPS and ICAS will share their mission planning and image processing status information with LTMS. Detailed requirements and operation concepts of LTMS will be described in this paper.

[P-5] Design of image processing system for efficient satellite image acquisition and product management

Dong-Oh Kim, Jun-Yeong Bok

Image Data System Development Division, Satellite Operation & Application Center, Korea Aerospace Research Institute

Korea Aerospace Research Institute (KARI, hereafter) is developing and operating various satellites such as KOrea Multi-Purpose SATellite (KOMPSAT, hereafter) 3, 3A and 5. Also KARI is developing additional satellites including KOMPSAT 6, 7, CAS500 series and etc. As the number of satellites increases, efficient satellite operation technology is required.

This paper describes function of managing order of user, function of to build imaging and receiving plan, and function of generation and managing product in designed consideration of efficient operation of ground system.

[P-6] Characteristic evaluation of a power supply on power electrical ground support equipment for satellite test

Young-Yun Kim, Dong-Chul Choi

Korea Aerospace Research Institute

We reports the power provision evaluation result of power supply used for integration of power EGSE. Power EGSE is very important for the power-up of satellite. Before flight of satellite, satellite has to be tested and verified comprehensively. The start of test and verification of satellite is to power-up of satellite. According to characteristics of the power avionics, Power EGSE has to provide power having the specific power-up profile. the profile is to have specific time from 0V to target voltage. To accommodate the specific power-up profile, two methods is applied. the one is software approach. the other is hardware. After implementation of both method on EGSE we conducted the evaluation both power provision status.

[P-7] Test Equipments for Space EEE Parts

Eui Keun Kim, Sang Hoon Lee, Dong Woo Lee, Ju Hyen Kim

Korea Aerospace Research Institute

In recent years, major advanced countries have recognized the development of space technology and space industry as a new growth engine of the national economy, and competition for space development is intensifying. Korea is also promoting the continual development of satellites by expanding private participation. Securing the competitiveness of space development is a key goal of medium and long term strategy of space development. However, in order to establish a space industrialization base and contribute to economic development by leading satellite technology, it is imperative to expand the base for testing and development of space parts(components) units. To support the efficient testing and localization of domestic space companies, the Korea Aerospace Research Institute and the Korea Testing Laboratory are establishing the space-parts(components) test center with test and inspection equipments and professional manpower. Generally, more than 100,000 EEE(Electrical, electronic, electromechanical) parts are required for satellite development, and it takes about two months to test the parts. In this study. we will examine the specifications, standards and the current state of construction of test equipments for space EEE parts.

[P-8] Indirect method of Alignment for reference axis using Laser tracker

Ju-Hyun Kim, Jung-Su Choi, Sang-Hoon Lee, Dong-Woo Lee, Eui-Keun Kim

KARI(Korea Aerospace Research Institute)

Alignment is the process of measuring the Cube Mirror attached to the payload to ensure that it is correctly located. As satellites perform missions in the space orbit, they cannot be maintained or repaired after being launched, unlike ordinary machines. Furthermore, in the case of a geostationary satellite, an unaligned payload can transmit a result with a greater error because of the altitude(36,000 km). Therefore, Alignment is the most important process in AIT(Assembly Integration & Test)

As the first step of alignment, Measuring reference axis requires obtaining a direction vector for Cube Mirror. In this case, it can be measured indirectly using a Laser tracker, three-dimensional contactless measuring device. This paper describes Indirect method of Alignment for reference axis using Laser tracker.

[P-9] Heat Treatment Effects on Performance of Ferromagnetic Ribbon Material for Fluxgate Magnetometer for Space Science Research Developed by Chungbuk National University

Joonsung Kim[1], Seunguk Lee[1], Sung-Jun Noh[1], Cheong-Rim Choi[1], Kyung-in Kang[2], Gi-HongRue[3], HyunhwaLee[1], Dooyoung Choi[1], Daeyoung Lee[1]

[1]*Chungbuk National University*
[2]*Satellite Technology Research Center, KAIST*
[3]*YeungJin University*

Chungbuk National University has been developing a fluxgate magnetometer for space science research. The final goal of the magnetometer is to achieve a noise level of hundreds of pT/$\sqrt{}$Hz to a few nT/$\sqrt{}$Hz at 1 Hz.

For this purpose, we used ferromagnetic material ribbon, Matglas 2714A, as sensor and carried out heat treatment processing experiments. The experimets were undertaken for various sets of sensor types according to the number of ribbons and heat treatment temperature. For these different sets of core sensors, we have tested hysteresis characteristic curves and performed the usual sensor linearity and noise tests. We have finally identified a best performing type of sensor.

[P-10] Understanding Product Development Process for Geo-Kompsat-2

Hyung-Wan Kim, Jeong-Su Choi, Jong-Seok Park

Korea Aerospace Research Institute

It is very hard to plan and control the schedule in a spacecraft development program. There are many subsystems and payloads in a spacecraft, so it is very complicated to exchange their information in design phases. In order to investigate the design processes, we can use several tools such as Iterative process maps, Iterative breakdown diagrams, Numerical DSM's, and Engineering change summary. In order to usderstand product development process of Geo-Kompsat-2, it is needed to use these tools. As a result, it is needed to study the objective of each tool and how to use them. It presents the application of these tools for Geo-Kompsat-2 Satellite development program.

[P-11] Research on the Automatic Operations Concept of Mission Planning for Geostationary Satellite

Hye-Won Kim, Jun Yeong Bok, and Daewon Chung

Korea Aerospace Research Institute

Geo-KOMPSAT-2A (Geostationary-KOrea Multi Purpose SAtellite-2A, GK-2A), the next generation meteorological satellite, which was successfully launched from Guiana Space Center in Kourou on 4th December 2018 (UTC), is currently operating in the payload IOT (In-Orbit Test) phase and is preparing to transit to the normal operation phase in the near future. GK-2A consists of two main payloads, the Advanced Meteorological Imager (AMI) and Korean Space Weather Monitoring (KSEM) to monitor weather conditions and space weather conditions, respectively. Especially, AMI imaging timeline has to be scheduled by operators through SOC (Satellite Operations Center) ground system in KARI (Korea Aerospace Research Institute) considering schedules of both satellite orbit adjustment and different calibrations. Based on the mission schedule, command procedure can be generated to transmit to the satellite and control the satellite.
In this study, we examine on the operation concept of GK-2A mission planning to be automatically operating Mission Planning Subsystem (MPS). GK-2A MPS is developed for mission scheduling of AMI and satellite. Among the main functions of MPS, automation function is the remarkable feature compared with COMS (Communication, Ocean, and Meteorological Satellite) MPS, the first Korea multi-mission geostationary satellite. Using the automation function, all kinds of output producing through MPS can be generated without any operator interventions on the assumption that the input data is exactly delivered before the appointed time. Therefore, the function should be more examined for diverse cases to deal with both the ordinary situation and the unanticipated exceptions in terms of normal operation phase. We expect that this study helps to establish the foundation of automatic operation concept for GK-2B MPS as well.

[P-12] Radiator configuration design of lunar lander

Hui-Kyung Kim[1,2], Dong-Young Rew[1]

[1]*Korea Aerospace Research Institute*
[2]*University of Science and Technology*

A radiator is designed to dissipate the internal heat of spacecraft. The radiator controls heat rates on its surface with characteristic optical properties. It has low absorptiviy and high emissivitiy; so, it reflects incident solar flux and emits its IR radiation. A lunar lander should endure the severe thermal environment of hot temperature on a lunar surface; then, the radiators are accommodated essentially to ensure thermal safety within allowable design temperatures. In case of a radiator on the lunar surface, it is the most desirable to be oriented in parallel with the lunar surface; that is, the radiator avoids the lunar surface and views the deep space completely. The only topmost side of the lunar lander bus corresponds to this direction; it cannot be affordable to sufficient radiator areas under the severe thermal environment.
This study researched on the radiator design turning the emitting direction of the radiator IR radiation using a reflector over the radiator. By applying this reflector-radiator design to the lunar lander, it can be anticipated that the radiators are accommodated avoiding the lunar surface and turning its IR radiation emitting direction into the deep space.

[P-13] In-Flight Performance Analysis on GEO-KOMPSAT-2A Satellite Attitude Determination

Keun Joo Park and Woo Yong Kang

Korea Aerospace Research Institute

GEO-KOMPSAT-2A satellite launched last December is currently under payload in orbit

test. To support the successful payload operation, the Attitude and Orbit Control Subsystem provides the accurate attitude information as well as spacecraft rate and gyro drift error information. In this paper, the attitude determination performance of GK2A satellite is presented through the flight data analysis.

[P-14] Review on the Ground Maintenacne of a Battery with S-P Configuration

Sung-Woo Park, Kyu-Dong Kim, Jeong-Hwan Yang, Hee-Sung Park, Jeong-Eon Park

Korea Aerospace Research Institute

A battery provides electrical energy to support launch and eclipse operations and to provide power for load peaks even in excess of solar array's power capability including fault clearance. To get the best performance of a battery during in-orbit operation, it is strongly required for the application users to keep a battery at the recommended environmental sites by the manufacturer after finishing acceptance test campaign until launch. And, it is more important to perform check voltages of each cells and packages periodically considering characteristics of specific cells and packages configuration and execute charge, discharge and cell balancing activity if they are needed depending on the cell's voltage check results. Moreover the on ground maintenance procedures are totally different depending on the battery package configuration; s-p configuration and p-s configuration. In this paper, general procedures, methods and cautions needed for the on ground maintenance for the s-p configured batteries including necessary incoming check items are presented and summarized.

[P-15] Design and manufacture of optical thermal vacuum chamber tilt unit

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The Korea Aerospace Research Institute is operating an optical vacuum chamber to test the orbital environment of the payload. The door of the optical vacuum chamber is moved by slide drive type, requiring the connection between the floor and the chamber according to the specimen entry and door opening and closing. Previously, the structure had been constructed between the floor and the chamber to be installed and disassembled manually, but there was a major problem with the risk of damaging the chamber door's o-ring. Therefore, the tilt unit improved by automatic drive method has been designed, manufactured and installed. In this paper, the design and load analysis results, manufacture and installation results of tilt unit were described.

[P-16] Lua vs. MicroPython for OBCP (On-Board Control Procedure) Programming Language

Su-Hyun Park

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On-Board Control Procedure(OBCP) is a script program which is executed on the spacecraft on-board computer for the spacecraft operation. It can be seen as the operational procedure which is not executed by the ground operator, but by the spacecraft embedded computer autonomously. For example, an OBCP can be written to perform the spacecraft mission. In order to take an image with payload camera, OBCP shall be able to send a sequence of telecommands to the On-Board Software (OBS). Another OBCP might monitor the spacecraft health status. To check the status of health, OBCP shall be able to read the telemetry data which is gathered from OBS. Accordingly, OBCP programming language shall provide an interface with the OBS programming language like C. It shall provide mathematical and logical operations, but must not be too complex and heavy to be integrated to OBS. To execute multiple OBCPs concurrently, OBCPs are preferred to have control structures like coroutine. In this paper, we compare Lua and MicroPython from the OBCP programming point of view. Both Lua and MicroPython can be a decent candidate for OBCP programming language because they are script language which are simple and light enough to write OBCPs.

[P-17] Polarity Test and IST for GRA of CAS500-1

Young-Woong Park, Hyung-Joo Yoon

Korea Aerospace Research Institute

There are introduced the Polarity test and Integration test(or Health check test) of GRA located on CAS500-1 during FM integration phase. Also the test results in progress are summarized. The polarity test is to check the polarity between GRA coordinates and Satellite coordinates after final integration on the satellite. It is very importance test item. The integration test or the health check test are to check the functional status before/after the several satellite tests. The procedure of these tests are more simple than the performance test.

[P-18] Mechanical Accommodation for Multiple Optical Payloads in a Geostationary Satellite

Jong Seok PARK, Jung Su CHOI, Hyung Wan KIM, Jae Dong CHOI

GK2 Program Office, Korea Aerospace Research Institute

Cheollian 2B is a kind of geostationary

multi-purpose satellite for two different missions. Both payloads are optical ones for earth observation, consisting of an ocean color imager for marine observation and a spectrometer for atmospheric composition monitoring.
The optical payload is generally divided into an electronics unit for performing data processing and control tasks, and a sensor unit for observation task including an optical subsystem and a detection subsystem. The electronics unit is mounted inside the spacecraft bus and is subjected to thermal control in connection with the bus, while the sensor unit is mounted on the upper part of the spacecraft, which is the spacecraft earth face, by independent thermal control from the spacecraft.
In order to satisfy the performance required by integrating multiple optical payloads on a satellite, it is necessary to thoroughly analyze the requirements of each payload and to optimize different design parameters. Therefore, it is essential to consider various kinds of design constraints.
This paper presents several design requirements considered in terms of mechanical systems for accommodating the GOCI-II(Geostationary Ocean Colo Imager II) and GEMS(Geostationary Environment Monitoring Spectrometer), and explains the payload interface structure introduced to meet the mechanical and thermal requirements while minimizing the effect on spacecraft design.

[P-19] Electrical Test Requirements of Compact Advanced Satellite-500 (CAS500) Flight Model (FM)

Jong-Oh Park[1], Hyeon-Jin Jeon[1], Bo-Sung Kim[2], Jin-Kon Bae[2]

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The CAS500 is standard platform for 500kg-class satellite. This standard platform is designed to support a variety of payloads with minimal design changes.
All of Flight Model (FM)units were delivered except Battery. The CAS500 FM Satellite is already integrated the units, harness and the various mechanical partson the structure. In this paper, I will introduce the electrical test requirements in the test plan for CAS500 Flight Model Satellite.

[P-20] Design of Level Product for GEO-KOMPSAT-2 AMI

Jinhyung Park

Korea Aerospace Research Institute

Korea Aerospace Research Institute(KARI) launched GEO-KOMPSAT-2A in Dec 2018. The GEO-KOMPSAT-2A has Advanced Meteorological Imager(AMI) payload for weather forecasting which is improved over procedessor MI in COMS(Communication Ocean Meteorological Satellite). KARI has developed Data Pre-processing Subsystem(DPS) for new AMI. the DPS reconstructs image from received packet and generates radiometric calibration result to product. Also, KARI designed newly level product for AMI. In this paper we describes design of level product which are generated from the AMI DPS. AMI DPS level product is divided into RAW, Level 0 and Level 1A according to the processing stage. And, each level product is consist of header file, pixel file, aux file and aux2 file. We designed level product to meet the requirements and roles. The product designed in this paper will be used to operate the GEO-KOMPSAT-2A AMI for the next 10 years.

[P-21] Introduction of Solar Array Simulator for space environment test of satellite

SuWan Bang, Yungoo Huh, Minjun Kim

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Many of the satellite projects being developed by Korea Aerospace Research Institute(KARI) include tests on launch environment test, orbital environment test, and electromagnetic wave environment test. These environment test equivalent to the AIT(Assembly, Integration & Test) space environment test during total assembling and testing of satellites on the ground before launch.
During orbital environment test, Solar Array Simulator(SAS) is used to power the satellite during testing. SAS is used to simulate space environment by simulating the power supply of satellite solar panels.
SAS must be able to supply power to satellites in a variety of scenarios which the satellites are operating in a space environment and supply power by simulating the I-V curves powered through the Solar Array. In the eclipse environment when the sunlight does not reach to satellite, the solar array can not supply power to the satellite, and the battery in satellite is used to supply electric power to the satellite and the battery is discharged. Conversely, when the sun is facing the satellite, the SAS supplies power and charges the battery supplies power to the satellite.
In this paper, there are briefly description of the structure of SAS.

[P-22] A Trend of Satellite Design Approach for Mass Production

Myung Jin Baek

Korea Aerospace Research Institute

Recent development in electronic devices has led to a decrease in the size and cost of the satellite. Korea space plan is to develop more than new 64 CAS500 satellites and 6 small satellites by 2040. A new business models in

space industry are to create a global monitoring or internet service space systems using a constellation of massive small satellites such as ICEYE or OneWeb satellite missions. The idea behind this approach is to use mainly Commercial Off The Shelf(COTS) electronic components and to build a satellite faster and cheaper. This satellite design approach will become possible by dramatically lowering the cost with high quality COTS devices and by making the product lines modular and automated. In this paper, by examining ICEYE and OneWeb satellites production approach, recent trend of satellite design approach is briefly introduced how to produce satellites cheaper and faster. Finally it is considered that this approach can be applied to CAS500 satellites making cheaper and faster.

[P-23] Radiometric Error Decomposition for Calibration Constant of SAR Satellite

Jae-Min Shin

Korea Aerospace Research Institute

The main issues for designing Synthetic Aperture Radar (SAR) Satellite are the resolution and radiometric accuracy. The reason is basically that these items are key parameters for lots of applications in the field of Radar Remote Sensing. The enhancement of SAR resolution has been attempted continually through a design method as extension of antenna length and operational bandwidth. However radiometric accuracy cannot be accomplished only through an design method. Inevitably calibration process should be performed in order to tune the radiometric error with respect to the designed requirement. It means that system parameters in orbit satellite should be changed by launch and space environment. In order to tune the radiometric error, error decomposition is required. For the decomposition, relative, absolute, processor, and noise errors are analyzed on the basis of Calibration Constant. According to the analysis result, the design for radiometric accuracy is organized and theoretically checked. Furthermore in-orbit Calibration activity for SAR Satellite under the design should be planned and performed.

[P-24] A Design and Implementation of Telemetry Processing Acceleration

Hyun-Kyu Shin

Korea Aerospace Research Institute

Telemetry data is the only way to get the status of satellites in orbit. It is very common that the telemetry frame has a complex structure in order to transmit much data to the ground under the very limited communication speed. This makes the telemetry processing system of the ground station more complicated. The telemetry processing system must meet real-time constraints and also should provide the exact result via post-processing on a set of period. To improve the speed of telemetry processing, this paper introduces a novel approach based on packet-centered parallel processing. The key idea is that telemetry processing can be done separately per packet and the packet descriptor has much information for parsing as much as possible. It is suitable to any types of telemetry regardless of LEO or GEO satellites. This paper shows the detailed design of telemetry processing acceleration and the result of its implementation.

[P-25] The G/T measurement of 2.4m X/Y-Type S-Band mesh TT&C antenna using solar flux density.

Sangil Ahn, Han Oh, Dong-Hyo Lee, Myungmuk Kim

Korea Aerospace Research Institute

KARI has studied the possibility of using in-house 2.4m X/Y-Type S-Band mesh antenna for TT&C application for polar region. Target missions covers current and future missions requiring simultaneous RHCP and LHCP downlink channels. The core requirement is minimum G/T values of 10dB for each channels. After fully integrated using COTS onto in-house X/Y positioner, the system was installed on roof and integrated with 3.6m diameter radome. Using sun as a radiowave source, Y-factor value of the 6.6dB, 6.5dB were obtained for RHCP and LHCP, respectively at 2250MHz. The G/T converted from Y-factor and solar flux density showed 11.05dB/K and 10.87dB/K, respectively, meeting minimum requirement value of 10dB. In this paper, we will describe overall description of in-house antenna system, test scenario, and measurement results.

[P-26] Satellite Abnormal Event Detection System through Fuzzy Garbage Model

Seung-Eun Yang

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Satellite is a very complex system that requires large domain specific knowledge. Thousands of telemetry are used to monitor the satellites state of health. Threshold checking and parameter trend analysis of a large amount of telemetry by expert human operators are applied in conventional spacecraft fault diagnosis and fault monitoring. However, it takes a lot of domain specific knowledge and expert human resources. In this paper, we propose satellite abnormal event detection system through fuzzy garbage model. Telemetry is changed in accordance with the operation condition and the sensitivity to variation of data or environment can be reduced through fuzzy logic. The system is composed of two fuzzy models - fuzzy nominal model and fuzzy garbage model. Each model is constructed by using satellite telemetry in normal condition

and abnormal condition. By comparing the output score from each model, satellite state is determined. Through the system, the anomaly can be detected faster and earlier with less domain knowledge and human effort.

[P-27] NMSC GK-2A Ground Segment SW Integration Test

Tae-Bong On, Chi-Ho Kang,, In-Hoi Koo, Hyun-Su Lim, Jin-Hyung Park, Jun-Young Bok

Korea Aerospace Research Institute

NMSC(National Meteorological Satellite Center) have established the ground segment for GK-2A(Geostationary Korea Multi Purpose Satellite - 2A), which was launched in December 2018. The ground system is designed to control the satellite, receive and process meteorological data from GK-2A. The ground system software integration test was conducted on the middle of 2018. In the paper, the progress and result of test is briefly presented.

[P-28] Vibration Test of Electro-Optical System of a Flight Model Middle Size Satellite

Sung-Hyun Woo, Nam-Jin Moon

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In the course of development of a satellite, a vibration test is quite important work to verify its design requirements and to acquire the dynamic characteristics by simulating the vibrational environment induced by the launch process events. In particular, it is more essential to the satellite equipment which is highly sensitive to the vibration environment such as high resolution camera system to be equipped on the satellites. Recently a flight model of the high resolution electro-optical system of a middle size satellite has been successfully tested at KARI' s vibration test facility. The paper provides overall process, configuration and results of the test.

[P-29] A mechanical approach to study the suppression of secondary particles and back-scattered particles in the charged particle detector

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Observing space-borne charged particles contributes to understanding the near Earth' s space environment. The charged particle detector performing in-situ measurement in space is designed to limit the direction and diffusion of space radiation and to obtain response from the necessary field-of-view. The particles entering the field-of-view can interact with the internal structure of the collimator that designed in the entrance unintentionally. Interacting particles can generate secondary electrons or back-scattered particles affecting the sensor signal and interfering the observation data of the space environment. This paper represents experimental research to reduce interference particles through the mechanical approach, taking into account the surface treatment and mechanical structure of the entrance collimator.

[P-30] Satellite coordination activities to acquire satellite frequency resources for geostationary orbit satellite programs

Seorim Lee

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Acquiring satellite frequency resources for satellite programs involves satellite coordination activities with international entities. While previous papers have been limited to describing the full process for acquiring satellite frequency resources from notification, coordination, to registration, this paper takes an in depth look at the coordination phase of this process. Coordination activities between satellite networks involve operator level and national administration level meetings as well as the exchange of correspondence letters. The choice of approach are dependent on factors such as the proximity in orbit, overlap in frequency band, and communication link characteristics of the satellite networks. It is through these coordination activities that satellite frequencies are in fact technically acquired. This paper aims to provide a comprehensive insight into such activities to support the better planning and implementation of future satellite coordination activities.

[P-31] Measurement of satellite molecular contamination using Wiping Method

Hye-Jin Yi, Hyok-jin Cho, Sung-Wook Park, Hee-Jun Seo

KARI(Korea Aerospace Research Institute)

The Method of Measuring the contamination of satellites can be divided into Particulate Contamination and Molecular Contamination. Molecular contamination can be divided into Direct and Indirect methods. Direct Method is a method of analyzing by exposing window and transmitting infrared rays with FT-IR. Indirect Method use a solvent to collect and analyze contamination.
In this Paper, We propose a method of manufacturing a clean Tissue and setting reference using Wiping method Which is one of the indirect method. We also confirmed using Wiping Method for the contamination status of M2 Bezel surface and HSTS of K7 for developed by KARI.

[P-32] Relative Timed Command Sequence Design for Low Earth Orbit Satellite

Jeong-Heum Im

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KARI (Korea Aerospace Research Institute) is developing a low earth orbit, earth observation satellite which weighs around 500kg. It is equiped with a high resolution electro-optical camera payload to provide 0.5m resolution panchromatic earth images. Its mission orbit is a sun synchronous orbit with an orbit altitude of around 500km.
The satellite is encapsulated inside the launch vehicle fairing with the condition its all powers are off. As soon as it is separated from the launch vehicle by the command generated from the launch vehicle side on orbit, RTCS (Relative Timed Command Sequence) starts to operate the satellite by referencing break-wire signals and a couple of flight mode indicators. RTCS is a sort of stored commands which is stored in SCSA (Stored Command Sequence Area). Each RTCS is executed at delta time after execution of the previous command. Once RTCS is activated, it is converted into an ATC (Absolute timed command) by using the delta time information. RTCS which is scheduled into ATC is stored in command stored area and it is executed at its corresponding absolute time. Deployment RTCS is designed to be executed right after the satellite is waken-up with flight mode status. Once the deployment RTCS is executed, solar arrays deployment, unit power configuration, thermal control, attitude control system activation and other procedures required to operate the satellite in the thruster based safe hold (TSH) mode are conducted. Safing RTCS is executed when fail-over is detected after success of solar array deployment. This paper describes the design of relative timed command sequence.

[P-33] A Study on Busbar Design for Next GEO Satellites with High Power Capability

Sung-Soo Jang

Korea Aerospace Research Institute

Next-generation geostationary satellites are increasingly demanding more and more solar array power with a few kilowatts to perform various mission during lifetime. In general, conventional harness will be applied for power distribution, but it can make a technical issues like as voltage drop, power dissipation, heat dissipation, EMI coupling, etc. Meanwhile, busbar in high power satellite can be considered more and more to distribute power to the loads form power sources effectively. Furthermore it can improve technical issues such as voltage drop, power dissipation, etc that existed in conventional harness. Despite the many advantages of busbar, many technical issues need to be considered for practical applications. Especially major technical issues are power and heat dissipation, EMI interference, weight and cost. In this paper, the results of trade-off using busbar are summarized in next GEO satellites with high power capability.

[P-34] Overall review of pyro-shock test results for several space parts

Jong-Hyub Jun

Korea Aerospace Research Institute

The pyro-shock environment test is essential to develope the parts of artificial satellite or launch vehicle. The test goal is to verify the structural strength for each specimen. KARI performs the environment test with a dedicated test facility subject to 1000 hz or 1500 hz heel frequency. This test is performed for qualification model of space parts. Each specimen such as space electronic box, mechanical structure, and sub-system has the specification to meet according to the system requirement. So shock test facility setting depends on the each specification.
KARI has a lot of test data for several space parts. Now the data is compared with each other in order to find out some trends or problems in KARI' s test system. And then the future plan is established in the point of test technique improvement.

[P-35] Impact of Orbit Maneuver on TLE Accuracy of KOMPSAT

Okchul Jung, Jaedong Seong, Daewon Chung

Korea Aerospace Research institute

TLE(Two Line Element), cataloged and published by CSPOC(Combined Space Operation Center) in United States, is readily available to identify the orbit information of space objects. In case of the absence in-house ephemeris of the satellite, TLEs are very essential for satellite operators and/or ground observers to get their orbits of interest and use them for scheduling the timeline of satellite missions as well as tracking. The accuracy of TLE, however, can be limited depending on a number of uncertain factors which include orbit type, orbit consistency and the condition of the space environment. Especially for an abrupt change of the orbital elements, its accuracy can be worse than expected. In this paper, TLE accuracy has been examined by using real flight data of KOMPSATs(Korea Multi-purpose Satellites). They have on-board GPS receiver which means their orbit can be estimated up to few meters. Using these precise orbit ephemeris as a reference, the position accuracy based on the TLE which is available right after orbit maneuver has been compared and analyzed.

[P-36] Design and Fabrication of Analog Acquisition System for Power EGSE

Seung Won Cho, Dong Chul Chae, Hyun Mo Gu

Korea Aerospace Research Institute

Electrical Ground Supporting Equipment (EGSE) is required to verify the function of low earth orbit or geostationary orbit satellite during Assembly Integration & Test. The Power EGSE is used to provide the power to the satellite and check the test interface with the satellite. The signal acquisition system acquire and measure the various analog values from the spacecraft. It includes the bus voltage monitoring, bus current monitoring, battery discharge voltage regulation voltage monitoring, battery discharge current monitoring, and battery cell temperature monitoring. It also provides the test point interface on the front panel. In this paper, the detailed design of the analog acquisition system for the power EGSE is presented and it is also described that the system is manufactured as designed.

[P-37] Introduction on Launch Early Orbit Phase (LEOP) and In Orbit Test (IOT) of GK2A

Chang-Kwon Cho

Korea Aerospace Research Institute

The Geostationary Earth Orbit-Korea Multi-Purpose SATellite-2A (GK2A) was launched on December 4, last year and carried out early satellite operation, and the initial operation of the Advanced Meteorological Imager(AMI) payload and the Korea Space Environment Monitor(KSEM) payload also was carried out. Currently, all functional tests have been completed and It is being performed on Navigation & Registration of Images.
The full deployment of solar panels was carried out through automatic sequence mounted in the memory of the satellite after separation from the launch vehicle. After the satellite's attitude was changed to a mode for directing the sun, 5 burn plan was performed to acquisite the target orbit using Liquid Apogee Engine(LAE). After acquiring the target trajectory, the attitude of the satellite is changed using thrusters towards the earth and then by using the Reaction wheel. The functional tests of the spacecraft bus were completed by maintaining the east-west positioning using the thruster for final orbital settling.
After the completion of the function test of the spacecraft bus, the initial activation and outgassing of AMI was started. After completion, the operation of the Loop Heat Pipe was operated and the image can be taken by opening the optical port cover. After image was shot, a radiometric calibration was performed. During the verification of the functions and performance of the AMI, KSEM also performed functional tests on particle detectors, magnetometers, and satellite charging monitors.
This paper is to briefly introduce the contents of the initial operation and in orbit test of the satellite after the launch of the GK2A

[P-38] SCP test in FSW developed based on RTEMS

Dong-Seok Chae

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We have been using VxWorks as a real-time operating system (RTOS) for satellite flight software (FSW). The use of open source Real-Time Executive for Multiprocessor Systems (RTEMS) is also considered as a real-time operating system, and RTEMS optimized for satellite FSW is under development. In order to check whether the RTEMS under development is working properly, RTEMS was transplanted instead of VxWorks in the existing FSW that has been verified. The same verification test was performed on several components of the FSW and RTEMS was verified to work normally. This paper summarizes the verification test results of the stored command processing (SCP), which is one of the FSW components performed in FSW developed on the basis of RTEMS.

[P-39] Cheollian-2A Main Sensor Unit Alignment Preparation and Adjustment.

JungSu Choi[1], JongSeok Park[1], InGul Kim[2]

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The Cheollian-2A is a follow-up geostationary meteorological mission satellite to continue the Cheollian-1 satellite, and it was launched into space at the end of 2018. The main mission of the Cheollian-2A satellite is 24 hours of continuous weather observation during its 10-year mission, and its resolution, observation cycle and observation channels have significantly improved compared to the Cheollian-1 satellite. As a result, the weight and size of the meteorological sensor unit have increased and alignment requirements must be met for the high performance. In addition, Payload Interface Structure(PIS) with carbon composite materials were applied because thermal deformation should be minimized. Three-dimensional measurements and position adjustment were applied using laser tracker when the PIS was mounted on the satellite structure, and alignment measurements using theodolites and prism mirror were performed when the meteorological sensor unit was assembled on the satellite. The actual alignment angles between the sensor line-of-sight and the sensor alignment reference prism mirror is provided by supplier, calculation of the required mirror orientation in the spacecraft axis, and alignment to this requirement. Finally the AMI sensor optical axis is aligned within the requirements for the satellite reference coordinate system.

[P-40] The introduction of MIMIC for geostationary orbit satellite

Yungoo Huh, Suwan Bang, Seungwon Cho

Korea Aerospace Research Institute

So far, KARI (Korea Aerospace Research Institute) has been developing so many satellites. Recently, geostationary orbit satellite has been successfully launched and is in initial operation.
As part of geostationary orbit satellite development project, MIMIC is designed and implemented for both satellite test on the ground and satellite operation after satellite launch. MIMIC is essential in order to monitor satellite status and analyze remote measurement data received from satellites. MIMIC has many predefined screens which is composed of visualized pictures, diagrams, text and so on. Whenever MIMIC receives the telemetry from geostationary orbit satellite, related MIMIC screen is updated and all telemetries from satellite are stored and retrieved for post processing. Especially, the MIMIC for geostationary orbit satellite has the feature to freely edit the MIMIC screens for MIMIC user convenience.
In this paper, the introduction of the MIMIC for geostationary orbit satellite will be introduced.for the calibration of XRT data.

[P-41] Introduction to Moon-based Earth Observation

Hwan-chun Myung, Jae-dong Choi

Korea Aerospace Research Institute

The Moon has been literally an original satellite of the Earth. At last, some studies showed feasibility to make a lunar-based Earth observation. Now that some nations are actively planning the moon projects in 2020s, many attention can be also paid to a lunar-based Earth observation. Though the Moon is located out of Van Allen Belt and vulnerable to a meteorites impact, no atmosphere and Earth-orbiting of Moon is very useful for the Earth observation. First of all, the paper starts with the interesting features of the Moon orbit, such as libration and celestial declination. Some simulation results are presented about what can be really observed from Moon. From the point that Moon is daily orbiting the Earth, it is very similar to LPO(Lagrange Point Orbit). However, it can be also differentiated in that its sublunar point repeatedly changes in every 27.21 days. Finally, the paper shows some candidates of the observatory instruments(visible and SAR) available on the Moon and explains the Change' e-3 program equipped with the Earth and star observation-instruments.

[P-42] The Major Operation Analysis of the Lunar Exploration Electro-Optic Payload Camera Electronic Module

Jong-Euk Park[1], Haeng-Pal Heo[1], Sang-Soon Yong[1], Kijun Lee[2]

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For the lunar exploration, the electro-optical camera for the purpose of acquiring image data of the moon from the lunar orbit is now undergoing the detailed design and testing of the verification model and the flight model is underway. Considering the poor operating environment, the overall mission performance and operating time have been determined and are also affected by the acquired image data due to the capacity limitations of the power, storage space, and transfer rate. In addition, the difference in the moon's radiation rate is so great that it is essential to design and operation of cameras that can satisfy all of these conditions. In the case of a mounted camera, the design and operation concept of a command to perform a mission was simplified, taking into account the limitations of communication with the ground station, and the compression of acquired image information was essential, taking into account the limitation of the storage and transmission. In the light of the big difference for lunar radiation, the design of the corresponding part is reflected in order to efficiently manage the amount of light projected on the image sensor.
In this paper, we analyze and describe the main operation for the efficient mission of the electro-optic camera which is mounted on the lunar probe to perform the image acquisition task of the moon.

[P-43] Software Developments of Decomposing CCSDS Packets for GEMS

Seok-Bae SEO, Seonghoon LEE

Korea Aerospace Research Institute

GEMS(Geostationary Environment Monitoring Spectrometer) has completed its installations on the GK2B (Geo-KOMPSAT 2B) Satellite. To verify the interface after the installation, the IST(Integrated System Test) has performed.
This paper explains the software development results to check decomposing CCSDS (Consultative Committee for Space Data System) Packets for the IST.

[P-44] Software Developments of Generating IMP Files for GEMS

Seok-Bae SEO, Seonghoon LEE

Korea Aerospace Research Institute

GEMS(Geostationary Environment Monitoring Spectrometer) has finished its installations on the GK2B (Geo-KOMPSAT 2B) Satellite. To verify the interface after the installation, the IST(Integrated System Test) has completed.
This paper explains the software development results to check uploading GEMS schedules using IMP (Instrument Mission Planning) files for the IST.

[P-45] Environmental tests of infra-red telescope structure qualification model

Jeoung-Heum Yeon, Won-Beom Lee, Jongguk Choe, Eung-Shik Lee, Sang-Soon Yong

Korea Aerospace Research Institute

Infra-red telescope structure is developing for the Earth observation. It will be developing in qualification model and flight model steps. In this paper, environmental tests results of qualification model are presented. As environmental tests, thermal cycling test, vibration test and shock test are performed. Test requirements, procedures and results will be described.

[P-46] Preliminary mechanical analysis and board level design enhancement of low earth orbit data recorder

Jong-Tae Lee[1], Eung-Shik Lee[1], Sang-Soon Yong[1], Ki-Jun Lee[2]

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The low earth orbit satellite requires data recorder to temporarily store taken images until the satellite reaches the contact area where data transmission to dedicated ground station is possible. As the demanded resolution of the satellite image has been increased, the size of the image also has been increased. It requires more memory space to retain the image and that has resulted in an increase in envelop dimension of memory equipment. Due to the limitation on the weight of space-born equipment, the larger memory equipment needs thorough mechanical analysis. we will present preliminary mechanical design of the data recorder and board level design enhancements for better mechanical performance.

[P-47] Determination of Times of minima for the Eccentric Eclipsing Binary Systems

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Eclipsing binary (EB) systems have offered significant observational information on the formation and evolution of stars. In particular, the eccentric EB (EEB) systems showing an apsidal motion are useful for testing orbital dynamics, stellar internal structure models, and tidal theories. To investigate such systems, it is essential to obtain times of minima over a long time-span. We have performed the photometric observations of EEBs at the Sobaeksan Optical Astronomy Observatory from February 2017 to March 2019 to acquire their times of minima. The target systems were selected from 623 systems listed in Kim et al. (2018) catalog. In this presentation, we report the times of minima determined from the photometric observations of them and discuss the results.

[P-48] Acceleration sites of solar energetic particles inferred from the three-dimensional geometry of shock waves associated with coronal mass ejections

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The observation of solar energetic particle (SEP) events by spacecraft widely separated in longitude results from processes associated with the acceleration, release and transport of SEPs on the Sun and in the inner heliosphere. We analyze the possibility that the distribution of SEPs in the inner heliosphere is due to their injection by shocks associated with coronal mass ejections (CMEs). We pay especial attention to a very widespread SEP event observed on 2014 February 25 that originated from a single flare-CME event. The SEPs were detected by near-Earth spacecraft (SOHO and ACE) located at 82° west of the flare site and STEREO-Ahead and -Behind, located at 125° east and 78° east of the flare site, respectively. The 3D geometric modeling of the shock wave associated with the parent CME reveals that the shock wave propagated laterally over 45° in longitude and intercepted the field lines nominally connecting the Sun with STEREO-Ahead and -Behind, below 4 solar radii (Rs) with an angle between the magnetic field and the shock normal ranging between 24°-79°, at the times estimated for the initial release of the SEPs. In contrast, the in-situ measurements indicate that the spacecraft located on the west of the flare established magnetic connection with the shock driven when its leading edge was already in the high corona (> 14 Rs). The shock properties measured at the spacecraft and the electron peak intensities of the SEPs were well correlated with the longitudinal separations of the spacecraft with respect to the flare site. We conclude that the shock wave propagating around the solar surface was responsible for the initial injection of SEPs in the low corona (< 4 Rs), whereas the CME-driven shock in the interplanetary space played a major role in the observed SEP intensity-time profiles.

[P-49] Neural network prediction model for relativistic electron flux at geostationary orbit

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The outer radiation belt is changed rapidly by solar wind condition. Particles that are trapped in Earth' s magnetosphere have an bad effect on many satellites. So, it is important to prevent these hazards. To protect the various risk, many researches have been progressed and prediction models have been developed. we have designed the electron flux prediction algorithm using artificial neural network (ANN) since 2016. We modified the ANN to solve the problem called overfitting, time shift and tried to improve the model performance. Input parameters are 1, 2, 3, 4 days ago data of solar wind (density, speed, IMF By and Bz), geomagnetic index (Dst, Kp) and electron flux data. The outputs of ANN are 24 hour ahead relativistic electron flux for each LT and we performed some correction for output. Also, we got another prediction results using same method adding Dst prediction data as input. As a result of the model, to some extent, we confirmed that time shift disappeared for every prediction time. Comparing with two results, we got better accuracy when use the Dst prediction data. The correlation coefficient and prediction efficiency are getting low according to prediction time. Our purpose is to get better and more precise accuracy when the prediction data used.

[P-50] Resolution of Solid State Telescope(SST) for the Small scale magNetospheric Ionospheric Plasma Experiments (SNIPE) mission

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In this time, we describe the resolution of Solid State Telescope(SST) onboard the Korea Astronomy and Space Science Institute satellite-1 (KASISat-1) for Small scale magNetospheric Ionospheric Plasma Experiments (SNIPE) mission. SNIPE mission consist of 4 KASISat-1, which have 6U sized nano-satellite and a sun-synchronous orbit at an altitude of 500 - 600 km [TBD]. The object is to understand the spatial and temporal variation of micro-scale plasma structures on the topside ionosphere. The SST will measure electrons in the range of 100 keV - 400 keV [TBD] with the geometrical factor (G = 0.02 cm2 sr) in parallel and perpendicular directions to the geomagnetic field. we performed resolution test by using bismuth(Bi)-207 radioisotope and Silicon Surface Barrier Detector of Canbbera Co. We compared with the Silicon Surface Barrier Detector model of AMETEK ORTEC results in that the FWHM of SST at 482 keV is 23.288 keV.

[P-51] Scattered Light Corrections for the Determination of Coronal Hole Plasma Properties Using the Solar X-Ray Telescope onboard Hinode Satellite

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The X-Ray Telescope (XRT) onboard Hinode, which was designed to observed a variety of coronal structures with temperature between 1 and 10 MK in the range of 34x34 arc min field of view (FOV) covering the full solar disk, has provided solar X-ray images for more than a decade and contributed to the progress in our understanding of coronal physics. In particular, long-term observation of coronal hole regions covering almost one solar cycle has an important meaning not only in the field of solar physics but also in relation to the space weather because the coronal hole is known as the source of solar winds. Detailed study on the physical conditions of solar plasma in the coronal hole and also the off-limb area will give us a clue to understand the boundary conditions and constraints on the theoretical mechanism of heating the coronal plasma.
An astronomical telescope is in general designed such that the best-focused image of an object is achieved at or very close to the optical axis, and inevitably the optical performance deteriorates away from the on-axis position. The Sun is, however, a large astronomical object and thus targets near the limb of full-disk images are placed at the outskirt of the field of view. Therefore, the optical design of a solar telescope should consider with care the uniformity of imaging quality over a wide FOV. Even after such a design effort, the off-axis performance of the solar telescopes should be characterized very carefully in order for the data away from the center to be properly interpreted.
We have evaluated the amount of scattered light inherent in the Hinode/XRT data by analyzing the in-flight images highly saturated during the solar flare events. It is revealed that, like the case of Yohkoh/SXT, the light scattered due to the roughness of mirror surface has a power-law distribution of r-2 and also shows clear energy dependence, which has enabled us to complete a full description of XRT PSF profile from the core to the scattering wing. A successful restoration of the scattered lights in the observed XRT images will provide us with more precise information on the physical quantities of solar coronal plasma in the off-limb regions. Many interesting results on the correction for Hinode/XRT scattered lights will be introduced and discussed thoroughly.

[P-52] Statistical Analysis of Small-scale Magnetic Flux Rope Structure using the Published Event Lists

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While the interaction of magnetic flux ropes with Earth' s magnetosphere has long been studied, small-scale magnetic flux rope has been studied since its discovery in 1995 (Moldwin et al, 1995). A large number of small-scale magnetic flux rope events have been compiled and several lists of them are currently available in the literature. In the present work, we work on statistical analysis of the small-scale flux rope events available from three lists. Two lists, each identified by using WIND spacecraft data and ACE spacecraft data, respectively, are published on website (fluxrope.info) from Hu et al. (2018). Another list is made available from Feng et al. (2008) using WIND spacecraft data. The three lists have different temporal intervals and distribution of physical indices. We report details of statistical analysis of these events from the lists to determine small-scale magnetic flux rope properties and compare them among the three lists.

[P-53] Application of deep learning to the forecast of X-ray flux profiles of solar major flares

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Intense X-ray flux from large flare events cause ionization in lower layer of the ionosphere on the sunlit side of Earth which can cause short-wave fade out. Due to the radiation travels at the speed of light, it is very difficult to pre-estimate the effects of hazard. In this study, we apply a Long short-Term Memory, which is a popular deep learning method for time dependent data, to the forecast of X-ray flux profiles of solar major(M and X-class) flares. For this we use GOES10 x-ray flux data with 1 minute time cadence and NASA flare catalogue from August 1998 to April 2006. 760 events are used for training and 85 ones for testing. We consider major flare events without double peaks, pre-flares, and abnormal distributions to train and test models. Our models use 30 minutes X-ray flux data to predict the next 30 minutes and stop the prediction at the peak flux. We compare our forecasting results giving the best performance with observations. The results are as follows. First, the root mean square error(RMSE) of the next 30 minute soft x-ray flux prediction with the LSTM model is 0.37. Second, RMSE of peak flux prediction with LSTM model is 0.27. This work was supported by Institute for Information & communications Technology Promotion(IITP) grant funded by the Korea government(MSIP) (2018-0-01422, Study on analysis and prediction technique of solar flares).

[P-54] Manually scaling two year (2017, 2018) ionogram datasets measured by Icheon and Jeju ionosondes

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Icheon and Jeju ionosondes have been monitoring ionosphere since 1998 and 2010, respectively. An Ionosonde transmits continuously series of radio waves vertically and receives reflected waves by the ionosphere that are recorded on ionograms. Ionospheric parameters, such as foF2 (peak frequency of the F2 layer), hmF2 (peak height of the F2 layer), and others, can be extracted from echo traces on the ionogram by usually using an automatic scaling program. are used. However, automatic scaling has significant potential to cause inaccuracy in the extracted parameters. In this study, we manually scaled hourly ionograms (about 34000) measured at Icheon (37.1° N, 127.5° E) and Jeju (33.4 ° N, 126.3 ° E) in 2017 and 2018. We will present comparison of manually scaled foF2s and hmF2s with those by an auto-scaling program (ARTIST4). We will then discuss how much automatic scaling results can be trusted for these ionosonde sites. We will also suggest ways in which manually scaled results can be utilized in the regional ionospheric modeling researches.

[P-55] A Study on Extension of Major Non-metallic Materials for Space

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Space materials, which have been used for the LEO (Low Earth Orbit) and GEO (Geostationary Earth Orbit) spacecrafts developed in Korea, with limited life-time characteristics are subject to lot(or batch) acceptance tests, and have the date of the manufacture and shelf-life expiration date marked on each lot(or batch). And, the storage conditions and shelf life should be stated in the procurement specification. The material whose shelf life has expired will be segregated from other conforming materials and not be used on the FM (Flight Model) fabrication unless the material is validated by means of appropriate tests. This paper shows the conceptual methods of this appropriate tests for the extension of the major shelf life materials for the space in order

to confirm whether the expired shelf life materials, which are stored in the controlled conditions of the procurement specifications, can be used for the DM(Development Model) during the short periods, or not.

[P-56] Structural analysis of Qualification Model (QM) for scientific instruments for the Small scale magNetospheric Ionospheric Plasma Experiments (SNIPE) mission

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In this time, we report the progress of Structural analysis of Qualification Model (QM) for scientific instruments for the Small scale magNetospheric Ionospheric Plasma Experiments (SNIPE) mission. The SNIPE mission will be launched in the second half of 2020 to resolve microscale plasma structure and their spatial, temporal variation on the topside ionosphere. It is equipped with scientific instruments to measure the geophysical phenomena such as electron microbursts, plasma trough, polar cap patches, bubbles/blobs, field aligned current and EMIC waves. The scientific instruments is comprised of SST (Solid State Detector; particle detector), MAG(MAGnetometer; magnetic field measurement device) and LP(Langmuir Probe; measurement for properties of electron and plasma device). we performed modal analysis and 10G analysis. In the modal analysis, the natural frequencies of payload unit are 365.68 Hz(1st), 438.65 Hz(2nd), 461.71 Hz(3rd), 475.21 Hz(4th) and 482.62(5th). In the 10G analysis, the maximum stress is 16.61 MPa and the maximum displacement is 0.025 mm. As a result of the analysis, the SNIPE payload has sufficient structural stability.

[P-57] Solar rotational periodicity of geosynchronous relativistic electron flux variation and its relationship with solar wind conditions during solar cycles 23 and 24

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The interplanetary magnetic field (IMF) and geomagnetic field are closely coupled to each other such that the solar wind, IMF and magnetospheric parameters often have similar periodic variations, as reported in some previous studies. In a recent study based on wavelet analysis, we have confirmed that IMF Bz in GSM coordinate has periodic variations at the solar rotational period and/or its harmonics predominantly in spring and fall seasons by Russell-McPherron effect when associated with well-organized IMF sector structure. In the present work, we extend the same analysis to geosynchronous relativistic electron (>2MeV) fluxes and other related parameters. We find that geosynchronous relativistic electrons often, but not always, exhibit periodic variations at the solar rotational period and its harmonics. The periodic properties of the geosynchronous relativistic electron fluxes are most closely correlated with those of AE index among the other parameters we tested. Furthermore, this is also closely related to periodic changes in the coupling function, $d\Phi_{MP}/dt$, suggested by Newell et al. (2007) to represent the rate at which the solar wind magnetic flux is opened at the magnetopause. We find that the extent to which the coupling holds between geosynchronous relativistic electrons and the $d\Phi_{MP}/dt$ function depends on solar cycle and phase. We further test a modified coupling function by taking into account the dynamic pressure effect. We will discuss implications of this result, including the usefulness and limitations of this coupling function.

[P-58] Development of a prototype verification system to validate the ASSA Model

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The Korean Space Weather Center (KSWC, RRA) developed a prototype of a verification system in 2018 that verifies the results of the models for forecasting and analyzing the space environment in operation. The Space Environment Forecast and Analysis Model Verification System is a system that standardizes the forecasts and observations data of each model and then validates them by applying the metrics recommended by the WMO. The system consists of 1) Model meta DB and verification data meta DB 2) Collecting and standardization of model data 3) Verification of model data 4) Presentation of verification results Web page. Testing was conducted by applying the ASSA model in operation at the Space Weather Center. Although sunspot detection showed a high hit rate after verification, corona hole detection showed a low hit rate. It will also apply to improvement of verification system and other forecast models in 2019.

[P-59] Observations for aurora and relevant polar upper atmospheric changes over Jang Bogo Station, Antarctica

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We have been collecting aurora images fromcolor-CCD All-Sky Camera (ASC) at Jang Bogo Station (JBS), Antarctica (74° 37' S,164° 13' E) since 2018. The JBS is located mostly in the boundarybetween the polar cap and the auroral region and since the establishment in2014, various observations for the polar upper atmosphere and the magnetospherehave been performed simultaneously together with the auroral observation. Inthis study, we analyze the 1-year observation for the aurora as well as thepolar upper atmosphere and the magnetosphere from the various groundinstruments such as ionosonde (VIPIR), Febry-Perot interferometer (FPI), magnetometers,and ASCs in order to study on the possible changes of the polar upperatmosphere during the occurrence of the aurora over the JBS. In thispresentation, we will show some preliminary results of this comparative studymainly using the auroral images from ASC and the simultaneous observations forthe ionosphere and the thermosphere.

[P-60] Operation concept for science data acquisition and preprocessing of KPLO Deep-Space Ground System (KDGS)

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To support the KPLO's mission to the Moon, KPLO Deep-Space Ground System (KDGS) is under development for service the KPLO's contact to ground. All telecommands and real-time SOH will be communicated with S-Band antenna. However science data and playback memory dump will be transferred to the ground using X-band antenna with a rate of 8.5 Mbps.
The X-band telemetry format follows the CCSDS Grade-2. The sync pattern follows by 2040 byte CADU with a Reed-Solomon code in it. Thus the sync pattern and CADU are repeated until completely transferred the data. Each CADU has a transfer frame and payload data inside and wrap it with a proper header and CRC code. The real-time operation subsystem (ROS) will save the X-band telemetry which pass the validation of its format and integrity. Saved telemetry will be pushed to the payload storage server (PSS) for preprocessing before distribution to a target subsystem.
Each science data has own unique VCID in the transfer frame header. Using VCID, telemetry will be separated and archieved individually. After each pass, 6 different science data file will be saved. PSS will strip the transfer frame header and keep the original format of space packet which is the output of each instrument.
In the study, we present the operation concept of science data acquisition and preprocessing before level 0 processing.

[P-61] Graphical Display Function of Korea Pathfinder Lunar Orbiter's Flight Dynamics Subsystem to Support Successful Flight Operation

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For the successful flight operation of the Korea Pathfinder Lunar Orbiter (KPLO) mission, Flight Dynamics Subsystem (FDS) for KPLO mission is now under development by Korea Aerospace Research Institute (KARI). Unlike the Earth observation mission, KPLO mission phase comprised of four different major phases and having total of ten different sub-phases. FDS is now currently plan to display diverse 2D, 3D views during real-time operation to support flight operation. Those of graphical views will include: flight trajectory with respect to the Earth and the Moon, ground track display which reflecting ground station contacts, maneuver execution segment during the flight and umbra and penumbra conditions, ect. Detailed content of each graphical display window will be changed and modified appropriately dependent to each different mission phases to maximize operational support. Current work will briefly introduce KPLO mission phases, then, associated current graphical display plan of KPLO FDS will be discussed with example screen shots.

[P-62] A Study on the control method of configuration control for maintaining the status of satellite configuration

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Maintaining configuration status in satellite configuration management is a set of activities to record and maintain necessary information such as approved configuration identifiers, proposed technology changes, and implementation of approved technology changes. As a result of the activities, each kind of configuration management related document is created and systematic management method is needed. In this paper, we propose a method to maintain the configuration of the KOMPSAT satellite and GEO-KOMPSAT-2 satellite, and propose a method to maintain the shape that can be applied to the new satellite development.