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2019년 10월 제28권 2호

사단법인 한국우주과학회
The Korean Space Science Society

차 례

<사단법인 한국우주과학회 입회 안내>

사단법인 한국우주과학회는 천문·우주과학 및 관련분야에 종사하는 여러분의 입회를 환영합니다. 우리 학회에 입회를 희망하시는 분은 입회원서 양식에 인적사항을 기재하시어 학회로 보내 주시거나 홈페이지에서 가입하시고 입회비와 연회비는 학회 은행계좌로 송금하시기 바랍니다.

▣ 보낼곳: 한국우주과학회
34055 대전광역시 유성구 대덕대로 776
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팩스 042-865-3392

▣ 은행계좌:
국민은행 012-01-0603-888
예 금 주 한국우주과학회

▣ 회비납부안내

회원구분	입회비	연회비
학생회원(학부생)	10,000원	-
정회원	10,000원	50,000원
회장, 부회장	-	100,000원
이사, 감사	-	100,000원

※ 회원의 구분은 정관 제6조에 의거하며, 변경된 연회비는 학회운영에 대한 규정 제2조에 의거한 사항입니다.

※ 뒷면의 입회원서를 복사하여 사용해 주십시오.

[표지사진 설명]

극지연구소의 두 번째 남극기지인 장보고과학기지와 자기권, 극지 고층대기, 오로라 관측을 위한 자력계, 전리권 레이더, 페브리-페로 간섭계, 오로라 전천 카메라 (위에서부터). 극지연구소 우주과학연구그룹은 세종과학기지에서 대기 중력파 등 고층대기 동역학적 특성 연구를 지속적으로 수행해오고 있으며, 남극장보고과학기지를 중심으로 전리권, 열권, 오로라, 자기권 등 우주환경으로 연구 영역을 확장하였고, 남극뿐만 아니라 북극에서도 이와 같은 연구를 수행 중이다.

입 회 원 서

<table>
<tr><td rowspan="2">성 명</td><td>한글</td><td rowspan="2">성 별</td><td rowspan="2">남/여</td><td rowspan="2">생 년 월 일</td><td colspan="2" rowspan="2">년 월 일</td></tr>
<tr><td>영문</td></tr>
<tr><td>자택주소</td><td colspan="2"></td><td>우편번호</td><td></td><td>전 화</td><td></td></tr>
<tr><td>직장주소</td><td colspan="2"></td><td>우편번호</td><td></td><td>전 화</td><td></td></tr>
<tr><td>e-mail</td><td colspan="4"></td><td>이동전화</td><td></td></tr>
<tr><td>직 장 명</td><td colspan="3"></td><td>직 위</td><td colspan="2"></td></tr>
<tr><td rowspan="5">학 력</td><td>학위명</td><td>입학년도</td><td>학위취득일</td><td colspan="2">학교명</td><td colspan="2">전 공</td></tr>
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<tr><td>경 력</td><td colspan="7"></td></tr>
<tr><td>연구 업적</td><td colspan="7"></td></tr>
</table>

위 본인은 귀 학회의 설립 목적과 취지에 찬동하여 이에 회원 가입을 신청합니다.

년 월 일

신청인: (인)

위 사람을 귀 학회의 회원으로 추천합니다(참고: 정관 7조 1항에 따라 추천인은 우리 학회 정회원이면 누구나 가능합니다.).

추천인 : 직장 및 직위	성명	(인)
추천인 : 직장 및 직위	성명	(인)

사단법인 한국우주과학회 귀중

한국우주과학회
2019년 가을 학술대회

일　　시 : 2019. 10. 23.(수) 13:00 ~ 25.(금) 11:30

장　　소 : 여수 베네치아 호텔&리조트

발표논문 : 초청강연 4편, 구두발표 77편, 포스터발표 148편, 총 229편

발표시간 : 초청강연(30분), 연구발표(10분~15분) 3세션~4세션 동시 진행

포스터 발표 : 1부　2019. 10. 23.(수)　15:30~16:30

2부　2019. 10. 24.(목)　12:50~13:50

후원 : 여수시 YEOSU CITY　전라남도 문화관광재단

사단법인 한국우주과학회

등록 및 교통 안내

1. 등록

회원의 등록비는 200,000원이며, 학생회원과 정회원 중 석·박사과정(전일제) 학생은 100,000원입니다. 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.

입회비: 10,000원, 연회비: 50,000원(학부학생회원은 입회비 10,000원, 연회비 면제)입니다.

학회계좌: 국민은행 012-01-0603-888
예금주 한국우주과학회

3. 발표자료 준비

구두발표: 발표자료는 파워포인트 파일로 준비하시기 바랍니다.

포스터발표: 포스터 발표 1부 세션은 10월 23일(수) 13시까지 지정된 장소에 게시하고, 24일(목) 10시에 수거하여 주시며, 2부 세션은 24일(목) 11시까지 게시하고, 25일(금) 10시에 수거하여 주시기 바랍니다. 집중발표 시간에 발표자는 자신의 포스터 앞에서 회원들의 질문에 답할 수 있도록 준비해 주시기 바랍니다. 포스터를 부착하지 않거나 학회 종료 후 수거하지 않은 회원은 추후 학회 발표가 제한될 수 있습니다(2006년 3차 이사회 결정).

4. 발표장

발표형식	구분	분과명
ORAL	Festa	- Invited Talk I, II, III, Ⅳ - Sun/Space Environment I, II, III - Special Session International Session
	Burano I	- Special Session Space Situational Awareness I, II - Special Session Ionosphere I, II
	Burano III	- Special Session AI/Deep Learning - Space Technology I, II - Space Application
	Burano II	- Moon/Planets/Solar System Exploration - The 9th Lunar Exploration Symposium
POSTER	Lobby	Space Situational Awareness AI/Deep Learning Moon/Planets/Solar System Exploration Solar System & Space Exploration Sun/Space Environment Space Astronomy Space Technology Space Application Ionosphere Miscellaneous

5. 교통

가. 주소 : 전라남도 여수시 오동도로 61-13(수정동 774-4) 여수 베네치아 호텔&리조트
(Tel : 061-664-0001)

나. 찾아오시는 길

▶자가용 이용

-서울시청: 약 3시간 50분 소요

-대전: 약 2시간 40분 소요

▶KTX 이용

-서울-여수엑스포역(2시간 50분 소요)

-오송-여수엑스포역(2시간 10분 소요)

▶여수 엑스포역 ↔ 여수 베네치아 호텔&리조트

-버스: 오동도 방면 정류장에서 2번 버스 탑승 → 박람회장 정류장 895 하차 (약 10분 소요 요금 1,300원)

-택시: 약 2분 소요, 요금 약 2,800원

-도보: 1 km 15분 소요

▶자세한 내용은 리조트 홈페이지 참조
http://www.yeosuvenezia.com/sub8/sub8_03.php

2019 KSSS FALL CONFERENCE PROGRAM

Oct. 23. (Wed)

Time	Functions
12:00~	Registration Open : Convention Lobby
13:00~13:10	Opening Ceremony : Festa
13:10~13:40	**Invited Talk I** Room : Festa Chair : KyungSuk Cho (KASI) Prof. Tetsuya Magara (Kyung Hee University) Evolution of Solar Magnetic Fields from Emergence to Eruption: Modeling and Its Application to Observations
13:40~13:50	Coffee Break

Room	Festa		Burano I		Burano III	
Session I	Sun & Space Environment (I) Chair: JooHyeon Kim (KARI)		Special Session Space Situational Awareness (I) Chair: EunJung Choi (KASI)		Special Session AI/Deep Learning Chair: KyoungWook Min (KAIST)	
13:50~14:05	I-1-1	ChangSup Lee	I-2-1	13:50~14:00 SiMon Kim	I-3-1	KangWoo Yi
			I-2-2	14:00~14:10 KiPyoung Sung		
14:05~14:20	I-1-2	HyuckJin Kwon	I-2-3	14:10~14:20 PurEum Kim	I-3-2	SuJin Lee
14:20~14:35	I-1-3	JunMo An	I-2-4	14:20~14:30 JeeHo Lee	I-3-3	EunYoung Ji
			I-2-5	14:30~14:40 NayEon Kim		
14:35~14:50	I-1-4	WonSeok Lee	I-2-6	14:40~14:50 Jin Choi	I-3-4	HyunJin Jeong
14:50~15:05	I-1-5	WooJin Park	I-2-7	14:50~15:00 JaeYoung Kim	I-3-5	KiMoon Kim
			I-2-8	15:00~15:10 SiWoo Kim		
15:05~15:20			I-2-9	15:10~15:20 HaYeon Choi	I-3-6	YeonJu Choi
15:20~15:30	Coffee Break					
15:30~16:30	**Poster Session (I) No.1~74**					
16:30~17:20	Society Subcommittee Meeting					
17:20~	Board Meeting					

Oct. 24. (Thu)

Time	Functions							
Room ·	Festa		Burano I		Burano III		Burano II	
Session II	Sun & Space Environment (II) Chair: CheongRim Choi (CBNU)		Special Session Space Situational Awareness(II) Chair: JangHyun Park (KASI)		Space Technology (I) Chair: SangIl Ahn (KARI)		Moon/Planets/Solar System Exploration Chair: Ho Jin (KHU)	
09:30~09:45	II-1-1	HeeEun Kim	II-2-1	HongSuh Yim	II-3-1	SangWon Lee	II-4-1	YoungRok Kim
09:45~10:00	II-1-2	JunHyun Lee	II-2-2	JungHyun Jo	II-3-2	YoungBum Song	II-4-2	JoRyeong Yim
10:00~10:15	II-1-3	JiWoo Kim	II-2-3	JeongYoo Hong	II-3-3	YoungMin Hwang	II-4-3	YoungJoo Song
10:15~10:30	II-1-4	SangYun Lee	II-2-4	JiWoong Yu	II-3-4	JongOh Park	II-4-4	BangYeop Kim
10:30~10:45	II-1-5	CheongRim Choi	II-2-5	Jin Choi	II-3-5	SeokBae Seo	II-4-5	Jeonghyun Kim
10:45~11:00	II-1-6	JungJoon Seough	II-2-6	EunJung Choi	II-3-6	SangIl Ahn	II-4-6	MinJi Jeong
11:00~11:10	Coffee Break							
11:10~11:40	**Invited Talk II** Room : Festa Chair : HongKyu Moon (KASI) Prof. Masateru Ishiguro (Seoul National University) A Review of Centurial Asteroid Research: From ~100 km-sized Asteroid to μm-sized Dust							
11:40~12:50	Lunch Time							
12:50~13:50	**Poster Session (II) No.75~148**						**The 9th Lunar Exploration Symposium (13:00~17:00)**	
13:50~14:20	**Invited Talk III** Room : Festa Chair : YoungSook Lee (CNU) Dr. Dieter Bilitza (NASA, *Chief Scientist*) IRI the International Standard for the Ionosphere							
14:20~14:50	**Invited Talk IV** Room : Festa Chair : GiHyuyk Choi (KARI) Thomas Reimer (German Aerospace Center DLR) SHEFEX Flight Test Program, Mission Overview							
14:50~15:00	Coffee Break							
Session III	Special Session International Session Chair: KwangSun Ryu (KAIST)		Special Session Ionosphere (I) Chair: WooKyoung Lee (KASI)		Space Technology (II) Chair: KiRyeok Yong (KARI)			
15:00~15:15	III-1-1	S. Eswaraiah	III-2-1	HyoSub Kil (Invt.)	III-3-1	HaeJin Choi		
15:15~15:30	III-1-2	SiBaek Yi	III-2-2	HyoSub Kil (Invt.)	III-3-2	Ki-Ryeok Yong		
15:30~15:45	III-1-3	IlHyun Cho	III-2-3	JaeHeung Park	III-3-3	JongSeok Park		
15:45~16:00	III-1-4	KhanHyuk Kim	III-2-4	JongKyun Chung	III-3-4	JongEuk Park		
16:00~16:15	III-1-5	GiJeong Kim	III-2-5	SangWoo Lee	III-3-5	KeunWoong Shin		
16:15~16:30			III-2-6	YoungBae Ham	III-3-6	TaeWoo Kim		
16:30~16:40	**Photo Time**							
16:40~18:00	**Regular General Meeting : Festa**							
18:00~20:00	**Banquet : 1F Firenze**							

Oct. 25. (Fri)

Time	Functions					
Room ·	Festa		Burano I		Burano III	
Session Ⅳ	Sun & Space Environment (III) Chair: SuYeon Oh (CNU)		Special Session Ionosphere (II) Chair: JongKyun Chung (KASI)		Space Application Chair: KyoungMin Roh (KASI)	
09:30~09:45	Ⅳ-1-1	KyungSun Park	Ⅳ-2-1	ByungKyu Choi (Invt.)	Ⅳ-3-1	SangTaek Lee
09:45~10:00	Ⅳ-1-2	HeeEun Wang	Ⅳ-2-2	JunSeok Hong	Ⅳ-3-2	TerKi Hong
10:00~10:15	Ⅳ-1-3	DaeYoung Lee	Ⅳ-2-3	SuIn Moon	Ⅳ-3-3	WonSik Nam
10:15~10:30	Ⅳ-1-4	JaeOk Lee	Ⅳ-2-4	JeongHeon Kim	Ⅳ-3-4	DongOk Ryu
10:30~10:45	Ⅳ-1-5	KyungEun Choi	Ⅳ-2-5	SeHeon Jeong	Ⅳ-3-5	JinPyong Jung
10:45~11:00			Ⅳ-2-6	YoungSook Lee	Ⅳ-3-6	GiHan Hong
11:00~11:30	Closing Ceremony : Festa					
11:30~	Tour					

Poster Session I

2019. 10. 23.(Wed) 15:30~16:30

Area	No	Author	Area	No	Author
Space Technology	P-1	JaeWook Kwon	Space Astronomy	P-38	KookSup Jo
Space Situational Awareness	P-2	ByoungGyun Lim	Space Application	P-39	JongPil Kong
Miscellaneous	P-3	ByungWook Jeong		P-40	SeongHui Kim
AI/Deep Learning	P-4	KyoungWook Min		P-41	YounKyu Kim
	P-5	NuRi Park		P-42	YoungSun Kim
	P-6	JongDae Sohn		P-43	HwanChun Myung
	P-7	SeungUk Lee		P-44	JongEuk Park
	P-8	SeongGyeong Jeon		P-45	SeokBae Seo
	P-9	EuiDong Hwang		P-46	JeoungHeum Yeon
Moon/Planets/Solar System Exploration	P-10	HaingJa Seo		P-47	SangSoon Yong
	P-11	SangYoun Shin		P-48	WonBeom Lee
	P-12	YunHo Jang		P-49	IlSeop Lee
Solar System & Space Exploration	P-13	JooHyeon Kim		P-50	JongWon Lee
	P-14	YoungJoo Song		P-51	JongTae Lee
	P-15	HoonHee Lee		P-52	JooHee Lee
	P-16	DaWoon Jung		P-53	SuYoung Chang
Sun/Space Environment	P-17	Danish Naeem		P-54	GabHo Jeun
	P-18	JongWoo Kwon		P-55	JinPyong Jung
	P-19	KyungChan Kim		P-56	GiHan Hong
	P-20	JinHyun Kim	Space Technology	P-57	JoRyeong Yim
	P-21	KeunChan Park		P-58	GmSil Kang
	P-22	HoSub Song		P-59	SangWook Kang
	P-23	Junho Shin		P-60	SooYeon Kang
	P-24	SuYeon Oh		P-61	ChiHo Kang
	P-25	KwangSun Ryu		P-62	InHoi Koo
	P-26	DaeJung Yu		P-63	DongGyu Kim
	P-27	AMi Yun		P-64	DongOh Kim
	P-28	JaeOk Lee		P-65	MyungMuk Kim
	P-29	JongKil Lee		P-66	YoungYun Kim
	P-30	JiHee Lee		P-67	EuiKrun Kim
	P-31	HwanHee Lee		P-68	HyungWan Kim
	P-32	HyeonJin Jeon		P-69	NamJin Moon
	P-33	GyeongBok Jo		P-70	SeungYong Min
	P-34	IlHyun Cho		P-71	BongKyu Park
	P-35	GwangSon Choe		P-72	SungWook Park
	P-36	KyuCheol Choi		P-73	JongBum Park
	P-37	GiHyuyk Choi		P-74	JongSeok Park

Poster Session II

2019. 10. 24.(The) 12:50~13:50

Area	No	Author	Area	No	Author
Space Technology	P-75	JongOh Park	Space Technology	P-112	EunSook Lim
	P-76	JooHo Park		P-113	JeongHeum Im
	P-77	JinHyung Park		P-114	JiHyeon Yim
	P-78	HeeSung Park		P-115	HyunSu Lim
	P-79	SuWan Bang		P-116	KyugnDuk Jang
	P-80	KwangYul Baek		P-117	SungSoo Jang
	P-81	MyungJin Baek		P-118	JongHyub Jun
	P-82	SunKi Baek		P-119	OkChul Jung
	P-83	HyunChul Baek		P-120	YoueYun Jung
	P-84	JunYeong Bok		P-121	SeungWon Cho
	P-85	HeeJun Seo		P-122	ChangKwon Cho
	P-86	JaeDong Seong		P-123	SungYong Cha
	P-87	SeungHee Son		P-124	DongSeok Chae
	P-88	JaeMin Shin		P-125	DongChul Chae
	P-89	HyunKyu Shin		P-126	SeungHyun Choi
	P-90	HyunJin Shin		P-127	SeungHun Ha
	P-91	SangIl Ahn		P-128	SungSik Huh
	P-92	HanWoong Ahn		P-129	HuiKyung Kim
	P-93	SeungEun Yang		P-130	YoungWoong Park
	P-94	TaeBong Oh		P-131	YunGoo Huh
	P-95	SungHyun Woo		P-132	KeunJoo Park
	P-96	JiHyeon Yoo		P-133	WooYong Kang
	P-97	SeokTeak Yun	Ionosphere	P-134	YoungSil Kwak
	P-98	YoungSu Youn		P-135	TaeYoung Kim
	P-99	DongHun Lee		P-136	Yeon Joon Jung
	P-100	MyeongShin Lee		P-137	WooYeon Park
	P-101	SangRok Lee		P-138	SeungBum Yang
	P-102	SangTaek Lee		P-139	TaeYong Yang
	P-103	SeoRim Lee	Miscellaneous	P-140	Chul Kang
	P-104	SeonHo Lee		P-141	ChunWon Kim
	P-105	SeungHun Lee		P-142	YoungJo Bae
	P-106	WooMin Lee		P-143	JaeHoon Song
	P-107	JaeSeung Lee		P-144	YoungChun Youk
	P-108	JaeYeol Lee		P-145	ChangEun Lee
	P-109	JuHun Rhee		P-146	TaeJin Lee
	P-110	ChoonWoo Lee		P-147	NaGyun An
	P-111	HyeJin Yi		P-148	JeongWoo Han

구두발표 논문 초록

10월 23일(수) 제1발표장 Festa

Invited Talk I

좌장: Kyungsuk Cho (KASI)

13:10 [IS-I]

Evolution of Solar Magnetic Fields from Emergence to Eruption: Modeling and Its Application to Observations

Tetsuya Magara

Department of Astronomy and Space Science, School of Space Research, College of Applied Science, Kyung Hee University

Solar eruptions are one of the most dynamic phenomena observed in the solar corona where coronal plasmas confined by twisted magnetic fields are rapidly ejected toward the interplanetary space. These eruptions are considered to occur at the final evolutionary stage of solar magnetic fields that emerge from the solar interior, form the so-called flux ropes containing coronal plasmas observed as solar prominences/ filaments, and finally erupt toward the interplanetary space. Solar eruptions are sometimes accompanied by explosive phenomena such as solar flares. In this talk, I show results from magnetohydrodynamic (MHD) simulations performed by our group and discuss a series of dynamic processes leading to a solar eruption. Magnetic Rayleigh-Taylor instability enables subsurface magnetic flux to emerge into the solar atmosphere and form a flux rope [1,2] which experiences quasi-static evolution characterized by the scale height of field strength and field-line curvature before it erupts [3]. We also explain how the magnetic structure of a prominence/ filament is dynamically formed in a flux rope [4]. Then we demonstrate a key mechanism causing the dynamic state transition from the quasi-static state to the eruptive state of a flux rope [5-7]. Finally, we show recent MHD simulations reproducing observed properties of real active regions [8,9].

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제1발표장 Festa

I-1 Sun & Space Environment (I)

좌장: JooHyeon Kim (KARI)

13:50 [I-1-1]

Variability of Airglow Emissions in Wind and Temperature Measurements from Fabry-Perot Interferometer King Sejong Station, Antarctica

Changsup Lee[1], Geonhwa Jee[1,2], Qian Wu[3], Jeong-Han Kim[1], Hosik Kam[4], Young-bae Ham[1,2], Yong Ha Kim[4]

[1]*Korea Polar Research Institute, Incheon, Korea*
[2]*University of Science and Technology, Daejeon, Korea*
[3]*High Altitude Observatory, NCAR, USA*
[4]*Chungnam National University, Daejeon, 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. Because the airglow emission height sensitively varies with a solar local time and a season, it is not possible to precisely determine what altitude airglow emission occurs at. Even though a few previous studies suggested representative heights of airglow emission such as OH band and 557.7 nm line, the true height information of these emission are still unknown. In this study, we try to figure out the temporal dependence of the airglow emissions using the KSS FPI and satellite (SABER/MLS) measurements. We also perform a direct comparison between the FPI and the meteor radar wind measurements considering time-varying airglow emission properties.

14:05 [I-1-2]

Simultaneous Observations of Pc1 Wave at Mid-to-high Latitudes in Antarctica

Hyuck-Jin Kwon[1], Khan-Hyuk Kim[1], Geonhwa Jee[2,3], Jeong-Han Kim[2], Changsup Lee[2]

[1]*School of Space Research, Kyung-Hee University*
[2]*Division of Polar Climate Sciences, Korea Polar Research Institute*
[3]*University of Science and Technology*

It is well known that an ionospheric wave guide centered around the maximum ionospheric electon density is main process of propagation of Pc1 pulsations. Korea Polar Research Institute (KOPRI) has been operated an array of search-coil magnetometers installed at Jang Bogo (JBS, −74.4° geographic

latitude, 164.1° geographic longitude), Neumayer (VNA, −70.4° geographic latitude, −8.2° geographic lonagitude), and King Sejong (KSS, −62.1° geographic latitude, −58.5° geographic lonagitude). VNA is located in the sub-auroral region at L = ~4.6 near the nominal location of the plasmapause. Since the region near the plasmapause is one of favored regions of EMIC wave generation, the KOPRI array allows us to examine how EMIC Pc1 waves generated near the plasmapause propagate poleward and/or equatorward with respect to VNA station. We observed Pc1 waves simultaneously identified at KSS, VNA, and JBS on 6 March 2019. The wave power is maximized at VNA. It is found that the Pc1 waves at VNA have higher attenuation as they propagate lower latitudes. The polarization sense was predominantly left-handed on the ground during propagation. We confirmed the Pc1 waves in the ionosphere when Swarm spacecraft pass over the sub-auroral region. Since Swarm spacecraft move a wide range of latitudes along a fixed longitude (i.e., the magnetic meridian) over the Pc1 wave duration, the wave attenuation rate along the latitude can be estimated. We compare the attenuation rates obtained from the Swarm data and the KOPRI array data.

14:20 [I-1-3]

Relation between ICME Properties and Space Weather Disturbances near the Earth

Junmo An[1], Tetsuya Magara[1,2], Keiji Hayashi[3], Yong-Jae Moon[1,2]

[1]*School of Space Research, Kyung Hee University*
[2]*Department of Astronomy and Space Science, Kyung Hee University*
[3]*Northwest Research Associates (NWRA)*

One of the main sources of space weather disturbances observed near the Earth orbit is the interplanetary coronal mass ejection (ICME). In this study, we investigate the relation between the physical properties of an ICME and the disturbances observed near the Earth through three-dimensional magnetohydrodynamic (MHD) simulations. We use a spheromak-type ICME and perform a series of simulations with various sets of ICME parameters. The ICME is injected into the background solar wind generated by MHD-Interplanetary scintillation (IPS) tomography method that uses solar magnetogram data and IPS data. We will compare simulation results to in situ observations near the Earth and discuss the relation between the physical properties of an ICME and the space weather disturbances near the Earth.

14:35 [I-1-4]

A Modeling Analysis of the Apparent Linear Relation between Mesospheric Temperatures and Meteor Height Distributions Measured by a Meteor Radar

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

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

The method of estimating a mesospheric temperature has recently been proposed by utilizing an apparent linear relation between atmospheric temperatures and full widths at half maximum (FWHMs) of meteor height distributions measured by a meteor radar. The advantage of the method is the ability of estimating the temperature directly from the FWHM of a meteor height distribution, whereas the traditional method has to adopt a temperature gradient model and to determine the slope of a meteor diffusion coefficient profile. However, this method assumes that the meteor height distribution is dominantly dependent on the atmospheric condition, rather than on meteor characteristics (mass, and velocity). In order to verify this assumption, we carried out meteor ablation simulation. The simulation results show that the FWHM of meteor height distribution increases linearly with the atmospheric temperature and its linear relation matches well with the observed relation. We also found that the observed characteristics of meteors are consistent with a Gaussian distribution of logarithmic masses that has the average value of $10^{-6.66 \pm 0.08}$ kg and this distribution is nearly invariable over the year. Therefore, we can conclude that observed meteor height distributions are mainly dependent on the atmospheric temperature, and thus can be used as a mesospheric temperature indicator with an appropriate calibration method.

14:50 [I-1-5]

Optical Calibration and Performance Measurement of the Mesospheric Airglow/Aerosol Tomography Spectroscopy (MATS) Satellite

Woojin Park[1], Arvid Hammar[2], Soojong Pak[1], Seunghyuk Chang[3], Jörg Gumbel[4], Dae Wook Kim[5,6]

[1]*Kyung Hee University*
[2]*Omnisys Instruments AB*
[3]*Korea Advanced Institute of Science and Technology (KAIST)*
[4]*Stockholm University*
[5]*James C. Wyant College of Optical Sciences, University of Arizona*
[6]*Department of Astronomy, University of Arizona*

The Mesospheric Airglow/Aerosol Tomography Spectroscopy (MATS) satellite is a Swedish atmospheric-research microsatellite. The limb telescope, the main optical instrument of the satellite, is linear astigmatism-free con-focal off-axis three

mirror telescope. It is a wide field of view (5.67° × 0.91°) camera with a f/7.4, 35 mm entrance pupil diameter (EPD). Its science mission is observation of the gravity wave in altitude 70–110 km. Six narrowband channels, 2 UV and 4 IR, observe noctilucent clouds and O_2 atmospheric band in the wavelength range of 270–772 nm. In this presentation, we will show the experimental data of optical calibration and performance measurement. Tolerance analysis, throughput measurement, and relative pointing are considered during the limb camera calibration process. Optical performances are evaluated in terms of the point source, the USAF target, MTF, and distortion measurements.

제2발표장 Burano I

I-2 Special Session Space Situational Awareness (I)
좌장: EunJung Choi (KASI)

13:50 [I-2-1]
Orbit Prediction Simulation for Future Military Space Surveillance System

Simon Kim[1,2], Hyung-Chul Lim[1], Mansoo Choi[1], Eunseo Park[1], Jin Choi[1], Sung-Yeol Yu[1], Ki-Pyung Sung[1]

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

First military optical space surveillance system in Korea will be launched in the end of this year. And then, the laser system will be followed in the next few years. Most essential function of those systems is to achieve good orbit prediction (OP) against space objects. The commercial orbit estimation program which is called orbit determination tool kit (ODTK) provides simulator tool that those future systems can process orbit prediction. In this paper, pseudo measurement data will be generated under practical environment. And various scenarios will be set by the type of data (optical, laser range and mixed data) and the location of laser system. The results show the possible OP accuracy depending on those various scenarios. And they will be good reference to establish the future military space surveillance system.

14:00 [I-2-2]
Software Design of Satellite Laser Ranging Station at Geochang Observatory

Ki-Pyoung Sung, Hyung-Chul Lim, Man-soo Choi

Korea Astronomy and Space Science Institute

Korea Astronomy and Space Science Institute (KASI) has been developed in a multipurpose Laser Ranging systems with EOS (Electro Optic Systems) at Geochang. The software has developed in able to operate local and remote, the developed software has been installed on five computers to reduce communication traffic and reuse modules. for communication between computers, it used IP and Port number. The software consists of client programs to communicate with the operator and server with core modules and utility. The server consists of many modules that machine manager, dispatcher, SLR application, Observatory Server, Ranging Server are core module to observe the satellite. This study introduces the software design of Geochang observatory.

14:10 [I-2-3]
Analysis of Kinetic Impactor Strategy Involving Swing-by Trajectories for Asteroid Deflection

Pureum Kim, Sang-Young Park

Dept. of Astronomy, Yonsei University, Seoul, Korea

Most of the proposed asteroid deflection techniques rely on inducing a very small velocity change of the incoming near-Earth object. The slight velocity change will cause its heliocentric orbit to be adjusted, ultimately lowering the probability of hitting Earth. Kinetic deflection by impacting a massive spacecraft on the target asteroid is one of the methods by which such a velocity change can be achieved, and is often considered the safest way. The effectiveness of the kinetic impactor strategy can be enhanced by making the velocity change bigger and earlier. Introducing a swing-by to the kinetic impactor trajectories can be considered for that enhancement. In this presentation, under the assumption that an impact event of Apophis on 2029 is highly likely, the strategy of kinetic impactor with trajectories containing a swing-by is analyzed.

14:20 [I-2-4]
Determination of Spin Axis about Defunct GLONASS Using Photometer

Jee-Ho Lee[1,2], Eun-Seo Park[2], Man-Soo Choi[2], Daniel Kucharski[3], Yu Yi[1]

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

The korea astronomy and space science institute (KASI) had studied about mechanical dynamics with defunct GLONASS satellites. It was developed from 1976 in Russia. The Space Environment Research Centre (SERC) detected photon quantity of 5 satellites using high-rate light curve detector from 2017 to 2018. We knew their spin rates by interval of peaks of

photon quantity that means large cross section of satellite received the sun light at that moment. Analyse position of the satellites from two line elements to know azimuth and elevation and transform the position in coordinate from Earth centered inertial to satellite body centered. We got the spin axis of satellites from trend lines of RA and Dec. It can be used to determinate attitude of satellites and make ephemeris precisely for space surveillance awareness.

14:30 [I-2-5]

A Study on Satellite Image Acquisition Method Using Adaptive Optics

Nayeon Kim[1,2], Mansoo Choi[1], Sungyeol Yu[1], Seonghwan Choi[1], Yu Yi[2]

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

The main purpose of this paper is to improve satellite images acquired using adaptive optics of Geochang satellite laser ranging station. Adaptive optics means improving optical device performance by correction optical distortion caused by atmospheric turbulence effects. Although there are many image preprocessing elements to improve optical distortion, this paper discusses adaptive optics image preprocessing using frame selection rate and image registration technique. In addition, the pre-processed images are collected and post-processed to further improve the image quality of the satellite to obtain the final image. Through this study, it is expected that the attitude and shape of satellites will be more accurate, which will contribute to the study of satellite dynamics and the calculation of precise orbit.

14:40 [I-2-6]

Analysis of Optical Tracking Measurement Accuracy for GEO Satellite Using OWL-Net

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

Korea Astronomy and Space Science Institute

The Optical Wide-field patroL-Network (OWL-Net) mainly aim to track domestic low-Earth Orbit (LEO) satellites and to monitor Geostationary Earth Orbit (GEO) region. In this research, we had campaign observation to analyze the accuracy of astrometric measurement for GEO satellite using the OWL-Net. The campaign was held for three months from Feb. 2019 to Apr. 2019. For domestic GEO region monitoring analysis, three sites in Mongol and South Korea was selected. The observation target was QZS-3 satellite due to the providing Precise Orbit Ephemeris (POE) using GPS sensor in the satellite. The astrometric measurement was compared with the simulated measurement using the POE. Also, the estimated orbit was compared with the POE. The In-track direction error was dominant and cross-track and radial error were presented in sub-arc second level for both analysis. In the case of the In-track error uncertainty was not exceed five arc seconds.

14:50 [I-2-7]

Analysis of the Optical Tracking Possibility of GTO Object for the Orbit Determination Using the OWL-Net

Jae-Young Kim[1], Chun-Hwey Kim[2], Sungki Cho[3]

[1]*Department of Astronomy and Space, Graduate School, Chungbuk National University*
[2]*Department of Astronomy and Space at Chungbuk National University*
[3]*Space Hazards Program Office and Space Surveillance Awareness Center, Korea Astronomy and Space Science Institute*

Rocket bodies on GTO have constant influence on orbit by apsidal motion and axis rotation. The Apsidal motion is influenced by the gravitational perturbation, the Earth's gravitational potential, and the non-gravitational perturbation, Earth's atmospheric drag and solar radiation pressure. And Axis rotation is influenced by the non-principal axis of inertia of the Rocket Body. This effect is due to the constant rotation of the values of the RAAN(Right Ascension of the ascending node, Ω) and the Argument of period (ω) by deg/day. Therefore, the current five OWL-Net sites in the Northern Hemisphere are limited in observation opportunities, which is why the Southern Hemisphere also needs observation stations. Among CZ-3B Rocket Body, NORAD ID 43709 rotates with −0.554 deg/day, Argument of period +0.315 deg/day for RAAN. GTO Rocket Body generally rotate about −0.1～−0.4 deg/day for RAAN, and +0.4～+0.7 deg/day for Argument of period.

In this study, we assume that the same observation stations were installed in five sites of the Northern Hemisphere OWL-Net and in the Australian Exmouth and Chile Vikuna of the Southern Hemisphere. The simulation period was from November 19, 2018 to March 3, 2019, and the increase of observation opportunities and the possibility of simultaneous observation of CZ-3B Rocket Body (NORAD ID 43709) were investigated. The orbital determination was determined by dividing the case; Case 1 was the orbital determination with only the Northern Hemisphere OWL-Net Site. Case 2 was the orbital determination including Australia Exmouth and Chile Vikuna in the southern hemisphere; and finally, the difference between the two cases was compared.

15:00 [I-2-8]

Casualty Risk Assessment of Reentry Debris

Siwoo Kim[1], Byeong-Un Jo[1], Eun-Jung Choi[2], Sungki Cho[2], Jaemyung Ahn[1]

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

Since the beginning of human space activities, the risk from reentering space debris has already been a foreseen issue. Over the last 40 years, more than 5,400 tons have survived during reentry, some of which have caused property damage, such as radioactive contamination. However, the risk of reentering space debris has not been seriously addressed in daily life because of the relatively small number of expected casualty compared to other risks. Nevertheless, preparation against the risk of reentering debris is essential, as the number of reentries is expected to increase, given the increasing number of space activities worldwide and the growing trend of satellite constellation missions. It is challenging to predict the risk of reentry because most reentering objects are uncontrolled and rely on observation only for their state information. This study presents a risk assessment technique of reentry debris which reflects the status of information available during reentry monitoring. In order to validate the methodology, a case study was conducted using past reentry.

15:10 [I-2-9]

Design and Application of KASIMM Database Model Considering Space Object Observation Characteristics

Ha-Yeon Choi[1], Jin-Su Kim[1], Su-Min Jang[1], Sang-Ho Bang[1], Eun-Jung Choi[2], Sunki Cho[2], Jung Hyun Jo[2]

[1]*SOLETOP Co., Ltd*
[2]*Korea Astronomy and Space Science Institute*

Space debris became a significant risk management element during satellite operations. Assuming that the LEO space debris is 5 cm in diameter and 10 km/s relative velocity, the energy exerted is equivalent to the impact of it hitting the bus. The possibility of a collision risk compounds when operating satellite and space objects are at a close proximity. In order to systematically manage such space debris, Korea Astronomy and Space Institute (KASI) and SOLETOP Co., Ltd. jointly developed the IMS (Integrated Management System), an integrated space risk information management system. IMS is a system that allows users to search for space debris and utilize image and data statistics to identify space hazards and perform integrated analysis. Since the data is provided through multiple paths, systematic management is required to utilize the data more efficiently. Therefore, KASIMM (Korea Astronomy & Space Institute Metadata Model, KASI's unique space risk integrated information management database) was applied to IMS. It also integrates data from each infrastructure such as OWL-Net optical observation data, radar observation data from other institutions, and CSpOC TLE data. This paper describes the design process and application examples of the KASIMM database model. KASIMM was designed by applying KASI's DB system optimized for scientific data to reflect the characteristics of space debris data. In addition, standardization was implemented based on ISO 19115 to use the data and metadata generated by the major organizations that provide various types of data. This resulted users with a power to access complex information easily by utilizing the DB system.

제3발표장 Burano III

I-3 Special Session AI/Deep Learning
좌장: KyoungWook MIin (KAIST)

13:50 [I-3-1]

Application of Deep Learning to the Forecast of Major Solar Flare X-ray Flux Profiles

Kangwoo Yi, Yong-Jae Moon, Daye Lim, Gyungin Shin

School of Space Research, Kyung Hee University

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 0.33, which is much better than the autoregressive method. Second, RMSE of peak flux prediction with LSTM model is 0.24. This model would be very useful for real-time forecasting of solar flares in

space weather agencies.

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).

14:05 [I-3-2]

East Asian foF2 Map Forecasting Using Deep Learning

Sujin Lee[1], Yong-Jae Moon[1,2], Eunsu Park[2], Seonggyeong Jeon[2], Kimoon Kim[2]

[1]*Department of Astronomy and Space Science, Kyung Hee University*
[2]*School of Space Research, Kyung Hee University*

High Frequency (HF) communication is one of the important radio communications using the reflections of the ionosphere to transmit radio waves upto thousands of kilometers distance. These frequencies are used in amateur (ham) radio operators, industries (mostly airlines) and government agencies. foF2 is the maximum usable frequency (MUF) that can be communicated through the F2 layer of the ionosphere. Its global real-time data are provided by various agencies through data from Ionozonde installed around the world, using the map of foF2 of the Australian Meteorological Administration. We generate East-Asian foF2 maps in 1 and 24 hours advance from Global foF2 images using deep learning based on conditional generative adversarial network (cGAN). The training data are from March to April in 2019 and the test data in May 2019. The AI-generated images are consistent with real ones with a high correlation coefficients (CC): 0.93 for the 1 hour forecast model and 0.89 for the 24 hour model. We think we can make a better model if we add more data that includes solar cycles and seasonal variations.

14:20 [I-3-3]

Generation of Global TEC Maps Using Pair of IRI and IGS TEC Images by Deep Learning

Eun-Young Ji[1], Yong-Jae Moon[1,2], Eunsu Park[2]

[1]*Department of Astronomy and Space Science, Kyung Hee University*
[2]*School of Space Research, Kyung Hee University*

The International GNSS Service (IGS) have been providing global ionospheric maps (GIM). The IGS final vertical total electron content (TEC) map product is released with a time delay of approximately two weeks. If global TEC maps are provided in real time, it would be very valuable for space weather monitoring. In this study, we make a global TEC generation model using a deep learning method based on conditional generative adversarial networks (cGANs). For this we consider pairs of IRI-2016 TEC map and IGS final TEC map images from 2008 to 2015 for training the model. We evaluate the model by comparing IGS final TEC maps and cGAN-generated TEC ones from 2016 to 2017. The global TEC map that our model generated is quite consistent with the IGS TEC map. Especially, ionospheric peak structures in both maps are successfully generated, while they are not in IRI-maps. Our study shows a sufficient possibility to generate global TEC maps in near real time if IRI models are generated in time.

14:35 [I-3-4]

Global Solar Magnetic Field Extrapolation Using AI-synchronic Data

Hyunjin Jeong[1], Yong-Jae Moon[1], Eunsu Park[1], Harim Lee[1], Taeyoung Kim[1,2]

[1]*School of Space Research, Kyung Hee University*
[2]*Department of Research and Development, InSpace Co.*

Global solar magnetic field extrapolations are primary input data for heliospheric models and space weather forecasts. However, the models have been calculated from synoptic photospheric magnetic field data in which farside magnetograms were taken more than ten days ago. We have made the global map using frontside and AI-generated farside magnetograms by a deep-learning model based on Conditional Generative Adversarial Network (cGAN). The farside magnetograms are generated from STEREO/EUVI 304 Å images and assimilated into daily synchronic frames whose farside is conventional synoptic data. And the map is calculated by the Potential Field Source Surface (PFSS) model. Our results are more consistent with observations (e.g., strength of active regions (AR), coronal hole boundaries and coronal field structures) than those of the conventional methods. And the results show continuous sequences of AR evolutions from farside to frontside of the Sun. We discuss the application of the new method and future works. 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).

14:50 [I-3-5]

Generation of COMS Visible Images from COMS IR Images by Deep Learning

Kimoon Kim[1], Ji-Hye Kim[3], Yong-Jae Moon[1], Eunsu Park[1], Gyungin Shin[1], Taeyoung Kim[1,2], Yerin Kim[3], Sungwook Hong[3]

[1]*School of Space Research, Kyung Hee University*
[2]*Department of Research and Development, Inspace*

[3]*Department of Environment, Energy, and Geoinformatics, Sejong University*

The Communication, Ocean, and Meteorological Satellite (COMS), the Korea's first geostationary multi-purpose satellite, has been providing the beneficial meteorological information with five spectral bands from visible (VIS) to infrared (IR) wavelengths. The COMS image at VIS band is only available during the day irrespective of its various applications. We consider an conditional Generative Adversarial Networks (cGAN)-based image-to-image translation method to generate COMS VIS images during the night. COMS IR and VIS images dataset from 2012 to 2017 were used for training our model. For evaluation of our model, another dataset of the COMS IR and VIS images during one year of 2018 were used. As a result, our model shows the successful AI-generated VIS images from IR images with a very strong positive correlation coefficient (r = 0.90) between real VIS images and AI-generated ones using 361 test sample images in the day. Consequently, our model produced the AI-generated VIS images using IR images during the night with no real VIS images. Our model is expected to be used in a variety of research fields.

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).

15:05 [I-3-6]

Super Resolution in Satellite Image with Deep Learning

YeonJu Choi

Korea Aerospace Research Institute

Super resolution is a technique used to reconstruct high-frequency information by using a deep learning, and it has recently been actively developed in the remote sensing fields. In this work, we propose a modified-GAN architecture with deep layers to super-resolve satellite images with a factor 4. The training data used in this study were obtained from the “WorldView-3” satellite-image dataset, and the testing data were obtained from the “WorldView-3 and KOMPSAT2” datasets.

15:30~16:30 1부 포스터 발표

10월 24일(목) 제1발표장 Festa

II-1 Sun & Space Environment (II)

좌장: CheongRim Choi (CBNU)

09:30 [II-1-1]

Statistical Analysis of Ion Heating at the Quasi-Perpendicular Bow Shock

Hee-Eun Kim[1], Ensang Lee[1], George K. Parks[2]

[1]*School of Space Research, Kyung Hee University, Korea*

[2]*Space Sciences Laboratory, University of California, Berkeley, CA, USA*

We have previously reported that the phase space distribution functions of the ions in the downstream region of Earth's quasi-perpendicular bow shock consist of cold core and hot components. The cold core component which is similar to the upstream solar wind ions is only slightly heated after the shock crossing. The hot component which comes from gyrating ions at the shock ramp has Maxwellian or Kappa distributions. In this study, we investigate statistical properties of the variations of temperature and density of the core and hot components according to the upstream solar wind conditions. The results show that the temperature of the cold core tends to increase with respect to the upstream solar wind speed while the temperature of the hot component has less correlation with the solar wind speed. Density ratio of the hot to the cold core components tends to increase in response to plasma beta and Mach number.

09:45 [II-1-2]

Investigation of Energy-dispersed Narrow Band Structures of H^+, He^+ and O^+ in the Plasmaspheric Region

Junhyun Lee, Ensang Lee, Khan-hyuk Kim

School of Space Research, Kyung Hee University

In this study, we report a new type of ion spectral structure, narrow-band structure, in the plasmaspheric region, using the measurements from the Helium Oxygen Proton Electron (HOPE) instrument onboard the Van Allen Probes (VAP) satellites. The narrow band structure is identified in the 0.1–20 keV with the gradual decrease of energy of the peak flux as the satellite moves outward from Earth. In the orbits earlier than observing the band structure, the nose-like structures are observed with much broader energy range, to deep inside the plasmasphere, and energy variation of the peak flux of the band structure is similar to the lowest energy variation in the nose-like structure. In case of the band

structure of heavy ions, they are formed closer to the Earth than the proton, which also occurs for the nose-like structures. However, different from the nose-like structure, the band structure is only observed on the outbound pass, which is the lower magnetic local time region than the inbound pass. In the statistical investigation for the spatial distribution of the band structure, the band structure occurs more frequently around the dusk sector inside L = 4. In addition, during the disturbed period, the occurrence rate of the band structure increases, similar to the nose-like structure. From these results, we suggest that the ion loss, which depends on different energies and locations, produces the band structure from the nose-like structure.

10:00 [II-1-3]

Statistical Analysis of Pc1 Fluctuations Observed by BOH Magnetometer

Jiwoo Kim[1], Junga Hwang[2,3], Hyangpyo Kim[4], Yu Yi[1]

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The Pc1 waves are observed inside the Earth's magnetosphere not rarely. And their characteristics are important to interpret the wave-particle interactions in the magnetosphere. Therefore, their wave properties change dynamically when they propagate from the source region to the ground. Detailed study of the wave features can contribute to investigate their evolution mechanisms depending on time and space. In this study, we statistically analyzed of the Pc1 waves observed by the BOH magneto- impedance (MI) sensor located at Republic of Korea (L = 1.3), for about one solar cycle (from Nov 2009 to Aug 2018). We analyzed the occurrence ratio by seasonal, temporal, and annual variation with the solar cycle, and also the wave properties such as a duration, a peak frequency and a bandwidth. In addition, we investigate the relationship of the Pc1 pulsations with geomagnetic activity, using Kp and Dst index at the time of the event. We found that the Pc1 waves frequently occurred at March, dawn (01–03 MLT) sector, and the declining phase of solar cycle. Also, they mostly continue for 2–5 minutes with the peak intensity of ~0.9 Hz. Most of the waves occurred during the relatively geomagnetically quiet days and the early recovery phase of the geomagnetic storm.

10:15 [II-1-4]

Dependency of Plasma Emission on Plasma-to-Cyclotron Frequency Ratio: PIC Simulation

Sang-Yun Lee[1], Peter H. Yoon[2,3,4], Ensang Lee[3]

[1]*The Satellite Technology Research Center, KAIST*
[2]*The University of Maryland, College Park, USA*
[3]*Kyung Hee University*
[4]*Korea Astronomy and Space Science Institute*

The study on the plasma emission is conducted through the Particle-In-Cell (PIC) and weak turbulence simulation methods. The solar flares generate electron beam in the solar wind and it excites the electron beam instability as well as the Langmuir decay instability, which is the mechanism for solar type II and type III radio burst phenomena. First, we compared the results of the complete set of equations of WT theory and the 2-dimensional PIC simulation for the unmagnetized plasma for the first time. It is found that the weak turbulence theory is largely valid, although some discrepancies are also found. Then we also analyzed the plasma emission in the magnetized plasmas. The previous study on the plasma emissions are researched in the unmagnetized plasma. However, the magnetic field near the sun is strong enough that the plasma to cyclotron frequency ratio (wpe/wce) ranges up to ~3 according to Parker model. Therefore, we also conducted a simulation study on the plasma emissions in the magnetized plasma. The wave properties of the Langmuir waves and plasma emissions in strongly magnetized plasmas are different from those in unmagnetized plasmas. The waves in the strongly magnetized plasmas are limited to short perpendicular wavenumber.

10:30 [II-1-5]

Anomalous Diffusion of Proton by Broadband Kinetic Alfven Wave

Cheong R. Choi[1], M. -H. Woo[2] Peter H. Yoon[3,4,5] D. -Y. Lee[1], K. S. Park[1]

[1]*Department of Astronomy and Space Science, Chungbuk National University,*
[2]*National Fusion Research Institute,*
[3]*Institute for Physical Science and Technology, University of Maryland,*
[4]*Korea Astronomy and Space Science Institute,*
[5]*School of Space Research, Kyung Hee University,*

In this study, we calculated diffusion coefficient along and across the magnetic field by employing an analytical particle orbit computation based upon a perturbative Hamiltonian dynamical method. The anomalous diffusion of proton by the broadband kinetic Alfven wave, which propagates obliquely with the constant background magnetic field, is found. In this approach, the diffusion coefficients for resonant and non-

resonant particles can be calculated by analytic method. It has been found that diffusion coefficient of resonant particles in parallel direction is linearly increasing with time while diffusion of nonresonant particles decrease inverse proportional to time. But in perpendicular direction, diffusion coefficient of both resonant and nonresonant particles decrease inverse proportional to time.

10:45 [II-1-6]

Wave Excitations Relevant to Thermodynamic Evolution of Solar Wind Proton and Kinetic Instability for Parker Solar Probe's Perihelion Encounters

Jungjoon Seough

Korea Astronomy and Space Science Institute, Korea

Understanding the physical processes of how the solar wind evolve in the interplanetary medium is an outstanding issue in heliospheric-physics community. Since the speed of the super-Alfvenic solar wind practically reaches a maximum constant value beyond a few tens of solar radii, in particular, the temperature of the solar wind plasma and its anisotropy are essential physical quantities to understand the thermodynamic evolution of the expanding solar wind. In the present study, we develop an expanding box model based on the velocity moment-based quasilinear kinetic analysis that incorporates the local kinetic physics, such as the turbulent heating based upon the phenomenology description and microinstabilities calculated by a self-consistently manner, into the large-scale expansion. We describe how the solar wind proton temperature anisotropy evolves in interplanetary space and discuss the wave excitation processes relevant to its evolution and kinetic plasma instabilities. The theoretical results may predict the presence of ion cyclotron waves near the location where Parker Solar Probe has explored, particularly, the first three perihelion encounters.

제2발표장 Burano I

II-2 Special Session Space Situational Awareness (II)
좌장: JangHyun Park (KASI)

09:30 [II-2-1]

Report on Recent Activities of OWL-Net

Hong-Suh Yim, Jang-Hyun Park, Jung Hyun Jo, Jin Choi, Dong-Goo Roh, Myung-Jin Kim, Sooyoung Kim, Sungki Cho, Eun-Jung Choi, Young-Sik Park, Hong-Kyu Moon, Young-Jun Choi, Jae-Mann Kyeong, Jiwoong Yu, Seong-Cheol Bang, Wonyong Han

Korea Astronomy and Space Science Institute

OWL-Net (Optical Wide-field Patrol Network) is a network of five optical telescopes at five countries by KASI (Korea Astronomy and Space Science Institute) for space situational awareness. OWL-Net, which finished its installation in 2016, started its official work in 2019 after a two-year test phase (2017-2018). For about three years, including the test period, we have improved some hardware and software to increase the stability of OWL observatories. To inspect and improve the performance of OWL-Net, we observed various types of objects for space surveillance. Also, we have exchanged space monitoring information with relevant organizations in Korea and abroad. Through these efforts, OWL-Net is now able to play a role as a 24 × 7 NSSAO (National Space Situational Awareness Organization) infrastructure, and hope to work to do more.

09:45 [II-2-2]

Global Trend of SSA and SSA Activities in Korea

Jung Hyun Jo, Sungki Cho, Hong-Suh Yim, Jang-Hyun Park, Mansoo Choi, Jeong Yoo Hong

Korea Astronomy and Space Science Institute

After the space policy directive 3 of the United States was released, military and civil activities on space situational awareness (SSA) had been dramatically focused. We have seen many stalled attempts to accomplish a framework on global level. However, the United States, European Community, and other space powers started feasible framework on SSA with eye-opening speed. Korea has early adopted a Basic plan to mitigate such environment though it has never been enough now. In this presentation, authors review very recent changes in SSA environment and our remedy to participate this wave of change.

10:00 [II-2-3]

Legal Response to a Space Object Collision Disaster in Korea

Jeongyoo Hong[1], Sungki Cho[1], Syeun Kim[1,2], Jung Hyun Jo[1]

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

There are two kinds of space disasters in Korea Law. One is collision of artificial space object and the other is nature space object.
Artificial space objects are managed by the Space Development

Promotion Act. Natural space objects are managed by the Basic Law on Safety Management. Risk management activities at each stage of risk management include prevention, preparation, response and recovery. In risk management activities, the preparation stage is divided into the interest level and the attention level, and the response stage is classified into the alert level and the severity level.

10:15 [II-2-4]

Analysis of Detectability of Space Surveillance Radar Test-bed for Beam Steering

Jiwoong Yu, Sungki Cho, Jin Choi, Eun-Jung Choi, Jung Hyun Jo

Korea Astronomy and Space Science Institute

KASI will develop a test-bed of the space surveillance radar in a phased array radar. Space Surveillance Radar Test-bed is a test radar for the development of detection technology and analysis of orbit determination of space objects. Because the phased array radar is capable of electronic beam steering and versatile operation, the space surveillance radar will be developed as a two-dimensional phased array radar. In this paper, the development concept and schedule of the space surveillance radar will be explained, and the performance of access and detection of space objects according to the beam operation of the space surveillance radar will be explained. The access is the cumulative number of space objects passing through the beam steerable range. This leads to the required number of simultaneous tracking or beam operations. Detection performance can be improved through pulse integration, and detection performance can vary with respect to transmit power and the number of transceivers. Analyze access statistics and detection performance to derive radar performance and operational methods.

10:30 [II-2-5]

Analysis of Tracking and Orbit Estimation Results of First Korean Satellite, KITSAT-1 with the Radar Observation

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

Korea Astronomy and Space Science Institute

In Sep. 2019, 16 space objects are registered in space catalog as launched by South Korea in low-Earth Orbit (LEO). Among those space objects, Korean Institute of Technology Satellite (KITSAT-1) is first satellite developed by SaTRec and University of Surrey. KITSAT-1 is orbiting the Earth orbit as space debris with 1,300 km height after the planned mission. Due to the relatively small size and height, the tracking of KITSAT-1 was discounted as a very difficult task. In this research, we analyzed the tracking results of KITSAT-1 for a year using the radar facilities of Leolabs Inc. The radar measurement from two sites in the United States were used to analyze. The tracking results was analyzed weekly based with the number of observation points for both sites. And the orbit estimation results using the weekly radar observation were compared with Two Line Elements (TLE) data from Combined Space Operation Center (CSpOC). The optical tracking example of KITSAT-1 was also analyzed in test phase of the OWL-Net.

10:45 [II-2-6]

Precision Orbit Determination System Using Radar and Optical Tracking Data for Space Situational Awareness

Eun-Jung Choi[1], Sungki Cho[1], Jae-Cheol Yoon[2]

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

Space Situational Awareness (SSA) requires the ability to detect a new space object, to continuously maintain the latest orbit element, and to observe the space objects periodically and track them exactly. In particular, the precise orbit determination, which is to accurately determine the ephemeris of an space object from the observed data, is required for the most important factor in evaluating the performance of the SSA system. With that goal in mind, in this research, the new precision orbit determination system using data obtained from radar and optical tracking system was developed to improve the capability for national SSA system. According to the characteristics of radar and optical sensors, this system supports the pre-processing of the data observed by each sensor and configures the observation modeling. Early orbit determination using radar and optical data, calibration for system bias, observation modeling for each sensor, and precision orbit dynamics for multiple satellites are included in this system.
This total solution for precision orbit determination using radar and optical tracking data can be used for almost the whole ground observation network for space object tracking.

제3발표장 Burano III

II-3 Space Technology (I)

좌장: SangIl Ahn (KARI)

09:30 [II-3-1]

Development of Thrust Modulation Algorithm for Formation Flying of the Four Nano-satellites of SNIPE Mission

Sangwon Lee, Sang-Young Park, Youngbum Song

Astrodynamics and Control lab, Department of Astronomy, Yonsei University, Seoul, Korea

The SNIPE mission is to observe spatial and temporal differences of the physical phenomena in the ionosphere of the Earth. To do that, the SNIPE mission utilizes formation flying of four nano-satellites. Each nano-satellite should control its orbit for formation maintenance and reconfiguration by using a thruster assembly. The thruster assembly consist of four nozzles. Because of the thrust error of each nozzle, the attitude of nanosat can be disturbed when firing thrust. Consequently the thrust direction error may be increased finally. Furthermore, due to the performance limitations, the reaction wheels can not control the attitude error while the thrusters are in operation. In this study, the thrust modulation algorithm is developed to maintain the thrust direction while the thrusters working. The thrust modulation algorithm of the SNIPE nanosat uses on/off control of each nozzle to generate torque reducing the attitude error and angular velocity due to the thrust error of each nozzle. Using this algorithm, SNIPE nanosats can generate the thrust within $1°(1\sigma)$ error in the desired direction.

09:45 [II-3-2]
Orbit Control Simulation of the Along-track Formation for SNIPE Mission

Youngbum Song, Sang-Young Park

Department of Astronomy, Yonsei University, Seoul, Korea

The SNIPE mission consists of four 6U size nanosats to perform research on the near-Earth space environment. Nanosats have to keep formation flying to observe the temporal and the spatial difference of physical phenomena. These scientific objectives derive two formation; along-track formation for the temporal observation and cross-track formation for the spatial observation. Four orbit control strategies are introduced to operate two formations. This presentation will show the simulation of the along-track formation to investigate the temporal physical difference. The study considers the operational constraints, the thrust constraints, and the orbital knowledge constraints to reflect anticipated on-orbit conditions. The algorithm calculating thrust direction and control duration is developed and verified so that the nanosats can keep the required relative distance utilizing J2 orbital perturbation and the multiple finite thrusting.

10:00 [II-3-3]
Study of Micro-Satellite Constellation Design and Station Keeping

Young-Min Hwang, Sang-Young Park

Astrodynamics and Control Lab, Department of Astronomy, Yonsei University, Seoul, Korea

In recent years, mission demand for various purposes using micro-satellites is increasing. Overseas, the 100 kg satellite has been equipped with a SAR (Synthetic Aperture Radar) payload to perform all-weather global observation, and provides image acquisition services using micro-satellites. Constellation of micro-satellites has attracted attention as a way to overcome the limitations of the revisit cycle of a large military reconnaissance satellite, and to improve the existing capability of military surveillance satellites. Development of a strategy is needed for operation of reconnaissance micro-satellites to monitor specific areas with good Figure of Merits. First, in this paper, to design the optimal satellite constellation to achieve intensive monitoring of the area around the Korean Peninsula (minimizing the Revisit, Time to cover by region), the walker-delta constellation is applied. Second, an absolute station-keeping method is developed and analyzed with various orbital error range to suggest a micro-satellite constellation maintenance strategy during a reconnaissance mission.

10:15 [II-3-4]
Policy-based Packet Design for Real-Time Data Downlink in Next Generation Mid-satellite

Jong Oh Park[1], Hyun Jin Jeon[1], Bosung Kim[2], Jin Gon Bae[2]

[1]*Korea Aerospace Research Institute*
[2]*Korea Aerospace Industries, Ltd.,*

We have proposed a paper called “Packet Optimization Design for Real-Time Data Downlink in LEO Satellite.” For empirical consideration, this paper proposed a down-link method that considers limited frequency radio, i.e., capacity, and allocates packets optimally in the capacity. Representatively, two factors were considered. First, the frequency band used in LEO satellite is S-band and thus its capacity is very restricted. Second, cycle and size of telemetry generated from unit (s) or module (s) can be different with its/their function (s) and mission(s). In addition, individual requirement (s) of the person (s) in charge of satellite subsystems should not be overlooked. Thus, in this paper, we propose a policy-based packet optimization method that can consider their requirement (s) confined to specific project, i.e., “Next Generation Mid-satellite Development” and design individual requirement (s) of the person (s) in charge of satellite

subsystems.

10:30 [II-3-5]

Implementations of BMDX Formted File Analyzer for the Abaco Systems' BusTools/1553

Seok-Bae Seo, Seonghoon Lee

Korea Aerospace Research Institute

The BusTools/1553 by the Abaco Systems is joined to monitor 1553B commands between GK2B Satellite and GEMS (Geostationary Environment Monitoring Spectrometer). This paper explains the software implementations to analyze 1553B log files using BMDX formated files. The BMDX file format was created to accommodate the new API_BM_MBUF structure as it was defined in the BusToos/1553-API v8.0 and later.

10:45 [II-3-6]

Tracking Performance Test with Kompsat Series Using 2.4 m X/Y-Type Antenna

Sangil Ahn, Han Oh, Dong-Hyo Lee

Korea Aerospace Research Institute

The 2.4 m X/Y-Type S-Band antenna was tested with operational kompsat series after validating G/T value with sun. Operational Kompsat-3, Kompsat-3A, and Kompsat-5 S-band telemetry downlink signals were received for both polarizations with S-Band antenna under test through programmable tracking scheme using TLE. Received RF signals were filtered, amplified, frequency down-converted, demodulated, bit-synchronized, frame-synced, de-randomized, RS decoded and finally converted into telemetry packet frame structure known as CCSDS CADUs. The CADU intergrity, frame continuity, and bit sync status, frame status and Eb/No values were monitored and recorded during real-time passses. Through repeated telemetry pass tests, the kompsat-3A and kompsat-3 telemetry were successfully recovered using dual-polarization for above 5-deg EL and Kompsat-5 telemetry showed good quality which is better than Eb/No value of 6dB for 5-deg EL in nadir polarization, RHCP. In this paper, we will show overall test scenario, test measurement, and conclusions.

제4발표장 Burano II

II-4 Moon/Planets/Solar System Exploration

좌장: Ho Jin (KHU)

09:30 [II-4-1]

Orbit Determination and Prediction Analysis on the Elliptical Mission Orbit of the Lunar Orbiter

Young-Rok Kim, Young-Joo Song, Jae-ik Park

Korea Aerospace Research Institute

Numerous lunar orbiter missions have employed the circular orbit in the mission phase around the Moon. The circular orbit has the advantage of providing the same altitude at any point of the orbit; therefore, payloads can plan and perform stable mission operation such as imaging, measuring, and monitoring. However, the elliptical orbit around the Moon can also be selected to the orbiter mission due to the restriction of mission characteristics such as insufficient fuel. Although spacecraft on circular orbit has better orbital error characteristics than those on an elliptical orbit, station-keeping maneuvers to maintain the altitude may be omitted on the elliptical mission orbit. In this study, we investigated the orbit determination (OD) and orbit prediction (OP) accuracies on an elliptical orbit around the Moon. For the true orbit generation, AGI's STK/Astrogator was used. The ODTK was utilized for measurements generation, OD, and OP. For the orbit quality evaluation, position and velocity uncertainties and differences between true and estimated orbits were examined. Then, we compared the OD and OP results of elliptical mission orbit with those of circular mission orbit. These results suggest a useful guideline for lunar orbiter mission which has elliptical mission orbit.

09:45 [II-4-2]

Development and Preflight Ground Test Plan of LUTI Image Level Process for KPLO

Jo Ryeong Yim, GmSil Kang, GwangSoo Shin, Dong-Gyu Kim

Korea Aerospace Research Institute

LUTI (LUnar Terrain Imager) is one of the main payloads of KPLO (Korea Pathfinder Lunar Orbiter) and LUTI Image Calibration and Analysis Subsystem (ICAS) has been developed by KPLO Program Office with other closely related ground systems such as MPS (Mission Planning Subsystem) including ancillary data generation, SDMS (Science Data Management Subsystem), and so on. In the previous research, we introduced the preliminary design concept and main data interfaces for ICAS, which mainly deals with the LUTI level process based on the LRO NAC (narrow angle camera) image processing tool using ISIS3 developed by USGS. The verification tests in ground are very essential tasks for the development of image level process software in order to check ICAS requirement's compliances status. In this paper we present the concept of ground verification (preflight

verification) for LUTI level process in accordance with the radiometric and geometric correction steps. For the radiometric image level processing, the LUTI Payload Development Team carefully performed radiometric calibration tests with a LUTI Qualification Model (QM) in an elaborately planned test configuration, and analyzed the radiometric calibration algorithms using the test data. They finally obtained calibration algorithms and parameters for LUTI which are slightly different forms from LRO's and provided them to ICAS to be implemented as intial development and in ground input calibration parameters. The partial results for radiometric correction level process (LP) will be presented in detail. Also, the study of verification concept for geometrical calibration process in ground has been investigated and the preliminary concept will be discussed.

10:00 [II-4-3]

Maneuver Planning Module In-house Code Performance Test Results for Korea Pathfinder Lunar Orbiter Flight Dynamics Subsystem

Young-Joo Song[1], Young-Rok Kim[1], Jonghee Bae[1], JungChul Seok[2], Unseob Lee[2]

[1]*Korea Aerospace Research Institute*
[2]*Satrec Initiative*

Korea Aerospace Research Institute (KARI) have been devoted numerous efforts for the successful flight operation of Korea Pathfinder Lunar Orbiter (KPLO) mission. One of the major effort is to secure core technologies on Flight Dynamics Subsystem (FDS) development as well as to learn operational knowledges to prepare Korea's future planetary exploration. As a part of this, In-house code have been developed which is able to plan diverse maneuvers used during the lunar flight, and associated test results are presented. Performance of In-house code is tested by comparing results obtained from real-flight performance proven software, System Tool Kit (STK) Astrogator. Using finite burn model as a basis, three different burn attitude options (update during burn, center burn and inertially fixed) were tested. As a result, maneuver planning results from In-house code found to be well matched to STK Astrogator's results, only having very small differences in both burn vector direction and duration. Especially, obtained maneuver duration as well as burn start and stop times were found to be matched within less than the order of several millisecond for every three different burn attitude options.

10:15 [II-4-4]

Feasibility Study about the Small Bodies Exploration near the Earth with Interplanetary Cubesats Using NURI (KSLV-II) Launch Vehicle

Bangyeop Kim

Korea Aerospace Research Institute

A feasibility study about the exploration plan to the small bodies near Earth with cubesats have been performed which launched by NURI (KSLV-II) launch vehicle. The NURI launch vehicle is planed to have two times of test launch at the year 2021. If the designed launch capability were confirmed, it could be estimated that a low weight space probe around 20～40 kg could earned the escape velocity from the Earth`s sphere of gravity influence. Recently, a large number of R&D programs are ongoing which about the interplanetary cubesats or cubecraft development in the U.S. and the European national space agencies as well as academical institutes, including the space industries. Considering the current accumulated technical experience in the nation and the assist of the up-to-date cubesat technology of the startup satellite industries, it could be concluded that the possibility is quite feasible to send cubecrafts to the near Earth asteroids and the Mars which launched by the level of the capability of the NURI launch vehicle.

10:30 [II-4-5]

Preliminary Design Study of Two-axis Mount System for All Sky Tracking without Discontinuity

Jeong-hyun Kim[1,2], Il-hoon Kim[2], Suna Kang[2], Du-yeon Ka[2], Jeong Ae Lee[2], Se-il Park[3], Ho Jin[1]

[1]*School of Space Research, Kyung Hee University*
[2]*SLLAB, Inc.*
[3]*LEEHYOUN IP LAW FIRM*

In case of the tracking mount of celestial bodies and flying objects, there are several types of mounts by the number of rotation axes and their direction. Most popular mount of tracking systems are consist of simple two-axis assembly type such as Equatorial and Alt-Azimuth mount. But these mounts have a major disadvantage which has inability to follow observation targets in the sky as the Earth spin or Zenith on its axis. But we found that two-axis mount is also able to overcome the disadvantage to change the angle of rotation axis. In this study, we present an improved mount design to overcome the observational limitation area and the structural blind spot which are disadvantages of the classical two-axis mount. We expect that this design will be a very efficient role of the tracking observation.

10:45 [II-4-6]

Properties of Active Contact binaries

Min-Ji Jeong, Chun-Hwey Kim

Chungbuk National University

In this study, we examine the properties of active contact binary systems. Physical parameters for 10 kepler contact binaries, showing quasi-periodic and anti-correlated variations in an eclipsing timing variation diagram and a light curve, were determined by the light curve modeling. Those were compared to the parameters of stable systems derived from results of Zola et al. (2017), and of other unstable systems where the quasi-periodic variation of the eclipsing timing is not showing but the light curve is varying. This result of our study shows that the active contact binary systems have different properties to stable systems in their parameters.

제1발표장 Festa

Invited Talk II

좌장: HongKyu Moon (KASI)

11:10 [IS-II]
A Review of Centurial Asteroid Research: From ~100 km-sized Asteroid to mm-sized Dust

Masateru Ishiguro

Seoul National University

In the current solar system, small bodies including asteroids are the most direct leftovers since the formation epoch. These bodies contain primordial records of the planetary formation, evolutional histories via numerous collisions and dynamical/thermal events. We planetary astronomers have conducted research of asteroids by means of telescopic observations from Earth orbit and deep space explorations to asteroids for a better understanding of solar system formation and evolution, and ultimately, the origin of life on Earth. Back to two centuries ago, the first asteroid was discovered in 1801 during a survey of a missing planet between Mars and Jupiter based on the prediction of the Titius-Bode law. Later, Hirayama (1918) noticed several groups of asteroids (so-called, asteroidal families) whose proper orbital elements are very similar to each other, although he was unable to figure out the formation mechanism of these asteroidal families. The discovery of IRAS dust bands in 1984 convinced researchers that the asteroidal families have been formed through collisional events, ejecting a huge amount of dust grains into interplanetary space. Nowadays, more than 100 asteroidal families are identified. In my presentation, I will introduce the history of the development of asteroid research on the basis of my interest, namely, the origins of interplanetary dust particles and space missions. In the first half, I will talk about the relationship between asteroidal families and interplanetary dust to set an initial goal of space missions. Then, I mention our efforts to realize the space missions to asteroids among Japanese community. Finally, I will introduce our recent activity among Korean planetary community toward the realization of a Korean asteroid mission.

12:50~13:50 2부 포스터 발표

제1발표장 Festa

Invited Talk III

좌장: YoungSook Lee (CNU)

13:50 [IS-III]
IRI the International Standard for the Ionosphere

Dieter Bilitza[1,2]

[1]*Department of Physics and Astronomy, George Mason University, USA.*
[2]*Space Physics Data Facility, NASA Goddard Space Flight Center, USA*

This presentation will give an overview of the International Reference Ionosphere (IRI) project and model. IRI is recognized as the official standard for the ionosphere by the International Standardization Organization (ISO), the International Union of Radio Science (URSI), the Committee on Space Research (COSPAR), and the European Cooperation for Space Standardization (ECCS). I will briefly review the history of the IRI project, its current status and report on some of the future plans for this project that is jointly sponsored by URSI and COSPAR. The presentation will introduce the latest version of the model (IRI-2016; Bilitza et al., Space Weather, 15, 418-429, doi:10.1002/2016SW0015932017) and discuss some of its successes and areas were future improvement are needed. Of special importance is a better description of IRI densities and temperatures at very low solar activities in view of the discrepancies found during the last unusually low and extended solar minimum (2007-2009) and because the current solar cycle may reach again very low solar activities. The topside electron density, in particular, has been shown to be overestimated by IRI in comparisons with C/NOFS, CHAMP, and GRACE satellite measurements. High priority is also given to the better use of solar ionosphere-effective indices or potentially the development of new ones. This is of particular urgency because of the recent revision of the sunspot number index that was the index of choice for many of the older sub-models used in IRI. We will discuss

potential solutions to this problem and short-term fixes currently applied in IRI. The extension into the plasmasphere is another area where more work and data are needed to come up with a standard model. An exciting new direction is the development of the Real-Time IRI based on an assimilation of real-time data into the IRI background model. For example, the effort of Galkin et al. (2012) using worldwide digisonde data from the Global Ionospheric Radio Observatory (GIRO) network. Other data sources of interest for assimilation into the Real-Time IRI are data from the Global Navigation Satellite Systems (GNSS). I will end with a discussion of validation and usage of the IRI model.

제1발표장 Festa

Invited Talk Ⅳ

좌장: GiHyuyk Choi (KARI)

14:20 [IS-Ⅳ]

SHEFEX Flight Test Program, Mission Overview

Dipl.-Ing. Thomas Reimer

German aerospace Center DLR, 70569 Stuttgart, Germany

Main goal of re-entry experiments is to verify technologies and simulation tools regarding hypersonic gas flow and structural response. A full scale re-entry test flight is expensive and needs in general a launch system with orbital capacity. To simplify and to reduce costs a step by step approach seems to be practicable and less risky. Thus, sounding rockets are a very attractive vehicle to perform related research. Even, they do not cover the whole performance to accelerate the entry vehicle to real re-entry conditions; they allow generating interesting flight conditions to verify aerodynamic simulation tools.

On June 22nd 2012 the second flight within the SHEFEX (Sharp Edge Flight Experiments) development program was successfully performed at Andoya Rocket Range in Norway. Despite of the loss of the hardware, 95% of the expected flight data was collected. This paper will present a short overview of the mission and the first results of the on board experiments. Most of the experiments were related to aerodynamic parameters and their structural response, but also innovative concepts for GNC and structural technology for some parts of the launch system could be demonstrated during the SHEFEX II flight. The detailed assessment and evaluation of the flight data will cover a couple of years and PhD's.

제1발표장 Festa

III-1 Special Session International Session

좌장: KwangSun Ryu (KAIST)

15:00 [III-1-1]

A Full Solar Cycle Observation of the Mesospheric Tidal Structures in the Antarctic Mesosphere and Lower Thermosphere Region: A First Report Using KingSejong Station (62.22°S, 58.78°W) Meteor Radar

S. Eswaraiah, Wonseok Lee, Junyeoung Hwang, Yong Ha Kim

Department of Astronomy, Space Science, and Geology, Chungnam National University, Daejeon, Korea.

Using a full solar cycle (January 2007 and December 2017) mesospheric wind dataset from the King Sejong Station (KSS)(62.22°S, 58.78°W) meteor radar, we investigate the seasonal, annual and inter-annual variations of the mesospheric tides (24 h,12 h, and 8 h). Our analysis reveals that ter-diurnal tides (8 h) (TDT) and semi-diurnal tides (12) (SDT) are more significant than the diurnal tides (24 h) (DT). The variability in the tidal amplitudes is larger at and above 90 km than the lower mesospheric region. Both TDT and SDT reached their maximum amplitudes during southern hemisphere (SH) spring and winter above ~90 km, whereas such features are not seen in the DT amplitudes. The zonal and meridional wind components are 90° phase-shifted, with similar amplitude in most of seasons, and this behavior is dominant in SDT above ~90 km than the other tides. Further, the phase structure manifests a dominant upward propagating mode in SH summer and downward propagating mode in SH winter above ~90 km, which is more predominant in the SDT. Most of the observed features differ from those reported in the Arctic, indicating large hemispheric asymmetry in the mesosphere tidal characteristics. We have also investigated the solar cycle effect on the mesosphere tides over the present observational region. The present 11-year KSS meteor radar observations provide new constrains and benchmark for models that seek to understand the mesospheric tidal forcing mechanisms in polar regions.

15:15 [III-1-2]

Solar Coronal Force-free Field Construction with a New Method Exactly Imposing the Boundary Conditions at the Coronal Base

Sibaek Yi[1], Hongdal Jun[1], Kyung-Suk Cho[2], G. S. Choe[1]

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Previously we developed a method for solar coronal force-free field (FFF) construction with a vector potential description based on a magnetofrictional procedure. As with other variational methods, our method was grounded on the principle of minimum energy at an equilibrium. However, the minimum energy principle can only be applied when field-line footpoints do not move. In FFF construction, one has to impose the boundary normal magnetic field and current density, or all three components of magnetic field (setting aside the overspecification problem). In either case, the footpoint positions are to be adjusted implicitly or explicitly to ensure the imposed boundary conditions. Thus, the minimum energy principle is not compatible with the boundary conditions. For this reason, the resulting force-free fields generated by all variational codes tend to deviate from the real solutions distanced away from the bottom boundary and to be dependent on the choice of the initial conditions. This tendency is more conspicuous in a highly twisted field such as the Titov-Demoulin flux rope than in a mildly wound field such as the Low & Lou field, which has long been used as a reference field in the test of FFF solvers. It is just lately that we have completed developing a totally new method to impose the bottom boundary conditions exactly and in a non-floating manner. The method employs two scalar functions to describe the magnetic field, which is unprecedented in the FFF solver history. Our new method can reproduce such highly twisted fields as Titov-Demoulin flux ropes. We have applied the new methods to AR 11974, which was investigated with our earlier code. We will report the difference in the results from our new and previous solvers as well as from other solvers publically available (or circulating). The present paper is also purposed to warn the community that all pre-extant FFF solvers more often than not bring about some misleading results.

15:30 [III-1-3]

Discovery of Highly Transient Chromospheric Recurrent Jets in a Polar Limb of a Coronal Hole Observed by the Hinode/SOT

Il-Hyun Cho[1], Yong-Jae Moon[1], Kyung-Suk Cho[2], Valery Nakariakov[1,3,4], Jin-Yi Lee[1], Yeon-Han Kim[2]

[1]*Kyung Hee University, Korea*
[2]*Korea Astronomy and Space Science Institute, Korea*
[3]*University of Warwick, UK*
[4]*Special Astrophysical Observatory, Russia*

A new type of chromospheric jets in a polar limb of a coronal hole is discovered in the Ca II filtergram of the Solar Optical Telescope on board the Hinode. For this, we identify temporal evolutions of maximum heights of 30 jets in the Ca II movie. The average lifetime is 20 ± 6 seconds ranging from 11 seconds to 36 seconds. The average speed is 132 ± 44 km/s ranging from 57 to 264 km/s. These are located at end-tails of those distributions of type II spicules. We also detect a possible counterpart of the jets in a cross-correlation map, which is clearly distinguished from type II spicules and chromospheric oscillations. Mass and energy fluxes contributed by the jets under appropriate assumptions will be presented based on statistical analysis.

15:45 [III-1-4]

Compressional Dayside Pc3-Pc4 Pulsations Propagating from the Inner Magnetosphere to the Low-latitude Ground

Khan-Hyuk Kim, Gi-Jung Kim, Hyuck-Jin Kwon

School of Space Research, Kyung Hee University,

Large amplitude upstream waves are generated in a large volume in front of the bow shock when the interplanetary magnetic field cone angle is small. Such upstream waves are a well-known source of Pc3-Pc4 waves (7–100 mHz) observed in the dayside magnetosphere. We use data acquired on 4 January 2014 by the Van Allen Probes and THEMIS probes and at the low-latitude Bohyun ground station (L = 1.3). Combined magnetic field data from the compressional component (bz) at the Van Allen Probes-A and the horizontal component (H) at the low-latitude Bohyun ground station show high coherence in the frequency band of ~10–50 mHz for seven hours. This indicates that the dayside compressional Pc3–Pc4 waves are propagating earthward. Using cross-phase spectral analysis of data from Van Allen Probes-A and Bohyun, we suggest that the compressional waves propagate at the average phase velocity of ~700–1,000 km/s along the Van Allen Probes-A and Bohyun line. The magnetic field data acquired by the THEMIS probes and Van Allen Probes-B do not show high coherence for long time interval in the broad frequency band of ~10–50 MHz. We will discuss what determines high coherence of the compressional Pc3–Pc4 waves propagating from the dayside magnetospher to low-latitude ground.

16:00 [III-1-5]

Quasi-periodic Modulation of Electromagnetic Ion Cyclotron Waves in the Outer Magnetosphere: Statistical Analysis of THEMIS Data

Gi-Jeong Kim, Khan-Hyuk Kim

Kyung Hee University

Electromagnetic ion cyclotron (EMIC) waves are generated by cyclotron instability of energetic ions (~10–100 keV) in the

equatorial region of magnetosphere. They are observed over a wide L range in frequency band of Pc1-Pc2 pulsations (0.1-5.0 Hz). Early studies of Pc1-Pc2 EMIC waves have been classified into two types: pearl structured (quasi-periodic occurrence of EMIC waves) and unstructured (continuous emission of EMIC waves). Modulation of Pc 1-2 pulsations has been attributed to either bounce of wave packet along a magnetic field line or association with Pc 5 pulsations driven by ring current drifting ions. Although pearl structured EMIC waves have been reported in several case studies, there is no statistical investigation of quasi-periodic modulation of EMIC waves. In this study we examine the periodicity of EMIC wave modulations using the magnetic field data acquired by THEMIS probes in the outer magnetosphere (L > 6). We will discuss what determines a recurrence time of EMIC waves and where such EMIC wave modulations occur.

제2발표장 Burano I

III-2 Special Session Ionosphere (I)
좌장: WooKyoung Lee (KASI)

15:00 [III-2-1] [III-2-2]
Unexplored Aspects of Ionospheric Electron Density Irregularities

Hyosub Kil

Johns Hopkins University Applied Physics Laboratory

Ionospheric electron density irregularities in low and middle latitudes are understood as nighttime phenomena. However, recent studies show that irregularities are not rare phenomena on the dayside. Lack of the study or interest of daytime irregularities is related to the difficulty of their detection; they are easily overlooked because of their small amplitudes compared with nighttime irregularities. This study presents new aspects of ionospheric irregularities identified from the investigation of small-amplitude irregularities in satellite observations. Various forms of irregularities occur on the dayside. They can be the remnants of nighttime irregularities or newly created on the dayside. We do not yet have a clear understanding of their origin. Conventional wisdom is that ionospheric irregularities in low and middle latitudes are associated with plasma bubbles and traveling ionospheric disturbances (TIDs), respectively. However, our investigation indicates that TIDs extend to equatorial region and equatorial bubbles can be transported to middle latitudes. From the behavior of small- and large-amplitude irregularities we infer the origin of ionospheric irregularities and the factors that control their global behavior.

15:30 [III-2-3]
Inter-hemispheric Field-aligned Currents in the Daytime Mid-latitude Ionosphere

Jaeheung Park

Korea Astronomy and Space Science Institute

Thermospheric wind diverging from the subsolar point generates a solar quiet (Sq) current vortex in the daytime low-/mid-latitude E-layer in each hemisphere. Potential difference between the two Sq current systems results in inter-hemispheric field-aligned currents (IHFACs). Previous studies on the IHFACs mostly focused on low-latitude regions. In this study we investigate climatology of IHFACs at mid-latitudes and small-scale current irregularities superposed upon them.

15:45 [III-2-4]
Relationship between Ionospheric Irregularities and GPS Cycle Slip/Multipath over the Region of Equatorial Ionization Anomaly (EIA) around the Longitude of 150°E

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*

The EIA is the most feature in the equatorial ionosphere with two electron density crests near ± 15° and trough at the geomagnetic equator. It has significant effects on radio communications and navigation systems due to its critical variabilities. Ionospheric irregularities of EIA region depend upon the season, solar activity, and latitude. In this presentation, we discuss the relationship between ionospheric irregularities from GPS TEC (Total Electron Content)/ROTI (Rate of TEC Index) measurements and the cycle slip/multipath of GPS L-band signals.

16:00 [III-2-5]
Manually Scaling Ionograms Measured from Icheon (37.14°N, 127.54°E) and Jeju (33.43°N, 126.30°E) in 2017 and 2018

Sangwoo Lee[1], Yong Ha Kim[1], Se-Heon Jung[1], Jong-Yeon Yoon[2]

[1]*Chungnam National University*
[2]*Korea Space Weather Center (KSWC), Jeju, Korea*

Ionosondes at Icheon (37.14°N, 127.54°E) and Jeju (33.43°N, 126.30°E) have been monitoring the ionosphere over the Korea Peninsular since 1998 and 2010, respectively. An

ionosonde transmits continuously HF radio waves vertically and records traces of reflected waves by the ionosphere on an ionogram in the form of their ranges and frequencies. Ionospheric parameters, such as foF2 (the critical frequency of the F2 layer), hmF2 (the peak height of the F2 layer) can be extracted from an ionogram by an automatic scaling program. However, an automatic scaling program sometimes interprets traces of reflected signals on an ionogram inadequately, resulting in absurdly inaccurate ionospheric parameters. In this study, we manually scaled total 33,679 ionograms measured hourly by Icheon and Jeju ionosondes in 2017 and 2018. The manual scaling method is adopted from the standard procedure defined in the handbook of Wakai et al. (1987). We compared manually scaled parameters of foF2, hmF2, foE (the critical frequency of the E layer), and foEs (the critical frequency of the sporadic E) with those of automatically scaled ones from ARTIST5002 (the built-in autoscaling program). We found that for 29% and 23% of ionograms the autoscaling resulted in misinformation on the F2 and E layers, respectively. We classified those misinterpreted ionograms into eight cases: five cases about the F layer and three cases about the E layer. We discuss the reliability of automatic scaled parameters, emphasizing the need of manual scaling when scientifically investigating the ionosphere with ionosonde data.

16:15 [III-2-6]

Occurrence of the Aurora over Jang Bogo Station, Antarctica: All-sky Image Processing and Its Preliminary Results

Young-bae Ham[1,2], Geonhwa Jee[1,2], Changsup Lee[1]

[1]*Korea Polar Research Institute, Incheon, South Korea*
[2]*University of Science and Technology, Daejeon, South Korea*

For the first time, a color CCD All-Sky Camera (ASC) has been operated at Jang Bogo Station (JBS, MLAT～80°) since 2018 for the research of the aurora which is frequently observed at JBS. In this study, we present the occurrence rate of the aurora by analyzing the ASC image data. Coordinate correction, selection process of the reliable images, and image processing for the recognition of the aurora were performed before the occurrence rate calculation. For the calculation of the occurrence rate, image region where the elevation angle is greater than 20° was partitioned into 100 equal-area cells. The occurrence rate was computed for each cell by binning the data with one-hour time interval. The results calculated from 2018 data show that the aurora dominantly appears in the geomagnetic northern horizon at MLT midnight. In the MLT dawn sector, the aurora frequently occurs in the whole sky, but relatively high occurrence rate in the geomagnetic northern sector. These results are consistent with other previous studies that showed asymmetry of the shape of the aurora oval.

제3발표장 Burano III

III-3 Space Technology (II)

좌장: KiRyeok Yong (KARI)

15:00 [III-3-1]

A Feasibility Study on Using Artificial Ground Control Points for Geometric Correction of Geo-Satellite Images

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

Korea Aerospace Reach Institute

A method of using ground landmarks as reference points is used for geometric correction of an image of a geostationary remote sensing satellites. When it is difficult to find the landmark on the ground due to clouds, the geometric accuracy of the image can not be guaranteed. In the case of a wide field of view camera, such as a meteorological satellites, a star map is used to measure the attitude of the satellite and use it for geometric correction. If the field of the view angle is narrow and the sampling time is not enough to observe the star, it is inevitable to rely on the landmark. A future geostationary satellite system, which requires hundreds of meters of position accuracy rather than several kilometers of position accuracy, has limitations in using existing landmarks. A new idea using artificial ground control points was suggested and a feasibility study was conducted.

15:15 [III-3-2]

Image Navigation & Registration In-Orbit Test of GEO-KOMPSAT-2A

Gi-Ryeok Yong, Sung-Sik Huh, Jae-Dong Choi

Korea Aerospace Research Institute

The GEO-KOMPSAT-2A was launched on December 5, 2018. After performing orbit raising operation, in-orbit activation checkout and in-orbit testing of spacecraft, IOT of space weather instruments and AMI, and radiometric correction, the INR IOT was performed for 110 days from 25 February. During INR IOT, dynamic impact analysis of two scanners of the AMI, dynamic characteristics during NS/EW station keeping and momentum dumping, star selection algorithms to be acquired by the AMI, star image processing, navigation filters and residual analysis, and thermal distortion and misalignment estimation, LOS motion compensation, landmark image processing, landmark based orbit determination, UTC/OBT synchronization error impact, resampling, landmark chip tuning and matching algorithm correction of INR performance evaluation tool, and performance analysis of INR requirements were performed. In this paper, we will briefly

present the INR IOT results of the GEO-KOMPSAT-2A.

15:30 [III-3-3]

Summary of Electrical and Mechanical Preparation Work for GK2A Launch

Jong-seok Park, Nayoung Lee, Jae-dong Choi
Korea Aeropspace Research Institute

This paper summarizes the electrical checkout and mechanical assembly which had performed in the preparation of the GEO-KOMSAT-2A (GK2A) satellite launch. GK2A, a South Korean geostationary meteorological satellite, was successfully launched from the launch site in Kourou, French Guiana, on the 4th of December 2018. In the early October 2018, the 60-day launch campaign began when GK2A was transferred from Daejeon, Korea to the Kourou launch site. In the facilities, GK2A satellite was subjected to an extensive electrical checkout. The fit-check was performed to verify the interfaces between the satellites and launcher elements. Also the fueling was done after the careful verification of the propulsion system. In parallel, GSAT-11 satellite built by ISRO (Indian Space Research Organization) arrived and was prepared for the combined operation. GSAT-11 was mounted on the upper stage of the launcher and GK2A was assembled on the lower stage. After the launch of GK2A, the launch campaign was completed in early December 2018, with the task of repacking the launch support equipment. The combined operation was so cooperative and time-limited work. The satellite launch preparation work was successfully completed by the efficient teamwork and the power constructive approaches. In this paper, we will briefly present the GK2A launch preparation and trouble-shooting efforts to successfully complete the relevant tasks of the upcoming GK2B launch.

15:45 [III-3-4]

Research Direction Analysis of the Electronic Module for the High Resolution GEO-Satellite Electro-Optic Camera System

Jong-Euk Park[1], SeungHoon Lee[1], Sang-Soon Yong[1], Kijun Lee[2]

[1]*Korea Aerospace Research Institute*
[2]*Chungnam National University, Department of Electronics Engineering*

Various next-generation satellite researches are being carried out globally. As one of them, the development of a futuristic electro-optical camera aiming at acquiring a high resolution image from a geostationary orbit is underway. Previous studies have been required for research in the field with advantages of power and image information transmission, and prior studies have been conducted through the production of prototypes to preempt the core technology of the research. Detailed specifications of optoelectronic parts required for satellite large - diameter cameras were derived, design directions for securing element technology were established, and further research directions were predicted. In the case of a camera electronic part supporting a focal plane for acquiring a large amount of image information in a geosynchronous orbit, the use of several sensor modules has various advantages including the production of sensor, compared with the use of a single-package image sensor. In this case, efforts to resolve some disadvantages are required. Future research and future research directions will be the cornerstone of the development of high resolution electronic optical camera for geosynchronous orbit.

16:00 [III-3-5]

Introduction to the Yearly Settlement Process for the National R & D Budget at the Government Level in Case of the Compact Advanced Satellite Development Project.

Keun-Woong Shin, Jong-Hwi Choi, Eung-Sik Park
Korea Aerospace Research Institute

It is important to secure stable budgets for the implementation of national R & D projects. The budget of the national R & D project is part of the government budget, and the budget for the previous year, the execution of the budget for the current year, and the preparation and deliberation of the budget for the next year are made. In this process, the performance of the previous year's budget and the execution rate of the current year's budget are considered in the preparation and deliberation of the next year's budget, which affects the stable securing of the planned budget.
This study examines the settlement process for the national R & D budget at the government level. In general, the settlement of the budget executed by the government is carried out through the settlement review of the National Assembly. It is a procedure to confirm the legitimacy and validity of the execution through the post-deliberation on the execution of the budget.

16:15 [III-3-6]

Educational Activities with NYSC 1 M Telescope for Youth

Taewoo Kim[1,2], Wonseok Kang[1]

[1]*National Youth Space Center*
[2]*Chungbuk National University*

National Youth Space Center operates NYSC 1m telescope for educational purposes. We have opened the call for

observation proposals of youth for 4 years and supported youth with educational programs and remote observation. In 2018, 15 observation proposals of youth were accepted and run. In addition, we have been providing the service observation to professional research team, for youth to engage with deep experience of astronomy. In this talk, we present the activities of education for youth, remote or service observation support, and future plans for public open of observational data.

10월 25일(금) 제1발표장 Festa

Ⅳ-1 Sun & Space Environment (III)
좌장: SuYeon Oh (CNU)

09:30 [Ⅳ-1-1]
Simulation Study on the Responses of the Earth's Magnetosphere and Ionosphere to Magnetic Flux Ropes

Kyung Sun Park, Dae-Young Lee, Cheong R. Choi

Dep. Astronomy and Space Science, Chungbuk National University

We performed global MHD simulations on the responses of the Earth's magnetosphere and ionosphere to the impact of large magnetic flux ropes (MFR) The magnetic field strength of MFR changes from 5 through 30 to 5 nT during 25 hours (e.g. size ~5644RE). We considered four types of MFR structures according to the alignment direction of the flux rope axis in the plane perpendicular to the Sun-Earth line. The simulation shows that the magnetic field of MFR where IMF has a southward B_z with dawnward or duskward B_y component lead to plasmoid formation in the tail. The peak values of cross-polar cap potential ranges from 25 kV to ~ 70-114 kV for all types of MFR. When the magnetic field of MFR has a southwhard B_z and duskward B_y (i.e. IMF angle has between 252° and 300°) for two types, strong earthward flow appears > 400 Km/s. At the same time, total magnetic field and plasma temperature increase and also the number density decreases. These features resemble bursty bulk flows which are often observed in the tail region.

09:45 [Ⅳ-1-2]
Comparison and Its Implications of Small Solar Wind Transients Available from Published Event Lists

Hee-Eun Wang[1], Dae-Young Lee[1], Kyung-Eun Choi[1], Kyung Sun Park[1], Kyung-Chan Kim[2]

[1]*Department of Astronomy and Space Science, Chungbuk National University*

[2]*Division of Science Education, Daegu University*

Since small-scale magnetic flux rope has been discovered in 1995 (Moldwin et al., 1995), their properties have been studied by several groups. Small-scale magnetic flux ropes have similar magnetic field structure as magnetic clouds, but have smaller size and different distribution of proton temperature and proton beta. Based on these properties, several small-scale magnetic flux rope lists have been published. Contrary to magnetic clouds, there is no standard criteria for small-scale magnetic flux rope. So, each published lists have different criteria to select events. In the present work, we compare three published lists, which have different criteria (Feng et al. 2008; Yu et al. 2016; Hu et al. 2018). Each list has different magnetic field strength criterion, beta criterion and proton temperature criterion, etc. We focus on comparison among these three criteria firstly. We obtain a statistical analysis on satisfaction of one criterion against another one. From these results, we investigate sensitivity of the criteria for identifying small-scale magnetic flus ropes.

10:00 [Ⅳ-1-3]
Strong Scattering of 90-degree Pitch Angle Electrons in the Outer Radiation Belt by Large Amplitude Electromagnetic Ion Cyclotron Waves

Dae-Young Lee[1], Kyung-Chan Kim[2], Cheong-Rim Choi[1]

[1]*Department of Astronomy and Space Science, Chungbuk National University*

[2]*Department of Earth Science Education, Daegu University*

Electromagnetic ion cyclotron (EMIC) waves can cause relativistic electron scattering and atmospheric precipitation primarily via cyclotron resonant interaction in the Earth's radiation belts. However, the conventional quasilinear resonance theory predicts that cyclotron resonance condition is hardly satisfied for near 90° pitch angle (PA) electrons, which constitute the major population of the outer radiation belt, such that scattering is effective mostly for low PA electrons. In contrast to this prediction, here we demonstrate using test particle calculations that even exactly 90° PA electrons can be scattered significantly by large amplitude EMIC waves. Finite wave force provides parallel transport of 90° PA electrons away from the equator, allowing cyclotron resonance conditions. Different types of resonance are responsible for major PA changes depending on wave normal angle: First and second order resonances for parallel and oblique waves, respectively. The nonlinear effects found here are applicable to various situations in planetary magnetospheres.

10:15 [Ⅳ-1-4]

Chaotic Speed Oscillations of Inner Corona Post-CME Blobs Observed by K-Cor on 2017 September 10

Jae-Ok Lee[1], Kyung-Suk Cho[1],
Valery M. Nakariakov[2]

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

Recently, several researchers show that the speed oscillations of CMEs are a common phenomenon associated with CME propagation and they might be explained by either dynamical equilibrium process between CMEs and ambient solar winds or self-oscillatory processes driven by vortex shedding. In this study, we investigate 20 low corona post-CME blobs having at least 7 height-time data points, which are observed at the heights between 1.15 and 2.07 Rs on 2017 September 10 by K-Cor observations, in order to find the speed oscillations of the inner corona post-CME blobs and their possible generation mechanisms. For this, we estimate the instantaneous projected speeds of the blobs in radial directions from the solar disk center and their linear speeds by using a first order polynomial fit. Using K-Cor intensity and running difference images, we also estimate the diameter of each low corona post-CME blobs. The main results are summarized as follows. (1) All blobs have experienced chaotic speed oscillations with instantaneous periods (30–230 seconds) and instantaneous amplitudes (128–902 km/s). (2) The oscillation amplitudes seem not to be correlated with the oscillation periods, observation heights, and linear speeds: correlation coefficients (CC) = −0.04 for oscillation periods, CC = 0.07 for observations heights, and CC = 0.22 for linear speeds, respectively. (3) When we roughly estimate the Strouhal numbers by using the observed diameter, linear speed, and instantaneous oscillation periods of each low corona post-CME blobs, we find that the Strouhal numbers range from about 0.2 to 1.9, which are consistent with those of fluid dynamics experiments of bluff spheres in uniform flows, while they are much higher than those of magnetohydrodynamic simulations of cylindrical shapes. (4) Strouhal numbers seem to be correlated with the linear speeds of low corona post-CME blobs and their diameters: CC = −0.69 for linear speeds and CC = 0.47 for blob diameters. Our results firstly demonstrate that not only the chaotic speed oscillations of low corona post-CME blobs might be effected by the vortex shedding driven by pre low corona post-CME blobs having bluff spherical shapes, but also our observations suggest the possibility of fluid-like vortex shedding in the post-CME ray.

10:30 [Ⅳ-1-5]

Large-scale Topological Structure of Small Solar Wind Transient Field Lines Inferred from Suprathermal Electrons at 1 AU

Kyung-Eun Choi[1], Dae-Young Lee[1],
Hee-Eun Wang[1], Seunguk Lee[1], Kyung Sun Park[1],
Kyung-Chan Kim[2]

[1]*Department of Astronomy and Space Science, Chungbuk National University*
[2]*Department of Earth Science Education, Daegu University*

The small solar wind transients (STs) have similar properties with large scale interplanetary coronal mass ejections (ICMEs), but their origins remain to be explained. In some studies, it has been suggested that STs can be generated by reconnection in the solar corona near the coronal hole boundary. Others suggest generation within the solar wind via reconnection, for example. Suprathermal electron is an indicator of connection of local interplanetary magnetic field (IMF) to the Sun. In the present work, we investigate the pitch angle distributions of suprathermal electrons for a large number of ST events during solar cycle 23 and 24 along with the determination of local IMF polarity to determine the structure of STs field lines. We find that STs at 1AU contain mostly, but not always, open field lines connected to the Sun and its polarity is consistent with large scale IMF sector structure. Based on this result we demonstrate their configuration at 1AU and further their possible origins.

제2발표장 Burano I

Ⅳ-2 Special Session Ionosphere (II)
좌장: JongKyun Chung (KASI)

09:30 [Ⅳ-2-1]

Ionospheric TEC Monitoring over South Korea Using BeiDou Navigation Satellite System

Byung-Kyu Choi, Woo Kyoung Lee,
Kyoung-Min Roh

Korea Astronomy and Space Science Institute

Global Navigation Satellite System (GNSS) has been used in ionospheric total electron content (TEC) monitoring. The BeiDou navigation satellite system (BDS) developed by China started operating in 2012. BDS satellites consist of geostationary Earth orbit (GEO), inclined geosynchronous orbit, and medium earth orbit. A unique characteristic of BDS GEO enables ionospheric TEC monitoring for any point. The GNSS stations, which are operated by the Korea Astronomy and Space Science Institute, can track BDS signals. In this study, we used BDS observations from the JEJU GNSS station for

ionospheric monitoring. From continuous measurement of BDS GEO satellites, we observe the diurnal variation in TEC time series. In addition, the statistical results of the difference between BDS TEC and Global Ionosphere Maps (GIMs) TEC are presented.

09:45 [Ⅳ-2-2]

Dawn-Dusk Asymmetry of the Ionospheric Phase Scintillation over Jang Bogo Station, Antarctica (74.62°S, 164.22°E)

Junseok Hong[1,2], Yong Ha Kim[1], Jong-Kyun Chung[2], Jaeheung Park[2,3], Hyuck-Jin Kwon[4], Jeong-Han Kim[5], Jong-Min Choi[2], Young-Sil Kawk[2,3]

[1]*Chungnam National University*
[2]*Korea Astronomy and Space Science Institute*
[3]*Korea University of Science and Technology*
[4]*School of Space Research, Kyung-Hee University*
[5]*Korea Polar Research Institute*

The ionospheric phase scintillation of Global Navigation Satellite System (GNSS) signals is commonly induced by ionospheric irregularities at high latitudes, causing socioeconomic problems. The ionospheric irregularities are generated in the regions of aurora, polar cap patch and polar cusp. Since 2016, Korea Polar Research Institute (KOPRI) and Korea Astronomy and Space Science Institute (KASI) have operated an ionospheric scintillation monitor at Jang Bogo Station (JBS) in Antarctica (74.62°S, 164.22°E), mostly located inside of the polar cap region. Our study on measurement data from the scintillation monitor has shown that ionospheric phase scintillations over JBS have temporal and spatial variations whose characteristics are dependent both on signal frequency and geomagnetic activity. In addition, the phase scintillations are stronger in magnetic local time (MLT) noon and dawn sector than in midnight and dusk sector. This asymmetry between noon and midnight seems to be related with the positions of polar cusp and polar cap patches. However, the asymmetry between dawn and dusk is not fully understood. By analysing 50 Hz magnetic field data from Swarm satellites, we found that the stronger phase scintillation in dawn may be associated with small scale field-aligned current (FAC) structures as well as the poleward extension of auroral oval. In this presentation, we discuss the possible mechanisms for dawn-dusk asymmetry of the ionospheric phase scintillation.

10:00 [Ⅳ-2-3]

Development of an Ionospheric Forecast Model over Jeju Station (33.43°N, 126.30°E) Using Long Short-Term Memory

Su-In Moon[1], Yong Ha Kim[1], Jeong-Heon Kim[2], Yong-Sil Kwak[2], Jong-Yeon Yun[3]

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

Ionospheric models aim to simulate and predict variations in the ionosphere. In this study, we attempted to develop an ionospheric forecast model to predict hourly foF2s and hmF2s up to 24 hours using a deep learning method. We adopted the method of Long Short-Term Memory (LSTM), which can catch on sequential variation among serial data, unlike traditional artificial neutral network models. The inputs of LSTM model were sequential data of the past 24 hours that included sunspot number, F10.7 flux, Ap, foF2s and hmF2s. The model learning data of foF2s and hmF2s were measured by Jeju ionosonde (33.43°N, 126.30°E, operated by Korean Space Weather Center) during a period of 2014–2016. The model performance was evaluated with a Root Mean Square Error (RMSE) and correlation coefficient (CC) between the measurement and the model prediction. The best foF2 model, having 45 neurons and 12 batch sizes, performed with an RMSE of 0.55 MHz and a CC of 0.96 when compared with the next hour measured value. The best hmF2 model, having 40 neurons and 24 batch sizes, preformed with an RMSE of 23.96 km and a CC of 0.82. The LSTM results were compared with TIE-GCM and IRI-2016 model for geomagnetically quiet and active periods. On geomagnetic quiet days, the LSTM model showed the best performance among the three models. On geomagnetic storm days, however, the IRI model performed better than the other two models.

10:15 [Ⅳ-2-4]

A Model Study on the Possibility of Long-Term Prediction for Regional Ionosphere Using Deep-Learning Algorithm

JeongHeon Kim[1], Su-In Moon[2], YoungSil Kwak[1], YongHa Kim[2], JongYeon Yun[3]

[1]*Korea Astronomy and Space Science Institute, KASI*
[2]*Chungnam National University, CNU*
[3]*Korea Space Weather Center, KSWC*

In our presentation, we present a study of the possibility for long-term predicting the regional ionosphere at mid-latitude by assimilating ionosonde predicted data derived from the deep-learning algorithms into the SAMI2-CNU model (Kim et al., 2019). In our previous study, we estimated the ionospheric drivers (neutral meridional wind, neutral atomic oxygen, and total ion density) from NmF2 and hmF2 observed in ionosonde and then input them into the SAMI2 model to calculate the accurate predictions until the next observations

were obtained (about 15 minutes). However, because the typical ionosonde is produced a new data for every 15 minutes, this model can only predict for 15 minutes. For that reason, another method is needed for long-term prediction of the ionosphere.
In this study, to overcome the weakness of short-term prediction, we utilize the Long Short Term Memory (LSTM) network, which is capable of learning long-term dependencies of the parameters of the ionosphere as the special kind of recurrent neural network technique. We applied the Jeju ionosonde (33.43°N, 126.30°E) long-term dataset to the LSTM algorithm to calculate 24-hour predictions for NmF2 and hmF2. Also, then these computed prediction values are inputted to the SAMI2-CNU model and are used to calculate new ionospheric drivers. In this way, we simulated the long-term predictions of NmF2 and hmF2 with high accuracy not only at locations where used observation data but also at other locations that are nearly meridional co-planar with the reference location. We here present the comparison of predicted values with measured values in terms of peak densities and heights of the F2 peak. Also, we discuss the possibility of predicting the ionosphere through assimilation modeling with deep-learning techniques.

10:30 [Ⅳ-2-5]

A Statistical Study of a Temporal 4D-var Correlation Parameter Used in a Data-assimilated Ionospheric Model at Mid-latitude

Se-Heon Jeong[1], Yong Ha Kim[1], Kwangsoo Kim[1], Nicholas Ssessanga[2]

[1] *Chungnam National University*
[2] *Research Institute for Sustainable Humanosphere, Kyoto University*

Since the ionosphere varies with time and space, a data-assimilated ionospheric model needs temporal and spatial correlation parameters. We have developed a four dimensional variation data assimilation (4D-var) model to estimate a current status of the ionosphere over the Korean Peninsular. In this 4D-var model, a Gauss-Markov filter is used with a temporal correlation parameter, called tau, which should be adjusted to produce optimal results from the model. The model utilizes the International Reference Ionosphere (IRI) 2016 model as the background model, and assimilates slant total electron contents (STECs) derived from 27 ground Global Positioning System (GPS) receivers in the Korean Peninsular. The model calculates the ionosphere in the region bounded by latitude (20°–50°N with 2.5 grid), by longitude (120°–150°E with 3°grid), and by altitude (100–500 km with 30 km, 500–1,400 km with 200 km grid). For tau values of 0.5–6 hr, we compared the model foF2 with ionosonde data in Jeju (33.43°N, 126.30°E), I-cheon (37.14°N, 127.54°E), Kokubunji (35.70°N, 139.50°E), Okinawa (26.33°N, 127.80°E), Wakkanai (45.40°N, 141.70°E), over the year 2015. The root mean square errors (RMSE) from the measured foF2s are constant with tau values for quiet days, but increases with tau up to ~1 hr for storm days. Therefore, we suggest that the 4D-var ionospheric model can use a tau value of ~1 hour for both quiet and storm days.

10:45 [Ⅳ-2-6]

Looking into the Source of Periodic PMSE Detection during High-speed Solar Wind Streams

Young-Sook Lee, Yongha Kim

Department of Astronomy, Space Science and Geology, Chungnam National Univeristy

In solar minimum years polar mesospheric summer echoes (PMSE) have been characterized with well responding to geomagnetic disturbances, which are caused by high-speed solar wind streams. In years of 2006 and 2008, for example, occurrences and reflectivities of PMSE were found as having 7, 9 and/or 13.5 day periodicities. The periodicities are well matched with the variations of solar wind speed and AE index in the corresponding years.
However, some doubts are in debating whether the periodicities are caused from the direct reflection of precipitating electrons or real PMSE creation due to lowered temperature.
In this study, we estimate the change of neutral density in the mesopause region with the proxy of peak height change of meteor flux at the geomagnetic disturbance occurrence. We found some coincident manifestations of neutral density decrease and sharp increase of PMSE occurrence upon commencing day of geomagnetic disturbance. In this aspect, the study includes the discussion of possible sources of the detected PMSE correlated with AE index during the recurrent high-speed solar wind streams.

제3발표장 Burano III

Ⅳ-3 Space Application

좌장: KyoungMin Roh (KASI)

09:30 [Ⅳ-3-1]

Current Status of Domestic Technology for Space Electronic Equipment

Sang-Taek Lee

Korea Aerospace Research Institute

At present, many kinds of space electronic equipment is

being developed by domestic industry. Especially in the field of electronics, the technology and functions of the domestic industry reach the world level in various fields, which is very advantageous for domestic development. In this paper, we review the current state of various technologies for the development of space electronics equipment and propose a technology development plan suitable for the current situation in Korea.

09:45 [Ⅳ-3-2]

Orbital Thermal Analysis of a Nanosatellite for Microgravity Scientific Missions

Ter-Ki Hong[1], Seul-Hyun Park[2]

[1]*Department of Mechanical System & Automotive Engineering Graduate School of Chosun University*
[2]*School of Mechanical System & Automotive Engineering, Chosun University*

A nanosatellite has gained an increased attention in the space industry due to relatively low production cst, short production period and improved performance compared to small satellites. Recently, the nanosatellite has been utilized as a ideal platform to perform microgravity scientific missions. In most of microgravity scientific missions, the operating temperature of a payload exposed to extreme space environments is one of important elements to successfully conduct the experiment. In the present study, we numerically investigate the temperature distribution of a 3U cubesatellite using a UG NX SST.
In particular, the temperature distribution of 3U cubesatellite in a Sun-synchronous was examined for two different attitude determination control modes, i.e., Nadirpointing and detumbling modes that are widely used. Numerical results indicate that the satellite operating in the detumbling mode causes a small temperature deviation for the scientific payload due to its inherent rotating dynamics on each axis.

10:00 [Ⅳ-3-3]

Experimental Study on Flame Spread of Solid Flammables with Low Thermal Inertia in Microgravity Environments

Won-Sik Nam[1], Ter-Ki Hong[1], Seul-Hyun Park[2]

[1]*Dept. of Mechanical System & Automotive Engineering Graduate School of Chosun University*
[2]*School of Mechanical System & Automotive Engineering, Chosun University*

During manned space exploration to Mars, crews are inevitably exposed to different gravity environments. In the present study, the flame spread characteristics were investigated from the perspective of fire safety for manned space module. To alter gravitational acceleration ranging from microgravity to Mars gravity, a series of parabolic campaigns are performed using a Boeing 727 operated by Zero G cooperation. The optical fiber with a low thermal inertia was selected as a solid combustible for parabolic flight experiments, The experimental results clearly show that the flame spread rate was the fastest in the microgravity environment compared to that in Mars gravity environment followed by earth gravity environment.

10:15 [Ⅳ-3-4]

Optical Measurement of Stray-light in Electro-Optical-Subsystem for the CAS500 Payload

Dongok Ryu[1], Sehyun Seong[2], Hyunju Seo[2,3], Seonghui Kim[1], Deog-gyu Lee[1], Sug-Whan Kim[2]

[1]*Korea Aerospace Research Institute*
[2]*Yonsei University*
[3]*Hanwha Systems*

The Electro-Optical-Subsystem (EOS) for CAS500 payload is 3-mirror Korsch type optical system as known for effective stray-light reducing performance from the separation between the focal plane region and the Cassegrain telescope. However, it is necessary to determine the stray-light contamination of the incident light sources from out of the field to the focal plane, passing through the baffle-less field stop in the EOS. First, we performed case studies of the stray-light path determination using a ray-tracing method including identification of critical and intervening surfaces in the EOS. We also estimated point source transmittance for the possible stray-light risky incident angles. Then, we tested to detect the stray-light pattern and measure the stray-light ratio with the incident angles. In this presentation, we will introduce the brief simulation process and the initial optical measurement result of the stray-light in the EOS caused out-of-field light source.

10:30 [Ⅳ-3-5]

The Design of Broadband Data Link for Satellite Using Optical Wireless Communications (OWC)

Jin Pyong Jung, Hee Won Park, Seung Hun Ha

Korea Aerospace Research Institute

Until now, the requirements for the resolution of satellite electro-optical cameras are expected to continue to fall below the submeter level.
In order to downlink this amount of video data to the ground, the transmission speed must be at least several Gbps. Currently, video data downlink uses an X-band RF signal but lacks additional scalability. Therefore, Optical Wireless Communications (OWC) technology has been proposed that

has advantages such as broadband, low power, low volume and weight reduction, and no international restrictions on frequency. In this paper, we analyze the advantages and disadvantages of OWC technology and describe a conceptual design for broadband data links for satellite.

10:45 [Ⅳ-3-6]

Preliminary Design of SIGN-pathfinder Cubesat and Drag-free System for Gravitational Wave Detection Space Experiment SIGN

GiHan Hong[1], Minhyo Kim[1], K. H. Lee[1], Minbin Kim[1], Il H. Park[1], Eunil Won[2]

[1]*Sungkyunkwan Univ. Physics Department, Institute Science Technology in Space*
[2]*Korea Univ. Physics Department*

SIGN-pathfinder is designed to measure the sensitivity of the SIGN (Stellar Interferometer for GravitatioNal wave) which is a next-generation space borne gravitational wave (GW) detector recently proposed by Il H. Park. Existing GW experiments such as LIGO and LISA are based on temporal coherence of laser. On the other hand, the SIGN is using star light instead of laser with spatial coherence, as being the world first of its kind. The SIGN is found to be sensitive to low-frequency ranges of GW regions resulting from the merger of super-massive black holes. To detect any changes by the disturbance of GWs in spatial coherence of star light in space, at least two satellites are required, and thus it is important to have the relative position between these satellites in precise control. We introduce a drag-free system (DFS) which is a device to measure the influence of external force acting on the satellite and the position change of the satellite. DFS is an essential instrument for the correction of GW data and the alignment of satellites as well. We present the preliminary design of the SIGN-pathfinder in a cubesat format and the drag-free system payload to determine the sensitivity of future SIGN experiments.

포스터발표 논문 초록

1부 발표시간 : 10월 23일(수) 15:30~16:30

[P-1] Processing Sequence of the AOCS Mode Transition for the Korea Pathfinder Lunar Orbiter

Jaewook Kwon, Dawoon Jung, Han Woong Ahn, Kwangyul Baek

Korea Aerospace Research Institute

The mission scenario of the Korea Lunar Pathfinder Orbiter (KPLO) is a unique challege that requires that Attitude Orbit Control Subsystem (AOCS) shall make control capabilities of each operational mode. This paper introduces all the mode processing sequence of attitude control subsystem which is defined by the flown down from the system mode. The attitude control subsystem submode consists of Sun pointing submode, Target pointing submode, Large Angle Maneuver submode, Del-v submode and Safe hold Submode. The sequence of the del-v mode is dealt with particularly in detail. Moreover, when the KPLO has fault on the mission operation, it has operation sequence for the fault management and recovery, in this paper, recovery seqeunces of the some of modes are descirbed as well. Then, the future works to mature the designing works is shown at the end of this document.

[P-2] A Study on Relative Radiometric Accuracy Characterized by Antenna Beam Pattern in Staring Spotlight Mode of Spaceborne SAR

Byoung-Gyun Lim[1], Hyoung-Jae Oh[2]

[1]*Korea Aerospace Research Institute,*
[2]*Chungnam National University.*

Radiometric accuracy in the SAR (Synthetic Aperture Radar) image is very important for obtaining accurate target information in the image. Staring spotlight mode, which is one of SAR operation modes, is useful for obtaining high resolution images, but it is difficult to satisfy relative radiometric accuracy in the outer region of the SAR images. In this paper, we analyzed the relative radiometric accuracy characteristics according to the antenna beam pattern in the staring spotlight mode of spaceborne SAR. We proposed a simple antenna beam pattern compensation algorithm to satisfy the relative radiometric accuracy.

[P-3] Development of Magnetometer Calibration System Test Model

Byungwook Jeong[1], Yunho Jang[1], Yonghae Hwang[2], Hyojeong Lee[3], Jehyuck Shin[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.*

We developed a calibration system that can be performed automatically using a 3-axis Helmholtz coil and a reference magnetometer to calibrate the magnetometer efficiently. The system configuration consists of a Helmholtz coil, a DC power supplies that can generate a user define magnetic field strength in tri-axis and a reference magnetometer (MAG612, Bartington). The PC-based software controls the calibration system. The power supplies were used a low cost commercial DC power supply which has a software control function. We also made a polarity control module for this system. To verify the operational stability of the calibration system, an Anisotropic Magneto-resistive magnetometer (HMC1001, 1002) was tested in this process to derive a full-range, offset and linearity. We were confirmed that the test system improve a test reliability and reduce the calibration process time compared to the manual operation. This paper introduces the calibration system configuration, the control software and the performance about a magnetometer calibration process.

[P-4] Construction of FUV All Sky Map from Incomplete Survey: Application of Deep Learning

Kyoung-Wook Min[1], Yeon-Ju Choi[2], Young-Soo Cho[3], Chang-Ho Woo[1]

[1]*Department of Physics, KAIST*
[2]*Korea Aerospace Research Institute*
[3]*Korea Astronomy and Space Science Institute*

Far-ultraviolet IMaging Spectrograph (FIMS), which was launched on 2003 September 27 on board the spacecraft STSAT-1, made an all sky survey in the wavelength band of 1335-1750 A over a period of one and a half years. However, due to the frequent interruption and early termination of operation caused by the spacecraft power problem, the FIMS survey covered only ~80% of the sky. In this paper, we present our efforts to fill the un-surveyed regions by adopting a deep learning algorithm. For input data, we used H alpha, color excess, neutral hydrogen, and X-ray maps as well as the FIMS survey results, all with a resolution of 1°. Further, the Galactic longitudes and latitudes were also employed to accommodate the global variation that may exist in the FUV map but not be represented in the above maps. We adopted multi-layer neural networks to connect the multi-wavelength inputs finally to the FIMS observations, thereby predicting the FUV intensities from other inputs for those not observed by FIMS. The results are in good agreement with the GALEX

observations that were carried out for the less bright mid- and high-latitude Galactic regions in the wavelength band quite similar to that of FIMS. We will also discuss possible application of the predicted FUV images to the modeling of dust scattering of starlights as similar simulations have been done quite successfully with the FIMS observations.

[P-5] Mission Proposal of Ozone Dynamics Investigation Nano-Satellite (ODIN)

Nuri Park[1], Yu Yi[1], Jeong Hun Jeong[1], Sunghwan Jang[1], Ik-Seon Hong[1,2], Heejung Yu[1], Seungbin Shin[1], Jiwoo Kim[1], Sejin Cho[1]

[1]*Department of Astronomy and Space Science, Chungnam National Unviersity*
[2]*Korea Astronomy and Space Science Institute (KASI)*

By protecting ultraviolet radiation from space, ozone layer plays critical role in maintaining biosphere on Earth. Since 1985, the first report of extreme local and seasonal decrease of ozone density in Antarctica, it is now well known that anthropogenic materials such as Freon gas (CFCs) can destroy ozone layer. To deeply understand interaction between human activities and environment, global and annual observations of Ozone Depleting Substances (ODSs) are critical. We designed cubesat to observe ODSs defined in Montreal Protocol globally. By using miniature sized spectrometer and optical camera as the payloads of the satellite, we are planning to do spectroscopy of the terrestrial atmosphere, specifically the stratosphere. From the retrieved data, we expect to determine the seasonal flow and global distribution of ODSs in stratosphere.

[P-6] Progress of the Engineering Qualification Model (EQM) 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, Won-Kee Park

Korea Astronomy and Space Science Institute, Korea

In this time, we describe the development of the Engineering Qualification Model (EQM) of scientific instruments onboard the Korea Astronomy and Space Science Institute satellite-1 (KASISat-1) for Small scale magNetospheric Ionospheric Plasma Experiments (SNIPE) mission to verify the performance of the payload. The scientific instruments are comprised of he Solid State Telescopes (SST), the Langmuir Probe (LP), the 3 Axis Fluxgate Magnetometer (MAG). The SST measure electrons in the range of 100 keV-400 keV [TBC] with the geometrical factor (G = 0.02 cm^2 sr) in parallel and perpendicular directions to the geomagnetic field. The LP measure the density from 2 × $10^3/cm^3$ to 5 × $10^6/cm^3$ [TBC] for ionospheric thermal electrons. The MAG measure Magnetic field of ± 50,000 nT [TBC] with the noise amplitude (FWHM = 1 nT). The space environmental tests of scientific instruments consisted of vibration test, thermal vacuum test, and each test was performed based on the SNIPE environmental test specification. The EQM for scientific instruments has passed the space environment test. we report the process and the result of the space environment test.

[P-7] Conceptual Design of KAIST CubeSat IPECK for Ionospheric Exploration

Seunguk Lee[1,2], Kwangsun Ryu[2], Seungho Lee[3], Jinsung Lee[3], Chang Youdong[3], Seong-ho Rhee[4]

[1]*Chungbuk National University*
[2]*Satellite Technology Research Center, KAIST*
[3]*Dept. of Aerospace Engineering, KAIST*
[4]*Dream Space World Inc.*

A 3U-size Cubsat named as IPECK (Ionospheric Plasma Exploration Cubsat of KAIST) was proposed and selected for the first round of the 2019 CubeSat contest program. The primary mission objective is to study the correlation between EIA (Equatorial Ionization Anomaly) and EEJ (Equatorial Electro-Jet) by measuring the plasma density and magnetic field in the low earth orbit. Furthermore, this will allow us to study the possibility of the correlation between EIA and earthquake occurrence. The second mission is to demonstrate the orbit maneuvering capability to form constellation in the next-step missions. To achieve the mission objectives, IPECK will be equipped with the impedance probe, the fluxgate magnetometer, and a liquid propellant. Impedance probe can observe EIA by measuring the density and temperature of the ionospheric plasma. Fluxgate can measure EEJ by measuring magnetic field disturbance. The plasma and magnetic field measurements will be made in the sunlit. The mono-propellant thruster which uses H_2O_2 as propellant will demonstrate the phase and orbit plane maneuvering capability that is essential to form evenly distributed satellite constellation in local time and in true anomaly within the orbit plane.

[P-8] Generation of Future Magnetograms from Previous SDO/HMI Data Using Deep Learning

Seonggyeong Jeon[1], Yong-Jae Moon[1], Eunsu Park[1], Kyungin Shin[1], Taeyoung Kim[2]

[1]*School of Space Research, Kyung Hee University*
[2]*Department of Research and Development, InSpace Co., Ltd*

In this study, we generate future full disk magnetograms in

12, 24, 36 and 48 hours advance from SDO/HMI images using deep learning. For this, we apply the conditional generative adversarial network (cGAN) algorithm to a series of SDO/HMI magnetograms. We use SDO/HMI data from 2011 to 2016 for training four models. The models make AI-generated images for 2017 HMI data and compare them with the actual HMI magnetograms for evaluation. The AI-generated images by each model are similar to the actual images. In the case of 12 hour forecast, the average correlation coefficients between the two images with 2 by 2 binning are 0.76 for full-disk images and 0.77 for active regions. We have a plan to use pix2pix HD and video2video translation networks for image prediction. 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-9] Conceptual Design of Ozone Dynamics Investigation Nano-Satellite (ODIN)

Eui Dong Hwang[1], Yeong Ju Park[1], Junho Song[1], Dong Yun Kwak[1], Kyeongsu Kim[1], Do Hui Kim[1], Geon Young Kim[1], Hyeonmin Lee[1], Geon Young Kim[1], Nuri Park[1], Ik-Seon Hong[1,2], Hosub Song[1,2], Yu Yi[1]

[1]*Department of Astronomy and Space Science, Chungnam National Unviersity*
[2]*Korea Astronomy and Space Science Institute (KASI)*

Ozone Dynamics Investigation Nano-Satellite (ODIN) is a cubesat project designed for the participation of 'CubeSat Competition 2019' hosted by Korean Aerospace Research Institute (KARI). Its main objective is to do spectroscopic observation of atmosphere to determine the global and seasonal distribution of Ozone Depleting Substances (ODSs) in stratosphere. Here, we present the preliminary designs and mission plans of ODIN. ODIN is expected to be located in Sun Synchronous Orbit (SSO). To maximize the effectiveness of its detection in corresponding orbit, the internal structure of ODIN is designed for nadir observation. We also test the feasibility of spectroscopy in SSO and planned the procedures and methods of limb observation, in case of emergency.

[P-10] Correlation of Hydroxyl and Solar Proton on Lunar Surface

Haingja Seo[1], Eunjin Cho[2,3], Jongdae Sohn[2], Ik-Seon Hong[2,4], Young-Jun Choi[2,3], Myungjin Choi[1]

[1]*InSpace (Intelligence in Space)*
[2]*Korea Astronomy and Space Science Institute*
[3]*Astronomy and Space Science, University of Science and Technology*
[4]*Department of Astronomy, Space Science and Geology, Chungnam National University*

It is known as hydroxyl is produced by the solar proton at lunar surface. There are incomplete minerals on lunar surface by impact of micrometeorites and/or cosmic ray, and they have chemically unstable oxide ion. The solar proton is implicated on oxide ion. The amount of hydroxyl depends on the number of solar proton. According to Cho et al. (2018) and Sim et al. (2017), when lunar surface is shielded by Earth's magnetosphere, the amount of hydroxyl is reduced. We are planning to compare numbers of solar protons reaching to the Moon and the amount of hydroxyl on lunar surface. We'll use the data for the solar proton as CRaTER/LRO, and for the hydroxyl as M3/Chandrayaan1, NIR3/Hayabusa2, and NIMS/Galileo. We expect that the amount of hydroxyl and numbers of solar proton will be proportional. If the result is revealed as expecting, we are planning to try to research using ACE data. The research will contribute to understanding the water circulation on the lunar surface.
This research was conducted by NRF (2018M1A3A3A02065832) support.

[P-11] The Study of the High Resolution Camera Mission Requirement Verification Concept in the Ground Test for the Lunar Exploration

Sang-Youn Shin[1], Haeng-Pal Heo[1], Hyungho Ko[2]

[1]*Korea Aerospace Research Institute (KARI) Satellite Payload Development Division*
[2]*Chungnam National University, Department of Electronics Engineering*

In this paper, the high-resolution camera mission requirement verification concept is studied for the lunar exploration. The main mission objective of the high-resolution camera is to obtain topographic map for the lander of the next lunar exploration program. In order to accomplish the mission objective, the mission requirements are defined and verified. Especially in this paper, the verification concepts are studied in the electrical test bed with the engineering model. According to the mission requirement verification items, the test configuration concepts are considered and parameters are analyzed. Also the verification result evaluation method is studied.

[P-12] A Feasibility Study of Lunar Seismometer Using Magnetometer

Yun-Ho Jang[1], Byungwook Jeong[1], Jehyuck Shin[1], Hyojeong Lee[1,2], Ho Jin[1,3], Khan-Hyuk Kim[1,3], Jongho Seon[1,3]

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The moonquake study provided important information about an internal structure and an evolution of the Moon, using five seismometers from Apollo 11 to 16 after the first lunar lander in 1969. According to the analysis of observation data in the 1970s, 78 epicenters were derived, and it also presented the type, a period of the moonquake, and a seismic belt existence. However, there was no lunar landing mission for lunar seismic observation after the Apollo mission. But recently, various lunar landing missions carry out internationally, so we suggested a new conceptual model to measure a moonquake as Korean participant payload for the CLPS (Commercial Lunar Payload Services) project. This seismometer is able to observe the moonquake information and the local surface magnetic field by two magnetometers. We expect that this seismometer shows seismic activity if a landing site has just a few nano tesla environment. In this paper, we introduce a feasibility study and proto design of a lunar seismometer using a magnetometer.

[P-13] Critical Design of Science Data Management Subsystem for KPLO

Joo Hyeon Kim[1], Seungbum Yang[2], Daesung Kim[2], Soyeon Kang[2]

[1]*Korea Aerospace Research Institute*
[2]*InSpace Co., Ltd.*

Science Data Management Subsystem (SDMS) has a role of management for the science data measured by the domestic science instruments onboard of KPLO which is one of subsystems in the KPLO Deep-space Ground System (KDGS). The SDMS consists of two modules of Science Data Management Module and KARI Planetary Data System. The science data management module (SDMM) is located at the KDGS Mission Operation Center(KMOC) with a connection of KDGS internal secured network. The KARI Planetary Data System (KPDS) is connected with internet for the public access although it is located at the KMOC internal.
The major functions of SDMM are the long-term preservation and the delivery of science data in the format of telemetry to the domestic science instrument developers. The science telemetry data will be processed by the developers. The major functions of KPDS are public release of the science data processed by the science instrument developers and the validation of the data with the NASA PDS4 standard. The KPDS serves an user friendly interface for the public users in order to easily search and acquire the data. We expect that it promotes the scientific achievements as many as possible.
In this paper, we present the system architecture, detailed function and data procedure in each module and show the graphic user interface prototype with a search engine for the public users.

[P-14] Propellant Settling Burn (PSB) Effect on Lunar Orbit Insertion (LOI) Maneuvers

Young-Joo Song, Young-Rok Kim, Donghun Lee, Jonghee Bae

Korea Aerospace Research Institute

During the flight operation of the Korea Pathfinder Lunar Orbiter (KPLO) mission, one of the most critical event is performing Lunar Orbit Insertion (LOI) maneuver. For the successful LOI maneuver execution, Propellant Settling Burn (PSB), also known as Liquid Settling Burn (LSB) or Ullage Burn (UB), should be fired during pre-defined amount of time before the ignition of main LOI burn. PSB is necessary to get the propellant floating around in the tanks to settle down near the pump inlets, to ensure a smooth flow of propellant to main engine. PSB can be performed by firing Attitude Control Thrusters (ACTs) and the total amount of settling time is dependent on the level of propellant in the tank. Current work analyzed effect of PSB on LOI maneuver. Due to PSB effect, small changes on the amount of total delta-V magnitude as well as fuel usage are expected with respect to delta-V plan established for trajectory design and analysis purposes. Unlike total delta-V magnitude and fuel usage, reference thrust direction for LOI burn is observed to significantly affected by PSB, especially when the LOI burn magnitude itself is relatively small. In real flight operation of KPLO, effect of PSB should be modeled and reflected while uploading maneuver command to minimize expected errors after maneuver execution.

[P-15] ECSS Standard Compatible with Test Script Engine of KPLO DSS (Dynamic System Simulator)

Hoonhee Lee

Korea Aerospace Research Institute

KARI is currently accelerating its development ahead of a critical review of the KPLO (Korea Lunar Pathfinder Orbiter) DSS (Dynamic System Simulator) which is a ground support simulator for KPLO operation. There are simulation models of the KPLO system within the DSS, and a script-based testing environment has been established to verify it. This environment is complied with the ECSS standard. This paper describes the simulation model verification procedure and the progress status of the standard script testing tool in DSS.

[P-16] Impact of DTM Resolution on Lunar

Spacecraft Guidance

Dawoon Jung

Korea Aerospace Research Institute

Lunar spacecraft may rely on products based on digital terrain models (DTMs) as a navigational reference or selenoreference. Numerous DTM products from previous or ongoing lunar missions exist, and are typically produced using lidar or photogrammetry. In order to be useful as a guidance reference, a DTM must have a resolution appropriate to the desired target position, ellipse size, and trajectory; landers may require a horizontal resolution in the tens of meters. However, lunar DTM products vary greatly in horizontal and vertical resolution depending on the mission and latitude. This work examines existing lunar DTM product resolutions, and attempts to show their impact on lunar spacecraft guidance.

[P-17] Study of Low-Frequency Waves in an Inhomogeneous Environment by Using Impulsive Source

Danish Naeem, Dong-Hun Lee

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Low-frequency waves have been studied by using numerical simulation in a 3-D box system. We have implemented the Yee Finite Difference Time Domain (FDTD) method to get the numerical solution. Waves are generated through excitation of an electric field component along the y-axis. The wave properties are investigated by dynamic spectra of the different components of electric and magnetic fields. The main purpose of this work is to study the wave theory by considering the magnetospheric dipole field with a box geometry. Later on, we will extend the code to the dipole geometry to get the more realistic picture of magnetospheric waves.

[P-18] Statistical Analysis of ULF Pc2-Pc3 Waves in the Topside Ionosphere Observed by Swarm Satellites during 2 Years

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In the topside ionosphere, Swarm satellites repeatedly observed ultralow frequency (ULF) wave activities in a broadband frequency range from 20 to 250 MHz (Pc2-Pc3 band) on the dayside and a narrowband from 20 to 50 MHz on the nightside below auroral latitudes (|MLAT| < 60°). We have statistically analyzed such ULF activities enhanced in two frequency bands (20-100 mHz, called Pc3 wave, and 100-200 MHz, called Pc2 wave) using Swarm magnetic field data for the interval of 2 years (2014-2015). The statistical results are as follows: (1) These Pc2 waves are frequently observed as transverse dominant waves on the dayside. (2) They disappear near the equator. (3) The occurrence rate of Pc2 waves is slightly higher in the postnoon sector than in the prenoon sector with a peak occurrence rate near the noon and there is no wave activity on the nightside. (4) Pc3 wave powers are also dominant in the transverse component. (5) Unlike Pc2 waves, however, Pc3 waves are observed near the equator both on the day and night sides. (6) Their power is higher on the dayside than on the nightside. In this paper we will discuss how and where transverse Pc2-Pc3 waves in the ionosphere are generated.

[P-19] Quantifying the Effect of Plasmaspheric Hiss on the Electron Loss from the Slot Region

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We present global statistical models of both wave amplitude and wave normal angle (WNA) of plasmaspheric hiss inside the plasmasphere using Van Allen Probe-A observations, which utilizes as inputs the time history of solar wind parameters and the AE index for each measurement of hiss waves. This model explains roughly 27% (32%) and 72% (79%) each of the variation of the observed hiss amplitude and WNA on the equatorial (nonequatorial) region. We present an example output of the model for a corotating interaction region-driven storm that reveals a clear dependence of hiss wave distribution on the magnetic local time (MLT): higher amplitudes with small WNAs are distributed rather on the dayside than on the nightside, which becomes more pronounced during the main phase. More interestingly, intense hiss on the dusk sector for magnetic latitude (MLAT) $\leq 10^{o}$ is propagated from the dawn sector after being excited, while it is locally intensified for MLAT $> 10^{o}$. We also examine how significantly the electron loss rates in the slot region can be changed by incorporating the model output of hiss waves into the time-dependent 2D Versatile Electron Radiation Belt (VERB) code that includes pitch-angle scattering by hiss waves only. Simulations using the VERB code show that during a typical timescale (roughly a couple of days) of the CIR-driven storm the nightside hiss waves with larger WNA ($> 30^{o}$) do not contribute to the electron loss in the slot region due to its low amplitude, while dayside hiss with WNAs less than 30^{o} and comparatively higher amplitudes leads to a substantial drop in flux, especially for a few hundred keV electrons. In addition, the degree of flux decrease is comparable to previous simulations where they assumed field-aligned (0^{o}) WNA distributions without its MLT dependence, implying that the previous assumption is reasonable for estimating the electron loss timescale in the

slot region but stress that more accurate modeling of wave amplitude should be considered.

[P-20] Developing and Calibration of a BITSE (Balloon-borne Investigation of Temperature and Speed of Electrons in the Corona) Polarization CCD Camera

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A Balloon-borne Investigation of Temperature and Speed of Electrons in the corona (BITSE) was developed with the goal of understanding the physical conditions in the solar wind acceleration region (from 2 to 9 solar radius in the sun center), measuring electron density, temperature, and velocity in the corona and verifying the filter system and image detector of the next generation coronagraph. We have developed and calibrated the BITSE Polarization CCD camera. For this we have used photoelectron detector performance test system by ourselves.
The results were compared with the values in the KAI-04070 sensor model manual provided by On-Semiconductor. We made good progress in the main characteristics of the camera such as read noise, dark current, electron-conversion gain, and quantum efficiency.

[P-21] Relativistic Electron Flux Prediction Model Based on Artificial Neural Network Using Flux Data from Two Satellites

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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 model using artificial neural network (ANN) and modified the ANN to solve the problem called overfitting, time shift. Input parameters are solar wind (density, speed, IMF By and Bz), geomagnetic index (Dst, Kp) and electron flux data from GK-2A and GOES. The outputs of ANN are 12, 24 hour ahead relativistic electron flux for each LT and we performed some correction for output. As a result of the model, we confirmed that time shift disappeared for every prediction time, but there is a little difference between observation and predicted values. Also, the correlation coefficient and prediction efficiency are getting low according to prediction time. Our goal is to get better and more precise accuracy in a improved way.

[P-22] Radiation Shielding Analysis Considering Secondary Particles for SNIPE Nano-Satellite in Space Environment

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SNIPE (Small scale magNetospheric and Ionospheric Plasma Experiments) is 6U sized nano-satellite mission to observe a space environment by Korea Astronomy and Space Science Institute (KASI). To analyze a radiation shielding in space environment at the Low Earth Orbit (LEO), we simulate a proton flux of several altitude by SPENVIS(Space Environment, Effects, and Education System), and depth-dose curves of several materials by GEANT4 (for GEometry ANd Tracking). Also, secondary particles generated by the incident protons are estimated, then research an effect of the secondary particles to electronics.

[P-23] Future Steps Necessary for the Detailed Calibration of Off-axis Characteristics for Japanese Solar X-Ray Telescopes

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To theoretically model the three dimensional coronal structures is sensitive to the values of plasma properties at the base of solar corona and thus requires beforehand accurate empirical description of those properties. Therefore, the studies on the physical state of solar corona near the off-limb areas will lead us to understand the important boundary conditions on the mechanisms of heating the coronal plasma. Japanese grazing incidence mirror telescopes, the Yohkoh Soft X-ray Telescope (SXT) and the Hinode X-Ray Telescope (XRT), have provided solar X-ray images for more than a couple of decades including two solar cycles. Since these

X-ray telescopes were designed to observe the Sun in the wide field of view covering full solar disk, targets near the limb area are placed at the outskirt of FOV. For this reason, the off-axis characteristics of solar telescope should be examined when we interpret the physical conditions of coronal plasma from the data taken at the regions far away from optical center. We have evaluated the vignetting effects of Yohkoh/SXT and Hinode/XRT by analyzing 2D distribution of effective area in the FOV using the data taken from pre-launch experiments. The amount of scattered lights inherent in these solar X-ray data has also been examined by analyzing the in-flight images highly saturated during the solar flare events. In spite of several recent advances of our research, it does not mean the calibration of off-axis characteristics for the full solar disk (synoptic) images can be properly performed, because what we have got at this moment are only a clue to resolve the problems. This presentation will explain the importance of accurate calibration of these instrumental effects, especially from the analyses of pre-launch and also in-flight data taken in the off-axis region, which have been revealed and also should be implemented in the near future.

[P-24] Difference in Solar Parameters Dependent on Solar Magnetic Polarity

Suyeon Oh

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The sunspots that increase and decrease in the 11-year cycle, have the reversed magnetic polarity every 11 years approximately at the solar maximum. This polarity reversal can make the difference between odd and even solar cycles in solar activity. We create the mean solar cycle expressed by phase using the monthly sunspot number for all solar cycles 1-23. We also generate the mean solar cycle for sunspot area, and solar radio flux within the allowance of observational range. As a result, the mean solar cycle has one large peak at solar maximum for odd solar cycles and two small peaks for most of even solar cycles. In this study, we present the difference the mean solar cycle of odd and even solar cycles.

[P-25] Operation Concepts and Data Distribution of the ISSS Payload Onboard NEXTSat-1 during Observational Phase

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During the last few months of early stage operation of NEXTSat-1, the instruments for Space Storm Study (ISSS) have tried different kinds of scenarios for verification. High Energy Particle Detector (HEPD) and Medium Energy Particle Detector (MEPD) were operated in the high latitude area to understand the space storm effect on the polar region and precipitating radiation belt particles. Plasma detector package (Langmuir Probe, Retarding Potential Analyzer and Ion Drift Meter) was operated in the mid to low latitude for the study of the ionospheric disturbances in the eclipse. We introduce the operational concepts to be carried out during the observation period. The data, quick look of each payload, and the user's manual are distributed through the http server and provided to each research group. In the future, the ISSS website will provide Level 1 level HDF files. The data format and algorithms to analyze the data with sample data are presented briefly.

[P-26] Negative MHD Wave Instability in the Presence of Flow

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MHD wave instability of tangential discontinuity at the flux tube boundary is studied for incompressible plasma in cylindrical coordinates where longitiduinal flow and viscosity are present in the inner and outer region of the flux tube, respectively. I consider the flow speed is smaller than the speed for KH instability to initiate. By deriving an analytical formula for the growth rate, The condition for the negative wave energy to be excited due to viscosity for underdense and overdense flux tubes is investigated and discussed.

[P-27] Economic Impacts of Space Weather on GNSS Market

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Solar activity has influences in various industrial fields. This study tried to analyze social and economical influence on Korean GNSS area during space weather disaster due to solar activity. By narrowing the target GNSS areas into LBS, Precision agriculture, Surveying and Construction, Roadways, Maritime, Aviation, and Railway, industrial damage in each

area has been calculated based on benefits using GNSS in each industrial areas. The study was also based on social and economic analysis of space weather impact from 2017 NOAA National Weather Service where the events has been divided into extreme and moderate. As the study applied those method into Korean environment, it has been calculated that $0.7 million (₩0.9 billion) to $0.9 million (₩1.1 billion) worth economic damage will occur during moderate, while there will be $17 million (₩21 billion) to $63.5 million (₩75.3 billion) economic damage in extreme event.

[P-28] Study on the Heating Mechanisms of the Solar Corona Using Multi-wavelength Observations: I. Data Selection and Analysis

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It is well known that there are two possible heating mechanisms that cause increasing temperatures dramatically from several thousand kelvins (chromosphere, 1000 km) to a few million kevlins (solar corona, 3000 km): one is direct current (DC) mechanisms related to magnetic reconnections and the other is alternative current (AC) mechanisms associated with waves. These mechanisms are also used to explain the increase of solar corona temperatures from a few million kevlins to a few tens of million kelvins. Until now, there are no statistical investigations on the heating mechanisms of the solar corona. In this study, we consider SDO/AIA, CoMP, Hinode/EIS data from 2011 to 2018. Here, the SDO/AIA data are used to estimate corona temperatures, and to check magnetic reconnection heating process. The CoMP and Hinode/EIS data are used to check wave heating processes. Finally, we will answer the following questions: (1) which mechanisms play an important role in solar coronal heating? (2) what is difference between solar activities (solar maximum and minimum) or coronal regions (active regions, quiet Sun, and coronal hole regions) ? In this presentation, we will show the data selection and analysis for this study.

[P-29] Improve Performance of Magnetospheric Particle Flux Prediction Algorithm (MPF) Using KIP and DIP Prediction Algorithm Result Data

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This paper written for algorithm result of MPF (Magnetospheric Particle Flux Prediction) performance compare with VAP-A beacon data. The algorithm uses as input data several magnetic activity indices that indicate the state of the radiating belt. Among the indices, an algorithm for predicting Kp and Dst was developed at the same time and the data produced by this algorithm was available. We modified the MPF algorithm with the data of the algorithm that replaces the actual data, and compared the result with the actual data.

[P-30] Modeling Study on the Polar Middle Atmospheric Responses to Medium Energy Electron (MEE) Precipitation

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Energetic particle precipitation (EPP) is an important source of chemical changes in the polar middle atmosphere during winter. Recently, it has been suggested from modeling study that chemical changes by EPP can cause dynamical changes of the atmosphere. Here, we study the atmospheric and climatic responses to the precipitation of medium-energy electron (MEE) during 2005–2013 by using Specific Dynamics Whole Atmosphere Community Climate Model (SD-WACCM). Results show that MEE precipitation significantly increases the amount of NOx and HOx, resulting in mesospheric and stratospheric ozone decreases by up to 55% and 20% respectively during polar winter. The ozone loss due to MEE precipitation induces the radiative warming in the polar lower mesosphere by up to 1.5 K averaged 9 years and by temporarily maximum of 24 K. The zonal wind reduces by down to 3 m s-1 averaged for 9 years and by temporarily maximum of 30 m s-1 in the polar middle atmosphere. The radiative warming was significantly disturbed in July 2009 during southern hemispheric winter. The disturbance of the radiative effect seems to generate due to the decrease of ozone loss in the lower mesosphere and the lower thermosphere even though the ozone loss in the upper stratosphere and middle mesosphere generate normally or greatly. The reduced ozone loss in the lower mesosphere and lower thermosphere induce the disturbance of radiative effect during wintertime and furthermore, the dynamic effect may be activated. To persist in the radiative effect by ozone loss

during polar winter, the ozone loss in the altitude ranges of 50–60 km and 80–100 km seems important.

[P-31] Parallelization of a Flux Emergence Simulation Using Message Passing Interface

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We improve a solar flux emergence simulation to understand the evolution of flux ropes from the convection zone to the corona on the Sun. It is regarded that the convection zone contains many flux ropes, and they develop into various active regions as they rise above the surface. Simulating two or more flux ropes needs large simulation domains with high spatial resolution and more calculation time compared to a case of a single flux rope. To resolve it, we upgrade an original simulation code written in Fortran 77 to a parallelized code using Message Passing Interface (MPI) library written in Fortran 90. The parallel computing allows to reduce computation time. We execute the parallelized code on the NEC SX-Aurora Tsubasa which has vector engine processors. Also it is compared with the original code on a scalar processor. The parallelized model is faster and able to handle a large amount of data. This means that more complex subsurface structures could be generated by numerical model, which helps to understand the evolution of flux ropes.

[P-32] A Study on the Spacecraft/Launch Vehicle Simulator Design for Its Electrical Interface Checkout

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Any spacecraft must be interfaced with a launch vehicle. Therefore, it is essential to check the electrical interface between a spacecraft and its launch vehicle before launch campaign. In order to check the electrical interface, spacecraft simulator or launch vehicle simulator is generally used because it is very difficult to locate both a spacecraft under development and its launch vehicle at the same place. In order to design a simulator, interface circuit design shall be considered intensively. Generally, the interface circuit shall be as close to that of its flight model (FM) as possible. That is because the purpose of the simulator is to check the electrical interface between the FM satellite and its FM launch vehicle. Other than the interface circuits implementation, test pins for harness, loop back testability, etc. shall be considered.
This paper discussed spacecraft/launch vehicle simulator design methodology. This paper can be a guideline for any simulator design.

[P-33] Structural Environment Test of Qualification Model in Science Payloads Unit for the Small Scale MagNetospheric Ionospheric Plasma Experiments (SNIPE) Mission

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To resolve the microscale plasma structure and temporal, spatial variation on the topside ionosphere, the Small scale magNetospheric Iohnospheric Plasma Experiments (SNIPE) mission is under developed by Korea Astronomy and Space science Institutde. The science payloads unit is consist of particle detector (Solid-State Telescope, SST), plasma properties measurement device (Langmuir Probe, LP), and magnetic field measurement device (MAGnetometer, MAG). In this paper, we report structural analysis result and vibration test result of the Engineering Model (EM) for science payloads unit. The vibration tests consist of sine wave and random vibration test and both test was performed based on the SNIPE mission environmental test specification. For the structural analysis, we performed 10G analysis for the check the max stress using by simulation tool. In conclusion, engineering model of science payloads unit for the SNIPE mission has passed the space environment test. The detail of test procedure and result are presented.

[P-34] Preliminary Results of Physical Properties of a Polar Coronal Hole Measured by the SDO/AIA

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We derive the number density, temperature, and flow speed of the electron in an off-limb coronal hole. The quantities are obtained from the differential emission measure (DEM) for the extreme ultraviolet (EUV) images of the SDO/AIA observed from 00 UT to 24 UT on 2017-Jan-3. The EUV images are temporally and spatially averaged to improve the signal-to-noise ratio before the DEM calculation. As a result, we derive an height profile of the number density as well as a DEM-weighted average temperature at the poles. We also find that the EM ratio of hot plasma relative to cool plasma increases as the height increases. From the time-height map of the EM, we detect propagating disturbances as in the EUV

channels. The speed estimated from the EM is slower than the speeds in the EUV images.

[P-35] Radiative Cooling Instability in Magnetized Plasmas with Shear Flows

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It is generally believed that the cool material in solar prominences is formed by condensation of hot coronal plasma through radiative cooling instability. It was argued by Zirker et al. (1998) that the existence of solar prominences (filaments) be conditioned by ubiquitous counter-streaming flows. Although thermal instability has extensively been studied in diverse optically thin plasmas, it has not been studied in magnetized plasmas with shear flows. We establish a magnetohydrodynamic (MHD) model with radiative cooling, plasma heating and anisotropic thermal conduction and put it in the form of an eigenvalue problem by linearization and Fourier transform of the governing equations. The eigenvalue problem is discretized in the direction of the shear variation and is numerically solved to obtain eigenfrequencies and eigenfunctions. For a shear velocity less than the Alfven velocity of the background plasma, the eigenvalue with the maximum growth rate is found to correspond to a thermal condensation mode, for which the density and temperature variations are anti-phased. Only when the shear velocity in the k-direction is near zero, the eigenfunctions for the condensation mode are of smooth sinusoidal forms. Otherwise each eigenfunction for density and temperature is singular like delta functions. Our results indicate that any non-uniform velocity field with a magnitude larger than a millionth of the Alfven velocity can generate singular eigenfunctions of the condensation mode. We therefore suggest that filamentary condensation (condensation at discrete layers or threads) should be quite a natural and universal process whenever a thermal condensation instability arises in magnetized plasmas.

[P-36] Development of ASSA Sunspot Model Validation System

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The Korean Space Weather Center (KSWC, RRA) developed the model verification system that verifies the results of the models for forecasting and analyzing the space environment in operation.

The model verification system standardizes the forecast data of the each model and observation data which is used for verification of the model result and validates the model result by applying the verification metrics recommended by the WMO. The system consists of 1) Meta DB that contains the meta data of model output and observaion data, 2) Collecting and standardizing module of the data, 3) Verifying module of the model data, 4) Web interface which visualize the verification result. It is applied to ASSA Sunpot model that is running at KSWC. As a result, ASSA Sunspot model showed a high hit rate in analysis of the area, location, magnetic field classification grade, Zpc classification grade, and flare prediction probability of sunspot. The model verification system will also work on the other models.

[P-37] The Variation of Vertical Distribution of Physical Properties of the Upper Atmosphere between 0-300 km Altitude and the Range of 120°E-180°E and 40°S-40°N for Design of Space Plane Thermal Protection System

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For the design of Korean Unmanned Small Space Plane (KUSSP), first of all we should know the vertical distribution of physical and chemical properties such as temperature, pressure, horizontal winds and chemical species. The KUSSP would start re-entry from at the sky of Australia and New Zealand and would land on an airport in the Korean peninsular through 3,000 km flight path with −1° flight angle and 45° of angle of attack. The space boundary of re-entry trajectory should be range of 120°E-180°E and 40°S-40°N in the Earth coordination system. For the detail design of KUSSP we should know the variation of physical and chemical properties such as mean value and maximum & minimum values. The upper atmospheric physical and chemical properties should be varied with ‘Season’, ‘Day/Night Time’ and ‘Solar Activity’. The Earth’s magnetic activity has random behavior, so it’s effect is not able to predict and mean variation could be negligible. In this study we analyse the variation of physical properties of upper atmosphere such as temperature, density and winds. We construct the data base of upper atmospheric physical properties and it will be very useful for the design of various re-entry vehicles.

[P-38] Initial Polishing Process Control to Determine Target TIF on SiC Substrate

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Total fabrication period of the SiC substrate has been challenging to determine by master optician due to the difficulty of polishing on SiC material. In the optical shop, optician normally enters input parameters into a polishing machine prior to polish out the mirror surface. The target surface removal rate, specified by an optician, are highly depending on polishing schedule. A very tight polishing schedule commonly thrusts adventurous larger target quantities on the optician. However, the target numbers should be determined by the reliability of relationships between the machine input parameter and output removal rate. In this study, we introduce an initial process control which can reliably suggest machine input parameters for polishing head. These parameters can control polishing processes to achieve the target TIF (Tool Influence Function) which is an unit polishing removal quantity on the SiC mirror optical surfaces.

[P-39] Study on the Internal Interface of Camera Electronics Module

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As complexity increases in CEM (Camera Electronics Module) in order to implement challenging requirements for high-performance electro-optical payload system, the effective design for internal interface between PSU (Power Supplier Unit), CCU (Camera Controller Unit) and FPU (Focal Plane Unit) which comprise the CEM is inevitable. In this paper, we study on general method for CEM internal interface in which we describe how we break down the requirement and list the resources necessary for meeting the requirement. As a results, we show how we implement the internal interface between each unit effectively.

[P-40] Optical Design and Performance Analysis for the Wide Field Satellite Camera

Seonghui Kim

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Wide field multi spectral camera for the advanced land imaging will be one of the next-generation satellite optical payload. The top requirement for the optical field should be more than ± 4 degrees to meet the 120 km swath width from 900 km altitude. The ground sampling distance shall be less than 5 m. We will present the requirement analysis, optical design, and the performance analysis results with un-obscured TMA configu ration.

[P-41] CDRS (Carbon Dioxide Removal System) Design Using the Microwave Heating Method in ECLSS (Environmental Control & Life Support System)

Younkyu Kim, Jongwon Lee, Joohee Lee

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ECLSS (Environmental Control & Life Support System) is an essential and indispensible system for humans to reside in space or on the moon or Mars, and one of the most important systems in ECLSS is the elimination of carbon dioxide from astronaut breathing in an enclosed environment. The removed carbon dioxide can be reused again for producing water or methane through Sabatier or Bosch reactor in a closed-loop system, especially CDRS can be used for an *In-Situ* Resources Utilization (ISRU) system to produce the necessary resources in places where the atmosphere is mostly composed of carbon dioxide, such as Mars. Therefore, this study is for the system design of CDRS, subsystem in ARS (Air Revitalization System) under development, for feasibility study on removing carbon dioxide. The CDRS can be divided into regenerative and non-renewable system depending on mission characteristics, and a comparative analysis of both methods has been performed as the missions. In the case of regenerative type, carbon dioxide adsorbed to the zeolite in the method of 4BMS (4-Bed Molecular Sieve) is applied indirectly to the heat of 200℃ or less using a general heating wiring device to remove carbon dioxide by heat. These methods were relatively inefficient due to long time to heat the desorption bed changing from room temperature to high temperature repeatably, resulting in longer cycles of carbon dioxide adsorption and desorption. Therefore, this paper proposed an new system using the microwave thermal device for making shorter cycle time in removing carbon dioxide, analyzed the main design parameter for drawing the optimal design values, and performed the feasibility study of the newly proposed system.

[P-42] Image Quality on TDI Sensors by Velocity Mismatch to Line-time

Youngsun Kim, Sang-Soon Yong

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Time Delay Integration (TDI) techniques gives the primary advantage on a signal-to-noise ratio for high-resolution camera system. However, various operation conditions on TDI sensors such as waveforms for charge transfer from electrical circuits, sensor parallelism to target direction, and velocity mismatch to line time can affect on image qualities, especially, dynamic MTF performance, at the TDI sensor's internal charge accumulations process. The dynamic integration time control method is used to the some cameras in order to

reduce dynamic MTF performance degradation by velocity mismatch. This paper studies the relation between the velocity mismatch to line time and dynamic MTF. In additioin, the various experimental cases changing target velocity and integration time, number of TDI, even reverse direction of target movement against charge transferring direction are carried out to investigate how much it affects on image quality and its performance. The experimental results are reviewed with quantitative analysis method in the paper.

[P-43] Development Trend of Chinese GEO-Meteorological Satellite

Hwan-chun Myung, Jae-dong Choi

Korea Aerospace Research Institute

In 2016, China successfully launched its first three-axis type of geostationary meteorological satellite (FY-4A). The second one of FY-4, FY-4b, is also expected to be in-orbit this year. Differently from the previous type (FY-2), FY-4 was developed to include an imager (AGRI), a sounder (GIIRS), a light imager (LMI), and a space –weather instrument (SEP) as well as the more stabilized attitude-orbit control system of S/C. The bus platform is based upon SAST- 5000 (5,400 kg, 3,200 W), developed by CASC/ SAST, with the design life of 7 years. As a main instrument, AGRI is equipped with 14 channels (VIS: 0.5～1 km, IR: 1～4 km), and it can scan the full disk in 15 minutes. In the next version(FY- 4B/4C), the number of channels and the spatial resolution will be increased to 15～18 and 0.5～2 km, respectively. GIIRS, as a spectrometer, has 914 channels over VIS/MWIR/LWIR with the spatial resolution of 2～16 km. It is planned in the next version of FY-4 to upgrade GIIRS with 1,189 channels and 8km resolution. Finally, the presentation ends with stressing the versatility of FY-4A by introducing the intial results (LMI image/electron flux/radiation dose etc.) of LMI and SEP.

[P-44] The Analysis of the Configuration and Main Operation for the Lunar Exploration Electro-Optic Payload Camera Acquisition Image Data

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

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[2]*Chungnam National University, Department of Electronics Engineering*

Mounted on the lunar probe, the electro-optic camera for the purpose of acquiring image data of the moon from the lunar orbit is performed to verify its function and performance through numerous ground tests to verify reliable operation in orbit. It is essential to check the function and performance of the camera, and to determine whether the acquired image is abnormal. In the case of the camera electronic unit, an image part having image information of a target and a header part containing the relevant information are included. In the case of the header, since the size of the entire data is limited, only the essential information for efficient operation of the camera operation and the acquired image information is included. The information contained in the header includes basic information of the camera, whether the image is compressed, the OBT time, the linerate, the integration time, and the data of the image sensor when the image is acquired. Verification of header information and acquisition images from camera acquisition data such as these is essential for ground test verification.

In this paper, the composition and main operation of the imaging analysis tool for efficient analysis of image information obtained through the numerous ground tests of the electronic optical tower camera mounted on the lunar probe and performed the moon's imaging acquisition mission are analyzed and described.

[P-45] An Analysis Software Implementation for GEMS Command History and Event History

Seok-Bae Seo, Seonghoon Lee

Korea Aerospace Research Institute

GEMS (Geostationary Environment Monitoring Spectrometer) house-keeping telemetry includes Command History and Event History to check command sequences and GEMS operations. This paper explains the software implementations to analyze GEMS Command History and GEMS Event History in the GEMS house-keeping telemetry.

[P-46] Performance Analysis of Space-born Telescope Structure Due to Environmental Conditions

Jeoung-Heum Yeon, Su-Young Chang, Sunghui Kim, Eung-Shik Lee, Sang-Soon Yong

Korea Aerospace Research Institute

Space-born telescope structure endures various environmental conditions such as launch vibration environment and in-orbit thermal environment. Even for the hard environmental condition space-born telescope structure should preserve its performance. In this paper performance analyses of telescope structure under the environmental conditions are introduced. Optical component deformation analysis for in-orbit hot and cold conditions are analyzed. Wave-front error analysis of the primary mirror under telescope mounting conditions also analyzed.

[P-47] The LEOP (Launch and Early Operation) Plan of GOCI-II on Geo-KOMPSAT-2

Sang-Soon Yong, Sung-Yong Cha, Gmsil Kang, Heong-Pal Heo

Korea Aerospace Research Institute,

GOCI-II (Geostationary Ocean Color Imager 2) is payload on Geo-KOMPSAT-2 satellite as follow-one of GOCI on COMS to observe ocean color and monitor ocean status around Korean peninsular. GOCI-II has improved geometric and radiometric performance than GOCI on COMS, such as full earth disc imaging, selectable local area monitoring and 13 spectral bands acquisition including star imaging band. GOCI-II is covered 2,500 km × 2,500 km FOR (Field of Regard) by stare-and-step operation method. Ocean color data is acquired 10 times for reference local area and one times for full disk per day. In this paper, the LEOP plan of GOCI-II was analyzed and described.

[P-48] The Focus Control Capability Verification of High Stability Telescope Structure Qualification Model for High Resolution Camera

WonBeom Lee, JeoungHeum Yeon, Jongguk Choe, SuYoung Chang, EungShik Lee

Korea Aerospace Research Institute

High resolution optical camera for space is designed and manufactured to ensure stability and performance against the load during launch and the thermal environment conditions that occur on orbit, and are verified through ground tests. After verifying that the performance of the payload remains unchanged, it is launched. Most optical cameras, however, will be equipped with a focus control system to prepare for a shift in focus due to unforeseen reasons. The focus control system plays a role of focusing by altering the position of the major optical components. In this paper, the HSTS QM is equipped with a focus control device that adjusts focus by thermal elastic deformation, and it is confirmed that the required performance of the focus control device is satisfied under the vacuum and temperature change.

[P-49] Radiation-hardened CMOS Digital Circuit Design of Infrared Detector System for Space Application

Ilseop Lee, Eung-Shik Lee, Sang-soon Yong

Korea Aerospace Research Institute

Most read-out integrated circuit (ROIC) for infrared detectors are fabricated by CMOS (Complementary metal-oxide-semi-conductor) process. The ROIC consist of CMOS analog and digital circuits, such as amplifier, register, analog-todigital converter (ADC), etc., which are vulnerable to the cosmic rays. For this reason, radiation hardened by design (RHBD) of circuits that compose the ROIC of the infrared detector for space application is required. In this paper, we will present a unit cell of radiation-hardened digital circuit designed with 0.11 μm CMOS technology with the simulation result for the radiation effect.

[P-50] A Roadmap on the ECLSS (Environmental Control & Life Support System) Development with ISRU (*in situ* Resource Utilization)

Jong-Won Lee, Joo-Hee Lee, Youn-Kyu Kim, Gi-Hyuk Choi,

Korea Aerospace Research Institute

In-Situ Resource Utilization (ISRU) refers to the performance practice of the acquisition, processing, production, storage, and utilization of the found or manufactured resources on other astronomical objects such as the Lunar, Mars etc. It can provide resources for life support, propellants, construction materials, and energy to a space exploration system and astronauts in long-term space exploration. Recently, NASA has announced the plan to return humans to the moon by 2024 called “Artemis program”. Thereby, they are carrying out a research on the ISRU. Currently, the Korea Aerospace Research Institute (KARI) is studying on the development of ECLSS, an essential system for a long-term mission of astronauts. ECLSS is a correlation with ISRU about making supplies, such as oxygen, water, and propellant for astronauts. Therefore, this presentation will introduce the basic research on the relation of the ISRU to ECLSS. Furthermore, we will make a suggestion on the development roadmap for the ECLSS with ISRU.

[P-51] Segmented Compressed Image Data Structure for Wide Swathwidth Image Data Compression of Low Earth Orbit Satellite

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

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

Low earth orbit satellites are demanding high resolution image for precise observation of the region of interest. In addition, the user want to increase the usability of the satellite image by acquiring wide area image possible at one time of imaging. These requirements lead to the increased processing power required for image compression. Image compression is normally used for reducing image transmission time to ground station. One way to reduce the resources and

to speed up the process for image compression, is to cut the image to the appropriate size and compress them in parallel. we will present how satellite image can be divided and compressed into tiles and transmitted in segments. We hope this will help development similar satellite image compression system.

[P-52] Air/Atmosphere Management System (AMS) Design of the Environmental Control and Life Support System (ECLSS) for the Manned Space Exploration

Joohee Lee, Younkyu Kim, Jongwon Lee, Gihyuk Choi

Korea Aerospace Research Institute

The environmental control & life support system (ECLSS) technology, which supplies fresh oxygen and clean water to astronauts, is a core technology for the manned space exploration missions such as the International Space Station (ISS) program, Moon and Mars exploration missions etc. ECLSS is consists of three major following parts; air/atmosphere management system (AMS), water recovery system (WRS), and waste management system (WMS).
Recently, the Korea Aerospace Research Institute (KARI) is developing a development model of air/atmosphere management system (AMS) that is one of the major parts of ECLSS. The first major function of AMS is to electrolyze water using oxygen generation system (OGS) and supply oxygen. The second function of AMS is to remove carbon dioxide with adsorbent media using carbon dioxide removal assembly (CDRA) system. Finally, the AMS is dedicated to eliminate trace contaminants produced by electronics, and human off-gassing etc.
Therefore, this paper will propose a development model design of air/atmosphere management system for ECLSS.

[P-53] Development of a Precise Positioning Device for a Large Optical Payload

Su-Young Chang, Youngchun Youk, Jongguk Choe, Eung-Shik Lee, Sang-Soon Yong

Korea Aerospace Research Institute(KARI) Satellite Payload Development Division

In this paper, a precise positioning device under development for a integration and testing of a large optical payload is described. At previous programs for optical payload development, a gimbal type devices were utilized to very accutately adjust a position and rotation of payload during integration and testing phase. KARI's OTVC (Optical Thermal Vacuum Chamber) is utilized for a optical testing of optical payload under thermally controlled vacuum environment, and this device has a limitation of height. For a optical testing of a Kari's up-to-date large optical payload, this kind of positioning device shall be chaged to other type with a much reduced height. In KARI's new concept, the optical payload will be mounted to a fixed frame, called a cradle, and then the cradle with the payload will be manipulated on a top of new positioning device. This new positioning device, called as a large hexapod, has a strict restriction in a height, but a large load capacity, very precise incremental motion and good repeatability. And this device shall be structurally stiff with not a small natural frequency, which is required to cut-off a micro vibration from base of the hexapod.

[P-54] A Study on the Satellite Image Validation Process Automation Method

Gab-Ho Jeun, Yoon-Jeong Jang, Dae-Won Chung

Korea Aerospace Research Institute

Most of small satellite constellation or low resolution satellite use the there own grid reference system to efficiently take the global image data. but, high resolution remote sensing satellite such as KOMPSAT take image data based on user's AOI (area of interest). Remote sensing data taken by KOMPSAT are received using a ground antenna system and provide to the user as a standard product through a image pre-processing. At this time, a image validation process should be conducted to verify that the new tasking images conform to user requirements. In many case, images taken from satellite may not be satisfied user requirements such as location, period, angle, cloud&shadow, snow&ice or image quality due to the various situations that can occur during satellite imaging. Therefore, image validation process is needed to provide suitable data or to additional tasking if the acquired data is not valid.
This paper describes the criteria and methods of image validation process and also describes the automation method.

[P-55] A Propose of Development and Management Approach Based on the Heritage for Satellite ICD (Interface Control Documents)

Jin Pyong Jung, Seung Hun Ha

Korea Aerospace Research Institute

The satellite system is characterized under the harsh environment of the universe and the inability to repair them after launch, and are generally designed to be conservative, applying many proven designs. However, in the case of payload systems, new designs are indispensable depending on the purpose and target performance of the satellite. In particular, the interface designs require a lot of changes compared to the existing Heritage. In this paper, we propose an approach that

can develop and manage an interface control document (ICD) that can be used in a small-scale development organization, and the characteristics of satellite development, which are produced in small quantities and difficult to mass reproduce. This approach is characterized by the use of standardized templates and standard texts. So, this can provide improved completeness of documents. This also provides an online review of relevant departments and stakeholders. So, it can increase working speed and efficiency. In addition, distributed documents can be viewed online for continuous configuration management.

[P-56] Drag Free System Payload of SIGN-pathfinder Cubesat for Measurement of the Sensitivity of Our Proposed Gravitational Wave Experiment SIGN

Minhyo Kim[1], GiHan Hong[1], K.H. Lee[1], Minbin Kim[1], Il H. Park[1], Eunil Won[2]

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The Stellar Interferometer for GravitatioNal wave (SIGN) experiment, using spatial coherence of star light instead of temporal coherence of laser, is newly proposed by Il H. Park. It turns out to be sensitive to low frequency range gravitational wave (GW) by filling the gap of frequencies nicely between the LISA space experiment and Pulsar Timing Array ground experiments. This method requires two or three small satellites for intensity or amplitude interferometer, respectively, to collect lights from a given star. Due to various origins of forces exerted on the satellites including cosmic particles or residual gases, a precise understanding of acceleration noises caused by these forces is crucial like other space borne GW experiments. In order to measure acceleration noises as well as control the satellite attitude in extreme precision, we are developing the Drag-Free System (DFS) payload onboard a CubeSat (called SIGN-pathfinder). The DFS is based on the capacitive position detector with a test mass floating within the satellite, which measures variation of the distance between the satellite and the test mass with the precision of μm order. We will introduce the concept and preliminary design of our DFS in this poster.

[P-57] Development and Performance Verification Using Software Based Simulator of Onboard Orbit Modules for KPLO

Jo Ryeong Yim

Korea Aerospace Research Institute

This paper describes the development and performance verification of the onboard orbit modules using a software based verification tool for KPLO. KPLO is a lunar orbiter developed by KARI, and the onboard orbit modules are the onboard orbit generation flight software (FSW) that supports spacecraft operation and attitude control by generating position and velocity information of celestial bodies such as the sun, moon, and earth as well as the spacecraft orbit information. In previous research, the orbit generation algorithms for Earth-Moon transfer orbits, orbit generation algorithms in lunar orbits, the sun and moon ephemeris generation algorithms, and on-orbit operation concepts were introduced. This paper shows that the performance analysis of each module by using MATLAB by MathWorks® and the software based performance verification results for the onboard orbit FSW codes. According to the development process of the spacecraft onboard software, a total of six onboard orbit generation software codes were implemented in the onboard orbit modules. In addition, an orbit simulator (OrbitSim) has been developed in order to verify the performance of the FSW codes. Based on these results, it can be confirmed that the performance required for the orbit modules is fully satisfied and the onboard orbit modules are properly developed.

[P-58] Non-linearity Analysis of Inter-bands for Geostationary Ocean Color Imager-II (GOCI-II)

Gmsil Kang, Sang-Soon Yong, Seong-Yong Cha

KARI Satellite Payload Development Division

The Geostationary Ocean Color Imager-II (GOCI-II) which is one of major payload for GK2-B is under development by KARI (Korea Aerospace Research Institute) to observe ocean around the Korean Peninsula from a geostationary platform. There are 12 spectral channels (narrow band) including one broad band channel for star imaging. During its mission operation, the radiometric gain of each pixel for each spectral channel will be periodically measured through solar calibration using on-board calibration devices, solar diffuser (SD) and diffuser aging monitoring devices (DAMD). It is known that the radiometric response of the GOCI-II shows nonlinear response through on-ground radiometric test. It is expected that non-linearity is caused mainly due to CMOS detector including readout circuit and video electronics. So the non-linearity will be the same regardless of spectral channels. Then, only linear gain for each spectral channel is needed to be assessed through solar calibration during in-orbit operation. This will simplify the in-orbit solar calibration. In this paper, similarity of non-linearity over spectral channel is analyzed. Using the known (common) non-linearity, the linear gain is assessed for each spectral channels using least square fitting. Then, fitting performance for all spectral channels are examined. Trend of fitting performance with respect to the

variation of dynamic range is analyzed. Sensitivity of non-linearity estimation to dynamic range is also examined.

[P-59] Analysis on the Station Acquisition Results for GEO-KOMPSAT-2A

Sang-Wook Kang, Bong-Kyu Park, Jae-Dong Choi

Korea Aerospace Research Institute

The GEO-KOMPSAT-2A (GK2A) was launched at Guiana space center located in the northwest of Kourou of the south America on December 4 21:10 39:00 2018 (UTC). During Launch and Early Operational Phase (LEOP) of GK2A, five maneuvers were performed to bring it from 119 deg of longitude to 128.25 deg of a target longitude in Geostationary orbit (GEO). Now GK2A is carrying out missions on meteorological observations over Korean peninsula and space observations at 128.25 deg of longitude in GEO. The size and mass of GK2A are 3.8 × 8.9 × 4.6 (m) and 3,500 kg respectively. In this study, we have analyzed the result of the station acquisition to transfer GK2A to a desired GEO.

[P-60] In-Orbit Assessment of Flight Software for COMS Meteorological Mission

Soo-Yeon Kang

Korea Aerospace Research Institute

COMS, which carries out meteorological observation, oceanic observation, and communications missions, is Korea's first geostationary multi-purpose satellite launched on June 26, 2010, has completed its seven-year mission and currently extending its mission. COMS was developed based on the communication satellite E3000 platform with the addition of meteorological payload and meteorological interface equipment for meteorological observations. While controlling and operating these equipments, it was required to develop flight software to perform autonomous meteorological observations for 48 hours without ground interference. This paper describes the requirements, design and development of COMS flight software for meteorological observation in detail. In addition, through the FDIR (Fault Detection, Isolation and Recovery) case that occurred during meteorological mission operation after launch, the newly developed meteorological flight software works perfectly according to the defined actions and protects meteorological equipments from single event upset. To date, all functions of COMS flight software has been successfully operating.

[P-61] Monitoring Ocean Surface Underneath Tropical Storms Using KOMPSAT-5 Wide Swath SAR

Chi-Ho Kang[1], Mi-Ri Kim[2], Ho-Il Cho[2]

[1]*Korea Aerospace Research Institute*
[2]*SI Imaging Service*

The ocean surface roughness influenced by wind and waves can be the source for the backscatter of the SAR signal, The active radar signal of SAR penetrates clouds and can image at any time of day. As a result, ocean surface underneath tropical storms can be detected by synthetic aperture radar (SAR). Finally, SAR can contribute to ocean surface information that cannot otherwise be obtained below the cloud with finer resolution. During 2019, there have been trials to acquire images of ocean surface roughness underneath large-scale tropical storms by using KOMPSAT-5 SAR wide swath mode. In this paper, we summerize the campaign to observe ocean surface underneath tropical storms and present resultant imagery, which shows eye shape and patterns of ocean surface wind driven by tropical storms are clearly shown.

[P-62] NMSC GK2A Ground System SW Integration Test I, II

In Hoi Koo, TaeBong Oh, Chi Ho Kang, Hyun-Su Lim, Dong Oh Kim, Jin Hyung Park, Jun Young Bok

Korea Aerospace Research Institute

NMSC (National Meteorological Satellite Center) have established the ground system for GK2A(Geostationary Korea Multi Purpose Satellite-2A), which was launched in December 2018. The ground system is designed and developed to control the satellite, receive and process meteorological data from GK2A. The first integration test of ground system software was conducted on the middle of 2018. And the second test, which is for verification and validation of integrated system software after satellite launch, was finished on August 2019. In the paper, the progress and result of the integration test is briefly presented.

[P-63] Prototyping Result of Mission Planner for KPLO Deep-Space Ground System

Dong-Gyu Kim[1], Han-Je Jo[2], Moon-Gi Kim[2]

[1]*Korea Aerospace Research Institute*
[2]*InSpace*

Korea Aerospace Research Institute (KARI) has been developing Korea Pathfinder Lunar Orbiter (KPLO) and KPLO Deep-Space Ground System (KDGS). One of the major functions of KDGS is Mission Planner (MIP) to generate bus and payload operation plan and derive command parameters for KPLO mission operation. KARI has chosen flexplan S/W for MIP and flexplan is a COTS S/W produced

by GMV and this S/W consists of External Interface Manager (EIM), Mission Environment Preparation (MEP), Planning Input Customization (PIC), Schedule Generation (SG), and Reporting & Query Tool (RQT).
In order to facilitate flexplan for MIP, KARI has defined draft version of KPLO oriented mission planning architecture such as KPLO events, tasks, resources, and decision tables. KPLO events are divided into Bus Operation Event (BOE), Payload Operation Event (POE), Flight Dynamics Operation Event (FOE), and Ground Operation Event (GOE). flexplan also requires a mission to define 4 types of tasks for each events, relevant resources and scheduling rules. In this paper, we will introduce overall architecture of KPLO mission planning based on flexplan S/W and present KPLO MIP preliminary design and prototyping result.

[P-64] Calculation of Valid Time Interval between Image Plan in Consideration of Satellite Maneuver Performance when Creating Image Collection Plan

Dong-Oh Kim, Jun-Yeong Bok

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

Korea Areospace Research Institute (KARI, hereafter) perform task for image collection and downlink planning, mission control, ingestion and processing for KOrea Multi-Purpose SATellite (KOMPSAT, hereafter).
It is important role of satellite to image the target and transmit to ground station. In order to image the target, the ground station must perform the image collection and downlink plan and transmit the generated plan information to the satellite in advance.
This paper describes to calculate the valid time interval between image plan in consideration of the satellite maneuver performance when creating image collection plan.

[P-65] A Study on the High-Speed Processing Techniques of Satellite SOH Data

Myungmuk Kim, Myeongshin Lee, Daewon Chung

Korea Aerospace Research Institute

Analyzing the SOH data for the safety of satellite operation is one of the main tasks of satellite operation. Satellite SOH data is divided into hundreds of thousands of blocks consisting of Hex values, and the data is output to processed data through pre- and post-processing. Due to the various procedures that occur during these analyses, it takes a long time to acquire data that can confirm the mission success. In this paper, we discuss the problems of the existing satellite SOH data processing method of Arirang satellite series and how to process the data at high speed.

[P-66] Development of a Robust Differential Pulse Input Circuit on Electrical Ground Support Equipment for the Differential Signal Operation of Satellite

Young-Yun Kim, Dong-Chul Choi, Yun-Ki Lee

Korea Aerospace Research Institute

After liftoff, satellites could not be modified or replaced so that their functions should be fully verified prior to launch on the ground. For the verification of satellite on the ground, electrical ground support equipment is used for the measurement of signal or the simulation of signals or the stimulation on test point. The function of electrical ground support equipment shall be ensured and well operated in any environment. If the electrical ground support system has different performance depending on the external environment, the test results are not reliable. This paper reports the design of the circuit having a function with differential input pulse stimulation and its test results after the implementation of the design having a robustness against external noise.

[P-67] Alignment Measurement and Calibration for Geostationary Satellite 10N Thrusters

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

Korea Aerospace Research Institute

Satellite thrusters generate thrust by injecting the propellant in the opposite direction using energy obtained from chemical reactions and thermodynamic expansion. The thrusters of geostationary satellites have both high and low thrust forces generally. The 400N Liquid Apogee Engine (LAE), which is the high thrust force, is mainly used for orbital correction. The 10N thruster, which is the low thrust force, is used for attitude acquisition, triaxial stabilization, orbital adjustment, direction change, and moment dumping. The thruster depends on the total shock required by the attitude control system, the thrust size, the duty cycle, and the position and quantity. Initial alignment measurement of thrusters is performed after satellite assembly has been completed. After various environmental tests, the final precision alignment measurement is performed. At this time, calibration and alignment re-measurement are required according to the measured value.
This paper describes the alignment measurement and calibration of 10N thrusters for geostationary satellite.

[P-68] Study for Successful System Integration and Test Planning

Hyung-Wan Kim, Jung-Su Choi, Jong-Seok Park
Korea Aerospace Research Institute

System integration and test planning is one of the most significant activities in a spacecraft development process. It should consider many aspects such as functional integration of a spacecraft subsystems and integration the spacecraft to the launch vehicle. In order to successfully plan this process we should know what the system integration is and what the system integration strategies and approaches are for a spacecraft development. In addition, system integration roles and responsibilities should be defined and integration approaches and test types should be studied. After studying all these elements for system integration and test planning, it needs to be discussed what the key elements and problems are for a successfully plan for a spacecraft development.

[P-69] Mass Properties Measurement for Geostationary Satellite

Nam-Jin Moon, Jong-Hyub Jun
Korea Aerospace Research Institute

Satellite needs to measure mass properties like mass, moment of inertia, and product of inertia during development process. They are essential information for attitude and orbit control of satellite during orbit movement.
KARI has being performing mass properties measurements for several satellites for about 20 years. The measurement equipment had been working well without any problems. But the parts in the equipment aged and had a lot of possibilities for failures due to aging. So the equipment has upgraded especially for electrical parts and software. The upgrade work was done successfully.
Upgraded machine was verified through acceptance tests, and then a developing geostationary satellite got the essential information of mass and moment of inertia using the machine.

[P-70] Vibration Test of APMU of KPLO

Seung-Yong Min, Hyun-Jin Shin, Beom-Suk Kang
Korea Aerospace Research Institute

Korea Pathfinder Lunar Orbiter (KPLO) has a High-Gain Antenna Assembly (HGAA) to communicate with ground stations on Earth. HGAA consists of Antenna Pointing Mechanism Unit (APMU) including an antenna and mechanisms, and Antenna Pointing Electronic Unit (APEU) to control APMU and communicate with BUS. A dish antenna of APMU is locked up until the antenna separation. After the separation, the antenna will rotate in two axes with hemispherical coverage. Currently various tests of APMU under launch and space environments are being performed. In this study, vibration test results of APMU and its notching analyses are summarized.

[P-71] Autonomous North/South Station-keeping Algorithm for Geostationary Satellites with Electrical Propulsion System

Bong-Kyu Park, and Jae-Dong Choi
Korea Aerospace Research Institute

Recently, thanks to the high efficiency of EP (Electrical Propulsion) system, the station-keeping maneuvers of geostationary satellites are gradually implemented with the EP system instead of the traditional chemical propulsion system. For the coming geostationary communication satellite, KARI also is planning to apply electrical propulsion system for north/south station-keeping maneuvers. The high efficiency of EP system allows the satellite to have longer mission life and/or to accomodate heavier payloads for the same level of launch mass. But the low thrust of EP system asks much frequent station-keeping maneuvers which results in heavy operational burden. For example, for the satellite with EP system, the north/south station-keeping maneuvers shall be performed once or twice per day in two or three ours of duration depending on the thrust level. Performing the station-keeping maneuver everyday by ground commands is big burden for ground operators. As a simple solution to this problem, we can consider the time-tag command based maneuver programming which can be performed once a week. However for the security of the communication mission in the event of permanent damage in ground facilities, this paper purposes simple autonomous north/south station-keeping algorithm using the orbit data fed from onboard GNSS receiver. Basically, autonomous station-keeping algorithm should be simple in order to avoid heavy computational burden. Feasibility of the proposed algorithm has been proven through computer simulations.

[P-72] The Thermal Vacuum Test Results for CAS500-1 EOS FM

Sung-Wook Park, Hee-jun Seo, Hyokjin Cho, Hye-jin Yi
Korea Aerospace Research Institute

For the payload of a satellite that undergoes harsh environments different form the ground in its space orbit, it is required to verify the optical performance and focus mechanism performance at high-vacuum and specified temperature range before liftoff. This paper described the thermal vacuum test results for the CAS500-1 EOS flight model conducted by the Korea aerospace research institute.

[P-73] Compact Advenced Satellited 500(CAS500) Direct Ingestion Subsystem Integration Test

Jong-Bum Park, Dong-Oh Kim

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

The Compact Advenced Satellited 500 (CAS500, hereafter) ground system at KARI consists of three elements: 1) Mission Control and Image Reception Element (MCIRE); and 2) Image Processing Element (IPE); and 3) Calibration/ Validation Element (CVE). The Direct Ingestion Subsystem (DIS) which is subsystem of MCIRE can be divided into a DIS Server for WO (work order) creation / management, a DIS Receiver for receiving / processing satellite images, and a DIS Client for monitoring satellite image reception status. This paper describes one DIS Server, one DIS Client, four DIS Receivers, and other devices are used to verify the normal operation and interface of each system.

[P-74] Trade-off Study for Electric Propulsion Application in a Geostationary Satellite

Jong Seok Park, Jung-Su Choi, Hyung Wan Kim, Bong Kyu Park, Jae Dong Choi

GEO-KOMPSAT-2 Program Office, KARI

The application of Electric Propulsion (EP) has been increasing in commercial communication satellites. This is due to the advantage that the energy source of the EP can be acquired easily from the sun in space.

The conventional Chemical Propulsion (CP) is a kind of limited system using chemical propellants loaded in the tanks and they take up more than half of the satellite launch mass. The EP application to satellite in-orbit attitude maneuver can dramatically reduce the propellants for the CP, allowing more mass to be assigned for payloads. In addition, the EP is applicable to even transfer orbit maneuver, making this payload capacity enlargement more prominent.

This paper presents the effects on spacecraft design and payload carrying capacity by the EP application, and makes suggestions for the future development of a Korean communication satellite.

2부 발표시간 : 10월 24일(목) 12:50~13:50

[P-75] Integration and Environment Test Plan of Compact Advanced Satellite500-1 (CAS500-1) Flight Model (FM)

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

[1]*Korea Aerospace Research Institute,*
[2]*Korea Aerospcae Industry*

The CAS500-1 is a 500 kg-class satellite for national territory management, agriculture and forestry management, disaster monitoring & control, Korean peninsula observation etc. And the CAS500-1 has a standard platform to support a variety of payloads with minimal design changes. The EQM (Engineering & Qualification Model) and FM (Flight Model) units of CAS500-1 standard platform are already delivered, integrated and tested successfully. Now the CAS500-1 FM satellite is ready to integrate the payload FM units. In this paper, I will introduce the integration and environment test plan for CAS500-1 FM Satellite.

[P-76] Polarity and Sensor to Actuator Test Result of Thruster and Reaction Wheel for Compact Advanced Satellite 500 Program

Jooho Park, Seung-Hun Lee, Hyungjoo Yoon

Korea Aerospace Research Institute

Thruster and reaction wheel are the representative actuators in satellite attitude control. Thruster is propellant-base actuator so it is closely related to the satellite's life time. Also, it can generate relatively high torques without momentum exchange. Therefore, thruster control is exciting because it is trade off between the efficiency and the control performance. Reaction wheel is another actuator for satellite attitude control. It makes more precise attitude control than the actuator. However, it requires momentum unloading because the reaction wheel is a momentum exchange device.
These actuators are located in the spacecraft body properly. Based on the correct location, the thruster and the reaction wheel can generate expected torque for the attitude control. For the verification of the design and the installation, the satellite necessarily performs ground test. It's called polarity test and sensor to actuator test. This paper presents the results of the two tests, especially focused on the actuators' response.

[P-77] Radiance Trend Analysis around the Korean Peninsula of GEO-KOMPSAT-2 AMI

Jinhyung Park

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Korea Aerospace Research Institute (KARI) has succesfully completed LEOP and IOT for GEO-KOMPSAT-2A (GK2A) and is in normal operation. Main purpose of GK2A is observation of FULLDISK, extended east Asia region and local area of Korean peninsula for improved weather forcasting. Advanced Meteorological Image(AMI) is payload for weather forecasting. AMI is observing FULLDISK for every 10 minutes, extended east Asia region and local area of Korean peninsula for every 2 minutes. KARI performs radiometric calibration to AMI observed images. In this paper, we analysis about radiance trend of east Asia region for one day which is observed in IOT period. The result of radiometric calibration has 6 channels for VNIR and 10 channels for MWIR and LWIR. VNIR channels are albedo affected by sun. We could see the change of day and night from VNIR channel radiance result. On the other hand, we could see the IR channels are not affected by sun. KARI will continue to follow the trend of AMI radiance for AMI performance analysis.

[P-78] Design of Bleed Resistor for Solar Array of LEO Satellites

Heesung Park

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In general electronics application, bleed resistors are used to discharge the electric charge stored in the power supply filter capacitor and conductive chassis of units. Bleed resistors for solar array of low-earth-orbit satellites not only discharge of charge on honeycomb panel but also prevent the short failure between solar cell and honeycomb panel. If a local positive bus short failure occurs, the short circuit current of the solar array flows to the ground through the bleed resistor, so it is necessary to select bleed resistors with suitable rated power. However, the rated power of the bleed resistor varies greatly depending on the orbit of the satellite. It is because bleed resistors are mounted on the rear of the solar array and have the same high temperature variation as the solar array due to the thin solar array structure. In eclipse, the rated power of bleed resistors is high due to the low temperature, so it is not risky, but during daylight, the rated power decreases rapidly because of the high temperature of solar array. In this paper, the role of bleed resistors for solar array is presented and the part selection method is suggested to ensure stable operation during missions under various space environment conditions through part derating analysis.

[P-79] Introduction of Control Monitor Test Set

for Launch Support of Satellite

SuWan Bang, Yungoo Huh

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Many of the low earth orbit satellite projects are developed by Korea Aerospace Research Institute (KARI). CMTS (Control & Monitor Test Set) which is manufactured for launching a low earth orbit satellite in Korea Aerospace Research Institute was called LSTS (Launch support Test Set) in the former low earth orbit satellite. Only the PCDU (Power Control Distribution Unit) is turned on when low earth orbit satellite is sent to space. Then solar array is unfolded and power is supported to other bus unit by PCDU. In order to perform a successful mission, before launch, it is should be tested that communication with the PCDU, monitoring, command & telemetry exchange, etc. These tests are needed until just before launch. The equipment is needed to successfully perform the pre-launch test. CMTS for launch should include functions which are power supply for PCDU and CMD, TML communication and log storage. The power supply for launch is operated only PCDU compared to the power that operates the entire bus, so it is composed of a supply that supplies relatively small power. The interface with the satellite is based on serial communication such as RS422 for CMD and TML communication. CMTS software for launch should be able to perform test script for launching and perform the power status of the satellite battery when it is launch phase, and hand over from the CMTS power supply to the satellite power supply when a certain voltage is over. The battery power charging algorithm should be applied differently depending on the voltage level such as CC (Constant Current) and CV (Constant Voltage). For these purposes, an automated battery charging algorithm is implemented and applied to the launch mission. This paper briefly describes CMTS for launch support of satellite.

[P-80] Star Tracker Blinding Analysis in Sun Pointing Submode of Korea Pathfinder Lunar Orbiter

Kwangyul Baek

Korea Aerospace Research Institude

Two-optical head star tracker is one of then attitude determination sensors for Korea Pathfinder Lunar Orbiter (KPLO). The performance and operation of star tracker is affected by external light from celestial bodies such as the Sun, Earth, and Moon. Line of sight direction of optical heads is determined by trade-off studies to minimize blind by celestial bodies and maximize accuracy of attitude determination under given mission operation. The accommodation of optical heads for KPLO was determined to secure star-observability during target imaging. This accommodation can be blinded by the Moon during Sun Pointing submode. The blind duration by the Moon during Sun Pointing submode on KPLO lunar mission orbit is analyzed for fault detection and recovery (FDIR) design.

[P-81] Next Generation Space Payload Development Trend Analysis

Sang Gyu Lee, Myung Jin Baek

Korea Aerospace Research Institute

In the future, various satellite developments are required which have satellite missions directly related to the quality of the life of the people, such as weather forecast enhancement, periodic growth and development of the agricultural produce and the forest trees monitoring, air pollution monitoring and water pollution measurement, and flood and drought monitoring. To acquire such data satisfying the satellite missions, electro-optic and radio wave payloads development are necessary and those are high resolution and wide-swath electro-optic cameras, microwave sounder, hyperspectral Imager and Synthetic Aperture Radar (SAR) which has various bands. Currently, electro-optic camera and some of radio wave payloads would be equipped with KOMPSAT, GEO-KOMPSAT and CAS500 satellites, and they are enhancing the technology levels. In this paper, next generation satellite payloads development necessity, current status and payload technology development trends are described.

[P-82] Design of Support Structures to Prevent Deflection of Large Thermal Vacuum Chamber Lifting System

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The vertical lifting platform (6.9 m × 6.1 m) is utilized in order to carry in/out the satellite-composite into/from the large thermal vacuum chamber at Korea aerospace research institute. The proof-load test on the lifting platform was carried out with 10-ton dummy mass to verify its structural stability. However, the structural deflection was observed from the initial proof-load test.

The additional support structures enhancing the structural strength of the lifting platform were installed on the X-lift section. The structural analysis results show that the deformation of the additional support structure is 0.52 mm and the

maximum stress is 140 MPa which are lower than the requirement and the allowable stress. This paper describes the design of the additional support structures and the structural analysis results.

[P-83] A Network Design of Simple Structure Using VSS Technology

Hyun-Chul Baek[1], Tae-Gun Son[1], Dae-Won Jung[1], Sang-Jung Lee[2]

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The recently configured network consists of a core switch in a central location and an access switch to connect to it based on 2 or 3 tier network structure. The traditional redundancy network which is designed to protect against failure creates multiple paths to access the core switch and has to be cut off all but one path to the destination. This would take 20 to 50 seconds to switch to the alternate path because one path is broken, which makes the network less reliable. The Virtual Switching System (VSS) technology can be solve multipath problems such as spanning tree and simplify network structure. It is configured like a single switch through virtualization. Thus, even if a failure occurs on one link, it is possible to bypass the error without wasting time, and achieve load balancing effect and fast switching. In order to achieve an efficient multi-satellite operation, we are also planning to build a network system based on the latest trend which has improved the stability of the network by applying VSS technology to core switches and Stackwise technology to access switches. In this paper, we will explain how to simplify network structure by utilizing VSS technology, and improve network service quality, such as load balancing and fast switching.

[P-84] GK2A Mission Planning System for Observation Area Movement

Jun-Yeong Bok, Hyunsu Lim, Hye-Won Kim

Korea Aerospace Research Institute

The GeoKOMPSAT-2A (GK2A) satellite is conducting weather observation on Earth and on the Korea Peninsula by using Advanced Meteorological Imager (AMI) payload. This payload performs meteorological observation by using registered AMI Operational timeline with Full Disk, Local Area, and Extended LA scene repeatedly. In this paper, we explain the Mission Planning System (MPS) for observation of GK2A and analyze the performance of the MPS considering urgent movement of the observation area.

[P-85] Analysis of Orbit Environment Test Configuration and Result for the KPLO LUTI

Heejun Seo, Hyokjin Cho, Sungwook Park, Hye jin Yi

Korea Aerospace Research Institute

The lunar orbiter (KPLO) 's high-resolution camera (LUTI) serves to photograph the lunar surface major areas for lunar lander landing candidates. KPLO LUTI is required to verify optical performance in space orbit environments, and to verify performance of camera electronics, thermal control's logic, thermal design in space orbit environments. Accordingly, to verify the optical performance of high resolution camera in high and low temperature environments, the test setup shall be configured that the temperature of the radiator, electronics, and optics can be controlled individually. so, independently controlled thermal control system and thermal control panels are used for temperature control to meet test requirements. In this paper, test configuration and condition, thermal panel's verification result for optical performance test, thermal vacuum test, thermal balance test of KPLO LUTI and a orbit environment test results are included.

[P-86] Antenna Availability Analysis for Korea Satellite Operation System

Jaedong Seong, Okchul Jung, Youeyun Jung, Daewon Chung

Korea Aerospace Research Institute

The main mission objectives of Korea Satellite Operation System (KSOS, hereafter) are the expedite provision of the national satellites information required for the national demand in various sectors. The KSOS will be established in Korean peninsula for KOMPSAT-2, KOMPSAT-3, KOMPSAT-5, KOMPSAT-3A, KOMPSAT-6, KOMPSAT-7, CAS500-1 and CAS500-2 (Target Satellites, hereafter) by December 2022. The KSOS includes 6 subsystems: USS (User Support Subsystem), IPS (Image Processing Subsystem), MCIRS (Mission Control and Image Reception Subsystem), AS (Antenna Subsystem), ITS (Information Technology Subsystem), DS (Data Subsystem). Especially, two new antennas will be developed for KSOS and there are two existing antennas for target satellites in Daejeon ground station and therefore, four antennas will be operated for 8 target satellites after end of 2022. This means that KSOS can communicate maximum four satellites simultaneously, but no more than five satellites simultaneously. Simultaneous contact of multiple satellites can occur depending on the orbit of target satellites and therefore, we investigated the ground antenna capability for 8 target satellites in this research. The number of simultaneous contact, conflict satellites and busiest time were investigated with target satellites orbit and ground station location.

[P-87] Design and Operation Concept for Science Data Telemetry Reception of KPLO's Instruments Using x-band Modem

Seunghee Son

Korea Aerospace Research Institute

KPLO is the first mission of Korea to the Moon and will be orbiting it to achieve various scientific goals. There will be a total of six instruments including NASA/ASU shadow cam aboard. KPLO bus will have two transponders for communications. One is S-band for telecommand and low-rate SOH telemetry and the other is X-band for high rate telemetry downloading to the ground. X-band telemetries are compose of science data and playback memory dump. The downloading rate is 8.5 Mbps speed.
Cortex HDR modem has been chosen for high speed telemetry reception and the real-time operation subsystem (ROS) is under development as a part of KPLO Deep-space Ground System (KDGS). In this study, we present the high rate x-band telemetry format and its acquisition processing to transfer data to the real-time operation subsystem in KDGS.

[P-88] A Suggestion for Calibration Items Considering the Future SAR Satellite System

Jae-Min Shin

Korea Aerospace Research Institute

In order to apply accurately SAR data for various fields, Calibration System is above all others in SAR Satellite Systems. Calibration System consist of generally several modules based on application capabilities of SAR Satellite. Those modules have currently five functions, which are for pointing, geolocation, relative radiometric, polarimetric and absolute radiometric calibration. However as for various applications, new calibration function additionally needs to be extended and developed because nowadays SAR Satellite System is being developed in order to satisfy specific demands for new applications. Future SAR System will be able to acquire the ability of very high resolution and very wide swath-width at the same time. On that basis, SAR data will be used for polarimetric, interferometric, multi-static applications and so on. Ultimately SAR data are merged totally with optic, sonic and other G.I.S. information. For the purpose of SAR data fusion, a new paradigm for Calibration needs to be suggested. In this study, an Stepwise Calibration Approach considered various applications is summarized conceptually.

[P-89] Performance Improvement of Telemetry Post Processing

Hyun-Kyu Shin

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In order to provide light-weight telemetry post processing functionality, a novel design with the parallelism and its implementation were introduced through the previous study. The rapid telemetry post processing exploits the advantages of multi-threaded design. This approach reduces the total processing time in accordance with the number of threads. However, there's no more distinct benefit at some point while more threads participate. To solve the stalled condition, profiling on the application has been conducted. The result of analysis could identified some race conditions between the frame parser threads. Each parser thread handles only one frame at the same time. During the parsing job, some basic informations are needed such as telemetry list data, packet contents data and discrete status list. These data are shared over the all threads. This can degrade the system performance. This paper introduces an approach for performance improvement and its results.

[P-90] Overall Harness Routing Concept Design in KPLO

Hyun-Jin Shin[1], Hyeon-Jung Park[2], Beom-Suk Kang[1], Seung-Yong Min[1], Cho-Young Han[1]

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In order to operate all of electric unit for spacecraft, harness is necessary with proper harness routing path. In the harness routing path design, there are many aspects to consider, such as harness class, interference with structure, spacecraft assembly concept and so on. Particularly in KPLO, new structure architecture was introduced to accommodate the huge propellant tank. Therefore new harness routing concept design is necessary with considering the KPLO new structure architecture. In this paper, new harness routing concept desing with considering structure characteristics will be introduced.

[P-91] RF Station Service for LEO Earth Exploration Satellites Mission Operations

Sangil Ahn, DurkJong Park

Korea Aerospace Research Institute

This study deals with antenna station operation service required mandatorily for the LEO mission operations. In Earth Exploration Satellite, the qualities of operation service and operational product are critical pre-requites for the successful mission operation because operation itself is impossible without reliable communication for spacecraft control and mission data downlink. The operational product

and service for both in mission phase and under flight status like normal and abnormal situations were surveyed in literatures and referenced on internet site. Service as well as service management were considered in communication service for space to space and between space and ground. It is expected to be good reference for any entity interested in providing station operational service and operational product due to its generality.

[P-92] A Study on the Potentiometer Data Processing of the Solar Array Drive Assembly for Korea Pathfinder Lunar Orbiter

Hanwoong Ahn

Korea Aerospace Research Institute

Korea Pathfinder Lunar Orbiter (KPLO) is the first lunar exploration project in Korea. KPLO has two solar panels that are rotating by solar array drive assembly. In order for the solar panel to point to the sun through the solar array drive assembly, the sun ephemeris data and the rotating angle of the solar panel are required. Generally, the potentiometer are used to measure the rotating angle of the solar panel. The potentiometer is composed of primary and redundancy, and has the dead-zone that cannot output data. In this paper, the potentiometer data processing that reduces the effect of the dead-zone is proposed.

[P-93] Preprocessing Method of a Satellite Telemetry for Principal Component Analysis

Seung-Eun Yang

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To monitor the state of health of a satellite, thousands of telemetry are defined. Low Earth Orbit (LEO) satellite revolute around the earth faster than the rate of the earth rotation and the altitude is bellow 2,000 km. The satellite contacts with the ground station at limited number of a day and the contact duration is about 10 minutes. LEO satellite generate telemetry at real time and store them in its internal mass memory. When it contacts to ground station, it transmits real time telemetry and also downloads the mass memory data called playback data that is stored at non-contact period. Normally, the downloaded playback data contains several orbit time. Therefore, it is impossible to execute trend analysis of the vast amount of playback data within the short contact time by human expert. To examine the large amount of data, principal component analysis (PCA) is widely used. PCA finds the transformation matrix that maximize the variance and it also reduce the data dimension with minimum loss of information. Therefore, PCA is a appropriate tool to analyze the large amount of playback data. The preprocessing of data is very important to achieve valid result through PCA. In this paper, an effective preprocessing method is described that removes the undesired impact from outlier.

[P-94] A Development of Experiment Tool to Analyze GK-2A Radiometric Calibration Algorithm

Tae-Bong On, Chi-Ho Kang, Jong-Beom Park

Korea Aerospace Research Institute

A software tool for GK-2A radiometric calibration algorithm analysis is one of the software of NMSC (National Meteorological Satellite Center) ground system. The main objective of tool is to support radiometric algorithm analysis by simulating level 1A product. It has designed and developed in order to experiment various cases usefully. Conditions such as multiple input, parameter setting and repeatability are considered in the design phase. And it is executable independently by separating with operation system. In the paper, the progress of development is briefly presented.

[P-95] Ground Verification of Clamp Band Separation System of a Geostationary Satellite

Sung-Hyun Woo, Chang-Rae Cho

Korea Aerospace Research Institute

Pyroshock environment induced by satellite's separation process from the launch vehicle can make a catastrophic demage on its primary structures and payloads. Thus it is of quite importance to simulate the launch vehicle separation by using the flight clamp band system and pyro devices, and to verify the satellite and its components design in terms of pyroshock requirements. Recently, a flight model of the geostationary satellite developed by KARI (Korea Aerospace Research Institute) was subject to the launch vehicle separation test in cooperation with the launch vehicle service provider in KARI's premises. This paper explains the overall configuration and procedure of the test with primary shock responses obtained at the launch vehicle interface.

[P-96] Verification of Validity of High Energy Particle Detector (HEPD) Data

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The High Energy Particle Detector (HEPD) onboard the Next Generation Small Satellite-1 (NEXTSat-1) has been operating since the launch. When Space Radiation Detectors (SRDs) including the HEPD and the Medium Energy Particle Detector (MEPD) are in operation, the HEPD detects electrons and protons with the energy range of 0.35 to 2 MeV and 3 to 20 MeV, respectively. In addition, the HEPD detects such particles through three telescopes corresponding to 0°, 45° and 90° to the local magnetic field. Having these specifications, the HEPD can detect high energy particles which precipitate from the inner magnetosphere into the earth's atmosphere. It can also monitor the state of the outer radiation belt and the solar proton event. To do these scientific works, it is important to verify reliability of HEPD data. In this presentation, we will validate HEPD data by comparing other satellite data.

[P-97] Study of LEO Satellite Out-put Impedance Matching Design Applying Load Characteristics

Seok-Teak Yun, Day-Young Kim, Sang Kon Lee
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Usually, LEO (low-earth orbiting) satellite power converter design is deal with various load change conditions. To minimaze the effect on other load and output voltage, the extra control loop design or circuits such as the output filer, additional power convert, battery are needed. Those kinds of adding controller and extra circuit can be a inefficient design. For example, adding the controller and power convert make the system complex, increase failure probability and cost. And, adding the extra output filter make the system bigger envelope and extra analysis is need for effect on inrush current. Therefore, the guide line of selection of extra circuit and control design is required for some load characteristics which periodic load change with high amplitude to avoid bulky system. In. this paper propose guide line for output impedance design of LEO satellite power converter by various load characteristics which load transition frequency, load current and impedance.

[P-98] Spacecraft and Launch Vehicle Electrical Interface Design for LEO Satellite

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The electrical interface between the spacecraft and launch vehicle is required two types of interfaces for spacecraft and electrical ground support equipment interface and the spacecraft and launch vehicle telemetry measurement system interface. The circuits of the electrical interface provide connections and disconnections of the connectors without arcing (short circuit) that can lead to inflammation of surrounding materials or vapor. The signal characteristics of electrical interface is defined as the voltage, current, resistance, shielding, and twisting requirements for the interface lines. The electrical ground support equipment provide the commanding to spacecraft and telemetry monitoring from spacecraft before launch via hardline. The launch vehicle telemetry measurement system provide the spacecraft telemetry monitoring after launch via RF link.

[P-99] Switching Time Design Problem for Single-Axis Slew Maneuvers

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A switching time design problem for single-axis slew maneuvers is addressed. In the problem, the unknown parameters are switching times in the smoothed control input profiles. Instead of numerical approaches, closed-form solutions are derived, which are convenient for implementation. The closed-form solution have wide applications such as robotic manipulator, computer disk derives, and double-gimballed scanning system. The unknown parameters can be calculated analytically, and the solutions will be verified. A finite jerk constraint and spin-to-spin state boundary conditions are taken into account in the problem to avoid undesirable response of flexible body. Constraints on the maximum slew rate and angular acceleration are also imposed to apply hardware constraints of a system. As a example of application for the single-axis slew maneuvers, an operational scenario for a double-gimballed scanning system is presented, and case studies will be carried out in this research.

[P-100] Design of Satellite Telemetry Monitoring System Based on Deep Learning Technology

Myeongshin Lee, Myungmuk Kim, Woomin Lee, Daewon Chung
Korea Aerospace Research Institute

SOH (State Of Health) monitoring for operational satellite is an important part of mission operations to ensure stable operation of satellites in orbit. In case of LEO satellites, SOH monitoring can be done in real time and non-real time. For the non real-time SOH monitoring, the received satellite status data is generally monitored by the OOL (Out-Of-Limit) method to determine the system's failure. The OOL method is

not aware of the gradual increase or decrease of state data because the upper and lower limits of the database are very large compared to the current operating state of the satellite. To compensate this problem, the operator looks through the plot manually, but there is a limit on the number of monitoring. To solve this problem, KGS (KOMPSAT Ground Segment) designed a system for satellite monitoring system based on deep learning. The designed system consists of telemetry extraction, data preprocessing, feature extraction and modeling. In this paper, we introduce the design system and application cases of KOMPSAT-2.

[P-101] Launch Vehicle Electrical Interface Design of Spacecraft

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In order to successfully launch the spacecraft after completion of design and assembly, it is essential to have an electrical interface to set up the state of spacecraft suitable for launch and to monitor the state of health until launch. The control interface consists of a power supply, communication and direct command stop the emergency situation. The purpose of monitoring interface is to check anomaly of the on board computer, electrical power subsystem, and propulsion subsystem. Boot up status of flight software which indicates the start of solar array deployment is also monitored to rule out the impact on launch process. In order to design launch vehicle electrical interface of the spacecraft, it is important to reflect the characteristics of the selected launch vehicle. The series of steps involved is as follows. Selection of control and monitoring signals, identification of voltage and current of signals, length and path of harness to interface with the launch vehicle, availability of launch vehicle multiplexer, number of pins and connectors, design to meet the double fault tolerance. This paper deals with the design of the launch vehicle electrical interface of spacecraft considering the above requirements.

[P-102] Introduce of Defects Found in Manufacturing and Verifying Space Electronic Equipment

Sang-Taek Lee

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Space electronic eqipment must perform normally without faults during a given mission in the space environment. Considering the difficulty in repairing and recovering in case of a failure, it is necessary to eliminate the possible failures and defects in advance and complete the development in a perfect state. This paper introduces the defects that occur during the manufacture of space electronics and their causes, and helps to reduce the frequency of defects by referring to the development of spaces electronic equipment.

[P-103] Protection of Satellite Frequency Resources for Geostationary Orbit Satellite Programs

Seorim Lee

Korea Aerospace Research Institute

Acquiring satellite frequency resources through satellite coordination activities is only the beginning of satellite frequency management activities. In order to ensure the nominal operations of a satellite, the frequency resources must be protected throughout the lifetime of the satellite. Such protection is achieved through the continuous monitoring and assessment of potential interference from other upcoming satellite networks. Long term planning for protecting and maintaining an acquired satellite network is also necessary. This paper aims to provide a comprehensive insight into the protection of satellite networks in order to support the better planning and management of satellite frequency resources.

[P-104] Fast Analytical Prediction of Spacecraft Agility Performance in Case of Big Changes in MOI

Seon-Ho Lee

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Nowadays the agility is becoming a dominant measure to evaluate the earth observation satellite performance for the successful mission fulfillment. Generally in order to verify the agility capability a numerical simulation should be carried out considering the spacecraft dynamics, attitude actuator (such as reaction wheels and CMGs), attitude control algorithm, and space environmental disturbances. Even if once the verification process went to completion, there still exist some chances that the spacecraft MOI changes dramatically as a result of the platform structure modification before launch. If this is the case, the numerical simulation should be conducted again consuming a lot of resource such as time and manpower. In this paper we proposed an alternative method to evaluate the spacecraft agility. The proposed method does not involve the bulky and time-consuming numerical simulation. Instead it predicts the spacecraft agility capability in a simple and fast way by an analytical calculation considering the attitude angle, rate, acceleration, torque, momentum profiles of the original spacecraft control system and extending those profiles to the new spacecraft with a changed MOI.

[P-105] Test Results of Attitude Control System Polarity and Sensor to Actuator Test for a Low Earth Orbit Satellite

Seung-Hun Lee, Hyungjoo Yoon

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Major test of Attitude Control System (ACS) at Flight Model (FM) development phase are polarity and sensor to actuator test. The polarity for ACS sensors is verified by external stimulus while the polarity of ACS actuators is tested through telecommand. During ACS sensor to actuator test, ACS flight software which incorporates sensors and actuators is verified. For a Low Earth orbit satellite sun sensor, star tracker, and gyro are used as sensors, and reaction wheel, thruster are employed as actuators. Combinations of each sensor and actuator are tested for ACS sensor to actuator test. By providing stimulus to a sensor test engineer check the expected operation of actuator. AOCS sensor to actuator test could be simulated at ACS Performance Analysis Simulator (APAS) environment. We show the test result of polarity and sensor to actuator for FM test and APAS simulation.

[P-106] Performance Improvement of Satellite Mission Control System through Optimization of Virtualization System

Woomin Lee, Myeongshing Lee, Myungmuk Kim, Daewon Jung

Korea Aerospace Research Institute

KOMPSAT Mission Operation Center is operating four LEO earth observation satellites including KOMPSAT-2, 3, 5 and 3A. As the number of operating satellites increased, the number of operating systems installed in the control center increased. Accordingly, the virtualization system was introduced through the reseach on applying virtualization in 2015, and gradually intergrated the operatoin system until recently. In the process of operation system into virtualization, it almost consumed the resources of the virtualization system, resulting in decrease in speed and performance of the operation system. In order to solve this problem, it is necessary to optimize the virtualization system resources and relocate the operation system. In this paper, describe the performance improvement according to optimization of virtualization system resources and relocation of operation system.

[P-107] Unit Test of Flight Software in Compact Advanced Satellite

Jae-Seung Lee

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Satellite flight software is in charge of overall satellite operation, : command and telemetry interfaces, monitoring and control of satellite state-of-health, mission operation management, fault detection and isolation, recovery, etc. Thus a defect in flight software can have a severe effect on satellite operation. To prevent from software malfunction, lots of tests are applied to development of flight software.

Unit test is one of the porcess in software logic/functional testing where individual units, components, or services of a software are tested. The purpose of unit test is to validate that each unit/component/service of the flight software performs per designed. A unit is the smallest testable part of flight software. In satellite flight software, a unit may be an individual function, component, or procedure, etc.

Usually, commercial unit testing tools are used for automated unit test environment. There are lots of tools which provide automation of dynamic or static unit test, such as Polyspace, VecterCAST, etc.

In this paper, the unit test environment for the flight software in Compact Advanced Statellite will be described. And we will briefly present the preparation, process, and the result of unit test using VectorCAST.

[P-108] Analysis and Implications of Overseas Cases for Building up Korea Earth Observation Satellite Data System

Jaeyeol Lee, Min-A Kim, Gabho Jeun, Jihyeon Yim, Daewon Chung

Korea Aerospace Research Institute

The development of satellite technology is improving the quality of satellite data and increasing the range of utilization, so the importance of satellite data is increasing. Advenced countries of satellite technology have a system that provides a systematic system for storing and processing a large amount of satellite data so that it can be immediately utilized in necessary fields. Korea operates the Arirang satellite series and needs an advanced data system to store and provide a large amount of satellite data, taking into account subsequent satellites to be launched within a few years. To this end, this paper introduces the operation examples of satellite data systems in advanced countries such as the U.S. and Europe.

[P-109] Radiation Shielding Effects of Composites Containing CNT (Carbon Nano Tube)

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The radiation environment in space requires the radiation shielding of the electonic devices of satellites. The proton is

a major particle that have the considerable effect on the radioactive damage to the electronics of the spacecraft. The material of the high atomic number is more effective for the radiation shielding than that of the low atomic number. Also, the composite reduces the penetration of the proton compared with the single material of the same mass. In this study, the composites containing CNT particles in the epoxy matrix are introduced. These composites include the CNTs as the random or alligned paticles. The CNT particles act as a fiber in a CFRP composite. The characteristics of the radioactive barrier of the CNT composites are discussed. And, the radiation shielding results of the graphite CFRP composite and CNT CFRP composite are shown.

[P-110] Risk Management Technique for Satellite System Development

Choon-Woo Lee

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In this paper, it is presented that risk management technique for satellite system development shall be applied to manage and control safely program development system because large-scale program such as satellite development confronts several kind risks elements (performance, schedule, costs) which are not only inevitable but also unexpectable during the whole phase of satellite development. In general, risk management process throughout the program life cycle to monitor and control risk is an iterative and adaptive process as follows: Risk Identification → Risk Analysis → Risk Management Plan & Risk Tracking → Risk Control. Continuous Risk Management (CRM) is a widely used technique within NASA, initiated at the beginning and continuing throughout the program life cycle to monitor and control risk. Main factors for risk analysis can be divided into cost, schedule and performance and if necessary, other risk factor related to safety, organization, procurement, acquisition, supportability, political, and programmatic risk can be added. For risk evaluation by qualitative methods, 3 by 3 or 5 by 5 Risk matrix is used to rank 3 risk level (Low-Medium-High). Risk matrix technique combine qualitative and semi-quantitative measures of likelihood with similar measures of consequences. In this paper, the qualitative risk management techniques which can be applied for satellite system development are proposed.

[P-111] Application of Tilt Sensor Correction Value for GK2B

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

KARI (Korea Aerospace Research Institute)

The GK2B (GEO-KOMPSAT2B) is installed horizontally in the chamber for orbit environmental test. As the direction of the heat pipe installed inside the satellite. The GK2B exposed to cryogenic temperatures in a vacuum environment, the horizontality of the satellite changes slightly. For the reason install the tilt sensor the check the change numerically. The value of the tilt sensor was set a correction value for application in the DAS (Data Acquisition System) developed by KARI.

[P-112] An Automated Scheduling of Multi Pass Stereo Imaging of KOMPSAT

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Multi pass stereo imaging is the imaging mode of acquiring a pair of images with different Roll angle by taking the same Area of Interest (AOI) in two different orbits. The acquired satellite images are used in various industries such as Digital Elevation Models (DEMs) Generation, Mapping, GIS-related Industries.
Currently operating optical satellites are KOMPSAT-2, 3 and 3A. The number of satellites is expected to increase in the future.
In this paper, we introduce the technique of automatically generating the Multi pass stereo Imaging preparing for the various and complex image acquisition requests of users.

[P-113] Spacecraft Bus Operation Test for the Preparation of Launch and Early Operation of a Low Earth Orbit Satellite

Jeong-Heum Im

Korea Aerospace Research Institute

Spacecraft bus operation test has been conducted for the preparation of launch and early operation of a low earth orbit satellite. Primary objectives of this test are to verify overall flight software operation including RTCS (relative timed command sequence) design and to verify all the connected operation of each subsystem (attitude/orbit control subsystem, electrical power subsystem, thermal control subsystem) in deployment phase. Secondary objectives of the test are to verify that EGSE (electrical test equipment) can provide proper tools for testing, operating and trouble shooting, and also to verify whether the command and telemetry database for all the system operation are well defined. For the test, flight software imbedded ETB (electrical test bed) was used. Various ground support equipments and test aids also supported the test. Three main scripts were prepared for the

test. The first one is solar array deployment success case. The second one is solar array deployment failure case and the last is a case that a fail-over occurs during in orbit activation checkout. The test result will be used for the preparation of unit activation checkout procedure, mode transition procedure and spacecraft bus early operation procedure.

[P-114] Trends in Foreign and Domestic Disaster Management Using Satellite Imagery

Jihyeon Yim, Guhyeok Kim, Jaeyeol Lee, Min-A Kim, Daewon Chung

Korea Aerospace Research institute

Satellite imagery is widely used in disaster and safety management owing to their wide availability and global coverage. In Korea, satellite imagery is being actively used to predict, identify, respond to, and recover from large forest fires such as the Goseong-gun and Sokcho-si wildfires that occurred in April 2019, as well as landslides, typhoons, and marine disasters. Globally, international cooperative organizations and private companies are actively working to facilitate the distribution of disaster-related satellite images. With increasing use of satellite imagery in disaster and safety management, greater understanding of the role and importance of satellite imagery is emerging.
In this paper, we examine the technologies of satellite imagery in disaster and safety applications and review their significance, utility, limitations, and future directions.

[P-115] To Enhance the Robustness of Weather Broadcasting Service by Combining Wired and Wireless Network

Hyun-Su Lim

Image Data System Development Division, Satellite Information Center, KARI

One of the geostationary meteorological satellite system's unique characteristics is meteorological data broadcasting services which distribute high resolution full-disk Earth image data and value-added data such as Level 2 meteorological product to end-users in real time. In Korea, the GEO-KOMPSAT-2A satellite, launched in November 2018, has begun its meteorological data broadcasting services following COMS-1. The broadcasting service using a satellite has a disadvantage of requiring a receiving device, but it has the advantage of continuously delivering a large amount of information in real time without ground network facility. Therefore this data delivery service via a wireless network can be especially helpful for developing countries having a poor terrestrial environment.
However, the loss of data packets can happen in wireless communications any time caused by interferences. This paper proposes to complement the limitation of wireless broadcasting service by combining wired network for better data transmission.

[P-116] Analysis of Electromagnetic Compatibility of Electrical Test Bed of Compact Satellite

Kyung-Duk Jang, Tae-Youn Kim, Jae-Woong Jang, Chang-Eun Lee

Korea Aerospace Research Institute

Electromagnetic compatibility verification of satellites is performed step by step in the order of units, electrical test bed (ETB), and satellite system. These step-by-step verification activities can help to ensure that potential risks can be identified and addressed in advance and to enhance development stability and reliability of satellite. In particular, electromagnetic compatibility verification at ETB phase in very important because it has the pre-test nature of the system level verification.
Electromagnetic compatibility analysis in satellite systems can be verified by conducting EMC tests. However, in the electric test bed phase, only the conducted emission and susceptibility tests are performed because the satellite units are installed on the ETB platform rather than the structure of the satellite.
In this analysis, the voltage noise of power lines at the power distribution unit output as well as the current noise of signal lines are measured in ETB system of compact satellite. Then, compared the measured noise to the CS qualification test level, and verified the compact satellite ETB system has EMC safety margin.

[P-117] Preliminary Study on the Application of Electric Propulsion System to the Next Generation GEO Communication Satellite

Sung-Soo Jang

Korea Aerospace Research Institute

Next generation geostationary communication satellite is being studied using an electric propulsion system to mount as many payloads as possible on it. In general, it is reported that satellites with an electric propulsion system can has a relatively larger capacity of payload than that using a conventional chemical propulsion system. The next generation communication satellite will be estimated about 3.5 ton class, which will be developed as next satellite of GK2. And it has been studied that development of propulsion system using fully Electric Propulsion or Hybrid Propulsion with chemical and electric thrusters. Fully Electric Propulsion will use only electric thrusters as satellite propulsion system. It will be used for orbit injection and attitude control in orbit. Hybrid

propulsion system, on the other hand, use chemical propulsion for orbit entry after separation from launch vehicle and for attitude control in orbit. Therefore this paper summarizes the evaluated results of the Fully Electric Propulsion System and Hybrid Propulsion System to accommodate the system design of the next generation GEO communication satellite. Also the major development specifications of the electric propulsion system, the design impacts of satellite, and the payload capacity were discussed.

[P-118] Modification Concept of Pyro-shock Test Machine

Jong-Hyub Jun, Chang-Rae Cho

Korea Aerospace Research Institute

The shock test in KARI is performed to verify the environment of shock condition like launch vehicle separation, solar array deployment, etc. The applicable test is done by the dedicated test machine KARI designed. The machine including metallic bullet, stand plate, and resonator works by pneumatic power around 0.8-2.5 bar. The resonator as a major part generates the characteristic frequency (heel frequency) that are 1,000 Hz or 1,500 Hz tailored for satellite parts. So the design of resonator is the key of test performance. KARI has a lot of experiences for pyro-shock test during developing space parts through many satellite programs. So KARI'pyro-shock machine has been working for a long time. The point to be modified in the machine shows up from the accumulated data. Now the idea of machine modification by analysis process is described in this research. New resonator concept is proposed especially for 1,500 Hz model.

[P-119] Satellite Mission Operations in KARI

Okchul Jung, Jaedong Seong, Youeyun Jung, Daewon Chung

Korea Aerospace Research Institute

KARI (Korea Aerospace Research Institute), as the national space development organization of South Korea, is operating 4 KOMPSATs (KOrea Multi-Purpose SATellites) in low earth orbit as of 2019, which is Earth observation satellite program to provide optical, radar and infra-red image data. Its main mission objectives are to provide the following GOLDEN applications (GOLDEN mission): Geographic Information System, Ocean Management, Land Management, Disaster Monitoring and ENvironment Monitoring. In order to meet the national demands for satellite data product and secure space asset, satellite mission operations project is conducted by KARI as well. Satellite mission operations is a huge area, dealing with mission planning, space flight dynamics including conjunction assessment, satellite control and health monitoring, image reception, ground antenna and network operation. This paper introduces comprehensive work scope of satellite mission operations in KARI and its achievement in terms of efficiency and stability. In addition, the success rate of satellite mission operations as a performance measure is also presented, and the lessons learned is provided as well.

[P-120] Concept of Operations for Korea Satellite Operation System

Youeyun Jung, Jaedong Seong, Woomin Lee, Saehan Song, Daewon Chung

Korea Aerospace Research Institute

Korea Satellite Opeartion System (KSOS) is an integrated satellite mission operation system under developed by Korea Aerospace Research Institute (KARI). Due to the limited capacity of current Daejeon site and facilities, it becomes important to secure new site and facilities after 2020. There will be three groups of Ground Segments (GSs) such as Jeju GS, Daejeon GS, and overseas GS (King Sejong, Germany, Weno, and Svalbard). Daejeon GS, which have been formally called KGS, will be used for backup mission operation system of Jeju GS. The system has six subsystems such as User Support Subsystem (USS), Image Processing Subsystem (IPS), Mission Controls and Image Reception Subsystem (MCIRS), Antenna Subsys- tem (AS), Information Technology Subsystem (ITS), and Data Subsystem (DS). Each subsystem have their own functions to ensure safety and success of missions and to properly deliver products to external users. Currently, KSOS will have an overall responsibility for eight satellites' flight operations. However, as the need for satellite information increases, so will the number of operating satellites. Therefore, KSOS will be a proper solution not only to operate multi-satellite mission efficiently and cost-effective, but also to facilitate satellite information utilization.

[P-121] System Design for Base Band EGSE

Seung Won Cho, Yun Goo Huh

Korea Aerospace Research Institute

Electrical Ground Supporting Equipment (EGSE) is utilized to check the status and the function of the satellite before the launch. The base band EGSE is required to control the satellite through the base band link and verify the signal interface of the satellite. The base band EGSE provide the link to communicate with the satellite without RF link. It generates the command signal on physical level and sends to the satellite. It also receive the telemetry signal from the satellite and sends to the client. The EGSE can establish the up and down communication link with RF EGSE. It includes the time synchronization function to provide accurate time

and frequency reference. In this paper, the detailed system design for the base band EGSE is presented.

[P-122] Introduction on Scenario-based Fault Management Test of GK2 at System Level

Chang-Kwon Cho, Young-Ho Cho, Dong-Young Kwon

Korea Aerospace Research Institute

The Geostationary Earth Orbit-Korea Multi-Purpose SATellite-2A (GK2A) was launched on December 4 last year and all functional tests and Navigation & Registration of Images were completed. Currently, the Korea Meteorological Agency (KMA) provides weather services such as weather forecasts to users. In order to achieve the satellite mission, it should be possible to simulate all space environments on the ground. It shall be possible to identify any failures that are likely, and isolate and recover from them. A series of actions like this is fault management. Recent satellites are highly complex due to various missions and are becoming more autonomous in operation. As a result, it is mounted on a satellite and programmed to manage hardware defects autonomously. In this paper, we show how the tests were conducted for the fault management by creating a scenario in which full deployment of solar panels was carried out after the satellite was separated from the Launcher and the position of the satellite has been changed to the sun pointing mode. In addition, the Liquid Apogee Engine (LAE) for target orbit is used and the final satellite's position is oriented toward Earth.

[P-123] GOCI-II Test Configuration in GK2B System Level Environment Test

Sung-Yong Cha[1], Myeong-Hoo Kwon[2], Sang-Soon Yong[1], Gmsil Kang[1]

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GOCI-II in GK2B (Geo-KOMPSAT2-B) satellite was developed to follow the mission from GOCI in COMS (Communication Ocean and Meteorological Satellite, Geo-KOMPSAT1). From the launch event to the geostationary orbit, the satellite will be exposed to various conditions such like a severe vibration and extreme cold & hot, vacuum environment. Thus the satellite has been taking a lot of time to verify its integrity. In the system level environment test, it takes the first priority to checking the operation of whole satellite system. Because the performance of all its sub-units were already verified in its instrument level test. In this paper, I will explain the whole test configuration between GK2B satellite bus and GOCI-II payload and analyze the system level environment test result.

[P-124] Additional Verification of Ground Commands

Dong-Seok Chae

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In general, when a satellite receives a ground command, the satellite executes the command after checking that the command is in a prescribed format and checking data integrity. If an inadequate command is sent to the satellite without an accurate determination of the satellite's condition on the ground, or if there is a problem with the command order or procedure, satellite control may malfunction, which may cause serious consequences that are difficult to recover. In other words, if the received command satisfies a prescribed format and data integrity, even if the current state of the satellite is not possible to execute the command immediately, or if the satellite can be at risk when the command is executed, there is a risk of processing the command without restriction. Accordingly, before executing the command, a procedure is required to check whether the command is normal on the satellite itself. This paper suggests to improve the safety of the satellite through self-verification of ground commands by checking prerequisites based on current satellite stauts for performing commands and filtering commands that do not meet the prerequisites.

[P-125] The Verification of Long Term Stability of the Newly Developed Solar Array Power Simulator for the Low Earth Orbit Satellite System Test

Dong-Chul Chae, Young-Yun Kim

Korea Aerospace Research Institute

We reports the newly developed solar array power simulator which is used for satellite system test and the results of long term stability test. The solar array power simulator should supply power instead of solar array panel on the ground test. Satellite system test is composed of several sub-system test. EPS test is one of satellite system test. The verification of the solar array regulator is one of EPS test and very important for the stable operation of satellite in power management point of view. The solar array regulator should regulate the input power generated by solar arrays to accommodate bus power specification. The solar array regulator will be operated for long time at thermal vacuum test phase. The verified solar array power simulator will successfully support the thermal vacuum system test.

[P-126] Analysis and Development of Active Cell Balancing Circuit for Satellite Battery System

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Young-Dal Lee[1], Cheolwoo Lim[2], Gun-Woo Moon[1]

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This paper introduces the analysis and development of a active cell balancing circuit for satellite battery systems. Lithium-ion batteries have high energy density and are used in many applications such as satellites. In general, lithium-ion battery cells have a low terminal voltage and are used in series. When the state of charge between the battery cells connected in series is different, there is a problem that the battery capacity is not sufficiently used. Accordingly, battery cell balancing circuits are frequently used. Therefore, in this paper, the cell balancing circuit suitable for satellite is analyzed. This paper includes the design and development of the circuit.

[P-127] The Software Design for the Camera Heater Control of CAS500-1 AEISS-C

Seunghun Ha, Jingwang Kim, Haeng-Pal Heo,
Deog-Gyu Lee, Sang-Soon Yong

Korea Aerospace Research Institute

Harsh environment of space demands many conditions for earth observation satellites to obtain fine images. Among those, it is necessary providing adequate thermal environment to high resolution optical camera to prevent unacceptable thermal distortion and therefore a degradation of the performance. In this paper, the software design for the camera heater control of CAS500-1 AEISS-C is presented. First, several modes for controlling the heaters are set according to the operation concept of the payload mission. In each mode, the camera is kept in respective target temperature and therefore the satellite can save the power consumption. The heater control has a fault control system for the malfunction of heaters and sensors. Spare heaters are prepared as a redundancy and if any heater becomes out of service, the control transits to spare one. In case of failure in temperature sensors, the heater operates in certain cycle as pre-defined in the ground.

[P-128] Development of Performance Evaluation Software for AMI L1B Product of GEO-KOMPSAT-2A

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Ji Yong Park[2], Jae-Dong Choi[1]

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In this paper, we introduce the development of performance evaluation software for Advanced Meteorological Imager (AMI) L1B product of GEO-KOMPSAT-2A. This software evaluates the Image Navigation and Registration (INR) performances by matching L1B product with high-resolution landmark chips based on Landsat imagery.

All landmark chips have 10x and higher resolution than each L1B product channel for sub-pixel accuracy. For the accurate landmark matching, solar zenith angles of all pixel in L1B product are computed, and the cloud-occluded pixels in image are detected to remove.

The software evaluates the L1B product by the metrics of absolute navigation, frame-to-frame registration, within-frame registration, swath-to-swath registration and channel-to-channel registration, and it displays all the performance evaluation results in real-time. The software helps not only evaluation of L1B product but also improvement of INR by providing detailed information for INR parameter tuning.

[P-129] Radiator Design with Parabolic Reflector for Lunar Lander

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The change of lunar surface temperature is nearly 100 K～400 K (about −170℃～−130℃) during between daylight and eclipse because it has optical properties like a blackbody. The thermal design of a lunar lander can be based on the thermal control methods generally applied to a satellite; but, the thermal design concept for a lunar lander is much different from that of the satellite, which orbits the Earth. Especially, radiator design is one of them. The radiator of the lunar lander can be directly affected by lunar IR emission; so, the radiator should be designed to avoid the view of the lunar surface as much as possible. The most effective position of the radiator for the lunar lander is the topmost side which is parallel to the lunar lander and totally viewed to the deep space; but, it is not enough to accommodate the required radiator area; the radiator should be therefore located on the side having the view of the lunar surface. In this case, an additional reflector could be considered to reduce the effect of the IR emission from the lunar surface; it reflects the incident lunar IR emission and change its heat path to head the preferable other direction.

This study focused on the radiator with a parabolic reflector and researched on its characteristics of the heat path and application to the lunar lander.

[P-130] Sensor-to-Actuator Test for GRA of CAS500-1

Young-Woong Park, Hyung-Joo Yoon

Korea Aerospace Research Institute

There are introduced the sensor-to-actuator test of GRA located on CAS500-1 during FM integration phase. Also the test results in progress are summarized. The sensor-to-actuator test is to check the control command logic being operated rightly by actuator (thrusters, reaction wheel) for the each-axis error of GRA after final integration on the satellite. It is very importance test process. The test configuration for the error generation on only each-axis of GRA should be established. And the reference results for the actuator reaction are prepared by the verified software simulator. These results will be used to compare with the FM test results.

[P-131] The Electrical Test Aids for the Spacecraft Integration and Test on the Ground

Yungoo Huh, Suwan Bang, Seungwon Cho

Korea Aerospace Research Institute

KARI (Korea Aerospace Research Institute) has been developing so many satellites including Korean lunar exploration mission. The test aids are used with EGSE (Electrical Ground Support Equipment) for satellite assembly, integration and validation phase prior to launch. Generally, EGSE is essential in order to control and monitor satellite during test phase on the ground before launch. A lot of electrical tests are conducted with EGSE to ensure that the related satellite is normally operated. Therefore, there are so many electrical test aids for each electrical satellite tests on the ground. Practically, many electrical test aids for Korean satellite programs (including Korean lunar exploration mission) have been deigned and manufactured until now. they are used or will be used for Korean satellite programs.
In this paper, the electrical test aids for the spacecraft integration and test on the ground will be introduced and we give a brief overview on the electrical test aids.

[P-132] Optimal GEO-KOMPSAT-2B Satellite Alignment Definition

Keun Joo Park, Woo Yong Kang

Korea Aerospace Research Institute

GEO-KOMPSAT-2B satellite which will be launched next February, has been completed its environment tests. Different from its predecessor (GEO-KOMPSAT-2A satellite), it is equipped with two optical payloads. To support the dual payload operation successfully, the alignment of each payload reference frame and AOCS units shall be defined accurately. In this paper, the definition of reference frames as well as its correlations between them is shown. Also, the optimization of alignment information from alignment measurement is given.

[P-133] Performance Analysis of the Sun or Earth Blind in the Multiple Head Star Tracker Assembly

Woo-Yong Kang, Kwangyul Baek

Korea Aerospace Research Institute

GEO-KOMPSAT-2A (GK2A) use star tracker assembly (STA) consisting of several optical head (OH) and one electric unit (EU) called multiple head STA. In previous satellite projects, a single head STA consisting of one OH and EU was used. The use of multiple head STA enable us to obtain the on orbit operation data that is different from single head STA. In particular, single head STA can not operate normally if there is the sun or earth interference. However, multiple STA operate normally without blinding OH. Since it operate normally, it is possible to performance analysis depending on the number of OHs used. Therefore, this paper describes the results of the analysis on the performance of multiple head STA in the sun or earth blind.

[P-134] Monitoring and Understanding of the Middle-latitude E- and F-region Field-aligned Irregularities Using the Daejeon 40.8 MHz Coherent Scatter Radar

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Electron density irregularities in the ionosphere interrupt the propagation of electromagnetic waves and are problematic for navigation and communication systems. For this practical importance, significant efforts have been made to establish information on the occurrence climatology of such irregularities, to understand the onset conditions of such irregularities, and to predict or avoid the impact of these irregularities on the society. While the irregularities occur in all latitudes, less attention has been paid to the irregularities in middle latitudes. This may be because the irregularities in middle latitudes are not as severe as those in other latitude regions. However, middle latitudes are also the place where various forms of irregularities occur.
A 40.8 MHz coherent scatter radar was built in Daejeon, South Korea (36.18ºN, 127.14ºE, dip latitude: 26.7ºN) on 29 December 2009, and has been monitoring the occurrence of field-aligned irregularities (FAIs) in the northern middle latitudes. It is possible to examine the statistical characteristics and the sources of the mid-latitude ionospheric irregularities based on the continuous and long-term observations. And

also, in October 2016, a meteor radar antenna array was constructed at the Daejeon VHF ionospheric radar site area in October 2016. The meteor radar observations can provide an understanding on the mechanism of occurrence of the E-region irregularities. In our talk, we will introduce the Daejeon VHF ionospheric and meteor radars and show the observation results from those radars.

[P-135] Solar Filament Detection Using Attention U-Net Based on Deep Learning

Taeyoung Kim[1], Hansol Jeong[1], Seung Bum Yang[1], Myungjin Choi[1], Hyunjin Jung[2], Seonggyeong Jeon[2], Daye Lim[2], Suk-kyung Sung[2], Yong-jae Moon[2]

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In this paper, we describe the overall process for the detection of filaments by applying a deep learning segmentation model for solar filament detection. As input data for the solar filament model, we used labeling results from H-Alpha images and sketch images provided by NOAA. Image processing technology was applied to pre-process H-Alpha images to enhance the outer-edge noise and filament. The input data consisted of 781 data which were generated within 20180.01-2019.05 period. The learning set, test set, and verification set consisted of 7:2:1 ratio, and the verification set was excluded from learning for the reliability of verification. Attention U-Net was used as a deep learning model for filament detection. In the case of Attention U-Net, the feature map is generated by weighting important features and segmented. Therefore, the result is better than general segmentation model (Deep U-Net) when detecting filament in H-Alpha image. The accuracy was calculated by evaluating the accuracy of the real area (the filament area in the NOAA sketch) and the case where it is detected at the same position as the result of the model. Through experiments, we identified the necessity of pre-processing H-Alpha image, hyper-parameter tuning technique for additional input data and model. Also, we'll be describing system configuration for the practical use of filament detection in the future, automation of model learning and operation strategy.

이 논문은 2019년도 정부(과학기술정보통신부)의 재원으로 정보통신기술진흥센터의 지원을 받아 수행된 연구임 (2018-0-01422, 태양흑점폭발 분석 및 예측기술연구 2차년도).

[P-136] A Statistical Study on the Relationship between Earthquakes and Ionospheric US-TEC Anomalies during the Solar Minimum of 2007-2010

Yeon Joon Jung, Sun Mie Park

Korea Science Academy of KAIST

Earthquake is the result of a sudden release of stored energy in the Earth's crust. Due to the great damage, constant efforts have been made to predict earthquakes. In the meantime, researches have revealed that ionospheric disturbances occur a few days before or after earthquakes. Therefore, attempts to investigate the probability of using these disturbances as an earthquake precursor are continuing. The purpose of this study is to identify and analyze the characteristics of pre-earthquake ionospheric Total Electron Contents (TEC) anomalies during the solar minimum of 2007-2010, using US-TEC data given by NOAA. Among earthquakes with magnitude M $\geq$ 5.0, TEC anomalies were shown in most of the earthquakes. Moreover, TEC anomalies were frequently observed in larger earthquakes (M $\geq$ 6.0) comparing to middle (6.0 > M $\geq$ 5.5) and smaller (5.5 > M $\geq$ 5.0) earthquakes. In addition, anomalies were generally shown over a large area at night (18:00～06:00 LT).

[P-137] Operational Dst Index Prediction Model Based on Combination of Artificial Neural Network and Empirical Model

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We develop an operational Dst index prediction model by combining empirical and artificial neural network models. Artificial neural network algorithms are widely used to predict space weather conditions. While they require a large amount of data for machine learning, large-scale geomagnetic storms have not occurred sufficiently in the last 30 years. Empirical models are based on the empirical equations derived by human intuition and do not depend on the amount of data. In this study, we distinguish between Corona Mass Ejection (CME) driven and Corotating Interaction Region (CIR) driven storms, estimate the minimum Dst values, and derive an equation for describing the main and recovery phase. The combined Korea Astronomy and Space Science Institute (KASI) Dst Prediction (KDP) model achieves good performance compared to previous models. This model could be used practically for space weather operation by extending prediction time up to 24 hours and updating model output every hour.

[P-138] Coronal Hole Detection Using Deep Learning

Seung Bum Yang[1], Hansol Jeong[1], Taeyoung Kim[1], Myungjin Choi[1], Hyunjin Jung[2], Seonggyeong Jeon[2], Daye Lim[2], Suk-kyung Sung[2], Yong-jae Moon[2]

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In this paper, we describe the overall process of data preprocessing, learning, and detection results for corona hole detection by constructing a detection model using deep learning-based segmentation techniques. The solar corona hole detection model is constructed using the sun observation image and the sketch image provided by NOAA, and uses a pair of data mapped based on the time between the two images. We extracted 1139 pairs of paired data based on time between sketch images of AIA193 image NOAA in the period of 2018.01-2019.05, and composed the learning set, test set, and verification set for deep learning in 7:2:1 ratio. As a preprocessing for learning, a label image of corona hole was generated. Since the information on corona hole cannot be automatically extracted from the sketch image, therefore, the AIA193 image and the NOAA sketch image are superimposed using an annotation tool and the masking image is labeled. Which is how we created the data set. The model was constructed using Deep U-Net and the validation dataset was excluded from training. Accuracy evaluation was calculated by applying Mean IoU method which is mainly used in image processing. Through experiments, we confirmed the possibility of solar corona hole detection by using deep learning-based model. We will describe in detail how to improve the accuracy of corona hole detection model and system configuration to service detection results.

이 논문은 2019년도 정부(과학기술정보통신부)의 재원으로 정보통신기술 진흥센터의 지원을 받아 수행된 연구임 (2018-0-01422,태양흑점폭발 분석 및 예측기술연구 2차년도).

[P-139] Morning Overshoot of Electron Temperature as Observed by the Swarm Constellation and the International Space Station

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The rapid increase of electron temperature in the early morning hours at low latitudes is a well-known ionospheric phenomenon called the morning overshoot. In this study we extensively investigate the dependence of morning overshoot on local time, season, latitude/longitude/altitude, and magnetic activity. Electron temperature and density data set used in this study are obtained from (1) the Swarm constellation at two different altitudes of 470 km and 520 km with three identical satellites and (2) the Floating Potential Measurement Unit (FPMU) on board International Space Station at an altitude of 400 km. Based on the data between 2014 and 2019 the main achievement of this study is as follows: (1) The morning overshoot generally weakens with decreasing altitudes. (2) It is strongest at the dip equator. With increasing latitudes the overshoot decreases gradually and shifts to later local times. (3) At off-equatorial regions the overshoot is stronger in the winter than in the summer hemisphere, especially at higher altitudes. (4) Lastly, the morning overshoot shows multi-day oscillations, which is significantly controlled by geomagnetic activity.

[P-140] A Study on the Change Procedure and Change Document Management for the Development of Compact Advanced Satellite 500-1

Chul Kang

Korea Aerospace Research Institute

Performing a satellite development project requires configuration management, a technical management activity that establishes and maintains consistent performance, functions, and physical characteristics to meet the required design and operating conditions, among which technical activity on changes is called configuration control management.
Configuration control management refers to 'the act of controlling the acceptance of a change in a feature identification document, such as a specification, drawing, or a product if it does not meet the requirements of the feature identification' and includes technical changes, specification mitigation and exemptions, and forms a technical review committee to determine whether to approve or reject the proposed technical changes, specifications, and exemptions. In this paper, we will explore the overall technical activities and management of changed documents on configuration control management carried out in the development of Compact Advanced Satellite 500-1, and suggest possible configuration control management measures for the next-generation Compact Advanced Satellite development.

[P-141] Performance Analysis of Mobile Down

Range System Antenna Using Sun Tracking

Chun-Won Kim, Dong-Hyun Kim, Soon-Ho Kwon, Jeong-Woo Han, Tae-Jin Lee

Korea Aerospace Research Institute

G/T, Pointing and Tracking accuracy are important for Tracking antenna system. Pointing accuracy is the angle difference between the direction which the antenna is actually pointed and the command angle for antenna operation. Tracking accuracy is the space angle between the main lobe direction on the antenna automatically track and RF maximum level direction. G/T is a figure of merit in antenna performance and determines Eb/No of receiving system, where G is antenna gain and T is noise temperature of receiving system.
G/T, pointing and tracking accuracy of Mobile Down Range System antenna measured and analyze by using sun Tracking.

[P-142] Performance Analysis of Next-Generation Ground Flight Termination System Transceiver for Space Launch Vehicle

Young-Jo Bae[1], Dong-Hyun Kim[1], Yong-Tae Choi[1], Il-Kyoo Lee[2], Eun-Young Chang[2]

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Ground Flight Termination System (GFTS) in Naro Space Center is used to terminate a flight of space launch vehicle when it deviates from the nominal trajectory for range safety. It uses a next-generation command method which is more secure than the legacy IRIG standard method. This paper present a general description of structure of Encoder & Exciter (Tx) and Verification Receiver (Rx), the nextgeneration command message format and shows the performance analysis results of GFTS transceiver. The Message Error Rate (MER) is less than 10^{-4} at SNR = 12dB that satisfy the IRIG standard.

[P-143] Understanding of Satellite Flight Software Based on E-FSS

Jae-Hoon Song, Bum-Soo Yoo, Jong-Wook Choi

Korea Aerospace Research Institute

E-FSS (Educational Flight Software Simulator) was developed to provide an efficient testing platform of satellite flight software. In an E-FSS, CPU, OBC, equipment and corresponding environment are compatibly simulated for unit test, integration test, and verification test. In this article, a brief introduction of E-FSS and its functional demonstrations are presented.

[P-144] Optical Window Characteristics of Optical Thermal Vacuum Chamber for High-resolution Electro-optical Camera Environment Test

Youngchun Youk, Seonghui Kim, Eungshik Lee, Sang-Soon Yong

Korea Aerospace Research Institute

For high-resolution electro-optical camera development, ground verification through space environment tests should be performed. One of the space environment tests, the thermal vacuum test verifies the optical performance of electro-optical camera under thermal vacuum environment. In order to perform the optical performance test, the light source illumination system may be located inside or outside the vacuum chamber. If the light source illumination system is located outside the chamber, the test shall be carried out through the chamber window. It is important to understand the window characteristics under vacuum condition because this change can directly affect performance verification. In this paper, we will present the chamber window characteristics under vacuum condition and how it affects the performance results of electro-optical camera.

[P-145] Improved of Electromagnetic Compatibility of Satellite Electronic Unit Using Power Distribution Module

Chang-Eun Lee, Jae-Woong Jang, Kyung-Duk Jang, Tae-Youn Kim

Korea Aerospace Research Institute

A satellite is made up of many electronic devices. These devices can generate conductive noise to each other and can be adversely affected by wires. Therefore, it is necessary to verify that the electronic devices consisting of the satellite is normally operating, without exceeding the requirements, in an environment with a certain level of noise. This paper discusses how to improve electromagnetic compatibility through conductive susceptibility tests, which apply 1 kHz pulse-modulated noise signals at the frequency band from 30 Hz to 50 MHz and to 1 Vrms or 1 Arms. And then, we verify the malfunctions and degradation of performance of target devices at above mentioned experimental conditions. we propose the method to identify and improve the possible phenomena in satellite electronic equipment using power distribution in the susceptibility test to conductive noise along the power line.

[P-146] Environment Reanalysis of Palau Station for the Stable Acquisition of Telemetry Signal

Tae-Jin Lee, Dong-Hyun Kim, Jeong-Woo Han,

Sun-Ho Kwon, Chun-won Kim

Korea Aerospace Research Institute

Recently, NARO Space Center built new telemetry ground station in Palau, South Pacific to ensure stable acquisition for the satellite separation telemetry data during the KSLV-II (Nuri) launch mission. Various conditions must be met for the Palau station to stable signal acquisition from the KSLV-II. Especially, it is essential to have a LOS (Line of Sight) between the Palau station and KSLV-II to get a stable signal acquisition from KSLV-II.
In this paper, we reanalyze the blind mask of the ground station and its surroundings according to nominal trajectory after the station installation.

[P-147] Telemetry RF Environment Analysis in NARO Space Center Using Wireless Insite Tool

Na-Gyun An, Chun-Won Kim, Dong-Hyun Kim, Soon-Ho Kwon, Jeong-Woo Han, Tae-Jin Lee

Korea Aerospace Research Institute

In this paper, we analyze effect of RF characteristics in operating NARO Space Center Telemetry equipments influenced by circumstance such as buildings, structures and mountainous landforms and study stable operating environment of Telemetry equipment. RF characteristics in signal path are analyzed by using Wireless Insite Tool after modeling NARO Space Center 3D graphic shape. we put antenna radiation pattern source in location of 1, 2, and 3 stage telemetry antenna and analyze change of RF characteristics in receiving location of Telemetry equipments. we find interference reason through analyzing change of RF characteristics and are able to analyze additional path loss and shaded area of RF characteristics.

[P-148] Performance Analysis of Digital Communication Technique for Telemetry System

Jeong-Woo Han, Dong-Hyun Kim, Sun-Ho Kwon, Chun-won Kim, Tae-Jin Lee

Korea Aerospace Research Institute

Recently, the studies on bandwidth efficiency of wireless communication system are being actively conducted due to the demand for transmission of high-resolution data and various data in telemetry systems. The TG (telemetry group) of RCC (Range Commanders Council) enacted the IRIG STD 106 for telemetry system criteria to prevent the problem such as signal interference between applications and establish system, bandwidth limit, and error propagation when the telemetry system was built. SOQPSK (shaped offset quadrature phase shift keying)-TG is introduced as a bandwidth efficiency modulation technique. In this paper, we analyze the SOQPSK-TG recommended by IRIG 106 and compare it with proven traditional analog communication (PCM-FM) and suggest the need for changing over to digital communication in telemetry system.

정관 및 규정

사단법인 한국우주과학회 정관

1995년 5월 3일 제정
1996년 5월 4일 개정
2014년 10월 30일 개정

제1장 총칙

제1조 (목적) 이 법인은 사회일반의 이익에 공여하기 위하여 공익법인의 설립운영에 관한 법률의 규정에 따라 우주과학의 발전과 그 응용 및 보급에 기여하고 나아가 과학의 발전에 이바지함을 목적으로 한다.

제2조 (명칭) 이 법인은 사단법인 한국우주과학회(이하 학회)라 칭하고, 영어명칭은 The Korean Space Science Society로 한다.

제3조 (사무소의 소재지) 학회의 사무소는 대전광역시 유성구 대덕대로 776 한국천문연구원 내에 둔다.

제4조 (사업) 학회는 제1조의 목적을 달성하기 위하여 다음 각 호의 목적사업을 행한다.
1. 학술적 회합의 개최
2. 학술간행물의 발행 및 배포
3. 학술자료의 조사, 수집, 교환
4. 학술의 국제교류
5. 과학기술진흥에 관한 지원 및 건의
6. 기타 본 학회 목적에 적합한 사업

제5조 (법인 공여이익의 수혜자)
1. 학회가 목적사업을 수행함에 있어서 그 수혜자에게 제공하는 이익은 이를 무상으로 한다. 다만, 부득이한 경우에는 미리 감독청의 승인을 받아 그 대가의 일부를 수혜자에게 부담시킬 수 있다.
2. 학회의 목적 사업의 수행으로 인하여 제공되는 이익은 수혜자의 출생지, 출신학교, 근무처, 직업 또는 기타 사회적 지위 등에 의하여 차별을 두지 않는다.

제2장 회원

제6조 (회원의 종류 및 자격) 학회 회원의 종류와 자격은 다음과 같다.
1. 정회원: 정회원은 우주과학에 관심을 갖는 개인으로서 대학에서 우주과학 또는 그에 관련된 과정을 수학한 자 또는 이사회에서 동등한 자격을 가진 자라고 인정된 자
2. 학생회원: 학생회원은 대학 학부 과정에서 우주과학 또는 그에 관련된 과정을 수학하고 있는 자 또는 이사회에서 동등한 자격을 가진 자라고 인정한 자
3. 준회원: 준회원은 정회원 중 과거 3년간 회원의 의무를 이행하지 아니한 자
4. 명예회원: 명예회원은 우주과학 발전에 공적이 현저하거나 학회의 목적달성에 큰 공적이 있는 자
5. 특별회원: 특별회원은 학회에 찬조 및 기부행위 또는 동등한 기여를 한 개인 또는 단체
6. 기관회원: 기관회원은 학회의 목적에 뜻을 같이하고 사업에 기여하는 학술 및 연구단체

제7조 (입회) 학회의 회원은 다음 각 호에 따라 그 자격을 얻을 수 있다.
1. 본 학회의 정회원 혹은 학생회원이 되고자 하는 자는 정회원 2인의 추천을 얻어 입회를 신청하고 이사회의 승인 후 입회금과 회비를 납부함으로서 회원이 된다.
2. 명예회원은 회장의 제청에 의하여 이사회에서 의결하여 총회에서 추대한다.
3. 특별회원 및 기관회원은 이사 2인의 추천에 의하여 이사회의 승인을 받아야 한다.

제8조 (의무와 권리) 학회 회원은 다음 각 호의 의무와 권리를 갖는다.
1. 정관 및 의결사항의 준수와 회비납부의 의무
2. 회원은 연구발표, 논문 기고 및 학술 활동에 참여할 수 있다.
3. 회원은 학회 운영에 참여 할 수 있으며, 별도 규정이 정한 바에 따라 선거권과 피선거권을 갖는다.

제9조 (회원의 탈퇴 및 권리의 정지)
1. 회원은 임의로 탈퇴할 수 있다.
2. 회원으로서 의무를 다하지 아니한 경우나 학회의 목적에 배치되는 행위 또는 명예나 위신에 손상을 가져오는 행위를 하였을 때에는 이사회의 의결로서 권리를 정지하거나 제명할 수 있다.

제3장 임원

제10조 (임원) 학회에 다음 임원을 둔다.
1. 회 장 1인
2. 부회장 1인 이상 3인 이내
3. 감사 2인
4. 이사 15인 이상 25인 이내 (회장, 부회장 포함)

제11조 (임원의 임기)
1. 임원의 임기는 2년으로 하며 연임할 수 있다. 다만, 회장은 연임할 수 없다.
2. 임원의 임기 중 결원이 생긴 때에는 2개월 이내에 이사회에서 보선하고, 보선에 의해 취임한 임원의 임기는 전임자의 잔여기간으로 한다.
3. 임원은 임기가 끝난 후일지라도 후임자가 선출 확정될 때까지

는 그 직무를 담당한다.

제12조 (임원의 선임방법)
1. 회장과 감사는 총회에서 직접선거로 선출하며, 부회장은 회장이 지명하고 이사의 절반은 투표로 선출하고 나머지 절반은 회장이 지명한다.
2. 상기 임원 선출을 위하여 임원선출방법을 별도로 정하여야 하며, 선출된 임원은 감독관청의 취임 승인을 받아야 한다.
3. 임기전의 임원의 해임은 총회의 의결을 거쳐 감독관청의 승인을 받아야 한다.

제13조 (회장 및 부회장의 직무)
1. 회장은 학회를 대표하고 학회 업무를 총괄하며, 총회 및 이사회의 의장이 된다.
2. 부회장은 회장의 직무를 보좌하며 회장 유고시 부회장 중 연장자가 회장의 직무를 대행한다.

제14조 (이사의 직무)
1. 이사는 이사회에 출석하여 학회의 업무에 관한 사항을 의결하며, 회장으로부터 위임받은 사항을 처리한다.
2. 필요에 따라 이사 중에서 총무, 재무, 학술 이사 등을 둘 수 있다.

제15조 (감사의 직무) 감사는 다음 각 호의 직무를 행한다.
1. 학회의 재산상황을 감사하는 일
2. 이사회의 운영과 그 업무에 관한 사항을 감사하는 일
3. 제1호 및 제2호의 감사결과 부정 또는 불법한 점이 있음을 발견할 때에는 이를 이사회, 총회에 그 시정을 요구하고 그래도 시정치 않을 때에는 감독관청에 보고하는 일
4. 제3호의 보고를 하기 위하여 필요한 때에는 총회 또는 이사회의 소집을 요구하는 일
5. 학회의 재산상황, 또는 총회, 이사회의 운영과 업무에 관한 사항에 대하여 회장 또는 총회, 이사회에서 의견을 진술하는 일
6. 총회 및 이사회의 회의록에 기명 날인하는 일

제4장 총회

제16조 (총회의 구성 및 기능) 총회는 정회원으로 구성하고 다음 각 호의 사항을 의결한다.
1. 임원 선출에 관한 사항
2. 정관 변경에 관한 사항
3. 예산 및 결산의 승인
4. 사업계획의 승인
5. 기타 중요한 사항

제17조 (총회 소집)
1. 총회는 정기총회와 임시총회로 나누며, 회장이 소집한다. 정기총회는 년 1회, 임시총회는 필요에 따라 소집할 수 있다.
2. 회장은 회의안건을 명기하여 회의 7일전에 각 회원에게 통보하여야 한다.
3. 총회는 제2항의 통지사항에 한하여서만 의결할 수 있다.

제18조 (총회의결과 정족수)
1. 총회는 국내에 있는 정회원 10분의 1 이상의 출석으로 개회한다.
2. 총회의 의사는 출석한 정회원의 과반수의 찬성으로 의결한다. 다만, 가부동수인 경우에는 의장이 결정한다.

제19조 (총회소집의 특례)
1. 회장은 다음 각 호의 하나에 해당하는 소집요구가 있을 때에는 그 소집 요구일로부터 20일 이내에 총회를 소집하여야 한다.
   ① 재적이사 과반수가 회의의 목적을 제시하고 소집을 요구한 때
   ② 제15조 제4호 규정에 따라 감사가 소집을 요구한 때
   ③ 국내에 있는 정회원의 10분의 1이상이 회의의 목적을 제시하여 소집을 요구한때
2. 총회 소집권자가 궐위되거나 또는 이를 기피함으로서 총회소집이 불가능할 때에는 재적이사 과반수 또는 국내에 있는 정회원 10분의 1 이상의 찬성으로 감독관청의 승인을 받아 총회를 소집할 수 있다.
3. 제2항에 의한 총회는 출석 이사 중 연장자의 사회아래 그 의장을 지명한다.

제20조 (총회의결 제적사유) 의장 또는 정회원이 다음 각 호의 하나에 해당하는 때에는 그 의결에 참여하지 못한다.
1. 임원 취임 및 해임에 있어 자신에 관한 사항
2. 금리 또는 재산의 접수를 수반하는 사항으로서 의장 또는 정회원 자신과 학회의 이해가 상반되는 사항

제5장 평의원회(삭제)

제21조 (평의원의 자격 취득과 상실)
삭제

제22조 (평의원회의 직무)
삭제

제6장 이사회

제23조 (이사회의 구성 및 기능) 이사회는 회장, 부회장 및 이사들로 구성되며 다음 각 호의 사항을 심의 의결한다.
1. 업무집행에 관한 사항
2. 사업계획 운영에 관한 사항
3. 예산 결산서 작성에 관한 사항
4. 총회에서 위임받은 사항

5. 정관에 의하여 그 권한에 속하는 사항
6. 기타 중요한 사항

제24조 (의결 정족수)
1. 이사회는 이사 정원수의 과반수가 출석하지 아니하면 개회하지 못한다.
2. 이사회의 의사는 출석이사 과반수의 찬성으로 의결한다. 다만 가부동수인 경우에는 의장이 결정한다.
3. 감사는 이사회에 출석하여 의견을 진술할 수 있다.

제25조 (이사회 소집)
1. 이사회는 회장이 소집한다.
2. 이사회를 소집하고자 할 때에는 적어도 회의 7일전에 목적을 제시하여 각 이사에게 통지하여야 한다.
3. 이사회는 제2항의 통지사항에 한하여서만 의결할 수 있다. 다만 재적이사 전원이 출석하고 출석이사 전원의 찬성이 있을 때에는 통지하지 아니한 사항이라도 이를 안건으로 채택하여 의결할 수 있다.

제26조 (이사회 소집의 특례)
1. 회장은 다음 각 호의 하나에 해당하는 소집요구가 있을 때에는 그 소집요구일로부터 20일 이내에 이사회를 소집하여야 한다.
   ① 재적이사 과반수로부터 회의의 목적을 제시하여 소집을 요구한 때
   ② 제15조 제4호에 의하여 소집을 요구한 때
2. 이사회의 소집권자가 궐위되거나 또는 이를 기피함으로서 7일 이상 이사회의 소집이 불가능할 때에는 재적이사 과반수의 찬성으로 감독관청의 승인을 받아 소집할 수 있다.
3. 제2항에 의한 이사회는 출석이사 중 연장자의 사회 아래 그 의장을 지명한다.

제27조 (서면의결 금지) 이사회의 의사는 서면의결에 의할 수 없다.

제7장 재산 및 회계

제28조 (재정) 학회의 재정은 다음의 수입금으로 충당한다.
1. 회원의 회비
2. 재산의 과실
3. 사업 수익금
4. 기부금 및 기타 수익금

제29조 (회계연도) 학회의 회계연도는 정부 회계연도에 따른다.

제30조 (세입, 세출, 예산) 학회의 세입, 세출, 예산은 매 회계년도 개시 1개월 전까지 사업계획서와 함께 이사회의 의결과 총회의 승인을 얻어 감독관청에 제출한다.

제31조 (예산외의 채무부담 등) 학회의 예산외의 채무의 부담이나 채권의 포기는 총회의 의결을 거쳐 감독관청의 승인을 받아야 한다.

제8장 보칙

제32조 (해산) 학회를 해산하고자 할 때에는 총회에서 국내에 있는 재적 정회원 3분의 2 이상의 찬동으로 의결하여 감독관청의 허가를 받아야 한다.

제33조 (해산법인의 재산 귀속) 학회가 해산할 때의 잔여 재산은 감독관청의 허가를 받아 국가 또는 지방자치단체에 귀속된다.

제34조 (정관 개정) 학회의 정관을 개정하고자 할 때에는 재적이사 3분의 2 이상의 찬성과 총회의 승인을 얻어야 한다.

제35조 (시행 세칙) 정관의 시행에 필요한 세부적인 사항은 이사회에서 정하여 총회의 승인을 얻어야 한다.

제36조 (공고사항 및 방법) 법령의 규정에 의한 사항과 다음 각 호의 사항은 이를 일간신문에 공고함을 원칙으로 한다.
1. 법인의 명칭
2. 학회의 해산
3. 학회 운영과 관련하여 이사회에서 공고하기로 의결한 사항

제37조 (설립당초의 임원 및 임기) 학회의 설립당초의 임원 및 임기는 다음과 같다.

	성 명	현 직	전화번호	임 기
회장	오규동	전남대학교 교수	062-520-6965	94.5-96.5
부회장	정장해	충북대학교 교수	0431-61-2313	94.5-96.5
이사	강영운	세종대학교 교수	02-460-0234	94.5-96.5
이사	김천휘	충북대학교 교수	0431-61-3139	94.5-96.5
이사	김철희	전북대학교 교수	0652-70-2807	94.5-96.5
이사	김호일	천문대 연구원	042-865-3217	94.5-96.5
이사	민경욱	한국과학기술원 교수	042-869-2525	94.5-96.5
이사	박경윤	시스템공학센터연구원	042-869-1571	94.5-96.5
이사	서경원	충북대학교 교수	0431-61-2315	94.5-96.5
이사	이영욱	연세대학교 교수	02-361-2689	94.5-96.5
이사	이용복	서울교육대학교 교수	02-580-5456	94.5-96.5
이사	이우백	표준연구원천문대장	042-865-3215	94.5-96.5
이사	조경철	한국우주환경연구소장	02-761-0031	94.5-96.5
이사	천문석	연세대학교 교수	02-361-2685	94.5-96.5
이사	최규홍	연세대학교 교수	02-361-2686	94.5-96.5
이사	한원용	천문대연구원	042-865-3217	94.5-96.5
감사	나일성	연세대학교 교수	02-361-2681	94.5-96.5
감사	이용삼	충북대학교 교수	0431-61-2314	94.5-96.5

부 칙

제1조 (시행일) 이 정관은 감독관청의 허가를 받은 날부터 시행한다.

1. 1995년 12월 26일 과학기술처장관 허가
2. 1996년 7월 24일 과학기술처장관 허가
3. 2014년 12월 03일 미래창조과학부장관 허가

학회운영에 대한 규정

2014년 10월 30일 제정
2016년 2월 18일 개정

제1조(목적) 한국우주과학회(이하 "학회") 정관 제35조에 근거하여 학회 운영에 필요한 사항을 규정함을 목적으로 한다.

제1장 회비

제2조(회비) 학회 정관 제7조, 제8조 및 제28조의 각 1호에 근거하여 회원이 납부해야 할 연회비는 다음과 같다.

1. 임원: 10만원
2. 정회원: 5만원
3. 학생회원: 1만원
4. 명예회원: 면제
5. 특별회원: 면제
6. 기관회원 : 이사회에서 결정

제3조(회비의 면제) 2년 이상 해외 체류하는 자에 한하여 연회비를 면제할 수 있다.

제2장 위원회 및 분과 활동

제4조(구분)

1. 학회 정관 제4조의 학회 활동에 관련하여 아래 각호와 같이 위원회, 분과회, 그리고 연구회를 둘 수 있다.
   ① (위원회) 위원회는 학회원의 학술활동에 대한 지원을 목적으로 한다.
   ② (분과회) 분과회는 학회원의 전문분야별 자율적 학술활동을 목적으로 한다.
   ③ (연구회) 연구회는 학회원의 특정 목적 학술 활동을 목적으로 한다.
2. 상설위원회로는 편집위원회, 포상위원회, 학술대회준비위원회를 둔다.
3. 특별 위원회는 학회의 필요에 따라 수시로 구성 및 해산할 수 있다.
4. 분과회의 전문 분야는 학회원들의 자율적 논의와 참여를 통하여 정하고 회칙을 정하여 이사회의 승인을 얻어야 한다.
5. 연구회의 특정 학술 활동 분야는 대내외적 요구에 따라 수시로 정할 수 있다.

제5조(편집위원회)

1. 편집위원회는 학회에서 발간하는 정기 학술지에 게재되는 논문의 심사, 편집 및 출판을 관장한다.
2. 학술이사가 위원장을 맡고, 국내위원은 15인 내외로 하며 정회원 중에서 이사회의 동의를 얻어 회장이 임명한다. 국외위원은 20인 내외로 하며 이사회의 동의를 얻어 회장이 임명한다. 임기는 모두 2년으로 한다.
3. 학술지 논문 투고규정 및 세부사항은 편집위원회에서 논의한 후 이사회의 의결을 거쳐 시행한다.

제6조(포상위원회)

1. 포상위원회는 학회를 통한 대내외 수상 관련 수상자 추천 및 선발을 관장한다.
2. 포상위원회의 구성은 위원장을 포함하여 5인 이내로 하되 위원은 정회원 중에서 이사회의 동의를 얻어 회장이 임명하며, 임기는 2년으로 한다.
3. 포상자의 추천 및 수상 관련 세부 규정을 둘 수 있으며, 이사회의 의결을 거쳐 시행한다.

제7조(학술대회준비위원회)

1. 학술대회준비위원회는 학회가 개최하는 정기 및 비정기 학술대회와 관련된 모든 것을 관장한다.
2. 위원회는 위원장을 포함한 8인 이내로 하며 위원은 정회원 중에서 이사회의 동의를 얻어 회장이 임명하며, 임기는 2년으로 한다.

제8조 (활동)

1. 세부 사업계획은 자체적으로 결정하여 수립한다.
2. 세부 규정 및 세부 사업계획은 이사회에 보고하여야 한다.
3. 필요시 학회에서 예산 및 행정 지원을 할 수 있다.

제3장 간행물

제9조(간행물) 학회의 간행물에 대해서는 다음과 같이 정한다.

1. 정기 학술대회의 발표순서가 담긴 회보는 총무이사가 담당한다.
2. 논문집 우주과학회지는 편집위원회에서 담당한다,
3. 기타 우주과학전반에 걸친 간행물에 관한 토의 및 규정은 필요에 따라 위원회를 두어 담당한다.

제4장 이사회 운영

제10조(이사회 운영)

1. 이사회 직무를 수행하기 어려운 이사는 휴직할 수 있다.
2. 휴직한 이사는 본 학회의 정관 24조 1항의 정원수에서 제외한다.

제5장 규정의 개폐 및 시행세칙

제11조 (세칙) 이 규정의 시행을 위해 필요한 세부사항은 이사회의 승인을 받아 별도로 정할 수 있다.

제12조 (규정 개폐) 이 규정을 개정하거나 폐지할 때는 이사회 재적 이사 과반수의 찬성과 총회의 승인을 받아야 한다.

부칙

제1조(시행일) 이 규정은 총회의 승인을 받은 2014년 10월 30일부터 시행한다.

이 규정은 이사회의 승인을 받은 2016년 2월 18일부터 시행한다.

제2조(경과조치) 이 규정이 제정되기 이전에 시행된 모든 사항은 이 규정을 따른 것으로 본다.

연구윤리위원회의 설치 · 운영에 관한 규정

제정 2008년 1월 2일

제1장 총칙

제1조 (목적)

이 규정은 사단법인 한국우주과학회(이하 "학회"라 한다) 회원으로서 연구를 수행하는 자의 연구윤리를 확립하고 연구부정행위를 사전에 예방하며, 연구부정행위 발생시 공정하고 체계적인 진실성 검증과 처리를 위한 비상설 연구윤리위원회(이하 "위원회"라 한다)의 설치 및 운영 등에 관한 사항을 규정함을 목적으로 한다.

제2조 (정의)

1. 연구부정행위(이하 "부정행위"라 한다)라 함은 다음 각 호가 정의하는 바와 같이 연구의 제안, 연구의 수행, 연구결과의 보고 및 발표 등에서 행하여진 위조·변조·표절·부당한 논문저자 표시·자료의 중복사용 등을 말한다. 다만, 경미한 과실에 의한 것이거나 데이터 또는 연구결과에 대한 해석 또는 판단에 대한 차이의 경우는 제외한다.

① "위조"는 존재하지 않는 데이터 또는 연구결과 등을 허위로 만들어 내는 행위를 말한다.

② "변조"는 연구 재료·장비·과정 등을 인위적으로 조작하거나 데이터를 임의로 변형·삭제함으로써 연구 내용 또는 결과를 왜곡하는 행위를 말한다.

③ "표절"이라 함은 타인의 아이디어, 연구내용·결과 등을 정당한 승인 또는 인용 없이 도용하는 행위를 말한다.

④ "부당한 논문저자 표시"는 연구내용 또는 결과에 대하여 과학적·기술적 공헌 또는 기여를 한 사람에게 정당한 이유 없이 논문저자 자격을 부여하지 않거나, 과학적·기술적 공헌 또는 기여를 하지 않은 자에게 감사의 표시 또는 예우 등을 이유로 논문저자 자격을 부여하는 행위를 말한다.

⑤ "자료의 중복사용"은 본인이 이미 출판한 자료를 정당한 승인 또는 인용없이 다시 출판하거나 게재하는 행위를 말한다.

⑥ 타인에게 위 제1호 내지 제4호의 행위를 제안·강요하거나 협박하는 행위

⑦ 기타 학계 또는 과학기술계에서 통상적으로 용인되는 범위를 현저하게 벗어난 행위

2. "제보자"라 함은 부정행위를 인지한 사실 또는 관련 증거를 해당 연구기관 또는 연구지원기관에 알린 자를 말한다.
3. "피조사자"라 함은 제보 또는 연구기관의 인지에 의하여 부정행위의 조사 대상이 된 자 또는 조사 수행 과정에서 부정행위에 가담한 것으로 추정되어 조사의 대상이 된 자를 말하며, 조사 과정에서의 참고인이나 증인은 이에 포함되지 아니한다.
4. "예비조사"라 함은 부정행위의 혐의에 대하여 공식적으로 조사할 필요가 있는지 여부를 결정하기 위하여 필요한 절차를 말한다.
5. "본조사"라 함은 부정행위의 혐의에 대한 사실 여부를 검증하기 위한 절차를 말한다.
6. "판정"이라 함은 조사결과를 확정하고, 이를 제보자와 피조사자에게 문서로써 통보하는 절차를 말한다.

제3조 (적용범위) 이 규정은 학회 회원의 연구활동과 직·간접적으로 관련 있는 자에 대하여 적용한다.

제4조 (다른 규정과의 관계) 연구윤리 확립 및 연구진실성 검증과 관련하여 다른 특별한 규정이 있는 경우를 제외하고는 이 규정에 의한다.

제2장 연구윤리위원회의 설치 및 운영

제5조 (소속등) 위원회는 학회내에 비상설위원회로 둔다.

제6조 (구성)

1. 위원회는 위원장 1인을 포함한 3인의 당연직위원과 3인의 추천직위원으로 구성한다.
2. 당연직위원은 학회 부회장 2인과 학술이사로 하며, 추천직위원은 학회장이 임명한다.
3. 위원장은 학술이사로 한다.
4. 위원회는 특정한 안건의 심사를 위하여, 특별위원회를 둘 수 있다.

제7조 (위원장)

1. 위원장은 위원회를 대표하고, 회의를 주재한다.
2. 위원장이 부득이한 사유로 직무를 수행할 수 없는 때에는 위원장이 미리 지명한 위원이 그 직무를 대행한다.

제8조 (위원의 임기) 위원의 임기는 위원회의 활동기한으로 제한한다.

제9조 (간사등)
1. 위원회의 원활한 업무수행을 위하여 간사 1인을 둘 수 있다.
2. 위원회의 각종 업무를 지원하기 위하여 전문위원을 둘 수 있다.

제10조 (업무) 위원회는 다음 각 호의 사항을 심의·의결한다.
1. 연구윤리 관련 제도의 수립 및 운영에 관한 사항
2. 부정행위 제보 접수 및 처리에 관한 사항
3. 예비조사와 본조사의 착수 및 조사결과의 승인에 관한 사항
4. 제보자 보호 및 피조사자 명예회복 조치에 관한 사항
5. 연구윤리 검증결과의 처리 및 후속조치에 관한 사항
6. 기타 위원장이 부의하는 사항

제11조 (회의)
1. 위원장은 위원회의 회의를 소집하고, 그 의장이 된다.
2. 회의는 재적위원 과반수이상의 출석과 출석위원 3분의 2 이상의 찬성으로 의결한다.
3. 위원장은 심의안건이 경미하다고 인정할 때에는 서면심의로 대체할 수 있다.
4. 위원회에서 필요하다고 인정될 때에는 위원이 아닌 자를 출석케 하여 의견을 청취할 수 있다.

제12조 (경비) 위원회의 운영에 필요한 경비를 학회예산의 범위 내에서 지급할 수 있다.

제3장 연구진실성 검증

제13조 (부정행위 제보 및 접수)
1. 제보자는 학회에 구술·서면·전화·전자우편 등 가능한 모든 방법으로 제보할 수 있으며 실명으로 제보함을 원칙으로 한다. 다만, 익명으로 제보하고자 할 경우 서면 또는 전자우편으로 연구과제명 또는 논문명 및 구체적인 부정행위의 내용과 증거를 제출하여야 한다.
2. 제보 내용이 허위인 줄 알았거나 알 수 있었음에도 불구하고 이를 신고한 제보자는 보호 대상에 포함되지 않는다.

제14조 (예비조사의 기간 및 방법)
1. 예비조사는 신고접수일로부터 15일 이내에 착수하고, 조사시작일로부터 30일 이내에 완료하여 학회장의 승인을 받도록 한다.
2. 예비조사에서는 다음 각 호의 사항에 대한 검토를 실시한다.
   ① 제보내용이 제2조 제1항의 부정행위에 해당하는지 여부
   ② 제보내용이 구체성과 명확성을 갖추어 본조사를 실시할 필요성과 실익이 있는지 여부
   ③ 제보일이 시효기산일로부터 5년을 경과하였는지 여부

제15조 (예비조사 결과의 보고)
1. 예비조사 결과는 위원회의 의결을 거친 후 10일 이내에 학회장과 제보자에게 문서로써 통보하도록 한다. 다만 제보자가 익명인 경우에는 그렇지 아니하다.
2. 예비조사 결과보고서에는 다음 각 호의 내용이 포함되어야 한다.
   ① 제보의 구체적인 내용 및 제보자 신원정보
   ② 조사의 대상이 된 부정행위 혐의 및 관련 연구과제
   ③ 본조사 실시 여부 및 판단의 근거
   ④ 기타 관련 증거 자료

제16조 (본조사 착수 및 기간)
1. 본조사는 위원회의 예비조사결과에 대한 학회장의 승인 후 30일 이내에 착수되어야 한다.
2. 본조사는 판정을 포함하여 조사시작일로부터 90일 이내에 완료하도록 한다.
3. 위원회가 제2항의 기간 내에 조사를 완료할 수 없다고 판단될 경우 학회장에게 그 사유를 설명하고 조사기간의 연장을 요청할 수 있다.
4. 본조사 착수 이전에 제보자에게 위원회 명단을 알려야 하며, 제보자가 위원 기피에 관한 정당한 이의를 제기할 경우 이를 수용하여야 한다.

제17조 (출석 및 자료제출 요구)
1. 위원회는 제보자·피조사자·증인 및 참고인에 대하여 진술을 위한 출석을 요구할 수 있다.
2. 위원회는 피조사자에게 자료의 제출을 요구할 수 있으며, 증거자료의 보전을 위하여 소속 기관장의 승인을 얻어 부정행위 관련자에 대한 실험실 출입제한, 해당 연구자료의 압수·보관 등의 조치를 취할 수 있다.
3. 제1항 및 제2항의 출석요구와 자료제출요구를 받은 피조사자는 반드시 이에 응하여야 한다.

제18조 (제보자와 피조사자의 권리 보호 및 비밀엄수)
1. 어떠한 경우에도 제보자의 신원을 직·간접적으로 노출시켜서는 아니되며, 제보자의 성명은 반드시 필요한 경우가 아니면 제보자 보호 차원에서 조사결과 보고서에 포함하지 아니한다.
2. 제보자가 부정행위 제보를 이유로 징계 등 신분상 불이익, 근무조건상의 차별, 부당한 압력 또는 위해 등을 받은 경우 피해를 원상회복하거나 제보자가 필요로 하는 조치 등을 취하여야 한다.
3. 부정행위 여부에 대한 검증이 완료될 때까지 피조사자의 명예나 권리가 침해되지 않도록 주의하여야 하며, 무혐의로 판명된 피조사자의 명예회복을 위해 노력하여야 한다.
4. 제보·조사·심의·의결 및 건의조치 등 조사와 관련된 일체의 사항은 비밀로 하며, 조사에 직·간접적으로 참여한 자는 조사 및 직무수행 과정에서 취득한 모든 정보에 대하여 누설하여서는 아니 된다. 다만, 정당한 사유에 따른 공개의 필요성이 있는 경우에는 위원회의 의결을 거쳐 공개할 수 있다.

제19조 (제척·기피 및 회피)
1. 위원이 해당 안건과 직접적인 이해관계가 있는 경우에는 그

직무집행에서 제척된다.
2. 위원회는 직권 또는 당사자의 신청에 의하여 제척의 결정을 한다.
3. 위원에게 직무수행의 공정을 기대하기 어려운 사정이 있는 경우에는 제보자와 피조사자는 기피신청을 할 수 있다.
4. 위원은 제1항 또는 제3항의 사유가 있는 때에는 위원장의 허가를 얻어 회피할 수 있다.

제20조 (이의제기 및 변론의 권리 보장) 위원회는 제보자와 피조사자에게 의견진술, 이의제기 및 변론의 권리와 기회를 동등하게 보장하여야 한다.

제21조 (본조사결과보고서의 제출)
1. 위원회는 의견진술, 이의제기 및 변론내용 등을 토대로 본조사결과보고서(이하 "최종보고서"라 한다)를 작성하여 학회장에게 제출한다.
2. 최종 보고서에는 다음 각 호의 사항이 포함되어야 한다.
   ① 제보 내용
   ② 조사의 대상이 된 부정행위 혐의 및 관련 연구과제
   ③ 해당 연구과제에서의 피조사자의 역할과 혐의의 사실 여부
   ④ 관련 증거 및 증인
   ⑤ 조사결과에 대한 제보자와 피조사자의 이의제기 또는 변론 내용과 그에 대한 처리결과
   ⑥ 위원 명단

제22조 (판정) 위원회는 학회장의 승인을 받은 후 최종 보고서의 조사내용 및 결과를 확정하고 이를 제보자와 피조사자에게 통보한다.

제4장 검증 이후의 조치

제23조 (결과에 대한 조치)
1. 위원회는 학회장에게 다음 각 호에 해당하는 행위를 한 자에 대하여 징계조치를 권고할 수 있다.
   ① 부정행위
   ② 본인 또는 타인의 부정행위 혐의에 대한 조사를 고의로 방해하거나 제보자에게 위해를 가하는 행위
2. 징계조치에 관한 사항은 별도로 정할 수 있다.

제24조 (기록의 보관 및 공개)
1. 예비조사 및 본조사와 관련된 기록은 학회에서 보관하며, 조사 종료 이후 5년간 보관하여야 한다.
2. 최종보고서는 판정이 끝난 이후에 공개할 수 있으나, 제보자·위원·증인·참고인·자문에 참여한 자의 명단 등 신원과 관련된 정보에 대해서는 당사자에게 불이익을 줄 가능성이 있을 경우 공개대상에서 제외할 수 있다.

제5장 기타

제25조 (시행세칙) 위원회는 이 규정의 시행을 위하여 필요한 세부사항을 별도로 정할 수 있다.

부 칙 1. (시행일) 이 규정은 2008년 1월 2일부터 시행한다.

포상위원회 운영에 관한 규정

2011년 10월 27일 제정
2011년 12월 7일 개정
2015년 1월 16일 개정
2017년 4월 27일 개정
2018년 10월 24일 개정

제1조 (목적) 본 학회 운영규정 제2장 위원회 및 분과활동, 제6조 포상위원회 규정에 따라 포상에 관련된 추천 및 수상관련 세부규정을 정함을 목적으로 한다.

제2조 (포상위원장의 역할) 포상위원장은 위원들을 회장에게 추천하고 위원회 소집, 회의 주재, 수상자 추천 등 제반 업무를 총괄하며 정기총회에서 위원회 활동 사항을 보고 한다. (신설, 2015.1.16)

제3조 (포상의 종류) 본 학회와 관련된 학술활동 및 대외활동에 있어서 뚜렷한 업적이 있는 경우 이에 대한 포상을 하며 그 종류는 다음과 같다. 세부적인 기준은 별도 포상위원회 내부기준으로 정한다.
1. 학술상: 학문적 업적이 뚜렷한 회원에게 매년 정기총회에 수여한다.
2. 두진 우주과학자상: 학문적인 업적이 뛰어난 박사학위 후 15년 이내의 회원에게 매년 정기총회에서 수여한다.
3. 신진 우주과학자상: 우주과학회 회원으로 학문적 업적이 뛰어나며 국내에서 박사학위를 취득 후 5년 이내의 회원에게 매년 정기총회에서 수여한다.
4. 에스이랩 상: 학회 발전에 기여한 학위과정 회원들에게 수여한다.
5. 공로상: 학회의 발전에 커다란 공헌을 한 회원에게 수여한다.
6. 특별상: 학회가 주관하는 활동에 대하여 그 업적이 뛰어난 자 또는 단체에게 수여한다.

제4조 (대외 추천요령) 대외에서 요청받는 포상에 대한 후보자 선정의 경우는, 적절한 기간을 설정하여 전체 회원에게 이 내용을 공지하며, 적절한 형태의 추천형식에 따라 추천을 받는다. 포상위원회에서 별도의 추천을 할 수 있다. 포상위원회에서는 이들 후보자 중에서 해당자를 선정하며, 회장이 결정한다.

제5조 (기타 사항) 선정 기준이 정해지지 않은 포상의 경우는 그 특

성에 따라 수상자 혹은 후보자 선정기준을 별도로 적용할 수 있으며, 회장이 포상위원회와 협의하여 선정한다.

제6조 (내부기준) 포상위원회 세부규정 시행을 위해 필요한 세부사항을 내부기준 또는 지침으로 정할 수 있다 (신설, 2015.1.16)

제7조 (운영규정 개폐) 이 규정을 개정하거나 폐지할 때는 이사회의 승인을 받아야 하며 총회에 보고하여야 한다 (신설, 2015. 1. 16)

부칙 (시행일)

1. 이 규정은 2011년 10월 27일부터 시행한다.
2. 이 규정은 2012년 1월 1일부터 시행한다.
3. 이 규정은 2015년 1월 16일부터 시행한다.
4. 이 규정은 2017년 4월 27일부터 시행한다.
5. 이 규정은 2018년 10월 24일부터 시행한다.

편집위원회 운영에 관한 규정

2014년 4월 24일 제정

제1장 총 칙

제1조 (목적) 본 한국우주과학회 (이하 본 학회) 정관 제4조 (사업) 2항 학술간행물의 발행 및 배포와 학회 운영에 대한 규정 제5조 (편집위원회) 임무와 위원 구성 조항과 관련된 제반 사항을 규정함을 목적으로 한다.

제 2조 (임무)
1. 본 위원회의 주임무는 학술간행물의 발간과 배포와 관련하여 논문의 기획, 접수, 심사, 편집, 관리 등을 주관한다.
2. 기획 논문집, 자료의 발굴 및 수집 등 본 학회에서 발간하는 모든 도서의 기획 및 편집 등을 주관한다.
3. 학회지 발간과 관련된 제반 규정을 정한다.

제2장 편집위원회의 구성

제3조 (위원회의 구성) 위원회의 위원은 학회 운영에 대한 규정 제5조에 의거하여 내국인 15인, 내외 외국인 20인 내외로 한다.

제4조 (위원의 선임)
1. 위원은 학회 운영에 대한 규정 제5조에 따라 지역과 전공 등을 고려하여 편집위원장이 추천하고 본 학회 이사회의 동의를 받아 회장이 임명한다.
2. 위원이 개인사정으로 인하여 사임하는 경우, 그 후임자를 즉시 새로 위촉한다.

제5조 (위원의 임기)
1. 위원의 임기는 학회 운영에 대한 규정 제5조에 의거하여 2년으로 한다.
2. 위원의 사임으로 인하여 새로 보임된 자의 임기는 전임자의 잔여임기로 한다.
3. 위원은 필요한 경우 연임할 수 있다.

제6조 (위원의 자격) 편집위원의 자격은 다음과 같다.
1. 학회 활동에 적극적이고 학술 활동을 활발히 하는 자.
2. 연구 업적이 국내외의 학계에서 현저한 자.

제7조 (위원의 의무)편집위원은 다음의 의무를 가진다.
1. 위원은 위원회 개최시에 특별한 사유가 없는 한 출석하여야 한다.
2. 위원은 공정해야 하고, 항상 학회와 학문 발전을 위하여 부단히 노력하여야 한다.

제8조 (위원장 및 부위원장의 선임)
1. 위원회의 위원장은 학회 운영에 대한 규정 제5조에 의거하여 학술이사가 당연직으로 맡는다.
2. 위원장은 위원회를 소집하고, 그 의장이 된다.
3. 위원장의 업무를 보조하기 위해 부위원장을 둘 수 있으며 부위원장은 위원장이 임명한다.
4. 위원장과 부위원장의 임기는 2년으로 하고 연임할 수 있다.

제9조 (회의 소집)
1. 회의 소집은 개최일 1주일 이전에 연락하여 위원장이 행한다.
2. 위원장이 임무를 수행하기 곤란할 때는 부위원장이 소집한다.

제10조 (의결)
1. 위원회는 재적위원 과반수 출석으로 성립하고, 출석위원 과반수의 찬성으로 결정한다.
2. 출석하지 못한 위원이 위임장을 제출한 경우, 출석인원에는 포함하되, 의결시에는 포함하지 않는다.
3. 시간이 촉박한 중대한 사항에 대하여는 위원장이 직접 전화나 전자우편 등으로 위원의 의견을 들어 결정할 수 있다.
4. 특정 사안에 대하여 위원장이 위원회의 위임을 받은 경우 위원장이 처리할 수 있다.

제11조 (문서 관리)
1. 위원회의 회의록은 반드시 작성하고, 작성일로부터 3년간 보관한다.
2. 위원회의 원고 접수, 관리, 심사위원 위촉, 심사결과 보고서 취합, 심사결과통보 등은 모두 문서로 하며, 그 문서는 3년간 보관한다.

제3장 학회지 Journal of Astronomy and Space Sciences(이하 JASS)의 발간

제12조 (분야) JASS는 천문학 및 우주과학 전반에 관한 주제의 영문논문을 출판한다.

제13조 (발행 횟수) JASS는 년 4회 발행하는 것을 원칙으로 한다.

제14조 (발행일) 발행일은 매년 3, 6, 9, 12월의 15일로 한다.

제15조 (발행 부수) 현재 회원수와 보관용 등을 감안하여 위원회에서 정한다.

제16조 (편집 체제) 한국우주과학회 학술지 투고 규정에 따른다.

제17조 (학회지 배포)
1. 회비를 납부한 회원에게 발행일로부터 15일 이내에 학회지를 우송하는 것을 원칙으로한다.
2. 발행일 이후에 회비를 납부한 회원에게는 당해연도 발행부를 일괄 우송한다.
3. 학술대회 등 다수 회원이 참석하는 회의 일정이 30일 이내에 계획되어 있는 경우, 우송을 연기할 수 있다.
4. 외국에 거주하는 회원의 우송료는 별도로 징수할 수도 있다.

제18조 (논문 접수 및 투고 논문의 관리) 논문은 연중 수시로 접수하며 투고논문은 반드시 접수 대장을 작성하여 관리한다.

제19조 (심사 의무)
1. 학회지에 게재할 논문은 반드시 심사를 거쳐야 한다.
2. 기획 논문 및 특별히 청탁한 원고나 외국인의 원고와 학술대회 발표논문 등은 위원장의 결정으로 심사를 면제할 수 있다.

제20조 (심사위원 위촉)
1. 심사위원의 위촉은 위원회의 결의로 편집위원장이 행한다.
2. 심사위원은 논문 1편 당 2인을 위촉한다. 단 위원회는 만일의 경우를 대비하여 후보위원 1인을 추가로 선정하여 둔다.
3. 심사위원의 위촉은 가급적 전공, 연령, 지역 등이 편중되지 않도록 위촉한다.
4. 논문 투고자와 근무지가 같거나 학연 등 특별한 관계가 있는 자를 심사위원으로 선정하지 않는 것을 원칙으로 한다.
5. 심사위원에게는 소정의 심사료를 지불한다.
6. 심사위원의 위촉에 관한 사항은 공개하지 않는다.

제21조 (심사위원 수칙)
1. 공평한 기준을 정하여 공정하게 평가하여야 한다.
2. 논문 심사결과 등을 타인에게 발설하여서는 안 된다.

제22조 (심사기준)
1. 심사위원은 심사대상 논문이 JASS가 추구하는 주제를 다루고 있고 기존에 발표되지 않은 새로운 결과임을 확인하여야 한다.
2. 심사위원은 심사대상 논문이 국제적 수준의 결과를 포함하고 있는지 판단하여야 한다.
3. 심사위원은 심사대상 논문이 JASS의 편집체제에 맞추어 작성되었는지 확인하여야 한다.
4. 심사위원은 심사대상 논문의 영문 교열을 확인하여야 한다.

제23조 (심사결과 보고) 심사위원은 심사 대상 논문을 접수한 날로부터 10일 이내에 소정의 심사결과 보고서를 위원회에 제출하여야 한다.

제24조 (심사결과 통보) 심사위원이 심사결과 보고서를 제출하면, 위원장은 심사위원의 성명이나 소속 등을 삭제하고, 즉시 그 결과를 투고자에게 전자우편으로 통보한다.

제25조 (수정보완)
1. 심사결과 통보를 받은 투고자는 심사위원의 수정의견을 최대한 반영하여 논문의 질적 향상을 도모하여야 한다.
2. 심사의 종합결과 '게재 가' 혹은 '수정 후 게재' 등급을 받은 투고자는 학회에서 정한 기일내에 수정논문을 학회에 제출해야 한다.
3. 심사의 종합결과, '수정 후 재심' 등급을 받은 논문 투고자는 충분히 연구보완 수정 후에 다음 호에 게재될 수 있도록 완벽하게 수정한 논문을 학회에 제출해야 한다.

제26조 (논문 투고자의 자격) 논문의 교신저자는 한국우주과학회 회원으로 한정한다.

제27조 (논문 게재료 납부)
1. 심사완료 게재된 논문의 투고자는 학회에서 지정한 기일까지 소정의 게재료를 납부하여야 한다.
2. 국제 학술회의, Symposium, Workshop 등의 Proceeding 논문을 JASS에서 출판하는 경우, 편집위원장의 청원으로 이사회의 동의를 받아 논문 게재료를 면제할 수 있다.
3. 위원회에서 요청한 논문이나 기타 본 학회의 국제성을 위한 특별한 원고에 대해서는 게재료를 징수하지 않는다.

제28조 (원고료) 위원회에서 요청한 논문이나 기타 본 학회의 국제성을 위한 특별한 원고에 대해서는 원고료를 지급할 수 있다.

제4장 규정의 개정

제29조 (개정절차) 이 규정의 개정은 이사회의 승인을 요한다.

제30조 (개정발표) 개정된 편집규정은 다음 호의 학회지에 게재하여 발표한다.
1. (효력발생) 이 규정은 2014년 1월 1일부터 시행한다.
2. (시행규칙) 이 규정의 시행에 필요한 세부사항은 편집위원회에서 별도로 정하여 이사회의 승인을 받는다.

임원 선출에 관한 규정

2011년 8월 26일 제정
2011년 12월 7일 개정
2014년 10월 30일 개정
2018년 10월 24일 개정

제1조 (목적) 한국우주과학회 정관 제12조 1항에 따라 임원선출에 관한 사항을 규정함을 목적으로 한다.

제2조 (선거권) 정회원 자격을 취득한지 만 1년이 경과된 회원은 선거권을 갖는다.

제3조 (임원 자격)
1. 회장은 최근 10년간 학회의 정회원으로 활동하고 있으며, 이사로 봉사한 경험이 있는 회원이어야 한다.
2. 이사는 최근 5년간 본 학회의 정회원으로 활동하고 있는 회원이어야 한다.
3. 감사는 10년간 본 학회의 정회원으로 활동한 회원이어야 한다.

제4조 (회장후보 선출)
1. 회장 후보는 선거권자 온라인 추천 투표에서 최소 10명 이상의 추천을 받은 자로 한다.
2. 제1항을 충족하는 복수의 후보자가 없을 경우, 이사회에서 최대 2명의 후보를 지명할 수 있다.
3. 회장은 회장 후보를 총회 개최 최소 1주일 전에 회원에게 알려야 한다.
4. 회장 후보 선출 온라인 추천 투표에서 선거권자 1인은 1명의 후보를 추천할 수 있다.
5. 회장 후보 선출 온라인 추천 투표는 임원선출 정기 총회 개최 30일 전에 실시하고 그 기간은 2주로 한다.

제5조 (회장 선출)
1. 회장은 총회에서 회장 후보를 대상으로 하여 선거권자의 무기명 비밀선거로 선출한다.
2. 무기명 투표에서 과반수의 득표를 한 후보자가 없을 경우 상위 득표자 2인을 대상으로 재투표하여 다수 득표자를 차기회장으로 한다.

제6조 (부회장 선출) 부회장은 회장이 지명한다.

제7조 (이사선출)
1. 전체 이사 수의 1/2을 선거권자 온라인 투표로 선출하며, 나머지 1/2은 차기 회장이 지명한다.
2. 이사 선출 온라인 투표는 선거권자 1인이 3명을 추천한다.
3. 투표 결과 상위 다득점자로 수락 여부를 거쳐 이사의 1/2을 확정한다.
4. 선출된 이사 중에서 총회 당일 회장 또는 감사로 선출되어 결원이 생긴 경우 차득점 순으로 수락 여부를 거쳐 이사로 확정한다.
5. 부회장, 총무, 재무, 학술이사는 회장이 지명하며, 당연직 이사가 된다.

제8조 (감사선출) 감사는 총회에서 직접선거로 선출한다.

제9조 (세칙) 이 규정의 시행을 위해 필요한 세부사항은 이사회의 승인을 받아 별도의 세칙으로 정할 수 있다.

제10조 (규정 개폐) 이 규정을 개정하거나 폐지할 때는 이사회 재적 이사 과반수의 찬성과 총회의 승인을 받아야 한다.

부칙 1. 이 규정은 2014년 10월 30일부터 시행한다.
2. 이 규정은 2018년 10월 24일부터 시행한다.

사단법인 한국우주과학회 용역사업 규정

2011년 12월 7일 제정

제1조 (목적) 이 규정은 용역사업의 시행에 대하여 필요한 사항을 규정함을 그 목적으로 한다.

제2조 (적용범위) 이 규정은 외부로부터 수탁하거나 학회 예산으로 직접 수행하는 용역사업에 적용한다.

제3조 (사업구분) 학회에서 수행하는 용역사업은 정관 제4조의 사업 중 다음 각 호의 사업에 한한다.
1. 우주과학 및 그와 관련된 분야의 기초 및 응용 연구, 연구지원, 기술교육
2. 우주과학 및 그와 관련된 분야의 자료의 발행과 보급
3. 국내외 관련 학회와의 기술 교류
4. 우주과학 및 그와 관련된 분야의 기준 및 규정의 제안
5. 정부, 공공단체, 기타 기관에 대한 자문 및 건의
6. 기타 학회의 목적을 달성하기 위한 사업

제4조 (연구진의 구성과 자격)
1. 연구진은 연구책임자, 연구원, 보조연구원으로 구성하며, 사업의 규모, 기간 및 사업비 등을 고려하여 필요한 경우에는 총괄 연구책임자를 둘 수 있다.
2. 연구진은 학회 회원으로 구성함을 원칙으로 한다. 다만, 학회에 해당분야 전공자가 없거나 보조연구원인 경우에는 예외로 할 수 있다.

제5조 (연구책임자의 자격과 선임)
1. 총괄 연구책임자 또는 연구책임자(이하 "연구책임자"라고 칭함)는 학계의 지식과 경험이 풍부한 전문가로서, 특히 연구분

야별로 연구진을 통솔하고 연구기획, 조정능력을 갖춘 자이어야 한다.

2. 연구책임자는 학회 분과위원회, 전문성, 지역성을 최대한으로 고려하여 회장이 선임한다. 단, 의뢰자가 연구책임자를 지명할 경우 의뢰자의 뜻에 따라 선임함을 원칙으로 하되, 지명된 회원이 연구책임자로 부적합하다고 판단되는 경우에 회장은 의뢰자와 협의하여 연구책임자를 변경할 수 있다.

제6조 (연구책임자의 역할과 책임)

1. 연구책임자는 연구진의 구성과 변경에 관하여 책임을 져야 한다.
2. 연구책임자는 연구사업의 진행, 성과의 신뢰성, 연구기간의 엄수 등 계약서의 모든 사항을 책임져야 한다.
3. 연구책임자는 수탁용역사업 종료 후 1년 이내에 사업수행성과에 대한 개요를 학회지 혹은 학회논문집에 게재하여야 한다.

제7조 (비용징수와 비용의 산정) 개인 또는 단체가 3조의 용역사업을 학회로 위탁하는 경우에는 필요한 비용을 징수한다. 용역비용 산정은 다음 각 호에 따른다.

1. 용역비용은 교육과학부 장관이 고시하는 연구개발사업 처리규정의 제20조의 연구개발비 사용(이하 정부기준)의 범위 내에서 학회와 의뢰자가 협의하여 정한다.
2. 전항에 규정되지 아니한 용역사업은 당해 사업 수행에 필요한 직접경비의 범위 내에서 학회와 의뢰자가 협의하여 정한다.

제8조 (정부기준 적용원칙) 정부기준의 적용은 다음에 따른다.

1. 직접인건비: 당해 사업에 참여하는 회원 및 외부전문가의 인건비로서 정부기준을 적용한다.
2. 직접경비: 당해 사업 수행에 직접 필요한 여비, 재료비, 인쇄비, 복사비, 시험비, 외부전문가 자문비 등을 포함한 실비를 계산 산출한다.
3. 간접경비: 간접경비의 계상은 의뢰자가 학회에 직접 의뢰한 경우는 전체 용역 금액의 20%로 하고, 의뢰자가 학회의 회원에게 직접 의뢰하였으나 그 회원이 학회를 통하여 수주하는 경우는 전체 용역 금액의 5%로 한다.

제9조 (용역비용의 수령 및 지출) 용역의뢰자가 용역기간 중에 용역비용의 일부만을 학회에 지급하고, 용역계약 만료 시 그 나머지 비용을 지급하는 경우, 학회는 원활한 연구 진행을 위해 필요한 비용을 연구책임자에게 선 지급할 수 있다.

제10조 (용역비용의 관리) 학회는 용역사업의 용역비용의 지출을 연구책임자와 협의 하에 관리할 수 있다.

제11조 자세한 운영내용은 운영세칙에 정한다.

부칙 1. (시행일) 본 규정은 2012년 1월 1일부터 시행한다.

한국우주과학회 학술지 투고 규정

1. PUBLICATION TYPES, QUALIFICATION FOR AUTHORSHIP

Five types of manuscripts are published in this journal: Editorials, Review Papers, Research Papers, Technical Papers, and Letters to the Editor.

Editorials:
Editorials are submitted by invitation only and will be on topics considered to be essential by the Editorial Board of the journal.

Review Papers:
Review papers will be published by direct submission as well as from invited experts. In both cases, the work will be subject to editorial review. Review papers should critically review topics not only to inform the reader of the background, but also to communicate the state of the art and outstanding research problems.

Research Papers:
Following a peer review, original findings within the scope of the journal will be published. Critical and new results of experiments or theories should be described in full-length research papers.

Technical Papers:
Articles in this category introduce scientific work on novel skills dealing with new methods and techniques.

Letters to the Editor:
Any issues of interests to the journal readership may be contained in letters to the editor. Letters concerning articles published earlier will generally be sent to the author of the previous research for possible response before publication.

2. RESEARCH AND PUBLICATION ETHICS

Research published in JASS must follow institutional, national, and international guidelines. For the policies on the research and publication ethics that are not stated in this instructions, International standards for editors and authors (http://publicationethics.org/node/11184) can be applied.

Authorship

An author is defined as one who has made a significant contribution to the overall design and execution of the experiment; the Korean Space Science Society thus deems all authors responsible for the entire paper.

Originality and Duplicate Publication

All submitted manuscripts should be original and should not be submitted to other scientific journals for consideration while under JASS review. No part of an accepted manuscript should be duplicated in other scientific journals without the permission of the Editorial Board. If duplicate publication related to papers in this journal is detected, the names of the authors will be announced in this journal, the authors' institutes will be informed, and the authors will be subject to restrictions on future publications in JASS.

CrossCheck is a multi-publisher initiative to screen published and submitted content for originality. JASS uses iThenticate software to detect instances of overlapping and reproduced text in submitted manuscripts. Detailed information about CrossCheck can be found at https://www.crossref.org.

Conflict of Interest Statement

Authors should disclose any conflicts of interest in their manuscripts.

3. PEER REVIEW PROCESS

Once manuscripts are submitted, they will be reviewed by two or more experts in the corresponding field. The Editorial Board may request that authors revise the manuscripts in light of the reviewers' suggestions. The authors should upload the revised files with a reply to each item in the reviewers' comments after revision of the manuscript. The authors should complete the revisions within 60 days of request. If the authors want to extend the revision period to more than 60 days, they should contact the Editorial Board. The manuscript review process should be completed after the second review. If the authors wish to engage in further revision, the Editorial Board may consider it. The Editorial Board will make a final decision on the approval for publication of submitted manuscripts and can request further corrections of the article text if necessary. Review and publication processes that are not described in the Instructions for Authors will be incorporated from the Editorial Pol icy Statements, approved by the Council of Science Editors Board of Directors (https://www.councilscienceeditors.org/resource-library/editorial-policies/white-paper-on-publication-ethics/2-3-reviewer-roles-and-responsibilities/).

4. COPYRIGHTS

The Korean Space Science Society requires a corresponding author to sign a copyright transfer agreement on behalf of all the authors in order to maintain and protect the ownership and the rights of the Society, as well as to protect the original authors from misappropriation of their work. If this agreement is not assented to, the Korean Space Science Society will not publish the manuscript. This agreement is sent with the proofs to the corresponding author.

5. PAGE CHARGES

Basic publication fee = ₩400,000 (US $400) + ₩20,000 (US $20) per page. Additional charges are applicable for color illustration(s), not to exceed ₩300,000 (US $300), priced as follows: 1st colored page at ₩200,000 (US $200) + 2nd and 3rd colored pages at ₩50,000 (US $50) each. English correction services are provided on request for JASS authors at 50% of the cost.

6. SUBMISSION OF MANUSCRIPT

AAuthors must submit manuscript files to the Editorial Office of the Korean Space Science Society using the online submission system of the Journal at http://janss.kr. We do not accept direct email submission to the Editor-in-Chief or Editors. Incomplete manuscripts will be returned to the author without review. Manuscripts submitted to the journal must represent reports of original research and must be written in English. Manuscripts are accepted for review under the condition that important parts of the study have not been published and are not being considered for publication. Also, no submission can be published without approval of the institution and all the authors. The usual prerequisites for publication will be originality, clarity, and significance as relevant to a better understanding of space science and technology.

7. MANUSCRIPT PREPARATION

Word Processors and Format of Manuscript:

Manuscripts should be submitted in the file format of Microsoft Word 2007 or a later version. Manuscripts

should be doublespaced, using a font size of 11. Pages should be numbered consecutively, beginning with the title page. Page numbers should be placed at the middle of the bottom of each page. There is no fixed maximum length for full-length papers, but they rarely exceed 30 double-spaced, typewritten pages on 210 × 297 mm (A4 size) paper, including figures and tables.

Research and Technical Papers

The manuscript for a research or technical paper should be organized in the following sequence: title page, abstract and keywords, introduction, methods, results, conclusion, acknowledgments, references, tables, and figure captions.

Title page:

The title page should include the full title of the article, authors' names, affiliations, footnotes, and a short title. The title should emphasize the principal objectives covered by the paper. Authors' names should be consistent and preferably be written in a standard form for all publications to facilitate indexing and to avoid ambiguity. If some of the authors have different affiliations, use superscript numbers (1, 2, 3 ···) after the surnames of authors and before the names of their affiliations. Use a dagger (†) after the name of one designated corresponding author. The contact information for correspondence should include the mailing address, e-mail address, telephone number, and the ORCID iD.

Abstract & Keywords:

The abstract should state the objectives and present salient conclusions in no more than 200 words. This should be a clear, concise summary describing the scope and purpose, methods or procedures, significant new results, and conclusions. The abstract should be written as one paragraph. At the end of the abstract, the keywords should be given in 3 to 6 words or phrases.

Introduction:

The paper should begin with an introduction that is written for the general reader of the journal as well as for the specialist. This section should include the background and objectives, together with significant prior works.

Methods:

The methods section should include sufficient information to allow the results to be repeated. Refer to published procedures

by citing both the original description and pertinent published modifications. Do not include extensive details unless they present a substantial modification. For commonly used methods, a simple reference is sufficient. If several alternative methodologies are employed, it is useful to identify the methods briefly as well as to cite the references.

Results:

The results should be described in logical order using text, tables, and illustrations, to make clear the protocol of the study. Where appropriate, tests should be described and supported by a reference to the original citation of the test.

Conclusions:

The conclusions section should highlight key findings and compare the results of the work to appropriate findings of other studies. The conclusions should be based on the evidence presented in the paper.

Acknowledgments:

The acknowledgments section is placed at the end of body. It can cite financial and any other support.

References:

References must be obviously related to the manuscript. In the text, references should be cited with the author's surname and year of publication. When reference is made to a work by two authors, both names should be given using "&" (e.g., Kim & Lee 1996); for three or more author names, give the first author followed by "et al." and the year (e.g., Park et al. 2010). Multiple references must be arranged in chronological order (e.g., Sohn 1982; Choi & Kang 1991; Ahn et al. 2003). If more than two papers with the same authors and publication years are cited, list a, b, c··· after the year to clarify (e.g., Jung & Han 2011a, b). Only cite articles or books already published or in press, not unpublished work "in preparation." In the references section, the references should be listed in alphabetical order by letter of the first author's surname. List the first five authors followed by "et al." if there are more than five authors. If more than two papers with the same authors and publication years are cited,

list a, b, c··· after the year in publication order. Abstracts of conferences should not be included in the references. Lines after the first line of a reference are indented by one tab space ("hanging indent" in MS Word). The style for citing papers in periodicals is surname and initials of authors, title, journal name, volume, first and last page numbers, year, and digital object identifier (DOI) if available. The styles to be used for references are as follows:

Journal articles:

1. Takahashi K, McPherron RL, Hughes WJ, Multispacecraft observations of the harmonic structure of Pc3-4 magnetic pulsations, J. Geophys. Res. 89, 6758-6774 (1984). https://doi.org/10.1029/JA089iA08p06758
2. Hwang KJ, Kuznetsova MM, Sahraoui F, Goldstein ML, Lee E, et al., Kelvin-Helmholtz waves under southward interplanetary magnetic field, J. Geophys. Res. 116, A08210 (2011). https://doi.org/10.1029/2011JA016596

Book, Book in series:

3. Kelley MC, The Earth's Ionosphere (Academic Press, San Diego, 1989).

Articles from book, conference or symposium proceedings:

4. Holmberg E, Magnitudes, colors, surface brightness, intensity distributions, absolute luminosities, and diameters

of galaxies, in stars and stellar systems, vol. 9, Galaxies and the Universe, eds. Sandage A, Sandage M, Kristian J (Univ. Chicago Press, Chicago, 1975), 123-157.

5. Capitaine N, Gambis D, McCarthy DD, Petit G, Pay J, et al., Proceedings of the IERS Workshop on the Implementation of the New IAU Resolutions, Observatoire de Paris, Paris, France, 18-19 April 2002.
6. Kim K, Hwang J, Sung S, Geosynchronous magnetic field variations associated with the passage of interplanetary shocks or solar wind discontinuities, in 2007 AGU Fall Meeting, San Francisco, CA, 10-14 Dec 2007.

Technical report:

7. Mazanek DD, Roithmayr CM, Antol J, Park SY, Koons RH, et al., Comet/asteroid protection system (CAPS): preliminary space-based system concept and study results, NASA Langley Research Center Technical Report, NASA/TM-2005-213758 (2005).

Dissertation:

8. Park SY, Optimization and guidance of ascent trajectories with inequality constraints, PhD Dissertation, Texas A&M University (1996).

Website:

9. National Radio Astronomy Observatory, Very long baseline array [Internet], cited 2011 Feb 20, available from: https://www.vlba.nrao.edu

Tables:

Each table should be prepared on a separate page and numbered with an Arabic numeral in the order of its appearance in the text. When it is difficult to present data that cannot be synthesized conveniently in the text, tables should be used. Authors should avoid extensively repeating in the text data that appear in tables. Abbreviated names should be defined when they are used for the first time in each table. Tables should have a concise and informative title with the table content between horizontal lines. Vertical lines should not be used. The structure should be clear, with simple column headings giving all units. A table should not exceed one page when printed. Use lower case letters in superscripts (a, b, c...) for special remarks. Unaltered computer output and notation are generally unacceptable.

Figures:

Each figure or figure plate must have a caption written in one paragraph. For figure plates, a summary statement should precede the specific explanation of each figure. Abbreviated names are not allowed when they are used for the first time in each figure. The explanatory caption of each illustration should be understandable without reference to the text. Number figures in order of citation. Authors should place the figure number in the lower-left corner of each figure, and the numbering order must be from left to right, and from top to bottom. Citations of figures in the text or parentheses are abbreviated, e.g., Fig. 1, Figs. 1 and 2, Figs. 1-3, (Fig. 1), (Figs. 1 and 2), (Figs. 1-3). When the text refers to both figures and tables, they may be mentioned in parentheses, e.g., (Table 1; Fig. 2) and (Tables 1-3; Figs. 4-6). Line drawings should be

prepared in high quality using India ink on tracing paper. Computer-generated graphics must be produced with high tones JOURNAL OF ASTRONOMY AND SPACE SCIENCES and resolution. Photographs must be of sufficient contrast to withstand the inevitable loss of contrast and detail during the printing process. Authors should double check whether the text withstands reduction and remains legible if a figure or a figure plate is reduced. Electron and light microscopic figures must be original or scanned copies from the original.

Review Papers

Review papers may be solicited or submitted. A comprehensive presentation of a topic should discuss previously published material. Topics of scientific consensus as well as topics that remain controversial may be dealt with in reviews. A review is organized as follows: title page including abstract and keywords, introduction, body text, conclusions or summary, acknowledgments, and references. Text that exceeds 5,000 words, excluding references, will not be accepted.

Letters to the Editor

Brief constructive comments about previously published articles and interesting new ideas should be submitted as Letters to the Editor. The body text should not exceed 1,000 words and should include references. The Editorial Board may edit the Letters. In the case of comments on previously published articles, Letters to the Editor should be submitted no more than three months after the original paper has been published. The Editorial Board may contact the authors for a response to the Letters.

General Points on Text Style

Verb tense:

Generally, authors should use the past tense or present perfect tense to delineate specific events in the past, including the procedures, observations, and data of the study that authors are reporting. Use the present tense for the authors' own general conclusions, firm conclusions of previous researchers, and generally accepted facts and phenomena. The Abstract, Methods, and Results should generally be in the past tense or present perfect tense, whereas most of the Introduction and some of the Conclusions can be in the present tense. However, the tense may be different in a single sentence.

Units:

If authors describe length, height, weight, and volume, they should use standard metric units. Temperature should be given in degrees Celsius. All other units should follow the International System of Units (SI). All units must be preceded by a space.

Numbers:

Except when beginning a sentence in the text, numbers should be Arabic numerals. Authors should use commas if numbers are greater than 999, e.g., 1,984,826. The 24-hour system is used to indicate time, e.g., 20:00 hr.

Abbreviations:

Abbreviations must be used as an aid to the reader, rather than as a convenience of the author, and therefore their use should be limited. Generally, avoid abbreviations that are used less than three times in the text, including tables and figure legends. Standard SI abbreviations and units in astronomy are recommended. Other common abbreviations are as follows (the same abbreviations are used for plural forms): hr (hour), sec (second), min (minute), day (not abbreviated), year (yr), and g (gravity).

한국우주과학회 제37차 정기총회

일 시 : 2019년 10월 24일 16:40

장 소 : 여수 베네치아 호텔&리조트

1. 정족수 확인 ····· 총무이사 곽영실
2. 개회선언 ····· 회장 김용하
3. 전회의록 낭독 ····· 총무이사 곽영실
4. 사업보고 ····· 총무이사 곽영실
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8. 감사보고 ····· 감사 한원용
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10. 안건 2. 2020년도 예산(안) 심의 ····· 재무이사 김관혁
11. 안건 3. 제19대 회장선출 건 ····· 회장 김용하
12. 안건 4. 감사선출 건 ····· 회장 김용하
13. 안건 5. 부회장, 이사 선출 건 ····· 회장 김용하
14. 기타 토의 ····· 회장 김용하
15. 폐회 ····· 다같이

한국우주과학회 제36차 정기총회 회의록

■ 소집연월일 : 2018년 10월 24일 18:00
■ 개 최 장 소 : 라마다 프라자 제주 호텔
■ 개 최 일 시 : 2018년 10월 24일(수) 18:00 - 18:40
■ 참 석 회 원 : 국내 거주 정회원 678명 중 70명 참석

국내 거주 정회원 678명 중 정회원 70명 참석으로 정관 제18조 1항에 의거 총 정회원의 1/10이상(성원 68명) 출석하였으므로 김용하 의장이 제36차 정기총회 개회를 선언함.

■ 전회의록 낭독
이의 없이 유인물대로 채택되었음.

1. 사업보고(곽영실 총무이사)
곽영실 총무이사가 2018년도 정기 학술대회, 학술지 및 학회보 발행, 이사회 회의에 대하여 보고하였으며 이의 없이 통과됨.

2. 학술대회준비위원회 보고(이대영 학술대회준비위원장)
이대영 학술대회준비위원장이 학술대회준비위원회 구성과 학술대회 개최실적에 대하여 보고하였으며 이의 없이 통과됨.

3. 학술보고(이유 학술이사)
이유 학술이사가 편집위원회 구성, 학술지 발간현황 대하여 보고하였으며 이의 없이 통과 됨.

4. 포상위원회 보고(곽영실代 총무이사)
손영종 포상위원장 대신 곽영실 총무이사가 포상위원회 구성, 2018년 한국우주과학회 학술상, 두진 우주과학자상, 신진 우주과학자상 및 에스이랩상 수상자, 제28회 과학기술우수논문상 수상자에 대하여 보고하였으며 이의 없이 통과됨.

5. 감사 보고(한원용)
김갑성, 한원용 감사가 2018년 1월 1일부터 9월 30일까지의 업무 및 회계감사를 실시(2018년 10월 12일), 한원용 회원이 그 결과를 보고하였으며 이의 없이 통과됨.

■ 의결 안건
안건 1. 2018년도 결산(안) 승인 건
김관혁 재무이사가 2018년 결산(안)을 보고하였으며 동의와 재청으로 원안대로 통과됨.

안건 2. 2019년도 예산(안) 승인 건
김관혁 재무이사가 2019년도 예산(안)에 대하여 보고하였으며 동의와 재청으로 원안대로 통과됨.

이상으로, 금일의 회의 목적인 안건이 전부 심의 종료되었으므로 의장이 폐회를 선언함.

위 결의를 명확히 하기 위하여 본 의사록을 작성하고 의장과 출석한 이사와 감사가 다음에 기명날인함.

오후 6시 40분 폐회

2018년 10월 24일
사단법인 한국우주과학회 제36차 정기총회

의 장	김 용 하 인	부 의 장	오 승 준 인
부 의 장	최 기 혁 인	총무이사	곽 영 실 인
재무이사	김 관 혁 인	학술이사	이 유 인
이 사	김 해 동 인	이 사	박 종 욱 인
이 사	유 광 선 인	이 사	이 대 영 인
이 사	이 동 훈 인	이 사	이 재 진 인
이 사	이 주 희 인	이 사	임 조 령 인
이 사	정 종 균 인	이 사	조 중 현 인
이 사	진 호 인	이 사	최 영 준 인

사업보고

1. 정기 학술대회 개최
(1) 봄 학술발표회
- 강릉 라카이샌드파인
- 일시 : 2019년 4월 24일(수)~26일(금)
- 논문발표 : 135편

(2) 제2회 KGU 연례학술대회 보고
- 장소 : 평창 알펜시아
- 일시 : 2019년 7월 3일(수)~5일(금)
- 논문발표 : 248편

(3) 가을 학술발표회
- 장 소 : 여수 베네치아 호텔&리조트
- 일 시 : 2019년 10월 24일(수)~26일(금)
- 논문발표 : 229편

2. 학술지 및 학회보 발행
(1) 영문학술지발간 : JASS Vol 36, NO. 1, 2, 3호 발간
(2) 한국우주과학회보 Vol 28 N0 1, 2호 발간

3. 이사회
- 회의 개최 및 주요안건
가. 2018년도 3차 회의(2018. 10. 24.) 라마다프라자제주
· 2018년 결산(안) 승인

· 2019년 예산(안) 승인
· 신입회원 인준: 정회원 28명, 학생회원 2명
· 2019년 사업계획(안) 승인
· 편집위원회 위원 추가 승인
· 2019년 학술대회 개최 장소: 회장단에 위임
· 임원선출 규정 변경
· 편집국 규정 변경
· 포상위원회 운영에 관한 규정 변경

나. 2019년 1차 회의(2019. 01. 22.) 대전 삿뽀로
· 학술이사 임명: 장헌영 회원 임명
· 학술대회준비위원장 임명: 이주희 회원 임명

다. 2019년도 2차 회의(2019.04.25.) 강릉 라카이샌드파인
· 신입회원 인준: 정회원 5명, 학생회원 1명
· 2020년 봄 학술대회 개최: 회장단에 위임

학술대회준비위원회 보고

1. 학술대회준비위원회 구성
- 임기 : 2018년 1월~2019년 12월
- 학술대회준비위원장 : 이주희
- 학술대회준비위원 : 김연한, 정종균, 진호, 황정아

2. 학술대회 개최 실적 보고
(1) 2018년 가을학술대회 및 제35차 정기총회
- 장소: 라마다 프라자 제주 호텔
- 일시 : 2018년 10월 24일(월)~26일(금)
- 발표논문 : 총 243편
  (초청강연 5편, 구두발표 70편, 포스터발표 168편)
- 등록인원 : 260명

(2) 2019년 봄 학술대회
- 장소: 강릉 라카이샌드파인
- 일시: 2019년 4월 24일(수)~26일(금)
- 발표논문: 총 135편
  (초청강연 4편, 구두발표 69편, 포스터발표 82편)
- 참가인원: 등록 165명

(3) 2019년 가을학술대회 (10월 14일 현재)
- 장소 : 여수 베네치아 호텔&리조트
- 일시 : 2019년 10월 23일(수)~25일(금)
- 논문발표 : 총 229편
  (초청강연 4편, 구두발표 77편, 포스터발표 148편)
- 등록인원 : 270명

학술보고

1. 편집위원회 구성
- 임기 : 2018년 1월~2019년 12월
- 편집위원장: 장헌영
- 부편집위원장: 이은상
- 편집간사: 이영숙
- 편집위원: 김방엽, 나자경, 박찬덕, 이기원, 이대희, 이병선, 이수창, 이재진, 이주희, 지건화, 최영준, Chung Yue Hui, Xinlin Li, Tapas Kumar Das, Edward F. Guinan, Boonrucksar Soonthornthum, Paul A. Evenson, David Ruffolo, Jeongwoo Lee, Eunhwa Kim, Ivan L. Andronov, Lee-Anne Mckinnell, Lin-Ni Hau, Vitaly P. Kim, Jiuhou Lei, Charles Lin, Huixin Liu, Valery Nakariakov, Yuichi Otsuka, Ilya Usoskin, Chao Xiong, Sungpil Yoon

2. Journal of Astronomy and Space Sciences 발간
(가) 출판현황
- 2018년 12월호 (Vol. 35, No.4) 영문 10편 출판
- 2019년 3월호 (Vol. 36, No.1) 영문 4편 출판
- 2019년 6월호 (Vol. 36, No.2) 영문 6편 출판
- 2019년 9월호 (Vol. 36, No.3) 영문 11편 출판

(나) 인쇄본 출판 : 학회 정회원 중 받길 희망하는 회원과 기관회원 배부, 학회 보관 20부

(다) On-line 출판 :
- JASS 홈페이지(http://janss.kr)
- KISTI에서 제공하는 과학기술학회마을
- 한국연구재단(KCI)
- ADS 등에서 무료로 원문 검색 가능

포상위원회 보고

1. 포상위원회 구성
- 임기 : 2018년 1월~2019년 12월
- 위원장 : 손영종
- 위원 : 곽영실, 장헌영, 진호, 채종철

2. 2017년 수상자 선정
(가) 2019년 한국우주과학회 학술상 - 한원용(천문연)

(나) 2019년 한국우주과학회 두진 우주과학자상 수상자
- 오수연(전남대)

(다) 2019년 한국우주과학회 신진 우주과학자상 수상자
- 김정희(현산중)

(다) 에스이랩상 수상자 -(주)에스이랩 지원
- 봄 학술대회 : 오형직(연세대)

- 가을 학술대회 : 홍준석(충남대)

(라) 제29회 과학기술우수논문상 수상
(시행처: 한국과학기술단체총연합회)
- 수상자 : 이영숙(충남대)
- 수여일 : 2019년 7월 4일
- 논문제목 : Unusual Radar Echo from the Wake of Meteor Fireball in Nearly Horizontal Transits in the Summer Polar Lower-Thermosphere
- 게재지명 : JASS.2018.35.2.83

감사 보고

(사)한국우주과학회 2019년 감사보고서

회계년도 : 2019. 1. 1.~ 2019. 9. 30.

사단법인 한국우주과학회장 귀하

본 감사는 2019년 10월 10일, 2019년 1월 1일부터 2019년 9월 30일까지 한국우주과학회에 대한 회계감사 및 업무감사를 실시하였다.

회계부문에서는 회계기간에 해당하는 결산서, 손익계산서, 대차대조표를 검토한 결과 재무제표의 모든 항목이 제반 규정대로 정확하게 표시되었으며, 차년도 사업예산도 규정에 따라 적법하게 계획되었다. 재무제표를 뒷받침하는 회계장부와 지출결의서, 통장 등 증빙서류도 제대로 정리되었으며, 통장잔액과 장부잔액이 일치한다는 사실을 확인하였다.

학술행사 사업으로 2019년 봄 학술대회가 4월 24일~26일 강릉 라카이샌드파인 리조트에서 개최되었으며, 우리 학회는 총 165명 등록하여 135편의 논문이 발표되었고, 봄 학술대회 사업비로 37,455,920원 사용되어 예산집행이 적절하게 이루어졌다.
2019년 9월 30일 현재 학회 유동자산은 386,891,596원이며 보통예금으로 167,891,596원, 정기예금으로 200,000,000원, 두진 우주과학자상 예금으로 6,000,000원, 신진 우주과학자상으로 13,000,000원을 운영하고 있다. 2019년 9월 30일 현재 2018년 말 대비 총자산이 37,563,799원만큼 증가하였다. 12월 결산시에는 가을학술대회 행사비 지출을 하고 나면 손익이 현재보다 다소 줄어들 것으로 예상되나, 학회 자금 운용이 예산대비 합리적으로 이루어지고 있음을 확인하였다.

사업부문에서는 2019년 발행된 JASS Vol.36, No.1 ~ No.3에 대한 학술지 발행사업비로 총 27,488,214원 사용되었다. 발행된 논문은 JASS 3월호 4편, JASS 6월호 6편, JASS 9월호 11편 총 21편의 논문이 발간되었다. 최근 우주과학회지 JASS는 ESCI(Emerging Sources Citation Index)에 등재되었으나, 논문의 질과 양을 더욱 향상시켜 가까운 미래에 SCI 등재 학술지가 될 수 있도록 학회 임원진과 회원님들의 적극적인 노력을 당부 드린다.

이상과 같이 2019년 9월 30일 기준으로 한국우주과학회 사업부문과 결산 회계처리 내역을 감사한 결과 결산서와 다르지 않다는 사실을 확인하고 이에 서명 날인한다.

2019년 10월 10일

사단법인 한 국 우 주 과 학 회

감사 김 갑 성 (인)

감사 한 원 용 (인)

안건 1. 2019년도 결산(안) 승인 건

1. 2019년도 결산서

2019년도 결산서

기간: 2019.1.1~2019.09.30. (사)한국우주과학회 (단위:원)

수입			지출		
과목	금액		과목	금액	
1.회비수입	23,890,000		1. 발행사업비	27,488,214	
1-1 연회비		23,890,000	1-1 인쇄비		7,372,200
1-2 특별회비		-	1-2 편집비		15,125,200
2.기부금	10,000,000		1-3 영문교열		2,096,434
2-1 지정기부금		10,000,000	1-4 발송비 외		2,894,380
3.학술발표회	69,200,000		2. 학술행사비	37,455,920	
3-1 봄학술대회		39,320,000	2-1 봄학술대회		37,455,920
3-2 가을학술대회		29,880,000	2-2 가을학술대회		-
3-3 비정기학술대회		-	2-3 비정기학술대회		-
4.게재료	14,588,000	14,588,000	3. 비정기활동사업비	-	
5.광고수입	10,000,000		3-1 대중화 사업 등		-
5-1 연구홍보		6,800,000	4. 위원회 사업비	300,000	300,000
5-2 기업광고		3,200,000	5. 회의비	1,577,700	1,577,700
6.지원금	11,637,112		6. 용역비	-	
6-1 과총		11,637,112	6-1 용역직접비		-
6-2 기타지원금		-	6-2 용역간접비		-
7.용역비	-		7. 급료와 임금	24,260,060	24,260,060
7-1 용역비		-	8. 4대보험료	1,723,240	1,723,240
8.사업수익	-		9. 운영비	1,698,230	1,698,230
8-1 용역간접비		-	10. 세금과공과/연회비	5,415,732	5,415,732
9.사업외수익	1,047,583	1,047,583	11. 출장비	2,879,800	2,879,800
수 입 계 ①	140,362,695		지 출 계 ④	102,798,896	
전년도 이월금 ②	349,327,797	(2018.12.31)	차기 이월금 (⑤=③-④)	386,891,596	*회계장부 잔액
합 계 (③=①+②)	489,690,492		합계	489,690,492	

전년도이월금	349,327,797
당기손익(+)	37,563,799
차기이월금	386,891,596

2. 전년도(2018 회계년도) 결산서

2018년도 결산서

기간: 2018.1.1~2018.12.31. (사)한국우주과학회 (단위:원)

수입			지출		
과목	금액		과목	금액	
1.회비수입	27,170,000		1. 발행사업비	26,847,433	
1-1 연회비		27,170,000	1-1 인쇄비		11,738,100
1-2 특별회비		-	1-2 편집비		4,080,000
2.기부금	5,000,000		1-3 영문교열		7,480,113
2-1 지정기부금		5,000,000	1-4 발송비 외		3,549,220
3.학술발표회	89,217,000		2. 학술행사비	56,322,680	3,549,220
3-1 봄학술대회		20,200,000	2-1 봄학술대회		11,437,990
3-2 가을학술대회		69,017,000	2-2 가을학술대회		44,884,690
4.게재료	29,040,775		2-3 비정기학술대회		-
5.광고수입	29,500,000		3. 비정기활동사업비	-	
5-1 연구홍보		12,900,000	3-1 대중화 사업 등		-
5-2 기업광고		16,600,000	4. 위원회 사업비	343,000	343,000
6.지원금	6,850,000		5. 회의비	3,227,300	3,227,300
6-1 과총		6,850,000	6. 용역비	-	
6-2 기타지원금		-	6-1 용역직접비		-
7.용역비	-		6-2 용역간접비		-
7-1 용역비		-	7. 급료와 임금	59,050,525	59,050,525
8.사업수익	-		8. 4대보험료	3,747,100	3,747,100
8-1 용역간접비		-	9. 운영비	6,945,470	6,945,470
9.사업외수익	20,524,554		10. 세금과공과/연회비	9,987,541	9,987,541
			11. 출장비	4,324,100	4,324,100
수 입 계 ①	207,302,329		지 출 계 ④	170,795,149	
전년도 이월금 ②	312,820,617	(2017.12.31)	차기 이월금 (⑤=③-④)	349,327,797	*회계장부 잔액
합 계 (③=①+②)	520,122,946		합계	520,122,946	

전년도이월금	312,820,617
당기손익(+)	36,507,180
차기이월금	349,327,797

안건 2. 2020년도 예산(안) 승인 건

1. 일반회계

단위 : 원

기간 2020. 1. 1 ~ 2020.

2020년도 예산 수입(안)		
과목	2020년 예산(A)	
	대분류	소분류
1. 회비수입	24,000,000	
1-1 연회비		24,000,000
1-2 특별회비		0
2. 기부금	0	
2-1 지정기부금		0
3. 학술발표회	91,000,000	
3-1 봄학술대회		43,000,000
3-2 가을학술대회		48,000,000
4. 게재료	36,000,000	
5. 광고수입	13,000,000	
5-1 연구홍보		6,000,000
5-2 기업광고		7,000,000
6. 지원금	15,000,000	
6-1 과총		15,000,000
6-2 연구재단		0
6-3 기타지원금		0
7. 용역비	0	
7-1 용역비		0
8. 사업수익	0	
8-1 용역간접비		0
9. 사업외수익	4,800,000	
합 계	183,800,000	

2020년도 예산 지출(안)		
과목	2020년 예산(A)	
	대분류	소분류
1. 발행사업비	36,900,000	
1-1 인쇄비		10,000,000
1-2 편집비		18,000,000
1-3 영문교열		4,400,000
1-4 발송비 외		4,500,000
2. 학술행사비	91,000,000	
2-1 봄학술대회		43,000,000
2-2 가을학술대회		48,000,000
3. 비정기활동사업비	0	
3-1 대중화사업 등		0
4. 위원회사업비	2,000,000	
5. 회의비	3,000,000	
6. 용역비	0	
6-1 용역직접비		0
6-2 용역간접비		0
7. 급료와 임금	32,000,000	
8. 보험료	2,400,000	
9. 운영비	4,900,000	
10. 세금과공과/연회비	8,600,000	
11. 출장비	3,000,000	
지 출 계	183,800,000	

2. 특별회계(정기예금)

항목	2020년(A)
특별회계	250,000,000
두진상	5,000,000
신진상	12,000,000
합계	267,000,000

안건 3. 제 19대 회장 선출 건

정관 제3장 제12조에 의거 제19대 회장을 선출하여 주실 것을 제안함.
선출된 회장의 임기는 2년 (2020. 01. 01.~2021. 12. 31.)이다.

- 온라인으로 추천된 회장 후보 : 이동훈(경희대), 이 유(충남대), 최기혁(항우연)

안건 4. 감사 선출 건

정관 제3장 제12조에 의거 감사를 선출하여 주실 것을 제안함.

선출된 감사의 임기는 2년 (2020. 01. 01.~2021. 12. 31.)이다.

안건 5. 부회장, 이사 선출 건

정관 제3장 제12조에 의거 부회장, 이사를 선출하여 주실 것을 제안함.

선출된 부회장과 이사의 임기는 2년 (2020. 01. 01.~2021. 12. 31.)이다.
부회장은 회장이 지명하고 이사의 절반은 투표로 선출하고, 나머지 절반은 회장이 지명하기로 함에 따라 이사선출 온라인 투표를 2019. 09. 24.~2019. 10. 07.까지 실시하였다.

한국우주과학회보
제28권 2호 2019년 10월
전화 042-865-3391 (FAX: 042-865-3392)
학회 홈페이지 http://ksss.or.kr

발행인 김용하
편집인 곽영실 · 고미희
발 행 사단법인 한국우주과학회
인 쇄 ㈜거목문화사(02-2277-3324)

학회 소재지 대전시 유성구 대덕대로 776 한국천문연구원 내
전화: 042-865-3391 / 팩스: 042-865-3392
학회대표메일: ksss@ksss.or.kr

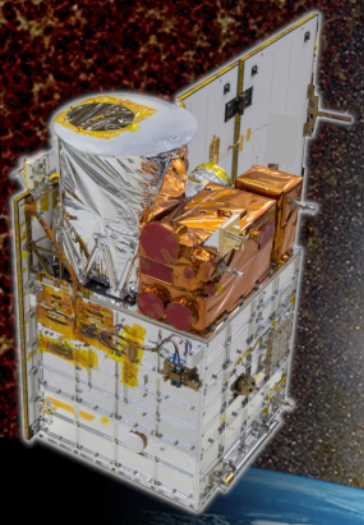
도움을 주신 기업

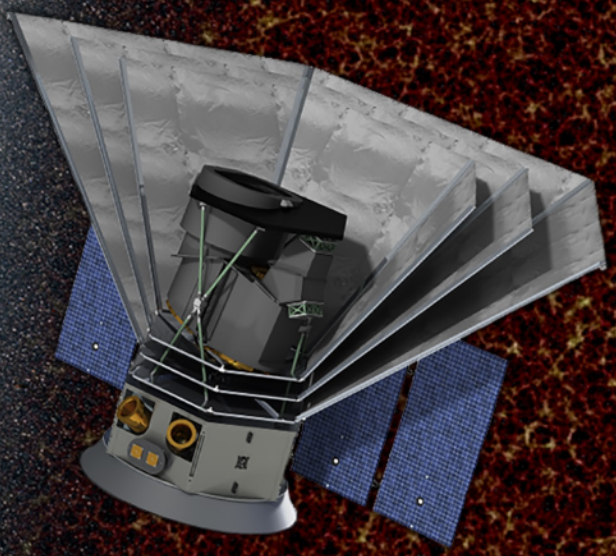
기관명	대표	연락처
(주)세트렉아이	김이을 대표이사	대전광역시 유성구 유성대로 1628번길 21, 1층 전화 042-365-7524
(주)에스이랩	오승준 대표이사	서울시 강남구 논현동 66-3 진영빌딩 5층 전화 02-888-0850
(주)지솔루션	김태훈 대표이사	대전시 유성구 문지로 193, 진리관 T213 전화 042-867-0140

도움을 주신 연구홍보 사업단

사업명	연구책임자	연락처
극지연구소 우주환경과 저층대기에 의한 극지고층 대기 변화 규명	지건화 박사	032-760-5306
한국천문연구원 K-GMT 과학백서	박병곤 박사	042-865-3207
한국천문연구원 차세대 소형위성 1호 적외선탑재체 우주 영상분광관측자료 활용연구	정웅섭 박사	042-865-3204
한국천문연구원 우주위험 대응 기술연구	조성기 박사	042-865-3236
연세대학교 은하진화연구센터	이영욱 교수	02-2123-2689

적외선 광역 영상분광 미션





NISS
차세대소형위성 1호 탑재체
(2018년 12월 발사 성공)

SPHEREx
(2023년 발사 예정)

NISS (근적외선 영상분광기)

- 차세대소형위성 1호 탑재체 (2018년 12월 발사 성공)
- **LVF(선형 파장 변화 필터)**를 활용한 근적외선 파장 영역(0.95~2.5 μm) 분광영상 관측 수행
- 국내 첫 영상분광 우주관측 기술 성공
- 가까운 외부은하 및 은하단 탐사 관측

SPHEREx

- 미국 NASA의 중형 탐사(MIDEX) 미션 (**2023년** 발사 예정)
- NISS와 같은 LVF와 **비축 광학계** 기술
- 근적외선/중적외선 파장 영역 (0.75~5 μm) **전천 영상분광 탐사**
- 한국 천문학계 참여 (관측 기기 개발 및 검보정 / 태양계부터 우주론까지 다양한 분야의 과학 연구)

KASI 한국천문연구원 | SaTReC

과학기술정보통신부

CALIFORNIA INSTITUTE OF TECHNOLOGY 1891 | JPL Jet Propulsion Laboratory California Institute of Technology | Ball | ipac | Korea Astronomy and Space Science Institute 한국천문연구원

CfA | THE UNIVERSITY OF CALIFORNIA IRVINE | THE OHIO STATE UNIVERSITY | ARIZONA STATE UNIVERSITY 1885 | R·I·T

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한국천문연구원은 우주위험으로부터
국민의 안전과 우주자산을 보호하는
임무를 수행하고 있습니다(우주개발진흥법 제15조).

- 우주위험에 대한 전문적 상시 감시 및 정보 통합관리 수행
- 신속한 우주위험 예·경보를 위한 국가대응체계 구축 및 운영 지원
- 우주위험 대비 역량강화를 위한 기술개발 및 시설 구축

KASI 한국천문연구원 Korea Astronomy & Space Science Institute

과학기술정보통신부

과학기술정보통신부 한국연구재단 선정 선도연구센터(SRC)

은하진화연구센터
Center for Galaxy Evolution Research (CGER)

- 주관연구기관 연세대학교 (센터장: 이영욱 교수)
- 참여기관 경북대학교, 경희대학교, 서울대학교, 이화여자대학교, 충남대학교

센터소개

그 동안 우리 연구진은 현대 천문학의 최대 화두인 은하의 형성 기원과 진화 연구 분야에서 괄목할만한 연구를 꾸준히 이어왔다. 은하진화 연구센터는 이와 같은 우리 연구진의 경험과 연구력을 한 곳에 결집하여, 가까운 은하의 항성종족으로부터 유추되는 기본지식을 발판으로 먼 은하를 이루는 항성종족을 이해하고, 여기에 활동은하핵 및 우주초기조건의 영향을 함께 고려함으로써 은하의 형성 기원 및 진화 과정의 총체적 규명에 도전하고 있다. 은하진화 연구센터는 자외선우주망원경 GALEX의 연장미션 수행, 허블우주망원경 및 최첨단 중대형 망원경을 사용하는 가시광 관측, 관측자료의 이론적 해석을 위한 첨단 은하진화모델 구축을 통해, 국제학계를 선도하는 다양한 연구를 수행하고 있다.

참여연구진

과제구분	연구과제명	성명	소속
제 1-1 세부과제	우리은하 헤일로의 형성과 진화	안덕근 이영선	이화여자대학교 충남대학교
제 1-2 세부과제	왜소타원은하의 형성과 진화	윤석진 이수창	연세대학교 충남대학교
제 2-1 세부과제	은하내 항성종족의 진화와 암흑에너지	이영욱 김석환 김태선	연세대학교 연세대학교 연세대학교
제 2-2 세부과제	활동은하핵(AGN)과 은하진화	우종학 정애리 박명구	서울대학교 연세대학교 경북대학교
제 2-3 세부과제	우주초기조건과 은하진화	이정훈 최윤영	서울대학교 경희대학교