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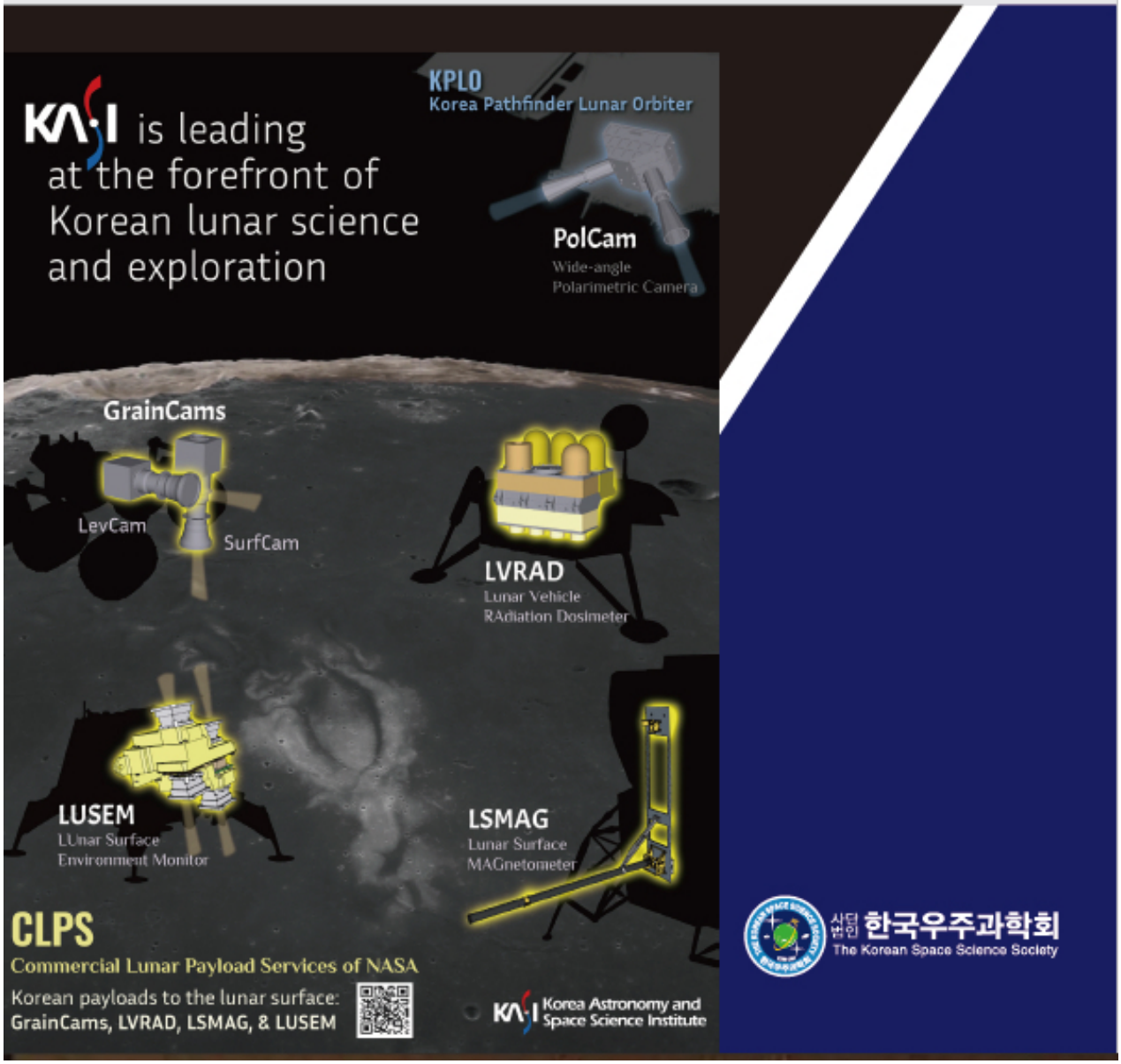


한 국 우 주 과 학 회

이 발표논문집은 2021년도 정부재원(과학기술진흥기금 및 복권기금)으로 한국과학기술단체총연합회의 지원을 받아 발간되었음

ISSN 1598-5601

한국우주과학회보

Bulletin of The Korean Space Science Society

2021년 10월 제30권 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
한국천문연구원 내
전화 042-865-3391
팩스 042-865-3392

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

▣ 회비납부안내

회원구분	입회비	연회비
학생회원(학부생)	10,000원	10,000원
정회원	10,000원	70,000원
회장, 부회장	-	150,000원
이사, 감사	-	150,000원

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

※ 뒷면의 입회원서를 복사하여 사용해 주십시오.

[표지사진 설명]

한국천문연구원이 수행 중인 한미 민간달착륙선 탑재체 공동개발 사업으로 NASA Commercial Lunar Payload Services에 탑재 예정인 한국측 과학탑재체 설계 개념도: LUSEM (달 우주환경 모니터), LVRAD (달 표면 우주방사선 측정기), LSMAG (달 표면 자기장 측정기), GrainCams (달 표토 3차원 영상카메라)

입 회 원 서

<table>
<tr><td>성 명</td><td colspan="2">한글
영문</td><td>성 별</td><td>남/여</td><td>생 년 월 일</td><td colspan="2">년 월 일</td></tr>
<tr><td>자택주소</td><td colspan="3"></td><td>우편번호</td><td></td><td>전 화</td><td></td></tr>
<tr><td>직장주소</td><td colspan="3"></td><td>우편번호</td><td></td><td>전 화</td><td></td></tr>
<tr><td>e-mail</td><td colspan="5"></td><td>이동전화</td><td></td></tr>
<tr><td>소 속</td><td colspan="4"></td><td>직 위</td><td colspan="2"></td></tr>
<tr><td rowspan="4">학 력</td><td>학위명</td><td>입학년도</td><td>학위취득일</td><td colspan="2">출신학교</td><td colspan="2">전 공</td></tr>
<tr><td>학사</td><td></td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>석사</td><td></td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>박사</td><td></td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>분과회
선택</td><td colspan="7">- 중복선택 가능
□ 태양우주환경분과 □ 우주탐사분과 □ 우주관측기기분과
□ 우주감시분과 □ 초소형위성분과 □ 활동 안함</td></tr>
<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
2021년 가을 학술대회

일　　시 : 2021. 10. 27.(수) 13:00 ~ 29.(금) 15:00

장　　소 : 라한 셀렉트 경주

발표논문 : 초청강연 4편, 구두발표 106편, 포스터발표 137편, 총 247편

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

포스터 발표 1부 : 2021. 10. 28.(목) 13:20~14:00

2부 : 2021. 10. 29.(금) 11:20~12:00

후　　원 : KOFST 한국과학기술단체총연합회　한국과학창의재단 Korea Foundation for the Advancement of Science & Creativity

사단법인 한국우주과학회

등록 및 교통 안내

1. 등록

회원의 등록비는 240,000원이며, 학생회원과 정회원 중 석·박사과정(전일제) 학생은 150,000원입니다. 사전등록을 하신 회원은 등록자 명부에 서명 후 학회보, 명찰을 수령하시기 바랍니다. 등록비 영수증은 홈페이지에서 발행 가능합니다.

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: 70,000원(학부학생회원은 입회비 10,000원, 연회비 10,000원)입니다.

학회계좌: 국민은행 012-01-0603-888(한국우주과학회)

3. 발표자료 준비

구두발표: 발표자료는 파워포인트 파일로 준비하시기 바랍니다.

포스터발표: 포스터 발표 1부 세션은 10월 28일(목) 12시까지 지정된 장소에 게시하고 28일(목) 17시에 수거하여 주시고, 2부 세션은 29일(금) 10시까지 게시하고 29일(금) 14시에 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 학회발표가 제한될 수 있습니다(2006년 3차 이사회 결정).

4. 발표장

	Room	Area
ORAL	Convention A	– Invited Talk I, II, III, IV – Apophis I, II – Space Industry – Nano/Microsatellite – Commercial Lunar Payload Service Space Radiation
	Convention B	– Space Technology – Space Application – Space Astronomy–Solar System & Space Exploration – Space Surveillance I, II – Sun & Space Environment III, V
	Convention C	– Sun & Space Environment I, II, IV, VI – 특별 포럼 – Science Culture
POSTER	Lobby	– Space Technology – Space Application – Space Astronomy – Nano/Microsatellite – Solar System & Space Expl. – Science Culture – Space Situational Awareness – Sun & Space Environment – Commercial Lunar Payload Service – Miscellaneous

5. 교통

가. 주소: 경상북도 경주시 보문로 338 KR 라한 셀렉트 (Tel: 054-748-2233)

나. 찾아오시는 길

▶KTX 이용시: 신경주역

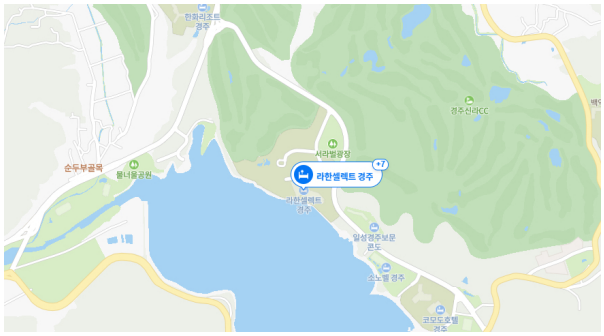
– 택시: 35분 내외, 약 25,000원

– 버스: 700(1시간 내외)

▶무궁화호 이용시: 경주역

– 택시: 20분 내외, 약 9,600원

– 버스: 경주우체국 정류장에서 10, 16, 18, 100-1, 150-1, 700(30분 내외)



2021 KSSS FALL CONFERENCE PROGRAM

Oct. 27. (Wed)

Time	Functions					
11:30~	Registration Open					
13:00~13:10	Opening Ceremony : Convention A 환영사: 최기혁 회장 (Gi-hyuk Choi) 축사: 박영득 한국천문연구원 원장 (Young-deuk Park)					
13:10~13:40	**Invited Talk I** Room : Convention A Chair : Gi-Hyuk Choi (KARI) Gi-Wook Nam (Intospace Co., Ltd.) Navigation Satellite System: The world and Korea					
13:40~13:50	Coffee Break					
Room	**Convention A**		**Convention B**		**Convention C**	
Session I	**Special Session : Apophis I** Chair : Hong-Kyu Moon (KASI)		**Space Technology / Space Application / Space Astronomy** Chair : Bong Kon Moon (KASI)		**Sun & Space Environment I** Chair : Ho Sik Kam (KASI)	
13:50~14:05	I-1-1	Young-Jun Choi	I-2-1	Bong Kyu Park	I-3-1	Ho Sik Kam
14:05~14:20	I-1-2	Myung-Jin Kim	I-2-2	Seok-Bae Seo	I-3-2	Young-Sook Lee
14:20~14:35	I-1-3	Yae Ji Kim	I-2-3	Joo Hee Lee	I-3-3	Jae Wook Lee
14:35~14:50	I-1-4	Joo Yeon Geem	I-2-4	Dae Jun Jung	I-3-4	Won Seok Lee
14:50~15:05	I-1-5	Sun Ho Jin	I-2-5	Jae Yeon Hyun	I-3-5	Geon Hwa Jee
15:05~15:20	I-1-6	Hee Jae Lee	I-2-6	Ji Min Han	I-3-6	Ji Hyeon Son
15:20~15:30	Coffe Break					
Session II	**Special Session : Apophis II** Chair : Myung-Jin Kim (KASI)		**Solar System & Space Exploration** Chair : Joo Hyeon Kim (KARI)		**Sun & Space Environment II** Chair : Kyung Sun Park (CBNU)	
15:30~15:45	II-1-1	Pu Reum Kim	II-2-1	15:30~15:40 Young-Rok Kim	II-3-1	Chan Haeng Lee
15:45~16:00	II-1-2	Min Sup Jeong	II-2-2	15:40~15:50 Seung Bum Hong	II-3-2	Woo Hyeong Seol
16:00~16:15	II-1-3	Youngmin JeongAhn	II-2-3	15:50~16:00 Eunhyeuk Kim	II-3-3	Jun Hyun Lee
16:15~16:30	II-1-4	Sun Kyu Lee	II-2-4	16:00~16:10 Jin Kyu Kim	II-3-4	Jong Woo Kwon
16:30~16:45	II-1-5	Tae Hyun Jung	II-2-5	16:10~16:20 Kil Ho Baek	II-3-5	Ki Wan Park
16:45~17:00			II-2-6	16:20~16:30 Haing Ja Seo	II-3-6	Dae Jung Yu
17:00~17:15			II-2-7	16:30~16:40 Seul-Min Baek	II-3-7	Khan-Hyuk Kim
			II-2-8	16:40~16:50 Hyeon Jun Kim		
			II-2-9	16:50~17:00 Jong-Won Lee		
			17:00~17:30	Solar system & Space Exploration Division Meeting		
16:00~17:00	한국우주과학회 발전 방안(SCI 등재방안 포함) 간담회 Room : Capella Hall					
17:30~18:30	Board Meeting Room : Capella Hall					

Oct. 28. (Thu)

Time	Functions					
09:00～09:30	**Invited Talk Ⅱ** Room : Convention A Chair : Su Yeon Oh (JNU) Jin-Yi Lee (KHU) Erupting Solar Plasma in Nonequilibrium States					
09:30～09:40	Coffe Break					
Room	**Convention A**		**Convention B**		**Convention C**	
Session Ⅲ	**Special Session : Space Industry** Chair : Jung A Hwang (KASI)		**Space Situational Awareness Ⅰ** Chair : Jae-Dong Seong (KARI)			
09:40～09:55	Ⅲ-1-1	Byung jin Kim	Ⅲ-2-1	Jung Hyun Jo	10:00～10:50	Sun & Space Environment Division Meeting
09:55～10:10	Ⅲ-1-2	Ho-Jin Lee	Ⅲ-2-2	Myung-Jin Kim		
10:10～10:25	Ⅲ-1-3	Myung Jin Choi	Ⅲ-2-3	Jang-Hyun Park		
10:25～10:40	Ⅲ-1-4	Sang Eun Yun	Ⅲ-2-4	Man-Soo Choi		
10:40～10:55	Ⅲ-1-5	Kwang-Hyun Lee	Ⅲ-2-5	Sung Ki Cho		
10:55～11:10	Ⅲ-1-6	Dong Kwen Jeon	Ⅲ-2-6	Ji Woong Yu		
11:00～12:30	**특별 포럼** Room : Convention C 진행 : 이병선 (ETRI) - 주제 : 대한민국 우주탐사 변화와 기회 - 발표 : 한국형 발사체 개발과 우주탐사 추진 전략 (양수석 KARI)					
12:30～13:20	Lunch Time					
13:20～14:00	**Poster Session Ⅰ (No. P1～P69)**					
Session Ⅳ	**Nano/Microsatellite** Chair : Hong Rae Kim (Soltop)		**Space Situational Awareness Ⅱ** Chair : Man-Soo Choi (KASI)		**Special Session : Science Culture** Chair : Jung A Hwang (KASI)	
14:00～14:15	Ⅳ-1-1	Seul Hyun Park	Ⅳ-2-1	Jin Choi	Ⅳ-3-1	14:00～14:30 Beom Jun Kim
14:15～14:30	Ⅳ-1-2	Sang-Hyun Lee	Ⅳ-2-2	Jae-Dong Seong	Ⅳ-3-2	14:30～15:00 Kyung Soo Moon
14:30～14:45	Ⅳ-1-3	Jun Chan Lee	Ⅳ-2-3	Si Woo Kim	Ⅳ-3-3	15:00～15:30 Hae Dong KIim
14:45～15:00	Ⅳ-1-4	Han Ik Kim	Ⅳ-2-4	Seung Hwan Choi	Ⅳ-3-4	15:30～16:00 Chae Kyung Sim
15:00～15:15	Ⅳ-1-5	Ho-Jin Lee	Ⅳ-2-5	Eun Jung Choi	16:00～16:30	과학문화 패널 토의
	15:15～16:40	Nano/Microsatellite Workshop & Division Meeting 이호진(솔탑) 이성희(컨택) 김해동(항우연) 최명진(한컴스페이스)	15:15～16:40	Space Situational Awareness Workshop & Division Meeting 조성기(천문연) 최성환(공군) 정옥철(항우연) 안재명(과기원)		
16:40～17:10	**Invited Talk Ⅲ** Room : Convention A Chair : Jung A Hwang (KASI) Hyun-Woo Shin (CEO of Hanwha Aerospace Co., Ltd.) The Commercial Space Age Is Now Here in Korea					
17:10～17:20	Coffee Break					
17:20～18:40	Regular General Meeting / Photo Time Room : Convention A					
18:40～20:30	Banquet Room : Convention C					

Oct. 29. (Fri)

Time	Functions					
09:00～09:30	**Invited Talk Ⅳ** Room : Convention A Chair : Hong-Kyu Moon (KASI) Elena Adams (Johns Hopkins University) NASA's Double Asteroid Redirection Test (DART): Earth Strikes Back					
09:30～09:40	Coffee Break					
Room	**Convention A**		**Convention B**		**Convention C**	
Session Ⅴ	**Special Session : Commercial Lunar Payload Service** Chair : Duk Hang Lee (KASI)		**Sun & Space Environment Ⅲ** Chair : Tae-Yong Yang (KASI)		**Sun & Space Environment Ⅳ** Chair : Jung Joon Seough (KASI)	
09:40～09:55	Ⅴ-1-1	Young-Jun Choi	Ⅴ-2-1	Jeong Heon Kim	Ⅴ-3-1	Hyun-Jin Jeong
09:55～10:10	Ⅴ-1-2	Min Sup Jeong	Ⅴ-2-2	Jin Koo Yim	Ⅴ-3-2	Eun Su Park
10:10～10:25	Ⅴ-1-3	Sung-Joon Ye	Ⅴ-2-3	Sun Mie Park	Ⅴ-3-3	Ha Rim Lee
10:25～10:40	Ⅴ-1-4	Sung Hwan Kim	Ⅴ-2-4	Se Heon Jeong	Ⅴ-3-4	Kang Woo Yi
10:40～10:55	Ⅴ-1-5	Go Woon Na	Ⅴ-2-5	Dong-Hee Kim	Ⅴ-3-5	Da Ye Lim
10:55～11:10	Ⅴ-1-6	Ho Jin	Ⅴ-2-6	Tae-Yong Yang		
11:10～11:20	Coffee Break					
11:20～12:00	**Poster Session Ⅱ (No. P70～P137)**					
12:00～13:00	Lunch					
Session Ⅵ	**Special Session : Space Radiation** Chair : Jong Dae Sohn (KASI)		**Sun & Space Environment Ⅴ** Chair : Su Yeon Oh (JNU)		**Sun & Space Environment Ⅵ** Chair : Jin-Yi Lee (KHU)	
13:00～13:15	Ⅵ-1-1	Uk-Won Nam	Ⅵ-2-1	Doo Young Choi	Ⅵ-3-1	Il-Hyun Cho
13:15～13:30	Ⅵ-1-2	Hong Joo Kim	Ⅵ-2-2	Kwang Sun Ryu	Ⅵ-3-2	Jae-Ok Lee
13:30～13:45	Ⅵ-1-3	Jae Young Kwak	Ⅵ-2-3	Jun Chan Lee	Ⅵ-3-3	Jung Joon Seough
13:45～14:00	Ⅵ-1-4	Suk Won Youn	Ⅵ-2-4	Keun Woong Shin	Ⅵ-3-4	Ji Min Hong
14:00～14:15	Ⅵ-1-5	Jin Hyun Kim	Ⅵ-2-5	Ji-Hye Baek	Ⅵ-3-5	Hwan Hee Lee
14:15～14:30					Ⅵ-3-6	Kyung-Eun Choi
14:30～15:00	**Closing Ceremony : Convention A**					

Poster Session

1부 : 10. 28. (Thu) 13:20~14:00

Area	No	Author	Area	No	Author
Space Technology	P-1	Gm Sil Kang	Space Technology	P-36	Hong Won Park
	P-2	Sang-Wook Kang		P-37	Myung Jin Baek
	P-3	Woo Yong Kang		P-38	Hyun Chul Baek
	P-4	In Hoi Koo		P-39	Jun Yeong Bok
	P-5	Hyun-Mo Gu		P-40	Hee Jun Seo
	P-6	Jae-Wook Kwon		P-41	Sae-Han Song
	P-7	Guhyeok Kim		P-42	Hyun-Kyu Shin
	P-8	Dong Oh Kim		P-43	Hyun Jin Shin
	P-9	Myung Muk Kim		P-44	Han Woong Ahn
	P-10	Min-A Kim		P-45	Seung-Eun Yang
	P-11	Min Jun Kim		P-46	Seok Teak Yun
	P-12	Sang Goo Kim		P-47	Young Su Youn
	P-13	Young Yun Kim		P-48	Sang Rok Lee
	P-14	Eui Keun Kim		P-49	Seo Rim Lee
	P-15	In Kyu Kim		P-50	Jae Yeol Lee
	P-16	Jung Do Kim		P-51	Ju Hun Rhee
	P-17	Joong Pyo Kim		P-52	Choon Woo Lee
	P-18	Jin Hyuck Kim		P-53	Hye Jin Yi
	P-19	Chang Kyoon Kim		P-54	Sung-Hyuck Im
	P-20	Chang Ho Kim		P-55	Eun Sook Lim
	P-21	Hyung Wan Kim		P-56	Jeong Heum Im
	P-22	Hee Seob Kim		P-57	Hyun-Su Lim
	P-23	Sang Man Moon		P-58	Kyugn Duk Jang
	P-24	Kyun Sang Park		P-59	Byung Kwan Jang
	P-25	Keun Joo Park		P-60	Sung-Soo Jang
	P-26	Bong Kyu Park		P-61	Ji Hyeon Yim
	P-27	Sun Ju Park		P-62	Jung Nam Jun
	P-28	Sung Woo Park		P-63	Jong Hyub Jun
	P-29	Sung-Wook Park		P-64	Hyeon-Jin Jeon
	P-30	Su-Hyun Park		P-65	Youe Yun Jung
	P-31	Eun-Bin Park		P-66	Seung-Won Cho
	P-32	Jae-Ik Park		P-67	Chang-Kwon Cho
	P-33	Jong Seok Park		P-68	Jung-Su Choi
	P-34	Jong Oh Park		P-69	Gab Ho Jeun
	P-35	Joo Ho Park			

Poster Session

2부 : 10. 29. (Fri) 11:20~12:00

Area	No	Author	Area	No	Author
Space Technology	P-70	Jae Dong Choi	Solar System & Space Exploration	P-104	Hyung Joo Yoon
	P-71	Seong Hwan Choi		P-105	Seung Bum Hong
	P-72	Sung Sik Huh		P-106	Joo Hee Lee
	P-73	Jeong Hoon Hyun		P-107	Youn Kyu Kim
	P-74	Soo-Yeon Kang	Science Culture	P-108	Youn Jeong Heo
	P-75	Myung Gil Kim	Space Situational Awareness	P-109	Tae Bong Oh
	P-76	Jo Ryeong Yim		P-110	Man-Soo Choi
	P-77	Moon-Jin Jeon	Sun & Space Environment	P-111	Ram Singh
Space Application	P-78	Young Sun Kim		P-112	Jin Hye Park
	P-79	Hwan-chun Myung		P-113	Seok Min Song
	P-80	Jong Euk Park		P-114	Jun Mo An
	P-81	Seok-Bae Seo		P-115	Hee Su Yang
	P-82	Jeoung Heum Yeon		P-116	Si Baek Yi
	P-83	Jong-Min Yeom		P-117	Young-Sook Lee
	P-84	Seong Suk Lee		P-118	Yong Ho Lee
	P-85	Won Beom Lee		P-119	Gwang Son Choe
	P-86	Il Seop Lee		P-120	Kyu-Cheol Choi
	P-87	Jong Tae Lee		P-121	Su Yeon Oh
	P-88	Su Young Chang		P-122	Sumaiay Rahman
	P-89	Dae Jun Jung		P-123	Hyeon Ock Na
	P-90	Jong Pil Kong	Commercial Lunar Payload Service	P-124	Hyeon Hu Park
Space Astronomy	P-91	Ha-Eun Kim		P-125	Woo Hyun Jo
	P-92	Seung Uk Lee	Miscellaneous	P-126	Chul Kang
	P-93	Uhn Mee Bahk		P-127	Chi Ho Kang
Nano/Microsatellite	P-94	Ki Duck Kim		P-128	Ju Hyun Kim
	P-95	Jin-Hyung Kim		P-129	Hyo Jun Kim
	P-96	Jong Dae Sohn		P-130	Dong Ok Ryu
	P-97	Ho Sub Song		P-131	Young Jo Bae
	P-98	Ji-Seok Kim		P-132	Na Gyun An
Solar System & Space Exploration	P-99	Bang Yeop Kim		P-133	Ji Mo Yang
	P-100	Ho Lak Kim		P-134	Young Chun Youk
	P-101	Kyung Sun Park		P-135	Chang-Eun Lee
	P-102	Young-Joo Song		P-136	Tae-jin Lee
	P-103	Jae-Hoon Song		P-137	Jae Hoon Jeong

특별포럼 개최

진행: 사회 이병선 박사(ETRI)

금년 10월 국산 한국형발사체(KSLV-2)가 성공적으로 발사되면, 이미 선진국 수준에 도달한 위성기술과 함께 대한민국은 우주개발 인프라와 대부분의 하드웨어 기술을 보유한 우주선진국이 됩니다. 이렇듯 우주선진국에 진입한 후 우주개발은 대부분의 우주선진국들과 같이 우주탐사와 우주활용으로 발전해 나아가야 할 것입니다. 금년 5월 문대통령의 방미 결과, 한국은 Artemis 유인달탐사 프로그램에 참여하는 것을 검토하기로 하였으며, 내년 8월에는 한국 최초의 달궤도선(KPLO)이 발사될 예정입니다. 이에 한국우주과학회에서는 우주관련 학회를 중심으로 정부, 산업체와 대학으로부터 관련 전문가들을 초청하여 대한민국의 우주탐사가 나아갈 방향과 전략을 토의하고자 합니다.

(1) 주제: 대한민국 우주탐사 변화와 기회

(2) 일시: 2021년 10월 28일(목) 11:00~12:30

(3) 장소 : 라한 셀렉트 경주 Convention C

(3) 발제발표 : 우주탐사 역사, 현황과 미래(양수석 박사, 전추진공학회장/항우연)(20분)

(4) 패널: ① 우주과학회(문홍규 박사, 천문연, 우주과학)
② 항공우주학회(방효충 교수, KAIST, 우주공학)
③ 항공우주시스템공학회(황진영 박사, 항우연, 우주정책)
④ 추진공학회(양수석 박사, 항우연, 우주공학)
⑤ 과학기술정보통신부(거대공공연구정책국, 우주정책)
⑥ 산업체(이준원 상무, 한화 Aerospace, 우주산업화)
⑦ 대학교(이동훈 교수, 경희대, 우주과학)

제1회 초소형위성분과 워크샵

– 국내 산업체 초소형위성 개발 현황 공유 국내 전문가 워크샵 –

■ 일시: 2021년 10월 28일(목) 15:15~16:40

■ 장소: 경주 라한셀텍트 컨벤션 A

■ 모시는 글

뉴스페이스 시대를 맞이하여 국내에서도 다양한 주체들이 초소형위성을 개발하고 있습니다. 특히, 민간 주도 우주개발이라는 패러다임에 맞게 국내 산업체에서도 초소형위성 개발을 위한 다양한 노력과 시도가 진행 중입니다. 또한, 정부도 보다 많은 민간산업체들이 우주 분야에 진출할 수 있도록 지원정책을 기획하고 있습니다. 본 초소형위성분과 워크샵에서는 국내 중소기업들의 초소형위성 개발 및 사업 추진 현황을 공유하고, 정부의 민간기업 초소형위성 활성화를 위한 '스페이스 이노베이션'(안)을 소개하는 시간을 갖고자 합니다. 본 워크샵을 통한 정보 공유를 통해 국내 초소형위성 산업 활성화뿐만 아니라, 국내 초소형위성 기술 수준을 가늠할 수 있을 것으로 기대합니다. 또한, 국내 민간 산업체들과 협력하여 초소형위성을 개발하고자 하는 산/학/연/관 상호 간의 정보 교류 네트워크의 장이 될 것으로 기대합니다. 관심 있으신 회원 여러분들의 많은 참석 바라겠습니다.

초소형위성분과 분과장 김해동 올림

■ 프로그램

시간	주제	발표
15:15~15:30	뉴 스페이스 이니시어티브: 한국 최초의 민간 상용 패스파인더 큐브샛, Solesat-1	이호진(솔탑)
15:30~15:45	광학탑재체(해상도 1.5 m)와 LCT 모듈을 탑재한 CONTEC Sat 1, 2호 소개	이성희(컨택)
15:45~16:00	초소형위성 민간산업체 지원을 위한 '스페이스 이노베이션' 사업 소개	김해동(항우연)
16:00~16:15	초소형위성을 활용한 영상분석서비스 소개	최명진(한컴스페이스)
16:15~16:40	초소형위성분과 분과회의	김홍래(솔탑)(간사)

워크숍 주제 발표 초록

[발표 1] A New Space Initiative: The First Commercial Pathfinder Cubesat of the Private Sector in Korea, Solesat-1

Ho-Jin Lee, Jinhyuk Kim, Hongrae Kim, Youngbo Sakong (Soletop Inc.)

The company Soletop is investing to develop its first own Cubesat dubbed as “Solesat-1”in-house as an initiative to lead the space industry democratization to drive a New Space Trend. In Korea, the space development is still in the public domain thus industrialization stays considered a process of implementation after technology transfer from R&D institution that has sponsored by government R&D programs. Thus the contract has been awarded to the experienced as well as affordable companies. For this reason the space industry has had a high entry barrier to small-medium enterprises who are challenging to the competition for government programs. A 3U-sized nanosatellite, Solesat-1 is under development for the sake of obtaining the space heritage as well as demonstrating its capability/technology to make its own satellite in-house. All the required works including mission design, system engineering, PA, module development, satellite AIT, EGSE, environmental test, ground system development and launcher contract are to be carried out by Soletop itself.
Solesat-1 development has started in Oct. 2020 and SDR and PDR are successfully completed through last summer. The launch is scheduled in late 2022 and all the development is on schedule. Solesat-1 will have an SSO with 500 km altitude. It has two missions: Soletop technology in-orbit verification and imaging/sensing demonstration. Cubesat platform, CAN interfaced boards/ modules, patented solar panel structure and separation, ground control and software will be verified primarily during the designated mission life time. As a second mission we are going to take images and video for demo using small EO camera purchased from Gomspace at the 500 km altitude. The image data will be transmitted to the Soletop Ground Station (SGS) for processing and assessment. The SGS has 3.7 m diameter S/X band reflector antenna that has LEO tracking capability. In addition, Solesat-1 is hosting a SWS (Space Weather Sensor) to be provided by the Griffith University of Australia and going to transmit/transfer to the sensed data to them via SGS.
Soletop is going to prepare for the various Cubesat application programs based on the Solesat-1 platform heritage once successful. The platform size will be expanded up to a few tens of cubes enough to host advanced payloads for technology verification as well as new mission/service demonstrations. For example, the next generation Solesat may have a large deployable antenna for data gathering and/or RF spectrum monitoring. The software defined radio based payloads will be carried for demonstration of the onboard signal processing capabilities for the services like SAR, communications, satellite IoT/M2M, realtime asset tracking like AIS/VDES and ADS-B, RF monitoring and geolocation. Once these pilots and/or pioneer are successful, a constellation of Solesat will be of course the next target for a commercial service deployment.

[발표 2] 광학탑재체(해상도 1.5 m)와 LCT 모듈을 탑재한 CONTEC Sat 1, 2호 소개

이성희(컨택)

㈜컨텍은 위성 영상의 직접 획득을 통한 위성영상활용서비스 사업의 강화를 위해, 고해상도의(1.5 m) 지구관측 위성(16U, 2기)을 개발하고 있다. 본 위성은 해상도 1.5M급의 영상 촬영이 가능하며, 전 세계에 구축되는 컨텍의 글로벌 지상국을 통해 준 실시간으로 영상 획득이 가능하다. 위성체에는 광학탑재체를 비롯하여 FSO(Free Space Optic) 통신을 위한 LCT(Laser Communication Terminal) 모듈도 탑재되며 컨텍의 OGS(Optical Ground Station)와 통신 시험도 이루어지게 된다. 본 위성 개발을 통해, 자체적인 위성영상데이터의 확보가 가능하며, 우주-지상국간 레이저통신 기술을 시험함으로써 차세대 통신기술의 실현가능성을 찾아볼 수 있다.

[발표 3] 초소형위성 민간산업체 지원을 위한 ‘스페이스 이노베이션’ 사업 소개

김해동(KARI)

국내에서도 최근 뉴스페이스 시대를 맞이하여 민간 주도의 위성 개발, 특히 초소형위성 분야에 진출하고자 하는 기업들이 늘어나고 있다. 또한, 정부도 민간기업의 우주분야 진출을 지원하고자 다양한 프로그램을 기획하고 있다. 하지만 우주 헤리티지가 부족한 중소기업 이하 기업들이 공공 우주임무 사업에 진입하기는 매우 어려운 상황이다. 이러한 환경을 반영하여 최근 정부에서는 우주 비즈니스 모델을 개발하

고자 하는 중소기업 이하 민간기업들을 지원하기 위한 스페이스 이노베이션 사업을 기획 중이다. 본 발표에서는 그동안 개최되었던 큐브위성 경연대회 및 공공분야 초소형위성 사업들과 달리 기획되고 있는, 중소기업 지원을 위한 초소형위성 개발 사업의 배경과 세부 프로그램에 대해 소개하고자 한다.

[발표 4] Image Analysis Service by Nano Satellite

Myung Jin Choi (HANCOM inSPACE)

The concept of nanosatellite was first introduced from an university R&D project 20 years ago. The application of nanosatellites today can be found in various fields such as Earth-Observation, Communication, Defense & Homeland Security.
In South Korea, HANCOM Group will be the first company in the private sector to launch nanosatellite (SEJONG-1). Demands for satellite data is rapidly growing and it is insufficient to keep up the demands with the government-led satellites only. For example, agriculture sector utilizes more than 60% of satellite data for its advantages of analysing broad areas with precision.
To fulfil such extensive demands, SEJONG-1 features a swath of 20 km, 7 bands, EO/IR sensors, all in 6U size. Starting with this first nanosatellite, there will be 50 more to be launched by HANCOM Group to create a constellation of nanosatellite, hence more data to be collected.
With SEJONG-1, HANCOM will begin satellite data services targeting multinational customers in various fields including calculating cultivation area, finding forest resources, natural disaster monitoring, urban change detection. In this journal, HANCOM (SEJONG-1) launch schedule, specification, application will be introduced.

제3회 우주감시분과 워크숍 & 우주감시분과 총회

■ 제목: 우주감시분야 국제협력 강화를 위한 국내 활동 공유

■ 일시: 2021년 10월 28일(목) 15:15~16:40

■ 장소: 경주 라한셀렉트 컨벤션 B

■ 모시는 글

최근 버진 갤럭틱, 스페이스X, 아마존 등 민간 우주여행을 앞세워 앞으로 핵심 산업이 될 우주산업을 선점하기 위한 전 세계 민간 기업들의 우주개발이 활발해지고 있습니다. 이와 더불어 인공위성과 우주쓰레기의 증가로 인해 우주 공간의 혼잡도도 증가하며, 인공우주물체의 추락과 충돌 위험도도 높아지고 있습니다. 우주에서의 안전하고 지속가능한 우주활동을 위한 우주감시 활동은 한 국가만의 역량으로 해결될 수 없는 전 지구적인 문제로 인식되어, UN 등 국제사회에서도 중요하게 논의되고 있습니다. 따라서 우주의 평화적 이용과 안전보장이라는 인류 공동 목표에 기여하기 위해서는 국가의 역량 발전과 함께 국내외적인 협력이 필수입니다. 이번 우주감시 워크숍에서는 국내 각 기관의 우주감시분야 국제협력의 경험과 노력 그리고 현황 등을 공유함으로써 국가적으로 우주감시 국제협력 역량을 강화하는데 기여하고자 합니다. 관심 있는 분들의 많은 참석을 기대합니다.

■ 프로그램

시간	주제	발표
우주감시분야 국제협력 강화를 위한 국내 활동 공유		
15:15~15:30	우주감시분과 총회 및 워크숍 개회	진행: 최은정(천문연)
15:30~16:10	우주상황인식/우주영역인식 현황과 국제 동향	조성기 센터장 (천문연 우주위험감시센터)
	공군 우주상황인식 국제협력 현황	최성환 대령/우주정보상황실장 (공군본부 우주센터 우주정보상황실)
	한국항공우주연구원 SSA연구활동 및 국제협력	정옥철 실장 (항우연 SSA연구실)
	교육분야의 SSA 국제협력 소개	안재명 교수 (KAIST 항공우주공학과)
16:10~16:40	우주감시분야의 국제협력 발전 방향 전체 토의	우주감시분과

* 우주감시분과: 위원장 최은정(천문연), 간사 김명진(천문연), 고문 김천휘(충북대)
운영위원: 강병국((주)솔탑), 박상영(연세대), 성재동(항우연), 안재명(KAIST), 최만수(천문연)

워크숍 주제 발표 초록

[발표 1] 우주상황인식/우주영역 인식 현황과 국제 동향

조성기(천문연 우주위험감시센터장)

최근 우주공간의 상업적 활용 경쟁, 우주군 창설에 따른 우주공간의 전장화, 우주탐사 경쟁에 의한 관리, 우주공간의 확장 등에 의하여, 우주상황인식/우주영역인식과 우주교통관리의 중요성과 필요성이 국제적인 공통의제로 논의되고 있다. 우주공간의 안전하고 공평한 활용을 위한 다자간 협력이 구체화 되고 있으며, 경제적 이익 선점과 국가안보 대상으로서의 우주공간 보호를 위한 각국의 경쟁이 치열한 상황에서, 우리나라의 효과적인 국제협력 방향 수립을 위한 우주상황인식/우주영역인식 대응 현황과 국제 협력 동향을 살펴보고자 한다.

[발표 2] 공군 우주영역인식(SDA) 국제협력 현황

최성환(공군본부 우주센터 우주정보상황실장)

공군은 전방위 우주위협에 대비하기 위해 스페이스 오디세이(Space Odyssey) 2050 프로젝트를 추진하고 있으며, 우주작전 수행에 필수적인 전자광학위성감시체계를 2022년 전반기 전력화할 예정이고, 고출력레이저위성추적체계, 레이더우주감시체계 등을 구축할 예정이다. 이에 우주감시 역량 보유국의 우주영역인식 능력 구축 현황을 알아보고, 공군의 국제협력 현황에 대해 소개한다.

[발표 3] 한국항공우주연구원 SSA연구활동 및 국제협력

정옥철(항우연 SSA연구실장)

한국항공우주연구원은 국가우주개발전문기관으로서 발사체 및 인공위성, 탐사선, 우주통신 지상시스템 등 다양한 형태의 연구개발 및 운영프로그램을 수행하고 있다. New Space 및 우주기반 서비스 상업화, 우주개발 다변화 등으로 우주물체가 급증함에 따라, 우주시스템 전주기(설계 · 개발 · 발사 · 운영 · 종료 등)에 대한 우주상황인식 연구를 통해 안전하고, 안정적이며, 지속 가능한 우주활동을 목표로 미래우주시대 대비 우주교통관제 단계 진입을 준비해야 한다. 본 발표에서는 한국항공우주연구원 SSA연구활동 및 국제협력 주요 경과를 소개한다.

[발표 4] 교육 분야의 SSA 국제 협력 소개

안재명(KAIST 항공우주공학과 교수)

본 발표에서는 교육 분야에서 이루어진 SSA 국제 협력 연구에 대해 소개한다. 2019년~2020년 사이에 이루어진 KAIST와 UT Austin 사이의 협력 연구를 중심으로 교육 분야 SSA 연구 협력 사례를 공유하고, 관련 시사점과 향후 추가 협력 연구 활성화를 위한 의견을 제시한다.

구두발표 논문 초록

10월 27일(수) 제1발표장 Convention A

Invited Talk I

Chair: Gi-Hyuk Choi (KARI)

13:10 [IS-I]

Navigation Satellite System: The World and Korea

Gi-Wook Nam

Intospace Co. Ltd., Korea Aerospace Research Institute

Global Navigation Satellite System is one of the most important IT infrastructure which provides PNT information to everywhere on earth.

It was developed for the military purpose but now plays the vital role in the modern world. From cellular telephony to disaster relief, from car navigation to air traffic control, GNSS is an application which is a central part of the lives of nearly every person in the world.

For this reason, the U.S. GPS was awarded by IAF as the "singular and successful project in the field of Space Applications, Space Science and Exploration, which could demonstrate through its implementation, that measurable benefit to humanity has been achieved."

In this presentation, GNSS and RNSS of the world are introduced along with KPS which will be launched in 2022 and completed in 2035 as the 7th Navigation Satellite System in the world.

제1발표장 Convention A

I-1 Special Session : Apophis I

Chair: Hong-Kyu Moon (KASI)

13:50 [I-1-1]

Rendezvous Mission to Apophis: I. Mission Overview

Young-Jun Choi[1,2] on Behalf of the RMA Team

[1]*Korea Astronomy and Space Science Institute*

[2]*University of Science and Technology*

An asteroid is important for understanding the condition of our solar system in early-stage because an asteroid, considered as a building block of the solar system, preserves the information when our solar system was formed. It has been continuously flowing into the near-Earth space, and then some asteroids have a probability of impacting Earth. Some asteroids have valuable minerals and volatiles for future resources in space activity. Korean government clarified, in the 3rd promotion plan for space activity, an asteroid sample return mission by the mid-2030s. However, it is almost impossible to do so based on only a single experience of an exploration mission to the Moon, Korea Pathfinder Lunar Orbiter, which will be launched in mid-2022. We propose a Rendezvous Mission to Apophis (RMA), beneficial in terms of science, impact hazardous, resource, and technical readiness for the space exploration of Korea.

14:05 [I-1-2]

Rendezvous Mission to Apophis: II. Science Goals

Myung-Jin Kim[1], Hong-Kyu Moon[1], Young-Jun Choi[1,2], Minsup Jeong[1], Masateru Ishiguro[3], Youngmin JeongAhn[1], Hee-Jae Lee[1], Hongu Yang[1], Seul-Min Baek[1], Jin Choi[1], Chae Kyung Sim[1], Dukhang Lee[1], Dong-Heun Kim[1,4], Eunjin Cho[1,2], Mingyeong Lee[1,2], Yoonsoo Bach[3], Sunho Jin[3], Jooyeon Geem[3], Hangbin Jo[3], Sangho Choi[5], Yaeji Kim[6], Yoonyoung Kim[7], Yuna Kwon[7]

[1]*Korea Astronomy and Space Science Institute*

[2]*Univ of Science and Technology*

[3]*Seoul National University*

[4]*Chungbuk National University*

[5]*Yonsei University*

[6]*Auburn University, USA*

[7]*Technical Univ of Braunschweig, Germany*

99942 Apophis is an Sq-type Potentially Hazardous Asteroid (PHA) with an estimated diameter of 370 m. It will approach the Earth down to 31,000 km from the surface during the encounter on April 13, 2029 UT, which is closer than geostationary satellites. According to NASA Sentry analysis, the impact probability has been eliminated over the next 100 years, but continuous monitoring is essential during and after the 2029 Earth encounter. In addition, changes in the surface, rotation, and shape of the asteroid are expected to occur during the 2029 approach. Therefore, the primary science goal of the Apophis mission is to global-map the asteroid before and after the Earth's approach. In this talk, we will present the scientific objectives of the mission.

14:20 [I-1-3]

Rendezvous Mission to Apophis: III. Tidal Resurfacing Model for (99942) Apophis during the 2029 Close Approach with Earth

Yaeji Kim[1], J. V. DeMartini[2]

[1]*Department of Aerospace Engineering, Auburn University*

[2]*Department of Astronomy, University of Maryland*

In the taxonomic classification of asteroids, S- and Q-types are both ordinary chondrites but show slightly different absorption features and spectral slopes [1]. While S-types have reddened, weathered surfaces, Q-types show bluer, fresher surface materials. This inconsistency is considered a result of interactions between space weathering and resurfacing. Tidally induced resurfacing driven by close encounters with terrestrial planets has been suggested as a critical contributor to reveal fresh materials beneath the weathered surfaces [2-5]. Earlier studies support this, statistically indicating that Q-types have experienced close encounters with terrestrial planets. We believe (99942) Apophis − expected to have a close Earth flyby within 6 Earth radii on April 13, 2029 − represents a golden opportunity for detecting tidal resurfacing [6].

Using a dynamic model [7] and discrete element method (DEM) [8], we numerically investigate the range of surface grain motions driven by the tidal forces from Earth on Apophis. The dynamic model simulates the orbital and spin evolution of Apophis 3 hours before and after the closest encounter and computes the surface slope evolution. The surface slope defines how a surface element normal is tilted with respect to the body center direction. The slope evolution indicates the change in slope in the direction of the net force (gravity, tidal, and rotational forces) acting on each facet. We then uniformly apply the accelerations computed by the dynamic model for selected surface elements to a periodic patch of polydisperse spherical grains in DEM simulations over the same encounter window. We alter the direction of the initial slope of each DEM patch to sample uncertainties in the spin state of Apophis. We then measure the scale of the regolith motion from the DEM simulations and associate this with the slope variations measured in the dynamic model to extrapolate statistics for the large-scale tidal resurfacing during the close approach.

This investigation to better understand the surface dynamics during the Apophis encounter could indicate possible sites to detect granular alterations for potential missions to Apophis, like the OSIRIS-REx extended mission [9] or KASI's Apophis Rendezvous Mission [10].

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14:35 [I−1−4]

Rendezvous Mission to Apophis: IV. Polarimetry, the Remote Sensing Technique to Determine the Particle Size on Airless Bodies

Jooyeon Geem[1], Minsup Jeong[2], Sunho Jin[1], Chae Kyung Sim[2], Yoonsoo P. Bach[1], Masateru Ishiguro[2], Yuna G. Kwon[3], Hong−Kyu Moon[2], Young−Jun Choi[2], Myung−Jin Kim[2]

[1]*Seoul National University*
[2]*Korea Astronomy and Space Science Institute*
[3]*Technische Universitt Braunschweig, Germany*

Investigation of the particle size on asteroids is important because it hints at their evolutional mechanisms (e.g., the dust sweeping by solar radiation pressure, thermal fracturing [1-3]). Several attempts have been conducted to determine particle size. While sample returning and in-situ microscopes have the great advantage of obtaining the particle size directly, they cannot provide synoptic information over the target surfaces [4, 5]. In remote-sensing imaging observations, it is hard to extract only particle size information because the observed quantities depend on the composition and viewing geometry [6, 7]. Even if a space probe visits the airless bodies, the limitation of camera resolution hinders from confirming the fine particles of $< \sim 1$ mm [8]. These restrictions make it difficult to study a large-scale distribution of particle size on the target bodies.

The Polarization Asteroid Camera (PolACam) mounted on the Korean Apophis mission will provide a unique opportunity for deriving the synoptic map of particle size (less than the submillimeter scale) over the whole surface of the Apophis [9], taking advantage of the heritage of the Korean Lunar Exploration Program [10]. This would be the first in-situ polarimetry reported on the asteroids. In this presentation, we will review the polarimetric research of asteroids especially focusing on particle size. Based on this review, we will explain how we can determine particle size via polarimetry. Finally, we will report a possible science of Apophis with the data.

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14:50 [I-1-5]

Rendezvous Mission to Apophis: V. Investigation of the Internal Structure – Direct and Indirect Methods

Sunho Jin[1], Yaeji Kim[2], Hangbin Jo[1], Hongu Yang[3], Yuna G. Kwon[4], Young-Joo Song[5], Ho Jin[6], Masateru Ishiguro[1], Minsup Jeong[3], Hong-Kyu Moon[3], Young-Jun Choi[3,7], Myung-Jin Kim[3]

[1]*Seoul National University*
[2]*Auburn University, USA*
[3]*Korea Astronomy and Space Science Institute*
[4]*Technical University of Braunschweig, Germany*
[5]*Korea Aerospace Research Institute*
[6]*Kyung Hee University*
[7]*University of Science and Technology*

Investigation of the internal structure of the asteroid would provide an essential clue to understanding the evolutionary history of the asteroid itself and, ultimately, the entire solar system. The mission target asteroid, (99942) Apophis, is a near-Earth, Sq-type asteroid with a diameter of ~300 m [1]. One of the most probable internal structures of Apophis is the rubble pile structure, regarded as the most common internal structure of the asteroid with a size ranging from 200 m to 10 km [2]. This structure is expected to be formed by reaccumulation after the catastrophic disruption of the parent body. Therefore, we would understand the formation and the collisional evolution process prevalent among main-belt asteroids. Moreover, the information on the internal structure also can be beneficial for the planetary defense. Since Apophis is one of the Potentially Hazardous Asteroids (PHAs), the research on the internal structure of the Apophis would provide a crucial constrain on the modeling of the asteroid redirection in the future. However, investigation of the internal structure of the asteroids by remote sensing observation is still challenging since what we can observe via remote sensing is only the very surface of the asteroid. Therefore, we consider two methods that directly and indirectly study the internal structure applicable to the Korean space mission.

The first technique is the direct detection of the seismic wave on the asteroid surface. Several studies inferred the presence of global and local seismic shaking events from the signature of regolith migrations and erasure of craters [3, 4]. Several sources, including tidal, thermal quakes, and impact of the interplanetary dust particles, are suggested as the possible cause of the seismic shaking [5]. We will review previous research on asteroidal seismology and their implications on the internal structure (e.g., [5]). Besides, we investigate the frequency of the seismic shaking caused by micrometeorite impacts. We used Meteoroid Engineering Model 3 (MEM3) model to calculate the impact frequency and the simplified model introduced in Miyamoto (2014) to estimate the maximum acceleration of the global seismic shaking event [6, 7]. We also plan to present corresponding requirements of the accelerometer based on the estimation above.

The second way, which was contrived by our group, is to compare the space weathering degree of the surface to the asteroid with similar physical properties. Space weathering is caused by micrometeorite impact and solar wind implantation, which alters the visible slope and albedo of the surface [8]. We suggest asteroid (25143) Itokawa with a similar spectral type (Sq-type) and diameter as a benchmark of the degree of the space weathering present on the S-complex asteroid [9]. First, we will present our ongoing research on the space weathering timescale of Itokawa. We estimated the timescale to be 1000 years from the size-frequency distribution of bright mottles on boulders. This short timescale implies the presence of the resurfacing mechanism, which slows down the progression of space weathering. Especially, Shestopalov (2013) conjectured that granular convection induced by global seismic shaking by non-destructive impacts is one of the most probable rejuvenation scenarios [10]. Since the global seismic shaking is influenced by the effectiveness of propagation of the seismic wave, we can infer the difference in the internal structure between Apophis and Itokawa [11].

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15:05 [I-1-6]

Rendezvous Mission to Apophis: VI. Observation Campaign during the 2021 Apparition

Hee-Jae Lee[1], Myung-Jin Kim[1], Dong-Heun Kim[1,2],

Hong-Kyu Moon[1], Young-Jun Choi[1,3] on Behalf of the Apophis Observation Team

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

It is important to reveal the physical properties of the target asteroid of the space mission for establishing the science goal and planning the mission operation. March 2021 was the last and best time for the Apophis observations before its next close approach in 2029. The closest approach of Apophis to the Earth occurred on March 6, 2021 (0.112 AU distance), and its visual brightness reached ~16.2 mag. So, we organized the observation campaign during the 2021 apparition to refine the spin state and 3D shape model and check the surface composition variations. The campaign involved dozens of countries and included ground-based photometry and spectroscopy, and spacecraft observations. In this talk, we will present the preliminary result of the Apophis observation campaign during the 2021 apparition.

제2발표장 Convention B

I-2 Space Technology / Space Application / Space Astronomy
Chair: Bong Kon Moon (KASI)

13:50 [I-2-1]

Mission Impact Analysis for Application of Electrical Propulsion System to KPS Satellites

Bong-Kyu Park

Korea Aerospace Research Institute

Recently, thanks to the high efficiency of EP (Electrical Propulsion) system, the orbit and attitude control of geostationary satellites are now being implemented with the EP system to replace the chemical propulsion system. 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. The KPS (Korea Positioning System) which consists of 7 satellites (3GEO+4IGSO) and provides local navigation service around Korean Peninsula, will start to be launched from 2027. For KPS, the accommodation of EP system needs to be discussed to be benefited of its significant advantage. One of the major points to be checked before final conclusion of accommodation of EP system in KPS system, is its impact on mission availability induced by tight requirement on orbit determination accuracy, long and frequent north/south station-keeping which is inevitable when using electrical propulsion system. In this paper, the station-keeping operation concept was studied and its impact to the mission availability was discussed.

14:05 [I-2-2]

A Simplified NUC Processing for the Compression of CAP-W Images

Seok-Bae Seo, Sang-Gyu Lee, Myung-Jin Baek, Sang-Burm Ryu, Eun-Su Kang, Hyeon-Cheol Lee

Korea Aerospace Research Institute

The NUC (Non Uniformity Correction) is applied to equalize detectors'characteristics and to improve the compression performances of them. This paper proposes a simplified NUC (SNUC) processing only for the compression performances. The images applied SNUC can be recovered by the ISNUC (Inverse SNUC) processing, the reverse operation of SNUC, after data transmissions from the satellite to the ground station. The SNUC and the ISNUC are invited for the compression performances in this paper, thus the conventional NUC processing is can be required to flat detectors'characteristics after proposed ones.

14:20 [I-2-3]

Development of an Air Management System for Life Support and Its Utilization in Manned Undersea Bases

Joohee Lee, Jongwon Lee, Younkyu Kim, Gihyuk Choi

Korea Aerospace Research Institute

The life support air management system for space exploration, which has been carried out for the purpose of developing KARI's manned space exploration core technology, consists of three major subsystems: oxygen generator, air purifier, and carbon dioxide removal system. This research, which has been carried out as a basic research project of KARI since 2019, will end this year. Since follow-up studies are opaque and need more time to apply directly to space exploration, we are seeking fields of application on the ground for the maintenance and development of the developed technology. One field among the various fields can be considered for utilization in manned submarine bases similar to the space environment. In this paper, we will explain the element technologies and utilization for using the developed air management system for life support in undersea base.

14:35 [I-2-4]

Verification and Integration Plan of EOS (Electro-Optical Subsystem) of the CAP-W Payload for the CAS-4 Satellite

Dae-Jun Jung[1], Jong-Un Kim[2], Sang-Gyu Lee[1]

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

CAP-W (Compact Advanced Payload with Wide Swath) is Electro-Optics Camera of the CAS-4 (Compact Advanced Satellite-4) satellite. The CAP-W payload has the 5 multi-spectral channel and capability of wide range of swath width with multi-path stereo imaging by taking a national agriculture and forest images. The verification and I&T (Integration and Test) plan from unit to system is a significant process for the performance of CAP-W payload. In this paper, EOS design of CAP-W payload is introduced briefly. The verification plan, flow and integration of optical module, electro-optical subsystem are described including test items such as MTF measurement, Geometric characterization, Spectral characterization, Radiometric characterization and End to end imaging test.

14:50 [I-2-5]

Analysis of the *Sohyeon-Donggungilgi* Records of Solar Halo Observations

Jaeyeon Hyun[1,2], Byeong-Hee Mihn[1,2], Ki-Won Lee[3], Sang Hyuk Kim[2], Uhn Mee Bahk[2,4]

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

We analyzed the observation records regarding solar halos in the 'Sohyeon-Donggungilgi (The Diary of the Sohyeon Crown Prince).' During the Joseon Dynasty, the Donggungilgi written by Sigang-won (Education Bureau of the Crown Prince) includes lots of astronomical observations as well as educational records of the crown prince. Sohyeon-Donggungilgi is a record from 1625, which is the year Prince Sohyeon (1612-1645) became the crown prince, to 1645, which is the year he died. In this study, however, we examined the records for about 11 years from 1625 to 1635, which is the period before the second Manchu invasion of Korea. Totally, there were 2,684 records regarding solar halo observation. The frequency of Hun (暈), Yi (珥), and Guan (冠) was greater than other phenomena, and they account for 94% of the total record. To verify what atmospheric optical phenomenon each record represents, the altitude of the sun at that time was calculated based on the season and observed time. In addition, we compared these results with the descriptions from books of Seoun-gwanji (Treatise on the Bureau of Astronomy) and 'Cheonmun-daeseong (Great Astronomical Work)' and the computer simulation provided by 'Arbeitskreis Meteore e.V.' in order to verify what each event represents in relation to modern atmospheric terms. As result, we concluded that 'Hun (暈),' 'Junghun (重暈),' 'Yi (珥),' and 'Baekhonggwanil (白虹貫日)' could be 22° halo, 22° and 46° halo, parhelion, and parhelic circle, respectively, and also phenomena like 'Gwan (冠),' 'Dae (戴),' 'Bae (背),' 'Li (履),' 'Gyohun (交暈)' could be related to several arcs tangent to 22° and 46° halo, like upper and lower tangent arcs, circumzenithal arcs, and parry arcs. On the other hand, further analysis will be needed in the case of interpretation of phenomena such as 'Geuk (戟),' because the descriptions of the references are different and the number of records is small.

15:03 [I-2-6]

Structural Characteristics of Confocal Off-Axis Three Mirror Telescope for Small Size Vehicle

Jimin Han[1], Woojin Park[2], Bongkon Moon[2], Geon Hee Kim[3], Sunwoo Lee[4], Youngjae Kim[3], Seunghyuk Chang[5], Dae-Hee Lee[2], Soojong Pak[1]

[1]*School of Space Research and Institute of Natural Science, Kyung Hee University,*
[2]*Korea Astronomy and Space Science Institute*
[3]*Hanbat National University*
[4]*Korea Basic Science Institute*
[5]*Center for Integrated Smart Sensors, Korea Advanced Institute of Science and Technology (KAIST)*

The space surveying using small vehicles such as UVA or small satellite have advantages of cost reduction and ease of development. Such small flights can only contain small payloads due to their compact size. In the case of an optical component of the telescope, the diameter and configuration of the optics need to be minimized and compacted. For the compact optical configuration, the freeform surface can be applied to remove the high-order aberrations such as coma or astigmatism without any corrective lens. Also, through LAF-TMS, the off-axis reflective optical system can achieve higher image quality than the on-axis reflective optical system for a Wide Field of View (FoV). LAF-TMS eliminates linear astigmatism via mathematical solutions.

However, the alignment process of these freeform and off-axis optical systems is challenging due to the optical performance is sensitive about the alignment error. So, not only the precision assembly but also the sturdy structure is important to maintain performance during the mission.

We are developing the infrared (MWIR, LWIR) spectrograph for wide FoV ground observation via UAV. The system has an entrance pupil diameter of 40 mm, F-ratio of 1.9, and FoV of 8.25° × 6.21°. It applies LAF-TMS configuration and freeform surface for all mirrors. The system has three mirror modules on a base frame. The base frame supports the entire structure through the plane frame structure. The mirrors have a duplex layer structure to minimize the surface deformation by the bolting effects during the assembly process. The mirror has two layers, and the gap between the layers restrains the stress transport from the assembly layer to the optical layer. Also, the triangular ear on the backside of the mirror has a role of constraint surface for precision assembly with the mirror holder. The material of all components is aluminum (Al 6061-T6). It has an advantage of the Coefficient of Thermal Expansion

(CTE) matching system that the optical performance is not affected by the external temperature environment. We performed the FEA to investigated the structural characteristics. The gravity and bolting stress are the most dominant external loads. We checked the safety of the system against the loads. Also, we analyzed vibration properties via modal and random vibration simulation

제3발표장 Convention C

I-3 Sun & Space Environment I

Chair: Ho Sik Kam (KASI)

13:50 [I-3-1]

Effect of Geomagnetic Activities on Decay Time of Meteor Trail

Hosik Kam[1], Young-Sil Kwak[1,2], Jeong-Heon Kim[1], Junseok Hong[1], Yong Ha Kim[3], Changsup Lee[4], Jeong-Han Kim[4], Tae-Yong Yang[1], Jaewook Lee[1,2], Seonghwan Choi[1]

[1]*Korea Astronomy and Space Science Institute*
[2]*Department of Astronomy and Space Science, Korea University of Science and Technology*
[3]*Department of Astronomy, Space, and Geology, Chungnam National University*
[4]*Division of Polar Atmospheric Sciences, Korea Polar Research Institute*

Echoes from meteor plasma trails observed by a meteor radar can be utilized to derive neutral temperatures in the mesosphere and lower thermosphere (MLT) region. The essence of the well-known method of estimating neutral temperature using meteor echoes is that the decay time of echo is a consequence of the ambipolar diffusion of ionized species in the trail through neutral background conditions. Therefore, traditional temperature estimation methods have a strong premise that the decay process of meteor trails depends on the background neutral temperature and pressure. However, several studies and our results suggest that the diffusion of meteor trails in the MLT region is controlled by not only neutral background conditions but also external sources such as electron-ion recombination. Therefore, the method of estimating the neutral temperature using the meteor decay time is not a robust method, especially during periods of strong geomagnetic activities. In this study, residual analysis was performed using the meteor echo data of the meteor radar from 2007 to 2021 installed at King Sejong Station (62°S, 58°W). We found a notable response that the decay time decreased and received power and signal-to-noise ratio increased with increasing geomagnetic activity.

14:05 [I-3-2]

Seasonal Characteristics of Vertical and Horizontal Propagations of Gravity Waves Observed from O(^{1}S) Airglow Emission with All-Sky Imager at Mt. Bohyun

Young-Sook Lee[1], Jun-Young Hwang[1,2], Yong-Ha Kim[1], Ho-sik Kam[3], Young-Sil Kwak[3], Seok-min Song[1]

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

The all-sky camera at Bohyun Astronomy observatory (36.2°N, 128.9°E) has been operating with a narrow band filter centered at 557.7 nm to observe the atomic oxygen airglow emission at ~96 km altitude. A total of 150 gravity waves were identified from the all-sky image data during the 2017-2019 period. The wave parameters (wavelength, period and propagation direction) were derived from the image analysis. Using the horizontal winds simultaneously measured by the meteor radar at Gyeryong, we were able to compute the dispersion relation of gravity waves in a 90-100 km altitude region, The computed dispersion relation allows to determine the nature of vertical propagation (e.g., evanescent, ducting, freely propagating). The observed waves were found to be mostly in freely propagation, taking up maximum 81% in summer and minimum 67% in winter. Ducted waves were 7%, 10 % in spring and summer, respectively. We will discuss the implication of the vertical propagation characteristics in terms of wave sources.

14:20 [I-3-3]

Study on the Secondary Waves Created by Wave-Wave Interaction between SDT and PWs in the MLT Region over King Sejong Station, Antarctica

Jaewook Lee[1,2], Young-Sil Kwak[1,2], Hosik Kam[1], Yong Ha Kim[3], Changsup Lee[4]

[1]*Divison of Space Science, Korea Astronomy and Space Science Institute*
[2]*Department of Astronomy and Space Science, Korea University of Science and Technology*
[3]*Department of Astronomy, Space Science and Geology, Chungnam National University*
[4]*Divison of Atmospheric Sciences, Korea Polar Research Institute*

Atmospheric variability displayed in the wind or temperature or density is related to atmospheric wave activity. Using Meteor Radar (MR), we measured and analyzed the neutral atmospheric

winds in the Mesosphere and Lower Thermosphere (MLT) region over King Sejong Station between March 2016 and February 2017. We calculated the Fourier transforms of zonal and meridional winds, and then found wave components such as semi-diurnal tide (SDT), planetary waves (PWs), and secondary waves. To identify the origin of the secondary wave, bispectral analysis was performed using hourly wind data from June to September 2016. The bispectral analysis showed the occurrence of non-linear interactions between SDT and PWs. This is a part of the evidence that the secondary waves were created by non-linear interactions between them. We also found that the spectral power of the sum-secondary wave is stronger than that of the difference-secondary wave between 80 km and 100 km altitude during the Australian winter of 2016. In addition, through the least-squares fitting analysis and FFT, the amplitude and phase of SDT and 16-day PW were calculated as a function of altitude. The phase information revealed that the SDT and 16-day PW propagated from the lower atmosphere.

14:35 [I-3-4]

Quasi-10-Day Wave Activity in the Mesosphere and Lower Thermosphere near 65°S Observed by Meteor Radars during 2012-2016

Wonseok Lee, Yong Ha Kim

Chungnam National University

The zonally separated meteor radars located in Davis (68.6°S, 77.9°E) and King Sejong Station (62.2°S, 58.8°W) are used to investigate the climatological variation of planetary wave activities in the mesosphere and lower thermosphere region during 2012-2016. The cross wavelet spectrum shows that the amplitude of planetary waves (period < 20 days) is maximum (minimum) in winter (summer), which is consistent with the presence of eastward prevailing winds in the middle atmosphere during winter. The prevailing eastward wind helps enhancing vertical propagation of westward propagating planetary waves. By adopting a phase difference technique, we extracted the westward propagating quasi-10-day wave with zonal wavenumber 1 (Q10DW, s = 1) from wind data measured by the two meteor radars. We found that the Q10DW was often active with a peak amplitude of ~35 m/s around the equinoxes in some years and during winter in another years. In order to identify the possible source of the wave, we will reconstruct the refractive index and critical layer for ray tracing, and Eliassen-Palm flux for wave propagation direction and magnitude of Q10DW in the middle atmosphere using MERRA-2 reanalysis data.

14:50 [I-3-5]

On the Determination of the Poleward Boundary of the Auroral Oval from All Sky Camera (ASC) Observations of the Aurora

Geonhwa Jee[1,2], Young-Bae Ham[1,2], Hyuck-Jin Kwon[1], Yoonseung Choi[1], Changsub Lee[1]

[1]*Korea Polar Research Institute*

[2]*University of Science and Technology*

The shape and latitudinal extent of the auroral oval mainly vary with magnetic local time and gemagnetic activity. There have been several studies on the dynamics of the auroral oval using satellite observations but the specific details are not well understood. The Korean Antarctic Jang Bogo Station (JBS) is located in the polar cap and auroral region, depending on the magnetic local time and magnetic activity condition, in the southern hemisphere. Since the field-of-view (FOV) of the All-Sky Camera (ASC) is greater than 10° in latitude, the nighttime ASC observations at JBS allow us to monitor the auroral occurrence in the boundary region between the polar cap and the auroral oval. In this study, we attempt to determine the poleward boundary of the auroral oval during nighttime from the analysis of the auroral occurrence at JBS.

15:05 [I-3-6]

72-Hour Forecasting of > 2 MeV Electron Fluxes at Geostationary Orbit by Deep Learning

Jihyeon Son[1], Yong-Jae Moon[1,2], Seungheon Shin[1]

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

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

In this study, we forecast hourly > 2 MeV electron fluxes at geostationary orbit for the next 72 hours using a deep learning model. The input data of the model are solar wind parameters (temperature, density and speed), IMF (|B| and Bz), geomagnetic indices (Kp and Dst), and electron fluxes themselves. All input data are hourly averaged ones for the preceding 72 consecutive hours. We use electron flux data from GOES-15 and -16, and perform cross-calibration to match the two data. Total period of the data is from 2011 January to 2021 March (GOES-15 data for 2011-2017 and GOES-16 data for 2018-2021). We divide the data into training set (January-August), validation set (September), and test set (October-December) to consider the solar cycle effect. Our main results are as follows. First, our model successfully predicts hourly electron fluxes for the next 72 hours. Second, root mean square error (RMSE) of our model is from 0.18 (for 1 h prediction) to 0.67 (for 72 h prediction), and prediction efficiency (PE) is from 0.97 to 0.53. Third, PE of daily averaged prediction shows higher score than previous studies: 0.91 for 1-day prediction, 0.73 for 2-day, and 0.60 for 3-day. Our study implies that the deep learning model can be applied to forecasting long-term sequential space weather events.

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).

제1발표장 Convention A

Ⅱ-1 Special Session : Apophis II
Chair: Myung-Jin Kim (KASI)

15:30 [Ⅱ-1-1]

Rendezvous Mission to Apophis: VII. Trajectory Design

Pureum Kim, Sang-Young Park

Astrodynamics and Control Lab., Yonsei University

A trajectory for the rendezvous mission of 99942 Apophis is currently being designed. The fundamental requirement for trajectory for this mission is to rendezvous the spacecraft with the asteroid several months before the close approach event of April 2029. This requirement is necessary for mapping of Apophis both before and after the event, which will enable us to identify the change of the asteroid terrain induced during the event. Furthermore, a few more constraints, such as maximum distance and phase angle before the rendezvous, have been implemented so as to ensure the safe optical navigation towards the end of the journey when the spacecraft is near Apophis. The current baseline trajectory requires the spacecraft to depart Earth in Oct 2027 and rendezvous with Apophis in Oct 2028, requiring Earth departure C3 energy of around 23.37 km^2/s^2 and delta-v of around 1.69 km/s. In addition to interplanetary trajectory design, proximity operation design progress will be discussed. Apophis is not massive enough to give the spacecraft a stable orbit at 10 km due to perturbations, most importantly due to solar radiation pressure (SRP). Therefore, SRP and other perturbations must be taken into account in designing proximity operation trajectory. A few preliminary ideas for proximity operation near the asteroid for mapping will be discussed.

15:45 [Ⅱ-1-2]

Rendevous Mission to Apophis: VIII. Science Instruments and Operation Scenario

Minsup Jeong[1], Young-Jun Choi[1,2], Hong-Kyu Moon[1], Myung-Jin Kim[1], Jin Choi[1], Bongkon Moon[1], Youngmin JeongAhn[1], Hee-Jee Lee[1], Masateru Ishiguro[3], Dukhang Lee[1]

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

Asteroid Apophis, a Potentially Hazardous Asteroid (PHA), will have an extremely close encounter with the Earth in 2029. To understand the physical properties during the gravitational perturbation, we are planning to visit the asteroid, and then five instruments are planning to operate. Polarization Asteroid Camera (PolACam) will measure the polarization properties of the asteroid. Multi-Band Camera will construct maps with seven bandpass filters, which are 320 nm, 430 nm, 545 nm, 705 nm, 860 nm, 955 nm, 1055 nm. Wide-Angle Camera will survey levitating dust particles from the asteroid surface. Laser altimeter will support to construct the maps of the asteroid. In addition, Infrared Spectrometer as an instrument candidate for international collaboration will conduct imaging spectrometry toward the asteroid. In this talk, we will discuss the details of the instruments and their operation scenario during the mission.

16:00 [Ⅱ-1-3]

Rendezvous Mission to Apophis: IX. Wide-Angle Camera Science

Youngmin JeongAhn[1], Hee-Jae Lee[1], Minsup Jeong[1], Myung-Jin Kim[1], Jin Choi[1], Hong-Kyu Moon[1], Young-Jun Choi[1,2]

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

The rendezvous mission to the Potentially Hazardous Asteroid (PHA) Apophis will be the first Korean space exploration beyond the Earth-Moon system. To ensure the mission's success, the spacecraft will be equipped with a wide-angle camera. This optical camera will function primarily to facilitate navigation to the target asteroid by observing background stars. During the operation, however, the wide-angle camera can also map the microgravity field of Apophis both with and without the support of the laser altimeter. Furthermore, the camera has power to capture possible ejecting particles from the surface as can be seen from the case of another PHA, Bennu. In this presentation, we will discuss the operation scenario of the mission with focus on the utilization of the wide-angle camera to conduct scientific research.

16:15 [Ⅱ-1-4]

Rendezvous Mission to Apophis: X. Spacecraft

Sun Kyu Lee[1], SueHyun Lee[1], HyukJae Lee[1], SangJin Kim[1], HoDong Kam[2]

[1]*Hanwha System*
[2]*Hanwha*

The development of asteroids and moon exploration continues

in advanced space countries. Following Hayabusa 2 (Japan) in 2014 and Osiris (USA) in 2016, India, China, Israel, as well as the United Arab Emirates in 2020, are competitively developing space development for deep space exploration. This study aims to analyze the concept of probe development and form a basic probe shape prior to the development of the near-Earth asteroid Apophis directly exploring the Earth in April 2029.

The Apophis probe can only complete its mission by conducting an exploration of about 272 times the distance from the moon. Therefore, it is necessary to focus on designing and producing deep space-oriented technologies such as deep space flight software, deep space propulsion system, and deep space communication technology.

Table 1 shows the distance from Earth. As shown in the table, Apopisca's longest distance has a probe relative distance of about 272 times the distance from Earth to the moon. In order to navigate this long distance, in-depth technology development for promotion, communication, and flight operation is essential compared to existing satellite projects, and it is expected to have a significant impact on the development of deep space in Korea.

Table 1. Distance from the earth

Division	Low orbit (LEO)	Geostationary Orbit (GEO)	Earth-Moon	Earth-Appophis (The Longest)
Distance (Km)	500-2,000	36,000	384,400	105,000,000

The Apophis probe expects the shape as shown in Fig. 1, and is expected to be about 2.3 m high, 1.6 m wide, and 1.8 m long. The internal components of the probe are divided into structural systems, propulsion systems, posture control systems, power systems, communication systems, and mounted software systems, and are composed of Harness systems. The structural system designed and interpreted support structures such as solar panels, payloads, and antennas based on the technology accumulated in the existing satellite business, and the thermal control system was also designed as an experience in the satellite business. The propulsion system was designed with a concept similar to a low-orbit satellite as a power control distribution unit for deep space exploration by applying a single propellant system.

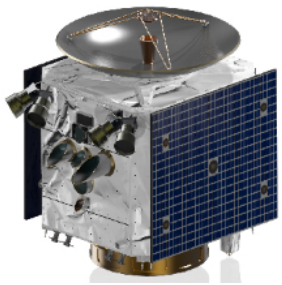

Fig. 1. Apophis Spacecraft's prediction

The main body of the probe was able to derive each line by analyzing the basic requirements and operational concepts of deep space exploration, and through this, the possibility of domestic development could be seen.

If deep-space technology is further developed based on satellite technology already possessed in Korea, it is expected that the development of probes will be successful with domestic private technology.

16:30 [Ⅱ-1-5]

Rendezvous Mission to Apophis: XI. KVN Tracking

Taehyun Jung[1,2], Jin Choi[1], Do-Young Byun[1,2], Jung Hyun Jo[1], Young-Jun Choi[1,2], Hong-Kyu Moon[1], Do-Heung Je[1], Myung-Jin Kim[1], Minsup Jeong[1]

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

Very Long Baseline Interferometry (VLBI) observations provide the highest angular resolution and astrometric precision in astronomy (e.g., a few ten micro-arcseconds). Based on this aspect, the VLBI tracking experiments has been successfully applied to a number of deep space missions to estimate the precise position of spacecraft. For example, more than 30 radio telescopes were participated in near-field (within solar system) VLBI tracking for the ESA Mars Express (MEX) Phobos-flyby, demonstrating the displacement between measured and predicted MEX position with the formal precision (3σ) of 34 μas (i.e., 35 m and 0.17 nrad) in right ascension. This year, for the first time, we carried out a Korean VLBI Network (KVN) single dish observation of the communication signal of the Communication, Ocean and Meterological Satellite (COMS) and successfully detected the signal at 19-20 GHz. At present, we are preparing the first VLBI tracking experiments for COMS with the KVN in order to examine and evaluate our strategy for rendezvous mission to Apophis. In this talk, we will present the KVN COMS results and on-going activities for KVN tracking for Apophis.

제2발표장 Convention B

Ⅱ-2 Solar System & Space Exploration

Chair: Joo Hyeon Kim (KARI)

15:30 [Ⅱ-2-1]

Orbit Determination Performance Analysis of Korea Pathfinder Lunar Orbiter Flight Dynamics System Using GRAIL Mission Data

Young-Rok Kim, Jonghee Bae, Young-Joo Song,
Jae-ik Park, SeungBum Hong

Korea Aerospace Research Institute

For the successful mission operation of the Korea Pathfinder Lunar Orbiter (KPLO), the ground system's flight dynamics system (FDS) is prepared. In this study, we used GRAIL mission tracking data for the orbit determination (OD) performance check of KPLO FDS. We selected arcs of three phases: trans-lunar cruise (TLC), lunar orbit insertion (LOI), and lunar mission of GRAIL-A spacecraft. S-band tracking TNF data (TRK-2-34 format) can be obtained from NASA Planetary Data System (PDS). Four-days, three-days, and two-days arcs were prepared for TLC, LOI, and lunar mission phases of the GRAIL-A, respectively. The OD module of KPLO FDS, which employs sequential filter/backward smoother technique, was used for OD performance analysis of GRAIL-A. Dynamic and measurement models were organized according to mission phases for better OD performance. For the OD quality assessments, we investigated measurement residuals, position uncertainty, and position differences by the NAIF GRAIL SPICE kernel. As a result, the OD performance of KPLO FDS was evaluated by real GRAIL-A tracking data for each phase. This study provides the expected OD performance level of KPLO FDS for three phases after launch.

15:40 [Ⅱ-2-2]

KPLO Dispersion Analysis on Lunar Orbit Insertion Burns

SeungBum Hong[1], Jae-Ik Park[1], Donghun Lee[2],
Young-Joo Song[1], Jonghee Bae[1], Young-Rok Kim[1]

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

The Korea Pathfinder Lunar Orbiter (KPLO) will be inserted with a set of lunar orbit insertion (LOI) burns; currently five burns are planned. In order to achieve successful lunar orbit acquisition and reliable fuel budget planning, the effect of thruster errors should be carefully analyzed. LOI burns utilized a set of four Orbit Maneuver Thrusters (OMTs). OMT's pointing errors and maneuver execution errors will affect the KPLO's lunar orbit state after a series of LOI burns. This study assumes OMT's pointing and maneuver execution errors with reasonable assumptions and performs Monte-Carlo simulation with 2000 runs. The dispersion analysis shows that AOP dispersion is severe while dispersions of other states are not. In addition, sensitivity analysis of each error source is performed to identify dominant error sources of orbit state dispersions after a series of LOI burns. The sensitivity analysis shows that maneuver execution accuracy is a main driver for AOP dispersion.

15:50 [Ⅱ-2-3]

Korea Pathfinder Lunar Orbiter: Candidate Sites for LUTI Imaging

Eunhyeuk Kim, Dong-Gyu Kim, Joo Hyeon Kim,
Jo Ryeong Yim, Gmsil Kang, Dong-Young Rew,
Joohee Lee, Yoon-Jeong Jang

Korea Aerospace Research Institute

A high resolution camera on-board Korea Pathfinder Lunar Orbiter (KPLO), LUTI (Lunar Terrain Imager) is intended to take images for 1) landing site candidates of Korean lunar landing mission, 2) scientifically valuable locations on the moon for investigating lunar resources, and evolutional history, and 3) locations on the moon for supporting collaborative research with the other payloads of KPLO. Korea Aerospace Research Institute (KARI) organized a working group in order to enhance the scientific output using LUTI images, and the first step is to prepare the list of LUTI imaging candidates for 1-year mission on the lunar orbit. We combined a research from domestic request on LUTI imaging sites (happened on summer of 2018), and the list of valuable lunar locations for landing and scientific research from literature. This leaves ~50 imaging sites. In addition, LUTI will take images for reference locations on the moon in order to calibrate and verify the image processing. Details including scientific merits on the LUTI imaging candidates will be presented.

16:00 [Ⅱ-2-4]

Enhanced Lunar Surface Image Acquisition through Lucky Imaging

Jinkyu Kim[1], Chae Kyung Sim[2], Minsup Jeong[2],
Hong-Kyu Moon[2], Young-Jun Choi[2,3],
Sungsoo S. Kim[1], Ho Jin[1]

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

We have been observing the polarization of the Lunar surface using the PolSpeck telescope installed at the Sierra Remote Observatory (SRO) in California, USA. To overcome the limitations of seeing and perform high-resolution Polarimetry, we searched for a lucky imaging algorithm suitable to improve the sharpness of our lunar images. First, we created pseudo-observation images by convolving the images from the Terrain Camera (TC) onboard the Kaguya spacecraft with the point-source images obtained with the PolSpeck telescope with an exposure of 0.01 sec. In order to evaluate how the algorithm performance varies with different terrains, ten regions were selected and cropped with 512 by 512 pixels. Then, we selected three algorithms with the best performance in simulation with

the Solar observation image (Popowicz et al., 2017) and one conventional algorithm as a comparison. We calculated the minimum exposure time to obtain the required intensity to provide a sufficiently accurate degree of polarization. Next, we evaluated how many candidate images we needed to select sufficiently sharp images. Finally, we compared whether stacking multiple 0.01-second exposure images has an advantage over taking one long exposure image.

16:10 [Ⅱ-2-5]

Optical Properties on the Walls of Lunar Craters Larger than 2 km

Kilho Baek[1], Sungsoo S. Kim[1], Chae Kyung Sim[2]

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

Previous studies have found that the lunar regolith has latitudinal and longitudinal dependences affected by the flux of space-weathering agents, such as solar wind particles and micro-meteorites. Especially, longitudinal trend is derived by the optical maturity (OMAT) difference between east and west walls of lunar impact craters and is caused by flux variation in solar wind particles when the Moon is in or out of the Earth's magneto-tail. Following Sim et al., who studied the space-weathering asymmetry inside lunar craters, here we apply the extended lunar crater database (Robbins et al.) to consider more and smaller craters. A total of 26,802 craters ranging from 2 to 150 km in diameter are used, more than 10 times the 1,872 in the previous study. We reproduce the dependences with the automated and detailed processes—finding rim, defining the inner structure and dividing wall quadrants of the craters. Using various information such as diameter, slope, and FeO abundance of lunar craters, we analyze optical properties of the wall quadrants.

16:20 [Ⅱ-2-6]

Applying Model for Lunar Crater Detection to Airless Body

Haingja Seo, Dongyoung Kim, Myungjin Choi

HANCOM inSPACE

It is an important method for researching the origin and evolution of solar system to counting impact craters of solar system bodies. There are many researches of solar system using number of impact craters, and scientiests manually count impact craters every time. Recently, it has researched to count impact craters of Mars and Moon, and the results are applied to may be infer surface age of celestial bodies. We already constructed the deep-learing model based on LROC images, and performed the varification. In this study, we try to detect impact craters of airless bodies applying our model made before, and analysis the results. We performed this process to upgrade model, and we expect that the upgrade model is able to be applied to similar lunar images as like LUTI.

16:30 [Ⅱ-2-7]

ULF Waves Observed by Lunar Prospector

Seul-Min Baek[1], Khan-Hyuk Kim[2], Jungjoon Seough[1], Young-Jun Choi[1,3], Ho Jin[2]

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

We have studied the spatial distribution of ultra-low frequency (ULF) in the vicinity of the Moon using Lunar Prospector (LP) magnetometer data obtained at ~100 km altitude during the period from 20 February 1998 to 30 November 1998. We statistically examine lunar ULF wave activity. They are mostly identified over a broad frequency range of 10–60 mHz at LT. The occurrence rate of the ULF wave is high on the dayside above strong magnetic anomalies and depends on the interplanetary magnetic field orientation. We also examine wave properties including the wave propagation direction and polarization. The wave characteristics associated with lunar magnetic anomalies are very similar to Kaguya observations, indicating that the ULF waves observed at LP and Kaguya are generated by the same mechanism. Although lunar ULF waves are commonly observed on the dayside above lunar magnetic anomalies, how they are established as a regular oscillation is not completely understood. In the present study, we suggest that the electromagnetic ion beam instability, driven by protons reflected from lunar magnetic anomalies, is the likely source of ULF waves observed at LP.

16:40 [Ⅱ-2-8]

Mars Atmospheric Entry, Decent, and Landing Technology

Hyeonjun Kim, Chulsung Ryu

Korea Aerospace Research Institute

It is focused on Lunar and Mars exploration missions as the Republic of Korea joined the Artemis Accords. Ultimate goal of the Artemis program is to send human to Mars in 2033. Domestic technology readiness level for Mars space exploration is low as Mars and Earth atmospheric entry technology has not yet to be experienced. Space vehicle's surface is exposed to exceedingly high temperature during hypersonic speed entry into a planet's atmosphere. Here, thermal protection technology is very important to explore planets with the atmosphere. The silica phenolic ablator has been developed for a stability test

of KSLV-II 75 tonf combustor in Korea, which has been developed for nozzle cooling of solid rocket motor. Therefore, Manufacturing technology of ablator has been already had but design knowledge has not. In this paper, we will briefly present Mars exploration overview with its entry technologies

16:50 [Ⅱ-2-9]

Design of Air Management System for the Manned Space Exploration

Jongwon Lee, Joohee Lee

Korea Aerospace Research Institute

This paper describes a concept design of Air Management System (AMS) for manned space exploration. The AMS is one of the subsystems of Environmental Control and Life Support System (ECLSS). The function of this system is to produce oxygen, remove carbon dioxide, eliminate hazardous trace contaminant, and control temperature & humidity in habitation module.
We used a 3W1H method (Who, Where, What, How), human-centered and mission-centered approach, to design the AMS. The human-centered design considers the quantitative requirements of the system using 'Who' and 'Where', and the mission-centered design considers the system control method and the astronaut's activity schedule using 'What' and 'How'.
In addition, the risk factors and countermeasures considered in developing the air management system are described. This can be used to design AMS in future manned exploration.

제3발표장 Convention C

Ⅱ-3 Sun & Space Environment II

Chair: Kyung Sun Park (CBNU)

15:30 [Ⅱ-3-1]

Storm-Time Electron Flux Variation Analysis in Terms of the Adiabatic Theory with Multisatellite Observations

Chanhaeng Lee, Jongho Seon, Woohyeong Seol, Kyu-Sung Chae, Go Woon Na

School of Space Research, Kyung Hee University

Electron flux variations observed by the three geostationary satellites, the Geo-KOMPSAT-2A (GK-2A), the Geostationary Operational Environmental Satellite 16 (GOES-16), and the Geostationary Operational Environmental Satellite 17 (GOES-17), during a geomagnetic storm are analyzed. In order to remove adiabatic effects in the flux variations, we estimate the electron fluxes of the three geostationary satellites in terms of the adiabatic theory using the Van Allen Probe (VAP) observations, which offer the electron radial distribution. The GK-2A, the GOES-16, and the GOES-17 are located at geographic longitudes of 128.2°E, 75.2°W, and 137.2°W, respectively. This wide local time coverage allows us to investigate the spatial evolution of the electron flux variations. In this paper, we will briefly present the calculation of the adiabatic fluxes and the cross-calibration of the three geostationary satellites. The analysis results of non-adiabatic flux variations on 11th May 2019 also will be presented.

15:45 [Ⅱ-3-2]

A Signature of Drift Echoes by Prompt Injection Observed from Multiple Satellites on May 11, 2019

Woo-Hyeong Seol, Jongho Seon, Chanhaeng Lee

School of Space Research, Kyung Hee University

Observations of drift echoes of electrons and protons in geostationary orbits during geomagnetic storms will be presented. On May 11, 2019, variations in particle fluxes and magnetic fields due to a prompt injection caused by Coronal Mass Ejection (CME) were observed from three geostationary satellites, GK-2A, GOES-16, and GOES-17. The injection of energetic particles into the magnetosphere may be induced by various solar wind drivers such as CME and Corotating Interaction Region (CIR). However, it is found that the signature of the injection significantly depends on the satellite locations, but not on the type of solar wind driver. An analysis of drift echoes will allow for an estimate of the drift period related to the particle energy. Observations from three geostationary satellites on May 11, 2019 strongly indicate a characteristic of flux enhancements with the satellite's location. We present the analysis of drift echoes with the observations of particle fluxes, magnetic fields, and solar wind parameters in the Earth's outer radiation belt.

16:00 [Ⅱ-3-3]

Low-Energy Particle Energization Caused by EMIC Wave Interaction: Van Allen Probes Observation

Junhyun Lee, Khan-hyuk Kim, Ensang Lee

School of Space Research, Kyung Hee University

We have studied the statistical properties of low-energy proton (H^+) and helium (He^+) ion flux enhancements associated with EMIC waves in the inner magnetosphere using Van Allen Probes data for 2013-2017. We identified 167 low-energy ion flux enhancements when the EMIC waves occurred in a

He-band or in a multiple band (H-band and He-band) with strong He-band and weak H-band wave activity and found that most of them occurred from the noon to the premidnight sector near the magnetic equator just inside the plasmapause. Of 167 flux enhancement events, 68 exhibited only He^+ flux enhancements, and 99 exhibited both H^+ and He^+ flux enhancements. The EMIC wave-associated flux enhancement events are mostly energized in the direction perpendicular to the background magnetic field. When both H^+ and He^+ fluxes are simultaneously enhanced, the H^+ flux events have a peak energy distributed in the range of 2–100 eV, and the peak energies of the He^+ flux events are distributed in the 2 eV to 600 eV range, implying that the helium ions are more energized than the protons. The peak energies of only He^+ flux enhancement without H^+ flux enhancement are mostly distributed in a lower energy range, 2–10 eV. The energization of H^+ and He^+ ions can be explained by a linear plasma flow associated with EMIC waves. We suggest that the wave-associated linear plasma motion is a likely mechanism to explain the observations.

16:15 [Ⅱ-3-4]

Hybrid Simulation of Low-Energy Particle Energization by EMIC Waves in the Inner Magnetosphere

Jong-Woo Kwon[1], Khan-Hyuk Kim[1], Kyungguk Min[2]

[1]*School of Space Research, Kyung Hee University*
[2]*Chungnam National University*

Electromagnetic ion cyclotron (EMIC) wavesgenerated by hot anisotropic ($T_\perp > T_\parallel$) protons (~10–100 keV), play an important role in accelerating cold (< 1 eV) protons (H^+) and helium (He^+) ions in the magnetosphere. Using a hybrid code with parameters found in the inner magnetosphere, we examine when and how EMIC waves interact with cold H^+ and He^+ ions. Hybrid simulations show that the low-energy particle energization occurs in two steps. In the first step, EMIC waves, which are linearly excited in the early stage of the simulation, interact with cold H^+ and He^+ ions, resulting in energization mostly in the direction perpendicular to the background magnetic field. The energization in this step is not associated with high-energy tail formation but bulk heating, a picture consistent with recent observations in the inner magnetosphere. In the second step, energization occurs during nonlinear evolution of EMIC waves, which is seen after about 150 ion gyroperiods. During this stage cold He^+ ions are much more energized than cold H^+ ions and the energization is associated with thermalization of He^+ ions occurring preferentially in the parallel direction. By comparing recent observations and the present simulation results, we suggest that low-energy particle energization by EMIC waves occurs at early stage of wave generation without nonlinear evolution of EMIC waves in the inner magnetosphere.

16:30 [Ⅱ-3-5]

Negative Turbulent Magnetic Diffusivity β Effect in a Magnetically Forced System

Kiwan Park, Myung-Ki Cheoun

Soongsil University

We studied the large scale dynamo process in a system forced by helical magnetic field. The dynamo process is basically nonlinear, but can be linearized with α & β coefficients and large scale magnetic field $\bar{B}$. A coupled semi-analytic equations based on statistical mechanics are used to investigate the exact evolution of α & β. This equation set needs only magnetic helicity $\bar{H}_M$ ($\equiv <\bar{A}\cdot\bar{B}>$), $\bar{B} = \nabla \times \bar{A}$ and magnetic energy $\bar{E}_M$ ($\equiv <\bar{B}^2> / 2$). α effect is thought to be related to magnetic field amplification. However, it is found that the averaged α effect decreases very quickly without a significant contribution to $\bar{B}$ field amplification. Rather, β effect contributing to the magnetic diffusion maintains a negative value, which plays a key role in the amplification with Laplacian ∇^2 ($= -k^2$). In addition, negative magnetic diffusion accounts for the attenuation of plasma kinetic energy E_v ($= <U^2> / 2$) (U: plasma velocity) as the system gets saturated. The negative magnetic diffusion is from the interaction of advective term $-U\cdot\nabla B$ from magnetic induction equation and the helical velocity field 'U'. In more detail, when 'U' is divided into the poloidal component U_{pol} and toroidal one U in the absence of reflection symmetry, they interact with $B\cdot\nabla U$ and $-U\cdot\nabla B$ from $\nabla \times <U \times B>$ leading to α effect and (negative) β effect, respectively. We discussed this process using the theoretical method and intuitive field structure model supported by the simulation result.

16:45 [Ⅱ-3-6]

Dissipative Instability of Magnetohydrodynamic Surface Waves in an Incompressible Cylindrical Plasma

Dae Jung Yu

Kyung Hee Unversity

Magnetohydrodynamic waves can be unstable due to dissipative instability (DI) when there are shear flow and dissipation process. The important feature of DI is that the wave is unstable when the velocity shear is below the Kelvin-Helmholtz instability (KHI) threshold. This instability is closely related to the negative energy wave excitation. We study the characteristics of DI by considering an axisymmetric flux tube where the steady flow and viscosity are present inside and outside the flux tube, respectively. We derive analytically the dispersion curves of the phase speed and growth rate (increment) for each azimuthal wave modes. We find that the sausage mode (higher azimuthal modes) can be strongly unstable when the longitudinal wave

number is large (small). Comparing the underdense and overdendse flux tubes, the wave modes in underdense flux tube can be more unstable than the overdense ones. It is also found that the critical speed for DI and the threshold for KHI depend on the longitudinal wave number. The range of DI that is between the critical speed and the KHI threshold crucially depend on the Alfven speed contrast between the inside and the outside of the flux tube. Finally, we present our current progress on the theory of DI in compressional plasmas.

17:00 [Ⅱ-3-7]

Mass Density Inferred from Toroidal Standing Alfven Wave Frequencies during H-Band EMIC Wave Interval

Khan-Hyuk Kim[1], Junhyun Lee[1], Kazue Takahashi[2]

[1]*Kyung Hee University, Korea*
[2]*Johns Hopkins University Applied Physics Laboratory, USA*

Van Allen Probes spacecraft observed strongly enhanced hydrogen (H^+) band electromagnetic ion cyclotron (EMIC) waves lasting more than 6 h without helium (He^+) band EMIC wave activity when the spacecraft were outside the plasmapause on 23 February 2014. During the H-band EMIC wave interval, multiple harmonics of toroidal mode standing Alfven waves were detected by the spacecraft. We estimated the local mass density using the observed third harmonic toroidal wave frequency and found that the average ion mass is close to 1 at both spacecraft. This indicates that the protons are dominant ion species for the H-band EMIC interval. From these spacecraft observations we suggest that the cold background ion composition plays a major role in determining the spectral properties of EMIC waves. In addition, we examine how low-energy H^+ and He^+ ions interact with the H-band EMIC waves.

10월 28일(목) 제1발표장 Convention A

Invited Talk Ⅱ

Chair: Su Yeon Oh (JNU)

09:00 [IS-Ⅱ]

Erupting Solar Plasma in Nonequilibrium States

Jin-Yi Lee

Kyung Hee University

Solar coronal plasma is optically thin and often interpreted assuming equilibrium ionization and Maxwellian electron velocity distributions. But, if the thermodynamical timescale in a rapidly evolving system is shorter than the ionization and recombination timescale, then the plasma is out of equilibrium ionization. The plasma can be far from the equilibrium ionization state because of rapid heating or cooling. Non-Maxwellian electron distributions can be caused by such as particle acceleration, turbulence, or shocks. High-energy observations show that their particle velocity distributions reveal suprathermal tails, which Kappa (κ) distribution functions can represent. These have high-energy tails deviating from a Maxwellian velocity distribution (i.e. thermal) and decreasing as a power law. In this talk I introduce how we apply the analyses in nonequilibrium states to the Atmospheric Imaging Assembly on board the Solar Dynamic Observatory and the X-ray Telescope on board Hinode. In addition, I introduce briefly what we can learn by comparing the ion charge states with various κ values in low solar corona with the observed ones in situ.

제1발표장 Convention A

Ⅲ-1 Special Session : Space Industry

Chair: Jung A Hwang (KASI)

09:40 [III-1-1]

Activities of Satrec Initiative (SI) in Space System Development

Byungjin Kim

Satrec Initiative Co., Ltd.

Founded in 1999 by the engineers who developed the first Korean satellites, SI has been developing high-performance small/medium satellite systems for Earth observation, space science, and telecommunication.
Particularly, with two subsidiaries (SIIS & SIA), SI companies integrate Earth observation business and also export satellite systems, image data, value added products, AI-based geo-intelligence solutions. Since the recent investment from Hanhwa Aerospace, SI expands its business domains to space explorations and other applications.
SI has announced a very high resolution Earth observation satellite, SpaceEye-T to be launched by 2024, which will let SI strengthen its market position.

09:55 [III-1-2]

A New Space Technology Innovation Company in Korea, Soletop

Ho-Jin Lee, Hongrae Kim, Youngbo Sakong

Soletop Inc.

The “Soletop” is a Space Innovation SME in Korea. The

Soletop's Logo stands for the company's vision of pursuing for a global TOP company in the satellite business sectors of space, ocean, land, and earth. It was established in 1995 and has grown up to 100 employee-sized SME with a couple of business areas: space and UAV/drone. In space business it develops Cubesats (including platform, components and modules), satellite ground systems including satellite control system and ground reception stations, satellite imagery-based application systems, and satellite/payload EGSE (Electrical Ground Support Equipment). In UAV business it develops the UAV ground control systems including mission planning system and training simulator system.

Soletop has been involved with the Korea national space development programs along with satellite ground control system and EGSE development starting from KOMPSAT1 program. It covers also a commercial GEO staellite ground control systems for example the Koreasat 5A/7. Soletop has a number of records of developing satellite ground stations for data reception from LEO as well as GEO satellites for weather data processing and/or earth imagery data processing. Domestic customers include national institutes and government agencies and international ones include Thailand GISTDA, Philippines PAGASA, Indonesia LAPAN, and African EUMESAT network. Soletop is developing a GK-2A satellite shipboard L-band terminal for reception and processing of the near real-time weather image data for a safer maritime fishing, traveling and recreational activities.

For Cubesats, it has started this business since 2014. Currently it develops and provides the Cubesat platforms, Cubesat boards/ modules and/or components, system mission design and analysis, system engineering, ground systems, and EGSE for Cubesat testing and operations. Soletop is participating to a number of the Cubesat development projects. The first heritage in space comes with the KMSL Cubesat launched in March 2021 where OBC and IFB were operating successfully for months operated by Chosun University. The other projects include: four 6U formation flying, scientific mission Cubesats "SNIPE", a 6U Cubesat for EO/IR technology demonstration project"STEP Cube Lab-II"and"S-STEP"project for design and prototyping of a SAR smallsat Constellation.

As a key technology development activities, Soletop is developing a global satellite IoT access demonstration with SDR-based IoT Payload (Onboard Processor), a deployable mesh antenna, a low thrust FEEP propulsion applicable to 3U Cubesat, and SDR-based Ka-band transmitter of 2Gbps data rate (QM).

Soletop is developing currently its first own 3U Cubesat dubbbed as "Solesat-1" in house as an initiative to lead the space industry in the New Space era for the sake of obtaining the space heritage as well as demonstrating its own in-house capability/technology to make its own satellite. Solesat-1 will have a SSO with 500 km altitude. It has two missions: Soletop technology in-orbit verification and imaging/sensing demonstration. The image data will be transmitted to Soletop Ground Station (SGS) for processing. SGS has 3.7 m diameter S/X band reflector antenna that has LEO tracking capability. Solesat-1 is hosting a SWS (Space Weather Sensor) to be provided by the Griffith University of Australia and going to transmit the sensing data to them via SGS.

Soletop is going to proceed with the successive Cubesat projects based on the Solesat-1 platform heritage. The platform size will be grown up to a few tens of cubes enough to host advanced payloads for technology verification as well as new mission/service demonstrations. A constellation of Solesat will follow of course for a commercial service deployment.

10:10 [III-1-3]

Image Analysis Service by Nano Satellite

Myung Jin Choi

HANCOM inSPACE

The concept of nanosatellite was first introduced from an university R&D project 20 years ago. The application of nanosatellites today can be found in various fields such as Earth-Observation, Communication, Defense & Homeland Security. In South Korea, HANCOM Group will be the first company in the private sector to launch nanosatellite (SEJONG-1). Demands for satellite data is rapidly growing and it is insufficient to keep up the demands with the government-led satellites only. For example, agriculture sector utilizes more than 60% of satellite data for its advantages of analysing broad areas with precision. To fulfil such extensive demands, SEJONG-1 features a swath of 20 km, 7 bands, EO/IR sensors, all in 6U size. Starting with this first nanosatellite, there will be 50 more to be launched by HANCOM Group to create a constellation of nanosatellite, hence more data to be collected.

With SEJONG-1, HANCOM will begin satellite data services targeting multinational customers in various fields including calculating cultivation area, finding forest resources, natural disaster monitoring, urban change detection. In this journal, HANCOM (SEJONG-1) launch schedule, specification, application will be introduced.

10:25 [III-1-4]

Introduction of IntoSpace Co., Ltd and Job Offering

Sangeun Yun[1,2], Gi Wook Nam[1,2]

[1]*IntoSpace Co., Ltd*

[2]*Korea Aerospace Research Institute, KARI*

IntoSpace is a spin-off company of KARI established in January 2021 to develop operation and maintenance technology for Korea Augmentation Satellite System (KASS). We are developing technology to monitor and maintain the performance

of KASS so that it can be used for aviation purposes. In addition, we are developing technologies for the operation of Urban Air Mobility (UAM), which is emerging as a new transportation device. Now, we are seeking Global Navigation Satellite System experts. If you have expertise in this field and want to create a future of the world with us, you can join IntoSpace.

10:40 [III-1-5]
Moasoft Corporation Introduction

Kwang-Hyun Lee

Moasoft Corporation

Moasoft corporation was established in 1998 with the aim of distributing global standard reliability analysis technology in Korea. Over the past 24 years, it has led smart defense innovations in the fields of SW development and reliability tests for Korean defense systems, comprehensive military support for weapons systems, and EMI/EMC issues. The company also has been participated in the SBAS project of the KARI supporting SW development and reliability management.
We are growing into a quality solution provider that services UAS/UAM and space systems also.

10:55 [III-1-6]
Beer To Space (BTS): Why Craft Beer with Space Marketing?

Dongkwen Jeon

CEO of The Satellite Brewing Co., Ltd

Established in 2017, the Satellite Brewing is a Korean craft brewery which releases its craft beers with space theme at major conveience store chains in Korea. Major products are 'Would YOU IPA' (우주IPA), 'Rocket Pils' (로켓필스), 'MARS-i-LAGER' (마시라거), and 'Juicy Galaxy' (쥬시갤럭시).
The start-up is the 5th largest craft brewery in the industry with the expected revenue of 12 million dollars in 2021.
An eccentric entrepreneur, Dongkeun Jeon, brews craft beers with a goal to send beers to space. His background motivation for rapid growth is the will of John F. Kennedy that such difficult "goal will serve to organize and measure the best of our energies and skills".

제2발표장 Convention B

Ⅲ-2 Space Situational Awareness I
Chair: Jae-Dong Seong (KARI)

09:40 [III-2-1]
Operation of OWL-Net as a Designated SSA Sensor in Korea

Jung Hyun Jo, Myung-Jin Kim, Hong-Suh Yim

Korea Astronomy and Space Science Institute

KASI has operated OWL-Net as a designated optical SSA sensor in Korea since 2019. Several domestic LEO and GEO satellites have been tracked. The final estinmated orbit has been provided to calibrate ground tracking antenna. Currently we are testing an optical and SLR combined solution strategy for well known orbits. In this presentation, the operation status of OWL-Net and products will be discussed.

09:55 [III-2-2]
OWL-Net: 2021 Progress Report

Myung-Jin Kim[1], Hong-Suh Yim[1], Dong-Goo Roh[1], Jin Choi[1], Jang-Hyun Park[1], Young-Sik Park[1], Jung Hyun Jo[1], Wonyong Han[1], Jiwoong Yu[1], Hong-Kyu Moon[1], Yoon-Ho Park[1], Sungki Cho[1], Young-Jun Choi[1,2], Eun-Jung Choi[1], Jaemann Kyeong[1]

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

OWL-Net (Optical Wide-field patroL Network) is the first space situational awareness facility of its kind in South Korea which consists of five identical 0.5 m wide-field telescopes with 4K by 4K CCDs. The five stations are located in Mongolia, Morocco, Israel, United States, and South Korea. They are being operated in fully autonomous mode with the minimum human intervention. The primary objective of OWL-Net is to track Korean domestic satellites. In addition, it can be possible to conduct time-series photometry of bright solar system objects. We will present the 2021 progress report of the OWL-Net telescopes.

10:10 [III-2-3]
KASI Meteor Monitoring Network Progress Report

Jang-Hyun Park, Dong-Goo Roh, Myungjin Kim, Sungki Cho, Jung Hyun Jo, Hong-Suh Yim

Korea Astronomy and Space Science Institute

KASI has been deveoping a meteor monitoring network covering the southern part of Korean peninsula based on 'National Preparedness Plan for Space Hazard'. Six meteor monitoring cameras were intalled last year and five more cameras are going to be installed in the end of this year. Total 16 cameras are supposed to be intalled to complete the monitoring network. We

are going to present some early results and future plans and to discuss some issues about network operation and data sharing.

10:25 [III-2-4]

Operation of Korean Satellite Laser Ranging Infrastructures

Mansoo Choi, Sung-Yeol Yu, Ki-Pyoung Sung, Eunseo Park, Hyung-Chul Lim, Jong Uk Park

Korea Astronomy and Space Science Institute

KASI (Korea Astronomy and Space Science Institute) has proceeded a governmental program named ARGO (Accurate Ranging system for Geodetic Observation) since 2008 to develop one mobile and one fixed SLR(Satellite Laser Ranging) systems, Sejong and Geochang SLR System respectively. Sejong SLR System, which will be completely developed in 2011, has the separate optical path that employs the 40 cm receiving and 10 cm transmitting telescopes. The system is a semi-automated and KHz laser ranging system with the single shot range precision of about one centimeter and NP precision better than 5 mm for LAGEOS satellite. Sejong SLR System is capable of tracking satellites with the laser retro-reflector array in the range of 300 to 25,000 km altitude and will provide 24 hour tracking coverage including daylight tracking. Geochang SLR System, which is equipped with a telescope of 1 m diameter, has the common optical path. Its basic function is also laser ranging to satellites with the laser retro-reflector array and it can have an additional function such as satellite imaging using an adaptive optics and space debris laser ranging.
This paper presents current status and plan of Sejong & Geochang SLR System which are development by Korea Astronomy and Space science Institute (KASI). SLR is considered to be the most accurate technique currently available for the precise orbit determination of Earth satellites. The SLR technique measures the time of flight between pulses emitted from laser transmitter and pulses returned from satellites with laser retro-reflector array. It provides millimeter level precision of range measurements between SLR stations and satellites.

10:40 [III-2-5]

Development of Near Space Optical Survey Telescope

Sungki Cho, Hong-Suh Yim, Jung Hyun Jo, Jaemann Kyeong, Myungjin Kim, Dong-Goo Roh, Hong Kyu Moon, Youngmin JeongAhn, Chung-Uk Lee, Dongjoo Lee

Korea Astronomy and Space Science Institute

Currently Korea astronomy and space science institute is developing the near space optical survey (NSOS) telescope. A 1.5 m class wide-field optical telescope for detecting asteroids larger than 140 m approaching within 19.5 LD (Earth-Moon distance). NSOS telescope will contribute to find new near Earth asteroids. NSOS Telescope has a field of view of 5 square degrees, an exposure time of 30 seconds, a filter specialized for asteroid detection, and an installation site with high observation rate of 82.4%. Since the telescope is installed in the southern hemisphere, it has the advantage of complementary observation of fast moving Near-Earth Asteroids discovered in the northern hemisphere. The NSOS development is currently in a design phase. We report the progress of NSOS telescope development.

10:55 [III-2-6]

Development and Progress on Space Surveillance Radar: KOSPAW Test Bed

Jiwoong Yu, Sungki Cho, Jung Hyun Jo

Korea Astronomy and Space Science Institute

Recently, the number of space objects has increased exponentially leading to a possibility of an increase in the number of space hazards; therefore, the Space Situational Awareness Program based on radars is currently being developed to counteract these events. The Korea Space Surveillance Active Phased Array Radar Window (KOSPAW) test bed is being developed to test radar technology in a phased array. Assuming that the number of elements in the antenna array is 28 by 28, the total number of elements is 784, which consists of a rectangular planar array. The radar is developed to detect radar cross section (RCS) of 5 m^2 for space objects at an altitude of 750 km. The tranmitted total power is 235 kW. The designed radar can effectively operate in tracking and searching modes.

제3발표장 Convention C

특별포럼

Chair: 이병선 (ETRI)

11:00

History, Today and Future of Space Exploration

Soo Seok Yang

Korea Aerospace Research Institute

For the past 70 years, mankind has continued to explore space. A total of 130 lunar missions were attempted, with 71 successes. Among them, 23 manned and unmanned moon landings were successful. A total of 49 launches and 76 missions were carried

out for the purpose of exploring Mars, and 39 missions were successful among them. So far, the Soviet Union successfully landed on Mars once and the United States landed it four times. Recently, the United States and China successfully landed on Mars at about same time. Deep space explorations also have been carried out 11 times by the United States. Recently, many countries have begun to take interest in space exploration again, and the investment in space exploration is expected to increase by more than 1.6 times in the next 10 years compared to the past. In particular, lunar exploration is attracting renewed attention, and the United States is set to attempt another manned lunar landing in 2024. At this point, in order to activate space exploration and move on to manned space exploration, it is also necessary to review the technical and cost limits of space exploration.

13:20～14:00 1부 포스터 발표

제1발표장 Convention A

Ⅳ-1 Nano/Microsatellite

Chair: Hong Rae Kim (Soltop)

14:00 [Ⅳ-1-1]

Calculation and Measurement of Electric Power Generated by 3U-Sized KMSL Nanosatellite during LEOP

Seul-Hyun Park[1], Myung-Kyu Lee[2]

[1]*Department of Mechanical Engineering, Chosun University*
[2]*Department of Mechanical System and Automobile Engineering, Graduate School of Chosun University*

The KMSL (Korea Microgravity Science Laboratory) nanosatellite, which was selected at the 2017 CubeSatellite Contest, is a 3U-sized satellite for microgravity scientific mission. It was successfully launched by Soyuz 2.1a from the Baikonur Space Center in Kazakhstan on March 22, 2021, and the first communication was successful at 23:44 Korean time on the day of launch. The paper describes a calculation of electric power generated by the KMSL nanosatellite's solar panels in low Earth orbit (LEO). Electric power estimated with selected parameters such as solar panel and MPPT efficiencies was then compared to that measured from in-orbit operation. The results clearly show the calculation of electric power generation with selected parameters is in good agreement with measured one.

14:15 [Ⅳ-1-2]

Development Status of Microsatellite Constellation System for New-Space Earth Observation

Sang-Hyun Lee[1], Chi-Wook Oh[1], Chol Lee[1], Son-Goo Kim[1], Chol-Woo Lim[1], Hungu Lee[2], Jae-Heon Jeong[3], Hyun-Ok Kim[3]

[1]*Satellite Technology Research Center, KAIST*
[2]*SaTReC Initiative*
[3]*Korea Aerospace Research Institute*

The microsatellite constellation system (NEOSAT) for new-space earth observation is a project to develop 11 satellites under 100 kg and utilization system to improve promptness and accuracy in national security and disaster response. Currently, critical design of first satellite, EM test, initial design of calibration and utilization system is in progress. Compact, lightweight, low power, low cost design concepts were applied to satellite development and COTS parts were used. In this paper, we will briefly present the development status for microsatellite constellation system.

14:30 [Ⅳ-1-3]

NEONSAT Constellation Phasing by Altitude Transition in the Effect of the Earth Gravitational Force

Junchan Lee, Tae-Jin Jeong, Hun-Kyu Seo, Sang-Hyun Lee

Satellite Technology Research Center (SaTRec), Korea Advanced Institute of Science and Technology

The NEONSAT is being manufactured for the purpose of national security and rapid disaster response by developing about 100 kg mass of 11 microsatellites under the supervision of the Korea Advanced Institute of Science and Technology. The satellites will be operated on an orbit plane with an altitude of about 500 km and an inclination angle of 97.4109°. Five satellites launched in the first half of 2026 will be operated at 10:30 LTDN and other five satellites planned to be launched in 2027 will be operated at 13:30 LTDN. The satellites will perform ground observation while forming a satellite group with the same phase difference, and to this end, each satellite acquires satellite constellation with equally spaced shape through altitude transition movement. This paper introduces the method of acquiring satellite constellation via the altitude transition when the satellite is in the effect of the Earth irregular gravitational force.

14:45 [Ⅳ-1-4]

1U Size Aspheric Cassegrain Telescope Development for a 3U CubeSat

Hanik Kim, Hyochoong Bang

Korea Advanced Institute of Science and Technology

One-unit sized hyperspectral camera has been developed to be equipped in three-unit sized CubeSat, Repeater Arrangement & Disaster Early View (RANDEV), and the second planned Korea Space Launch Vehicle- (KSLV-II) called Nuri will carry the satellite to 700 km sun-synchronous earth orbit. The optical design of the payload was assessed using Modulation Transfer Function (MTF) variation to optimize the performance and tolerance of possible drawings in constraints. The constraints are one-unit size, the curvature ranges of fabricable aspheric lens and mirror surfaces, fabrication errors, and the temperature variation of payload structure by orbiting. The one-unit size constraint is defined to 100 mm × 100 mm × 1,400 mm which includes the top side space of the CubeSat in the Poly-Picosatellite Orbital Deployer, and the diameter of the primary mirror is 80 mm. In order to enhance the performance and tolerance in the constraints, the mirrors and lens surfaces should be asphere and the aspheric drawing should be checked whether these are fabricable with acceptable errors. The temperature range is assumed to be -100-300℃, and the maximum tube length expansion is 304 μm by the thermal effect. Since this temperature variation degrades the performance and tolerance of optical drawings, the length expansion is compensated with the other components' length contraction of the payload influencing surface distances and the material of the components is different to the tube material.

15:00 [Ⅳ-1-5]

A New Space Initiative: The First Commercial Pathfinder Cubesat of the Private Sector in Korea, Solesat-1

Ho-Jin Lee, Jinhyuk Kim, Hongrae Kim, Youngbo Sakong

Soletop Inc.

The company Soletop is investing to develop its first own Cubesat dubbed as "Solesat-1" in-house as an initiative to lead the space industry democratization to drive a New Space Trend. In Korea, the space development is still in the public domain thus industrialization stays considered a process of implementation after technology transfer from R&D institution that has sponsored by government R&D programs. Thus the contract has been awarded to the experienced as well as affordable companies. For this reason the space industry has had a high entry barrier to small-medium enterprises who are challenging to the competition for government programs. A 3U-sized nanosatellite, Solesat-1 is under development for the sake of obtaining the space heritage as well as demonstrating its capability/technology to make its own satellite in-house. All the required works including mission design, system engineering, PA, module development, satellite AIT, EGSE, environmental test, ground system development and launcher contract are to be carried out by Soletop itself.

Solesat-1 development has started in Oct. 2020 and SDR and PDR are successfully completed through last summer. The launch is scheduled in late 2022 and all the development is on schedule. Solesat-1 will have an SSO with 500 km altitude. It has two missions: Soletop technology in-orbit verification and imaging/sensing demonstration. Cubesat platform, CAN interfaced boards/modules, patented solar panel structure and separation, ground control and software will be verified primarily during the designated mission life time. As a second mission we are going to take images and video for demo using small EO camera purchased from Gomspace at the 500 km altitude. The image data will be transmitted to the Soletop Ground Station (SGS) for processing and assessment. The SGS has 3.7 m diameter S/X band reflector antenna that has LEO tracking capability. In addition, Solesat-1 is hosting a SWS (Space Weather Sensor) to be provided by the Griffith University of Australia and going to transmit/transfer to the sensed data to them via SGS.

Soletop is going to prepare for the various Cubesat application programs based on the Solesat-1 platform heritage once successful. The platform size will be expanded up to a few tens of cubes enough to host advanced payloads for technology verification as well as new mission/service demonstrations. For example, the next generation Solesat may have a large deployable antenna for data gathering and/or RF spectrum monitoring. The software defined radio based payloads will be carried for demonstration of the onboard signal processing capabilities for the services like SAR, communications, satellite IoT/M2M, realtime asset tracking like AIS/VDES and ADS-B, RF monitoring and geolocation. Once these pilots and/or pioneer are successful, a constellation of Solesat will be of course the next target for a commercial service deployment.

제2발표장 Convention B

Ⅳ-2 Space Situational Awareness II

Chair: Man-Soo Choi (KASI)

14:00 [Ⅳ-2-1]

Case Study of Angle-Only Orbit Determination Using the OWL-Net: Normal Operation Phase

Jin Choi, Myung-Jin Kim, Dong-Goo Rho, Eun-Seo Park, Eun-Jung Choi, Hong-Suh Yim, Jung Hyun Jo, Sungki Cho

Korea Astronomy and Space Science Institute

The Optical Wide-field patroL-Network (OWL-Net) is global network of robitic telescopes for observing Korean Low Earth Orbit (LEO) satellites and monitoring Geostationary Earth Orbit (GEO) region as Space Situational Awareness (SSA) facility. The orbit determination process is being performed on a weekly basis. In this study, case of orbit determination results are reported during normal operation of the OWL-Net in 2021.

14:15 [Ⅳ-2-2]

Study on the Historical On-Orbit Breakup Events

Jaedong Seong, Okchul Jung, Youeyun Jung, Sae-Han Song

Korea Aerospace Research Institute

Currently, 53% of space objects present in orbit are space debris generated by satellite on-orbit break-up. Many of the space objects break-up in orbit for various reasons, such as fuel system problems and intentional explosions, still exist in orbit and threaten operating satellites. In this study, related content was introduced based on a report on orbital break-up events published by NASA in 2018. It includes statistics on 242 orbital division events reported so far, ratios according to causes of break-up, major division events based on fragment generation numbers, and case studies.

14:30 [Ⅳ-2-3]

Space Object Collision Risk Analysis Using Different Orbital Data Sources

Siwoo Kim[1], Jinsung Lee[1], Eunjung Choi[2], Sungki Cho[2], Jaemyung Ahn[1]

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

The number of objects in Earth's orbit is increasing rapidly due to the increase in space missions for various purposes. In particular, constellation missions, such as Starlink, significantly increase the spatial density of a specific orbit region, causing an increase in the collision risks themselves and satellites in the neighborhood orbits. The collision probability between two space objects can be estimated using the state and covariance of each object. However, the collision probability value is highly sensitive to the initial conditions; therefore, it is important to gather accurate data. In this research, the collision risk of space objects is analyzed using different sources of orbital data. A case study is conducted using three types of data: TLE of CSpOC, Operator's serial data, and orbital data based on optical observation.

14:45 [Ⅳ-2-4]

SpaceMap: A Near-Realtime Web Server for Conjunction Assessments and Space Optimization Problems

Seunghwan Choi[1], Hyunwoo Kim[1], Taegyu Hwang[1], Junhee Jang[1], Joonghyun Ryu[2], Deok-soo Kim[1,2]

[1]*Department of Mechanical Engineering, Hanyang University*
[2]*SpaceMap Inc.*

The busy Earth orbit is becoming busier with more spacecrafts being launched. Hence, the probability of collsion between space objects is increasing. We introduce a near-realtime web server SpaceMap which can answer to conjunction assessment queries very quickly and answer to various optimization problems such as finding the fastest data transmission paths through satellites between pairs of cities in future, the good maneuver path to avoid a predicted conjunction, etc. The official version of the current testbed SpaceMap that can be accessed at http://www.spacemap42.com/ will be served on AWS in near future.

15:00 [Ⅳ-2-5]

Preliminary Design of NSSAO Integrated Space Situational Awareness System

Eun-Jung Choi[1], Sungki Cho[1], Do-Hyun Kil[2], Byung-Kook Kang[2]

[1]*Korea Astronomy and Space Science Institute*
[2]*Soltop*

NSSAO (National Space Situational Awareness Organization) started developing an integrated SSA operating system with a three-year plan from 2021. SSA depends on the collection and analysis of data. There are a number of issues associated with collecting data from the range of available sources including domestic sensors, commercial and public data. The data integrators and data centers should be able to handle several type of data. The data center would gather the sensor raw data and analyze the risk assessment for the national safety reasons. The SSA information service would be needed for the civil services also. Therefore the integrated SSA system framework is needed to distribute and share SSA data. In this paper, the preliminary design contents of National Space Situational Awareness System development are presented. With PDR complete, the Integrated SSA system now moves into the critical design phase.

제3발표장 Convention C

Ⅳ-3 Special Session : Science Culture
Chair: Jung A Hwang (KASI)

14:00 [Ⅳ-3-1]

Bridging between Scientists and General Public: The Role of Science Communication

Beom Jun Kim

Department of Physics, Sungkyunkwan University

Achievements of science and technology have been shaping our daily lives in modern era in many aspects. New findings are reported day by day, and their applicabilities are often realized in the form of technological outputs. It has been becoming more important for everyone to understand the new scientific findings and their implications in our society. In this talk, I would like to share my personal experience in science communication with public. I emphasize that such activity is beneficial not only for public, but also for the individual scientist. Science communication makes it possible for a scientist to get to the very essence of the achievement and also provides a unique chance to think over what is its implication in our culture and society.

14:30 [Ⅳ-3-2]

Science and Culture Activities Using Entertainment and Documentary Broadcasting

Kyungsoo Moon

PLAYLABS, Korea

Science has been regarded as a field of current affairs/culture in the content/media industry. As a means of conveying science in an easy-to-understand manner to the public in the genre of science documentary, it is still fulfilling its function. However, many changes have occurred in the media ecosystem since COVID-19. As the time spent at home increases and the channels and devices that consume contents diversify, the public has become interested in various contents, and science, which has stayed in the liberal arts field, has begun to emerge as an important material for entertainment programs. As a means of popularizing science, we examine what kind of scalability the entertainment program has.

15:00 [Ⅳ-3-3]

Efforts to Participate in Academic Advisory on Scientific and Cultural Contents

Hae-Dong Kim[1,2]

[1]*Korea Aerospace Research Institute*

[2]*University of Science and Technology*

Through academic advisory activities on science and cultural contents, the public's awareness and understanding of science culture is being raised. An important part of these activities is to reconcile the difference between the expectations of the general public and the quality of science and cultural contents provided. For example, there is a big difference between advisory activities for career counseling for middle and high school students and academic lectures for cultivating the culture of general adults. In addition, it is important to provide appropriate contents according to the level requested by participants for academic advice and lectures for the general public and military personnel engaged in the field of broadcasting and communication. In this lecture, I will show the differences between the scientific and cultural contents provided for the general public so far, and describe how to prepare the lecture contents according to the lecturers and how to deliver them effectively.

15:30 [Ⅳ-3-4]

Public Science Communication: Diverse Authors Writing Diverse Books

Chae Kyung Sim

Korea Astronomy and Space Science Institute

Books that focus on science intensify the understandings and enthusiasms of the already-science-lovers, who compose a narrow range of general readers. We suggest that attracting apathetic readers to science would lessen the gap between them and science and increase the general public's mental, practical, and political support for the science community. In other words, we need diverse authors writing diverse aspects of science. This talk will share recent experiences in publishing an essay that describes a scientist's life and a colloquy book. The positive responses to those books show a seldom taken road for the science communication with the general public beyond science fans. We will also discuss the importance, influence, and ways of keeping records of a science project of any scale.

제1발표장 Convention A

Invited Talk Ⅲ
Chair: Jung A Hwang (KASI)

16:40 [IS-Ⅲ]

The Commercial Space Age is Now Here in Korea

Hyun-Woo Shin
CEO of Hanwha Aerospace Ltd.

The global space industry is rocketing into a new frontier as private enterprises are becoming the main drivers of space development and exploration. They are developing various space based business from broadband communications and cargo/passenger delivery to space travel and tourism.
Hanwha has been involved in the space industry since 1994, when it contributed to the development of mono-propellant thrusters for the Korea Multi-Purpose Satellite-1 (KOMPSAT-1, Arirang-1) led by the Korea Aerospace Research Institute (KARI). Since then, Hanwha's various aerospace businesses have made crucial contributions to Korea's journey into space. Hanwha Aerospace has participated in the development of liquid engines for the Korea Space Launch Vehicle (KSLV) series. The upcoming launch of Korea's first fully indigenous carrier rocket, the Korea Space Launch Vehicle-II (KSLV-II) will be a landmark moment for the Korean aerospace industry. Beyond providing the thrust to break through the Earth's gravitational pull, Hanwha is also taking steps to engage in satellite businesses. For instance, in 2021, Hanwha Aerospace acquired a 30 percent stake in Satrec Initiative (SI), a company that develops high-performance small/medium satellite systems for Earth observation (EO) missions and has contributed to the success of over 30 international and domestic space programs over the past 30 years.
Through this acquisition, Hanwha Aerospace has vertically integrated business areas related to EO. Hanwha Aerospace will launch EO satellites manufactured by SI, which will also provide ground stations for monitoring and controlling satellites. SI's subsidiaries, SI Imaging Services and SI Analytics, focus on providing satellite-based services, such as satellite imagery distribution, as well as artificial intelligence (AI)-based geospatial analytics services.
Space-based communications will also get a boost from Hanwha Systems, which acquired the business and assets of Phasor Solutions, a British satellite antenna start-up, in 2020. Hanwha Phasor's technology is geared toward the development and manufacture of electric beamforming antenna systems, which make it possible for people in aircrafts, ships and remote locations to quickly access reliable wireless communications at all times. Hanwha Systems is also partnering with Kymeta, a U.S.-based satellite technology start-up that is developing ways to use light to communicate with satellites, which would greatly miniaturize the equipment needed for global communications. For now more than 95% of the revenue earned in the space sector is from the space-for-earth economy. However we will be reaching the first states of a space-for-space economy (and eventually the entire terrestrial economy) as Space will be getting more and more crowded with upcoming efforts of governments and private companies that seek to explore space. Hanwha will proactively participate space exploration programs such as Apophis mission and set our sights on the space-for-space business models including asteroid mining and in-orbital satellite service.
Hanwha's comprehensive value chain will be key to seizing New Space business opportunities, which are yet to be properly tapped in Korea. In order to bring out the combined capabilities, Hanwha has organized a task force titled "Space Hub," that will orchestrate research, development and investments across a wide spectrum of business areas. Through vertical integration, Hanwha will continue to unlock new opportunities to generate new business opportunities and accelerate Korea's space ecosystem.

10월 29일(금) 제1발표장 Convention A

Invited Talk Ⅳ
Chair: Hong-Kyu Moon (KASI)

09:00 [IS-Ⅳ]
NASA's Double Asteroid Redirection Test (DART): Earth Strikes Back

Elena Adams
Johns Hopkins Applied Physics Laboratory

Asteroids have been hitting Earth for billions of years. In 2022, the Earth strikes back with DART, the Double Asteroid Redirection Test. Launching this fall, DART is the world's first full-scale planetary defense test, demonstrating one method of asteroid deflection technology. The DART mission will prove that a spacecraft can autonomously navigate itself to a target asteroid and intentionally collide with it, a method of asteroid deflection known as kinetic impact. DART will also demonstrate and test a slew of other new technologies for NASA, and help us better prepare for an asteroid that might pose a threat to Earth, should one be discovered.
The DART spacecraft, which was built and will be operated by the Johns Hopkins Applied Physics Laboratory (APL) in Laurel, Maryland, at the direction of NASA's Planetary Defense Coordination Office (PDCO), will launch from Vandenberg Space Force Base in California on a SpaceX Falcon 9 rocket. In this talk, I will give a brief overview of the DART mission, its challenges, and the launch plan.

제1발표장 Convention A

V−1 Special Session : Commercial Lunar Payload Service
Chair: Duk Hang Lee (KASI)

09:40 [V−1−1]

Korean Scientific Instrument for Commercial Lunar Payload Service

Young−Jun Choi[1,2], Chae Kyung Sim[1], Dukhang Lee[1]

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

Korea has the lunar exploration program including Korea Pathfinder Lunar Orbiter (KPLO) which will be rescheduled to launch on 2022 recently and future Lunar Lander near 2030s. Korea Astronomy and Space Science Institute (KASI) and NASA HQ Science Mission Directorate agreed to initiate the exploration working group to develop and support joint science project. some science instruments from Korean community will be provided for US Commercial Lunar Payload Service (CLPS). KASI has selected four instruments, based on scientific merit and technology readiness. In this talk, the scientific justification of successful instruments and conceptual design will be presented.

09:55 [V−1−2]

Progress on Developing GrainCams and Operation Analysis as an Instrument for Lunar Rover

Minsup Jeong[1], Young−Jun Choi[1,2], Sungsoo S. Kim[3], Dukhang Lee[1], Chae Kyung Sim[1], Bongkon Moon[1], Seonghwan Choi[1], Dae−Hee Lee[1], Jihun Kim[1], Mingyeong Lee[2], Minbae Kim[1]

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

The top layer of the lunar regolith has been formed in a particular micro-structure, usually called “fairy castle structure”. The fairy castle structure is expected to be highly porous, containing grains piled up like a tower. This particular structure affects light scattering behavior on the lunar surface such as reflectance and opposition effect. Therefore, understanding the fairy castle structure is informative to analyze the physical properties of lunar regolith. Furthermore, the grains in lunar regolith can levitate by various external forces such as electric force and micro-meteoroid impact. The levitating dust was first detected by Apollo astronauts. However, many of levitating dust’s properties are still unknown. GrainCams aims at understanding the characteristics of grains that are on the surface and levitating. GrainCams, consisted of Surface Camera (SurfCam) and Levitating dust Camera (LevCam), is an instrument candidate for Commercial Lunar Payload Services (CLPS), lunar landing mission by NASA. We are developing GrainCams to land on the Moon in 2025. In this talk, we will give a presentation about developing progress and science operation.

10:10 [V−1−3]

Scientifc Application of LVRAD

Sung−Joon Ye[1], Sukwon Youn[1], Uk−won Nam[2], Won−Kee Park[2], Jongdae Sohn[2], Junga Hwang[2], Young−Jun Choi[2], Hongjoo Kim[3], Sunghwan Kim[4], Insoo Jun[5]

[1]*Department of Applied Bioengineering, Graduate School of Convergence Science and Technology, Seoul National University*
[2]*Korea Astronomy and Space Science Institute*
[3]*Department of Physics, Kyungpook National University*
[4]*Department of Radiological Science, Cheongju University*
[5]*Jet Propulsion Laboratory, California Institute of Technology, California, USA*

Seoul National Universty (SNU), Korea Astronomy and Space Science Institute (KASI), Kyungpook National Universty (KNU), and Cheongju University (CJU) are developing a radiation dosimeter called LVRAD (Lunar Vehicle Radiation Dosimeter) planned to land at lunar South Pole in 2025 solar maximum to measure and analyze the radiation environment on the lunar surface. LVRAD consists of PDS (Particle Dosimeter and Spectrometer), TED (Tissue Equivalent Dosimeter), and NS (Neutron Spectrometer) to measure lunar surface radiation environment and evaluate the biological effects on the lunar surface. PDS consists of Si and CsI detector to measure proton energy spectrum of 1-10 MeV, 10-100 MeV, and 100 MeV~. TED is a gas filled detector surrounded with plastic detector for anticoincidence to estimate absorbed dose, dose equivalent, and ambient dose equivalent of charged particles and neutrons. NS consists of two modules: NS-F (Fast Neutron Spectrometer) and NS-E (Thermal/Epithermal Neutron Spectrometer). NS-F measures fast neutrons with energies of 1 to 10 MeV and evaluate biological effects of fast neutrons. NS-E measures thermal and epithermal neutron counts.
This work was supported by the National Research Foundation of Korea (NRF) Grant funded by Korea government (MSIP) (NRF-2020M1A3B7108845).

10:25 [V−1−4]

Energy Calibration by MC−50 Proton Beams for Energy Spectroscopy and Radiation Dosimetry on the Moon

Sunghwan Kim[1], Bobae Kim[2], Hong Joo Kim[2], Hwanbae Park[2], Sukwon Youn[3], Sung-Joon Ye[3], Uk-won Nam[4], Bong-Kon Moon[4], Won-Kee Park[4], Jeonghyun Pyo[4], Jongdae Sohn[4], Junga Hwang[4], Jaejin Lee[4], Insoo Jun[5]

[1]*Cheongju University*
[2]*Kyungpook National University*
[3]*Seoul National University*
[4]*Korea Astronomy and Space Science Institute*
[5]*Jet Propulsion Laboratory, California Institute of Technology, California, USA*

We designed and developed a spectrometer based on a silicon semiconductor detector to measure protons' energy spectrum and estimate the equivalent dose on the Moon. The used pin silicon sensor in the spectrometer was produced by Kyungpook National University and had an effective area of 20 mm × 20 mm and a thickness was 650 μm. For the proton beam's energy calibration, the MC-50 cyclotron in KIRAMS with Al degraders was used. The proton beam energies from the cyclotron are 22 MeV and 45 MeV, and the beam current is below 0.5 nA. The results are compared to the calculated results by GEANT4 simulation and measured results by the scintillation detector. This work was supported by the National Research Foundation of Korea (NRF) Grant funded by the Korea government (MSIP) (NRF-2017M1A3A4A01077173) and (NRF-2020M1A3B7108845)/ The authors express their sincere thanks to the staff of the MC-50 Cyclotron Laboratory (KIRAMS), for the excellent operation and their support during the experiment.

10:40 [V-1-5]

Lunar Space Environment Monitor (LUSEM) for CLPS Mission: Science Goals and Current Status

Go Woon Na[1], Jongho Seon[1], Kyu-Sung Chae[1], Woo-Hyeong Seol[1], Chan-Haeng Lee[1], Young-Jun Choi[2,3], Chae Kyung Sim[2], Dukhang Lee[2], Seul-Min Baek[2], Jun Yong Park[4], Young Jin Jun[4]

[1]*Kyung Hee University*
[2]*Korea Astronomy and Space Science Institute*
[3]*University of Science and Technology*
[4]*Satrec Initiative Co., Ltd.*

The interaction of the Moon and the Earth's magnetotail has received relatively small attentions, despite the fact that the Moon spends at least 5-7 days in the Earth's magnetotail. Throughout previous lunar missions, the Charged Particle Lunar Environmental Experiment (CPLEE) of Apollo 14, with an energy measurement range of 50 eV to 50 keV, was almost the only experiment to measure the plasma sheet population of charged particles on the lunar surface. The lunar orbiters, however, have observed significant distributions of charged particles in the energy range of 50 keV to 1 MeV. The LUnar Space Environment Monitor (LUSEM) aboard the Commercial Lunar Payload Services (CLPS) mission will measure the population and the distributions of charged particles above ~50 keV on the lunar surface when the Moon is located in the Earth's magnetosheath, the plasma sheet, and the magnetotail lobe. Therefore, LUSEM will provide a unique opportunity to study the interaction of the Earth's magnetotail and the Moon, which has not been well explored by previous lunar missions. In this paper, we will briefly present the scientific objectives, the current status of the instrument development including the test results, and the near-term plan.

10:55 [V-1-6]

Preliminary Design of LSMAG Instrument for Lunar CLPS Mission

Ho Jin[1], Khan-Hyuk Kim[1], Hyojeong Lee[2], Derac Son[3], Seul-Min Baek[4], Hyeonhu Park[1], Yun-Ho Jang[1], Woohyun Jo[1], Jehyuck Shin[1]

[1]*School of Space Research, Kyung Hee University*
[2]*NARA Space Technology*
[3]*Sensorpia*
[4]*Korea Astronomy & Space Science Institute*

The Korea Astronomy and Space Science Institute (KASI) is participating as a South Korean partner in the Commercial Lunar Payload Services (CLPS) of NASA. KASI selelected four instruments for CLPS program. The Lunar Surface MAG netometer (LSMAG) instrument is one of them and the scientific mission objective is the moon's surface magnetic field investigation.

The LSMAG seems to land in the Schrödinger Basin near the SPA (South Pole Aitken) region in the 2025-2026 timeframe. Recently many Lunar scientific objectives focus on the south pole area exploration to answer questions of the water issue, the age and chemical composition investigation of SPA etc. The knowing an age of the SPA basin extends beyond the Moon to Earth and the history of the early Solar System. Furthermore we expect the new observations of magnetic field waves and surface magnetic field. The LSMAG instrument consist of two units which are a boom unit and a FCE unit. The boom has two three-axis fluxgate magnetometers and one accelerometer and anisotropic magnetoresistive sensors. In this paper, we introduce the scientific objectives and preliminary design of LSMAG instrumnet.

제1발표장 Convention B

V-2 Sun & Space Environment III

Chair: Tae-Yong Yang (KASI)

09:40 [V-2-1]

A Comparative Study on the Global Characteristics of the Topside Ionosphere between the 23/24 & 24/25 Solar Minimum Periods Using the COSMIC Data and the Physics-Based Model

JeongHeon Kim[1], Young-Sil Kwak[1,2], Jaeheung Park[1], Tae-Yong Yang[1], Ho-Sik Kam[1], Woo Kyoung Lee[1], Jaewook Lee[1,2], YongHa Kim[3], JunChan Lee[4], KyungWook Min[4]

[1]*Korea Astronomy and Space Science Institute, KASI*
[2]*University of Science and Technology, UST*
[3]*Chungnam National University, CNU*
[4]*Korea Advanced Institute of Science and Technology, KAIST*

Recently, after the minimum of the 24/25 solar cycle, a new 25 solar cycle has been started. The minimum periods of the previous 23/24 solar cycle were unusually long, and consequently, lower solar radiation was emitted. Thus, the thermosphere, which is the ionosphere's source, contracted, and the ionosphere's electron density was also decreased. In this study, we analyzed the effects of the ionosphere during the 24/25 solar minimum and compared to the 23/24 solar minimum. To cover the two solar minimum periods, we used the COSMIC-1 & 2 Radio occultation data. We conducted a comparative analysis focusing on the topside ionosphere and also analyzed the vertical total electron contents (VTEC) among the COSMIC data. As a result, the 24/25 solar minimum shows the more significant global electron density than 23/24 solar minimum, about 5.6% (0.5%), -8.6% (4.7%), and 50.2% (32.8%) on average during the day (night) during equinoxes, June solstice, and December solstice. What is unique is that during the 24/25 minimum December (335-365 doy of 2020), both day and night, the electron density is significantly higher compared to the previous solar minimum period. The other seasons are pretty much the same between two minimum periods, with variations within 10%. To find the ionospheric drivers that cause these results, we analyzed the solar EUV radiation (FISM & NRLTSI2 model) and the thermosphere density (O/N2 ratio of TIMED/GUVI). It was possible to confirm the temporary high solar radiation energy and high O/N2 ratio in December of the 24/25 minimum. Using the SAMI3 ionospheric physics-based model, we estimated and calculated how much each ionosphere driver could contribute to the global electron density and estimated the increased electron density in the recent solar minimum. In this talk, we will show the drivers of electron density in the ionosphere according to the recent change in the solar minimum and present the analysis results.

09:55 [V-2-2]

Time-Series Forecasting of Global TEC Maps Using a Set of Deep Learning Models

Jinkoo Yim[1], Yong-Jae Moon[1,2], Hyun-Jin Jeong[1]

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

In this study, we develop a set of deep learning models to make a time-series forecasting of global Total Electron Content (TEC) maps using an image-to-image translation method based on conditional generative adversarial networks. For training our deep learning models, we use the International GNSS Service (IGS) TEC maps from 2003 to 2012. One model uses two input data (t-12 and t + 0 IGS TEC map) and generate 6 TEC maps with a cadence of 12 hours (t + 12, t + 24, t + 36, t + 48, t + 60 and t + 72). The other five models are made by sequentially shifting two hours back for input and output data. Finally, our models provides a time-series forecasting up to 72 hours with 2-hour time cadence. Our models are tested for solar maximum period (2013-2014) and minimum period (2017-2018) data. For evaluation we compare our model results and IGS TEC maps using Pearson correlation coefficient (CC), root mean square error (RMSE), bias, and standard deviation (STD). The results of one-day forecasting predicted by our models are 0.98, 2.57 TECU, -0.13 TECU and 2.45 TECU for mean CC, RMSE, bias and STD, respectively, which are better than the previous models. Our study shows that a set of deep learning models successfully generate a time-series forecasting of TEC maps. 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).

10:10 [V-2-3]

Ionospheric Anomalies Associated with Strong Earthquakes in North America as Observed by US-TEC and DEMETER

Sun Mie Park[1], Kwangsun Ryu[2], Kyungwook Min[3]

[1]*Korea Science Academy of KAIST*
[2]*Satellite Technology Research Center, KAIST*
[3]*Korea Advanced Institute of Science and Technology*

Recent studies have provided a plausible relationship between seismic activity and ionospheric disturbances. To elucidate seismo-ionospheric disturbances, we have been analyzed the temporal and spatial characteristics of ionospheric disturbances

for two strong earthquakes ($M \geq 6.5$) that occurred in North America in 2009 and 2010 (the period of minimum solar activity), using the United States total electron content (US-TEC) data. The variations in the TEC have been compared with the changes in the topside plasma density measured by the Detection of Electro-Magnetic Emissions Transmitted from Earthquake Regions (DEMETER) satellite. Positive or negative TEC anomalies around the epicenters appeared before and after the earthquakes. Positive anomalies occurred more frequently than negative ones. Although TEC anomalies appeared at all local times, strong anomalies usually occurred from late afternoon to dawn (16–6 LT). Earthquake-related TEC anomalies were typically limited to the earthquake region, whereas geomagnetic activity-related TEC anomalies appeared over a vast region. In Addition, most abnormal increases in the topside electron density obtained by the DEMETER over the seismic zone coincided with the TEC anomalies. Therefore, the variations observed in the TEC and topside electron density before and after the earthquakes indicates that these ionospheric disturbances are related to seismic activities.

10:25 [V-2-4]

Reconstruction of the Regional Total Electron Content Maps over Korean Peninsula Using Deep Convolutional Generative Adversarial Network (DCGAN) and Poisson Blending

Se-Heon Jeong[1,2], Woo Kyoung Lee[2], Soojeong Jang[2], Yong Ha Kim[1], Junseok Hong[2], Byung-Kyu Choi[2]

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

Total electron content (TEC) from Global Navigation Satellite System (GNSS) stations are essential parameters representing the ionosphere phenomenon. However, due to the geographical limitation of ground-based GNSS stations, data are not available in the ocean area. Previous studies have suggested several interpolation techniques to make up the unavailable data coverage in the TEC map. Nevertheless, their results do not provide the appropriate features of ionospheric variation. Artificial intelligence (i.e., neural network, deep learning) has recently shown good performance in reconstructing images. In this study, we employ a deep learning technique called Deep Convolutional Generative Adversarial Network — Poisson blending (DCGAN-PB) to reconstruct the regional TEC map in the vicinity of the Korean Peninsula (25.5°–41°N / 120°–135.5°E). Excluding the test periods of 2010 (solar minimum) and 2014 (solar maximum), we train the DCGAN with TEC data from the International Reference Ionosphere (IRI) model in the period of 2002–2019 as a reference, and then optimize the results using observational TEC data from the KASI GNSS network (mapping). Before applying the Poisson Blending (PB) algorithm to DCGAN results described above, we evaluate model performance by comparing TECs from DCGAN with those from IRI, global ionospheric maps (GIM) and the KASI GNSS network for 2010 and 2014. The comparisons show the highest correlation and lowest root mean square errors between DCGAN TECs and KASI TECs. We also compare DCGAN and DCGAN-PB TECs with foF2 (F2 layer critical frequency) measured by two ionosonde stations (Jeju, I-Cheon) in Korea. The comparison indicates that DCGAN TECs generally offer a higher correlation with foF2 values than those from IRI and GIM for both high and low solar activity years. Furthermore, the DCGAN model performed well for the geomagnetic storm periods. Finally, we apply PB to DCGAN TEC maps to reflect a detailed structure of TECs.

10:40 [V-2-5]

F-Region Depletion in the Polar Cap Ionosphere under Quiet Geomagnetic Conditions

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

[1]*Kyung Hee University, South Korea*
[2]*Korea Polar Research Institute, South Korea*

F-region electron density depletion observed in the polar cap ionosphere is studied using measurements made from VIPIR/Dynasonde and FPI instruments at Jang Bogo Station (JBS) in Antarctica. We focus on F-region depletion (known as polar hole) events that occurred during geomagnetically quiet periods. 41 polar holes were identified by JBS VIPIR/Dynasonde in 2018–2019. They are mostly distributed from the premidnight (MLT = 2100 h) to dawn sector (MLT = 0600 h) and last one to five hours. We also examined neutral parameters (wind and temperature) at ~250 km observed by JBS FPI. For the polar hole intervals under quiet geomagnetic conditions, the neutral temperature was much lower than that under moderate geomagnetic conditions. However, the neutral wind does not depend on geomagnetic activity. In this study we discuss why the neutral wind and temperature for the polar hole intervals differently respond to geomagnetic conditions.

10:55 [V-2-6]

The First Report on the Afternoon E-Resion Plasma Density Irregularities in Middle Latitude

Tae-Yong Yang[1], Young-Sil Kwak[1,2], Jaewook Lee[1,2], Jaeheung Park[1,2], Seonghwan Choi[1]

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

We report the afternoon observations of the mid-latitude E-region

FAIs made by the Daejeon radar for the first time. We describe in detail the experiment of the Daejeon radar. We present the midlatitude afternoon E-region FAIs' statistical characteristics based on the continuous radar observations since 1 January 2010. The afternoon E-region FAIs' echo SNR is found to be as high as 35 dB, mostly occurring around 100–135 km altitudes. We also found that the most spectral widths of the afternoon echoes are close to zero, indicating that the irregularities during the afternoon are not related to turbulent plasma motions. Afternoon E-region FAI is observed with significant seasonal variation, with a maximum in summer and a minimum in winter. Moreover, to investigate the afternoon E-region FAIs and Es relationship, the FAIs have also been compared with Es parameters derived from an ionosonde located at Icheon (37.14°N, 127.54°E, 27.7°N dip latitude), which is 100 km north of Daejeon.

제3발표장 Convention C

V-3 Sun & Space Environment IV

Chair: Jung Joon Seough (KASI)

09:40 [V-3-1]

The First Release of Solar Farside Ai-Generated Magnetograms

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

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

We have greatly improved AI-generated solar farside magnetograms from STEREO/EUVI observations than before. We have modified our previous deep learning model and configuration of input datasets to generate more realistic magnetograms. First our model, which is called pix2pixCC, uses an update loss function: that of pix2pixHD model and correlation coefficient values between the real and generated data. Second, we construct input datasets of our model: solar farside EUV observations together with frontside data pairs of EUV observations and magnetograms. We expect that the frontside data pairs provide the historic information of magnetic field polarity distributions. When we train and evaluate the model with frontside input and target datasets, the fronside pairs are replaced by the pairs that were recorded one Carrington rotation before. Our results show that the present model is much better than our previous model (Jeong et al. 2020, ApJ Letter) in view of several metrics. In addition, the AI-generated farside magnetograms produce consistent polar field strengths and magnetic field polarities with those of nearby frontside SDO/HMI magnetograms for solar cycles 24 and 25. Our AI-generated Solar Farside Magnetograms (AISFMs) are now publicly available on line. In addition, we present several application methods and results using AISFMs. We construct synchronic global magnetic field maps with SDO/HMI and AISF magnetograms, and extrapolate solar coronal magnetic fields from them. We show that our results are much more consistent with EUV observations than those of the conventional method. And we suggest several prospects to study global magnetic connectivity with multi-view point observations, e.g., STEREO, Parker Solar Probe, and Solar Orbiter.

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).

09:55 [V-3-2]

Pixel-to-Pixel Translation of Solar EUV Image for Determining DEMs by Deep Learning

Eunsu Park[1], Harim Lee[1], Yong-Jae[1,2], Jin-Yi Lee[1], Il-Hyun Cho[1], Kyung-Sun Lee[3], Daye Lim[1], Hyun-Jin Jeong[2], Jae-Ok Lee[4]

[1]*Department of Astronomy and Space Science, Kyung Hee University*
[2]*School of Space Research, Kyung Hee University*
[3]*Astronomy Program, Department of Physics and Astronomy, Seoul National University*
[4]*Korea Astronomy and Space Science Institute*

We design a deep learning model for the pixel-to-pixel translation of solar Extreme Ultraviolet (EUV) data. For this, we apply a multi-layer perceptron (MLP) based deep learning model by assuming that all pixels of solar EUV data are thermally independent one another. We use 6 SDO/AIA EUV channel data, of which 3 channels (17.1 nm, 19.3 nm, and 21.1 nm) are used as the input data and the remaining 3 channels (9.4 nm, 13.1 nm, and 33.5 nm) as the target data. We train the model using SDO/AIA EUV images at every 00:00 UT in 2011: i.e., around 358 × 4 K × 4 K pixels. We apply our model to several solar structures (coronal loops in an active region and above the limb, coronal bright patch, and coronal hole) in SDO/AIA data for testing and then determine differential emission measures (DEM). Our results from this study are as follows. First, our model successfully generates three solar EUV channel data using the other three solar EUV channel data. Second, our model generates the solar EUV data with less noise, no boundary effects, and a clearer expression of small structures when compared to a CNN-based deep learning model. Third, the estimated DEMs using three SDO/AIA channel data and three model-generated channel data for four coronal structures are consistent with those using six SDO/AIA channel data. Fourth, for a region in the coronal hole, our estimated DEM using model-generated data is more consistent with that

of the stacked data with 50 frames than that of single frame data, demonstrating that our model greatly reduces the noise in solar EUV data such as stray and/or scattered lights from outside of coronal holes.
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).

10:10 [V-3-3]

Investigation of Physical Characteristics of the Carrington Event Using Deep Learning

Harim Lee[1], Daye Lim[1], Eunsu Park[1], Yong-Jae Moon[1,2]

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

We apply an image translation model, which is a popular deep learning method based on conditional Generative Adversarial Networks (cGANs), to the generation from sunspot drawings to the corresponding magnetograms. For this, we train a model using pairs of sunspot data from Debrecen Photoheliographic Data (DPD) and their corresponding SOHO/MDI & SDO/HMI magnetogram from 1996 to 2018 except for every September and October. We evaluate the model by comparing pairs of actual magnetograms and the corresponding AI-generated ones in September and October. Our results show that AI-generated magnetograms unsigned magnetic fluxes are well consistent with those of the original ones. By applying this model to the Carrington sunspot drawing, we successfully produce AI-generated magnetogram and estimate its unsigned magnetic flux. Using several empirical relationships (magnetic flux vs. CME speed, CME speed vs. ICME speed, and ICME speed vs. Dst) in 23 and 24th solar cycle, we conjecture the Dst value of the Carrington event, about −1100 nT, which is similar to those from other methods.
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).

10:25 [V-3-4]

Application of Deep Reinforcement Learning to the Forecast of Solar Major Flare

Kangwoo Yi, Yong-Jae Moon

School of Space Research, Kyung Hee University

In this study, we have applied deep reinforcement learning to solar major flare forecast. For this, we use full-disk magnetograms at 00:00 UT from Solar and Heliospheric Observatory/Michelson Doppler Imager (1996 August-2010 December) and Solar Dynamics Observatory/Helioseismic and Magnetic Imager (2011 January-2019 December) and Geostationary Operational Environmental Satellite X-ray flare data. The solar cycle 23 and the solar cycle 24 data are used for training and test, respectively. Our deep learning flare forecast model based on the Convolutional Neural Network (CNN) predicts “Yes or No" of daily flare occurrence for M- and X-class. We adopt a deep Q-learning network (DQN), a method of deep reinforcement learning, for model training. We test the DQN model performance using various reward guidance and compare them with the other models based on different methods, in view of various skill scores such as true skill statics (TSS) and Appleman’s skill score (ApSS). Our results show that the reinforcement learning could improve flare model performance under the guidance of proper rewards.
This work was supported by the Basic Science Research Program through the NRF funded by the Ministry of Education (NRF-2019R1A2C1002634), the Korea Astronomy and Space Science Institute (KASI) under the R&D program (project No. 2021-1-850-05) supervised by the Ministry of Science and ICT, and 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).

10:40 [V-3-5]

A New Solar Flare Forecast Model with Probability, Mean, and Standard Deviation of Daily Peak Flux

Daye Lim[1], Yong-Jae Moon[1,2], Hyun-Jin Jeong[2]

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

We present a new solar flare forecast model with probability, mean, and standard deviation of daily peak flux. For this, we consider line-of-sight magnetic flux from the SOHO/MDI and SDO/HMI, and flare lists from GOES from 1996 to 2021. Our model predicts two types of forecast results when a magnetic flux of an active region (AR) is given. First, a probability of flares greater than C-class and a probability of flares greater than M-class within a day are predicted respectively. Second, statistical parameters such as mean and two times standard deviation (± 2σ) of x-ray peak flux of the strongest flare within a day is predicted. We consider verification of two forecast results as follows. First, the probability results are verified by calculating various skill scores after changing to binary classification using thresholds. Second, we evaluate the statistical parameters by defining that the predicted result is true positive when an observed x-ray peak flux of the strongest flare is within the range from −2σ to +2σ. Our model provides

information on daily observation of different flare magnitude, which is expected to be practical for flare forecast operators. This work was supported by the 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).

11:20～12:00 2부 포스터 발표

제1발표장 Convention A

VI-1 Special Session : Space Radiation

Chair: Jong Dae Sohn (KASI)

13:00 [VI-1-1]

FM Development of Low Earth Orbit Space Radiation Dosimeter (LEO-DOS) Onboard the NEXTSat-2

Uk-won Nam[1], Won-Kee Park[1], Sukwon Youn[3], Bong-Kon Moon[1], Jongdae Shon[1], Jeonghyun Pyo[1], Junga Hwang[1], Jaejin Lee[1], Sunghwan Kim[2], Sung-Joon Ye[3]

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

The LEO-DOS (the low earth orbit space radiation dosimeter) is a scientific payload of the NEXTSat-2, which is the next generation small satellite program in Korea to be launched on 2022. The major scientific objectives of the LEO-DOS are to map the dos contribution by charged particles and neutrons in LEO, to study the space radiation and environment variations at the solar minimum activity and to verify the relative biological effectiveness (RBE) of neutrons for radiation risk assessment. The LEO-DOS consists of an ANT-TEPC (anti-coincidence TEPC) and a REF-TEPC (reference TEPC). The ANT-TEPC is a TEPC instrument in combination with a plastic detector for detecting charged particles and will separate the dose contribution by charged particles and neutrons using the anti-coincidence method. The REF-TEPC is consists of a CLYC instrument for fast neutron spectrometer in combination with a plastic veto detector to reduce the affect of charged particles. The LEO-DOS is expected to provide accurate and comprehensive in-situ measurement of the local radiation environment in the low earth orbit (550 km). In this paper, we will present the FM development status on LEO-DOS.

This work was supported by the National Research Foundation of Korea (NRF) Grant funded by Korea government (MSIP) (NRF-2017M1A3A4A01077173).

13:15 [VI-1-2]

Development of Fast Neutron Spectrometers for the LVRad

Hong Joo Kim[1], Phan Quoc Vuong[1], Nguyen Duy Quang[1], Sinchul Kang[1], Uk-Won Nam[2], Won-Kee Park[2], Jongdae Sohn[2], Junga Hwang[2], Sukwon Youn[3], Sung-Joon Ye[3], Sunghwan Kim[4]

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

We are developing the fast neutron spectrometers (NS-F) for the LVRad. The NS-F composes of two novel inorganic scintillators which can perform neutron spectroscopy with $^{35}Cl(n,p)^{35}S$ and $^{35}Cl(n,a)^{32}P$ reactions in the energy range of 0.5-5 MeV. It require to have good pulse shape discrimination (PSD) between gamma, proton and alpha particles for the neutron spectroscopy. Also we plan to install a organic scintillator which can separate between proton recoiled by neutron elastic scattering and gamma by PSD method in the neutron energy range from 2-20 MeV. We tested the performance of both a stilbene and a EJ-276 scintillator. We will present a 1.5 inch $LaCl_3$ crystal scintillator growth and performance as well as performance comparison between stilbene and EJ-276 scintillator using both gamma and neutron source.

This work was supported by the National Research Foundation of Korea (NRF) Grant funded by the Korea government (MSIP) (NRF-2020M1A3B7108845).

13:30 [VI-1-3]

Comparison of Aviation Route doses by Using CARI-7A Program with Liulin-6K and TEPC Measurements during 2020-2021 Flights

Jaeyoung Kwak[1,2], Junga Hwang[1,2], Ukwon Nam[1], Heebok Ahn[3,4], Kyuwang Kim[3,5], Kyle Copeland[6]

[1]*Korea Astronomy and Space Science Institute*
[2]*Department of Astronomy and Space Science, University of Science and Technology*
[3]*Air Line Pilots Association of Korea*
[4]*Graduate School of Air & Space Law, Korea Aerospace University*
[5]*Hanseo University*
[6]*U.S. Federal Aviation Administration, Civil Aerospace Medical Institute, Institute, Protection and Survival*

Research Laboratory

It is important that comparing doses from different CARI-7A dose with different galactic cosmic ray (GCR) options since most aviation company currently use CARI-6 series as an aviation route dose assessment program which is an old version of CARI-7A. We compare the model outputs using various options of galactic cosmic ray models and fluence-to-dose conversion coefficients with in-situ measurements data obtained from Liulin-6K and TEPC (Tissue Equivalent Proportional Counter). We performed measurements in commercial aircraft cockpit for total eighteen months over 2020 and 2021. In terms of GCR models, the route doses from BON'14 model are the highest and those from ISO (HP), BON'11, and ISO (15390) model get lower in sequence. For a fluence-to-dose conversion coefficient, ICRP Publication 60 shows the highest dose values while ICRP Publication 103 shows the lowest dose values. For each fluence-to-dose conversion coefficient option, the sequence of GCR model values is maintained. Among various output dose values, BO14 & ICRP Publication 60 options are most consistent with measured data from both Liulin-6K and TEPC measurements. CARI-7A data considering Forbush decrease and revised geomagnetic cutoff rigidity will be applied in the near future. Also, a case study including additional TEPC and liulin-6K data will be conducted as well.

This work was supported by the project "A Study on the Forecasting Model of Space Radiation and the Improvement of Measuring Equipment", funded by the Korea Foundation of Nuclear Safety.

13:45 [VI-1-4]

Simulation of a Space Radiation Environment and Radiation Damage

Sukwon Youn[1], Uk-won Nam[2], Won-Kee Park[2], Jongdae Sohn[2], Junga Hwang[2], Bongkon Moon[2], Young-Jun Choi[2], Hong Joo Kim[3], Sunghwan Kim[4], Insoo Jun[5], Sung-Joon Ye[1]

[1]*Department of Applied Bioengineering, Graduate School of Convergence Science and Technology, Seoul National University*
[2]*Korea Astronomy and Space Science Institute*
[3]*Department of Physics, Kyungpook National University*
[4]*Department of Radiologcial Science, Cheongju University*
[5]*Jet Propulsion Laboratory, California Institute of Technology, California, USA*

For radiation dosimeters to evaluate the biological effects of and analyze the energy spectrum of a space radiation environment, such as low Earth orbit (LEO) or lunar surface, Monte Carlo simulations were performed to predict their performance and radiation damage of their electronics. Space ENVironment Information System (SPENVIS) (https://www.spenvis.oma.be/) developed by European Space Agency (ESA) were used to model the space radiation environment. Galactic cosmic rays (GCR), solar particle events, and trapped particles were modeled for the radiation environment of LEO and the lunar surface. Monte Carlo N-Particle transport code (MCNP) was used for Monte Carlo simulations to predict the performance of the radiation dosimeters and the radiation damage of electronics.

This work was supported by the National Research Foundation of Korea (NRF) Grant funded by Korea government (MSIP) (NRF-2017M1A3A4A01077173, NRF-2017M1A3A4A01077220 and NRF-2020M1A3B7108845).

14:00 [VI-1-5]

Radiation Damages in CODEX CMOS Polarization Camera

Jinhyun Kim[1], Juhyung Kang[2,3], Jihun Kim[2], Seonghwan Choi[2], Ukwon Nam[2], Yeon-Han Kim[2]

[1]*Kyung Hee University*
[2]*Korea Astronomy and Space Science Institute*
[3]*Seoul National University*

The Coronal Diagnostic Experiment (CODEX) Polarization Camera was tested with gamma-ray irradiation (Co60) to confirm the camera's performance by the space radiation. The target mission required an irradiation with gamma-ray of 20 Gy, but we tested with gamma-ray of 200 Gy to confirm the electric parts survival. To confirm the performance change of the camera due to gamma irradiation, we have used photoelectron detector performance test system and analyzed using Photon Transfer Curve (PTC) method. As a result of the analysis, the linearity of the camera was preserved, but the basic characteristics of the camera such as Conversion Gain and Full Well Capacity have decreased by 2-3%. Especially, it was confirmed that the Quantum Efficiency decreased by at least 60%.

제2발표장 Convention B

VI-2 Sun & Space Environment V

Chair: Su Yeon Oh (JNU)

13:00 [VI-2-1]

Development of Thermostat for the Fluxgate Magnetometer in Icheon Geomagnetic Observatory and Stability Evaluation after Installation

Doo-Young Choi[1], Dae-Young Lee[1], Seunguk Lee[1], Joonsung Kim[1], Kyu-Cheol Choi[2], Junghee Cho[3]

[1]*Chung-buk National University*
[2]*SELab*
[3]*Korean Space Weather Center*

Sudden changes in the space environment cause damage to human society as a whole. It is important to build a prediction model for such damage, and geomagnetic observation is an important factor for such a model. It has been known that magnetometers used to measure the Earth's magnetic field are affected by temperature variations. In this study, a thermostat was developed and installed to control temperature of fluxgate magnetometer sensor at the Icheon Geomagnetic Observatory. Temperature control was designed to be performed using a non-magnetic heater, and temperature stability and magnetic field data stability were evaluated after installation of the thermostat. As a result, it was confirmed that the temperature was maintained at a constant level and the stability of magnetic field data was improved.

13:15 [VI-2-2]

Introduction to the Scientific Goal and Prototype Design of the IAMMAP Scientific Instrument for the CAS500-3 Satellite

Kwangsun Ryu[1], Ho Jin[2], Junchan Lee[1], Seunguk Lee[1,3], Chang-Ho Woo[1], Jinkyu Kim[1], Wonho Cha[1], Dongkook Kim[1], Jeong-gi Seo[1], Bong-ju Koo[1], Seong-Og Park[1], Du-young Choi[3], Jeongrim Choi[3], Kwangho Yoo[4], Jaehyuk Shin[2], Woohyun Cho[2]

[1]*SaTReC, KAIST*
[2]*Kyunghee University*
[3]*Chungbuk National University*
[4]*Chungnam National University*

The Ionospheric Anomaly Monitoring by Magnetometer And Plasma-probe (hereafter, IAMMAP) is one of the scientific instruments for the Compact Advanced Satellite 500-3 (CAS 500-3) which is planned to be launched in 2025. The main scientific objective of IAMMAP is to understand the complicated correlation between the equatorial electro-jet (EEJ) and the equatorial ionization anomaly (EIA) which play important role in the dynamics of the ionospheric plasma behavior in the dayside equator region. IAAMAP consists of an impedance probe for precise plasma measurement and magnetometers for EEJ current intensity. The measurement along quasi-meridional plane makes the measurement suitable for studying EIA and EEJ. The newly-devised impedance probe is expected to get electron density of the ionosphere with unprecedented precision by measuring upper-hybrid frequency (fUHR) of the plasma which is not affected by the satellite geometry, the spacecraft potential, or contamination unlike Langmuir probes. The high precision magnetometers is employed also in deriving the plasma parameters from the fUHR as well as independent scientific role in studying the complicated current system in the ionosphere and magnetosphere.

13:30 [VI-2-3]

Qualified Model Design and Preliminary Experiment of Langmuir Probe for Ionospheric Anomaly Monitoring by Magnetometer and Plasma Probe (IAMMAP)

Junchan Lee[1], Kwang-Sun Ryu[1], Chang-Ho Woo[1], Seung-Wook Lee[2]

[1]*Satellite Technology Research Center (SaTRec), Korea Advanced Institute of Science and Technology*
[2]*Chungbuk National University*

Langmuir Probe (LP) as sub-payload for Advanced Impedance Probe for Ionospheric Monitoring (AIPIM)of Ionospheric Anomaly Monitoring by Magnetometer And Plasma Probe (IAMMAP) is designed to measure ionospheric plasma in daytime. An advanced electrical and mechanical configuration has been applied based from Langmuir Probe launched in existing Korea satellite. Miniaturization and modularity concept is adopted to the design and manufacturing process. Main objective of the LP is computing electron density and temperature when the satellite passes certain geophysical latitude in order to assist Impedance Probe (IP), another sub-payload in AIPIM, at calibartion and validation procedure after launch. Qualified Model (QM) has been developing and integration test and environment test is planned to be implemented in Apr 2022.

13:45 [VI-2-4]

Introduction of Program Budget Codes by Ministries Participating in the CAS500 Development Program

Keun-Woong Shin, Ji-Mo Yang, Dong-In Han, Eung-Sik Park

Korea Aerospace Research Institute

In March 2015, the first development of the next-generation medium-sized satellite series developed as a national R&D program was initiated under the supervision of the Korea Aerospace Research Institute. As of 2021, CAS 500-2, 4, and 3 are being developed under the supervision of industry, and the development of CAS500-5 is scheduled to begin in 2022. For stable satellite development, it is essential to secure stable research funds, and these research funds are secured through the annual government budgeting process. In this study, we briefly examine the budget system of the government's budgeting program and examine the types of program budget codes for each government department participating in the CAS500

development program.

14:00 [VI-2-5]

Korean Space Observation Data Strategies: Directions and Recommendations

Ji-Hye Baek, Seonghwan Choi, Jongyeob Park, Sujin Kim, Chae Kyung Sim, Tae-Yong Yang, Minsup Jeong, Young-Soo Jo, Young-Jun Choi, Minsu Shin

Korea Astronomy and Space Science Institute

The most important purpose of the space mission in the field of astronomy and space science is to acquire high-resolution and high-quality data. The data lifecyle starts with the science goals for the mission. Accordingly, it is necessary to establish a space observation data strategies based on the recognition of the need for a systematic and strategic approaches to manage the data. As a preparatory step, the data strategy of the National Aeronautics and Space Administration, which has been developed from a broad understanding and long-term experience for space observation data, was analyzed. Based on the analysis, we propose a strategic direction and recommendations for Korean space observation data strategies. We also expect those will be the basis for establishing space observation data policies in the future.

제3발표장 Convention C

VI-3 Sun & Space Environment VI

Chair: Jin-Yi Lee (KHU)

13:00 [VI-3-1]

Recurrently Propagating Intensity Disturbances along Coronal Pseudostreamers

Il-Hyun Cho[1], Yong-Jae Moon[1], Kyung-Suk Cho[2,3], Dae Jung Yu[1], Harim Lee[1], Jin-Yi Lee[1]

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

A pseudostreamers, or unipolar streamer is a coronal ray-like structure that separates a coronal holes. The pseudostreamer is known to be associated with slow solar winds at 1 AU. There is still no unambiguous observation of an out-flowing structure along the pseudostreamer in the distant corona. In this study, we detect propagating intensity disturbances (PIDs) along pseudostreamers in the LASCO/C3 FOV propagating from C2 FOV observed from Jan 2 to Jan 4 in 2017, which enables an exploration of their kinematic properties, for the first time. We analyze time-distance images based on 13 slits on pseudostreamers and construct lagged cross-correlation maps. From this, we calculate occurrence periods of PIDs and their instantaneous speeds as a function of distance. It is found that the occurrence periods range from ~3 to ~15 hours. The speeds are well fitted with a power law function, $v(r) = v_0(r-2.5R_{Sun})^c$, where v_0 and c are 103 ± 26 km/s and 0.41 ± 0.11, respectively. This allows a rapid acceleration below ~6 solar radii which could be explained by a Parker's solar wind in a non-isothermal corona and nor-radial expansion of magnetic flux tubes.

13:15 [VI-3-2]

Observational Investigation on the Turbulent Heating Efficiency of Coronal Alfven Wave

Jae-Ok Lee[1], Kyoung-Sun Lee[2], Jungjoon Seough[1], Hyung-Jin Jeong[3]

[1]*Korea Astronomy and Space Science Institute*
[2]*Seoul National University*
[2]*Kyung Hee University*

It is numerically well proven that the heating efficiency of Alfven wave turbulence is proportional to its velocity amplitude and inversely proportional to the plasma beta. In this study, we examine whether or not (1) coronal loops with higher Alfven wave energy fluxes are hotter under the same condition of plasma beta and (2) coronal loops in lower plasma beta are hotter in the same wave energy fluxes. For this, we investigate a few tens of coronal loops above 11 non-flaring active regions in solar cycle 24. To estimate their Alfven wave parameters such as velocity amplitude and phase speed, we use Coronal Multichannel Polarimeter (CoMP), which provide two-dimensional spectroscopic quantities (LOS Doppler velocity and line width) of the Fe XIII 10747 Å line in the off-limb solar corona between 1.05 and 1.35 Rs with spatial resolutions of 4.5 arcsec/pixel and temporal cadences of 30 seconds. We determine electron density of the coronal loops by using the emissivity-ratio method with CoMP Fe XIII 10747 and 10749 Å filter images, and/or differential emission measure (DEM) inversion with SDO/AIA 94, 131, 171, 193, 211, and 335 Å filter images. The DEM inversion is also used for determining their EM-weighted temperatures. In order to derive magnetic field strength, we apply potential-field source surface model and/or non-linear force free field extrapolation. Using the estimated Alfven wave parameters and plasma conditions of our selected coronal loops, we can calculate their Alfven wave energy fluxes besides plasma beta, and examine observational relationship between Alfven wave energy fluxes (or plasma beta) and temperature. We will show preliminary results on the turbulent heating efficiency of coronal Alfven wave.

13:30 [VI-3-3]

Recent Progress in Understanding Alfvenic Slow Wind

Jungjoon Seough

Korea Astronomy and Space Science Institute

Alfvenic fluctuations are distinct features observed in fast solar wind originating from coronal holes at high latitude. The slow wind streams, on the other hand, typically are less Alfvenic and their origins are less certain. Recent observations, however, have shown the evidence that a small equatorial coronal hole can be a source of slow Alfvenic solar wind. In this study, we will present a review of the physical characteristics of Alfvenic slow wind and discuss the physical processes associated with their heating and thermalization processes as well as plasma waves at kinetic scale.

13:45 [VI-3-4]

A Statistical Study of Thermodynamic Evolution for Alfvenic Slow Wind

Jimin Hong[1], Jungjoon Seough[2], Kyungguk Min[1]

[1]*Department of Astronomy, Space Science and Geology, Chungnam National University*
[2]*Korea Astronomy and Space Science Institute*

In this study, we present the effect of Coulomb collisions on thermodynamic evolution of solar wind protons, especially the so-called “Alfvenic slow wind.” By making use of Helios-1 data during the solar minimum phase of solar cycle 21 (1975-1977), we have analyzed the radial evolution of physical quantities responsible for collisional processes of solar wind protons and have identified three different examples of Alfvenic slow wind streams depending on the values of the proton specific entropy. We report the difference in collisional properties between them and discuss the possible origin of Alfvenic slow wind.

14:00 [VI-3-5]

A Steady-State Solar Wind Model with Alfven Wave Turbulence

Hwanhee Lee[1], Jungjoon Seough[1], Bo Li[2], Yeon-Han Kim[1], Kyung-Suk Cho[1]

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

The slow solar wind has a dense plasma and a low proton temperature compared with the fast solar wind. It means that Coulomb collisions might be important physical process responsible for the thermodynamic evolution of the slow solar wind. Recently a new collisional frequency has been reported, which considers the magnetic field, i.e., the effect of cross-field particle collisions through the gyro-motions. By using the steady-state solar wind model with the Alfven-wave turbulence and magnetic field line curvature, we examine the effect of Coulomb collisions on the evolution of solar wind proton temperature anisotropy and discuss the importance of collisional thermalization in the interplanetary space.

14:15 [VI-3-6]

Distinguished Features for Axial Distribution of Small-Scale Magnetic Flux Ropes Observed at 1AU

Kyung-Eun Choi[1], Dae-Young Lee[1], Katsuhide Marubashi[2]

[1]*Department of Astronomy and Space Science, Chungbuk National University*
[2]*National Institute of Information and Communications Technology, Tokyo, Japan*

The small-scale magnetic flux ropes (SMFRs) have a similar topology to the large scale flux ropes, e.g. magnetic clouds (MCs), but their global structure connected from the solar surface is mostly open as studied in our previous work. SMFRs have been suggested from both solar and interplanetary origins equally, and still under active debate. Applying the force-free model fitting, we have selected 261 SMFRs from Wind observation during solar cycles 23 and 24. As one of the results, there was an interesting feature from the fitting result that the axes of SMFRs are focused on near 45° or 225° of azimuthal angle relative to the Sun-Earth line. In this work, to examine these specific azimuthal angles of SMFRs, we investigated the background IMF of each SMFRs and then compared the direction of background IMF and the axis of SMFRs. We found that the majority of SMFRs in the axial directions are roughly orthogonal to the background IMF directions. This statistical trend remains the same regardless of the helicity of the SMFRs which can be either left-handed or right-handed, each occurring roughly equally. This result is new and may shed some light on the origin of SMFRs. We discuss the possibility that this newly-found trend of SMFR orientations imply that the SMFRs are created in the heliospheric current sheet through magnetic reconnection.

포스터발표 논문 초록

1부 발표시간 : 10월 28일(목) 13:20~14:00

[P-1] Analysis of Impact of Noisy PRNU of Lunar Train Imager (LUTI)

Gmsil Kang, Jong-Euk Park, Sangyoun Shin, Haeng Pal Heo

KARI Satellite Payload Development Division

The LUTI (LUna Terrain Imager) is one of major payloads of KPLO (Korea Pathfinder Lunar Orbiter). The LUTI radiometric performances such as PRNU, nonlinearity, and SNR have been measured by using a uniform light source. Also its radiometric response modeling has been performed and radiometric model for radiance image retrieval has been constructed. The LUTI is designed to acquire a high resolution visibel image of lunar surface. It consists of two identical cameras in order to comply requirement of image swath. There are optic module which is cassegrain type telescope (two mirrors & two lenses), a linear CCD with optical filter and electronics including power unit. The GSD of the LUTI at nominal 100 km orbit is 2.5 m. Two cameras are integrated on the same bezel with tilt angle to have overlap pixels. Any difference between images from two cameras due to gain difference should be corrected thorough on-ground image processing. In this paper, the impact of noisy PRNU on a retrieved image is examined. In case of LUTI, the PRNU is acquired through nonlinear radiometric model fitting over output dynamic range from 10% to 90% of saturation level. Noisy pattern in the PRNU can be caused by noisy samples used for radiometric model fitting. SNR of samples over dynamic range depends on output level. The noise of samples can be reduced by using averaged samples. The PRNU patterns are acquired for different sets of samples with different average and the deviation between PRNU are examined. Also, the residual PRNU in radiance image after PRNU correction are analyzed for different PRNU sets.

[P-2] Investigation on the Status of Development of Geostationary Communication Satellites and Mars Exploration Performed Abroad

Sang-Wook Kang, Yee-Jin Cheon

Korea Aerospace Research Institute

In this study, the status of development of geostationary communication satellites and Mars exploration conducted abroad was investigated. Various geostationary communication satellites having large deployable antennas and Mars exploration missions were investigated. In addition, the basic characteristics of Mars such as the size, atmosphere, and soil of Mars were searched. Currently, the United States is in the process of the Artemis program, and through it, plans to construct a lunar base and explore deep space such as Mars and asteroid exploration. The Mars, which has the highest possible existence of life, has great value as mankind's second earth. The most important part of Mars exploration is the Mars landing stage. For the success of Mars exploration, a key technology to safely land a Mars rover on the Martian surface is required. Through this study, it was possible to confirm the specifications of various Mars exploration missions carried out abroad, and also to obtain the specifications of large deployable antennas for geostationary communication satellites. In the future, Korea also has a plan to carry out the Mars exploration. Therefore, this study will be a good reference for Korea's future Mars exploration.

[P-3] Analysis of Precautions in the Initial Operation of the Star Tracker

Woo Yong Kang, Kwangyul Baek

Korea Aerospace Research Institute

The multiple head star tracker consists of one electronic unit(EU) and several optical heads (OHs). Star information obtained from several OHs is calculated in one EU. Its performance is better than a single head star tracker composed one OH and EU. However, multiple head star tracker is a disadvantage in that the amount of computation increases by using only one EU. In particular, the acquisition stage where stars are not visible, there is a possibility of errors as the amount of computation increases in the electronic unit. In the satellite initial operation phase, OH may not be able to acquire stars because it is blocked by the Earth and Sun. In this case, the star tracker may not operate normally. In this paper, we introduce the procedure for stable star tracker operation in the satellite initial operation phase.

[P-4] Analysis about the Possibility of Frequency Interference between PVSAT and KOMPSAT Satellite Networks

In Hoi Koo[1], Young-Wook Kim[2], Sang-Yoon Kim[2]

[1]*Korea Aerospace Research Institute*
[2]*WAVEON Inc.*

For the reason that the demand for national satellites development increases, obtaining a new frequency slot for satellite operation is becoming more difficult than ever. Thus, for the efficient use of the frequency resources,
It is necessary to analyse the possibility of the interference between satellite networks to determine the availability of the re-using the frequency. This paper shows the result of the

interference analysis between the Performance Verification Satellite (PVSAT), which is planned to be launched in 2022, and the KOrea Multi-Purpose SATellite (KOMPSAT) series. The methodology used in this paper for the interference analysis has been done based on the interference criteria and method introduced in the recommendation published by International Telecommunication Union (ITU). Since the operation time of each satellite is different, actual amount of the interference between satellite networks analysed by specific simulation is required. The amount of the interference has been calculated with respect to the shift of the elevation angle within the communication boundary of the associated earth station. The number of event of interference between satellite networks in the South Korean territory is identified first and the amount of interference at each access time has been investigated. Based on the result of the analysis, the possibility of mutual operation has been verified.

[P-5] A Study on the Standardization Design Concept of Power Electrical Ground Support Equipment Composition for Satellite Test

Hyun-Mo Gu, Dong-Chul Chae, Min-Jun Kim, Kyung-Keun Kim

Korea Aerospace Research Institute

Among electrical ground support equipments that must be prepared for satellite tests, it will be shortly described what kind of function and how it is currently used in relation to limitedly electrical ground support equipment for satellite power supply and launch check used. To limitedly electric ground support equipment for satellite power supply and launch check and derive an initial concept of how to take standardized design concepts in the future based on our experience in satellite testing. Based on this initial design concept, electrical ground support equipments for satellite power supply and launch check are divided into several electric ground support equipments. Also, it will be briefly described the names of each equipment, the pros and cons of their functions, and the different things from the experiences acquired in the previous satellite testing.

[P-6] Dynamic Model Validation on Attitude Simulator for KPLO Delta-V Mode

Jae-Wook Kwon, Jongah Kim, Gwang-yeol Baek, Da-un Jung

Korea Aerospace Research Institute

KPLO (Korea Pathfinder Lunar Orbiter) has several missions supposed to take images and measure scientific data at the Moon. In order to get the Moon from the Earth, it needs to adjust the way to follow the trajecotry that has been designed. AOCS (Attitude Orbit Control Subsystem) has developed several control modes and verified each performance to check compliance. LUNASIM (LUNar Attitude SIMulator) is the state-of-the-art simulator which hosts dynamic model and contollers for all of AOCS modes. This paper shows how to build the dynamic model that is necessary to consider for Delta-V mode and the result of its validation through the LUNASIM. The dynamic model contains the flexible models for solar array and the sloshing models for fuel in a tank. All of KPLO's design values and uncertainties are based on modeling its dynamics.

[P-7] Development of Image Process Monitoring System

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

Korea Aerospace Research Institute

The KOMPSAT image is generated through a series of processes such as image collection planning, imaging, receiving, ordering, and image processing. Currently, the image process is processed according to an automated system. However, depending on the situation, such as error occurrence or emergency image processing, operator intervention is required, and necessary information must be checked passively.
This paper describes the basic design of the development of a Process Monitoring (PM) system that can manage a series of processes for image processing in one program.

[P-8] Guidance Profile File Processing Speed Improvement for Urgent Image Collection Planning

Dong-Oh Kim, Jun-Yeong Bok

National Satellite Operation & Application Center, Korea Aerospace Research Institute

Korea Aerospace Research Institute is responsible for operating KOrea Multi Purpose SATellite. In order for the satellite to perform mission, it is necessary to Image Collection Planning. Mission is divided into normal mission and urgent mission. In general, it is operated as a normal mission. When urgent mission occurs, it is necessary to complete the establishment of Image Collection Planning within the specified time. In this paper, the contents of improving GPF (Guidance Profile File) processing speed using multi-GPF are summarized.

[P-9] Modem Configuration Method of Overseas Ground Station for Satellite Command Transmission

Myungmuk Kim, Hyun-Chul Baek, Jong-Bum Park, Okchul Jung

Korea Aerospace Research Institute

The Korea Aerospace Research Institute (KARI) operates the KOMPSAT (Korea Multi-Purpose Satellite) series and a CAS500 (Compact Advanced Satellite 500) series. The number of operating satellites is increasing every year, and the number of overseas ground stations to utilize them is also increasing. Overseas ground stations support multiple satellites with one modem, and the COP-1 settings applied to each satellite are also different, so understanding the structure of the modem and COP-1 is essential. In this paper, the application method of COP-1 based on the CRT, the modem used by the Korea Aerospace Research Institute, and the configuration method of other modems in the future are also presented.

[P-10] The Advancement of an Artificial Intelligence-Based Optical Satellite Image Automatic Cloud Calculation System

Min-A Kim[1], Ji Hyeon Yim[1], Kyeongmi Jeon[2], Gu Hyeok Kim[1], Jae Yeol Lee[1]

[1]*Korea Aerospace Research Institute*
[2]*Satrec-i Imaging Service*

The optical image of a Korea Multi-Purpose Satellite generates a standard image by removing or minimizing errors and noise included in the signal values of the image and geometric distortion captured by the satellite. Since it takes processing time to process standard images of optical satellites using algorithms such as geometry correction and atmospheric/ radiometric correction, it generates a list of standard images in the pre-processing stage of standard images so that users can easily read/order optical images. In this case, the list of standard images registered in the search system includes clouds, and provides a search function according to the cloud level so that cloud occupancy can be analyzed according to the ratio of clouds included in the image and a valid image to generate a standard image. The automatic cloud analysis system currently in operation divides the catalog into 16 × 16 grids and calculates the ratio of clouds in units of 5% when clouds are larger than a certain size and thicker. The conventional technology analyzes that detection performance is good when the size of the cloud is large and thick, but detection performance is low when the cloud is small and light. In addition, when an area such as snow is large or textured information is small, an error occurs in detecting the eye area as a cloud. Therefore, since the grid-type automatic cloud analysis system judges objects by looking at only a part of the grid, there are limitations in performance and location accuracy. This paper sets conditions and standards for analyzing cloud share included in the list of standard images based on artificial intelligence, uses optimized model learning to minimize human resources for cloud analysis, and uses analyzed result values to remove fog or create mask layers for cloud areas.

[P-11] Analysis of the Effect of Harness Characteristics between Electrical Ground Support Equipment and Launch Vehicle

MinJun Kim, Dong-Chul Chae, Yun-Goo Huh, Hyun-Mo Gu

Korea Aerospace Research Institute

The satellite is mounted on the payload fairing part of the LV (launch vehicle) before launch. In order for the satellite developer to check the status of the satellite before launching the satellite, the satellite must be connected to the EGSE (electrical ground support equipment) by harnesses. The battery mounted on the satellite must be sufficiently charged prior to launch using the associated EGSE. In addition, it is necessary to ensure that the satellite is ready for launch until just before launch. Battery charging and satellite status check could be known through the LV interface, and the LV interface and EGSE are connected by harnesses. Depending on the characteristic of the harness, the state of the satellite signal might be changed and the condition of the signal can have a significant effect on the satellite. In this paper, we study the degree of the satellite signal voltage drop according to the length of the harness.

[P-12] The Study on Memory Size Analysis for High Speed Data Transmission on GEO Satellite

Sang-Goo Kim

Korea Aerospace Research Institute

The geostationary orbit satellite is designed as a system that directly transmits scientific data and meteorological data collected in real time to the ground stations. At this time, a high-speed data transmission system is required to stably transmit the collected data to the ground stations. Therefore, a system that collects multiple payload data at once and transmits it to the ground must be designed so that there is no problem in real-time data transmission by securing sufficient memory size. In this paper, memory size analysis is performed for stable transmission according to the size of the generated data.

[P-13] A Stduy on the Method of the Makeup of the Failure on Launch Support EGSE (LSE) on the Launching Table

Young-Yun Kim, Chul-Dong Chae

Korea Aerospace Research Institute

KARI succeeded in launching several satellites into space with the aid of LSE. Satellite should have its designed status like battery temperature, propellant pressure and its relays position, etc. at the moment of lift-off. The required status is being checked by the communication between LSE and satellite and

by measuring the analog signals from satellite by LSE. In this study we present the experience of the makeup method on the failure of LSE and several backup equipment, conditions are introduced to makeup the failure of LSE on launch pad.

[P-14] Iterative Learning Control for Shock and Vibration in the Satellite Shipping Container

Eui Keun Kim, Choon Woo Lee

Korea Aerospace Research Institute

When the satellite development is completed, ground and air transportation is carried out to perform the launch site campaign and launch service. Satellites are usually loaded in containers for satellite transport. Containers for satellite transport are designed, manufactured, and verified in consideration of required environmental conditions and safety factors. The satellite container is structurally composed of a base frame for securing and supporting the lower rigidity, a spring system using a wire rope isolator, and an L-fixture necessary for fixing the satellite in the horizontal direction. For the performance test of the satellite container, the actual ground transport rehearsal is performed using the STM (Structure Thermal Model) before the flight model satellite transport. At this time, the main point is to check the amount of shock and vibration. This study performs ILC (Iterative Learning Control) to control the amount of shock and vibration and derive the appropriate spring constant.

[P-15] The Results of NASA Deep Space Network (DSN) RF Compatibility Test.

In-Kyu Kim, Sang-Man Moon, Chang-Kyoon Kim, Ki-Ho Kwon, Won-Gyu Lim, Dong-Young Kwon

Korea Aerospace Research Institute, KARI

To be supported by the NASA deep space antenna for Korea Pathfinder Lunar Orbiter (KPLO) mission. The space telecommunication tion should perform the DSN RF compatibility test according to the RF test procedures. The DSN RF compatibility test will be helpful with the telecommunication design and interfaces. Also, this test will aid to approve to using the support and service of DSN antenna. KPLO has two communication links. One is S-band frequency band. This band used for sending the command data to KPLO and receiving the SOH telemetry data from KPLO. The others is X-band frequency band. This band only used for receiving the payload data from KPLO. This paper describes KPLO telecommunication system do DSN RF compatibility test results. This test is able to confirm the KPLO telecommunication subsystem performances and system design compatibility with DSN telecommunication system.

[P-16] Structural Analysis for Pressure Control Assembly Attached to Isolation System of Korea Pathfinder Lunar Orbiter

Jungdo Kim, Sun-Won Kim, Su-Hee Won

Korea Aerospace Research Institute

Pyro valve, one of components of Pressure Control Assembly (PCA), cause a shock that can damage electronic equipments during valve operation. In order to reduce shock level on each equipment of Korea Pathfinder Lunar Orbiter (KPLO), an additional isolation system that separates pyro valve from the satellite structure by using elastomer dampeners has been developed. Made with a ballast plate and dampeners, isolation system can damage tubing pipe or joint parts of PCA, and structural safety must be verified under launch environment. In this study, maximum acceleration and displacement in which isolation system for PCA can withstand are calculated based on FE analysis. Then, the values are compared to the Coupled Load Analysis(CLA) in order to assess structural safety.

[P-17] Satellite TC&R RF Compatibility Analysis

Joong-Pyo Kim

Korea Aerospace Research Institute

The receiver of the TC&R subsystem in satellite is perturbed by the RF signals generated from the TC&R transmitter and the payload transmitters. The telecommand and ranging functions of the TC&R receiver shall not be disturbed with the specified signals (interference tolerance mask) at TC&R receiver input. The TC&R RF compatibility analysis includes the TC&R transmitter, the collocated spacecraft telecommand frequencies, the payload uplink signals, the payload transmitted signals. It is necessary to derive the antenna coupling factor between TC&R receive antenna and the payload transmit antenna. With the specified signal level at TC&R receiver input and the calculated antenna coupling factor, the TC&R RF compatibility analysis was performed. The analysis has showed that neither the TC&R transmitter nor the payload transmitter will disturb the TC&R receiver system.

[P-18] Verification Method of a Low Earth Orbit Satellite Uplink System with Error Injection

Jin-Hyuck Kim, Jin-Ho Lee

Korea Aerospace Research Institute

An uplink in the communication system of low-orbit satellites directly affects the survival of satellites. To ensure the survival of satellites, the stability and security should take into account that communication error may occur from unexpected failures and hacking. When a satellite receives uplink data with errors,

various verifications are required to ensure that errors are handled as pre-defined processes.
In this paper, we suggest verification methods for general low-orbit satellite uplink systems, as well as environment and method for uplink with errors.

[P-19] Analysis of DTNPL Packet Delay on PDHU of KPLO

Changkyoon Kim[1,2], Sangman Moon[1]

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

During the interoperability test of the DTNPL, we found unexpected packet delay for the DTNPL on the PDHU (Payload Data Handling Unit) of the KPLO (Korea Pathfinder Lunar Orbiter). To find out a cause of this phenomenon, several tests were performed and finally we found the lack of clock signal as a root cause of the packet delay In this paper, we will briefly describe a analysis flow including a test configuration, performed test cases, the root cause, and the final solution.

[P-20] Acoustic Test Results Assessment for STM (Structural Thermal Model) of Geo-Stationary Satellite

Chang Ho Kim

Korea Aerospace Research Institute

Satellite structure should be designed to accommodate and support safely the payload and equipments necessary for its own missions and to secure satellite and payloads from severe launch environments. The launch environment is composed of quasi-static load, sine vibration load, acoustic load and shock load. The acoustic environment induces the random vibration, which especially is important the safety of electronic equipment. The qualification of design and the safety of equipment was assessed by testing with ground model, which is called by STM(Structural Thermal Model).

[P-21] Satellite Launch Campaign Operational Requirements

Hyung-Wan Kim, Jung-Su Choi

Korea Aerospace Research Institute

Satellite Launch Campaign Operational Requirements are needed for the campaign preparation with Launch Vehicle team and its partners and the spacecraft project. The activities for spacecraft team is composed of the various phases, i.e., early preparation, spacecraft & GSE arrival, spacecraft preparation, spacecraft final check, spacecraft filling, combined operations, and pack for return. In order to perform these operations, all activities should be clearly defined in advance, so the interfaces and suppliers can be prepared. In addition, the launch campaign duration is limited and the site is unfamiler to the spacecraft team. As a result, defining the satellite launch campaign operational requirements can be help to avoid the lack of preparation and make a successful launch campaign. The contents of theses requirements are studied in this paper.

[P-22] Information Service Design for Optical Microsatellite Constellation System

Heeseob Kim, Hyun-Ok Kim, Sun-Gu Lee

Korea Aerospace Research Institute

Recently high resolution satellites have been used in various fields. Especially microsatellites with one meter resolution have received a lot of attention since planet revolutionized the earth observation industry with the highest frequency satellite data. In Korea, 11 optical microsatellites and an application support system are being developed for the purpose of observing the korean peninsula. The application support system plans to provide satellite information services for disaster management and use of specialized fields. In order to continuously expand the services of the application support system, it is necessary to consider future services in the development stage. For this purpose, we analyzed the use cases of optical satellites and classified them into several groups in the perspective of input, technology and user services. Based on the survey and analysis a common profile is derived. Though three items in the use of specialized fields will be implemented at first due to development cost and schedule limitations, the common profile concept will be considered through the application support system design process.

[P-23] Data Channel BER and Eb/No Effect Varying Center Frequency and Tracking Range Setup Using KPLO X-Band X-DLTS

Sangman Moon, Changkyoon Kim, Inkyu Kim, Hyun-Chul Lee

Korea Aerospace Research Institute

For wireless communication receivers, accurate selection of center frequency and carrier tracking ranges are one of the ways to improve reception capabilities. The KPLO X-Band communication transmits 8.5 Mbps data using OQPSK modulation. This communication system uses RS code or Concatenated Code (RS + Convolution Code) as FEC, and the Eb/N0 value must be maintained at 10.5 dB or more to satisfy the performance of the BER 10^{-5} level. In this case, it should be possible to satisfy the desired requirements by selecting an accurate center frequency and setting an appropriate carrier tracking range. This

paper discusses the changes of BER and E_b / N_0 under the change of center frequency and the carrier tracking range.

[P-24] Urgent Mission Timeline Analysis for Low Earth Orbit Satellite

Kyunsang Park

Korea Aerospace Research Institute

In the low earth orbit satellite, it is necessary to effectively acquire the target images according to the user requests. Therefore, the analysis of the urgent mission scenario is inevitable in the early development phase of the satellite. From this analysis, several performance criteria can be allocated to the requirements of the satellite development. In that point, this paper analyzes the execution of the urgent mission in the aspect of timeline.

[P-25] Attitude Command Processing for Inclined Geosynchronous Earth Orbit Communication Satellite

Keun Joo Park[1], Bong Kyu Park[1], Hyoungyoll Jun[2]

[1]*Geostationary Satellite SE&I Team, KARI*
[2]*Geostationary Satellite Program Office, KARI*

Geosynchronous Earth orbit communication satellites are normally equipped with large solar array panels to generate the necessary power. In the application of local navigation system such as Korean Positioning System, however, several satellites in the inclined geosynchronous Earth orbit (IGSO) are also required to be operated. Since the pointing of navigation payload towards Earth is anticipated, the solar array panels of IGSO satellites may not point the Sun. Thus, a specific guidance of satellite attitude as well as the solar array panel position command is required so that the solar array panels toward the Sun while the satellite Earth deck points the Nadir direction.
In this paper, the yaw steering scheme for IGSO satellite and associated solar array position command are presented with its limit in practical operation. A mission design to mitigate the limit is also described.

[P-26] GK3 Wheel Offloading to Cope with Momentum Accumulation Induced by Station-Keeping Using Electrical Propulsion System

Bong-Kyu Park, Jun Hyoung Yoll

Korea Aerospace Research Institute

The high efficiency of EP system allows the satellites to stay in its orbit for longer duration of time or to be able to accomodate heavier payloads for the same level of launch mass. The GK3 (GEO-KOMPSAT-3) which is a communication satellite which accommodate three types of payloads, will be launched in mid of 2027. The GK3 will be equipped with 2 sets of EP thrusters on the north panel with 45 offset angle to the east/west direction to perform north/south station-keeping. Two EP thrusters will be fired at same time in order to make the resulted thrust heading south. EP system of GK3 has no pointing mechanism. Therefore it is not possible thrust vector to pass through center of gravity as it moves depending on epoch of mission life. This makes torque cancellation using EP thruster itself not possible. Estimation of momentum accumulation shall be stochastic as the precise location of center of gravity and thrust direction are not predictable. The amount of momentum accumulation and direction will decide the concept of wheel offloadning and the propellant budget for wheel offloading. This paper introduces the concept of the wheel offloading and the analysis results of momentum accumulation and propellant budget for wheel offloading.

[P-27] Introduction of Satellite Operation Applying the International Standard ISO Quality Management System

Sunju Park, Okchul Jung, Myeongshin Lee

Korea Aerospace Reserach Institute

The Korea Aerospace Research Institute (KARI) manages satellite operations in accordance with the standards of quality management systems established by ISO (International Organization for Standardization) for stable mission operation of national development satellites. The researcher obtained certification from the ICR International Certification Institute in November 2010, conducted a transition review to the 2015 revision of the ISO 9001 quality management system in 2018, and continues to conduct satellite operations through internal and expert use every year. In addition to the satellite operation quality management manual, the institute is preparing measures to respond to failures and prevent recurrence in satellite operation according to normal operation manuals, national satellite failure response manuals, problem management procedures, and change request management procedures. The researcher laid the foundation for more effective satellite operation by developing and operating a web-based OpsNet system for efficient quality management system operation.

[P-28] Anomaly Review and Modification of Status Telemetry Interfaces between Spacecraft Bus System and Battery System with Serial Connection

Sung-Woo Park

Korea Aerospace Research Institute

In LEO applications, batteries are used to provide operational power for the satellites during launch phase before solar panel separation, eclipse period and daytime when the satellite required is larger than that of the solar array generated. When high bus operational power is required, such as satellites with SAR payloads, high bus voltages are typically needed to minimize the voltage drop caused by high current. On the spacecraft with unregulated primary bus system, the most common way to accomplish high bus voltage is to connect batteries in series. But, when using the serial connection of two batteries, it is needed a lot of caution on the command and status telemetry interfaces between space bus system in charge of signal interfaces and battery electronics system. In this paper, the root cause of an anomaly occurred in the cascaded batteries is reviewed. Additionally, the modification of status telemetry interfaces to prevent similar problems which could be caused by the reference potential discrepancy of two batteries are also proposed.

[P-29] Orbit Environment Tests for Mid-Sized Satellite Flight Model

Sung-Wook Park[1], Hee-jun Seo[1], Sang-hoon Lee[1], Hyokjin Cho[1], Soo-hwan Jun[1], Hye-jin Yi[1], Sun-ki Baek[2], Keun-sik Kim[2]

[1]*Korea Aerospace Research Institute*
[2]*Hanyang ENG*

The performance of satellite must be verified under the space orbit environment before the launch. The objective of thermal balance test is to verify the spacecraft thermal design and to obtain temperature data for the verification of math model and correlation between the test and math model results. The objective of thermal vacuum test is to expose the spacecraft under the thermal vacuum environments. The spacecraft shall meet its functional performance objectives before, during and after exposure to the environmental extremes specified herein. This paper described the thermal vacuum and thermal balance test results of mid-sized satellite flight model.

[P-30] Prototype Design of OBCP (On-Board Control Procedure) State Transition Diagram

Su-Hyun Park

Korea Aerospace Research Institute

Korea Aerospace Research Institute has been developing an OBCP (On-Board Control Procedure) execution engine based on Lua. Lua is a small and simple script language written in C. The OBCP execution engine is to be integrated to the spacecraft flight software so that the flight software automatically executes multiple OBCPs for spacecraft mission, failure detection and recovery. This paper introduces which states an OBCP can have and when the state transition occurs. On the initialization of flight software, the default state of an OBCP is empty state. The next state is the stage for loading the script from the ground. Currently, the OBCP execution engine is not integrated to the flight software which provides the telecommand processing function, so the loading state is skipped in this Paper. Instead, the OBCP goes to the ready state through the Lua initialization, which performs the Lua thread creation and the Lua script loading. An OBCP which is on ready state shall be able to be paused, resumed or stopped by the ground command. In this paper, the OBCP state diagram was implemented in prototype level and tested on the spacecraft simulator with a debugging shell interface. This interface allows us to call the functions such as Pause_OBCP and Resume_OBCP as if the flight software is commanded by the ground.

[P-31] Development of an Integrated Geostationary Satellite Data Management System

Eun-Bin Park[1], Hyun-chul Baek[1], Sae-Han Song[1], Ki-Young Park[2], Tae-Yang Kim[2]

[1]*Korea Aerospace Research Institute, KARI*
[2]*Intelligent OPerationS, IOPS*

Korea Aerospace Research Institute (KARI) operates three geostationary satellites. One of them, Communication Ocean and Meteorological Satellite (COMS), completed its Earth observation mission in March of this year. The other two satellites, Geostationary Korea Multi Purpose Satellite 2A (GK-2A) and 2B, are performing their Earth observation missions. KARI ground station receives, processes, and stores the Earth observation data observed by geostationary orbit satellite. However, since the current ground system receives, processes, and stores each satellite data separately, it is difficult to manage the Earth observation data. Therefore a system for integrated management of geostationary data is required for the efficient data management and operation. This study will introduce the development of an integrated geostationary data management system and the construction of a prototype.

[P-32] Analysis of Effect of Momentum Desaturation on Lunar Mission Orbit for Korea Pathfinder Lunar Orbiter

Jae-ik Park, Jun Bang, SeungBum Hong, Jonghee Bae, Young-Joo Song, Young-Rok Kim, Young Ho Cho

Korea Aerospace Research Institute

This study analyzed the effect of Delta-V generated from the thruster used to cancel out the angular momentum of the

reaction wheel on the orbit during the KPLO lunar mission. The reaction wheel mounted on the KPLO bus system may reduce the angular momentum component aligned along three axes. When the reaction wheel reaches momentum saturation, it can no longer reduce the spacecraft's momentum. The KPLO performs a maneuver called momentum dumping or angular momentum desaturation using the thruster. During the KPLO lunar mission, external disturbance torques that affect the orbiter such as gravity gradient and solar radiation torque, resulting in a total torque of 2.54×10^{-5} Nm. It was analyzed that this torque generates an angular momentum of a total of 1.53 Nms, which requires about 0.06 m/s of Delta-V for desaturation. We assume that Delta-V occurs in the x-direction of the body axis in a lunar mission orbit with an altitude of 100 km and an orbit inclination of 90 degrees and we present how these changes affect orbit parameters such as position, velocity, altitude, and orbit inclination.

[P-33] Communication Payload Accommodation Design for a Geostationary Satellite

Jong Seok Park[1], Jung Su Choi[1], Keun Joo Park[1], Hyoung Yoll Jun[2]

[1]*Geostationary Satellite SE&I Team, KARI*
[2]*Geostationary Satellite Program Office, KARI*

Currently, a geostationary public communication satellite carrying three different communication payloads is under development based on the inherent geostationary satellite platform, GEO-KOMPSAT. Each payload is responsible for a flexible broadband communication service to implement HTS (High Throughput Satellite) communication in the Ka-band frequencies around the Korean Peninsula, a service that collects and transmits information related to water resources on the ground, and a satellite based augmentation service by participating in the KASS (Korea Augmentation Satellite System). Since the existing GK platform is dedicated to earth observation missions, various design changes are required to accommodate the communication payloads. In addition, it is planned to adopt an electric propulsion system and a geostationary GNSS (Global Navigation Satellite System) navigation system to enhance the platform performance. In this paper, it is presented the interface design to accommodate these three communication payloads and implement platform enhancement.

[P-34] LEOP Results of Compact Advanced Satellite500-1

Jong-Oh Park, Jeong-Hum Im

Korea Aerospace Research Institute

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 CAS500-1 was launched by Soyuz launcher on March 22, 2021, at the Baiconur launch site, Kazakhstan. Just after launch and seperation from launcher, CAS500-1 Satellite's units were checked and the performance were validated almost 3 months successfully. In this paper, I will introduce the results of the LEOP (Launch & Early Operation Plan) of CAS500-1 Satellite.

[P-35] Data Processing Analysis of Coarse Sun Sensor for Spacecraft Attitude Control

Jooho Park, Hyungjoo Yoon

Korea Aerospace Research Institute

Coarse Sun Sensor (CSS) is one of the sensors for the spacecraft attitude control. Because of its simple structure and analog output characteristic it has a high reliability compared to other on-board units. There is a reason why CSS is preferred for the safe mode instead of an accurate attitude sensor like a star traker which requires a complex structure and high level algorithm with relatively low reliability. To utilize the CSS's output for the spacecraft attitude control, addtitional process should be required. The output current will be changed from analog to digital unit through the data processing. Also, the value is supposed to be adjusted like scale up, down or resizing. Although the same CSSs are adopted, the measurement values seem like different on the middle processing stage because of the processing. However, the final result will be exactly the same. This paper compares two types of the processing based on the same CSSs and draws meaningful conclusions.

[P-36] Payload Fault Management Design and Test Results for the Next Korean SAR Satellite

Hong Won Park

Korea Aerospace Research Institute

The next Korean SARsatellite as an all-weather observation satellite is being developed in FM (Flight Model) I&T (Integration and Test) phase. The SAR payload is composed of SSS (SAR Sensor Subsystem) and DLS (Data Link Subsystem). In spite of no unifying guideline for fault management, the SAR payload fault management is mainly implemented in Flight Software (FSW) of an on-board computer based on the heritage program. For SAR payload fault management, the FSW monitors whether various parameters such as temperature, voltage and unit configuration, etc are within a valid range and whether all functions are running properly. As soon as the FSW detect the anomaly, the FSW should perform an appropriate Fault Detection, Isolation and Recovery (FDIR) corresponding to an anomaly condition. Usually, it follows two basic

approaches, onboard reconfiguration to a redundant unit or fail to safe hold mode which requires ground operation. In this paper, we present the payload fault management design for the next Korean SAR satellite and showed that the onboard FSW of the satellite is capable of providing autonomous fault detection and isolation under various anomaly conditions.

[P-37] CAP-W Localization Status of the CAS500-4 Satellite

Myung-Jin Baek, Sang-Gyu Lee, Sang-Burm Ryu, Eun-Su Kang, Seok-Bae Seo, Hyeon-Cheol Lee

Korea Aerospace Research Institute

CAP-W (Compact Advanced Payload with Wide Swath) is the payload of CAS500-4 satellite and is composed of 5-channel multi-spectral Electro-Optic Subsystem (EOS) and Payload Data Transmission Subsystem (PDTS). EOS is composed of Optical Module (OM) and Camera Electronics Module (CEM). PDTS is composed of Image Data Handling Unit (IDHU), X-band Transmitter (XTX) and X-band Antenna Assembly (XAA). The goal of CAP-W project is not only to successfully develop the high resolution Electro-Optic payload with swath width of more than 120 km, but also to achieve full localization of relevant technologies such as design, manufacturing, integration and tests of CAP-W. To achieve hardware local development, KARI had contracted with Korean local industries for EOS and PDTS localization. In this paper, it is shown that CAP-W system design technologies including payload integration and test is categorized into 51 items and that they are fully 100% localized. Also, it is shown that CAP-W equipment technologies are categorized into 18 items, and 17 items are localized(94.4% of localization rate). Accordingly, overall technology localization goal of 97% is achieved. Finally, the most up-to-date EOS and PDTS engineering models are shown in this paper.

[P-38] Functional Analysis of Bi-Direction Data Transfer System for Security Enhancement

Hyun-Chul Baek[1], Tae-Gun Son[1], Myung-Shin Lee[1], Sang-Jung Lee[2]

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

The infrastructure network consisted of a closed network. It was the only case of security issues caused by physical attacks or user manipulation mistakes. As information and communication services are applied to network, security incident caused by cyberattacks such as hacking, malware, and ransomeware is increasing. Public institutions are separating logical or physical networks and applying secure USB, 1-way data transmission systems to transfer data between different networks. Since security incidents are caused by security USB and user carelessness, they are being replaced with Bi-directional data transfer system equipped with boards dedicated to physical transmission and reception. The current method of data transfer was to connect a serial cable or UTP cable to one side only. Therefore, there was a problem that the receiver could not send a response to the transmitter because the line was not connected in the reverse direction. And also, the transmitter does not aware of data errors being transmitted, receiver failures, external network system failure, etc. we want to include loss management functions such as ECC code and transmission rate control for transmitter of bi-direction data transmission system, and to include the ability to respond to error checking and packet loss for receiver of it. In this paper, we will analyze system function such as data loss, error response methods, and filtering using file extension that can occur when data is transferred between different networks using an bi-direction data transfer system.

[P-39] Multi Mission Direct Ingestion Subsystem Based on Framework

Jun-Yeong Bok, Dong-Oh Kim, Sang-Il Ahn

Korea Aerospace Research Institute

In this paper, we describe the design of the K7 Direct Ingestion Subsystem (DIS). The ground segment operates an integrated reception system capable of receiving multi satellites image. KOMPSAT-7 has improved data transmission rate compared to existing satellites. We developed K7 DIS for supporting multi mission including KOMPSAT-7 based on TCP-IP. The HDR-4G receiver in ground segment performs bit synchronization, Reed-Solmon decoding, and frame synchronization. K7 DIS saves the image data in the form source packets in real time from the receiver by using TCP-IP access service. The test result shows that the 500 Mbps of image data per channel could be received without signal loss.

[P-40] An Orbit Environment Test for the System Level of KPLO FM

HeeJun Seo, SangHoon Lee, Hyokjin Cho, SungWook Park, SooHwan Jun, Hyejin Yi

Korea Aerospace Research Institute

The Korea Pathfinder Lunar Orbiter (KPLO) is required to verify electrical performance, thermal design, thermal hardware and control logic in space orbit environments. The purpose of thermal vacuum and thermal balance test is a functional performance verification of spacecraft electronic boxes at system level within acceptance temperature limits, verify KPLO FM thermal design and thermal hardware Function, and to acquire the test data for thermal math model correlation. To simulate the acceptance temperature limits for each unit, an IR

heaters are used to meet the requirements. In this paper, test configuration and preparation works for thermal vacuum test and thermal balance test of KPLO and a orbit environment test results are included.

[P-41] Current Status of Optical Measurements for Space Debris

Sae-Han Song, Jaedong Seong, Youeyun Jung, Okchul Jung

Korea Aerospace Research Institute

Space Debris is one of the major threat to the satellites in operation. Korea Aerospace Research Institute (KARI) requires the best precise orbit data of secondary objects extracted by observation instrument to conduct the mitigation of the collision risk between national space assets and space debris. In this paper, we briefly introduce the international status of optical instrument systems and summarize the characteristics of each optical systems which each agency is currently operating and present the plan for utilizing the information of the secondary object.

[P-42] A Novel Method of Semantic Analysis for Flight Software

Hyun-Kyu Shin

Korea Aerospace Research Institute

Onboard flight software (FSW) performs the role of managing satellites including command reception from the ground, telemetry transmission, health status monitoring and so on. To achieve the mission, FSW is requested many requirements. One of them is to support the maximum mission availability of satellites. In order to maximize availability, appropriate FDIR is needed and FSW must support this design concept. A Resilient design methodology is one of the ways to implement maximizing availability. The previous research used to focus on MTTF to increase availability. Recently, research is underway to reduce MTTR. To minimize MTTR, FSW design change is mandatory with the new features of the onboard computer. This paper introduces a novel method of semantic analysis for flight software in order to minimize MTTR.

[P-43] Shadow Analysis for KPLO

Hyun-Jin Shin, Beom-Suk Kang, Seung-Yong Min, Hyung-Wan Kim

Korea Aerospace Research Institute

There are two solar array panels in the KPLO, and it is rotated by 1 axis gimbal to get the solar power efficiently in lunar orbit. Solar panels of the KPLO is rotated depending on sun beta to minimize Sun incidence angle in lunar orbit in order to maximize the power generation. Therefore KPLO attitude, Sun-beta angle and rotation angle of solar panels are essential parameters to calculate the power generation. And shadow analysis using these parameters has very important role to calculate the power generation. In this paper, spacecraft attitude with solar panel rotation angle at various sun beta angle in lunar orbit was shown and result of shadow analysis for KPLO introduced breifly.

[P-44] Polarity Test for Actuators of KPLO

Hanwoong Ahn, Kwangyul Baek

Korea Aerospace Research Institute

KPLO is Korea's first lunar exploration project satellite. KPLO is composed of Reaction Wheel Assembly (RWA) and Attitude Control Thruster (ACT), which are attitude control actuators, and Solar Array Drive Assembly (SADA) for sun tracking. If the behavior of the RWA and ACT is different from the expected value, the satellite cannot keep the attitude stabilization. Also, if the polarity of SADA is incorrect, the solar panel cannot be directed toward the sun, which may cause problems with the satellite power system. Therefore, it is important to test the polarity of the actuators of KPLO after FM assembly. This paper will discuss the polarity test methods and results of the actuator of KPLO.

[P-45] A LEO Satellite Diagnosis Method through Playback Data Time Span Division Analysis

Seung-Eun Yang

Korea Aerospace Research Institute

Every generated telemetry is stored into mass memory because the contact time and period is limited for LEO (Low Earth Orbit) Satellite. When the satellite is in contact area, the data is transferred as playback to ground station and it is applied to check the state of satellite. However, it is challenging to analyze the telemetry in short time by human operator because thousands of telemetry exist and it is accumulated for several hours. In addition, engineering knowledge is necessary to identify the problem and cause of it. To overcome the challenging task, we propose a time span division analysis method that automatically detect the anomalous time period. For the first step, split the accumulated playback data into one orbit time data and get PCA (Principal Coefficient Analysis) coefficient. It is possible to achieve reduced informative data from massive data through PCA. Anomalous orbit can be defined by comparing the coefficient for each orbit. Also, the major telemetry is identified by level of contribution to PCA and it reveals the cause of the problem. Therefore, the anomalous orbit and the cause of the problem are identified by the proposed method

without any engineering knowledge.

[P-46] Generated Power Prediction for LEO Satellite

Seok-Teak Yun, Day-Young Kim, Sang Kon Lee
Korea Astronomy and Space Science Institute,

The power prediction of Low earth orbiting (LEO) satellites is closely related to the power system and mission requirements of the satellites. That is, according to the generation of power, a power balancing section that meets the requirements of the satellite is determined, and the capacity of the battery for power storage is selected. Therefore, it is possible to accurately predict the amount of power that can be generated accurately, so that the size and capacity can be optimized. There are several methods for predicting generated power, and each method has pros and cons.
In this paper, formula-based, probability, and data-based power generation prediction methods were reviewed, and a study was conducted on methods applicable to low-orbit satellites.

[P-47] Power Distribution Design for Pulsated Load Condition of Satellite

Young-Su Youn, Sung-Woo Park
Korea Aerospace Research Institute

The IR cooler unit of IR module units has current-pulsated load characteristics. The current -pulsated load characteristic has and effect that cause the regulated power bus of the power control distribution unit to fluctuate. The IR module power distribution unit and battery provide stabilization of the regulated power bus against current-pulsated load characteristic of IR cooler unit operation. The IR module power distribution unit has a protection circuit of battery against overcharge by active control and an interface circuit of status monitoring and telecommand allowing the system and ground operate the power system of satellite. The battery is used to stabilize the regulated power bus of satellite against a current-pulsated load., so the battery has a capability to output higher than the regulated power bus voltage. Output voltage range of the battery shall not be changed even though any cell failures are occurred in the battery.

[P-48] Electromagnetic Compatibility Environment Test of Satellite System

Sangrok Lee, Tae-Youn Kim, Jae-Woong Jang, Kyung-Duk Jang, Chang-Eun Lee
Korea Aerospace Research Institute

The purpose of the Electromagnetic Compatibility (EMC) environment test of satellite system is to evaluate the electromagnetic noise caused by conducted and radiated emission of electronic units. It has the main purpose to prevent serious defects caused by communication failure and functional failure in advance [1, 2, 3]. Although the unit level EMC environment test is performed prior to the system, it is difficult to reflect the effect of the actual flight model harness and the interaction with other electronic units. Also, in the case of launch vehicle radiated susceptibility and radiated emission specification, it is decided after launch vehicle contract. Accordingly, it is difficult to determine the exact test level at the design stage. Therefore, it is absolutely necessary to conduct the system EMC environment test of satellite in terms of complementing the deficiencies as well as the design details of the past. This paper deals with the efficient test design. Validation items include conducted emission, conducted susceptibility, radiated emission, radiated susceptibility, launch vehicle radiated emission compatibility, launch vehicle radiated susceptibility, and RF auto compatibility. The selection and reasons for test items, as well as the operation mode of the satellite and the method of setting the mechanical measurement shape, will be covered.

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[3] A. Ciccolella, F. Marliani, EMC in Space Systems : Current Practices and Future Needs - The ESA Perspective, The Radio Science Bulletin, No. 328, pp.9-19, Mar. 2009

[P-49] Frequency Resource Planning for Future Geostationary Satellite Programs

Seorim Lee
Korea Aerospace Research Institute

In preparation for future geostationary satellite programs, frequency resources for the program must be either allocated or newly acquired. KARI is presently managing three geostationary satellite networks registered in the MIFR of the ITU. A plan to efficiently acquire the necessary frequency resources for future geostationary satellite programs as well as utilize and maintain the present resources is needed. This paper reviews the status and process in which a preliminary strategy is established to acquire frequency resources for future geostationary satellite programs.

[P-50] Automatic Database Registration and Distribution Design of Satellite Image Customized

Processing System Considering the Use of Work Orders

Jaeyeol Lee, Min-A Kim, Jihyeon Yim, Guhyeok Kim, Gabho-Jeun

Korea Aerospace Research Institute

The Korea Aerospace Research Institute is operating Arirang Satellites 3, 3A, and 5, and is scheduled to launch Arirang Satellites 6 and 7 within the next two years. In recent years, as the number of satellites increases, the usage of satellite images is also continuously increasing.
As the usage of satellite image increases, it is necessary to improve the processing method or procedure for providing satellite image faster than before. Arirang satellite imagery accepts and provides orders according to user requests, and the processing process for providing images is as follows. In general, it consists of the procedures of image/image collection request (order), satellite image collection (image collection), data processing and image generation (image processing), image editing (image customizing), and user provision (distribution). Satellite images receive user orders and order information is recorded in the order management system. A standard image is created through pre-processing such as radiation correction and geometric correction through the work instruction, and is distributed to users after image editing. The image customizing system work procedure registers standard images in the database and distributes them through image customization and inspection. Image registration is essential to use in the system, and besides Image, it registers key information of image necessary for database management along with bundle set files such as RPC, Browse and Thumb Image, Browse world and Auxiliary. Image registration in the existing system uses the method of acquiring the necessary values in the database from the Image and xml format auxiliary files. Only image information can be registered, and order information and order status information are manually entered by the operator. The new database registration method using work orders acquires image and image information from Image and Auxiliary files, and acquires order information and order status information from work orders. By using OrderID and ProductID obtained from Image and orderID and ProductID recorded in the work order, it is possible to know whether the image and the content of the work order are the same image. In addition, after image customization is completed, information on the processing process and completion status is delivered to the order management system. Through this, the entire processing process and status can be recorded and monitored, enabling efficient database management of the image customized system.

[P-51] A Study on Planetary Surface Exploration Device Other than Earth

Juhun Rhee

Korea Aerospace Research Institute

The fully autonomous robots, which are essential tools in the space exploration, are typically created to land on the solid surface of the planets or other planetary mass celestial bodies. They study the planets habitability, seek the signs of the past microbial life, collect and catch the samples, and prepare for the future human missions. In this study, the news of the newspaper and the research materials on the space helicopter, which is a technology demonstration to test powered, controlled flight on another world, are collected and investigated/reviewed. Specially, the NASA's Mars helicopter "Ingenuity (Name)" is introduced. Also, other rovers and devices (or instruments) designed and fitted into the specific exploration missions appropriate and suitable to the environments of the planets or other planetary mass celestial bodies are illustrated.

[P-52] Review on Satellite Performance and Loss Factor Evaluation for Satellite Launch and In-Orbit Insurance

Choon-Woo Lee

Korea Aerospace Research Institute

In general, satellite performance in orbit after launch shall be definitely evaluated to calculate the loss of amount as the claim payment when happening partial or total loss of predefined satellite performance factor.
Several aspects of LEO (low Earth Orbit) satellite performance for Launch and in-orbit insurance coverage shall be carefully considered including Image Quality, Image Capacity, Solid State Recorder Capacity, Image Downlink Capability, Satellite Agility and etc. In case of LEO electro-optical satellite, the quality of an image obtained from satellite can be fully evaluated using 3 performance criteria — Nadir Ground Resolution (NGR), Modulation Transfer Function (MTF), Signal to Noise Ratio (SNR).
In addition, there are several key factors damaging on satellite daily performance over mission life such as Image Capacity, Solid State Recorder Capacity, Image Downlink Capability, Satellite Agility. The individual daily performance values of satellite are calculated using the partial loss and total loss value of each key factor. That is, each satellite performance factor has "partial loss value"which is considered as no insurance loss and "total loss value" which can drive the overall performance Factor for the affected band to zero. Finally, satellite insurance loss amount can be calculated, summating each performance factors over the entire mission.
In this paper, how to quantitatively evaluated satellite performance in orbit for insurance coverage and how to calculate the loss of amount for claim payment are introduced as the general

reference of LEO elector-optical satellite insurance.

[P-53] Review of Infrared Spectrometer calibration result for Molecular Contamination

Hye Jin Yi, Hyok-jin Cho, Sung-Wook Park, Hee-jun Seo, Sang-hoon Lee, Soo-hwan Jun

Korea Aerospace Research Institute

Contamination of satellites includes particle contamination capable of identifying the size or the μm and molecular contamination in the form of a film made of molecular layer by Outgassing a satellite component made of a polymer material such as an adhesive, paint, MLI. Particle contamination is easily managed by blocking incoming particles using a filter or improving the workinng environment. but Molecular contamination has a very sensitive effect on the satellite performance depending on the materials and amount. Infrared spectrometer was utilized to measure the molecular contamination according to ESA (European Space Agency) PSS-01-705 document. And Review of infrared spectrometer calibration was performed for 4 standard materials.

[P-54] In-Orbit Launch System Using A Rotating Flywheel

Sung-Hyuck Im, Junseong Lee, Keejoo Lee

Korea Aerospace Research Institute

Existing launch vehilcles use the thrust system to insert the payload on the target orbit in a short time or to insert the payload on the parking orbit. For orbit transfer, a propulsion system is required, and the propulsion system must maintain the propulsion component such as propellant tanks, engine, control system, and etc. until the payload reaches the target orbit. To overcome this inefficiency, a launch method separated from the propulsion system, not the self-propelled method, is required. In this paper, we propose the in-orbit launch system using a rotating flywheel. The proposed in-orbit launch system consists of a wheel, ion thrusters, an operating system, and etc. We will also introduce a method to control the wheel imbalance that occurs during payload launching. In addition, the construction and operation method of the proposed launch system will be presented.

[P-55] Design of Weather Information Management System for the Utilization of Weather Data in High Resolution Optic Satellite

Eunsook Lim[1], Euna Cho[2], JungNam Jun[1], MyeongShin Lee[1]

[1]*Korea Aerospace Research institute*

[2]*SI-Imaging Service, SIIS*

In this paper, to improve the effective image acquisition rate of the High Resolution Optic Satellite, the design of the weather information management system for utilizing weather data in image collection and downlink planning will be described. The weather information management system periodically collects meteorological data from domestic and foreign weather data providing sites such as NOMADS and the Korea Meteorological Administration, and performs the function of generating various types of weather information according to the purpose of use in real time. The weather data generated by the weather information management system is managed in the database to facilitate search and confirmation. It is designed in consideration of scalability to add other weather information in the future.

[P-56] Early Orbit Operation Summary for a Low Earth Orbit Electro-Optical Satellite

Jeong-Heum Im

Korea Aerospace Research Institute

CAS500-1 satellite was transported to Baikonur cosmodrome in Kazakhstan for launch campaign in January 2021. After completing combined operation and checkout with Soyuz launch vehicle at the launch site, the satellite was launched into the space on 22nd March 2021. Just after the separation of the satellite from the launch vehicle, the satellite started its on-board autonomous operation. First contact between the satellite and ground station was made successfully. The satellite's orbital elements were identified and the status of the satellite's health was checked. The whole early orbit phase consisted in three sub-phases, they were IAC (Initial Activation and Checkout) phase, IOT (In-orbit Test) phase and CV (Calibration and Validation) phase. IAC was performed to confirm each unit's aliveness, software functionality and satellite maneuver capability including del-V burn test. During the IOT phase, combined image chain which included payload, spacecraft and ground station has been confirmed. During calibration and validation phase, image characterization and image performance check has been conducted.

[P-57] Key Considerations for Developing Rain Attenuation Prediction System Based on Supervised Machine Learning

Hyun-Su Lim

Korea Aerospace and Research Institute

On ground, when telemetry frame loss or corruption occurs, it is caused by a failure of a satellite or ground receiving equipment or the influence of the operating environment.
To receive raw image and telemetry data of GK2B (Geo-

KOMPSAT-2B) ocean and environmental payloads, KARI uses an X-band link antenna with a 10-meter diameter Cassegrain type. The X-band link is generally known to have less rainfall attenuation than the Ka/Ku band, but data loss due to rain may occur during heavy rain. A system is being developed to predict the failure of X-band link acquisition due to rainfall attenuation effect by using a machine learning algorithm as input data of AWS (Automatic Weather System) weather information and X-Band signal strength. This paper introduces key considerations and lessons to generate training data set (labeling problem), and select meaningful data features, because input data quality and feature selection has a significant impact on the outcome of system performance.

[P-58] Verification Method of RF Compatibility of Transmitters and Satellite

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

Korea Aerospace Research Institute

The satellite has various transmitters such for telemetry transmission, image data downloading, broadcasting/communication, etc. Usually, since the radiation power of the transmitter is very large, the electric field generated by transmitter can affect the satellite's unit and cause malfunction. Therefore, it must be verified whether the all of the units and subsystems of satellite have RF compatibility with the satellite's transmission system. Verification is usually carried out through analysis and testing. The analysis is performed by calculating the electric field intensity generated by transmitting antenna to the satellite's unit and comparing the values to the RS test level. The electric field intensity should be less than the RS test level at the unit level. The test is performed by RS testing, and the RS testing level should be higher than the above field intensity for the safety margin. This paper shows the detailed analysis and test method for the RF compatibility verification of satellite and transmission system.

[P-59] Preliminary Thermal Analysis for Thermal Vacuum and Balance Test of Korea Pathfinder Lunar Orbiter

Byungkwan Jang, Jang-Joon Lee, Bum-Seok Hyun

Korea Aerospace Research Institute

Currently, Korea Pathfinder Lunar Orbiter (KPLO) is in the assembly stage and Korea Aerospace Research Institute (KARI) is preparing for space environment tests. We will conduct a thermal vacuum and balance test first of the environment tests. The thermal vacuum test simulates the space thermal environment to verify that the equipment and payloads of the orbiter maintain an operating temperature range. It is necessary to perform preliminary thermal analysis through a thermal model before proceeding with the test. Through this analysis, the temperature of each equipment can be predicted in advance during the test. The lunar orbiter, a thermal vacuum chamber, infrared heaters, and testing mechanical devices were modeled, and this models were used to simulate cold and hot thermal balance test conditions. In this paper, we will explain the results of this preliminary thermal analysis in brief.

[P-60] Design Tradeoffs in the Full Electric and Full Chemical Propulsion GEO Satellites

Sung-Soo Jang

Korea Aerospace Research Institute

Recently, there is an increasing tendency to use a fully electric propulsion system to replace the existing chemical propulsion system in the platform of a geostationary orbit satellite. The use of an electric propulsion system with high specific thrust can dramatically reduce the amount of fuel for propellants compared to a chemical propulsion system, so the weight of the geostationary orbit satellite platform can be greatly reduced. When considering the launch of the next-generation KPS satellite using a Korean launch vehicle, the launch mass of the next-generation KPS satellite with the chemical propulsion system will be expected to reach about 4.2 tons. But the launch mass of the KPS with the fully electric propulsion system will be considered to reach about 2.8 tons. The KPS satellite with electric propulsion system can save more than 33% of propellant fuel compared to when chemical propulsion system is applied. Using a chemical propulsion system, it can reach geostationary orbit within two weeks. But using an electric propulsion system, it takes about 4 to 5 months to reach geostationary orbit. Considering 4-5 months of operation in transitional orbit, the effects of cosmic radiation can aggravate the aging of satellite electronics.

[P-61] Analysis of Trends and Potential Hazard of Deep-Fake Technology from the Perspective of Satellite Imagery Applications

JiHyeon Yim, Min-A Kim, JaeYeol Lee, GuHyeok Kim, Myeong Shin Lee

Korea Aerospace Research institute

Recently, Deep-Fake technology, in which AI Artificial Intelligence existing images and creates virtual images, is actively used in the image fields or is becoming a social problem as it is used for other purposes. satellite imagery that contains the crucial components of earth surface is being actively studied using deep-learning. therefore, it also is necessary to consider the potential hazard of the technology in the field of satellite imagery. In this study, First, the recent

researches of deep-fake and its detection were described and analyzed. Next, the negative impact of the technology in the filed of future Satellite Imagery Applications is reviewed.

[P-62] Detailed System Design to Automatically Generate Image Downlink Schedule

Jung-Nam Jun[1], Eun-Suk Lim[1], Eun-A Cho[2], Gab-Ho Jeun[1]

[1]*Korea Aerospace Reserch Institute*
[2]*Satrec-i Imaging Service*

Integrated Satellite Operation is necessary because of development of Earth Observation Satellite and increase in the number of satellite in operation. For Multiple Satellite Operation, ground system must be integrated and automated.
Satellite Image Schedule is generated by Multi-Satellite Scheduling System (MSS) and it saved in satellite memory storage, and then image data is downlinked to ground receiving station. In order to receive image data it must considered operating condition both ground receiving station and satellite also parameter of user's request.
This paper describes detail design of Multi-satellite Downlink Schedule System (MDS). The main items are the system architecture for software and GUI and file interface for internal and external system.

[P-63] Design of Test Adapter for Mass Property Measurement in the Aerospace Field

Jong-Hyub Jun, Nam-jin Moon, Sung-Hyun Woo

Korea Aerospace Research Institute

Aerospace part and system is designed considering required movement like translation and rotation in the air. So mass properties like COG (center of gravity), MOI (moment of inertia), and POI (product of inertia) are significant factors for those designs because flying object should be estimated for correct movement by the properties. So those properties should be measured for the each product during development to verify the design as exact as possible. The exact measurement depends on the various factors like measurement equipment performance, test adapter design, installation method, and so on.
In this paper, we will briefly present the design concept of mass property measurement adapter for more exact solution in the aerospace field with flight object like satellite and aircraft parts.

[P-64] Unified Architecture of Reconfiguration Unit Software with Flight Software for Compact On-Board Computer in Small Spacecraft

Hyeon-Jin Jeon

Korea Aerospace Research Institute

Current trend in the field of small spacecraft design is to pursue compactness and lightness. Among many state-of-the-art technologies, this paper focuses on the compact design for on-board computer.
In general, on-board computer is designed to have separate modules for the reconfiguration unit (RU) and the processor for flight software (FSW) with those redundancies for high-reliability, respectively. However, if the RU is implemented as a software, it can be incorporated with FSW so that the RU module can be removed or merged into the processor module. In addition, in order to get high-reliability, it can be designed that the two processor modules, i.e., primary and redundant processor modules works under hot-redundancy such that one side of the processor executes the FSW incorporated with the RU software and the other side of processor executes only the RU software. Namely, the RU software runs under hot redundancy concept and the FSW runs under cold redundancy concept. Furthermore, with a sophisticated state-machine, FSW can smoothly jump over to its redundant side whenever a major fault event is occurred.
This paper proposed the unified architecture of RU software with FSW for compact on-board computer. This can be a good example for designing small spacecrafts.

[P-65] Analysis of Space Situational Awareness Related ISO Standard Document Hierarchy

Youeyun Jung, Jaedong Seong, Okchul Jung

Korea Aerospace Research Institute

The International Organization for Standardization (ISO) has published various standard documents on Space Situational Awareness (SSA), especially on space debris mitigation. Among the published documents, ISO 24113:2019 "Space Systems — Space Debris Mitigation Requirements" sets out the highest requirements for space debris mitigation. Details of these requirements are described in documents below hierarchically such as "ISO16127 Prevention of break-up of spacecraft" or "ISO16164 Disposal of spacecraft in LEO". The organized standard documents are applicable for various SSA activities as well as spacecraft manufacturing and operating. Therefore, in order to specify the direction of KARI's SSA activities as a designated institute for National Space Development and Spacecraft Operations, the structural hierarchy of the ISO document was analyzed and prepared.

[P-66] Software Design of Base Band EGSE

Seung Won Cho, Yun Goo Huh, Hyun Mo Gu

Korea Aerospace Research Institute

The function of satellite is verified through various tests during AIT (Assembly, Integration, and Test). Electrical Ground Supporting Equipment (EGSE) is the major test equipment required to verify the satellite. Base Band EGSE plays a role in communication with Satellite during test. It controls satellite by sending telecommand and checks the status by receiving telemetry. Additionally, it controlls the component of EGSE and stores the test data. In this paper, the detailed software design of base band EGSE will be introduced.

[P-67] A Study on GK3 Fault Management Architecture Process Development

Chang-kwon Cho, Bongkyu Park, Jong Seok Park, Keunjoo Park

Korea Aerospace Research Institute

Unlike the Chollian Satellite 2, the geostationary orbit public complex communication satellite (GK3) is not an observation satellite but a communication satellite. It consists of three payloads: a Flexible Broad Band Communication (FBCS) payload, a Satellite Based Augmentation System (SBAS) payload, and a Data Collection System (DCS) payload. It is the first geostationary orbit communication satellite being developed in Korea. In general, fault management is a method of detecting and isolating a failure when a failure occurs and then taking measures to ensure that the satellite is safe. If the purpose of fault management of observation satellites is to prioritize satellite safety, communication satellites should be able to provide services continuously by providing maximum availability to users of satellites. Since most of the existing satellites developed in Korea are observation satellites, a fault management architecture suitable for geostationary orbit communication satellites is required.
In this paper, we would like to introduce the progress made while developing the fault management architecture of geostationary orbit public complex communication satellites (GK3).

[P-68] Initial Design of Korean Next Geostationary Multi-Purpose Satellite Mechanical System

Jung Su Choi, Jong Seok Park

Korea Aerospace Research Institute

This paper introduces the initial mechanical design of the Geo-Kompsat-3 satellite. The Korea Aerospace Research Institute began developing the third geostationary multi-purpose satellite Geo-Kompsat-3 in June 2021 and aims to launch it in 2027. The Geo-Kompsat-3 is a geo-communication satellite for the purpose of public service with three main payloads, Flexible Broad Band Communication (FBCS) payload, Satellite Based Augmentation System (SBAS) payload, and Data Collection System (DCS) payload. The initial mechanical system design starts with Geo-Kompsat-2 (2A launch: 2018.12 and 2B launch: 2020.02) as the basic concept, and the design needs to be modified to improve satellite performance. The Geo-Kompsat-3 satellite plans to apply Global Navigation Satellite System (GNSS) and hybrid (Bi-propellant chemical + Electrical) propulsion systems that were not applied to GK2. And due to the dual solar array wings, large size deployable antennas, high power transponders and payload antennas on the earth deck, many mechanical interface design changes are required for Geo-Kompsat-3 satellite.

[P-69] A Study on the Automation of Satellite Image Validation and Data Generation Process Using Cloud Mask Information

Gab-Ho Jeun, Jung-Nam Jun, Min-A Kim

Korea Aerospace Research Institute

The global satellite information application market has been growing for the reason of huge volume of remote sensing database from the satellite constellation and improvement of image analysis technology such as artificial-intelligence. For this reason, user requirement to use the satellite information in a timely manner are increasing.
KARI ground operation system, which operates KOMPSAT series satellites, is also carrying out integrated satellite ground system development project to reduce the data delivery time and operating cost through integration and automation.
In previous study, manual operation step were identified though the definition of the satellite data processing and distribution procedures. in addition, semi-automatic data processing and distribution work flow method and effect excluding manual operation step were defined.
In this study, by automation of manual operation work flow, a method for selecting and providing satellite data fulfilled with user requirement in a timely manner is to be defined.

2부 발표시간 : 10월 29일(금) 11:20～12:00

[P-70] A Study on the Utilization of Geostationary Orbit Public Communication Satellite (GEO-KOMPSAT-3)

Jae-Dong Choi

Korea Aerospace Research Institute

Recently, due to large-scale fires such as forest fires, earthquakes, and sinking of fishing boats. public safety issues continue to increase not only only in Korea but also abroad. In particular, the importance of marine protection activities is gradually increasing due to illegal fishing activities of Chinese ships in Korean territorial waters. However, the national maritime police's satellite communication network installation ships operating in territorial waters out of reach of the ground network are increasing rapidly, but the available satellite bandwidth remains at half of the growth rate of usage traps, making it difficult to stable marine rescue activities and korean territorial waters protection activities. This study aims to present the necessity and various application fields of public disaster communication satellites(GEO-KOMPSAT-3) in response to stable maritime rescue activities, territorial protection activities, flood prevention and monitoring, strengthening aviation safety management capabilities, and future satellite communication market changes.

[P-71] FPGA-based Electronics Platform for Space Imaging Camera

Seonghwan Choi[1], Jung-Woong Kim[2], Gwang-Hee Jeong[3], Jihun Kim[1], Jinhyun Kim[1], Juhyung Kang[1], Ji-Hye Baek[1], Jongyeob Park[1], Byeongchae Bang[3], Heesu Yang[1], Uk-Won Nam[1], Yeon-Han Kim[1], Kyung-Suk Cho[1]

[1]*Korea Astronomy and Space Science Institute*
[2]*I-TRIX Technology, Inc.*
[3]*AntBridge, Inc.*

This presentation introduces an FPGA-based electronics platform for space imaging system. The Korea Astronomy and Space Science Institute (KASI) has designed imaging camera electronics with a platform concept that can be easily applied to various CCD and CMOS sensors. The electronics platform enables us to develop reliable imaging cameras with limited cost and schedule. It consists of a power board, an image processor board, an interface board, a radiation-hardened monitor board, and a sensor daughterboard. It was designed by considering the vacuum, temperature, radiation, and vibration conditions at the satellite launch and during operation in the space environment. In particular, even if all parts are not composed of radiation-hardened parts, the platform can monitor the state of the FPGA, and restore or respond to errors caused by Single Event Upset. The electronics architecture is applied to COronal Diagnostic EXperiment (CODEX) mission joint with NASA. We developed software to control the imaging camera and also developed a camera characteristics measurement system. Recently we carried out space environment tests successfully. This architecture can also be utilized as an On-Board Computer by adding interface electronic expansions. We are planning to apply to other space missions that follow.

[P-72] Landmark Image Processing Result of In-Orbit Test for Image Navigation and Registration of Hyperspectral Satellite Images

Sungsik Huh, Ki-Lyeok Yong

Korea Aerospace Research Institute

In this paper, we introduce the landmark image processing result of In-Orbit Test (IOT) of Image Navigation and Registration (INR) System for Geostationary Environment Monitoring Spectrometer (GEMS) on GEO-KOMPSAT-2B. GEMS does not acquire star images, so INR system utilizes only landmarks for image geometric correction. However, GEMS image bands have low land-water radiance distinction, so it resulted in difficulty in real-time landmark image matching using the shoreline chips. Therefore, the method of matching with AMI Level-1B images, which are already geometry-corrected, was tested during the INR IOT. In order to match the GEMS resampled images with AMI Level-1B images, the observation region, time, and band between the two images were aligned equally. Unlike conventional methods of matching coastline, this method allows for uniform matching of the entire imaging area by the payload, including the cloud area, allowing for precise calibration of the LOS model parameters.
This results showed the possibility of performing geometric inter-calibration between different satellite imaging payloads.

[P-73] The Operation Concepts of Attitude Maneuver and On-Board Antenna Tracking for Electro-Optical Satellites on LEO to Secure Image Transmission Time

Jeonghoon Hyun

Korea Aerospace Research Institute

Electro-optical satellites on LEO transmits collected image data to ground stations using on-board X-band antenna. In order to secure X-band RF margin for image transmission, antenna

tracking profile should be produced in consideration of antenna beam width, satellite's maneuver plan through mission scenario, the location of ground stations, and antenna maneuver constraints. Among these parameters, it is common to determine how to maneuver the satellite before the calculation for antenna tracking profile since imaging is of higher priority than download in general. However, in case of image data generation rate increasing with higher resolution and relatively low rate of X-band downlink, in order to quickly acquire and analyze images, it is necessary to increase the priority of reserving image transmission time. Specifically, since the pointing type of azimuth-elevation has restrictions on antenna maneuver and incurs effective beam width shrinking at acquisition-of-signal (AOS) and loss-of-signal (LOS) due to longer slant range from a ground station, it could be considered to proactively maneuver the satellite without reducing mission profit. This report analyzes the attitude maneuver of satellite required to secure image transmission time in various operating environments, and explores satellite and antenna operation concepts.

[P-74] Processor throughput Assessment of the KPLO Flight Software

Soo-Yeon Kang

Korea Aerospace Research Institute

Performance requirements for KPLO (Korea Pathfinder Lunar Orbiter) flight software are memory utilization and processor throughput. In this paper, the processor throughput verification and results are described. processor throughput requirement of KPLO flight software is that the software shall use no more than 75% of the available processor throughput. In order to measure processor throughput in a situation similar to actual KPLO operation, it was measured for each step of the actual operation scenario in the KPLO System Operation Test performed on the ETB (Electrical Test Bed). Measurement results and analysis show that KPLO flight software meets processor throughput requirement.

[P-75] A Study on the Fault Analysis and Failure Rate Test Methods for Predicting Failure Rates of Space-Grade Electical, Electronic and Electromechanical Parts

Myung-Gil Kim, Je Guen Lee, Hong Soo Lee, Sun Hee Sihn

SpaceK Inc

Satellites are being R&D with a technical verification through many simulations and tests on the ground, since they cannot be repaired when they are placed in orbit after they are launched. Recently it is required to develop electric, electrical and electromechanical parts (EEEparts) with high performance and efficient for spacecrafts that need ultra-reliability and light weights. In particular, EEEparts has evolved system reliability into a top-level industry by predicting failure rates as a way to provide reliable performance to systems using high-reliability components. In this study, it was proposed a method of predicting the failure rate for these EEEparts and calculating the failure rate through reliability tests, thereby comparing the prediction and the actual value to study a method of presenting a more stable and reliable failure rate. Generally used in the space application, EEEparts predicts failure rates using MIL-HDBK-217 F, Telcodia and Bellcore, etc., and data on such failure rates is databased by RCA and provided as a library, but the technique of testing and validating real data is a time when much research is needed. Therefore, in this study, it was proposed a method of calculating the failure rate through accelerated life test during reliability test.

[P-76] A Study on the Concept of On-Orbit Absolute Misalignment Calibration for Geometric Correction of KPLO LUTI Images

Jo Ryeong Yim, Hyungjoo Yoon

Korea Aerospace Research Institute

LUTI is one of the main payloads installed in KPLO, and ICAS is being developed by KPLO ground station to process LUTI images. The geometrical accuracy of an image depends, first of all, on how well the camera is geometrically corrected. The geometric correction of the image is divided into three main parts: time error correction, internal CCD distortion correction, and external camera alignment error correction. In particular, the geometrical accuracy is highly dependent on the external geometrical correction accuracy, that is, the alignment information of the sensor. The alignment information of the LUTI CCD sensors will be measured on the ground before launching the satellite and will be updated in the frame kernel for the coordinate and frame definition among SPICE kernels. For low earth orbit satellites, the misalignment correction parameters are obtained by performing absolute sensor misalignment calibration using the images, geocentric coordinate system and GCPs. In this paper, based on the absolute sensor misalignment calibration technique used for KOMPSAT series and the method used for determination of the LRO's exterior orientation parameters, we present a preliminary concept of absolute misalignment calibration of LUTI CCD sensors with respect to the body frame.

[P-77] Spacecraft Bus Operation for Trajectory Correction Maneuver of Korea Pathfinder Lunar Orbiter

Moon-Jin Jeon, Young Ho Cho

Korea Aerospace Research Institute

After separated from the launch vehicle, Korea Pathfinder Lunar Orbiter (KPLO) cruises the ballistic lunar transfer (BLT) trajectory. To maintain KPLO in the reference trajectory, several trajectory correction maneuvers (TCMs) are required. The spacecraft bus supports essential functions for TCMs such as DV burn by thruster firing, attitude control while DV burn, and communication for TC/TM. The bus operation for TCM can be categorized into 4 types according to the main thruster for DV burn and antenna for communication during TCM.

1) TCM by ACT Burn with LGA Downlink
2) TCM by ACT Burn with HGA Downlink
3) TCM by OMT Burn with LGA Downlink
4) TCM by OMT Burn with HGA Downlink

The main thruster for TCM will be decided by required delta-V for each TCM. The antenna to be used will be decided considering the coverage of each antenna in the S/C attitude for TCM. In this paper we presents S/C bus operation design results for TCM.

[P-78] PID Controller Design and Tuning of Focus Mechanism Controller for Satellite Camera

Youngsun Kim, Haeng-Pal Heo

Korea Aerospace Research Institute

The focus mechanism with hateable rings can be used for a satellite electro-optical camera in order not to have the risk to be stuck mechanically. Usually the focusing can be acquired in the camera system by temperature control between the upper rings and the lower rings. The PID controller has advantages at the control accuracy and convergency. The paper shows the PID controller design and especially emphasizes on the gain tuning method and the results. At first the PID gain is determined at the controller design phase considering the rising time, stabilization time and overshoot as well as control accuracy. And then these gain values are optimized to compromise the performance parameters using actual satellite camera system. Various parameter tunings are carried out and the results are reviewed in the paper.

[P-79] Simulator Development for Launch Vehicle Flight Trajectory

Hwan-chun Myung, Hyoung-yoll Jun

Korea Aerospace Research Institute

GEO-based launch vehicle detection is getting much more attention from the military space application point of view. As a development tool of such a space-based detection system, the proposed simulator is designed to provide 2D geographical flight trajectory of a launch vehicle, 2D flight trajectory based upon a GEO detector, 3D flight trajectory using 3D models, 3D attitude variation of a launch vehicle, and a real-time flight information such as distance/altitude/mass/velocity/flight time. The simulator largely consists of three parts: GUI, 3D graphic window, and dynamic simulation of a launch vehicle. For the Python-based dynamics (M-3S) of the launch vehicle considered, the Python language is used to develop the dynamic simulation part and 2D plots. Meanwhile, the other graphical parts including 3D models are programmed using C#. In order to merge two different languages: Python and C#,'Python Runtime library in C#'is applied to the simulator. Using the proposed simulator, it is further expected that the trajectory projection algorithms with a single GEO-satellite or multiple GEO-satellites are implemented under the real disturbance of a quantization noise (embedded in a detector) and a pointing error (due to a satellite attitude).

[P-80] Electronic Ground Support Equipment Technology Research for the Development of Electro-Optical Camera System

Jong-Euk Park, Eung Shik Lee, Haeng-Pal Heo

Korea Aerospace Research Institute

In the development of high resolution satellite payload camera, the optical module is completed after designing, assembling, and arranging large mirrors and structure, and is combined with the camera electronics to form a satellite electro-optical payload system. In the alignment process with the camera electronics, precise alignment is required for high performance of the payload system, and after camera alignment, various test steps (environment and function) are performed. It is necessary to develop electronic ground support equipment to effectively carry out this process. General ground test equipment supports the functions necessary for the development and testing of the electronic system, but in the development of the electro-optic satellite payload system, supports the special required function based on the information and knowledge acquired through the development of various prior projects. In this paper, the better implementation and operation method necessary for the development of electronic ground support equipment with added functions that can be effectively used for testing and aligning electro-optical system to ground test equipment that can perform ground tests of basic electronic systems is suggested.

[P-81] Preliminary Operation Concepts of the CAP-W Payload Missions

Seok-Bae Seo, Sang-Gyu Lee, Myung-Jin Baek, Sang-Burm Ryu, Eun-Su Kang, Hyeon-Cheol Lee

Korea Aerospace Research Institute

CAP-W (Compact Advanced Payload with Wide-swath) is the payload of the CAS500-4 satellite, which has 5 m GSD multi

spectral bands and 120 km imaging swath. The CAP-W is designed as five operation modes - off mode, survival mode, standby mode, mission-ready mode, and mission execution mode - to meet observation requirements with its subsystems. Mission duty cycle, imaging time, transition time, line rate, TDI, and compression are studied to design a preliminary operation concept of the CAP-W on the current PDR milestone.

[P-82] Studies about the Impacts of Interface Irregularity on the Optical Performances of Spaceborne High Resolution Camera

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

Korea Aerospace Research Institute

Optical performances of spaceborne high resolution camera is sensitive to the environmental and interface conditions. The primary mirror of spaceborne high resolution camera has large aperture size and extremely light weighted for the accommodation on the Spacecraft. The mounting of the camera on the Spacecraft shall be performed on the regularly flat interface with stress-free condition as far as possible. However, perfectly flat condition is not exist and there are the tolerances on the irregularity. In this study the impact of the interface irregularity on the optical performances of the high resolution camera is analyzed. The deformation of the interface is transferred to the camera through flexure structure. The deformation of the flexure also impacts on the deformation of the primary mirror and degrades the optical performance. These study will help for the developing of the optical performance budget and specifying the interface condition for the high resolution camera.

[P-83] The Estimates of Land Surface Reflectance of KOMPSAT-3 and 3A Multispectal Images Using 6S Radiative Transfer Model and GOCI Based Atmospheric Information

Jong-Min Yeom, Jong-Sung Ha, Seungtaek Jeong

Korea Aerospace Research Institute

In this study, we estimated the land surface reflectance from KOMPSAT-3 and 3A multispectral images over Korea Peninsula domain. To calculate surface reflectance of KOMPSAT-3 and 3A, the atmospheric correction should be performed by incorporating with radiative transfer model and atmospheric information such as aerosol optical depth, water vapor and total ozone column. In the case of radiative transfer model, the Second Simulation of a Satellite Signal in the Solar Spectral (6S) was applied by estimating look-up table (LUT). For atmospheric condition, the physical model based method using dark target approach, separation techniques, and spectral shape matching was applied to estimate aerosol optical depth from geostationary ocean color imager (GOCI). Finally, estimated surface reflectance would be considered as one of main the value-added products and it used for disaster monitoring, agriculture and renewable energy potential fields.

[P-84] Extreme Warm Episode Prediction in the Equatorial Pacific Ocean from Remote Sensing Satellites

Seongsuk Lee[1], Yi Yu[1], Jungsung Park[2]

[1]*Chungnam National University*

[2]*Korea Institute of Atmospheric Prediction Systems, KIAPS*

Earth's oceans have accumulated about 93 % of the heat excess generated by anthropogenic forcing and natural variability. The accumulated thermal energy changes the sea surface temperature (SST) and causes sea level rise, thereby changing the physical process of the ocean. Sea level change results from changes in many different parts of the climate system and thus serves as an integrative measure of climate change. On a short time scale (decadal to multi centennial), sea level fluctuations are caused by internal variability of the climate system, such as El Nino and La Nina occurring in the equatorial Pacific Ocean. Over the past 25 years, sea level altimeters have continuously supported high-precise sea level data on global and regional scales. We investigated extreme warm, cold and normal episodes in Nino regions and analyzed the spatial tendency and correlation of the SST and ocean surface currents related to sea level change. During the extreme warm episode period, the oceanic indicators show a positive correlationin the equatorial East Pacific Ocean and relatively less significant during the cold episode period. Furthermore, we confirmed the correlation between latitude 30N-40N and longitude 140W-120W region (warm blob) and Nino regions. Temperature rise in the Warm blob region contributes to the SST and sea level rise inNino regions. The form of warm blob does not appear during the general warmedition period, but it does appear prior to the development of extreme warmedition. As a result, we can forecast the extreme warm episode using thedevelopment of the warm blob.

[P-85] Verification and Supplementation of the Device through the Measurement of Specimen Thermal Expansion in Thermal Cycling

Won-Beom Lee, Jeoung-Heum Yeon, Jong-guk Choe, Haeng Pal Heo

Korea Aerospace Research Institute

The verification test was conducted on equipment for measuring thermal expansion of the certification model in a space

environment. The cause of the measurement error derived from this test was analyzed and confirmed through a ambient test. Therefore, the test configuration was supplemented by reflecting the derived causes, and the thermal expansion verification test for the specimen in a space environment was completed.
This paper describes the measurement and supplementation of thermal expansion of specimens through the thermal cycling test.

[P-86] CMOS Image-Sensor (CIS) Developement for the CAP-W

Ilseop Lee, Jong-Pil Kong, Sang-gyu Lee

Korea Aerospace Research Institute

CEM (Camera Electronc Module) for CAP-W (Compact Advanced Payload with Wide swath) has detectors capable of detecting five multi-spectral bands for observation of vegetation and forests over a wide area. Each detector consists of a CIS (CMOS Image-Sensor) die made by CMOS process on a silicon wafer and a package that mounts the CIS die, and this detector is called CIS. In this paper, we will present the CIS development process used in the CAP-W.

[P-87] Mission Data Separation Method while Performing Consecutive Downlink Missions

JongTae Lee, Eung Shik Lee, Haeng-Pal Heo

Korea Aerospace Research Institute

In order to increase data transmission efficiency, the concept of continuously transmitting data without turning off the transmitter between missions was introduced. Ground equipment is necessary to classify the data of each mission for different post-processing. In existing case, the mission data can be distinguished in the RF receiving signal locking process required in the transmitter turning off and on process, but no longer valid. Mission data classification by mission time line is easier on the ground station but it's not easy to implement on the ground test equipment. To overcome this situation, the first CADU indication flag on reserved transfer frame header field is proposed. With using idle CADU detection, it is useful to classify and start recording of downlinked mission data into another folder by ground test equipment.

[P-88] Functional Test under Vacuum Condition of a Precise Positioning Device for a Large Optical Payload

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

Korea Aerospace Research Institute(KARI) Satellite Payload Research Division

In this paper, a functional test under vacuum condition of a precise positioning device is described for a final acceptance of it. This device is for an integration and testing of a large optical payload both under ambient and vacuum condition. Most of requirements for this device were verified at a manufacturers's factory before shipping, but final functional test was conducted at KARI's site. Mechanical Interface and Electrical interface were checked at optical bench in ambient condition. And then after moving of whole optical bench including this device and other UUT on it, proper working under vacuum condition in KARI's OTVC (Optical Thermal Vacuum Chamber). From one extreme position to the other extreme postion, this large hexapod device was smoothly working under actual UUT weight through a command from a controller located outside the chamber.

[P-89] Design of EOS (Electro-Optical Subsystem) of the CAP-W Payload for the CAS-4 Satellite

Dae-Jun Jung[1], Jong-Un Kim[2], Sang-Gyu Lee[1]

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

CAP-W (Compact Advanced Payload with Wide Swath) is Electro-Optics Camera of the CAS-4 (Compact Advanced Satellite-4) satellite. The CAP-W payload has the 5 multi-spectral channel and capability of wide range of swath width with multi-path stereo imaging by taking a national agriculture and forest images. The EOS (Electro Optical Subsystem) of CAP-W payload consist of OM (Optical Module) and CEM (Camera Electronics Module). In this paper, EOS design of CAP-W payload is introduced. Overview of EOS, design of OM (Optical Module) including optics and structure, design of thermal analysis, design of CEM (Camera Electronics Module) and performance of EOS are described.

[P-90] CEM (Camera Electronic Module) Development for CAP-W (Compact Advanced Payload with Wide Swath)

Jong-pil Kong[1], Seunghun Ha[1], Sang-Gyu Lee[1], Jiho Yun[2]

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

KARI is developing a payload called CAP-W (Compact Advanced Payload with Wide swath) that is a unique payload of CAS-4 (Compact Advanced Satellite-4). In order to meet required compactness, it is inevitable to put high priority on small size and light weight in its design. This paper describes compact design concept of CEM (Camera Electronic Module).

It plays critical role for EOS (Electro-Optical Subsystem) compactness as main component of CAP-W because its design normally defines the size of focal area of the EOS, thereby defining overall envelope of EOS. It also describes key features of CEM caused by using CMOS imager as detecting device of incoming light energy.

[P-91] Photometric Observations of Transiting Extrasolar Planets with the CBNUO Telescope

Ha-Eun Kim[1,2], Joh-Na Yoon[1,2], Taewoo Kim[3], Tobias C. Hinse[4], Yonggi Kim[1,2]

[1]*Chungbuk National University Observatory*
[2]*Department of Astronomy and Space Science, Chungbuk National University*
[3]*National Youth Space Center*
[4]*Department of Astronomy and Space Science, Chungnam National University*

The Somangnet network (Im et al. 2021) aims to use small- and medium-sized telescopes for follow-up observations of transiting exoplanets orbiting around bright host stars. CBNUO has observed 45 exoplanets for 94 days with the 0.6 m telescope since 2011. We will present recent results of our observations and analysis of a select few systems. The newly observed transiting exoplanets require frequent observations for an in-depth understanding of the physical properties of transiting planets.

[P-92] Preliminary Design of Impedance Probe for Ionospheric Anomaly Monitoring by Magnetometer and Plasma Probe (IAMMAP)

Seunguk Lee[1,2], Kwang-Sun Ryu[1], Chang-Ho Woo[1], Jang Eun Jin[1], Junchan Lee[1]

[1]*Satellite Technology Research Center (SaTRec), Korea Advanced Institute of Science and Technology*
[2]*Chungbuk National University*

The Compact Advanced Satellite 500-3 (CAS 500-3) is planning to be launched in 2025 on the Korea Space Launch Vehicle and will carry an Ionospheric Anomaly Monitoring by Magnetometer And Plasma Probe, IAMMAP. The main scientific objective of IAMMAP is to observe the Equatorial Electro Jet (EEJ) and Equatorial Ionization Anomaly (EIA) phenomena occurring especially near the equator region. IAMMAP instrument consists of Advanced Impedance Probe for Ionospheric Monitoring (AIPIM) for precise plasma density measurement and Wing Magnetometers (WMAGS) for measure magnetic field residue produced by zonal current (EEJ) distinct from the pre-existing geo-manetic field. Impedance Probe and Langmuir Probe (LP) are sub-payloads of AIPIM. Impedance Probe is developed to overcome the limitations of LP, which is affected by contamination on probe surface and the satellite structure and surface potential. In this paper, we introduce a initial result of ground experiment and further plans to improve the performance for the qualified model scheduled to deliver in 2022

[P-93] Classification and Distribution of Astronomical Records of Hyeonjong-Donggung-Ilgi

Uhn Mee Bahk[1,2], Byeong-Hee Mihn[2,3], Ki-Won Lee[4], Sang Hyuk Kim[2], Jaeyeon Hyun[2,3]

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

The Hyeonjong-Donggung-Ilgi contains the daily records made by the Sigangwon (A Royal Educational Office) when Hyeonjong, the 18th king of the Joseon dynasty, was the crown prince (1649-1659). Astronomical observations for 2,012 days were recorded in the Hyeonjong-Donggung-Ilgi, which was written over a period of 3,657 days. However, the number of astronomical events was 3,092, counting a single day record containing observations of more than one different event separately. We classified 3,092 astronomical events into 16 categories based on the Seoun-gwan-Ji (Treatise on the Bureau of Astronomy), unlike previous studies, which were based on the Jeungbomunheon-Bigo (Revised and Enlarged Edition of the Comparative Review of Records and Documents). We then grouped each category into largely five phenomena, namely atmosphere (sun, moon, cloud categories), eclipse (solar and lunar eclipses categories), daylight appearance (Venus and Jupiter categories), apparition (meteor, comet, aurora, guest star, and sunspot categories), and appulse (entering, trespassing, eating, etc. categories). Each group accounted for 58%, 0.6%, 17.1%, 20.6%, and 3.3% in total, respectively. In addition, we analyzed the distribution of the number of astronomical events based on the period. The maximum and minimum number of astronomical events were found in 1657 and 1655, respectively, with an average 309 events per year. On the other hand, the maximum and minimum number of events were observed in March and July, respectively. It was estimated that the number of events was minimum in June because of the rainy season in Korea. In the future, we intend to analyze the records of each category in detail and compare the results with those of modern computations, wherever possible.

[P-94] Trajectory Design for CubeSat Rendezvous and Proximity Operations

Kiduck Kim, Hae-dong Kim

Korea Aerospace Research Institute

In recent years, on-orbit servicing techniques for previously launched satellites such as in-orbit repair, refueling, and deorbit are being actively studied. In the development and verification stage of these technologies, CubeSats are being used more than medium and large scale satellites in terms of cost and development period. In addition, the aforementioned technologies must precede the rendezvous and proximity operation of two satellites that can be distinguished by chaser and targets. Therefore, this paper designs trajectories for rendezvous and proximity operations of the CubeSat. In order to perform the mission, of course, a thruster must be included as a actuator. However, thrusters that can be used in CubeSat have limitations in thrust levels due to their size and low power, and should be reflected in the design process. In this paper, an appropriate relative orbit is selected according to the available thrust level and the characteristics of the designed orbit is analyzed.

[P-95] Precise Alignment Method among Visual-Based Heterogeneous-Sensors for Constructing Space Object Pose Estimation Dataset

Jin-Hyung Kim, Hyunho Jeon

Korea Aerospace Research Institute

Thanks to the reusable space rocket technology, space launch cost is decreasing continuously. In addition, thanks to the rapid development of semiconductor and electronic technology, deep neural network-based AI technology, which is widely known as deep learning, can be applied to the space environment. DNN-based AI technology is attracting attention because it can respond more flexibly to situations compared to existing autonomous technology. Deep learning technology is one of the machine learning techniques, which is highly dependent on the quality of the dataset. Unlike the terrestrial environment, in the case of space applications, high-contrast images according to sunlight are predominant, and most space objects are equipped with reflective materials such as MLI and solar panels. Therefore, it is difficult to estimate the state based on visual information. With this background, in order to develop a DNN-based technology for estimating the state and pose of a space object from visual information, it is necessary to build a rich and high-quality dataset. KARI is in process of constructing an pose-visual data (i.e. 2D image, 3D point cloud, etc.) pair dataset for a 6U-class nanosatellite using a motion capture system and visual information-based heterogeneous sensors. In the case of using a motion capture system, it is possible to estimate the 6 DoF pose of the object by attaching a fiducial marker to the object. The data construction system gathers precise pose information and visual data pair about the target nano-satellite and heterogeneous visual sensors using the motion capture system. Even if the motion capture system is precisely calibrated and the mechanical mounts for nano-satellite and sensors are precisely machined, it is inevitable to be occurred positional errors. In this study, we present a method for precise alignment between coordinates between motion capture systems and multiple sensors to improve data set quality.

[P-96] Development of the Solid State Telescope Instrument of the SNIPE Mission for Observing Small Scale Ionospheric and Magnetospheric Plasma Phenomena

Jongdae Sohn, Jaejin Lee, Junga Hwang, Young-Sil Kwak, Jaeheung Park, Tae-Yong Yang, Uk-Won Nam, Won-Kee Park and SNIPE Payload Team

Korea Astronomy and Space Science Institute

In this time, we report the development of the Flight Model (FM) of Solid State Telescope (Solid State Particle Detector) instrument onboard the Korea Astronomy and Space Science Institute satellite-1 (KASISat-1) to observe small sacle ionospheric and magnetospheric plasma phenomena. The space weather instruments for Small scale magNetospheric Ionospheric Plasma Experiments (SNIPE) mission is made up of the Solid State Telescopes (SST), the Langmuir Probes (LP), the 3 Axis Fluxgate Magnetometers (MAG). The SSTs detect high energy electrons in the range of 100 keV-400 keV with the geometrical factor ($G = 0.02\ cm^{-2}\ sr^{-1}$) in two directions, one parallel direction and the other perpendicular to the earth's magnetic field. The time resolution of the SST shall be within 0.01 s. The energy resolution of the SST shall be within 10% ($\Delta E / E$). The FM of SST for the SNIPE mission have the integration testing and system testing. and then, We perform calibrations for Solid State Particle Detector using radioisotopes. We describe the results of the development and the calibration for the SST.

[P-97] Geometric Factor Analysis of Solid State Telescope for the SNIPE Mission

Hosub Song[1,2], Jongdae Sohn[1], Jaejin Lee[1], Yu Yi[2]

[1]*Korea Astronomy and Space Science Institute*

[2]*Department of Astronomy, Space Science and Geology, Chungnam National University*

We describe an analysis based on Geant4 about a geometric factor of solid state telescope (SST) for the Small scale magNetospheric and Ionospheric Plasma Experiments (SNIPE) mission. The geometric factor is a significant parameter of space particle detectors that expresses response performance depends on the effective dimensions of the detector facing a certain solid angle, and also called 'gathering power', which means the sensitivity and the efficiency for detecting energetic particles. The SST in which two telescopes are crossed is a silicon particle detector to measure electrons, and designed in consideration of

the geometric factor. Using Geant4, it is simulated to operate according to the designed geometric factor in the detected electron energy range as 100–400 keV. As a result, it is verified that in a given environment, the geometric factor of SST is calculated as 0.02 $cm^2 \cdot sr$, which is the expected value.

[P-98] A Study on Method of Nanosatellite Thermal Model Correlation by Optimization Algorithm

Ji-Seok Kim[1], Hae-Dong Kim[1,2]

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

As the missions of satellites have recently diversified, the role of nanosatellite is also becoming important. Accordingly, there are many mission payloads or high heat loads in nanosatellite, and it leads to increase the importance of thermal design and thermal conrol of nanosatellite. However, due to the structure and development characteristics of nanosatellite, the uncertainty of thermal model and thermal design is relatively high compared to large practical satellite. In order to reduce the uncertainty, thermal vacuum test (TVT) are conducted, and thermal model correlation process is performed based on the TVT data. However, the thermal model correlation process generally takes a lot of time through trial and error. In particular, because nanosatellite have a structure in which several stack frames and payloads are connected to one frame, it is thermally connected if there is no specific thermal isolation. Therefore, we tried to efficiently reduce thermal uncertainty by proposing a method for correlation of nanosatellite thermal model using an optimization algorithm in this study.

[P-99] A Study on the Method of Calculating the Optimal Launch Period of the Asteroid Exploration Mission

Bangyeop Kim

Korea Aerospace Research Institute

A basic study was conducted on how to determine the launch timing of a space probe targeting an Earth-approaching asteroid. In order to determine the launch timing of the space probe which is heading for an asteroid approaching the Earth's orbit, accurate current orbit information of each asteroid must be obtained first of all. Next, pre-scenario information such as Earth's orbit information, main engine performance information of the probe, the number of gravity-assisted maneuvers, and maximum flight time limit must be determined. Using this information and open source path finding programs such as PyKEP and EMTG, a method for finding the launch time of an asteroid probe was studied.

[P-100] Development Plan for High Thrust Electric Propulsion System in KARI

Holak Kim, Su-kyum Kim

Korea Aerospace Research Institute

Electric Propulsion is one of the most promising propulsion systems for space applications such as space exploration, orbit raising, station keeping, attitude control, etc. Korea Aerospace Research Institute (KARI) is recently started to develop 200 mN class high thrust electric propulsion system for GEO satellite missions in near future with AP satellite and Korea Advanced Institute of Science and Technology (KAIST) from 2021 to 2026. The key requirements of the electric thruster are 200 mN of thrust, 1500 s of specific impulse, and 1.25 MNs of total impulse. In this presentation, detailed plan for development of EP system will be discussed.

[P-101] Global MHD Simulation of Mercury's Magnetosphere

Kyung Sun Park, Dae-Young Lee, Cheongrim Choi

Department of Astronomy and Space Science, Chungbuk National University

We performed global MHD simulations of the Mercury's magnetosphere to answer the question, how magnetic reconnection drives magnetosphere under variables solar wind conditions with IMF angles. The solar wind near Mercury orbit used in simulations are velocity of 300 km/s, number density of 30 cm^{-3}, and magnetic field strength of 20 nT for weak solar wind cases. The number of grid points is (nx ny, nz,) = (500, 200, 200) with grid spacing 0.05 RM. The sampling time is 5sec during the simulation. The magnetic reconnection occurs quickly at the dayside and tail region, and the tail reconnection region are located close to the Mercury for pure southward IMF case. The small chain plasmoid with reconnection are ejected in tail. The plasma sheet becomes thin after the strong reconnection. The dawn-dusk asymmetries in the plasma sheet appear for cases of 315° and 45° of IMFangle.

[P-102] Korea Pathfinder Lunar Orbiter Mission Flight Dynamics Subsystem Operation Preparation Status

Young-Joo Song[1], Jonghee Bae[1], Young-Rok Kim[1], SeungBum Hong[1], Jae-ik Park[1], Jun Bang[1], Donghun Lee[2]

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

Recently, the Korea Pathfinder Lunar Orbiter (KPLO) Flight Dynamics Subsystem (FDS) has been successfully designed and

implemented. For the successful operation of the KPLO FDS, Korea Aerospace Research Institute (KARI) is now devoting many efforts to operate FDS successfully. FDS operation concepts are being established, and relevant template scenarios are developed for both nominal and contingency mission cases. The implemented detailed function of the FDS and its workflows are double-checked with Space Exploration Engineering (SEE) Co., a US company that has past real-flight operation experiences on the lunar mission. Also, KARI and the National Aeronautics and Space Administration (NASA) Johnson Space Center (JSC) is making significant efforts together to be ready for the joint operation of the KPLO. Current work will discuss the operational preparation status for KPLO FDS.

[P-103] Payloads Interfaces for the Korea Pathfinder Lunar Orbiter (KPLO): Focusing on the Event Schedules from System Integration Perspective

Jae-Hoon Song

Korea Aerospace Research Institute

The Korea Pathfinder Lunar Orbiter (KPLO) is being developed as the first space explorer of Republic of Korea. Six payloads including ShadowCam recruited by NASA were accepted for the KPLO to fulfill a variety of space missions. In this article, a brief history of the payloads interfaces for the KPLO are described from system integration perspective especially with the event schedules.

[P-104] Precision Control Technologies for Free-Space Laser Communication and Space Telescopes

Hyungjoo Yoon

Korea Aerospace Research Institute

The presentation provides a brief overview of precision control technologies which are essential to implement the free-space laser communication and the space telescopes. These areas are attracting a lot of interests among academics and industry in Korea, because they can be potential candidates for the future deep-space exploration program of Korea. The presentation briefly introduces the basic concept of the free-space laser communication technology as well as the control issues underlying in this challenging field. In addition, it presents other control issues required to implement the sate-of-art space telescope system. These control issues consists of precision spacecraft attitude control, beam-pointing control, beam jitter rejection, and the wavefront control using the adaptive optics technology. The evaluation of these technologies of Korea is also presented in the conclusion.

[P-105] KPLO Trajectory Correction Maneuver Design and Trajectory Operation Procedure Considering Orbit Maneuver Thruster Calibration Burn

SeungBum Hong, Jae-Ik Park, Young-Joo Song, Jonghee Bae, Jun Bang, Young-Rok Kim

Korea Aerospace Research Institute

The Korea Pathfinder Lunar Orbiter (KPLO) will utilize four Orbit Maneuver Thrusters (OMTs) and eight Attitude Control Thrusters (ACTs) for burn execution. Especially, OMTs will be used during the critical burns such as a deterministic trajectory correction maneuver (TCM) and lunar orbit injection burns since they will be used for large burns bigger than 10 m/s. However, OMTs are newly developed for the KPLO mission, so no data in the space environment is available. WSB/BLT trajectory used for KPLO's translunar transfer is a highly sensitive trajectory; precise impulse is very important. Therefore, we are considering the OMT calibration burn in the early phase of translunar phase to estimate thrust precisely. This study shows the result of TCM design considering OMT calibration burn and provides a glimpse of OMT calibration operation procedure.

[P-106] Lunar Landing Sites Analysis for Lunar Manned Mission

Joohee Lee, Dongyoung Rew

Korea Aerospace Research Institute

After the Apollo lunar landing program in the United States from 1969 to 1972, the lunar exploration plan, which had been stagnant for a while, began to be restarted by Asian countries such as Japan, China, and India in the mid-2000s. Korea also plans to launch a lunar orbiter in August 2022 to explore the moon. And in 2024, NASA in the United States is preparing for the Artemis Program to land humans on the moon again. Accordingly, in this paper, we investigated and analyzed the candidate areas for landing sites on the lunar South Pole to confirm the existence and utilization of water by humans landing on the moon.

[P-107] Thermal Analysis for Conceptual Design of Thermal Control System for a Manned Habitation Module on Lunar Surface

Younkyu Kim[1], Ter-Ki Hong[2], Jongwon Lee[1], Joohee Lee[1]

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

A manned habitation module is important system for space

crews to safely conduct exploration activities on lunar surface, and thus it can be utilized to habitation base or mobile robot. In this study, thermal analysis is conducted for conceptual design of thermal control system for the habitation module on lunar surface. First of all, the thermal model of lunar surface is designed, simulated, and validated by comparing the simulated surface temperature value to real lunar temperature data and reference data. In addition, the simple conceptual model for thermal analysis of the habitation module is designed and simulated using the thermal model for lunar surface. Through the thermal simulation, average temperature of conceptual model is obtained during lunar one day with 29 earth days and lunar latitude. Moreover, the thermal analysis is conducted for various models applying thermal control system with passive elements such as MLI and radiator and active elements such as heater. From the results, the conceptual design of thermal control system is suggested and moreover, the system requirements for survival in lunar harsh thermal environment can be also obtained.

[P-108] Development of Space-Related STEAM Activities Using 3D Printing, Coding, and Robotics Technologies

Youn-Jeong Heo[1,2], Hyoungbum Kim[1], Yonggi Kim[1]

[1]*Chungbuk National University*
[2]*Creative Education Lab., RTS*

With the development of science and technology, changes are taking place in industrial structures and occupations, and changes are also required in education for fostering future talents. According to the 2022 revised curriculum implementation plan announced by the Ministry of Education, it is emphasized that the 2022 curriculum should contain basic competencies of the future society such as students' self-directed learning ability, and rapidly changing social changes including artificial intelligence. Accordingly, it is required to develop educational programs that can actively respond to the changes in the curriculum through various teaching and learning methods. Therefore, this study intends to develop space-related STEAM activities using 3D printing, coding, and robotics technologies so that they can be utilized as resources and learning materials for students and educators. These activities can satisfy student's curiosity and interest in space science and astronomy, and increase their understanding of space technology. Ultimately, it is possible to cultivate the adaptive capacity of the future society and the right awareness and attitude toward space development.

[P-109] Processing Test of KOMPSAT-5 Image with ALOS PALSAR DSM

Tae-Bong On

Korea Aerospace Research Institute

In this paper, processing test result of KOMPSAT-5 data with ALOS PALSAR global digital surface model, which has approximately 30 meters of spatial resolution, is briefly presented.

[P-110] Analysis of Daytime Tracking Performance of Satellite Laser Ranging System

Mansoo Choi[1], Su-Sung Jeong[2], Sang-Young Park[2]

[1]*Korea Astronomy and Space Science Institute*
[2]*Hanwha Systems*

SLR (Satellite Laser Ranging) measures the two-way flight time of ultra-short laser pulses from a ground station to a satellite with a millimeter ranging accuracy, which has been used for precise orbit determination, space geodesy, earth physics, space situational awareness and so on. KASI (Korea Astronomy and Space Science Institute) has conducted SLR project since 2008 for the purpose of space geodesy research, technology development of precise orbit determination and basic infrastructure establishment of space situational awareness.
Currently, KASI has built SLR in Sejong and Geochang, and utilized SLR data to verify the precise orbits of the STSAT-2C and KOMASAT-5. In recent years, due to the fall or collision of space debris, its satellites have been threatened, and in terms of security, laser tracking of space objects is receiving great interest in order to protect their own space assets and protect the safety of the people.
In this study, link budget analysis according to the performance of the main components of SLR was performed. In addition, the daytime laser tracking performance for LAGEOS and GK-2B satellites were analyzed through the link budget analysis results.

[P-111] Role of the IMF By in Electric Field Disturbance in the Ionosphere

Ram Singh[1,2], T. K. Pant[1], Yong Ha Kim[2], Young-Sook Lee[2]

[1]*Vikram Sarabhai Space Centre (VSSC), Space Physics Laboratory, Thiruvananthapuram, India*
[2]*Department of Astronomy and Space Science, Chungnam National University*

The geomagnetic activity is mainly driven by the z-component of interplanetary magnetic field (IMF Bz), which dominates all solar wind coupling functions. It is also well known that the prompt penetration (PP) electric field is directly related to the turning of southward IMF Bz conditions. In this work, we report an observation of PP electric field associated with reorientations of IMF By under the steady northward IMF Bz

condition. For this study we have analyzed total polar cap potential (Φpc) in the northern hemisphere, mid-latitude SuperDARN radars (i.e., Hokkaido and Blackstone), geomagnetic field variations (at high, mid, and low latitudes), and vertical plasma drifts nearly at the antipodal points over the Asian and American sectors. The vertical plasma drifts, SuperDARN echo power (dB), geomagnetic field variations, and Φpc are well correlated with IMF By reorientations, indicating that the disturbances in the electric field at low latitudes are caused by IMF By. Simultaneously, periodic oscillations in ionospheric drift, dB (echo power), geomagnetic field, and Φpc suggest that these oscillations are caused by fluctuations in DP 2 currents and reverse convection in the polar region.

[P-112] Revisiting Magnetic Field Configurations of Solar Energetic Particle Source Regions by Synchronic Potential Field Source Surface Model

Jinhye Park[1], Hyun-Jin Jeong[2], Yong-Jae Moon[1,2]

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

We revisit magnetic field configurations of the source regions of 6 solar energetic particle (SEP) events accelerated near or behind the limbs. For this, we use a new potential field source surface model (AI-PFSS) at $2.5R_{\odot}$ at a near real-time basis using AI-generated farside magnetograms by Jeong et al. (2020). By comparing AI-PFSS and conventional PFSS from HMI synoptic data (HMI-PFSS), we find several interesting differences on the SEP source regions and their magnetic field configurations between them. 1) The structure and size of source active regions (ARs) are significantly changed. The total unsigned magnetic field fluxes of the ARs are mostly stronger in AI-PFSS rather than HMI-PFSS except for one case. 2) In particular, newly emerging ARs are observed near the SEP source regions in the AI-PFSS for two cases. The locations of the emission features in the full-sun EUV synchronic maps are consistent with ARs in the AI-PFSS. 3) The inversion lines are remarkably changed due to the appearance and/or disappearance of Ars for one case. The propagation directions of the source eruptions in the running difference EUV images are consistent with the configurations of the inversion lines in the AI-PFSS. 4) The source polarity is changed for one event. The polarity of the spacecraft magnetic footpoint, calculated by Parker spiral field assumption, is also different for the other event. The polarity in the AI-PFSS is consistent with that from in-situ measurement. This study shows that AI-PFSS is able to give a better understanding of SEP source regions and their magnetic field connections.

[P-113] Observation of Eastward Plasma Convection Flow in the High Latitude Ionosphere Using SuperDARN Radar

Seok-min Song, Young-Sook Lee, Yong Ha Kim, Ram Singh

Department of Astronomy and Space Science, Chungnam National University

We report the observation of eastward flow plasma convection in the post-midnight sector during summer using Super Dual Auroral Radar Network (SuperDARN). For this study, we used Pykkvibear radar (63.86°N 19.20°W, Pyk) looking at eastward including 16 beams, of which the azimuth angle of 53°-56° was specifically used to observe plasma zonal motion. The observations are able to confirm the eastward flow of convection from the line-of-sight velocity. We checked the observed echoes from Pyk site in terms of time and height. The observed plasma flow was consistent with the results from Active Magnetosphere and Planetary Electrodynamics Response Experiment (AMPERE), which suggested the inflow and outflow of the plasma were overlapped each other. Especially during substorms in summer, we saw the radar echoes in motion eastward as well as upward/downward for 00^{h}–04^{h} [UT]. The evident vertical motion of plasma was found in the filed-aligned current system observed by the AMPERE. We will present the observations of energetic electron flux using POES/TED,SEM-2 over the region spatially and temporally coincided with the plasma motion observed.

[P-114] Comparison of the WSO and GONG Magnetogram Synoptic Maps for 3-D Global MHD Simulation of the Solar Corona and Solar Wind

Junmo An

Department of Astronomy and Space Science, KHU

The magnetogram synoptic maps of the Sun are a primary observation-based source of many 3-D global Magnetohydrodynamic (MHD) simulation models for the solar corona and solar wind. Here we use magnetogram synoptic maps obtained from the Wilcox Solar Observatory (WSO) and Global Oscillation Network Group (GONG) as input data of a 3-D global MHD simulation code, named REPPU (REproduce Plasma Universe), to investigate differences depending on the synoptic maps used. We show the solar corona and solar wind produced by the MHD simulation can have some significant differences, even though synoptic maps used may look similar in general. Lastly we discuss possible reasons for these results.

[P-115] Development of the Mechanism Control

Electronics and the Filter Wheel Assembly of the CODEX

Heesu Yang[1], Juhyung Kang[1,2], Seonghwan Choi[1], Jihun Kim[1], Ji-Hye Baek[1], Jongyeob Park[1], Jinhyun Kim[1], Yeon-Han Kim[1], Suchan Bong[1], Kyung-Suk Cho[1]

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

The COronal Diagnostic EXperiment (CODEX) is a KASI-NASA joint mission designed to measure the electron's temperature and velocity in the corona via the polarized brightness ratio of carefully selected UV-band filters. Therefore the mechanisms of the CODEX have to work appropriately without failure. We present the development processes of the Mechanism Control Electronics (MCE) and the Filter Wheel Assembly (FWA). The MCE controls two FWAs, an aperture door, and a launch lock. The designs of the MCE and the FWA are considered the vacuum, temperature (-50-95C), vibration (random < 30 G), and radiation (> 20 krad) conditions at the launch and during the operation in space. The engineering model of the MCE and the FWAs are passed several tests: TVac, Vibration, TID, and SEU. After the critical design review in October, we will build a flight model in 2021 and test them with the acceptance level. After delivering the MCE & the FWAs to NASA, we will assemble them into the coronagraph. The CODEX is planned to launch and install in the International Space Station (ISS) by 2023.

[P-116] Poloidal-Toroidal Representation of Magnetic Field and the Sufficient Conditions for It

Sibaek Yi, Gwangson Choe

Kyung Hee University

The decomposition of the magnetic field in an infinite domain outside a star into a poloidal part and a toroidal part has long been used in the solar, stellar and planetary dynamo community. The poloidal-toroidal representation is known to be possible in the spherical, Cartesian and cylindrical coordinate systems with one coordinate surface as the reference surface, in which the field lines of the toroidal magnetic field entirely reside. However, no study has yet addressed the problem of what else coordinate systems accommodate the poloidal-toroidal decomposition. We have derived sufficient conditions for a scalar field to be a reference variable for a poloidal-toroidal representation. It has been found that the components of the metric tensor should satisfy certain conditions. This result tells why the circular cylinder surface, though looking feasible, cannot be a reference surface for a poloidal-toroidal representation.

[P-117] Strategy of Utilizing Bohyun Astronomical Observatory for Space Science

Young-Sook Lee[1], Yong Ha Kim[1], Young-Sil Kwak[2], Changsup Lee[3], Joeng-Han Kim[3], Jong-Kyun Jung[2], Jae-heung Park[2], Hee-su Yang[2], Kwan-Hyuk Kim[4], Jung-Hyeon Cho[2], Su-yeon Oh[5]

[1]*Chungnam National University*
[2]*Korea Astronomy and Space Science Institute*
[3]*Korea Polar Research Institute*
[4]*Kyung Hee University*
[5]*Chonnam National University*

Many ideas have been suggested for enhancing the utilization of Bohyun Astronomical observatory for space science. The ground-based observations in space science can be classified according to the observation target of the suggeseted instruments: density, temperature and wind with lidar (radar); temperature with 2D mapper; wind with Fabry-Perot instrument; TEC-temporal/spatial variations with GNSS scintillation monitor; communication with/tracking satellites with UHF communication station; muon, neutron detection with the detectors; seeing measuring with the corresponding instrument; EMIC wave with search coil magnetometer. We will present the details of the suggested instruments, the measuring object and the anticipated cost. In addition, the preference of scientists will be surveyed on site at the KSS conference.

[P-118] Investigation on km-Scale Variations of Mesospheric OH Temperatures from Sky Spectra of Sloan Digital Sky Survey (SDSS) in 2011-2018

Yong Ho Lee, Yong Ha Kim, Young Sun Lee

Chungnam National University

From the sky spectrum (15150-15800 Å) of Sloan Digital Sky Survey (SDSS), which has been operating at Apache Point Observatory (32°N 105°W) in 2011-2018, we investigated km-scale variations of temperatures in the OH airglow layer at ~87 km. Based on the optical thin nature, we selected R_1 (2) and R_1 (3) lines in OH (4-2) band for OH rotational temperature estimation. Since the OH rotational population is in local thermodynamic equilibrium (LTE) at the OH airglow layer, the OH rotational temperature represents a mesospheric temperature at that altitude. The field of view of SDSS spectroraph subtends 4 km by 4 km at the OH layer, and are probed by 35 sky points. We obtained independently OH temperatures from those sky points, thereby allowing to make a temperature map over the 4 km × 4 km layer for the exposure time of 500 sec. We analyzed the time series of the temperature map over 40 min by using the 2D Lomb-Scargle method. The Lomb-Scarge analysis showed nearly constant wavenumbers from the series of the temperature maps, despite the migration of the observed

sky area during the 40 min period. The constant wavenumber variation should be due to the instrumental variation among the 35 sky measurements, rather than due to km-scale atmospheric waves. We also analyzed the effect of the observing elevation angle on the OH temperatures, but found no significant temperature variation with the elevation angle. These null results confirm that the OH airglow layer is thick enough to show km-scale variation or elevation variation in the estimated OH temperatures, even from the spatially high resolution observation. However, we were able to derive semidiurnal temperature variation of 50 K from the continuing series of the temperature maps over the entire night.

[P-119] Filamentary Structures of Solar Prominences

Gwangson Choe, Sibaek Yi

Kyung Hee University

Solar prominences are cool and dense material suspended in the hot and tenuous solar corona. Solar prominences are thought to be formed by condensation of hot coronal plasma by radiative cooling instability. In solar prominences, ceaseless counter-streaming flows are observed, which are considered to be a necessary condition for maintenance of the cool structure. Some people suggest a dynamic model of solar prominences, in which the cool material should be continuously supplied from and depleted into the lower atmosphere. We propose that the counter-streaming flows and the filamentary structures are the inseparable cause and effect in thermal condensation instability in the presence of shear flows. By a linear stability analysis, we have found that the eigenfunction of the thermally unstable mode is always spiky like delta functions unless the speed of shear is extremely small. This finding may explain why astrophysical objects cooler than the surroundings mostly have filamentary structures.

[P-120] Comparison and Analysis of Geomagnetic Data of KSWC and INTERMAGNET

Kyu-Cheol Choi[1], Dae-Kyu Shin[1], Jung-Hee Jo[2]

[1]*SELab. Inc,.*

[2]*Korea Space Weather Center, RRA*

The Korea Space Weather Center (KSWC, RRA) operates geomagnetic observatories in Icheon, Gangneung and Jeju. To verify the reliability of geomagnetic observations in Korea, 17 geomagnetic observations near the Korean Peninsula were compared and analyzed by the INTERMAGNET. Geomagnetic data were calculated before and after removing solar regular change (Sr) from the geomagnetic horizontal component (H) for one year 2016. Icheon and Gangneung geomagnetic observations showed a high correlation between the values before and after the removal of Sr and the values of the INTERMAGNET observations, while Jeju showed a high correlation between the values after the removal of Sr. Jeju Island was changed by reflecting the characteristics of sea and basalt. Also, this change is thought to have affected Sr. The high correlation of values after the removal of Sr shows high reliability of geomagnetic observations in Icheon, Gangneung, and Jeju, like those from internationally recognized stations, and is expected to be used for domestic and foreign research.

[P-121] Seasonal Variation of Cosmic Ray Intensity at Oulu Neutron Monitor

Suyeon Oh[1], Jaesik Jeong[1], Jongil Jung[2]

[1]*Chonnam National University*

[2]*Chungnam National University*

Neutrons are representative secondary particles that are generated by interactions between primary cosmic rays, mostly protons and the nuclei of atmospheric gas compounds. The intensity of neutrons has a typical modulation with various periods and reasons, such as diurnal and solar variation or transient events. This study examines that neutrons have seasonal variations using the daily data at the Oulu neutron monitor. Additionally, we introduce the normalization method for daily data to eliminate the effects of solar activity across time. We use two transformations: transformations with respect to the grand mean and yearly mean. We also discuss the origins of seasonal variations at Oulu neutron monitor.

[P-122] Fast Generation of 3D Solar Coronal Density Data from 2D Synoptic Magnetic Field Based on MAS by Deep Learning

Sumiaya Rahman, Seungheon Jeon, Hyun-Jin Jeong, Yong-Jae Moon

School of Space Research, Kyung Hee University

Generation of 3D coronal electron number density distribution is more convenient and faster using deep learning models. On the other hand, Magnetohydrodynamic (MHD) simulation process is quite complicated and requires a lot of computing resource and time. Therefore, in this study we applied a well-known deep learning model Generative Adversarial Networks (GANs) to generate 3D coronal electron number density distribution from photospheric solar magnetic fields. For this, we consider 2D synoptic map in magnetic field as an input and coronal electron density for given solar radii as an output, which was simulated with the MHD Algorithm outside a Sphere (MAS) model. 4272 pairs of inputs and outputs are used for training and testing from 2010 June to 2020 May. For this work we train 21 deep learning models to cover from 2 to 30 solar radii. We find that the generated 3D electron densities are quite

consistent with those of the simulated one at not only lower solar radii but also higher radii: specifically, high mean correlation coefficient (0.95) and excellent mean Structure Similarity Index (SSIM) value (0.99). It is noted that the computing time of solar coronal density distribution from 2 to 30 solar radii by our deep learning models is about 35 secs under NVIDIA TITAN XP GPU, which is much less than a typical simulation time of MAS. The generated coronal density distribution can be used for space weather models on real-time basis.

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[P-123] Comparison of CME Mass from Three Different Observations: SOHO/LASCO, STEREO/SECCHI COR2, and Stereoscopic Ones Using GCS Model

Hyeonock Na[1], Yong-Jae Moon[1,2]

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

In this study, we compare coronal mass ejection (CME) mass determined from three different observations: (1) SOHO/LASCO C3, (2) STEREO/SECCHI COR2-A, and (3) stereoscopic observations (STEREO/SECCHI COR2 A and B) using a graduated cylindrical shell (GCS) model. For this study, we select 24 partial halo CMEs observed at the SOHO/LASCO and also simultaneously observed at the STEREO/SECCHI from 2008 to 2013. In the single observation case, the CME mass is determined from the assumption that all CME electrons lie on the plane of the sky. The CME mass from the stereoscopic observations is estimated by the assumption that all electrons of the CME lie to the plane along the propagation direction. The propagation direction of the CME is estimated by using the GCS model. In this study, the CME mass estimated from the GCS model is taken from the KinCat catalog. As preliminary results, we find that the correlation coefficients between the CME mass estimated from three different observations are similar to one another: CC = 0.59 for LASCO vs. the stereoscopic observations, CC = 0.59 for COR2-A vs. the stereoscopic observations, and CC = 0.54 for LASCO C3 and COR2-A. We also find that on average, the CME mass from the stereoscopic observation are about two times larger than those of the two single observations, which is consistent with our previous study (Na et al. 2021).

This work was supported by institute for information & communications Technology Promotion (IITP) grant funded by the Korea government (2018-0-01422, Study on analysis and prediction technique of solar flares).

[P-124] Thermal Analysis for the LSMAG Payload Instrument on the Lunar Surface

Hyeonhu Park[1], Ho Jin[1], Jehyuck Shin[1], Yunho Jang[1], Woohyun Jo[1], Dukhang Lee[2]

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

In the case of a payload instrument for space exploration, thermal analysis is an essential task to ensure the manufacturing requirements, operation stability and thermal design is necessary for the payload to maintain within the operating temperature range. The Lunar Surface MAGnetometer (LSMAG) is developing as a payload of the Commercial Lunar Payload Services (CLPS) and will measure the magnetic field on the lunar surface during Lunar daytime. Since the average temperature of the lunar surface varies greatly depending on the latitude during daytime, thermal design is required accordingly. In this study, we performed a thermal analysis of the boom units including magnetic field sensors which are exposed outside the lander during daytime at equator and 80 degrees latitude. Also, we just considered a passive thermal control system using Multi-Layer Insulation (MLI). We verified this temperature model by comparing it with the lunar surface temperature data of Apollo 17. This model is modified based on the TherMoS Regolith Model. As the results, the ratio of absorptivity and emissivity (α/ε) of MLI (10 layers) outer-cover materials was determined to keep the operating temperature range by latitude. Tedlar and Teflon satisfying $\alpha/\varepsilon < 0.4$ at the equator, and Kapton and Betacloth satisfying $0.6 < \alpha/\varepsilon < 1.0$ at 80 degrees latitude met the payload instrument temperature requirements.

[P-125] Performance Test of an AMR and Accelerometer on the LSMAG Attitude Module

Woohyun Jo, Ho Jin, Hyeonhu Park, Jehyuck Shin, Yun-Ho Jang

School of Space Research, Kyung Hee University

To obtain a boom attitude information within one degree requirement in a lunar gravity environment, An accelerometer is required. Therefore, Magnetometer and a MEMS accelerometer is adopted into LSMAG. AMR is used not only for measuring unpredicted large magnetic field values or confirming the effect of magnetic distortion from satellites, but also for checking attitude information. And, Accelerometer is also used together with AMR to obtain attitude information against gravity direction. The performance verification of AMR is performed inside a Helmholtz coil by comparing with the measured magnetic field value of the reference sensor that was verified by the KRISS calibration facilities. The performance verification of the accelerometer is carried out by a laboratory-level test

module using an FPGA. As a result of the LSMAG EM module test, We confirmed that AMR had a less than 10 nT resolution in the measurement range of ± 60 μT. In the case of the accelerometer, the resolution showed 25 μg. In gravity environment on the lunar surface, the acceleration resolution can converted to 150 μg, which is about 0.01 degree resolution. it satisfies the requirement of 1 degree. In the future, we plan to test the stability and reliability of sensors through space environment tests.

[P-126] A Study on the Security Management Plan for Sharing Technical Data through Collaboration with Partner Companies for Satellite Development for KOMPSAT

Chul Kang

Korea Aerospace Research Institute

In order to develop a KOMPSAT, it is necessary to cooperate with a joint design company and manufacturer for the design, manufacture, and assembly test of each part of the satellite. Through collaboration, design, verification, manufacturing, testing, and delivery of each part of the satellite are made. Technical documents are necessary for a series of activities such as these, and technical documents including specifications, production drawings, procedures and test reports are included in these documents. In addition, development work is carried out by sharing these technical documents at each development stage. Up to now, collaboration, that is, sharing management of technical data, has been shared and managed through direct delivery of e-mail systems and hard copy documents. This management method has security management problems such as e-mail hacking, network vulnerabilities, and problems such as loss of documents. Therefore, it is intended to establish a system structure and operation management system by suggesting an operation plan for solving the security problem of sharing technical data and managing the sharing of technical data through external collaboration through online.

[P-127] Ocean Surface Underneath Tropical Storms Observed by KOMPSAT-5 Satellite in 2021

Chiho Kang[1], Dong-Min Lee[2], Ho-Il Cho[2]

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

The roughness of ocean surface, which is driven by wind and waves, can be the source of the backscatter of the synthetic aperture radar (SAR) signal, of which can penetrates clouds and arrive at the Earth's surface and the return to the satellite at any time of day. So, ocean surface underneath tropical storms can be also detected using SAR. As a result of it, SAR system can provide information on ocean surface which cannot otherwise be obtained below the cloud with finer resolution. During 2021, there have been trials to observe ocean surface for retrieving the roughness underneath large-scale tropical storms by applying KOMPSAT-5 SAR wide swath mode. In this paper, we summerize the campaign to observe ocean surface underneath tropical storms and present resultant imagery.

[P-128] Measurement of Precise Alignment for Satellite Thruster Using Laser Tracker

Ju-Hyun Kim, Seung-Yong Min, Jung-Su Choi, Dong-Woo Lee, Eui-Keun Kim

Korea Aerospace Research Institute, KARI

The most used method when measuring the precise alignment of satellites is to measure the azimuth/elevation angle using Theodolite. This method needs the theodolite to collimate the optical mirror that reflects the laser on the measurement object. However, due to the structure of the satellite, a situation in which collimation is difficult may occur. In order to solve this problem, the Korea Aerospace Research Institute conducted precision alignment measurement for the thruster using a laser tracker and a specially manufactured jig. This paper describes the thruster measurement procedure (jig adjustment, measurement procedure) using a laser tracker.

[P-129] Introduction of a DC Supply Noise Measurement Technique Using a Voltage-Controlled Oscillator

Hyojun Kim

Korea Aerospace Research Institute

DC supply noise can degrade the performance of the electronic components (e.g. amplifier or analog-to-digital converter) in the spacecraft. To measure the supply noise with high DC voltage, an oscilloscope with a high-attenuation probe or a spectrum analyzer with a DC block filter can be used. The probe or the filter prevents high voltage damage to the measurement instrument due to high DC voltage as an input signal, but they reduce the input dynamic range of the supply noise and filter out the low-frequency noise, respectively. In this study, a technique for measuring DC supply noise using a voltage-controlled oscillator (VCO) is presented. The VCO that converts voltage information to frequency information helps to measure the supply noise using a spectrum analyzer. This technique does not require any attenuator or filters that degrade the measurement performance.

[P-130] Robust Double Fitting Edge Spread Function Construction for the Vibration Sensitive

Slanted Edge Method

Dongok Ryu

Korea Aerospace Research Institute

The performance of the electro-optical (EO) payload system can be characterized based on modulation transfer function (MTF) estimation using the slanted edge method. The integrated and assembled EO payloads are sensitive to vibration conditions in the laboratory environment. This presentation introduces the robust double fitting method of the edge spread function (ESF) construction from the vibration perturbative knife-edge images from EO payload in slanted edge methodology. The new fit method of the ESF has tested both cases of the optical design and the EO payload system measurement with a comparison among the conventional MTF estimation methods.

[P-131] Dual MCP (Master Command Panel) Design of GFTS (Ground Flight Termination System) Based on Ethernet Protocol

Young-Jo Bae, Dong-Hyun Kim, Yong-Tae Choi, Jae-Hoon Jeong

Korea Aerospace Research Institute

GFTS (Ground Flight Termination System) is a command system to transmit a flight termination control command to space launch vehicle for safety purpose. Legacy MCP (Master Command Panel) was designed as a single equipment (no redundancy) based on PLC protocol. To enhance operational reliability and flexibility, MCP was designed and developed as dual (redundancy) equipments based on multicast ethernet protocol. And switchover function between two MCPs were tested successfully in Naro Space Center.

[P-132] Performance Analysis of RF Signal Receiving Techniques based on Flight Simulation Test

Na-Gyun An, Dong-Hyun Kim, Sun-Ho Kwon, Jeong-Woo Han, Chun-Won Kim, Tae-Jin Lee, Min-Seok So, Jae-Hoon Jeong

Korea Aerospace Research Institute

In this paper, we analyze performance of RF signal receiving techniques. In order to analyze performance, We took Flight simulation Test at Naro space center and received PCM data from on-board transmission. We recorded real-time IF data on recorder and replay data according to RTR Configuration. we analyzed RTR performance by using DPS (Data Processing System) Algorithm. DPS Algorithm calculates the number of Frame error count depanding on signal quality. After comparing the results by the number of Frame error count, we found optimized combination of RF signal receiving techniques.

[P-133] Overview of Geo-Kompsat3 Development Project

Jimo Yang, Eungsik Park

Korea Aerospace Research Institute

Geo-Kopmsat3 development project started in April 2021. Geo-Kopmsat3 development project aims to provide public satellite communication services to strengthen national disater and safety response capabilities and prepare for future mobile communication paradigm shift. The main contents are to develop one 3.5 ton geostationary orbit communication satellite equipped with three types of communication payloads, a control system for satellite, and a ground system for verification of three types of communication payloads.

[P-134] 1.5 m Autocollimation-Alignment Telescope Development

Youngchun Youk, Dongok Ryu, Hyung-Yun Noh, Sinwook Kim, Jong-Pil Kong, Haeng-Pal Heo

Korea Aerospace Research Institute

An Autocollimation-Alingnment Telescope (AAT) is a very useful metrology instrument for verify an optical system under test. Especially, AAT will be used to align and measure the performance and characteristics of an electro-optical camera. Like other common metrology tools, the performance of the AAT must be accurate enough to clearly identify the system under test. To develop the AAT, we focused on the nominal design, the manufacture of the two optical mirrors, the structural elements for alignment, the alignment and assembly, and the environmental conditions. In this paper, we will cover the assembly and performance measurement results of AAT.

[P-135] A Study on the Difference in Radiated Emission of RF Equipment according to the Type of Satellite

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

Korea Aerospace Research Institute

Currently, there are various types of satellites such as Multi-Purpose Satellite and Compact Advanced Satellite as domestic satellites. Internal electronic equipment used for each satellites is not the same. electromagnetic compatibility of all electronic equipment should be executed to ensure before installed on the satellite. Each satellite has a different limit line for Radiated Emission. This paper discusses E-field Radiated Emission experimental data in the RF equipment equally mounted on various satellites. In this paper used the data

applied to Korea Multi-Purpose Satellite, Compact Advanced Satellite and Korea PathFinder Lunar Orbiter.

[P-136] Comparative Analysis of Google DEM and Flight Simulation Test Result for the Blind Mask of Ground station

Tae-Jin Lee, Dong-Hyun Kim, Sun-Ho Kwon, Jeong-Woo Han, Chun-Won Kim, Na-Gyun An, Min-Seok So, Jae-Hoon Jeong

Korea Aerospace Research Institute

Recently, NARO Space Center performed the flight simulation test for preparation of KSLV-II (Nuri) Launch Mission. Cause the complex terrain of NARO Space Center, LOS (Line of Sight) analysis for the ground station should be considered prior to flight simulation test. During the initial phase, the analysis was performed based on SRTM, which is the open source data of the NASA, but due to the problem of its precision, there was a significant error in complex terrain conditions. However, the analysis based on Google DEM estimated much more similar result to the actual. These results were confirmed through the flight simulation test results conducted by the NARO Space Center, and the estimated error was around 2 degree.

[P-137] System for Monitoring Ground Flight Termination System Components

Jaehoon Jeong, Young-Jo Bae

Korea Aerospace Research Institute

Ground Flight Termination System (GFTS) is a command system for sending a flight termination control command to safely abort the flight of a space launch vehicle. It includes basic components such as a master control panel (MCP), an encoder and exciter (EE), and a verifier (VR). This paper presents a system for comprehensive monitoring and debugging of various GFTS components. The proposed system is able to manage multiple GFTS components through the serial (RS-232) to ethernet converter or the PCI serial board.

정관 및 규정

사단법인 한국우주과학회 정관

1995년 5월 3일 제정
1996년 5월 4일 개정
2014년 10월 30일 개정
2020년 10월 29일 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 회장의 직무를 대행 한다.

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. 다만, 위임장도 출석으로 간주한다
2. 총회의 의사는 출석한 정회원의 과반수의 찬성으로 의결한다. 다만, 가부동수인 경우에는 의장이 결정한다. 다만, 위임장은 표결권을 가질 수 없다

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. 이 중 기부금은 모금액 및 활용 실적을 홈페이지에 공개 한다.
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 보 칙

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 규정) 정관의 시행에 필요한 세부적인 규정은 이사회에서 정하여 총회의 승인을 얻어야 한다. 단, 일부 규정은 이사회의 승인만으로 시행 할 수 있다

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

부칙

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
4. 2020년 11월 23일 국립중앙과학관장 허가

학회운영에 대한 규정

2014년 10월 30일 제정
2016년 10월 27일 개정
2020년 10월 29일 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: 15만원
2. 정회원: 7만원
3. 학생회원: 1만원
4. 명예회원: 면제
5. 특별회원: 면제
6. 기관회원: 이사회에서 결정
7. 입회비: 1만원

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. 편집위원장은 이사회의 동의를 얻어 회장이 지명하고 위원장 유고시 부위원장이 직무를 대행한다. 임기는 2년으로 하고 연임 할 수 있다.
3. 편집위원은 20인 내외로 하며 위원장의 추천을 받아 회장이 임명한다. 임기는 2년으로 하고 연임할 수 있다.
4. 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 Journal of Astronomy and Space Sciences는 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 총회의 승인을 받은 2016년 10월 27일부터 시행한다.

이 규정은 총회의 승인을 받은 2020년 10월 29일부터 시행한다.

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

임원 선출에 관한 규정

2011년 8월 26일 제정
2011년 12월 7일 개정
2014년 10월 30일 개정
2018년 10월 24일 개정
2020년 10월 29일 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. 단, 비등기 이사로 협동이사 및 실무이사를 둘 수 있고 이사회의 동의를 얻어 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, 학술이사, 편집위원장은 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.
3. 이 규정은 2020년 10월 29일부터 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 특성에 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)

부 칙 (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
2020년 10월 22일 개정
2021년 9월 28일 개정

제1장 총칙

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.

제2조 (임무)

1. 본 위원회의 주임무는 학술간행물의 발간과 배포 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 편집위원 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 잔

여임기로 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 회장이 지명한다.
2. 위원장은 위원회를 소집하고, 그 의장이 된다.
3. 위원장의 업무를 보조하기 위해 부위원장을 둘 수 있으며 부위원장은 위원장이 임명한다. 위원장의 유고시는 부위원장이 위원장 역할을 대행 한다.
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) 삭제

제16조 (편집 체제) 한국우주과학회 학술지 투고 규정에 따른다.

제17조 (학회지 배포) 발송을 신청한 정회원에게만 배포한다.

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 편집위원이 행한다.
2. 심사위원은 논문 1편 당 2인을 위촉한다. 단, 편집위원은 만일의 경우를 대비하여 후보 심사위원 1인을 추가로 선정할 수 있다.
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. 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 결과

를 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 게재 될 수 있도록 완벽하게 수정한 논문을 학회에 제출해야 한다.

제26조 (논문 투고자의 자격) 삭제

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 학회지 Journal of Space Technology and Applications(이하 JSTA)의 발간

제29조 (분야) JSTA는 우주 응용 및 우주과학 전반에 관한 주제의 국문 또는 영문논문을 출판한다.

제30조 (발행 횟수) JSTA는 년 4회 발행하는 것을 원칙으로 한다.

제31조 (발행일) 발행일은 매년 2, 5, 8, 11월의 말일로 한다.

제32조 (편집 체제) 한국우주과학회 학술지 투고 규정에 따른다.

제33조 (학회지 배포) 발송을 신청한 정회원 및 기타 요청자에게 배포한다.

제34조 (논문 접수 및 투고 논문의 관리) 논문은 연중 수시로 접수하며 투고논문은 반드시 접수 대장을 작성하여 관리한다.

제35조 (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.

제36조 (심사위원 위촉)
1. 심사위원의 위촉은 편집위원이 행한다.
2. 심사위원은 논문 1편 당 2인을 위촉한다. 단, 편집위원은 만일의 경우를 대비하여 후보 심사위원 1인을 추가로 선정할 수 있다.
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. 심사위원의 위촉에 관한 사항은 공개하지 않는다.

제37조 (심사위원 수칙)
1. 공평한 기준을 정하여 공정하게 평가하여야 한다.
2. 논문 심사결과 등을 타인에게 발설하여서는 안 된다.

제38조 (심사기준)
1. 심사위원은 심사대상 논문이 JSTA가 추구하는 주제를 다루고 있고 기존에 발표되지 않은 새로운 결과임을 확인하여야 한다.
2. 심사위원은 심사대상 논문이 JSTA의 편집체제에 맞추어 작성되었는지 확인하여야 한다.
3. 심사위원은 심사대상 영문 논문의 영문 교열을 확인하여야 한다.

제39조 (심사결과 보고) 심사위원은 심사 대상 논문을 접수한 날로부터 10일 이내에 소정의 심사결과 보고서를 위원회에 제출하여야 한다.

제40조 (심사결과 통보) 심사위원이 심사결과 보고서를 제출하면, 위원장은 심사위원의 성명이나 소속 등을 삭제하고, 즉시 그 결과를 투고자에게 전자우편으로 통보한다.

제41조 (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 기일 내에 수정논문을 학회에 제출해야 한다.
3. 심사의 종합결과 '수정 후 재심' 등급을 받은 논문 투고자는 충분히 연구보완 수정 후에 다음 호에 게재 될 수 있도록 완벽하게 수정한 논문을 학회에 제출해야 한다.

제42조 (논문 게재료 납부)
1. 심사완료 게재된 논문의 투고자는 학회에서 지정한 기일까지 소정의 게재료를 납부하여야 한다.
2. 국제 학술회의, Symposium, Workshop 등의 Proceeding 논문을 JSTA에서 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.

제43조 (원고료) 위원회에서 요청한 논문이나 기타 본 학회의 국제성을 위한 특별한 원고에 대해서는 원고료를 지급할 수 있다.

제5장 규정의 개정

제44조 (개정절차) 이 규정의 개정은 이사회의 승인을 요한다.

제45조 (개정발표)

1. (효력발생) 이 규정은 2014년 4월 25일부터 시행한다.
   이 규정은 2020년 10월 22일부터 시행한다.
   이 규정은 2021년 9월 28일부터 시행한다
2. (시행규칙) 이 규정의 시행에 필요한 세부사항은 편집위원회에서 별도로 정하여 이사회의 승인을 받는다.

연구윤리위원회의 설치 · 운영에 관한 규정

2008년 1월 2일 제정
2020년10월 22일 개정

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 변형삭제함으로써 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, 조사과정에서의 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 1인과 학술이사, 편집위원장으로하며, 추천직위원은 회장이 임명한다.
3. 위원장은 부회장이 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 구술서면·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 제2조제1항의 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 압수보관 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 아니 한다.
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 변론내용과 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 (시행규정) 위원회는 이 규정의 시행을 위하여 필요한 세부사항을 별도로 정할 수 있고 이사회의 승인을 받아야 한다.

제26조 (규정 개폐) 이 규정을 개정하거나 폐지할 때는 이사회의 승인을 받아야 한다.

부 칙 1. (시행일) 이 규정은 2008년 1월 2일부터 시행한다.
이 규정은 2020년 10월 22일부터 시행한다.

사단법인 한국우주과학회 용역사업 규정

2011년 12월 7일 제정
2020년 1월 21일 개정

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 연구분야별로 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 의

뢰자와 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%이상으로 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.

부 칙 (시행일)

1. 본 규정은 2012년 1월 1일부터 시행한다.
2. 이 규정은 2020년 1월 21일부터 시행한다.

한국우주과학회 제39차 정기총회

일 시 : 2021년 10월 28일(목) 17:20

장 소 : 라한 셀렉트 경주

1. 정족수 확인 ····· 총무이사 이주희
2. 개회선언 ····· 회장 최기혁
3. 전회의록 낭독 ····· 총무이사 이주희
4. 사업보고 ····· 총무이사 이주희
5. 학술대회준비위원회 보고 ····· 위원장 황정아
6. 학술보고 ····· 위원장 오수연
7. 포상위원회 보고 ····· 위원장 이병선
8. 감사보고 ····· 감사 김용하
9. 안건 1. 2021년 결산(안) 심의 ····· 재무이사 곽영실
10. 안건 2. 2022년도 예산(안) 심의 ····· 재무이사 곽영실
11. 안건 3. 학회운영에 대한 규정 개정 건 ····· 회장 최기혁
12. 안건 4. 제20대 회장선출 건 ····· 회장 최기혁
13. 안건 5. 감사선출 건 ····· 회장 최기혁
14. 안건 6. 부회장, 이사 선출 건 ····· 회장 최기혁
15. 기타 토의 ····· 회장 최기혁
16. 폐회 ····· 다같이

한국우주과학회 제38차 정기총회 회의록

■ 소집연월일 : 2020년 10월 29일(목) 16:50
■ 개 최 장 소 : 제주 신화월드
■ 개 최 일 시 : 2020년 10월 29일(목) 16:50~18:00
■ 참 석 회 원 : 국내 거주 정회원 623명 중 66명 참석

국내 거주 정회원 623명 중 정회원 66명 참석으로 정관 제18조 1항에 의거 총 정회원의 1/10이상(성원 63명) 출석하였으므로 최기혁 의장이 제38차 정기총회 개회를 선언함.

■ 전회의록 낭독
이의 없이 유인물대로 채택되었음.

1. 사업보고(이주희 총무이사)
이주희 총무이사가 2020년도 정기 학술대회, 학술지 및 학회보 발행, 이사회 회의에 대하여 보고하였으며 이의 없이 통과됨.

2. 학술대회준비위원회 보고(황정아 학술대회준비위원장)
황정아 학술대회준비위원장이 학술대회준비위원회 구성과 학술대회 개최실적에 대하여 보고하였으며 이의 없이 통과됨.

3. 학술보고(오수연 편집위원장)
선종호 편집위원장이 편집위원회 구성, 학술지 발간 현황에 대하여 보고하였으며 이의 없이 통과됨.

4. 포상위원회 보고(이주희代 총무이사)
이병선 포상위원장 대신 이주희 총무이사가 포상위원회 구성, 2020년 한국우주과학회 학술상, 두진 우주과학자상, 신진 우주과학자상 및 에스이랩상 수상자, 제30회 과학기술우수논문상 수상자에 대하여 보고하였으며 이의 없이 통과됨.

5. 감사 보고(김천휘 감사)
김용하, 김천휘 감사가 2020년 1월 1일부터 9월 30일까지의 업무 및 회계 감사를 실시(2020년 10월 8일), 김천휘 감사가 그 결과를 보고하였으며 이의 없이 통과됨.

■ 의결 안건
안건 1. 2020년도 결산(안) 승인 건
곽영실 재무이사가 2020년 결산(안)을 보고하였으며 동의와 재청으로 원안대로 통과됨.

안건 2. 2021년도 예산(안) 승인 건
곽영실 재무이사가 2021년도 예산(안)에 대하여 보고하였으며 동의와 재청으로 원안대로 통과됨.

안건 3. 한국우주과학회 정관 개정 건
한국우주과학회 정관 개정(안)을 승인할 것을 제안하였고, 동의와 재청으로 원안대로 개정하기로 결의함.

안건4. 학회 운영에 대한 규정 건
학회 운영에 대한 규정 개정(안)을 승인할 것을 제안하였고, 동의와 재청으로 원안대로 개정하기로 결의함.

안건5. 임원선출에 대한 규정 건
임원 선출 규정 개정(안)을 승인할 것을 제안하였고, 동의와 재청으로 원안대로 개정하기로 결의함.

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.

18시 00분 폐회
2020년 10월 29일
사단법인 한국우주과학회 제38차 정기총회

의 장	최 기 혁 인	부 의 장	박 장 현 인
부 의 장	이 동 훈 인	부 의 장	이 유 인
총무이사	이 주 희 인	재무이사	곽 영 실 인
학술이사	선 종 호 인	이 사	김 관 혁 인
이 사	김 병 진 인	이 사	김 해 동 인
이 사	박 종 욱 인	이 사	오 수 연 인
이 사	윤 재 철 인	이 사	조 경 석 인
이 사	지 건 화 인	이 사	채 종 철 인
이 사	최 영 준 인	이 사	황 정 아 인
감 사	김 용 하 인		

사업보고

1. 정기 학술대회 개최
(1) 봄 학술발표회
- 장 소 : 여수 히든베이
- 일 시 : 2021년 4월 28일(수)~30일(금)
- 논문발표 : 159편

(2) 가을 학술발표회
- 장 소 : 라한 셀렉트 경주
- 일 시 : 2021년 10월 27일(수)~29일(금)
- 논문발표 : 247편

2. 학술지 및 학회보 발행
(1) 영문학술지발간 : JASS Vol 38, NO. 1, 2, 3호 발간

(2) 국문학술지발간 : JSTA Vol 1, NO. 1, 2호 발간
(3) 한국우주과학회보 Vol, 30 N0. 1, 2호 발간

3. 분과회 워크숍 개최
(1) 초소형위성분과 워크숍
- 장 소 : 부산 해운대 웨스틴조선 호텔
- 일 시 : 2021년 7월 1일(목)~2일(금)
- 논문발표 : 22편
- 참가자 : 245명

(2) 우주관측기기분과 워크숍
- 장 소 : on-line
- 일 시 : 2021년 8월 19일(목)~20일(금)
- 논문발표 : 23편
- 참가자 : 122명

(3) 우주감시분과 워크숍
- 장 소 : 여수 히든베이
- 일 시 : 2021년 4월 29일(목)

4. 이사회
- 회의 개최 및 주요 안건
가. 2020년도 4차 회의(2020. 10. 28.) 제주 신화월드
· 2020년 결산(안) 승인
· 2021년 예산(안) 승인
· 신입회원 인준: 정회원 37명, 학생회원 3명

나. 2020년 5차 회의(2020. 12. 07.) On-line
· 편집위원장 임명
· 국문학술지 창간 승인
· 우주탐사분과 회칙 개정(안) 승인
· 국문학술지 명칭 및 창간 TFT 위원 임명

다. 2021년 1차 회의(2021. 02. 18.) On-line
· 학술대회 등의 학회 초청강사 지원 범위 승인
· 실무이사 임명
· 학술이사의 역할 승인
· 국문학술지 명칭 및 창간 TFT 위원 임명

라. 2021년도 2차 회의(2021.04.28.) 여수 히든베이
· 신입회원 승인: 정회원 24명
· 학회 직원에 대한 임금체계(안) 승인
· 국문학술지 명칭 승인
· 기관회원 승인

마. 2021년도 3차 회의(2021.09.28.) On-line
· 학회운영에 대한 규정 개정 승인
· 편집국 규정 개정 승인
· 편집위원회 운영 규정 개정 승인
· 한국우주과학기술단체연합회 결성 승인

학술대회준비위원회 보고

1. 학술대회준비위원회 구성
- 임기 : 2020년 1월~2021년 12월
- 학술대회준비위원장 : 황정아
- 학술대회준비위원 : 김해동, 문홍규, 민병희, 박재흥, 봉수찬, 최병규, 최정림

2. 학술대회 개최 실적 보고
(1) 2020년 가을학술대회 및 제38차 정기총회
- 장소 : 제주 신화월드
- 일시 : 2020년 10월 28일(수)~30일(금)
- 발표논문 : 총 257편
(초청강연 4편, 구두발표 93편, 포스터발표 160편)
- 등록인원 : 312명

(2) 2021년 봄 학술대회
- 장 소 : 여수 히든베이
- 일 시 : 2021년 4월 28일(수)~30일(금)
- 발표논문 : 총 159편
(초청강연 3편, 구두발표 81편, 포스터발표 75편)
- 등록인원 : 223명

(3) 2021년 가을학술대회 (10월 15일 현재)
- 장소 : 라한 셀렉트 경주
- 일 시 : 2021년 10월 27일(수)~29일(금)
- 논문발표 : 총 247편
(초청강연 4편, 구두발표 106편, 포스터발표 137편)
- 등록인원 : 약 290명

학술 보고

1. 편집위원회 구성
- 임기 : 2020년 1월~2021년 12월
- 편집위원장 : 오수연
- 부편집위원장 : 김해동
- 편집국장 : 김숙경
- JASS 편집위원 : 강명석, 곽영실, 구본준, 김경자, 김방엽, 김해동, 민경욱, 박상영, 오수연, 이재진, 이지윤, 정웅섭, 조경석, Eun-Hwa Kim, Kyeong Ju Hwang, Boonrucksar Soonthornthum, Chao Xiong, Charles Lin, Chung Yue Hui, David Ruffolo, Edward F. Guinan, Huixin Liu, Ilya, Usoskin, Ivan L.

Andronov, Jeongwoo Lee, Jiuhou Lei, Lee-Anne Mckinnell, Lin-Ni Hau, Paul A. Evenson, Sungpil Yoon, Tapas Kumar Das, Valery Nakariakov, Valery V. Hegai, Xinlin Li, Yuichi Otsuka
- JSTA 편집위원 : 김병진, 김은혁, 박상영, 박설현, 박은서, 송영주, 이성희, 이호진, 임조령, 장태성, 진 호, 최은정, 황정아

2. 학술지 발간

(가) Journal of Astronomy and Space Sciences 출판현황
- 2020년 12월호 (Vol. 37, No. 4) 4편 출판
- 2021년 3월호 (Vol. 38, No. 1) 7편 출판
- 2021년 6월호 (Vol. 39, No. 2) 6편 출판
- 2021년 9월호 (Vol. 40, No. 3) 4편 출판
- 인쇄본 출판 : 학회 정회원 중 받길 희망하는 회원과 기관회원 배부, 학회 보관 20부

(나) Journal of Space Technology and Application 출판현황
- 2021년 5월호 (Vol. 38, No. 1) 19편 출판
- 2021년 8월호 (Vol. 39, No. 2) 8편 출판
- 인쇄본 출판 : 학회 정회원과 기관회원, 기업체 배부, 학회 보관 20부

(다) On-line 출판
- JASS 홈페이지(http://janss.kr)
- JSTA 홈페이지(http://jstna.org)
- KISTI에서 제공하는 과학기술학회마을
- 한국연구재단(KCI)
- ADS 등에서 무료로 원문 검색 가능

포상위원회 보고

1. 포상위원회 구성
- 임기 : 2020년 1월~2021년 12월
- 위원장 : 이병선
- 위원 : 선종호, 오승준, 이주희, 최영준

2. 2021년 수상자 선정

(가) 2021년 한국우주과학회 학술상 - 곽영실(천문연)

(나) 2021년 한국우주과학회 두진 우주과학자상 수상자
- 최은정(천문연)

(다) 2021년 한국우주과학회 신진 우주과학자상 수상자
- 박은수(경희대)

(다) 에스이랩상 수상자 - (주)에스이랩 지원
- 김푸름(연세대)

(라) 제31회 과학기술우수논문상 수상
(시행처: 한국과학기술단체총연합회)
- 수상자 : 민경국(충남대)
- 수여일 : 2021년 9월 10일
- 논문제목 : Linear Instability and Saturation Characteristics of Magnetosonic Waves along the Magnetic Field Line
- 게재지명 : JASS.2020.37.2.94

감사 보고

(사)한국우주과학회 2021년 감사보고서

회계년도 : 2021. 1. 1.~ 2021. 9. 30.

사단법인 한국우주과학회장 귀하

본 감사는 한국우주과학회가 2021년 1월 1일부터 2021년 9월 30일까지 수행한 회계와 업무에 대한 감사를 2021년 10월 12일에 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 일치함을 확인하였다.

학술행사 사업으로 2021년 봄 학술대회가 4월 28일~30일 여수 히든베이에서 개최되었으며, 우리 학회는 총 223명이 등록하여 159편의 논문이 발표되었고, 봄 학술대회 사업비로 총 25,448,4000원의 예산이 적절하게 집행되었다. 특별세션으로 국내 태양 우주 환경 관측 자료 활용 현황, 우주방사선, 과학문화 발표가 있었다.

학술지 발행사업으로는 2021년 발행된 JASS 학술지 인쇄비와 편집비로 총7,761,600원이 사용되었고, JASS 3월호 7편, JASS 6월호 6편, JASS 9월호 4편 등 총 17편의 논문이 발간되었다. 특히 올해 국내 우주기술 및 응용 분야에 중점을 두고, 국내 우주분야 민간 산업체 포함 산,학,연 및 기관의 정보 공유 및 활성화를 목표로 하여 5월 말 국문학술지인 우주기술과 응용(JSTA) 창간호를 발간하였다. JSTA 학술지 인쇄비와 편집비로 총13,316,400원이 사용되었고, JSTA 5월호에 19편, JSTA 8월호에 8편의 논문이 발간되었다. 이외 JSTA 홈페이지, 논문투고시스템 구축비 등 총8,680,441원 사용 되어 발행사업비 비용은 총 29,758,441원 사용되었다. JSTA에 기업 광고를 기재하여 약 10,000,000원의 수익도 발생했다.

2021년 9월 30일 현재 학회 유동자산은 478,792,495원이며 보통예금으로 213,792,492원, 정기예금으로 250,000,000원, 두진 우주과학자상 예금으로 4,000,000원, 신진 우주과학자상으로 11,000,000원을 운영하고 있다. 2021년 9월 30일 현재 2020년 말 대비 총자산이 58,403,926원 만큼 증가하였다. 특히 8월 15일에 (주)더쎌라잇브루잉 회사와 후원 협약서를 체결하여 3년 동안 연 1,000만원의 후원금을 받게 된 것은 큰 성과가 아닐수 없다. 또한 봄학술대회 전라남도관광재단과 여수시의 지원금, 초소형 워크숍 기여금 등으로 수입이 발생하였다. 12월 31일 결산시에는 가을학술대회 행사비 지출을 하고 나면 손익이 현재보다 현저히 줄어들 것으로 예상된다.

이상과 같이 2021년 9월 30일 기준으로 한국우주과학회 사업부문과 결산 회계처리 내역을 감사한 결과 결산서와 다르지 않다는 사실을 확인하고 이에 서명 날인한다.

2021년 10월 12일

사단법인 한 국 우 주 과 학 회

감사 김 용 하 (인)

감사 김 천 휘 (인)

안건 1. 2021년도 결산(안) 승인 건

2021년도 결산서

기간 2021.1.1.~2021.9.30. (사)한국우주과학회 (단위: 원)

수 입			지 출		
과목	금액		과목	금액	
1.회비수입	38,400,000		1. 발행사업비	29,758,441	
1-1 연회비		38,400,000	1-1 JASS인쇄비		2,728,000
1-2 특별회비			1-2 JSTA인쇄비		7,919,800
2.기부금	10,000,000		1-3 JASS편집비		5,033,600
2-1 지정기부금		10,000,000	1-4 JSTA편집비		5,396,600
3.학술발표회	95,075,000		1-5 발송비 외		8,680,441
3-1 봄학술대회		40,820,000	2. 학술행사비	25,448,400	
3-2 가을학술대회		54,255,000	2-1 봄학술대회		25,448,400
3-3 비정기학술대회			2-2 가을학술대회		
4.게재료	10,958,000		2-3 비정기학술대회		
4-1 JASS게재료		6,758,000	3. 비정기활동사업비		
4-2 JSTA게재료		4,200,000	3-1 대중화 사업 등		
5.광고수입	19,100,000		4. 위원회 사업비	1,620,000	1,620,000
5-1 연구홍보		6,700,000	5. 회의비	932,400	932,400
5-2 기업광고		12,400,000	6. 용역비		
6.지원금	13,058,500		6-1 용역직접비		
6-1 과총		7,230,000	6-2 용역간접비		
6-2 기타지원금		5,828,500	7. 내부인건비(퇴직금)	53,713,490	53,713,490
7.용역비			8. 4대보험료	3,600,800	3,600,800
7-1 용역비			9. 운영비	3,503,390	3,503,390
8.사업수익			10. 세금과공과/연회비	12,399,580	12,399,580
8-1 용역간접비			11. 출장비	1,170,800	1,170,800
9.사업외수익	3,959,727	3,959,727			
수 입 계 ①	190,551,227		지 출 계 ④	132,147,301	
전년도 이월금 ②	420,388,569	(2020.12.31)	차기 이월금 (⑤=③-④)	478,792,495	*회계장부 잔액
합 계 (③=①+②)	610,939,796		합 계	610,939,796	

전년도이월금	420,388,569
당기손익(+)	58,403,926
차기이월금	478,792,495

안건 2. 2022년도 예산(안) 승인 건

(단위: 원)　　기간 2022. 1. 1~2022. 12. 31.

2022년도 예산 수입(안)		
과목	2021년 예산(A)	
	대분류	소분류
1. 회비수입	40,000,000	
1-1 연회비		40,000,000
1-2 특별회비		0
2. 기부금	10,000,000	
2-1 지정기부금		10,000,000
3. 학술발표회	100,000,000	
3-1 봄학술대회		40,000,000
3-2 가을학술대회		60,000,000
4. 게재료	24,000,000	
4-1 JASS		18,000,000
4-2 JSTA		6,000,000
5. 광고수입	30,000,000	
5-1 연구홍보		10,000,000
5-2 기업광고		20,000,000
6. 지원금	6,000,000	
6-1 과총		6,000,000
6-2 연구재단		0
6-3 기타지원금		0
7. 용역비	0	
7-1 용역비		0
8. 사업수익	0	
8-1 용역간접비	0	0
9. 사업외수익	6,000,000	
합 계	216,000,000	

2022년도 예산 지출(안)		
과목	2021년 예산(A)	
	대분류	소분류
1. 발행사업비	40,000,000	
1-1 JASS인쇄비		6,000,000
1-2 JSTA인쇄비		8,000,000
1-3 편집비		9,000,000
1-4 JSTA편집비		9,000,000
1-5 발송비 외		8,000,000
2. 학술행사비	75,000,000	
2-1 봄학술대회		30,000,000
2-2 가을학술대회		45,000,000
3. 비정기활동사업비	0	
3-1 대중화사업 등		0
4. 위원회사업비	5,000,000	
5. 회의비	2,000,000	
6. 용역비	0	
6-1 용역직접비		0
6-2 용역간접비		0
7. 급료와 임금	75,000,000	
8. 보험료	7,200,000	
9. 운영비	2,800,000	
10. 세금과공과/연회비	7,000,000	
11. 출장비	2,000,000	
지 출 계	216,000,000	
차기이월(당기손익)	0	
수 입 계	216,000,000	

안건 3. 학회 운영에 대한 규정 건

학회 운영에 대한 규정 개정(안)

현 행	개정(안)
제5조(편집위원회)	제5조(편집위원회) ① 학회에서 발간하는 정기 학술지 Journal of Astronomy and Space Sciences(이하 JASS), 우주기술과 응용(Journal of Space Technology and Applications, 이하 JSTA)에 각각의 독립적인 편집위원회를 둔다.
① 편집위원회는 학회에서 발간하는 정기 학술지에 게재되는 논문의 심사, 편집 및 출판을 관장한다.	② 각 편집위원회는 학회에서 발간하는 해당 정기 학술지에 게재되는 논문의 심사, 편집 및 출판을 개별 관장한다.
② 편집위원장은 이사회의 동의를 얻어 회장이 지명하고 위원장 유고시 부위원장이 직무를 대행한다. 임기는 2년으로 하고 연임 할 수 있다.	③ 해당 정기 학술지의 편집위원장은 이사회의 동의를 얻어 회장이 지명하고 위원장 유고시 부위원장이 직무를 대행한다. 임기는 2년으로 하고 연임 할 수 있다.
③ 편집위원은 20인 내외로 하며 위원장의 추천을 받아 회장이 임명한다. 임기는 2년으로 하고 연임 할 수 있다.	④ 각 편집위원회의 편집위원은 20인 내외로 하며 위원장의 추천을 받아 회장이 임명한다. 임기는 2년으로 하고 연임할 수 있다.
④ 학술지 논문 투고규정 및 세부사항은 편집위원회에서 논의한 후 이사회의 의결을 거쳐 시행한다.	⑤ 각 학술지 논문 투고규정 및 세부사항은 해당 편집위원회에서 논의한 후 이사회의 의결을 거쳐 시행한다.
제3장 간행물 ② 논문집 Journal of Astronomy and Space Sciences는 편집위원회에서 담당한다,	제3장 간행물 ② 논문집 JASS는 JASS 편집위원회에서 JSTA는 JSTA 편집위원회에서 각각 담당한다.

안건 4. 제 20대 회장 선출 건

정관 제3장 제12조에 의거 제20대 회장을 선출하여 주실 것을 제안함.
선출된 회장의 임기는 2년(2022. 01. 01.~2023. 12. 31.)이다.
- 온라인으로 추천된 회장 후보(가나다 순): 곽영실, 김영수, 박장현, 이동훈, 이유

안건 5. 감사 선출 건

정관 제3장 제12조에 의거 감사를 선출하여 주실 것을 제안함.
선출된 감사의 임기는 2년(2022. 01. 01.~2023. 12. 31.)이다.

안건 6. 부회장, 이사 선출 건

정관 제3장 제12조에 의거 부회장, 이사를 선출하여 주실 것을 제안함.
선출된 부회장과 이사의 임기는 2년(2022. 01. 01.~2023. 12. 31.)이다.
부회장은 회장이 지명하고 이사의 절반은 투표로 선출하고, 나머지 절반은 회장이 지명하기로 함에 따라 이사선출 온라인 투표를 2021. 09. 28.~2021. 10. 12.까지 실시하였다.

한국우주과학회보
제30권 2호 2021년 10월
전화 042-865-3391 (FAX: 042-865-3392)
학회 홈페이지 http://ksss.or.kr

발행인 최기혁
편집인 이주희 · 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