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사단법인 한국우주과학회

The Korean Space Science Society

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<사단법인 한국우주과학회 입회 안내>

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

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■ 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]

한국천문연구원은 민간 달 착륙선에 탑재될 달 우주환경 모니터(LUSEM)의 비행모형을 착륙선 개발 및 달 수송 서비스 담당업체로 이송해 상태점검 및 기능시험을 마쳤다. LUSEM은 한국천문연구원이 <민간달착륙선 탑재체 국제공동연구> 사업의 일환으로 경희대학교와 함께 개발했으며, 미국 NASA의 민간 달 수송 서비스(Commercial Lunar Payload Services, CLPS)를 통해 2024년 달 표면에서 운용될 예정이다.

한국우주과학회

2023년 가을 학술대회

일 시 : 2023. 10. 25.(수) ~ 27.(금)

장 소 : 여수 베네치아호텔@리조트

포스터 집중 발표 : 2023. 10. 26.(목) 16:30~18:00

후

원 :



한국과학창의재단
Korea Foundation for the Advancement of Science & Creativity



여수시
YEOSU CITY



전라남도 문화관광재단



대한민국육군
Republic of Korea Army

본 사업은 기획재정부의 복권기금 및 과학기술정보통신부의 과학기술진흥기금으로 추진되어 공익 및 사회적 가치 실현과 국가 과학기술 발전에 기여합니다.

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등록 및 안내

1. 등록

회원의 등록비는 270,000원이며, 학생회원과 정회원 중 석·박사과정(전일제) 학생은 150,000원입니다. 사전등록을 하신 회원은 학회보, 명찰을 수령하시기 바랍니다. 등록비 영수증과 참가확인증은 홈페이지에서 발행 가능합니다.

2. 발표자료 준비

구두발표: 발표자료는 파워포인트 파일로 준비하시기 바랍니다. 위촉된 심사위원이 우수 구두발표를 선정하여 폐회식 때 시상합니다(세션별 좌장이 심사하지 않음).

포스터발표: 포스터발표는 A0 사이즈 1장(A0 사이즈 1장 내에 들어갈 분량, 예를 들면 A3 8장) 크기이며 10월 25일(수) 16시까지 지정된 장소에 게시하고, 27일(금) 10시까지 수거해 주시기 바랍니다. 집중발표 시간에 발표자는 자신의 포스터 앞에서 회원들의 질문에 답할 수 있도록 준비해 주시기 바랍니다. 위촉된 심사위원이 우수 포스터발표를 선정하여 폐회식 때 시상을 합니다. 포스터를 부착하지 않거나 학회 종료 후 수거하지 않은 회원은 추후 학회발표가 제한될 수 있습니다.

3. 발표장

컨벤션센터	부라노 I	부라노 II	부라노 III	페스타	올리비아
- Invited Talk (I), (II), (III)	- Tutorial - 우주응용	- 안보우주 (I), (II), (III)	- SS: Open New Horizon with	전시부스 & 포스터발표	아이돌봄
- 태양 및 우주환경 (I), (II),(III)	- 초소형위성 - 우주감시	- SS: K-DRIFT - 우주기술	L4 Mission - 달과 우주탐사:		
- 우주천문	- SS: 과학기술인의 대중 소통		과학기술 그리고 정책 - SS: SpaceAI 2023:		
- 지상 및 우주 인프라 운영 기술			인공지능, 우주를 만나다		
- SS: 차세대 중형위성 3호 (I), (II)			- SS: 우주생명현상 탐색 - SS: 우주 마이크로중력 환경 활용		

4. 교통 안내

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

나. 찾아오시는 길

▶ 자가용 이용

서울시청 출발: 약 3시간 50분 소요 / 대전 출발: 약 2시간 40분 소요

▶ KTX 이용

서울-여수엑스포역(2시간 50분 소요) / 오송-여수엑스포역(2시간 10분 소요)

▶ 여수 엑스포역 ↔ 여수 베네치아 호텔&리조트

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

- 택시: 약 2분 소요, 요금 약 2,800원

- 도보: 1 km 15분 소요

▶ 자세한 내용은 리조트 홈페이지 참조

http://www.yeosuvenezia.com/sub8/sub8_03.php

5. 구두발표 색인표

I - 1 - 1

세션번호 발표장 발표순서

2023 KSSS FALL CONFERENCE PROGRAM

Oct. 25. (Wed)

Time	Functions							
11:00~	Registration : 컨벤션센터							
12:30~12:35	Opening Ceremony : 컨벤션센터 환영사 : 이 유 회장							
12:35~12:40	휴식(Break Time)							
12:40~13:10	Invited Talk I		Room : 컨벤션센터			Chair : 조경석(천문연)		
	Bhuwan Joshi (Physical Research Laboratory (PRL), India) Solar Eruptions and Space Weather: Aditya-L1 Perspective							
13:10~13:20	휴식(Break Time)							
Room	컨벤션센터		부라노 I		부라노 II		부라노 III	
Session I	우주천문 / 지상 및 우주인프라 / 태양 및 우주환경 I 좌장: 김수진(천문연)		Tutorial		안보우주 I 좌장: 최호성(육군)		SS: Open New Horizon with L4 Mission 좌장: 임은경(천문연)	
13:20~13:35	I-1-1	강현지	김태영(AIFactory) ChatGPT 진화의 시작: RAG와 외부도구 연동	I-3-1	길민영	I-4-1	조경석	
13:35~13:50	I-1-2	Ulkar Karimova		I-3-2	추동욱	I-4-2	황정아	
13:50~14:05	I-1-3	이지우		I-3-3	박성한	I-4-3	이대영	
14:05~14:20	I-1-4	Khojiakbar Karimov		I-3-4	김한석	I-4-4	문용재	
14:20~14:35	I-1-5	윤준무		I-3-5	배지원	I-4-5	이진성	
14:35~14:50	I-1-6	강원석		I-3-6	박재필	I-4-6	김화영	
14:50~15:05	I-1-7	Lasany Arfin Kunja		I-3-7	송석민	I-4-7	설우형	
15:05~15:20	I-1-8	정종일		I-3-8	노경민	I-4-8	유광선	
15:20~15:35	I-1-9	송병권				I-4-9	최정림	
15:35~15:50	I-1-10	Miyashita Yukinaga				I-4-10	한정열	
15:50~16:00	휴식(Break Time)							
Session II	태양 및 우주환경 II 좌장: 이준현(경희대)		우주응용 / 초소형위성 좌장: 서석배(항우연)		SS: K-DRIFT 좌장: 고종완(천문연)		SS: 우주생명현상 탐색 좌장: 이충욱(천문연)	
16:00~16:15	II-1-1	남옥원	II-2-1	서석배	II-3-1	고종완	II-4-1	주영지
16:15~16:30	II-1-2	곽재영	II-2-2	이진아	II-3-2	김도훈	II-4-2	김민선
16:30~16:45	II-1-3	손종대	II-2-3	윤철환	II-3-3	김윤종	II-4-3	심만섭
16:45~17:00	II-1-4	오대현	II-2-4	신임휴	II-3-4	이가영	II-4-4	홍성욱1
17:00~17:15	II-1-5	박이경	II-2-5	구민아	II-3-5	변우원	II-4-5	류동욱
17:15~17:30	II-1-6	양희수	II-2-6	정성근	II-3-6	홍성용	II-4-6	김윤종
17:30~17:45	태양우주환경분과 회의		초소형분과 회의		우주관측기기분과 회의		II-4-7	홍성욱2
17:45~							우주탐사분과 회의	

Oct. 26. (Thu)

Time	Functions							
09:00~09:30	Invited Talk II		Room : 컨벤션센터		Chair : 강경인(과기원)			
	김해동 (경상국립대학교) Space Technology Development and Space Exploration in the NewSpace Era							
09:30~09:40	휴식(Break Time)							
Room	컨벤션센터		부라노 I		부라노 II		부라노 III	
Session III	SS: 차세대 중형위성 3호 I 좌장: 광영실(천문연)		우주감시 좌장: 노동구(천문연)		안보우주 II 좌장: 나경수(ADD)		SS: SpaceAI 2023: 인공지능, 우주를 만나다 좌장: 한정열(천문연)	
09:40~09:55	III-1-1	문신혜	III-2-1	이진성	III-3-1	한상철	III-4-1	최성환
09:55~10:10	III-1-2	이지승	III-2-2	김명진	III-3-2	나경수	III-4-2	이강우
10:10~10:25	III-1-3	이우경	III-2-3	이희재	III-3-3	이대희	III-4-3	이하림
10:25~10:40	III-1-4	감호식	III-2-4	최진	III-3-4	박수중	III-4-4	정현진
10:40~10:55	III-1-5	백지혜	III-2-5	성재동	III-3-5	신구환	III-4-5	김록순
10:55~11:10	III-1-6	유광선	III-2-6	김윤학	III-3-6	김건희	III-4-6	박성홍
11:10~11:25	III-1-7	이승욱	III-2-7	변용익	III-3-7	최현주	III-4-7	김정현
11:25~11:40	III-1-8	최정림			III-3-8	이병선		
11:40~13:00	점심(Lunch)							
Session IV	SS: 차세대 중형위성 3호 II 좌장: 김용해(충남대)		우주감시 워크숍 & 분과총회		우주기술 좌장: 서행자(항우연)		달과 우주탐사: 과학과 기술 그리고 정책 좌장: 김주현(항우연)	
13:00~13:15	IV-1-1	광영실	주제: 우주 위험 통합 분석 시스템 소개 조종현(천문연) 안재명(과기원) 이동현(한국항공대학교)		IV-3-1	배정주	IV-4-1	이어진
13:15~13:30	IV-1-2	길효섭			IV-3-2	김방엽	IV-4-2	김푸름
13:30~13:45	IV-1-3	장수정			IV-3-3	박미영	IV-4-3	이재희
13:45~14:00	IV-1-4	김정현			IV-3-4	고대호	IV-4-4	이민경
14:00~14:15	IV-1-5	홍준석			IV-3-5	배경훈	IV-4-5	배종희
14:15~14:30	IV-1-6	조유진			IV-3-6	김동규	IV-4-6	방준
14:30~14:45	IV-1-7	박수환			IV-3-7	강경인	IV-4-7	홍승범
14:45~15:00	IV-1-8	홍지민						
15:00~15:10	휴식(Break Time)							
15:10~16:30	정기총회 (Regular General Meeting) & 사진촬영(Photo Time)							
16:30~18:00	포스터 세션 (Poster Session)							
18:00~20:30	Banquet : 컨벤션센터							

Oct. 27. (Fri)

Time	Functions									
09:00~09:30	Invited Talk III		Room : 컨벤션센터			Chair : 정종균(천문연)				
	이어진 (서울과학종합대학원대학교) 극지인, 우주인, 위험인									
09:30~09:40	휴식(Break Time)									
Room	컨벤션센터		부라노 I		부라노 II		부라노 III			
Session V	태양 및 우주환경 III 좌장: 정세현(천문연)		SS: 과학이 대중에게 달기까지, 연구자의 역할 고찰 좌장: 김태훈(서울대)		우주기술 / 안보우주 III 좌장: 최현주(ADD)		SS: 우주 마이크로중력 환경 활용 좌장: 최기혁(항우연)			
09:40~09:55	V-1-1	감호식	V-2-1	황정아	V-3-1	엄태윤	V-4-1	최기혁		
09:55~10:10	V-1-2	이호진	V-2-2	설아침	V-3-2	안상일	V-4-2	이명규		
10:10~10:25	V-1-3	손지현	연구자의 과학소통에 대한 토론 - 참가자 - 이종민(UST/교수) 김연미(작가) 이정순(한국과학창의재단)		V-3-3	최성환	V-4-3	이진우		
10:25~10:40	V-1-4	정세현			V-3-4	정종균	V-4-4	이근우		
10:40~10:55	V-1-5	이재원			V-3-5	이금오	V-4-5	김준현		
10:55~11:10	V-1-6	김희은			V-3-6	최호성	V-4-6	문제현		
11:10~11:25	V-1-7	이원석			V-3-7	조성환	V-4-7	전유전		
11:25~11:40	V-1-8	조일현					V-4-8	박설현		
11:40~11:55	V-1-9	민경국					V-4-9	박준수		
11:55~12:30	Closing Ceremony : 컨벤션센터 우수 구두발표상, 우수포스터상 시상식 (SEE YOU in 40th KSSS 2024 Meeting)									

Poster Session

10. 26. (Thu) 16:30~18:00

Area	No	Author	Area	No	Author
달과 우주 탐사	P-1	이정현	우주기술	P-30	윤용식
	P-2	김은혁		P-31	허성식
	P-3	김상준		P-32	이상록
	P-4	송영주		P-33	연정흠
	P-5	배종희		P-34	전갑호
	P-6	홍승범		P-35	이명준
	P-7	조우인		P-36	김영윤
	P-8	조은진		P-37	이창은
	P-9	문상만		P-38	한조영
	P-10	송재훈		P-39	신현진
	P-11	김세린		P-40	정유연
	P-12	임조령		P-41	장수영
	P-13	박현후		P-42	박진형
	P-14	김인규		P-43	이서림
	P-15	이민재		P-44	김형완
	P-16	김대영		P-45	전문진
	P-17	이석주		P-46	박홍원
SS: Open New Horizon with L4 Mission	P-18	임은경		P-47	김용복
SS: SpaceAI 2023: 인공지능, 우주를 만나다	P-19	한승호		P-48	장경덕
SS: 차세대 중형위성 3호	P-20	김영철		P-49	박성우
우주감시	P-21	송하룡		P-50	정다운
	P-22	강은수		P-51	송승남
	P-23	김응현		P-52	조승원
우주천문	P-24	김성은		P-53	김동오
	P-25	김주형		P-54	김희경
	P-26	서윤경		P-55	박근주
	P-27	채승민		P-56	박종석
초소형 위성	P-28	김민기		P-57	박종오
	P-29	안상일		P-58	박수현
				P-59	김창균

Poster Session

10. 26. (Thu) 16:30~18:00

Area	No	Author	Area	No	Author	
우주기술	P-60	강범석	지상 및 우주 인프라 운영기술	P-89	강 철	
	P-61	민승용		P-90	김동현	
	P-62	이길호		P-91	김명목	
	P-63	임현수		P-92	김민아	
	P-64	최정수		P-93	김성현	
	P-65	임정흠		P-94	김춘원	
	P-66	김진형		P-95	김형욱	
	P-67	원영진		P-96	마진아	
	P-68	임은숙		P-97	박영재	
	P-69	강우용		P-98	안나균	
	P-70	김구혁		P-99	이우민	
	P-71	조창권		P-100	이태진	
	P-72	신현규		P-101	임성혁	
	P-73	신재민		P-102	전정남	
	P-74	이재승		P-103	정철훈	
	우주응용	P-75		이재열	P-104	한정우
		P-76		김경근	P-105	최규철
P-77		김명길	P-106	이강우		
P-78		김연규	P-107	김수진		
P-79		김영선	P-108	나성호		
P-80		명환춘	P-109	나현옥		
P-81		박종역	P-110	박진혜		
P-82		서석배	P-111	이재욱		
P-83		이일섭	P-112	백준호		
P-84		이종태	P-113	김보경		
P-85		이주희	P-114	Madeeha Talha		
P-86		정대준	P-115	이진이		
P-87		최연주	P-116	이영숙		
P-88		최종국	P-117	박경선		

한국우주과학회 2023 가을학술대회 튜토리얼

- **일시:** 2023년 10월 25일(수) 13시 50분
- **장소:** 여수 베네치아호텔&리조트 부라노 I
- **강사:** 김태영(AIFactory)
- **주제:** ChatGPT 진화의 시작: RAG와 외부도구 연동
- **대상:** 학부생 대학원생 및 학회 참여자

우주는 그 방대함과 깊이 속에 끝없는 비밀들을 품고 있습니다. 이를 탐구하는 우주과학 분야에서는 광대한 데이터와 복잡한 문제들에 직면하게 됩니다. 이런 복잡성을 다루기 위해, 혁신적인 AI 도구인 ChatGPT의 활용이 중요해지고 있습니다. 그렇지만 ChatGPT만의 활용만으로는 한계가 있습니다. 여기서 RAG(Retrieval-Augmented Generation)가 주목받게 되었습니다. RAG는 최신 프롬프트 엔지니어링 기법 중 하나로, 기존 데이터베이스나 지식 그래프에서 필요한 정보를 검색, ChatGPT의 응답을 풍부하게 보강합니다. 이를 통해 인류가 축적한 방대한 우주 지식을 기반으로, 복잡한 질문에도 정밀하고 상세한 답변이 가능하게 되었습니다. 더불어, 외부 데이터베이스, API, 클라우드 서비스와 같은 다양한 플랫폼과의 연동을 통해 ChatGPT는 단순한 질의응답을 넘어 다양한 작업의 자동화 및 서비스 확장에 활용될 수 있습니다. 지금까지 우주과학 전산시스템과 AI와 연동할 수 있는 기회가 온 것입니다. 실제 사례들의 시연 및 실습을 통해 연동의 가능성을 직접 체험하게 됩니다. 이번 세미나는 우주와 AI, 이 두 분야의 무한한 가능성의 만남을 중심으로, 우주과학 연구자들이 ChatGPT와 같은 AI 도구를 효과적으로 활용하는 방법과 전략에 대해 함께 탐색하고 학습하는 시간이 될 것입니다.

제7회 우주감시분과 워크숍 & 우주감시분과 총회

- **제목:** 우주 위험 통합 분석 연구 소개
- **일시:** 2023년 10월 26일(목) 13:10~14:15
- **장소:** 여수 베네치아 호텔 & 리조트, 부라노 I
- **모시는 글**

우주과학회 회원 여러분을 제7회 우주감시분과 워크숍에 초대합니다.

최근 지구 궤도상의 우주 환경이 점점 복잡해짐에 따라 우주 물체의 궤도상 충돌 위험과 지구 추락 위험 또한 지속적으로 증가하고 있습니다. 정부의 “대한민국 우주경제를 향한 5대 장기 우주개발 미션” 중 하나인 “우주안보 확립”에 우주상황인식이 포함되는 등, 이러한 우주 위험에 대응하기 위한 노력 또한 중요해지고 있습니다.

이번 워크숍에서는 현재 진행 중인 우주 위험 통합 분석 연구 현황을 공유하고, 향후 발전과 효과적인 확산을 위한 토론의 시간을 갖고자 합니다. 또한 워크숍 이후에 이어지는 분과 총회에서는 현안의 공유와 분과 발전을 위한 논의가 진행될 예정입니다.

관심 있는 회원님들의 많은 참석을 기대합니다. 감사합니다.

■ 프로그램

시간	주제	발표
우주 위험 통합 분석 연구 현황 공유 및 협력 워크숍		
13:10~13:15	우주감시분과 워크숍 개회	안재명(KAIST)
	우주 위험 통합 분석 시스템 개발 현황	조중현(한국천문연구원)
13:15~14:00	우주 충돌 위험 분석을 위한 환경 모델링 연구 현황	안재명(KAIST)
	종합 토의	안재명(KAIST)
14:00~14:15	우주감시분과 총회(우주감시분과 현안 소개 및 분과 발전을 위한 논의)	이동현(한국항공대학교)

* 우주감시분과 위원장 안재명(KAIST), 간사 이동현(한국항공대학교)

* 운영위원: 강병국((주)솔탑), 김명진(한국천문연구원), 김성우((주)텔레픽스), 김은희(세종대학교),
성재동(한국항공우주연구원), 최진(한국천문연구원)

구두발표 논문 제목 및 시간표

10월 25일(수)

제1발표장 (컨벤션센터)

12:40 [IS-I]

Solar Eruptions and Space Weather: Aditya-L1 Perspective

Bhuwan Joshi

Udaipur Solar Observatory, Physical Research Laboratory, India

13:20 [I-1-1]

Performance Test Results of Space Search Coil Sensor

Hyeonji Kang¹, Ho Jin¹, Yunho Jang¹,
Seungmin Lee¹, Junhyun Lee¹, Hyeonhu Park¹,
Woojin Jo¹, Juhyeong Kim¹, Khanhyuk Kim¹,
Jinsang Kim², Ik Joon Chang², Ickhyun Song³

¹*School of Space Research, Kyung Hee University*

²*Department of Electronic Engineering, Kyung Hee University*

³*Department of Electronic Engineering, Hanyang University*

13:35 [I-1-2]

Orbital Distribution and Potential Interstellar Origins of Sungrazing Comets

Utkar Karimova, Yu Yi

Department of Astronomy and Space Science, Chungnam National University

13:50 [I-1-3]

Initial Stage of Dynamic Tool Influence Function on SiC Mirror Surface Using Orthogonal Velocity Tool

Jiwoo Lee^{1,2}, Jeong-Yeol Han^{3,4}, Ju-Hyun Suk¹,
Won-Jae Doo⁵

¹*Department of Division of Energy and Optical Technology Convergence, Cheongju University*

²*LeO SPACE Inc.*

³*Korea Astronomy and Space Science Institute*

⁴*University of Science and Technology*

⁵*Department of Astronomy and Space Science, Chungnam National University*

14:05 [I-1-4]

Major Flaring Activity Depending on the Phase of 3D Magnetic Free Energy

Khojiakbar Karimov¹, Harim Lee², Yong-Jae Moon^{1,2},
Jihye Kang², Hyun-Jin Jeong², Mingyu Jeon¹,
Jihyeon Son¹, Kanya Kusano³

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

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

³*Institute for Space-Earth Environment Research, Nagoya University, Japan*

14:20 [I-1-5]

Comparison of SDO/AIA EUV Images and AI-Generated Ones from SO/EUI

Junmu Youn¹, Harim Lee², Yong-Jae Moon^{1,2},
Hyun-Jin Jeong², Il-Hyun Cho², Jin-Yi Lee²

¹*School of Space Research, Kyung Hee University*

²*Department of Astronomy and Space Science, College of Applied Science, Kyung Hee University*

14:35 [I-1-6]

Demonstration of Free Space Optical Communication Using 10 Gbps Modules at a Distance of 9 km

Wonseok Kang¹, Taewoo Kim¹, Sang Hoon Oh¹,
Yong-Sun Park^{1,2}, Jung-Hoon Kim^{1,3}

¹*Spacebeam, Inc.*

²*Seoul National University*

³*SETsystem, Inc.*

14:50 [I-1-7]

Effectiveness of Radiation Shields Constructed from Martian Regolith and Different Polymers for Human Habitat on Mars Using MULASSIS/GEANT4 and OLTARIS

Lasany Arfin Kunja¹, Md. Abdullah Al Zaman²

¹*Department of Space Geology, Chungnam National University Graduate School*

²*Northern University Bangladesh*

15:05 [I-1-8]

Study on the Asymmetric Cosmic Ray Modulation of Forbush Decrease Related to Propagation Direction of Interplanetary Coronal Mass Ejection

Jongil Jung¹, Suyeon Oh¹, Yu Yi², Jongdae Sohn³

¹*Chonnam National University*

²*Chungnam National University*

³*Korean Astronomy and Space Science Institute*

15:20 [I-1-9]

Coupling of Long-Term Zonal Wind Trends in Southern Winter between the Mesopause and Stratosphere

Byeong-Gwon Song, In-Sun Song
Yonsei University

15:35 [I-1-10]

Stepwise Development of the Auroral Onset Arc and the Near-Earth Magnetotail Associated with Substorm Onsets

Yukinaga Miyashita^{1,2}, Madeeha Talha^{1,2,3},
Akimasa Ieda⁴, Shinobu Machida⁴
¹*Korea Astronomy and Space Science Institute*
²*University of Science and Technology*
³*Pakistan Space and Upper Atmosphere Research Commission (SUPARCO), Karachi, Pakistan*
⁴*Institute for Space-Earth Environmental Research, Nagoya University, Japan*

16:00 [II-1-1]

Initial Results of LEO-DOS Instrument on Board the NEXTSat-2

Uk-won Nam¹, Won-Kee Park¹, Bongkon Moon¹,
Sukwon Youn², Jaeyoung Kwak^{1,3}, Jongdae Sohn¹,
Young-Jun Choi¹, Jeonghyun Pyo¹, Jaejin Lee¹,
Junga Hwang^{1,4}, Sunghwan Kim⁵, Hongjoo Kim⁶,
Sung-Joon Ye², Hongyoung Park⁷, Taeseong Jang⁷,
Jungho Kim⁷
¹*Korea Astronomy and Space Science Institute*
²*Radiological Physics Laboratory, Seoul National University*
³*Korea Research Institute of Standards and Science*
⁴*University of Science and Technology*
⁵*Department of Radiology, Cheongju University*
⁶*Kyungpook National University*
⁷*Satellite Technology Research Center, KAIST*

16:15 [II-1-2]

Global Dose Map Generation and L-Shell Calculation Using NEXTSat-2 LEO-DOS Initial Results

Jaeyoung Kwak^{1,2}, Uk-won Nam¹, Won-Kee Park¹,
Junga Hwang^{1,2}, Bongkon Moon¹, Sukwon Youn³,

Jongdae Sohn¹, Young-Jun Choi¹, Jeonghyun Pyo¹,
Jaejin Lee¹, Sunghwan Kim⁴, Hongjoo Kim⁵,
Sung-Joon Ye³, Hongyoung Park⁶, Taeseong Jang⁶,
Jungho Kim⁷

¹*Korea Astronomy and Space Science Institute*

²*Department of Astronomy and Space Science, University of Science and Technology*

³*Radiological Physics Laboratory, Seoul National University*

⁴*Department of Radiology, Cheongju University*

⁵*Kyungpook National University*

⁶*Satellite Technology Research Center, KAIST*

⁷*Korea Research Institute of Standards and Science*

16:30 [II-1-3]

Total Ionizing Dose and Displacement Damage Results of Commercial-Off-The-Shelf for a Super Low Earth Orbit Optical Satellite

Jongdae Sohn^{1,2}, Hojin Lee^{1,2}, Junga Hwang^{1,2},
Jaeyoung Kwak^{1,2}, Hyosang Yoon³

¹*Korea Astronomy and Space Science Institute*

²*University of Science and Technology*

³*Korea Advanced Institute of Science and Technology*

16:45 [II-1-4]

Enhancement of GK2A/KSEM PD Data Quality and Changes in PD Data Service

Daehyeon Oh, Jiyoung Kim

National Meteorological Satellite Center, Korea Meteorological Administration

17:00 [II-1-5]

Statistical Study of Background Cold Ions Energized by Negative Spacecraft Potential

Yi-Kyeong Park, Khan-Hyuk Kim, Junhyun Lee,
Ho Jin

School of Space Research, Kyung Hee University

17:15 [II-1-6]

Suggestions on the Development of the Solar Instrumentations

Heesu Yang, Donguk Song, Ryun Young Kwon
Korea Astronomy and Space Science Institute

제2발표장 (부라노 I)

16:00 [II-2-1]**1553 BMDX Analysis Software for CAP-W ETB Test**

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

16:15 [II-2-2]**Construction of and Analysis on Rigid Body Potentials for Proximity Maneuvers around Small Celestial Bodies**

Jinah Lee, Chandeok Park
Department of Astronomy, Yonsei University

16:30 [II-2-3]**Development of High-Reliability Ceramic Packaging Technology for Space Applications with Emphasis on Hermetic Sealing and Leak Testing**

Cheol-Hwan Youn¹, Seong-Geuen Jeong¹,
Ki-shik Kim¹, Ki-Sang Park¹, Mi-Young Park²

¹*MID*²*Satellite Technology Research Center, KAIST***16:45 [II-2-4]****The Development Plan for the Bus System of the 18U Cubesat has Earth Observation and Formation Flying Missions in Low Earth Orbit**

Im-Hyu Shin¹, Dong-Guk Kim¹, Il-Young Jang¹,
Hyun-Tae Choi¹, Young-Min Kim¹, Won-Ho Cha¹,
Mina Koo¹, Tae-Yoon Eom¹, Goo-Hwan Shin¹,
Jae-Hun Jang², Jeong-In Yun², Hyo-Sang Yoon²,
Bong-Kon Moon³, Dae-Hee Lee³, Jae-Jin Lee³,
Chang-Gon Kim⁴, Soo-Jong Park⁴, Gun-Hee Kim⁵,
Kyung-Su Na⁶, In-Young Hwang⁶

¹*Satellite Technology Research Center, KAIST*²*Spacecraft Prototyping Laboratory, KAIST*³*Korea Astronomy and Space Science Institute, KASI*⁴*Kyung Hee University*⁵*Hanbat National University*⁶*Agency for Defense Development***17:00 [II-2-5]****Development of a 1U Modular Structure for Internal Unit Placement of SPACE SCANer**

Mina Koo¹, Im-Hyu Shin¹, Dong-Guk Kim¹,
Il-Young Jang¹, Hyun-Tae Choi¹, Young-Min Kim¹,
Won-Ho Cha¹, Tae-Yoon Eom¹, Goo-Hwan Shin¹,
Jae-Hun Jang², Jeong-In Yun², Hyo-Sang Yoon²,
Bong-Kon Moon³, Dae-Hee Lee³, Jae-Jin Lee³,
Chang-Gon Kim⁴, Soo-Jong Park⁴, Gun-Hee Kim⁵,
Kyung-Su Na⁶, In-Young Hwang⁶

¹*Satellite Technology Research Center, KAIST*²*Spacecraft Prototyping Laboratory, KAIST*³*Korea Astronomy and Space Science Institute, KASI*⁴*Kyung Hee University, South Korea*⁵*Hanbat National University, South Korea*⁶*Agency for Defense Development***17:15 [II-2-6]****Study for Usage of COTS EEE Parts for Space Application**

Seongkeun Jeong¹, Jinuk Seo¹, Hyunung Oh²

¹*MID Co., Ltd.*²*Korea Aerospace University School of Aerospace and Mechanical Engineering (Additional Post: Agency for Defense Development)*

제3발표장 (부라노 II)

13:20 [I-3-1]**The Role of Satellites to Strengthen Ground Forces and Considerations in Weaponization**

Min-Young Gil

ROK Army Headquarters Policy Office (Policy Training in Korea Aerospace Research Institute)

13:35 [I-3-2]**After Action Review of SNIPE Operations and the Future of Small-Scale Satellites Operation Focused on Army**

Dong-Wook Chu, Jin-su Ha

Korea Astronomy Space Science Institute, ROKA Augmented

13:50 [I-3-3]**Research on Future Outer Space Conflicts Using Fuzzy-AHP Technique**

Seonghan Park¹, Sechan Song², Jaehoon Bae¹,
Jin-Ho Park¹, Sunhong Kim², Juhee Kim¹

¹*Korea Military Academy*

²*Korean Army Headquarters*

14:05 [I-3-4]

Military Satellite Image Object Detection Based on YOLO v7 and Stable Diffusion

HanSeok Kim

Korea National Defense University

14:20 [I-3-5]

Persistent Space Surveillance Using the Theory of Functional Connections

Jiwon Bae^{1,2}

¹*Republic of Korea Army*

²*Texas A&M University Aerospace Engineering*

14:35 [I-3-6]

Earthpaper: Satellite Image Service Platform for Military

Jae-Pil Park, Minsik Kim, Hyungjik Oh,
Dongmin Lee, Hyungwook Oh, Yeongho Kim

Nara Space Technology

14:50 [I-3-7]

Analysis of Tip/Tilt Correction of Beam Wandering for Space Laser Communication

Seok-Min Song^{1,2}, Hyung-Chul Lim¹, Mansoo Choi¹,
Yu Yi²

¹*Korea Astronomy and Space Science Institute*

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

15:05 [I-3-8]

Strategy Analysis for Precision Orbit Determination of Regional Navigation Satellite System Based QZSS Case

Kyoung-Min Roh

Korea Astronomy and Space Science Institute

16:00 [II-3-1]

K-DRIFT to Space: Exploring the Low-Surface-Brightness Universe

Jongwan Ko^{1,2}, K-DRIFT Team³

¹*Korea Astronomy and Space Science Institute*

²*University of Science and Technology*

³*K-DRIFT Team*

16:15 [II-3-2]

K-DRIFT to Space: Fabrication of Freeform Mirrors of the K-DRIFT Pathfinder

Dohoon Kim¹, Gisung Park¹, Changhee Lee¹,
JaeYeong Jo¹, Hong Ki Kim¹, Taejong Kim¹,
Minho Seo¹, Yunjong Kim², Jongwan Ko^{2,3},
K-DRIFT Team⁴, Young-Soo Kim¹

¹*Green Optics Co., Ltd.*

²*Korea Astronomy and Space Science Institute*

³*University of Science and Technology*

⁴*K-DRIFT Team*

16:30 [II-3-3]

K-DRIFT to Space: Alignment and Integration of K-DRIFT Pathfinder and Tolerance Analysis of K-DRIFT G1

Yunjong Kim¹, K-DRIFT Team²

¹*Korea Astronomy and Space Science Institute*

²*K-DRIFT Team*

16:45 [II-3-4]

K-DRIFT to Space: Performance Analysis and Error Control Strategy for the Optical System

Gayoung Lee^{1,2}, K-DRIFT Team³

¹*Kyungpook National University*

²*Korea Astronomy and Space Science Institute*

³*K-DRIFT Team*

17:00 [II-3-5]

K-DRIFT to Space: Observation Strategy on the Ground and Science Drivers

Woowon Byun¹, K-DRIFT Team²

¹*Korea Astronomy and Space Science Institute*

²*K-DRIFT Team*

17:15 [II-3-6]

K-Drift to Space: Big Data and Astronomical Research

Sungrynog Hong¹, K-DRIFT Team²

¹*Korea Astronomy and Space Science Institute*

²*K-DRIFT Team*

제4발표장 (부라노 III)

13:20 [I-4-1]

Open New Horizon with L4 Mission: Vision and Planning

K.-S. Cho¹, J. Hwang¹, E.-K. Lim¹, J.-Y. Han¹,
S.-H. Choi¹, J. Seough¹, R.-S. Kim¹, S.-H. Park¹,
Y.-S. Kim¹, J.-D. Sohn¹, J.-H. Baek¹, J.-Y. Kwak¹,
Y.-J. Moon², J. Seon², K.-S. Ryu³, C.-H. Lee⁴

¹*Korea Astronomy and Space Science Institute*²*Kyung Hee University*³*Korea Advanced Institute of Science and Technology*⁴*Korea Areospace Industries*

13:35 [I-4-2]

From the Moon to the Aviation Altitude, Space Radiation Research in Korea

Junga Hwang¹, Jongdae Sohn², Ukwon Nam²,
Jaeyoung Kwak²

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

13:50 [I-4-3]

Suprathermal Solar Wind Electrons and Their Connection to the Expected L4 Mission Sciences

Dae-Young Lee¹, Kyung-Eun Choi², J. Seough³,
J. A. Hwang³, K. S. Cho³, J. H. Seon⁴, K. S. Ryu⁵

¹*Chungbuk National University*²*UC-Berkeley*³*KASI*⁴*Kyung Hee University*⁵*KAIST*

14:05 [I-4-4]

Scientific Subjects of the Heliophysics L4 Mission by Remote-Sensing Observations

Yong-Jae Moon¹, Kyung-Suk Cho², Sung-Hong Park²,
Roksoon Kim², Eun-Kyung Lim², Harim Lee¹,
Hyun-Jin Jeong¹, Jihye Kang¹, Il-Hyun Cho¹,
Hyeonock Na¹, Jinhye Park¹, Kangwoo Yi¹

¹*Department of Astronomy and Space Science, College of Applied Science, Kyung Hee University*²*Korea Astronomy and Space Science Institute*

14:20 [I-4-5]

Solar Surface Visibility Analysis for Triangular**Lagrange Point's Vertical Periodic Orbits**

Jinsung Lee¹, Sung-Hong Park², Kyung-Suk Cho²,
Junga Hwang², Arik Posner³, Jaemyung Ahn¹

¹*Korea Advanced Institute of Science and Technology*²*Korea Astronomy and Space Science Institute*³*NASA Headquarters*

14:35 [I-4-6]

Spacecraft System Design Concept and Development Plan for L4 Mission

Hwayeong Kim¹, Jaehwee Doh¹, Jong-Jin Jang¹,
Junga Hwang², Kyung-Suk Cho²

¹*Korea Aerospace Industries, Ltd. (KAI)*²*Korea Astronomy and Space Science Institute (KASI)*

14:50 [I-4-7]

Conceptual Study of a Solar High-Energy Particle Detector Assuming an L4 Mission

Woo-Hyeong Seol¹, Jongho Seon¹, Khan-Hyuk Kim¹,
Kwangsun Ryu², Jungjoon Seough³, Jongdae Sohn³,
Junga Hwang³, Kyung-Suk Cho³, Dae-young Lee⁴

¹*School of Space Research, Kyung Hee University*²*Satellite Technology Research Center, Korea Advanced Institute of Science and Technology*³*Korea Astronomy and Space Science Institute*⁴*Chungbuk National University*

15:05 [I-4-8]

Conceptual Design of *In-Situ* Measurement Instruments of Heliospheric Plasma and Electromagnetic Field for L-4 Mission

K. Ryu¹, S. W. Lee^{1,2}, J. Seon³, K.-H. Kim³,
J. Seough⁴, J. D. Son⁴, J. A. Hwang⁴, K. S. Cho⁴,
K.-C. Kim², D. Y. Lee²

¹*SaTReC, KAIST*²*Chungbuk National University*³*Kyung Hee University*⁴*Korea Astronomy and Space Science Institute*

15:20 [I-4-9]

Study of Ion Particle Diffusion by Kinetic Alfvén Waves

Cheong-Rim Choi¹, Min-Ho Woo², Kwang-Sun Ryu³,
Dae-Young Lee¹, Peter H Yoon⁴

¹*Department of Astronomy and Space Science, CBNU*²*Korea Institute of Fusion Energy*

³*Satellite Technology Research Center, KAIST*

⁴*Institute for Physical Science and Technology, University of Maryland, USA*

15:35 [I-4-10]

Conceptual Design of Optical and EUV Telescopes with Instruments for the L4 Mission

Jeong-Yeol Han^{1,2}, Jongyeop Park¹, Sung-Hong Park¹, Eun-Kyung Lim^{1,2}, Donguk Song¹, Kyung-Suk Cho^{1,2}, Jaehyeon Kyeong³, Jiwoo Lee³

¹*Korea Astronomy and Space Science Institute*

²*University of Science and Technology*

³*LeO SPACE Inc.*

16:00 [II-4-1]

Sedimentary Record and Past Surface Environment on Mars: Gale Crater

Young Ji Joo

Major of Environmental Geosciences, Pukyong National University

16:15 [II-4-2]

Exploring Life Signatures in Water Ice on Mars

Minsun Kim¹, Min-Su Shin¹, Sun-Ju Chung¹, Sungwook E. Hong^{1,2}, Ryun Young Kwon¹, Yunjong Kim¹, LiCE Team³

¹*Korea Astronomy and Space Science Institute*

²*University of Science and Technology*

³*LiCE Team*

16:30 [II-4-3]

Isotopic Biosignatures on Early Earth and Potentially Elsewhere in the Solar System

Min Sub Sim

Seoul National University

16:45 [II-4-4]

Search for Radio Technosignatures

Sungwook E. Hong^{1,2}, Minsun Kim¹, Taehyun Jung¹, Hyunwoo Kang¹, Min-su Shin¹, Bong Won Sohn¹

¹*Korea Astronomy and Space Science Institute*

²*University of Science and Technology*

17:00 [II-4-5]

Development and Validation of a Novel Global

Earth Model for Exoplanet Imaging and Spectral Analysis

Dongok Ryu

Korea Aerospace Research Institute

17:15 [II-4-6]

Overview of Exploring Coronagraph and Starshade Technology for Direct Imaging of Exoplanets

Yunjong Kim¹, Sungwook E. Hong^{1,2}, Ryun-Young Kwon¹, Hyunwoo Kang¹, Minsun Kim¹

¹*Korea Astronomy and Space Science Institute.*

²*University of Science and Technology*

17:30 [II-4-7]

Search for Biosignature at the Ocean Worlds

Sungwook E. Hong^{1,2}, Minsun Kim¹, Sun-Ju Chung¹, Min-su Shin¹

¹*Korea Astronomy and Space Science Institute*

²*University of Science and Technology*

10월 26일(목)

제1발표장 (컨벤션센터)

09:00 [IS-II]

Space Technology Development and Space Exploration in the NewSpace Era

Hae-Dong Kim

Gyeongsang National University

09:40 [III-1-1]

Operation Scenario and Payload Data Analysis for CAS500-3 Mission

Shin-Hye Moon, Yang-Woo Seong, Young-Cheul Kim, Seok-Soo Kim

Korea Aerospace Industries, Ltd.

09:55 [III-1-2]

Development of a Space Biology Payload BioCabinet (Stem Cell Bio 3D Printing and 3D Cell Culture System) Mounted on the CAS500-3

JiSeung Lee¹, YoungJin Lee¹, Kyunghee Kim¹, Olatunji Ajiteru¹, Chan Hum Park^{1,2}

¹*Nano-Bio Regenerative Medical Institute, School of Medicine, Hallym University*

²*Department of Otorhinolaryngology-Head and Neck Surgery, Chuncheon Sacred Heart Hospital, College of Medicine, Hallym University*

10:10 [III-1-3]

ROKITS: A Space-Borne Wide-Field Auroral/Airglow Imager for CAS500-3

Woo Kyoung Lee^{1,2}, Seonhwan Choi¹,
Kyoung-Min Roh^{1,2}, Young-Sil Kwak^{1,2},
Chanhaeng Lee¹, Jongyeop Park¹, Jihye Baek¹,
Jihun Kim¹, Yunjong Kim¹, Dukhaeng Lee¹,
Tae-Young Yang¹, Jaeheung Park^{1,2},
Jong-Kyun Chung¹, Geonhwa Jee^{2,3}, Hyosub Kil⁴,
Larry J. Paxton⁴

¹*Korea Astronomy and Space Science Institute*

²*University of Science and Technology*

³*Korea Polar Research Institute*

⁴*Johns Hopkins University Applied Physics Laboratory*

10:25 [III-1-4]

A Strategic Approach to Process ROKITS Image Data for Aurora and Atmospheric Gravity Wave Detection

Hosik Kam¹, Young-Sil Kwak^{1,2}, Woo Kyoung Lee^{1,2},
Seonghwan Choi¹

¹*Korea Astronomy and Space Science Institute*

²*University of Science and Technology*

10:40 [III-1-5]

Ground Software Design for ROKITS

Ji-Hye Baek, Jongyeob Park, Seonghwan Choi,
Wookyung Lee

Korea Astronomy and Space Science Institute

10:55 [III-1-6]

EQM Test Results and Readiness for Flight Model of IAMMAP for CAS500-3 Satellite

Kwangsun Ryu¹, Seunguk Lee^{1,2}, Su-Hwan Park¹,
Jimin Hong¹, Seong-og Park¹, Jinkyu Kim¹,
Wonho Cha¹, BonJu Koo¹, Dooyoung Choi²,
Cheong Rim Choi²

¹*Satellite Technology Research Center, KAIST*

²*Department of Astronomy and Space Science, Chungbuk National University*

11:10 [III-1-7]

Development of the AIMAG EQM Model on CAS500-3

Seunguk Lee^{1,2}, Kwangsun Ryu², Dooyoung Choi¹,
Seong-og Park², Jinkyu Kim², Wonho Cha²,
Bon-ju Koo², Jimin Hong², Su-Hwan Park²,
Cheongrim Choi¹, Dae-Young Lee¹

¹*Chungbuk National University*

²*Satellite Technology Research Center, KAIST*

11:25 [III-1-8]

Status of Development of Magnetic Noise Removal Algorithm Using CAS500-3 Satellite Magnetometer

Cheong-Rim Choi¹, Tongnyeol Rhee², Seung-Uk Lee¹,
Doo-Young Choi¹, Chang-Ho Woo³, Kwang-Sun Ryu³

¹*Department of Astronomy and Space Science, CBNU*

²*National Fusion Research Institute*

³*Satellite Technology Research Center, KAIST*

13:00 [IV-1-1]

ROKITS' Science Goal: Understanding the Response of the Ionosphere-Thermosphere System to External and Internal Forcing

Young-Sil Kwak^{1,2}, Woo Kyoung Lee^{1,2},
ROKITS Team³

¹*Korea Astronomy and Space Science Institute*

²*University of Science and Technology*

³*ROKITS Team*

13:15 [IV-1-2]

Earth's Auroral Exploration through Optical Imager Observations: Development of a New Mission Concept and Deep-Learning based Auroral Oval Model

Hyosub Kil

Johns Hopkins University Applied Physics Laboratory

13:30 [IV-1-3]

Aurora Boundary Map Completion with Deep Learning Techniques and the Contribution of ROKITS

Soojeong Jang¹, Jeong-Heon Kim², Woo Kyoung Lee²,
Hyosub Kil³, Se-Heon Jeong², Young-Sil Kwak^{2,4}

¹*Kyung Hee University*

²*Korea Astronomy and Space Science Institute*
³*Johns Hopkins University Applied Physics Laboratory*
⁴*University of Science and Technology*

13:45 [IV-1-4]

Estimating the Auroral Boundary: Empirical Models and ROKITS Contribution

Jeong-Heon Kim¹, Soojeong Jang², Young-Sil Kwak^{1,3},
 Woo Kyoung Lee¹

¹*Korea Astronomy and Space Science Institute, KASI*
²*Kyung Hee University, KHU*
³*University of Science and Technology, UST*

14:00 [IV-1-5]

Ionospheric GNSS Scintillations at High Latitudes Associated with Auroral Activities

Junseok Hong¹, Jong-Kyun Chung¹, Woo Kyoung Lee^{1,2},
 Changsup Lee³

¹*Korea Astronomy and Space Science Institute*
²*University of Science and Technology*
³*Korea Polar Research Institute*

14:15 [IV-1-6]

Variations of Auroral Occurrence and Field-Aligned Currents (FACs) with Geomagnetic Activity at Jang Bogo Station, Antarctica

Yujin Cho^{1,2}, Geonhwa Jee^{1,2}, Young-Bae Ham^{1,2},
 Hyuck-Jin Kwon¹, Jaeheung Park^{2,3}

¹*Korea Polar Research Institute*
²*University of Science and Technology*
³*Korea Astronomy and Space Science Institute*

14:30 [IV-1-7]

Verification of the Langmuir Probe Electronics Board of IAMMAP for CAS500-3 Satellite

Su-Hwan Park¹, Kwangsun Ryu¹, Seunguk Lee^{1,2},
 Jimin Hong¹, Seong-og Park¹, Jinkyu Kim¹,
 BonJu Koo¹, Changho Woo¹

¹*Satellite Technology Research Center, KAIST*
²*Department of Astronomy and Space Science, Chungbuk National University*

14:45 [IV-1-8]

Development of EGSE Software for Calibration of IAMMAP Instrument Units in CAS500-3

Jimin Hong¹, Kwangsun Ryu¹, Seong-og Park¹,

Su-Hwan Park¹, Seunguk Lee^{1,2}, Seongho Han³,
 Taeyoon Eom¹

¹*Satellite Technology Research Center, KAIST*
²*Department of Astronomy and Space Science, Chungbuk National University*
³*Department of Mechanical Engineering, KAIST*

제2발표장 (부라노 I)

09:40 [III-2-1]

Space Object Environment Model: Reviews and Insights

Jinsung Lee¹, Siwoo Kim², DongUk Lee¹,
 Jaemyung Ahn¹, Eun-Jung Choi³, Jin Choi³,
 Jiwoong Yu³, Sungki Cho³, Jung Hyun Jo³

¹*Korea Advanced Institute of Science and Technology*
²*Korea Institute of Defense Analyses*
³*Korea Astronomy and Space Science Institute*

09:55 [III-2-2]

NSOS- α : The First Korean Asteroid Survey Telescope

Myung-Jin Kim, Hong-Suh Yim, Jaemann Kyeong,
 Youngmin JeongAhn, Hee-Jae Lee, Hong-Kyu Moon,
 Dong-Goo Roh, Jung Hyun Jo, Jang-Hyun Park,
 Sungki Cho

Korea Astronomy and Space Science Institute

10:10 [III-2-3]

Operational Strategies of NSOS- α for Enhancing Near-Earth Asteroid Detection

Hee-Jae Lee, Myung-Jin Kim, Youngmin JeongAhn,
 Hong-Kyu Moon, Dong-Goo Roh, Hong-Suh Yim,
 Jaemann Kyeong, Jung Hyun Jo, Jang-Hyun Park,
 Sungki Cho

Korea Astronomy and Space Science Institute

10:25 [III-2-4]

NSOS-Beta (Near Space Optical Survey-Beta): Optical Wide-Field Patrol for MEO/GEO Space Objects

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

Korea Astronomy and Space Science Institute

10:40 [III-2-5]

Development and Operation Status of Space Object Collision Risk Management System for KARI

Jaedong Seong, Okchul Jung, Youeyun Jung, Saehan Song

Korea Aerospace Research Institute

10:55 [III-2-6]

Korea Meteor Monitoring and Observation Network (KMONet): The Introduction of Observation & Operation Rate of the Network and the Demonstration of Statistical Detection ResultsYun Hak Kim¹, Dong-Goo Roh¹, Jang-Hyun Park¹, Sungki Cho¹, Jung Hyun Jo¹, Jeong Yoo Hong¹, Hong-Suh Yim¹, Mansoo Choi¹, Myung-Jin Kim¹, Eun-Jung Choi¹, Jin Choi¹, Jiwoong Yu¹, Hee-Jae Lee¹, Jaemann Kyeong¹, Ki pyoung Sung¹, Sung-Yeol Yu¹, Seokmin Song^{1,2}, SeongHo Son³¹*Korea Astronomy and Space Science Institute*²*Chungnam National University*³*Open Sky Partners Inc.*

11:10 [III-2-7]

Civil Network for Optical SSA

Yong-Ik Byun

Yonsei University

제3발표장 (부라노 II)

09:40 [III-3-1]

Development Trends of Signals Intelligence Satellites

Sang Sul Han, Hong Rae Kim, Kyung Su Na

Agency for Defense Development

09:55 [III-3-2]

Advantage of the Formation Flying of the Cube Satellite ConstellationKyung-Su Na¹, Sang Sul Han¹, Inyoung Hwang¹, Hongrae Kim¹, Daehee Lee², Jae Jin Lee²¹*Agency for Defense Development*²*Korea Astronomy and Space Science Institute*

10:10 [III-3-3]

SpaceSCANer: Innovative Convergence of CubesatsDaehee Lee^{1,2}, Jaejin Lee¹, Goo-Hwan Shin³, Soojong Pak⁴, Geon Hee Kim⁵, SpaceSCANer Team⁶¹*Korea Astronomy and Space Science Institute*²*Department of Aerospace Engineering, KAIST*³*Satellite Technology Research Center, KAIST*⁴*Kyung Hee University*⁵*Department of Defense and Space Engineering, Hanbat University*⁶*SpaceSCANer Team*

10:25 [III-3-4]

Off-Axis Reflective Optics Onboard CubeSat for Infrared Astronomy and Space Based EO/IR SurveillanceSoojong Pak¹, SpaceSCANer Team²¹*Kyung Hee University*²*SpaceSCANer Team*

10:40 [III-3-5]

18U SPACE SCANer CubeSat Missions and ApplicationsGoo-Hwan Shin¹, Im-Hyu Shin¹, Dong-Guk Kim¹, Il-Young Jang¹, Hyun-Tae Choi¹, Young-Min Kim¹, Won-Ho Cha¹, Tae-Yoon Eom¹, Mina Koo¹, Jae-Hun Jang², Jeong-In Yun², Hyo-Sang Yoon², Bong-Kon Moon³, Dae-Hee Lee³, Jong-Dae Shon³, Jae-Jin Lee³, Chang-Gon Kim⁴, Soo-Jong Park⁴, Gun-Hee Kim⁵, Kyung-Su Na⁶, In-Young Hwang⁶¹*Satellite Technology Research Center, KAIST*²*Spacecraft Prototyping Laboratory, KAIST*³*Korea Astronomy and Space Science Institute, KASI*⁴*Kyung Hee University*⁵*Hanbat National University*⁶*Agency for Defense Development*

10:55 [III-3-6]

Aspheric Reflective Optics Ultra-Precision Machining TechnologyGeon Hee Kim¹, Jong Gyun Kang², Joong Kyu Ham², Hwan Ho Maeng², Seong Hyeon Park³¹*Department of Defense and Space Engineering, Hanbat University*²*Department of Mechanical Engineering, Chungnam University*³*Department of Mechanical Engineering, Hanbat University*

11:10 [III-3-7]

Regulating Security Measures for Defense Space

Missions

Hyun Joo Choi¹, Kanghee Lim², In Ho Seo¹,
Min Ji Bae¹, Ji Hee Yoo¹, Kyeong Keun Kim¹

¹*Agency for Space Development, ADD*

²*Center for Army Analysis & Simulation, ROK Army*

11:25 [III-3-8]

Analysis of the LEO Communications Satellite Constellations Pass through GEO Communications Satellite Earth Station

Byoung-Sun Lee^{1,2}

¹*Electronics and Telecommunications Research Institute*

²*University of Science and Technology*

13:00 [IV-3-1]

Ultralight Spacecraft: Boom-Type Solar Sail for Earth Orbit-Rising Demonstration Mission

Jungju Bae¹, Kwangchun Park², Jaeyoung Kang¹

¹*Mechanical Eng., Inha University*

²*Aerospace Eng. Sci., University of Colorado*

13:15 [IV-3-2]

A Study on the Changes in Long-Term Orbital Elements of Inclined Orbit Geosynchronous Satellites

Bangyeop Kim

Korea Aerospace Research Institute

13:30 [IV-3-3]

Development of High Reliability Memory Components for Space Applications Using Hermetic Ceramic Packaging Technology

Mi Young Park¹, Dongkuk Kim¹, Seyeon Kim¹,
Bonju Gu¹, Jeongki Seo¹, Seongkeun Jeong²

¹*Korea Advanced Institute of Science and Technology*

²*MID Co., Ltd*

13:45 [IV-3-4]

Introduction to the Integration, Alignment, and Performance Tests of the Simple Offner Type Hyperspectral Imager

Dai Ho Ko¹, Jinsuk Hong²

¹*Korea Aerospace Research Institute*

²*Hanwha Systems*

14:00 [IV-3-5]

Comparative Analysis of Thermal Control Methods for Thermal Stability of Cube Satellites

Gyeonghun Bae, Minkyu Kang, Hakjin Lee,
Rho-Shin Myong

*Department of Mechanical and Aerospace Engineering,
Gyeongsang National University*

14:15 [IV-3-6]

KPLO Deep-Space Ground System Event Schedule Generator Development and Operation

Dong-Gyu Kim¹, Eunheyuk Kim¹, Seok Soo Noh²,
Hee-Yoon Choung³

¹*Korea Aerospace Research Institute*

²*HANCOM inSPACE*

³*IOPS*

14:30 [IV-3-7]

Mission of KITSAT Satellite Return to Acquire Space Exploration Technology

Kyungin Kang

Satellite Technology Research Center, KAIST

제4발표장 (부라노 III)

09:40 [III-4-1]

Introduction to SpaceAI Program to Promote Artificial Intelligence in Space Science and Technology

Seonghwan Choi¹, Chanwoo Kim², Eunsu Park¹,
Harim Lee³, Hwanhee Lee¹, Jeong-Heon Kim¹,
Ji-Hye Baek¹, Rok-Soon Kim¹, Sung-Hong Park¹,
Taeyoung Kim⁴, Yong-Jae Moon³

¹*Korea Astronomy and Space Science Institute*

²*KAIST Academy*

³*Kyung Hee University*

⁴*AI Factory*

09:55 [III-4-2]

Preliminary Results of Solar Energetic Particle Flux Profile Prediction by Deep Learning

Kangwoo Yi¹, Jaewon Lee¹, Hwanhee Lee²,
Yong-Jae Moon¹

¹*Kyung Hee University*

²*Korea Astronomy and Space Science Institute***10:10 [III-4-3]****Preliminary Prediction of Active Region Evolution by Novel Deep Learning Models**Harim Lee¹, Eunsu Park², Yong-Jae Moon^{1,3}, Jihyeon Son³, Kyoung-Sun Lee⁴, Jinhye Park¹, Karimov Khojiakbar³, Yerim Lim³, Seonghwan Choi²¹*Department of Astronomy and Space Science, College of Applied Science, Kyung Hee University*²*Korea Astronomy and Space Science Institute*³*School of Space Research, Kyung Hee University*⁴*Astronomy Program, Department of Physics and Astronomy, Seoul National University***10:25 [III-4-4]****Preliminary Results of AI-Based Solar Photospheric Flux Transport Models**Hyun-Jin Jeong¹, Mingyu Jeon¹, Daeil Kim¹, Youngjae Kim¹, Ji-Hye Baek², Yong-Jae Moon¹, Seonghwan Choi²¹*Kyung Hee University*²*Korea Astronomy and Space Science Institute***10:40 [III-4-5]****Development of an Interplanetary Coronal Mass Ejection Detection Algorithm Using Artificial Intelligence**Roksoon Kim¹, Jongyeob Park¹, Woong Jeon²¹*Korea Astronomy and Space Science Institute*²*KyoungHee University***10:55 [III-4-6]****Developing a Deep Learning Model for Solar Flare Irradiance Translation**Sung-Hong Park¹, Junmu Youn², Seungwoo Ahn², Jeongheon Kim¹, Kangwoo Yi²¹*Korea Astronomy and Space Science Institute*²*Kyung Hee University***11:10 [III-4-7]****Preliminary Results for Deep Learning-Based Solar Flare Irradiance Prediction Model**Jeong-Heon Kim¹, Sung-Hong Park¹, Junmu Youn², Seungwoo Ahn², Kangwoo Yi²¹*Korea Astronomy and Space Science Institute, KASI*²*Kyung Hee University, KHU***13:00 [IV-4-1]****Humanitarian Operations of the Icebreaker Research Vessel (IBRV) in Polar Regions: Lessons for Space Rescue Strategies**Eojin Yi¹, Joowoong Park², Kyunghwan Kim³, Woo Seok Choi^{4,5}¹*aSSIST University*²*Korea Aerospace Research Institute*³*MoonLeap Space System Inc.*⁴*Keyu Internal Medicine Clinic*⁵*KAIST***13:15 [IV-4-2]****Exploring Cheaper Rideshare/Piggyback Options to Flyby with Asteroids Passing by Earth**

Pureum Kim, Sang-Young Park

*Yonsei University***13:30 [IV-4-3]****Relationship between Energization of Moon-Originating Ions and Terrain Type on the Lunar Surface**Jaehee Lee¹, Khan-Hyuk Kim¹, Seul-Min Baek², Ho Jin¹, Yoshifumi Saito³, Masaki N. Nishino³, Shoichiro Yokota⁴¹*School of Space Research, Kyung Hee University*²*Korea Astronomy and Space Science Institute*³*Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency*⁴*Osaka University, Japan***13:45 [IV-4-4]****Laboratory Study for Light Scattering of 3D Printed Lunar Fairy Castle Structure**Mingyeong Lee^{1,2}, Minsup Jeong¹, Young-Jun Choi^{1,2}¹*Korea Astronomy and Space Science Institute*²*University of Science and Technology***14:00 [IV-4-5]****Precision Orbit Determination Results in the Commissioning Phase of Danuri**

Jonghee Bae, Young-Joo Song, SeungBum Hong, Jun Bang

Korea Aerospace Research Institute

14:15 [IV-4-6]

KPLO Collision Avoidance Maneuver #1 Planning and Execution Result

Jun Bang, SeungBum Hong, Young-Joo Song,
Jonghee Bae

Korea Aerospace Research Institute

14:30 [IV-4-7]

Introduction to Multimission Automated Deepspace Conjunction Assessment Process (MADCAP)

SeungBum Hong, Jun Bang, Jonghee Bae,
Young-Joo Song

Korea Aerospace Research Institute

10월 27일(금)

제1 발표장 (컨벤션센터)

09:00 [IS-III]

A Polar-, A Space-, and A 'Risky' Person

Eojin Yi^{1,2}

¹*aSSIST University*

²*Korean Society of Polar Medicine (KSPM)*

09:40 [V-1-1]

Analysis of the Characteristics of Gravity Waves over the Korean Peninsula Using Specular Meteor Radar

Hosik Kam¹, Young-Sil Kwak^{1,2}, Tae-Yong Yang¹,
Jeongheon Kim¹, Jaewook Lee^{1,2}, In-Sun Song³,
Byeong-Gwon Song³

¹*Korea Astronomy and Space Science Institute*

²*University of Science and Technology*

³*Yonsei University*

09:55 [V-1-2]

Multilayer Shields that Shield Satellite Electronic Components from Cosmic Radiation

Hojin Lee^{1,2}, Jongdae Sohn^{1,2}, Junga Hwang^{1,2,3},
Hyosang Yoon³

¹*University of Science and Technology (UST)*

²*Korea Astronomy and Space Science Institute (KASI)*

³*Korea Advanced Institute of Science and Technology (KAIST)*

10:10 [V-1-3]

Preliminary Prediction of IMF Southward Components (Bz) for the Next 6 Hours by Deep Learning

Jihyeon Son¹, Yong-Jae Moon^{1,2}, Kyung Sun Park³,
Young-Sil Kwak⁴

¹*School of Space Research, Kyung Hee University*

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

³*Department of Astronomy and Space Science/Basic Science Research Institute, Chungbuk National University*

⁴*Space Science Division, Korea Astronomy and Space Science Institute*

10:25 [V-1-4]

Development a Two-Dimensional Regional Ionospheric Total Electron Content Prediction Model based on Deep Learning Approach

Se-Heon Jeong¹, Woo Kyoung Lee¹, Soojeong Jang²,
Hyosub Kil³, Jeong-Heon Kim¹, Young-Sil Kwak^{1,4}

¹*Korea Astronomy and Space Science Institute*

²*Kyung Hee University*

³*Applied Physics Laboratory, Johns Hopkins University*

⁴*University of Science and Technology*

10:40 [V-1-5]

Solar Limb Flare Prediction Using SDO/AIA EUV Intensity and Its Deep Learning Implementation

Jaewon Lee¹, Yong-Jae Moon^{1,2}, Kangwoo Yi²,
Hyun-Jin Jeong², Harim Lee²

¹*School of Space Research, Kyung Hee University*

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

10:55 [V-1-6]

Ions at the Shock Ramp of a Quasi-Perpendicular Bow Shock Observed by MMS

Hee-Eun Kim¹, Ensang Lee¹, George K. Parks²

¹*School of Space Research, Kyung Hee University*

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

11:10 [V-1-7]

Investigating the Impacts of Internal Atmospheric Variability on the Ionosphere during the 5 April 2010 Geomagnetic Storm

Wonseok Lee, In-Sun Song, Ja Soon Shim,

Hoijin Uh

Department of Atmospheric Sciences, Yonsei University

11:25 [V-1-8]

Correlation between EUV Intensity Spikes and Mean Intensities on the Solar Disk

Il-Hyun Cho, Yong-Jae Moon, Jin-Yi Lee,
Junmo An

Kyung Hee University

11:40 [V-1-9]

Energy Coupling from Magnetosonic Waves to High-Frequency Electromagnetic Ion Cyclotron Waves: Statistical Analysis

Kyungguk Min¹, Qianli Ma²

¹*Chonnam National University*

²*UCLA*

Tae-Yoon Eom¹, Im-Hyu Shin¹, Dong-Guk Kim¹,
Il-Young Jang¹, Hyun-Tae Choi¹, Young-Min Kim¹,
Won-Ho Cha¹, Mina Koo¹, Goo-Hwan Shin¹,
Jae-Hun Jang², Jeong-In Yun², Hyo-Sang Yoon²,
Bong-Kon Moon³, Dae-Hee Lee³, Jae-Jin Lee³,
Chang-Gon Kim⁴, Soo-Jong Park⁴, Gun-Hee Kim⁵,
Kyung-Su Na⁶, In-Young Hwang⁶

¹*Satellite Technology Research Center, KAIST*

²*Spacecraft Prototyping Laboratory, KAIST*

³*Korea Astronomy and Space Science Institute, KASI*

⁴*Kyung Hee University, South Korea*

⁵*Hanbat National University, South Korea*

⁶*Agency for Defense Development*

09:55 [V-3-2]

The Study on Link Degradation due to TT&C Frequency Sharing in Geo-Synchronous Constellation Mission

Sangil Ahn, Wonsub Choi, Bangyeop Kim

Korea Aerospace Research Institute

10:10 [V-3-3]

Introduction to the Development and Applications of Space-Grade Polarized Imaging Cameras

Seonghwan Choi¹, Jungwoong Kim², Gwanghui Jeong³,
Byungchae Bang³, Jihun Kim¹, Jongyeob Park¹,
Ji-Hye Baek¹

¹*Korea Astronomy and Space Science Institute*

²*I-Trix Technology Inc.*

³*AntBridge Inc.*

10:25 [V-3-4]

GNSS Time Delay and Interference

Jong-Kyun Chung, Junseok Hong

Korea Astronomy and Space Science Institute

10:40 [V-3-5]

Ground-Based Reusable Launch Vehicle Mission Design and Economic Analysis

Keum-Oh Lee, Daeban Seo, Junseong Lee,
Jaesung Park

Korea Aerospace Research Institute

10:55 [V-3-6]

Energetic Electron Flux Enhancement Induced by NWC Transmitter

제2발표장 (부라노 I)

09:40 [V-2-1]

The Importance of Public Communication in Science Culture in Korea

Junga Hwang^{1,2}

¹*Korea Astronomy and Space Science Institute*

²*University of Science and Technology*

09:55 [V-2-2]

The Difficulties in Accurate Public Communication Learned from the 2023 Super Blue Moon

Ah-Chim Sul^{1,2,3}, Yonggi Kim², Hyoungbum Kim²,
Han-Earl Park¹, Dong-Hyo Sohn¹, Hye-im Jeong¹,
Hye-lim Jeong³

¹*Korea Astronomy and Space science Institute*

²*Chungbuk National University*

³*Korean Amateur Astronomical Society*

제3발표장 (부라노 II)

09:40 [V-3-1]

Power Budget Analysis for the 18U SPACE SCANer CubeSat

Ho-Sung Choi¹, Jaeheung Park², Magnus F. Ivarsen³

¹Republic of Korea Army

²Korea Astronomy and Space Science Institute

³University of Oslo

11:10 [V-3-7]

Military Utilization and Application of Low Earth Orbit Satellite Communications

Sunghwan Cho, Hochan Lee, Yongchul Kim

Korea Military Academy

¹Korea Research Institute of Standards and Science

²Department of Applied Measurement Science, University of Science and Technology

10:40 [V-4-5]

Preliminary Design of a LED Module for Use as a Laser Alignment Aid between a FSO Communication Nanosatellite and an Optical Ground Station

Jun-Hyeon Kim, Seul-Hyun Park

Department of Mechanical Engineering, Chosun University

10:55 [V-4-6]

Altered Gravity Force Hinders Proper Development of Multi-Dendritic Arborization in a Harsh Touch Sensory Neuron PVD in *C. elegans*

Je-Hyun Moon, Jin I Lee

Division of Biological Science and Technology, Yonsei University

11:10 [V-4-7]

Proposing a New Paradigm for Space Medicine with Traditional Korean Medicine (K-Space Medicine)

Yoojeon Jeon

JYJ Eversnow Center for Integrative Medicine

11:25 [V-4-8]

Experimental Study on the Flame Spread of Thermally Thin Wires in Microgravity

Seul-Hyun Park

Department of Mechanical Engineering, Chosun University

11:40 [V-4-9]

Exploration of Biomaterials Effective in Preventing Muscle Atrophy due to Microgravity

Junsoo Park¹, Siyun Lee¹, Rackhyun Park², Inho Choi¹, Takeshi Nikawa³

¹Division of Biological Science and Technology, Yonsei University

²Department of Life Science, Yong-In University

³Departments of Nutritional Physiology, Institute of Biomedical Sciences, Tokushima University Graduate School, Japan

제4발표장 (부라노 III)

09:40 [V-4-1]

Korea's Long Term Road Map of Manned Space Program

Gi-Hyuk Choi, Joo-Hee Lee

Korea Aerospace Research Institute

09:55 [V-4-2]

Power Budget and Profiling of a 3U Nano-Satellite for Free Space Optical Communication

Myung-Kyu Lee¹, Young-Min Ko², Tae-Jung Ahn², Seul-Hyun Park³

¹Graduate School of Chosun University

²Department of Optical Engineering, Chosun University

³Department of Mechanical Engineering, Chosun University

10:10 [V-4-3]

Preliminary Investigation into the Use of LED as a Nanosatellite Identifier in Orbit

Jin-Woo Lee, Seul-Hyun Park

Department of Mechanical Engineering, Chosun University

10:25 [V-4-4]

Status of Materials Study Using Levitation Techniques in International Space Station and Korea Research Institute of Standards and Science

Geun Woo Lee^{1,2}, Yong Chan Cho¹, Lei Wang¹, Thi Huu Nhat Le¹, Yun-Hee Lee¹

포스터발표 논문 제목

10월 26일(목) 16:30~18:00

▶ 달과 우주 탐사

[P-1] KPLO Science Data Receiving Management S/W Development and Operation

Junghyun Lee

Korea Aerospace Research Institute(KARI)

[P-2] KPLO/Lunar Terrain Imager (LUTI) Flight Calibration: Non-Uniformity Correction

Eunhyeuk Kim

Korea Aerospace Research Institute

[P-3] Temporal and Spatial Variations of the 3-Micron CH₄ and C₂H₆ Northern Aurorae of Jupiter

Sang Joon Kim¹, Chae Kyung Sim²,
Thomas R. Geballe³, Yuk L. Yung⁴, Steve Miller⁵,
Sungho Lee², Chihiro Tao⁶

¹*Kyung Hee University*

²*Korea Astronomy and Space Science Institute*

³*Gemini Observatory*

⁴*Caltech*

⁵*University College London*

⁶*Institute of Space and Astronautical Science*

[P-4] Korea Pathfinder Lunar Orbiter Extended Mission Orbit Options: A Quick Analysis of Potential Candidate Mission Orbits

Young-Joo Song, SeungBum Hong, Jonghee Bae,
Jun Bang

Korea Aerospace Research Institute

[P-5] Case Study of Extended Mission for Danuri: Flight Dynamics Analysis in Lunar Polar Orbit with 50 ± 20 km

Jonghee Bae, SeungBum Hong, Jun Bang,
Young-Joo Song

Korea Aerospace Research Institute

[P-6] Planning, Execution, and Analysis of KPLO Orbit Maintenance Maneuvers

SeungBum Hong, Jonghee Bae, Young-Joo Song,
Jun Bang

Korea Aerospace Research Institute

[P-7] One Year Magnetic Field Observations of KPLO Mission

Woojin Jo¹, Ho Jin¹, Khan-Hyuk Kim¹,
Ian Garrick-Bethell², Hyeonhu Park¹, Junhyun Lee¹,
Yunho Jang¹, Hyeonji Kang¹, Juhyeong Kim¹,
Seungmin Lee¹, Seul-Min Baek³

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

²*University of California, Santa Cruz*

³*Korea Astronomy and Space Science Institute*

[P-8] Influence of Grain Size on Lunar Spectral Data in Space Weathering Analysis

Eunjin Cho¹, Chae Kyung Sim², Minsup Jeong²,
Young-Jun Choi^{2,3}, Yu Yi¹

¹*Chungnam National University*

²*Korea Astronomy and Space Science Institute*

³*University of Science and Technology*

[P-9] KPLO X-Band Link Budget Analysis and Comparison between BLT and on Lunar Orbit

Sangman Moon, Changkyoon Kim, Inkyu Kim,
Hyeon-Cheol Lee

Korea Aerospace Research Institute

[P-10] Chronological Records of Risk Management for the Lunar Exploration Program to Develop Korea Pathfinder Lunar Orbiter (KPLO)

Jae-Hoon Song

Korea Aerospace Research Institute

[P-11] Polarimetric Measurements of Apollo Soil Samples by Particle Size

Serin Kim¹, Shuai Li², Minsup Jeong³, Kilho Baek¹,
Sungsoo S. Kim¹, Eunjin Cho⁴

¹*Kyung Hee University*

²*University of Hawaii at Manoa*

³*Korea Astronomy and Space Science Institute*

⁴*Chungnam National University*

[P-12] KPLO SPICE Kernels: Preparation of Official Release Archive #1

Jo Ryeong Yim¹, Seung Woo Kim², Dong-Gyu Kim¹

¹*Korea Aerospace Research Institute*

²*I-OPS*

[P-13] Numerical Model of Impact Crater on the Jeokjung-Chogye Basin in Korean Peninsula

Hyeonhu Park¹, Ho Jin¹, Ian Garrick-Bethell²,
Brandon C Johnson³, Seungmin Lee¹

¹*School of Space Reseach, Kyung Hee University*

²*University of California, Santa Cruz*

³*Purdue University*

[P-14] The Estimation of Licklider Transmission Protocol (LTP) Bundle Delivery Time with KPLO Channel Error Measurement

In-Kyu Kim, Sang-Man Moon

Korea Aerospace Research Institute, KARI

[P-15] A Study on the 3-D Inversion for the Lunar Crustal Magnetic Anomaly Data

MinJae Lee, Hyung Rae Kim, Seolyeong Lee

Kongju National University

[P-16] Analysis of Ablative Materials of Thermal Protection System for Sample Return Missions

Dae-Yeong Kim, Gi-Hyuk Choi

Korea Aerospace Research Institute

[P-17] Data Preprocessing for Learning-Based Lunar Terrain Mapping

Huigeon Kim, Seokju Lee

Korea Institute of Energy Technology

▶ **SS: Open New Horizon with L4 Mission**

[P-18] Scientific Goal and Requirements for Solar Chromospheric Imaging Spectrograph for L4

Eun-Kyung Lim, Donguk Song, Sung-Hong Park,
Jeong-Yeol Han, Kyung-Suk Cho, Seonghwan Choi,
Rok-Soon Kim, Jungjoon Seough, Junga Hwang

Korea Astronomy and Space Science Institute

▶ **SS: SpaceAI 2023: 인공지능, 우주를 만나다**

[P-19] Optimization of Correlation Parameters for TIF Depth on SiC Mirror Using Deep Learning

Seung Ho Han¹, Jeong-Yeol Han², Eunsu Park²,
Jiwoo Lee^{3,4}, Wonjae Doo⁵, WooJin Kim⁶,
Yong-Jae Moon⁷

¹*Department of Physics, Kongju National University*

²*Korea Astronomy & Space Science Institute*

³*Department of Division of Energy and Optical Technology Convergence, Cheongju University*

⁴*LeO SPACE Inc.*

⁵*Department of Astronomy and Space Science, Chungnam National University*

⁶*Department of Mechatronic Engineering, Chungnam National University*

⁷*Kyunghee University*

▶ **SS: 차세대 중형위성 3호**

[P-20] Result for CAS500-3 (Compact Advanced Satellite500-3) Critical Design Applied with CAS500 Standard Platform

Youngcheul Kim, Junseong Kim, Jin-Gon Bae,
Shin-Hye Moon, Seok-Soo Kim

Korea Aerospace Industries, Ltd.

▶ **우주감시**

[P-21] A Performance Comparison of Radio Refraction Error Correction Methods for Space Launch Vehicle Tracking

Ha-Ryong Song, Dong-Young Shin

Korea Aerospace Research Institute

[P-22] An Introduction of Payload Data Transmission System for CAS500-4

Eun Su Kang, Sang Burm Ryu, Sang Gyu Lee

Korea Aerospace Research Institute

[P-23] How Catastrophic Collisions Caused by Space Debris are Defined

Eunghyun Kim, Jaedong Seong, Okchul Jung

Korea Aerospace Research Institute

▶ **우주천문**

[P-24] Modeling of CO Lines from Star-Forming Regions at Intermediate Redshift

Sungeun Kim^{1,2}, Min Yan³, Eun Joo Shin^{2,4}

¹*Department of Physics and Astronomy, Sejong University*

²*Department of Astronomy and Space Science, Sejong University*

³Harvard-Smithsonian Center for Astrophysics

⁴Observatory for Children

[P-25] Feasibility Study of Magnetic Field Sensor for Lunar Exploration Probe

Juhyeong Kim¹, Seungmin Lee¹, Ho Jin¹, Ian Garrick-Bethell², Khan-Hyuk Kim¹, Hyeonhu Park¹, Yunho Jang¹, Hyeonji Kang¹, Woojin Jo¹

¹School of Space Research, Kyung Hee University

²University of California, Santa Cruz

[P-26] Trial Operation of an Oral History Archive Web Service Platform for Astronomy and Space Science in Korea

Yoon Kyung Seo¹, Youngsil Choi¹, Jeong-Yeol Han¹, Junghee Kang², Jaeheung Kim²

¹Korea Astronomy and Space Science Institute

²ITTogether Co., Ltd.

[P-27] Design of 1,064 nm Homodyne Detector for Observation of Quantum Squeezed State of Light

Seungmin Chae¹, Ueejeong Jeong², Gyoik Kim³, Yunjong Kim², Chang-Hee Kim², Sungho Lee², Yeonsang Park¹

¹Chungnam National University

²Korea Astronomy and Space Science Institute

³Kyung Hee University

▶ **초소형 위성**

[P-28] Summary of Problem Reports of 6U Nanosatellites

Min-Ki Kim, Won-Sub Choi, Jin-Hyung Kim, Ji-Seok Kim

Korea Aerospace Research Institute

[P-29] The Key Points for Link Support of 4 of 3U Cubesats on Nuri 4th Launch Campaign with a KARI Cubesat Antenna

Sangil Ahn

Korea Aerospace Research Institute

▶ **우주기술**

[P-30] Research on NASA's Moon to Mars

Strategy and Objectives Development

Yong-Sik Yoon, Jong-Min Lim, Hee-Kwang Eun

Korea Aerospace Research Institute

[P-31] Experiments to Improve Channel-to-Channel Image Registration for Mid-Infrared Water Vapor Bands of GK-2A AMI

Sungsik Huh

Korea Aerospace Research Institute

[P-32] Analysis of System Influence by Power Line Common Mode Current of Satellite Electronics Unit

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

Korea Aerospace Research Institute

[P-33] MTF Measurement Characteristic Analysis of Space Telescope by Using Fermi and Error Functions

Jeoung-Heum Yeon, Jong-Pil Kong

Korea Aerospace Research Institute

[P-34] A Study on the Usable Satellite Image Acquisition Rate Using KSOC Satellite Image Database and Global Cloud Information

Gab-Ho Jeun, Myung-Jun Lee, Na-Young Kwon

Korea Aerospace Research Institute

[P-35] An Interface Design between Order System and Data System for Shortening the Time from Order to Distribution of Archiving Satellite Images

Myung-Jun Lee, Gap Ho Jeon, Nayoung Kwon, Min-A Kim, Gu Hyeok Kim, Seong Heon Kim, Myeong Shin Lee

Korea Aerospace Research Institute

[P-36] A Review of Launch Site Campaign of CAS500 from the Electrical Perspective

Young-Yun Kim

Korea Aerospace Research Institute

[P-37] A Study on the Need for Time-Domain

Testing of Satellite Conducted Emission

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

[P-38] Empirical Investigation for the Effects of Thickness and Size of White Painting Applied on the Solar Array Backside

Cho Young Han
Korea Aerospace Research Institute

[P-39] KPLO Mass Budget Review

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

[P-40] Importance of Protecting Space Environment Via the IADC Space Debris Environment Report

Youeyun Jung, Jaedong Seong, Saehan Song,
Eunghyun Kim, Okchul Jung
Korea Aerospace Research Institute

[P-41] Optical Payload Thermal-Design Verification at System-Level Thermal Vacuum Test

Su-Young Chang, Hyung-yun Noh, Jong-Pil Kong
Korea Aerospace Research Institute (KARI) Satellite Payload R&D Division

[P-42] Science Image and Auxiliary Data Telemetry Matching Algorithm for GEO-KOMPSAT-2 GEMS

Jinhyung Park
Korea Aerospace Research Institute

[P-43] Acquiring and Maintaining Frequency Resources in a Changing Frequency Environment for Geostationary Satellite Programs

Seorim Lee
Korea Aerospace Research Institute

[P-44] Mechanical Ground Support Equipment for Geo-Kompsat-3 Integration and Test

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

[P-45] On-Borad Time Management for 1 Year after Launch of KPLO

Moon-Jin Jeon
Korea Aerospace Research Institute

[P-46] Design and Test Results of S-AIS Secondary Payload of the Next Korean SAR Satellite

Hong Won Park
Korea Aerospace Research Institute

[P-47] The Impact of CMG Evacuation on Performance

Yong-Bok Kim
Korea Aerospace Research Institute

[P-48] A Study on the Conducted Susceptibility Test of Satellite Unit according to the Changes of Bus Voltage

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

[P-49] Review on the Current Unbalance Anomaly among Solar Array Regulator Converters in Parallel Operation

Sung-Woo Park, Hyung-Jun Jang
¹*Korea Aerospace Research Institute*
²*Korea Aerospace Industry*

[P-50] Effect of Image Processing Parameters on Accuracy of an On-Orbit Visual Inertial Navigation Filter

Dawoon Jung^{1,2}, Seungkeun Kim²
¹*Korea Aerospace Research Institute*
²*Chungnam National University*

[P-51] Jeju Korea Satellite Operations Center Image Collection Planning Subsystem Composition and Operation Status

SeungNam Song, JungNam Jun, Eunsook Lim,
MyeongShin Lee
Korea Aerospace Research Institute

[P-52] Design of Validation Rack for Solar Array

Simulator

Seung Won Cho, Dong-Chul Chae
Korea Aerospace Research Institute

[P-53] Prototype of NEONSAT's Imaging and Downloading Planning Function

Dong Oh Kim, Chi Ho Kang, Jun Yeong Bok, Jong Bum Park, Daehoon Yoo
Satellite Ground Station R&D Division, National Satellite Operation and Application Center, Korea Aerospace Research Institute

[P-54] Thermal Control Concept and Thermal Design on Space Exploration Vehicle with Radioisotope Heat Source

Hui-Kyung Kim^{1,2}
¹*Korea Aerospace Research Institute*
²*University of Science and Technology*

[P-55] System Level Integration Validation Tests for a GEO Satellite Electric Propulsion Subsystem

Keun Joo Park, Su Kyum Kim, Hyoung Yoll Jun
Korea Aerospace Research Institute

[P-56] Propellant Estimation for a Geostationary Telecommunication Satellite

Jong Seok Park, Jung Su Choi, Keun Joo Park, Hyoung Yoll Jun
GEO-KOMPSAT-3 Program Office, KARI

[P-57] Development Trend for the Small Satellite

Jong-Oh Park, Yong-Sik Chun
Korea Aerospace Research Institute (KARI)

[P-58] Telecommand Processing Software Design for Navigation Satellites

Su-Hyun Park
Korea Aerospace Research Institute

[P-59] Trend Analysis of Single Error on PDHU of Danuri

Changkyoon Kim^{1,2}
¹*Korea Aerospace Research Institute*
²*Korea Advanced Institute of Science and Technology*

[P-60] KPLO FM Solar Array Deployment Test

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

[P-61] ESD Screen and Cho-Foil Finalization of KPLO at the Launch Site

Seung-Yong Min¹, Hyun-Jin Shin¹, Beom-Suk Kang¹, Hyung-Wan Kim¹, Kwang-Soo Na²
¹*Korea Aerospace Research Institute*
²*ELM Inc.*

[P-62] Three-Dimensional Thermal Analysis for Predicting the Power Consumption of Heaters in GK3 in Transfer Orbit

Gilho Lee, Jung Hoon Kim
Korea Aerospace Research Institute

[P-63] Operational Methods of Low Earth Orbit Satellites Using Relay Satellites

Hyun-Su Lim
Korea Aerospace and Research Institute

[P-64] GK3 Communication Antennas Accommodation Design

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

[P-65] Integrated Operation Concept Design and Analysis for LEO Satellite Constellation

Jeongheum Im
Korea Aerospace Research Institute

[P-66] Robotic Testbed for Pose Estimation Research of Tumbling Space Object

Jin-Hyung Kim
Korea Aerospace Research Institute

[P-67] Preliminary Electrical Interface Design of Electric Propulsion System for GEO-KOMPSAT-3

Young-Jin Won
Korea Aerospace Research Institute

[P-68] Development of Multi-Satellite Integrated Overseas Ground Station Pass Selection Program for Satellite Image Downlink

Eunsook Lim¹, Euna Cho², JungNam Jun¹, MyeongShin Lee¹

¹*Korea Aerospace Research Institute*

²*SI-Imaging Service, SIIS*

[P-69] Attitude Control FDIR in the GEO-KOMPSAT3

Woo Yong Kang

Korea Aerospace Research Institute

[P-70] Enhancement of Low Orbit Satellite Image Processing Monitoring System

Guhyeok Kim, Min-A Kim, SeongHeon Kim, MyeongShin Lee

Korea Aerospace Research Institute

[P-71] GK3 FDIR (Failure Detection Isolation Recovery) Hierarchical Design Progress on Development Phase

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

Korea Aerospace Research Institute

[P-72] Design of Remote Agent for Flight Software Development

Hyun-Kyu Shin

Korea Aerospace Research Institute

[P-73] Study on Future SAR Satellite and Its Applicational Information

Jae-Min Shin

Korea Aerospace Research Institute

[P-74] Study on Version Control Systems for the Configuration Management of Satellite Flight Software

Jae-Seung Lee

Korea Aerospace Research Institute

[P-75] Designed to Improve the Satellite Image Processing Procedure of CPS

Jaeyeol Lee, Jihyeon Yim, Min-A Kim,

Guhyeok Kim, Myeongsin-Lee

Korea Aerospace Research Institute

[P-76] Method for Multi-Satellite Integration Test with EGSE at AIT

Kyung-Keun Kim

Korea Aerospace Research Institute

[P-77] Establishment of an Optical Ground Station for Laser Communication Prototype Development a Function Verification

Myung-Gil Kim, Kang-Toi Yoon, Do-Hoon Kim, Je Geun Lee

SpaceK Inc

▶ 우주응용

[P-78] Functional Test Result and Analysis of Air Management System for Undersea Platform

Younkyu Kim, Joohee Lee

Korea Aerospace Research Institute

[P-79] Methods to Improve Dynamic Range in Satellite Electro-Optical Camera System

Youngsun Kim, Haeng-Pal Heo

Korea Aerospace Research Institute

[P-80] Development Trend of QKD (Quantum Key Distribution) Payload

Hwan-Chun Myung, Sung-Soo Jang

Korea Aerospace Research Institute

[P-81] Verification Focus Control Method of Electro-Optic Camera System for Satellite in Thermal Vacuum Test

Jong-Euk Park, Haeng-Pal Heo

Korea Aerospace Research Institute

[P-82] Image Chain Tests Using CAP-W EM

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

Korea Aerospace Research Institute

[P-83] Electro-Optical Performance Test Result of CMOS TDI Image-Sensor Flight Model for

CAP-W Payload

Ilseop Lee, Jong Pil Kong, Sang-Gyu Lee
Korea Aerospace Research Institute

[P-84] Jitter Characteristics Improvement on Serial Data Interface of Space-Born Memory Equipment

Jong-Tae Lee, Haeng-Pal Heo
Korea Aerospace Research Institute

[P-85] Emergency Operation Plan Design of Air Management System for Undersea Base Platform

Joohee Lee, Younkyu Kim, Jongwon Lee
Korea Aerospace Research Institute

[P-86] Results of the Thermal Vacuum Tests for the Performance Verification of the CAP-W Payload of CAS-4 Satellite

Dae-Jun Jung¹, Jong-Un Kim², Sang-Gyu Lee¹
¹*Korea Aerospace Research Institute*
²*SATREC INITIATIVE*

[P-87] Ground Rupture and Crack Detection and Analysis Method in Various Environments Using Deep Learning Technology

Yeonju Choi
Korea Aerospace Research Institute

[P-88] Utilizing Response Surface Method for Optical System Alignment

Jongguk Choe, Goeun Kim, Dongok Ryu, Haengpal Heo
Korea Aerospace Research Institute

▶ 지상 및 우주 인프라 운영기술

[P-89] Research on Improving Preparatory Test Procedures and Efficient Test Technical Document Management to Support Satellite Testing

Chul Kang
Korea Aerospace Research Institute

[P-90] Application of Data Quality Encapsulation (DQE) and Correlated Source Selector (CSS) in

Telemetry Ground Station

Dong-Hyun Kim, Chun-Won Kim, Soon-Ho Kwon, Jin-A Ma, Jeong-Woo Han, Tae-Jin Lee, Na-Gyun An, Min-Seok So
Korea Aerospace Research Institute

[P-91] Efficient Satellite Data Receiving System Structure Proposal Using Overseas Ground Stations

Myungmuk Kim, Gyeoul Lee, Woomin Lee
Korea Aerospace Research Institute

[P-92] Concept of Image Processing System Considering Concurrent Operation in Remote Areas

Min-A Kim, Guhyeok Kim, Seong Heon Kim, MyeongShin Lee
Korea Aerospace Research Institute

[P-93] Development of DB Reset Tool for KOMPSAT-5 Image Processing Automation

SeongHeon Kim, GuHyeok Kim, Min-A Kim, MyeongShin Lee
Korea Aerospace Reserch Institute

[P-94] A Study on the Feeding Performance for Monopulse Tracking Antenna

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Jina Ma^{1,2}, Soonho Kwon¹, Nagyun An¹, Taejin Lee¹, Minseok So¹, Chunwon Kim¹, Jeongwoo Han¹, Donghyun Kim¹, Intae Hwang²
¹*Korea Aerospace Research Institute*
²*Chonnam National University*

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²*Chungnam National University*

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Satellite Ground Station R&D Division, Korea Aerospace Research Institute (KARI)

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Kyu-Cheol Choi¹, Dae-Kyu Shin¹, Seung-Jun Oh¹, Yong-Ha Kim², Won-Hyeong Lee³

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²*ChungNam University*

³*Korea Space Weather Center, RRA*

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[P-107] Microwave Solar Flare Spectra Obtained by KSRBL

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¹*Korea Astronomy and Space Science Institute*

²*School of Space Research, Kyung Hee University*

[P-108] On the Possibility of Geomagnetic Jerk to Affect Earth Rotation

Sung-Ho Na, Yu Yi

Chungnam National University

[P-109] Minimization of the Degeneracy Problem in the Determination of CME 3-D Parameters by L1, L4, and L5 Observations

Hyeonock Na¹, Yong-Jae Moon^{1,2}

¹*Department of Astronomy and Space Science, Kyung Hee University*

²*School of Space Research, Kyung Hee University*

[P-110] Observation and Simulation Study on the Response of the Earth's Magnetosphere and Ionosphere at the Occurrences of the GLE Events

Jinhye Park¹, Kyung Sun Park²

¹*Department of Astronomy and Space Science, College of Applied Science, Kyung Hee University*

²*Department Astronomy and Space Science, Chungbuk National University*

[P-111] Characteristics of the Thermospheric Winds over the Korean Peninsula

Jaewook Lee^{1,2}, Young-Sil Kwak^{1,2}, Hosik Kam¹, Jeongheon Kim¹, Tae-Yong Yang¹

¹*Korea Astronomy and Space Science Institute*

²*University of Science and Technology*

[P-112] Classification of Ionograms in the Polar Region by the Vertical Incidence Pulsed Ionospheric Radar at Jang Bogo Station, Antarctica

Junho Back^{1,2}, Geonhwa Jee^{2,3}, Hyuck-Jin Kwon², Khan-Hyuk Kim¹, Changsup Lee^{2,3}, Young-Bae Ham^{2,3}

¹*School of Space Research, Kyung Hee University*

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³*Department of Polar Science, Korea University of Science and Technology*

[P-113] Solar Interior Currents Assumed by Global Photosphere Magnetic Fields

Bogyong Kim, Yu Yi

Chungnam National University

[P-114] Relation between Stepwise Development of Auroral Onset Arc and Geomagnetic Pulsations

and Perturbations at High and Low Latitudes at Substorms Onsets

Madeeha Talha^{1,2,3}, Yukinaga Miyashita^{1,2}

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²*Korea Astronomy and Space Science Institute (KASI)*

³*Pakistan Space & Upper Atmosphere Research Commission (SUPARCO)*

[P-115] Application of a Nonequilibrium Model to Solar Wind Plasma

Jin-Yi Lee¹, Junmo An¹, John C. Raymond², Chengcai Shen²

¹*Kyung Hee University*

²*The Center for Astrophysics | Harvard & Smithsonian*

[P-116] Near-Midnight Eastward Flow Typically Increasing with Geomagnetic Activity in the PMSE Layer

Young-Sook Lee¹, Yukinaga Miyashita^{2,3}, Akira Kadokura⁴, Ram Singh¹, Geonhwa Jee⁵, Yong Ha Kim¹, Ram Singh¹, Young-Sil Kwak^{2,3}

¹*Chungnam National University*

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⁵*Korea Polar Research Institute*

[P-117] Comparison of Ionosphere Models and SuperDARN Observations

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²*Korea Astronomy and Space Science Institute*

구두발표 논문 초록

10월 25일(수) 제1발표장 컨벤션센터
 Invited Talk I
 Chair: 조경석(천문연)

12:40 [IS-I] Solar Eruptions and Space Weather: Aditya-L1 Perspective

Bhuwan Joshi
 Udaipur Solar Observatory, Physical Research Laboratory, India

The Aditya-L1, launched on 2023 September 2, is the first space-based solar observatory of the Indian Space Research Organization (ISRO). The spacecraft will carry seven payloads and provide uninterrupted observations of the Sun and solar wind from the first Lagrangian (L1) point. The observatory consists of a suite of seven payloads for remote sensing as well as *in-situ* measurements of the solar phenomena. There are four remote sensing payloads which include a coronagraph observing in visible and infrared, a full disk imager in Near Ultra-Violet (NUV), and two full-sun integrated spectrometers in soft X-ray and hard X-ray. For *in-situ* measurements, the spacecraft is equipped with three instruments including a magnetometer, to study the plasma and magnetic field variations associated with the solar wind and transient solar eruptions. Aditya-L1 is truly a mission for multi-messenger solar astronomy from space that aims to provide a comprehensive exploration of the Sun and consequences of solar phenomena in the interplanetary medium. In this talk, I will highlight the science objectives of the Aditya-L1. A special emphasize will be given to discuss outstanding research problems in the area of large-scale solar eruptions that form a key component of the Sun-Earth relationship.

제1발표장 컨벤션센터
 I-1 우주천문 / 지상및 우주인프라 / 태양 및 우주환경 I
 Chair: 김수진(천문연)

13:20 [I-1-1] Performance Test Results of Space Search Coil Sensor

Hyeonji Kang¹, Ho Jin¹, Yunho Jang¹,
 Seungmin Lee¹, Junhyun Lee¹, Hyeonhu Park¹,

Woojin Jo¹, Juhyeong Kim¹, Khanhyuk Kim¹,
 Jinsang Kim², Ik Joon Chang², Ickhyun Song³

¹School of Space Research, Kyung Hee University
²Department of Electronic Engineering, Kyung Hee University
³Department of Electronic Engineering, Hanyang University

Since the space exploration began, the scientific observations have been continued to understand the physical properties of space environment. For this scientific investigations, various observation instruments such as particle detectors and magnetometers have been developed and widely used. In the magnetic field investigations, we are now developing a new space search coil magnetometer (SSCM). It have been measured oscillating magnetic fields in frequency range from a few Hz to tens of kHz and observed space electromagnetic plasma waves.

The main scientific objective of SSCM is the observation of electromagnetic waves on the Moon and a Cis-lunar space. Specifically magnetosonic wave, plasmaspheric hiss wave, whistler mode chorus wave occur from a few Hz to several tens of kHz, with intensities on the order of several hundred pT. Therefore, the sensor's Noise Equivalent Magnetic Induction (NEMI) is required to be at least 10 pT/Hz^{1/2}.

In the development stages, we had been tested and classified the various types of the sensor core configurations. The frequency response and NEMI had been performed to compare the specification of each cores using the same induction coil. Under our design requirement, the stacked core showed the highest induction voltage output. But it appeared voltage fluctuations at high frequency.

In case of the rolling core structure, it has a mass advantage comparing with any other sensor configurations. Therefore, we developed the search coil sensor with rolling sheet core type. The SSCM has a frequency range of 10 Hz up to 40 kHz and a NEMI of 6 pT/Hz^{1/2} at 1 kHz. Also, we developed a data processing system by integrating the sensor with an FPGA. In this paper, we introduce the performance of three types of sensor cores and results of data processing using FPGA.

13:35 [I-1-2] Orbital Distribution and Potential Interstellar Origins of Sungrazing Comets

Ulkar Karimova, Yu Yi
 Department of Astronomy and Space Science, Chungnam National University

In our comprehensive study of the distribution of comet groups within our solar system, we employed a multifaceted approach that included scatter matrix plotting, density-based spatial clustering (DBSCAN), and precise classification methods. Our analysis focused on discerning patterns in the orbital directions

of sungrazing comets, shedding light on their origins and dynamics. Through the application of DBSCAN, we successfully classified the comets. Most prominently, our results unequivocally revealed a striking dichotomy in the orbital directions of sungrazing comets. A significant proportion of the Kreutz comet group exhibited clockwise orbits, aligning with the prevalent motion of solar system objects, while the Meyer, Kracht, and Marsden groups predominantly displayed anticlockwise orbits. We propose a thought-provoking hypothesis regarding the potential interstellar origins of a subset of Kreutz comets and some of the clockwise-rotating objects within our solar system. Our conjecture suggests that these comets may have been captured by the Sun's gravitational pull after originating within interstellar space, thus accounting for their distinct orbital directions. Furthermore, our research underscores the remarkable characteristics of Kreutz comets, characterized by their exceptionally high velocities at perihelion Zdenek Sekanina. These velocities, which often exceed the Sun's capture threshold, raise intriguing questions about the ultimate fates of these comets. Many Kreutz comets are hypothesized to be expelled from the solar system or disintegrate upon close solar encounters, leaving their potential return orbits uncertain. In conclusion, our study unveils intriguing insights into the orbital distribution of sungrazing comets.

13:50 [I-1-3]

Initial Stage of Dynamic Tool Influence Function on SiC Mirror Surface Using Orthogonal Velocity Tool

Jiwoo Lee^{1,2}, Jeong-Yeol Han^{3,4}, Ju-Hyun Suk¹, Won-Jae Doo⁵

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²*LeO SPACE Inc.*

³*Korea Astronomy and Space Science Institute*

⁴*University of Science and Technology*

⁵*Department of Astronomy and Space Science, Chungnam National University*

Silicon carbide (SiC) mirrors are applied in various space optical components due to outstanding rigidity and high thermal conductivity. However, SiC mirrors are difficult to fabricate and improve surface quality. Measuring the unit removal volume with Tool Influence Function (TIF) can improve the surface quality. Recently, there has been increasing interest in dynamic TIF studies using polishing heads with feed rates, which suggests a different approach from traditional static TIF studies. We present the initial stage of dynamic TIF on SiC mirror surfaces using the Orthogonal Velocity Tool (OVT) polishing machine. The results show the capability to control nano-level unit removal volumes through input parameters. Additionally, we present the plan for polishing on an entire aperture at a flat

SiC mirror using a unit removal volume.

14:05 [I-1-4]

Major Flaring Activity Depending on the Phase of 3D Magnetic Free Energy

Khojiakbar Karimov¹, Harim Lee², Yong-Jae Moon^{1,2}, Jihye Kang², Hyun-Jin Jeong², Mingyu Jeon¹, Jihyeon Son¹, Kanya Kusano³

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

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

³*Institute for Space-Earth Environment Research, Nagoya University, Japan*

In this study, we investigate solar magnetic free energy (MFE) using two different approaches. First, we examine the relationship between MFE and 86 major solar flares (> M-class) using seven active regions (ARs). Second, we compare 2D and 3D MFE of seven ARs. We took 3D data from non-linear force-free extrapolations from Nagoya University, and 2D data from SHARP. We define three flare phases based on MFE: rising, peak (defined as when MFE exceeds 80% of its maximum value), and declining phase. For each phase, we calculate the solar flare occurrence rate by dividing the number of flares by the duration of each phase. From this study, we can conclude that the flare occurrence rates during the rising and peak phases are almost similar and significantly higher than those during the declining phase. Furthermore, the flare occurrence rate for the peak phase, particularly for X-class flares, is notably higher than that for the rising phase. In the second approach, we find one interesting fact for about 40% of the events 2D MFE increases while 3D MFE decreases during the flare, implying different behaviors of photospheric and coronal magnetic fields.

14:20 [I-1-5]

Comparison of SDO/AIA EUV Images and AI-Generated Ones from SO/EUI

Junmu Youn¹, Harim Lee², Yong-Jae Moon^{1,2}, Hyun-Jin Jeong², Il-Hyun Cho², Jin-Yi Lee²

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 generate extreme ultraviolet (EUV) images (94, 131, 193, 211, and 335 Å) from Solar Orbiter (SO)/Extreme Ultraviolet Imager (EUI) channels (174 and 304 Å) by deep learning. These channel data are not available in SO/EUI but in SDO/AIA channels. The model we use for image translation is called Pix2PixCC. The SDO/AIA data sets we use

for training and testing the model, cover a single solar cycle from 2011 to 2021. Then we apply the model to SO/EUI data sets, which observed from 2022 January to 2023 June. For input data, we calibrate the intensity of inner solar disk between SO/EUI and SDO/AIA with the same median value when the two instruments are in conjunction (2022/03/07). Pearson correlation coefficients (PCCs) between real images and AI-generated ones for SDO data sets are 0.90, 0.97, 0.96, 0.96, and 0.95 at 94, 131, 193, 211, and 335 Å, respectively. Finally, we apply our model to SO/EUI images. Our results show that our AI-generated data together with SDO and SO data are able to investigate solar EUV structures stereoscopically. As a next step, we will derive DEM from SO/EUI and AI-generated EUV data.

14:35 [I-1-6]

Demonstration of Free Space Optical Communication Using 10 Gbps Modules at a Distance of 9 km

Wonseok Kang¹, Taewoo Kim¹, Sang Hoon Oh¹, Yong-Sun Park^{1,2}, Jung-Hoon Kim^{1,3}

¹Spacebeam, Inc.

²Seoul National University

³SETsystem, Inc.

The Laser Communication Terminal (LCT) and Optical Ground Station (OGS) are the two crucial components of Laser Satellite Communications and Free Space Optical Communication (FSOC). In the course of the development of LCT and OGS, the FSOC experiments are of tremendous importance. Because it provides us with invaluable information such as characterization of the optical system of LCT and OGS and also quantitative measurement of the attenuation depending on the communication distance and the atmospheric attenuation due to scattering and turbulence. In April 2023, we reported preliminary results of the FSOC experiment at 0.5 km distance, and mentioned that it would be extended to 3 km distance. Here, we present the demonstration of HD live streaming by FSOC at a distance of 9 km in Osong with a new module of LCT. The optical laser signals from the 10G SFP+ module were amplified from +2 dBm to +23 dBm and the beam divergence of the laser communication terminal is about 100 μrad. The transmitted signals were received at the OGS with the 0.25 m F/8 reflector at a distance of 9 km. The detected power level was about -3 dBm and we successfully received the HD live streaming video for 2 min. In addition to this, we tested the feasibility of beam stabilization by a fast steering mirror. It was successfully confirmed to correct the beam wandering with RMS < 1 pixel.

14:50 [I-1-7]

Effectiveness of Radiation Shields Constructed from Martian Regolith and Different Polymers for

Human Habitat on Mars Using MULASSIS/GEANT4 and OLTARIS

Lasany Arfin Kunja¹, Md. Abdullah Al Zaman²

¹Department of Space Geology, Chungnam National University Graduate School

²Northern University Bangladesh

Mars exploration and the possibility of future Martian colonization have generated much interest in recent years. However, several problems make long-term permanence on Mars challenging, one of which the radiation environment of the red planet. To ensure long term durability on the Mars surface against the deleterious effect due to radiation, effective radiation shields are compulsory. This paper presents the effectiveness of Radiation shields made of Martian regolith and light, hydrogeneous polymers to protect astronauts on the Martian surface. Monte Carlo simulations were performed using a Geant4-based tool, Multi-layered shielding simulation software. The shielding properties were studied using low energy charged particle spectra from Mars Science Laboratory-Radiation Assessment Detector and particle (proton, alpha and iron ions) with energies of 1 GeV/n. On-Line Tool for the Assessment of Radiation in Space (OLTARIS) is used for calculating the effective dose equivalent for the galactic cosmic ray spectra on the Mars surface. Martian regolith with Lithium Hydride (LiH) demonstrated greater efficiency in dose reduction. Based on the OLTARIS study, at 15 g/cm², these shields are even better than an aluminium shield of the same dimension.

15:05 [I-1-8]

Study on the Asymmetric Cosmic Ray Modulation of Forbush Decrease Related to Propagation Direction of Interplanetary Coronal Mass Ejection

Jongil Jung¹, Suyeon Oh¹, Yu Yi², Jongdae Sohn³

¹Chonnam National University

²Chungnam National University

³Korean Astronomy and Space Science Institute

A Forbush decrease (FD) event, which can be observed by ground-based neutron monitors (NMs), shows a depression of cosmic ray (CR) intensity. Most of previous studies explained that the CR intensity modulation of FDs is dependent on only the location and cutoff rigidity of NM stations. However, we found an asymmetric CR intensity decrease of FD event at NMs with similar cutoff rigidity in the northern and southern hemispheres. In this study, we identified CR intensity modulation of the FD events at different NM stations due to propagation direction of interplanetary coronal mass ejection (ICME). Using the images taken by coronagraphs of twin spacecraft of the STEREO and CR intensity data of NMs with similar cutoff rigidity in the northern and southern hemispheres, we propose

that the asymmetric CR modulation of FD events can be determined by the propagation direction of the associated ICME.

15:20 [I-1-9]

Coupling of Long-Term Zonal Wind Trends in Southern Winter between the Mesopause and Stratosphere

Byeong-Gwon Song, In-Sun Song

Yonsei University

In this study, we examine relations between the observed long-term trends of the zonal wind in the mesopause regions ($z = 80\text{--}100$ km) at King Sejong Station (KSS) in the Antarctic Peninsula, and wind trends in the Southern Hemisphere (SH) middle atmosphere using 15-year (March 2007–November 2021) meteor radar at KSS, Aura MLS observations and the MERRA-2 reanalysis data. During July, statistically significant positive wind trends appear above $z = 90$ km and near the stratopause ($z \sim 45\text{--}65$ km) over the KSS, while negative trends exist between the two layers. In the SH winter, positive (negative) correlations are observed between the mesopause wind and stratospheric (mesospheric) winds in polar regions, while the opposite correlations can be found for the low-latitude winds. The observed positive mesopause wind trends near KSS are connected, through the thermal wind relation, to cooling (warming) trends induced by the upward (downward) residual mean circulation trends over the high-latitude mesosphere and low-latitude stratosphere (the high-latitude stratosphere), which implies the vertical coupling throughout the SH winter middle atmosphere.

15:35 [I-1-10]

Stepwise Development of the Auroral Onset Arc and the Near-Earth Magnetotail Associated with Substorm Onsets

Yukinaga Miyashita^{1,2}, Madeeha Talha^{1,2,3}, Akimasa Ieda⁴, Shinobu Machida⁴

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Our previous studies showed that an auroral arc develops stepwise at the beginning of a substorm. After initial auroral brightening, the auroral onset arc extends azimuthally while its wave-like structure gradually grows. The wave-like structure then enhances further and grows more rapidly, and finally

poleward expansion begins. Here, using data from the Time History of Events and Macroscale Interactions during Substorms (THEMIS) spacecraft and ground-based all-sky imagers, we attempted to link stepwise auroral onset arc development to near-Earth magnetotail changes associated with substorms. Case studies show that low-frequency waves are amplified in the plasma sheet, accompanying a pressure increase likely due to the arrival of an earthward flow from a tailward region, a few minutes after initial auroral brightening and nearly simultaneously with enhancement of the wave-like auroral structure. Another few minutes later dipolarization began nearly simultaneously with auroral poleward expansion. Furthermore, we estimated the growth rate of ballooning instability in the near-Earth magnetotail from a magnetohydrodynamic (MHD) theory. We find that the growth rate of ballooning instability develops in three steps in conjunction with auroral three-step development. Based on these observations, we discuss a possible scenario of near-Earth magnetotail development in the substorm initial phase.

제3발표장 부라노 II

I-3 안보우주 I

Chair: 최호성(육군)

13:20 [I-3-1]

The Role of Satellites to Strengthen Ground Forces and Considerations in Weaponization

Min-Young Gil

ROK Army Headquarters Policy Office (Policy Training in Korea Aerospace Research Institute)

In conjunction with the Ministry of National Defense's 'Defense Innovation 4.0' promotion plan, the Army is promoting the 'Army TIGER 4.0' project, a representative brand of the Army and a key combat system for future ground forces. In addition, the Army will actively utilize surveillance reconnaissance satellites, communication satellites, and navigation satellites to implement the maneuvering, intelligence, and networking of Army TIGER units. The roles and expected effects of the aforementioned three types of satellites were presented to strengthen ground forces, as well as considerations for designing a LEO satellite communication system, the need for a LEO tactical reconnaissance satellite, and the direction of upgrading the ground weapon system. In particular, the first consideration for designing a LEO satellite communication system is to predict the amount of information distribution after integrating the future communication structure, and the second is to prepare countermeasures against various space security threats.

13:35 [I-3-2]

After Action Review of SNIPE Operations and the Future of Small-Scale Satellites Operation Focused on Army

Dong-Wook Chu, Jin-su Ha

Korea Astronomy Space Science Institute, ROKA Augmented

As a part of SNIPE project, Korea Astronomy and Space Science Institute leading project, the goal of ROKA augmented personnel is to suggest user requirements of LEO satellites focused on Army purpose and accumulate satellites operations experiences to build future space operations concept in Army which is in accordance with "Army TIGER 4.0".

In this after action review, we will briefly handle SNIPE project and present the future small-scale satellites operation.

13:50 [I-3-3]

Research on Future Outer Space Conflicts Using Fuzzy-AHP Technique

Seonghan Park¹, Sechan Song², Jaehoon Bae¹, Jin-Ho Park¹, Sunhong Kim², Juhee Kim¹¹*Korea Military Academy*²*Korean Army Headquarters*

Starting with the launch of American SpaceX communication satellite that has been active in the Ukraine-Russia war, outer space is becoming an important battlefield in determining victory and the interest on utilization of outer space has been increasing. Recently, Republic of Korean Army has been initiating policies to develop power construction in outer space. However, the progress of space power construction faces various challenges including domain disputes, boundaries, and international legal complexities surrounding outer space. In this study, we attempt to derive the role of Republic of Korea Army's space policy by confirming the weight and importance of conflict factors to space experts through the Fuzzy-AHP technique. we will briefly present that the weight or importance of future outer space conflicts by Korean experts to confirm the roles in Korean Army's outer space policy using Fuzzy-AHP

14:05 [I-3-4]

Military Satellite Image Object Detection Based on YOLO v7 and Stable Diffusion

HanSeok Kim

Korea National Defense University

In this paper, we present a novel approach to improve object detection performance in low-resolution satellite imagery based on the Stable Diffusion and YOLOv7 models. Researchers have

been trying to analyze satellite images acquired by military reconnaissance satellites using AI models, but they have not been able to overcome the limitation that when the resolution of satellite images is low, the performance of object detection models such as YOLO is also low. Therefore, if the resolution of the image is increased through the Stable Diffusion model, the performance of the object detection model is expected to be improved. In this paper, the performance of YOLOv7 object detection model according to satellite image resolution is compared and analyzed based on the average precision (AP) scale using the 'satellite image object reading' dataset provided by AI HUB.

14:20 [I-3-5]

Persistent Space Surveillance Using the Theory of Functional Connections

Jiwon Bae^{1,2}¹*Republic of Korea Army*²*Texas A&M University Aerospace Engineering*

The Persistent Space Surveillance (PSS) strategy is designed to continuously detect targets and overcome the previously studied Periodic Close Encounter (PCE) problem; i.e. the periodic surveillance of targets. This study addresses the traditional need to monitor military-threatening targets and repair or check the status of commercially expensive satellites, but also the modern need for space traffic management and the removal of space debris. In this study, persistent surveillance is defined as the need to keep observation distance below a certain threshold (i.e., distance from the target) while the target orbits the Earth. In addition, the optimal solution needs to maintain a proper monitoring distance despite the effects of perturbation, and eliminate the risk of Earth-impacting or hyperbolic trajectories. The proposed technique satisfies the following three constraints needed to be sufficiently close and compatible with the target's orbit: orbit shape, orbit orientation, and observation distance. The Genetic Algorithm (GA) is used to optimize orbital elements that satisfy the three constraints. To apply the proposed model to the numerical examples, propagation is performed using the Theory of Functional Connection (TFC), which has been verified in other studies. All of the above processes are verified by simulating the existing Low Earth Orbit (LEO), Geostationary Orbit (GEO), and Highly Elliptical Orbit (HEO) satellites as targets.

14:35 [I-3-6]

Earthpaper: Satellite Image Service Platform for Military

Jae-Pil Park, Minsik Kim, Hyungjik Oh, Dongmin Lee, Hyungwook Oh, Yeongho Kim

Nara Space Technology

Comprehensive and fast decision making is the most important thing for military. Because of that, every operation of modern warfare basically needs satellite image data. But current satellite image service platform is not optimized for military field and military people. Nara Space Technology's satellite image service platform, Earthpaper is focused to solve that problem. This paper, introduces Earthpaper's intuitive UX/UI for unfamiliar user with satellite data. It also contains the results of on web applications for military such as super resolution and various object detection.

14:50 [I-3-7]

Analysis of Tip/Tilt Correction of Beam Wandering for Space Laser CommunicationSeok-Min Song^{1,2}, Hyung-Chul Lim¹, Mansoo Choi¹, Yu Yi²¹*Korea Astronomy and Space Science Institute*²*Department of Astronomy and Space Science, Chungnam National University*

Laser communication has been considered as a novel method for earth observation satellites with generation of high data volume. It offers faster data transmission speeds compared to conventional Radio Frequency (RF) communication due to the short wavelength and narrow beam divergence. However, precise alignment between the transmitter and receiver is essential to guarantee effective and reliable laser communication, which is achieved by Pointing, Acquisition, and Tracking (PAT) system. In the case of downlink and uplink channels, laser beams experiences beam spreading, broadening and wandering as well as scintillation. In particular, the beam wandering leads to so-called Angle-of-Arrival (AoA) variance resulting in jitters and then pointing errors. The AoA degrades the performance of communication channel in terms of bit error rate, due to the fluctuation of received power, which can be compensated by a tip-tilt mirror. In this study, we address the atmospheric turbulence effect on the laser communication channel including beam wandering. And the performance of tip/tilt correction is analyzed in terms of the AoA fluctuation and collected power on the detector.

15:05 [I-3-8]

Strategy Analysis for Precision Orbit Determination of Regional Navigation Satellite System Based QZSS Case

Kyoung-Min Roh

Korea Astronomy and Space Science Institute

Asia-Pacific area becomes a hot place of Navigation Satellite

System. South Korea has started to develop Korean Positioning System last year. It is the fourth regional navigation satellites system (RNSS) following BeiDou-2 of China, Navic of India, and QZSS of Japan. Therefore it is expected to encourage lots of areas to use KPS signals. Precision orbit determination (POD) is a starting point of using KPS as meaning measurements. In here, POD of RNSS are analyzed based on examples of QZSS.

제4발표장 부라노 III

I-4 SS: Open New Horizon with L4 Mission

Chair: 임은경(천문연)

13:20 [I-4-1]

Open New Horizon with L4 Mission: Vision and PlanningK.-S. Cho¹, J. Hwang¹, E.-K. Lim¹, J.-Y. Han¹, S.-H. Choi¹, J. Seough¹, R.-S. Kim¹, S.-H. Park¹, Y.-S. Kim¹, J.-D. Sohn¹, J.-H. Baek¹, J.-Y. Kwak¹, Y.-J. Moon², J. Seon², K.-S. Ryu³, C.-H. Lee⁴¹*Korea Astronomy and Space Science Institute*²*Kyung Hee University*³*Korea Advanced Institute of Science and Technology*⁴*Korea Aerospace Industries*

The Sun-Earth L4 Lagrange point is a strategically significant location in space that offers exceptional opportunities for observing solar activity and studying the heliospheric environment. With its uninterrupted and wide-angle view of the Sun-Earth line, this vantage point enables continuous monitoring of the interconnections between the Sun, Earth, and even the Moon through remote sensing observations. In-situ measurements of solar radiation, solar wind, and the heliospheric magnetic field at L4 are of immense significance as they contribute to monitoring and predicting the radiation environment. This forecasting capability is crucial for ensuring the safety of future human exploration missions to the Moon and Mars. The L4 mission was recently added to the 4th national space promotion plan of Korea, which has led to in-depth research and planning to assess Korea's ability to carry out L4 missions and come up with the right strategy. This presentation will provide an overview of the ongoing planning efforts for the L4 mission and present a compelling vision for it as a flagship project for Korea's next generation in space.

13:35 [I-4-2]

From the Moon to the Aviation Altitude, Space Radiation Research in Korea

Junga Hwang¹, Jongdae Sohn², Ukwon Nam²,
Jaeyoung Kwak²

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

²*Korea Astronomy and Space Science Institute*

The Korea Astronomy and Space science Institute (KASI) has independently developed the Korean Radiation Exposure Assessment Model for Aviation Route Dose (KREAM) in collaboration with the Korea Meteorological Administration (KMA) from 2012 to 2016. The results of this research are being displayed in real time in the KMA's aviation weather information for major international air routes, and the KASI's own website allows users to calculate the radiation dose for past, present, and future air routes.

Next Generation Small Satellite-2 (NEXTSat 2), the main payload of the Nuri-3 launch on May 25, 2023, also carries the Low Earth Orbit Space Radiation Dosimeter (LEO-DOS), a space radiation payload. LEO-DOS is currently operating in its initial mode, and its initial data is being analyzed. In this presentation, we show the distribution of protons and neutrons in low-Earth orbit and the radiation exposure map using the initial data from LEO-DOS.

The KASI is also developing the LVRAD, a space radiation payload to be sent to the Artemis IV lunar lander. LVRAD is scheduled to be sent to the South Pole of the Moon in early 2024. One of the main scientific missions of the Artemis IV mission is early warning of solar energetic particles.

In order to prepare for deep space exploration such as lunar exploration and Martian exploration, and to prepare for crewed space exploration, the development of space radiation prediction models is essential. Therefore the radiation observation data in L4 location will be very useful for the manned space mission.

13:50 [I-4-3]

Suprathermal Solar Wind Electrons and Their Connection to the Expected L4 Mission Sciences

Dae-Young Lee¹, Kyung-Eun Choi², J. Seough³,
J. A. Hwang³, K. S. Cho³, J. H. Seon⁴, K. S. Ryu⁵

¹*Chungbuk National University*

²*UC-Berkeley*

³*KASI*

⁴*Kyung Hee University*

⁵*KAIST*

In situ observations at multiple points near 1 au such as L4/L5 as well as L1 are critical for improving our understanding of detailed solar wind structure. Such observations are useful and desired for in-depth study on impacts of specific solar wind structures on the magnetosphere and interactions between the solar wind and local interstellar medium particles that penetrate

into the heliosphere. This talk is intended to contribute to the L4 mission design, which is currently under consideration by Korean solar and space science community, by introducing several selected topics that can be promising for future studies based on observations at L4, L5 as well as L1, hoping all available in near-future. While there are various topics which will benefit greatly from multiple *in situ* observations near 1 au, in the present talk we will focus on how the suprathermal electrons in the solar wind can be connected to various science issues.

14:05 [I-4-4]

Scientific Subjects of the Heliophysics L4 Mission by Remote-Sensing Observations

Yong-Jae Moon¹, Kyung-Suk Cho², Sung-Hong Park²,
Roksoon Kim², Eun-Kyung Lim², Harim Lee¹,
Hyun-Jin Jeong¹, Jihye Kang¹, Il-Hyun Cho¹,
Hyeonock Na¹, Jinhye Park¹, Kangwoo Yi¹

¹*Department of Astronomy and Space Science, College of
Applied Science, Kyung Hee University*

²*Korea Astronomy and Space Science Institute*

The Sun-Earth Lagrange point L4, which is called parking spaces of space, is considered one of the unique places where the solar activity and heliospheric environment can be observed continuously and comprehensively. The L4 mission affords a clear and wide-angle view of the Sun-Earth line for the study of the Sun-Earth, and Sun-Moon, and Sun-Mars connections from remote-sensing observations. The L4 mission will significantly contribute to advancing heliophysics science, improving space weather forecasting capability, and extending space weather studies far beyond near-Earth space, and risk reduction from solar radiation hazards on human missions to the Moon and Mars. The present talk outlines the importance of L4 observations by using remote-sensing instruments and advocates comprehensive and coordinated observations of the heliosphere at multi-points including other planned L1 and L5 missions. In this talk we will review scientific perspectives on three main topics in view of remote sensing observations: (1) evolution of active regions, (2) coronal mass ejections and coronal structures, and (3) solar energetic particles and their source regions.

14:20 [I-4-5]

Solar Surface Visibility Analysis for Triangular Lagrange Point's Vertical Periodic Orbits

Jinsung Lee¹, Sung-Hong Park², Kyung-Suk Cho²,
Junga Hwang², Arik Posner³, Jaemyung Ahn¹

¹*Korea Advanced Institute of Science and Technology*

²*Korea Astronomy and Space Science Institute*

³NASA Headquarters

We analyze and perform trade-off studies between inclinations of the vertical Sun-Earth L4 and L5 periodic orbits and optical payload specifications for Solar surface visibility. The Sun-Earth L4 and L5 periodic orbit's optimal arrival dates for maximum solar pole observation are geometrically determined. The Solar surface visibility analysis is performed for a single satellite at L4 or L5, and a pair of satellites at L4 and L5 to explore the synergistic effects.

14:35 [I-4-6]

Spacecraft System Design Concept and Development Plan for L4 Mission

Hwayeong Kim¹, Jaehwee Doh¹, Jong-Jin Jang¹, Junga Hwang², Kyung-Suk Cho²

¹Korea Aerospace Industries, Ltd. (KAI)

²Korea Astronomy and Space Science Institute (KASI)

In July 2023, Korea Aerospace Industries (KAI) and Korea Astronomy and Space Science Institute (KASI) signed a cooperative system to strengthen space exploration and are conducting joint research for "spacecraft development for L4 mission". In this project, KAI establishes a platform development plan through precedent research for space probe system development as well as space science payload interface design. In addition, KAI will identify major technologies of the space exploration system and form a technology commercialization and localization items for major components.

In this paper, we propose the spacecraft development strategies for L4 mission and quick review result about candidate payloads acceptability with KAI's standard platforms. The results of this paper will be embodied and optimized through preliminary and detailed design in the future.

14:50 [I-4-7]

Conceptual Study of a Solar High-Energy Particle Detector Assuming an L4 Mission

Woo-Hyeong Seol¹, Jongho Seon¹, Khan-Hyuk Kim¹, Kwangsun Ryu², Jungjoon Seough³, Jongdae Sohn³, Junga Hwang³, Kyung-Suk Cho³, Dae-young Lee⁴

¹School of Space Research, Kyung Hee University

²Satellite Technology Research Center, Korea Advanced Institute of Science and Technology

³Korea Astronomy and Space Science Institute

⁴Chungbuk National University

Observations at the Sun-Earth Lagrange Points are expected to be a crucial satellite mission, ultimately enhancing the physical understanding of the solar environment by significantly expanding

observations of the Sun and the heliosphere from a spatial perspective. Among these missions, observations at the L4 position, which leads the Earth in its orbit around the Sun, are expected to provide complementary data to the United States L1 mission, SwFO, scheduled for launch in late 2020, and European L5 mission, VIGIL. The scientific significance of L4 observations is expected to be diverse and profound.

In this paper, we aim to conduct a conceptual study of a high-energy particle detector capable of measuring solar energetic particles in the energy range of approximately 30 keV to 30 MeV that can operate at the L4 position. Specifically, we will analyze the specifications and scientific objectives of high-energy particle detector payloads that are planned for or have been operated on missions such as L1 and L5. We will also consider the types and range of observational physical quantities that should be selected to maximize scientific outcomes when operating a similar payload on future L4 missions.

15:05 [I-4-8]

Conceptual Design of *In-Situ* Measurement Instruments of Heliospheric Plasma and Electromagnetic Field for L-4 Mission

K. Ryu¹, S. W. Lee^{1,2}, J. Seon³, K.-H. Kim³, J. Seough⁴, J. D. Son⁴, J. A. Hwang⁴, K. S. Cho⁴, K.-C. Kim², D. Y. Lee²

¹SaTReC, KAIST

²Chungbuk National University

³Kyung Hee University

⁴Korea Astronomy and Space Science Institute

Lagrange point observations are expected to be important satellite missions that will ultimately improve the physical understanding of the heliosphere by expanding the observation range of the Sun and the solar wind for a long time without additional propulsion fuels. Among them, observations at the L-4 position leading the Earth in orbit can provide complementary observations with the U.S. L-1 mission, SwFO (Space Weather Follow On), India's Aditya-L1 mission, and Europe's L-5 mission, VIGIL (sentry, or guard in Latin). This research intends to conduct a conceptual study of low-energy plasma and electromagnetic field observation devices among various payloads that can be operated at L-4 location. It analyzes the scientific or operational objectives, as well as the specifications, of the instruments for plasma and electromagnetic field observation, scheduled to be operated in L1 and L5, or operated on existing solar missions. Furthermore, it analyzes the connectivities and differences of the related space science payload technologies accumulated through the low earth orbit, geostationary satellites, and lunar exploration satellites. Based on the analyses, we propose a roadmap for securing long-term technology evolution to reach a successful L-4 mission deployment, including

overseas cooperation or technology influx.

15:20 [I-4-9]

Study of Ion Particle Diffusion by Kinetic Alfvén Waves

Cheong-Rim Choi¹, Min-Ho Woo², Kwang-Sun Ryu³, Dae-Young Lee¹, Peter H Yoon⁴

¹*Department of Astronomy and Space Science, CBNU*

²*Korea Institute of Fusion Energy*

³*Satellite Technology Research Center, KAIST*

⁴*Institute for Physical Science and Technology, University of Maryland, USA*

Kinetic Alfvén waves are known to have a notable impact on the energization and heating of ion particles within the solar wind plasma and diverse space environments. In this study, we investigate how ion particles diffuse through their interaction with kinetic Alfvén waves in the solar wind plasma and employ a new analytical approach based on the Hamiltonian dynamic test particle method. The current method’s analytical characteristics reveal an interesting fact that the pure inductive component of the electric field in the parallel direction associated with kinetic Alfvén waves hardly contributes, especially in the limit of $Ti/Te \ll 1$.

15:35 [I-4-10]

Conceptual Design of Optical and EUV Telescopes with Instruments for the L4 Mission

Jeong-Yeol Han^{1,2}, Jongyeop Park¹, Sung-Hong Park¹, Eun-Kyung Lim^{1,2}, Donguk Song¹, Kyung-Suk Cho^{1,2}, Jaehyeon Kyeong³, Jiwoo Lee³

¹*Korea Astronomy and Space Science Institute*

²*University of Science and Technology*

³*LeO SPACE Inc.*

The L4 mission will significantly contribute to advancing heliophysics science, improving the capability of space weather forecasting, and extending space weather studies beyond near-Earth space. This presentation outlines a conceptual design of an optical telescope for solar H-alpha and photospheric vector magnetic field observation, and an EUV telescope for solar corona. In addition, we will discuss design directions for advancing the conceptual design of a solar optical telescope.

제1발표장 컨벤션센터

II-1 태양 및 우주환경 II

Chair: 이준현(경희대)

16:00 [II-1-1]

Initial Results of LEO-DOS Instrument on Board the NEXTSat-2

Uk-won Nam¹, Won-Kee Park¹, Bongkon Moon¹, Sukwon Youn², Jaeyoung Kwak^{1,3}, Jongdae Sohn¹, Young-Jun Choi¹, Jeonghyun Pyo¹, Jaejin Lee¹, Junga Hwang^{1,4}, Sunghwan Kim⁵, Hongjoo Kim⁶, Sung-Joon Ye², Hongyoung Park⁷, Taeseong Jang⁷, Jungho Kim⁷

¹*Korea Astronomy and Space Science Institute*

²*Radiological Physics Laboratory, Seoul National University*

³*Korea Research Institute of Standards and Science*

⁴*University of Science and Technology*

⁵*Department of Radiology, Cheongju University*

⁶*Kyungpook National University*

⁷*Satellite Technology Research Center, KAIST*

The LEO-DOS instrument to measure radiation levels in LEO on board the NEXTSat-2 (the Next Generation small satellite-2) was launched successfully on May 25, 2023 using the Nuri KSLV-III. Due to the highly complex nature of the radiation fields encountered in low-Earth orbit (LEO) and interplanetary space, space radiation dosimetry presents one of the most significant challenges in the discipline of radiation protection. The main mission of the LEO-DOS instrument is to create a global map of doses by charged particles and neutrons. The LEO-DOS is equipped with a tissue-equivalent particle detector and a fast neutron dosimeter to accomplish this mission. Thanks to the stable LEOP (Launch and Early Orbit Phase) operation of the N2 satellite, the global mapping mission was achieved early. We present results of on-orbit data obtained from LEO-DOS in a dawn-dusk Earth orbit with an average altitude of 550 km.

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

16:15 [II-1-2]

Global Dose Map Generation and L-Shell Calculation Using NEXTSat-2 LEO-DOS Initial Results

Jaeyoung Kwak^{1,2}, Uk-won Nam¹, Won-Kee Park¹, Junga Hwang^{1,2}, Bongkon Moon¹, Sukwon Youn³, Jongdae Sohn¹, Young-Jun Choi¹, Jeonghyun Pyo¹,

Jaemin Lee¹, Sunghwan Kim⁴, Hongjoo Kim⁵,
Sung-Joon Ye³, Hongyoung Park⁶, Taeseong Jang⁶,
Jungho Kim⁷

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⁶*Satellite Technology Research Center, KAIST*

⁷*Korea Research Institute of Standards and Science*

The NEXTSat-2 mounted LEO-DOS (Low Earth Orbit Space Radiation Dosimeter) consists of two main detectors, a tissue-equivalent particle detector and a fast neutron dosimeter, for counting charged particles and fast neutrons on the low-earth orbit, respectively. From the LEO-DOS data, it was able to calculate absorbed dose, D and dose equivalent, H for charged particles and neutrons. Using these results, we have generated global maps of fluxes and the doses. For the map generation, we set 1×1 degree² latitude and longitude cells and averaged over count or dose data which belongs to each cell. Also, we performed a procedure to calculate L-shell and build it up as a database for future studies with dose data. To calculate L-shell, we converted the given spherical GEO coordinates to cartesian GSM coordinates and traced geomagnetic fields along the field lines to the geomagnetic equatorial plane. We adopted IGRF 13 model as an internal magnetic field model, and Tsyganenko 89 model as an external magnetic field model. To unify the way to build a database with python language, the L-shell calculation procedure has also been built in the same language.

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

16:30 [II-1-3]

Total Ionizing Dose and Displacement Damage Results of Commercial-Off-The-Shelf for a Super Low Earth Orbit Optical Satellite

Jongdae Sohn^{1,2}, Hojin Lee^{1,2}, Junga Hwang^{1,2},
Jaeyoung Kwak^{1,2}, Hyosang Yoon³

¹*Korea Astronomy and Space Science Institute*

²*University of Science and Technology*

³*Korea Advanced Institute of Science and Technology*

In this time, we report total ionizing dose and displacement damage effects on On-Board Computer (OBC) candidates of Commercial-Off-The-Shelf (COTS) for Super Low Earth Orbit (SLEO) optical satellite. The Optical Satellite aims to operate for more than two years with the mission of taking high-resolution images with a resolution of 50 cm at an altitude of

300 km or less and. This satellite is a small Earth observation satellite weighing about 100 kg suitable for super low earth orbit. The space radiation environment has not only vacuum and extreme temperatures, but also strong cosmic radiation. Various cosmic radiation, such as protons and heavy ions that exist in space, can cause malfunction of satellites. We performed Total Ionizing Dose (TID) and Displacement Damage (DD) experiments on Arduino modules and Raspberry Pi modules to select OBC candidates for ultra-low altitude optical satellites. We describe the total ionizing dose and displacement damage results on OBC candidates for the SLEO optical satellite.

16:45 [II-1-4]

Enhancement of GK2A/KSEM PD Data Quality and Changes in PD Data Service

Daehyeon Oh, Jiyoung Kim

National Meteorological Satellite Center, Korea Meteorological Administration

The Korean Space Weather Monitor (KSEM) is a space weather payload on the GeoKomsat-2A (GK2A) geostationary satellite. For over two years since July 2019, the KSEM's Particle Detector (PD) has been measuring energetic particle flux in the geostationary orbit. The KSEM PD comprises 6 sets of electron and proton sensors that provide real-time particle flux measurements within an energy range of 100 keV to 2 MeV. In this presentation, we introduce the history and current status of data production and quality enhancement. Furthermore, we discuss the results of intercomparisons with data from GOES-16 MPS-HI and address future challenges.

17:00 [II-1-5]

Statistical Study of Background Cold Ions Energized by Negative Spacecraft Potential

Yi-Kyeong Park, Khan-Hyuk Kim, Junhyun Lee,
Ho Jin

School of Space Research, Kyung Hee University

When the satellite is negatively charged, the background cold ions are energized to the level of spacecraft charging. They are believed to be energized by the electrostatic field generated by the negative spacecraft charging. We have studied the characteristics of three major ion species (H^+ , He^+ , and O^+) energized by negative spacecraft charging. 64 events were identified with the minimum spacecraft potential, less than -10 V for 2 years (2013–2014) by using data obtained from the Van Allen Probes. All events were observed outside the plasmopause in the post-midnight sector (MLT $\sim 0-6$ hr) during substorm activities. Our analysis suggests that ion composition contains an $H^+:O^+ : He^+$ order of ion dominance. We examine the contribution of H^+

and heavy ion species (He^+ and O^+) to the background plasma. We also investigate the densities and composition including the local average ion mass $M (= \rho / n_e)$.

17:15 [II-1-6]

Suggestions on the Development of the Solar Instrumentations

Heesu Yang, Donguk Song, Ryun Young Kwon
Korea Astronomy and Space Science Institute

These days, space weather has become more important because of the competitive space development and exploration. The Sun stands out as the most crucial and unique source of space weather. Various observational instruments are currently in operation and under development for solar research. This presentation introduces the missions developed and investigated domestically over the past decade, then we discuss the scientific objectives of newly investigated ground-based and space solar missions. This presentation will introduce small projects and plans to acquire the new technology applicable to solar observations via rocket and balloon missions. We hope that the presentation initiates critical and active discussions within the solar research community.

Jinah Lee, Chandeok Park

Department of Astronomy, Yonsei University

This study presents a comprehensive framework for constructing rigid body potentials to estimate gravity of a small body acting on its probe. (The ‘rigid body potential’ is defined as the potential of a small body concerned with the probe with finite volume in its vicinity.) The rigid body potential formulation involves volume integration on the probe body, for which three distinct gravity estimation models of small bodies are implemented. The proposed rigid body potentials are adopted to analyze dynamic environments of probes with the gravitational interaction between orbit and attitude. Additionally, this study describes how to apply the formulation in detail in the case that small bodies are modelled as point masses. It turns out that the potential’s Hessian plays a significant role in constructing the rigid body potential. We focus on investigating its impact concerning the choice of gravity estimation models and analyzing its influence on the orbit-attitude coupled motion. The computational load associated with each gravity model is observed as multiples of the time required for potential estimation, to be 0.60, 1.55, and 2.13. This approach will subsequently be combined with Lie group-based integrators, thereby their application in the analysis of orbital-attitude coupled motions.

제2발표장 부라노 I

II-2 우주응용 / 초소형위성

Chair: 서석배(항우연)

16:00 [II-2-1]

1553 BMDX Analysis Software for CAP-W ETB Test

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 imaging payload of the CAS500-4 satellite. The CAP-W EM (Electrical Model) has been completed its design and installed at CAS500-4 ETB (Electrical Test Bed) configuration. This paper explains 1553 BMDX file, a general 1553 format, processing software to analyze CAP-W EM status on the CAS500-4 ETB Test.

16:15 [II-2-2]

Construction of and Analysis on Rigid Body Potentials for Proximity Maneuvers around Small Celestial Bodies

16:30 [II-2-3]

Development of High-Reliability Ceramic Packaging Technology for Space Applications with Emphasis on Hermetic Sealing and Leak Testing

Cheol-Hwan Youn¹, Seong-Geuen Jeong¹, Ki-shik Kim¹, Ki-Sang Park¹, Mi-Young Park²

¹MID

²Satellite Technology Research Center, KAIST

In pursuit of high-reliability ceramic packaging technology tailored for space applications, this research focuses on the utilization of robust ceramic package substrates resilient to external environmental factors, such as thermal deformation, vibrations, and shocks. We delve into the implementation of Hermetic packaging techniques and the conduction of performance assessments, encompassing Screening and Leakage Acceptance Test (LAT).

The primary objective in achieving hermetic sealing for space-grade SRAM memory development is to employ Vacuum Sealing to fill the internal cavity of the package, thereby preventing contamination from the external environment. This approach also allows for the modulation of thermal conductivity by reducing it, consequently facilitating thermal conductivity control. Furthermore, it ensures a balanced equilibrium between internal and external pressures, effectively mitigating sensitivity

to shocks and vibrations, thus enhancing the physical integrity and safety of the package.

Presently, the sealing process is underway employing Nitrogen and Vacuum, with the evaluation of sealing integrity performed through Leak Tests. In this paper, we define two categories of Leak Tests: Gross Leak and Fine Leak, and conduct a study on instances of Gross Leak failures as well as cases of successful sealing through process improvements.

This research has been funded by High Reliability Space Grade Memory Components Development Program of the Korea Ministry of Science & ICT (MSIT).

16:45 [II-2-4]

The Development Plan for the Bus System of the 18U Cubesat for Earth Observation and Formation Flying Missions in Low Earth Orbit

Im-Hyu Shin¹, Dong-Guk Kim¹, Il-Young Jang¹, Hyun-Tae Choi¹, Young-Min Kim¹, Won-Ho Cha¹, Mina Koo¹, Tae-Yoon Eom¹, Goo-Hwan Shin¹, Jae-Hun Jang², Jeong-In Yun², Hyo-Sang Yoon², Bong-Kon Moon³, Dae-Hee Lee³, Jae-Jin Lee³, Chang-Gon Kim⁴, Soo-Jong Park⁴, Gun-Hee Kim⁵, Kyung-Su Na⁶, In-Young Hwang⁶

¹*Satellite Technology Research Center, KAIST*

²*Spacecraft Prototyping Laboratory, KAIST*

³*Korea Astronomy and Space Science Institute, KASI*

⁴*Kyung Hee University*

⁵*Hanbat National University*

⁶*Agency for Defense Development*

KAIST Satellite Research Technology Center, as a joint research institute, is in charge of the development of the bus system in the 18U Cubesat Project, under the general management of KASI, which has earth observation and formation flying missions in low earth orbit. In this paper, we will present the development plan for the bus system of the 18U Cubesat including the bus system requirement review and design concepts.

17:00 [II-2-5]

Development of a 1U Modular Structure for Internal Unit Placement of SPACE SCANer

Mina Koo¹, Im-Hyu Shin¹, Dong-Guk Kim¹, Il-Young Jang¹, Hyun-Tae Choi¹, Young-Min Kim¹, Won-Ho Cha¹, Tae-Yoon Eom¹, Goo-Hwan Shin¹, Jae-Hun Jang², Jeong-In Yun², Hyo-Sang Yoon², Bong-Kon Moon³, Dae-Hee Lee³, Jae-Jin Lee³, Chang-Gon Kim⁴, Soo-Jong Park⁴, Gun-Hee Kim⁵, Kyung-Su Na⁶, In-Young Hwang⁶

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⁴*Kyung Hee University, South Korea*

⁵*Hanbat National University, South Korea*

⁶*Agency for Defense Development*

KAIST Satellite Research Center has been developing a 1U modular as the internal unit of the structure in the SPACE SCANer project. The developed 1U modular structure can be used to independently place SPACE SCANer internal devices. The size of a 1U modular is the same as the size of a 1U CubeSat structure. Before developing the 1U modular, we conducted a preliminary study on the 1U CubeSat frame. The 1U CubeSat frame was found to have weak rigidity when manufactured based on PLA (Polylactic Acid) material using a 3D printer. To compensate for this, if producing a 1U modular structure, the rigidity of the frame will increase through mechanical processing. The 1U modular structure developed in this project will be practically applied to ultra-small satellite structures of various sizes in the future.

17:15 [II-2-6]

Study for Usage of COTS EEE Parts for Space Application

Seongkeun Jeong¹, Jinuk Seo¹, Hyunung Oh²

¹*MID Co., Ltd.*

²*Korea Aerospace University School of Aerospace and Mechanical Engineering (Additional Post: Agency for Defense Development)*

The reliability of COTS EEE Part is relatively low compared to space-grade components, but by applying COTS electronic components with the advantages of multi-function and high performance in a small package, the board size, weight, and number of components are reduced, and board circuit complexity is reduced, ultimately leading to reliability and cost savings. Additionally, low power consumption has the effect of reducing solar panel and battery capacity, which has a significant impact on the overall weight and size of the satellite.

Recently the reliability of COTS EEE part has improved significantly with the introduction of the latest production techniques. COTS in plastic packages is being applied to almost all military-grade defense products that require high reliability, and is also being actively used in small satellites. This study examines ways to utilize COTS for space application.

본 논문은 국방과학연구소의 2019 미래도전기술개발사업 PM 기획사업(초소형 SAR 위성군 설계 및 제작을 통한 운용능력 확보)을 통해 도출된 연구결과입니다.

제3발표장 부라노 II

II-3 SS: K-DRIFT

Chair: 고종완(천문연)

16:00 [II-3-1]

K-DRIFT to Space: Exploring the Low-Surface-Brightness UniverseJongwan Ko^{1,2}, K-DRIFT Team³¹*Korea Astronomy and Space Science Institute*²*University of Science and Technology*³*K-DRIFT Team*

We are developing K-DRIFT (KASI Deep Rolling Imaging Fast Telescopes) adopting a state-of-art off-axis freeform three-mirror design to optimally explore the low-surface-brightness (LSB; less than $\sim 0.1\%$ of the ground-based night sky brightness) universe. As a test model, we have developed the K-DRIFT pathfinder in 2021, installed at the Bohyunsan Optical Astronomy Observatory, and conducted a year-long on-sky test observations for the optical system performance evaluation. Based on the results, we confirmed the pathfinder's efficient capability of the LSB feature detection and developed an analysis algorithm to improve the freeform optical system. We are currently developing the next generation of the K-DRIFT (K-DRIFT G1), which aims to survey the entire LSB sky in the Southern Hemisphere. Lastly, I would like to introduce the future roadmap of the K-DRIFT project.

16:15 [II-3-2]

K-DRIFT to Space: Fabrication of Freeform Mirrors of the K-DRIFT PathfinderDohoon Kim¹, Gisung Park¹, Changhee Lee¹, JaeYeong Jo¹, Hong Ki Kim¹, Taejong Kim¹, Minho Seo¹, Yunjong Kim², Jongwan Ko^{2,3}, K-DRIFT Team⁴, Young-Soo Kim¹¹*Green Optics Co., Ltd.*²*Korea Astronomy and Space Science Institute*³*University of Science and Technology*⁴*K-DRIFT Team*

We fabricated three freeform mirrors of the K-DRIFT pathfinder which adopts a confocal off-axis freeform three-mirror system with a 300 mm entrance pupil diameter. During the fabrication process, we reduced the weight of the primary mirror by 58%. Front surfaces of these freeform mirrors were formed by a series of production process, including grinding, polishing, forming, and finishing. Measuring surface profile has been performed by using Coordinate Measuring Machines (CMMs)

for the grinding process and an interferometer with Computer Generated Holograms (CGHs) for polishing, forming, and finishing process. Finally, the surface measurement results for all three mirrors were well within the required value of 20 nm RMS.

16:30 [II-3-3]

K-DRIFT to Space: Alignment and Integration of K-DRIFT Pathfinder and Tolerance Analysis of K-DRIFT G1Yunjong Kim¹, K-DRIFT Team²¹*Korea Astronomy and Space Science Institute*²*K-DRIFT Team*

The KASI-Deep Rolling Imaging Fast Telescope (K-DRIFT) is a confocal off-axis freeform three-mirror system designed for the detecting extended low surface brightness structures. We have successfully developed and operated the K-DRIFT pathfinder at the Bohyunsan Optical Astronomy Observatory, which enabled us to capture faint and diffuse stellar structures formed during the evolution of galaxies. Based on these achievements, we are developing the next generation of the K-DRIFT, hereafter we refer to as K-DRIFT G1. The difference between the optical specification of the K-DRIFT pathfinder and the K-DRIFT G1 are as follows: 1) the entrance pupil diameter is the same as 300 mm, however, the clear aperture of the primary mirror increased from 350 mm to 500 mm. 2) the focal ratio is reduced from 4 to 3.5, 3) the field of view is extended from $1.07^\circ \times 1.07^\circ$ to $4.43^\circ \times 4.43^\circ$, 4) the focal plane array size is increased from $22.5 \text{ mm} \times 22.5 \text{ mm}$ with $11 \mu\text{m}$ pixels to $81.2 \text{ mm} \times 81.2 \text{ mm}$ with $10 \mu\text{m}$ pixels. In this paper, we briefly present the alignment and integration process of the K-DRIFT pathfinder and the tolerance analysis of the K-DRIFT G1. We will also discuss the results and development plans for K-DRIFT G1.

16:45 [II-3-4]

K-DRIFT to Space: Performance Analysis and Error Control Strategy for the Optical SystemGayoung Lee^{1,2}, K-DRIFT Team³¹*Kyungpook National University*²*Korea Astronomy and Space Science Institute*³*K-DRIFT Team*

We are developing K-DRIFT to optimally explore the low-surface-brightness universe. K-DRIFT's unobscured off-axis freeform three-mirror system can reduce stray light and efficiently eliminate high-order aberrations at the image plane. Therefore, it can secure a wide field of view with homogeneous point spread functions. After a year of on-sky test observation

with the K-DRIFT pathfinder at Bohyunsan Optical Astronomy Observatory, we demonstrated and confirmed the three performance degradation factors with end-to-end optical simulation study. Based on this, we recently corrected these error sources and re-evaluated the performance. As a result, optical performance was significantly improved, and our analysis fidelity has been confirmed. In this presentation, we introduce K-DRIFT pathfinder's optical performance analysis algorithm and error-correcting strategy.

17:00 [II-3-5]

K-DRIFT to Space: Observation Strategy on the Ground and Science Drivers

Woowon Byun¹, K-DRIFT Team²

¹*Korea Astronomy and Space Science Institute*

²*K-DRIFT Team*

Low-surface-brightness (LSB) features in a nearby universe can give us crucial insights into the mass assembly history of galaxies and galaxy clusters. In addition, the LSB regime is a good laboratory for studying star formation properties in low-density regions, which are sensitive to stellar feedback. Beyond this significance, LSB imaging is quite challenging due to its vulnerability to various systematic uncertainties. The K-DRIFT is an LSB-optimized telescope adopting an off-axis linear-astigmatism-free three-mirror system, which can provide deep and clean imaging data. Over the next few years, we will conduct LSB surveys covering the Southern Hemisphere sky with ground-based telescopes named K-DRIFT G1. Here, we present our observation strategy and expected imaging performance. We also introduce several science drivers that can be studied with deep imaging data.

17:15 [II-3-6]

K-Drift to Space: Big Data and Astronomical Research

Sungrynog Hong¹, K-DRIFT Team²

¹*Korea Astronomy and Space Science Institute*

²*K-DRIFT Team*

In the era of modern astronomy, we have been experiencing a significant increase in the availability of extensive big datasets, surpassing the capabilities of conventional single-node data processing tools. In this talk, I provide a concise overview of contemporary big data technologies and demonstrate their practical applications in handling big astronomical datasets, using the illustrative examples from Gaia DR3 and Panstarrs DR1.

제4발표장 부라노 III

II-4 SS: 우주생명현상 탐색

Chair: 이충욱(천문연)

16:00 [II-4-1]

Sedimentary Record and Past Surface Environment on Mars: Gale Crater

Young Ji Joo

Major of Environmental Geosciences, Pukyong National University

Our understanding of the surface environment of deep-time Mars has advanced greatly over the last decade, due to Gale Crater exploration carried out by Curiosity. A thick sedimentary sequence crops out inside the impact crater that was formed approximately 3.5–3.8 Ga. Images, chemistry, and mineralogy of the sedimentary sequence acquired by the rover enabled researchers to reveal that the strata were deposited in fluvial and lacustrine environments back when liquid water was still abundant on the planet's surface. Until the sample return mission in 2033, the information gathered by Curiosity could serve as the sole window to the planet's past environment. Hence, the data collected using the rover instrument, which is simpler than state-of-the-art equipment operated in Earth's laboratories, is being utilized to reconstruct changes in provenance and weathering intensity, by applying traditional and canonical paleoenvironmental indicators. Meanwhile, weathering process of Mars' crust, which differs compositionally from that of Earth, changes in the planet's chemical environment and their effects on weathering, and sediment transport across the crater's edge are examples of potential areas we could pursue via thorough investigation of analogous sites on Earth. This presentation will review the findings from the Gale Crater and provide an overview of the Mars' past environment reconstructed from its sedimentary record.

16:15 [II-4-2]

Exploring Life Signatures in Water Ice on Mars

Minsun Kim¹, Min-Su Shin¹, Sun-Ju Chung¹,
Sungwook E. Hong^{1,2}, Ryun Young Kwon¹,
Yunjong Kim¹, LiCE Team³

¹*Korea Astronomy and Space Science Institute*

²*University of Science and Technology*

³*LiCE Team*

Liquid water, energy source and chemical elements such as C, H, N, O, P, and S are essential ingredients for building habitable environment of planets and moons. Liquid water is

the most important ingredient for habitability. Earth is not the only object in our solar system with liquid water. Ocean Worlds, such as Europa and Enceladus, are also believed to have oceans beneath their thick icy crust. Several Mars missions such as the Mars Reconnaissance Orbiter (MRO) and Phoenix have discovered the water ice on surface and subsurface of Mars. Water ice is distributed not only polar regions, but also on the surface and subsurface of Mars from mid-latitudes (~45 degree) to high-latitude (~60 degree), and even distributed sporadically and temporally in equator region. Since many microorganisms exist in icy environments such as glaciers and ice sheets on Earth, the water ice regions on Mars are potentially habitable sites where life signatures can be explored. Recently, Korea announced plans for a Mars orbiter (~2035) and a lander (~2045). We can consider habitability and biosignatures as scientific goals and subjects of the Korean Mars orbiter and lander missions. In this presentation, we introduce the International Mars Ice Mapper (I-MIM) and Mars Life Explorer (MLE) concepts designed to map subsurface water ice, and search for signatures of life and understand the habitability of ice near the Martian surface, respectively. The technology and experiences required through Mars ice explorations will be related and expanded to potential future Korean explorations of Ocean Worlds.

16:30 [II-4-3]

Isotopic Biosignatures on Early Earth and Potentially Elsewhere in the Solar System

Min Sub Sim

Seoul National University

Biology dominates the cycles of energy and elements at the Earth's surface environments, where abiotic reactions are often too slow to reach equilibrium, while geochemistry dictates which microbial processes take place. This interplay between biosphere and geosphere has shaped our planet over geologic time, and our understanding of Earth's surface environments owes to investigations of microbial activities through deep time. For example, many of the bio-essential elements have more than one stable isotopes, and microorganisms commonly discriminate against heavy isotopes, resulting in a wide range of isotope fractionation that can be preserved in sedimentary rocks over geologic time. Until recently, Earth was the only celestial body to investigate the co-evolution of the planet and its biota, but over the past two decades, the scientific exploration of planets and moons by rovers and satellites has provided an unprecedented opportunity to examine nature's geologic experiments conducted with different initial compositions and under varying conditions, potentially including the emergence of life. Interestingly, although insufficient to distinguish biological from abiotic effects, large variations in sulfur isotope

ratios ($^{34}\text{S}/^{32}\text{S}$) have already been detected on Mars, comparable to biological fractionation on Earth. A robust and universal interpretation of the geochemical biosignatures requires knowledge and understanding of all the different mechanisms that may have led to their formation, but ongoing technological advances may remove this ambiguity and allow potential biological and abiotic contributions to be resolved in the near future. In particular, the analysis of all three isotopic ratios of sulfur has much to contribute to our search for life on Mars and other extraterrestrial bodies in the Solar System.

16:45 [II-4-4]

Search for Radio Technosignatures

Sungwook E. Hong^{1,2}, Minsun Kim¹, Taehyun Jung¹, Hyunwoo Kang¹, Min-su Shin¹, Bong Won Sohn¹

¹*Korea Astronomy and Space Science Institute*

²*University of Science and Technology*

Technosignature, previously known as SETI (search for extraterrestrial intelligence), is the scientific evidence of past or present extraterrestrial civilizations. Since NRAO's Project Ozma was performed in 1960, most of the noticeable technosignature searches have been done by radio telescopes, hoping to find strong and narrow bandwidth signals that cannot be explained by known natural processes. In this presentation, we suggest what the Korean community could contribute the technosignature research. This includes the new SETI project with Korea VLBI Network (KVN) and future radio stations at the farside of the moon in the future.

17:00 [II-4-5]

Development and Validation of a Novel Global Earth Model for Exoplanet Imaging and Spectral Analysis

Dongok Ryu

Korea Aerospace Research Institute

This study presents a ray-tracing-based global Earth model designed for direct imaging and spectral analysis of exoplanets. The model provides a comprehensive representation of Earth's key components, including the Sun, atmosphere, land, and ocean, with a focus on spatial, spectral, and temporal characteristics. The study showcases the potential of integrating this Earth system model with instrument models for space instrument missions through a hypothetical telescope design and data comparison. The simulation results are rigorously compared with observational data, revealing a notable 50 μm increase in the separation between primary and secondary mirrors when compared to diffraction-limited conditions through defocus mapping and edge spread function measurements.

17:15 [II-4-6]

Overview of Exploring Coronagraph and Starshade Technology for Direct Imaging of ExoplanetsYunjong Kim¹, Sungwook E. Hong^{1,2},
Ryun-Young Kwon¹, Hyunwoo Kang¹, Minsun Kim¹¹*Korea Astronomy and Space Science Institute,*²*University of Science and Technology*

Since the discovery of the first exoplanet in 1995, over 5,000 exoplanets have been discovered. Most exoplanet discoveries have relied on indirect observation techniques - such as transit, radial velocity, and microlensing methods - that observe the changes of the host stars caused by the interaction with exoplanets.

Recently, the discovery of numerous exoplanets has raised questions about the possibility of extraterrestrial life. One should discover Earth-like exoplanets and obtain their spectroscopic data from direct observations to answer such questions. However, most Earth-like planets are about 10^{-10} dimmer than their host stars, making them difficult to observe directly due to the diffraction caused by the structure of telescopes. To overcome this challenge, NASA is developing instruments that block the light from host stars, such as coronagraphs and starshades. These instruments are included in NASA's roadmap for exoplanet observation.

In this presentation, we introduce the concepts of coronagraphs and starshades, which lead the way in NASA's direct exoplanet observation. We also discuss KASI's plans for developing observation instruments for exoplanet exploration with a similar concept.

17:30 [II-4-7]

Search for Biosignature at the Ocean WorldsSungwook E. Hong^{1,2}, Minsun Kim¹, Sun-Ju Chung¹,
Min-su Shin¹¹*Korea Astronomy and Space Science Institute*²*University of Science and Technology*

"Are we alone in the universe?" is the fundamental question of mankind. To search for the life signatures in the universe, there have been a lot of research and space explorations, especially in our solar system. In this presentation, we introduce the definition and characteristics of "biosignature." The current situations and plans for searching for biosignatures in our solar system are reviewed, especially at Ocean Worlds such as Europa and Enceladus, where life signatures are more likely to exist than in other places in the solar system. Finally, we discuss the opportunities and strategies for the Korean scientific community to participate in searching for biosignatures in the solar system.

10월 26일(목)

제1발표장 컨벤션센터

Invited Talk II

Chair: 강경인(과기원)

09:00 [IS-II]

Space Technology Development and Space Exploration in the NewSpace Era

Hae-Dong Kim

Gyeongsang National University

The newsface era is changing a lot in the way humans develop space technology and explore space. In the past, the method of developing space technology under the leadership of the government was huge budget and inefficient development, but in recent years, it has changed to develop a wide variety of space technologies in an innovative way centered on the private sector. If the way and direction of space exploration toward the unknown world were just an expression of curiosity, such as the origin of space and the origin of humanity, now it is changing to an era aimed at space exploration in relation to the space economy and space industry. In this lecture, we would like to introduce changes in the way space technology is developed and changes in the direction of space exploration in the newsface era.

제1발표장 컨벤션센터

III-1 SS: 차세대 중형위성 3호 I

Chair: 광영실(천문연)

09:40 [III-1-1]

Operation Scenario and Payload Data Analysis for CAS500-3 MissionShin-Hye Moon, Yang-Woo Seong, Young-Cheul Kim,
Seok-Soo Kim*Korea Aerospace Industries, Ltd.*

CAS500-3 (Compact Advanced Satellite500-3) conducts three science missions: BioCabinet, IAMMAP (Ionospheric Anomaly Monitoring by Magnetometer And Plasma-probe) and ROKITS (Republic of Korea Imaging Test System). BioCabinet takes photos of cell culture every two days; IAMMAP constantly monitors changes in the ionospheric space environment and magnetic field every second. ROKITS observes wide-area auroral and airglow phenomena for 60.4 minutes during a single orbit with a period of 96.8 minutes. These three payloads data

is stored in IDHU (Image Data Handling Unit). However, due to the constrained number of contacts which occurs 3 times a day at its minimum, the analysis of payload data plays a vital role in effectively managing IDHU capacity. This paper presents the payload operation scenario and provides the results of IDHU memory analysis.

09:55 [III-1-2]

Development of a Space Biology Payload BioCabinet (Stem Cell Bio 3D Printing and 3D Cell Culture System) Mounted on the CAS500-3

JiSeung Lee¹, YoungJin Lee¹, Kyunghee Kim¹, Olatunji Ajiteru¹, Chan Hum Park^{1,2}

¹*Nano-Bio Regenerative Medical Institute, School of Medicine, Hallym University*

²*Department of Otorhinolaryngology-Head and Neck Surgery, Chuncheon Sacred Heart Hospital, College of Medicine, Hallym University*

It has been reported that the incidence of cardiovascular disease increases rapidly during astronauts' stay in space. However, compared to many studies, there have been no reports on 3D bioprinting and 3D cell culture in space, except for research conducted on the ISS. The majority of studies which are based on ISS, cannot be conducted independently and domestically. There are problems with high costs, the inability to test high-risk pathogens, and the disclosure of core technology and research data. Therefore, within BioCabinet, an astrobiology payload mounted on the Cas500-3, vascular differentiation and 3D culture of stem cells using 3D bioprinting techniques are conducted to provide a fundamental solution to cardiovascular diseases that can have fatal consequences for astronauts. This aims to lay the foundation for Space Biology and Medicine by securing fundamental biotechnology data for blood vessel regeneration in astronauts.

10:10 [III-1-3]

ROKITS: A Space-Borne Wide-Field Auroral/Airglow Imager for CAS500-3

Woo Kyoung Lee^{1,2}, Seonhwan Choi¹, Kyoung-Min Roh^{1,2}, Young-Sil Kwak^{1,2}, Chanhaeng Lee¹, Jongyeop Park¹, Jihye Baek¹, Jihun Kim¹, Yunjong Kim¹, Dukhaeng Lee¹, Tae-Young Yang¹, Jaeheung Park^{1,2}, Jong-Kyun Chung¹, Geonhwa Jee^{2,3}, Hyosub Kil⁴, Larry J. Paxton⁴

¹*Korea Astronomy and Space Science Institute*

²*University of Science and Technology*

³*Korea Polar Research Institute*

⁴*Johns Hopkins University Applied Physics Laboratory*

The Republic Of Korea Imaging Test System (ROKITS) is a wide-field auroral/airglow imager being developed by the Korea Astronomy and Space Science Institute (KASI). ROKITS is set to be deployed aboard the Korean Compact Advance Satellite (CAS500-3), which is scheduled for launch in 2025. CAS500-3 will orbit at an altitude of 600 km with an inclination of 98° (LTAN: 12:40 PM). Having successfully passed the Critical Design Review in May 2023, ROKITS is currently in the process of building a flight model. The imager comprises three lens assemblies and one on-board computer, enabling it to provide auroral and airglow images at two spectral bands (OI 557.7 nm and OI 630.0 nm) with a narrow bandpass filter (3 nm, FWHM), as well as visible images without a filter. ROKITS offers a 90° field of view, allowing for an imaging swath of approximately 700 km.

The primary scientific objective of ROKITS is to delineate the boundary of the auroral oval and characterize various auroral shapes. Using the coincident ROKITS and DMSP/SSUSI observations, we aim to investigate the auroral boundaries in visible and FUV wavelengths and resolve fine auroral structures within SSUSI FUV images. Concurrent ground-based observations of auroras will also be used to study the evolution of auroral structures. In addition to auroral observations, ROKITS OI 557.7 nm emission data will be used for the study of atmospheric gravity waves and their roles in the generation of plasma bubbles and traveling ionospheric disturbances in low and mid latitudes.

10:25 [III-1-4]

A Strategic Approach to Process ROKITS Image Data for Aurora and Atmospheric Gravity Wave Detection

Hosik Kam¹, Young-Sil Kwak^{1,2}, Woo Kyoung Lee^{1,2}, Seonghwan Choi¹

¹*Korea Astronomy and Space Science Institute*

²*University of Science and Technology*

The ROKITS, to be deployed on the Compact Advance Satellite 500-3 which will be launched in 2025, is designed as a space-borne 2-dimensional wide-field auroral/airglow imager equipped with filters for OI 557.7 nm and 630.0 nm wavelength. Its primary scientific objective is to investigate auroral oval shapes and formation over polar region. Additionally, ROKITS aims to observe the atmospheric gravity waves captured on OI 557.7 nm airglow layer images emitted from an altitude of 96 km. This presentation proposes a new and simple method for utilizing ROKITS data or any other space-borne 2-dimensional consecutive images by sample data from the Canadian e-POP mission's fast auroral imager, launched in 2013. Furthermore, this presentation suggests a method for detecting atmospheric gravity waves and its utilizing study.

10:40 [III-1-5]

Ground Software Design for ROKITSJi-Hye Baek, Jongyeob Park, Seonghwan Choi,
Wookyung Lee*Korea Astronomy and Space Science Institute*

We present the process of designing the ground software for the Republic of Korea Imaging Test System (ROKITS). The ground software consists of mission control part and data pipeline part. Mission operation and telemetry monitoring concerns the software, COSMOS, which enables the user to manage the communication and control of embedded systems. The data pipeline is based on SpaceWeatherPy (SWPy), which is an open source python project for space science data included Heliophysics and Planetary Science of Korea Astronomy and Space Science Institute. We also plan to develop the operational planning tool for ROKITS autonomy.

10:55 [III-1-6]

EQM Test Results and Readiness for Flight Model of IAMMAP for CAS500-3 SatelliteKwangsun Ryu¹, Seunguk Lee^{1,2}, Su-Hwan Park¹,
Jimin Hong¹, Seong-og Park¹, Jinkyu Kim¹,
Wonho Cha¹, BonJu Koo¹, Dooyoung Choi²,
Cheong Rim Choi²¹*Satellite Technology Research Center, KAIST*²*Department of Astronomy and Space Science, Chungbuk National University*

IAMMAP (Ionospheric Anomaly Monitoring by Magnetometer And Plasma-probe) is one of the scientific instruments for the Compact Advanced Satellite 500-3 (CAS 500-3), which is planned to be launched by Korean Space Launch Vehicle in 2025. The main scientific objective of IAMMAP is to understand the complicated dynamics associated with the equatorial electro-jet (EEJ) and the equatorial ionization anomaly (EIA) in the dayside equator region. IAMMAP consists of a disk-type Langmuir probe (LP), an impedance probe (IP), and a magnetometer set (Adaptive In-phase MAGnetometer, AIMAG) for precise plasma measurements and minute current detection. In this paper, the design, manufacturing process, and test results of IAMMAP EQM (Engineering Qualification Model) are introduced briefly. EQM boards are demonstrated working properly in connection with interface modules and EGSE software. The performance tests in a plasma chamber and magnetic shielding can be introduced to verify that EQM instruments satisfy the science-driven requirements. Finally, the modifications based on EQM design and tests are summarized for confirming the readiness for the flight model manufacturing in the near future.

11:10 [III-1-7]

Development of the AIMAG EQM Model on CAS500-3Seunguk Lee^{1,2}, Kwangsun Ryu², Dooyoung Choi¹,
Seong-og Park², Jinkyu Kim², Wonho Cha²,
Bon-ju Koo², Jimin Hong², Su-Hwan Park²,
Cheongrim Choi¹, Dae-Young Lee¹¹*Chungbuk National University*²*Satellite Technology Research Center, KAIST*

The Ionospheric Anomaly Magnetometer And Plasma-probe (IAMMAP) is a space science payload package on the CAS500-3. It is scheduled to launch in 2025 aboard the Korean Space Launch Vehicle (KSLV-III). The purpose of IAMMAP is to investigate the complicated correlation between equatorial electro-jet (EEJ) and equatorial ionization anomalies (EIA). The EEJ is a strong flow of electric currents from east to west near the equator at an altitude of about 100 km. The Adaptive In-phase MAGnetometer (AIMAG), as a part of IAMMAP instrument set, is a unique-design fluxgate magnetometer to observe the magnetic field perturbations produced by the EEJ. Since CAS500-3 is operated at an altitude of ~600 km and the magnetic field perturbations produced by EEJs at this altitude are estimated to be 1-10 nT, the resolution of the AIMAG was designated to be less than 1 nT. Fluxgates are known to be very sensitive to temperature changes in space. One of the reasons for this is that the phase of the pick-up circuit output is severely affected by temperature variation. AIMAG is equipped with a feature to adaptively changing the phase by adding a dual-edge flip-flop in front of the phase sensitive detector (PSD), to minimize or to eliminate the temperature sensitivity. We briefly introduce the AIMAG design and EQM test results with comparison with the traditional fluxgate pick-up scheme.

11:25 [III-1-8]

Status of Development of Magnetic Noise Removal Algorithm Using CAS500-3 Satellite MagnetometerCheong-Rim Choi¹, Tongnyeol Rhee², Seung-Uk Lee¹,
Doo-Young Choi¹, Chang-Ho Woo³, Kwang-Sun Ryu³¹*Department of Astronomy and Space Science, CBNU*²*National Fusion Research Institute*³*Satellite Technology Research Center, KAIST*

The CAS500-3 satellite, aimed for launch in March 2025, is being developed for the purpose of space science and technology verification. This satellite will be equipped with the IAMMAP (Ionospheric Anomaly Monitor by Magnetometer and Plasma-probe) payload, which is designed to monitor

ionospheric disturbances. To enhance the accuracy of magnetic observation, a magnetic noise cancellation program utilizing multiple magnetometers is being developed. This paper presents an overview of the magnetic noise cancellation program and provides examples of its effectiveness in removing magnetic noise.

제2발표장 부라노 I

III-2 우주감시

Chair: 노동구(천문연)

09:40 [III-2-1]

Space Object Environment Model: Reviews and Insights

Jinsung Lee¹, Siwoo Kim², DongUk Lee¹,
Jaemyung Ahn¹, Eun-Jung Choi³, Jin Choi³,
Jiwoong Yu³, Sungki Cho³, Jung Hyun Jo³

¹*Korea Advanced Institute of Science and Technology*

²*Korea Institute of Defense Analyses*

³*Korea Astronomy and Space Science Institute*

This paper reviews software tools and associated models to describe the space object environment and its evolution over time. The tools are categorized based on their objectives (engineering debris model vs. evolutionary debris model) and collision analysis methods (full-factorial experiments vs. grid cell method). Insights from the review to reflect on the development of the Korean space object environment model are introduced.

09:55 [III-2-2]

NSOS- α : The First Korean Asteroid Survey Telescope

Myung-Jin Kim, Hong-Suh Yim, Jaemann Kyeong,
Youngmin JeongAhn, Hee-Jae Lee, Hong-Kyu Moon,
Dong-Goo Roh, Jung Hyun Jo, Jang-Hyun Park,
Sungki Cho

Korea Astronomy and Space Science Institute

The NSOS- α (Near Space Optical Survey-alpha) telescope is the first asteroid survey telescope in Korea. It aims to discover and catalog NEAs (Near-Earth Asteroids) specifically focus on PHAs (Potentially Hazardous Asteroids), which could pose a threat to the Earth. To achieve this goal, the 1.5-meter wide-field optical telescope with a five-square-degree field of view will be installed and operated at the Cerro Tololo Inter-American Observatory (CTIO), in Chile. The conceptual design of the telescope has been completed by a collaboration between KASI

(Korea Astronomy and Space Science Institute) and the NSF's National Optical-Infrared Astronomy Research Laboratory (NOIRLab) in 2022 and we plan to have a first light image in the beginning of 2027. The NSOS- α telescope will be the first dedicated observation facility for NEAs survey in the southern hemisphere using a 1.5-meter class telescope. We expect that there will be a high possibility of complementary synergy with the Vera C. Rubin Observatory, previously referred to as the Large Synoptic Survey Telescope (LSST). In this presentation, a mission and overview for the NSOS- α telescope will be addressed.

10:10 [III-2-3]

Operational Strategies of NSOS- α for Enhancing Near-Earth Asteroid Detection

Hee-Jae Lee, Myung-Jin Kim, Youngmin JeongAhn,
Hong-Kyu Moon, Dong-Goo Roh, Hong-Suh Yim,
Jaemann Kyeong, Jung Hyun Jo, Jang-Hyun Park,
Sungki Cho

Korea Astronomy and Space Science Institute

Discovery and tracking of Near-Earth Asteroids (NEAs), particularly Potentially Hazardous Asteroids (PHAs), constitute the cornerstone of our efforts to prepare for and mitigate potential risks associated with these objects. As part of this endeavor, the Korea Astronomy and Space Science Institute (KASI) is planning to install the Near Space Optical Survey-alpha (NSOS- α) telescope at the Cerro Tololo Inter-American Observatory (CTIO) in Chile. The NSOS- α telescope will feature a 1.5-meter aperture and an expansive $2.24^\circ \times 2.24^\circ$ field of view. The installation is scheduled for completion by the end of 2026. We are currently engaged in a collaboration with the distinguished University of Arizona's Catalina Sky Survey (CSS) team, renowned for their successful NEA observation surveys. Our objective is to adapt and enhance their observational strategies and data processing pipeline to optimize the efficient operation of NSOS- α and maximize its outcomes. In this presentation, we will provide an overview of CSS's observational techniques and discuss how NSOS- α plans to implement comparable or adapted methods for the detection of Near-Earth Asteroids.

10:25 [III-2-4]

NSOS-Beta (Near Space Optical Survey-Beta): Optical Wide-Field Patrol for MEO/GEO Space Objects

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

Korea Astronomy and Space Science Institute

A dedicated infrastructure, known as NSOS-beta (Near Space Optical Survey-beta), is planned to be developed for the detection, identification, tracking, and monitoring of space objects in orbits above 2,000 km. The system aims to independently generate orbit information for space objects and continuously monitor both the medium Earth orbit (MEO) and geostationary Earth orbit (GEO) regions on the Korean Peninsula. Through this system, we expect gaining improved orbit determination precision compared to the current utilization of OWL-Net (Optical Wide-field patrol-Net), acquiring independent orbit information for space objects in both MEO and GEO that pose collision risks, and providing orbit information for the space risk integration system. In this presentation, we will describe the system configuration and expected performance.

10:40 [III-2-5]

Development and Operation Status of Space Object Collision Risk Management System for KARI

Jaedong Seong, Okchul Jung, Youeyun Jung, Saehan Song

Korea Aerospace Research Institute

Currently, KARI monitors 6 LEO satellites and 3 GEO satellites for collision risks 24 hours, enabling prompt collision avoidance maneuvers to ensure safe and stable operations. Since Chinese ASAT (Anti-SATellite Test) in 2007, the monitoring of collision risks between space objects and operational satellites has been taken seriously, leading to the development of various collision risk management systems to respond quickly and efficiently to such situations. This paper provides an introduction to the space object collision risk management system developed from 2007 to the present, the current status of artificial space objects around Earth, and the system currently in operation. Additionally, it outlines future prospects and plans for the system.

10:55 [III-2-6]

Korea Meteor Monitoring and Observation Network (KMONet): The Introduction of Observation & Operation Rate of the Network and the Demonstration of Statistical Detection Results

Yun Hak Kim¹, Dong-Goo Roh¹, Jang-Hyun Park¹, Sungki Cho¹, Jung Hyun Jo¹, Jeong Yoo Hong¹, Hong-Suh Yim¹, Mansoo Choi¹, Myung-Jin Kim¹, Eun-Jung Choi¹, Jin Choi¹, Jiwoong Yu¹, Hee-Jae Lee¹, Jaemann Kyeong¹, Ki pyoung Sung¹, Sung-Yeol Yu¹, Seokmin Song^{1,2}, SeongHo Son³

¹*Korea Astronomy and Space Science Institute*

²*Chungnam National University*

³*Open Sky Partners Inc.*

Korea Meteor Monitoring and Observation Network (KMONet) is a monitoring camera network system with a total of 21 cameras at 16 locations. The main role of this system is to surveil sky and detect bright enough falling meteors (or even fireballs) on the south Korean peninsula.

Since we aim the level of performance for the system as a quasi-real-time detection and alert, the system operates 24/7 and also the trajectory analysis is carried out in order to estimate the potential crash areas for a successive work.

In addition, by utilizing the system and, for an additional purpose, we also set our further goal which is about studying the origin of meteors and its parent bodies by recovering their orbits and restoring the meteorites based on the statistically estimated crash areas.

In this talk, we introduce the operation and observation rates of KMONet and demonstrate the statistical results of meteors detected during the 2023 pilot operation period.

11:10 [III-2-7]

Civil Network for Optical SSA

Yong-Ik Byun

Yonsei University

We developed and deployed all-sky monitoring systems covering most of mainland Korea. The system consists of either 5 or 7 sets of cameras depending on the site visibility condition. Every night, a total of 136 cameras (22 stations) record the sky at the rate of 25 frames per second. Automated processes run near real time, detecting and extracting trajectories of hundreds of meteors brighter than 6th mag and this is followed by multi-site correlation and orbital analysis in the morning hours. In order to extend the SSA capability, we are developing advanced all-sky surveillance systems reaching 8th magnitude for fainter meteors and space objects, and also a narrow field system reaching 11th mag with automatic pointing and tracking capability. Examples of data product and analysis will be presented.

제3발표장 부라노 II

III-3 안보우주 II

Chair: 나경수(ADD)

09:40 [III-3-1]

Development Trends of Signals Intelligence Satellites

Sang Sul Han, Hong Rae Kim, Kyung Su Na
Agency for Defense Development

Starting with the launch of a spherical shape ‘signals intelligence (hear in after SIGINT)’ satellite called SOLRAD in the United States in 1960, advanced countries in space technology such as the United States, Russia, France, and China have developed series of SIGINT satellites. The United Kingdom officially withdrew from the European Union in January 2020. Since the declaration of the BREXIT, the development of SIGINT satellites is being promoted in earnest secretly in the United Kingdom. SIGINT satellites are treated as strategic space assets that play a decisive role in important diplomatic and security decisions, and are closely related to the RF sensor technology, so several countries with high quality SAR satellite technology are developing and operating signals intelligence satellites. And orbital condition and operational concept of SIGINT satellite are various from GEO to LEO and from static listening to dynamic tracking with formation flight.

09:55 [III-3-2]

Advantage of the Formation Flying of the Cube Satellite Constellation

Kyung-Su Na¹, Sang Sul Han¹, Inyoung Hwang¹,
 Hongrae Kim¹, Daehee Lee², Jae Jin Lee²

¹*Agency for Defense Development*

²*Korea Astronomy and Space Science Institute*

Nowadays LEO satellite constellation concept is broadly researched and developed all over the world. In many operation concepts of satellite constellation, formation flying has various advantages especially for military usage. As a following work to SNIPE, Agency for Defense Development (ADD) and KASI launched a future challenging program, so called ‘Development of rapid reaction cubeSat constellation for widesswath surveillance and reconnaissance’. After the launch of the satellites, they carry out the formation flying in orbit. When the cubeSat constellation fly in line abreast, relatively widesswath image data can be acquired. On the contrary, if they fly in single file, the revisit time for specific area of interest becomes considerably reduced, therefore the change of the target can be detected very easily. As a result, the formation flying concept could be applied to military operation according to various situations.

10:10 [III-3-3]

SpaceSCANeR: Innovative Convergence of Cubesats

Daehee Lee^{1,2}, Jaejin Lee¹, Goo-Hwan Shin³,
 Soojong Pak⁴, Geon Hee Kim⁵, SpaceSCANeR Team⁶

¹*Korea Astronomy and Space Science Institute*

²*Department of Aerospace Engineering, KAIST*

³*Satellite Technology Research Center, KAIST*

⁴*Kyung Hee University*

⁵*Department of Defense and Space Engineering, Hanbat University*

⁶*SpaceSCANeR Team*

In the era of “New Space”, demands for the Cubesats are increasing exponentially, with various complexity, technology, and reliability. In this talk, we will present the SpaceSCANeR mission, which aims a constellation surveillance and reconnaissance using Cubesats.

10:25 [III-3-4]

Off-Axis Reflective Optics Onboard CubeSat for Infrared Astronomy and Space Based EO/IR Surveillance

Soojong Pak¹, SpaceSCANeR Team²

¹*Kyung Hee University*

²*SpaceSCANeR Team*

Even a small telescope onboard a small satellite has limited optical resolution, its wide field-of-view can maximize the surveillance area and the observation frequency. In this presentation we review the technical feasibility of the off-axis reflective optics whose f-number is small enough for a diffraction-limited infrared observation and whose physical size is compact enough for onboarding a CubeSat. We present the design and test results of the prototype models of the innovative linear-astigmatism-free 3-mirror off-axis reflective telescopes, which were developed for space-based infrared astronomical observations. We also present a new optical module design of the EO/IR sensor for space based surveillance and reconnaissance.

10:40 [III-3-5]

18U SPACE SCANeR CubeSat Missions and Applications

Goo-Hwan Shin¹, Im-Hyu Shin¹, Dong-Guk Kim¹,
 Il-Young Jang¹, Hyun-Tae Choi¹, Young-Min Kim¹,
 Won-Ho Cha¹, Tae-Yoon Eom¹, Mina Koo¹,
 Jae-Hun Jang², Jeong-In Yun², Hyo-Sang Yoon²,
 Bong-Kon Moon³, Dae-Hee Lee³, Jong-Dae Shon³,
 Jae-Jin Lee³, Chang-Gon Kim⁴, Soo-Jong Park⁴,
 Gun-Hee Kim⁵, Kyung-Su Na⁶, In-Young Hwang⁶

¹*Satellite Technology Research Center, KAIST*

²*Spacecraft Prototyping Laboratory, KAIST*

³*Korea Astronomy and Space Science Institute, KASI*

⁴*Kyung Hee University*

⁵*Hanbat National University*

⁶*Agency for Defense Development*

Since the launch of Sputnik-1 in 1957, satellite technology has made many advances. The emergence of the SpaceX reusable launch vehicle in 2010 marked the beginning of the new space era in which the private sector leads the space segment. Going back to the history of the local space program, small to large-scale satellites have been utilized in many space fields, including remote sensing. In this way, using mid-sized satellites to large-sized satellites requires a large budget and has the disadvantage of taking a long development period. Following the development method required by the New Space era, there is a wind of expansion of missions using ultra-small cube satellites in the domestic space program. The 18U CubeSat configuration called SPACE SCANeR considering missions and applications was proposed.

10:55 [III-3-6]

Aspheric Reflective Optics Ultra-Precision Machining Technology

Geon Hee Kim¹, Jong Gyun Kang², Joong Kyu Ham², Hwan Ho Maeng², Seong Hyeon Park³

¹*Department of Defense and Space Engineering, Hanbat University*

²*Department of Mechanical Engineering, Chungnam University*

³*Department of Mechanical Engineering, Hanbat University*

The demand for precision optical systems is rapidly increasing not only in the aerospace sector but also in various fields such as military, automotive, and medical industries. This has led to a growing interest in optical system design and manufacturing technologies. Among them, reflective optical systems with low optical distortion, high resolution, and various focal lengths are used as infrared optical payloads for devices such as microscopes, satellites, and unmanned vehicles, and domestic research in this area is also actively progressing. Recently, there has been a demand for research on the ultra-precision machining of aspheric reflective mirrors made from various materials to be used as mission payloads in order to construct high-specification optical systems. Consequently, the ultra-precision technology for reflective mirrors using various materials is essential for the development of high-specification optical systems. This paper introduces key precision optical system production technologies for manufacturing aspheric reflective optical systems.

11:10 [III-3-7]

Regulating Security Measures for Defense Space Missions

Hyun Joo Choi¹, Kanghee Lim², In Ho Seo¹, Min Ji Bae¹, Ji Hee Yoo¹, Kyeong Keun Kim¹

¹*Agency for Space Development, ADD*

²*Center for Army Analysis & Simulation, ROK Army*

The developers, managers, and government officials that works for the 425 program, which is the first space program that is administered by ROK's defense regulations had to face and solve numerous issues that are not suited for Space Development programs. Complying to Defense Security regulations was also a hard task to implement, for very often the Defense Security regulations would conflict not only with conventions used in the space community but even with international or national law. More often were cases that there were no guidelines for security measures, thus guidelines had to be made while implementing the program. Discussions on applying security measures are presented, including satellite insurance, frequency registration, sharing information with foreign entities, and other issues that needs discussion are presented. In addition, a framework for security regulations for defense space programs are suggested.

11:25 [III-3-8]

Analysis of the LEO Communications Satellite Constellations Pass through GEO Communications Satellite Earth Station

Byoung-Sun Lee^{1,2}

¹*Electronics and Telecommunications Research Institute*

²*University of Science and Technology*

It is natural for Low Earth Orbit (LEO) communications satellites to pass through the field of view of Earth station antennas facing geostationary communications satellite. In Korea, there have already been cases where geostationary satellite earth stations were affected by radio interference from LEO satellites. The Starlink and OneWeb satellite constellations, which are ushering in the new space era and starting satellite communication services using hundreds to thousands of LEO communication satellites, also continue to pass through the field of view of the Earth station antenna that is looking at the GEO communication satellites. In this paper, we analyze the events through orbit prediction how often the 4,237 Starlink satellites and 634 OneWeb satellites orbiting as of June 26, 2023 pass within the field of view of the earth station antenna toward KoreaSat 6 (Mugunghwa 6) located at 116 degrees east longitude.

제4발표장 부라노 III

III-4 SS: SpaceAI 2023: 인공지능, 우주를 만나다

Chair: 한정열(천문연)

09:40 [III-4-1]

Introduction to SpaceAI Program to Promote

Artificial Intelligence in Space Science and Technology

Seonghwan Choi¹, Chanwoo Kim², Eunsu Park¹, Harim Lee³, Hwanhee Lee¹, Jeong-Heon Kim¹, Ji-Hye Baek¹, Rok-Soon Kim¹, Sung-Hong Park¹, Taeyoung Kim⁴, Yong-Jae Moon³

¹*Korea Astronomy and Space Science Institute*

²*KAIST Academy*

³*Kyung Hee University*

⁴*AI Factory*

We are planning and promoting the SpaceAI program to support the application of artificial intelligence (AI) in the field of space science and technology. Raising research productivity may be the most valuable among all the advantages of AI. It can help discover more scientific knowledge and make science more efficient. The capabilities of AI itself are regression and classification, and they are being applied in various ways in the field of space science and technology. More specifically, AI is being applied to space science such as data processing and analysis, data-based discovery, large-scale surveys, and simulations, and to space technology such as autonomous operations, optimizing resource allocation, enhancing navigation and guidance, enhanced communication, astronaut support, and risk mitigation. Applying AI to research ultimately requires significant computing skills, although there are a variety of open tools that can be easily used. We can learn computing skills and conduct research at the individual research level, but we need to conduct research more quickly and achieve research results through collaboration with data scientists, programming experts, and AI experts. Additionally, hardware environments such as high performance computing systems, storage system for storing large amounts of data, and high-speed network must be provided. Many science and technology researchers are trying to apply AI to their research, but we have found that it takes too much time to get results or they give up altogether. The SpaceAI program has been conceived with the primary objective of reducing the entry barrier for researchers seeking to leverage artificial intelligence (AI) in the domain of space science and technology. This initiative aims to foster collaboration among experts across diverse fields and provide access to the abundant computing resources of various institutions. Additionally, the program endeavors to endorse the dissemination of intellectual properties, including patents and software, as well as papers. Through these concerted efforts, we are expecting that SpaceAI not only cultivate a vibrant research culture but also yield significant and valuable contributions to the field. In this talk, we will introduce SpaceAI program and the progress of SpaceAI 2023.

09:55 [III-4-2]

Preliminary Results of Solar Energetic Particle

Flux Profile Prediction by Deep Learning

Kangwoo Yi¹, Jaewon Lee¹, Hwanhee Lee², Yong-Jae Moon¹

¹*Kyung Hee University*

²*Korea Astronomy and Space Science Institute*

It is certainly believed that proton flux at geosynchronous orbit is an important index to measure space weather risks. High energetic proton flux can causes communication disturbance, spacecraft anomaly, and biological issues. National oceanic atmospheric administration (NOAA) define a solar proton event as an event that the ≥ 10 pfu (particle flux unit) of ≥ 10 MeV protons, and warns them with S scale in NOAA space weather scales. In this study, we apply several deep learning methods to solar proton flux profile prediction. For this, we consider proton flux, electron flux, X-ray flux, and information of active regions from 1996 to 2019. We mainly analyze GOES data associated with NOAA S scale, and also consider STEREO data to increase number of data for better model optimization. Now we are developing several deep learning models which are good to analyze time series data, such as sequence-to-sequence which used for the solar flare X-ray flux profile prediction. Preliminary results of our models will be presented. This work is part of the SpaceAI project from Korea Astronomy.

10:10 [III-4-3]

Preliminary Prediction of Active Region Evolution by Novel Deep Learning Models

Harim Lee¹, Eunsu Park², Yong-Jae Moon^{1,3}, Jihyeon Son³, Kyoung-Sun Lee⁴, Jinhye Park¹, Karimov Khojiakbar³, Yerim Lim³, Seonghwan Choi²

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²*Korea Astronomy and Space Science Institute*

³*School of Space Research, Kyung Hee University*

⁴*Astronomy Program, Department of Physics and Astronomy, Seoul National University*

Solar active regions are important for solar physics research and have been used as an input for various space weather forecasting models. In this study, we are developing a prediction model for solar active region evolution using video prediction methods based on deep learning. For the dataset, we use magnetograms observed by Solar Dynamics Observatory (SDO) / Helioseismic and Magnetic Imager (HMI). For magnetograms, we use the Cylindrical Equal Area (CEA) projected HMI Active Region Patches (HARPs) data provided by JSOC, which have an advantage that they have the same area per pixel, without any additional data pre-processing. We consider 720 HARPs within ± 30 degrees of the solar central meridian and with HARPs of 512×512 size from May 2010 to May 2023 (about 1 million

images at 12 minute intervals). For the deep learning models, we consider several spatiotemporal prediction models, such as ConvLSTM and Top-tier video prediction models. Our models are designed to predict the change of active regions over the next 24 hours. Our study is a new attempt to predict the evolution of solar active regions using deep learning and is meaningful in providing useful information on solar activity forecasts. This work was supported by the SpaceAI project from Korea Astronomy and Space Science Institute (KASI) and Kyung Hee University (KHU).

10:25 [III-4-4]

Preliminary Results of AI-Based Solar Photospheric Flux Transport Models

Hyun-Jin Jeong¹, Mingyu Jeon¹, Daeil Kim¹,
Youngjae Kim¹, Ji-Hye Baek², Yong-Jae Moon¹,
Seonghwan Choi²

¹*Kyung Hee University*

²*Korea Astronomy and Space Science Institute*

In this study, we are developing an AI-based photospheric flux transport model. As a preliminary work, we predict next solar rotation (27.3 days) synoptic maps using a deep learning model. We use synoptic maps for the last 3 solar rotations as the model input. The synoptic map is a global magnetic field map of the solar surface constructed by merging together solar frontside magnetograms, and has been widely used for initial boundary conditions of several space weather prediction models. Here we train our deep learning models, which are based on the Pix2PixCC model, using data sets of SDO/HMI and SOHO/MDI synoptic maps from 1996 to 2023. We show preliminary results from our deep learning model, and compare them with those from the persistence model and conventional photospheric flux transport models, which include the effects of differential rotation, meridional flow, and diffusion on the solar surface. Our model can approximately generate magnetic features, e.g., diffusion of solar active regions and the motions of supergranules. We discuss advantages and disadvantages of our models in view of overall magnetic field evolution. We present several positive prospects of our new methodology for the study of the sun and space weather forecast.

10:40 [III-4-5]

Development of an Interplanetary Coronal Mass Ejection Detection Algorithm Using Artificial Intelligence

Roksoon Kim¹, Jongyeob Park¹, Woong Jeon²

¹*Korea Astronomy and Space Science Institute*

²*KyungHee University*

Identifying interplanetary coronal mass ejections (ICMEs) in solar wind observations is crucial for scientific objectives, such as understanding the evolution and propagation of CMEs and the embedded magnetic flux rope structures. It is also essential for practical purposes, such as comprehending their impact on geomagnetic storms. However, the observation of ICMEs in solar wind data is highly diverse, making it challenging to promptly detect the onset of ICME structures, which signifies their arrival at Earth. In this study, our aim is to develop an ICME detection algorithm using AI techniques, utilizing ACE solar wind observations and the Richardson and Cane ICME list from 1998 to 2022. Through this effort, we intend to lay the foundation for a real-time ICME automatic detection algorithm for future space weather forecasting. We believe that the ICME detection lists generated in this manner will prove invaluable for the physical study of CME-ICME interactions.

10:55 [III-4-6]

Developing a Deep Learning Model for Solar Flare Irradiance Translation

Sung-Hong Park¹, Junmu Youn², Seungwoo Ahn²,
Jeongheon Kim¹, Kangwoo Yi²

¹*Korea Astronomy and Space Science Institute*

²*Kyung Hee University*

Solar flares are observed as sudden, intense and localized brightenings in the solar atmosphere. When flares occur in the solar front disk as seen from the Earth, their earthward electromagnetic radiation, particularly ultraviolet (UV) and X-ray, can significantly impact the conditions of the Earth's ionosphere. This is one of important reasons to better understand the characteristics of both UV and X-ray emissions from flares. We developed a deep learning model with a time series dataset of: (as input) soft X-ray irradiance measured between 0.1 and 0.8 nm by the Geostationary Operational Environmental Satellites (GOES) and (as output) UV irradiance for flare emission lines within a wavelength range of ~10 to 100 nm observed by the Extreme ultraviolet Variability Experiment (EVE) onboard the Solar Dynamics Observatory (SDO) for thousands of flare events. Here we will present the details of the model development and performance as well as its science applications.

11:10 [III-4-7]

Preliminary Results for Deep Learning-Based Solar Flare Irradiance Prediction Model

Jeong-Heon Kim¹, Sung-Hong Park¹, Junmu Youn²,
Seungwoo Ahn², Kangwoo Yi²

¹*Korea Astronomy and Space Science Institute, KASI*

²*Kyung Hee University, KHU*

When solar flares occur, solar irradiance rapidly increases and penetrates the Earth’s atmosphere. In particular, due to the influx of enhanced Extreme Ultraviolet (EUV) and X-ray radiation, the Earth’s ionosphere experiences amplified ionization processes. This phenomenon leads to disturbances in the D and E layers, while in the F layer, it causes disruptions in ground-to-satellite communication and introduces signal delays. However, the current space weather monitoring and forecasting systems are incapable of promptly predicting changes in solar irradiance for the next few hours when solar flares occur. To overcome these prediction limitations, we aim to develop a model that predicts approximately three hours after the occurrence of a solar flare, spanning from X-ray to EUV wavelengths, by applying deep learning techniques to the reconstructed solar irradiance observational data from 2003 to the present, which was originally developed in the FISM model. We have selected M-class or higher solar flare events from 2003 to the present, collecting a total of 1,100 events. For deep learning training, we utilized a total of 90 data points at one-minute intervals from 1.5 hours before the flare occurrence to the flare peak time as input data, covering the X-ray wavelength range of 0.1 nm to 0.8 nm. As output data, we prepared 180 data points, spanning from the flare peak time to three hours later, representing the recovery period. The model predicts across a total of five wavelength bin bands, including the X-ray and EUV. From the total of 1,100 events, we divide the dataset into training, validation, and test sets at an 8:1:1 ratio. The deep learning code used for model development has been primarily tested with simple multi-layer perceptron (MLP) method. This study is part of the SpaceAI project, and in this presentation, we plan to share preliminary results. We aim to discuss the identified issues in the preliminary results and establish future development directions.

The ionosphere/thermosphere is the boundary that divides the Earth and space, and is constantly changing under the influence of energy coming from outside the Earth, such as the sun and magnetosphere above, and the lower atmosphere, such as the stratosphere and mesosphere, below. These rapid changes in the ionosphere/thermosphere greatly deteriorate the performance of satellite operations, satellite navigation systems such as GPS, and radio communications. To understand the response of the ionosphere-thermosphere system to external and internal forcing, the Korea Astronomy and Space Science Institute (KASI) is developing ROKITS (Republic of Korea Imaging Test System), an imager that observes aurora/airglow at high resolution with a wide field of view (90 degrees viewing angle) from space. ROKITS will be mounted on the Korean Compact Advance Satellite (CAS500-3), scheduled to be launched in 2025, and will make observations in a polar orbit passing between noon and midnight at an altitude of 600 km. ROKITS observes aurora and atmospheric gravity waves at high resolution with two spectral bands (OI 557.7 nm and OI 630.0 nm) with a narrow band-pass filter and a visible band camera without a filter. From aurora observations, we aim to estimate the energy flowing from outside the Earth to high-latitude regions and identify the resulting ionosphere-thermosphere changes. To this end, we will examine the spatiotemporal changes in the aurora oval, the small-scale structure characteristics of the aurora, the correlation between the aurora and ionospheric electron density changes, and the correlation between GNSS scintillation and aurora. In addition, from atmospheric gravity wave observations, we aim to estimate the energy propagating from the Earth’s lower atmosphere and investigate the resulting ionosphere-thermosphere changes. To this end, we will examine the generation characteristics of atmospheric gravity waves and their relationship with ionospheric disturbances (plasma bubbles, TIDs, etc.). To achieve ROKITS’ scientific goals, it will also be linked with ground observations. ROKITS observations are expected to contribute to verifying and improving the performance of the aurora prediction model for estimating external energy, which is essential information for global ionosphere/high atmosphere prediction. In this talk, we would like to share ROKITS’ scientific goals with the community.

제1발표장 컨벤션센터

IV-1 SS: 차세대 중형위성 3호 II

Chair: 김용하(충남대)

13:00 [IV-1-1]

ROKITS’ Science Goal: Understanding the Response of the Ionosphere–Thermosphere System to External and Internal Forcing

Young-Sil Kwak^{1,2}, Woo Kyoung Lee^{1,2},
ROKITS Team³

¹Korea Astronomy and Space Science Institute

²University of Science and Technology

³ROKITS Team

13:15 [IV-1-2]

Earth’s Auroral Exploration through Optical Imager Observations: Development of a New Mission Concept and Deep-Learning based Auroral Oval Model

Hyosub Kil

Johns Hopkins University Applied Physics Laboratory

Auroras, which manifest as bright airglows in polar regions, result from the input of solar and magnetospheric energy into

Earth's upper atmosphere. Prominent space weather phenomena associated with auroras include the reduction of satellite lifetime due to atmospheric expansion, geomagnetically induced currents affecting electric power infrastructures, and the impact of ionospheric perturbations on communication and navigation systems. NASA's Geospace Dynamics Constellation (GDC), scheduled for launch around 2030, aims to understand the upper atmosphere's response to varying external energy inputs through multiple satellite observations. The Republic of Korea Imaging Test System (ROKITS), developed by KASI and set to launch in 2025, is an all-sky imager in visual/infrared visible wavelengths, designed to provide high-resolution auroral images. To align with these missions and address gaps in our current understanding of external forcing and its effect, KASI and JHU/APL are jointly developing a new mission concept and a deep-learning based auroral oval model. This presentation provides an overview of these efforts.

13:30 [IV-1-3]

Aurora Boundary Map Completion with Deep Learning Techniques and the Contribution of ROKITS

Soojeong Jang¹, Jeong-Heon Kim², Woo Kyoung Lee², Hyosub Kil³, Se-Heon Jeong², Young-Sil Kwak^{2,4}

¹*Kyung Hee University*

²*Korea Astronomy and Space Science Institute*

³*Johns Hopkins University Applied Physics Laboratory*

⁴*University of Science and Technology*

Space-based observations only observe a part of the aurora oval according to the orbit. For this reason, to know the full shape of the aurora oval the empirical model is used. So, we plan to develop an aurora model to determine the auroral boundary. For this, we use deep learning techniques to complete an aurora map from partially observed data such as GUVI and SSUSI, and obtain its boundaries. Because there is no observation data of a full auroral oval, we use the Ovation Prime model (OP)-2010. In this work, we examine the auroral energy flux during November 2003 to check for differences between the OP-2010 results and GUVI observations. Furthermore, we anticipate that the data observed postmidnight through the ROKITS mission will contribute to the improvement of the model we are developing.

13:45 [IV-1-4]

Estimating the Auroral Boundary: Empirical Models and ROKITS Contribution

Jeong-Heon Kim¹, Soojeong Jang², Young-Sil Kwak^{1,3}, Woo Kyoung Lee¹

¹*Korea Astronomy and Space Science Institute, KASI*

²*Kyung Hee University, KHU*

³*University of Science and Technology, UST*

In this study, we assess the accuracy of identifying auroral boundaries using the latest IRI-2020 model and the OVATION PRIME (OP) model, and report on their potential. To investigate the boundaries of the auroral region, we selected geomagnetic storms that occurred on December 14–15, 2006, and September 7–8, 2017, as our target events. Additionally, as preliminary results, we focused our analysis solely on the Northern Hemisphere. For model validation, we utilized observational data for the 2006 event from EDR-AUR observations obtained by TIMED/GUVI and for the 2017 event, we employed EDR-AUR data observed by DMSP/SSUSI for comparison. The analysis results indicated that the IRI-2020 model could calculate the equatorward boundary more accurately than the OP model, but it tended to extend somewhat further toward the equator compared to observational data. Conversely, the OP model had limitations in accurately calculating the detailed elliptical boundaries of the auroral region. Ultimately, these two models can calculate the shape of the auroral oval for regions where satellite or ground observations are not feasible. Therefore, when combined with the results of the ROKITS mission's observations in the future, we believe they can serve as valuable empirical models for performance evaluation and validation of ROKITS observational data.

14:00 [IV-1-5]

Ionospheric GNSS Scintillations at High Latitudes Associated with Auroral Activities

Junseok Hong¹, Jong-Kyun Chung¹, Woo Kyoung Lee^{1,2}, Changsup Lee³

¹*Korea Astronomy and Space Science Institute*

²*University of Science and Technology*

³*Korea Polar Research Institute*

When Global Navigation Satellite System (GNSS) signals depart to ground from the satellites they penetrate ionosphere which is composed of free electrons and ions. The ionospheric signal delays can be corrected under the normal condition of the ionosphere, but the ionospheric electron densities can be disturbed owing to several physical mechanisms. Spatially and/or temporally rapid variations of the ionospheric electron densities may cause the diffractions on the GNSS signals, and it leads to the loss of signals lock on GNSS receiver which is called as GNSS scintillations. During the ionospheric GNSS scintillation events, availability of the GNSS-based systems becomes low hence it is important to investigate the sources. The auroral activity is one of main reasons for GNSS scintillations high latitudes, and Compact Advanced Satellite 500-3 (CAS 500-3) will load the instrument capturing the auroral activities on the space. Republic of Korea Imaging Test

System (ROKITS) will be onboard in CAS 500-3 is designed to observe the OI 630.0 nm and OI 557.7 nm auroral emissions. The moving platform based auroral activity observations will be expected to be valuable to compare with ground-based GNSS scintillation researches. In this presentation, we look back the GNSS scintillation researches associated with the auroral activities and discuss their potential scientific research items.

14:15 [IV-1-6]

Variations of Auroral Occurrence and Field-Aligned Currents (FACs) with Geomagnetic Activity at Jang Bogo Station, Antarctica

Yujin Cho^{1,2}, Geonhwa Jee^{1,2}, Young-Bae Ham^{1,2},
Hyuck-Jin Kwon¹, Jaeheung Park^{2,3}

¹*Korea Polar Research Institute*

²*University of Science and Technology*

³*Korea Astronomy and Space Science Institute*

Aurora All-Sky camera (ASC) has been operated at Jang Bogo station (JBS), Antarctica for observing aurora in visible frequency with color CCD since 2018. The auroral observation can be utilized to investigate the characteristics of the boundary between the polar cap and the auroral oval since JBS is mostly located near the boundary region. Using 5-year observation of the ASC auroral images, we produced the auroral occurrence maps over the JBS to identify the poleward boundary of the auroral oval (i.e., the polar cap boundary). The auroral occurrence maps were further compared with the distribution of Field-Aligned Currents (FACs) obtained from SWARM satellite to investigate the correlation between the polar cap boundary and the distributions of FACs. It was found that the upward FACs are dominant at higher geomagnetic latitude in the MLT morning sector (07–09 MLT) when the auroral occurrence is maximized at JBS. We also performed the comparison between the auroral occurrences and FACs with the different magnetic activity conditions in order to investigate their variations with magnetic activity.

14:30 [IV-1-7]

Verification of the Langmuir Probe Electronics Board of IAMMAP for CAS500-3 Satellite

Su-Hwan Park¹, Kwangsun Ryu¹, Seunguk Lee^{1,2},
Jimin Hong¹, Seong-og Park¹, Jinkyu Kim¹,
BonJu Koo¹, Changho Woo¹

¹*Satellite Technology Research Center, KAIST*

²*Department of Astronomy and Space Science, Chungbuk National University*

The Ionospheric Anomaly Monitoring by Magnetometer And

Plasma-probe (IAMMAP) is one of the scientific instruments for the Compact Advanced Satellite 500-3 (CAS500-3). The Langmuir probe (LP) of IAMMAP is a disk-type probe that measures the plasma current in order to determine the electron density and temperature for monitoring the Equatorial Ionization Anomaly (EIA). The LP is designed to be operated by a PCB called the LP Electronics Board (LPEB). Data obtained from the LP is converted into digital signals by the Analog-to-Digital converter (ADC) and then transferred to the Image Data Handling Unit (IDHU) via a channel link. In this process, it is necessary to confirm whether the sweep voltage is correctly applied and the plasma current value is read out without any distortions. To verify the performance of the LPEB Engineering Qualification Model (EQM), we executed predefined scenarios to optimize the observation parameters such as amplitude, frequency, and bias voltage. In addition, we identify that data packets obtained from the LP are transferred without any losses. The overall electronics boards and probe are installed in a plasma chamber, which provides a similar physical condition as the ionosphere, to verify that the plasma current is properly read out via trans-impedances and ADC circuits. The derived plasma parameters are compared with outputs from the impedance probe, which can play as a reference for plasma density values.

14:45 [IV-1-8]

Development of EGSE Software for Calibration of IAMMAP Instrument Units in CAS500-3

Jimin Hong¹, Kwangsun Ryu¹, Seong-og Park¹,
Su-Hwan Park¹, Seunguk Lee^{1,2}, Seongho Han³,
Taeyoon Eom¹

¹*Satellite Technology Research Center, KAIST*

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³*Department of Mechanical Engineering, KAIST*

IAMMAP is a scientific instrument onboard the CAS500-3 to investigate the EEJ and EIA. It consists of AIPIM (Advanced Impedance Probe for Ionospheric Monitoring), which consists of the sub-units LP & IP, and AIMAG (Adaptive In-phase MAGnetometer). To secure accurate in-situ plasma and magnetic field measurements, the detailed calibration of the units must be performed, so that a high performance interface software with functions of real-time data transfer and display, and saving data for further analyses is required. For this purpose, we developed a IAMMAP-dedicated EGSE (Electrical Ground Support Equipment) software. This software is designed to be compatible with the hardware components to help the module developers calibrate it more easily and intuitively. Implemented in Python, the EGSE allows easy-to-use data loading and saving, and provides real-time data transfer using UART and channel link protocols. A science data visualization UI provides user-defined

configuration features. The EGSE software is utilized in the EQM (Engineering Qualification Model) performance test in the plasma chamber and will be optimized throughout the FM (Flight Model) development and calibration in the near future.

제3발표장 부라노 II

IV-3 우주기술

Chair: 서행자(황우연)

13:00 [IV-3-1]

Ultralight Spacecraft: Boom-Type Solar Sail for Earth Orbit-Rising Demonstration Mission

Jungju Bae¹, Kwangchun Park², Jaeyoung Kang¹

¹*Mechanical Eng., Inha University*

²*Aerospace Eng. Sci., University of Colorado*

Design, control and space mission for solar sail spacecraft has been studied under the support of National Research Foundation (NRF) since 2018. A solar sail is a ultralight cubesat-sized spacecraft propelled by unlimited solar radiation pressure in space. This feature enables the solar sail to fly in non-Keplerian trajectory up to 20% of light speed. Particularly, the solar sail with the gravity-stabilized long boom was designed for an earth orbit-rising demonstration mission as a feasible Korean space mission in near future. We will briefly present our novel design and control algorithm for solar sail system optimized in attitude control effort during the earth orbit-rising mission.

13:15 [IV-3-2]

A Study on the Changes in Long-Term Orbital Elements of Inclined Orbit Geosynchronous Satellites

Bangyeop Kim

Korea Aerospace Research Institute

A simulation of the long-term orbital change of a geosynchronous satellite with a large orbital inclination angle of more than 40 degrees was performed. The MEGSD (Mean Equatorial Geocentric System of Date) analysis model was applied to include the perturbing forces of the sun and the moon, and the results were compared with the execution results of the FreeFlyer, a commercial orbit simulation tool. In particular, by predicting long-term orbital inclination angle changes due to changes in the Right Ascension of Ascending Node (RAAN) of satellite orbits, it can be used as reference material to find the optimal operation RAAN of an inclined orbit geosynchronous satellite constellation.

13:30 [IV-3-3]

Development of High Reliability Memory Components for Space Applications Using Hermetic Ceramic Packaging Technology

Mi Young Park¹, Dongkuk Kim¹, Seyeon Kim¹,
Bonju Gu¹, Jeongki Seo¹, Seongkeun Jeong²

¹*Korea Advanced Institute of Science and Technology*

²*MID Co., Ltd*

Using hermetic ceramic packaging, localization technology for high reliability space grade memory components is being developed.

Domestic commercial memory chips that have not yet been proven for space application are used to localize completely. Therefore the design technologies for space qualified memory component using commercial memory chips is important. One of them is space radiation effect verification technology for selecting commercial memory chips suitable for space application. In addition, the development of hermetic packaging process technology is essential. It is composed of multilayer high temperature co-fired ceramic (HTCC) manufacturing, fine pitch lead process for miniaturization, assembly, and hermetic sealing process technologies.

The evaluation of component for space application must also be performed to detect any design and construction defects that may affect component reliability and to predict component operation during qualification test.

This paper introduces the results of the development of localization technology for highly reliable space grade memory components using hermetic ceramic packages including the above mentioned.

This research has been funded by High Reliability Space Grade Memory Components Development Program of the Korea Ministry of Science & ICT (MSIT).

13:45 [IV-3-4]

Introduction to the Integration, Alignment, and Performance Tests of the Simple Offner Type Hyperspectral Imager

Dai Ho Ko¹, Jinsuk Hong²

¹*Korea Aerospace Research Institute*

²*Hanwha Systems*

Imaging spectrometer consists of telescope(s) that collects input photons and spectrometer(s) that disperses focused light onto the detector along its wavelength. Integration and alignment methods of the spectrometers are deeply related with its design concept and alignment instruments available. Among many spectrometer types the offner type spectrometer allows its integration and alignment concepts easy to comprehend and

also provides relatively superior keystone and smile performances. In this presentation, integration and alignment methods of the simple offner type spectrometer are presented and various spectrometer performance test methods such as keystone, smile, spectral registration and bandpass function measurements are also introduced.

14:00 [IV-3-5]

Comparative Analysis of Thermal Control Methods for Thermal Stability of Cube Satellites

Gyeonghun Bae, Minkyu Kang, Hakjin Lee,
Rho-Shin Myong

*Department of Mechanical and Aerospace Engineering,
Gyeongsang National University*

Satellites operate in a space thermal environment experiencing extreme temperature deviations in which the sun with a blackbody temperature of 6,000°C and deep space with a temperature of -270°C coexist. Therefore, thermal control design is essential for the mission to operate and succeed. There are two main heat control methods to protect satellites: active and passive. The method that suits the satellite's environment must be selected and applied. Various factors, such as manufacturing process, cost, time, and power, should be considered. There are cases where the most stable method in terms of heat control cannot be applied. In order to ensure that satellite internal components maintain a stable temperature under limited conditions, thermal requirements must be met even if different thermal control methods are applied. In this research, a case study was conducted to secure thermal stability, applying various thermal control methods to ensure thermal stability, which led to the success of a 3U-class simple-shaped cube satellite in its mission in low-orbit. Based on the analysis results, the pros and cons of each heat control method are analyzed. A Geometrical Mathematical Model and a low-orbit space environment were constructed to prove its effectiveness using C&R Technologies' commercial software Thermal Desktop and RadCAD. Based on this, the system's numerical thermal model (Thermal Model) was established through SINDA/FLUINT. Temperature analysis was conducted for the Mathematical Model. The results of this study are intended to be used in thermal control design for future CubeSat development.

14:15 [IV-3-6]

KPLO Deep-Space Ground System Event Schedule Generator Development and Operation

Dong-Gyu Kim¹, Eunheyuk Kim¹, Seok Soo Noh²,
Hee-Yoon Choung³

¹*Korea Aerospace Research Institute*

²*HANCOM inSPACE*

³*IOPS*

Korea Aerospace Research Institute (KARI) has launched Korea Pathfinder Lunar Orbiter (KPLO) in Aug 2022 and been operating KPLO on the lunar orbit since Dec. 2022. KARI has developed the Event Schedule Generator (ESG) in order to calculate ground antenna contact time to KPLO with NASA Deep Space Network (DSN) and Korea Deep Space Antenna (KDSA) and identify ground contact event such as X-band contact period, X-band contact gap, solar conjunction to KPLO and ground stations. The ESG also provides configuration section to define minimum contact period, minimum contact gap between antenna stations, and minimum X-band contact duration. KARI has deployed the ESG into KPLO Mission Operation Center (KMOC) and KMOC operators generate KPLO Event Schedule file with DSN schedule generated by NASA JPL and KDSA to KPLO view predict produced by Flight Dynamics Subsystem (FDS) in order to generate contact mission timeline and provide contact plots to KPLO Science Operation Centers (SOCs). The DSN-KDSA gap review file generated by the ESG is used for KARI to identify ground contact gap and request NASA JPL to add additional DSN contact or extend DSN coverage to acquire X-band contact and ranging time for downloading KPLO science instruments observation data and orbit determination. This paper will present the major functions of the ESG software and the status of ESG operation in KMOC.

14:30 [IV-3-7]

Mission of KITSAT Satellite Return to Acquire Space Exploration Technology

Kyungin Kang

Satellite Technology Research Center, KAIST

Technologies for the return of KITSAT satellite are closely linked to technologies for space exploration such as asteroid exploration. In this presentation, we would like to introduce a step-by-step program for technology demonstration of the technology development roadmap for our satellite return and examine the applicability of the corresponding space exploration technology. The main missions at each stage can be divided into space debris removal to protect the space environment, space orbit service, space sample return, and return of the KITSAT satellite.

In Korea, there are no satellite programs that have demonstrated space verification of related technologies, so when carrying out projects for deep space exploration or planetary exploration, the dependence on foreign technologies for related technologies increases, leading to repetitive problems when carrying out follow-up exploration programs. Difficulties are expected in establishing new space exploration programs. It is expected that the development of technology related to returning to KITSAT

satellite will contribute to the revitalization of domestic space exploration programs.

제4발표장 부라노 III

IV-4 달과 우주탐사: 과학과 기술 그리고 정책

Chair: 김주현(항우연)

13:00 [IV-4-1]

Humanitarian Operations of the Icebreaker Research Vessel (IBRV) in Polar Regions: Lessons for Space Rescue Strategies

Eojin Yi¹, Joowoong Park², Kyunghwan Kim³, Woo Seok Choi^{4,5}

¹*aSSIST University*

²*Korea Aerospace Research Institute*

³*MoonLeap Space System Inc.*

⁴*Keyu Internal Medicine Clinic*

⁵*KAIST*

To develop strategies to address potential emergencies astronauts might encounter on space station, we investigated humanitarian rescue activities in polar region, which is similar extreme environmental conditions with outer space. In particular, we analyzed the humanitarian rescue operations and emergency response incidents aboard the Korean icebreaker research vessel (IBRV) 'Araon'. While Araon's primary missions involve scholarly research expeditions and logistical supply, it also engages in rescue operations for vessels in distress when necessary. We found a total of six humanitarian rescue activities from 2010 to 2020, including the repatriation of nationals isolated abroad due to COVID-19 in 2020. These findings can be instrumental in establishing a medical emergency response system on spacecraft and space stations.

13:15 [IV-4-2]

Exploring Cheaper Rideshare/Piggyback Options to Flyby with Asteroids Passing by Earth

Pureum Kim, Sang-Young Park

Yonsei University

Improvements in space surveillance facilities and techniques allow detection of near-Earth asteroids (NEAs) passing by Earth much earlier than the actual encounter. Such encounters may provide planetary scientists with valuable information on asteroids themselves as well as the change in their properties (e.g., spin state change or resurfacing) caused by close planetary encounters. In such events, dedicated flyby missions during the

close encounter events can overcome the limitation of ground-based observations; however, considering the short duration of scientific operations that such flyby missions can permit, it would be ideal to limit the budget of such flyby missions. In that aspect, rideshare or piggyback (instead of a dedicated launch) becomes a desirable approach for low-budget asteroid flyby missions in the near-Earth regime. In this study, we first discuss a few mission constraints that are generally applicable to low-budget asteroid flyby missions that employ rideshare/piggyback options. Thereafter, a case study comparing several rideshare/piggyback options to an NEA called Apophis, which is to pass by Earth in April 2029, is discussed. Several possibilities such as a rideshare to a geostationary transfer orbit, and a piggyback mission on Earth orbiters, L1 missions, or lunar missions are analyzed and compared.

13:30 [IV-4-3]

Relationship between Energization of Moon-Originating Ions and Terrain Type on the Lunar Surface

Jaehee Lee¹, Khan-Hyuk Kim¹, Seul-Min Baek², Ho Jin¹, Yoshifumi Saito³, Masaki N. Nishino³, Shoichiro Yokota⁴

¹*School of Space Research, Kyung Hee University*

²*Korea Astronomy and Space Science Institute*

³*Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency*

⁴*Osaka University, Japan*

We analyze data acquired by the Kaguya satellite on 14 October 2008 when the Moon was in the terrestrial magnetotail lobe to gain new insight into energization of ions originating from the Moon. The Moon-originating ions were detected over a broad range of latitudes from -80° to 50° above the Moon's dayside at ~ 100 km altitude. The fluxes of the Moon-originating ions were observed at energies from ~ 50 to $\sim 1,000$ eV. Additionally, these ions exhibited a wide distribution pitch angle spanning from ~ 45 to 90° . The energy levels of ions originating from the Moon show rapid changes, either increasing or decreasing by a factor of ~ 10 within 8 min without the solar zenith angle dependence. Such rapid energy changes were observed over the highland regions. These observations are discussed in light of possible acceleration mechanisms of Moon-originating ions, including temporal and spatial effects.

13:45 [IV-4-4]

Laboratory Study for Light Scattering of 3D Printed Lunar Fairy Castle Structure

Mingyeong Lee^{1,2}, Minsup Jeong¹, Young-Jun Choi^{1,2}

¹*Korea Astronomy and Space Science Institute*

²*University of Science and Technology*

SurfCam is a light-field camera designed to observe the three-dimensional microstructure of the lunar regolith's uppermost layer as part of GrainCams. This lunar fine structure, called a 'fairy castle structure,' consists of loosely stacked grains with high porosity. It appears to connect with the light scattering on the lunar surface, particularly involving the multiple scattering at small phase angles. Unfortunately, it is hard to study the physical properties of the lunar fairy castle structure in the lab because of the difficulties reproducing and sustaining the high-porosity structure in the Earth's environment.

To overcome this limitation, we have adopted 3D printing techniques. We printed 24 simplified lunar fairy castle structures with a resolution of 10 μm . The reflectance of the samples was measured at the small phase angles of less than 5 degrees to investigate the effect of the microstructure at small phase angles.

We present our laboratory work as a pre-scientific study of SurfCam. We discuss the light scattering for the porosity of the fairy castle structure derived from the experiment result.

14:00 [IV-4-5]

Precision Orbit Determination Results in the Commissioning Phase of Danuri

Jonghee Bae, Young-Joo Song, SeungBum Hong, Jun Bang

Korea Aerospace Research Institute

Danuri was launched on August 5, 2022, and has successfully performed the lunar science mission in the lunar polar orbit. Danuri arrived at the Moon throughout the ballistic lunar transfer trajectory, and sequential lunar orbit insertion maneuvers were performed. After lunar orbit acquisition phase, Danuri was in the commissioning phase to check out and calibrate the bus system and payloads. And then the nominal science mission was started. For the operation in the flight dynamics perspective, daily orbit determination (OD) is carried out and the maneuver planning of the next maneuver is performed based on the OD result. In addition, products including the definitive and predictive ephemeris are generated and delivered to subsystems of Korea Deep Space Ground System (KGDS). Precision orbit determination (POD) is performed separately from daily flight dynamics operation. POD is the process of accurately estimating the position and velocity of Danuri in the lunar orbit using the tracking data from deep space antenna. The period for performing POD is based on one month. In this study, POD results in the commission phase of Danuri are analyzed and presented. The orbit difference between daily OD and POD is described for the POD analysis.

14:15 [IV-4-6]

KPLO Collision Avoidance Maneuver #1 Planning and Execution Result

Jun Bang, SeungBum Hong, Young-Joo Song, Jonghee Bae

Korea Aerospace Research Institute

The Korea Pathfinder Lunar Orbiter (KPLO, also known as Danuri) performed the first collision avoidance maneuver (CAM) on 21 Jun 2023 (UTC) to clear collision risk with Chandrayaan-2. This paper summarizes the background of CAM1 decision, the results of case studies during the planning activity, and the execution result of CAM1 from the flight dynamics viewpoint. After CAM1, the collision risk was eliminated until the next scheduled maneuver of KPLO and Chandrayaan-2.

14:30 [IV-4-7]

Introduction to Multimission Automated Deepspace Conjunction Assessment Process (MADCAP)

SeungBum Hong, Jun Bang, Jonghee Bae, Young-Joo Song

Korea Aerospace Research Institute

The likelihood of spacecraft encounters in lunar orbits has increased significantly as Lunar missions become more prevalent. Since Korea Pathfinder Lunar Orbiter (KPLO) started its science mission on December 28, 2022, the assessment of potential conjunctions with other spacecraft has been facilitated through the utilization of NASA's Multimission Automated Deepspace Conjunction Assessment Process (MADCAP). MADCAP serves as a safety protocol for celestial body orbiting missions, primarily focusing on screening NASA spacecraft's ephemeris data for potential conflicts. However, MADCAP also welcomes ephemeris data from non-NASA spacecraft to ensure safe coexistence. This paper provides a concise introduction to the MADCAP and offers an overview of recent conjunction assessment events involving KPLO and other spacecraft, describing the collaborative efforts to ensure the safety and success of lunar missions.

16:30~18:00 포스터 발표

10월 27일(금)

제1발표장 컨벤션센터

Invited Talk III

Chair: 정종균 (천문연)

09:00 [IS-III]

A Polar-, A Space-, and A 'Risky' PersonEojin Yi^{1,2}¹*aSSIST University*²*Korean Society of Polar Medicine (KSPM)*

“Extremes meet.” Over a hundred years, human beings, as a ‘polar person’ having grasped the Antarctic is now even trying to settle down the ‘South Pole’ of the Moon as a ‘space person’. The manned lunar exploration and moon base missions ultimately stare at expedition to the deep space. It is essential to understand the major hazards to human space flight and requires mankind’s knowledge and technology for appropriate countermeasures. To ensure the success of each space mission, human factors must be adequately addressed within the realm of ‘risk management’. This understanding also deepens our comprehension of human adaptation in extreme environment. In the not-to-distant future, human research at the intersection where these ‘two poles’ meet (human in space and analogue studies) will unveil new horizons in life and medical sciences, providing vital insights for space travel, exploration, and habitation.

This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (grant number 1345341447).

제1발표장 컨벤션센터

V-1 태양 및 우주환경 III

Chair: 정세현(천문연)

09:40 [V-1-1]

Analysis of the Characteristics of Gravity Waves over the Korean Peninsula Using Specular Meteor RadarHosik Kam¹, Young-Sil Kwak^{1,2}, Tae-Yong Yang¹, Jeongheon Kim¹, Jaewook Lee^{1,2}, In-Sun Song³, Byeong-Gwon Song³¹*Korea Astronomy and Space Science Institute*²*University of Science and Technology*³*Yonsei University*

The specular meteor radar (MR) located in Gyeryong (36.2°N, 124.1°E) and operated by KASI observes the under-dense meteor trails and their radial velocities in the mesosphere and lower thermosphere (MLT) region. The radial velocity of meteor echoes is determined by measuring Doppler shift and temporal variation of the phase in the back-scattered signal, and it is estimated using a least-squares linear fit to the phase time series. Typically, radial velocity reserves as a powerful tool for estimating the mean flow in the MLT region. Additionally, the perturbed radial velocity is considered to be influenced by gravity waves, and this conceptual quantity is used to calculate the gravity wave momentum flux. In this study, we derived and verified the gravity wave momentum flux for 5 years (2018–2022) from KASI MR. We will present our findings on the characteristics of gravity waves over the Korean Peninsula.

09:55 [V-1-2]

Multilayer Shields that Shield Satellite Electronic Components from Cosmic RadiationHojin Lee^{1,2}, Jongdae Sohn^{1,2}, Junga Hwang^{1,2,3}, Hyosang Yoon³¹*University of Science and Technology (UST)*²*Korea Astronomy and Space Science Institute (KASI)*³*Korea Advanced Institute of Science and Technology (KAIST)*

Cosmic radiation consists of galactic cosmic radiation from outside the solar system and solar cosmic radiation from solar activity. Cosmic radiation is a charged particle with high energy and has a great effect on satellites and humans operating in space. Space radiation is one of the important issues to consider in satellite design, especially since TID, SEE, and DD phenomena occur when charged particles pass through the electrical components of a satellite. One of the ways to reduce cosmic radiation damage is to use shield. To develop a shield, the volume, mass, and development budget of the satellite must be considered. Furthermore, material and thickness also must be considered for optimal shield. High-density materials have high radiation shielding efficiency, but generate secondary particles. On the other hand, low-density materials have low radiation shielding efficiency but do not generate secondary particles. Therefore, an appropriate combination of high and low density materials should be used. This study used Geant4 and MCNP 6.2, radiation simulation programs based on Monte Carlo techniques, to conduct simulations to find the optimal shield in a space environment at an altitude of 400 km. There are a total of seven candidates for shielding materials, including low-density aluminum, high-density copper, nickel, and tungsten. The thickness of the shield was divided into 10 mm and 20 mm, and the optimal shield was calculated in both cases.

10:10 [V-1-3]

Preliminary Prediction of IMF Southward Components (Bz) for the Next 6 Hours by Deep Learning

Jihyeon Son¹, Yong-Jae Moon^{1,2}, Kyung Sun Park³, Young-Sil Kwak⁴

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

³*Department of Astronomy and Space Science/Basic Science Research Institute, Chungbuk National University*

⁴*Space Science Division, Korea Astronomy and Space Science Institute*

In this study, we predict interplanetary magnetic field (IMF) southward component (Bz) for the next 6 hours by deep learning. For this we develop Multi Layer Perceptron models using solar wind data (V, N, T) and IMF (Bt, Bx, By, Bz) in OMNI from 2000 to 2022. We use the preceding 12 hours of data as input, and the next 6 hours data as target data. We consider Bz values below the negative standard deviation (about -3 nT) for at least 6 hours. This process yields a total of 4,360 datasets, which are divided into training and test sets. We apply 9-fold cross validation to our model: 8 months for training sets and 4 months for test sets. Consequently, total 9 models are trained, and they show averaged RMSE ranging from 1.64 nT for 30-minute prediction to 3.26 nT for 6-hour prediction. Our model can capture declining phases of Bz as well as increasing phases. Although this study presents preliminary results in Bz prediction, we can see a sufficient potential for predicting Bz under specific conditions.

10:25 [V-1-4]

Development a Two-Dimensional Regional Ionospheric Total Electron Content Prediction Model based on Deep Learning Approach

Se-Heon Jeong¹, Woo Kyoung Lee¹, Soojeong Jang², Hyosub Kil³, Jeong-Heon Kim¹, Young-Sil Kwak^{1,4}

¹*Korea Astronomy and Space Science Institute*

²*Kyung Hee University*

³*Applied Physics Laboratory, Johns Hopkins University*

⁴*University of Science and Technology*

In this study, we develop the model predicting the regional ionospheric total electron content (TEC) map in the vicinity of the Korean Peninsula (26.5°-40°N, 121°-134.5°E) for the next twenty-four hours by employing a deep learning techniques called Convolution Long Short-Term Memory (ConvLSTM) and LSTM. TEC maps reconstructed from the Deep Convolutional Generative Adversarial Network - Poisson Blending

(DCGAN-PB) model (Jeong et al. (2022)) are used. Data from 2002 to 2018 were used as training data, and the test period was set to 2019. The performance of the prediction models (LSTM, ConvLSTM, IRI-2016) is evaluated by comparing model results with ground truth. As a result, it was confirmed that the deep learning models developed in this study successfully predicted the TEC map than the empirical model. Especially, the TEC prediction performance of the ConvLSTM model among the prediction models has the best performance for TEC prediction in the vicinity of the Korean Peninsula. This is because the ConvLSTM model is trained taking into account the influence of spatio-temporal conditions on TEC predictions. Therefore, the ConvLSTM model can be used to predict 2-dimensional regional ionospheric TEC map.

10:40 [V-1-5]

Solar Limb Flare Prediction Using SDO/AIA EUV Intensity and Its Deep Learning Implementation

Jaewon Lee¹, Yong-Jae Moon^{1,2}, Kangwoo Yi², Hyun-Jin Jeong², Harim Lee²

¹*School of Space Research, Kyung Hee University*

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

We propose an unprecedented solar limb flare prediction model using SDO/AIA. Projection effects in solar white light and magnetogram data hinder accurate flare forecasts near the solar limb. Through the statistical flare analysis of SDO/AIA EUV data, our model predicts the probability of major solar limb flare occurrence within a day. We use SDO/AIA 94 and 131 Å wavelengths that have high correlations with X-ray flare class from 2010 to 2022. For the same period, we select 252 flares stronger than M1 class and located at the limb region (larger than 60 degrees in longitude). For our study we define the limb intensity as the summation of SDO/AIA over the limb region. We compute the flare occurrence probability as a function of limb intensity. Our major result can be summarized as follows. First, the major limb flare occurrence probability strongly depends on both intensities. Second, for 94 Å, the largest probability is about 37.7%. For 131 Å, the largest probability is about 30.4%. Combining the wavelengths resulted in a higher probability—39.6%. Our study provides a positive possibility for major limb flare prediction by using solar EUV data. We also present preliminary results of our deep-learning application for the limb flare prediction.

10:55 [V-1-6]

Ions at the Shock Ramp of a Quasi-Perpendicular Bow Shock Observed by MMS

Hee-Eun Kim¹, Ensang Lee¹, George K. Parks²

¹*School of Space Research, Kyung Hee University*

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

Observations by AMPTE/IRM and ISEE have shown that the reflected, gyrating ions form bunching distributions in the $V_{\parallel} - V_{\perp}$ plane in the immediate downstream region of the shock and the ions are well-thermalized toward the downstream region. The model by Sckopke et al. (1983) explained how rings or toruses of secondary ions are likely to form in velocity space, at least temporarily as an intermediate step toward thermalization. Our previous study using Cluster observations shows that the solar wind ions are not fully thermalized across the shock boundary but consist of the core and hot components in the downstream region of the shock and they experience independent heating processes. In this study, we focus on how the thermalization process of the hot component, which comes from the reflected, gyrating ions, occurs at the shock ramp using MMS data. Our results support the model suggested by Sckopke et al. (1983) that the gyro-phase bunching is formed in the direction perpendicular to the magnetic field, and the ring distributions of the secondary ions are key features of ion distributions in the $V_{\parallel} - V_{\perp}$ plane. The MMS results will be discussed in the qualitative and quantitative side.

11:10 [V-1-7]

Investigating the Impacts of Internal Atmospheric Variability on the Ionosphere during the 5 April 2010 Geomagnetic Storm

Wonseok Lee, In-Sun Song, Ja Soon Shim, Hoijin Uh

Department of Atmospheric Sciences, Yonsei University

Understanding the influence of internal atmospheric dynamics on the ionosphere during geomagnetic storm is critical for accurate space weather forecasting. To address the impacts, we conduct numerical simulations using the Whole Atmospheric Community Climate Model with Thermosphere and Ionosphere Expansion (WACCM-X) for the 5 April 2010 geomagnetic storm. The lower atmospheric dynamics are nudged using the Modern-Era Retrospective analysis for Research and Applications version 2 reanalysis data during the full period of experiment (analysis run). The other experiments (forecast runs) are performed without specified dynamics 20 days, 10 days, 5 days, 2 days, and 1 day before the storm onset, respectively. Our results show that significant deviations in the amplitude and phase of migrating diurnal (DW1), semi-diurnal (SW2), and non-migrating (DE3) tides from the analysis run 2 or 3 days after nudging is turned off. Notably, the amplitude of DW1 consistently decrease in the forecast runs. This deviation attributes to the tidal-induced winds in the E-region, affecting the vertical plasma drift velocity in the F-region. Furthermore,

after 10 days without nudging, the Total Electron Content (TEC) departures from the analysis run in the high-latitude region. The deviations of TEC are related to the variation of O/N2 ratio due to changes in meridional circulation. Overall, our study highlights the crucial role of lower atmospheric dynamics in space weather forecast for ionosphere even during the geomagnetic storm period.

11:25 [V-1-8]

Correlation between EUV Intensity Spikes and Mean Intensities on the Solar Disk

Il-Hyun Cho, Yong-Jae Moon, Jin-Yi Lee, Junmo An

Kyung Hee University

We examined the relationship between nanoflare-like small scale intensity spikes and the coronal heating. For this, we selected 1000 random positions from the east side of the solar disk observed in the SDO/AIA 171 channel and tracked them during one week. At each position, we defined $\pm 10''$ box and calculated its averaged intensity. The intensity spike was defined as a peak intensity exceeding the threshold that was defined as three times of mode of absolute deviation in the 5-minutes time interval. By analyzing the intensity spikes, we found that the correlation between the number of spikes and mode intensity for 1-hour, ranges from 0.4 to 0.8 over 80% of positions. The histogram of waiting times was well fit by the Poisson function but showed an overabundance shorter than 50 s. It was also found that the histogram of enhanced intensities of the spikes is well fitted by the power law with the slope of -3.73 , suggesting a significant contribution of intensity spikes to coronal emissions.

11:40 [V-1-9]

Energy Coupling from Magnetosonic Waves to High-Frequency Electromagnetic Ion Cyclotron Waves: Statistical Analysis

Kyungguk Min¹, Qianli Ma²

¹*Chonnam National University*

²*UCLA*

In the inner magnetosphere, fast magnetosonic waves (MSWs) are known to resonantly interact with ring current protons, causing these protons to gain energy preferentially in the direction perpendicular to the background magnetic field. An anisotropic distribution of enhanced ring current protons is a necessary condition to excite electromagnetic ion cyclotron (EMIC) waves which are known to facilitate a rapid depletion of ultra-relativistic electrons in the outer Van Allen belt. So, when a simultaneous observation of high-frequency EMIC

(HFEMIC) waves, anisotropic low-energy protons, and MSWs was first reported, a chain of energy flow from MSWs to HFEMIC waves through proton heating was naturally proposed. Here, we carry out a statistical analysis using Van Allen Probes data to provide further insights into this energy pathway. Our results show that the occurrence of HFEMIC waves exhibits good correlation with enhanced flux and anisotropy of low-energy protons which is marginally stable to the HFEMIC instability. In contrast, the correlation between the low-energy protons and the occurrence and power of MSWs is rather poor, casting doubt on the first chain of energy flow. Furthermore, quasilinear diffusion analysis indicates that MSWs are not very effective for low-energy proton heating for most of the cases. We suggest that an alternative explanation for the origin of these protons in the inner magnetosphere is in need.

제2발표장 부라노 I

V-2 SS: 과학이 대중에 가 닿기까지, 연구자의 역할 고찰
Chair: 김태훈(서울대)

09:40 [V-2-1]

The Importance of Public Communication in Science Culture in Korea

Junga Hwang^{1,2}

¹Korea Astronomy and Space Science Institute

²University of Science and Technology

In order to become a leading science and technology (S&T) power, we need to increase public understanding and interest in S&T. To achieve this, it is necessary to promote science culture and strengthen the social responsibility of S&T. Public communication is the most important element of science culture. By communicating with the public at their level of understanding and actively engaging with them, researchers and scientists can help promote science culture and fulfill their social responsibility.

In addition, public communication is important to help prevent people from being misled by pseudoscience. Pseudoscience is a type of false or misleading science that is often presented as if it were true. It can be harmful to public health and safety, and it can also lead to poor decisions about important issues. By providing accurate scientific information to the public, public communication can help people to identify pseudoscience and make informed decisions about their lives.

Although science culture activities are being actively conducted in various fields in Korea, there is still a lack of public communication activities that speak to the public at their level of understanding. When researchers and scientists talk about

S&T in a way that is relevant to the public's interests and use simple language and examples to explain S&T, they can contribute significantly to increasing public understanding and interest in S&T.

09:55 [V-2-2]

The Difficulties in Accurate Public Communication Learned from the 2023 Super Blue Moon

Ah-Chim Sul^{1,2,3}, Yonggi Kim², Hyoungbum Kim², Han-Earl Park¹, Dong-Hyo Sohn¹, Hye-im Jeong¹, Hye-lim Jeong³

¹Korea Astronomy and Space science Institute

²Chungbuk National University

³Korean Amateur Astronomical Society

Even if the research institute provides accurate astronomical information, the credibility of the institute decreases as false information spreads through the media.

This study analyzed the cause of these problems through the case of the so-called 'Super Blue Moon', investigated the public's perception, and discussed future improvement directions.

제3발표장 부라노 II

V-3 우주기술 / 안보우주 III

Chair: 최현주(ADD)

09:40 [V-3-1]

Power Budget Analysis for the 18U SPACE SCANer CubeSat

Tae-Yoon Eom¹, Im-Hyu Shin¹, Dong-Guk Kim¹, Il-Young Jang¹, Hyun-Tae Choi¹, Young-Min Kim¹, Won-Ho Cha¹, Mina Koo¹, Goo-Hwan Shin¹, Jae-Hun Jang², Jeong-In Yun², Hyo-Sang Yoon², Bong-Kon Moon³, Dae-Hee Lee³, Jae-Jin Lee³, Chang-Gon Kim⁴, Soo-Jong Park⁴, Gun-Hee Kim⁵, Kyung-Su Na⁶, In-Young Hwang⁶

¹Satellite Technology Research Center, KAIST

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³Korea Astronomy and Space Science Institute, KASI

⁴Kyung Hee University, South Korea

⁵Hanbat National University, South Korea

⁶Agency for Defense Development

The SPACE SCANer, consisting of 18U CubeSats, aims to engage in formation flying for the immediate observation of Earth during urgent situations. The power budget analysis is required to determine the electrical power subsystem (EPS)

specifications, including solar panels and batteries, in order to develop the engineering model. Analyzing the power budget, it was assumed that the CubeSat flies in a low Earth orbit and should be fully charged during every orbit. The results reveal that the depth of discharge met the power requirements in the initial de-tumbling mode following separation from the launch vehicle. This paper aims to design an appropriate EPS that supports other subsystems in terms of power generation, storage, and distribution to ensure the successful completion of the SPACE SCANer project.

09:55 [V-3-2]

The Study on Link Degradation due to TT&C Frequency Sharing in Geo-Synchronous Constellation Mission

Sangil Ahn, Wonsub Choi, Bangeop Kim

Korea Aerospace Research Institute

It takes a considerable amount of time to apply for and allocate the frequencies of the satellite group for mission operations, and it usually takes even longer time to get the licenses for different TT&C frequencies.

Usually, depending on the number of satellites that make up the satellite constellation mission, it is possible to apply for several separate frequencies and to apply for the single same frequency.

This study shows the results of analyzing how the link performance can be affected with respect to the ground antenna diameter size in geo-synchronous constellation mission.

As a result of the analysis, if only the minimum separation angle in space between cluster satellites is guaranteed, the quality of the link is insignificant even if the same frequency is applied.

10:10 [V-3-3]

Introduction to the Development and Applications of Space-Grade Polarized Imaging Cameras

Seonghwan Choi¹, Jungwoong Kim², Gwanghui Jeong³, Byungchae Bang³, Jihun Kim¹, Jongyeob Park¹, Ji-Hye Baek¹

¹*Korea Astronomy and Space Science Institute*

²*I-Trix Technology Inc.*

³*AntBridge Inc.*

This talk introduces a polarized imaging camera designed for robust space applications against radiation and thermal vacuum environments. Satellite observation technology encompasses *in-situ* measurement and remote sensing, with the latter demanding high-quality imaging camera technology suitable for space conditions. Additionally, polarization measurement tech-

nology in space exploration serves as a powerful tool for obtaining information unattainable by other means. The developed polarized imaging camera adopts a pixel-separated structure, wherein a polarization filter is placed on each pixel of the image sensor, enabling simultaneous measurement of different polarization components. In contrast to traditional techniques involving the rotation of polarization filters or multi-channel imaging, the polarized imaging camera achieves precise polarization measurements previously unattainable, thanks to its characteristics of simultaneity and spatial congruence. The space-grade polarized imaging camera is designed on an FPGA-based hardware platform, with considerations for high compatibility to support various CCD or CMOS sensors. It was developed for the joint project between the Korea Astronomy and Space Science Institute and NASA, the International Space Station's Solar Corona Graph (CODEX) mission, aimed at measuring temperature and velocity parameters of solar corona plasma. This camera is planned for future utilization in diverse space exploration missions, offering potential applications in various fields due to its capacity to extract information not easily discernible in conventional visible or thermal infrared observations.

10:25 [V-3-4]

GNSS Time Delay and Interference

Jong-Kyun Chung, Junseok Hong

Korea Astronomy and Space Science Institute

The ionosphere, which directly affects the performance of the Global Navigation Service System (GNSS), varies in electron number density (Ne) and irregularity depending on solar and geomagnetic activities and the intensity of ionospheric storms. The ionospheric variation cause time delay error and scintillation, respectively. Since the ionosphere is an space environmental hazard with regional characteristics, it is necessary to collect and analyze long-term measurements. In addition to GNSS ionospheric scintillation, the possibility of GNSS signal interference due to multi-navigation signals, low-orbit satellite communication radio interference, and various other causes is increasing recently. In this presentation, we will present the domestic GNSS time delay due to solar storms and the GNSS measurements of positioning error, time delay, C/No, scintillation from the Araon icebraing research vessel in Arctic sea.

10:40 [V-3-5]

Ground-Based Reusable Launch Vehicle Mission Design and Economic Analysis

Keum-Oh Lee, Daeban Seo, Junseong Lee, Jaesung Park

Korea Aerospace Research Institute

Since SpaceX made reusable launch services affordable with the Falcon 9, countries have been increasingly demanding the development of reusable launch vehicles. In South Korea, a ground-based reusable launcher with a 35-ton methane engine has been studied, which can deliver about 2 tons of payload to SSO and 45 degrees LEO when the first stage is recovered on the ground. If the first stage is landed on a maritime drone ship, 2.5 tons of payload can be delivered to SSO. A reusable first stage launch on a methane reusable launch vehicle is expected to cost about \$20 million, making it cheaper to launch than a Falcon 9.

10:55 [V-3-6]

Energetic Electron Flux Enhancement Induced by NWC Transmitter

Ho-Sung Choi¹, Jaeheung Park², Magnus F. Ivarsen³

¹Republic of Korea Army

²Korea Astronomy and Space Science Institute

³University of Oslo

Space weather effects can endanger human technologies in space. These space weather changes are generally natural phenomena, but some conceivable threats are artificially created by humans. Australian NWC (North West Cape) signal transmitter is known to strongly interfere with the topside ionosphere. Parrot et al. (2007) first reported the ionospheric heating phenomena from a powerful VLF transmitter (NWC) in Australia, with perturbations observed in broad band plasma waves, lower hybrid waves, electron densities, electron temperatures, ion temperatures, etc. Sauvaud et al. (2008) found an enhancement in 100–600 keV electron fluxes at L = 1.4–1.7 linked to NWC transmitter, and Graf et al. (2009) showed electron precipitation from the inner radiation belt at L~1.9 induced by NPM transmitter in Hawaii. Zhang et al. (2018) present flux enhancements with 30–100 keV electrons related to NWC transmitter for the first time, which were observed by the GOES satellite at night. Similar to the 100–300 keV precipitated-electron behavior, the low energy 30–100 keV electron precipitation is primarily located east of the transmitter. Using NEXTSat-1/ISSS-MEPD data, we present the evidence of electron precipitation in the vicinity of the NWC site as well as its conjugate region.

11:10 [V-3-7]

Military Utilization and Application of Low Earth Orbit Satellite Communications

Sunghwan Cho, Hochan Lee, Yongchul Kim

Korea Military Academy

Satellite communication, owing to its ability to facilitate

communication from anywhere without being constrained by terrain or location, can be immensely valuable in military operations. Nonetheless, the current utilization of geostationary satellite communication networks in the military comes with limitations in terms of low bandwidth, mobility, and high latency. To overcome these constraints, the adoption of low Earth orbit (LEO) satellite communication becomes imperative. Advanced military nations, including South Korea, are actively pursuing various endeavors such as independent development and the military integration of commercial satellites for LEO satellite communication. Consequently, this paper will explain how to incorporate LEO satellites within military operations, with a particular focus on elucidating security facets associated with employing commercial networks in military contexts. Furthermore, the paper will present specific elucidations concerning orbit design that can align with security prerequisites and cater to military requisites.

제4발표장 부라노 III

V-4 SS: 우주 마이크로중력 환경 활용

Chair: 최기혁(항우연)

09:40 [V-4-1]

Korea's Long Term Road Map of Manned Space Program

Gi-Hyuk Choi, Joo-Hee Lee

Korea Aerospace Research Institute

Korea has entered the threshold of becoming a space advanced nation with the successful launch of the Korean launch vehicle KSLV-2 and the lunar orbiter KPLO in 2022. Accordingly, we must now move beyond the hardware development stage of satellites and launch vehicles and move into the space mission development stage where space exploration, space science, and space utilization are emphasized. In addition, the 4th Space Development Promotion Basic Plan announced in December 2022 presents the realization of a space economy as the most important goal. Therefore, the expansion of the space industry is necessary, and for this, it is necessary to start manned space development, which Korea has not yet begun in earnest. Manned space technology includes technologies for human life and safety, such as life support technology, space microgravity environment utilization experiments and production technology, and core technologies essential for space industrialization. In addition, since all technologies used in existing unmanned space systems must increase safety and reliability by more than 10 times, advancement of space technology can be achieved. This is why more than 30% of the budgets of space agencies in

advanced countries are invested in manned space development. It is also judged to be a space technology that needs to be started as soon as possible in order to participate in the Artemis manned lunar exploration and manned Mars exploration in which Korea plans to participate in the future. One of the key areas of manned space technology is selecting and training astronauts and space crews. In order for Korean astronauts to perform space flights, they must perform a mission to test important space technologies that the public can understand. For example, in low-Earth orbit, research on space medicine for long-term stay in space, development of core materials in the semiconductor and battery fields, which are Korea's major industries, and carrying out a mission to find water at the south pole of the moon in the Artemis lunar exploration, as well as exploration of He3, an energy source for future humanity.

09:55 [V-4-2]

Power Budget and Profiling of a 3U Nano-Satellite for Free Space Optical Communication

Myung-Kyu Lee¹, Young-Min Ko², Tae-Jung Ahn², Seoul-Hyun Park³

¹Graduate School of Chosun University

²Department of Optical Engineering, Chosun University

³Department of Mechanical Engineering, Chosun University

CPSat (Cosmic Pulsating nano-Satellite), scheduled for launch in 2025 on a KSLV-II, is Korea's first nano-satellite designed to perform a series of free space optical communication missions. Because free-space optical communication payloads consume a significant amount of instantaneous power during mission operations, power analysis based on mission scenarios is critical for mission success.

This work has evaluated if the power generation and power storage are sufficient to support the mission and to verify requirement satisfaction. Results obtained from the analysis clearly demonstrate that the battery capacity over the orbit returns back to full charge in an early orbit operation mode and a normal mode, verifying that the spacecraft is sufficiently supported by the electrical power system. In the mission mode, the battery charge was found to slowly drain but the battery charge status became stable promptly after the end of the free optical communication mission, which lasted about 9 minutes, as the satellite maneuvered into sun-pointing mode.

10:10 [V-4-3]

Preliminary Investigation into the Use of LED as a Nanosatellite Identifier in Orbit

Jin-Woo Lee, Seoul-Hyun Park

Department of Mechanical Engineering, Chosun University

CPSat (Cosmic Pulsating nano-Satellite), scheduled for launch in 2025 on a KSLV-II, is designed to perform a series of space optical communication missions. The CPSat includes an optical identifier for nanosatellite, which uses short, omni-directional flashes of LED light. A unique optical identifier is intended to be read by a small ground telescope equipped with an APD sensor. This study investigated whether an optical signal generated by LEDs can be read from orbit on the ground. The results obtained from the analysis clearly show that using APD attached on the telescope is accurate enough to keep the satellite within a small field of view for the duration of an observation.

10:25 [V-4-4]

Status of Materials Study Using Levitation Techniques in International Space Station and Korea Research Institute of Standards and Science

Geun Woo Lee^{1,2}, Yong Chan Cho¹, Lei Wang¹, Thi Huu Nhat Le¹, Yun-Hee Lee¹

¹Korea Research Institute of Standards and Science

²Department of Applied Measurement Science, University of Science and Technology

In this talk, we will introduce the study of materials properties by using electrostatic levitation and electromagnetic levitation techniques in International Space Station (ISS) and Korea Research Institute of Standards and Science (KRISS). Using microgravity brings lots of advantages which cannot be obtained in Earth, such as container-free and gravitational convection-free, high accuracy of the measurement, high purity crystal growth, and so on. One of the active researches that has been conducting in ISS is thermophysical properties of materials using levitation techniques. In this talk, we will describe the technical concept of levitation techniques and the activity of the researches with high melting temperature materials in ISS. Similar studies are carrying out using the electrostatic levitation in KRISS. We will introduce the examples of the study with metallic and aqueous solution samples in KRISS.

10:40 [V-4-5]

Preliminary Design of a LED Module for Use as a Laser Alignment Aid between a FSO Communication Nanosatellite and an Optical Ground Station

Jun-Hyeon Kim, Seoul-Hyun Park

Department of Mechanical Engineering, Chosun University

CPSat (Cosmic Pulsating nano-Satellite), scheduled for launch in 2025 on a KSLV-II, is designed to perform a series of space

optical communication missions. During its optical communication missions, CPSat will only use a body pointing approach to align with an optical ground station. CPSat is equipped with a flashing LED in order to allow the optical ground station to quickly recognize and align with the CPSat when it enters the optical communication mission mode. In this study, we estimated the optical power of LED light required to observe CPSat through a telescope at an optical ground station. In addition, we validated the LED on-off scenarios required for rapid alignment with the optical ground station.

10:55 [V-4-6]

Altered Gravity Force Hinders Proper Development of Multi-Dendritic Arborization in a Harsh Touch Sensory Neuron PVD in *C. elegans*

Je-Hyun Moon, Jin I Lee

Division of Biological Science and Technology, Yonsei University

Space flight experiments have shown that altering gravity can affect many biological processes including muscle and bone development (Vandenburgh 1999). However, gravity's effect on neuronal development is not clear. Previously, we showed that hypergravity affects axonal development of DD/VD motor neurons (Kalichamy 2016). Here, we investigate the effects of altering gravity on neuron dendrite development by observing the PVD neuron, a harsh touch sensory neuron, in *C. elegans* in different gravity conditions. The PVD sensory neuron develops post-embryonically, and by adulthood displays intricately organized and non-overlapping dendrites spanning the entire body length. To investigate whether PVD development is normal in altered gravity, we exposed *C. elegans* to 100G hypergravity in a centrifuge from egg to young adult. We identified hypergravity-induced abnormal structures in the PVD neuron, particularly 4° branch defects including "L" and "T" shape 4° branch defects. Since basement membrane protein UNC-52/perlecan is known for its fundamental role for patterning PVD 4° branches and increased "L" and "T" shape 4° branch defects (Liang 2015), we exposed UNC-52/perlecan mutants to hypergravity. Results show that unc-52 mutants can suppress hypergravity-induced PVD "L" and "T" shape 4° branch defects.

In addition, we exposed *C. elegans* to different gravity forces and gravity time frames and show that PVD 4° branches are affected by 100G hypergravity during 48–72 hr time frame which is consistent with the timing of the development of these branches.

We also performed *C. elegans* transcriptome analysis and identified putative genes that may be involved in the hypergravity-induced PVD defects. This work will offer a fundamental foundation for elucidating how hypergravity alters neuron dendrite development in *C. elegans*.

Finally, we are analyzing samples from the International Space Station after two spaceflight missions, MME2 (ESA 2021) and Neural Integration System (JAXA 2022).

Keywords: Hypergravity, PVD neuron, Dendrite structure, Space biology

11:10 [V-4-7]

Proposing a New Paradigm for Space Medicine with Traditional Korean Medicine (K-Space Medicine)

Yoojeon Jeon

JY Eversnow Center for Integrative Medicine

Much of our understanding of life today is rooted in its continuous development and existence under Earth's gravity (1G). The force of gravity diminishes inversely with the square of the distance from Earth. In the Low Earth Orbit (LEO), where the International Space Station (ISS) orbits, the gravitational force is about 10% less compared to that on Earth's surface. However, due to the free-fall of spacecraft and astronauts towards Earth, they experience a state of weightlessness known as 'microgravity,' where everything is falling towards Earth together. Microgravity alters several physiological factors, as phenomena such as buoyancy, sedimentation, and convection are absent, while properties of liquids such as cohesion, adhesion, and surface tension become more prominent. This significant shift in gravity-dependent fluid properties and phenomena affects the flow and distribution of vital physiological fluids, including blood, interstitial fluid, lymphatic fluid, and cerebrospinal fluid, ultimately posing a health risk by interfering with body functions that rely on Earth's gravity.

One notable effect of microgravity is fluid redistribution, causing extra-cranial soft tissue edema, which dampens the senses of smell, taste, and possibly hearing. Importantly, prolonged exposure to the space environment, considering all identified health hazards including radiation and microgravity, has a net chronic effect on human physiology that is pro-inflammatory and pro-senescence, leading to accelerated biological deterioration and aging compared to individuals on Earth. Scott Kelly, upon his recent return to Earth, expressed concern about how fruits and vegetables seem to deteriorate faster in space, making him contemplate the potential impact on his own cells.

Notably, this acceleration of aging is closely linked to the promotion of inflammation, highlighting the critical role of changes in body fluids. Traditional Korean Medicine (TKM), with a rich history spanning over 1,800 years, has a profound understanding of body fluids and has effectively addressed issues related to inflammation and aging. Leveraging TKM's insights into body fluid circulation, I propose an interdisciplinary convergence of research encompassing TKM, Western

medicine, engineering, biophysics, and related fields. Through such collaboration, I envision the development of K-space medicine, a distinct and innovative branch of space medicine globally, integrating the best of both worlds to address the unique challenges of space exploration.

Keywords: microgravity, aging, traditional Korean medicine, body fluids

11:25 [V-4-8]

Experimental Study on the Flame Spread of Thermally Thin Wires in Microgravity

Seul-Hyun Park

Department of Mechanical Engineering, Chosun University

Microgravity experiments have traditionally been carried out using limited resources such as drop towers, parabolic flights, sounding rockets, and long-duration orbital platforms (e.g. ISS). However, the limited access to these facilities has resulted in both high costs and long lead times for microgravity research groups [1]. The capabilities, advantages, and disadvantages of these various facilities have been well documented over the years. The feasibility of new platforms for microgravity combustion research, such as a drone and a nanosatellite, was investigated in this study. To that end, a series of flame spread experiments on a thin wire were designed to facilitate microgravity combustion research. The flame spread results clearly show that the flame spread rates measured from drone experiments agree fairly well with those measured from parabolic flight experiments, demonstrating the feasibility of a drone as a new microgravity research platform. Another microgravity research platform, a nanosatellite carrying a

combustion science payload, is proposed and discussed in this study as part of an effort to standardize combustion experiments in microgravity based on preliminary orbit operation analysis.

11:40 [V-4-9]

Exploration of Biomaterials Effective in Preventing Muscle Atrophy due to Microgravity

Junsoo Park¹, Siyun Lee¹, Rackhyun Park², Inho Choi¹, Takeshi Nikawa³

¹*Division of Biological Science and Technology, Yonsei University*

²*Department of Life Science, Yong-In University*

³*Departments of Nutritional Physiology, Institute of Biomedical Sciences, Tokushima University Graduate School, Japan*

Long-term stay in space causes muscle atrophy, one of the hurdles preventing long-term space exploration, like a mission to Mars. We studied two novel reagents, Cbl-b inhibitory peptide (Cblin) and celastrol, a quinone methide triterpene, in preventing muscle atrophy. Cblin is an inhibitor of Cbl-b, which is muscle atrophy-associated ubiquitin ligase and has been reported to play an essential role in unloading muscle atrophy caused by spaceflight. Celastrol is reported to ameliorate muscle atrophy by modulating the expression of heat shock proteins. To examine the function of Cblin and celastrol, rat L6 muscle cells were sent to space to induce muscle atrophy under microgravity and incubated with Cblin and celastrol. We demonstrated the modulation of muscle atrophy-related genes by RNA-seq analysis, and the implication of the experiments will be discussed

포스터발표 논문 초록

발표시간 : 10월 26일(목)
16:30~18:00

[P-1] KPLO Science Data Receiving Management S/W Development and Operation

Junghyun Lee

Korea Aerospace Research Institute(KARI)

Science data of Danuri are divided into seven categories: SOH, KMAG, KGRS, PolCam, LUTI A, LUTI B, and SHC. It is stored in the PDHU in the spacecraft and received to the ground via the X-band. The data type are classified into PB online (received during the contact time) and PB offline (manually receive the saved data through SLE after the contact ends) when DSN networks are used. For data consistency (confirming contact time of data received through PB offline) and missing data monitoring (comparison of expected size and received data), we have been recorded manually, which must be done within the given pass (approximately 1 hour); however, manual recording and management of the 7 scientific data generate huge man-hour, requiring full/partial automation. Therefore, automation S/W is currently developing.

[P-2] KPLO/Lunar Terrain Imager (LUTI) Flight Calibration: Non-Uniformity Correction

Eunhyeuk Kim

Korea Aerospace Research Institute

Korea Pathfinder Lunar Orbiter (KPLO, or Danuri) is successfully operating at the pre-defined mission orbit around the moon, and it is now approaching to the end of 1st mission duration (Dec. 31, 2023). KPLO mission will be extended by two more years thanks to remaining fuel to use at the lunar orbit. A high resolution camera on-board KPLO (called Lunar Terrain Imager; LUTI) is taking images of lunar surface from Jan. 1, 2023, and expected to provide with images for the candidate locations of future lunar landing mission of Republic of Korea. Flight calibration of LUTI is one of important baseline activities for the preparation of LUTI's final product for the public release. With this poster presentation I describe the on-going activities of LUTI's flight calibration focused on non-uniformity (or flat fielding) correction.

[P-3] Temporal and Spatial Variations of the 3-Micron CH₄ and C₂H₆ Northern Aurorae of Jupiter

Sang Joon Kim¹, Chae Kyung Sim²,
Thomas R. Geballe³, Yuk L. Yung⁴, Steve Miller⁵,
Sungho Lee², Chihiro Tao⁶

¹*Kyung Hee University*

²*Korea Astronomy and Space Science Institute*

³*Gemini Observatory*

⁴*Caltech*

⁵*University College London*

⁶*Institute of Space and Astronautical Science*

Jupiter's 8-micron CH₄ north polar hot spot has been observed for more than four decades, since it was detected in 1980. The causes of both its shape and longevity are not understood, although several mechanisms have been proposed to explain its existence. We investigate the temporal and spatial variations of the hot spot using infrared data of the north polar regions observed with Gemini North/GNIRS and Juno/JIRAM near 3 microns, where CH₄ and C₂H₆ as well as H₃⁺ line emissions occur. Using the obtained data between 2013 and 2022, we have detected transient 3-micron CH₄ and/or C₂H₆ bright spots within the northern auroral regions. We find significant intensity variations of CH₄, and C₂H₆ bright spots and noticeable shifts for the bright spots during the period. We also find lack of correlations between the auroral emission intensities and solar wind parameters for the years of 2013, 2018, 2013, and 2022. We will present the implication of these findings in terms of the formation of the hot spot.

[P-4] Korea Pathfinder Lunar Orbiter Extended Mission Orbit Options: A Quick Analysis of Potential Candidate Mission Orbits

Young-Joo Song, SeungBum Hong, Jonghee Bae,
Jun Bang

Korea Aerospace Research Institute

Launched on August 5th, 2022, South Korea's Korea Pathfinder Lunar Orbiter (KPLO) successfully entered its target lunar orbit via a successful Tran-Lunar Cruise (TLC) and Lunar Orbit Acquisition (LOA) phases. Currently, KPLO is transmitting various science data as its original plan. Thanks to the successful navigation of KPLO to the Moon, a recent decision has been made to carry out an extended mission. The discussion is underway regarding which orbit KPLO will operate in for its extended mission, deviating from its original plan of maintaining an altitude of 100 ± 20 km with a 90-degree inclination for one year. This study presents quick analysis results for potential candidate mission orbits for the KPLO extended mission. Mainly, orbit options from January 2024 to December 2027 have been analyzed, and the required orbit maintenance delta-V and fuel budgets were estimated. Feasibilities are also assessed for each extended mission year with various

orbit options, such as maintaining the current mission orbit conditions or establishing a new frozen orbit around the Moon. The work presented here offers preliminary results, with a more detailed orbit design to follow based on input from the instrument team to enhance scientific outcomes.

[P-5] Case Study of Extended Mission for Danuri: Flight Dynamics Analysis in Lunar Polar Orbit with 50 ± 20 km

Jonghee Bae, SeungBum Hong, Jun Bang,
Young-Joo Song

Korea Aerospace Research Institute

Danuri has performed the lunar science mission on the lunar polar orbit with 100 ± 20 km. The nominal science mission is planned to be conducted for one year, and if there is remaining fuel at the end of the nominal mission phase, an extended mission is planned. It was confirmed that less fuel than expected was consumed for trajectory correction maneuvers resulting from launch vehicle separation errors. Consequently, after calculating the fuel required for the nominal mission phase, it was determined that there is remaining fuel available for extended mission operations.

The extended mission will be determined through consultations between Korea Aerospace Research Institute and the instrument teams of Danuri. As of now, the plan is to maintain the same orbit as the nominal mission phase for one year following the completion of the nominal mission phase. This study presents a case study of the extended mission, which conducts numerical simulations and analysis from a flight dynamics perspective, assuming an altitude of 50 km for lunar orbit. This study analyzes the results related to the required orbit maintenance maneuvers and delta-V for operating in a lunar orbit at an altitude of 50 ± 20 km.

[P-6] Planning, Execution, and Analysis of KPLO Orbit Maintenance Maneuvers

SeungBum Hong, Jonghee Bae, Young-Joo Song,
Jun Bang

Korea Aerospace Research Institute

The Korea Pathfinder Lunar Orbiter (KPLO), also known as Danuri, entered Lunar orbit on December 28th, 2022, following a thorough commissioning phase in January 2023. In its current phase, KPLO is actively engaged in conducting a suite of scientific investigations. These scientific missions are facilitated by the maintenance of its orbital parameters, as the spacecraft is tasked with perpetually circling the Moon at an altitude of 100×100 km in a polar orbit. To achieve this consistent orbit, KPLO is required to execute a series of Orbit Maintenance Maneuvers (OMMs). These OMMs are imperative to counteract

the effects of lunar gravity fluctuations, ensuring that KPLO maintains its desired orbital parameters. Without regular OMMs, KPLO will impact the Lunar surface within a few months as eccentricity gradually increases. As of the latest update in September 2023, four OMMs have been successfully executed. This paper presents the planning, execution, and analysis of these OMMs. Additionally, it also provides a future OMM plan.

[P-7] One Year Magnetic Field Observations of KPLO Mission

Woojin Jo¹, Ho Jin¹, Khan-Hyuk Kim¹,
Ian Garrick-Bethell², Hyeonhu Park¹, Junhyun Lee¹,
Yunho Jang¹, Hyeonji Kang¹, Juhyeong Kim¹,
Seungmin Lee¹, Seul-Min Baek³

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

²*University of California, Santa Cruz*

³*Korea Astronomy and Space Science Institute*

Since the launch of the Korea Pathfinder Lunar Orbiter (KPLO) on August 5, 2022, KPLO Magnetometer (KMAG) has been observing magnetic fields in the BLT journey and a lunar 100 km altitude orbit during last one year.

KMAG initiated magnetic field measurements after launch, successfully observing the magnetopause. Besides, during the BLT cruise phase, in-flight calibration, such as offset determination, was carried out using interplanetary magnetic field (IMF) measurements. It also verified the data reliabilities by comparison with DSCOVR mission. The sensor offset of KMAG fluxgate varies by approximately 10 nT/month. Accordingly, zero-offset adjustments were periodically performed employing Davis-Smith (D-S) method.

On the lunar orbit, the primary objectives are investigating the Moon and its surrounding space environment.

In the nominal operation phase on the Moon, KMAG has detected the lunar magnetic induction response and the lunar crustal field in various regions. The lunar induced field observations have been achieved by comparing measurements from KPLO, which orbits closely to the Moon, and Themis B/C, which follows a highly elliptical orbit around the Moon. This is a very first observation evidence. In addition, the KMAG has observed lunar surface magnetic anomaly region successfully. It is not expected a such result because the lunar magnetic field is too weak to detect the magnetic field at the 100 km altitude operation. The lunar magnetic anomalies were observed within 0.2 nT accuracy and it was verified comparison with Surface Vector Model (SVM).

Originally the KPLO mission life time was one year but it has been extended two more years until the end of 2025. We expect more detailed lunar surface magnetic field observations on a lower orbit during the extended mission phase.

One of the issues is the spacecraft magnetic interference which is generated from spacecraft maneuvers, various current flows

and battery charging/discharging etc. These noise sources are diverse and complicated. We aim to eliminate these noise fields and provide data products suitable for end-user by early 2024. In this paper we present observation results, data analysis works and future works.

[P-8] Influence of Grain Size on Lunar Spectral Data in Space Weathering Analysis

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The Hapke radiative transfer model is widely used in planetary science to analyze the particulate surface. This model enables us to compute submicroscopic metallic iron and/or mineral component abundances. Since lunar regolith is typically influenced by grains within 10–20 micron range, many researchers assumed a grain size of 15 microns when using the Hapke model. However, certain lunar regions exhibit distinct grain sizes, such as fresh crater ejecta containing large grains, resulting in spectral variations. Before considering the influence of grain size variation on lunar surface analysis within the Hapke model, we test estimations of submicroscopic metallic iron abundance using the method developed by Trang et al. (2019) across different grain sizes within the Lunar Soil Characterization Consortium (LSCC). This effort enhances our understanding of grain size influence on lunar spectral data, contributing to more accurate surface information.

[P-9] KPLO X-Band Link Budget Analysis and Comparison between BLT and on Lunar Orbit

Sangman Moon, Changkyoon Kim, Inkyu Kim, Hyeon-Cheol Lee

Korea Aerospace Research Institute

On the lunar orbit to the earth, KPLO (Korea Pathfinder Lunar Orbiter named Danuri) uses the X-band downlink communication system for downloading the KPLO SOH (State of Health) playback data and 6 mission payloads data. During downloading the data, the ground station should lock the RF carrier center and modulation signal symbol. RF carrier center frequency and OQPSK (8.5 Mbps with RS-coded) symbol should be within acquisition range. The acquisition range is different between during BLT and on Lunar orbit. Also, The acquisition process is different between NASA DSN (Deep Space Network) and KDSA (Korea Deep Space Antenna). In this paper, for locking RF carrier center frequency and modulation signal symbol, X-band link budget tool is used for predicting X-band received signal power level of the ground

station during the KPLO mission on the lunar orbit. This predicting X-band received signal power level is used for maintain RF carrier center frequency lock and symbol lock for good data download.

[P-10] Chronological Records of Risk Management for the Lunar Exploration Program to Develop Korea Pathfinder Lunar Orbiter (KPLO)

Jae-Hoon Song

Korea Aerospace Research Institute

As the first project of Space Exploration R&D Project in Korea, the Lunar Exploration Program to develop Korea Pathfinder Lunar Orbiter (KPLO) was completed successfully. During seven consecutive project years, a variety of risk and issue are identified for technical perspectives and management perspectives. In this article, chronological records of the Lunar Exploration Program are briefly reviewed with respect to the risk management procedure in the Lunar Exploration Program Office in Korea Aerospace Research Institute (KARI).

[P-11] Polarimetric Measurements of Apollo Soil Samples by Particle Size

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Polarization properties of the moon include information of lunar soil such as grain size and composition. Polarization phase curves offer the polarization properties but there is a lack of related research and laboratory experiments using lunar samples. For this reason, we performed polarimetric measurements of Apollo soil samples at various phase angles (15, 20, 25, and 100 degrees) in three bands (B, V, and R). A total of five Apollo samples were used: two Apollo 14 samples (14163 and 14260) and three Apollo 16 samples (61141, 61221, and 65701). The samples were sieved to different size groups (< 25, 25–45, 45–90, and 90–150 μm) including the bulk group (< 150 μm). We investigate the correlation between the grain sizes and degree of polarization and their wavelength dependence. Also, we examine the negative branch within the phase angle range of 15° to 25°. In the negative branch, minimum polarization and inversion angle are measured to study their relationship to the grain size and single-particle scattering.

[P-12] KPLO SPICE Kernels: Preparation of

Official Release Archive #1Jo Ryeong Yim¹, Seung Woo Kim², Dong-Gyu Kim¹¹*Korea Aerospace Research Institute*²*I-OPS*

KPLO (Korea Pathfinder Lunar Orbiter) launched August 5th in 2022 is the first Korea's space exploration satellite for the Moon developed by Korea Aerospace Research Institute. Currently, KDGS for KPLO mission operation center generates and provides ancillary data of KPLO for helping processing science data to KPLO science teams and participating scientists in a standard ancillary data format, SPICE kernels, offered by NAIF (The Navigation and Ancillary Information Facility). The KPLO SPICE data will be made available to public and scientists starting from January 2024 through KPDS. In preparation of the first archive kernels for public release, the kernel items (operational kernels and new structured kernels that had not been provided so far) were identified. The accuracy of operational definitive spk were improved through long-period orbit determination. The day-long CK kernels were merged into week-long CK kernels. With these kernels, preliminary official archiving kernels were generated in a bundle kernel using NPB tool provided by NAIF. This paper deals with the preliminary archiving kernel items, form, NPB generation test results and public release plan.

[P-13] Numerical Model of Impact Crater on the Jeokjung-Chogye Basin in Korean PeninsulaHyeonhu Park¹, Ho Jin¹, Ian Garrick-Bethell², Brandon C Johnson³, Seungmin Lee¹¹*School of Space Reseach, Kyung Hee University*²*University of California, Santa Cruz*³*Purdue University*

The Jeokjung-Chogye Basin (JCB) in Hapcheon is the first bowl-shaped geomorphological impact crater found on the Korean Peninsula. Previous studies suggested that planar deformation features (PDFs) and shatter cones in a 142-meter-deep core (CR05) were formed by shock waves during impact cratering. It has been theorized that the PDFs, as microscopic indicators, necessitate a pressure range of 15–35 gigapascals (GPa), while the shatter cones, observed at the macroscopic level, are thought to manifest under pressures of no less than 2–10 GPa. In this study, we conducted a numerical simulation of the JCB formation process to track the peak shock pressure at the depth where the two pieces of evidence were located, utilizing the iSALE-2D shock physics code. The estimated diameter of impactor that formed JCB is 200 meters. To simplify impact conditions, the material of the impactor and the impact target is composed of granite, and the impact speed and angle are assumed to be 15 km/s and vertical, respectively. In

this paper, we have compared the results of the previous study with the simulation results and have discussed the differences. In the future, if magnetic field observations in this region are included, we expect that the process of JCB formation will be more quantitatively understood.

[P-14] The Estimation of Licklider Transmission Protocol (LTP) Bundle Delivery Time with KPLO Channel Error Measurement

In-Kyu Kim, Sang-Man Moon

Korea Aerospace Research Institute, KARI

Korea Pathfinder Lunar Orbiter (KPLO) is successfully carrying out the lunar exploration missions. KPLO Mission Operation Center (KMOC) is receiving the various science and engineering experiment data from lunar orbiter. One of them is the channel error over space region. We are never experience to find out the real channel error before.

Therefore, this paper is focused on the Bundle Delivery Time Estimation with real channel error and compare simulation results that is applied by real and theoretical values.

From the our study, The channel error couldn't be impacting the communication link and bundle delivery time over space region. However, we believe that the intermittent disruption due to solar system's inner planets orbiting and spacecraft orbit movement causes server influence to communication link error. In the future, we are going to evaluate the our method using the experiment with hardware equipment.

[P-15] A Study on the 3-D Inversion for the Lunar Crustal Magnetic Anomaly Data

MinJae Lee, Hyung Rae Kim, Seolyeong Lee

Kongju National University

In recent years, several developed countries have been actively engaged in lunar explorations and researches. The importance of lunar research has been steadily elevated, driven by the quest to understand the presence of water on the Moon and its potential role as a forward base for the Mars exploration. In line with these global efforts, South Korea launched the 'DANURI' mission on August 5th, 2022, resulting in increase of domestic lunar research.

The payloads of the DANURI mission include a 3-axis magnetometer, which is instrumental in deciphering the lunar magnetic field's history and observing its interactions with geophysical and space environmental factors. To harness the data from DANURI's magnetometer, this study aims to utilize a 3D inversion by a program commonly used in the Earth's magnetic anomaly research. By applying this program, we intend to determine the parameters such as the size, depth, magnetic orientation, and magnetic intensity of magnetic bodies

on the Moon. These findings will be applied to advance research into the lunar magnetic history.

[P-16] Analysis of Ablative Materials of Thermal Protection System for Sample Return Missions

Dae-Yeong Kim, Gi-Hyuk Choi

Korea Aerospace Research Institute

Project Mercury and Project Gemini ran from 1958 to 1966. The Apollo Project to land astronauts on the moon began in 1966. And the Viking Project to explore Mars began in 1968. The development of Pioneer-Venus and Galileo-Jupiter, which had much more extreme entry conditions than Apollo, also began. Small missions include pathfinder and stardust. Recently MSL, led by JPL, is a project that started in 2001 to land a rover on Mars.

[P-17] Data Preprocessing for Learning-Based Lunar Terrain Mapping

Huigeon Kim, Seokju Lee

Korea Institute of Energy Technology

As the Korea Pathfinder Lunar Orbiter (KPLO) continues its lunar mission, the Lunar Terrain Imager (LUTI) plays a crucial role in supporting landing operations and generating highly detailed terrain maps. The requirement for precise and efficient techniques in lunar terrain mapping has grown to become exceptionally imperative for upcoming landing missions. Traditional mapping algorithms face challenges related to scalability and adaptability when incorporating new sources of topographic information to perform highly autonomous missions such as landings. In contrast, learning-based techniques offer a promising path forward in addressing these issues. In this paper, we present a comprehensive introduction to the fundamental data preprocessing steps essential for designing learning-based 3D reconstruction algorithms. Our approach is demonstrated on data acquired from the Lunar Reconnaissance Orbiter's Narrow Angle Camera (LRO NAC).

[P-18] Scientific Goal and Requirements for Solar Chromospheric Imaging Spectrograph for L4

Eun-Kyung Lim, Donguk Song, Sung-Hong Park, Jeong-Yeol Han, Kyung-Suk Cho, Seonghwan Choi, Rok-Soon Kim, Jungjoon Seough, Junga Hwang

Korea Astronomy and Space Science Institute

L4 is one of the Sun-Earth Lagrangian points, which is located 60 deg ahead of Earth's orbit and is known as a meta-stable location along with L5, at 60 deg behind Earth's orbit. Considering the effects of Earth-facing halo CMEs or SEP

events on space weather hazards, taking advantage of these two vantage points for space-weather monitoring and advanced forecasting is one of the important goals we should succeed in shortly. Compared to L5, L4 has some advantages in monitoring and forecasting SEP events and their sources, such as flares or CMEs. Source active region of severe SEPs that is magnetically connected to the Earth often locates near the west limb, which cannot be seen from L5. From L4, on the other hand, any pre-eruptive characteristics of source active regions and their atmospheric composition can be investigated in detail with a minimum projection effect. Korean researchers in heliophysics and solar physics recently submitted a white paper on NASA Heliophysics 2024 decadal survey, suggesting our vision and willingness to carry out this vast and vital mission. We propose the Solar Chromospheric Imaging Spectrograph as one payload for L4 and share our scientific goal and requirements.

[P-19] Optimization of Correlation Parameters for TIF Depth on SiC Mirror Using Deep Learning

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In order to make an optical surfaces, quantitative polishing process is required. Our polishing process remains Tool Influence Function (TIF) depth as an unit removal volume on SiC materials. The polishing process includes various parameter combinations in between pressure, wheel velocity, dwell time and TIF depth. We have explored the combinations under a deep learning model to obtain a certain correlation. As a result, our model demonstrates an error margin of approximately 12 nm. In this presentation, we present a nanometer level controllability of SiC mirror polishing based on deep learning model to achieve high precision optical surfaces for space observation.

[P-20] Result for CAS500-3 (Compact Advanced Satellite500-3) Critical Design Applied with CAS500 Standard Platform

Youngcheul Kim, Junseong Kim, Jin-Gon Bae, Shin-Hye Moon, Seok-Soo Kim

Korea Aerospace Industries, Ltd.

Based on national space development road map, The CAS500 with 500 kg mass were developed for standard platform and export strategy model. The CAS500-3 is the satellite utilizing a standard platform that has been developed to minimize design change with respect to the CAS500-1 and 2. In addition, payloads for CAS500-3, which consists of BioCabinet, IAMMAP (Ionospheric Anomaly Monitoring by Magnetometer And Plasma-probe) and ROKITS (Republic of Korea Imaging Test System) to verify space scientific technology, are successfully designed to satisfy the required mass, and power budget for the CAS500-3 applied with CAS500 standard platform. In this paper, we will describe critical design results for the CAS500-3 and the plan for the next year.

[P-21] A Performance Comparison of Radio Refraction Error Correction Methods for Space Launch Vehicle Tracking

Ha-Ryong Song, Dong-Young Shin

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Radio refraction of tracking radar occurs when the electromagnetic wave of radar go through the atmosphere which has the various speed of propagation. Thus, the results of radar tracking for a space launch vehicle follow a curved rather than straight path and the refraction causes tracking performance degradation especially for low elevation angle. To offset this problem, various refraction correction methods have studied so far. In this paper we compare two distinct methods. The first approach is a Clark's model based method aided by extended Kalman filter. Another method is NASA ray trace which utilizes higher order integration technique and includes iterative loop. We simulate these two algorithms for KSLV-II 3rd mission's radar data and represent performance comparison results.

[P-22] An Introduction of Payload Data Transmission System for CAS500-4

Eun Su Kang, Sang Burm Ryu, Sang Gyu Lee

Korea Aerospace Research Institute

The Korea Aerospace Research Institute is currently developing the payload for CAS500-4 dedicated to agricultural and forestry applications. The payload for this agricultural and forestry satellite is equipped with a wide-angle camera capable of capturing imagery from an altitude of 888.3 kilometers, with a range extending up to 120 kilometers above the Earth's surface. This has necessitated changes in the design of the Payload Data Transmission System (PDTS) when compared to the previous first and second-generation satellites. Furthermore, due to performance improvements and the discontinuation of

certain components, modifications have been made to the design of the data transmission unit. In this paper, we introduce the design of PDTS and current status for CAS500-4 including future plan.

[P-23] How Catastrophic Collisions Caused by Space Debris are Defined

Eunghyun Kim, Jaedong Seong, Okchul Jung

Korea Aerospace Research Institute

As the object are increasing more and more, the collision possibility on operational or non- operational space vehicles is getting higher. Therefore it is important to identify the failure modes caused by impacts. If catastrophic collision is considered as one of them, it is necessary to define the collision threshold. It can quantify the space debris mitigation guidelines for the spacecraft operation and the space environment protection activities. So the defining the criteria for a catastrophic collision was one of the important issues in last 41th Inter-Agency Space Debris Coordination Committee (IADC). First of all there must be defined what a catastrophic situation is. The catastrophic situation can be defined based on the correlation between the vehicle status and the space environment. Then threshold examples such as a size of impactor, the kinetic energy of target mass, or the fragmentation cloud size after an impact were presented.

[P-24] Modeling of CO Lines from Star-Forming Regions at Intermediate Redshift

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We present the radiative transfer equation calculation for photon transport for the rotational transitions of CO molecule where the spectral lines are optically thick, and the systemic velocity is larger than the thermal line width. The solution of the radiative transfer equation gives the ¹²CO and ¹³CO line ratios as a function of the total molecular H₂ volume density for different values of the gas kinetic temperatures. This analysis using the ¹²CO and ¹³CO line ratios and the radiative transfer equation can be applied to calculate the hydrogen molecule content in galaxies at various redshift ranges.

[P-25] Feasibility Study of Magnetic Field Sensor for Lunar Exploration Probe

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The observation of the magnetic field plays an important role in investigating the space environment and celestial bodies. In the case of lunar missions, it also provides clues about curious features related to the internal structure and magnetic anomalies.

Generally, there are two methods for measuring the magnetic field of a celestial body: one is on-orbit measurement, and the other is on-ground measurement. However, the on-orbit method measures the magnetic field only at a certain altitude. Additionally, the on-ground method is limited in its ability to observe just only the landing site.

To overcome these constraints, we are studying a fly-to-impact (FTI) scenario using a probe similar to an impactor. The FTI scenario involves the carrier (main spacecraft) ejecting a probe, which then the probe flies through several orbits until it collides with the surface. This method allows the probe to carry out observations over a specific and interesting area, as well as at various altitudes along its descent orbits. The probe also can be achieved at a low cost, similar to CubeSats.

For this, the probe's magnetometer has to be miniaturized, and three functions are also required: communication, attitude measurement, and positioning.

First, we investigated four candidate magnetometers that were appropriate sensors. The first one is the KMAG, which is already an operating magnetometer on the KPLO mission. This magnetometer was designed to fit the CubeSat standard for a similar purpose to this scenario. The others include an RM3100 inductive sensor, an HMC1001 AMR sensor, and a DRV425 fluxgate sensor. In this presentation, we present the test results of these magnetometers regarding their characteristics and performances.

[P-26] Trial Operation of an Oral History Archive Web Service Platform for Astronomy and Space Science in Korea

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Since 2017, the Korea Astronomy and Space Science Institute has been conducting an oral history project by recording interviews with key figures involved in the historical development of research fields related to astronomy and space science. In addition, the development of a web-based oral history archive platform was completed in 2022 and is currently undergoing testing for subject classification, filing, digital preservation, and secure public access to significant records from each period of the institution's history. As a continuation of

the previous study, this study will describe the detailed design, implementation, system testing, and trial operation after development of the archive is completed. Oral history archives can be registered and modified on a file and item basis in administrator mode, and the text management and data statistics functions are designed to identify the status of the records stored in the system. General access users will have access to historical and biographical searches powered by an open source-based search engine available on the user interface, as well as access to topical content. The system is currently being beta tested by administrators and a select number of users to update the metadata of oral histories. In the near future, the oral archive web service platform will be used as an educational resource to provide secure viewing access to the collated material, as well as serving as a priming tool for future interviewees. It is also intended to serve as the basis for expanded oral archival research in time for the establishment of the Korean Space Agency.

[P-27] Design of 1,064 nm Homodyne Detector for Observation of Quantum Squeezed State of Light

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The interferometric method is one of the fundamental techniques for the detection of gravitational waves. A microscopic amount of changes in the length of the laser interferometer's arm are induced by gravitational waves passing through it. Quantum noise disturbs measuring the small changes in the incoming light to the detector. The squeezed light is able to reduce the quantum noise, which enables more sensitive detection of gravitational waves. In this study, we designed and built a homodyne detector to measure the squeezed state of the 1,064 nm light. To improve the detector's sensitivity, a high-efficiency photodiode with a quantum efficiency of more than 90% was employed and the optimized amplification circuit was designed. We present the electrical design of the homodyne detector and the optical setup to test its performance.

[P-28] Summary of Problem Reports of 6U Nanosatellites

Min-Ki Kim, Won-Sub Choi, Jin-Hyung Kim,
Ji-Seok Kim

Korea Aerospace Research Institute

Korea Aerospace Research Institute (KARI) has developed 6U nanosatellites, including SNIPE. With the main system, many kinds of cubesat units are also localized. There have been many

problems since the initial phase of the development. The problems are categorized into system level, unit level, and management. This presentation shows the brief summary of characteristics of the problems of developing the nanosat units and system.

[P-29] The Key Points for Link Support of 4 of 3U Cubesats on Nuri 4th Launch Campaign with a KARI Cubesat Antenna

Sangil Ahn

Korea Aerospace Research Institute

The Ministry of Science and Information Technology, MSIT, has supported the fabrication, test and launch of cubesats developed by university graduate and under-graduate students as a part of the space manpower training program. The fourth launch of the Nuri rocket will be carried out in 2025 with six 3U cubesats developed by domestic universities.

In the case of the cubesats to be launched this launch and LEOP campaign, the KARI cubesat antenna will support the 4 of 3U cubesats.

In this study, the contents of reviewing the parameters to be considered and adjusted if necessary for mission support are shown. As a result of the study, it was confirmed that operational consideration factors are necessary along with measures to eliminate overlapping frequencies of satellites, and it was confirmed that they needed to be considered in the detailed design stage.

[P-30] Research on NASA's Moon to Mars Strategy and Objectives Development

Yong-Sik Yoon, Jong-Min Lim, Hee-Kwang Eun

Korea Aerospace Research Institute

The 4th Space Development Promotion Plan (draft) was announced in December 2022. The plan includes a long-term space development mission with the vision of realizing powerhouse in the space economy by 2045, expanding the space exploration area to deep space such as the moon and Mars and promoting an independent space exploration plan. For the success of these space missions, several technologies are required to withstand the extreme space environment, And consistent research planning and support are needed to address these required technologies.

This papers describes the content and strategy of NASA's moon to Mars plan. In addition, we consider the development direction of moon and Mars for the success of the domestic space development promotion plan.

[P-31] Experiments to Improve

Channel-to-Channel Image Registration for Mid-Infrared Water Vapor Bands of GK-2A AMI

Sungsik Huh

Korea Aerospace Research Institute

Geostationary meteorological satellites produce a variety of useful products through complex operations between multiple level-1B channel images, so it is desirable to have high co-registration performance. However, some infrared channel images, where the distinction between land and sea is not clear, cannot be calibrated with high-resolution landmarks with absolute positioning, and need to be processed by other methods.

In this paper, experiments focused on improving the calibration parameters for channel-to-channel registration of MWIR channels of AMI are conducted. Among the five MWIR channels of AMI, three mid-infrared water vapor channels, which cannot be calibrated using landmarks, were directly matched with other channel images to find accurate calibration parameters. The identified parameters that can improve the channel-to-channel registration performance and the result are presented.

[P-32] Analysis of System Influence by Power Line Common Mode Current of Satellite Electronics Unit

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

Korea Aerospace Research Institute

In this paper, system influence analysis is dealt with when the common mode current measured at the power line exceeds the specification during the unit level emc test of satellite. First of all, it is necessary to check the performance and function of the common mode filter installed at the power input stage of unit, and correct it if there is a difference from the previously defined design details. If there is no abnormality in the performance and function of the filter, it is necessary to analyze the effect of the measured common mode current level on the system. In this paper, adjacent harness interference, radiated susceptibility of unit, PCDU voltage fluctuation, and ground displacement voltage of satellite structure analysis are covered.

[P-33] MTF Measurement Characteristic Analysis of Space Telescope by Using Fermi and Error Functions

Jeoung-Heum Yeon, Jong-Pil Kong

Korea Aerospace Research Institute

Modulation Transfer Function (MTF) is the most commonly used optical performance index for the electro-optical telescope.

It also applies to space telescope. MTF value at nyquist frequency which corresponds to the image sharpness at ground sampling distance spacial frequency is set to the major requirement specification for the development of space telescope. However, there are some difficulties in precisely measuring MTF at ground for the high-resolution space telescope. Instabilities of measurement setup and environment such as air flow and temperature gradient could lead to the oscillating MTF measurement results. It is recommended to use more stable indexes such as relative edge response and 90/10 response when the environmental condition is unstable. In this study, MTF measurement characteristics are analyzed in comparison with relative edge response and 90/10 response. Fermi and error functions are used to approximate the measurement data. The relations between optical performance indexes can guide the validity of the current measurement results and help the measurement process.

[P-34] A Study on the Usable Satellite Image Acquisition Rate Using KSOC Satellite Image Database and Global Cloud Information

Gab-Ho Jeun, Myung-Jun Lee, Na-Young Kwon

Korea Aerospace Research Institute

The Korea Satellite Operations Center (KSOC) currently operates 4 LEO earth observation remote sensing satellites such as KOMPSAT and CAS500. Among them, KOMPSAT3, 3A and CAS1 can take high-resolution optical images. Optical images provide better visual identification compared to radar images, making them relatively in high demand among satellite application users. But, usable image acquisition can be challenging due to weather factors such as clouds.

This paper analyze the region and time specific usable image acquisition rates based on a global satellite image database acquired in 2022 and global cloud cover statistics provided by NASA. Also, it can be enhance the reliability of satellite information services by updating feasibility study parameters.

[P-35] An Interface Design between Order System and Data System for Shortening the Time from Order to Distribution of Archiving Satellite Images

Myung-Jun Lee, Gap Ho Jeon, Nayoung Kwon, Min-A Kim, Gu Hyeok Kim, Seong Heon Kim, Myeong Shin Lee

Korea Aerospace Research InInstitute

The main objective of most satellite operations is to accurately transmit information and images from space to users. In particular, Earth observation images acquired through low-orbit

satellites having not only optical but also radar payloads are used in a wide variety of fields, with inducing a huge space industry. In order to improve the value of the satellite images, much development is being done specifically to shorten the time required for distribution to users. In this paper, we introduce a method to shorten the time from order to distribution of archiving satellite images.

[P-36] A Review of Launch Site Campaign of CAS500 from the Electrical Perspective

Young-Yun Kim

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The launch campaign is a series of tasks performed at the launch site after the transportation of a satellite to the launch site for launch after completion of development. The process of the launch campaign is determined through discussion with the company that operates the launch vehicle and the launch site through the actual survey. In this paper, we describe the electrical tasks performed on low-orbit satellites in the launch site campaign. The first task performed when the satellite arrives at the launch site is to check the electrical condition of the satellite. This is to confirm the SOH of the satellite, for which the inspection of the electrical ground support equipment must be preceded. Once the inspection is complete, the equipment is connected to the satellite and the SOH of the power system, attitude control system, and other parts of the satellite is checked. Then, the first electrical connection test between the satellite and the launch vehicle, which is performed several times during the campaign, is performed using a satellite simulator. And as part of the work related to the final shape of the satellite's launch, electrical work for fuel charging, check of the NEA installed, and check and installation of the IFJ are performed. Once all the shapes are complete, the final electrical connection test with the launch vehicle is performed before the launch rehearsal. The final rehearsal is performed after the satellite is connected to the top of the launch vehicle, and the launch of the satellite on the launch day is performed. The rehearsal and the performance on the launch day are exactly the same, and the battery of the satellite is fully charged and the basic condition of the satellite is periodically checked.

[P-37] A Study on the Need for Time-Domain Testing of Satellite Conducted Emission

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

Korea Aerospace Research Institute

Satellite Conducted Emission (CE) tests are performed to ensure that noise flowing through power and signal lines does not affect adjacent interconnected units. In military standards, this

test is performed in the frequency domain.

This paper explains why time-domain testing is necessary for accurate noise measurement when testing satellite systems and units. CE testing in the frequency domain can generally measure from 30 Hz or higher, and precision may vary depending on the characteristics of the measurement equipment such as monitoring probes. Additionally, depending on test conditions such as measurement step and sweep time, some noise signals may be missed. To overcome these limitations and make accurate noise measurements, it is important to measure time domain ripple. This paper compares the time-domain ripple obtained from CE testing with the frequency-domain test results, analyzes noise signals, and discusses the importance of time-domain testing. Time-domain ripple measurements achieve best results when used in conjunction with frequency-domain testing.

This is expected to contribute to ensuring the stability of the satellite system by identifying the causes and characteristics of noise and taking appropriate measures.

[P-38] Empirical Investigation for the Effects of Thickness and Size of White Painting Applied on the Solar Array Backside

Cho Young Han

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The performance of a solar array is mainly dependent on its solar cell efficiency. The lower temperature of a solar cell can get better efficiency so that a thermal painting is normally applied on the backside of a solar array to obtain solar cell efficiency enhanced. As an anomaly, after a thermal vacuum testing of a white painted solar panel, the central parts of a painting were peeled off. This failure was scrutinised closely and it was strongly suspicious of the painting thickness out of the specification as well as the size of a painted area incurring deformation due to thermal stress. In order to verify this postulation, noble specimens were conceived and the achievable verification procedure was established. The resultant test results were also analysed accordingly.

[P-39] KPLO Mass Budget Review

Hyun-Jin Shin, Beom-Suk Kang, Seung-Yong Min

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KPLO had been suffered from a lack of system mass budget. It finally led to change of Lunar transfer trajectory design in order to reduce the use of fuel. Previous trajectory design baseline of KPLO was the phasing loop transfer. As mentioned above, to save the fuel of KPLO, Lunar transfer trajectory was changed to the Ballistic Lunar Transfer (BLT).

So, it is important to manage the mass budget properly. To

review the mass budget evaluation will be the first step for mass budget management.

In this paper, we will review the mass budget evaluation through design and AIT phase of KPLO. It lead us to learn lessons from KPLO mass budget problem.

[P-40] Importance of Protecting Space Environment Via the IADC Space Debris Environment Report

Youeyun Jung, Jaedong Seong, Saehan Song, Eunghyun Kim, Okchul Jung

Korea Aerospace Research Institute

The Inter-Agency Space Debris Coordination Committee (IADC) is a global governmental platform established to facilitate the international coordination of efforts concerning both human-made and natural space debris concerns. KARI joined the IADC as a member agency in 2014 and has been attended to the annual meeting since then.

The IADC Working Group 2 (WG2) has been focused on the space environment and making its database to define the state of the past, current, and future environment for the sustainable space. Particularly, the WG2 has updated a report for the Space Debris Environment every year. In this paper, the importance of space environment protection is assessed through the contents of this report.

[P-41] Optical Payload Thermal-Design Verification at System-Level Thermal Vacuum Test

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Korea Aerospace Research Institute (KARI) Satellite Payload R&D Division

In this paper, a thermal-design verification of large-aperture optical payload is described, conducted at a system-level thermal vacuum test. Function of payload thermal-control unit is to maintain temperatures of a whole payload within allowable limits. To perform this thermal control function properly, active methods like heaters controlled by processor operated based on thermistors temperature are applied in addition to passive methods like MLI, surface coating, heat-pipes and radiators. For a major electrical components with large heat-generation during operation, dedicated cooler assemblies, consisting of heat-pipes and radiators, are installed to do a tight thermal control. Even though most of thermal features of payload are verified in other tests like unit level or payload-level thermal balance test, some thermal features are verified in this system-level thermal vacuum test, because a test set-up of this test is most similar with in-orbit one.

[P-42] Science Image and Auxiliary Data

Telemetry Matching Algorithm for GEO-KOMPSAT-2 GEMS

Jinhyung Park

Korea Aerospace Research Institute

Korean Aerospace Research Institute (KARI) has launched GEO-KOMPSAT-2B (GK2B) in 2020. And, currently, GK2B is operating successfully. GK2B is equipped with GEMS for environmental observation in Northeast Asia. KARI developed and is operating Data Pre-processing Subsystem (DPS) for image receiving and radiometric calibration processing. Image data telemetry and aux. data telemetry are used for radiometric calibration. Due to mismatching between image and auxiliary telemetry packet for reason of lack of information in image telemetry packets, difference of generation period and timestamp shifting between image and aux. data telemetry, real-time processing cannot be performed. In this paper, we introduce telemetry matching algorithm. Proposed algorithm corrects timestamp in telemetry packet using integration time and co-adding number which are observation parameter.

[P-43] Acquiring and Maintaining Frequency Resources in a Changing Frequency Environment for Geostationary Satellite Programs

Seorim Lee

Korea Aerospace Research Institute

Recent trends show that the demand for non geostationary satellite networks is greater than geostationary satellite networks and is continuously increasing. Protecting frequency resources from non geostationary satellite networks has been considered a consultation activity rather than coordination as overlap with the service area of geostationary satellite networks has usually been limited due to the orbital characteristics of non geostationary satellite networks. With the increase in number of non geostationary satellite networks and the actual number of non geostationary satellites that use each network, this may no longer be true. This paper reviews the trends and processes involved in the protection of frequency resources for geostationary satellite networks from non geostationary satellite networks to support the future planning of activities to acquire and maintain frequency resources for geostationary satellite programs.

[P-44] Mechanical Ground Support Equipment for Geo-Kompsat-3 Integration and Test

Hyung-Wan Kim, Jung-Su Choi

Korea Aerospace Research Institute

The successful development, assembly, and deployment of satellites necessitate intricate mechanical and electrical support

systems on the ground. Known as Mechanical Ground Support Equipment (MGSE) and Electrical Support Equipment (EGSE), these systems play pivotal roles in satellite manufacturing and testing processes. This paper aims to provide a comprehensive review of various types of MGSE utilized in Geo-Kompsat-3 development program, elucidating their purpose and functionality. More importantly we introduce a systematic approach to MGSE testing protocols to ensure the satellite's operability and longevity once deployed. Through the examination of case studies and real world applications, this paper serves as a vital resource for engineers and researchers engaged in satellite manufacturing, offering insight into optimized MGSE usage and testing methodologies.

[P-45] On-Borad Time Management for 1 Year after Launch of KPLO

Moon-Jin Jeon

Korea Aerospace Research Institute

Korea Pathfinder Lunar Orbiter (KPLO) spacecraft uses on-board time (OBT) provided by the onboard computer to excute planned commands and provide reference time for payload operation. Because the OBT is not synchronized to external signal, it may differ from the exact time known on the ground. Furthermore, the 1-second intervals generated by the on-board computer can vary depending on the temperature around the crystal oscillator, resulting in time drift. To maintain on-board time close to Coordinated Universal Time (UTC), the ground system is monitoring the time offset between OBT and UTC. When the time offset increases, we can change the OBT to synchronize to UTC. Also, the OBT drift rate can be adjusted by changing 1-second intervals to slow down the increase of the time offset. In this paper, we present the OBT management result for 1 year after launch of KPLO. The results show that drift rate is related to the Sun beta angle of KPLO.

[P-46] Design and Test Results of S-AIS Secondary Payload of the Next Korean SAR Satellite

Hong Won Park

Korea Aerospace Research Institute

This paper presents the detailed design and test results of the S-AIS (Space-based Automatic Identification System) payload, which is the secondary payload of the next Korean SAR satellite.

The S-AIS payload consists of two receivers and four antennas. In detail, the receiver is composed of one interface board and two decoder boards in a housing and its main function process the received AIS signal in two modes, OBP (On-Board Processing) and OGP (On-Ground Processing). The receivers

interface electrically with the IBMU and PCDU. The electrical interfaces are verified through the DC integration and electrical integration with the spacecraft bus. The amount of data is analyzed taking into account operating time, sampling rates, allocated channels and number of antennas used. The pulse duration for the antenna deployment is adjusted through the tests and its deployment status is verified by checking the hardline telemetry. Also the fault management of the receiver was designed and verified by an appropriate fault injection in flight model.

In conclusion, this paper suggests that S-AIS system was electrically and mechanically designed as intended and that each function was verified through various tests at the system level.

[P-47] The Impact of CMG Evacuation on Performance

Yong-Bok Kim

Korea Aerospace Research Institute

The Control Moment Gyro (CMG) serves as an actuator for generating rotational torque and momentum for the attitude control of satellite. It operates by altering the orientation of a high-speed rotating flywheel's axis of rotation using gimbals to generate torque. In comparison to the main actuator used in the previous satellites, the reaction wheel, CMG can produce significantly greater torque, ten to hundreds of times more, leading to substantial improvements in satellite attitude maneuvering performance. CMG mechanism consists of a momentum wheel, which provides a constant angular momentum, and a gimbal drive mechanism that rotates perpendicular to the angular momentum vector to generate gyroscopic torque. To maintain the performance of CMG momentum wheel, especially during high-speed rotation, it is crucial to keep the interior of the wheel as close to a vacuum as possible. This is done to prevent excessive windage drag, power loss, and associated heat generation. Therefore, measures such as removing moisture that could potentially enter from the outside or injecting ultra-pure dry nitrogen are taken. This paper shows the impact of these measures not being appropriately implemented on the acceleration of the momentum wheel.

[P-48] A Study on the Conducted Susceptibility Test of Satellite Unit according to the Changes of Bus Voltage

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

Korea Aerospace Research Institute

The conducted susceptibility test of the satellite units is performed for the purpose of verifying the immunity of the units by assuming various bus voltage change cases. There are

many CS test items for the satellite units according to the test specification, but the representative CS test items are sinewave injection, short duration transient, long duration transient, fuse clearing transient, etc.

The sinewave injection test applies sinusoidal signals in 30 Hz to tens of MHz, although the frequency range varies depending on the test specification. The short duration transient test simulates bus voltage changes caused by a unit's switching or motor operation, and applies a 100% of the input voltage with a few μ s pulse width. The long duration transient test simulates the case when a large amount of power is consumed instantaneously, such as a radar system, and applies a signal with pulse of tens of ms. The fuse clearing transient test simulates the case of occurrence and recovery of fuse blowing event, and the input voltage drops to 0 V for several milliseconds to tens of milliseconds and then returns to its nominal voltage during testing.

[P-49] Review on the Current Unbalance Anomaly among Solar Array Regulator Converters in Parallel Operation

Sung-Woo Park, Hyung-Jun Jang

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It is very common to implement large power capability converters as low-capacity converters in parallel due to many advantages compare to build as a single large-capacity one. But, for the realization of even power sharing among converters, it is very important to realize same current-sharing between converters operating in parallel. Additionally, it is also very important to prevent the failure occurred on one module from propagating to others. During system level state-of-health test of a LEO satellite, current unbalance anomaly was monitoring in the solar array regulator converters in operating as 2 of 3 redundancy. Output current of one converter among 3 was very low and another two converter were operating by distributing the entire current. In this paper, anomaly status, root cause investigation and troubleshooting process were summarized.

[P-50] Effect of Image Processing Parameters on Accuracy of an On-Orbit Visual Inertial Navigation Filter

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Navigation that fuses visual and inertial information is crucial when operating on-orbit near uncooperative targets. In order to be used efficiently in navigation algorithms such as feature matching and pose estimation, images acquired from a navigation

camera must be processed to normalize brightness and geometry and to mitigate noise. This work examines the effect image processing parameters have on the accuracy of an on-orbit navigation filter. Trade-offs between accuracy and computational performance is discussed, with an aim for deploying on flight hardware.

[P-51] Jeju Korea Satellite Operations Center Image Collection Planning Subsystem Composition and Operation Status

SeungNam Song, JungNam Jun, Eunsook Lim, MyeongShin Lee

Korea Aerospace Research Institute

The Korea Aerospace Research Institute (KARI) has opened a Korea Satellite Operations Center (KSOC) in efficiently operate all satellites, which are expected to increase to over 70 by 2030, in the era of Newspace. The center, which opened on November 29, 2022, has transferred the operation systems of the Korea Multi-Purpose Satellite (KOMPSAT) 3 and 3A in 2022, and the Compact Advanced Satellite 500 (CAS500) 1 and KOMPSAT 5 in 2023. Additionally, the satellites that will be launched in the future will also be operated at the Jeju KSOC. In line with this, the Jeju KSOC operates Image Collection Planning Subsystem (ICPS) to ensure efficient and comprehensive satellite imaging and downlink. There are ICPS that generates imaging planning and downlink planning for the entire Earth, Multi-Satellite Scheduling System (MSS) that automatically generates the most optimal imaging planning in multi-satellite and various imaging orders, and Multi-Satellite Download Scheduling System (MDS) that automatically generates downlink plans that consider ground station operating conditions and user requirements. In this paper, we introduced the current status of the stable operation of the ICPS based on the Jeju Center operation.

[P-52] Design of Validation Rack for Solar Array Simulator

Seung Won Cho, Dong-Chul Chae

Korea Aerospace Research Institute

Electrical Ground Supporting Equipment (EGSE) is utilized during the development of satellites in the Assembly Integration & Test (AIT) Phase. Among them, the Solar Array Simulator (SAS) serves as equipment designed to simulate and test the operation of solar panels, emulating solar energy to generate specific voltage and current outputs. This enables the performance testing and verification of various scenarios in orbit. In this paper, we present the design details and measurement parameters of the validation rack, which is intended to verify the reliability of the SAS before its deployment in satellite testing.

[P-53] Prototype of NEONSAT's Imaging and Downloading Planning Function

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The Korea Aerospace Research Institute (KARI) is engaged in the mission of developing and operating satellites.

These satellites orbit the Earth and perform tasks related to imaging missions and downloading missions. The imaging mission means that a satellite photographs a specific area of the Earth to collect images or data. The downloading mission means that receiving data or signals transmitted by a satellite to the ground.

This paper introduces a prototype for the imaging and downloading plans of the NEONSAT.

[P-54] Thermal Control Concept and Thermal Design on Space Exploration Vehicle with Radioisotope Heat Source

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In the design of spacecraft for space exploration, one critical aspect to consider in light of the external space environment is the distance from the Sun. This factor directly impacts the spacecraft's ability to derive power from solar panels.

Given the current efficiency of solar panels and the state of battery technology, medium-sized spacecraft can operate missions within the range of Mars or even up to Jupiter. However, in cases of unfavorable solar conditions or with large-scale spacecraft, power supply from solar panels alone may not be sufficient.

In such circumstances, the use of radioisotope becomes a viable option. Radioisotopes continuously emit heat due to its half-life, which can be utilized as a heat source. There are two possible methods: utilizing the heat from radioisotopes directly like as a heater in RHU (Radioisotope Heating Unit), or converting this heat into electrical power as a power source in RTG (Radioisotope Thermal Generator).

RHU serve to maintain the spacecraft's temperature by using a constant heating, thereby reducing the power budget at the system level to operate the heater. And, RTG directly produce power from the heat of radioisotope, making them suitable as power sources for spacecraft that operate at distances where solar panels cannot generate sufficient power.

The application of RHU and RTG in spacecraft necessitates thermal design technologies distinct from those used in

conventional spacecraft thermal control. This study analyzed the thermal control concepts and thermal design cases for planetary exploration spacecraft and rovers equipped with RHUs or RTGs. Furthermore, it evaluates the potential and approaches for incorporating the use of radioisotopes in the development of domestic space exploration vehicles.

[P-55] System Level Integration Validation Tests for a GEO Satellite Electric Propulsion Subsystem

Keun Joo Park, Su Kyum Kim, Hyoung Yoll Jun

Korea Aerospace Research Institute

A GEO communication satellite of which mission life is 15.3 years is being developed by Korea Aerospace Research Institute. Due to the extended mission life comparing with its predecessors, the electric propulsion subsystem is considered from the project planning. However, since electric propulsion subsystem has several constraints in the operation during the ground test, the subsystem validation during the spacecraft integration and test phase needs specific test procedures and ground support equipment.

In this paper, the test procedures for the electric propulsion subsystem validation required during system level integration tests are presented.

[P-56] Propellant Estimation for a Geostationary Telecommunication Satellite

Jong Seok Park, Jung Su Choi, Keun Joo Park, Hyoung Yoll Jun

GEO-KOMPSAT-3 Program Office, KARI

A public multi-functional telecommunication satellite, GEO-KOMPSAT-3, adopts a hybrid propulsion system consisting of chemical and electric thrusters to perform orbit transfer and orbit maintenance. Hybrid propulsion systems are increasingly employed on geostationary satellites to increase payload mass. For the operation of these propulsion systems, propellant is loaded on board, and one of the most influential factors for geostationary satellites is the velocity increment to reach geostationary orbit provided by the launch vehicle, which is determined by the launch vehicle performance and the inclination angle of the launch site location.

In this paper, it is estimated the propellant consumption required for orbit transfer and on-orbit operation by each candidate launch vehicle for the GK3, and it is assessed the life time extension by additional propellant loading.

[P-57] Development Trend for the Small Satellite

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Korea Aerospace Research Institute (KARI)

Until now in Korea, various satellites from large to cubesat are developing for various demand. Korea Aerospace Research Institute (KARI) had developed from large to small satellites for public demand such as Korean peninsula observation for territory management, agriculture and forestry management, disaster monitoring and Lunar exploration etc.

Recently, many small satellites under 100 kg grade are developing for various purpose with constellation.

In this paper, we will briefly present the current trend to develop small satellites simultaneously with cost effectively.

[P-58] Telecommand Processing Software Design for Navigation Satellites

Su-Hyun Park

Korea Aerospace Research Institute

Korea Aerospace Research Institute (KARI) has been developing a series of low Earth Orbit (LEO) and Geostationary Earth Orbit (GEO) satellites for observation and communication purpose. KARI is now working on a navigation satellite system, in order to transmit time and positioning signal around Korea peninsula. Navigation satellites communicate with ground station via telecommands and telemetries in the same way as other LEO and GEO satellites produced by KARI. The telecommand processing software, however, has to be changed since the embedded computer has been newly designed for navigation satellites. Especially, the uplink decoder, which is a part of the embedded computer for the ground telecommands reception and decoding, is updated to merge LEO and GEO satellite design of KARI. In this paper, we explain and demonstrate how the telecommand processing software is designed and tested for the new embedded computer of navigation satellites.

[P-59] Trend Analysis of Single Error on PDHU of Danuri

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The PDHU on Danuri is a unit that receives, stores, and transmits data from the payloads of Danuri. Since Danuri was launched in August 2022, a small piece of its memory has been defective because it was continuously exposed to external radiation, and some part of the data was affected. However, its EDAC (Error Detection and Correction) function automatically corrects those errors, and then the whole data has been transmitted without any errors. This paper describes the trend of a single error on the PDHU and its effect.

[P-60] KPLO FM Solar Array Deployment Test

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Hyung-Wan Kim

Korea Aerospace Research Institute

The KPLO (Korea Pathfinder Lunar Orbiter) was successfully launched on August 5th, 2022. And the KPLO is carrying out the mission on 100×100 lunar orbit.

The KPLO has 2 solar arrays. The solar array consists of a yoke and a solar panel. The yoke and solar panel are connected with tape-hinge. The solar array must be folded inside the launch vehicle fairing because solar array is bulky when deployed. And it must be deployed in space. Therefore deployment stability must be verified on the ground before launch. The solar array deployment test was conducted for checking deployment using a deployment test device that can compensate for gravity. And the deployment test was carried out successfully.

[P-61] ESD Screen and Cho-Foil Finalization of KPLO at the Launch Site

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Korea Pathfinder Lunar Orbiter (KPLO), which is currently in the nominal mission phase, was developed complying ESD requirements. In order to be unsusceptible to the effects of ESD, ESD screen made of bronze mesh shall cover the gap between structure panels and the cut-outs of each panels. ESD screen is also to be grounded to the structures by aluminum conductive tape (Cho-Foil). Almost job of ESD screen of KPLO was performed prior to the shipping to the launch site. However, remaining job of ESD Screen and Cho-Foil was finalized at the launch site. In this paper, ESD screen and Cho-Foil finalization of KPLO at the launch site is summarized.

[P-62] Three-Dimensional Thermal Analysis for Predicting the Power Consumption of Heaters in GK3 in Transfer Orbit

Gilho Lee, Jung Hoon Kim

Korea Aerospace Research Institute

The three-dimensional thermal analysis was conducted to predict the required power of the heater to control the temperature of satellite components of the GK3 (Geostationary Earth Orbit Korea Multipurpose Satellite 3) in transfer orbit. In the transfer orbit, the solar arrays are deployed in the order of stow, partial deployment, and full deployment. In the stage before full deployment, some areas of OSRs, which are installed to cool the satellite components, are shaded by the solar arrays which

are not deployed. The attitude of the satellite varies depending on time in the transfer orbit. With the consideration of the situation of solar arrays and the attitude of the satellite, a three-dimensional thermal mathematical model for the satellite was proposed. Based on the proposed model, the amount of power consumption of the heaters in transfer orbit was predicted.

[P-63] Operational Methods of Low Earth Orbit Satellites Using Relay Satellites

Hyun-Su Lim

Korea Aerospace and Research Institute

Low Earth Orbit (LEO) satellites operating in closer orbit to the ground are suitable for high-resolution image observation missions. In order to further increase the resolution of observation images, high-performance optical/infrared sensors and image radars are being developed to improve their performance. The development of these sensors will result in a larger capacity of data to be transmitted to the ground, making immediate transmission of observation data impossible due to the limited ground communication time of LEO satellites. This paper proposes an operation plan to expand the limited communication time of low-orbit satellites using a relay satellite that can communicate with the ground at all times. Observation data from low-Earth orbit satellites are immediately transmitted to the ground through a relay satellite. Satellite command/telemetry data required for LEO operations can be also transmitted without direct interference with the ground. For efficient operations of LEOs using relay services, link scheduling is a vital element to ensure minimal time taken for LEO imaging and delivery to the ground.

Considering optimal factors, LEO's imaging scheduling and link scheduling between LEO and relay satellites should be performed on the ground and delivered to each satellite in advance before the scheduling execution time.

[P-64] GK3 Communication Antennas Accommodation Design

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

Korea Aerospace Research Institute

GEO-KOMPSAT-3 is a geostationary communication satellite intended for public use by the government. It includes key payloads like FBCS (Flexible Broad Band Communication), SBAS (Satellite Based Augmentation System), and DCS (Data Collection System), with various antennas like deployable reflector, herix array, and horn antennas. In addition to payload antennas, satellite operation antennas, such as the S-band TM/TC antenna and GNSS receiving antennas, are also configured for Earth orientation. Due to the constrained spatial arrangement of

these diverse antennas, efforts were made to minimize interference effects, particularly with respect to GNSS receiving antennas. This study conducted research to select antenna placement positions and angles that minimize interference impact and ensure optimal performance.

[P-65] Integrated Operation Concept Design and Analysis for LEO Satellite Constellation

Jeongheum Im

Korea Aerospace Research Institute

This paper describes integrated operation concept design and analysis for a low earth orbit satellite constellation. Operating observation satellites in low orbit provides great advantages such as obtaining high resolution images and reducing power consumption. However, under limited ground system network conditions, operating observation satellites in low orbit is subject to data transmission time constraints between the low earth orbit satellites and ground system. The disadvantages can be resolved by introducing a geostationary data relay satellite into the data transmission chain between low earth orbit satellites and ground stations, United States and Europe have already introduced these concepts and have been operating TDRS (Tracking and Data Relay Satellite) and EDRS (European Data Relay Satellite) systems to provide data relay and communication of low orbit satellites without establishing additional ground stations. In this paper, the satellite constellation consists of several high resolution observation satellites and a geostationary data relay satellite. The revisit time to the observation area and the system response time from the transmission of observation commands from the ground station to the satellite to the transmission of imaging data from the satellite to the ground station were reviewed.

[P-66] Robotic Testbed for Pose Estimation Research of Tumbling Space Object

Jin-Hyung Kim

Korea Aerospace Research Institute

Recently, various missions have been proposed in the space industry thanks to the advancement of reusable launch vehicles, high-performance on-board computers, robot and sensor technologies.

In particular, visual sensor-based on orbit servicing missions are emerging due to the development of artificial intelligence technology. Various organizations are conducting research to estimate the 6 DoF pose of space objects, and fundamental research for on-orbit servicing is also underway at the KARI. In this study, I introduce a robotic testbed to study the 6 DoF pose estimation technology of tumbling relative space objects among the elemental technologies for performing on-orbit

servicing in the space. The testbed consists of a 7-axis collaborative robot arm, ToF and visible band cameras, 3D LIDAR, a motion capture system, a microsatellite mockup with space-grade solar cells, and a mockup tumbling device.

[P-67] Preliminary Electrical Interface Design of Electric Propulsion System for GEO-KOMPSAT-3

Young-Jin Won

Korea Aerospace Research Institute

The Geosynchronous Earth Orbit-Korea Multi-Purpose Satellite-3 (GEO-KOMPSAT-3) is a multi-band communication satellite that will provide broadband satellite communication services using Ka-band Flexible Broadband Communication System (FBCS) in the Korean Peninsula and surrounding seas. Additionally, GEO-KOMPSAT-3 will support a Data Collection System (DCS) mission using the L-band and a Satellite Based Augmentation System (SBAS) mission utilizing the L-band and C-band for satellite navigation augmentation service.

GEO-KOMPSAT-3 will employ an electric propulsion system for North-South Station Keeping(NSSK) operations.

In this paper, we aim to briefly present the results of the preliminary electrical interface

design for the electric propulsion system of GEO-KOMPSAT-3. The electric propulsion system for GEO-KOMPSAT-3 comprises six Propulsion Power Units (PPUs) to supply power, six Propellant Management Assemblies (PMAs) to transfer Krypton from the tank to the thrusters, six thrusters, and two tanks. Based on the preliminary interface design results, KARI will finalize the electrical interface design and prepare for verification tests.

[P-68] Development of Multi-Satellite Integrated Overseas Ground Station Pass Selection Program for Satellite Image Downlink

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The reason for using overseas ground station for image downlink in low-orbit satellites is that it is necessary to efficiently manage the memory of limited satellites to acquire more images to reflect the requests of various users. For satellite memory management, in addition to the Jeju ground station, overseas ground stations such as Svalbard and Germany are used to receive images stored in memory, empty the satellite memory, and then reflect other users' requests. In addition, since CAS500-1 operates as a partial downlink that divides and receives image data, it is essential to use overseas ground stations to acquire images as quickly as possible after imaging.

Currently, the operator selects the orbit of the overseas ground station to receive the satellite images by considering contact duration and overlap time between satellites. As a result, we developed a multi-satellite integrated overseas ground station pass selection program by applying standardized pass selection criteria to automatically select downlink passes in consideration of overlap between satellites.

[P-69] Attitude Control FDIR in the GEO-KOMPSAT3

Woo Yong Kang

Korea Aerospace Research Institute

GEO-KOMPSAT3 (GK3) is a communication satellite, it must ensure the continuity of its mission. From an attitude control perspective, even in the event of a malfunction in the attitude control unit, it must be capable of performing attitude control to meet mission requirements. Therefore, attitude control is divided into hardware and software components to support Fault Detection, Isolation, and Recovery (FDIR).

In the hardware part of attitude control, there are features to detect problems and automatically recover from them. Additionally, in the attitude control software, there are functions that allow for attitude control to be performed using other attitude controller in case some of the attitude control hardware fails.

This paper introduces the configuration of attitude control FDIR and then describes the recovery procedures based on both hardware and software components.

[P-70] Enhancement of Low Orbit Satellite Image Processing Monitoring System

Guhyeok Kim, Min-A Kim, SeongHeon Kim.
MyeongShin Lee

Korea Aerospace Research Institute

The Korea Aerospace Research Institute (KARI) is currently using a Process Monitoring (PM) system developed for monitoring imaging, receiving, and image processing in low Earth orbit satellites. Operators can use this subsystem to check the status of image receiving, processing, and backup. While KARI is currently managing four low Earth orbit satellites, it has automated the distribution process for raw data and standard images to facilitate timely response to the needs of subsequent satellites and requesting organizations. With the addition of this automated system, there's a growing need for monitoring these subsystems. Moreover, additional development is necessary to enable all operators to monitor for emergency imaging requests.

This paper aims to describe the enhancements made to the existing PM system, enabling it to monitor the distribution process for raw and standard images, as well as to respond to

urgent imaging requests.

[P-71] GK3 FDIR (Failure Detection Isolation Recovery) Hierarchical Design Progress on Development Phase

Chang-kwon Cho, Bongkyu Park, Jong Seok Park,
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This year, the preliminary design review (PDR) of the geostationary public multi-purpose communication satellite was conducted, defining the design baseline. Fault management is also being designed in accordance with the progress of the project. The current design progress includes the definition of the basic design concept, including the definition of redundancy status, ON/OFF status according to system mode, and Safing Procedure according to the launch post-automation operation scenario, using the top-down method. In addition, the system architecture of fault detection, isolation, and recovery (FDIR) has been designed.

This paper summarizes the contents performed after the basic Fault Management design concept. Based on the FMECA of each subsystem unit, the failure modes defined from the unit level to the subsystem and the contents to be performed on board were analyzed and summarized.

In the future, it is planned to define the functions based on the analyzed contents and proceed with the design of fault management, isolation, and recovery (FDIR) of the final system and satellite bus.

[P-72] Design of Remote Agent for Flight Software Development

Hyun-Kyu Shin

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The flight software receives ground commands, transmits status data to the ground, and controls various onboard devices to enable the satellite to perform its original mission. The development and verification of such flight software requires several devices related to the operation of the flight software, including an onboard computer in which the flight software operates. The software development environment should be able to provide various situations and scenarios for effective development and verification. In general, STBM, a software development model of an onboard computer, is used in a software development environment, and several simulators are configured to simulate devices. These various simulators require interworking of time synchronization and state information to provide a specific scenario. The Remote Agent works with mounted computers and various simulators to provide status information and time synchronization according to conditions. This introduces the

design of the Remote Agent for effective flight software development and verification.

[P-73] Study on Future SAR Satellite and Its Applicational Information

Jae-Min Shin

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As technology advancement, Complex Information is more and more important than single dimensional one. Generally images, which are acquired by not only camera but also Satellites, consist of two types of single dimensional data. They are information comes from a reference axis of an imaging equipment and its perpendicular axis. However nowadays more additional information is indispensably required in order to be applied on 3D spatial information, which is useful for real world applications. Furthermore characteristic data is integrated to the spatial information. Those are called Complex Information. At the part of Satellite Developments, those kinds of needs have been realized by various trials. Especially the needs have been satisfied by the method of Optical and SAR Satellite developments. Although the Data Fusion using SAR and Optical Satellite Data is not easy, Techniques for Complex Information has to be developed for Future Applicational Information. Therefore in this study, especially data and technology related to SAR satellites for Complex Information are surveyed. Using its results, relevant Applicational points are discussed.

[P-74] Study on Version Control Systems for the Configuration Management of Satellite Flight Software

Jae-Seung Lee

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During the development of satellite flight software, configuration management for the flight software is indispensable. In previous satellite project, PVCS (Polytron Version Control System) was used for software configuration management and build environment. PVCS is COTS program, and lots of useful functions as well as detailed user manuals are provided. As an advantage of COTS product, its functionalities are fully verified and any problems can be fixed by the manufacturer if it occurs. Furthermore, all the software development process, such as version control, link and locator, compilation, and building final image can be integrated into one program. On the other hand, the license should be purchased per developer and it contains too many functions which are not required or unavailable to a certain satellite project. Also, lots of functions may affect to the operation speed. Due to these problems and to reduce development budget, WinCVS has been adopted as a

configuration management tool for satellite flight software. WinCVS is OSS (Open Source Software) and freeware. It provides all the core functions required for version control system and windows-based interface which most developers are familiar with. There are many kinds of version control system, such as cvs, svn, and git.

Individual tool has pros and cons respectively. Recently, git is adopted as a configuration management tools widely. WinCVS is centralized version control system, and git is distributed version control system. Which one to use depends on the development environment of a certain satellite project.

In this paper, we introduce the characteristics and compare the operational method for WinCVS and git respectively to determine which configuration management tool is feasible for the next satellite project.

[P-75] Designed to Improve the Satellite Image Processing Procedure of CPS

Jaeyeol Lee, Jihyeon Yim, Min-A Kim,
Guhyeok Kim, Myeongsin-Lee

Korea Aerospace Research Institute

KARI operates the KOMPSAT Series and CAS500-1. Follow-up satellites, KOMPSAT-6 and 7, CAS500-2, and Nano Satellites constellation will also be launched soon. As the scope of satellite image utilization using artificial intelligence and big data technology increases, requests to order large quantities of satellite images are increasing. In addition, satellite images can be distributed and utilized quickly to increase their utility value. KARI has been continuously improving processing procedures and improving the system so that satellite images can be received and provided quickly.

The CPS has been using when developed KOMPSAT-2 began operating. The CPS consists of a desktop, storage, and S/W (database) for work. Satellite images are registered in a database and distributed after inspection, processing, and confirmation procedures. The current system is structured in such a way that it passes the administrator's confirmation at all stages and proceeds to the next procedure. This is a procedure that is carried out through accurate verification and has stability. However, it has a disadvantage in the speed of satellite image processing. In particular, in order to check all satellite images, it is necessary to directly check the images with the naked eye, which takes a lot of time when checking a large amount of images. Additionally, since there is a lot of operator intervention, there is always a possibility of human error occurring.

Due to the above-mentioned characteristics, the current CPS operation is finding it increasingly difficult to respond to the demand for large orders and quick. In addition, considering follow-up satellites that will be launched in the future, it is expected that there will be more demand for satellite information. Accordingly, there is a need to redesign the CPS

to respond to future situations.

In order to design a new CPS, we identified problems in advance and considered the necessary elements. First, a processing procedure was needed to automate the worker-centered work processing procedures as much as possible. The goal was to eliminate and simplify unnecessary processing procedures as much as possible in terms of software and hardware. And previously, we set the goal of speeding up the processing speed by using these two things.

The newly designed satellite image editing system's procedures are the same as the previous registration, inspection, processing, confirmation, and distribution procedures, but the detailed procedures have been improved.

By designing it in a way that improves the shortcomings of the existing system, process automation and procedure simplification were achieved. Simplification of procedures and automation of processing have contributed to speeding up the process, and the work intensity of workers is expected to be reduced, enabling efficient system operation.

[P-76] Method for Multi-Satellite Integration Test with EGSE at AIT

Kyung-Keun Kim

Korea Aerospace Research Institute

As many satellites are replicate for cluster- satellite, many integration tests must be done. Conventional satellite integration testing is required the same number of EGSE and satellite. Because there was not much demand for satellite at that time. But SpaceX is launched so many satellite at now, they will launch more that 40,000 satellite to LEO. It is difficult to meet the demand of satellite in current space manufacture system. To meet this demand, We propose a method of satellite testing with multiple satellite and minority EGSE based on mass production.

[P-77] Establishment of an Optical Ground Station for Laser Communication Prototype Development a Function Verification

Myung-Gil Kim, Kang-Toi Yoon, Do-Hoon Kim,

Je Geun Lee

SpaceK Inc

Due to the rapid advancement of artificial satellite and increasing demand, various types of satellite being developed to perform a wide range of missions. Particularly, with the growing trend of highly capacity image acquisition and SAR data, there is a limitation in satellite communication time, and RF-based transmission capacity is limited. As an alternative to address this challenge, space technology leading nations have been intensifying research and development in the field of laser communication since the early 20th century. Recently, successful

launches of experimental satellites for data transmission in both Low Earth Orbit and geostationary Orbit have been achieved. Laser communication is gaining signification attention not only because it allows for the high-capacity data transmission during short communication windows but also due to its excellent security advantages. As a result, it is being increasingly recognized as a communication method that is well suited for the defense industry's requirements, receiving more attention than civilian applications.

In this study, a prototype lase transceiver module for laser communication has been developed. to validate this, an Optical Ground Station was established, and a system was created for virtual missions where spacecraft communication with each other at a distance of approximately 1km using virtual images acquired by the payload. In the future, the plan includes consolidating the specifications for the system configuration and developing a small satellite for space environment testing and validation

[P-78] Functional Test Result and Analysis of Air Management System for Undersea Platform

Youngkyu Kim, Joohee Lee

Korea Aerospace Research Institute

This study describes the test results and analysis of the air management system to supply oxygen, remove carbon dioxide and harmful substances, etc. for the habitation module of a three-person crew in a structure (platform) installed 30 meters below the seabed for 27 days. The air management system is mainly composed of an oxygen generation system, a carbon dioxide removal system, and an air purification system, and this test was conducted in a ground test module simulating a subsea platform. First, the test was conducted for oxygen concentration maintenance, water electrolysis system reliability, and ultrapure water requirement through PEM type water electrolysis system. Then, the carbon dioxide removal unit was tested for carbon dioxide partial pressure (concentration) maintenance, carbon dioxide removal performance, air circulation impact test, temperature and humidity impact test, canister replacement test, and emergency situation test. Based on these test results, we will apply them to the design of the air management system to be installed on the actual undersea platform in the future.

[P-79] Methods to Improve Dynamic Range in Satellite Electro-Optical Camera System

Youngsun Kim, Haeng-Pal Heo

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Dynamic Range (DR) is representative electro optical performance in the satellite camera. Basically DR is determined in the detector itself such as Full Well Capacity (FWC) and noise

characteristics. However, we can improve it in the camera system level as well. One method is to remove unnecessary offsets. It can be achieved by acquiring the analog offset parameters in darkness. If the system has a few parallel processing paths, it should be applied in each path. In addition to it, it can be improved by analog gain adjustment to match the detector and ADC full range. The linearity and Photon Transfer Curve (PTC) characteristics should be considered in order not to affect the other performance. Finally, the paper shows the how much it is improved by applying and testing these methods in the satellite electro optical camera.

[P-80] Development Trend of QKD (Quantum Key Distribution) Payload

Hwan-Chun Myung, Sung-Soo Jang

Korea Aerospace Research Institute

The quantum communication is known to be very secure and robust against eavesdropping. In particular, the QKD (Quantum Key Distribution) technology is getting much more attention in terms of establishing an encryption key between two places. The main protocols of QKD are largely classified into DV (Discrete Variable)- QKD and CV (Continuous Variable)-QKD. In order to implement such protocols in a space, some experimental tests have been successfully done. In 2014, Japan developed the quantum limited LEO-to-ground link using the micro-satellite SOCRATES (Alt. 600 km). It was equipped with SOTA, the small optical transponder terminal. The experiment showed the successful reception of the quantum signal (DV-QKD) from SOTA, compensating the atmospheric propagation effect with the adaptive optics. After that, China proved in 2017 that the DV-QKD technology was still feasible over 1,200 km through a space. The satellite Micius (Alt. 500 km), launched in 2016, was used to realize the long-distance quantum communication network with the quantum key transceiver. Differently from the previous experiments, the feasibility of the CV-QKD method was also explored by Europe in 2013, based upon the LCT (Laser Communication Terminals) of Alphasat I-XL (at GEO). The test result supported applicability of the CV-QKD protocol with the laser communication system, which was already commercially available.

[P-81] Verification Focus Control Method of Electro-Optic Camera System for Satellite in Thermal Vacuum Test

Jong-Euk Park, Haeng-Pal Heo

Korea Aerospace Research Institute

In order to improve the acquired image quality of the satellite electro-optical camera, precise focus control of the camera system is required. The focus control method that is reviewed

from the initial design of the electro-optic camera and passed through design, manufacturing, and assembly tests is applied. For reliability and contamination prevention of satellite systems, a thermal control type focal plane control method for focusing is used. It is operated by the lens barrel with focus control installed and the camera controller and power supply unit of the camera electronic module to control it, and is first tested and verified in a laboratory environment.

The function and performance of the camera's focus control method implemented in this way are finally verified in the space environment test conducted before the launch of the satellite. In the thermal vacuum chamber, in a state of being disconnected from the external environment, in a state that simulates the environment in space, the implemented focal plane controller is tested and verified.

In this paper, the operation of the finally completed thermal-controlled focus control system in a thermal vacuum chamber test simulating the space environment was confirmed, the operation results were confirmed through functional and performance tests, and future improvement plans were proposed.

[P-82] Image Chain Tests Using CAP-W EM

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 observation payload of the CAS500-4 satellite. The CAP-W EM (Electrical Model) has been finished its design and mounted at CAS500-4 ETB (Electrical Test Bed) configuration. This paper describes image chain test to check operating CAP-W EM on the CAS500-4 ETB Test.

[P-83] Electro-Optical Performance Test Result of CMOS TDI Image-Sensor Flight Model for CAP-W Payload

Ilseop Lee, Jong Pil Kong, Sang-Gyu Lee

Korea Aerospace Research Institute

Two Complementary Metal-Oxide Semiconductor (CMOS) Image-sensors with Time Delay Integration (TDI) operation are mounted on the CAP-W (Compact Advanced Payload-Wide swath) of CAS500-4 (Compact Advanced Satellite-4) to observe the agricultural and forest resources. TDI CMOS Image-sensor (CIS) for CAP-W has five multi-spectral (MS) bands to achieve mission objectives. The CIS flight model has been developed and sensor-level functional and EO (electro-optical) performance testing has been completed. In this paper, the EO performance test results of CMOS TDI Image-sensor flight model will be described.

[P-84] Jitter Characteristics Improvement on Serial Data Interface of Space-Born Memory Equipment

Jong-Tae Lee, Haeng-Pal Heo

Korea Aerospace Research Institute

Recently, the serial data interface is used more than the parallel data interface as part of a method to reduce the effect of noise on inter channel interference. To send data by a serial interface, it is necessary to convert the word unit data into continuous 1 bit unit data which is implemented with commercially available SERDES (Serializer/Deserializer) chip or IP (Intellectual Property). SERDES interface called Wizard-Link was used for large data transmission between internal boards of space-born memory device and there were intermittent CRC error in extreme temperature conditions. This document describes how to overcome the error that occurred during the development process, and it is hoped that it will be a reference for the development of similar electronic devices.

[P-85] Emergency Operation Plan Design of Air Management System for Undersea Base Platform

Joohee Lee, Younkyu Kim, Jongwon Lee

Korea Aerospace Research Institute

The Korea Aerospace Research Institute (KARI) has been developing an air management system for undersea base platform since 2022. The main air management system includes an oxygen generation system, a carbon dioxide removal system, an air purification system. Among them, the core system that plays a key role is an oxygen generation system that electrolyzes water to obtain oxygen. There may be various risk variables on the 30 m undersea base platform, so it is necessary to establish an emergency operation plan. Therefore, it is also essential to establish an emergency operation plan of the air management system for human life. The water electrolytic oxygen generation system used on the 30 m underwater base platform receives electricity from the ground and uses it. In this paper, an emergency operation plan to maintain human life will be introduced under the assumption that an emergency situation occurs in which the oxygen generation system is temporarily unavailable.

[P-86] Results of the Thermal Vacuum Tests for the Performance Verification of the CAP-W Payload of CAS-4 Satellite

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The CAP-W (Compact Advanced Payload with Wide Swath) is an electro-optics camera that is installed on the CAS-4 (Compact Advanced Satellite-4) satellite. The CAP-W payload is equipped with five multispectral channels and has the capability to capture images with a wide range of swath width. The payload is specifically designed to capture images related to national agriculture, water resources, and forests.

In order to verify the performance of the CAP-W payload, a comprehensive set of in-orbit environment tests are planned, including vibration and thermal vacuum tests. The thermal vacuum test simulates the extreme temperature and pressure conditions of space and evaluates the payload's performance under these conditions.

The MTF test measures the capability of the payload to transfer spatial information from the object being imaged to the image captured by the sensor. It is a critical factor that determines the sharpness and clarity of the images captured by the payload. The MTF test is performed under thermal vacuum conditions to simulate the extreme temperature and pressure conditions of space and ensure that the payload's performance is consistent even under these conditions.

In this paper, we outline the results for the thermal vacuum test of EOS and describe the both design of local shroud for temperature control in vacuum chamber and blank test of local shroud itself.

[P-87] Ground Rupture and Crack Detection and Analysis Method in Various Environments Using Deep Learning Technology

Yeonju Choi

Korea Aerospace Research Institute

On Earth, various types of surface ruptures occur on the surface as a result of earthquakes caused by faults. And on the surface of the Moon, where there is no atmosphere, craters are created when meteoroids collide with the surface of the Moon and rilles are created that looks like a dried river caused by lava flows into the lunar ocean. In this study, we will look at studies that have detected and analyzed various types of surface ruptures using deep learning technology. In addition, we introduce a catalog of training datasets in various environments used for rupture/crater detection, algorithms, and performance analysis methods.

[P-88] Utilizing Response Surface Method for Optical System Alignment

Jongguk Choe, Goeun Kim, Dongok Ryu, Haengpal Heo

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In this study, the alignment method for an optical system using

response surface method (RSM) is discussed. Performance measurement of optical systems is time-consuming and excluding environmental influences can be challenging. To address this, a method that combines simulation with actual measurements was proposed. By utilizing ray tracing simulations, the response surfaces of optical system aberrations which are based on the position of optical modules can be obtained. Subsequently, experimental design was applied to minimize the number of actual experiments. As a result, the coefficients of the response surfaces through experiments are consistent with those from simulation results. Finally, a predictive model was completed by incorporating deviations representing current performance. It is expected that this predictive model will enable rapid alignment optimization.

[P-89] Research on Improving Preparatory Test Procedures and Efficient Test Technical Document Management to Support Satellite Testing

Chul Kang

Korea Aerospace Research Institute

In order to develop a multi-purpose satellite, design verification is required along with satellite design, and this series of activities is called satellite verification testing. In order to perform a satellite verification test, preliminary preparation work is required before the satellite test.

This is called the satellite test preparation procedure. Currently carrying out satellite development

We will learn about pre-test procedures for satellite testing, post-test processing procedures, and technical documents issued during test work, and describe improvements after identifying problems in processing procedures and operations. In addition, we would like to propose a processing plan using the already established technical data management system to improve and streamline the processing procedures for use in the next satellite test.

[P-90] Application of Data Quality Encapsulation (DQE) and Correlated Source Selector (CSS) in Telemetry Ground Station

Dong-Hyun Kim, Chun-Won Kim, Soon-Ho Kwon,
Jin-A Ma, Jeong-Woo Han, Tae-Jin Lee,
Na-Gyun An, Min-Seok So

Korea Aerospace Research Institute

In the case of aerospace telemetry with relatively long-distance trajectory (thousands of kilometers or more), the link quality of the entire flight pass cannot be satisfied with a single ground station, so multiple ground stations are used to ensure overall link reliability. At that time, the process of selecting the signal

with the best quality among several received signals and combining them into an integrated stream is called Best Source Selection (BSS).

These BSS technique has been developed to support protocols that provide real-time data quality indexes and use maximum likelihood detection methods for multiple bit sources, which have recently been adapted to standard and included in Appendix 2G of IRIG 106-17.

In this paper, we reviewed the standard for Data Quality Index (DQM) and Data Quality Encapsulation (DQE) described in the document and the application of CSS implemented by applying them.

[P-91] Efficient Satellite Data Receiving System Structure Proposal Using Overseas Ground Stations

Myungmuk Kim, Gyeoul Lee, Woomin Lee

Korea Aerospace Research Institute

Korea Aerospace Research Institute (KARI) is using overseas ground stations to efficiently operate the KOMPSAT and CAS500 series. KARI has multiple overseas ground stations along the mission orbit for efficient missions. On the other hand, each of these overseas ground stations has different ground system configurations and settings. When the number of operational satellites or overseas ground stations increases, these configurations and settings can create important problems in terms of system errors and security management. Here, we propose a system structure that minimizes the system, error, and security management problems that can occur when receiving satellite data from an overseas ground station.

[P-92] Concept of Image Processing System Considering Concurrent Operation in Remote Areas

Min-A Kim, Guhyeok Kim, Seong Heon Kim,
MyeongShin Lee

Korea Aerospace Research Institute

The KARI needs to establish an integrated operation of national earth observation satellites and data management and service systems in preparation for the demand for satellite information of subsequent operating satellites in 2024, including the four satellites in operation.

Therefore, by developing and upgrading an integrated satellite information operation system, a multi-layered satellite information service was provided by establishing an efficient collection, processing, management, and distribution system for national satellite information, and a separate national satellite integrated operation center was established in consideration of scalability, security, and transmission environment, and is being operated

simultaneously in Daejeon and Jeju.

This paper introduced an image processing-based integrated satellite information operation system and described the operation concept of the image processing system considering simultaneous operation in Jeju and Daejeon using the integrated satellite information operation system.

[P-93] Development of DB Reset Tool for KOMPSAT-5 Image Processing Automation

SeongHeon Kim, GuHyeok Kim, Min-A Kim, MyeongShin Lee

Korea Aerospace Research Institute

Currently, KOMPSAT-5 operated by the Korea Aerospace Research Institute uses an image processing system linked to the database. When a problem occurs in the DB during image processing, there are times when the resources allocated to the DB need to be removed, and the DB must be reset to free the resources and then process the image again. In this process, there are two ways: one way to reset it by entering a query in the DB, and the other way to completely delete the DB and set a new one manually. The former method is generally used, but occasionally, when unresolved problems arise, the latter method is used. When resetting, you must remotely access each Level Processor server, terminate the running processing programs, and start the reset. Because we are manually working on all image processing servers currently in operation. The resources required for this process are large, and to shorten the resources, we designed a program using Python that can be reset with a single program execution.

[P-94] A Study on the Feeding Performance for Monopulse Tracking Antenna

Chun-Won Kim, Jeong-Woo Han, Jin-A Ma, Tae-Jin Lee, Na-Gyun An, Min-Seok So, Soon-Ho Kwon, Dong-Hyun Kim

Korea Aerospace Research Institute

In this paper, the characteristics of monopulse tracking antennas according to feed performance are presented. As for the performance of the reflector antenna, the gain and side lobe level change depending on the gain and beam width of the feed. The monopulse gain and tracking performance changes due to the difference between the sum and azimuth/elevation differential channel pattern gain and the phase value. Therefore, in this paper, we would like to present the change in the performance of the monopulse tracking antenna according to the change in feed pattern, gain, phase.

[P-95] Comparison of Test Facilities for Satellite

Electromagnetic Performance Evaluation

Hyung-Uk Kim, Seong-Bin Lim, Yun-Goo Huh

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The continuous advancement of modern satellite technology emphasizes the indispensable role of satellites in various application areas such as communication, location tracking, environmental monitoring, and military use. Consequently, the electromagnetic performance evaluation of satellites is increasingly recognized as a mission of utmost importance. This paper aims to compare and explain the advantages and disadvantages of the Compact Payload Test Range (CPTR) and Near Field Scanner (NFS) as methods for conducting electromagnetic performance evaluations of satellites in line with technological advancements. Additionally, we propose the integration and operation of CPTR and NFS as a means to enhance the accuracy and efficiency of performance evaluations.

Keywords: CPTR, compact payload test range, NFS, near field scanner

[P-96] Analysis on Real-Time Data Processing Results of Ground Telemetry Stations for KSLV-II 3rd Launch Mission

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For KSLV-II launch mission, six ground telemetry stations are operated in NARO Space Center. The on-board telemetry equipment transmits telemetry signals containing the flight trajectory and status of the launch vehicle to the ground stations. In each ground telemetry station, the acquired telemetry signals are processed and transferred to data processing system (DPS). The DPS extracts important information from received data, makes quick look message (QLM) and distributes it to mission control system in real-time for monitoring the progress of launch mission. In this paper, we will describe the real-time algorithm of DPS and the results of KSLV-II 3rd launch mission.

[P-97] Launch Vehicle Trajectory Optimization Using Direct Shooting Method

Young-Jae Park, Byoung-Jin Moon

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This study suggests a trajectory optimization method as a design method for a launch vehicle's nominal trajectory. A launch vehicle's nominal trajectory analysis is a basic step in

a launch vehicle's flight safety analysis and refer to CFR 417 documents. The trajectory optimization of the launch vehicle is a multi-phase optimization problem and considers discontinuity such as stage separation. The performance index function maximizes orbit injection launch vehicle's mass property by minimizing the flight time. Optimization design variables were used by angle of attack, and side-slip angle for each phase. The trajectory optimization methods used the direct shooting method. The trajectory optimization was fulfilled using the KSLV-II's model.

[P-98] RF Link Analysis of the KSLV-II 3rd Launch Result

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In this paper, we analyzed RF link of the KSLV-II 3rd launch result at Jeju tracking station. In order to analyze RF link of aeronautical telemetry system, we should consider antenna pattern, transmit power, antenna gain to noise temperature (G/T) of ground station, data rate, space loss, polarization loss, atmospheric loss, multi-path loss, etc. In the environment of actual launch missions, there are some other barriers impacting on RF link such as plume loss at the flight event and antenna gain null when launch vehicles have different angle. We analyze RF link more accurate by calculating antenna gain depending on the angle which ground station aim launch vehicles. Additionally, according to RHCP, LHCP polarization, we are able to predict RF link after analyzing launch vehicles antenna pattern. We compare the results of actual KSLV-II received RF level and ground station RF link prediction with simulation antenna pattern according to polarization.

[P-99] Design of Web Server-Based iDIS to Increase Operational Efficiency

Woomin Lee, Gyeoul Lee, Myeongshin Lee

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KOMPSAT Mission Operation Center is operating iDIS (Integrated Direct Ingestion Subsystem) that can receive images of all KOMPSAT. Currently operating iDIS is operated as an independent system for each ground site. Therefore, MT (mission timeline) for image reception schedule registration is also provided separately for each site. For this reason, it takes a lot of time to resolve problems that occur at each system, and management of each system is difficult. Additionally, the number of satellites in operation is expected to increase.

In this paper, to improve the efficiency of image reception system operation and management, propose a web server-based iDIS that manages, monitors, processes, and transmits receivers all site from one server.

[P-100] CCSDS 131.0 Standard LDPC Code for Rate 7/8 and Analysis of Simulated Test Results

Tae-Jin Lee, Dong-Hyun Kim, Soon-Ho Kwon, Jin-A Ma, Jeong-Woo Han, Chun-Won Kim, Na-Gyun An, Min-Seok So

Korea Aerospace Research Institute

CCSDS (The Consultative Committee for Space Data Systems) Standards specified various channel coding schemes for telemetry. The Low-Density Parity Check code for 7/8 rate as a CCSDS recommended code, achieves good error correction performance. The simulation test for the channel coding schemes were implemented by MATLAB[®] and the conditions are as below. The LDPC code paired with Soft-decision BPSK (Binary Phase Shift Keying) modulation schemes and the LDPC decoder has the "Belief Propagation Algorithm (BPA)". The algorithm iterates the decoding process up to 10 times to ensure sufficient error correction performance. LDPC for 7/8 rate scheme achieve coding gain by 5.3 dB than uncoded BPSK. While, the convolutional code and the reed-solomon coding schemes have achieve coding gain by 4.3 dB, 4.1 dB each with the same condition. Given the linearity of the LDPC, LDPC is an attractive coding scheme for the telemetry.

[P-101] Conceptual Study on LIDAR-Based Attitude Determination of a Launch Vehicle

Sung-Hyuck Im

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A navigation system of a launch vehicle must perform accurate initial attitude alignment after erecting a vehicle. Currently, To align the attitude of the navigation device, the optical alignment equipment installed at the launch site is used to perform initial attitude alignment. Therefore, it is necessary to install a window for optical alignment on the side of the launch vehicle. Additionally, since a launch vehicle is composed of two or more stages, bending may occur due to external influences or structural defect. Structural abnormalities can be detected through a direct observation with the naked eyes. LIDAR is a device that measures distance using a laser. LIDAR is capable of generating more than 100,000 to 1 million point clouds per second, has a measurement accuracy of less than 1 cm, and can measure the shape of large structures with a measurement distance of tens to hundreds of meters.

In this paper, we proposed a concept of installing LIDAR on the launch pad after erecting the launch vehicle, generating a

real-time point cloud of the launch vehicle, and then comparing it with the 3D model of the launch vehicle to measure the attitude of the launch vehicle and to detect abnormalities. The attitude accuracy of the launch vehicle according to variation of the number and geometric arrangement of LIDAR was analyzed.

[P-102] A Study on the System Integration for the Operation of Optimal Image Collection Planning of LEO Satellite

Jung-Nam Jun, Eun-Suk Lim, Gab-Ho Jeun, Myeong-Shin Lee

Korea Aerospace Research Institute

The image collection planning of low-orbit satellite for the global region is to generate an optimized imaging and downlink plan in consideration for the requirements of various users and the constraints of complex satellites.

Initially, the image collection plan was based on the concept of a single satellite operation, and the imaging and downlink plan was generated using the image collection planning system. However, satellites are continuously launched according to the space development plan, so multiple satellites must be operated at the same time. Accordingly, an integrated image collection planning system based on the concept of multi-satellite operation is essential.

In this paper we will define the concept of integrated image collection plan operation and describe in detail a development plan to integrated the system based on this.

[P-103] Design and Implementation of an Interface SW for Utilizing NEONSAT Simulator

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In Mission Control Element (MCE) of NEONSAT Ground System, NEONSAT Simulator (SIM) is employed as one of the subsystems in the element for validation and test of operation procedures, exchange of data, and for operator training. Although the SIM can run as a stand-alone function with its own designated control software, the SIM itself is not directly accessible from the other subsystems. Especially, explicit data paths between the SIM and the Satellite Operation Subsystem (SOS) are required for effective simulation since the SOS handles real-world telecommand (TC) and telemetry (TM) packets for the satellite. To this end, we introduce a new SIM-SOS interface (SSIF) software that provides a connectivity between the SIM and the SOS with appropriate data format conversion for compatibility. With a simple Python-based

design and implementation of SSIF, we confirm that SIM can be fully utilized as a compatible subsystem of the MCE by effectively interplaying with main functions of the SOS.

[P-104] Performance Analysis of SOQPSK-TG Technique in Multi-Path Channel of Naro Space Center

Jeong-Woo Han, Chun-won Kim, Sun-Ho Kwon, Dong-Hyun Kim, Jin-A Ma, Tae-Jin Lee, Na-Gyun An, Min-Seok So

Korea Aerospace Research Institute

Recently, the space industry has been transitioning to the new space era. In telemetry, high-speed data rate, improved reliability, and increased bandwidth efficiency are required. SOQPSK-TG is one of the wireless communication techniques in the IRIG106 standard to meet these requirements. Naro Space Center also needs to perform an analysis of the telemetry communication technique adopted as IRIG106 standard for the launch mission of various space launch vehicles in the new space era. In particular, the Naro Space Center must perform performance analysis at the beginning of the space launch mission because signal interference occurs due to its geographical characteristics during wireless communication between the space launch vehicle and the ground telemetry station.

In this paper, we analyzed the performance of SOQPSK-TG based on the channel environment obtained through Naro Space Center wireless environment measurements.

[P-105] Analysis of the Occurrence Tendency of Sporadic E-Layer in Korea

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Sporadic E (Es) represents a thin layer of enhanced electron density in the ionospheric E region. The electron density at Es is 2-3 times greater than that of surrounding and even reaches to 10^{12} m^{-3} . The Es layer has a thickness of about 1-2 km and its horizontal length is tens to hundreds of km. The Es is a major factor influencing radio wave in the HF and VHF bands. In order to develop a model for predicting the occurrence of the Sporadic E layer, the daily and monthly occurrence frequency of the Sporadic E layer was analyzed, and correlation analysis was performed between solar activity and geomagnetic disturbance. foEs were highest near noon in the summer, and h'Es were highest at 06:00, decreased until noon, and then increased again at 16:00. By season, April was the highest and decreased until August, but then rose again. The incidence of

Es in Icheon occurs a lot at 12:00 and 20:00, and seasonally high in June. The incidence of Es in Jeju occurs a lot at 11:00, and June is high seasonally. Solar minimum have a higher incidence than maximum.

In mid-latitudes, the Es layer is formed when the long-lived metallic ions ablated from meteors are converged by horizontal neutral wind shear, and correlation analysis will be performed in the future.

[P-106] Application of Deep Reinforcement Learning to the Forecast of Solar Flares

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In this study, we present the application of deep reinforcement learning to the forecasting of major solar flares. For this, we consider full-disk magnetograms at 00:00 UT from the Solar and Heliospheric Observatory/Michelson Doppler Imager (1996–2010) and the Solar Dynamics Observatory/Heliographic and Magnetic Imager (2011–2019), as well as Geostationary Operational Environmental Satellite X-ray flare data. We apply Deep Q-Network (DQN) and Double DQN, which are popular deep reinforcement learning methods, to predict “Yes or No” for daily M- and X-class flare occurrence. The reward functions, consisting of four rewards for true positive, false positive, false negative, and true negative, are used for our models. The major results of this study are as follows. First, our deep-learning models successfully predict major solar flares with good skill scores, such as HSS, F1, TSS, and ApSS. Second, the performance of our models depends on the reward function, learning method, and target agent update time. Third, the performance of our deep-learning models is noticeably better than that of a convolutional neural network (CNN) model with the same structure: 0.38 (CNN) to 0.44 (ours) for HSS, 0.47 to 0.52 for F1, 0.53 to 0.59 for TSS, and 0.09 to 0.12 for ApSS.

[P-107] Microwave Solar Flare Spectra Obtained by KSRBL

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We present microwave solar flare spectra obtained by KSRBL (Korean Solar Radio Burst Locator). The KSRBL is dedicated to observe the sun in the frequency range between 4.3 GHz to 18 GHz which is able to capture the gyrosynchrotron emission during solar flares. For the study, we have examined microwave spectra of 28 radio bursts obtained by the KSRBL from 2021 November to 2023 May, and in addition, we referred to the data from the NoRP (Nobeyama Radio Polarimeters) which provide

solar fluxes at seven fixed frequencies of 1, 2, 3.75, 9.4, 17, 35, and 80 GHz. The continuous spectrum of the KSRBL has an advantage to find the turnover frequency of gyrosynchrotron emission which occurred mostly at the frequency less than 17 GHz. In the poster, we present the preliminary result of the study.

[P-108] On the Possibility of Geomagnetic Jerk to Affect Earth Rotation

Sung-Ho Na, Yu Yi

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Geomagnetic field is generated by convection of the liquid core of the Earth. Several former studies claimed the connection between the geomagnetic jerks and change in the Earth spin rotational state – particularly in the Chandler wobble phase variation. However, we could not infer strong causal relationship between the Chandler wobble time series and events of geomagnetic jerks. Based on the result of a former study of geomagnetic jerk simulation, we assess its effect on the Earth spin rotation.

[P-109] Minimization of the Degeneracy Problem in the Determination of CME 3-D Parameters by L1, L4, and L5 Observations

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It is difficult to determine a unique three-dimensional structure of a CME using only a single observation data because the same projected structures are generated from different three-dimensional structures (the degeneracy problem). This problem can be minimized by using additional observation data. In this study, we test how many three-dimensional structures are reduced when using multi-view observations rather than single-view observations. This study uses a synthetic CME with a radial height of 16Rs, an angular width of 90°, and a source location of N15E20 as a reference CME. The projection of the reference CME from L1, L4, and L5 is generated by a full ice-cream cone model. In each viewpoint, we estimate the root mean square (RMS) error between the projected heights of the reference and those of an arbitrary three-dimensional structure. We select the three-dimensional structures with an RMS error of less than 0.1Rs as the solution of the reference. We find the overlapping values in the solutions obtained from the following viewpoint pairs: L1-L4, L1-L5, and L4-L5. For the single viewpoint, the numbers of solutions are 77 for L1, 13 for L4, and 12 for L5, respectively. On the other hand, using multi-view observations dramatically reduces the numbers of solutions: a

unique solution for L1-L4 and L4-L5, and 3 for L1-L5, respectively.

[P-110] Observation and Simulation Study on the Response of the Earth's Magnetosphere and Ionosphere at the Occurrences of the GLE Events

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Solar energetic particles (SEPs) are composed of protons, electrons, and heavy ions with energies ranging from hundreds of keV to MeV, and they are observed throughout the heliosphere. Large-scale SEP events are one of the most critical phenomena in terms of space weather. They pose a risk of radiation exposure to humans and equipment in space. SEPs are accelerated in magnetic reconnection regions and by coronal mass ejection (CME)-driven shocks in the solar corona. A few large and fast SEPs are detected on the ground, called ground level enhancements (GLEs). In this study, we examine 19 GLE events during solar cycle 24 and 25. The sources are mostly located in the western regions, and the other two events are located at E09° and E08°. They are associated with X-class flares except for two events (M-class). The CME speeds range from 700 km/s to 3,200 km/s. Out of the 19 events, 13 have pre-CMEs, leading to a decrease in the Dst index when GLE events precipitate into the ground. In this study, we specifically conducted simulations for the event that occurred on 2012 May 17, which corresponds to this case. We investigate the response of the Earth's magnetosphere and ionosphere using the 3D global MHD simulation for the GLE event. We present the relations between the characteristics of GLEs, associated solar activities, and the state of Earth's magnetosphere as well as ionosphere.

[P-111] Characteristics of the Thermospheric Winds over the Korean Peninsula

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The global thermospheric circulation is important for understanding the upper atmosphere. In this study, we present for the first time the characteristics of the thermospheric winds over the Korean Peninsula. For this purpose, we use wind data from the meteor radar operated by the Korea Astronomy and Space Science Institute and the Michelson Interferometer for

Global High-resolution Thermospheric Imaging (MIGHTI) onboard the Ionospheric Connection Explorer (ICON) satellite from January 2020 to December 2021. Meteor radar measurements provide wind data for the mesosphere and lower thermosphere (MLT) region at altitudes 80 to 100 km. ICON/MIGHTI generated the data needed to analyze upper thermospheric winds at altitudes ~91 to ~300 km. Although there are limitations to wind data periods because ICON/MIGHTI did not supply the wind data every hour over the Korean Peninsula, we have constructed extended-wind profiles covering the MLT region and the thermosphere from both instruments. From the extended-wind profiles, we derived meaningful characteristics of the mid-latitude thermospheric winds, corresponding to the meridional global circulation.

[P-112] Classification of Ionograms in the Polar Region by the Vertical Incidence Pulsed Ionospheric Radar at Jang Bogo Station, Antarctica

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The electron density profile of ionogram is traditionally estimated using image process based on the shape of echoes reflected at the ionosphere. Vertical Incidence Pulsed Radar (VIPIR) with Dynasonde, however uses the 3-D inversion program named NeXtYZ, which is estimated the electron density profile with phase analysis of reflected echoes. In this study, we automatically classify ionograms obtained from VIPIR/Dynasonde installed at Jang Bogo Station (JVD) for 5-year period from 2017 to 2021 to valid the efficiency of NeXtYZ program. We found that more than 60% of ionograms show reasonable electron density profile, while NeXtYZ did not properly calculate electron density profiles under dynamic structure of polar ionosphere, for example sporadic-E and aurora. And the distribution of good profiles depend on the magnetic local time and season. Such dependence maybe due to effect of solar irradiation. In the future work, we will improve the classification code and develop new method to make reasonable electron density profile under disturbed condition of the ionosphere.

[P-113] Solar Interior Currents Assumed by Global Photosphere Magnetic Fields

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Chungnam National University

We used the solar corona magnetic field coefficients data recorded by the Wilcox Solar Observatory to calculate the multipole magnetic field using spherical harmonics. Then, we divided it into axis-symmetric and non-axis-symmetric components and observed its properties for 4 solar cycles from 1976 to 2019. The main results as follows: 1) the phase of octupole is similar to the phase of dipole. The correlation coefficient between the two is 0.75. 2) the axis-symmetric component phases of octupole and dipole have a 98% similarity. 3) at the equator, the absolute magnitude of the axis-symmetric component is greater for dipole, and their phases are opposite. Our results suggest that when discussing the dynamo mechanism, it may be useful to consider the axis-symmetric terms and non-axis-symmetric terms of the octupole, rather than discussing the solar magnetic field as a dipole. This provides an opportunity to propose new conditions for dynamo mechanisms, which have imbalances between observations and theories and whose coefficients are so approximated that they are problematic.

[P-114] Relation between Stepwise Development of Auroral Onset Arc and Geomagnetic Pulsations and Perturbations at High and Low Latitudes at Substorms Onsets

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The Substorm is a very complex phenomenon and after several extensive studies, the triggering mechanisms behind it in the magnetosphere are still not fully understood. The scientific community's interest in substorm originates from a puzzling problem related to the physics behind this phenomenon. Pi1 and Pi2 pulsations and perturbations in geomagnetic fields are considered as indicators of substorms onset. The main objective of this study is to investigate the relation between the stepwise development of auroral onset arc (initial brightening (IB), enhancement of the wavelike structure (EW), and poleward expansion (PE)), Pi1 and Pi2 pulsations, and geomagnetic perturbations. In this work, we analyzed 19 substorm events using THEMIS ground-based magnetometer data along with All-Sky Imagers (ASI) data. The preliminary analyses show that Pi1 mostly appears after substorm onset at the time of enhancement of wavelike structure at high latitudes while at low latitudes, their appearance is not very frequent. Contrary to Pi1, low-frequency Pi2 pulsations mostly appear before or at the time of IB at both high and low latitudes. High-frequency Pi2 pulsations appear at or a few minutes after PE at high and at low latitudes. Generally, a small increase/decrease near IB and a pronounced increase/decrease near PE occur in geomagnetic perturbations.

[P-115] Application of a Nonequilibrium Model to Solar Wind Plasma

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The solar wind is a continuous stream of charged particles from the solar atmosphere into the interplanetary medium in the solar system. The charged particles reach the moon, mars, and other planets as well as the Earth, affecting their space environment. Therefore, it is important to understand the physical properties of the solar wind plasma in the present space era. We investigate the charge states of the solar wind plasma compared with the predicted charge states using a 3-D MHD solar wind model. The charge states are calculated by using a time-dependent ionization model with various κ -values, which represent the deviation from Maxwellian electron velocity distributions. The charge states of the solar wind freeze-in, even though the solar wind continues to expand and cool as it propagates. Therefore, the charge states will reflect the history of heating and acceleration in the solar corona. We use a 3-D MHD simulation results by Reproduce Plasma Universe (REPPU) solar wind model during the interval of Carrington Rotation 2028 (from 24 March to 21 April 2005) for the temperature, density, and velocity as input for the nonequilibrium model and compare the charge states observed by the Solar Wind Ion Composition Spectrometer (SWICS) on board the Advanced Composition Explorer (ACE). This is the first challenging work of applying the nonequilibrium model to the solar plasma. We present our results and discuss what we learn for further studies of the nonequilibrium solar plasma in detail.

[P-116] Near-Midnight Eastward Flow Typically Increasing with Geomagnetic Activity in the PMSE Layer

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This study reports summer D-region strong echoes can be subjected to eastward fast flow both at low and high K-values in near midnight sector.

As a case study, the Iceland HF radar near-gate echoes are observed simultaneously with the polar mesospheric summer

echo (PMSE) and optical aurora by the EISCAT VHF radars at Tromso and Syowa, respectively, during a local $K = 6.5$ substorm.

D-region active states, such as pulsating aurora, can be identified by their enhanced echo number and non-uniformly enhanced intensity in the near-gate range (1–2 gates). Near-gate echoes in summer are characterized by echo intensity that remains steady through altitude during or after the active state, lasting from ~ 20 minutes to ~ 2 hours due to PMSE production. In summer the average eastward velocities for events tends to increase with local K values, with a median of 90 m/s for 3-year summer events, while the remaining seasons do not respond for $K < 4$. The processes of PMSE production near midnight sector can be accompanied by eastward fast flow either under geomagnetically quiet condition or that subject to auroral activity, but more enhanced speeds when $K \geq 4$.

[P-117] Comparison of Ionosphere Models and SuperDARN Observations

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During the solar minimum, we carried out a high-resolution 3D MHD simulation for the magnetosphere and ionosphere on June 8, 2019. There are no sunspot numbers, CMEs, and flares during the period. However, it confirmed the magnetosphere and ionosphere were being disturbed.

The study shows the results of comparing different ionospheric models to each other and to SuperDARN observation data for the event. Also, We introduce the differences between the results of the ionospheric simulation by the solar wind and magnetosphere impact and the results of the Wiemer ionospheric model. We can see the simulated potential from the global MHD and the SuperDARN observed values agree closely, but it was confirmed that the potential implemented in the Wimer model was 50–90 kV different. We present the results of the analysis of factors that cause these differences.

한국우주과학회 제41차 정기총회

일 시 : 2023년 10월 26일(목) 15:10

장 소 : 여수 베네치아호텔&리조트

1. 정족수 확인 총무이사 정종균
2. 개회선언 회장 이 유
3. 전회의록 낭독 총무이사 정종균
4. 사업보고 총무이사 정종균
5. 학술대회준비위원회 보고 위원장 박경선
6. 편집위원회 보고 위원장 지건화, 김해동
7. 포상위원회 보고 위원장 이동훈
8. 감사보고 감사 최기혁
9. 안건 1. 2023년 결산(안) 심의 재무이사 이주희
10. 안건 2. 2024년도 예산(안) 심의 재무이사 이주희
11. 안건 3. 명예회원 추대 건 회장 이 유
12. 안건 4. 임원선출 규정 개정 건 회장 이 유
13. 안건 5. 제21대 회장선출 건 회장 이 유
14. 안건 6. 감사선출 건 회장 이 유
15. 안건 7. 부회장, 이사 선출 건 회장 이 유
16. 기타 토의 회장 이 유
17. 폐회 다같이

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